# Sulfur isotopic evidences from 1.6-1.0 Ga sediments in North China for Mesoproterozoic atmospheric oxygenation

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The Mesoproterozoic era (1.6 to 1.0 Ga ago) was referred as a remarkably stable interval in crustal dynamics and climate, with persistently low levels of atmospheric oxygen. Canfield and his colleagues suggested that sulfidic environments were prevailing in Mesoproterozoic oceans. However, latest reports suggested a progressive oxygenation event took place in ~1570 Ma oceans according to negative Ce anomaly and Fe speciation in Mesoproterozoic sediments from North China. Here, we report new paired sulfur isotope data in carbonate associated sulfates (CAS) and sedimentary pyrites (Py) in Mesoproterozoic carbonate samples from North China. Co-variations in sulfate and pyrite sulfur isotopic compositions may provide new insight into sulfur cycle and redox condition evolution in Mesoproterozoic oceans.

Late Paleoproterozoic (1650-1600 Ma ago) and Early Mesoproterozoic (1600-1570 Ma ago) sediments show high $\delta^{34}S$ values both in carbonate associated sulfates and sedimentary pyrites, and minimum sulfur isotopic fractionation ( $\triangle\ ^{34}S=\delta^{34}S_{CAS}-\delta^{34}S_{py}$). Those sulfur isotope data indicate that low seawater sulfate concentration and a low level of atmospheric oxygen in the Late Paleoproterozoic and Early Mesoproterozoic. Then, moderate $\delta^{34}S$ values of CAS and pyrites and moderate sulfur isotopic fractionation suggest an increasing sulfate concentration associated with a rise in atmospheric oxygen level at ~1570 Ma. High δ 34Scas values, low δ34Spy values and large sulfur isotopic fractionation ( △ 34S= δ 34SCAS- δ 34Spy) indicate that atmospheric oxygen levels furtherly increase at the stage of the Wumishan and Hongshuizhuang (ca.1500-1470 Ma). However, spatial differences in sulfur isotopes suggest that chemical heterogeneity still existed in the Mesoproterozoic oceans aftermath progressive oceanic oxygenation.

Acknowledgements: This work is supported by the National Natural Science Foundation of China (Grants No. 41272041).