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More sediment quantification required! Constraining estimates of exhumed volumes and documenting grain character to improve process-based understanding of source-to-sink systems

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A diverse range of modern and ancient source-to-sink configurations have been documented. These systems have, or will, evolve in time and space, which complicates interpretation of stratigraphic successions. Increasingly, particulate flux from catchments through transition zones to sedimentary basins is being constrained over different timescales. These data help to support prediction of sedimentation patterns. However, our understanding of process controls on the segregation of grain sizes and types along the transport profile is still in its infancy. Furthermore, in deeper time we need to improve estimates of the volumes and types of exhumed particulate material to improve mass balance estimates.

We present results from a diverse range of ancient systems to highlight how quantitative approaches to sediment across a range of times scales, and from different positions along a source-to-sink profile, can help to reduce uncertainties in predicting sediment distribution, and interpretation of stratigraphic successions. Estimates for the timing and volume of sediment generated during the Mesozoic exhumation of SW Africa have been constrained. The 'missing' volumes in the immediate offshore record are used to interpret that the main sink was the Falkland Plateau, which is now separated from its source by 6000 km. Also from southern Africa, integrated heavy mineral and clast assemblage analysis from fluvial terrace deposits onshore Orange River and offshore shelf deposits highlight the importance of understanding grain durability, and cautions against using clast types as simple provenance indicators. Farther into the sink, detailed grain analysis along Cenozoic clinothems, from both offshore New Jersey is used to highlight the importance on shelf process regime in the segregation of grains of different size and shape in time and space. Finally, a well-studied deep-water system exposed in the Karoo Basin, South Africa, is used to demonstrate the process control on sediment dispersal patterns. More sediment is stored in the silt-rich levees on the slope than basinward in the sand-rich lobes. This demonstrates the role of density-stratified sediment gravity flows in the segregation of grain-sizes, which feeds in the morphodynamics of deep-water systems.

Thus, sedimentary processes are a fundamental control on the dispersal of sediment at every part of the transport system. Therefore, significant addition value can be gained from more detailed data being collected from sediments to improve the efficacy of process-based numerical forward models, and to improve understanding of the stratigraphic record at all parts of source-to-sink systems.