More than Rates or Dates: the Power of Amalgamation when Tracing Landscape-scale Processes with ^{10}Be

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Boulder dates and bedrock erosion rates have been the bread and butter of cosmogenic nuclide science for more than a decade. Isotopes of He, Be, Ne, Al, and Cl illuminate the dark geochronologic recesses of the Pleistocene beyond the radiocarbon timescale, when luminescence dating fails, and where racimized shells are absent. But cosmogenic nuclides can do much more than constrain the history of points on Earth's surface. By exploiting the power of amalgamation, cosmogenic nuclides can help us understand landscape-scale processes and overcome the sometimes devastating spatial variability in nuclide concentration. This talk will review amalgamation techniques and results, and present new data.

Rivers - nature's amalgamators

A handful of river sand contains thousands of quartz grains, each of which has a unique and unknowable history. Yet, together these grains tell a coherent story of landscape erosion and sediment production. Numerous isotopic studies demonstrate efficient fluvial mixing down drainage networks. Regression analysis of river-sediment ^{10}Be data sets from around the world suggests tectonic setting and slope as overriding controls on erosion rate. Grain-size specific nuclide analysis allows process inference. In humid regions, with deep soil cover and extended periods of near-surface weathering, grain size is inversely related to ^{10}Be concentration reflecting differing sources and exposure histories. In arid regions, dominated by rock slopes and thin soil, grain size and nuclide concentration are unrelated suggesting more uniform exposure histories.

Throwing dirt in a bag - geologists extend nature's work

Sometimes nature doesn't do enough amalgamation and geoscientists need to help out. On both low-gradient, grussy, desert piedmonts in the Mojave Desert and also on steep, soil-mantled slopes in the Great Smoky Mountains, samples amalgamated from 7 to 20 soil pits dug along slope-parallel transects reveal soil processes including stirring, erosion, and deposition. Everywhere, we find an active layer, where transported sediment is well mixed. In the desert, sediment is stirred dm by episodic surface flow. On humid slopes, soil is stirred more deeply, primarily by tree-throw. In contrast to river networks, ^{10}Be concentration in soil generally increases downslope as sediment is dosed during slow, creeping transport. Average rates of downslope transport can be inferred from these data. Pebbles are washed down gentle desert piedmonts at cms to dms per year. Soil creeps down steeper mountain slopes at similar rates.