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Spatial and Temporal Changes in Geochemistry at Spring Sites near Breccia Pipe Uranium Deposits of Grand Canyon Region, AZ

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Characterization of spatial and temporal chemical variability in groundwater of the area of breccia pipe uranium mining withdrawal around the Grand Canyon is necessary to understand potential changes related to mining activity and climatic variation. Two springs in perched aquifers north of Grand Canyon (Pigeon and Willow) and two springs in the deeper regional aquifer south of Grand Canyon (Horn and Salt Creek) that are located near known mineralized breccia pipe deposits have been monitored for chemical variation for almost a decade. Perched springs from this study show higher chemical variability compared with the regional springs. Lowest uranium concentration at Pigeon Spring (56 µg/L) during this study was associated with the highest tritium value (5.4 pCi/L), which indicates periodic pulses of modern water moving through the perched groundwater system to this spring. Regional groundwater in the Horn Creek drainage is located downgradient from the Orphan Mine, which is a former uranium and copper mine in the process of reclamation. Groundwater emerging from regional aquifer springs at the highest location in the east fork of the Horn Creek drainage has the highest uranium concentration (257 µg/L) found in groundwater in the Grand Canyon and low tritium (0.9 pCi/L). Groundwater discharging from alluvial material at a lower elevation in the Horn Creek drainage has lower uranium concentration (23 µg/L) as well as higher tritium values (2.6 pCi/L). Salt Creek drainage is located to the west of Horn Creek and has similar chemistry to groundwater in Horn Creek. Groundwater chemistry in Horn and Salt Creek is anomalous compared to other groundwater discharging from the regional aquifer to Grand Canyon and the source of the anomalous chemistry is not well understood. In this complex hydrologic region, spatial and temporal variability need to be assessed prior, during, and following mining activity to understand natural and anthropogenic changes to the system. These measurements are especially needed during a period of changing climate, where changes along the groundwater flow paths may take years to decades to manifest at the spring outlet.