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Comments on "Gravity field of the southern Colima graben" by W. L. Bandy, C. A. Mortera-Gutierrez and J. Urrutia Fucugauchi

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In a recent paper, Bandy *et al.* (1993) report the results of modeling marine gravity data for the continental margin of the Jalisco Block. In Figure 5 of its paper, one would expect line A-A' to be normal to the longest dimension of the anomaly, as they use a two-dimensional model, where density does not change along strike. However, line A-A' actually runs parallel to strike, against the common usage in two-dimensional models.

The lateral dimensions of gravity anomalies impose some restrictions in the selection of a gravity model. Consider the gravity effect of a slab with constant density of 1000 kg/m^3 (Figure 1). The slab is 1 km thick and is located at a depth of 1 km below the observer. Initially, let the width *b* and the length *a* of the slab be 300 km, and decrease the width of the slab until it reaches a final width of 2 km, thus approaching a two-dimensional structure. Finally, let the length be reduced until de structure becomes again three-dimensional. Both the length and the width of the slab thus have a final size of 2 km (Figure 1).

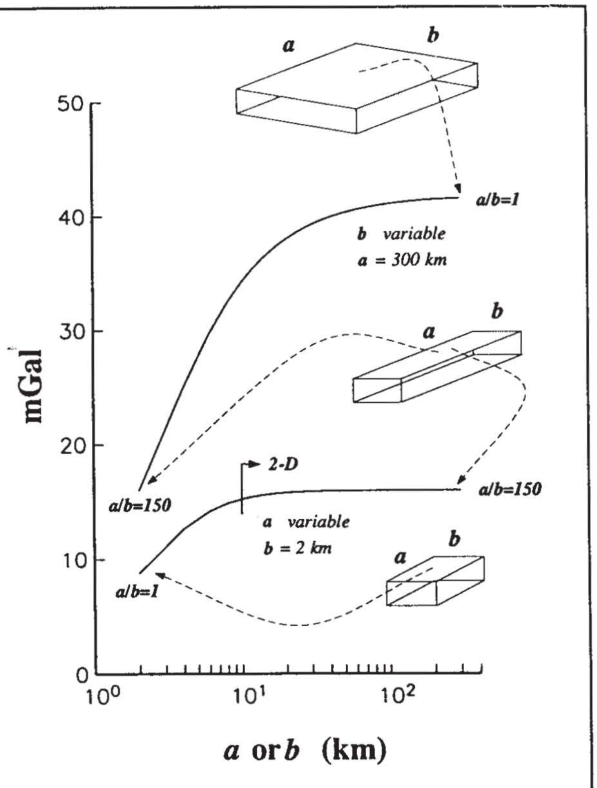

Fig. 1. Gravity effect over the geometrical center of a prism for different values of its length *a* and width *b*. The prism is one km thick and its density contrast is 1000 kg/m^3.

ONE-DIMENSIONAL MODELS

For geological structures whose density varies mainly with depth, such as sedimentary basins characterized by a uniform rate of deposition with time and without lateral changes in density, the observed gravity will be uniform over the surface of the basin. When the characteristic length of the basin is about 300 km, the gravity anomaly can be modelled by the Bouguer slab formula (Bullen, 1975, p. 13). As shown at the top of Figure 1, the applicability of such a model requires characteristic length greater than 200 km.

TWO-DIMENSIONAL MODELS

Some geologic structures, such as dikes, mid-ocean ridges and trenches may be considered two-dimensional. The signature of the gravity anomaly over such geological structures does not change very much over adjacent cross sections. Under such conditions the use of a two-dimensional model, that is, one where density is allowed to change in the direction perpendicular to strike and along the vertical, may be appropriate.

Most two-dimensional models found in the literature are based on the line-integral method first proposed by Hubert (1948) and made popular by Talwani *et al.* (1959). As shown in the middle of Figure 1, the characteristic length of a truly two-dimensional model should exceed its width by at least two orders of magnitude. However, for practical purposes this requirement may be relaxed when the ratio of the length of the source body to its width (a/b) is grater than five. However, the ratio a/b along line A-A' in Bandy *et al.* (1993) is only 0.5.

THREE-DIMENSIONAL MODELS

When the ratio a/b is less than 5, we are dealing with a three-dimensional structure and we should use a three-dimensional model. Many models though based on simple geometries, are capable of explaining three-dimensional gravity anomalies.

The gravity anomaly (Profile A-A') as modeled by Bandy *et al.* (1993) does not show the typical signature of a two-dimensional structure; nor is it normal to the longest dimension of the anomaly. Hence the two-dimensional gravity model depicted in their Figure 5, and particularly the proposed thickness and density of the seaward extension of the Colima graben, should be viewed with caution.

In elongated structures, when gravity anomalies are sufficiently linear, the body is said to be two-dimensional, in the sense that its density can be represented by $\rho(x, y,z)=\rho(x,z)$. Bandy *et al.* (1993) assume the existence of a graben structure offshore Manzanillo running normal to the coast, since the profile runs parallel to the coast. Notice, however, that the gravity anomalies adjacent to its profile are lineated parallel to the coast. Thus, how can we assume a two-dimensional distribution in density? The data require choosing an appropriate model. 2 1/2-D models are useful when the structure has a limited strike length, yet they still require a 2-D density structure.

The Bouguer anomaly (onshore) does not suggest the presence of a graben-like structure. On the other hand, free-air anomalies (offshore) are strongly affected by the depth to sea-floor. It is likely that the free-air anomaly south of the profile A-A' is an artifact of the bathymetry. Also, 2-D and 2 1/2-D models have an invariant geometry in the strike direction, which means that sea-floor bathymetry is invariant. This condition is not achieved in a direction normal to the continental margin at Manzanillo, because of the Manzanillo canyons.

What is the material within the proposed grabens? The density of 2.50 g/cm^3 used by Bandy *et al.* (1993) may correspond to low-density limestones, deeply buried and highly compacted shales, or highly compacted sandstones. This precludes the presence of unconsolidated sediments (1.7-2.3 gr/cm^3) at shallow depths, which should account for most of the defect of mass in the grabens. Thus, a smaller thickness is required to explain the data.

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