geoconvention
Virtual Event
September 21-23
2020
CSPG • CSEG • CWLS • GAC • MAC • IAH

Hydrocarbon Maturity Assessment of the Morondava Basin, Offshore Madagascar

Fouad Faraj[a], Alexander Braun[a], Christine Yallup[b], Colin Saunders[b]
[a]Queen's University, Department of Geological Sciences and Geological Engineering
[b]Landmark, Halliburton

Linking the tectonic history of a region to the basin evolution is critical for assessing petroleum source rock maturity. In the present work, we take the approach of incorporating regional tectonic context for estimating source rock maturity using 1D basin models. The Morondava Basin is located on the western Madagascan margin and is used as a case study with the primary objective to evaluate the hydrocarbon source rocks. In the case of the Morondava Basin, Triassic and Jurassic rifting events had an impact on the thermal history of the basin and were incorporated into the 1D basin models. Although the reconstructed basin model inputs from the tectonic history are unique for the Morondava Basin, in principle, the approach presented here is applicable for other rifted basins both onshore and offshore.

There are three major source rock groups in the Morondava Basin, and the 1D basin modeling results indicate that: (i) The Early Triassic continental source rocks are overmature, and the hydrocarbons were expelled in the Mid to Late Jurassic, (ii) The Mid Jurassic deep marine source rocks are in the oil window, and the hydrocarbons were expelled from the Late Jurassic to Early Cretaceous in the shallow offshore and from the Late Cretaceous to present day in the deep offshore, and (iii) The Cretaceous deep marine source rocks are immature and have not expelled any significant amount of hydrocarbons. In terms of hydrocarbon maturity, the Mid Jurassic source rocks are oil prone and considered the most prospective.

The 1D basin models indicate that for all source rock maturation parameters, with increasing distance offshore, the hydrocarbon maturity decreases. When comparing the shallow and deep offshore, both the mid Jurassic source rock transformation ratio and vitrinite reflectance decrease deeper offshore.

The top of the oil and gas window has been visualized through modified cross sections in both the northern and central offshore Morondava Basin. The decreasing maturity trend with increasing distance offshore is evident in both the northern and central sections. The hydrocarbon maturity is consistent in the north to south direction, subparallel with the shoreline. The consistency in hydrocarbon maturity parallel to the shoreline suggests that the upper and lower thermal boundary conditions, heat flow, and mudline temperature, respectively, are the main controls driving the source rock maturity since these inputs vary directly with the decreasing crustal thickness and increasing water depth further offshore. Thermal boundary conditions were derived from the tectono-stratigraphic history, highlighting that it is crucial to incorporate the key tectonic events of a region to the basin evolution model for assessing hydrocarbon source rock maturity.

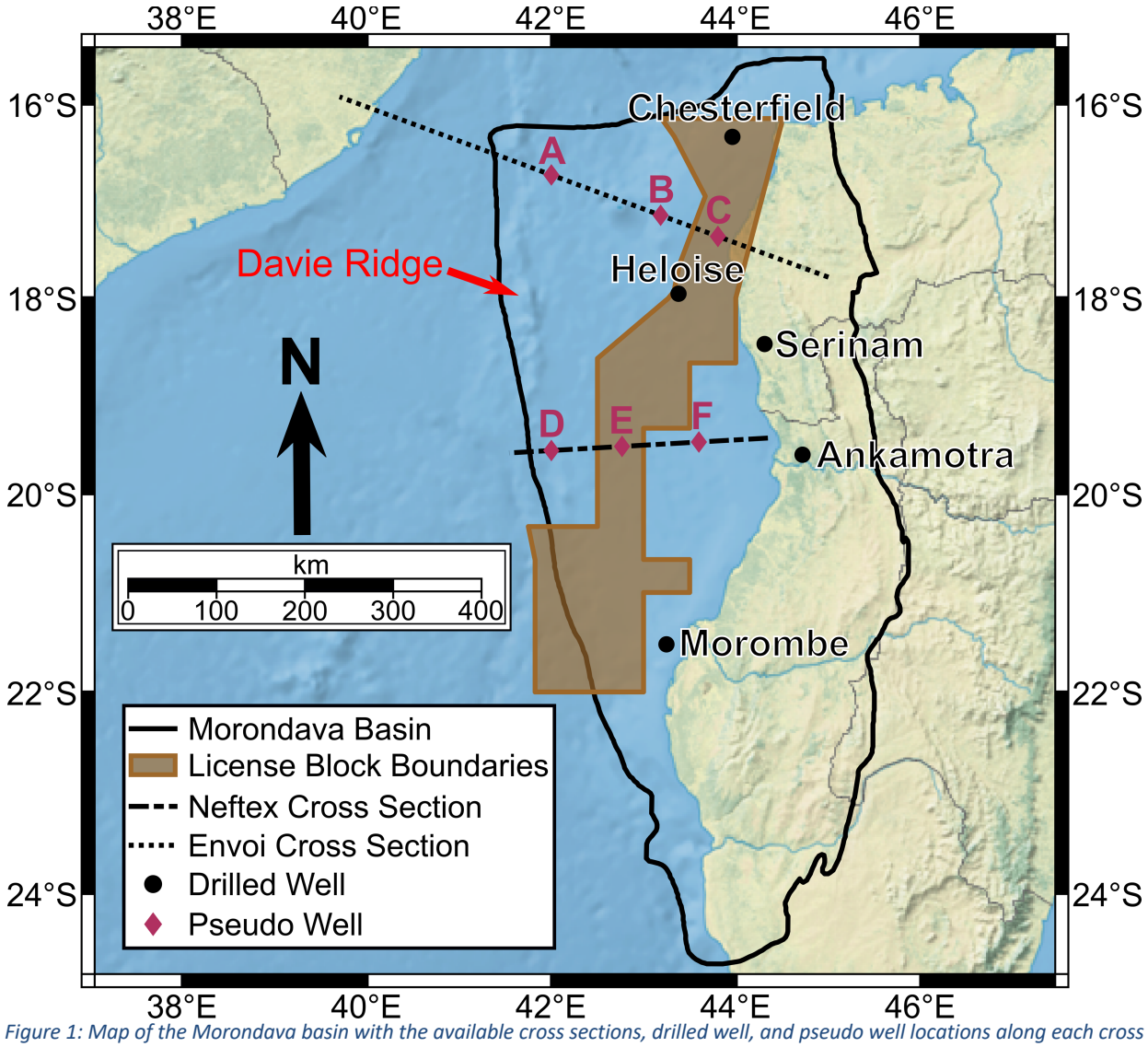

Figure 1: Map of the Morondava basin with the available cross sections, drilled well, and pseudo well locations along each cross section. Location data taken from Tari et al. (2017) and Envoi (2011).

References

Envoi, 2011. Energy Venture Opportunities International. Mozambique Channel (offshore Africa), Juan de Nova, est permit, Morondava Basin, Wessex Exploration farm-out brochure.

Tari, G., Hannke, K., Schretter, I., Rock, G., Allan, T., 2017. Turonian sill complexes in the offshore Morondava Basin, Madagascar: Trap formation by compound forced folding. In: Search and Discovery Article 11015. AAPG Asia Pacific Region GTW, Influence of Volcanism and Associated Magmatic Processes on Petroleum System, Oamaru, New Zealand.