

## **Salt Presence and Petrophysical Properties Analysis in Reconsolidated Mudrocks**

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### **ABSTRACT**

Operators producing gas from organic matter rich mudstone formations have observed that flowback water after hydraulic fracture stimulation is much more saline than the injected fracture fluid. Based on a study in the Marcellus Shale (Blauch et al., 2009), several hypotheses have been put forward to explain this behavior, including: primary dissolution of allochthonous salt, encroachment of basinal brine, and mobilization of hypersaline connate fluid. The presence of salt in shale pores is not commonly reported, although salt healed fractures are cited in the literature. One possible explanation for the paucity of reports documenting pore filling salt in shale reservoirs may be the lack of salt preservation procedures during coring and core handling operations.

The objectives of this research are to identify and quantify the presence and distribution of salt in a reconsolidated mudrock. Fundamental to this is to understand the evolution of pore fluid salinity during resedimentation experiments, where we have developed sample handling protocols for salt preservation. These observation and methods developed in resedimented material may be used to guide analysis of subsurface sample material. The impact of precipitated salt minerals on porosity, permeability, and electrical properties are also measured. The reconsolidation process allows us to produce a mudrock in the laboratory under controlled conditions that will favor salt precipitation. As a baseline for understanding, core handling, salt presence, salt distribution, and fluid rock interactions, a series of reconsolidation experiments have been performed (Germaine, A.V., 2009) in which mudrocks of known starting mineralogy, particle size distribution and saturating brine salinity have been made in the laboratory. Three different starting mineralogies and three different high salinity brines (nine possible scenarios) are used to make the starting slurries. The slurries are compressed in oedometer cells using a stress step and hold protocol (Dudley, et.al., 1994). Conductivity changes of the expelled brine are measured during the resedimentation experiment. Samples are allowed to equilibrate with axial loads up to 4000 psi. Samples of expelled brine will be collected at each pressure step and analyzed via Inductively Coupled Plasma (ICP) in order to monitor changes in brine composition resulting from exchange with clay minerals, and to assess the contribution of bound water to the expelled fluid.

Post-consolidation NMR and dielectric (saturated and dried) measurements will be made and the samples dried in a vacuum oven. Once dried, the samples are prepared for imaging in the SEM and in thin section. SEM imaging will be performed on fresh and ion milled surfaces of rock material. Additionally, pre- and post-test X-ray Diffraction (XRD) and X-ray Fluorescence (XRF) measurements are made. Imaging results from resedimented samples created to ensure the precipitation of salt in mudrock pore systems will guide analysis and handling of preserved subsurface samples of shale reservoirs where high salinity flow back waters have been observed.