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Differentiated environment responses of three large igneous provinces from the Permian to Triassic

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Massive volcanism during geological history has reshaped environments and driven biological turnover, especially large igneous provinces (LIPs). There are three LIP events during the Permian to Triassic, including the Siberian Trap LIP and the Central Atlantic Magmatic Province (CAMP) which separately triggered the end-Permian and end-Triassic mass extinctions, and the Wrangellia LIP in late Triassic which be associated with the enhanced global precipitation and biological turnover. However, the causality between the diverse volcanism and the evolution of environments remains uncertain.

Sedimentary mercury (Hg) anomalies and isotopes are commonly used as proxies for massive volcanic activities given the potential of widespread distribution, rapid deposition over millennia, and isotopic fingerprinting. Here, we summarize the Hg records and the associated environmental effects of these LIPs. The Siberian Trap LIP, dominated by volcanic outgassing from subaerial eruptions, released large quantities of ^{13}C-depleted carbon and volcanic Hg, leading to elevated temperatures, arid climate, and widely documented Hg spikes with a positive shift of Hg odd-isotope (represented by $\Delta^{199}Hg$). The subsequent enhanced weathering resulted in the increment in carbon burial and Hg abundance, as well as the slight negative shift of $\Delta^{199}Hg$, or a significantly negative shift of $\Delta^{199}Hg$ Hg under the oceanic anoxic or photic zone euxinia. The CAMP was initially intrusive activities marked by heating of organic-rich sedimentary rocks, resulting in the release of thermogenic carbon and Hg and a negative shift of $\Delta^{199}Hg$, followed by extrusive activities, which released volcanogenic carbon and Hg and resulting in a positive shift of $\Delta^{199}Hg$. Water vapor and volcanic gases from the submarine eruptive of the Wrangellia LIP were transported from the equator to high latitudes through ocean currents and atmospheric circulation. This affected the global hydrological cycle, contributing to enhanced terrestrial runoffs, burial of large quantities of land-based organic matter, and negative shift of $\Delta^{199}Hg$. Therefore, the explosive eruptive behavior and release of volcanogenic gases from both submarine and subaerial LIPs could drastically alter the environment, causing biological turnover and even extinction.