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Hydrogeochemical constrains from U activity ratios measured in spring waters: Example of the granitic Ringelbach catchment (Vosges Mountain, France)

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This study presents a detailed analysis of major element concentrations and U and Sr isotope ratios in water samples from the main springs located in the small (0.36 km2) granitic catchment (Ringelbach creek Catchment, Vosges, France), monthly collected during two hydrological years from October 2004 to September 2006. The data highlights that at a scale of a small watershed, large spatial variations in the chemical and isotopic compositions (Sr-U) of the spring waters on granitic lithology can occur along with significant temporal variations in the elemental concentrations and elemental concentration ratios of the waters for a given spring.
The increase in the alkalinity, the major element (Na, Ca and Mg) concentrations, and especially the U activity ratios of the granitic spring waters with decreasing elevation of the spring in the watershed certainly indicate that the length of the water pathway within the bedrock is a primary parameter to take into account for explaining the geochemical characteristics of the granitic spring waters. The modeling of the (234U/238U) activity ratio variations in spring waters using a simple stationary 1D reactive transport model that considers dissolution, precipitation and alpha recoil allows for the determination of the dissolution rate of the granitic bedrock and the water residence time for the granitic springs within the catchment. These results highlight that the analysis of different springs emerging along the slope of a single watershed enables a simple method to characterize the different stages of water evolution along the water pathway.