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Sulfur in clinopyroxene: a new approach to reconstruct sulfur budgets and environmental impacts of past magmatic episodes

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Reconstructing the volatile budgets of magmas emplaced throughout geological time is a long-standing challenge. We propose a novel approach to quantify the sulfur content of clinopyroxene-phyric melts, applicable to ancient magmatic systems such as Large Igneous Provinces (LIPs). Sulfur concentrations in clinopyroxene from basaltic magmas are determined using Synchrotron X-ray in-situ microfluorescence, and equilibrium melt sulfur concentrations are calculated using established partition coefficients [1]. Large volumes of greenhouse gases emitted by LIPs drove long-term global warming [2]. However, the potential for repeated short-lived volcanic winters triggered by SO_2 release has gained increasing attention from the LIP-community [3-4]. Historical sulfur-rich eruptions (e.g., the 1783–84 Laki fires and the 1991 Pinatubo eruption) caused short-term global or regional cooling with environmental and societal impacts. LIP-forming eruptions occurred as brief and repeated pulses, far more voluminous than these historical events, and may have triggered recurrent volcanic winters. Superimposed on long-term warming, such cooling episodes would have placed severe stress on ecosystems. Yet their short duration makes them difficult to detect in the stratigraphic record [4-5]. Our method provides a complementary "within-magma" approach to trace sulfur-rich magmatic pulses capable of generating volcanic winters. Because clinopyroxene is an early and nearly ubiquitous phase in LIP magmas, this approach enables reconstruction of sulfur budget variations across lava sequences and identification of sulfur-rich intervals as potential drivers of volcanic winters [6]. We will present results from the Deccan Traps and Franklin LIPs and discuss future developments of this approach.

References

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