The Nature and Significance of Regional Unconformities in the Hydrocarbon-bearing Neogene Sequence Offshore West Sabah.

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The Tertiary N.W. Sabah basin is a 350 km long, 140 km wide NE-SW orientated sedimentary basin containing up to 12 km of predominantly siliciclastic sediments. The basin history can be divided into two phases:

1. *Pre-Middle Miocene deposition of deep marine deposits with tectonic imbrication related to southeastward subduction along the forerunners of the Palawan Trough/NW Borneo Trench.*

2. *Post Middle Miocene deposition after the cessation of subduction by a series of northwest-prograding shelf/slope sequences associated with important wrench-faulting in the basement.*

Although a small amount of oil and gas has been discovered in the Pre-Middle Miocene deep water deposits, all commercial accumulations discovered to date are in the Post Middle Miocene deposits.

The boundary between the two sequences is an unconformity at the landward margin of the basin, where deformation was the most intense, with terrestrial or coastal deposits directly overlying deep marine sediments. Towards the northwest, this 'Deep Regional Unconformity' becomes a conformable horizon. The deformation of individual structures at this time clearly occurred together with regional tilting down towards the northwest. There are indications that the Deep Regional Unconformity reappears beneath the inner wall of the Palawan Trough/NW Borneo Trench as an onlap surface above imbricate thrust slices but this correlation is based solely on seismic data.

Deposition of the post Middle-Miocene sequence was characterised by syn-depositional tectonic deformation. However, accelerated rates of deformation at certain times resulted in the formation of five regional unconformities which provide the correlation framework of the basin. These unconformities are: the Lower and Upper Intermediate Unconformities (LIU and UIU) in the late Middle Miocene, the Shallow Regional Unconformity (SRU) in the middle Late Miocene and Horizons II and I in the Pliocene and Pleistocene

respectively. Each of these unconformities was the product of both local structure formation and a regional tilting down towards the northwest. Typically each unconformity passes from an erosion surface to an onlap surface towards the NW.

Repeated re-activation of basement wrench faults in response to varying regional stress fields on five occasions has lead to a complicated tectonic and stratigraphic picture. Layer maps indicating which structures were active prior to the formation of a given unconformity, and the line along which that unconformity passes into a conformable sequence, demonstrate that the inner part of the NW Sabah basin is underlain by at least four separate basement blocks which were internally deformed only at certain times and remained undeformed at other times, presumably due to the relative orientation of the regional stress pattern and the block-bounding faults. A swing in the orientation of the major structures (from N-S in the south to NE-SW in the north) at around P. Mangalum in the centre of the basin coincides with an inferred tectonic block boundary and, although the exact orientation of the dividing line is unclear, probably represents transverse segmentation of the margin.

The style of deformation also varied temporally. Erosion of the UIU and Horizon II were both being preceded by open flexural folding and tilting whereas the LIU and SRU were associated with tight folds and reverse or strike slip faulting.

The layer maps demonstrate, despite the local structural complexity, the seaward migration of successive unconformities as the landward basin margin was progressively uplifted. This pattern is familiar from other trench-related/fore-arc basins.

The character of each unconformity depends not only upon the nature of the preceding deformation phase but also upon rates of regional relative sea level change. For instance deformation associated with the Lower Intermediate Unconformity took place during a relative sea level high stand with the result that the unconformity is commonly a non-erosional submarine onlap surface. The Upper Intermediate Unconformity in North Sabah is an erosional surface in most places but was followed by a rapid relative sea level rise resulting in carbonate deposition. The Shallow Regional Unconformity was followed by a slower rate of relative sea level rise and appears to be a shoreface erosion plane over large areas.

In a tectonically active basin the interactions between rates of relative sea level change, rates and timing of structural growth, and changes in the rates of sediment input, control the depositional histories. The interaction of these factors is well illustrated by considering the nature of the five unconformities and intervening deposits in three superficially similar synclines: the Labuan, Prichard and Furious synclines.

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