Lithofacies and Reservoir Heterogeneity and Architecture of Carbonates D5 and D6 Members, Upper Dhruma Formation (Middle Jurassic), Outcrop Analog from Central Saudi Arabia

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ABSTRACT

The well-exposed Jurassic carbonate outcrops in central Saudi Arabia provide an excellent opportunity to characterize the detailed microfacies heterogeneity and stratigraphic architecture within the real inter-well spacing. The current study integrates microfacies and stratigraphic analysis of the D5 and D6 Members in outcrops to define lithofacies, cyclicity, and high-frequency sequences. More than 130 samples were examined from the petrographyical point of view along with high-resolution photomosaic analysis. The outcrop photomosaic was used to map and to assess the reservoir bodies architecture and continuity. Eight lithofacies types were identified namely: (1) skeletal peletal spiculitic wackestone, (2) peloidal echinoderm packstone, (3) fissile shale, (4) peloidal spiculitic echinoderm pack-grainstone, (5) cross-bedded peloidal skeletal oolitic grainstone, (6) oolitic grainstone, (7) skeletal foraminiferal peloidal packstone, and (8) skeletal foraminiferal wackestone. Fissile shale represents the most dominant lithofacies type in studied intervals. These lithofacies types were grouped into five major carbonate paleoenvironments that range from distal-to-proximal ramp setting. The high-resolution outcrop photomosaic shows the lateral continuity of strata which extends to 60 m vertically, and laterally for a distance of more than 680 m without significant lateral facies change. The vertical stratigraphic analysis revealed 53 cycle and cycle sets with 5th to 6th order. The parasequences range in thickness from centimeters to six meters with an average of 1.5 m. The latter were stacked to form four high-frequency sequences with thickness range from 1 m up to 14 m, and generally showed an increasing thickness and overall shallowing upward trend. The Jurassic maximum flooding surface (MMFSJ30) was placed within a thick transgressive shale/mudstone interval. The entire succession of D5 and D6 Members represent a single depositional sequence of 3rd order magnitude. The findings of this study might help to enhance reservoir description and prediction and eventually serve to optimize reservoir exploration and development of subsurface equivalent.