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Geochemical Compositional Changes due to Fracturing Fluid Interaction with Caney Shale, South Central Oklahoma, USA

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Unconventional shale reservoirs in the North America are characterized by high clay compositions which influence their reactions with drilling and fracturing fluids considerably. These minerals react with engineered fluids with adverse consequences on petrophysical properties of reservoirs. Knowledge of reaction process and the products of reaction of clay minerals with engineered fluids is therefore a significant consideration in development of unconventional reservoirs.

In this study, selected portions of 650 feet core of retrieved the Caney Shale is investigated to understand the mineralogy and geochemical response to fracturing fluids with focus on clay minerals. Petrophysical logs from the well are used to delineate zones of interests, specifically pay zones where rock-fluid geochemical reactions are critical. Batch reactor experiments are conducted at reservoir temperature (95^{o}C) and ambient pressure using the following fluids: 2% Potassium Chloride; 0.5% Choline Chloride solutions and; deionized water used as control.

X-Ray Diffraction (XRD) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) are employed for mineralogical composition and effluent analysis respectively. Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS) is used to assess the elemental changes from reaction between rocks and fluid samples. Computed Tomographic scanning and X-Ray Fluorescence of the entire core length are used to upscale results from batch experiments. Geochemical modeling of batch reactor experiment is undertaken with TOUGHREACT software to help corroborate and extrapolate results obtained from batch reactor experiments.

Preliminary results from XRD show samples have identical mineralogical compositions, mainly quartz, carbonates and clays, but different quantities. Elemental compositions of effluent are mainly influenced by the carbonate and clay minerals. Carbonate minerals release ions in solution by dissolution whilst the leading mechanism of ion contribution from clays is by ion exchange. Experimental data and modeling results converge for pH and some elemental compositions, though there is significant divergence in other elements notably, Aluminum (fig. 1).

Our research provides multi-scale, multi-dimensional understanding of geochemical responses of Caney formation to hydraulic fracturing fluids. Results from this study contributes to understanding mechanisms of subsurface rock-fluid interactions. This helps to optimize fracturing fluid compositions for hydraulic fracturing projects within the Caney formation.

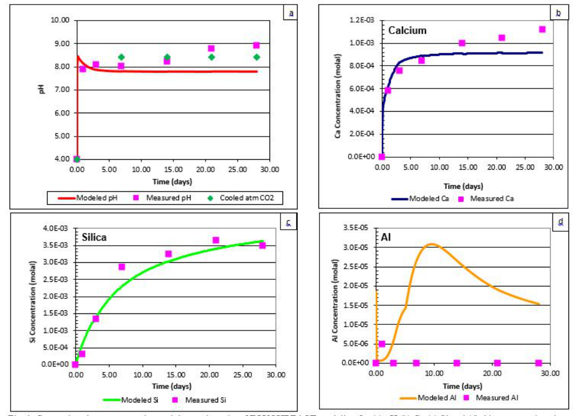

Fig. 1: Comparison between experimental data and results of TOUGHREACT modeling for (a) pH (b) Ca (c) Si and (d) Al concentrations in effluent.