Sulfate and Silicate Diagenetic Mineralization in the Barnett Shale, Texas

Earl B. Manning, S. Johari Pannalal, Devin P. Dennie, John C. Deng, Matthew S. Zechmeister, and R. Douglas Elmore
School of Geology and Geophysics, The University of Oklahoma, Norman, OK.

An understanding of minerals and their source fluids is critical in evaluating the reservoir and fracture potential of oil and gas shales. Samples taken from cores of the Barnett Shale within the Fort Worth Basin contain an array of minerals precipitated during diagenesis. Sulfate rich veins, not commonly documented in the literature, are observed in the Barnett Shale along with veins containing silicates and carbonates. The sulfate minerals barite, celestine, and occasional anhydrite are predominantly found in carbonate rich intervals replacing vein calcite. Other minerals associated with these sulfates include authigenic albite and euhedral quartz. Albite has also been found replacing phosphate nodules and calcite cement in the matrix. Electron microprobe data collected from sulfates in veins in the Barnett Shale documents that a solid solution exists between barite and celestine, which reflects an evolving fluid. One vein shows that Strontium (Sr) in barite ranges from <1 to 23 mol% whereas the Barium (Ba) in celestine ranges from 18 to 44 mol%. Also, a 1:1 mol% ratio of Sr/Ba has been observed in barite/celestine within other veins. Strontium ($^{87}Sr/^{86}Sr$) isotope values from sulfates range between 0.708322 and 0.708323 indicating enrichment in ^{87}Sr. In addition, radiogenic values ranging from 0.708037 to 0.711920 are found in calcite within veins with the highest values near the Ouachita thrust. An internal source (e.g. dissolution of feldspar grains) may explain those values that are slightly radiogenic. The highly radiogenic values, in combination with the proximity to the thrust, suggest that externally derived fluids, perhaps orogenic fluids from the Ouachita thrust zone, precipitated minerals in late fractures.