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Mantle Sulfur Cycle: A Case for Non-Steady State ?

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Data published over the last 5 years show that the early inference that mantle is isotopically homogeneous is no more valid. Instead, new generation data on lavas range over a significant $^{34}S/^{32}S$ variability of up to 5‰ with $\delta^{34}S$ values often correlated to Sr- and Nd-isotope compositions. This new set of data also reveals the Earth's mantle to have a sub-chondritic $^{34}S/^{32}S$ ratio, by about ∼1‰

We will present at the conference our published and unpublished data on samples characterizing the different mantle components (i.e. EM1, EM2, HIMU and LOMU). All illustrate ^{34}S-enrichments compared to MORB with $\Delta^{33}S$ and $\Delta^{36}S$ values indistinguishable from CDT or chondrites at the 0.03‰ level. These data are consistent with the recycling of subducted components carrying sulfur with $\Delta^{33}S$ and $\Delta^{36}S$-values close to zero.

Archean rocks commonly display $\Delta^{33}S$ and $\Delta^{36}S$ values deviating from zero by 1 to 10 ‰Ṫhe lack of variations for $\Delta^{33}S$ and $\Delta^{36}S$ values in present day lava argue against the sampling of any subducted protolith of Archean age in their mantle source. Instead, our data are consistent with the occurrence of Proterozoic subducted sulfur in the source of the EM1, EM2, LOMU and HIMU endmember at the St-Helena island. This is in agreement with the age of those components early derived through the use of the Pb isotope systematic.

Currently, the negative $\delta^{34}S$-values of the depleted mantle seem to be associated with mostly positive values of enriched components. This would be inconsistent with the concept a steady state of sulfur. Assuming that the overall observations of recycled sulfur are not biased, the origin of such a non-steady state remains unclear. It could be related to the relatively compatible behavior of sulfur during partial melting, as the residue of present-day melting can be shown to always contain significant amounts of sulfide (50% of what is observed in a fertile source). This typical behavior likely prevents an efficient extraction of mantle S over time, hence inhibiting quantitative mixing between surface and mantle S. This also allows the preservation of any primitive signature of the deep sulfur cycle to be potentially recorded.