

Late Triassic to Lower Jurassic Clastic Depositional Systems of Saudi Arabia – New Play in a Mature Basin

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ABSTRACT

Late Triassic and Lower Jurassic carbonates form important reservoirs on the Arabian Plate and hydrocarbons have been produced from fields in Iraq and Syria. In Northern Iraq, the Triassic has proven to be a separate petroleum system, which was only discovered in the last decade. Source rocks exist in the Kurra Chine Formation in Iraq/Syria and in the Marrat Formation within Saudi Arabia.

Detailed outcrop descriptions and near-outcrop, shallow wellbores are integrated with deep exploration wells in Eastern Saudi Arabia, to map the lateral variation in sedimentary facies and stratigraphy of the Late Triassic to Middle Jurassic Minjur, Marrat and Lower Dhurma formations. The combination of 2D seismic data, wireline logs, biostratigraphy and core-based sedimentology data, has led to the recognition of a series of third order chronostratigraphic units with local definition of individual system tracts. This framework constrains several poorly-understood petroleum systems, with future exploration potential that augments the mature, more fully explored Jurassic systems of Saudi Arabia.

The Minjur, Marrat and Lower Dhurma formations were deposited during a period of transition between tectonic inversion and differential subsidence in the Late Triassic, followed by rifting of Gondwana in the early Middle Jurassic, a period when global sea levels were generally rising. The sedimentary responses to these controls were a switch from predominantly fluvio-deltaic clastics of the Minjur Formation, to mixed carbonates and clastics of the Marrat and Dhurma formations, ultimately to the establishment of platform carbonates of the Tuwaiq Mountain Formation.

During the Late Triassic to Early Middle Jurassic, large amounts of clastic sediments were shed off the uplifted Hadramaut Arch and fed into the basin to the north by a series of tidally influenced deltas. Prograding clinoformal geometries have been recognized from seismic data within the Late Triassic-Early Jurassic Minjur Formation, and evidence of delta front slumping and slurried mass flows can also be seen in core. The tidal channels are characterized by clean, 15-40 feet thick, blocky gamma ray profiles. Individual channel sand bodies are difficult to correlate between wells, and are locally replaced by intervals of thinly bedded, estuarine sandstones and coal-bearing, carbonaceous, lagoonal mudstones. These more marine facies become increasingly common within the Lower Dhurma Formation, which was deposited during a period of transgressive flooding and delta top abandonment.

Two self-contained petroleum systems appear to operate in this megasequence. In the Rub' Al-Khali, a dry-gas system with geochemistry of Type III kerogen has been proven by recent exploration wells. The source is believed to be coaly intervals interbedded with the Lower Dhurma marine sand reservoirs. In Northern Saudi Arabia, to the east of the Summan platform, oil in Minjur and Marrat carbonates is believed to have been sourced from laterally-equivalent basinal facies to the north.