

# Late Cretaceous to Pleistocene foraminiferal biostratigraphy and palaeogeographic reconstructions in Andaman basin, India

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Foraminiferal occurrences comprising, planktic, smaller, and larger benthic foraminifera from thirteen wells are analyzed to establish a biostratigraphic framework of the Andaman Basin from Fore-Arc to Back-Arc area. Characteristic planktic and larger benthic foraminifera recorded from the wells have helped recognize Late Cretaceous to Pleistocene chronostratigraphic units in the basin. In the Fore-Arc area, sediments ranging from Late Cretaceous to Pleistocene are recorded and, in the Back-Arc area sediments ranging from Early Miocene to Late Pliocene are recorded. The variation in foraminiferal biostratigraphy and palaeoenvironmental setup along dip direction from Fore-Arc to Back-Arc and along strike directions in Fore-Arc area is captured to comprehend the distribution of chronostratigraphic units in time and space. Besides, palaeogeographic setup of Andaman Basin has been reconstructed at Late Oligocene and Early, Middle, and Late Miocene tops. During Late Oligocene inner shelf conditions of deposition prevailed in the area surrounding the Island Arc. Further, towards the eastern side of the island arc, the palaeoenvironmental conditions were middle to outer shelf which became bathyal further east and shallower, inner shelf towards the northeast. The palaeobathymetry became relatively shallower during Early Miocene as compared to Late Oligocene towards the eastern side of the Andaman Islands resulting in the formation of positive area adjoining wells F and G. Further east of Island Arc in the Fore-Arc as well Back-Arc area, the palaeobathymetry was relatively deeper where the sediments were deposited under the middle to outer shelf conditions. During the Middle and Late Miocene varying inner shelf to bathyal conditions of deposition prevailed in the Fore-Arc area; whereas, deposition in the Back-Arc area took place under outer shelf to bathyal and bathyal conditions, respectively. The evaluation of biostratigraphic setup in the Fore-Arc and Back-Arc areas and reconstruction of palaeogeographic setup from Late Oligocene to Late Miocene shall help refine the geological model of the area for hydrocarbon exploration activities.

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## INTRODUCTION

Andaman Basin is situated towards the south-eastern part of the Bay of Bengal around the Andaman-Nicobar chain of islands and is surrounded by the Irrawaddy delta in the north, Malaya Peninsula in the east, Sumatra pluton in the south, and the Bay of Bengal in the west. In contrast to the other east coast basins of India, the Andaman Basin to the far-east is an active margin. The Andaman and Nicobar Islands, lying along with an Island Arc system, encompass an outer-arc accretionary wedge as well as the Fore-Arc, Volcanic Arc, and the Back-Arc Basin (Fig. 1). In the Fore-Arc, the main speculative play types consist of stratigraphic pinch out. In the Back-Arc Basin, major inverted anticline structures are forming large four-way dip closures and three-way fault closures. The deepwater Back-Arc Basin in the Andaman offshore is a major frontier province. The Andaman Basin

evolved due to soft and hard collision and convergence of subducting greater Indian Plate below the overriding SE Asian Plate since Cretaceous time. The subduction/ oblique subduction, magmatic intrusion, and Back-Arc spreading have led to the development of various sub-basins. The tectonic elements from west to east are Trench, Island-Arc, Fore-Arc, Volcanic-Arc, and Back-Arc associated with converging plate boundaries. The Andaman Nicobar Islands fall in the general trend of Burma and Sumatra oil-bearing provinces. A geological survey on the island was started by ONGC as early as 1959. A total of 22 wells have been drilled so far (15 in shallow water and 07 in deep water). The initial exploration activities were confined to the outer Fore-Arc area. Fifteen shallow water wells were drilled and gas (biogenic) was discovered in well H in 1980 from Middle Miocene limestone. During NELP regime focus shifted to the inner Fore-Arc area. Six deepwater wells were drilled in Fore-Arc and one in Back-Arc. Well A in Fore-Arc flowed gas in MDT sampling.

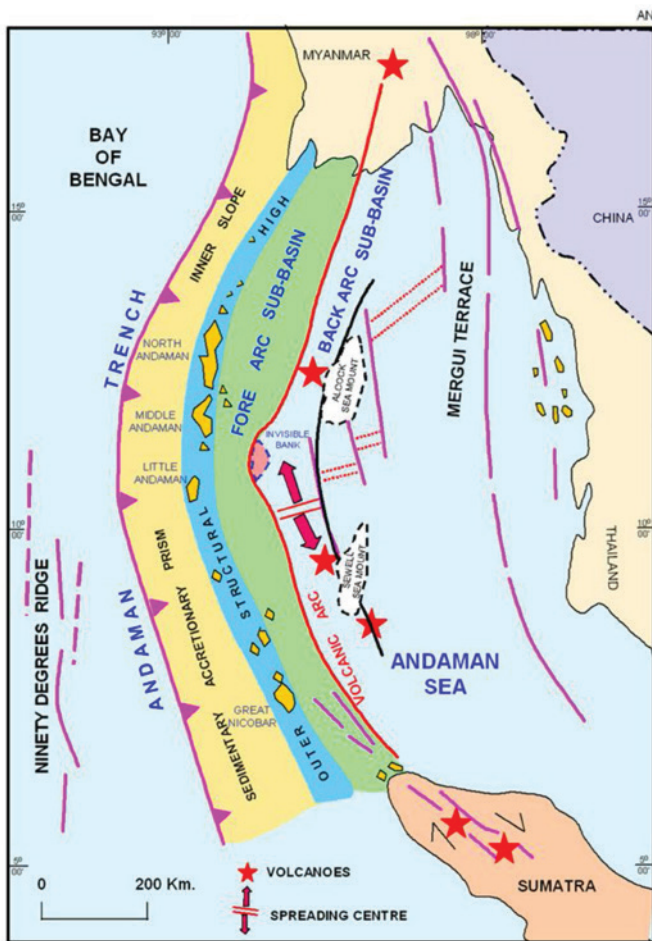


Fig. 1. Tectonic elements of Andaman Basin (modified after Curray, 2005).

### Fore-Arc Basin

The area between Outer High in the west and Volcanic Arc in the east is known as Fore-Arc. Towards the north it extends up to the Burmese Chindwin-Minu basin and towards south up to West Sumatra. The Fore-Arc area has a deep submarine valley with water depth up to 3000 m in its central part which shallows up in the east as well as west towards Volcanic Arc and Outer Structural High, respectively (Pandey *et al.*, 1993). The western margin of the Fore-Arc area is very steep and bounded by an Eastern Margin Fault (Roy, 1983); whereas, the eastern margin of the Fore-Arc is gentler towards the Volcanic Arc.

### Back-Arc Basin

The Back-Arc area is a north and south-extending deep basin lying east of the Volcanic Arc. The Andaman Sea is regarded as an area of high heat flow where new oceanic crust is being formed since the Miocene by rifting and the Back-Arc area is the continuity of the same (Curray *et al.*, 1979).

## GENERALIZED STRATIGRAPHY

The earliest lithostratigraphic account of Andaman Island based on geological reconnaissance established Paleogene stratigraphic units unconformably underlying the Neogene Archipelago Group. ONGC field geologists Chandra and Guha (1963); Chatterji (1964); Chatterjee (1967); Karunakaran *et al.* (1968, 1975) and Srivastava *et al.* (1974) mapped the various stratigraphic units within Paleogene and Neogene Groups in Andaman, Nicobar, and Archipelago Islands. Pandey *et al.* (1993) reviewed the lithostratigraphy and formation nomenclature of the Andaman Basin (Fig. 2). Out of the twenty-two wells drilled in Andaman Offshore, only two wells (M and B) have penetrated the basement and the rest terminated in Paleogene and Neogene successions.

## MATERIALS AND METHODS

Foraminiferal data from four wells namely, A, B, C, and D, totaling approximately 358 samples have been generated, and foraminiferal data of nine wells namely A, B, C, D, E, F, G, H, I, J, K, L and M (Fig. 3) have been utilized from previous studies along with filling of data gaps and rechecking the age boundaries, wherever required (Singh *et al.*, 1981, 1986; 2011; Raju and Chidambaram, 1986a, 1986b, 1989; Mathur, 1993). The foraminiferal slides are housed in the repository of Palaeontology Laboratory, KDMIPE, Dehradun. Standard laboratory techniques (Pandey and Rao, 1991) were followed for the processing of samples for foraminifera. The literature referred for planktic foraminifera comprises Kennett and Srinivasan (1983) and Bolli *et al.* (1985). The variation in foraminiferal biostratigraphy along strike and dip directions is captured in Figs. 4-6. The palaeoenvironmental variations along strike and dip direction are depicted in Figs. 7-9. Palaeogeographic reconstructions are carried out at Late Oligocene, Early Miocene, Middle Miocene, and Late Miocene tops (Figs. 10 to 13). For palaeogeographic reconstructions data from previously studied wells that are not a part of the studied profiles are also included to have a regional picture.

## BIOSTRATIGRAPHY

The biostratigraphic study involved foraminiferal data of thirteen wells namely, A, B, C, D, E, F, G, H, I, J, K, L, and M (Fig. 3). The biostratigraphy of the basin is discussed below.

### Fore-Arc Basin

*Late Cretaceous:* The oldest sediments of Late Cretaceous are recorded in three wells i.e., H, K, and M. The wells H, K and M terminated at 3734 m, 4088 m and 3972

m respectively. The well M was terminated in the basement. Characteristic Campanian-Maastrichtian foraminifera recorded in the wells H (3271-3734 m), K (3250-3930 m), and M (3275-3970 m) includes *Globotruncana stuartiformis*, *Rugoglobigerina* sp., etc.

**Paleocene:** Late Paleocene sediments are recorded in wells H (3223-3271 m), G (4388-4984 m) and M (1200-3275 m). Characteristic Paleocene foraminifera recorded in these wells include *Globigerina velascoensis* and *Morozovella aequa* etc.

**Early Eocene:** Early Eocene sediments are encountered in wells G in the interval 3502-4388 m. Undifferentiated Eocene sediments are encountered in well M in the interval 525-1200 m. Characteristic foraminifera recorded in the interval includes *Globigerina inequispira* and *Subbotina frontosa*. Early Eocene is a hiatus in well H.

**Middle Eocene:** Middle Eocene sediments are encountered in well H in the interval 2953- 3028 m. Characteristic foraminifera recorded in the interval includes *Morozovella lehneri* and *M. aragonensis*. Middle Eocene is a hiatus in well G.

**Late Eocene:** Late Eocene sediments are encountered in wells F (3360-4420 m) and G (3006-3502 m). In well K undifferentiated Late Eocene to Late Oligocene sediments are encountered in the interval 2170 to 2300 m. Undifferentiated Late Eocene to the early part of Late Oligocene sediments are also recorded in the interval 2593-2829 m in well H. Characteristic foraminifera recorded in the interval include *Globigerina inequispira*, *G. lozanoi*, *Asterocyclina ruteni*, etc.

**Early Oligocene:** Early Oligocene sediments are encountered in wells D, F, and G in the interval 4620-4744 m, 2144-3360 m, and 1999-3006 m, respectively. Undifferentiated Oligocene is recorded in well M in the interval 270-525 m. Characteristic foraminifera recorded in the interval include *Globigerina ampliapertura*, *Globorotalia opima*, *Nummulites fichteli*, etc.

**Late Oligocene:** Late Oligocene sediments are encountered in wells A, B, D, F, and G in the intervals 4940-5110 m, 3630-3700 m, 4300- 4620 m, 1120-2144 m, and 1372-1999 m, respectively. Well B was terminated in the basement which was recorded from 3700 to 3766 m. Characteristic foraminifera recorded in the interval include *Globigerina ciperoensis*, *Gg. opima nana*, *Spiroclypeus ranjanae*, *Miogypsina (Miogypsinoides) formosensis*, *M. (Miogypsinoides) bantamensis*, *Miogypsinoides* sp., etc.

**Early Miocene:** Early Miocene sediments are encountered in wells A, B, D, and L in the intervals 4732-4940 m, 3325-3630 m, 3390-4300 m, and 580-2510 m respectively. Undifferentiated Early to Middle Miocene sediments are recorded in well K in the interval 1405-2140 m. Characteristic foraminifera recorded in the interval includes *Globorotalia (F.) birnageae*, *Globigerina opima nana*,

*Globigerinoides primordius*, and *Miogypsina (M.) tani*. In well F Early Miocene sediments are missing suggesting a hiatus at 1120 m. In well G planktonic foraminiferal zones N-4 to N9 are missing suggesting a hiatus at 1372 m covering Early Miocene to early Middle Miocene. Early Miocene is also a hiatus in wells H and M.

**Middle Miocene:** Middle Miocene sediments are encountered in wells A, B, C, D, F, G, H and J in the intervals 4170- 4732 m, 3105-3325 m, 4520-4725 m, 2900-33900 m, 875-1120 m, 1246-1372 m, 2305- 2590 m and 650-2225 m, respectively. Undifferentiated Middle Miocene to Pliocene sediments are encountered in well K in the interval 190-1380 m. Characteristic foraminifera recorded in the interval include *Globorotalia mayeri*, *Gr. fohsi*, *Gr. peripheroacuta*, *Gr. peripheroronda*, *Gr. archeomenardii*, *Gr. praemenardii*, *Gr. mayeri*, *Lepidocyclina* sp., *Miogypsina (M.) antillea*, *M. (M.) globulina*, etc. In well M Early and Middle Miocene are a hiatus. In well G, planktonic foraminiferal zones N-13 to N-15 are absent suggesting a hiatus at 1246 m.

**Late Miocene:** Late Miocene sediments are encountered in wells A, B, C, D, G, J and M in the intervals 3040-4170 m, 2645-3105 m, 3520-4520 m, 2430-2900 m, 970-1246 m, 190-650 m, and 240-270 m, respectively. Undifferentiated Late Miocene to Early Pliocene sediments are recorded in well H in the interval 905-2305 m. In the well K late Middle Miocene to early Late Pliocene sediments are recorded in the interval 516-1380 m. Characteristic foraminifera recorded in the interval include *Globorotalia merotumida*, *Globoquadrina baroemoenensis*, *Gq. dehiscens*, *N. continuosa*, etc.

**Early Pliocene:** Early Pliocene sediments are encountered in wells A, B, C, D, G and J in the intervals 2950-3040 m, 2525-2645 m, 2957-3520 m, 2310-2430 m 880-970 m and 77-190 m, respectively. Early Pliocene to Early Pleistocene sediments are encountered in well H in the interval 520-905 m. Pliocene sediments are encountered in wells M in the intervals 123-240 m. Characteristic foraminifera recorded in the interval includes *Globorotalia plesiotumida*, *Gr. (Hirsutella) margaritae*, *Pulleniatina primalis*, *Dentoglobigerina altispira*, *D. altispira globosa*, *Sphaeroidinellopsis paenedehiscens*, *Ss. seminula*, *Neogloboquadrina acostaensis*, etc.

**Pleistocene:** Pleistocene to recent sediments are encountered in well H in the interval 180-520 m. Characteristic foraminifera recorded in the interval include *Globorotalia tumida*, *Gl. menardii*, *Gl. crassula*, *Pulleniatina finalis*, *Pu. obliquiloculata*, *Globigerinoides ruber*, *Gs. sacculifer*, *Gs. quadrilobatus*, etc.

## Back- Arc Basin

**Early Miocene:** Only one well viz., E has been drilled in the Back-Arc Basin where the oldest sediments encountered in the interval 4475-4625 m pertain to Early Miocene age. Characteristic foraminifera recorded in the interval include *Globorotalia nana* and *Globigerinoides primordius*. Interval 4625-5500 m is unfossiliferous. Undifferentiated Early to Middle Miocene sediments are recorded in the interval 4050-4475 m and it is characterized by *Globigerina praebulloides*,

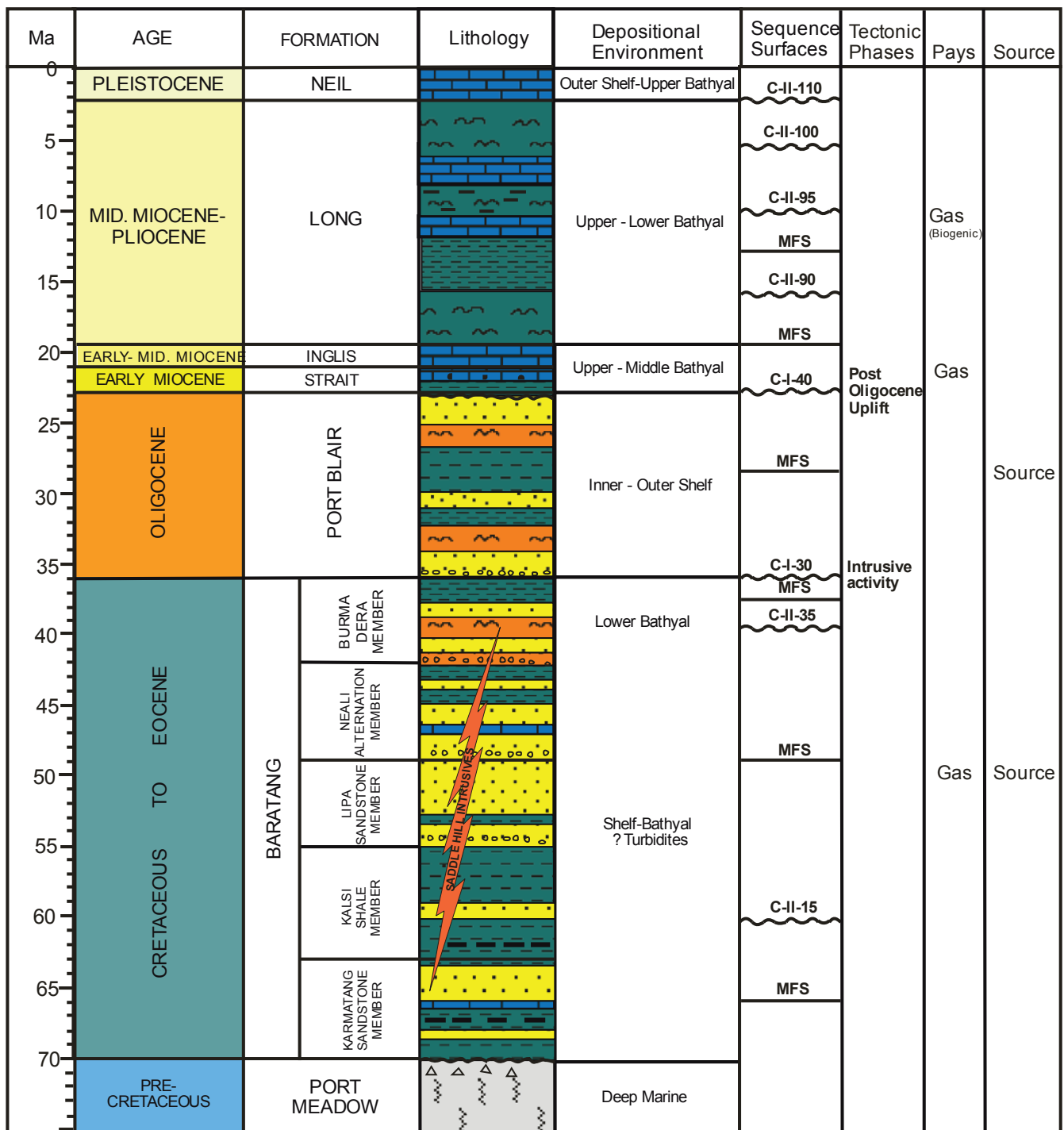


Fig. 2. Generalized Stratigraphy of Andaman Basin (after Panday *et al.*, 1993) (Sequence surfaces after PS Cube Report, 2008)

*Globorotalia mayeri*, *Globoquadrina dehiscens*, and *Globigerinoides subquadratus*.

*Globigerinoides mitra*, *Gs. subquadratus*, *Gs. triloba* and *Orbulina universa*.

**Middle Miocene:** Middle Miocene sediments are recorded in the interval 3370-4050 m. Characteristic foraminifera recorded in the interval includes *Globorotalia peripheroacuta*, *Globorotalia praescitula*, *Gl. praefohsi*, *Gl. mayeri*, *Gl. archeomenardii*, *Neogloboquadrina continua*, *Globigerinella praesiphonifera*, *G. aequilateralis*,

**Late Miocene to Early Pliocene:** Undifferentiated Late Miocene to Early Pliocene sediments are recorded in the interval 3190-3370 m which are characterized by *Sphaeroidinellopsis paenedehiscens*, *Sphaeroidinella dehiscens*, *Neogloboquadrina acostaensis*, and *Globigerinoides obliquus extremus*.



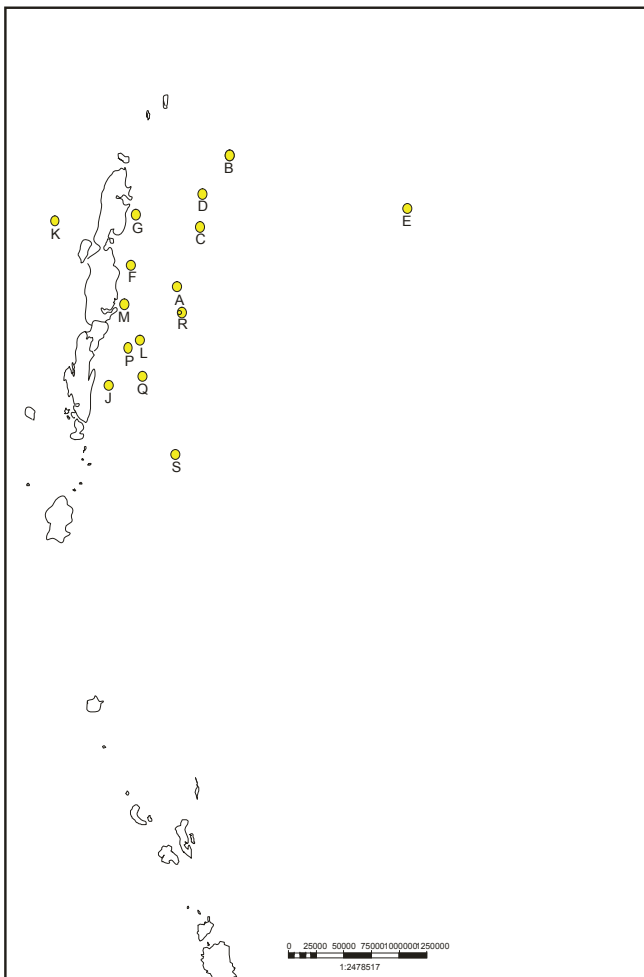


Fig. 3. Location of wells studied in Andaman Basin

**Late Pliocene:** Late Pliocene sediments are recorded in the interval 2948-3190 m. Characteristic foraminifera recorded in the interval include *Globorotalia tumida*, *Gl. menardii*, *Gl. crassula*, *Neogloboquadrina humerosa*, *Pulleniatina praecursor* and *P. finalis*.

## BIOSTRATIGRAPHIC CORRELATIONS

A total number of three biostratigraphic profiles, two along the strike direction and one along the dip direction are prepared based on the foraminiferal data as discussed below:

The dip profile involving wells K, G, C, and E is along the W-E direction (Fig. 4). The oldest sediments recorded along this profile pertain to Late Paleocene in the well G, where a 596 m thick succession of Late Paleocene sediments is recorded. Sediments pertaining to Early Eocene to Late Eocene and to Late Oligocene are recorded in this well. Middle Eocene is a hiatus in this well. In well E the pre-Early Miocene sediments encountered in the interval 4625 to 5500 m are unfossiliferous. Early Miocene sediments are recorded in well E, while they are represented by a hiatus

in the well G. Undifferentiated Early to Middle Miocene sediments are recorded in well K. Thin Middle Miocene sediments are encountered in well G while the thickness of Middle Miocene sediments is more than 680 m in well E and the well C bottomed out in Middle Miocene. Thick Late Miocene sediments (1000 m) are recorded in well C and their thickness is 276 m in well G. In wells K and E, the Late Miocene sediments are undifferentiated from the overlying Early Pliocene sediments. The considerable thickness of Early Pliocene sediments is recorded in well C and the youngest sediments encountered pertain to Late Pliocene in well E.

The strike profile comprising wells I, H, L, A, C, and B is along the SW-NE direction (Fig. 5). The oldest sediments of Late Cretaceous are encountered in well H. The wells I and A were terminated in Late Oligocene. Early Miocene sediments are encountered in wells I, L, A and B, while Early Miocene is a hiatus in well H. Middle Miocene sediments are encountered in all the wells excepting in well L where Middle Miocene to Recent sediments are undifferentiated. A thick succession of Late Miocene is encountered in wells A, C, and B while undifferentiated Middle Miocene to Pliocene sediments are encountered in well I and Late Miocene to Early Pliocene in well H. The youngest sediments recorded in wells A, C, and B pertain to Early Pliocene, in well I Early Pliocene to Middle Pleistocene, in well H Pleistocene to Recent and in well L ?Middle Miocene to Recent.

The second strike profile comprising wells J, I, H, M, F, and G is also along the SSW-NNE direction (Fig. 6). The oldest sediments of Late Cretaceous are recorded in wells H and M. The well G terminated in Late Paleocene, F in Late Eocene, I in Late Oligocene, and J in ?Oligocene. A thick succession (2075 m) of Late Paleocene sediments is encountered in well M. Undifferentiated Eocene and Oligocene is recorded in well M, while thick successions of Late Eocene, Early Oligocene, and Late Oligocene sediments are recorded in wells F and G. Early Miocene is a hiatus in well H and G, while in well M, Early to Middle Miocene is a hiatus. Late Miocene is differentiated in wells J, M, and G, while in well I undifferentiated Middle Miocene to Pliocene and in well H undifferentiated Late Miocene to Early Pliocene are recorded. The youngest sediments recorded in well F pertain to Early to Middle Miocene; in wells J, M, and G to Pliocene. In wells, I and H, the youngest sediments recorded are dated as Early Pliocene to Middle Pleistocene and Pleistocene to Recent, respectively.

## PALAEOGEOGRAPHY

Palaeoenvironmental variations are depicted in wells K, G, C, and E along with the dip profile (Fig. 7) and wells I, H, L, A, C, B and J, I, H, M, F, G along with two-strike profiles in figures 8 and 9. Based on foraminiferal studies palaeogeographic maps of the Andaman area have been prepared at Late Oligocene and Early Miocene and Late Miocene. While making palaeogeographic maps, available palaeoenvironmental data from other wells such as O, P, Q, R, and S which are not a part of the studied profiles, have also

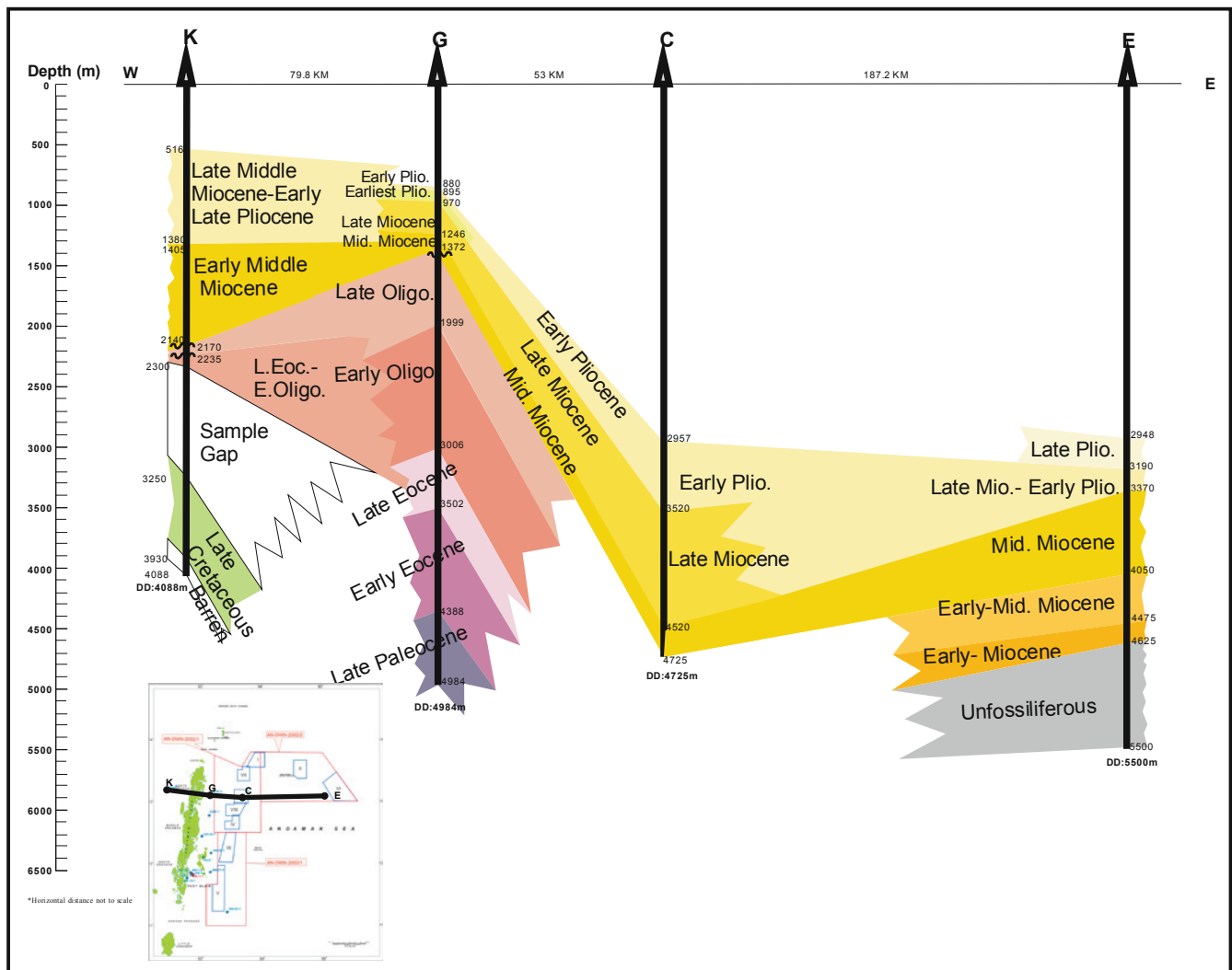


Fig. 4. Biostratigraphic correlation of wells K, G, C & E along dip direction in Andaman Basin

been incorporated to have a comprehensive understanding of the palaeogeographic conditions of the area. The palaeogeographic set up of the area at Late Oligocene and Early, Middle, and Late Miocene is discussed as below:

**Late Oligocene:** During Late Oligocene inner shelf conditions of deposition prevailed in the area surrounding the Island Arc (Fig. 10). Towards the eastern side in wells N, H, O, I, H, P, L, and M the paleoenvironmental conditions were middle to outer shelf. Further east, the sediments in wells Q, R, A, F, and G were deposited under bathyal conditions. Towards northeast shallower conditions of deposition (inner shelf) prevailed in wells C, D, and B.

**Early Miocene:** The palaeobathymetry became shallower during the Early Miocene as compared to the Late Oligocene towards the eastern side of the Andaman Islands (Fig. 11). The area surrounding wells F and G became a positive area and sediments in wells H, I, N, O, and M were deposited under inner shelf conditions. Further east, the palaeobathymetry was relatively deeper where the sediments of wells Q, P, L, R, A, C, D, and B were deposited under middle to outer shelf conditions.

**Middle Miocene:** Inner to middle shelf conditions of deposition prevailed during Middle Miocene around the Island Arc in wells K and H (Fig. 12). On the eastern side of the island arc in wells O, P, F, and G the bathymetry was outer shelf while on the western side in well T outer shelf to bathyal. Further east, deeper bathymetric conditions prevailed in well D where the deposition took place under bathyal conditions. Sedimentation at the sites of well S, R, C, D, and E took place under outer shelf to bathyal conditions while shallower conditions of deposition *i.e.*, inner to outer shelf in well A and middle to outer shelf in wells J and Q prevailed.

**Late Miocene:** During Late Miocene, the sediments were deposited under inner to middle shelf conditions around the island arc in wells K and H, O, and Q (Fig. 13). On the eastern side of the island arc in wells P, F and G the palaeoenvironment was an outer shelf, while on the western side in well T, outer shelf to bathyal conditions prevailed. Towards the east, the bathymetry became deeper and well B sediments were deposited under bathyal conditions. Further east, the sediments in wells C and D were deposited under

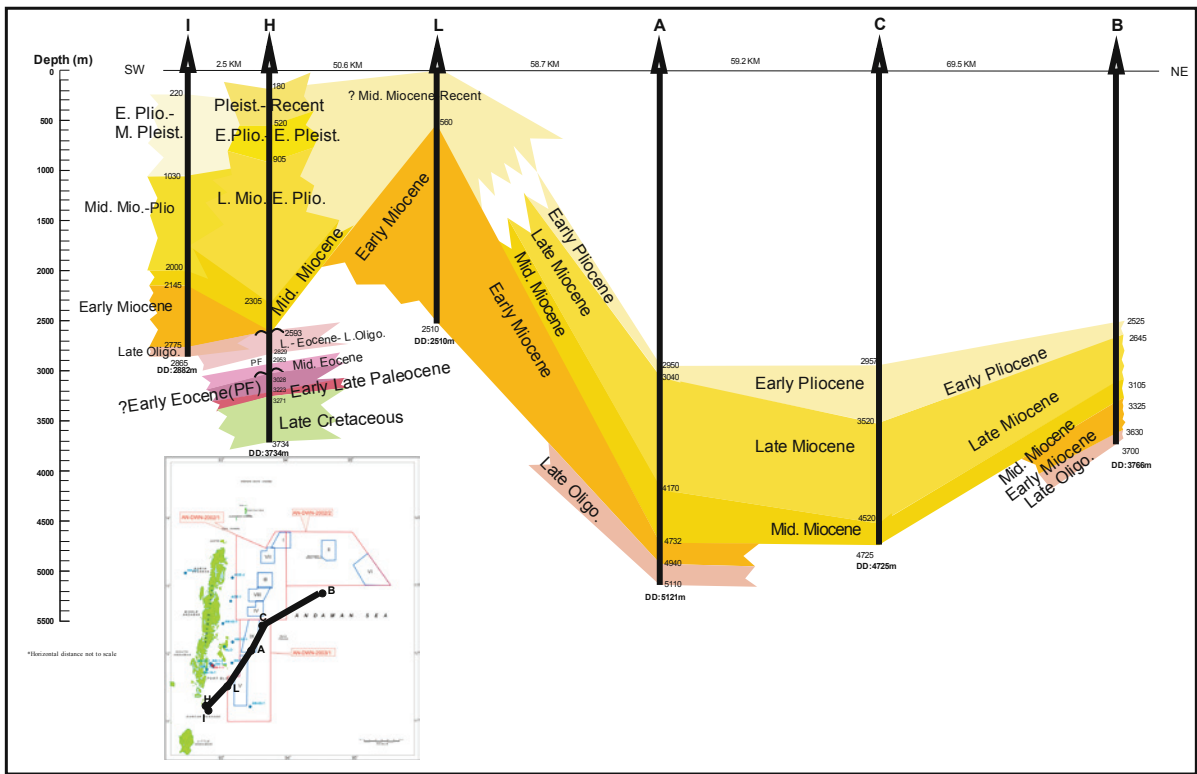


Fig. 5. Biostratigraphic correlation of wells I, H, L, A, C & B along strike direction in Andaman Basin

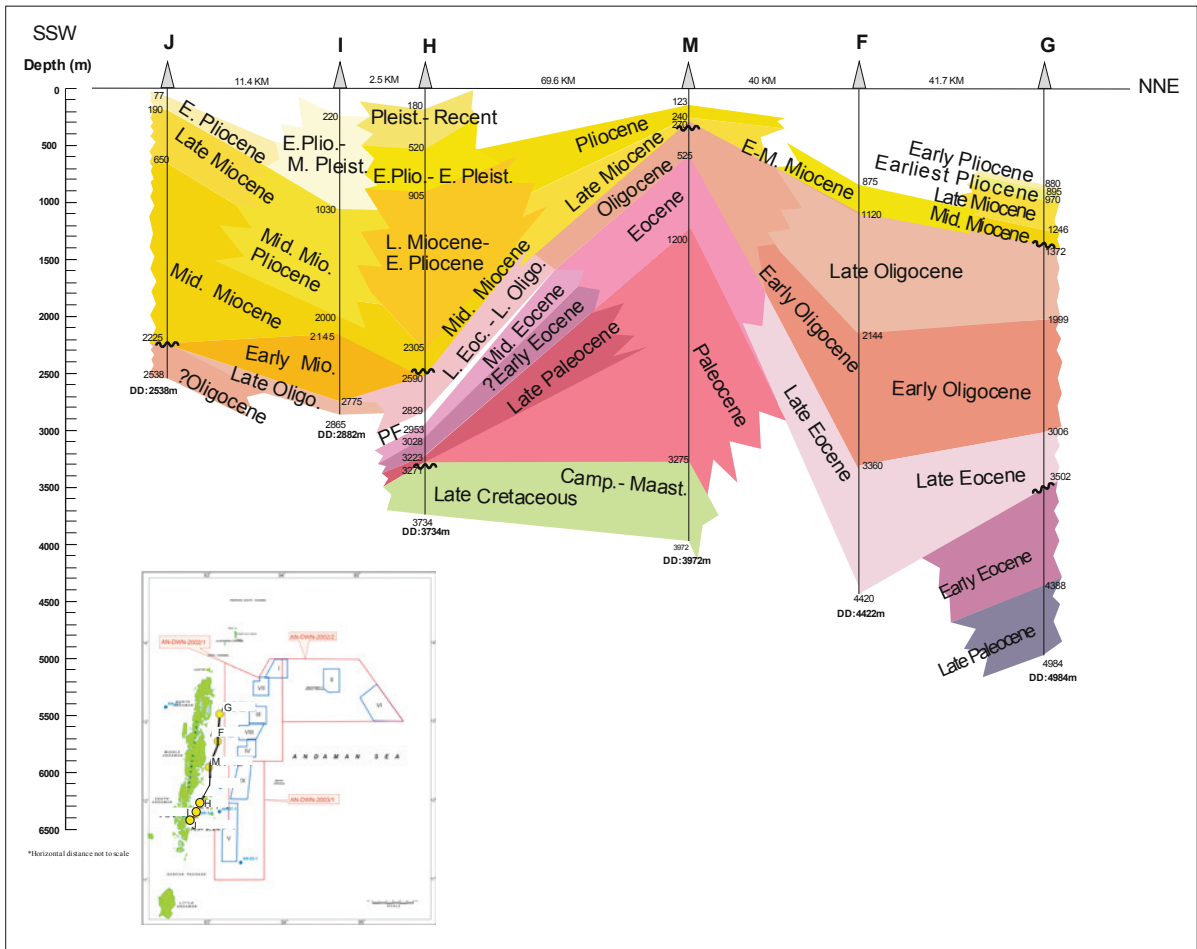


Fig. 6. Biostratigraphic correlation of wells J, I, H, M, F & G along strike direction in Andaman Basin

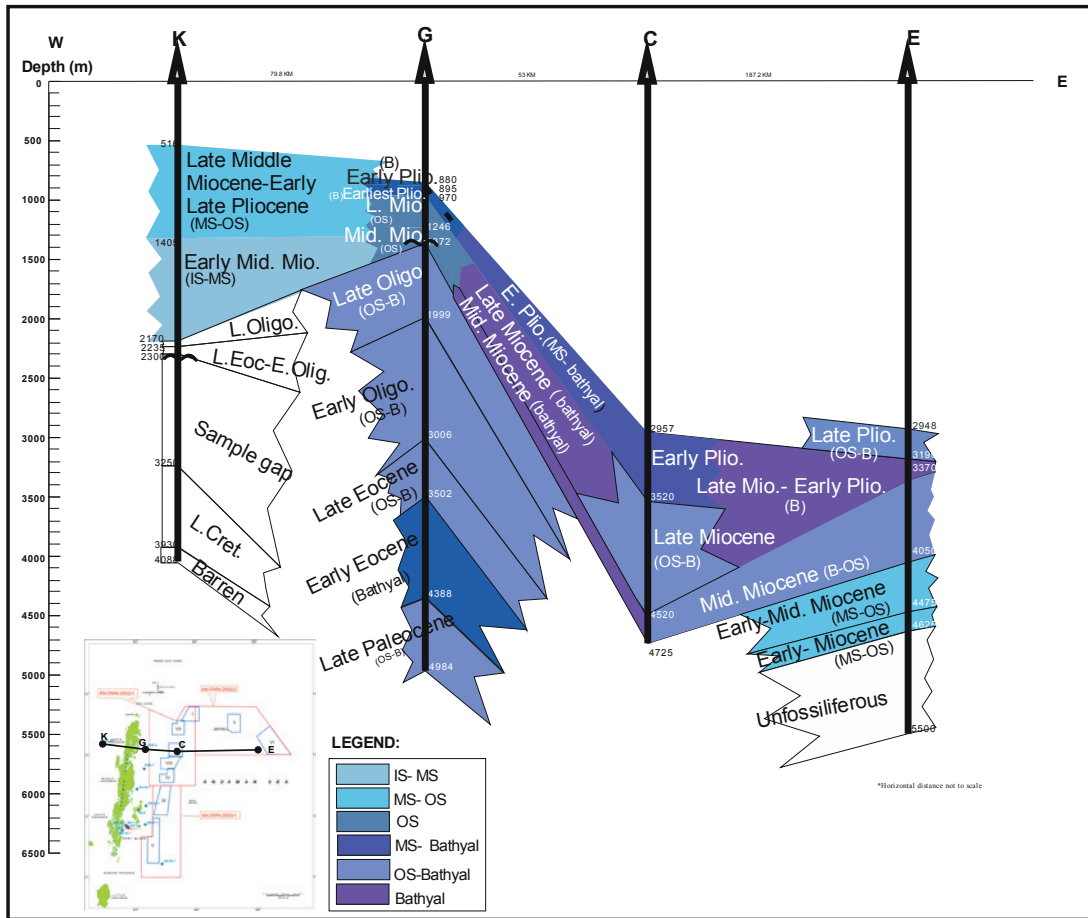


Fig. 7. Palaeoenvironmental correlation of wells K, G, C & E along dip direction in Andaman Basin

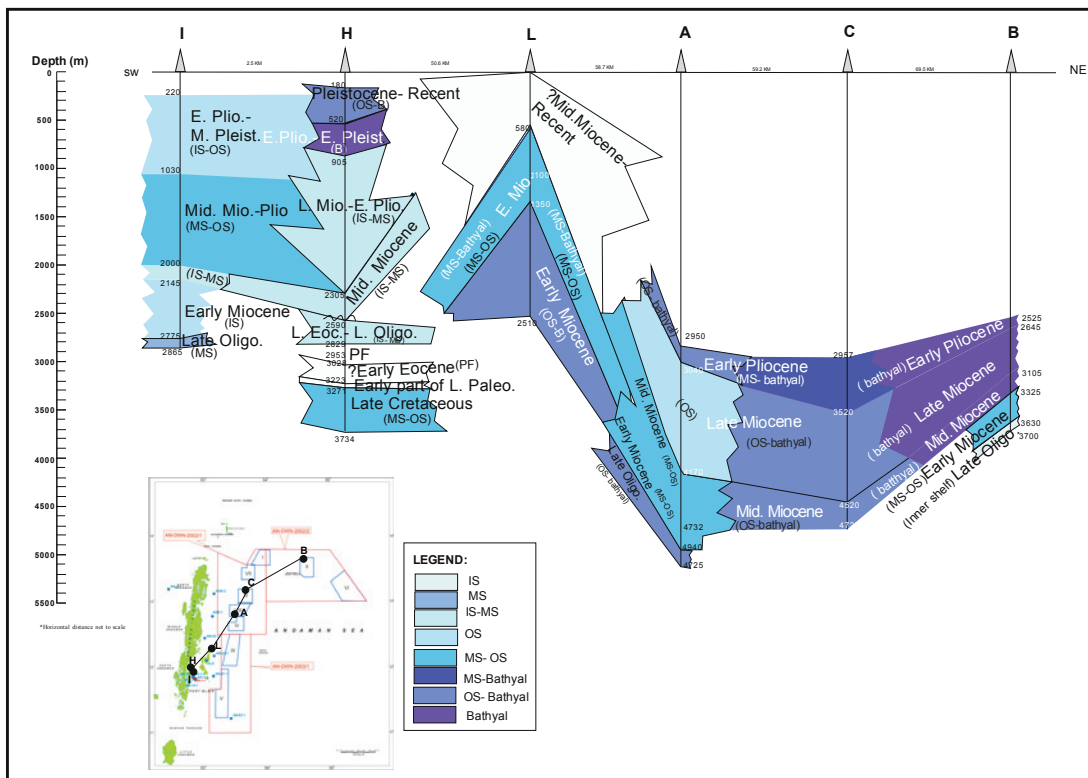


Fig. 8. Palaeoenvironmental correlation of wells I, H, L, A, C & B along strike direction in Andaman Basin.



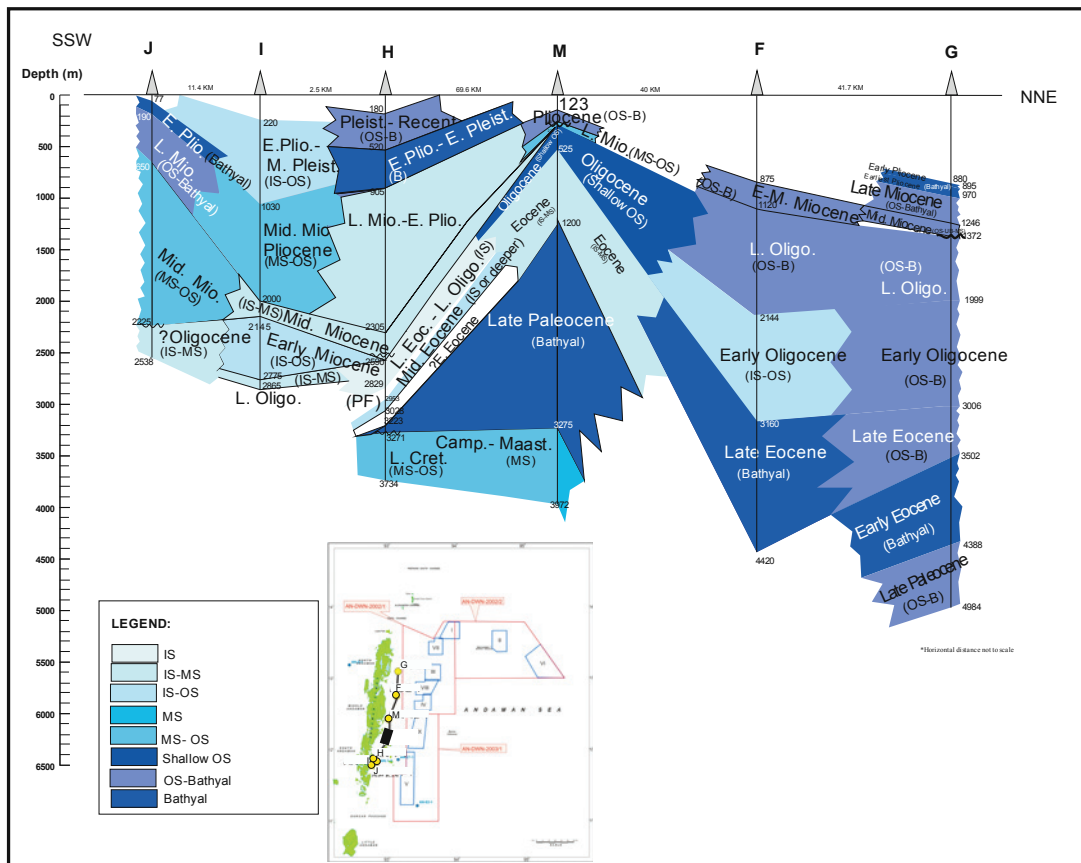


Fig. 9. Palaeoenvironmental correlation of wells J, I, H, M, F & G along strike direction in Andaman Basin

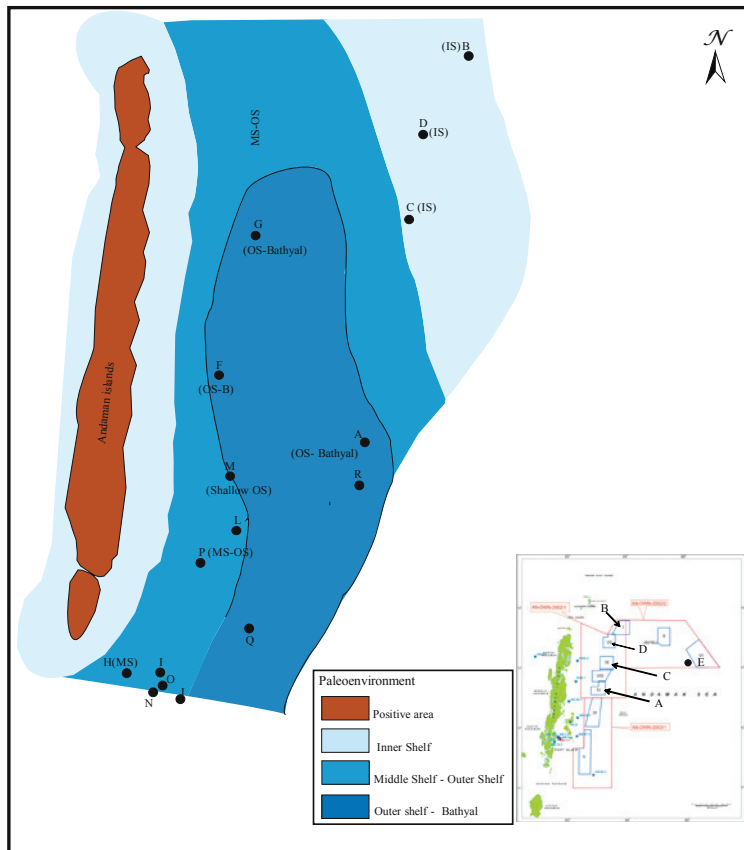


Fig. 10. Palaeogeographic map at Late Oligocene top in the Andaman Basin

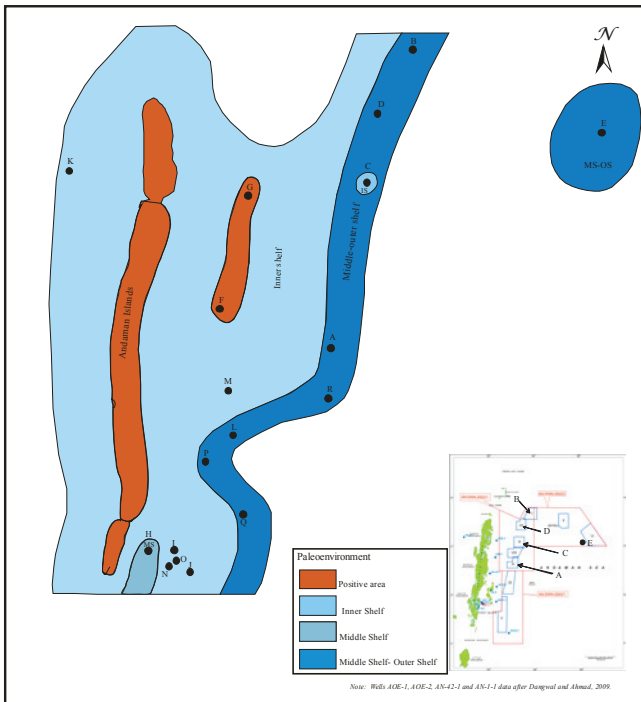


Fig. 11. Palaeogeographic map at Early Miocene top, Andaman Basin

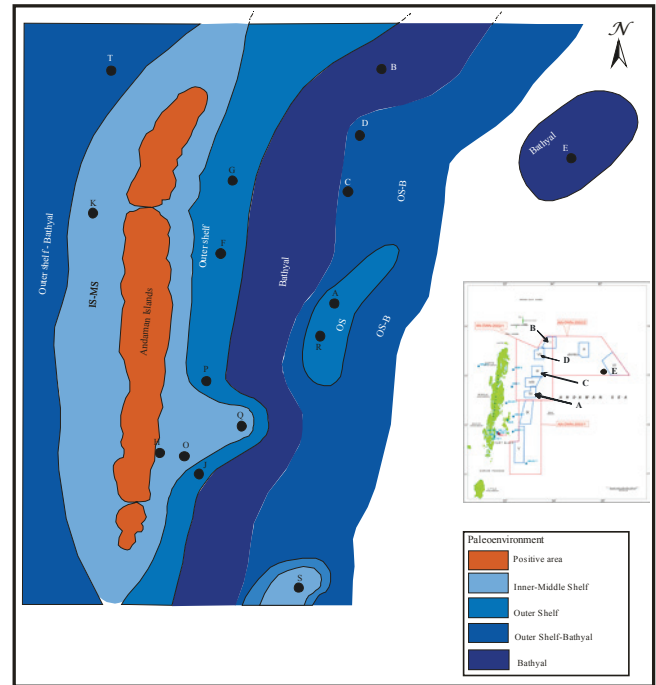


Fig. 13. Palaeogeographic map at Late Miocene top, Andaman Basin

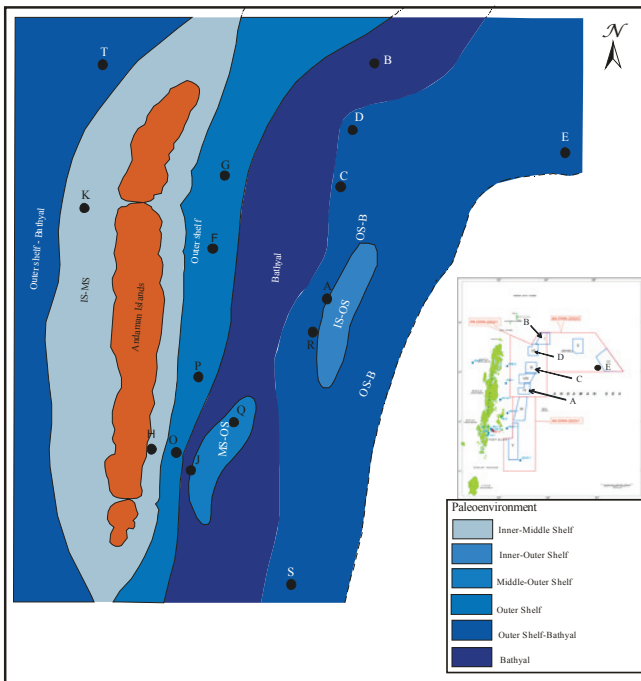


Fig. 12. Palaeogeographic map at Middle Miocene top, Andaman Basin

the outer shelf to bathyal conditions. The sediments around wells R, A, and S were deposited under relatively shallower conditions. While the palaeoenvironmental conditions were outer shelf to bathyal in wells R and A, the sediments were deposited under inner shelf conditions in well S. In the Back-Arc Basin in the area around well E, the deposition took place under bathyal conditions.

## DISCUSSION

In the Fore-Arc Basin, foraminifera ranging from Late Cretaceous to Pleistocene are recorded. The characteristic Campanian-Maastrichtian foraminifera recorded in the area include *Globotruncana stuartiformis*, *Rugoglobigerina* sp., etc., Paleocene foraminifera include *Globigerina velascoensis*, and *Morozovella aequa*, etc., Early Eocene foraminifera include *Globigerina inequispira*, *Subbotina frontosa* etc., Middle Eocene foraminifera include *Morozovella lehneri* and *M. aragonensis* etc., Late Eocene foraminifera include *Globigerina inequispira*, *G. lozanoi*, *Asterocyclina ruteni*, etc., Early Oligocene foraminifera include *Globigerina ampliapertura*, *Globorotalia opima*, *Nummulites fichteli*, etc., Late Oligocene foraminifera include *Globigerina ciproensis*, *Gg. opima nana*, *Spiroclypeus ranjanae*, *Miogypsina (Miogypsinoides) formosensis*, *M. (Miogypsinoides) bantamensis*, etc., Early Miocene foraminifera include *Globorotalia (F.) birnageae*, *Globigerina opima nana*, *Globigerinoides primordius*, and *Miogypsina (M.) tani*. Middle Miocene foraminifera include *Globorotalia mayeri*, *Gr. fohsi*, *Gr. peripheroacuta*, *Gr. peripheroronda*, *Gr. archeomenardii*, *Gr. praemenardii*, *Gr. mayeri*, *Lepidocyclina* sp., *Miogypsina (M.) antillea*, *M. (M.) globulina*, etc. Late Miocene foraminifera include *Globorotalia merotumida*, *Globoquadrina baroemoenensis*, *Gq. dehiscens*, *N. continua*, etc., Early Pliocene foraminifera include *Globorotalia plesiotumida*, *Gr. (Hirsutella) margaritae*, *Pulleniatina primalis*, *Dentoglobigerina altispira*, *D. altispira globosa*, *Sphaeroidinellopsis paenedehiscens*, *Ss. seminula*, *Neogloboquadrina acostaensis*, etc. Pleistocene foraminifera include *Globorotalia tumida*, *Gl. menardii*, *Gl. crassula*, *Pulleniatina fnalis*, *Pu. obliquiloculata*, *Globigerinoides*

*ruber*, *Gs. sacculifer*, *Gs. quadrilobatus*, etc.

In the Back-Arc Basin, foraminifera ranging from Early Miocene to Late Pliocene are recorded. Characteristic Early Miocene foraminifera recorded in the area include *Globorotalia nana*, *Globigerinoides primordius* etc., Middle Miocene foraminifera include *Globorotalia peripheroacuta*, *Globorotalia praescitula*, *Gl. praefohsi*, *Gl. mayeri*, *Gl. archeomenardii*, *Neogloboquadrina continuaosa*, *Globigerinella praesiphonifera*, *G. aequilateralis*, *Globigerinoides mitra*, *Gs. subquadratus*, etc. Undifferentiated Late Miocene to Early Pliocene foraminifera include *Sphaeroidinellopsis paenedehiscens*, *Sphaeroidinella dehiscens*, *Neogloboquadrina acostaensis*, and *Globigerinoides obliquus extremus*. Characteristic Late Pliocene foraminifera recorded in the area include *Globorotalia tumida*, *Gl. menardii*, *Gl. crassula*, *Neogloboquadrina humerosa*, *Pulleniatina praecursor* and *P. finalis*.

## CONCLUSIONS

- The Fore-Arc Basin evolved during Late Cretaceous; whereas, the oldest sediments encountered in the Back-Arc Basin pertain to the Early Miocene.
- Late Cretaceous has been penetrated in only three wells, namely, H, K, and M.
- During Late Oligocene, inner shelf to bathyal conditions

are envisaged for the Fore-Arc Basin.

- The area adjoining wells F and G became positive during the Early Miocene. Further east of the island arc in the Fore-Arc as well Back-Arc area, the sediments were deposited under the middle to outer shelf conditions.
- During the Middle Miocene, inner shelf to bathyal conditions of deposition prevailed in the Fore-Arc Basin; whereas, deposition in the Back-Arc Basin took place under outer shelf to bathyal conditions.
- During Late Miocene, the sediments were deposited under varying inner shelf to bathyal conditions in the Fore-Arc Basin; however, in the Back-Arc Basin deposition took place under bathyal conditions.
- The evaluation of Late Cretaceous to Pleistocene biostratigraphic setup in the Fore-Arc and Back-Arc and paleogeographic reconstructions across the basin will further strengthen the geological modeling for hydrocarbon exploration activities in the basin.

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