

Stable Isotope Signatures in Carbonates as a Tool for Hydrocarbon Exploration

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Early marine aragonite cements are commonly precipitated from pore waters at the basal portions of coral skeletons. Inorganic Mg-calcite may also be added to the coral skeleton during early diagenesis in the marine environment. The progressive addition of early diagenetic inorganic aragonite and calcite toward the base of massive corals in Western Australia and Papua New Guinea produces an apparent increase in density and an increase in $\delta^{13}\text{C}$. Both diagenetic aragonite and Mg-calcite precipitated in the marine environment are enriched in ^{13}C relative to coral aragonite. A comparison of the change in density and change in $\delta^{13}\text{C}$ values in our corals leads to sound interpretations of the relation between the nature and degree of diagenesis and their effect on the $\delta^{13}\text{C}$ values. Additional consideration of the relationship between $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ signatures confirmed the above interpretations. Calcite has almost the same density as aragonite (2.71 cf 2.93 g/cm³), and thus the addition of similar amounts of secondary calcite in the Papua New Guinea coral and secondary aragonite in the Ningaloo Reef coral would produce the same density increase. An apparent increase in density of about 25% due to infilling of pores in the coral skeleton would be accompanied by a $\sim 1.6\text{‰}$ decrease in $\delta^{13}\text{C}$ in the coral affected by the precipitation of secondary inorganic aragonite as the latter is enriched in ^{13}C , relative to coral aragonite. Inorganic Mg-calcite precipitated in equilibrium with seawater is also enriched in ^{13}C relative to pristine coral aragonite (O'Neil et al. 1969), though not to the same extent as inorganic aragonite. Despite this, $\delta^{13}\text{C}$ would still show a decrease of $\sim 0.7\text{‰}$ towards the present.