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New Exploration Models for an "Old" Play: Terminal Neoproterozoic to Early Cambrian Intrasalt Carbonates of Oman

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Intrasalt carbonates of the Terminal Neoproterozoic to Early Cambrian Ara Group represent one of the complex deep oil exploration plays in Oman and presently constitute a significant part of Petroleum Development Oman's undrilled prospect portfolio. The total-in-place proven oil reserves within the intrasalt carbonates exceed 300 million barrels.

The Ara Group consists of a cyclic sequence of carbonates, evaporites and siliciclastics. Ara group carbonates contain the most prolific proven reservoirs of the Huqf Supergroup. This can be ascribed to a unique combination of rich carbonate source rocks and porous dolomite stratigraphically trapped in Ara salt at 3 to 4 km depth, hence commonly over-pressured (='stringer' carbonates). The carbonates have been deposited on rimmed shelf and/or carbonate ramp settings. The deeper parts of the basin were periodically anaerobic, resulting in the preservation of substantial amounts of organic material and the formation of hydrocarbon source rocks (e.g., Athel Silicilyte).

Although potentially rewarding, with well flow rates up to 8800 bbls/day of 30° API oil, the play was found to be complex with respect to reservoir quality prediction, hydrocarbon charge, production behavior, and seismic imaging.

A main challenge was the identification and interpretation of Precambrian-specific lithofacies and depositional environments and their translation into (predictive) exploration play models.

By integrating data from outcrop analogues with subsurface log, core, and borehole-image data, key stringer carbonate lithofacies have been recognized, each of which corresponds to a particular depositional setting. Reservoir facies include shallow-water ooid/pelodial grainstones, thrombolite buildups and laminated source-rock facies, where primary porosity has been preserved. Carbonate source rocks were deposited as sapropelic laminites and laminated mudstones in basinal settings. Stacking patterns of lithofacies in the various carbonate cycles differ based on sediment flux and available accommodation space, resulting in a set of facies models. These facies models can be tied to seismic geometries, allowing a better pre-drill risk assessment.

To date, the success rate of the exploration drilling campaign is 60%. The total proven oil reserves in the intrasalt carbonates exceed 150 million barrels.