Investigation of scaling in Marcellus shale during a laboratory simulated hydraulic fracturing fluid flow and shut-in period

WEI XIONG[1], JOHNATHAN MOORE[2], J. ALEXANDRA HAKALA[3], DUSTIN CRANDALL[3], CHRISTINA LOPANO[3]

[1] ORISE National Energy Technology Laboratory
[2] AECOM National Energy Technology Laboratory
[3] National Energy Technology Laboratory

The Marcellus shale formation has become a key contributor to US natural gas production due to hydraulic fracturing techniques. Precipitation of scale minerals such as barite and calcite may cause clogging in fractures that reduce gas production. However, volume expansion of scale minerals may also propagate new fractures and release more gas from the shale matrix in the long term. This self-limiting/enhancing scaling process is not well studied. Our previous studies have shown the potential for mineral scale formation along fracture surfaces, particularly in locations where fluid flow may be limited (Vankeuren et al., 2017). This study expands on the work by Vankeuren et al. (2017) to better understand properties impacting mineral scale nucleation and growth. Fractured Marcellus shale cores were investigated in a flow-through system for a short duration, followed by longer term static interactions (to mimic a shut-in period) at elevated temperature and pressure relevant to real site conditions. Comparison between natural water and deionized water as base fluid with industrial hydraulic fracturing chemicals was made to examine the effect of natural surface water constituents on scale mineral formation. Pre- and post-reaction cores after flow-through reaction and static reaction were analyzed using scanning electron microscopy and computed tomography to show the location and extent of secondary precipitates. Aqueous species in influent and effluent were measured using inductively coupled plasma mass spectrometry to identify speciation and calculate mineral saturations in the system. Results from this study will provide context on fracture-to-core geochemical reactions that could impact long-term hydrocarbon production from unconventional shales.