The Chaco-Paraná Basin from GOCE and Integrated Terrestrial/Satellite Gravity Data: Unraveling Major Lithosphere Discontinuities

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Abstract
The Chaco-Paraná basin (CPB) is located in the South American plate, mainly in the northeast of Argentina. Its oldest sediments are related to the Eopaleozoic and, from the Late Carboniferous to the Early Cretaceous, it shares a common sedimentation history with the Paraná Basin (PB) (southeastern Brazil). The Asunción High separates these two basins, and a lithosphere with distinct characteristics for each of them has been distinguished through both seismological and deep magnetotelluric (MT) studies. Crustal thicknesses of roughly 32 km and 42 km have been determined for the CPB and PB, respectively. These changes are discussed herein through the analysis of two global potential field models, the EGM2008 model, which encompasses both terrestrial and satellite data, and an entirely satellite one, derived from GOCE data. The results, in accordance with others aforementioned, suggest a crustal, and possibly a lithospheric scale, suture zone.

Introduction

Figure 1: Topographic map of part of South America. The contour of the basins as well as the geological structures which separate them (in blue) are from Miliani (2000). The CPB covers an area of approximately 700,000 km² and it is limited to the east by the PB, with the Asunción High separating them; to the west by the Sierras Pampeanas. Its geomorphology is characterized by a low-land (~100 m a.s.l.).

Geopotential field models

Figures 2 and 3: Bouguer Anomaly Maps (BAM) (2008) and GOCE (degree 250, Paill et al., 2011) models.

Figure 4: Profiles along the white dotted lines in Figs. 2 and 3. We highlight that from intermediate- to long-wavelengths the geopotential models agree, predicting the same anomalies. It is also possible to observe an abrupt change in the amplitude of the regional gravity which varies from 10-20 mGal over the CPB to ~80 mGal in the PB.

Figure 5: Upward continuation of the Bouguer anomaly map derived from GOCE. The steep gradient that separates the two basins continues northwards, separating the PB from the Pantanal basin, where a deep magnetotelluric session (red line) has been carried out (Fig. 8).

Vertical derivative of upward continued field

Figure 6: Upward continuation to 15 km of the BAM (white rectangle in Figs. 2 and 3) from EGM2008 field. A NE-SW trend and negative anomalies can be observed in the PB, whereas in the CPB the anomalies are scattered, tending to be more positive. Thus, a major suture zone between both basins can be inferred (white curve).

Seismological and deep MT studies

Figure 7: Crustal thickness map from receiver function (Bionchi, 2008). Snake and James (1997) suggest crustal thicknesses of 32 km for the CPB and 42 km for the PB.

Depth of Moho derived from Gravity data

Figure 9: Total sedimentary package of both basins digitized from Miliani et al. (2000)

Figure 10: a) Gravity Effect owing to Sedimentary thickness (GES) calculated from rectangular prisms algorithm (Chaves, 2010); b) GOCE data in the study area; c) GOCE data minus GES; d) Depth of Moho estimated using a density contrast of 300 kg/m³ and a mean depth of 38 km according to the Parker-Oldenburg method (Gómez-Ortiz and Agarwali, 2004).

Conclusions
The change in the crustal thickness estimated from the inversion of the gravity data derived from the GOCE mission (~35 km for the CPB, ~42 km for the PB), jointed to the analysis aforementioned, the MT vertical session and the seismological studies, indicates a major lithosphere discontinuity which suggests the existence of a suture zone between the basins.

References
Bolognini et al., Mapping lithospheric sutures and amalgamated terrains within the Paraná basin integrating EM induction and gravity data. Submitted to J. American Earth Sciences.