## Stratigraphic framework and palaeoenvironment interpretation of PM303 and adjacent areas, North Malay Basin

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The stratigraphic framework and depositional environments of PM303 and its adjacent areas were re-assessed using selected well and regional seismic data, as part of a PRSS-SEPM joint study of the North Malay Basin. This paper presents some of the preliminary results from the joint study. Seismic interpretation was made on multi-vintage 2D data acquired in 1993, 1996 and 1997. Biostratigraphic data were reviewed using multi-source data that were generated in the 1980s and 1990s. In addition, new biostratigraphic data from three wells were also included.

The wells that were used in this study mostly penetrated the Groups A/B, D, E, F and H sediments in PM303. The older stratigraphic intervals were penetrated by several wells outside the block. Lower Group H sediments were deposited during late Early Miocene whilst the upper H was deposited during early Middle Miocene (Fig. 1). This is based on the occurrence of an intra-Group H, NN4/NN5 nannofossil zone boundary, dated as 16.2 Ma. This conclusion has enabled the subdivision of Middle and Lower Miocene sections of Group H in the study area. The Group F sediments were deposited during Middle Miocene. This is based on the recognition of the NN5/NN6 nannofossil zone boundary within upper Group F. The datum is dated as 13.5 Ma. Similarly, deposition of Group E sediments mostly occurred during the Middle Miocene, except for the uppermost part.

Within upper Group E, the last consistent downhole occurrence of the regional palynological marker, *Stenochlaenidites papuanus*, which has been dated as 9.5 Ma elsewhere in this region, suggests that this interval and the overlying Group D sediments are within the Upper Miocene. The age of the overlying Group B ranges from late Upper Miocene to Pleistocene. The base of Group B is bounded by a tectonically-induced regional unconformity, which is estimated to be 7 Ma old. This conclusion is based on the occurrence of N17 planktonic foraminifera zone and NN11 nannofossil zone, immediately above the unconformity. Within the study area, this unconformity represents about 1.5 Ma. These findings imply that the basal Group B Unconformity is an Upper Miocene event rather than Middle Miocene, as previously thought, and may be correlated to similar Late Miocene semi-regional unconformities in the West Natuna Basin, offshore Sabah and southern Vietnam.

Depositional environments in the study area were interpreted using a model that was based on published materials and a modern analogue. By taking into account of the wide, ramp margin nature of the basin, a relatively broad and gently-sloping coastal plain was assumed. The coastal plain bears very distinctive vegetation belts and may be further differentiated on the basis of their microfossil content and lithologic characters. For example, the lower coastal

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## plain may be divided into front mangrove, back mangrove and fresh water/peat swamp, grading laterally in a fluvial system, to lower estuarine, upper estuarine and inter-tidal fresh water, respectively.

Seismic attributes associated with each depositional environment were identified to assist in the seismic facies interpretation. Generally, the coaly sequence in the fresh water swamp/ back mangrove/front mangrove environment is characterised by high amplitudes, high to moderate frequency and continuous seismic reflectors. Seismic reflectors in the coastal environment, however, are rather variable in amplitudes and discontinuous due to channel cuts. The inner shelf is indicated by moderate amplitude, moderate frequency and continuous to moderately continuous seismic reflectors.

Palaeogeographic maps were generated for Groups D to I, based on the integration of biostratigraphy, well sequence stratigraphy and seismic facies interpretation. Deposition of the pre-Group B sediments fluctuated predominantly within the fresh water/back mangrove and inner shelf environments. An inner shelf condition was most extensive laterally during Middle/ Early Miocene upper Group H times (Fig. 2). This is indicated by the widespread distribution of top Group H marine shale. This event is thought to be associated with the high eustatic sealevel phase. In contrast, during the latest part of Middle Miocene (middle Group E), a widespread development of fresh water/back mangrove swamp conditions across the entire PM303 area occurred (Fig. 3). The middle Group E palaeogeographic map indicates that the coastline was at its most distal location. This event is thought to be the result of the Middle Miocene regional sea-level fall.

Although broadly similar to and confirming the existing stratigraphic framework of the Malay Basin, the chrono-stratigraphic framework, established as part of the joint study, provides a better definition of the Base Group B Unconformity and a better understanding of facies distribution in PM303 and the adjacent areas. This chrono-stratigraphic framework and the facies distributions were used in the joint study, and provided better understanding and constraints for:

- The evaluation of the reservoirs and seals distribution,
- The evaluation of potential source rock development and distribution,
- The palinspastic re-construction and forward stratigraphic modelling of the study area, and
- 1D maturity and 2D basin modellings of the study area.

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