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Coupling data from U-series and 10Be CRN to evaluate soil steady-state in the Betic Cordillera

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The regolith mantel is produced by weathering of bedrock through physical and biochemical processes. At the same time, the upper part of the regolith is eroded by gravity mass movements, water and wind erosion. Feedback's between production and erosion of soil material are important for soil development, and are essential to reach long-term steady-state in soil chemical and physical properties.

Nowadays, long-term denudation rates of regolith can be quantified by using in-situ cosmogenic nuclides (CRN). If the soil thickness remains constant over sufficiently long time, soil production rates can be determined. However, the a priori assumption of long-term steady-state can be questionable in highly dynamic environments. In this study, we present analytical data from two independent isotopic techniques, in-situ cosmogenic nuclides and Uranium series disequilibrium. The disequilibrium of Uranium isotopes (238U, 234U, 230Th, 226Ra) is an alternative method that allows assessing soil formation rates through isotopic analysis of weathering products.

Nine soil profiles were sampled in three different mountain ranges of the Betic Cordillera (SE Spain): Sierra Estancias, Filabres, Cabrera. All soils overly fractured mica schist and are very thin (< 60cm). In each soil profile, we sampled 4 to 6 depth slices in the soil profile, the soil-bedrock interface and (weathered) bedrock. Three of the nine soil profiles were sampled for U-series isotope measurements at EOST (University of Strasbourg). The surface denudation rates (CRN) are about the same in the Sierra Estancias and Filabres (26 ± 10 mm/ky) and increase up to 103 ± 47 mm/ky in the Sierra Cabrera. The spatial variation in soil denudation rates is in agreement with the variation in catchment-wide denudation rates presented by Bellin et al. (2014) which present the highest rates in the Sierra Cabrera (104-246mm/kyr). Moreover it roughly coincides with the pattern of long-term exhumation of the Betic Cordillera. Results from first simulations of the U-series disequilibrium model rather suggest that soil production rates are of the same order of magnitude in the Sierra Estancias and Cabrera. In the Sierra Filabres, the U-series disequilibrium in the depth profile do not respect the hypotheses of the model therefore no rates of soil production could be constrain for this profile.

Thanks to the coupling of the two isotopic datasets the long term soil development will be explored in two profiles. This study highlights that comparison and combination of analytical techniques is useful to further unravel the mechanisms of chemical and physical weathering in such dynamic environments.

Bellin, N., Vanacker, V., and Kubik, P. W., 2014, Denudation rates and tectonic geomorphology of the Spanish Betic Cordillera: Earth and Planetary Science Letters, v. 390, p. 19-30.