A recent study by Schlumberger petrotechnical experts* examined the prospectivity of the Zambezi Delta area.

**Expanding the understanding of the Zambezi Delta area**

A RECENT STUDY assessed the hydrocarbon potential of the Zambezi Delta area of Mozambique. A team of Schlumberger petrotechnical experts relied on seismic measurements, gravity calculations and local exploration well data to construct a 3D model of interpreted horizons. They also evaluated the prospectivity of this frontier area by identifying and characterising the presence of five essential components of a petroleum system: source rock, reservoir, trap, seal and migration.

The study concluded that all necessary components for a working petroleum system exist in the Zambezi Delta area. Additional data acquisition and evaluation will enhance the model and provide additional insight. Accurate models and hydrocarbon prospectivity information are critical for operators, particularly as new Mozambique licensing opportunities arise.

The offshore area is relatively underexplored with a paucity of wells.

**Regional history and geology**

In 1948, hydrocarbon exploration activities intensified in the southeastern African nation of Mozambique. The efforts led to the Gulf Oil discovery of the Pande gas field in 1961 and subsequent onshore gas discoveries at the Buzi and Temane fields in 1962 and 1967 respectively. Following years of political instability and national unrest, Mozambique became increasingly receptive to oil and gas exploration. By 2011, the number of drilled wells reached 141.

Rovuma and Mozambique are two major basins in the Republic of Mozambique. The geology of these passive continental margin basins varies from north to south. Deepwater gas discoveries occurred in the Rovuma Basin between 2010 and 2012, confirming its role as a prolific gas province. Anadarko and ENI operate the Barquentine and Mamba offshore gas fields (Figure 1).

Regional studies have also indicated significant discovery potential in the Zambezi Delta area. In 2010, Anadarko and ENI drilled the Nemo-1, Zambezi-1, Zambezi-3 and ZD-E-1 shallow shelf exploration wells (Figure 1). They recognised the possibility for significant variations in the sedimentary sequences given the complex tectonic history of the area (Figure 2).

The scope of this work included mapping and characterisation of seven ZDD horizons, including shelf and fault locations. The model interpreted horizons for the following sedimentary sequences: Karoo-Belo, Upper Jurassic, Lower Cretaceous, Upper Cretaceous, Paleocene, Eocene-Oligocene-Lower Miocene and Upper Tertiary-Quaternary (Figure 3).

**Sedimentary sequence model**

The experts sought to improve understanding of the area, particularly as related to the development of the Zambezi Delta Depression (ZDD). The depth of the thick ZDD sedimentary sequences exceeds the record length of existing seismic data for the area.

The offshore area is relatively underexplored with a paucity of wells; nevertheless, the understanding of the basin has recently been boosted with the acquisition of 35,000 km of multiclient data with ObiQ® sliding-notch broadband acquisition and imaging technique in 2013, including approximately 10,000 km over the Zambezi-Save area. This is in addition to the 12,000 km of legacy and reprocessed seismic data from this area.

The Schlumberger petrotechnical experts assessed the five critical components of a petroleum system to determine the elements of a petroleum system to determine the prospectivity of the offshore Zambezi Delta area. They evaluated the five critical components of a petroleum system.
working petroleum system: source rock, reservoir, trap, seal and migration.

Model interpretations and previous research indicate that active source rock may include the Late Karoo, Domo, Lower Grudja and Cheringoma Formations. As previously noted, the Karoo sequence contained a narrow lagoon or lake where conditions may have supported the development of oil-bearing source rock. Seismic data also reveals that areas in the rotated fault block sections display low amplitude contrast, another possible indication of source rock. Model analysis suggests the Domo Formation in the Lower and Upper Cretaceous sequences is another possibility. Previous research also points to the offshore portion of Lower Grudja as oil-prone source rock. Lastly, while indications suggest the onshore portion of the Cheringoma Formation is source rock, additional research is required to make a similar determination for the offshore portion.

The experts identified several potential reservoirs, a second petroleum system requirement. The likely terrigenous and carbonate formations may represent reservoirs in the Upper Jurassic Karoo while the Maputo Formation and Lower Domo Formation are possibilities in the Lower Cretaceous sequence. High contrast amplitude responses suggest reservoir potential in the section of the Domo Formation located in the Upper Cretaceous. The study also identified necessary seals. The Upper Domo and Lower Domo Formations, unconformities such as the Jurassic-Cretaceous boundary and deposition of shales and mud within the Tertiary may all act as seals.

Porous materials, faults and fractures within the ZDD may provide required migration routes, the final petroleum system requirement. The experts concluded that all five components are present, indicating a high hydrocarbon potential. Amplitude anomalies and contrast variations within 2D seismic reports support this determination.

The Schlumberger study expanded the understanding of the Zambezi Delta area by successfully creating a 3D model of the ZDD. The related petroleum system analysis indicated high hydrocarbon prospectivity for the Zambezi Delta area. As with all frontier environments, additional seismic studies, new gravity data, advanced processing techniques and more exploration well data will help refine models and confirm conclusions.

References

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