Uncovering the sulfur isotopic composition of fluids from HP-metamorphic slab

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In order to better understand the fate and behavior of sulfur in subduction zones and the sulfur isotopic signature in arcs, we analyzed the $^{33}S/^{32}S$, $^{34}S/^{32}S$ and $^{36}S/^{32}S$ ratios (expressed as $\delta^{34}S = (^{34}R_{sample}/^{34}R_{std} - 1) * 1000$; $\Delta^{33}S = \delta^{33}S - ((1 + \delta^{34}S/1000)^{0.515} - 1) * 1000$ and $\Delta^{36}S = \delta^{36}S - ((1 + \delta^{34}S/1000)^{1.89} - 1) * 1000$) in eclogite breccias, serpentinites, metasediments from the Lower Shear Zone (LSZ) of Monviso (Alps, Italy) recording evidence of a channelized fluid flow at the metamorphic peak ~ 550°C and 2.6 GPa, as well as metabasalt and metagabbros unaffected by these fluids.

The $\delta^{34}S$ ranges from -12.4 to 20.8 ± 0.2‰, $\Delta^{33}S$ from 0 to 0.07 ± 0.01 and $\Delta^{36}S$ from -0.3 to 0.4 ± 0.2‰. Metabasalt and metagabbros non-affected by fluids have a $\delta^{34}S$ between 0 and 2‰ that suggests a magmatic origin and/or hydrothermal alteration on the seafloor whereas other samples in the LSZ are ^{33}S-^{34}S-enriched compared to the former, except a metasediment being ^{34}S-depleted. Furthermore, the absence of sulfate and the magnetite precipitation in the LSZ suggest that the fluid was reduced, with sulfur as HS^- or H_2S. We can interpret our data using at least two sources of S that were mixed in the fluid. A first one is ^{33}S-^{34}S-enriched and could derive from sulfates from either evaporite of the Dora Maira unit or from antigorite breakdown ($\delta^{34}S$ ~ 21‰). The second source is ^{34}S-depleted and ^{33}S-enriched and could be typified by sulfate reduced by microorganisms on the seafloor in sediments and altered oceanic crust.

This study clearly illustrates that arc lavas could have variable $\delta^{34}S$ from negative values (biogenic sulfides in altered oceanic crust and sediments) to positive values (evaporite and/or antigorite breakdown).

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