TG04

Regional Reservoir Quality of a Tight Gas Play: the Ordovician Sarah Formation in the Rub' Al Khali Basin of Southern Saudi Arabia

A.P. Briner (South Rub Al-Khali Co. Ltd), M. Hulver* (South Rub Al-Khali Co. Ltd), A. Azzouni (South Rub Al-Khali Co.Ltd) & C. Harvey (South Rub Al-Khali Co. Ltd)

SUMMARY

The South Rub Al-Khali Company Limited (SRAK) is an incorporated Joint Venture formed by Shell Saudi Ventures Limited (50% share) & Saudi Arabian Oil Company (50% share) to explore for non-associated gas in the South Rub 'al Khali Basin in the Kingdom of Saudi Arabia. SRAK has employed a play-based rather than prospect-based exploration strategy, with available well, outcrop, and seismic data being integrated to aid reservoir prediction and characterization of tight gas reservoirs.

Five exploration wells have been drilled to date in SRAK's Contract Area 2, four of which penetrated Upper Ordovician Sarah Formation glaciogenic sandstone successions as a primary reservoir target. Of the first three wells, cores from two wells have fair reservoir properties, but quality is much poorer in a third well and a number of relevant offset wells. A key aspect of tight gas reservoirs is gas shows during drilling with no hydrocarbon recovery upon testing. This phenomenon has been reported from several wells within the Kingdom. The prediction of conventional vs. tight reservoir properties was therefore critical for targets, depths, and drilling strategies for future SRAK wells.

This study examined Sarah Formation reservoir quality through analysis of core laboratory analyses and sedimentology, with integration of western Rub' al Khali (Wajid) outcrop studies and glacial environment analogues. Quality trends are clearly heterogeneous and not simply characterized by single factors such as burial depth, but have strong relationships to primary depositional facies and palaeogeographic setting. Porosities are highly variable within and between facies, such that moderate to good porosities (5-15%) are evident to depths of 18,000ft. Reservoir quality trends are best characterized when examined in the context of glacial vs non-glacial environments, and marine vs non-marine environments. For example, marine-influenced glacial fluvial braided systems can have good porosities (6-14%) and permeabilities (1->100 mD), while non-marine & non-glacial fluvial braided/sheetflood, as well as non-marine glacial deltaic facies tend to have tight gas properties with variable porosities (1-15%) and low permeabilities (<1 mD). Thin section analysis indicates that the uniformly low permeability of some facies is due to a high clay matrix content, while the good permeability seen in the marine-influenced glacial fluvial braided facies is related to chlorite content.

These reservoir quality results and depositional environments were integrated into regional palaeogeographic maps, to use as a predictive tool to decrease reservoir risk for SRAK's fourth well. However, accurate "sweet spotting" good reservoir was not possible, given the reservoir heterogeneity of available well data, palaeogeographic & stratigraphic complexity of glaciogenic analogues, and poor seismic resolution at depth in the Rub' al Khali. A Tight Gas strategy was therefore utilized to maximize hydrocarbon detection from good or poor reservoirs in the fourth well, using a diesel-based drilling fluid in UBD (underbalanced drilling) mode. This technology enabled SRAK to efficiently evaluate the well's hydrocarbon potential without prolonged logging, sampling, fracturing, and testing.