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EROSION RATE PATTERNS IN THE GRAND CANYON AND GRAND STAIRCASE PREDICTED FROM ROCK STRENGTH PATTERNS WITH NEW DEVELOPMENTS ON THE STREAM POWER INCISION MODEL

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Variable erodibility in layered rocks is pervasive on the Colorado Plateau, complicating interpretation of landscape evolution. The rate of erosion is not inversely proportional to rock strength, but evolves as base level fall drives upstream migrating incision waves. Analysis of kinematic wave speed of erosion predicted by the stream-power incision model shows that undermining at strong-over-weak rock contacts locally enhances erosion rates. This significant amplification of erosion rate is predicted to depend on the ratio of rock strengths and contact dip. If quartz-yield is derived preferentially from cliff-forming strong units in detrital samples, then erosion rates determined from concentrations of ^{10}Be in fluvial sediments can be much greater than the rate of base level fall. Detrital cosmogenic erosion rates in headwater catchments in the Grand Staircase, Utah, exhibit erosion rates amplified (median 365 m/Ma) beyond base level fall rate (~75 m/Ma) by a factor consistent with model predictions and estimates of variation in rock strength of the underlying stratigraphic units. In contrast, local base level fall rate and therefore erosion rate is reduced above weak-over-strong contacts as bench topography forms above canyons incised into stronger rock. Landscape evolution modeling shows canyon topography can form with or without increased base level fall rate in weak-over-strong stratigraphy but is distinguished by erosion rate patterns. Apparent incision and erosion rate patterns in Grand Canyon suggest cosmogenic isotope measurements in Grand Canyon are primarily controlled by base level fall and are higher than base level fall rate outside the canyon, indicative of a base level fall rate increase. Numerical simulations suggest complex stratigraphy allows average erosion rate, despite high local variability, to remain similar to base level fall rate if amplified erosion rates nearly balance with reduced erosion rates in cliff-slope topography. Despite complexity due to rock strength, the topography of Grand Canyon appears to be caused primarily by a geologically recent (<6 Ma) increase in base level fall rate.

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T6. Colorado Plateau Landscape Evolution -- Grand Canyon- and Upper Basin-Focused Colorado River Evolution II
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