

Vanadate attenuation by iron(II)-bearing phases

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Vanadium (V) is an emerging environmental contaminant with several anthropogenic sources including mining and mineral processing, and petroleum and coal production [1,2,3]. Despite a recent increase in V geochemistry studies, substantial knowledge gaps remain [2,3]. In particular, very few studies have examined V geochemistry in anoxic environments [4]. We conducted laboratory batch experiments to study aqueous V(V) attenuation rates and mechanisms by Fe(II)-bearing phases—magnetite [Fe₃O₄], siderite [FeCO₃], pyrite [FeS₂], and FeS—commonly found in anoxic soils, sediments, and aquifers.

Synthetic Fe(II)-bearing phases were suspended in a 0.05 M NaCl solution within an anoxic chamber. The suspensions (2 g L⁻¹) were spiked with 100 μM (5 mg L⁻¹) V(V) and continuously stirred for 3 or 48 hours. Suspension samples were collected over time to quantify V(V) removal kinetics. Inductively coupled plasma–mass spectrometry (ICP–MS) was used for V quantification and high performance liquid chromatography–ICP–MS (HPLC–ICP–MS) was used to quantify aqueous V(V), V(IV), and V(III) concentrations. Solids were flash-frozen, freeze-dried, and analyzed by transmission electron microscopy–energy dispersive X-ray spectroscopy (TEM–EDX) and X-ray absorption spectroscopy (XAS).

Our results demonstrate V(V) attenuation occurs rapidly with magnetite, siderite, and FeS. Limited V(V) attenuation was observed with pyrite. XAS data indicates that sorption and reduction reactions contributed to V(V) attenuation by siderite and FeS, whereas magnetite promoted only sorption over the experimental duration. Additionally, HPLC–ICP–MS and XAS results suggest V(V) reduction occurred *via* surface-mediated electron transfer from Fe(II) or S(-II) atoms rather than dissolved Fe(II). Our new findings indicate that V(V) mobility would be limited by interactions with surfaces of Fe(II)-bearing phases in anoxic environments.

[1] Watt et al. (2018) *Environ. Sci. Technol.*, **52**, 11973–11974. [2] Schlesinger et al. (2018) *PNAS*, **52**, E11092–E11100. [3] Huang et al. (2016) *Chem. Geol.*, **417**, 68–89; [4] White and Peterson (1996), *Geochim. Cosmochim. Acta*, **60**, 3799–3814.