Regional-Scale Characterization of the Arbuckle Group's Depositional History and Cap Rock Facies Variations and Their Role on Arbuckle Reservoir Characteristics and Saltwater Injection (Part 1 & 2)

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ABSTRACT

(Part 1) The carbonates of the Arbuckle Group were deposited in the Mid-Continent from shallow Cambrian and Early Ordovician seas. In places, the Arbuckle Group was deposited as a fill amongst strongly eroded Precambrian geomorphic features. Deposition of a cap rock facies on the top of the Arbuckle Group consists of six primary types: porous sand (porosity >= 6%), tight sand (porosity <= 6%), shaley sand, shale, multi-storied porous sand/shale sequences, and multi-storied tight lime/tight sand/shale sequences.

During the Post-Hunton (Acadian) uplift, the Arbuckle Group was uplifted with most or all of the overlying strata removed by erosion in north-central, central and northeastern Oklahoma. This uplift and erosion created over-pressure within the Arbuckle Group relative to depth. Gases and fluids most likely escaped either into the atmosphere where the Arbuckle was exposed or through permeable sand cap facies directly overlying the Arbuckle. The Arbuckle Group was subjected to additional intervals of reburial, uplift and erosion of overlying sediments, and reburial during the Late Devonian through Early Permian Periods. Late stage dolomitization most likely occurred during Late Pennsylvanian with subsequent re-compaction of Arbuckle Group Strata.

(Part 2) Reservoir properties have not been well documented within the literature for the Arbuckle Group. However, increased attention has been directed towards the Arbuckle due to its importance as a reservoir for saltwater disposal and the apparent relationship between saltwater injection and seismic activity. The location of these seismic events is concentrated in north-central and central Oklahoma. Of interest is the relationship between seismic activity and cap facies of the Arbuckle Group in areas of Arbuckle saltwater injection. Generally, in those areas where the cap rock facies is porous, seismic activity is at a minimum and in those areas where the cap facies is impermeable, seismic activity has frequently occurred. This relationship may be the result of fluid saturations within the Arbuckle Group dramatically changing from pressure changes and fluid loss during the Post-Hunton uplift. Additionally, pressure gradients calculated from the final shut-in pressures of 266 drill stem tests of the Arbuckle suggests lower pressure gradients in those areas with a permeable cap facies and higher pressure gradients in those areas of impermeable cap facies. However, the overall average pressure gradient is less than the average pressure gradient for other formations, which suggests an under-pressured characteristic for the Arbuckle Group.