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Rheology of rocks at convergent plate boundaries: Thermal-mechanical coupling

T.V. Gerya (1)

(1) Geophysical Fluid Dynamics Group, Institute of Geophysics, Department of Geosciences, ETH-Zurich, Switzerland (taras.gerya@erdw.ethz.ch)

Convergent plate boundaries are sites of significant magmatic and seismic activity associated with strong deformation and intense heat and mass transfer. Plate interaction along these boundaries involves several major plate tectonic processes such as subduction, continental collision, lithospheric delamination, slab breakoff etc. Since direct observation of these processes on human time scale is very limited progress in their understanding depends crucially on numerical geodynamic modelling approaches. In turn, predictive power of this modelling depends on our knowledge of rheology of rocks under conditions of strong variations in physical parameters, especially temperature. Increase in temperature causes exponential lowering of viscosity of rocks and therefore temperature variations strongly affect styles and intensity of lithospheric deformation. Due to the thermal feedback from dissipation of mechanical energy deformation and temperature in plate convergence zones can be strongly coupled which is especially relevant for higher convergence rates. We studied this thermal-mechanical coupling on the basis of geochemical-petrological-thermomechanical numerical experiments. Numerical method allows simultaneous modelling of plate deformation and shear heating with realistic visco-elasto-plastic rheology, heat and mass transfer, phase transformations, volatiles and magmas transport. Three major plate tectonic settings are addressed: (1) intraoceanic subduction, (2) active continental margins and (3) continental collision zones.