Controls on Variable Hydrothermal Dolomitization Geometries in Shallow-Marine Carbonates Using the Benicàssim Outcrop Analogue as a Case Study (Maestrat Basin East Spain)

Shuqing Yao[1], Enrique Gomez-Rivas[1], John Howell[1], and Juan Diego Martín-Martín[2]

[1]Geology & Petroleum geology, University of Aberdeen, Aberdeen, United Kingdom.
[2]Departament de Geoquímica, Petrologia i Prospecció Geologica, Universitat de Barcelona, Barcelona, Spain.

ABSTRACT

Structurally-controlled hydrothermal dolostone bodies (HTD) are a key component of dolomitized reservoirs. These bodies can have a variety of geometries, and predicting them in the subsurface is critical for reservoir management. Outcrop analogues can significantly contribute to understanding the fundamental depositional, structural and diagenetic factors that control the distribution of dolostones and thus reservoir quality. This study uses the world-class Aptian-Albian Benicàssim outcrops (E Spain) to study the main controls on the transition between different dolomite geometries using (i) high-resolution mapping of facies, structures and reaction fronts with the help of LIDAR and UAV virtual outcrop models and (ii) detailed logging and correlation of facies and stratigraphic sequences. The results show that a large-scale continuum of dolostone geometries can be observed from a large, E-W oriented fault, which acted as the main feeding point for the warm dolomitizing fluids coming from below. Massive dolostone patches occur within 1 km of this fault while stratabound dolostone geobodies extend up to 7 km away from it, showing a transition between fault-restricted and stratabound dolomitization geometries. Dolomitization is restricted to the uppermost 800 m of the total 1500 m of the Benassal Formation. This is probably associated with the presence of low-permeability formations above which acted as seals, forcing the ponding of dolomitizing fluids in the uppermost parts of this succession. Stratabound dolomitization preferentially affects layers near maximum flooding zones and areas with deeper water facies, showing a positive correlation with the matrix content. This may be explained by the observation that dolomitization tends to initially replace the host rock's matrix, triggering the reaction of the whole rock. Non-dolomitized limestones are generally either highly cemented grainstone facies with very low permeabilities or muddy facies that contain dense networks of wavy stylolites, meaning that permeability modification by pre-dolomitization diagenetic processes resulted in in the preservation of certain limestone beds. Moreover, isolated fracture patterns constrain the continuity of stratabound dolostones at different scales, while connected fracture networks seem to facilitate much longer lateral dolostone extensions.