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Sediment recycling buffers the sensitivity of Andean alluvial fans to external forcing

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Grain size fining of riverbed sediment from source to sink has long been established as a key physical observable recording important environmental information. The spatial distribution of basin subsidence and the volume and calibre of sediment supplied from a mountainous source region are often assumed the dominant controls on downstream grain size fining in a basin. Alluvial fans in the Iglesia Basin, West Argentina, are expected to respond to varying subsidence histories and the deglaciation of their source areas since the Last Glacial Maximum. We have constructed a 3D model of basin subsidence within the Iglesia basin and measured the grain size of modern sediment along three alluvial fans. Using the 3D model to constrain patterns of subsidence across the three fans, we use a numerical model based on the principle of self-similarity to try to replicate the measured downstream fining trends. We find that the measured trends cannot be reproduced for any input scenario where sediment is only sourced from the fan apices, implying the downstream grain size fining trends on these fans are buffered to their external boundary conditions.

By adapting a self-similar downstream grain size fining model, we demonstrate that the measured sediment grain size trends can be reconstructed when sediment is introduced not only from a single point source, at the apex of each fan, but also laterally, from tributaries and through fan surface recycling. For the first time, this work quantifies the loss of sensitivity to external forcing by buffering within the depositional sink, highlighting the potential for signals of environmental forcing to be processed and shredded by the dynamics of the sediment routing system.

This has significant implications for studies using the sedimentary record to reconstruct climate and tectonic forcing and the imprint on landscape and basin evolution.