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Depositional Controls on the Distribution of Ferroan Dolomite Cement in Virgelle Member (Eagle-Equivalent) Sandstones, Writing-on-Stone, Southern Alberta, Canada

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 freshwater–saline water mixing zones that tracked progradation of the storm-dominated shoreface and estuarine depositional system in the late Santonian.

Ferroan dolomite overgrowths in the middle shoreface form relatively thin rims around detrital dolomites (10–50μm, 0.2–5%), but form poikilotopic patches of cement up to 1 mm in size within estuarine channel lithofacies (0–10%). Overgrowths fill partially dissolved feldspars and engulf kaolinite aggregates, but predate localized calcite cementation. Within estuarine channel deposits and subjacent uppermost shoreface sandstones, dolomite cement accounts for significant reduction of both porosity and permeability, up to 10% and 1,700mD, respectively.

Carbon and oxygen isotope analyses allow clear distinction between detrital dolomite of marine, platformal type, $\delta\ ^{18}O$=–6 $^{o/oo}$PDB, $\delta\ ^{13}C$=0.6 $^{o/oo}$PDB, and ferroan dolomite cement precipitated in strongly fresh-water diluted pore waters ($\delta\ ^{18}O$=–12.5 $^{o/oo}$PDB, $\delta\ ^{13}C$=–2$^{o/oo}$PDB). Texture, distribution and isotopic signature of ferroan dolomite cements are consistent with very early precipitation in two distinct settings: (1) within and surrounding estuarine channel sands in a broad, tide-induced zone of daily, km-scale, advection-controlled mixing; *and*, (2) within the underlying shoreface in a narrow, ?metre-scale, ?diffusion-controlled mixing zone arising from slow, regional progradation of the shoreface and attached fresh-water lens, at a time scale of 10^2 million years.