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Uranium tracing using lead stable isotope in sediments near a uranium milling site in Guangdong, China

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Typical metal contents including U, Th, Pb, Zn, Cu, and Mn, sediment mineralogy and Pb isotope ratios were analyzed to identify contaminant fate and transport pathways of sediments near an active uranium (U) milling zone in the Guangdong Province, China. High enrichment of U and other trace metals was shown for both the surface sediments and those across the depth profile. By scanning electron microscopy coupled with energy-dispersive spectrometry (SEM-EDS), trace metals were found to be largely associated with diatom frustules in the sediment profile. The three-isotope graph ($^{206}Pb/^{207}Pb$ versus $^{208}Pb/^{206}Pb$) for the sediments and for the U tailing showed a strong linear trend (r^2 = 0.97), which allowed a quantitative source apportionment based on a binary mixing model. Using the U tailing ($^{206}Pb/^{207}Pb$: 1.9461) and the local background sediment ($^{206}Pb/^{207}Pb$: 1.2049) as the two end members, the calculation revealed that along the depth profile, 6.1% - 50% of the sediment material originated from the U milling waste.

This study highlights that (1) biogenic silicates may regulate the transfer of trace metals in the aquatic system and (2) the specific Pb isotope ratios in U ores can be used for quantitative source tracing to examine U milling impacts on natural environment.

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