Contrasting Deformation Mechanisms Within Porous and Tight Carbonate Rocks: Insights From the Matera High (Southern Italy)

Raffaele Di Cuia[1] and Paolo Pace[1]

[1]GEPlan Consulting, Ferrara, Italy.

ABSTRACT

The study of fracture characteristics analysed from outcrop analogues allows understanding the nature and evolution of fracture networks providing key insights in predicting migration pathways of hydrocarbons. Deformation bands (DBs) are low-displacement strain localization zones of deformation occurring in porous rocks, which are related to a variety of mechanisms. Conversely, discrete mechanical discontinuities as fractures and faults (F&Fs) accommodate deformation in tight rocks with a broader range of displacement and configuration. The surface expression of these contrasting deformation mechanisms within porous and non-porous carbonates are here presented from the Matera high outcrop analogue, a horst feature within the foredeep-foreland of the Southern Apennines. There, extensionally faulted Cretaceous shallow-water tight limestones of the Apulian Platform are unconformably overlain by Tertiary porous calcarenites. DBs appear as light-coloured, mm- to cm-thick structures forming protruding ridges in the pale cream bioclastic calcarenites. They are mostly compactive shear bands also associated with some pressure-solution, oriented at high angles to bedding and widely distributed. Pure compaction bands also occur but are less diffuse. Compaction is evident as a reduction of pore space within the DB, relative to the porous host rock. Grain reorganization and pressure solution mainly accommodate strain localization. There are single bands, zone of bands, conjugate sets, swarms or more organized networks. Some of the high-angle DBs are nowadays open or partially open due to gravitational instability. Outcrop- and large-scale extensional faults, sub-vertical throughgoing fracture corridors, fracture sets and sub-horizontal stylolites characterise the tight Cretaceous carbonates. Fracture sets are with dm-to-m spacing and are organized in roughly perpendicular sets with mutual cross-cutting relations. All of these F&Fs are also locally associated to paleokarst dissolution features. DBs and F&Fs are characterised by similar trends. The two contrasting deformation mechanisms here described from the Matera outcrop analogue have opposite perturbations on porosity and permeability: DBs dramatically decrease porosity in porous carbonates constituting potential barriers to fluid flow whereas F&Fs enhance permeability of tight rocks. The results of this field characterization may help to understand reservoir characteristics with coupled porous-tight carbonates.