

**Subsurface Geochemical Rock-Fluid Interactions in Caney Formation, South-Central  
Oklahoma Oil Province (SCOOP)**

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The share of energy supply from unconventional hydrocarbon resources have witnessed continuous growth in the United States in the last two decades. This trend is expected to remain the same for at least, the next two decades. Most unconventional hydrocarbon reserves are however locked up in shale reservoirs with ultra-low permeability. Producing from these reservoirs requires application of hydraulic fracturing technologies to increase the permeability of the reservoirs and make the hydrocarbons accessible. The challenge with fracturing, however, has been the sustainability of productivity of hydraulically fractured reservoirs. Most hydraulically fractured reservoirs witness significant declines in production after two (2) to five (5) years. This is believed to be the result of fracture closure by both geochemical and geo-mechanical causes, the former being more pervasive and critical. Understanding long-term geochemical rock-fluid interactions in the subsurface is therefore essential to solving this problem. The main objective of this study is to evaluate the factors and mechanisms controlling subsurface geochemical interactions that instigate permeability loss in hydraulically fractured reservoirs in the long-term.

This study employs static batch reactor experiments between produced fluids and powdered samples from cored rocks and rock cuttings investigate rock-fluid interactions in hydraulically fractured reservoirs. Samples used for these experiments are selected from specific depths within the Caney Formation in Southern Oklahoma. These samples were crushed and grounded to particle sizes passing 400 $\mu$ m before micronized to further reduce their size. The ground powders are mixed with produced fluids recovered from same reservoir as rocks and put in oven, preset at 95°C for 30-day reaction period. Deionized water is also used as fluid medium for some samples to provide reference point during interpretation of results. Experiments are conducted at atmospheric pressure and mixtures are sealed to ensure minimum interaction with atmospheric oxygen.

Evaluation of samples is programmed to be conducted pre-experiment and post-experiment to ascertain the changes that resulted from rock-fluid interactions. Tools used for characterization of samples included: Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS) and X-Ray Diffraction (XRD) for rock powder microstructure, elemental evolution, and

mineralogical transformation. Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) for elemental analyses of effluent. Results from these techniques are subsequently integrated to understand the geochemical changes that have taken place.

Preliminary results show transformation in mineralogical composition of samples due to dissolution of pyrites and carbonates as well as transformation of feldspar to clay minerals. XRD diffractograms of pre-experiment and post experiment samples also show increased amorphous compositions especially around 2-theta angles of clays supporting the theory of illite deflocculation and fines migration. EDS elemental analyses of rock samples show appreciable variations of composition of various elements, mainly reduction of counts post-experiment. Increased elemental concentrations of Ca, Si, Na, and Ba with corresponding decrease in concentrations of Al, Mg and Fe in effluent points to considerable geochemical reactions between fluids and formation.

This study provides insight on subsurface geochemical interactions over the long-term within the Caney Formation, in South Central Oklahoma Oil Province (SCOOP). It highlights factors and mechanisms that control rock-fluid interactions in the subsurface and provides insights on the long-term impacts of these reactions. This work can serve as basis for finetuning the chemical composition of hydraulic fracturing fluids to mitigate long-term permeability losses.