Integrated analysis of hydrogeologic and biogeochemical processes controlling Technetium mobility at the Hanford site, Washington State, USA

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Historic nuclear power and weapons operations resulted in an enduring legacy of approximately six billion cubic meters of radionuclide-contaminated soil and groundwater. Technetium (^{99}Tc) is one of the primary risk-driving contaminants and of the most problematic in the environment. At the Hanford Site, over 500 Ci of ^{99}Tc was released to the vadose zone as part of past site operations. However, the complex hydrogeology of the subsurface and associated biogeochemical cycles result in a variety of technical, scientific and financial challenges for ^{99}Tc remediation efforts.

The mobility of ^{99}Tc in the geologic medium is mainly a result of redox chemistry. Long believed to exist as the pertechnatate anion (TcO_4^-) and predicted to be highly mobile in the predominantly oxidizing groundwaters, with eventual discharge to the Columbia River, ^{99}Tc is one of the site's major risk-drivers for remediation.However, recent results have demonstrated the fractionation and persistance of ^{99}Tc through the existance of three different species. There are two primary means by which ^{99}Tc can be immobilized in subsurface environments: (1) indirect (abiotic) and (2) direct (biotic). Although much has been learned about the physiology and metabolic potential of single microbial species (pure cultures) that immobilize ^{99}Tc, major gaps exist in our understanding of the functioning of these and other microorganisms in natural and contaminated ecosystems. To this end , we will present results of an on-going multidsicplinary investigation that provides an integrated, comprehensive understanding of the hydrogeologic, and biogeochemical processes controlling ^{99}Tc behavior and fate in complex subsurface system. This information is further being used to develop tools that integrate the chemical and biological reaction network influencing the mobility of ^{99}Tc in the subsurface.

Gas geochemistry and soil CO_2 flux in active volcanic areas, China

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Changbaishan intra-plate volcano and Tengchong hydrothermal area are two of the active volcanic areas in China. In order to better understand current status of magma/hydrothermal activities of the Changbaishan intra-plate volcano and Tengchong hydrothermal area, we have conducted the soil gas survey and bubbling gas sampling from hot springs around the Tianchi crater lake and Rehai geothermal area.

In Changbaishan volcano, the results show that CO_2 is the major component gas for most samples. The maximum value of helium isotopic ratio of 5.8 R_A (where $R_A = {}^3He/{}^4He$ in air) implies more than 60% of helium is contributed by mantle component, while carbon isotope values fall in the range of -5.8 to -2.0‰ (vs. PDB), indicating magmatic source signatures as well. Nitrogen dominated samples, 18Dawgo, have helium isotopic ratio of 0.7 R_A and carbon isotope value of -11.4‰, implying the gas source might be associated with regional crustal components beneath 18Dawgo. The first-time systematic soil CO_2 flux measurements indicate the flux is ca. 22.8 g m^{-2} day^{-1} and 6.8 g m^{-2} day^{-1} at the western and southern flank of Changbaishan, which is at the same level as the background value in the Tatun Volcano Group (24.6 g m^{-2} day^{-1}), implying that Changbaishan may not be as active as TVG.

In Tengchong hydrothermal area, the preliminary results show that CO_2 is the major component gas for most samples. The helium and carbon isotopic ratio fall in the range of 0.5 R_A to 3.5 R_A and -4.7 to -1.6 ‰ (vs. PDB), respectively. We also analyzed the hot springs water. The δD and $\delta^{18}O$ values fall in the range from -59.8 to 84.6 ‰ and -6.20 to -12.38 ‰ (vs. SMOW), respectively. Rehai has the highest helium isotopic ratio of 3.5 R_A, which implies ca. 40% of helium is mantle-derived. The δD and $\delta^{18}O$ results implied the water in this area was affect by primary magmatic water. Nevertheless, samples from Banglazhang and Shihchiang hydrothermal areas show much lower helium isotopic ratio of 0.8 R_A and 0.5 R_A, respectively. It suggests that the local tectonic setting plays an important role for the gas degassing in this area.

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