# An Investigation of the Applicability of Gravimetric and Magnetometric Methods of Geophysical Prospecting

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ABSTRACT

This paper is an account of an investigation made by the Dominion Observatory with a gravity meter and magnetometer over sulphide concentrations at East Sullivan, Val d'Or, Que., in June, 1947. The topographic relief over the area does not exceed 20 feet. The overburden varies from 0 to 50 feet. The west orebody had been outlined by extensive drilling. The average density contrast between the sulphide body and surrounding rocks is 0.5.

Two hundred and sixty gravity and one hundred and ninety magnetic stations were observed. The results are shown on contour sketches. A detailed account is given of the methods employed to reduce the gravity observations. The survey shows that both gravimetric and magnetic methods are useful in delineating sulphide deposits under the conditions in which they occur at East Sullivan. The results indicate that the buried contact of the syenite intrusive southeast of the orebody could be traced with the gravimeter and that the magnetometer was of little value for that purpose.

Gravity anomalies due to the varying depths of overburden are negligible as compared to the magnitude of the total anomalies.

## Introduction

THE project was first suggested at a meeting of the Associate Committee on Geophysics of the National Research Council in September, 1946. At that time it was pointed out that the accuracy and speed of operation of the new gravity meters made them of special importance for geophysical prospecting and it was highly desirable to have an objective test of the performance of an instrument of this kind in delineating an orebody of known dimensions and density characteristics.

Several years ago, a private company did some work with a gravimeter over the Amulet deposits, near Noranda. Unfortunately, the topography there is rather rugged, with hills and ravines exceeding 100 feet, so that the topographical effects rendered it impracticable to distinguish between anomalies due to the sulphides and those due to surface irregularities. An orebody of a typical nature, where the disturbing topographical corrections were not excessive, was therefore sought.

Two areas were suggested, the Quemont in the vicinity of Noranda, and the East Sullivan in the Val d'Or area. The Quemont ore deposit lies under a lake, and calculations indicated that the anomaly would probably be smaller than the error in computing the effects of the irregularities of the lake bottom. The East Sullivan property is situated on relatively level ground, relief not exceeding 20 feet. The sulphide concentrations there are covered with a swampy overburden varying between 10 and 50 feet in depth and were considered more suitable for the investigation.

The purpose of the investigation was threefold:

(1) To determine the applicability of the gravity meter to the delineation and possible discovery of sulphide deposits similar to those at East Sullivan.

(2) To determine whether or not the anomalies due to the concentration of sulphides predominate sufficiently to distinguish them from those due to irregularities in the contact of bed-rock with overburden of varying density.

(3) To compare the gravimetric and magnetic anomalies due to the orebody.

## Field Work and Reductions

### *Geology*

The mine lies within an area underlain by volcanic rocks of Keewatin age, which consist chiefly of a series of acidic to basic lavas, encasing the ore deposit, and which in its vicinity are highly altered and replaced by the disseminating sulphides. The ore consists chiefly of pyrite, chalcopyrite, pyrrhotite, and sphalerite, with a very minute amount of galena, and carries some gold and silver. It occurs in three

Table I.—Table of Rock Densities

| Rock Type | Number of Samples | Density | |
|---|---|---|---|
| | | Range | Weighted Mean |
| Syenite porphyry | 8 | 2.68 – 2.84 | 2.76 |
| Diorite porphyry | 5 | 2.65 – 2.96 | 2.80 |
| Andesitic fragmental | 10 | 2.67 – 2.96 | 2.86 |
| Andesitic flow | 6 | 2.82 – 2.94 | 2.88 |
| Andesitic porphyrite | 2 | 2.90 – 2.90 | 2.90 |
| Weighted mean | | | 2.815 |
| Sulphides (sample lots Nos. 1-17) | 1,137 tons | | 3.273 |

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main masses, known as the West, Central, and East orebodies; there is some indication from drilling that the Central and East orebodies merge into one body at depth. A major structural feature associated with the deposit and bounding the orebody to the southeast and east is an intrusive mass of coarse syenite porphyry.

Numerous drill core samples of the various rocks in the vicinity of the mine were tested for density, and the management of East Sullivan Mines provided specific gravity measurements for ton lots of the sulphides. These results are listed in Table I. The mean density contrast between the sulphides and the country rocks in the area covered by the survey was 0.5; between the syenite porphyry and the rocks enclosing the ore deposit the contrast varied from 0.1 to 0.2.

### *Plan of the Survey*

An area 1,700 feet square was laid out on a grid of north-south lines previously surveyed by the mining company. On these lines, field stations were spaced at 100-foot intervals except near the orebodies, where the spacing was decreased to 50 feet to permit greater detail. A base station was established near the centre of the area from which the gravity and elevation difference of each field station was measured. It is located (Figure 3) at the intersection of the east-west line N 10,900 with the north-south line E 4,000 and is 900 feet north and 1,000 feet east of the station with co-ordinates N 10,000 and E 3,000 at the southwest corner of the Figure.

A standard engineer's precision level was used for the levelling. Closure errors were kept to one-tenth of a foot.

### *Gravity Observations*

The gravity measurements were made with a North American gravity meter, rented from the North American Geophysical Company, of Houston, Texas.

The gravimeter was calibrated in Houston by repeated readings over two selected points whose gravity difference of 20.73 milligals had previously been well established. The value of 0.2425 milligal per scale division was obtained. This value was later confirmed by comparison with numerous Canadian pendulum stations.

By repeated readings at thirteen field stations, it was found that the probable error of the gravity measurements was about 0.04 milligals. It is thought that most of this error is reading error, since the elevation and latitude differences were determined with sufficient accuracy to give errors not exceeding 0.02 milligals. For detailed work where small gravity differences are encountered, a smaller scale value, preferably about 0.1 milligal per scale division, would reduce the reading error of the instrument.

**Figure 1.—Showing transport of gravimeter between stations.**

The gravimeter crew consisted of an instrument man and an assistant who carried the instrument between stations by man-pack (see Figure 1). Field stations were observed by a series of loops; that is, an observation is made at the base station, followed by observations at a series of field stations, after which return is made to base and a reading repeated. This procedure is necessary to determine the 'drift' of the instrument due perhaps to incomplete thermal and barometric control, effects of minor shocks during transportation, and the tidal variation of gravity. Base readings were repeated at least every two hours.

### *Reduction of Gravity Observations*

Observed gravity must be corrected for certain large known influences which are likely to mask the desired results. Corrections are made for instrumental drift, latitude, elevation, and sometimes for terrain and regional effects.

A drift curve for a short period of observing is shown in Figure 2, and the reduction to gravity units for the same period is given in Table II.

The instrument readings for field stations, corrected for drift, are subtracted from the base reading and the difference $\Delta R$ converted to gravity differences, $\Delta g$, by multiplying by the scale constant of the instrument.

Because of the rotation and the spheroidal shape of the earth, there is a normal gradient of gravity from the equator to the poles. This is given by the international gravity formula $\gamma_0 = 978.049\,(1 + 0.0052884 \sin^2\phi - 0.0000059 \sin^2 2\phi)$. Differentiating this with respect to the latitude $\phi$ and substituting a value in feet for the mean radius of the earth, a correction factor for latitude is obtained that can be accurately used over a limited area. It is given by $C = 2.476 \times 10^{-4} \sin 2\phi$ milligals per foot, where $\phi$ is the latitude of the base station. For this survey, $C = 2.462 \times 10^{-4}$ mg. per foot and the correction is positive for stations south, and negative for stations north, of the base station (see Table III, column 4).

Observed gravity values must also be corrected for elevation differences by adding to them the quantity K.h, where h is the elevation difference between the field station and the base, and K is a constant which depends upon the density of the surface layer. In areas where the topographic relief is great, an accurate determination of density is needed; otherwise, it would be impossible to distinguish the gravity anomalies from the effect of surface irregularities. In this case, the most reliable determination can be made by making a gravity profile over some local topographic feature (a hill, valley, or both) characteristic of the area. Several methods have been developed, a graphical solution by Nettleton(1) and least square methods by Seigert(2) and Legge(3). The least square methods are perhaps the less laborious and make the result independent of the judgment of the computer.

In areas where relief is small, such as at East Sullivan, a larger error in the density determination is permissible, and systematic sampling of surface rocks will suffice. On this survey, an elevation factor of 0.06

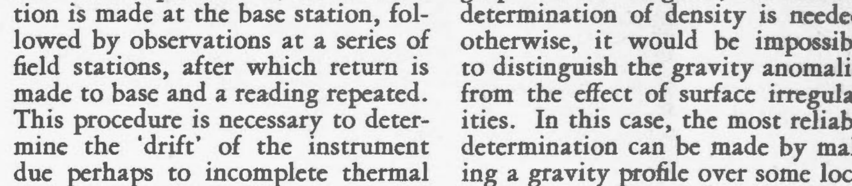


**Figure 2.—Gravimeter drift curve, June 17th, 1947.**

Table II.—Observed Gravity

| Station | Time | Reading | Drift Correction | Corrected Reading | ΔR | Δg |
|---|---|---|---|---|---|---|
| Base | 08 55 | 295.8 | 0 | 295.8 | 0 | 0 |
| L35, N9 | 09 04 | 293.7 | 0 | 293.7 | −2.1 | −51 |
| 8 | 08 | 293.9 | 0 | 293.9 | −1.9 | −46 |
| 7 | 14 | 297.0 | 0.1 | 297.1 | 1.3 | 32 |
| 6 | 20 | 296.5 | +0.1 | 296.6 | 0.8 | 19 |
| 5 | 25 | 296.5 | +0.1 | 296.6 | 0.8 | 19 |
| 4 | 28 | 296.7 | +0.1 | 296.8 | 1.0 | 24 |
| 3 | 33 | 296.2 | +0.1 | 296.3 | 0.5 | 12 |
| 2 | 43 | 295.6 | +0.2 | 295.2 | −0.6 | −15 |
| 0 | 55 | 295.0 | +0.2 | 295.2 | −0.6 | −15 |
| L34, N0 | 58 | 295.5 | +0.2 | 295.7 | −0.1 | −2 |
| 1 | 10 05 | 295.5 | +0.3 | 295.8 | 0 | 0 |
| 2 | 11 | 295.3 | +0.3 | 295.6 | −0.2 | −5 |
| 3 | 21 | 295.1 | +0.3 | 295.4 | −0.4 | −10 |
| 4 | 28 | 296.3 | +0.4 | 296.7 | 0.9 | 22 |
| 5 | 35 | 297.0 | +0.4 | 297.4 | 1.6 | 39 |
| 6 | 38 | 297.8 | +0.4 | 298.2 | 2.4 | 58 |
| 7 | 43 | 296.1 | +0.4 | 296.5 | 0.7 | 17 |
| 8 | 47 | 293.7 | +0.4 | 294.1 | −1.7 | −41 |
| Base | 10 55 | 295.3 | +0.5 | 295.8 | 0 | 0 |

milligal per foot corresponding to an average surface density of 2.67 was used (see Table III, column 6). It was later found by sampling that the mean density of the country rock was 2.82 (see Table I), giving an elevation factor of 0.058 milligal per foot.

At the conclusion of the survey, the profile method of density determination was tested by making a gravity profile over a small hill about three-quarters of a mile away.

In areas where the topography is irregular, and there are abrupt changes in elevation near the gravity station, further corrections are necessary because excesses of mass lying above, as well as deficiencies below, the station, tend to decrease gravity. These are called terrain corrections and are always positive. At East Sullivan, terrain corrections were considered unnecessary. For a few stations in the vicinity of the shaft, where rock from the mine was piled, the maximum terrain correction was 0.03 milligal.

### *Magnetic Observations*

The magnetic observations were made with an Askania vertical intensity magnetometer. The instrument was equipped with a new temperature-compensated magnetic system with a sensitivity of 23.4 gammas per scale division. The observing procedure was much the same as for the gravity work. Readings were repeated at the magnetic base station several times during the day to determine the variation of the earth's magnetic field. The readings at the field stations were first corrected for this variation and then subtracted from the base reading to give the magnetic anomaly in scale divisions, which can be converted if desired into gammas by multiplying by the scale constant of the instrument.

## Results

### *The Bouguer Gravity Map*

The corrected gravimetric data are shown on a map of the area in Figure 3. Bouguer gravity, for each station site, has been plotted in units of one-hundredth of a milligal. It varies from −214 units in the southeast corner of the area to 60 units over the orebody, a total of 2.74 milligals. These are relative values only and their sign has no other significance than to represent the variation in Bouguer gravity above or below that of the selected base station.

The manner in which these 'Bouguer gravity' values are obtained is indicated in Table III. They represent for each station the sum of the corresponding quantities in columns 3, 4, and 6. By 'observed gravity' is meant the observed difference in gravity between that at the station and that at the base, a positive difference indicating a value of gravity greater than that at the base. The latitude correction is positive for stations south of the base and negative for those to the north. Similarly, the elevation correction is negative for stations lower in elevation than the base and positive for those above the base. If the combined latitude and elevation corrections accounted completely for the difference between the field station and the base, the value of 'Bouguer gravity' would be zero at the field station, as it is assumed to be at the base. 'Bouguer gravity' in this paper thus corresponds to the Bouguer anomaly frequently employed in regional and other investigations, with the limitation that, in this paper, the gravity anomaly at the base is assumed to be zero.

Lines of equal gravity anomaly have been drawn using a contour interval of 0.1 milligal.

The important geological formations are shown on the same map. This information was obtained from a preliminary geological map supplied by officials of the East Sullivan mine, who pointed out that the mapping, particularly for the eastern region, was not necessarily accurate as very little exploratory work had been carried out, at that time, between the 450-foot level and the surface, and it was possible that the position shown for the East orebody at the surface could be as much as 150 feet in error. The position of the orebodies at the 450-foot level, as

Table III.—Reduction of Bouguer Gravity

| (1) Station Number | (2) h (Feet) | (3) Observed Gravity Δg | (4) Latitude Correction C | (5) (3)−(4) | (6) Elevation Correction K.h. | (7) Bouguer Gravity (5)+(6) |
|---|---|---|---|---|---|---|
| Base | 0 | 0 | 0 | 0 | 0 | 0 |
| L35, N9 | 6.5 | −51 | 0 | −51 | 39 | −12 |
| 8 | 6.4 | −46 | 2 | −44 | 38 | − 6 |
| 7 | −1.7 | 32 | 5 | 37 | −10 | 27 |
| 6 | −1.5 | 19 | 7 | 26 | − 8 | 18 |
| 5 | −3.3 | 19 | 10 | 29 | −20 | 9 |
| 4 | −4.5 | 24 | 12 | 36 | −27 | 9 |
| 3 | −5.1 | 12 | 15 | 27 | −31 | − 4 |
| 2 | −6.0 | 0 | 17 | 17 | −36 | −19 |
| 1 | −7.6 | −15 | 20 | 5 | −46 | −41 |
| 0 | −8.4 | −15 | 22 | 7 | −50 | −43 |
| L34, N0 | −6.8 | − 2 | 22 | 20 | −41 | −21 |
| 1 | −7.4 | 0 | 20 | 20 | −44 | −24 |
| 2 | −6.2 | − 5 | 17 | 12 | −37 | −25 |
| 3 | −5.4 | −10 | 15 | 5 | −32 | −27 |
| 4 | −4.2 | 22 | 12 | 34 | −25 | 9 |
| 5 | −2.3 | 39 | 10 | 49 | −14 | 35 |
| 6 | −1.3 | 58 | 7 | 65 | − 8 | 57 |
| 7 | −1.0 | 17 | 5 | 22 | − 6 | 16 |
| 8 | −5.8 | −41 | 2 | −39 | 35 | − 4 |

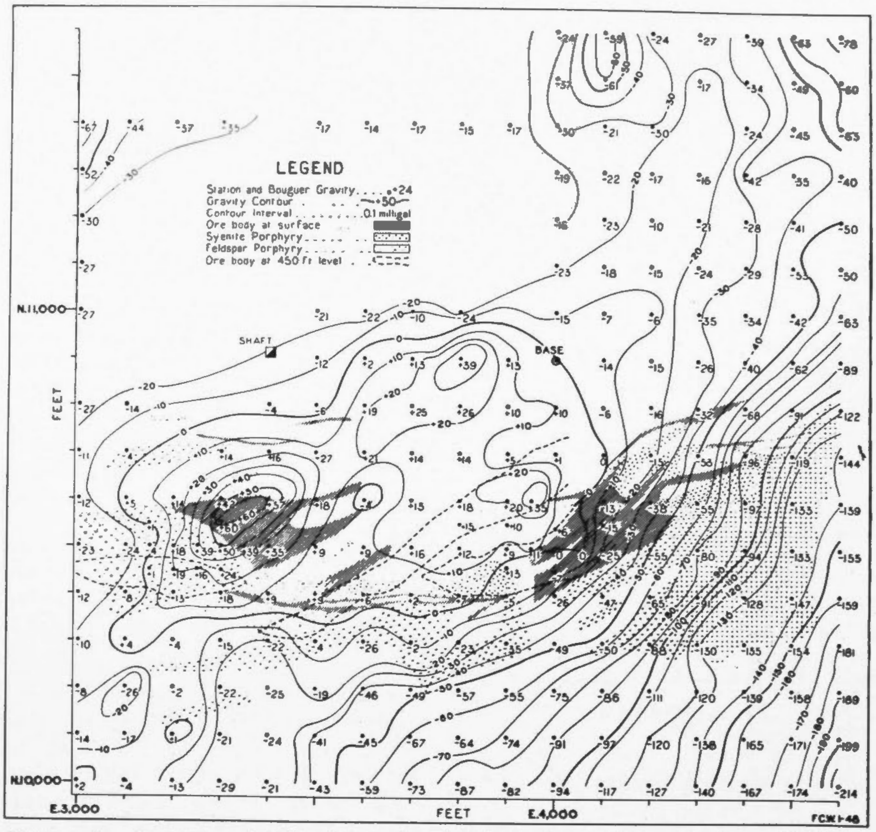


**Figure 3.—Bouguer gravity from gravimeter observations at East Sullivan mine, Val d'Or, Que.**

indicated by drilling, is accurately shown.

The dominating features of the gravity pattern are three gravity highs, one lying over the West orebody, one over the Central and East orebodies, and one to the north and directly west of the base station, at station E. 3,800, N. 10,900. There is only a small diminution in gravity in the region separating the gravity maxima. To the southeast, over the syenite intrusive, lies a gravity low with a steep gradient to the northwest, characterized by a series of closely spaced contours.

### *Interpretation of Gravity Results*

Gravity anomalies reflect the horizontal variations in the density of formations near the surface and represent the integrated effect of all departures from the homogeneous mass distribution assumed in reducing the gravity data for each station. Because, theoretically at least, an infinite number of mass distributions may produce the same gravity effect at the surface, it is impossible to make a unique quantitative solution from gravity results alone. Nettleton(1) points out that some control other than gravity is needed. The control may be from drilling, which gives the depth to contacts of density contrast, or it may come from employment of some other geophysical method. With the aid of the added control, hypothetical structures may be computed until a reasonable fit is made with the observed results.

If no other control is available, much can be learned from a qualitative analysis of the gravity map. Gravity anomalies always have greater lateral extent than the mass distribution causing the anomaly. For a given density contrast, a small mass near the surface could produce the same effect at a gravity station as a much larger mass at depth. However, the larger mass at depth would affect a much larger area and the gravity contours would be characterized by broad, widely spaced curves extending to a considerable distance beyond the boundaries of the disturbing mass.

Referring to Figure 3, the closely spaced concentric contours over the West orebody would indicate a body of small lateral extent and extending to no great depth. On the other hand, the widely spaced contours in the central area would seem to indicate a large mass or masses extending to considerable depth. The gravity contours to the southeast show the presence of a large structure of relatively low density for the area, striking approximately N.40°E. and dipping to the northwest.

It is readily seen that the large gravity high to the west is closely associated with the West orebody. As this area has been well explored and the dimensions of the orebody are known, it is later shown by computation that the anomaly is for the most part entirely due to the heavy sulphides. For the Central and Eastern orebodies, which had not at the time been explored above the 450-foot level, the correspondence is not so obvious. Although the gravity high coincides reasonably well with the position of the orebody at the 450-foot level, it is about 150 feet northwest of the map position of the ore at the surface, exactly the reverse of what might be anticipated. It is probable that the syenite intrusion, being of lighter material than both the sulphides and the andesite, and possibly dipping to the northwest, contributes considerably to the displacement. It is im_

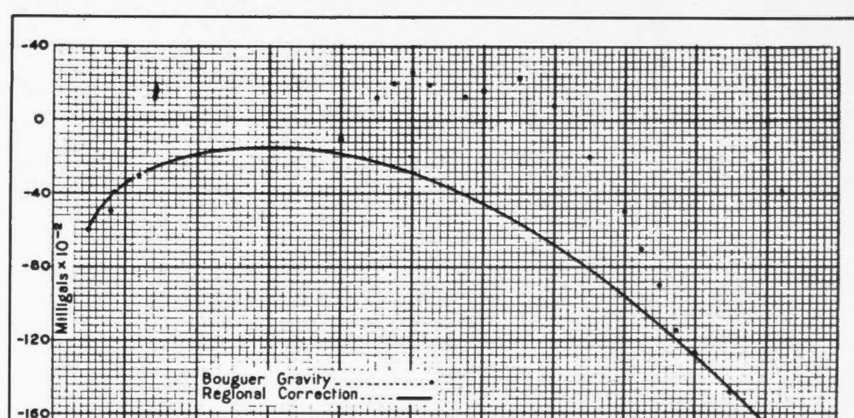


**Figure 4.—Bouguer gravity profile and regional correction curve.**

probable, however, that this could account for all of the displacement and it is more likely that the surface map is in error.

The results also show another area of high gravity comparable to that over the Central and East orebodies, reaching a maximum of 39 units at station E. 3,800, N. 10,900. Further exploratory work is needed in this area to decide if it has commercial possibilities.

### *The Residual Gravity Map*

As the Bouguer anomaly represents the integrated effect of all masses below the station, it is often found that the effect of larger basement structures is reflected on the gravity map in the form of a regional gradient. To investigate the magnitude and form of the anomalies due to the smaller surface structures, it is usual to make a regional correction by subtracting the effect of the larger structure.

An attempt has been made to isolate the anomalies due to the sulphide concentrations by removing the gradient believed due to the syenite porphyry. In Figure 4, Bouguer gravity has been plotted from the map along a profile at right angles to the contours and in the direction of the maximum gradient, from station E. 4,600, N. 10,000 (near the southeast corner of the area represented by Figure 3) to station E. 3,000, N. 11,400 (near the northwest corner of the same Figure). A smooth and regular correction curve, assumed to represent the effect of the syenite, was drawn to eliminate the peaks of the total anomaly, which were assumed to be due to the orebody. It was further assumed that the regional correction was the same for all points on the same line at right angles to the line from which the regional correction curve was drawn.

In Figure 5, the residual gravity values have been plotted and contoured. The orebodies at the surface and at the 450-foot level (as far as the drilling had developed) are shown. The removal of the regional effect has made no very perceptible change in the position or shape of the contours over the West orebody, but over the Central and East bodies, since they are closer to the syenite, the effect has been to broaden the contours and to centre the gravity high over the ore at depth. Further, the shape of the contours would seem to indicate that the disturbing mass extends and pitches to the northeast, possibly as far as station E. 4,200, N. 11,000. The flexures appearing in the contours to the northeast are also some indication of the presence of two disturbing bodies at depth.

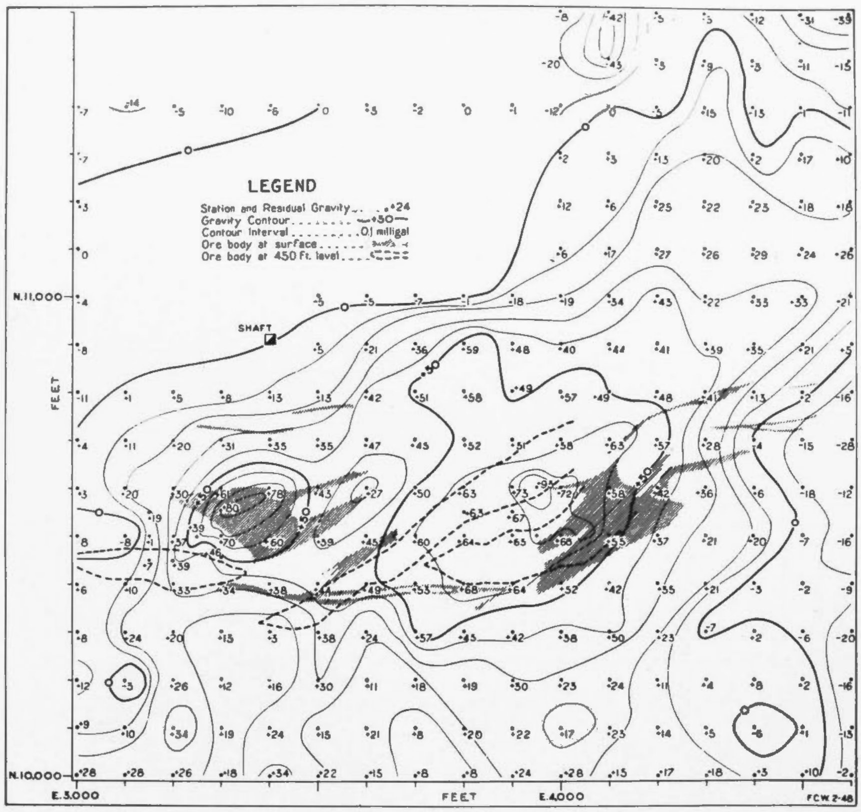


**Figure 5.—Contours of residual gravity after regional correction has been applied.**

Figure 6 represents a gravity profile across the West orebody on line E. 3,300. The orebody, the dimensions of which were determined by drilling, is shown in section. The anomaly due to the body was computed using a density contrast of 1.0, and the maximum was reduced to coincide with the observed maximum. The best fit was obtained by using a density contrast of 0.7. Although this value agrees closely with that obtained by actual density measurements, it must be remembered that there is some uncertainty as to the zero point of the anomaly after the removal of the regional effects. However, the correspondence between the observed value and computed value from the actual dimensions of the ore deposit is evidence that the assumptions made in reducing the observational data were well founded and that the residual anomalies are due to the sulphide concentrations.

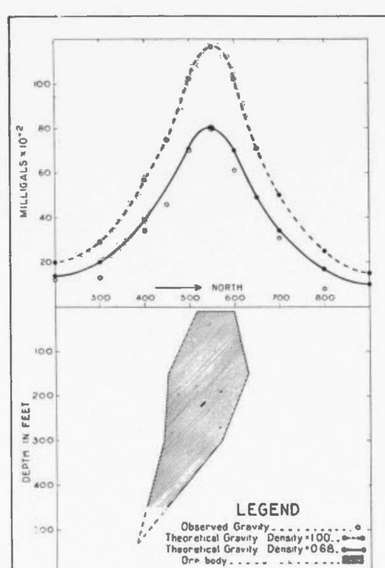


**Figure 6.—Section of West orebody and gravity profile showing observed and calculated anomalies.**

### *The Effects of the Overburden*

As to the question whether the variations in the thickness of overburden, with densities differing from that of the bed-rock, are of sufficient magnitude to mask the anomaly due to the orebody, or to the particular structural feature associated with the deposit, the answer can be more easily given by a consideration of the magnitude of the gravimetric anomalies. Bouguer gravity over the small area of the investigation varies from −2.14 to +0.60, or a total of 2.74 milligals. The overburden varies from 0 to 50 feet, with an average depth of 15 feet. If the density contrast between bed-rock and overburden was of the order of 0.6, the maximum anomaly due to an infinite bed of overburden 20 feet

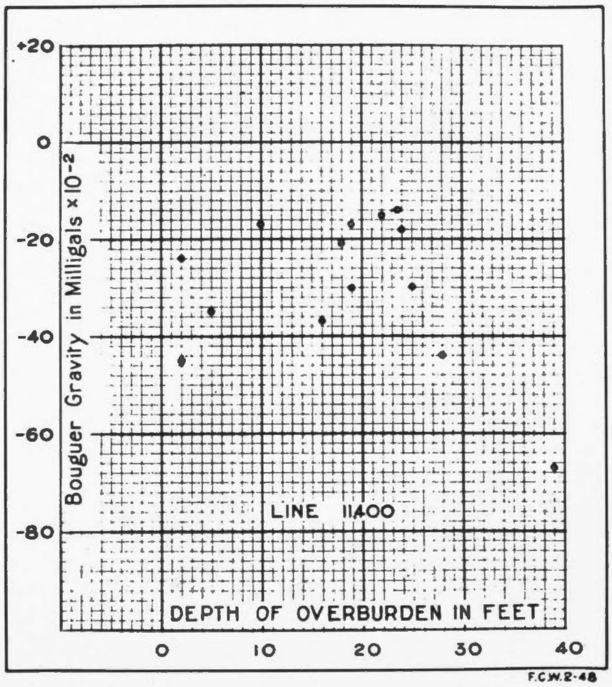


**Figure 7a.—Depth of overburden and Bouguer gravity on line N11,400.**

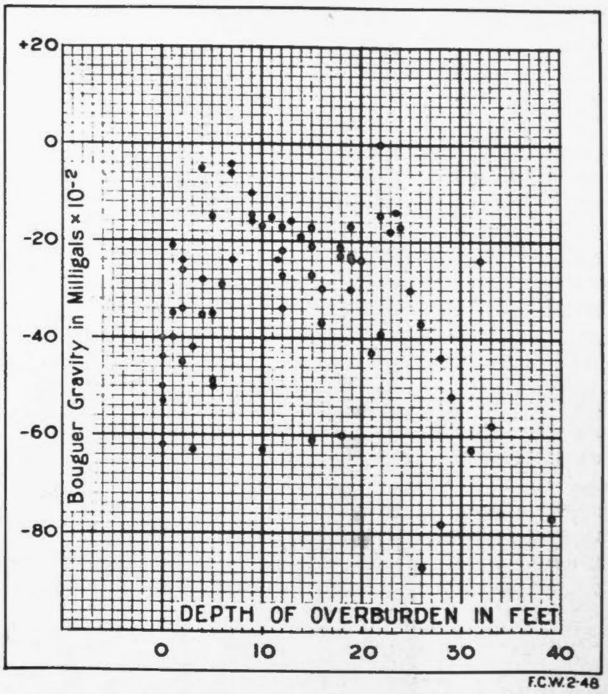


**Figure 7b.—Depth of overburden and Bouguer gravity for stations at which the depth is known.**

thick would be 0.15 milligals, which is less than 6 per cent of the total anomaly.

The depth of overburden on the east-west line N. 11,400 varies from 2 to 40 feet, and in Figure 7*a* the Bouguer gravity for each station is plotted against the depth of overburden. Similarly, in Figure 7*b*, the same has been plotted for all stations, 69 in number, where the depths of overburden are known. These results would seem to indicate that, whatever the effects the varying depths of overburden have on the gravity ancmalies, they are not large enough to show any obvious relation to the total anomaly.

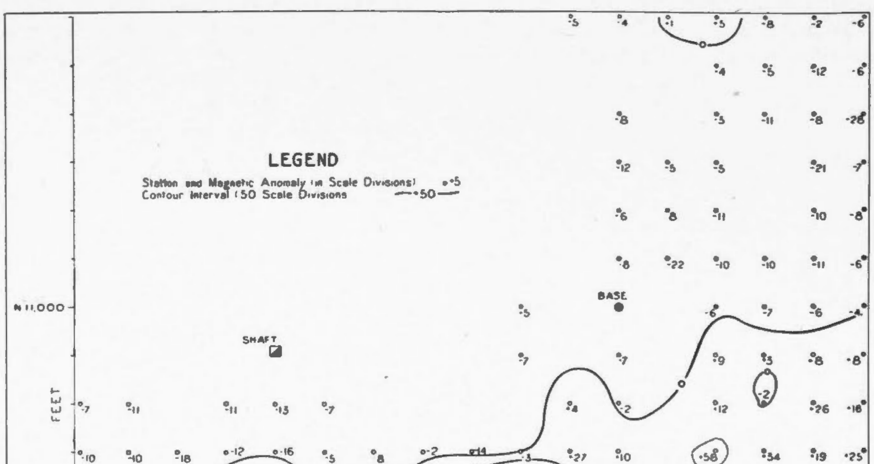


**Figure 8.—Contours of vertical magnetic intensity over East Sullivan ore deposit.**

### *The Magnetic Results*

The results of the magnetic observations are shown in Figure 8. The anomaly in vertical magnetic intensity, in scale divisions, is plotted at each station site and the area is contoured using an interval of 50 scale divisions.

The range in variation for the area is 457 scale divisions, or approximately 10,700 gammas. Most of this is represented by the two magnetic highs in the vicinity of the orebodies. Over the rest of the area, the values range from −250 gammas to 750 gammas, with the higher values to the southeast over the syenite intrusive.

The magnetic highs appear to be definitely asscciated with the mineralized zones and they are probably due to the large amount of pyrrhotite and to scattered magnetite associated with the deposit. Over the West orebody, an intense magnetic south pole produces a positive anomaly of 10,000 gammas or more. Over the Central and East bodies, the magnetic pattern is somewhat broken and consists of two positive anomalies of nearly 4,900 gammas, and a negative anomaly of about 500 gammas appears about 150 feet to the southwest. It is likely that the positive anomalies are due to south magnetic poles and that the negative anomaly is due to the corresponding north pole at a considerable depth.

The marked correspondence between the gravity and magnetic anomalies over the orebodies points to a common origin which would necessarily be a magnetic body of considerable density. Particularly over the West body, the contours are similar. The magnetic high is only about 50 feet south of the gravity high and probably closer agreement would have resulted with a greater number of magnetic stations. While the relative magnitude of the anomalies, both gravitational and magnetic, is the same for both orebodies, the gravity highs extend over a much larger area, and there is only a small diminution in gravity over the ground separating the areas of maximum gravity. This is not so for the magnetic anomalies. As only part of the ore mass is of magnetic material, the intensity falls off rapidly to the normal value a short distance from the magnetic high. Although this is not necessarily typical, it might be considered one disadvantage of the magnetic method as compared to gravity methods of prospecting, as apparently, from Figure 8, both magnetic highs could have been overlooked on a reconnaissance survey if the station interval was as small as 200 feet.

## Conclusions

The investigations show conclusively that concentrations of sulphides, under the conditions in which they occur at East Sullivan, can be outlined by the gravity meter, and that gravity methods may be advantageously applied to such structural problems as the tracing of buried contacts between geological formations.

The results show that the gravity anomalies due to varying depths of overburden are negligible as compared to the magnitude of the total anomalies.

The magnetic results show that the magnetometer is of considerable value in locating buried sulphide deposits. Magnetic highs were found to be definitely associated with mineralization and, although they do not extend over as large an area as the gravity highs, they bear the same relative magnitude to each other. From the results of this survey, the magnetometer would appear to be of little value in tracing the buried contact of the syenite intrusive.

Compared with magnetic prospecting methods, a gravimetric survey may prove somewhat more expensive. The cost of gravity meters varies from about $7,000 to $10,000, or they can be rented for about $500 per month. Instrument readings can be taken with approximately the same speed as they can with a magnetometer, but for gravity work the elevation of each station, as well as that of the surrounding terrain, must be accurately known. The cost per station with a gravity meter will vary enormously, depending on the amount of detail with which the area is covered and the nature of the topography encountered.

Although these investigations have been limited to an area which could be considered as ideal only in that disturbing topographical corrections were negligible, it can be safely said that the gravity meter definitely has its place in base-metal prospecting. It is hoped that an opportunity will soon be afforded to study the limitations of the method by extending these investigations to more rugged regions.

## Acknowledgments

The writer wishes to express his indebtedness to the officials and staff of East Sullivan Mines for their co-operation during the survey, to Mr. Theo. Koulomzine of the firm of Koulomzine, Brossard and Company, of Val d'Or, whose engineers carried out the levelling of the stations and assisted with the gravity work, and to Mr. Wm. Bowman, of Ottawa, an undergraduate of Queen's University, who took the magnetometer readings.

The writer is also indebted to Mr. A. H. Miller, of the Dominion Observatory, for helpful suggestions in planning the work and in the preparation of the paper.

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