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Combined analysis of Uranium series nuclides and in situ ^{10}Be in a weathering profile located in the Strengbach catchment (Vosges massif, France)

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Recent studies underline the potential of U series nuclides to quantify the regolith production rate in weathering profiles [1] [2]. In addition, the estimates of both exposure age and mean denudation rate from a single cosmogenic isotope analysis has become possible due to the recent improvement of in situ ^{10}Be depth profile methodology [3]. In this work, we propose to combine the analysis of Uranium-Thorium-Radium isotopes with the cosmogenic in situ ^{10}Be in a weathering profile extending from the topsoil to the fractured granitic bedrock at 2 m depth to better estimate both production and denudation rate of regolith. The weathering profile is located on the summit of the watershed and has been sampled at high spatial resolution (15 samples). Whole rock data show different trends of variation of major and trace element concentrations and also of U-Th-Ra disequilibria in the upper part of the regolith (0-80 cm) and the deeper part of the fractured saprolith and/or bedrock (100cm-200cm). The data indicate that the Uranium series isotopes in the surface of the profile are difficult to interpret in term of weathering rate, while the disequilibria in the deeper weathered bedrock show a smooth trend. The modeling of the U-Th-Ra data in this deeper part of the profile is performed with a common approach of gain/leaching radionuclide coefficient determination and leads to a regolith production rate of 30 ± 10 T/km²/year. In addition, a numerical optimization for nonlinear inverse problem has been performed to estimate the exposure age and the mean denudation rate at the summit from the beryllium data. The results show that the exposure age of the profile is about 20 000 years and that the mean denudation rate is 37 ± 15 T/km²/year. The calculated exposure age suggests that a modification of the surface state of the summit, probably related to the last glaciation, occurred about 20 000 BP. The consistency between the regolith production rate and the soil denudation rate suggests therefore that in such a temperate context, the long-term mass balance of soil developed on granitic bedrock would be close to a steady state.

References

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