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Clay mineralogy and Hf-Nd isotopic compositions on clay fractions: Source-to-sink analysis of signal propagation in the Cape basin during the late Cretaceous

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Recent studies have applied different isotopic systems (e.g., Mg and Li) to constrain the evolution of chemical weathering in response to tectonic and climatic forcings. However, studies exploring the propagation of combined erosion and chemical weathering signals within a source-to-sink system remain scarce. In this study, we present Hf and Nd isotopic data combined with clay mineral assemblages from the continental slope (site O-A1) and the abyssal plain (DSDP site 361) in the Cape Basin during the late Cretaceous. The source-to-sink system composed by this basin and the South African Plateau represents an ideal setting to explore the response of chemical weathering and erosion to tectonic and climatic forcings, as the southwestern African margin recorded both a major uplift event and a global long-term cooling during the late Cretaceous.

Results from DSDP site 361 highlight a predominance of smectite within the clay assemblages (60-95%), indicative of a seasonally contrasted semi-arid/semi-humid climate. A concomitant increase in primary clay minerals (e.g., illite) is depicted in the Campanian – Danian interval, suggesting a relative increase in physical erosion. Results from O-A1 site display higher relative proportions in primary clay minerals over smectite (20-40%) throughout the late Cretaceous, but the presence of R1 type illite/smectite and chlorite/vermiculite mixed layers point to an overprint of the clay signal by burial diagenetic processes, impeding an interpretation of such assemblages in terms of evolution in continental surface processes. In contrast, the De_{Hf} signal remains rather consistent among the sites, suggesting a sustained increase of weathering during the late Cretaceous, although the increase in values is more pronounced at site OA-1 and started earlier, 90 Ma versus 77 Ma at DSDP site 361. Such decoupling is likely linked to a buffering effect in signal propagation along the basin.

Altogether, our data suggest that the tectonic uplift of the southwestern African margin has resulted in enhanced chemical weathering and erosion of the South African Plateau. Furthermore, the combination of data from proximal and distal sites highlights the importance of a source-to-sink approach to interpret sedimentary archives in terms of changes in surface continental processes.