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Geologic and structural controls on river Sr and U isotopes in central Texas

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The hydrogeology of central Texas includes complex interaction between surface water and hydraulically connected aquifer systems. Previous studies have estimated that in Hill Country of central Texas, baseflows from connected aquifers have contributed to more than 30% of stream flow while the rest is from runoff generated from rain falls. In addition, river water chemistry is influenced by climatic, geologic and land use factors. In central Texas rock units such as limestone and shale trend NE-SW, perpendicular to the flow of major rivers. These rivers also cross important geologic structures, including the Llano uplift (granitic basement) and the Balcones fault zone. Studies have shown the important controls of Balcones fault zone on both the distribution of fractured aquifer system and the quality of groundwater in this region. Our study focused on understanding the potential influences of geology on water flow paths and river chemistry at both local and regional scales. This study aimed to detect changes in river chemistry due to rock lithology and geologic structures: 1) we seek to identify changes in major element concentrations from rivers that cross these structures; 2) we utilize U and Sr isotope ratios to trace the contribution of baseflows from groundwater aquifers and springs into rivers and to illustrate how underlying geology affects river water chemistry in mid-size (10s-100s km spatial scale) river systems. Our study shows that in this region, rivers traversing through Paleozoic-Mesozoic carbonate rocks exhibit elevated electrical conductivity (EC) and bicarbonate (HCO3) concentrations due to chemical weathering processes, while those flowing over Proterozoic crystalline rocks demonstrate lower EC levels. This study also reveals significant trends in strontium and uranium isotopic ratios, providing insights into water-rock interactions and potential groundwater influences in the BFZ and the Llano Uplift. These insights advance our understanding and knowledge of the hydrogeological processes and implications for water resource management, groundwater sustainability, and contamination mitigation efforts in central Texas.