

Influence of Structural and Tectonic Evolution on the Petroleum System(s) Development Within the Pletmos Basin, Offshore South Africa: Implications for Hydrocarbon Prospectivity

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Abstract

The relatively frontier Pletmos Basin represents a major underexplored area within the south-eastern continental margin, off the coast of South Africa. This intracratonic basin is said to have undergone characteristic cycles and/or tectonostratigraphic phases typical of a rift basin system. It encompasses several structural highs and asymmetrical troughs, comprising up to 7 km of Mesozoic - Cenozoic sedimentary rock packages with several marine organic-rich shales that are considered potential source rocks. Albeit the proven potential from prior exploration efforts during the preceding decades, the geologic evolution and petroleum geology has been rarely studied, thus, remains poorly documented. The key objectives were to identify the stages of basin evolution, interrelationships between tectono-cycles and trapping physiognomies, and how rifting styles differ and affect trap formation, to confer the impact of the evolution on the petroleum potential of the area. An integration of analytical and numerical modelling techniques was utilized in an effort to ascertain the presence and describe the tectono-stratigraphic architectures of petroleum system elements. This allow to the defining of migration patterns and relevant constraints. As a first step, we defined the crustal architecture and structural framework configuration of the basin. 2D and high-resolution 3D seismic datasets integrated with Bouguer gravity and magnetic data enabled us to

improve understandings of the local structural geology and identify faults, and allowed us to study in detail the structures that developed during the geometric evolution. This integration allowed the definition of the differences in fault-structures, subsidence patterns, sediment stacking patterns and heat flow, and identification of possible basinal migration paths. In addition, basin geometries and associated active processes that might have led to potential hydrocarbon seeps. Consequently, this provided insights into the lithospheric dynamics and sub-surface features, different phases of evolution, tectonic deformation, and geodynamic drivers of basin development, along with the genetic relationships of structures within the petroleum system(s). These results will ensue to the reconstruction of geo-histories, and establishing of thermal maturation evolutions, generation timing, expulsion efficiencies and source rock contributions to the generated hydrocarbons.

Keywords: Geodynamics, lithosphere deformation, stratigraphy, thermal history, petroleum systems