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Missing negative $\Delta^{33}S$ reservoir in mantle inferred from 2.7 Ga komatiite

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Sulfur mass-independent fractionation (S-MIF) was originated from the photolysis of SO_2 in an anoxic atmosphere, and thus constrain the O_2 concentration in the Archean atmosphere [1,2]. The enigmatic asymmetry in the $\Delta^{33}S$ record may tell something about the global sulfur cycle [3]. The average of all the reported $\Delta^{33}S$ values is in favor of positive $\Delta^{33}S$ values. The 'missing' negative $\Delta^{33}S$ has not yet been identified, though the mantle is a potential candidate for this missing reservoir. Here, we analyzed multiple sulfur isotopes of the 2.7 Ga komatiite in the Belingwe greenstone belt [4]. Petrological observation demonstrated that sulfides represent igneous origin. The most depleted samples tend to show a negative $\Delta^{33}S$ value indicating that the S-MIF signature derived not from crustal contamination but from their source mantle. The $\Delta^{33}S$ values correlate with the initial Sr-Nd-Pb isotope composition, which suggests that their isotope system is accountable for ancient mixing between a depleted mantle and a S-MIF-bearing component, whereas the assimilated lava has more enriched and do not have S-MIF. We conclude that the S-MIF-bearing component represents seawater sulfate ($\Delta^{33}S < 0‰$) probably incorporated into a shallow part of the oceanic lithosphere. Then, the S-MIF-bearing oceanic lithosphere may have subducted and stored in the deep mantle, which could be the source of the komatiite. From modern OIBs, negative $\Delta^{33}S$ values were also observed from sulfide inclusions in olivine [5,6], but we demonstrate more robust and direct evidence that the missing sulfur exists as a part of subducted Archean oceanic lithosphere.

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