Scavenging of ^{230}Th and ^{231}Pa at the Bermuda Rise

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Abstract

The Bermuda Rise is a site of great paleoceanographic interest due to its high sediment accumulation rates, due in part to intense lateral advection. The particle-reactive U-series nuclides ^{230}Th and ^{231}Pa have been used at the Bermuda Rise and elsewhere as tracers of ocean circulation (e.g. AMOC), but their use is complicated by the influence of particle composition on the scavenging of these radionuclides. The recently initiated Bermuda Rise Flux Project (BaRFlux) offers an opportunity to resolve some of the processes controlling the delivery of ^{230}Th and ^{231}Pa to the seafloor. BaRFlux aims to better constrain the sedimentation process at the Bermuda Rise through sampling filterable particles in the water column as well as sinking particles caught in sediment traps. We have deployed a mooring consisting of 10 sediment traps, with two traps each at water depths of 300, 1000, 1500, 2500 and 4200 meters. Each depth has a trap collecting particles as a function of time and a trap separating particles in situ according to their settling velocity. The sediment trap mooring is turned around ever 3 months. Seawater samples also have been taken to characterize the distributions of ^{230}Th and ^{231}Pa in the water column. This contribution will present preliminary results on the effects of particle flux, particle sinking velocity and lateral advection on the scavenging of ^{230}Th and ^{231}Pa from the water column to the sediment at this site.

Understanding gas dynamics in unsaturated fractured granite using SF_6, CO_2, Rn and other noble gases.

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The Roselend Natural Laboratory

In the Roselend Natural Laboratory (French Alps), a tunnel provides access to the heart of unsaturated fractured crystalline rocks at 55 m depth below ground surface (Figure 1). This underground research facility allows studying gas transfer between a 60 m^3 chamber isolated at the dead-end of the tunnel and vertical and horizontal boreholes at the surface. Transport properties were determined at various scales using these boreholes and chamber.

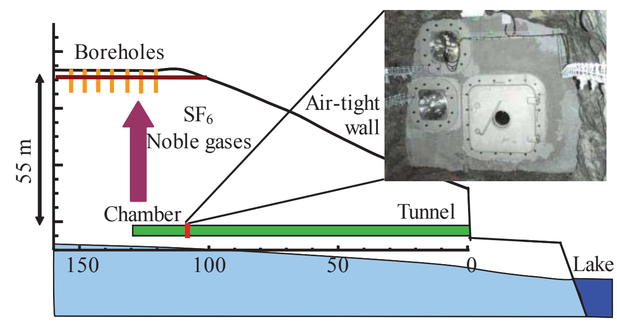

Figure 1: Setting of the Roselend Natural Laboratory, near the artificial Roselend lake, with the isolated chamber and boreholes.

Experimental and numerical results

We carried out a field-scale tracing experiment using SF_6 with the aim to serve for a forthcoming experiment using helium-3 and other noble gases. SF_6 was injected in the isolated chamber at 150 mbar above atmospheric pressure during 2 hours. SF_6 breakthrough was detected after only 10 hours at the ppb level in several surface boreholes, consistent with advective transfer in major fractures. SF_6 concentration in the surface progressively increased up to 30 ppm, and started to decrease 4 months after injection, indicating slow migration in the porous matrix.

^{222}Rn and CO_2 (concentration and $\delta^{13}C$) are monitored on the long term in the tunnel and at the surface. These gases are naturally produced by the rock. Air without tracer repeatedly injected from the chamber is able to flush large amounts of these gases out of the porosity.

These experiments are used to better understand gas dynamics and residence time in this dual porosity medium, in response to natural solicitations (meteorological, biological, geochemical, mechanical) and particularly barometric pressure fluctuations and variable water saturation. Numerical modeling is presented to account for the driving processes deduced from observations.