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Tittel
VLF-Magnetic measurments in the Otta - Myrum area

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Pekka Mikkola	12/12 1975	Soumen Malmi OY

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Sammendrag

VLF-MAGNETIC MEASUREMENTS IN THE OTTA-MYRUM AREA
IN SEPTEMBER 1975

SUOMEN MALMI OY
1975-12-12

PEKKA MIKKOLA

VLF-MAGNETIC MEASUREMENTS IN THE OTTA-MYRUM AREA IN SEPTEMBER 1975

Appendices

1. INTRODUCTION

According to the contract between Otta Malm A/S and Geobor A/S, Suomen Malmi Oy carried out geophysical measurements and surveying near Otta in the Myrum area during the period 1975-09-17.....25. The VLF-magnetic measurements, altogether 23 profilekilometers, and staked out lines, altogether 7.8 kilometers covered an area of 2.25 km^2. These measurements were similar to those made by Suomen Malmi Oy in February 1975 in Aasoren (Report 23 - 51, 1975-06-12).

The aim of the investigations was to locate geological conductors in the Myrum area to ascertain the geological structure in the surroundings of the Aasoren area and to detect possible sulfide mineralizations in the area. Magnetic measurements were made to support the VLF-interpretations and to give better picture of the bedrock structure.

The results of the measurements are portrayed in the form of contour maps on scale 1 : 5000. Three extra orthogonal VLF-profiles are on scale 1 : 2000. The qualitative interpretation of the VLF anomalies has been chiefly based on the relation of the real component to the imaginary component. In the interpretation of the magnetic anomalies a curve-fitting technique and two-dimensional platelike models were used. The most important VLF-anomalies are described in the form of a list in appendix 1. The results of the interpretations are given in appendix 2 as an interpretation map and as magnetic interpretation profiles in appendices 6 - 18.

The field crew consisted of a foreman and two observers. The line spacing was 100 meters and the point spacing along lines was 20 meters in the case of VLF measurements and 10 meters in the case of magnetic measurements.

2. VLF MEASUREMENTS

The receiving apparatus was a Ronka EM 16 made by Geonics Ltd. The radiostation NAA (17.8 kHz) in Maine, USA and the radiostation FUO (15.1 kHz) in France, in the case of the three orthogonal profiles, served as transmitters. The apparatus measures the inclination of the magnetic component of the electromagnetic field (real component) and a quantity that is proportional to the phase difference between the primary and the secondary fields (imaginary component). The results have been fraser-filtered, which means that the points of inflection of the original data have been transformed to anomaly peaks. The filtered data is easy to visualize as contour maps and at the same time the effect of the topography and regional anomalies is diminished. The filtered data has been contoured on scale 1 : 2000 and optically reduced to scale 1 : 5000 and further appended on the topographic maps (appendices 3a and 3b). The orthogonal profiles are contoured on scale 1 : 2000 in appendices 4a and 4b.

The power line running through the area parallel to the general geological strike disturbed the measurements near the power line and possibly some conductors have been hidden by the effect of the power line. The VLF map indicates numerous VLF conductors in the area of which most are quite poor conductors. The relatively broad line spacing makes the connecting of anomaly peaks on adjacent lines difficult and even speculative in some cases. The VLF method gives prominence to features which are perpendicular to the primary field and thus also to the measuring lines. However, the VLF map indicates two intersecting strike directions of anomalies. Most of the anomalies have a strike direction of 310^{o} - 340^{o} but there are also some anomalies with a strike direction of 70^{o}. Furthermore it would have been possible to connect still more anomalies (e.g. numbers 10, 11 and 14) in the direction of 70^{o}.

It is possible that many of the poor conductors represent shear zones or very weak sulfide impregnations. On the other hand an excellent conductor like number 2 has features of a typical graphite schist anomaly. Thus without detailed geological information the moderate conductors with well conducting parts seem to be most interesting. However, with the VLF method alone it is not possible to get very detailed and reliable information on anomaly sources and thus it has to be considered as a method which is suitable for giving quickly a general view of the conductors in the area. The VLFanomalies have been listed in appendix 1 and summarized in the interpretation map (appendix 2).

3. MAGNETIC MEASUREMENTS

The magnetic survey was made using a Scintrex MP2 proton magnetometer, which measures the total component of the flux density of the geomagnetic field and which has a reading accuracy of 1 gamma. The diurnal variations of the geomagnetic field were eliminated by means of base line measurements. The smoothed values habe been contoured on scale 1 : 2000 and optically reduced to scale 1 : 5000 and appended to topographic maps (appendix 5).

The area is very weakly magnetized and no clear magnetic zones appear in the results. In this respect the Myrum area differs clearly from the Aasoren area. It can even be noticed that the pyrrhotite detected in drilling gives no magnetic anomaly. However, a routine curve fitting interpretation for the anomalies in the area was carried out using two dimensional semi-infinite plates as modells. The values T_O = 50200 gammas and $I_O = 81^g$ have been used in the calculations. The interpretated profiles and the results are shown in appendices 6 - 18. The interpretation parameters which were possible to vary are: the horizontal location of the upper left corner of the plate XØ (m), the dip FII (1^g), the depth tu the upper surface Z (m), the width of the plate D (m) and the effective susceptibility K (10^{-6} cgs). The distance to the lower surface of the plate (H) was thought to be very large. The reliability of the interpretations is diminished by simplicity of the models. The effect of possible remanent magnetism has been overlooked. Also it appears that the semi-infinite plate modell is perhaps not a specially suitable geometric modell to the anomalies in the area which often seem to be roundish and varying in strike direction.

There is no clear correlation between the VLF conductors and the magnetic zones. Even the strike directions differ from eachother.This is probably caused by the two intersecting strike directions of conductors and by the broad line spacing. However, at the southeast part of the area a clear similarity in the forms of the magnetic and VLF anomalies can be noticed (anomalies 12,13 and 14).

4. SUMMARY

Technically the undertaking succeeded well and without any special difficulties if the effect of the power line is not taken into account. The measurements that were carried out gave no direct indications of possible ore formations. The most pronounced result of the magnetic measurements was that the area is very weakly magnetized (very little magnetite) and that the structure of the bedrock is probably quite complicated (no clear anomaly patterns).

VLF measurements pointed out several conductors with at least two different strike directions. Most of the conductors were poor and none of them resembled very much the Aasoren anomalies. Without detailed geological information anomaly number 6 has to be considered as the most interesting one. More detailed information on the detected conductors might be achieved with slingram-measurements or in rough topography with shootback-measurements. If a conductor outcrops or is penetrated by a drill hole, charged potential measurements are recommended for more detailed investigations.

Espoo 1975-12-12

SUOMEN MALMI OY
Geophysical Department

Pekka Mikkola

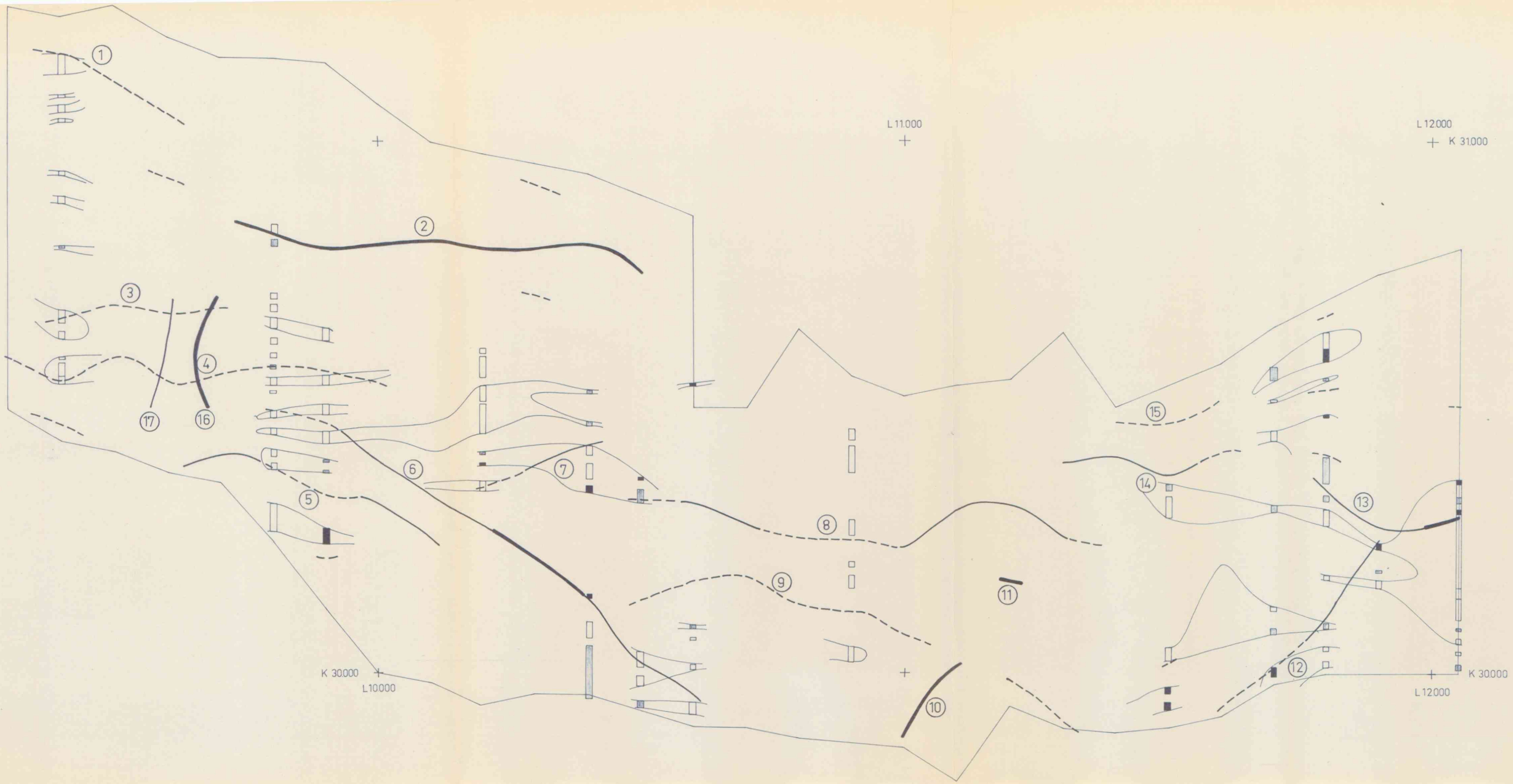
Pekka Mikkola
Geophysicist

LIST OF VLF ANOMALIES

no./L-co.	R (f%)	I (f%)	T (γ)	length (m)	Remarks
1/9.4	+ 10	+ 52	+ 8	> 400	Very poor conductor, possibly caused by overburden.
2/10.0	+ 98	- 20	+ 10	800	Good conductor under conducting overburden. Might be caused by graphite schist.
3/9.6	+ 14	+ 5	+ 43	350	Poor conductor situated on the NE side of a weakly magnetized zone. Possibly a shear zone.
4/9.6	+ 19	+ 1	+ 15	> 800	Poor conductor especially at the SE end where weak magnetization occurs. Possibly a shear zone.
5/10.0	+ 63	+ 23	- 35	> 500	Conductivity varies between poor and moderate. Situated between magnetic anomalies.
6/10.3	+102	- 3	+101	> 1000	Conductivity chiefly between moderate and good. Intersects with numbers 9 and 7. An interesting anomaly.
7/10.4	+ 57	0	+ 23	> 500	Conductivity changes from poo to moderate. Strike differs from general trend. Could be continuated to the western side of number 6.

no/L-co.	R (f%)	I (f%)	T (γ)	length (m)	Remarks
8/11.0	+ 87	+ 14	- 42	1000	Conductivity varies between poor and moderate. Varying strike. The SE end could be connected to anomalies 10,11 and 14.
9/10.7	+ 18	+ 13	- 26	> 1000	Poor conductor which intersects anomalies 6 and 10. Possibly caused by a shear zone or weak sulfide impregnation.
10/11.1	+100	+ 26	- 39	> 200 - 900	Good conductor which might continue to anomaly 14 differing from the general strike
11/11.2	+ 93	+ 4	- 57	< 200	Good conductor which might belong to the same horizon as anomaly 10.
12/11.8	+ 47	- 11	+150	400	Conductivity between poor and moderate. Strike differs from the general trend. Might be associated with magnetization.
13/11.9	+ 70	+ 13	+315	> 300	Conductivity varies from good to moderate. Is clearly connected to a magnetic zone. Might belong to the same horizon as anomaly 14.
14/11.5	+ 76	+ 55	- 80	300	Chiefly a moderate conductor which is possibly a continuation of anomaly 13.

no/L-co.	R (f%)	I (f%)	T (γ)	length (m)	Remarks
15/11.5	+ 19	+ 9	- 98	200	Poor conductor parallel to anomaly 14.
16/K=30.6	+167	+ 3	- 40	> 200	Good conductor which is visible only in orthogonal profiles.
17/K=30.5	+ 41	+ 7	- 20	> 200	Moderate conductor parallel to anomaly 16.



Magnetic zones

K ≥ 2500 x 10^{-6} cgs

1000 ≤ K < 2500 x 10^{-6} cgs

K < 1000 x 10^{-6} cgs

Conductive zones

good , conductivity

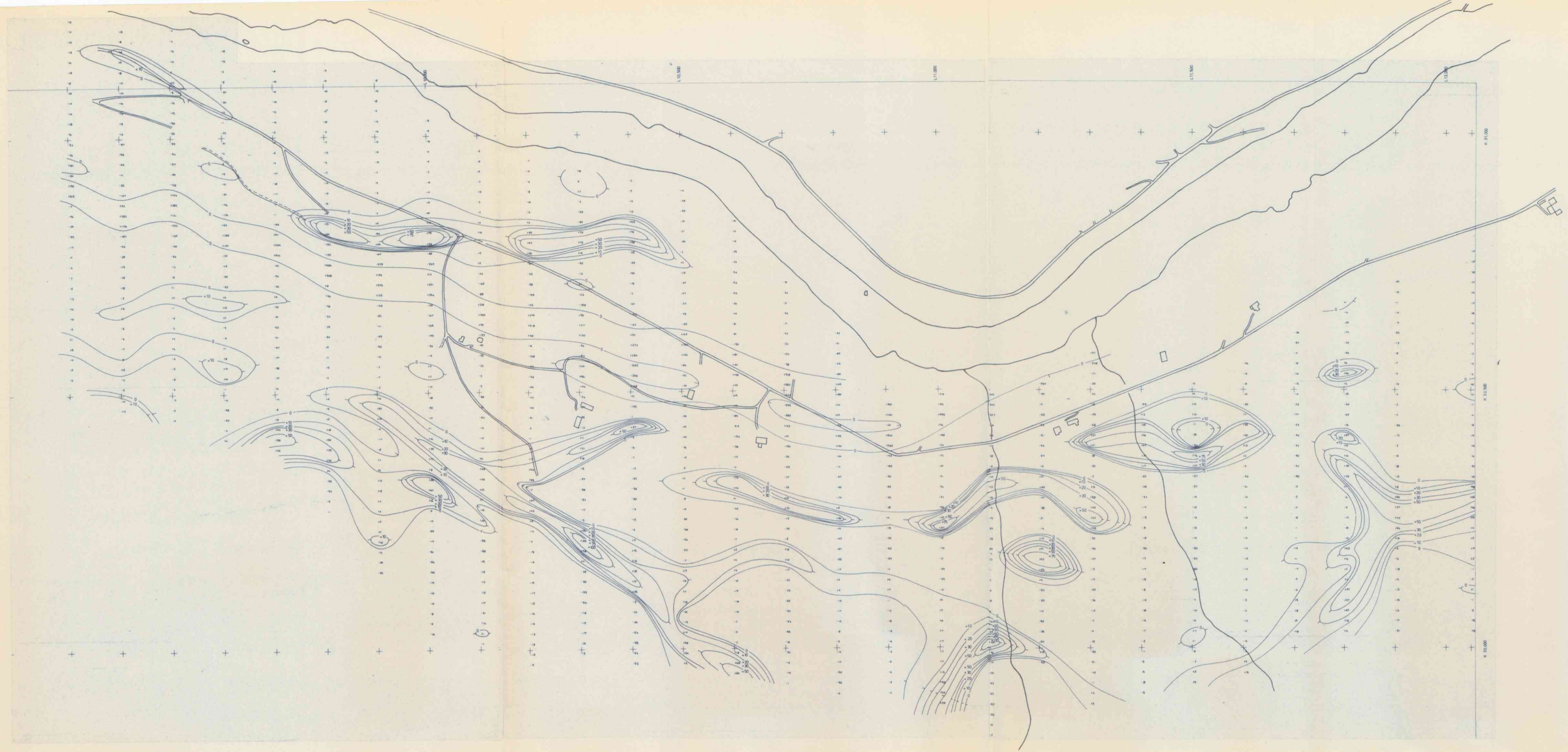
moderate

poor

⑫ etc anomalies referred in the text and App.1

SUOMEN MALMI OY	1:5000	draw	A S	12.75
		insp	PM	12.75
Interpretation map				
OTTA, Myrum				

App. 3a



Contours: 0, +10, +20, +30, +50, +75, +100, +150 %

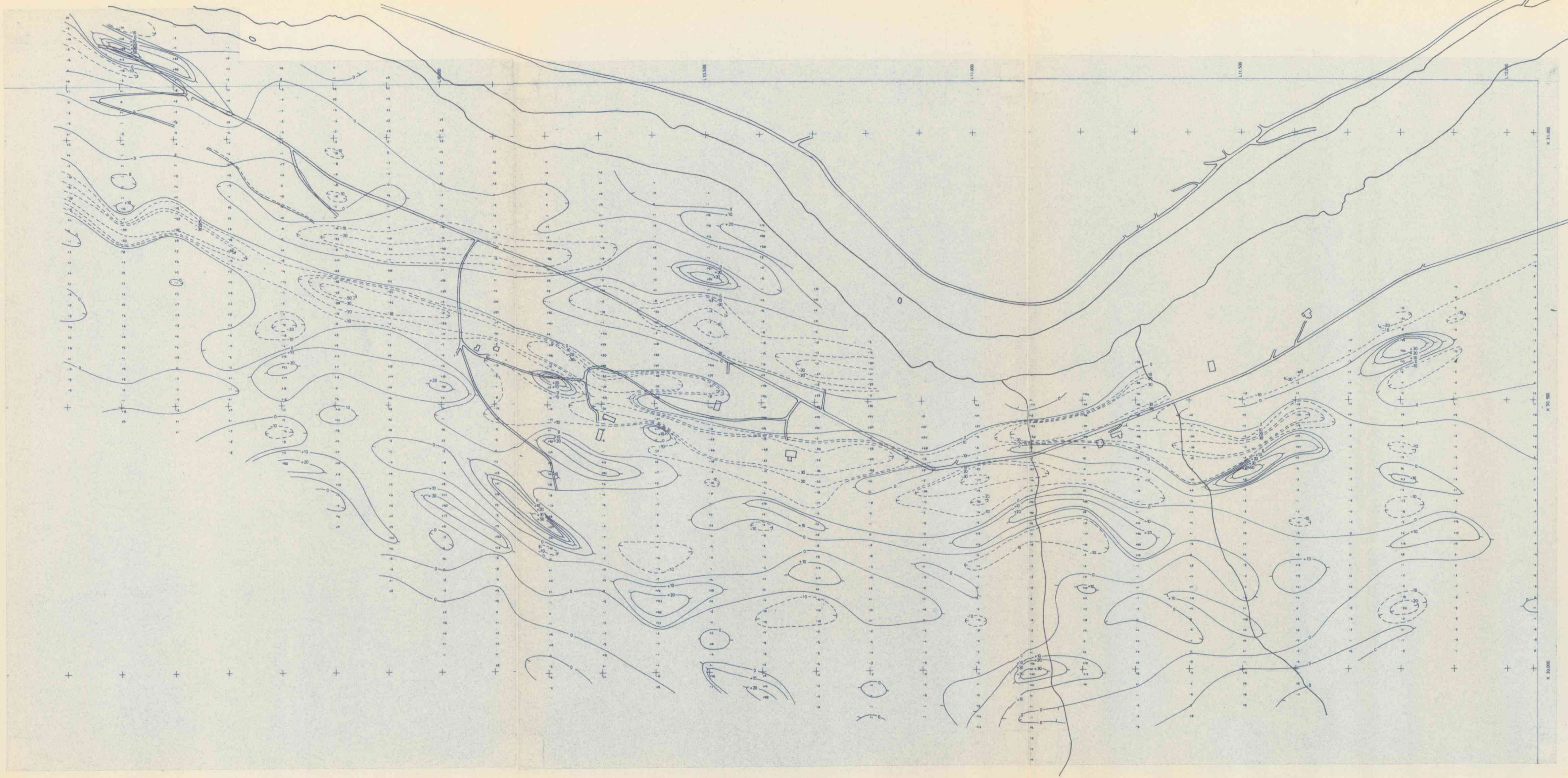
Transmitter: NAA 17,8 kHz

Instrument: Geonics EM-16

Fraser - filtered

SUOMEN MALMI OY	1:5000	meas	RK	9.75
		draw	SM	11.75
		insp.	PM	11.75
VLF – map Real component				
OTTA, Myrum				

App. 3 b



Contours: −100, −75, −50, −30, −20, −10, 0

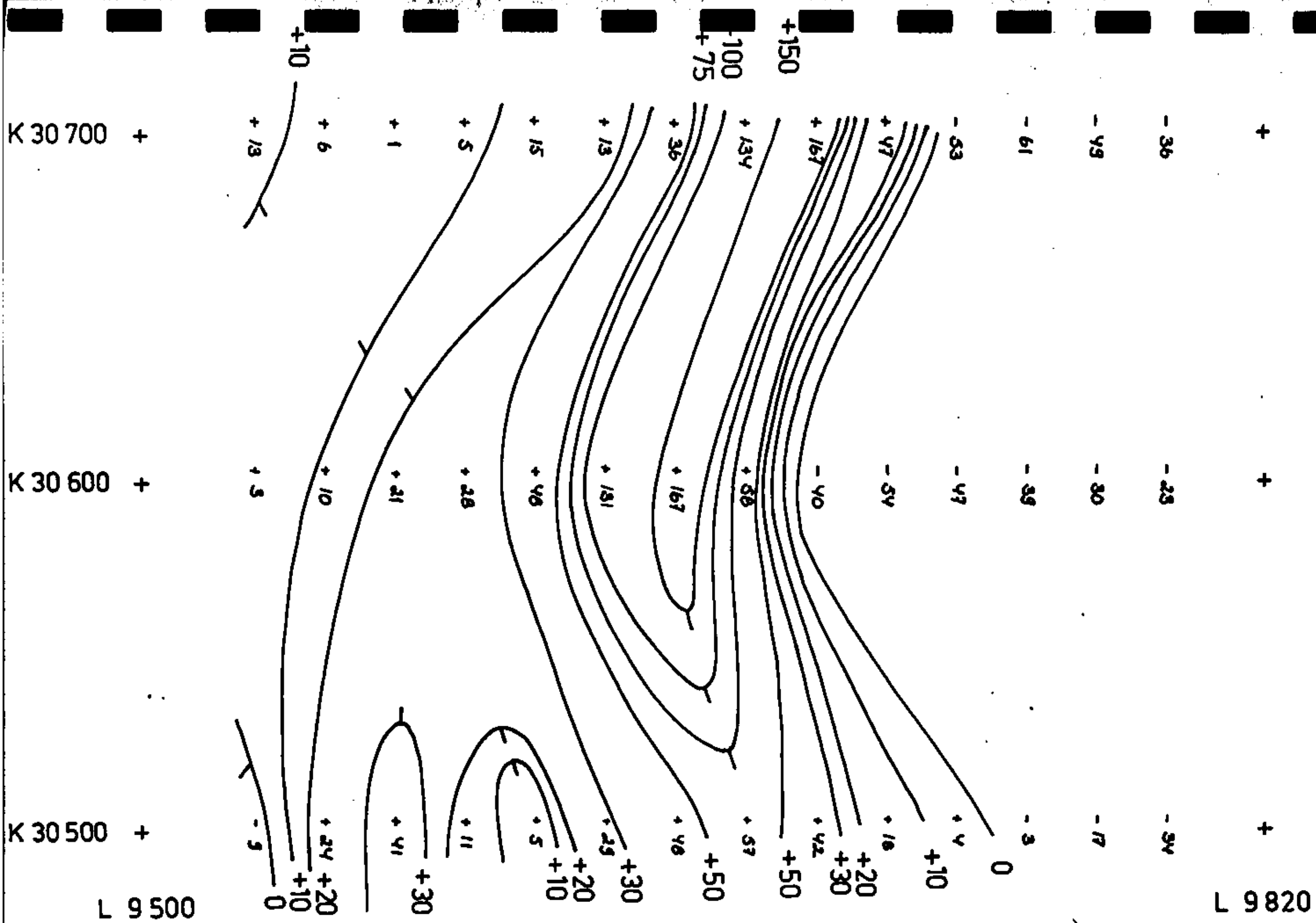
+10, +20, +30, +50, +75, +100, +150 %

Transmitter: NAA 17,8 kHz

Instrument: Geonics EM - 16

Fraser - filtered

SUOMEN MALMI OY	1:5000	meas RK 9.75 draw SM 11.75 insp PM 11.75
VLF - map Imaginary component		
OTTA, Myrum		



Contours: 0, +10, +20, +30, +50, +75, +100, +150 %

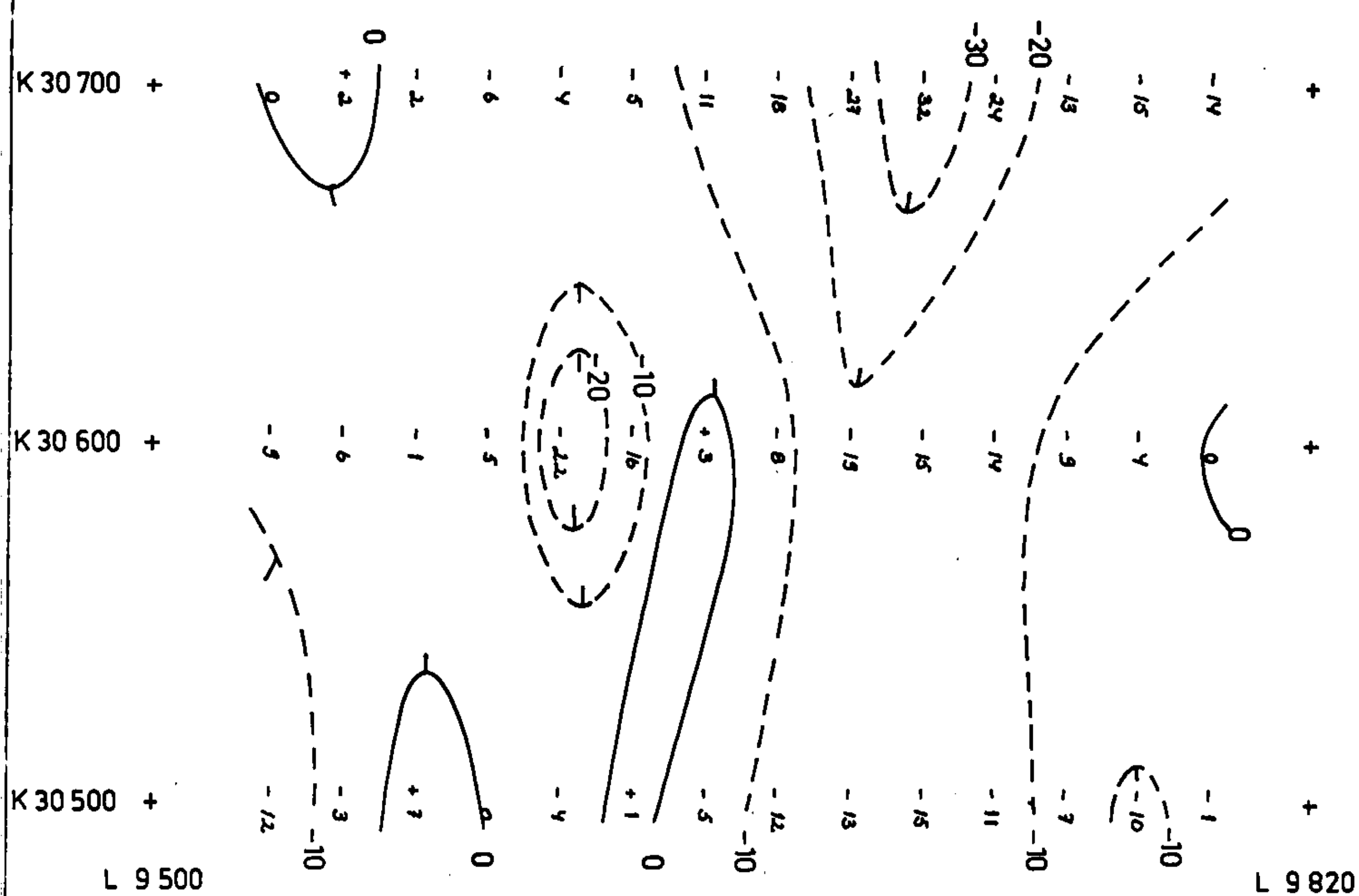
Transmitter: FUO 15,1 kHz

Instrument: Geonics EM-16

Fraser-filtered

SUOMEN MALMI OY	1:2000	meas.	TK	9.75
		draw.	AS	12.75
		insp.	PM	12.75
VLF - map Real component				
OTTA, Myrum				

App. 4b



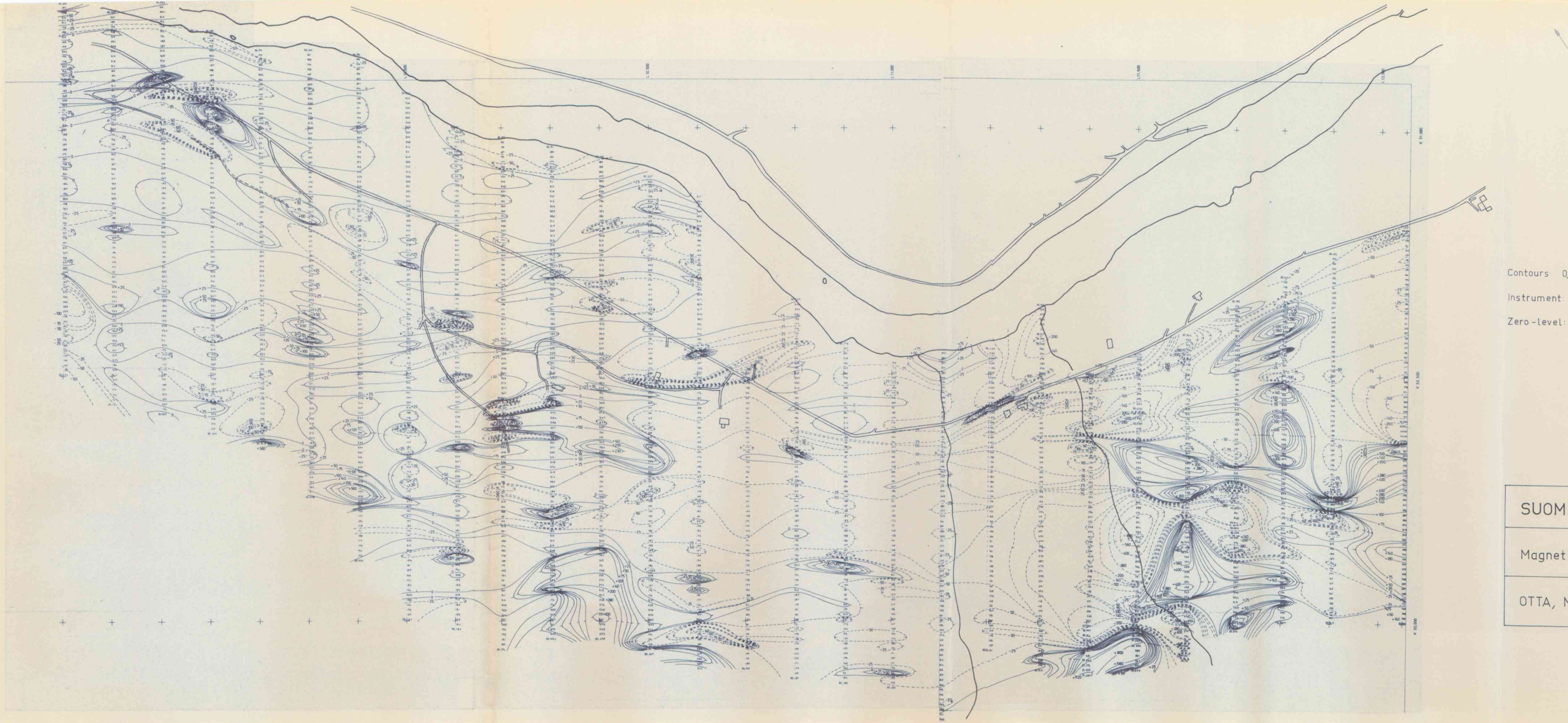
Contours: 0, -10, -20, -30 %

Transmitter: FUO 15,1 kHz

Instrument: Geonics EM-16

Fraser-filtered

SUOMEN MALMI OY	1:2000	meas.	TK	9.75
		draw.	AS	12.75
		insp.	PM	12.75
VLF - map Imaginary component				
OTTA, Myrum				



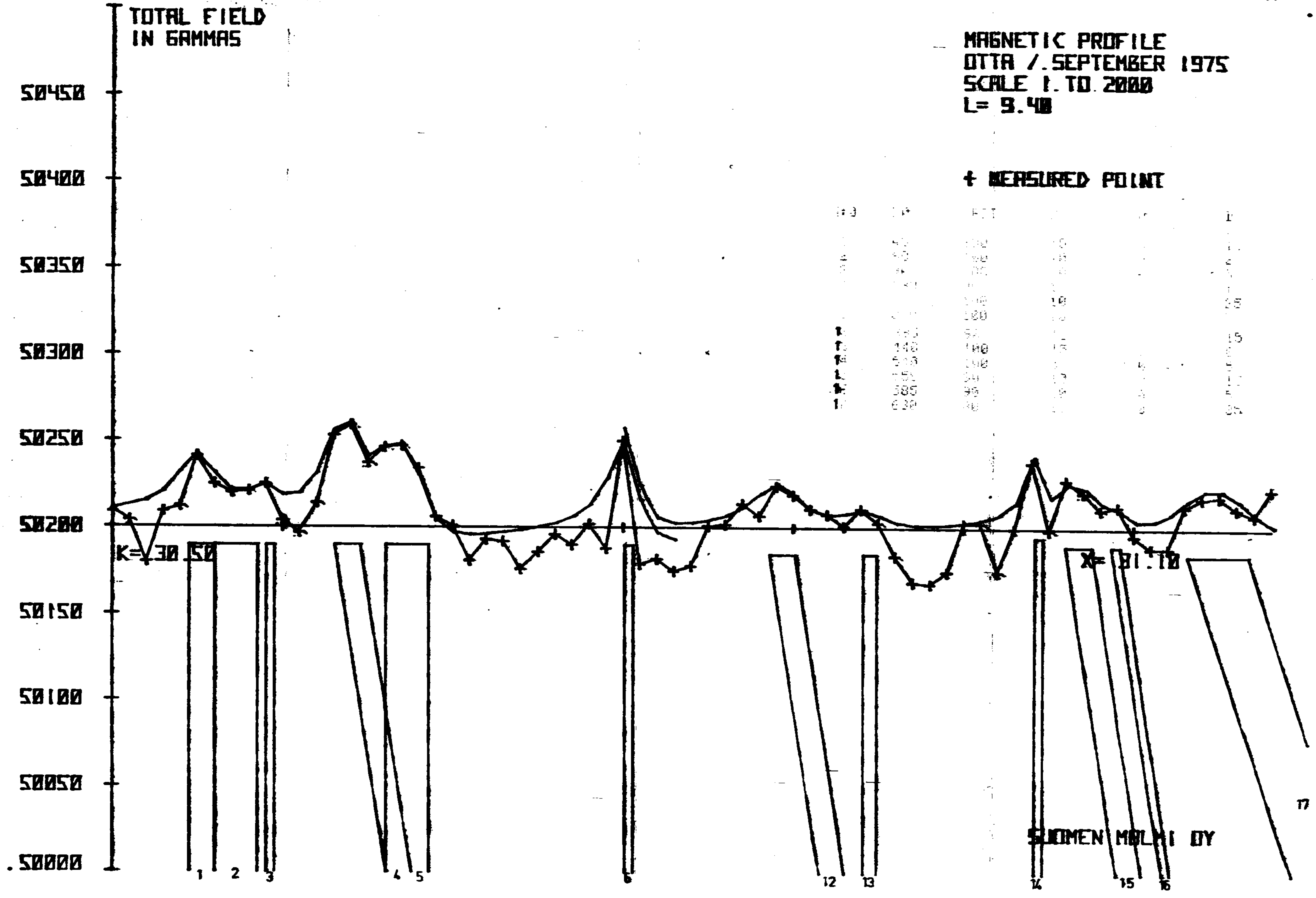
Contours 0, ±25, 50, 75, 100, 140, 200, 280, 400 γ

Instrument: Proton magnetometer MP 2

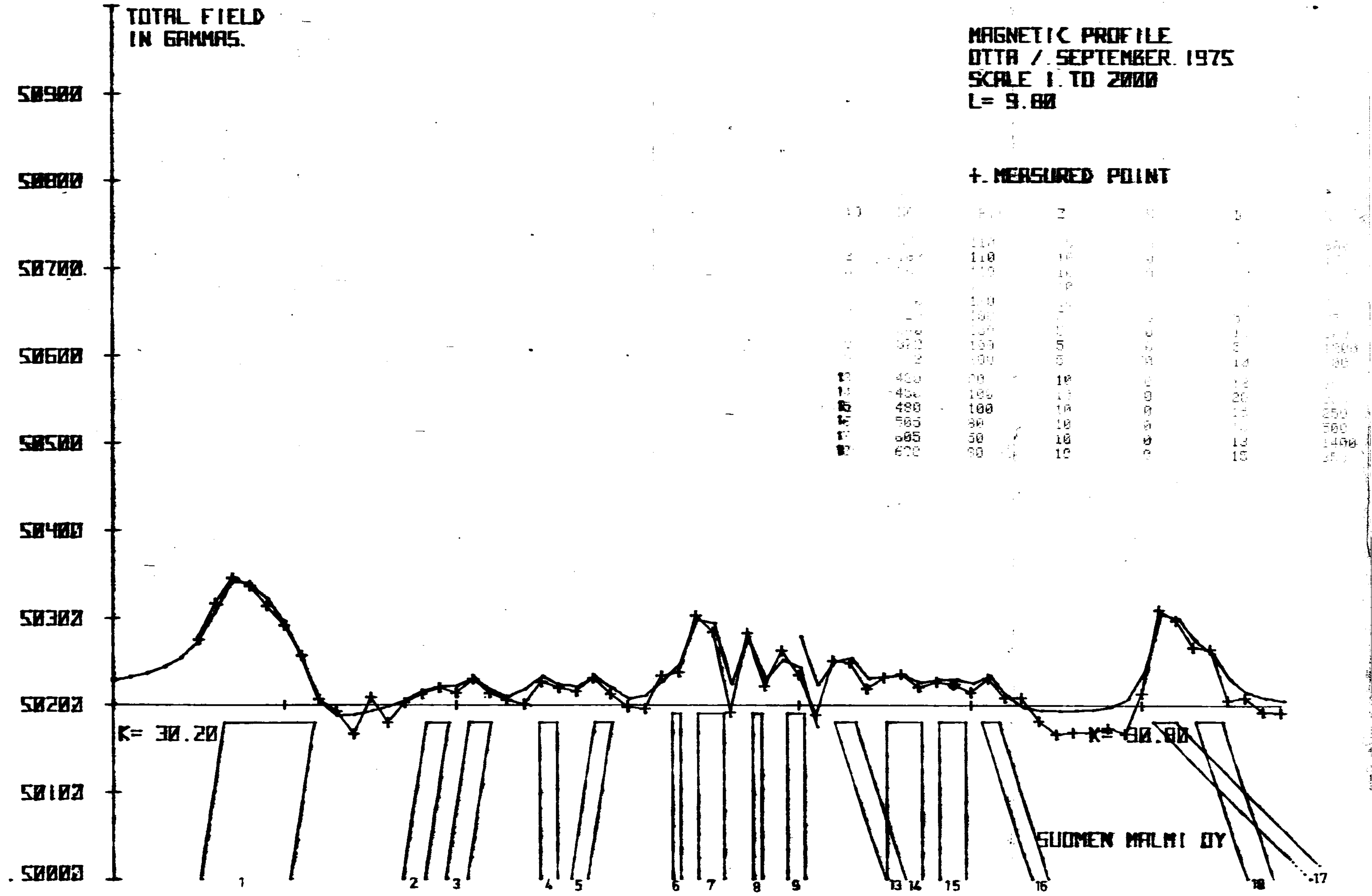
Zero-level: 50 200 γ

SUOMEN MALMI OY	1:5000	meas	JV	9.75
		draw	SM	11.75
		insp.	PM	11.75
Magnetic map				
OTTA, Myrum				

App. 6

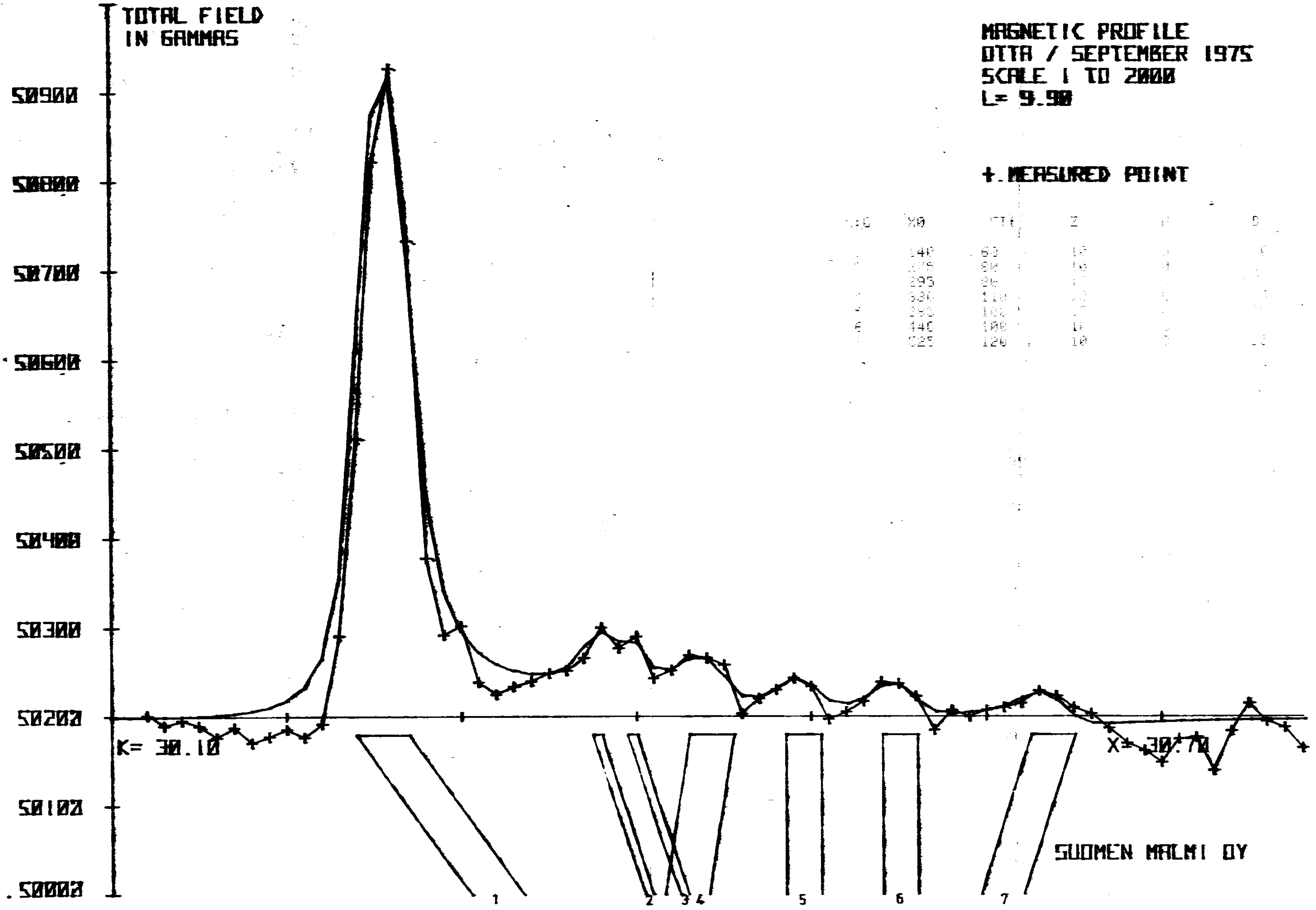

TOTAL FIELD
IN GAMMAS
MAGNETIC PROFILE
OTTA /. SEPTEMBER 1975
SCALE 1. TO 2000
L= 9.40
+ MEASURED POINT
50450
50400
50350
50300
50250
50200
50150
50100
50050
.50000
K= 30.50
X= 31.10
1
2
3
4
5
6
12
13
14
15
16
17
SUOMEN MALMI OY

App. 7



TOTAL FIELD
IN GAMMAS.
MAGNETIC PROFILE
OTTA / SEPTEMBER 1975
SCALE 1 TO 2000
L= 9.00
+ MEASURED POINT
50900
50800
50700
50600
50500
50400
50300
50200
50100
50000
K= 30.20
K= 30.00
SUOMEN MALMI OY
1
2
3
4
5
6
7
8
9
13
14
15
16
18
17

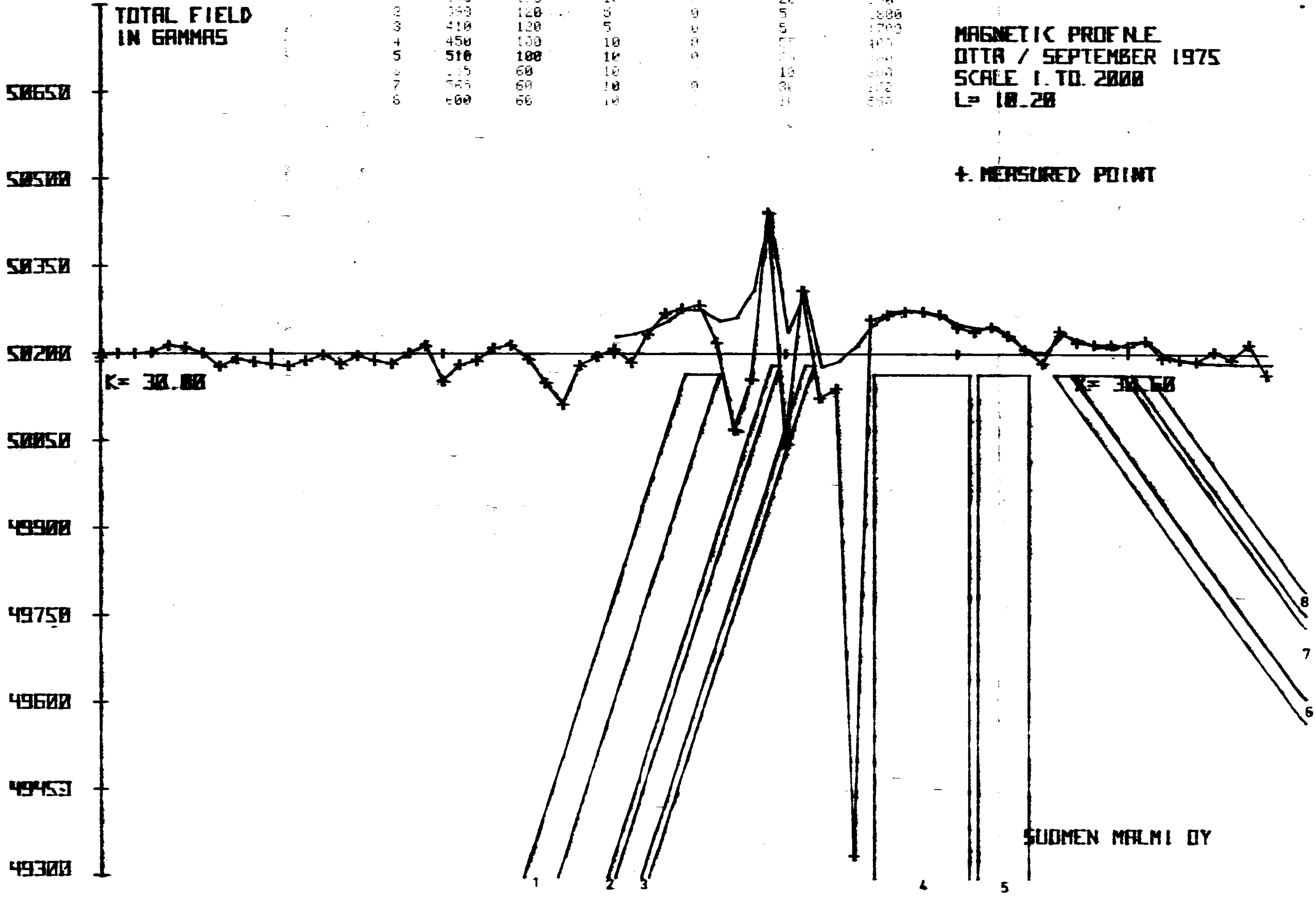
App. 8


TOTAL FIELD
IN GAMMAS
MAGNETIC PROFILE
OTTA / SEPTEMBER 1975
SCALE 1 TO 2000
L= 9.90
+. MEASURED POINT
50900
50800
50700
50600
50500
50400
50300
50200
50100
50000
K= 30.10
X= 30.70
1
2
3
4
5
6
7
SUOMEN MALMI OY

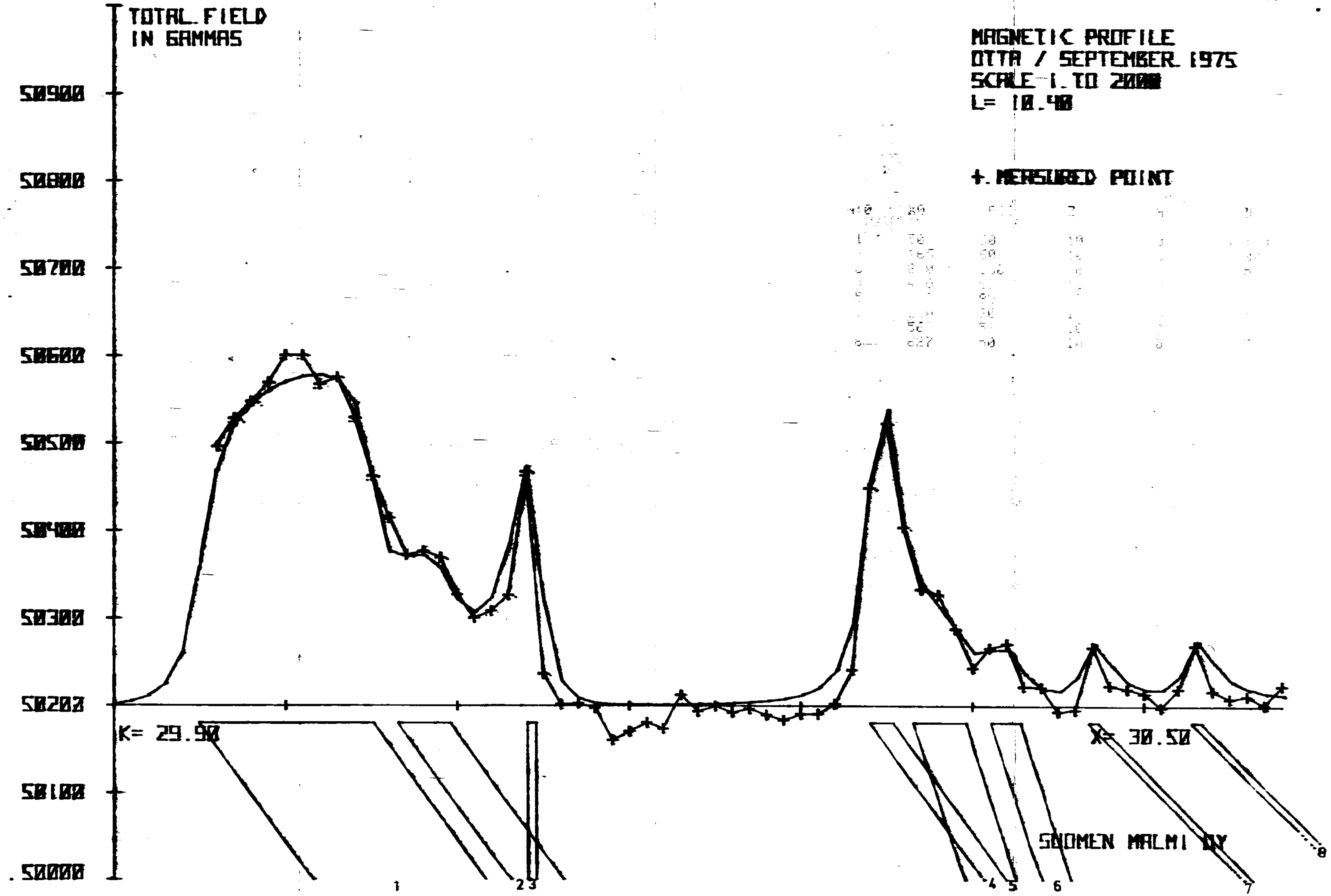
App. 9

N:0	X0	FII	Z	H	D	K
1	340	[illegible]	10	[illegible]	20	[illegible]
2	[illegible]	120	5	0	5	[illegible]
3	410	120	5	0	5	[illegible]
4	450	100	10	0	[illegible]	[illegible]
5	510	100	10	0	[illegible]	[illegible]
6	[illegible]	60	10		10	[illegible]
7	565	60	10	0	[illegible]	[illegible]
8	600	60	10		[illegible]	[illegible]

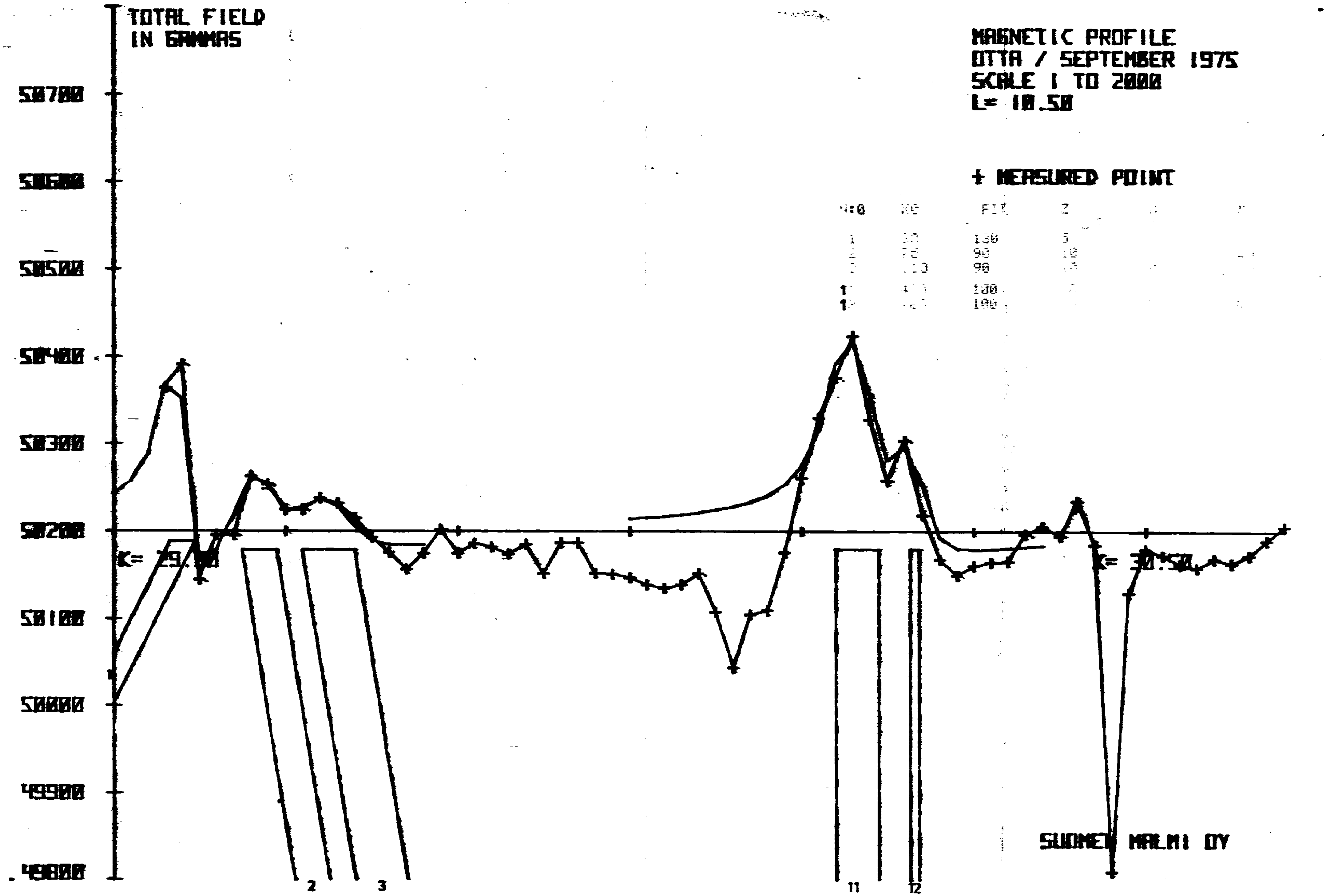
MAGNETIC PROFILE
OTTA / SEPTEMBER 1975
SCALE 1. TO. 2000
L= 10.20

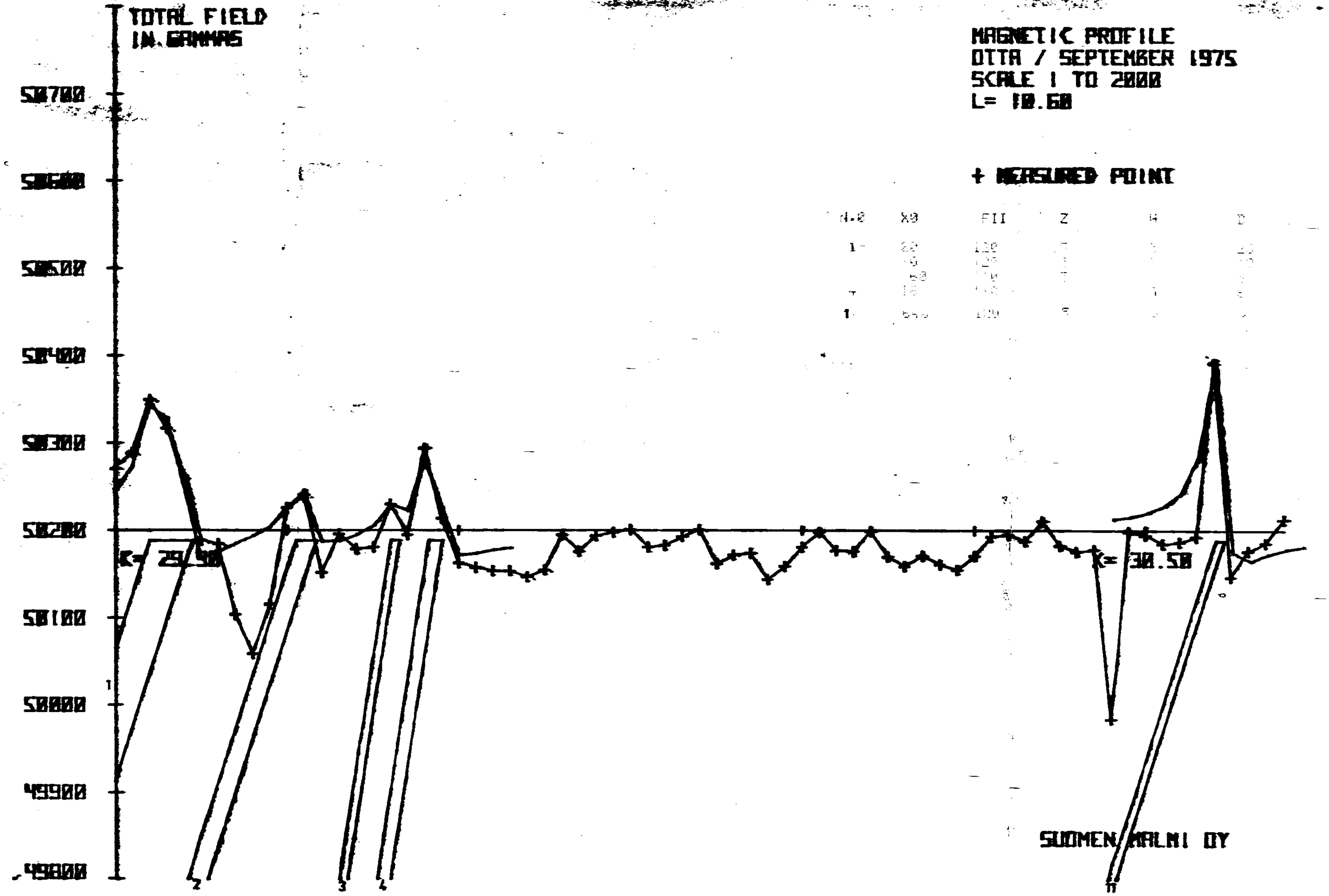


App. 10


TOTAL FIELD
IN GAMMAS
50900
50800
50700
50600
50500
50400
50300
50200
50100
50000
MAGNETIC PROFILE
OTTA / SEPTEMBER 1975
SCALE 1. TO 2000
L= 10.40
+. MEASURED POINT
K= 29.90
X= 30.50
SUOMEN MALMI OY
1
2
3
4
5
6
7
8

App. 11


TOTAL FIELD
IN GAMMAS
MAGNETIC PROFILE
OTTA / SEPTEMBER 1975
SCALE 1 TO 2000
L= 10.50
+ MEASURED POINT
50700
50600
50500
50400
50300
50200
50100
50000
49900
49800
K= 29.
K= 3 .50
2
3
11
12
SUOMEN MALMI OY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MAGNETIC PROFILE
OTTA / SEPTEMBER 1975
SCALE 1 TO 2000
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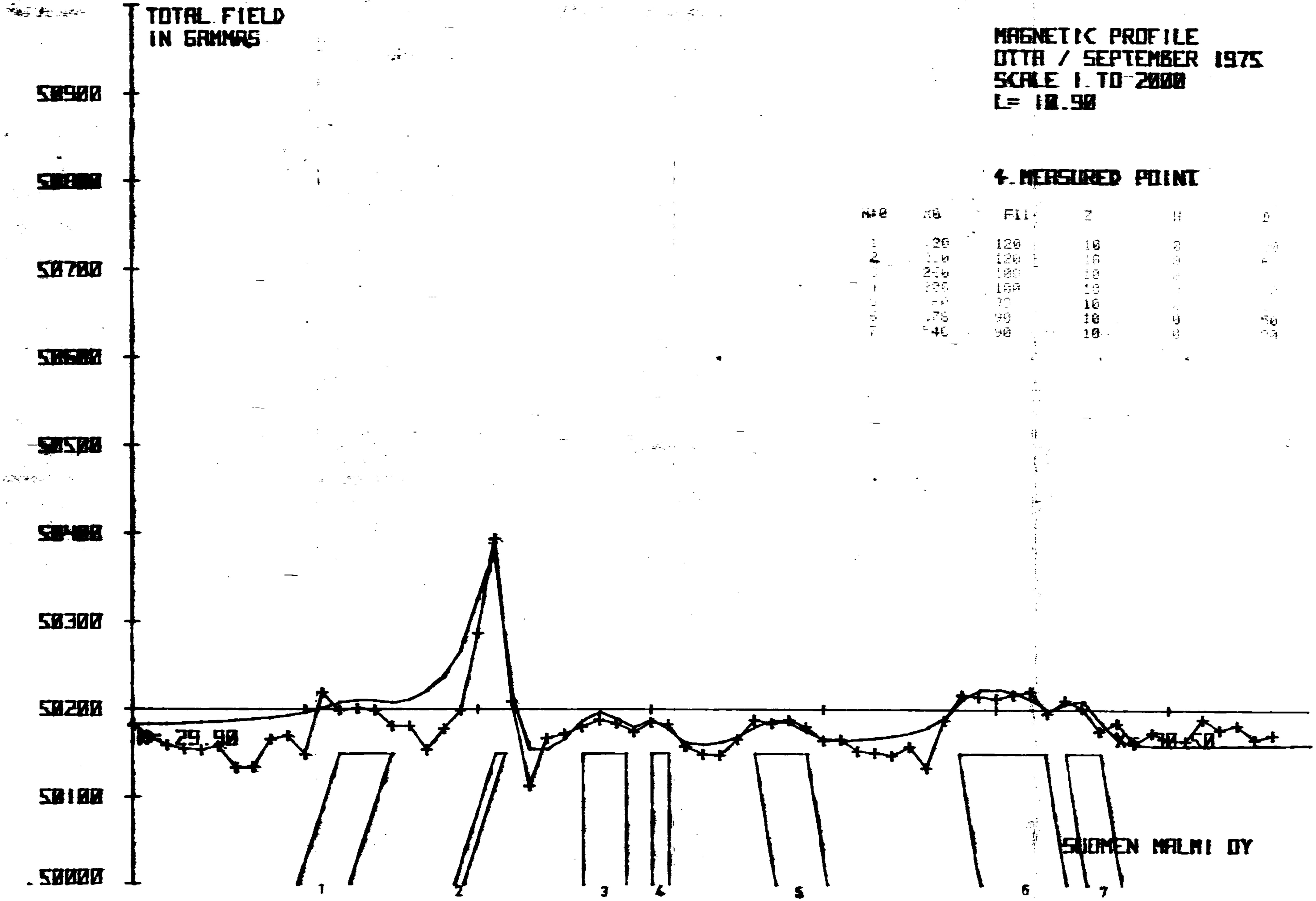
+ MEASURED POINT
50700
50600
50500
50400
50300
50200
50100
50000
49900
49800
K= 29.50
K= 30.50
1
2
3
4
11
SUOMEN MALMI OY



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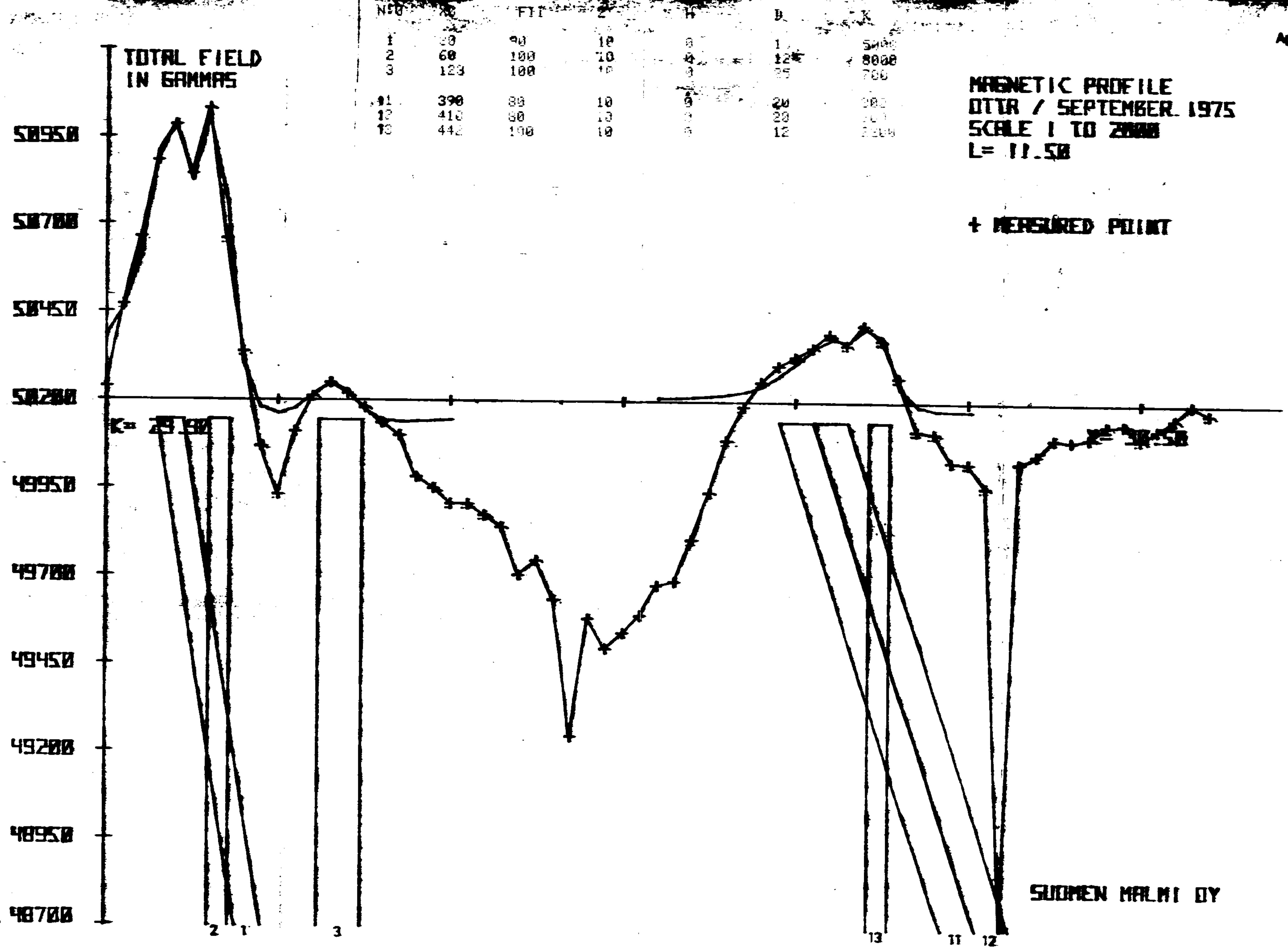
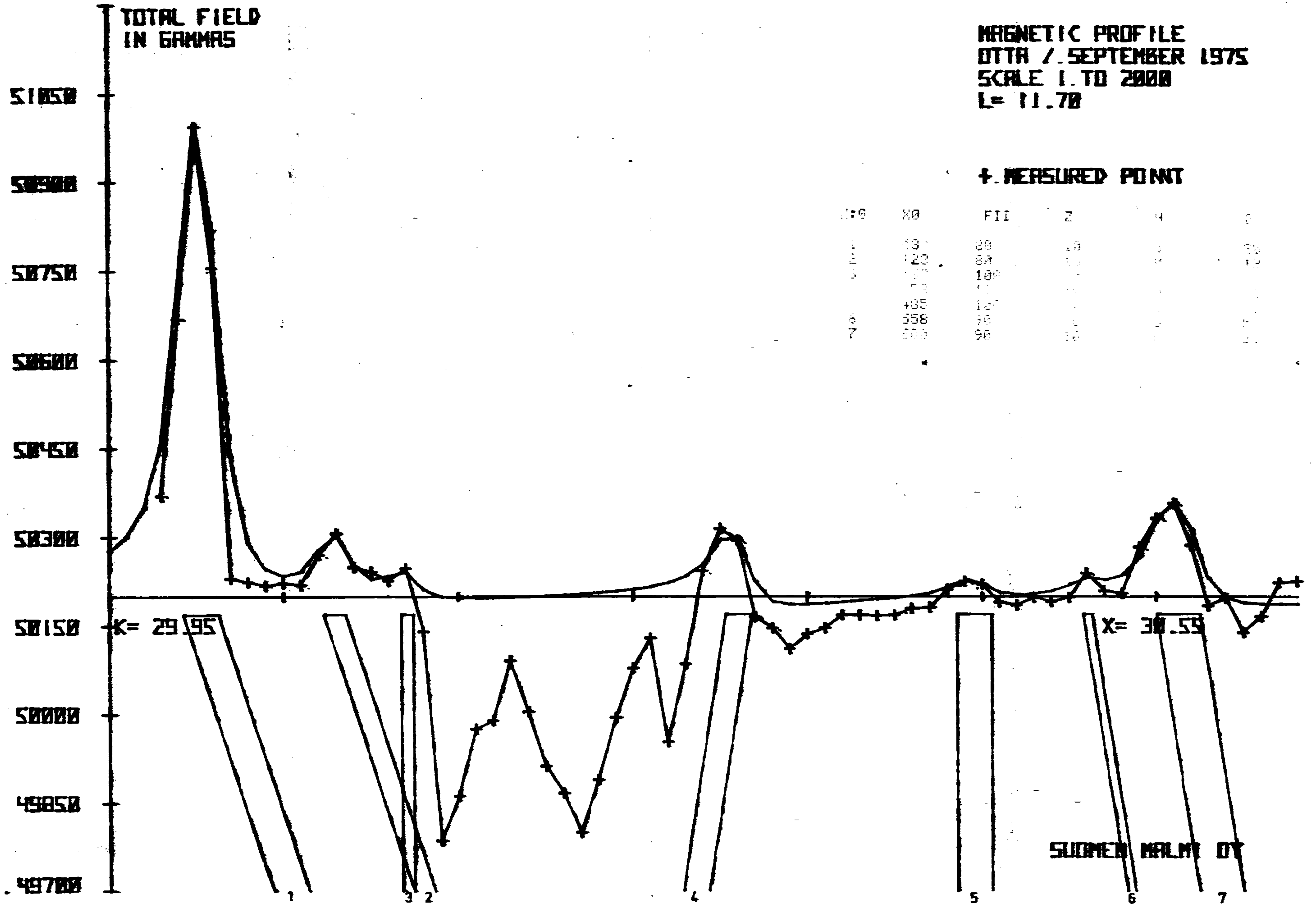
2	[illegible]	120	10	[illegible]	[illegible]
[illegible]	2[illegible]0	100	10	[illegible]	[illegible]
[illegible]	[illegible]	100	10	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]
[illegible]	[illegible]76	90	10	0	50
7	[illegible]40	90	10	0	[illegible]

App. 14


TOTAL FIELD
IN GAMMAS
MAGNETIC PROFILE
OTTR / SEPTEMBER 1975
SCALE 1 TO 2000
L= 11.50
+ MEASURED POINT
N:O X0 FII Z H D K
1 20 90 10 0 1 5000
2 60 100 10 0 12 8000
3 123 100 10 0 25 700
11 390 80 10 0 20 200
12 410 80 10 0 20
13 442 100 10 0 12
50950
50700
50450
50200
49950
49700
49450
49200
48950
48700
K= 29.90
K= 38.50
2
1
3
13
11
12
SUOMEN MALMI OY



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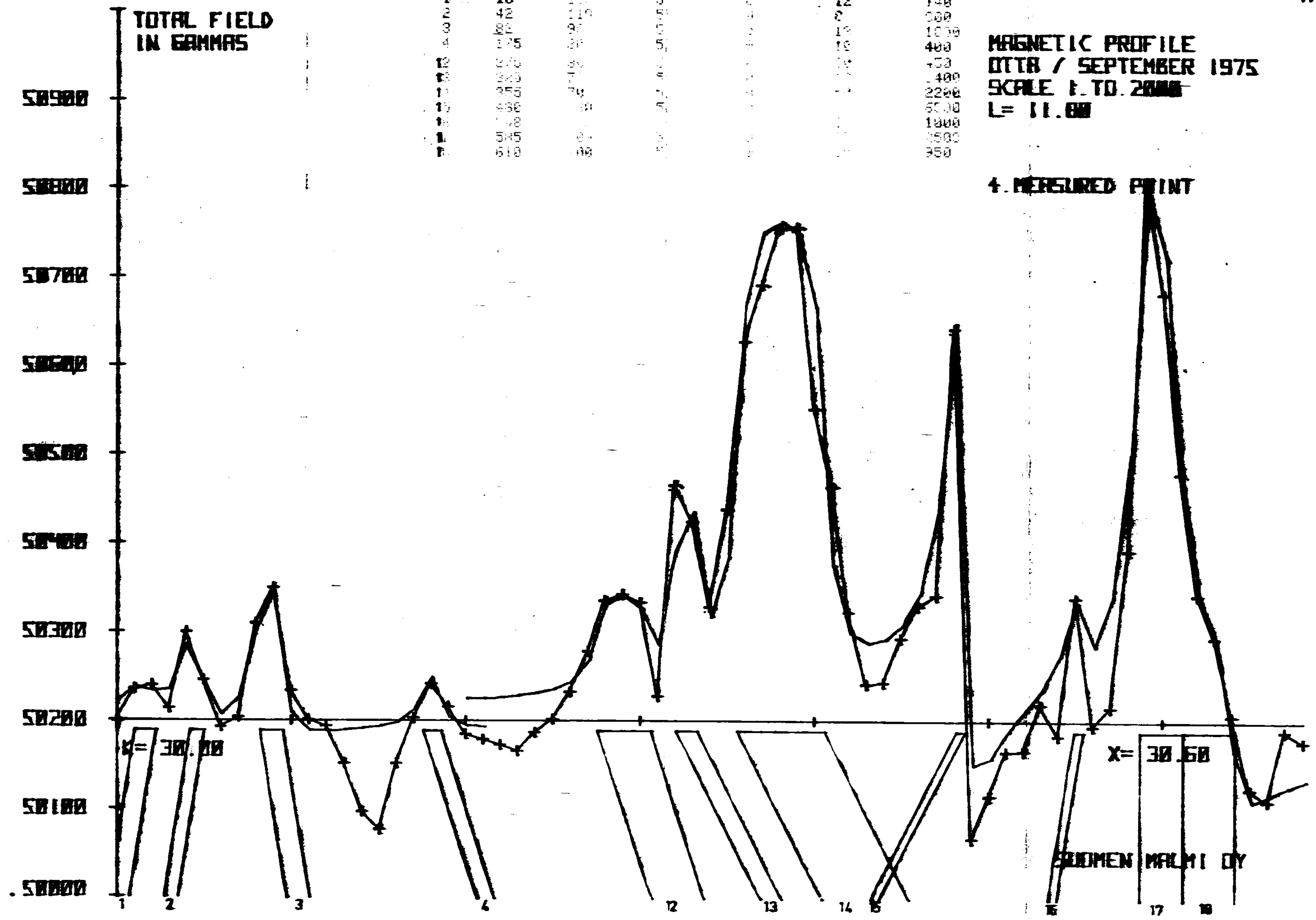
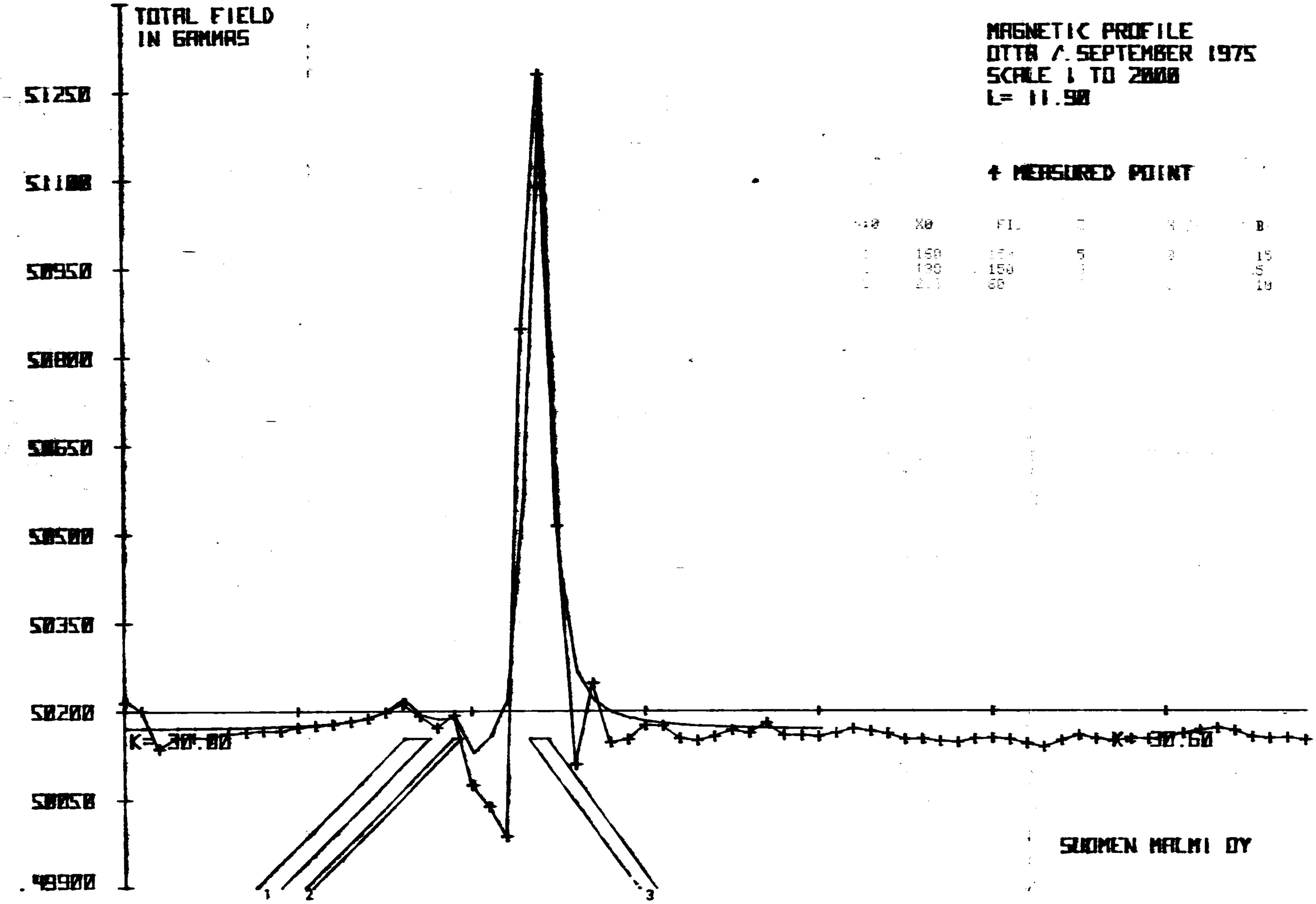
[illegible]	[illegible]	10[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	+85	[illegible]	[illegible]	[illegible]	[illegible]
6	558	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	90	[illegible]	[illegible]	[illegible]

App. 16

NRO	X0	FII	Z	H	[illegible]	K
1	10	[illegible]	5	[illegible]	12	140
2	42	[illegible]	5	[illegible]	[illegible]	[illegible]00
3	82	[illegible]	[illegible]	[illegible]	[illegible]	1000
4	175	[illegible]	5	[illegible]	[illegible]	400
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]400
[illegible]	355	[illegible]	[illegible]	[illegible]	[illegible]	2200
[illegible]	[illegible]	[illegible]	5	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1000
[illegible]	5[illegible]5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	350





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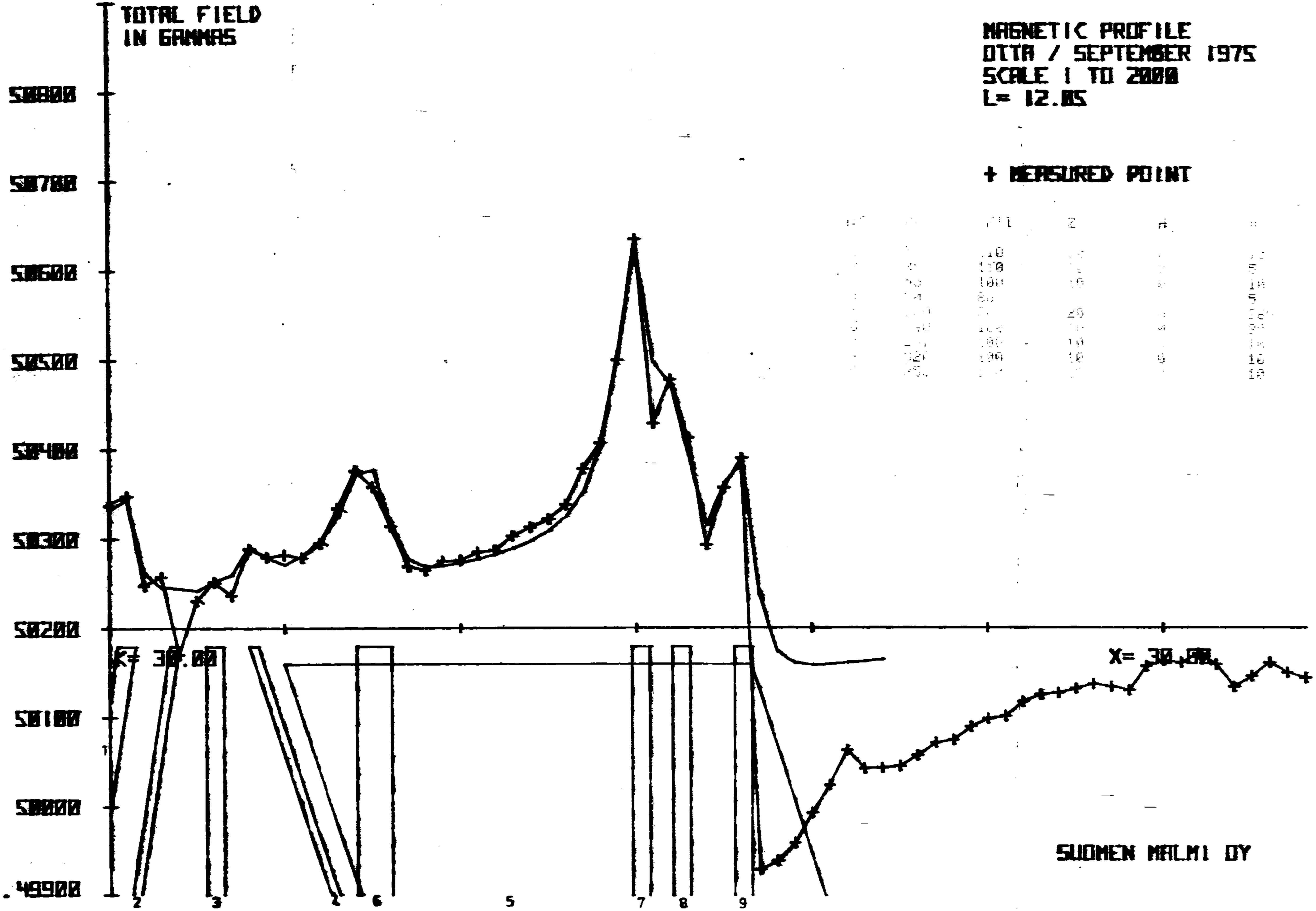
[illegible]	130	150	[illegible]		5	[illegible]
[illegible]	[illegible]	60		[illegible]	10	[illegible]

SUOMEN MALMI OY


TOTAL FIELD
IN GAMMAS
MAGNETIC PROFILE
OTTA / SEPTEMBER 1975
SCALE 1 TO 2000
L= 12.05
+ MEASURED POINT
50800
50700
50600
50500
50400
50300
50200
50100
50000
49900
X= 30.00
X= 30.00
2
3
4
6
5
7
8
9
SUOMEN MALMI OY