Preservation of Limestone in Dolomitized Carbonate Evaporite Reservoirs

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Carbonate evaporite successions are commonly dolomitized by the process of brine reflux. Dolomitization can be pervasive but is often incomplete resulting in the preservation of isolated limestone intervals. Distinct differences in limestone and dolomite petrophysical properties impact the distribution of reservoir quality and optimization of lithology-specific reservoir management strategies. Existing conceptual models propose that permeability heterogeneity during reflux is the principal control on the presence and distribution of limestone in otherwise dolomitized successions. Bedded evaporites behave as aquitards sheltering underlying limestone whereas pre-dolomitization cements retard and deflect the flow of reflux brines. We propose an alternative explanation for limestone preservation based on Reactive Transport Models that couple fluid flow with chemical reactions. Simulations based on partially dolomitized cycles of the Albian Upper Glen Rose Formation, reveal the complex propagation and evolution of multiple dolomite fronts during episodic brine reflux. Preservation of intervening limestone occurs in our simulations as a consequence of dolomite kinetics and independently of permeability heterogeneity. Brines generated after consecutive sedimentation events descend through the section cross-cutting sequence stratigraphic surfaces. Variation in the rate of dolomitization controlled by dolomite abundance can result in the spatial dislocation of the source of reflux brine, an evaporite bed, and the resulting dolomite body. The duration of brine generating conditions that drive both time equivalent and younger reflux events is also a critical control on limestone preservation potential. Simulation results demonstrate a new viable predictive concept that has significant implications for correlation of reservoir connectivity in partially dolomitized carbonate evaporite successions.