Changing Conditions Across the Permo-Triassic Boundary: Evidence from the Re-Os Isotope System

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The Permo-Triassic boundary marks the largest documented extinction event in earth history. Deciphering underlying causes and the related cascade of events at this critical juncture can enlighten our understanding of global feedbacks during modern climate change. Calibrating climate change in deep time requires precise geochronometry linked to paleoenvironmental proxies. The Re-Os isotope system offers both time pins and a highly sensitive isotopic tracer ($^{187}Os/^{188}Os$).

Organic-rich shales contain a treasure trove of information on paleo-climatic conditions. Just as the concentrations of other trace elements in shales depend on paleoenvironment [1], the $^{187}Os/^{188}Os$ ratio preserved in black shales depends on both global and local conditions. The $^{187}Os/^{188}Os$ of global seawater, captured under anoxic conditions in organic-rich muds, reflects the balance between radiogenic continental input and chondritic sources from seafloor mafic volcanism and meteorites. In restricted basins, the short residence time of Re and Os causes $^{187}Os/^{188}Os$ to reflect local basin input. In sum, a shale's $^{187}Os/^{188}Os$ ratio is a snapshot of the balance between continental erosion and mafic volcanism - or even the drastic altercation produced by a meteorite impact.

Four precise Re-Os ages and corresponding initial $^{187}Os/^{188}Os$ ratios for shale sections from the Norwegian Sea, Barents Sea, and Svalbard define a spike in seawater $^{187}Os/^{188}Os$ across the P-T boundary. Between the Changhsinian (Latest Permian) and Anisian (Middle Triassic), seawater $^{187}Os/^{188}Os$ climbed from <0.6 to >0.8, then dropped to <0.7 [2,3], mirroring a spike in seawater 87Sr/86Sr. Unlike Rb-Sr, U-Pb, and other long-standing chronometers, Re and Os are strongly fractionated into organic s and sulfides. Thus, the Re-Os system is ideal for acquiring data from organic-rich shales. With Re-Os, we can correlate extinction events reflected in shale fauna with other global events - assembly or break-up of supercontinents, generation of large igneous provinces, bolide impacts, changes in ocean redox conditions - linking cause and effect closely in time.

(1) Algeo, T.J. & Maynard, J.B. (2008) Geosphere, v. 4, p. 872-887.
(2) Xu, G. et al. (2009) Geochimica et Cosmochimica Acta, v. 73, p. A1463.
(3) Georgiev, S. et al. (2009) EOS Transactions (submitted, AGU meeting).

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