
In situ produced ^{10}Be and ^{26}Al measurements in shale quartz reveal patterns of erosion in the layered rocks of the southern Appalachian Mountains

Darryl Granger^{*†1} and Xianmei Huang^{‡1}

¹Purdue University [West Lafayette] – United States

Abstract

Cosmogenic nuclides are routinely used to quantify erosion and weathering rates in quartz-bearing rocks, but there have been few measurements in very-fine-grained rocks such as siltstone and shale. Because the grain size in these rocks is similar to the recoil length for cosmogenic nuclide production, it is important to verify measurement accuracy. We measured ^{10}Be and ^{26}Al across a range of grain sizes, demonstrating reproducibility down to scales of only several microns.

We applied this method to constrain denudation rates in the Valley and Ridge province of the Appalachian Mountains in southwestern Virginia. In this iconic fold-and-thrust belt, ridges are upheld by resistant sandstones, while anti-dip mountain flanks and valleys are underlain by shale and limestone. The mountains are steep and forested, and some slopes are mantled by relict colluvial deposits and/or sandstone boulders.

Results from two different transects reveal that the sandstone mountain ridges are eroding from 15-30 m/My, consistent with previous measurements based on sand-sized quartz regionally. However, erosion rates in siltstone and shale are slower, from ~3-15 m/My, even though the hillslopes are steep and formed in erodible rocks. This pattern could reflect declining relief, with ridges eroding more quickly than valleys. Alternatively, the cosmogenic nuclides may be recording a relict signal of faster erosion of the ridges due to periglacial processes during the Last Glacial Maximum (LGM). Ongoing work reconstructing paleo-erosion rates from LGM sediments will help test this hypothesis.

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*Speaker

†Corresponding author: dgranger@purdue.edu

‡Corresponding author: huan1238@purdue.edu