Geophysical Research Abstracts
Vol. 12, EGU2010-9306-1, 2010
EGU General Assembly 2010

Effect of horizontal mantle flow on subduction dynamics: insights from 2D and 3D numerical modeling.

Juan Rodriguez-Gonzalez (1), Ana M. Negredo (1), Eugenio Carminati (2,3)

(1) Departamento de Geofísica y Meteorología, Facultad de CC. Físicas, Universidad Complutense de Madrid, Spain (juan.rodriguez@fis.ucm.es), (2) Dipartimento di Scienze della Terra, Università di Roma "La Sapienza", Roma, Italy, (3) Istituto Geologia ambientale e Geoingegneria – CNR, Roma, Italy

The existence of a relative flow between upper mantle and lithospheric plates has been a matter of debate for the last years. It has been argued that, If hotspots are assumed to be of deep origin, some plates move eastward with respect to the mantle, but if hotspots are shallow sourced then all the plates move westward. This westward motion of plates would result in an eastward-directed mantle flow, which opposes or accompanies subduction depending on its polarity. In fact some authors suggest that geological and geophysical observations indicate that the interaction between the slab and this mantle flow strongly controls the characters of subduction-related orogens and slabs. However, no consensus has been reached on this issue.

The influence of this hypothetical mantle flow (either global or regional) on the dynamics of subduction has not been extensively explored through numerical modeling before. We address this subject in 2D and 3D numerical simulations of the dynamic evolution of subduction processes. We impose a sublithospheric horizontal flow as a boundary condition, and investigate the effects on subduction dynamics of varying the velocity and direction of this imposed flow.

2D models show that the influence of a horizontal sublithospheric mantle flow is stronger in the deeper part of the slab. As the plate sinks into the asthenosphere, the mantle flow is channeled between the tip of the slab and the top of the lower mantle (ten times more viscous than the overlaying mantle) causing a dramatic increase of flow velocity in this region. Therefore, slab dip is either increased or decreased depending on the sense of the imposed flow, and its effect increases with slab depth.

We have developed instantaneous 3D models to evaluate the importance of toroidal and poloidal components of flow in the process. We have measured these components for different slab widths and depths, showing that toroidal flow increases with the slab depth. We infer from comparison with 3D models, that 2D models overestimate the effect of mantle flow on slab dip, as material is not allowed to flow around the slab edges. However, these 3D models highlight that the effect of the imposed horizontal mantle flow on slab dip is still significant.