Paper 5

Facies organisation and depositional environments of coal-bearing successions within the Nyalau Formation (Oligocene-Late Miocene) in Bintulu area (Tinjar Province), Sarawak

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The Nyalau Formation (Oligocene-Late Miocene) which outcrops around the Bintulu town in Sarawak is the onshore extension of the oil-bearing successions of the Balingian Province in offshore Sarawak. This formation represents an important analogue to the petroleum systems that occur in the offshore, oil-prone province. This paper describes the sedimentology and facies organisation of several coal-bearing outcrops of the Nyalau Formation in south Bintulu, and offers possible interpretation of their depositional environments.

Along the Bintulu-Tatau road south of Bintulu town, a road-cut at Sungai Mas exposes nearly 15 metres of coal-bearing, sand-shale-clay succession. This upward-fining succession is made up of at least five different lithologies, reflecting the interaction of different depositional processes.

At the base, about six meters of cross-bedded, wavy-bedded and laminated/draped sandstone is exposed. This unit, which is interpreted as a sandy, inter-tidal deposit, is overlain by about 2.1 m of distinct light-gray, clayey seat earth. Clay-XRD analysis of this rootlets-bearing, fossil soil layer shows that it is highly enriched in kaolinite minerals. A thin (~ 3–5 cm) coal layer lies immediately on top of the clayey unit. On top of the coal layer, about 10 cm of thin, silt-coal interbedding occur. A two meter thick of dark, carbonaceous and silty shale overlies the coal facies association. The whole section is capped by more than five meters thick of dark gray, carbagillitic shale. The seat earth, coal and related, coalified units are interpreted as swamp-to-coastal floodplain deposits. The overall facies organisation at the Sungai Mas outcrop, which is a shallowing-upward succession, reflects deposition within a distributary system in a tide-influenced, coastal plain environment.

At the Bintulu New Airport site, a small hill-cut exposes more than a hundred metres of coal-bearing, sand-shale-clay succession. This thick succession can be separated into five different fining-upward, shallowing-upward cycles. The lowermost fining-upward cycle is a 20 metre, mud-dominated cycle with a 1.5 metre basal sandstone capped by more than 18 metres of laminated mudstone.

The basal sandstone unit show draped, wavy- and flaser-bedded structures while the laminated mudstone is marked by the presence of thin sand-silt lenses. Several distinct and laterally continuous layers of iron-oxide are found interbedded within the mudstone unit. This cycle is interpreted as a tide-influenced, flood-plain environments. The iron-oxide layers probably represent iron-pan deposits formed during intermittent periods of emergence.

The second cycle is also a mud-dominated succession. At the base, two amalgamated beds of trough (~6 m), cross-bedded and bioturbated (Ophiomorpha) sandstone with well-developed mud-drapes occur. This is overlain by more than 22 meters of laminated-to-lenticular bedded mudstone, with a few well-developed, isolated rippled-sandstone lenses. This cycle is characteristic of a tidal-flat setting, with the basal sand unit representing a small tidal-channel fill.

The third cycle exposed at the new airport site is a heterolithic succession. The cycle is made up of about 20 meters of inter-succession of wavy- and rippled-bedded sandy intervals and mud-dominated lenticular-bedded intervals. The inter-succession of the sandy and the muddy heterolithic units reflects the dynamics of the depositional processes, alternating between a lower inter-tidal sand-flat zone to an upper inter-tidal, mud-flat environment. This cycle is interpreted to represent part of the intertidal margin of a tide-dominated estuary or a broad river bank.

Warta Geologi (Newsletter of the Geological Society of Malaysia), Vol. 28, No. 5, September-October 2002

The fourth cycle is the coal-bearing fining-upward succession. The basal 8.0 meters of sandstone show flat-to-low angle cross-bedded structures, with fairly well-developed drapes and laminations. Bioturbation is common but not pervasive here. This is overlain by about 2 meters of generally sandy, sand-shale alternation. The thickness of each sand and shale layers are between 2 to 5 cm. Most of the sand layers display well-developed mud- and carbonaceous-drapes. A 1.5 metres thick muddy siltstone unit, with interbedded thin sandstone layers (bearing distinct carbonaceous/plant debris laminae), overlies the sand-shale alternation bed. This unit is succeeded by a dark gray, laminated-to-lenticular bedded mudstone. Overlying this mudstone is 2.0 meters of dull gray, clayey mudstone similar to the one found at Sungai Mas outcrop (seat earth). A thin (about 20 cm) layer of dark brown silty clay overlies the seat earth, which is then overlain by about 15 cm of coal seam. This cycle is capped by about 4 metres of light gray, clayey mudstone.

Only the basal part of the topmost cycle is exposed at the outcrop. This is represented by a thick (about 9 m), medium-to-coarse grained, trough cross-bedded sandstone. This yellowish-coloured sandstone unit display medium- to large-scale trough cross-bedding. Each of the trough cross-bedded sets are internally laminated and in places shows well-developed, carbonaceous/plant debris drapes and laminations. The unit is sparsely bioturbated.

The upper two cycles (Cycle 4 and 5) is interpreted to represent part of a well-vegetated, distributary network of a tide-dominated coastal plain. The facies and stratal organisation of the Nyalau Formation rocks in south Bintulu describes a channelised, tide-influenced, well-vegetated, coastal plain environment. This setting is probably similar to the present day micro-tidal coastal plain of Sarawak.