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Grain size dependency of cosmogenic nuclide concentrations in alluvial sediment in an arid zone catchment.

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Based on cosmogenic ^{10}Be and ^{26}Al analyses in 15 individual detrital quartz pebbles (16-21 mm diameter) and cosmogenic ^{10}Be in an amalgamated medium sand sample (250-500 μm diameter) all collected from the outlet of the upper Gaub River catchment in Namibia, quartz pebbles yield lower model erosion rates than those yielded by amalgamated sand.

^{10}Be and ^{26}Al concentrations in the 15 individual pebbles range from $\sim$0.2 to $\sim$22.7 x 10^6 atoms.g^{-1} and $\sim$1.3 to $\sim$72.8 x 10^6 atoms.g^{-1}, respectively. When amalgamated, the pebbles yield average ^{10}Be and ^{26}Al concentrations of $\sim$6.7 and $\sim$27.3 x 10^6 atoms.g^{-1}, respectively. These average concentrations yield minimum and maximum ^{10}Be model erosion rates of $\sim$0.4 and $\sim$2.1 m.Myrs^{-1}, and minimum and maximum ^{26}Al model erosion rates of $\sim$0.3 and $\sim$1.4 m.Myrs^{-1}, respectively. In contrast, the amalgamated sand yields an average ^{10}Be concentration of $\sim$0.8 x 10^6 atoms.g^{-1}, and associated minimum and maximum ^{10}Be model erosion rates that are an order of magnitude larger than those obtained for the amalgamated pebbles (i.e., $\sim$4.8 and $\sim$13.0 m.Myrs^{-1}, respectively).

Modelling results suggest that a difference in sediment transport times of the order of 10^5-10^6 years is necessary to explain the difference in cosmogenic nuclide inventories between the pebble and sand samples. Given the small catchment size and lack of accommodation space, such long transport times are unrealistic for the Gaub catchment. Furthermore, the ^{26}Al/^{10}Be ratios in the pebbles are indicative of simple exposure histories, suggesting that burial, and thus, storage of the pebbles has not been substantial. Therefore, the difference in nuclide concentrations between the pebble and sand samples cannot be caused solely by longer sediment residence times for the pebbles than for the sand grains.

The inconsistency between the ^{10}Be and ^{26}Al in the pebbles and the ^{10}Be in the amalgamated sand is best explained by differential sediment sourcing. The amalgamated sands leaving the catchment are an aggregate of grains originating from quartz-bearing rocks in all parts of the catchment. Thus, the cosmogenic nuclide inventories of these sands record the overall average lowering rate of the landscape. The pebbles originate from the more slowly eroding vein quartz outcrops, ubiquitous across the catchment, and thus their cosmogenic nuclide inventories only record the overall average lowering rate of the outcrops.

These results highlight the importance of carefully considering geomorphology and grain size when sampling for catchment-wide erosion-rate studies, as well as in interpreting cosmogenic nuclide data in alluvial sediment.