Fracture stratigraphy, fault architecture and DFN modeling of both diffuse and localized fracture networks

Fabrizio Agosta
University of Basilicata, Sciences, Potenza, Italy (fabrizio.agosta@unibas.it)

Quantification of the geometry, distribution, and dimension of fracture networks is key to fully understand the petrophysical properties of outcrop-to-reservoir scales rock volumes. On these regards, Discrete Fracture Network (DFN) modeling is a very useful tool to compute the values of fracture porosity and equivalent permeability of geo-cellular volumes populated with stochastic or deterministic fracture networks. Independently of their size and cell dimensions, the single geocellular volumes are populated by inputting the following parameters for each fracture set: (i) length; (ii) aspect ratio; (iii) mechanical and hydraulic apertures; (iv) fracture intensity, and (v) attitude. A sensitivity analysis is always carried out in order to test the seeding procedure of the employed software, and to check the validity of the fracture aperture values employed as input data. The latter values, in fact, are the most critical to assess from outcrop and laboratory analyses. The present contribution focuses on the results of recent works performed on the fractured limestone rocks of the Apulian Platform, which are widely exposed along the Italian peninsula. Outcrops are first introduced in order to define the fracture stratigraphy and fault architecture of the Meso-Cenozoic limestone rocks. Then, the criteria behind the construction of DFN models are illustrated. Methods employed for the build of individual fracture units and single fault damage zone domains are illustrated. Finally, the computed values of fracture porosity and equivalent horizontal permeability obtained for multiple DFN models are presented. Discussion of the data focuses on the fluid accumulation and migration properties of the fractured limestone rocks by considering their amount of exhumation experienced during Plio-Quaternary times. Results of DFN modeling could be helpful to optimize the appraisal and development operations of hydrocarbon reservoirs, and minimize the pollution of freshwater aquifer. In fact, the Apulian carbonates host in the underground significant amounts of freshwater of the Mediterranean Region, and the largest oil and gas reserves of continental Europe. Furthermore, the results could shed new lights into the role exerted by faults and fractures on subsurface CO₂ storage in depleted carbonate reservoirs, a practice that envisioned to decrease the greenhouse gas concentration in the atmosphere in the next future.