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The sulfur isotopic composition of Earth's mantle

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Earth's mantle is the product of large-scale planetary differentiation. The geochemical composition of Earth's mantle was set during core-mantle equilibrium, but such a primary signature could have been modified by billions of years of subduction. Here, we attempt to constrain the influence of these processes on the mantle's composition with isotopic variations in sulfur (S), a volatile, siderophile, and chalcophile element. The sulfur isotopic composition of the mantle sources of Mid-ocean ridge basalts (MORBs), expressed as $\delta^{34}S=((^{34/32}S_{Sample}/^{34/32}S_{Standard})-1)\times1000$, ranges from -1.3±0.3‰ to -0.7±0.1‰ and is different from that of chondrites ($\delta^{34}S=0.1\pm0.4$‰). This was originally interpreted as a consequence of core-mantle differentiation [*1*]. However, MORBs are the product of partial melting and underwent crystal fractionation under sulfide saturation. Those processes may blur the link with their mantle sources [*2*]. Consequently, it remains uncertain whether MORBs faithfully record the bulk mantle isotopic signature.

The S mantle concentration is inferred from peridotite samples [*3*]. In this study, we present the sulfur multi-isotopic (^{32}S, ^{33}S, ^{34}S, ^{36}S) signature of peridotites and pyroxenites from the Balmuccia massif (Ivrea Zone, Italian Alps). Due to their fertile nature, the Balmuccia peridotites have been used to estimate the S concentration in Earth's mantle [*4*]. All peridotites used here exhibit low or negative loss-on-ignition values (LOI<0.23%), indicating minimal alteration. They span a wide range of S and Al_2O_3 concentrations, suggesting variable degrees of melt depletion. Preliminary results show that peridotites have near-zero values. The most fertile samples have $\delta^{34}S$ between 0.1±0.4 and 1.2±0.4‰. They also show positive ^{33}S values between 0.036±0.010 and 0.082±0.010‰. This differs from chondritic averages of -0.007±0.014‰ [*5*], and from estimates of asthenospheric sulfur of 0.004±0.006‰ (e.g.,*1*). Our preliminary ^{33}S data argue that Balmuccia peridotites record recycled sulfur, likely introduced in the massif during refertilization, suggesting that the massif samples should not be regarded as representative samples of the mantle for its sulfur isotope budget.

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