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Data Repository Item for: Mantle upwelling, magmatic differentiation and the meaning of axial depth at fast-spreading ridges

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Gravity Anomalies

The free air gravity data between the Clipperton and Siqueiros fracture zones is compiled from the National Geophysical Data Center (NGDC) and from the UNDERSHOOT experiment. (The gravity data and maps are courtesy of J. P. Canales and are available from the RIDGE 2000 Data Portal, www.marine-geo.org/ridge2000/). Fig. DR1 shows mantle Bouguer anomalies (MBA, Fig. DR1A & B) and residual mantle Bouguer anomalies (RMBA, Fig. DR1C & D). The MBA is the free air gravity anomaly corrected for the gravitational effect of the three-dimensional topography of the seafloor and Moho (Kuo and Forsyth, 1988). The water, crustal and mantle densities used are 1.0 g/cm$^3$, 2.73 g/cm$^3$ and 3.3 g/cm$^3$, respectively. The MBA is calculated in two ways: (i) by removing a constant crustal thickness (6 km; Fig. DR1A) and (ii) by removing the seismically-measured crustal thickness from Canales et al. (2003) (Fig. DR1B). The MBA maps have the same basic structure as those calculated for this area by Wang et al. (1996) using crustal thickness derived from seismic reflection data (Barth and Mutter, 1996). The RMBA is the MBA after removing the gravitational effect of the mantle thermal structure due to the transform-ridge-transform geometry (Phipps Morgan and Forsyth, 1988). The thermal expansion coefficient of the mantle used is 3.4x10$^{-5}$ °C$^{-1}$. We show the RMBA calculated both by removing a constant crustal thickness (6 km; Fig. DR1C) and by removing the seismically-measured crustal thickness (Fig. 2A & B; Fig. DR1D).

At fast-spreading ridges, measuring crustal thickness is essential for interpreting gravity anomalies. This is because gravity anomalies at fast-spreading ridges are typically very smooth (e.g., Figs. DR1A & C), yet seismic measurements show
considerable variation in crustal thickness (Fig. 2A). Thus, while the constant-crustal-thickness MBA or RMBA is commonly interpreted to reflect crustal thickness variations, this does not accurately reflect the structure of the seismically-measured crust at fast-spreading ridges. Indeed, when the measured crustal thickness is removed, the gravity field shows greater variability and structure (e.g., Figs. DR1B & D). As a consequence, it is the RMBA, where the measured crustal thickness is removed (Fig. DR1D), that accurately reflects variations in crustal and/or mantle density.

References


Fig. DR1: Gravity anomalies between the Clipperton and Siqueiros fracture zones. Mantle Bouguer anomalies (MBA) calculated by removing: (A) a 6-km-thick crust, (B) the seismically-measured crustal thickness. Residual mantle Bouguer anomalies (RMBA) calculated by removing: (C) a 6-km-thick crust, (D) the seismically-measured crustal thickness. Details are in the data repository discussion on gravity anomalies.