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Tracking the $^{26}Al/^{10}Be$ source-area signal in sediment-routing systems of arid central Australia

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Sediment-routing systems continuously transfer information and mass from eroding source areas to depositional sinks. Understanding how these systems alter environmental signals is critical when it comes to inferring source-area properties from the sedimentary record. We measure cosmogenic ^{10}Be and ^{26}Al along three large sediment-routing systems ($\sim$ 100,000 km^2) in central Australia with the aim of tracking downstream variations in $^{26}Al/^{10}Be$ inventories and to identify the factors responsible. By comparing 56 new cosmogenic ^{10}Be and ^{26}Al measurements in stream sediments with matching data (n = 55) from source areas, we show that $^{26}Al/^{10}Be$ inventories in hillslope bedrock and soils set the benchmark for relative downstream modifications. Lithology is the primary determinant of erosion-rate variations in source areas and despite sediment mixing over hundreds of kilometres downstream a distinct lithological signal is retained. Postorogenic ranges yield catchment erosion rates of $\sim$ 6–11 m/m.y. and silcrete-dominant areas erode as slow as $\sim$ 0.2 m/m.y. $^{26}Al/^{10}Be$ inventories in stream-sediments reveal overall downstream-increasing minimum cumulative burial terms up to $\sim$ 1.1 m.y. but more generally $\sim$ 400–800 k.y. The magnitude of the burial signal correlates with increasing sediment cover downstream and reflects assimilation from storages with long exposure histories, such as alluvial fans, desert pavements, alluvial plains, and aeolian dunes. We propose that the tendency for large alluvial rivers to mask their $^{26}Al/^{10}Be$ source-area signal differs according to geomorphic setting. Signal preservation is favoured by i) high sediment supply rates, ii) high mean runoff, and iii) a thick sedimentary basin pile. Conversely, signal masking prevails in landscapes of i) low sediment supply, ii) discontinuous sediment flux, and iii) juxtaposition of sediment storages with notably different exposure histories.