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Produced Water Lithium Enrichment Mechanisms within the Utica Shale and Point Pleasant Formation, Appalachian Basin, USA

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To meet predicted 2050 energy storage demands, non-traditional sources of lithium (Li) may be necessary to achieve an approximate 500% increase in supply. Oil- and gas-produced water, wastewater generated during hydrocarbon production, are brines that can contain total dissolved solids concentrations up to 350,000 mg/L (10´ greater than seawater) and Li concentrations >100 mg/L. U.S. sedimentary basins with highest known produced water Li concentrations include the Gulf Coast, Appalachian, and Williston Basins. Appalachian Basin brines from the Devonian Marcellus Shale and the Ordovician Utica Shale and Point Pleasant Formation (UPP) are candidates for potential Li resource recovery (Li > 80 mg/L). Knowledge gaps exist related to geologic mechanisms for lithium enrichment in Appalachian Basin and UPP produced water. Identifying distinct UPP isotopic compositions could aid in the evaluation of Li extraction potential beyond elemental composition studies. In this study, we measured the major element geochemistry and isotopic compositions (δ^{7}Li, δ^{11}B, δ^{138}Ba) from produced water and core samples of the UPP. Our results suggest that there are depth-dependent thermal maturity and water-rock controls (i.e., clay mineral diagenesis) on Li concentrations in the UPP brines. For instance, produced water Li concentrations from the UPP are most enriched where the Mg/Li molar ratios, δ^{7}Li, and δ^{11}B are relatively low where depth, temperature, and calculated gas-oil-ratio are relatively high. Variation in Li concentrations in UPP brines emphasizes that basin-specific Li source and enrichment studies may be necessary to inform potential Li resource recovery from unconventional sources such as produced water.