Insight into the use of U- and Th-series nuclides for soil-production rates determination

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Over the last decades, the U- and Th-series isotopes were used to determine weathering rates in various environments (e.g.,1-5), but some concerns may arise about the use of these chronometers in soil profiles. The objective of this study was to address two of these concerns: the impact of a land cover change and the bedrock characteristics on these chronometers. This study was carried out in the Breuil-Chenue experimental forest site (Morvan, France) developed by INRA-BEF. In 1976, the native forest was partially clear-felled and replaced by monospecific plantations (oak, Douglas and spruce). The site is separated in two adjacent blocks which distinguished by different grain-sizes of the same granite bedrock. Three podzolic soil profiles developed on the coarse grain-size granite were sampled under the native forest, replanted oak and Douglas stands respectively and one soil profile was sampled under the native forest developed on the fine grain-size granite. Some selective extractions were performed in order to investigate the distribution of U and Th among different soil phases, including the cation exchangeable fraction, Fe-Mn amorphous oxides (ammonium-oxalate extraction) and silicate minerals.

No significant amount of U and Th was detected in the exchangeable fraction, but the oxalate-extracted phase (mainly amorphous Fe-Mn oxides and organics) holds up to 25 % of these elements, with clear pedogenic redistribution through all the profiles. In all the four different soil profiles the activity ratios of the U-series nuclides vary within a narrow range of values: from 0.94 to 0.95 for ($^{234}U/^{238}U$) and from 1.19 to 1.22 for ($^{230}Th/^{234}U$), but our results demonstrate that the podzolic pedogenic processes may significantly impact the shallowest soil layers (0-40cm), making these horizons unsuitable for U-series dating. In contrast, the deepest soil layers do not show observable vegetation-derived or grain-size effects on the U-Th series. The soil production rate can therefore be calculated from these latter.

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Metal adsorption on mosses: Towards a universal adsorption model

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Physico-chemical characterization was performed for four moss species (*Hypnum sp*., *Sphagnum sp*., *P. purum* and *B. rutabulum*) and five metals (Cu^{2+}, Cd^{2+}, Ni^{2+}, Pb^{2+} and Zn^{2+}). Chemical composition of mosses showed that all 4 mosses exhibit similar concentration of Cu and Zn. For Pb and Cd, *Sphagnum sp*. is the most enriched.. The amount of metal released as a function of time for each moss allow to classify the moss species in the following order. For Cu^{2+}, Ni^{2+} and Pb^{2+}: *B. rutabulum* > *P. purum* > *Sphagnum sp*. ≥ *Hypnum sp*.. For Cd^{2+}, *P. purum* > *B. rutabulum* > *Hypnum sp*. ≥ *Sphagnum sp*.. For Zn^{2+}, this sequence is *P. purum* > *B. rutabulum* > *Sphagnum sp*. ≈ *Hypnum sp*.. During this experiment, the DOC amount measurements showed that *Sphagnum sp*. released the lower DOC concentration. The acid-base surface titration of moss species from pH 3 to 11 indicated that *Sphagnum sp*. was species with more negative excess of charge. The pH of point zero charge (pH_{PZC}) was computed as 5.01 ± 0.13, 4.64 ± 0.1, 4.96 ± 0.14 and 6.23 ± 0.25 for *Hypnum sp*., *Sphagnum sp*., *P. purum* and *B. rutabulum* respectively. The adsorption of metal as a function of pH showed different pattern depending on the metal and allow to classify them as following: for Cu^{2+}, *P. purum* > *B. rutabulum* > *Hypnum sp*. > *Sphagnum sp*.. For Cd^{2+} and Zn^{2+}, *B. rutabulum* > *Sphagnum sp*. > *P. purum* > *Hypnum sp*.. For Ni^{2+} and Pb^{2+}, *B. rutabulum* > *P. purum* > *Hypnum sp*. > *Sphagnum sp*. The metal adsorption on moss surfaces as a function of aqueous metal concentration showed a close relationship between moss species for each individual metal. The adsorption order can be expressed by following. For Cu^{2+}, *P. purum* ≈ *Sphagnum sp*. ≈ *B. rutabulum* > *Hypnum sp*.. For Cd^{2+}, *Sphagnum sp*. > *B. rutabulum* > *Hypnum sp*. > *P. purum*. For Ni^{2+}, *Sphagnum sp*. ≈ *Hypnum sp*. ≈ *P. purum* ≈ *B. rutabulum*. For Pb^{2+}, *B. rutabulum* > *Hypnum sp*. > *Sphagnum sp*. > *P. purum*. For Zn^{2+}, *B. rutabulum* ≈ *Sphagnum sp*. ≈ *Hypnum sp*. > *P. purum*. Eventually, a Linear Programming Modeling was applied for experimental data in order to compute the pK_s, pK_m and pK_a.

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