

Noble gas and halogen recycling at subduction zones

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Recent findings of subducted halogens and noble gases with seawater and sedimentary pore-fluid signatures in exhumed mantle wedge peridotites [1], as well as seawater-derived heavy noble gases (Ar, Kr and Xe) in the convecting mantle [2], provide observations that allow us to investigate the processes that control the return of volatile and highly incompatible elements into the mantle. To verify whether and how such subduction fluids modify the composition of the mantle beneath subduction zones, we are investigating noble gas and halogen compositions of olivines and mantle-derived xenoliths in arc lavas from Western-Pacific subduction zones (Izu, Kamchatka and N. Philippines) and those of seafloor sediments and basalts from NW margin of the Pacific plate.

MORB-like ³He/⁴He and halogen ratios of the olivines indicate insignificant contributions to the arc magmas of radiogenic ⁴He and pore-fluid-like halogens, both of which are observed in the subduction fluids released from a slab at a depth of 100 km [1]. In contrast, mantle-derived xenoliths exhibit pore-fluid-like halogens and heavy noble gases but MORB-like He. The high I/Cl ratios of pelagic clays and radiolarian cherts can account for the enrichment of iodine in subduction fluids relative to sedimentary pore-fluids [1], whereas contributions of halogens and noble gases from altered oceanic basalts are limited.

The significantly smaller contributions of subducted noble gas and halogen in the arc magmas relative to those in the mantle wedge peridotites may result from a difference in the P-T condition of the slab in each subduction zone, or from dilution by mantle-derived halogens and He when the subduction fluid induced partial melting. The former implies a relatively small amount of the pore water subduction fluids would be released from a cold slab at a sub-arc depth resulting in further subduction of halogens, heavy noble gases and potentially water, to great depths in the mantle.

[1] Sumino *et al.* (2010) *EPSL* **294**, 163-172. [2] Holland & Ballentine (2006) *Nature* **441**, 186-191.

Formation of Magnetite within aquifer sediments and its effects on Arsenic mobility

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One commonly attempted remediation approach for groundwater Arsenic (As) contamination involves stimulating iron (Fe) mineral transformations that affect aqueous As concentration. However, successful strategies are difficult to develop and implement, in part because many Fe minerals are only stable under a narrow window of redox conditions. Magnetite (Fe₃O₄) is a promising target mineral for As remediation due to its stability over a wide range of Eh-pH conditions. Recent studies have found that magnetite is capable of retaining As through surface adsorption and also trapping arsenate As(V) into its structure. However, the factors that promote magnetite formation and As incorporation and adsorption are poorly established.

Here, we did a series of columns, loaded with reduced aquifer sediments from the Dover Landfill Superfund site. We stimulated the formation of As-bearing magnetite, tested its ability of maintaining As retention and evaluated its capability of sequestering additional As. All columns were conducted at circumneutral pH, similar to site conditions but much lower than is normally considered ideal for magnetite formation. The columns were equilibrated with continuous oxygen-free artificial groundwater containing lactate and sodium arsenite As(III), during which As release was observed. Then sodium nitrate and ferrous sulfate were added to the same influent groundwater, which sequestered As on solids quickly and yielded considerable magnetite as suggested by magnetic separations of a sacrificed column. (Synchrotron X-ray absorption spectroscopy as well as sequential extraction will be used to identify and quantify solid-phase Fe and As speciation). These amended columns were able to maintain low aqueous As concentrations even when influent groundwater with high lactate concentration (and no As) were introduced to encourage reduction and also able to continue to retain As after subsequent arsenite and lactate additions.