Characterization Of Permeability Enhancement And Selective Dolomitization In Bioturbated Carbonate Media

C.A. Polo, I. Deshenenkov, F. Khaldi, Saudi Aramco; P. Tarabbia, Saudi Aramco Exploration

Abstract

Objectives/Scope: Biogenically driven chemical and physical alteration of primary carbonate sedimentary fabrics due to bioturbation can result in burial fabric-selective dolomitization. Recent studies have demonstrated that in generally tight carbonates, this type of modification can lead to the selective enhancement of permeability. Herein, we document the influences of bioturbation on facies quality in the Lower Cretaceous in Saudi Arabia. We present a case study of biogenic enhancement in tight facies and provide a conceptual framework for burrow-associated permeability enhancement.

Methods, Procedures, Process: Core description, thin-section petrography and scanning electron microscopy (SEM) assessments allowed the identification of an intricate, highly connected, mixed horizontal and inclined burrow system dominated by the activity of Thalassinoides. Sedimentological analysis based on core samples reveals that burrowed, tight-facies range from mudstones to mud-dominated packstones and wackestones with abundant skeletal fragments and pellets. Overall, sediment deposition took place on a low-gradient carbonate platform along the eastern border of the Arabian Shield. The preponderance of fine-grained lithology along with intense bioturbation (robust occurrences of Thalassinoides) suggest deposition in the sheltered, inner part of the platform during the early Cretaceous.

Results, Observations, Conclusions: Selective dolomitization occurs in burrow fills and is commonly surrounded by a non-dolomitized lime mud matrix. Selective burrow dolomitization results in improved intergranular porosity and constitutes a mechanism for permeability enhancement in an otherwise low-permeability matrix. In the case study presented herein, high burrow connectivity suggests that a pathway for basinal fluid flow was likely established in the subsurface. As recent research shows, this is primarily influenced by the: 1) concentration and preferential orientation of permeable trace fossils; 2) degree of permeability contrast between burrows and the surrounding matrix; and, 3) three-dimensional connectivity of the Thalassinoides network system.

Novel/Additive Information: Here, Thalassinoides occupy a significant volume of the rock compared to the fractures and this fact enhances the permeability and transmissivity of an otherwise low-permeability matrix. Recognition and proper analysis of bioturbated intervals and the role they play in reservoir petrophysics will aid in the selection of future drilling targets in similar biogenically modified intervals in the study area.