Unlocking Potential Opportunities and Addressing Challenges in the Jurassic Mafraq Reservoir in Oman

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Abstract

The Early to Middle Jurassic Mafraq play (partly equivalent to Marrat) is a mixed siliciclastics-carbonate interval and is the lowermost unit of Sahtan Group in Oman. It is overlain by Dhruma Formation and underlain with an angular unconformity by the Minjur, Jilh, Sudair or Khuff formations of the Akhdar Group. It represents the top seal for the aforementioned formations. It comprises alluvial-fluvial to marine successions that onlaps on the tilted and eroded Permo-Triassic Akhdar Group (Permian – Triassic). Mafraq Formation is thicker in the north in the vicinity of Lekhwair where it could be divided into Early Jurassic Lower Mafraq Member and Middle Jurassic Upper Mafraq Member. Lower Mafraq is mainly clastics while the Upper Mafraq is mainly carbonates around Lekhwair area. However, Upper Mafraq extends further to the south and it is a mixed siliciclastics-carbonate system. This study focuses on the Upper Mafraq Member in Central Oman area with the objective of understanding the depositional characteristics of Mafraq Formation and the challenges related to its reservoir characterization. Heavy minerals and zircon geochronology analysis was performed in order to understand the sediments source and distribution in Mafraq times. Samples were collected from outcrops, cores, and cuttings. The study suggests that there are three sources of sediments input into the Mafraq basin: an eastern local provenance and another provenance from the Arabian Shield sourced from the west and south directions. The different sediment inputs into the basin during Mafraq time resulted in a curved shoreface line.

A well was drilled in Central Oman and encountered an oil accumulation in Mafraq. However, other neighboring wells were found dry which triggered this study. A core was acquired to build the regional understanding in the area and to integrate the conventional core data with the log data. The results concluded that the sandstone intervals have good reservoir quality while the sand prone heterolithics have moderate reservoir quality. There were also high-density intervals that were thought to be tight siliciclastics intervals from petrophysical evaluation of the well. These intervals were not tested due to the high-density readings and therefore, calculated porosity was minimal. However, it was found that these intervals consist of iron ooids grainstones (Goethite, Siderite and Fe Oxide) where the iron caused the increase in density. The iron ooids intervals have good porosities and permeabilities and high grain densities that reaches up to 3.3g/cm3. There is also a possible missed pay in the sandstone interval of the upper part of Upper Mafraq where it displays high resistivity and high-density unit caused by the anomalous concentration of pyrite (25%). However, these good reservoir quality and high iron content intervals can be easily missed in the logs. Therefore, it is always recommended to use sonic logs while logging Mafraq.