INTERPRETATION OF GRAVIMETRIC AND MAGNETIC DATA: A SHORT REVIEW

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ABSTRACT: This paper briefly reviews the most common methods of interpretation of gravimetric and magnetic data. Only the most general methods are mentioned and special consideration is item to those which are designed for micro computer applications.

INTRODUCTION

Nobody today is in the position to know all the methods developed or under development in his speciality. The universality here as elsewhere in science does not exist anymore. I have tried to select only those articles which deal with general techniques and/or methods of interpretation. The selection is necessarily subjective: I hope that authors whose contributions are not mentioned understand that another reviewer might judge the relative merits and important points quite differently from the way I have done.

Most of the interpretation methods are based on simple hypotheses and therefore in spite of the large spectrum of potential applications, they could be completely unadapted to certain kinds of problems.

The choice of the best method for a particular problem requires good judgement and the last privilege lies with the interpreter.

Most of the methods quoted in this review can be adapted for the use with microcomputers (PC's) as the reader will see. If the forecasted power of these instruments prove true then all the methods described here, including the most sophisticated inversion techniques, could be implemented.

GRAVITY

Although considerable progress has been achieved in the modeling and inversion of gravity data it is pleasant and instructive to begin this review with the method of characteristic points (also called the master chart technique). Starting with an hypothesis about the
simplified geometry of the disturbing body (sphere, cylinder, dyke, etc.) it is possible to use some characteristic points of the anomaly (e.g. distance between certain extrema) to find the essential parameters e.g.: depth, mass, diameter etc. For this purpose only a set of precomputed master charts are necessary.

Fundamental work on interpretation by the trial and error method (also called curve matching) was done by Talwani, Worzel and Landismann (1959) and Talwani and Ewing (1960). In these methods the cross-section of the two-dimensional disturbing bodies are approximated by vertical polygons whose the number of sides depend on the complexity of the body. In the three-dimensional case the body is approximated by horizontal thin layers with polygonal surfaces.

The use of both these procedures allows a exact and reasonably fast modeling of complex structures composed of several bodies of different densities as well as the modeling of variable density bodies. A more modern approach to the same problem has been given by Kv (1977) but to the knowledge of the present author this method has not yet been used.

A very interesting approach to the three dimensional modeling is due to Goetze (1982). In this method the body, instead of being approximated by thin layers or vertical prisms, is approximated by polyhedrons with triangular faces.

One can immediately see the advantages of this procedure: A very good approximation can be performed with a limited number of polyhedrons and consequently any change of the shape of the body can be carried out with only few data manipulations. A second interesting aspect of this method is that it is possible to compute the effect of very large structures in which earth curvature has to be taken into account. It seems that from all the trial and error interpretation methods available this one is the most promising.

Both of those techniques are well-suited for use with microcomputers especially in interactive mode.

A more elaborate approach to the problem is to find directly the geometry of a body from its gravity anomaly assuming constant density.

Generally in this case the disturbing body is decomposed into vertical prisms. The depth of the top or bottom of each prism is adjusted by least-squares (Vogel,1964) or point by point (Laporte, 1954) techniques.

The most difficult problem in these techniques is to find a procedure that leads to a quick and sure convergence.

All the methods described so far can be adapted to the optimization technique using algorithms described by Marquardt (1963) and Powell (1965), for example.

Gerard and Debeglia (1975), starting with a method first described by Laporte (1954) use the properties of gravity and magnetic fields in the frequency domain to find the depth of the surface separating two mediums of different densities or susceptibilities. To do this they determine two fundamental geometric parameters: the mean depth of the interface, and the characteristic distribution function for the deviation around this mean.