In Situ Sulfur Isotopes from Mineral Systems in the Proterozoic Capricorn Orogen

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We present a regional-scale compilation of in situ sulfur isotopes from various mineral systems within the Proterozoic Capricorn orogenic belt in Western Australia. Our work demonstrates an orogen-wide spatial and temporal discrepancy between the preservation of anomalous mass independent fractionated (MIF) sulfur ($\Delta^{33}S$ and $\Delta^{36}S$). Certain gold deposits within the Proterozoic orogen yield $\delta^{34}S$ from +10.09 to +15.92 with a negligible $\Delta^{33}S$ (0.00–0.15), whereas others yield $\delta^{34}S$ from -1.57 to +0.97 with a significant $\Delta^{33}S$ (0.21–0.39) and $\Delta^{36}S$ (-5.83–0.08).

To better understand the processes promoting the remobilization of anomalous $\delta^{34}S$ and MIF sulfur to Proterozoic mineral deposits, in situ sulfur isotope data collected by secondary ion mass spectrometry are coupled with quantitative crystal lattice orientation and trace elemental maps collected by electron backscatter diffraction and laser ablation-inductively coupled plasma mass spectrometry, respectively. Internal variations and zoning inherent to the analyzed pyrite grains are integral in deciphering (1) the primary source(s) of sulfur, and (2) the mechanisms resulting in sulfur-liberating episodes.

This work sheds new light on the discrepancy between metal endowment within Archean cratons and their interleaving Proterozoic orogenic belts. It is part of a greater effort to investigate how anomalous sulfur isotope signatures can be transported from well-endowed Archean cratons to be accumulated and stored in mineral systems within Proterozoic orogenic belts.