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In-situ lead and multiple sulfur isotope analyses of sulfides in Eoarchean peridotites provide evidence for early crustal recycling

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Previous studies have revealed that remarkably well-preserved Eoarchean peridotites found in the cores of ultramafic enclaves south of the Isua Supracrustal Belt in southern West Greenland contain sulfur with positive bulk rock $\Delta^{33}S$ values, indicating that they have incorporated sediment deposited on Earth's surface prior to the Great Oxidation Event [1]. Here, we present new in-situ lead and multiple sulfur isotope analyses of sulfides within these peridotites conducted using secondary ion mass spectrometry (SIMS), as well as petrographic observations and compositional analysis of the sulfides by electron microprobe. Consistent with the bulk results, least squares weighted average $\Delta^{33}S$ values in the least overprinted (Group 1 [1]) peridotites were +0.20±0.02(2σ)‰, and $\Delta^{33}S$ values in peridotites whose trace and bulk elemental compositions reflect higher degrees of melt overprint (Group 2 [1]) were +0.09±0.03(2σ)‰. Sulfides in the peridotites were found to be predominantly composed of pentlandite and pyrrhotite, consistent with the typical sulfide mineralogy of mantle rocks. Amphibole overgrowing the sulfides indicates that they predate the amphibolite facies metamorphism these rocks experienced in the Neoarchean. Finally, the lead isotopic compositions of the sulfides are consistent with Eoarchean origins followed by re-equilibration with surrounding rock at ~2.7Ga. Given the correlations observed in previous work between $\Delta^{33}S$ values and concentrations of melt-mobile, fluid-immobile elements in these rocks [1], it is likely that the sulfur isotope compositions of the peridotites were not significantly overprinted by the event that re-equilibrated the lead isotopes in the sulfides. Rather, they appear to have been influenced by earlier magmatic processes. Taken together, these results add weight to previous interpretations of bulk sulfur isotope results suggesting that these rocks incorporated surface-derived sulfur in a mantle wedge environment in the Eoarchean, implying an early beginning to horizontal tectonic processes at 3.8Ga or earlier.

[1] Lewis et al. (2022) EGU 22-5226