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Mass extinctions, recovery and resilience

The nitrogen cycle and the Ammonium Ocean hypothesis for the end-Permian Mass Extinction

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The aftermath of end-Permian mass extinction was marked by a ∼5 million year interval of poorly-understood, extreme environments that likely hindered biotic recovery. Contemporary nitrogen isotope variations are considered, using a new conceptual model, to support a scenario that shows intensive nitrate-removal processes gradually depleted the global oceanic nitrate inventory during long-lasting oceanic anoxia. Enhanced nitrogen fixation shifted the oceanic nitrogenous nutrient (nutrient-N) inventory to an ammonium-dominated state. Ammonium is toxic to animals and higher plants but fertilizes algae and bacteria. This change in ocean chemistry could account for the intense and unexplained losses of nektonic taxa and the proliferation of microbial blooms in the Early Triassic. The transition from a nitrate ocean to an ammonium ocean was accompanied by a decrease in respiration efficiency of organisms and a shrinking oceanic nutrient-N inventory, ultimately leading to generally low productivity in the Early Triassic oceans. These unappreciated nutrient changes during episodes of prolonged ocean anoxia may be the key life-limiting factor at such times.