EGU24-15776, updated on 18 Dec 2024
https://doi.org/10.5194/egusphere-egu24-15776
EGU General Assembly 2024

Microcomputed Tomography Unravels CO_2-fluid/rock Interaction in Elba's Carbonated Serpentinites

Roberto Emanuele Rizzo[1], Samuele Papeschi[2], Edoardo Baroncini[1], and Paola Vannucchi[1]
[1]Department of Earth Sciences, University of Florence, Florence, Italy (robertoemanuele.rizzo@unifi.it)
[2]Institute of Geosciences and Georesources, CNR, Florence, Italy

Carbonation of serpentinites is a crucial factor in controlling the earthquake cycle in subduction zones. Serpentinites are commonly found within subduction zones, both in the mantle wedge above subducting slabs and on the incoming plate, formed from peridotites exposed directly on the ocean floor. Carbonation of these serpentinites often results from the “contamination” of CO_2-rich fluids derived from sediments involved in the subduction. This process leads to the formation of carbonate minerals within the serpentinite, which in turn influences the mechanical properties of the rock. A critical factor affecting the spatial and temporal progress of carbonation reactions - and thus their potential to trigger mechanical instabilities at the plate boundary - is the emergence of a permeable network of cracks and pores, which facilitates the interaction of CO_2-rich fluids with the serpentinite rocks.

We present a detailed three-dimensional (3D) characterization of variously carbonated serpentinite samples through computed microtomographic (μCT) imaging integrated with a machine learning algorithm (i.e. Random Forest classifier) to segment the different mineral phases. Machine learning offers a robust and accurate means of identifying and quantifying the carbonate phases, leveraging the Random Forest capacity for handling complex, multidimensional data. This allows for a comprehensive 3D examination of the alteration phases affecting the serpentinite samples and provides quantitative insights into the volumes and geometries of the carbonate vein networks. Our focus is on samples from an exhumed subduction channel separating the fossil Cretaceous – Eocene accretionary prism (Ligurian Units) from the continent-derived nappes of the Northern Apennines. The subduction channel, part of the Norsi – Cavo Complex, is exposed over approximately 10 km along the N-S strike on the Island of Elba, consisting of oceanic sediments and ultramafic rocks detached from the prism base. Our analyses reveal that carbonation preferentially follows pre-existing serpentine veins, exploiting inherent anisotropies in the rock. In addition, the geometry of the vein network, as illuminated by the μCT 3D data, can help us to correlate with the carbonation timescale and fluid fluxes, as inferred from geochemical data.

The presence of carbonate-rich fluids can be responsible for increasing pore-fluid pressure, pushing the rock toward failure. The formation of extensive carbonate vein networks can also lead to a net volume increase in the original serpentinite, thus increasing instability. The observed

preferential distribution of carbonates along pre-existing structures not only provides crucial insights into the mechanics of subduction zones but also offers valuable implications for CO_2storage models, highlighting potential fluid migration and reaction pathways.