

HOW QUICKLY DOES GRANITE ERODE -- EVIDENCE FROM ANALYSES OF IN SITU PRODUCED 10-Be, 26-Al, AND 36-Cl

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Granite and other crystalline rocks underlie a large portion of Earth's surface and are the substrate on which a number of distinctive landforms such as pediments and inselbergs have evolved. Although these landforms have received over a century of study, the rate at which inselbergs form and the "age" of their bare, bedrock surfaces remain poorly constrained. Recent advances in mass spectrometric techniques have allowed measurement of isotopes produced primarily by cosmic ray bombardment in the uppermost several meters of Earth's surface. Using models beholden to a variety of assumptions, measured isotope abundances can be used to estimate maximum limiting erosion rates and minimum limiting exposure ages for samples collected from landform surfaces.

In the past three years, we have made over 150 accelerator mass spectrometric isotopic analyses of samples collected from granite landforms in a variety of climatic and tectonic environments. Inselbergs of the semi-arid cratonic Eyre Peninsula, south-central Australia are some of the most stable landforms in the world. Measured abundances of 10-Be and 26-Al indicate that the tops of five of these granitic domes are eroding at rates significantly less than 1 m/My (meter per million years). Isotope abundances from the arid and tectonically active Alabama Hills, eastern Sierra Nevada (USA) indicate model rates of erosion varying from 2 m/My at the tops of the heavily varnished inselbergs to 20 m/My on saprolitized and presumably exhumed pediment surfaces. Samples collected from bornhardts of the sub-humid Llano uplift (central Texas, USA) have model erosion rates ranging from 2 m/My for bare rock at the top of the domes to >100 m/My for deeply weathered saprolite on the steeply dipping dome margins. Granitic and gneissic domes in the humid southeastern United States appear to eroding at about 10 m/My.

Our data suggest that granite, exposed in a variety of tectonic and non-glacial climatic settings, erodes quite slowly -- on the order of a meter to perhaps a few tens of meters in a million years. Despite such stability, field evidence and data from multiple isotope analyses strongly suggest that inselbergs are actively eroding landforms. Because these bedrock outcrops are losing mass from their surface, isotopic evidence useful for determining when an inselberg first emerged from the grass-covered plain has long since been eroded. Dating such landforms using the abundance of cosmogenic isotopes is therefore not tractable.

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