Numerical modeling of iron-corrosion and interaction with bentonite

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In deep geological repositories, bentonite is preferred as a possible Engineered Barrier (EB) to isolate the High Level Waste (HLW) from the biosphere. Over time, the iron canister of the HLW corrodes under anaerobic conditions and interactions between the EB and the corrosion products of the iron canister modify the properties of the bentonite. Besides, formation water in the host rock (Opalinus clay) affects the bentonite, too.

The aim is to calculate changes in porewater chemistry, mineral dissolution and precipitation as well as its effects on permeability and porosity changes on process level to assess the long term behavior. Cation exchange and surface complexation are not considered in this model. The system is modeled as a 1D model for a timescale of 10.000 years. Due to low permeabilities of both bentonite and clay the mass transport entirely takes place by diffusion, leading to small changes of constituents only. Precipitation of corrosion products decreases the porosity of the system. For calculations the code TOUGHREACT [1] is used with PetraSim [2] as user interface. TOUGHREACT adds reactive geochemistry to the multi-phase flow code TOUGH2 [3].

[1] Xu, T., Sonnenthal, E., Spycher, N., Pruess, K.: TOUGHREACT User's Guide: A Simulation Program for Non-isothermal Multiphase reactive Geochemical Transport in Variably Saturated Geologic Media, 2006, LBNL, UC: Berkeley, California, USA. [2] Thunderhead Engineering: PetraSim 5, User Manual, 2005, Manhattan, Kansas, USA. [3] Pruess, K.: TOUGH2: A general purpose numerical simulator for multiphase fluid flow, 1990, LBNL, UC: Berkeley, California, USA.

Large geochemical variations in submarine HIMU basalts

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We report the geochemical compositions of submarine basalts collected by a manned submersible from Rurutu, Tubuai, and Raivavae in the Austral Islands, French Polynesia, where subaerial basalts exhibit robust HIMU isotopic signatures. The ^{40}Ar/^{39}Ar ages of the submarine basalts overlap with those of the subaerial basalts with the exception of one sample from Tubuai. While the major element compositions are similar between the submarine and subaerial basalts for each island, the submarine basalts exhibit much larger variations in Pb, Sr, Nd, and Hf isotopic compositions than those previously reported in subaerial basalts. The submarine basalts with less-radiogenic Pb isotopes show systematically lower abundances in highly incompatible elements than the basalts with radiogenic Pb isotopes. The overall geochemical variations are best explained by a two-component mixing between the melt derived from the HIMU reservoir on one hand and the melt from the depleted asthenospheric mantle entrained by an upwelling plume on the other. The present and compiled data demonstrate that the HIMU reservoir has uniquely low ^{176}Hf/^{177}Hf for a given ^{143}Nd/^{144}Nd, suggesting it being formed by subduction of an ancient slab. Moreover, the Nd/Hf ratios of the HIMU basalts, together with the curvilinear aspect of the ^{143}Nd/^{144}Nd–^{176}Hf/^{177}Hf mixing trend, suggest higher Nd/Hf for the HIMU reservoir than for the depleted mantle component. Such elevated Nd/Hf of the HIMU reservoir could reflect metasomatic enrichment processes of the mantle by a partial melt derived from subducted material during reservoir formation.

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