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In situ sulfur isotope analysis of Archean basalts associated with the Belingwe komatiite: Implications for recycling of oceanic lithosphere

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The radiogenic isotope compositions of ocean island basalts (OIB) and mid-ocean ridge basalts (MORB) indicate that the Earth's mantle is chemically heterogeneous, resulting from the recycling of crustal material through plate tectonic processes. Still, the timing of the onset of this process remains uncertain. The bulk sulfur isotope measurement of the Belingwe komatiites at 2.7 Ga suggests the presence of subducted oceanic lithosphere in the deep mantle [1]. However, sulfide minerals are susceptible to alteration processes, raising concerns that bulk analyses may not reliably represent the original mantle source composition. In this study, we present in situ sulfur three-isotope data obtained by secondary ion mass spectrometry (SIMS) from sulfide minerals in a 2.7 Ga LREE-depleted basalt sample associated with the Belingwe komatiites. Petrographic observations indicate the presence of two distinct pyrite populations. The first is volcanic pyrite (<50 μm) that is disseminated in the groundmass. The second is larger hydrothermal pyrite that overprints the original basalt textures along with secondary minerals. Chalcopyrites are small and occur within the groundmass, which is interpreted as volcanic origin. The sulfur isotope data show a negative correlation between $\Delta^{33}S$ and $\delta^{34}S$ values, and Volcanic pyrites and chalcopyrites have negative $\Delta^{33}S$ values, while secondary hydrothermal pyrites have near-zero $\Delta^{33}S$ values, suggesting a mixing process between two distinct sulfur reservoirs. The bulk sulfur isotope composition falls within the mixing array, consistent with the SIMS measurement. The negative $\Delta^{33}S$ signature is interpreted as recycled Archean marine sulfates that were incorporated into the komatiite source mantle in the deep mantle by subduction of altered oceanic crust?. A surface sulfur with $\Delta^{33}S \approx 0$ ‰ mixed with the source mantle signature through hydrothermal alteration processes during or after the eruption. The results support that the negative $\Delta^{33}S$ value observed in the bulk measurement have the volucanic origin, and suggest that oceanic sulfate fixed in oceanic lithosphere has been subducted into the deep mantle for at least 2.7 billion years.

[1] Sulfur in Archean komatiite implies early subduction of oceanic lithosphere, Kubota et al., (2022), *Earth and Planetary Science Letters* 598, 117826