DETERMINING TWO DIMENSIONS OF A CONCEALED CHROMITE ORE BY MICRO-COMPUTER MODELLING OF MAGNETIC TOTAL FIELD INTENSITY PROFILE

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ABSTRACT. — Computer modelling, using Manik Talwani's method to determine the two dimensions of an ore body is described. It is shown that quite accurate determination of the two dimensions of ore body is possible with such application. It is suggested that such applications could be very useful for better programming of drilling and better estimation of ore bodies in chromite.

INTRODUCTION

During the research, so named «Searching unknown-unseen chromite ore deposits with a protonmagnetometer», which was supported by Turkish technical and research council, so called TÜBİTAK, some distinct anomaly were detected between chromite deposits and surrounding hostrock, after taking and evaluating some 4000 measurement in the 1.1 sq. km. Finally six probable ore deposition place and some 11 drillings on them were suggested.

As far as studied case concern, in one of the probable ore deposition area, two dimension of probable chromite ore deposit size was tried to be found, with the help of it's magnetic susseptibility and imagined ore shape in microcomputer.

The field research, including geophsical, geological and mineralogical work, has taken place in 1982 and 1983 sommers period, whilst the laboratory work were done in 1983-1984 winters, so M.A.G. 617 TUBİTAK project were completed within 3 years. Especially this study, which is based on, but not a part of mentioned project, was carried out some part of 1984 winter period.

The used path for research as follows; Five cross-section, so named as (C-D), (E-F), (G-H), (J-K), (L-M), were chosen over one of the probable ore deposition area, which is placed just NW of örnek ocak area and contoured on the 1:10.000 scaled total magnetic intensity map (Fig. 1). If it is noticed to mentioned cross sections (Fig. 3,4,5,6,7), that earth's total magnetic intensity as well as topografic condition were demonstrated on top another on the same page. At the end of rutin comparison of the topografic and magnetic sections together, it was realized, that high earth's total magnetic intensity values comes out on the high topografic part of sections in general, although it is not a rule.

On the contrary of this general view in the studied area, especially on the left part of the cross-section (L-M), some distinct earth's total magnetic intensity values were detected and all research diverted to find out this phenomena and cause of this unignorable magnetic value increases.

Before start the research, some other relevant studies were normally checked, but somehow there was no single study came cross, which is directly related with chromite reserve analysis with microcomputer. In fact, there are many studies, which were noticed, suggest some different methods of computer programme for evaluation of ore reserve in two or three dimension (see ref 1-to 15).

As a matter of fact, that the computer programme, was used in this studied case, was developed by Manik Talwani. In an other words, this present study's target is not a programme making for computer, on the contrary, try to show a probability of a reserve analysis for chromite ore in the ultrabasic area, with a computer.

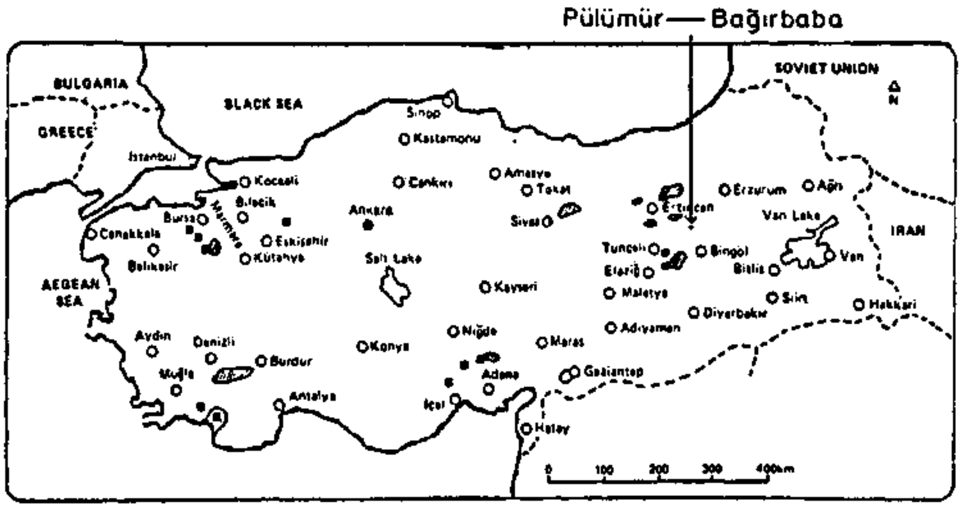


Fig. 1A - Location of the studied area in Turkey.

It is normally suggested, that some geologic 1 geophysical and the other suitable ways should be tried, before final reserve analysis is made in the studied area. As it is known, that even ore is throughly detected, the right outcropping and mining method should be decided carefully in advance of drillings.

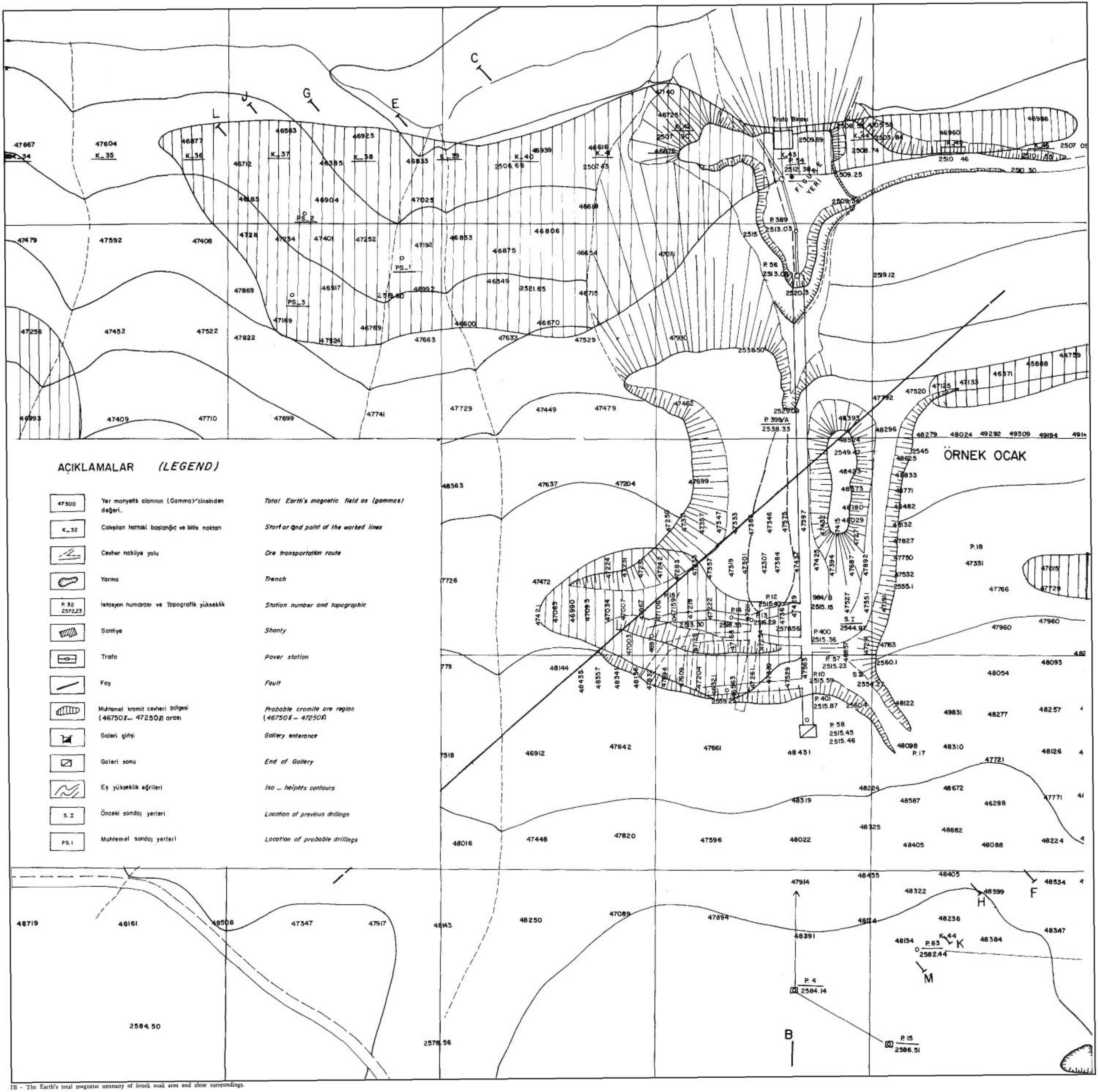
The present method is one of these ways, which may show the right economical path for mining. The specifity of this work is not only, that it was done by microcomputer, besides it was tried on chromite ores, in the low ferromagnetic ultrabasic area, which has no distinct ferromagnetic value, if it is compared with ferromagnetic Iron, thus the studied case was needed more sensitive care than usual.

MATERIAL AND METHOD

Earth's total magnetic intensity measurements were taken with 20 m. intervals at the field, whilst 4 m. intervals was used around örnek ocak ore deposition vicinity in order to improve trustability of measurements. As it was mentioned in advance that roughly 4000 measurement were taken within 1.1 sq. km.

The other maps was not included to this articel just because, they have not got any direct relation with the present study. Thus, örnek ocak, where chromite deposits are still under mine, was chosen and all topographic and magnetic cross-section were taken over it in advance.

At first, bell-like anomaly on section (L-M) was drawn by computer with the help of 11 points (Fig. 2), than probable ore body's shape, which causes bell-like anomaly at the field, was tried to be found in two dimension. So that some 73 imaginary ore shapes were coded to computer in order to find out the most probable ore shape. Due to publishing problems, except some typical examples, most of them were not included to the present articel.



1B - The Earth's total magnetic intensity of örnek ocak area and close surroundings.

In exception, Figure 8B, 9B, 10B and 11B were obtained with using same imagined shape (8A), but changing the real magnetic susseptibility value in between (0.0015-0.0025) emu (electro magnetic unity). At last of these trials (Fig. 13A, B; 14A, B; 15A, B; 16A, B), changing the real magnetic susseptibility values and imaginary ore shapes, the most probable ore shape and its anomaly were found, which can fit in to the anomaly, which was drawn according to earth's total magnetic intensity values, which were detected by proton magnetometer at the studied area (Fig. 17A, 17B).

If one would able to prepare some more cross-sections very close to section (L-M), than it may became possible to find out rough third dimension and more exact reserve analysis can be made.

Just before given one specific example to show followed path during model analysis, used constant and abbreviations should be explained.

On the microcomputer programme;

X — 1:500 scaled cross-section were placed on X abscissa as (m)

F = Measured total magnetic intensity of earth at the studied area placed on Y ordinate as gammas (g)

A = Inclination angle, 58° at the studied area

B = Denclination angle, 2° at the studied area

C = Cross-section strike's angle from north
At the studied area, it is 40° for all
(C-D), (E-F), (G-H), (J-K), (L-M) sections

K = The real magnetic susseptibility values for chromite ore, which were found at the laboratory in between (0.0015-0.0025) emu

The earth's total magnetic intensity's background of studied area is 46 500 g, but for this present study, above 47 000 g level was accepted as «fit in» part, for obtained computer graphic and graphic obtained from field measurement.

It can be seen easily, if it is noticed the first 5 cornered imagined ore shape (8A), which is 1:1000 scaled on the Y ordinate, 1:500 scaled on the X abscissa and computed, with found susseptibility value.

At the first trial, the real magnetic susseptibility value of chromite ore is accepted as K=0.0017 emu, but after trial, it was seen that the graph obtained, did not fit in to bell-like anomaly, which was obtained from (L-M) cross-section of field measurement.

Than for the same shape, different susseptibility values (0.0019, 0.0022, 0.0024 emu) were tried, but still «fit in» graph could not have been obtained (Fig. 9B, 10B, 11B). Later on, imagined ore shape was changed and 6 cornered shape in different coordinate and position were tried with different k values.

At the end of 73 trials, the most probable ore shape and the most «f it in» position were obtained (Fig. 17 A,B).

According to this final ore shape, the probable ore, with 85 m. depth and roughly 30 m. width, situated roughly 15 m. from surface level.

Table 1 - The real susseptibility value of chromite samples, which were collected from örnek ocak area

MAGNETIC SUSSEPTIBILITY TABLE

M.A.G. 617
City: TUNCELİ **Town: Pülümür** **Subdistrict or village : Karagöl - Bağırbaba**

Sample location		*Instrumental measurments*				*Apparent density*			*True density*						*True Susсept.*
Station no. V. Y. Coordinates	*No.*	*Background* (R_1)	*Measurment* (R_2)	*The difference* R_1-R_2=ΔR *ohm*	*Apparent Suscept.* K-6 10	*M* (ρv)	*Va* (cm³)	*Da* (ρv/cm³)	*M* (ρv)	*Vm* (cm³)	*Dm* (ρv/cm³)	$\frac{Dm}{Da}$	$fi=\frac{1.413}{d^2}$	$fd=\frac{2.413}{d^2}$	$K=Ka\frac{Dm}{Da}$ C.G.S.
43.70.050															
0.01.400	41	10803	10603	200	714		45			24		1.875			1891.65
43.71.100															
6.02.086	63 A	10803	10626	177	631.89		40			21		1.90			1696.43
» »	63 B	10803	10577	226	805.82		42			21		2.00			2280.07
» »	63 C	10803	10547	256	913.92		39			20		1.95			2518.16
» »	63 D	10803	10656	147	524.79		43			22		2.047			1517.90

Tunceli Pülümür

Point	*X*	*Z*	*V*
1	0	52	—5.00000E+002
2	10	47	—5.20000E+002
3	25	40	—4.30000E+002
4	37	35	—2.00000E+002
5	50	30	3.00000E+001
6	69	23	2.00000E+002
7	81	22	5.00000E+001
8	90	21	—2.00000E+002
9	100	21	—3.50000E+002
10	115	17	—4.10000E+002
11	130	10	—3.00000E+002

F = 46500
A = 58
C = 40
B = 2

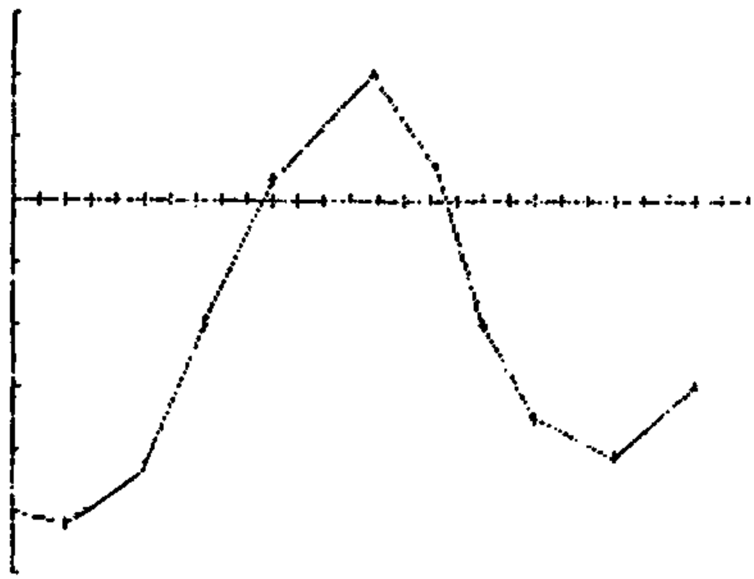


Fig. 2 - Bell-like anomaly from the section (L-M) was drawn with the help of 11 points by micro computer.

DISCUSSIONS AND RESULTS

The main weakness of the suggested method is that not being managed to prove it with drillings. The studied vicinity's concession right belong to private bodies and naturally managed by them, therefore neither TÜBİTAK, nor any other relevant goverment establishment, such as MTA, Etibank, would have beenable to support these suggested drillings. Besides, it was seen very difficult to persuade private miners for such heavy investment.

A part of this main weakness, there is another important point was that, surrounding host-rock interference, either positive or negative direction was not being able to calculated in the computer programme. But even than, it was found quite useful to try as it is.

After working some other places with the same method and seeing the result of drillings, than ore can search, in what condition and how, the surrounding rocks magnetic susseptibility interference, add or deduct from calculation in the computer programme.

Besides all, one must be careful, while collecting hand samples. Naturally more sample collection would improve the sensitivity of the results, whieh would be obtained at the laboratory.

Susseptibility measurement should be repeat as much as one can, in order to minimize faulty measurement probability.

During the magnetic susseptibility analysis, samples were grinded into a rice and/or cracked-wheat size, than measurement took place. But, samples can be grinded in to a different mesh size and compare the results respectively. Finally, if all results would have come out to be affirmative to the present method, it can be said that, in the studied part of the searched area, some 85 m. depth, and roughly 30 m. width chromite deposit was detected. Even the" thickness of ore is accepted only as 10 m. and tenore of chromite is accepted as 40-42 % Cr_2O_3, than roughly 50.000 tons of pure chromite supposed to be found. If one would like to find out exact thickness of ore, instead of 10 m. estimation, than should try to prepare topographic and magnetic cross-sections very close to (L-M) section, and do exactly same process for each.

As it is known, that for the time being in Turkey, either government managed mining companies or rich private companies have computer facilities, so that it is worth to try this type of advance work before drillings, in order to spare time and money.

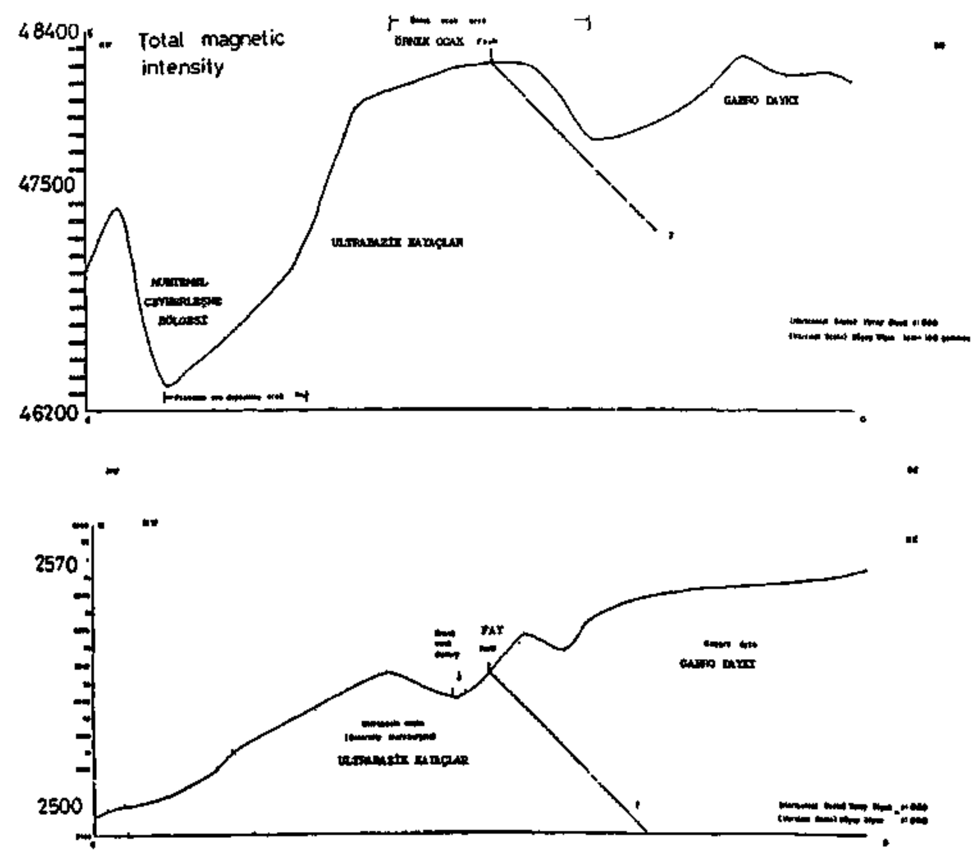


Fig. 3 - The cross-section (C-D).

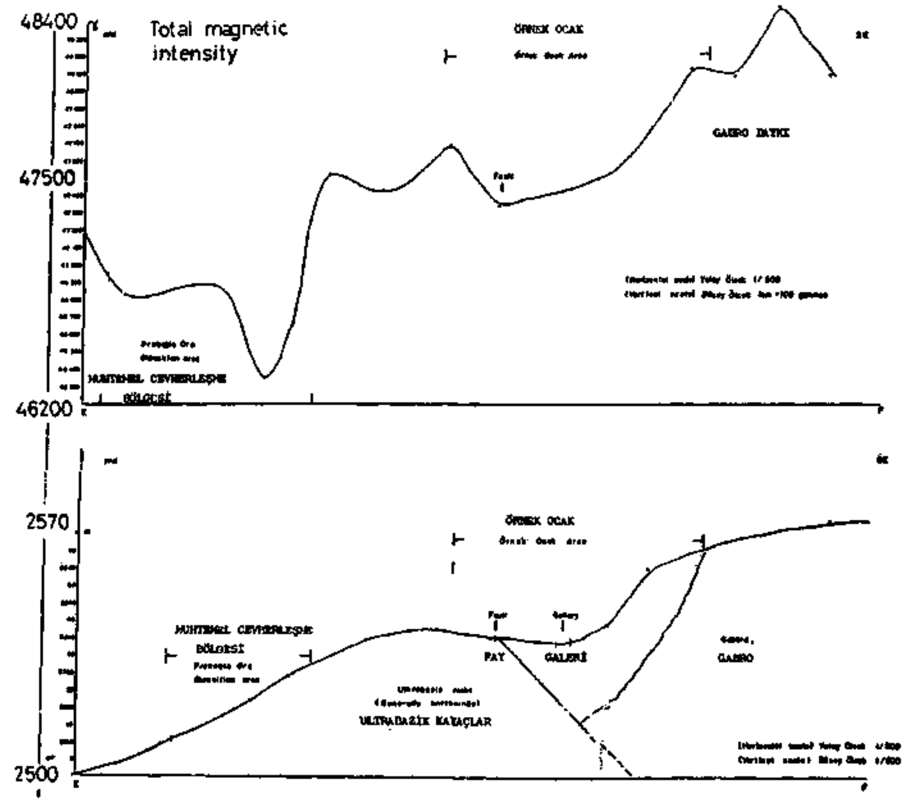


Fig. 4 - The cross-section (E-F).

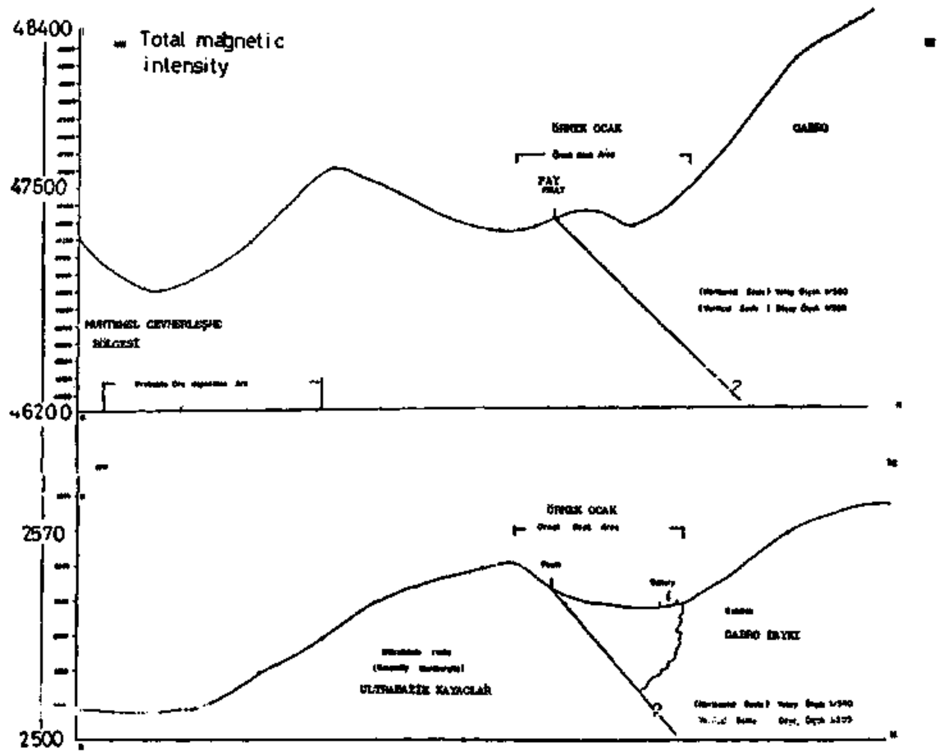


Fig. 5 - The cross-section (G-H).

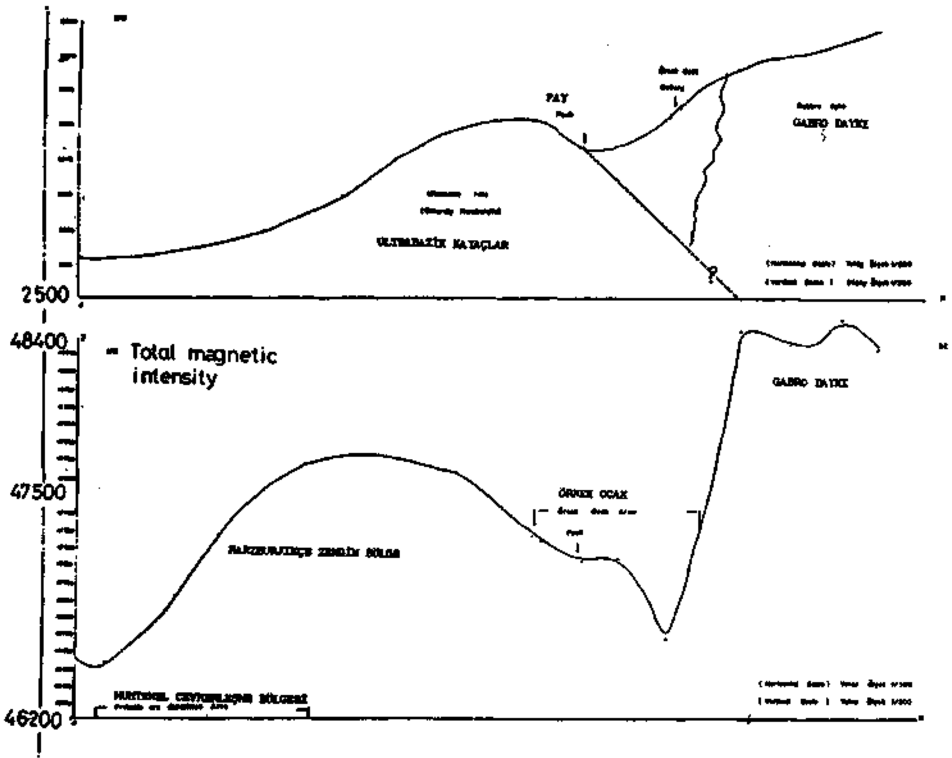


Fig. 6 - The cross-section (J-K).

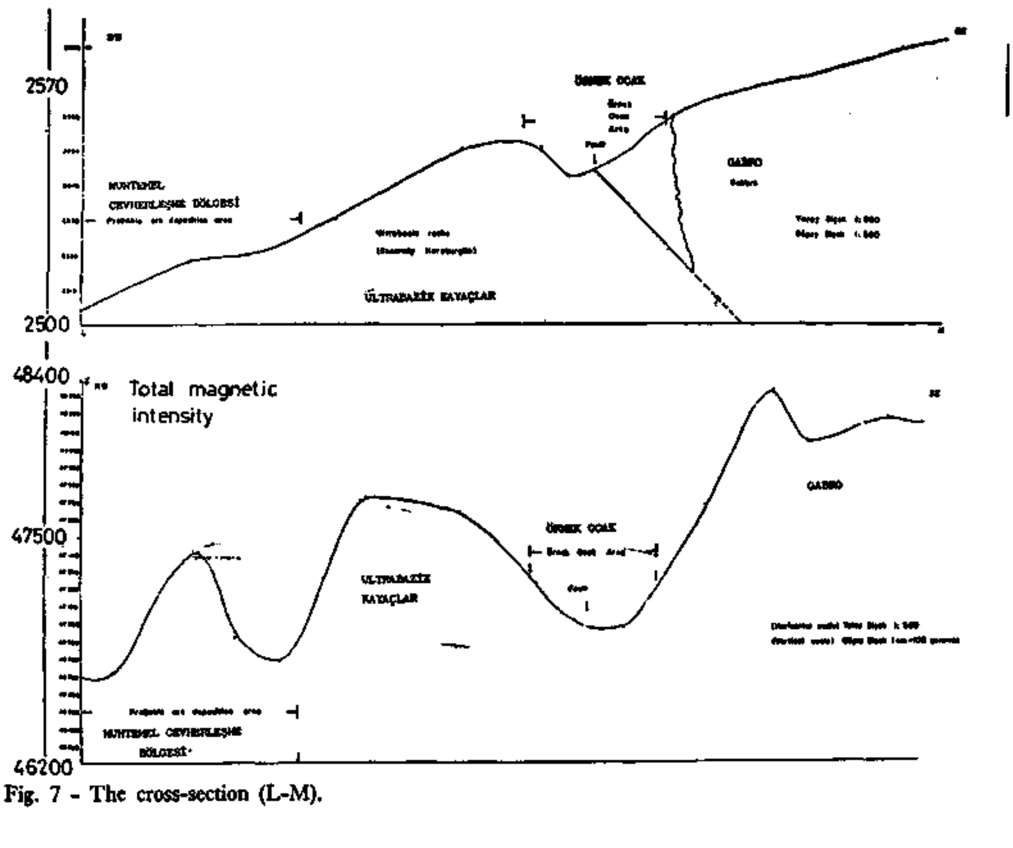


Fig. 7 - The cross-section (L-M).

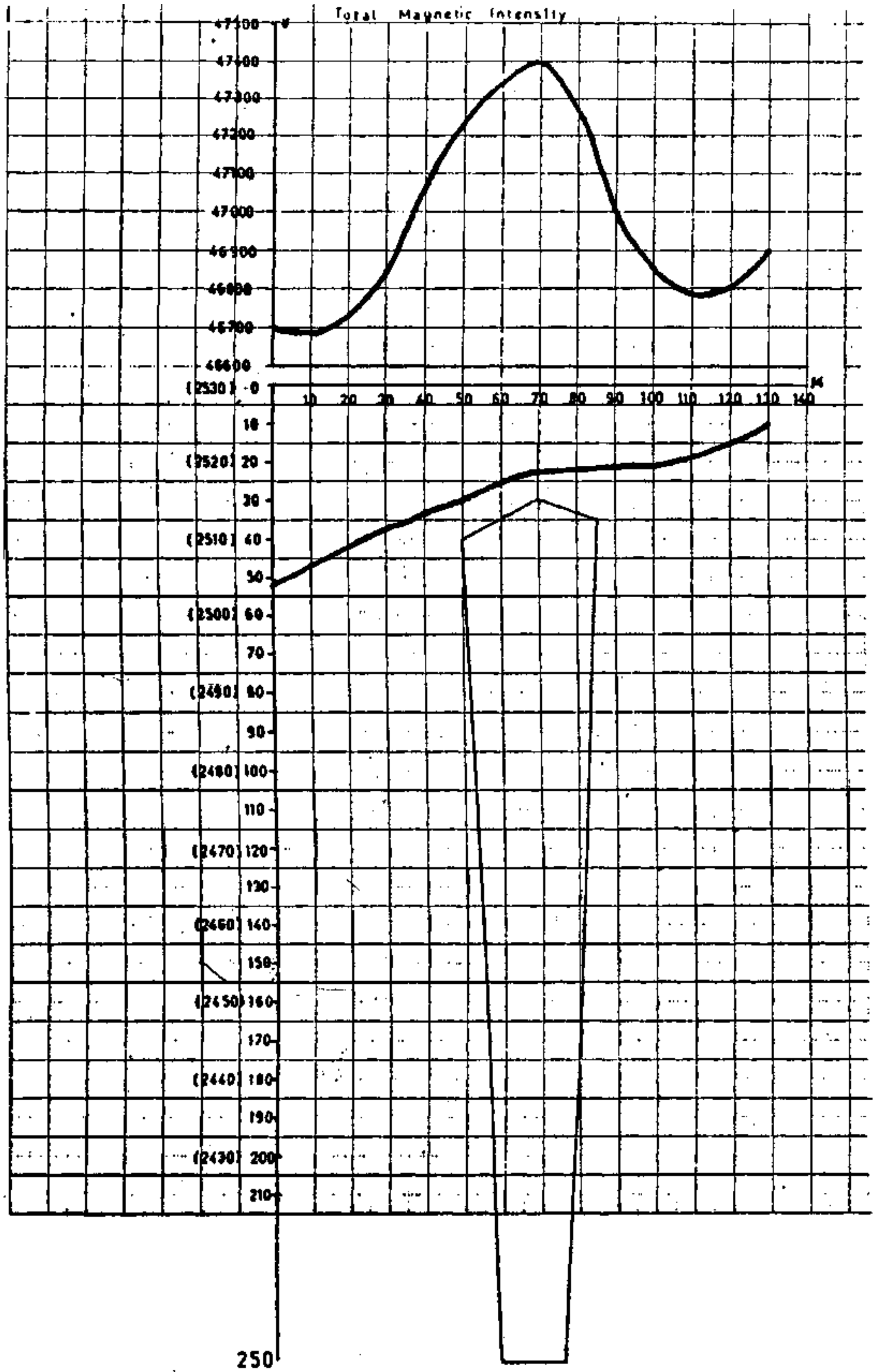


Fig. 8A - The first suggested ore shape.

K= 0.0017

Corner numbers of the polygon : 5

Corner coordinates of the polygon

Corner no.	Coordinates
1	(70,30)
2	(50 , 40)
3	(60 , 250)
4	(75 , 250)
5	(85 , 35)

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Magnetic anomaly calculation of tuwo dimensional prisms by Talwani method

I	*X*	*Z*	*T*
Point no.	*Horizontal distance*		*Calculated gamma values*
1	0	32	—4.35878E+001
2	10	47	—4.65745E+001
3	25	40	—4.82039E+001
4	37	35	—3.26673E+001
5	50	30	1.01703E+002
6	69	23	2.87616E+002
7	81	22	1.83513E+002
8	90	21	8.48207E+001
9	100	21	2.77355E+001
10	115	17	6.11447E+000
11	170	10	1.87876E+000

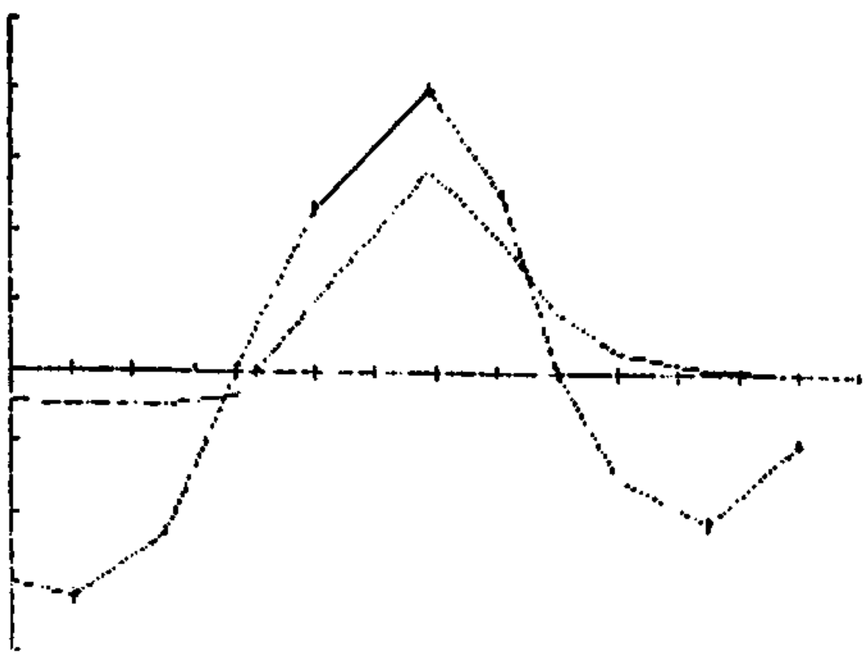

Fig. 8B - The graph is drawn by microcomputer with the help of shape 8 A and K=0.0017 emu real susseptibility value of chromite sample.

K = 0.0019
Corner numbers of the polygon : 5
Corner coordinates of the polygon

Corner no.	*Coordinates*
1	(70 , 30)
2	(50 , 40)
3	(60 , 250)
4	(75 , 250)
5	(85 , 35)

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Magnetic anomaly calculation of two dimensional prisms by Talwani method

I Point no.	*X*	*Z* Horizontal distance	*T* Calculated gamma values
1	0	52	—4.87158E+001
2	10	47	—5.20539E+001
3	25	40	—5.38750E+001
4	37	35	—3.65329E+001
5	30	30	1.13668E+002
6	69	23	3.20782E+002
7	81	22	2.05103E+002
8	90	21	8.47996E+001
9	100	21	3.09985E+001
10	115	17	6.83382E+000
11	130	10	2.09980E+000

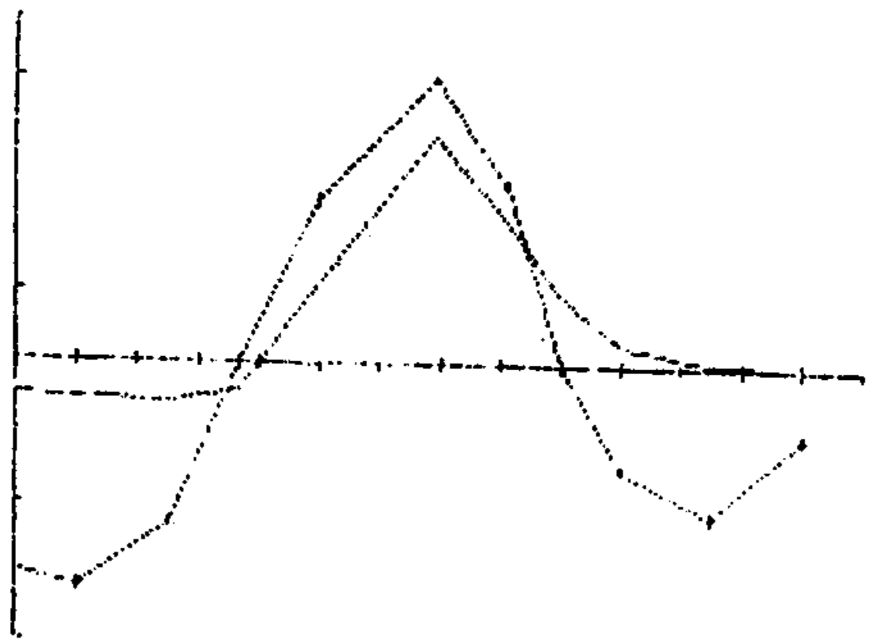

Fig. 9B - The graph is drawn by microcomputer with the help of shape 8 A and K=0.0019 emu real susseptibility value of chromite sample.

K = 0.0022
Corner numbers of the polygon : 5
Corner coordinates of the polygon

Corner no.	*Coordinates*
1	(70 , 30)
2	(50 , 40)
3	(60 , 250)
4	(75 , 250)
5	(85 , 35)

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Magnetic anomaly calculation of two dimensional prisms by Talwani method

I	*X*	*Z*	*T*
Point no.	*Horizontal*	*distance*	*Calculated gamma values*
1	0	52	—5.64077E+001
2	10	47	—6.02729E+001
3	25	40	—6.23816E+001
4	37	35	—4.23012E+001
5	50	30	1.31616E+002
6	69	23	3.71432E+002
7	81	22	2.37487E+002
8	90	21	1.09768E+002
9	100	21	3.68930E+001
10	115	17	7.91284E+000
11	130	10	2.43134E+000

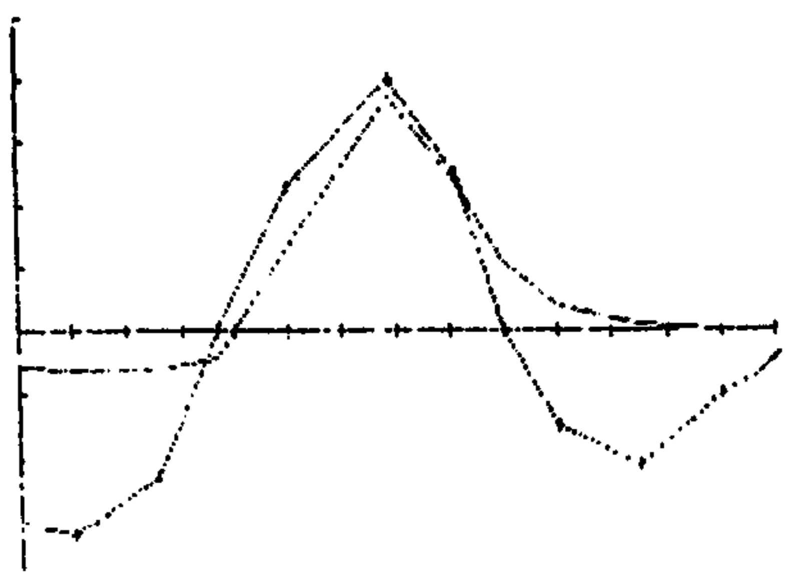

Fig. 10B - The graph is design by microcomputer with the help of shape 8 A and K=0.0022 emu real susseptibility value of chromite sample.

K = 0.0024
Corner numbers of the polygon : 5
Corner coordinates of the polygon

Corner no.	*Coordinates*
1	(70 , 30)
2	(50 , 40)
3	(60 , 250)
4	(75 , 250)
5	(85 , 35)

Corner no.	*Coordinates*
1	(70 , 30)
2	(50 , 40)
3	(60 , 250)
4	(75 , 250)
5	(85 , 35)

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Magnetic anomaly calculation of two dimensional prisms by Talwani method

I Point no.	*X* Horizontal	*Z* distance	*T* Calculated gamma values
1	0	52	—6.15357E+001
2	10	47	—6.57522E+001
3	25	40	—6.80526E+001
4	37	35	—4.61468E+001
5	50	30	1.43581E+002
6	69	23	4.05198E+002
7	31	22	2.59077E+002
8	90	21	1.19747E+002
9	100	21	3.91560E+001
10	115	17	8.63219E+000
11	130	10	2.65237E+000

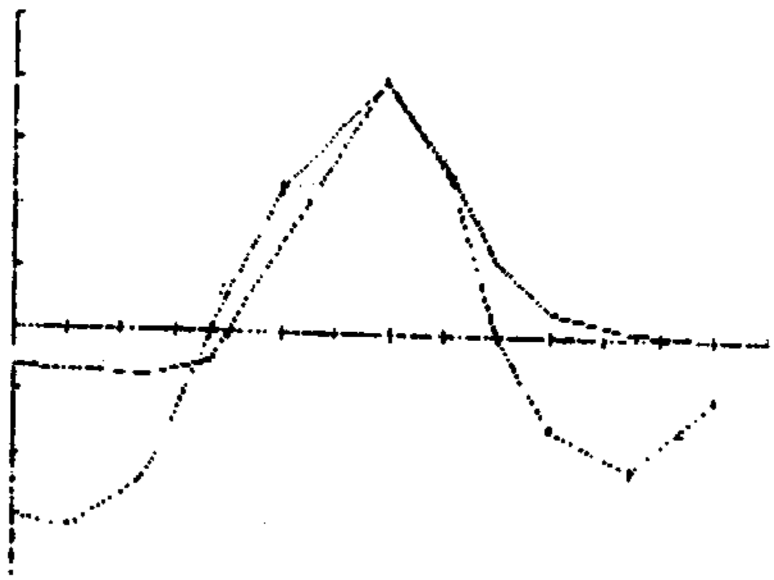

Fig. 11B - The graph is drawn oy microcomputer with the help of shape 8 A and K=0.0024 emu real susseptibility value of chromite sample.

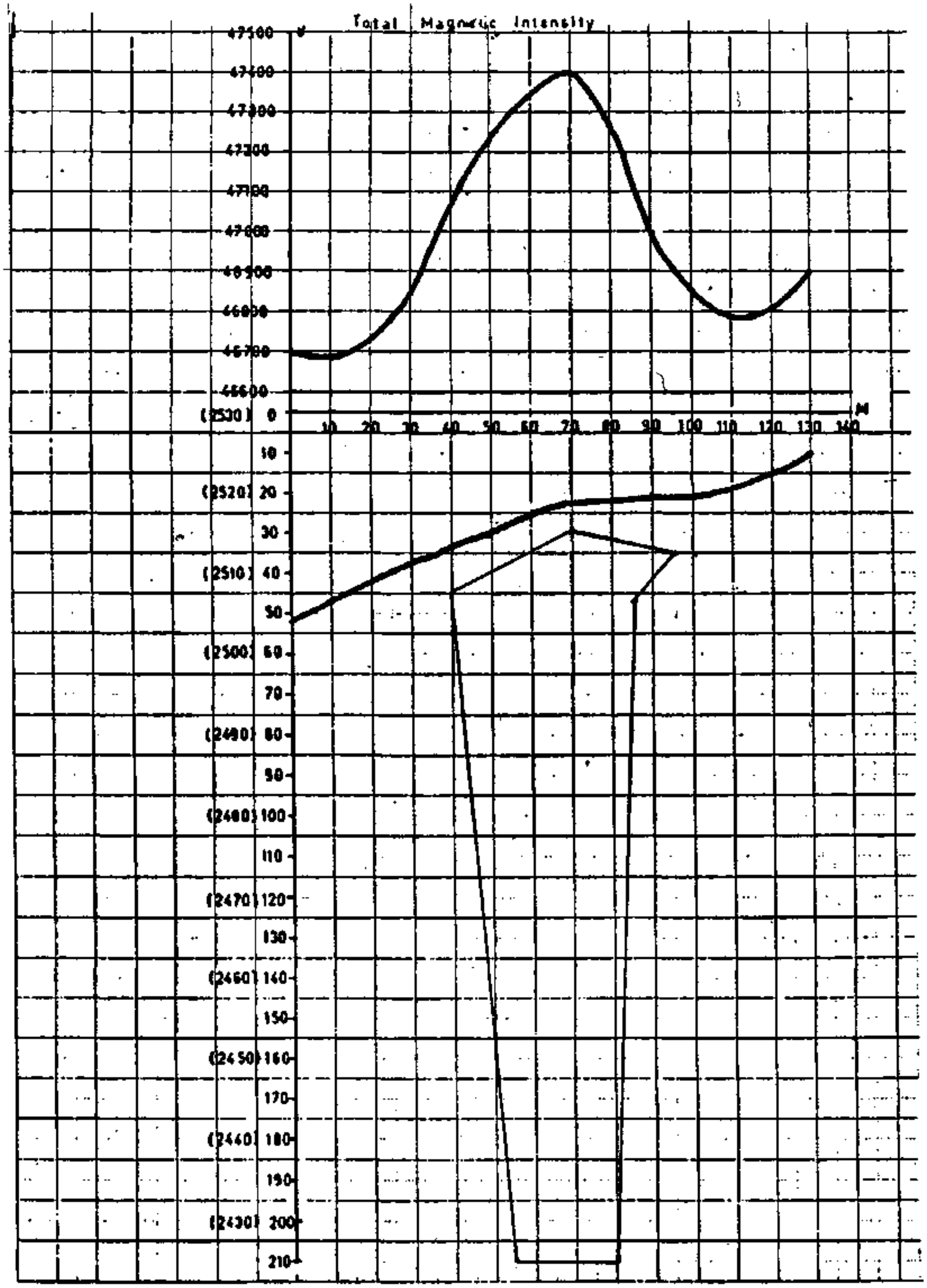

Fig. 12A - The new suggested ore shape.

K = 0.0025
Corner numbers of the polygon : 6
Corner coordinates of the polygon

Corner no.	*Coordinates*
1	(70 , 30)
2	(40 , 45)
3	(55 , 210)
4	(80 , 210)
5	(85 , 47)
6	(95 , 35)

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Magnetic anomaly calculation of two dimensional prisms by Talwani method

I Point no.	*X* Horizontal	*Z* distance	*T* Calculated gamma values
1	0	52	—9.58305E+001
2	10	47	—1.02363E+002
3	25	40	—9.11875E+001
4	37	35	3.86762E+001
5	50	30	2.64409E+002
6	69	23	4.48427E+002
7	81	22	3.35426E+002
8	90	21	1.86521E+002
9	100	21	5.49421E+001
10	115	17	4.03052E+000
11	130	10	—1.85880E+000

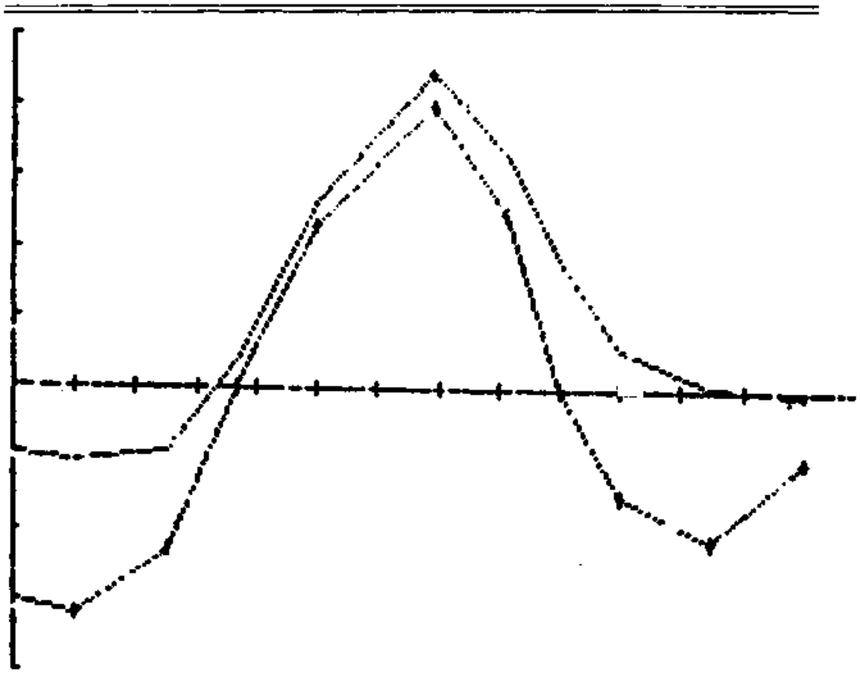

Fig. 12B - The graph is drawn by microcomputer with the help of shape 12 A and K=0.0025 emu the real susceptibility value of chromite sample.

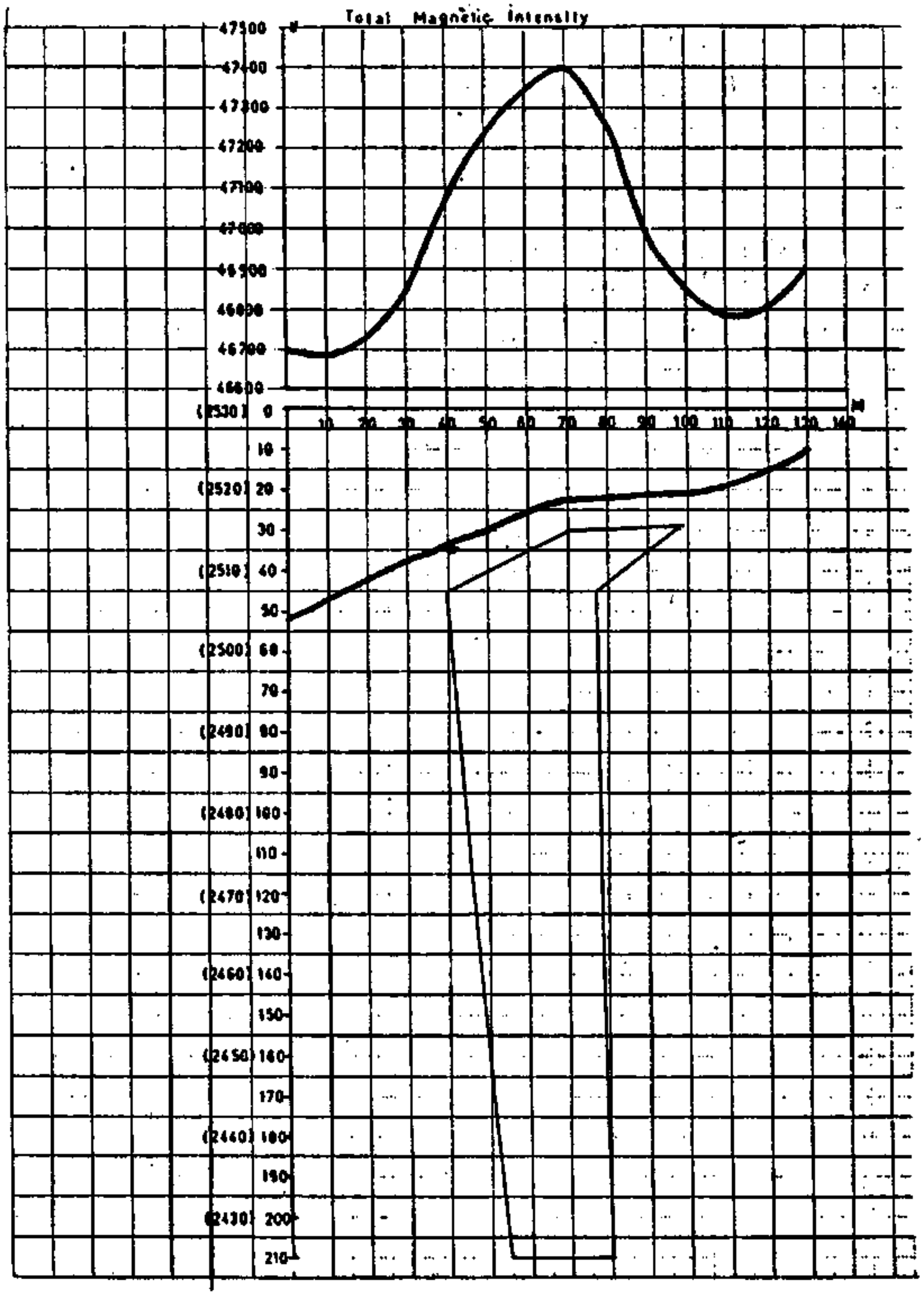

Fig. 13A - The suggested ore shape.

K = 0.0025

Corner coordinates of the polygon

Corner no.	*Coordinates*
1	(70 , 30)
2	(40 , 45)
3	(55 , 210)
4	(80 , 210)
5	(77 , 45)
6	(98 , 29)

Tunceli Pülümür

Magnetic anomaly calculation of two dimensional prisms by Talwani method

I Point no.	*X* Horizontal	*Z* distance	*T* Calculated gamma values
1	0	52	—8.58624E+001
2	10	47	—9.19589E+001
3	25	40	—8.16611E+001
4	37	35	4.44529E+001
5	50	30	2.56747E+002
6	69	23	3.94203E+002
7	81	22	3.11761E+002
8	90	21	1.77768E+002
9	100	21	1.97633E+001
10	115	17	—1.10789E+001
11	130	10	—7.34844E+000

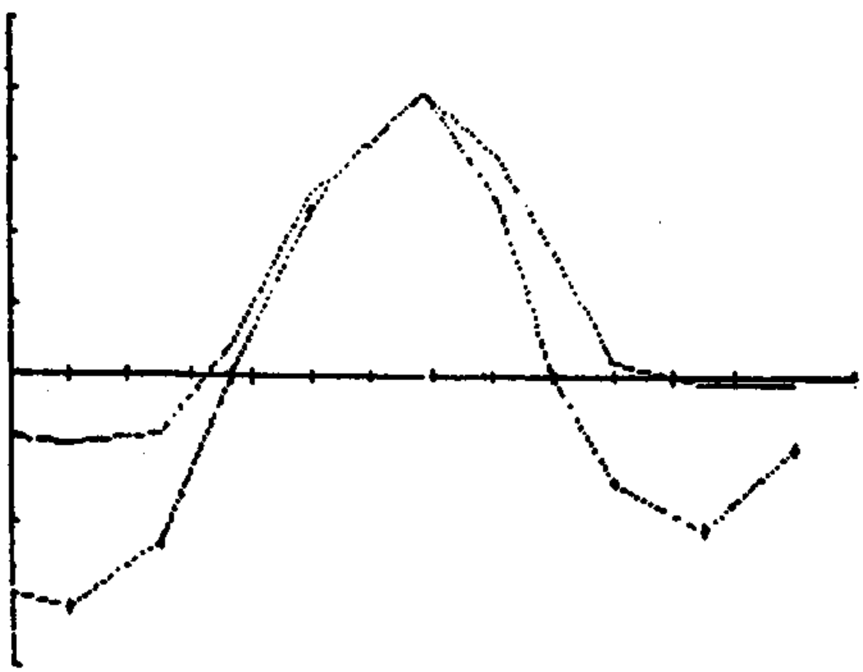

Fig. 13B - The graph is drawn by microcomputer with the help of shape 13 A and K=0.0025 emu the real susseptibility value of chromite sample.

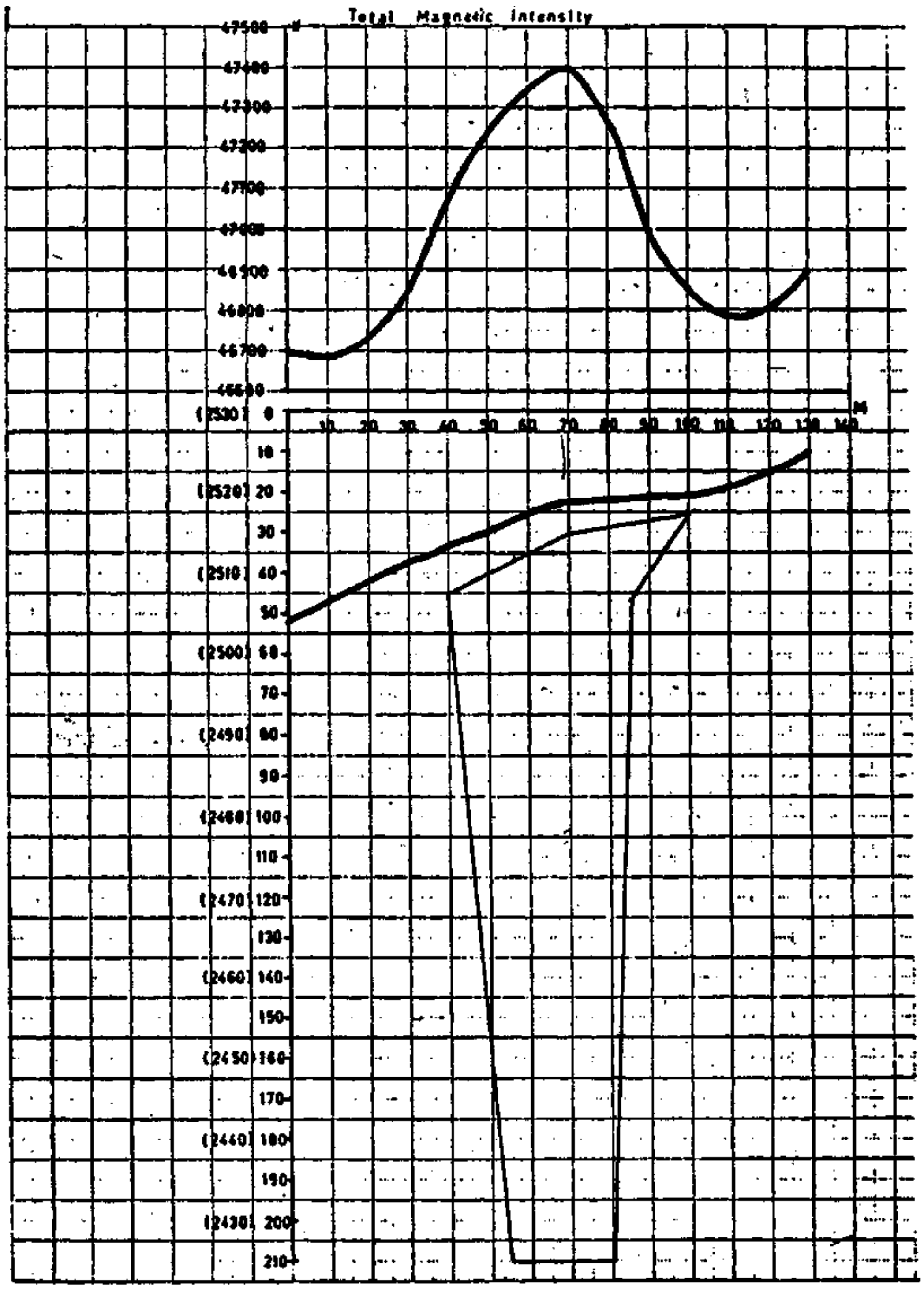

Fig. 14A - The suggested ore shape.

K = 0.0025
Corner numbers of the polygon : 6
Corner coordinates of the polygon

Corner no.	*Coordinates*
1	(70 , 30)
2	(40 , 45)
3	(55 , 210)
4	(80 , 210)
5	(85 , 47)
6	(100 , 25)

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Magnetic anomaly calculation of two dimensional prisms by Talwani method

I	*X*	*Z*	*T*
Point no.	*Horizontal*	*distance*	*Calculated gamma values*
1	0	52	—9.85706E+001
2	10	47	—1.05905E+002
3	25	40	—9.71108E+001
4	37	35	2.88970E+001
5	50	30	2.44920E+002
6	69	23	4.13660E+002
7	81	22	4.09930E+002
8	90	21	3.27209E+002
9	105	21	8.33651E+001
10	115	17	—1.46027E+001
11	130	10	—9.40075E+000

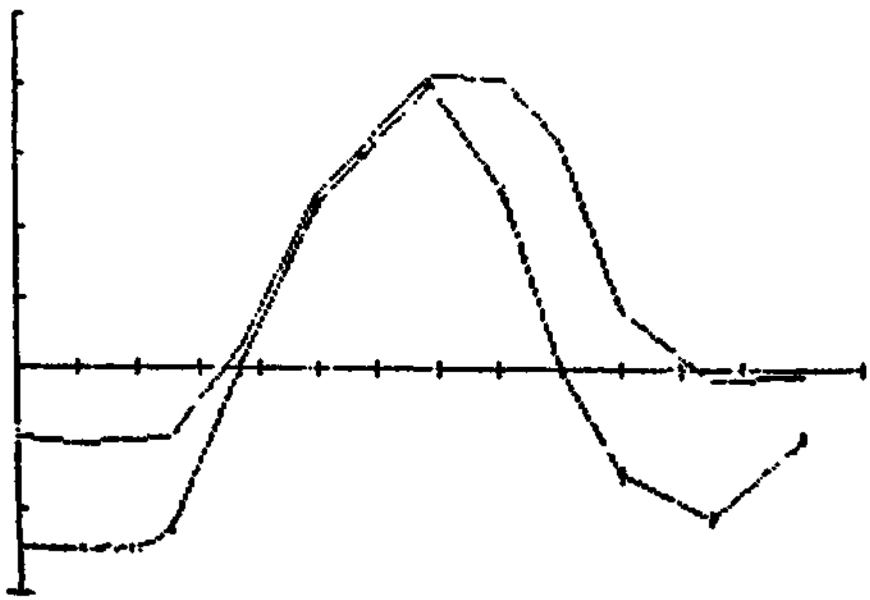

Fig. 14B - The graph is drawn by microcomputer with the help of shape 14 A and K=0.0025 emu the real sussceptibility value of chromite sample.

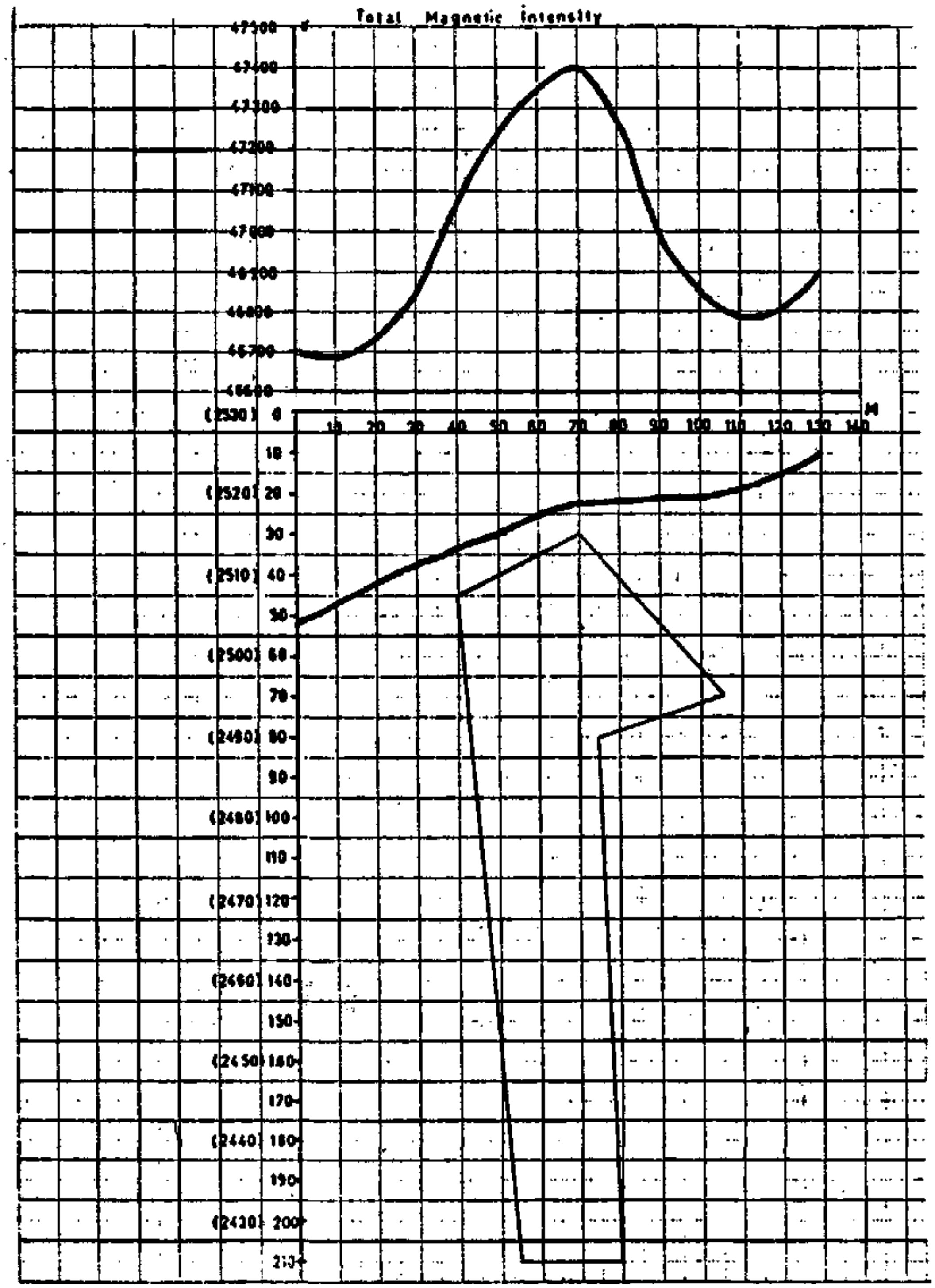

Fig. 15A - The suggested ore shape.

K = 0.0025
Corner numbers of the polygon : 6
Corner coordinates of the polygon

Corner no.	*Coordinates*
1	(70 , 30)
2	(40 , 45)
3	(55 , 210)
4	(80 , 210)
5	(75 , 80)
6	(105 , 70)

Tunceli Pülümür
Magnetic anomaly calculation of two dimensional prisms by Talwani Method

I Point no.	*X*	*Z* Horizontal distance	*T* Calculated gamma values
1	0	52	—9.47469E+001
2	10	47	—1.02405E+002
3	25	40	—9.23563E+001
4	37	35	4.00534E+001
5	50	30	2.79975E+002
6	69	23	4.26836E+002
7	81	22	2.33643E+002
8	90	21	1.34899E+002
9	100	21	6.59235E+001
10	115	17	1.82314E+001
11	130	10	3.35604E+000

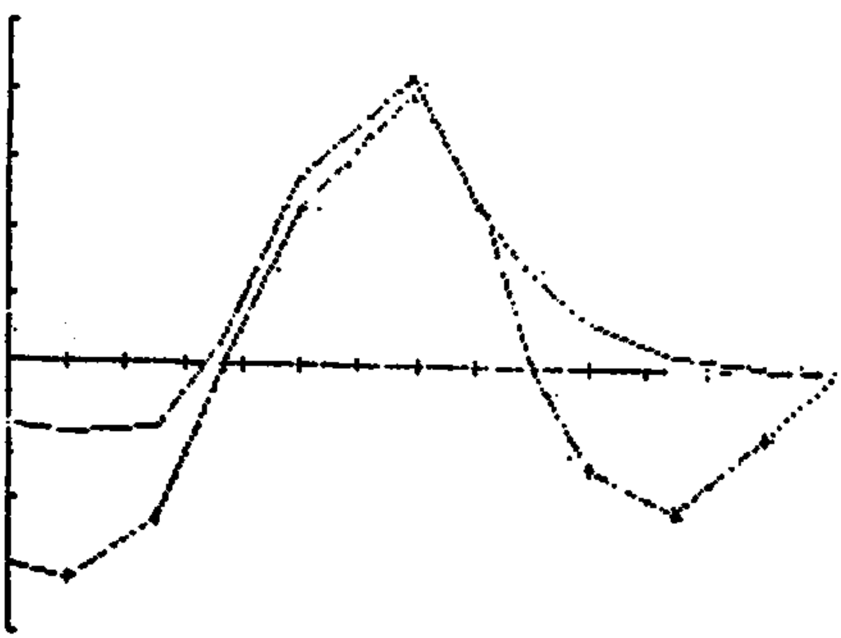

Fig. 15B - The graph is drawn by microcomputer with the help of shape 15 A and K=0.0025 emu the real susseptibility value of chromite sample.

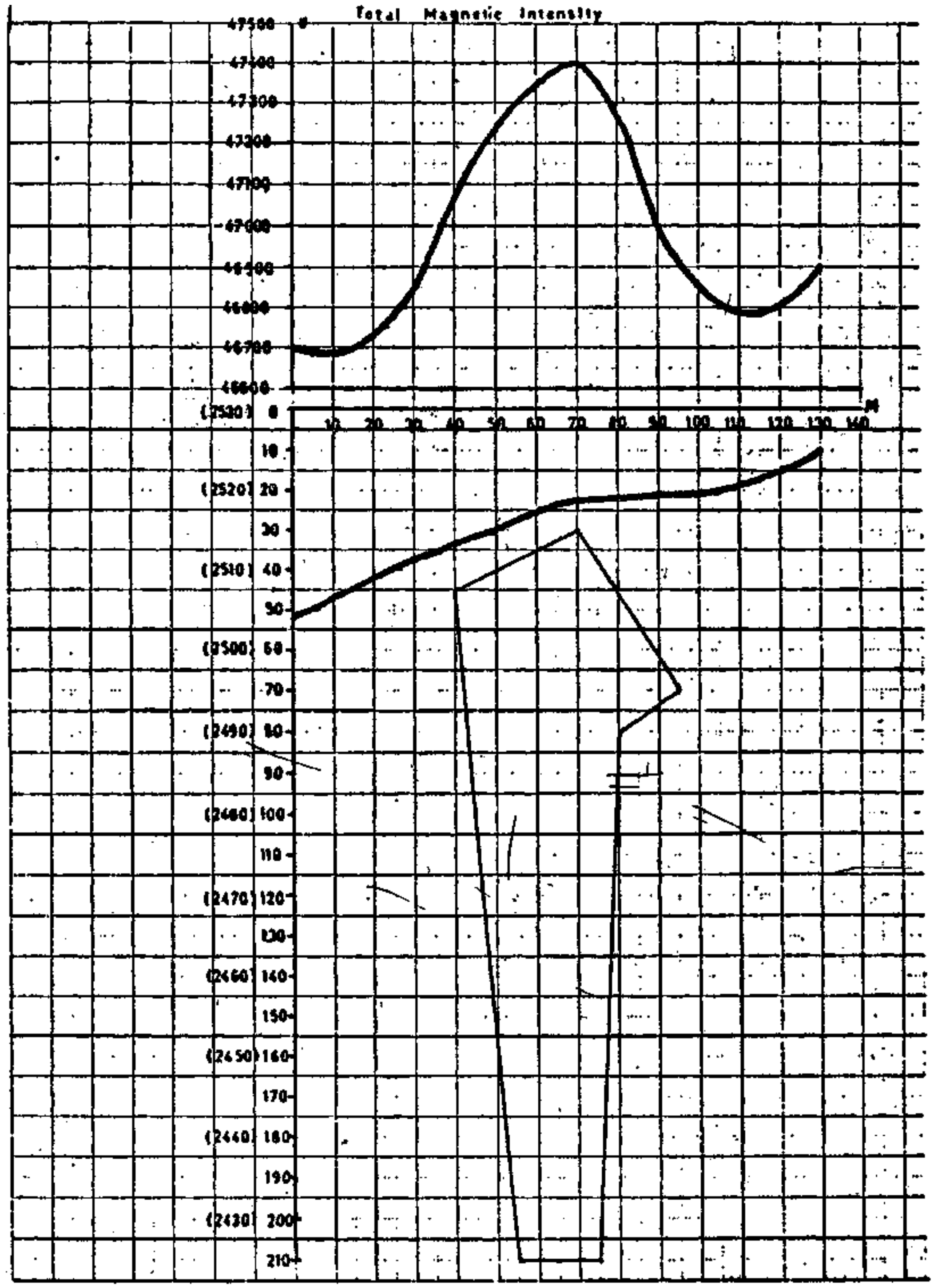

Fig. 16A - The suggested ore shape.

K = 0.0025

Corner numbers of the polygon : 6

Corner coordinates of the polygon

Corner no.	*Coordinates*
1	(70 , 30)
2	(40 , 45)
3	(55 , 210)
4	(75 , 210)
5	(80 , 80)
6	(95 , 75)

Tunceli Pülümür

Magnetik anomaly calculation of two dimensional prisms by Talwani method

I Point no.	*X*	*Z*	*T* Calculated gamma values
	Horizontal	*distance*	
1	0	52	—9.08993E+001
2	10	47	—9.65380E+001
3	25	40	—8.19111E+001
4	37	35	5.51905E+001
5	50	30	2.97188E+002
6	69	23	3.99885E+002
7	81	22	1.90296E+002
8	90	21	1.03186E+002
9	100	21	4.71294E+00
10	115	17	1.28561E+001
11	130	10	2.49310E+000

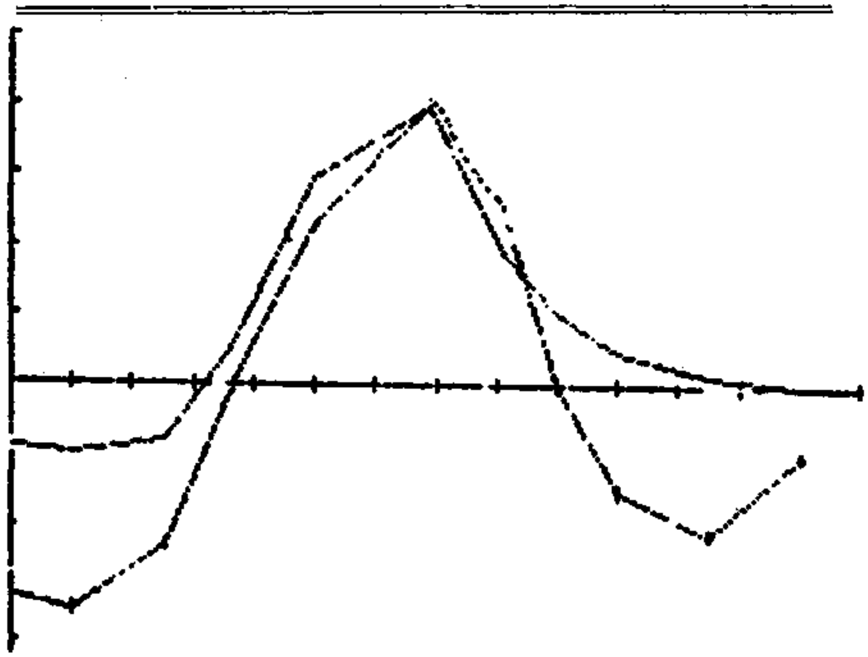

Fig. 16b - The graph is drawn by microcomputer with the help of shape 16 A and K=0.0025 emu the real susseptibility value of chromite sample.

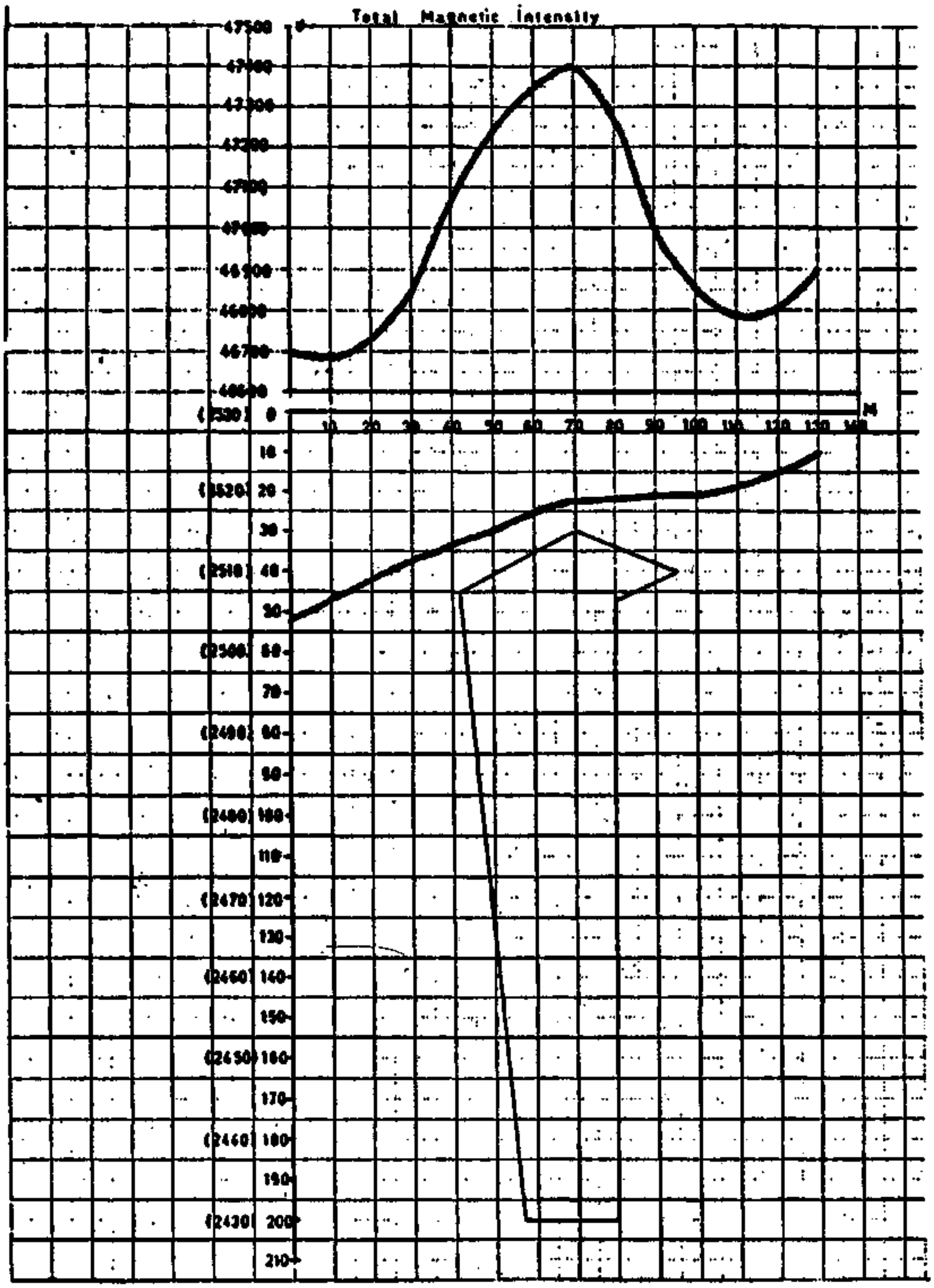

Fig. 17A - The most ideal ore shape which is found after 73 trial.

K = 0.0024

Corner numbers of the polygon : 6

Corner coordinates of the polygon

Corner no.	*Coordinates*
1	(70 , 30)
2	(42 , 45)
3	(57 , 200)
4	(80 , 200)
5	(80 , 47)
6	(95 , 40)

Tunceli Pülümür

Magnetic anomaly calculation of two dimensional prisms by Talwani method

I	*X*	*Z*	*T*
Point no.	*Horizontal distance*		*Calculated gamma values*
1	0	52	—8.09269E+001
2	10	47	—8.67043E+001
3	25	40	—8.00498E+001
4	37	35	1.37344E+001
5	50	30	2.27617E+002
6	69	23	4.01627E+002
7	81	22	2.50349E+002
8	90	21	1.22763E+002
9	100	21	3.41601E+001
10	115	17	5.04258E+001
11	130	10	—3.13139E+000

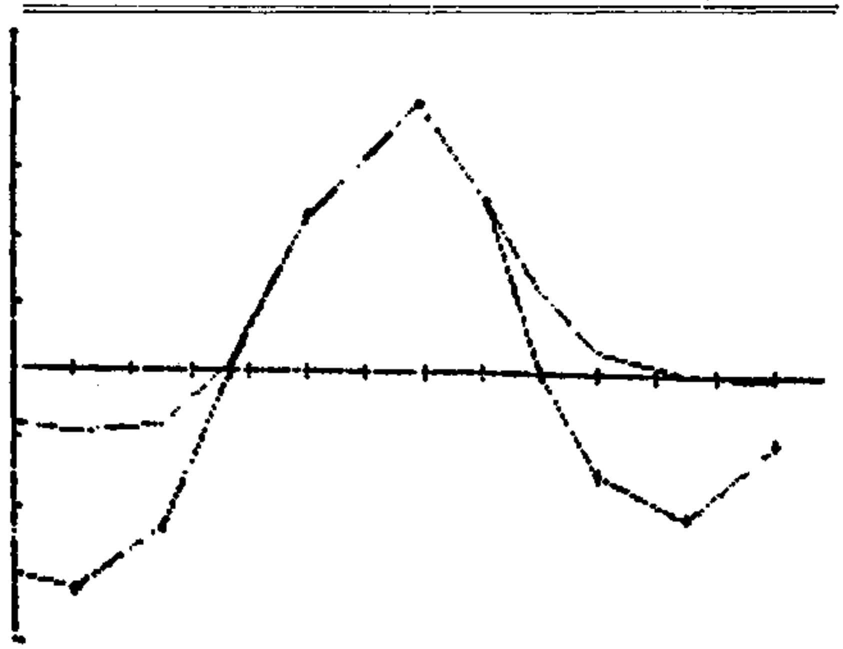

Fig. 17B - The graph is drawn by microcomputer with the help of the most ideal shape 17 A and K=0.0024 emu the real susseptibility value of chromite sample.

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