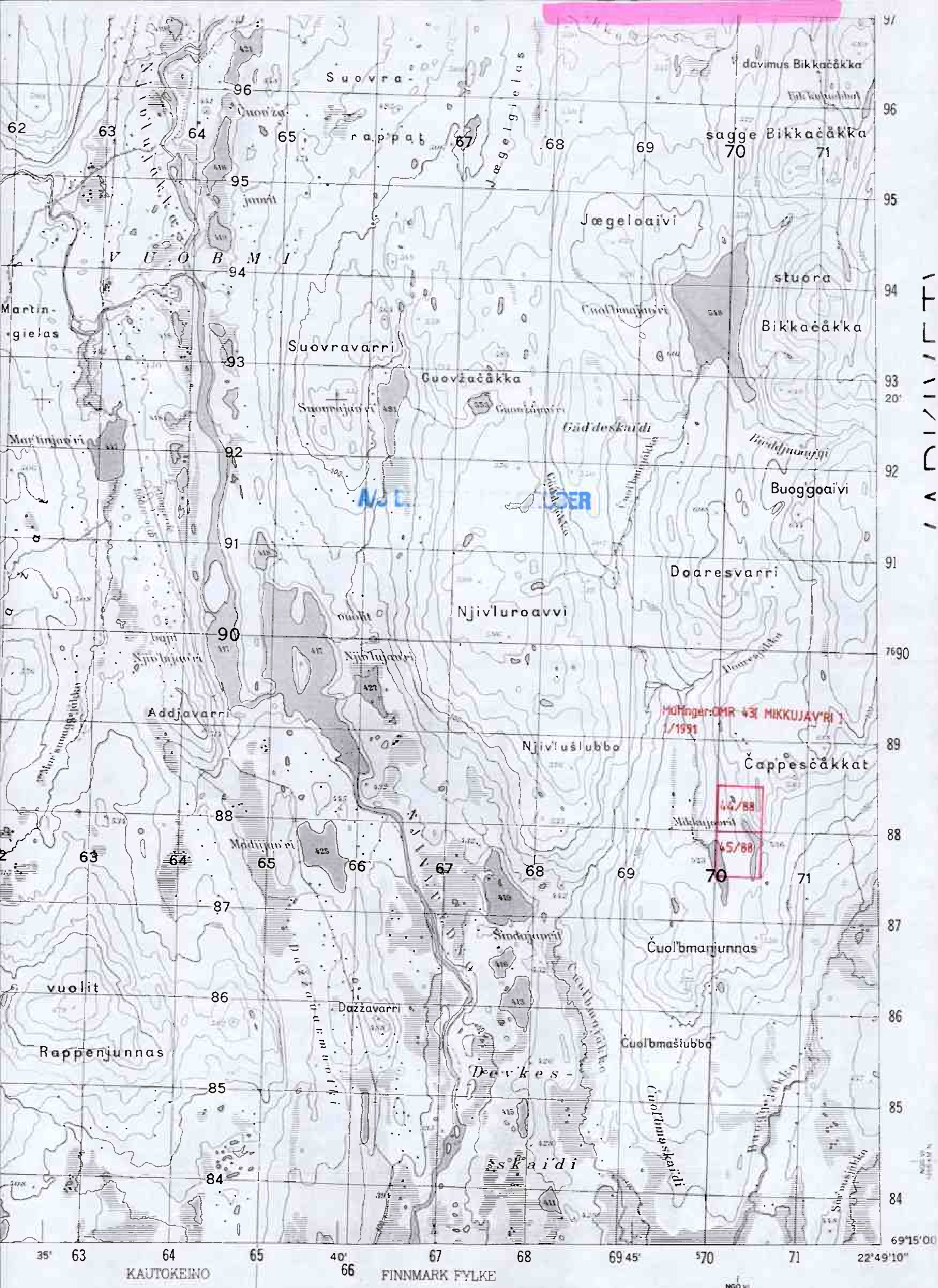

5 Kilometers

5000 Yards

GEOPHYSICAL OPERATIONS IN THE BIDJOVAGGE REGION IN SPRING 1986

Summary

The most laborous survey will be time domain EM (TDEM) measurements with EM37 equipment in the area 43 or Mikkujavri in April lasting about three weeks. The known conductive horizon is tried to be followed to the depths. In Suovrarappat a small copper orebody is situated in a narrow space between two graphitic horizons and is known to alter into hematite in another direction. There is only a thin overburden, and therefore it is possible to try to determine the boundaries of the outcropping rock species by inductive conductivity meter, EM31 or Gefinex 200. Some magnetic, slingram and broadside slingram profiles are measured in the both areas. The available airborne data of the whole region is to be processed into grey tone and colour composite images. Some petrophysics is going to be done, too.

Arrangements

EM37 survey is going to occur starting the 2nd of April and lasting 15 full working days. The operator, Jouko Longi and equipment are coming from Helsinki by train and jeep. Two men of ASPRO are assisting the survey. They will meet on the 2nd of April ~~in Bidjovaggen mine cafeteria at 8 o'clock~~. A skidoo and sleigh are necessary for transportation, as the survey area is over 10 km from the road. Longi teaches his assistants to operate EM37, and after some success starts processing the data with HP9845 micro, still supervising and helping when the next transmitter loop must be laid down.

Magnetic and slingram profiles are measured before the 2nd of April in Mikkujavri and the survey grid positioned by ASPRO team. Suovrarappat area can be measured during the TDEM survey taking place in Mikkujavri.

Geophysicist Ensio Lakanen is attending the field work on the 14th of April till 18th or more if necessary. He reviews the results so far and possible extra instructions for the survey are negotiated with the geologist Ragnar Hagen. He also supervises conductivity measurements of Suovrarappat target area.

Computer processing of airborne data has already started in the Espoo office of Outokumpu Oy Exploration and is undertaken as fast as possible. Interpretations and reporting will be carried out also in Espoo.

Survey sites (appendix 1) and outlines

The whole agreement region of these activities covers about 1000 km^2, almost a squared area the centre located at 22° 45' E longitude and 69° 15' N latitude, the respective coordinates are 570, 7683. The airborne data covers almost the whole region and it is divided about fifty - fifty to NGU survey in 1980-81 and Dighem survey in 1983, which is the eastern part. The processing aims to produce grey tone images of the whole region concerning magnetic and EM in-phase and out-of-phase components. Principal component analysis should help correlating the three data sets and an optimized colour composite image of the principal components is the final product. Grey tone images give structural and bedrock information and colour composite hopefully pinpoints special target areas.

Mikkujavri (area 43) is located close to the centre of the region. Survey profiles are shown in appendix 2. EM37 survey is comprised of 3 km long and 0.5 km broad belt and is measured in 50 x 100 m grid. This means altogether about 300 stations equaling 20 points per day. Both vertical (Z) and one horizontal (X, parallel to profiles) are registered. The effective use of ski-doo, open terrain and data logger makes this number of points reasonable. Because of the narrow space between two long conductive zones and the target known to dip almost vertically to west, the transmitter loop must be positioned to the western side of the target. Fortunately the terrain is more even there and happens to be in the same direction the transportation comes from. The western long side of the loop is located little to west of the long conductive zone being so "outside" the target area. This is to minimize undesired responses and enhance the response of almost vertical target. Six loops 300 x 500 m^2 are needed to cover the area with maximum current output (20 - 30 A). Survey profiles can intersect the loop and be extended from the loop's sides about the distance equaling their length, 500 m in this case. Transmitter is generator powered stand alone system, and is situated at one corner

of the loop. The next loop is laid down by one man and skidoo while other two are measuring. Transmitter and receiver must be synchronized two times a day.

Three magnetic and slingram profiles, 250 m long each, are measured to complete the earlier survey. Broadside slingram (coils parallel to geological strike, but perpendicular to profile measured) is carried out for the first time here and five lines, 250 m long each are occupied. Coil separation is 25 m and three frequencies, (222, 888 and 3555 Hz) are measured with 12.5 m point spacing. This configuration gives sharp boundary estimates for shallow conductors and different frequencies discriminate conductivity contrasts.

In Suovrarappat area there are two small ore showings close to each other. No basic ground geophysics (only Turam in the 60s) has been carried out here, so magnetic and slingram are the first elements needed. Profiles to be measured are shown in appendix 3. Target area No. 1 contains 8 lines 300 m each. Magnetic is surveyed with double line and point density, however. Three of the profiles are also carried out with broadside configuration just as in Mikkujavri. 9 lines are surveyed in the target area No. 2 again 300 m long each, and three are measured with broadside, too.

To further elucidate the geophysical discriminating abilities "one-man" slingrams EM31 and Gefinex 200 are tried for bordering the known copper orebody in the target area No. 1.

Petrophysical determinations are undertaken for suitable amount of samples in NGU Trondheim and Outokumpu Espoo.

List of the equipments needed from Finland

	Weight
EM 37 TDEM unit	
Transmitter console	20 kg
Generator and motor engine	60 "
Wire reels, à 400 m	20 "
(4 per loop)	(80)"
Receiver console	22 "
Receiver coil	8 "
Tripod	3 "
KTP-84 data logger	1 "
EM 31 conductivity meter	9 "
Gefinex 200 boulder hunter	4 "

HP 9845 micro	60 kg
KTP-84 cassette unit	1 "
Epson printer	10 "
Cassettes	2 "
Printer paper	10 "

Estimated expenses (ASPRO assistants excluded)

	FIM	NOK
Rental of EM 37 and KTP data logger, 15 days à 2000 FIM	30000	40800
HP9845, 15 days à 200,-	3000	4100
EM31 (Gefinex 200), 5 days à 100,-	500	700
Operator salary, 15 days à 1350,-	20300	27600
Accommodation and daily allowances c. 25 days à 380,-	9500	12900
Train Hki - Roi - Hki (car in train)	1700	2300
Car Roi - Bidjovaggen - Roi, 900 km à 2,20	2000	2700
Geophysicist salary, 5 days à 2100,-	10500	14300
Accommodation and daily allowances, 5 days à 380,-	1900	2600
Flight and car rental Hki - Roi - Bidjovaggen - Roi - Hki	3100	4200
Interpretation and reporting c.	20000	27200
Unspecified (ata-garnet, insurances and unexpected)	10000	13600
	112500	153000
Cost of each additional survey day of EM37, salary, accommodation and daily allowance	1460	2000
Rentals of EM37, KTP-84 and HP9845	2200	3000
	3660	5000
Airborne data processing c.	30000	41000

Suggestions

Older EM37 data of the northern extensions of Bidjovaggen orebelt are going to be interpreted anew by Outokumpu. Some magnetic modeling of airborne data in selected profiles might be useful, too.

Some test sites close to Bidjovaggen mine could be measured using conductivity meter. One that is possibly going to be trenched and another one close to Kautokeino road, where the flora has been clearly poisoned by extra copper, might be useful to check.

Spectral-IP should be put to trial here, and Suovrarappat, target No. 1 is ideal for that. If it were successful it will open us a new way of finding sulfide orebodies close to graphitic rocks. Laboratory determinations of selected samples should be done first and can be done in Geological Survey of Finland.

Detailed gravity survey might indicate larger massive sulfide orebodies where the terrain is even and overburden thin.

Ensio Lakanen
Research geophysicist

APPENDICES

1 Survey sites in the Bidjovagge region
2 Area 43 or Mikkujavri and outlined EM37 and slingram profiles
3 Suovrarappat area and outlined slingram profiles
4 Equipment description of EM37
5 Introduction to TDEM
6 A successful application of the transient method
7 Depth inversion techniques, DIT
(4-7 included only in R. Hagen's copy)

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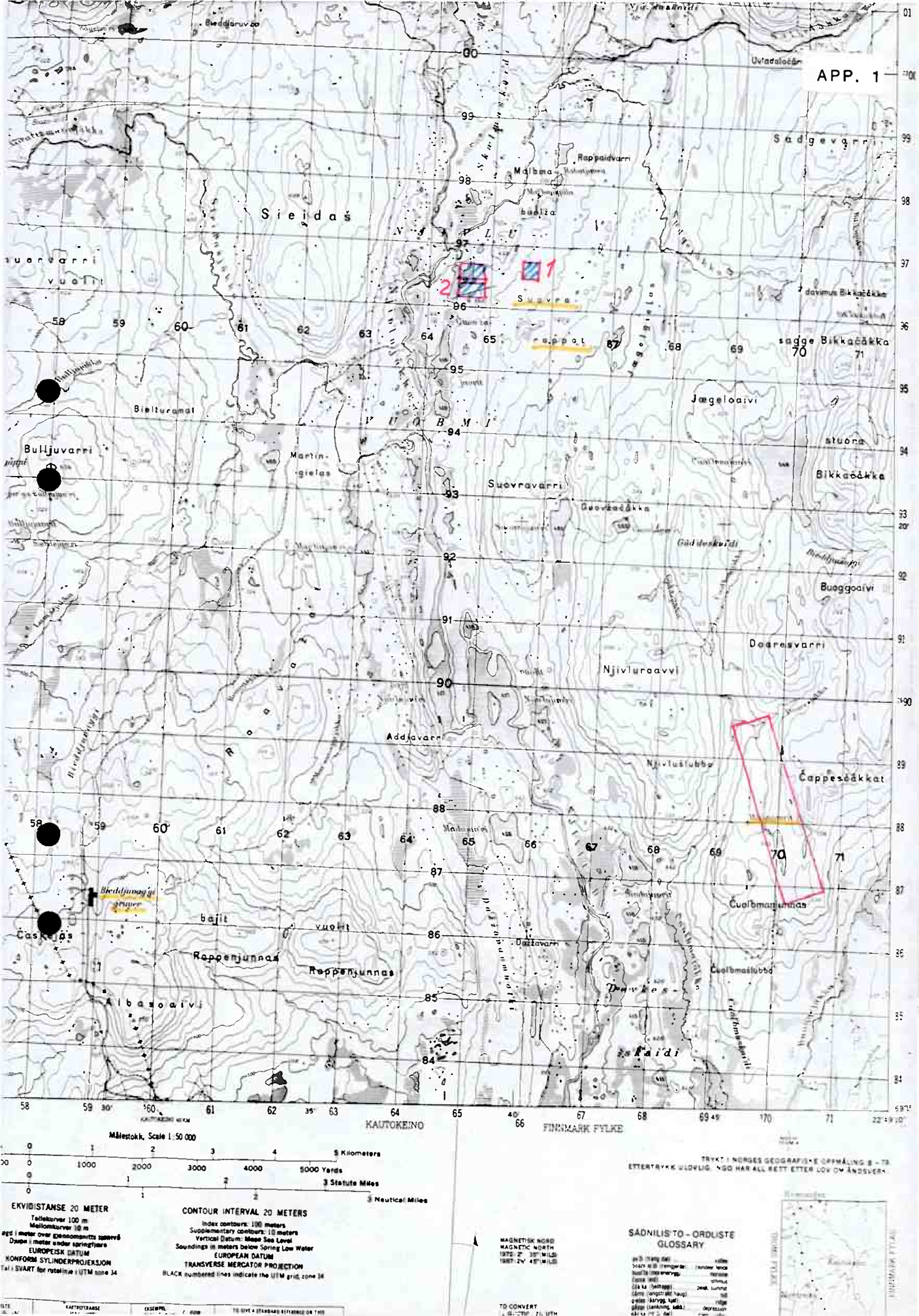
K Mäkelä	OKHI
E Rauhamäki	OKME
O Inkinen	"
E Lakanen	"

APP. 1


Bieddjuruvza
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Sådgevarri
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davimus Bikkačákka
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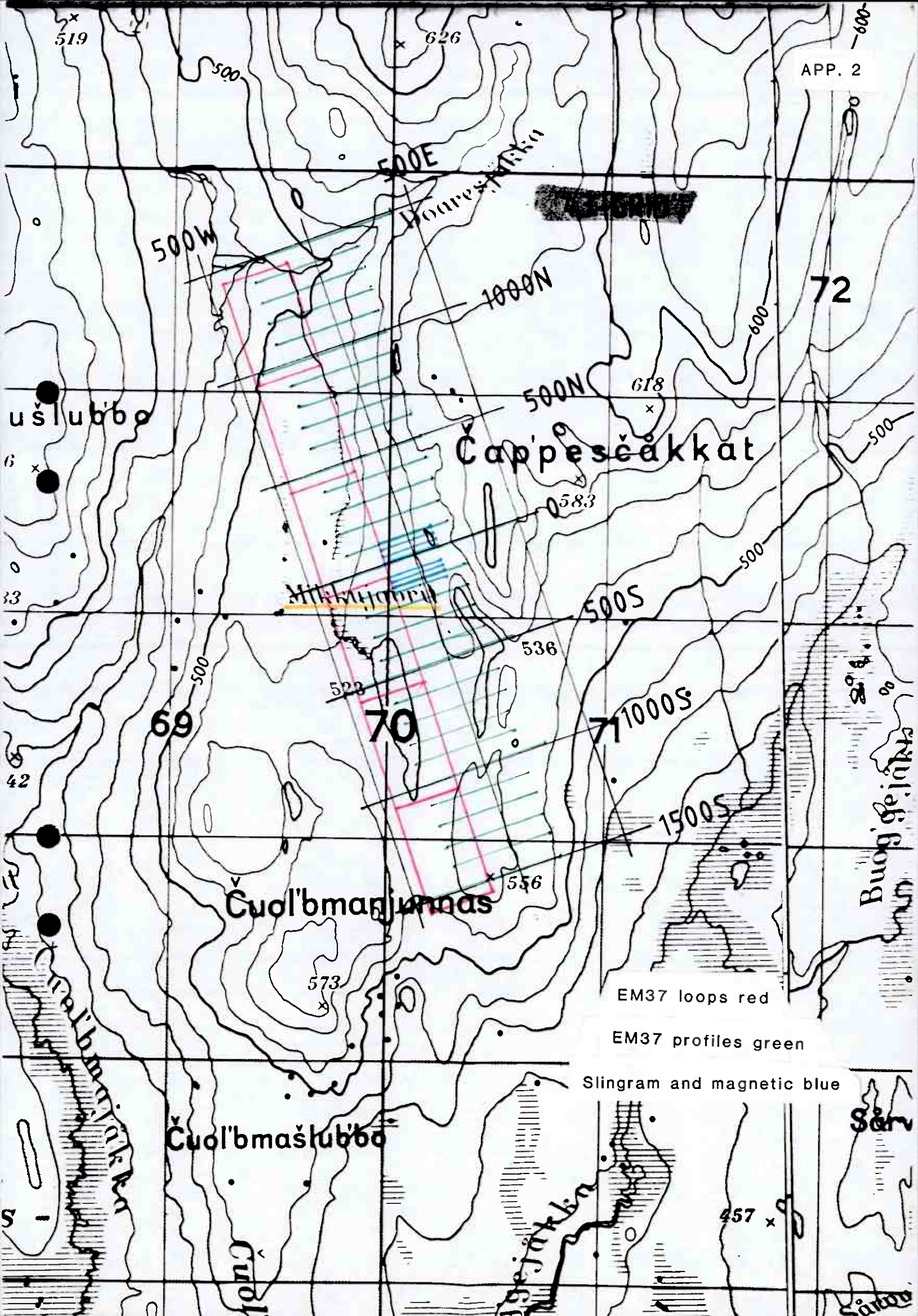
Bielturamat
Jægeloaivi
Bulljuvarri
Martin-gielas
V U O B M I
stuora
Bikkačákka
Suovravarri
Guovžačákka
Gád deskáidi
Buoggoaivi
Doaresvarri
Njivluraavvi
Addjavarri
Njivlušlubba
Čappesčákkat
Bieddjuvag'gi gruver
bajit
vuolit
Časkejas
Rappenjunnas
Rappenjunnas
Čuolbmanjunnas
Čuolbmašlubbo
Albasoaivi
Dažžavarri
KAUTOKEINO
FINNMARK FYLKE
Målestokk, Scale 1:50 000
5 Kilometers
5000 Yards
3 Statute Miles
3 Nautical Miles
EKVIDISTANSE 20 METER
CONTOUR INTERVAL 20 METERS
Index contours: 100 meters
Supplementary contours: 10 meters
Vertical Datum: Mean Sea Level
Soundings in meters below Spring Low Water
EUROPEAN DATUM
TRANSVERSE MERCATOR PROJECTION
BLACK numbered lines indicate the UTM grid, zone 34
EUROPEISK DATUM
KONFORM SYLINDERPROJEKSJON
MAGNETISK NORD
MAGNETIC NORTH
SÁDNILISTO - ORDLISTE
GLOSSARY
TRYKT I NORGES GEOGRAFISKE OPPMÅLING 8 - 79
ETTERTRYKK ULOVLIG. NGO HAR ALL RETT ETTER LOV OM ÅNDSVERK
TO CONVERT


APP. 2
500E
500W
1000N
500N
500S
1000S
1500S
72
71
70
69
Čappeščákkat
Čuol'bmanjunnas
Čuol'bmašlubbo
ušlubbo
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618
583
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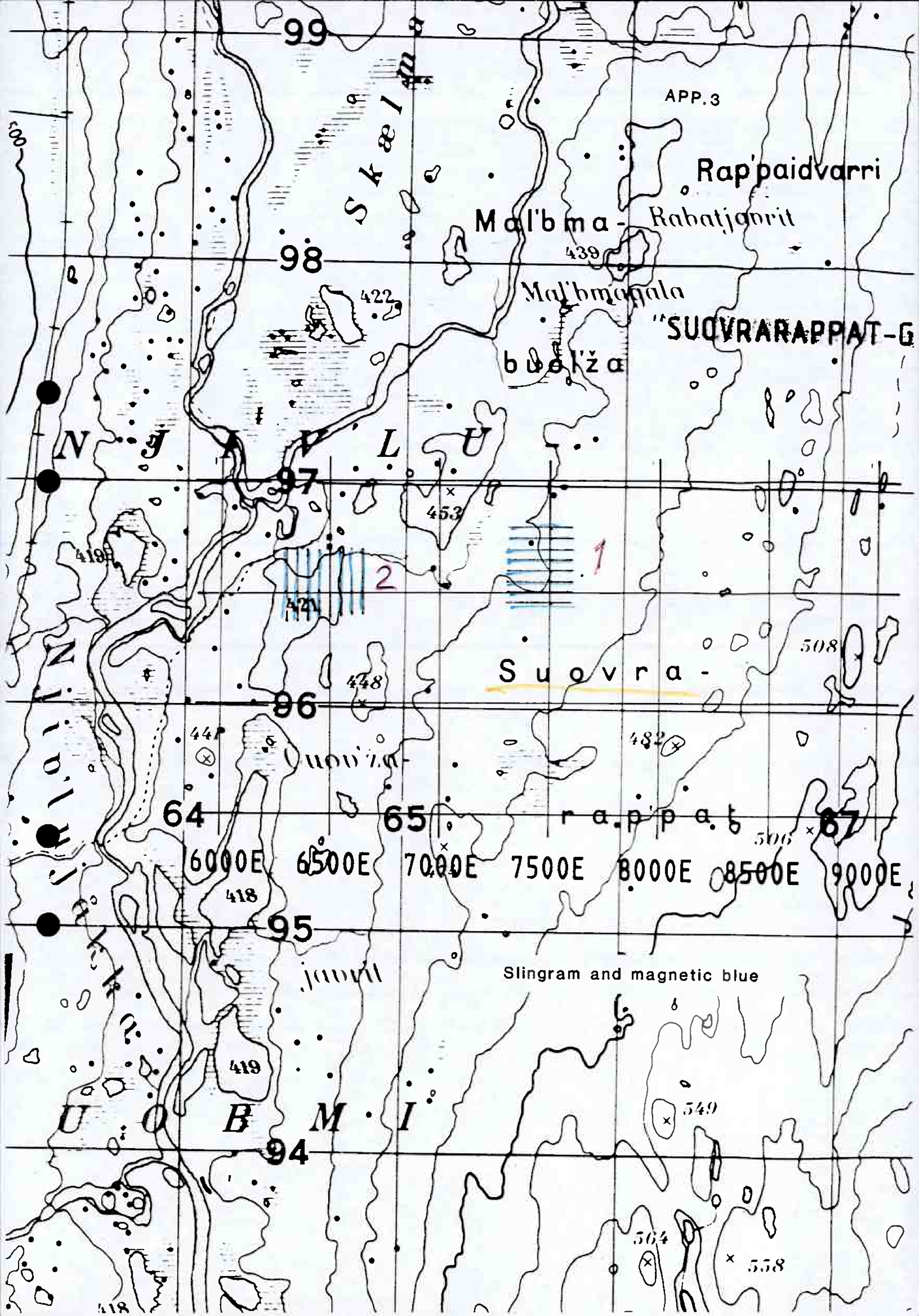
556
573
457
600
500
EM37 loops red
EM37 profiles green
Slingram and magnetic blue



99
APP.3
Skælma
Rap'paidvarri
Mal'bma-
Rabatjávrit
439
98
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Mal'bmagala
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96
482
64
65
rappat
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6000E
6500E
7000E
7500E
8000E
8500E
9000E
418
95
Slingram and magnetic blue
jávrit
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418

Equipment

The ground transient EM device EM37-3 is manufactured by Geonics Ltd., Canada. This instrument was first introduced in 1980, but has been updated so that this unit is the latest No. 3 version delivered in 1984.

Transmitter consists of a console weighing 20 kg and power unit with 5 HP Honda gasoline engine coupled to 120 V, 3-phase, 400 Hz alternator weighing 60 kg. Output power is 2.8 kW, maximum current 30 A and voltage 150 V. The transmitter loop was built up with 4 mm^2 isolated copper wire; 9 reels with 400 m, 20 kg each were available. The current waveform in the transmitter consists of alternating bipolar current pulses with a slow exponential turn-on and a rapid linear shut-off (turn-off) time depending on the loop size and current, normally less than 0.5 ms. The repetition rate can be set at 2.5 or low, 6.25 or medium, and 25 Hz or high.

Receiver consists of a console weighing 22 kg and air-cored 100 cm dia. coil weighing 8 kg. A coil holder is supplied to facilitate measurement along three axes. The measured quantity is the time rate of decay of magnetic flux at 20 logarithmically spaced time channels covering range from 0.08 at high to 80 ms at low repetition rate. 4 digits plus sign LED display is used and integration time can be selected from 2^n (n = 4, 6, 8, 10, 12, 14) cycles at 25 Hz. The effective area of the coil is about 100 m^2. Synchronization of receiver to transmitter can be maintained with oven controlled high stability quartz crystals. Receiver energy is taken from 12 V rechargeable NiCd batteries of 20 Ah.

At the receiver the induced voltage in the coil is measured in millivolts. The reading is normalized by dividing with the effective area of the coil and the current in the transmitter loop and is written in nanovolts per A x $meter^2$ (nV/Am^2).