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Tittel
Geophysical investigations in Øksetjern grid Iveland

Forfatter	Dato	Bedrift
F Nixon	1972	Sulfidmalm A/S

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Evje og Hornnes Iveland	Aust-Agder	Østlandske	15123	Mandal

Fagområde	Dokument type	Forekomster
Geofysikk	Rapport	Øksetjern
Råstofftype	**Emneord**	
Malm/metall	Ni Cu	

Sammendrag
Denne har vi to eksemplarer av

FN A/S.

FOR FALCONBRIDGE NIKKELVERK A/S

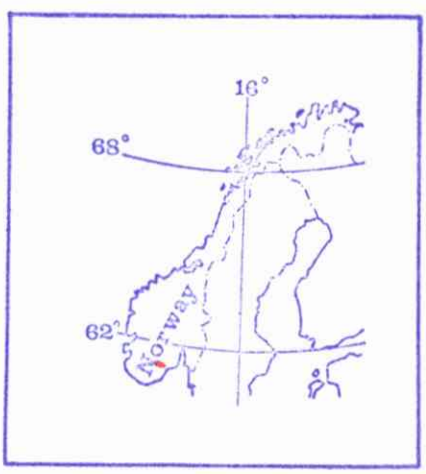
A/S SULFIDMALM

PROJECT 905-7

GEOPHYSICAL INVESTIGATIONS

ØKSETJERN GRID IVELAND, NORWAY.

F. NIXON



INTRODUCTION

This report presents the results of a V.L.F. EM survey, ground magnetic survey and follow up I.P. in the Øksetjern grid, Central Iveland, South Norway.

LOCATION

The Øksetjern grid is located in the central part of the Evje-Iveland area, north west of the Kjettevann area, where Sulfidmalm have carried out drilling programs outlining nickel sulphides in association with gabbroic and ultrabasic rocks.

GEOLOGY

The geology of the Evje-Iveland area has been described by the writer in various reports to Sulfidmalm. In the Øksetjern area the dominant rocks are gabbro and gabbroic gneiss with amphibolites and several small outcrops of ultrabasic rocks. Several strong tectonic zones cut the area. New investigations in the Kjettevann area suggest that the main gabbro type at Kjettevann is of a younger age than those of the Øksetjern area, these belonging to an older complex into which the Kjettevann gabbro was intruded. The ultrabasics of both areas are considered to be genetically associated with the older complex.

In contrast to the Kjettevann area no nickel deposits were known in the Øksetjern area, and the geophysical investigations were based on elephant country theory.

CHOICE OF METHOD

The V.L.F. method was chosen for this initial reconnaissance after orientation testing of various mineralized properties in the Iveland area where both massive sulphides and disseminated sulphides have been covered by the following methods.

A) ABEM gun.

B) Crone CEM unit.

C) McPhar I.P. frequency effect unit.

C) Geonics V.L.F. EM16 unit.

Of these methods only the V.L.F. and I.P. units proved capable of locating both types of mineralization present in the area. As no I.P. unit was immediately available the initial survey was carried out using the V.L.F. (see appendix 1).

WORK CARRIED OUT

An area of approximately 4 km^2 was covered by the initial V.L.F. and magnetic surveys. Profile separation was 100 m and observations were made for every 25 m.

A Geonics V.L.F. EM16 instrument was used.

As transmitter the military radio transmitter at Rugby England (code GBR) was used. Frequency is 16.0 kH2 and radiated power 500 kw.

For the magnetic survey a McPhar M700 Fluxgate magnetometer was used.

The V.L.F. and mag. surveys were carried out in winter conditions during February of 1972. The survey was hampered by abnormal winter conditions which resulted in some of the lakes being free of ice.

As a follow up to the V.L.F. survey a small scale I.P. survey was run using a McPhar P650 unit. The following lines were run.

300 N	680 W	-	820 E
1oo N	980 W	-	440 W
0	120 W	-	360 E
200 S	1040 W	-	500 W
300 S	360 W	-	30 W.

The I.P. survey was carried out under summer conditions.

TREATMENT OF DATA

The magnetic data is presented as an isoanomaly map. The V.L.F. data is presented on two map sheets, one showing the in phase (real component) tilt angle profiles and the other showing the in phase data contoured after the Frazer method. The I.P. profiles area presented as conventional profiles showing resistivity, frequency effect and resulting metal factors for n - 1, 2, 3 and 4.

Before going on to treat the interpretation of the data some background information is given concerning the V.L.F. method.

The V.L.F. transmitting stations operating for communications with submarines have a vertical antenna. The antenna current is thus vertical, creating a concentric horizontal magnetic field around them. When these magnetic fields meet conductive bodies in the ground, there will be secondary fields radiating from these bodies. The equipment measures the vertical components of these secondary fields. The vertical components are expressed in percentages.

V.L.F. EM dip angle data often yields complex patterns that require considerable study for a proper interpretation, the relatively high transmitted frequency of about 20,000 Hz can result in a large geological noise component. In order to case interpretation a method has been developed by Frazer whereby somewhat noisy, noncontourable dip angle data is transformed into less noisy contourable data. Without going into the theoretical basis for this procedure, the filtered output or contourable quantity simply consists of the sum of the observations at two consecutive data stations subtracted from the sum at the next two consecutive data stations. Normally negative values are not contoured since being caused by dip angle flanks they do not aid interpretation, but confuse the picture. V.L.F. EM contoured data generally peaks very close to the top of a conductor.

INTERPRETATION

In interpretation the following points should be borne in mind.

1) In conductive ground the depth of exploration is severely limited.

2) Anomalies tend to be generated by conductivity changes in the overburden, or at the overburden, bedrock interface.

3) Because of the relatively high frequency, poor conductors such as sheared contacts, breccia zones, narrow faults, alteration zones and porous flow tops normally produce V.L.F. anomalies.

4) Since the frequency is high, the response factor of many geological conductors is above the range where appreciable quadrature (out of phase) effects are generated. Phase-shifts are more usually associated with the effects of conductive ground on the primary and secondary signals. Quadrature measurements cannot often be used to assist in discriminating between geological conductors of higher and lower conductivities.

From the contoured in phase maps two main anomaly zones are apparent. A westerly anomaly zone and a central anomaly zone. An offsett of the westerly zone runs from 400 W on 600 N to 250 W on 800 N.

The westerly anomaly zone extends from 700 W on 600 N to 900 W on 900 S. The anomaly forks off two minor offsets, one at 750 W/300 N trending NNW and one at 950 W/300 S trending SSW. The strongest part of the anomaly runs from 650 W/500 N to 800 W/300 S with a peak between 250 N and 450 N.

The strongest part of the anomaly is associated with a magnetic high - 2000 - 4000γ and the general trend of the anomaly follows the magnetic trend.

From a study of the structural geology of the area and arial photographs in scale 1:5,000 it is obvious that this anomaly in its entirety follows definate tectonic features (faults), even the two offshoot anomalies following fault traces.

This anomaly zone was subsequently covered by three I.P. profiles. Line 300 N, 100 N and 200 S. As can be seen from the enclosed profiles there is an I.P. response on each line corresponding to the position of the V.L.F. anomalies.

On line 300 N the I.P. survey unfortunately only started to come into the anomaly zone before the profile had to be stopped because of a lake. However coming into the V.L.F. anomaly there is a marked decrease in resistivity, an equally marked rise in frequency effect and a resulting metal factor value ranging from 13 to 26. As we know the V.L.F. anomaly lies together with a fault zone and the I.P. anomaly can be interpreted as an accumulation of clay like minerals in the fault zone or as a reflection of oxide or sulphide mineralization in association with the fault.

The I.P. profile on line 100 N reflects a small resistivity decrease over the V.L.F. anomaly, there is no definate frequency effect response.

On line 200 S the strongest part of the V.L.F. anomaly is narrow. The I.P. profile is somewhat complicated, but again shows a somewhat "trouser" type lower resistivity zone, but with a decrease in frequency effect.

Along this fault zone ultrabasic rocks have been mapped, although no sulphides have been noted. It is concluded that the westerly V.L.F. anomaly zone is caused by a major fault system, along the line of which small bodies of ultrabasic rock have been intruded. The strongest part of the anomaly between 250 and 450 N may represent an accumulation of sulphides in such an ultrabasic body. From the shape of the individual profiles the "conductor" seems to be fairly steep dipping and of moderate depth 25 - 75 m.

The central anomaly zone runs roughly from 250 E/900 N to 150 W/1000 S. Two small offshoot anomalies trend SW and NE of the strongest part of the main anomaly which is between 100 S and 400 S. A strong portion also exists between 100 S and 400 S, and these two strong portions appear to be slightly offsett, possibly by the strong EW running fault shown on the map.

Again this anomaly zone is associated with tectonic zones but of a much weaker nature than those in the westerly anomaly.

This central anomaly exept for the northern part (north of 0) runs oblique to the general magnetic trend and does not seem to have any definate magnetic associations.

Three I.P. profiles cross the zone, i.e. 300 N 0, 300 S.

On line 300 N the I.P. profile shows a slight decrease in resistivity between 100 and 200 E (although the resistivity is still fairly high). There is also a marked decrease in frequency effect.

On line 0, both the main zone and the small offshoot at 150 E show up as weak resistivity lows.

Line 300 S also shows low resistivity and low frequency effect.

The general area of the major parts of the anomaly are poorly exposed and covered by swampy ground, however one outcrop of ultrabasic has been found between 50 S/300 E and 100 N/300 E and there is a corresponding V.L.F. anomaly and weak I.P. response. The ultrabasic was entirely barren.

Again it is concluded that the anomaly reflects structural trends and contrasts between ultrabasic/gabbro, amphibolite contacts. The I.P. profiles give no cause to suspect any interesting mineralization.

A geochemical soil survey was carried out on 5 profiles across the westerly anomaly. Because of lack of funds not all of these samples have been assayed and the results when available will be presented as an appendix to this report.

CONCLUSIONS AND RECOMMENDATIONS

1) V.L.F. EM survey has outlined two main anomaly zones together with minor zones that are not regarded as significant.

2) Both main zones co-incide with tectonic zones where ultrabasic are known to be in association.

3) No sulphides have been found in association with the anomalies.

4) It is suggested that the main anomaly zones reflect faults and the stronger portions of the anoamlies may represent sulphide accumulation either in or near fault zones or in ultrabasic rocks associated with the fault zones.

5) None of the anomalies are considered to be of prime economic interest and no further work is recommended at present.

6) If planned investigations of the Kjettevann deposit lead to a working mine the better parts of these anomalies should be tested with conventional EM.

Appendix 1.

Map no. Ø9 shows the results of a V.L.F. test profil over a known conductor at Kjettevann, which gave a good I.P. response. The source consists of partly massive, but mainly disseminated sulphides associated with an ultrabasic.

The same profile was also surveyed with

1) ABEM 60 m cable, 1760 Hz, 30 m stations with no response.

2) CRONE horizontal shootback, 100 m coil seperation, 5010 Hz, 25 m stations with no response.

3) CRONE co-axial shootback, 100 m coil seperation, 5010 Hz, 25 m stations no response.

LIST OF ENCLOSURES.

A/S SULFIDMALM

INTER-OFFICE MEMORANDUM

Date: 13th November, 1972

To: Falconbridge Nikkelverk A/S ✓

cc: A.M. Clarke, D. R. Lochhead,
F. Nixon

From: J. B. Gammon

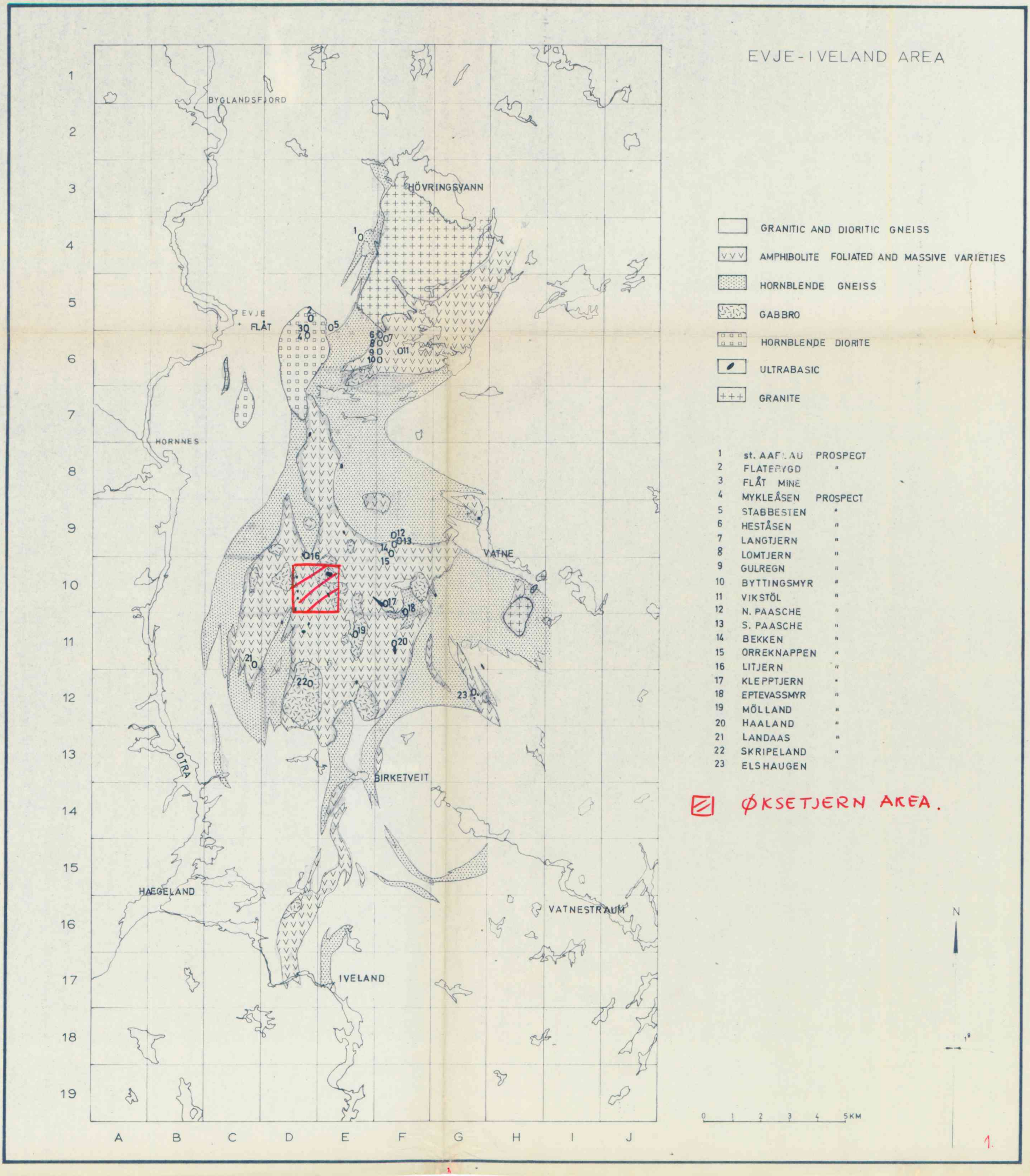
Subject:

905-7, Øksetjern area, Iveland Norway. BV 458

Please find attached Nixon's report on geophysics in the Øksetjern area at Evje-Iveland. Enclosed maps Ø1 and Ø2 clearly show the use of Fraser contouring of V.L.F. data. Although targets have been outlined by this work, further testing will await an economic appraisal of the region as a whole.

Joe B Gammon.

MOTTATT 14. 11. 72		BESV.	ARK.
ADM. DIR.	VRJ	FORSKN./UTV.	
TEKNISK DIR.		EL. LYSEAVD.	
PERSONALDIR.		M.L. AVD.	
ADM. SJEF		R. & SM. AVD.	
INNKJ. AVD.		EL.TEKN.AVD.	
REGNSK. AVD.		INSTR. AVD.	
SIKRN. AVD.		MEK. AVD.	
JERNMET.		PROSJ. AVD	
SAKSBEARB.			SVARDATO


EVJE-IVELAND AREA
GRANITIC AND DIORITIC GNEISS
AMPHIBOLITE FOLIATED AND MASSIVE VARIETIES
HORNBLENDE GNEISS
GABBRO
HORNBLENDE DIORITE
ULTRABASIC
GRANITE
1 st. AAFLAU PROSPECT
2 FLATEBYGD "
3 FLÅT MINE
4 MYKLEÅSEN PROSPECT
5 STABBESTEN "
6 HESTÅSEN "
7 LANGTJERN "
8 LOMTJERN "
9 GULREGN "
10 BYTTINGSMYR "
11 VIKSTÖL "
12 N. PAASCHE "
13 S. PAASCHE "
14 BEKKEN "
15 ORREKNAPPEN "
16 LITJERN "
17 KLEPPTJERN "
18 EPTEVASSMYR "
19 MÖLLAND "
20 HAALAND "
21 LANDAAS "
22 SKRIPELAND "
23 ELSHAUGEN
ØKSETJERN AREA.
BYGLANDSFJORD
HÖVRINGSVANN
EVJE
FLÅT
HORNNES
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OTRA
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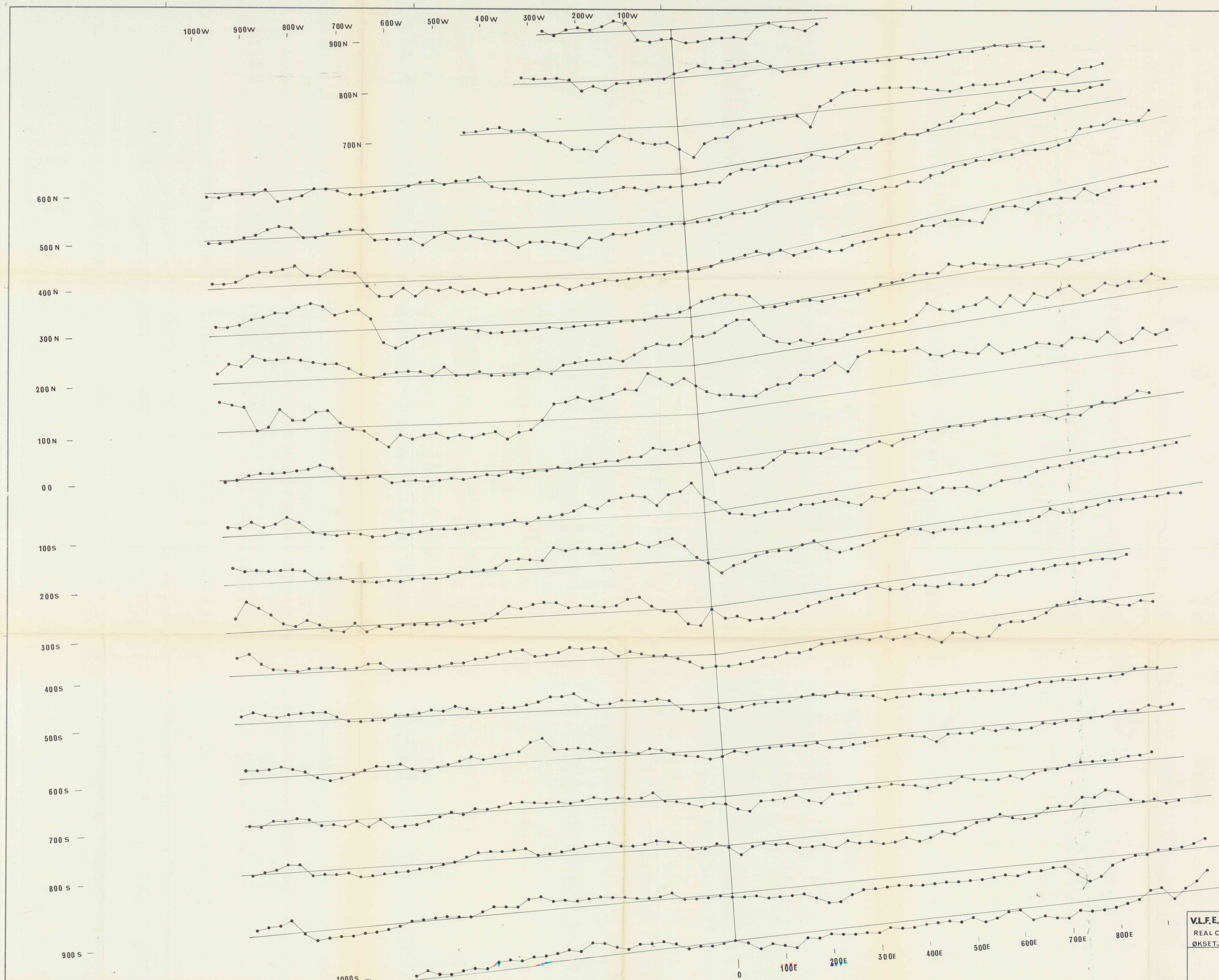

N

GBR

SCALE

profile

transmitter GBR rugby england.
freq. 16 kHz.
radiated power 500 kw.

Readings towards ⟶ E

geonics EM16 VLF electromagnetic unit.

0 50 100 150 200 m

V.L.F.E.M. SURVEY. REAL COMPONENT, TILT ANGLE, ØKSETJERN, IVELAND, NORWAY.	Scale 1:2500	Obs. fih,fn Draw. jj Trac. jj Chk. fn	feb 72 sep .. .. ..
	Map. no. Ø1		
A/S Sulfidmalm	2		
	Map. sheet 1181b EVJE		

1000W
900W
800W
700W
600W
500W
400W
300W
200W
100W
900N
800N
700N
600N
500N
400N
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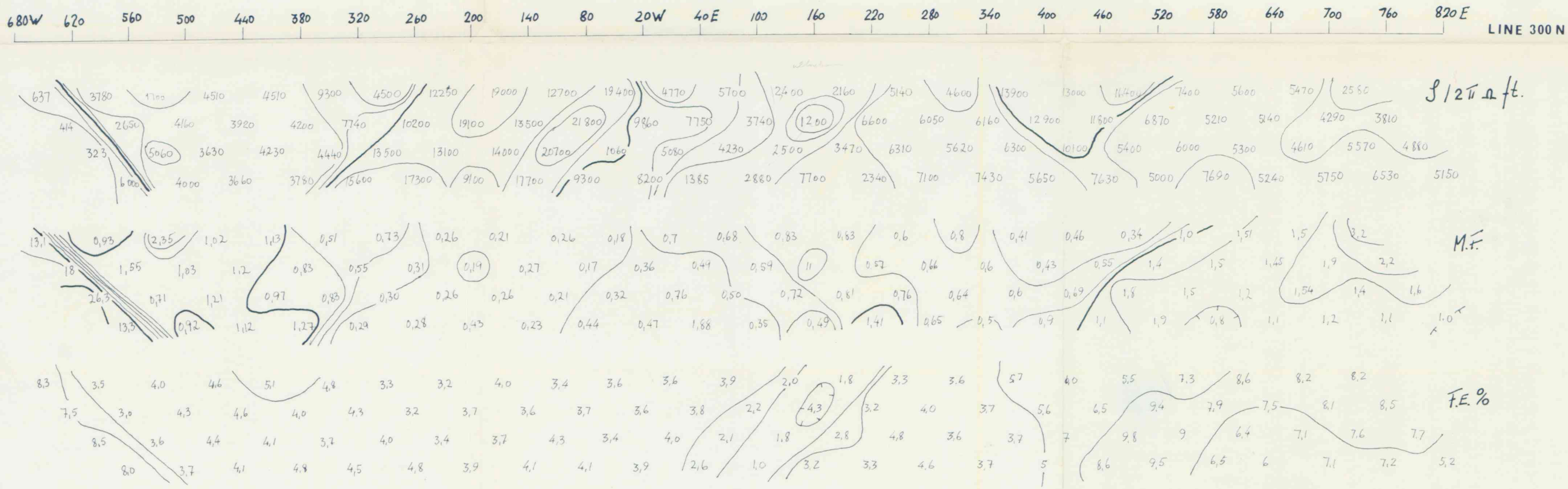
GBR
MAJOR TECTONIC LINES
TECTONIC LINES.
transmitter GBR rugby england
freq. 16kHz
radiated povver 500kw
Readings towards ⟶ E
geonics EM16 VLF electromagnetic unit
contouring frazer method
0 10 100 150 200 m.
V.L.F.E.M. SURVEY
(REAL COMPONENT CONTOURED)
ØKSETJERN, IVELAND, NORWAY
A/s Sulfidmalm
Scale
1:2500
Obs. FH,FN FEB 72
Draw. FN SEP72
Trac. FN ··
Chk. FN ··
Map. no. Ø2.
3
Map. sheet M816 EVJE

MAGNETIC ANOMALIES ØKSETJERN GRID IVELAND.	Scale 1;2500	Obs. FN feb 72 Draw. FN aug 72 Trac. FN aug 72 Chk.	
	Map. no. Ø3		
A/s Sulfidmalm	4		
	Map. sheet M816 EVJE		



McPHAR MODEL P650
freq. 0,3125 & 5 cps.

I.P. SURVEY ØKSETJERN GRID, IVELAND AUST-AGDER, NORWAY.	SCALE 1:3000	OBS.	
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A/S SULFIDMALM	MAP NO. Ø4.		
	MAP SHEET M 816. EVJE.		

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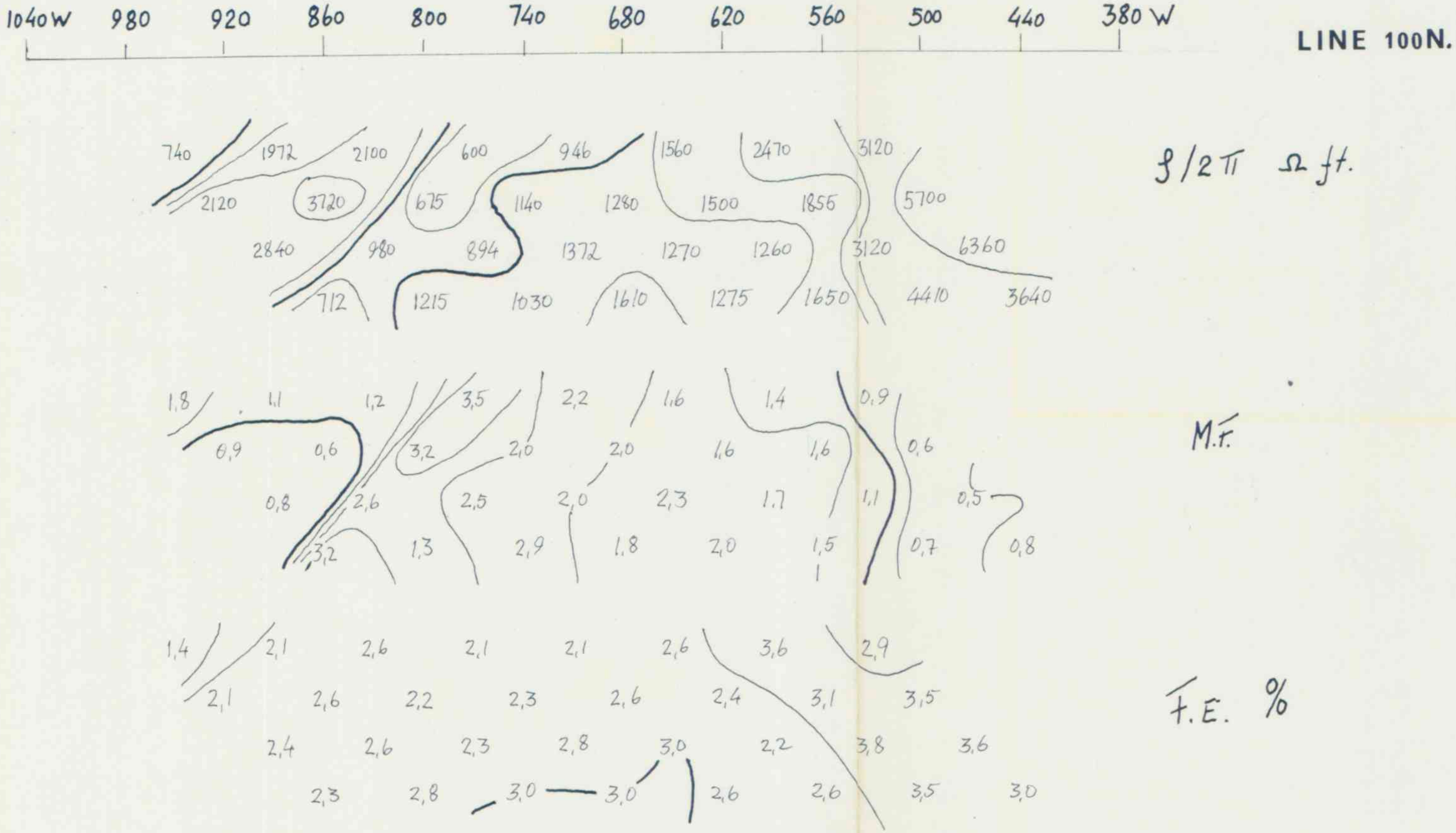

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freq 0,3125 & 5 cps.

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6

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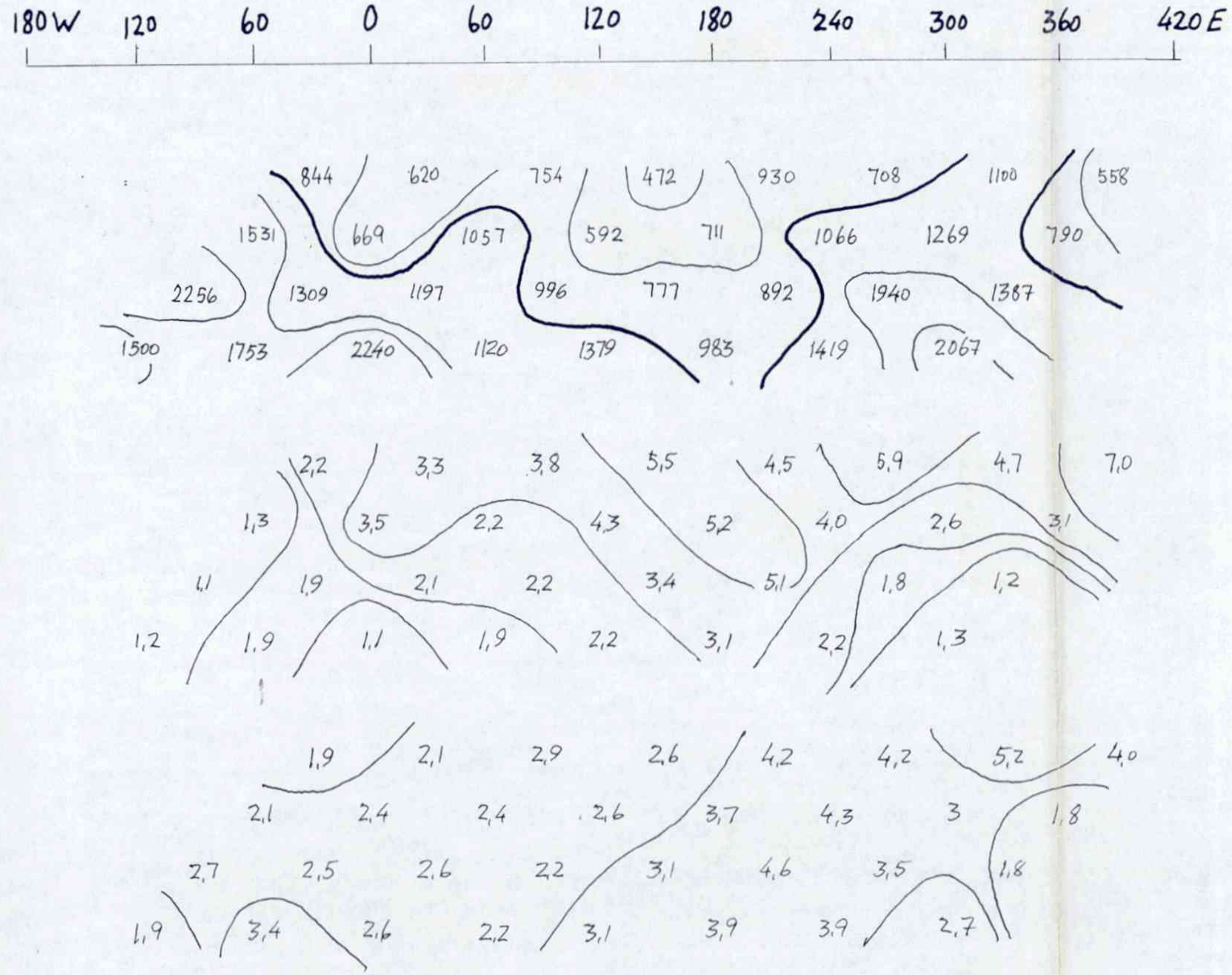

LINE 0.

ρ/2π Ω ft.

M.F.

F.E. %.

M^C^PHAR MODEL P650
freq. 0,3125 & 5 cps.

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A/S SULFIDMALM	MAP NO. Ø6.		
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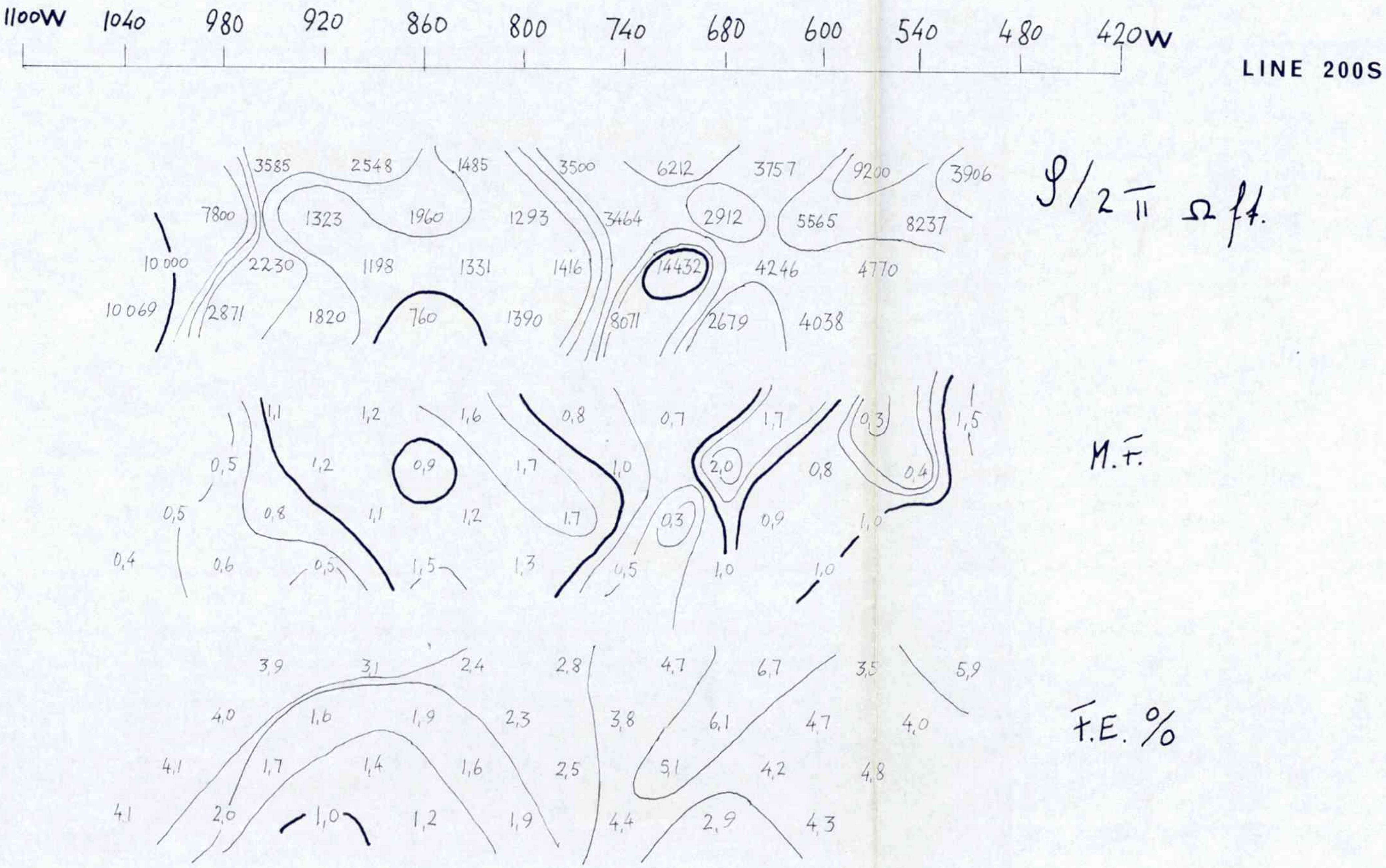

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freq. 0,3125 & 5 cps.

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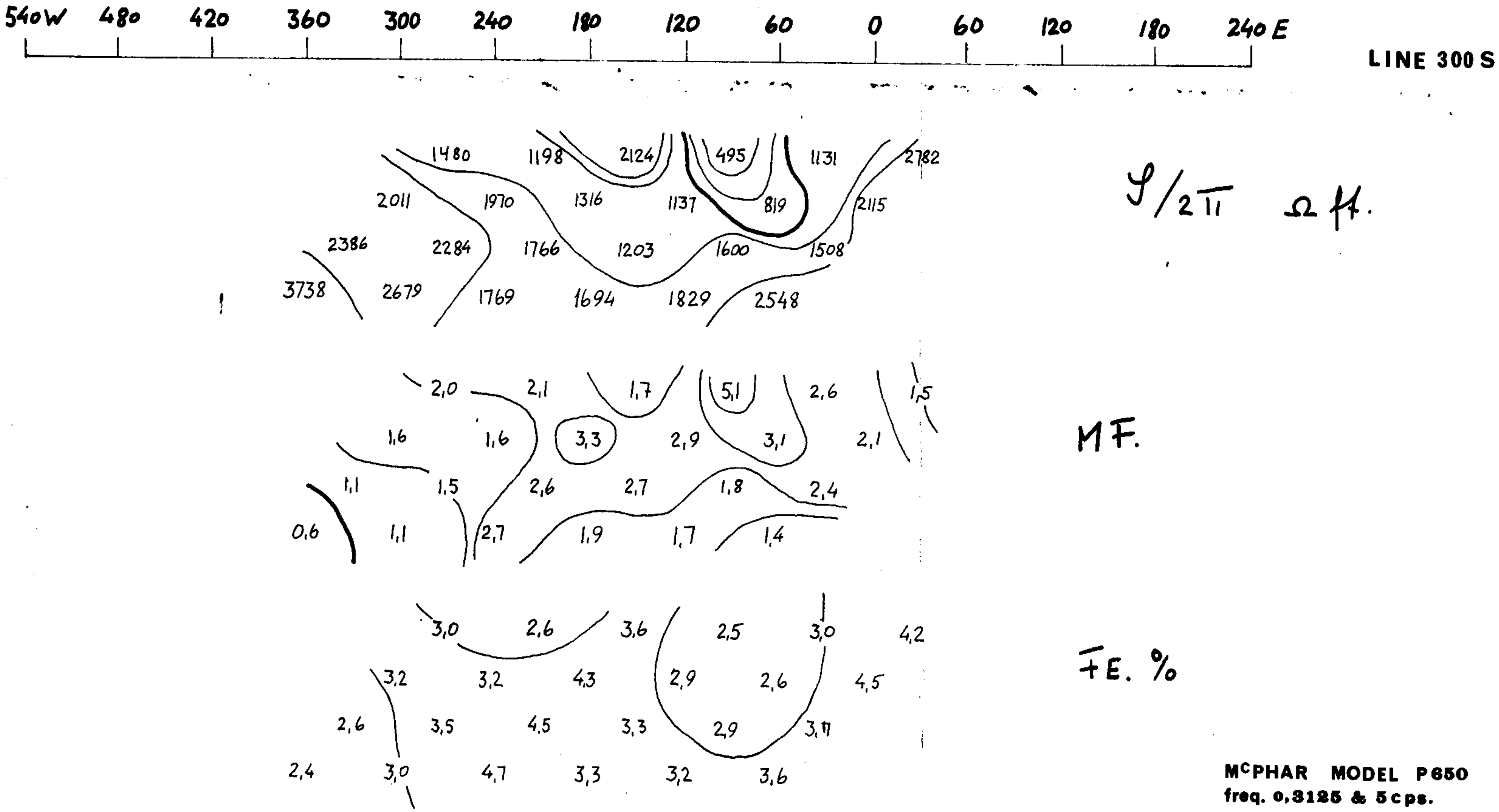

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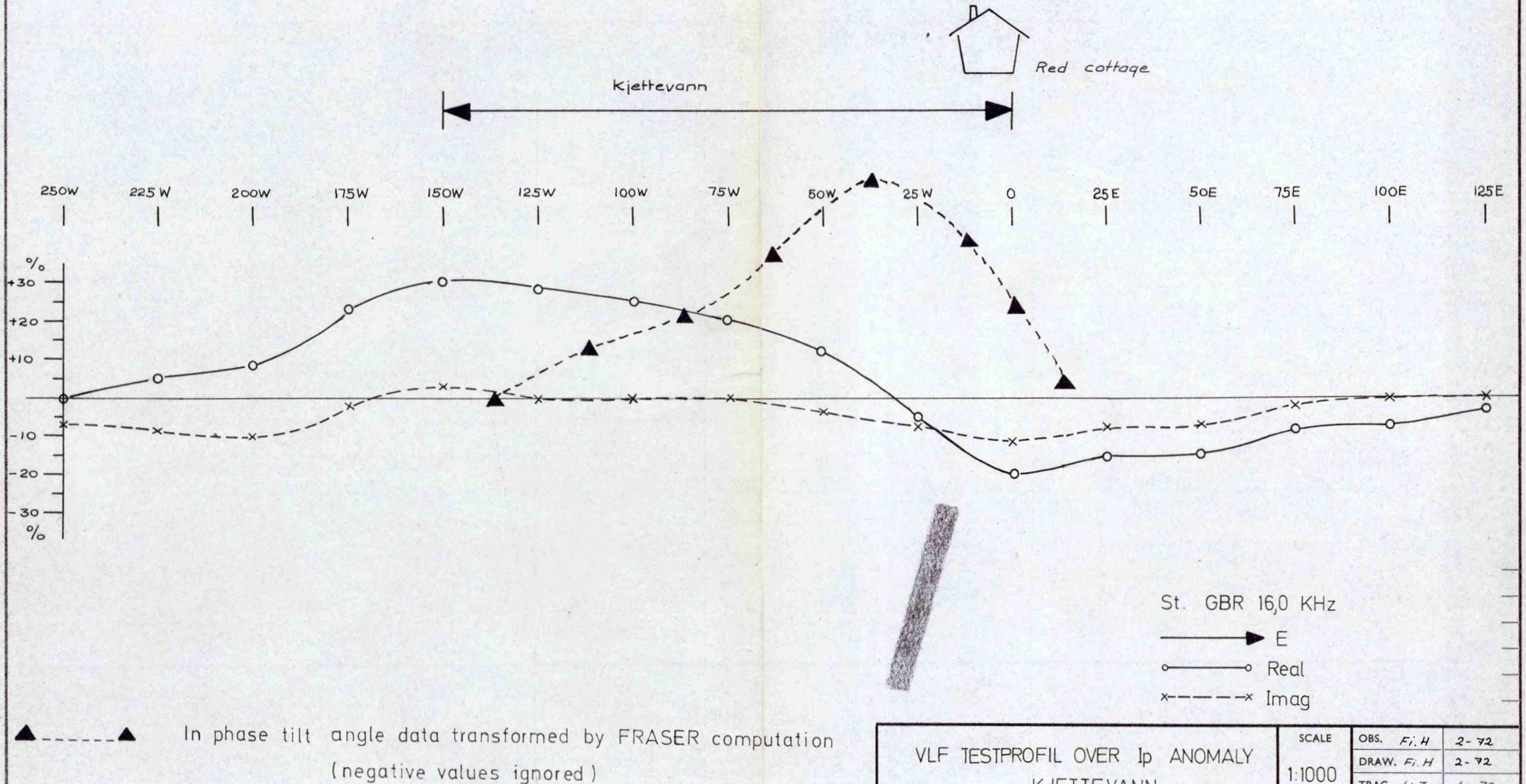

VLF TESTPROFIL OVER Ip ANOMALY
KJETTEVANN

Innst.: Geonics EM 16

SCALE 1:1000	OBS. Fi. H	2-72
	DRAW. Fi. H	2-72
	TRAC. U.T.	4-72
	CHK. FIH	10-72

A/S SULFIDMALM

MAP NO. Ø9

10

MAP SHEET M816 EVJE

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