CO_2 in the seismic cycle: provenance, migration and sequestration in fault zones

(Proposer Prof. Raffaele Sassi)

Understanding the circulation of fluids in the Earth's crust is essential for a wide range of geological and environmental processes, as well as for the sustainable management of natural resources and the assessment of seismic hazard. CO_2 gained increasing interest for several reasons including its origin and circulation, and relative influence on the CO_2 global budget, as well as CO_2 storage.

The main source of natural CO_2 has been identified in the mantle; however, the decarbonation of carbonate rocks may produce significant amounts of CO_2. The origin and the circulation of CO_2 is likely affected by several mechanisms such as mixing with resident fluids, CO_2 sorption and dissolution, rock-water-gas interaction, and, in the seismic cycle, frictional heating and mechanochemical processes which induce temporal changes in fluid geochemistry. These mechanisms affect production and migration of CO_2-enriched fluids through fractures and faults with consequences on CO_2 concentration and isotopic composition in soil gas and dissolved in spring water, and on aftershock migration during seismic sequences. Lastly, CO_2 is a radon carrier. Given that radon is the main source of ionizing radiation related to indoor air quality understanding the relation between radon and CO_2 is relevant for reducing risks to radon exposure.

Here we propose a deep exploration into the interaction between CO_2 enriched-fluids and rocks along faults and fractures through laboratory experiments and field measurements in selected fault zones. Two possible study areas, characterized by different host rocks and faulting regimes, can be possibly considered: crystalline-basement rocks and strike-slip regime (Pusteria Valley, Eastern Italian Alps) and carbonate sequences and normal slip regime (Central & Northern Italian Apennines).

The Ph.D. candidate will conduct experiments and analyses using facilities available at INGV and Department of Geosciences which include:

(1) a permeameter, designed to study fluid-rock interaction in both intact and saw cut rocks at crustal conditions at 2-3 km depths; (2) rotary shear machines (SHIVA at INGV-Rome and ROSA&HYDROS at the Dept. of Geosciences), also equipped with mass spectrometers and devices for fluid recovery designed to study friction and fluid-rock interaction in cohesive and non-cohesive rocks over a wide range of loading (normal stress, stain rate, etc.) and ambient temperature (20 to 500°C) and fluid pressure conditions (up to 70 MPa); (3) equipment for microstructural (micro-CT and dual beam FIB-FEG-STEM equipped with WDS, EDS, EBSD and CL analysers), mineralogical (XRD, micro-Raman, etc.), microanalytical-geochemical (XRF, FTIR, ICP-MS, etc.), and isotopic characterization, and (4) real-time soil-gas monitoring equipment.

These results will be used to determine the proportion of CO_2 released from the crust vs. the CO_2 released from the mantle, the interaction between minerals and CO_2-rich fluids in open fractures, and the mechanisms and rates of CO_2 production during faulting.

Scientific Collaborations

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Available funds

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