Identifying temporally and spatially changing boundary conditions at an aquifer – Aquitard interface using helium in porewater

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Abstract

Helium concentrations and ^{3}He/^{4}He isotope ratios of porewater, groundwater and rock were measured on samples collected from a Jurassic sediment sequence at the Mont Terri underground rock laboratory (Northern Switzerland). Porewater He data of rock samples collected from borehole BDB-1 at high spatial resolution across a karstic limestone unit (Passwang Formation) into the underlying claystone sequence (Opalinus Clay, Staffelegg Formation) describe a continuous profile from the water-conducting zone in the limestone into the clay-rich rocks of low permeability. Concentrations of ^{4}He, ^{3}He and their parent nuclides in the rock allow calculating in-situ production and accumulation terms. Since the time of sedimentation, 90% - 97% of the in-situ produced ^{4}He has been released to the porewater. Today only 2.5% of the maximum possible accumulated ^{4}He is still retained in the porewater while the major part of in-situ produced ^{4}He was removed from the system presumably by porewater–groundwater exchange. The porewater ^{4}He concentrations show a diffusion profile from the aquitard towards the aquifer, reflecting a) a transient state