Uranium Retention by Biogenic Magnetite

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Introduction

Uranium mobility, and therefore its potential hazard, is highly dependent on its chemical speciation and redox state. Recently there has been great interest in the possibility of remediation of uranium contaminated sites through uranium immobilization via *in situ* reduction of U(VI) to U(IV) by dissimilatory metal reducing bacteria. A variety of organisms, including Shewannella Putrafaciens (CN32), have been shown to reduce both Fe(III) to Fe(II) and U(VI) to U(IV). Additionally, batch studies have shown that CN32 will simultaneously reduce both Fe(III), as ferrihydrite, and aqueous U(VI) at significant rates.

Previous investigations of microbial induced ferrihydrite reduction under dynamic flow conditions have shown significant soluble Fe(II) production that in turn drives extensive down gradient ferrihydrite to magnetite conversion.

The current study examines uranium dynamics in the presence of both CN32 and ferrihydrite under flow conditions. Uranium (U(VI)) in a synthetic groundwater medium was introduced in to a column packed with ferrihydrite coated sand that was inoculated with Shewanella Putrafaciens (CN32).

Results

As anticipated from previous studies, significant reductive dissolution of ferrihydrite and subsequent magnetite formation occurred. Although migration of the U(VI) through the column was greatly retarded, no appreciable uranium reduction was observed, as determined by XANES spectroscopy. Instead, the uranium appears to be primarily associated with the secondary magnetite.

After 21 days (~60 pore volumes) substantial uranium breakthrough was observed. At this point the synthetic groundwater medium was changed to "contaminat free" groundwater to investigate the uranium release rate. After another 21 days less than 15% of the uranium had been released from the system, indicating a relatively strong uranium sorption complex. EXAFS spectroscopy was utilized to elucidate the bonding environment of the sorbed uranium.

Conclusions

Despite no significant microbial reduction of the U(VI) was observed, microbial activity within the column had profound effects on the uranium transport through the production of new biogenic mineral phases.

Sediment subduction and magma genesis in the central Aleutian arc

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Recent investigations of arc volcanism have suggested that Hf isotopic signatures may vary with the amount of sediment being subducted (e.g., Marini et al., 2000; Woodhead et al., 2001). Oblique subduction of the Pacific plate beneath the central and eastern Aleutian arc results in the lateral movement of subducting fracture zones with time. High Sr and Pb isotopic ratios in lavas from Seguam Island led Singer et al. (1996) to propose that the Amlia fracture zone introduced anomalously high amounts of sediment into the magma source beneath Seguam. The Amlia fracture zone was subducted beneath Yunaska Island several million years prior to its subduction beneath Seguam and has not yet been subducted beneath Atka Island. New Hf, Sr, Nd, and Pb isotope data test the idea that this "point source" delivered anomalous amounts of sediment and that this has influenced the Hf isotopic signatures of different volcanoes along the arc.

176Hf/177Hf ratios for Seguam (n=4) and Yunaska (n=7) samples fall between 0.283125 and 0.283177, whereas samples for Atka (n=4) range consistently higher (176Hf/177Hf = 0.283192-0.283228±12 e-6, avg. 2σ error). Hafnium isotopic compositions from a single island show some variation outside of error, but the most striking difference is the markedly higher Hf isotopic signature of Atka relative to Seguam and Yunaska. This Hf isotopic signature correlates inversely with Sr and Pb isotopic ratios corroborating the influence of subducted sediments upon Hf. However, these same lavas have moderately high Ba/La (36-60), a signal that has been interpreted to reflect a slab-derived component, perhaps produced during dewatering of subducted oceanic crust. Correlations between isotopic ratios, Ba/La, and distance along the arc suggests that the chemical contribution of the fracture zone sediments to the source is superimposed upon a more robustly expressed slab component.

References

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