Depositional Controls on the Distribution of Dolomite Cement in Virgelle Member Sandstones, Writing-on-Stone, Alberta

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Based on petrographic criteria and constraints from stable isotope analyses ($\delta^{18}O$, $\delta^{13}C$), the distribution of ferroan dolomite cement in Virgelle Member sandstones at Writing-on-Stone Provincial Park, southern Alberta, can be linked to very early diagenesis within fresh-water / saline water mixing zones that tracked progradation of the storm-dominated shoreface and estuarine depositional system in the late Santonian.

Detrital dolomite grains are abundant in middle shoreface sandstones (3.3–8%) but nearly absent in uppermost shoreface and estuarine channel deposits (0–3%). In contrast, ferroan dolomite overgrowths in the middle shoreface form relatively thin rims around detrital dolomites (10–50 μm, 0.2–5%), but form poikilotopic patches of cement up to 1 mm in size within estuarine channel lithofacies (0–10%). Overgrowths engulf kaolinite aggregates and fill partially dissolved feldspars, but predate calcite and quartz cementation. Within channel deposits and subjacent uppermost middle shoreface sandstones, dolomite cement accounts for significant reduction of both porosity and permeability.

Carbon and oxygen isotope analyses allow clear distinction between detrital dolomite of marine, platformal type, $\delta^{18}O = -6.3^{o/oo}$ PDB, $\delta^{13}C = 0.6^{o/oo}$ PDB, and ferroan dolomite cement precipitated in strongly fresh-water diluted pore waters ($\delta^{18}O_{AVG} = -12.4^{o/oo}$ PDB, $\delta^{13}C_{AVG} = -1.8^{o/oo}$ PDB). Texture, distribution and isotopic signature of dolomite cements are consistent with very early precipitation in two distinct settings: *i)* within/below estuarine channel sands in a broad, tide-induced mixing zone; and, *ii)* within the underlying shoreface in a narrow mixing zone arising from slow, regional progradation of the shoreface and attached fresh-water lens.