

## **Little-Known Differences in Tuwaiq Mountain Petroleum Generation: Implications for Different Unconventional Resource Play Fairways**

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### **ABSTRACT**

The relationship between the Jurassic Tuwaiq Mountain Formation source-rock maturity, petroleum generation, over-pressuring and expulsion-fracturing was evaluated over the Arabian intra-shelf basin in Saudi Arabia. This is part of the ongoing assessment of Jurassic unconventional resources in Saudi Arabia. The evaluation revealed two separate Tuwaiq Mountain petroleum sub-systems (high-sulfur and low-sulfur) with different rates of petroleum generation. The differences in the petroleum sub-systems are related to the differences in the source rock organo-facies which resulted in two separate Tuwaiq Mountain mature source rock play fairways in the Arabian intra-shelf basin.

API gravity, organic-sulfur content and pyrolysis data for Jurassic source rocks in the Arabian intra-shelf basin were analyzed. The main findings explained puzzling thermal maturity behaviors at different depths. Transformation ratios and petroleum-generation pressures were mapped and correlated with models for high-sulfur and low-sulfur Tuwaiq Mountain source rocks. The transformation ratio models were generated by using estimated kinetics for petroleum-generation in the Tuwaiq Mountain source rocks. They were also compared to various published source rock models that range from low-sulfur Type II to high-sulfur Type IIS. The evaluation also included a derived map of petroleum-expulsion fractures for Tuwaiq Mountain source rocks. This map was shown to be a promising tool to define the limits of the unconventional mature source rock play fairway and possible areas of higher productivity.

It is concluded that natural, pressure-induced fracturing of low-permeability, mature Tuwaiq Mountain source rocks is crucial prior to significant petroleum expulsion. Petroleum expulsion itself is a direct consequence of petroleum generation and over-pressuring. Based on that, it is implied that although the petroleum generated by mature Tuwaiq Mountain source rocks in the Arabian intra-shelf basin has migrated and accumulated in adjacent large structural traps, most of it has remained in, or adjacent to, these organic-rich source rocks. Any differences in the organo-facies can cause differences in the rate of petroleum generation, suggesting different unconventional resource play fairways.

These insights can guide exploration for unconventional resources existing in extremely low-permeability, self-sourced, fractured, organic-rich mudrocks in the deep parts of basins where they are thermally mature.