Geochemical modeling of water-granite interaction in Beishan Area, NW-China

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Granite in Beishan Area, NW-China, has been selected as the host rock of the potential site for a geological repository of high-level radioactive waste (HLW) in China. In order to understand the long-term response of granite to groundwater activities under the conditions of geological disposal of HLW, geochemical simulations of water-granite interaction were conducted using the geochemical reaction path code EQ6.

Based on the typical chemical compositions of granite and groundwater in the area, the modeling was designed to simulate the geochemical reactions when the groundwater encounters the granite in a closed system with negative temperature gradient from 300°C to 100°C. At the beginning of the simulation, the reaction progress variable Z_i=0, the groundwater (GW) started reacting with the granite at 300°C, and the temperature was dropping with a step of -25°C. The Z_i approached to 1 when the temperature decreased to 25°C.

Calculations of saturation indices (SI) of muscovite, quartz and kaolinite indicated that the SI of these minerals should change with temperature variation. Muscovite, quartz and kaolinite could precipitate from the GW at temperatures below 250°C, 100°C and 75°C respectively in the study site.

The modeling showed that muscovite, kaolinite and quartz could dissove in the GW at higher temperatures and precipitate from the GW at lower temperatures. It suggested that the minerals could deposite from the GW and seal the fractures of the granite during the GW moved from the near field with higher temperatures to the far field with lower temperatures in the potential site for a geological repository for HLW. The mineral precipitation seemed to be favorable for retardation of radionuclides migration in the granite.

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Free ion controls on Zn and Cd uptake by coastal plankton: A field test of the free ion hypothesis

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Culture experiments in metal ion buffer systems indicate that Zn and Cd uptake by marine algae is controlled by concentrations of free metal ions or dissolved inorganic species. Thus, to predict algal uptake of Zn and Cd, one must know the extent of complexation of these metals by organic ligands. Moreover, due to metal-metal interactions, uptake of Cd increases substantially with decreasing Mn^{2+} and Zn^{2+} ion concentrations. To test these laboratory-based predictions, we used radiotracers (^{109}Cd, ^{65}Zn and ^{14}C) to measure Cd and Zn uptake rates and carbon fixation rates in natural assemblages of plankton in the Elizabeth River and Hampton Roads, Virginia, a contaminated estuarine system. By dividing plankton Zn and Cd uptake rates by C-fixation rates we obtained estimates of steady-state Zn:C and Cd:C ratios in the plankton. These values were then related to the free ion concentrations of Cd^{2+} and Zn^{2+} (measured by DPASV) and Mn^{2+} (estimated from dissolved Mn). Free zinc ion concentrations ranged widely, from 122 nM in the upper Elizabeth River to 0.006 nM in Hampton Roads, owing to large variations in dissolved zinc and in organic complexation. Over this range, relationships between Zn:C in plankton and $[Zn^{2+}]$ agreed well with those for cultured algae grown in metal ion buffer systems. Cadmium ion concentrations decreased from 30 to 1.6 nM from the upper to the lower estuary, and measured Cd:C in the plankton first decreased and then increased over this range. This unusual behaviour appears to be largely caused by a concomitant decrease in dissolved Mn (from 930 to 7 nM), which enhances Cd uptake by the Mn transport system, a major pathway for Cd accumulation in phytoplankton. The field Cd:C values agreed remarkably well with those measured in laboratory cultures of the diatom *Thalassiosira pseudonana* for similar combinations of controlling metal ions (Cd^{2+}, Mn^{2+}, and Zn^{2+}).