Quadruple sulfur isotope records of quartz-rich sandstones of the 3.22 Ga Moodies Group (Barberton Greenstone Belt, South Africa)

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Sulfur isotope is a strong proxy to decipher atmospheric and biological processes on Earth and have provided important constraints on the atmospheric chemistry in the Archean. The 3.22 Ga Moodies Group, the stratigraphycally upper part of the Barberton Greenstone Belt (BGB), South Africa, is interpreted as the oldest terrestrial to marine transitional succession (e.g., [1]). The lower Moodies Group consists mainly of quartzitic sandstones with cross beddings and flat and wavy laminas (putative fossilized microbial mats, [2]), deposited in shallow water settings. The unique petrology and depositional environnement of the Moodies made this group an interesting target for better understanding the Paleoarchean (3.6-3.2 Ga) sulfur cycle. The sulfur isotope and other geochemical analyses were conducted on 46 samples collected from a 350 m thick Moodies succession (upper MdQ1) in the Saddleback Syncline in the central BGB. The $\delta^{34}S$ values of sulfide in the rocks vary between –8 and +2‰, whereas the $\Delta^{33}S$ values range from +0.05 to +0.25‰. The $\Delta^{33}S$ values are small but show significant mass independent fractionation of sulfur isotopes (S-MIF). The present Moodies sulfur records can largely be explained by the mixing between a primary atmospheric sulfur and a secondary sulfur derived from a hydrothermal fluid after deposition. The frequent occurrence of micro quartz and muscovite/sericite cements in the rocks suggests postdepositional metasomatic fluid circulation and supports the mixture with juvenile sulfur. The Moodies data are not on the conventional Archean reference array (ARA) on the $\delta^{34}S$-$\Delta^{33}S$ cross plot and imply that the Paleoarchean sulfur cycle is different from the Neoarchean (2.8-2.5 Ga) cycle. Other Paleoarchean records support this apparent evolution of the sulfur cycle during the Archean time.

[Ref] [1] Homann et al. (2015) Precam. Res. 266, 47-64. [2] Noffke et al. (2006) Geology 34, 4, 253-256.