Isotopic evidence for Uranium retardation in zeolitic rocks at Yucca Mountain, Nevada

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Retardation of radionuclides by sorption in the nonwelded tuffs below the proposed high-level nuclear waste repository in the unsaturated zone at Yucca Mountain, Nevada, is a positive attribute of the natural barrier. Alteration of volcanic glass in these tuffs produced thick, widespread zones of zeolite- and clay-rich rocks with high sorptive capacities. The alteration of glass to zeolites, however, was accompanied by reduction in the matrix porosity and permeability causing most flow to occur through fractures, which may have decreased the overall effectiveness of radionuclide retardation in the zeolitic rock matrix.

Chemical and uranium-series isotopic compositions were measured in samples of unfractured and rubble rock from core, surfaces of natural fractures in the core, and in rock leachates and pore water extracted from these core samples. Uranium concentrations in sodium acetate leachates indicate that the mobile ^{238}U is 0.3 to 1.7 percent of total ^{238}U in rock samples and allow estimates of the time-integrated in situ U distribution coefficient K_d ($K_d=C_{solid}/C_{water}$, where C is concentration). Use of median U concentrations in pore water (0.005 µg/mL) and sodium acetate leachates (0.035 µg/g rock) yields an estimate of the ^{238}U K_d value of 7 mL/g.

Samples of rock from unfractured core, rubble core, and fracture surfaces have similar $^{234}U/^{238}U$ activity ratios (AR) ranging from 0.92 to 1.16, indicating both enrichments and depletions in the daughter ^{234}U relative to the parent ^{238}U. In contrast to the rock, all pore water and rock leachate samples have elevated $^{234}U/^{238}U$ AR ranging from 1.1 to 5.2. The chemical and isotopic data indicate that the matrix in zeolite- and clay-rich rocks is capable of exchanging uranium with ^{234}U-enriched percolating water and that retardation of radionuclides can occur in altered rocks below the proposed repository.

Weathering of Ca- and P-bearing minerals by fungi in a northern hardwood forest

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In many ecosystems, mineral weathering is the initial source of calcium and phosphorus, both of which are essential nutrients for plants. Mycorrhizal fungi are symbiotically associated with tree roots and exude organic acids that enhance mineral dissolution and transfer nutrients to trees (e.g., Jongman *et al*., 1997). Understanding this process in forests of the northerneastern USA is important because acid deposition has increased Ca leaching from Ca-poor soils such as those with granitic parent material.

To test the role of fungi in weathering of Ca- and/or P-bearing minerals, mesh bags containing quartz (as a control), quartz plus 1% wollastonite ($CaSiO_3$), or quartz plus 1% apatite ($Ca_5(PO_4)_3F$) were buried in mineral soil beneath American beech (*Fagus grandifolia* Ehrh.), sugar maple (*Acer saccharum* Marsh.), and mixed spruce and basalm fir stands (*Picea rubens* Sarg. and *Abies balsamea* L.) at the Hubbard Brook Experimental Forest, New Hampshire, USA. A 50-µm mesh size was chosen to exclude roots but allow fungal hyphae to enter the bags.

Microbial community composition and biomass in the mesh bags and surrounding soil were characterized and quantified using phospholipid fatty acid (PLFA) analysis. Fungal biomass (estimated as moles of fungi-specific PLFA 18:2ω6 and 18:1ω9c) in the soil and control bags did not differ significantly among stand types. In contrast, the degree of fungal colonization in apatite- and wollastonite-amended bags varied significantly with stand type. In the beech stands, fungal biomass was significantly greater in the apatite-amended bags, suggesting that apatite dissolution stimulated fungal colonization. In the spruce-fir stands, the fungal biomass did not vary as a function of the mineral assemblage, suggesting that the natural supply of Ca and P in these stands is high enough to meet nutrient demands. In the sugar maple stands, fungal biomass was significantly lower in the wollastonite-amended bags relative to the control and apatite-amended bags. The different response in each stand type appears to be related to the type of fungi present as well as the nutrient status of the soils. These results are important for evaluating nutrient demands of vegetation, and the effects of microbial community composition on the mineral dissolution of Ca and P-bearing minerals.

Reference

Jongmans A.G. *et al*., (1997), *Nature* **389**, 683-683.