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Investigations in South Pasvik 1978

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F Nixon, E Kreivi, F Hansen	19.02 1979	Sulfidmalm A/S

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Malm/metall	Ni Cu	

Sammendrag

1) The discovery of nickel and copper rich ultramafic boulders seen in the light of the regional geology gives hope to finding bedrock mineralization within the area of interest.

2) Boulder tracing has located various types of ultramafic,and three outcrops have been found.

3) Magnetics seems to pick up ultramafic bodies and suggest that these lie along tectonic zones.

4) Various quaternary features suggest an irregular ice-front in the area with the possibility og several ice-transport directions.

5) At this stage of the investigaitons we do not have enough information or understanding of the area to be able to pinpoint source targest for the boulders with any degree og certainty.

6) Work will continue in 79 using more diversified geophysical methods.

Inkluderer flyfotogeologi fra Robertson Research

1 duplikat

FAGRAPPORT Fm. 351/79 FB
TECHNICAL REPORT A/S SULFID MALM

Dato/Date	Rapport Nr./Report No	Kartblad/Mapsheet	
19.2.79	494.78.23	2333 II, III	

Forfatter
Author F. Nixon, E. Kreivi, F. Hansen

Tittel/Title

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Andre relevante rapp
Other relevant reps.

472.77.23
480.78. U.S.S.R.
483.78.23
484.78.

Kommentarer/Comments

Fordeling
Distribution

- [X] Canada
- [⊗] Nikkelverket
- [⊗] Kristiansand
- [X] Oslo
- [X] SYDVARANGER
- [X] C.T.A.COATS.
- [ ]
- [ ]

INTRODUCTION

The southern portion of the Pasvik area is dominantly underlain by biotite-hornblende gneisses and migmatites of Archaen age which are regionally a continuation of the gneiss belt of the Allarachensk area in the U.S.S.R. where two nickel bearing ultramafics are mined some 40 km from the Norwegian border.

The area was partly flown by helicopter EM and mag in 1976 but did not become of immediate interest, however, until late 1977 when several blocks of heavily mineralized ultramafic were found over a small area near Rømlingås.

The boulders, which were of a peridotitic nature gave the following assays:

Sample	Ni%	Cu%	S%
79 A	3.20	0.64	10.6
79 B	3.15	1.37	11.6
79 C	4.20	1.84	13.0
80 EK	0.43	0.33	1.65
81 EK	3.47	0.53	10.8

The area of interesting boulder finds was located some 1.5 km down ice from a strong HEM Conductor and this anomaly was initially thought to be a probable source. Drilling, however, proved the anomaly to be caused by barren pyrrhotite associated with amphibolite. Subsequently the area in 1978 was subjected to more systematic exploration. The following methods being applied.

1) Boulder tracing using prospector, dog and geophysical methods. Subsequent petrographic and chemical work.

2) Geophysics. A) Regional winter geophysics; V.L.F. mag.

   B) Detail, V.L.F., shootback, mag., I.P.

3) Till geochemistry

4) Quarternary geology

5) Aerial-photo and satellite interpretation

6) Minor drilling

BOULDER TRACING

The area is heavily covered by glacial till and within the course of the prospecting work only 3 outcrops of ultramafic have been found over the area of some 120 km^2.

The dominant ice-transport direction seems to be towards NE (N 22° E).

Boulder tracing has located many ultramafic boulders. The boulders vary in size from fist size up to huge boulders of 15 x 10 m dimensions.
Many of the boulders are covered by till and vegetation and these have been discovered by use of a hand held PROXAN-EM unit.

All ultramafic boulders were given a field classification and tested in the field with D.M.G. for nickel. (A card index is on file of all ultramafic boulders.) Subsequent test work has included thin section and chemical assay.

The following field classification was used:

1) M. peridotite (olivine rich)

2) Pyroxene rich

3) Serpentine rich

4) Amphibole rich

and combinations of these four classes.

Two new areas of nickel/copper rich boulders were discovered. The first was a collection of three largish boulders of a meta peridotite located some 1800 m down ice (NE) of the initial boulder find at Rømlingås. Samples from the boulders gave the following assays:

Sample nr,	Location	Ni%	Cu%	S%
6.K M. 78	4030 W/13970 N	0.45	0.43	2.06

Microscopically this boulder is very similar to the boulders on Rømlingåsen, and may well come from the same source.

The second area is located some 1800 m SE of the Rømlingåsen where two heavily weathered boulders of a meta peridotitic rock type were discovered. Assays returned.

Sample nr.	Location	Ni%	Cu%	S%
38. EK 78	3655 W/11075 N	1.75	0.28	4.32
43. EK 78	3745 W/10952 N	3.00	0.24	8.8

A similar boulder was also discovered some 400 m to the west.

44 EK 78	4100 W/11005 N	0.62	0.60

Boulders 38 and 43 are located at the southern end of a magnetic anomaly complex and an ultramafic outcrop is also located here (37 EK 78). This outcrop is of serpentinized ultramafic and contains no sulphides.

The relation of these new boulders to the outcrop and magnetic complex is not clear. The boulders are up-ice of the anomaly and heavily weathered and probably represent a source further up-ice to the south.

In addition to the ultramafic boulders several boulders of a amphibolitic rock with quartz and barren pyrrhotite (up to 30%) have been found. Also some in the area covered by ground-geophysics, these boulders are similar to the mineralization found in hole L.B.23.77 and are thought to represent the long E.M. zones picked up by the geophysics.

After this season's boulder tracing we now have many ultramafic boulder finds in the south Pasvik area and several clear patterns have emerged, but the source of the nickel bearing boulders has of yet not been located.

The most clear "boulder train" seems to be located in the western part of the area. The first boulder in this train was located in 1977, 1.4 km west of Hauge in Vaggetem. The boulder was a metaperidotite with a weak "droplet-type" sulphide impregnation. This train has now been followed over some 20 km (towards the Russian-Finnish border) and several hundred boulders have been found. Assays indicate 0.2 - 0.3% Ni and ca. 0.3% Cu.

The boulders are especially concentrated in an area to the east of Sortbrysttjern and south towards Ellenvann. A limited number of boulders are also found south of Ellenvann.

Also on the west side of Ellenvann and to the north and west of Ødevann similar boulders have been found.

An outcrop of a similar rock type to these boulders has been located at Kranglefjell in the Pasvik National Park (74 EK 77). A similar outcrop has also been located at Rajavaara in Finland.

These rock types are dominantly medium grained, non foliated, have a (blasto) hypidiomorphic texture and are weakly magnetic.
Under the microscope the main silicates are olivine, augite with two monoclinic amphiboles (probably hornblende and kaersutite). Accessory silicates are orthopyroxene, plagioclase, biotite, garnet, apatite and spinel.
The main sulphides and oxides are pyrrhotite and ilmenite with pentlandite, chalcopyrite and magnetite as accessories.
These observations would now seem to indicate that the main source for this type of ultramafic material is located far south in Pasvik, but the spread of boulders in an east-west direction, and the two outcrops indicate that there are probably several ultramafic intrusions which lie in a belt from Finland, over Ellenvann and Kranglefjell and eastwards between Ødevann and U.S.S.R.

An outcrop of a more amphibolitized peridotite occurs some 3 km SE of Ødevann and some 700 m from the Russian border. (34 EK 79). A small boulder train of dominantly large boulders is located down ice of this outcrop. Two similar boulder concentrations some 2 and 4 km down ice may represent different sources and if so may suggest several parallel zones within this area.

Within the grid area two small trains of quartz and pyrrhotite bearing amphibolites have been outlined - these are thought to be derived from EM anomalies (one of which was drilled in 1977).

Also within the grid area small ultramafic "trains" are tentavily outlined as being derived from magnetic anomaly areas (these are thought to represent ultramafics - indeed one such anomaly has been proved by drilling).

Thus it would seem that we have in the Pasvik area boulder trains of different dimensions. This is not unexpected in this flat area of glaciation.

As of yet no clear boulder trains have been established for the nickel bearing boulders although the remarkable concentration near Rømlingås may to some suggest a local source.

Although microscopic work is still underway some conclusions can be made from the macroscopic and microscopic investigations of the boulders.
The most common boulder type seems to be what has been termed in the field meta peridotite or droplet type. These boulders are spread over the entire area but are most abundant in the south and west and comprise the long boulder trains mentioned above. Under the microscope these boulders are remarkably similar, main silicates are pyroxene-olivine and amphibole in varying amounts and the rocks fall into the general classification olivine-hornblende pyroxenites.

The nickel rich boulders, however, are essentially olivine rich with the main silicates being olivine, monoclinic amphibole and chlorite. They can be termed meta-peridotite and are clearly distinctive.

Serpentine rich ultramafic boulders are also present - especially NW of the grid area.

Various amphibole rich types are also present especially in the eastern and southern parts of the area.

Preliminary investigations of boulders thought to be derived from magnetic anomalies near to the Rømlingås boulder finds indicate a meta peridotitic variety somewhat intermediate between the nickel rich blocks and the droplet types.
The main silicates are monoclinic amphibole, olivine and monoclinic pyroxene with accessory serpentine, chlorite and carbonate, with minor ilmenite and magnetite and rare pentlandite grains.

An interesting acidic boulder located some 2 km north of Rømlingås was identified under the microscope as an oligoclase syenite with chalcopyrite, pentlandite, covellite, pyrrhotite, sphalerite, metallic Bismuth and bismusthinite. The rock assayed 0.67 % Ni and 1.12% Cu.
The examination of the boulder types is continuing and it is hoped that the present investigations will throw more light on distinguishing various types and ultimately helping to locate the sources.

GEOPHYSICAL WORK

A VLF and mag survey was carried out in winter conditions covering 154 profil kms, in an area centered in Rømlingås. The results were described in report H 38.78.23.

The main features of the VLF results were fairly long anomalies that have little or no magnetic response. Subsequent drilling and boulder tracing seems to suggest that they are caused by graphite or pyrrhotite bearing amphibolite horizons.

The magnetic anomalies are generally small circular to elongated dipole areas that often occur in clusters and have a somewhat zonal distribution.

It is thought on the basis of boulder finds and drilling that the majority of the magnetic anomalies represent ultramafic bodies.
A number of anomalies have been checked and detailed with magnetics, V.L.F. shootback, I.P. and resistivity.

Two shoot-back anomalies that were drilled were caused by graphite.

Prior to drilling I. P. and resistivity surveys were carried out over two circular magnetic anomalies on Rømlingås just south of the main block finds. The results are enclosed. Fig. shows the calculated gradient array resistivity data in ohm/m contoured with a log. contour interval. The magnetic high gives a resistivity low but the contrast to the surrounding rock types was poor. (The assumed ultrabasic apparent resistivity is about 3000 ohm/m or less. This is obviously not caused by massive ore mineralization and probably reflects the magnetite content.)

In the northern part of the surveyed area a marked resistivity low (with no magnetic expression) was picked up: - this was drilled with graphite being the cause of the anomaly.

Based on this year's experience with geophysics in Pasvik it would seem that possibly a combination of magnetics and I.P. (resistivity) is the most useful exploration tool. Magnetics seem to be able to pick up the ultramafic bodies but the supposed irregular geometry of the mineralization (compare Allarechensk) seems better suited to I.P. or even PEM, than the V.L.F. or shootback EM methods.

A detailed analysis of all 1978 geophysical data is now underway and any new features will be reported as an appendix to this report.

Plans for winter 1979 include more regional magnetics to cover as much as possible of the area between the U.S.S.R. and the National Park.

GEOCHEMICAL INVESTIGATIONS

Till sampling was carried out over several of the magnetic targets outlined during the winter geophysics. Samples are being assayed by the Sydvaranger company and the results will be reported as an appendix to this report.

QUARTERNARY GEOLOGY

A study of the available literature and our own investigations seem to show the inland ice over the interior of Pasvik and adjacent Finnish and Russian territories moved mainly towards NNE and NE.

There is some evidence from the region that the main direction of ice flow may have gradually turned from NNE - NE towards N as the deglaciation proceeded possibly over a long time interval. Ice movement co-inciding with a still later deglaciation phase seems to have been generally towards NNE - NE and thus co-incident with the oldest of the deglaciation stages.

Still later, however, the ice movements seem to have been highly influenced by various local topographical circumstances as the ice successively disappeared.

The area is covered by varying thicknesses and types of glacial and glacio-fluvial deposits.

Hummocky moraines are a common feature, their heights vary and they consist of sandy moraine and surface boulders which can be up to 4 - 5 m in diameter. In places the concentration of boulders is so large as to completely cover underlying material.

Ice directed drainage is marked by various eskers. The main esker orientation is NNE, but some eskers have been interpreted as having a E - W orientation (aerial photo interpretation).
A large esker runs from the delta formed Tomamoen northwards many kilometers. Just north of Tomamoen it is connected to an eastern esker branch which continues southwards to a further esker in the upper (Russian) reaches of the Pasvik valley.

The Tomamoen glacio-fluvial delta received material from the SSW via a 15 m deep canyon. With the exception of drainage channels and a few small kettles the deposit has an even terrace surface which gradually assumes esker form in the north.

Another important feature in the area are De Geer moraines which have been recognized west of Vaggatem and to the north and east of Tomamoen. The ridges near Vaggatem are 2 - 5 m high, 15 - 20 m wide and strewn with sharp slightly rounded boulders up to 1.5 m in diameter. The direction and pattern of these ridges would tend to suggest that they were deposited by a glacier from the west whilst the area to the east was an open fjord area.

De Geer moraines in the south to the N and NE of Tomavann run slightly parallel to the large Tomamoen esker and appear to be concave to the NW.

The pattern of these moraines in the area may indicate a very irregular shaped ice front with a calving bay in the area between Vaggatem and Tomamoen and may also indicate that ice movement in the very late stages of deglaciation has been controlled by local conditions and may be quite different from the general ice direction.

It is felt that these late deglaciation activities are very important when considering the source of boulders in the area and more detailed investigations will be carried out on this matter in the coming season.

AERIAL PHOTO INTERPRETATION

A fracture and lineation interpretation of the entire Pasvik region has been carried out by Robertson Research. Their report is enclosed as appendix 1.

DIAMOND DRILLING

Although no drilling was planned for the 1978 season the opportunity arose to drill a limited meterage in Pasvik using a machine taken down from Sydvarangers iron-ore operations in Kirkenes.

It was decided to test three geophysical anomaly targets in the detailed grid area.

Hole 1SP was drilled on a magnetic anomaly south of the main boulder finds. It was suspected that the anomaly was caused by an ultramafic. Drilling confirmed the presence of ultramafic but no sulphides were found.

Hole 2SP was put down on a strong shoot back EM and resistivity anomaly just north of the magnetic anomaly drilled by 1SP. The cause of the anomaly was graphite.
Hole 3SP was drilled on a shootback EM anomaly with weak magnetic association. The anomaly was found to be caused by a magnetic bearing graphitic horizon.

Although no mineralization was intersected by the three short drillholes. the program did throw some light on the cause of various anomaly types and also gave some interesting intersections of the bedrock of the area, proving the existence of the ultramafic material.

Drill logs are attached.

31.1.79

CONCLUSION AND DISCUSSION

Based on the available information so far accumulated in the south-Pasvik area four important and significant facts are worthy of comment.

1) The discovery of nickel and copper rich ultramafic boulders seen in the light of the regional geology gives hope to finding bedrock mineralization within the area of interest.

2) The presence of numerous ultramafic boulders within the area and the discovery of three ultramafic outcrops strengthens the hope expressed in point 1).

3) The fact that magnetic measurements seem to be able to pick up ultramafic bodies is highly significant and encouraging. The possibility that the magnetic anomalies may lie along tectonic zones is also significant.

4) The recognition of various quaternary features (De Geer moraines) that suggest an irregular ice-front and thus the possibility for some ice-movement in a different direction then the main transport is important.

At this stage of the investigations we do not have enough information or understanding of the area to be able to pinpoint source targets for the boulders with any degree of certainty.

Some interesting targets (magnetic anomalies with E.M. association) do exist, but it is felt that a continuation of the methods employed so far is necessary to complete our understanding of the situation.

Work on the classification of the boulder finds and their relationship to the magnetic pattern will give us a better understanding of the ultramafic distribution, and it is felt that a clear understanding of the quaternary situation is essential to an unravelling of the various boulder trains especially the implications of a possible calving bay in the area of interest - as this could mean ice-transport at right angles to the main general direction that has so far been the basis of the boulder tracing efforts.

Work on all these aspects is and will continue in 1979.

A/s SULFIDMALM

DIAMOND DRILL RECORD

LOCATION: 450 S/60 W BEARING: N80E DIP: 60° HOLE NO: 1/SP/78 SHEET NO: 1a

LOGGED BY: E.K. STARTED: 17.10.78 PROPERTY South Pasvik

CASING: 12 m FINISHED: 26.10.78 Romlingås

CORE SIZE: T 32 mm TESTS (CORRECTED):

From	To		Description
0	7.35		Overburden
7.35	29.90		Meta-peridotite (olivine-pyroxene - amphibole)
			- no sulphides
			very magnetic
			14.35 - 16.20 Chlorite rock.
29.90	38.00		Quartz - feldspar gneiss - thin amph - mica. bands.
	38.00		End of hole.

Core angles

7.70	55°	Foliation
11.60	50°	"
11.80	33	Fault
12.70	28	"
14.20	16	Contact
15.30	47	Foliation
16.40	0	Fault
18.50	40	Foliation
20.30	48	"
27.90	48	"
30.30	70	"
33.40	70	"
36.50	68	"

The meta-peridotite is obviously the reason for the strong mag. anomaly. The rock is similar to the weathered blocks just north of this and similar magnetic anomalies on Rømlingås. Also similar to the ultramafics in the area of Korsvann - Lille Føllvann farther to the NW.

E. H. A.s 5000 5 73

A/s SULFIDMALM

DIAMOND DRILL RECORD

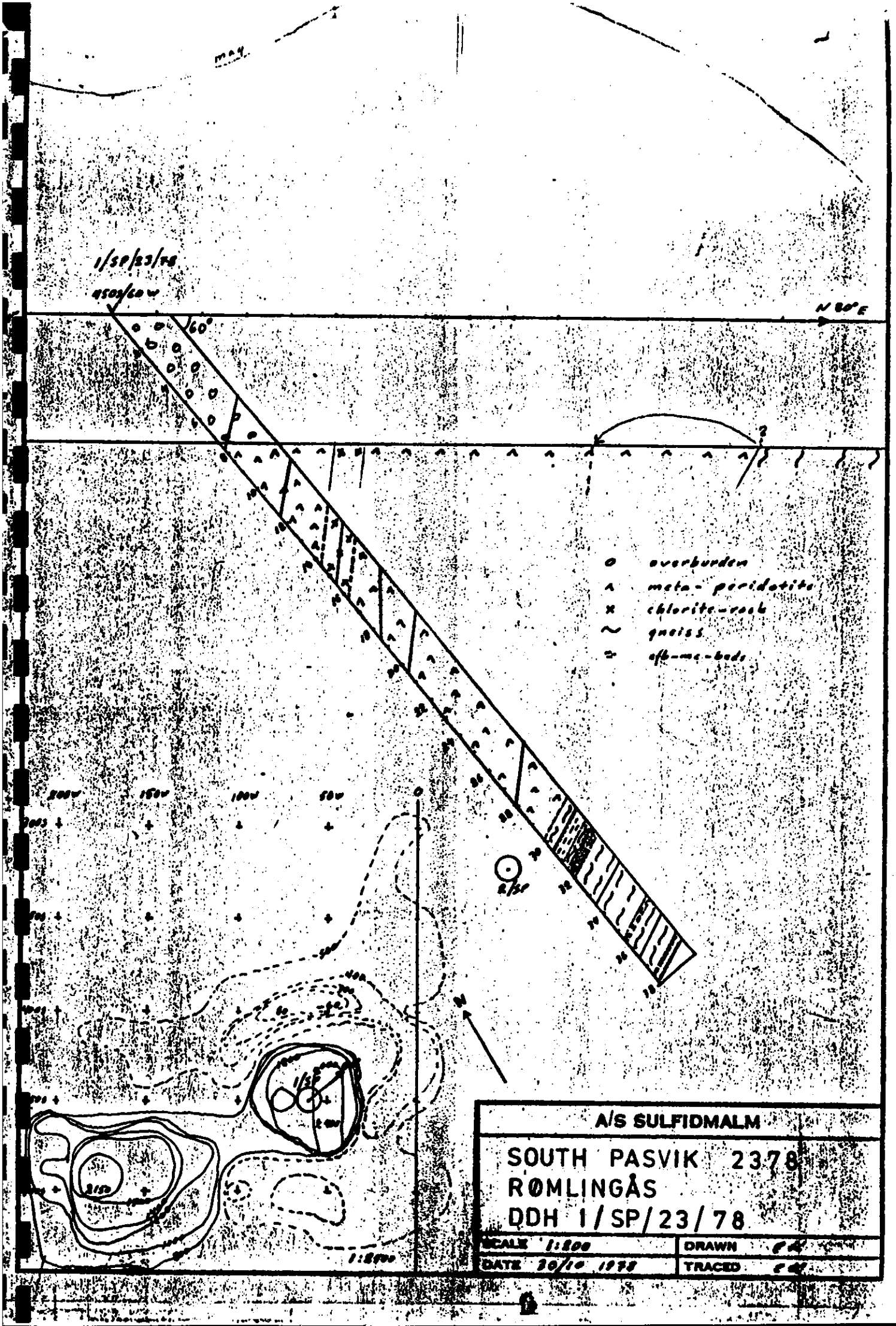
LOCATION: 450 S/60 W BEARING: N80°E DIP: 60° HOLE NO: 1/SP/78 SHEET NO: 1

LOGGED BY: E.K. STARTED: 17.10.78 PROPERTY South Pasvik

CASING: 12 m FINISHED: 26.10.78 Romlingås

CORE SIZE: T 32 mm TESTS (CORRECTED):

From	To		Description
0	7.35		Overburden
			Large blocks in till.
			0 - 1.5 Blocks of garnetiferous medium grained,
			very schistose amphibolite, with rare po.
			1.5-7.35 One block of m.gr. amphibolite.
			Several blocks of qtz.fel. gneiss similar to the
			outcrops in the general area.
7.35	29.90		Meta-peridotite
			Main minerals are olivine, pyroxene and amphibole with some
			serpentine. The rock is med. gr. homogeneous, very dark in
			colour, weak foliation, very magnetic with no trace of sulphides.
			Partly very broken especially 7.35 - 12.00.
			14.20 - 14.35 Qtz. vein.
			14.35 - 16.20 Chlorite rich zone light green in colour and
			fairly massive.
29.90	38.00		Quartz-feldspar-gneiss.
			The contact with the meta-peridotite is quite sharp, slightly
			brecciated with an increase in amphibole and chlorite.
			The gneiss is light in colour, med. gr. and homogeneous,
			the main minerals being quartz, feldspar and some mica.
			The rock is cut by several narrow amphibole - mica bands.
	38.00		End of hole.


1/SP/23/78
050°/60°W
60°
N 80° E
overburden
meta-peridotite
chlorite-rock
gneiss
ofb-mc-bods
200W
150W
100W
50W
1:800
A/S SULFIDMALM
SOUTH PASVIK 2378
RØMLINGÅS
DDH 1/SP/23/78
SCALE 1:800
DRAWN
DATE 30/10 1978
TRACED

A/S SULFIDMALM

DIAMOND DRILL RECORD

LOCATION: 325S/50 E BEARING: ..... DIP: 90° HOLE NO: 2/SP/78 SHEET NO: 1a

LOGGED BY: E.K. STARTED: 30.10.78 PROPERTY South Pasvik

CASING: 10 m FINISHED: 7.11.78 Rømlingås

CORE SIZE: T2 32 mm TESTS (CORRECTED): .....

From	To		Description
0	10.00		Overburden
10.00	17.30		Quartz-feldspar gneiss.
17.30	18.20		Mica-gneiss.
18.20	18.83		Quartz-feldspar gneiss.
18.83	23.95		Mica gneiss - some cp. specks.
23.95	47.45		Amphibolite - weak magnetic response
			30.55 - 33.10. Thin graphitic layers + magnetite.
47.45	47.65		Granitic rock.
	47.65		End of hole.
			The thin graphitic layers could be the source of the shoot-back E.M. anomaly.

E. H. A.s 5000 5 73

A/s SULFIDMALM

DIAMOND DRILL RECORD

LOCATION: 325 S/50 E BEARING: ..... DIP: 90 HOLE NO: 2/SP/78 SHEET NO: 1

LOGGED BY: E.K. STARTED: 30.10.78 PROPERTY South Pasvik

CASING: 10 m FINISHED: 7.11.78 Rømlingås

CORE SIZE: T2 32 mm TESTS (CORRECTED): .....

From	To		Description
0	10.00		Overburden.
			Large blocks in the till, mainly blocks of quarts-feldspar gneiss and some garnetiferous amphibolite.
.00	17.30		Quartz-feldspar-gneiss.
			Main minerals are quartz, white or slightly pinkish feldspar, some mica and amphibole.
			Well folicated, in parts brecciated by feldspar. Several mica and amphibole layers.
			Non magnetic and no conductive layers.
			10.70 - 11.05 Fel. breccia.
			10.75 - 10.83 Amph-mica layer
			11.05 - 11.15 ----"------
			14.04 - 14.58 Fel. breccia.
			14.58 - 14.77 Mica-amph layer.
17.30	18.20		Mica-gneiss.
			Main minerals are feldspar quartz and mica with some amphibole. Med. gr. non-magnetic.
.20	18.83		Quartz-feldspar gneiss (as above)
.83	23.95		Mica-gneiss, as above but with odd speck of cp.
			19.50 - 19.64 Qtz - fel. breccia.
			20.00 - 20.40 Amph. rich, some brecciation cp (rare)
			22.65 - 22.90 Amph rich layer.
			23.87 - 23.93 Fel. breccia.
.95	47.45		Amphibolite.
			Garnetiferous, fine grained, some feldspar and mica rich layers.

A/S SULFIDMALM

DIAMOND DRILL RECORD

LOCATION: 325 S/50 E BEARING: ..... DIP: 90° HOLE NO: 2.SP.78 SHEET NO: 2

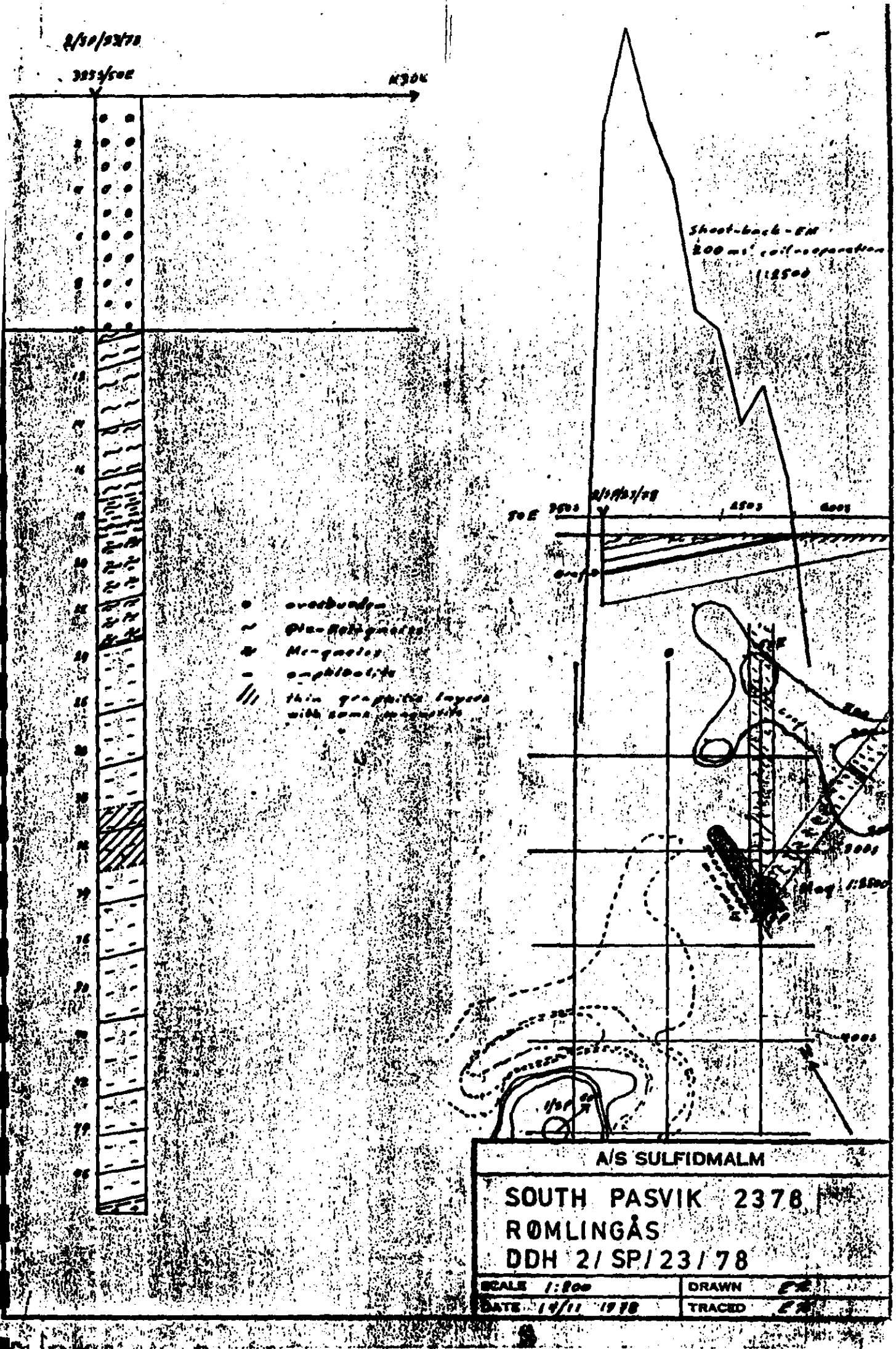
LOGGED BY: E.K. STARTED: 30.10.78 PROPERTY South Pasvik

CASING: 10 m FINISHED: 7.11.78 Rømlingås

CORE SIZE: T2 32 mm TESTS (CORRECTED): .....

From	To		Description
23.75	47.45		Occasional weak po. impregnation.
			Slightly magnetic.
			30.55 - 33.10. Thin graphite-rich layers with some magnetite.
47.45	47.65		Granitic rock.
			Main minerals quartz and feldspar.
			Some garnets med. gr.
	47.65		End of hole.
			Core Angles
			10.50 83 Foliation
			11.70 74 "
			14.30 77 "
			16.40 78 "
			18.50 79 "
			21.80 77 "
			23.70 77 "
			26.50 77 "
			28.40 77 "
			31.50 80 "
			34.50 79 "
			36.40 77 "
			39.50 80 "
			42.80 78 "
			44.40 82 "
			46.00 80 "
			47.40 78 "

E. H. A.s 5000 5 73


Shoot-back-EM
200 m coil-separation
1:2500
A/S SULFIDMALM
SOUTH PASVIK 2378
RØMLINGÅS
DDH 2/SP/23/78
SCALE 1:200
DRAWN
DATE 14/11 1978
TRACED

A/s SULFIDMALM

DIAMOND DRILL RECORD

LOCATION: 10500 N/5960 W BEARING: ..... DIP: 90 HOLE NO: 3/SP/78 SHEET NO: 1a

LOGGED BY: E.K. STARTED: 9.11.78 PROPERTY South Pasvik

CASING: 18.00 FINISHED: 15.11.78 Bjørntjern

CORE SIZE: 32 mm TESTS (CORRECTED): .....

From	To		Description
0	17.50		Overburden
17.50	27.55		Mica gneiss
			22.90-27.55 Graphite and megnetite rich bands. 2% po.
27.55	37.60		Amphibolite
			30.50 - 30.80 Thin graphite bands 5% po + mt
			31.33 - 31.53 -------"---------- some mt
			37.45 - 37.60 -------"----------
37.60	40.00		Mica gneiss.
40.00	49.10		Amphibolite.
49.10	50.20		Mica gneiss.
	50.20		End of hole.
			The graphite and magnetite explain the strong EM and weak MAG anomalies.

E. H. A.s 5000 5 73

A/S SULFIDMALM

DIAMOND DRILL RECORD

LOCATION: 10500 N/5960 W BEARING: ..... DIP: 90 HOLE NO: 3/SP/78 SHEET NO: 1

LOGGED BY: E.K. STARTED: 9.11.78 PROPERTY South Pasvik

CASING: 18.00 FINISHED: 15.11.78 Bjørntjern

CORE SIZE: 32 mm TESTS (CORRECTED): .....

From	To		Description
0	17.50		Overburden
			0 - 10.00 Sand.
			10.00 - 17.50 Blocks of mica gneisses and some amphibolites, quite light in colour. One block of graphite with 80% po.
.50	27.55		Mica gneiss.
			Mica - quartz with some feldspar. Some garnetiferons and amphibole rich layers.
			17.50 - 20.00 Feldspar and amphibole rich with some garnets and odd po.
			20.15 - 21.90 2% po. impreg.
			22.53 - 23.05 Amph -feldspar rich.
			22.90 - 27.55 Graphite and magnetite banded with some 2% po.
.55	37.60		Amphibolite.
			Garnetiferons, feldspar banded, some magnetite and odd po.
			27.50 - 27.60 Fractured
			28.20 - 27.30 "
			29.23 - 29.30 Qtz band
			30.50 - 30.85 Thin graphite bands with 5% po and some mt.
			31.33 - 31.53 Graphite bands + mt.
			31.55 - 31.65 Qtz - feldspar layer
			32.80 - 32.85 -------"----------
			33.50 - 33.75 10% po.
			33.50 - 33.75 Mica gneiss
			34.32 - 35.10 -----"-----
			37.45 - 37.60 Graphite bands + mt.
.60	40.00		Mica gneiss - fine gr. main minerals quartz - feldspar and mica.

A/s SULFIDMALM

DIAMOND DRILL RECORD

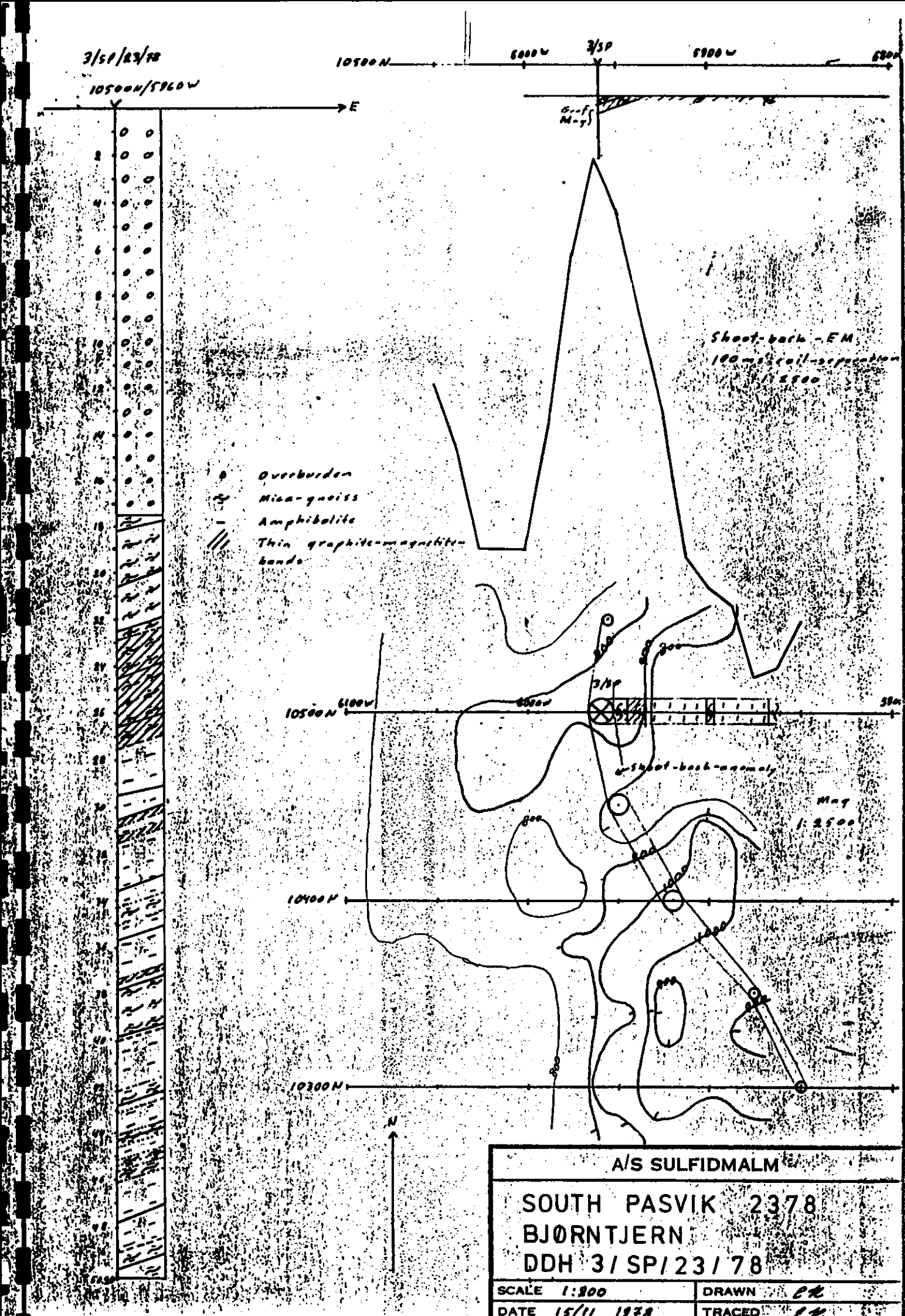
LOCATION: 10500 N/5960 W BEARING: ..... DIP: 90 HOLE NO: 3/SP/78 SHEET NO: 2

LOGGED BY: E.K. STARTED: 9.11.78 PROPERTY South Pasvik

CASING: 18.00 FINISHED: 15.11.78 Bjørntjern

CORE SIZE: 32 mm TESTS (CORRECTED): .....

From	To		Description		
0.00	49.10		Amphibolite (as above)		
49.10	50.20		Mica gneiss (as above)		
	50.20		End of hole		
			Core angles		
			18.20	77	Foliation
			20.60	64	"
			22.50	72	"
			24.50	70	"
			26.60	73	"
			29.50	78	"
			30.50	71	"
			33.60	70	"
			35.70	72	"
			37.80	71	"
			39.80	73	"
			42.80	71	"
			44.30	73	"
			47.80	68	"
			49.80	71	"

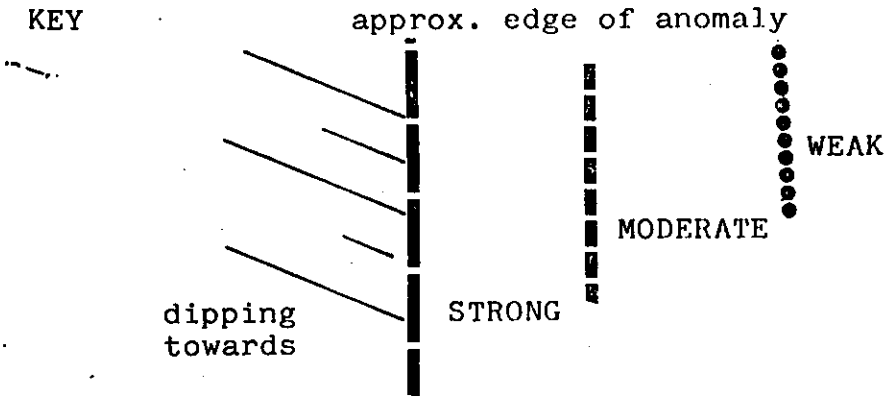

3/SP/23/78
10500N/5960W
E
10500 N
6000W
3/SP
5900W
6800
Surf
Mag
Shoot-back - EM
100 m coil-separation
1:2500
Overburden
Mica-gneiss
Amphibolite
Thin graphite-magnetite-bands
10500N
6100W
6000W
3/SP
5800
Shoot-back-anomaly
Mag
1:2500
800
900
1000
1100
10400 N
10300 N
N
A/S SULFIDMALM
SOUTH PASVIK 2378
BJØRNTJERN
DDH 3/SP/23/78
SCALE 1:200
DRAWN
DATE 15/11 1978
TRACED

LIST OF ENCLOSURES

1. Summary map of results.	1:20000.
2. Aerial photo of boulder area showing glacial features.	1:20000.
3. V.L.F. dip angle winter survey.	1: 7500.
4. Magnetic winter survey.	1: 7500.
5. Appendix 1. Crone shootback results.	1: 7500.
6. Mag. survey Rømlingås showing area covered by resistivity survey.	1: 2500.
7. Rømlingås resistivity survey.	1: 2500.
8. Rømlingås I.P. profile 50W. 50m.dipoles.	
9. " " " " 25m "	
10. " " " " 12.5m "	
11. " " profile 450S. 25m. dipoles.	
12. " " profile 150W. 25m. dipoles.	
13. Appendix 2. Report on photointerpretation of the Pasvik area by Robertson Research.	
13A. Fracture pattern. Southern area.	1:50000.
13B. " " Northern area.	1:50000.

Appendix 1. Crone EM. horisontal shootback measurements.

The enclosed map shows interpretated conductor-traces from CHSB measurements. Coil sep. 100m.,frequency 1830Hz.(med. freq)



All the anomalies found in the area are in general striking N - S, and are indicating shallow and gently dipping conductors.
Depth seems to be from 5-15 m.
Dip estimates 10-40 west.
The general anomaly complexity suggests source to consist of several narrow sones. This makes both depth and dip determination ineffective.

The anomalies are interpreted as graphite and/or po. horisons.

Based on this seasons work the shootback is not now considered a suitable tool for follow up work in this area.

REPORT ON PHOTOINTERPRETATION OF THE PASVIK AREA NORWAY

Report No. 6019

by

N.B.Brown B.Sc.

Project No. RRES/A/789/51-353

Prepared for:-

A/S Sydvaranger,
Prospekteringskontoret,
Nordraaks Vei 2 - 1324 Lysaker,
Norway.

Prepared by:-

Robertson Research International Ltd.,
Ty'n-y-Coed,
Llanrhos,
Llandudno LL30 1SA,
Gwynedd,
North Wales.

CONTENTS

Accompanying maps

I

INTRODUCTION

This project was commissioned by A/S Sydvaranger following discussions between Mr. N.B. Brown of Robertson Research International Limited and Messrs. T.L. Svederup and K. Mølk of A/S Sydvaranger together with their Consultant Prof. J. Bugge.

The terms of reference were to carry out photointerpretation over the area defined using the 1:20.000 scale photos provided with particular attention to the tectonic features of the area such as faults, fractures, lineations and their intersections.

Accordingly, interpretation was carried out, the compilation scale and basis chosen having been 1:50.000 as overlays to the two paper-based geological map sheets provided. The planimetric base of those sheets had been derived from airphotomosaics at that scale (original scale 1:20.000).

A/S Sydvaranger had provided airphotos, a composite airphotomosaic, Landsat photographs with an interpretation report, an airborne geophysical report with maps and several geological reports. Using the geophysical data in conjunction with the interpretation of faults, fractures and lineations areas of potential further interest were compiled at a scale of 1:100.000.

At the meeting in London it had not been required that the overall geology be interpreted since further fieldwork was to be carried out. However, the main esker and moraine fields have been delineated in order to show their relationship to the overall pattern of lineation.

INTERPRETATION

The overall grain of the total lineation field is dominated by the NE-SW trend of glacial erosional and depositional features. In many places this grain coincides with and is undoubtedly influenced by lithology and shearing or fracturing. It would have been preferable if the grain due to glacial lineation alone could have been eliminated thus leaving a "residual total fracture field", but this proved impossible.

Features marked on the maps are as follows :-

1. Major or extended faults, fractures or lineations.
2. Lineations, joints and fractures.
3. Main scarps associated with good outcrop or subcrop.
4. Main esker and moraine fields.

Compilation has been based directly on the planimetric base of the geological maps provided, rather than the reduced scale airphotomosaic and hence there may be minor scale differences between the total lineation overlays and that mosaic. However, it seemed more relevant to compile on this basis since the overlays can more readily be fitted to the geological and the geophysical maps at 1:50.000.

Inspection of the overlays shows the relative areas of outcrop and subcrop displaying lineation and the assumption has been made that the greater the lineation density is, the greater is the probability of outcrop or subcrop with relatively shallow soil, even in those areas of heavy tree cover. In those areas covered by glacial outwash soils, it is still possible to delineate main fracture directions from drainage directions and differences in the soil textures.

A comparison of the total lineation field has been made with the magnetic and electromagnetic survey results of Terratest AB, and Figure I shows at a scale of 1:100.000 the locations of zones of potential interest. These zones have been chosen on the following criteria :-

a. abundance of lineations or fractures.

b. intersection zones of (a).

c. coincidence of the lineations and the structural trends of the geophysical (magnetic or electromagnetic) anomalies.

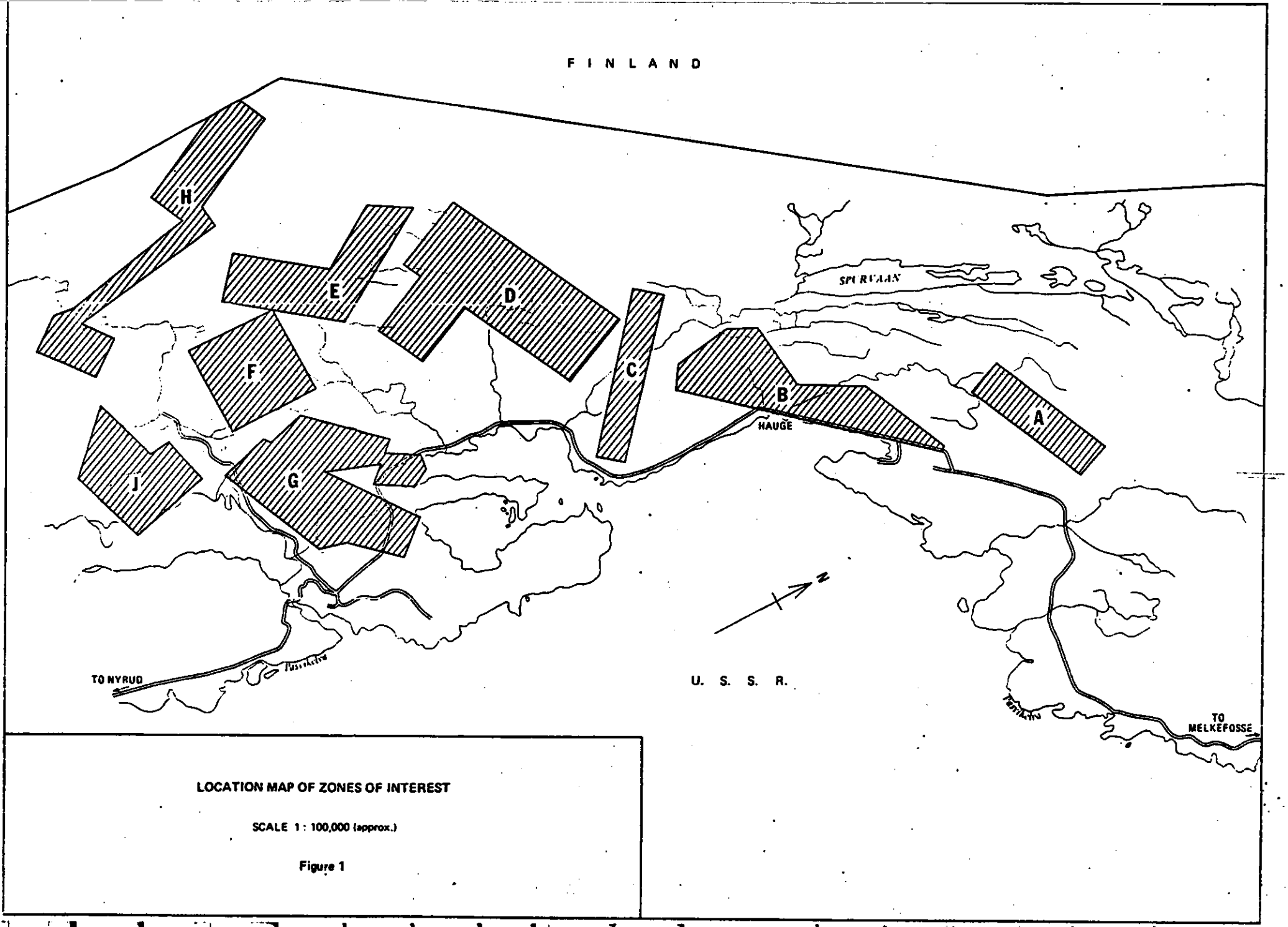
d. coincidence of (b) and (c) above with steep aeromagnetic gradients.

CONCLUSIONS

The tree and soil cover and the density of ground observations provided are such that the structural geology and lithological boundaries cannot be determined with adequate accuracy. Further, the hypothesis of a "mantled gneiss dome" to the east of Villrenvann cannot be substantiated by the fracture distribution. It must be assumed that this hypothesis derived from the arcuate disposition of magnetic anomalies and the presence of the few field observations then available. Nevertheless, a conjunctive use of the total lineation distribution with the geophysical results leads to the selection of Zones A through J of Figure 1.

The mode of further examination in these zones is at present difficult to suggest since the results of the 1978 field mapping are not yet available. However, we may suggest that the following proceedure be considered.

1. That with your foreknowledge of the fieldwork carried out in 1978, the areas of greatest lineation density or intersection interest be considered for a more intensive field checking during 1979.
2. That the field checking should involve geochemical sampling in stream sediment or bedrock.
3. That those areas having significant geological, geochemical or geophysical interest are subjected to more detailed EM or IP ground surveys.



LOCATION MAP OF ZONES OF INTEREST

SCALE 1 : 100,000 (approx.)

Figure 1

FAGRAPPORT
TECHNICAL REPORT

A/S SULFIDMALM

Dato/Date	Rapport Nr./Report No	Kartblad/Mapsheet	
12.3.79.	494.78.23 appendix 3	2333 II,III	

Forfatter
Author F.Nixon

Tittel/Title

I.P effect,conductivity and magnetic susceptibility measurements on 11 ultramafic boulders from Pasvik.

Resyme/Summary

The magnetic susceptibility measurements are fairly similar and appear to be non-selective in picking out mineralized targets.

The I.P. effects are generally high and all the samples give a good effect with the exception of samples 18KM and 26EK.

Conductivity seems to give good contrasts.

Based on these few samples it would seem that detailing of magnetic/geochemical targets would be best carried out by a method selective to conductivity.

Andre relevante rapp
Other relevant reps.

472.77.23
480.78.USSR.
483.78.23.
484.78.
494.78.23.

Kommentarer/Comments

Fordeling
Distribution

- [ ] Canada
- [ ] Nikkelverket
- [X] Kristiansand
- [ ] Oslo

A/S SULFIDMALM

INTRODUCTION

A selection of 11 ultramfic samples from the Pasvik program have been tested in the laboratory for the following parameters: I.P. effect, conductivity and magnetic susceptibility.
Prior to the measurements the samples were soaked in water for 2 weeks, and then dried.

Conductivity was measured using 1000 p/s alternating current whilst the I.P. measurements were carried out with electrical impulses of 2 seconds duration with measurements being taken 0.21 seconds after electrical break.

Both I.P. and conductivity measurements were taken in three different directions and the quoted results are an average of these three readings, Most samples have had measurements taken on two different parts of the sample (a,b,)
The uncertainty for the I.P. measurements is ca. 10 %, conductivity 50% and susceptibility 20%.

The work was carried out in the geophysical laboratories of the Norwegian Geological Survey.

RESULTS

		I.P. %	Conduc (ohm.m)	Suscep
Sample 3 GK 78	A	25	5500	6×10^{-4}
	B	11	1500	5×10^{-4}

Dark med.gr. massive, weakly magnetic with no visible sulphides.

		I.P. %	Conduc	Suscep
Sample 3 LN 78	A	16	1500	70
	B	16	1500	60

A greyish massive med.gr. amphibole rich ultramafic strongly magnetic and with 2-3 % sulphides as a spotty dissemination.

Ni %	Cu %	S %
0.22	0.28	1.48

Sample 17 KM 78		I.P. %	Conduc	Suscep.
	A	27	4800	20
	B	26	5000	20

Coarse gr.massive anthophyllite rich ultramafic weakly magnetic with 1-2% even dissemination of po.

A/S SULFIDMALM

Sample 18 KM 78	I.P.%	Conduc	Suscep
	4.4	20.000	30

Dark fine-med.gr. massive amphibole rich ultramafic moderately magnetic with slight po. dissemination

Sample 26 EK 78		I.P. %	Conduc	Suscep
	A	7.4	4.000	5
	B	5.7	5.000	20
	C	4.1	4.500	3

Med-coarse gr. massive ultramafic, primary pyroxenes in a brownish ground mass. Weakly magnetic with a few sulphide specks.

Sample 32 EK 78		I.P.%	Conduc	Suscep
	A	75	30	80
	B	45	600	30

Med.gr. massive ultramafic pyroxenes enveloped by fine gr. amphiboles and serpentine moderately - to strong magnetic with weak fine grained pyrrhotite dissemination.

Sample 44 EK 77		I.P. %	Conduc	Suscep
	A	27	17.000	1
	B	17	21.000	0.5

Dark med.gr. massive ultramafic with even gr.texture, rounded brown pyroxene (some olivine) in a green amphibole matrix. Weakly magnetic with odd. Sulphide blebs.

Sample 79 EK 77		I.P. %	Conduc	Suscep.
	A	67	0.2	50
	B	68	0.2	40

Med gr. olivine rich m.peridotite , strongly magnetic with 20-30% fine-med gr. sulphide dissemination.

Ni	Cu	S
3.15	1.37	11.6

Sample 106 EK 77	I.P.	Conduc	Suscep.
	15	400	40

Med.gr. olivine - pyroxene - hornblendite, moderately to strongly magnetic with no visible sulphides.

Sample I.SP. 78	I.P.%	Conduc	Suscep.
Top	50	22	60
Bottom	54	650	40

Samples from top and bottom of ultramafic intersected in drill hole 1.SP.78. A med.gr. massive olivine-pyroxene-hornblendite with development of serpentine. Strongly magnetic with no visible sulphides.

Ni	Cu	S
0.16	0.02	0.24

Comments

General comments based on the available information whould tend to suggest that the only parameter which gives good contrast is the conductivity. The magnetic susceptibility measurements are fairly similar and appear to be non-selective in picking out mineralized targets. The I.P. effects are generally high and all the samples give a good effect with the exception of samples 18 KM and 26 EK.

Based on these few samples it would seem that detailing of magnetic/geochemical targets would be best carried out by a method selective to conductivity.

9.3.79
FN/em

RAJAVAARA

VAGGETEM

ELLENTJERN

ROAD

KORSVANN

SORTBRYSTTJERN

GJØKÅSEN

GJØKVANN

ROMLINGÅS

BLANKKVANN

BJØRNTJERN

TOMMASVANN

ELLENVANN

SKINNPOSE VANN

PARVANN

ØDEVANN

RAJTAKURU

GRENSEVANN

GRENSEFOSS

PASVIK RIVER

U.S.S.R.

FINLAND

National Park

diabase

MAIN ICE MOVEMENT

N

LEGEND:

○ OUTCROP
- ULTRAMAFIC
- GRANITIC GNEISS
- MICA SCHIST
- AMPHIBOLITE

△ BOULDER
- OLIVINE RICH NI BEARING META PERIDOTITE
- NI BEARING OLIGOCLASE SYENITE
- OLIVINE-HORNBLENDE-PYROXENITES (DROPLET TYPE)
- AMPHIBOLITIC ROCK WITH QUARTZ AND PO.

- AMPHIBOLE RICH ULTRAMAFIC BOULDER
- SERPENTINIZED " "
- PYROXENE RICH " "
- OLIVINE RICH " "

△ NI BEARING BOULDER (ASSAY OR D.M.G.)

23EK78 SAMPLE NUMBER

⊢33 DIP AND STRIKE OF OUTCROP

HELICOPTER MAGNETIC ANOMALY

GROUND " "

HELICOPTER E.M. ANOMALY

GROUND " "

DE GEER MORAINES

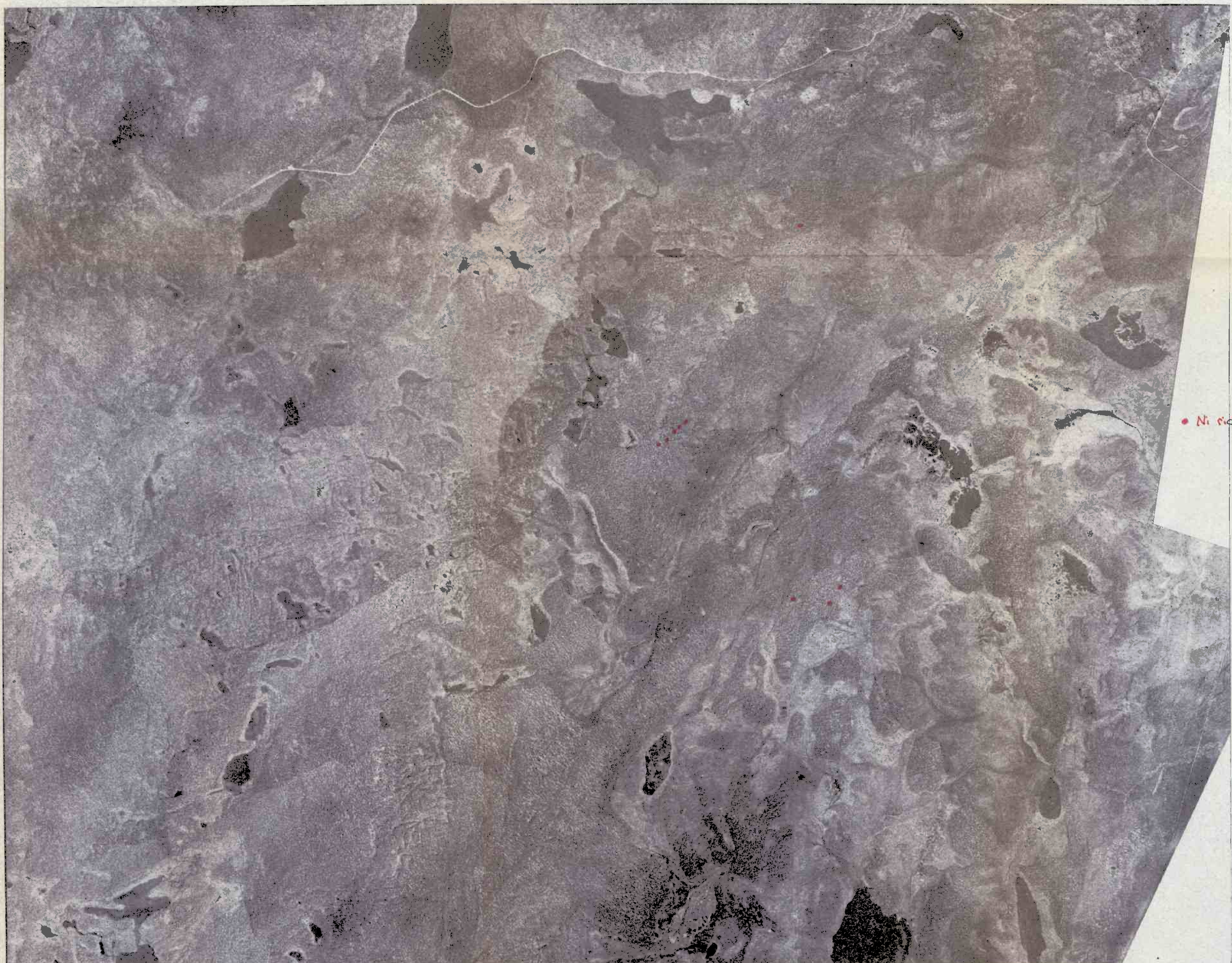
ESKER

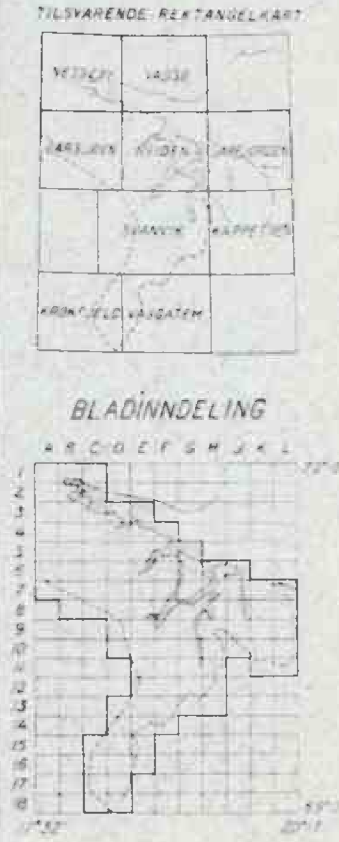
SORTED DEPOSITS OF TOMMAMOEN DELTA

South Pasvik Summary map Bouldertracing 1977, 1978	Scale 1:20,000	Obs. EK,KM 77-78	
		Draw. EK, LN " "	
		Trac. LN 1-79	
		Chk.	
	Map. no.		
A/S Sulfidmalm	23-79-E2		
	Map. sheet		

FOTOGRAFISK MOSAIKK
ÖVER
SØR-VARANGER

BL. 17 D





18°25' ØST OSLO

Fremstilt av WIDERØE'S FLYVESELSKAP A/S
på grunnlag av bilder opptatt juli 1957

KEY MAP Scale 1:100000

SOUTH PASVIK 23 N 1:5000

V.L.F. DIP ANGLE

% SULPHIDHALM

KEY MAP Scale 1:100000

SOUTH PASVIK 23 N 1:5000

V.L.F. DIP ANGLE

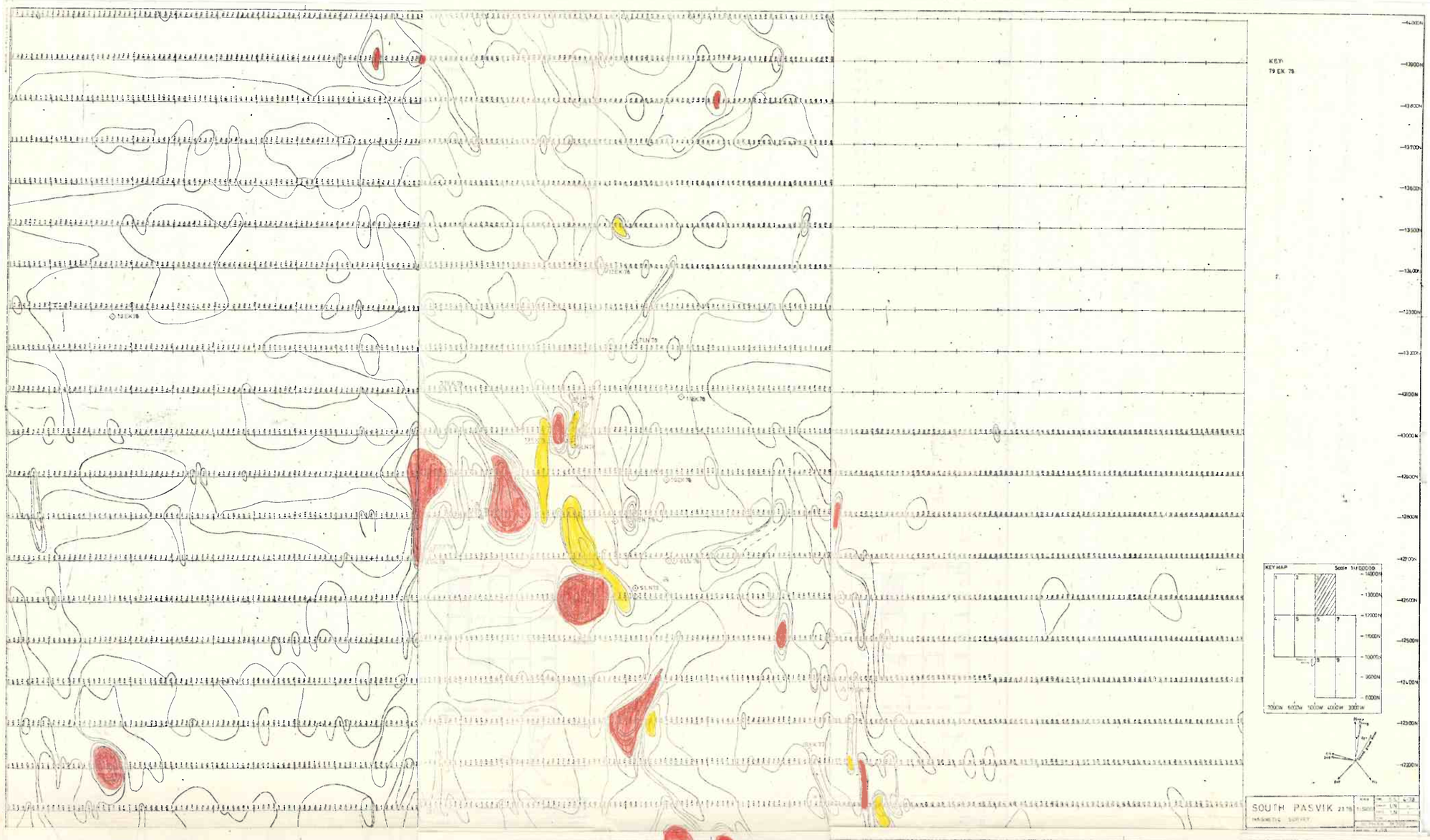
% SULPHIDHALM

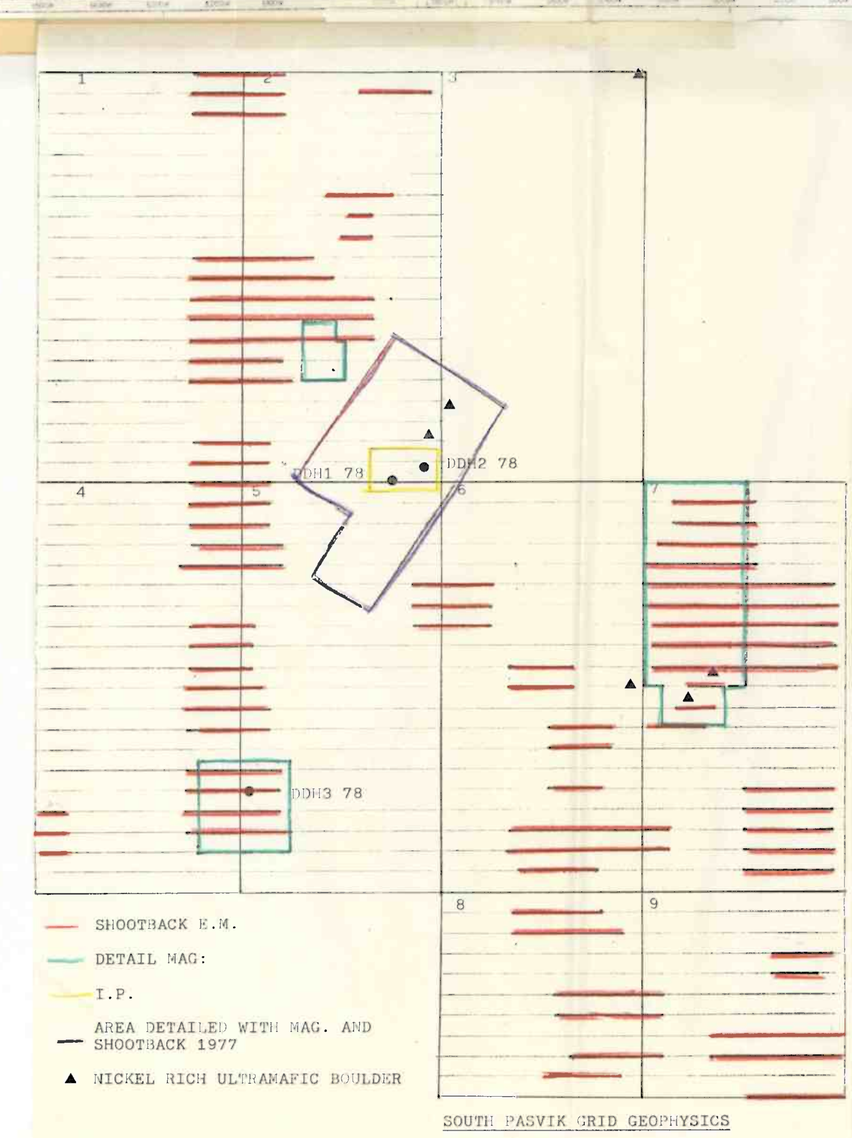
Key map Scale 1:100000

SOUTH PASVIK-2370

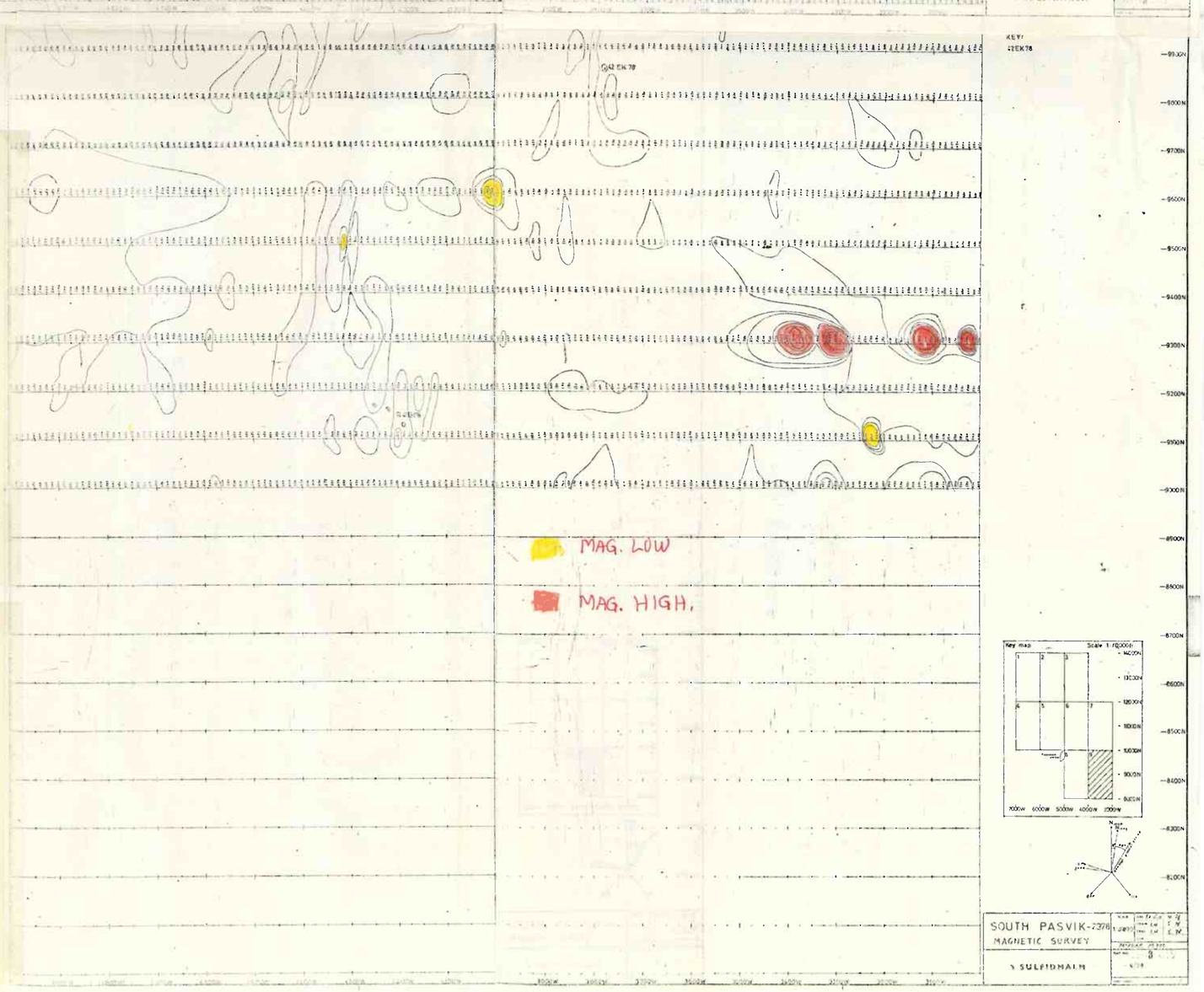
V.L.F. DIP ANGLE

% SULPHIDHALM





SOUTH PASVIK GRID GEOPHYSICS



KEY:
79 EK 78

KEY MAP Scale 1:400000

SOUTH PASVIK
MAGNETIC SURVEY

KEY:
11 LN 78
15 EK 78
37 EK 78
38 EK 78
43 EK 78
10 LN 78
11 LN 78
12 LN 78
13 LN 78
14 LN 78

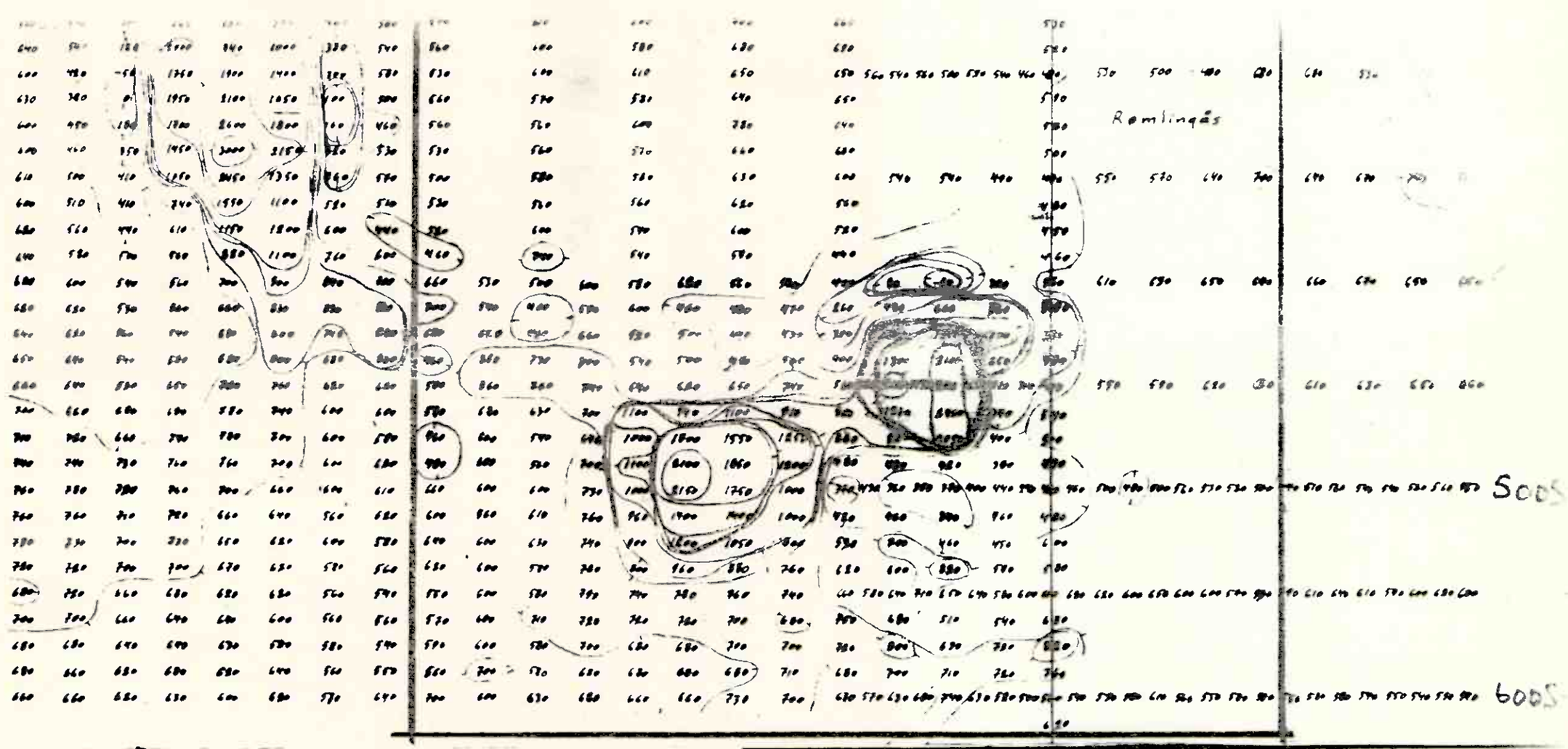
KEY MAP Scale 1:400000

SOUTH PASVIK
MAGNETIC SURVEY
S SULFIDHALM

KEY:
42 EK 78

KEY MAP Scale 1:400000

SOUTH PASVIK
MAGNETIC SURVEY
S SULFIDHALM



PASVIK 2377
RÖMLINGÅS
MAG
McPhar 700

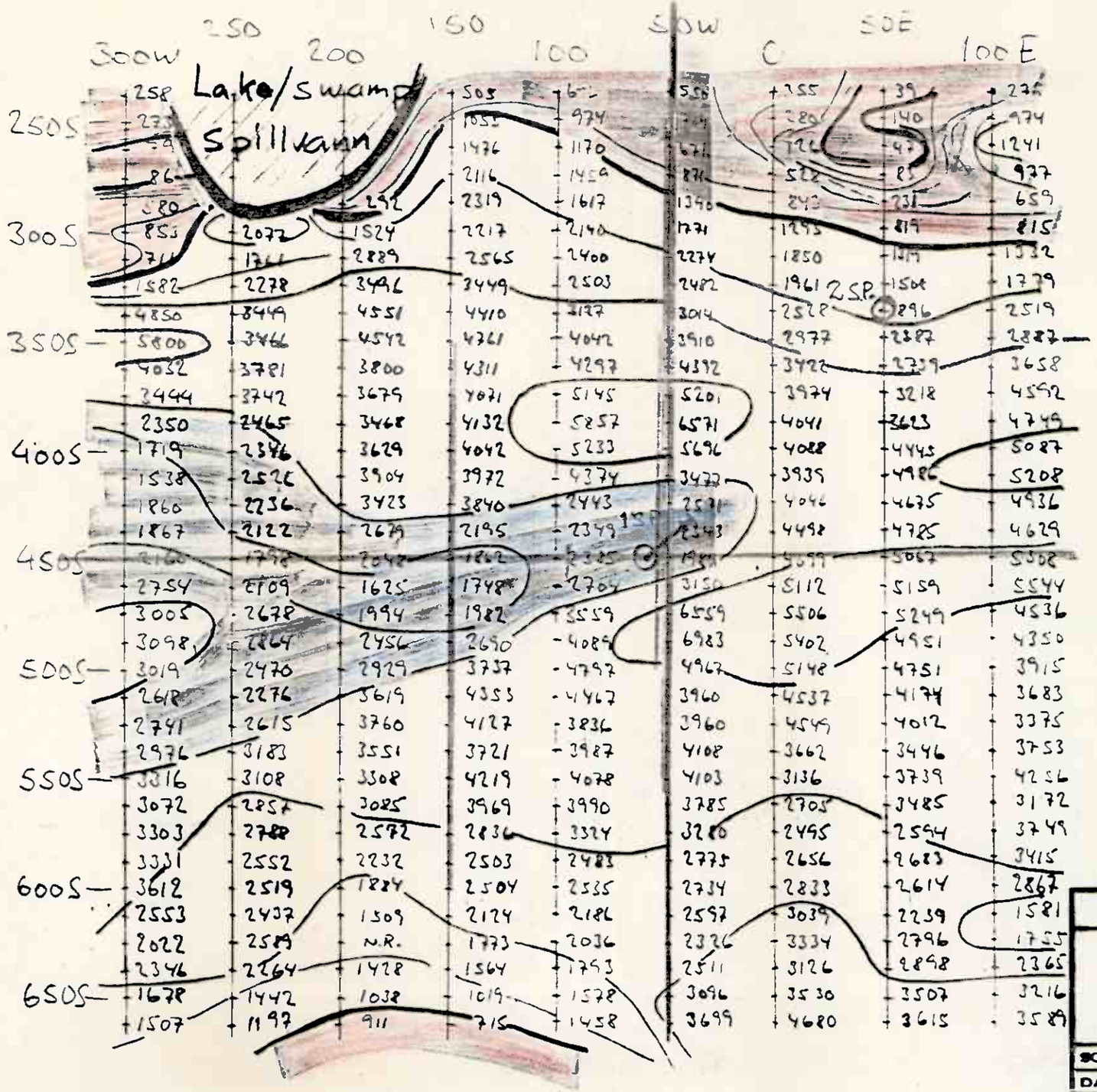
SCALE
1 : 2500

OBS. KS, GK, EK
DRAW. EK
TRAC. EK
CHK.

MAP NO.
MAP

½ SULFIDMALM

MAP SHEET



Log. contours:

1 - 1,5 - 2 - 3 - 5 - 7,5

All values in Ω/m.

Gradient array

f = 5 Hz

S = 350m.

a = 25 m.

C-C line = 100W

C_1 = 100S

C_2 = 800S

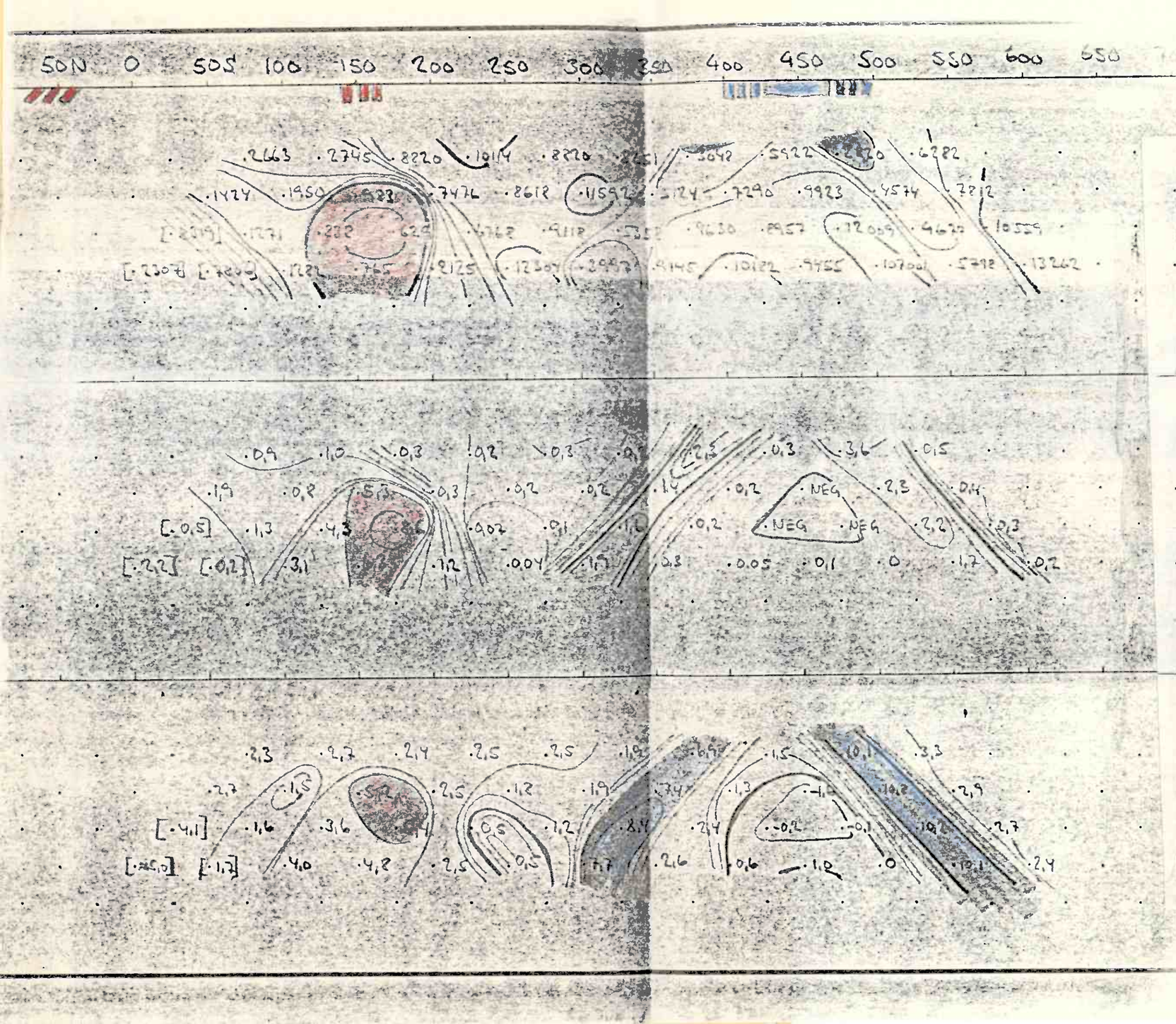
Innst.: McPhar P660

A/S SULFIDMALM

Rømlingås, Pasvik S.

Resistivity survey

SCALE	1:2500	DRAWN	
DATE	19-78	TRACED	



INDUCED POLARIZATION

PASMK S

Rømlingås

LINE 50W

LEGEND

ARRAY: DIPOLE - DIPOLE

UNIT: P660

FREQUENCIES: 0.3 - 5Hz

SCALE: 1:12500

DATE: 25-9-78

DATA BY: FH

REMARKS:

LOGARITHMIC CONTOURS - 1.0,

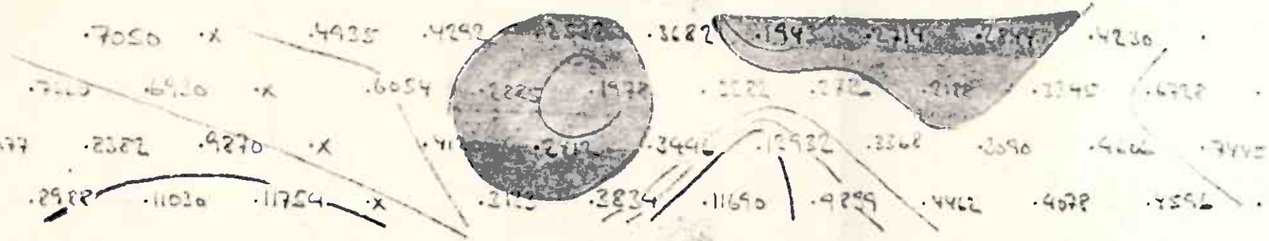
I.P. ANOMALY - STRONG

MODERATE

WEAK

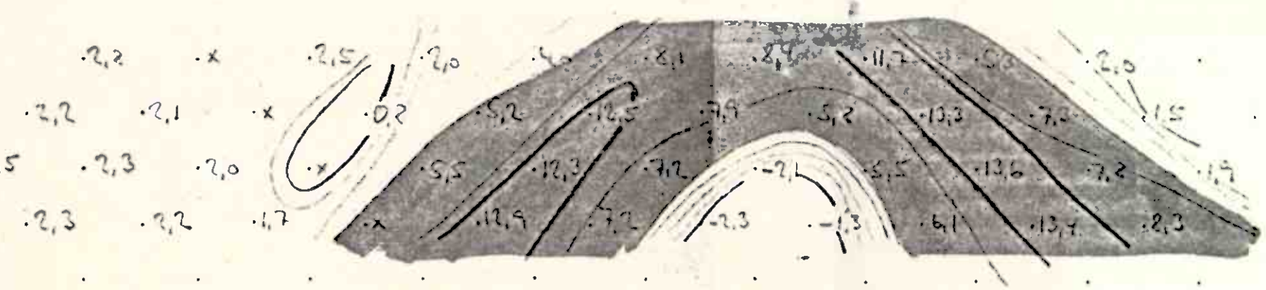
250 275 300 325 350 375 400 425 450 475 500 525 550 575 600S

RESISTIVITY



METAL FACTOR (M.F.)

% FREQUENCY EFFECT (P.F.E.)



Kamiringa

LINE 50W

LEGEND

ARRAY: DIPOLE - DIPOLE 25m

UNIT: PG60

FREQUENCIES: 0.3 - 5 Hz

SCALE: 1:1250

DATE: 22/9

DATA BY: FIN

REMARKS: X = data lost

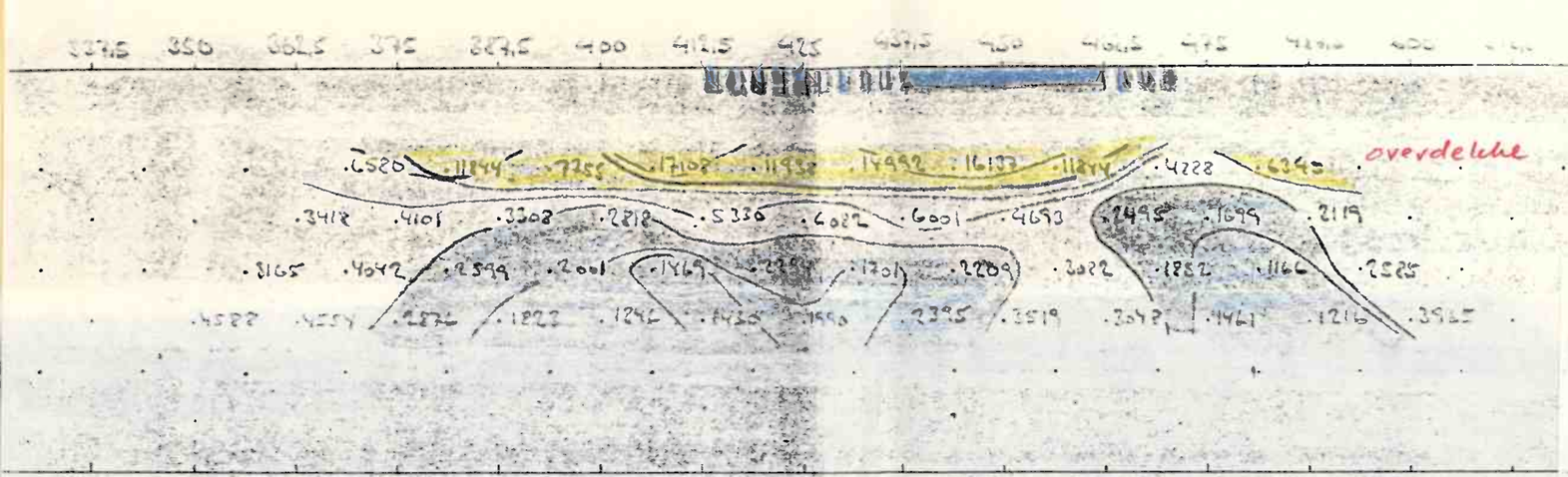
LOGARITHMIC CONTOURS - 1 0, 1 5, 2, 3, 5, 7 5

I P ANOMALY - STRONG

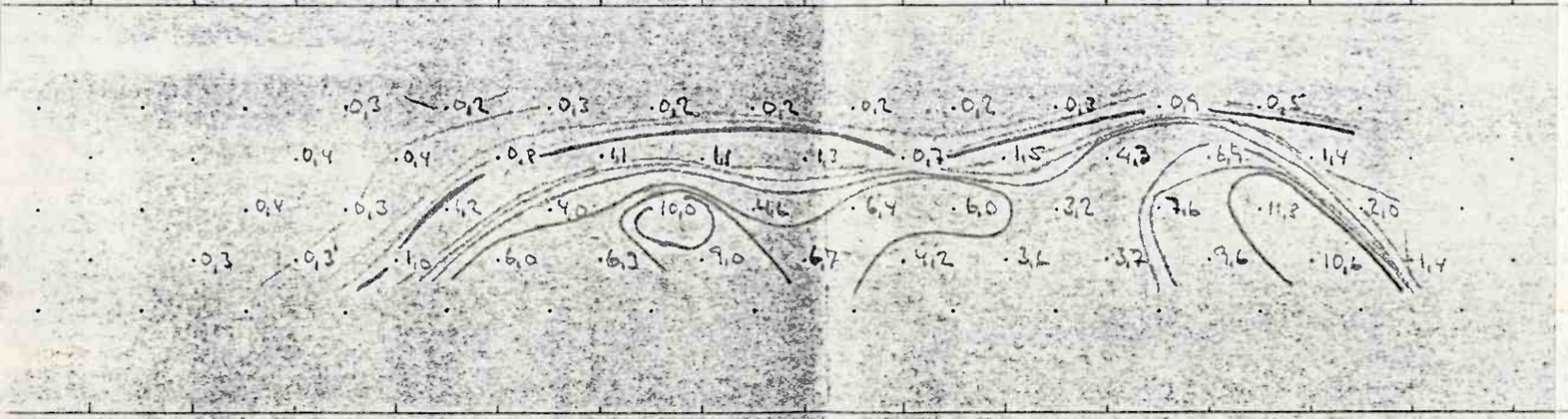
MODERATE

WEAK

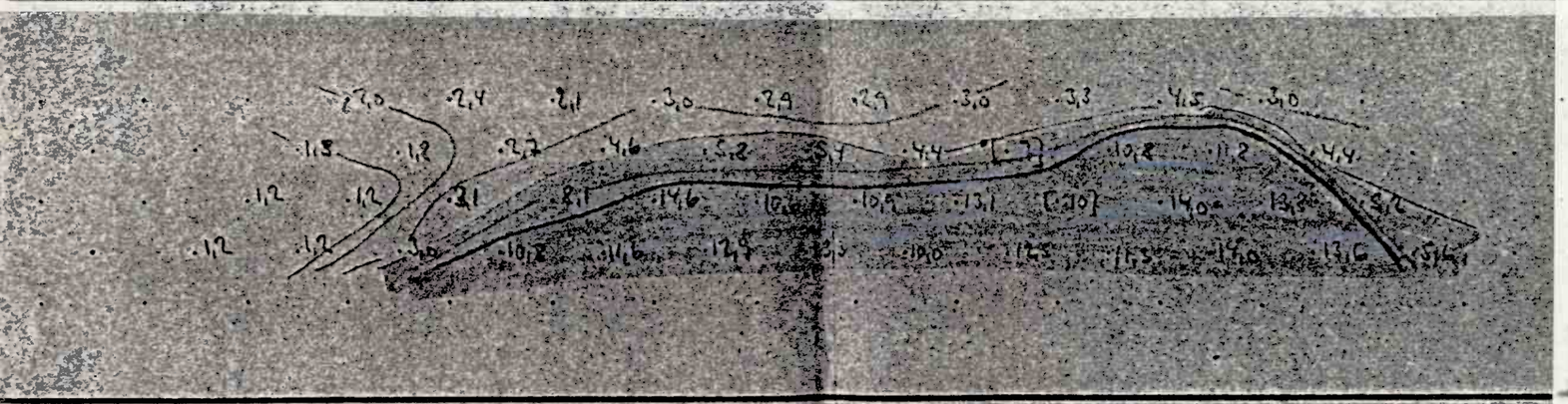
DWG. No. 3



METAL FACTOR (M.F.)



% FREQUENCY EFFECT (P.F.E.)



LINE 50W

LEGEND

ARRAY: DIPOLE-DIPOLE 12.5m

UNIT: 7660

FREQUENCIES: 0.3-5 Hz

SCALE: 1"=625'

DATE: 24-9-78

DATA BY: FH

REMARKS:

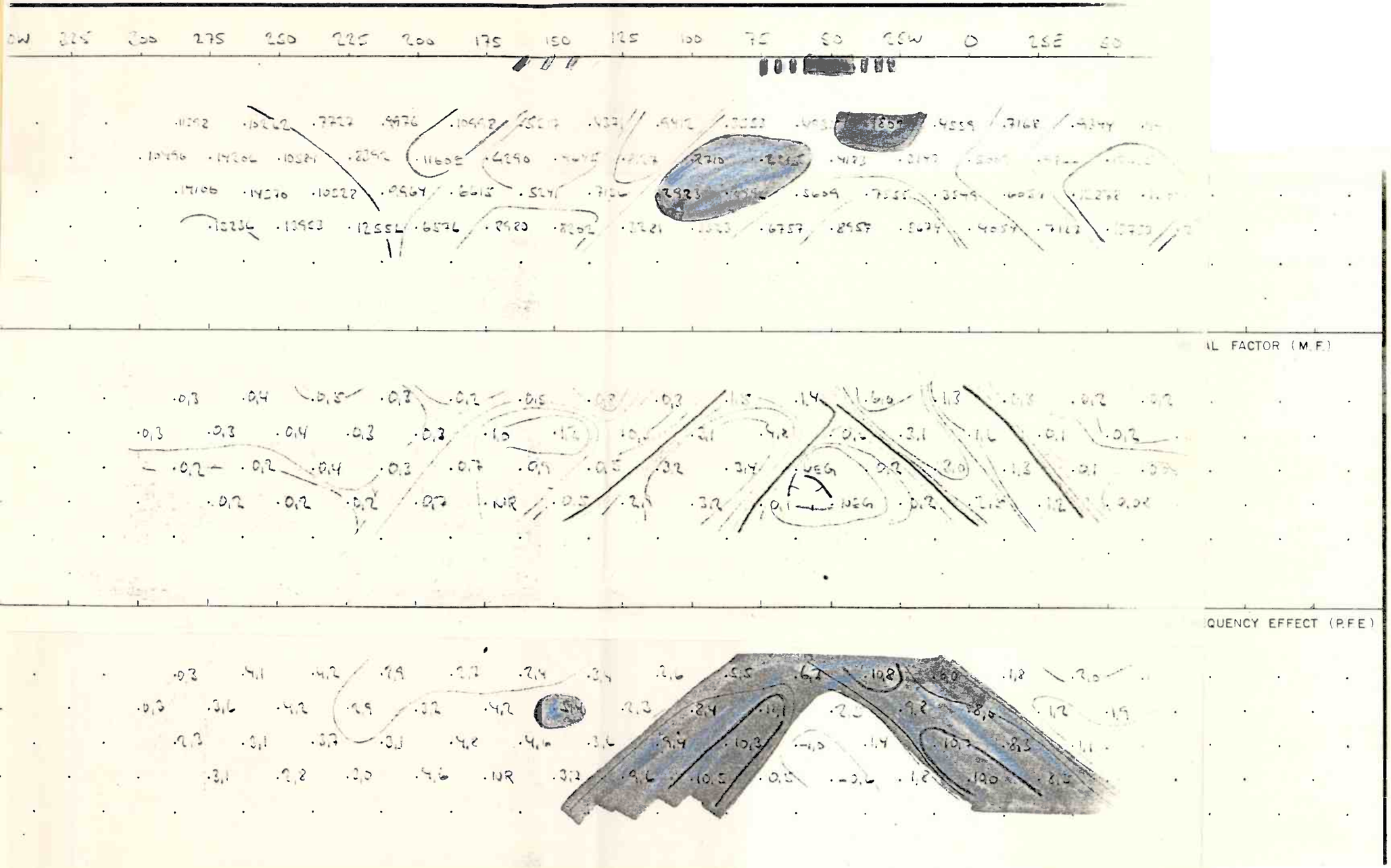
LOGARITHMIC CONTOURS - 1.0, 1.5, 2, 3, 5, 7.5

I.P. ANOMALY - STRONG

MODERATE

WEAK

DWG. No. 5



PROJECT

Kasvik S.
Romingds

LINE 4505

LEGEND

ARRAY: DIPOLE - DIPOLE 25m

UNIT: Phase

FREQUENCIES: 03 - 5Hz

SCALE: 1:1250

DATE: 23-9-82

DATA BY: [illegible]

REMARKS:

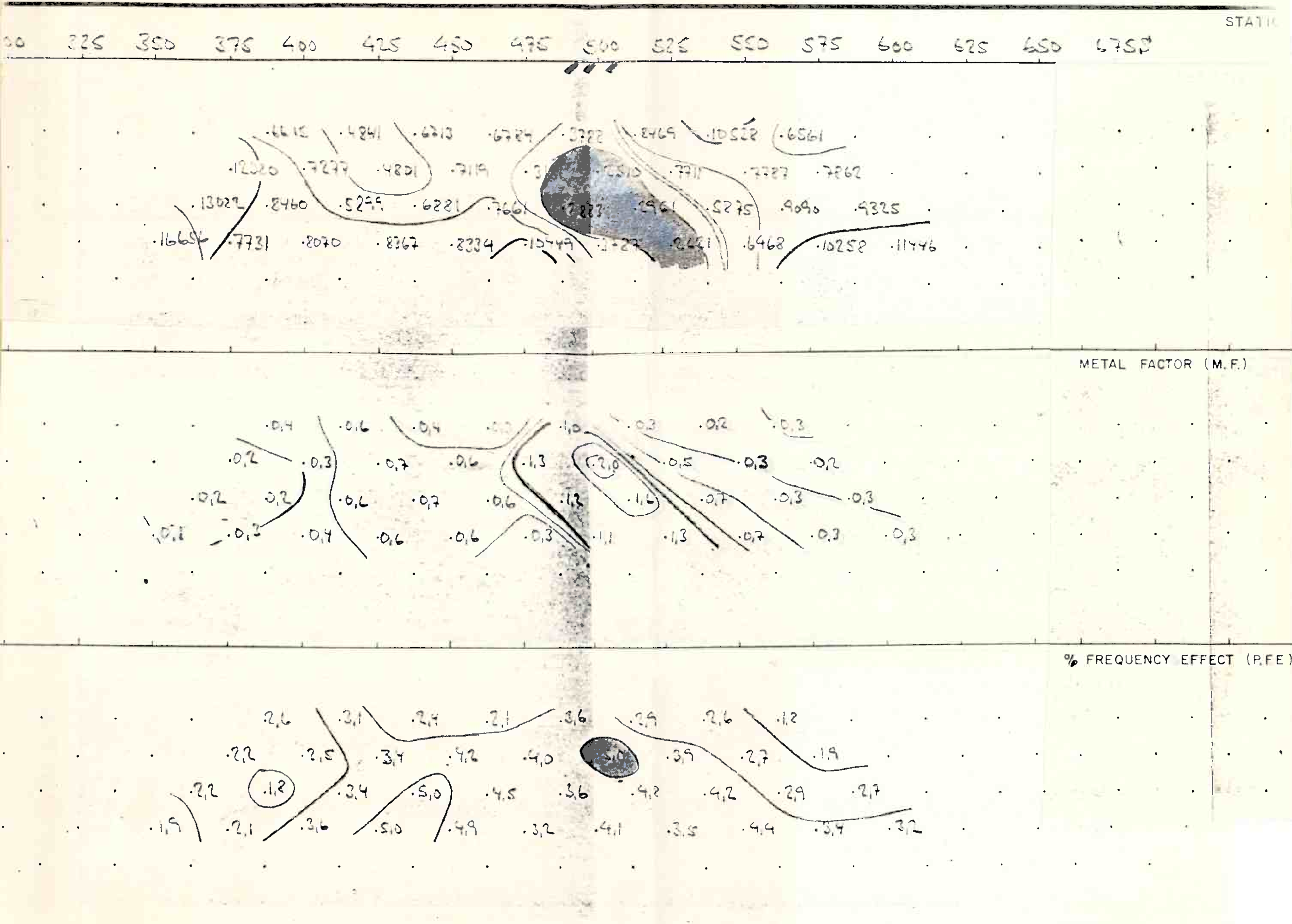
LOGARITHMIC CONTOURS - 1.0, 1.5, 2, 3, 5, 7.5

I.P ANOMALY - STRONG

MODERATE

WEAK

DWG. No. 6



INDUCED POLARIZATION SURVEY

PASVIK S PROJECT

Romlingås

LINE 150W

LEGEND

ARRAY: DIPOLE - DIPOLE 25m

UNIT: P660

FREQUENCIES: 0,3 - 5Hz

SCALE: 1:1250

DATE: 26-9-72

DATA BY: FH

REMARKS:

LOGARITHMIC CONTOURS - 1.0, 1.5, 2, 3, 5, 7.5

PASVIK SOUTH (JAWB-73) FRACTURE AND LINEATION INTERPRETATION

FINLAND

NO PHOTO COVER

U. S. S. R.

Pasvikelva

NO PHOTO COVER

NO PHOTO COVER

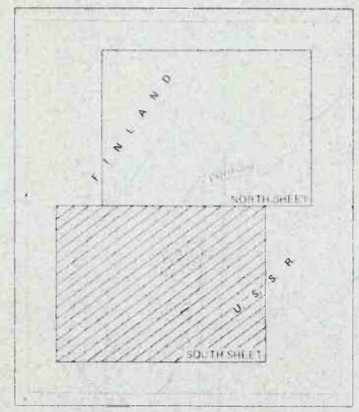
DELTA

NO PHOTO COVER

NO PHOTO COVER

LEGEND

- Major Fractures
- Major Rock Scarps
- Glacial deposits
- E ..... Eskers
- M ..... Moraines
- Fractures & Lineations



MAP INDEX

Prepared for: ARTIESELSKABET SYDVARANGER
PROSPEKTERING SKONTORET NORDRAAKS,
Vn 2 - 1324,
Lysakei,
Norway.

December 1978

Compilation Note:- Compilation of photodata onto planimetric base of geological map reference JAWB - 73 provided by Client

SCALE 1 : 50,000 Approx

Prepared by: ROBERTSON RESEARCH INTERNATIONAL LIMITED.
Ty n-y Coed,
Llanrhos,
Llandudno,
Gwynedd,
LL30 1SA
Britain

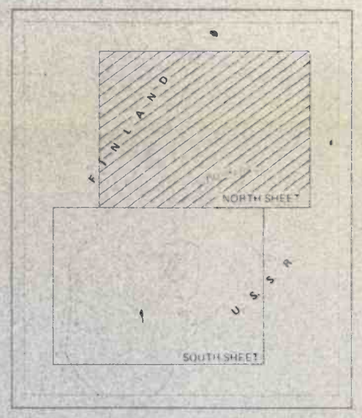
Drawing no. 6019-51 - 393 4314

23-79-E4

PASVIK NORTH (JAWB-73) FRACTURE AND LINEATION INTERPRETATION

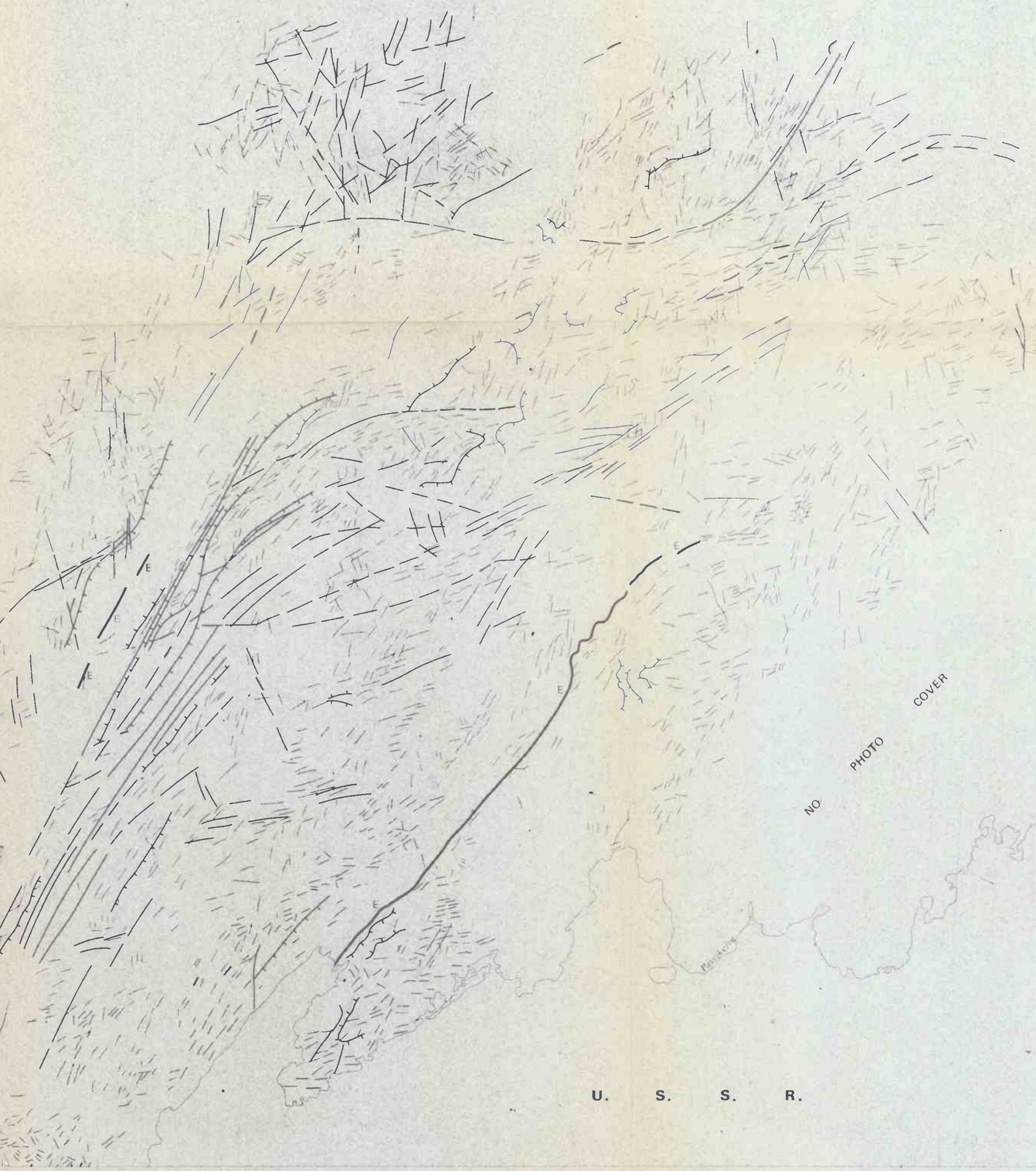
LEGEND

- Major Fractures
- Major Rock Scarps
- Glacial deposits
- E . . . . . Eskers
- M . . . . . Moraines
- Fractures & Lineations



MAP INDEX

LIMIT OF STEREO PHOTO COVERAGE PROVIDED



Prepared for ARTIESELSKABET SYDVARANGER
PROSPEKTERING SKONTORET NORDRAAKS,
Vei 2 - 1324,
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Britain.

Drawing no. 6019/51 353.4314

23-79-E4