

South Oman Al Khlata Play Revisited: Play and Portfolio Rejuvenation through Integrated Data-Driven Play Based Exploration

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Abstract

The Al Khlata Formation in South Oman is one of the major producing clastic reservoirs in the Sultanate of Oman and accounts for ~25 % of discovered in place hydrocarbon volumes to date. The Al Khlata formation was deposited during the Permo-Carboniferous glacial period on top of the Early Carboniferous unconformity and consists of three main unconformity bound members recognized as the P9, P5 and P1 with the youngest interval P1 including the Rahab shale Member. These member units are defined by their palynological signatures and cannot be recognized with any confidence without palynological analyses. Despite it been one of the core producing plays in South Oman, it's complexity is challenging to unravel due to the impact of salt tectonics, seismic imaging challenges and the lack of integration of a vast amount of subsurface data.

As part of the Play and Portfolio rejuvenation efforts in South Oman, PDO has recently completed an integrated data-driven Play based Exploration (PBE) study. This integrated data-driven evaluation utilizes results of high-resolution biostratigraphy, sedimentology, fluid geochemistry, petroleum systems modelling, petrophysics, drilled hole analysis and detailed seismic interpretation both at regional and opportunity scales.

Hydrocarbon charge into the Al Khlata Play is from pre-salt Nafun/Ara source rocks with migration via direct access to mature source kitchens areas, back spill phenomena and/or through salt welds, deep-seated faults, and capillary forces. Sub-regional extensive reservoir development (fluvial braided outwash- delta plain facies) occurs in the Al Khlata P5 and P9 sequences with areas of local reservoir development in the Al Khlata P1. Integration of core, logs, BHI analysis and seismic derived thicknesses highlights areas of potentially high net reservoirs vs. areas of low net reservoirs. The regionally well-developed Rahab shale provides the overall top seal for hydrocarbon accumulations in the Al Khlata play. It is laterally extensive and forms an excellent seal. In areas where the Rahab shale has been eroded, the Cretaceous Nahr Umr shales also provides a regional top seal. Additionally, locally developed intra Al Khlata seals have been identified in the Al Khlata P5 and P9 resulting in multiple reservoir-seal pairs. Observed structures and trapping geometries are related to salt kinematics and dissolution of the underlying salt. Diverse trapping configuration have been identified using the newly improved 3D seismic data and they include structural fault-bounded closures, 4-way dip closures and structural-stratigraphic opportunities.

All these elements have been integrated in Play element maps (reservoir-charge-seal) opens further opportunities in white space areas and delivered a portfolio of exciting exploration opportunities which have been included in the exploration funnel to be tested in 2023/2024.