Geophysical Research Abstracts
Vol. 18, EGU2016-12590, 2016
EGU General Assembly 2016

Hydraulic structure of a fault zone at seismogenic depths (Gole Larghe Fault Zone, Italian Southern Alps)

Andrea Bistacchi (1), Silvia Mittempergher (1), Giulio Di Toro (2,3), Steve Smith (4), Paolo Garofalo (5), and Alice Vho (1)

(1) Università degli Studi di Milano Bicocca, Department of Earth and Environmental Sciences, Milano, Italy (andrea.bistacchi@unimib.it), (2) Università degli Studi di Padova, Dipartimento di Geoscienze, Padova, Italy, (3) University of Manchester, School of Earth, Atmospheric & Environmental Sciences, Manchester, UK, (4) University of Otago, Geology Department, Dunedin, New Zealand, (5) Università degli Studi di Bologna, Bi.Ge.A. Department, Geological & Environmental Sciences Section, Bologna, Italy

The Gole Larghe Fault Zone (GLFZ, Italian Southern Alps) was exhumed from c. 8 km depth, where it was characterized by seismic activity (pseudotachylytes), but also by hydrous fluid flow (alteration halos and precipitation of hydrothermal minerals in veins and cataclasites). Thanks to glacier-polished outcrops exposing the fault zone over a continuous area > 1 km2, the fault zone architecture has been quantitatively described with an unprecedented detail (Bistacchi 2011, PAGEOPH; Smith 2013, JSG; Mittempergher 2016, this meeting), providing a rich dataset to generate 3D Discrete Fracture Network (DFN) models and simulate the fault zone hydraulic properties.
Based on field and microstructural evidence, we infer that the opening and closing of fractures resulted in a toggle-switch mechanism for fluid flow during the seismic cycle: higher permeability was obtained in the syn- to early post-seismic period, when the largest number of fractures was (re)opened by off-fault deformation, then permeability dropped due to hydrothermal mineral precipitation and fracture sealing. Since the fracture network that we observe now in the field is the result of the cumulative deformation history of the fault zone, which probably includes thousands of earthquakes, a fundamental parameter that cannot be directly evaluated in the field is the fraction of fractures-faults that were open immediately after a single earthquake.
Postseismic permeability has been evaluated in a few cases in the world thanks to seismological evidences of fluid migration along active fault systems. Therefore, we were able to develop a parametric hydraulic model of the GLFZ and calibrate it, varying the fraction of faults/fractures that were open in the postseismic period, to obtain on one side realistic fluid flow and permeability values, and on the other side a flow pattern consistent with the observed alteration/mineralization pattern. The fraction of open fractures is very close to the percolation threshold of the DFN, and under these conditions the permeability tensor is strongly anisotropic, resulting in a marked channelling of fluid flow in the inner part of the fault zone.
Amongst possible seismological applications of our study, we will discuss the possibility to evaluate the coseismic fracture intensity due to off-fault damage, a fundamental mechanical parameter in the energy balance of earthquakes.