SHORT NOTE

THEORY OF THE BOUGUER ANOMALY

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Although the Bouguer anomaly is the form of the gravitational field most commonly utilized for the investigation of geologic problems on land, the true significance of the combined free-air and Bouguer correction is frequently misunderstood by geologists, geophysical students, and many senior geophysicists with specializations in areas other than potential fields. This confusion arises from the established practice of describing the Bouguer anomaly as having been reduced to a common datum, suggesting that the reduced gravity values are those that would be observed if the measurements could be made on the datum plane (e.g., Dobrin, 1976, p. 417).

The absurdity of this is readily apparent if the case of a mass deviation lying between the surface containing the observation points and the datum plane is examined critically. If the reduced field is really that which would be measured on the datum plane, then the depth-to-source determined from the gravity anomaly associated with the mass deviation must be a negative value. This is certainly not true.

The Bouguer anomaly values do not lie on a common plane, but are rather deviations from the theoretical values at the actual point of measurement. The misconception has apparently been caused by the common practice of applying the corrections to the observed data rather than to the theoretical value, although the various corrections are also theoretical in nature.

In general, the theoretical gravity value is considered to be the value at sea level at the latitude of the station as determined by a standard equation, such as the 1930 International Gravity Formula. Normally, the free-air correction is then applied to the observed data. However, the free-air correction is computed on the basis of the theoretical vertical gradient of the gravitational field without consideration of possible deviations in the gradient due to the presence of anomalous masses. In fact, such deviations are sufficiently common and significant that measurement of them holds promise of some day becoming a valuable exploration technique (Hammer and Anzoleaga, 1975). The free-air correction, therefore, is a theoretical quantity that should be properly applied to the computed sea level gravity value to adjust it to the theoretical value at the observation elevation.

Likewise, the Bouguer correction is a theoretical quantity as it assumes an infinite, homogeneous layer of constant thickness, an obvious deviation from reality. Its purpose is to adjust the theoretical value of gravity at the point of observation to include the effect of an idealized mass layer.

In summary, the free-air and Bouguer corrections are idealized quantities whose proper function is to adjust the computed value of gravity at sea level to determine the theoretical value at the point of observation. The only significance of the datum plane is that all of the mass below the datum contributes to the Bouguer anomaly gravity field, while only deviations from the idealized mass distribution are included from above the datum. Therefore, the individual Bouguer anomaly values do not lie in a common plane, but are located at the varying elevations of their respective points of measurement.

The preceding discussion would seem to cast doubt on the validity of many "depth determination" techniques as most assume coplanar data. However, the error is appreciable only in regions of high topographic relief. For such areas, Henderson and Cordell (1971) have formulated a finite harmonic series approximation technique for adjusting the Bouguer anomaly values to a common horizontal plane lying above the anomaly source.

REFERENCES

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