Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07258, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07258
EGU General Assembly 2008

A kinematic model for the Apennines as the crustal manifestation of a retreating subduction zone

S.D. Willett (1), M.T. Brandon (2), F.J. Pazzaglia (3), R.A. Bennett (4), and N. Fay (4)

(1) Dept. of Earth Sciences, ETH-Zurich, Zurich, Switzerland, (2) Dept of Geology and Geophysics, Yale University, New Haven, CT, USA, (3) Dept. of Earth and Environmental Science, Lehigh University, Bethlehem, PA, USA, (4) Dept. of Geosciences, Univ. of Arizona, Tuscon, AZ, USA.

Extension of the upper plate above subduction zones is common throughout the Mediterranean. Although the geodynamical process is loosely associated with slab sinking or rollback into the mantle and absolute retreat of the upper plate away from the subduction boundary, important questions remain as to how this geodynamic process manifests itself into upper plate deformation. Recent geomorphic, structural and geodetic studies of the northern Apennines of Italy illustrate this situation well. The NE front of the Apennines presently exhibits active shortening in response to Adriatic subduction whereas the range crest and western flanks of the range undergoing horizontal extension related to the upper plate stretching. We present kinematic and dynamic models for this setting to explain (1) how mantle kinematics are translated into crustal strain and (2) how the crustal strain is distributed with closely juxtaposed extension and contraction. Mantle deformation beneath the Apennines can be partitioned into subduction-driven corner flow and a horizontal stretching component due to rollback of the slab relative to a stable point in the upper plate. Superposition of these flow fields produces a stagnation point beneath the upper plate where upwelling mantle impinges on the plate and diverges. This serves as the locus of mantle extension of the upper plate. Surface strain, however, depends on how that deformation is transmitted through the crust. We use viscous-plastic finite element models to demonstrate how the crust responds to simultaneous, but spatially separated, contraction and

extension of the underlying mantle. The models reproduce regions of contraction and extension with their proximity being a function of the mantle displacement field, and the size of the orogenic crustal welt. A particularly important effect is produced by including laminated crustal strength. With a mid-crustal detachment, extension of the mantle can be transmitted tens of kilometers laterally to produce shallow crustal extension. Shallow extension is encouraged by topographic gradients and the system thus develops a strain pattern with a contractional orogen developing high topography, and shallow crustal extension destroying that topography and translating the crustal extension into the ‘backarc’ where deep plate extension occurs. The system achieves a near steady-state with deep structural underplating underlying shallow crustal extension, but we emphasize that this occurs only in the case where an intra-crustal detachment is present to transfer extensional strain to the mantle extension locus. In the case of the Apennines this model fits available geodetic, geomorphic and structural data well. Contraction is constrained to the deep frontal (NE) part of the orogenic wedge. Extension occurs above this underplating zone at the highest elevations of the Apennines and a mid-crustal detachment serves to separate these regions and translate the extensional strain westward to the margin of the Tyrrhenian Sea, where we propose mantle extension to be localized. The lack of a distinct geodetic signal is explained by this depth reversal in strainrate, and the uplift pattern as well as the structural history of contraction followed by extension are well explained by this kinematic model.