Fluid Evolution in Cambrian-Ordovician Knox Group Reservoirs

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Archived formation water chemistry data (n~ 930) from Precambrian to Pennsylvanian rocks in the Appalachian and Illinois Basins of Kentucky were used to reconstruct basin hydrostatigraphy. The analysis shows that deeper Cambrian-Ordovician waters in the Knox Group were sometimes significantly less saline than what would be predicted by salinity trends in shallower Silurian and younger reservoirs. The contrast in salinity trends between younger and older reservoirs suggests the presence of an aerially extensive confining unit in Upper Ordovician strata that separates fluid populations possibly at the basin scale. Less saline waters in the Knox also suggest mixing with meteoric waters. The critical question, especially in deeper parts of the basins, is, are these relatively "young" meteoric waters that infiltrated along structural highs or "old" meteoric waters that penetrated exposure surfaces during or shortly after Knox deposition? The distinction is also important because the Knox is being evaluated as a possible carbon sequestration reservoir at depths of -2,500 ft (reference to sea level, SL) and deeper.

Recent measurements in two wells away from structural highs illustrate efforts to characterize the evolution of deeper Knox formation water chemistry. The KGS-Blan #1, located in Hancock County, Kentucky approximately 115 miles west of the Cincinnati arch crest, sampled waters from two Knox zones at -3,165 to -3,189 and -4,485 to -4,505 ft (SL) in the Beekmantown Dolomite and Gunter Sandstone, respectively. Salinities equaled 56,775 and 97,192 mg/L, respectively, and, were less than would be predicted for this depth relative to the shallower Paleozoic salinity trends. Farther south in the Planet Energy-West #1 in Hickman County, Tennessee, Knox waters sampled from the Chepultepec Dolomite at –1,569 to -2,299 ft (SL) contained 452 mg/L total dissolved solids. The low salinities are notable given the depth and location 60 miles west-southwest of the center of the Nashville Dome. In the absence of bedded salts, dilution and evaporation proportionately influence the concentration of chloride (Cl) and bromide (Br). Their respective concentrations in the West well (Cl= 88 mg/L, Br= 0.3 mg/L) suggest that marine waters were diluted with meteoric water, whereas those for the Beekmantown (Cl= 41,300 mg/L; Br= 174 mg/L) and Gunter (Cl= 60,700 mg/L; Br= 293 mg/L) in the Blan well suggest evaporated marine waters. Notwithstanding the apparent different water evolution histories in the two wells, a meteoric influence in both is suggested by the delta18O and deltaD measurements. Values for the West (delta18O= -6.35 per mil, deltaD= -38.3 per mil) and Blan (delta18O= -5.1 to -5.5 per mil, deltaD= -40 to -41.5 per mil) wells are close to the meteoric water line. The next important step in our investigation is to address the "young"

versus “old” question, by estimating the age of Knox waters in the West well using tritium and chlorine-36 isotope analyses.