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Revisiting the Younger Dryas Trigger

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The Younger Dryas (YD; ~12.9–11.7 ka) was an abrupt return to near-glacial conditions during the last deglaciation and is widely linked to disruptions of Atlantic Meridional Overturning Circulation (AMOC). However, the external forcing capable of initiating such rapid ocean circulation reorganization remains debated. This study applies osmium isotopes and highly siderophile elements (HSE: Os, Ir, Ru, Pt, Pd, Re) as tracers of volcanic forcing and ocean–atmosphere teleconnections at the onset of the YD.

We present new $^{187}Os/^{188}Os$ and HSE data from the Page-Ladson site, a well-dated, continuous sedimentary archive spanning the YD boundary. The onset interval is marked by a shift to unradiogenic $^{187}Os/^{188}Os$ ratios, coincident with elevated Os and Re concentrations and a Cl-chondrite–normalized HSE pattern consistent with volcanic aerosol deposition. Elemental fractionations indicate high-temperature magmatic volatilization and atmospheric transport rather than meteoritic input. Comparable unradiogenic excursions are observed at Hall's Cave and the Debra L. Friedkin site, demonstrating a stratigraphically coherent signal across multiple depositional environments in North America.

The osmium isotope excursions align with a cluster of major bipolar eruptions (~12.98–12.87 ka) recorded in ice cores from Greenland and Antarctica. The cumulative radiative forcing of this eruptive interval exceeds that of the most volcanically active centuries of the Common Era, implying hemispherically asymmetric cooling capable of perturbing North Atlantic surface buoyancy fluxes. Such forcing provides a viable mechanism for weakening AMOC and amplifying high-latitude cooling through ocean–atmosphere feedbacks.

These results highlight $^{187}Os/^{188}Os$ and HSE systematics as emerging geochemical tracers linking explosive volcanism to millennial-scale ocean circulation change. The data support a volcanically driven perturbation at the onset of the YD and illustrates the sensitivity of the climate system to short-lived but intense external forcing.