# Lithospheric-scale 3D model of the southern Central Andes (https://doi.org/10.5880/GFZ.4.5.2020.001)

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## 1. Licence



## 2. Citation

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## 3. Model area

Model coordinates are given in UTM map projection (UTM Zone 19S)
Datum: World Geodetic System 1984.

Model bounds in UTM Zone 19S:
Easting: from 200000 m to 900000 m
Northing: from 5700000 m to 6800000 m

Model bounds in longitude/latitude (WGS 84):
Longitude: from -72.4543 to -64.3973
Latitude: from -38.8488 to -28.86550

## 4. Abstract

The Central Andean orogeny is caused by the subduction of the Nazca oceanic plate beneath the South-American continental plate. In Particular, the southern Central Andes (SCA, 27°-40°S) are characterized by a strong N-S and E-W variation in the crustal deformation style and intensity. Despite being the surface geology relatively well known, the information on the deep structure of the upper plate in terms of its thickness and density configurations is still scarcely constrained. Previous seismic studies have focused on the crustal structure of the northern part of the SCA (~27°-33°S) based upon 2D cross-sections, while 3D crustal models centered on the South-American or the Nazca Plate have been published with lower resolution.

To gain insight into the present-day state of the lithosphere in the area, we derived a 3D model that is consistent with both the available geological and seismic data and with the observed gravity field (Rodriguez-Piqueda et al., 2020) . The model consists on a continental plate with sediments, a two-layer crust and the lithospheric mantle being subducted by an oceanic plate. The model extension covers an area of 700 km x 1100 km, including the orogen (i.e. magmatic arc, main orogenic wedge), the forearc and the foreland.

## 5. Relevance

The presented 3D structural model resolves the thickness and density distribution of the main layers that make up the SCA lithosphere. Through the integration of a large amount of diverse data, we are able to link the crustal configuration with different tectonic domains which were previously defined based on the (near)-surface geology. The present-day crustal configuration most likely reflects differences in the tectonic evolution of each tectonic domain.

This model can be used as a base to investigate the regional 3D temperature distribution and the rheological field in the SCA. Therefore, it contributes to discussions about the role of the upper plate on the short- (i.e. earthquake-related) and long-term (i.e. mountain-building related) deformation pattern, as well as on the subduction geometry (i.e. slab dip).

## 6. Methods

Different data sets were integrated to derive the lithospheric features:

- We used the global relief model of ETOPO1 (Amante and Eakins 2009) for the topography and bathymetry.
- The sub-surface structures were defined by integrating seismically constrained models, including the South-American crustal thickness of Assumpção et al. (2013; model A; 0.5-degree resolution), the sediment thickness of CRUST1 (Laske et al. 2013) and the slab geometry of SLAB2 (Hayes et al. 2018).
- Additionally, we included seismic reflection and refraction profiles performed on the Chile margin (Araneda et al. 2003; Contreras-Reyes et al. 2008, 2014, 2015; Flueh et al. 1998; Krawzyk et al. 2006; Moscoso et al. 2011; Sick et al. 2006; Von Huene et al. 1997).
- Besides, we used sediment thickness maps from the intracontinental basin database ICONS (6 arc minute resolution, Heine 2007) and two oceanic sediment compilations: one along the southern trench axis (Völker et al. 2013) and another of global-scale (GlobSed; Straume et al. 2019).

To build the interfaces between the main lithospheric features, we compiled and interpolated these datasets on a regular grid with a surface resolution of 25 km. For that purpose, the convergent algorithm of the software Petrel was used. We assigned constant densities within each layer, except for the lithospheric mantle. In this case, we implemented a heterogeneous distribution by converting s-wave velocities from the SL2013sv seismic tomography (Schaeffer and Lebedev 2013) to densities. The python tool VelocityConversion was used for the conversion (Meeßen 2017).

To further constrain the crustal structure of the upper plate, a gravity forward modelling was carried out using IGMAS+ (Schmidt et al. 2010). The gravity anomaly from the model (calculated gravity) was compared to the free-air anomaly from the global gravity model EIGEN-6C4 (observed gravity; Förste et al 2014; Ince et al. 2019). Subsequently, the crystalline crust of the upper plate was split vertically into two layers of different densities. We inverted the residual between calculated and observed gravity to compute the depth to the interface between the two crustal layers. For the inverse modelling of the gravity residual, the Python package Fatiando a Terra was used (Uieda et al. 2013)

## 7. Technical Information

For each layer, the depth to the top surface, thickness and density can be found as separate files. All files contain identical columns:

- Northing as "X Coord (UTM zone 19S)";
- Easting as "Y Coord (UTM zone 19S)";
- depth to the top surface as "Top (m.a.s.l)" and
- thickness of each layer as "Thickness (m)".

The header 'Density' indicates the bulk density of each unit in kg/m3. For the oceanic and continental mantle units, a separate file is provided with a regular grid of the density distribution with a lateral resolution of 8 km x 9 km and a vertical resolution of 5 km. The containing columns are: Northing as "X Coord (UTM zone 19S)"; Easting as "Y Coord (UTM zone 19S)"; depth as "Depth (m.a.s.l)" and density as "Density (kg/m3)"

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## 9. Related Work

Data presented here were derived from an extensive list of related works (Amante and Eakins, 2009; von Huene et al. 1997; Flueh et al. 1998; Araneda et al. 2003; Krawczyk et al. 2006; Sick et al. 2006; Heine 2007; Contreras-Reyes et al. 2008, 2014, 2015; Moscoso et al. 2011; Laske et al. 2013; Schaeffer and Lebedev 2013; Völker et al. 2013; Assumpção et al. 2013; Förste et al. 2014; Hayes et al. 2018; Ince et al. 2019; Straume et al. 2019)

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