Multi-Realizations Geostatistical Modeling: Implication on Reservoir Quality and Heterogeneity: Outcrop Analogue of the Khuff Reservoirs

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ABSTRACT

The Khuff reservoirs are known for having heterogeneous properties which occur at inter-well and sub-seismic scale. Unrealistic geological modeling of these properties will impact optimal development and assessment of the Khuff reservoirs. The main objective of this paper is to build outcrop-based and valid geological models. In this study we build multi-realization models based on three stratigraphic levels. The models are based on a high-resolution sequence stratigraphy framework and a lateral resolution of 5 m. 120 well sections are logged for proper sedimentological and petrophysical description. The wells are systematically arranged with 5 meter interwell spacing and coverage area of 750 m (north-east) by 450 m (south-west). The Upper Khartam carbonates are composed of seventeen lithofacies with the oolitic grainstone (40%), recrystallized limestone (22%), bioclastic grainstone/packstone (4.4%), and non-fabric preserved dolomite (2.4%) making up the bulk of the stratigraphy. Although the data was drastically distorted at the high-frequency sequences, bedset level to some extent preserved the original data. The Upper Khartam carbonates are composed of complex amalgamated beds of different architectural elements and lithofacies types. Critically, these will impact reservoir heterogeneity and continuity and eventually fluid flow and productivity. Therefore, the detailed bed-level information is used to model the Upper Khartam carbonates. For this case, Sequential Indicator Simulation method is used and the detailed variogram parameters are deterministically provided. Most critically, these models are valid and consistent with the detailed sedimentological and sequence stratigraphic data. Sequential Gaussian Simulation is used to model the petrophysical properties. Detailed matching process indicates major and minor directions of petrophysical properties at 70 and 330 degree respectively, indicating that they follow the depositional trend. However, porosity of intertidal sheets is of great horizontal ranges when compared with that of intertidal channels and creeks. They former has an average range of about 300 m while the latter has an average ranges of about 150m. However, the minor porosity ranges of the different architectural types have the same values of about 50m. Permeability variograms show no control of architectural types on ranges and continuities. Generally, the permeability has major ranges of about 200m wile minor continuity is about 60m.