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

SONLU FARKLAR, RÖLÂKSASYON VE AMPİRİK 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

$$V\ (x,y) = V_0 + a_{10}\ x + a_{01}\ y + a_{20}\ x^2 + a_{02}\ y^2 + a_{11}\ xy + \ldots$$
$$= \sum_{i=0}^{\infty} \sum_{j=0}^{\infty} a_{ij}\ x^i\ y^j$$

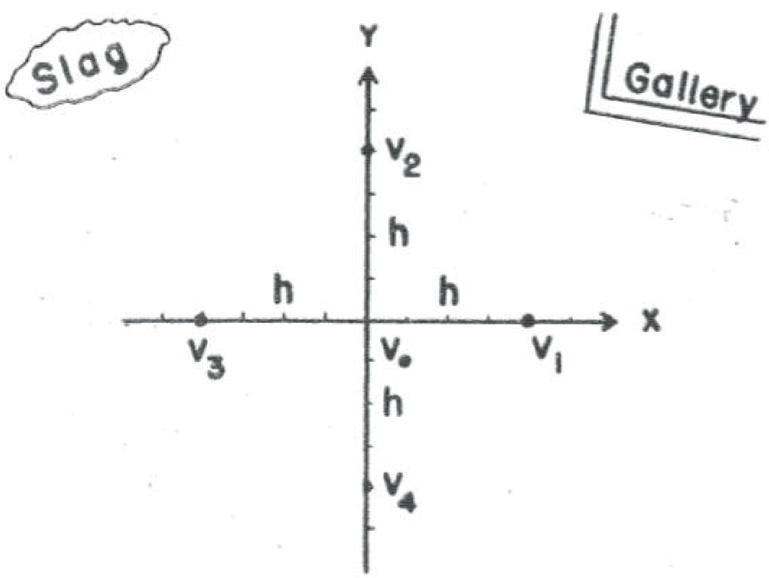


Fig. 1

the value of the function V at the origin is

$$V(0,0) = V_0 = a_{00}$$

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

$$V_1 = V(h,0) = \sum_{i=0}^{\infty} a_{i0}\, h^i = V_0 + a_{10}\, h + a_{20}\, h^2 + \dots$$

$$V_3 = V(-h,0) = V_0 - a_{10}\, h + a_{20}\, h^2 + \dots\dots\dots$$

and

$$V_1 + V_3 = 2\, V_0 + 2\, a_{20}\, h^2 + 2\, a_{40}\, h^4 + \dots\dots\dots$$

$$V_2 + V_4 = 2\, V_0 + 2\, a_{02}\, h^2 + 2\, a_{04}\, h^4 + \dots\dots\dots$$

Since the value of the Laplacian at the origin is

$$(\nabla^2 V)_0 = 2\, a_{20} + 2\, a_{02},$$

one can write

$$\frac{V_1 + V_2 + V_3 + V_4 - 4\, V_0}{h^2} = (\nabla^2 V)_0 + \text{terms in } h^2.$$

As the choice of the origin is not essential to the argument abovea the foregoing expression relates ^2V 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

$\nabla^2 V = O$ by the Laplace difference equation

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

or

$$V_0 = \frac{V_1 + V_2 + V_3 + V_4}{4}$$

i.e. the value of V, 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, 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, therefore the 6 points will be reduced to 5.

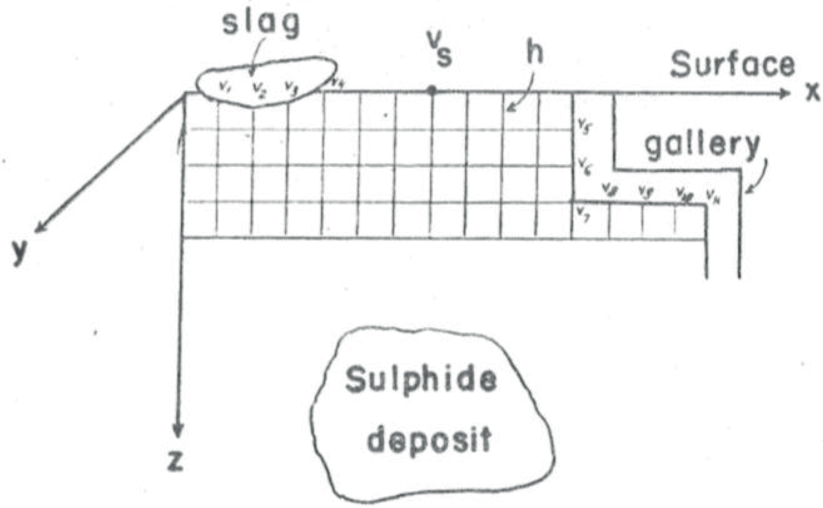


Fig. 2

Procedure for ca1cu1ation

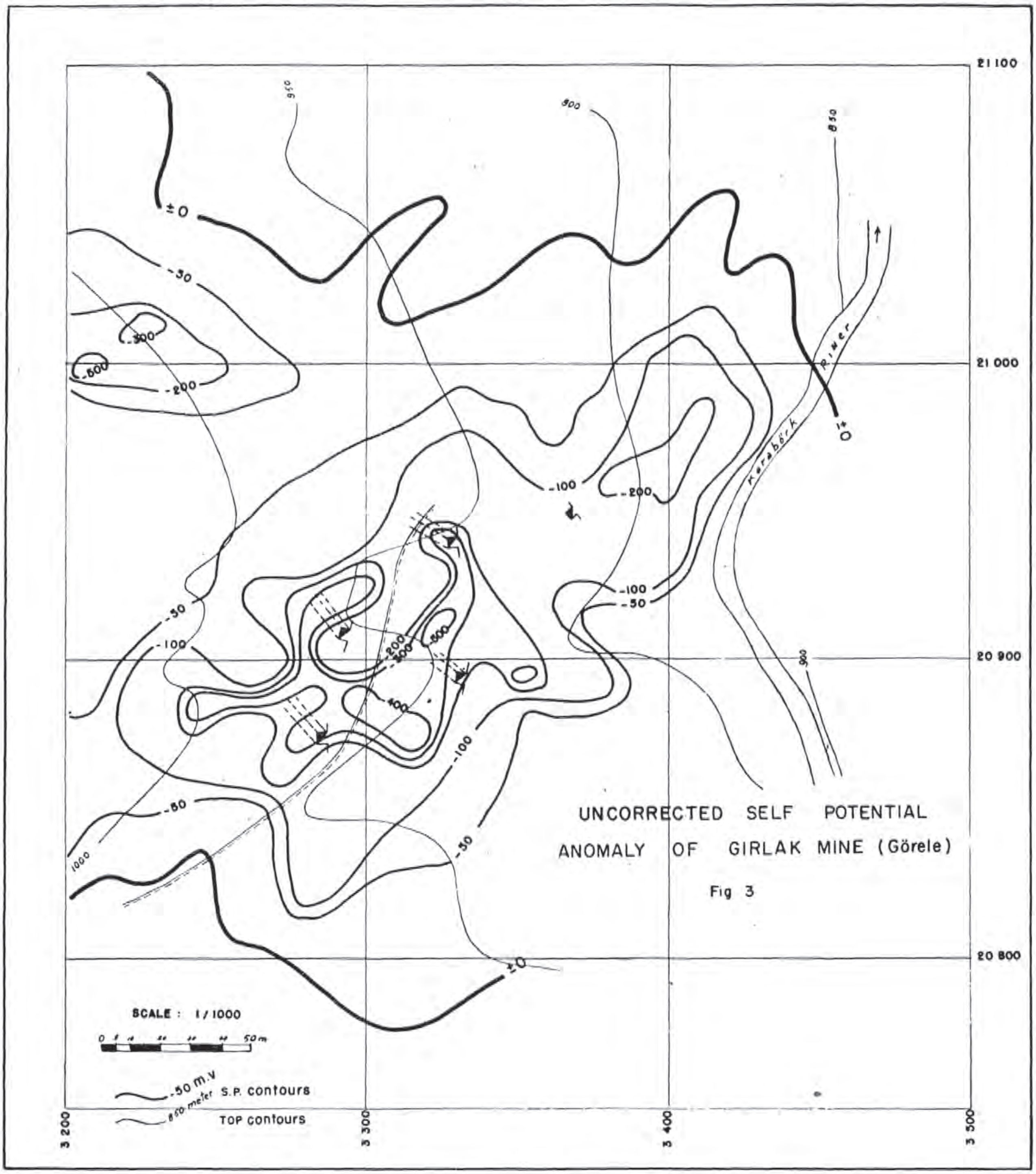
As shown in Fig, 2, the potential values in the gallery and at the boundary of the slag are measured (V1,V2….) and starting from these

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.

An example

This method was applied to clear the effect of the galleries in the Gırlak Mine District (Tirebolu), where the galleries containing acid waters produced self potential with the result of distorting the equi-po-tential 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. 4, 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 smoothyl and the



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

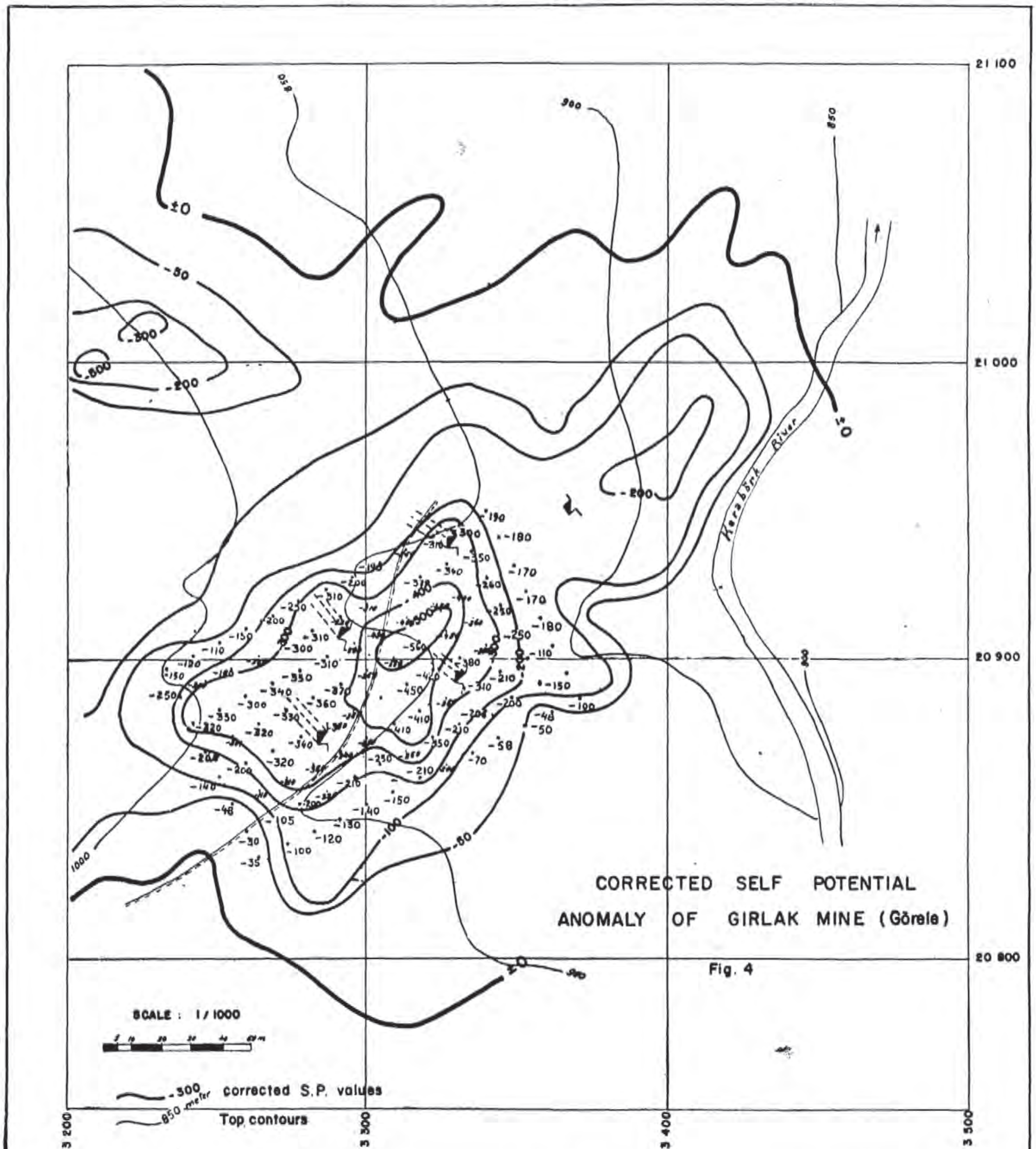

CORRECTED SELF POTENTIAL
ANOMALY OF GIRLAK MINE (Görele)
SCALE : 1/1000
-300 corrected S.P. values
850 meter Top contours
Karaböğrk River
21 100
21 000
20 900
20 800
3 200
3 300
3 400
3 500

Fig. 4

400 m.v. contour tour runs around the 500 m.v. contour. In the uncorrected map,these 2 contours were closed apart 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 other, 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,

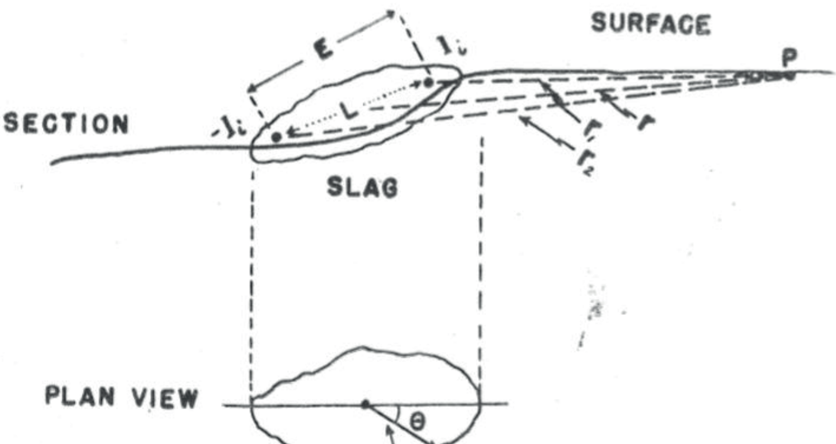


Fig. 5

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

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where : I is the current source for each pole, p the resistivity of the country rock.

The potential at P,

$$V_P = \frac{\rho I_i}{2\pi}\left(\frac{1}{r_1} - \frac{1}{r_2}\right) \simeq \frac{\rho I_i}{2\pi} \cdot \frac{L_i}{r_2}$$

$$M_i = \frac{\rho I_i}{2\pi} L_i$$

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

$$M = \sum_{i=1}^{n} M_i = \frac{\rho}{2\pi} \sum_{i=1}^{n} L_i I_i$$

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

$$M = \frac{\rho}{2\pi} L \sum_{i=1}^{n} I_i$$

$$\sum_{i=1}^{n} I_i = I$$ where I is the total slag current.

$$M = \frac{\rho L}{2\pi} I.$$

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

$$V_s = \frac{E}{2} f(\odot) = \frac{M}{S^2}$$ where $f(\odot)$ is a function of the angle as shown in Fig. 5.

therefore

$$M = \frac{E}{2} \cdot f(\odot) \cdot S^2$$

Since E/2 . f(⊙). and S can be directly measured, M can be 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 :

a) The variation of the quantity E/2 . f(⊙). 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,

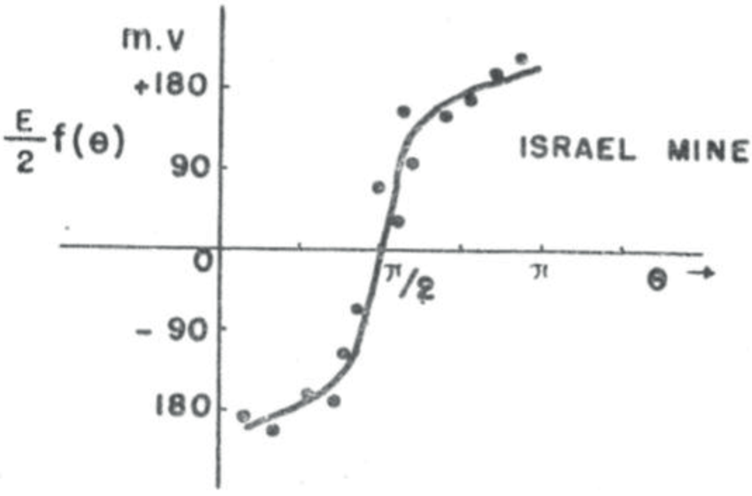

Fig. 6

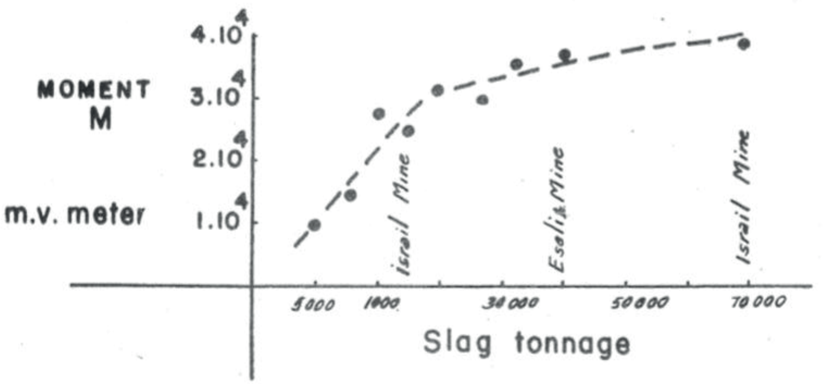

Fig. 7

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, shows that the total slag moment increases very rapidly up to 20,000 tons, then the rate of variation decreases appreciably.

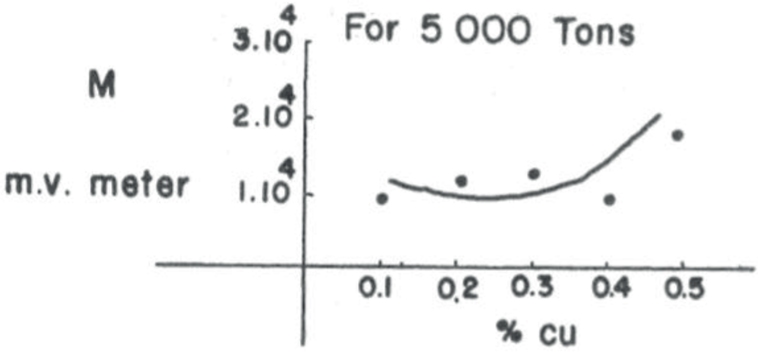

Fig. 8

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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