Paper P18

Diverse Origins of Carbonate Cements Revealed By Carbon and Oxygen Isotopic Analysis

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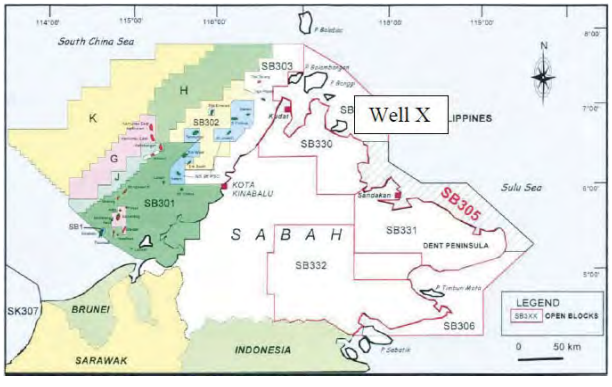
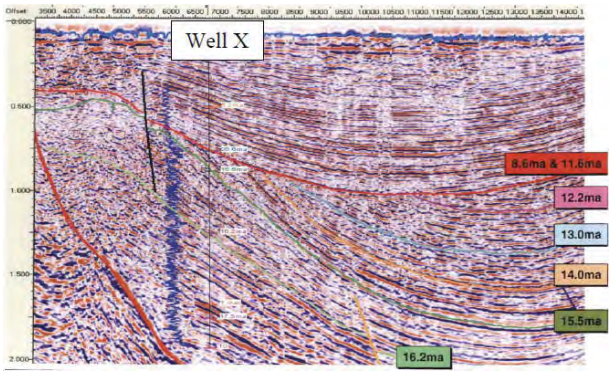
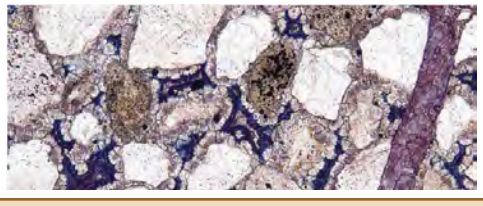
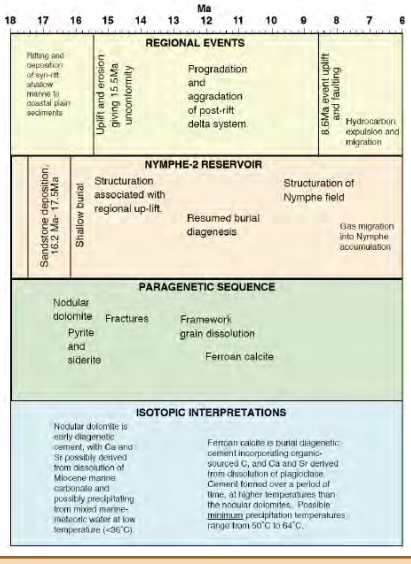
Well X, drilled in Block SB 305 in the Sandakan Basin tested a large inversion structure the upper portions of which are cute by a major unconformity. Intraformational seals retain hydrocarbons at levels unaffected by the erosional episode.

Two cores were recovered from Lower Miocene reservoir sections. The reservoirs are of shallow marine facies and show extensive bioturbation with distinctive forms such as Ophiomorpha present. Less bioturbated intervals show potential hummocky cross bedding, recording the influence of storm waves, transporting sediment from the coastal to shallow offshore areas.









Core one is highly unusual for a Miocene reservoir section anywhere in Malaysia in that it is extensively cemented by porosity occluding carbonate cements. Visual examination indicates that both dolomite and calcite are present and suggests thqt the cementation history is complex and multigenerational.

Cementation and mechanical compaction are two major diagenetic processes for these sandstones. Fe-calcite and/or authigenic siderite are common in calcite-rich sandstones and calcite/siderite-rich sandstones. Authigenic minerals are relatively rare in other sandstones, and include pyrite and Fe-calcite. Understanding the origins and thus possible distribution of these cements is important for reservoir characterisation and modelling.

Siderite is common in this sandstone and mostly occurs in a grain-coating manner. Fe calcite is common as well, occluding intergranular areas and fractures. It is apparent that Fe-calcite formed after siderite.

While petrographic analysis allows determination of the nature and relative timing of cement precipitation it does not give information on the thermal conditions or potential origins of the cements. To this end isotopic analysis was carried out to constrain possible sources of the carbonate in the cements (marine; basinal water-rock interaction; meteoric; mixtures) and constrain the range of possible precipitation temperatures and precipitating water $d^{18}O$ values for the authigenic carbonate cements. Although not conclusive, these data could be used to check consistency with a high (late) or low (early) temperature of precipitation.

Synthesis suggests the early, nodular dolomites may have formed shortly after deposition and early, shallow burial of the reservoir sandstones – possibly associated with the 15.5Ma regional up-lift (when there may have been mixing of meteoric waters in the reservoir sandstone). The later ferroan calcites may have formed during the period of resumed burial from about 12Ma until the structuration of the area associated with the 8.6Ma event and subsequent hydrocarbon expulsion and migration.

Future work will integrate the results of the isotope analysis with thermal modelling of the well and surrounding areas to determine the applicability of this technique to any future situations where understanding a complex diagenetic history is important for reservoir characterisation.

Warta Geologi (Newsletter of the Geological Society of Malaysia), Vol. 38, No. 2, April-June 2012