

Hydrocarbon Source Rocks of the Maragh Low

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Abstract : Biostratigraphical analyses of well sections from the Maragh Low in the Eastern Sirt Basin has allowed high resolution correlations to be undertaken. Full integration of this data with available palaeoenvironmental, lithological, gravity, seismic, aeromagnetic, igneous, radiometric and wireline log information and a geochemical analysis of source rock quality and distribution has led to a more detailed understanding of the geological and the structural history of this area. Pre Sirt Unconformity two superimposed rifting cycles have been identified. The oldest is represented by the Amal Group of sediments and is of Late Carboniferous, Kasimovian / Gzelian to Middle Triassic, Anisian age. Unconformably overlying is a younger rift cycle which is represented the Sarir Group of sediments and is of Early Cretaceous, late Neocomian to Aptian in age. Overlying the Sirt Unconformity is the marine Late Cretaceous section. An assessment of pyrolysis results and a palynofacies analysis has allowed hydrocarbon source facies and quality to be determined. There are a number of hydrocarbon source rock horizons in the Maragh Low, these are sometimes vertically stacked and they are of fair to excellent quality. The oldest identified source rock is the Triassic Shale, this unit is unconformably overlain by sandstones belonging to the Sarir Group and conformably overlies a Triassic Siltstone unit. Palynological dating of the Triassic Shale unit indicates a Middle Triassic, Anisian age. The Triassic Shale is interpreted to have been deposited in a lacustrine palaeoenvironment. This particularly is evidenced by the dark, fine grained, organic rich nature of the sediment and is supported by palynofacies analysis and by the recovery of fish fossils. Geochemical analysis of the Triassic Shale indicates total organic carbon varying between 1.37 and 3.53. S₂ pyrolysate yields vary between 2.15 mg/g and 6.61 mg/g and hydrogen indices vary between 156.91 and 278.91. The source quality of the Triassic Shale varies from being of fair to very good / rich. Linked to thermal maturity it is now a very good source for light oil and gas. It was once a very good to rich oil source. The Early Barremian Shale was also deposited in a lacustrine palaeoenvironment. Recovered palynomorphs indicate an Early Cretaceous, late Neocomian to early Barremian age. The Early Barremian Shale is conformably underlain and overlain by sandstone units belonging to the Sarir Group of sediments which are also of Early Cretaceous age. Geochemical analysis of the Early Barremian Shale indicates that it is a good oil source and was originally very good. Total organic carbon varies between 3.59% and 7%. S₂ varies between 6.30 mg/g and 10.39 mg/g and the hydrogen indices vary between 148.4 and 175.5. A Late Barremian Shale unit of this age has also been identified in the central Maragh Low. Geochemical analyses indicate that total organic carbon varies between 1.05 and 2.38%, S₂ pyrolysate between 1.6 and 5.34 mg/g and the hydrogen index between 152.4 and 224.4. It is a good oil source rock which is now mature. In addition to the non marine hydrocarbon source rocks pre Sirt Unconformity, three formations in the overlying Late Cretaceous section also provide hydrocarbon quality source rocks. Interbedded shales within the Rachmat Formation of Late Cretaceous, early Campanian age have total organic carbon ranging between, 0.7 and 1.47%, S₂ pyrolysate varying between 1.37 and 4.00 mg/g and hydrogen indices varying between 195.7 and 272.1. The indication is that this unit would provide a fair gas source to a good oil source. Geochemical analyses of the overlying Tagrifet Limestone indicate that total organic carbon varies between 0.26% and 1.01%. S₂ pyrolysate varies between 1.21 and 2.16 mg/g and hydrogen indices vary between 195.7 and 465.4. For the overlying Sirt Shale Formation of Late Cretaceous, late Campanian age, total organic carbon varies between 1.04% and 1.51%, S₂ pyrolysate varies between 4.65 mg/g and 6.99 mg/g and the hydrogen indices vary between 151 and 462.9. The study has proven that both the Sirt Shale Formation and the Tagrifet Limestone are good to very good and rich sources for oil in the Maragh Low. High resolution biostratigraphical interpretations have been integrated and calibrated with thermal maturity determinations (Vitrinite Reflectance (%Ro), Spore Colour Index (SCI) and T_{max} (°C) and the determined present day geothermal gradient of 25°C / Km for the Maragh Low. Interpretation of generated basin modelling profiles allows a detailed prediction of timing of maturation development of these source horizons and leads to a determination of amounts of missing section at major unconformities. From the results the top of the oil window (0.72% Ro) is picked as high as 10,700' and the base of the oil window (1.35% Ro) assuming a linear trend and by projection is picked as low as 18,000' in the Maragh Low. For the Triassic Shale the early phase of oil generation was in the Late Palaeocene / Early to Middle Eocene and the main phase of oil generation was in the Middle to Late Eocene. The Early Barremian Shale reached the main phase of oil generation in the Early Oligocene with late generation being reached in the Middle Miocene. For the Rakb Group section (Rachmat Formation, Tagrifet Limestone and Sirt Shale Formation) the early phase of oil generation started in the Late Eocene with the main phase of generation being between the Early Oligocene and the Early Miocene. From studying maturity profiles and from regional considerations it can be predicted that up to 500' of sediment may have been deposited and eroded by the Sirt Unconformity in the central Maragh Low while up to 2000' of sediment may have been deposited and then eroded to the south of the trough.

Keywords : Geochemical analysis of the source rocks from wells in Eastern Sirt Basin.

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