Going Steady: Using multiple isotopes to test the steady-state assumption at the Susquehanna Shale Hills Critical Zone Observatory *(Invited)*

Details

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Abstract

Regolith-mantled hillslopes are ubiquitous features of most temperate landscapes, and their morphology reflects the climatically, biologically, and tectonically mediated interplay between regolith production and downslope transport. Despite intensive research, few studies have quantified both of these mass fluxes in the same field site. Here, we exploit two isotopic systems to quantify regolith production and transport within the Susquehanna Shale Hills Critical Zone Observatory (SSHO), in central Pennsylvania. We present an analysis of 131 meteoric ^{10}Be measurements from regolith and bedrock to quantify rates of regolith transport, and compare these data with previously determined regolith production rates, measured using uranium-series isotopes. Regolith flux inferred from meteoric ^{10}Be varies linearly with topographic gradient (determined from high-resolution LiDAR-based topography) along the upper portions of hillslopes in and adjacent to SSHO. However, regolith flux appears to depend on the product of gradient and regolith depth where regolith is thick, near the base of hillslopes. Meteoric ^{10}Be inventories along 4 ridgetops within and adjacent to the SSHO indicate regolith residence times ranging from ~ 9 - 15 ky, similar to residence times inferred from U-series isotopes (6.7 ± 3 ky - 15 ± 8 ky). Similarly, the downslope flux of regolith (~ 500 - 1,000 m^2/My) nearly balances production (850 ± 22 m^2/My - 960 ± 530 m^2/My). The combination of our results with U-series derived regolith production rates implies that regolith production and erosion rates along ridgecrests in the SSHO may be approaching steady state conditions over the Holocene.

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