ELIMINATION OF SLAG AND GALLERY EFFECTS FROM THE SELF POTENTIAL MEASUREMENTS BY MEANS • OF FINITE DIFFERENCES, RELAXATION AND EMPIRICAL METHODS*

SONLU FARKLAR, RÖLÂKSASTON VE AMPÎRÎK METODLARLA CÜRUF VE GALERİLERİN SELF POTANSİTEL TESİRLERİNİN HESAPLANMASI

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ÖZET,— Cüruf ve asitli galerilerin self potansiyel **tevlit** ettikleri malûmdur, Bunların mevcut olduğu maden, bölgelerinde elde edilen self potansiyel **anomalilerinin** tefsiri gayri hassas ve bazan da imkânsız olmaktadır, Bu iki tesirin total anomaliden çıkarılarak geri kalan kısmının tefsiri **icabetmektedir.**

Bu iki tesirin hesaplanması için sonlu farklar- metodu inkişaf ettirilmiş ve **Gırlak** Maden Bölgesinde (Tirebolu) beş galeri muvacehesinde yapılan self potansiyel etüdüne tatbik edilmiştir. Galerilerin **sınırlarında** ölçülen **değerlerden** başlanarak^ elde edilen lineer **aljebrik** denklemler rölâksasyon metodu ile halledilmiştir, Meydana çıkan **tashihli** self potansiyel haritasında **ekipotansiyel** konturların daha düzgün olduğu ve **maksimumların** birleştiği görülmüştür.

Ayrıca, cüruf tesirini hesaplamağa yarayan ve arazi ölçüleriyle **ampirik** olarak tâyin edilebilen bir «cüruf **duble** momenti» **formülü** istihraç edilmiş"ve bunun yön tonaj ve bakır tenörü ile değişmesi incelenmiştir.

INTRODUCTION

İt is **well** known that **the** existence of slag heaps and galleries containing acid waters, near sulphide deposits/ make It extremely **difficult,** If not **impossible,** to Interpret **the** self potential measurements .taken around them. This is **due** to **the** generation of self potentials by the slags and wet galleries, having -magnitudes of **the** same order as those given.- by the deposit itself, **Hence,** the elimination of such effects from the total anomaly is essential **for** an intelligible interpretation of the **total** anomaly.

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The problem of elimination of these effects is attacked in two ways :

1. By the method of finite differences with the resulting linear equations solved by relaxation methods,

2. By an empirical method of finding the self potential moment of the slag or gallery and thereby proceeding to the calculation of the spurious effect.

1 — METHOD OF FINITE DIFFERENCES

In this method the differential equation is replaced by an approximating difference equation and the region by a set of discrete points. This permits one to reduce the problem to the solution of systems of algebraic equations, which may involve hundreds of unknowns. Then relaxation methods could be applied to solve these equations.

Let us suppose that the potential values V at the boundary of the slag heap and the gallery are measured and therefore known, In the neighborhood of any interior point of the medium enclosing the gallery or slag (taken, for the moment, as the origin of coordinates), we can write

$$V(x,y) = V_0 + a_{10}x + a_{01}y + a_{20}x^2 + a_{02}y^2 + a_{11}xy + \ldots,$$

$$= \sum_{i=0}^{\infty}\sum_{j=0}^{\infty} a_{ij}\, x^i y^j$$

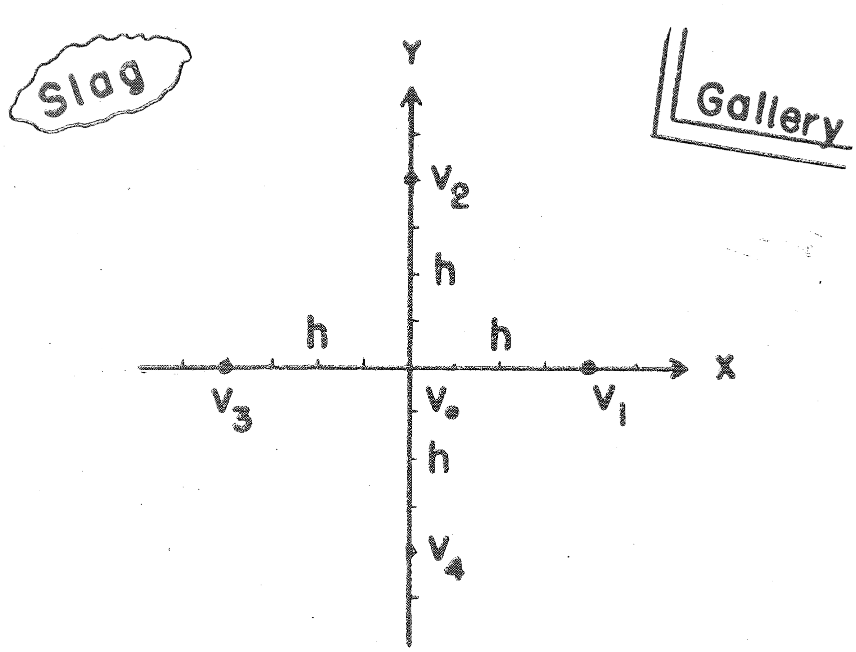


Fig. 1

the value of the function Y at the origin is

$$V(0,0) - V_{,,} - a_{00}$$

while at the neighboring net points to the left and right,, one has (see Fig« 1), - • .

$$V. = V(h,0) = \overset{eo}{Z} \text{ aioh*} = V_o + a_{lo} h + a_{20} h^2 + \ldots$$

$$V_g = V(-b,0) = V_o - a_{10} h + a_{20} h^2 + \ldots\ldots$$

and

$$V_l + V_3 - 2 V_o + 2 a_{30} h^s + 2 a_{40} h^* + \ldots\ldots$$

$$V_2 + V_4 - 2 V_o + 2 a_{02} h^* + 2 a_{04} h^* + \ldots\ldots$$

Since the value of the Laplacian at the origin is

$$(V^a V)_0 - 2 a_{20} + 2 a_{02?}$$

one can write

• — - — - ^ - -_^ ^ - - i — _ _ ! . = = $(V^2 V)_0$ + terms in *W*,

As the choice of the origin is not essential to the argument above$_a$ the foregoing expression relates $\nabla^2 V$ at any point to the value of V at that point and to the neighboring values. We drop the terms in h^2 and replace the Laplace differential equation \72y_0 by the Laplace difference equation

$$V(x + h,y) + V(x - h,y) + V(x,y + h) + V(x,y - h) \\ - 4V(x,y)=O$$

or

i.e. the value of V_5 at any point outside the gallery or slag is the mean of its values at the four immediate neighboring points.

If the problem is 3 dimensional, as shown in Fig, 2_3 the value of V due to the gallery and slag will be the mean of 6 neighboring points. If the required point is at the surface*, one of the points in the z direction will be in the air where $V = O_5$ therefore the 6 points will be reduced to 5.

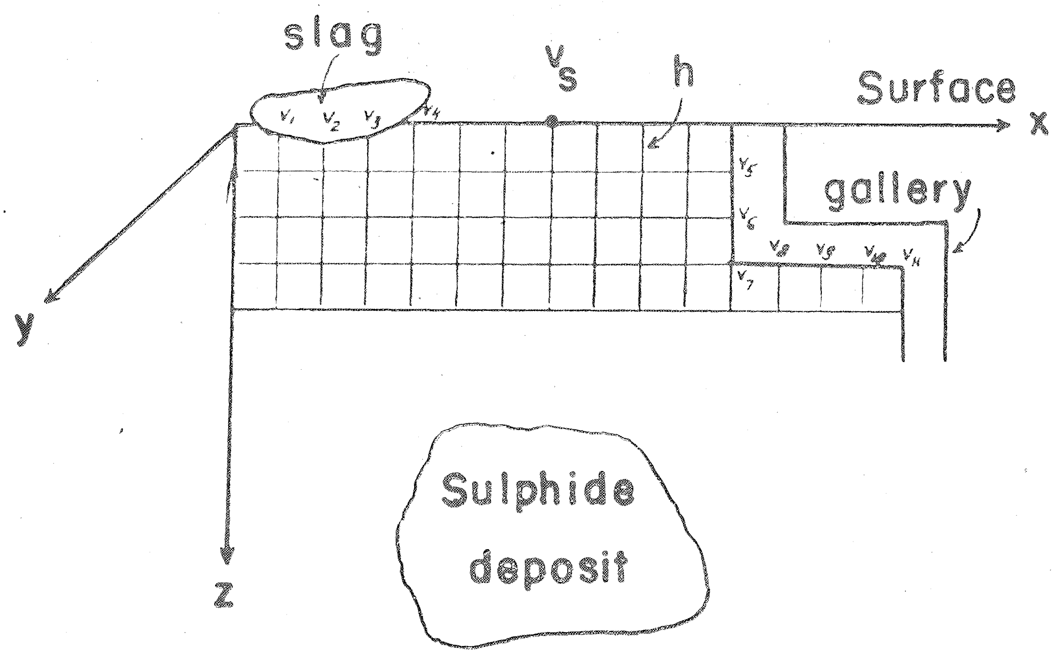


Fig. 2

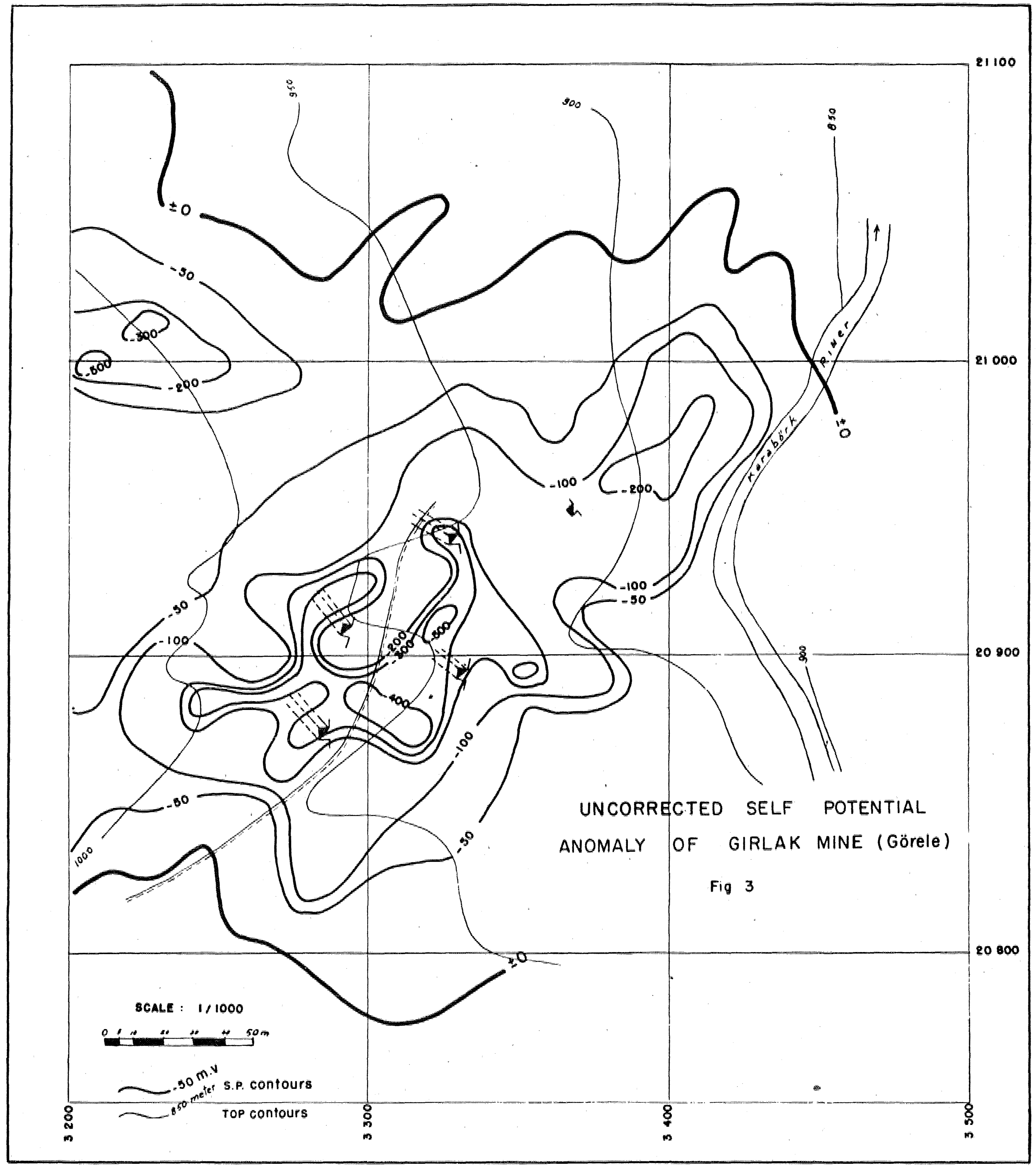
Procedure for calculation

As shown in Fig, 2^ the potential values in the gallery and at the boundary of the slag are measured (V_v V_2 9Sffl) and starting from these known values, linear algebraic equations relating to the 5 - point mean values are written. Applying the relaxation methods^ these equations can be solved with ease and the effects of the gallery and the slag at the surface (Vs) are obtained. Subtracting this from the total anomaly, the anomaly due solely to the sulphide deposit can be obtained,

A il example

This method was applied to clear the effect of the galleries in the Girlak Mine District (Tirebolu)$_5$ where the galleries containing acid waters produced self potential with the result of distorting the equipotential surface-lines. Fig, 3 shows the total anomaly^ including both the effects of the deposit and the gallery. It is seen that the equipotential lines are buckled badly, due to the effect of 5 galleries.

In Fig$_s$ 4j the effect of the galleries is eliminated by the finite differences method as outlined above« The figures on Fig. 4, show the corrected S.P. values. The corrected S.P. contours run more


UNCORRECTED SELF POTENTIAL
ANOMALY OF GIRLAK MINE (Görele)
Fig 3
SCALE : 1/1000
0 50m
-50 m.V S.P. contours
850 meter TOP contours
Karabörk River
21 100
21 000
20 900
20 800
3 200
3 300
3 400
3 500
±0
-50
-100
-200
-300
-400
-500
950
900
850
1000

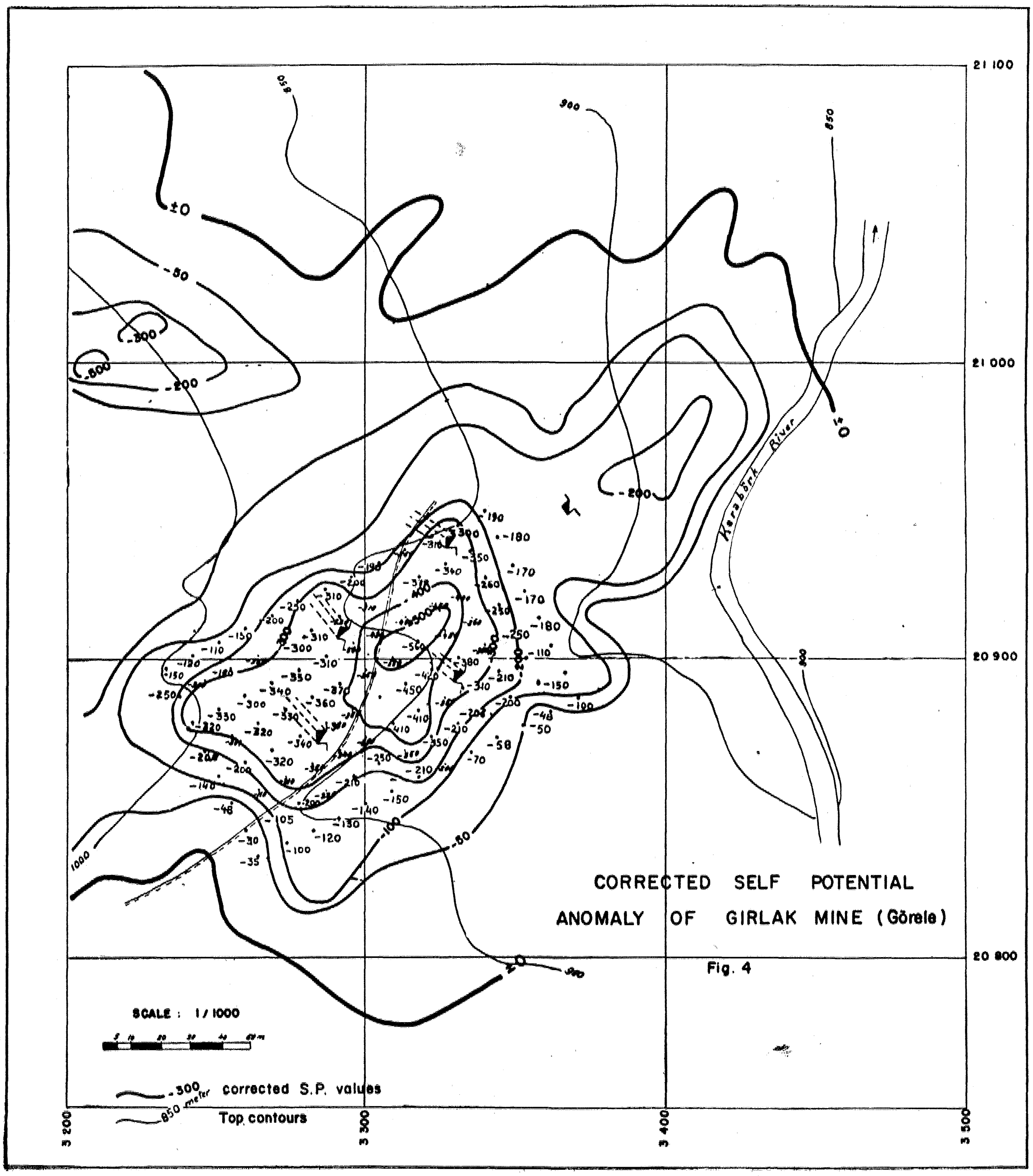

CORRECTED SELF POTENTIAL
ANOMALY OF GIRLAK MINE (Görele)
Karabörk River
SCALE : 1/1000
-300 corrected S.P. values
850 meter Top contours
21 100
21 000
20 900
20 800
3 200
3 300
3 400
3 500

Fig. 4

smoothly and the **400** m,v. contour runs around the 500 m.v. contour« In the **unconnected** mapf these 2 contours were closed apart from each other,

2 — EMPIRICAL METHOD

This method Is applied to find a. quantity called the **«moment** of slag- doublet» by which the approximate effect of the slag could be calculated.

Let us suppose that the heap of slag Is not elongated or **sheet-like,** but has 3 dimensions comparable with each **othei,** and assume that it has finite number of poles localised at some zone at **its** edges, This is actually the case as seen from Fig, 6, **Then,** as seen **from** Fig. **5,**

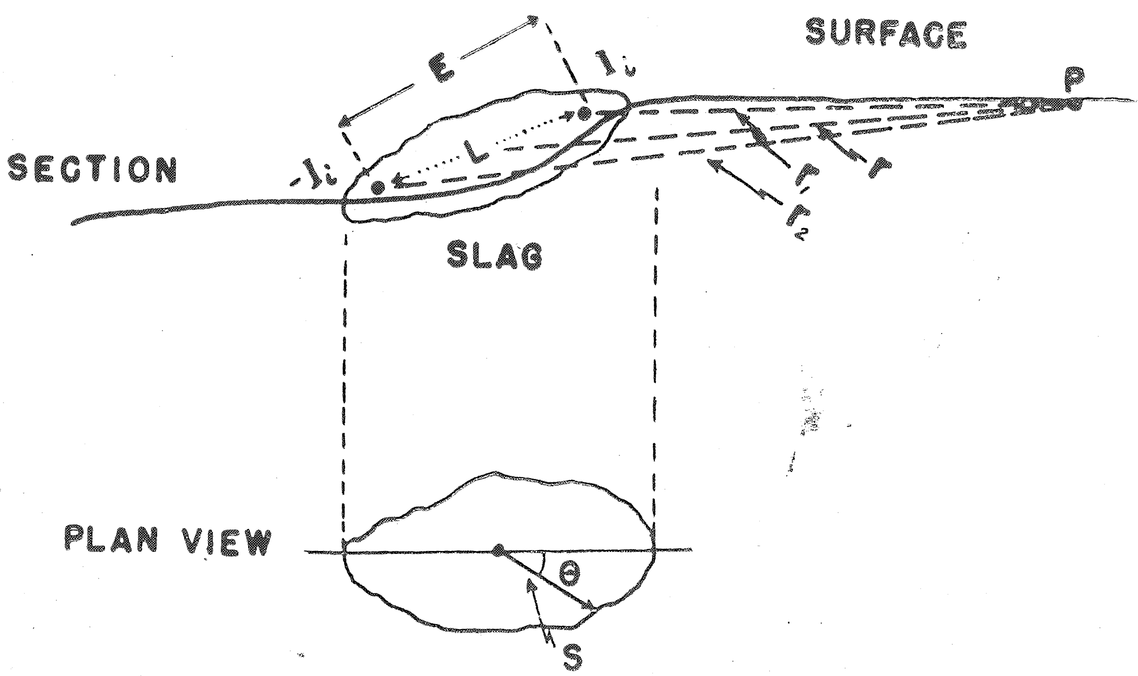


Fig. 5

$$\frac{I}{2\pi r_1^2} = -\frac{I}{\rho}\cdot\frac{dv}{dr_1} \qquad V = \frac{\rho I}{2\pi r_1}$$

where : I is the current source for each pole,

ρ the resistivity of the country rock.

The potential at F,-

Y» pı r - ' v f i * • L

Mi - - ^ Li

where Mi is defined as the slag moment per doublet« The total slag **moment** due to all the doublets would be approximately

n o n

if **the** dimensions of the slag heap are nearly the same (L)5

M ,-'- L Zl°

n
J£ Ii _-T where 1 is the total slag current»

M = — L

if the **maximum** voltage on the slag is E, then the potentia Vs at the boundary of the slag is :

vT _^_„ ff'~\ —— where f(("o) is a. function of
h ~: 2 ^J S2 the angle as shown in Fig. 5,

therefore

E
M = - o " • f(0)' S^

Since —^— f("v) and S can be directly measured, M can b(

calculated. This quantity, in **turn,** can be used to calculate the effect of the slag at the required point«

A number of • **measurements** were made on different **sla£** heaps in Tirebolu area., with a view to studying ı

a) The variation of the quantity ~r~~ * f (CO) with the **direc tion,**

b) The change of the total slag moment with the quantity of **slag,**

c) The variation of the total slag moment with the coppe; content of the slag,

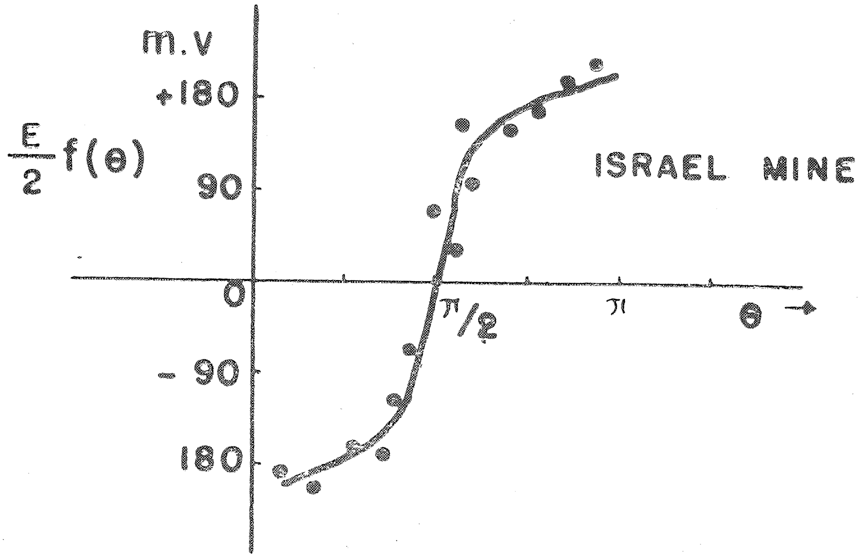


Fig. 6

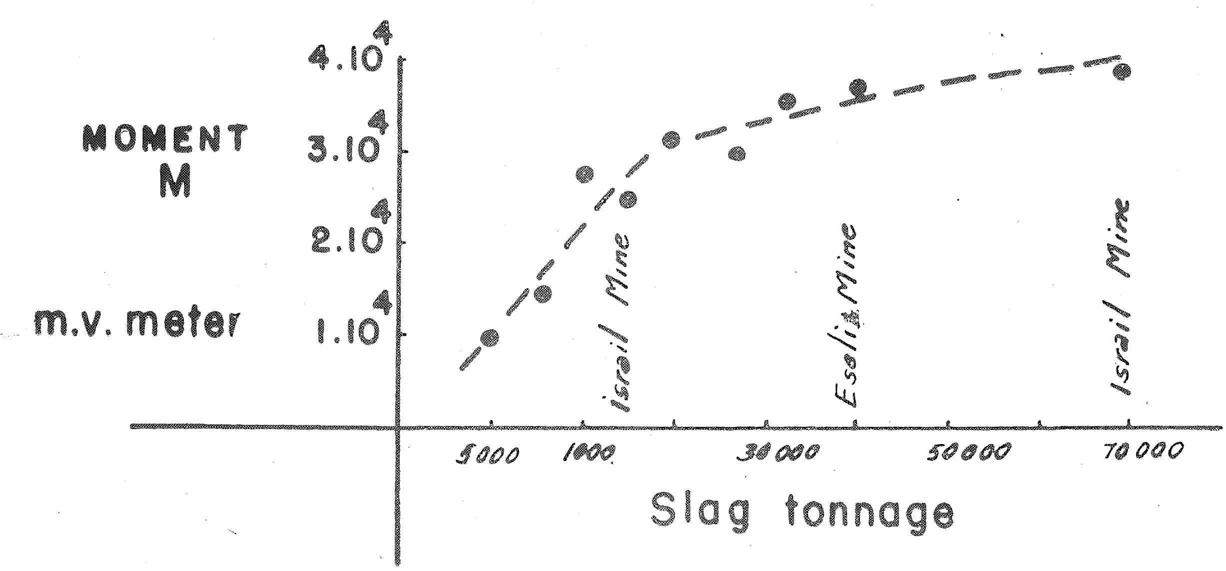


Fig. 7

These are shown In **Fig,** 6, 7 and 8. It is seen from Fig, 6, that **the** potential at the slag boundary is **continuous,** but the poles are localised within a small angular space. This justifies the summing of moments« Fig, 7_5 shows that the total slag moment increases very rapidly up to 20,000 tons, then the rate of variation, decreases appreciably.

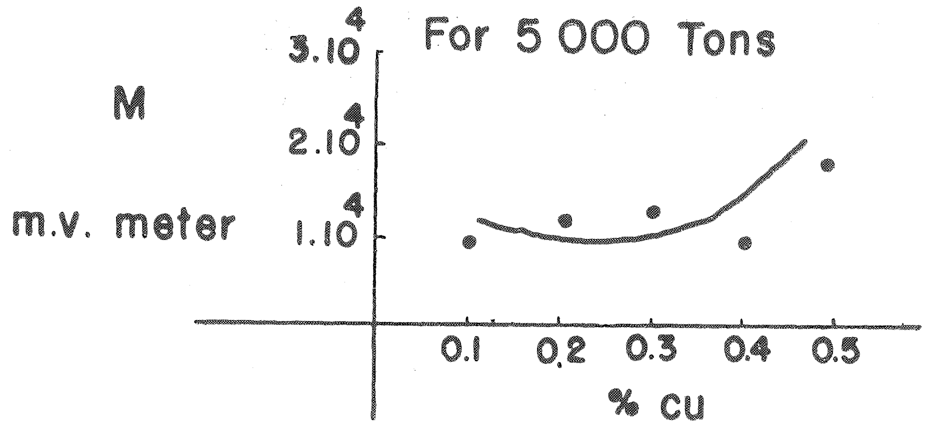


Fig. 8

The variation of the slag moment with the copper content, as shown in Fig, 8, docs not seem to change appreciably up to 0,5 % Cu. .

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REFERENCES

LIEBMANNs G, (1950): Solution of partial differential equations with a resistance network analogue, *British Journal of Applied Physics^* .V. 1, pp. 92 -103«

SOUTHWELL, R. V. (1940) : Relaxation methods In engineering science« *Oxford\ Clarendon Press,*

SOUTHWELL^ R« V. (1946) : Relaxation methods in theoretical physics. *Oxford\ Clarendon. Press.*

H. JEFFREYS, B. S. Jeffreys (1946) : Methods of mathematical physics, *Cambridge^. University Press.*