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CEMENT-STRATIGRAPHY OF TIGAPAPAN UNIT, SABAH BASIN: CLUE TO TIMING OF HYDROCARBON MIGRATION

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The Tigapapan Unit (upper Miocene) in the Tigapapan Field is a bioclast-rich clastic-carbonate mixture and has been interpreted as a progradation storm-shoal complex. Cathodoluminescence, geochemical, and isotope studies of four wells indicate that the sediments have undergone a complex diagenetic history including at least 11 cementation episodes (stages A to K). These episodes can be related to distinctive cement textures, reflecting various burial stages, thermal regimes and carbon sources. The stages of diagenetic evolution are as follows: The stages of diagenetic B-radiaxial-fibrous calcite; C-scalenohedral, blocky calcite; D-blocky and vein-filling Fe-calcite; E-vein-filling Fe-calcite; F-clay-associated dolomite; G-H: dolomite; I-J: ankerite; and K-late Fe-rich calcite. Five episodes of fracturing and dissolution have also been identified.

Each cement stage shows distinctive differences in Sr^{4+}, Mn^{2+}, Mg^{2+} and Fe^{2+} concentrations, correlatable over the whole Tigapapan Field. These differences are believed to reflect changes in paleo-pore fluids from which the carbonate cements were precipitated.

The cementation occured from very early to late phases at near surface to 2.0 km depth. The early, stage A cement ($\delta^{13}C$ =- 33.7‰ PDB, $\delta^{18}O$ = -0.1‰ PDB) was precipitated at near surface temperature. With progressive burial and temperature increase, oxygen isotopes become strongly negative (stage K: δ^{13} C = +1.7 ‰ PDB, $\delta^{18}O$ = 6.8‰ PDB). Oxygen isotope data indicate that cements were precipitated at relatively low temperature regimes, between 26° C (early, stage A cement) to about 70° C (late, stage K cement).

The presence of oil-stains indicates that the timing of oil migration was after stage E and before stage F, when the reservoir was at 54° C, corresponding to a burial depth of 1.2 km, assuming the present day geothermal gradient of 25.3° C/km and allowing for compaction.