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Spatial Variability in Carbonates Reservoir Quality: Case Study from the Middle Miocene Dam Formation Outcrop, Eastern Saudi Arabia

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Detailed spatial variability in carbonate lithofacies and their reservoir properties is important aspect for reservoir quality prediction. This study aimed to characterize the reservoir quality of different carbonate lithofacies and to demonstrate the high-resolution spatial variability in their reservoir quality. The outcrop of middle Miocene Dam Formation in Eastern Saudi Arabia was targeted to fulfill the objective of this study. In this context, three genetically-different carbonate lithofacies were selected, those are: (1) skeletal oolitic grainstone, (2) burrowed wackestone, and (3) stromatolite boundstone. Those lithofacies were selected to cover wide range of subsurface reservoir composition and textures. Using a regular sampling procedure, samples were collected laterally from the selected lithofacies. The laboratory analyses included petrographic description, porosity and permeability measurements from plugs, and SEM. Experimental semivariograms were constructed for porosity and permeability to investigate their spatial variability. The reservoir quality of those lithofacies showed fair porosity-permeability relationship for the skeletal oolitic grainstone. In contrary, poor relationships were obtained for both; the burrowed wackestone, and the stromatolite boundstone. In spite of the inconsistent porosity-permeability relationship of the selected lithofacies, the trends of high-resolution spatial variability showed good similarity. Fairly, same trends of porosity and permeability variations were attained for all three lithofacies, indicating the influence of primary composition, sorting and packing of grains on the reservoir properties in outcrop scale. The differential diagenetic features which are denoted from petrography and SEM had affected the reservoir quality, however, no clear influence was observed on the trends of the spatial variability. This indicates that high- resolution (meter-scale) continuity in reservoir quality of carbonate lithofacies can be extended for several meters. The study demonstrated the importance of considering high-resolution trends of variability/continuity in carbonate reservoir properties for better evaluation of reservoir quality. As high variability trends is highly expected in larger scale, detailed and large-scale depositional and diagenetic models can be adopted for further prediction of spatial variability in subsurface reservoir properties.