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The flowback and produced water of shale gas from China: characteristics and distinguishing

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With increasing shale gas extraction through hydraulic fracturing and horizontal drilling in China, due to its high levels of metals and other contaminants, diposal of wastewater from flowback and produced water (FP water) that is coextracted with shale gas has been a major challenge in central China. Hence, increasing production of shale gas with minimal environmental effects requires adequate knowledge of the FP water. Here we investigate systematically the chemical and isotopic characteristics of FP water from the shale gas of Upper Ordovician Wufeng-Lower Silurian Longmaxi formations in the Sichuan Basin and surrounding areas, demonstrate the distribution characteristics of associated resources in FP water, and distinguish any pollution to water environment.

Great achievements of shale gas development have been made in Sichuan Basin and its surrounding areas. The FP water is characterized by high levels of organic compounds, salts (chloride, bromide, etc.), metals (lithium, sodium, etc.), and naturally occurring radioactive elements (^{226}Ra, etc.). The chloride is mostly 20000~25000 mg/L in the Changning and Fuling shale gas fields, around 10000 mg/L in Weiyuan shale gas field and reached 28000 mg/L in Guizhou province, which is systematically lower than that in the Marcellus shale (averagely ~70000 mg/L). The lithium is typically 20~30 mg/L in most FP water, and it reached 59 mg/L in the Weiyuan shale gas field, which is above the industrial comprehensive utilization standard (13.1 mg/L) and reached the standard for separate mining (24.6 mg/L). The FP water has relatively very high $^{87}Sr/^{86}Sr$ (averagely 0.719) ratios, combined with the elemental geochemistry, the FP water can be easily distinguished from other fluids. In the Changning shale gas field, according to the strontium isotopic ratios, it demonstrates that the relatively high level of TDS in shallow underground water is due to the contamination from Permin/Triassic formation water. In the Fuling shale gas field, treatment of the FP water results in ~40% reduction of the salts and selective (80–90 %) removal of some of the inorganic contaminants. This study provides a geochemical framework for characterization of FP water, and thus the ability to reuse or distinguish between different sources of water.