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Coupling groundwater residence time and 234U/238U isotopic ratios in a granitic catchment (Vosges, Eastern France)

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Weathering processes are active in surface waters but groundwater also represents no neglectable chemical fluxes. As residence-time in groundwater are high, silicate weathering might take place and control Si, Ca and C fluxes. Weathering processes can be deduced from U isotopic ratios but the kinetics of these processes remain relatively poorly constrained.
In order to better characterize these processes, we have coupled residence-times deduced from anthropogenic gases (CFC and SF6) analysis and 234U/238U isotopic ratios determination. Samples were collected in the Strengbach catchment (Hydro-geochemical Observatory OHGE, Vosges, eastern France). Two campaigns were carried out in May and August 2015 during two highly contrasted hydro-climatic periods. Both springs and boreholes down to 80 m depth have been sampled.
A very clear geochemical distinction is observed between groundwater from surface springs and deeper groundwater from boreholes. Springs show much lower residence-time (few years) and specific chemical composition. Deeper groundwater have residence-time of several decades and different geochemical composition. A clear SF6 production is observed with increasing SF6 concentrations with residence-time.
The campaign of May is characterized by highly groundwater levels and spring fluxes. All groundwater show very low residence time, except in the boreholes at depth greater than 40 m. Conversely, during low groundwater-level period in August, the residence times are much higher and CFC concentrations indicate a large mixing process between surface groundwater and deeper levels.
The 234U/238U isotopic ratios confirm this vertical zonation in the boreholes, with much higher activity ratios in the deep ground-waters from borehole than in the surface and spring waters; Such high U activity ratios are indicative of long water-rock interactions, which is consistent with the long residence times deducted from the CFC and SF6 data.