Measured Water Saturations in Mudstones: Preliminary Evidence for the Introduction of Water Through Drilling and Completion Practices

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Gas-in-place (GIP) models play a critical role in the assessment and valuation of unconventional reservoirs. Integral to these models is an accurate quantification of hydrocarbon and water saturations within pores. Standard Gas Research Institute (GRI)-based shale core analysis involves determination of the in-situ fluid saturations by measuring the amount of fluids extracted from the sample. Reported core water saturations for the Marcellus Shale in highly productive areas average approximately 30% of the pore volume. However, calculations of cation exchange capacity demonstrate that the clays in the reservoir are under-saturated with respect to water, indicating the clays would absorb water. It is commonly observed that the full load of water pumped during completions is rarely captured during the flow back, suggesting its possible uptake by the formation. In order to understand the nature of water/rock interactions in the Marcellus Shale, several field and lab experiments were carried out on fluids to analyze for oxygen and deuterium isotopes. When these data points are plotted on $\delta 18O$ and $\delta 2H$ plot, they follow an evaporation trend that originates at the isotopic signature of the surface waters used in the drilling mud and completion fluids. These observations would suggest that some portion of the water extracted during GRI shale core analysis is an artifact of the drilling process and not in situ, yielding an underestimation of gas-filled porosity and resultant calculated GIP.