AAPG Datapages/Search and Discovery Article #90318 ©2018 AAPG/Middle East GTW, Carbonate Reservoirs of the Middle East & Their Future Challenges, Abu Dhabi, UAE, January 30 – February 1, 2018

Carbon Isotope Chemostratigraphy, Nannofossil Biostratigraphy and Geochemical Characterization of Organic-Rich Source Rock Intervals in the Upper Cretaceous Shilaif Formation, Abu Dhabi, U.A.E

Emina Helja[1], Dominik Hennhoefer[2], Aisha Al Suwaidi[2], Thomas Steuber[2], and Cinzia Bottini[3]

[1]Abu Dhabi National Oil Company Onshore (ADNOC Onshore)
[2]Khalifa University of Science and Technology
[3]University of Milan

ABSTRACT

We present new, high-resolution bulk carbonate carbon-isotope records of three stratigraphically continuous cores as part of a multidisciplinary study whose primary aim is to establish a chronostratigraphic framework for the Upper Cretaceous Shilaif Fm. based on sedimentology, geochemical source rock evaluation, calcareous nannofossil biostratigraphy and carbon isotope chemostratigraphy. The studied cores provide a SW-NE transect of depositional paleoenvironments across the Shilaif intra-shelf basin in Abu Dhabi, extending from the northern paleo-basinal center (PB-1) to the eastern and northeastern paleo-slope (wells PS-1 and PS-2, respectively). Sediments within the cores represent three shallowing-upward sequences of alternating organic-rich and organic-lean carbonates. Four facies associations were identified, representing basinal to mid-ramp facies of a homoclinal ramp system.

In the basinal well, three organic-rich source rock intervals with excellent generative potential were identified, one within each of the Shilaif sequences, whilst in the more proximal slope wells, only Shilaif Sequences 1 and 3 were determined to contain source rock intervals. The source rock interval within Sequence 1 has the highest organic richness with TOC values up to 22 wt% and the greatest generative potential. The organic matter is mainly Type II with Type IIS in negligible quantities. Despite their high generative potential, the source rock intervals are thermally immature to early mature in the paleo-basinal well PB-1, immature in the structurally shallower paleoslope well PS-1 and early mature in the structurally deepest well, PS-2. Thus, the potentially producible oil is either in-situ generated during early maturation or has migrated laterally from stratigraphically equivalent intervals in the adjacent, structurally deeper synclines.

TOC values for non-cored wells were computed using the Passey ΔLogR technique and utilized as control points for mapping the thickness of organic-rich intervals (TOC values > 1.8 wt. %). The thickness of Sequence 1 and 3 organic-rich intervals is highest in the intra-shelf depocenter ranging from 110 to 180 ft. and from 50 to 80 ft., respectively, decreasing towards the south east and north west platform margins and is eroded in the southeastern areas of Mender and Lekhwair. The organic-rich intervals show an upward decrease in areal extent, with the organic-rich interval in Sequence 1 being the most widespread and that of Sequence 3 being constrained by the profusely narrowing basin.

The $\delta^{13}C_{carb}$ curve in PS-1, calibrated against nannofossil biostratigraphy, is characterized by positive excursions recognizable in global carbon-isotope reference curves and corresponding to the latest Albian Oceanic Anoxic Event (OAE 1d), the mid-Cenomanian Event (MCE I) and the Cenomanian/Turonian (OAE 2). The $\delta^{13}C_{carb}$ curves in the other wells, PB-1 and PS-2, only span the Cenomanian-Turonian interval and

correlate well with the PS-1 $\delta^{13}C_{carb}$ curve, further delimiting the stratigraphic extent of OAE 2. In conjunction with nannofossil biostratigraphy and the $\delta^{13}C_{carb}$ records, a significant increase in calcisphere abundance and the occurrence of thin-shelled bivalves recorded after the OAE 2 isotope excursion correspond to global bioevents and provide additional tools for defining the Cenomanian-Turonian boundary.

Organic matter deposition is not concomitant with the carbon isotope excursions pertaining to OAE 1d and OAE 2 within the highstand deposits, but instead corresponds to the preceding, local negative isotope excursions within the transgressive deposits. This suggests that organic richness in the restricted Shilaif intra-shelf basin was not restricted to basinal anoxic settings and that other factors such as enhanced primary productivity and sediment accumulation rates played a role in the deposition and preservation of organic matter.