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# Density structure of the Central Andes from 3D integrated gravity modelling

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## INTRODUCTION

The key motivation to study the Central Andes (between 20-29°S and 76-61°W) is because it is a subduction related cordillera that accommodates the Earth's largest plateau formed without continent-continent collision. Moreover, a wealth of geophysical and geological information has been produced during the last years, probably making the Central Andes the geophysically most densely covered convergent continental margin, and providing a huge amount of constraining data (e.g. Yuan *et al.* 2002, Brasse *et al.* 2002, ANCORP 2003, Schurr and Rietbrock 2004). The major goal of this model is to contribute to an integrated understanding of the geodynamic features and processes of the Central Andes (e.g. Kirchner 1996, Kösters 1999)

## METHODOLOGY

We present a model of the density structure up to a depth of 1200 km produced through a 3D forward modelling of the Bouguer anomaly. Offshore Bouguer anomalies were calculated from the 2001 KMS global free-air anomaly data base (Andersen and Knudsen 1998) considering GEBCO bathymetry (www.ngdc.noaa.gov/mgg/gebco/gebco.html). Onshore gravity data includes measurements made under the umbrella of the German Collaborative Research Center SBF 267 "Deformation Processes in the Andes". We used the interactive modelling tool IGMAS, which provides a wide range of GIS functions in a 3D space to integrate other geophysical models, information, and data from both geophysics and geology (e.g. Götze 1984, Schmidt and Götze 1999, Götze and Schmidt 2002, http://geophysik.uni-kiel.de/~sabine/Sabine_IGMAS.html).

Our model consist of 31 parallel E-W planes extending between 12-35°S and 57-79°W. The final 3D density structure shows a very good fit between the measured and modelled gravity fields (Fig. 1). The correlation coefficient between the measured and modelled anomalies is 1, and the standard deviation of the residual anomaly is 17.8 $10^{-05}$ (m/s$^2$). The geometry of our model is constrained by seismic reflection and refraction profiles, receiver function analysis, hypocenter locations, magnetotelluric data, different tomographic studies, thermal models and numerous structural balanced cross sections (Fig. 2) (e.g. McQuarrie and DeCelles 2001, Yuan *et al.* 2002, Brasse *et al.* 2002, ANCORP 2003, Schurr and Rietbrock 2004) . The density values assigned to the different bodies forming the model were constrained based on information and assumptions about the chemical and/or mineralogical composition and pressure-temperature conditions expected for each body. We included a partial melting zone at midcrustal depths under the Altiplano-Puna (Low Velocity Zone in Fig. 2; density contrast -0.04Mg/m$^3$) and considered the presence of a rheologically strong block beneath the Salar de Atacama basin (density contrast 0.05Mg/m$^3$), according to recent seismic studies (Schurr and Rietbrock 2004).

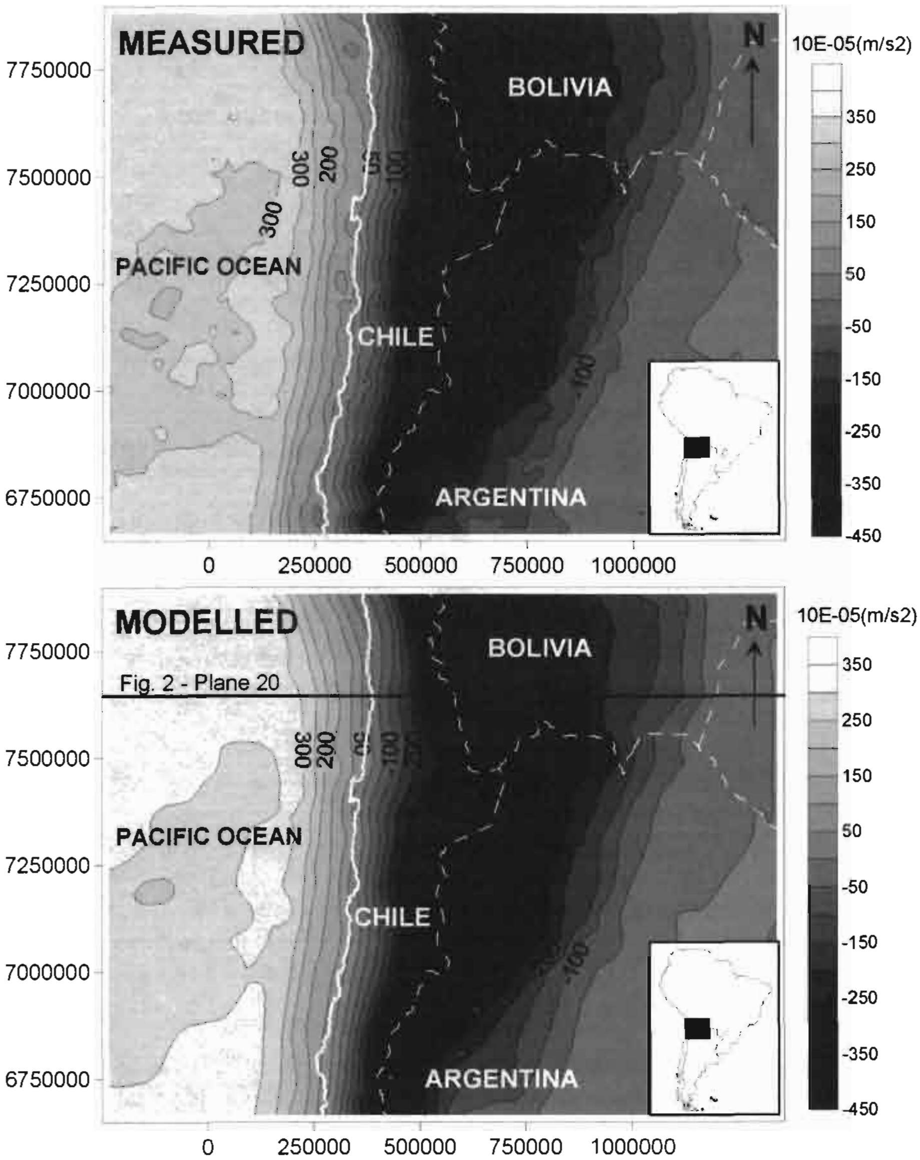

Figure 1: Measured and modelled Bouguer anomalies in the study area. The position of the modelling plane number 20 depicted in Figure 2 is shown.

## RESULTS AND CONCLUSIONS

On the base of our model, we produced a contour map of the upper surface of the subducting slab below the continental margin, which is in accordance with the slab geometries proposed previously by other authors. The modelled Moho was compared with Airy and flexural (Vening-Meinesz) isostatic Mohos, and with the Moho depths obtained from receiver functions analysis (Yuan *et al.* 2002). Residual gravity maps were prepared considering the gravity effect of the subducting slab and of the isostatic and modelled Mohos (Fig. 3) in order to gain insight on the compensation mechanisms. The upper and lower limits of the possible amount of partial melting that occurs in the Andean Low Velocity Zone is estimated.

In this study we have demonstrated how 3D gravity modelling, integrating geophysical and geological information, could help to reveal the geodynamic processes involved in the building of Central Andes orogen.

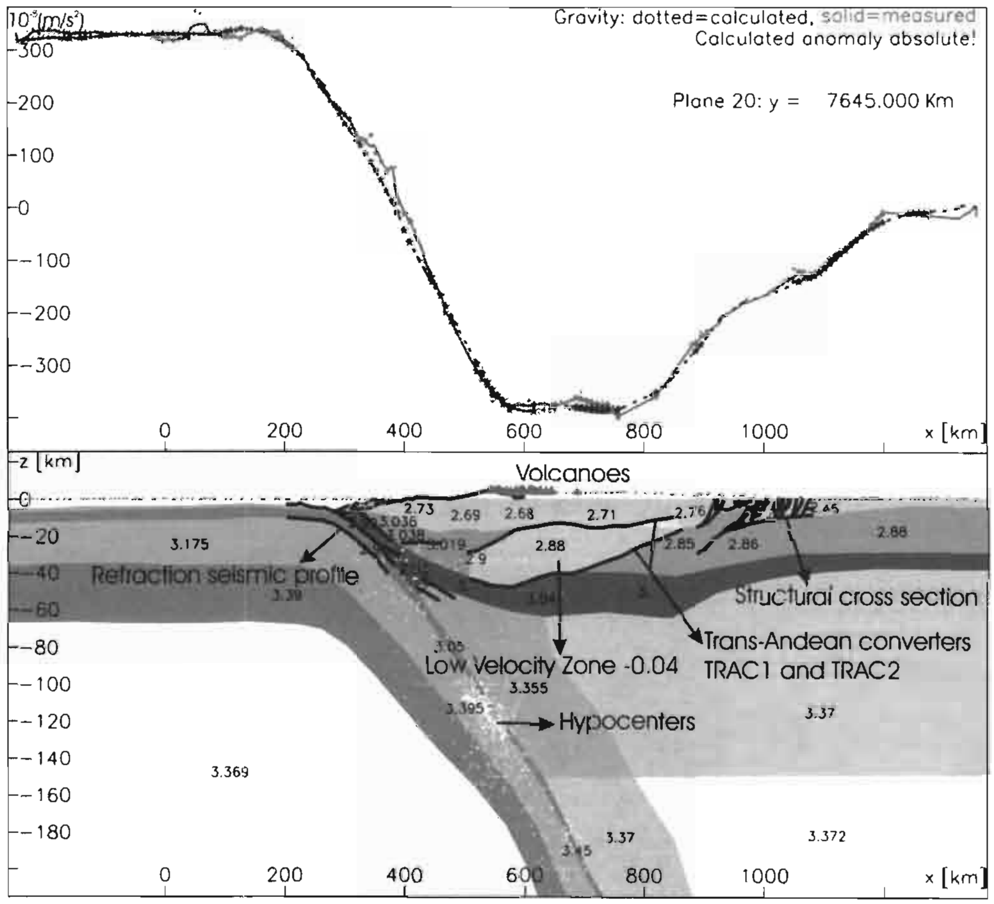

Figure 2: One of the 31 modelling planes at 21.3°S, showing the density structure and some of the constraining data.

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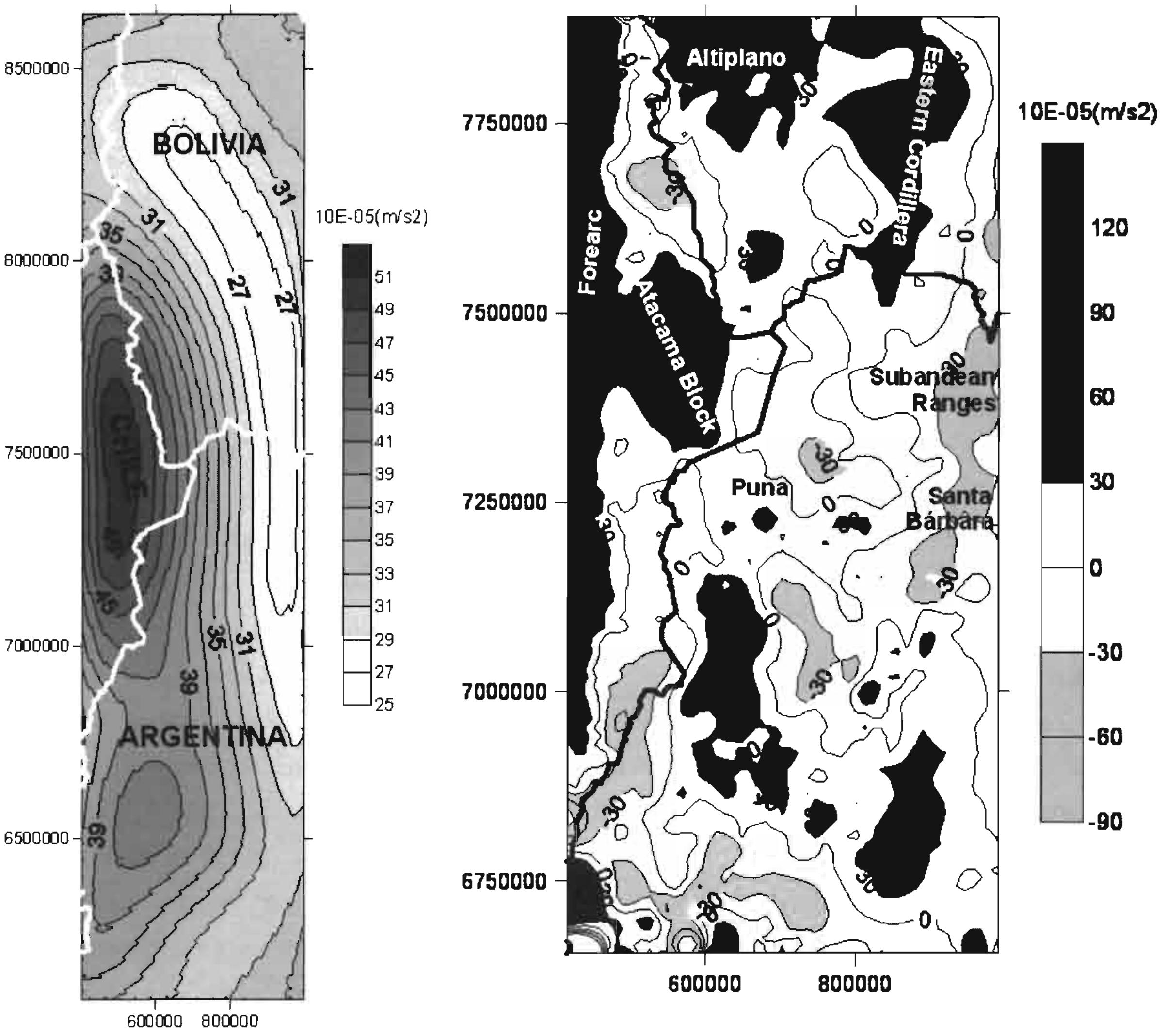

Figure 3: Left: Gravimetric effect of the subducted Nazca plate up to a depth of 440 km, assuming a density contrast of 0.0235 Mg/m$^3$. Right: Residual gravity field obtained by subtracting the effect of the subducted plate (left) and the effect of the modelled Moho (with a density contrast of -0.5 Mg/m$^3$) from the Bouguer anomaly. Positive values (dark tones) are observed in the forearc, the Atacama block, the Bolivian Altiplano-Eastern Cordillera and striking NNW-SSE in the southern Puna. Local negative values (light tones) can be seen along the recent volcanic arc and along the Subandean Ranges and Santa Bárbara System.