Onshore To Offshore Trends In Modern And Miocene Mixed Carbonate-Siliciclastic Systems Across The Land-Attached Sarawak Shelf.

(Original short abstract)

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Abstract

Although isolated Miocene build-ups in SE Asia commonly form prolific hydrocarbon reservoirs, their equivalents on clastic-dominated land-attached shelves remain poorly known and underexplored. Here, onshore to offshore trends in carbonate development and reservoir quality are assessed across the NW Borneo shelf through study of modern systems, surface outcrops and subsurface wells. Dive data, spatial mapping and environmental data (including ROV, side scan sonar and shallow seismic) has been investigated across a coastal to shelf margin transect on the modern Sarawak shelf. A multidisciplinary programme of fieldwork, core study, petrography and geochemical analyses allowed evaluation of spatio-temporal variations in deposition, diagenesis and pore system development of the Miocene deposits. Likely controlling influences and the dynamic interactions between siliciclastics and carbonates on the shelf are evaluated. For the Miocene deposits, >200 samples were studied via transmitted light, cathodoluminescent and scanning electron microscopy together with stable isotopic characterisation (O, C and Sr).

Carbonates developed as localised low-, and higher-relief build-ups, as well as more continuous sheet-like deposits in near-coast to shelf margin positions. Molluscs, corals, larger benthic foraminifera and coralline algae are common constituents. Most samples show evidence for marine micritisation and just in shelf margin positions isopachous cements. However, burial diagenesis predominates in the form of compaction, neomorphism, fracturing, late leaching and dolomitisation. Near-coastal carbonates commonly contain siliciclastics, as do some shelf margin deposits that interdigitate with, or are covered in siliciclastics. Some early, probable meteoric leaching affected inner shelf deposits prior to pervasive neomorphic to blocky/poikilotopic calcite cement formation. On the basis of $\delta^{18}O$ V-PDB values of -4.5 to -7.9‰ equivalent to $\delta^{18}O$ V-SMOW values of 0 to -4‰ at 25-40°C and $\delta^{13}C$ V-PDB values of -0.6 to +1.6‰ cementation probably reflects alteration from terrestrial groundwaters in meteoric aquifers derived from the humid landmass of Borneo. Despite this cementation, moderate energy inner- to mid-shelf grainstones from the core of mounded carbonates still retain, or have enhanced porosity (<8%) over their lower energy counterparts (<4% porosity). Retention of primary porosity

and/or late burial dissolution (often associated with saddle dolomite formation) enhancing predominantly primary and minor secondary porosity is key to reservoir quality development in outer-shelf deposits. Best porosity (<20-35%) is in high energy grainstones and rudstones from outer-shelf to shelf-margin positions that experienced minimal clastic influx, most commonly from backstepping to aggradational carbonate sequences. Although stable isotopes for shelf margin calcite cements are consistent with precipitation from marine derived fluids ($\delta^{18}O$ V-PDB values of -3.6 to -5.4‰), those for the late dolomites are suggestive of fluids of meteoric origin ($\delta^{18}O$ V-PDB values of -5.2 to -7.4‰ equivalent to values of -0.3 to -6.3‰ V-SMOW at 40 to 60 °C). Critical factors for carbonate development on siliciclastic dominated shelves are: (1) the dynamic interactions with siliciclastics and carbonate producers/strata, (2) local environmental conditions, (3) antecedent topography, and (4) the link between changing environmental conditions and accommodation space. Critical factors for reservoir quality development in carbonates from siliciclastic dominated shelves in the equatorial tropics are: (1) development and preservation of primary porosity, (2) cementation associated with meteoric aquifers draining large humid equatorial landmasses, and (3) burial leaching and fluid pathways.