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Sulfur isotopic composition of the Tristan-Gough plume source

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Sulfur isotopes offer new insights into the origin of Earth's mantle heterogeneity. At present-day, processes modifying sulfur produce isotopic fractionations that depend on the relative mass differences between its different isotopes. In contrast, Archean/earliest Proterozoic sediments exhibit mass-independently fractionated sulfur isotopes (MIF-S) acquired through photochemical reactions in the oxygen-poor atmosphere. The persistence of recycled MIF-S through subduction and eventual rise in a mantle plume has been demonstrated in two studies of single sulfide inclusions in phenocrysts for two South Pacific plumes [1,2] of HIMU and EMI endmember composition. The time constraints placed on the recycled component of the HIMU and EMI endmembers by S-MIF raises the question whether this might represent a general feature of plumes with such geochemical affinities.

Here we present sulfur isotopes of 46 mineral-hosted sulfide inclusions from 11 rocks from Tristan (Tristan da Cunha, Inaccessible, Nightingale) and Gough islands, the most recent activity of the major 130 Ma-long-lived EMI-type Tristan-Gough plume system with a root at the core-mantle boundary related to the African LLSVP. Data sets from Tristan and Gough are distinct, consistent with the lateral Pb-Nd-Hf isotopic zonation of this plume [3]. Gough is characterized by $\delta^{34}S$ close to zero, and a range in $\Delta^{33}S$ from zero to slightly positive values with the most extreme inclusion exhibiting positive MIF-S averaging at $\Delta^{33}S$=+0.25± 0.09 ‰(stdev, n=6). Tristan has negative $\delta^{34}S$ -7 to -0.9‰ and $\Delta^{33}S$ from -0.23 to +0.23‰ with an average of -0.04± 0.12 ‰(stdev, n=34) and no clear indication for MIF-S. Although Tristan and Gough have Sr-Nd-Hf-Pb isotopic characteristics with affinity to the enriched mantle I (EMI) global mantle endmember, they clearly exhibit distinct sulfur isotopic characteristics from each other and also distinct from EMI-type Pitcairn, with no MIF-S in Tristan, negative $D^{33}S$ in Pitcairn and positive $\Delta^{33}S$ in Gough. Despite variable origin, MIF-S in both Pitcairn and Gough suggests their EMI-type sources contain recycled surface material that is >2.45 Ga old.

[1] Cabral et al. (2013), *Nature* 496, 490-494. [2] Delavault et al. (2016), *PNAS* 113, 12,952-12,956. [3] Rohde et al. (2013), *Geology* 41, 335-338.