Centennial- to millennial-scale hard rock erosion rates deduced from luminescence-depth profiles

The measurement of erosion and weathering rates in different geomorphic settings and over diverse temporal and spatial scales is fundamental to the quantification of rates and patterns of earth surface processes. A knowledge of the rates of these surface processes helps one to decipher their relative contribution to landscape evolution – information that is crucial to understanding the interaction between climate, tectonics, and landscape. Consequently, a wide range of techniques has been developed to determine short (<10^2 a) and long-term (>10^4 a) erosion rates. However, no method is available to quantify hard rock erosion rates at centennial to millennial timescales. Here we propose a novel technique, based on the solar bleaching of luminescence signals with depth into rock surfaces, to bridge this analytical gap. We apply our technique to glacial and landslide boulders in the Eastern Pamirs, China. The calculated erosion rates from the smooth varnished surfaces of 7 out of the 8 boulders sampled in this study vary between <0.038 ±0.002 and 1.72 ±0.04 mm ka⁻¹ (the eighth boulder gave an anomalously high erosion rate, possibly due to a recent chipping/cracking loss of surface). Given this preferential sampling of smooth surfaces, assumed to arise from grain-by-grain surface loss, we consider these rates as minimum estimates of rock surface denudation rates in the Eastern Pamirs, China.

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