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Control of the U and Th behaviour in forest soils

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U- and Th-series disequilibria and U, Th, Fe and Al speciation, were measured in several soil profiles from the experimental forest site of Breuil (Morvan, France) in order to address the impact of the vegetation on U and Th nuclides behaviour in soils. Thirty-five years after an experimental clear-felling of the native forest, the soil developed under two replacing mono-specific plantations (Oak and Douglas fir) were therefore compared to the undisturbed native forest soil. The analogous physical and chemical properties of these soils before the replacement were formerly demonstrated. Our results suggest that a shift in the Iron distribution seems to occur under the stand replaced by Oaks, with a significant replacement of Fe-bearing silicates by well crystallized Fe oxides. In contrast, such evolution was not demonstrated in the soils under Douglas fir. The concurrent loss of U and Th from the soils under Oak was tentatively related to the dissolution of Fe-bearing minerals. A mass balance calculation demonstrates that the observed increase in U oxalate-extracted fractions can quantitatively be explained through the entire profiles by a mere dissolution of up to 20% of U-Fe-bearing silicated minerals, without significant re-adsorption onto the amorphous Fe-Al oxides for U. Beside this primary release from Fe-bearing silicate minerals, the mobility of U and Th seems more likely controlled by Al phases rather than Fe oxides in surface layers during further pedogenic processes. Indeed, some of the U- and Th series disequilibria seem to be strongly related to Al dynamic in these layers. This relationship can be seen in the native forest profiles as well as in the replaced profiles, suggesting that this feature is not linked to the cover change. The redistribution of U and Th isotopes through these pedogenic processes therefore rule out the use of U-series for weathering rate determination in shallowest soils layers. In contrast, below 25 cm, the release of U and Th as well as the change of their distribution among the soil phases does not affect U- and Th series disequilibria. The activity ratios measured in oxalate leachates and the residues allow to demonstrate that the dissolution of a U-bearing silicate mineral and the consequent release of up to 20% of U would shift the ($^{234}\text{U}/^{238}\text{U}$) and ($^{230}\text{Th}/^{234}\text{U}$) ratios by less than 2%. These results therefore reveal that, after 35 years, no significant impact of the cover change on U-series disequilibria was recorded in the main part of the soil profiles, which, at this stage, justify the use of these nuclides as chronometers for weathering determination.