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Tracking Hydroclimate Variability Using Radiogenic Isotopes and Bayesian Mixing Models: A Case Study from the Iberian Margin (IODP 397) during the Late Quaternary

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Radiogenic isotopes (Pb, Sr, and Nd) are powerful tracers for lithogenic provenance in marine sediments yet overlapping sources often complicate interpretation. Along continental margins, the lithogenic fraction reflects varying contribution from wind-blown dust and fluvially transported material—both highly sensitive to climate variability and AMOC coupling. In the case of dust, changes in dust provenance may track latitudinal shifts in wind belts, while variations in fluvial inputs relate to river discharge and continental hydroclimate. To quantitatively resolve these mixed sources, we applied the MixSIAR Bayesian mixing model (Stock et al., 2018) to Pb and Nd isotope data from IODP Site U1587A (Iberian Margin).

This site is uniquely positioned with the North African dust plume and receives fluvial input from the Tagus River, providing a natural laboratory to disentangle eolian and fluvial contributions. High sedimentation rates (11-20 cm/kyr) enable high resolution reconstruction across the Holocene and Late Pleistocene—intervals of significant African monsoon variability driven by ITCZ and North Atlantic Storm track shifts.

Pb isotope ratio ($^{206}Pb/^{204}Pb$) show more radiogenic values during humid periods (Bolling-Allerod and the African Humid Period), and relatively unradiogenic values during cold North Atlantic stadials associated with AMOC slowdowns (Heinrich Stadial 1 and Younger dryas). MixSIAR modeling indicates a distinct increase in African dust contributions during these cold intervals. These findings suggest that a weakened AMOC and subsequent North Atlantic cooling acted as a potential driver for enhanced atmospheric dust delivery to the margin. Ongoing work to further refine the fluvial-to-eolian ratio will clarify how terrestrial runoff and atmospheric transport co-vary in response to rapid AMOC-driven climate oscillations and their feedback on global biogeochemical cycles.

Stock,B. et al. brianstock/MixSIAR 3.1.9. Zenodo, https://doi.org/10.5281/zenodo.1209993 (2018).