

XAFS analysis of co-precipitated arsenate on Mg-bearing minerals

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Introduction

In natural environment, the enrichment of anionic species such arsenate As(V) and borate in Mg-bearing minerals was observed during serpentinization process which is characterized by alkaline pH condition.

In this research, we examine the arsenate environment in synthesize Mg-bearing minerals formed in Mg-Si-Al system at 25 °C. Samples of As(V) sorbed to Mg-bearing minerals were prepared by adding As instantaneously in various mixing ratio of Mg, Si and Al at alkaline condition and studied by XAFS spectroscopy.

Materials and methods

Arsenate sorption was conducted during mineral formation at alkaline condition by adding appropriate amounts of Na₂HAsO₄·7H₂O solution instantaneously during the mixing of Mg, Si and Al solutions with a final As(V) concentration of 100 ppm. The Mg/Si/Al molar ratios were MSA: 712, 613..316 with a total volume of 100 mL. The pH of the solutions were then adjusted to pH = 11±0.5 and were shaken for 7 days at 25°C. The precipitates were collected by centrifugation and washed with deionized water. The solid samples were freeze dried prior to XAFS analysis.

Arsenic K-edge XAFS spectra were measured at BL9A, Photon Factory, KEK, Japan, with a fluorescence XAFS measurement system in SX mode where sets ionization chamber for I₀ and Lytle type fluorescence detector for I_f counting. Synchrotron radiation from 2.5 GeV storage ring was monochromatized with Si(111) double crystal monochromator and scanned from 11.3600 to 12.9592 keV to obtain the As K-edge XAFS spectra. The incident beam was collimated into 2.5×0.8 mm² with a slit. The XANES and EXAFS were used to determine the oxidation state and local coordination environment of arsenic in the solid phase.

Results and discussion

The absorption edges of As sorbed by Mg-bearing minerals during co-precipitation experiments were all located at 11,871 eV (Figure 1), corresponding the determined value of Na₂HAsO₄. Figure 2 shows the RDF profile with peak positions derived from the As K-

edge EXAFS of coprecipitated arsenate during MSA 712 to 514 formation. The results revealed that the first coordination shell was attributed to the As(V)-O interatomic distance of 1.695±0.003Å, with a CN of 4 which is consistent with the molecular structure of As(V) ion. However, only MSA 712 sample showed a clear second shell coordination peak centered at 3.4±0.02Å which could be fitted to Mg or Al. The observed corresponding fit of As-Al bond length in MSA 712 sample is within the range of 3.16 to 3.51Å reported in previous studies. Aside from the observed As-Al bonding in the examined samples, no other peaks were observed that correspond to other bonding environment for As(V).

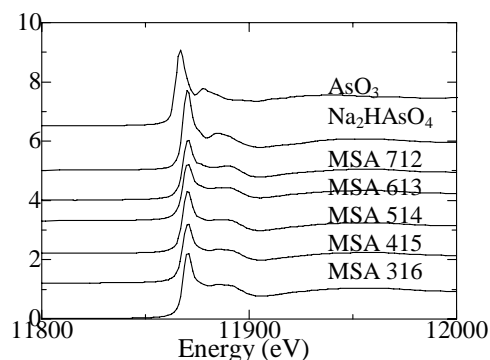


Figure 1. The As K-edge XANES spectra

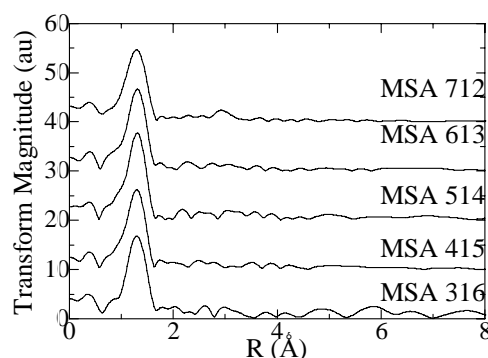


Figure 2. The experimental RDF profile derived from the As K-edge EXAFS.

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