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Utilizing isotopes and community-based research to investigate sources of groundwater uranium contamination in a mining-affected Northeastern Arizona community

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In Northeastern Arizona, community concerns about water quality are linked to a 1979 uranium mine tailings pond-dam collapse that released radioactive effluent into a river system upstream of many communities, several of which are Indigenous. On top of this acute exposure to uranium, the region experienced chronic exposures resulting from continuous discharges of mine waste into the river up until 1986. In addition to mining-related contamination, the region's multi-layered aquifer system contains naturally occurring uranium and arsenic, allowing for potential geogenic contamination of groundwater. Previous research in one community located on the border between Navajo Nation and Northeastern Arizona revealed uranium contamination in groundwater, but was inconclusive as to exact sources of contamination. Concerns remain for many community stakeholders, who rely on groundwater for household purposes and livestock ranching. Ongoing mixed-methods research combines a geochemical investigation into contamination sources with community-based participatory research focused on the local water experience and stakeholder priorities. So far, 27 water sources have been sampled: 26 from groundwater and one from surface water. Samples were analyzed for general water chemistry, trace metals, stable water isotopes (O, H, S, Sr) and radionuclides (U-234, U-235, U-238, Ra-226, Ra-228). Trilinear diagrams display a heterogeneity of groundwater types in two different bedrock aquifers and the alluvial aquifer below the river. Isotopic data indicate the possibility of both natural and anthropogenic sources of uranium. Sulfur isotope data and uranium activity ratios (U-234/U-238) suggest at least one well in the alluvial aquifer as a candidate for containing mine drainage water. Questions remain about specific flow paths, ages, and sources of recharge, motivating further seasonal sampling of the alluvial aquifer. Future activities include holding "water workshops" to engage in dialogue with stakeholders about water quality and concerns on impacts on the community. Findings from both the geochemical study and workshops are reported back to the community and final results will be compiled jointly with stakeholders into future water recommendations for the community. The study is unique in its combination of geochemistry research with community-based methods, filling a critical research gap needing to be addressed for work towards more sustainable water outcomes.