**Reactive Transport Models of Structurally Controlled Hydrothermal Dolomite in Carbonate Reservoirs**

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Hydrothermal dolomitization is the dominant control on reservoir quality in several hydrocarbon accumulations including the Trenton-Black River trend in the USA and Ladyfern and Clarke Lake fields in Canada. In addition hydrothermal dolomitization has been interpreted in several giant Middle East reservoirs including Ghawar in Saudi Arabia. Structurally controlled hydrothermal dolomitization describes the replacement of limestone with dolomite and/or the precipitation of dolomite cement and associated MVT minerals (anhydrite, sulfides, quartz and fluorite) as a consequence of subsurface brines that ascend upwards through fault and fracture systems. This fluid rock interaction in the burial environment has the potential to both improve and/or degrade reservoir quality depending on the properties of the host rock, fluid composition and spatial position relative to structure.

TOUGHREACT, a reactive transport model that couples fluid flow with chemical reactions, was used to simulate hydrothermal dolomitization. Specifically we investigated the sensitivity of hydrothermal dolomite to: fault permeability / flow rates of ascending fluids, reservoir heterogeneity (alternating high and low permeability strata), temperature of host rock and ascending fluids (including their relative temperature difference), fault spacing / multiple fault scenarios, fault vertical separation and strata juxtaposition, episodic versus continuous brine injection and subsurface brine composition (in particular, Na-Cl vs. Ca-Cl brines).

Results from 2D and 3D models suggest that diagenetic modification and evolution of petrophysical properties in response to hydrothermal dolomitization are a complex function of the hydrodynamics and fluid chemistry. Variations in fault and matrix permeability strongly control the spatial patterns of diagenesis. Brine chemistry of both the host rock and the ascending fluids affect the extent and distribution of dolomitization. Na-Cl brines produce more dolomite than Ca-Cl brines because of higher Mg/Ca ratios but this result is salinity and temperature dependent. Hanging wall fault blocks are preferentially dolomitized. Depending on their permeability, relay zones between faults can act as groundwater flow divides that may remain undolomitized. For the systems simulated, hydrothermal dolomitization enhances matrix porosity and permeability but fault zones begin to seal due to the precipitation of anhydrite and dolomite cement.