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Zircon as a tracer of erosion processes in river drainage systems

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Detrital sediments provide average samples of the continental crust formed at different times and in different places. Some lithologies are more susceptible to erosion than others, and one issue is to understand how the compositions of a range of source rocks are then recorded in the sediments. The relative contributions of different source terrains are usually expressed through an erosion factor 'K', or an equivalent erosion parameter. Studies based on existing draining systems have often considered K as a constant factor in both space and time, or more recently, have proposed that this might vary as a function of the uplift rates in response to tectonic forcing. The determination of K, and the extent to which it varies in different erosion systems, has fundamental implications for models of continental growth based on radiogenic isotopes in continental sediments.

We report the first estimates of K from integrated Hf and U-Pb isotopes in detrital zircons, and Nd isotope ratios of bulk recent sediments along an active river system, the Frankland River in SW Australia. The Frankland River is one of a series of southward flowing rivers that developed along the southwest coast of Western Australia following the break-up of Australia and Antarctica at $\sim$65 Ma. It has a length of $\sim$320 km and the catchment area is 4630 km2. It offers an opportunity to link sediments to their source rocks, because it drains just two crustal blocks with distinctive age components, the Archean Yilgarn craton and the Proterozoic Albany-Fraser mobile belt. The distribution of Hf model ages in detrital zircons sampled along the river offers insight into the proportions of different source terranes that have contributed to the bulk sediment. We show that the erosion factor K is not constant and it increases by a factor of 2-3 downstream, and with the gradient of the river. It is concluded that values of K = 4-6 are representative of mature river systems that sample large source areas. These values should therefore be used to re-evaluate models of crust formation and evolution through time, since many previous models used values of K = 2-3, which biases the outcomes to younger ages of crust formation.