Geophysical Research Abstracts
Vol. 17, EGU2015-685, 2015
EGU General Assembly 2015

Improved 3D density modelling of the Central Andes from combining terrestrial datasets with satellite based datasets

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As horizontal gravity gradients are proxies for large stresses, the uniquely high gravity gradients of the South American continental margin seem to be indicative for the frequently occurring large earthquakes at this plate boundary. It has been observed that these earthquakes can break repeatedly the same respective segment but can also combine to form M>9 earthquakes at the end of longer seismic cycles. A large seismic gap left behind by the 1877 M∼9 earthquake existed in the northernmost part of Chile. This gap has partially been ruptured in the Mw 7.7 2007 Tocopilla earthquake and the Mw 8.2 2014 Pisagua earthquake. The nature of this seismological segmentation and the distribution of energy release in an earthquake is part of ongoing research. It can be assumed that both features are related to thickness variations of high density bodies located in the continental crust of the coastal area. These batholiths produce a clear maximum in the gravity signal. Those maxima also show a good spatial correlation with seismic asperity structures and seismological segment boundaries.

Understanding of the tectonic situation can be improved through 3D forward density modelling of the gravity field. Problems arise in areas with less ground measurements. Especially in the high Andes severe gaps exist due to the inaccessibility of some regions. Also the transition zone between on and offshore date data displays significant problems, particularly since this is the area that is most interesting in terms of seismic hazard. We modelled the continental and oceanic crust and upper mantle using different gravity datasets. The first one includes terrestrial data measured at a station spacing of 5 km or less along all passable roads combined with satellite altimetry data offshore. The second data set is the newly released EIGEN-6C4 which combines the latest satellite data with ground measurements. The spherical harmonics maximum degree of EIGEN-6C4 is 2190 which corresponds to a surface resolution of approximately 10 km.

There are 'pros' and 'cons' for each dataset depending on the regional extent of the target to be modelled. The EIGEN-6C4 can clearly improve the overall regional structure of the model as for instance artefacts as well as errors in areas with less data coverage could be removed. But on a more local scale the resolution of this dataset is still too low to resolve structures related to seismic hazard. Here the terrestrial data is needed to connect seismic segment boundaries and asperities with the varying thickness of high density batholiths underneath the coastal area. And thus relate these structures to the distribution of high energy release in large earthquakes.