

**Petroleum Geology Conference and Exhibition 2008**

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**Poster 7****CONDENSED SECTION INTERVALS WITHIN THE CYCLE II (EARLY MIOCENE) OF THE D35 FIELD, BALINGIAN PROVINCE, OFFSHORE SARAWAK: OCCURRENCE AND SIGNIFICANCE**ABDUL HADI ABD RAHMAN<sup>2</sup>, DAVID MARTYN INCE<sup>1</sup> AND KERRIE L. BANN<sup>3</sup><sup>1</sup>PETRONAS Carigali Sdn. Bhd., Level 16, Tower 2, PETRONAS Twin Towers, 50088 Kuala Lumpur, Malaysia<sup>2</sup>Energy Quest Sdn Bhd, 7th Floor, Menara Promet, Jalan Sultan Ismail, 50250 Kuala Lumpur<sup>3</sup>Ichnofacies Analysis Inc., 9 Sienna Hills Court SW, Calgary, AB, T3H 2W3, Canada.

A marine condensed section is a thin stratigraphic interval characterized by very slow depositional rates (<1-10 mm/yr). The interval often comprises fine-grained sedimentary rocks characterized by the presence of highly radioactive and organic rich shales, glauconite, chemical sediments and hardgrounds/firmgrounds. The interval may be thoroughly bioturbated, variably fossiliferous and locally show concretionary cement.

Condensed sections reflect particularly slow accumulation rates and thereby representing a significant span of time within only a thin layer. Condensed sections commonly develop during transgressions, in such cases they may be connected with “maximum flooding surfaces” and form important sequence stratigraphic markers.

The Cycle II (Early Miocene) reservoir intervals of the D35 field in Balingian Province, offshore Sarawak comprises thick, stacked, low-angle to cross-bedded sandstones, sandy conglomerate and wavy-to-irregularly laminated sandstone which are invariably bioturbated. These are interbedded with thick, sparsely bioturbated mudstones and several coal and paleosol horizons.

One major and four minor condensed sections have been identified within the cored intervals. The recognition of these thin but stratigraphically significant intervals is critical in the re-interpretation of the depositional framework of the Cycle II succession of the D35 field. Their occurrences indicate significant episodic marine incursions across the field area and beyond.

A major condensed section (Figure 1) identified within the Basal Interval of Cycle II is correlatable across the D35 field. The interval is complex, and contains a wide variety of trace fossil assemblages. These vary from stressed brackish water suites to very diverse, fully marine suites. Key surfaces, many demarked by palimpsest (time break) assemblages and *Glossifungites* ichnofacies (indicating firmground development), are closely spaced and commonly amalgamated. These, originally separate, thin intervals of condensed facies were clearly deposited in disparate sedimentary environments. They represent amalgamated, top truncated sequences and reflect maximum flooding intervals deposited during high stand events.

A second, thin, condensed interval has been identified within the Lower Cycle II (LC-II) sub-interval, which is the main hydrocarbon reservoir. The reservoir is interpreted as lobate to sheet-like mouth bars, distributary channels and limited tidal flat complexes. At least four lobes of the mouth bar complex can be recognized, which are separated by brackish estuarine shale. The thin, *Glossifungites* interval occurs near the top of LC-II, above an estuary/channel margin sandstone facies. It is in turn overlain by a nine-foot, conglomeratic sandstone representing part of a channelised, mouth bar/distributary channel sandbody. The *Glossifungites* ichnofacies indicates that a brackish environment was affected by a phase of marine inundation followed by a time break, during which the surface was inhabited by a community of opportunistic organisms. These changes may be related to lobe switching or sediment starvation. The occurrence of this interval indicates that the deposition of the different mouth bar lobes were not continuous, but occurred through time with major breaks.

Near the base of Middle Cycle II (MC-II) two closely spaced and thin condensed intervals are present. These *Glossifungites* intervals, formed near the top of thick brackish estuarine mudstone and immediately overlain by estuarine channel-bay head sandbodies, represent sediment starvation periods within the isolated basin.

A further condensed section in well D35-5 (6150-6142 ft) is marked by the presence of *Ophiomorpha*, *Zoophycos*,



Figure 1: Two core intervals which represent part of the major condensed section identified within the Basal Interval of Cycle II. This condensed interval is correlatable in the cores and well logs across the D35 field. This thick condensed interval is extremely condensed and complex, and contains enigmatic and diachronous stratigraphic stacking and juxtaposition of disparate marine and marginal marine deposits. A wide variety of trace fossil assemblages occur, ranging from stressed brackish water suites to very diverse fully marine suites. They represent amalgamated, top truncated sequences and reflect maximum flooding intervals deposited during high stand.

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Scolecia, Chondrites, Teichichnus, Asterosoma, Cruziana, Rhizocorallium, Thalassinoides, Terebelina and Paleophycus, which form a palimpsest. The diverse assemblage is indicative of nearly normal saline conditions.

Stratigraphically higher again, a further condensed section is represented by heavily bioturbated beds, stacked one on top another. The bioturbation is pervasive, with BI of 3-4 grades, and in places reaching 6. Thalassinoides and Diplocraterion are seen below an erosive transgressive surface, pervasive overprinting and stacking of fully-marine and near marine/brackish assemblages is recognised. This condensed section represents an extended period of marine transgression.

The recognition of these marine-influenced condensed intervals has been crucial in the reinterpretation of the environment of deposition of the D35 field reservoir interval. A coastal-estuarine depositional model now replaces the earlier Mississippi-type fluvio-deltaic model, with the importance of sea-level changes being more fully recognised.