

Tectonic Disposition of Back-Arc Andaman Basin and its Hydrocarbon Potential*

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Abstract

This study synthesizes the geological setting and tectonic evolution of Andaman Basin and its bearing on hydrocarbon exploration. This crescent shaped basin is bordered in the west by the Andaman-Nicobar chain of islands and by Burma, Thailand and Malaysia land masses in the east (Figure 1). Geologically it is located in a back-arc setting of the prominent Indonesian island-arc. An interesting relationship of nearly straight ridges with the curvilinear subduction zones is highlighted during the present study. Varying zones of gravity anomalies in this island arc system were realized several decades ago. The area includes the Chindwin Basin, Salin Basin, Prome Embayment, Irrawaddy River Delta, Gulf of Martaban, and the Andaman Sea.

Tectonics

Roy (1983) in earlier times considered the geographical boundary of Andaman Basin, around the Andaman chain of islands. Later, this was suggested to be divided into fore-arc and back-arc basins (Misra, 2010). Apart from the island arc system, the arc region is dominated by 90 East Ridge. This totally submerged ridge is nearly straight and is mapped for approximately 16,000 kms. In gravity data it has a conspicuous positive signature. Several earlier workers thought it to be a remnant of a trail left by a hot spot, gave rise to Rajmahal volcanoes located north of the Bengal Basin. The presence of innumerable fractures parallel to the 90 degree ridge suggests a prominent component of extensional tectonics in the tectonic evolution of this region, which was so far believed to be under the compressional regime of a convergent plate boundary. The Andaman chain of islands represents an island-arc system which continues as a subduction zone in Sumatra-Java region of East Indies (Figure 2).

Interpretation of high resolution gravity data has brought out two parallel trenches with prominent gravity lows. These gravity lows are separated and bordered by gravity highs. From the tectonic point of view this region is highly complex, as it is located in the proximity of a subduction zone. This subduction zone is believed to exist on the eastern side of Andaman-Nicobar chain of islands, where volcanism is recorded intermittently. In southern continuation, however, rampant volcanism prevails along this zone. Back arc basins are gaining much importance as they are found to have fairly good potential for hydrocarbons.

It has emerged from the present study that the petroliferous Irrawaddy Rift System continues from land area into the Andaman Sea through its delta region in the middle. Finding of an uninterrupted Tertiary sedimentary sequence comprising pre-, syn- and post-rift sediments indicates that the area has been under extensional tectonics since the beginning of Cenozoic.

An interesting relationship of nearly straight ridges with the curvilinear subduction zones is another highlight of the present study. It can be seen that the 90 East Ridge is in close vicinity with the convergent boundary and island-arc system in its northern part and gradually separates leaving a triangular basin, which has innumerable gravity highs and lows trending in a NNE-SSW direction. A thick sedimentary pile suggests high potential of hydrocarbons. In a similar setting, one more nearly straight ridge is identified on the eastern side of the Lakshadweep chain of Islands. This ridge, starting from the Kerala coast in the north, can be traced to the Carlsberg Ridge. Between these two, the 85 degree East Ridge is located which is found to be curvilinear and encircles the Island of Sri Lanka. This is also supported by geological details obtained from seismic profiles, extensive coral reef complexes and drill hole data. Therefore, this study does not support the theory of compressional tectonics related to a subduction zone.

Interpretation of satellite data shows that the gently sinuous Burmese arc in land areas gets bifurcated just before entering the oceanic region. The Andaman-Nicobar chain of islands and eastern arc passes through the Malayan Peninsula and merges with the great island-arc chain of the East Indies. It has also been interpreted that this island chain is gradually advancing towards the west. This is evidenced by the development of a new chain of smaller islands. These chains of volcanic islands witness extremely high seismicity. The December 26, 2005 disastrous Sumatra earthquake which caused worldwide tsunami effect was located on the Andaman-Nicobar chain of islands.

Hydrocarbon Potential

The hydrocarbon potential of this entire region was earlier graded to be poor, because of rampant volcanism in the island-arc setting. With the advent of the plate tectonic-related hot spot concept, the 90 East Ridge and similar oceanic ridges were believed to represent trails of hot spots. This concept was detrimental for hydrocarbon exploration, since it was believed that heat melting the lithosphere might have vaporized the hydrocarbon. However, during the last two decades a thick column of sedimentary rocks has been discovered in a rapidly subsiding tectonic environment. The availability of a huge quantity of good quality organic material due to

tropical climatic conditions was assured. Quick thermal maturity and trapping mechanisms are also quite favorable in this tectonic setting. Exploration activity therefore started gaining momentum and many world class hydrocarbon pools have been discovered. With the availability of high quality data it has now become possible to plan exploration activity.

This area prognosticates for more detailed exploration because source rock, reservoir rock with antecedent tectonic activity continues in this area. Discovery of the three major pools Kuala Langsa, Arun and North Sumatra Offshore (NSO) suggest that the entire basin needs to be reviewed and explored.

Acknowledgement

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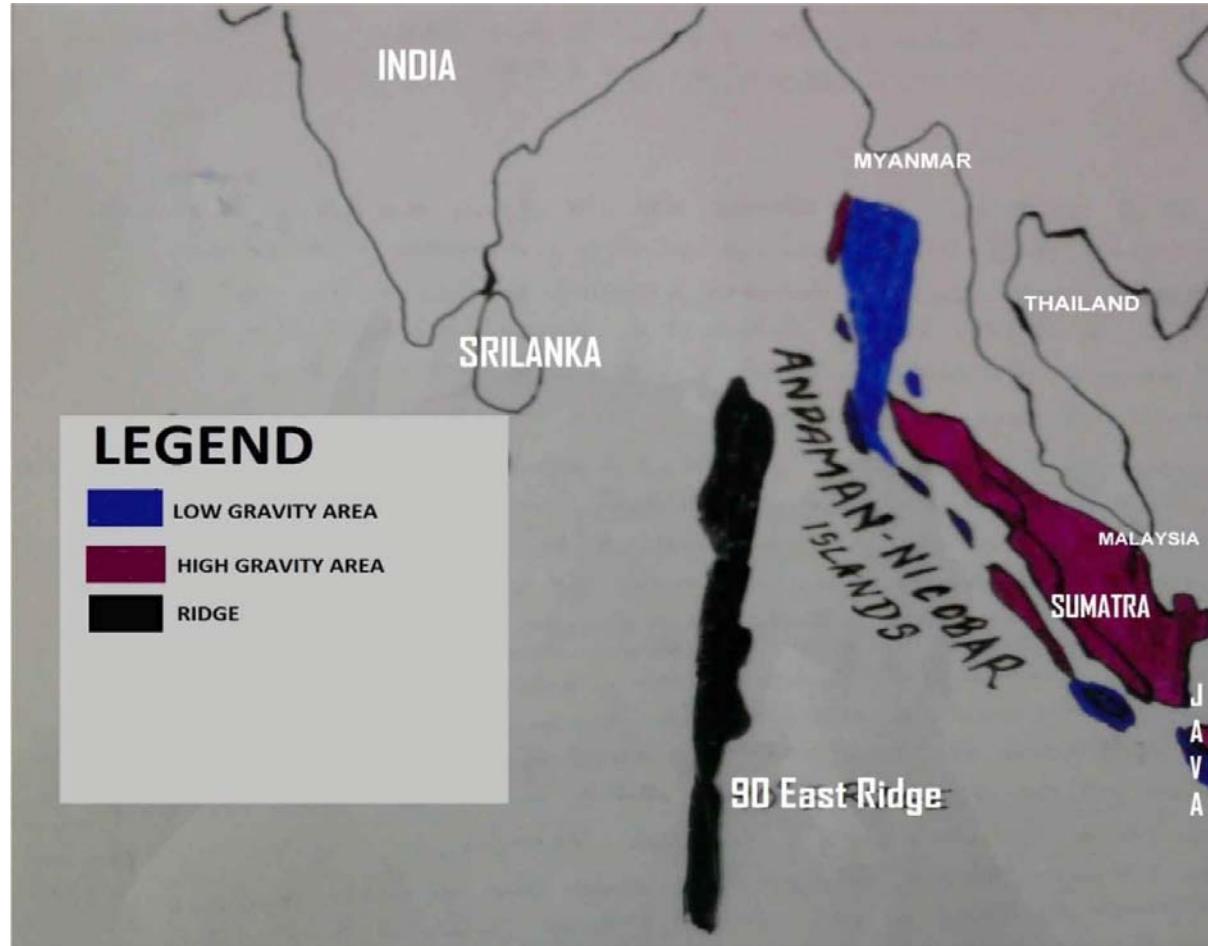


Figure 1. Map showing important tectonic features in the vicinity of the Andaman Basin and surrounding region.

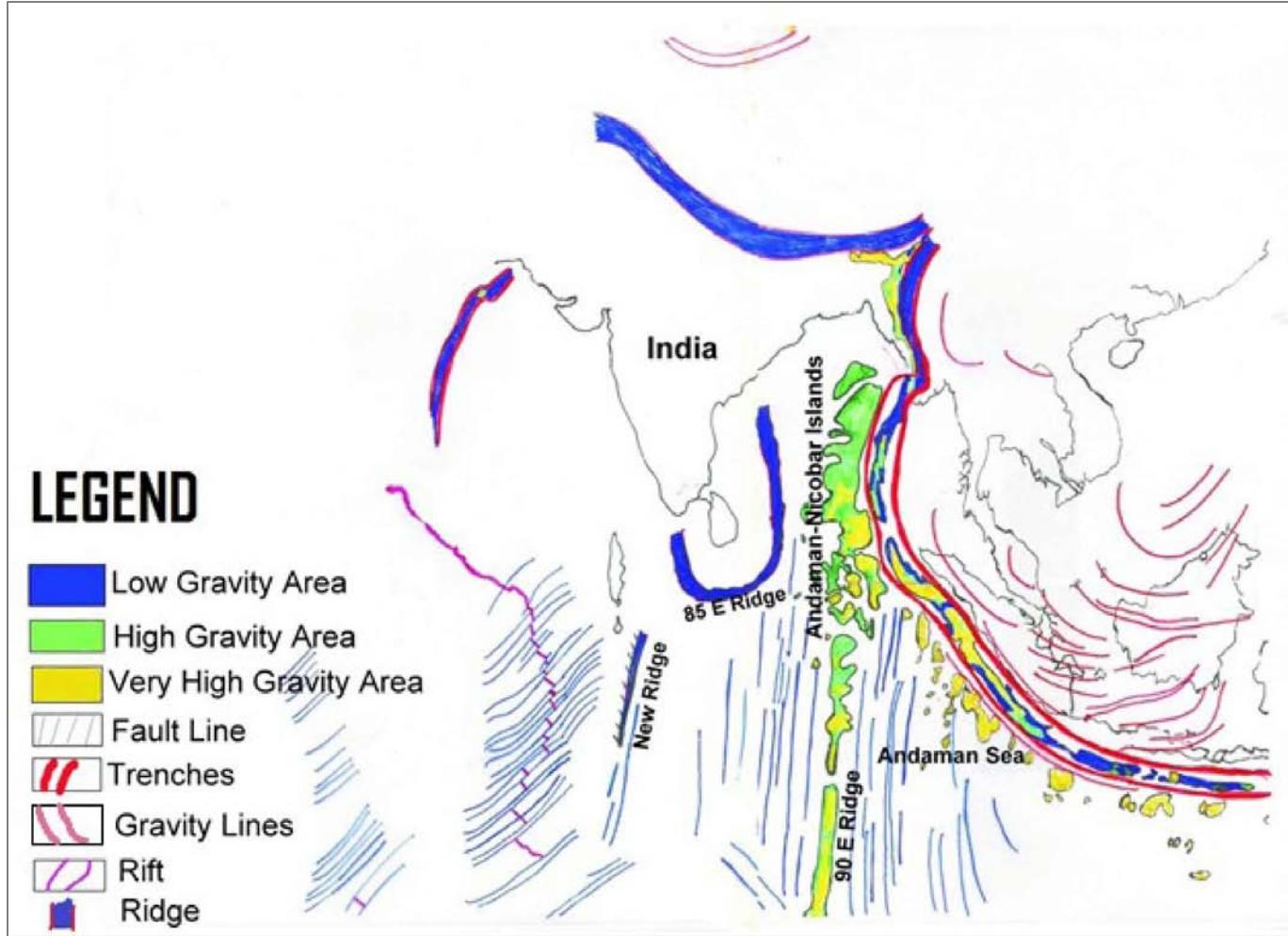


Figure 2. Interpretation of gravity data of the northern Indian Ocean.