Discovering Tertiary Reservoir Potential, Challenges and Appraisal Journey

Mohammed S. Al Harrasi[1], Azzan Al Harrasi[1], Ahmed Nasser Al Naabi[1], Marwa Al Harthi[1], Musallam Al Rawahi[1], Salim Al Siyabi[1], Khamis Al Subhi[1]

[1]Daleel Petroleum L.L.C.

Abstract

The Lower Tertiary Shammar Formation is extensive throughout Oman Block-5 and covering wider areas in north Oman. Its facies represent shallow marine deposit mainly consisting of interbedded shale and limestone. It is also known as an effective seal in Block-5 where it lies unconformably on top of the Late Cretaceous Natih carbonate reservoir.

An exploration well drilled in May-2021 resulted in an unexpected discovery of a clastic reservoir at base Shammar. For the first time in Block-5, oil bearing Shammar sandstone was tested as prolific reservoir with good porosity and permeability. The hydrocarbon is stratigraphically trapped in localized topographic lows sealed by shales of the overlying Shammar and underlying Fiqa, sub-cropping under the base Tertiary unconformity.

Daleel Petroleum undertook an appraisal campaign alongside with regional reservoir evaluation using an integration of seismic interpretation, well logs including FMIs, and core analyses to delineate the trap, reservoir extent & volume, connectivity and dynamic behavior. The multi-discipline integration along with the drilling results has revealed the edges of the sand reservoir from one side and oil-water contact from the other.

Although the reservoir is sub-seismic, different seismic attributes were used to preliminarily outline the field. Detailed seismic work was initiated by extracting the acoustic impedance properties of the targeted formation and porosity volume using a model-based deterministic post-stack seismic inversion. Moreover, spectral decomposition was extracted to predict the sand distribution within the field and integrated with other geological data to optimize the location of the appraisal wells.

The acquired core data from the Shammar sandstone reveals a composition of dominantly fine-grained to very fine-grained stacked sandstone beds with an overall upward-fining trend. This trend is accompanied with an upward increase in bioturbation intensity and frequency of intercalated siltstone laminae and beds. According to the image log data, no faults or fractures were observed. The sandstones are mainly low-angle laminated to locally cross-stratified. Integration of geological data indicate a local trend of moving from proximal depositional setting where coarse-grained facies, cross bedding, high angle beds, thick bedding and erosional surface in base Shammar are interpreted, to a more distal depositional setting where thin flat bedding, heterolithic facies, bioturbation and sharp contact with Fiqa are interpreted. This suggests deposition is probably in a tidally- influenced setting, which would place the Shammar sandstones into the distal reaches of a channel system in proximity to a shoreline or part of an estuary system where tidal influence is strong enough to influence the depositional pattern of the river-dominated sandstones.

Throughout the drilling of appraisal wells, downhole pressure data were collected from all wells to monitor the depletion of reservoir pressure across the entire area, assess the field connectivity and to gain insights into aquifer and reservoir properties. These pressure data were integrated with two years' of well production data and other geological information to construct a Material Balance Tank Model (MBAL). This model proved important in evaluating the Stock Tank Oil Initially In Place (STOIIP), identifying primary drive mechanisms, and evaluating the potential impact of various development scenarios on reservoir pressure.