Integrated Sedimentological Approach to Assess Reservoir Quality and Architecture of Khuff Carbonates: Outcrop Analog, Central Saudi Arabia

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The Permian to Triassic Khuff carbonate reservoirs (and equivalents) in the Middle East are estimated to contain about 38.4% of the world's natural gas reserves. Excellent exposed outcrops in central Saudi Arabia provide good outcrop equivalents to subsurface Khuff reservoirs. This study conduct high resolution outcrop scale investigations on an analog reservoir for upper Khartam of Khuff Formation. The main objective is to reconstruct litho- and chemo- stratigraphic outcrop analog model that may serve to characterize reservoir high resolution (interwell) heterogeneity, continuity and architecture. Given the fact of the limitation of subsurface data and toolsin capturing interwell reservoir heterogeneity, which in turn increases the value of this study.The methods applied integrate sedimentological, stratigraphic petrographic, petrophysical data and chemical analyses for major, trace and rare earth elements. In addition, laser scanning survey (LIDAR) was also utilized in this study. The results of the stratigraphic investigations revealed that the lithofacies range from mudstone, wackestone, packestone and grainstone. These lithofacies represent environments ranging from supratidal, intertidal, subtidal and shoal complex. Several meter-scale and less high resolution sequences and composite sequences within 4th and 5th order cycles were also recognized in the outcrop analog. The lithofacies and architectural analysis revealed several vertically and laterally stacked sequences at the outcrop as revealed from the stratigraphic sections and the lidar scan. Chemostratigraphy is effective in identifying lithofacies and sequences within the outcrop analog. Moreover, different chemical signatures were also recognized and allowed establishing and correlating high resolution lithofacies, reservoir zones, layers and surfaces bounding reservoirs and non-reservoir zones at scale of meters or less. The results of this high resolution outcrop analog study might help to understand and evaluate Khuff reservoir heterogeneity, quality and architecture. It might also help to fill the gap in knowledge in reservoir characterization models based on low resolution subsurface data alone.