Geophysical Research Abstracts
Vol. 15, EGU2013-945, 2013
EGU General Assembly 2013

3D temperature model of south-western South America

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Temperature (T) and pressure (P) control the thermodynamics and physico-chemical behavior of Earth materials. PT conditions regulates by one side the type and relative amount of minerals forming a rock for a given chemical composition, and by the other also the physical properties of these minerals. Therefore, knowledge about the internal thermal structure of the lithosphere is fundamental in order to predict spatial variations on primary rocks properties, which further regulate the geodynamic behavior of plates, their thermomechanic configuration and tectono-magmatic evolution. Due to this fundamental role, increasing efforts are being dedicated to generate reliable models of temperature distribution inside the lithosphere for different tectonic regions of the planet. Such models should include a sufficiently large number of good-quality and well-distributed surface heat flow measurements that can be used to invert geothermal gradients. However, most of the world, including the south-western margin of South America, lack such measurements and other indirect approaches must be applied in order to derive the thermal structure. Here we present a regional-scale thermal model for the Andean margin between 18ºS and 45ºS. This model is based on an exisiting 3D geological model for this region that unifies a large geophysical database (seismicity, 2D and 3D seismic velocity models, receiver functions, land- and satellite-derived gravity) into a lithospheric-scale representation of the geometry for main geotectonic discontinuities like the subducted slab upper surface, the lithosphere-astenosphere boundary (LAB), continental crust-mantle boundary (Moho) and intracurstal discontinuity (ICD). From a regularly gridded interpolation of these geometries at a spatial resolution of 15 km, we computed at each grid node a 1D geothermal gradient that we then merged to create the 3D thermal structure. We assume that the lithosphere geotherm is defined by heat conduction with radioactive heat production regulated by the compositional structure of crust and mantle, and impose that the temperature at the base of the continental lithosphere is dictated by a particular condition. For the region east to the intersection of LAB with the subducted slab, we assume that the LAB correspond to the intersection of a adiabatic astenosphere with the conductive lithosphere and take its temperature as defined by the potential temperature of the adiabat at the surface and a constant adiabatic gradient. The thermal structure at the forearc region to the west of LAB-Slab intersection is defined by the temperature at the plate interface, which we compute considering the heat flow coming from the subducted plate, fault friction and a reduction factor that depends on convergence velocity and subduction geometry. We have tested different combinations of the many parameters involved in defining the model and compared the resulting values of surface heat flow against a compiltation of measurements in order to evaluate the performance of the models. Our preferred model fits most of the data and we will show here some examples of the usefulness of the model for estimating the geothermal energy potential of the region and the understanding of the thermomechanic behavior of the lithosphere in relation with active magmatism and tectonics.