Geothermal Convection at Tengiz: Reactive Transport Models of Predictive Diagenesis and Evidence from the Rocks

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Reactive Transport Models that couple fluid flow and chemical reactions were used to test the viability of pre and post burial geothermal convection in the Tengiz carbonate platform reservoir. Simulations demonstrate that geothermal convection can drive diagenetic reactions capable of modifying reservoir quality. Specific model predictions include: 1) Concurrent dissolution and cementation in a mixed-convective system prior to burial in the platform rim, 2) Dissolution by forced convection prior to burial towards the platform center, 3) Perpetuation of early diagenetic patterns, but at lower rates after burial, 4) Dissolution beneath salt-withdrawal basins and cementation in the platform interior due to free convective flow modified by halokinetics and 5) Minor to no dolomite.

Ongoing Tengiz reservoir characterization studies were used to evaluate model predictions. Core and petrographic data support or at least do not rule out model predictions 2), 3) and 5). Enhanced porosity that is stratigraphically discordant, vertically-oriented and platform-centric supports model predictions 2) and 3). Dolomite is present in the Carboniferous section but is generally volumetrically insignificant supporting prediction 5). Model prediction 1) is possible, but has been overprinted by later cementation and dissolution. A zone of enhanced porosity beneath a salt dome and not the adjacent withdrawal basin suggests model prediction 4) is either invalid or has been overprinted by later diagenesis. This case study demonstrates the potential of Reactive Transport Models to develop viable and testable hypotheses that if integrated with observations from the rock record results in improved process-based predictions of carbonate reservoir quality.