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Scaling relationships and permeability structures of fault zones crosscutting tight Cretaceous platform carbonates (Murge Plateau, southern Italy)

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Fault zones may exert a first-order control on fluid flow by acting either as a barrier and/or conduit in the subsurface. Faults often include highly fractured damage zones encompassing cataclastic bodies (fault core) where most of the deformation is localized. Especially in tight carbonates, both porosity and permeability significantly increase within the fault damage zones, while the fault cores behave as a hydraulic barrier for cross-fault fluid flow. The general validity of this hydraulic-deformational characterization of fault zones is influenced by several factors including displacement distribution, fault geometry, modalities of fault propagation, fault slip direction, mechanical rock properties and environmental conditions of deformation (mainly lithostatic burial and pore fluid pressure).

In order to investigate the inner structure of tight platform carbonates, and hence gain new insights on the related fault permeability, we study the fault dimensional parameters (i.e. damage zone and core thickness variations relative to the amount of displacement) of different types of faults cropping out in the Murge Plateau, southern Italy. The Murge Plateau represents the Plio-Pleistocene foreland of the South-Apennines orogenic belt which is characterized by a relatively-thick lithosphere and a little deformed sedimentary cover. The outcrops in Murge Plateau are good analogues of the Upper Cretaceous carbonate systems of the peri-Adriatic area that represent important hydrocarbon reservoirs in southern Italy.

In this work, we compute the scaling relationships between fault dimensional parameters and the cumulative frequency distributions of the fault-related fracture networks (i.e. spacing and opening). The scaling relationships are fitted by power-law, logarithmic or exponential relationships, in agreement with different degree of faults development within the geo-structural contest of this sector of the Apenninic foreland. Based on the relative thickness between fault damage zones and fault cores, we infer different permeability structures associated to the studied faults. These last parameters are strongly affected by the presence of both sedimentary dykes, which include large clasts of breccias, clay material and calcite, and karst that often is present within the fault damage zones.