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Carbon degassing from Large Igneous Provinces during mass extinction events: Insights from melt and fluid inclusions

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Carbon species and other volatiles degassed in vast amounts from Large Igneous Provinces (LIPs) were likely the main responsible of climatic and environmental perturbations that led to multiple biosphere upheavals throughout Earth's history. The end-Triassic mass extinction, one of the worst biotic crises in the Phanerozoic, coincided in time with the emplacement of the Central Atlantic Magmatic Province (CAMP). The investigation of melt and fluid inclusions in magmatic crystals of CAMP basaltic rocks with different analytical techniques allowed characterizing and quantifying the carbon species involved in the emplacement of this LIP. Gas exsolution bubbles of melt inclusions, mainly hosted by clinopyroxene in crystal clots of CAMP lava flows from North America, Africa and Europe, preserve gaseous CO_2 derived from the mantle and/or assimilated from the lower-middle crust [1]. The reconstructed CO_2 concentrations in CAMP magmas suggest a degassing of up to 10^5 Gt CO_2 during the entire CAMP activity, and an amount of CO_2 degassed by each CAMP pulse comparable to that projected for anthropogenic emissions over the 21^{st} century. Moreover, vapour- and liquid-rich fluid inclusions, mainly hosted by late-magmatic quartz as interstitial crystals of CAMP sills from South America, preserve gaseous CH_4 derived from magma–sediment interaction [2]. The intrusive volume of CAMP magmas in Brazilian Amazonia hints a fluxing in the order of 10^3 Gt CH_4 generated or remobilized from the host, organic-rich sedimentary sequence. The biogeochemical box modelling for the main phase of CAMP activity shows that intense and pulsed degassing of exclusively volcanic CO_2 may have caused global warming, with temperature increases up to 5 °C, and ocean acidification, with pH drops about 0.2 log units, implying devastating biotic consequences [3]. Data from melt and fluid inclusions indicate both deep and shallow carbon sources for CAMP magmatism, and provide solid constraints on CAMP degassing for the end-Triassic palaeoclimatic modelling. The application of the same approach to other mass extinction-related LIPs is already offering insightful preliminary results.

[1] Capriolo *et al.* (2020), *Nature Communications* **11**, 1670. [2] Capriolo *et al.* (2021), *Nature Communications* **12**, 5534. [3] Capriolo *et al.* (2022), *Global and Planetary Change* **209**, 103731.