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Physical and Transport Properties of the carbonate-bearing faults: experimental insights from the Monte Maggio Fault zone (Central Italy)

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Physical properties of fault zones vary with time and space and in particular, fluid flow and permeability variations are strictly related to fault zone processes.
Here we investigate the physical properties of carbonate samples collected along the Monte Maggio normal Fault (MMF), a regional structure (length ∼10 km and displacement ∼500 m) located within the active system of the Apennines. In particular we have studied an exceptionally exposed outcrop of the fault within the Calcare Massiccio formation (massive limestone) that has been recently exposed by new roadworks. Large cores (100 mm in diameter and up to 20 cm long) drilled perpendicular to the fault plane have been used to: 1) characterize the damage zone adjacent to the fault plane and 2) to obtain smaller cores, 38 mm in diameter both parallel and perpendicular to the fault plane, for rock deformation experiments.
At the mesoscale two types of cataclastic damage zones can be identified in the footwall block (i) a Cemented Cataclasite (CC) and (ii), a Fault Breccia (FB). Since in some portions of the fault the hangingwall (HW) is still preserved we also collected HW samples. After preliminary porosity measurements at ambient pressure, we performed laboratory measurements of Vp, Vs, and permeability at effective confining pressures up to 100 MPa in order to simulate crustal conditions.
The protolith has a primary porosity of about 7 %, formed predominantly by isolated pores since the connected porosity is only 1%. FB samples are characterized by 10% and 5% of bulk and connected porosity respectively, whilst CC samples show lower bulk porosity (7%) and a connected porosity of 2%. From ambient pressure to 100 MPa, P-wave velocity is about 5,9-6,0 km/s for the protolith, ranges from 4,9 km/s to 5,9 km/s for FB samples, whereas it is constant at 5,9 km/s for CC samples and ranges from 5,4 to 5,7 for HW sample. Vs shows the same behaviour resulting in a constant Vp/Vs ratio from 0 to 100 MPa that ranges from 1,5 to 1,98 where the lower values are recorded for FB samples. Permeability of FB samples is pressure dependent starting from 10-17 m2 at ambient pressure to 10-18 m2 at 100 MPa confining pressure. In contrast, for CC samples, permeability is about 10-19 m2 and is pressure independent.
In conclusion, our dataset depicts a fault zone structure with heterogeneous static physical and transport properties that are controlled by the occurrence of different deformation mechanisms related to different protolites. At the moment we have been conducting experiments during loading/unloading stress cycles in order to characterize possible permeability and acoustic properties evolution induced by differential stress.