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20. Application of gravity methods to mineral exploration.

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Gravity methods do not, except in rare circumstances, displace magnetic or electrical methods in exploration work. However, for all the doubts expressed about their use in this field, gravity methods have definite applications as may be seen from the examples given later in the text. Before considering these examples the requirements of a precise gravity survey need to be examined.

In most mineral surveys gravity stations must be levelled in order that accuracy be maintained. Elevation is normally the major problem in gravity surveys and the precision of the levelling may be deduced from consideration of the scale of the likely anomalies; 50 mm is equivalent to 0.01 mgal Bouguer anomaly. Station positions should be known relative to one another, in a north-south direction, to better than 15 m. Positioning of adjacent stations on a given traverse is no problem. It is preferable, but not necessary, to know the real position in latitude. A 15 m error of latitude is equivalent to 0.01 mgal Bouguer anomaly. Instrumental accuracy is normally better than 0.02 mgal. Terrain corrections *must* be applied and a careful correction will reduce terrain errors to about 5%. The accuracy of a 0.50 mgal correction is about 0.02-0.03 mgal; the overall precision of a levelled, corrected survey is 0.03-0.04 mgal.

The gravity survey is very rapid and more than 150 stations can be comfortably walked and read in one day. Levelling to 50 mm accuracy is also quite rapid. Back-up work in terms of data preparation, reduction and correction will be 2-3 days for each full field day. In all locations where lines have been cut for other methods a follow-up gravity survey may be very worthwhile and cheaper than any other *quantitative* method.

To be effective the gravity method requires a density or mass contrast; normally the ore body in country rock. If a body is small, nearness to the surface becomes a critical factor. The greater the contrast and the larger the body the better and more likely a good result.

What information can a gravity survey give? It can pinpoint certain types of ore deposit, be correlated with other methods to sort out various possibilities before drilling and give a unique, reliable estimate of ore reserves which is not possible with any other method. Ore estimates are possible without assuming anything about the shape or depth of the ore body, although a density estimate is necessary.

Geological controls and careful interpretation are necessary in company with all other procedures to deduce a realistic shape for the body. Suppose, for example, there is an anomaly of 1 mgal over an area of 300 x 300 m. The anomalous field is that due to a mass of 2.15 million tonnes. To get an estimate of the ore body itself we must know the density contrast ranges involved and since the proportional error involved is small the contrast need not be known with great accuracy. If the ore has an average density of 4.1 g/cm^3 and the country rock 2.7 g/cm^3, then the mass of ore is about 6 million tonnes. In the following discussion all ore estimates are taken from McAndrew (1965).

SAVAGE RIVER IRON DEPOSIT

The following discussion is restricted to the Savage River central deposit. Urquhart (1966) and Hughes (1965) state that ore reserves cannot be reliably given. Estimates based on drilling results are unreliable due to variation in ore quality. Although various density assumptions are necessary a reasonable overall figure can be deduced from gravity information. The suggested procedure in cases such as this is undoubtedly a magnetic survey first to find the approximate position of the ore bodies and the relative richness of ore. A gravity survey incidental to this would confirm the main ore pockets and give estimates of the quality of ore. The dip of the ore body or other peculiarities would also be noted which would not be reflected simply in the magnetic survey. Ore estimates can be calculated for parts of a field.

Urquhart states that the average ore density is 4.1 g/cm^3. On this basis, an ore zone 80 m wide would give an anomaly of 5 mgal if it passes to 180 m in depth or 8 mgal if to 800 m in depth. In a reconnaissance survey stations would need to be 15 m apart to locate such bodies and 8 m apart in detailed follow-up work. A gravity survey would thus work well in this situation, accuracy being no problem even in the worst parts of the terrain. A maximum terrain correction might be about 2 mgal (accurate to 0.10 mgal).

KING ISLAND SCHEELITE DEPOSIT

If a gravity survey had been undertaken as soon as the first trace of ore was found the anomalies obtained would have been 3-4 mgal. The extent and dip of the ore would also have been deduced. A not unrealistic ore reserve could also have been calculated directly on a basis of an ore density of 4 g/cm^3. The method could even now be used to delimit this deposit, or other possible adjacent deposits. A station spacing of 8-20 m would be adequate for detailed work and 30-50 m for reconnaissance work.

VEIN DEPOSITS (e.g. RENISON BELL, CLEVELAND)

Due to their small size vein deposits present many problems. Gravity methods could never be contemplated for reconnaissance work but might in certain circumstances be useful following self-potential, induced potential and magnetic surveys as a means of distinguishing ore deposits from mere electrical anomalies.

However, a vein 8 m wide, 300 m deep and 150 m long with ore of density 4.6 g/cm^3 would give an average anomaly of 0.3 mgal peaking to 0.8 to 1 mgal. To be successful surveys should have a station spacing of about 2 m. Best results are obtained if the vein is exposed or nearly so. Accuracy at all stages is absolutely essential.

ROSEBERY LEAD-ZINC DEPOSIT

The Rosebery ore bodies are relatively small but quite dense and have contrasts up to 3 g/cm^3. Assuming an average width of 12-15 m anomalies of the order of 2.5-3.0 mgal are possible. Again with application of close spacing (3 m) the bodies could be comfortably traced, or checked once indicated with other methods.

MT LYELL COPPER DEPOSIT

At first appearances the Lyell ore bodies present problems by their disseminated character. Even so the method could reveal and delimit the ore bodies. Calculations are based on figures more typical of the West Lyell body. Assuming a minimum density contrast of 0.3 g/cm^3, not abnormal for ore with 15% pyrite, an ore lens 80 m wide by 600 m thick and 1,000 m long would give an average anomaly of 0.6 mgal peaking to 1.3-1.5 mgal. The length of the body is not a critical factor in producing a significant anomaly; its breadth is far more critical. In these circumstances a line spacing of 100 m and a station spacing of 10-20 m would give a good coverage and pick out the ore masses and more importantly the more concentrated segregations. The latter will be denser and if of any size will produce significant distortions in the anomaly pattern. Terrain corrections might be substantial (up to 4 mgal) but this, as has been shown, will not upset the overall accuracy of the survey.

ULTRABASIC COMPLEXES

Gravity methods are ideally suited to establish the form of ultrabasic, basic intrusions. The form can then be related to mineralisation and drilling targets proposed.

REPLACEMENT DEPOSITS

The method can be usefully applied where limestones and dolomites are the host rocks. Where the host rock is concealed gravity methods are well suited since limestones have densities of about 2.70 g/cm^3 and dolomites 2.90 g/cm^3 compared to a normal west coast country rock density of 2.5-2.7 g/cm^3.

GRANITE CUPOLAS

Many vein deposits are related to nearby granite cupolas. Since most Tasmanian granites are less dense than the intruded rocks the result is a depression in the gravity field. A gravity survey in the central north of the State has related the Back Creek-Lefroy goldfield to a cupola-like structure in granodiorite. The location of such sources is of considerable value in studies of vein deposits.

Gravity methods can be used to determine whether gossans or apparent gossans are related to real ore bodies since electrical methods may give unreliable results.

In many instances other methods cannot be used. For example no electrical or magnetic surveys are possible in worked or built up areas (*e.g.* Zeehan) but gravity surveys can succeed or have a chance of success since they are unaffected by man's workings. The method can be employed underground.

LEADS

Although leads are principally of interest in northern Tasmania gravity surveys have been successfully carried out at Scottsdale, around Hobart and on the north coast. However they can only succeed if the survey is carefully done *and* terrain corrected. Basalts associated with the leads may cause problems in interpretation but need not necessarily rule out such surveys, whereas seismic and electrical potential methods are precluded.

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