Erosion and the sediment conveyor in central Australia

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Why are the Neogene sedimentary fills across central Australia generally thin and discontinuous? One long-standing explanation is that sluggish tectonism and intensified aridity have combined to suppress rates of erosion and sediment production yielding a landscape crowded with inherited, pre-Miocene forms. Quantifying rates of sediment production, residence time and transport is possible with numerous methods, but the recent growth of cosmogenic nuclide (CN) analysis has provided unprecedented quantitative insights to rates of landscape evolution. Measurements of *in situ* produced cosmogenic ^{10}Be and ^{26}Al integrate rates of surface processes over million-year timescales—the last part of the Neogene in which aridity has strengthened across the continental interior. We present a compilation of ~600 published and unpublished ^{10}Be and ^{26}Al measurements from central Australia with a focus on the Neogene Eyre Basin and its periphery.

Outlying and inlying bedrock uplands serve as engines of sediment production via erosion of bedrock. Surrounding the bedrock outcrops are vast sediment conveyors of varying efficiency and tempo: hillslopes, pediments, and alluvial fans are interim storage/burial zones for sediment in transit to the network of low-gradient rivers, dunes, and playas towards base level. Interactions between fluvial and aeolian processes are especially pertinent to sediment flux in the Eyre Basin. Major rivers such as the Cooper and Finke traverse dunefields in their lower reaches where quantities of alluvia are recirculated into dunes and vice versa. Tracking the trajectories of sediment from source-to-sink (including aeolian recirculation) remains a major challenge, but is central to unravelling the sedimentary dynamics of central Australia's Neogene basins. Based on the CN compilation we estimate 1) spatially averaged erosion rates at the scale of a hillslope or river catchment; 2) point-based erosion rates on bedrock surfaces; 3) residence time of sediment in hillslope regolith and alluvial fans; and 4) cumulative burial history of sediments in transit.

Catchment-scale erosion rates (n~100) are consistently low (<10 m/Myr) and include some of the lowest rates ever measured (~0.3 m/Myr); however, a small group of catchments in the Flinders Ras yield higher erosion rates (~30–60 m/Myr). Bedrock hillslopes (n~200) tend to erode even slower (<5 m/Myr), with a subset of Flinders Ras sites again being the exception (~10–30 m/Myr) and suggesting the influence of recent tectonism. Several CN depth-profiles measured on hillslopes and alluvial fans indicate sediment residence times >0.5 Myr, and high-resolution sampling along three hillslopes with differing morphology (linear, convex, and concave) reveals major variations in sediment production and transport rates that hint at the long-term evolution. In the rivers, fluvial sediments show a weak tendency to increase cumulative burial history downstream (1–2 Myr), consistent with the expanding accommodation space for storage and burial. Dune sediments sampled in the Simpson and Tirari dunefields (n~16) contain cumulative burial histories (up to 1.5 Myr) similar to that of the intersecting rivers. This points to an intimate mix of fluvial and aeolian processes in areas approaching base level. Curiously, these sediments occur in the lowest part of the continent and contain the longest histories of cumulative burial, yet do not form part of the thickest sedimentary fills in the Eyre Basin.