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Impact of Reservoir Heterogeneity on Field Development and Reservoir Management of the Mishrif Reservoir, West Qurna I, Southern Iraq

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SUMMARY

The Mishrif reservoir comprises the main discovered developed reservoir at West Qurna I field in southern Iraq and has been on production intermittently since 1999. Core, log and dynamic reservoir data are being integrated to characterize and model the impact of reservoir heterogeneity on reservoir performance and development plans, including waterflood response.

The Mishrif reservoir comprises the main discovered developed reservoir at West Qurna I field in southern Iraq and has been on production intermittently since 1999. Core, log and dynamic reservoir data are being integrated to characterize and model the impact of reservoir heterogeneity on reservoir performance and development plans, including waterflood response. Reservoir heterogeneity is driven mainly by stratigraphy and depositional facies, and an integrated sequence-stratigraphic model has been developed to guide reservoir characterization and modeling. Shallow-water skeletal grainstone facies comprise a relatively small volume of the reservoir, but form the dominant flow units in the reservoir. Permeabilities range from 10's to 1000's of millidarcies based on integration of core and well test measurements. Due to the long-term shallowing-upward trend within the Mishirf, grainstone is mainly developed in the regressive, upper Mishrif zones, when accommodation space was more limited. Permeabilities in grainstones are enhanced by dissolution associated with subaerial exposure at sequence boundaries. Outer-shelf packstone and wackestone facies comprise the bulk of the reservoir rock volume and are dominated by microporosity. These facies exhibit high porosity (> 20 %), but low permeability (< 10 millidarcies) due to small pore throat sizes. Microporosity is developed throughout the Mishrif, but is dominant in the wackestone/packstone facies of the transgressive lower Mishrif (includes Rumaila Formation).

The permeability contrast between high-permeability grainstone and low-permeability packstone/wackestone facies presents significant challenges to reservoir development and management. One challenge is optimizing waterflood effectiveness. The permeability contrast between high- and low-permeability rock types will result in differential waterflood advance and reservoir sweep, with water moving more rapidly through the higher-permeability flow units and potentially by-passing a large rock volume with lower permeability. Production and injection logging indicate that grainstone intervals account for the majority of reservoir production and injection in the upper Mishrif. The geometry and connectivity of the grainstone bodies vary significantly by sequence-stratigraphic interval, ranging from field-wide thief zones, to more discontinuous grainstones of limited lateral extent (1-2 km). Waterflood design and completion strategies need to be developed and managed on a zonal basis to account for these geologic variations. Another challenge is optimizing recovery from low-permeability microporous rock. A large volume of reserves is in microporous rock, especially within the lower Mishrif. Appraisal of the lower Mishrif with high-angle wells is planned.