

## **Cretaceous Clastic And Carbonate Reservoirs Across The Gulf Of Aden: Say'un-Al-Masila Basin Of Southern Yemen Versus Al-Mado Basin Of Northern Somalia**

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### **ABSTRACT**

The Mesozoic rifting of the Gondwanaland resulted in several discrete basins in the Afro-Arabian side of the continent. The Say'un-Al Masila Basin of Southern Yemen and the Al Mado Basin of Northern Somalia were among the earliest Mesozoic sedimentary basins in the region. The two basins were contiguous prior to the Oligocene rifting of the Gulf of Aden and resulted from a NW-SE rifting system (called here Say'un-Al Mado Graben) induced by the separation of the Indian continent. Early Jurassic clastic sequences of the Kohlan and Adigrat sandstones floored the Say'un-Al Masila and Al Mado basins, respectively. Middle to Late Jurassic marine transgression allowed establishment of a carbonate platform in the two basins where the Amran Group in Say'un-Al Masila Basin and the Al Mado Group in the Al Mado Basin succeeded (with transitional contacts) the Kohlan and Adigrat formations, respectively. By latest Jurassic? – Early Cretaceous, the Say'un – Al Mado rifting had been rejuvenated, forming further down-warping of the graben with elevated flanks of the Erigabo-Mukalla High to the west and Alula-Fartaq High to the east. The rejuvenated Say'un – Al Mado graben had a funnel shape in plan view, tapering northwestward (in Yemen) and open southeastward (through Northern Somalia) to the Tethys Ocean (paleo-Indian Ocean). The Cretaceous fill in the Say'un – Al Mado Graben consisted of clastic sequences predominant in the western flanks of the basin (Tawila Group of Yemen and Yesomma Formation of Northern Somalia) and carbonate sequences predominant in the southeastern areas (Mahra Group and Tisje Formation, respectively). The sandstones of the Tawila Group (e.g., Qishn clastics and Harshiyat Formation) and the Yesomma Formation were deposited in a complex system of braided to low sinuosity meandering rivers, tidal-dominated estuarine and deltaic environments. The sandstone provenance was the uplifted shoulders of the basins, transported by braided channels and offloaded in a marginal marine setting. The clastic influx decreased southeastward where carbonate sedimentation flourished in a shallow marine environment and represented by the Mahra Group and the Tisje Formation. Carbonate sand shoals, lagoonal wacke-/mudstones and rudistic buildups are the main constituents of these carbonates.

The Qishn Formation contains excellent reservoir units with porosity of 18 to 23% and permeability of up to ten darcies. In the Masila Block 14 of southern Yemen, it contains estimated reserves of over one billion barrels of recoverable oil. Unlike the relatively intense hydrocarbon exploration activity in Yemen, Somalia's hydrocarbon resources are under-explored with only about 20 wells in the northern basins (including the Al Mado Basin and others). Nevertheless, the little geological knowledge from the Yesomma and Tisje formations (correlative with the prolific Cretaceous reservoirs of the Say'un – Al Masila Basin) indicate good reservoir intervals (up to 300 m thick and 14% porosity) with interbeds of source shales that contain a TOC of up to 5%. Significant source rocks in several Jurassic horizons are also recognized in the region. Furthermore, most of the drilled wells have shown oil staining and gas shows within the Cretaceous section of the Al Mado Basin. Maturity of these hydrocarbons ranges from immature to post-mature with oil window between 1500 m and 2400 m in areas with relatively high geothermal gradient. Thus, the Cretaceous strata of the Al-Mado Basin of Northern Somalia are promising potential targets for hydrocarbon exploration.