Geophysical Research Abstracts
Vol. 19, EGU2017-16146, 2017
EGU General Assembly 2017

3D multi-scale velocity structure of an active seismogenic normal fault zone (Central Apennines, Italy)

Michele Fondriest (1), Tom Mitchell (2), Maurizio Vassallo (3), Giuseppe Di Giulio (3), Fabrizio Balsamo (4), Francois Passelegue (1), Marta Pischiutta (3), Giulio Di Toro (1,3,5)

(1) School of Earth and Environmental Sciences, University of Manchester, Manchester, UK, (2) University College of London, Earth Sciences Department, London, UK, (3) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy, (4) Dipartimento di Fisica e Scienze della Terra, University of Parma, Parma, Italy, (5) Dipartimento di Geoscienze, University of Padova, Padua, Italy

The characterization of physical properties of fault zones (e.g., ultrasonic velocities, elastic moduli, porosity and fracture intensity of the fault zone rocks) is a relevant topic in reservoir geology (exploration and exploitation) and fault mechanics, for the modelling of both long-term quasi-static and fast dynamic fault zone evolution with time. Here we characterized the shallow subsurface velocity-elastic structure of the active Vado di Corno normal fault zone (Campo Imperatore, Central Apennines, Italy) which is up to > 300 m thick. Based on a detailed structural mapping of the fault footwall block covering a $\sim$ 2 km long fault segment, four main structural units separated by principal fault strands were recognized: (i) cataclastic unit, (ii) breccia unit, (iii) high-strain damage zone, (iv) low-strain damage zone. The single units were systematically sampled along a transect ($\sim$ 200 m) orthogonal to the average strike of the fault and characterized in the laboratory in terms of petrophysical properties (i.e. Vp, Vs, static and dynamic elastic moduli, porosity). The cataclastic and breccia units (Vp = 4.68$\pm$0.43 kms-1, Vs = 2.68$\pm$0.24 kms-1) were significantly "slower" compared to the damage zone units (Vp = 5.43$\pm$0.53 kms-1, Vs = 3.20$\pm$0.29 kms-1). A general negative correlation between ultrasonic velocity and porosity values was reported. Moreover three dimensional acoustic anisotropy was quantified within the different units with respect to the mapped fault strands, and related to the deformation fabrics (i.e. open fractures, veins) observed at the sample scale.

A Vp - Vs seismic refraction tomography was then performed in the field along a profile ($\sim$ 90 m) across the fault zone. The tomographic results clearly illuminated fault-bounded rock bodies characterized by different velocities (i.e. elastic properties) and geometries which match with the ones deduced from the structural analysis of the fault zone exposures.

Fracture intensity measurements (both at the sample and outcrop scale) were performed to investigate the scaling relation between laboratory and field measurements. These results were then coupled with ultrasonic velocity vs. confining pressure (0-30 MPa) profiles measured in the laboratory to extrapolate the subsurface velocity structure of the fault zone to larger depths (up to $\sim$ 1 km). The final dataset of physical properties was used to build a three dimensional velocity-elastic model of the Vado di Corno fault zone based on the fault zone structure inferred from the mapping.

This type of studies are extremely relevant to better understand the petrophysical evolution and geophysical expression of active fault zones during the seismic cycle and represent the base for modern and robust fault mechanics models developed both in quasi-static or dynamic rupture scenarios.