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Tectonic Models for the Development of Basins and Rises in the Deepwater Andaman Sea: Implications for Petroleum Systems

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Abstract

The Cenozoic basins occupying the shelfal areas of the Andaman Sea are reasonably well known through drilling and seismic reflection data. Passing into the deeper water areas there are less constraints on basin development due to the absence of wells and the more regional nature of the seismic data. Regional plate reconstructions tend to shrink the area of the Andaman sea to a small area in the Early Cenozoic (<25-30% of the present day area) and much of the later area increase is a consequence of Neogene seafloor spreading. However, the nature of the crust in the deepwater Andaman sea is highly contentious. Curray (2005) defined a large area including the Alcock and Sewell Rises, the Central Basin, and the western half of the East, or East Andaman Basin that was proposed as being composed of Neogene oceanic crust. Given the generally negative correlation between the occurrence of hydrocarbon fields and oceanic crust, this interpretation is highly pessimistic for successful exploration. However, the interpretation was made in the absence of industry seismic data across the East Andaman Basin. Correlations of regional seismic lines from the Mergui Basin in Thailand (with 19 wells) to the East Andaman Basin indicated an important diachronous (?) unconformity in the Early to Middle Miocene that marks the end of extension. This unconformity is present in the East Andaman Basin and indicates a thick (>3 km) faulted section occurred prior the unconformity. The section is inferred to be of Oligocene-Miocene age, and probably overlies thinned continental crust, not oceanic crust. Applying modern concepts of passive margin development (modified for a back-arc setting) to the Andaman Sea suggests that areas thought of as oceanic crust (particularly the Alcock and Sewell Rises) could actually be highly extended continental crust, giving hope for the presence of source rock, and higher geothermal gradients. Gravity modeling, indicates that the rises, and the East Andaman Basin are mostly composed of thinned continental crust. The crustal thicknesses derived from 2D and 3D seismic data where a possible Moho reflection is imaged, are a good match with the gravity data. The Central Basin is also controversial, whether it represents Pliocene-Recent spreading, predominantly Miocene spreading, or is not oceanic crust at all. The Andaman sea evolved from near pure extension (WNW-ESE) during the late Palaeogene, to highly oblique extension (NNW-SSE) during the Neogene, to strike-slip dominated deformation (Late Miocene-Recent). These changes in extension direction and deformation style probably reflect the switch from slab rollback-driven extension to India coupling with Myanmar and driving oblique extension/dextral strike slip. A change in dominant direction of sediment supply (from Peninsular Thailand/Myanmar, to a northerly source) accompanied these changes. The East Andaman, Mergui-North Sumatra and Martaban Shelf basins, along with the Alcock and Sewell Rises and Central Andaman Basin (CAB) were all involved with this deformation, which became increasingly focused on the CAB and the rises with time.

At present a number of major issues can be addressed but not fully resolved including: 1) The distribution, timing, volume and origin of magmatism in the basins, 2) the causes and significance of strong crustal reflections imaged on 2D and 3D seismic data. Elements of both volcanic and non-volcanic margins appear to be present in the East Andaman Sea, with well developed necking of continental crust (perhaps due to dry mafic, granulite facies lower crust) and extensive igneous intrusions in the lower and middle crust. Understanding the basement and

margin type is clearly an important initial step to understanding the petroleum potential of the basins in the deepwater area of the Andaman Sea. However, constraints are sufficiently loose at present that a range of significantly different tectonic models still need to be considered.