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Field-Scale Migration of ^{99}Tc and ^{129}I at the Nevada Test Site

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As a result of 828 underground nuclear weapons tests conducted between 1951 and 1992 at the Nevada Test Site (NTS), more than 1E+6 TBq of long-lived radionuclides (actinide device residuals, fission and activation products, etc.) are residual. Included in the radiologic inventory are ^{99}Tc (technetium) and ^{129}I (iodine) that are presumably mobile in groundwater and potentially toxic to down-gradient receptors. Understanding the controls of radionuclide mobility associated with these nuclear tests provides insights into the behavior of these same radionuclides in groundwater associated with the proposed Yucca Mountain high-level nuclear waste repository as well as the fidelity of numerical predictions of long-term repository performance.

We synthesize a substantial body of data collected on the distribution of ^{99}Tc and ^{129}I associated with radionuclide migration studies at NTS, at field scales over distances of hundreds of meters and for durations up to forty years, under hydrogeologic conditions very similar to the proposed geological repository at Yucca Mountain. The results show that Tc does not necessarily exist as a mobile and conservative species TcO_4^-, as commonly assumed. This is not unexpected as the speciation and migration behavior of ^{99}Tc will be significantly controlled by the redox conditions of the nuclear test-induced cavity (initial distribution) and surrounding groundwater (subsequent migration). Numerous lines of evidence suggest that the chemical environment of a nuclear test cavity is likely to have a reducing nature immediately following a detonation. These conditions may persist for decades after a test. Recent *in situ* redox potential measurements indicated that groundwaters at multiple locations of the NTS are not oxidizing as previously believed. Mobility of Tc species ($TcO_2 \cdot nH_2O$) is greatly reduced in non-oxidizing environment. Speciation of iodine and the reactivity and mobility of ^{129}I species is also complex in the groundwater at the NTS.

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