U-series disequilibria in primary minerals of granitic soil

S.RIHS[1], D.FRIES[1,2], A.GONTIER[1], E. PELT[1], D. LEMARCHAND[1], F.CHABAUX[1], M.P. TURPAULT[3]

[1]Laboratoire d'Hydrologie et de Géochimie de Strasbourg, EOST, 1 rue Blessig, 67084 Strasbourg Cedex, France

[2] present address: Ocean and Earth Science, National Oceanography Centre, Southampton SO14 3ZH, UK

[3] Laboratoire de Biogéochimie des Ecosystèmes Forestiers, INRA, 54280 Champenoux, France

Over the last decades, U-series disequilibria were successfully used to determine weathering rates in regoliths and soils. However, most of the studies deal with bulk soil samples and the mineralogical origin of the disequilibria observed in soils remains unclear. Our work therefore aims to compare the U-series disequilibria recorded by the primary minerals in granitic soils. Muscovites, perthitic feldspars (mixture between Na and K feldspars) and biotites were hand-picked in four horizons of a soil profile from the experimental Breuil-Chenue site (France) developed by INRA-BEF team. The ($^{234}U/^{238}U$), ($^{230}Th/^{234}U$) and ($^{226}Ra/^{230}Th$) activity ratios were measured in addition to ^{232}Th concentrations.

The perthitic feldspars show a loss of U and Th toward the shallow horizons, concomitant to the major elements loss. However, ($^{234}U/^{238}U$) and ($^{230}Th/^{234}U$) ratios only sligthly deviate from radioactive equilibrium, suggesting a weathering process of these minerals that do not strongly fractionnate U isotopes and U-Th ratio. In contrast, both phyllosilicates (muscovite and biotite) show more pronounced U-series disequilibria. Several samples of muscovite display a significant gain of external U, probably promoted by the primary low U and Th concentrations of these minerals. Biotites samples show much higher U and Th concentrations and an especially large preferential loss of ^{234}U. Additionally, we notice an unexpected preferential loss of Th isotopes relative to ^{238}U, disconnected from the major elements evolution. These features suggest an incongruent leaching of U and Th isotopes, in contrast to perthitic feldspars. The analysis of the ($^{234}U/^{238}U$) ratio extracted from the biotite interlayer allows to propose a explanation for the enhance mobility of ^{234}U. Finally, an open-system leaching model permits to determine mineral weathering rates from the measured U-series disequilibria.

These results highlight that the U-series nuclides provide some valuable informations on the weathering processes and rates simultaneously affecting different mineral types within a soil.