Temperature structure of the Andean subduction zone as derived from the 3D geometry of crustal and upper mantle discontinuities

Andres Tassara¹, Joaquin Julve¹, Iñigo Echeverría¹, and Ingo Stotz²

¹Universidad de Concepcion, Departamento Ciencias de la Tierra, Concepcion, Chile (andrestassara@udec.cl)
²University of Kopenhagen, Denmark

The distribution of temperature inside active continental margins plays a fundamental role on regulating first order geodynamic processes as the isostatic balance, rheologic behavior of crust and mantle, magmagenesis, volcanism and seismogenesis. In spite of these major implications, well-constrained 3D thermal models are known for few regions of the world (Europe, Western USA, China) where large geophysical databases have been integrated into compositional and structural models of crust and lithospheric mantle from which a thermal model is derived. Here we present a three-dimensional representation of the distribution of temperature underneath the Andean active margin of South America (10°-45°S) that is based on a geophysically-constrained model for the geometry of the subducted slab, continental lithosphere-asthenosphere boundary (LAB), Moho discontinuity and an intracrustal discontinuity (ICD). This input model was constructed by forward modelling the satellite gravity anomaly under the constraint of most of the seismic information published for this region. We use analytical expressions of 1D conductive continental geotherms with adequate boundary conditions that consider the compositional stratification of crust and mantle included in the input model, and the advective thermal effect of slab subduction. The 1D geotherms are assembled into a 3D volume defining the thermal structure of the study region. We test the influence of several thermal parameters and structural configurations of the Andean lithosphere by comparing the resulting surface heat flow distribution of these different models against a database containing heat flow measurements that we compile from the literature. Our results show that the thermal structure and derived surface heat flow is dominantly controlled by the geometry of the thermal boundary layer at the base of the lithosphere, i.e. the slab upper surface below the forearc and LAB inland. Variations on the modeled configuration of the continental lithosphere (i.e. the way on which the geometry of the continental Moho and ICD are considered into the definition of a space-variable thermal conductivity or the length scale for radiogenic heat production) have an effect on surface heat flow that is lower than the average uncertainty of the measurements and therefore can be considered as second-order. The simplicity of our analytical approach allows us to compute hundreds of different models in order to test the sensitivity of results to changes on thermal parameters (conductivity, heat production, mantle potential temperature, etc), which provides a tool for discussing their possible range of values in the context of a subduction margin. We will also show how variations of these models impact on the Moho temperature and therefore in the expected mechanical behavior of crust and mantle in this geotectonic context.