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Fluid flow along faults in carbonate rocks

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The study of fluid flow in fractured rocks plays a key role in reservoir management, including CO_2 sequestration and waste isolation. We present a mathematical model of fluid flow in a fault zone, based on field data acquired in Majella Mountain, in the Central Apennines (Italy). The Majella is a thrust related, asymmetric, box shaped anticline. The mountain carbonate outcrops are part of a lower Cretaceous-Miocene succession, covered by a siliciclastic sequence of lower Pliocene age.

We study a fault zone located in the Bolognano Formation (Oligo-Miocene age) and exposed in the Roman Valley Quarry near the town of Lettomanoppello, in the northern sector of the Majella Mountain. This is one of the best places in the Apennines to investigate a fault zone and has been the subject of numerous field studies. Faults are mechanical and permeability heterogeneities in the upper crust, so they strongly influence fluid flow. The distribution of the main components (core, damage zone) can lead a fault zone to act as a conduit, a barrier or a combined conduit-barrier system. We integrated existing and our own structural surveys of the area to better identify the major fault features (e.g., kind of fractures, statistical properties, geometry and pertrophysical characteristics).

Our analytical model describe the Bolognano Formation using a dual porosity/dual permeability model: global flow occurs through the fracture network only, while rock matrix contain the majority of fluid storage and provide fluid drainage to the fractures. Pressure behavior is analyzed by examining the pressure drawdown curves, the derivative plots and the effects of the characteristic parameters. The analytical model has been calibrated against published data on fluid flow and pressure distribution in the Bolognano Formation.