

STRUCTURAL PATTERNS WITHIN THE TERTIARY BASEMENT OF THE STRAIT OF MALACCA

LIEW KIT KONG

PETRONAS Research & Scientific Services, Lot 1026 PKNS Industrial Estate, 54200 Hulu Kelang

The Tertiary basement of the Strait of Malacca (Malaysian waters) slopes gently towards southwest. Northerly trending grabens have been mapped within the basement at discrete locations. These grabens, from south to north, are the Kukup Graben, Johor Graben, Port Klang Graben, Angsa Graben, Sabak Graben, Southern Graben, Central Graben, Eastern Graben, East Penang Graben, West Penang Graben, North Penang Graben, MSS-XA Graben, Northern Graben, Thai Border East Graben and Thai Border West Graben. These grabens/depressions may represent regional fracture zones.

All grabens are elongated in the northerly direction. A majority of the grabens have major bounding faults on the western margin of the graben. The maximum depth of the grabens range from 2700 ft to 13000 ft. Central graben is the deepest graben. Tertiary basement topography of some grabens have been altered by later structural modification during ?Late Miocene. Negative flower structures, folded younger sedimentary sequences and tilting of younger sedimentary sequences are evidences of this later structural overprint.

These grabens can be grouped into (1) Bengkalis Trough related grabens, (2) Pematang-Balam Trough related grabens, (3) Asahan Arch-Kepulauan Aruah Nose related grabens and (4) Tamiang-Yang Besar High related grabens. These graben groupings are also elongated in the northerly direction.

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The Bengkalis Trough related grabens include the Johor Graben and the Kukup Graben. These grabens are situated about 60 km east of the N-S trending Bengkalis Trough. Both grabens are aligned in NNE direction. Tjia (1988, 1989) suggested that in late Cretaceous-early Tertiary time, the Bengkalis segment of the Bentong-Bengkalis suture experienced normal faulting that created the depression. Lateral faulting occurred in the Oligocene (?) and the Miocene. Pleistocene NW striking reverse faults have superimposed upon earlier trends. Wong (1990) believed that the Johor Graben is genetically related to the Bengkalis Trough in Central Sumatra. This graben could have developed as a side graben of Bengkalis Depression (see Moulds, 1989).

The Pematang-Balam Trough related grabens are the Port Klang Graben, Angsa Graben and Sabak Graben. These grabens are situated north of the N-S trending Balam Trough and Pematang Trough and could be the northern extension of the troughs. The Kepulauan Aruah Nose is situated west of these grabens. These grabens are aligned in a NNW direction. The Port Klang Graben and Sabak Graben are northerly elongated grabens whilst the Angsa Graben which is situated between these two grabens is oval in shape.

Grabens located between the Asahan Arch and the Kepulauan Aruah Nose are Central Grabens, Southern Graben, Eastern Graben, West Penang Graben, North Penang Graben and East Penang Graben. Collectively, these grabens are aligned in the NNE direction. Major bounding faults for these grabens are situated on the western margin of these grabens (except Central Graben).

Grabens that are situated north of the N-S Tamiang and Yang Besar High are the Northern Graben, MSS-XA Graben, Thai Border East and Thai Border West. The Northern and MSS-XA Graben which are situated on the southern part of this graben grouping are aligned in a NNE direction. Thai Border West and Thai Border East are aligned in a N-S direction. There is no preferred sloping direction of these grabens.

These graben groupings resemble regional left-stepping *en echelon* fractures with an average horizontal separation of 150 km. They are situated between regional highs and could have been initiated during Lower Oligocene by right lateral wrenching in a NW-SE direction.

Pre-Tertiary structures exerted strong influence on the development of Tertiary basins. Pre-Tertiary lineament patterns of the Strait of Malacca (Malaysian waters) trend northerly whilst those offshore of the east coast Peninsular Malaysia trend NW-SE (see Liew, 1993). Therefore, the structural development of Tertiary basins/depressions in the Malay Basin and the Strait of Malacca are subjected to different kinematics.

Tertiary depressions/grabens in the Strait of Malacca are formed along pre-Tertiary reactivated zones of weaknesses. The Strait of Malacca region could be a structural buffer zone between Peninsular Malaysia and Sumatra. It is postulated that the scattered Tertiary basins on the west coast of the Peninsular Malaysia were produced by late Tertiary structural adjustments mainly involving faulting. These basins are aligned with the major faults (Gobbett, 1973; Stauffer, 1973). If formation of the depressions in these two areas are geologically related, then the maximum size of the Tertiary basins onshore (before subsequent erosion) would not have been bigger than that of Central Graben or Port Klang Graben. Furthermore, it can be inferred that some of the major lineaments in Peninsular Malaysia have experienced movement during Tertiary.
