



Bergvesenet

Postboks 3021, N-7441 Trondheim

Rapportarkivet

Bergvesenet rapport nr

6208

Intern Journal nr

Internt arkiv nr

Rapport lokalisering

Gradering

Kommer fra arkiv

Grong Gruber AS

Ekstern rapport nr

NGU 1289/4

Oversendt fra

Grong Gruber AS

Fortrolig pga

Fortrolig fra dato:

Titel

Geokjemosk kartproduksjon og malmleting i Grongfeltet.

I : A review of the production of 1:50 000 regional stream sediment geochemical maps of Grongfeltet and

Forfatter

David C. Smith

Dato

År

1977

Bedrift (oppdragsgiver og/eller oppdragstaker)

Kommune

Grong
Namskogan
Røyrvik

Fylke

Nord-Trøndelag

Bergdistrikt

1: 50 000 kartblad

1: 250 000 kartblad

Grong

Fagområde

Geokjemi

Dokument type

Forekomster (forekomst, gruvefelt, undersøkesfelt)

Råstoffgruppe

Malm/metall

Råstofftype

Sammendrag, innholdsløstegnelse eller innholdsbeskrivelse

Som vedlegg til rapporten ligger rapport fra Mo - felt Nesåpiggen.

VII.

GRUNNLEGGENDE
GEOLOGISKE



NORGES GEOLOGISKE UNDERSØKELSE

**GEOKJEMISK KARTPRODUKSJON OG
MALMLETING I GRONGFELTET**

NGU Rapport nr. 1289/4

**I : A review of the production of 1:50 000
regional stream sediment geochemical maps
of Grongfeltet**

and

**II : A final compilation of data from
geochemical exploration for Mo and Cu in
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April 1977

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List of Example Maps.

Regional 1:50 000 Stream Sediment Geochemical Maps - Grongfeltet.

A total of 60 such maps are now complete (see table 3); of these 11 were published in December 1976 and the remaining 49 await only permission for publication.

As examples to show the different ppm ranges, symbol sizes and frequency distributions for each element all of the Andorsjøen maps (excluding Cd) are presented here.

As examples to show the distribution of sample sites over the 11 different map sheets, all of the Zn maps are presented here.

Thus the following 20 maps can be found in this report.

- 1546 -BEKK - 1823 IV - Ag symb.
- 1546 -BEKK - 1823 IV - Co symb.
- 1546 -BEKK - 1823 IV - Cu symb.
- 1546 -BEKK - 1823 IV - Fe symb.
- 1546 -BEKK - 1823 IV - Mn symb.
- 1546 -BEKK - 1823 IV - Mo symb.
- 1546 -BEKK - 1823 IV - Ni symb.
- 1546 -BEKK - 1823 IV - Pb symb.
- 1546 -BEKK - 1823 IV - V symb.
- 1546 -BEKK - 1823 IV - Zn symb.
- 1546 -BEKK - 1824 I - Zn symb.
- 1546 -BEKK - 1823 IV - Zn symb.
- 1546 -BEKK - 1824 III - Zn symb.
- 1546 -BEKK - 1924 I - Zn symb.
- 1546 -BEKK - 1924 II - Zn symb.
- 1546 -BEKK - 1923 I - Zn symb.
- 1546 -BEKK - 1824 II - Zn symb.
- 1546 -BEKK - 1923 IV - Zn symb.
- 1546 -BEKK - 1924 IV - Zn symb.
- 1546 -BEKK - 1924 III - Zn symb.

List of Maps prepared for this project.

* denotes maps not included in this report.

District - hele GRONGFELTET, scale 1:250 000, oppdrag 1276.

Map number

1276-01 *	Bekkesedimenter	Oversikt (superseded by map 1276-02)
1276-02	Bekkesedimenter	Oversikt over prøvetatt områder, oppdrag nummer, årstall, kartblad nummer.
1276-03	Bekkesedimenter	Som 1276-02 med generell geologi etter Sverdrup (NGU rapport nr. 1166) (see appendix for symbol list) og Mo-bekkesedimentanomalier og frekvensfordelinger.

District - FREMSTFJELL-FELTET, scale 1:5 000, oppdrag 1289.

<u>Map number</u>	<u>Sample type</u>	<u>Map type</u>
1289-01*	Bekkesedimenter	Cu+Mo anomalier (superseded by map 1289-27)
1289-02*	Bekkesedimenter	Cu+Mo anomalier (superseded by map 1368-07)
1289-03	Bekkesedimenter+soil+rock	Prøvenummer - oppdrag 1289
1289-04	Bekkesedimenter	Mo analysetall
1289-05	Bekkesedimenter	Pb/Zn/Cu analysetall
1289-06	Bekkesedimenter	Ni/Co/Ag analysetall
1289-07	Bekkesedimenter	V/Mn/Fe analysetall
1289-08	Bekkesedimenter	Mo symboler
1289-09	Bekkesedimenter	Cu symboler
1289-10	Bekkesedimenter	Pb symboler
1289-11	Bekkesedimenter	Zn symboler
1289-12	Bekkesedimenter	Ni symboler
1289-13	Bekkesedimenter	Co symboler
1289-14	Bekkesedimenter	V symboler
1289-15	Bekkesedimenter	Ag symboler
1289-16	Bekkesedimenter	Mn symboler
1289-17	Bekkesedimenter	Fe symboler
1289-18*	Bekkesedimenter	♂ Mo symboler in adjacent districts
1289-19*	Bekkesedimenter	♂ Cu symboler in adjacent districts
1289-20*	Bekkesedimenter	♂ Pb symboler in adjacent districts
1289-21*	Bekkesedimenter	♂ Zn symboler in adjacent districts
1289-22*	Bekkesedimenter	♂ Ni symboler in adjacent districts
1289-23*	Bekkesedimenter + soil	♂ Prøvesteder ved Gaizervatnet 1:20 000
1289-24	Bekkesedimenter	Glødetap analysetall
1289-25	Bekkesedimenter	Glødetap symboler + bekkeorden
1289-26	Bekkesedimenter	Prøvenummer - oppdrag 1289
1289-27	Bekkesedimenter	Cu+Mo kryss
1289-28	Bekkesedimenter	Cu+Mo kryss +mulingsområder 1-1-76
1289-29	Bekkesedimenter	Mn+Fe kryss uten grunnlag
1289-30	Bekkesedimenter	Mn+Fe kryss med grunnlag
1289-31	Bekkesedimenter	Mn+Fe kryss med 2 frekvensfordelinger
1289-32	Bekkesedimenter	Cu+Mo+Mn+Fe med 2 frekvensfordelinger
1289-33	Bekkesedimenter	Cu+Mo+Mn+Fe med 4 frekvensfordelinger
1289-34	Bergart + Jord + Møser	Prøvenummer - oppdrag 1368

♂ these maps are available in NGU report nr. 1289/2.

District - SANDDØLA-NESÅVATNA, scale 1:20 000, oppdrag 1368.

<u>Map number</u>	<u>Sample type</u>	<u>Map type</u>
1368-01	Bekkesedimenter	Prøvenummer
1368-02	Bekkesedimenter	Mo analysetall
1368-03	Bekkesedimenter	Cu analysetall
1368-04	Bekkesedimenter	Mo symboler
1368-05	Bekkesedimenter	Cu symboler
1368-06	Bekkesedimenter	Mo symboler §
1368-07	Bekkesedimenter	Cu+Mo kryss
1368-08	Bekkesedimenter	Cu+Mo kryss § §
1368-09	Bergart	Generell geologi § § §
1368-10	Bekkesedimenter	Høyde over havet av prøvestedet
1368-11	Jord + Mose	Prøvenummer
1368-12	Bergart	Prøvenummer

§ includes Smith's mutingsforslag of 20-11-75

§ § includes Haugen's 61 mutingsområder of 1-1-76

§ § § assembled from Gale's report NGU nr. 1293.

District - ANDORSJØEN, scale 1:50 000.

<u>Map number</u>				
1546	-	BEKK	-	1823 I - Ag tall
1546	-	BEKK	-	1823 I - Co tall
1546	-	BEKK	-	1823 I - Cu tall
1546	-	BEKK	-	1823 I - Fe tall
1546	-	BEKK	-	1823 I - Mn tall
1546	-	BEKK	-	1823 I - Mo tall
1546	-	BEKK	-	1823 I - Ni tall
1546	-	BEKK	-	1823 I - Pb tall
1546	-	BEKK	-	1823 I - V tall
1546	-	BEKK	-	1823 I - Zn tall

District - NAMSSKOGAN, scale 1:50 000.

Map number

1546	-	BEKK	-	1824 II	-	Ag	tall
1546	-	BEKK	-	1824 II	-	Co	tall
1546	-	BEKK	-	1824 II	-	Cu	tall
1546	-	BEKK	-	1824 II	-	Fe	tall
1546	-	BEKK	-	1824 II	-	Mn	tall
1546	-	BEKK	-	1824 II	-	Mo	tall
1546	-	BEKK	-	1824 II	-	Ni	tall
1546	-	BEKK	-	1824 II	-	Pb	tall
1546	-	BEKK	-	1824 II	-	V	tall
1546	-	BEKK	-	1824 II	-	Zn	tall

District - hele GRONGFELTET, scale 1:50 000.

Map number

1546	-	BEKK	-	1823 IV	-	Prøvenummer	ANDORSJØEN
1546	-	BEKK	-	1824 I	-	Prøvenummer	BREKKVASSELV
1546	-	BEKK	-	1823 IV	-	Prøvenummer	GRONG
1546	-	BEKK	-	1824 III	-	Prøvenummer	HARRAN
1546	-	BEKK	-	1924 I	-	Prøvenummer	HUDDINGSVATNET
1546	-	BEKK	-	1924 II	-	Prøvenummer	LIMINGEN
1546	-	BEKK	-	1923 I	-	Prøvenummer	MURUSJØEN
1546	-	BEKK	-	1824 II	-	Prøvenummer	NAMSSKOGAN
1546	-	BEKK	-	1923 IV	-	Prøvenummer	NORDLI
1546	-	BEKK	-	1924 IV	-	Prøvenummer	RØYRVIK
1546	-	BEKK	-	1924 III	-	Prøvenummer	TUNNSJØEN

District - RØYRVIK, scale 1:50 000, oppdrag 1573.

<u>Map number</u>	<u>Sample type</u>	<u>Map type</u>
1573-01	Bekkesedimenter	Cu prøvetatt fra bil (A og B prøver)
1573-02	Bekkesedimenter	Cu prøvetatt på fjellet hver 250 m.
1573-03	Bekkesedimenter	Cu prøvetatt på fjellet pluss A-prøver fra bil.
1573-04	Bekkesedimenter	Cu i utplukket prøve fra fjellprøvetaking, men som kunne ha vært prøvetatt fra fullstendig bil-og båt prøvetaking.

District - SANDDØLA-NESÅVATNA, scale 1:50 000, oppdrag 1573.

<u>Map number</u>	<u>Sample type</u>	<u>Map type</u>
1573-05	Bekkesedimenter	Ag symboler
1573-06	Bekkesedimenter	Co symboler
1573-07	Bekkesedimenter	Cu symboler
1573-08	Bekkesedimenter	Fe symboler
1573-09	Bekkesedimenter	Mn symboler
1573-10	Bekkesedimenter	Mo symboler
1573-11	Bekkesedimenter	Ni symboler
1573-12	Bekkesedimenter	Pb symboler
1573-13	Bekkesedimenter	V symboler
1573-14	Bekkesedimenter	Zn symboler

Introduction.

This report describes the production of regional geochemical maps of Grongfeltet (Part I) and provides a compilation of data on the follow-up geochemical exploration for Mo and Cu in the Sanddøla-Nesåvatna area in southern Grongfeltet (Part II).

Part I records work carried out by NGU personnel way back to 1964 whilst Part II records the work of the field projects in 1974 and 1975 variously known as the "Langtjern Project", "Trondhjemite Project" or "Molybdenum Project".

Most of the author's time and effort has been utilised for Part I in organising the stream sediment field and analytical data from Grongfeltet and in establishing a streamlined production system. This has resulted in the publication of the first 11 1:50 000 regional stream sediment geochemical maps of Grongfeltet, completion of 49 others ready for immediate publication, and commencement of several more.

The remaining time available has been expended on Part II in field work and in selecting stream sediment, soil, moss and bedrock samples for chemical analysis, and controlling and guiding the data through to the stage of data plotting. The field work and chemical analytical programmes are complete, and the map plotting programme is essentially complete. The required polished and thin sections of the rock samples have been manufactured though detailed petrographic studies have not been made. Some interpretation of the data has been presented previously in reports 1289/1 in 1974, 1289/2 in 1975, 1289/3 in 1976, in diverse notes and proposals (see appendix 1) and some is presented here in this final report 1289/4 of 1977.

It has not proved possible, unfortunately, to carry out as much interpretative work for Part II as was hoped. However, this hurried compilation records or references all the necessary raw data for an integration of the geochemical surveys with geological and geophysical surveys. Furthermore the geochemical data provided here is considerably in excess of that specified in the budget arrangement for the 1975 field project (compare appendix 2 with tables 6 - 13).

David C. Smith

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30 April 1977

I.1 Preface.

The first eleven 1:50 000 regional stream sediment geochemical maps of the Grong District were published by NGU in December 1976. This report provides the first compilation of all of the stream sediment data from Grongfeltet and an up to date review of the progress achieved with map production.

Since a comprehensive record of sample collection, chemical analysis and map plotting was not built up from the beginning of ^{the} stream sediment sampling programme in 1964, this compilation necessitated considerable historical research to make it as accurate as possible. Due to the absence of original data or relevant information in some cases, there are a few omissions in the data and a few inaccuracies may be expected in the compilation.

The map production routine has now been organised such that production of the remaining geochemical maps of the Grong District will be a relatively straightforward matter.

I.2 Map sheets.

The stream sediment survey areas for each field season were selected according to prospecting considerations by Grong Grube A/S and/or NGU, usually with no regard for the boundaries of Norway's grid system for 1:50 000 map sheets. Excluding samples taken in 1961 in the Sørli district, all of the samples taken lie on one of the following eleven 1:50 000 map sheets

ANDORSJØEN	1823 IV
BREKKVASSELV	1824 I
GRONG	1823 IV
HARRAN	1824 III
HUDDINGSVATNET	1924 I
LIMINGEN	1924 II
MURUSJØEN	1923 I
NAMSSKOGAN	1824 II
NORDLI	1923 IV
RØYRVIK	1924 IV
TUNNSJØEN	1924 III

except that a very small number lie on the edge of map sheet MAJAVATN 1925 III and have been ignored here.

Map nr. 1276 - 02 displays the location of the map sheets and shows the approximate areas covered by each field season's sampling; as indicated by the year and the oppdrag number. It can be seen that in general terms the surveying began in the Joma area in 1964-65, then continued into the Gjersvik, Skorovatn and Rosset - Godejord areas during 1969-1972 and finished with the Sanddøla - Nesåvatna areas during 1973 - 1975.

Although samples were normally collected at a uniform density, this density was occasionally changed according to prospecting criteria; this is particularly noticeable on map sheets HARRAN and NAMSSKOGAN (see map 1276 - 02). The sampling density and boundaries of survey areas are therefore generally unsuitable for the production of regional geochemical map sheets. Only map sheets RØYRVIK and perhaps BREKKVASSELV can be considered to have a satisfactory distribution of samples.

Table 1 indicates the precise relationship between the samples taken within each oppdrag and the map sheet upon which they are located. Prøve-nummerkart enclosed here give the exact locations of all samples on all eleven map sheets.

Apart from the excluded samples on MAJAVATN map sheet, some samples taken between map sheets ANDORSJØEN and GRONG and between NAMSSKOGAN and HARRAN are also excluded here. This unfortunate situation arose from the fact that all draughting of map sheets GRONG and HARRAN was based on NGO's series M711 topographic maps whilst for all other map sheets NGU's air photograph mosaic was used as a base. This resulted in a narrow zone, up to 1 km wide, being draughted on neither set of maps.

There are many topographical inaccuracies on several map sheets, in particular the directions of stream flow. This is either due to occasional misinterpretation of air photographs or to errors on the older NGO maps series M711 1:50 000. Some inaccuracies have been corrected but many remain. Since new NGO maps are now available for all eleven map sheets except MURUSJØEN, the remaining topographic inaccuracies could be corrected, but in general this will necessitate a re-examination of original field overlays to air photograph and will necessitate a considerable amount of work.

On the new NGO series M711 map sheets, some of the map sheet names have changed; thus NAMSSKOGAN has become SKOROVATN.

Table 1 also indicates the sampling carried out by Skorovass Grube A/S in 1968-1969. These samples were analysed by NGU and are plotted on the regional map sheets. Other samples taken in 1970 were analysed by Terratest A/S by an analytical technique different to that at NGU and are therefore not taken into account here. Other samples taken in 1971 were analysed for Cu, Pb, Zn and Ni by "Mosal" (? Mosjøen Aluminium) by an atomic absorption technique and have been plotted on the regional maps. NGU received data plotted on transparent maps and does not possess the original sample numbers.

Skorovass Grube A/S produced some enlarged 1:20 000 maps of stream sediment sites on the Namsskogan 1:50 000 map sheet. Their sample numbers do not agree with those on NGU's maps but the sample sites appear to be the same. The following correlation appears to be true.

<u>Year</u>	<u>Skorovass numbers</u>	<u>NGU numbers</u>	<u>NGU oppdrag</u>	<u>Samples archived</u>	<u>Analytical method & location</u>		<u>Data plotted</u>
1968	0- 999	510- 933	836	NGU	AAS	NGU	Yes
1969	1000-1999	1- 952	912	NGU	AAS	NGU	Yes
1970	2000-2999	No	No	?	Spekt.	Terratest	No
1971	3000-3999	?	No	?	AAS	MOSAL	Yes
1973	4000-4999	2001-2316	1177	NGU	AAS	NGU	Yes

Some stream sediment samples were taken in the Grong District as part of detailed follow-up prospecting projects. Their high density of sample sites is unsuitable for draughting on the regional 1:50 000 map sheets and thus they have been excluded from the map production. They include: -

<u>Year</u>	<u>Oppdrag</u>	<u>Samples</u>	<u>Location</u>	<u>Map sheet</u>
1965	602	1001-1972	Orvannet	?
1969	912	701- 852	Verdal	?
1970	974	8479-8628	Gjersvik	Røyrvik
1970	974	1801-1850	?	?
1974	1289	1- 282	Fremstfjellfeltet	Namsskogan

Excluding these detailed surveys, a total of 14212 stream sediment samples have been collected by NGU in the Grong District.

1.3 Sampling technique.

The routine stream sediment sampling technique at NGU has been described by Bølviken, Krog and Næss (1976) on p. 383 in the Journal of Geochemical Exploration, volume 5 no. 3. The essential features are that stream sediment material is wet-sieved in the field and that the sieve size is 0.18 mm. Other details are given by Bølviken et al (op cit.) as follows:

"The sieve is filled with stream water and placed horizontally on the ground. Active stream sediments, collected with the trowel from the middle of the stream, or at least 1 m from the bank, are placed in the sieve and screened by stirring with the fingers or a kitchen spatula. Coarse material not passing through the screen is discarded, and the procedure repeated until sufficient fine-grained material is obtained in the collecting pan. Stream water is added to keep a constant high water level in the sieve during the sieving process. After settling for a few minutes, the water in the collecting pan is decanted, and the sediment sample transferred to a pre-numbered paper bag. Total sampling time at each site normally varies between 10 and 30 minutes depending on the local conditions."

Samples were normally taken every 250 m along streams without tributaries, plus a new sample in each tributary. In general first-order streams were ignored, but all second-and larger-order stream were sampled.

The oppdrag number is the essential identifier of a sample (along with its sample number within the oppdrag) for its location in sample bags, in analytical bottles, on maps and elsewhere.

Sample numbers within an oppdrag are generally consecutive. However, occasionally new numbers have started in new areas giving rise to gaps (see especially oppdrag 1177 on table 1). Also a few samples were lost or damaged prior to analysis. Several samples were analysed for some elements but not for others, since all of the original material had already been used up during the previous analyses. Thus the total number of analysed samples plotted on a map often differs by a small quantity from the number of samples collected from that map sheet.

All work concerning the production of regional geochemical maps in the Grong District to date at NGU concerns only stream sediment samples. Other samples (soil, moss, rock) have been collected for prospecting projects and are not yet intended for publication on a regional scale.

Innumerable sampling errors no doubt exist and include variations in
 i) an individual sampler's technique, ii) between different samplers,
 iii) geological/geomorphological /geochemical factors at different sites,
 iv) short- and long-term climatic variations, v) transport, storage and
 drying. A thorough systematic investigation and evaluation of these
 potential and actual errors has never been made.

The historical investigation of earlier surveys revealed a few disturbing
 facts, in particular that i) some stream sediment samples from oppdrag
 1177 in 1973 were stored wet for two months before drying; since the
 chemical changes, such as element migration ^{between the adjacent sample bags} are unknown, this data must
 be treated with caution; to what extent this kind of fault occurred in other
 surveys is not known.

ii) different field samplers at NGU have considerably different habits in
 the collection of the organic-rich fine fraction of the stream material;
 this presumably leads to significant sampling errors.

It is nevertheless hoped that in general most analytical results are reliable
 up to a factor of three times greater or smaller than the result provided,
 though in individual cases a factor of perhaps ten or more may occur.
 Thus as a working hypothesis one assumes that an analysed metal content
 of 30 ppm represent a true value lying within the range 10 - 90 ppm.

I.4 Analytical technique.

The routine sample treatment and analytical technique at NGU is as follows.
 1 g of dried, re-sieved (- 0.18 mm) sample is digested with 5 ml 1:1 HNO_3
 for 3 hours at 110°C , then diluted to 20 ml, and filtered. Elements are
 then determined in solution by atomic absorption spectrometry. Normally
 only one analytical determination is made for each element in each sample
 and this raw data value is plotted directly on the maps. Analytical control
 is monitored by duplicating the analyses of selected samples, usually
 including the highest values. However, the accuracy and precision of
 this routine hot-extractable heavy-metal atomic absorption analytical
 technique has not been thoroughly evaluated, though the precision is likely
 to be better than the uncertainties in the sampling technique.

Samples collected during the early surveys in the Grong District were analysed for only Cu, Ni, Pb and Zn in most cases, though a few samples were analysed for Cd, Co and V. In 1969 (oppdrag 905) extensive roadside sampling took place and these samples were analysed for Cr. Subsequently some samples were analysed for Ag, Fe and Mn. Then in 1973 Mo analysis began. In order to have complete sets of data for comparative and regional studies and regional map production, analysis began in 1974 of old samples for new elements. Excluding Cr, eleven elements have been selected (Ag, Cd, Co, Cu, Fe, Mn, Mo, Ni, Pb, V, and Zn) and determinations of all these elements in all samples has been requested. Table 2 indicates the progress of the analytical programme by April 1977. This shows that the only data lacking is Mo in those samples collected prior to 1972, Ag, Cd, Co, Fe and Mn in all samples collected during 1972 and in one group during 1973, and Cd in those samples collected after 1972. When the programme is complete 156 332 analytical determinations will have been made.

I. 5 Data plotting.

Table 4 provides a review of the symbol sizes utilised for each metal on the regional 1:50 000 maps. Ideally the frequency distribution of metal concentrations on a particular map should be plotted before choosing the ranges of symbol sizes to be used. In practice however, it was necessary to decide the symbol ranges before all of the necessary analytical data was available. Also the fact that different map sheets have different frequency distributions necessitates either different symbol ranges on each map or a fixed symbol system which occasionally leads to some maps been dominated either by large or by small symbols. The latter case was chosen such that the symbol sizes were standardised.

The number of symbols per tenth power was chosen according to the steepness of the cumulative frequency distribution curve of the available data at an early stage, and is four for Cu, Fe, Mn, Ni, V and Zn and five for Ag, Co, Mo, Pb. Medium-sized symbols were chosen to represent concentrations close to the medians of the frequency distributions.

Small discrepancies occur between the symbol system given in table 4 and the symbols plotted on some maps. This results from an inconsistent policy applied by different workers in dealing with the precise numbers used as limits for each symbol range. The upper limit to a range should be the antilog of the relevant fourth or fifth part of unity. Thus $\text{antilog } 0.2 = 1.585$. Depending on the number of digits neglected or not in rounding, on rounding up or down, and on the 10th power involved, several alternative ppm limits can be chosen every 10th power as follows: -

1.	15.	158.	1585.
2.	16.	159.	1586.
1.5	15.8	158.5	1585.
1.6	15.9	159.0	1590.
1.	10.	100.	1000.
1.5	15.	150.	1500.
1.6	16.	160.	1600.

Furthermore the choice of the lower limit for the next symbol can be 0.1, 1.0, 10 or 100 greater than the upper limit for the preceding symbol.

The discrepancies are generally insignificant at low ppm values but are more common at higher values. Thus 399 ppm Pb ought to plot as a star since it exceeds the antilog 2.6 (398.1 ppm) value, but in fact it is plotted as a large circle. Compare also 39 ppm Mo with 40 ppm Pb which ought to have the same number. Moreover at high concentrations the 4- or 5-symbols per 10th power rule was occasionally changed; for example the smaller star normally denotes 1800 ppm Ni but has been also used to denote 3200 ppm Ni. Such discrepancies will however, not lead to a sample being plotted more than one size greater or smaller than its correct size.

It is suggested that these discrepancies are eliminated in future projects by establishing a fixed system of establishing digits.

I. 6 Map Production.

Eleven elements determined on samples located on eleven map sheets gives rise to 121 geochemical maps which can be published.

Progress with map production is indicated on table 3 where a four-fold classification is employed.

Thus 11 maps have already been published (December 1976), 49 are ready for publication and thus awaiting only authorisation, 13 are partly complete and 48 have not yet begun to be draughted. Several maps which are partly complete are presently held up by a lack of complete chemical analytical data.

In order to facilitate and maintain a complete and up-to-date review of the detailed state of map production a special "kontrollskjema" has been prepared (appendix 3). One kontrollskjema is utilised for each individual map. Thus 121 kontrollskjema are kept in one archive binder in the geochemical draughting room. They are stored first in alphabetic sequence of map sheet name and second in alphabetic sequence of element symbol within each section. Four sections are established comparable to the four-fold classification on table 3. Map sheet NAMSSKOGAN needs two sheets for the kontrollskjema since there are so many different oppdrags involved. Each kontrollskjema specifies exactly which map sheet and element it concerns and the draughtsman/woman regularly fills in the progress achieved according to the set of instructions (appendix 4). Thus the kontrollskjema integrates and records the progress achieved, it being assumed that the samples were correctly sampled, analysed, located and plotted by the respective workers. When all the items are complete a geochemist certifies that all is in order by signing the "godkjennelse" and then the map is ready for publication.

I. 7 Comments.

Only the production of the regional geochemical maps of Grongfeltet has been described here since the obviously-necessary statistical treatment and geochemical interpretation has so far only been done in connection with specific local ore exploration projects. Thus data treatment and

interpretation ought to be carried out on a regional scale; the results could conveniently be published as map descriptions in NGU's blue "skrifter" series. Even if the data is not exhaustively treated before publication of the map, at least the data available on the maps should be examined for indications of potential ore mineralization of types other than the conventional Cu, Ni, Pb or Zn ores sought in Grongfeltet. Thus for example the Mo stream sediment anomalies on the Røyrvik map sheet ought to be investigated prior to publication of that map (see appendix II)

It is perhaps appropriate at this time to reappraise the need for the production of all 121 maps. Geochemical maps can be useful in a wide variety of fields other than ore-exploration such as agriculture, area planning, geo-medicine and others. However, it is questionable whether NGU's geochemical maps of Grongfeltet, having irregular sample densities and distributions and mostly being drawn on innaccurate topographic base maps, are sufficiently well-suited to justify the continued expense of their production and publication.

It may also be appropriate to review the most beneficial method of production of these maps. No computing work has yet been carried out upon the regional stream sediment data in Grongfeltet. It has taken one or two draughtsmen several years of full-time work to reach the present stage of map production. However, it is likely to take only about two years full-time work for one draughtsman/woman to complete the work with the new streamlined production routine. Theoretically all of these maps could be produced in a couple of hours rather than a couple of years by utilising a modern EDB data storage/retrieval/plotting system. Previous experience of attempts to apply such a system in NGU's geochemical section have been described in "A preliminary assessment of the EDB system NGUSYS with comments on the use of EDB for statistical treatment of geochemical data and the production of geochemical maps" by David C. Smith, 7 April 1975 (reproduced here in appendix 5). Those early attempt were thus not encouraging and suggest that it would take much more than a couple of years at unspecified cost to create a fool-proof EDB system to allow the rapid production of all these maps.

Er ikke med i denne høpi, er det for grunnbort stuff? Tth.

II.1 FIELD WORK

In 1973, regional stream sediment surveys were carried out in three districts : Berg (ANDORSJØEN), S. Tunnsjøen (TUNNSJØEN + NAMS-SKOGAN), and N. E. Røyrvik (RØYRVIK + HUDDINGSVATNET) and a reconnaissance survey was made in the Heimdalshaugen district (HARRAN + NAMSSKOGAN) (see map 1276-02). Field notes are recorded on the routine field cards archived in NGU's geochemical section.

In 1974, stream sediment surveys were carried out in the Skarffjellet - Gaizervatnet district (regional), Fremstfjellet district (detailed) and lower Nesåadalen (reconnaissance). Field notes from all are recorded on the routine field cards. Field notes from a few days prospecting and rock-collecting by the author in the Fremstfjellet district are recorded in appropriate parts of NGU reports 1289/1 og /2.

In 1975, stream sediments were collected in the Reinsjøen/Piggvatn district mostly on a regional scale but with some reconnaissance surveying into the Sanddøla trondhemite. Field notes are recorded on the routine field cards. Field notes from D. C. Smith's prospecting, including a few days mapping, are provided in appendix 12 here. T.H. Tan's prospecting/mapping work is noted in his report of December 1975 included here in appendices 10 & 27.

Field workers in 1974 and 1975 were as follows:

1974: Smith + Sjørdal + 2 temporary assistants (Solberg + Sandberg).

1975: Smith + Ekremsæter + Tan (from Grong Grube A/S) + 1 temporary assistant (Gravbrøt)

All samples collected are recorded in appendix 31.

II.2 STREAM SEDIMENTS

II.2.1 Introduction.

The most important Mo + Cu results from the 1974 regional survey (oppdrag 1276), detailed survey (oppdrag 1289) and reconnaissance survey (oppdrag 1289) (see map 1276-02 for locations) were recorded briefly in NGU report nr. 1289/1. They were discussed further in NGU report nr. 1289/2 along

with a full discussion of the Mo, Cu, Pb, Zn & Ni results from all the 1974 surveys and also the 1973 regional surveys (oppdrag 1177) which had not been previously recorded.

The Mo + Cu results from the 1975 regional survey were provided in NGU report nr. 1289/3 where the new Sanddøla - Nesåvatna 1:20 000 base map was presented. Map 1368-08 which was included there simultaneously presents the Mo and Cu results together with the 61 mutingsområder of 1-1-76.

Analytical results are now available for ten elements Ag, Co, Cu, Fe, Mn, Mo, Ni, Pb, V, & Zn from all surveys in the Sanddøla - Nesåvatna district.

II.2.2 Map data.

In order to simplify access to the data from different years, oppdrags and previous reports, all of the maps prepared for this project (a total of 94, are assembled in this report (see list of maps). They are briefly noted below.

Map numbers 1276-01 to -03.

Maps -01 and -02 are 1:250 000 oversikt maps which provide an instant review of all stream sediment surveys in the whole Grong District together with identifying oppdrag numbers, dates and map sheets. The up-to date version (-02) is therefore a key map.

Map -03 shows the new Mo-anomalies revealed by the analysis for Mo in samples collected in previous years. Other earlier samples are still awaiting Mo analysis, so some parts of the map are incomplete (see tables 1 & 2). Three areas on the RØYRVIK map sheet are worthy of detailed follow-up studies, in particular the locality N. E. of Røyrvik habitation, since preliminary data is as promising as the preliminary data in the Fremstfjellet District in 1973. Appendix 11 gives the author's proposal for further exploration in these new districts. Appendix 15 provides a geological key for map 1276-03.

Mo is also recorded from Grynndalsdammen, Tunnstøflyene (appendix 17.)

Map numbers 1289-01 to -26.

These maps provide the analytical data values, symbols and sample sites for 10 elements in the detailed survey over Fremstfjellet on the scale 1:5 000. Special 1:50 000 maps (-18 to -22) show the surrounding regional pattern for 5 elements. Two maps provide data on loss-on-ignition and on stream order which are relevant to an interpretation of the element values. The relationship between element concentration and symbol size on the 1:5 000 maps, given on the maps, is not necessarily the same as on the regional 1:50 000 maps.

Map numbers 1289-27 to -34

These were produced to display data on 4 different elements simultaneously as an aid to interpreting the distribution of Mo and Cu with reference to the distribution of Mn and Fe. They were also produced as an experiment in cartography and have been widely welcomed as an advance in visual display of geochemical data. This aspect is described in section II. 2. 3.

Map 1289-34 provides sample localities for the rocks of oppdrag 1368.

Map numbers 1368-01 to -12

These maps on the scale of 1:20 000, drawn from NGU's air photograph mosaic over the Grong District, present the data from the Sanddøla - Nesåvatna district more clearly than is possible on the 1:50 000 scale regional maps. They provide data from all of the different surveys which came within the bounds of the map (which has almost the same longitude boundaries as the NGO series M711 1:50 000 map sheets ANDORSJØEN and NAMSSKOGAN and has latitudes selected to just include the Sanddøla and Nesåa rivers) except for the detailed survey at Fremstfjellet (oppdrag 1289). Data from the latter are presented on the maps from oppdrag 1289 described above. The surveys included on these maps are therefore :

<u>Year</u>	<u>Oppdrag</u>	<u>District</u>
1973	1177	Berg
1973	1177	Heimdalshaugen
1974	1276	Skarfjellet - Gaizervatnet
1974	1289	Nesådalen
1975	1368	Reinsjøen/Piggvatn

This set of maps provides data on sample sites, and on Mo and Cu in stream sediments with the author's new plotting technique utilising crosses (appendix 13), and displays two muting proposals - that proposed by Smith (20-11-75) and that enacted by Haugen (1-1-76). Also provided is a compilation of Gale's 1:20 000 geological maps from NGU report nr. 1293 (map -09) ^(see appendix A15-2) and raw data for an investigation of the relationship between the altitude of stream sediment sites and element concentrations ^(map -10) (cf. appendix 6). *Appendix 18 provides a list of element concentration districts (cf. p 26 in NGU report 1289/3).*

Map numbers 1546 - BEKK.

Part I of this report described the production of 1:50 000 regional stream sediment geochemical maps over the Grong District and presented examples of 20 finished maps in which the chemical data is displayed in the form of circular symbols according to standardised element concentration: symbol size relationships (table 4). The raw chemical data for the two maps (ANDORSJØEN and NAMSSKOGAN) which cover the Sanddøla - Nesåvatna district (maps 1368-01 etc.) is archived on chemical data sheets in many different locations because of the diverse oppdrags and years of field work and of analysis. In order to provide the necessary data in a more accessible form, 20 maps (10 each for ANDORSJØEN and NAMSSKOGAN) giving the element concentrations for 10 elements are presented here. The sample site numbers are given on the following "prøvenummer" maps (see below). Chemical data for the remaining 9 map sheets in Grong District are not included here since they are not so directly concerned with the Sanddøla - Nesåvatna district.

In order to record the precise extent of stream sediment sampling in Grong-feltet, and to clarify the distribution of oppdrags- and map sheets summarised in table 1, "prøvenummer" maps of all 11 map sheets are also included here.

Map numbers 1573-01 to -04.

These four maps were prepared as part of an investigation into the optimum sampling density of stream sediment surveys which is described in section II. 2. 4.

Map numbers 1573-05 to -14.

Cu and Mo are the only elements plotted to date on the 1:20 000 maps (see maps 1368-01 to -12 above). Regional 1:50 000 maps of the other 8 elements are not yet complete for the NAMSSKOGAN map sheet (see table 3). However, the southern part of the NAMSSKOGAN sheet and the northern part of the ANDORSJØEN sheet are complete. These have been combined on to a set of special 1:50 000 maps which cover exactly the same area as the 1:20 000 maps and are presented for the elements Ag, Co, Cu, Fe, Mn, Mo, Ni, Pb, V and Zn on map numbers 1573-05 to -14 respectively. The relationship between element concentration and symbol size is the same as given in table 3 and on all other 1:50 000 maps.

II. 2. 3 An experiment in the cartographical presentation of geochemical data.

Geochemical maps commonly show data from only one element. Cartographical research is in progress in various geochemical institutions in the world in an attempt to devise an optimum method for presenting multi-variable geochemical data simultaneously, which would greatly assist in the interpretation of geochemical surveys. However, no single technique has yet received consensus support.

At NGU it is conventional to plot circular symbols for one element with the size of the circles representing metal concentrations. Two elements, Mo and Cu, were of most interest in this exploration project in southern Grongfeltet, and thus the author decided to devise a suitable technique for easily presenting data on two or four elements simultaneously.

Instead of the conventional circular symbols, sample sites are indicated by crosses with one axis per element. The crosses have constant length (7 mm) and their thickness represents the metal concentration according to a scale provided with the frequency distribution diagram. The cross shape "+" or "X" was considered slightly superior to an alternative "L" shape.

It was found convenient to use two thicknesses per tenth power and thus the 6 thicknesses available commercially suitably cover 3 tenth powers which is generally adequate. The ppm ranges for each element were chosen such that the median for the element distributions lay between the 3rd and 4th thicknesses, thus providing a comparable density of the different thicknesses for different elements.

Cu + Mo were first draughted on to the usual base map (1289-002) to yield map 1289-27, but Mn + Fe (inclined at 45°) were plotted on a plain transparent overlay (1289-29). This overlay was then reproduced with a base map underlay (1289-002) to yield a map (1289-30) upon which the frequency curves for Mn and Fe were drawn (1289-31). Map 1289-32 was produced by copying the Mn + Fe overlay (1289-29) with the Cu+Mo underlay (1289-27) to yield a 4-element map (1289-32) upon which the remaining two frequency curves were drawn yielding the final product (1289-33).

The production technique was considered satisfactory but is capable of improvement. In particular the sample sites on the overlay can be located more precisely to ensure that the crosses are superimposed accurately. Instead of constructing crosses from commercially-available lines, suitable crosses or at least ready-prepared lines of appropriate length could be ordered commercially.

One of the reasons for developing this plotting technique is that these kinds of lines and crosses are particularly suitable for certain computerised drawing machines such as the Kingmatic at NTH. Thus a computer system could easily be developed for reading large amounts of chemical data and plotting selected elements and combinations of elements. The 90° and 45° angles of the lines could be changed and perhaps more than four elements could be plotted, though six would appear to be a maximum to preserve the usefulness of the technique. The technique of utilising the thickness of lines to represent concentration is considered superior to using the length of lines as is done on some geochemical maps in the British Geological Survey, since the latter causes considerable interference and confusion between the different sample sites.

It is considered that this new plotting technique has useful advantages over the conventional technique of plotting circular symbols. It is thus recommended for implementation, in its present or a modified form, as a routine technique in the production of geochemical maps and certain kind of geological and geophysical maps.

Map 1276-03 exhibits the use of a lines instead of circles to represent just one element and shows that line symbols are well-suited to the presentation of closely-spaced sample sites which would be totally obscured by circular symbols.

II. 2. 4 A comparison of sampling densities and distributions of different techniques of stream sediment surveying.

NGU uses two major techniques of stream sediment surveying : 1) "road-sampling" by which two samples are collected from every stream intersecting every road such that all sampling sites are easily accessible by car, 2) "mountain-sampling" by which the samplers leave roads and walk into the mountains, often for many days, and collect one sample every 250 m upstream every stream greater than a certain very small size. The advantages of the two techniques are that a greater distance can be covered per unit time by "road-sampling", whilst a more uniform and meaningful sampling distribution can be obtained by "mountain-sampling". Mountain-sampling was employed in NGU's Grongprosjektet whilst car-sampling was employed in NGU's Blyprosjektet. Both projects involved many years, thousands of samples and great cost, and now that both are completed one could make a useful cost/benefit analysis of the two sampling techniques.

As a first step, a preliminary investigation was started with the RØYRVIK map sheet since this map sheet has the greatest extent of surveying with the "mountain-sampling" technique and also has the greatest number of roads on the map sheets from the Grong District.

The element Cu was arbitrarily selected. Map 1573-01 records the "road-sampling" data from oppdrag 905 in 1969, including some sampling by boat at lakesides. Map 1573-02 records the "mountain-sampling" data from numerous oppdrags from 1964 to 1973 (see map 1276-02). Map 1573-03 records both sets of data and is not significantly different from map -02. Road- and lakeside-sampling is, however, useful when carried out prior to mountain-sampling as is usually the case.

Map 1573-04 shows the sampling distribution which would have occurred if the road- and lakeside-sampling of 1969 had been more complete (compare map 1573-02).

The cost of sampling and analysis, and the benefit from the results from mountain-sampling are considerably greater than the cost of sampling and analysis, and benefit from car-sampling but both probably have similar benefit per unit cost. It is the opinion of the author that both techniques are inefficient because of a too-high density of samples. In particular a) mountain-samplers tend to concentrate on streams near to their camp-site and thus tend to saturate some drainage basins whilst hardly touching others thus creating inhomogeneous sample distributions and b) car-samplers often take samples from several nearby streams of similar size and underlying bedrock which do not provide much extra information than any one of them alone.

It is suggested that in future

- i) An effort is made to restrict sampling to streams within a more restricted stream order range, i.e. excluding rivers (greater than stream order 5) and drainage channels (smaller than stream order 3). In this connection one can examine map 1289-25 which shows 282 samples from stream orders 1 - 5 of which 50 are from stream orders 3 - 5. If collected for a regional survey with a density slightly lower than one per 250 m along only stream orders 3 - 5 then about 20 samples would have been collected and it is suggested that this would be an optimum number. The Fremstfjellet survey was of course not a regional survey; sampling all first and second order streams is considered fully justified in this detailed survey.

- ii) Topographic maps or air photographs should be examined beforehand, if available, such that sample sites can be selected beforehand as much as possible. This would lead to a more uniform and scientifically - useful selection of sample sites, and would assign this important selection to the geochemist in charge, rather than to the relatively inexperienced field samplers. Indeed a lack of adequate preparation is probably the greatest single cause of inefficiency in stream sediment surveys which are often not regarded as sufficiently important scientifically to justify proper scientific management.
- iii) The "mountain-sampling" technique involves taking one sample every 250 m (or another fixed distance) up each stream and taking two at every stream junction (one in each stream immediately above the junction). Since a junction is not often exactly 250 m above the preceding sample site, then the average inter-sample distance is obviously reduced which results in a greater sample density than might be expected or desired. Sampling per unit distance is therefore inefficient, except in long stretches of a stream devoid of tributaries, and should be discontinued. Sampling should therefore be restricted to stream junctions. This would be even more efficient in terms of time in the field, especially when many field parties comprise two samplers, since both could sample simultaneously in the streams immediately above the junction. Furthermore this rule would be less ambiguous to inexperienced samplers, as are, unfortunately, most stream sediment samplers employed during summer field seasons in Norway.
- iv) "Road-sampling" could be improved
 - a) by reducing the number of streams sampled by cutting out the lower order streams, and closely-spaced higher-order streams, b) by walking (if possible) upstream to the first stream junction and to take samples in each stream rather than to sample only just above the roadside, c) by walking into the mountains to take samples, in areas inaccessible by road, with a density comparable to the car-sampling.

Such a sampling plan would provide a valuable reasonably-uniform coverage over the whole map-sheet with considerably reduced field, analytical, and data treatment and production costs compared to a full mountain-sampling survey but would provide geochemical information almost as valuable.

This sampling plan can be refined by a detailed statistical study and a more detailed cost/benefit analysis of the area to be surveyed ^{with reference to} the precise purpose of the survey.

II. 2. 5 Comparison of Stream Sediment, Moss and Bank Samples.

In order to carry out a preliminary investigation into the comparative geochemical characteristics of stream sediment, moss and stream bank samples, all 3 sample types were collected at five normal stream sediment sites in Rettbekken in Fremstfjellfeltet (oppdrag 1289). The moss and bank samples were also ashed, $> 180 \mu$ and analysed $< 180 \mu$ (appendix 13-1).

The sampling technique and analytical data are provided in appendix 13.

Preliminary inspection of the Pb, Zn, Mo & Cu data reveals the following relationships of hot HNO_3 -extractable metal concentrations:

- 1) Moss $\gg$ Bank in 100% of cases
- 2) Moss $\gg$ Sediment $\gg$ Bank in 75% of cases
- 3) Moss Ash $>$ Bank Ash in 95% of cases
- 4) Moss Ash $>$ Bank Ash $>$ Moss $>$ Bank in 75% of cases
- 5) the duplicates generally gave a good reproducibility
- 6) the moss samples give higher loss-on-ignition (range 33-59%) than the bank samples (range 22-45%), bearing in mind that these are $\div 180 \mu$ samples (appendix 13-1) and thus do not include the moss leaves. $\int$ As an example of the most common relationship between the different samples, the Cu values for stream sediment sample site 37 are listed here.

Moss Ash	$>$	Bank Ash	$>$	Moss	$>$	Sediment	$>$	Bank	site nr. 37
2650	$>$	2010	$>$	900	$>$	720	$>$	505	ppm Cu

It appears from this data that a stream survey based only on moss samples or only on bank samples may give a pattern of element distributions over about 75% similar to a survey based only on sediment samples. The difference of up to 25% of relationships may be sufficient to mislead the investigator in consideration of local anomalies but will be of less consequence for the overall survey.

Having established that a difference exists, the next question is : - which of these sampling media most accurately represents the distribution of elements in the underlying bedrock ? NGU has insufficient data to answer this important question. SGU has a large amount of data which

they regard as evidence that bank sampling of organic material is superior to midstream sampling of sediment (see J.-O. Larsson, Journal of Geochemical Exploration, 1976, vol 6, no. 1/2 p 233 - 250). Moss-sampling has not been adequately tested in Scandinavia; on the basis of the data described here from Rettbekken, and from Storvatnet (Gaizervatn) (see section II.4) the author suggested that moss-sampling may have application in certain topographic environments (see D. C. Smith, Journal of Geochemical Exploration, 1976, vol 5, no. 3, p 338, in appendix 7 here).

II. 2. 6 Stream Sediment Fractions - Special Investigation.

Stream sediment samples ^{mainly} consist of a mixture of silt, clay and organic material. The proportions vary considerably from site to site. In order to examine the distribution of metals between the heavier and lighter fractions of this mixed material, special investigations were carried out in the field and in the laboratory. The results are given in appendix 14.

Preliminary inspection of the results of separating three fractions by wet separation (appendix 14-1) show the following features in the case of hot HNO_3 -extractable metal concentrations in the four elements Pb, Zn, Mo & Cu.

- 1) For all sample sites and all elements there is a consistent trend of increasing metal content from the heaviest (silt) through to the lightest (organic + ? clay) fraction.
- 2) The ratio of metal concentrations lightest/heaviest varies widely between elements (e. g. less than 2 for Ni but up to 10 for Cu) but is less variable for one element at different sites.
- 3) For Mo and Cu the ratio lightest/heaviest is mostly between 4 and 9. Thus the ratios lightest/mixed and mixed/heaviest generally lie between 2 and 3.

- 4) As expected the element concentration in the normal stream sediment always has values between those of the lightest and heaviest fractions.
- 5) One can deduce that, depending on the composition, a normal stream sediment sample may have a Mo or Cu result up to 3 times too high or too low compared to a hypothetical standardised mixed material of average heaviest/lightest fraction ratio.

Preliminary inspection of the results of separating three fractions by dry separation (appendix 14-2) show the following features in the case of the four elements Cu, Zn, Mo & Pb.

- 1) The highest metal concentration is always in the middle fraction for all elements and all samples, with the exception of Mo and Pb in samples 2028 & 2029.
- 2) The heaviest fraction tends to give metal values randomly higher or lower than the lightest fraction.
- 3) The wet and dry separation techniques clearly separate according to different qualities of the sample material.

The last point is particularly evident in the loss-on-ignition data (appendix 14-3) which mainly reflects the organic content, but also to some extent the clay content. Here one can see that the loss-on-ignition is always associated with high metal concentrations.

It is suggested that this data is examined more closely with a view to clarifying the influence of the composition of normal stream sediment samples. The sampling technique should then be revised accordingly in an attempt to improve the reliability of stream sediment surveys.

II.2.7 Reliability of Stream Sediment Surveys

- Different samplers and analysts.

The Sanddøla - Nesåvatna district has been surveyed with regional stream sediment sampling in three different years with different field samplers. These diverse samples have been treated and analysed by the same techniques but over a period of three years by different analytical staff. Thus in order to combine the data for scientific interpretation it is necessary to examine the precision and accuracy of the different batches of data.

As a first stage in this program, 15 dried and sieved samples were selected from each of the four oppdrag involved as follows.

<u>Sample number</u>	<u>Oppdrag</u>	<u>Year</u>	<u>Field samplers</u>	<u>Field dates</u>	<u>Analytical dates</u>	<u>Analysts</u>
21- 23	1177	1973	Ekremsæter	8/6-73	3/7 -17/12.74	TW-ER-EB
135- 137	1177	1973	Elstad	12/6-73	3/7 -17/12.74	ER-EB-TW-TS
449- 451	1177	1973	Ekremsæter	18/6-19/6.73	3/7 -17/12.74	ER-EB-TW-TS
2001-2003	1177	1973	KG/EG (Skorovas)	25/6-73	17/12.73-29/4.75	EB-TS-TT
3110-3112	1177	1973	Elstad	2/8-73	5/3.74-29/4 .75	TS-HT-TT
48- 51	1276	1974	Sørdal+Sandberg	11/7-74	2/9.74-31/1 .75	KB-TS
140- 141	1276	1974	Sørdal+Sandberg	17/7-74	17/10.74-31/1.75	DS-TS
281- 285	1276	1974	Sørdal+Sandberg	30/7-74	17/10.74-31/1.75	DS-TS
311- 314	1276	1974	Sørdal+Sandberg	1/8-74	17/10.74-31/1.75	DS-TS
55- 57	1289	1974	Smith + Solberg	13/7-74	30/8.74-15/1 .75	KB-TS
93- 95	1289	1974	Smith + Solberg	14/7-17/7.74	30/8.74-15/1 .75	KB-TS
115- 118	1289	1974	Smith + Solberg	17/7-74	30/8.74-15/1 .75	KB-TS
296- 297	1289	1974	Smith	20/8-74	23/9.74-29/1 .75	DS-TS
310- 312	1289	1974	Smith	25/8-74	23/9.74-29/1 .75	DS-TS
321- 325	1368	1975	Ekremsæter + Gravbrøt	29/7, 1/8 8/8 75	21/1.76-29/1 .76	TW-HT
341- 350	1368	1975	Ekremsæter + Gravbrøt	8/8-10/8-75	21/1.76-29/1 .76	TW-HT

DS = David Smith
TS = Torbjørn Sørdal
KB = Kirsti Buvarp
TW = Tore Wolden

HT = Hans Thoresen
EB = Eva Brorson
TT = Trond Thorvaldsen
ER = Eva Rannov

These 60 samples were then prepared for analysis and analysed all in one new batch. The new analytical values for 10 elements are provided in appendix 34 along with the original values for comparison.

Comparison of the new and old values for each element in each sample will provide a) an estimate of the reproducibility of the analytical technique and b) an indication if this reproducibility is significantly different with different analysts or different dates of analysis.

Preliminary inspection reveals a reasonably good, and often remarkably good, correlation between the new and old analytical values for all 10 elements in all 60 samples with only minor exceptions, particularly in the case of some high Fe concentrations and some low Mo concentrations.

In view of the only moderate reliability of the sampling technique in stream sediment surveying, as described in sections II. 2. 6 and II. 2. 8, the evidence here shows that any errors due to the reproducibility of the analysts or their analytical technique are relatively insignificant.

II. 2. 8 Reliability of Stream Sediment Surveys

- Multiple Sampling and Grain Size Fractions and Comparison with Organic-Rich Stream Bank Sampling.

In an attempt to assess the reliability of NGU's routine technique of taking only one stream sediment per site, multiple sampling was carried out over a short distance in one particular stream with known high values for at least one metal.

The selected stream is at Snertingdal in the Gjøvik district where NGU has carried a considerable amount of geochemical, geological and geophysical exploration, particularly for Pb. The stream is the one in which lies NGU's drill hole number 3, (see Bjørlykke, A. ; Bølviken, B. ; Eidsvig, P. and Svinndal, S. : "Exploration for disseminated lead in southern Norway", Prospecting in areas of glacial terrain, ed. Jones, M. J. , MIMM, 1973.

The chosen site was approximately 100 m upstream of the drill hole, from just above the entrance of a minute stream from the west up to a point where a fallen tree lay over the stream. Over this distance of 25 metres one mid-stream sample was taken every metre and wet-sieved into three separate fractions in the field. All samples were taken on the same day (1-6-74) by the same worker (Smith) with the same equipment (NGU's standard field sieve) under stable weather conditions (dry).

Further details of the stream are listed below.

channel width	- ca. 70 cm
water depth	- ca. 10 cm
water velocity	- slow
water level	- medium
sediment colour	- brown
composition	- gravel > sand > silt > clay > organic
bedrock outcrops	- none
loose boulders	- some

Organic-rich bank samples (of section II. 2.5) were also collected alongside each stream sediment sample. At each site, 1 m apart, one sample was collected at water level from the right bank when looking upstream. The live vegetation cover, about 1 cm of moss, was first removed and then the bank material lying from 0 to 5 cm above water level, from 0 to 5 cm into the bank, and from a distance of 10-15 cm along the bank was dug out with a handtrowel. In contrast to the stream sediment samples, the stream bank material had a composition: gravel < sand < silt < clay < organic. The first five samples (1026-1030) were wet sieved in the field into the same three fractions as the stream sediments. However, this proved impracticable so the remaining twenty samples were only collected in the field and were dry-sieved in the laboratory into three fractions.

The samples and fractions available are listed below.

<u>Year</u>	<u>Oppdrag</u>	<u>Sample number</u>	<u>Size fraction</u>
1974	1257	X 1001 - 1025	$\pm 180\mu$
1974	1257	Y 1001 - 1025	$+ 180\mu - 600\mu$
1974	1257	Z 1001 - 1025	$+ 600\mu$
1974	1257	X 1026 - 1050	$\pm 180\mu$
1974	1257	Y 1026 - 1050	$+ 180\mu - 600\mu$
1974	1257	Z 1026 - 1050	$+ 600\mu$

All samples were dry-sieved and subsequently analysed in an identical fashion.

Analytical results for hot HNO_3 -extractable Pb, Zn and Cu for all 50 X and Y fractions are provided in appendix 35.

The bedrock here is Upper Ringsaker Quartzite which frequently contains Pb mineralisation. Previous stream sediment, mineral soil and humus samples all showed significant Pb concentrations in the range 100 - 1000 ppm.

The role of four variables can be examined in this data i) 25 different sample sites, ii) 2 different sampling media, iii) 2 different size fractions and iv) 3 different elements. The last can be suitably studied by correlation analysis. The first three can be conveniently studied by calculating standard deviations and by an analysis of variance. Preliminary inspection of the data reveals the following points.

i) Statistical reproducibility of the results for the same size fraction and same sample type but 25 different samples.

a) Stream Sediment $\pm 180\mu$.

These show a very wide variation from 260 ppm to 1400 ppm Pb over a distance of only 8 metres. Zn shows an identical pattern to Pb in terms of the samples with highest and lowest values. Cu does not show a similar pattern but this is probably due to its overall low values.

b) Stream Bank $\pm 180\mu$.

These show a smaller range of values for Pb, 180 - 660 ppm. Again the highest and lowest Zn values tend to correlate with those of Pb whilst those of Cu do not.

c) Stream Sediment $+ 180\mu \pm 600\mu$.

These coarser stream sediments, also show a smaller range of values for Pb, 140 - 400 ppm, and both Zn and Cu show very little variation.

d) Stream Bank $+ 180\mu \pm 600\mu$.

The coarser stream bank samples show a similar ^{but wider} range of Pb values to both b) and c) above, 130 - 770 ppm, whilst Zn and Cu are again relatively constant.

ii) Comparison of 2 different sampling media.

a) $\pm 180\mu$ fractions.

The five stream sediment i.a) and five stream bank samples i.b) show similar relationships between Pb and Zn but the Pb values of the former are approximately twice as high as those of the latter; with Zn the ratio is somewhat less; with Cu the values are essentially the same. However, the lowest and highest values in each sampling media do not correspond.

b) $+ 180\mu \pm 600\mu$ fractions.

The coarse fractions of each sampling medium tend to yield comparable metal ranges for each metal but again the lowest and highest values do not correspond.

iii) Comparison of 2 different size fractions.

a) Stream Sediments.

The finer samples clearly yield higher metal concentrations than the coarser and this is maintained in the different elements. There is a close correspondence between the lowest and highest values.

b) Stream Bank.

These show less distribution between the two size fractions. Again the lowest and highest values correspond.

From this preliminary investigation one can tentatively conclude that:

- 1) Fine-grained stream sediments have the advantage of higher metal concentrations than coarse-grained stream sediments but have the disadvantage of a wider range of values. Both give corresponding anomaly patterns.
- 2) Both stream bank sample fractions tend to give similar metal values and ranges as the coarse stream sediments but they do not give corresponding low/high relationships. Thus a stream bank sample and a stream sediment sample collected alongside are no closer related to each other than to other bank or sediment samples
- 3) The wide range of metal values in the same sample type and same fraction clearly reflects differences in the composition of the samples. This is especially marked in the fine stream sediments where differences in the organic : clay : silt : ratios cause up to a factor of 5.4 difference in metal values. This value is comparable to the factor of 4-9 indicated by the investigation of stream sediment fractions described in section II. 2.6. It supports the working hypothesis given in section I.3 that a factor of ^{about} 9 (3x greater or smaller than the average) is typical for the reliability of stream sediment metal concentrations as determined by NGU's routine sampling and analytical technique.

II.3 SOIL.

In 1974 5 soil samples were collected in the Gaizervannet district (oppdrag 1276, samples 1001 - 1005). Their field locations (map 1289-23) and analytical data for 10 elements are given in NGU report 1289/2. The analytical data is reproduced here in appendix 28.

In 1974 20 soil samples were collected over the Cu deposit at Amøbetjernet (oppdrag 1289, samples 1021 - 1040). Their field locations are provided on maps 1289-08 to -12 along with analytical data for Mo, Cu, Ni, Pb and Zn which are discussed in report 1289/2. Analytical data is now also available for Ag, Co, Fe, Mn and V and is provided in appendix 29.

In 1974 organic-rich stream bank samples, which are related to soil horizons, were collected in Rettbekken (oppdrag 1289, samples 1001-1020) and are described in section II.2.5

In 1975 24 soil samples were collected in the Sanddøla - Nesåvatna - Gaizervatnet district (oppdrag 1368, samples 3001 - 3037). Field and analytical data for 10 elements in these and 13 other samples of secondary media (moss, organic film, plant, gravel) are provided in appendix 30.

The most interesting results from these samples have been described in report 1289/3. *The organic film yielded the highest Mo content of any secondary media in Grangfallet (1260 ppm, appendix A30, sample 1368 - 3015).*

II.4 MOSS.

In 1974 a few moss samples were collected in Rettbekken (oppdrag 1289 samples 1001 - 1020) for a comparison with stream sediment samples and organic-rich stream bank samples. They are described in section II.2.5.

In 1975 a few moss samples were collected in the Gaizervatnet district (oppdrag 1368, samples 3001 - 3037) ^{partly} for a successful clarification of previous stream sediment anomalies suspected of being false (see report 1289/3).

The analytical data for 10 elements is available here in appendix 30. Samples from both locations were mentioned in the publication listed as (f) in appendix 1.

II. 5 BEDROCK.

II. 5. 1 Assaying.

Altogether 47 rock samples from oppdrags 1289 and 1368 have been analysed by optical emission spectrography for the ten trace elements Ag, Co, Cu, Fe, Mn, Mo, Ni, Pb, V, Zn and sometimes for Cd and Ti, (tables 5 - 7).

A further 76 rock samples from oppdrag 1289 (the 1974 field investigation in the Fremstfjellet district) have been analysed by atomic absorption spectroscopy for hot HNO_3 -extractable Cu, Mo, Pb and Zn (table 8).

Then a further 75 rock samples from oppdrag 1368 (the 1975 field investigation in the Sanddøla - Nesåvatna district) have also been analysed by atomic absorption spectroscopy for hot HNO_3 -extractable Cu and Mo (table 9).

The results in tables 5 -8 have been mentioned at various stages in reports 1289/1, 1289/2 and 1289/3.

The samples listed in table 9 were selected either a) for establishing if Mo and/or Cu existed in diverse rock types such as fresh trondhjemite or pyritised schist in which no mineralisation could be seen or b) for assaying the quantity of Mo and/or Cu in rocks with visible mineralisation.

The value of this analytical programme will be maximised by a detailed comparison of the analytical data with a close study of the hand specimens and their locations, but this unfortunately cannot be attempted^{just} now. It can however, be noted that: -

- i) The richest Cu occurrences are at Amøbetjernet and Kroktjernet as described in report 1289/3, the former showing up to 30% Cu metal and the latter up to 2.6%.

X-ray diffraction studies were carried out on two ore samples from Kroktjernet, and on two from Amøbetjernet.

The results confirmed the presence of the following minerals in addition to pyrite and magnetite.

<u>X-ray film</u>	<u>Sample</u>	<u>Locality</u>	<u>Minerals</u>
7045	1368 - 1144	Kroktjernet	Chalcopyrite
7044	1368 - 1149	Kroktjernet	Chalcopyrite
7041	1368 - 1254	Amøbetjernet	Chalcopyrite + Molybdenite
7027 } 7028 }	1368 - 1256	Amøbetjernet	Chalcopyrite + Molybdenite

Despite the occurrence of silver, blue, violet and red colours which appear to be distinct from chalcopyrite or molybdenite, no other Cu or Mo or any Ag minerals were reported ^{by X-ray diffraction} from either locality.

- ii) Localities showing over 1% Cu are listed below (see maps 1368-08 and -12). Apart from Amøbetjernet which contains substantial Mo, but not in typical Mo gullies, all of these Cu occurrences are not related to the various Mo occurrences described below.

<u>Locality</u>	<u>Table</u>	<u>Samples</u>
Amøbetjernet	7	1368-1250, -1256, -1260; 1289-3032
	8	1289-3032, 3034, 3036, 3038
Kroktjernet	7	1368-1151, -1149
	9	1368-1147, 1152, 1155
Fremstjernet	9	1368-1038
Skarfjellet	9	1368-1191, 1192
Gaizervatnet	9	1368-1215
Reinsjøen	7	1368-1268
Reinbekken	9	1368-1267

- iii) A large rust zone on the northern face of Skarfjellet can be seen from the col between Skarfjellvatnet and Reinsjøen. It has not yet been visited but it may well be comparable to the pyrite zones on the south face of Skarfjellvatnet and thus may account for the Cu stream sediment anomalies east of Skarfjellvatnet (map 1368-08).

- iv) > 1000 ppm Mo occurs over distances exceeding 100 m at four main locations (map 1289-08): -

Nålbekken (table 9 1368-1164, table 7 1368-1117)

Smaltjernet - Lavtjernene (table 9 1368-1168, 1199, 1201, 1203;
table 7 1368-1166)

Nedrebekken (table 9 1368-1181, 1185, 1188, 1189, 1190)

Stuttbekken (table 7 1368-1127)

all of which show some features of the special Mo gullies described in NGU report 1289/3 and published in no. (g) in appendix 1.

- v) > 1000 ppm also occurs in a ^{(1368-1091)(table 9)} loose block above Myrbekken and such blocks, almost certainly in situ nearby, may account for the Mo stream sediment anomalies in Myrbekken (map 1289-08).
- vi) Most of the anomalous Mo streams north of the line between Myrbekken and Lavtjernene can therefore be accounted for by moderately-rich Mo mineralisation of the type discovered already. However, it is virtually certain that the extent of this mineralisation within this area is far more widespread than the few scattered discoveries made by sledgehammer work or by blasting.
- vii) Mo mineralisation on Fremstfjellet and in Rettbekken and Brattbekken (map 1289-08) was reported in NGU reports 1289/1-3 (see table 8 here, samples 1289-3003 & 3005, 3061, 3066) (Fremstfjellet), 3049 & 3051 (Rettbekken) and 3044 & 3047 (Brattbekken).
- viii) Mo mineralisation has not yet been found in Tretjernbekken or in Trappebekken (map 1289-08) but this area has not been exhaustively prospected yet. MoS_2 in the underlying bedrock is exceedingly probable.

- ix) Mo mineralisation at Amøbetjernet was reported in NGU reports 1289/1-3 (see table 5 sample 1289-3038, table 7 samples 1368-1256 & 1260, table 8 samples 1289-3034 & 3038).
- x) > 1000 ppm Mo is proven on Nesåpiggen (table 7 samples 1368-1309 & 1311).
- xi) 500 ppm Mo occurs in a loose block at the western end of Langløftvannet (table 7 sample 1368-1225).
It must be assumed to exist in situ in the hillside above, since significant Mo stream sediment anomalies exist here (map 1368-08) and appropriate geological conditions exist here (i. e. a contact of a substantial trondhjemite against greenstone). This area has equivalent economic potential to the Fremstfjellet and Nesåpiggen Mo mineralised districts and the author has consistently been recommending that this district west of Langløftvannet is muted (see appendix 9).
- xii) Mo mineralisation is proven south-east of Gaizervatn (table 7 sample 1368-1223, table 9 sample 1368-1224).
but so far this is not shown to be as rich or as extensive as at Fremstfjellet. Nevertheless the geological and geochemical criteria are virtually identical and if the Gaizervatn district is prospected and blasted as much as Fremstfjellet then it is very likely that more, richer and wider Mo mineralisation will be found.
- xiii) So far the richest (1.44% Mo metal, sample 1368-1166, table 7) and most common Mo mineralisation occurs in the Nålbecken - Smaltjernet - Nedrebekken areas of the Fremstfjellet district and this is the obvious starting point for a drilling program.
- xiv) The wide occurrence of Mo in southern Grongfeltet clearly suggests genetically related Mo activity on a large scale. The absence of discoveries of Mo mineralisation between the presently known occurrences is more likely due to a) a lack of adequate budgets for field searching (sledge hammering, blasting and drilling and to b) geomorphological features which cause Mo exposed at the bedrock surface to be rapidly leached away and accumulated in secondary geochemical media, than to c) an absence of intervening Mo mineralisation. Thus it is deduced that the Fremstfjellet - Gaizervatn zone in southern Grongfeltet is a substantial Mo province.

II.5.2 Bedrock Major and Minor Element Petrochemistry.

The 10 rock specimens selected for chemical analysis of major and minor elements are listed in table 14 along with their locality and general rock type. They include 6 different trondhjemites representing the main types found: epidotised (1108), sericitised (1109), white without MoS_2 (3132), white with MoS_2 (1115), white with MoS_2 and CuFeS_2 (1182) and pink with MoS_2 (3046). Also included are two early basic types - diorite (1141) and microdiorite (1110) - and two late acid types - aplite (1121) and a microporphyry (1163).

Preliminary inspection of the data for 10 major elements (SiO_2 , Al_2O_3 , Fe_2O_3 , FeO , TiO_2 , MgO , CaO , Na_2O , K_2O , MnO) (tables 10 & 13) and 13 minor elements (Y, Sr, Rb, Zn, Ni, Ba, V, Co, Pb, Li, Ag, Mo, Cu) (tables 11, 12 & 13) reveals several significant features which are briefly noted below.

- 1) The 6 trondhjemites are markedly different in terms of Ca, Na and K contents, except that 1108 and 3132 have some features in common.
- 2) The white trondhjemites tend to have high K whilst the pink trondhjemite (and pinkish aplite and microporphyry) tend to have high Na.
- 3) The two trondhjemites which dominate in the field - epidotised (green and unsheared) and sericitised (grey and sheared) - are sharply distinguished in their Ca contents. Since these two types are intimately associated in the field, and such a chemical gradient for Ca is unlikely to result from a metamorphic process, it appears that two distinct intrusions of trondhjemite exist. Their boundaries in the field are, however, sometimes difficult to locate because of the occurrence of transitional petrographic types.
- 4) All of the other 4 trondhjemites and the two other acid rocks have Ca contents close to those in the epidotised or sericitised trondhjemites and thus these are no transitional ^{chemical} types, only high - or low - Ca types.
- 5) All 8 intermediate or acid rocks also tend to belong to either high - or or low - Na types but there are more transitions than with Ca, e.g. 1109. Na and K correlate inversely, excepting 1109,

and thus the sum of Na + K is relatively constant for all 8 rocks. However, the 2 Na types do not correlate with the 2 Ca types.

- 6) MoS₂-bearing trondhjemites are not obviously distinguishable chemically from barren trondhjemites.
- 7) As expected the basic rocks are notably richer in Fe, Ti, Mg, Ca, Mn, Zn, Ni, V and Co. The diorite is considerably richer in Ca and Fe.
- 8) The microporphyry displays some similarities with the epidotised trondhjemite; *they* may be more closely related to each other genetically than to the other rock types.
- 9) The aplite is particularly acid, sodic and rich in Pb.

These few analyses provide a valuable starting point for a petrogenetical study of the igneous rocks in the Sanddøla - Nesåvatna district. Provisional conclusions include : -

- a) the overall chronology is : first basic, then intermediate and finally acid intrusion,
- b) the basic episode includes at least 2 magma types,
- c) the intermediate episode includes at least 2 major trondhjemite types : Ca-rich and Ca-poor,
- d) if the Na and K distribution is ^{of} igneous origin, then there are at least 5 distinct trondhjemite types; this distribution may however have been strongly affected by regional Na- or K-metasomatism,
- e) the aplite is extremely silicic such that late-stage hydrothermal silicification probably took place.
- f) a long and complex igneous and metamorphic history is evident in the Sanddøla - Nesåvatna trondhjemite and its contact rocks; this history is not likely to be unravelled without a substantial commitment to detailed structural, petrographic and geochemical studies.

II. 5. 3 Geology.

The southern part of the Sanddøla - Nesåvatna - Gaizervatn area was mapped by Gale in 1972-1974 (NGU report 1293). In general this geological mapping (and also previous ^{stream} sediment prospecting surveys) ceased at the contact of greenstone and sediment units with the Sanddøla trondhjemite. This is precisely where the most promising Mo mineralisation lies. Available mapping is therefore inadequate for an economic study of the Mo mineralisation. This is exemplified by the fact that the Sanddøla trondhjemite exhibits at least 5 kinds of trondhjemite with additional basic and acid igneous rocks outcropping near the contact with the greenstone and sedimentary country-rocks.

Only a few days mapping were attempted in 1975 since most field work by Smith and Tan involved Mo hunting by sledge hammering and blasting. The relevant geological notes are recorded in Smith's field notes (appendix 12), Tan's preliminary report (appendix 10) and Tan's preliminary map (appendix 27).

The 151 rock samples collected by Smith in 1974 (oppdrag 1289) are listed in appendices 19-20 together with partially complete preliminary macroscopic descriptions.

The 268 rock samples collected by Smith and 50 by Tan in 1975 (oppdrag 1368) are listed in appendices 22-25 together with partially complete preliminary macroscopic descriptions.

All thin sections and polished sections which have been manufactured are listed in appendix 26. Preliminary microscopic examination of the 1974 rock samples is given in appendix 21.

None of these tabulations are complete since none of these subprojects has been completed in the time available. They are to some extent out of date and in error. They are not included here to provide any solid body of data on bedrock geology. They are included here only to avoid losing the data from those samples which have been at least partially studied.

The type of Mo mineralisation (MoS_2 with quartz in pyritised trondhjemite) is described in report 1289/3.

Geophysical surveys have detected major geological units near Reinsiden (magnetic) (see report 1289/3) and the prominent rust zone at Gaizervatnet (VLF, appendix 36).

The contact zone of the Sanddøla trondhjemite clearly needs detailed mapping. In view of the difficulties in the field distinguishing different original rocks which have been altogether sheared, sericitised, epidotised, chloritised, silicified and pyritised it would of great scientific, as well as economic, benefit if the mapping geologist has an opportunity to examine the available thin sections and hand specimens before commencing in the field.

Ø. Pettersen's work in 1974 in the Fremstfjellet district is recorded in appendix 16.

II.6 ECONOMIC POTENTIAL.

The objectives of this project were : -

- a) to confirm the reality of the high Mo-anomalies in stream sediments in the Fremstfjellet district revealed by the 1973 regional survey,
- b) to locate the precise positions of the maxima of the Mo anomalies,
- c) to investigate the cause of these anomalies, in particular to ascertain if it is due to concentration processes in the secondary geochemical media or to primary concentrations which might be of economic interest,
- d) to find primary occurrences of molybdenite mineralisation,
- e) to investigate the nature of the mineralisation in relation to its host rock,
- f) to make an estimate of the economic potential of the Mo occurrences in southern Grongfeltet,

Items a) and b) were achieved by the 1974 follow-up survey in the Fremstfjellet district (oppdrag 1289; NGU reports nr. 1289/1 and 1289/2 (see appendix 1)).

Item c) was discussed in NGU report nr. 1289/3 (see appendix 1) where it was shown that the Mo anomalies in stream sediments are partly due to secondary concentration processes but this only occurs to a significant extent where abundant Mo is available from primary concentrations.

Items d) and e) were satisfied by the field work in 1975 which discovered many localities of molybdenite in quartz-impregnated trondhjemite in the Fremstfjellet district, and at isolated occurrences at Nesåpiggen, Gaizervatnet, Langløftvatnet and Amøbetjernet. Most of the Mo occurrences were discovered by searching for the special gullies described in NGU report 1289/3 and in the author's publication (g) listed in appendix 1. Since ordinary geological hammers and even sledgehammers are inadequate to penetrate the zone of trondhjemite from which Mo has been weathered out, in 1975 several outcrops were blasted. The results (NGU report 1289/3) revealed up to 1.44% Mo metal in narrow veins with promise of this grade continuing at depth.

Having completed parts a) to e) of the project it is necessary to comment on f), the economic potential. Comments have been made previously in many of the reports and notes listed in appendix 1, particularly in NGU report 1289/3. This report presents a considerable amount of data on many different aspects of the project but it has not been possible in the time available to examine properly the available bedrock data. This assessment is therefore of necessity based on a superficial knowledge of the bedrock data and a more thorough knowledge of the data from the secondary geochemical media.

The following comments can be made to conclude this report.

- 1) Mo mineralisation in bedrock is proved to exist in several areas in southern Grongfeltet.
- 2) Mo mineralisation will probably be found in northern Grongfeltet if the new anomalies are followed up.
- 3) The richest Mo mineralisation so far discovered lies at Smaltjernet ^{Nedre bekken} and Nålbebben in the Fremstfjellet district.
- 4) Similarly rich Mo mineralisation will probably be found in the other areas showing Mo anomalies in stream sediments if they are investigated with the same intensity as has happened in the Fremstfjellet district.
- 5) Stream sediments have been shown to be valuable in locating Mo mineralisation in Grongfeltet, but discovery of the primary occurrences requires a search particularly for the special Mo-gullies.

- 6) Dynamiting is necessary to reveal the genuine Mo content in un-weathered trondhjemite.
- 7) There is good reason to believe that Mo-rich quartz impregnations continue at depth but this will never be discovered without drilling at least one hole. (see page 34, point xiii)
- 8) The geological history of the Sanddøla trondhjemite and its contact rocks is more complex than appears on the maps of Foslie and Gale and will not be unravelled without a substantial commitment to structural mapping and detailed petrological studies.
- 9) The ^{genetic} relationship between the Mo mineralisation and the diverse country rocks is unknown in detail; in general the original source was evidently a trondhjemite magma but igneous, metamorphic and metasomatic interactions with the contact rocks apparently played an important role.
- 10) Southern Grongfeltet displays many characteristics in common with typical and untypical "porphyry" Mo and/or Cu districts in North America and the USSR, in particular the association of intermediate to acid plutonic bodies with intermediate volcanic rocks and of molybdenite with quartz and pyrite and occasionally chalcopyrite.
- 11) The chances that further Mo mineralisation exists at depth, if not on the surface, within Grongfeltet must be considered high, and thus adequate to justify further exploration, especially drilling.
- 12) The chances that economically - viable Mo deposits exist are impossible to assess with the present data based on such a small budget.

However, if one is exploring for Mo, as is presumably the ^{fundamental} objective of this whole project in view of the increasing world price of Mo, one could hardly wish for more promising geochemical and geological criteria. MoS_2 is apparently not picked up adequately by available geophysical methods, thus a lack of promising geophysical evidence for Mo mineralisation, such as in appendices 32 and 33, is irrelevant.

Table 1.
BEKKESEDIMENT GEOKJEMISKE KART OVER GRONGFELTET

Kontrollskjema

Korrelasjon mellom oppdrag og kartblad m. h. t. prøvesteder

Årstall	Oppdrag	Prøvenummer		Antall	Sum	Andorsjøen	Brekkevasselv	Grong	Harran	Huddingsvatnet	Limingen	Murusjøen	Namsskogan	Nordli	Røyrvik	Tunnsjøen	§	§§	§§§
		fra	til																
		Prøvetatt ved NGU																	
1964	561	1	1900	1900	-					x x					x				
1964	561	2001	3100	1100	3000					x x					x				
1965	602	1	124	124	-					x x									
1965	602	201	226	26	-					x									
1965	602	301	395	95	245					x x									
1969	905	5001	6856	1856	-	x x x x				x x		x x x x			x				
1969	905	7501	7538	38	1894										x				
1970	974	8001	8478	478	-										x x				
1970	974	8479	8628	150	-										x				
1970	974	8629	9328	700	1328										x				
1971	1075	1	786	786	786	x x									x				x
1972	1122	3001	6312	3312	-	x x x									x				
1972	1122	6501	7014	514	3826	x					x x x x x x				x				x
1973	1177	1	340	340	-						x x				x				
1973	1177	361	374	14	-	x													
1973	1177	441	458	18	-	x													
1973	1177	461	472	12	-	x													
1973	1177	501	1976	1476	-														
1973	1177	2001	2316	316	-					x					x				
1973	1177	3001	3166	166	2342								x			x			
1974	1276	1	396	396	396				x				x						x
1974	1289	283	317	35	35	x							x						
1975	1368	1	360	360	360	x							x						
Total =					14212														
		Prøvetatt ved Skorovas Grube A/S																	
1968	836	510	609	100	-										x				
1968	836	801	933	133	233										x				
1969	912	201	499	299	-										x				
1969	912	501	631	131	-										x				
1969	912	900	952	53	483	x x									x				
1971	x	3000	3999	?	?										x				
Total =					716														

§ prøvene er ikke tatt med p. g. a. at de ligger på kartblad MAJAVATN

§§ prøvene er ikke tatt med p. g. a. at de ligger på kartblad ANDORSJØEN og GRONG

§§§ prøvene er ikke tatt med p. g. a. at de ligger på kartblad NAMSSKOGAN og HARRAN

Table 3.

BEKKESEDIMENT GEOKJEMISKE KART OVER GRONGFELTET.

Kontrollskjema.

Korrelasjon mellom kartblad og element m.h.t.
kart produksjon.

			Ag	Cd	Co	Cu	Fe	Mn	Mo	Ni	Pb	V	Zn
ANDORSJØEN	1823	IV	■		■	■	■	■	■	■	■	■	■
BREKKVASSELV	1824	I				■				■	■		■
GRONG	1823	IV	■		■	■	■	■	■	■	■	■	■
HARRAN	1824	III	■			■	■	■	■	■	■	■	■
HUDDINGSVATNET	1924	I				■				■	■		■
LIMINGEN	1924	II				■				■	■		■
MURUSJØEN	1923	I				■				■	■		■
NAMSSKOGAN	1824	II	■		■	■	■	■	■	■	■	■	■
NORDLI	1923	IV				■				■	■		■
RØYRVIK	1924	IV				■				■	■		■
TUNNSJØEN	1924	III	■		■	■	■	■	■	■	■	■	■

. betyr at tegningsarbeid ikke har begynt.

/ betyr at tegningsarbeid delvis er utført.

▣ betyr at kart er ferdig for utgivelse.

■ betyr at kart er utgitt.

1) Det er 11 kartblad med 11 elementer d.v.s. 121 kart.

2) Utgitte kart:

Årstall:

Antall:

1976

11

1977

1978

1979

1980

Table 4. Regional 1:50 000 Stream Sediment Maps over Grongfjeldet
Correlation between symbol size and ppm concentration range for eleven elements.

[illegible]

TABLE 5.

Chemical Analyses of Rocks - TRACE ELEMENTS

Analytical method - optical emission spectrograph

Date received : 13-8-74

Oppdrag : 1289

Number of samples : 12

Sample type : selected ore-rich chips

Pr. nr.	Co ppm	Ni ppm	Ag ppm	Cu ppm	Cd ppm	Ti ppm	V ppm	Mo ppm	Mn ppm	Pb ppm	Zn ppm	Fe ca. %
1289-3014	6	10	< 1	10	< 300	3000	6	1	100	< 30	20	2
" 3020	30	10	< 1	60	< 300	3000	300	2	300	< 30	15	7
" 3022	60	100	< 1	100	< 300	3000	100	20	2000	< 30	25	9
" 3030	3	30	< 1	6	< 300	3000	200	1	1000	< 30	< 10	13
<u>1</u> " 3038	3	30	100	> 3000	< 300	300	3	1000	30	< 30	< 10	6
" 3041	3	30	< 1	300	< 300	30	3	< 1	10	< 30	< 10	1
" 3044	3	3	< 1	10	< 300	3000	20	300	60	< 30	< 10	2
" 3055	60	3	< 1	600	< 300	3000	10	3	300	< 30	< 10	7
" 3074	30	6	< 1	100	< 300	3000	60	3	300	< 30	340	9
<u>1</u> " 3083	300	300	< 1	> 3000	< 300	3000	100	10	1000	< 30	< 10	20
" 3089	30	30	< 1	100	< 300	3000	100	2	1000	< 30	50	25
" 3109	3	3	< 1	30	< 300	1000	30	< 1	3000	< 30	15	4

TABLE 6

Analytical method - optical emission spectrograph
 Date received - 7-10-75
 Oppdrag nr. - 1289 and 1368
 Number of samples - 6
 Sample type - selected chips

Pr. nr.	Fe	Cu	V	Ni	Co	Pb	Mn	Mo	Zn	Ag
<u>Group 1</u>										
1368-1128	0.35%	60 ppm	i. f.	i. f.	i. f.	i. f.	0.008%	i. f.	10 ppm	1 ppm
" 1131	2.2 %	3 ppm	60 ppm	10 ppm	10 ppm	"	0.08 %	"	80 ppm	"
" 1136	18 %	300 ppm	0.03%	30 ppm	60 ppm	"	0.08 %	"	40 ppm	"
" 1140	5.2 %	6 ppm	0.02%	10 ppm	30 ppm	"	0.05 %	"	70 ppm	"
<u>Group 2</u>										
1289-3029	ca 11 %	0.05%	0.03%	0.015%	20 ppm	"	0.14%	"	80 ppm	"
" 3086	ca 38 %	0.09%	0.08%	0.01%	60 ppm	"	0.07%	"	40 ppm	"

TABLE 7

Chemical Analyses of Rocks - TRACE ELEMENTS

Analytical method - optical emission spectrograph
 Date received - 30-11-75
 Oppdrag nr. - 1289 & 1368
 Number of samples - 29
 Sample type - whole rocks

Pr. nr.	% Mo	% V	% Mn	% Cu	% Fe	% Ni	% Co	% Pb	% Zn	ppm Ag
Group 1										
1368-1026	<0.003	0.005	0.03	0.004	3.6	<0.003	<0.004	<0.01	<0.005	<5
1040	<0.003	0.005	0.1	0.004	30	<0.003	<0.004	<0.01	0.02	<5
1128	<0.003	<0.005	0.02	0.1	5.0	0.01	0.004	<0.01	0.005	<5
1146	<0.003	0.1	0.2	0.7	50	0.02	0.15	<0.01	0.01	30
1151	0.004	0.005	0.1	2.6	40	0.02	0.15	<0.01	<0.005	20
1218	0.004	0.04	0.03	0.05	40	0.005	<0.004	<0.01	<0.005	<5
1222	<0.003	0.005	0.005	0.003	4.7	<0.003	<0.004	<0.01	<0.005	<5
1225	0.05	<0.005	0.005	0.005	3.3	<0.003	<0.004	<0.01	<0.005	<5
1237	<0.003	0.2	0.2	0.1	60	<0.003	0.01	<0.01	0.02	<5
1248	<0.003	0.005	0.005	0.2	5.5	0.003	0.004	6.7	2	150 ⁸⁵
1250	<0.003	<0.005	0.2	30.0	35	<0.003	<0.004	0.017	0.01	170 ¹³⁵
1268	<0.003	0.005	0.1	1.1	25	<0.003	<0.004	<0.01	<0.005	<5
1289-3005	0.09	0.02	0.1	0.5	25	0.005	0.01	<0.01	<0.005	<5
1368-1309	0.10	0.005	0.01	0.002	4.5	<0.003	<0.004	0.046	<0.005	<5
1368-1320	<0.003	<0.005	0.01	0.003	1.3	<0.003	<0.004	<0.01	<0.005	<5
Group 2										
1368-1117	0.49	<0.005*	0.01*	0.003*	3.1	<0.003	<0.004*	<0.01	0.01	10
1127	0.44	<0.005*	0.005*	0.004*	4.0	<0.003	<0.004*	<0.01	0.01	<5
1145	<0.003*	0.12	0.12	0.08	60	0.012	0.008	<0.01	0.01	<5
1149	0.004*	<0.005	0.021	1.92	40	0.02	0.2	<0.01	<0.005	30 ^{3.5}
1166	1.44	<0.005	0.013	0.20	24	0.011	0.004	<0.01	<0.005	<5
1187	0.03	0.005*	0.03*	0.1	3.9	<0.003*	<0.004*	<0.01	<0.005	<5
1223	0.01	0.005	0.004	0.004	3.2	0.003	<0.004	<0.01	<0.005	<5
1246	0.005*	0.039	0.10	0.36	50	0.14	0.008	<0.01	0.005	<5
1256	0.27	0.005	0.039	21.4	30	<0.003	0.004	<0.01	0.01	180 ¹³⁵
1260	0.30	0.005	0.031	1.63	5.3	<0.003	0.004	<0.01	0.01	<5
1311	0.67	0.005	0.009	0.002	3.7	<0.003	0.009	0.024	<0.005	<5
1289-3032	0.02*	<0.005	0.035	27.6	40	<0.003	<0.004	0.017	0.01	120 ¹⁰⁵
1289-3066	1.07	0.005	0.010	0.008	25	<0.003	<0.004	<0.01	<0.005	<5
1289-3083	0.005*	0.031	0.14	0.98	35	0.045	0.009	<0.01	0.01	<5

* Halvkvantitative verdier

Understrekte Ag-verdier : Geokjemi standardmetode atom absorpsjon

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TABLE 8

Chemical Analyses of Rocks - TRACE ELEMENTS

Analytical method - hot HNO_3 -extractable metals by atomic absorption spectrometry
 Date received - 28-4-76
 Oppdrag nr. - 1289
 Number of samples - 76
 Sample type - whole rocks

Pr. nr.	Zn ppm	Cu ppm	Pb ppm	Mo ppm
1289-3003	12	580	20	1010
05	26	2400	20	860
08	1670	278	10	<10
3010	213	59	10	10
12	190	46	10	10
14	40	39	10	<10
16	193	20	30	10
19	80	165	30	<10
20	62	79	20	<10
22	115	174	30	40
24	37	201	30	20
26	29	158	10	10
28	102	38	40	10
3030	33	17	20	<10
32	142	23.1%	130	140
34	50	8.1%	50	810
36	137	23.4%	110	90
38	42	10.7%	60	800
41	5	216	10	<10
42	5	840	10	10
3044	10	1760	10	480
45	11	430	10	40
47	11	2410	10	450
49	8	390	20	310
51	42	245	20	440
53	186	990	40	20
55	77	243	20	10
57	255	248	30	10
59	4	109	10	60
3061	16	42	10	640
62	32	12	20	160
64	66	269	10	10
66	8	107	20	5100
68	94	282	20	90
3070	4	51	10	1350
72	166	206	20	30
74	380	111	20	20
76	34	51	20	10
78	27	280	20	30
3080	39	225	30	50

Pr.nr.	Zn ppm	Cu ppm	Pb ppm	Mo ppm
1289-3083	77	7900	40	40
85	88	650	30	20
87	93	133	30	< 10
89	92	225	30	< 10
91	19	123	20	10
93	42	460	30	10
95	22	127	30	10
97	72	33	40	10
99	43	12	20	10
3102	63	410	40	20
04	87	177	30	20
05	99	660	30	50
07	55	49	60	10
09	50	39	60	10
3111	15	6	20	10
13	32	16	30	10
15	51	18	30	10
17	41	133	30	30
19	46	207	40	10
3121	36	10	20	10
23	23	6	10	< 10
25	31	8	10	< 10
27	9	6	10	< 10
29	11	10	10	10
3131	30	18	< 10	< 10
33	10	9	10	< 10
35	5	5	10	< 10
37	14	15	10	10
39	5	7	< 10	< 10
3141	7	7	10	10
43	10	7	10	< 10
45	9	7	< 10	< 10
47	14	5	< 10	< 10
49	26	7	< 10	< 10
3151	52	9	10	10
53	23	360	10	10

TABLE 9

Chemical Analyses of Rocks - TRACE ELEMENTS

Analytical method - hot HNO_3 -extractable metals by atomic
 absorption spectrometry
 Date received - 20-9-76
 Oppdrag nr. - 1368
 Number of samples - 75
 Sample type - whole rocks

Pr. nr.	Cu ppm	Mo ppm
<u>Group 1</u>		
1368-1001	17	7
15	234	5
22	242	73
27	32	25
31	28	10
33	15	12
47	120	14
1055	7	14
59	10	17
64	14	18
76	11	1
78	11	9
79	246	64
1080	344	76
82	156	12
83	11	20
85	20	46
87	1610	31
1091	18	1030
97	4350	36
<u>Group 2</u>		
1368-1016	10	<10
38	1.27%	<10
99	49	<10
1100	94	<10
04	70	<10
12	365	<10
13	52	15
16	69	380
23	190	850
24	180	<10
26	42	490
29	66	<10
1141	49	<10
47	1.05%	15
52	0.89%	25
54	880	<10
55	0.24%	<10
1164	89	0.70%
67	245	900
68	235	1000

Pr. nr.	Cu ppm	Mo ppm
1368-1172	112	600
78	380	30
79	29	<10
81	113	0.51%
83	480	240
85	145	2150
88	1600	1150
89	94	2200
1190	78	3850
91	1.17%	175
92	0.55%	30
95	1650	240
96	415	490
99	245	1800
1200	2050	500
01	109	3350
02	525	50
03	67	2800
05	340	10
06	18	155
09	35	<10
1214	245	<10
15	1.35%	<10
16	345	50
17	570	30
19	135	<10
1220	2050	<10
21	350	<10
24	36	280
33	1060	<10
38	280	<10
1240	325	15
43	230	<10
44	1800	20
1267	1.50%	<10

A n a l y s e r a p p o r t

fra : NGU Kjemisk avdeling

til : NGU Kjemisk avdeling (D. Smith)

- Oppdrag: 1) Bestemmelse av hovedbestanddeler.
2) Sporelementanalyse
3) Bestemmelse av V, Co, Pb, Li, Ag
4) Kjemisk bestemmelse av Mo, Cu, FeO.

10 bergartsprøver
Oppdrag 1368

Utført: Spektrografisk lab. og Kjemisk lab.

Resultat:

1) Kvantometerbestemmelse av hovedbestanddeler, angitt i % :

Prøve mrk.	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	MgO	CaO	Na ₂ O	K ₂ O	MnO
1368-1108	66.4	16.40	3.43	0.33	1.30	4.05	6.06	1.35	0.06
1368-1109	70.7	16.75	2.10	0.21	0.71	0.53	5.28	2.80	0.01
1368-1110	52.3	17.27	8.86	0.91	6.94	7.20	3.66	0.10	0.17
1368-1115	67.9	14.98	3.05	0.25	0.83	3.12	3.76	2.90	0.02
1368-1121	80.5	11.99	0.57	< 0.05	0.15	0.30	7.04	0.15	< 0.01
1368-1141	46.6	16.20	11.38	1.38	7.83	10.32	3.13	0.55	0.20
1368-1163	69.4	15.49	2.89	0.34	1.12	4.26	7.39	0.50	0.04
1368-1182	77.3	10.70	1.29	< 0.05	0.50	0.76	3.49	3.05	< 0.01
1289-3046	70.0	15.77	1.74	0.19	0.40	0.98	7.07	1.50	< 0.01
1289-3132	65.2	15.77	2.10	0.26	0.53	3.39	4.81	2.55	0.05

2) Bestemmelse av sporelementer, angitt i ppm.

Prøve mrk.	Y	Sr	Rb	Zn	Ni	Ba
1368-1108	15	1735	22	34	4	874
1368-1109	8	438	66	23	i.f.	758
1368-1110	13	2152	i.f.	99	24	30
1368-1115	10	1830	64	15	i.f.	1400
1368-1121	i.f.	270	i.f.	i.f.	i.f.	121
1368-1141	42	2485	i.f.	124	37	256
1368-1163	17	1635	i.f.	25	i.f.	240
1368-1182	10	383	45	i.f.	i.f.	3399
1289-3046	5	855	28	i.f.	i.f.	1151
1289-3132	7	1369	60	40	i.f.	1355

i.f. = ikke funnet

Table 11

T 11

3) Bestemmelse av V, Co, Pb, Li og Ag, angitt i ppm.

Prøve mrk.	V	Co	Pb	Li	Ag
1368-1108	30	6	< 30	< 100	< 1
1368-1109	10	3	< 30	< 100	< 1
1368-1110	250 x)	30	< 30	< 100	< 1
1368-1115	20	3	< 30	< 100	< 1
1368-1121	< 3	< 3	100	< 100	< 1
1368-1141	360 x)	60	< 30	< 100	< 1
1368-1163	30	6	< 30	< 100	< 1
1368-1182	6	6	30	< 100	< 1
1289-3046	20	< 3	< 30	< 100	< 1
1289-3132	20	< 3	< 30	< 100	< 1

De ovenfor angitte verdier er halvkvantitative verdier
bortsett fra de som er merket x) som er kvantitative verdier.

Table 12

T12

4) Kjemisk bestemmelse av Mo, Cu og FeO, angitt i %

Pröve mrk.	Mo	Cu	FeO
1368-1108	< 0.01	< 0.01	0.99
1368-1109	< 0.01	< 0.01	1.10
1368-1110	< 0.01	< 0.01	4.35
1368-1115	0.01	< 0.01	0.51
1368-1121	< 0.01	< 0.01	0.15
1368-1141	< 0.01	< 0.01	5.71
1368-1163	< 0.01	< 0.01	0.76
1368-1182	0.046	0.025	0.30
1289-3046	0.072	< 0.01	0.31
1289-3132	< 0.01	< 0.01	0.44

KJEMISK AVDELING

Aslak Kvalheim
direktør

Gjert Chr. Faye
lab.ing.

Table 13

T 13

Table 14.List of rocks selected for major element analysis.

<u>Specimen number</u>	<u>Locality</u>	<u>Rock type</u>
1368-1108	Kroktjernet	Epidotised trondhjemite
1368-1109	Kroktjernet	Sericitised trondhjemite
1368-1110	Kroktjernet	Microdiorite
1368-1115	→ Nålbecken	White trondhjemite + MoS_2
1368-1121	Kroktjernet	Aplite
1368-1141	Kroktjernet	Diorite
1368-1163	Korttjerndalen	Microporphyry
1368-1182	Nedrebekken	White trondhjemite + MoS_2 + CuFeS_2
1289-3046	Brattbekken	Pink trondhjemite + MoS_2
1289-3132	Gjætingdalen	White trondhjemite

Thin sections are available of all ten specimens.

APPENDIX 1.

List of reports, publications and notes concerning geochemical exploration after Mo and Cu in southern Grongfeltet from 1974 (NGU oppdrag nr. 1289, 1274 & 1368).

Reports.

- A) "Follow-up of copper and molybdenum geochemical anomalies in the southern part of Grongfeltet : Field work and analytical results for Cu and Mo". NGU report 1289/1, D.C. Smith, October 1974.
- B) "Regional and detailed stream sediment surveys over the Sanddøla trondhemite and associated rocks in southern Grongfeltet : Maps and frequency distributions for Mo, Cu, Pb, Zn and Ni". NGU report 1289/2, D.C. Smith, May 1975.
- C) "A review of the available geological and geochemical data on the Sanddøla - Nesåvatna Mo-Cu prospects, Grong District (Trondhemitt-prosjektene 1974 og 1975)". NGU report 1289/3, D.C. Smith, November 1976.
- D) "Geokjemisk kartproduksjon og malmløting i Grongfeltet.
I : A review of the production of 1:50 000 regional stream sediment geochemical maps of Grongfeltet.
II : A final compilation of data from geochemical exploration for Mo and Cu in southern Grongfeltet." NGU report 1289/4, D.C. Smith, April 1977.

Publications.

- E) "Grong, the correlation of altitude and the tree line with Pb in stream sediments", D.C. Smith, in the Journal of Geochemical Exploration, vol. 5, no. 3, p. 227, October 1976, (appendix 6 here).

- f) "Storvatnet and Rettbekken, moss-trapped stream material as a prospecting medium", D.C. Smith, in the Journal of Geochemical Exploration, vol. 5, no. 3, p 338, October 1976, (appendix 7 here).
- g) "Oppdagelse av molybdenitt-mineralisering som resultat av en geomorfologisk tolkning av bekkesedimentanomalier", D.C. Smith, sammendrag, Malmgeologisk Symposium -76, 15.-17. november 1976, Røros, (appendix 8 here).

Notes.

- h) "Notat om muting i Sanddøla - Nesåvatna området i Sør-Grongfeltet med hensyn til Mo- og Cu-mineralisering". D.C. Smith, 20. november 1975, (appendix 9 here).
- i) "Rapport feltarbeide i Grongfeltet sommeren 1975 (Foreløpig rapport Trondhemitt-undersøkelsen)". T.H. Tan, Desember 1975, (appendix 10 here).
- j) "Forslag til Molybdenprosjektet 1976", D.C. Smith, 13. september 1976, (appendix 11 here).

NORGES GEOLOGISKE UNDERSØKELSE

BUDGET FOR TRONDHJEMITE - PROSJEKT 1975

<u>Salaries and field allowances</u>	<u>N.G.U.</u>	<u>Grong Gruber</u>	<u>This budget.</u>
Salary - Smith	✓		
Salary-Ekremstater	✓		
Salary-Gravbröt			3.841.50
Salary-Tan		✓	
Allowances-Smith			5.573.45
Allowances-Ekremstater			3.551.20
Allowances-Gravbröt			1.560.-
Allowances-Tan		✓	
<u>Equirment.</u>			
1 set of 1:10000 air photographs			809.75
<u>Transport</u>			
Seaplane			
1/2 of total cost of kr.3.350.- for 2 tours from Trondheim and several within Grongfeltet			1.675.-
Car - Smith			870.-
Car - Ekremstater			1.333.80
			<u>19.219.70</u>
<u>Services.</u>			
Dynamite -		✓	
<u>Analyses</u>			
360 stream sediments			
37 gravel, sand, soil, organic and moss samples			
103 rocks			
500 samples analysed for Mo and Cu by atomic absorption (routine method: hot HNO ₃ extractable) @ kr 15.			7500
x) 10 rocks analysed by quantometer for Si, Al, Ti, Ca, Mg, Fe(tot) Na, K, Mn @ kr 250.			2500
Special samples analysed semiquanti- tatively by optical spectrograph for Mo, Cu, Pb, Zn, Ni, Ag, Co, V, Fe, Mn			
9 July, 1975 - 2 samples @ kr 50.			
25 July 1975 - 4 samples			
October 1975 - 10 samples x)			?

NORGES GEOLOGISKE UNDERSØKELSE

Subsequent work

Thin Section Manufacture
 Map Draughting
 Computer Processing
 Scientific Investigation
 Report Writing and Reproduction

<u>N.G.U.</u>	<u>Gronng Gruber</u>	<u>This budget</u>
✓		
✓		
✓		
✓		
✓		

Totals

NB. The two numbers denoted x) could be reduced by half in order to reduce costs if necessary.

Trondheim, 16.9.1975

David C. Smith
 Project - leader

Oppdrag

Prøver

Nummer
kartblad
Navn

Element

KONTROLLSKJEMA FOR GEOKJEMISKE KART OVER GRONGFELTET

Oppdrag			
Årstall			
Prøvenummer - fra			
" - til			
" - antall			
" - sum			
1. Analysert			
2. Prøvestedene og nummerne			
Tallverdiene			
Symboler			
Stjerner			
3. Frekvens - kurven			
- antallet			
- symboler			
4. Tittel - element			
- kartblad			
Tekst - 250 m			
- feltarbeid			
- analysering			
- utgitt			
Kartinndeling			
Kartnummer			
5. Godkjent (navn)			
6. Reprografert			
Arkivert			
Utgitt (mnd., årstall)			
7. Data EDB behandlet (se annet kontr. skjema)			
8. Data bearbeidet (se annet kontr. skjema)			
9. Data rapportert (se annet kontr. skjema)			

• trengs utføring

\ delvis utført

X ferdig utført

BEMERKNINGER

INSTRUKS FOR UTFYLING AV KONTROLLSKJEMA FOR GEOKJEMISKE KART OVER GRONGFELTET

OVERSKRIFT

Det er ett kontrollskjema for hvert kartblad, for hvert element, dvs. 11 kartblad x 11 elementer = 121 kontrollskjema, alltid oppbevart i et oversikts- og kontrollarkiv.

Kartblad nummer og navn og element-symbol står øverst.

Vi har nå oppdrag nr. 1546, og prøvetype er bekkersedimenter skrevet som BEKK øverst.

HVER KOLONNE

Oppdrag : Skriv oppdragsnummer for feltarbeid.

Årstall : Skriv årstall for feltarbeid.

Prøvenummer : Skriv nummer "fra - til" så ofte som nødvendig, Antall i oppdrag gjelder hele dette oppdrag.

Sum på kartet : Skriv antall prøver for alle oppdrag som er inntegnet på kartet (vent til frekvenskurven er beregnet).

Pkt. 1. Gjelder kjemisk analyseringsarbeid.

Analysert : Skriv \ eller x når data er ferdig utlevert fra kjemisk laboratorium, og er kontrollert.
≡

Pkt. 2 - 4. Gjelder tegnearbeid. (Bruk symboler på skjemaet).

Prøvestedene og nummerering: Skriv om de er tegnet på prøve-nummerkart.

Tallverdiene : Skriv om de er tegnet på tallverdikart.

OBS ! Følgende punkter gjelder bare symbolkartet.

Symboler: Skriv om de er tegnet på symbolkart.

Stjerner : Burde stå som "høyeste tall", skriv om det høyeste tall og andre høye tall på forskjellige steder på kartbladet er tegnet ved siden av symbolene.

EN KOLONNE

OBS! Fortsett bare om alle oppdrag er ferdig med punktene 1 og 2.

Frekvenskurven: Skriv om kurven er tegnet på diagrammet.

Frekvensantall : Skriv over diagrammet antallet av symboler som står på kartet. Dette kan bli forskjellig fra "sum på kartet" om noen prøver mangler analytisk data og ikke kan fåes.

Frekvenssymboler: Skriv om forklaringen av symbolstørrelse står under diagrammet.

Tittel: Skriv om elementnavn og kartblad-nummer og navn står som overskrift på bladet.

250 m: Skriv om dette tall og andre punkter er skrevet på tekstblokken.

Feltarbeid: Skriv om årstallene er nedtegnet under tekstblokken.

Analysering: Skriv om årstallet er nedtegnet under tekstblokken.

Utgitt: Skriv om årstallet er nedtegnet under tekstblokken.

Kartinndeling: Skriv om kartbladets posisjon er vist ved kartinndeling.

Kartnummer: Skriv om kartnummer står nederst på høyre side av bladet i formen : "geokjemiske kartnr. 1546-BEKK-1824 II - Cu symb." Dette gjelder også tallverdikart med "tall" istedetfor "symb.".

Pkt. 5. Godkjent : Skriv navn (ikke initialer) på den geokjemiker som har godkjent at alle punkter som står ovenfor, er ferdig utført, slik at navnetrekket betyr at kartet kan bli utgitt uten videre. Oppgi dato for denne godkjennelsen.

Pkt. 6. Gjelder behandling etter at tegnearbeidet er ferdig.

Reprodusert: Skriv dato når kopien er laget og arkivert for salg.

Arkivert: Skriv dato når original, symbolkart og tallverdikart er arkivert i NGU's kartarkiv.

Utgitt: Skriv dato når utgivelse er offisielt gjort.

Pkt. 7 - 9. Gjelder behandling, bearbeiding og rapportering av de kjemiske, geografiske og statistiske data. Disse trenger egne kontrolskjema.

Bemerkninger: Om det er noen bemerkninger skriv dem her.

Trondheim, 3. februar 1977

D. C. Smith

D. C. Smith
geokjemiker

GRONG: THE CORRELATION OF ALTITUDE AND THE TREE LINE WITH LEAD
IN STREAM SEDIMENTS

D.C. Smith

Geological Survey of Norway, Trondheim, Norway

Location and topography

The area examined covers approximately 100 km² in the Grong District about 200 km northeast of Trondheim, central Norway. Glacial action has produced an undulating topography rising from just over 200 m up to almost 1000 m.

A dense forest, mainly of pine, spruce and birch, covers the landscape up to 500 m. Between 500 and 600 m, conifers are rare and stunted whilst birch is common but stunted to about 2 m high. Between 600 and 700 m conifers are absent whilst birch is rare and stunted to less than 0.3 m high. Above 700 m the landscape is barren being represented only by bedrock outcrops interspersed with innumerable bogs and small lakes and occasional moraine deposits. Vegetation is limited to abundant lichens, mosses, grasses, ferns and heather growing in a thin soil cover comprising mostly humus with fragments of weathered bedrock.

Geology

Bedrock and mineralization. The bedrock consists successively of pelitic schists, a basic volcanic suite, a calcareous sedimentary formation, an intrusive acid plutonic suite and finally an arkosic conglomerate, all of which have been subjected to low-grade metamorphism. Most of the geological boundaries, which include both unconformable and fault contacts, are parallel to the regional schistosity.

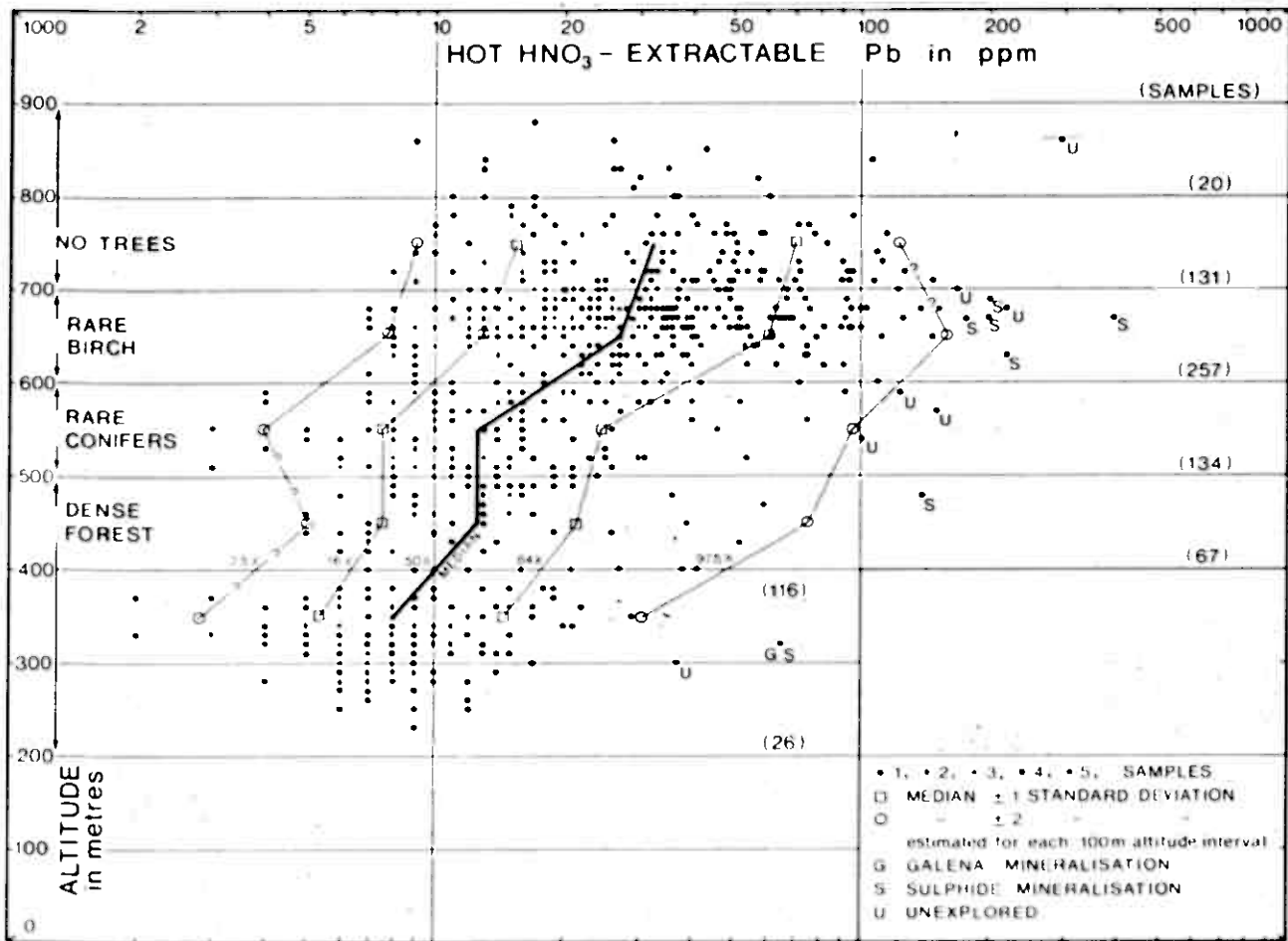


Fig. 33. Altitude, tree distribution, and Pb contents of stream sediments, Grong area, Norway.

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The dominant known mineralization in the Grong District is a series of massive sulphide deposits within the basic volcanic suite containing variable quantities of pyrite, magnetite, chalcopyrite, sphalerite and galena. However, although several rust zones are presently under investigation, only one such deposit has yet been found within the area described here.

Investigation and results

Objective. This area is part of a region of about 3000 km² which has been partially surveyed by a combination of geological, geochemical and geophysical methods in connection with exploration principally aimed at massive sulphide deposits.

Sampling. Altogether about 15,000 stream sediment samples have been collected within the Grong District. Active midstream material comprising mostly inorganic sediment, but with some organic component, was sampled at 250-m intervals along all sizes of streams and was wet-sieved in the field using a 0.18-mm nylon sieve.

Analysis. The samples were analyzed by a routine procedure of digesting 1 g of dried, re-sieved sample with 5 ml 1 : 1 HNO₃ for 3 hours at 110°C, diluting to 20 ml, filtering and determining 10 elements in solution by atomic absorption spectrometry. Interest was focussed on the determinations of Cu, Zn and Pb and follow-up prospecting was directed to those subareas showing clusters of anomalies for these elements. Anomalies were identified by the 97.5% threshold of the cumulative frequency distribution for the individual metal contents, i.e. approximately the median plus 2 standard deviations threshold in units of log ppm since the distributions approach lognormality.

Results. Up to 1972 the results within the whole Grong District produced scattered anomalous subareas for Cu, Zn or Pb which were subsequently followed up and which often revealed sulphide mineralization. The 1973 survey in an area of relatively low altitude yielded relatively low Pb contents whilst the 1974 survey in an adjacent area of relatively high altitude yielded relatively high Pb contents. Indeed 21% of the 1974 samples showed Pb contents greater than the 97.5% threshold for the entire pre-1974 regional surveys (52 ppm Pb) yet no significant sulphide mineralization, and in particular no galena, had been found during geological mapping of this area.

Comparison of the Cu, Zn and Pb contents of stream sediments with the underlying bedrock indicated a general correlation of Cu and Zn with the basic volcanic suite whilst Pb presented a confusing picture. Since a superficial study of the data indicated some kind of relationship between the Pb content and the altitude of the sample sites, the results from the 1973 and 1974 surveys, a total of 751 samples, were plotted on a diagram of these two variables along with an outline of the distribution of trees (Fig. 33).

Fig. 33. Altitude, tree distribution, and Pb contents of stream sediments, Grong area, Norway.

The curves drawn in Fig. 33 represent the 16 and 84 cumulative percent and the 2.5 and 97.5 cumulative percent thresholds of Pb content determined for each 100-m range in altitude (i.e. approximately equivalent to the median plus 1 and 2 standard deviations, respectively). Apart from the 200–300-m and 800–900-m intervals which have insufficient numbers of samples, the results display a consistent increase in Pb content with increasing altitude with the greatest increase occurring between 500 and 700 m, that is exactly within the zone between dense forest and the complete absence of trees. The threshold for the identification of Pb anomalies based on the 97.5 cumulative percent criterion varies from about 30 ppm at 350 m to about 130 ppm at 650 m.

Preliminary examination of these data with respect to bedrock type showed that in three specific subareas each of about 3 km² underlain by only the acid plutonic suite at altitudes around 400 m, 600 m and 800 m, nearly all of the samples fall within the respective ranges 5–15, 15–40 and 40–100 ppm Pb whilst in two specific subareas underlain by only the basic volcanic suite, one at around 300 m and the other at around 700 m, almost all samples contain, respectively, less than 15 ppm Pb and greater than 40 ppm Pb. Considering the subareas overlying intimately associated acid and basic igneous and also sedimentary rocks most samples contain less than 25 ppm Pb within one such subarea at around 500 m whilst within another at around 700 m most samples contain greater than 40 ppm Pb. Thus the pattern of increasing Pb content with increasing altitude appears to hold for different types of bedrock.

Locally there is a strong geological control of the distribution of trees, for example at some contacts there is a sudden drop in tree density with a corresponding decrease in soil thickness and increase in bedrock exposure as one passes from the basic to the acid igneous rock suite. This modifies the relationship between the tree line and altitude such that the tree line ranges across a 200-m-wide altitude zone. Nevertheless the regional distribution of bedrock type does not seem to have a significant effect upon the tree line.

The variable threshold for anomalies in Fig. 33 suggests that the 98 anomalies indicated by the regional threshold (52 ppm Pb) and the 19 anomalies indicated by the local 97.5% threshold for these 751 samples (114 ppm Pb) can be replaced by 14 of which 1 is close to a known Pb-bearing sulphide deposit and all others which have so far been investigated in the field can be related to prominent rust zones. Indeed the sample site near the only galena mineralization gave 65 ppm Pb which lies below the local threshold.

Conclusions

The results are considered sufficient to infer a reasonably significant correlation between the Pb content of stream sediments and altitude and the tree line though many more samples need to be examined in this way to obtain a more accurate quantitative assessment.

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A qualitative relationship between high Cu content in stream sediments above the tree line (ca. 350 m) in northern Norway and between high Pb content in stream sediments above the tree line (ca. 1000 m) in southern Norway were noted by Bolviken (1967, pp. 245-247) and Bjorlykke et al. (1973, p. 123), respectively. These workers proposed that heavy metals are leached out of the bedrock more rapidly at higher altitudes because of more extensive frost-weathering and then they are taken up by the humus layer in the soil thus forming higher metal concentrations at higher altitudes because of the thinner development of humus available to bind heavy metals, and then finally they are transported to streams by subsequent erosional processes. This hypothesis is compatible with the data from the Grong area and thus it is possible that Pb in many of the stream sediment samples with high Pb content has been derived from widely disseminated weak Pb mineralization, perhaps in silicates such as feldspar rather than in sulphides, and therefore these samples may not be indicators of significant galena mineralization.

In addition to the bedrock factor and the frost-weathering and humus factors mentioned above, there are, however, several other factors which might have an effect upon the geochemical path of Pb and possibly cause the correlation between altitude and Pb content, for example the scavenging effects of Fe and Mn, the chemical role of other elements such as Cu and Zn, the binding capacity of organic material, the frequency distribution of stream order, and climatic factors. Nevertheless, influence of these factors would not necessarily affect the validity of the concept of a variable anomaly threshold. Factors that could challenge this concept include identification in the future of a genuine geochemical province which partly covers this area or discovery of some significant difference in routine field or laboratory techniques as carried out by different workers. None of these various factors has yet been quantitatively assessed. Superficial observation suggests that there are some correlations but they appear to be weaker than that with the tree-line factor.

Despite these uncertainties in the causes of the Pb/altitude correlation, it is suggested that attention to the results of the correlation may prove profitable in stream sediment exploration for Pb.

Grong represents model F II.

STORVATNET AND RETTBÆKKEN: MOSS-TRAPPED STREAM MATERIAL AS A PROSPECTING MEDIUM

D.C. Smith

Geological Survey of Norway, Trondheim, Norway

Introduction

Moss-trapped stream material was collected from a very limited number of normal stream sediment sample sites as a preliminary experiment to investigate the geochemical characteristics and prospecting potential of this sampling medium. Samples were taken at two nearby localities, Storvatnet and Rettbekken, during a regional stream sediment survey in the Grong District of central Norway which is described elsewhere in this issue (p. 227).

Geology

Bedrock and mineralization. Both localities lie in the central part of the Scandinavian Caledonides. The northwestern half of the map of the Storvatnet locality (Fig. 120) is underlain by a chalcopryite + pyrite-bearing basic volcanic suite intimately intruded by a molybdenite + pyrite-bearing acid plutonic suite. The southeastern half comprises a sedimentary suite of conglomerate and arkose derived from the two igneous suites. The Rettbekken stream flows over the two igneous suites.

Overburden. Till is absent and soil cover is minimal such that a great proportion of bedrock is exposed between many small bogs and lakes. All streams contain abundant moss growing on bedrock, on loose blocks and over sediments; often moss covers the entire width of the stream bed.

Investigation and results

Sampling. The stream sediment samples were collected by a routine technique of -0.18 mm wet-sieving in the field.

Clumps of moss at or below water level were plucked by hand or scraped off rock with the aid of a trowel or knife, then squeezed gently to eliminate most of the water without losing too much fine material. Ten separate clumps, around $2\text{ cm} \times 2\text{ cm} \times 2\text{ cm}$ after squeezing, were collected, regardless of moss species, within 5 m up and downstream of the normal stream sediment sampling site, and were then packed into a paper sample bag. These samples were heavier than -0.18 mm sieved stream sediment samples but much lighter than unsieved bulk stream sediment samples. Collecting the moss clumps took considerably less time than searching for sites with suit-

able stream sediments, wet-sieving samples and washing the sieving equipment in the field.

Back in the laboratory the moss clumps were dried and then broken up by hand to release all of the mineral and organic material trapped by the moss and finally shaken through a 0.18-mm nylon sieve. In addition to mineral and organic material, similar to that found in normal stream sediment samples, these samples include fragments of the outer layers of the moss leaves which therefore contain heavy metals bound on the surface of and within the living matter. Usually about 1 g of sieved material was obtained but occasionally the weight was lower than that desired. The laboratory treatment took more time than for stream sediments because of the greater volume of the clumps and the necessity to break them up, but these problems could probably be reduced or solved by modifying the treatment or the equipment.

Analysis. All samples were analyzed by a routine procedure of digesting 1 g of sample with 5 ml 1 : 1 HNO_3 for 3 hours at 110°C , diluting to 20 ml, filtering and determining Cu and Mo in solution by atomic absorption spectrometry.

Results. Fig. 120 presents four maps which display the Cu and Mo contents of the routine stream sediment samples in the Storvatnet area and of the moss-trapped stream material at seven sampling sites. In all four cases the bedrock pattern of high Cu and/or Mo at particular locations within the two igneous suites and low Cu and Mo within the sedimentary suite is consistently reflected in the secondary media. However, the pattern is more distinct with Mo in stream sediments and with Cu in moss-trapped stream material than in the other two cases. Perhaps in streams with low Mo activity Mo is bound more strongly by moss leaves than by the components of normal stream sediments whilst these media have similar binding capacities in streams with high Mo activity thus giving a reduced anomaly/background contrast. Such behaviour is not evident with Cu since the contrast is enhanced. Nevertheless individual examination of the moss-trapped stream material results would lead to essentially the same deductions concerning bedrock mineralization as individual examination of the stream sediment results.

Rettbekken gave 270–520 ppm Cu, 34–77 ppm Mo from four normal stream sediments 100 m apart and 445–560 ppm Cu, 39–45 ppm Mo from moss clumps collected at the same four sites. At a fifth site 100 m further upstream, the results were 720 ppm Cu, 143 ppm Mo in the normal sediment sample and 900 ppm Cu, 305 ppm Mo in the moss-trapped stream material. Thus at each site the two different media gave broadly comparable results. Between the first four sites and the fifth there is a significant difference in the metal content consistently shown by Cu and Mo in both media. This is attributed partly to the fact that at the fifth site the moss leaves were black instead of green and speckled with an orange-coloured coating, presumably

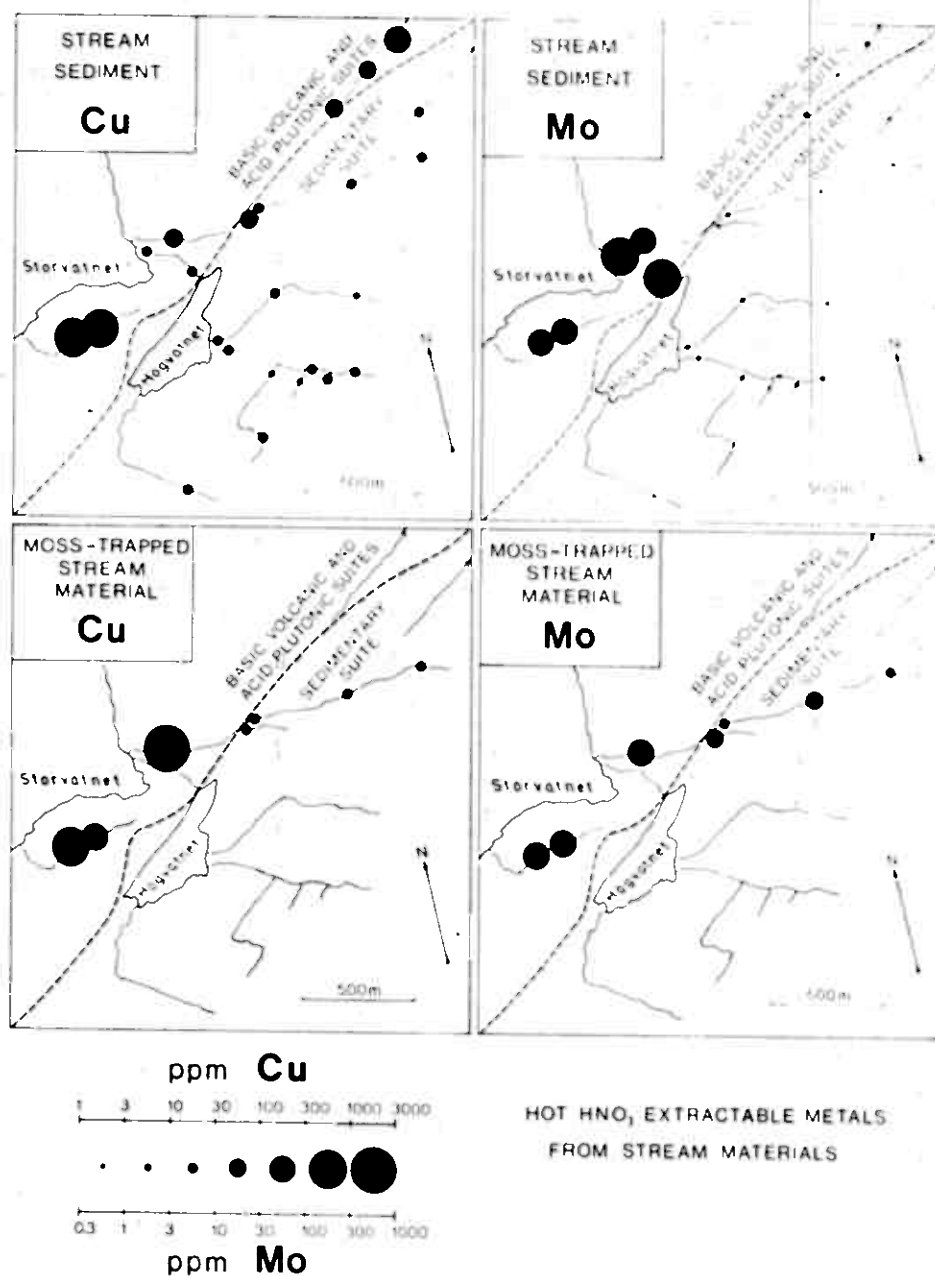


Fig. 120. Cu and Mo in stream sediments and moss-trapped stream material, Storvatnet area, Norway.

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a result of its proximity to an exposure of mineralized pyritized bedrock. However, this site gave a higher value of loss-on-ignition (59 wt.%) compared to the other four sites (34–50 wt.% in the moss-trapped stream material), presumably since the stream was more boggy at the fifth site thus providing a greater proportion of organic material which could concentrate heavy metals. Hence there are two factors which can explain the metal enrichment.

Conclusions

Clearly the results must be treated with caution because of the limited quantity of data available but it is tentatively concluded that moss-trapped stream material sampling tends to reveal a similar pattern of metal distribution to that of normal stream sediment sampling but generally gives enhanced analytical results because of a higher proportion of organic material derived from the moss.

If the reliability of surveys based on moss-trapped stream material can be confirmed, then use of this sampling medium can alleviate three difficulties often found with stream sediment sampling:

(1) Shortage of sediments, such as in areas of high relief where the most readily accessible sediment in fast-flowing streams may be that trapped by moss.

(2) Shortage of water, due to small streams or to dry seasons, which hinders wet-sieving.

(3) Shortage of time, for example in areas with difficult access, which reduces the size of the surveyed area.

As a consequence of the first two factors, composite samples of moss clumps from different streams could be collected in regions with a high density of low-order streams or of seepage zones thus providing a more homogeneous geochemical coverage than could be obtained by fewer single samples. In conjunction with the vital third factor of time saved by the fast collection of moss clumps, it is suggested that a long-distance composite sampling program of moss-trapped stream material could be devised for regional exploration to yield a more uniform coverage over wider areas than can be achieved with stream sediment sampling under the same financial constraints.

Storvatnet and Rettbekken represent models F II and N II–III.

MALMGEOLOGISK SYMPOSIUM -76, 15.-17. november 1976, Røros.

"Oppdagelse av molybdenitt-mineralisering som resultat av en geomorfologisk tolkning av bekkesedimentanomalier".

D. C. SMITH, Norges geologiske undersøkelse,
Postboks 3006,
7001 Trondheim.

Regional geokjemisk prospektering i is-erodert terreng i de sentrale nordiske kaledonider ga noen høye Mo-anomalier i bekkesedimentene. Regional geologisk prospektering, som ble utført samtidig, førte til et par funn av ubetydelig molybdenitt-mineralisering på kvartsganger i forbindelse med svovelkis-impregnert trondhemitt. Oppfølging av bekkesedimentanomalier ga noen svært høye Mo-verdier, mens bare et ti-talls nye funn av svake Mo-mineraliseringer ble funnet.

De lite lovende oppfølgings-resultatene indikerte at Mo-anomaliene kunne skyldes konsentrasjonsprosesser i det sekundære geokjemiske miljø i stedet for høye primærkonsentrasjoner. Imidlertid viste det seg at Mo-mineraliseringene opptrådte i forbindelse med noen spesielle langstrakte fastfjellsgrøfter, som vanligvis er ca. 4 meter dype og ca. 3 meter brede. Noen av grøftene inneholder en liten bekk, men dreneringsområdene er likevel for små til at vann alene kan være skyld i dannelsen av en slik grøft. Likedan er dybden for stor til at isbrebevegelser kan være årsaken.

Ved den videre vurdering ble det framsatt en arbeidshypotese der en antar at molybdenitt løses ut av grunnvann om sommeren med etterfølgende frostsprengning av den resterende bergart om vinteren. Dette medfører en kraftig forvitring, som på grunn av at mineralisering opptrer i lange, smale og rette ganger, har gitt en tilsvarende grøftutvikling. Som en følge av denne hypotesen begynte en nå å lete etter slike grøfter og flere nye mineraliseringer ble funnet.

En videre undersøkelse av forekomstene viser at mineraliseringen opptrer i bunn- og sidevegger av grøftene og ikke i områdene utenfor. Det viser seg også at Mo-gehalten øker når en kommer under den forvitrede overflaten. En antar følgelig at ytterligere mineralisering vil bli funnet under grøftene og ikke i områdene imellom.

Konklusjonen er at en regional bekkesedimentundersøkelse viste seg å være en effektiv letemetode for Mo-mineralisering, som ikke ble funnet ved bergrunnsprospektering. Det er også klart at uansett i hvilken grad den geomorfologiske hypotesen er korrekt, så var hypotesen avgjørende for oppdagelsen av flere mineraliseringer.

Norges Geologiske Undersøkelser
20 november 1975

- Til - Administrasjonen (for NGU)
- Haugen (for Grong Grube A/S)
- Svinndal (for Industridepartement)

Fra - Smith (leder av Trondhjemst. H. Prosjektet 1975)

NOTAT OM MUTING I SANDDØLA - NESÅVATNA OMRÅDET
I SØR - GRONGFELTET
MED HENSYN TIL MO - OG CU - MINERALISERING

INNLEDNING

Vedlagt mine forslag om sikring av mineralrettigheter i Sanddøla - Nesåvatna området i Sør - Grongfeltet som ønskes den 21 november 1975.

Alle forslag er forelagt på grunn av de er basert bare på en kortvarig sammen vurdering av gammel data med preliminaer ny disponibel data uten bearbeiding pluss noen inntrykker fra feltarbeidet. Derfor er det mulig at forslagene om muting må revideres når alle disponibel data er bearbeidet og ny data er forelagt.

På grunn av den korte varsel om tidsfristen er dette notat ikke korrigert for språk og ikke maskinskrivet; derfor flere feilene skulle ventes.

KORT UTDRAG AV KUNNSKIP I DAC

1. Bekkesedimenterprøver : 1974 vist høy Mo og Cu konsentrasjoner : flere steder men særlig i områdene Fremstfjellet, Øst Skarfjellet, Nesøpiggan og Gaizer vannet.
2. Bekkesedimenterprøver : 1975 vist middels Mo og Cu konsentrasjoner : noen nye områder i nærheten av disse nevnte områder slik at det er bare én uavbrutt Mo og Cu geoteknisk provins for den meste part tilknyttet til området med blanding av brøddbrutt og grønskinn fastfjell.
3. Synlig Mo-mineralisering : fastfjell var funnet : 1974 i noen steder innen Fremstfjellet området av Smith og Gale, og et sted ved Gaizer vannet av Gale.
4. Synlig Mo-mineralisering : fastfjell var funnet : 1975 i flere steder innen Fremstfjellet området av Smith, et sted ved Nesøpiggan av Tan, to steder ved Gaizer vannet av Smith og et lite blokk ved Lang løft vannet av Smith. Det er sikkert at mer Mo malm lokaliteter skal finnes innen denne Mo provins med detaljert leting.
5. Synlig Cu-mineralisering : fastfjell var funnet : 1974 og 1975 : flere steder men vanligvis er det svake unntagen Ampbektjernet og Kvoktjernet og Reinbekken.
6. Tre steder innen Fremstfjellet området var sprengt : 1975 og alle vist rikere malm enn var samlet ved bruk av en slegge.

<u>STED</u>	<u>FAST FJELL</u>	<u>MALM</u>
Smaltjernet	tondhyemitt	molybdenglans + kvarts ganger + lite kobberkis + svovelkis
Amøbetjernet	skifret tondhyemitt og skifret konglomerat	rik kobberkis + svovelkis + lite magnetkis + molybdenglans uten kvarts
Kroktjernet	dioritt / tondhyemitt	rik magnetkis + svovelkis + noen kobberkis

7. På overflaten vist Smaltjernet ingen Mo
 Ved bruk av sleggen vist det ca. 0.18% Mo
 Etter sprenging vist det ca. 0.5% Mo
 Etter boring skal det vise ----- ? Mo

8. Amøbetjernet viser ca. 10% Cu og Kroktjernet
 viser ca. 1% Cu. Begge lokalitetene viser noen
 andre elementer d.v.s. Co, Ni, V, Pb.

9. En løsløkk ved Kroktjernet viser ca. 2% Zn
 og ca. 3% Pb. Pb er ikke funnet i
 fast fjell men Svingebekken vist ca. 0.18% Zn

10. Orienterende kartlegging : 1975 : Fremsoffellet området (Smith) og : Nesåpiggen området (Tan) vist at geologi av området Sanddøla-Nesåvatna er mer komplisert enn tenkt før slik at både Forlie's og Gale's geologiske kart er ikke tilstrekkelig for malmspekulering .
- Noen områder kartlagt som trondhjemitt inkluderer gabbro, hornblenditt, dioritt, diverse grønn, grå og hvit trondhjemitt typer og leucocratisk ganger, allt av forskjellige kornstørrelse, forskifning og metamorfose forandring (klorittisation, sericitisation, epidotisation, kvarts impregnering o.s.v.).
- Grensen av disse intrusive eruptive bergarter mot effusive grønnstein er ikke så klart som det ser ut på Gale's geologisk kart 1293-05, -06 og -07.

11. Petrologisk undersøkelse av handstykker av steinprøver fra 1974 og 1975 er delvis ferdig men mikroskopisk undersøkelse av tynn slipper og polertslipper er ikke enda begynt. Noen foreløpige bemerkninger er listet under.
- MO vanligvis forekommer innen ganger av molybdenglass og kvarts fra ca. 1mm til ca. 10 cm tykk med ukjent utstrekningen.
 - Dise ganger alltid forekommer innen trondhjemitt, vanligvis en type som er meget leucocratisk, kaolinisert og forskifet, men hornblenditt eller dioritt og også kontakten mot grønnstein

er ofte i nærheten. Utstrekningen av denne trondhjemitt type er ikke kartlagt; kanskje det er sammen bergart som nevnes av Gale som "fine-grained trondhjemitt".

- c) Svovelkis alltid forekommer i trondhjemitt ved siden av disse ganger og ofte forekommen innen gangene men vanligvis i begge tilfelle er det svak mineralisering.
- d) Kobberkis forekommer i noen av trondhjemitt med disse ganger men det er svak og ikke særlig tilknyttet til gangene.
- e) Molybdenglans også forekommer i noen få steder som en tynn film uten kvarts innen trondhjemitt men ikke bare den leucocritisk trondhjemitt nevnt ovenfor.
- f) Kopperkis forekommer i flere steder med svovelkis men vanligvis er det meget svakt.
- g) Ved Åmsetjernet forekommer rik kobberkis med svovelkis, noen film av molybdenglans og lite magnetitt forekommer med omfang ca. 2×2 meter ved overflaten med ukjent utstrekning.
- h) Ved Huskjetnet forekommer rik magnetkis med en uvanlig blå farge; også kobberkis og svovelkis. Malm omfang er ca. 4×3 , ved overflaten med ukjent utstrekning. Ved Reinbekken finnes lite mineralisering i to steder med mindre malm omfang.

- i) Det ser ut at Mo-mineralisering innen trondhjemitt og Cu-mineralisering innen grønnstein var hovedsakelig uavhengig (unntagen Ampbeternet kanstje). Både Mo og Cu innen samme fastfjell er antagelig et resultat av mobilisering under metamorfose.
- ii) På grunn av komplisert blanding av diverse trondhjemitt og grønnstein type med usikkert kontakter er det kanskje fornuftig å betrakte områdene kartlagt som trondhjemitt eller grønnstein som ett Mo + Cu provins.
- 12) Foreløpig bearbeiding av data viser at høy Mo eller Cu konsentrasjoner i bekkesedimenten er avhengig på mindre bekkeorden, høy organisk -, Fe- og Mn-innhold i bekkesedimenten og fastfjell type. Men det ser ut at den viktigste virkning er den type av fastfjell slik at høy Mo eller Cu i bekkesedimenten virkelig indikere Mo eller Cu mineralisering i fastfjell i nærheten.
- 13) En teori å forklare vanstokigheten å finne molybdenglans på overflaten og samtidig å forklare de høy Mo konsentrasjoner i bekkesedimentet i felten i soner som en resultat av en detalert undersøkelse av en del av Smoltjernets området. Nålbecken er en type eksempel.

Teori

- a) Parallel soner av rik Molybdenglans + Kvarts ganger ($\geq 0.5\%$ Mo) av ukjent bredde og utstrekning og dybde (man kanstje $1m \times 1km$?) forekommer innen trondhjemitt fastfjell.
- b) Etter isaltenen molybdenglans løste seg opp inni vannet ved overflaten om sommeren slik at fastfjell ved overflaten var bare kvarts med mange huller. Om vinteren var bergarts strukturen ødelagt med is inni hullene. Derfor disse ganger var forvitret fortore enn vanlig trondhjemitt og nå man finner nett kort bekker med en dybde (f.eks. 4m) større enn bredden (f.eks. 3m) med lite vann slik at de kan ikke forklares med vanlig forriting av isbreer eller elver.
- c) Om dette virkning skjedde skulle man finne ingen malm på overflaten ved siden av bekken, svakt malm (f.eks. $0.1 - 0.5\%$ Mo) inni fastfjell på veggene til bekken, inni blokkene falt ned fra veggene, inni fastfjell blottet i bunnen til bekken og inni noen løsblokker som er egentlig "in situ" i bunnen, og rik malm skulle finnes direkte under bekken.
- d) Mo som er løst opp fra fastfjell ganske lett er straks absorbert ganske lett av organisk materiale innen bekken. Derfor

Kanskje høy Mo konsentrasjoner i bekkesedimenter
 gir indikere Mo i fastfjell ganske nær.

- 4) De grunn av dette teori var Mo lebyg
 konsentrert på 0 fenne lille dybde rette bekker.
 Noen var funnet og av Mo mineralisering funnet
 i veggene og bunnen av bekken.

- 15) Foreløpig ligning med bekkesedimenter anomalier
 i andre delen av verden viser at Mo anomalier
 i Grongfeltet er høyere enn Mo anomalier
 ved porphyry Mo gruver i Canada.

Om teori om rikere malm soner under
 bekken er bekreftet, ser det ut at
 Sanddøla - Nesavatne området kan ha
 betydelig potensjal for økonomisk Mo forekomster.
 Om teori er ikke bekreftet skal malm
 potensjal minke mye.

- 16) Bearbeiding av disponibel data skulle hjelpe å
 forstå malm genesis men mye mer feltarbeid
 av diverse type trenges for en tilstrekkelig
 vurdering av malm potensjal kan lages.

Om det er riktig at molybdenglans løse seg opp
 fort er det helt nødvendig å bruke en
 bormaskin for malm leting.

- 17) Uten å bore minst ett hull må man
 gjette veldig mye med mutingsoppsmåler.

MUTINGSFORSLAG

Mutingsforslaget basert på en foreløpig vurdering i dag om alle kunnskap nevnt ovenfor er tegnet på kart nummer 1368-06 og også skisset på det oversiktskart etter Svinndal; begge er vedlagt her.

Mutingsforslaget var laget med hensyn til

- i) kjent Mo±Cu mineralisering
- ii) Mo og Cu anomalier i bakkersedimenter
- iii) utstrekning av tondkjennitt og grønnstein

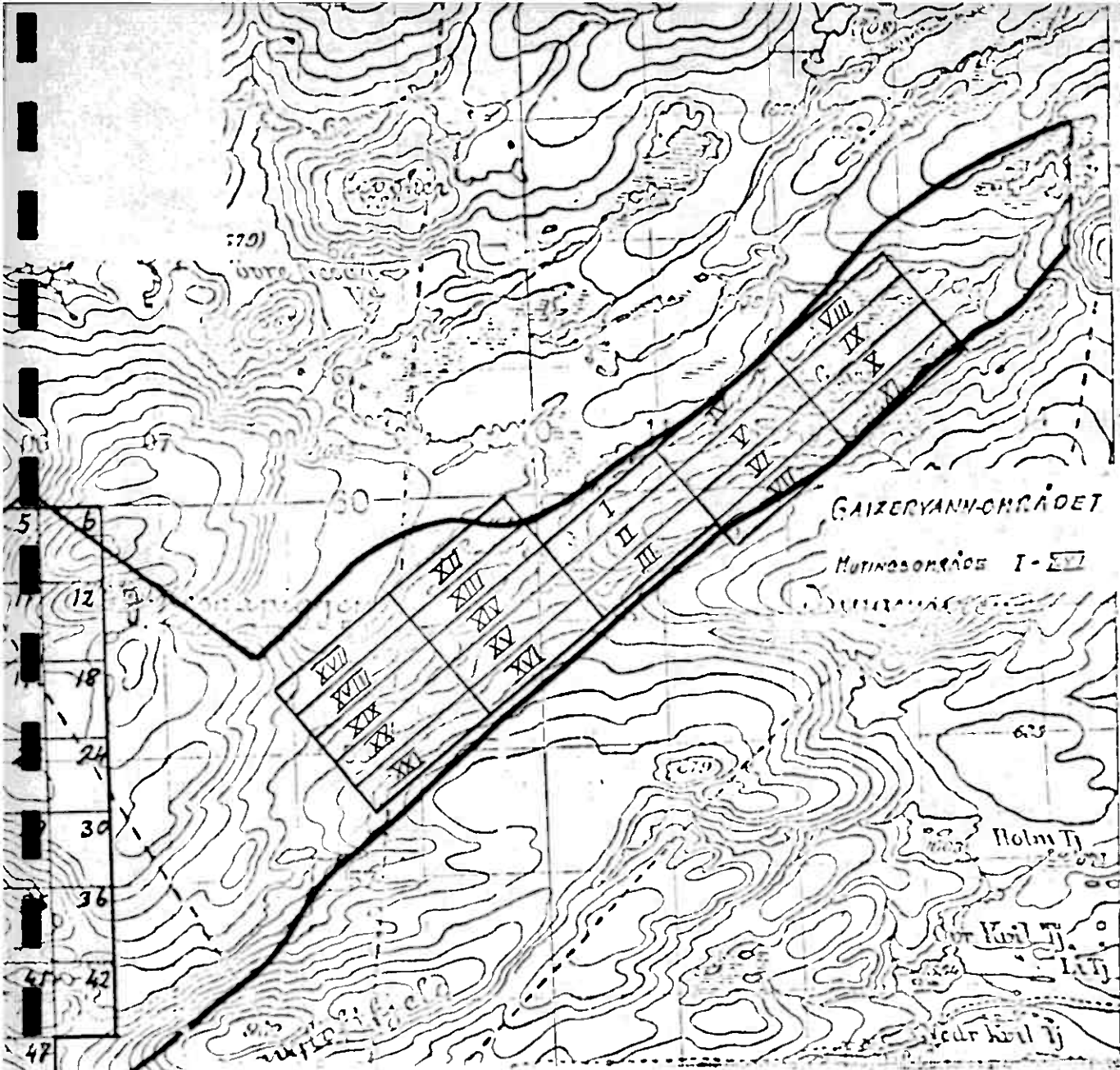
men også med hensyn til

- i) bare små deler av området er prospektert slik at man kan vente ukjent mineralisering
- ii) en Mo + Cu geokjemisk provins har mer betydning enn noen enkelte anomalier
- iii) tondkjennitt eller grønnstein uten de ^{nærliggende} andre [^] har mindre malms potensjal mens sedimentær bergart opprinnert fra tondkjennitt eller grønnstein kan være av interesse.

Mutingsforslaget tar hensyn bare til geologiske/geokjemiske kriterier og ikke til tidligere mutingsnetter.

David Smith

20 november 1975



OVERSIKT OVER
MUTINGS OMRAÅDER

[etter SVINNBAL des. 74]

1. januar 1975

SANDDØLA - NESÅVATNA OMRAÅDET

SØR-GRONGFELTEN

KARTBLAD AMS M 711 ANDORSTØEN 1823 I

1:50,000 NAMSKOGAN 1824 II

NGU KART fra OPPDRAG 1289 og 1368

MUTINGS FORSLAG 20-11-75

[etter SMITH]

RAPPORT FELTARBEIDE I GRONGFELTET SOMMEREN 1975
(FORELØPIG RAPPORT TRONDHJEMITTUNDERSØKELSEN)

Feltarbeidet fant sted i perioden 7/7 til 5/8. Den første uken gikk med i orienterende samtaler med Viggo Wiik i Grong om prosjektets opplegg og andre spørsmål, og dessuten noen rekognoserende turer i den sydlige del av Trondhjemittfeltet, bl.a. de kis- og molybdenmineraliserte lokaliteter ved "Amøbevannet" og Fremstfjellet.

Det aktuelle område (se skisse I) ble delt i to deler, den sydlige del, som omfatter bl.a. "Amøbevatnet", "Kort-tjern", og Fremstfjellet, ble undersøkt av David Smith, NGU, den nordlige del, som omfatter bl.a. Reinsjøen og Nesåpiggen-traktene, ble undersøkt av meg.

Terrenget er meget tungt, det har mange bratte skrenter, og består eller av avvekslende snaufjell og myrer. Den nordlige del av området ligger over tregrensen og høyden varierer mellom 650 m og 800 m over havet. Nesåpiggens topp ligger på 988 m høyde. Området rundt Nesåpiggen ligger meget isolert til og dette gjorde prospekteringsarbeidet spesielt vanskelig. Det er nettopp på syd- og nordvesthelningen av Nesåpiggen at indikasjonene på molybdenmineralisering, har kommet fram.

I september ble Nesåpiggens nordvesthelning på ny besøkt. Resultatene fra denne turen er inarbeidet i denne rapport.

Geologi

Innenfor den nordlige del av området opptrer følgende bergartstyper:

Trondhjemittiske bergarter

Diorittiske og gabbroide bergarter

Grønnsteiner og skifre

Bergartenes fordeling i området fremgår av kartet, som synes å antyde at trondhjemittlegemet blir delt i to av en ca. 0,5 til 1 km bred grønnsteinsformasjon.

Trondhjemitt opptrer som flere variasjoner mellom hornblendeførende trondhjemitt og trondhjemitt uten mørke mineraler. Feldspaten er hvit, svakt grønnlig og svakt rosa. Rosa feldspat antas å være K-feldspat mens den grønne feldspat er foreløpig antatt å være saussurittisert plagioklas. Mikroskopisk undersøkelse av bergarten har ennå ikke funnet sted. Trondhjemitten er vanligvis grov til middelskornet, men forskifrete og mylonittiserte soner ble funnet på flere steder. Det er kanskje i noen av disse mindre skyvesoner at molybdenmineralisering fortrinnsvis har funnet sted.

Av grønnsteinene og -skifre ble det funnet også flere varianter. Bergarten kan kanskje deles inn i to hovedtyper, den ene som består av overveiende amfibol og feltspat (sannsynligvis albitt), og den andre bestående hovedsakelig av kloritt og muligens også albitt. Også denne inndeling er foreløpig bare basert på makroskopisk undersøkelse. Grønnsteinsformasjonen mellom Reinsjøen og Langløftvannet er hyppig gjennomgått av syrrer ganger og sills, kanskje særlig i nærheten av trondhjemittmassivet. Dette gjorde det praktisk talt umulig å trekke en skarp grense mellom disse to bergartsenhetene. Innenfor grønnsteinsformasjonen ble det noen ganger påtruffet lag eller partier av kvartsittiske bergarter, som ganske ofte er meget sterkt mineralisert, hovedsakelig med py men også litt cp. En ca. 100 - 200 m bred "overgangssone" mellom grønnsteinsformasjonen og den nordenforliggende trondhjemitt består av grovkonete, basiske- til intermediære eruptiver. Disse bergartene kan være dioritter, hornblenditter og hornblendediortitter.

Det ble observert flere småfoldninger i grønnsteinen. En tverrforkastning like vest for Langløftvannet, som George Gale allerede har antydnet i sin rapport, ble litt nøyaktigere kartlagt. Det ble ellers ikke brukt mye tid til tektoniske studier i de 4 ukene som var til disposisjon.

Rundt Skarfjellet, noen km syd for Reinsjøen, forekommer en annen grønnsteinsformasjon. Ettersom man må gå ut fra at denne sonen er ganske godt undersøkt av Gale i tidligere år, har en ikke tilbragt mye tid i dette område. Grønnsteinen på Skarfjellet er kanskje mere tektonisert enn grønnsteinen ved Reinsjøen. Den har svære rustsoner som er synlig på meget stor avstand. Ca. 200 m - 400 m øst for Skarfjelltoppen ble det oppdaget putestruktur på grønnsteinsblotningene.

Mineralisering

Svovelkis er et meget hyppig opptredende mineral og ble funnet i ganske store mengde i grønnsteinsformasjonen ved Reinsjøen. Kisen opptrer i selve grønnsteinen (og -skifere¹) og de tidligere omtalte kvartsittiske lag blant grønnsteinen. Særlig i den sistnevnte kvartsitten kan kisinholdet være så høy som 50 volum% eller mer. Kobberkis kan også bli funnet i kvartsitten, men som regel som meget underordnet mineral. På grunn av den meget utstrakte rustdannelse er de kismineraliserte partier i grønnsteinsformasjonen meget godt synlig på stor avstand.

Også i grønnsteinsformasjonen rundt Skarfjell forekommer det ganske utstrakt kismineralisering, kanskje i enda sterkere grad enn ved Reinsjøen. Det ble opplyst at Øystein Pettersen har foretatt prospekteringsarbeider på Skarfjellet, åpenbart med lite oppmuntrende resultat.

I nærheten av tidligere nevnte tverrforkastning, og ca. halvveis mellom Langløftvann og Piggtjernet, ble det funnet en 5 - 10 m lang blotning med meget oppsprukken, sanns. felsittisk bergart, som er forholdsvis rikt mineralisert med cp. Blotningen er dessverre nokså sterkt ^{av}frøvitret. Denne lokalitet er hittil den eneste i den nordlige undersøkelsesområde hvor det ble funnet cp i noen nevneverdig grad.

Kismineralisering har også funnet sted i trondhemitten, men bare i atskillig mere beskjedne grad og i så fall nesten utelukkende som svovelkis. Imidlertid ble molybden-glansen nettopp funnet i trondhemitt. I to lokaliteter i den nordlige undersøkelsesområde ble det påvist molybdenanomalier i bekk sedimenter. Ved den ene lokalitet (Nesåpiggenes sydhelning) forekommer molybden-glansen sammen med litt py i glidespeil i trondhemitt. Ved den andre lokaliteten (Nesåpiggenes nordvesthelning) ble molybden-glansen funnet som isolerte flekker i en finkornet, kvartsrik trondhemitt.

Kommentar

Av en rekke grunner hadde en ikke anledning til å være lengere i felten enn 3 - 4 uker. Dessuten kunne en, på grunn av den meget isolerte beliggenhet av Nesåpiggen-traktene, ikke være lengere ved molybdenanomaliene enn noen få timer per dagstur. Molybdenmineraliseringen ved Nesåpiggen er derfor ikke tilstrekkelig undersøkt, og hverken feltobservasjonene eller de medbragte prøvene behøver å gi et riktig inntrykk av forholdene.

Vi har kanskje fått et noe mere sikkert bilde av forholdene i de kismineraliserte soner i grønnsteinen, til tross for at en helst hadde brukt mere tid til undersøkelsene her. Det ser ut som om kismineraliseringen i den egentlige grønnsteinen er en forholdsvis svak impregnasjon av svovelkis og evt. magnetkis, men på grunn av en del faktorer opptrer den som svære og tydelige rustsoner i terrenget. Kismineraliseringen i de tidligere omtalt kvartsittiske innleiringer blant grønnsteinen synes mere interessant. Kisinnholdet er atskillig større. Det var ikke mulig å fastslå mektighet og feltutstrekning av disse uten graving eller røsking. Heller ikke dette funn kunne betraktes som økonomisk lovende, ettersom det var intet som tydet på at det var Cu eller andre tungmineraler tilstede i noen grad.

Den kobbermineraliserte felsitten, som ble funnet i en liten blotning mellom Langløftvannet og Piggtjernet, er verd nærmere oppfølging for å finne ut feltutstrekning og mektighet.

Som forslag til feltvirksomhetene i det nordlige området for sommeren 1976 vil en sette fram følgende:

1. Fortsatt prospektering/rekognosering ved molybdenanomaliene rundt Nesåpiggen,
2. Oppfølgingsarbeid ved den kobbermineraliserte felsitten,
3. (Eventuelt) Kartlegging av de kvartsittiske innleiringer i grønnsteinen som ser ut til å være rikt kismineralisert.

Til : Avd.dir. Kvalheim
Fra : Geokjemiker Smith
13.9. 1976.

FORSLAG TIL MOLYBDENPROSJEKTET 1976.

Mo-analysering i Sanddøla-Nesåvatnaområdet var medtatt i Trondhemitt-prosjektene i 1974 og 1975, og viste betydningsfull Mo-mineralisering av porphyry-Mo type flere steder. Disse resultater er delvis rapportert og delvis under bearbeiding.

Alle bekkesedimentprøver samlet i Grongfelten i 1972 og 1973 er nå analysert på Mo, siden dette element ikke var tatt med før. Tidligere var det analysert på Cu, Pb, Zn og Ni og senere utvidet til Ag, Co, V, Fe, Mn og delvis Cd og Cr.

De nye Mo analysetall viser andre Mo anomalier, særlig i 4 områder; Nordli, nordøst Røyrvik, nordvest Røyrvik og Steinfjellet. Bare 1 av de nye 4 lokaliteter er delvis undersøkt av NGU tidligere: Steinfjellet, hvor det finnes Cu og Pb anomalier av ukjent kilde.

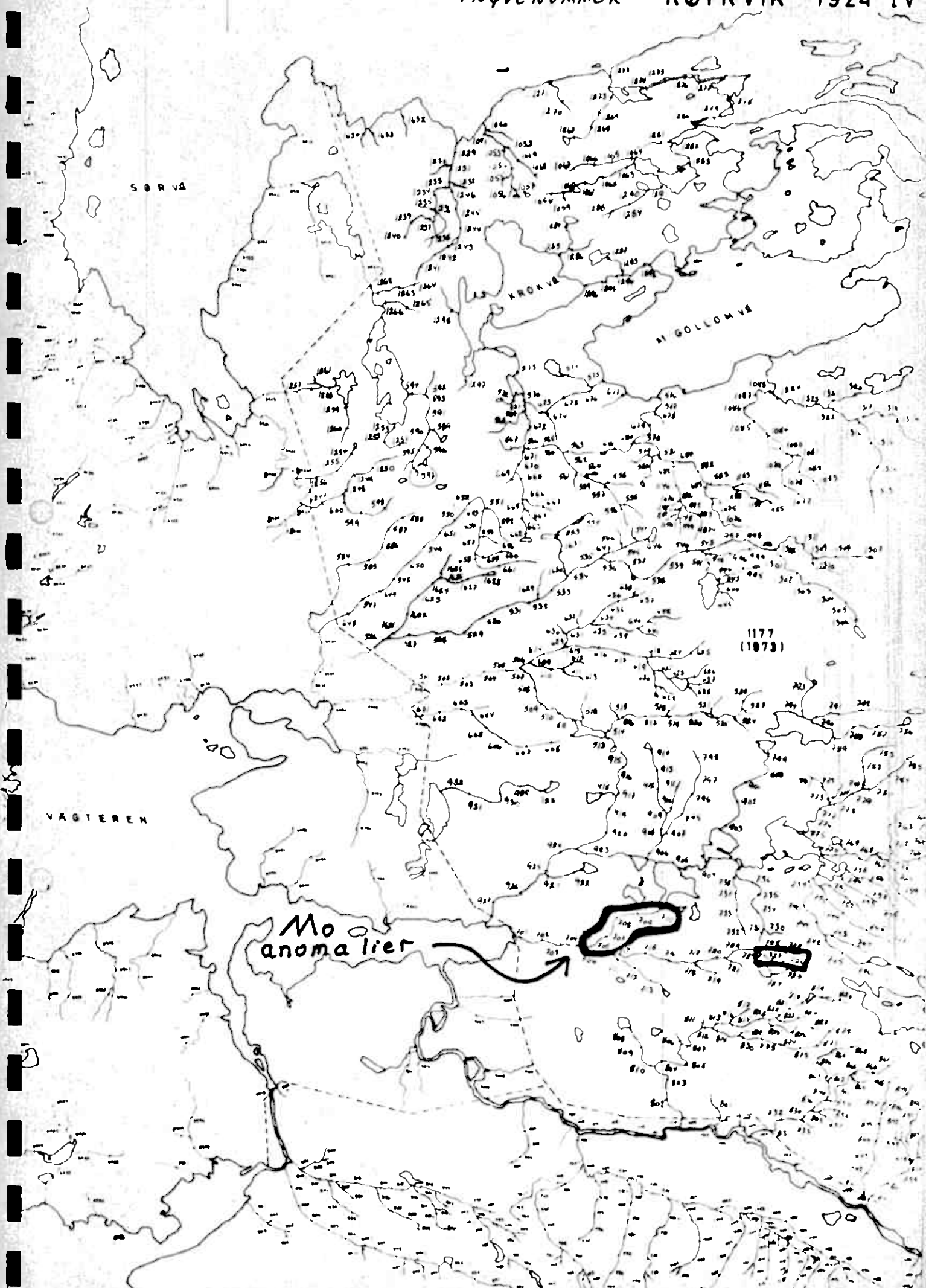
De bergrunns geologiske kart viser at i 3 av de nye lokaliteter finnes noen granittiske bergarter. Det er ikke utenkelig at alle disse er en og samme bergart, selv om de har fått forskjellige navn på kartene. Bergartene ligner på de trondhemitter som opptrer i tilknytning til Mo-mineraliseringen i området Sanddøla-Nesåvatna. Dette indikerer mulighet for Mo-mineralisering under store deler av Grongfeltet.

Det foreslås et lite orienterende Molybdenprosjekt før vinteren, hvor Smith prospekterer områdene og tar bergartsprøver og Ekremsøter følger opp bekkesedimenter anomalier med nye bekkesedimenterprøver for å bekrefte og definere anomalier bedre. 5 - 10 dager i felten, inklusiv reise skulle greie seg bra. Tidsrommet skal være avhengig av snøforholdene på fjellet og sesong for elgjakten. Ca. 100 prøver bør samles og analyseres på Mo og Cu. Bearbeiding kunne utføres samtidig som bearbeiding av Trondhemittprosjektene, men resultatene kunne skrives i forskjellige rapporter.

se side AII-2 til AII-5

Anomali/bakgrunn kontrast på nordøst Røyrvik, lokaliteten er 200:2 ppm Mo og derfor foreslås at NGU muter denne lokaliteten. De øvrige 3 lokaliteter har mindre kontrast, slik at videre opplysninger trengs før muting foreslås.

Det foreslås også at bekkesedimentprøvene fra tidligere år skal analyseres for Mo. Det trengs oppslutning av ca. 4000 pr. fra 1969, 1970 og 1971, og om prøvene finnes, ca. 2000 pr. fra 1964 - 1965.



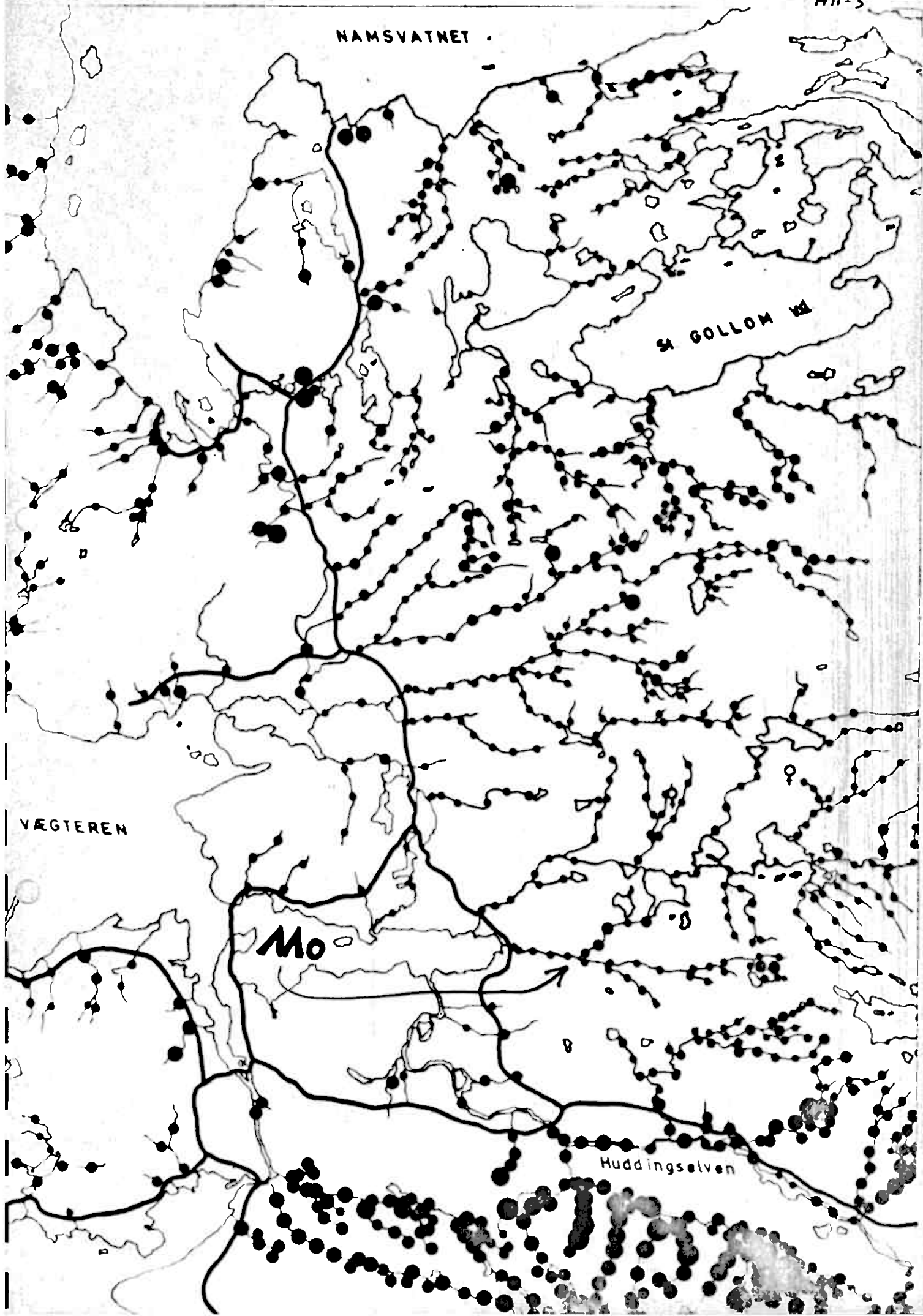
NAMSVATNET .

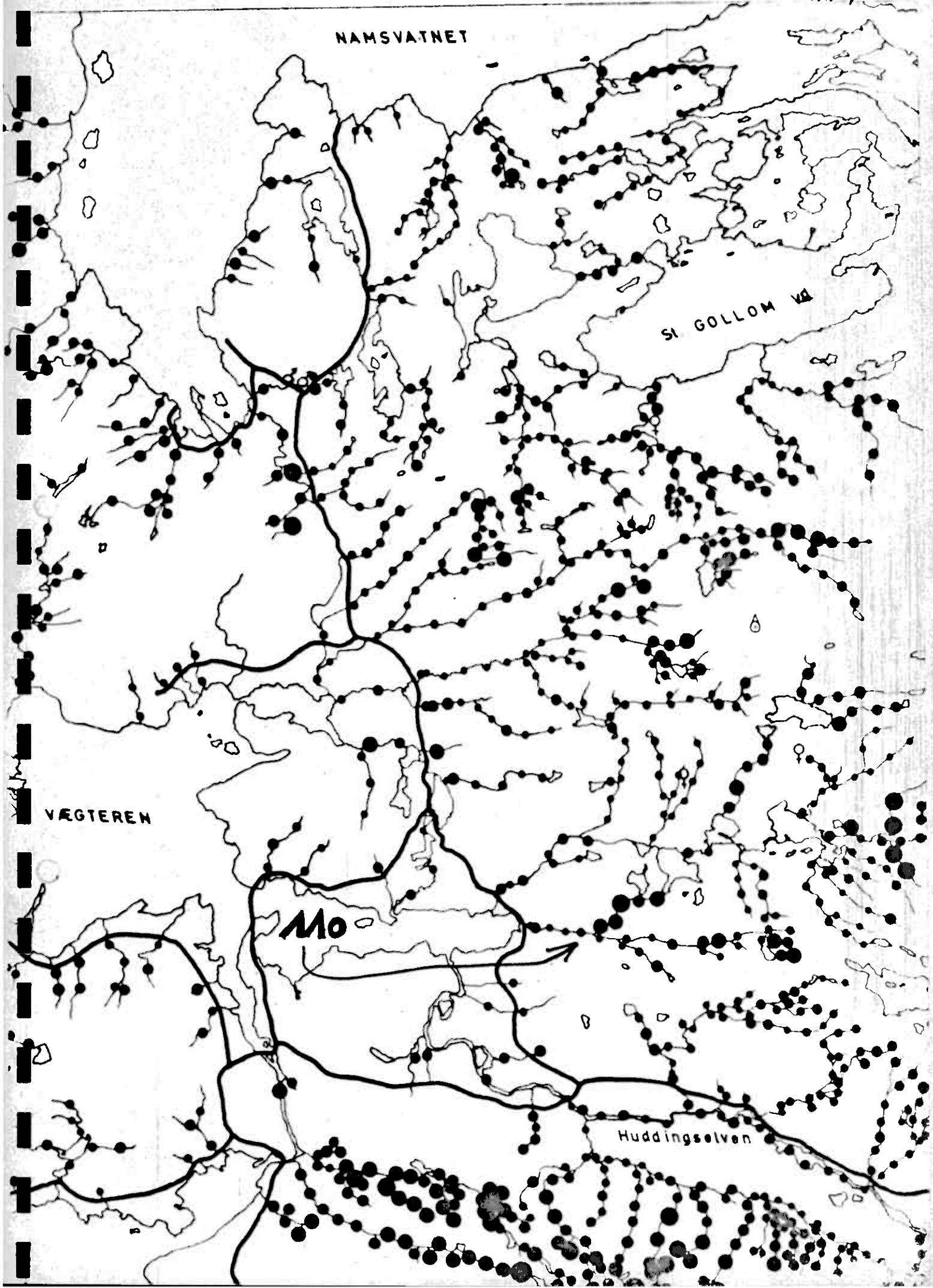
SA GOLLOM

VÆGTEREN

Mo

Huddingselven





NAMSVATNET

SI GOLLOM VA

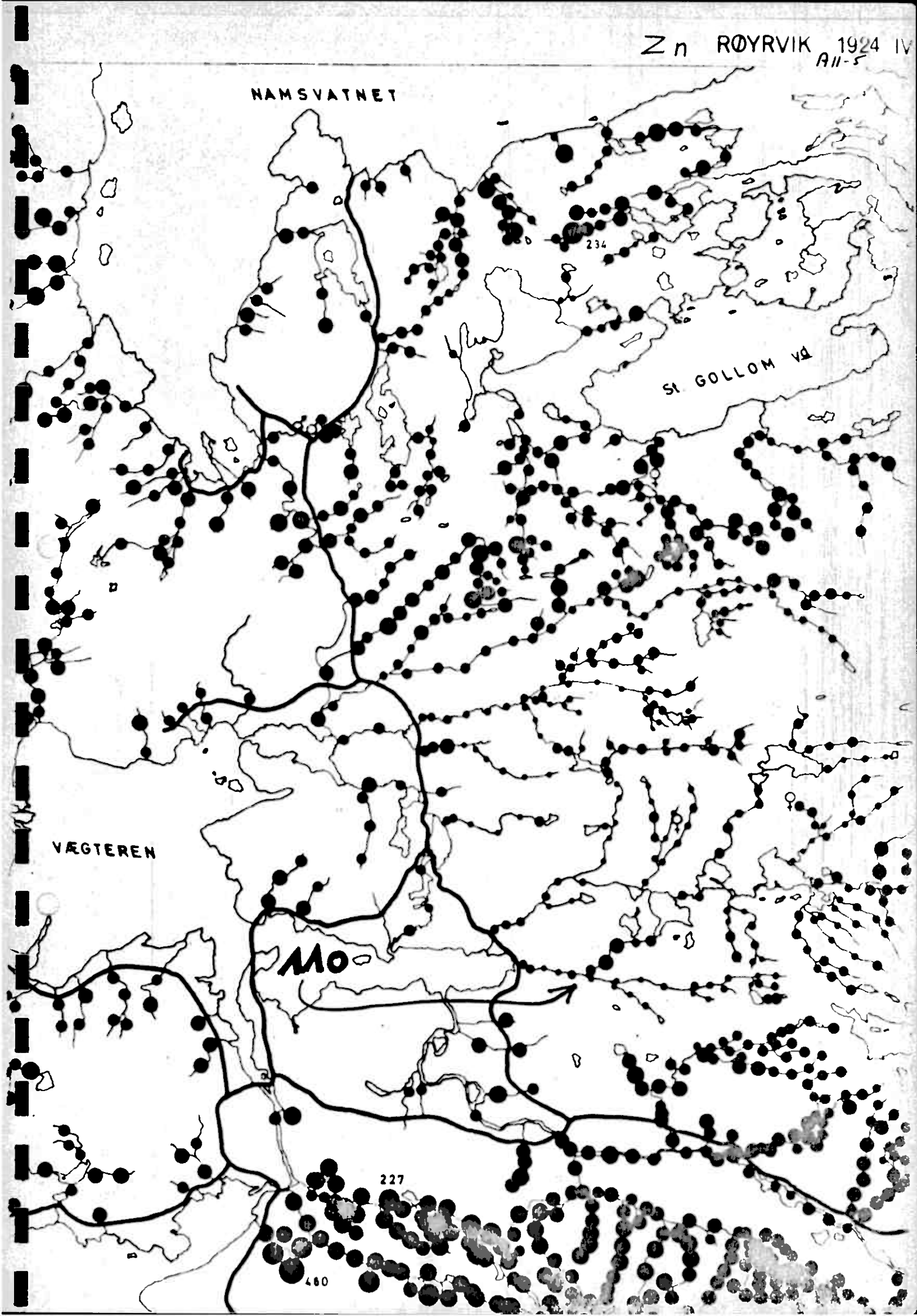
VÆGTEREN

Mo

234

227

480



FIELD NOTES - DAVID SMITH - SUMMER 1975

SANDDØLA - NESÅVATNA DISTRICT, GRONG

NGO series M711 1:50 000 mapsheets ANDORSJØEN and NAMSSKOGAN

Abbreviations.

- L = Locality number
 F = Fly Foto number of Nor-Fly series 357
 S = Strike measured on a 360° compass
 D = Dip measured on a 90° clinometer
 B = Bearing measured on a 360° compass
 P = Plunge measured on a 90° clinometer

1001 etc. are rock sample numbers, oppdrag 1368.

SKARFJELLSVANNET - walking southwards F 1209

L1

Shear zone S122° D 52° NE, almost entirely chlorite + quartz.
 Good foliation parallel to strike and dip, good lineation B 52° P 48° NE.
 Quartz rods parallel to chlorite lineation, ca. 5 mm diameter, ca. 5 cm length of rods, also quartz bands ca. 5 mm wide where not rodded.
S158° D 85° N of a quartz vein, 5 cm wide, straight, pure quartz.
 Rock has irregular alternate chlorite-rich and quartz-rich bands; lineation best in chlorite-rich bands 1001. Most intense shearing along stream bed. Quartz rods prominent on weathered surfaces 1002 & 1003.
 Conclusion: Some kind of trondhjemite or diorite sheared, metasomatised and segregated into chlorite- or quartz-rich layers.

L2

2 quartz veins 8 & 15 cm wide S180° D 80° E.

L3

2 quartz veins 7 & 20 cm wide S160° D 80° W.

L4

Quartz vein 2 - 7 cm wide S120° D 80° SW.
 Several quartz lenses wedge out after 1-2 m.
 Quartz lenses, veins and rods may be related, but veins may be later.

L5

Interbanded chlorite- or quartz-rich bands 5 - 50 cm wide, some diffuse, some distinct S110° D 80° N.
 Identical rock type to L1, L2, L3 & L4. Chlorite-rich layers superficially resemble greenstone.

L6

Top of ridge, 10 m. S. from L5
 Microdiorite or greenstone 1004 apparently intrusive into quartz-rodded schist but has its own foliation S80° D 90°, oblique to schist S350° and minor narrow veins which do not continue into the schist.

L7

Foliated trondhjemite S130° D 3° NE.

L8

Top of ridge.
 Foliated trondhjemite 1005 S130° D 75° NE.
 Impregnated by epidote and grey quartz veins parallel to lineation S150° D 60° NE, and chlorite veins S40° D 25° W.

L9

Porphyritic microdiorite 1006. Diorite 1008 which is strongly sheared parallel to cross-cutting epidote + chlorite + pink ? K-feldspar veins

S170° D80° E. Quartz-rodged trondhjemite 1007 on uphill side. Porphyritic trondhjemite 1009. No clear contacts. 1006 may be chilled margin of 1009. Coarser diorite/hornblendite 1010 within the diorite unit.

Westwards of L9, quartz-rodged trondhjemite and diorite are often in close proximity but contact obscure. Subparallel directions of quartz rodding and shearing in diorite.

L10 Top of ridge.

Quartz rodged trondhjemite is now rusty and contains sulphide 1111, 1112, 1113, 1114 & 1115 (same sample) from a ca. 10 cm wide band which is very rusty.

Contact between quartz-rodged trondhjemite and diorite can be narrowed down to 3 cm above swamp and snow patch. Schistosity in diorite is related to epidote + quartz veins and is essentially conformable to the contact, whilst quartz-rodding appears oblique. Contact likely to have been affected by shearing movements.

Below L10 On southern side.

Can see some quartz rods in some of many very rusty ca. 10 cm wide patches or bands, impregnated by pyrite presumably but not definitively after rodding. Relatively fresh diorite 1020. 1016 epidote - impregnated quartz-rodged trondhjemite. Porphyry dyke injects diorite, prominent white plagioclase, other phenocrysts quartz, white mica + ? hornblende. Dyke clearly cuts schistosity and epidotised layers in diorite. Both porphyry 1017 and diorite 1019 become green at contact 1018 indicating mineral reaction.

SKARFJELLSVATNET to FREMSTTJERNET

F 1209

L10 Again.

1021 and 1022 (same sample) of another rusty patch of quartz-rodged trondhjemite.

L11 W-side of Korttjern

1023 good epidotised trondhjemite.

L12 Top of ridge.

1024 sericitised, not epidotised, trondhjemite S100° D60° N, of weak foliation due to planes of sericite.

1025 epidotised, not sericitised, trondhjemite on opposite side of a narrow gully from S1024.

1026 & 1027 adjacent specimens a few metres further south, contain sulphide and a red shiny translucent mineral.

L13 Near Linjebekk

1028 sericitised trondhjemite in a gully. Between L12 and L13 bedrock has either sericitised or epidotised trondhjemite.

L14 In a gully below scree N of Fremsttjernet.

1029 sericitised trondhjemite sheared into layers, some richer in chlorite than others, some layers almost pure chlorite 1031. 1030 shows boundary between two layers. Gully presumably represents a shear zone.

L15 Fremsttjernet.

Sheared trondhjemite 1032 S85° D60° N.

L16

Perfectly layered quartzite, rusty, 1033, $S102^{\circ} 55^{\circ} N$
1034 greenish rock some 10 m lower.
1035 sheared trondhjemite like 1032 10 m lower at water's edge,
S95^{\circ} D37^{\circ} N. All samples 1033 - 1035 collected from a gully with
 continuous exposure of rusty continually-varying rock type. Strike approx.
 parallel.

L17

Traverse along a gully from little lake southward to Fremsttjernet.
1036 green trondhjemite followed by veins of 5 - 10 cm wide trondhjemite
 cutting greenstone and its foliation. Several rusty patches. Some irregular
 quartz veining. Malachite occurs in trondhjemite 1037 and in quartz vein
1038. Further south and round to west is rusty greenstone 1039 (+ chip
 sample 1040) with sulphide; somewhat irregular veining by trondhjemite.

L18

On top of the big cliff over Fremsttjernet.
 Quartzite again. Sheared rock 1041. Unsheared microtrondhjemite
1042 at hill top. Many other rock types here, all are rusty, chloritised
 and/or quartz rich, probably impregnated by quartz, except for 1042.
 Conclusion: this southern contact of the trondhjemite is exceedingly
 complicated at first glance.
S95^{\circ} D65^{\circ} N of flaggy rock 1043 at the summit of Fremsttjern peak.
 May be Gale's "calcareous sediment".

L19

Chloritic quartzite with good bedding or foliation S80^{\circ} D55^{\circ} N at
 lakeside.

L20

On ridge, 100 m SE of L19.
 Chloritic quartzite 1044.

L21

Other side of gully.
 Limestone 1045, bedding not seen, but gully is parallel to the quartzite
 foliation.

Oppdrag 1289

FREMSTFJELL FELTET

Rettbekken

Mose og Sideprøver

÷180 μ Glødetap

M= 2 Moss samples at each stream sediment site, below water level, 10 clumps each, about 1 metre apart, midstream, 15m from s.s. site,

B= 2 Bank samples, also 10 clumps each, soil horizon at water level, right-hand bank only (facing upstream) i.e. northern bank

Each of a duplicate comprise the same set of 10 clumps, but were thereafter treated separately.

N. G. U. Foraskning. 1289 Art. 130 Side Temp. 430° Tid 2+ Basis Navn Bitt Dato

Prove nr.	Skål	Brutto	Tara	Innv.	Forasket	Glødetap	% Gl.tap	% Aske	Type	Bektesed.	Marknad
1001	1	40,962	41,962	5	44,963	1,999	32,98%	60,02%	M	30	
1002	2	40,560	41,260	5	44,067	1,993	39,86%	60,14%	M	"	
1003	3	51,621	41,621	10	48,494	2,127	31,27%	68,73%	B	"	
1004	4	52,296	42,296	10	49,114	3,182	31,82%	68,18%	B	"	
1005	5	45,305	41,305	4	43,308	1,997	49,93%	50,07%	M	31	
1006	6	43,093	39,093	4	41,083	2,010	50,25%	49,75%	M	"	
1007	7	49,580	39,580	10	46,575	3,005	30,05%	69,95%	B	"	
1008	8	50,905	40,905	10	48,543	2,362	23,62%	76,38%	B	"	
1009	9	44,623	42,623	2	43,641	2,982	49,10%	50,90%	M	33	
1010	10	42,900	39,900	3	41,401	1,499	49,97%	50,03%	M	"	
1011	11	43,377	39,377	10	47,140	2,237	22,37%	77,63%	B	"	
1012	12	50,657	40,657	10	48,563	2,094	20,94%	79,06%	B	"	
1013	13	45,546	42,546	5	43,780	1,766	35,32%	64,68%	M	36	
1014	14	41,862	39,862	2	41,221	0,641	32,50%	67,50%	M	"	
1015	15	51,548	41,548	10	48,738	2,810	28,10%	71,90%	B	"	
1016	16	50,290	40,290	10	47,195	3,095	30,95%	69,05%	B	"	
1017	17	44,025	40,165	4	41,812	2,353	58,83%	41,17%	M	37	
1018	18	43,204	38,004	5	40,001	3,003	62,06%	37,94%	M	"	
1019	19	50,074	40,074	10	45,453	4,621	46,21%	53,79%	B	"	
1020	20	49,254	39,254	10	44,815	4,439	44,39%	55,61%	B	"	

All samples treated identically: - dried, broken up, sieved -180 μ ,

Loss-on-ignition ($\approx$ organic content) determined on the same fraction as for the metal determinations, that is the -180 μ fraction. This is not the same ignition as that to prepare the asket samples (appendix 13-3) since that was on the +180 μ fraction of the first sieving.

1289

18

1 gr 20 ml

Smith

1/974 Rose + Side pr.

23 8 74 3H

268 74 3H

80 u

	2/9-74	2/9-74	2/9-74	5/9-74	5/9-74	8/9-74	8/9-74	11/9-74	11/9-74	11/9-74	11/9-74
	K2	K2	K2	K2	K2	K2	K2	K2	K2	K2	K2
	10 200	10 200	10 200	20 400	20 400	5 100	5 100	5 100	5 100	5 100	5 100
	0.5 10	0.5 10	0.5 10	1 20	1 20	0.5 10	0.5 10	0.5 10	0.5 10	0.5 10	0.5 10
Element	Pb	Zn	Mn	cu	Ni	Co	Ag	V	Mn	Fe	
1001	89	46	39	500	11	17	12	48	540	2.2	
2	91	43	39	470	13	13	13	50	390	2.2	
3	87	44	41	430	12	12	13	51	300	2.3	
4	79	43	40	389	13	14	1.1	53	410	3.3	
5	89	40	46	560	11	18	1.2	38	630	1.7	
6	87	42	44	560	12	19	1.1	37	710	1.6	
7	49	40	40	270	10	8	0.9	56	260	1.8	
8	49	38	36	265	12	8	0.8	54	230	1.9	
9	75	44	44	490	12	9	1.2	48	270	2.2	
1010	77	41	41	500	12	9	1.4	48	250	2.1	
1011	46	34	22	222	10	6	0.8	47	180	1.7	
2	49	33	22	228	13	7	0.8	53	190	1.8	
3	79	31	40	460	14	10	1.0	41	210	1.7	
4	76	34	38	430	12	9	0.9	40	200	1.6	
5	59	38	37	350	11	7	0.6	42	160	1.6	
6	65	27	46	380	11	7	0.7	45	160	1.7	
7	430	25	320	100	15	16	1.3	98	240	1.95	
8	410	27	290	900	15	16	1.1	104	210	2.7	
9	94	20	64	520	12	6	0.8	35	20	1.1	
102	40	18	70	470	11	6	0.7	37	20	1.3	

Remanent
10 elements: More
of Side pr.

1289

GRON - Smith Th Arset More

3 10 TH

1g 20ml

	10/11-75	10/12/74	10/12/74	10/12/74	6/1-75	8/1-75	9/1-75	10/1-75	10/1-75	11/1-75	
	DS	DS	DS	TS	TS	TS	TS	TS	TS	TS	
	10 200	100 200	12 200	2 40	5 100	9.5 10	10 200	100 200	200 40%		
	1 20	10 200	1 20	0.5 10	1 20	0.25 0.5	0.5 10	1 100	250 0.5%		
	Mo	Cu	Zn	Pb	Ni	Co	Ag	V	Mn	Fe%	
Percent	OK										
4001	110	1530	88	317	37	45	2.4	115	900	3.0	
2	67	1340	80	281	25	24	2.0	83	500	2.5	
3	78	980	74	217	22	26	1.8	100	580	3.3	
4	78	1000	78	226	23	30	1.7	104	670	3.5	
5	106	1540	89	261	26	37	1.6	76	910	2.5	
6	115	1570	91	268	27	44	1.7	83	1130	2.6	
7	94	900	79	154	21	14	1.4	126	400	3.1	
8	82	830	71	144	19	14	1.4	117	370	3.0	
9	130	1550	102	235	31	23	2.0	124	510	3.9	
4010	144	1570	101	240	35	25	2.1	129	510	4.0	
1	53	740	61	149	22	12	1.3	123	330	3.5	
2	56	830	71	167	22	12	1.2	115	330	3.6	
3	100	1560	71	260	25	22	1.4	83	360	2.0	
4	100	1620	79	267	26	23	1.5	88	390	3.0	
5	84	1250	82	186	22	12	1.4	93	240	2.6	
6	97	1220	83	202	20	15	1.2	106	270	3.1	
7	105	2600	65	1220	35	27	1.9	260	570	4.4	
8	98	2700	77	1220	37	37	2.0	260	540	4.02	
9	198	2020	47	300	20	13	1.0	100	170	2.7	
402	225	2000	43	296	31	15	1.5	100	180	3	

RETBOKEN

10 element: Arset More of Sinter

Sample treatment: dried, broken up, sieved with 180 μ + 180 μ fraction (mostly max lenses or nuclei) ignited, then the ash sieved through - 180 μ and the <180 μ fraction analyzed by atomic absorption to give the metal content in ppm of the ash.

Sample numbers 4001 - 4020 correspond to 1001 - 1020 in the unashed samples

R13-2

1289 21 1974 BH 228 1974 BH 180 μ
 Smith 1974 Bokkesd
 218 1974 BH 228 1974 BH 180 μ

Date	2/9-74	2/9-74	29/1-75	5/9-74	6/1-75	8/1-75	9/1-75	16/1-75	10/1-75	14/1-75	Bokkesd. site 1289-
Name	KB	KB	KB	KB	TS	TS	TS	TS	TS	TS	
1st	10 200	10 200	10 200	20 400	2 40	1 20	0.05 10	10 200	10 200	200 400	
2nd	0.5 10	0.5 10	1 20	10 200	5 100	0.5 10	0.025 0.5	0.5 10	5 100	0.5 0.5	
Prevent	Pb	Zn	Mo	Cu	Ni	Co	Ag	V	Mn	Fe	
2001	29	39	24	149	11	11	0.5	44	310	1.9	-30
2	74	53	42	380	14	16	1.0	54	520	2.6	"
3	117	62	46	740	13	18	1.2	50	570	2.5	"
4	30	37	6	144	10	7	0.6	30	220	1.0	-39
5	119	82	30	600	18	35	1.0	46	820	2.1	"
6	176	95	36	1000	19	53	1.5	44	1230	2.4	"
7	10	22	6	74	12	6	0.4	33	250	0.9	-24
8	23	39	15	268	13	15	0.4	39	390	1.2	"
9	49	59	29	780	18	30	0.8	49	690	1.7	"
2010	23	44	19	123	12	9	0.6	101	500	1.6	-25
1	31	60	25	226	11	11	0.6	122	580	2.0	"
2	77	100	61	980	18	30	0.9	100	930	2.8	"
3	8	24	4	35	10	6	0.4	25	180	0.8	-26
4	16	26	10	84	12	7	0.5	25	190	0.9	"
2015	57	62	27	344	20	16	0.7	36	360	1.4	"
6											
7											
8											
9											
10											

first - heaviest - mostly silt
 second - medium - mixed
 third - lightest - mostly organic

At the sites of 5 normal stream sediment samples, an extra sample was taken. By means of stirring the sediment in the bottom pan and using different nest times before decanting, the material was collected as 3 separate fractions which were then dried and analysed as normal samples.

Stream Sediment Fractions WET SEPARATION

Appendix 14

1289

22

19 20-1

GRIND

For Analysis

12.5 to 25

-120

Date	23/9/74	23/9/74	29/11-75	24/9/74	4/1-75	6/1-75	9/1-75	12/1-75	10/1-75	14/1-75
Name	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS
1st	10 200	10 200	10 200	10 200	2 40	7 20	105 10	10 200	10 200	2000 40%
2nd	05 10	1 20	1 20	05 10	0.5 10	0.5 10	0.025 0.5	0.5 10	1 100	250 0.5%
3rd	Cu	Zn	MO	Pb	Ni	Co	Ag	V	Mn	Fe%
Provenance										
1										
2										
3										
4										
5										
2016	149	28	48	29	14	6	0.2	47	120	1.1 -07
2017	151	28	47	29	13	6	0.2	46	120	1.1 "
2018	80	18	26	17	10	4	0.2	32	100	0.8 "
2019	260	17	48	22	22	8	0.7	56	140	1.8 -38
2020	580	30	103	46	10	8	0.8	51	130	1.8 "
2021	280	22	60	28	14	6	0.4	40	120	1.3 "
2022	840	45	42	16	26	12	0.8	54	240	2.0 -64
2023	2500	108	96	36	28	15	0.9	49	290	2.2 "
2024	960	58	54	25	17	10	0.4	39	240	1.5 "
2025	5	12	3	11	20	15	0.5	55	550	1.2 -82
2026	26	32	16	22	15	14	0.6	40	860	1.5 "
2027	10	34	6	32	10	5	0.3	26	350	0.9 "
2028	1290	139	260	27	45	125	0.8	190	840	5.0 -98
2029	1370	147	190	30	46	103	0.8	189	1810	4.8 "
2030	790	72	104	37	29	53	0.7	158	1040	3.2 "

 Bekked
nr.
1289-

Normal stream sediment samples were rechecked. After routine drying and sieving to 180µ the material was separated into three fractions by vibrating on a glimmer board. The analytical results for each sample give first the heavier fraction (mostly silt) and lastly the lightest fraction (mainly organic).

DRY SEPARATION

0.5g 2019

0.5g 2022

0.2g 2025

914-2

N. G. U. Foraskning. 1289 Art. <i>b. sed</i> Temp. <i>430°</i> Tid <i>20t</i> Basis _____ Navn <i>34</i> Dato _____									
Prøve nr.	Skål	Brutto	Tara	Innv.	Forasket	Glødetap	% Gl.tap	% Aske	Merknad
2001	101	<i>Tomm</i>							Bekked. nr. 1289-30
2002	102	45555	43555	2	45125	0.430	21.50 %	78.50 %	"
2003	103	48720	43720	5	46397	2.323	46.40 %	53.54 %	"
2004	104	53860	43160	10	53615	0.245	0.245 %	99.55 %	1289-39
2005	105	53255	43255	10	52526	1.329	13.29 %	86.71 %	"
2006	106	53404	43404	10	50362	3.042	30.42 %	69.58 %	"
2007	107	48599	43599	5	48527	0.072	1.24 %	98.76 %	1289-24
2008	108	42465	42465	5	47061	0.404	8.08 %	91.92 %	"
2009	109	42115	42115	5	45896	1.219	24.38 %	75.62 %	"
2010	110	<i>Tomm</i>							1289-25
2011	111	<i>Tomm</i>							"
2012	112	<i>Tomm</i>							"
2013	113	47016	42016	5	46939	0.077	1.54 %	98.46 %	1289-26
2014	114	52397	42397	10	51756	0.641	0.641 %	99.359 %	"
2015	115	45427	42427	3	44534	0.893	29.77 %	70.23 %	" WET ↑
2016	116	46022	41022	5	45543	0.479	9.28 %	90.72 %	1289-07 DRY ↓
2017	117	52358	42358	10	51190	1.168	11.68 %	88.32 %	
2018	118	52620	42620	10	52385	0.295	0.295 %	99.705 %	

N. G. U. Foraskning. 1289 Art. <i>b. sed</i> Temp. <i>430°</i> Tid <i>20t</i> Basis _____ Navn <i>34</i> Dato _____									
Prøve nr.	Skål	Brutto	Tara	Innv.	Forasket	Glødetap	% Gl.tap	% Aske	Merknad
2019	119	<i>Tomm</i>							1289-33
2020	120	46217	41217	5	45709	1.108	22.16 %	77.84 %	
2021	121	42812	40812	2	42665	0.147	1.35 %	98.65 %	
2022	122	40976	38976	2	40736	0.240	12.00 %	88.00 %	1289-64
2023	123	45790	40790	5	44738	1.052	21.04 %	78.96 %	
2024	124	44640	39640	5	44302	0.338	6.76 %	93.24 %	
2025	125	<i>Tomm</i>							1289-82
2026	126	44812	44812	5	48756	1.056	21.12 %	78.88 %	
2027	127	46725	41725	5	46421	0.304	6.58 %	93.42 %	
2028	128	45145	40745	5	44618	1.127	22.54 %	77.46 %	1289-98
2029	129	46416	44416	2	46024	0.412	7.60 %	92.40 %	
2030	130	46190	44190	2	46054	0.136	6.80 %	93.20 %	

GEOLOGISK TEGNFORKLARING TIL KART NGU 1276-03.

fra kart NGU 1166-10 etter Sverdrup.

- a Høymetamorfe bergarter i nordvest.
- b Gjersvik-dekke med intrusiver.
- c Sanddøla-Limmingen gruppen.
- d Fyllitt-grønstens serien.
- e Børgefjell Massivet.
- f Gellvernokko-dekke.
- g Leipik-dekke.
- h Olden-dekke.
- i Seve-dekke.
- j Østlige kambro-silur bergarter.

- 16 Green coloured phyllite, siltstone and sandstone on map 1293-07.
- 15 Calcareous psammite.
- 14 Arkose and conglomerate derived from trondhjemite.
- 13 13. Meta sediments; calcareous semi-pelite and arkose. 13a. Calcareous pelites, semipelite and phyllites in Elstadelven. 13b. Non-calcareous arkose, sandstone and minor phyllite north of Elstadelven. ~~13c. Pseudo-conglomerate and/or conglomerate~~
- 12 12. Trondhjemite, medium grained; 12a. Fine-to medium grained; 12b. Fine-medium grained with disseminated pyrite; 12c. Trondhjemite intruded into greenstones.
- 11 11. Gabbro, medium-grained; 11a. fine-grained.
- 10 10. Calcareous sediments (phyllite, siltstone, conglomerate and sandstone). 10a. Mylonite^K
- 9 Conglomerate derived from greenstone and keratophyre; with minor sandstone ~~in the~~ west of Gaizer vann
- 8 8. Quartzite horizons; 8a. Silicic rocks of unknown origin in Fremsttjern area; 8b. Calcareous silicic rocks of unknown origin (map 1293-06).
- 7 Keratophyre.
- 6 6. Basic volcanic rocks: ^{6a.} greenstone; ^{6b.} tuffs and volcanic sediment; ^{6c.} mainly volcanic sediment. Contains minor keratophyre.
- 5 Basic volcanic rocks: amphibolitic, generally layered; contains minor keratophyre.
- 4 Limestone/marble.
- 3 Pelitic and psammitic rocks, phyllitic in part. Probably equivalent to 2.
- 2 Mica schists with garnet and kyanite.
- 1 1. Gneiss, undifferentiated: ^{1a.} medium-to coarse-grained; ^{1b.} fine-to medium-grained; ^{1c.} layered gneiss.

Helianomali nr. 19 (f.f. 357.501 - matt).

Målemetode: SP. Ingen anomalier.

Helianomali nr. 21 (f.f. 357.504 - matt).

Anomalien funnet ved minigun. To topper. Fant Tynn py-stripe sammen med Fe-kvartsitt på sydligste anomalitopp, ingenting på den andre.

Anomalien bør sjekkes med VLF/APEX.

Helianomali nr. 22 (f.f. 357.502 - matt).

Målemetode: SP. Ingen anomalier.

Helianomali nr. 32 (f.f. 357.704 - matt).

Målemetode: minigun, VLF, SP. Røsket på VLF-anomalien og fant 20cm py-sone (vasskis) samt 5cm mt.

Helianomali nr. 33 (f.f. 357.704 - matt).

Målt, røsket og funnet py-sone i 1973. VLF-profilet ga annen anomalitopp enn gun-målingene, men i dette tilfelle ga minigun korrekt anvisning.

Helianomali nr. 36 (f.f. 357.806 - matt).

Målemetode: SP. Røsket og funnet tre tynne py-striper i grønnstein.

Helianomali nr. 42 (f.f. 357.806 - matt).

Målemetode: SP. Mange svake anomalier og APEX-topper.
Ikke røsket.

FREMSTFJELL.

- a) Geolog Gale fant en tynn cpy-stripe i SV-kant av et lite tjern kalt "Amøbetjern" på D. Smiths anomalikart fra Mo/Cu-prospekteringen. VLF-målinger ga ubetydelige utslag over sonen som lokalt når opp i 10 - 15cm's mektighet, men forøvrig er en ubetydelig cpy-stripe. F.f. 357.1206 - glansa.

- b) Mo/Cu-impregnasjonssonen på Fremstfjell ble befart sammen med Gale, Smith & Co. Mitt inntrykk er følgende: prøvetakingen av jord, bergart og humus har gitt til dels sterke anomalier såvel på denne sonen som på enkelte andre lokaliteter. Anomaliene skyldes mineralisering i dagen. Fjellet er for det meste godt blottet, og det en kan se av py/Mo/Cu i dagen er svært tynne saker. Det tyder på at konsentreringen i bekkesedimenter og jord har vært sterk. Enkelte større Mo-anomalier forklares av mindre lokaliteter med ~1% Mo i kvarts. De sterke Cu-anomaliene er uoppklarte. Videre undersøkelser bør i første omgang ta sikte på å undersøke Fremstfjellssonen ved røsking for å få begrep om gehalter i friskt fjell og variasjoner innen sonen. Forøvrig henvises til Gales rapport.
- c) Vi fant en tynn py/mt-stripe nord for Langtjern og målte noen VLF-profiler. Sonen som kan følges mer enn én kilometer inn mot Mo/Cu-sonen på Fremstfjell, ga svært svake anomalier. Analyse av py-prøve ga 0,2% Cu, 0,0% Zn.

Lenger opp i skråningen mot Skarvfjell ble observert to andre rustsoner. Analyser av kis fra den nederste ga 0% Cu og Zn.

F.f. 357.1208 - glansa.

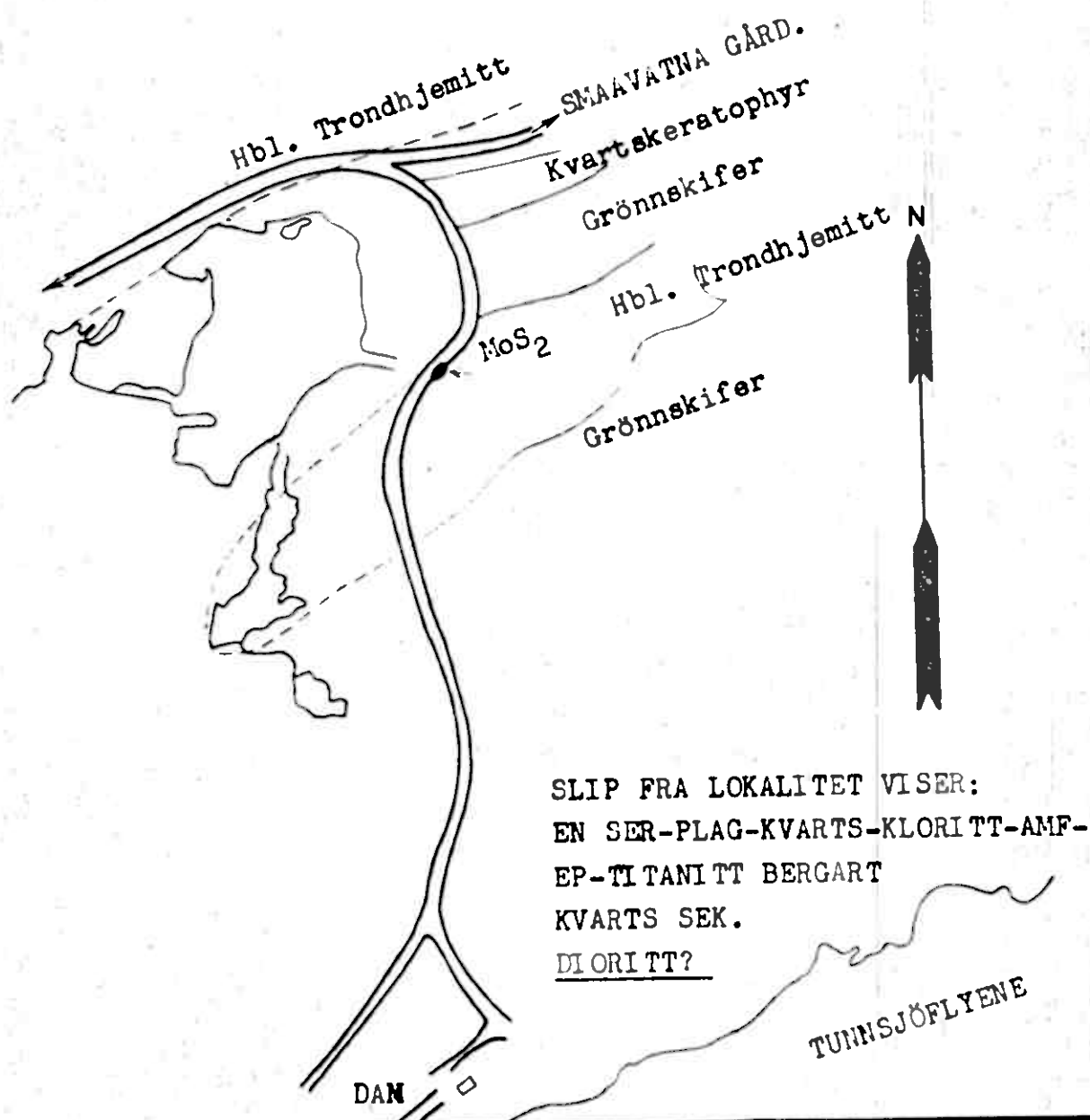
SMÅVATNAN.

Det ble boret fem hull på anomalier fra turammålinger i 1973. Bare malmsone er logget, de er dessuten analysert på Cu, Zn og Fe. Resultater:

Bh.	Koordinater	Helling	Interv.	Beskrivelse	%Cu	%Zn	%Fe
1		90°	30,00 39,00	Gr.st., enkelte blåkvarts/mt-striper. Skifr. 90 - 80°			
			40,51=1,51	Gr.st. m. po/py-str.	0,00	0,00	12,2
			50,00	Gr.st.			
2		90°	40,00 43,00=3,00	Gr.st. m. po/py-imp.	0,01	0,01	6,4
			54,85	Massiv gr.st.			
			71,70=16,85	Gr.st. m. po/py-imp. og po/py-vev i soner på opptil 1m's mekt.	0,01 - 0,04	0,00 - 0,10	3,3 - 35,2
3		60°	110,00 118,25	Gr.st. m. mt-striper og -imp. 60 - 70°.			
			119,70=1,45	Po/py-striper i gr.st.	0,02	0,02	13,9
			121,62	Gr.st.			
			122,57	Po/py-vev og -imp.	0,02	0,01	24,8
			130,00	Gr.st.			

MOS₂ ER PÅVIST. OPPTRER SOM EN TYNN FILM I SPREKKER I KVARTSRIKE PARTIER I EN AMFIBOLFÖRENDE TRONDHJEMITT, TRONDHJEMITTEN VIRKER INTRUSIV.

7 stk. PRÖVER(SLITS) 905/400-407 BLE TATT. VÅTVEISANALYSE VAR NEGATIV. PRÖVENE BLE KONTROLLERT PÅ RÖNTGEN.
D.V.S. IKKE PÅVIST MENGDER OPPTIL 0,003% Mo.....



MoS₂ - LOKALITET
VED GRÖNNDALSDAMMEN-TUNNSJÖFLYENE

M 1:5000

Obs. Kv. 1969
Tegn. Kv. 1974
Trac. H.E. 1974

NORGES GEOLOGISKE UNDERSÖKELSE
TRONDHEIM

Fig. 3

LIST OF CONCENTRATION DISTRICTS

(on the combined 1:50 000 Namsskogan + Andorsjøen map)

<u>Number</u>	<u>Name</u>	<u>Element priority</u>
1	Øst Finbuvatnet	Zn, Cu, Mo, Pb
2	Vest Koltjernet	Zn, Cu, Pb
3	Sydøst Fremsttjernet	Zn, Pb
4	Øst Fremsttjernet	Mo, Pb, Zn, Cu
5	Øst Fremstfjellet	Mo, Cu, Pb, Zn
6	Vest Fremstfjellet	Cu, Mo, Pb, Zn
7	Syd Skarfjellet	Cu, Zn, Mo, Pb
8	Øst Korttjernet	Mo, Pb, Zn
9	Sydvest Langløftfjellet	Zn, Pb, Cu
10	Sydøst Langløftfjellet	Zn, Pb, Cu
11	Øst Skarfjellet	Mo, Cu, Zn
12	Syd Piggvannet	Cu, Mo, Pb, Zn
13	Nordøst Piggvannet	Mo, Pb
14	Vest Nesåpiggen	Cu, Pb
15	Vest Øvre Nesåvannet	Cu, Zn, Pb
16	Syd Øvre Nesåvannet	Cu, Pb
17	Øst Nesåpiggen	Pb, Zn
18	Sydøst Nesåpiggen	Cu, Pb, Zn
19	Vest Blåmuren	Mo, Cu, Pb
20	Nord Blåmuren	Cu, Pb, Zn
21	Nordøst Gaizervannet	Cu, Pb, Zn, Mo
22	Nord Gaizervannet	Pb, Zn

LEGEND

Appendix 19

A19-1

oppdrag 1289 årstall 1974
bergartsprøver
foreløpig beskrivelse

L = Leds blokk

F = Fast fjell

R = Rich part of hand specimen taken for analysis

P = Poor " " " " " "

S = Spectrographic Analysis

t = thin sections

G = Greenstone

T = Trondhjemite

U = Uncertain

U(T) .. probably was Trondhjemite

U(G) .. Greenstone

P = Pyrite (Marcasite, Pyrrhotite)

C = Chalcopyrite

L = Malachite

M = Molybdenite

H = Sphalerite

S = Silicified

E = Epidotized

C = Chertified

v = veins, thickness in mm.

d = disseminated

c = clusters

SAMPLE hand specimen	NUMBER chip for analysis	SITU LOWE	LOCALITY	THICKNESS in centimeters	REF.	ROCK TYPE	MINERALIZATION P C L M H S E C T	VEINS DIP.	POS. veins size	REMARKS
3001		L	Fremstøff	10 cm		U(T)	P - M - E - T	2 d	v 1	
3002	3003	L	"	10 cm		U(T)	P(E) - M - S E C	v 2 (1)	v 1	
3004	3005	L	"	10 cm		U(T)	P - M - S E C	20 d	v 1	
3006		F	Sving Bekk	10 cm		G	P(C) - H - - -	v 2	c	clusters of small veins of feld 3
3007	3008	F	"	10 cm		G	P(C) - H - - -	v 3	v 3	
3009	3010	F	"	10 cm		G	(P)	v 1		
3011	3012	F	"	5 cm		(G)U	P(C)	c	c	see 300
3013	3014	F	"	10 cm	S	U(T)	P - - - S(E) C	v 2		
3015	3016	F	"	5 cm		(U)	P - - - - C T	v 1		
3017	B	F	Tpr Bekk	5 cm		(U)	(P) - L - - S(E) C	d		the country Cu and export
3018	3019	F	"	"		G(U)	(P) - - - U(E) C	d		
"	3020	P	"	"	S R	U	(P) - - - S(E) C	d		
3021	3022	F	"	5 cm	S	U	- L - - - C	d		rich in Cu (10)
3023	3024	F	"	5 cm		U	P - - - S - -	d		
3025	3026	F	"	5 cm		U	P - - - S C	d		Wg. feldspar
3027	3028	F	"	100 cm		U	P - - - S - T	d		
3029	3030	F	"	2 cm	S	(G)U	P - - - S E	d		blue black mineral
3031	3032	F	Amfote Fjern	100 cm		U	- C L	d		
3033	3034	F	"	"		U	- C - - S -	d		
3035	3036	F	"	"		U	- C - - S - C T	d		
3037	3038	F	"	"	S	U	- C - - S - C T	d		black black mineral
3039	3040	F	Bratt Fjellat	10 cm	S	Q	(P)(C) - S (C)	c	c	(P) in 3042
3040	3042	F	"	"		Q	- S			
3043	3044	F	Bratt Bekk	5 cm	S R	T	(P) - M - - C T	d		v 2
"	3045	F	"	"	P	T	(P) - M - - C T	d		v 2
3046	3047	F	"	"		T	(P) - M - - C T	d		v 2
3048	3049	L	Fremstøff	10 cm		T	P - M - - C T	v 1 d		v 1
3050	3051	L	"	10 cm		T	P - M - - C T	d		v 1
3052	3053	F	Rett Bekk	100 cm		(G)U	P - - - (E) C	d		
3054	3055	F	"	"	S	U(T)	P(C) - - - C	d	d	
3056	3057	L	Bratt Bekk	20 cm		G	P(C) - - - C	d	d	Cu enrichment
3058	3059	F	Fremstøff	5 cm		U	P - - - S	d	d	Cu enrichment
3060	3061	F	"	20 cm	R P	U(T)	P - - M - S	d		v 1
"	3062	F	"	"		U(i)	P - - M - S	d		v 1
3063	3064	F	"	10 cm		G	P - - - C	d		
3065	3066	F	Fremstøff	10 cm		T	(P) - M - S(E) U(T)	v 2		v 6

Shimada hard specimen	Number Sp. for analysis	STN	LOCALITY	Thickness in centimeters	REP.	Rock Type	MINERALIZATION	VEGETATION	Soil	Water	Notes
							P C L M H S E C				
3067	3068	F	Smalghem	20		V(1)	- - - - C	d			Similar to 3077
3069	3070	F	"	9		V(1)	- - - - S				v. C. 3
3071	3072	F	"	20		G	- (C) - - - C	d	d		
3073	3074	F	"	"	S	G	- (C) - - - C	d	d		
3075	3076	F	Kortzen Bekk	20		G	- (C) - - - S E -	d	d		
3077	3078	F	"	20		U(1)	- - - - - C	v. d			Similar to 3077
3079	3080	F	"	10		C	- - - - - C	v. d			Similar to 3077
3081	3083	F	Frederiksen Tjern	30	S	V	- C - M - (S) E C	d	c	d	Similar to 3077
3082	3085	F	"	"		V	- C - M - (S) E C	d	c	d	Similar to 3077
3084	3085	F	"	20		G	- - - M - (S) - C	d			dark grayish
3086	3087	F	"	50		V	- - - M - (S) - C	d			dark grayish
3088	3089	F	"	50	S	V	- - - M - (S) - C	d			dark grayish
3090	3091	F	Nedre Bekken	300		V	- (S) - - - (S) E -	v. d			dark grayish
3092	3093	F	Sving Bekk	10		G	- - - - - C	d			
3094	3095	F	"	5		V	- - - - - C	v. d			
3096	3097	F	Top Bekk	5		V	- - - - - (S) (C) -				
3098	3099	F	"	100		(C) V	- - - - - (S) T				
3100	3101	F	"	1		(C) V	- (C) - - - - -	d	d		dark grayish
3101	3102	F	"	5		(C) V	- (C) - - - - -	d			
3103	3104	F	"	5		(C) V	- (S) (C) - - - -	d			
3104	3105	F	"	"		(C) V	- (S) (C) - - - -				
3106	3107	F	"	10		V	- - - - - S				
3108	3109	F	"	10	S	V	- - - - - S				
3110	3111	F	Nedre Bekk	100		T	- - - - - T	d			
3112	3113	F	"	50		V	- - - - - C T	d			
3114	3115	F	"	1000		G	- - - - - (C)				
3116	3117	F	Frederiksen Tjern	50		V	- - - - - S C	d			
3118	3119	F	"	100		V(1)	- - - - - C	d			

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Notes: 2. Handwritten notes in the right margin.

David Smith's prøvesamlingTrondhemitt-prosjekt sesong 1974FORELÖPIG MAKROSKOPISK BESKRIVELSE

av T.H. Tan

pr.nr.

oppdrag 1289

- 3001 Arkosisk eller granittisk bergart?
Grovkornet 0 - 4 mm
Sulfidmineralisert py, mo.
Trondhemitt?
- 3002 ds.
- 3003 -
- 3004 Nærmest kompakt sulfidknoll eller ~~leire~~ ^{-linse} (py) i kvartsitt eller trondhemitt?
- 3005 -
- 3006 Finornet, mørk sanns. kvartsrik bergart (kvartsitt?) Sulfid-mineralisert, py i småkorn og tynne stringers.
- 3007 Grå, lyse-grå-(grønnlig i fersk brudd). ^{Meget} finkornet. I forvitret flate grønnlig. Småputer? Grønnstein. Noen mørke amygdules. Py i mm store årer mellom "putene".
- 3008
- 3009 Finkornet, mørkegrå i fersk brudd. Grønnlig i forvitret flate. Massiv grønnstein.
- 3010
- 3011 Finkornet, mørkegrå i fersk bruddfl. grønnlig i forvitret fl. Litt skifrig, noe ^{kloritt} eller/og serissitt. Litt sulfidmineralisert (py) i små terninger (0.1 mm).
- 3012

- 3013 Tildels gangkvarts.
Tildels kataklastisk, finkornet. Lys, nesten hvit kvarts-feltspat bergart. Noen små prikker av mørkt mineral. Trondhemitt eller keratofyr? (Ts. *ønskes*).
- 3014
- 3015 I fersk bruddflate lys, minner sterkt om nummer 3013. Mange stikk og glidespeil, som er mørke, og har litt serissitt.
- 3016
- 3017 I fersk brudd lyse grå, finkornet kvarts ?
Kvartsitt ?
- TS 3018 I fersk brudd lyse grå - grønn, finkornet m. svarte linser av 0.5 - 4 mm. Kan det være en basisk pyroklastisk bergart ?
- 3019
- 3020
- 3021 Altfor forvitret. Forvittringsfarge rød (hematitt farge).
- 3022
- 3023 Kompakt, finkornet py.
- 3024
- TS 3025 Finkornet, tett. Kvarts. Litt sulfidimpregnert. Kvartsitt
- 3026
- 3027 Porøst, middelskornet py og kvarts i 50% - 50%.
- 3028
- 3029
- TS 3030

- 3031 Porøs bergart. Tildels forvitret i hulrom cp, kvarts, limonitt, litt malakitt, ~~N~~esten kompakt cp.
- 3032
- 3033 som 3031
- 3034
- 3035 som 3031
- 3036
- 3037 som 3031
- 3038
- 3039 gangkvarts
- 3040 gangkvarts
- 3041
- 3042
- 3043 Grovkornet (3-4 mm) feltspat (plagiokl., lys-gule) meget lite kvarts, meget lite glimmer (serisitt) litt forskifret.
Trondhemitt.
- 3044
- 3045
- TS 3046 Stort sett som nr. 3043
- 3047
- 3048 Trondhemitt som nr. 3043. Sulfidmineralisert (py-terninger).
- 3049
- 3050 Trondhemitt, sanns. meget tektonisert. En del py.
- 3051
- 3052 Meget finkornet. Skifrig. Mørke grønn-svart. Ganske hard (*alb*, -klorittskiifer?). Grønnskiifer. Noen py-impregnasjon.

3053

3054 I fersk bruddflate lysegrå. I skifrichetsplan grønn. Middels-
kornet - finkornet. Antakelig hovedsaklig kvarts og feltspat, med
kloritt i mange glideplaner

3055 Mørke grønn, finkornet. Skifrig. Sanns. litt bløtere enn 3052.
Klorittskifer.

TS

3056

3057

TS

3058 I fersk bruddflate: hvit. I forvitret flate brunlig - rødlig p.g.a.
jernhydroksyd. Meget finkornet. Bare kvarts.
Kvartsitt.

3059

3060 Sterkt tektonisert, med Fe-oksyder og hydroksyder i sprekke-
flatene. Hoveds. plagioklas (?), muligens sanssurittisert.

3061

3062

3063 Fersk bruddflate. Grønnlig-grålig. Noe skifrig, muligens gjennom-
gått noe "shearing". Finkornet. Basisk ell. intermediær bergart
som ble tektonisert med nydannelse av kloritt og epidot ?

3064

3065 Grovkornet, massiv, gjennomskåret av noen opake (mt) soner.
Litt kvarts, rødlig og grønnlig feltspat. Trondhemitt, av Sanns,
kvarts~~son~~sonittisk sammensetning.

3066

3067 Fin- til middelskornet. Lyse grønn.
Klorittrik. Kvarts, feltspat.

TS

Grønnstein ?

3068

- 3069 Tett, massiv - finkornet. Kvartsgang med litt glimmer?
- 3070
- 3071 Samme som nr. 3067.
- 3072
- 3073 Finkornet, noe skifrig, grønn. Grønnskifer, eller litt ~~parkifret~~ ^{forskifret} basisk eller ^{inter} mediær (gang-) bergart?
- 3074
- TS 3075 Lagdelt bergart av lys (hvit), lysegrønn og grønne lag. Sedimentær bergart eller tuff?
- 3076
- TS 3077 Finkornet, svakt lagdelt bergart.
- 3078
- TS 3079 Trondhemitt som 3067, med basisk xenolitt.
- 3080 *saussurittisert*
- TS 3081 Middels- grovkornet. Grønn- mørkegrønn i fersk bruddflate. Brun i forvitret flate. Hornblende og ~~sourouittrikt~~ plagioklas med sulfid (py). Metagabbro eller metadioritt.
- Kontroller igjen, stemmer ikke med mkr. beskrivelse.*
- 3082 Det samme som 3081
- 3083
- 3084 Grønn- mørkegrønn i fersk bruddflate. Brun i forvitret flate. skifrig. Mye kloritt, kanskje også amfibol, sulfidimpregnasjon (py-terninger).
- 3085
- TS 3086 Middels- grovkornet. Massiv mørkegrønn- svart. Hornblenditt med magnetitt.
- 3087
- 3088
- 3089

- 3110 Gråhvit. Grovkornet. Kvarts. Plagioklas (litt saussurittisert)
Hornblende - sulfid (py). Trondhemitt.
Kontroller igjen, ~~beskrivelse~~ ^{ur} beskrivelse stemmer ikke helt med
mikr. beskrivelse. [↑]
tekstur
- 3111
- 3112 Matrix lysegrå og finkornet. 2- 4 mm store plagioklas ⁿ ~~fe~~okrystaller.
Sulfider (py og kanskje cp). Trondhemitt. Sammenlign med 3094.
- 3113
- 3114 Grønn. Finkornet. Tett. Grønnstein (sannsynligvis mineral-
innhold albitt, epidot, kloritt).
- 3115
- 3116 Lys-hvit. Kvarts-feltspatgang.
- 3117.
- 3118 Grønnlig lys. Finkornet. Tektonisert Trondhemitt ?
- 3119
- 3120 Lys-hvit. Grovkornet. Kornene er avrundet. Sanns. av
trondhemittisk eller granittisk sammensetning, men ~~det~~ er det
ikke en erosjonsprodukt fra en granitt ?
- 3121
- 3122 Fin- til middelskornet. Lys. Kvarts, saussurittisert plagioklas.
(k feldspat ?) litt serisitt.
Trondhemitt (kanskje noe kvartsmonsonittisk).
- 3123
- 3124 Lys - hvit. Grovkornet. Kvarts, plagioklas, litt hornbl.
Trondhemitt.
- 3125
- 3126 Lys-hvit. Grovkornet. Kvarts, feltspat (saussurittisert plagiokl.)
(og k-feltspat ?). Litt hornblende. Trondhemitt (event. noe
monsonittisk).

3127

3128

Grønnlig - lys - hvit.

Store, ca. 4-5 mm store feⁿokrystaller i middelskornet matrix.Feⁿokrystall^{ene}~~er~~ er sonert plagioklas. Matrix trondhemitisk ^f
Porfyrisk trondhemitt.

3129

3130

3132

TS

Lys-hvit. Grovkornet. Avrundete korn?

Feltspat (plagiokl. og event. litt k-feltspat)

Kvarts.

3133

3134

Lys-hvit. Grovkornet.

Kvarts. Saussurittisert plagioklas.

(og k-feltspat ?)

Trondhemitt (event. noe kvartsmonsonittisk).

3135

3136

Lys-gråhvitt. Grovkornet.

2-3 m store feⁿokrystaller av saussurittisert plagioklas^r,Kvarts. Trondhemitt.

3137

3138

TS

Grå-hvit. Grovkornet.

Trondhemitt.Slip-beskrivelse antyder store feⁿokrystaller av saussurittisert plagioklas. Sjekk håndstykket !

3139

3140

TS

Lys-hvit. Grovkornet. 55 mm

Kvarts og plagioklas (~~saussurittisert~~).Trondhemitt. saussurittisert

3141

3142

Hvit. Finkornet og tett. Sannsynl. kvarts og feltspat. (lys og finkornet deformert parti i trondhemitten ?)

- 3143
- TS 3144 Grå.
Sjekk håndstykket en gang til
- 3145
- 3146 Sammenlign med 3122
- TS 3147
- 3148 Grønnlig-grå.
TS Grovkornet. Plagioklas, kvarts, kloritt eller hornblende.
Hornblende trondhemitt.
- 3149
- TS 3150 Skifrig. Finkornet. Grønn.
Kloritt, serisitt, kalsitt.
Kalkholdig serissittskifer.

Appendix 21DAVID SMITH's SLIPSAMLING

Sesong 1974.

Ref. hans prøvesamling fra samme sesong.

pr.nr. Foreløpig Mikroskopisk slipbeskrivelse. av T.H. Tanoppdrag 12893007

Finkornet
 Feltspat → sanns. albitt
 Biotitt
 Amfibol grønn - fargeløs
Grønnstein, sanns. basisk vulkanitt.

3018

Finkornet
 epidot
 kloritt
 feltspat, sanns. albitt
 tynne årer av kvarts
Grønnstein.

3025

Finkornet
 Hoveds. kvarts
 kloritt
 epidot
 opake mineral. (py)
Kvartsitt.

3029

3031

Opake mineraler med sanns. ? i sprekkfyllinger.
 epidot
 kvarts
 kloritt
 muscovitt

3046

Fenokrystaller (eller porfyroklaster ?) av sonert,
 saussurittisert plagioklas.
 Finkornig matrix av kvarts - feldspat (albitt)
 muscovitt
Porfyrisk - Trondhemitt.

3048

Ingen fenokrystaller.
 Saussurittisert plagioklas.
 Litt kvarts.
 Muscovitt
 Epidot
 Opake (py)
Trondhemitt.

- 3056 Kloritt (bl. permin)
Muscovitt
litt epidot
Kvarts
Klorittskifer.
- 3058 Kvarts, nesten 100%.
Noen få opake mineraler .
Meget lite serissitt
Kvartsitt.
- 3065 Kataklastisk bergart.
Sanns. relikter av saussurittisert plagioklas.
Mye sjakkbrettalbitt.
Kvarts
Serissitt
Trondhemitt av sannlig opprinnelig
kvarts monsonittisk sammensetning.
- 3067 Tett, meget skifrig, finkornet.
Kloritt
Albitt (mange inneslutninger, oppr. plagioklas)
Epidot
Kvarts i kluser (sanns. av senere dato)
Grønnstein - grønnskifer.
- 3069 Kvarts (nesten 100%)
Litt muscovitt
- 3075 Skifrig, noe lagdelt, finkornet.
Albitt - (eller plagiokl.)
Epidot
Grønn hornblende } i bestemte lag.
Opake mineraler
Sanns. lagdelt basisk tuff ?
- 3077 Feltspat → albitt eller syr plagioklas
Grønn hornblende
Epidot
Kloritt
Opake ertsmineraler
Grønnstein
- 3079 Store fenokrystaller av saussurittisert plagioklas
i matriks av:
saussurittisert plagioklas
epidot
muscovitt
kvarts → kanskje av senere dannelse ?
Trondhemitt

- 3081 Opake ertsmineraler
Epidot (og zoisitt ell. kl. soisitt)
Kloritt
Kvarts
Kontroller igjen, stemmer ikke med makr. beskrivelse.
- 3086 Grønn hornblende
Magnetitt
Plagioklas
Kloritt
Magnetittrik metagabbro.
- 3090 Hornblende, grønn
Epidot
Saussurittisert plagioklas
Magnetitt
Metagabbro (eller metadioritt)
- 3094 Fenokrystaller av saussurittisert plagioklas og
grønn hornblende
Matriks av
kvarts/feltspat (meget finkornet, ikke nærmere
undersøkt)
hornblende
epidot
Hornblende-holdig trondhemitt eller - dioritt.
- 3096 Finkornet
Epidot
Litt amfibol
Kloritt
Kvarts
(og feltspat ?)
Tektonisert grønnstein (bas. vulkanitt) med kvartstilførsel ?
- 3098 Fin- til middelskornet
Amfibol
Epidot
Kloritt
Feltspat → albitt ?
Grønnstein
- 3103 Epidot
Kloritt
Kvarts
(Feltspat)
Erts med titanittrand
Grønnstein - tektonisert.
Må kontrolleres igjen. Stemmer ikke med makroskopisk
beskrivelse

- 3110 Store saussurittiserte plagioklas-fenokrystaller
Mindre (feno)krystaller av epidot.
Matrix : Meget finkornet
sanns. kvarts og feltspat
muskovitt
kloritt
titanitt

Sterkt saussurittisert porfyrisk Trondhemitt ?

Kontroller igjen. Teksturbeskrivelse stemmer ikke helt
overens med mak. beskr.
- 3132 Fenokrystaller av saussurittisert plagioklas, tildels
oppsprukket, tildels avrundet (?) korrodert med
tilvekst av fersk albitt.

Matrix : Kvarts
Albitt
Muskovitt
Amfibol
Titanitt
Epidot
Zerkon (?)

Porfyrisk Trondhemitt
- 3134 Store fenokrystaller av saussurittisert plagioklas
tildels oppsprukket, tildels avrundet.
Korrodert og ofte omringet med fersk albitt.

Matriks: Albitt ofte i meget store masser
Kvarts
Epidot
Muskovitt

Porfyrisk Trondhemitt (av oppr. tonalittisk sammensetning,
med senere nydannelse av albitt ?)
- 3136 Store fenokrystaller av saussurittisert plagioklas.
Soneringen såvidt synlig.
Tildels sterkt korrodert med mulig nydannelse av
albitt omkring.
Amfibol

Matrix : Kvarts
Albitt (sjakkbrett albitt sett én gang)
Epidot
Titanitt } store krystaller
Apatitt }

porplyrisk Trondhemitt.
- 3140 Fenokrystaller : Saussurittisert plagioklas
sonert.
Matrix : Albitt, tildels sjakkbrett (er dette albittisert k-feltspat ?)
Kvarts
Muskovitt
Epidot
Amfibol

Porplyrisk Trondhemitt

- 3142 Mylonitt, med åpenbare glidestrukturer
med grano- og porphyroklaster av kvarts, plagio-
klas (albitt?)
Soner av sannsynligvis epidot (meget finkornet).
Sanns. mylonittisert Trondhemitt.
- 3144 Store krystaller av saussurittisert plagioklas
(3 - 4 mm store).
Matrix : Kvarts
Plagioklas → saussurittisert, nå albitt og epidot
Muskovitt
Albitt med sjakkbrettsturktur
Trondhemitt porfyr
- 3146 Store krystaller av saussurittisert plagioklas
Kvarts
Kloritt } i knusningssoner
Muskovitt }
Karbonat }
Epidot }
Trondhemitt
- 3148 Store fenokrystaller av sterkt saussurittisert plagioklas.
Matriks av : Kvarts
Plagioklas (litt "fersk", men allikevel
litt saussurittisert)
Epidot } pseudomorf ? sanns. hornblende
Kloritt }
Sjakkbrettalbit
Apatitt
Porfyrisk (hornblende-) trondhemitt
- 3150 Sterkt klastisk.
Kloritt i slirer
Kvarts
Feltspat
Karbonat
Kalkholdig fyllitt

KEY TO APPENDICES 23 and 24

- a denotes that the sample has been analysed for Mo and Cu or that it has been sent for analysis
- t denotes that the sample has been ^{thin}-sectioned or that it has been sent for sectioning
- l denotes that the sample comes from a loose block
- f denotes that the sample comes from in situ (foot/hill)
- LOCATION gives the number of the particular location
- DISTRICT gives the name of the immediate environment
- AIRPHOTO gives the number of the 1:10000 air photograph in series 357
- ROCK TYPE gives the name applied to the rock either in the field or during subsequent examination of the hand specimen but prior to thin section examination
- MINERALISATION indicates the presence of pyrite (py), chalcopyrite (cp), molybdenite (mo) or another ore mineral (*)
(?) denotes uncertainty
- ALTERATION indicates the presence of chloritisation (Cl), epidotisation (Ep), sericitisation (Sr), quartz-veining (Qz) or another type (*)
- SCHISTOSITY indicates the quality (none, weak, strong) of any linear or layered structure i.e. schistosity, shearing, lineation, foliation, banding, layering
- REMARKS mentions any special features
- STRIKE of schistosity on a 360° circle
- DIP of schistosity on a 360° circle

PEDROCK JOURNAL

TRINIDAD

PROJECT

OPPOSITE - 1368

YEAR - 1975

GEOLOGIST - Smith

LOCATION NUMBER	DISTANCE	AIRPHOTO # 10000 scale 357	ROCK TYPE	SAMPLE NUMBER	STRIKE SLIP	DIP	REMARKS
L1	Skarfjellvatnet	1209A	gneiss - chlorite schist	1001	f	122 22 NE	lineation - bearing 52°, plunging 48° NE
			chlorite - gneiss schist	1002	f	91 51 N	" 40 38 NE
L2	"	"	chlorite - gneiss schist	1003	f		gneiss vein - strike 158, dip 85 NE
L3	"	"	chlorite - gneiss schist	—			" 180 80 E
L4	"	"	chlorite - gneiss schist	—			" 160 80 W
L5	"	"	chlorite - gneiss schist	—			" 120 80 SW
L6	"	"	chlorite - gneiss schist	1004	f	110 80 N	
L7	"	"	chlorite - gneiss schist	1005	f		
L8	"	"	chlorite - gneiss schist	1006	f		
L9	"	"	chlorite - gneiss schist	1007	f		
"	"	"	chlorite - gneiss schist	1008	f		
"	"	"	chlorite - gneiss schist	1009	f		
"	"	"	chlorite - gneiss schist	1110	f		
"	"	"	chlorite - gneiss schist	1111	f		
"	"	"	chlorite - gneiss schist	1112	f		
"	"	"	chlorite - gneiss schist	1113	f		
"	"	"	chlorite - gneiss schist	1114	f		
"	"	"	chlorite - gneiss schist	1115	f		
"	"	"	chlorite - gneiss schist	1116	f		
"	"	"	chlorite - gneiss schist	1117	f		
"	"	"	chlorite - gneiss schist	1118	f		
"	"	"	chlorite - gneiss schist	1119	f		
"	"	"	chlorite - gneiss schist	1020	f		
"	"	"	chlorite - gneiss schist	1021	f		
"	"	"	chlorite - gneiss schist	1022	f		
"	"	"	chlorite - gneiss schist	1023	f		
"	"	"	chlorite - gneiss schist	1024	f		
"	"	"	chlorite - gneiss schist	1025	f		
"	"	"	chlorite - gneiss schist	1026	f		
L11	Kottijarvi	1209B	chlorite - gneiss schist	1027	f	120 60 N	
L12	"	"	chlorite - gneiss schist	1028	f		

Appendix 23
Rock Samples - opposite 1368
Locality List

AKS-1

BEDROCK MAPPING for TRONDHEIMITE PROJECT

OPDRAG - 1368
 YEAR - 1975
 GEOLOGIST - Smith

360°/90°

LOCATION NUMBER	DISTRICT	AIRPHOTO 1:10000 10m 357	ROCK TYPE	SAMPLE NUMBER	L f	SCHISTOSITY STRIKE DIP	REMARKS
L13	Linge bekken	1209 B		1028	f		
L14	Linge bekken	1207 B		1029	f		
"	"	"		1030	f		
"	"	"		1031	f		
L15	Fremstjernst	"		1072	f	85° 60°N	
L16	"	"		1033	f	102° 55°N	
"	"	"		1034	f		
"	"	"		1035	f	95° 37°N	
L17	"	"		1036	f		
"	"	"		1037	f		
"	"	"		1038	f		
"	"	"		1039	f	135° 50°N	
"	"	"		1040	f		
L18	"	"		1041	f		
"	"	"		1042	f		
"	"	"		1043	f	95° 65°N	
L19	"	"		—		80° 35°N	
L20	"	"		1044	f		
L21	"	"		1045	f		
L22	"	"		1046	f		
"	"	"		1047	f		
L23	Skarfellvatnet	1209A	Trondhjemite	1048	f		
L24	"	"		1049	f		
L25	"	"		1050	f	95° 65°N	lineation - bearing 50° plunge 55° NE
"	"	"		—			gneiss vein, strike 72°, dip 80° N
L26	"	"		1051	f		
"	"	"		1052	f	160° 50°E	
"	"	"		1053	f	95° 60°N	
L27	"	"		1054	f		
"	"	"		1055	f		

BEDROCK MAPPING for TRONDHEIMITE PROJECT

OPDRAL - 1368
YEAR - 1975
GEOLOGIST - J.M.H.

360°/90°

LOCATION NUMBER	DISTRICT	AIR PHOTO 1:10000 100m 357	ROCK TYPE	SAMPLE NUMBER	L f	SCHISTOSITY STRIKE DIP	REMARKS
L29	Skarvollvatn	1209D		—			gneiss - strike 100 dip 60 N
L30	"	"		1056			
"	"	"		1057			
L31	"	"		1058			
"	"	"		1059			
L32	"	"		1060			
"	"	"		1061		145 0°	contact - strike 105 dip 50 N
L33	"	"		1062			
"	"	"		1063			
L34	"	"		1065			
"	"	"		1066			
"	"	"		1067			
L35	"	"		1068			
"	"	"		1069			
"	"	"		1070			
L36	"	"		1071			
"	"	"		1072			
"	"	"		1073			
"	"	"		1074			
"	"	"		1075			
L37	"	"		—		100 80 S	
L38	"	"		—		160 70 E	
L39	"	1209A		—			
L40	"	"		1076			
"	"	"		1077			
"	"	"		1078			

BEDROCK MAPPING for TRONDHEIMITE PROJECT

OPDRAG - 1368
YEAR - 1975
GEOLOGIST - J.M.M.

360°/90°

LOCATION NUMBER	DISTRICT	AIRPHOTO 1:10000 10m 337	ROCK TYPE	SAMPLE NUMBER	L /	SCHUTTWITZ STRIKE DIP	REMARKS
L41	Køfjell	1209 B		1079	2		
"	"	"		1080	2		
L42	Totjembekken	1209 C		1081	1	90 60 N	
"	"	"		1082	1		
L43	"	"		1083	1		
L44	"	1209 B		1084	1		
"	"	"		1085	1		
L45	"	"		—		75 50 N	
"	"	"		—			
L46	Totjembekken	1209 C		1086	1		
"	"	"		1087	1		
L47	Troppelbekken	"		1088	1	55 45 NW	
L48	Øvre bekken	"		1089	1		
"	"	"		1090	1		
"	"	"		1091	1		
"	"	"		1092	1		
"	"	"		1093	1	90 60 V	
"	"	"		1094	1	90 75 V	
"	"	"		1095	1	90 90 V	
L49	Amgøbekken	1207 D		1096	1	90 50 V	
L50	"	"		1097	1		

BEDROCK MAPPING for TRONDHEIMITE PROJECT

OPDRAG - 1368
 YEAR - 1975
 GEOLOGIST - Smith

360°/90°

LOCATION NUMBER	DISTRICT	AIRPHOTO 1:10000 series 357	ROCK TYPE	SAMPLE NUMBER	L f	SCHISTOSITY STRIKE DIP	REMARKS
L51	Amphibegmet	1207 D	limestone	—		70 70 W	
L52	"	"		1097	f		
L53	"	"		1098	f		
L54	"	"		—			
L55	"	"		1099	f		
L56	"	1207 B		1100	f		
L57	Fremegmet	"		1101	f	90 50 N	
"	"	"		1102	f		
"	"	"		1103	f		
"	"	"		1104	f		
L58	Øvrebekken	1209 B		1105	f		blue patch
L59	Krokstjernmet	"		1106	f		
"	"	"		1107	f		
"	"	"		1108	f		
"	"	"		1109	f		
"	"	"		1110	f		
"	"	"		1111	f		
"	"	"		1112	f		
L60	"	"		—			
L61	"	"		—			
L62	Nalbekken	"		1113	f		
L63	"	"		1114	f		
L64	"	1209 C		1115	f	85 80 N	Weg vein. co. state 60-70 m. p. 600
"	"	"		1116	f		
"	"	"		1117	f		
"	"	"		1118	f		cross-cutting the veins
"	"	"		1119	f		
"	"	"		1120	f		
"	"	"		1121	f		

BEDROCK MAPPING for TRONDHEIM PROJECT

 OFFDRAK - 1368
 YEAR - 1975
 GEOLOGIST - S.M.H.

360°/90°

LOCATION NUMBER	DISTRICT	AIRPHOTO 1:10000 series 357	ROCK TYPE	SAMPLE NUMBER	L f SCHISTOSITY STRIKE DIP	REMARKS
L 66	Smalljernet	1209C		1122	f	
11	"	"		1123	f	
L 67	"	"		1124	f	
11	"	"		1125	f	
L 68	"	"		1126	f	
11	"	"		1127	f	

BEDROCK SAMPLING for TRONDEMITE PROJECT
 OPPDRAG - 1368 YEAR - 1975

COLLECTOR - SMITH

SAMPLE NUMBER	a t l f	LOCATION NUMBER	DISTRICT	ROCK TYPE	MINERALIZATION Pg Cp Mo *	ALTERATION Cl Ep Sr Gz *	SCHISTOSITY	REMARKS
1001	f	41	Kortjennysgen	quartz-chlorite schist		u	strong	} probably sheared hornblendeitic or dioritic rock
1002	f	41	"	chlorite-quartz schist		u ?	weak	
1003	f	41	"	chlorite-quartz schist		u Sr	weak	
1004				plag - hornblende - mica		?	weak	
5				epidote-quartz impregnation		u Ep Gz	strong	original rock obliterated
6				quartz-hornblende - mica porphyry		Ep	none	preservable of mica?
7				chlorite-hornblende		u ? Gz	weak	
8				micro-diorite		?	weak	
9				hornblendeite		? Sr	weak	pink + green foliation
10				hornblendeite		? Gz	none	
11				chlorite-quartz schist		u	strong	prominent quartz rods
12				" + mica	17	Ep Gz	weak	5mm quartz-chlorite veins
13				quartz-feldspar rock	17	Gz	strong	original rock obliterated
14				green schist	17		weak	
15				"			"	
16				chlorite-hornblende		u ?	weak	light green plagioclase
17				micro-diorite		? ?	weak	dark green plagioclase
18				contact of 1017 + 1019		? ?	weak	periphery is greener than 1019
19				quartz-hornblende porphyry			none	" hornblende
20				micro-diorite			weak	
21				"	17	u ? ?	weak	rusty green rock
22				"			"	"
23				hornblendeite (green)		Ep Sr	none	typical epidotized hornblende
24				hornblendeite (green)			strong	typical hornblendeite
25				hornblendeite		Ep	none	
26				hornblendeite	22	Sr	weak	2 hornblendeite + mica mineral
27				"			"	
28				hornblendeite		Sr	weak	
29				hornblendeite		u ? Sr	strong	
30				hornblendeite		u Sr	"	

Sample list

Rock Sample
 Opening 1965

Appendix 24

P24-1

OPDRAG -

BEDROCK SAMPLING for TRONDHEMITE PRO. CT
YEAR -

COLLECTOR -

SAMPLE NUMBER	a t l f	LOCATION NUMBER	DISTRICT	ROCK TYPE	MINERALIZATION Pg Cp Mo *	ALTERATION Cl Ep Sr Qt *	SCHISTOSITY	REMARKS
10	31			green schist		Cl	strong	
32				quartzite		Sr ?	strong	probably originally trondhjemite
33				micro hornblende			strong	or ? micro hornblende
34				micro trondhjemite		Cl Sr	strong	? volcanic rock
35				trondhjemite - diorite		Ep	weak	zoned on contact
36				trondhjemite	*		none	malachite + calcite
37				trondhjemite	* ep *		none	malachite + calcite
38				green schist	Pg ? *	Cl	strong	
39				"	"		"	
40				"		Cl	strong	
41				"		Cl	strong	sediment or micro trondhjemite
42				micro trondhjemite		Sr	weak	
43				micro trondhjemite		Cl	strong	
44				quartzite		Cl ?	strong	or micro trondhjemite
45				limestone			weak	
46				? sediment		Sr	strong	
47				"			"	
48				trondhjemite (green)		Ep	none	typical
49				trondhjemite (grey)		Cl ?	weak	typical
50				greenschist		Cl ?	strong	probably originally sediment
51				blotched trondhjemite		Cl Ep	weak	
52				quartz - epidote vein		Cl Ep	strong	
53				100% quartzite		Cl Ep	strong	late, oblique epidote veins
54				trondhjemite		Cl	weak	compositional, plagioclase
55				"		"	"	"
56				green schist		Cl Ep	strong	with epidote veins
57				epidote - calcite		Ep	none	
58				micro hornblende		Cl	weak	
59				micro hornblende		"	weak	
60				trondhjemite		Cl	weak	compositional, plagioclase

OPPD RAG -

BEDROCK SAMPLING for TRONDHEMITE PROJ.
YEAR -

COLLECTOR -

SAMPLE NUMBER	a t l f	LOCATION NUMBER	DISTRICT	ROCK TYPE	MINERALIZATION Pj Cp Mo *	ALTERATION Cl Ep Sr Qz *	SCHISTOSITY	REMARKS
1061				chlorite-epidote schist		Cl Ep	strong	deformed
62				microdiorite			weak	unusual matrix
63				micro hornblende			weak	
64				hornblende	Pj ?	Cl	none	? anorthopyrite
65				green schist		Cl	strong	(? chlorite + plagioclase)
66							none	quartz - schistosity
67				hornblende			none	
68				diorite + micro-gneiss			weak	contact
69				hornblende			none	
70				micro-gneiss - hornblende		Qz	strong	
71				microdiorite			none	
72				leucocratic gneiss			none	
73								
74				micro-gneiss - hornblende			none	unusual matrix
75				micro-gneiss			none	
76				yellowish hornblende		Cl	weak	
77				leucocratic hornblende			none	xenoliths of grey - leucocratic
78				felsite			none	
79					Pj ?		none	hematite veins
80								
81				micro-gneiss - hornblende		S	weak	metallic
82								
83							weak	
84								
85								
86								
87								
88								
89								
90								

OPPDAG -

BEDROCK SAMPLING for TRONDHEMITE PROJ. 27
YEAR -

COLLECTOR -

SAMPLE NUMBER	a l f	LOCATION NUMBER	DISTRICT	ROCK TYPE	MINERALIZATION Pj cp mo *	ALTERATION Cl Ep Sr Qz *	SCHISTOSITY	REMARKS
091				10000 trondhemitic		Sr	weak	
92				trondhemitic		Cl Sr	weak	
93				trondhemitic		Cl	weak	
94				trondhemitic		Cl	weak	
95				epidote-quartz mrgy		Ep Qz	strong	
96				trondhemitic		Sr	weak	green feldspar
97				chloritoid trondhemitic	*	Cl	weak	malachite
98				chlorite schist		Cl Sr	strong	
99				pyroxenite				
1100				trondhemitic		Sr		
1101				trondhemitic		Cl Sr Qz	weak	
102				"		Cl Sr Qz	strong	
103				?		Cl	weak	
104				"				
105				?	Pj		weak	black patches; quartz lustre
106				diomite			weak	
107				hornblende			none	
108				trondhemitic (green)		Ep Sr	none	
109				trondhemitic (grey)			weak	
110				buff			weak	
111				greenstone			weak	
112				greenschist		Cl	strong	
113				trondhemitic		Sr	none	
114				trondhemitic			weak	
115				trondhemitic			weak	
116				trondhemitic		Qz	weak	
117				trondhemitic		Qz	weak	
118				trondhemitic		Sr Qz	weak	
119				trondhemitic + felsite		Sr	strong	felsite rim
120				trondhemitic		Sr	strong	

OPPD RAG -

BEDROCK SAMPLING for TRONDEMITE PRO. CT
YEAR -

COLLECTOR -

SAMPLE NUMBER	a t l f	LOCATION NUMBER	DISTRICT	ROCK TYPE	MINERALIZATION Pg Cp Mo *	ALTERATION Cl Ep Sr Pz *	SCHISTOSITY	REMARKS
121				felsite		Sr	weak	vein - 1119
122				epidote - quartz vein		Ep Sr Pz	weak	
123				amphibolite + mafic	Pg ?		strong	
124				epidote - quartz vein	Pg no	Ep Sr	none	hard / diorite + hblite / greenstone
125				microcline - quartz vein	Pg no	Ep Sr Pz	strong	no moly. in white quartz
126				microcline - quartz vein	Pg no	Ep Sr Pz	strong	probably hard - host
127				pyrite - quartz vein	Pg *	Ep	strong	
128				microcline - quartz vein	Pg *	Ep	none	malachite, microcline host
129				microcline - quartz vein	Pg *	Ep	weak	
130				microcline + green rock			weak	blue surface vein
131				microcline - quartz vein		Cl Ep	strong	epidote veins
132				microcline - quartz vein	Pg	Cl Ep	weak	brown mineral ? calcite
133				microcline - quartz vein		Cl Ep Sr Pz	weak	"
134				microcline - quartz vein		Cl Ep Sr Pz	strong	epidote veins
135				microcline + green rock	Pg	?	strong	compare 1130
136				microcline + green rock	Pg			
137				microcline + green rock	Pg		weak	
138				microcline - quartz vein	Pg	Cl Ep Sr	strong	uncertain host
139				epidote schist		Cl Ep Sr	weak	
140				microcline - quartz vein		Cl ? Sr	strong	
141				microcline			weak	
142				microcline + green rock	Pg *	Cl Ep	weak	blue magnetite
143				microcline			weak	
144				pyrite - quartz vein	Pg Ep *	Cl	strong	blue magnetite (blue-green?)
145				pyrite - quartz vein	Pg Ep *	Cl	weak	blue magnetite + BORNITE
146				pyrite - quartz vein	Pg Ep *	Cl Ep Sr	weak	blue magnetite + BORNITE
147				pyrite - quartz vein	Pg Ep *	Cl Ep	strong	blue magnetite + BORNITE
148				pyrite - quartz vein	Pg Ep *	Cl Ep	weak	blue magnetite + BORNITE
149				pyrite - quartz vein	Pg Ep *	Cl Ep	weak	blue magnetite
150				pyrite - quartz vein	Pg Ep *	Cl Ep	weak	blue magnetite + BORNITE

OPPD RAG -

BEDROCK SAMPLING for TRONDHEMITE PRO. CT
YEAR -

COLLECTOR -

SAMPLE NUMBER	a t l f	LOCATION NUMBER	DISTRICT	ROCK TYPE	MINERALIZATION py cp mo *	ALTERATION cl Ep Sr Qz *	SCHISTOSITY	REMARKS
15								
50								
53								
54								
55								
156								
157								
158								
159								
160								
161								
162								
163								
164								
165								
166								
167								
168								
169								
170								
171								
172								
173								
174								
175								
176								
177								
178								
179								
180								

OPPD RAG -

BEDROCK SAMPLING for TRONDHEMITE PROJ.
YEAR -

COLLECTOR -

AMPLE NUMBER	a t l f	LOCATION NUMBER	DISTRICT	ROCK TYPE	MINERALIZATION py cp mo *	ALTERATION cl Ep Sr Qt *	SCHISTOSITY	REMARKS
181								
182								
183								
184								
185								
186								
187								
188								
189								
190								
191								
192								
193								
194								
195								
196								
197								
198								
199								
200								
201								
202								
203								
204								
205								
206								
207								
208								
209								
210								

BEDROCK SAMPLING for TRONDHEMITE PROJECT
 OPPDRAG - 1368
 YEAR - 1975

COLLECTOR - Smith

SAMPLE NUMBER	a t l f	LOCATION NUMBER	DISTRICT	ROCK TYPE	MINERALIZATION py cp mo *	ALTERATION cl Ep Sr Qz *	SCHISTOSITY	REMARKS
12 11								
12								
13								
14								
15								
16								
17								
18								
19								
12 20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
12 30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
12 40								

OPPD RAG -

BEDROCK SAMPLING for TRONKHEMITE PRO. CT
YEAR -

COLLECTOR -

SAMPLE NUMBER	a t l f	LOCATION NUMBER	DISTRICT	ROCK TYPE	MINERALIZATION py cp mo *	ALTERATION cl Ep Sr Qz *	SCHISTOSITY	REMARKS
1241								
242								
243								!! blue-green mag.
244								
245								!! blue green magnetite
246								
247								
248								
1249			Amphetjernet	quartz-rich ore	cp *	cl Sr Qz	none	? bornite, azurite, malachite, bl ^o magnetite
250				malachite-sericite-rich ore	cp *	Sr	weak	hematite, malachite
251				trondhjemite-rich ore	cp mo *	cl Sr	weak	? bornite, malachite, ? magnetite
252				rusty ore	cp *	cl Sr	weak	malachite
253				trondhjemite-rich ore	cp mo *	cl Sr Qz	weak	? bornite, malachite
254				trondhjemite-rich ore	cp mo *	cl	weak	azurite, malachite, magnetite
255				chalcopyrite-rich ore	cp *	cl Qz	weak	? bornite, azurite, malachite, bl ^o magnetite
256				bornite-rich ore	cp *	cl Qz	weak	bornite
257				chalcopyrite-rich ore	cp *	Sr	none	malachite
258				trondhjemite-rich ore	cp ? *	cl Sr	weak	malachite, magnetite
259				azurite-rich ore	cp *	cl Sr	weak	? bornite, azurite, malachite
260				molybdenite-azurite-rich ore	cp mo *	cl Sr	weak	malachite
261				hematite-chalcopyrite ore	cp *	cl Qz	weak	? bornite, azurite, malachite
262				ore vein in trondhjemite	cp mo *	cl Sr Qz	weak	azurite, malachite, bl ^o magnetite
263			Amphetjernet	trondhjemite	cp *	Sr	weak	malachite
264	Gryndal	dammen	see Appendix II	trondhjemite	mo	cp Qz	weak	molybdenite in quartz vein
265	-Tromsø	flyene	see Appendix II	epidote-quartz vein		cl Ep Qz	strong	
266			Reinbakken	magnetite ore	*	Ep	none	magnetite
267			Reinbakken	pyrite-chalcopyrite ore	cp *		none	magnetite, malachite
268			Reinbakken	pyrite-quartz rock	py cp	Qz	weak	cp at edge
269								
1270								

TRONDHJEMITT-PROSJEKTET

pr. nr.
oppdrag
1368STELANDROVER

Samlet av T.H. Tan

lokalitet

- 1271 (3) Grønn-lysegrønn, hard, tett, finkornet. Felsp (ab?), kloritt. Grønnstein. Breksierte og mineralisert med py, litt mt(?). Rust på overflaten.
- 1272 (5)
- 1273A (6) Mørkegrønn, tett, finkornet. Amfibol, felsp., kloritt. Grønnstein. "Stringer" av py, po. Rustet.
- 1273B (6) Finkornet, grønn-lysegrønn, seig, massiv. Kloritt og albitt?. Grønnstein. Nye py, kanskje po, også mt i oktaedre.
- 1273C (6) Grå, tett, finkornet, meget svak lagning. Kvartsitt? Fint. impregn. med py.
- 1274 (7) Lysegrå, massiv, middels- til grovkornet. Felspat (K-felsp. + plag), amfibolrelikter?, Trondhemitt.
- 1275 (9) Svart, tett, finkornet med sprekker og stikk fylt av epidot. Brun forvittringsflate, Mistanke om ultrabasitt.
- 1276A 11) Grønn, tett, finkornet. Albitt og kloritt. Grønnstein. Fint impr. med po?
- 1276B 11) Grønn, tett, finkornet. Albitt, kloritt, meget lite amfibol. Grønnstein.
- 1276C 11) Lys, flekket, Felspat, amfibol. Trondhemitt, eller dioritt.
- 1276D 11) Grønnlig. Hvitt feldsp. 50% og grønnlig amfibol 50%. Grov, middelskornet. Hornbl. dioritt
- 1276E 11)
- 1277 17) Lysegrå, grov- middelskornet. Felsp. og hornblende. Dioritt. Noe po.
- 1278 17) Mørk, svart, grovkornet. Hornblende, litt kvarts? Hornblenditt.
- 1279 17) Hvitt med svarte flekker. Feldsp. (plag. + K-feldsp.) 50%, hornbl. 50%. Dioritt eller hornbl.-trondhemitt.
- 1280 19) Lys-hvit. Feldsp. Trondhemitt.

- 1281 20) Lys, middelskornet. Feldsp. (K-feldsp. + plag.), kvarts, amfibol. Trondhemitt.
- 1282
- 1283A 21) Grønn- lysegrønn, skifrig, tett, finkornet. Kloritt, litt amfibol. Grønnstein/-skifer. Litt py.
- 1284 22) Sterkt skifrig, grønnlig, kanskje porfyroklastisk. Tektonisert trondhemitt.
- 1285 22) Grå, massiv, grovkornet. Trondhemitt.
- 1286A 23) Grå-grønnlig, grov-middelskornet, massiv,. Grønnlig feldsp (saussuritert plag.?) og rosa feldsp (K-feldsp.), kvarts, kloritt. Trondhemitt.
- 1286B 23) Lys, grovk., Feldsp. (plag. og K-feldsp.), kvarts hornbl. Trondhemitt
- 1286C 23) Lys, grønnlig, flere glideplaner. Middelsk. Trondhemitt, tektonisert og serisittisert.
- 1286D 23) Grønnlig, massiv. Plagioklas (grønnlig, saussuritert plag.?), kloritt. Trondhemitt.
- 1287 23) Grønn, skifrig, finkornet. Kloritt, feldspat?, Grønnskifer. Rustet, men ingen mineralisering å se.
- 1288
- 1289
- 1290 25) Lys, middelskornet, massiv. Feldsp., kvarts, meget lite amfibol. Trondhemitt.
- 1291 24) Lys - lysegrønn, tildels meget grovkornet. Kvarts, feldsp., kloritt og/eller epidot. Bgt.-type usikker. Litt py.
- 1292A 24) Hørkegrønn, skifrig. Kloritt, feldsp.-porfyroklaster (eller -klaster?). Grønnskifer.
- 1292B 24) Lysegrønn, skifrig, mylonittisk. Mylonittisert trondhemitt. mye serisitt.
- 1293A 25) Grønn- lysegrønn, massiv, tett og finkornet, hard. Sanns. kvarts og feldspat (grønnlig). Finkornet Trondhemitt. Py- mineralisering. Rust på overfl.

- 1293B 25) 2 deler: 1) Hvit, finkornet, tett, Kvarts og K-feldsp.? Aplitt? 2) Lysegrønn, tett, middeels- til finkornet. Saussurittisert plagioklas? Finkornet trondhemitt.
- 1294 26) Grafittskifer, litt rustet.
- 1295 28) Mørk, middels- til grovkornet, skifrig, feldsp., hornblende. Hornblendegneiss. Litt py. Rustet.
- 1296A 29)
- 1296B 29) Grønn, grovkornet (opp til 3/4 cm), Amfibol (uralittisert pyroksen?), finkornet feldspat. Metagabbro?
- 1297 30) Mørkegrønn. Kloritt. Grønnskifer. mineralisert med py og mt. Sterk rustet på overflaten.
- 1298A 31) Lys, grønnlig, middelskornet. Kvarts, feldsp. (plagiokl., noe saussurittisert), kloritt og epidot (lite). Trondhemitt.
- 1298B 31) Lys, middelskornet. Kvarts, feldsp., noe kloritt. Trondhemitt.
- 1299 32) Lys, sv. grønnlig, middels til grovkornet. Kvarts, p. og. og K-feldsp., kloritt. Trondhemitt.
- 1300 33) Hvit, tett, finkornet. Kvarts, epidot i sprekker og stikk. Arkosisk kvartsitt?
- 1301 33) Lysegrønn, tett, finkornet. Kloritt og/eller epidot, albitt?. Grønnstein. Litt po eller py i sprekker.
- 1302 33)
- 1303 33) Lysegrønn, flintaktig, finkornet, Sannsynligvis feldsp. og epidot. Bergartstype usikker.
- 1304 33) Lysegrønn, tett, finkornet. Feldspatit? Hera-
tofy? Svakt mineralisert med py eller po.
- 1305 33) Helt identisk med nr. 1300.
- 1306 39) Grå, middelskornet. Kvarts, feldspat, kloritt. Bergartstype usikker. Mineralisert med cp, py og kanskje litt mt.
- 1307A 40) Grå - grønnlig, mørk med hvite flekker, middelskornet. Hornblende og feldspat i like store mengder. Ep-rik hornblenditt eller hbl-dioritt?

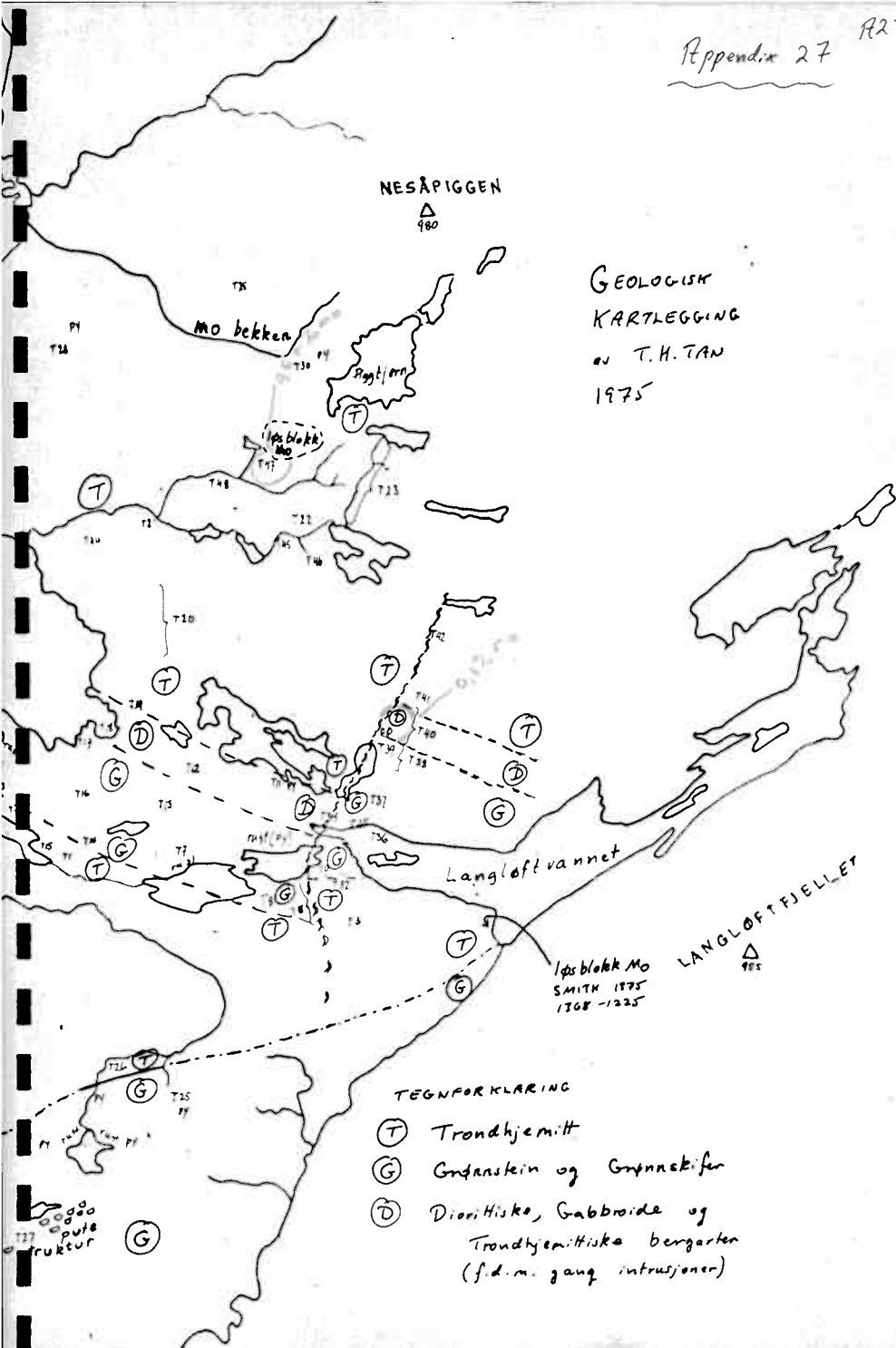
- | | | |
|-------|-----|--|
| 1307D | 40) | Grå, finkornet. Kvarts og feldsp., hornblende kloritt?. Bergartstype usikker. |
| 1308 | 40) | Lysogrønn med mørke flekker. <u>Algioklas</u> (sausurittisert) og hornblende (uralittisert pyrokse ² n)
<u>Metagabbro?</u> |
| 1309 | 40) | Lys, middelskornet. Feldspat, kvarts. <u>Trondhemitt</u> . |
| 1310 | 45) | Lys, grønnlig, litt skifrig. Feldspat, kvarts, serissitt. <u>Trondhemitt</u> . litt py. |
| 1311 | 47) | |
| 1312 | 47) | |
| 1312 | 47) | |
| 1313 | 47) | |
| 1314 | 47) | |
| 1315 | 47) | |
| 1320 | 4A | |

Appendix 26.List of thin and polished (P) sections manufactured.

<u>Oppdrag 1289</u>		<u>Oppdrag 1368</u>
3007		1004
3018	P	1006
3025		1007
3029		1017
3031	P	1019
3046	P	1028
3048		1048
3050		1049
3056	P	1056
3058		1058
3065	P	1060
3067		1062
3069	P	1063
3075	P	1069
3077	P	1070
3079		1071
3081	P	1072
3086	P	1073
3090		1074
3094		1075
3096		1077
3098		1078
3103		1108
3108		1109
3110		1110
3112	P	1111
3114		1115
3120		1118
3122		1119
3124		1125
3126		1127
3128		1141
3132		1163
3134		1164
3136		1169
3138		1182
3140		1190
3142		1224
3144		1226
3146		1263
3148		1273 B
3150		1273 C
		1275
SUM 42 thin sections		1276 B
		1280
		1281
		1286
		1301
		1305
		1306
		1310
		1313

SUM 52 thin sections

TOTAL = 94 thin sections





Analytical Results from the Gaizervannet Soil Survey.

Determinations in duplicate of the HNO_3 -soluble metal content of the parent material (C horizon).

Element/Sample	1001	1002	1003	1004	1005
Mo	157	2	27	1	4
Mo	122	0	25	0	3
mean Mo ppm	(140)	(1)	(26)	(1)	(4)
Cu	580	37	200	68	40
Cu	600	38	170	68	39
mean Cu ppm	(590)	(38)	(185)	(68)	(40)
Pb	17	16	13	16	17
Pb	17	14	12	15	16
mean Pb ppm	(17)	(15)	(13)	(16)	(17)
Zn	54	3	16	15	30
Zn	48	4	14	18	32
mean Zn ppm	(51)	(4)	(15)	(17)	(31)
Ni	77	2	14	11	23
Ni	76	2	12	13	24
mean Ni ppm	(77)	(2)	(13)	(12)	(24)
Co	25	2	14	7	15
Co	23	2	12	7	15
mean Co ppm	(24)	(2)	(13)	(7)	(15)
V	255	22	97	52	41
V	235	18	85	46	37
mean V ppm	(245)	(20)	(91)	(49)	(39)
Ag	1.8	0.2	0.6	0.4	0.6
Ag	1.7	0.2	0.7	0.3	0.5
mean Ag ppm	(1.8)	(0.2)	(0.7)	(0.4)	(0.6)
Mn	420	30	90	120	320
Mn	380	20	70	120	310
mean Mn ppm	(400)	(25)	(80)	(120)	(315)
Fe	18.8	0.3	8.8	1.8	3.0
Fe	19.6	0.3	8.5	1.8	3.0
mean Fe %	(19.2)	(0.3)	(8.7)	(1.8)	(3.0)

Appendix 29

AMPHIBETERNET SOIL SURVEY

Analytical Results for 10 elements

opprings
Lignin

20

1 cup 20ml

SMITH - GRANGE 74 in field

	9/9-74	9/9-74	22/74	4/1-75	2/1-75	2/1-75	4/1-75	11/1-75	11/1-75	
	DS	DS	DS	DS	DS	DS	DS	DS	DS	
	10 200	2 40 10 200	10 200	10 200	1 20 100	10 200	10 200	10 200	10 200	
	20 10	0.5 10 1 20	20 10	2 10	5 100	10 200	10 200	10 200	10 200	
	OK									
	Ca	Zn	Mo	Pb	Ni	Co	Ag	V	Mn	Fe
1	171	16	12	13	12	6	0.5	40	100	0.9
2	43	10	7	12	9	5	0.3	49	70	1.2
3	14	28	2	32	14	4	0.2	6	20	0.4
4	58	30	0	11	23	9	0.3	36	160	1.3
5	52	42	17	14	34	14	0.5	43	350	2.1
6	11	11	1	10	7	4	0.3	32	80	0.5
7	16	37	1	13	23	9	0.4	42	170	1.5
8	11	12	1	14	14	6	0.3	38	110	1.1
9	12	8	4	32	16	4	0	12	0	0.4
10	17	24	2	12	20	7	0.3	43	120	1.5
11	8	14	1	24	14	8	0	32	100	1.1
12	6	14	2	14	12	6	0.2	14	40	0.6
13	6	14	2	26	14	4	0.2	34	20	0.8
14	12	8	8	40	20	4	0	12	40	0.4
15	27	24	2	12	26	8	0.3	49	130	1.6
16	28	22	2	17	21	9	0.3	37	120	1.8
17	28	37	3	25	108	20	0.6	23	410	3.3
18	42	28	3	19	29	11	0.3	45	140	1.6
19	10	7	2	21	8	4	0.4	39	60	0.6
20	5	6	2	20	11	3	0.2	41	50	0.5

total refect

800

800

800

Appendix 30.

Samples of soil, moss, organic film, plant and gravel

Oppdrag 1368 Sanddøla - Nesåvatna - Gaizervatnet

Sample number	Sample type	Depth cm	Thickness cm	Colour	Locality
3001	JORD	3 - 9	12	rød sand	Nålbekken
3002	JORD	6 - 8	15	rød sand	Nålbekken
3003 } ϕ	JORD	10 - 15	15	undergrunn	Nålbekken
3004 } ϕ	JORD	4 - 9	15	rød jord	Nålbekken
3005	JORD	5 - 10	18	undergrunn	Nålbekken
3006	JORD	8 - 10	> 10	brun jord	Nålbekken
3007	JORD	12 - 14	> 14	brun jord	Nålbekken
3008 } ϕ	JORD	15 - 17	17	leire	Nålbekken
3009 } ϕ	JORD	9 - 11	17	brun jord	Nålbekken
3010	JORD	5 - 10	20	undergrunn	Nålbekken
3011 } ϕ	MOSE	0 - 3			Nålbekken
3012 } ϕ	JORD	10 - 15	> 20		Nålbekken
3013 } ϕ	MOSE	0 - 3			Nålbekken
3014 } ϕ	JORD	10 - 15	> 20		Nålbekken
3015	ORANSJE	0 - 0,3			Nålbekken
	ORGANISKE				
	FILM				
3016	JORD	15 - 20	> 20	brun jord	Stuttbekken
3017	JORD	15 - 20	> 20	brun jord	Stuttbekken
3018	JORD	10 - 15	> 15	blandet jord	Stuttbekken
3019	JORD	10 - 15	> 15	brun jord	Stuttbekken
3020	JORD	10 - 15	> 15	brun jord	Stuttbekken
3021	JORD	5 - 8	> 8	brun jord	Nesåpiggen
3022	JORD	15 - 18	20	grå-brun sand	Nesåpiggen
3023	JORD	10 - 15	> 15	grå sand	Nesåpiggen
3024	JORD	5 - 10	10	brun jord	Nesåpiggen
3025	MOSE	bekkesed	343		Gaizervannet
3026	MOSE	bekkesed	344		Gaizervannet
3027	MOSE	bekkesed	345		Gaizervannet
3028	MOSE	bekkesed	346		Gaizervannet
3029	MOSE	bekkesed	347		Gaizervannet
3030	MOSE	bekkesed	348		Rustbekken
3031	MOSE	bekkesed	349		Rustbekken
3032 } ϕ	MOSE	0 - 2			Kobberbekken
3033 } ϕ	PLANTE				Kobberbekken
3034 } ϕ	JORD	2 - 10	> 10	brun jord	Kobberbekken
3035	JORD	15 - 20	> 20	rust jord	Rustbekken (nord)
3036	JORD	15 - 20	> 20	rust jord	Rustbekken (syd)
3037	RUST GRUS				

ϕ denotes samples from
exactly the same site
but from different horizons

1368

Inn 19 Port 20 ml

Disse 3^{te} prøver var kjølt i gangen og var mye annerledes på grunn av uhomogenisert prøver på grunn av dårlig risting. De var sikket igjen og analysert 2 ganger.
Disse verdier er gjennomsnittet av alle 4 kjølinger med mye bias til den siste. Beregningene var gjort av T. Volden og originale data ble beholdt.

Sted

Grong

År 1975

Annr

Innv

19

av

Dppst

19

av

Anal met

Kornst

= 180 µ

6 7 8 9 10 11 12 13 14 15 16 17											
Dato	TV	TV	TV	TV	TV	TV	TV	TV	TV	TV	TV
Navn	TV	TV	TV	TV	TV	TV	TV	TV	TV	TV	TV
1. st. ppm/avl	0.5	0.5	1.20	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2. st. ppm/avl	0.5	0.5	5.100	10.200	10.200	5.100	20.040	0.5	0.5	5.100	40.800
Prøvenr	A	A	A	A	A	A	A	A	A	A	A
	Ca	Mg	Co	Pb	Zn	Ni	Fe	Hg	V	Mn	
3001	87	119	3	25	3	1	0.86	0.2	61	26	
2	90	315	6	16	7	3	1.94	0.3	58	50	
3	48	15	6	11	8	5	1.48	0.2	47	75	
4	85	73	3	18	4	1	0.82	0.1	39	21	
5	56	55	6	12	15	8	1.16	0.2	59	86	
6	700	30	3	11	7	1	0.16	0.2	17	45	
7	1000	38	3	9	3	1	0.18	0.4	18	12	
8	80	84	11	10	28	15	1.75	0.4	45	158	
9	400	45	3	13	3	1	0.22	0.3	2	10	
3010	25	12	3	21	3	1	0.64	0.4	15	8	
1	430	32	5	20	11	5	0.53	0.6	16	27	
2	380	27	6	21	13	7	0.73	1.0	25	70	
3	507	326	9	88	16	2	1.72	0.5	19	14	
4	892	215	9	44	15	9	0.85	1.3	17	36	
5	420	1260	10	44	15	3	4.50	0.4	15	20	
6	1017	20	3	10	7	1	0.19	0.2	8	27	
7	644	24	3	6	3	1	0.40	0.2	12	20	
8	10	135	9	22	13	13	1.63	0.2	67	27	
9	14	46	10	15	14	6	3.05	0.3	105	160	
3020	450	146	7	25	9	12	0.50	0.6	14	44	

Analytisk Data

Hh. Homogen (Tom for stoff)

Hh. Homogen (Tom for stoff)

A30-2

512

Grong

• 1975 •

APP

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C.

QCS.

8

1

673 788

Korras:

 $\div 180^\circ$

Date	TV	TV	TV	TV	TV	TV	TV	TV	TV	TV
Name	TV	TV	TV	TV	TV	TV	TV	TV	TV	TV
1st	05' 10	05' 18	05' 10	15' 10	1' 20	05' 10	00' 40	00' 05	05' 10	4' 80
2nd	5' 100	5' 100	10' 200	5' 100	10' 200	5' 100	100' 040	00' 50	5' 100	400' 800
Proven	Cu	Mn	Co	Pb	Zn	N.	Fes ^o	Hg	V	Mn
3021	20	19	6	16	16	12	0.64	0.2	22	83
2	12	19	6	10	13	7	1.06	0.2	40	84
3	26	47	9	7	24	15	1.27	0.2	35	140
4	12	11	7	18	19	7	1.40	0.3	41	90
5	27	8	17	180	145	15	1.27	0.5	30	017*
6	22	12	11	112	80	15	1.32	0.3	29	540
7	32	4	5	58	28	4	0.34	0.4	7	375
8	24	12	4	19	18	3	0.37	0.1	7	165
9	1280	33	32	93	83	19	1.36	0.3	18	1110
3030	171	40	38	98	90	18	1.44	0.4	30	736
1	835	55	52	200	62	17	780	1.2	43	020*
2	950	1	6	45	16	6	0.84	1.0	26	85
3	240	1	1	1	1	1	0.01	0.1	1	1
4	560	1	4	19	6	1	0.50	1.1	31	42
5	860	165	41	45	39	11	20.50	1.8	62	146
6	128	5	57	15	23	15	4.00	2.0	38	17
3037	13	46	82	23	51	32	41.00	1.4	18	0114

Appendix 31.

List of samples collected in 1974 and 1975

by D. C. Smith and co-workers

<u>Oppdrag</u>	<u>Samples</u>			<u>Type</u>	<u>Location</u>	<u>Report 1289/4 section</u>
	<u>from</u>	<u>to</u>	<u>sum</u>			
1257	1 -	25	25	Stream sediment	Snertingdal	II. 2. 8
1257	26 -	50	25	Stream bank	Snertingdal	II. 2. 8
1276	1 -	396	396	Stream sediment	Gaizervatnet	II. 2. 2
1276	1001 -	1005	5	Soil	Gaizervatnet	II. 3
1289	1 -	282	282	Stream sediment	Fremstfjellet	II. 2. 2
1289	283 -	317	35	Stream sediment	Kolitjernet - Nesåelva	II. 2. 2
1289	1001 -	1020	20	Moss + bank	Rettbekken	II. 2. 5
1289	1021 -	1040	20	Soil	Amøbetjernet	II. 3
1289	2001 -	2015	15	Stream sediment (wet separated)	Fremstfjellet	II. 2. 6
1289	2016 -	2030	15	Stream sediment (dry separated)	Fremstfjellet	II. 2. 6
1289	3000 -	3119	119	Rock	Fremstfjellet	II. 5
1289	3120 -	3151	32	Rock	Kolitjernet - Nesåelva	II. 5
1289	4001 -	4020	20	Ashed samples (1001 - 1020)	Rettbekken	II. 2. 5
1368	1 -	360	360	Stream sediments	Sanddøla - Nesåvatna - Gaizervatnet	II. 2. 2
1368	1001 -	1268	268	Rock	Fremstfjellet - Gaizervatnet	II. 5
1368	1271 -	1320	50	Rock	Nesåpiggen	II. 5
1368	3001 -	3037	37	Soil + moss m/m	Sanddøla - Nesåvatna - Gaizervatnet	II. 3 & 4

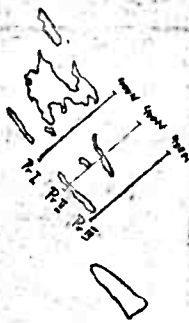
Appendix 32

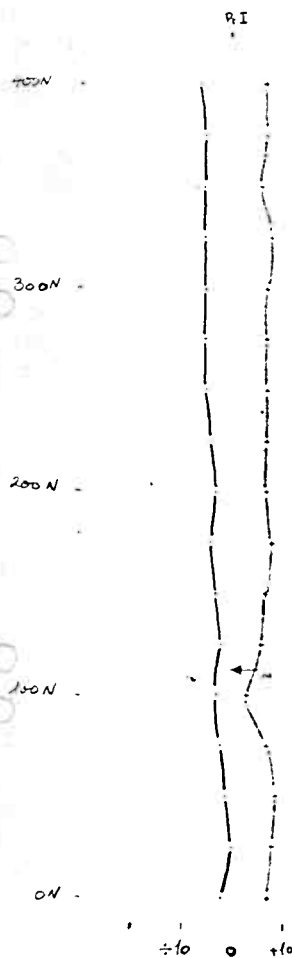
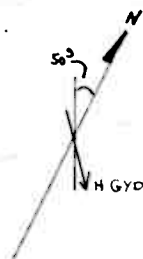
A32-1

VLF måling 1976 - Amøbetjernet

V. 65

357.1206





— — — — — Reell
 - - - - - Imag
 ↓ Anomali

VLF-måling 1976

AMBETJERN ØST
 M 1:2500
 station GYD

Tegn. 13/12-76

Pr I

Pr II

Pr II

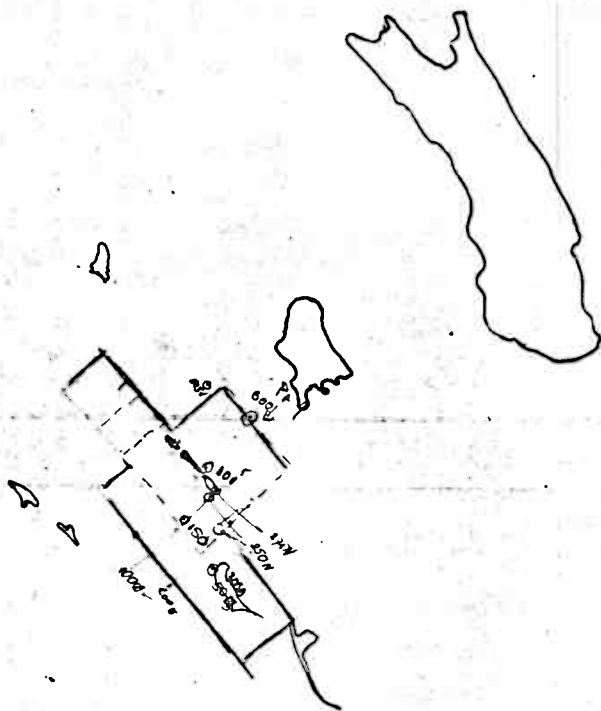
Append. x 33

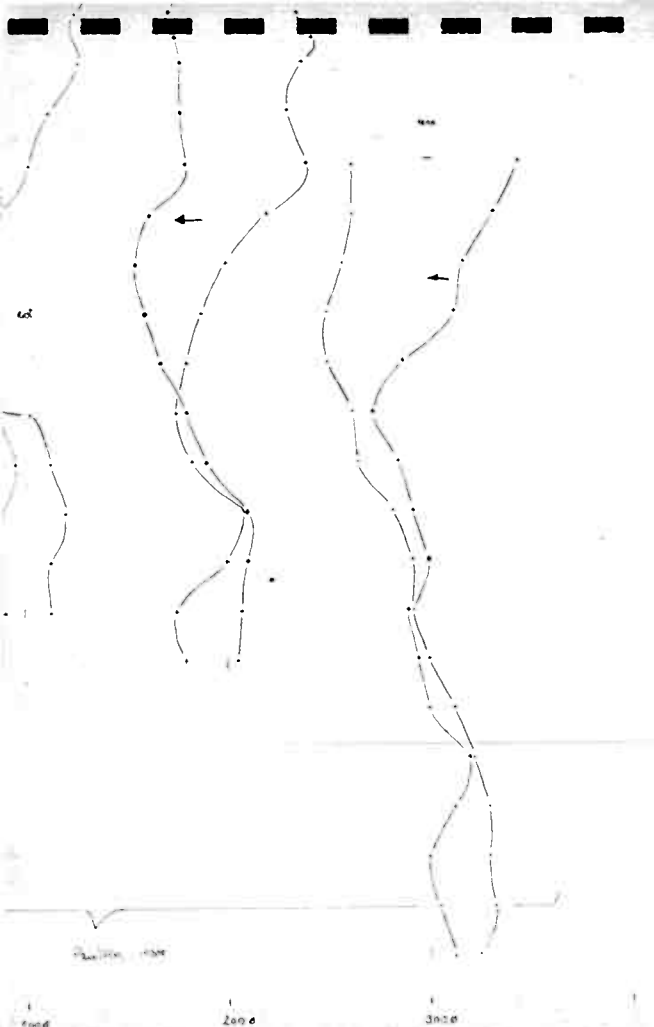
A33-1

VLF-måling 1976 - SMALTJERNET

(357)

1209





VLF-måling 1976

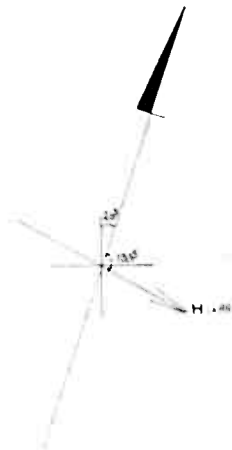
FREMSTFJELL - SMALTJERN

M 1.2500

Stasjon: NAA

Inst: Geonics EM 16
Paulsen

målt T.H.T./M.E. 1/9/76
Tegn. at 14/2/76



0.00 0.01 0.02

600N -

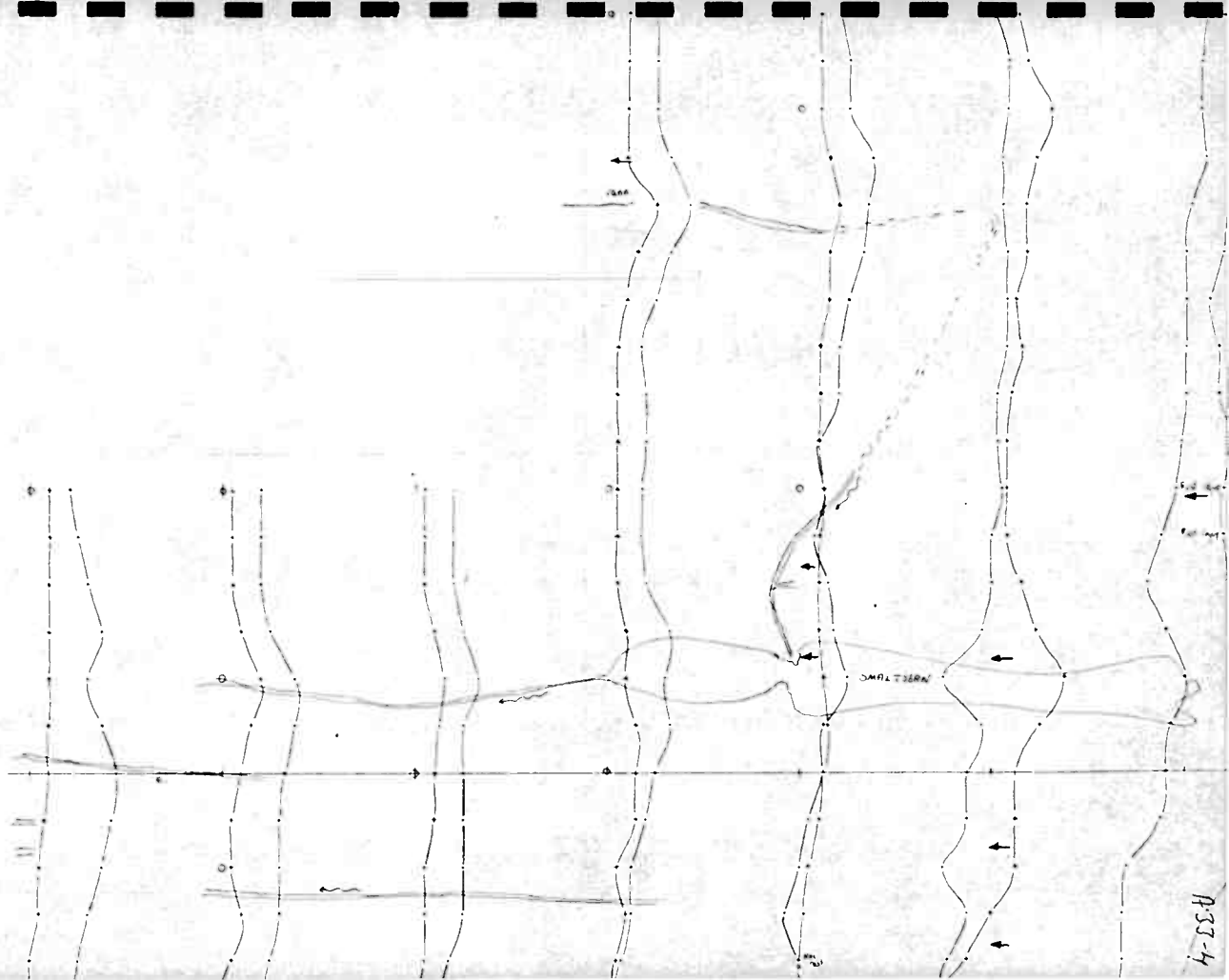
500N -

400N -

300N -

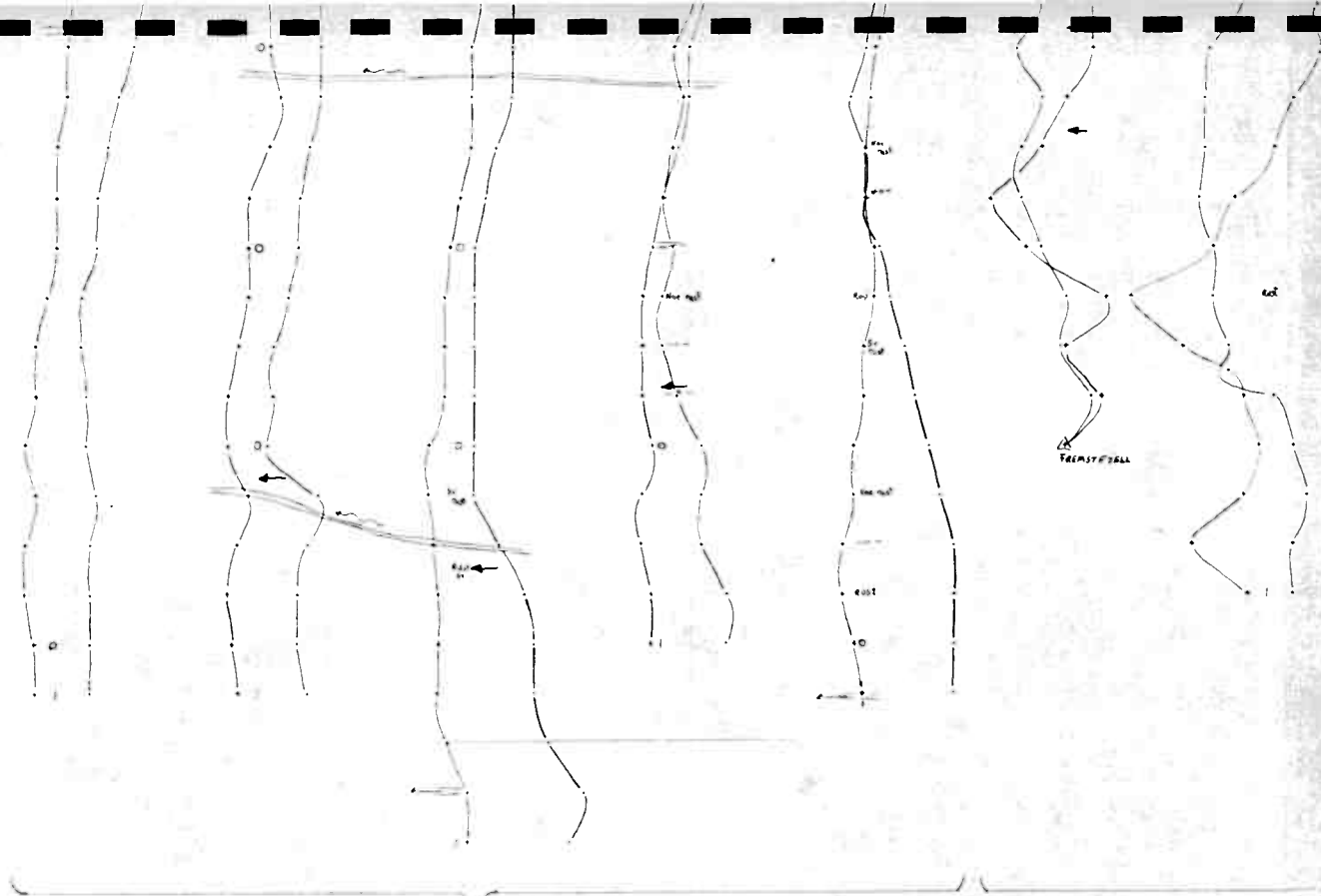
200N -

100N -



1133-4

2004 -
1004 -
203 -
1003 -
2005 -



5" 1/4 (malt med senderen i ryggen)

300

400

500

600

700

800

900

1000

Date	17/2-76	20/2-76	18/2-76	18/2-76	18/2-76	18/2-76	20/2-76	20/2-76	18/2-76	20/2-76							
Navn	TS	TS	TS	TS	TS	TS	TS	TS	TS	TS							
1st part	5 100	10 200	5 100	10 200	5 100	5 100	5 100	4,25 5.0	2000 4,00%	40 800							
2nd part	0,2 4	0,2 4	0,5 10	0,2 4	0,5 10	0,5 10	0,5 10	1,01 0.2	100 0,20%	4 80							
Proven	A	B	Cu	Mo	Pb	Zn	Ni	Co	V	Ag	% Fe	Mn					
21	15	< 2	7	61	39	15	20	0,3	3,41	810							
22	4	< 2	5	26	12	7	20	0,2	1,45	300							
23	9	< 2	9	44	12	9	46	0,2	1,38	174							
135	12	< 2	10	39	23	8	31	0,2	1,10	170							
36	980	19	60	170	24	42	25	6,2	12,80	120							
137	13	< 2	10	31	24	8	38	0,2	1,02	129							
449	112	32	112	228	46	28	56	1,2	4,00	0,22%							
450	72	< 2	24	113	79	45	136	0,7	4,95	0,35%							
451	45	5	134	580	36	39	95	0,9	5,00	0,85%							
2001	18	< 2	12	74	28	19	63	0,4	2,10	0,18%							
02	16	< 2	15	57	18	14	60	0,3	1,76	0,10%							
2023	10	< 2	17	59	11	14	32	0,3	1,53	0,13%							
310	7	< 2	12	29	21	11	38	0,4	2,71	180							
11	16	< 2	30	80	28	32	56	0,6	2,84	620							
212	9	< 2	15	55	57	21	53	0,2	1,71	260							

NEW DATA

1834-1

1177

Korinn

015 / 111 / 111

Innov

Fort

Sied

At

Art

Ann



19

5

Cops

3

Angl met

Kornst

Original

l. g. Kjølling.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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1276
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GRONG

Ä. 1374 Ag!

2000

1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563 2564 2565 2566 2567 2568 2569 2570 2571 2572 2573 2574 2575 2576 2577 2578 2579 2580 2581 2582 2583 2584 2585 2586 2587 2588 2589 2590 2591 2592 2593 2594 2595 2596 2597 2598 2599 2600 2601 2602 2603 2604 2605 2606 2607 2608 2609 2610 2611 2612 2613 2614 2615 2616 2617 2618 2619 2620 2621 2622 2623 2624 2625 2626 2627 2628 2629 2630 2631 2632 2633 2634 2635 2636 2637 2638 2639 2640 2641 2642 2643 2644 2645 2646 2647 2648 2649 2650 2651 2652 2653 2654 2655 2656 2657 2658 2659 2660 2661 2662 2663 2664 2665 2666 2667 2668 2669 2670 2671 2672 2673 2674 2675 2676 2677 2678 2679 2680 2681 2682 2683 2684 2685 2686 2687 2688 2689 2690 2691 2692 2693 2694 2695 2696 2697 2698 2699 2700 2701 2702 2703 2704 2705 2706 2707 2708 2709 2710 2711 2712 2713 2714 2715 2716 2717 2718 2719 2720 2721 2722 2723 2724 2725 2726 2727 2728 2729 2730 2731 2732 2733 2734 2735 2736 2737 2738 2739 2740 2741 2742 2743 2744 2745 2746 2747 2748 2749 2750 2751 2752 2753 2754 2755

Date	Pb-76	29%Zn	Al-76	15%Zn	10%Zn	12%Zn	1%Zn	2%Zn	1%Zn	1%Zn	1%Zn
Name	TS	TS	TS	TS	TS	TS	TS	TS	TS	TS	TS
1st PC	5 100	10 200	5 100	10 200	5 100	5 100	5 100	5 100	5 100	5 100	5 100
2nd PC	0.2 4	0.2 4	0.2 4	0.2 4	0.2 4	0.2 4	0.2 4	0.2 4	0.2 4	0.2 4	0.2 4
A											
Recovery	B	Cu	Mo	Pb	Zn	Ni	Co	V	Ag	%Fe	Mn
48		450	173	260	94	15	33	63	0.9	3.5	0.12%
49		350	56	28	84	38	24	51	0.5	1.8	460
50		116	30	24	31	16	12	28	0.2	1.1	300
51		47	3	24	64	14	13	50	0.3	1.4	350
140		11	69	43	31	10	11	35	0.3	1.2	240
141		12	47	28	51	12	12	33	0.2	1.1	220
281		528	8	63	73	28	104	135	1.1	6.34	2.11%
282		Tom	—	—	—	—	—	—	—	—	—
283		146	5	42	68	17	47	400	1.1	9.00	990
284		Tom	—	—	—	—	—	—	—	—	—
285		Tom	—	—	—	—	—	—	—	—	—
311		110		12	21	10		20	0.2	0.52	105
312		105		14	21	10		21	0.3	0.83	108
313		8		29	93	52		23	0.7	3.96	0.27%
314		4		37	87	39		28	0.3	1.67	490

NEW DATA

AS4-3

1276

GAONG

1974 BERKESEDIMENT

22 8 74

5/4 74	30/1 75	2/4 74	3/4 74	7/1 75	8/1 75	16/1 75	9/1 75	14/1 75	10/1 75
KB	1	KB	KB	TS	TS	TS	TS	TS	TS
20 400	10 100	10 200	20 400	5 100	1 20	10 200	0.05 1.0	2000 40 100	100 2000
10 200	1 20	0.5 10	1 20	2 40	5 100	0.5 10	0.025 0.5	250 0.5%	5 100
				0.5/10					
Cu	Mo	Pb	Zn	Ni	Co	V	Ag	%Fe	Mn
48 390	175	220	83	18	27	51	0.9	2.9	970
49 349	59	28	85	37	24	45	0.6	1.8	450
50 115	28	20	29	14	11	27	0.4	1.0	300
51 50	2	22	63	16	13	46	0.5	1.4	350
140 11	66	37	29	11	9	32	0.3	1.5	260
141 12	44	26	43	12	9	26	0.3	1.1	220
281 525	6	68	74	25	125	168	1.2	4.7	2140
282 620	8	72	44	17	66	66	1.0	3.3	1070
283 159	4	41	71	17	49	410	1.2	6.8	990
284 Tom	—	—	—	—	—	—	—	—	—
285 315	11	83	61	16	15	86	1.1	3.5	170
311 15	124	12	18	11	7	19	0.4	0.8	110
312 15	122	13	21	9	7	20	0.3	0.9	140
313 66	6	58	82	56	21	22	0.5	3.6	3000
314 17	3	35	59	39	19	29	0.5	1.7	540

OLD
DATA

A34-4

Upstr 1269 Kart nr. 11 Org/till/tell 12 Innv Fort
 Sted GRONG i 1974 Art B.sed. Ann

Innv 1 19 av Copsi 1 19 av Angl met Kernst

Date	172-76	212-76	18-76	15-76	12-76	29-76	20-76	17-76	20-76								
Navr	TS	TS	TS	TS	TS	TS	TS	TS	TS								
1. st. oppg.	5 100	10 200	5 100	10 200	5 100	5 100	0.25 50	100 400	40 800								
2. st. oppg.	0.2 4	0.2 4	0.5 10	0.2 4	0.5 10	0.5 10	0.1 0.2	100 0.20	4 80								
Proven	Ca	Mo	Pb	Zn	Ni	Co	V	Ag	% Fe	Mn							
55	840	860	430	123	29	290	91	0.8	630	1207							
56	75	11	8	10	7	4	20	0.1	0.59	115							
57	460	242	28	26	12	8	42	1.2	1.99	148							
93	10	< 2	18	24	11	11	33	0.3	0.96	270							
94	1740	112	114	58	42	31	110	1.8	3.76	620							
95	880	77	54	90	28	21	124	1.4	2.97	370							
115	220	32	74	86	30	37	140	0.6	2.55	800							
116	40	6	22	211	61	67	310	1.4	7.20	1320							
117	53	133	119	87	16	13	55	0.6	3.75	158							
118	41	76	53	28	11	10	43	0.3	1.53	310							
296	10	5	26	52	15	12	36	0.3	1.29	600							
297	21	3	31	90	52	19	39	0.5	2.08	740							
310	6	2	13	19	13	9	40	0.3	1.93	270							
311	19	3	26	63	17	15	38	0.3	1.29	580							
312	Tom																

NEW
DATA
B34-5

1289

GAONG

1974 BEKRESIDIMENT

19 8 74

4/9 74	29/1 75	30/8 74	2/9 74	6/1 75	7/1 75	15/1 75	9/1 75	14/1 75	10/1 75										
KB	?	KB	KB	TS	TS	TS	TS	TS	TS										
20 400	10 200	10 200	10 200	2 40	1 20	5 100	0.05 1.0	2000 4.0 %	100 2000										
10 200	1 20	0.5 10	1 20	0.5 10	50 100	0.5 10	0.005 0.5	350 0.5 %	5 100										
Cu	Mo	Pb	Zn	Ni	Co	V	Ag	% Fe	Mn										
55 850	930	490	113	24	290	86	0.7	6.2	1.24 %										
56 84	13	11	10	8	4	16	0.2	0.7	130										
57 400	240	27	20	11	8	39	1.0	1.7	160										
93 9	1	19	20	10	9	27	0.2	0.8	290										
94 1680	110	107	60	37	27	110	1.6	3.2	610										
95 960	91	57	89	25	20	125	1.5	2.9	420										
115 207	33	72	89	29	35	136	0.8	2.5	820										
116 44	6	24	210	56	64	310	1.5	5.9	1440										
117 59	144	119	94	13	9	46	0.6	3.4	150										
118 41	77	52	31	8	8	36	0.4	1.2	320										
296 14	6	24	58	18	14	32	0.1	1.2	600										
297 28	6	28	94	56	22	32	0.6	2.2	920										
310 8	0	10	20	12	8	26	0.2	1.6	260										
311 24	4	30	69	18	16	32	0.2	1.2	640										
312 16	2	14	33	12	10	46	0.4	1.8	250										

OLD
DATA

1974-6

1368
GRONG 1975

GRONG

1975

შედეგად

19 av 19 av And me! Kornst

[illegible]

1368

19r. 20 ml

GRON4

1975 BEKKESSEDIMENT : 180 H

Date	TV	HT	TV	HT	21/1, 76	22/1, 76	23/1, 76	21/1, 76	22/1, 76	23/1, 76	24/1, 76	25/1, 76	26/1, 76	29/1, 76
TV	TV	HT	TV	HT	TV	TV	TV	TV	TV	TV	TV	TV	TV	TV
05 10	05 10	05 10	05 10	05 10	05 10	05 10	05 10	05 10	05 10	05 10	025 50	025 50	025 50	4 80
5 100	10 200	5 100	10 200	5 100	5 100	5 100	5 100	5 100	5 100	5 100	0.025 0.5	0.025 0.5	0.025 0.5	40 800
Cu	Mo	Pb	Zn	Ni	Co	V	Ag	% Fe	Mn					
321	63	54	7	13	4	4	18	0,2	0,54	90				
322	16	10	67	62	22	16	42	0,4	1,30	450				
323	18	13	30	47	14	13	36	0,3	1,20	330				
324	18	1	54	80	16	19	43	0,4	1,85	0,15%				
325	7	1	25	40	9	10	28	0,3	1,00	279				
341	75	0	22	39	12	12	29	0,2	1,38	255				
342	15	0	32	38	16	10	34	0,3	1,30	230				
343	11	0	38	57	11	11	34	0,2	1,35	555				
344	15	0	37	61	12	10	28	0,3	1,15	225				
345	86	0	37	74	30	24	106	0,7	3,54	620				
346	13	1	32	52	14	11	31	0,2	1,30	400				
347	69	38	26	46	14	12	30	0,2	1,36	270				
348	810	39	155	72	17	43	34	0,9	4,10	0,14%				
349	400	94	58	42	11	27	31	1,0	7,50	605				
350	16	1	51	43	12	8	35	0,3	1,19	165				

OLD
DATA

R34-2

1257

David Smith 1779 - Sediment

+ Bank

6 = 75.37

1257

1257

David Smith 1974 - Sediment

+ Bank

10.3 75 34

$$= 600 + 180$$

		134125	241175	284725
		TV	TV	TV
		1 20 25 30 35 40		
		50 1000 14 2000 18 2000		
		76	Zn	Cur
X	1001	320	61	7
	2	480	100	11
	3	420	80	8
	4	840	101	9
	5	350	74	8
	6	410	81	8
	7	510	110	13
	8	300	67	8
	9	700	105	10
X	1010	480	91	9
	1	1400	135	11
	2	670	89	8
	3	710	80	7
	4	640	85	8
	5	660	67	8
	6	130	105	10
	7	930	142	12
	8	640	118	11
	9	250	57	6
X	1020	390	87	7

		25/125	25/175	25/125
		TV	TV	TV
		2000	05 10	05 10
		2000	2000	2000
Y	Y	76	76	76
	100	175	48	5
	2	160	54	6
	3	150	45	5
	4	350	56	6
	5	140	47	6
	6	215	57	6
	7	150	47	6
	8	165	42	5
Y	9	200	50	6
	101	190	53	6
	1	260	53	5
	2	245	54	5
	3	290	53	6
	4	340	65	6
	5	252	46	6
	6	100	54	6
	7	335	76	7
	8	250	77	7
Y	9	170	47	5
	102	270	60	7

1735-1

1257

David Smith

1974

Sediment
+ Bank

1g for 20ml

-180 g

1257

David Smith

1974

Sediment
+ Bank

1g for 20ml

-600 + 180

			25/4/75	29/4/75	12-4/75					
			TV	TV	TV					
			1	20	05	10	05	10		
			50	1000	10	200	10	200		
X	1021	PL	600	101	10					
		2	230	48	5					
		3	660	98	11					
		4	350	57	7					
		5	540	78	8					
G	1030	6	320	87	8					
		7	260	75	9					
		8	190	47	6					
		9	200	63	7					
		10	500	100	10					
G	1040	1	380	90	11					
		2	330	58	9					
		3	310	71	9					
		4	180	47	7					
		5	100	37	6					
G	1040	6	340	71	9					
		7	320	75	10					
		8	450	64	8					
		9	410	62	10					
		10	240	56	7					

			25/4/75	29/4/75	12-4/75					
			TV	TV	TV					
			1	20	05	10	05	10		
			50	1000	10	200	10	200		
Y	1021	PL	270	63	7					
		2	185	46	5					
		3	380	72	8					
		4	230	63	6					
		5	170	42	6					
G	1030	6	280	83	8					
		7	220	65	8					
		8	175	51	6					
		9	220	77	7					
		10	365	86	9					
G	1040	1	380	97	10					
		2	300	65	9					
		3	300	72	8					
		4	160	43	6					
		5	218	43	7					
G	1040	6	430	105	11					
		7	420	90	11					
		8	220	78	10					
		9	370	61	9					
		10	260	62	6					

R35-2

1257

David Smith

1974

Sediment
+ Bank

10.3 75 BH

1g Fort 2cm

-180 μ

1257

David Smith

1974

Sediment
+ Bank

10.3 75 BH

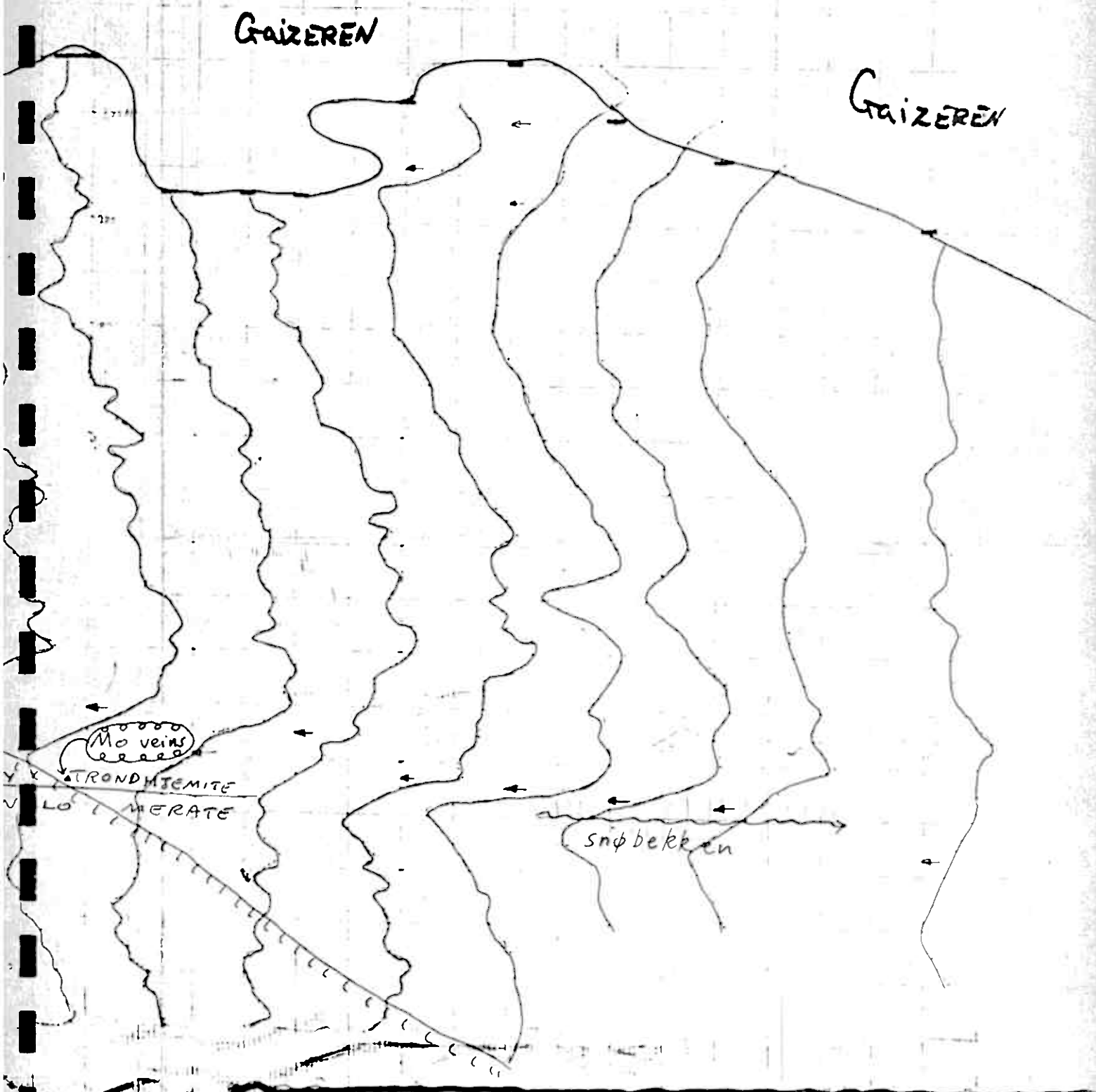
1g Fort 2cm

-600 + 180 μ

Stative	Series	10.3 75 BH	10.3 75 BH	10.3 75 BH
X	1041	390	83	8
	2	190	54	6
	3	220	64	7
	4	240	69	8
	5	270	65	7
	6	210	43	7
	7	660	70	9
	8	540	116	11
	9	420	82	11
	1050	330	54	9
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			

Stative	Series	10.3 75 BH	10.3 75 BH	10.3 75 BH
Y	1041	150	50	6
	2	135	49	6
	3	130	48	7
	4	220	70	8
	5	160	51	6
	6	215	47	7
	7	770	76	8
	8	345	92	9
	9	310	72	8
	1050	370	58	9
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			

A35-3



No veins
 Locality L98
 Samples 1223-1224
 Oppdrag 1368
 Year 1975
 Geologist - Smith

Graizer - området
 VLF-måling, juli -75.
 M 1:5000

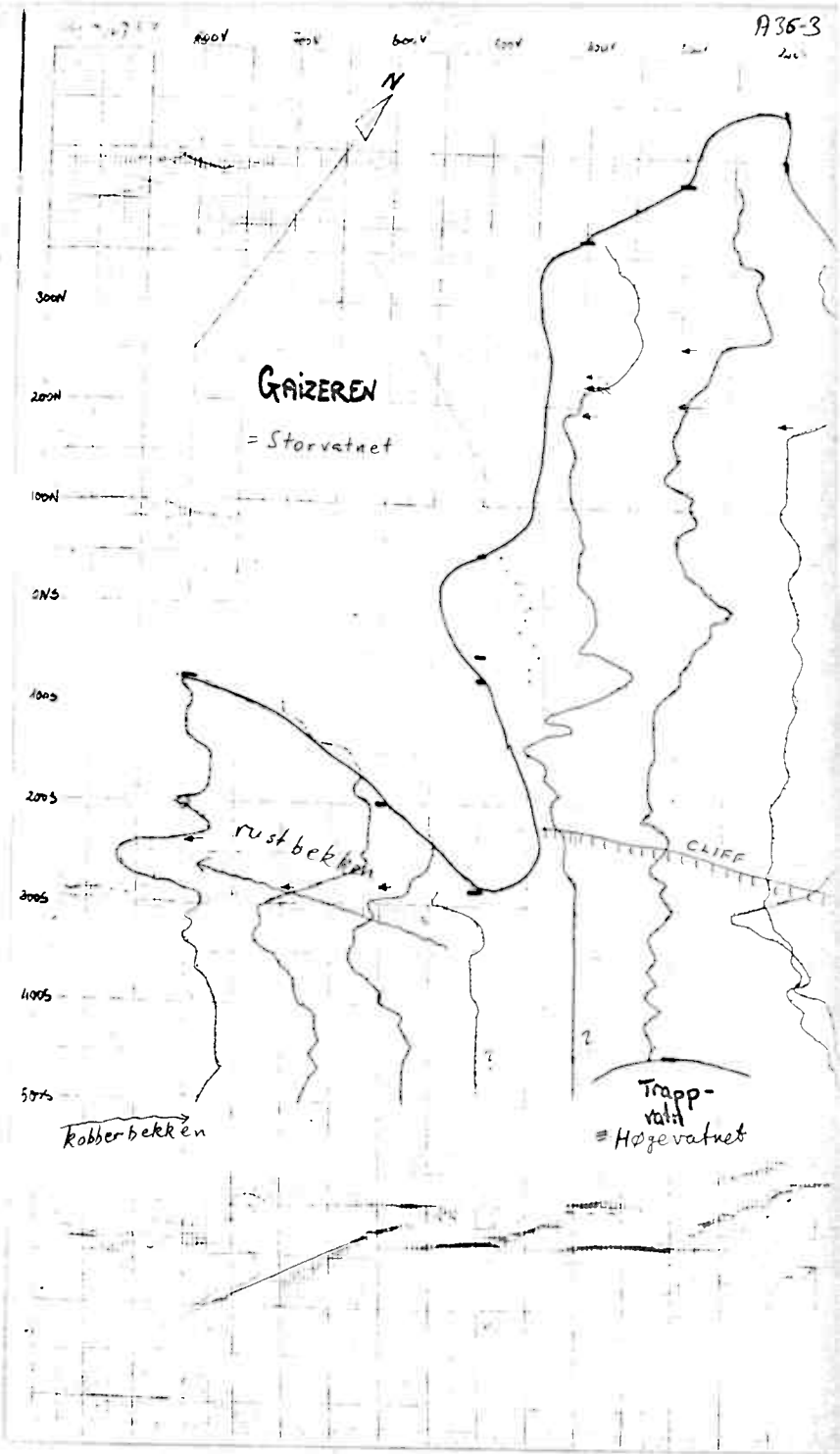
Pr. 100V - 600B : FOU (stasjon)
 Pr 800V - 200V on 8000-10000 : BOF (— —)

GAIZEREN

CLIFF

RUSTY & STRONDATEMITE
CONGLOMERATETrapp-
vann
= Høgevatnet

Mo Venn
 Locality L 98
 Samples 1223-1224
 Opparm 1308
 Year 1975
 Geologist - Smith



OVERSIKT + INNHOLDSFORTEGNELSE

RAPPORT Mo-felt Ness 1994.

(D.S. & H.)

NGU 1289/4

unofficially T.H.T.

Dette ble gitt meg våren '77
Selve rapporten manus ble det til jeg ikke.
Smith selv har meddelt meg sommeren
'76 at manuskriptet ble innlevert til
Karlheim og Bolviken. Har gjennomgått
rapporten i fona. Appendix m 5
ble åpenbart tatt ut av NGU før det
ble sendt til Gr.Gr.

GEOKJEMISK KARTPRODUKSJON OG

MALMLETING I GRONGFELTET

NGU Rapport nr. 1289/4

I : A review of the production of 1:50 000
regional stream sediment geochemical maps
of Grongfeltet

and

II : A final compilation of data from
geochemical exploration for Mo and Cu in
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April 1977

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April 1977

Saksbehandler : David C. Smith

Norges geologiske undersøkelse
Kjemisk avdeling
Postboks 3006, 7001 Trondheim
Tlf. : (075) 15860

Contents of NGU Report nr. 1289/4.

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- 4 Correlation between symbol size and ppm concentration range

5 - 9 Chemical Analyses of Rocks - Trace Elements.

- | | | |
|---|----------------|-------------------------|
| 5 | Oppdrag - 1289 | date received - 13-8-74 |
| 6 | - 1289 & 1368 | 7-10-75 |
| 7 | - 1289 & 1368 | 30-11-75 |
| 8 | - 1289 | 28-4-76 |
| 9 | - 1368 | 20-9-76 |

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by David C. Smith, 7 April 1975.
6. "Grong: the correlation of altitude and the tree line with lead in stream sediments". D.C. Smith, Journal of Geochemical Exploration, vol. 5, no. 3, 1976. 5
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List of Example Maps.

Regional 1:50 000 Stream Sediment Geochemical Maps - Grongfelltet.

A total of 60 such maps are now complete (see table 3); of these 11 were published in December 1976 and the remaining 49 await only permission for publication.

As examples to show the different ppm ranges, symbol sizes and frequency distributions for each element all of the Andorsjøen maps (excluding Cd) are presented here.

As examples to show the distribution of sample sites over the 11 different map sheets, all of the Zn maps are presented here.

Thus the following 20 maps can be found in this report.

1546	-BEKK	- 1823 IV	- Ag	symb.
1546	-BEKK	- 1823 IV	- Co	symb.
1546	-BEKK	- 1823 IV	- Cu	symb.
1546	-BEKK	- 1823 IV	- Fe	symb.
1546	-BEKK	- 1823 IV	- Mn	symb.
1546	-BEKK	- 1823 IV	- Mo	symb.
1546	-BEKK	- 1823 IV	- Ni	symb.
1546	-BEKK	- 1823 IV	- Pb	symb.
1546	-BEKK	- 1823 IV	- V	symb.
1546	-BEKK	- 1823 IV	- Zn	symb.
1546	-BEKK	- 1824 I	- Zn	symb.
1546	-BEKK	- 1823 IV	- Zn	symb.
1546	-BEKK	- 1824 III	- Zn	symb.
1546	-BEKK	- 1924 I	- Zn	symb.
1546	-BEKK	- 1924 II	- Zn	symb.
1546	-BEKK	- 1923 I	- Zn	symb.
1546	-BEKK	- 1824 II	- Zn	symb.
1546	-BEKK	- 1923 IV	- Zn	symb.
1546	-BEKK	- 1924 IV	- Zn	symb.
1546	-BEKK	- 1924 III	- Zn	symb.

List of Maps prepared for this project.

* denotes maps not included in this report.

District - hele GRONGFELTET, scale 1:250 000, oppdrag 1276.

Map number

1276-01 *	Bekkesedimenter	Oversikt (superseded by map 1276-02)
1276-02	Bekkesedimenter	Oversikt over prøvetatt områder, oppdrag nummer, årstall, kartblad nummer.
1276-03	Bekkesedimenter	Som 1276-02 med generell geologi etter Sverdrup (NGU rapport nr. 1166) (see appendix for symbol list) og Mo-bekkesedimentanomalier og frekvensfordelinger.

District - FREMSTFJELL-FELTET, scale 1:5 000, oppdrag 1289.

<u>Map number</u>	<u>Sample type</u>	<u>Map type</u>
1289-01*	Bekkesedimenter	Cu+Mo anomalier (superseded by map 1289-27)
1289-02*	Bekkesedimenter	Cu+Mo anomalier (superseded by map 1368-07)
1289-03	Bekkesedimenter+soil+rock	Prøvenummer - oppdrag 1289
1289-04	Bekkesedimenter	Mo analysetall
1289-05	Bekkesedimenter	Pb/Zn/Cu analysetall
1289-06	Bekkesedimenter	Ni/Co/Ag analysetall
1289-07	Bekkesedimenter	V/Mn/Fe analysetall
1289-08	Bekkesedimenter	Mo symboler
1289-09	Bekkesedimenter	Cu symboler
1289-10	Bekkesedimenter	Pb symboler
1289-11	Bekkesedimenter	Zn symboler
1289-12	Bekkesedimenter	Ni symboler
1289-13	Bekkesedimenter	Co symboler
1289-14	Bekkesedimenter	V symboler
1289-15	Bekkesedimenter	Ag symboler
1289-16	Bekkesedimenter	Mn symboler
1289-17	Bekkesedimenter	Fe symboler
1289-18*	Bekkesedimenter	♂ Mo symboler in adjacent districts
1289-19*	Bekkesedimenter	♂ Cu symboler in adjacent districts
1289-20*	Bekkesedimenter	♂ Pb symboler in adjacent districts
1289-21*	Bekkesedimenter	♂ Zn symboler in adjacent districts
1289-22*	Bekkesedimenter	♂ Ni symboler in adjacent districts
1289-23*	Bekkesedimenter + soil	♂ Prøvesteder ved Gaizervatnet 1:20 000
1289-24	Bekkesedimenter	Glødetap analysetall
1289-25	Bekkesedimenter	Glødetap symboler + bekkeorden
1289-26	Bekkesedimenter	Prøvenummer - oppdrag 1289
1289-27	Bekkesedimenter	Cu+Mo kryss
1289-28	Bekkesedimenter	Cu+Mo kryss +mutingsområder 1-1-76
1289-29	Bekkesedimenter	Mn+Fe kryss uten grunnlag
1289-30	Bekkesedimenter	Mn+Fe kryss med grunnlag
1289-31	Bekkesedimenter	Mn+Fe kryss med 2 frekvensfordelinger
1289-32	Bekkesedimenter	Cu+Mo+Mn+Fe med 2 frekvensfordelinger
1289-33	Bekkesedimenter	Cu+Mo+Mn+Fe med 4 frekvensfordelinger
1289-34	Bergart + Jord + Moser	Prøvenummer - oppdrag 1368

♂ these maps are available in NGU report nr. 1289/2.

District - SANDDØLA-NESÅVATNA, scale 1:20 000, oppdrag 1368.

<u>Map number</u>	<u>Sample type</u>	<u>Map type</u>
1368-01	Bekkesedimenter	Prøvenummer
1368-02	Bekkesedimenter	Mo analysetall
1368-03	Bekkesedimenter	Cu analysetall
1368-04	Bekkesedimenter	Mo symboler
1368-05	Bekkesedimenter	Cu symboler
1368-06	Bekkesedimenter	Mo symboler §
1368-07	Bekkesedimenter	Cu+Mo kryss
1368-08	Bekkesedimenter	Cu+Mo kryss § §
1368-09	Bergart	Generell geologi § § §
1368-10	Bekkesedimenter	Høyde over havet av prøvestedet
1368-11	Jord + Mose	Prøvenummer
1368-12	Bergart	Prøvenummer

- § includes Smith's mutingsforslag of 20-11-75
 § § includes Haugen's 61 mutingsområder of 1-1-76
 § § § assembled from Gale's report NGU nr. 1293.

District - ANDORSJØEN, scale 1:50 000.

<u>Map number</u>				
1546	-	BEKK	-	1823 I - Ag tall
1546	-	BEKK	-	1823 I - Co tall
1546	-	BEKK	-	1823 I - Cu tall
1546	-	BEKK	-	1823 I - Fe tall
1546	-	BEKK	-	1823 I - Mn tall
1546	-	BEKK	-	1823 I - Mo tall
1546	-	BEKK	-	1823 I - Ni tall
1546	-	BEKK	-	1823 I - Pb tall
1546	-	BEKK	-	1823 I - V tall
1546	-	BEKK	-	1823 I - Zn tall

District - NAMSSKOGAN, scale 1:50 000.Map number

1546	-	BEKK	-	1824 II	-	Ag	tall
1546	-	BEKK	-	1824 II	-	Co	tall
1546	-	BEKK	-	1824 II	-	Cu	tall
1546	-	BEKK	-	1824 II	-	Fe	tall
1546	-	BEKK	-	1824 II	-	Mn	tall
1546	-	BEKK	-	1824 II	-	Mo	tall
1546	-	BEKK	-	1824 II	-	Ni	tall
1546	-	BEKK	-	1824 II	-	Pb	tall
1546	-	BEKK	-	1824 II	-	V	tall
1546	-	BEKK	-	1824 II	-	Zn	tall

District - hele GRONGFELTET, scale 1:50 000.Map number

1546	-	BEKK	-	1823 IV	-	Prøvenummer	ANDORSJØEN
1546	-	BEKK	-	1824 I	-	Prøvenummer	BREKKVASSELV
1546	-	BEKK	-	1823 IV	-	Prøvenummer	GRONG
1546	-	BEKK	-	1824 III	-	Prøvenummer	HARRAN
1546	-	BEKK	-	1924 I	-	Prøvenummer	HUDDINGSVATNET
1546	-	BEKK	-	1924 II	-	Prøvenummer	LIMINGEN
1546	-	BEKK	-	1923 I	-	Prøvenummer	MURUSJØEN
1546	-	BEKK	-	1824 II	-	Prøvenummer	NAMSSKOGAN
1546	-	BEKK	-	1923 IV	-	Prøvenummer	NORDLI
1546	-	BEKK	-	1924 IV	-	Prøvenummer	RØYRVIK
1546	-	BEKK	-	1924 III	-	Prøvenummer	TUNNSJØEN

District - RØYRVIK, scale 1:50 000, oppdrag 1573.

<u>Map number</u>	<u>Sample type</u>	<u>Map type</u>
1573-01	Bekkesedimenter	Cu prøvetatt fra bil (A og B prøver)
1573-02	Bekkesedimenter	Cu prøvetatt på fjellet hver 250 m.
1573-03	Bekkesedimenter	Cu prøvetatt på fjellet pluss A-prøver fra bil.
1573-04	Bekkesedimenter	Cu i utplukket prøve fra fjellprøvetaking, men som kunne ha vært prøvetatt fra fullstendig bil-og båt prøvetaking.

District - SANDDØLA-NESÅVATNA, scale 1:50 000, oppdrag 1573.

<u>Map number</u>	<u>Sample type</u>	<u>Map type</u>
1573-05	Bekkesedimenter	Ag symboler
1573-06	Bekkesedimenter	Co symboler
1573-07	Bekkesedimenter	Cu symboler
1573-08	Bekkesedimenter	Fe symboler
1573-09	Bekkesedimenter	Mn symboler
1573-10	Bekkesedimenter	Mo symboler
1573-11	Bekkesedimenter	Ni symboler
1573-12	Bekkesedimenter	Pb symboler
1573-13	Bekkesedimenter	V symboler
1573-14	Bekkesedimenter	Zn symboler

Introduction.

This report describes the production of regional geochemical maps of Grongfeltet (Part I) and provides a compilation of data on the follow-up geochemical exploration for Mo and Cu in the Sanddøla-Nesåvatna area in southern Grongfeltet (Part II).

Part I records work carried out by NGU personnel way back to 1964 whilst Part II records the work of the field projects in 1974 and 1975 variously known as the "Langtjern Project", "Trondhemite Project" or "Molybdenum Project".

Most of the author's time and effort has been utilised for Part I in organising the stream sediment field and analytical data from Grongfeltet and in establishing a streamlined production system. This has resulted in the publication of the first 11 1:50 000 regional stream sediment geochemical maps of Grongfeltet, completion of 49 others ready for immediate publication, and commencement of several more.

The remaining time available has been expended on Part II in field work and in selecting stream sediment, soil, moss and bedrock samples for chemical analysis, and controlling and guiding the data through to the stage of data plotting. The field work and chemical analytical programmes are complete, and the map plotting programme is essentially complete. The required polished and thin sections of the rock samples have been manufactured though detailed petrographic studies have not been made. Some interpretation of the data has been presented previously in reports 1289/1 in 1974, 1289/2 in 1975, 1289/3 in 1976, in diverse notes and proposals (see appendix 1) and some is presented here in this final report 1289/4 of 1977.

It has not proved possible, unfortunately, to carry out as much interpretative work for Part II as was hoped. However, this hurried compilation records or references all the necessary raw data for an integration of the geochemical surveys with geological and geophysical surveys. Furthermore the geochemical data provided here is considerably in excess of that specified in the budget arrangement for the 1975 field project (compare appendix 2 with tables 6 - 13).

David C. Smith

David C. Smith
Geochemist

30 April 1977

TRONDHJEMITE-PROJECT 1975DETAILED PLAN FOR GEOLOGICAL FIELD WORK.

TYPE OF WORK

1. Prospecting.

- a) Search for new mineralization, especially in the vicinity of known stream sediment anomalies, mineralization and prospects.
- b) Carry out local detailed structural mapping of all mineralization found.
- c) Blast and trench the most interesting mineralized outcrops.
- d) Take selected samples for thin section studies and for trace element chemical analysis of mineralized and relevant unmineralized rock.

2. Outline geological mapping using 1:10 000 air photographs.

- a) Locate the south-eastern margin of the Sanddøla trondhjemite and the contacts of inclusions within the main trondhjemite and of trondhjemite intrusions without.
- b) Identify different rock types within the trondhjemite and attempt to map different units.
- c) Examine some districts recently mapped by NGU in order to try to standardise and coordinate all recent mapping in the area.
- d) Take selected samples for thin section studies and for major element chemical analysis of the principal rock types.

3. Additional geological work.

- a) Make reconnaissance excursions beyond the area selected to aid a regional interpretation.
- b) Take composite rock samples or dust samples at each mutingspunkt for trace element chemical analysis.

Note on priorities.

If field work has to be curtailed for any reason then 1a, 1b and 1d should be regarded as the first priority; 2a, 2c and 2d as the second priority and everything else as lower priority.

Area to be examined.

The area to be examined is selected as that covered by the air photographs:

1107 - 1109	1309 - 1315
1207 - 1215	1415 - 1417

of series V65 357 Nor flyveselskap, 1:20 000

This area covers:

- i) both the Fremstfjellet - Nesåpiggen and the Gaizervann mutingsområder and the isolated Øvre Nesåvannet mutingsområdet,
- ii) the entire south-eastern contact of the Sanddøla Trondhemite (according to Foslie) from Midtre Nesåvannet to Koltjernet,
- iii) some inclusions within the trondhemite and some trondhemitic intrusions without,
- iv) almost all of the stream sediments with high concentrations of Mo, Cu, Pb or Zn.

About half of this area has already been mapped on a scale of 1:20 000 by NGU. Also about half of this area has been surveyed by regional stream sediment sampling.

Logistics.

If all goes well with the use of a plane to fly in field equipment and food then a base camp will be set up on the eastern side of Skarfjellsvannet on Monday 14 July and the first field tour can commence (ca. 14 - 27 July). The second and probably final field tour (ca. 28 July - 10 August) will be partly operated from a camp in the Gaizervannet district and partly from the Skarfjellsvannet camp.

A car based at Berg gård can be used for acquiring fresh food between the tours. It is hoped that the field equipment and rock samples can be flown out on about 10 August.

Allocation of areas of responsibility.

During the first field tour Smith should concentrate on the photograph areas

1107 - 1109	Koltjernet, Fremsttjernet, Skarfjellsvannet
1207 - 1209	Fremstfjellet
1308 (part of)	Skarfjellet

whilst Tan should concentrate on the photograph areas

1212 - 1215	Piggvannet, Nesåpiggen, Øvre Nesåvannet
1310 - 1311	Langløftfjellet, Langløftvannet

During the second field tour Tan should concentrate initially on the photograph areas

1314 - 1315	Øvre Nesåvannet, Vest Gaizervannet
-------------	------------------------------------

whilst Smith should concentrate initially on the photograph areas

1415 - 1417 Øst Gaizervannet

When back at the Skarfjellsvannet base camp both Smith and Tan can complete unfinished work in the central or western areas, can examine outcrops within each other's area and perhaps supervise some blasting. If possible Smith should make some reconnaissance excursions into the centre of the Sanddøla trondhemite whilst Tan can look over the area of Zn and Pb anomalies around Langløftfjellet. A list of concentration districts (districts with several samples having concentrations greater than the median + 1 standard deviation for any element) and their allocation is appended below.

Subsequent laboratory work and report writing.

The following sequence of events is proposed:

- 1) choose samples for thin section manufacture, and chemical analysis for major and minor analyses (DCS + THT).
- 2) draw a new 1:20 000 base map (J E).
- 3) draw in the new mapping in the central area (THT) and the south-western and north-eastern areas (DCS) and the relevant parts already mapped by NGU (perhaps modified by DCS and THT).
- 4) final production of a new 1:20 000 geological map of the project area (J E).
- 5) write separate draft reports on results and interpretation for the separate areas (DCS + THT), including the bedrock studies of 1974 (DCS).
- 6) criticise each others reports and then rewrite maintaining individual responsibility (DCS + THT).
- 7) write an introduction to the project report (DCS).
- 8) write an assessment of mineral potential in the area and make recommendations for future exploration and for releasing, holding or extending the mutingsområdet (DCS + THT; separately if not in agreement).
- 9) final production of the report on Trondhemite Project 1975 set out as follows:

Text - Introduction

Results and Interpretation : the south-western and north-eastern areas

Results and Interpretation : the central area

Assessment and Recommendations

Appendices - Petrographic data

Chemical Analyses of Bedrock

Geological Map

Trondheim, 10 July 1975

David Smith

David Smith
project-leader

LIST OF CONCENTRATION DISTRICTS

(on the combined 1:50 000 Namsskogan + Andorsjøen map)

<u>Number</u>	<u>Name</u>	<u>Element priority</u>	<u>Allocation</u>
1	Øst Finbuvatnet	Zn, Cu, Mo, Pb	-
2	Vest Koltjernet	Zn, Cu, Pb	Smith
3	Sydøst Fremsttjernet	Zn, Pb	"
4	Øst Fremsttjernet	Mo, Pb, Zn, Cu	"
5	Øst Fremstfjellet	Mo, Cu, Pb, Zn	"
6	Vest Fremstfjellet	Cu, Mo, Pb, Zn	"
7	Syd Skarfjellet	Cu, Zn, Mo, Pb	"
8	Øst Korttjernet	Mo, Pb, Zn	"
9	Sydvest Langløftfjellet	Zn, Pb, Cu	Tan
10	Sydøst Langløftfjellet	Zn, Pb, Cu	"
11	Øst Skarfjellet	Mo, Cu, Zn	"
12	Syd Piggvannet	Cu, Mo, Pb, Zn	"
13	Nordøst Piggvannet	Mo, Pb	"
14	Vest Nesåpiggen	Cu, Pb	"
15	Vest Øvre Nesåvannet	Cu, Zn, Pb	"
16	Syd Øvre Nesåvannet	Cu, Pb	"
17	Øst Nesåpiggen	Pb, Zn	"
18	Sydøst Nesåpiggen	Cu, Pb, Zn	"
19	Vest Blåmuren	Mo, Cu, Pb	Smith
20	Nord Blåmuren	Cu, Pb, Zn	"
21	Nordøst Gaizervannet	Cu, Pb, Zn, Mo	"
22	Nord Gaizervannet	Pb, Zn	Smith or Tan

TRONDHJEMITT-PROSJEKTET

lokale

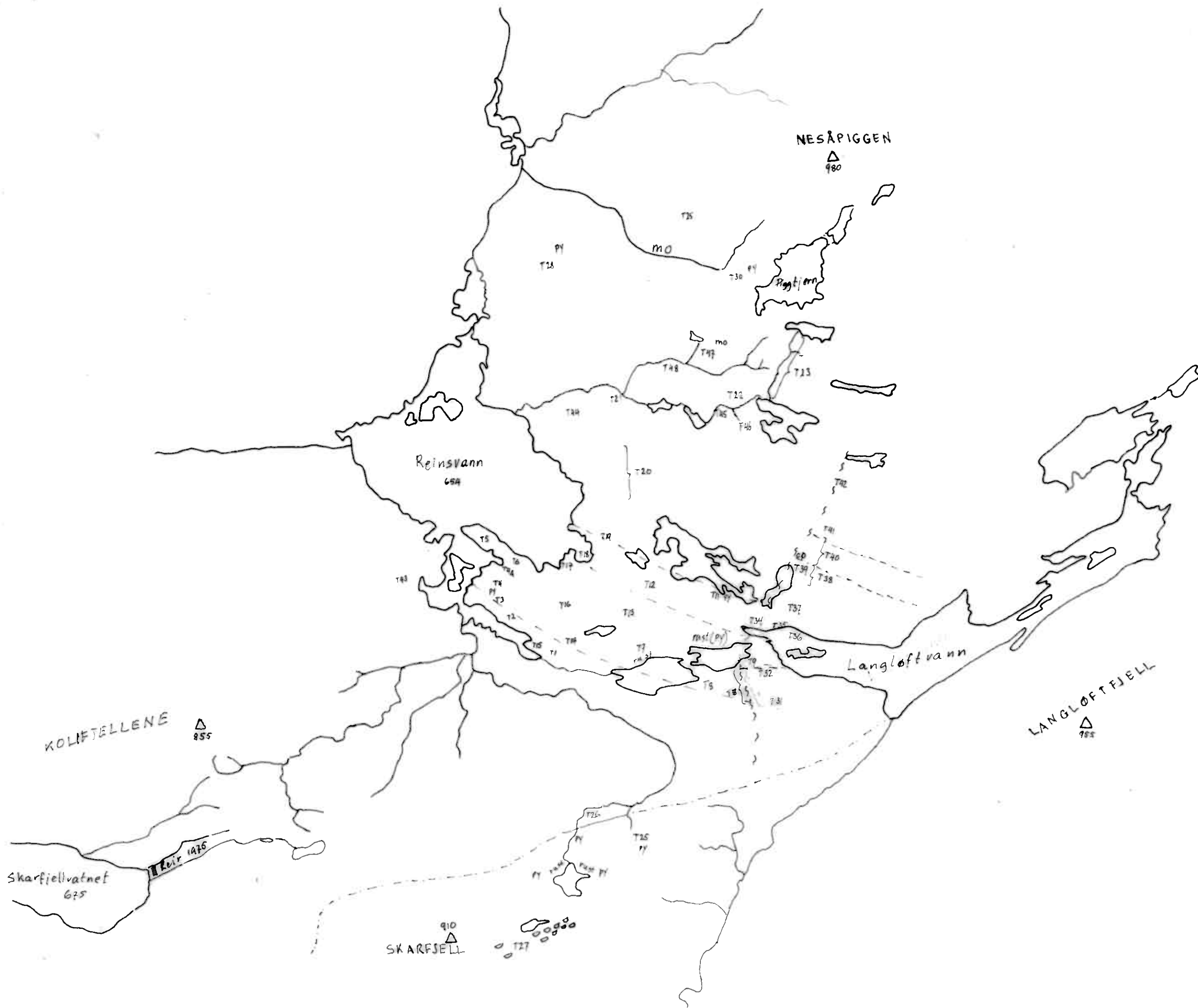
STEINPRØVER.

- 1271 (3) Grønn-lysegrønn, hard, tett, finkønet. Felsp (ab?), kloritt. Grønnstein. Breksierte og mineralisert med py, litt mt(?). Rust på overflaten.
- 1272 (5)
- 1273A (6) Mørkegrønn, tett, finkornet. Amfibol, felsp., kloritt. Grønnstein. "Stringers" av py, po. Rustet.
- 1273B (6) Finkornet, grønn-lysegrønn, seig, massiv. Kloritt og albitt?. Grønnstein. Mye py, kanskje po, også mt i oktaedre.
- 1273C (6) Grå, tett, finkornet, meget svak lagning. Kvartsitt? Fint. impregn. med py.
- 1274 (7) Lysegrå, massiv, middels- til grovkornet. Felspat (K-felsp. + plag), amfibolrelikter?, Trondhemitt.
- 1275 (9) Svart, tett, finkønet med sprekker og stikk fylt av epidot. Brun forvitningsflate. Mistanke om ultrabasitt.
- 1276A 11) Grønn, tett, finkornet. Albitt og kloritt. Grønnstein. Fint impr. med po?
- 1276B 11) Grønn, tett, finkornet. Albitt, kloritt, meget lite amfibol. Grønnstein.
- 1276C 11) Lys, flekket, Felspat, amfibol. Trondhemitt, eller dioritt.
- 1276D 11) Grønnlig. Hvit feldsp. 50% og grønnlig amfibol 50%. Grov, middelskornet. Hornbl. dioritt
- 1276E 11)
- 1277 17) Lysegrå, grov- middelskornet. Felsp. og hornblende. Dioritt. Noe po.
- 1278 17) Mørk, svart, grovkornet. Hornblende, litt kvarts ? Hornblenditt.
- 1279 17) Hvitt med svarte flekker. Feldsp. (plag. + K-feldsp.) 50%, hornbl. 50%. Dioritt eller hornbl.-trondhemitt.
- 1280 19) Lys-hvit. Feldsp. Trondhemitt.

- 1281 20) Lys, middelskornet. Feldsp. (K-feldsp. + plag.), kvarts, amfibol. Trondhemitt.
- 1282
- 1283A 21) Grønn- lysegrønn, skifrig, tett, finkornet. Kloritt, litt amfibol. Grønnstein/-skifer. Litt py.
- 1824 22) Sterkt skifrig, grønnlig, kanskje porfyroklastisk. Tektonisert trondhemitt.
- 1285 22) Grå, massiv, grovkornet. Trondhemitt.
- 1286A 23) Grå-grønnlig, grov-middelskornet, massiv,. Grønnlig feldsp (saussuritert plag.?) og rosa feldsp (K-feldsp.), kvarts, kloritt. Trondhemitt.
- 1286B 23) Lys, grovk., Feldsp. (plag.og K-feldsp.), kvarts hornbl. Trondhemitt
- 1286C 23)Lys, grønnlig, flere glideplaner. Middelsk. Trondhemitt, tektonisert og serisittisert.
- 1286D 23) Grønnlig, massiv. Plagioklas (grønnlig, saussuritert plag.?), kloritt. Trondhemitt.
- 1287 23) Grønn, skifrig, finkornet. Kloritt, feldspat?, Grønnskifer. Rustet, men ingen mineralisering å se.
- 1288
- 1289
- 1290 24) Lys, middelskornet, massiv. Feldsp., kvarts, meget lite amfibol. Trondhemitt.
- 1291 24) Lys - lysegrønn, tildels meget grovkornet. Kvarts, feldsp., kloritt og/eller epidot. Bgt.-type usikker. Litt py.
- 1292A 24) Mørkegrønn, skifrig. Kloritt, feldsp.-porfyroblaster (eller -klaster?). Grønnskifer.
- 1292B 24) Lysegrønn, skifrig, mylonittisk. Mylonittisert trondhemitt. mye serisitt. og feldsp. og litt py. og 2) lysegrønn, tett, middels- og finkornet, massiv, 24) 1293
- 1293A 25)G Grønn- lysegrønn, massiv, tett og finkornet, hard. Sanns. kvarts og feldspat (grønnlig). Finkornet Trondhemitt. Py- mineralisering. Rust på overfl.

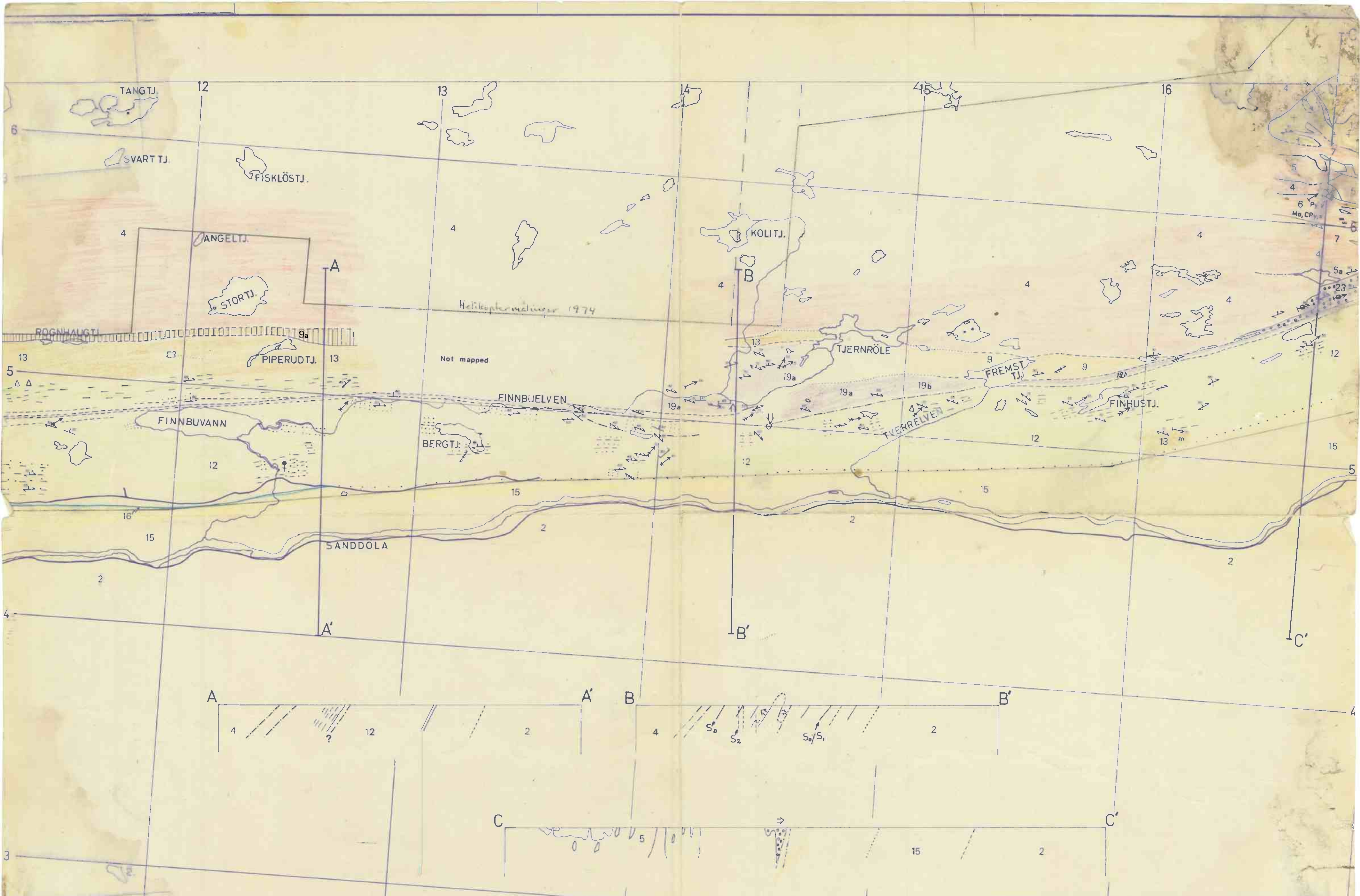
- 1293B 25) 2 deler: 1) Hvit, finkornet, tett, Kvarts og K-feldsp.? Aplitt? 2) Lysegrønn, tett, middeels-til finkornet. Saussurittisert plagioklas? Finkornet trondhemitt.
- 1294 26) Grafittskifer, litt rustet.
- 1295 28) Mørk, middels- til grovkornet, skifrig. Feldsp., hornblende. Hornblendegneiss. Litt py. Rustet.
- 1296A 29)
- 1296B 29) Grønn, grovkornet (opp til 3/4 cm), Amfibol (uralittisert pyroksen?), finkornet feldspat. Metagabbro?
- 1297 30) Mørkegrønn. Kloritt. Grønnskifer. mineralisert med py og mt. Sterk rustet på overflaten.
- 1298A 31) Lys, grønnlig, middelskornet. Kvarts, feldsp. (plagiokl., noe saussurittisert), kloritt og epidot (lite). Trondhemitt.
- 1298B 31) Lys, middelskornet. Kvarts, feldsp., noe kloritt. Trondhemitt.
- 1299 32) Lys, sv. grønnlig, middels til grovkornet. Kvarts, plag. og K-feldsp., kloritt. Trondhemitt.
- 1300 33) Hvit, tett, finkornet. Kvarts, epidot i sprekker og stikk. Arkosisk kvartsitt?
- 1301 33) Lysegrønn, tett, finkornet. Kloritt og/eller epidot,,albitt?. Grønnstein. Litt po eller py i sprekker.
- 1302 33)
- 1303 33) Lysegrønn, flintaktig, finkornet, Sannsynligvis feldsp. og epidot. Bergartstype usikker.
- 1304 33) Lysegrønn, tett, finkornet. Feldspatirik? Keratofoyr? Svakt mineralisert med py eller po.
- 1305 33) Helt identisk med nr. 1300.
- 1306 39) Grå, middelskornet. Kvarts, feldspat, kloritt. Bergartstype usikker. Mineralisert med cp, py og kanskje litt mt.
- 1307A 40) Grå - grønnlig, mørk med hvite flekker, middelskornet. Hornblende og feldspat i like store mengder. Pp-rik hornblenditt eller hbl-dioritt?

- 1307B 40) Grå, finkornet. Kvarts og feldsp., hornblende
kloritt?. Bergartstype usikker.
- 1308 40) Lysegrønn med mørke flekker. Palgioklas (saus-
surittisert) og hornblende (uralittisert pyroksen)
Metagabbro?
- 1309 40) Lys, middelskornet. Feldspat, kvarts. Trondhjemitt.
- 1310 45) Lys, grønnlig, litt skifrig. Feldspat, kvarts,
serissitt. Trondhjemitt. litt py.
- 1311 47)
- 1312 47)
- 1312 47)
- 1313 47)
- 1314 47)
- 1315 47)
- 1320 4A Under Nussipiggen - Kvarkefiske bergart
Middelskornet finkornet m/ble svache flekker (mo?)

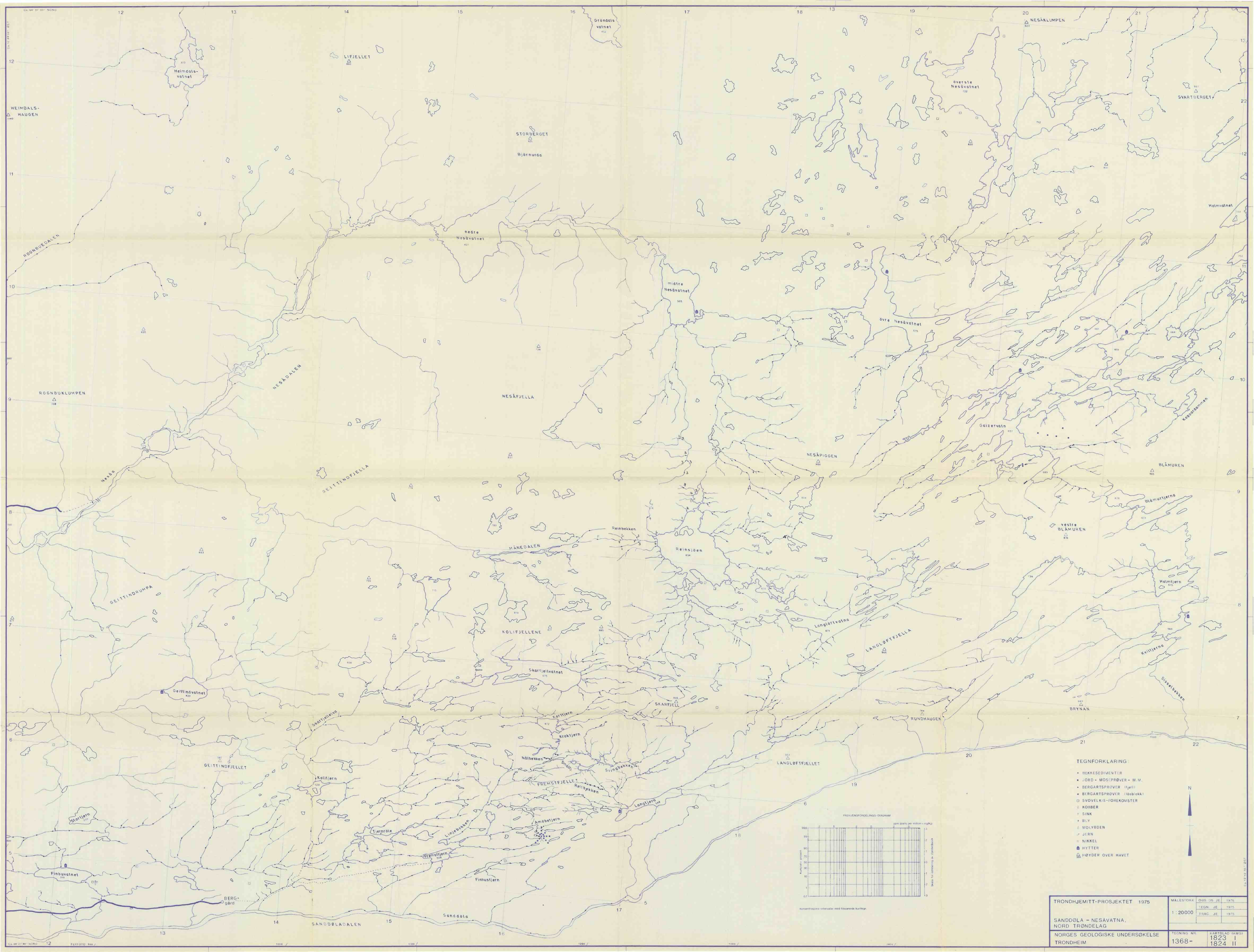




1:20.000
1973-kart
G. Gale.

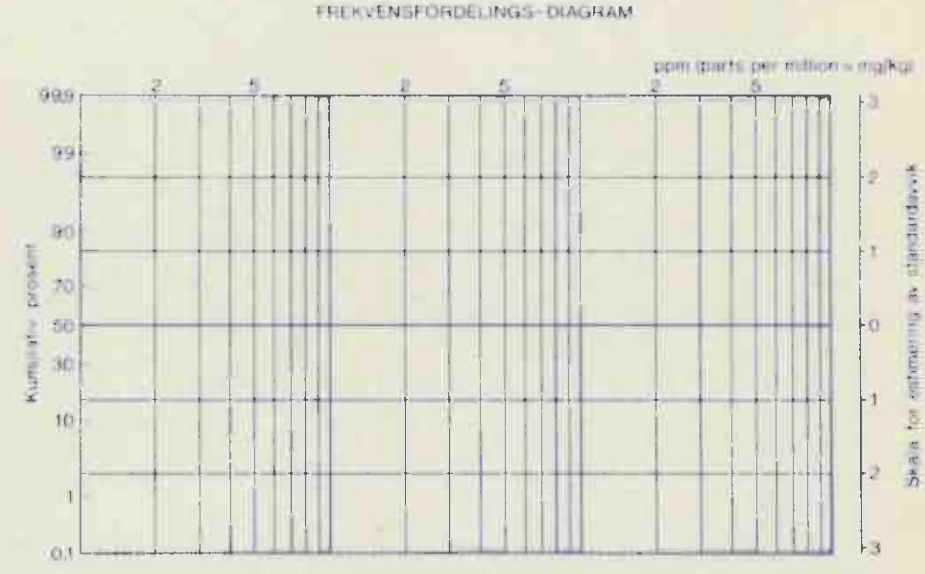


GRONGPROSJEKTET 1973 GEOLOGICAL MAP FINNBUVANN	MÅLESTOKK		DBS. G. GAI
	1:20.000		TEGN. G. G.
			TRAC. H. E.
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR.		KAR
	1189 - 02		18

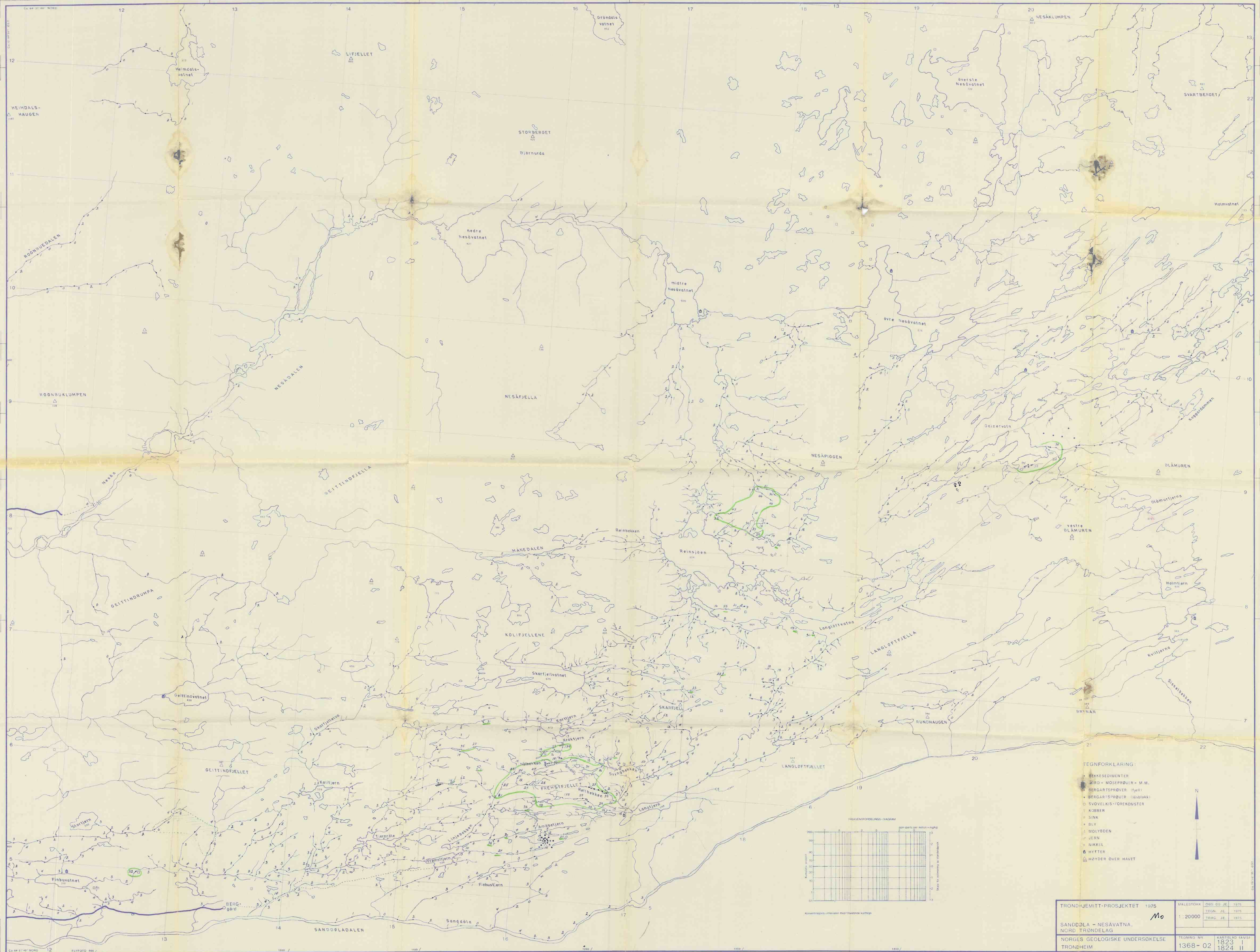


TEGNFORKLARING:

- BEKKESEDIMENTER
- JORD - MOSEPROVER - M.M.
- BERGARTSPROVER (fjell)
- BERGARTSPROVER (isbrikk)
- SVØLVKIS-FOREKOMSTER
- KOBBER
- SINK
- BLY
- MOLYBDEN
- JERN
- NIKKEL
- HYTTEN
- ▲ HØYDER OVER HAVET



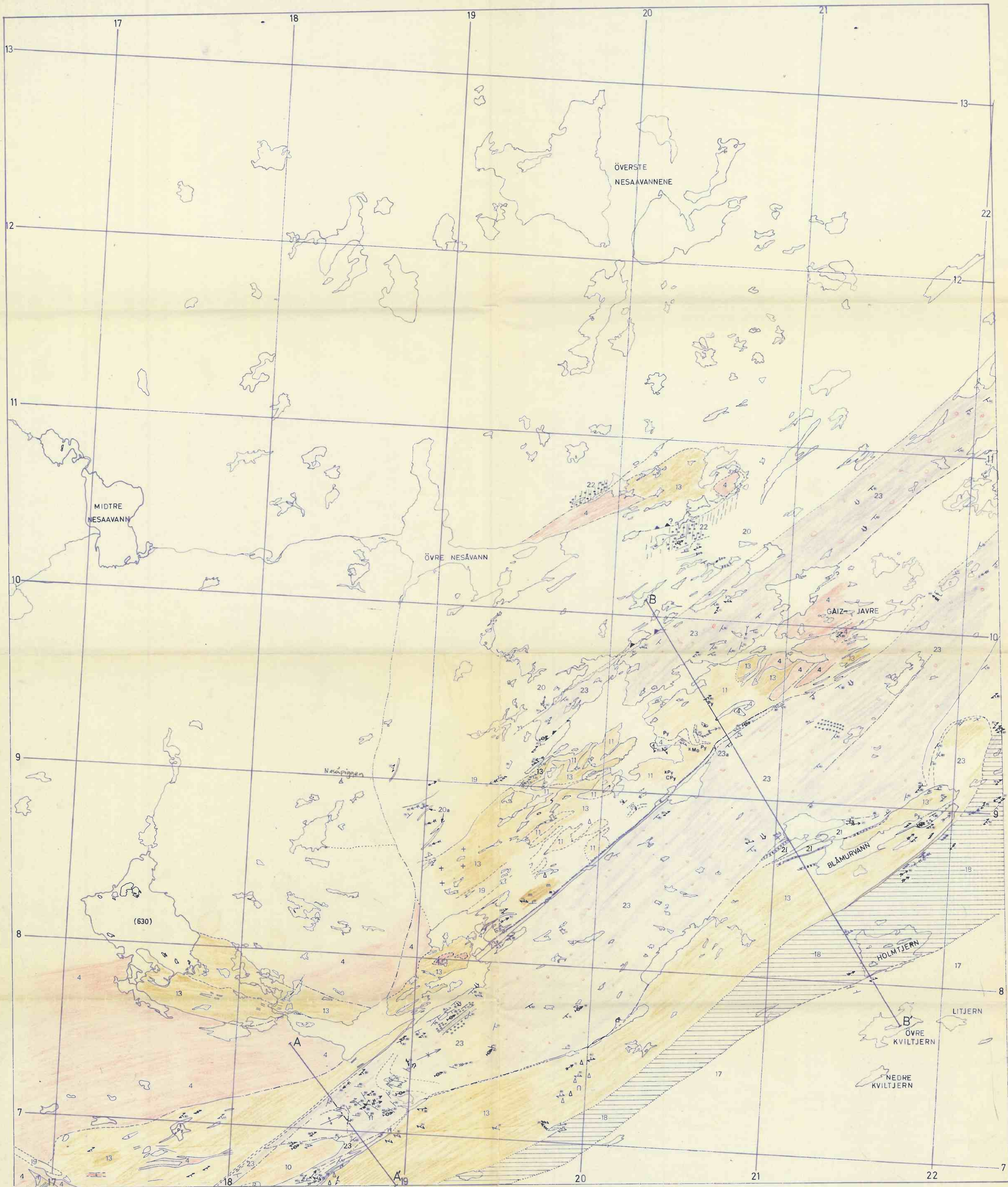
TRONDHEIM-PROSJEKTET 1975		MALSTOKK	OBS. DS. JE	1975
SANDDØLA - NESAVATNA, NORD-TRONDALAG		TEGN. JE	1975	
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM		TRAC. JE	1975	
1:20000		TEGNING NR.	1368-	
		KARTBLAD (AMS)	1823 I	1824 II



TEGNFORKLARING:

- BERKESEDIMENT
- GIRD - MOSEPRØVE - M.M.
- BERGARTSPRØVE (fjell)
- BERGARTSPRØVE (lagblokk)
- SVOVELKIS-ØREKOMSTER
- KOBBER
- SINK
- BLY
- HOLYSDEN
- JERN
- NIKKEL
- HYTTER
- ØYER OVER HAVET

TRONDHEIM-PROSJEKTET 1975		MALESTOKK	
SANDDAL - NESAVATNA, NORD-TRØNDELAG		1:20000	1823 I
NORGES GEOLOGISKE UNDERSØKELSE		TRONDHEIM	1824 II



GRONGPROSJEKTET 1973

GEOLOGICAL MAP
NESAÄVANN

NORGES GEOLOGISKE UNDERSÖKELSE
TRONDHEIM

MÅLESTOKK

1:20.000

TEGN. NR.

1189-04

OBS. G. GALE 1973

TEGN. G. G. 1974

TRAC. H. E. 1974

KARTBLAD (AMS)

1824 II B