

The effect of arsenic on the nucleation and growth of schwertmannite: An *in situ* SAXS study

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The acid regimes of AMD are conducive to the formation of nano-sized schwertmannite, which plays a major role in the cycling of contaminants. However, the nucleation and growth kinetics of schwertmannite are poorly defined. The aims of this study were to characterise the sequestration of arsenic associated with nano sized schwertmannite *via* the *in situ* quantification of the formation mechanisms. Synchrotron-based time-resolved Small Angle X-ray Scattering (SAXS), interfaced with a rapid mixing stopped-flow cell, was used to investigate the nucleation and growth of schwertmannite nanoparticles from solution with varying concentrations of arsenate (0-2.5 mM). Experiments were performed on station 6.2m at the UK Synchrotron Radiation Source (SRS) and data analysis was performed using GNOM and DAMMIN. The rates and mechanisms of particle formation were studied and particle size, pair length distribution, and particle shape evolution were quantified. The results show that both the reaction induction times and the rate of schwertmannite nucleation are suppressed with increasing As-concentration. Shape analysis suggests particle growth by aggregation of sphere-like particles: a process that is suppressed by the presence of As.

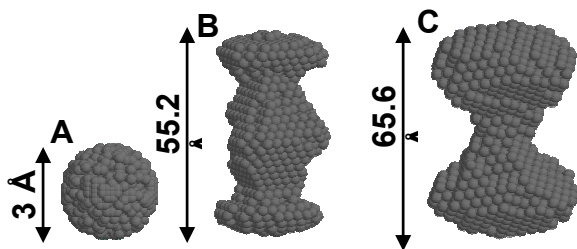


Figure 1. Average particle shape for a schwertmannite particle at A. 30 s B. 600 s (both 0 mM As), and C. with 2.5 mM As at 600 s.

Thermochemistry of arsenic minerals

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Introduction

Arsenic represents a major concern for drinking water supplies not only in USA (Ryker, 2003) but also in other countries around the world (Zhang, et al., 2002, Saha, 2003, Bundschuh, et al., 2004). Despite its high toxicity, the available thermodynamic data for arsenic containing minerals are scarce or not well determined (Nordstrom and Archer, 2003). Using these data, it is hard to model the behavior of arsenic in the environment.

The purpose of this research is to develop a technique to measure the enthalpies of formation of different arsenic containing minerals and review the available thermodynamic data in order to establish thermodynamically consistent datasets.

Analytical method

A custom built Tian-Calvet twin, high temperature calorimeter from Thermochemistry Facility, UC Davis will be used to carry out this research. The high-temperature oxide melt calorimetry will be used at 700 °C as is described by Navrotsky (1977, 1997), with sodium molybdate $3\text{Na}_2\text{O} \cdot 4\text{MoO}_3$ as solvent.

Results

The research is in progress and the data will be reported.

References

- Bundschuh J., et al., (2004), *Applied Geochemistry* **19**. 231-243.
Navrotsky A., (1977), *Phys Chem Minerals* **2**. 89-104.
Navrotsky A., (1997), *Phys Chem Minerals* **24**. 222-241.
Nordstrom D. K. and D. G. Archer, (2003), Arsenic in ground water, Kluwer Academic Publishers, 1-25.
Ryker S. J., (2003), Arsenic in ground water, Kluwer Academic Publishers, 165-178.
Saha K. C., (2003), *Critical Reviews in Environ. Sci. Technol.* **30**. 127-163.
Zhang H., et al., (2002), *Environ. Geol.* **41**. 638-643.