OSLO

Client: A/S Sulfidmalm

NGU report no. 1270

Helicopter-borne magnetic and electromagnetic survey over MASI KAUTOKEINO, FINNMARK

6 - 12 September 1974

Responsible leader: Henrik Håbrekke geophysicist
Operator: Oddvar Blokkum technician

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335/94/17

INTRODUCTION

The geophysical department of NGU received a contract from A/S Sulfidmalm to carry out a geophysical survey by helicopter over an area (in this report called Masi) west and noth of Masi, between Alta and Kautokeino. The total area covered was 250 sq.km. NGU has previously carried out an aeromagnetic survey (by fixed wing aircraft) over the same area.

SURVEY CONDITIONS

Weather conditions should be reasonably good in order to get successful results. Such measurements cannot be carried out in strong winds, rain or fog. If the wind is too strong, the measuring probe would swing, resulting in a high noise level in the receiver. The noice also increases in rain, and moreover the visibility would be reduced so that the low flight altitude could be maintained. During the measurements over the Masi area the weather conditions were good.

The speed of the helicopter is held to about 100 kph during the actual survey, and the height over the ground is kept constant at about 170 ft. The base map must be of good quality so that the navigator could give the correct course and height. This is especially important if one has few reference points on the ground to go by, like rivers, lakes, roads etc. A photomosaic of 1:20 000 scale was used during this programme. The quality of the mosaic was good, and there were few navigation problems.

During magnetic surveys, either from a fixed wing aircraft, from a helicopter or on the ground, one must guard oneself against the fact that variations of the magnetic field of the earth one measures are dependent on time. This is achieved by placing a magnetometer in the survey area which registers just such variations. On days with high magnetic activity the survey must be discontinued. We did not have any days with such high variations in the magnetic field.

High-voltage power transmission lines have a serious interference effect on electromagnetic readings, the zone of interference often extending 100-200 m on either side of the power-line.

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Other electromagnetic transmitters will also interfere with the EM readings. There was no interference from power transmission lines or other sources of electrical noise in the Masi Survey.

SURVEY METHODS, INSTRUMENTS

During the survey of the Masi area, two of the physical properties of the earth were measured, i.e. the total magnetic field of the earth, and the variations of the electrical conductivity on the ground under the helicopter.

The magnetic field was measured with a Sander proton magnetometer, type NPM 4. This instrument consists of a measuring probe and an amplifier, which are placed in a cigar-shaped instrument container, 65 ft below the helicopter. Due to the large distance between the probe and the helicopter, the magnetic field was measured with great accuracy. The proton magnetometer is a point-registering instrument. The time-interval between each measuring point should be as short as possible, but if this is too short, the accuracy of the instrument would suffer. During the measurements over the Masi area this interval was 1 second. The speed of the helicopter being 100 kph, this would mean that one reading is made every 25 meters. One tries to keep the altitude of the helicopter at 170 ft, and the instrument container would then be 100 ft over the ground.

The instrument container also houses the mainpart of the electromagnetic instruments which are of the type Sander EM 3.

The transmitting and receiving coils are placed at a distance of about 7 m distance from each other, at either end of the container. This is of the coaxial type, and the system is very little influenced by noise because of its special construction. The depth penetration is consequently relatively large, and is indicated by Sander Geophysics Ltd. to be about 100 m under the ground surface in favourable conditions. The system measures both the real and imaginary components of the signals from the conductor under the measuring probe.

This "anomaly signal" is read in parts per million (ppm) of the signal that the transmitting coil induces in the receiver coil. The system is indicated to have a noise limit of 0.5 ppm for the imaginary component, and 1 ppm for the real component. These figures are naturally related to the most favourable cases with quiet weather and good topographic conditions.

The registration of the magnetic and electromagnetic data was done in the helicopter on a six-channeled oscillograph recorder of the type Century 444. Two channels were used for magnetic, and two for electromagnetic readings. The fith channel was used for the recording of the data from the radar altimeter of the type Bonzer TR 70. This measures the height of the helicopter over the ground with an accuracy within 10 ft. The sixth channel recorded the fiducial points from the Sander CM 3-12 camera. This photographs the ground every other second, and the film is numbered with the same code as used on the recording paper. To make the plotting of the registered anomalies easier, the navigator on the helicopter marks off the easily recognisable points along the traverses on the photo mosaic. Such points are also registered on the recording paper.

While the survey was being carried out, a magnetic ground station was established at the base at Suolovuobme fjellstue in order to register, and to be warned by, the diurnal changes in the earth's magnetic field. This station of an Elsec proton magnetometer and a recorder, and the field is measured and recorded with an accuracy of $\pm$ 1 gamma.

OPERATION

The limits of the area, the bearing of the profile-lines, and the distances between these lines, were determined after consultation with A/S Sulfidmalm. The southern portion of the area was flown with approximately north-south flight-lines, the remainder with east-west flight-lines. Flight-line spacing was 200 m. A total of 1260 line-km was flown, the total area covered being 250 sq.km.

The aerial survey was carried out in the period 6-12 Sept. and Suolovuobme Fjellstue was used as landing ground for the helicopter.

The helicopter was a Hughes 500, owned by A/S Helilift, Hamar, and the crew was:

Helge Siljeberg pilot

Finn Hegle mechanic

Each evening after the completion of the day's readings the majority of the electromagnetic anomalies were plotted on a photomosaic and A/S Sulfidmalm's geologist, E. Kreivi, was able to immediately follow-up some of the anomalies that were registered.

PROCESSING

The first step in processing of the results is the plotting of the correct profile courses on the photo mosaic. On average, one point was plotted for each flown kilometer. We have assumed that the helicopter had kept the same course and speed between these points. The transfer of the measured magnetic data to the plotted profiles on the mosaics was then carried out after the scale of the profile papers was adjusted to the scale of the mosaic. The magnetic data are then contoured with 100 gammas' interval. The electromagnetic readings were given corrections with the help of the radar altimeter's recording, to a special reference height of 170 ft. This is done to eliminate the variations in the amplitude of the anomalies due to the varying heights between the helicopter and the ground. The electromagnetic results are then plotted on the mosaic and contoured in the same fashion as the magnetic results.

Because of differences in anomaly-amplitude different contour-intervals are used for the real and imaginary component maps.

Normally electromagnetic anomalies are reported only as negative anomalies because the primary field measured by the receiver coil drops when the instrument passes over a conductor.

Positive real component anomalies do occur however and these are shown differentiated by hachuring on the accompanying maps.

RESULTS

The results of the survey over the Masi area are presented on the following maps in a scale 1:20 000.

2 mags. contour maps,	with flight lines	Pl. 1270/1-2
2 electromagn. contour maps, real component	with flight lines	Pl. 1270/3-4
2 electromagn. contour maps, imaginary component	with flight lines	Pl. 1270/5-6
2 interpretation maps,	with flight lines	Pl. 1270/7-8

When interpreting the electromagnetic anomalies one should understand that an EM helicopter-survey should be considered as a regional survey, and that the primary purpose of such a survey must be to locate objects at or under the surface which have electrical conducting properties which differentiate them from their surroundings. One can in addition map the extent of these conductors in two dimensions, and, if conditions are favourable, make a rough estimate of the depth of burial of the conductor.

Using both the real and imaginary maps one can make a general interpretation of the anomalies registered. With such a general interpretation it is assumed that the conductors can be considered as thin vertical sheets, of large strike and down-dip extent (greater than 200-300 m strike-length and over 100 m depth). By comparing the real and imaginary components one can then form some idea of the conductivity of the body, usually expressed as the product of the conductivity and thickness (sigma xt) of the hypothetical sheet.

The interpretation maps in this report are worked out from the response curves published by Sander Geophysics Ltd.

The interpretation of the electromagnetic anomalies are based on the assumptions mentioned above, with regard to the geometry, and moreover on the assumption that the conductor has the same magnetic permeability as the surrounding rocks.

The numbers plotted on the interpretation maps represent conductivity-thickness and should be of assistance in prioritising anomalies. Anomalies with high (sigma xt) product will be the most important in such a general interpretation and should be checked first. There are many strong anomalies in the Masi survey area, and the majority are indicative, both in size and form, of long, thick graphite-schist zones with very good conducting properties.

In the Masi area we registered several relatively strong positive real anomalies coincident with magnetic anomalies. This applies especially to the north part of the survey area. These positive anomalies are hachured on the real component maps.

Magnetic anomalies are often registered by this electro-magnetic system. These will often give positive real component values and in some cases moderate negative imaginary component readings. Interpretation of such anomalies is impossible using the normal (sigma xt) method. Experience gained by Dr. Sander in Canada has shown that positive real component anomalies are often due to magnetite dispersed through basic rocks. Coincident negative imaginary component values may indicate moderate conductivity which is also not uncommon for example in basic rocks which have undergone serpentinization. In the portions of the survey area where interpretive conditions are difficult the real and imaginary component maps can therefore only be used to locate and map the conducting zones which are present.

One should also remember that the Sander system, and most other helicopter-systems, favour vertical conductors because of the vertical, coaxial geometry of the trans-mitting and receiving coils. Thin flat-lying conductors will therefore be poorer targets for such systems.

The magnetic maps show the total magnetic field over the area. A 100-gamma contour interval was used and the same general features emerge as on the earlier aeromagnetic map of the area.

Airborne magnetic readings are not dependent on reading-height to the same extent as electromagnetic or radiometric readings and fixed-wing magnetic surveys often give a better general view of the geologic formations and contacts than helicopter-borne, where the detector is very near the ground-surface. Helicopter surveys better discrimination of individual small anomalies, and this in turn leads to a more detailed map.

NORGES GEOLOGISKE UNDERSØKELSE
Geophysical department

(signed) Henrik Håbrekke
geophysicist

Aksojavrre

Sivesjavrre

Raisot- javret

Suolojavrre

Salgganjavrre

Ladnatjavrre

(Altaelva)

Koter 0-25-50-75-100 ppm

Flylinje med plottet punkt

0 0,5 1km

NORD

A/S SULFIDMALM	MÅLESTOKK	MÅLT H.H.	SEPT. 74
HELIKOPTERMÅLINGER 1974		TEGN. H.M.	JAN. 75
EM-IMAGINÆR KOMPONENT	1:20000	TRAC. H.S.	FEB. 75
MASI, FINNMARK		KFR.	
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 1270-06	KARTBLAD (AMS) 1934 III	

1270-06

Salgganjavrre

Ruoddojavrre

Suolojavrre

Duolbbajavrre

Sodnajavrre

Kaldoaivvatjohka

Salvvajavrre

Maskjokka

Lukket område uten anomalier

Koter 0-25-50-75-100 ppm

Flylinje med plottet punkt

0 0,5 1km

NORD

A/S SULITJELMA
HELIKOPTERMÅLINGER 1974
EM-IMAGINÆR KOMPONENT
MASI, FINNMARK
NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM

MÅLESTOKK 1:20000

MÅLT H.H. SEPT. 74
TEGN. H.H. JAN. 75
TRAC. H.S. FEB. 75
KFR.

TEGNING NR. 1270-05

KARTBLAD (AMS) 1933 IV

Salgganjavrre

Ruoddojavrre

Suolojavrre

Duolbbajavrre

Sodnajavrre

Salvvajavrre

Masljokka

Kautokeinoelva

52 Ledningsevne (Ω·t

DL Dårlig ledningsevne (Ω·t) ≤ 2

SL Svak " 2 < (Ω·t) ≤ 10

GL God " 10 < (Ω·t) ≤ 50

ML Meget god " (Ω·t) > 50

Flylinje med plottet punkt

0 0,5 1km

NORD

A/S SULFIDMALM

HELIKOPTERMÅLINGER 1974

ELEKTROMAGNETISK TOLKNINGSKART

MASI, FINNMARK

NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM

MÅLESTOKK	MÅLT H.H.	SEPT.	74
1:20000	TEGN. H.H.	JAN.	75
	TRAC. & H.S.	FEB.	75
	KFR.		

TEGNING NR. 1270-07

KARTBLAD (AMS) 1933 IV

Aksejavrre

Stilajavre

Ratsot- javret

Suolojavrre

Salgganjavrre

Ladnatjavrre

(Altaelva)

1.

10.

20.

30.

40.

50

60.

(51) Ledningsevne σ·t

DL Dårlig ledningsevne (σ·t)< 2

SL Svak —"— 2<(σ·t)<10

GL God —"— 10<(σ·t)<50

ML Meget god —"— (σ·t)>50

Flylinje med plottet punkt

0 0,5 1km

NORD

A/S SULFIDMALM HELIKOPTERMÅLINGER 1974 ELEKTROMAGNETISK TOLKNINGSKART MASI, FINNMARK	MÅLESTOKK 1:20000	MÅLT H.H.	SEPT. 74
		TEGN. H.H.	JAN. 75
		TRAC. Ø. H.S.	FEB. 75
		KFR. [illegible]	
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 1270-08	KARTBLAD (AMS) 1934 III	

Aksojavrre

Silteslavrre

Raisot- javret

Suoloajavrre

Salgganjavrre

Ladniatjavrre

(Alttaelva)

1.

10.

20.

30.

40.

50.

60.

Positiv reell-komponent

Lukket område uten anomalier

Koter 0-50-100-150-200ppm

Flylinje med plottet punkt

0 0,5 1km

NORD

A/S SULFIDMALM HELIKOPTERMÅLINGER 1974 EM-REELL KOMPONENT MASI, FINNMARK	MÅLESTOKK 1:20000	MÅLT H.H. SEPT 74 TEGN. H.H JAN 75 TRAC. H.S FEB. 75 KFR.	
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 1270-04	KARTBLAD (AMS) 1934 III	

1270-04

Salggajavrre

Ruoddajavrre

Suolojavrre

Duolbbajavrre

Sodnajavrre

Salvvajavrre

Masijokka

Kautokeinoelva

70.

80.

90.

100.

110.

120.

130.

140.

150.

160.

170.

180.

190.

200.

Lukket område uten anomalier

Koter 0-50-100-150-200-300-400 ppm

Flylinje med plottet punkt

0 0,5 1km

NORD

A/S SULITJELMA
HELIKOPTERMÅLINGER 1974
EM-REELL KOMPONENT
MASI, FINNMARK

NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM

MÅLESTOKK	MÅLT H.H.	SEPT. 74
	TEGN. H.H.	JAN. 75
1:20000	TRAC. Ø. H.S.	FEB. 75
	KFR. H.H.	

TEGNING NR.	KARTBLAD (AMS)
1270-03	1933 IV

Aksjavrre

Slisajavrre

Raisot-javret

Sipolajavrre

Salgganjavrre

Ladnatjavrre

(Altaelva)

NORD

0 0,5 1km

52300 Magnetisk isoanomalikurve med intervall 100 γ

52300 Lukket lavere område

Flylinje med plottet punkt

A/S SULFIDMALM HELIKOPTERMÅLINGER 1974 MAGNETISK TOTALFELT MASI, FINNMARK	MÅLESTOKK	MÅLT H.H.	SEPT. 74
		TEGN. H.H.	JAN. 75
	1:20000	TRAC. H.S.	FEB. 75
		KFR. H.H.	
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 1270-02	KARTBLAD (AMS) 1934 III	

Salgganjavrre

Ruoddojavrre

Duolbbajavrre

Soadnajavrre

Saivvajavrre

Masijokka

Kautokeinoelva

Magnetisk isoanomalikurve med intervall 100γ

Lukket lavere område

Flylinje med plottet punkt

0 0,5 1km

NORD

A/S SULFIDMALM HELIKOPTERMÅLINGER 1974 MAGNETISK TOTALFELT MASI, FINNMARK	MÅLESTOKK 1:20000	MÅLT H.H. SEPT TEGN. H.H. JAN. TRAC. Ø.H.S. FEB. KFR.	
NORGES GEOLOGISKE UNDERSØKELSE TRONDHEIM	TEGNING NR. 1270-01	KARTBLAD 1933 I

A/S SULFIDMALM

INTER-OFFICE MEMORANDUM

Date: 3rd September, 1975

To: Falconbridge Nikkelverk A/S

cc: W. D. Harrison, H. T. Berry, R. B. Band, E. Kreivi

From: J. B. Gammon ✓

Subject:

905-17m. Helicopter geophysics, Masi. Report No. 335/74/17.

Please find attached the results of the NGU helicopter geophysics survey in the Masi area. These results are being evaluated on the ground as part of the summer 1975 field programme.