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Regolith production rates from 238U-234U-230Th disequilibrium in a deep granitic weathering profile (Longnan, SE China)

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The present study seeks to evaluate the application of the ^{238}U-^{234}U-^{230}Th radioactive disequilibrium methodology for the determination of the regolith production rates in thick weathering profiles marked by long histories, encountered under various climate regimes, but still very little studied by these techniques. For this purpose, ^{238}U-^{234}U-^{230}Th disequilibria have been analyzed in a ≈ 11 m-deep profile developed on a granitic bedrock in south China (Longnan, Jiangxi Province) under a subtropical climate. The results demonstrate that in such deep weathering profiles the determination of weathering rates from the analysis of U-series nuclides in bulk rock samples cannot be recovered by applying in one step to the entire alteration profile the modeling approach classically used to interpret the U-series nuclides, i.e. the "gain and loss" model. The modeling has to be made on subsections of relatively small size (<1 or 2 meters of thickness), so that the model assumptions can be met, especially the constancy of the mobility parameters along the weathering zone. The results also confirm that the upper part of the weathering profiles marked by the vegetation/biological influences and responding to the short-term climate variations is not well adapted for applying the U-series nuclides methodology for recovering regolith production rates. Based on the data, regolith production rates were estimated independently on four different zones of the profile. Similar values of ~2m/Ma have been obtained whatever the level, suggesting that such a profile of more than 5 million years would be formed at a relatively stable long-term production rate (averaged over several thousand years). This slow production rate of 2 m/Ma can be reconciled with the previously published in situ ^{10}Be data from the same profile, when assuming non steady-state erosion of the upper part of the profile. Slow denudation rates similar to the U-series derived production rates of 2 m/Ma can thus be obtained with a minimum exposure time of 40 ky, and an inherited component of 20-25*10^4 at/g originating from the exhumed deeper part of the profile. Altogether the data demonstrate that the combined analysis of U-series and cosmogenic nuclides, which has the potential to become a relevant approach to constrain the dynamics of continental surfaces, requires (a) dense and deep sampling for both nuclides studies, and (b) also to consider more systematically the polyphased and variable

history of erosion of the continental surface during the Quaternary. These results have implications for the interpretation of long-term accumulation of ^{10}Be at depth and ^{10}Be data variations in granitic alteration profiles.