CORRESPONDENCE

BOUGUER ANOMALIES OVER CONTINENTS AND OCEANS

At the outset, I sincerely thank the Editor for publishing my note (*JGSI*, v.58, pp.466-467). I am also thankful to A.U.S. Sarma for his correspondence supplementing (?) my note (*JGSI*, v.59, p.286). As it was a short note, I had deliberately avoided giving all details. It should be clear that the theory of the gravity field was not questioned. The mute point is whether the Bouguer anomaly i.e., the gravity observation with associated conceptual corrections really indicates the gravity field or is it proportional to the vertical gradient of gravity?

However, I would like to clarify some of the points. There are two versions in vogue about the theory of Bouguer anomaly based on the applied corrections either to the observed gravity or the theoretical gravity which are at different levels. Most of the textbooks belong to either of the two schools of thought. One version is by Dobrin (1976) in which free-air, Bouguer and terrain corrections are applied to the observed data at ground level and the data is considered as reduced to the datum of theoretical gravity at sea level. It implies that the reduced values are those that would be observed if the measurements could be made on the datum plane. Some even, consider that the masses above the datum are completely shaven off. The second version, with a critical appraisal of the theory of Bouguer anomaly, is by Ervin (1977) in which the free-air and Bouguer corrections are applied to the theoretical gravity at sea level and the data is considered as projected to the surface of the observed gravity. In this, the Bouguer values do not lie on a common plane but are located at varying elevations of their respective points of measurements. The purpose for which the free-air correction is conceptualized is totally defeated. To bring the data onto a common plane, methods like harmonic analysis are generally used. This, in my opinion, is purely to retain the signatures of the gravity anomaly. Why the free-air correction factor is not used in such a case? In both the cases the Bouguer values do not vary without any mass transfer and the only difference is the divergent concepts indicating the levels at which measurements are reckoned.

The application of free-air correction is mandatory even in geodetic study. Is it only to achieve a positive correlation with topography? We are aware that on a flat ground, the normal, free-air and Bouguer gravity anomalies indicate similar features with only a change in the background levels. The normal, free-air and Bouguer anomalies in high undulating topography also indicate similar features provided all the anomalies are brought on to one datum at the highest point of elevation by applying free-air correction factor only. Under what conditions can this happen is to be assessed. In this context, our views have been expressed as the third and only version that Bouguer anomaly may be considered as proportional to the vertical gradient of gravity in which case, the observed gravity and the theoretical gravity remain at two different levels. In such a case, the role of the free-air correction in the Bouguer anomaly is only for a comparison purpose in the assumed Bouguer density of the medium. This is similar to the envisaged role of theoretical gravity in the Bouguer anomaly. The free-air and normal gravity anomalies actually represent the Bouguer anomalies for assumed densities of 0 and 7.365 gm/cc respectively. Thus, the Bouguer anomaly appears to be structurally controlled. After all, the gravity field and the proportional vertical gradient are inverse to each other. If this were true, eventually the question boils down as to whether measurements of elevations are necessary in the gravity prospecting.

Although the concept of Bouguer anomaly appears to have been introduced in the theory of isostasy, it may be said that always a satisfactory explanation can be given by modelling of anomalies, as it involves only the mass distribution. But does it represent the truth? As more data gets accumulated, refinement in theoretical aspects is also expected and only in such cases the science progresses. It should never be treated as a dogma. The fact that leading Australian journals are publishing tutorial articles on gravity indicates that there are misconceptions among many practicing geophysicists. In the process, people like me are reluctant to explain the anomalies under the garb of structure, geoid and isostasy.

90, Kirlampudi Layout
Visakhapatnam - 530 017
Andhra Pradesh

M. KESAVAMANI

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