Sequence Stratigraphy and Exploration Potential of the Upper Cretaceous-Miocene Sections, Deep Water Morondava Basin, Western Madagascar

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Abstract

The offshore Morondava Basin is a frontier exploration area along the western margin of Madagascar. The untested Upper Cretaceous-Miocene section rests in 500-1,800 m waterdepths. A 3,200 km^2 time-migrated 3-D seismic data set was interpreted to develop the sequencestratigraphic framework, which then helped to evaluate the trapping potential of the Oligocene-Miocene turbidite deposits. Onshore exploration made several gas and heavy oil discoveries. Six offshore wells were drilled in shallow water - all dry holes - two of which are within the study area. Four second-order Cretaceous-Miocene megasequences (MS) were defined. Each megasequence is composed of multiple third-order sequences. Megasequences vary in structure, time-thickness, depositional environment, seismic facies, and areal distribution. MS 1 (UpperCretaceous-Maastrichtian) consists of deepwater shales, which are cut by several igneous sills and dikes of variable age. MS 2 (Paleocene-Oligocene) comprises an aggradational carbonate bank with thinner shales deposited in the southern portion of the study area. A major erosional event removed significant volumes of MS 1 and 2 sediments regionally (up to 1.2 seconds, TWTT); this event is represented by a regional truncating reflection (Oligocene sequence boundary). MS 3 (Oligocene-Miocene) comprises seven sequences deposited in abase-of-slope setting. These sequences, which consist of channel and levee-overbank deposits, onlap the Oligocene sequence boundary, and each sequence backsteps successively farther upslope.

Additionally, these sequences migrate northward in a laterally offset stacking pattern. MS 4 (Miocene) represents the re-establishment of a progradational margin, and comprises sets of prograding clinoforms updip, and downlapping reflections basinward. The lack of exploration wells means the reservoir and seal lithologies cannot be directly analyzed. However, the seismic data indicate that multiple stratigraphic traps and structural traps that overlie igneous intrusions are present. Three stratigraphic trapping styles are present: updip pinchout, channel fill, and erosional truncation. Potential structural traps include compound forced-folding and compactional drape structures. Hydrocarbons sampled from seafloor sediment cores indicate source rocks are present in the area. Updip (onshore) wells show average TOC values of 2.5% in the proposed Cretaceous marine shale source rock interval.