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Thallium isotopic constraints on the role of recycled components in the source of Siberian Trap basalts

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Large Igneous Provinces (LIPs) represent the remnants of some of the largest and most voluminous magmatic eruptions that occurred throughout Earth history. The vast quantities of erupted magma are commonly thought to originate from deep-seated mantle plumes, yet multiple lines of isotopic evidence indicate that recycled materials are not uncommon in LIP mantle sources.

Stable thallium isotope variations (ε^{205}Tl) serve as an additional tracer for recycled components in the mantle. This system is especially sensitive to several recycled components, including low-temperature altered oceanic crust (AOC; low ε^{205}Tl signatures, down to -15), pelagic sediments (up to +4), and Fe-Mn oxides (up to +12), whereas the mantle and continental crust have ε^{205}Tl of -2 [1]. Here we investigate Tl isotopes in a well-characterized set of Siberian Trap basalts [2]. Thallium isotopic separation was performed at Indiana University – Bloomington, using the method from [1], where a mix of NIST SRM 997 and NIST SRM 981 (2.5 ppb Tl:10 ppb Pb) was used for bracketing and for mass bias correction during measurement by MC-ICP-MS.

The studied basalts vary from trachybasalts and high-Mg picrites to low-Ti tholeiites. Thallium concentrations vary from ~ 0.01 to 0.5 ppm and ε^{205}Tl ranges from lower to higher values than estimated for the mantle. These values do not appear to correlate with weathering proxies, degassing extents, major-oxide contents, trace-element ratios, or radiogenic isotopes. Also, we do not find obvious correlations between sulfide accumulation/depletion and ε^{205}Tl. A straightforward interpretation would be that heavy ε^{205}Tl signatures reflect recycled pelagic sediments and/or Fe–Mn oxides in the mantle source, whereas light ε^{205}Tl values record contributions from recycled low-temperature AOC. Additional work is required, however, to confirm our preliminary data and to robustly demonstrate the presence of recycled crustal materials in the mantle source of the Siberian traps.

[1] Nielsen et al. 2017. Rev. in Min. and Geochem., P. 759-798.

[2] Marfin et al. 2024. GCA., V. 375, P. 106-122