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Tittel

Rapport vedr. rutil/granat-undersøkelser 1994.
Samarbeidsprosjekt mellom DuPont, NGU og Garnet AS

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Råstofftype	**Emneord**	
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Sammendrag

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   C) Diamantboring.
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4. Referanser, Fire vedlegg.

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B.

BVM515

GARNET AS

P.b. 8158 Spjelkavik
N-6022 ÅLESUND
Bankgiro 5354.05.03199
Postgiro 0802 4556213

RAPPORT VEDR. GRANAT/RUTIL-UNDERSØKELSER 1994

(Samarbeidsprosjekt mellom Du Pont, NGU og Garnet AS)

INNHOLD

1. Tidligere undersøkelser.

Gabbro-bergartene i Dalsfjord-området har vært gjenstand for mineralogiske undersøkelser og gruvedrift i flere perioder siden beg. av 1900-tallet.

Innhold av massive- og impregnasjons-forekomster av magnetitt/ilmenitt-malm i dette området har derfor vært kjent lenge. De nevnte bergarters tilknytning til **eklogitt** og de muligheter som ligger i dette, bl.a. **rutil-mineraliseringer**, var mindre kjent før et program for slike undersøkelser startet midt på 1970-tallet.

Etter den tid. er mye gjort også på dette feltet, og spesielt de siste 2-3 år etter at Du Pont fattet interesse for denne typen bergarter som mulig TiO2-kilde i 1991.

Jernmalm-forekomstene ved Gjølanger (Saurdal) ble rel. nøye undersøkt av Cristiania Spigerverk i 1950-årene med sikt på tilskudd av Fe-Ti-V-malm til Bremanger smelteverk. Det ble boret ca. 1400 m kjerneborhull, vesentlig mot områdene med massiv magnetitt/ilmenitt-malm. Ett av hullene, Dbh. 8, ble imidlertid boret gjennom det som senere er benevnt som **Saurdal-eklogitten,** og dette materialet er gjennomgått på nytt i forb. med arbeidet de seneste år, ref. **App. 1** i rapport av A.Kornelussen & al., **Vedlegg 2.**

2. Undersøkelser de seneste år.

Utført arbeid.

I 1992-94 er det gjennomført rel. omfattende undersøkelser av eklogitt-bergartene i området, inkl. **geologisk kartlegging/prøvetaking, geofysiske målinger** både på bakken og fra helikopter, og **kjerneboring** av utvalgte anomalier.

Hensikten med arbeidet har vært først og fremst å se nærmere på omfang og kvalitet på rutil- og granat-innholdet i de nevnte bergarter.

Organisering, finansiering.

Geologisk kartlegging, prøvetaking og analyser er for det meste planlagt og praktisk gjennomført som et samarbeid mellom NGU og Garnet AS, og med Du Pont som en viktig støtte ved utforming av program-innhold og som økonomisk bidragsyter. Det samme gjelder forsåvidt også det gjennomførte helikopter-programmet vedr. geofysiske målinger.

Garnet AS har foruten feltmessig bistand vedr. geologiske arbeider generelt, hatt som viktigste oppgave å være koordinator for gjennomføring av kjerneborings-programmer både i 1993 og 1994/95. Videre er det utført rekognoserende opprednings- og prosess-undersøkelser vedr. framstilling av **granat-konsentrat**, da vi har vurdert dette som den mest nærliggende mulighet for økonomisk utnyttelse av eklogitt-mineraliseringen.

Prosess-arbeidet er bl.a. utført i samarbeid med Denver SALA, se rapport vedlagt, **vedlegg 3.**

3. Utført arbeid 1994

Som nevnt ovenfor, har feltarbeidet i 1994 vært konsentrert omkring 4 ulike hoved-oppgaver -

A. Geologisk kartlegging, prøvetaking
B. Geofysikk
C. Diamantboring
D Prelim. opprednings forsøk

A. Geologisk kartlegging. prøvetaking.

Dette arbeidet har hovedsaklig foregått i områdene syd og vest for Saurdal/Risaskardet mot Hellevikåsen og Drøsdal/Sellevoll. se vedl. kart. **Vedlegg 1**. Hensikten har vært å forsøke å knytte de ulike eklogitt-mineraliseringene sammen til et mer helhetlig bilde geologisk/stratigrafisk. På grunn av de tektoniske aktiviteter i området. er dette et svært vanskelig arbeid som på langt nær kan sies å være ferdig.

Arbeidet er planlagt/koordinert av NGU/Du Pont. som også har finansiert det meste. men også med bistand fra Garnet AS/Prosp.fondet finansielt og praktisk feltarbeid fra Garnet AS..

B. Geofysikk

Dette arbeidet er utført i form av et helikopter-program som måler **magnetometri** og **radiometri.** Det er målt over et vel 200 km2 stort område fra Fure i vest og østover forbi Flekke og mot Sande. se kart vedlegg 1. Arbeidet ble gjennom-ført høsten 1994. Kart og rapport forelå først vinteren/våren 1995. slik at hovedoppgaven i 1995 vil være geologisk oppfølging av fremkomne anomalier i marken

Alt arbeid under dette kap. er planlagt og utført av NGU. finansiert av NGU/Du Pont. og NGU står for rapportering.

C. Diamantboring.

I området rundt **Saurdal/Risaskardet** ble det i oktober-januar 1994/95 gjennomført et mindre kjerneboring-program.. Hullene var planlagt og plassert på grunnlag av geofysiske anaomalier fra et bakkemag. program gjennomført i 1993 (Lauritzen 1993). hvor det kom fram noen rel. kraftige mag.anomalier i et sterkt overdekket. delvis myrlendt område med svært få blotninger.

For å få dette undersøkt nærmere. ble det derfor besluttet å prøve kjerneboring. Avhengig av resultat, var det planlagt inntil 3 hull for å få en best mulig oversikt over mulige mineraliseringer.

Dhh. S 1 er satt i en skråning like ovenfor kanten av et rel. stort myrområde syd for Hovden. se kart **vedlegg 1.** og rapport, **vedlegg 2.**

Området benevnes også som Risaskardet. På grunn av utstrakt hjortejakt i området. ble arbeidet med boringen først startet etter 25.oktober. Etter en periode med mye nedbør, bød det på rel. store utfordringer å få borutstyret fram til borcplassen med bruk av traktor-transport!!

Hull 1 ble påsatt med 70g fall mot N. og ble boret til vel 60 m. da det oppsto problemer med ras i hullet og påfølgende fastboring. Under arbeidet med å få borstrengen løs. flyttet selve borriggen seg noe. slik at det etterpå viste seg umulig å finne igjen påhugget under jordbandet. Videre progresjon mot dypet. innebar derfor boring av **nytt** hull.
Borkjernen ble logget og målt med X-MET. og uten at det ble lokalisert spesielt interessante skjæringer. TiO2-innholdet var svært lavt. og lite eklogitt er synlig. Den magnetiske anomalien skyldes trolig kloritt-amfibolitt-skifer med magnetitt som er synlig i dm-tykke bånd. se forøvrig en mer utførlig kjerne-logg i **vedlegg 2, App.4**

På grunnlag av disse rel. negative resultatene. ble det besluttet å forlate borplassen og starte boring i posisjon **S 2**. Denne ligger 400-500 m SØ for S1 og 60-70m høyere opp. Med erfaringene fra transporten til borhull 1 i friskt minne. ble det raskt besluttet å satse på helikopter-transport til S2 og videre til S3!

Bortsett fra litt venting i forbindelse med dårlig flyvær. gikk dette meget bra.

Dbh. S 2 er påsatt med samme retning som S 1. N10 Ø, og med fall 65 . Hullet er boret til 136 m og skjærer en frisk eklogitt-sone med rel. gode TiO2-verdier mellom 60 og 115 m. dog med mange gneis/amfibolitt-soner innimellom, se mer nøyaktig logg i **App. 4, vedlegg 2**.

Et skjematisk profil som viser borhull S1 og S2 i forhold til utgående eklogitt-sone og gammelt skjerp. er vist **side 3b i rapport, vedlegg 2**. Det kan her se ut som om en rel. flatt-liggende eklogitt-sone med magnetitt/ ilmenitt strekker seg mot S under åsryggen kalt Liane. se top.kart. M=1:5000 **side 3a i rapport, vedlegg 2**.

Etter ca. 115 m er bergarten vesentlig gneis. og hullet ble derfor avsluttet ved vel 136m. da anomali-årsaken trolig var dokumentert. og siden det ikke var indikasjoner på dypere-liggende formasjoner av interesse.

Dbh. S 3 er påsatt i selve Sørdalshaugen for å skaffe ytterlige informasjon vedr. mektighet og kvalitet på eklogitten her. og med spesiell vekt på variasjon i rutil-innholdet.

Borhullet har retning N10Ø som de to andre. og fallet er 70 N. Hullets første del gjennomskjærer en rel. frisk granat- og titanrik eklogitt til ca.50m. Deretter følger en rel. lang sekvens med retrogradert eklogitt. men fortsatt gode TiO2-verdier (vesentlig som ilmenitt) ned til ca. 130m. Videre er det mer variable bergartstyper med eklogitt - delvis retrogradert. amfibolitt- og kloritt-soner som veksler hyppig. Fortsatt rel. høye TiO2-verdier. men vesentlig som ilmenitt.Enkelte mindre soner (dm) med massiv magnetitt-ilmenitt-malm, er sterkt magnetiske.

Det er titanrike bergarter til ca. 155 m. deretter følger en sekvens med kloritt-amfibolitt-bergarter. delvis med magnetitt-soner som tynne bånd. Dette minner mye om det som ble observert i bh. S1 og S2. og kan indikere en stratigrafisk tilsvarende posisjon. Fra 183 m er bergarten for det meste båndet gneis. noe som tyder på at eklogitt/amfibolitt-formasjonen på det nærmeste er gjennomboret. selv om en ekstremt titan-rik sone (63.4%) ved 190m (70 cm) kan tyde på noe annet. Hullet ble avsluttet på 193m. se forøvrig mer omfattende kjerne-logg. **App.4 i vedlegg 2.**

Diskusjon vedr. resultater, konklusjon.

Resultatene fra S 3 viser rel. godt samsvar med resultatene fra re-analysering av Bh 8 (1955), som også gjennomsetter Sørdals-eklogitten ca. 500 m lenger Ø. Variasjonen i rutil-gehalten i Bh. 8 er vist i fig. 7 i rapport. vedlegg 2. mens en tilsv. analyse av bh. S3 ennå ikke foreligger.

Faktum er imidlertid at totalt titan-innhold i eklogittene ved Sørdal er rel. høyt, ca. 3-4% i gjennomsnitt.

Forholdet mellom ilmenitt og rutil varierer imidlertid mye. og dette har sammenheng med tildels omfattende **retrogradering av eklogitten**. noe som omvandler rutil til ilmenitt og sek. magnetitt. I gjennomsnitt synes ca. 1/3 av TiO2-innholdet å foreligge som **rutil**. mens resterende 2/3 er **ilmenitt**.

Sørdals-eklogitten synes å bestå av en ca. 200m tykk "plate" som faller med 30-40 mot S. Bredden Ø-V er ca. 1 km. og basert på helikopter-anomalien som er svært tydelig over dette området. kan utstrekningen mot syd være betydelig...

Forekomsten representerer dermed et betydelig volum. men kvalitetn m.h.t. rutil/ilmenitt-innhold er meget varierende. Div. alternativ vedr. muligheter er nærmer omtalt i rapport. **vedlegg 2.**.

Arbeidet med oppfølging av nevnte helikopter-målinger vil fortsette i 1995. og det kan da trolig fastslås nærmere hvordan forekomstens utstrekning mot dypet/syd forløper.

Når det gjelder mer detaljere opplysninger om det arbeidet som er utført. henvises til rapport med bilag. **Vedlegg 2.**

D. Oppredningforsøk - eklogitt/granat.

Det er i løpet av høsten/vinteren 1994/95 gjennomført oppredningsforsøk i batch-skala med en prøve på ca. 400 kg eklogitt. Hovedmålsettingen har vært å undersøke muligheten for fremstilling av **blåsesand-produkt** v.hj.a. **gravitativ separasjon av eklogitt.**

Produktet skal ha kornstørrelser i området 0,2 - 1,5 mm, være mest mulig fritt for finstoff (støv) og holde mest mulig granat.

Tidligere forsøk har vist at dette er praktisk mulig, men planen var nå å få dette gjennomført som et **skala-forsøk** hvor nødv. parametere m.h.t. **utvinning, tekniske data, produkt-kvalitet** m.v. skulle dokumenteres nøye for senere bruk i økonomiske lønnsomhets-kalkyler.

Fremstilling-metoden skulle som nevnt være gravitativ sep. og planen var å gjennomføre forsøk med både vaskebord og spiral hver for seg, og evnt. i kombinasjon om det skulle vise seg interessant.

Det ble gjort en avtale med Denver SALA vedr. den praktiske utførelsen av forsøkene, og de har igjen delvis samarbeidet med Minpro i Strässa. Utført arbeid og resultater er nærmere omtalt i rapport, **Vedlegg 3.**

Resultatet viser at der er fullt mulig å fremstille rel. gode granat-produkter med nevnte metoder. vaskebord synes å gi detn mest selektive separasjon, mens spiral gir best utbytte av total påsetning.

Evnt. supplerende sep.forsøk samt vurdering av lønnsomhet m.v. vil det bli arbeidet videre med i 1995/96.

4. Referanser, vedlegg.

Vedlegg 1: - Geologisk kart over Gjølanger-området med lokaliserte TiO2-anrikede områder
- Mag.anomalikart , Lauritzen 1993, Saurdal-Risaskardet.
- Geologisk detalj-kart Saurdal eklogitt-kompleks med resultat av støvprøvetaking 1993

Vedlegg 2: Rapport A.Korneliussen & al. March 1995 med bilag, App. 1-4

Vedlegg 3: Opprednings-forsøk med eklogitt - Denver SALA.

Vedlegg 4: Økonomisk oversikt vedr. arbeid med granat/rutil-prosjekt Sunnfjord 1994.

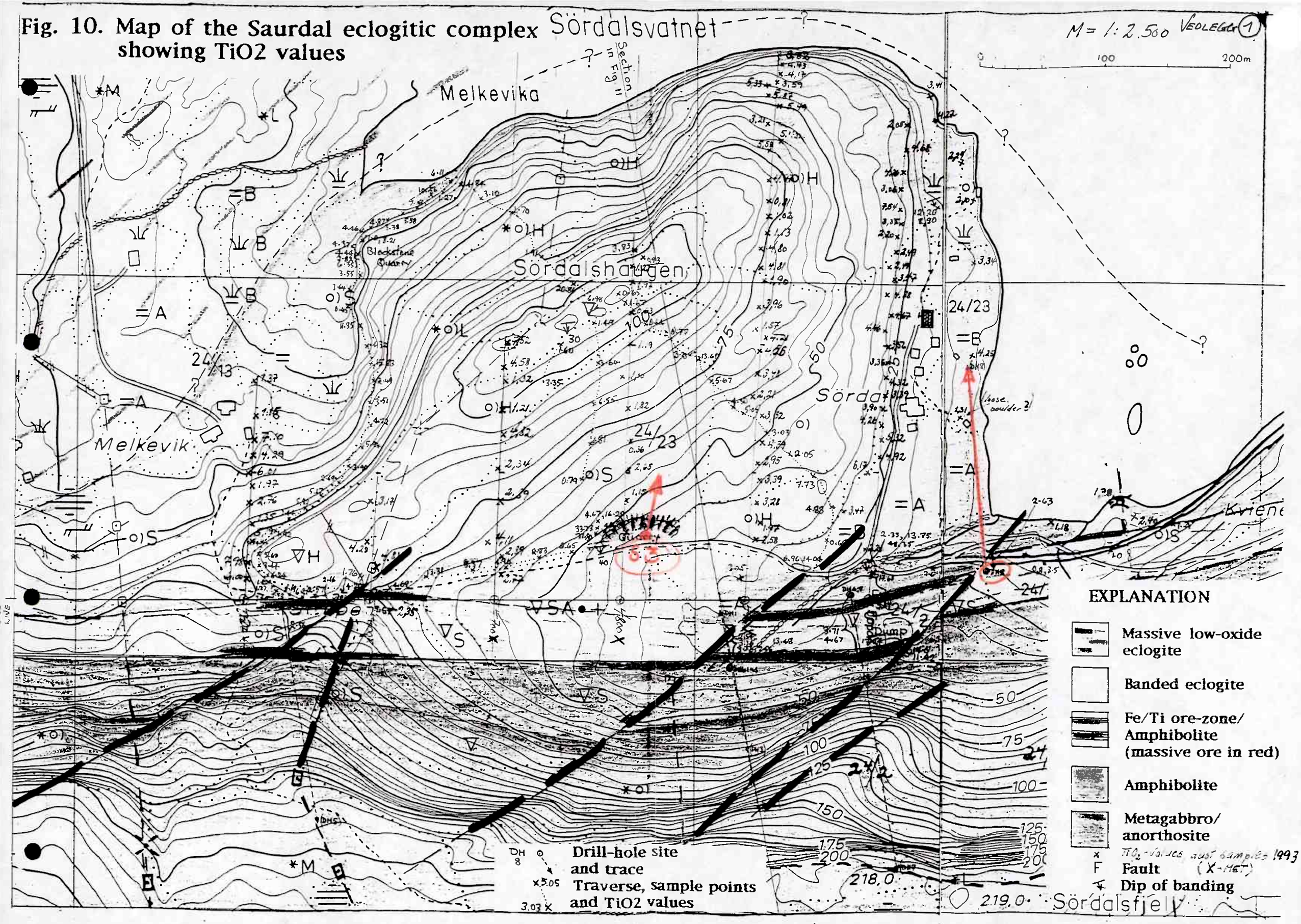
Spjelkavik, Juli 1995

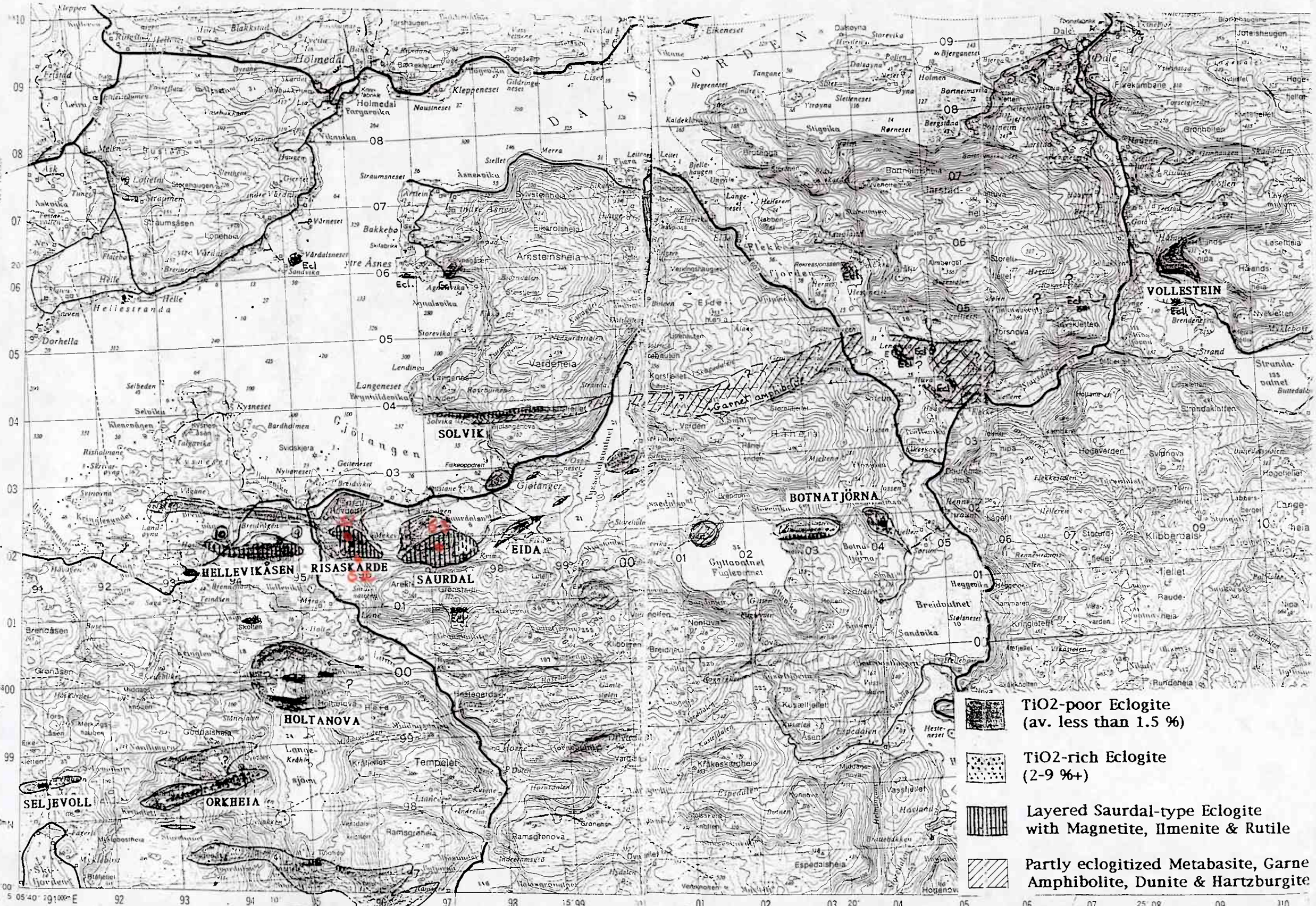
Svein Parr

VEDLEGG 1-4

VEDLEGG (1)

Fig. 10. Map of the Saurdal eclogitic complex showing TiO2 values




SOLVIK
EIDA
HELLEVIKÅSEN
RISASKARDE
SAURDAL
HOLTANOVA
SELJEVOLL
ORKHEIA
BOTNATJÖRNA
VOLLESTEIN
Garnet amphibolite
TiO2-poor Eclogite
(av. less than 1.5 %)
TiO2-rich Eclogite
(2-9 %+)
Layered Saurdal-type Eclogite
with Magnetite, Ilmenite & Rutile
Partly eclogitized Metabasite, Garne
Amphibolite, Dunite & Hartzburgite

MAGNETISK TOTALFELT

Bakkemålinger

SØRDAL

Fjaler

Sogn og Fjordane

DDH-R①
70° dip.
S1

DDH-R②
N 10° Ø
Dip 65°
S2

PSAUDOLOGARITMISK SKALA (nT)

10 000
5 000
2 000
1 000
500
0

M 1 : 5000

km
0.0 0.1 0.2 0.3

NGU 1993
GEOLOGICAL SURVEY OF NORWAY

VEDLEGG (2)

VEDLEGG (2)

Rutile-bearing eclogites in the Saurdal-Risaskardet area, Dalsfjord region, Sogn og Fjordane

Information summary March 1995

By: A.Korneliussen, E.Eide, L.Furuhaug and L.P.Nilsson

Figures:

Appendix:

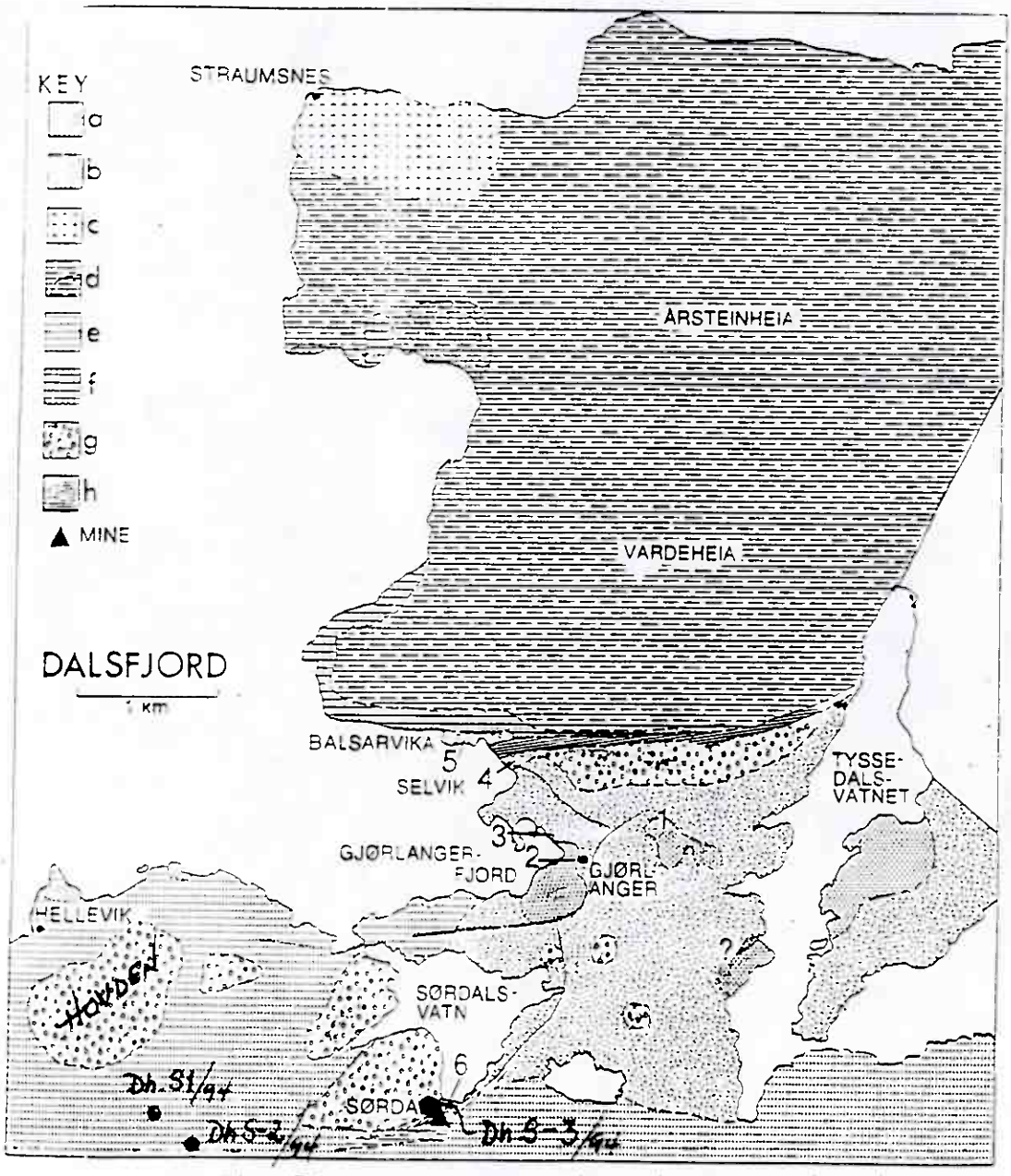


Fig. 31. Geology of the Gjølanger area, based on mapping by S. Cuthbert 1979/80. Key: a. gnt pyroxenites; b. granodioritic gneisses; c. gnt-free amphibolite; d. banded bio-fsp gneiss, some granitic; e. gnt amphibolite; f. mica-gnt amphibolite; g. coronites; h. chlorite-magnetite schists.

FIG. 2

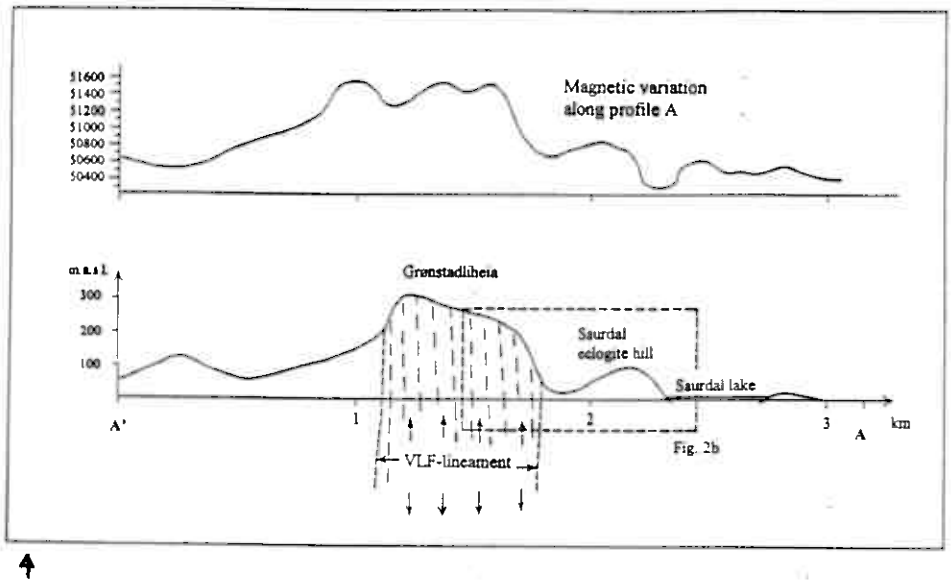
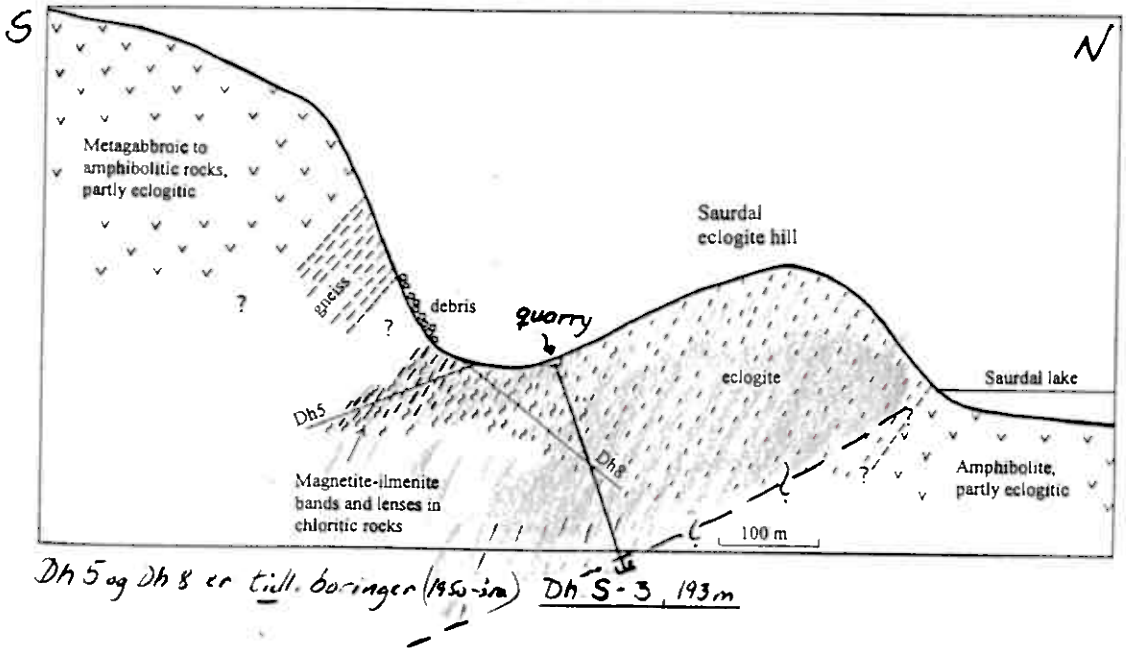


Fig. 2a: N-S vertical profile, Saurdal.

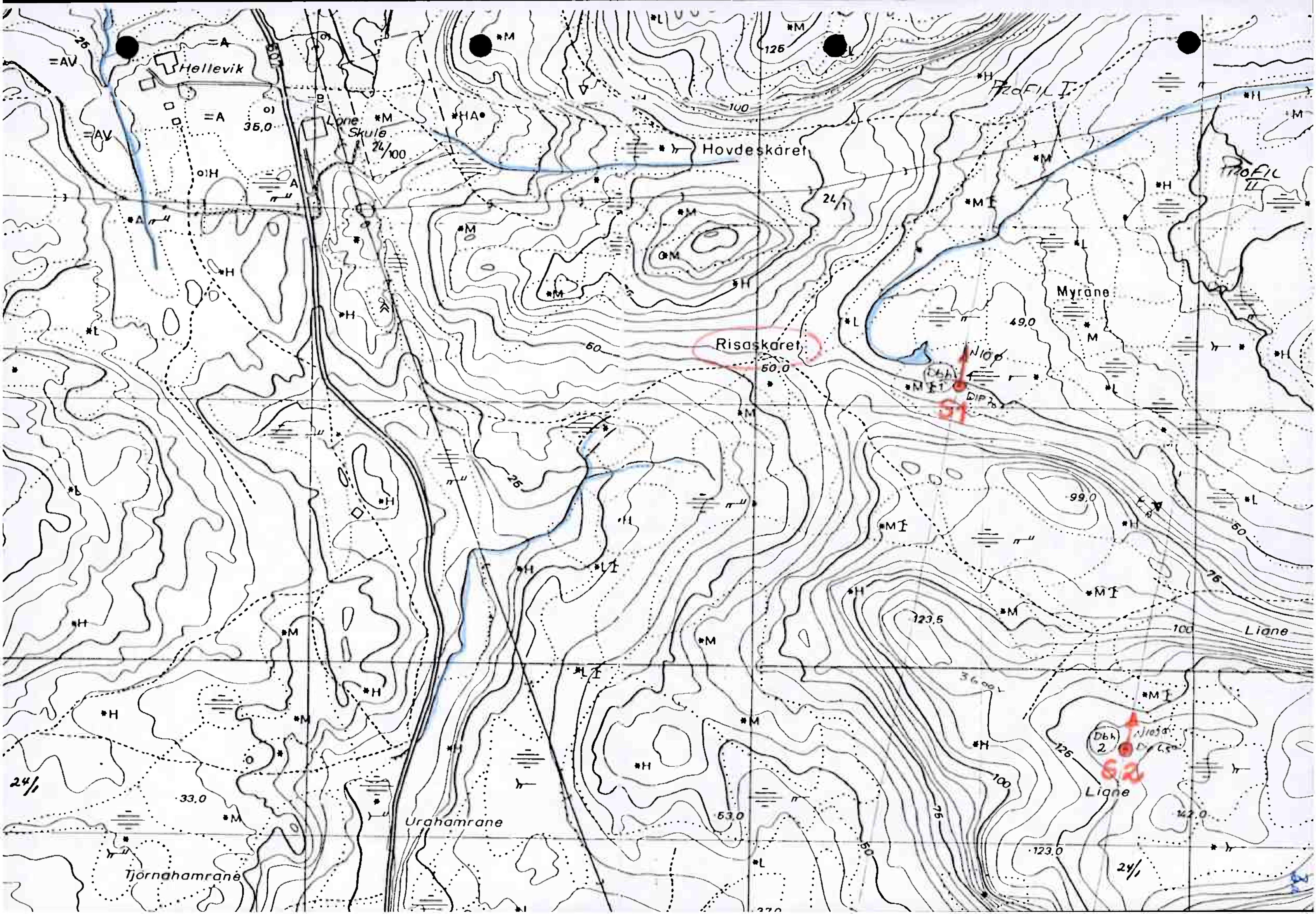


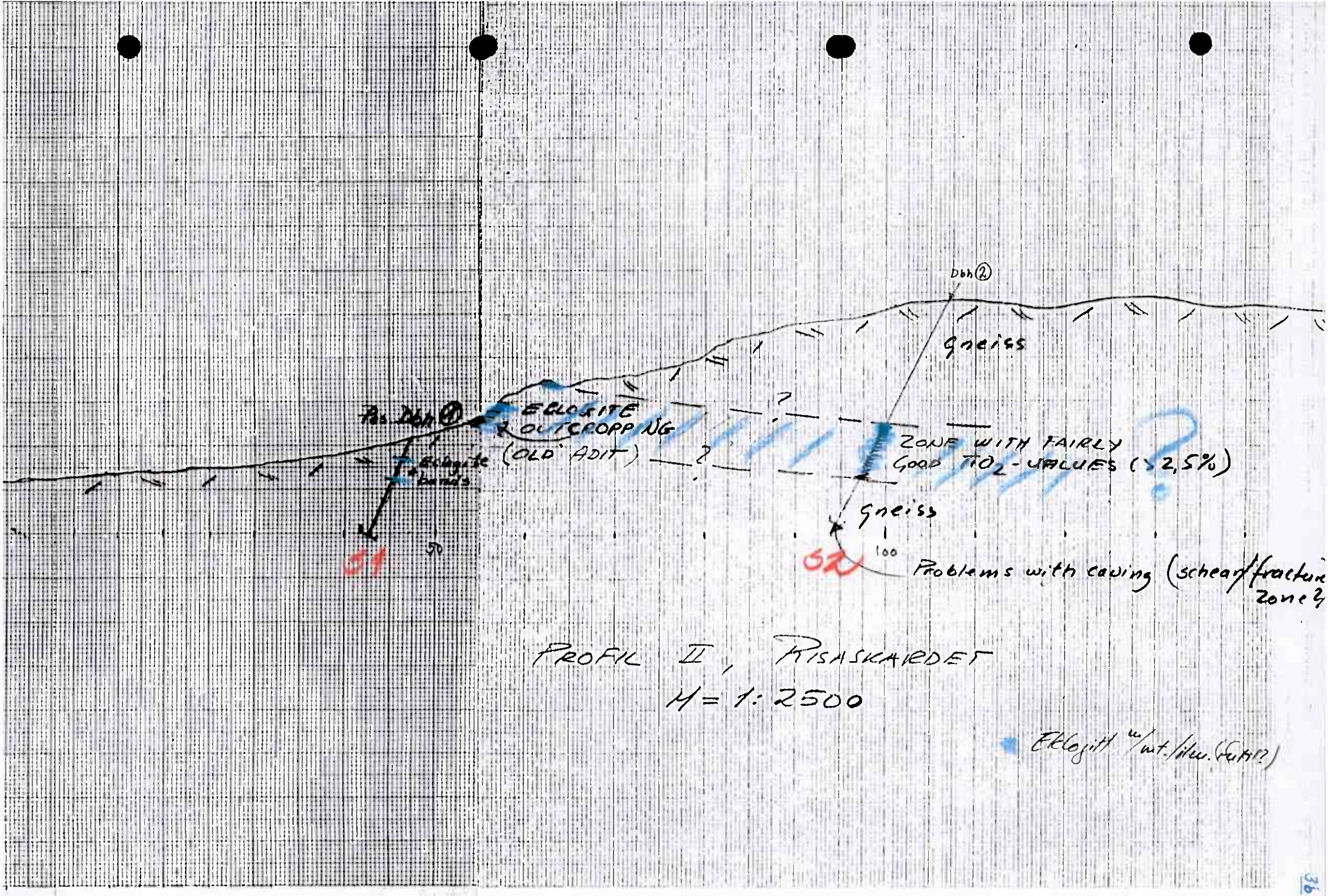
1. Previous investigations

At the beginning of this century gabbroic rocks in the Dalsfjord region experienced prospecting and small-scale mining for magnetite (Fig. 1) . The deposits, however, were found to be small and, due to magnetite/ilmenite intergrowths, the magnetite concentrates generated had a fairly high and unwanted Ti-content.

The company Rausand Gruber A/S, a mining company operating a vanadiferous magnetite-ilmenite deposit near Kristiansund, carried out a drilling program for V-bearing magnetite at Saurdal in 1956. Available information from this 1956-investigation have been compiled by Parr (1993).

In NGU's investigations of rutile-bearing eclogites in the region in 1978-79, the eclogite at the northern side of the Saurdal magnetite-ilmenite ore-zone (called the Saurdal eclogite) was identified as rutile-bearing, but not regarded as being of economic interest (Korneliussen, 1980).


Hellevik
=AV
=A
Lone Skule
24/100
35,0
Hovdeskaret
PROFIL I
PROFIL II
24/1
Risaskaret
50,0
49,0
Myrane
Dbh 1
S1
99,0
123,5
Liane
Dbh 2
S2
142,0
123,0
53,0
33,0
Urahamrane
Tjørnahamrane



PROFIL II, RISHAUGEN

M = 1:2500

Eklogitt m/wt.-filw. (Rutil?)

Five to six years ago a company started to quarry a white-mica rich eclogite variety at Saurdal for block-stone. Due to cracks in the rock they had problems in taking out sufficiently large blocks and mainly for this reason, the quarrying has now stopped.

Four sets of chip-samples of eclogite taken in the block-stone quarry in 1991 contained 2.81% rutile on average. These samples were followed up in more detail by the DuPont/NGU project in 1992 by X-MET analyses directly on the rock surface over the eclogite body (Garson, 1993), and the drill-cores from Rausand Gruber's 1956-investigation were relogged at Løkken, including X-MET analyses on the cores (Garson, 1993; Korneliussen, 1992). Drill hole 8 (Dh8) was then, in 1993, analysed in 10m sections for rutile and major elements, and the same year 107 drill-dust samples were taken to obtain additional information on the rutile distribution over the eclogite body. In addition, a ground-magnetic survey over the Saurdal eclogite was carried out westwards to investigate the continuation of the Saurdal rocks in this direction. A magnetic anomaly at Risaskardet was investigated by two drill-holes in late automn 1994 and, as a part of the same drilling program, a third hole was put down from the block-stone quarry at Saurdal.The locations of these drillholes are shown in Fig. 2.

2. General geology

The geology of Saurdal and its surrounding areas is characterized by basic rocks that range from coarse, practically undeformed gabbros with preserved primary minerals, through several variations of sheared and metamorphosed gabbros, to eclogite. These basic rocks are frequently intruded by a low-K tonalitic rock that is deformed together with the metabasic rocks. Cuthbert (1985) has divided this central part of the Gjølanger-Flekke area with its various basic and intrusive acidic rocks into two units called the Flekke and the Gjølanger units respectively (Fig. 1). The area to the north consists predominantly of paragneisses (Cuthbert's Vardeheia unit) and to the south predominatly of orthogneisses (The Jostedal Complex).

Description of the major rock-types in the Saurdal area (modified from Cuthbert 198x):
Granitoid gneisses:
Tonalitic gneisses:
Amphibolites:
Gabbroic rocks:
Eclogites:
Chloritic schists:

The region experienced Caledonian high-pressure metamorphism in which miscellaneous basic rocks were transformed into eclogite. However, the eclogitization process was inhomogeneous and large volumes of gabbroic rocks were not at all or incompletely transformed into eclogite. In the eclogitization process, magnetite and ilmenite broke down, with the iron substituting into garnet and the titanium remaining to form rutile. Practically all variations of rutile/ilmenite ratios can be found.

It is generally accepted that deformation associated with fluid infiltration stimulates eclogitization if the pressure is sufficiantly high (Austrheim, 1990). Gabbroic rocks in the Gjølanger area are often eclogitized along distinct shear-zones, but gradual eclogitization of gabbroic bodies is also common (see Cuthbert (1985) for a more detailed description of this phenomenon). All eclogites such as those at Drøsdal and Orkheia are deformed and folded together with the surrounding gneisses. The eclogitic minerals seem to have crystallized under this deformation period. It is probable that deformation and associated fluid infiltration is an important factor in the eclogitization of basic rocks in the region.

Most eclogites in the region are retrograded. At Saurdal amphibolite facies retrogression is well reflected in the alteration of omphacitic clinopyroxene to pale green symplectitic aggregates of plagioclase and diopsidic clinopyroxene and hornblende. Rutile is normally not affected at the beginning stage of this retrogression. During more extensive retrogression, i.e. amphibolitization, rutile begins to alter to ilmenite and secondary magnetite starts to form.

The most extensive retrogression is chloritization; this is accompanied by the breakdown of garnet and hornblende, continuation of rutile alteration to ilmenite, and formation of more secondary magnetite. The end-product of this retrogression is a magnetite-bearing chloritic schist. Chloritization tend to be extensive along E-W trending late shear-zones. Such shear-zones tend to show up on the VLF helicopter geophysical map; one such lineament go through the Saurdal area.

3. Oxide mineralization types

Magnetite-ilmenite ore in metagabbro

Magnetite-ilmenite cumulate layers and impregnations occur within the metagabbroic rocks. At Saurdal such oxide enrichments were subject to small-scale mining for magnetite at the beginning of this century. The ore occurs as irregular, less than one m-thick, closely spaced layers and lenses of massive to semi-massive magnetite/ilmenite along the southern margin of the Saurdal eclogite body.

The nine drill-holes drilled in 1956 by Rausand Gruber, in total 1400 m, are available at NGU's core-storage at Løkken. Eight of these drill-holes (Dh1 to 8) are from four profiles approx. 150 m apart at Saurdal, and one (Dh9) was drilled east of Solvik at the Gjølanger bay. The positions of these drill-holes are shown in Fig. 2. The 1956-investigation did not identify any significant volumes of magnetite-ilmenite ore. However, impregnations of Ti-oxides occur in eclogitic rocks on the northern side of the Mt-Ilm ore-zone.

The Saurdal magnetite contains from 0.14% to 0.75% V and from 0.12% to 2.37% Cr, based on Rausand Gruber's analyses of magnetite concentrates made from the drill-cores (Geis 1979). Of these holes Dh8 is the only one that gives a good (207m) section through rutile-mineralized eclogite.

Dh8 is directed northwards, cutting the eastern part of the Saurdal eclogite at depth. Dh1 to 7 are directed southwards (see Garson, 1993) and cut dm-thick zones of magnetite-ilmenite ore surrounded by eclogite that has been variably altered.

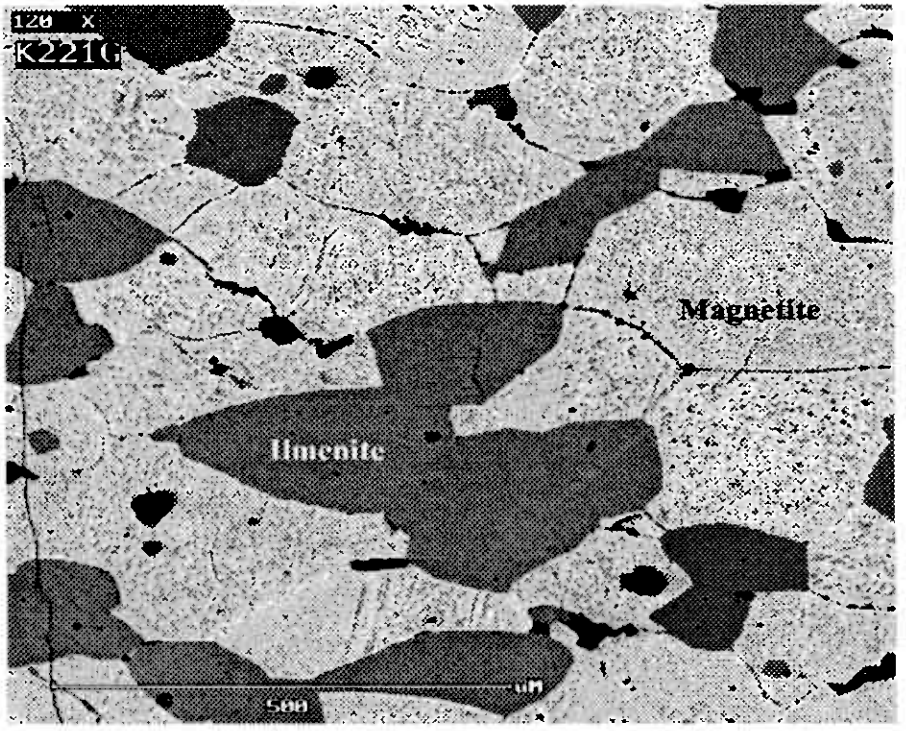


Fig. 3: SEM back-scattered electron image of massive magnetite-ilmenite ore from the old Saurdal Fe-Ti mine (cf. Fig. 2). The magnetite contains numerous tiny exsolutions of an Al-bearing mineral that is probably spinel ($MgAl_2O_4$) and ilmenite. Ilmenite and spinel are not distinguishable on this picture.

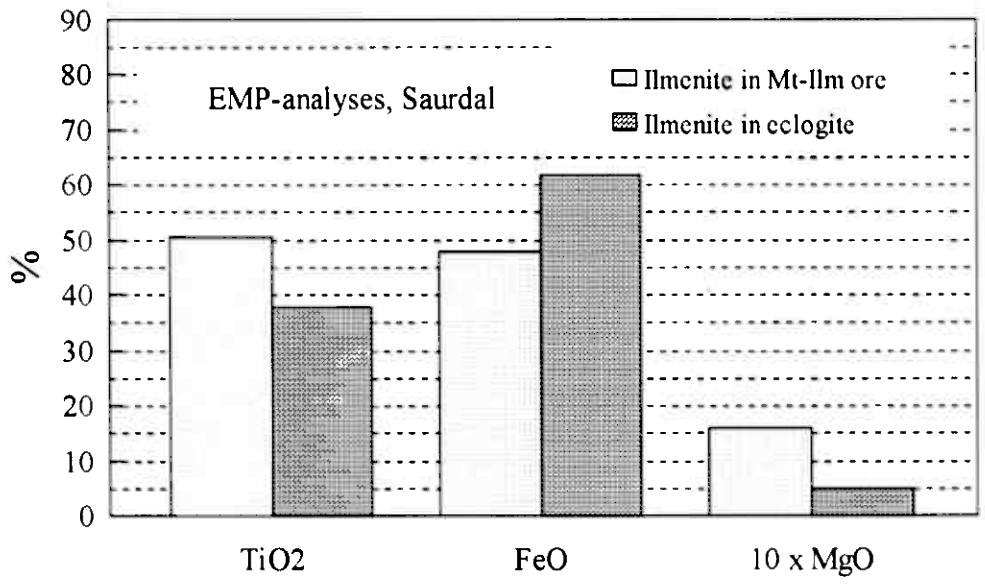


Fig. 4: Average wt.% TiO_2, FeO and MgO (x10) content in ilmenite from the massive Fe-Ti ore (cf. Fig. 3) and ilmenite from the Saurdal eclogite (cf. Fig.6), respectivelty. Analyses by electron microprobe. The complete analyses are given in Appendix x .

Rutile-ilmenite in eclogitized gabbro

Average rutile, TiO_2 and Fe_2O_3 content in 5 sample-sets from the Saurdal eclogite is given in Table 1. Comparatively high TiO_2-values for the X-MET analyses directly on in-situ rock surface may indicate that the oxides tend to stand out on the rock surface making them better exposed than the silicates. X-MET analyses directly on the rock surface are probably not a reliable method for

collecting data when precise information on TiO_2 content is needed. The X-MET analyses are, however, fully satisfactory in the reconnaisance stage at rutile investigations. Based on these results the TiO_2-content in the Saurdal eclogite is 3-4% with a highly variable rutile/ilmenite-ratio.

Table 1: Average content of rutile, TiO_2 and Fe_2O_3 in different sample sets from the Saurdal eclogite. (1) Chip-samples from the block-stone quarry (Korneliussen 1994). (2) Field X-MET analyses directly on the rock surface (Garson, 1993). (3) X-MET analyses directly on Dh8-core (Korneliussen 1993). (4) Laboratory analyses of 10 m-sections of Dh8 (Korneliussen,1994). (5) Drill-dust samples (Korneliussen 1994).

Sample set	**1**	**2**	**3**	**4**	**5**
TiO2	3,32	4,78	4,28	3,04	3,58
Fe2O3	17,21	18,51	18,63	20,79	20,18
Rutile	2,81			1,18	1,40
Ilmenite	1,02			3,72	4,36
Rutile vs. TiO_2	85 %			39 %	39 %

The amount of titanium present as rutile is very variable. The rutile content tends to be highest in low-magnetic samples with low- to intermediate iron content (approx. 20% Fe_2O_3, Fig.21c in Korneliussen, 1994). Iron-rich samples contain less rutile and more ilmenite, and they are more magnetic; they tend to contain magnetite as relics after the original oxide assemblage, or contain secondary magnetite formed during the chloritization process. Large samples, such as the 10-m sections of Dh8 and the drill-dust samples, may contain both types of magnetite.

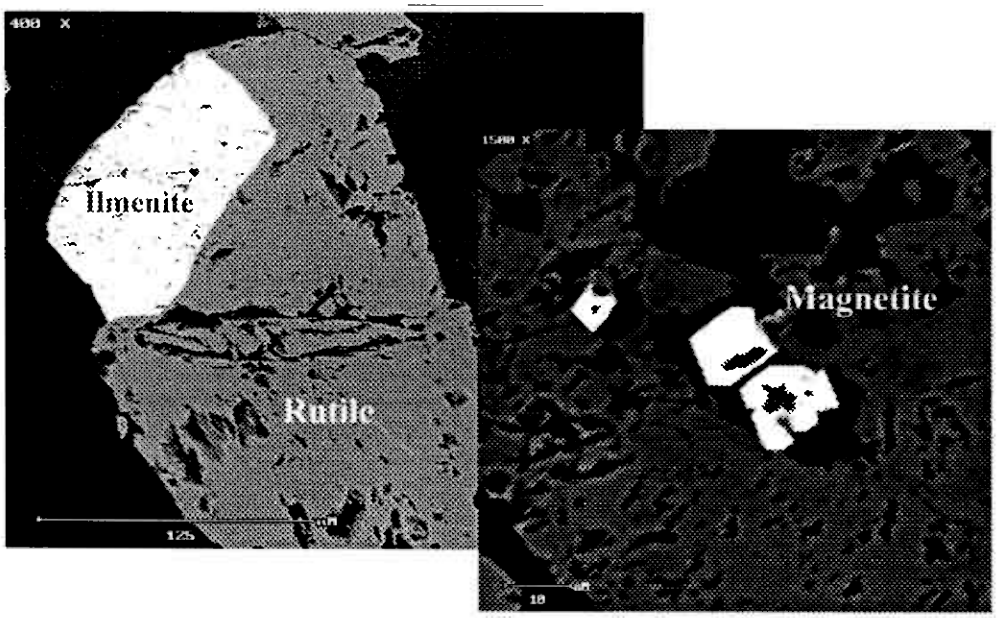


Fig. 5: SEM back-scattered electron image of rutile-ilmenite intergrowth (left) in eclogite and secondary magnetite formed during retrogression of the eclogite (right). Both pichtures are from sample K663.78, Saurdal eclogite.

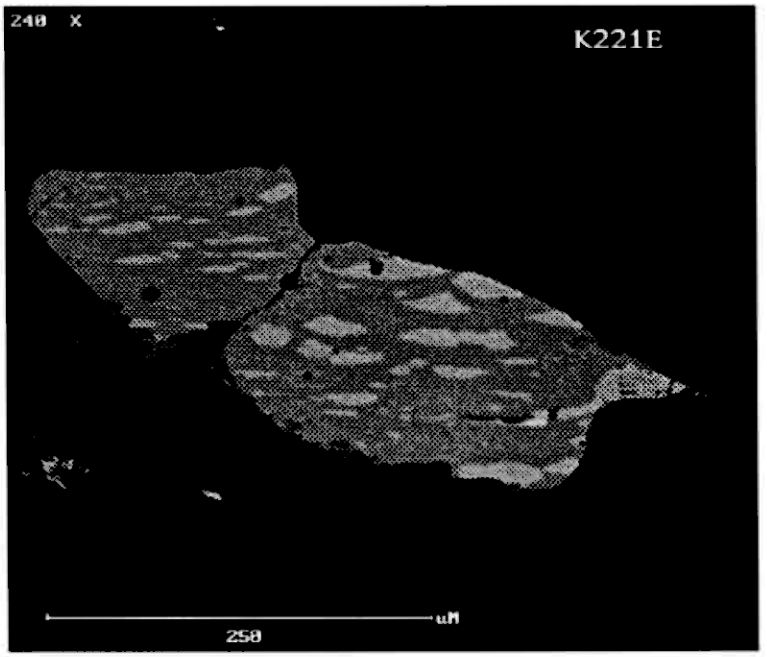


Fig. 6: SEM back-scattered electron image of ilmenite with hematite exsolutions, Saurdal eclogite.

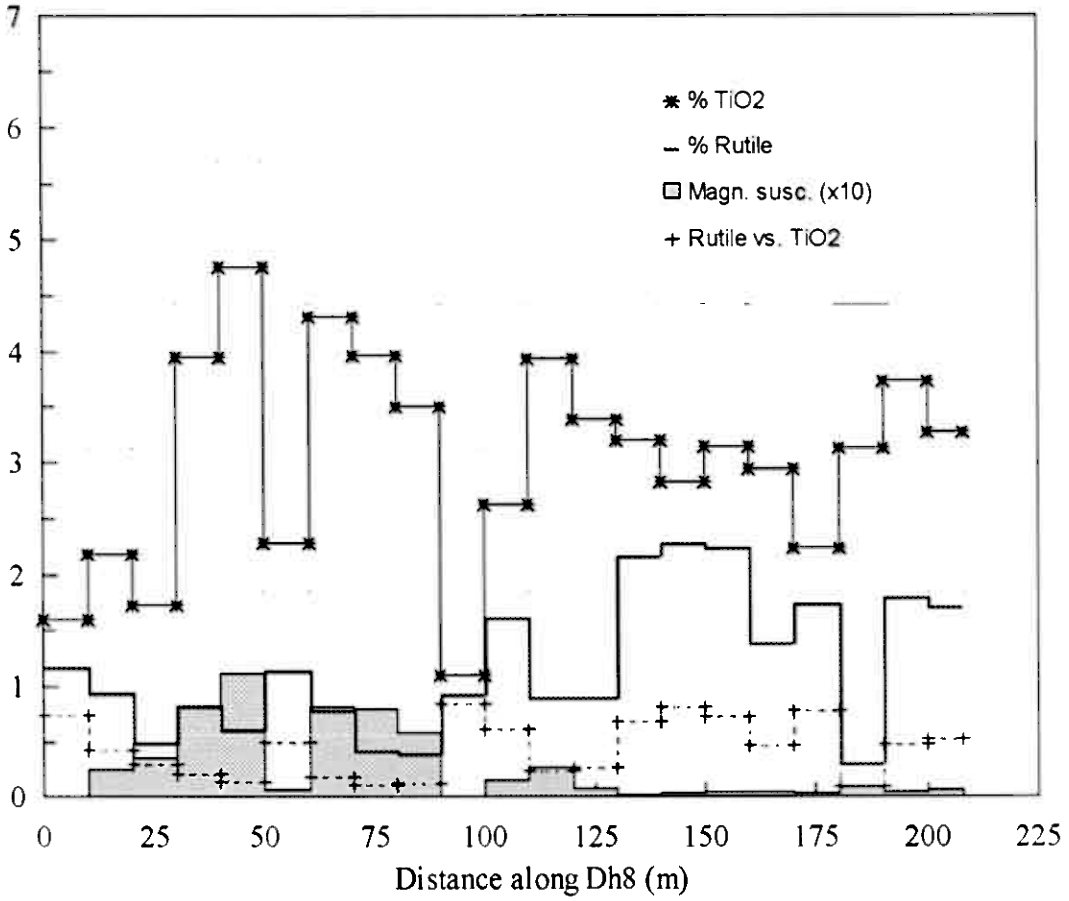


Fig. 7: The variation of rutile, TiO_2, magnetic susceptibility and rutile/TiO_2 along Dh8, Saurdal eclogite.

Magnetite - ilmenite in chloritic schists

The most extensive retrogression of eclogite is chloritization; this is accompanied by the breakdown of garnet and hornblende, rutile alteration to ilmenite, and formation of secondary magnetite. The end-product of this retrogression is a magnetite-bearing chloritic schist. Occasionally the magnetite-content reaches 20-30%; such magnetite mineralizations were subject to some prospecting activities at the beginning of this century, but the deposits were not of sufficiant size for mining. Relics of garnet-amphibolite are commonly found within the chloritic schists.

4. Geophysical results

On the significance of magnetism

Two strongly magnetic rock-types are known from the Saurdal-Gjølanger area:

(1) Primary magmatic magnetite-ilmenite cumulate horizons only modestly affected by the eclogitization process.

(2) Magnetite-bearing chloritized zones that have been formed by extensive greenschist

Some of the drill-dust samples from the Saurdal eclogite contain one or both these types of highly retrogression of eclogite or other basic rocks.

magnetic rocks (Table 2). The rutile content in the drill-dust samples tends to be highest at low to moderate magnetic susceptibility levels. The susceptibility interval 0.100-1.00 is an exception to this general rule in that it shows a high rutile content. The TiO_2-content tends to increase with magnetic susceptibility (Table 2) indicating a significant component of primary magnetite-ilmenite in the most magnetic parts of the Saurdal eclogite. These data show that rutile in the Saurdal geologic situation is in some way associated with highly-magnetic rocks, but there *is no direct linear correlation between rutile content and magnetic susceptibility* (see Fig. 21 in Korneliussen, 1994).

Table 2: Average rutile, TiO_2, Fe_2O_3 (total; XRF-anal.) and magnetic susceptibility (SI units) in intervals of increasing magnetic susceptibility, drill-dust samples from the Saurdal eclogite (Korneliussen 1994).

Magn.susc. intervals	*Rutile*	*Rutile / TiO_2*	*TiO_2*	*Fe_2O_3*	*n*
<0.001	1,89	86%	2,20	16,22	10
0.001-0.002	1,74	60%	2,89	17,46	33
0.002-0.003	1,53	55%	2,76	17,55	17
0.003-0.005	1,08	25%	4,34	21,68	8
0.005-0.010	1,37	32%	4,26	20,84	11
0.010-0.020	0,96	27%	3,55	20,47	7
0.020-0.100	0,41	9%	4,60	25,10	14
0.100-1.000	2,27	27%	8,32	36,04	5

Fig. 8 gives average magnetic susceptibilities of eclogite, tonalitic gneiss, magnetite-bearing chloritic schists (completely chloritized basic rocks) and semi-massive magnetite-ilmenite ore from the old Saurdal Fe-Ti mine. High magnetism is primarily an indication of primary magmatic magnetite-ilmenite cumulate horizons. At Saurdal such rocks are eclogitized, variably rutile-bearing, and with the primary magnetite-ilmenite mineralizations partly preserved. Additional magnetism is caused by secondary magnetite formed during retrogression of the eclogite.

According to these observations magnetism may be a good tool in order to localize bodies of the Saurdal type, but is probably less useful in the detailed scale.

Based on these relationships, it is reasonable to assume that the major source of the large magnetic anomaly at Saurdal which shows up on the helicopter magnetic map, is a rock type similar to those sampled by the drill-dust sampling program and with magnetic susceptibility values as shown in Table 2.

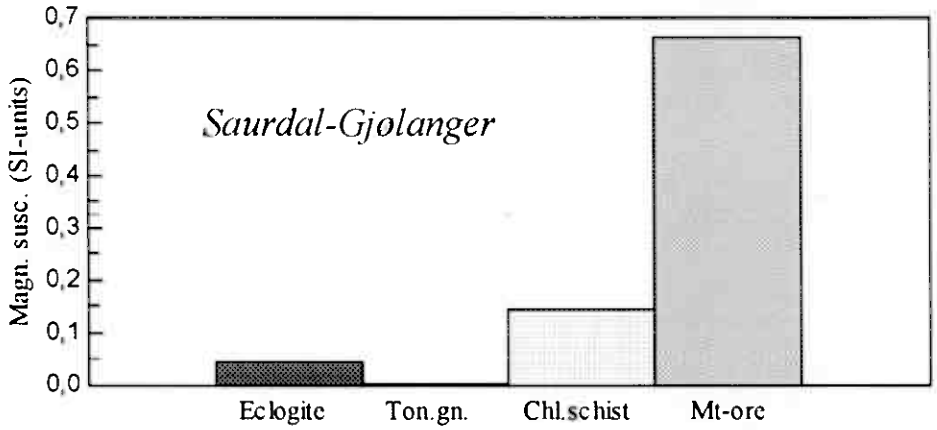


Fig. 8: Average magnetic susceptibility for eclogite, tonalitic gneiss, chloritic schist and semi-massive magnetite-ilmenite ore, Saurdal area. The complete measurements are given in Appendix x.

The ground-magnetic survey

A series of ground-magnetic profiles (Lauritzen, 1993) over the Saurdal eclogite and farther westwards were made in 1993 in order to follow the westward continuation of the Saurdal rocks and identify new rutile-bearing occurrences. It was considered possible that the rutile-bearing eclogite at Saurdal has a diagnostic magnetic signature which, if found elsewhere in the surroundings, could lead to new discoveries of rutile-bearing rocks.

The Saurdal rocks were found to show very variable magnetic signatures (Lauritzen, 1993), that are characteristic features. A similar area of variable magnetic signatures was identified approx. 1 km west of Saurdal. This western area is significantly covered by vegetation. One small hill within the area is found to contain rocks similar to the Saurdal eclogite; one small adit from the prospecting period at the beginning of this century shows that the prospectors were aware that this area could be a continuation of the Saurdal rocks. Two diamond drill-holes (Dh S1 and Dh S2) were put down in Desember 1994 to obtain information sufficiant to make an economic evaluation of the situation with respect to rutile. As shown by the core-logs (Appendix 4) these anomalies are primarily caused by magnetite-bearing chloritized basic rocks including eclogite. The eclogite present (approx 40m core length in Dh S2) is of Saurdal type with XMET TiO_2-values in the range 3-4%. Based on these cores the Risaskardet magnetic anomalies do not indicate rutile-ore of economic interest.

Helicopter survey 1994

Magnetic susceptibility and radiometric measurements in the Saurdal area and elsewhere (measured on the ground; see ENV no. 2-5) showed contrasting magnetic and radiometric signatures between eclogite and other rock-types, and indicated that a helicopter geophysical survey could be a good tool in the continued rutile/eclogite exploration. A test helicopter-geophysical program were then carried out in late autumn 1994. Since the area that was flown contains known eclogites of different types, such as Saurdal and Orkheia (see Fig. 1), this survey should demonstrate if this method is convenient

for rutile/eclogite prospecting. A good evaluation of the results cannot , however, be done until follow-up work on the ground have been completed during the summer 1995.

Table 3: Magnetic susceptibility of rock-types in the area covered by the helicopter geophysical survey.

Rock	Magn. susc. (SI-units)	Comments
Granitoid gneisses	0.001 - 0.010	Micellaneous felsic gneisses varying from dioritic to granitic in composition.
Tonalitic gneisses	0.001 - 0.010	A characteristic low-K gneiss of tonalitic composition that commonly occurs associated with eclogites in the Førdefjord and Dalsfjord regions.
Metabasite	0.001 - 0.005	Amphibolitic rock with low Fe-Ti content that occurs in the Dalsfjord region in large quantities. It is usually low-magnetic.
Metagabbro I	0.001- 0.010	Normal metagabbro with some magnetite and ilmenite (< 1% oxides).
Metagabbro II	0.010 - 0.050	Metagabbro enriched in magnetite - ilmenite (1-5% oxides).
Eclogite	0.001 - 0.002	Magnetism mainly due to garnet and some ilmenite. Fe-rich eclogites (usually also Ti-rich) that are garnet-rich, commonly contain 1-3% ilmenite, and are more magnetic than the Fe-Ti poor eclogites.
Retrograded eclogite I	0.004 - 0.010	Slightly retrograded eclogite with secondary magnetite mainly along cracks with some ilmenite (<1% oxides). Fe-Ti rich eclogites tend to have more secondary magnetite as a result of retrogression than Fe-Ti poor varieties.
Retrograded eclogite II	0.010 - 0.050	Significant amonts of secondary magnetite dust in chloritized parts of the eclogite (1-5% oxides).
Chloritic schist	0.050 - 0.200	End-product of eclogite alteration with only relics of eclogite (or other basic rock) present. The magnetite content is 5-20%.
Fe-Ti ore	0.200 - 0.600	Strong impregnations to semi-massive magnetite - ilmenite ore (magmatic) in metagabbro or such mineralizations within eclogite but only modestly affected by the eclogitization process.

6. Discussion of ore potensial

Estimations of ore potential must consider the following factors:

(1) The TiO_2-content of the Saurdal eclogite is generally in the range 3-4% (cf. Table 1). Approximately 1/3 of the TiO_2 occurs in rutile and 2/3 in ilmenite, though the rutile/ilmenite ratio is very variable in different parts of the eclogite.

(2) The Saurdal eclogite, as observed in the eclogite hill at the Saurdal farm, may represent a thick sheet or lens, internally folded, dipping 30-40° southwards (see Fig. 2). A drill-hole from the block-stone quarry drilled in January 1995 (DhS3;Fig. 2) gives an eclogite thickness of 190m before passing into gneiss. This observed eclogite is, as shown by the helicopter-magnetics, at the northern margin of an approx. 1 km^2-large magnetic anomaly (see also Fig. 2). *Thus, the horizontal projection of the eclogite body can be regarded as defined by this magnetic anomaly, and its thickness might be considerable.*

(3) Rutile tends to alter to ilmenite during retrograde alteration of the eclogite. This is distinct under the greenschist facies chloritization process which tends to occur along shear-zones where water-rich fluids have had access. At Saurdal the most intense retrogression, in the form of chloritization, can be observed along the E-W trending valley at the southern margin of the Saurdal eclogite hill (Fig. 2); chloritization is also distinct in certain parts of the S3 drill-hole (see the core-log in Appendix 1). This chloritization zone falls together with an E-W trending lineament showing up on the VLF helicopter-geophysical map (see Fig. 2a,b). That means that the fairly low rutile/ilmenite-ratio found in parts of the Saurdal eclogite is due to retrogression induced by fluids mainly along this lineament and, consequently, *eclogite well outside this lineament might have a higher rutile/ilmenite ratio.*

(4) The original gabbro had cumulate accumulations of magnetite-ilmenite. During eclogitization magnetite generally decomposes, with the iron going into garnet. However, at the eclogitization of the Saurdal rocks, parts of the massive/semimassive Fe-Ti oxides survived eclogitization; these are now represented by magnetite-ilmenite bands and lenses in eclogite. Those parts of the eclogite containing such mineralizations will have a low rutile/ilmenite ratio, and the magnetic susceptibility will be very high. This mineralization type is probably the major source of the Saurdal helicopter-magnetic anomaly.

The available information is insufficiant to give a reliable estimate of the ore resource situation, but speculative estimations can be made.

An optimistic estimate: Assuming (a) The major part of the Saurdal has not been severely retrograded and that the main source of the helicopter-magnetic anomaly is bands and lenses of primary Fe-Ti oxides that have survived the eclogitization in the area. In this case the eclogite might have a low rutile/ilmenite ratio within these bands but a high rutile/ilmenite ratio away from the bands. (b) The average TiO_2-content is around 4% of which 2/3 is rutile (i.e. 3 % rutile). Locally the rutile grade can be much higher. (c) The average thickness of the eclogite is 200m. *In this case the Saurdal eclogite deposit contains 600 mill. tons averaging 3% rutile.*

Pessimistic estimate alternative 1: The main source of the helicopter-magnetic anomaly is secondary magnetite in chloritized basic rocks with only small amounts of associated rutile-bearing eclogite. Then the overall rutile/ilmenite ratio will be very low, and, consequently, the deposit will have no economic interest.

Pessimistic estimate alternative 2: The major source of the magnetic anomaly is primary magmatic oxides that have not only survived eclogitization but the gabbro itself is not at all or is uncompletely eclogitized; the overall rutile/ilmenite ratio will then be low.

Pessimistic estimate alternative 3: The major source of the magnetic anomaly is primary magmatic oxides within strongly chloritized eclogite, and the overall rutile content is very low.

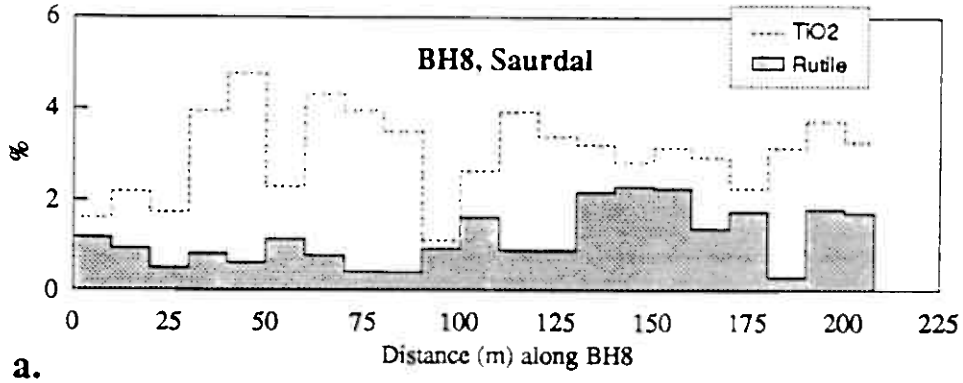
An intermediate (realistic?) estimate: Most probably the source of the magnetic anomaly is a combination of primary Fe-Ti oxides and some secondary magnetite formed during retrogression of eclogite similar to what is observed at the Saurdal farm and in the drill-cores which all are within or very close to the intersection of the VLF-lineament and the helicopter-magnetic anomaly. In this estimate the deposit size would be 300-400 mill. tons of eclogite similar to the Saurdal eclogite hill averaging approx. 2 % rutile + 2-3% TiO_2 as ilmenite. Parts of the deposit will have 3-4% rutile.

7. Conclusion

The Saurdal eclogite occurs within the northern part of a significant helicopter-magnetic anomaly. The source of this magnetic anomaly is presumably a combination of primary magnetite-ilmenite in eclogitized gabbro (probably the main magnetic source) and secondary magnetite formed during retrogression of the mafic rocks. The Saurdal area could contain some hundred million tons of eclogite with 3-4% TiO_2 of which approx. 2% TiO_2 occur as rutile. There is a good chance that parts of this eclogite volume contains more than 2% rutile.

Continued investigations: The next step in the rutile exploration is to make a detailed geologic follow-up the the helicopter geophysical results on the ground in order to come up with a reasonably good explanation of the geophysical results, and point out potential locations for rutile-bearing eclogites. This can be done in May-June 1995. Then a good evaluation of the area can be done in July/August 1995.

8. References



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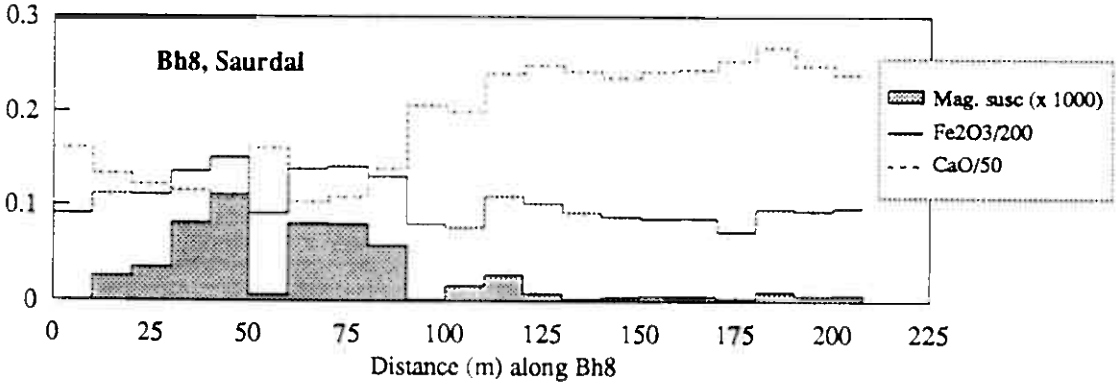

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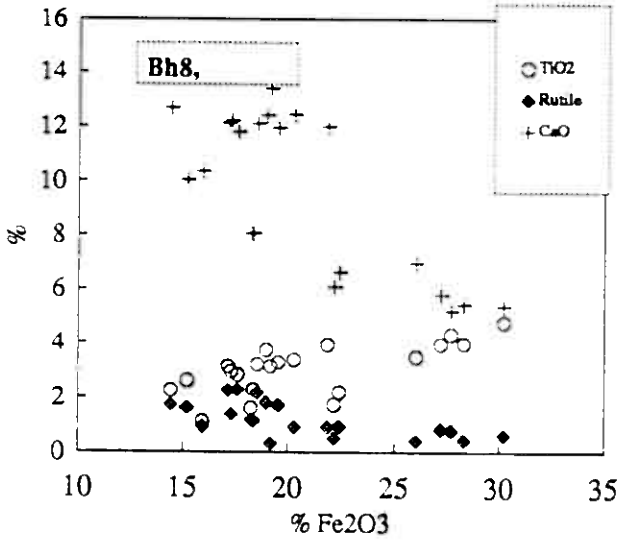

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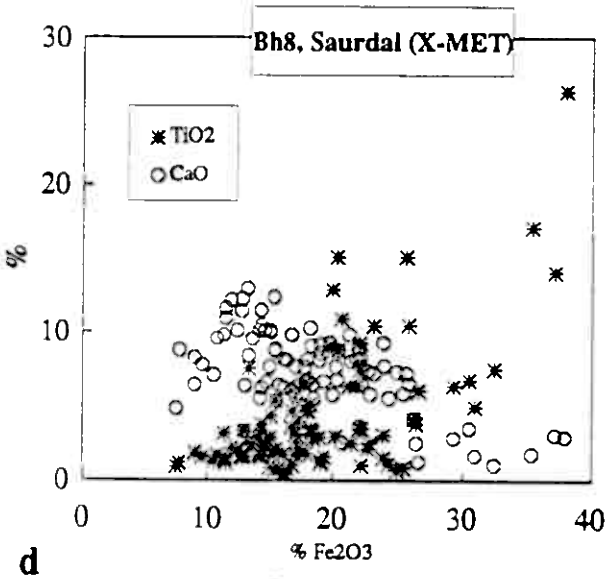
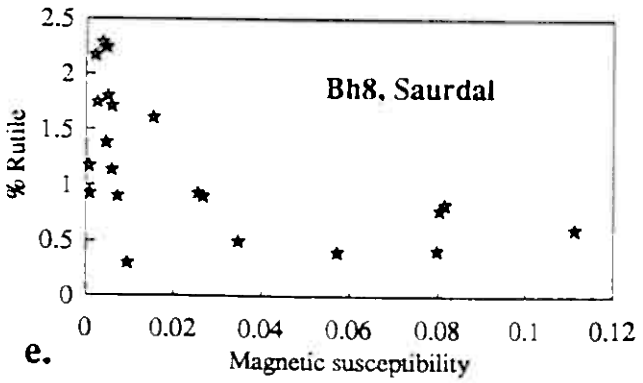


d

Average: 4.28% TiO2, 18.63% Fe2O3, 7.40% CaO



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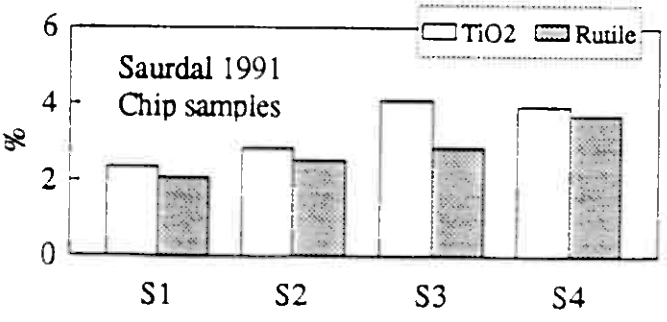


Saurdal 1993

Drill-dust samples (NGU's sampling method)

ICP HCl-soluble analyses at NGU (Rutile procedure)

X-MET analysed by R.McLimans and M.Garson (directly on drill-dust in the field)

X-MET analyses by S.Parr (milled drill-dust samples)

	X-MET analyses on pulverized samples (1)			(1)-(2)		First X-MET anal. on drill-dust		ICP-analyses (HCl-soluble) (2)									
	TiO2	Fe2O3	CaO	RUTILE calc.	Rel.% Rutile	TiO2	RUTILE calc.	SiO2 sol.	Al2O3 sol.	Fe2O3 sol.	TiO2 sol.	MgO sol.	CaO sol.	Na2O sol.	K2O sol.	MnO sol.	P2O5 sol.
1	**2.74**	22.51	4.72	**0.55**	20%	2.58	0.39	7.21	8.83	14.02	**2.19**	7.32	1.85	0.59	0.18	0.09	0.11
2	**2.10**	19.62	7.17	**0.81**	39%	1.97	0.68	1.53	6.36	8.83	**1.29**	4.23	2.07	0.65	0.14	0.07	0.18
3	**3.48**	20.11	11.39	**0.99**	28%	3.28	0.79	0.79	3.06	7.76	**2.49**	1.08	1.76	0.25	0.12	0.08	0.11
4	**3.60**	20.66	12.25	**0.62**	17%	3.39	0.41	0.49	2.70	8.60	**2.98**	0.92	1.69	0.15	0.12	0.08	0.11
5	**3.03**	18.84	11.18	**0.09**	3%	2.95	0.01	0.30	3.04	10.54	**2.94**	1.49	1.90	0.25	0.12	0.12	0.11
6	**5.44**	24.58	10.09	**0.38**	7%	4.39	-0.67	0.18	2.94	16.45	**5.06**	1.08	1.61	0.19	0.12	0.10	0.11
7	**5.71**	24.47	9.99	**0.31**	5%	3.52	-1.88	0.15	2.46	18.55	**5.40**	0.98	1.33	0.17	0.12	0.09	0.11
8	**2.38**	13.90	10.24	**2.01**	84%	2.21	1.84	0.41	4.00	4.87	**0.37**	1.08	1.98	0.25	0.26	0.06	0.20
9	**4.56**	21.77	11.92	**-0.30**	-7%	3.48	-1.38	0.22	2.48	12.60	**4.86**	0.97	1.53	0.16	0.12	0.09	0.15
10	**4.75**	21.54	8.04	**3.04**	64%	4.66	2.95	0.90	4.69	8.78	**1.71**	1.70	1.67	0.23	0.16	0.08	0.17
11	**3.86**	20.10	10.53	**2.33**	60%	4.21	2.68	0.97	4.25	7.88	**1.53**	1.26	1.98	0.24	0.12	0.09	0.11
12	**1.64**	15.05	7.76	**1.50**	91%	1.57	1.43	0.12	3.87	4.96	**0.14**	1.42	1.54	0.25	0.20	0.06	0.21
13	**4.63**	18.70	9.80	**4.44**	96%	3.96	3.77	0.41	3.39	5.17	**0.19**	0.99	1.71	0.21	0.12	0.07	0.17
14	**1.93**	19.65	11.11	**1.80**	93%	1.90	1.77	0.83	4.26	6.04	**0.13**	1.14	2.29	0.32	0.12	0.07	0.29
15	**5.09**	22.97	9.72	**-0.04**	-1%	4.81	-0.32	0.12	3.22	13.70	**5.13**	1.44	1.72	0.31	0.16	0.10	0.13
16	**4.99**	22.28	9.77	**1.01**	20%	4.80	0.82	0.33	3.39	11.32	**3.98**	1.14	1.54	0.16	0.12	0.09	0.11
17	**1.29**	12.26	9.03	**1.11**	86%	1.13	0.95	0.25	6.30	5.17	**0.18**	1.84	2.35	0.54	0.12	0.06	0.19
18	**1.04**	12.83	8.01	**0.93**	89%	1.02	0.91	0.31	6.24	5.57	**0.11**	2.15	2.17	0.44	0.27	0.07	0.14
19	**0.92**	12.94	7.70	**0.88**	96%	0.81	0.77	0.49	4.67	4.38	**0.04**	1.81	2.10	0.41	0.12	0.06	0.24
20	**5.10**	20.40	10.51	**0.25**	5%	4.77	-0.08	0.03	2.67	11.75	**4.85**	1.11	1.51	0.15	0.12	0.09	0.11
21	**2.66**	19.89	10.71	**2.44**	92%	3.21	2.99	0.76	4.91	7.40	**0.22**	1.48	2.58	0.32	0.12	0.09	0.32
22	**6.26**	25.28	8.54	**0.87**	14%	5.58	0.19	0.42	3.67	16.20	**5.39**	1.11	1.77	0.18	0.12	0.11	0.15
23	**5.18**	15.57	11.78	**4.58**	88%	4.42	3.82	0.34	3.90	5.94	**0.60**	1.18	3.72	0.35	0.12	0.08	1.44
24	**6.37**	23.79	8.70	**0.61**	10%	5.49	-0.27	0.11	3.06	15.75	**5.76**	1.21	1.54	0.18	0.12	0.10	0.13
25	**6.34**	24.57	9.64	**0.20**	3%	5.87	-0.27	0.25	3.10	16.38	**6.14**	1.34	1.59	0.20	0.12	0.09	0.13
26	**4.93**	22.33	10.08	**3.64**	74%	5.33	4.04	0.70	4.05	8.43	**1.29**	1.17	2.23	0.09	0.12	0.09	0.11
27	**3.60**	16.84	10.52	**3.39**	94%	3.59	3.38	0.81	4.27	6.01	**0.21**	1.20	1.87	0.18	0.12	0.08	0.11

Vedl. 2, App. (2)

28	4.26	20.53	11.62	-0.11	-3%	4.17	-0.20	0.20	3.31	11.	4.37	1.24	1.67	0.16	0.16	0.0	0.13
29	3.78	18.37	11.17	2.83	75%	4.43	3.48	0.28	3.52	6.37	0.95	1.10	1.88	0.20	0.12	0.08	0.20
30	4.07	22.07	11.07	-0.19	-5%	3.82	-0.44	0.02	2.44	16.18	4.26	0.92	1.26	0.10	0.12	0.10	0.15
31	3.17	18.61	12.40	-0.10	-3%	2.82	-0.45	0.02	2.85	8.28	3.27	1.08	1.72	0.15	0.12	0.09	0.19
32	2.55	16.64	13.54	-0.38	-15%	2.55	-0.38	0.02	1.61	7.16	2.93	0.96	1.22	0.10	0.12	0.09	0.11
33	2.10	16.47	7.65	1.95	93%	2.23	2.08	0.90	6.15	6.46	0.15	1.80	2.18	0.52	0.12	0.06	0.18
34	2.18	14.44	7.86	1.93	89%	2.05	1.80	0.62	4.85	5.75	0.25	1.29	1.89	0.42	0.21	0.06	0.17
35	4.79	25.22	6.18	0.25	5%	4.68	0.14	0.02	9.14	22.52	4.54	5.46	3.09	0.77	0.28	0.19	0.14
36	4.42	16.77	11.60	2.89	65%	4.26	2.73	0.02	3.22	6.99	1.53	1.55	2.06	0.30	0.12	0.09	0.13
37	2.91	18.62	11.21	2.48	85%	3.06	2.63	0.33	4.62	6.75	0.43	1.51	2.51	0.32	0.12	0.09	0.26
38	8.63	30.46	9.57	0.46	5%	7.54	-0.63	0.02	2.45	31.52	8.17	2.01	1.38	0.15	0.12	0.12	0.11
39	4.13	22.18	11.31	-0.16	-4%	3.37	-0.92	0.02	2.30	16.72	4.29	1.73	1.94	0.22	0.12	0.11	0.18
40	1.92	20.05	10.09	1.76	92%	2.20	2.04	2.02	5.98	7.87	0.16	1.47	2.61	0.15	0.20	0.08	0.14
41	3.14	19.42	13.13	-0.02	-1%	2.49	-0.67	0.26	2.42	8.75	3.16	1.02	1.86	0.13	0.12	0.09	0.11
42	2.48	17.09	13.97	2.02	81%	2.49	2.03	0.59	3.43	4.97	0.46	1.02	2.30	0.19	0.12	0.07	0.11
43	3.21	20.60	12.18	0.19	6%	3.47	0.45	0.36	3.43	10.76	3.02	1.37	2.13	0.22	0.12	0.10	0.11
44	5.14	24.31	9.96	0.28	5%	4.88	0.02	0.02	3.33	17.36	4.86	1.46	1.61	0.16	0.12	0.17	0.11
45	5.74	24.40	10.47	-0.09	-2%	4.67	-1.16	0.09	2.69	20.69	5.83	1.73	1.89	0.31	0.20	0.12	0.11
46	4.38	22.29	11.66	0.87	20%	4.46	0.95	0.30	3.85	13.31	3.51	1.50	2.46	0.30	0.12	0.11	0.11
47	4.00	21.68	7.17	1.53	38%	3.56	1.09	0.02	7.80	14.73	2.47	3.85	2.84	0.80	0.14	0.13	0.11
48	3.81	23.71	7.70	0.11	3%	3.36	-0.34	0.17	4.18	14.68	3.70	2.38	1.74	0.32	0.12	0.11	0.11
49	4.54	22.69	11.55	0.74	16%	4.32	0.52	0.24	3.43	14.05	3.80	1.61	2.00	0.23	0.21	0.12	0.11
50	3.09	18.82	10.79	2.52	82%	3.39	2.82	0.44	3.79	7.14	0.57	1.11	1.88	0.24	0.37	0.13	0.11
51	3.78	19.60	10.35	3.40	90%	3.90	3.52	0.75	3.74	6.27	0.38	1.04	1.74	0.22	0.12	0.06	0.11
52	4.11	21.39	8.60	2.77	67%	4.26	2.92	0.67	4.84	8.86	1.34	1.78	2.23	0.45	0.22	0.07	0.11
53	5.79	24.86	9.15	0.23	4%	5.32	-0.24	0.12	3.42	16.71	5.56	2.13	2.65	0.56	0.30	0.13	0.35
54	5.34	24.84	6.90	2.37	44%	4.92	1.95	1.42	6.60	13.05	2.97	2.29	2.46	0.53	0.20	0.08	0.11
55	6.53	26.71	6.92	1.38	21%	6.17	1.02	0.33	6.45	19.09	5.15	3.01	2.68	0.58	0.42	0.12	0.11
56	4.03	21.51	8.30	0.54	13%	3.47	-0.02	0.21	4.59	12.27	3.49	2.05	2.06	0.40	0.12	0.11	0.11
57	2.62	17.55	7.23	2.17	83%	2.24	1.79	0.23	6.10	7.44	0.45	2.44	2.48	0.97	0.13	0.07	0.23
58	17.56	42.67	3.71	4.39	25%	17.68	4.51	0.21	6.39	50.08	13.17	2.91	1.24	0.18	0.17	0.18	0.11
59	5.84	27.98	10.55	0.25	4%	5.84	0.25	12.11	4.72	14.70	5.59	0.87	3.62	0.25	0.12	0.17	1.39
60	1.25	12.11	10.45	0.99	79%	1.31	1.05	4.36	5.03	4.31	0.26	1.38	2.63	0.88	0.12	0.05	0.38
61	4.95	19.89	8.02	4.38	88%	4.25	3.68	1.52	5.41	8.54	0.57	2.42	2.01	0.41	0.22	0.08	0.14
62	3.00	18.29	6.38	1.93	64%	3.34	2.27	0.73	3.58	7.05	1.07	1.92	1.46	0.63	0.21	0.04	0.13
63	2.35	16.93	14.23	-0.06	-3%	2.10	-0.31	0.02	1.50	6.59	2.41	1.49	7.86	0.44	0.16	0.09	5.39
64	2.13	18.31	8.10	1.51	71%	2.24	1.62	1.45	6.30	7.79	0.62	1.71	2.46	0.74	0.12	0.07	0.16
65	2.92	16.29	11.50	1.21	41%	4.22	2.51	0.02	2.24	5.55	1.71	1.83	2.12	0.44	0.15	0.05	0.25
66	3.20	20.07	7.24	0.77	24%	3.41	0.98	0.02	7.92	13.40	2.43	4.60	3.14	0.91	0.46	0.11	0.11
67	1.48	16.97	7.81	1.21	82%	1.27	1.00	0.26	3.76	4.97	0.27	1.52	1.61	0.31	0.12	0.06	0.15
68	0.84	8.25	8.14	0.68	81%	1.15	0.99	0.02	4.11	3.31	0.16	1.20	1.65	0.61	0.12	0.03	0.12
69	2.12	14.77	11.42	1.98	93%	2.65	2.51	0.48	3.71	4.18	0.14	1.07	2.15	0.24	0.21	0.07	0.19
70	0.44	12.29	8.46	0.26	59%	0.36	0.18	0.02	5.13	4.66	0.18	1.90	2.13	0.43	0.18	0.06	0.22
71	1.71	15.75	8.45	1.65	97%	1.82	1.76	0.45	3.53	4.06	0.06	1.13	1.59	0.18	0.12	0.05	0.11

72	**1.20**	12.57	8.47	**1.13**	94%	1.00	0.93	0.33	3.86	3.8	**0.07**	1.17	1.66	0.28	0.39	0.0	0.12
73	**1.18**	12.08	7.30	**1.12**	95%	1.19	1.13	0.27	3.68	3.68	**0.06**	1.12	1.56	0.31	0.12	0.04	0.11
74	**0.83**	11.74	8.39	**0.80**	96%	0.63	0.60	0.35	3.18	2.91	**0.03**	1.10	1.47	0.25	0.12	0.04	0.15
75	**1.58**	14.65	8.33	**1.54**	98%	1.97	1.93	0.35	3.64	3.73	**0.04**	1.26	1.66	0.23	0.20	0.04	0.16
76	**1.24**	12.39	8.54	**1.19**	96%	1.23	1.18	0.35	4.15	4.11	**0.05**	1.26	1.79	0.31	0.21	0.05	0.15
77	**0.93**	11.56	7.97	**0.85**	91%	0.93	0.85	0.02	4.41	3.85	**0.08**	1.61	1.69	0.60	0.12	0.04	0.11
78	**3.43**	17.58	10.74	**3.22**	94%	3.83	3.62	1.13	4.52	6.08	**0.21**	1.22	2.08	0.26	0.26	0.07	0.11
79	**7.04**	22.88	11.16	**2.53**	36%	7.52	3.01	0.34	2.60	12.49	**4.51**	0.87	1.33	0.09	0.12	0.09	0.12
80	**4.06**	17.30	10.02	**3.75**	92%	4.58	4.27	0.76	4.17	5.72	**0.31**	1.02	2.05	0.18	0.12	0.07	0.11
81	**1.64**	11.69	8.47	**1.52**	93%	1.32	1.20	0.16	3.25	3.35	**0.12**	0.88	1.81	0.30	0.37	0.05	0.41
82	**1.27**	13.62	8.12	**1.17**	92%	1.21	1.11	0.16	3.09	4.01	**0.10**	1.08	1.28	0.16	0.24	0.05	0.13
83	**2.61**	16.53	11.88	**2.21**	85%	4.82	4.42	0.19	3.03	4.56	**0.40**	0.79	2.19	0.16	0.12	0.06	0.18
84	**4.36**	18.83	8.08	**4.17**	96%	2.34	2.15	0.95	4.62	6.57	**0.19**	1.16	1.92	0.16	0.12	0.07	0.22
85	**3.00**	18.70	10.60	**0.35**	12%	2.89	0.24	0.13	2.67	9.14	**2.65**	1.13	1.64	0.18	0.16	0.10	0.12
86	**3.27**	19.92	10.46	**2.23**	68%	4.11	3.07	0.92	3.86	8.02	**1.04**	1.43	2.49	0.32	0.12	0.11	0.19
87	**2.41**	17.29	11.41	**1.48**	61%	2.89	1.96	0.47	3.33	6.68	**0.93**	1.08	2.09	0.22	0.12	0.12	0.11
88	**2.81**	17.19	9.28	**2.34**	83%	2.77	2.30	0.44	5.20	6.93	**0.47**	2.39	3.76	0.90	0.31	0.09	1.02
89	**2.35**	17.22	8.54	**0.88**	37%	2.35	0.88	0.02	6.51	8.38	**1.47**	3.59	2.93	0.81	0.12	0.09	0.18
90	**4.53**	22.19	9.36	**2.32**	51%	4.81	2.60	0.71	4.59	10.57	**2.21**	1.39	2.39	0.29	0.12	0.10	0.19
91	**4.20**	21.37	10.26	**0.69**	16%	4.28	0.77	0.33	3.97	11.08	**3.51**	1.42	2.14	0.23	0.28	0.13	0.11
92	**2.95**	20.15	8.25	**1.28**	43%	3.17	1.50	0.29	6.22	10.62	**1.67**	2.59	2.93	0.53	0.53	0.11	0.44
93	**5.27**	21.75	8.67	**4.46**	85%	6.00	5.19	1.11	5.07	8.13	**0.81**	1.46	2.21	0.26	0.25	0.09	0.11
94	**7.02**	33.82	1.89	**1.46**	21%	7.98	2.42	0.02	7.09	34.15	**5.56**	8.99	0.24	0.04	0.12	0.12	0.11
95	**5.26**	28.88	5.97	**0.50**	10%	5.19	0.43	0.02	6.73	26.61	**4.76**	6.62	2.45	0.47	0.24	0.19	0.18
96	**1.35**	13.82	7.62	**1.10**	81%	1.35	1.10	0.19	4.64	5.39	**0.25**	1.90	2.24	0.68	0.12	0.06	0.21
97	**3.58**	26.38	7.13	**0.29**	8%	2.76	-0.53	0.02	5.56	26.04	**3.29**	8.06	0.48	0.05	0.32	0.14	0.11
98	**1.86**	18.68	11.60	**1.57**	84%	1.97	1.68	1.45	5.51	7.56	**0.29**	1.77	3.26	0.32	0.12	0.14	0.62
99	**5.14**	34.99	0.00	**1.40**	27%	6.01	2.27	1.21	1.84	32.15	**3.74**	11.18	0.21	0.03	0.22	0.12	0.13
100	**4.10**	34.88	0.00	**1.28**	31%	4.29	1.47	0.18	2.34	35.25	**2.82**	16.87	0.20	0.04	0.29	0.28	0.14
101	**7.78**	33.85	0.00	**2.80**	36%	7.10	2.12	0.02	5.01	38.90	**4.98**	9.53	0.07	0.02	0.12	0.22	0.12
102	**1.42**	27.99	1.24	**0.56**	39%	1.15	0.29	0.85	3.27	22.01	**0.86**	12.51	0.45	0.03	0.12	0.15	0.37
103	**1.91**	30.77	1.26	**0.60**	31%	1.37	0.06	1.32	2.61	27.64	**1.31**	16.51	0.40	0.03	0.15	0.22	0.26
104	**1.84**	19.39	10.23	**0.14**	8%	1.98	0.28	1.36	4.30	8.61	**1.70**	1.22	2.16	0.26	0.12	0.15	0.38
105	**2.55**	24.79	7.38	**0.44**	17%	2.40	0.29	0.87	7.91	13.71	**2.11**	4.76	3.35	0.59	0.25	0.16	0.11
106	**1.46**	16.29	7.14	**1.28**	88%	1.18	1.00	1.12	5.25	6.78	**0.18**	2.17	1.88	0.85	0.20	0.07	0.12
107	**1.93**	19.84	8.20	**1.28**	66%	2.05	1.40	0.23	6.95	8.74	**0.65**	3.15	3.12	0.71	0.12	0.08	0.30
Av.	**3.58**	20.18	8.98	**1.40**	39%	3.49	1.31	0.66	4.28	11.26	**2.18**	2.43	2.01	0.33	0.17	0.09	0.25

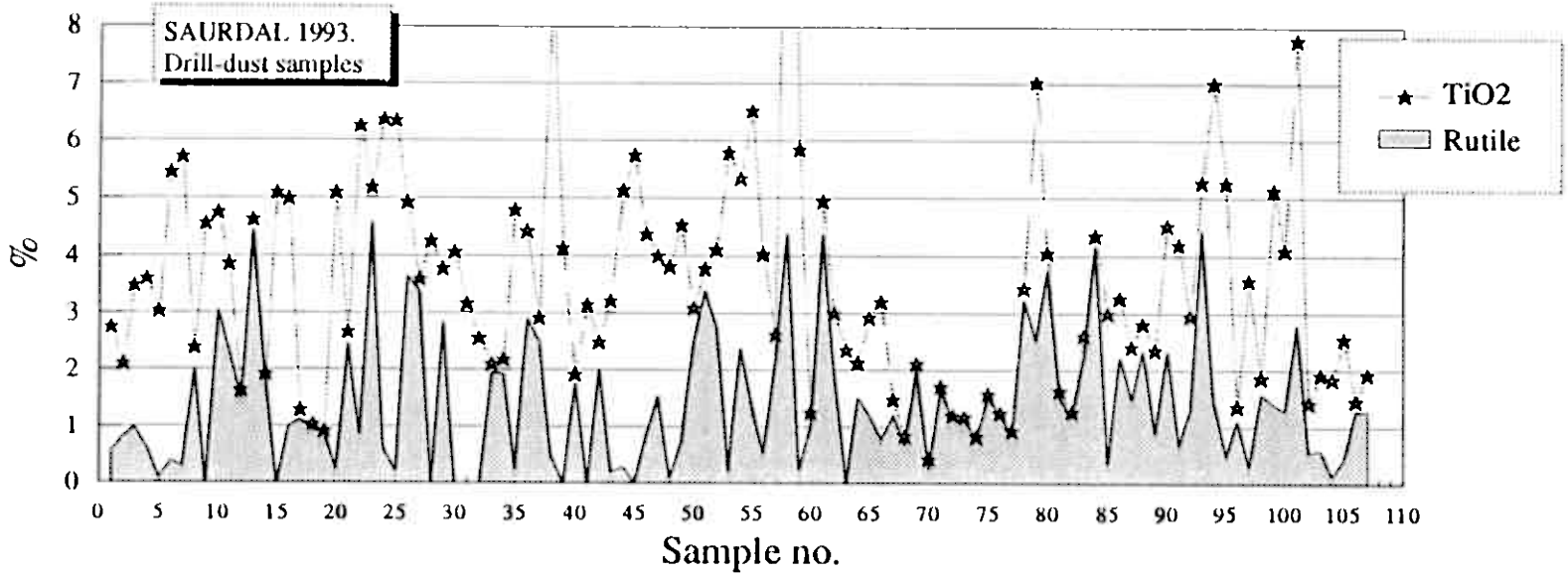
Average rutile (%)

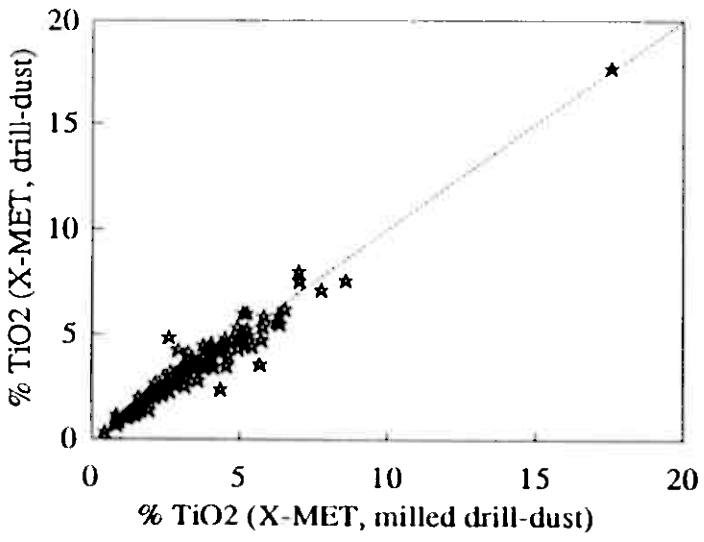
Addiotional sample no 108:

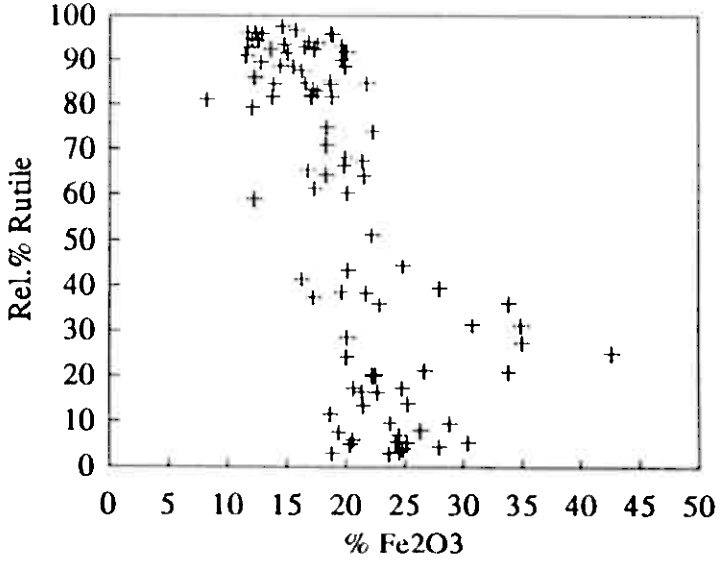
108	**3.74**	20.41	10.54	**1.00**	27%			0.67	4.19	11.23	**2.74**	1.62	2.05	0.29	0.36	0.10	0.11

Saurdal 1993 ● Drill-dust samples

Saudust.wk4

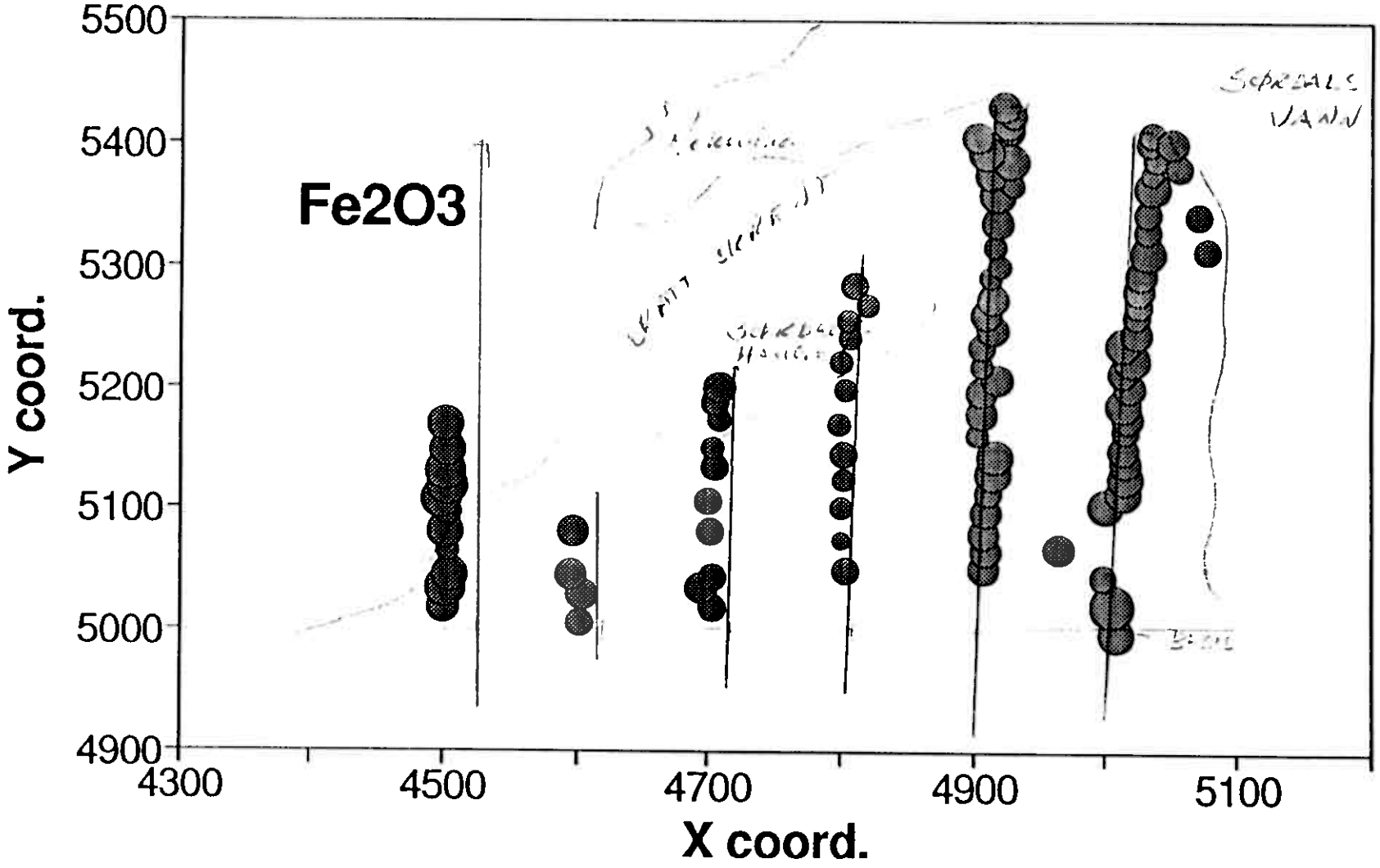






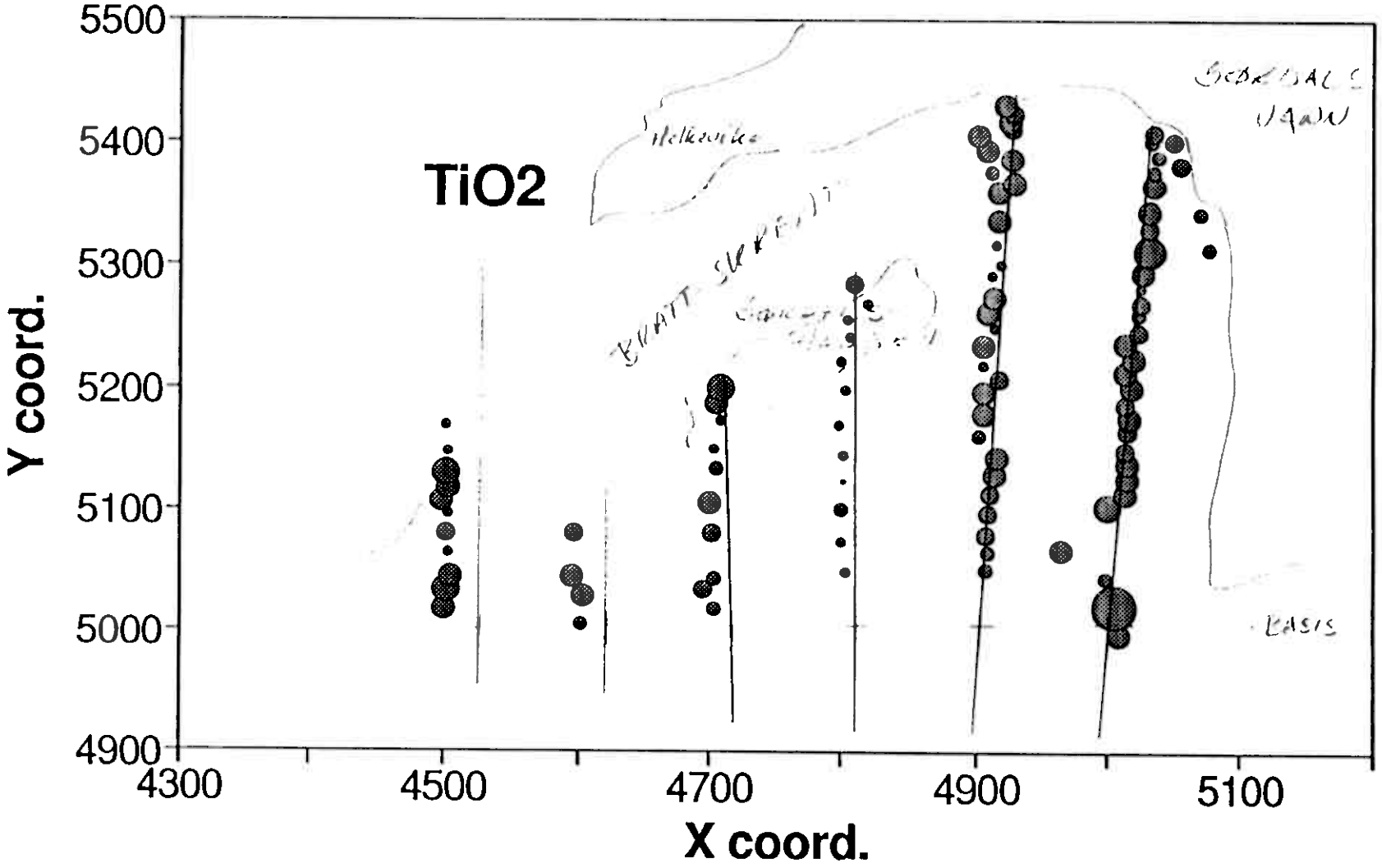
Saurdal 1993

Drill-dust samples



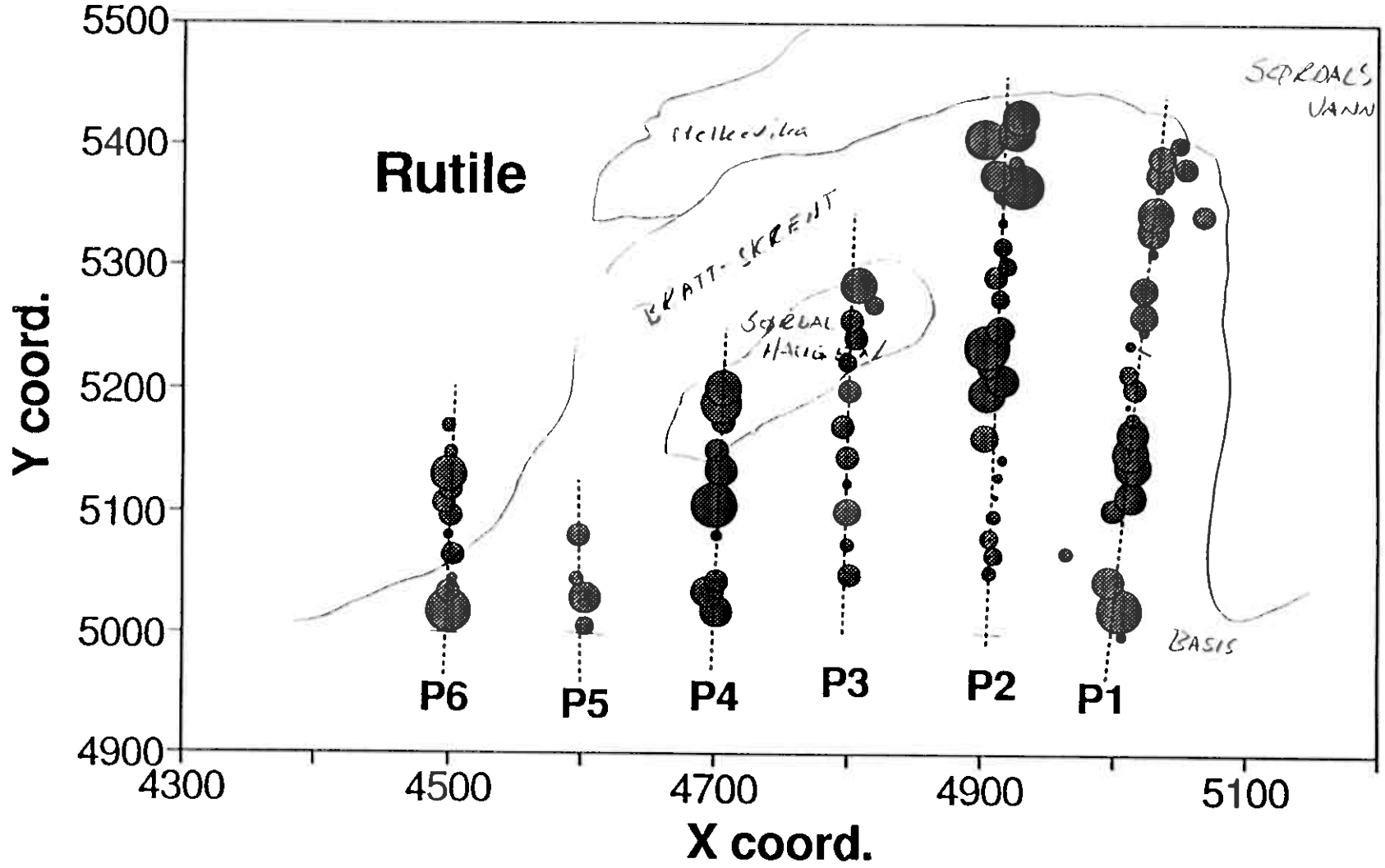
Saurdal 1993

Drill-dust samples



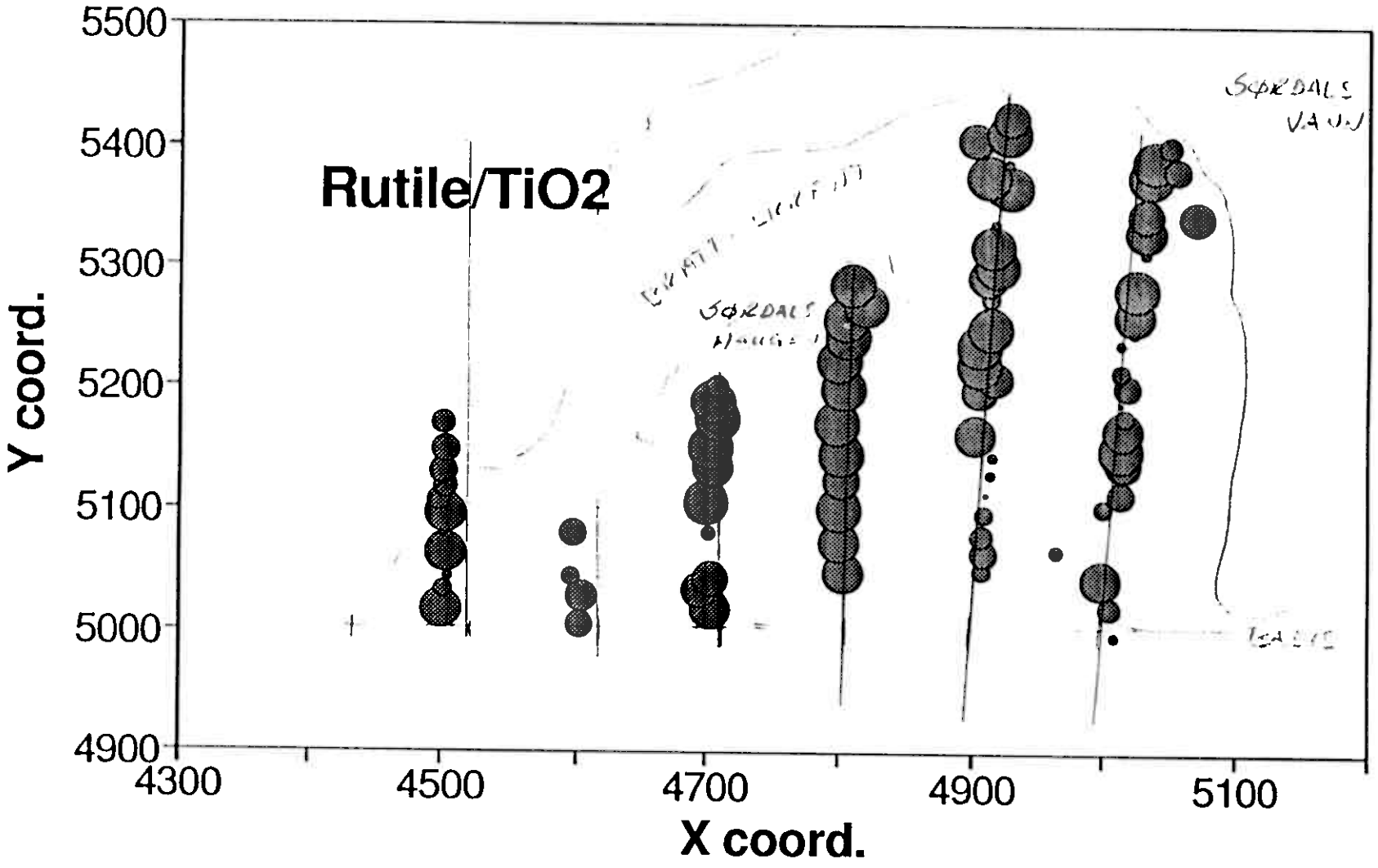
Saurdal 1993

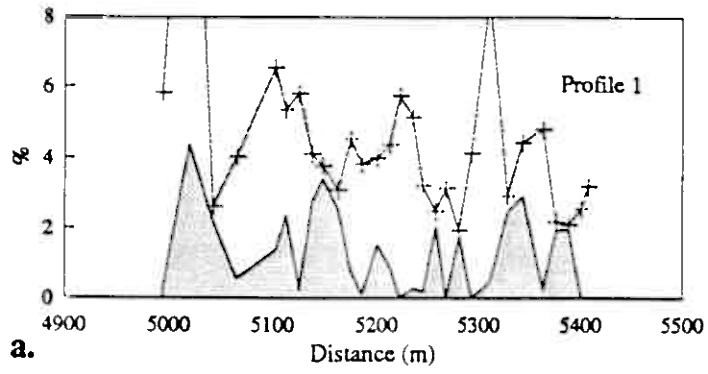
Drill-dust samples



Saurdal 1993

Drill-dust samples

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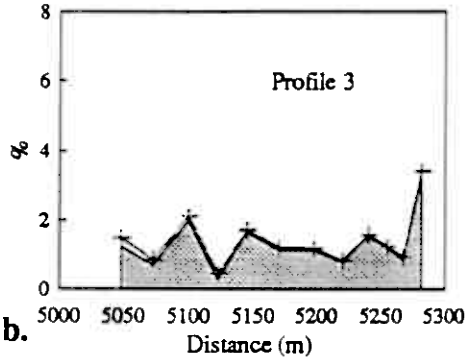
%
Distance (m)

a.


Profile 3
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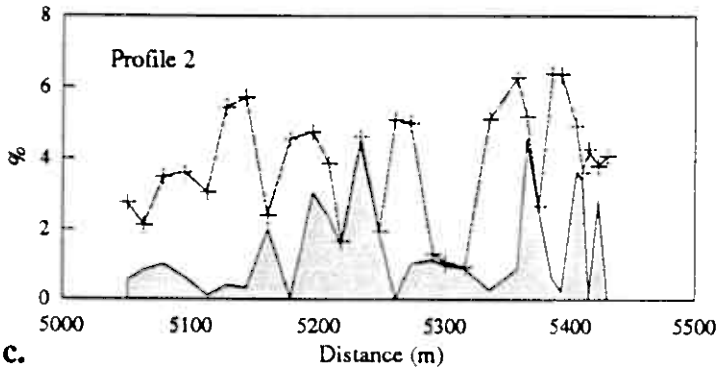
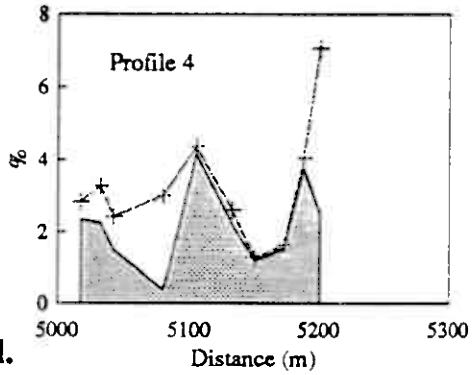
Distance (m)

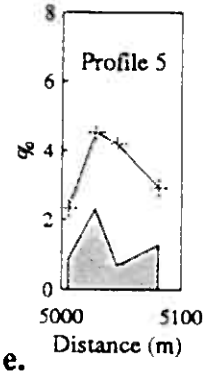
b.


Profile 2
%
Distance (m)

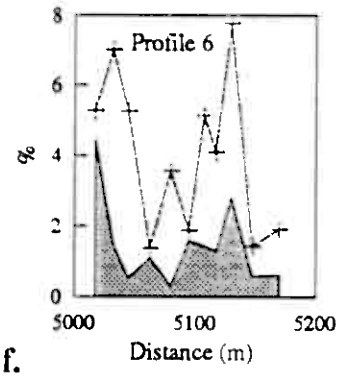
c.


Profile 4
%
Distance (m)

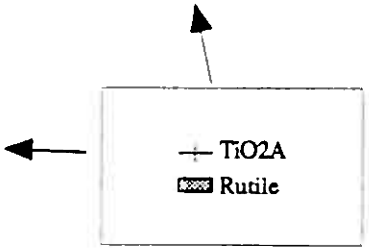
d.

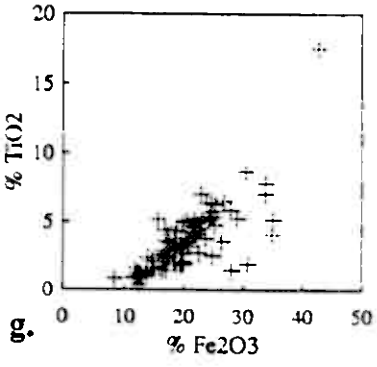

Profile 5
%
Distance (m)

e.

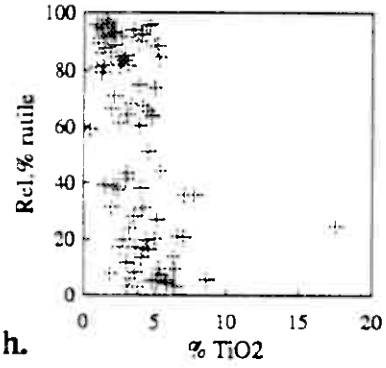

Profile 6
%
Distance (m)

f.

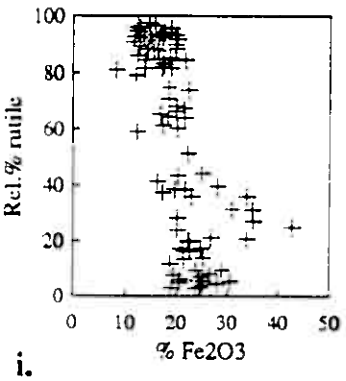

TiO2A
Rutile


% TiO2
% Fe2O3

g.


Rel.% rutile
% TiO2

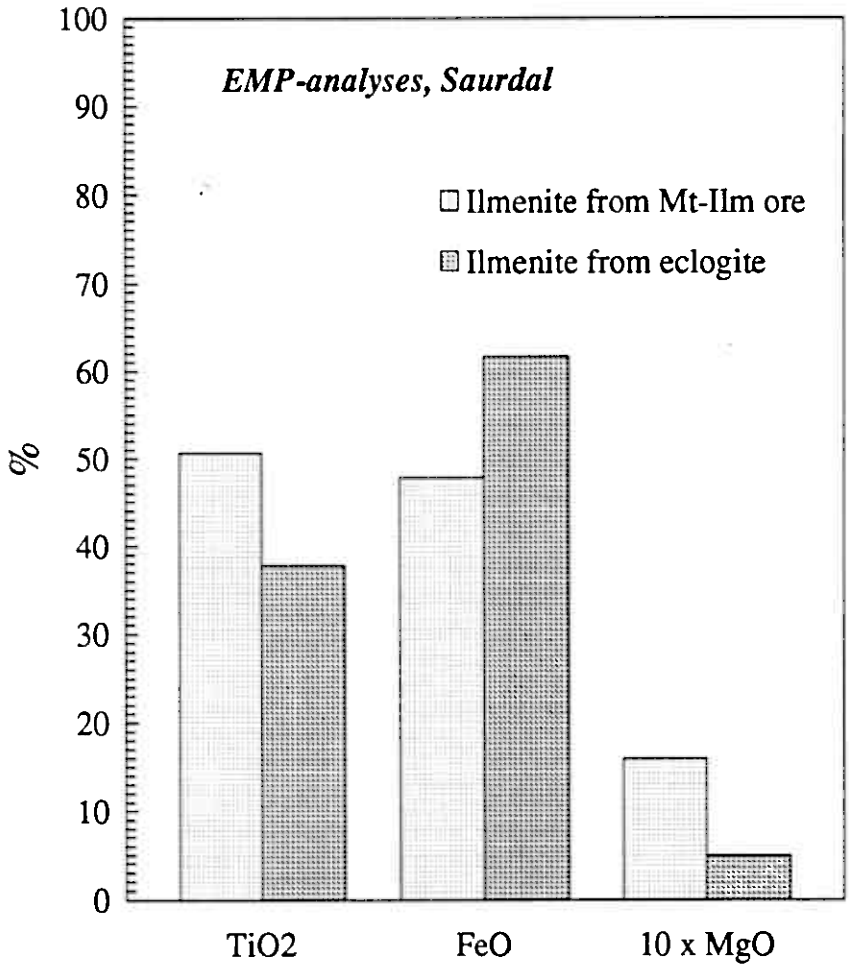
h.


Rel.% rutile
% Fe2O3

i.

VEDL.(2), App.(3)

EMP back-scatter images and ilmenite analyses, Saurdal.



Average TiO2, FeO and MgO in ilmenite from Saurdal.
Normalized analytical values.

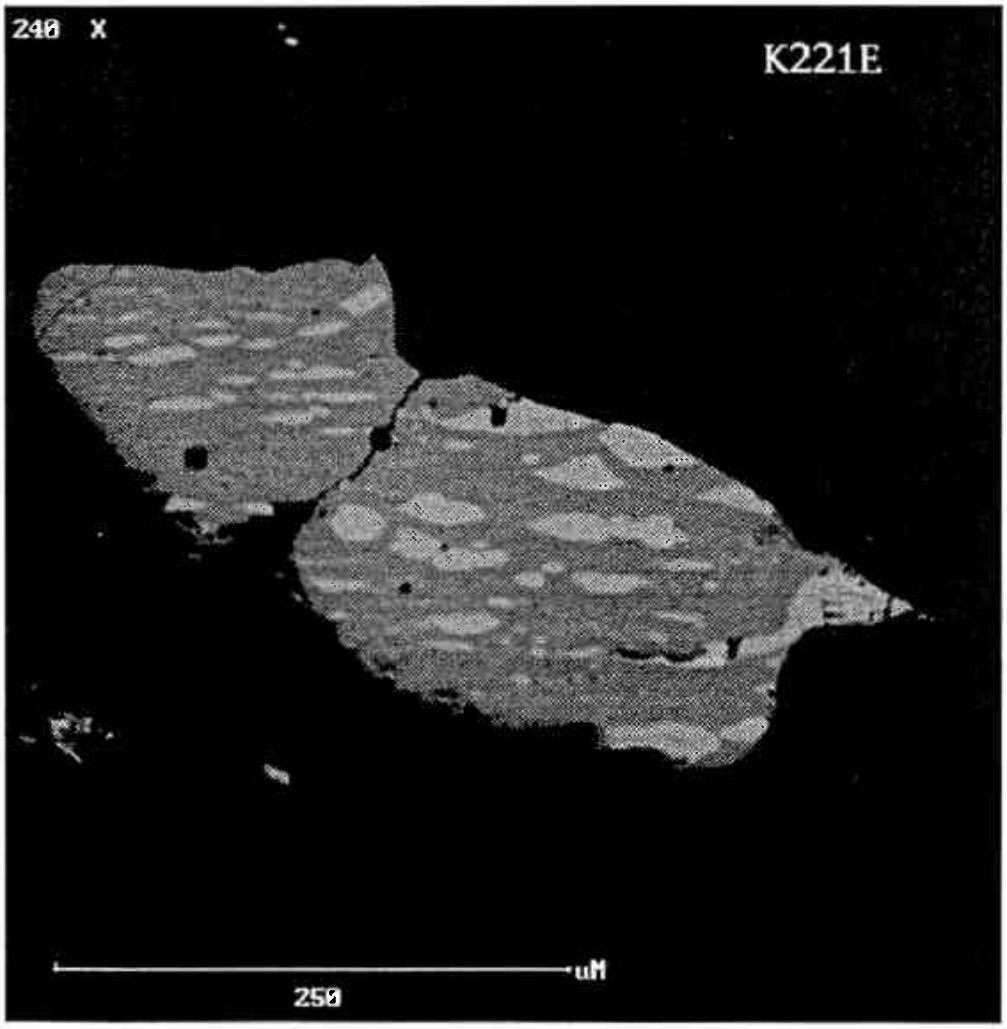
Sample	Anal. no.	Mineral	Point/areal analyses	TiO2	FeO	CaO	MgO	Al2O3	Sum
K221g.94	2	Ilmenite	Point anal.	49.57	44.67	0.00	1.61	0.01	95.86
K221g.94	3	Ilmenite	Point anal.	49.26	43.92	0.00	1.91	0.02	95.11
K221g.94	4	Ilmenite	Point anal.	48.52	43.09	0.00	1.91	0.02	93.54
K221g.94	5	Ilmenite	Point anal.	49.95	43.93	0.00	1.94	0.01	95.83
K221g.94	8	Ilmenite	Point anal.	50.14	45.50	0.00	1.32	0.03	96.99
K221f.94	11	Ilmenite	Point anal.	49.91	44.04	0.01	1.43	0.00	95.39
K221f.94	12	Ilmenite	Point anal.	50.27	43.82	0.00	1.75	0.00	95.84
Average K221g,f.94 ilmenite:				***48.25***	***45.50***	***0.00***	***1.52***	***0.02***	***95.28***
K221e.94	15	Ilmenite	0.005 mm2	38.40	55.01	0.00	0.27	0.03	93.71
K221e.94	17	Ilmenite	0.0001 mm2	43.20	52.09	0.00	0.62	0.00	95.91
K221e.94	18	Ilmenite	0.005 mm2	31.24	59.82	0.00	0.39	0.05	91.50
K221e.94	19	Ilmenite	0.001 mm2	33.29	59.11	0.00	0.48	0.02	92.90
K221e.94	20	Ilmenite	0.001 mm2	30.25	52.51	0.00	0.37	0.08	83.21
K221e.94	21	Ilmenite	0.005 mm2	32.25	57.79	0.00	0.47	0.01	90.52
K221e.94	22	Ilmenite	0.005 mm2	34.27	54.36	0.01	0.50	0.05	89.19
K221e.94	23	Ilmenite	0.005 mm2	33.53	58.61	0.03	0.49	0.01	92.67
K221e.94	24	Ilmenite	0.005 mm2	34.20	55.97	0.01	0.46	0.00	90.64
Average K221e.94 ilmenite:				***34.51***	***56.14***	***0.01***	***0.45***	***0.03***	***91.14***

				Normalized values					
Sample	Anal.	Min.	Point/areal analyses	TiO2	FeO	CaO	MgO	Al2O3	Sum
K221g.94	2	Ilmenite	point anal.	51.71	46.60	0.00	1.68	0.01	100.00
K221g.94	3	Ilmenite	point anal.	51.79	46.18	0.00	2.01	0.02	100.00
K221g.94	4	Ilmenite	point anal.	51.87	46.07	0.00	2.04	0.02	100.00
K221g.94	5	Ilmenite	point anal.	52.12	45.84	0.00	2.02	0.01	100.00
K221g.94	8	Ilmenite	point anal.	51.70	46.91	0.00	1.36	0.03	100.00
K221f.94	11	Ilmenite	point anal.	52.32	46.17	0.01	1.50	0.00	100.00
K221f.94	12	Ilmenite	point anal.	52.45	45.72	0.00	1.83	0.00	100.00
Average K221g,f.94 ilmenite:				***50.62***	***47.77***	***0.00***	***1.59***	***0.02***	***100.00***
K221e.94	15	Ilmenite	0.005 mm2	40.98	58.70	0.00	0.29	0.03	100.00
K221e.94	17	Ilmenite	0.0001 mm2	45.04	54.31	0.00	0.65	0.00	100.00
K221e.94	18	Ilmenite	0.005 mm2	34.14	65.38	0.00	0.43	0.05	100.00
K221e.94	19	Ilmenite	0.001 mm2	35.83	63.63	0.00	0.52	0.02	100.00
K221e.94	20	Ilmenite	0.001 mm2	36.35	63.11	0.00	0.44	0.10	100.00
K221e.94	21	Ilmenite	0.005 mm2	35.63	63.84	0.00	0.52	0.01	100.00
K221e.94	22	Ilmenite	0.005 mm2	38.42	60.95	0.01	0.56	0.06	100.00
K221e.94	23	Ilmenite	0.005 mm2	36.18	63.25	0.03	0.53	0.01	100.00
K221e.94	24	Ilmenite	0.005 mm2	37.73	61.75	0.01	0.51	0.00	100.00
Average K221e.94 ilmenite:				***37.81***	***61.66***	***0.01***	***0.49***	***0.03***	***100.00***

Eclogite News and Views

SAURDAL. EMP back-scatter image of ilmenite (dark grey) with hematite exsolutions (light grey) from ilmenite-rich bands in eclogite.

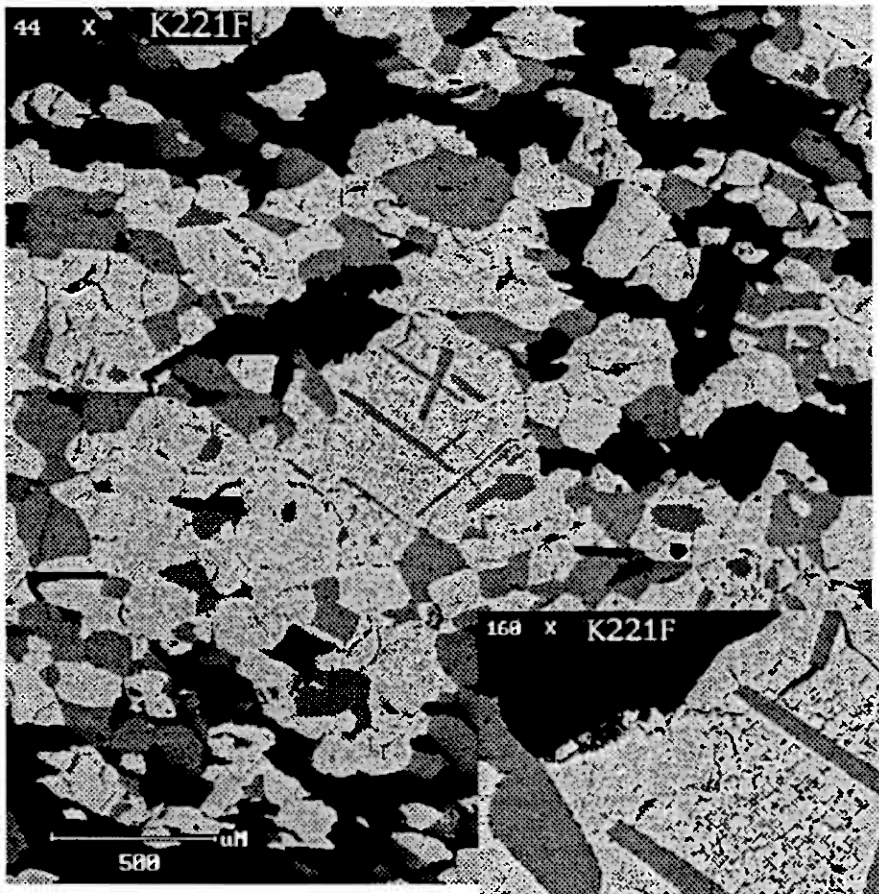
Sample K221E.94. Block-stone quarry, Saurdal eclogite, Dalsfjord region.



Eclogite News and Views

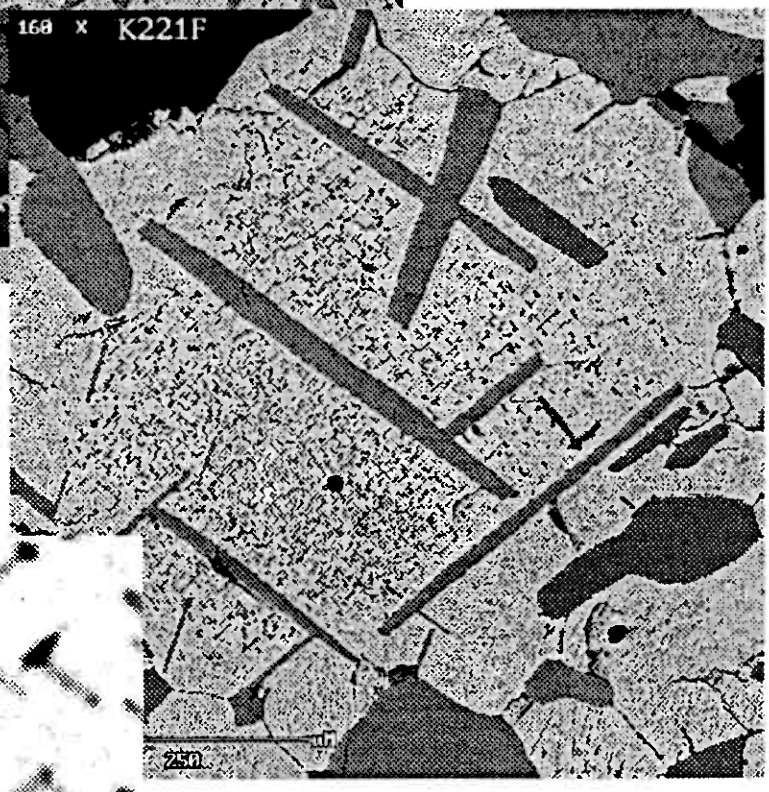
Fe-Ti oxides, Saurdal.

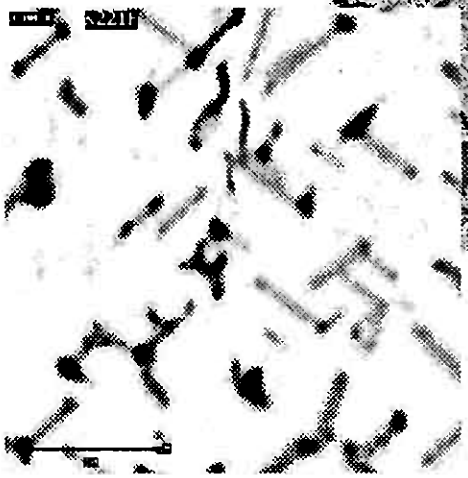
Sample K221F.94 from the tailings of the old Fe-Ti mine at the southern margin of the Saurdal eclogite.



Left: Ilmenite (dark grey) and magnetite (light grey) in massive Fe-Ti ore from the old Saurdal mine.

Below: Ilmenite lammellae in magnetite.





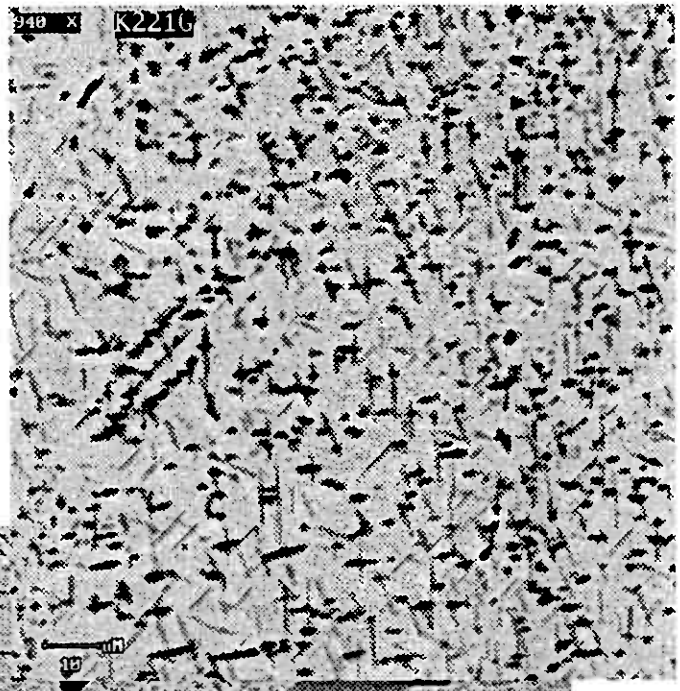
Left: Numerous tiny ilmenite exsolution lammellae (grey) and exsolution blebs of spinel in magnetite.

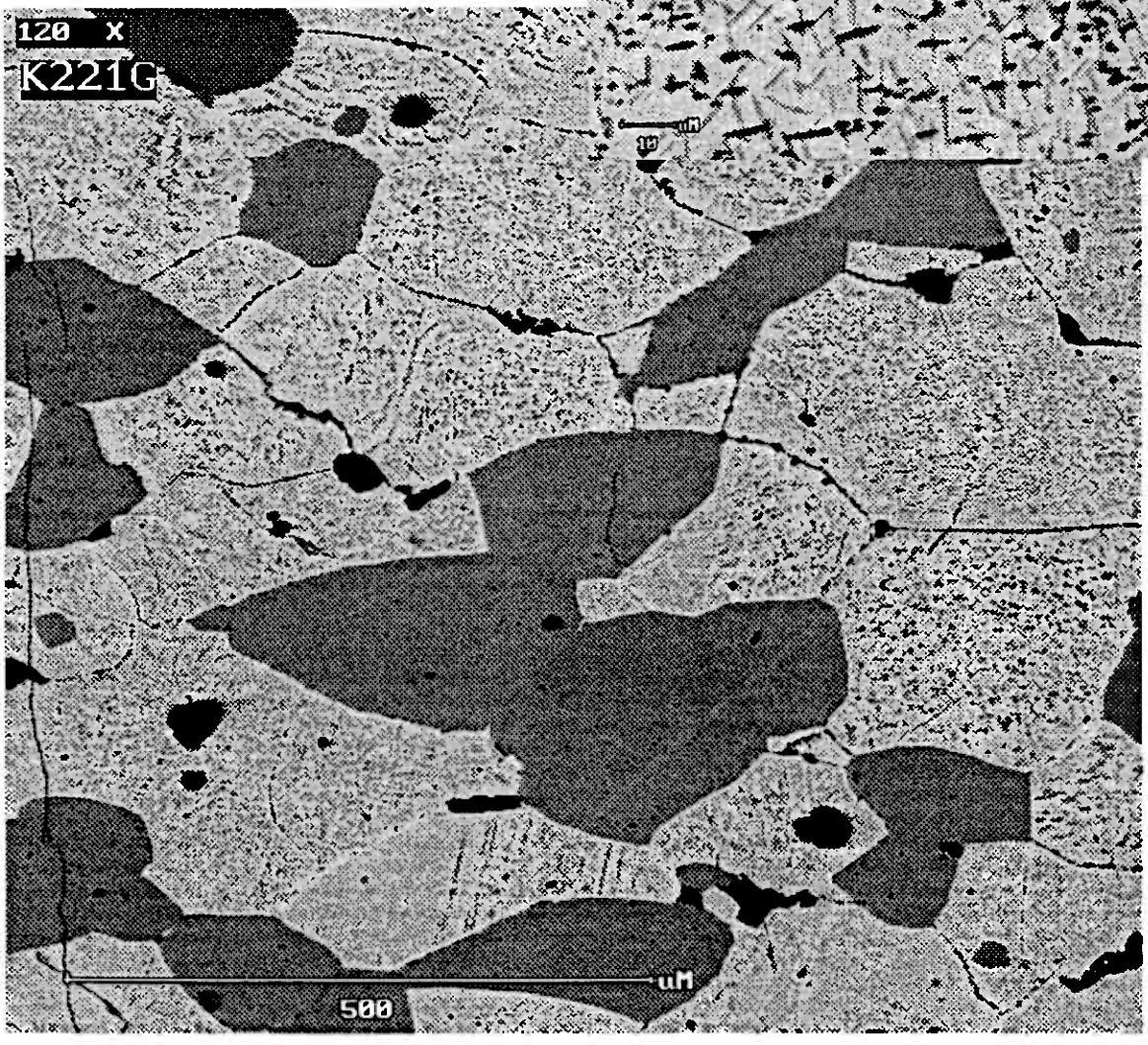
Eclogite News and Views

Fe-Ti oxides from the old Saurdal mine (sample K221G.94).

Right: Numerous tiny exsolution lammellae of ilmenite and exsolution blebs of spinel in magnetite

Lower image: Massive ilmenite (dark grey) - magnetite (light grey) ore from the old Saurdal mine at the southern margin of the eclogite body.





VEDL. (2) / APP. (4)

02-May-95

Drill-core information

About the drill-holes Dh-S1, S2 and S3 (1994/95):

Dh-S1, S2 and S3 were drilled in Desember 1994 and January 1995 by Tekobor A/S. The drilling program was directed by Svein Parr, Garnet A/S/Stokke Industri, with DuPont as collaboration partner. The drilling was supported bty Prospekteringsfondet. NGU is collaborating with DuPont and Garnet A/S in these investigations. The compilation of core information is paid by DuPont and NGU; therefore this core report is becoming a part of NGU's report to DuPont.The purpose of Dh-S1 and -S2 was to investigate ground-magnetic anomnalies (see NGU-report 93.100 "Ground magnetic survey at the Saurdal eclogite, Fjaler" by T. Lauritzen) which resembled the magnetic signatuire of over the Saurdal eclogite hill. The Risaskardet area is heavily covered by vegetation and soil/till and drilling was needed to investigate the character of the rock. The purpose of Dh-S3, which was put down in the Saurdal eclogite quarry, was to investigate the thickness of the eclogite and obtain additional information of the character of the eclogite including the the variations in rutile content.

Drill-hole locations:

Dh-S1 (Risaskardet): Position UTM 2959.00E/68020.00N, map 1117,1. Direction/dip: N10E/70.

Dh-S2 (Risaskardet): Position UTM 2961.00E/68017.00N, map 1117,1. Direction/dip: N10E/65.

Dh-S3 (Saurdal quarry): Position UTM 2972.00E/68019.00N, map 1117,1. Direction/dip: N10E/70.

Saurdal

1

Drill-hole Dh-S1

Length (m): ***0,00 - 5,00*** ***Dh-S1*** *Sample:* *Mag susc / Q-value:* *1*

Missing section.

Density (g/cm3):	*%TiO2 - %Fe2O3 (XMET; n=3):*
	0,00 - 0,00

Length (m): ***5,00 - 8,00*** ***Dh-S1*** *Sample: S1/7,6* *Mag susc / Q-value: 0,39594 / 0,8100*

Chl-amphibole schist/5-5.3m: relict after eclogite; lg, f-gr patches (10cm thick) symplect after omphacite, + grt, amphib., minor oxide; 5.3-5.45m=late fract w/ tremolite, + sulfide, oxide; 5.3-8.0m: chl-amph-oxide schist: relict grt, white zones of trem + fsp; slt foliated to laminated to mottled appearance; grt repl by fsp, chl, amph, oxide.

Density (g/cm3):	*%TiO2 - %Fe2O3 (XMET; n=3):*
3,155	***0,74 - 17,99***

Length (m): ***8,00 - 11,00*** ***Dh-S1*** *Sample: S1/10,0* *Mag susc / Q-value: 0,00063 / 4,0500*

Chl-mica-epidote schist/Grt-absent; laminated/foliated; see minor crenulation devel; epidote pods strung out parallel to foliation; 10-11 m level has v. regular, thin alternating green and white layers (chlor, amph vs. qtz, fsp); 8-9.7m = v. magnetic; 9.7-11m = non-magnetic.

Density (g/cm3):	*%TiO2 - %Fe2O3 (XMET; n=3):*
3,052	***0,43 - 9,90***

Saurdal

Length (m): 11,00 - 14,00 **Dh-S1** Sample: Mag susc / Q-value: /

Grt-bearing to grt-free chlor-amph schist/Weakly to non-magnetic; 11-11.8m: finely laminated free-white schist w/ minor grt porphyroblasts; chl, white mica, fsp, actinolite; 11.8-14m: grt-bearing, chl-actinolite schist; sli. foliation, gen'lly coarse-gr: grt as relicts w/ fsp, chlor replacement; minor Fe-stained oxide: grts were c-grained (now replaced)

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 14,00 - 17,00 **Dh-S1** Sample: S1/15,2 Mag susc / Q-value: 38,0000 / 0,4400

Grt-bearing to grt-free chlor-amph schist/Massive to coarsely folated, weakly magnetic; 14-15m: amph-chlorite-fsp schist w/ relict grt porphyrobl; 15-16.4m: grt-free, chlorite-amph-fsp schist; fsp pseudomorphs after grt; 16.4-17m: grt-relicts + chlor, amph, fsp.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,134	0,31 - 12,76

Length (m): 17,00 - 20,00 **Dh-S1** Sample: Mag susc / Q-value: /

Chlorite-actinolite schist/Slightly foliated to massive, c-grained; 17-19m: chl-amph-fsp, w/ or w/o grt porphyrobl; some grt completely repl. by fsp+chl; v. coarse grt blasts @ 18.3-18.4 (1-cm) w/ thick rims chlorite, v. magnetic; 19-20m: more massive, chl-fsp-actinolite; v. scarce relict grt.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 20,00 - 23,00 **Dh-S1** Sample: Mag susc / Q-value: /

Chlorite-amph-fsp schist to kyanite-grt schist/20-20.9m: c-gr, sli. foliated chl-amph-fsp schist; 20.9m: begin to see grt porphyroblasts again, becomes thinly laminated, gray-white-green (metatuffaceous?); really well-laminated @21.8 m and w/ assembl grt, fsp, kyanite, amphibole. Ky as obvious coarse, blue prisms. Weakly magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 23,00 - 27,00 **Dh-S1** Sample: Mag susc / Q-value: /

Laminated grt-kyanite gneiss/Grt-fsp-kyanite-amphibole-qtz; mineralogic banding obvious. Weakly magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 27,00 - 30,00 **Dh-S1** Sample: S1/20,6 Mag susc / Q-value: /

Grt-kyanite gneiss/As above w/ more variation in grt sizes; v. c-gr grt @28.7-29.8m level.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Saurdal

Length (m): 29,60 - **Dh-S1** Sample: S1/29,6 Mag susc / Q-value: 0,00069 / 2,5400

MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,236	**0,57** - 8,75

Length (m): 30,00 - 40,00 **Dh-S1** Sample: S1/30,45 Mag susc / Q-value: 0,00090 / 5,8900

Greenish-gray gneiss to grt amphibolite/Monotonous green-gray assembl w/ uneven f-grained grt development; 34-35-5m: symplectitic omph(?) + grt; kyanite observed @ 32.1-32.15m. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,231	**0,64** - 9,63

Length (m): 33,00 - **Dh-S1** Sample: S1/33, Mag susc / Q-value: 0,00353 / 54,7600

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,256	**1,46** - 15,44

Length (m): 35,54 - **Dh-S1** Sample: S1/35,54 Mag susc / Q-value: 0,00041 / 0,0000

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
2,984	**0,31** - 6,01

Length (m): 40,00 - 49,00 **Dh-S1** Sample: S1/47,7 Mag susc / Q-value: 0,08350 / 9,6900

Variable but mostly green-gray gneiss w/ local grt/Variation on gray-green gneiss w/ local, c-gr grt; local mgt-enrichment @ 47.0-47.75 and 48-48.9m; some chlorite-mgt rich areas (47.7 m level); poss. formerly retrogr eclogite in this section?

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
2,969	**0,14** - 12,61

Length (m): 49,00 - 63,30 **Dh-S1** Sample: S1/50,85 Mag susc / Q-value: 2,13246 / 8,0800

Retrogr, mgt-rich amph-chlorite-tremolite gneiss/Banded, greenish-gray rock; v. mgt rich w/ mgt disseminated as lg, individ, patches and flecks; amph-chlor-tremolite(?)-qtz-rock w/ disseminated mgt throughout; locally have lg grt porphyroblasts (54.25-55.4 m); missing core = 55-56 m. 54.8 m level = grt rich w/ ilmenite (no mgt). MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,161	**0,81** - 19,58

Saurdal

Length (m): 54,80 - **Dh-S1** Sample: S1/54,8 Mag susc / Q-value: 0,00299 / 12,5000

In thin-section:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,603	**2,85** - 17,83

Drill-hole Dh-S2

Length (m): 0,00 - 2,00 **Dh-S2** Sample: Mag susc / Q-value: /

Missing core

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 2,00 - 10,00 **Dh-S2** Sample: Mag susc / Q-value: /

Banded greenish-gray gneiss/Possible metatuff, metagraywacke? Banded gneiss with tendency to fine-grained eclogite pods (cm-size boundins); locally rich in pale mica. No oxides

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 10,00 - 20,00 **Dh-S2** Sample: S2/15,65 Mag susc / Q-value: 0,00115 / 0,5300

Banded greenish-gray gneiss/Relatively fine-grained with local small (cm-size) pods of eclogite. @ 15.5 and 18.6 m have 'semi-eclogite'. Local, weak sulfide disseminations (py, chalcopy, pyrrho?) but no oxide enrichment observed. Non-magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,24	**0,67** - 9,85

Length (m): 18,65 - **Dh-S2** Sample: S2/18,65 Mag susc / Q-value: 0,00294 / 0,7900

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,24	**1,10** - 9,27

Length (m): 20,00 - 30,00 **Dh-S2** Sample: S2/25,8 Mag susc / Q-value: 0,00049 / 0,0000

Banded greenish-gray gneiss/Contains variable amounts of eclogite or eclogitic gneiss; eclogitic material consists of garnet rimmed by green amphibole. No oxide enrichments. Non-magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,141	**0,66** - 7,45

Length (m): 30,00 - 40,00 **Dh-S2** Sample: S2/31,35 Mag susc / Q-value: 0,00092 / 0,8900

As all the above (green-gray gneiss) but more massive/Similar to previous; fine-grained garnet sparsely dispersed; white mica occurs sporadically (+feldspar, qtz). Cracks filled with serpentine.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,205	0,49 - 10,57

Length (m): 32,50 - **Dh-S2** Sample: S2/32,5 Mag susc / Q-value: 0,00072 / 0,7900

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,227	0,92 - 10,24

Length (m): 40,00 - 50,00 **Dh-S2** Sample: S2/47,75 Mag susc / Q-value: 0,00093 / 0,8700

Green-gray gneiss (banded to massive)/As above with eclogite-like material at 47,75 m ('semi-eclogite').

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,236	0,44 - 12,08

Length (m): 50,00 - 60,00 **Dh-S2** Sample: S2/55,75 Mag susc / Q-value: 0,09097 / 16,2800

Green-gray gneiss and oxide-rich amphibolite/50.0-55.0 m is banded gneiss; @ 55,7 m monotony broken by presence of magnetite and dark green, locally chlorite-rich schist + occasional coarse patches grt. Magnetic 55.4-59.6 m. 55.0-60.0 m: garnet w/ pronounced reaction rims: zone is prob. retrograded eclog? No rutile or ilm observed.
MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,213	1,50 - 19,33

Length (m): 56,40 - **Dh-S2** Sample: S2/56,54 Mag susc / Q-value: 2,36786 / 4,7500

MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,609	3,92 - 22,62

Length (m): 57,60 - **Dh-S2** Sample: S2/57,6 Mag susc / Q-value: 0,24273 / 5,3200

MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
2,985	1,05 - 14,88

Saurdal

Length (m): 59,80 - **Dh-S2** Sample: S2/59,8 Mag susc / Q-value: 0,00025 / 3,1900

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
2,927	0,23 - 4,63

Length (m): 60,00 - 70,00 **Dh-S2** Sample: S2/64,7 Mag susc / Q-value: 1,59028 / 6,1300

Green-gray gneiss to garnet amphibolite/60.0-63.0 m: relatively massive gr-gray gneiss w/ abundant grt (semi-eclogite); 64-68 m: more mafic, darker green, larger grt porphyroblasts, local mgt + chlorite; epidote + tremolite in radiating clusters in vein (67.7 and 69.65 m); 68-70 m: monotonous gneiss; Local sulfide and mgt enrichment @ 63.9, 67.45 m; no rutile or ilm.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,566	4,80 - 22,13

Length (m): 68,50 - **Dh-S2** Sample: S2/68,5 Mag susc / Q-value: 0,00137 / 0,6900

MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,472	3,13 - 15,15

Length (m): 70,00 - 72,00 **Dh-S2** Sample: S2/71,1 Mag susc / Q-value: 0,00480 / 2,2900

White mica-garnet amphibolite/Finely laminated due to contrast mineralogy (wh. mica+fsp versus amphibole-rich bands); similar to green-gray gneiss above but > grt porphyroblasts (replaced by fsp+amph); contains actinolite,wh. mica, fsp, chlorite, relict grt, minor sulfide. Non-magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
2,946	0,86 - 8,37

Length (m): 72,00 - 75,00 **Dh-S2** Sample: S2/73,7 Mag susc / Q-value: 0,00314 / 0,5400

Retrograde eclogite to grt amphibolitic gneiss/72-73.5m: f-grained, laminated gneiss (metatuff?); minor grt replaced by fsp; 74-74.5m: fine-grained, light green (symplectite?) zone w/late, anastomosing veins of fsp+epid; relict grt;74.5-75m; retrog eclog to eclog; var. sized grt porphyroblasts+amph, sympl.minor sulfide; ilm + rutile?; weakly magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,377	2,52 - 15,62

Length (m): 75,00 - 78,00 **Dh-S2** Sample: S2/75,4 Mag susc / Q-value: 0,00180 / 0,4600

Phengite eclogite to oxide-rich retrog eclog to grt amphib/75-76 m: grt amphibolite; c-gr grt porphyrobl of var. sizes to clusters surrounded by amph+fsp; some titanite;76-77m: retro eclog?; coarse grt porphyrobl assoc w/ stngs,blebs oxide, amph, symplect, minor sulfides; some ilmenite?;77-78m: retrog 'Saurdal' eclog; banded wh mica, qtz, grt, omph, amph, mgt/ilm

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,365	3,04 - 15,11

Saurdal

Length (m): 78,00 - 81,00 **Dh-S2** Sample: S2/78,4 Mag susc / Q-value: 0,01696 / 3,6400

Retrograde eclog to grt amphib/78-80 m: Grt, omph, symplect, amph, minor sulfides, oxide as rutile-ilm or rutile-titanite; grt evenly distrib, sli flattened; late veins of fsp+amph, syn-shear vein devel (79.5-79.6: banded wh mica+fsp); 80-81 m: banded grt-mica amphibolite; grt as sm. broken porphyrobl, evenly distrib, rimmed by amph, +fsp,qtz, stringers of ilm, mgt+rutile? MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,312	2,13 - 15,55

Length (m): 81,00 - 84,00 **Dh-S2** Sample: Mag susc / Q-value: /

Oxide-bearing retrog eclogite, grt amphibolite/Banded to f-gr massive w/ slight foliation; grt ubiquitous as clusters, clumps, stringers flattened along foliation: matrix dk green amph, lt green symplect, some wh. mica+ chlorite (81-82.4m), mgt/ilm; magnetic character variable but not strong; minor sulfides esp. in cm-wide sheared veins (81.0-81.2, 81.4-81.6, 82.3-82.5)

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 84,00 - 87,00 **Dh-S2** Sample: S2/85,0 Mag susc / Q-value: 0,00767 / 1,3900

Chlorite-magnetite schist to retrog eclog/84-86.1 m: Grt as massive porphyrobl, aggregates and stringers, + amph, mgt/ilm, ilm/rutile, omphacite, minor sulfides; wh. mica banding @ 84-84.4); late amphiboite veinlets: rel. weak magnetism; 86.1-87m: chlorite-actinolite-mgt/ilm schist; coarsely foliated, massive and rel. f-grained; Ep+fsp+vein sulfides @86.1,86.5-.6. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,427	3,03 - 17,38

Length (m): 87,00 - 90,00 **Dh-S2** Sample: Mag susc / Q-value: /

Chlorite-mgt rock, grt amphibolite/87-87.5m: massive chl-mgt + fsp in coarse grt clumps (+rutile, ilm, mgt); 87.5-88m: grt-rich chloritized rock; grt clusters filled w/ amph, mgt/ilm, symplect; relict rutile?; 88-89m: sli. foliated, f-gr massive chlorite-mgt-ilm-fsp, qtz rock; 89-90m: v-fine-gr, massive green rock; chlor+ serpentine+mgt/ilm, minor sulfides; cracks w/amph+qtz.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 90,00 - 94,00 **Dh-S2** Sample: S2/90,2 Mag susc / Q-value: 0,02926 / 8,2900

Chlorite-mgt gneiss + grt amphib/ 90-91.4m: milky green/dk green + flecks of oxide, minor grt; pale grt patches w/ amph-oxide rims; 2 amphs?; 91.4-93m: c-gr, sli. foliated chl-amph-mgt schist w/ minor grt; flecks, stringers mgt(+ilm), 2 amphs; 93-94 m: grt-rich, grt amphibolite, clumps and ductiley deformed f-gr grt aggregs cut by amph, mgt, ilm + symplect; all magnetic

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,128	1,32 - 12,07

Length (m): 94,00 - 97,00 Dh-S2 Sample: S2/95.1 Mag susc / Q-value: 0,00709 / 2,0300

Chlorite-mgt gneiss + grt amphib/94-96 m: Chl-mgt rich rock w/ grt-richer portions, some retrog eclog?; grt as f-gr aggregs in conc. zones + amph, mgt, chl, minor fsp, ilm?; var. magnetic: ductilely folded; Ep-vein @94.2-94.3; 96-97m: chl- mgt-fsp-tremolite rock w/ gt-mgt-relict omph zone @96.5-96.6; mgt as flecks, ductiley deform. stringers.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3.134	**0,83** - 13,19

Length (m): 97,00 - 100,00 Dh-S2 Sample: Mag susc / Q-value: /

Chlorite-mgt gneiss + grt amphib/97-98m: banded chl-fsp-mgt- sulfide gneiss; grt-mgt zone @ 97.4-97.5m; 98-98.5m: v. grt-rich zone; mainly lg grt cluster w/ ductiley interstitial mgt, amph, symplect?; 98.5-100m: finely laminated chl-mgt-mica-amph-fsp gneiss; minor distrib grt (replaced by fsp). Felsic-richer zones are most magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 100,00 - 105,60 Dh-S2 Sample: Mag susc / Q-value: /

Chlorite-mgt-amph gneiss/Banded-foliated mafic gneiss w/ minor grt; whole section magnetic: 100-101.5m: chl-fsp-tremol- mgt schist; 101.5-102.2m: as above but w/ grt clumps/clusters surr. by chl/mgt; 102.2-105.6m: grt-poor to grt-free chl-tremol- fsp-mgt gneiss; foliated/banded; mgt as coarse bands, flecks or stringers; thicker bands tremolite, wh. mica, fsp.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0.00

Length (m): 105,60 - 109,00 Dh-S2 Sample: S2/107.0 Mag susc / Q-value: 0.02203 / 19,4700

Retrog eclog to grt amphib to chl schist/105.6-107.5m: grt-bearing amphib to eclog; grt in thick zones as aggregs ductilely cut by amph/mgt; thin patches w/ symplect (omp); 107.5-108m: mgt-chl-fsp rock (black and green, ductilely mingled);108-108.6: grt-bearing chl-mgt rock; grt in aggregs, surr. by mgt/ilm;108.6-109m: banded chl-trem-mgt gneiss

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3.291	**3,64** - 22.04

Length (m): 109,00 - 112,00 Dh-S2 Sample: S2/109.9 Mag susc / Q-value: 1,54701 / 8,9100

Chlorite schist/Massive to foliated, rel. coarsely xilne chlorite-rich schist; 109-110.8m: chl-trem-mgt schist; mostly chlor w/ tremol(bladey, coarse, wh-gray), green amph, mgt, biotite, fsp; (109-110.1= strongly magnetic); 110.8-112m: grt-bearing chlor schist + fsp, qtz bands, biot, amph; grt replaced by chlorite. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3.584	**5,78** - 25,57

Length (m): 112,00 - 115,00 Dh-S2 Sample: S2/112,6 Mag susc / Q-value: 0,00098 / 1,1300

Biot-amphibole gneiss to mafic (green) schist/Transition rock; 112-112.8m: green, rel. massive, c-grained, weakly foliated: grt porphyrobl replaced by biot, chl, oxide, matrix of chlor, amph, biot, oxide: sharp contact @112.8; 112.8-114m: banded, coarse grt augen (0.5 cm), biot, amph, fsp, qtz, oxide incl in grt and mtx; 114-115m: bio-amph-fsp-grt gneiss

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,109	0,47 - 13,97

Length (m): 113,70 - Dh-S2 Sample: S2/113,7 Mag susc / Q-value: 0,00115 /

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,56 - 8,28

Length (m): 115,00 - 120,00 Dh-S2 Sample: Mag susc / Q-value: /

Green-gray banded gneiss/Biot-green amph-fsp-qtz, minor sulfide, grt, oxide gneiss; distinct banding w/ fsp-qtz rich layers alternating w/ more mafic; grt rel. sparsely distrib porphyroblasts; sli. ductile deform, evident; non-magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 120,00 - 127,00 Dh-S2 Sample: S2/120,9 Mag susc / Q-value: 0,00063 / 0,9800

Finely laminated green-gray gneiss/gray-green alternating w/ white laminae; qtz, fsp, amph, biotite, f-grained and rare grt, titanite, oxide, sulfide, minor chlorite; weakly magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
2,86	3,69 - 8,41

Length (m): 127,00 - 130,00 Dh-S2 Sample: Mag susc / Q-value: /

Banded, biot-amph-fsp gneiss/Fsp-qtz, green amph, biotite, grt augen replaced by biotite

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	0,00 - 0,00

Length (m): 130,00 - 133,00 Dh-S2 Sample: S2/130,8 Mag susc / Q-value: 0,00098 / 1,0700

Homogeneous hornblende-mica-fsp gneiss/Relatively amph-rich (greenish-black), fsp, qtz, phengite, minor biotite, oxide inclusions in fsp and matrix, minor sulfides; not v. magnetic; no grt; amphibolitic zone has mottled appearance; other areas sli. more banded

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
2,816	1,13 - 8,56

Saurdal

Length (m): 133,00 - 136,40 **Dh-S2** Sample: Mag susc / Q-value: /

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Finely banded biot-fsp-amph gneiss/green gray to pale green, white, finely foliated gneiss; fsp-qtz-biotite-amph, minor grt; late, thin cross-cutting felsic veins; weakly magnetic; missing section= 133.6-134m.		0,00 - 0.00

Drill-hole Dh-S3

Length (m): 0,00 - 3,00 **Dh-S3** Sample: Mag susc / Q-value: /

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Variably retrogressed with several phengite-rich zones. Local large garnet clusters. Visible green amphibole and symplectite after omphacite.		-

Length (m): 3,00 - 6,00 **Dh-S3** Sample: Mag susc / Q-value: /

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Medium to coarse-grained. Oxide-enrichment at 5.50-5.65 m (mt/ilm).		-

Length (m): 6,00 - 9,00 **Dh-S3** Sample: S3/6,5 Mag susc / Q-value: 0,01043 / 1,5100

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Varies from medium-grained, rel. garnet-rich (6-8 m) to fine-gr. assembl. nearly garnet-absent (8.20-8.70 m).	3,402	5,47 - 18,81

Length (m): 9,00 - 12,00 **Dh-S3** Sample: S3/9,5 Mag susc / Q-value: /

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Fine-grained, fairly fresh eclogite: omphacite- and/or symplect. dominated (green color). 11.0-12.0 m garnet v-fine grained with retrograde textures.		8,56 - 24,44

Length (m): 12,00 - 15,00 **Dh-S3** Sample: S3/12,6 Mag susc / Q-value: 0,01655 / 4,9500

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogte/Mostly fine- to med-grained, variably retrogressed. Most strongly altered at ~13.10 m where fine-gr symplect. dominates. Local sulfide (Py) enrichment. Oxide enrich. = 13.5-14.75 m.	3,402	3,11 - 16,82

Length (m): 15,00 - 18,00 **Dh-S3** Sample: S3/17,5 Mag susc / Q-value: 0,00132 / 1,9500

Eclogite/Visible rutile at 17.5 m (sample for thin section), otherwise mainly fresh with var. retrogr. portions. F-grained garnet. Altered most at 15.0-15.35 m

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,424	4,94 - 16,24

Length (m): 18,00 - 21,00 **Dh-S3** Sample: Mag susc / Q-value: /

Eclogite/Fresh ecl. at 20.0-21.0 m with lg. pyrite cubes @ 20.42 m. Rather fine-gr., fresh @ 18.0-20.0 m. Oxide enrich. @ 18.0-18.20 m (mt/ilm).

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 21,00 - 24,00 **Dh-S3** Sample: S3/23,0 Mag susc / Q-value: 0,00724 / 0,5000

Eclogite/Rel. fresh. Markedly magnetic (hand magnet) @ 22.70 m. Oxide enrich. betw. 22.00-22.30 m and 22.80-22.95 m.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,654	4,87 - 18,86

Length (m): 24,00 - 27,00 **Dh-S3** Sample: Mag susc / Q-value: /

Eclogite/Very variable degrees alteration. Strongly altered (later felsic "intrusion") to qtz-fsp-phengite assembl. @ 25.60-26.27 m. No magnetic reaciton with hand magnet.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 27,00 - 30,00 **Dh-S3** Sample: S3/29,5 Mag susc / Q-value: 0,00543 / 1,0500

Eclogite/Ranges fr. rather strongly retrogr and sheared assemblage (29-29.5 m) toward coarse-gr, rel. fresh eclog (27.3-28.0 m). Late, str-slip displacements (29.2-29.45) w/ felsic veins (1 cm).

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,251	1,09 - 12,00

Length (m): 30,00 - 33,00 **Dh-S3** Sample: Mag susc / Q-value: /

Eclogite/Rather fresh eclog.; varies from f-gr to coarse-gr, locally mod. to strong retrogr. Strong mt/ilm-accumulation ~30.95-31.20 m. Highly magnetic at 31.09.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 33,00 - 36,00 **Dh-S3** Sample: Mag susc / Q-value: /

Felsic eclogite/Moderately retrogr. Sm. patches of phengite in slight 'web texture' arrangement. No magnetic markers: no oxide accumulation.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
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Length (m): 36,00 - 39,00 **Dh-S3** Sample: Mag susc / Q-value: /

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Transition fr fresh, fine-gr eclog. (38.0-39.0 m) to strongly retrogr. eclog. w/ up to 50% felsic material + amphibole. Retr. eclog. w/ qz-fsp schlieren 37-38 m. No magnetic zones: no oxide.		-

Length (m): 39,00 - 42,00 **Dh-S3** Sample: Mag susc / Q-value: /

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Fresh (39.0-41.0 m): 41-42 m slightly more retrogr. or dominated by fine-gr garnet + omphacite and abundant fine-gr pyrite dissemination.		-

Length (m): 42,00 - 45,00 **Dh-S3** Sample: S3/42,9 Mag susc / Q-value: 0,03181 / 4,5300

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Variably retrogressed. Late, cross-cutting amph. veinlets 44.5-44.8 m, (some + qtz-fsp). @43.85 m strong retrogr. assoc.with veined qtz-fsp: garnet resorbed. No marked magn. zone. MICROSCOPYING:	3,494	5,25 - 18,39

Length (m): 45,00 - 48,00 **Dh-S3** Sample: S3/45,9 Mag susc / Q-value: 0,00328 / 4,2800

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Variation from fresh to retrogressed.	3,4	1,72 - 13,28

Length (m): 48,00 - 51,00 **Dh-S3** Sample: Mag susc / Q-value: /

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/ Patchy distr. of grt + mt/ilm. Late amph. veinlets. 50.5-51.0 m: v. coarse-gr (pegmatitic) and assoc. with coars ilm/mt. 50.0-50.5: v. green eclog. with omph >> grt. Retrogr. 48.4-48.9 m.		-

Length (m): 51,00 - 54,00 **Dh-S3** Sample: S3/52,5 Mag susc / Q-value: 0,04291 / 24,140

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
'Oxide' eclogite/V. green and red. coarse patches ('pegmatitic'). Rutile blended w/ grt? Omp + some amph., qtz. coarse clumps pyrite. Thick stringers of oxide (mt/ilm) obvious.53-54 m: fine-gr blebs of grt + oxide stringers (magnet.). Syn-shear deformation apparent. MICROSCOPYING:	3,758	2,73 - 22,34

Length (m): 54,00 - 57,00 **Dh-S3** Sample: Mag susc / Q-value: /

Retrog eclogite-felsic amphibolite/Slight, coarse foliation; strung-out garnet patches+ oxide (ilm + rt?) +/- felsic material, sulfides (c-gr= 2mm). Magnetic only @ 54-54.4 m: blebs, patches of mgt/ilm in matrix of grt, omph, amph, + sulfides. Late amph. veinlets. Late pheng. cracks.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 57,00 - 60,00 **Dh-S3** Sample: Mag susc / Q-value: /

Retrograde eclogite/ Coarsely banded, sheared. Zoned dark-light green, white, reddish. Grt. as aggreg. in smeared patches+ pheng.,amph, fsp, qtz. Rare grt as indiv. porphyroblasts. Variable magnetism--none strong. Minor c-gr sulfides+/- oxide (ilm). Veinlets of amph+ zoisite.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 60,00 - 63,00 **Dh-S3** Sample: Mag susc / Q-value: /

Felsic variation, retrogr. eclogite/Garnet as relict coarse patches +/- oxide (rutile + ilm), in ductilely strung-out pattern. Fairly c-gr, granoblastic texture. Some sli. felsic zones w/ fsp around grt. + qtz, sulfides. Weakly magnet.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 63,00 - 66,00 **Dh-S3** Sample: S3/65,4 Mag susc / Q-value: 0,02083 / 40,1600

Grt amphibolite-felsic amphib-retrog eclogite/Fairly c-grained, blotchy grt, hornblende, pyroxene, disseminated sulfides (pyrite), + oxide (mgt/ilm); symplectite @ 64-65 m. Fresh eclogite has rutile, hbl, pyrite. Sli. magnetic. 63.0-64.0m: Felsic variety, abund. fsp+pheng, symplectite + grt.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,374	**3,49** - 18,99

Length (m): 66,00 - 69,00 **Dh-S3** Sample: S3/68,4 Mag susc / Q-value: 0,00651 / 2,3500

'Web-textured' retrogr. eclogite/ Web-texture from net of felsic+pheng. material around mafic material. 66.0-66.4: Grt-bearing version of felsic amphibolite/retrog. eclog., oxides (mgt/ilm), symplectite after omph., +sulfides. 66.4-69: Coarse, web-amphibolite, weakly magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,041	**1,96** - 9,88

Length (m): 69,00 - 72,00 **Dh-S3** Sample: Mag susc / Q-value: /

Web-textured, felsic amphibolite (WTFA)/Coarse webbing, sli. flattened/sheared. Webbing= qtz.fsp.phengite. 69-70 m: some indiv. preserved garnet porphyroblasts. Minor dispersed magnetic reaction. Oxide as single grains or thin stringers.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 72,00 - 75,00 **Dh-S3** Sample: Mag susc / Q-value: /

WTFA/Complete 'webbing' throughout section (qtz,fsp,phengite). Rare garnet. Amphibole-dominant mafic mineral. Weakly magnetic. Oxides as tiny, dispersed single grains.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 75,00 - 78,00 **Dh-S3** Sample: S3/77,2 Mag susc / Q-value: 0,01003 / 29,9300

WTFA to retrog. eclog./75.0-76.0 m: Retrogr. eclog. w/ pale sympl. + flattened grt aggreg.; fair amt. oxide (ilm), weakly magnet. 76-77 m: felsic amphibolite + zois.?, web-text. 77-77.5 m: Flattened stringy aggs. of grt+sympl+ amph, oxide (ilm). 77.5-78 m: WTFA

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,334	**5,43** - 15,01

Length (m): 78,00 - 81,00 **Dh-S3** Sample: S3/79.8 Mag susc / Q-value: 0,00072 / 3,0200

Felsic garnet amphibolite/ 78.0-80.7 m: banded felsic grt amphib.; single porphyrobl of grt in amph+felsic (pheng, fsp, qtz) matrix. Sheared; weakly magnetic. 78.3-78.6: grt richer zone. 80.7-81 m: retrogr eclogite, some oxide as rutile + ilm; granobl grt, amph, omphacite.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
2,953	**30,5** - 5,91

Length (m): 81,00 - 84,00 **Dh-S3** Sample: Mag susc / Q-value: /

Felsic, retrog. to retrogr eclogite/81-83.3 m: Felsic, retr. eclog. Sli. foiated to blotchy grt+symplect+amph+felsic stringers. 82.3-82.6= grt-richer zone. 83.3-84 m: retrogr. to fresh eclogite; Some oxide as rutile, + ilm, symplect, amph, 1-cm wide zone mgt, minor sulfides.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 84,00 - 87,00 **Dh-S3** Sample: S3/84,8 Mag susc / Q-value: 0,00288 / 1,5400

Grt amphibolite, retrog eclog to felsic grt amphib/84-86.1 m: some patchy, granobl. fresh eclog; else variable degrees felsic-grt amphib. ('Saurdal'-appearance). Weak foliation. Grt in sympl+amph, pheng, fsp, qtz. Oxide stringers weakly magnet. 86.1-87 m: grt amphibolite; 2 large veins w/ coarse sulfides, felsic material. F-gr garnet, +amph, oxide, sulfide matrix.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,547	**3,59** - 16,33

Length (m): 87,00 - 90,00 **Dh-S3** Sample: S3/89,9 Mag susc / Q-value: 0,11503 / 2,2300

Retrog. eclog to oxide/felsic amphibolite/87-87.5 m: banded green-white (fsp,qtz,amph)+oxide, sulfide, relict grt. Mild to strongly magnetic. 87-89 m: amphibolite to grt-amphib. 89-90 m: V. retrog. eclog. to fresh eclog.; grt patches in symplect., amph, oxide. Flattened deform. Patchily magnetic (mgt+ilm). Oxide as thin stringers. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,494	**5,71** - 20,43

Length (m): 90,00 - 93,00 Dh-S3 Sample: S3/91.2 Mag susc / Q-value: 0,07333 / 1,8300

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Retrog. eclog. to oxide amphibolite/90-90.9 m: Patchy, aggs. of grt, symplect., amphib., oxide (ilm). Weak magnet. 90.9-92.4 m: Grt poor-absent except 10 cm at 91.5 m; majority as amphibole + visible oxide flecks. 92.4-93 m: V. retrog. eclog.: sympl+relict grt+fsp+oxide (mgt/ilm) flecks	3,445	7,21 - 21,32

Length (m): 93,00 - 96,00 Dh-S3 Sample: S3/93,9 Mag susc / Q-value: 0,00148 / 2,1600

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Retrog. oxide-rich eclogite/Patchy (grt clusters+flecks oxide, symplect. amph), mottled, to f-grained. Flecks of oxide prevalent; minor Fe-staining sulfides: fresh, granoblastic eclogite @ 94m (+rutile, ilm). Minor magnetite in 2 thin zones. Amphib. veinlets (late).	3,415	2,19 - 13,07

Length (m): 96,00 - 99,00 Dh-S3 Sample: S3/97,9 Mag susc / Q-value: 0,00918 / 48,3800

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Retrog. oxide-rich eclogite/Varies from mottled, blotchy (as above), to single grt porphyroblasts in sea of symplect. Some mgt, but overall weak magnetism. Some rutile blended with ilmenite; minor sulfides (Fe-staining). MICROSCOPYING:	3,619	7,86 - 21,20

Length (m): 99,00 - 102,00 Dh-S3 Sample: S3/100,2 Mag susc / Q-value: 0,00918 / 0,7900

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Retrog eclog. to felsic 'Saurdal'-type eclog./100.6-101 m: missing section. 99-101 m: phengite-rich retrogr. eclogite; coarse phengite(+fsp?) zones, amphibole, relict garnet; 100.5-100.6: thin ilm+rutile+eclogite zone; 101-102 m: retrog eclog. w/ felsic + symplect material, coarse grt clumps, sheared patches, oxide stringers; rutile surr by ilm?; weakly magnetic.	3,451	2,24 - 10,33

Length (m): 102,00 - 105,00 Dh-S3 Sample: S3/102,8 Mag susc / Q-value: 0,00553 / 1,2800

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Retrog. to fresh, oxide-rich eclogite/Fairly coarse-gr, well-preserved (granoblast.) grt + omph +amph +sympl+oxide stringers, flecks+sulfide; minor qz, fsp. 102-102.5 m: f-grained, single grts in omph.; 102.5-105: large patches/aggs of grt. Weakly magnetic, minor strongly magn. areas. Poss. relict rutile (+ilm)? Late amph, qtz veinlets.	3,524	3,42 - 17,39

Saurdal

Length (m): 105,00 - 108,00 **Dh-S3** Sample: Mag susc / Q-value: /

Retrog, oxide-rich eclog to amphibolite/105-106 m,106.5-107 m, 107.3-108 m: retrog eclogite + oxide (rutile+ilm?): varies from ductiley banded to homogen. assembl grt, symplect, amph, oxide (mgt/ilm in flecks and stringers; minor sulfide.106-106.5,107-107.3 m: amphibolite, banded green+white, relict grt, much oxide (mgt/ilm). Chatter fractures w/ qz prevalent.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 108,00 - 111,00 **Dh-S3** Sample: S3/108,9 Mag susc / Q-value: 0,40713 / 9,5200

Fine-gr amphibolite to retrg eclog to oxide eclog/Gen'l patchy, homog mix of grt, sympl, amph, fsp, oxide. Most v. magnetic. Oxides as stringers, blebs. 108-109: retrog. eclog., inhomog: grt, oxide, sympl to grt amphib. to grt+oxide zones+sulfides; 109-109.4: sulfide-oxide rich (+grt, amph); 109.4-110.2: v. grt-rich, + sympl/amph. oxides, poss. rutile relicts, sulfides. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,456	5,18 - 22,93

Length (m): 109,40 - **Dh-S3** Sample: S3/109,4 Mag susc / Q-value: 0,14806 / 13,1500

MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,904	9,66 - 25,09

Length (m): 111,00 - 114,00 **Dh-S3** Sample: S3/111,8 Mag susc / Q-value: 0,00914 / 1,7600

Black, oxide-rich, retrog eclogite/Patchy clusters/aggreg broken garnets, surrounded by amph + thin oxide stringers; sli. shear-deformed foliation; rel. homogeneous mineral distrib; impregnated sulfides; magnetic overall. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,355	2,35 - 14,38

Length (m): 114,00 - 117,00 **Dh-S3** Sample: S3/115,7 Mag susc / Q-value: 0,72934 / 15,4200

Variably retrog eclogite - amphibolite/114-114.3,115-115.3: Patchy, ductiley folded, pale green retrog eclog: grt aggreg, +amph, symplect, late amph veinlets; 114.3-115: retrog eclog to oxide amphibolite, sli banded; thin garnet patches, oxide (sli magn) stringers, amph;115.3-117: V. retrog eclog to oxide-amphibolite; patchy grt, symplect,amph,ilm+mgt flecks,sulfides. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,459	6,69 - 22,47

Length (m): 117,00 - 120,00 Dh-S3 Sample: Mag susc / Q-value: /

Variably retrog eclogite+ amphibolite/117-118 m: retrog eclog; sheared w/ thin elongate grt patches, symplect, green amph, minor sulfides, variably but not stongly magnetic (ilm+mgt);118-119: eclogite; grt in coarse patches, aggregates+symplect, amph, oxide (rutile+ilm), 118-118.7: flecks, blebs mgt+ilm+relict grt+amph, sulfide; 119-120: strongly retrog eclog+amphibolite

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 120,00 - 123,00 Dh-S3 Sample: Mag susc / Q-value: /

Eclogite w/ zones grt amphibolite/Coarse, shear-deformed foliation; patches complex symplect+felsic minerals, amph, grt; some zones v. amph + (mgt/ilm) areas. Grt-richer zones + rutile, well-preserved @ 120.5-121, 121.3-122, 122.7-122.8 m. 120-120.5: V. magnetic, + impregnated sulfides. Late amphibole veinlets.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 123,00 - 126,00 Dh-S3 Sample: Mag susc / Q-value: /

Retrog. eclogite + minor amphibolite/Locally strongly magnetic; sli. magnetic overall; some grt-rich zones w/ thin strings of rutile associated. Grt-poorer zones w/ symplect.+amph+blebs of mgt/ilm. Late amphibole veinlets. 123-123.5: amphibolite (amph, fsp, qz + mgt/ilm, sulfides).

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 126,00 - 129,00 Dh-S3 Sample: S3/127,8 Mag susc / Q-value: 0,02645 / 0,8100

Amphibolite w/ minor retrog eclogite and eclogite/126-127: fresh, c-grained eclogite; grt, symplect, omph+qtz, oxides (some as rutile); 127-128.5: banded, green+white amphibolite; 128.5-129: retrog. eclogite; massive, pale green symplect, equigranular grt, amphibole; late cracks filled w/ sulfides+qtz.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,104	5,45 - 12,12

Length (m): 129,00 - 132,90 Dh-S3 Sample: S3/131,5 Mag susc / Q-value: 0,01504 / 2,7000

Eclogite/Fairly massive, fresh; sli. > retrogr. in 129-130 m. Sli. foliation; grt equigranular in clumps and dispersed; fresh omph, some symplect, minor sulfides, some rutile; 129-130: 2 amphiboles, stringers of mgt+ilm in 5-cm wide zones. Felsic patches.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,434	3,76 - 17,38

Length (m): 132,90 - 136,00 Dh-S3 Sample: S3/134,0 Mag susc / Q-value: 0,00453 / 1,3200

Felsic-mafic retrog eclogite/132.9-134: disseminated sulfide+ oxide in sm. augen in amphibolite; eclogite @ 132.9 mark (coarse grt, oxide (some rutile)): 134-135.3: retrog. eclog. ductiley deformed/foliated; thin stringers felsic material (+amp, epid, chlorite, sulfide, oxide= low magnetic); 135.3-136: v. felsic, ductiley deformed retrog eclog; relict grt aggreg, amph.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,081	**1,98** - 13,20

Length (m): 136,00 - 139,00 Dh-S3 Sample: S3/137,1 Mag susc / Q-value: 0,00126 / 1,5600

Retrog, felsic eclogite/Coarse, felsic (qtz-fsp-pheng) patches (3x1 cm) around grt+rutile/ttn?+amph+symplect; ductiley deformed ('swirled' texture).

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,013	**0,50** - 6,03

Length (m): 139,00 - 142,10 Dh-S3 Sample: Mag susc / Q-value: /

Felsic, ductiley deformed grt amphibolite/139-139.3: Coarse grt aggreg, symplect, + c-grained rutile (~0.5cm patches/aggreg strung out into sympl of omph+grt):139.3-140: Felsic amphibolite; fsp, qtz, titanite, minor amphib; 140-142.1: retrog eclog; replacement text after grt, +amph, fsp, symplect, phengite, oxide (mgt/ilm?), chlorite

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 142,10 - 144,30 Dh-S3 Sample: S3/142,3 Mag susc / Q-value: 0,01022 / 3,7800

Oxide-rich, sli. retrog. eclogite/142.1-143: eclogite w/ coarse, interlocking patches grt (granular aggregates), oxide stringers (mgt, rutile+ilm), sulfides; vague foliation; 143-144.3: retrog eclog; grt porphyroblasts replaced by fsp, amph; sulfides, mgt/ilm.
MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,48	**7,00** - 21,93

Length (m): 144,30 - 145,20 Dh-S3 Sample: Mag susc / Q-value: /

Amphibolite/Chlorite+actinolite+qtz+fsp+phengite+oxide; grt totally pseudomorphed, no pyroxene. Oxides as elongate blebs, lenses; cores of sulfide+oxide surrounded by thin oxide rinds. Sharp gradation into eclogite @144.3 m.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 145,20 - 148,90 Dh-S3 Sample: S3/145,5 Mag susc / Q-value: 0,00710 / 2,2900

Oxide-rich, retrog. eclogite/145.2-148: dark, black-green-red eclogite w/ oxides; massive; stringers of mgt, but most oxide as ilm+rutile or rutile; minor sulfides, minor chloritized alteration zones; 148-149: pale green eclogite; grt aggregates, symplect, broken and surrounded by amph+fsp+oxides. Some chlorite and phengite+fsp stringers.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,34	**2,12** - 13,35

Length (m): 148,30 - Dh-S3 Sample: S3/148.3 Mag susc / Q-value: 0,00344 / 0,3400

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,498	**2,28 - 13,85**

Length (m): 148,90 - 151,90 Dh-S3 Sample: S3/150.5 Mag susc / Q-value: 0,00870 / 1,6600

Oxide-rich, retrog. eclogite (missing section 149.8-150.0)/Banded, pale green-red-black eclogite; fine-gr aggreg. or single porphyrobl grt, resorbed by amph+fsp, +symplect; some zones w/ > fsp+phengite; occasional stringers of rutile+ilm, poss. some titanite?; overall coarsely xllne; toward 149 m get fresher eclogite, coarser grt; late amphib. veinlets.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,383	**2,91 - 17,52**

Length (m): 151,90 - 154,90 Dh-S3 Sample: S3/153.6 Mag susc / Q-value: 0,00227 / 2,2000

Retrograde eclogite/151.9-154.5: Variably retrog, sli. banded eclog; grt porphyrobl w/ retrog coronas, other zones w/ fresh omph+grt. Elongate stringers of concentr. oxide (mgt/ilm?), some are ilm + rutile? in 1-2mm thick stringers, stretched over cms. 154.5-154.9: amphibolite, with gradual transition to retrogr eclog. Phengite, fsp, qtz, chlorite bands througout.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,361	**2,09 - 11,83**

Length (m): 154,90 - 155,90 Dh-S3 Sample: S3/155,4 Mag susc / Q-value: 0,05155 / 8,5200

Ilm-mgt-bearing eclogite/Masssive patches of broken, reddish grt aggregates with intimately associated stringers (sub parallel to coarse foliation) of ilm+mgt (not always exceptionally magnetic). Some good xllne pyroxene, otherwise a lot of amph, qtz, minor sulfides; 154.7-154.9: granoblastic amph, qtz, + grt. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,498	**5,52 - 19,89**

Length (m): 155,90 - 158,90 Dh-S3 Sample: Mag susc / Q-value: /

Grt-mgt amphibolite/Banded, w/ secondary mgt in concentrated layers (+ chlorite, grt), and stringy, patchy appearance; these alternate w/ mgt-free, grt+chlorite+amph zones; grt pale, fine-gr or as f-gr aggregates; aggreg. broken and filled w/ amph + mgt-ilm. Some mgt 'disseminated'.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 158,90 - 161,90 Dh-S3 Sample: Mag susc / Q-value: /

Chlorite-mgt-grt amphibolite/Banded mgt-rich and mgt-free zones as in above section; poss. second generation garnet here = red-orange porphyroblasts; low TiO2 (XMET meas.); sharp contact with mgt-ore zone below.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 161,90 - 163,70 **Dh-S3** Sample: S3/162,9 Mag susc / Q-value: 5,71627 / 0,9600

Chlorite-mgt ore zone/Black and green, finely banded; comprises chlrotte + massive magnetite, some amphibole and v. minor grt. Dense and extremely magnetic. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
4,332	-

Length (m): 163,70 - 165,50 **Dh-S3** Sample: Mag susc / Q-value: /

Chlorite-mgt-grt amphibolite/Blend of 2 types: 1) Formerly c-grained aggreg. of grt+ ilm/rutile (primary), now fracture and filled w/ amph+chlor+mgt+mica+sulfides (chalco+pyr); 2) chloritized zones w/ v. relict grt + prevalent stringers mgt+fsp (black on white); grt can also be surrounded by stringers concentr. mgt+ilm; some retrogr replacement of grt.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 165,50 - 168,50 **Dh-S3** Sample: S3/165,9 Mag susc / Q-value: 0,67862 / 2,3600

Massively chloritized amphibolite w/ disseminated magnetite/ Sli. grt-poorer versions of 1) and 2) above w/ additional third type: thoroughly chloritized rock w/ mgt, amph, ilm + pheng. MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,346	3,60 - 22,60

Length (m): 167,10 - **Dh-S3** Sample: S3/167,1 Mag susc / Q-value: 0,10322 / 3,2300

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,425	1,87 - 18,49

Length (m): 168,50 - 172,40 **Dh-S3** Sample: Mag susc / Q-value: /

Grt-bearing amphibolite/Amph + relict grt + chlorite + some qtz/fsp + access. biotite clusters (cm-size), oxide (some mgt, but most only weakly magnetic); weak banding.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 172,40 - 173,30 **Dh-S3** Sample: Mag susc / Q-value: /

Amphibolite/Relict grt+amph+fsp+qtz+phengite+Fe-oxide (Fe-staining)+ chlorite zones. Evidence of late, brittle fracture, but dominant feature is of ductile/shear-deformation. Has a green+white striped appearance. Not v. magnetic.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
	-

Length (m): 173,30 - 176,30 Dh-S3 Sample: S3/174,9 Mag susc / Q-value: 0,00083 / 0,8600

Banded amphibolite/Banded biotite,fsp,grt, qtz alternates w/ mafic (grt, amph, qtz, oxide); chlorite along fractures (1-2cm wide); fine-gr sulfide (pyrite), weakly magnetic (esp. in chloritized zones); grt is fine to med-gr, broken, retrogressed.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET: n=3):
3,116	**0,91 - 11,18**

Length (m): 176,30 - 178,40 Dh-S3 Sample: S3/178,3 Mag susc / Q-value: 0,00117 / 9,6300

Chloritized amphibolite/Chlorite, actinolite, phengite, fsp, qtz, Fe-oxides, mgt, some stringers/patches of ilmenite; grt-richer zone (10-cm thick) w/ grt in clusters, ductiley deformed appearance, broken and 'filled' by amph+fsp+ilm.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,113	**0,49 - 15,70**

Length (m): 178,40 - 181,50 Dh-S3 Sample: Mag susc / Q-value: /

Garnet amphibolite/Variably retrograded; granoblastic, grt+amph+omph+qtz+symplect; grt var. sizes, broken but ubiquitous; some veins with chlorite + coarse sulfides.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET: n=3):
	-

Length (m): 181,50 - 183,90 Dh-S3 Sample: S3/183,4 Mag susc / Q-value: 0,00102 / 0,5800

Garnet amphibolite/181,5-182,9: rounded grt porphyroblasts (1-2 mm) w/ reaction coronas, + amph, oxides, relict omph; 182,9-183,9: Grt-poorer zone, mainly amph, fsp qtz; slightly magnetic w/ cm-wide chloritized cracks.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,171	**0,72 - 14,96**

Length (m): 183,90 - 188,00 Dh-S3 Sample: S3/184,5 Mag susc / Q-value: 0,00063 / 1,5700

Banded gneiss/Alternating, sheared bands of green+white mineral layers: fsp, qtz, green amph; relict grt w/ fsp coronas; some small, preserved eclogite lenses (1-1,5 cm-diameter); weak to no magnetism.

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,047	**0,13 - 9,05**

Length (m): 186,90 - Dh-S3 Sample: S3/186,9 Mag susc / Q-value: 0,00093 / 2,1400

MICROSCOPYING:

Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
3,196	**0,85 - 8,54**

Saurdal

Length (m): 188,00 - 190,00 Dh-S3 Sample: S3/189,1 Mag susc / Q-value: 0,00148 / 6,1700

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Banded, ductiley deformed; grt+omph+flattened, rel. coarse (2 mm) rutile patches; zones of gneissic material (phengite+fsp) of 0.5-1 cm thicknesses. Some c-grained sulfides; sli. magnetic. Late amphibole veinlets. MICROSCOPYING:	3,556	**0,84 - 15,98**

Length (m): 190,00 - 190,70 Dh-S3 Sample: S3/190,7 Mag susc / Q-value: 0,00144 / 3,1300

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Eclogite/Ductiley-deformed; c-grained aggreg. (cm-size) pale red grt with blended rutile, c-gr clusters omphacite; some sulfides/ oxides (c-gr), mainly in mineralized cracks; some patches quite magnetic.	3,656	**63,4 - 16,61**

Length (m): 190,70 - 193,00 Dh-S3 Sample: S3/192,1 Mag susc / Q-value: 0,00054 / 3,7800

	Density (g/cm3):	%TiO2 - %Fe2O3 (XMET; n=3):
Gneiss/Banded; phengite, amph, qtz, fsp, titanite, w/ sm boudins of grt+omph. Meta-tonalite? MICROSCOPYING:	3,144	**0,17 - 8,26**

VEDLEGG (3)

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DENVER SALA

TELEFAX

SALA INTERNATIONAL AB
S-733 25 SALA SWEDEN
Tel. +46 224 57000 Telex 7536 SALA S
Direct dial. 57167

Date: 1995-07-25

Number of pages incl. this: 8

From
Gustav von Wachenfeldt
Process Equipment

To
A/S GARNET,STOKKE IND.A/S
Ålesund , Norge

Att.: Svein Parr
Telefax No.: +47-70 14 81 89
Your Ref..

Telefax No.: +46 224 16950
Our ref.:
Copy to.: SVEDALA A/S : Ö. Hannisdal

Subject:Seperation av granater , Rapport .

Bäste Svein !

Oversänder härmed rapport över våra försök i Sala med anrikningsspiral samt också en jämföreise med resultaten från de gjorda försöken hos MINPRO med skakbord .
En skiss med förslag till flytschema för en kapacitet av 25 t/h med angivande av viss huvudutrustning
har också bifogats . Detta skall ses mera som ett diskutionsunderlag och måste kompletteras och detaljeras i ett antal punkter .
Hoppas att detta är tillfyllest åtminstone för tillfället och inför Ditt kommande projektmöte .
Vi behöver senare ha en genomgång för att diskutera detta mera i detalj .
Jag ser fram emot att få ta del av Dina kommentarer .

Många hälsningar

Gustav

Process-Ass.
SALA
Ved. Svensk

3/2

Summering av resultat

Jämförelser mellan försöken hos MINPRO (skakbord) och hos DENVER SALA (anrikningsspiral) visas i diagramform i Bilagorna 2 , 3 och 4 för de fraktioner som testats både på skakbord och anrikningsspiral .
På grund av osäkerheten i analyseringen av granatinnehållet i de produkter som erhållits vid de olika försöken , blir inte dessa jämförelser helt entydiga .

Fraktionen - 2 + 1 mm

Enbart testad hos MINPRO .
Denna fraktion ger endast en mycket ringa mängd granat , 2,5 vikt % , av möjligt acceptabel halt .
71 % granat , medan övriga granater i denna fraktion torde föreligga som halvkorn .
Vid 60 % granatinnehåll blir viktsutbytet ca. 9 % .
Nedmalning och klassering i en produktionsanläggning bör ske till att allt är finare än 1 mm , och således kommer denna fraktion ej att gå vidare till separationen .

Fraktionen - 1 + 0,5 mm

Som syns av kurvorna i diagrammet i Bilaga 2. ger skakbordet en selektivare separation än anrikningsspiralen .
Analysosäkerheten av granatinnehållet gör dock att den beräknade granatanalysen för hela fraktionen skiljer sig relativt mycket , 40,1 % (MINPRO) mot 45,1 % (SALA) . Detta gör att skillnaden i selektivitet kanske inte är så stor som kurvorna och deras lutningar indikerar .
Enligt kurvorna blir viktsutbytet , vid en halt av 60 % granat , ca. 30 % för anrikningsspiralen jämfört med ca. 57 % för skakbordet .
Magnetseparationsförsöket på denna fraktion har gett ett förvånansvärt bra resultat , med bakgrund till tidigare erfarenheter , varför denna separationsteknik borde kunna användas som ett komplement till ett gravimetriskt separationssystem .

Fraktionen - 0,5 + 0,2 mm

Som syns av kurvorna i diagrammet i Bilaga 3. ger skakbordet även här en selektivare separation än anrikningsspiralen .
Analysosäkerheten av granatinnehållet gör även här att den beräknade granatanalysen för hela fraktionen skiljer sig relativt mycket , 45,2 % (MINPRO) mot 52,2 % (SALA) .
Enligt kurvorna blir viktsutbytet , vid en halt av 60 % granat , ca. 63 % för anrikningsspiralen jämfört med ca. 71 % för skakbordet .
Den tyngsta produkten från skakbordet , Prod. 1 , har en lägre granathalt än nästföljande produkt , Prod. 2 . Detta tyder på att ett eller flera mineral med samma eller högre spec. vikt finns i malmen och hamnar i de finare fraktionerna , eftersom denna tendens inte visar sig i de grövre fraktionerna . Bl.a har en liten mängd TiO_2 har analyserats i malmprover , varför det kan röra sig om rutil / ilmenit .

Fraktionen - 0,2 mm

Som syns av kurvorna i diagrammet i Bilaga 4. är selektiviteten här bättre för anrikningsspiralen än för skakbordet .
Den beräknade granatanalysen för hela fraktionen är nu exakt samma , 35,3 % .
Ingen produkt har nått en halt över 60 % granat . En jämförelse vid t.ex. 30 % viktsutbyte ger halterna ca. 53 % granat för anrikningsspiralen jämfört med ca. 47 % granat för skakbordet .
Tendensen med lägre granathalt i den tyngsta skakbordsprodukten finns även här och är ännu tydligare vilket förstärker riktigheten i ovanstående antagande .

De genomförda försöken , MINPRO och SALA , indikerar en bättre separationsselektivitet med skakbordet jämfört med anrikningsspiralen . Skakbordet har också den fördelen att en noggrannare inställning av de olika produktuttagen kan göras , vilket medför förbättrad följsamhet vid eventuella svängningar av malmens granatinnehåll .

Ett förslag till flytschema med angivande av huvudutrustning återfinns i Bilaga 5 .

MINPRO AB

Date
1995-04-03

Ref code

Your date

Your ref

Our ref
MP Bengt-Arne Bergström, gb

Garnet AS
At: Svein Parr
P b 8158 Spjelkavik
N-6022 ÅLESUND NORGE

Granatförande prover

Översänder enligt överenskommelse prover från den gravimetriska separeringen utförd på skakbord vid MINPRO i Strässa.

Till NGU i Trondheim har skickats 26 prover från försök 1 (granatrikt prov) för analysering (se följebrev).

Bifogar även en del försöksresultat från malning, siktning och den gravimetriska separationen.

Med vänlig hälsning

MINPRO AB

Bengt-Arne Bergström

MINPRO AB

Odalvägen
S-711 77 STRÅSSA
Sweden

Telephone

National 0581-431 10
International +46-581-431 10

Telefax

0581-432 40
+46-581-432 40

"Gravimetrisk separering av granatförande gods"

Bil 1

"Dry milling in SALA mill, followed by screening on 2mm screen, recirc. of coarse grains back to rod mill."

Försök 1-2 Torrmalning i Salakvarn med efterföljande siktning på 2mm och recirkulering av grovt material tillbaka till stångkvarnen.

Malningsresultat

Kvarndata

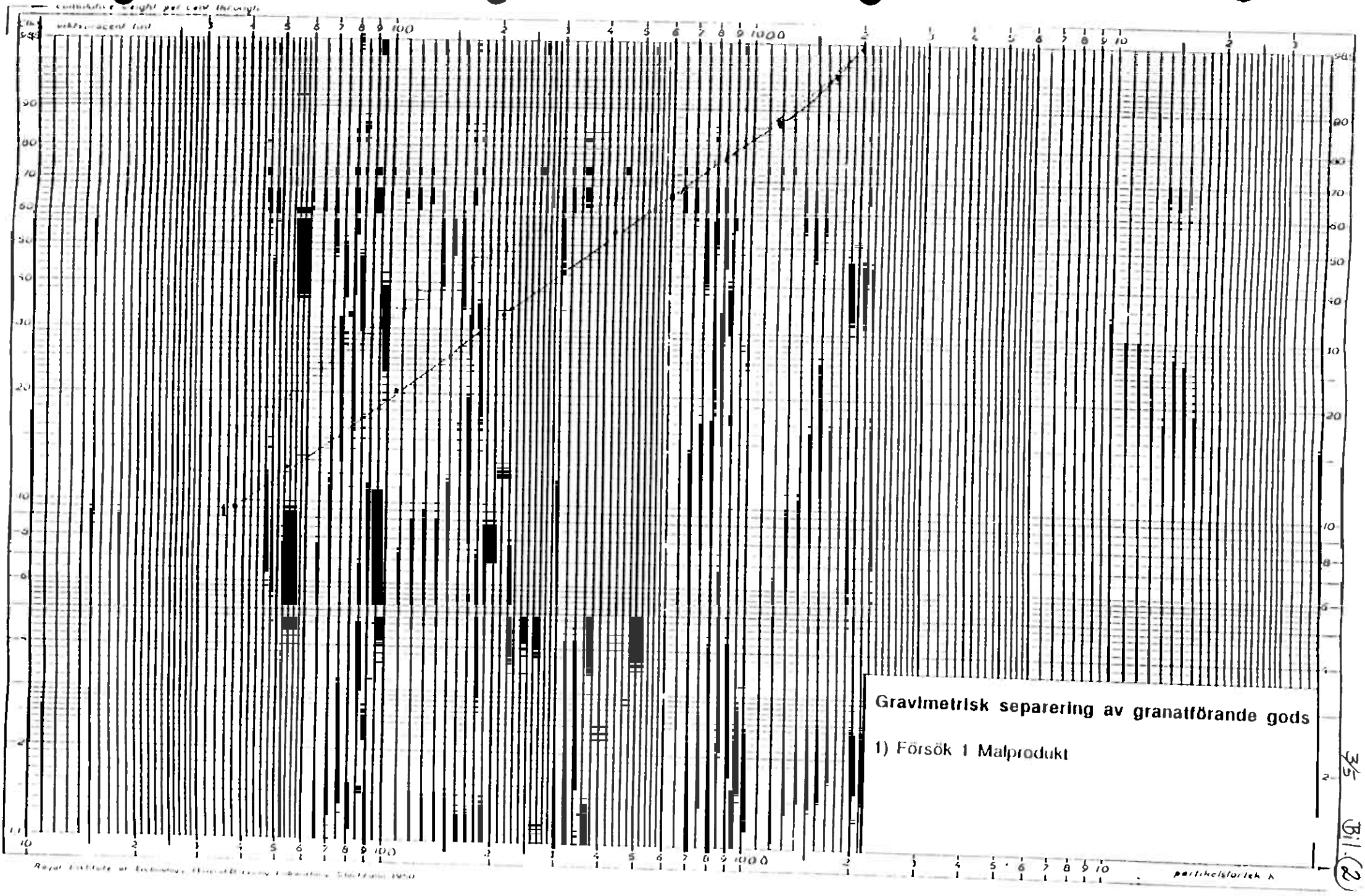
Kvarndimension, mm		600*900
Varvtal, rpm		36
Varvtal % av kritiska	(rpm, % of critical)	62
Verkningsgrad, %	(efficiency, %)	60
Utmatning	(outlet)	Perfert
Malkroppar	(milling med.)	250 kg 1" och 2" stänger. (låg fyllnadsgrad) (rods)

Malningsdata

	Försök 1
Malningstid, h (milling time)	0,72
Kapacitet, kg/h (capasity)	600
Kvarneffekt, kw brutto (mill effect, gross)	2,22
Kvarneffekt, kw netto (" , net)	1,33
Energiförbrukning, kwh/ton netto (Energi consump., net.)	2,2

Siktresultat

Maskvidd	F:1 Utg.kvarn	F:1 Malprod.
mm	Ack%fint	Ack%fint
4.750	99.9	
3.350	99.0	
2.360	97.0	
1.700	92.9	95.8
1.180	84.1	86.7
0.850	75.0	77.3
0.600	63.2	65.1
0.425	52.3	53.9
0.300	41.5	42.8
0.210	32.0	33.0
0.150	24.8	25.6
0.106	19.6	20.2
0.075	14.8	15.3
0.053	12.1	12.5
0.038	9.3	9.6

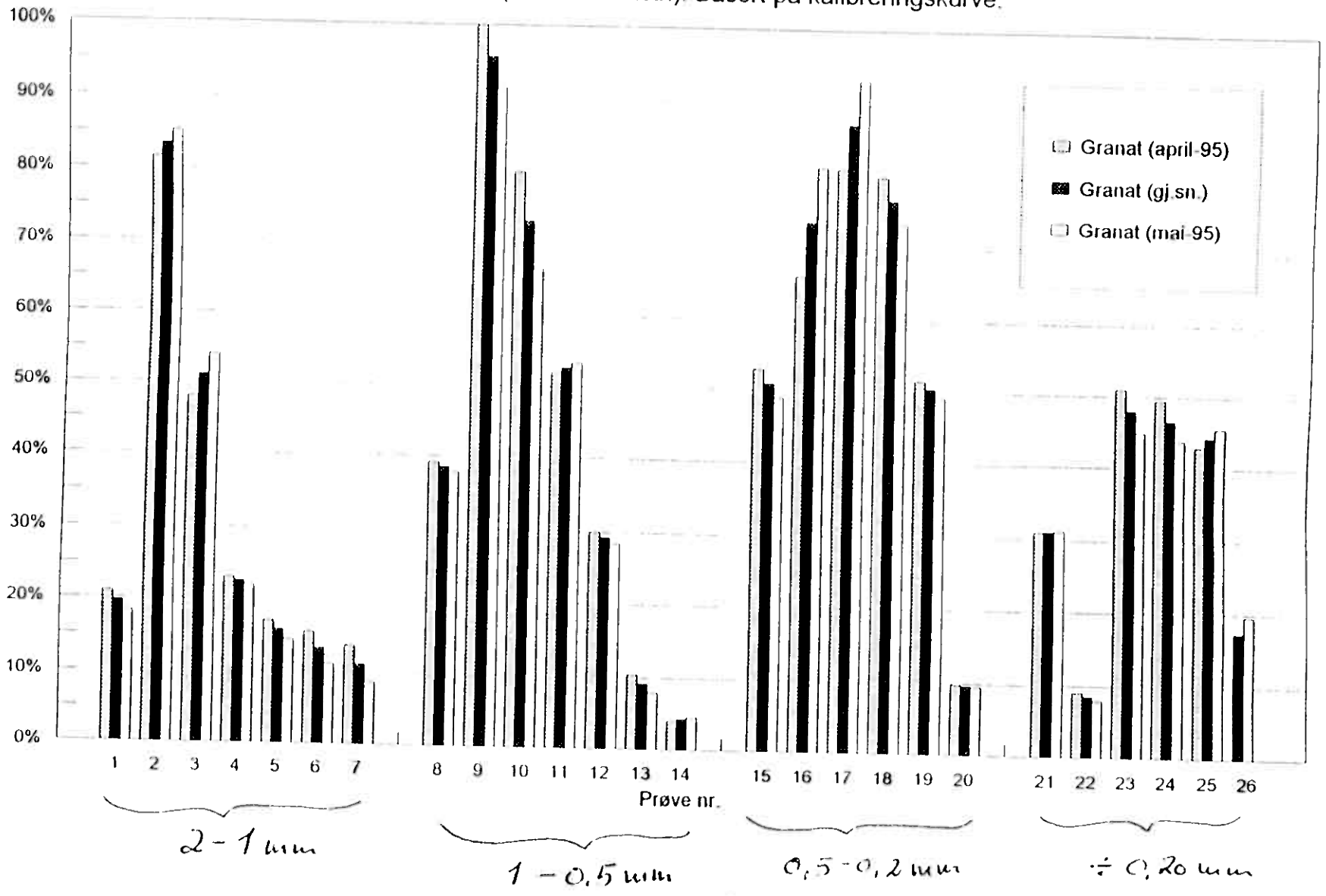


Gravimetrisk separering av granatförande gods

1) Försök 1 Malprodukt

30/5 PREMINÆRT – Li diskuterer dette på telefon. Vår

XRD april/mai 1995 (Stokke Industri). Basert på kalibreringskurve.



Gravimetrisk separering av granatförande gods

Bil 3 Inkl. mineral-analys

Försök 1

Siktning på Derrick sikt samt gravimetrisk separering på skakbord av fraktionerna 2-1mm, 1-0,5mm, 0,5-0,2mm och <0,2mm.
(Nominella öppningar på siktdukarna 1,18mm, 0,57mm och 0,26mm.)

Siktresultat

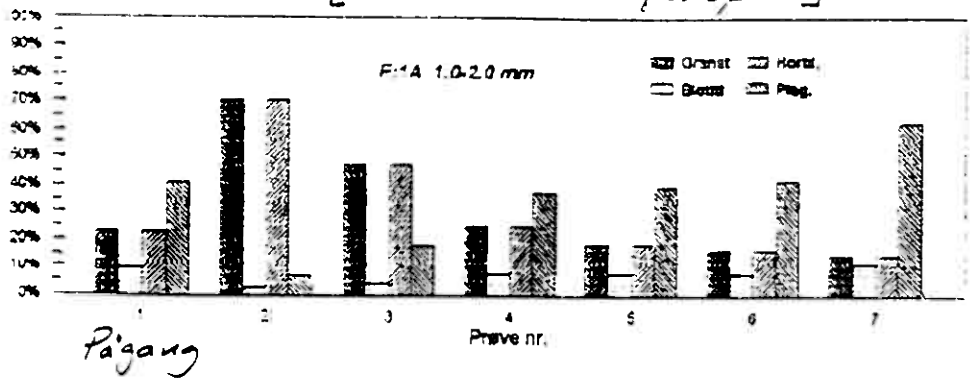
Fraktion mm	Vikt kg	Vikt %
2-1	113	27,5
1-0,5	125	30,4
0,5-0,2	72	17,5
<0,2	101	24,6
Ingående	411	100,0

baserat på areal 21,1 vol %

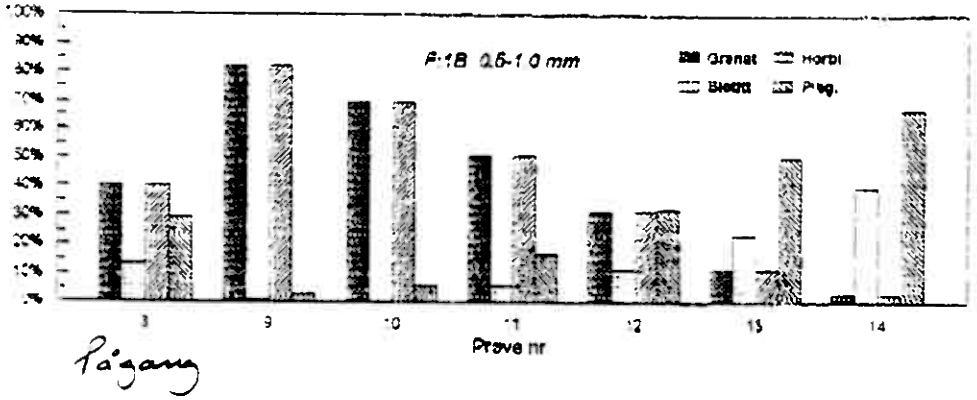
Skakbordsresultat

Försök Kapacitet kg/h	Fraktion mm	Produkter	Vikt % Sep.	Vikt % Tot.	Granater % i provet	Granater Förd
1A 140	2-1	Prod. 1 tung	2,5	0,7	71	1,4
		Prod. 2	11,2	3,1	49 52,2	4,3
		Prod. 3	14,4	4,0	25	2,9
		Prod. 4	21,2	5,8	19	3,1
		Prod. 5	27,2	7,5	17	3,6
		Prod. 6 lätt	23,5	6,4	15	2,7
		Ingående	100,0	27,5	23	18,1
1B 120	1-0,5	Prod. 1 tung	10,2	3,1	82	7,3
		Prod. 2	18,1	5,5	70	11,0
		Prod. 3	18,4	5,0	51	7,2
		Prod. 4	24,3	7,4	32	6,8
		Prod. 5	24,1	7,3	11	2,3
		Prod. 6 lätt	6,9	2,1	4	0,2
		Ingående	100,0	30,4	40	34,8
1C 120	0,5-0,2	Prod. 1 tung	4,0	0,7	61	1,2
		Prod. 2	12,1	2,1	71	4,3
		Prod. 3	21,6	3,8	70	7,8
		Prod. 4	31,3	5,5	51	8,0
		Prod. 5-6 lätt	30,7	5,4	10	1,5
		Ingående	100,0	17,5	45	22,8
1D 120	<0,2	Prod. 1 tung	0,3	0,1	9	
		Prod. 2+3	2,0	0,5	50	0,7
		Prod. 4	8,6	2,1	49	2,9
		Prod. 5	56,3	13,8	44	17,2
		Prod. 6+7	32,8	8,1	16	3,7
		Ingående	100,0	24,6	35	24,6
		Hela Provet		100,0	35	100,0
		Granatkonc.		15,9	72	32,8

Mineralogiske analyser (XRD)
[Vaskevann - forsøk]



Pågang



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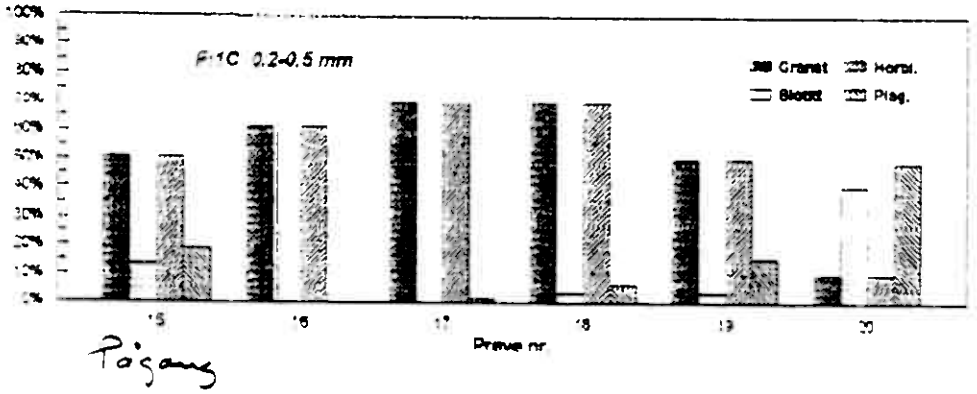
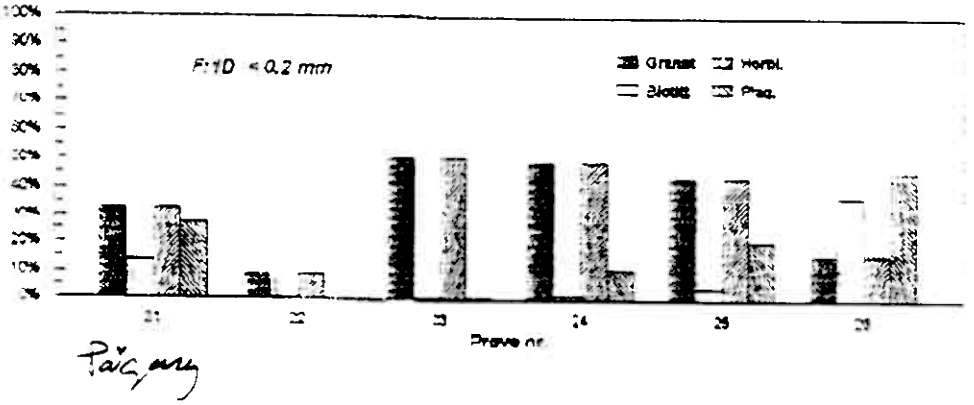


Pågang



Pågang

GARNET A / S

Spiralanrikningsförsök i Sala 1995 - 05 - 29 :

Försöksutrustningen framgår av Bilaga 1, där även försöksbetingelser och viktsfördelningar från de tre genomförda spiralförsöken och magnetseparationsförsöket finns angivna .

Setup of test equipment showed in Bilaga 1, incl weight distribution of both Spiral- and mag.sep tests.

Den använda anrikningsspiralen är av typ HG8 , som har möjlighet till 4 olika produkuttag . Av dessa användes dock endast 3 vid dessa försök . P4 togs ut tillsammans med P3 .

Spiral used, HG8, with 4 diff. prod.openings. Only 3 used in test prog. P4 & P3 combined!

Försöksmaterialet var samma som använts vid de tidigare försöken hos MINPRO . Strässa . Prov 1 (Försök 1) och med de fraktioner som där framställdes , dock ej fraktionen - 2/+ 1 mm .

Same test material as used at Minpro, and same fractions, except -2/+1 mm.

Analyseringen av granatinnehållet i de olika separationsprodukterna har utförts av NGU , Trondheim , Norge .

* Min. analysis by NGU

RESULTAT AV SPIRALFÖRSÖK :

Produkter :
P 1 = Koncentrat
P 2 = Mellanprodukt
P 3 (+ P4) = Avfall
Totalt = Ingående

Försök No.	Fraktion mm	Produkt	Vikt %	Halt % Granat	Fördelning % Granat	Ack.Vikt %	Ack. Halt % Granat	Ack.Förd. % Granat
1	0,5 - 1,0	P 1 *	19,0	61,9	26,1	19,0	61,9	26,1
		P 2	56,9	49,2	62,1	75,9	52,4	88,1
		P 3	24,1	22,2	11,9	100,0	45,1	100,0
		Totalt	100,0	45,1	100,0			

Försök No.	Fraktion mm	Produkt	Vikt %	Halt % Granat	Fördelning % Granat	Ack.Vikt %	Ack. Halt % Granat	Ack.Förd. % Granat
2	0,2 - 0,5	P 1	13,9	68,8	18,3	13,9	68,8	18,3
		P 2	71,3	53,9	73,6	85,2	56,3	91,9
		P 3	14,8	28,5	8,1	100,0	52,2	100,0
		Totalt	100,0	52,2	100,0			

Försök No.	Fraktion mm	Produkt	Vikt %	Halt % Granat	Fördelning % Granat	Ack.Vikt %	Ack. Halt % Granat	Ack.Förd. % Granat
3	- 0,2	P 1	12,3	58,4	20,3	12,3	58,4	20,3
		P 2	21,4	49,8	30,2	33,7	52,9	50,5
		P 3	66,3	26,4	49,5	100,0	35,3	100,0
		Totalt	100,0	35,3	100,0			

RESULTAT AV MAGNETSEPARATIONSFÖRSÖK : (P1)

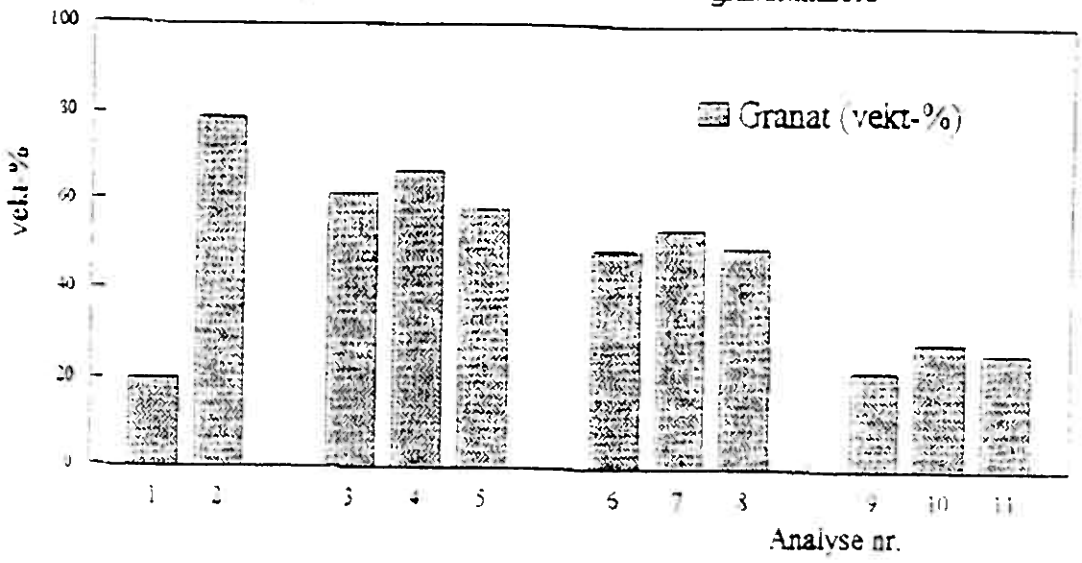
Försök	Fraktion mm	Produkt	Vikt %	Halt % Granat	Fördelning % Granat
HF	0,5 - 1,0	Magn.	46,0	79,0	77,1
250 rpm		O-Magn.	54,0	20,0	22,9
Roll 4:4		Totalt	100,0	47,1	100,0

*

1

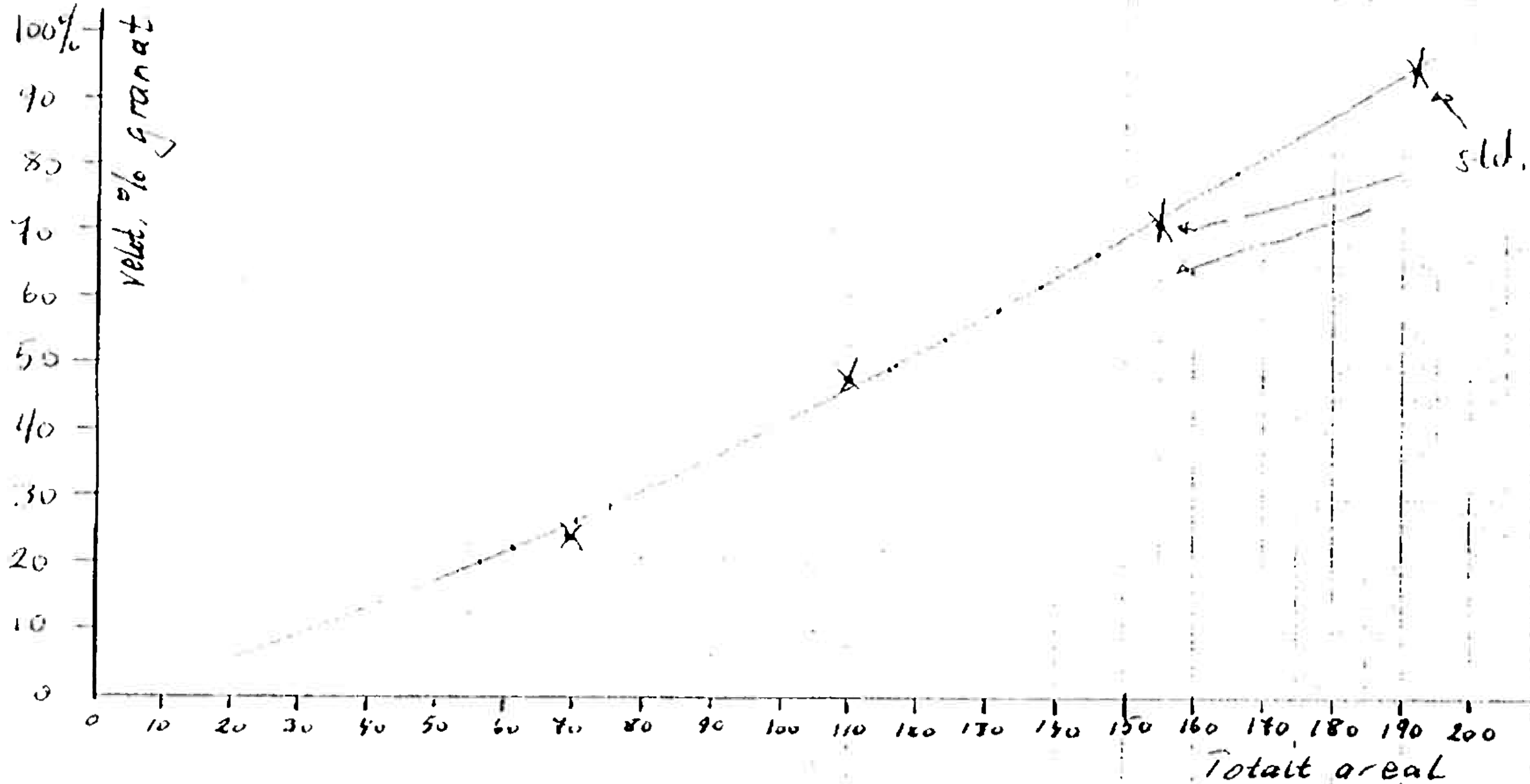
Oppredningsfraksjoner, Sala (juni 1995)

Semi-kvantitativ XRD-bestemmelse av granatinnhold



NB!
Analysene er semikvantitative m.h.p. absoluttnivå og de relative variasjoner. Bedre pålitelighet i de relative variasjoner kan oppnås ved å kjøre parallellprøver.

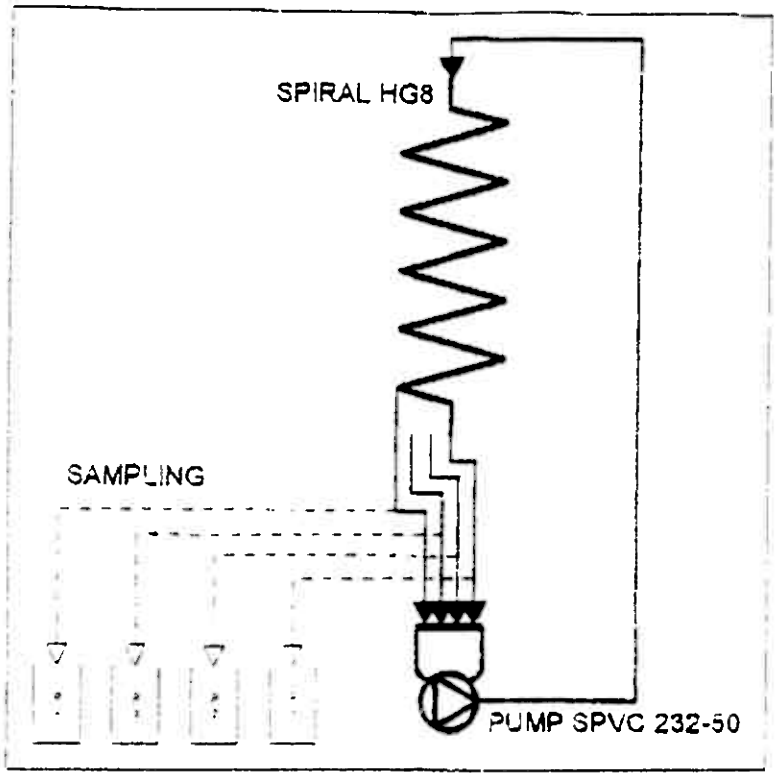
Anal. nr.	*Fullstendig prøvebetegnelse*				*Areal (tot.)*	*% Gnt (Gnt.std.)*	
1	HGMS	tørr	umagn.	0.5-1.0 mm	*56,40*	*20,0*	T1/P1
2	HGMS	tørr	magn.	0.5-1.0 mm	*166,22*	*79,0*	
3	Spiral	T1	P1	0.5-1.0 mm	*137,32*	*61,9*	H-prod.
4	Spiral	T2	P1	0.2-0.5 mm (?)	*145,80*	*66,3*	
5	Spiral	T3	P1	< 0.2 mm (?)	*131,74*	*58,4*	
6	Spiral	T1	P2	0.5-1.0 mm	*115,70*	*49,2*	Mid.-prod.
7	Spiral	T2	P2	0.2-0.5 mm (?)	*123,89*	*53,9*	
8	Spiral	T3	P2	< 0.2 mm (?)	*116,99*	*49,8*	
9	Spiral	T1	P3	0.5-1.0 mm	*61,21*	*22,2*	Avg.
10	Spiral	T2	P3	0.2-0.5 mm (?)	*75,22*	*28,5*	
11	Spiral	T3	P3	< 0.2 mm (?)	*70,29*	*26,4*	


Vekt. % granat
100%
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Totalt areal
std.

1/2

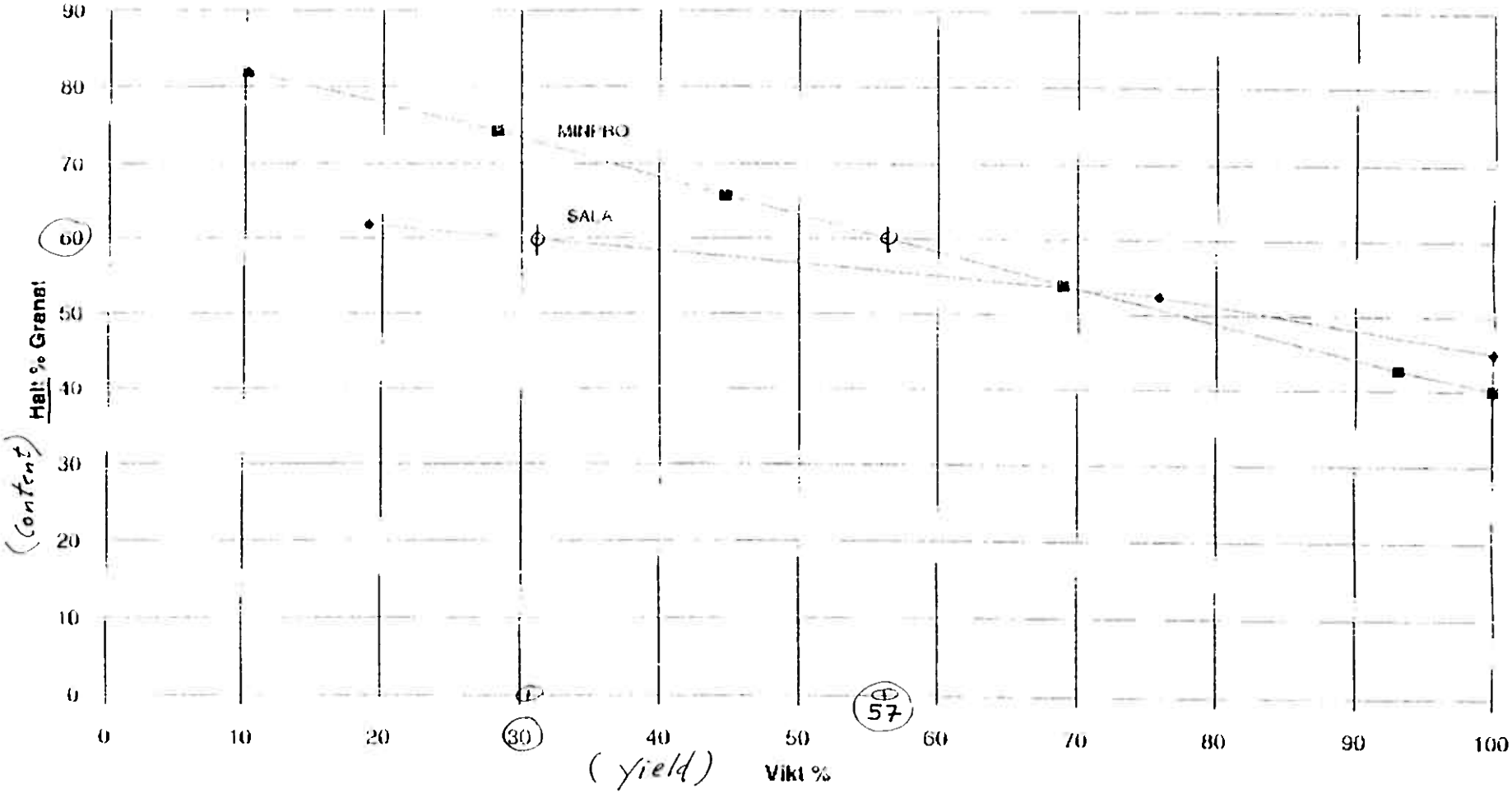
Garnet A/S

Spiralförsök 1995-05-29

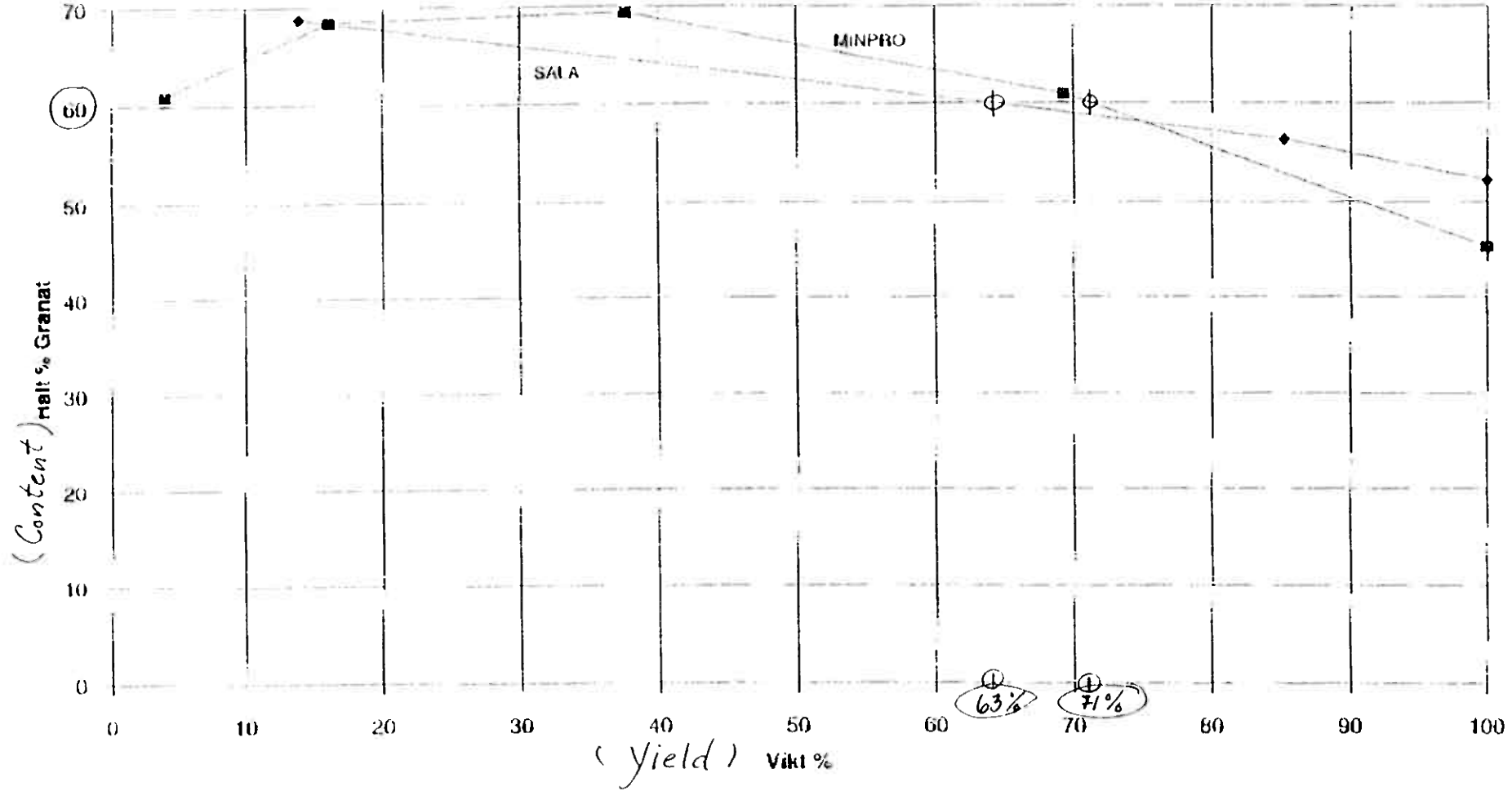


Test No	Sample	Fraction	Product	Weight %	% solids	Capacity	
		mm				Slurry	Solids
						m³/h	tph
1	AO 5160	0.5-1	P1	19,0	62,6	0,30	0,16
			P2	56,9	72,3	0,80	0,48
			P3	24,1	12,0	1,78	0,21
			Total	100,0	32,2	2,88	0,85
2	AO 5160	0.2-0.5	P1	13,9	58,9	0,23	0,12
			P2	71,3	87,4	1,07	0,81
			P3	14,8	5,9	2,17	0,13
			Total	100,0	28,3	3,47	0,85
3	AO 5160	-0.2	P1	12,3	61,1	0,25	0,13
			P2	21,4	59,4	0,45	0,23
			P3	66,3	21,3	3,53	0,71
			Total	100,0	27,2	4,23	1,07
High Force test							
250 rpm							
roll 4:4	AO 5160	0.5-1	Mag	46,0			
			Omag	54,0			
			Total	100,0			

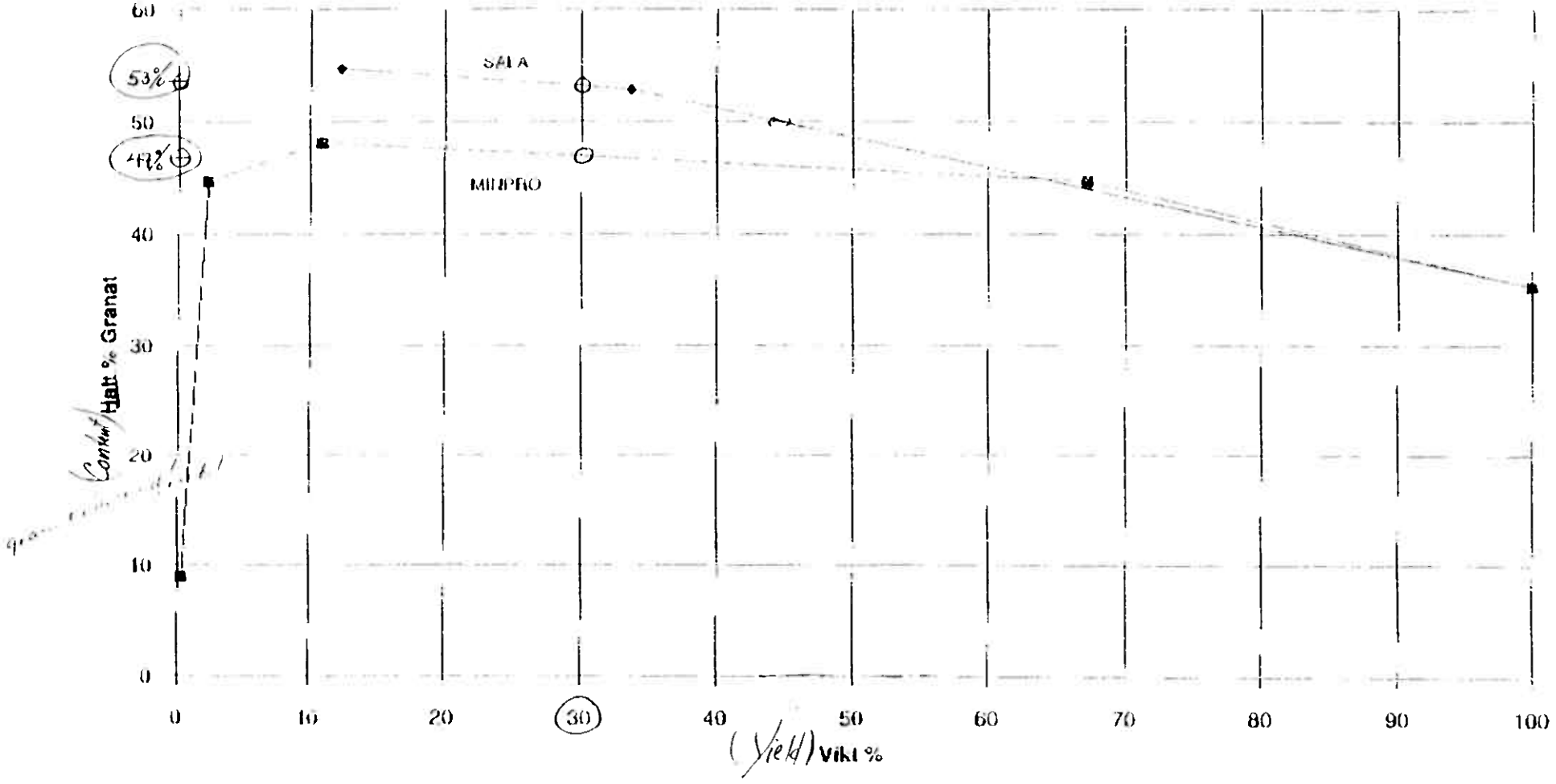
Fraktion - 1 + 0,5 mm



Fraktion - 0,5 + 0,2 mm



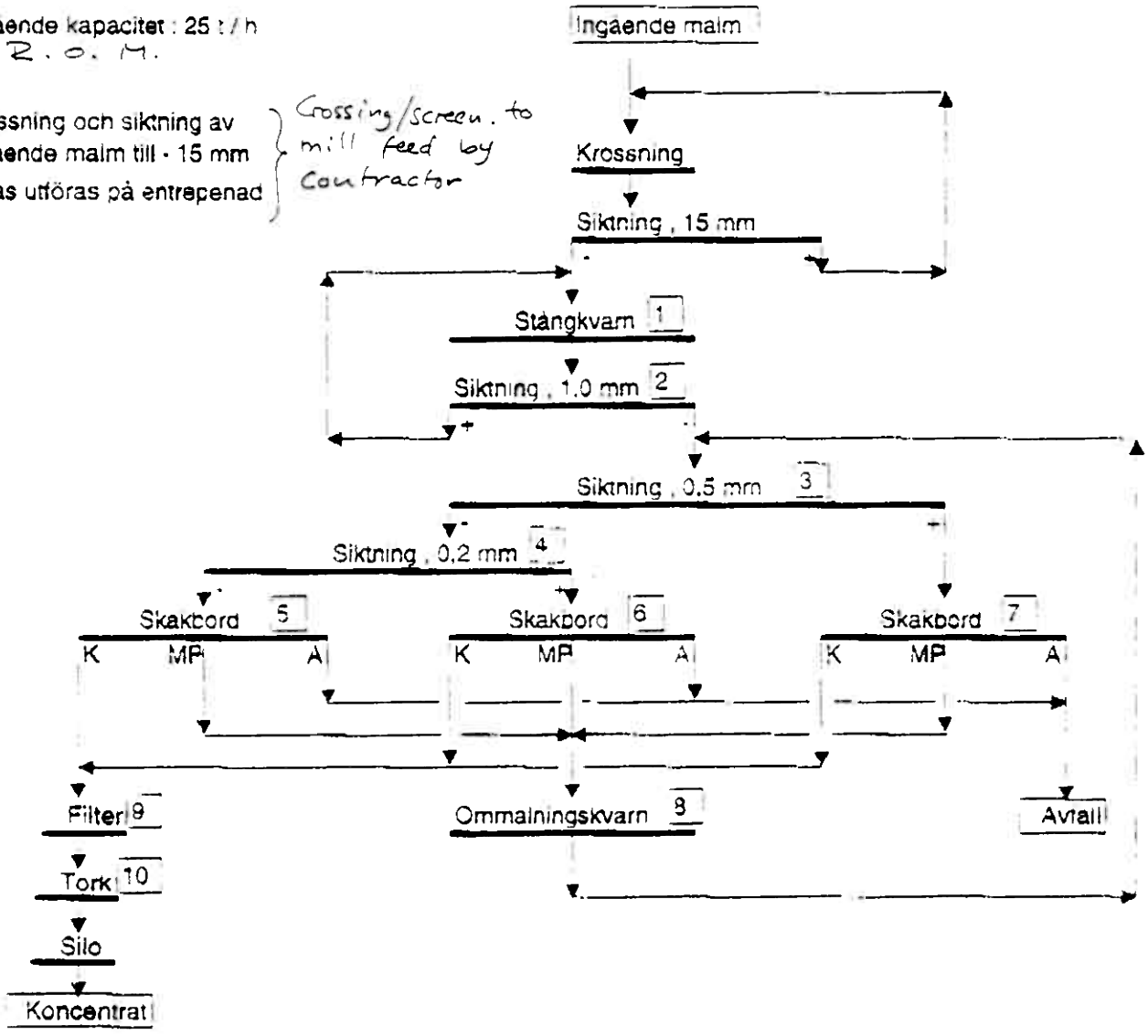
Fraktion - 0,2 mm



Förslag till flytschema

Ingående kapacitet : 25 t / h
R. O. M.

Krossning och siktning av ingående malm till - 15 mm antas utföras på entrepenad } Crossing/screen. to mill feed by Contractor



Huvudutrustning :

Position	Benämning	Antal	Typ	Anmärkning
Rod mill	1 Stångkvarn	1	SRR dia. 1,8 x 3,3 m Motor 2x50 kW	
Screen	2 Sikt		Masköppning □ 1,0 mm	Anges senare
— . —	3 Sikt		Maskoppning □ 0,5 mm	Anges senare
— . —	4 Sikt		Maskoppning □ 0,2 mm	Anges senare
Shak. table	5 Skakbord	5	Deister 999 , triple , slamnbbat	
— . —	6 Skakbord	3	Deister 999 , triple , sandnbbat	
— . —	7 Skakbord	1	Deister 999 , triple , sandnbbat	
Remill. mill	8 Ommalningskvarn	1	SRR dia. 1,2 x 2,4 m Motor 30 kW	Kul-/Stång-kvarn
Filter	9 Filter	1	TFF 1812	
Dryer	10 Tork	1		Anges senare

Ej angivet : flytschemat :Magnetseparator typ HF (permanent starktält)

DENVER SALA

TELEFAX

SALA INTERNATIONAL AB
S-733 26 SALA SWEDEN
Tel. +46 224 57000 Telex 7536 SALA S
Direct dial. 57203

Date: 1994-10-26

Number of pages incl. this: 2 + 1

From
Carl Montán
Process Systems

To
SVEDALA AS

Att.: ÖIVIND HANNISDAL
Telefax No.:
Your Ref.:

Telefax No.: +46 224 16950
Our ref.: S94.490 093
Copy to.:

Subject: GRANAT PROJEKT NORGE, STOKKE INDUSTRI AS

BUDGETOFFERT NR S94.490 093
Modulbyggd anläggning för 12 t/h för framställning av granat-blästersand.

Bäste Öivind,

Vi har härmed nöjet att presentera en **budgetoffert på SEK 12 000 000:-** för en modulbyggd anläggning till STOKKE INUSTRI AS, kontaktman Svein Parr.
Anläggningens kapacitet är för 12 t/h inående gods och slutprodukten är granat-blästersand.

Process beskrivning – se bilagt flytschema
Anläggningsgränser:
- Inmatningsficka för – 20 mm gods
- Utlopp torken för koncentrat
- Utlopp avfallsförtjockare

Material krossat till –20 mm levereras av annan till anläggningens inmatningsficka.
Från fickan matas materialet till en stångkvarn som är i sluten krets med en sikt på 2 mm.
Produkten –2 mm pumpas till en sikt på 1 mm. Fraktionen 1–2 mm går till två-stegs gravimetrisk separering med spiraler.
Produkten –1 mm pumpas till en sikt på 0,5 mm. Fraktionen 0,5–1 mm går till två-stegs gravimetrisk separering med spiraler.
Produkten –0,5 mm pumpas till en sikt på 0,2 mm. Fraktionen 0,2–0,5 mm går till två-stegs gravimetrisk separering med spiraler.
Produkten –0,2 mm pumpas till avfall.
Avfallet från den gravimetriska separationen för fraktionerna 1–2 mm och 0,5–1 mm pumpas till en cyklon. Överloppet går till 2 mm sikten medan underloppet går till stångkvarnen.
Avfallet från den gravimetriska separationen för fraktionerna 0,2–0,5 mm går till avfall.
Totalavfallet går till en förtjockare för återvinning av processvatten. (Ej inritat i flytschemat men inkluderat i priset). Underloppet pumpas till avfallsupplag.

SVEDALA

TELEFAX

Koncentratet från den gravimetriska separationen går till ett filter för avvattning och därefter till en tork.

Övrigt
Vi har priser på vad krossningen kostar i Värmlandsguld.
Krossning till -16 mm kostar SEK 45 per ton
Krossning till -8 mm kostar SEK 23 per ton

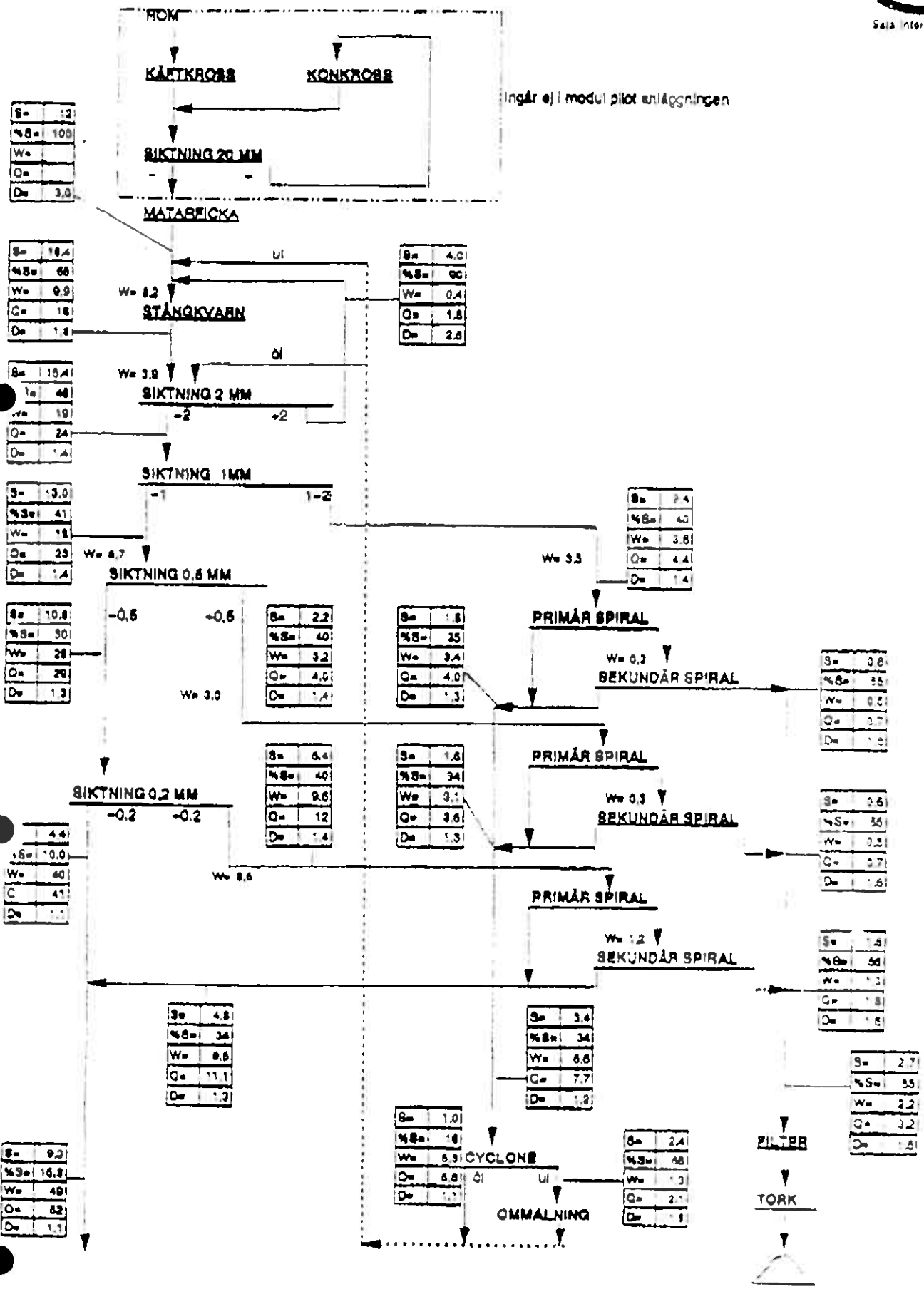
Vi hoppas denna offert möter kundens behov.

Med vänlig hälsning

Carl Montán

GRANAT - PROJEKT NORGE
PRELIMINÄRT FLYTSCHEMA MED MATERIAL OCH VATTENBALANS

DENVER SALA
Sala International



VEDLEGG 4

VEDLEGG (4)

BERGVESNET

Leiv Eirikssonsv. 39
Postb. 3021 Lade
7002 TRONDHEIM

Attn.: Bjarne Lieungh

Spjelkavik 14.02. 1995

VEDR. STØTTE TIL RUTIL/GRANAT-UNDERSØKELSER SUNNFJORD

Det vises til tidligere søknad og Deres tilsagn dat. 23.03.94 vedr. tilskudd til prospektering etter rutil/granat i eklogitter, Sunnfjord.

Arbeidet som omfattes av omsøkte prosjektmidler, ble avsluttet i marken i januar -95 (boring), men pågår fortsatt, bl.a. med analyser av innhentet borkjerne-materiale.

Kostnadsrammen for omsøkte prosjekt, er imidlertid oppfylt, og det oversendes hermed revisor-attestert regnskap for hittil utførte arbeider.

I forhold til søknaden, er det foretatt en viss omprioritering, bl.a. fordi NGU i ettertid valgte å gjennomføre geofysikk-arbeidene for egen regning. Besparelsene her er bl.a. benyttet til mer omfattende kjerneboring (boret 400 m mot omsøkt 300 m).

Vi håper at disse endringene er innenfor rammen av det søkeren har adgang til uten spesiell tillatelse.

Siden arbeid fortsatt gjenstår, vil en endelig rapport først foreligge i april/mai-95.

Resultatene av de utførte arbeider er imidlertid oppløftende på flere måter:

- ***Utført geofysikk** (høst-94) har gitt en rekke interessante anomalier for oppfølging i -95, både med geologi og event. også mer boring!*

- ***Kjerneboringen** har gitt svært verdifull informasjon om både generell geologi i området, og om Saurdal-forekomsten spesielt.*

- ***Prosess-arbeidet** har også tilført ny og verdifull informasjon om mulighetene for å fremstille salgbare konsentrater av både rutil og granat.*

En nærmere beskrivelse om utførelse og resultat vil komme i slutt-rapporten.

*Totalt har samarbeidet mellom Garnet AS, Du Pont og NGU utløst investeringer i rutil/granat-prospektering i størrelsesorden **8-10 mill NOK** både i 1993 og 1994! Hovedtyngden av dette bæres av Du Pont (prosess-utvikling), men det er helt klart at*

uten det etablerte, positive samspillet og aktiv medvirkning fra Bergvesnet, hadde dette knapt vært mulig!

Selv om prospektering helt klart både er risikofylt og langsiktig investering, har nevnte arbeider også betydelig sysselsettings-effekt på kort sikt:

1) Lokalt i form av hytteleie, transport, service m.v.

2) Regionalt/sentralt i form av oppdragsvirksomhet (boring, helikopter-leie, prosess-arbeid m.v.)

3) Deltakende selskap, her både NGU (1-2 årsverk), Garnet AS (1/2 årsverk) og Du Pont (2-3 årsverk)

Prospekteringsfondet har derfor etter vår mening en svært så viktig funksjon, for selv om tilgjengelige midler er rel. små, representerer de en betydelig katalysator m.h.t. å tiltrekke seg selskap med nødvendig risiko-kapital, og på den måten bidra til å bevare interessen for å utvikle norsk malm/mineral-virksomhet!

At det ikke er funnet plass for slike midler i 1995 er derfor sterkt beklagelig, og det bør arbeides aktivt for å få dette på plass igjen i 1996-budsjettet.

For ordens skyld kan nevnes at våre planer for -95 sesongen tyder på rel. omfattende arbeid, som nevnt bl.a. med oppfølging av geofysiske anomalier.
Skulle det derfor bli aktuelt med utdeling av prosjektmidler, håper vi derfor å komme i betraktning, og hører nærmere fra Dem i så tilfelle.

Som det vil framgå av vedlagte prosjekt-regnskap, er det hittil bokført utgifter totalt på kr. 649.176,38 til dette prosjektet i 1994, og vi ber om at tilsagnsmidlene utbetales så snart som råd.

Med hilsen
Garnet AS

Svein Parr

Vedlegg: Prosjekt-regnskap

GARNET AS

P.b. 8158 Spjelkavik
N-6022 ÅLESUND
Bankgiro 5354.05.03199
Postgiro 0802 4556213

4/3

1. **PROSJEKT - REGNSKAP SAURDAL/RISASKARDET, FJALER KOMMUNE**

(Vedr. tilskudd fra Prosp.fondet 1994)

KOSTNADSOVERSIKT - HOVEDPOSTER

	Regnskap 07.02. 95	Tilsagn 24.03.94
* Arbeid /omk. eget personell	kr 219.313.65	kr 140.000,-
* Eksterne kostnader NGU	" 20.689.00	" 120.000,-
* Eksterne kostnader Diamantboring	" 346.743.05	" 250.000,-
* Eksterne kostnader Prosess-arbeid	" 62.430.68	" 100.000,-
SUM KOSTN. TOTALT, SAURDAL/RISASK.	KR 649.176.38	KR 610.000,-

Spjelkavik 07.02. 1995

Garnet AS

Svein Parr

Revisorbekreftelse

Kostnadene i regnskapet pr. 07.02.95 er kontrollert mot underdokumentasjon. Kostnader vedrørende egne ansatte er beregnet på grunnlag av fordeling av medgått tid på de ulike prosjekter. Det er benyttet standard timesats på kr 350,-. De andre kostnadene er i samsvar med eksterne bilag.

Ålesund, den 13. februar 1995
REVISJONSFIRMA AMUND FRØYSA ANS

Amund Frøysa ANS
Statsaut. revisorer
Revisor nr. 959565643

Ole Martin Sæter
statsaut. revisor

GARNET AS

P.b. 8158 Spjelkavik
N-6022 ÅLESUND
Bankgiro 5354.05.03199
Postgiro 0882 4556213

KOSTNADSOVERSIKT - DETALJ-REGNSKAP.

*** Arbeid eget personell.**

- Planl. av feltarbeid/boring/prosessforsøk	40t a kr 350	kr.	14.000.00
- Feltarbeid Saurdal/Risaskardet 1994 (17d)	80t a kr 350	"	28.000.00
- Oppfølging av diam.boring " " (15d)	80t a kr 350	"	28.000.00
- Reiseomk. feltarbeid/diam.boring iflg.	**(bilag 1)**	"	66.320.30
- Reiseomk. i forb. med prosess-arbeid	**(bilag 2)**	"	34.043.75
- Div. omk. (tlf.,rettigheter m.v.) "	**(bilag 3)**	"	48.949.60
Sum arbeid/omk. eget personell			**kr 219.313.65**

*** Eksterne kostnader NGU.** **(bilag 4)**

- Leie av NGU-personell (reiseomk)	kr	4.449.00
- Analyser, rapporter m.v.	"	16.240.00
Sum ekst. kostnader NGU		**kr 20.689.00**

*** Eksterne kostnader Diamantboring** **(bilag 5)**

- Utgifter bore-entreprenør	kr	256.803.90
- Utgifter transport m.v.	"	78.419.15
- Innkvartering mannskaper	"	11.520.00
Sum ekst, kostnader diamantboring		**kr 346.743.05**

*** Eksterne kostnader prosess-forsøk** **(bilag 6)**

- Utgifter prosess-forsøk	kr	50.336.73
- Frakt av prøvemateriale	"	12.093.95
Sum eksterne kostnader prosess-forsøk		**kr 62.430.68**

SUM KOSTNADER TOTALT SAURDAL/RISASKARDET **KR 649.176,38**