Hydrocarbon Plumbing System in the Oman Basin: Insights from Tricyclic and Tetracyclic Profiles, Steranes, and Carbon Isotope Analysis

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Abstract

Oman Basin holds multiple petroleum systems of Paleozoic-Mesozoic ages. Multiple source elements, multiple families of oil are well documented and published as well. In this article we will present our interpreted oil types based on our regional relook on biomarkers and isotope signature patterns. And we will also hypothesize on regional plumbing pattern based on oil to source inferred correlation and spatialization of oil families. We constructed and compared normalized “Tricyclic Profiles” (TP) for oils from the Paleozoic to Mesozoic reservoirs. We also examined Sterane ratios, Carbon isotopic values for oil distinction and grouping. Regionally, we found six distinct oil families: North Huqf, South Huqf, “Q”, Safiq, Jurassic, and Cretaceous oils. From published literatures, we also recognized six potential source units namely Abu Mahara (Precambrian), Nafun (Precambrian), Ara- Dhahaban (Lower Cambrian), Safiq/Sahmah (Silurian), Hanifa/Tuwaiq/Diyab (Jurassic), and Natih (Cretaceous).

Commonly, the distribution of these oil families is confined geographically and stratigraphically, however cross stratigraphic migration and mixed signatures are also recognized. We observed that (1) South Huqf Oman oil is primarily distributed in the Haima Supergroup reservoir (Precambrian/Cambrian) within the South Oman Salt Basin, (2) North Huqf Oman oil is discovered in the Lower Cretaceous reservoir in the northern area, (3) “Q” oils are distributed in the central area and commonly found in Haushi reservoirs (Permian), (4) Safiq oil being more concentrated in the western regions in Haushi reservoirs (Permian), (5) Diyab/Hanifa-sourced oils are primarily discovered in Lower Cretaceous reservoirs in the northwest of Oman, and (6) Natih oil is commonly found within the Cretaceous reservoirs of the Fahud sub-basin. Furthermore, Cretaceous reservoir oils show a high tendency for oil mixing due to the complex hydrocarbon generation from multiple source rocks older than the Natih formation. This study demonstrated that “Tricyclic Profile” approach can be utilized as a rapid screening tool for oil typing and source facies interpretation. The crude oil of Oman exhibited diverse types with distinct profile patterns, indicating contributions from different sources. Contributions from progressively younger sources are added and mixed with contributions from older sources in progressively younger reservoirs. This analysis is beneficial for a more comprehensive and consistent understanding of hydrocarbon occurrences throughout the entire basin.