



Continental erosion and the gross control of topography over multiple time and space scales

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Erosion, like deposition, is a combination of tectonic and climatic forcing, as well as internal processes inherent to sediment transport systems. Long-term (thousands to hundreds of thousands of years) measurements implicitly average many shorter-term erosion rates (time periods up to 10^2 years) that similarly integrate a plethora of actual erosion processes at a pace set by the tectonic forcing. Erosion rates measured over shorter timescales (e.g. sediment yield, reservoir infill) show greater variance due to the stochastic nature of erosion and surface process interactions. What first-order controls set the pace for gross erosion of a river basin? Over which space and time scales do these controls operate?

To address these questions, we have compiled previously published data from studies of in-situ produced cosmogenic ^{10}Be in fluvial sediments to create a global dataset that includes ^{10}Be concentrations and calculated erosion rates. Paired with these denudation rates are local, basin-scale physiographic characteristics determined from the 3 arc second Shuttle Radar Topography Mission (SRTM) for each basin represented by CRN data. At cosmogenic-averaging timescales of 10^3 - 10^6 years, mean basin elevation and relief (as well as the related topographic metrics of maximum basin elevation, mean relief, and mean slope) are equally correlated with log-transformed average basin denudation. Each correlation explains $\sim 45\%$ of the erosion rate variance. Mean elevation of the basin can predict long-term denudation to within an order of magnitude. Mean elevation is the most appropriate predictor of denudation averaged over these time scales because, globally, it is a surrogate for the propensity for convergence

or divergence of sediment flux within transport systems.

An exponential relation between basin-averaged elevation and erosion rate derived from global ^{10}Be data has a form virtually identical to that in existing datasets of large-river sediment yield to the world's oceans (Summerfield and Hulton, 1994). There is a weakly correlated exponential relation between basin-averaged elevation and sediment yield from a compilation of mesoscale-catchments only and basin-averaged elevation does not correlate with average elevation for small-scale catchments (Schäuble, 2005). The correspondence of cosmogenic ^{10}Be -based and sediment yield-based denudation rates to average elevation of the basins, irrespective of their discrepant time scales, implies that at millennial timescales and large spatial scales, secular variation in erosion and sediment transport across Earth's surface is less than the current short-term spatial variability from basin to basin.

Schäuble, H., 2005, Sedimentfrachtprognosen mit GIS: neue Strategien für globale Modellgleichungen unter besonderer Berücksichtigung von Staudämmen und des zeitlichen Wandels. Dissertation TU Darmstadt, Institut für Angewandte Geowissenschaften.

Summerfield, M.A., Hulton, N.J., 1994, Natural controls of Fluvial denudation rates in major world drainage basins, *Journal of Geophysical Research*, v. 99, p. 13871-13883.