Geophysical Research Abstracts, Vol. 8, 04692, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04692

Consequences of STEP's in the Calabrian subduction region

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The southern Tyrrhenian is a back-arc basin associated with roll back of the Calabria trench zone in a region of slow convergence between the African and the European plates. Seismic activity and tomography indicate that in the present situation subduction is restricted to the Calabrian arc, showing a narrow west dipping slab attached to the Ionian lithosphere. For subduction to continue, tearing of oceanic lithosphere at the horizontal termination of the trench is a geometric consequence. We refer to this relatively common feature in plate tectonics as a Subduction-Transform Edge Propagator, or STEP. STEP propagation may result in substantial deformation, rotation and topography, with a very specific time-space evolution. Here we investigate the consequences of slab edges and STEP faults on the dynamics of the lithosphere and the uppermost mantle of the Calabrian subduction system through 3D numerical models. We solve for mechanical equilibrium and investigate the response to density sinking of the slab combined with the observed plate velocity between continental Africa and Europe.

The effect of STEP propagation is assessed by comparing subduction models with locked and free continuations of the STEP fault, in a setting which is remotely reminiscent of the Calabrian subduction region. Those two cases are respectively representative for a situation in which tearing of the lithosphere has not (yet) occurred and a situation where resistance to tearing is negligible. Stress build up at the STEP's, compression in the overriding plate and vertical sinking of the slab and overriding plate are characteristics of the locked STEP model.

Based on regional geometry data, we next constructed a model more specifically for the Calabrian subduction zone, with the specific aim to compare model predictions with local and regional observations. This model includes STEP faults on both the

northern and southern ends of the Tyrrhenian Sea, including a part of the Malta Escarpment. The preliminary result we present are based on a linear visco-elastic rheology. The locked STEP's result in an evolution of the surface response in time, as the relative importance of the involved forces changes. Effective stresses in the overriding plate will lead to back-arc extension at first, followed by compression. As no compression has been observed in the Tyrrhenian sea STEP propagation should occur before this point. We propose a situation in which roll-back through STEP propagation of the Calabrian slab shows periodicity, divided in two phases: 1) a phase of loading during which the STEP's are locked, as implemented in our model. 2) STEP propagation releasing the stress in a relatively short time and enabling the slab to sink further.