Structure and arsenate uptake of Fe(III)-Al-precipitates

ANDREAS VOEGELIN* AND ANNA-CATERINA SENN

Eawag, Swiss Federal Institute of Aquatic Science and Technology, Überlandstrasse 133, CH-8600 Dübendorf
(*correspondence: andreas.voegelin@eawag.ch)

The neutralization of acid Fe(II)- and Al-containing drainage by mixing with near-neutral surface water results in Fe(II) oxidation and formation of Fe(III)-Al-precipitates that may scavenge trace elements like As [1]. In previous work, we investigated how dissolved phosphate (P) and silicate affect the structure of Fe oxidation products at near-neutral pH in the absence of Al [2,3]. The aim of this study was to examine how increasing Al levels affect the structure and arsenate (As(V)) uptake of Fe(III)-Al-precipitates. Synthetic Fe(III)-Al precipitates were formed at 0.5 mM Fe+Al by spiking 1% (v/v) of an acidic Fe(II)+Al solution (50 mM; 1 mM HCl) into oxygenated 4 mM Ca-bicarbonate electrolyte buffered to pH 7.0 with CO_2 gas and containing 7 μM As(V). The experiments were performed at molar Al/(Al+Fe) ratios of 0, 0.1, 0.2, 0.5 and 1 and P/(Al+Fe) ratios of 0, 0.05, 0.1, 0.3, 0.5, 0.75 and 1.5 (5×7 combinations). After complete precipitation (4 h), unfiltered and filtered (0.1 μm) solutions were collected for analysis by ICP-MS and the precipitates were dried for analysis by Fe K-edge XAS and TEM.

For P-free precipitates, XAS data indicated a shift in Fe coordination from lepidocrocite-like in the absence of Al to dominantly ferrihydrite-like at an Al/(Al+Fe) ratio of 0.5. At all Al/(Al+Fe) ratios, increasing P/(Al+Fe) ratios caused a shift in Fe coordination towards amorphous Fe(III)-phosphate. TEM analyses will reveal the extent to which Fe and Al formed mixed or invididual precipitates. At P/(Al+Fe) ratios >0.5, P exhibited only a slight preference for co-precipitation with Fe(III) rather than Al, whereas As(V) exhibited a clear preference for co-precipitation with Fe(III). At P/(Al+Fe) ratios <0.5, however, small Al fractions enhanced As(V) and P uptake relative to the pure Fe system, most likely due to the effect of Al on Fe coordination. The differences in precipitate structure and in P and As(V) interaction with Al and Fe(III) were reflected in dissolved As(V) concentrations that varied over nearly two orders of magnitude as a function of molar Al/(Al+Fe) or P/(Al+Fe) ratio.

[1] Adra *et al Environ. Sci. Technol.* **47**: 12784, 2013 [2] Voegelin *et al Geochim. Cosmochim. Acta* **74**: 164, 2010 [3] Kaegi *et al Geochim. Cosmochim. Acta* **74**: 5798, 2010