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Magma-shale interaction and volatile mobilization at LIPs: insights from kinetic experiments

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Large Igneous Provinces (LIPs) whose magma plumbing systems intersect sedimentary basins are linked to upheavals of Earth's carbon and sulfur cycles and thus climate and life history. However, the mechanisms underlying magma-sediment interaction and mobilization of sediment-derived volatiles are unclear. To address this knowledge gap, we present the results of short time-scale "kinetic" petrological experiments (T = 1200 °C and P = 150 MPa) that explore interaction between basaltic melt and carbonaceous shale using starting materials from the Canadian High Arctic LIP and the Sverdrup Basin in which it intrudes [1]. Our experiments show that entrainment of shale xenoliths in basaltic melt causes shale to shatter due to incipient thermal stress and devolatilization, which accelerates assimilation by increasing reactive surface area. Shale assimilation therefore facilitates transfer of sediment-derived volatile elements to the shallow parts of LIP magma systems, whereupon carbon dominates the vapor phase whilst sulfur is partitioned into sulfide melt droplets. This study reveals that although carbon and sulfur are efficiently mobilized during magma-shale interaction, sulfides can sequester sulfur – an important climate cooling agent – and therefore boost the net warming effects of carbon at shale-intersecting LIPs.

[1] Deegan, F.M., *et al*. (2022), Magma-shale interaction in Large Igneous Provinces: Implications for climate warming and sulfide genesis. *J. Petrology* 63, 1-10. https://doi.org/10.1093/petrology/egac094