Permian large igneous provinces and their paleo-environmental impacts

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The Permian is an important period in the history of the earth, characterized by the emplacement of at least four large igneous provinces (LIPs) (Emeishan, Tarim, Siberian, and Panjal), world-class Ni-Cu-sulfide deposits and Fe-Ti-V oxide deposits, and double mass extinctions at Permian-Triassic Boundary (PTB) and Guadalupian-Lopingian Boundary (GLB). It seems that many sub-systems of the Earth are intimately linked during this particular period, with ultimate driving forces from a superplume activity. This paper summarizes some recent advances in the studies of the Emeishan LIP and paleoenvironmental changes at the end-Permian. (1) The Emeishan basalts were emplaced at ~259 Ma over a short period of less than 1 Ma [1]. Systematic correlation and comparison of biostratigraphic units of the Maokou limestone, which lay underneath the flood basalts, reveal a domal thinning of the strata in the Emeishan LIP, which agree remarkably well with those predicted by numerical modeling [2]. Systematic spatial variations are observed across the domal structure in the distribution and thickness of clastic and carbonate sediments, the extent of erosion, thickness, and chemistry of volcanic rocks, and the crust-mantle structure, which are best explained by a mantle plume [3,4]. (2) To discriminate the potential causes of the PTB mass extinction, records of ocean pH, redox and temperature are reconstructed across the GLB and PTB, based on $\delta^{11}B$, $\delta^{98/95}Mo$ of carbonates and $\delta^{18}O$ of conodont apatite from the Meishan stratotype section in South China [5]. Analyses suggest ocean acidification was the driving force of the PTB mass extinction. The decreasing $\delta^{11}B$ is accompanied by an increase in $^{143}Nd/^{144}Nd$ of detrital components in carbonates, suggesting simultaneous outpouring of huge amount of mantle materials to ocean and CO_2 to the atmosphere over a very short period of time. The Siberian Trap volcanism was responsible for these events, as it is perhaps the sole known process on Earth which was capable of doing so.

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