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Interpreting erosion frequency and magnitude from luminescence profiles in boulders

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Exposed bedrock is ubiquitous on terrestrial and planetary landscapes, yet little is known about the rate of bedrock erosion at a granular scale on timescales longer than the instrumental record. As recently suggested, using the bleaching depth of luminescence signals as a measure of bedrock erosion may fit these scales. Yet this approach assumes constant erosion through time, a condition likely violated by the stochastic nature of erosional events. Here we simulate bleaching in response to power-law distributions of removal lengths and hiatus durations. We compare simulation results with previously measured luminescence profiles from boulder surfaces to illustrate that prolonged hiatuses are unlikely and that typical erosion scales are sub-granular with occasional loss at mm scales, consistent with ideas about microflaws governing bedrock detachment. For a wide range of erosion rates, measurements are integrated over many removal events, producing reasonably accurate estimates despite the stochastic nature of the simulated process. We hypothesize that the greater or equal erosion rates atop large boulders compared to rates at ground level suggest that subcritical cracking may be more influential than aeolian abrasion for boulder degradation in the Eastern Pamirs, China.