Characterization of a tight chert reservoir at the Precambrian-Cambrian boundary: the Athel Silicilyte, South Oman Salt Basin

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ABSTRACT

The Precambrian-Cambrian Athel Silicilyte is an enigmatic chert unit of up to 390 m thick that it is bounded stratigraphically by two thick shale units. It is found as slabs (each slab typically 2 × 6 km across) entrapped within salt domes at a depth of 4-5 km in the South Oman Salt Basin. This formation is a prolific self-charged reservoir that characterised by high porosity (up to 34 %), very low permeability (0.02 mD), organic carbon-rich (average TOC = 3 wt. %) and high oil saturation (80 %), which is light (48º API) and sour (1.5 % H_2S). It is developed through vertical wells with massive hydraulic fracc'ing.

Despite the economic value of the Athel Silicilyte, its vertical and the lateral variability are not fully understood. It is crucial to understand the variability and what is controlling it in order to help selecting the best reservoir zones for fracc'ing as well as to predict the reservoir behaviour during production. This study therefore aims to investigate the variability of the Athel Silicilyte. Detailed Core investigation and sampling was carried out in absence of any outcrops. Core samples were examined using petrographical (optical and electron microscopy) and whole-rock geochemical analyses (XRD, XRF and TOC) in order to classify different lithofacies present. Classified lithofacies were then calibrated to wireline log responses to identify a characteristic log response for each lithofacies in order to facilitate the interpretation of uncored wells/intervals. The vertical and lateral variability were then investigated.

Detailed investigation revealed that the Athel Silicilyte consist of six lithofacies reflecting variability in detrital material contents (three silica-rich facies), sediment remobilisation (slumped and brecciated lithofacies) and diagenetic modification (carbonate-cemented lithofacies). The silica-rich facies being the most abundant (representing more than 97 % of the total thickness) and they comprises up to 95% microcrystalline quartz, with traces of silt-sized quartz grains, pyrite and clay minerals. The increase in detrital component contents (both silt-size quartz and clay minerals) in the silica-rich facies is associated with a decrease in the microcrystalline quartz contents. Facies with lower volumes of microcrystalline quartz are predominating in the Upper Athel Silicilyte, at the lower most of Athel succession and towards the basin margins. They characterised by high porosity values and thus represent the best reservoir facies.