

# Subsurface Geochemical Rock-Fluid Reaction in Caney Shale of Southern Oklahoma

Gabriel Adua Awejori<sup>1</sup>, Wenming Dong<sup>2</sup>, Christine Doughty<sup>2</sup>, Nicolas Spycher<sup>2</sup>, Fengyang Xiong<sup>1</sup>, and Mileva Radonjic<sup>1,3\*</sup>

<sup>1</sup>Geomimicry and Barrier Materials Labs, School of Chemical Engineering, Oklahoma State University, Stillwater, OK 74078, USA

<sup>2</sup>Energy Geosciences Division, Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720, USA

<sup>3</sup>Boone Pickens School of Geology, Oklahoma State University, Stillwater, OK 74078, USA

\*Corresponding author: mileva.radonjic@okstate.edu

## **Abstract**

Production rate in hydraulically fractured reservoirs is expected to decline with time linearly in log-log space, with a slope of  $-1/2$ . However, most hydraulically fractured reservoirs witness a faster decline especially after 2 to 5 years of production, indicating a loss of permeability. Several studies have tried to diagnose the predominant mechanism driving this loss, but the findings remain divergent between geo-mechanical stress dynamics or geochemical rock-fluid reactions. In this study, the cause of permeability decline is studied from the perspective of geochemical rock-fluid reactions. The main consideration for this approach is the pervasive nature of geochemical reactions, which allows its effect to reach even the smallest pores within the reservoir.

This study employs static batch reactor experiments using rock powders, field fracturing fluids and produced fluids, while deionized water is used as a control. Sample parameters are evaluated before and after reactions using X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS) and inductively coupled plasma mass spectroscopy (ICP-MS) techniques. The results are integrated to characterize the geochemical changes due to rock-fluid reactions. Experiments are subsequently modeled to understand the long-term trends of reactions and the potential reactions products as well as their impact on permeability of the formation.

Preliminary results show mineralogic and elemental transformations in rock powders reacted with both fracturing and produced fluids. Dissolution of pyrite and feldspar and increased illite composition are evident in both sets of experiments, while dissolution of carbonate minerals is more pronounced in fracturing fluids. Elemental concentrations in effluent also showed significant disparities from initial fluid compositions. Modeling corroborated the mineralogical and elemental changes observed from the laboratory evaluations.

This study provides insight on the impacts of adverse geochemical rock-fluid reactions on permeability losses in hydraulically fractured reservoirs. The increased illite composition tends to shift reservoir rock characteristics from brittle to ductile and thus facilitates the rapid permeability loss. This knowledge will therefore serve as input in fine-tuning fracturing fluid compositions to mitigate long term permeability losses.

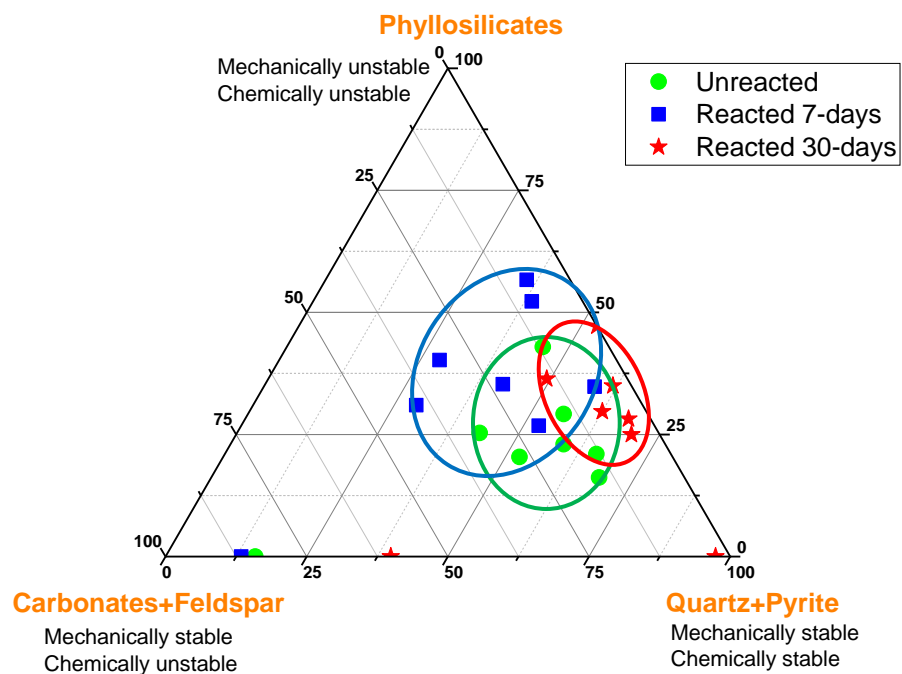


Figure 1: Comparison of unreacted samples of rock powder to 7 days and 30 days reacted samples using field fracturing fluids