Reservoir Geological Framework of Upper Miocene Shallow Marine Sandstones in the Erb West Field, Offshore Sabah, NW Borneo

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The Erb West field is a prominent NE-SW trending anticlinal structure containing sizeable gas and oil reserves. The hydrocarbons are contained within a ca. 800 ft thick sequence of Upper Miocene shallow marine sandstones, in which eight main sandstone reservoirs have been defined (M4 and N2-N8 Sands). The development and quality (porosity and permeability) of these reservoir sands display significant variations across the field and this has influenced both hydrocarbon distribution and field development strategy. The nature and origin of these variations in reservoir characteristics are discussed in terms of the depositional and tectonic setting of the Erb West field.

The reservoir interval comprises a series of gradationally-bounded facies types, ranging from mudstones, through mixed sand-mud (heterolithic) lithologies, into well-sorted sandstones. These facies are typically arranged in coarsening upward sequences which are paralleled by increases in sandstone porosity (15 to 26%) and permeability (10-2000 mD). Neritic microfaunas and abundant bioturbation indicate a shallow marine or shelf environment of deposition. Within the sandstones common parallel to wavy lamination (probably including hummocky cross-stratification), wave ripples and grading are considered indicative of a storm-dominated depositional regime, probably within an inner shelf setting.

The main reservoir sands (N Sands) are interpreted as having been derived from the reworking of coastal sediments flanking the emergent and tectonically-active Erb High. These sands were also probably partly associated with erosion of a regionally extensive unconformity (the Shallow Regional Unconformity-SRU), with the N Sands progressively onlapping the SRU to the southeast of the field. The result is a stack of transgressive shelf sands which individually display progradational sequences.

These coarsening upward sequences are ca. 50-100 ft thick and are recognised by funnel-shaped gamma ray log patterns. Correlation of facies and log sequences across the field indicate good continuity of individual packages but they exhibit variations in facies types, thickness and rock quality. This typically comprises the following trend: (1) relatively condensed, "proximal" sequences to the E and NE, (2) well-developed, complete ("intermediate") sequences in the centre of the field, and (3) well-developed but finer grained, "distal" sequences to the W and NW. Superimposed on this facies trend is a subsidence trend which is manifested by a northward increase in the gross thickness of individual reservoir units (i.e. increasing towards the more distal part of the basin). The resulting reservoir quality maps show optimum sand development in the central part of the field which decreases in both proximal (to E and NE) and distal (to W and NW) directions.

This reservoir geological framework has been used as a basis for predicting rock quality and pore volume distribution, for estimating hydrocarbon reserves and for planning and monitoring the development of the Erb West field, some aspects of which will be discussed.

The palaeobathymetrical curve for Sarawak was constructed with data from the Balingian and Luconia Provinces only. In the thicker, mainly Upper Miocene/Pliocene deposits of the Baram Delta Province, these major oscillations cannot be identified with certainty. There, palaeobathymetrical changes are generally small (less than 100') and numerous (several per biozone). It appears that in this area, where average rates of deposition were often 3 to 5 times as high as in Balingian/Luconia, the depositional history was

largely controlled by high subsidence and sedimentation rates, which largely obscured regional sea level changes.

In the interval between 16 and 3.5 m.y. the similarity between the global sea level curve and the palaeobathymetric curve for NW Sarawak is striking, and it suggests that in the Balingian/Luconia Provinces an equilibrium between subsidence (compaction) and sedimentation existed during this time interval, whereby regional transgressions and regressions were largely controlled by eustacy. For the interval older than 16 m.y., no correlation between the global sea level curve and the palaeobathymetric curve for NW Sarawak is possible, which is probably due to the fact that during this time the effect of global sea level changes was largely masked by the major tectonic movements which affected NW Sarawak in the Early Miocene.

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