Brazil's Pre-Salt Lacustrine Reservoirs: Modeling Early Mineral Precipitation

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Abstract

Brazil's Pre-Salt Lacustrine Reservoirs; Modeling Early Mineral Precipitation Lacustrine carbonate reservoirs in Brazil's deep water pre-salt play are variably overprinted by dolomite, Mg-smectite, silica, and calcite. These minerals result from chemical sedimentation, biochemical sedimentation, and burial diagenesis. Calcite→dolomite→Mg-smectite is a mineral precipitation sequence observed in pre-salt thin sections that is consistent with mineral-saturation sequences observed in some modern evaporative lakes. Waters from Lake Yoa, Chad, produce such a mineral saturation sequence due to progressive evaporation. Constraining where mineral precipitation occurs is an important reservoir quality consideration. This work aims to develop predictive concepts for reservoir quality in the Brazil pre-salt that are grounded in an understanding of the hydrogeological framework and how it controls water chemistry and associated mineral precipitation. Convolving a Lake Yoa-like evaporative geochemical model with platform topography and lake level variations allows predictions to be made regarding mineral distribution. A series of simple models for lacustrine carbonate platforms has been constructed as a physical framework for mineral dissolution and precipitation driven by cyclical lake level and salinity variations: 1) Deeper water (tens of meters) over platforms at the time of deposition will impose chemical conditions consistent with the chemistry of the surface waters in adjacent basins. In the case of fresh water, calcite is favored. 2) Water depths of just a few meters across platform tops will drive more extensive evaporation and favor minerals such as dolomite. On larger platforms, interior locations may experience even more extensive evaporation and favor Mg-smectite precipitation. 3) Lake levels coincident with platform tops may drive strong evaporative

concentration of waters ponded in low, restricted areas. Dolomite followed by Mg-smectite can be expected in such locations. Karst may develop in exposed mounds. 4) Base levels significantly below platform tops will produce widespread karst and may drive extensive evaporative concentration of waters in the adjacent basins. The conceptual model presented here suggests that persistent and repeating patterns of mineral dissolution and precipitation can be expected. These patterns have been tested on field examples and can be used to constrain reservoir quality within the context of seismically resolvable platform topography and structure in un-drilled locations.