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Tittel

Geological Investigations in the Gildeskŭl district.

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Sammendrag

Rapport fra forskjellige geologiske arbeider i Gildeskŭl. Geokjemisk undersokelse av et granittmassiv ved Bjellŭtind, molybdenglans og kopper. Arbeider i Sörfinset - omradet i samband med marmor - og kvarts -forekomst, wolfram som schelitt. Kismineraliseringer pa Sandhornoya er undersokt. Mjönesfjell-Pb-Zn omrade kort omtalt. Kjemiske analyser mangler. Beiarn

Geological Investigations in the Gildeskål District.

Summary:

A description of geochemical work around the Bjellatind Granite Gneiss Massif is followed by a geological report on the mineralisation (MoS_2 and Cu) associated with the Massif. The geology of the Sørfinset area is described with special reference to mineralisation and the possible economies of the Quarts and Marble of the area. Finally, the known points of mineralisation in the Sør-Sandhornøen area are described with a brief description of the regional geology.
A brief description of the Mjønesfjell Pb/Zn area is also included (Bodø-Fauske road).

Introduction:

The work in the Gildeskål district was undertaken from 26th June 1968 to the 27th August 1968. The whole area is included on the AMS Maps:

Gildeskål	1929 - 11
Strømøen	2029 - 111
Glomfjord	1928 - 1
(Arstaddal	2028 - 1V)

The first 2 weeks were spent on geochemical sampling, the rest of the time was devoted to geological work. The area is large and a boat was recenary for communications to the north side of Sørfjorden and to Sør-Sandhornøen.

Aerial photographs were unfortunately not available at the time of the research, and therefore the 1:50 000 AMS maps were made and an enlarged (modified) map of the Bjellatind area.

I was assisted in the field by K. J. Valla (Valosen, Bodø) who also acted as interpreter. I am indebted to his help and also that of several local people - notably Sigvald Seljeseter (Oterstrand).

The weather was very bad while visiting the Sandhornøen area.

Geochemical Sampling. Map No. I

Geochemical sampling was carried out around the Bjellatind Granite Gneiss Massif in order to detect high MoS_2 values. This work was carried out before the geological situation had been studied, certain mineralized zones almost certainly "contaminating" the results in a few places.

1. Soil Profiles:

2 soil profiles were taken on the Northern shores of Laksaadalvatn (east of Laksaadal Gruber I). The brown Fe and Mo rich "B" horizon was taken as a sample (In medium 1 l. sample bags) and another sample of "humus" was taken (In a large 2 l. bag).

The "B" horizon varied in depth from a few cm's to ½ m. In a few places the distinct brown colour was not easily seen, the darkest layer being taken for the sample. Both profiles ran into waterlogged marshy ground nearer the lake edge, where boulder clay and glacial eratics made sampling difficult. (No visible "B" horizon). In these cases the samples were taken from a standard depth of ½ m. The spacing was 10 - 15 m (approx).

The purpose of the sampling was to detect any continuation of the Laksaadal Gruber Pegmatites.

Samples nos. 1 → 9 and 31 → 39

Both of the profiles crosseda ridge feature - as marked on the map which is believed to represent the pegmatite zone.

2. Stream Samples:

3 stream profiles were taken, 2 from small streams on the northern shore of Laksaadalvatn in order to detect the possible continuation of the Laksaadal Gruber pegmatites. The 3rd from the major river to the east of Laksaadalvatn, in order to detect possible concentrations of MoS_2 on the eastern side of the Massif.

Sand and gravel from the river bed was removed and sifted (from places where the river had deposited!) taking care to keep the fine grade sediment. The sample was packed into a small bag (½ l.)

The 1st stream profile (sample Nos. 10 - 23) ran into an unknown mine tip around about sample No. 23, having crosseda zone of pegmatites at 21 + 22.

The 2nd stream profile crosseda ridge (as marked on the map) which is thought to represent the pegmatite zone.

The river profile was probably contaminated at 45 where an MoS_2 bearing pegmatite zone crosses the river (point 18 - Bjørnjota). There are also several old workings along the eastern edge of the gneiss, there are drained by streams running down to the river and therefore there have probably contaminated the river. Also points 17, 25 and 26 are thought to be near the river (see point map), and although we could not find these points they may have contaminated the stream.

The stream samples were taken every 10 - 15 m and the river samples every 200 - 250 m.

Sample Nos. 10 → 23, 24 → 30 and 40 → 60.

In addition a collection of samples was made at the base of the Bjellatind Cliff (northwest face) on the 100 m high plateau. The granite is drained by several streams, and in spring the whole cliff face is probably drained by snow melt water.

The samples were packed into medium 1. bags. The samples at approx No. 70 should have detected mineralisation from pegmatites above this point.
The samples were taken as far as possible from stream sediment.

Sample Nos. 62 → 84

3. Sample from Galtskart Gruber:

Large pieces of rock from the Galtskart Gruber tip were crushed by hammer on a wooden board, from approx 500 kg of crushed rock about 30 - 40 kg were removed for further crushing at Sulitjelma and for analysis.

Analysis results:

4. Sample from Mine tip sands at Oterstrand:

At Oterstrand a large expanse of sand is found by the sea (200 m long and > 50 m wide). This sand is from the crushing and flotation plant and contains (W)-scheelite and small flakes of MoS_2 in considerable amounts.
A 10 m^2 grid was set up and several kg were taken from each point (½ m deep hole) discarding the surface leached layer (taking the blue sand). The whole amount was thoroughly mixed and 5 large bags of the sand were sent to N.G.U. for analysis.

Analysis results:

5. Drilled samples from Border of Granite Gneiss:

A Cobra portable drill was used to obtain a profile of samples across the northern edge of the Bjellatind Massif. The run started several meters into the country rock schists and finished well into the massif. The zone of pegmatites near the contact were therefore traversed, across strike.
Two holes were drilled, at each point to a depth of ½ m.
The samples so obtained were then mixed and 1 medium bag (1 l.) filled. The drill tips contained tungsten carbide and therefore analysis for (W) is not possible.

Sample Nos. 85 → 111 Distribution as on Map.

No.(separation)	Rock Type	Result of Analysis
85 10 m	Garnet-Mica Schist	
86 10 m	" " "	
87 10 m	" " "	
88 10 m	" " "	
89 5 m	" " "	
90 5 m	" " "	
91 3 m	" " "	

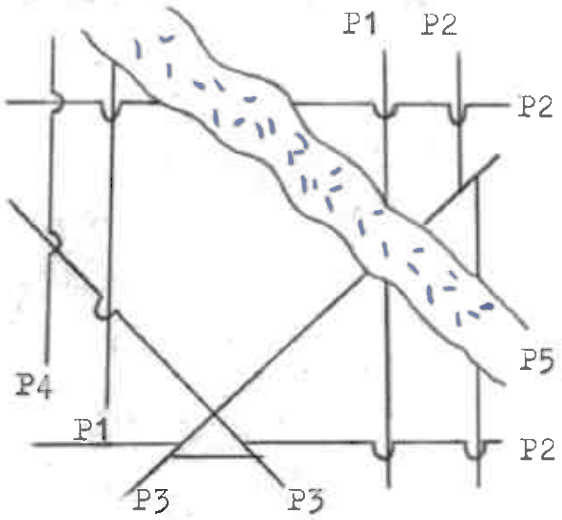
No.	(separation)	Rock Type	Result of Analysis
92	3 m	Garnet-Mica Schist	
93	1 m	" " "	minor Pegmatite Zone near contact.
97	1 m	" " "	
94	1 m	" " "	
(95		Pegmatite at Contact)	
96	1 m	Granitic Gneiss	
98	1 m	" "	
99	3 m	" "	
100	5 m	" "	
101	5 m	" "	
102	10 m	" "	
103	10 m	" "	
104	10 m	" "	
105	10 m	" "	
106	10 m	" "	
107	10 m	" "	
108	15 m	" "	
109	20 m	" "	
110	20 m	" "	
111	20 m	" "	

Bjellatind Granite Gneiss Massif and Mineralisation.

The Bjellatind Granite Gneiss is exposed in the core of a gentle F3 fold (N → S axis). The northern edge is possibly overturned by the Laksaadalv^{e} fold (W → E axis). The granite is a fairly uniform, well laminated, pink microcline, plagcoclase, quartz, biotite,(hornblende) gneiss with spasmodic magnetite crystals. (See Holmes 1960 Thesis). The enveloping schist include, pelites, semipelites and calc-pelites with thin marbles and amphibolites. Repetition of this units on Bjellatind suggest F1 folding. The lamination in the gneiss, the contact (usually sharp) and the schistosity of the envelope are all concordant.
Structural considerations suggest sliding around the whole massif:

Galtskart, Laksaadalsv^{d}, Lysv^{d} slides.

The granite and envelope schists are intruded by pegmatites of varying thickness. In the granite several sets are found, the largest of these being marked on the map.
Throughout the granite 1 set of pegmatites is developed in the place of foliation (< 5 cm thick), these are especially prominent towards the edge of the mass ie in the upper part of the massif. A 2nd set cuts the foliation at approx. 90° (steep dip).
Both of these are cut by a conjugate set of pegmatites (<20 cm thick). This conjugate set often displaces the earlier sets by a few cms. A latter foliation set is also found, which cuts this conjugate set. Around the eastern edge of the massif and just north and east of Bjellatind a latter set of thick pegmatites is found (½ - 3 m thick).



Systematic Pegmatite veining

P_1= thin pegmatites + quartz veins.

P_1 and P_2 are occasionally folded by F2 folds. The present distribution of the sets is the results of F3 folds, and therefore they are pre F3 in age (PS may be syn F3).

The mineralisation in the granite is sporadic, occasional MoS_2 is found as spots in the gneiss, but most $CuFeS_2$ and MoS_2 is found in pegmatites.

The MoS_2 or $CuFeS_2$ is concentrated at the ends of qtz. veins and pegmatites or at the cross cut points. However MoS_2 is in general very rare. It is found along the eastern edge in several P5 type pegmatites (Open cast in 1918), with $CuFeS_2$. It is also found at point (27) NE of Bjellatind.

Those pegmatites external to the massif are of PS type with occasional quartz stringers (cross cutting F2 folds, but folded by F3). In general they follow the schistosity plane, but local complications due to folding and crosscutting or thining may occour. The MoS_2 and/or $CuFeS_2$ is desseminated in the pegmatites or concentrated near the edges. The pegmatite zone along North Laksaadalsv^d (3 major pegmatites) contains 0.3 - 0.2 % MoS_2 with W in the form of scheelite. The MoS_2 content lastens to the east until it becomes very rare in the NE corner. It then increases slightly in amount along the eastern contact and $CuFeS_2$ begins to appear. This zone is then fairly constant down to Lysv^d.
No Mo, Cu or W was detected on the SE side of Bjellatind. The NW side of Bjellatind shows some MoS_2 and $CuFeS_2$ (and W) which increases in amount to the west up to Galtskart Gruber, and possibly beyond it. Those exposed pegmatites in the west however are thin and show only slight mineralisation.

A Cu zone ½ m - 2 m thick is found high up on Galtskart (See map). It follows a thin marble but is apparently not continuous.

It would appear therefore that the richest ore zone is that of the pegmatites in the country rock several meters from the top of the gneiss contact.

Sørfinset Area Mineralisation.

The mineralisation in this area follows a different pattern to that of the Bjellatind Massif. Pegmatites are relatively rare and the MoS_2 is found more often in quartzites, quartz veins or as desseminations in schist. It is very rare however and is only seen easily at points 9 , 10 , and 14 . Cu is also found in thin irregular veins or zones in the marbles and schists. These zones contain large amounts of pyrite and are often of short extent. They are not frequent enough to be economic. Disseminated pyrite and possibly Cu is found in the Gildeskål marbles (Analysis result for Cu=).

These points on the west side of Sørfjord are also of this irregular pyrite/Cu type.

Considerations on Bjellatind - Sørfinset MoS_2 and W Mineralisation.

The fact that the mineralisation is found in many different environments eg pegmatites, quartz veins, quartzites etc. and that many of these are post F2 pre F3 in age places the age of mineralisation at post-F2 (min.).
It is difficult to explain the variation in concentration over the area, but it is obvious that pegmatites and quartz veins provide a means for concentration. The complexity of the Oterstrand - Laksaadal area, where 3 slides and a major antiform meet, (and obscure gneisses are encountered) would suggest an ideal environment for pegmatites and qtz veins (and possibly subsequent mineralisation). This is backed up by

1. The few outcrops eg leucocratic gneiss by sea shore shows abandant qtz. and pegmatitic veins.

2. Lack of outcrop - suggests highly skattered or veined rock.

It is suggested therefore that geophysical work be carried out around the NW end of Laksaadal to try and locate any possible pegmatites (the possibility of $CuFeS_2$ in the veins should aid detection).

Economies of Quartz and Marble Sørfinset.

The stratigraphy is as shown on the Legend for Map I. The Gildeskål Marble Group consists of marbles, mica schists, calc-schists, and quartzites (with subsequent remobilisation to give quartz veining). The general structure is that of an Antiform (Sørfjord Antiform). Complex folding is found to the south around the closure of this F3 fold. Similar complex relations are found near the schist inliers to the NW.

The Quartz is present as two units (10 - 15 m thick), the presence of thin mica bands, lineation and lateral extend highly suggest them to be quartzites with a sedimentary origin. The quartz has been analysed at 98·7 - 99 % SiO_2 with low Fe, (S and P being very low) Fe and mica (Al rich) are present as local impurities (easily avoided when mining). The map produced by the NGU for the quartz is not very correct, and their estimate of 90.000 tonnes is extremely low (min.= 1.000.000 tonnes, possibly much more). Their drilling programme was mainly a waste of money as they only measured the thickness of the quartz in areas where this was known from geological considerations.
If any future work is contemplated it would be better to explore partially unexposed areas where the possibility of large flat quartzites with little overburden is present. (Consult the local "quartz"man - Arntsen, Sørfinset). Areas of flat or steeply dipping quartz which has small overburden are:
1. Circular outcrop area SW of Nonshaugen.
2. At approx 74267/4552, where the outcrop NW of Nonshaugen provides a large flat expanse of quartz. Two similar quartzite bands are found at Sund 74385/4586, where they dip at 30 - 40° to the east (they are purer than those at Sørfinset and could also be easily removed).

The marble at Sørfinset contains disseminated pyrite, which is not tolerable for industrial $CaCo_3$. At 74281/4563 a trench in the marble shows schist underlying it at a depth of 2 - 3 m. Other geological evidence points to the fact that the marbles are of limited thickness and that complex folds would make the appearence of schist at depth difficult to determine. This would give problems with any attempted large scale operation. The amount of glacial drift overburden is also high in certain areas, and it would appear that the marbles are not economic.

A pure calcite marble is found at the top of the succession on Høgsetdalen 74305/4548. This is 30 - 40 m thick and projects 100 m to the south before schist overburden occours. However it thins rapidly to the west and is of limited lateral extent. The other marbles on this peninsular are similar to those at Sørfinset, and are also therefore uneconomic.

The other marbles that were examined in the Gildeskål Group, at

Inndyr and Sund showed high mica and pyrite content and complex structure with schist, they too would appear therefore to be uneconomic.

The marbles on Femns, Arnøen,and Sandhornøen were not examined.

Sandhornøen - Sundsfjord Area Mineralisation.

The general geology of the area is clearly shown in "Rutland and Nicholson 1965" QJGS. The Meløy, Sundsfjord, Alsvik and Harefjell group all dip Broadly speaking to the east. Several prominent slide zones are present between the groups and the Sundsfjord group contains several slide zones within it. Minor folds and granitisation make the local geology complex in several places in the east, although a more regular sequence and structure is found to the west. All those zones of mineralisation that were found contained pyrite and a little Cu or magnetite, only one point was thought to gield MoS_2 (Skjellvik 74380/4655) and this was very small in amount. Apart from the occassional pyrite/Cu consentration in thin discontinuous marbles or schists 3 possibly extentious zones were found: -

(Time and weather made detailed research impossible - the following are suggestions only).

1. Morsdal Kvartsnes - Sundsfjord Cu zone.
   A marble with basic and granitic veining by pegmatites and amphibolites (located in hornblendic schists)in a zone 2 - 5 m thick contains several areas of mineralisation - Desseminated metallic pyrite like crystals.
   Sample XI =

   This zone is possibly continuos to the Skjellvik area.

2. Bjørnvik - Kjøpstad - Suvikaksla Magnetite Zone.
   A magnetite bearing vein (17 % analysis for Fe) is found in the cliffs at these places, the locals report that it is the same zone which is in agreement with the geology.

3. Asgottsletta - Kisfjell Cu Zone.
   A pyrite/Cu ore zone ½ m - 1 m thick in marbles with pegmatitic veining is found on the shore at Asgottsletta.

   +++++ / +++++ gneiss - Harefjell group

   marble + Cu

   AAAAA / AAAA Dark amphibolite

   Cu is reported on Kisfjell in several localities, one of which we were unable to locate. The dip here is to the west about 25° and this zone on the shore could possibly be projected up to Kisfjell.

Areas 1. and 3 may be worth a more detailed approach however the ore content of all exposures seen was very low and did not appear to be of economic proportions.

Mjønnesfjellet.

Pb/Zn reported at Mjønnesfjellet (Bodø - Fauske road).

A mineralized zone was found in the west face of Mjønnesfjell (seen as a brown stain in cliff from Mjønnes). The hill and valley are composed of sparagmitic rocks with many barren pegmatites cutting the area. The dip was complex but to the north (minor folds 090/50 W). The ore zone was very poor in minerals (no Pb or Zn found - Cu present) and pinched or folded out to the NW. It's extent to the E is not known.

LIST OF RESULTS ON INVESTIGATION OF REGISTERED POINTS

(Point No)	(Name)	(Position and Comments)
(1)	Vigdel	Cu in Qtz vein on shore (Asbestos vein also) 74325/4525
(2)	Skavoldalen	Cu in marbles 74305/4603
(3)	Skavold	Cu reported on Skavoldknubben (found in Qtzites) 74294/4591
(4)	Høgsetdalen	Cu in Qtzite and as zone in marble 74305/4545
(5)	Tømmervik	Cu 74285/4565
(6)	Storvikneset, Dal	Cu in zones in marble (By sea) and in schist (road cutting) Pyrite + Cu ? disseminated in marble 74323/4584
(7)	Valle, Utmark	(Jens Nilsen , Sørfinset) Cu in zones in schist and marble.
(8)	Degro, Storvik	(John Johannesen) Pegmatite, possibly Cu. Magnetite? in Granite.
(9)	Juvik Kjellingskavet	(By the road) MoS_2 74262/4537
(10)	Juvik Kjellingskavet	(By old road cutting to mine) MoS_2 74262/4541
(11a)	Skjellvik 74379/4666	(MoS_2 approx at 74380/4655) reported by:- (Cu " " 74375/4646) Daniel Eilertsen Skjelvik +Alfred Olsen
(11b)	Kammeren	(74364/4659) Cu at 74365/4665 Magnetite near top of hill (reported!) 74363/4644
(12)	Kvartsvik	74335/4637 Cu zone runs from 74330/4642 to the northwest in cliff. Morsdal and Sundsfjord occourences possibly the same zones (74292/4632)
(13a)	Kjøpstad	74390/4680 (Fe - 17 %) Magnetite at Bjørnvik 74381/4689 Kjøpstad 74390/4680 possibly Juvikaksla 74402/4683 all same vein
(13b)	Asgottsletta	74355/4680 Cu zone by sea (possibly extends up to (74345/4694) occourences reported on Kisfjell). Cu reported at 74355/4695 or 74375/4695
(13c)	Klikvik	74330/4620 Small Cu zone very poor!
	Vindvik	74310/4625 Cu west side of harbour
(14)	Fornaken	74275/4563 MoS_2 in Quartzite (mystery mineral - see specimens)
(15)	Kvittindvatn	74215/4564 Pegmatites, Qtz veins, Cu in veins and marble.
(16)	Høljefjell	74257/4550 ?
(17)	Jetstigen	(Geitstien) ?
(18)	Bjornjota	74258/4553 MoS_2 in quartzite

(19)	Katvatn	near Galtskart Gruber : Same point? (no exposure at Katvatn).
(20)	Lysvann	74225/4528 Cu in Peg in gneiss
(21)	"	74215/4560 MoS_2 in peg near contact.
(22)	Tendvatn	74281/4560 Cu desseminated in marble/schist contact.
(23)	Hellebergene	74274/4560 ?
(24)	Djupdalen	and (24B)Blodgvismyren (74275/4557) Open Cast (ref.: Andreas Opsal).
(25)	Kvanstifossen	
(26)	Tverrdalselva, Øverdalen	?
(27)	Storskaret	74235/4540 (MoS_2) and Cu
(28)	Hambogen	(ref.: Andreas Opsal) 74273/4543 ($Cu+MoS_2$)
(29)	Ørntua	74261/4547
(30)	Langsletta	74265/4550
(31)	Storhaugsletta	(marshv100 m south of point (30)) ? No result
(32)	Lillebalghaugen	? (Point not known)

Other areas where we were told of mineralisation:

a. Vandet (Cu) 4765, 74468

b. Middagsfj.(Fe) 472, 74435

Strømøen Sheet 2029 - III

Conclusions.

The main (MoS_2) and (W) mineralisation is found in the border pegmatites of the Bjellatind Granite Gneiss. Geophysical investigation could be used to explore the unexposed area Oterstrand - Laksaadalv where the expected complexity would offer good chances for pegmatites and quartz veining with subsequent mineralisation.

The quartz at Sørfinset and Sund is considered to be of economic proportions and purity, and easy to remove in part.

The marbles are nor considered economic due to pyrite contamination and structural difficulties with removal.

The Sundsfjord - Kvartsnes - Morsdal zone and the Kisfjell - Asgotsletta zone of the Sandhornøen area possibly worth a more detailed investigation.

LEGEND TO MAP I

Cu - Copper

Mo - Molybdenum

Structural Succession:

Grey Silty Schist (Sparagmitic) 999-90
+ Nordhaugen Sparagmite

Calcareous Pelitic Schist 101-6

Mica-Schist 999-59

Lysvd Slide (F2a)

South

Calc Pelites 101-6
Marbles 101-2
Amphibolite 101-23
Marble 101-2

} Envelope Pelitic and Semi Pelitic Schists -25

Amphibolitic Gneiss

} Granitic Gneiss 999-70

Base Not Seen

North

Marble, Pelite 101-2 / 999 59
Mica Schist (Brown) 999 59
Quartzite 999-25
Schist (Brown) 999-59
Quartzite 999-245
Garnet-Mica Schist 999-59
Calcareous "Sandstone" 999-5
Quartz } Marble 101-2 / 999 245
mica schist } 999-59

} GILDESKÅL GROUP

Base Not Seen

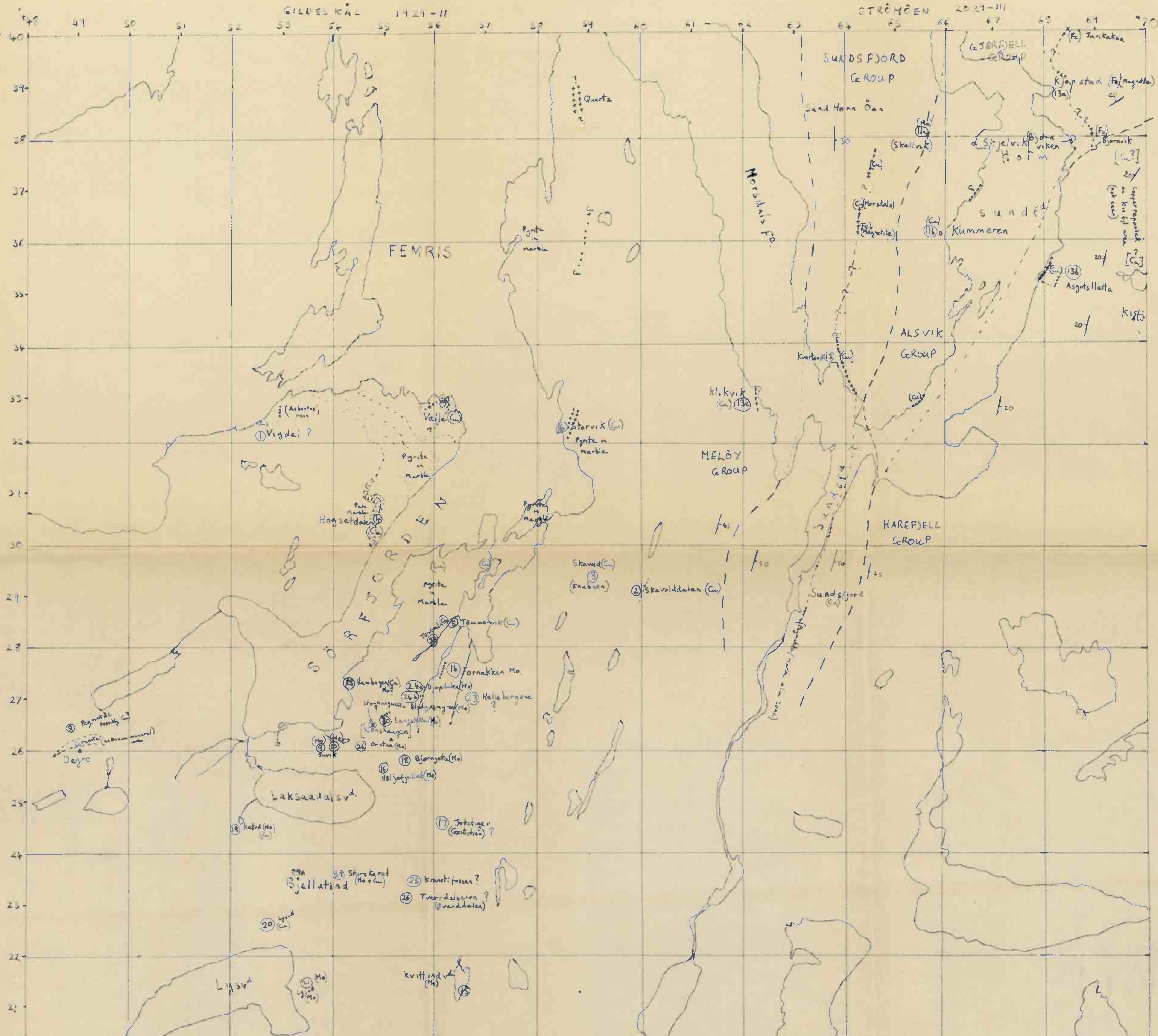
RELATIONS OBSCURE

Leucocratic Biotite Gneiss 999-70
Impure Marble 101-140
Amphibolitic Gneiss 101-23

① Southern and Northern Successions Separated By Laksaadal Slide

② Eastern Silty Schist Successions Seperated From Bjellatind Group and Gildeskal Group By Lysvd Slide

Grätset
Auden
Skipneset
SÖRFJORDEN
Kvarenaset
Storskj.
APPROX. POSITION OF GALTSKART SLIDE
Oterstranden
Gilset
Opsal
Alten
Nonshaugen
GILDESKÅL SLIDE
LAKSAADALUR SLIDE
Electric Pylon Line
Soil
Stream
Laksaadlen
Drill Samples
Svabergene
LAKS SLIDE
Middags haugen
Laksaadalsv^d^
(10)
Katv^d^
Bjeliatind
886
Mo. Detected on this side
Langfj
732
Lysv^d^
(351)
Kvittind
1069
Kvittindv^d^
H. Mason Map I
Bjelliatind – Sørfinnset Geology
Scale = 1cm ≡ 1Km
Tegn.
Trac.
Kfr.
Målestokk
Erstatning for:
Erstattet av:



Scale 1cm = 1/2 km 1:50,000 [DRAWN FROM AMS MAPS] 1929-II 2029-III 1928-I 2028-IV

MAP II

Meløy Group: pelites + semi pelites schists + psammites (occ. calc pelites)

Sundsfjord Group: Granitised Schists + Gneiss :- (pelites + hornblende schists + marbles)

Alsvik Group: homogeneous mica poor feldspathic schist

Gyterfjell Group: Gneisses + occ. hornblende schist

Harefjell Group: " " "

LOCATION MAP FOR REGISTERED MINERALISATION POINTS.

H. Mason.

Geological Investigations in the Gildeskål District.

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1. Soil Profiles:

2 soil profiles were taken on the Northern shores of Laksaadalvatn (east of Laksaadal Gruber I). The brown Fe and Mo rich "B" horizon was taken as a sample (In medium 1 l. sample bags) and another sample of "humus" was taken (In a large 2 l. bag).

The "B" horizon varied in depth from a few cm's to ½ m. In a few places the distinct brown colour was not easily seen, the darkest layer being taken for the sample. Both profiles ran into waterlogged marshy ground nearer the lake edge, where boulder clay and glacial eratics made sampling difficult. (No visible "B" horizon). In these cases the samples were taken from a standard depth of ½ m. The spacing was 10 - 15 m (approx).

The purpose of the sampling was to detect any continuation of the Laksaadal Gruber Pegmatites.

Samples nos. 1 → 9 and 31 → 39

Both of the profiles crossed a ridge feature - as marked on the map which is believed to represent the pegmatite zone.

2. Stream Samples:

3 stream profiles were taken, 2 from small streams on the northern shore of Laksaadalvatn in order to detect the possible continuation of the Laksaadal Gruber pegmatites. The 3rd from the major river to the east of Laksaadalvatn, in order to detect possible concentrations of MoS_2 on the eastern side of the Massif.

Sand and gravel from the river bed was removed and sifted (from places where the river had deposited!) taking care to keep the fine grade sediment. The sample was packed into a small bag (½ l.)

The 1st stream profile (sample Nos. 10 - 23) ran into an unknown mine tip around about sample No. 23, having crossed a zone of pegmatites at 21 + 22.

The 2nd stream profile crossed a ridge (as marked on the map) which is thought to represent the pegmatite zone.

The river profile was probably contaminated at 45 where an MoS_2 bearing pegmatite zone crosses the river (point 18 - Bjørnjota). There are also several old workings along the eastern edge of the gneiss, there are drained by streams running down to the river and therefore there have probably contaminated the river. Also points 17, 25 and 26 are thought to be near the river (see point map), and although we could not find these points they may have contaminated the stream.

The stream samples were taken every 10 - 15 m and the river samples every 200 - 250 m.

Sample Nos. 10 → 23, 24 → 30 and 40 → 60.

In addition a collection of samples was made at the base of the Bjellatind Cliff (northwest face) on the 100 m high plateau. The granite is drained by several streams, and in spring the whole cliff face is probably drained by snow melt water.

The samples were packed into medium 1. bags. The samples at approx No. 70 should have detected mineralisation from pegmatites above this point.
The samples were taken as far as possible from stream sediment.

Sample Nos. 62 → 84

3. Sample from Galtskart Gruber:

Large pieces of rock from the Galtskart Gruber tip were crushed by hammer on a wooden board, from approx 500 kg of crushed rock about 30 - 40 kg were removed for further crushing at Sulitjelma and for analysis.

Analysis results:

4. Sample from Mine tip sands at Oterstrand:

At Oterstrand a large expanse of sand is found by the sea (200 m long and > 50 m wide). This sand is from the crushing and flotation plant and contains (W)-scheelite and small flakes of MoS_2 in considerable amounts.
A 10 m^2 grid was set up and several kg were taken from each point (½ m deep hole) discarding the surface leached layer (taking the blue sand). The whole amount was thoroughly mixed and 5 large bags of the sand were sent to N.G.U. for analysis.

Analysis results:

5. Drilled samples from Border of Granite Gneiss:

A Cobra portable drill was used to obtain a profile of samples across the northern edge of the Bjellatind Massif. The run started several meters into the country rock schists and finished well into the massif. The zone of pegmatites near the contact were therefore traversed, across strike.
Two holes were drilled, at each point to a depth of ½ m.
The samples so obtained were then mixed and 1 medium bag (1 l.) filled. The drill tips contained tungsten carbide and therefore analysis for (W) is not possible.

Sample Nos. 85 → 111 Distribution as on Map.

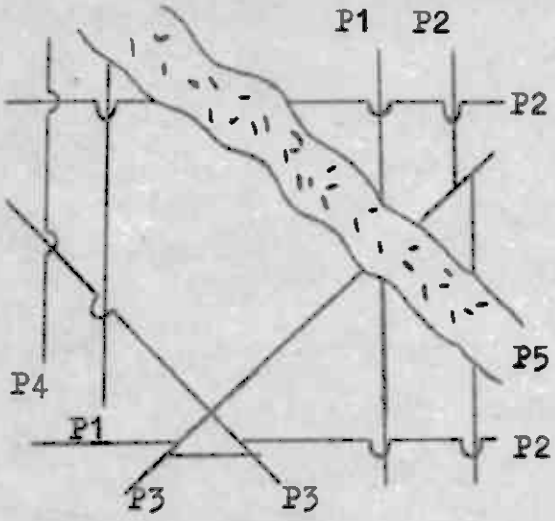
No.(separation)	Rock Type	Result of Analysis
85 10 m	Garnet-Mica Schist	
86 10 m	" " "	
87 10 m	" " "	
88 10 m	" " "	
89 5 m	" " "	
90 5 m	" " "	
91 3 m	" " "	

No.	(separation)	Rock Type	Result of Analysis
92	3 m	Garnet-Mica Schist	
93	1 m	" " "	minor Pegmatite Zone near contact.
97	1 m	" " "	
94	1 m	" " "	
(95		Pegmatite at Contact)	
96	1 m	Granitic Gneiss	
98	1 m	" "	
99	3 m	" "	
100	5 m	" "	
101	5 m	" "	
102	10 m	" "	
103	10 m	" "	
104	10 m	" "	
105	10 m	" "	
106	10 m	" "	
107	10 m	" "	
108	15 m	" "	
109	20 m	" "	
110	20 m	" "	
111	20 m	" "	

Bjellatind Granite Gneiss Massif and Mineralisation.

The Bjellatind Granite Gneiss is exposed in the core of a gentle F3 fold (N → S axis). The northern edge is possibly overturned by the Laksaadalv^{e} fold (W → E axis). The granite is a fairly uniform, well laminated, pink microcline, plagcoclase, quartz, biotite,(hornblende) gneiss with spasmodic magnetite crystals. (See Holmes 1960 Thesis). The enveloping schist include, pelites, semipelites and calc-pelites with thin marbles and amphibolites. Repetition of this units on Bjellatind suggest F1 folding. The lamination in the gneiss, the contact (usually sharp) and the schistosity of the envelope are all concordant.
Structural considerations suggest sliding around the whole massif: Galtskart, Laksaadalsv^{d}, Lysv^{d} slides.

The granite and envelope schists are intruded by pegmatites of varying thickness. In the granite several sets are found, the largest of these being marked on the map.
Throughout the granite 1 set of pegmatites is developed in the place of foliation (< 5 cm thick), these are especially prominent towards the edge of the mass ie in the upper part of the massif. A 2nd set cuts the foliation at approx. 90° (steep dip). Both of these are cut by a conjugate set of pegmatites (<20 cm thick). This conjugate set often displaces the earlier sets by a few cms. A latter foliation set is also found, which cuts this conjugate set. Around the eastern edge of the massif and just north and east of Bjellatind a latter set of thick pegmatites is found ($\frac{1}{2}$ - 3 m thick).



Systematic Pegmatite veining

P_1= thin pegmatites + quartz veins.

P_1 and P_2 are occasionally folded by F2 folds. The present distribution of the sets is the results of F3 folds, and therefore they are pre F3 in age (PS may be syn F3).

The mineralisation in the granite is sporadic, occasional MoS_2 is found as spots in the gneiss, but most $CuFeS_2$ and MoS_2 is found in pegmatites.

The MoS_2 or $CuFeS_2$ is concentrated at the ends of qtz. veins and pegmatites or at the cross cut points. However MoS_2 is in general very rare. It is found along the eastern edge in several P5 type pegmatites (Open cast in 1918), with $CuFeS_2$. It is also found at point (27) NE of Bjellatind.

Those pegmatites external to the massif are of PS type with occasional quartz stringers (cross cutting F2 folds, but folded by F3). In general they follow the schistosity plane, but local complications due to folding and crosscutting or thining may occour. The MoS_2 and/or $CuFeS_2$ is desseminated in the pegmatites or concentrated near the edges. The pegmatite zone along North Laksaadalsv^{d} (3 major pegmatites) contains 0.3 - 0.2 % MoS_2 with W in the form of scheelite. The MoS_2 content lastens to the east until it becomes very rare in the NE corner. It then increases slightly in amount along the eastern contact and $CuFeS_2$ begins to appear. This zone is then fairly constant down to Lysv^{d}.
No Mo, Cu or W was detected on the SE side of Bjellatind. The NW side of Bjellatind shows some MoS_2 and $CuFeS_2$ (and W) which increases in amount to the west up to Galtskart Gruber, and possibly beyond it. Those exposed pegmatites in the west however are thin and show only slight mineralisation.

A Cu zone ½ m - 2 m thick is found high up on Galtskart (See map). It follows a thin marble but is apparently not continuous.

It would appear therefore that the richest ore zone is that of the pegmatites in the country rock several meters from the top of the gneiss contact.

Sørfinset Area Mineralisation.

The mineralisation in this area follows a different pattern to that of the Bjellatind Massif. Pegmatites are relatively rare and the MoS_2 is found more often in quartzites, quartz veins or as desseminations in schist. It is very rare however and is only seen easily at points 9 , 10 , and 14 . Cu is also found in thin irregular veins or zones in the marbles and schists. These zones contain large amounts of pyrite and are often of short extent. They are not frequent enough to be economic. Disseminated pyrite and possibly Cu is found in the Gildeskål marbles (Analysis result for Cu=).

These points on the west side of Sørfjord are also of this irregular pyrite/Cu type.

Considerations on Bjellatind - Sørfinset MoS_2 and W Mineralisation.

The fact that the mineralisation is found in many different environments eg pegmatites, quartz veins, quartzites etc. and that many of these are post F2 pre F3 in age places the age of mineralisation at post-F2 (min.).
It is difficult to explain the variation in concentration over the area, but it is obvious that pegmatites and quartz veins provide a means for concentration. The complexity of the Oterstrand - Laksaadal area, where 3 slides and a major antiform meet, (and obscure gneisses are encountered) would suggest an ideal environment for pegmatites and qtz veins (and possibly subsequent mineralisation). This is backed up by

1. The few outcrops eg leucocratic gneiss by sea shore shows abandant qtz. and pegmatitic veins.

2. Lack of outcrop - suggests highly skattered or veined rock.

It is suggested therefore that geophysical work be carried out around the NW end of Laksaadal to try and locate any possible pegmatites (the possibility of $CuFeS_2$ in the veins should aid detection).

Economies of Quartz and Marble Sørfinset.

The stratigraphy is as shown on the Legend for Map I. The Gildeskål Marble Group consists of marbles, mica schists, calc-schists, and quartzites (with subsequent remobilisation to give quartz veining). The general structure is that of an Antiform (Sørfjord Antiform). Complex folding is found to the south around the closure of this F3 fold. Similar complex relations are found near the schist inliers to the NW.

The Quartz is present as two units (10 - 15 m thick), the presence of thin mica bands, lineation and lateral extend highly suggest them to be quartzites with a sedimentary origin. The quartz has been analysed at 98·7 - 99 % SiO_2 with low Fe, (S and P being very low) Fe and mica (Al rich) are present as local impurities (easily avoided when mining). The map produced by the NGU for the quartz is not very correct, and their estimate of 90.000 tonnes is extremely low (min.= 1.000.000 tonnes, possibly much more). Their drilling programme was mainly a waste of money as they only measured the thickness of the quartz in areas where this was known from geological considerations.
If any future work is contemplated it would be better to explore partially unexposed areas where the possibility of large flat quartzites with little overburden is present. (Consult the local "quartz"man - Arntsen, Sørfinset). Areas of flat or steeply dipping quartz which has small overburden are:
1. Circular outcrop area SW of Nonshaugen.
2. At approx 74267/4552, where the outcrop NW of Nonshaugen provides a large flat expanse of quartz. Two similar quartzite bands are found at Sund 74385/4586, where they dip at 30 - 40° to the east (they are purer than those at Sørfinset and could also be easily removed).

The marble at Sørfinset contains disseminated pyrite, which is not tolerable for industrial $CaCo_3$. At 74281/4563 a trench in the marble shows schist underlying it at a depth of 2 - 3 m. Other geological evidence points to the fact that the marbles are of limited thickness and that complex folds would make the appearence of schist at depth difficult to determine. This would give problems with any attempted large scale operation. The amount of glacial drift overburden is also high in certain areas, and it would appear that the marbles are not economic.

A pure calcite marble is found at the top of the succession on Høgsetdalen 74305/4548. This is 30 - 40 m thick and projects 100 m to the south before schist overburden occours. However it thins rapidly to the west and is of limited lateral extent. The other marbles on this peninsular are similar to those at Sørfinset, and are also therefore uneconomic.

The other marbles that were examined in the Gildeskål Group, at

Inndyr and Sund showed high mica and pyrite content and complex structure with schist, they too would appear therefore to be uneconomic

The marbles on Tomns, Arnøen, and Sandhornøen were not examined.

Sandhornøen - Sundsfjord Area Mineralisation.

The general geology of the area is clearly shown in "Rutland and Nicholson 1965" QJGS. The Meløy, Sundsfjord, Alsvik and Harefjell group all dip Broadly speaking to the east. Several prominent slide zones are present between the groups and the Sundsfjord group contains several slide zones within it. Minor folds and granitisation make the local geology complex in several places in the east, although a more regular sequence and structure is found to the west. All those zones of mineralisation that were found contained pyrite and a little Cu or magnetite, only one point was thought to gield MoS_2 (Skjellvik 74380/4655) and this was very small in amount. Apart from the occassional pyrite/Cu consentration in thin discontinuous marbles or schists 3 possibly extentious zones were found: -

(Time and weather made detailed research impossible - the following are suggestions only).

1. Morsdal Kvartsnes - Sundsfjord Cu zone.
   A marble with basic and granitic veining by pegmatites and amphibolites (located in hornblendic schists) in a zone 2 - 5 m thick contains several areas of mineralisation - Desseminated metallic pyrite like crystals.
   Sample XI =

   This zone is possibly continuos to the Skjellvik area.

2. Bjørnvik - Kjøpstad - Suvikaksla Magnetite Zone.
   A magnetite bearing vein (17 % analysis for Fe) is found in the cliffs at these places, the locals report that it is the same zone which is in agreement with the geology.

3. Asgottsletta - Kisfjell Cu Zone.
   A pyrite/Cu ore zone ½ m - 1 m thick in marbles with pegmatitic veining is found on the shore at Asgottsletta.

   +++++ / +++++ gneiss - Harefjell group

   marble + Cu

   AAAAA / AAAA Dark amphibolite

   Cu is reported on Kisfjell in several localities, one of which we were unable to locate. The dip here is to the west about 25° and this zone on the shore could possibly be projected up to Kisfjell.

Areas 1. and 3 may be worth a more detailed approach however the ore content of all exposures seen was very low and did not appear to be of economic proportions.

Mjønnesfjellet.

Pb/Zn reported at Mjønnesfjellet (Bodø - Fauske road).

A mineralized zone was found in the west face of Mjønnesfjell (seen as a brown stain in cliff from Mjønnes). The hill and valley are composed of sparagmitic rocks with many barren pegmatites cutting the area. The dip was complex but to the north (minor folds 090/50 W). The ore zone was very poor in minerals (no Pb or Zn found - Cu present) and pinched or folded out to the NW. It's extent to the E is not known.

LIST OF RESULTS ON INVESTIGATION OF REGISTERED POINTS

(Point No)	(Name)	(Position and Comments)
(1)	Vigdel	Cu in Qtz vein on shore (Asbestos vein also) 74325/4525
(2)	Skavoldalen	Cu in marbles 74305/4603
(3)	Skavold	Cu reported on Skavoldknubben (found in Qtzites) 74294/4591
(4)	Høgsetdalen	Cu in Qtzite and as zone in marble 74305/4545
(5)	Tømmervik	Cu 74285/4565
(6)	Storvikneset, Dal	Cu in zones in marble (By sea) and in schist (road cutting) Pyrite + Cu ? disseminated in marble 74323/4584
(7)	Valle, Utmark	(Jens Nilsen , Sørfinset) Cu in zones in schist and marble.
(8)	Degro, Storvik	(John Johannesen) Pegmatite, possibly Cu. Magnetite? in Granite.
(9)	Juvik Kjellingskavet	(By the road) MoS_2 74262/4537
(10)	Juvik Kjellingskavet	(By old road cutting to mine) MoS_2 74262/4541
(11a)	Skjellvik 74379/4666	(MoS_2 approx at 74380/4655) reported by:- (Cu " " 74375/4646) Daniel Eilertsen Skjelvik +Alfred Olsen
(11b)	Kammeren	(74364/4659) Cu at 74365/4665 Magnetite near top of hill (reported!) 74363/4644
(12)	Kvartsvik	74335/4637 Cu zone runs from 74330/4642 to the northwest in cliff. Morsdal and Sundsfjord occourences possibly the same zones (74292/4632)
(13a)	Kjøpstad	74390/4680 (Fe - 17 %) Magnetite at Bjørnvik 74381/4689 Kjøpstad 74390/4680 possibly Juvikaksla 74402/4683 all same vein
(13b)	Asgottsletta	74355/4680 Cu zone by sea (possibly extends up to (74345/4694) occourences reported on Kisfjell). Cu reported at 74355/4695 or 74375/4695
(13c)	Klikvik	74330/4620 Small Cu zone
	Vindvik	74310/4625 Cu west side of harbour very poor!
(14)	Fornaken	74275/4563 MoS_2 in Quartzite (mystery mineral - see specimens)
(15)	Kvittindvatn	74215/4564 and marble. Pegmatites, Qtz veins, Cu in veins
(16)	Høljefjell	74257/4550 ?
(17)	Jetstigen	(Geitstien) ?
(18)	Bjornjota	74258/4553 MoS_2 in quartzite

(19)	Katvatn	near Galtskart Gruber : Same point? (no exposure at Katvatn).
(20)	Lysvann	74225/4528 Cu in Peg in gneiss
(21)	"	74215/4560 MoS_2 in peg near contact.
(22)	Tendvatn	74281/4560 Cu desseminated in marble/schist contact.
(23)	Hellebergene	74274/4560 ?
(24)	Djupdalen	and (24B)Blodgvismyren (74275/4557) Open Cast (ref.: Andreas Opsal).
(25)	Kvanstifossen	
(26)	Tverrdalselva,	Øverdalen ?
(27)	Storskaret	74235/4540 (MoS_2) and Cu
(28)	Hambogen	(ref.: Andreas Opsal) 74273/4543 ($Cu+MoS_2$)
(29)	Ørntua	74261/4547
(30)	Langsletta	74265/4550
(31)	Storhaugsletta	(marshv100 m south of point (30)) ? No result
(32)	Lillebalghaugen	? (Point not known)

Other areas where we were told of mineralisation:

a. Vandet (Cu) 4765, 74468

b. Middagsfj.(Fe) 472, 74435

Strømøen Sheet
2029 - III

Conclusions.

The main (MoS_2) and (W) mineralisation is found in the border pegmatites of the Bjellatind Granite Gneiss. Geophysical investigation could be used to explore the unexposed area Oterstrand - Laksaadalv where theexpected complexity would offer good chances for pegmatites and quartz veining with subsequent mineralisation.

The quartz at Sørfinset and Sund is considered to be of economic proportions and purity, and easy to remove in part.

The marbles are nor considered economic due to pyrite contamination and structural difficulties with removal.

The Sundsfjord - Kvartsnes - Morsdal zone and the Kisifjell - Asgotsletta zone of the Sandhornøen area possibly worth a more detailed investigation.

14°
15°
20 km
67°30
67°
13°
Norafolda
Sørfolda
Rössvik
Kjerringöy
Misfjord
Heggmovatn
Valnesfjord Group
Venset Group
Fauske Group
LANDEGÖDE
Vaagen Group
Alvnes
Öines
Skjerstadfjord
Bodö Group
TVERR LAND
HJARTÖY
Bodö
Saltfjord
BLIKKSVAER
Misvaerfjord
Alsvik Group
Palbrakken Group
Gjeterfjell Group
Saurvatn Group
SANDHORNÖY
N. ARNÖY
S. ARNÖY
FLEINA
Gildeskål
FUGLÖY
FEMRIS
Sørfjord
Sundsfjord
Lurfjell
Kykkelvatn
Beiarneset
Harefjell Group
Sokumfjell Marble Group
Sokumvatn
Meløy Group
Kunna
Fellvatn
Arstadvatn
Vegdal
MELÖY
Glomfjord
Storglomvatn
ÅMÖY
Holandsfjord
SVARTISEN
RODÖY
Tjongsfjord
Meifjord
Arctic Circle
HÖGTUVA
Langvatn
A
P
Q
C
8°
16°
24°
68°
64°
62°
NORWAY
SWEDEN
FINLAND
Harefjell Group
Sundsfjord Group and Gjeterfjell Group
Palbrakken & Alsvik Groups
Vegdal and Bodo Groups
Marble Groups Sokumfjell etc.
Venset Group
Meloy Vaagen & Saurvatn Groups
Rocks of Sparagmitic character in the Meloy & Vaagen Groups
Basement granitic gneisses etc.
Ice
ABC PQ, XY Lines of sections

Rutland & Nicholsen

(6)

LEGEND TO MAP I

Cu - Copper

Mo - Molybdenum

Structural Sucession:

Grey Silty Schist (Sparagmitic) 999-90
+ Nonshaugen Sparagmite

Calcareous Pelitic Schist - 101-6

Mica - Schist 999-59

Lysvd Slide (F2a)

South

Calc Pelites 101-6

Marbles 101-2

Amphibolite 101-23

Marble 101-2

} Envelope Pelitic and Semi Pelitic Schists -25

Amphibolitic Gneiss } Granitic Gneiss 999-70

Base Not Seen

North

Marble + Pelite 101-2 - 999 59

Mica Schist (Brown) 999 59

Quartzite 999-25

Schist (Brown) 999-59

Quartzite 999-245

Garnet-Mica Schist 999-59

Calcareous "Sandstone" 999-5

Quartz } Marble 101-2 - 999 245

mica Schist 999-59

Base Not Seen

} GILDESKÅL GROUP

RELATIONS OBSCURE

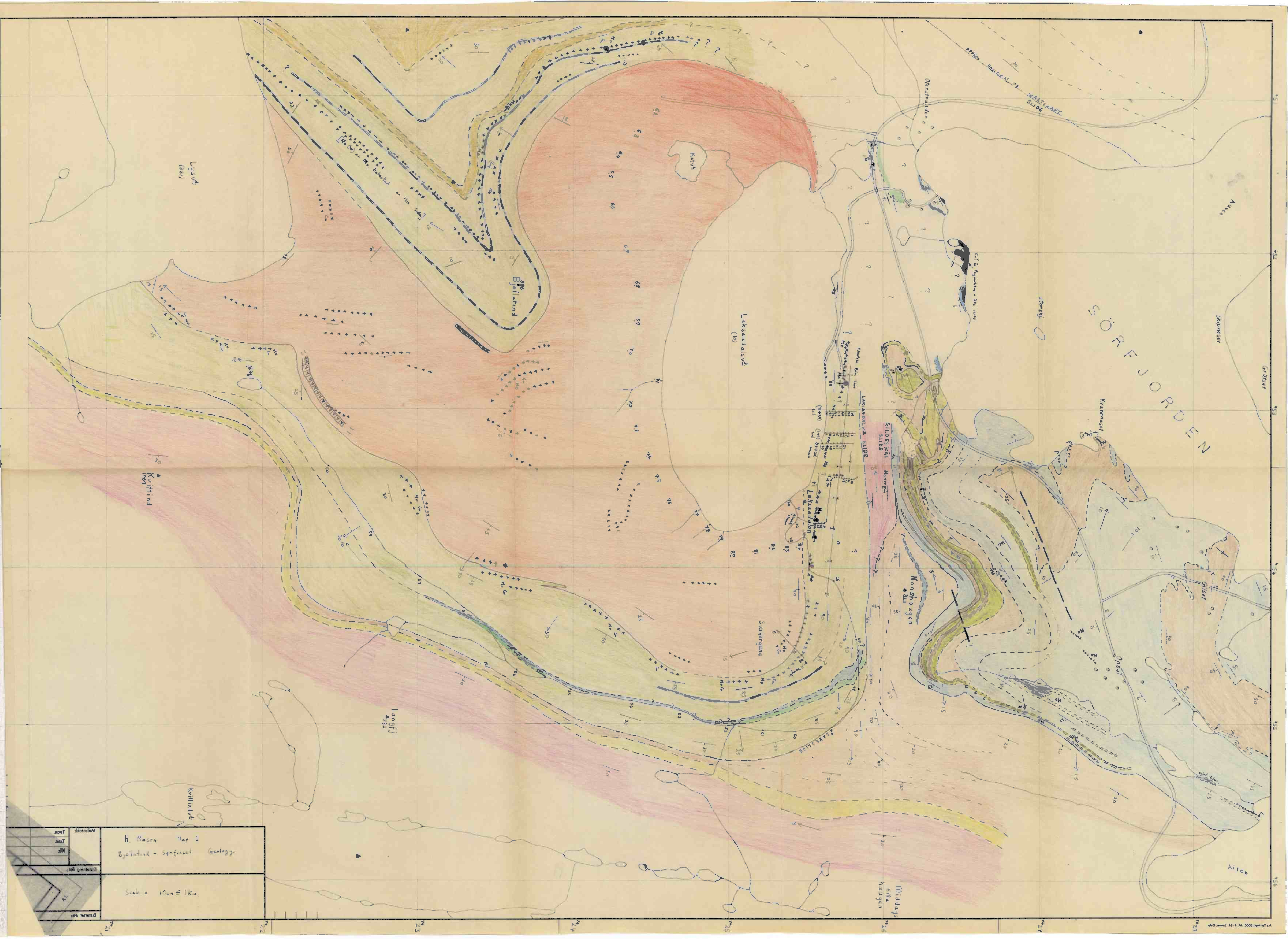
Leucocratic Biotite Gneiss 999-70

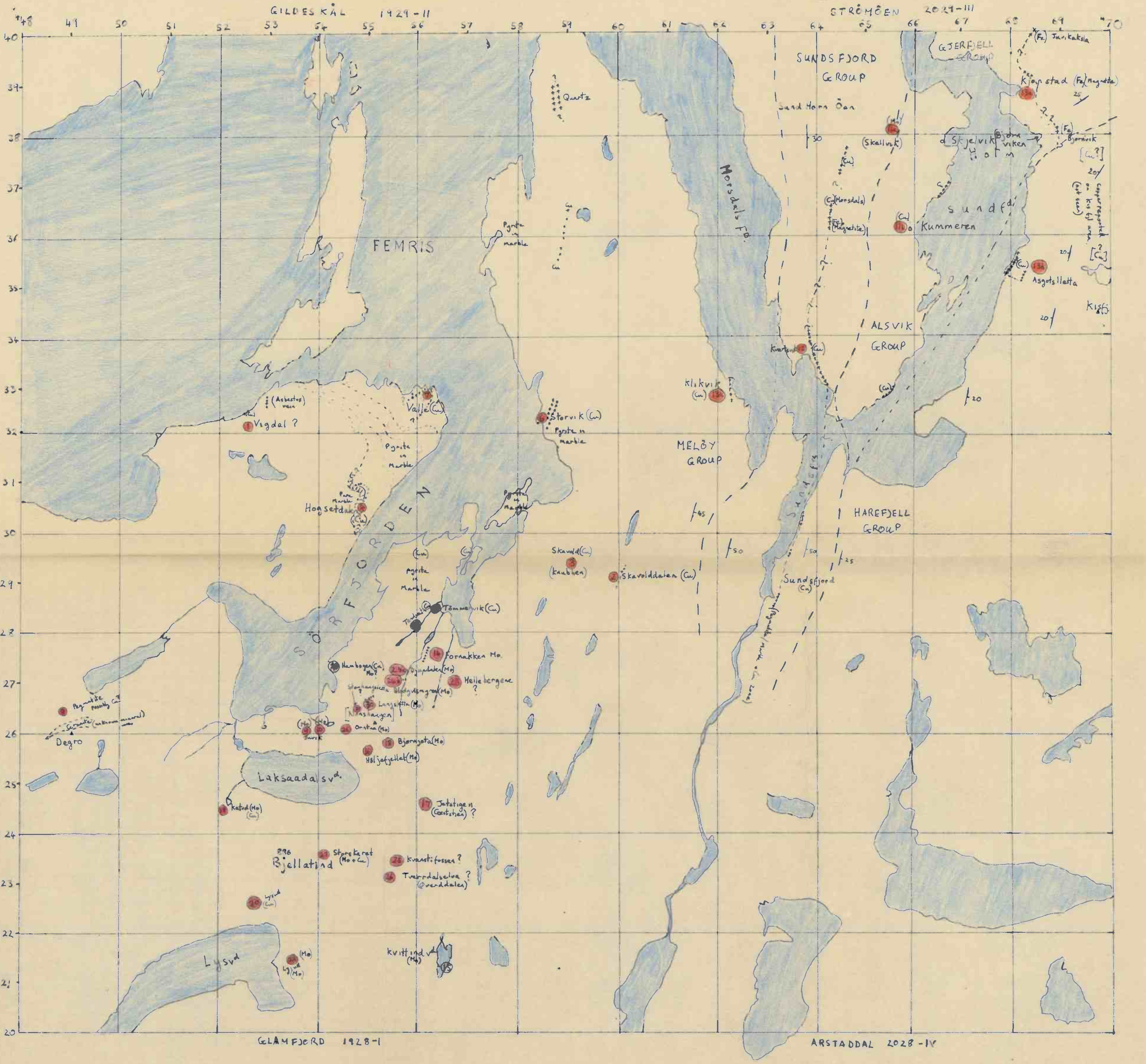
Impure Marble - 101-140

Amphibolitic Gneiss 101-23

① Southern and Northern Successions Seperated By Laksaadal Slide

② Eastern Silty Schist Successions Seperated From Bjellatind Group and Gildeskal Group By Lysvd Slide





Scale 1cm = 1km i.e. 1:50,000 [DRAWN FROM AMS MAPS] 1929-II 2029-III 1928-I 2028-IV

MAP II

Melöy Group : pelitic + semi pelitic schists & psammites (occ. calc pelites)

Sundsfjord Group : Granitised Schists & Gneiss :- (pelitic & hornblendic schists & marbles)

Alsvik Group : homogeneous mica poor felspathic schist

Gyterfjell Group : Gneisses & occ. hornblendic schists

Harefjell Group : " " "

LOCATION MAP FOR REGISTERED MINERALISATION POINTS.

H. Mason.