

## Geochemical Source Rock Characterization

Peter Nederlof<sup>1</sup> and Pierre van Laer<sup>2</sup>

<sup>1</sup>Consultant

<sup>2</sup>ADCO

### Abstract

Despite the dramatic drop in crude oil prices, the National Oil Companies in the GCC countries continue to evaluate and pursue resource plays. Oil companies in Abu Dhabi, Dubai, Oman, Kuwait and Saudi Arabia have all produced oil from source rocks now and as a result, source rock characterization studies have seen a strong revival in the Arabian Gulf region.

Before the rapid growth in unconventional oil and gas output in the US, the main application of source rock characterisation was to quantify the charge risk of exploration prospects. Source rock quality in 'kitchen areas' was extrapolated from analysis of cuttings samples in exploration wells that were drilled many miles away on structural highs. Source rock cores were never taken and variabilities in organic matter type and maturity remained largely undetected. The assessment of resource plays requires a more detailed geochemical source rock characterisation and a dedicated geochemical data acquisition program. Source rock characterisations for resource play development integrate the results of (1) mud gas logging, (2) source rock pyrolysis and kinetic studies and (3) source rock extract analysis. The main objectives are to understand the fluid phase, the fluid properties and the volume of oil in place, which is estimated from source rock conversion and the ratio of expelled vs. retained hydrocarbons. Source rock cores are now widely available, allowing high density sampling and high resolution analysis programs.

In Abu Dhabi, two Mesozoic source rock intervals have been identified as having the highest potential for commercial development: the Middle Cretaceous Shilaif Formation and the Upper Jurassic Diyab Formation. The US Energy Information Agency estimates the oil potential of the Shilaif at 22 billion bbls. and the gas potential of the Diyab at over 120 tcf. Like the age equivalent Natih Formation in Oman, the Shilaif source rock reaches maturity in relatively small areas and Shilaif generated oil accounts for only a small fraction of the conventionally produced oil in Abu Dhabi. In fact, Shilaif oil is only produced from a single reservoir unit in one of the main onshore fields.

Although hundreds of wells with deeper objectives have been drilled through the Middle Cretaceous, only 1 dedicated shale oil well, drilled in 2015, has targeted the Shilaif source rock in the deeper part of a synclinal area. The Shilaif source rock in this location consists of three organic-rich units, separated by tight carbonate reservoirs, one of which is a 'water-wet zone' of 200 ft. thickness. The results from the source rock characterisation show dramatic differences between the three units. The conventional biomarkers maturity parameters suggest a low maturity for the top zone and high maturity for the lowermost zone, despite a limited difference in depth (400 ft.) and the small difference in temperature (5<sup>0</sup>C). The maturity differences suggest a sharp 'oil window' and a narrow range in activation energies. It is anticipated that the observed variations in the maturity parameters will, in future, allow the identification of the best producing intervals. Results from this study emphasise the fact that source rock characterisations for resource play assessment should be based on the analysis of a large number of samples, covering the entire source rock interval.