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Geochemical fingerprinting sources of arsenic, aluminum, and lead to the San Juan River through the Navajo Nation, Four Corners region, USA

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The San Juan River, located in the semi-arid Four Corners region, USA, is a vital source of water for the region, including the Native American Navajo Nation. The Navajo Nation Environmental Protection Agency identified elevated concentrations of arsenic, aluminum, and lead under high flow hydrologic regimes. Sources of metals could include bedrock lithologies and alluvial deposits, legacy hard rock mining, abandoned uranium mines and mills, natural mineralized deposits, oil and gas development, coal mining, coal-fired power plants, urban areas, illegal trash dumping, overgrazed areas, and subsurface agricultural return flows. To identify the source(s) of these elements, surface water, sediments, and rocks were collected throughout a 230 kilometer section of the San Juan River and tributaries. Baseflow surface water samples were collected at 16 points on the San Juan River in February 2021. Tributaries to the San Juan including twenty-eight ephemeral channels and five perennial channels (four of which are fed by agricultural return water) were sampled during the spring snowmelt and summer monsoons of 2021. Major and trace element analyses of water and sediments provides evidence for the source of arsenic, aluminum, and lead to the river. Scanning electron microscopy on tributary sediments and rock or terrace deposits helps to identify the major contributing mineralogy and potential sources of trace- and major-elements. Streamflow of the ephemeral channels was estimated using unmanned aerial systems and photogrammetry techniques. Determining the relative contribution and effect of each source to the San Juan River will help the Navajo Nation, public drinking-water managers, irrigation districts, scientists, and the public in their efforts to protect the environment and human health.