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Quantifying the erosion of the world's largest impact crater using cosmogenic nuclides: the Vredefort Dome, South Africa.

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The world's largest meteorite impact crater, the Vredefort Dome, has been the subject of extensive studies relating to its age, geology and geomorphology. However, there are no studies pertaining to the rate at which the rocks in the crater remnant are eroding, which can provide insight into the development of the landform over time. This study used the cosmogenic nuclides ^{10}Be and ^{26}Al, extracted from purified quartz samples, to investigate erosion rates along the Vaal River as it traverses the impact crater. The Vaal River flows in mixed bedrock-alluvial terrain through the dome, crossing two different bedrock lithologies. The river is multi-channelled (anabranching) atop the granitoids exposed in the core of the dome, then downstream flows as a single channel through a narrow canyon cut into the quartzites that form the rim of the dome. We collected 14 samples from the two rock types to assess lithologic controls on erosion rate and determine landscape erosion history. Results from the analysis of both isotopes were in close agreement; here, we report outcrop erosion rates based on the ^{10}Be. The average ^{10}Be-determined erosion rates (± 1 SD) along the active river channel for the quartzite (n = 4) and granitoid (n = 6) regions are 1.90 ± 0.12 and 2.19 ± 0.14 m/Ma respectively. Additional samples from older, now elevated (>5 m) strath terraces developed atop quartzite (n = 4) indicate slightly lower average apparent erosion rates of 1.65 (± 0.09) m/Ma. The data demonstrate that the erosion rates along the active river channel are similar between the two lithologies despite differences in rock hardness. The resistant, slowing eroding quartzites serve as the local base level for the river upstream, promoting the development of anabranching, which disperses bedrock erosion over a wider area of the crater. We infer that both bedrock hardness and channel characteristics are important controls on erosion rates along the river. Collectively, the dataset further illustrates the low bedrock erosion rates that prevail across large areas of the southern African interior.