De-Risking Hydrocarbon Charge for the Post Salt Haushi- Haima Play in the Greater Harweel Area, South Oman Salt Basin (SOSB)

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Abstract

The Post Salt Haushi-Haima succession in South Oman are major producing clastic reservoir, representing about 31% of the total discovered hydrocarbon oil volumes in the PDO Block 6 concession area. Most discoveries so far have been in the eastern part of the SOSB or the Eastern flank area, where hydrocarbon charge is from mature pre-salt source intervals. Exploration efforts have mainly focused on this proven charge fairway area, leaving the western part relatively underexplored for the post-salt play. In the Greater Harweel area (GHA), located in the southwestern part of the SOSB, previous exploration has largely targeted pre-salt reservoirs with minimal focus on post-salt exploration, leading to risks and uncertainties regarding access to hydrocarbon charge for the Post salt reservoirs due to the absence of discoveries in the area. Limited exploration in this region further contributes to the challenge.

As part of Play and Portfolio rejuvenation efforts in South Oman, PDO has completed an integrated charge assessment for the Post Salt Haushi-Haima play in the GHA. This evaluation utilizes results of drilled hole analysis, fluid inclusion studies, petroleum systems analysis, petrophysics, and seismic interpretation at regional and opportunity scales. Proven reservoir-seals are developed with the Haushi and Haima successions, while the Nahr Umr and Rahab shales act as overall effective regional top seals. The Al Khlata mudrock facies and the Haima intraformational seals are also predicted to be effective top seals. Structures and trapping geometries are linked to salt kinematics and dissolution of the underlying salt. Hydrocarbon charge is predicted to come from pre-salt Nafun source rocks, with migration occurring through salt welds, deep-seated faults, and capillary forces. Fluid inclusion stratigraphy (FIS) was performed on five wells and enhanced by thin sections analysis and microthermometry from hydrocarbon-enriched zones. The objective of the selected wells was mostly for the pre-salt reservoirs and were outside a valid closure at the post-salt Haushi - Haima interval.

Micro shows were evident in several formations across the five wells, including Dammam, UER, Natih, Gharif, and Amin. Paleo-charge was observed through visible petroleum fluid inclusions at Gharif, Base Rahab, Al Khlata, and Haima (Ghudun, Mahwis and Amin Formations). Generally, low petroleum fluid inclusion abundance was observed in three wells, suggesting possible hydrocarbon migration in the area. On the other hand, two wells in the Amin formation showed moderate to high visible inclusion abundance, suggesting the presence of a paleo-oil column with possible multiple distinct hydrocarbon charge, as well as Proximity to Pay (PTP) at Gharif, Al Khlata and Ghudun Formations.

The results of the FIS study analysis, integrated with the petroleum systems analysis and portfolio maturation results, have demonstrated the existence of a hydrocarbon migration pathway from mature pre-salt source intervals into post-salt reservoirs. This de-risks the initial hydrocarbon charge access risk and helps to polarize the charge risk for the Post salt Haushi-Haima portfolio in the GHA. However, the

sufficiency of charge volumes may be challenging for some identified opportunities. Additionally, this study predicts that seal retention related to fault seals poses a potential risk, as the integrity of some of the bounding faults may be compromised due to fault juxtaposition.