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Origin of saline springs in Tajikistan: evidence from hydrochemical and isotopic characteristics

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During the evolution of the ancient Neo-Tethys Ocean, a series of Meso-Cenozoic salt basins were formed, stretching from Central Asia to Tarim in northwestern China. These salt basins, including the greater Central Asia Salt Basin, Shache salt subbasin, and Kuqa salt subbasin, share a common tectonic evolution and sedimentary background dating back to the Jurassic period. The Central Asia Salt Basin (CASB) is a vast marine salt basin that spans across Uzbekistan, Turkmenistan, Tajikistan, and Afghanistan. It originated from the Jurassic to Early Cretaceous periods and contains world-class giant marine potash deposits. Estimated potash reserves (calculated in terms of K_2O) in the Central Asia salt basins range from approximately 3.9 to 5.4 billion tons. The potassium salt deposits in this region are believed to have formed primarily within the Gaurdak Formation during the late Jurassic period. Tajikistan has two giant Jurassic salt diapirs that protrude close to the surface. In these salt diapiric regions, a few exposed salt springs exist, which are utilized by local residents to produce raw salt through salt pans. To investigate the origin and industrial potential of these salt springs, a comprehensive analysis of the elements and isotopes found in the brine of these springs was conducted. Among the 6 brine samples studied, 3 of them (from 37.4mg/L to 52.7 mg/L, with an average of 44.8 mg/L) have lithium content reaching industrial utility levels (24.7mg/L). The potassium chloride content in all samples (ranging from 0.45% to 3.8%, with an average of 3.02%) is close to or exceeds the minimum industrial utilization standard (0.5%). The results of the analysis indicate that the brine originates from the dissolution of groundwater into the salt mine. Deep brine recharge is facilitated by deep faults, leading to elevated lithium content in some salt spring waters. This research sheds light on the geological processes that have shaped the formation of these salt basins and provides insights into the industrial potential of the salt springs in Tajikistan.