Fault-Related Hydrothermal Alteration of Carbonate Reservoirs

Langhorne B. (Taury) Smith
Smith Stratigraphic LLC, Albany, NY
smithstrat@gmail.com

Abstract

Hydrothermal alteration occurs when relatively high-pressure, high-temperature fluids flow up active faults and into permeable formations that underlie sealing shales, or other low permeability strata. This process can and commonly does occur at relatively shallow burial depths of less than a kilometer and in many cases less than 500 meters.

Solubility of carbonates (and other minerals) is directly affected by changes in composition, temperature, pressure, P_{CO2}, pH, and salinity and all of these may be fluctuating on short time scales in fault-related hydrothermal systems. Hydrothermal fluids may directly precipitate or dissolve carbonate and other minerals and may also mix with in situ fluids leading to further dissolution or precipitation.

Hydrothermal alteration products include, but are not restricted to, matrix dolomitization, recrystallized limestone (including development of microporosity), pore- and fracture filling saddle dolomite, calcite, anhydrite, quartz, fluorite, bitumen, authigenic clay minerals, sulfides and more. Porosity can be created by recrystallization and dissolution of carbonates and other minerals but can also be destroyed by mineralization. In lower permeability host rocks, brecciation, hydrofracturing and zebra fabrics occur near fault zones.

Hydrothermal alteration can occur around almost any type of fault, but reservoirs are most commonly created or enhanced around basement-rooted strike-slip, extensional and especially transtensional faults. Vertical and lateral heterogeneity in the distribution of porosity can be explained by proximity to faults. This model should be considered along with other popular diagenetic models, especially in reservoirs with significant lateral heterogeneity.