

The sorption of Cr and As in a multi-element system onto freshwater lake sediments: mobility across pH value and their redox states.

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Anthropogenic activities such as the burning of fossil fuels, mining activities, and municipal waste contribute towards the increasing release of oxyanions such as chromate (Cr), arsenate (As), vanadate (V), selenate (Se), molybdate (Mo), and antimonate (Sb). Despite numerous available studies related to the redox behaviour of oxyanion-forming contaminants in the environment, they were mostly single element system and/or conducted on synthetic minerals. However, a real contamination event usually involves a mixture of contaminants entering the environment.

We examined the sorption of Cr and As onto freshwater lake sediments in the presence of V, Se, Mo, and Sb across a pH range of 4 to 10. The lakes being studied are in Scotland, UK with varying mineralogical composition and contamination history. Kinghorn Loch was heavily polluted by bauxite residue leachate in the early 1980s; Loch Fitty has a history of coal mining, but now it is planned to be repurposed as a leisure park; and Loch Leven is a nature reserve with regular monitoring. All the lake sediments samples were spiked with 30-57 mg L⁻¹ of Cr(VI), As(V), V(V), Mo(VI), Se(VI), and Sb(V) in their oxyanion form and allow them to mix for 48 hours to reach equilibrium with pH adjusted in the range of 4-10.

Figure 1 shows the pH against percentage of the sorbed contaminants. Acid to neutral condition does not increase the mobility of Cr and As, while the change of pH from neutral to alkaline promotes the release of Cr and As, making them more mobile in the alkaline condition.

Further X-Ray absorption spectroscopy (XAS) of the sediments was able to determine the oxidation states of the sorbed Cr and As. Figure 2 shows the K-edge XAS spectra (Beamline B18, Diamond Light Source Synchrotron, UK) of X-ray absorption near edge structure (XANES) of sorbed Cr and As. Based on the spectra, Cr(VI) was reduced to the less toxic Cr(III) and As(V) was sorbed as As(V).

From both Figure 1 and 2, it can be inferred that the behaviour of Cr and As in the sediment-water interface are similar despite the different mineralogical composition of the lake sediments.

