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Multiple sulfur isotopic records of pyrite in the Doushantuo Formation from South China

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The chemical composition of the Ediacaran ocean underwent significant transformation that were intricately linked to atmospheric oxidation and the early evolution of animal life. In this study, we present new data on multiple sulfur isotopes ($\Delta^{33}S$ and $\delta^{34}S$) derived from pyrite in the Doushantuo Formation in South China. Our findings reveal a negative excursion in $\Delta^{33}S$ that coincides with a positive excursion in $\delta^{34}S$ within the upper Doushantuo Formation across various sections. This sulfur isotopic variation is also associated with the Shuram carbon isotopic negative excursion. We conducted several models of sulfur cycling, which yielded the following conclusions: (1) the oxidation of substantial amounts of organic carbon by sulfate may have significantly contributed to the negative carbon isotopic excursion during the Ediacaran period; (2) during the initial phase of the negative carbon isotopic excursion, there was minimal reoxidation of H_2S/pyrite, indicating a predominantly reducing environment; (3) in the subsequent phase of the negative excursion, approximately half of the H_2S/pyrite underwent reoxidation, suggesting a transition towards a more oxidizing environment in seawater and sediment; (4) sulfate reduction processes generated considerable quantities of H_2S that remained unreoxidized, potentially resulting in euxinic conditions in shallow or restricted aquatic environments.