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3D pore-network analysis and permeability estimation of deformation bands hosted in carbonate grainstones.

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In porous rocks strain is commonly localized in narrow Deformation Bands (DBs), where the petrophysical properties are significantly modified with respect the pristine rock. As a consequence, DBs could have an important effect on production and development of porous reservoirs representing baffles zones or, in some cases, contribute to reservoir compartmentalization. Taking in consideration that the decrease of permeability within DBs is related to changes in the porous network properties (porosity, connectivity) and the pores morphology (size distribution, specific surface area), an accurate porous network characterization is useful for understanding both the effect of deformation banding on the porous network and their influence upon fluid flow through the deformed rocks.
In this work, a 3D characterization of the microstructure and texture of DBs hosted in porous carbonate grainstones was obtained at the Elettra laboratory (Trieste, Italy) by using two different techniques: phase-contrast synchrotron radiation computed microtomography (micro-CT) and microfocus X-ray micro-CT. These techniques are suitable for addressing quantitative analysis of the porous network and implementing Computer Fluid Dynamics (CFD)experiments in porous rocks.
Evaluated samples correspond to grainstones highly affected by DBs exposed in San Vito Lo Capo peninsula (Sicily, Italy), Favignana Island (Sicily, Italy) and Majella Mountain (Abruzzo, Italy). For the analysis, the data were segmented in two main components porous and solid phases. The properties of interest are porosity, connectivity, a grain and/or porous textural properties, in order to differentiate host rock and DBs in different zones. Permeability of DB and surrounding host rock were estimated by the implementation of CFD experiments, permeability results are validated by comparing with in situ measurements.
In agreement with previous studies, the 3D image analysis and flow simulation indicate that DBs could be constitute of zones with compaction, cementation and cataclasis; where porosity, pores connectivity and permeability are reduced. However, some structures such as fractures and dissolution surfaces can ease the fluid flow.

Keywords: Deformation bands, X-ray computed tomography, Permeability.