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Alluvial fan sensitivity to glacial-interglacial climate change: case studies from Death Valley.

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The effects of climate change on eroding landscapes and the sedimentary record remain poorly understood. The measurement of regional grain size trends in stream-flow deposits provides one way to address this issue because, in principle, these trends embed important information on the dynamics of sediment routing systems and their sensitivity to external forcings. In many cases, downstream stratigraphic fining is primarily driven by selective deposition of sediment. The relative efficiency of this process is determined by the physical characteristics of the input sediment supply and the spatial distribution of subsidence rate, which generates the accommodation necessary for mass extraction.

Here, we measure grain size fining rates from apex to toe for alluvial fan systems in Death Valley, California, which have well-exposed modern and late Pleistocene deposits, where the long-term tectonic boundary conditions are known and where climatic variation over this time period is well-constrained. Our field data demonstrate that input grain sizes and input fining rates do vary noticeably over the late Pleistocene-Holocene period in this study area, although there is little evidence for significant changes in rates of faulting in the last 200 ky. For two catchments in the Grapevine Mountains for which we have excellent stratigraphic constraints on modern and 70 ka fan deposits, we use a self-similarity based grain size fining model to understand changes in sediment flux to the fans over this time period. When calibrated with cosmogenically-derived catchment erosion rates, our results show that a 30 % decrease in average precipitation rate over this time-frame led to a 20 % decrease in sediment flux to the fans, and a clear increase in the down-fan rate of fining. This supports existing landscape evolution models that relate a decrease in precipitation rate to a decrease in sediment flux, but implies that the relationship between sediment flux and precipitation rate may be sub-linear. Consequently, this study shows that small mountain catchments and their alluvial fans can be highly sensitive to climate changes over timescales of 10 to 100 ky. However, we also observe this sensitivity is lost when sediment is remobilised and recycled over a time period longer than the duration of the climatic perturbation.