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Evaluating geogenic and mining-related uranium occurrence in groundwater in a Northeastern Arizona community

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On the Colorado Plateau in the southwest United States, residents' concerns about groundwater quality stem from legacy uranium mining impacts and localized mineral deposits in water-bearing geologic units. This is especially true for Indigenous and non-Indigenous communities located in the Puerco River Valley. Valley residents are concerned about groundwater metal contamination from a uranium mill tailings pond-dam collapse in 1979 and simultaneous mine drainages that released metal-laden wastewater into the Puerco River and the underlying alluvial aquifer. Pinpointing contamination sources in the area is further complicated by the presence of uranium deposits within the Chinle Group, which may leach metals into deep groundwater. Although it is known that both geogenic and mining contamination exist in groundwater in one community bordering the Navajo Nation in rural Northern Arizona, less is understood about the specific mechanisms of uranium occurrence and release into the alluvial and bedrock aquifers. Ongoing community-based research investigates the specific sources of recharge, ages, and potential flow paths of water sources in the study area.

Forty-two water sources were sampled for this study, including 40 groundwater wells. These samples were analyzed for trace metals, stable water isotopes (O, H, S), radionuclides (U-234, U-238), modern compounds (pharmaceuticals, artificial sweeteners), and age tracers (Tritium, C-14). Uranium activity ratios indicate mining sources of uranium in the shallow (< 30 meters) alluvial aquifer. Age proxies and tracers further support this claim, indicating younger, modern recharge in mine drainage-containing wells. On the other hand, C-14 and stable isotope ratios suggest heterogeneity in groundwater chemistry from the deeper (> 30 m) Chinle aquifer. Additionally, geochemical modeling results support the presence of uranium-Ca-CO3 complexes, which is critical knowledge for future water treatment discussions. Further analysis is needed to strengthen prediction models of uranium groundwater occurrence in the area. Building on these fundamental findings, water-focused listening sessions will be conducted to synthesize data alongside community priorities, ultimately enabling development of specific water recommendations. The approaches employed in this study, which combine geochemistry and community-based research, are increasingly needed to address complex water resource issues for arid and semi-arid communities located on the Colorado Plateau and beyond.