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Regional and detailed stream sediment surveys over the Sanddøla trondhjemite and associated rocks in southern Grongfeltet.

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Mo, Cu, Pb, Zn and Ni.

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NORGES GEOLOGISKE UNDERSØKELSE

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1. ABSTRACT

- many stream sediment samples with high concentrations of Mo, Cu, Pb, Zn and Ni were discovered by the 1973 and 1974 geochemical surveys.
- the previously defined Sanddøla and Østre Skorovas Cu, Pb and Zn provinces are united and enhanced by new high-metal samples in the Fremstfjellet and Nesåpiggen districts which also define a new Mo province. The Østre Skorovas province is extended up to Tunnsjøen for Cu, Pb and Zn.
- Mo, Cu and Zn mineralisation has been found in the Fremstfjellet area; these elements show a good correlation between high-metal concentration in stream sediment samples and the principal underlying bedrock type as follows: Mo - trondhjemite and trondhjemite/greenstone contacts, Cu - greenstone and trondhjemite/greenstone contacts, Zn - greenstone.
- Pb or Ni mineralisation has not been found in southern Grongfeltet; these elements do not show a good correlation between underlying bedrock type.
- the metal contents of the stream sediment samples are believed to have been influenced by geomorphological (altitude and stream order), chemical (organic and Fe $\pm$ Mn contents) and geological (bedrock type) factors; the strongest control is estimated to have been geological for Mo and Zn, geomorphological for Pb but all factors for Cu and Ni.
- several districts merit detailed follow-up studies; regional geochemical and geological mapping ought to be extended into adjacent unexplored areas.
- the area holds promise for finding new Mo $\pm$ Cu and Cu $\pm$ Zn mineralisation; there is a lower probability of finding Pb or Ni mineralisation.

2. INTRODUCTION

Regional stream sediment surveys have been made in various districts within Grongfeltet during the period 1964 - 1974. An outline map of the surveyed areas is given in map nr. 1276-01. Maps and frequency distributions for Cu, Pb, Zn and Ni for the surveys up to and including 1972 (a total of 11055 samples) were presented in NGU report 1166, February 1973; see table 1.

Regional and reconnaissance and detailed stream sediment surveys (a total of 3025 samples) and two pilot soil surveys (a total of 25 samples) were made in 1973 and 1974; see table 2. All of the samples collected in 1973 and 1974 have been analysed for ten elements (Mo, Cu, Pb, Zn, Ni, Co, V, Ag, Mn, Fe) except for the samples in the Røyrvik district.

A chart indicating the progress with map production is given in table 3. Since the majority of the 1973/1974 samples plot on either the Andorsjøen or Namskogan map sheets and also since the areas of greatest geochemical interest are close to the contact of these maps, a special combined 1:50 000 map has been produced for this report. The detailed surveys in Fremstfjellfeltet (stream sediment survey at Fremstfjellet and the soil survey at Amøbetjernet) are both given on a special 1:5 000 map, in which a small 1:20 000 inset map shows the regional data available prior to the detailed survey. On the 1:50 000 maps Fremstfjellet lies between Korttjernet and Langtjernet. These two maps are presented and described here for Mo, Cu, Pb, Zn and Ni. Map production for the other five elements is not complete; discussion of this data will be reserved for a subsequent report.

Sample site numbers for the regional surveys are archived at NGU, but they are provided for the detailed Fremstfjellfeltet surveys in NGU report 1289/1, October 1974. A special 1:20 000 map of the Gaizervannet-Blåmuren area (1289-23) shows the soil sample sites in relation to the surrounding stream sediment sample sites.

All samples were analysed by the routine NGU procedure of drying, sieving through 180μ, digesting 1 g of sample with 5 ml 1:1 HNO_3 for 3 hours at ca. 110°C, diluting to 20 ml, filtering and determining the elements in solution by atomic absorption spectrometry. Since Mo was not a routine element for analysis the analytical procedure used to

obtain preliminary results for the preliminary NGU report 1289/1 October 1974 was not fully tested beforehand. Subsequent tests indicated the necessity of adding Al to all standard solutions and checking a minimum content of Al in all sample solutions since the atomisation of Mo is strongly dependent on the Al content. The consequences of this are that all Mo results given in the preliminary report 1289/1 are almost exactly 2 x too high.

The significance of an individual stream sediment sample with a high heavy metal content is dependent on chemical factors such as the content of other heavy metals, on geomorphological factors such as stream order and the proportions of organic material and on the interpretative method for defining geochemical anomalies such as choosing percentage limits of frequency distributions or curve-splitting or correlation analysis. Allowance for these factors would undoubtedly affect the pattern of geochemical anomalies, but it is not expected to eliminate the validity of the various geochemical provinces discussed in this report, except perhaps in the case of lead.

The data available in this report is particularly suited to multivariate analytical techniques such as principal component analysis for making such allowances. Until a study of this kind is made, a sequential list of significant samples would be of only limited validity and is not included here. Thus this report is confined to a discussion of frequency distributions and map patterns for the two special maps; the individual raw data values are archived at NGU.

Reference is often made in this report in generalised regional terms to bedrock type underlying the stream sediment samples; for this purpose Foslie's generalised regional maps are used rather than the more recent and more detailed but incomplete NGU maps.

NGU report 1166 (p. 9) described the spatial distribution of stream sediment samples with "high concentrations"; these were defined as those samples with a metal content within the range represented by the highest 2.5% of the frequency distribution i. e. equivalent to those exceeding the median (M) + 2 standard deviations (S) in the case of perfectly lognormal distributions. For the purpose of report 1166 the terms "concentration zone" and "geochemical province" were used according to the following definitions: -

"concentration zone" = an area with either a cluster of high concentrations or one or more very high concentrations, or both.

"geochemical province" = a larger area comprising several concentration zones which are interpreted on geochemical criteria to belong to the same group.

For the purpose of this report a description of the spatial distribution of samples with medium concentrations is also included since areas are defined as "low", "medium" or "high" if all their samples have concentrations less than M + 1S, M + 2S and M + 3S respectively. An area is defined as "extreme" if it contains any value greater or equal to M + 3S.

The concentration limits for each of these divisions can easily be read off the frequency distribution diagram on each map; they are listed at the beginning of each description in this report together with minimum and maximum values.

The concentration intervals represented by particular symbol sizes on the maps are identical to those used earlier in Grongproject except with some elements for the use of stars at the upper end of the frequency distribution. The symbols are given below the frequency distribution on each map.

3. MOLYBDENUM SURVEY

3.1 Regional Distribution of Mo — Map 1289 - 18.

min.	=	0 ppm	
M	=	2 "	
M + 1S	=	6 "	= upper limit of low distribution
M + 2S	=	39 "	= " " " medium "
M + 3S	=	150 "	= " " " high "
max.	=	175 "	

The regional frequency curve is approximately linear but the map pattern shows strong geographical control and some geological control. Since the frequency curve is only gently inclined, then four symbol sizes are required to represent the difference between M + 1S and M + 2S in contrast to the usual one or two symbols; the consequence of this is that differences between low and high concentrations are more conspicuous on the maps for Mo than for the other elements.

Low Mo areas can be identified N. W. and S. of Nesåelva, N. and N. E. of Nesåpiggen, and E. and S. of Langtjernet. Medium Mo areas are found W. of Fremsttjernet, E. of Skarfjellet, and N. E. of Gaizervannet. High Mo areas occur at Fremstfjellet, S. W. of Nesåpiggen and S. E. of Gaizervannet.

There is a reasonable correlation between stream sediment Mo concentration and bedrock geology as follows:

Low Mo - Heimdalshaugen gabbro, N. and W. Sanddøla trondhjemite, Øvre Nesåvannet limestone-conglomerate.

Medium Mo - in the vicinity of contacts of trondhjemite with greenstone or trondhjemite - derived arkose.

High Mo - same as for medium Mo but mostly on the trondhjemite side of a contact with greenstone.

Background Mo values in stream sediments in other parts of world are usually around 1-2 ppm, i.e. comparable to the low Mo distribution in Grongfeltet. Two of the high Mo areas have known Mo mineralisation (Fremstfjellfeltet and Gaizervannet - NGU report 1189, May 1974 and NGU report 1289/1, October 1974).

Mo geochemical provinces can be defined by the spatial distribution of the concentration zones, i.e. around Fremstfjellet and S. E. of Neså-piggen.

The geographical limits to the Mo provinces can be predicted from the known contacts of trondhjemite with greenstone. Thus the most likely extension of these provinces are to the N. W., N. and S. of Nesåpiggen and N. W. of Skarfjellet.

The Mo concentrations in the samples on the adjacent mapsheet Harran are all less than 6 ppm; on the adjacent mapsheet Tunnsjøen the highest concentration is 11 ppm.

3.2 Fremstfjellet. Distribution of Mo. Map 1289 - 08.

min.	=	1	ppm
M	=	18	"
M + 1S	=	80	"
M + 2S	=	220	"
M + 3S	=	800	"
max.	=	930	"

This frequency curve is approximately linear and parallel to the regional curve, but it lies at considerably higher Mo concentrations. Indeed only 2% of the samples have Mo concentrations $\geq$1 ppm in contrast to 35% of the regional samples. Thus the Fremstfjellet distribution is extreme in comparison with the regional distribution. About 30% of the Fremstfjellet samples have concentrations equal to or exceeding M + 2S (i.e. 39 ppm) of the regional distribution (i.e. the stars or the two largest circles on the map).
The six highest concentrations (>250 ppm) are confined to Tretjern-bekken and the vicinity of Smaltjernet. All high concentrations are confined to a broad N. W. - S. E. belt between Korttjernet and the western end of Langtjernet with extensions westwards along trappebekken and Myrbekken. There is a strong probability of finding further high Mo concentrations in sediments from streams lying to the west of Smaltjernet on account of those already found in streams draining from the west.

The geological contact between the Sanddøla trondhjemite and greenstone in this area is very confused as a result of blocks, apparently xenoliths, of greenstone within the trondhjemite, and also petrogenetic convergence of the rock types by greenschist facies metamorphism and metasomatism. However, an approximation to the principal contact of the trondhjemite runs from Korttjernet and over Brattfjellet to the eastern end of Langtjernet where it turns and is in contact with a sedimentary unit which runs just south of Stortjernet and Amøbetjernet. The predominantly greenstone district north-east of the principal contact shows no high Mo concentrations. This is also true of the trondhjemite in the south of Fremstfjellfeltet where it is in contact with sediments. The contrasting high Mo streams Myrbekken and Trappebekken, and medium Mo streams Totjernbekken, Gjemtbekken and Kinktjernet suggest some E-W structural control of the Mo mineralisation. NGU report 1189, May 1974 indicated an E-W zone of molybdenite-chalcopyrite-pyrite-bearing trondhjemite from Bratt bekken to Fremstfjellet. The high Mo streams Tretjernbekken and Myrbekken suggest a further westward extension of this zone.

The new finds of Mo mineralisation in 1974 (NGU report 1289/1, October 1974) were confined to this Brattbekken-Fremstfjellet zone or between Fremstfjellet and Korttjernet, but this may be a consequence of the limited extent (see map) of a small bedrock prospecting programme. Prospecting along Myrbekken, Tretjernbekken, Trappebekken and to the west of Smaltjernet will probably yield new finds of Mo mineralisation.

3.3 Conclusions for Mo.

Low Mo concentrations occur over 1) gabbros, 2) sedimentary rocks not derived from trondhjemite, and 3) trondhjemite not in contact with greenstone or trondhjemite-derived sediments.

Medium Mo concentrations essentially occur over a wide area of interfingered relatively narrow belts of trondhjemite, greenstone and trondhjemite-derived sediments situated to the East and South of the Sanddøla trondhjemite.

High or extreme Mo concentrations are confined to the marginal zones of trondhjemite adjacent to greenstone and the metasomatised contact rocks. These zones are the most likely sites of any substantial Mo deposits.

There are essentially two contrasting explanations for the extreme Mo distribution at Fremstfjellet. It may represent a genuine concentration of Mo in the bedrock in which case the Fremstfjellet area is promising for further exploration; this is suggested by the several finds of outcropping Mo mineralisation in the area. Alternatively it may represent geochemical processes as yet unknown but probably some function of climate, weathering and biological activity which concentrated Mo into stream sediment samples in which case the area is of more academic than economic interest; this is supported by the observations that several but not all, high Mo samples also have high Fe $\pm$ Mn concentrations or high organic contents. Another factor that may be relevant is that this detailed survey included a greater proportion of samples from first order streams than the regional survey.

4. COPPER SURVEY

4.1 Regional Distribution of Cu. Map 1289 - 19.

min.	=	0 ppm	
M	=	13 "	
M + 1S	=	34 "	low
M + 2S	=	111 "	medium
M + 3S	=	700 "	high
max.	=	1190 "	

The regional frequency curve indicates some high Cu concentrations in addition to those expected from a log-normal distribution. These high Cu concentrations are displayed on the map as a cluster in the Fremstfjellet area. However, there is a distinct geographical displacement of the Cu cluster and the Mo cluster in the area.
The Cu cluster has a relatively sharp NW - SE boundary to the south-west but extends north-eastwards for a few kilometers before dying out. The Mo cluster has a relatively sharp NW - SE boundary to the north-east but extends south - westwards for a few kilometers before dying out. Thus there is a 1 km wide NW - SE zone between Korttjernet and Langtjernet of regional high Mo + high Cu concentrations along the 1 km wide inter-digitated trondhjemite + greenstone contact. Outside this zone, the trondhjemite (S. W.) shows high Mo + medium Cu whilst the greenstone (N. E.) shows high Cu + medium Mo concentrations. The only exception to this generalisation is the 50 ppm Mo sample due north of Langtjernet, but this may not be highly significant in view of its high Fe content.

A low Cu distribution similar to the low Mo distribution exists over trond-hjemite and gabbro along Nesåelva and to the north-west and south.
A large area of low Cu concentrations also occurs around Tunnsjøelva.

The whole of the remaining parts of the map can be described as a medium Cu distribution with several small clusters of high concentrations, particularly around the 620 ppm sample N. E. of Gaizervannet, the 282 ppm sample N. of Skarfjellet and some lesser values around Nesåpiggen.
The streams within $1\frac{1}{2}$ km of Skorovatn gruve do not show high Cu concentrations according to the M + 2S threshold of 111 ppm.

NGU report 1166, February 1973 defined a Sanddøla Cu province extending westwards from Finnbuvatnet and including Rosset and Skiftesmyr (a total of 10 samples with concentrations greater or equal to M + 2S (65 ppm) of the regional distribution recorded in that report); an Østre Skorovatn Cu province extending north-eastwards from the sample with 134 ppm at Øvre Nesåvannet (11 samples ≧ 65 ppm) and a Vestre Skorovatn Cu province ranging from Skorovatn gruve to near Heimdalsvannet and northwards (42 samples exceeding 65 ppm, some of which are related to the taubane). On the combined 1:50 000 map sheet the new data yields just over 100 samples ≧ 65 ppm (i.e. more than all three provinces combined) of which nearly 50 samples are scattered around the Skarfjellet-Nesåpiggen-Gaizervannet area whilst nearly 50 others are concentrated into Fremstfjellet, the remainder being scattered between Fremstfjellet and Finnbuvannet. Also 12 high values (maximum 156 ppm) occur on the Tunnsjøen map sheet, but none occur on the Harran map sheet.

Thus the Sanddøla and Østre Skorovas Cu provinces are united, extended and enhanced into a stronger Sanddøla-Fremstfjellet-Nesåpiggen-Østre Skorovatn-Tunnsjøen-Cu-province around the perimeter of the Sanddøla-trondhjemite and up to Tunnsjøen. This province may extend into the unexplored eastern and southern regional zones of the trondhjemite and possibly into the unexplored areas south of Gaizervannet.

4.2 Fremstfjellet. Distribution of Cu. Map 1289 - 09.

min.	=	3	ppm
M	=	58	"
M + 1S	=	320	"
M + 2S	=	930	"
M + 3S	=	?	"
max.	=	1850	"

The frequency curve lies at considerably higher concentrations than the regional curve. About 40% of the Fremstfjellet samples contain over 111 ppm Cu (M + 2S for the regional distribution) i.e. the stars and the four largest circles. The map shows that all high concentrations are

confined to the 1 km wide NW-SE contact zone between Korttjernet and Langtjernet, except for four in Myrbekken (all of which show Mo anomalies) and four below Tynntjernet (none of which show Mo anomalies). Although on the Fremstfjellet map sheet the Cu anomalies below Tynntjernet seem to be an isolated eastern cluster, the regional map shows several more anomalies further east. Four of the five highest Cu concentrations (>1000 ppm) occur around Smaltjernet (all of which show high Mo concentrations) but the fifth draining from the west below Korttjernet does not show a high Mo concentration, nor does it show a high Fe concentration. The latter anomaly (1640 ppm Cu) lies close to the new Cu mineralisation found in 1974 (NGU report 1289/1, October 1974) but it belongs to a different drainage system and must be derived from another as yet unknown Cu mineralisation. The intriguing fact that the streams draining the new Cu mineralisation do not have high Cu concentrations, but do have high Mo concentrations, was mentioned in the earlier report. The fact that half of the streams draining into the area from the west show >100 ppm Cu supports the prediction based on the regional data that the regional Cu province extends some way into the trondhjemite. All samples in the south-western part of the area show very low Cu concentrations, including the high Mo stream Trappebekken.

4.3 Conclusions for Cu.

A continuous Cu province (Sanddøla-Fremstfjellet-Neståpiggen-Østre Skorovas-Tunnsjøen) of high Cu streams exists along the south-eastern perimeter of the Sanddøla trondhjemite and along the main greenstone belt to Tunnsjøen and it may extend into the trondhjemite. The greatest density of high Cu concentrations occurs within and N. E. of Fremstfjellfeltet.

Fremstfjellfeltet is dominated by a 1 km wide NW-SE zone of high Mo + Cu concentrations. The south-western and north-eastern margins of this area generally show low or medium concentrations of both Mo and Cu, but notable exceptions are Myrbekken (high Mo + high Cu), Tynntjernet (low Mo + high Cu) and Trappebekken (high Mo + low Cu).
The most promising sites for finding further Cu mineralisation appear to be the marginal zones of greenstone in contact with trondhjemite.

5. LEAD SURVEY

5.1 Regional Distribution of Pb — Map 1289-20

min.	=	0 ppm	
M	=	13 "	
M + 1S	=	33 "	low
M + 2S	=	77 "	medium
M + 3S	=	230 "	high
max.	=	390 "	

That part of the regional frequency curve above 10 ppm Pb closely approximates a lognormal distribution. Low Pb areas exist N. W. of Nesåelva, around Tunnsjøelva and around Tunnsjøen. Otherwise the whole of the remaining parts of the map show a medium Pb distribution with widely scattered high Pb concentrations. Two samples between Skarfjellet and Nesåpiggen have Pb concentrations exceeding M + 3S.

The densest cluster of high Pb concentrations is the north-eastern part of Fremstfjellfeltet. Several districts further to the N. E. show smaller clusters (cf. Mo and Cu).

NGU report 1166, February 1973) defined a Vestre Skorovas Pb province between Lilleaaen and Tunnsjøflyerne (a total of 37 samples with concentrations greater or equal to M + 2S (52 ppm) of the regional distribution recorded in that report) and an Østre Skorovas Pb province from Øvre Nesåvannet towards Tunnsjøen (23 samples ≧ 52 ppm). 2 samples ≧ 52 ppm W. of Finnbuvannet were not considered sufficient for defining a Sanddøla Pb province.

The new data yields about 100 samples ≧ 52 ppm. (i. e. more than both provinces combined, cf. Cu). Thus the Østre Skorovas Pb province extends around the perimeter of the Sanddøla trondhjemite though Nesåpiggen and Fremstfjellet to Finnbuvannet being relatively strong in the Nesåpiggen and Fremstfjellet districts but relatively weak further west towards Finnbuvannet (cf. Mo and Cu). The five westward - draining streams north of Kolitjern tend to suggest that the Pb province extends into parts of the trondhjemite (cf. Mo and Cu). 17 high Pb concentrations (maximum 208 ppm) on the Tunnsjøen map sheet extend the Pb province to Tunnsjøen (cf. Cu). No new anomalies occur on the Harran map sheet.

Despite the regional overlap of the Mo, Cu and Pb provinces there are differences in detail, and Pb does not show a close relationship between stream sediment analyses and bedrock type, unlike Mo and Cu. The inter-relationships of Pb with Mo and Cu are varied as indicated below.

Pb	Mo	Cu	District	Bedrock
high	high	high	Fremstfjellet	t + g
			(between lakes between Nesåpiggen and Skarfjellet)	t + g
high	high	low	E. of Fremsttjernet	t + g + s
"	"	"	S. W. of Nesåpiggen	t
high	low	high	S. and E. of Skarfjellet	g + s
"	"	"	S. W. and N. E. of Gaizervannet	t + g + s
"	"	"	N. of Nesåpiggen	g
high	low	low	N. E. of Korttjernet	t + g
"	"	"	S. E. of Fremsttjernet	g

where t denotes trondhjemite or related acid igneous rocks
g denotes greenstone
s denotes sedimentary rocks.

No lead mineralisation was reported for the Vestre or Østre Skorovas Pb provinces defined in NGU report 1166.

5.2 Fremstfjellet Distribution of Pb. Map 1289-10.

min.	=	6 ppm
M	=	26 "
M + 1S	=	85 "
M + 2S	=	200 "
M + 3S	=	350 "
max.	=	490 "

The frequency curve closely approximates a lognormal distribution at considerably higher values than the regional curve. About 20% of the Fremstfjellet samples contain over 77 ppm Pb (M + 2S for the regional distribution) i.e. the star, the three largest circles and some of the fourth. However, the map pattern shows no clusters and is almost random. Thus the area could be considered as one with high background Pb distribution devoid of significant anomalies.
Nevertheless the samples with high Pb contents correlate quite well with those of high Mo and/or high Cu contents, but this might be related to geochemical factors in the stream sediments (e.g. Fe or organic contents) rather than to common Pb + Mo + Cu mineralisation. For example the sample with highest Pb content (490 ppm) also has the highest Mo and Fe contents and a very high Cu content. Also the sample with the second highest Pb content (290 ppm) shows high Fe, medium Mo and low Cu contents. No lead mineralisation has yet been found in the Fremstfjellet area.

5.3 Conclusions for Pb.

A continuous Pb province (Sanddøla - Fremstfjellet - Nesåpiggen - Østre Skorovas - Tunnsjøen) of high Pb streams exists along the south-eastern perimeter of the Sanddøla trondhjemite and along the main greenstone belt to Tunnsjøen and it may extend into the trondhjemite. The greatest density of high Pb concentrations occurs within and N.E. of Fremstfjellfeltet. In all these respects the distribution of Pb is similar to that of Mo and Cu. However, there are local differences in the interrelationship of Pb, Mo and Cu, and there is no clear relationship between Pb in stream sediments and bedrock geology.

The Pb anomalies in stream sediments may reflect a widely disseminated weak Pb mineralisation. Nevertheless the possible existence of localised enriched Pb mineralisation cannot yet be dismissed.

6. ZINC SURVEY

6.1 Regional Distribution of Zn. Map 1289-21.

min.	=	4 ppm	
M	=	44 "	
M + 1S	=	92 "	low
M + 2S	=	205 "	medium
M + 3S	=	600 "	high
max.	=	1450 "	

The whole regional frequency curve closely approximates a lognormal distribution.
This curve is steeper than those for Mo, Cu and Pb and as a result of this and the standard choice of symbol sizes most of the difference between M + 1S and M + 2S is represented by only one symbol; the consequence being that the difference between low and high distribution is less distinct visually on the map than for Mo, Cu and Pb.

Thus low Zn areas exist between Gjaetingvannet and Heimdalsvannet (cf. Mo, Cu and almost true of Pb) and around Tunnsjøelva (cf. Cu and Pb). The densest cluster of high Zn concentrations is the north-eastern part of Fremstfjellfeltet and further to the N. E. (cf. Pb and Cu, but unlike Mo). Unlike Mo, Cu and Pb, Zn shows a low distribution S. W. of Nesåpiggen.

NGU report 1166, February 1973 defined a Vestre Skorovatn Zn province between Lilleaaen and Tunnsjøflyene (a total of 28 samples with concentrations greater or equal to M + 2S (175 ppm) of the regional distribution recorded in that report) and an Østre Skorovatn Zn province from Øvre Nesåvannet towards Tunnsjøen (20 samples $\geq$ 175 ppm), and a Sanddøla Zn province westwards from Finnbuvannet (18 samples $\geq$ 175 ppm).

The new data yields 1 result exceeding 175 ppm E. of Gaizervannet which can be considered part of the Østre Skorovatn Zn province, and 2 such results near Finnbuvannet which can be considered part of the Sanddøla Zn province.

Unlike Mo, Cu and Pb, there are no high Zn concentrations S. W. of Neså piggen or S. of Kolitjern to unite the Østre Skorovatn and Sanddøla provinces. Thus the 18 new high Zn samples S. W., S. and E. of Skarfjellet form an isolated Zn province. The 4 isolated high Zn samples S. and E. of Fremsttjernet also have high Pb but not high Mo or Cu concentrations and could be considered as a south-western extension of this new Zn province. The eastern part of this also displays a close association of Zn with Pb but not Mo or Cu. 16 new high Zn concentrations (maximum 600 ppm) occur south of Tunnsjøen and represent an extension of the Østre Skorovas Zn province up to Tunnsjøen (cf. Cu and Pb). 1 high Zn sample occurs on the Harran map sheet over gabbro.

Zn mineralisation is recorded in NGU report 1166, February 1973, from several localities within the Sanddøla Zn province but not in the Østre Skorovas Zn province. All Zn provinces mentoned above occur almost entirely over greenstone.

6.2 Fremstfjellet Distribution of Zn. Map 1289-11.

min.	=	6	ppm
M	=	40	"
M + 1S	=	80	"
M + 2S	=	160	"
M + 3S	=	285	"
max.	=	288	"

In contrast to the frequency curves for Mo, Cu and Pb, the Fremstfjellet curve for Zn is virtually identical with the regional curve and indeed it lies at slightly lower concentrations. The map pattern shows a relatively even distribution in contrast to those for Mo and Cu, but similar to that for Pb. Nevertheless higher Zn concentrations occur in the eastern and northern districts mainly over greenstone, and represent part of the new Zn province.

Minor Zn mineralisation (ca. 1800 ppm) was found by the author in greenstone i Svingbekken which can account for the stream sediment concentration (269 ppm) 100 metres downstream at the junction with Brattbekken. All six Pb concentrations represented by the largest circles are confined to Svingbekken + tributaries, Trekanttjernet and downstream of Korttjernet and provide indication of the most promising sites for finding further Zn mineralisation.

6.3 Conclusions for Zn.

A new Zn province of high Zn concentrations is defined which overlaps the central part of the Sanddøla-Fremstfjellet-Nesåpiggen-Østre Skorovas-Tunnsjøen Cu- and Pb province. It is weakly connected with the Sanddøla and Østre Skorovas-Tunnsjøen Zn provinces.

Strong correlations exist between high Zn streams and greenstone, and between low Zn streams and trondhjemite.
Weak Zn mineralisation has been observed in greenstone in that part of the Fremstfjellet area which lies within the new Zn province.

7. NICKEL SURVEY

7.1 Regional Distribution of Ni. Map 1289-22.

min.	=	0 ppm	
M	=	16 "	
M + 1S	=	29 "	low
M + 2S	=	65 "	medium
M + 3S	=	130 "	high
max.	=	240 "	

The regional frequency curve for Ni has a shape similar to the Pb curve but is steeper like the Zn curve, which therefore tends to make the map pattern more uniform.

Low Ni areas can be identified between Gjaetingvannet and Heimdalsvannet (cf. Mo, Cu and Zn and almost true of Pb), N. of Skarfjellet (unlike all of the other elements), S. W. of Nesåpiggen (cf. Zn), and between Korttjernet, Langtjernet and Fremsttjernet. Perhaps the most conspicious feature on the map is that the last two low Ni areas coincide with the highest Mo areas. All of these low Ni areas lie mainly over trondhjemite.

Medium Ni distributions exist over wide areas of the map whilst high Ni distributions are restricted to a few areas - Lilleaaen (cf. Cu, Pb and Zn), Tunnsjøflyene (cf. Cu, Pb and Zn), N. of Gaizervannet (cf. Pb and Zn), E. of Skarfjellet (cf. Pb and Zn), W. of Heimdalsvannet and W. of Fremsttjernet. This last area shows a cluster of high Ni concentrations S. of Kolitjernet in contrast to all of the other elements.

The M + 2S threshold for the regional Ni distribution recorded in NGU report 1166, February 1973 is 113 ppm; only one sample in this map sheet exceeded this threshold (240 ppm at Lilleaaen). The new data yields only 9 samples $\geq$ 113 ppm Ni: 2 E. of Skarfjellet, 3 S. of Kolitjernet and 4 between Tunnsjøen and Havdalsvannet on the Tunnsjøen map sheet. No Ni mineralisation is recorded from these map sheets apart from Lillefjellklumpen E. of Skorovasklumpen.

7.2 Fremstfjellet Distribution of Ni. Map 1289-12.

min.	=	3 ppm
M	=	13 "
M + 1S	=	20 "
M + 2S	=	30 "
M + 3S	=	-
max.	=	56 "

The Fremstfjellet frequency curve lies at lower concentrations than the regional curve and is steep such that 95% of the samples lie within the range 5 - 30 ppm and the maximum is only 56 ppm Ni. The only points of interest are the tendency of lower values on the western side (cf. the Fremstfjellet Zn pattern) and the fact that the higher Ni concentrations occur at the head of Smaltjernet and E. of Lavtjernene in samples with high Mn and Fe contents.

7.3 Conclusions for Ni.

The factors most closely related to the Ni distribution are the Zn distribution and greenstone bedrock. The trondhjemite always shows low Ni whilst the Heimdalshaugen gabbro shows both low and high Ni distributions.

The absence of known Ni mineralisation and the small number of high Ni concentrations in the southern half of the map is not encouraging from the economic point of view. Nevertheless the source of the high Ni streams should be examined during a follow-up of Zn anomalies in southern Grongfeltet.

8. SOIL SAMPLING AT GAIZERVANNET.

Map nr. 1289-23 shows the five soil sample sites at the eastern side of Gaizervannet. Also shown are the sites of all the stream sediment samples east of Gaizervannet which were collected by the 1974 regional survey. The soil samples were collected because of some molybdenite mineralisation in a quartz vein and also in a chalcopyrite - pyrite vein within an angular erratic which were found in 1973 (see p. 20 and fig. 4, p. 25 in NGU report 1189, May 1974). A geological description of this area can be found in NGU report 1293, June 1975.

Analytical results for the soil samples are listed in table 4. Sample 1001 contains considerably more Mo (140 ppm) and Cu (590 ppm) than the other samples, but this is also true for all of the elements and in view of the extremely high Fe content (19.2%) the significance of the Mo and Cu contents is difficult to assess. Sample 1003 contains the second highest content of Fe, Mo, Cu, V and Ag whilst sample 1005 contains the second highest contents of Mn, Pb, Zn, Ni and Co. Sample 1002 and 1004 with the lowest Fe contents have insignificant contents of all elements.

Even if heavy metals tend to be enriched in Fe-rich material, the Fe content of sample 1001 does suggest proximity to pyritised bedrock, probably with minor Mo and Cu mineralisation. In view of the two high Mo and one high Cu streams immediately south of the soil samples this area merits a closer inspection of bedrock.

9. SOIL SAMPLING AT AMØBETJERNET.

9.1 Introduction.

Twenty soil samples were collected in a radiating pattern around the extremely weathered chalcopyrite-rich mineralisation found in 1974 at a lake referred to as Amøbetjernet in NGU report 1289/1, October 1974. Some field data and the analytical data are provided in table 5. The sample sites, frequency distribution and symbol maps for Mo, Cu, Pb, Zn and Ni are provided on the Fremstfjellfeltet maps 1289-08 to 1289-12 respectively.

The depth to bedrock ranged between 12 and 50 cm (mean 29 cm). The samples were collected from the parent material adjacent to the bedrock. This material was however very variable in colour, organic and sediment content, grain size and overall soil texture.

Only one sample site (1037) showed a profile containing a bleached layer (10 cm thick) and a distinct humus layer (1 cm thick). Three sample sites from boggy terrain contained a great thickness of mossy humus (samples 1027, 1034 and 1040). Otherwise most sample sites did not show a distinct profile development since the vegetation graded into a brown clayey or sandy soil rich in organic material. Four samples in particular did not comprise normal parent material: 1023 organic-rich clay; 1024 green clay; 1025 green sand, and 1029 organic-rich clay. Thus in only twelve samples was the sampled material reasonably similar - a brown or dark-brown organic-rich clayey sandy earth.

9.2 Results.

The essential features of the frequency distributions are tabulated below.

Element.	Map	Minimum	Median	Maximum
Mo	1289-08	0 ppm	2 ppm	17 ppm
Cu	1289-09	5 "	15 "	171 "
Pb	1289-10	10 "	17 "	40 "
Zn	1289-11	6 "	15 "	42 "
Ni	1289-12	7 "	14 "	108 "

9.3 Conclusions.

The analytical data must be treated with caution in view of the wide variation of the sampled material. The map patterns do not show any convincing clusters for any element or correspondence between elements except for a weak tendency for higher concentrations north-westwards of the centre.

The only samples which could be considered as anomalous are 1021 (Cu and Mo), 1025 (Mo) and 1037 (Ni). Sample 1021 (171 ppm Cu) was collected adjacent to bedrock ca. 1 metre above and ca. 1 metre away from mineralised bedrock containing several % Cu. Thus although this rich Cu source would have been detected by a soil survey using this sampling grid, it would probably have been missed if soil sample site 1021 had been a few metres further away.

This mineralisation was not detected by the regional stream sediment survey, presumably because drainage from this outcrop flows directly into Amøbetjernet where any metal concentrations will be diluted.

The petrogenesis of the Cu mineralisation is not known; a petrological investigation is required. No conclusions about possible extension of the mineralisation can be drawn from the present data.

10. COMMENTS

The 1973 and 1974 stream sediment surveys (mainly south of Skorovatn) produced more "high" concentrations of Cu, Pb, Zn and Ni on the Namskogan and Andorsjøen map sheets than all previous surveys (mainly north of Skorovatn). Also a large number of high Mo concentrations were found. Thus the area south of Skorovatn merits further exploration.

The previously described Sanddøla and Østre Skorovas Cu, Pb and Zn provinces are essentially united into a continuous Sanddøla - Fremstfjellet - Neså piggen - Østre Skorovas - Tunnsjøen province around the southern and eastern perimeter of the Sanddøla trondhjemite and along the main greenstone belt up to Tunnsjøen. A new province of high Mo concentrations is established in the Fremstfjellet - Neså piggen district. The few high Ni streams are not considered sufficient to define any Ni provinces.

In the Fremstfjellet area the probable source rock for some of the high metal concentrations in stream sediments can be identified as a result of the Mo, Cu and Zn mineralisation found in 1974 of which some examples are listed below. However, there are several other cases where such correlations between metal concentrations in stream sediments and in bedrock, and also bedrock type cannot yet be made.

Locality	Bedrock Type	Stream Sediment		Bedrock	
Smaltjernet	trondhjemite	nr. 94	110 ppm Mo	nr. 3070	1780 ppm Mo
Lavtjernene	trondhjemite	nr.280	57 ppm Mo	nr. 3061	440 ppm Mo
Lavtjernene	trondhjemite	nr.245	66 ppm Mo	nr. 3066	6880 ppm Mo
Nedrebekken	trondhjemite	nr. 59	88 ppm Mo	nr. 3005	1050 ppm Mo*
Nedrebekken	trondhjemite	nr. 59	520 ppm Cu	nr. 3005	2630 ppm Cu*
Rettbekken	greenstone	nr. 30	440 ppm Cu	nr. 3053	980 ppm Cu
Smaltjernet	greenstone	nr. 97	1440 ppm Cu	nr. 3072	220 ppm Cu
Svingbekken	greenstone	nr.161	135 ppm Cu	nr. 3008	240 ppm Cu
Svingbekken	greenstone	nr.161	269 ppm Zn	nr. 3008	1800 ppm Zn

* This sample was not found in situ.

Ni shows very few high concentrations in stream sediments and no mineralisation is recorded in southern Grongfelt; the closest relationship to the Ni stream sediment distribution is that of Zn and hence predominantly greenstone bedrock except for one high Ni stream over gabbro.

High concentrations of Pb occur in many stream sediment samples but they do not correlate consistently with any of the other elements or with the underlying bedrock type and no Pb mineralisation is recorded in southern Grongfeltet. However, there is one factor which shows a correlation with Pb contents, namely altitude, since most high Pb concentrations are confined to streams lying above the tree-line (ca. 600 metres). This relationship appears to apply to the entire Grongfelt, except over the Heimdalshaugen gabbro which probably has a very low Pb content. The Pb content of the other rock types is probably leached out of the bedrock which is more frost-weathered at high altitudes than at low, and then is concentrated into the organic components of the thinly developed soil cover. Finally this Pb is picked up by streams. This hypothesis was put forward to explain the high Pb content in streams above 1000 m. around Vardal (p 123 in Bjørlykke et al, "Exploration for disseminated lead in southern Norway", p 111 - 126 in "Prospecting in areas of glacial terrain", edited by Jones, IMM, 1973), and to explain a large zone of Cu anomalies on ground over 350 m. near Repparfjord in Finnmark (p 245 in Bølviken, "Recent geochemical prospecting in Norway", p 225 - 253 in "Geochemical Prospecting in Fennoscandia", edited by Kvalheim, Interscience, 1967).

It is probable therefore that the Pb anomalies in Grongfeltet are largely related to geomorphological factors. It is likely that the other elements are to some extent affected in the same way. However, bedrock type appears to exert the strongest control over Mo and Zn. The effect of the chemical relationships between organic content and contents of Fe and Mn and the other elements has not yet been evaluated. There is undoubtedly a tendency for samples with high organic and/or Fe and/or Mn contents to have high contents of Mo, Cu, Pb, Zn and Ni. It is thought unlikely that allowance for these chemical factors would eliminate the various geochemical provinces described in this report. Thus the area is considered promising for finding new Mo, Cu and Zn mineralisation.

Further exploration should be concentrated on the trondhjemite and related minor acid intrusions for Mo; on the greenstone and associated sedimentary and metamorphic rocks for Zn; and on all these rock types for Cu but especially near contacts of greenstone and trondhjemite. Pb and Ni are not considered to merit independent exploration but they should be followed up as part of further exploration for Mo, Cu or Zn.

Proposals for further exploration using stream sediments surveys are listed below in order of decreasing priority:

1) fill up the conspicuous gaps in the surveyed areas which yield samples with high metal contents to obtain a more accurate picture of anomalous districts and of their relationships to bedrock.

2) follow up the anomalous streams draining from unsurveyed areas e.g. N. W. of Fremstfjellet.

3) extend the regional survey for a few kilometres into the Sanddøla trondhjemite to clarify the relationship of Mo and Cu anomalies with respect to the trondhjemite contact.

4) make reconnaissance surveys into all unexplored areas in order to clarify the regional relationships between stream sediment anomalies and bedrock types.

5) complete the regional survey of the whole of the Namskogan map sheet to permit publication.

In addition research should be pursued into understanding the effect upon concentrations of heavy metals in stream sediments by geomorphological and chemical factors in particular altitude, stream order, organic content and Fe/Mn precipitation.

Several areas need to be explored by prospecting, local detailed structural mapping and rock sampling for analysis in order to find the mineralisation which is the source of the metal-rich stream sediment samples and also for subsequent petrological studies in an attempt to understand the genesis of the mineralisation.

The most promising new districts for Mo and/or Cu are:

a) Fremstfjellet
b) N. W. of Fremstfjellet
c) N. E. of Skarfjellet
d) S. W. of Nesåpiggen
e) S. E. of Gaizervannet
f) Amøbetjernet

The most promising districts for Zn and/or Cu are:

g) S. and E. of Skarfjellet
h) S. E. of Fremsttjernet
i) Finnbuvannet
j) Øvre Nesåvannet
k) N. E. of Gaizervannet

In addition 1:20 000 geological mapping should be extended into all areas showing metal-rich stream sediments and over a broad belt along the eastern margin of the Sanddøla trondhjemite.

Trondheim, 10 July 1975

David C. Smith

David C. Smith

Provisional edition 29 May 1975
Revised edition 10 July 1975

Table 1. List of regional sediment surveys in Grongfeltet up to February 1973.

Year	Oppdrag	Number of samples	District	Map sheets
NGU				
1964-65	561+602	3245	E. of Limingen + Joma	Huddingsvatnet + Røyrvik + Limingen
1969	905	1894	W. of Tunnsjøen[x)]	All
1970	974	1328	S. of Namsvatn S. E. of Gartland W. of Limingen	Røyrvik + Majavatn Grong + Harran Røyrvik + Tunnsjøen
1971	1075	786	N. W. of Gjersvik E. of Grong	Røyrvik + Brekkvasselv Grong + Harran
1972	1122	3826	E. of Namsdalen	Røyrvik + Brekkvasselv Namskogan + Tunnsjøen
			E. of Nordli	Nordli + Murusjøen + Tunnsjøen

(Source of data - pages 5 - 8 in NGU report 1166).

Skorovas Gruber				
1968	836	1 - 999	Lilleaaen	Namskogan
1969	912	1001 - 1999	Søre Grøndalsfjellet	Namskogan
1970	Terratest[xx)]	2001 - 2999	Grøndalsvatnet	Namskogan
1971	? - ?	3001 - 3999	Øvre Nesåvatnet	Namskogan

(Source of data - NGU map archive).

Notes.

x) Oppdrag 905 included surveys along the banks of the large lakes and along all roads within Grongfeltet and also roads between Nordli and Sørli.

xx) The data from the Terratest surveys is not draughted on to the 1:50 000 geochemical maps since the samples were not analysed by NGU's standard routine.
The other surveys by Skorovas Gruber totalled 974 samples.

Table 2. Summary of geochemical surveys in Grongfeltet between February 1973 (NGU report 1166) and May 1975 (this report).

Stream sediment surveys.

Year	Oppdrag xx)	Sample numbers	Number of samples	Type of survey	District	Map sheets
1973	1177	1- 374 441- 472	405	Regional	Sanddøladalen	Andorsjøen x)
1973	1177	501-1976	1475	Regional	Røyrvik	Røyrvik + Huddingsvatnet
1973	1177	2001-2316	316	Regional	Tunnsjøen	Namskogan + Tunnsjøen
1973	1177	3001-3116	116	Recon-naisance	Heimdals-haugen	Namskogan x) + Harran
1974	1276	1- 396	396	Regional	Nesåpiggen	Namskogan + Andorsjøen
1974	1289	1- 282	282	Detailed	Fremstfjellet	Andorsjøen
1974	1289	283- 317	35	Recon-naisance	Nesåelva	Namskogan + Andorsjøen
Soil Surveys.						
1974	1276	1001-1005	5	Detailed	Gaizervannet	Namskogan
1974	1289	1021-1040	20	Detailed	Amøbetjernet	Andorsjøen

x) Since the base maps for Andorsjøen and Namskogan were draughted from air photographs whilst the base maps for Grong and Harran were draughted from old 1:50 000 maps, there is a north-south band, 1 km wide, between these sheets which is not yet draughted on any 1:50 000 maps and which contains some sample sites.

xx) Field work was conducted by the following personnel:

Oppdrag 1177 Ekremsæter + Elstad + Grong Gruber A/S

Oppdrag 1276 Sørdal

Oppdrag 1289 Smith

Table 3. Chart of map production for stream sediment surveys, to June 1975.

1:50 000

1823	IV	GRONG	.	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	Cd	Cr
1823	I	ANDORSJØEN	(Mo)	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	.	Cr
1923	IV	NORDLI	.	(Cu)	(Pb)	(Zn)	(Ni)	.	V	.	.	.	.	Cr
1923	I	MURUSJØEN	.	(Cu)	(Pb)	(Zn)	(Ni)	.	V	.	.	.	.	Cr
1824	III	HARRAN	Mo	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	Cd	Cr
1824	II	NAMSKOGAN	(Mo)	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	Cd	Cr
1924	III	TUNNSJØEN	Mo	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	Cd	Cr
1924	II	LIMINGEN	.	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	Cd	Cr
1824	I	BREKKVASSELV	.	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	Cd	Cr
1924	IV	RØYRVIK	.	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	Cd	Cr
1924	I	HUDDINGSVATNET	.	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	Cd	Cr
1925	III	MAJAVATN	.	Cu	Pb	Zn	Ni	Co	V	Ag	Mn	Fe	Cd	.
Combined		{NAMSKOGAN ANDORSJØEN}	(Mo)	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	Cd	Cr

1:5 000

FREMSTFJELLFELTET	(Mo)	(Cu)	(Pb)	(Zn)	(Ni)	Co	V	Ag	Mn	Fe	.	.
---	---	---	---	---	---	---	---	---	---	---	---	---

. denotes that no samples have been analysed

Mo " " some " " " "

Mo " " all " " " "

(denotes that some analyses have been draughted

( ) " " all " " " "

Table 4. 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)

Table 5. Field and Analytical Data for the Amøbetjernet Soil Survey.

Sample number	Depth to Bedrock cm	Thickness of Humus + recent vegetation	Colour	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ni ppm
1021	15	8	brown	12	171	13	16	12
1022	25	10	dark brown	7	48	12	10	9
1023	12	10	brown	2	14	32	28	14
1024	35	7	green	0	58	11	30	23
1025	40	3	green	17	52	14	42	34
1026	30	15	dark brown	1	11	10	11	7
1027	45	3	dark brown	1	16	13	37	23
1028	25	12	dark brown	1	11	14	18	14
1029	25	15	dark brown	4	12	32	8	16
1030	35	5	brown	2	17	12	24	20
1031	25	10	dark brown	2	8	24	14	14
1032	20	5	brown	2	6	14	14	12
1033	35	10	brown	2	6	26	14	14
1034	45	35	brown	8	12	40	8	20
1035	18	5	brown	2	27	18	24	20
1036	30	3	brown	2	28	17	22	21
1037	32	1	light brown	3	28	25	37	108
1038	50	5	brown	3	44	19	28	29
1039	20	3	brown	2	10	25	7	8
1040	18	5	brown	2	5	20	6	11

1825 1925

1824 1924

1823 1923

1972 (1122)
1970 (974)
1973 (1177)
1971 (1075)
1969 (905)
1964–65 (561) (602)
1970 (974)
1972 (1122)
1969 (905)
1968–71 (836/912)
1973 (1177)
1974 (1276)
1970 (974)
1973 (1177)
1971 (1075)
1972 (1122)
1961 (407)

TERRATEST (anat.)

Ca. GRENSE FOR NGU's FLYBILDEMOSAIKK

1823 I ANDORSJØEN
IV GRONG

1824 I BREKKVASSELV
II NAMSKOGAN
III HARRAN

1923 I MURUSJØEN
II RENGEN
IV NORDLI

1924 I HUDDINGSVATNET
II LIMINGEN
III TUNNSJØEN
IV RØYRVIK

1925 III MAJAVATN

1971 årstall
(1075) oppdragsnummer

PRØVETATT OMRÅDE
prøvepunktavstand ca. 250–500m

Prøvetatt langs vei eller fra båt 1969

Oppdrag 1289, FREMSTFJELLET, detaljert provetaking 1974

Oppdrag 1177/1289, orienterende provetaking

TILSTØTENDE BLAD

N

5 0 5 10 15 20 25 km

GRONGPROSJEKTET
Oversiktskart over GRONGFELTET
Geokjemiske bekkesediment-undersökelser

NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM

MÅLESTOKK		
1:250.000	OBS. J.E-DS.	1964-65/68-74
	TEGN. J.E.	MARS 1974
	TRAC. J.E.	FEB. 1975
	KFR. DS-BB	FEB. 1975

TEGNING NR.	KARTBLAD (AMS)
1276-01	NQ 33-34-13 NQ 33-34-9

1276 (1974)
KORT-TJERNET
FREMSTFJELLET
LANGTJERNET
FREMST-TJERNET
1177 (1973)
GRONGPROSJEKTET 1973
BEKKESEDIMENTER –
Regional prøvetaking
SANDDØLADALEN, NORD TRØNDELAG
NGU Oppdrag nr. 1177
KARTGRUNNLAG: Flyfotoserie nr. 357 – bilde nr. 1206 / 1307
KORTTJERNET
HØYTJERNENE
SMALTJERNET
LAVTJERNENE
SAMMENLØPTJERNET
TYNNTJERNET
TREKANTTJERNET
BRATTFJELLET
Nedrebekken
Øvrebekken
Totjernbekken
FREMSTFJELLET
Rettbekken
Brattbekken
Svingbekken
Myrbekken
GRENSE FOR BERGARTSPRØVER
Tretjernbekken
Linjebekken
Gjemtbekken
Trappebekken
KINKTJERNET
STORTJERNET
MELLOMTJERNET
LILLETJERNET
LANGTJERNET
GRENSE FOR BEKKESEDIMENTER
FREKVENSFORDELINGS-DIAGRAM
AMOBE-TJERNET
TEGNFORKLARING:
BEKKESEDIMENTER. 282 stk.
JORDPRØVER. (C-horisont) 20 stk.
BERGARTSPRØVER. (fjell) 50 stk.
BERGARTSPRØVER. (løsblokk) 5 stk.
GRONGPROSJEKTET 1974
BEKKESEDIMENTER. HNO_3–LØSELIG Mo
FREMSTFJELL-FELTET
SANDDØLADALEN, NORD TRØNDELAG
MÅLESTOKK 1 : 5000
OBS. D.S. 1974
TEGN. D.S. 1974
TRAC. J.E. 1974
KARTGRUNNLAG: DM 151-1 / DL 151-4
NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM
TEGNING NR. 1289-08
KARTBLAD (AMS) 1823 I


GRONGPROSJEKTET 1973
BEKKESEDIMENTER –
Regional prøvetaking
SANDDØLADALEN, NORD TRØNDELAG
NGU Oppdrag nr. 1177
KARTGRUNNLAG: Flyfotoserie nr. 357 – bilde nr. 1208 / 1307
1276 (1974)
1177 (1973)
KORT-TJERNET
FREMSTFJELLET
LANGTJERNET
FREMST-TJERNET
580
KORTTJERNET
HÖY TJERNENE
SMALTJERNET
LAVTJERNENE
SAMMENLÖPTJERNET
TYNNTJERNET
TREKANTTJERNET
BRATTFJELLET
Nedrebekken
Øvrebekken
Totjernbekken
Myrbekken
Linjebekken
Gjemtbekken
Troppebekken
KINKTJERNET
FREMSTFJELLET
Rettbekken
Brattbekken
Svingbekken
Tretjernbekken
GRENSE FOR BERGARTSPRØVER
GRENSE FOR BEKKESEDIMENTER
LANGTJERNET
LILLETJERNET
STORTJERNET
MELLOMTJERNET
AMÖBE-TJERNET
1640
1170
1440
1680
1850
12500
12000
11500
11000
13500
13000
724500
724000
723500
723000
722500
FREKVENSFORDELINGS-DIAGRAM
TEGNFORKLARING:
BEKKESEDIMENTER. 282 stk.
JORDPRØVER. (C-horisont) 20 stk.
BERGARTSPRØVER. (fjell) 50 stk.
BERGARTSPRØVER. (løsblokk) 5 stk.
GRONGPROSJEKTET 1974
BEKKESEDIMENTER, HNO3 – LØSELIG Cu
FREMSTFJELL - FELTET
SANDDØLADALEN, NORD TRØNDELAG
NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM
MÅLESTOKK 1 : 5000
OBS. D.S. 1974
TEGN. D.S. 1974
TRAC. J.E. 1974
KARTGRUNNLAG: DM 151-1 / DL 151-4
TEGNING NR. 1289-09
KARTBLAD (AMS) 1823 I


1276 (1974)
KORT-TJERNET
FREMSTFJELLET
LANGTJERNET
FREMST-TJERNET
1177 (1973)
Målestokk 1 : 20000
GRONGPROSJEKTET 1973
BEKKESEDIMENTER -
Regional prøvetaking
SANDDØLADALEN, NORD TRØNDELAG
NGU Oppdrag nr 1177
KARTGRUNNLAG: Flyfotoserie nr 357 - bilde nr. 1208 / 1307
12500
12000
11500
11000
724500
724000
723500
723000
722500
KORTTJERNET
HÖYTJERNENE
SMALTJERNET
LAVTJERNENE
SAMMENLÖPTJERNET
TYNNTJERNET
TREKANTTJERNET
Nedrebekken
Övrebekken
Totjernbekken
490
BRATTFJELLET
FREMSTFJELLET
Rett bekken
Bratt bekken
Svingbekken
GRENSE FOR BERGARTSPRØVER
Myrbekken
Tretjernbekken
Linjebekken
Gjemtbekken
Trappebekken
KINKTJERNET
290
STORTJERNET
MELLOMTJERNET
LILLETJERNET
LANGTJERNET
GRENSE FOR BEKKESEDIMENTER
FREKVENSFORDELINGS-DIAGRAM
ppm (parts per million = mg/kg)
Kumulativ prosent
Skala for estimering av standardavvik
NAMSKOGAN-ANDORSJØEN
JORDPRØVER
OPPDRAG
282 pr
Konsentrasjons-intervaller med tilsvarende karttegn
AMÖBE-TJERNET
13500
13000
12500
TEGNFORKLARING:
BEKKESEDIMENTER. 282 stk.
JORDPRØVER. (C-horisont) 20 stk.
BERGARTSPRØVER. (fjell) 50 stk.
BERGARTSPRØVER. (løsblokk) 5 stk.
GRONGPROSJEKTET 1974
BEKKESEDIMENTER. HNO3-LØSELIG Pb
FREMSTFJELL-FELTET
SANDDØLADALEN, NORD TRØNDELAG
MÅLESTOKK 1 : 5000
OBS. D.S. 1974
TEGN. D.S. 1974
TRAC. J.E. 1974
KARTGRUNNLAG: DM 151-1 / DL 151-4
NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM
TEGNING NR. 1289-10
KARTBLAD (AMS) 1823 I


1276 (1974)
KORT-TJERNET
FREMSTFJELLET
LANGTJERNET
FREMST-TJERNET
1177 (1973)
Målestokk 1 : 20000
N
GRONGPROSJEKTET 1973
BEKKESEDIMENTER -
Regional prøvetaking
SANDDØLADALEN, NORD TRØNDELAG
NGU Oppdrag nr. 1177
KARTGRUNNLAG: Flyfotoserie nr. 357 - bilde nr. 1208 / 1307
12500
12000
11500
11000
724500
724000
723500
723000
722500
13500
13000
12500
KORTTJERNET
HÖY TJERNENE
SMALTJERNET
LAVTJERNENE
SAMMENLÖPTJERNET
TYNNTJERNET
TREKANTTJERNET
BRATTFJELLET
Nedrebekken
Øvrebekken
Totjernbekken
Myrbekken
Linjebekken
Gjemtbekken
Trappebekken
KINKTJERNET
FREMSTFJELLET
Rettbekken
Brattbekken
Svingbekken
Tretjernbekken
GRENSE FOR BERGARTSPRØVER
GRENSE FOR BEKKESEDIMENTER
STORTJERNET
MELLOMTJERNET
LILLETJERNET
LANGTJERNET
ÅMÖBE-TJERNET
210
199
264
287
190
269
FREKVENSFORDELINGS-DIAGRAM
ppm (parts per million = mg/kg)
Kumulativ prosent
Skala for estimering av standardavvik
JORDPRØVER 20 stk.
NAMSKOGAN-ANDORSJØEN
Konsentrasjons-intervaller med tilsvarende karttegn
TEGNFORKLARING:
BEKKESEDIMENTER. 282 stk.
JORDPRØVER. (C-horisont) 20 stk.
BERGARTSPRØVER, (fjell) 50 stk.
BERGARTSPRØVER, (løsblokk) 5 stk.
GRONGPROSJEKTET 1974
BEKKESEDIMENTER, HNO3 - LØSELIG Zn
FREMSTFJELL - FELTET
SANDDØLADALEN, NORD TRØNDELAG
MÅLESTOKK 1 : 5000
OBS. D.S. 1974
TEGN. D.S. 1974
TRAC. J.E. 1974
KARTGRUNNLAG DM 151-1 / DL 151-4
NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM
TEGNING NR. 1289-11
KARTBLAD (AMS) 1823 I

1276 (1974)

1177 (1973)

KORT-TJERNET

FREMST-TJERNET

FREMSTFJELLET

LANGTJERNET

N

Målestokk 1 : 20000

0 1 Km

GRONGPROSJEKTET 1973
BEKKESEDIMENTER – Regional prøvetaking
SANDDOLADALEN, NORD TRØNDELAG

NGU Oppdrag nr. 1177

KARTGRUNNLAG: Flyfotoserie nr. 357 – bilde nr. 1208 / 1307

12500 12000 11500 11000

724500

724000

723500

723000

722500

KORTTJERNET

HØYTJERNENE

SMÅLTJERNET

LAVTJERNENE

SAMMENLØPTJERNET

TYNNTJERNET

TREKANTTJERNET

BRATTFJELLET

FREMSTFJELLET

Nedrebekken

Øvrebekken

Tollerndbekken

Myrbekken

Linjebekken

Gjemtbekken

Trappebekken

KINKTJERNET

Rettbekken

Brattbekken

Svingbekken

GRENSE FOR BERGARTSPRØVER

Tretjernbekken

LILLETJERNET

STORTJERNET

MELLOMTJERNET

LANGTJERNET

GRENSE FOR BEKKESEDIMENTER

AMØBE-TJERNET

FREKVENSFORDELINGS-DIAGRAM

ppm (parts per million = mg/kg)

Kumulativ prosent

Skala for estimering av standardavvik

Konsentrasjons-intervaller med tilsvarende karttegn

TEGNFORKLARING:

- BEKKESEDIMENTER, 282 stk.
- JORDPRØVER, (C-horisont) 20 stk.
- BERGARTSPRØVER, (fjell) 50 stk.
- BERGARTSPRØVER, (løsblokk) 5 stk.

GRONGPROSJEKTET 1974
BEKKESEDIMENTER, HNO_3– LØSELIG Ni
FREMSTFJELL - FELTET
SANDDØLADALEN, NORD TRØNDELAG

MÅLESTOKK 1 : 5000

OBS. D.S. 1974
TEGN. D.S. 1974
TRAC. J.E. 1974

KARTGRUNNLAG DM 151-1 / DL 151-4

NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM

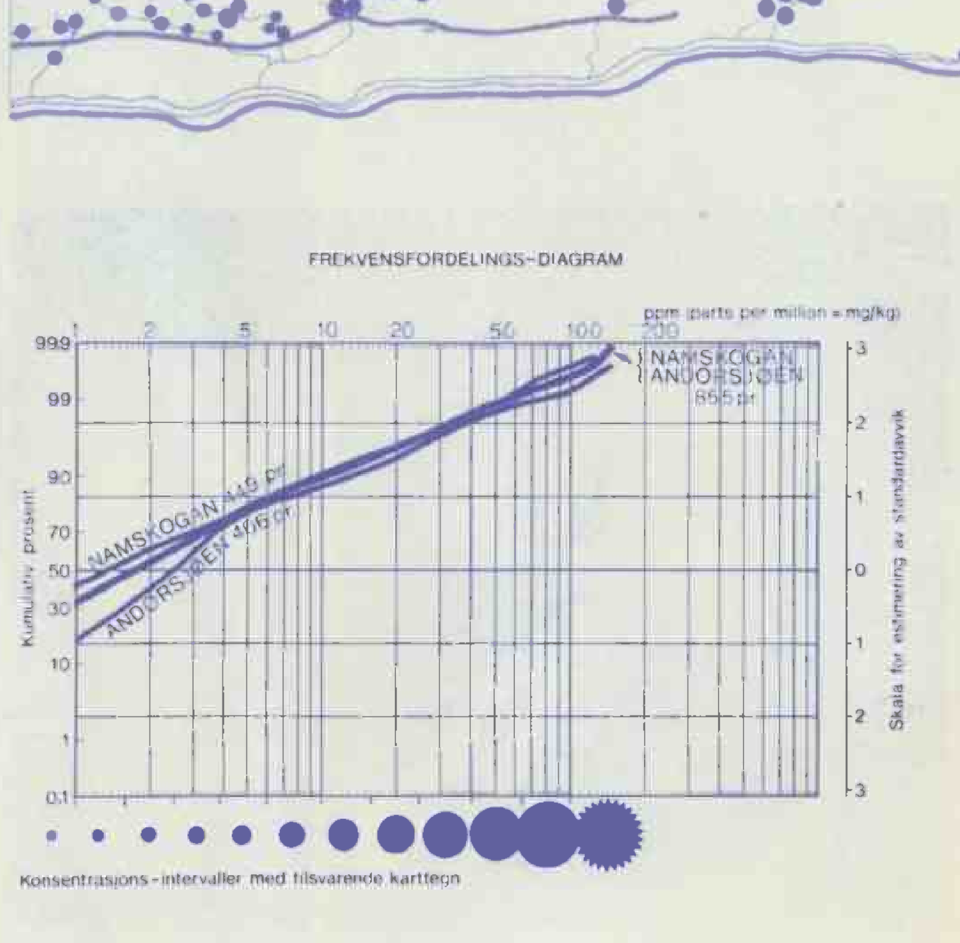
TEGNING NR. 1289-12

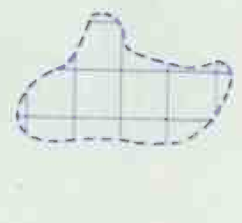
KARTBLAD (AMS) 1823 I

BEKKESEDIMENTER

MOLYBDEN, SYRELØSELIG

NORGES GEOLOGISKE UNDERSØKELSE





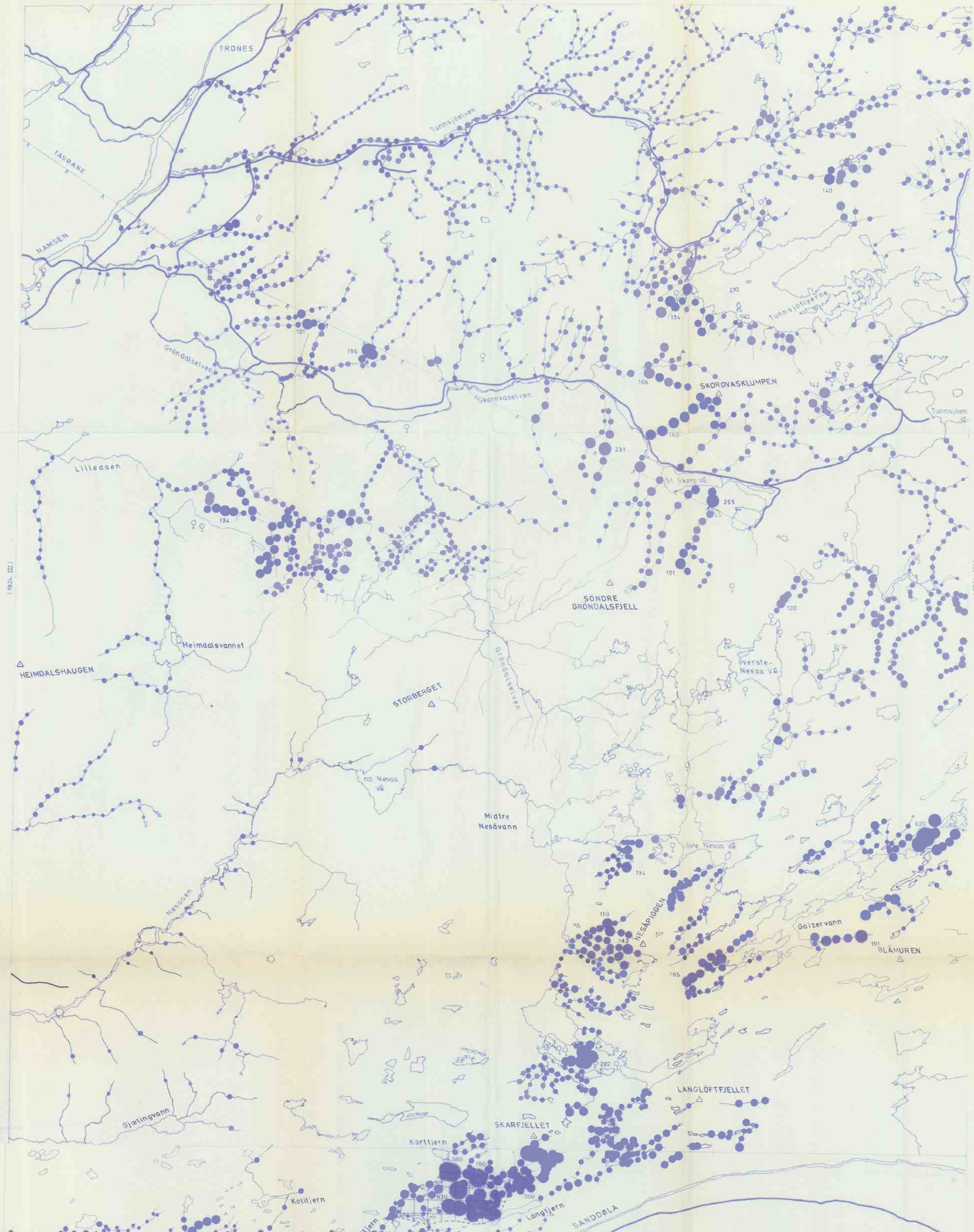
FREMSTFJELLET:
BEKKESEDIMENTER.
Detaljert prøvetaking

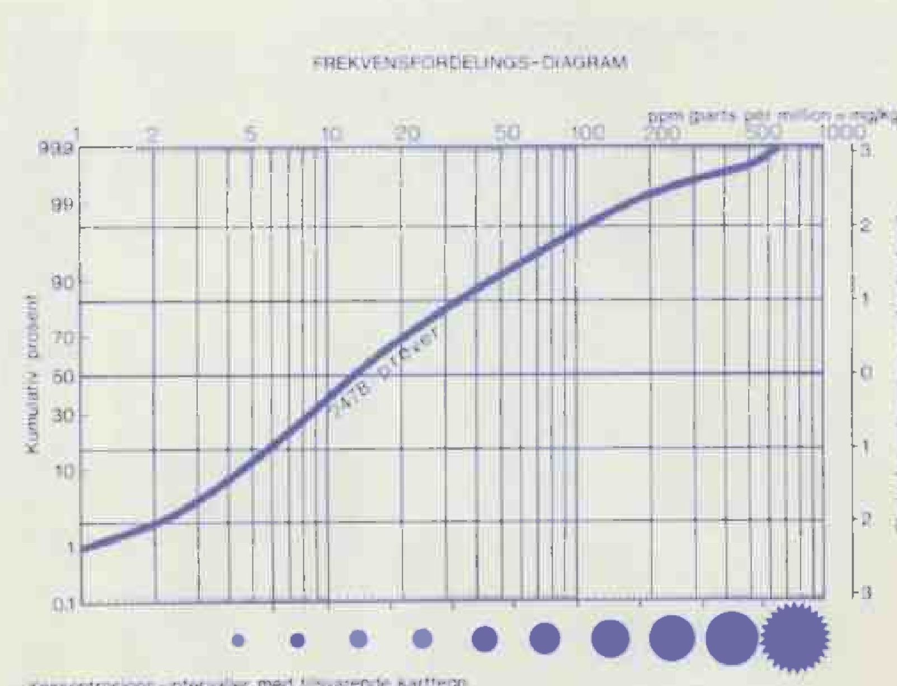
GRONGPROSJEKTET 1973-74 BEKKESEDIMENTER, HNO_3-LØSELIG Mo ANDORSJØEN (nordre del) - NAMSKOGAN, NORD TRØNDELAG	MÅLESTOKK 1:50000	OBS. DS. TEGN. JE. TRAC. JE.	1973-74 1975 1975
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR 1289 - 18	KARTBLAD (AMS) 1823 I 1824 II	

BEKKESEDIMENTER

KOBBER, SYRELØSELIG

NORGES GEOLOGISKE UNDERSØKELSE





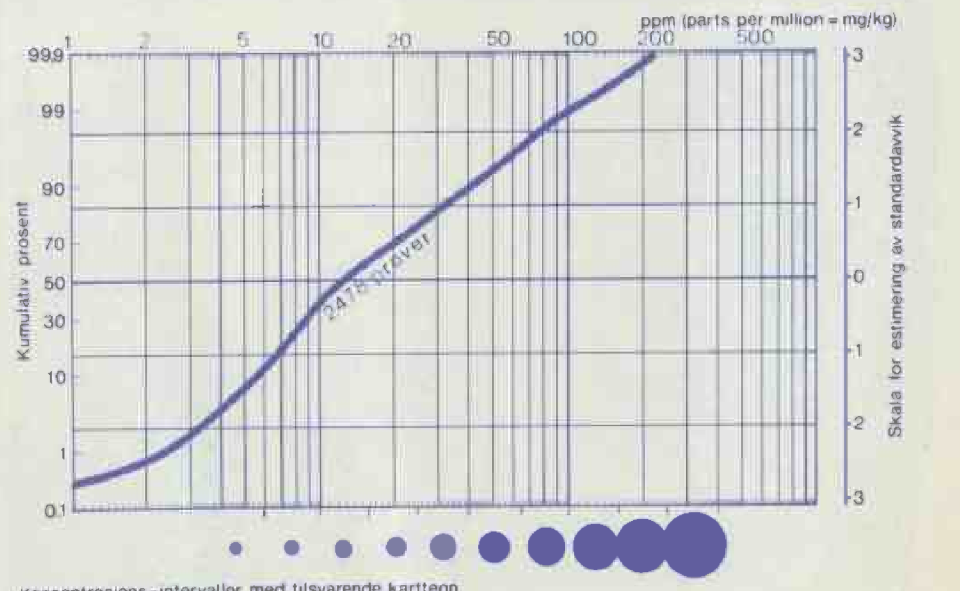
FREMSTFJELLET:
BEKKESEDIMENTER.
Detaljert prøvetaking

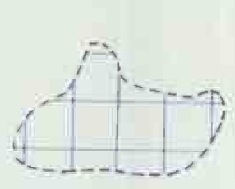
GRONGPROSJEKTET 1969 - 74 BEKKESEDIMENTER, HNO_3-LØSELIG Cu ANDORSJØEN (nordre del) - NAMSKOGAN, NORD TRØNDELAG	MÅLESTOKK 1:50000	OBS. D.S.-J.E. TEGN. J.E. TRAC. J.E.	1969 - 74 1975 1975
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 1289 - 19	KARTBLAD (AMS) 1823 I 1824 II	

BEKKESEDIMENTER

BLY, SYRELØSELIG

NORGES GEOLOGISKE UNDERSØKELSE





FREMSTFJELLET:
BEKKESEDIMENTER.
Detaljert prøvetaking

GRONGPROSJEKTET 1969 – 74 BEKKESEDIMENTER, HNO_3-LØSELIG Pb ANDORSJØEN (nordre del) – NAMSKOGAN, NORD TRØNDELAG	MÅLESTOKK 1:50000	OBS. DS-JE 1969 – 74 TEGN. JE 1975 TRAC. JE 1975
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR 1289 – 20	KARTBLAD (AMS) 1823 I 1824 II

BEKKESEDIMENTER

SINK, SYRELØSELIG

NORGES GEOLOGISKE UNDERSØKELSE

(1824 I)

TRONES

TAUBANE

NAMSEN

Tunnsjøelven

348

212

Tunnsjøtjørne

Grøndalselven

330

Skorovaselven

SKOROVASKLUMPEN

△ 330

505

Tunnsjøen

313

395

265

St. Skorovåg

409

Lilledalen

1450

567

(1824 II)

(1824 III)

SØNDRE GRØNDALSFJELL

236

228

281

Heimdalsvannet

HEIMDALSHAUGEN

Grøndalselven

Øverste-Nesaa Vå

STORBERGET

Nedre Nesaa Vå

207

351

Midtre Nesåvann

Øvre Nesaa Vå

Nesaaen

NESAPIGGEN

Galzervann

BLÅMUREN

LANGLOFTFJELLET

Gjælingvann

SKARFJELLET

Korttjern

318

Kolitjern

Langtjern

SANDDØLA

Fremstjern

207

Finbuvannet

187

189

195

568

184

FREKVENSFORDELINGS-DIAGRAM

ppm (parts per million = mg/kg)

1 2 5 10 20 50 100 200 500 1000

Kumulativ prosent

999 99 90 70 50 30 10 1 0.1

2479 prøver

Skala for estimering av standardavvik

+3 +2 +1 0 -1 -2 -3

Konsentrasjons-intervaller med tilsvarende kartfarge

FREMSTFJELLET:
BEKKESEDIMENTER.
Detaljert prøvetaking

GRONGPROSJEKTET 1969 - 74
BEKKESEDIMENTER, HNO_3 - LØSELIG Zn
ANDORSJØEN (nordre del) -
NAMSKOGAN, NORD TRØNDELAG

NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM

MÅLESTOKK	OBS. DS. JE	1969 - 74
1:50000	TEGN. JE	1975
	TRAC. JE	1975

TEGNING NR.	KARTBLAD (AMS)
1289-21	1823 I 1824 II

BEKKESEDIMENTER

NIKKEL, SYRELØSELIG

NORGES GEOLOGISKE UNDERSØKELSE

(1624 I)

TRONES

TAUBANE

NAMSEN

Grøndalselven

Tunnsjøelven

Tunnsjøflyene

Tunnsjøen

Skorovaselven

SKOROVASKLUMPEN

St. Skorova vg

Lilleåga

240

(1624 III)

(1924 III)

SØNDRE GRØNDALSFJELL

Heimdalsvannet

HEIMDALSHAUGEN

STORBERGET

Grøndalselven

Overste-Nesaa vg

Ind. Nesaa vg

Midtre Nesåvann

Ovre Nesaa vg

Nesåga

NESÅPIGGEN

Gaizervann

BLÅMUREN

LANGLØFTFJELLET

SKARFJELLET

130

Korttjern

Gjætingvann

Kollitjern

Fremstjern

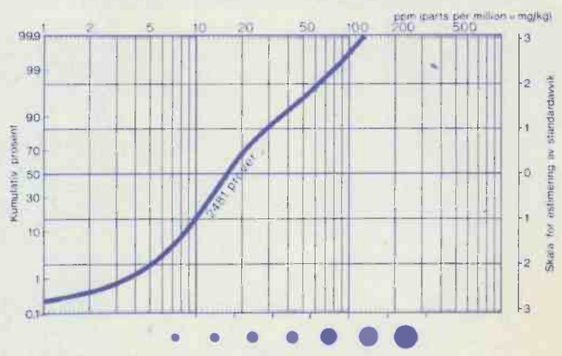
Langtjern

SANDDØLA

Finbuvannet

131

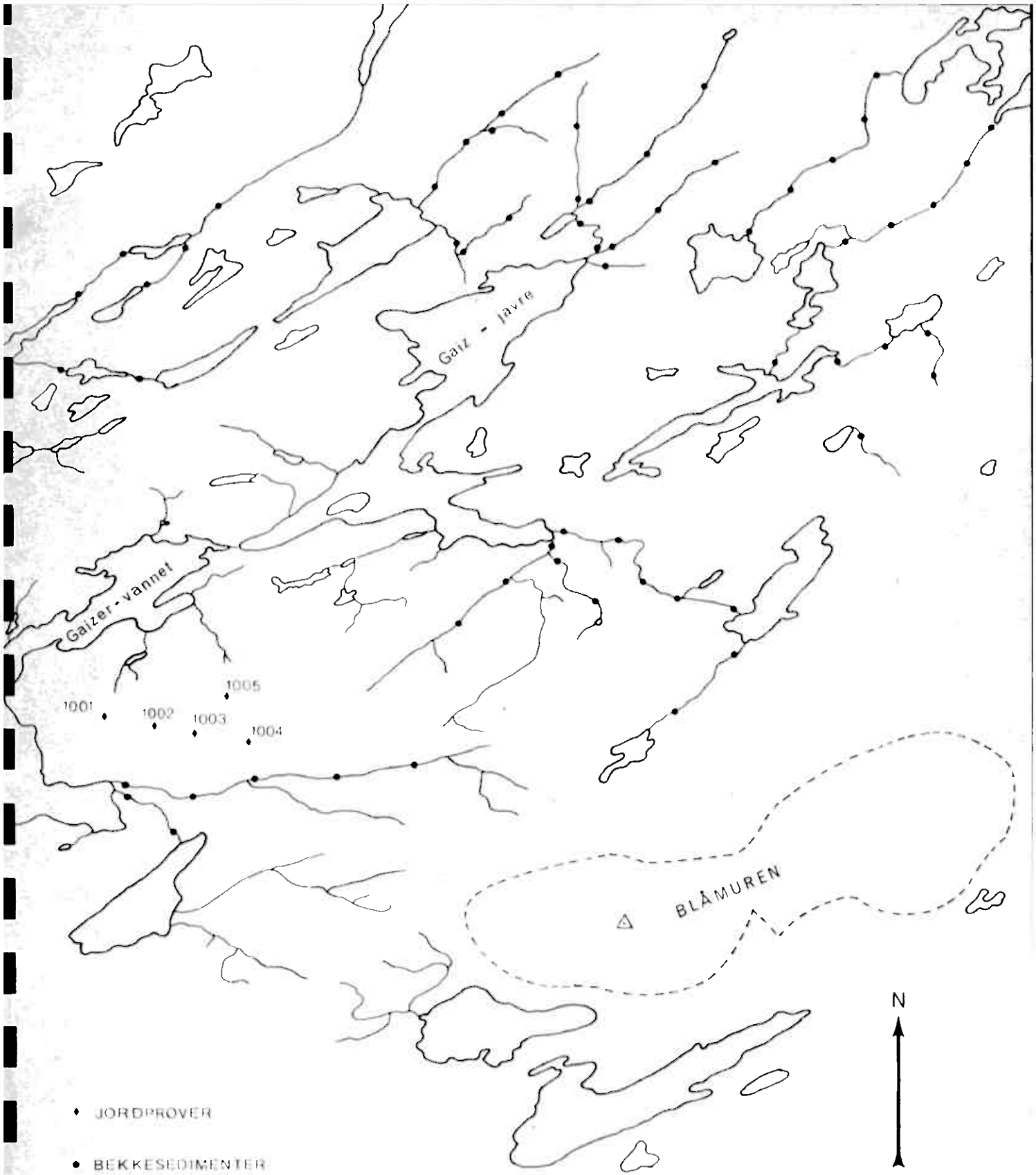
FREKVENSFORDELINGS-DIAGRAM



Konsentrasjons-intervaller med tilsvarende kartlegn

FREMSTFJELLET:
BEKKESEDIMENTER.
Detaljert prøvetaking

GRONGPROSJEKTET 1969 - 74 BEKKESEDIMENTER, HNO_3-LØSELIG Ni ANDORSJØEN (nordre del) – NAMSKOGAN, NORD TRØNDELAG	MÅLESTOKK 1 : 50 000	OBS. DS-JE TEGN. JE TRAC. JE	1969 - 74 1975 1975
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 1289 - 22	KARTBLAD (AMS) 1823 I 1824 II	



GRONGPROSJEKTET 1974

JORDPROVER

GAIZER-VANNET – BLÅMUREN

SANDDOLADALEN. NORD TRONDELAG

MÅLESTOKK	OBS. DS	1974
	TEGN. JE	1975
1 : 20000	TRAC. JE	1975

FLYFOTO Serie 357, bilde 1415 - 1417

NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM

TEGNING NR.	KARTBLAD (AMS)
1289 - 23	1824 II