A/S SULFIDMALM INNER FINNMARK PROJECT

REPORT ON GEOLOGICAL MAPPING AND EXPLORATION WORK 1965-1966

PART IV

EXPLORATION WORK

by E.G. Haldemann and E. Overwien.

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1. GENERAL PROSPECTING OPERATION (E.G.H.)

A. GENERAL REMARKS

It should perhaps be born in mind that although a large portion of our area was geologically unexplored, it has nevertheless been seasonally inhabited by Same people for many hundred years. The Same are sharp observers and the chances that significant gossans or outcrops of sulphide ore should have escaped detection in a country where exposures are rare and usually far between are rather remote. In that respect, Finnmark is no different from the rest of western Europe. Therefore, it is only by modern exploration techniques and geological studies which include phenomena often associated with mineralizations and a search for less obvious minerals that we could expect results in such an old country.

Apart from the work by H. Bjørlykke, H. Wennervirta and Boye Flood mentioned in PART II, chapter 2, of this report, all previous work in the area was concerned with prospecting for gold. The "gold rush" in Finnmark started in 1866 with the discovery of alluvial gold near Karasjok by Bergmester Tellef Dahll. The following small deposits were worked in our area before World War II: Helligdalen near Angeli, "Baltos Gullfelt" on the Skiecamjokka, and "Thesens Gullfelt" near Larsfossen (Gorzzejokka). These deposits were described together with others in the region by H. Bjørlykke (N.G.U. No.236, 1966). He mentions that very small amounts of sperrylith and cooperite were identified in the gold-bearing sands by X-ray and spectroscopic methods. Bjørlykke postulates that these platinum minerals derived from sulphide ores in serpentine rocks of the area. Gold washing is still going on today in the Lemmenjokka, about 40 kilometers to the east of Njullasfjell, In Finland.

The fact that Messrs. Harry Lundmark and Harry Erstad, two experienced Canadian prospectors, were engaged for field work when our project started, may call for some comment. A large portion of the area was combed by these prospectors (cf.Fig.3 in PART II). It is admitted that they covered their ground quicker and perhaps more systematically than the geologists, (including the writer), who were frequently destracted by geological phenomena of an academic rather than economic interest at the early stage of the investigations. Thus, from a purely practical point of view the result of the prospectors' work could be evaluated almost immediately. In terms of a total assessment of geological phenomena, however, it posed some problems. All their rock samples had to be re-classified and a lot of time was taken up by photogeological studies in order to compile geological maps from their field records. The writer spent several days with the prospectors and has later revisedtwo areas covered by them (Elvkrokfjell 1966; Grinvann 1967). The different lines of approach to some extent enabled cross-checks between the areas investigated by the prospectors and the geological parties but, in retrospect, the writer is of the opinion that it would have been better, if one geologist had operated together with them.

Due attention was paid to erratic boulders which may indicate the existence of mineralizations in areas covered by glacial deposits, swamps and lakes. However, in order to trace boulders to their source one should have a clear picture of the direction of ice movement and a knowledge of the morphological history of a country. In the area investigated by the geologists, all observed blocks and boulders of ultrabasic rocks were plotted on the maps. North of Røesjø, at an altitude of 400 to 455 m, boulders of ultrabasics could be traced from outcrops over a distance of 1200 m in a NNE direction. This direction of ice movement is further corroborated by striae observed in the neighbourhood. In the Våkdalsvann area, boulders frequently occur in situ, or close to exposed rock. These observations indicate that there was only a local glaciation during the last Ice Age. The evidence also suggests that the ground which now stands above 490 m was not covered by ice during the last Ice Age and that even some lower ground may have been free of ice. Unfortunately, nothing is known about earlier glaciations in the region. Judging by their alignments, numerous wide valley floors on interfluves are interpreted as remnants of an earlier drainage in an easterly to southeasterly direction. The present river system is directed to the north. H. Bjørlykke has tried to throw some light on some of these problems in his study on alluvial gold occurrences in Inner Finnmark.

Photo E.G.H. 16.7.1965.

Messrs. Erstad and Overwien using one of the Canadian light-metal canoes in the upper Gorzzejokka to the south of Grinvann.

Photo E.G.H. 16.7.1965.

Picture shows nature of poorly exposed country to the east of Gorzzejokka (Grinvann area) where H. Lundmark discovered a sulphide mineralization in a shear in siliceous amphibolite.
From l. to r.: Messrs. Erstad, Overwien, Lundmark and Christensen.

Boulder prospecting proved disappointing mainly because nothing of economic significance was found. Panning for heavy minerals provided data which could not be interpreted satisfactorily because the alluvial and fluvioglacial deposits include material which has been re-deposited from one or several earlier "generations" of such deposits. For instance, 3 out of 6 samples contain 0.6 to 1.5% sillimanite which has not been detected in any of the 1200 rock samples collected.

Laboratory reports which bear on the exploration work have previously been distributed. In this connection, reference is made also to the writer's Interim Report on Economic Aspects of the Finnmark Project dated December 31st, 1966.

B. GORZZEJOKKA AREA

There are very few outcrops in the country to the north of Gavnevann-Bosminvann and to the west of the upper Gorzzejokka covered by H. Erstad. An occurrence of soapstone and a body of meta-harzburgite, 1000 m long, were located to the west of Gurbis (see Fig.1, locality A). Erstad observed specks of pyrite and pyrrhotite in amphibolitic rocks, mica schists and segregations of basic material in quartzofeldspathic gneiss in several exposures close to the Gorzzejokka. He did not, however, report anything of economic significance from this part of his area.

The area to the northwest of Bosminvann and to the east of the upper Gorzzejokka was investigated by H. Lundmark. Sample No. 1545/G18/HL1 from a block found by him to the south of Jervfjell (Fig.1, locality B) was examined by R. Buchan. In Min.Section Report No.470 it is described as a completely serpentinized and carbonatized peridotite with less than 1% sulphides, mainly pyrite with occasional blebs of chalcopyrite, millerite and violarite. Buchan noted that the "sulphide assemblage is similar to many observed in ultrabasic rocks from N. Manitoba and N. Ontario". An assay on the ground sample gave 0.26% Ni.

About 2 km to the north of Gurbis, Lundmark discovered a NNE striking mineralized shear which he could trace over a distance of nearly 1500 m (Fig.1, locality C). He recognized pyrrhotite, pyrite, traces of chalcopyrite and some carbonates and reported that the rusty

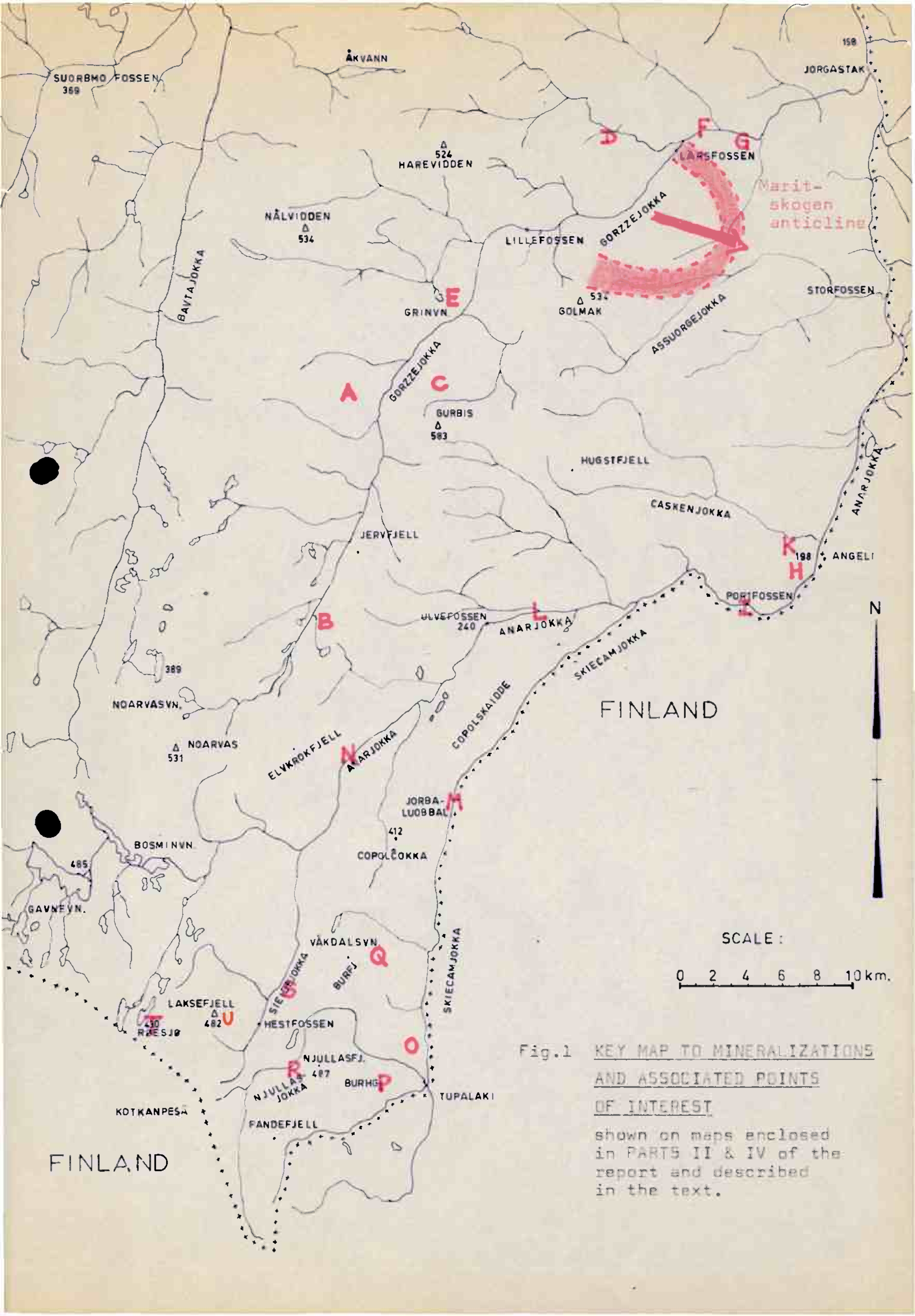


Fig.1 KEY MAP TO MINERALIZATIONS AND ASSOCIATED POINTS OF INTEREST

shown on maps enclosed in PARTS II & IV of the report and described in the text.

colours indicated a width of 3 to 4 meters. Samples 1545/H23/HL3 and 1545/H26/HL7 were described in the mentioned report by R. Buchan who concluded that they represent a sheared and mineralized contact between quartzite and pyroxenite, showing contact metasomatic effects. The disseminated sulphides consist mainly of pyrrhotite (about 25% markasitized), and minor chalcopyrite.

In the northern part of their area, Messrs. Lundmark and Erstad systematically examined all magnetic and EM anomalies shown on the available aerial geophysical survey maps, and also the mineralized shear zones on the Gorzzejokka previously described by Boye Flood. This led to the discovery of a number of basic and ultrabasic rocks by Erstad but in many cases the anomalies are situated in areas completely covered by glacial material and swamps. It is for this reason that it cannot be said to what kind of rocks the big magnetic anomaly to the north of Larsfossen relates. Two bodies of ultrabasics were found to be the cause of the local magnetic anomalies in the Haalkeelven to the west of Larsfossen. The western of these lens-shaped bodies is about 1000 m long and strikes in an E-W direction (Fig.1, locality D). Sample 1545/M17/HE4 from this body was examined by Buchan; according to his report pleonaste and chrome spinel are the prominent accessories and specks of sulphides are quite rare in the rock classified as harzburgite.

Eight, or possibly 15, EM anomalies recorded over the poorly exposed plateau to the south of Larsfossen fall into a definite zone inside the amphibolites and intercalated biotite hornblende gneiss of the Maritskogen anticline shown on sheet Golmak of the 1:20'000 maps (enclosed in PART II of this report; see also airborne geophysical map 1:50'000, sheet 2033 II). Lundmark observed some sulphides and a 5 cm thick graphite band in outcrops which fall into this folded zone. The fact, that the EM anomalies follow the same suite of rocks from the south to the north side of the easterly plunging Maritskogen anticline strongly suggests that they are caused by conformable graphite bearing horizons with associated minor sulphides (see sketch on Fig.1).

Some of the EM anomalies to the west and southwest of Grinvann appear to relate to mica schists which carry some pyrite and pyrrhotite. None of the airborne anomalies of the northern area led to the discovery of economically interesting mineralizations.

Noteworthy mineralized shears were discovered by the prospectors on both sides of the Gorzzejokka to the SE of Grinvann and on the NE-side of Grinvann (Fig.1, locality E). The shears were originally believed to fall into a continuous zone and were described accordingly in previous reports. The area was re-investigated in 1967 by E. Overwien and the writer, and an EM ground survey was carried out. The work will be described in a separate report. Sulphide samples collected by the prospectors looked attractive macroscopically, particularly a massive sulphide breccia, but the result of all analyses carried out in Kristiansand was very disappointing. The best values obtained were: Ni 0.05%; Co 0.01%; Cu 0.28%. Samples 1545/J27/HL4 and 1545/J27/HL5 were described by R. Buchan who concluded that the massive sulphide breccia, essentially composed of heavily markasitized pyrrhotite, did not contain any pentlandite. This is born out by the result of a wet chemical assay made in Thornhill: Ni 0.06%; Cu 0.11%. It may be added here that the result of the recent work does not alter the verdict.

Boye Flood reported on the mineralization in alternating layers of amphibolites and granodioritic gneiss which occurs on the Gorzzejokka, about 2 km downstream from Larsfossen (Fig.1, locality F). He observed that the sheared, NW striking rocks carry graphite and a poor impregnation of sulphides, mainly pyrite. The best values of 3 analyses were as follows: Ni 0.01%; Co 0.007%; Cu 0.008%. The work by the prospectors merely confirmed Flood's results. The occurrence falls into a gap in the airborne survey, but the geological setting indicates that it is situated in the northern flank of the above-described Maritskogen anticline and zone of EM anomalies.

The second occurrence on the Gorzzejokka previously described by Flood was re-examined by Lundmark (Fig.1, locality G). Lundmark recorded that the sheared sulphide zone is 40 m long and about 5 m wide, and composed of massive pyrrhotite, pyrite, traces of chalcopyrite, and some graphite. It was not registered by the airborne geophysical survey. The analysis of a sample collected by Lundmark showed: Ni 0.04%; Co 0.014%; Cu 0.8%; Fe 26.1%; S 18.1%. The values are higher than the ones given by Flood but they do not change his conculsion that the pyrrhotite is very poor in nickel and that the two occurrences investigated by him in the lower Gorzzejokka "should not attract any further interest". The same holds true for a sulphide-bearing shear found to the south of the Gorzzejokka and about 1000 m to the east of the just described one.

The prospectors were also panning for gold at the site of the old "Thesens Gullfelt" near Larsfossen and elsewhere in the area but details of this work were not recorded. On completion of the Gorzzejokka prospecting work, Lundmark reported that "nothing of economic value was seen".

C. ANARJOKKA AREA

To the north of Storfossen, the long magnetic anomaly which runs along the west side of the Anarjokka was investigated and some traverses were made with the handmagnetometer. The anomaly roughly parallels the boundary of the granulite zone and extends over amphibolitic rocks which include some altered basic rocks. Accessory chalcopyrite was noted in such basic rock but nothing of economic significance was found. In the poorly exposed area west of the line Storfossen-Helligskogen, the available evidence indicates the presence of migmatitic granites and gneisses. It was considered unattractive from an economic point of view and, consequently, reconnaissance traverses were widely spaced.

Some interesting mineral associations were discovered in the Helligskogen area. The pyroxene-bearing biotite-garnet-plagioclase-amphibole fels or "gabbro pegmatite" is briefly described under basic dyke rocks in PART II, chapter 4. Samples 0/21A and 0/21B were examined by R. Buchan. According to Min.Section Report No.447 and Appendix dated January 27th, 1966, they are coarse-textured gabbroic rocks composed of andesine-labradorite and ortho-pyroxene with a secondary silicate assemblage and apatite. The coarse pink garnets are pyrope-almandine (R.I. 1.77 - 1.79). Opaque oxides and sulphides add up to 4% in some samples. Clino-enstatite, actinolite and radioactive inclusions in biotite were determined in other samples, and also accessory tourmaline and zircon. The presence of slightly radioactive minerals was further confirmed by Geiger counter tests in the field. Specks of molybdenite were noted macroscopically. A "scapolite-apatite-hornblende pegmatite" discovered in the strike direction of the "gabbro pegmatite" was described by Buchan as altered pyroxenite with 15% scapolite (Sample H/14; see Fig.1, locality H).

An elongated, lens-shaped or dyke-like body of pyroxenite is present at the rapids called Portfossen (Fig.1, locality I). In sample O/18, Buchan determined pyrrhotite (2%), marcasite and pyrite (6%), fine grains of chalcopyrite (2%) and cracks infilled with goethite. He also observed that apatite is a prominent accessory mineral. A sample analyzed in Kristiansand gave: Ni 0.15%; Co 0.008%; Cu 0.014%; Fe 8.6%; S 1.3%. Graphite schists were found in a nearby shear zone.

It is interesting to note that the described pneumatolitic-hydrothermal mineral-association, the basic and ultrabasic dyke rocks and graphite bearing shear fall into a belt in the border zone of the granulite complex and anorthosite massif of Angeli, Finland. This border zone is generally interpreted as a thrust belt. Long, narrow lenses of ultrabasics occur in the southern continuation in Finland but, so far, no economically significant mineralization was found in this belt.

Panning at the old gold washing site in Helligdalen produced 1 to 3 flakes of gold per pan (Fig.1, locality K).

In the amphibolitic rocks in the gorge below Ulvefossen, V.H. Wiik observed bands containing over 5% pyrite (Fig. 1, locality L). This produced a conspicuous rusty colour on foliation and joint planes over a distance of about 1500 m. Sample W/9 from such a band was described in the mentioned report by Buchan.

Good exposures were encountered in the Skiecamjokka to the north and south of Jorbaluobbal. E. Overwien mapped several dykes of altered ultrabasics and a long, narrow zone of a meta-gabbroic rock with minor pyrrhotite in a sequence of partly migmatized paragneisses and amphibolites. Some pegmatitic soda-feldspar rocks were also noted. The river runs more or less parallel to the foliation strike, thus only a limited section of the sequence could be studied. However, the available observations suggest that one is dealing with a comparatively low level or "root-zone" of a thrust belt. A concentration of pyrite was discovered in a narrow layer of a banded paragneiss to the northeast of Jorbaluobbal. Sample O/51 from this occurrence was examined by Buchan and so were samples O/62A&B and O/69A&B of meta-ultrabasics from localities south of Jorbaluobbal. Pyrrhotite with accompanying pentlandite, mainly intergranular or blocky, and traces of millerite were recognized. The samples genrally contain a fair amount of magnetite (4-8%). A special spectrographic analysis of serpentinite 0/69 (Fig.1, locality M) made in Kristiansand gave the following result:

Au	Pd	Pt	Rh	
0.04	0.20	0.20	0.10	ppm

Overwien also located a weak mineralization in a fractured hornblende gneiss adjacent to a dyke of serpentinite in the upper Anarjokka (Fig.1, locality N). Sheared paragneiss from the same locality contained graphite.

No economically interesting sulphide mineralization was found in the course of the Anarjokka investigation.

D. NJULLAS AND REMAINING SOUTHERN AREA

Field work in the southern area started in 1965 and was continued in 1966 (cf.Fig.3, PART II). Airborne geophysical survey maps cover the greater portion of the area. The recorded magnetic and EM anomalies were examined geologically and followed up by geophysical ground surveys. The outcome of this work is described in chapter 3 below but some points of geological interest and additional information are added here.

A number of exposures of basic and ultrabasic rocks were mapped in the southern strip along the Skiecamjokka. This strip is situated in the continuation of the rocks described above from Jorbaluobbal. One small magnetic anomaly about one kilometer to the west of the river probably relates to a serpentinite found nearby (Fig.1, locality O). No sulphide mineralization was observed in this part of the area.

The strongest magnetic anomaly of the southern area was recorded to the east of Burhaugen (Fig.1, locality P). Outcrops are present only on the margin of the anomaly but they indicate that it is caused by magnetite-bearing quartzite which is locally sheared and brecciated. The magnetite is accompanied by minor pyrite and is probably concentrated in several parallel shears. The rocks were previously described by Boye Flood (cf.chapter 3, D.6, and enclosed geophysical survey map).

A plug-like body of serpentinite (meta-peridotite) surrounded by foliated and locally folded actinolite-chlorite schists was discovered by Per Aagaard, one of our students, to the southeast of Vaakdalsvann (Fig.1, locality Q). It is situated between lines P35 and P36 and was not registered by the airborne survey. The "Aagaardtoppen" body and neighbouring area were mapped in detail by Lars Kirksæther and handmagnetometer traverses were made by V.H. Wiik. No noteworthy sulphide assemblage was found but chrysotile asbestos noted in a folded layer would appear to be quite unique for this part of Finnmark. The result of the geological investigation is presented on the enclosed map 1:5000.

Lenticular bodies of gabbros occur in a belt which strikes from Njullasfjell in a northerly direction over Burfjell to Copolcokka, i.e. over a distance of at least 15 km. These gabbro bodies stand out topographically as ridges and low hills. On the airborne survey map which covers the southern end of the gabbro belt, they show up as magnetic anomalies, particularly the highest part of Njullasfjell. Detailed geological investigations indicated that the magnetic pattern is at variance with the outcrop pattern of the gabbros. However, it seems to be in support of the geological interpretation of these gabbros as large lenticular bodies emplaced along a steeply easterly dipping, composite thrust zone. The nature of the gabbro was studied by V.H. Wiik (see PART II, chapter 4). Samples 0/74A & B from Burfjell were described by R. Buchan in Min.Section Report No.447. He observed that the altered gabbro and related scapolitized rock contain 4 to 5% ilmenite, or ilmenite and magnetite, 1 to 2% pyrite, and traces of chalcopyrite and pyrrhotite. No significant sulphide mineralization was found in the field (cf.also chapter 3, D.5 and 7, below).

The Njullasjokka EM anomaly zone detected by the airborne geophysical survey was followed up by ground surveys by E. Overwien and party. The anomaly zone includes several conductors which could be traced from south of Njullasjokka (Fig.1, locality R) across the river and in a northerly direction to the west of Vaakdalsvann. Numerous occurrences of more or less sheared ultrabasics and micaceous rocks with sulphides and, in places, graphite were found in this 300 to 400 m wide belt which is interpreted as thrust zone. The ultrabasic rocks shown on sheet Inari-Utsjoki of the geological map of Finland (scale 1:400'000), at the southern tip of our area, also fall into the alignment of the anomaly zone. Unfortunately, there are only boulders and no outcrops of ultrabasics on Pandefjell and there is no clear-cut proof of a link between the outcrop in Finland and those of Njullasjokka. But a total length of over 20 km is quite probable for the Njullasjokka EM anomaly zone.

The geology and mineralization of the Njullasjokka EM anomaly zone is described below by E. Overwien and the result of Buchan's examination of sample 0/110 is mentioned there. The writer's observations from a visit to the Njullasjokka are recorded on the geological sketch section, Fig.2. So far, results of assays did not show any economically attractive concentrations of nickel-copper sulphides. However, the magnitude of some of the recorded EM anomalies is very remarkable (see enclosed "Map from central Njullas ..." and geophysical survey maps).

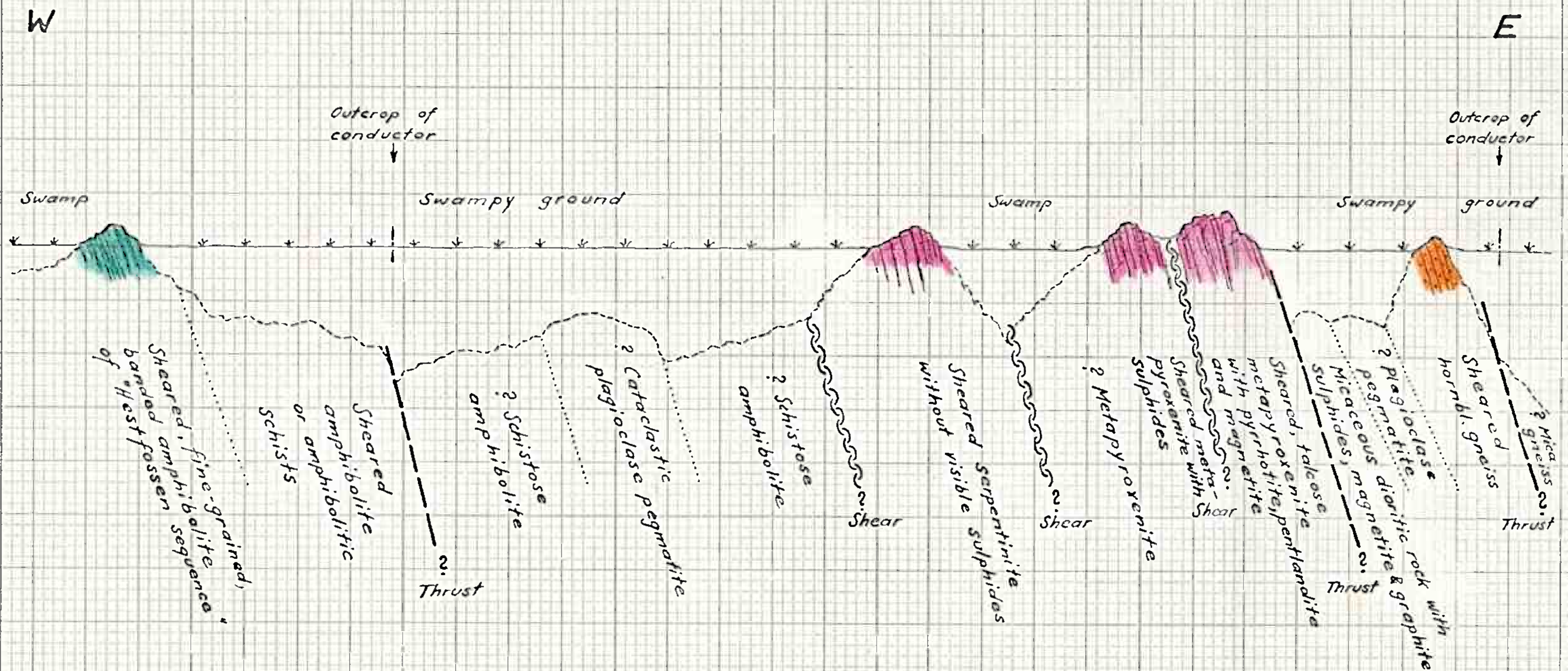
Fig.2

NJULLAS-JOKKA EM-ANOMALY

Geological Sketch Section south of river between Profiles 720S and 840 S with tentative interpretation of subsurface conditions

by E. G. Haldemann, 29. July, 1966.

SCALE 1 : 500



E.G.H. 25.4.1967.

On the flat surface to the east above Sieidejokka, Lars Kirksæther found a small outcrop of a serpentinized peridotite in a suite of northerly striking quartzofeldspathic gneiss and amphibolitic rocks (Fig.1, locality S). Numerous blocks of ultrabasics noted in the neighbourhood, with concentrations indicating an in situ position in places, suggested the presence of a fair-sized body. Much time was spent on checking blocks for mineralization. Several DMG tests on sulphide-bearing samples were positive. A phlogopite serpentinite examined by R. Buchan (Min.Section Report No.499) contained 2% pentlandite and slightly less pyrrhotite, and over 3% magnetite + chrome spinel. A fire assay carried out in Kristiansand on a collection of rocks (EGH/533) from the "Kirksæther Ravine" occurrence gave:

Ag	Au	Pd	Pt	Rh	
8	0.09	0.3	0.2	0.2	ppm

The ultrabasic rocks do not show up as an anomaly on the airborne geophysical survey maps. Geophysical ground surveys outlined 3 conductors parallel to each other as well as to the Njullasjokka EM anomaly zone which is about 900 m to the east (see chapter 3, D.4, and enclosed geophysical map on which all geological observations are recorded).

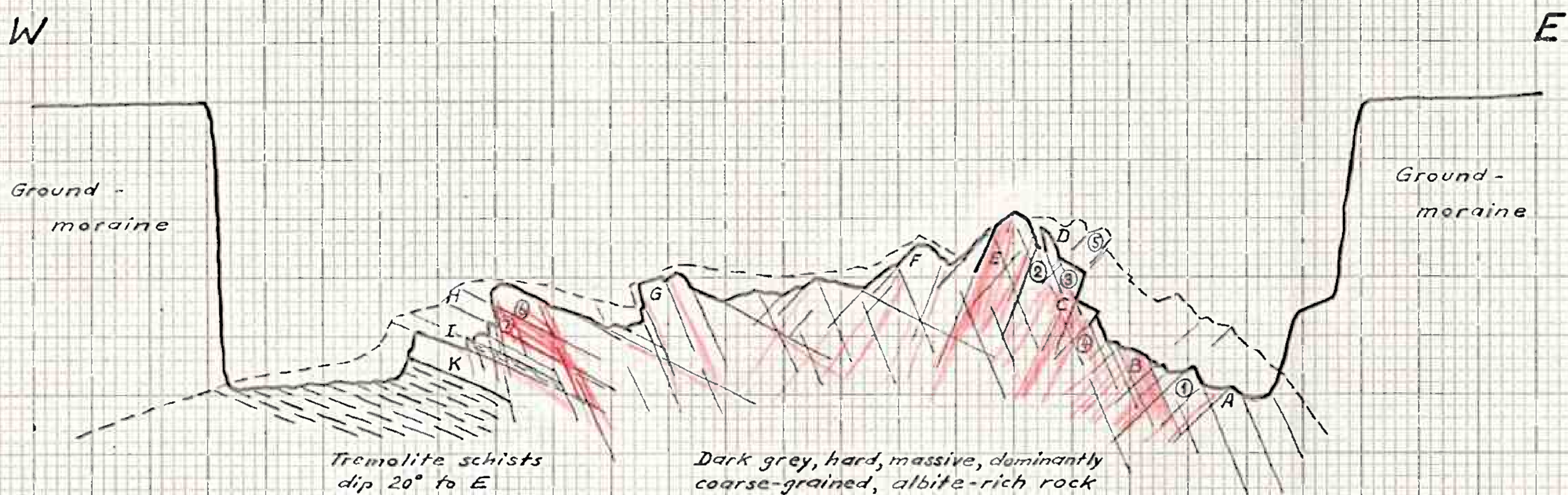
The eastern Røesjø EM anomaly detected by the airborne survey and followed up by EM ground work in 1965, extends over a zone which is almost completely covered by glacial deposits. A small outcrop mapped as pegmatite provided no clue as to the cause of the anomaly. On August 8th, 1966, a 10 m long prospecting trench was started at line 360 S, where E. Overwien had predicted a minimum thickness of overburden over the conductor (Fig.1, locality T). Bedrock was encountered one to two meters below surface and blasting revealed a fractured, pegmatitic, albite-rich rock with sulphides. Samples EGH/542(A)&(B) from the trench and sample O/124 from a cut in the nearby outcrop of pegmatite were described by R. Buchan who interpreted the rocks as of probable metasomatic origin. The sulphide content of these rocks varies from traces to about 6% pyrite-marcasite after pyrrhotite and includes a little molybdenite (order of 0.001 to 0.01%) and traces of chalcopyrite. The results of spectrographic analyses and of a fire assay for gold and platinum minerals were very disappointing. The mineralization is described below by Overwien. The writer's field observations are presented on the geological section, Fig.3.

RÖESJÖEN EM-ANOMALY PROFILE 360 S

Geological Section of Prospecting Trench

by E. G. Haldemann, 12. August, 1966.

SCALE 1 : 50



FRACTURES (dominantly joints):

① Str. 117°; dip 65° SW
② Str. 243°; dip 79° NW
③ Str. 140°; dip 72° SW
④ Str. 41°; dip 72° SE
⑤ Str. 252°; dip 75° NNW
⑥ Str. 305°; dip 50° NNE
⑦ Str. 41°; dip 81° SE

CONDUCTOR : calculated dip 66° E

SAMPLES EGH/542 — Sulphides

A
B Ore<1%; plag. 50%; micr. 30%; qz. 20%; bi.
C Ore 1-5%; plag: micr: qz = 1:1:1
D
E Ore ± 1%; plag. 40%; qz. 40%; micr. 20%
F
G
H
I
K Ore<1%; plag. 40%; qz. 30%; micr. 30%

EGH

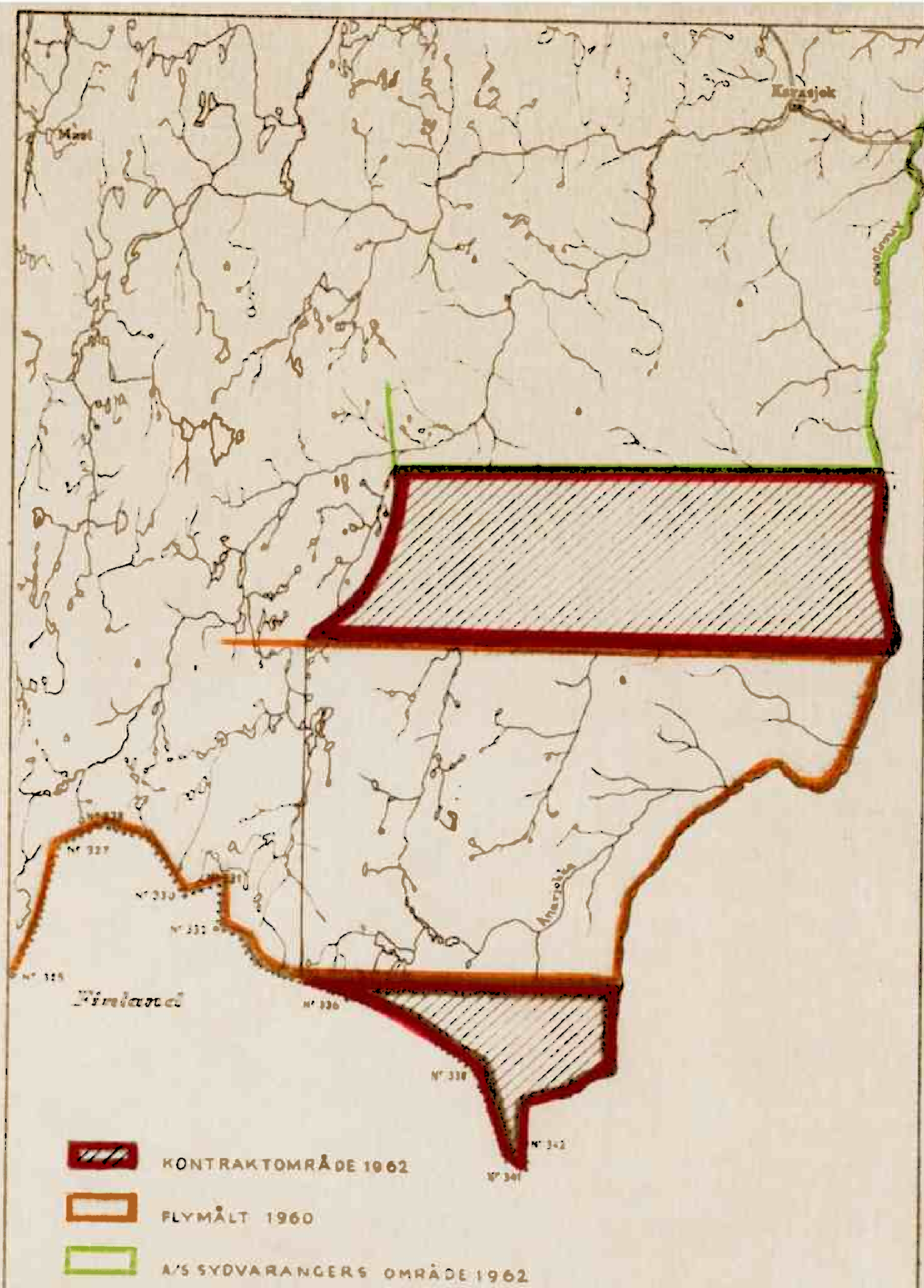
Fig. 3

Photo E.G.H. 10.8.1966.

The prospecting trench along profile 360 S of eastern Røesjø EM anomaly looking in a westerly direction. Fractured, sulphide-bearing albite-rich rock of metasomatic origin was encountered 1 to 2 m below surface and over a length of 9 m. Trench had total length of 10 m and tremolite schists were found at end of trench marked by one of the students. The last ridge feature in middleground and terrain in background is occupied by the Røesjø granite. The two Røesjøs are situated between the ridges in the middleground and cannot be seen.

Some of the anomalies detected by the airborne survey fall into areas where no outcrops could be located. In case of the Laksefjell magnetic anomaly (Fig.1, locality U), the few marginal outcrops do not provide an entirely satisfactory explanation as to the cause of the feature. Several of the recorded EM anomalies could not be confirmed by geophysical ground surveys.

The geological traverse along Njullasjokka from its confluence with the Skiecamjokka in the east to Kotkanpesä in the west did not produce anything of possible economic significance beyond the mentioned observations from the Njullasjokka EM anomaly zone. Geiger counter traverses were made from Skiecamjokka along Njullasjokka and then over Njullasfjell to Njullas Camp, and also along parts of the Kotkanpesäsection (pegmatites) with negative results.



BILAG TIL KONTRAKT MED

A/S SULFIDMALM

1962

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1 : 500000	TEGN	
	TRAC	
	KFR	

NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM

Fig.4

2. AIRBORNE GEOPHYSICAL SURVEY (E.O.)

A. GENERAL

This chapter is essentially a condensed translation of the geophysical report dated September 28th, 1965, written by Director I. Aalstad, Geophysical Department of Norges Geologiske Undersøkelse in Trondheim. For map references etc. the original report is enclosed.

The report deals with combined magnetic and electromagnetic airborne survey carried out by the Geophysical Department of N.G.U. on behalf of A/S Sulfidmalm. Two separate areas of a total of 1300 km^2 were covered between Karasjok and Njullas. The profiles were flown in an east-west direction at a height of 100 m above ground, the distance from one profil to the next is 1000 m in the northern area and 500 m in the southern one.

The topographic conditions were considered favourable for an airborne survey, but it proved difficult to navigate the plane with the desired accuracy because of the poor quality of the existing topographical maps.

B. INSTRUMENTS AND SURVEY METHOD

The survey was carried out with a Lockheed 12, twin-engine plane. For magnetic measurements the plane was equipped with a continuously recording type AN-ASQ-3A magnetometer. To minimize the effect of magnetic material in the plane, the detector unit was placed at the end of a 2 m long tube fixed to the rear end of the plane. A complete compensation of the magnetic disturbances caused by the plane was accomplished by means of small magnets. The magnetometer is a flux-gate instrument and contain 3 flux-gate coils, 1 measuring coil and 2 orientating coils. By means of servo-motors, which are controlled by signals from the orientation coils, the measuring coil will always be directed along the lines of force in the magnetic field, independent of movements of the plane. The signal from the measuring coil is transferred to a recorder in the plane, which will register variations in the total field of the earth. The measuring-accuracy of the magnetometer is approximately 1 gamma. Maximum deflection of the recorder pen is about 10 cm, and it can be adjusted to correspond to 100, 200, 500, 1500 or 5000 gammas. When the anomalies exceed the chosen value for maximum deflection, the scale can be displaced in steps of 50, 500 or 5000 gammas. Thus even high anomalies can be measured with high accuracy.

The electromagnetic equipment used was developed and produced by Geofysisk Malmleting (now Geophysical Department of N.G.U.). It consists of a horizontal transmitter loop around the plane and a receiver-coil attached to a towing line 120 - 150 m behind the plane and 40 - 50 m below it. The transmitter loop is supplied with alternating current which generates an alternating electromagnetic field of force. By passing possible conductors in the ground, there will be induced alternating current in these. By means of the receiver-coil the phase displacement between the primary field and the secondary field from the induced currents is measured, and the phase displacement will be registered. The measurement is made simultaneously on two different frequencies, respectively 500 and 2500 periods per second. The registration occurs on two different channels on the same recorder as the magnetometer-recordings.

The height of the plane above the ground was measured continuously by means of a radio-altimeter of the type AP-A-1. The height was recorded simultaneously on a special channel on the same recorder as the magnetic and electromagnetic readings.

In order to state the exact cource of the flight lines a 35 mm strip camera was installed in the plane to take numbered photographs of the ground at intervals of approximately 2 seconds. Every picture taken was marked automatically on the common recorder, and thus co-ordinated with the other recordings.

The survey took place from the 5th - 9th of July under good weather conditions. For corrections of the daily variations in the earth magnetic field and for drift in the magnetometer a check-point was chosen in the northern area and one in the southern to which the profiles were attached. Finally, one flight was made across the 2 check-points so that all profiles could be referred to the same magnetic level.

C. DATA PROCESSING.

A photo-mosaic was made by N.G.U. using the "slottet templates" method. A number of the photographs taken during the survey were identified and plotted on a transparent sheet covering the mosaic, and the profiles were drawn through these points.

The magnetic recordings were corrected for drift and daily variations and then plotted. Assuming that the plane was flying along straight lines with constant speed between every photograph, the plotted figures should be at the right spot on the map. These figures form the basis of the magnetic contour maps. The figures are related to an arbitrary chosen level.

The plotted points also served to mark the electromagnetic anomalies along the profiles. In order to separate the recordings of the two frequencies, the anomalies of 2500 p/s and 500 p/s were plotted respectively above and below the profile lines.

D. RESULTS

The result of the airborne survey is presented on the contour maps in scales 1:20'000 and 1:50'000.

With regard to the magnetic anomalies the following ought to be mentioned:

(1) The magnetic field is only measured along the indicated profiles, while the contours are estimated to run as a connection between points with the same intensity. The contours therefore already represent an interpretation of the measurements.

(2) The maps show the variations in the total earth-magnetic field and not, as in the case of ground survey, in the vertical field. For anomalies running east-west these might be somewhat displaced compared to the masses causing the anomalies.

The used electromagnetic system gives anomalies 4 to 5 times stronger for flat lying conductors than for steeply dipping ones. Therefore, the possibility of detecting a conducting zone depends on its dip.

As already mentioned only the phase displacement is registered. However, by measuring simultaneously with 2 frequencies it should be possible to say something about the conductibility: A poor conductor only gives an anomaly on the higher frequency, (2500 p/s), a medium-good conductor will give approximately the same anomalies on both frequencies, and a good conductor only an anomaly on the lower frequency (500 p/s).

E. ADDITIONAL INFORMATION

During a visit to N.G.U. in May 1967, quite a lot of the recording tapes were checked by the writer. It was learned that a part of the survey was carried out under weather conditions with local concentration of static electricity which made it necessary to frequently adjust the EM instrument. It is therefore possible that some conductors were lost and that some of the more dubious anomalies were caused by the weather conditions. Over some mountains, and also where navigation errors accurred, the altitude of several profiles was probably in parts too high (above 6 - 800 feet) to detect possible conductors. This is clearly demonstrated across the Njullasjokka EM-zone.

Those deflections on the recording tapes interpreted as anomalies by the writer were added to the original map with a special symbol.

Many magnetic and electromagnetic anomalies detected by the airborne survey were checked in the field for outcrops and by geophysical methods (see chapters on General Prospecting Operation and Geophysical Ground Survey).

Special maps in scale 1:50'000 were made to show the airborne anomalies checked on the ground (Enclosures).

3. GEOPHYSICAL GROUND SURVEY (E.O.)

A. GENERAL

In 1965/1966, all geophysical ground surveys with the exception of some magnetometer traverses were carried out in the southern area covered by the airborne survey.

B. ELECTROMAGNETIC INSTRUMENT AND SURVEY METHOD

The used electromagnetic equipment is an EM GUN produced by ABEM in Sweden. The primary field is set up by a transmitter unit, consisting of a transistorised oscillator and a transmitter coil wound on a ferrite core (the transmitter staff). The measurements are made with a receiver unit consisting of a receiver staff and a compensator-amplifier unit. A pair of headphones connected to the amplifier serve as a null instrument when measuring. The transmitter and the receiver staffs are connected to the compensator-amplifier unit by a lightweight reinforced cable.

The instrument works on two frequencies (1760 c/s and 440 c/s), and the compensator is calibrated so that the readings on its two scales correspond to the in-phase (Real) and the out-of-phase (Imaginary) components of the field vector expressed as percentages of the primary field strength.

In the field a baseline is laid parallel to the suspected conductor and traverses are run by means of a compass. The feeding cable between the transmitter and receiver (60 m) is used as a tape. The distance between the profiles for a reconnaisance survey was 240 m, but for more detailed work traverses were made at 120 m and 60 m intervals.

The terrain in the investigated area was usually flat and therefore favourable for an EM survey, but small lakes and numerous swamps make it often difficult to run continuous profiles. In hilly terrains a Paulin barometer was used to measure the difference in altitude between receiver and transmitter staff for calculating the terrain correction for observed real component of the vertical field vector.

C. MAGNETOMETER SURVEYS

The instrument used was a small handmagnetometer made by N.G.U. (accuracy 100 without using tripod). Traverses were run by the compass and pacing method or along EM profiles, and observations were normally taken every 10 m.

D. DESCRIPTION AND INTERPRETATION OF FIELD WORK

The chapter mainly deals with the surveys carried out during the summer of 1966, but the work in the Røesjø area previously reported on is also briefly reviewed (see Report from a Geophysical Survey in the Njullas area of Kautokeino Herred in Finnmark, Norway, August 1965).

Maps of areas surveyed in 1966 and the amended map of Røesjø E are enclosed. A special map in scale 1:20'000 from central Njullas was made to show all EM anomalies detected by airborne and ground surveys, and all outcrops within the area investigated by ground geophysics in 1966.

1. Area N of western and eastern Røesjø

Most of the airborne EM anomalies in this area show up very well on the highest frequency (2500 c/s) on the recording tape, while on the lower frequency (500 c/s) the readings are rather dubious. The ground survey carried out in 1965 did not detect any definite conductors over the airborne anomalies, although within the investigated area there occur some weak and irregular anomalies. Since the anomalies mainly occur above swamps, their appearance would be influenced by the swamps. The anomalies do not represent the normal shape of a conductor with dip which could be expected in this area. Magnetite in the bedrocks could also produce some of the anomalies.

2. The eastern Røesjø anomaly, (see map).

A strong conductor was outlined over the airborne EM anomalies in 1965. Trenching was carried out in 1966 in profile 360 S from the hanging wall to the foot wall of this conductor. Bedrock exposed in the trench is a fractured, sulphide-bearing, albite pegmatite with minor microcline of probable metasomatic origin.

Photo E.G.H. 29.8.1965.

Geophysical ground survey with the EM GUN in the area covered by glacial deposits in the northern part of the eastern Røesjø EM anomaly.

Photo E.O. 10.8.1966.

Trenching along profile 360 S of eastern Røesjø EM anomaly.

The pegmatite contains locally up to 6 % pyrite-marcasite after pyrrhotite. Although sulphides are enriched along joint planes it is dubious that this weak mineralization can produce such a comparatively strong conductor.

Beneath the foot wall of the pegmatite there is a rotten, soapy, and faintly rustcovered actinolite-chlorite schist with some biotite. If this rock, which is very weathered near the surface, carries a sufficient amount of sulphides, (or graphite), and has a certain extension in the strike direction, it may cause the detected EM anomaly.

Blasting in the outcrop near the anomaly in profile 240 S showed that it was mineralized in the same way as the pegmatite in the trench, but it seemed to contain somewhat more molybdenite as scattered blebs. To establish what really produces the EM anomaly one would have to put down a short drill hole or do some more trenching.

3. The Njullasjokka EM anomaly zone (see maps).

The airborne survey detected several EM anomalies associated with magnetic highs along a N-S striking zone near Njullasjokka. (Elsewhere Njullasjokka is referred to as Njullaselv or Njullas River). In 1962, B. Flood found ultrabasics near this zone and it was decided to follow up the airborne anomalies by ground geophysics and mapping.

Several more or less strong conductors, often arranged in an en echelon pattern, were traced for nearly 8 km to the north and south of Njullasjokka. The zone probably extends further southwards as there are weak indications of possible conductors in this direction on the recording tape to as far south as the border of Finland. In the northernmost airborne profile (nr. 35) adjustments of the EM instrument have taken place just above this zone, but from the EM map one can see that anomalies still occur in the northernmost profile on ground.

The EM anomalies appear to follow a 300-400 m wide structural zone, probably a thrust, along which ultrabasics seem to have been intruded. East of Njullasvann and southwards this zone of more or less sheared and cataclastic rocks seems to follow the eastern border of the Hestfossen sequence of amphibolites. Approximately 2.5 km N of the Njullasvann the border bends towards northwest while the anomaly zone continues towards north.

Outcrops within the zone are only found near Njullasjokka and partly along the eastern shore of some lakes 1-2 km N of the river. Elsewhere, the zone is covered by swamps and moraine, probably with a thickness of 10-20 m. The strongest anomalies occur in the river section where the conductors will be situated closest to surface. The EM anomalies are believed to be caused by several N-S striking zones containing sulphides and possibly graphite in places. Sheared talcose serpentinites, waterfilled fractures and to a large extent swampy ground will also influence the conductivity of the ground.

Sulphides amounting to less than 10% are found in a fractured talcose serpentinite (metapyroxenite) in the river section. The sulphide assemblage consits of pyrrhotite enclosing blocky and flame pentlandite. Chalcopyrite, chrome spinel and magnetite are also present. Two samples analysed in Kristiansand contained 0.2 and 0.26 % Ni.

Traverses with the handmagnetometer indicated that the serpentinite is probably more than 250 m long and approximately 50 m wide. In the eastern part of the zone there are several elongated bodies or dykes of meta-ultrabasics giving rise to very high magnetic anomalies. They seem to be situated just east of the strongest EM anomalies and contain much more monoclinic amphibole than the former rock.

In an outcrop of a dense, fine-grained, greyish-greenish gneiss with granular texture and consisting of 70% plagioclase, 20% phlogopite and muscovite and minor chlorite, clinozoisite, rutile, apatite and sphene, the same assemblage of sulphides occurs as dissemination and as enrichments along fracture planes. The mineralization is much weaker than in the serpentinite, and the rock also contains around 1% of graphite.

Sulphides also occur in a special type of sheared mica schist described in PART II under micagneiss/micaschist. The outcrop is situated near a lake 1300 m N of the river and contains up to 5% sulphides as elongated grains parallel to the foliation. The sulphides consists mainly of pyrrhotite with minor chalcopyrite and marcasite. Ilmenite and magnetite are present, and graphite occurs as an accessory.

A sample from another outcrop of probably the same schist 300 m further to the north contains 2% ilmenite and 3% graphite. It is possible that this schist acts as a weak conductor. Diamond drilling seems to be the only way to find out what causes the EM anomalies.

Photo E.O. 4.8.1966.

Picture shows the flat ground to the east above Sieidejokka as seen looking in a NE direction. Here, a small outcrop of serpentinized peridotite was found and a subsequent EM ground survey led to the discovery of the Kirksæther Ravine EM anomaly which was not recorded by the airborne geophysical survey.

4. The Kirksæther Ravine near Landgudelv (Sieidejokka) (see map).

A poorly exposed occurrance of a serpentinized peridotite within a sequence of amphibolites and quartzofeldspathic gneisses near Landgudelv contains up to 5% sulphides. According to Buchan, one specimen contained 30% olivine, 25% serpentine, 20% phlogopite, 10% talc, and 6% carbonate. Blocky pentlandite and pyrrhotite in fairly equal amounts are normally accompanied by chrome spinel and/or magnetite in intergranular patches.

No airborne EM anomalies were detected over this peridotite, but because it contained some sulphides, it was decided to run some profiles with the EM GUN over the ground. It can also be mentioned that 10 m east of the outcrop there are some small blocks of a dioritic rock with granoblastic texture containing more than 30% of oligoclase and probably less than 5% pyrrhotite and marcasite. Another small block within the investigated area contained some graphite (less than 5%).

The brief ground survey detected 3 medium to strong conductors which seem to be parallel to the foliation of the surrounding gneisses. From the 4 profiles with 120 m intervals it is impossible to say anything about the extension of the conductors.

A traverse across the peridotite with a handmagnetometer indicated that it is very narrow. Because of the lack of outcrop the only way to find out what causes the EM anomalies is to drill. However, one should first do some supplementary EM and magnetometer work.

5. Airborne EM anomaly in profile 39 in the southern part of Burfjell (see map).

The airborne EM anomaly which is obvious from the recording tape on both frequencies, probably occurs above the extension of the Burfjell gabbro towards south. Traverses with the EM GUN did not detect any conductor, but the magnetometer outlined the magnetic high indicated by the airborne survey.

One profile was extended westwards to cross a known occurrence of an ultrabasic dyke. In-phase values higher than 100% across the dyke could be explained by a high content of magnetite.

6. Magnetic high east of Burhaugen (see map).

Two EM traverses across the magnetic high of 6000 were negative. In-phase values higher than 100% near the centre of the anomaly could be due to a high magnetite content. Quartzites and mica gneisses some hundred meters west of the anomaly and also north of it near the Njullas river are locally fractured and brecciated with magnetite and minor pyrite precipitated along joint planes.

Traverses with the handmagnetometer gave an irregular pattern of magnetic anomalies near the centre of the magnetic high detected by the airborne survey.

7. The Njullasfjell magnetic high (see map).

An aeromagnetic anomaly of 4550 at Njullasfjell is caused by a hyperite gabbro or metagabbro which locally contains a fair amount of opaques. One specimen showed approximately 4% ilmenite, 3% magnetite, 1% pyrrhotite and traces of chalcopyrite.

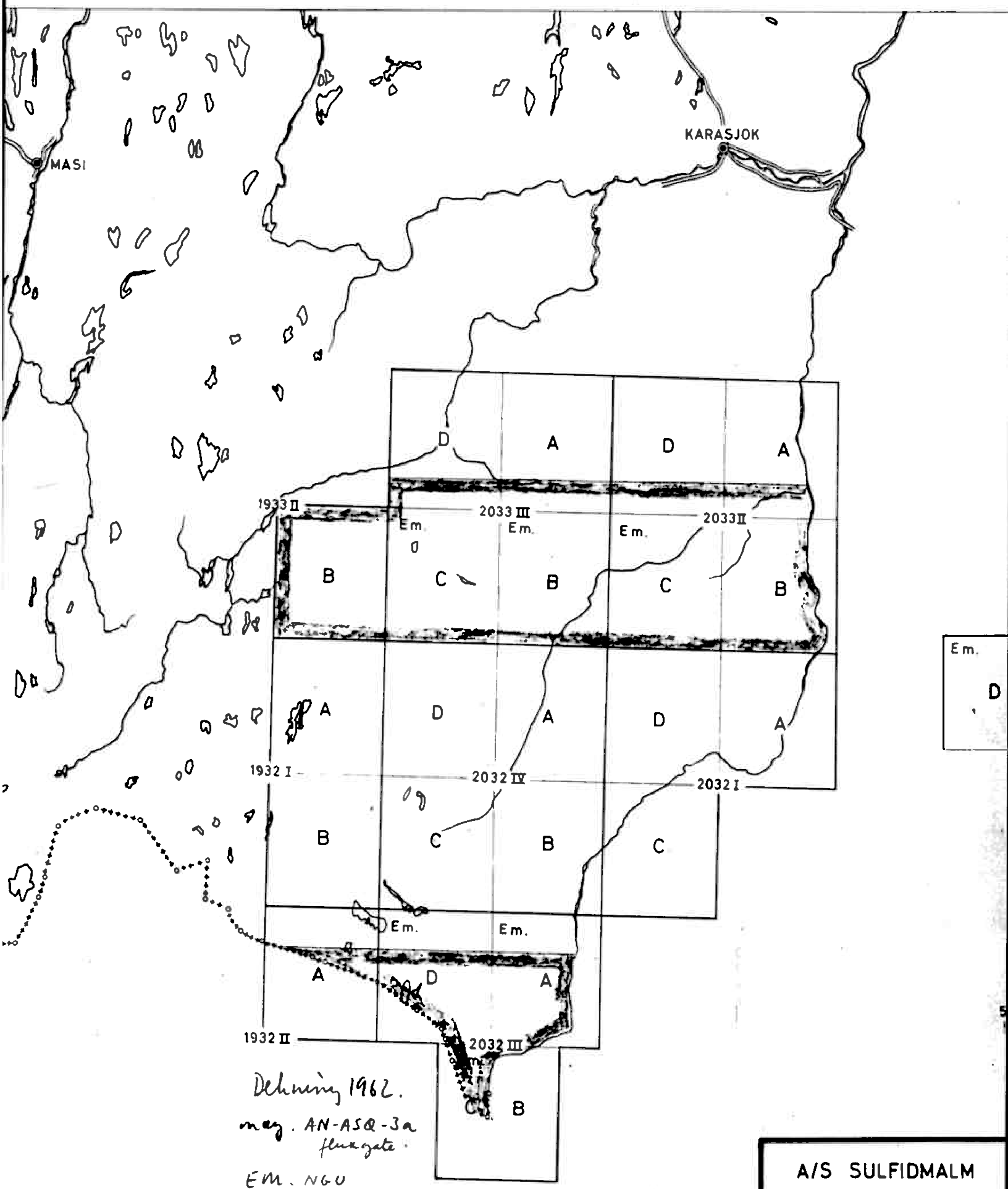
4 traverses on ground across the intrusive did not detect any conductors. Some high in-phase readings are probably caused by concentrations of magnetite. Two profiles with handmagnetometer agree well with the airborne magnetic high.

8. Airborne EM anomaly in profile 52 (see map).

The anomaly shows up very well on the recording tape, and there is also a dubious one on the highest frequency in the next profile to the north. The EM survey on ground gave someweak anomalies which are interpreted as an effect of the overburden or magnetite in the bedrock.

9. Airborne EM anomaly in profile 49 at western part of Burhaugen (see map).

The ground survey over this airborne anomaly, which is evident on the high frequency but somewhat dubious on the lower one on the recording tape, was quite negative.



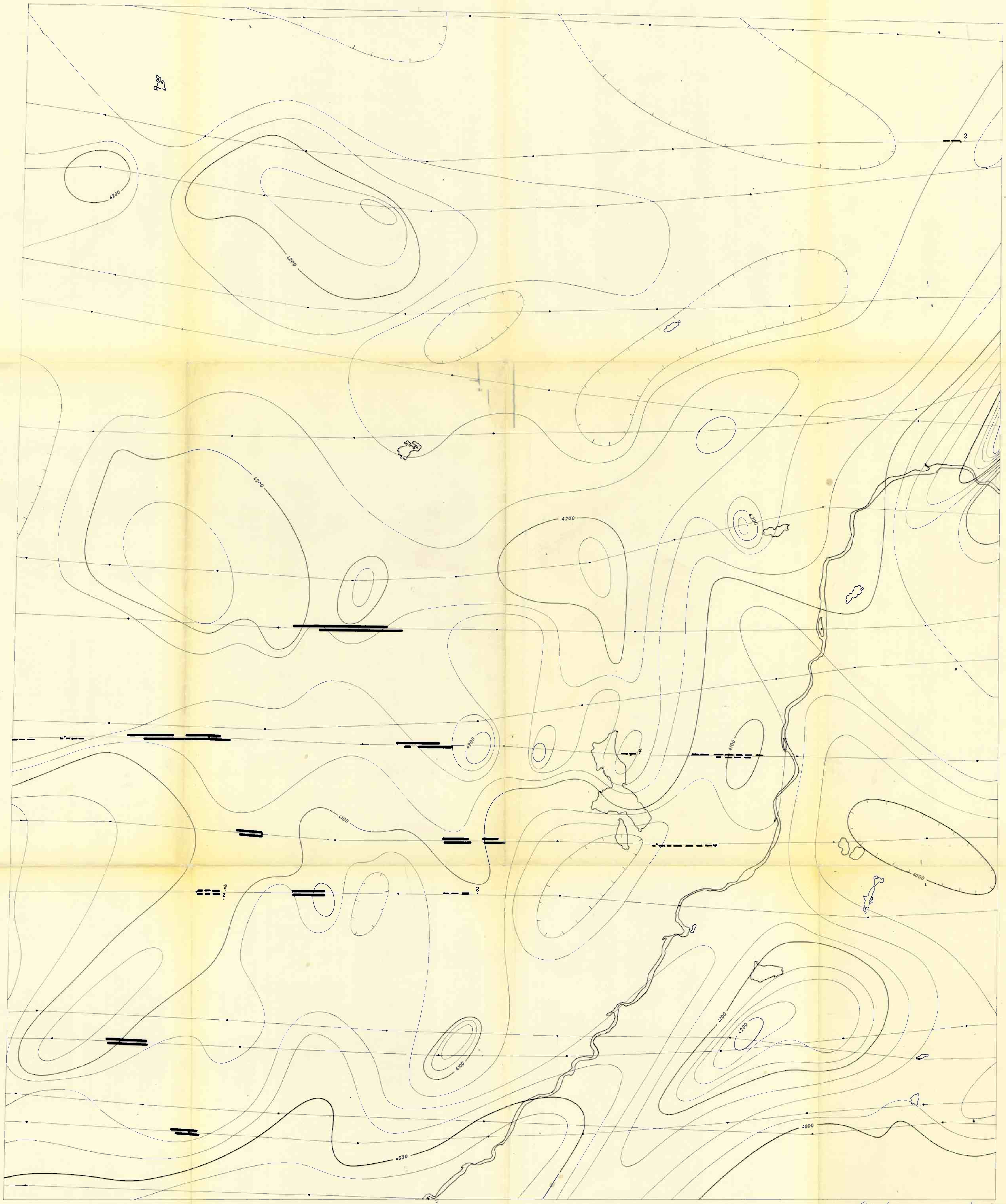
A/S SULFIDMALM

FLYMÅLINGER 19

FINNMARK –

NORGES GEOLOGI

TRONDHEIM



TEGNFORKLARING

Flylinje med plottet punkt

4600 Magnetisk kote

Lukket lavere område

N

Måleskala

0.2 0 0.4 0.8 1.2 Km

Bladdeling

A	D	A	D	A	
1933 II B	C	2033 III B	C	2033 II B	
A	D	A	D	A	
1932 I B	C	2032 IV B	C	2032 I B	
A	D	A			
1932 II	2032 III C	B			

Grinvann

Airborne geophysical maps 1:20000
used 1967

A/S SULFIDMALM FLYMÅLINGER 1962 – MAGNETISK KART FINNMARK, KARASJOK / NJULLAS	MÅLESTOKK CA: 1:20000	MÅLT H.H/K.B. JULI 1962 TEGN. I.AA. APR. 1965 TRAC. G.G. MAI 1965 KFR. I.AA.	
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 378 –	KARTBLAD (AMS) 2033 III B	

TEGNFORKLARING:

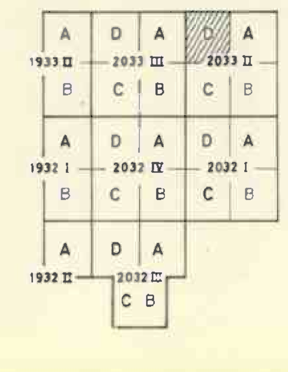
- Flylinje med plottet punkt
- 4600 Magnetisk kote
- Lukket lavere område

N

Måleskala

0.2 0 0.4 0.8 1.2 Km.

Bladdeling



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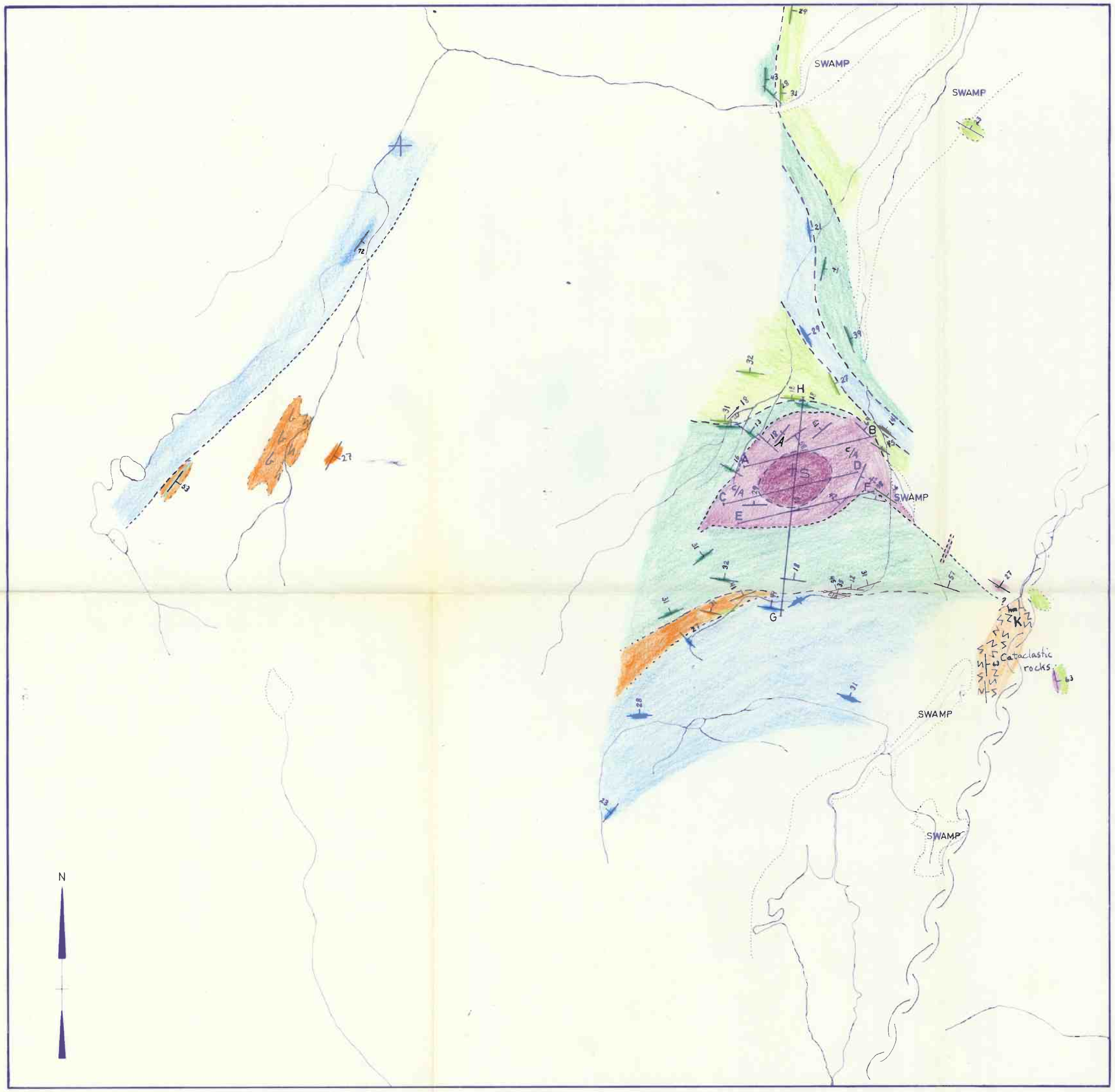
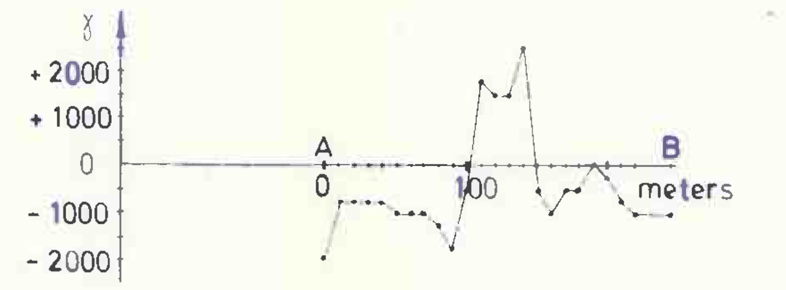
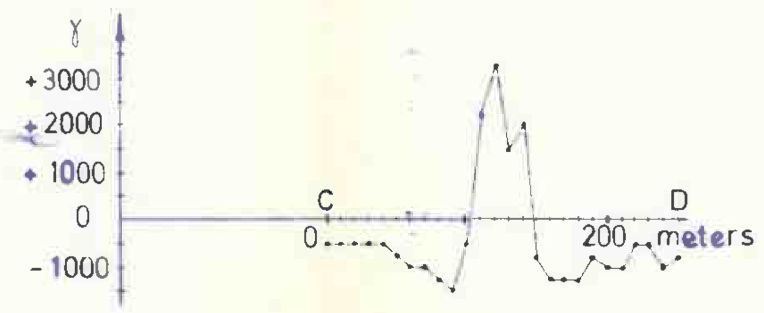
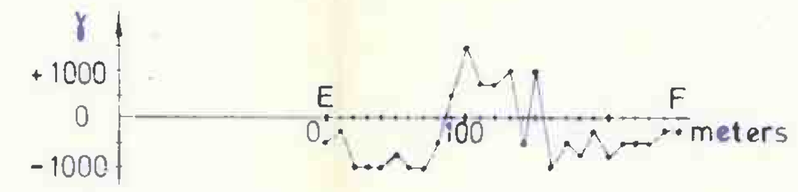
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 378 –	KARTBLAD (AMS) 2033 II D	

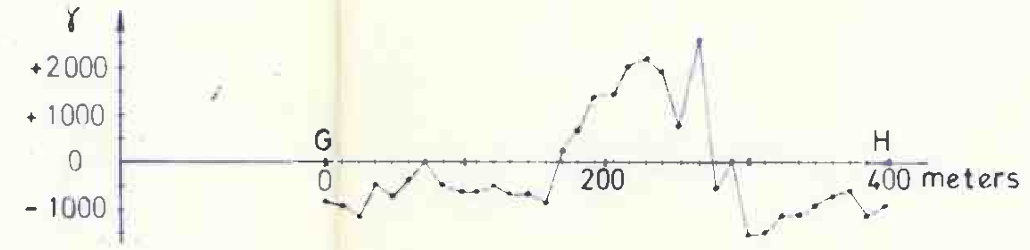

RÖESJÖEN E.
480 W
360 W
240 W
120 W
BASE LINE
120 E
py, mc (po, mo)
py, mc (po, mo)
CAMP
N
EM ANOMALIES
BLOCK WITH DISSEMINATED PYRITE
META ULTRABASITE
GREY PEGMATITE AND GNEISS
AMPHIBOLITE
OUTCROP
SWAMP
STRIKE AND DIP
REINDEER FENCE
out of phase
× 1760 c/s
> 100 %
in phase
∘ 440 c/s
< 100 %
1 mm = 1%
OUTCROPPING OF CONDUCTOR
STRIKE AND DIP OF CONDUCTOR
TRENCH
BLAST
840 S
720 S
600 S
480 S
360 S
240 S
120 S
0
120 N
240 N
360 N
480 N
600 N
720 N
840 N
960 N
1080 N
1200 N
1320 N
1440 N
1540 N
1680 N
1880 N
1920 N
A/S SULFIDMALM
ELECTROMAGNETIC MAP FROM EASTERN RÖESJÖ KAUTOKEINO HERRED FINNMARK, NORWAY.
MÅLESTOKK 1 : 4000
OBS: SC. EO.
TEGN: E.O. 1965
TRAC: B.H. 14.10.65
KFR:
NORGES GEOLOGISKE UNDERSÖKELSE TRONDHEIM
TEGN. NR. 5
KARTBL. 2032 III











AMPHIBOLITE

GNEISS/MICA SCHIST

ALBITE GNEISS w/ AMPHIBOLITE SCHLIEREN

CATACLASTIC ROCKS: MYLONITIC, PARTLY GRANULATED OR BRECCIATED

CHLORITE-ACTINOLITE SCHISTS (A- ASBESTOS)

SERPENTINITE

0 50 100 200 300 400 500 meters

ROCK DISTRIBUTION AND MAGNETOMETRIC PROFILES AT AAGAARDTOPPEN LOCALITY, NJULLAS, KAUTOKEINO AREA, FINNMARK, NORWAY.	SCALE 1:5000	OBS: LK. JUL.1966 DRAWN: LK. AUG.1966 TRAC: JSM. DEC.1966
A/S SULFIDMALM KRISTIANSAND S.	4	MAP SHEET 2032 III

LEGEND

SWAMP

LOW GRAVEL RIDGE

E.M. ANOMALIES

2500 c/s

500 c/s

FLIGHT LINE 52

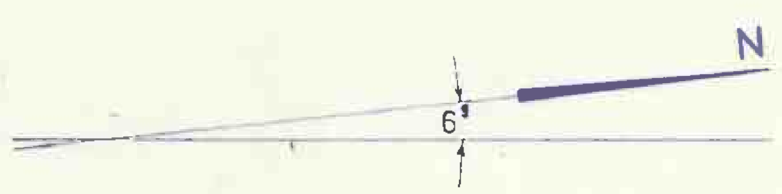
OUT OF PHASE
× 1760 c/s

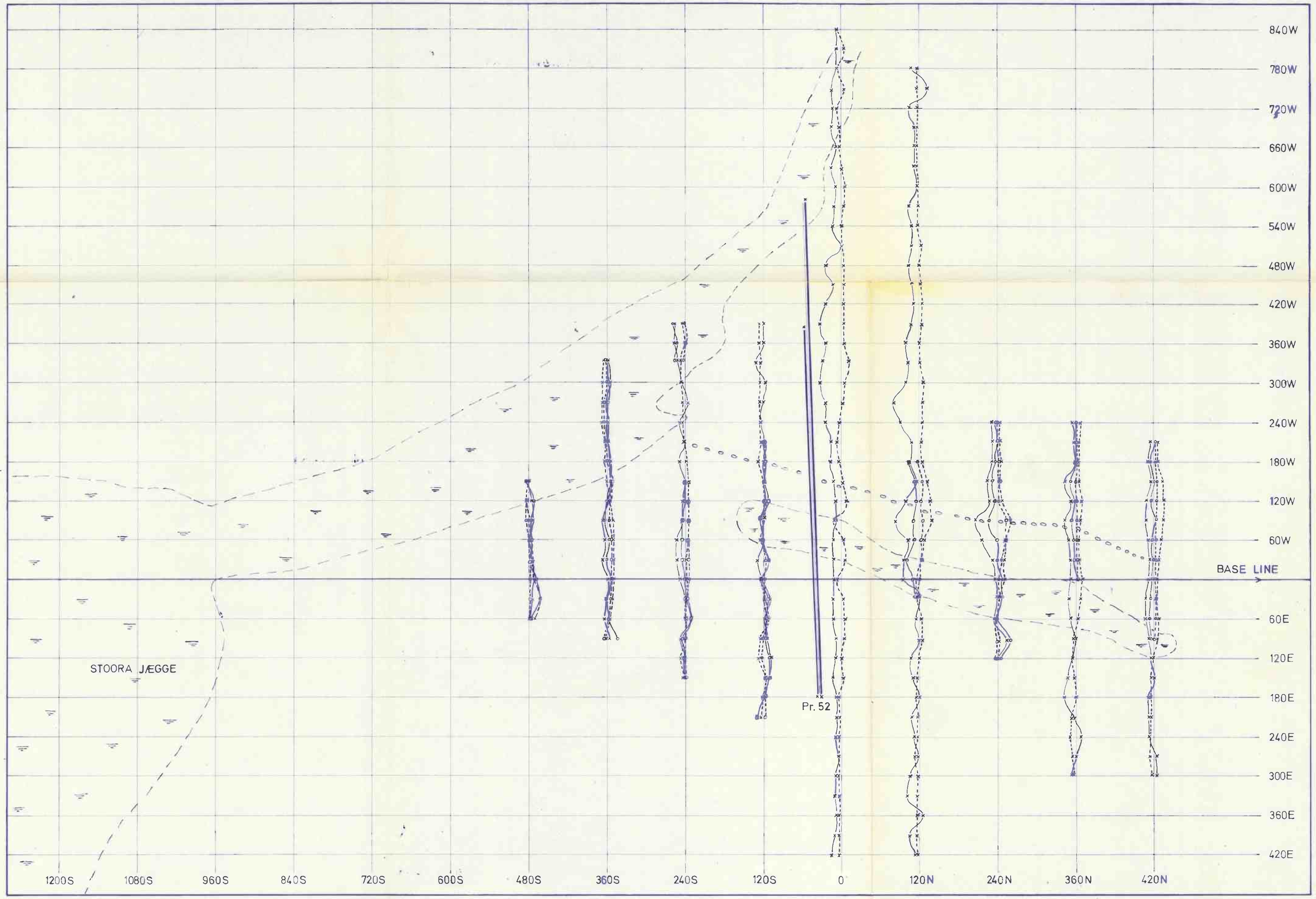
IN PHASE
• 440 c/s

>100%

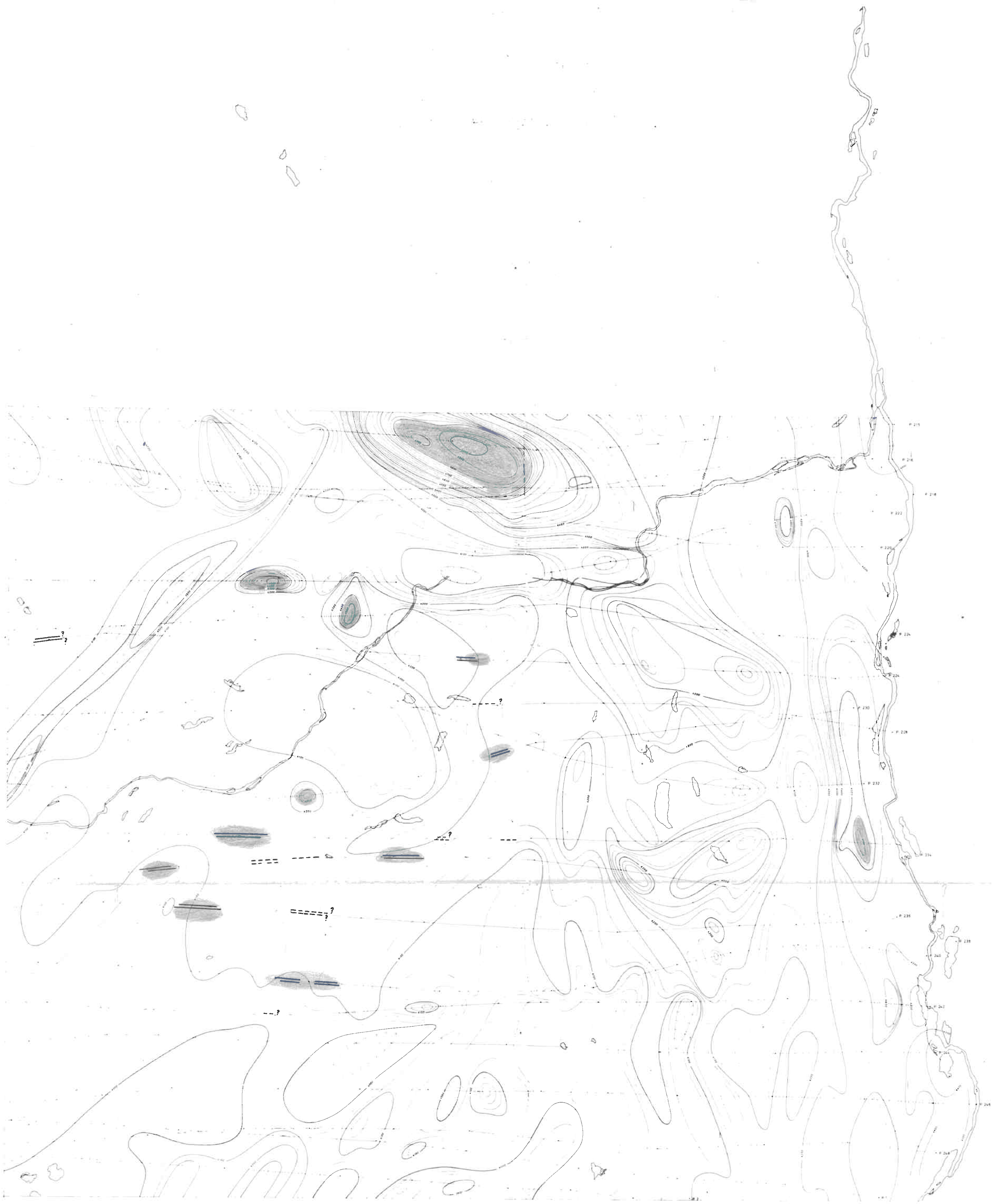
<100%

1mm = 1%





ELECTROMAGNETIC MAP FROM THE GROUND SURVEY OF PART OF THE AERIAL PROFILE 52, NJULLAS, KAUTOKEINO AREA, FINNMARK, NORWAY.	SCALE 1:4000	OBS: KÅN. EEN. IS.	JUN.1966
		DRAW: EO.	JUL.1966
		TRAC: JSM.	DEC.1966
A/S SULFIDMALM KRISTIANSAND S.	13	MAP SHEET 2032 III	



TEGNFORKLARING:

Flylinje med plottet punkt

4600 Magnetisk kote

Lukket lavere område

2500 c/s / 500 c/s — E.M. ANOMALIES

2500 c/s / 500 c/s — E.M. ANOMALIES FOUND ON RECHECK OF RECORDS AT NGU (MAY 1967)

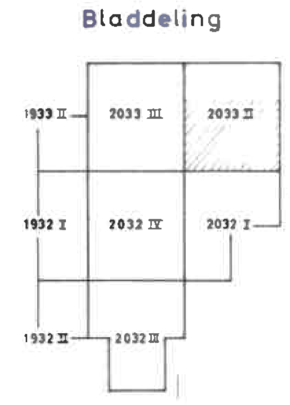
ANOMALIES CHECKED FOR OUTCROPS

N

Måleskala

0,5 0 1 2 km

Bladdeling



A/S SULFIDMALM FLYMÅLINGER 1962 — MAGNETISK KART **FINNMARK**, KARASJOK / NJULLAS	MÅLESTOKK CA. 1 : 50 000	MÅLT TEGN. TRAC. KFR.	Juli 1962 Apr. 1965 Mai 1965
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR: 378 — 16 (3)	KARTBLAD (AMS) 2033 II	

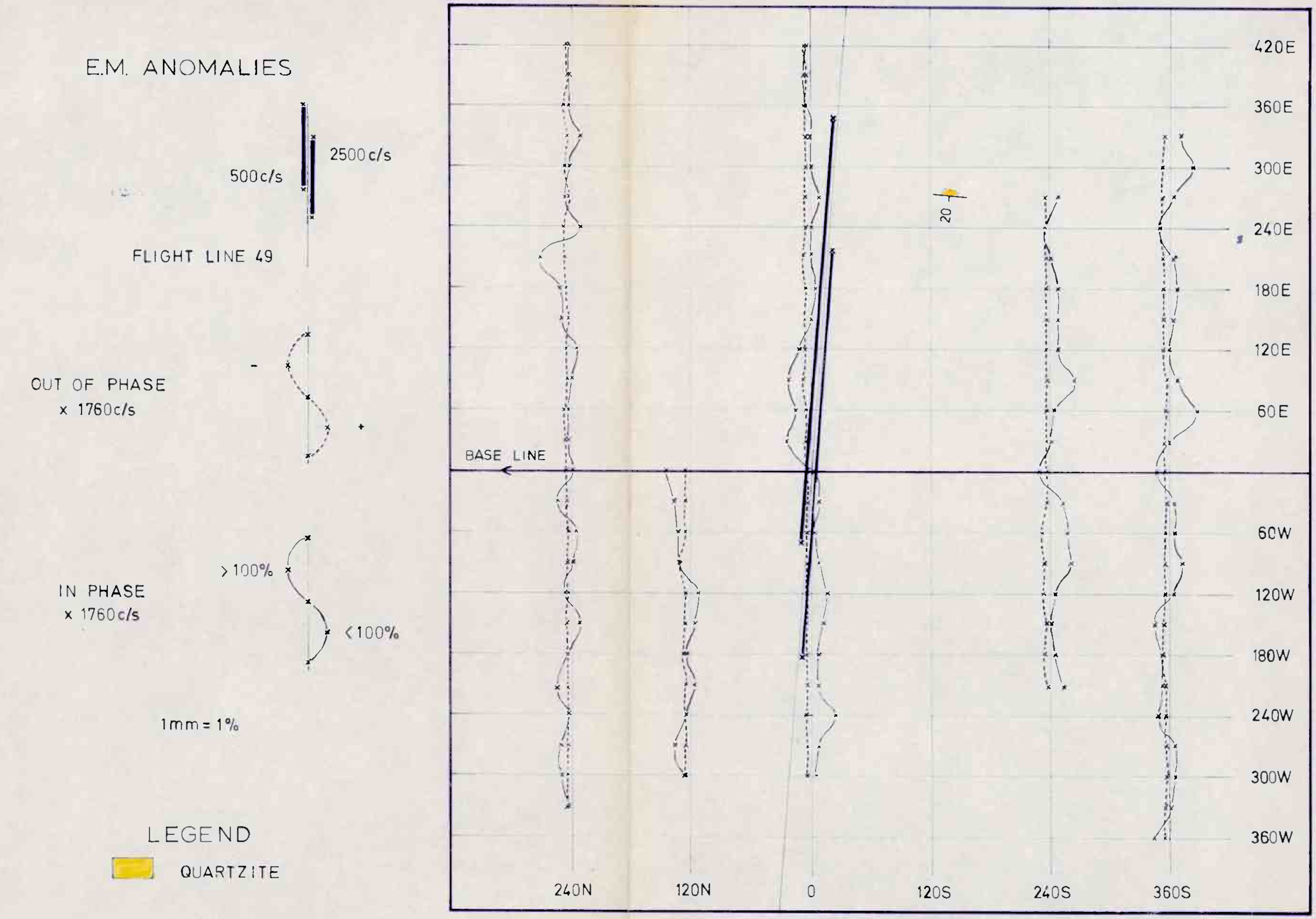
ELECTROMAGNETIC MAP FROM THE GROUND SURVEY AT NJULLAS-JOKKA
NJULLAS, KAUTOKEINO AREA, FINNMARK, NORWAY.

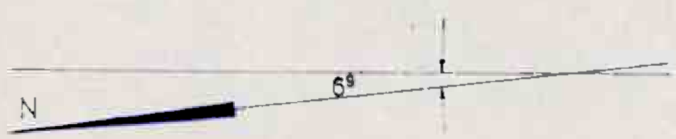
SCALE		
1:4000	OBS: KAH IS EEH EO	JULY 1966
	DRAW: KAH EEH EO	1966
	TRAC: EA EO JSM	1967

A/S SULFIDMALM
KRISTIANSAND S

MAP NR. 7

MAP SHEET 2032 III





ELECTROMAGNETIC MAP FROM THE GROUND SURVEY IN PROFILE 49 AT THE WESTERN PART OF BURHAUGEN, NJULLAS, KAUTOKEINO AREA, FINNMARK, NORWAY.	SCALE 1:4000	OBS: KAH	JUL. 1966
		DRAW: EEH.	JUL. 1966
		TRAC: JSM.	JAN. 1967
A/S SULFIDMALM KRISTIANSAND S.	14	MAP SHEET 2032 III	

GEOPHYSICAL MAP FROM THE GROUND SURVEY IN PROFILE 39 AT THE SOUTHERN PART OF BURFJELL, NJULLAS, KAUTOKEINO AREA, FINNMARK, NORWAY.

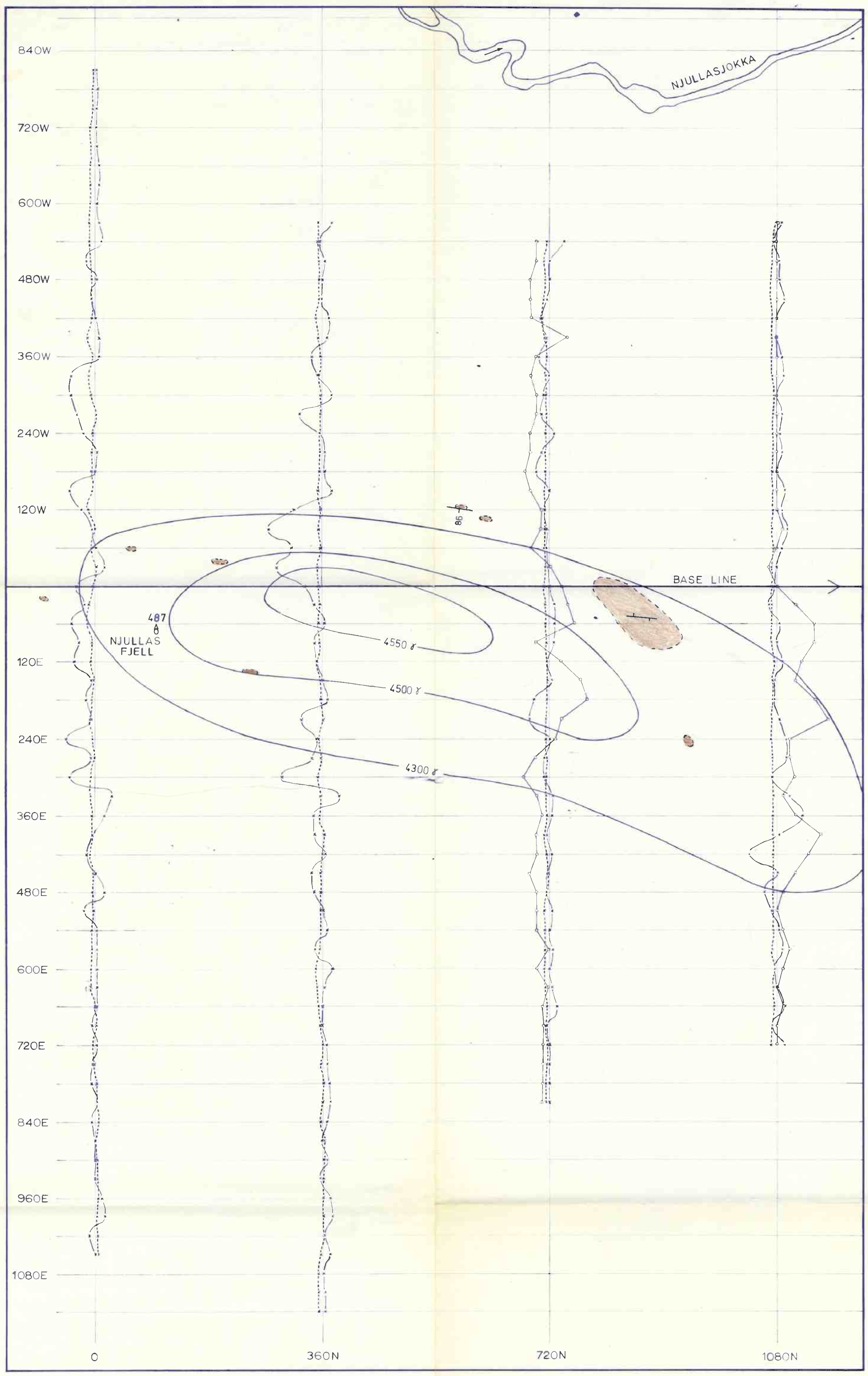
SCALE 1:4000	OBS: HAH. IS. EEH.	AUG. 1966
	DRAW: EO.	JAN. 1967
	TRAC: JSM.	JAN. 1967

A/S SULFIDMALM
KRISTIANSAND S.

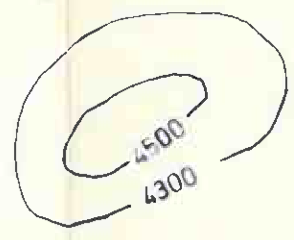
10

MAP SHEET 2032 III

MAGNETIC ANOMALIES
MAGNETIC CONTOURS (AIRBORNE SURVEY)
γ VALUES (GROUND SURVEY)
1mm = 100 γ
E.M. ANOMALIES
OUT OF PHASE
x 1760c/s
>100%
IN PHASE
x 1760c/s
<100%
1mm = 1%
LEGEND
QUARTZITES, MAINLY IMPURE (FRACTURED ALONG CANYON)
MICA GNEISS AND BIOTITE SCHIST
FOLIATION
MINOR FOLD AXIS
CANYON < 10m. DEEP
LINEAMENT
BASE LINE
5500
6000
PR5
PR4
PR3
PR2
PR1
+ 6000 γ
+ 5000 γ
+ 4000 γ
+ 3000 γ
+ 2000 γ
+ 1000 γ
- 1000 γ
N
68°
0 50 100 200 300M
GEOPHYSICAL MAP FROM THE GROUND SURVEY OF THE MAGNETIC HIGH EAST OF BURHAUGEN IN NJULLAS, KAUTOKEINO AREA, FINNMARK, NORWAY.
SCALE 1:2000
OBS: AM. BL. EEH. JUL.1966
DRAW: EO. JAN.1967
TRAC: JSM. JAN.1967
A/S SULFIDMALM
KRISTIANSAND S.
MAP NR. 11
MAP SHEET 2032 III



MAGNETIC ANOMALIES



MAGNETIC CONTOURS (AIRBORNE SURVEY)

γ VALUES (GROUND SURVEY)

1mm = 100 γ

E.M. ANOMALIES

OUT OF PHASE x 1760 c/s

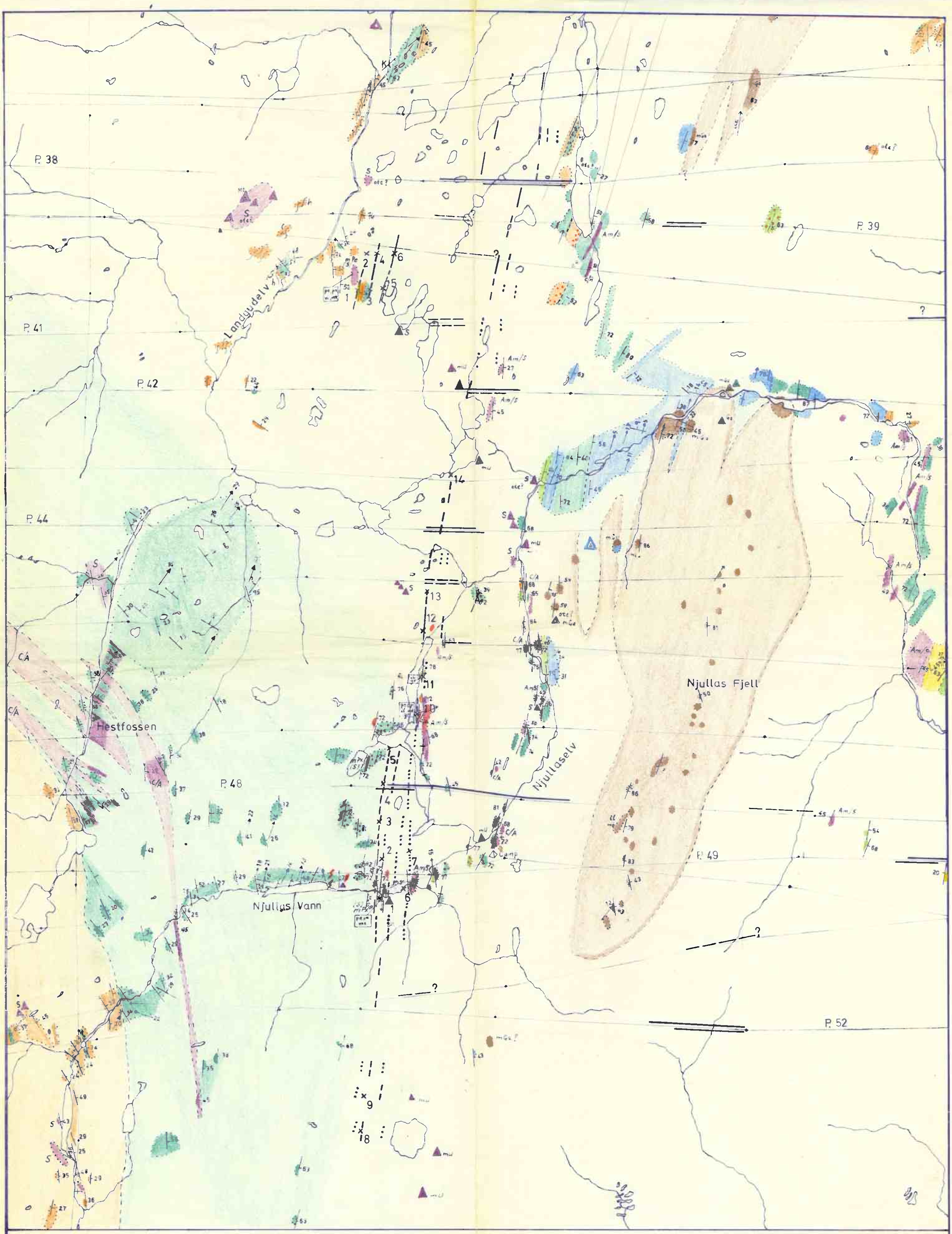
IN PHASE >100% < 100% x 1760 c/s

1mm = 1%

GABBRO AND METAGABBRO

FOLIATION

GEOPHYSICAL TRAVERSES ACROSS THE NJULLASFJELL MAGNETIC HIGH IN NJULLAS, KAUTOKEINO AREA, FINNMARK, NORWAY.	SCALE 1:4000	OBS: EEH. KAH. IS.	JUL.1966
		DRAW: IS. EO.	AUG. 1966 JAN. 1967
		TRAC: JSM.	JAN. 1967
A/S SULFIDMALM KRISTIANSAND S.	MAP NR. 12	MAP SHEET 2032 III	



N

E.M. ANOMALIES (GROUND SURVEY)
(Relative Conductivities)

——	strong conductor
- - -	medium conductor
····	weak conductor

0,2 0 0,4 0,8 1,2 KM

M = 1 : 20000

E.M. ANOMALIES (AIRBORNE SURVEY)

2500 c/s
500 c/s
Flight Line

2500 c/s
500 c/s
E.M. ANOMALIES FOUND ON RECHECK OF RECORDS AT NGU (MAY 1967)

X (No.) : Proposed Claim Points

LEGEND

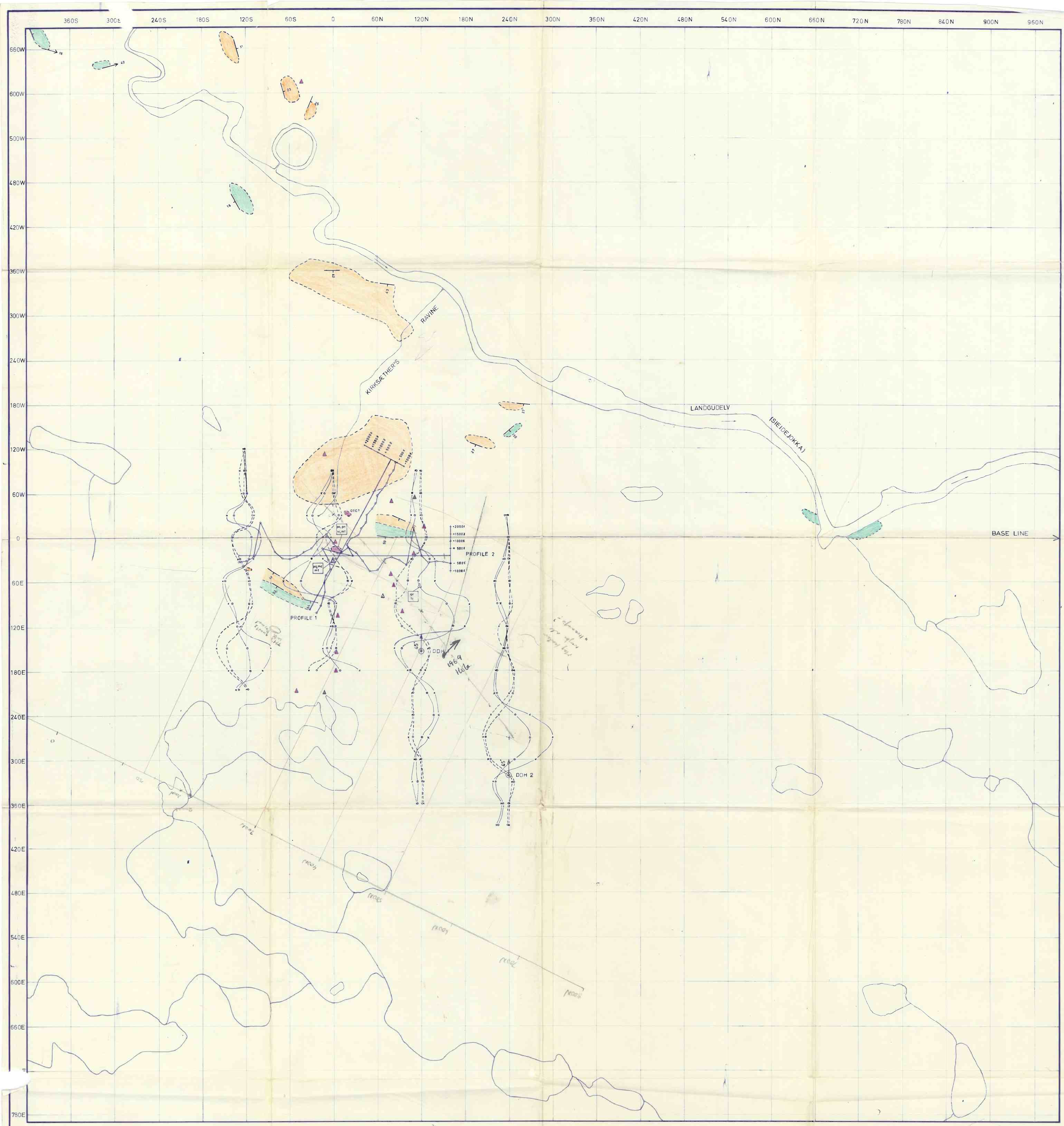
- QUARTZ-PLAGIOCLASE PEGMATITE
- GABBRO / METAGABBRO
- META-ULTRABASIC
- AMPHIBOLITE
- QUARTZITE
- QUARTZO-FELDSPATHIC GNEISS (K - granitic gneiss, h - hornblende gneiss)
- MICA GNEISS d - disthene
- ALBITE GNEISS

mPe - meta peridotite
mPx - meta pyroxenite
S - serpentinite
Am/S - amphibole-serpentine rock
C/A - chlorite-actinolite rock

- MIGMATIZATION
- FOLIATION
- FOLD AXIS
- SHEAR ZONE
- OUTCROP
- APPROXIMATE BOUNDARIES
- BLOCK

ch	chalcopyrite
pn	pentlandite
po	pyrrhotite
vi	violarite
il	ilmenite
mt	magnetite
gr	graphite

MAP FROM CENTRAL NJULLAS SHOWING OUTCROPS AND E.M. ANOMALIES IN THE NJULLAS, KAUTOKEINO AREA, FINNMARK, NORWAY.	SCALE 1: 20000	OBS:	1966
		DRAW:	1967
		TRAC:	1967
A/S SULFIDMALM KRISTIANSAND S.	6	MAP SHEET 2032 III	



LEGEND

- META-ULTRABASICS, mainly talcose serpentinite
- AMPHIBOLITES (partly banded, folded, and migmatized)
- QUARTZO-FELDSPATHIC GNEISS, mainly quartz dioritic
- △ BLOCKS
- APPROXIMATE EXTENSION OF OUTCROP
- FOLIATION
- FOLD AXIS
- 45° proposed drill point

po pyrrhotite — vi violarite — mt magnetite — gr graphite
pn pentlandite — mc marcasite — li limonite

E.M. ANOMALIES

1mm = 1%

x 1760 c/s — OUT OF PHASE

>100% — o 440 c/s <100% — IN PHASE

MAGNETIC ANOMALIES

1mm = 100 γ

N 6°

GEOPHYSICAL MAP FROM KIRKSÆTHER'S RAVINE NEAR LANDGUDELV IN NJULLAS, KAUTOKEINO AREA, FINNMARK, NORWAY.	SCALE 1:2000	OBS: AM LK EEH IS. EO JUL/AUG. '66
		DRAW: LK. EO. JUL. 1966 JAN. 1967
		TRAC: JSM. FEB. 1967
A/S SULFIDMALM KRISTIANSAND S.	MAP NR. 9	MAP SHEET 2032 III

TEGNFORKLARING:

Flylinje med plottet punkt

4600 Magnetisk kote

Lukket lavere område

2500 c/s 500 c/s E.M. ANOMALIES

2500 c/s 500 c/s E.M. ANOMALIES FOUND ON RECHECK OF RECORDS AT NGU (MAY 1967)

ANOMALIES CHECKED FOR OUTCROPS

N

Måleskala

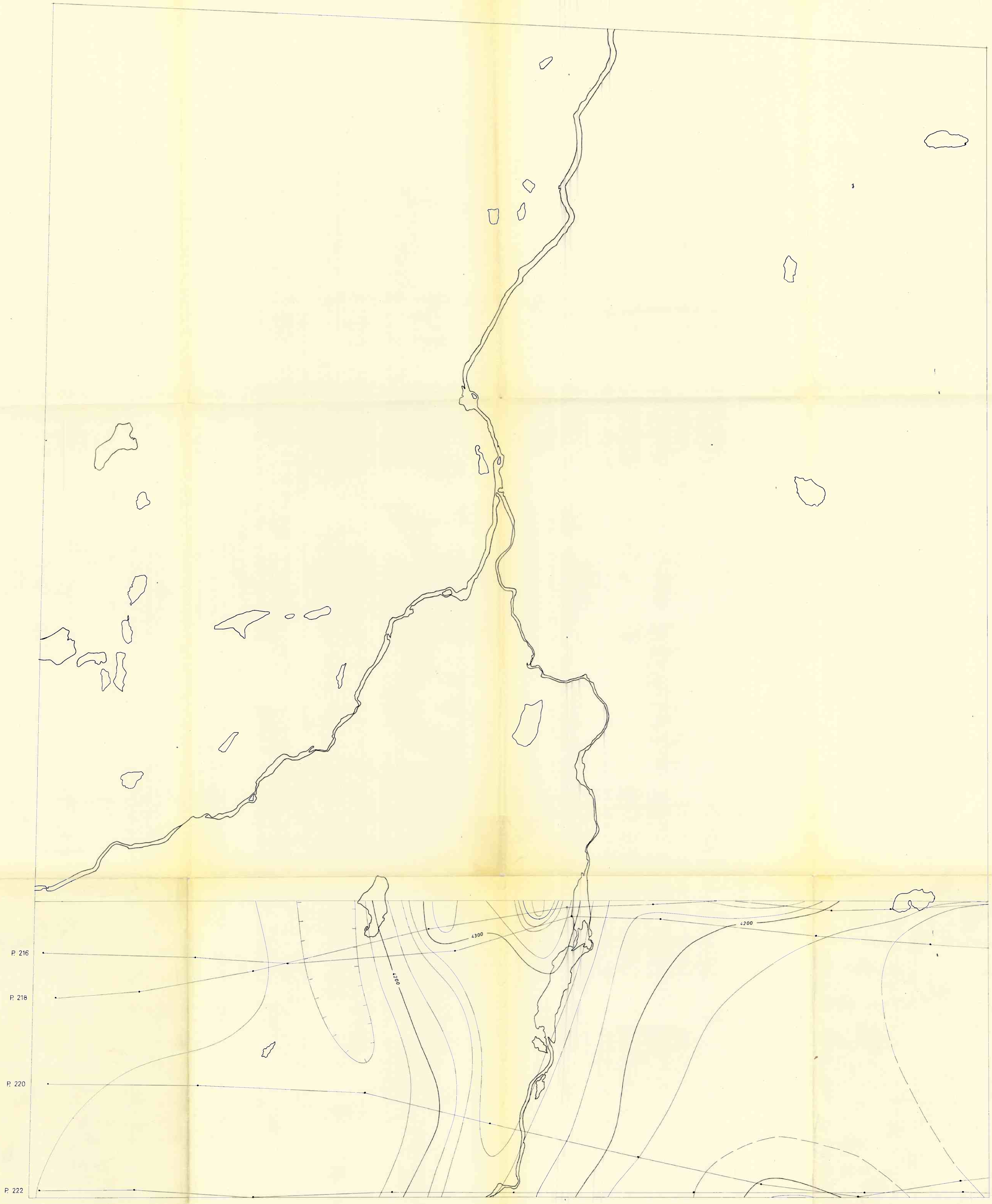
0.5 0 1 2 km

Bladdeling

1933 II	2033 III	2033 II
1932 I	2032 IV	2032 I
1932 II	2032 III	

A/S SULFIDMALM FLYMÅLINGER 1962 — MAGNETISK KART **FINNMARK**, KARASJOK / NJULLAS	MÅLESTOKK CA. 1 : 50 000	MÅLT TEGN. TRAC. KFR.	Juli 1962 Apr. 1965 Mai 1965
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR: 378 — 15 (2)	KARTBLAD (AMS)	


NJULLAS VANN
BASE LINE
DDH 4
DDH 3
DDH 5
NJULLAS-JOKKA
600W
540W
480W
420W
360W
300W
240W
180W
120W
60W
0
60E
120E
180E
240E
300E
360E
420E
1080S
960S
840S
720S
600S
480S
360S
240S
120S
0
120N
240N
360N
480N
600N
720N
840N
960N
1080N
1200N
1320N
1440N
1560N
1680N
1800N
1920N
2040N
2160N
2280N
2400N
2520N
2640N
2760N
2880N
3000N
3120N
TRAVERSE A-C OVER WEAKLY MINERALIZED TALCOSE SERPENTINITE WITH PHILIPS PW 4010 GEIGER COUNTER.
× COUNTS DURING 10 MINUTES
– UNCERTAINTY
Counts/min
TRAVERSE D-F OVER SHEARED META ULTRABASIC WITH PHILIPS PW 4010 GEIGER COUNTER.
× COUNTS DURING 10 MINUTES
– UNCERTAINTY
Counts/min
LEGEND
BLOCK
PLAG. PEGMATITIC PATCHES
PLAG. PEGMATITES
META-ULTRABASICS
AMPHIBOLITE
DIORITIC ROCK WITH MICA
QUARTZO-FELDSPATHIC GNEISS
MICA GNEISS
SWAMP
ch chalcopyrite
pn pentlandite
po pyrrhotite
he hematite
mt magnetite
il ilmenite
gr graphite
cat. cataclastic
schistosity
FOLIATION
FOLD AXIS
LINEATION
mPx meta-pyroxenite
S serpentinite
Am/S amphibole + serpentine
b biotite
d disthene
garnet
proposed drill points
E.M. ANOMALIES
OUT OF PHASE
440c/s
1mm = 1%
OUTCROPPING OF CONDUCTOR
STRIKE OF CONDUCTOR
MAGNETIC ANOMALIES
1mm = 100 γ
GEOPHYSICAL MAP FROM THE GROUND SURVEY AT NJULLAS-JOKKA IN NJULLAS, KAUTOKEINO AREA FINNMARK, NORWAY.
SCALE 1:4000
OBS: KAH IS AM EEH EO JULY 1966
DRAW: IS JSM EO 1966
TRAC: EA EO JSM MARCH 1967
A/S SULFIDMALM
KRISTIANSAND S
MAP NR. 8
MAP SHEET 2032 III

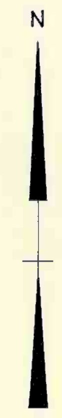


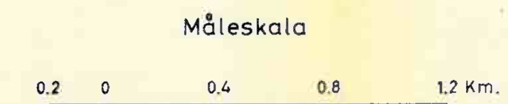
TEGNFORKLARING:

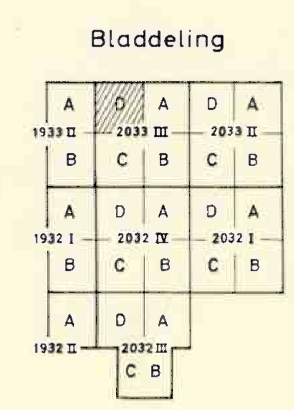
Flylinje med plottet punkt

4600 Magnetisk kote

Lukket lavere område







A/S SULFIDMALM FLYMÅLINGER 1962 — MAGNETISK KART **FINNMARK**, KARASJOK / NJULLAS	MÅLESTOKK CA: 1: 20 000	MÅLT H.H/KB. JULI 1962 TEGN. I.AA. APR. 1965 TRAC. G.G. MAI 1965 KFR. I.AA.	
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 378 —	KARTBLAD (AMS) 2033 III D	

TEGNFORKLARING:

Flylinje med plottet punkt

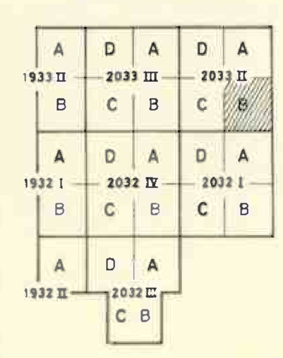
Magnetisk kote

Lukket lavere område

Måleskala

0.2 0 0.4 0.8 1.2 Km.

Bladdeling



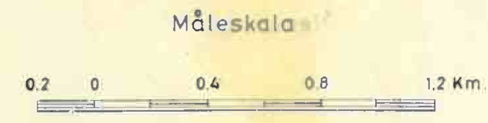
A/S SULFIDMALM FLYMÅLINGER 1962 – MAGNETISK KART **FINNMARK**, KARASJOK / NJULLAS	MÅLESTOKK CA: 1 : 20 000	MÅLT H.H/KB JULI 1962 TEGN. I.AA. APR. 1965 TRAC. G.G. MAI 1965 KFR. I.AA.
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 378 –	KARTBLAD (AMS) 2033 II B

TEGNFORKLARING:

- Flylinje med plottet punkt
- 4600 Magnetisk kote
- Lukket lavere område

N

Måleskala



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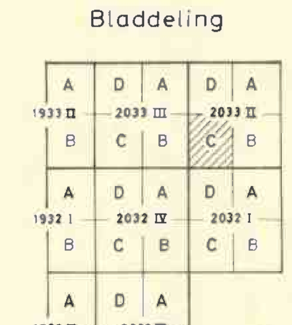
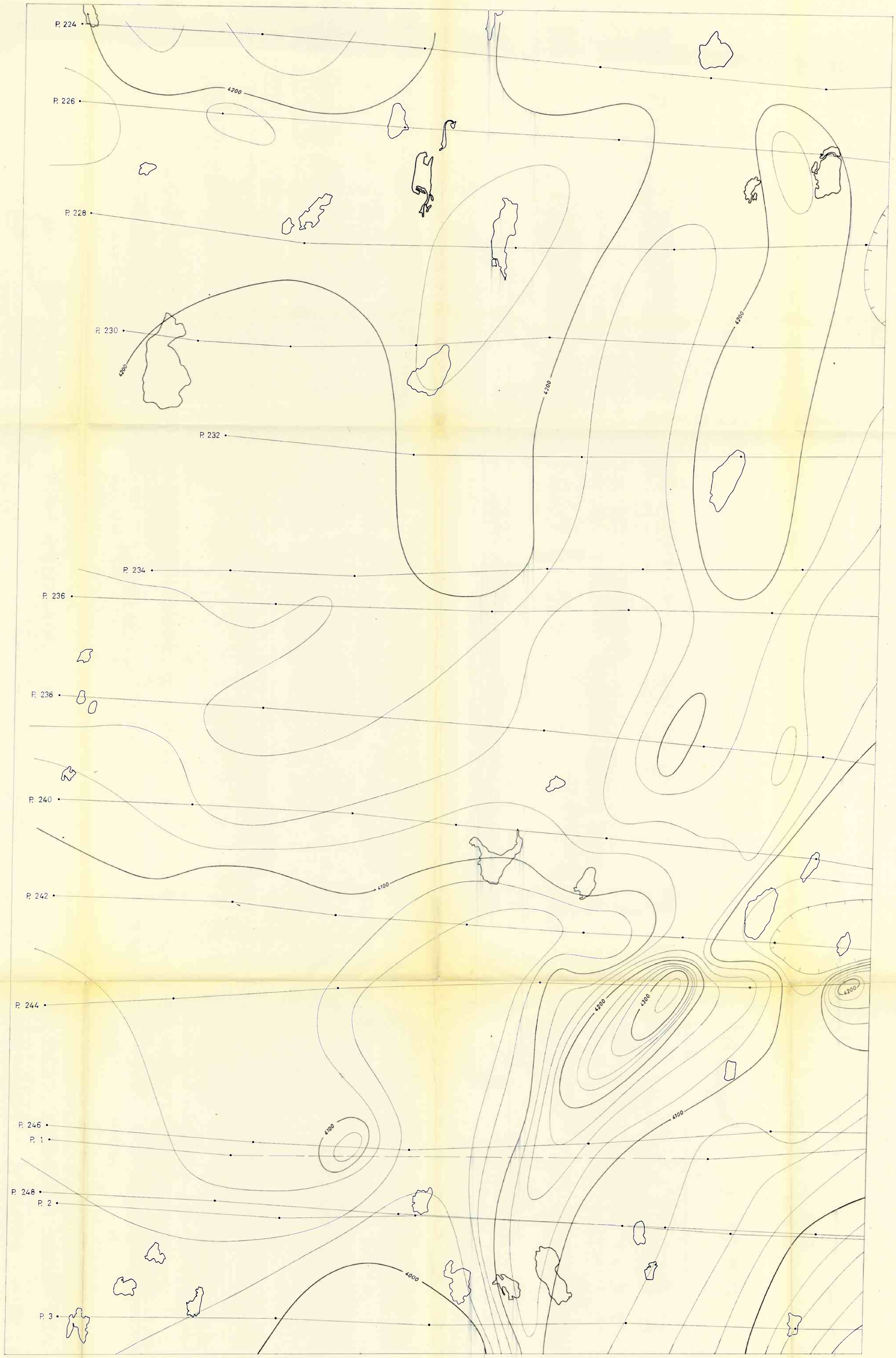


A/S SULFIDMALM FLYMÅLINGER 1962 — MAGNETISK KART **FINNMARK**, KARASJOK / NJULLAS	MÅLESTOKK CA: 1 : 20 000	MÅLT H.H./KB. JULI 1962 TEGN. I.AA. APR 1965 TRAC. G.G. MAI 1965 KFR. I.AA.
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 378 —	KARTBLAD (AMS) 2033 II C



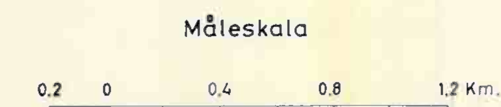
TEGNFORKLARING:

Flylinje med plottet punkt

4600 Magnetisk kote

Lukket lavere område

Måleskala



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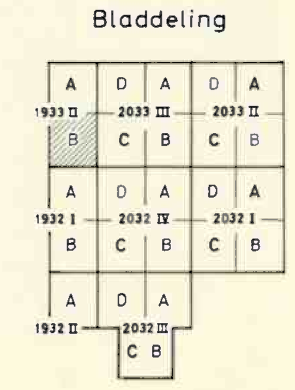
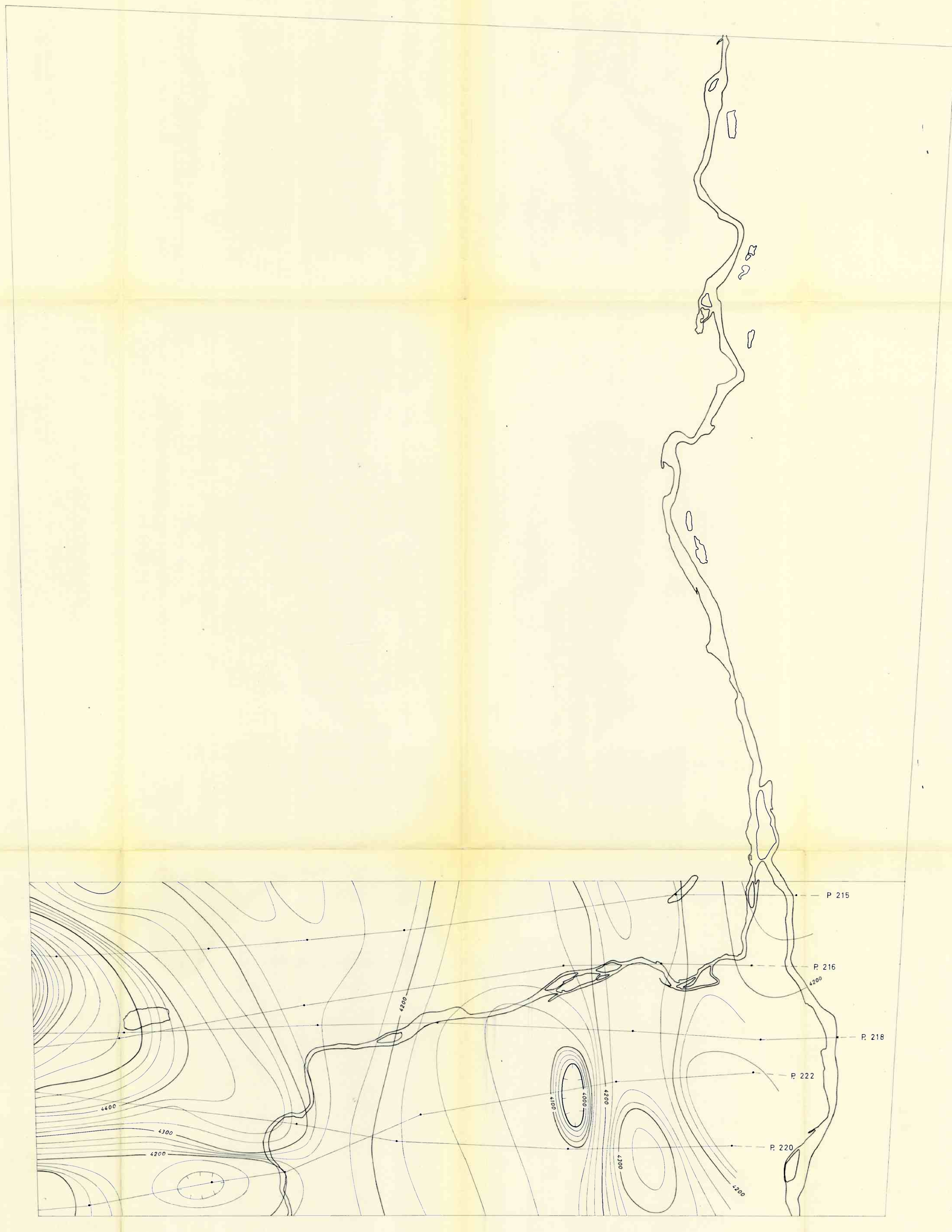


A/S SULFIDMALM FLYMÅLINGER 1962 — MAGNETISK KART **FINNMARK**, KARASJOK / NJULLAS	MÅLESTOKK CA: 1 : 20 000	MÅLT HH/KB JULI 1962 TEGN. I.AA. APR. 1965 TRAC. G.G. MAI 1965 KFR. I.AA.
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 378 —	KARTBLAD (AMS) 1933 II B

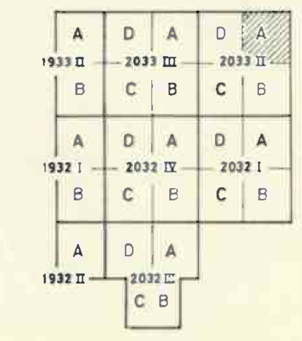


TEGNFORKLARING:

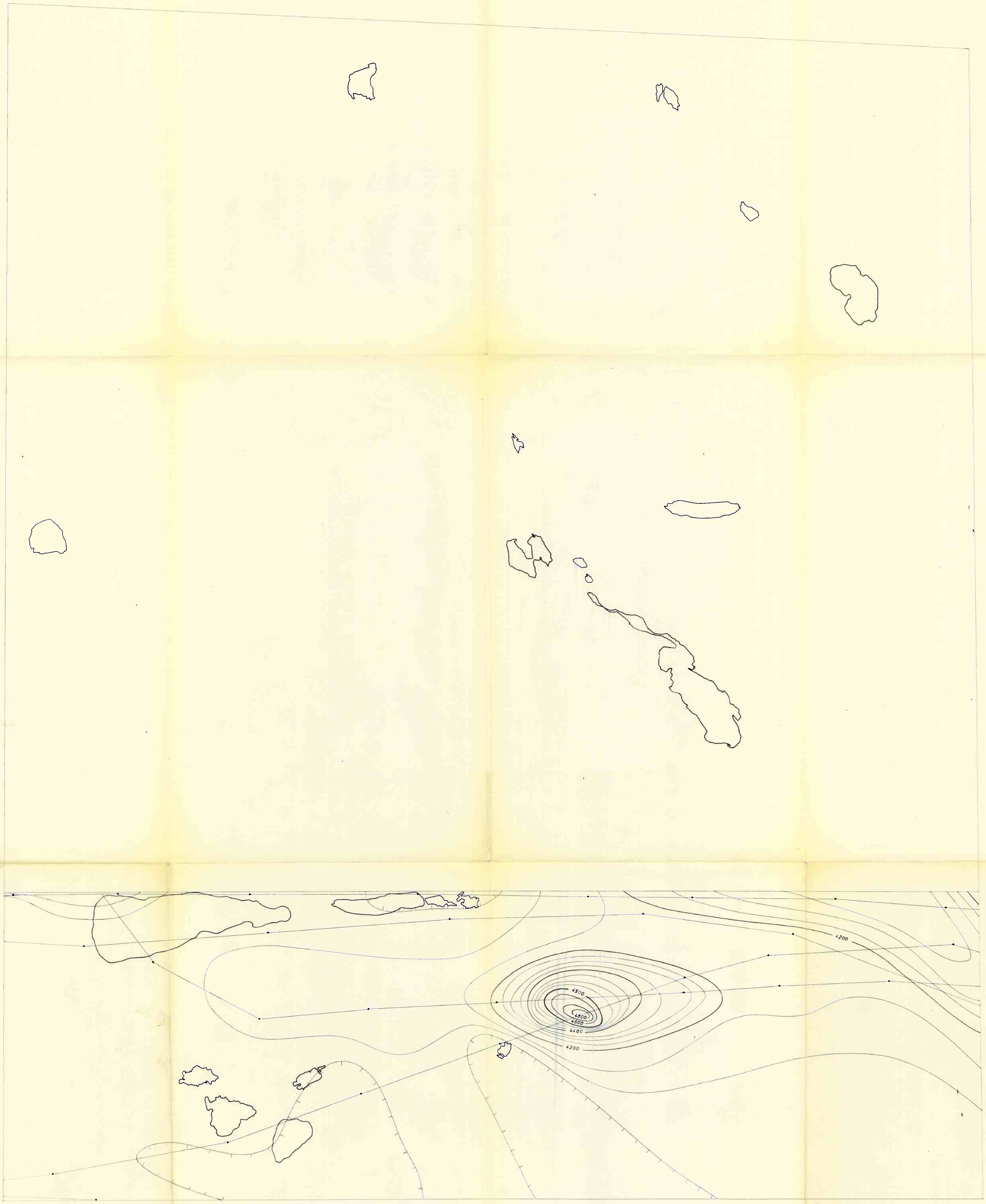
- Flylinje med plottet punkt
- 4600 Magnetisk kote
- Lukket lavere område

Måleskala

Bladdeling



A/S SULFIDMALM FLYMÅLINGER 1962 – MAGNETISK KART **FINNMARK**, KARASJOK / NJULLAS	MÅLESTOKK CA: 1 : 20 000	MÅLT H.H/KB. JULI 1962 TEGN. I.AA. APR. 1965 TRAC. G.G. MAI 1965 KFR. I.AA.	
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 378 –	KARTBLAD (AMS) 2033 II A	



TEGNFORKLARING:

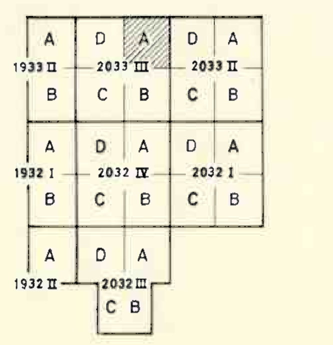
- Flylinje med plottet punkt
- 4600 Magnetisk kote
- Lukket lavere område

N

Måleskala

0.2 0 0.4 0.8 1.2 Km.

Bladdeling



A/S SULFIDMALM FLYMÅLINGER 1962 – MAGNETISK KART **FINNMARK**, KARASJOK / NJULLAS	MÅLESTOKK CA: 1: 20000	MÅLT H.H./KB. TEGN. I.AA. TRAC. G.G. KFR. I.AA.	JULI 1962 APR. 1965 MAI 1965
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 378 –	KARTBLAD (AMS) 2033 III A	