

## An XAFS analysis of co-precipitated selenate on Mg-bearing minerals

Einstine OPISO<sup>\*1</sup>, John CHARNOCK<sup>2</sup>, Tsutomu SATO<sup>1</sup>, Sohtaro ANRAKU<sup>1</sup>, Chiya NUMAKO<sup>3</sup>  
Tetsuro YONEDA<sup>1</sup>

<sup>1</sup>Laboratory of Environmental Geology, Graduate School of Engineering, Hokkaido University, Kita  
13 Nishi 8, Kita-ku Sapporo 060-8628, Japan

<sup>2</sup>School of Earth, Atmospheric and Environmental Sciences, Williamson Building, Manchester  
University, Oxford Road, Manchester M13 9PL, UK

<sup>3</sup>Graduate School of Human and Natural Environment Science, Tokushima University, 2-1  
Minamijosanjima-cho, Tokushima 770-8506 Japan

**Introduction**

The high mobility of selenate at alkaline pH condition due to its low adsorption on predominantly negatively charged minerals in natural environment proved to be an important factor of consideration for its immobilization in such condition. Hence, it is necessary to study stable mineral phases that can act as major sorbing solid for selenate. In this research, we examine the selenate sorption mechanisms onto synthesize Mg-bearing minerals formed in Mg-Si-Al system at alkaline condition by XAFS spectroscopy.

**Materials and methods**

Selenate sorption was conducted during mineral formation at alkaline condition by adding appropriate amounts of Na<sub>2</sub>SeO<sub>4</sub> solution instantaneously during the mixing of Mg, Si and Al solutions with a final Se(VI) concentration of 100 ppm. The Mg/Si/Al molar ratios were MSA: 613, 514 and 415 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.

Selenium 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 I<sub>0</sub> and Lytle type fluorescence detector for I<sub>f</sub> counting. Synchrotron radiation from 2.5 GeV storage ring was monochromatized with Si(111) double crystal monochromator and scanned from 12.3600 to 12.9592 keV to obtain the Se K-edge XAFS spectra. The incident beam was collimated into 2.5×0.8 mm<sup>2</sup> 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**

From the XANES data, the absorption edges of Se sorbed by hydrotalcite (MSA 613) and serpentine (514 & 415) phases were all identical and matched the selenate standard located at 12,665 eV which indicate that the sorbed selenate mainly exist in its hexavalent form. Figure 1 shows the Se K-edge XANES spectra of selenium coprecipitated with hydrotalcite and serpentine

phases. The Se K-edge EXAFS of selenate coprecipitation on selected MSA 613 to 415 samples is shown in Figure 2. In all samples, it is possible to adequately fit the experimental data with single Se–O shell with CN of 4 at 1.64 to 1.65 Å. This bond distance is consistent with previously published data on Se–O distances. However, no second shell peak was detected in addition to the first second shell coordination environment of Se–O which could suggests that the coordination environment of selenate on hydrotalcite and serpentine was outer-sphere.

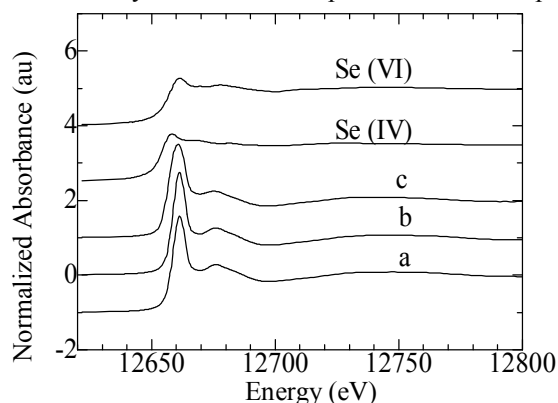


Figure 1. The As K-edge XANES spectra. Note: MSA 415(a) to MSA 613 (c)

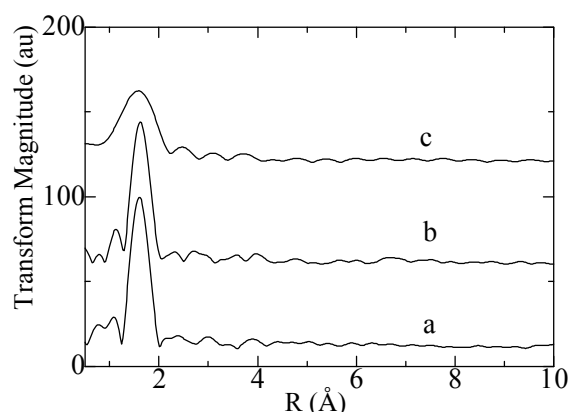


Figure 2. The experimental RDF profile derived from the As K-edge EXAFS. Note: MSA 415(a) to MSA 613 (c)

\* einstine@eng.hokudai.ac.jp