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Early Cretaceous Deltaic Deposits of the Zubair Formation, SE Iraq: Depositional Controls on Reservoir Performance

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SUMMARY

The Early Cretaceous (Barremian-Aptian) Upper Sandstone (Main Pay) Member of the Zubair Formation is the main producing reservoir in the supergiant Rumaila oil field of southeast Iraq. Whilst the field has been on production for c. 60 years, significant resources remain. Key to their economic development is an improved subsurface description based on the synthesis of diverse static and dynamic data. Geological heterogeneities at a range of scales impact reservoir performance, reservoir management decisions and future field development strategies.

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At the field-scale, an appropriate reservoir layering scheme is critical for effective reservoir management since it controls fluid movement, pressure stratigraphy and injector-producer conformance. Detailed core sedimentology and biostratigraphic analysis has enabled the identification of two ~50-60m thick fourth-order regressive-transgressive cycles in the Main Pay Member of the Zubair Formation. These cycles highlight the phased advance and retreat of a large river-dominated, tidally-influenced delta. Pro-delta/bay-fill mudstones at the base of these cycles are laterally extensive over 10s km and form effective baffles to pressure and fluid communication. This geological understanding informs a completion strategy, in which separate reservoir layers are completed independently in order to minimise the risk of fluid movement between separate reservoir layers.

At the kilometre-scale, geobody geometries and reservoir lateral connectivity control sweep efficiency. Detailed mapping of reservoir layers has been integrated with surveillance data to determine the distribution of remaining resources and target infill wells. In the higher net-to-gross south of the field good lateral reservoir connectivity results in a relatively stable flood front. In contrast, greater geological complexity in the north of the field, together with the presence of an immobile tar mat, results in a complex flood front with multiple areas of poor sweep.

Finally, at the bed-scale, a number of fine-scale geological heterogeneities impact reservoir sweep efficiency. Such small-scale heterogeneities are common in paralic reservoirs such as the Zubair Formation and include cross-bedded sandstones, mud drapes, abrupt grain-size variations and bioturbation amongst others. These all act to generate a heterogeneous flood front at the small-scale. Integration of image logs with repeat surveillance data has advanced our understanding of these phenomenon in Rumaila. An improved understanding of the geological controls on sweep efficiency and the number of pore volume displacements needed to reach residual oil saturations informs future water handing needs as production from the Main Pay reservoir approaches its 61st year.