Geophysical Research Abstracts
Vol. 14, EGU2012-10872, 2012
EGU General Assembly 2012

The role of rock anisotropy in developing non-Andersonian faults: staircase trajectories for strike-slip faults

M.R. Barchi, C. Collettini, and G. Lena
Perugia University, Italy (mbarchi@unipg.it)

Thrust and normal faults affecting mechanically heterogeneous multilayers often show staircase trajectories, where flat segments follow less competent units. Within flat segments the initiation/reactivation angle, θ, which is the angle that the fault makes with the $\sigma 1$ direction, is different from that predicted by the Andersonian theory. This suggests that fault trajectory is mainly controlled by rock anisotropy instead of frictional properties of the material. Our study areas are located in the Umbria-Marche fold-thrust belt, within the Northern Apennines of Italy. The area is characterized by a lithologically complex multilayer, about 2000 m thick, consisting of alternated competent (mainly calcareous) and less competent (marls or evaporites) units. At the outcrop scale, some units show a significant mechanical layering, consisting of alternated limestones and shales. Due to the complex tectonic evolution of the Apennines, well developed sets of conjugate normal, thrust and strike-slip faults are exposed in the region.
The study outcrop, Candigliano Gourge, is characterized by steep (dip > 60°) NE dipping beds, affected by conjugate sets of strike-slip faults, exposed in the eastern limb of a NE verging anticline. The faults develop within the Marne a Fucoidi Fm., a Cretaceous sedimentary unit, about 70 m thick, made of competent calcareous beds (about 20 cm thick), separated by marly beds (1-20 cm thick). The conjugate strike-slip faults are formed after the major folding phase: in fact the strike-slip faults cut both minor folds and striated bedding surfaces, related to syn-folding flexural slip.
Faults show marked staircase trajectories, with straight segments almost parallel to the marly horizons and ramps cutting through the calcareous layers. Slip along these faults induces local block rotation of the competent strata, dilational jogs (pull-aparts), extensional duplexes and boudinage of the competent layers, while marly levels are strongly laminated. In order to reconstruct the $\sigma 1$ direction, calcite veins syntectonic to strike-slip faulting, have been used to constrain the $\sigma 1$–$\sigma 2$ plane: fixing the $\sigma 2$ direction at the conjugate fault intersection, the $\sigma 1$ is oriented N15°, forming an angle of about 70° with the bedding direction. Once constrained the $\sigma 1$ direction, we have calculated the θ angle that is comprised between 40° and 55°, resulting therefore larger than expected from Andersonian theory, i.e. 22°-32° for friction coefficient in the range of 0.5-1.0. Initiation/reactivation angles, θ, as a function of the different lithologies, are less than 35° for calcareous beds, 50°-70° for the marly and clayey layers, and around 60° for the black shales.
Our studies, focused on strike-slip small displacement faults, show that: 1) irrespective of the $\sigma 1$ orientation, ramp and flat form along competent and less competent material respectively and 2) the overall fault orientation/initiation is at high-angle to the $\sigma 1$ direction.
Our results suggest that rock anisotropy and layering are one of the possible causes for faulting at high angle to the $\sigma 1$ direction, i.e. fault weakness. Further studies are required to up-scale the results of our outcrop-based study to crustal scale structures.