Rapid enhancement of chemical weathering recorded by extremely light seawater lithium isotopes at the Permian-Triassic boundary

With the support by the National Natural Science Foundation of China and the Chinese Academy of Sciences, the research team led by Profs. Xiao YiLin (肖益林) and Shen YanAn (沈延安) at the University of Science and Technology of China found that the Siberian Traps erupted at the end-Permian plausibly enhanced the continental chemical weathering during the period and might have ultimately caused the great dying at the Permian-Triassic boundary, which was published in *PNAS* (PNAS. 1711862115).

The Permian-Triassic boundary (PTB) at ~251 Myr marked the most severe mass extinction in the history of life, with over 80% of all marine species and ~70% of terrestrial vertebrate genera, and most land plants as well. The PTB is characterized by a series of abrupt ecosystem changes, such as increase of atmospheric CO_2 concentration, rapid global warming, terrestrial wildfires, acid rains, ocean acidification, and marine anoxia. The causes of the extinction are under debate but have been attributed to including massive flood basalt volcanism, meteorite impact, marine anoxia, and massive methane clathrate dissociation.

Lithium (Li) isotope geochemistry of sedimentary carbonates is a promising and newly developed indicator for ancient global weathering rate. Unlike other isotopic systems (e. g. Sr, Os), riverine Li signals are exclusively dominated by weathering of silicate rocks; hence they can provide unique information on silicate weathering rate and carbon dioxide consumption during weathering.

By analyzing the Li isotopic compositions in sedimentary rocks from the Meishan section of South China, the research term found extremely depleted seawater Li isotopic signatures at the PTB. Theoretical modeling indicates a rapid enhancement of continental weathering during the period. Researchers also found that the enhanced weathering pulse started ~300 Kyr before the end-Permian mass extinction, which is consistent with the eruption time of Siberian Traps. Hence, the enhanced continental weathering was most likely triggered by the eruption of Siberian Traps, and the accompanying rapid global warming and acid rains.

Chemical weathering of silicate consumes atmospheric CO_2 and brings HCO_3^-, dissolvable cations (such as Mg^{2+}, Ca^{2+}, Na^+) and suspended matters to the marine system, playing a critical role to link the terrestrial and marine ecological crises. The new finding demonstrates that, rapidly enhanced continental weathering may deliver excessive nutrients to oceans, leading to marine eutrophication, anoxia, acidification, and ecological perturbation, and thus might ultimately have led to the end-Permian mass extinction.

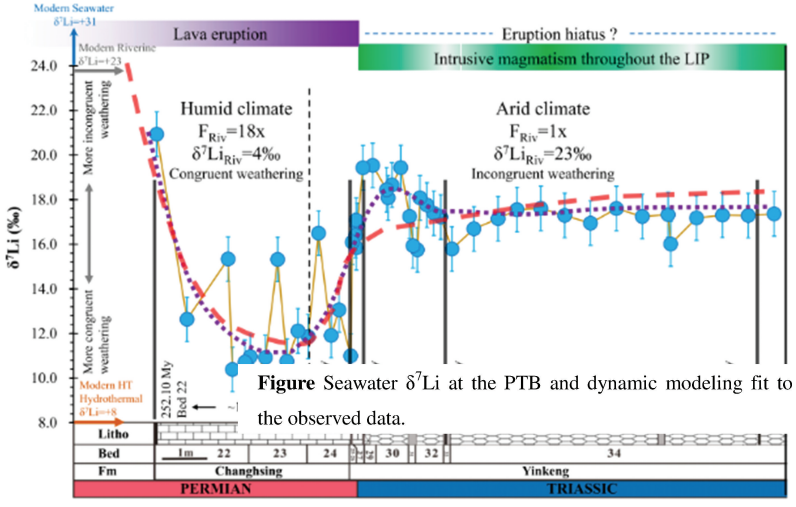

Figure Seawater δ^7Li at the PTB and dynamic modeling fit to the observed data.

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