Geochemical Footprints in Shale-CO_2 Packed Bed Experiments and Impacts on Microfractures

ABIOLA OLABODE[1], MILEVA RADONJIC[2*]

[1]Louisiana State University, aolabo2@lsu.edu
[2]Louisiana State University, mileva@lsu.edu

The injection of carbondioxide (CO_2) in large scale as obtainable in carbon sequestration programs and in environmentally friendly hydraulic fracturing processes (using supercritical CO_2), long term rock-fluid interaction can affect reservoir and seal rocks properties. The mineralogical components of sedimentary rocks are geochemically active particularly under enormous earth stresses, which generate high pressure and temperature conditions in the subsurface. It has been postulated that the effect of mineralization can lead to flow impedance in the presence of favorable geochemical and thermodynamic conditions. This experimental modelling research investigated the impact of in-situ geochemical precipitation on conductivity of fractures. Geochemical analysis were performed on four different samples of shale rocks, effluent fluids and recovered precipitates both before and after CO_2-brine flooding of crushed shale rocks at moderately high temperature and pressure conditions. The results showed that most significant diagenetic changes in shale rocks after flooding with CO_2-brine, reflect in the effluent fluid with predominantly calcium based minerals dissolving and precipitating under experimental conditions. Major and trace elements in the effluent fluid (using ICP-OES analysis) indicated that multiple geochemical reactions are occurring with almost all of the constituent minerals participating. The geochemical composition of precipitates recovered after the experiments showed diagenetic carbonates and opal (quartz) as the main constituents. The bulk rock showed little changes in composition except for sharper and more refined peaks on XRD analysis, suggesting that a significant portion of the amorphous content of the rocks have been removed via dissolution by the slightly acid CO_2-brine fluid that was injected. However total carbon (TOC) analysis showed a slight increase in carbon content of the bulk rock. Micro-indentation results suggested slight reduction in the hardness of the shale rocks and this reduction appears dependent on diagenetic quartz content. It can be inferred that convective reactive transport of dissolved minerals are involved in nanoscale precipitation-dissolution processes in shale. This reactive transport of dissolved minerals can occlude micro-fracture flow paths, thereby improving shale caprock seal integrity with respect to leakage risk under CO_2 sequestration conditions.