Paleo-erosion rates with cosmogenic nuclides: a synthesis of erosion and climate over million-year timescales

DARRYL E. GRANGER[1]*, JILL A. MARSHALL[2], JOSHUA J. ROERING[3], ZHIJUN ZHAO[4] AND FERNANDO V. LAUREANO[5]

[1]Earth Atmos. and Planet. Sci., Purdue Univ., W. Lafayette, IN, USA (*correspondence: dgranger@purdue.edu)
[2]Earth and Planet. Sci., Univ. California, Berkeley, CA, USA
[3]Geological Sci., Univ. Oregon, Eugene, OR, USA
[4]Geographical Sci., Nanjing Normal Univ., Nanjing, China
[5]Pontifícia Univ. Católica de Minas Gerais, Betim, MG Brazil

Cosmogenic nuclides in stream sediment are well-established for inferring basin-averaged erosion rates. The same nuclides measured in sedimentary archives can be used to learn about erosion rates in the past, after correcting for radioactive decay. The age of the deposit must be either known independently or solved by burial dating using a cosmogenic radionuclide pair such as $^{26}Al/^{10}Be$. Accurate estimation of paleo-erosion rates requires consideration of several factors in addition to those normally considered for modern erosion rates. These include (1) cosmogenic nuclide accumulation during sedimentation (2) production after burial, (3) variations in production rate through time, which can be especially significant at lower latitudes, and (4) changes in source area elevation due to uplift or subsidence.

We will present a synthesis of paleo-erosion rates measured throughout the globe to address the role of climate change in erosion. Over the past 15 years there have been conflicting interpretations of the role of climate in regulating physical erosion rates. It is clear that climate can strongly influence erosion rates in extreme environments, for example by glaciation or by regulating landslide frequency in threshold landscapes. The degree to which erosion rates vary in unglaciated soil-mantled landscapes has remained less certain, and can be measured with cosmogenic nuclides. Most of our sites span the initiation of Plio-Pleistocene climate change, and one preserves a detailed record across the last glacial maximum (LGM). Erosion rates at our low latitude sites (Brazil, South Africa) are slow and have remained largely unchanged, despite periods of river aggradation and incision. In contrast, erosion rates at most European and North American sites show a systematic increase in erosion rates associated with a much cooler and often periglacial regime. The role of periglacial processes is highlighted at a site in Oregon where erosion rates increase markedly during the LGM, most likely due to frost-shattering of the bedrock.