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U-Ra fractionations in surface waters :

Clues from Strengbach watershed (Vosges – France)

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U-series disequilibrium in river waters are recognized to be helpful geochemical tracers and chronometers to constrain the nature and the timescale of weathering processes at watershed scale. Such a use requires however precise knowledge of the main processes controlling fractionations among U-series nuclides in surface waters and during weathering. In order to characterize these processes, ^{238}U-^{234}U-(^{230}Th)-^{226}Ra disequilibrium have been analyzed in stream and spring waters collected on the experimental Strengbach catchment (Observatoire Hydro-géochimique de l'Environnement, http://ohge.u-strasbg.fr) (Vosges, France) at different hydrological periods. In addition, U-series disequilibrium has been analyzed in roots, branchs and leaves of main tree species growing in the watershed.

The results show that at the scale of such a small watershed, the (^{234}U/^{238}U) and (^{226}Ra/^{238}U) activity ratios in spring and stream waters are marked by a large range of variations : from 0.823 to 1.112 for (^{234}U/^{238}U) and from 0.65 to 31.6 for (^{226}Ra/^{238}U). The (^{234}U/^{238}U) activity ratios of the springs are anti-correlated with the emergence altitude of waters. The (^{226}Ra/^{238}U) activity ratios follow the same trend. Such variations could be linked to the water pathways in the watershed substratum : waters with deep pathways, i.e. emerging at low altitudes, would mobilize U and Ra from "fresh" rocks and hence would exhibit (^{234}U/^{238}U)$>$1 and the highest (^{226}Ra/^{238}U); waters with shallower pathways, i.e. emerging at higher altitude, would interact with previously weathered horizons and hence would display (^{234}U/^{238}U) $<$1 and the lowest (^{226}Ra/^{238}U). The leaching of radium would be thus more important than that of uranium in this granite weathering context. In addition, the U-Ra data,

especially the comparison of (^{226}Ra/^{238}U) activity ratios with Rb/U ratios in water samples and vegetation demonstrate that a significant part of Ra carried by the spring and stream waters is affected by vegetation recycling.

This study clearly demonstrates the interest of the U-series disequilibrium to determine the origin of the weathering fluxes carried by river waters at watershed scale. Moreover, this work suggests an important role of the vegetation on the geochemical signature of surface waters by the litter recycling and emphazes the potential use of (^{226}Ra/^{238}U) activity ratios to constrain this recycling.