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SPEAKERS CLUB

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Coupled Evolution of Landscapes and Detrital Records

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Detrital mineral records, whether extracted from modern sediment samples or older stratigraphy, represent crucial datasets for reconstructing changes in, and interactions between, tectonics, landscape form, and climate. Implicit in the interpretation of most detrital records are assumptions of spatially and temporally invariant erosion rates and similarly invariant concentrations of the target mineral(s) within a source landscape (i.e. delivery of target minerals to the fluvial and eventually depositional system occurs uniformly throughout a source catchment). However, spatially invariant erosion within a landscape is rarely the case and the potential for significant differences in mineral concentrations are expected between different bedrock units. This has led this assumption to be questioned in several pioneering studies of well characterized natural landscapes using a variety of different detrital mineral techniques, but it is difficult to quantify the potential magnitude of biases that may be introduced by violations of these assumptions on a broader scale with isolated field examples alone. To address this problem, I have coupled a suite of detrital mineral models to a model of landscape evolution to allow for the generation of synthetic detrital mineral records and more direct testing of the potential degree of biasing induced by both variable erosion rates and mineral concentrations. Specifically, I use a modified version of the CHILD landscape evolution model (LithoCHILD), which supports numerous lithologies with different erodibilities (and different mineral concentrations) within a landscape. To explore a range of different detrital mineral records, I couple LithoCHILD results to: (1) a simple model of U-Pb ages of detrital zircons; (2) a modified version of the CRONUS codes to simulate production of 10Be and cosmogenic erosion rates; and (3) Pecube to simulate bedrock cooling ages along with a simple sediment mixing model to produce detrital thermochronologic records. The results suggest that each detrital mineral system is sensitive to different aspects of both landscape evolution and variability in target mineral concentration. The sensitivity of U-Pb ages of detrital zircons is mostly dictated by the nature of the source populations, cosmogenic erosion rates are only influenced if there are significant biases in quartz concentrations, and both bedrock and detrital thermochronometers can be significantly perturbed by changes in landscape form and spatial variation in erosion rates but the effect is the most extreme in lower temperature systems. More generally, this approach is potentially extremely powerful to better understand the contributions to uncertainty in a variety of detrital mineral records and to develop strategies for combining multiple techniques to both correct for biases but also extract more information from these datasets.