Geophysical Research Abstracts
Vol. 13, EGU2011-8261, 2011
EGU General Assembly 2011

The geochemical signature of carbonate-hosted seismogenic faults

Nicola De Paola (1), Giovanni Chiodini (2), Takehiro Hirose (3), Carlo Cardellini (4), Stefano Caliro (2), and Toshihiko Shimamoto (5)

(1) University of Durham, Earth Sciences, Durham, United Kingdom (nicola.de-paola@durham.ac.uk, +44 0191 3342301), (2) Osservatorio Vesuviano, Istituto Nazionale di Geofisica e Vulcanologia, Naples, Italy, (3) Kochi Institute for Core Sample Research, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan, (4) Dipartimento di Scienze della Terra, Universita' di Perugia, Perugia, Italy, (5) Institute of Geology, China Earthquake Administration, Beijing, China

Laboratory experiments have been performed at sub- ($\approx$ 0.01 m/s) to seismic slip rates (>1 m/s) on dolomite gouges of the Triassic Evaporites in Northern Apennines (Italy), which hosted the 1997 Colfiorito Mw $\leq$ 6 earthquakes.

Experimental faults are lubricated as marked falls in the steady state sliding friction coefficients, $f \approx 0.1$, is observed at seismic slip rates, as opposed to values of $f \geq 0.6$ attained for sub-seismic slip rates. Fault lubrication was associated with decarbonation reactions and CO2 emissions triggered by frictional heating in the experimental slip zone which produced: 1) new and exotic mineral phases (e.g. Mg-calcite, periclase/brucite, lime/portlandite); 2) isotopic fractionation between the newly generated and the original mineral phases.

When extrapolated to natural seismic fault conditions, experimental results show that coseismic release of CO2 can represent a shallow and localised source of very high fluid fluxes in the brittle crust, comparable to measured fluxes from deeper sources (e.g. mantle degassing). Modelling results show that when large amounts of coseismically released CO2 interact with deep saline aquifers, the geochemical signature produced may be very weak and difficult to detect in groundwater. Conversely, it should be possible to measure and monitor the geochemical signature of large amounts of coseismically released CO2 which are directly dissolved in shallow, less saline aquifers.

We conclude that the integration of microstructural/mineralogical observations and geochemical data from experimental faults allow the definition of a distinct and measurable geochemical signature associated with high temperature physical-chemical processes. During earthquake propagation in natural carbonate fault zones, the operation of the same processes observed in the laboratory can: a) release significant amounts of CO2, which are comparable to those released by deeper sources (e.g. mantle degassing); b) represent a relatively shallow and localised source of very high fluid fluxes of CO2 in the brittle crust; c) produce groundwater post-seismic geochemical signatures which can potentially be measured and monitored, depending on the geochemical nature of the aquifers present at different depths.

The integration of results from laboratory experiments, performed at seismic condition in carbonate rocks, and geochemical analyses can: a) aid in the development and calibration of monitoring strategies of geochemical properties of water in seismically active areas; b) provide insights into seismic fault zone processes (e.g. constraints on the coseismic temperatures).