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Constraining the timescales of sediment transport in lowland regions using U-series isotopes and morphometric analysis

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Abstract

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Constraining the timescales of sediment transport in lowland regions using U-series isotopes and morphometric analysis

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The uranium-series (U-series) isotopes are fractionated by chemical and physical weathering, and undergo radioactive decay on timescales relevant to Earth-surface processes (103–106 a). The comminution age technique is based on the disequilibrium between 234U and 238U due to the effects of alpha-decay in fine-grained (< 63 μm) sediment [1]. The calculated comminution age represents the sediment residence time i.e. the time elapsed since a sediment grain was formed by weathering from bedrock, until its eventual deposition. When applied to fluvial systems, this integrates storage in the weathering profile, transit time in the catchment and any temporary storage in alluvial deposits.

Despite the majority of global sediment flux to the oceans being derived from slowly eroding lowland regions, still little is known with regard to the dominant controls of erosion in these areas [2]. Here we apply the comminution age technique to the six major catchments in the Gulf of Carpentaria basin (GOC) in northern Australia to investigate the temporal dynamics of erosion in lowland regions. In addition, the geomorphometric properties of the catchments were measured using Geographic Information System techniques (GIS) in order to disentangle topographic vs. climatic controls on the sediment residence time.

The sediment residence times calculated from U-series isotopes do not increase linearly downstream which reflects the complicated nature of sediment transport in lowland regions. The sediment residence time appears to be broadly correlated with mean annual precipitation but this relationship is less clear following consideration of the geomorphometric properties of each sub-catchment. This highlights the tendency of geochronological approaches to oversimplify the mechanisms of sediment transport in fluvial systems. Understanding what controls the temporal dynamics of erosion in fluvial system on millennial timescales requires the combination of the hitherto commonly separate approaches of geochronology and geomorphometrics.

[1] DePaolo et al. (2006), Earth and Planetary Science Letters, 248, 394-410. [2] Willenbring et al. (2013), Geology 41, 343.