MEASURING MULTIPLE COSMOGENIC NUCLIDES: WHAT THEY TELLS US ABOUT THE STABILITY AND COVER HISTORY OF BEDROCK SURFACES

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Bare bedrock surfaces crop out over much of the world in geomorphic environments ranging from mountain ranges to cratons. Unraveling the processes affecting such surfaces, in particular, quantifying the rate at which they lose mass, the pattern of mass loss, and the history of burial and exposure, has proven to be difficult and controversial. The difficulty results from the fact that bedrock outcrops are erosional surfaces and the material needed to understand their evolution has long-since eroded away.

For nearly a decade, investigators have been measuring the abundance of nuclides (3-He, 10-Be, 14-C, 21-Ne, 26-Al and 36-Cl) produced in rock by cosmic-ray bombardment. The abundance of any single nuclide can be used to calculate a maximum limiting erosion rate by assuming that the sampled surface is steadily eroding. Our measurements on silicic rocks, collected from 7 sites outside mountain ranges, show that limiting erosion rates (ε) scale inversely with mean annual precipitation: ε (m/My)=2.6 x annual precip (mm) + 0.4 m/My

But, the story is not so simple. Our measurement of multiple nuclides (26-Al and 10-Be) show unambiguously that the history of many exposed rock surfaces includes periods of burial during and/or after exposure. While such multiple isotope measurements cannot be used to assign definitive exposure histories, they can be used to set limits on total exposure time and maximum erosion rate. For example, in Australia, isotopic abundance in samples collected from the bare rock tops of granitic inselbergs mandate cover by now-vanished sheet structures or eolian debris. On the highlands of Baffin Island, weathered rock outcrops have isotopic signatures indicative of burial most likely by cold-based ice or snow fields during or after cosmic-ray exposure. For these older samples and we presume many others, such burial means that calculated limiting erosion rates and exposure ages, based on individual nuclide measurements, are respectively, overestimates and underestimates of up to ten-fold.

cosmogenic-nuclide, erosion, exposure-history, granite