Determining the early incision history of the Colorado Plateau using an innovative dating method

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The early incision history of the Colorado Plateau remains highly debated. Multiple stages of uplift and erosion appear to exist and attempts to constrain these events have resulted in conflicting conceptual models. Over a century of thermochronologic, geodynamic, stratigraphic, and geomorphologic studies have not resolved the timing, mechanisms, and history of the plateau's incision, including the Grand Canyon. A new approach is necessary to help reconcile their differences. High-energy cosmic ray particles produce secondary particles when they interact with nuclei of atoms in the atmosphere or exposed minerals. Secondary muons are 209 times the mass of an electron, and because of their small mass they interact weakly with matter. Thus, muons can penetrate deeply into the subsurface, and cause further interactions to produce rare terrestrial cosmogenic nuclides (TCN). The TCN techniques have previously been limited to depths of 130 m below the valley bottom along a mine stope that runs laterally across the valley. The concentration of muogenic ^{10}Be produced from oxygen and silicon in the quartz, will be proportionate to the flux of cosmic radiation received over the past 8 Ma. The spatial pattern of the concentrations will reflect the cosmic ray shielding by the overlying crust. If the incision occurred recently, the ^{10}Be concentrations will be greatest under the deepest portion of the valley. Older or slower incision histories will generate other spatial distributions. Currently eight ^{10}BeO targets are being prepared at Dalhousie University and will be tested at Lawrence Livermore National Laboratory. With this project, we hope to first and foremost determine the viability of detecting muogenic isotopes for future applications of the dating method, and to accurately determine the incision history of the Colorado Plateau.

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