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# The origin of sulfur in Canary Island magmas and its implications for Earth's deep sulfur cycle

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Oxygen fugacity ($fO_2$) controls whether sulfur is present as sulfide or sulfate in silicic magmas: increasing $fO_2$ can lead to an order of magnitude increase in sulfur solubility [1]. This is reflected in the sulfur content of comparatively reduced and oxidised melts erupting at mid-ocean ridges (0.1-0.15 wt%) and at subduction-related volcanic arcs (up to 0.7 wt%), respectively [2]. Some ocean islands basalts (OIBs), including those erupted at El Hierro in the Canary Islands, reach S contents similar to subduction-related magmas [3]. While at subduction zones elevated sulfur contents and $fO_2$ is explained by slab-mantle interaction [1], the cause of sulfur enrichment and oxidation at ocean islands is more enigmatic.

We use sulfur isotope ($\delta^{34}S$) microanalyses of melt inclusions and glasses alongside bulk $\delta^{34}S$ analyses of lavas from El Hierro to investigate the origin of observed sulfur enrichment. Melt inclusions have $\delta^{34}S$ values between -1.6‰ and +4.1‰ (V-CDT), and S contents between 200 and 5300 µg/g, while lavas have $\delta^{34}S$ between -15.5 and +1.4‰ and S contents <400 µg/g. Using degassing and melting models we estimate undegassed melt $\delta^{34}S$ (between 0±2‰) and mantle source S content (310±120 µg/g) for El Hierro magmas. On average, 60% of the sulfur in the mantle source is of recycled origin. To satisfy radiogenic isotope constrains on the fraction of recycled material in the mantle source (<10% [5]) we estimate that the recycled component should contain ≥1800 µg/g sulfur. A silica-rich partial melt of recycled oceanic crust could reach these modelled sulfur contents if it was partially oxidised ($Fe^{3+}/\sum Fe$ of >0.15). Based on our results we propose that recycling of $Fe^{3+}$ in silicates is the source of elevated $fO_2$ in OIBs, while silicate melts that contain $S^{6+}$ offer an effective pathway for oxidation in the upper mantle via melt-rock reactions.

**References:**

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