

Possible influence of permafrost melting on $^{234}\text{U}/^{238}\text{U}$ activity ratios in Alpine groundwater.

Surbeck, H., *Kies, A. & **Aviolat, P.

Centre d'Hydrogéologie (CHYN), University of Neuchatel, Switzerland, heinz.surbeck@unine.ch
*Laboratoire Physique des Radiations (LPR), University of Luxembourg, antoine.kies@uni.lu
**Bureau d'ingénieurs et géologues Tissières SA, Martigny, Switzerland, pascal.tisseres@mycable.ch

Primordial ^{238}U ($T_{1/2} = 4.5\text{e}9\text{y}$) decays by the emission of an alpha particle to the short lived ^{234}Th ($T_{1/2}=24\text{d}$). During alpha decay part of the decay energy is transferred to the daughter nuclide. This recoil energy (72 keV) is large enough to kick out the atom from a regular lattice site. Thus such a radionuclide becomes more vulnerable to leaching than its neighbouring atoms. Successive decays via a short-lived intermediate nuclide ($^{234\text{m}}\text{Pa}$, $T_{1/2}=1.2\text{m}$) lead to the long-lived ^{234}U ($T_{1/2}=2.5\text{e}5\text{y}$). ^{238}U and ^{234}U may thus be found in different chemical environments, with the ^{234}U more vulnerable to leaching (Osmond & Ivanovich 1992). This may explain why one frequently finds $^{234}\text{U}/^{238}\text{U}$ activity ratios larger than 1 in groundwaters. Values up to 3 are rather common, also in Swiss groundwaters.

Larger $^{234}\text{U}/^{238}\text{U}$ ratios are to be expected in waters passing through soils or heavily fractured rocks that have long (> 100'000 y) been isolated from (liquid) water. An example for this are extremely high $^{234}\text{U}/^{238}\text{U}$ ratios of up to 16 found in groundwater mixing with water from melting permafrost in Siberia (Tokarev et al. 2006).

It would be worth to look for similar effects in Alpine groundwaters with known or suspected contribution from melting permafrost. Of particular interest are regions with increased uranium concentrations, areas where high uranium levels in spring water have already been found (Surbeck et al. 2006). In the Swiss Alps catchment areas close to the permafrost limit and with known uranium mineralizations are mainly located in the canton of Valais, south of the Rhone between Val de Trient and Val d'Herens, north of the Rhone between the Baltschiedertal and the Grimsel pass.

At one of the springs that may become influenced by permafrost melting, a spring in the Val Ferret, we plan to install a uranium monitoring system. Selective uranium adsorption on a thin film and subsequent in-situ alpha spectrometry will allow to determine the $^{234}\text{U}/^{238}\text{U}$ activity ratio with a temporal resolution of 1 to 2 days (Surbeck 2000). The system will be fully automatic, with the spectra transmitted as an SMS message to our lab in Neuchatel.

Actually the $^{234}\text{U}/^{238}\text{U}$ ratio in this spring water is 1.1 ± 0.4 at a ^{238}U level of (34 ± 6) mBq/l (= (2.7 ± 0.5) ppb uranium). This uranium activity is large enough to give sufficiently good counting statistics, but small enough that additional uranium arriving would be easily seen.

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