

## The Cretaceous System of the Al-Mado Basin, northeastern Somalia (Puntland State): a promising frontier basin akin to the petroleum-rich basins of the Arabian Peninsula

Osman Salad Hersi

Department of Geology, University of Regina

### Abstract

The eastern region of Africa, along with the Arabian Peninsula, formed the eastern margin of Gondwana prior to latter's disintegration in late Triassic – Early Jurassic periods. In most of the Mesozoic Era, the Afro-Arabian region dominated by two depositional systems: a roughly north-south elongated shelf of the Tethys Ocean on its eastern side and continental environments on its western side. The latter was a site of siliciclastic source and deposition whereas the shelf was dominated by carbonate deposition. The Al Mado Basin, located in northern part of Somalia (eastern Sanaag and Bari regions) was a prominent site of deposition defined by a NW-SE-oriented paleosag. The basin is filled by Jurassic to Cretaceous strata that correlate with coeval stratigraphic units in southeastern Arabia of Yemen and Oman. The Cretaceous System of the basin is not uniform throughout the basin; mixed clastic-carbonate strata of the Tisje Formation occur in its northwestern sections whereas carbonates dominate its southeastern margin along the Indian Ocean (the Hafun Margin). Lithologic and biostratigraphic correlations between the Cretaceous systems of the Al Mado Basin and the southeastern Arabian basins indicate continuity of the depositional system across the Gulf of Aden.

The Tisje formation is well-exposed along the sea-facing cliffs of eastern Al-Mado and western Al-Miskat mountain range (northern Puntland); it lies unconformably on the carbonates of the Jurassic Period. The Tisje Formation consists of two members; a lower member dominated by carbonates and upper member of mixed carbonate-clastic sequence. Thirteen informal lithostratigraphic units (1 to 13) were recognized; units 1 to 10 belong to the lower member and the other three units belong to the upper member. These units include, from bottom to top: 1) conglomeratic sandstone, 2) bioturbated marls interbedded with bioclastic mudstone to wackestone, 3) thickly-bedded, bioclastic wackestone to grainstone with subordinate marl interbeds, 4) bioclastic marls, 5) massive to thickly-bedded bioclastic packstone, grainstone and rudstone interbeds, 6) Orbitolina-rich marls with bioclastic mudstone to wackestone interbeds, 7) calcareous sandstone with coquina layers, 8) very fossiliferous, massively- to thickly-bedded packstone to rudstone with orbitolinids, alveolinids, corals, rudists, and echinoids, 9) marls with sandy limestone interbeds, 10) thickly-bedded bioclastic wackestone to grainstone, 11) medium to coarse-grained sandstone, 12) bioclastic mudstone to packstone with rudistic rudstone interbeds, 13) sandstone with pedogenic features. The Tisje Formation is unconformably overlain by Auradu Formation of latest Maastrichtian to early Eocene age. Biostratigraphic attributes of the various units of the Tisje Formation suggest that units 1 to 5 are Aptian in age and correlate with Qishn Formation of Yemen and southern Oman, and Kharab to Shuaiba formations of northern Oman and UAE. Units 6 and 7 are Albian in age and correlate with the Kharfot Formation of the Jeza-Qamar Basin (eastern Yemen and southern Oman) and Nahr Umr Formation of northern Oman and UAE. Units 8, 9 and 10 are Cenomanian to Turonian in age and correlate with the Dhalqut Formation of the Jeza-Qamar Basin and the Natih/Maudud formations of north Oman and UAE. The fossiliferous carbonates of unit 12 have apparent conformable contact with the underlying and overlying sandstones (i.e., units 11 & 13, respectively) and dated as Campanian in age. These three units most likely correlate with upper Mukalla Formation (southeastern Yemen), Samhan Fm (southern Oman) and Fiqa Fm (northern Oman). The Maastrichtian

lower portion of the Auradu Formation correlates with the Sharwayn and Simsima formations of Yemen and Oman.

The Cretaceous sequence of the Hafun Margin (southeastern Al Mado Basin) is dominated by carbonate strata that constitute Cotton and Gumburo formations. These rocks are poorly studied due to lack of outcrops. Few drilled wells along the Indian Ocean side of the basin cut through these strata. The Cotton Formation consists of bioclastic limestone with reefal components interbedded with shales. The Gumburo Formation is Late Cretaceous in age consists bioclastic mudstone to grainstone and reefal limestone with foraminifera, corals, rudists and mollusks. The ages of the Cotton and Gumburo formations are not well-documented. Available publications indicate that they span between early and late Cretaceous. They may correlate with the lower and upper units of the Tisje Formation, respectively, but more refining work is required for both lithologic and biostratigraphic means.

The Cretaceous shallow marine depositional system of northeastern Somalia (Puntland Shelf) is well-developed and preserved in the study area. Although the late Cretaceous compressional tectonics (emplacement of the Semail Ophiolites) that had generated extensive structural traps in the Arabian Peninsula do not appear to have affected northern Somalia, seismic data from the study area demonstrate existence of extensional tectonics and generation of potential hydrocarbon traps. Geologic data from the study area are also encouraging and indicate existence of a functioning petroleum system.