

Origin of the Mid-Cretaceous Heavy Oils from the Safaniya Sandstone Reservoir, (Wasia Formation), Saudi Arabia

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ABSTRACT

Heavy oil and natural bitumen deposits dominate the world oil inventory. There are several mechanisms by which heavy oil and natural bitumen form. They could originate by an early expulsion of oil from low- maturity-organic rich carbonate source rocks (Type II-S), or by in-situ natural alteration processes of conventional oils during migration or in the reservoir. Understanding heavy oil and natural bitumen formation mechanisms, and the geological factors controlling their occurrences, is of importance for petroleum exploration and production. While biodegradation has been found to be the main mechanism producing most Albertan Oil Sands, Venezuelan Orinoco belt heavy oils and other biodegraded oil fields, the origin of the Saudi heavy oils is much less clear.

Geochemical characterization of heavy oils across the mid-Cretaceous Safaniya (SFNY) reservoir in Saudi Arabia was conducted using bulk and molecular composition analysis of these oils to gain insight into their origin. They were mostly generated at an early stage of maturation ($RC \approx < 0.6\%$) from a high sulfur (7.8% S), carbonate source rock (Type II-S) deposited under a highly reducing environment. Also, the data reveals a significant depletion in the low molecular weight (LMW) polycyclic aromatic hydrocarbons (PAH) concentrations in the petroleum near the oil water contact zone, possibly caused by water washing. However, the unrealistic volumes of water required to cause such a gradient in the LMW PAH concentrations in the SFNY reservoir necessitates a broader study on the hydrology of the Arabian basin. Measuring hydrogen and oxygen isotopes, and oil/water partition coefficients might help in understanding the interactions between static water and petroleum compound classes and allow a firm conclusion on whether water washing was the main cause for the compositional gradients observed in the LMW PAH of the studied oils.