Episodic release and transport at the Peña Blanca repository analog site

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Geologic, geochemical, and hydrologic data from the Nopal I uranium deposit at Peña Blanca, Mexico, make it a useful natural analog to the potential nuclear waste repository at Yucca Mountain, Nevada. Field, mineralogic, geochemical, and geochronologic data provide evidence for episodic radionuclide releases from primary UO_2 and episodic aqueous transport at Peña Blanca. Maximum limits on long-term release rates and minimum limits on episodic release rates have been estimated from secondary uranyl minerals and uraniferous caliche. Although the alteration mineral paragenesis at Peña Blanca is comparable to experimental results for conditions like Yucca Mountain, it may represent changing natural conditions, e.g., metasomatism, cooling, or evolving hydrologic conditions. A likely oxidation event is recorded by uranophane dated at 3.2-3.4 Ma; uranium decay series disequilibria indicate multiple stages of uranium mobilization and deposition in fracture minerals and host rocks on a time scale of hundreds of thousands of years; and a uranium migration event at about 50 ka is recorded by uranium rich caliche and opal. Yearly or seasonal differences in aqueous uranium concentrations and isotope ratios reflect variations in release and transport rates on short time scales. These and other data provide perspectives on episodic processes at Yucca Mountain and contribute to the conceptual basis and validation of performance models for the potential repository.

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Coupled modelling of the source-term for radionuclide release from nuclear waste forms in the near-field

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In order to assess the safety function “containment and minimisation of release” of the near field of disposed radioactive waste forms it is necessary to investigate the coupling of the dissolution of the waste form with the dominant near field processes for relevant water access scenarios. Coupled modelling has been performed using geochemical/transport codes and radiolysis models for the principal waste forms high-level waste glass and spent nuclear fuel. Dominant near field processes considered include container corrosion, hydrogen generation, mass transfer for radionuclides and other waste matrix components in corrosion products and buffer materials, geochemical conditioning of near field solution chemistry, sorption of radionuclides on specific surface sites in the nano-sized pore space of near field materials and the radiolytic decomposition of pore water.

The rate limiting steps in waste form dissolution and secondary phase formation mechanism and the associated radionuclide mobilisation chemistry (solubility, solid solution formation, speciation, redox stability) are strongly influenced by the near field constraints.

Principal results for the dissolution of nuclear waste glass are (1) the quantification of the extension of an influence sphere within which silica sorption on container corrosion products will strongly enhance glass dissolution rates and (2) the quantification of pH plume extending from the glass into the pore water of near field materials.

Principal results for spent fuel are the quantification of the extension of redox fronts caused by radiolysis and by hydrogen from container corrosion.