Geophysical Research Abstracts
Vol. 12, EGU2010-8548-1, 2010
EGU General Assembly 2010

From flat to steep subduction: The role of thermal state of overriding plate on subduction dynamics.

Juan Rodriguez-Gonzalez (1), Ana M. Negredo (1), and Mágali I. Billen (2)

(1) Departamento de Geofísica y Meteorología, Facultad de CC. Físicas, Universidad Complutense de Madrid, Spain (juan.rodriguez@fis.ucm.es), (2) Department of Geology University of California, Davis, USA

Slab dip varies significantly, both between different, and along single subduction zones. Such variations have been investigated and explained to be the result of either 1) a balance between the downward torque on the slab due to its weight and the upward torque exerted by suction forces from the induced corner flow in the viscous mantle wedge or 2) motion of the overriding plate relative to the trench.

Provided that old subducting plates are colder and denser than young plates, variations in the slab dip should correlate with slab age. However, recent statistical analyses do not find this expected correlation. Instead, several counterexamples show shallow angle subduction for old plates and steeper subduction for young slabs. Also the occurrence of long flat subducting segments is not completely understood, as the conditions proposed for flat subduction, namely buoyant oceanic plateaus and/or rapid trenchward motion of the overriding plate, are not always fulfilled.

Whereas the effect of the thermal state of the subducting plate on slab dip has been widely studied by means of numerical modeling, the influence of the thermal state of the overriding plate remains poorly elucidated. This thermal state is expected to significantly influence the suction force in the mantle wedge, by means of the temperature dependence of the viscosity.

We present the results of numerical dynamic models of subduction along 2D vertical sections. Equations of conservation of mass, momentum and energy for a 2D incompressible fluid are solved. We have assumed a non-Newtonian rheology, using a power law viscosity for which different rheological parameters have been tested. We have run several simulations in which we vary the age of the overriding and subducting plates in order to test its effect on the slab dip. As expected, older subducting plates lead to steeper slab dips. Moreover, colder overriding plates result in shallower slab dips, because the viscosity in the mantle wedge is higher, thus increasing the suction force in the mantle wedge. We successfully reproduce steep subduction of very young lithosphere provided that the overriding plate is hot enough to prevent significant corner flow suction. We also reproduce the occurrence of flat subduction for cold overriding plates. A thin layer of high strain rate is created between the upper surface of the slab and the base of the overriding plate. This layer of reduced viscosity decouples both plates allowing long flat segments to form.