

Stability of poorly crystalline arsenate phases in the presence of different phosphate levels

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The competition of arsenic with phosphate for sorption sites has been extensively studied, but the long-term stability of poorly crystalline or amorphous arsenic phases at elevated phosphate levels remains unclear. This study investigated the impact of different phosphate levels (0 mM, 0.5 mM, and 50 mM of NaH_2PO_4) on the stability of amorphous ferric arsenate (AFA, $\text{FeAsO}_4 \cdot x\text{H}_2\text{O}$) and poorly crystalline yukonite (Yuk, $\text{Ca}_2\text{Fe}_3(\text{AsO}_4)_3(\text{OH})_4 \cdot 4\text{H}_2\text{O}$) in both synthetic phases and naturally occurring composite materials (mining waste and soil). The effect of phosphate on the stability of these arsenate mineraloids was studied using a batch experiment and monitored for one year. The results showed that an increase in phosphate concentration led to an increase in extracted As from all samples. The total As content in synthetic solids dropped by 50 % at 50 mM phosphate solution compared to 0 mM, while the P levels reached > 80 g/kg. However, XRD analysis did not determine any phase transformations in the synthetic phases. Chemical microanalyses of the synthetic phases indicated that As was replaced in the structure of AFA and Yuk by phosphorus, suggesting their low stability at high phosphate levels. Substantial release of As (~13 %) and sequestration of P (up to 6.5 g/kg) was also observed in the AFA-rich waste and Yuk-rich soil, but no chemical changes were documented in the AFA and Yuk phases. Microprobe analyses suggested that the major mechanism of As and P exchange in the mine waste and soil involved sorption processes with the omnipresent Fe (oxyhydr)oxides. These findings suggest that the instability of amorphous or poorly crystalline arsenate phases at high phosphate conditions could be effectively suppressed by the coexistence of effective As sorbents such as Fe (oxyhydr)oxides.

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