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Integrated Characterization of the Top Shuaiba Formation Reservoir Quality in Northern Oman Oil Fields

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ABSTRACT

The impact of diagenesis on reservoir petrophysical properties is often underestimated, despite the fact that both depositional and diagenetic processes control pore geometries and hence reservoir complexity.

Although pore shape and size can significantly affect permeability, there is a lack of published data as to the geometry of carbonate pore systems. Seismic and core data of the Shuaiba Formation in northern Oman oil fields highlight the occurrence of seismic and core-scale open and cemented fractures within this formation, which may have affected its diagenetic evolution, yet only few published studies focused on the diagenesis and how it enhances the heterogeneity of the Shuaiba Formation as a reservoir.

This paper presents the first regional, integrated analysis (i.e. petrography, geochemistry, and structural evaluation) of the uppermost 10-15 m of the Shuaiba Formation in a number of oil fields North Oman, where a significant modification in porosity, mostly by solution-enhancement, was documented below the Albian-Aptian unconformity. Different hypotheses were tested to justify this modification, including dissolution during subaerial exposure, corrosion by burial fluids, and dissolution by fluids sourced from compacted overlying shales of the Nahr Umr Formation. Detailed characterization of the Shuaiba Formation pore system and pore filling cements was conducted, including classification of pore types and geometries and their regional distribution within lithofacies, identification and geochemical characterization of the main diagenetic cements, and timing of pore modification relative to the main tectonic events that postdate the deposition of the Shuaiba Formation.

The results of this study show little evidences for porosity enhancement by the subaerial exposure of the Shuaiba Formation. No evidences for shale compaction- related dissolution was found. The majority of the pores are interpreted to have been generated by the up-dip migration of hot fluids during hydrocarbon charge in the Late Cretaceous, largely enhancing microporosity within the matrix. A phase of dissolution occurred possibly at the end of the Late Cretaceous in a telogenetic setting which was associated with precipitation of euhedral, sulphur isotope- depleted pyrite. Breaching of deeper seals is believed to cause recharge of hydrocarbon in the Late Tertiary which might have contributed to the enhancement of the pore system of the Shuaiba Formation in the fields with mixed oils.