Hydrothermal Dolomitization and Leaching of Carbonate Reservoirs

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Hydrothermal alteration of carbonate reservoirs occurs when relatively high-pressure, high-temperature fluids flow at high rates up active faults and into permeable formations that underlie sealing shales, evaporites or other low permeability strata. Most reservoir-enhancing diagenesis is associated with strike-slip and especially transtensional faulting. Because of the spatial link to faults, hydrothermal alteration commonly produces heterogeneity in reservoir quality and distribution.

Hydrothermal alteration products include, but are not restricted to, saddle and matrix dolomite, recrystallized limestone (including development of microporosity), pore- and fracture filling calcite, anhydrite, quartz, fluorite, barite, bitumen, authigenic clay minerals, sulfides, and more. Significant leaching of limestone, dolomite, and other minerals by hydrothermal fluids is a common occurrence and can be a primary control on reservoir quality. Hydrothermal leaching likely occurs from cooling, low pH fault-derived hydrothermal fluids. Cooler fluids can hold more carbonate and CO_2 in solution than relatively warmer fluids so cooling fluids should become progressively undersaturated and more acidic. Some brecciation, leaching and microporosity development previously attributed to meteoric diagenesis may be hydrothermal in origin.

Hydrothermally altered carbonate reservoirs appear to be very common in the Middle East. The Permo-Triassic Khuff Formation has common saddle dolomite cemented breccias, zebra fabrics and sulfide deposits. Fault-related dolomitization also occurs in some of the overlying Jurassic and Cretaceous reservoirs, but hydrothermal alteration in these units more commonly consists of leaching and microporosity development. A better understanding of the processes, products and indicators of hydrothermal alteration will help improve the bottom line.