The soil hillslope conveyor belt- quantifying bioturbation and erosion

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Key geomorphological processes such as bioturbation, erosion and sedimentation influence soil formation. These processes can be quantified from soil particle properties by luminescence techniques, through the measurement of particle age and of the proportion of mineral grains which are involved in soil mixing either vertically or laterally. In this study fifteen samples have been measured with single grain infrared luminescence stimulated (IRSL) applied to feldspar. The sampling was carried out at different depths in four soil profiles on a hillslope under natural vegetation located in the Cardeña and Montoro Natural Park, near Cordoba, Spain. This study presents a simple analytical model using the diffusion-advection equation to simultaneously quantify bioturbation, erosion and sedimentation rates along a hillslope. The model is calibrated with the burial ages which have been calculated with IRSL technique. An uncertainty study was applied to establish the parameters of better fit to the measured data. A global sensitivity analysis was done to assess the importance of the parameters in the model. The obtained results show a variation of the bioturbation diffusivity parameter of 47 mm2/year in the profile located in the bottom part of the hillslope and 4.8 mm2/year on the top of the hillslope. There is high uncertainty with the exact estimation of the erosion and sedimentation, but the results point to bioturbation as being the dominant process. The relationship between the soil mixing and diffusivity is calculated with a good fit, showing the potential of this analytical model.
This work reveals the prospective of IRSL single-grain techniques to quantify pedoturbation processes.