GEOCHEMICAL AND GEOMECHANICAL RESPONSES OF CANEY SHALE TO FRACTURING FLUID COMPOSITIONS AT RESERVOIR CONDITIONS

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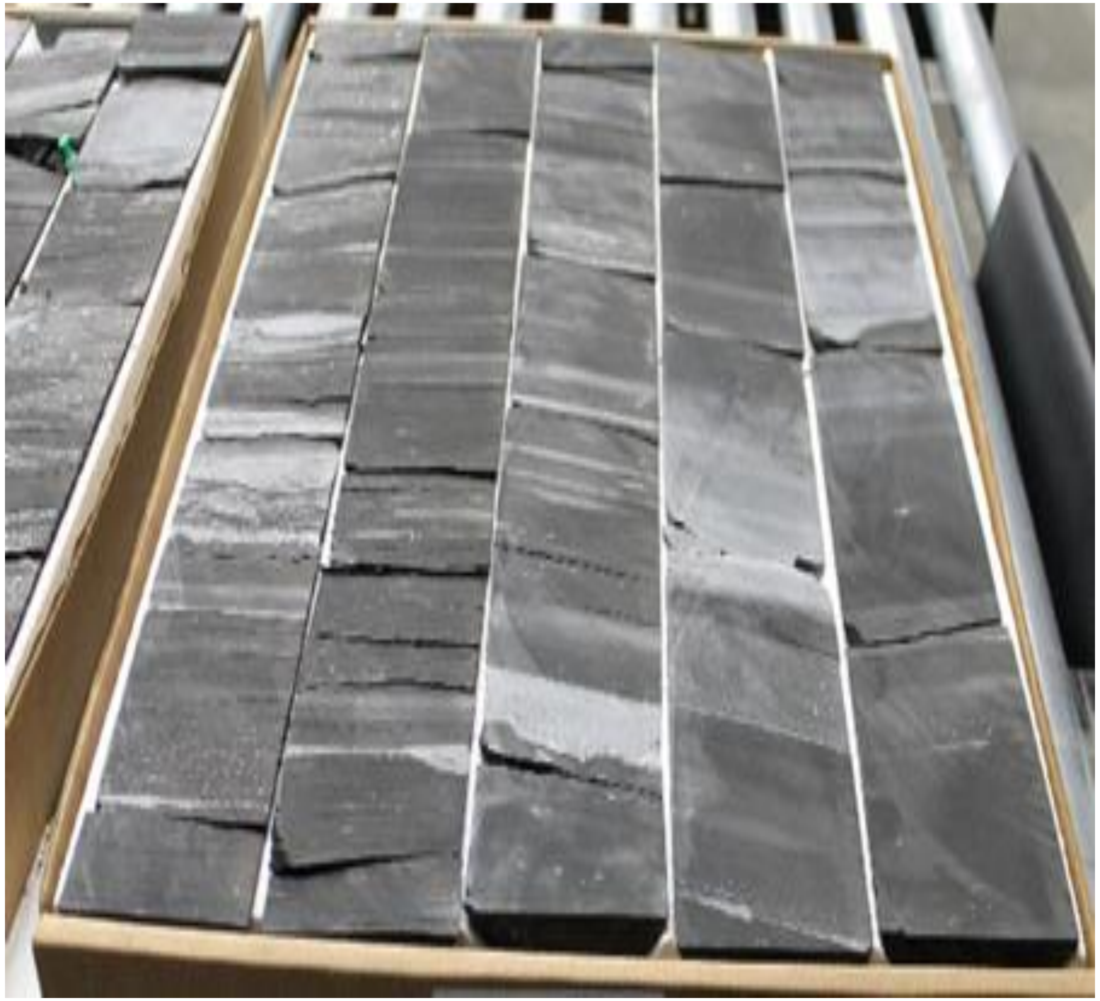
PRESENTATION OUTLINE

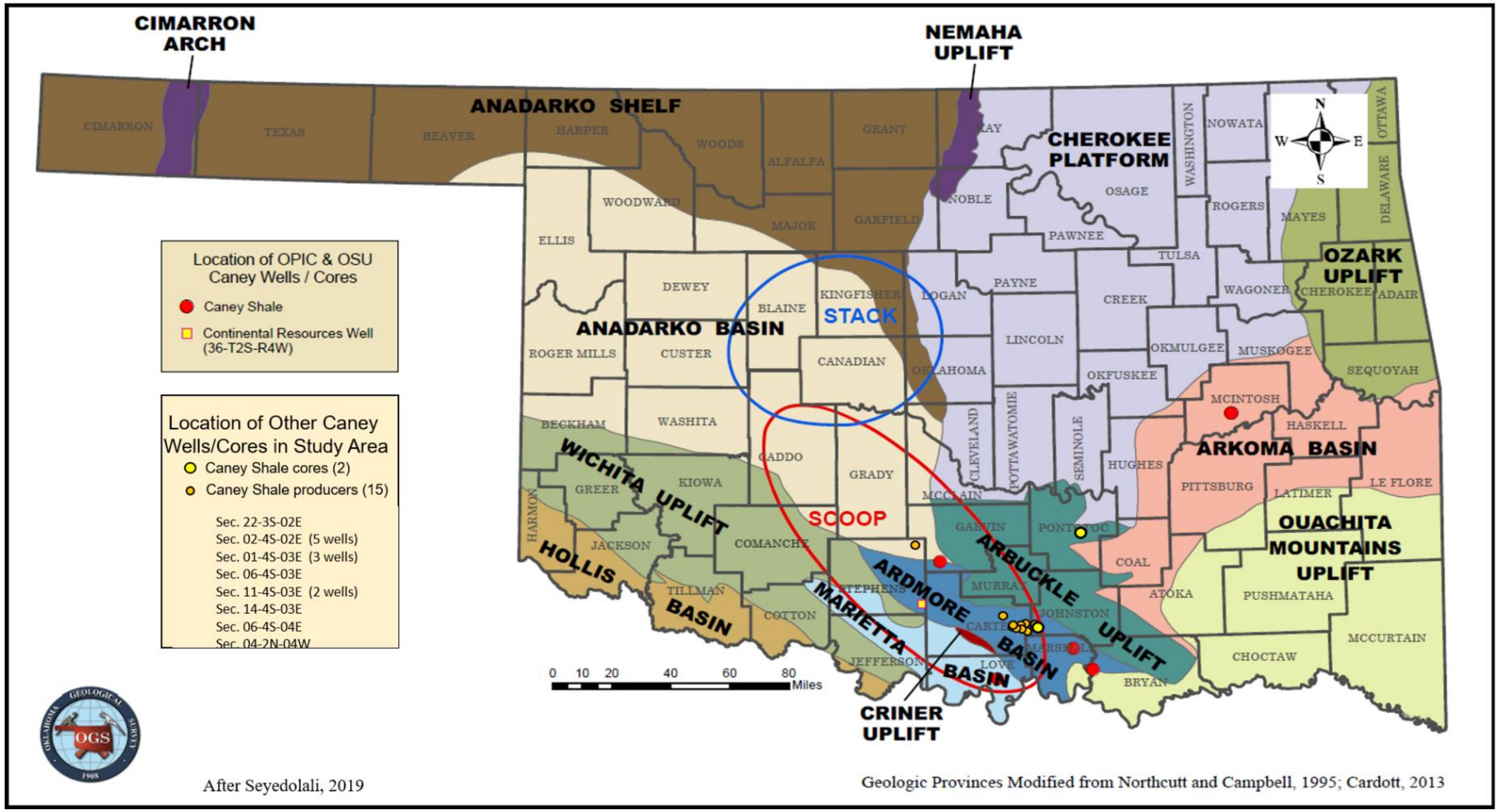
- ❑ Introduction
- ❑ Objectives
- ❑ Materials and Methodology
- ❑ Results
- ❑ Conclusions and Recommendations



Retrieved Core from Caney Shale on Display

INTRODUCTION

- The Caney shale is a promising unconventional reservoir in South-Central Oklahoma Oil Province (SCOOP)
- It overlies the more brittle Woodford Shale which has been the target of drilling over the years
- The Caney Shale has been found to contain substantial hydrocarbon deposits
- Historically, the Caney Shale has been considered a seal or source rock due to its high clay content

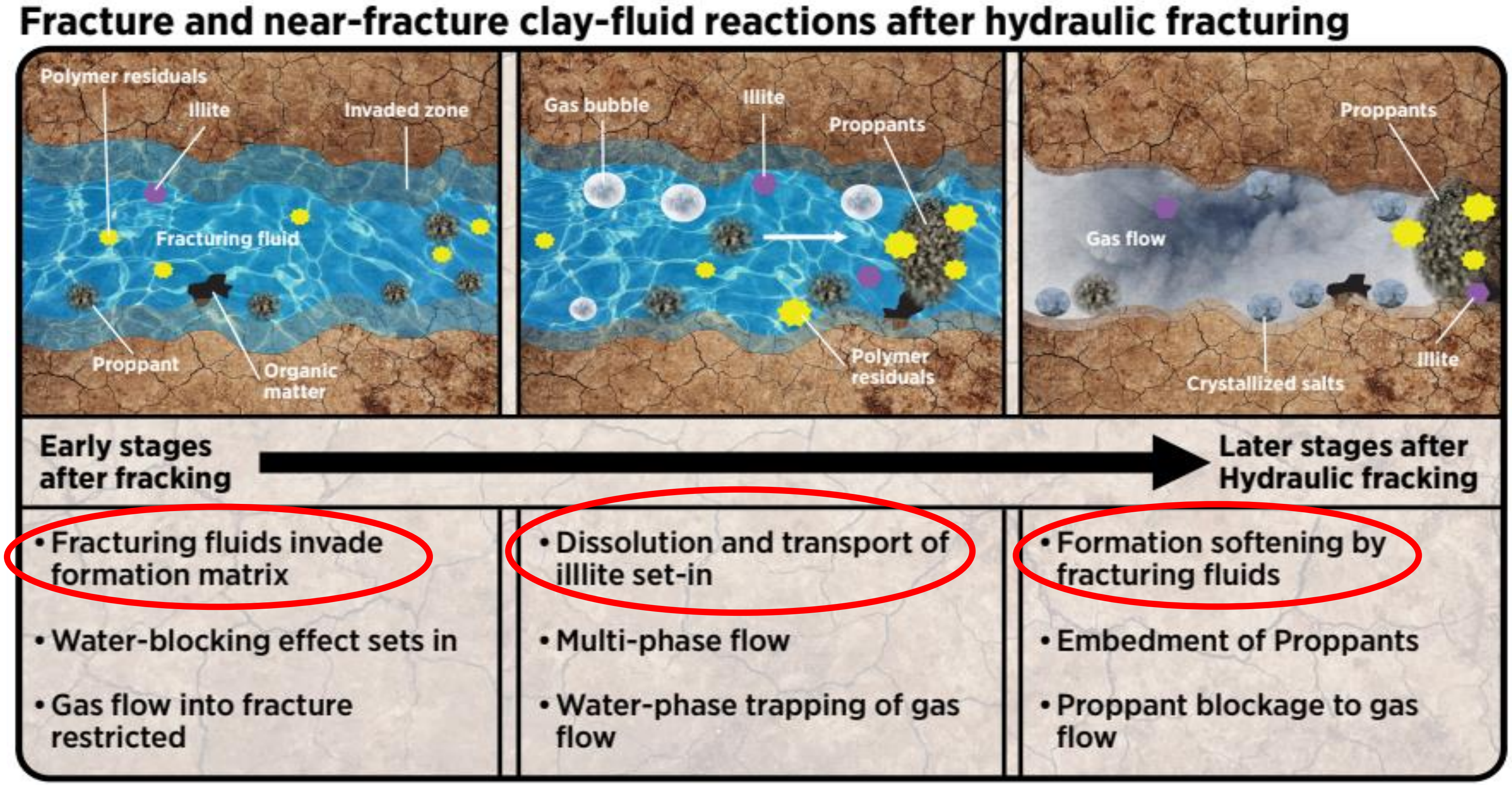


- Relatively less work has been done to fully characterize the geochemical and geomechanical responses of the formation to Hydraulic Fracturing Fluids (HFFs)

OBJECTIVES

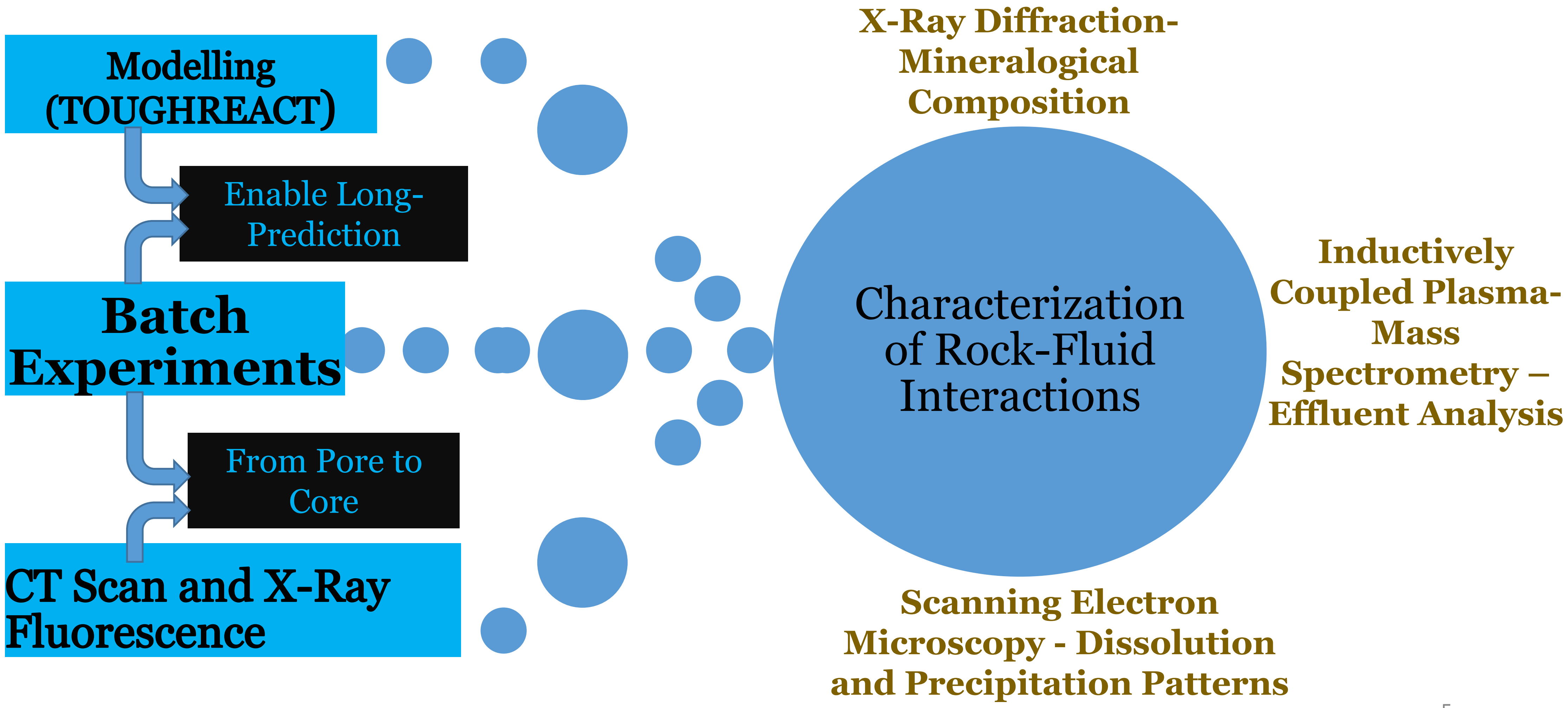
Investigate rock responses to HFFs. Key concerns are:

- Dissolution and precipitation of Minerals
- Clay swelling and Migration of fines
- Impact of these on reservoir petrophysical properties



MATERIALS AND METHODLOGY

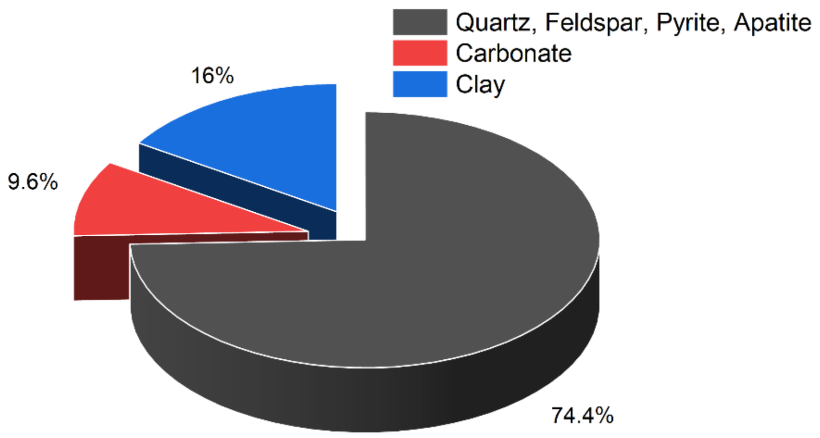
Experimental and Simulation Design



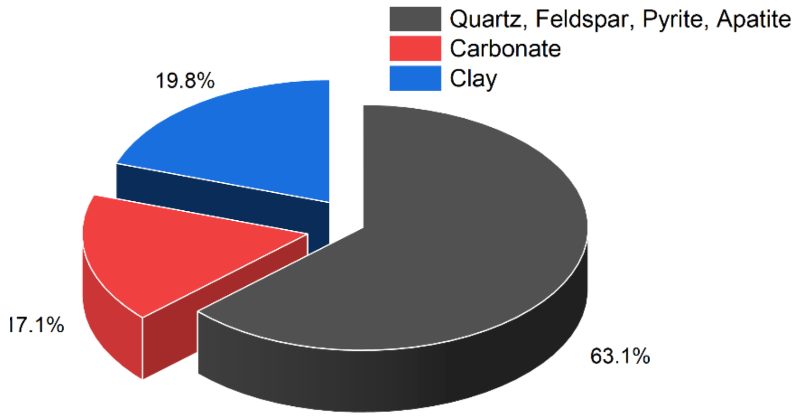
MATERIALS AND METHODLOGY

Fluid Samples and Rock Samples

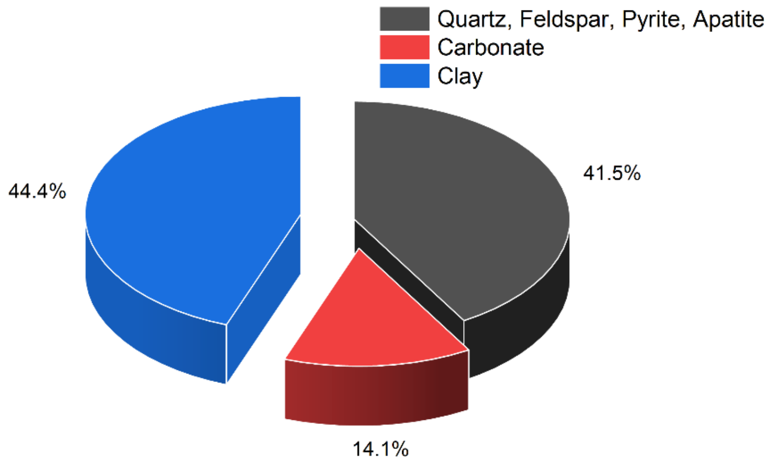
- Three Fluid Compositions: Deionized Water (Base, pH~7), 2% Potassium Chloride Solution (pH~4), and 0.5% Choline Chloride Solution (pH~4)
- Three rock samples selected at different depths: High Quartz (HQ), Moderate Quartz, Carbonate and Clay (MQ) and High Clay (HC)



Sample HQ



Sample MQ



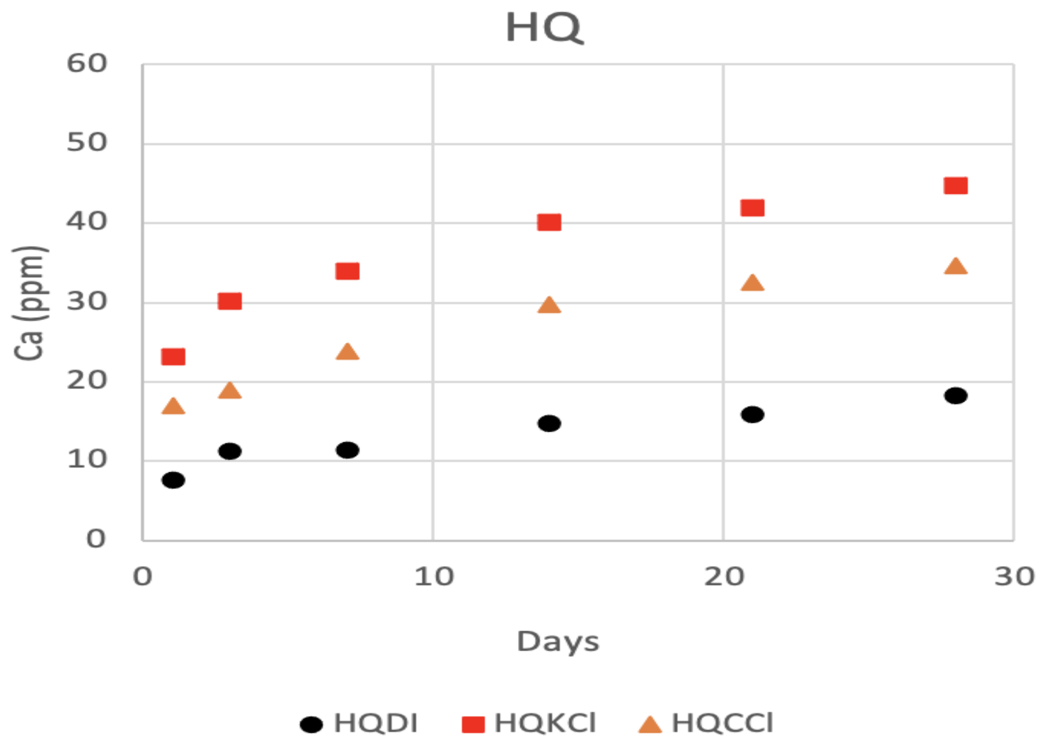
Sample HC

RESULTS

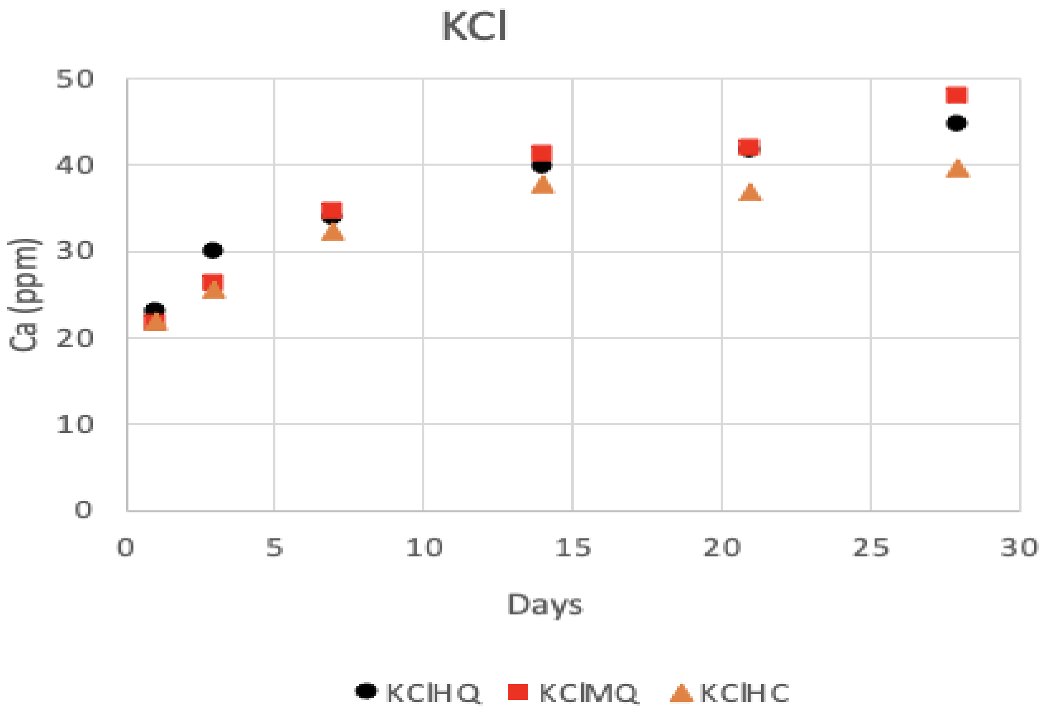
Which is the main driving force of geochemical reaction?

Fluid composition or Rock Composition?

Impact of Fluid Composition on elemental concentration in effluent

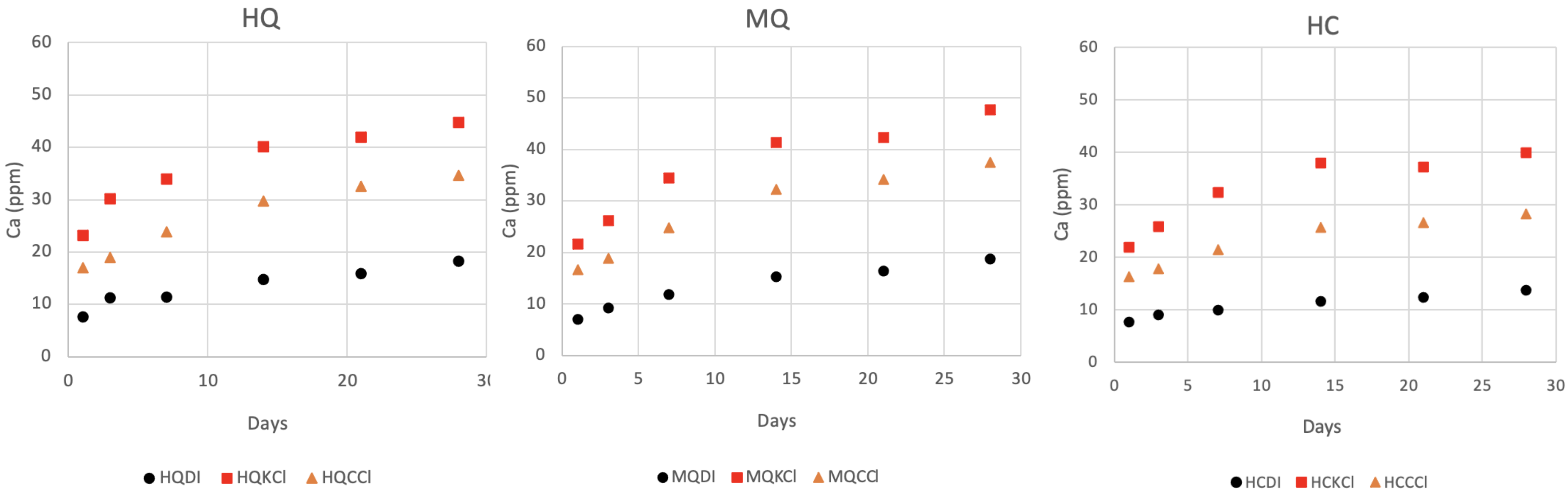


Impact of Rock Composition on Elemental Concentration in effluent



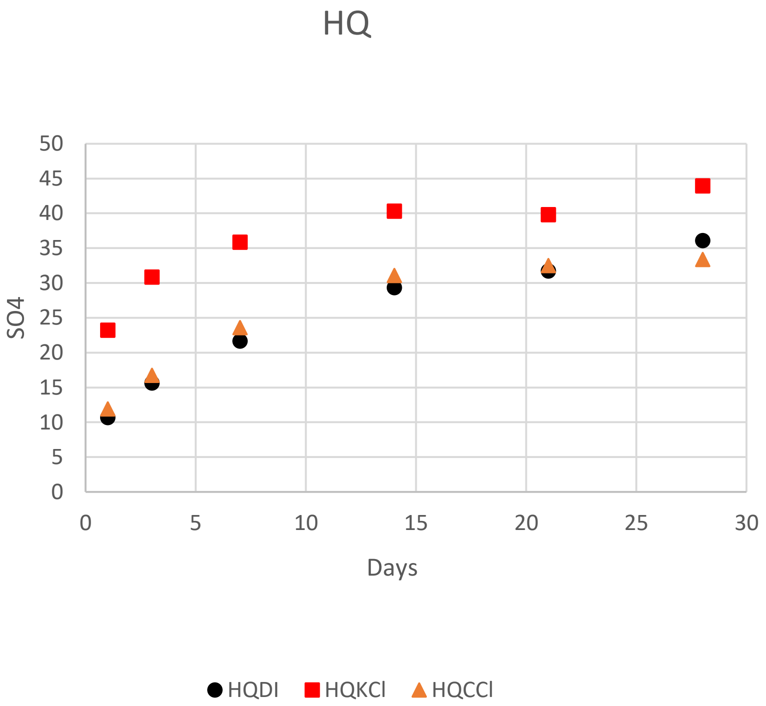
RESULTS

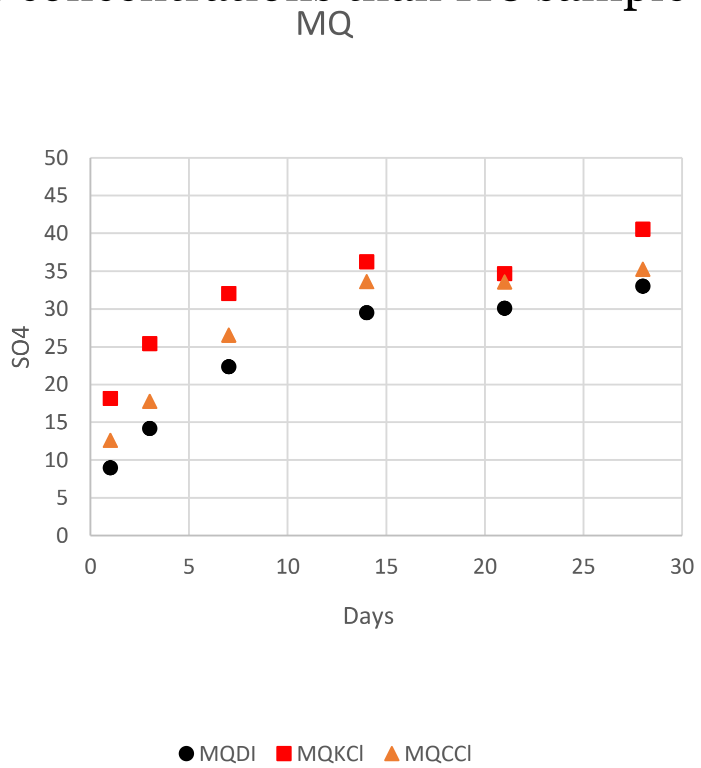
- Ca elemental concentration distinguishable for each fluid type
- Ca from Calcite and Dolomite Dissolution
- Potassium Chloride>Choline Chloride>Deionized water
- HQ and MQ samples have higher concentrations than HC sample

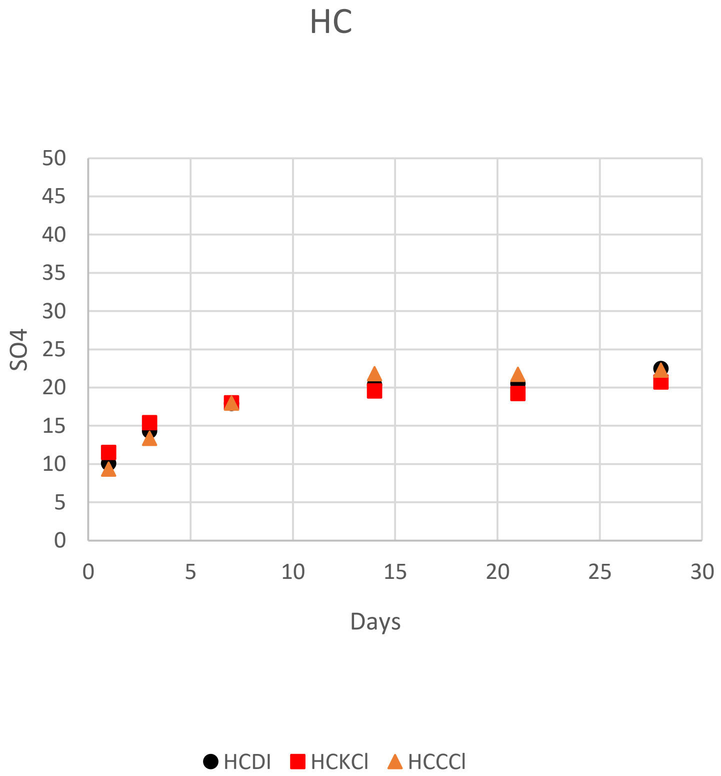


RESULTS

- SO4 elemental concentration distinguishable for each fluid type
- SO4 from Dissolution of Pyrite
- Potassium Chloride>Choline Chloride>Deionized water
- HQ and MQ samples have higher concentrations than HC sample

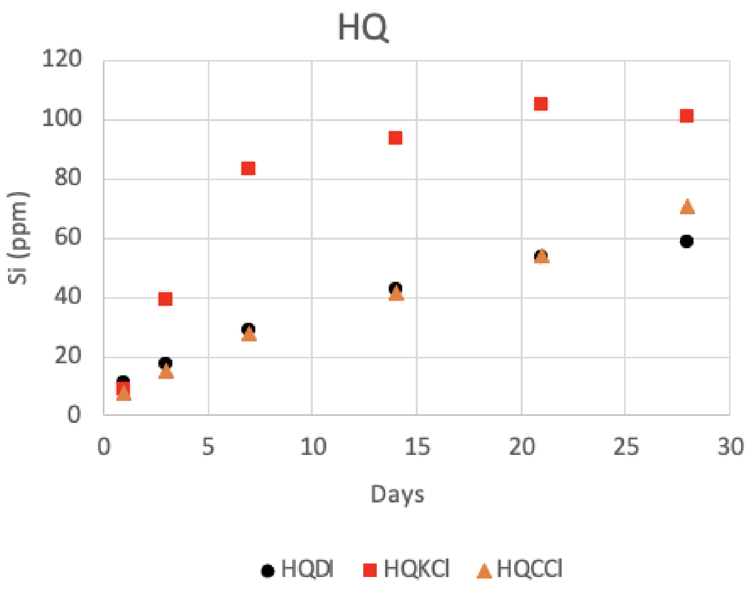


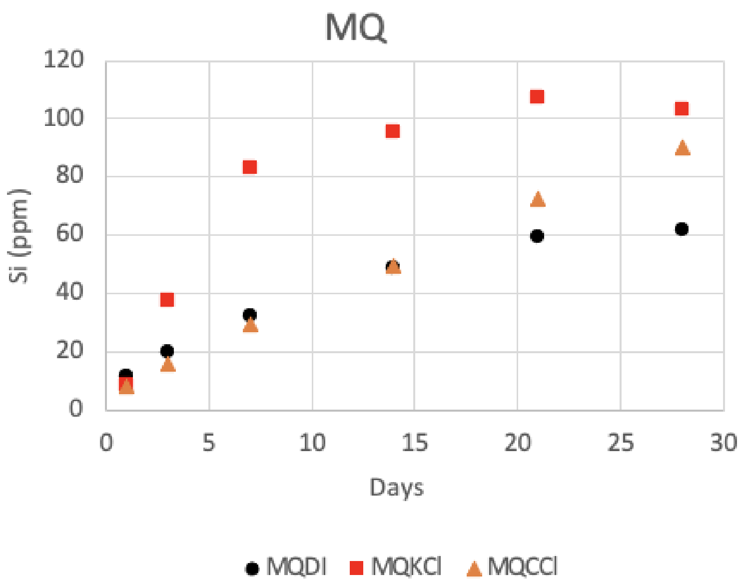


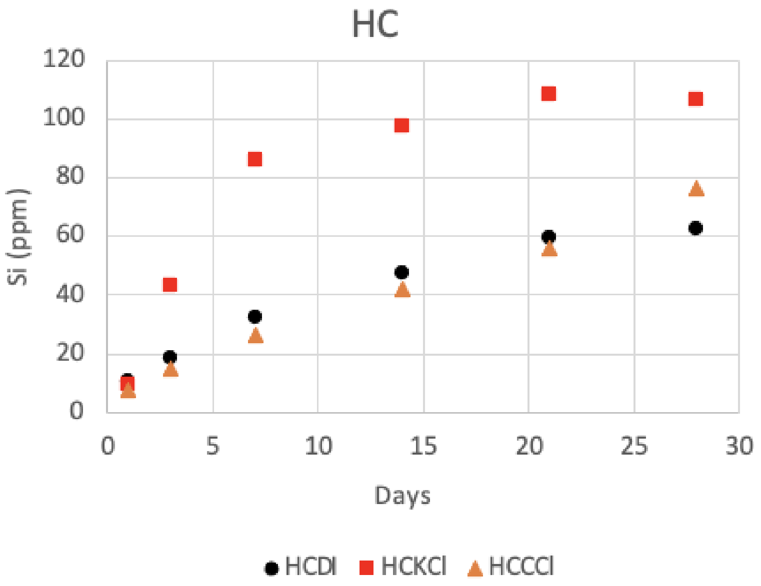


RESULTS

- Si elemental concentration for various fluids clearly distinguishable
- Si from Quartz and Clay minerals (Much from Clay Minerals)
- Potassium Chloride>Choline Chloride>Deionized Water
- Si ions most likely from the clay and feldspathic component of the rock





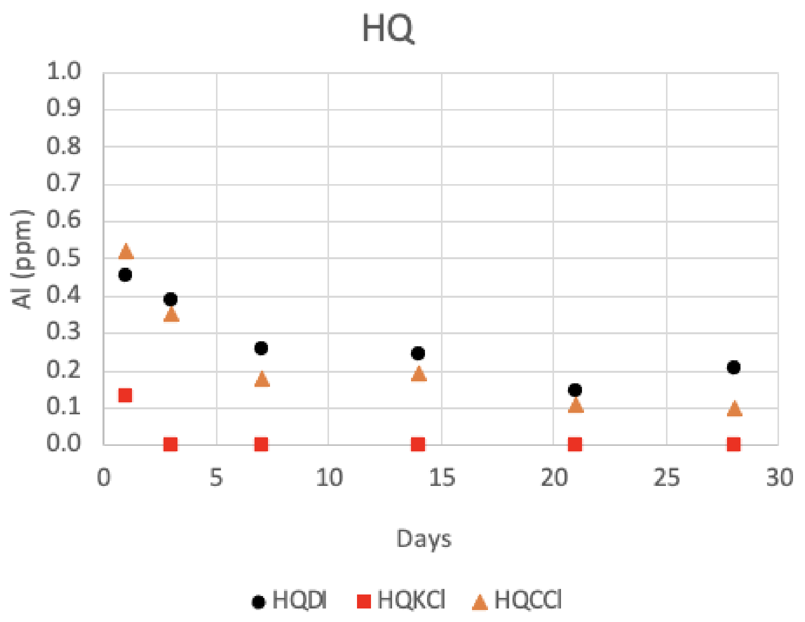


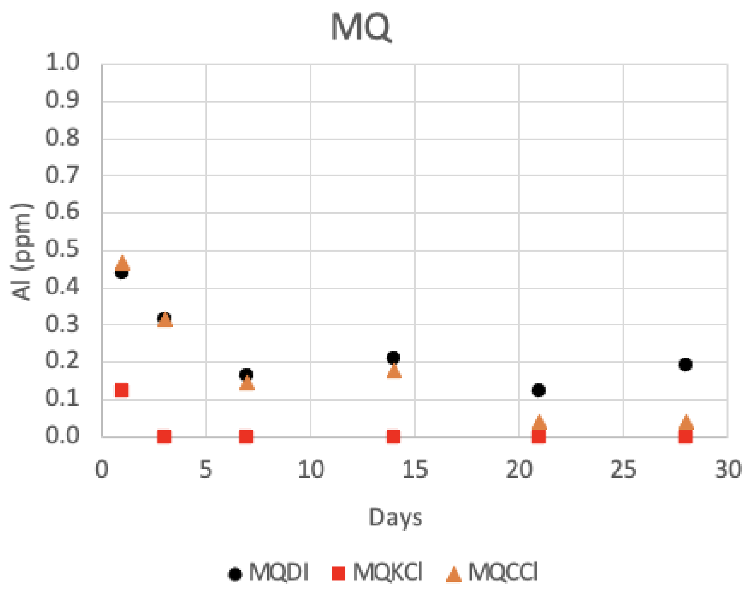
RESULTS

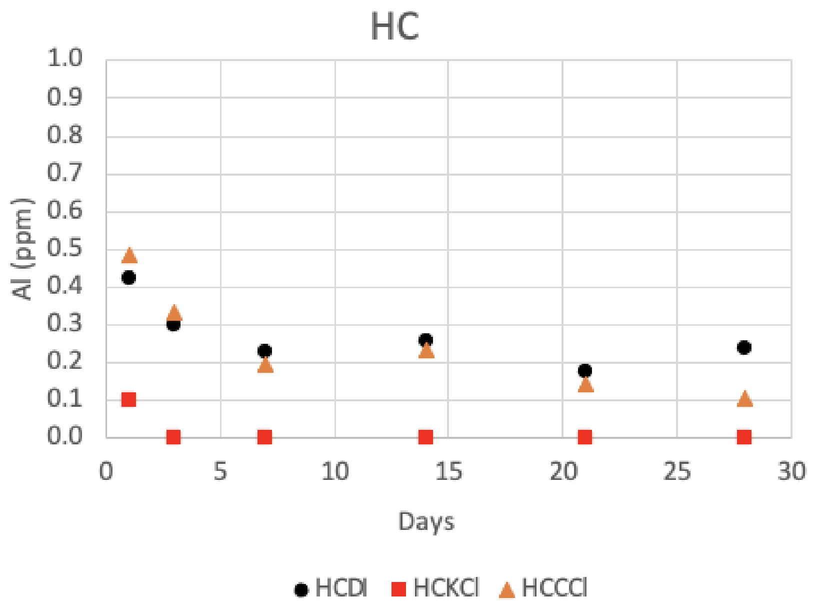
Al and Mg are the only elements to show sharp drop in elemental concentrations with time: Precipitation? Possible substitution?

- Aluminum elements in solution are from dissolution and cation exchange in clay minerals

- Magnesium elemental concentration is mainly from dissolution of dolomite, but clay dissolution and cation exchange in clays also contribute

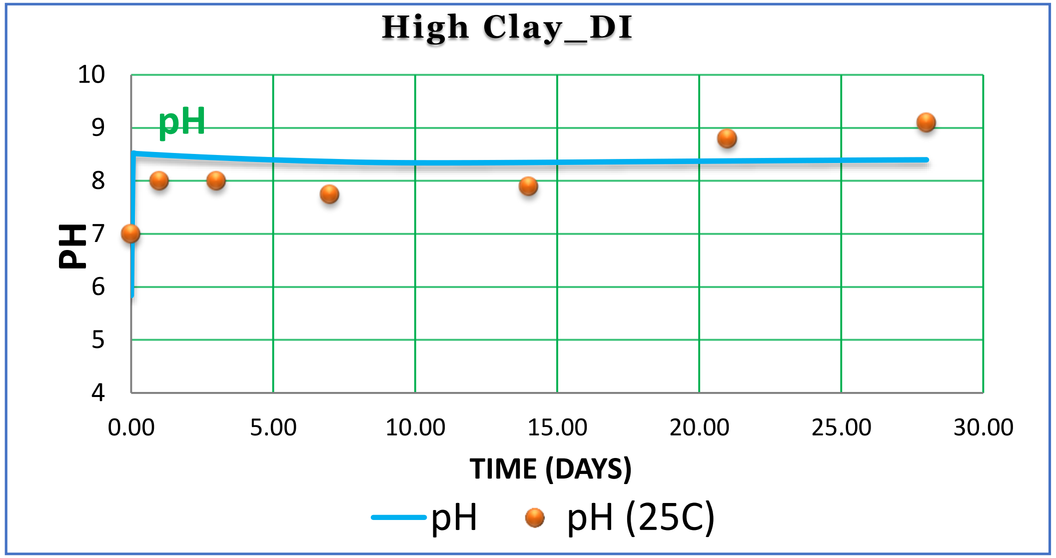


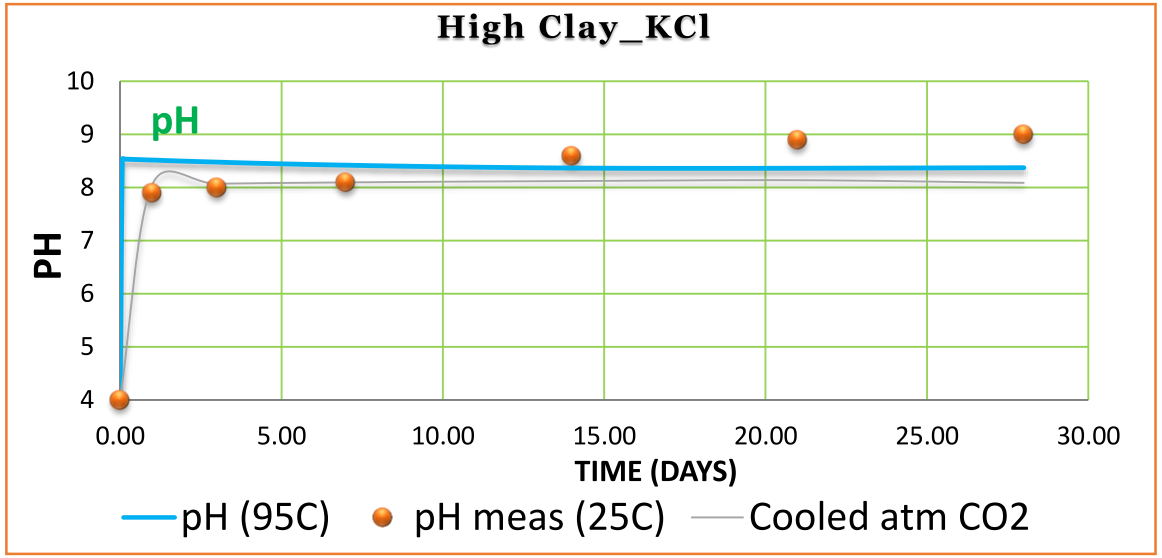


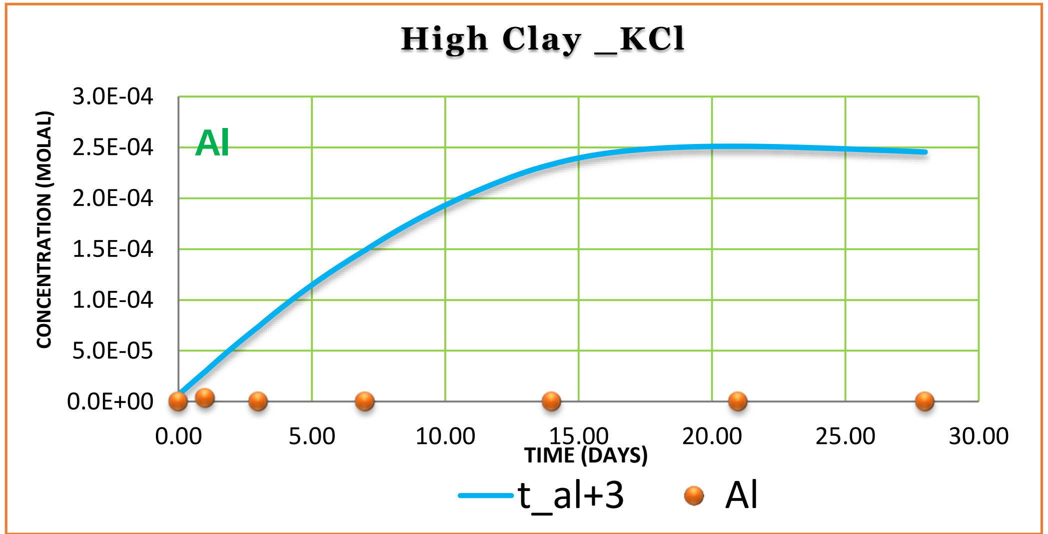


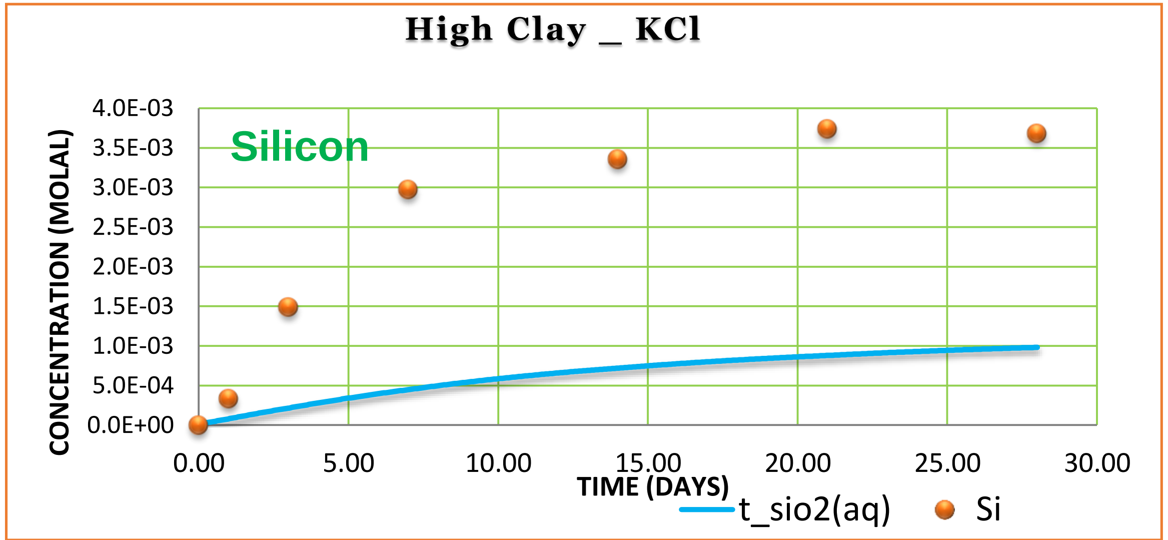
RESULTS

Except pH values, modelled values and experimental values showed significant disparities

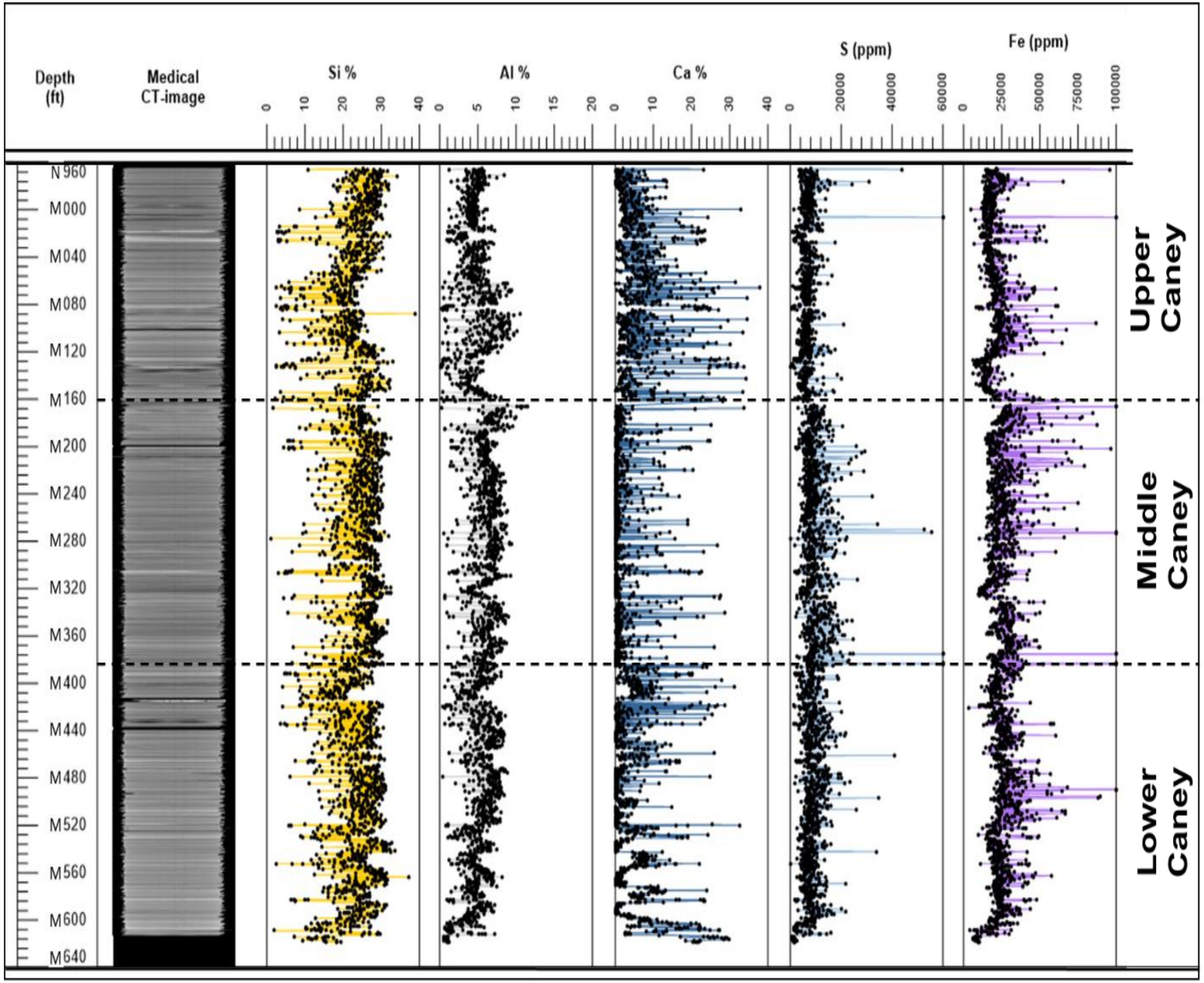








RESULTS



Three informal Divisions based on XRF results:

- Upper Caney shows decreased Si concentration through heavily bioturbated intervals and Al and Fe rich intervals (Clay and Carbonate Rich Zone)
- For the middle Caney, Al and Si concentrations remain consistent whilst Ca is low (Quartz-rich shale zone)
- In the lower Caney, sharp increase in Ca is observed whilst Al and Si constant (Carbonate zone followed by High Quartz Shale)

CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

- Dissolution and precipitation of minerals during rock-hydraulic fracturing fluid interaction are largely the function of fluid composition
- Carbonates and Clays are more susceptible to geochemical reactions whilst Quartz is relatively unaffected by reactions
- Increasing clay composition of samples adversely impact the dissolution of quartz and carbonate minerals
- KCl and CCl stabilized clay minerals and promotes dissolution of quartz and carbonates
- KCl effected greater stabilization of clay minerals thus leaving initially leached elements in solution, therefore higher concentrations
- Greater stabilizing effect of potassium chloride may be explained by the greater ability of potassium cations to exchange for cations in clay interlayers and locking of the interlayers from further interaction with surrounding fluids

Recommendations:

- Working on improving geochemical and physical characterization of the rocks and fluid samples for modelling in our next work
- Further work will be conducted to explain trends of Al and Mg elemental concentrations: Precipitation? or substitution?
- Longer periods for experiments to determine the time limits of KCl and CCl effectiveness in preventing adverse clay-fluid reactions especially considering pH values continued increasing throughout the experiment

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