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Northern Rub' Al-Khali Upper Jurassic – Lower Cretaceous Petroleum System

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For abstract, PTO
No full paper available

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The Jurassic–Lower Cretaceous petroleum system in the northern Rub' Al-Khali Basin contains some of the largest oil and gas accumulations of the Middle East. Carbon isotopes and biomarkers indicate that the main source of hydrocarbons originated from the Jurassic-aged Tuwaiq Mountain and Hanifa basinal source rocks. Other source rocks, despite being less significant and being often overlooked, have also contributed in considerable amounts to the charge and include the Jurassic Jubaila and the Lower Cretaceous Habshan, Thamama and lower Bab intervals. All these source rocks are marine carbonates and the kerogen type is mainly, but not exclusively, represented by the oil-prone, low-activation energy and sulphur-rich type IIS. We are presently reviewing the stratigraphic setting of the source rocks to better map out their thickness distribution and initial source rock properties.

The main reservoirs are the Lower Cretaceous Thamama and Shu'aiba formations and the Upper Jurassic Arab Formation. The main seals are the Hith anhydrite, the dense unit above the Thamama F reservoir and the Nahr Umr Formation.

Heat-flow analysis and thermal history derived from burial history and large-scale tectonic constraints indicate that most of the petroleum from the previously mentioned source rocks was generated/expelled during the Cenozoic whereas the main phase of structural development started earlier in the Turonian.

Migration to the reservoirs occurred both by vertical and lateral migration. Sets of reservoirs bounded by one of the main seals may show close to common free-water level (FWL). Besides top-seal capillary entry pressures, faults/fractures do also control vertical migration. The fault behavior is dependent on their respective orientation and the maximum horizontal stress rotation through geologic time. The lateral migration has also a major impact on the hydrocarbon distribution. It is linked to the development of the Oman foreland, which resulted in the eastward tilting of the structures, which in turn, induced substantial dismigration towards the west.

The major in-reservoir alteration is represented by Thermochemical Sulphate Reduction (TSR) in the Arab reservoirs, which controls the cracking of hydrocarbons and the generation of vast amounts of H_2S .

Whereas the main conventional hydrocarbon resources of the Upper Jurassic–Lower Cretaceous have been discovered in the large four-way closures, substantial additional resources are anticipated in more complex fault and stratigraphic trapping settings, as well as in production from unconventional hydrocarbon sources.