Controls governing the spatial distribution of sediment arsenic concentrations and solid-phase speciation in a lake impacted by legacy mining pollution.

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Abstract: Forty-seven sediment cores were collected as part of a spatial survey of Long Lake, Yellowknife, NWT, Canada to elucidate the physical and geochemical controls on the distribution of arsenic (As) in sediments impacted by the aerial deposition of arsenic trioxide (As2O3) from ore roasting at legacy gold mines. High-resolution profiles of dissolved As in bottom water and porewater were also collected to determine As remobilization and diffusion rates across the sediment-water interface. Arsenic concentrations in Long Lake sediments ranged from 2.2 to 3420?mg?kg-1 (dry weight). Two distinct types of sediment As concentration profiles were identified and are interpreted to represent erosional and depositional areas. Water depth is the best predictor of As concentration in the top 5?cm of sediments due to the inferred focusing of fine-grained As2O3 into deeper water. At greater sediment depths, iron (Fe) concentration, as a likely indicator of As, Fe, and sulphur (S) co-diagenesis, was the best predictor of As concentration. The sediments are a source of dissolved As to surface waters through diffusion-controlled release to bottom water. Arsenic concentrations, solid-phase speciation, and diffusive efflux varied laterally across the lake bottom and with sediment depth due to the interplay between sediment-focusing processes and redox reactions, which has implications for human health and ecological risk assessments.

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