Atmospheric sulfur in the Orogenic Gold Deposits of the Archaean Yilgarn Craton

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The elusive source of sulfur in Archaean orogenic gold deposits is a highly contested area of research, with different models of deposit formation calling on a variety of crustal and mantle sources to explain the anomalous (10-100 x average crustal abundance) amounts of sulfur in these systems. Possible sources of sulfur in Archaean orogenic gold deposits include supracrustal rocks [1], mid crustal magmatic hydrothermal systems [2] or even deeper reservoirs, such as the lower crust or mantle [3].

Our natural laboratory to address this knowledge gap is the highly metal endowed Yilgarn Craton, where we measured the multiple sulfur isotope signature of representative sulfide-bearing auriferous samples from 24 Archaean orogenic gold deposits varying in size and geological setting. Utilising the chemically conservative mass-independently fractionated sulfur (MIF-S) isotope signatures, we fingerprinted a major source of sulfur in these deposits. Contrarily to previous studies, our data show that they display very strong MIF-S isotope anomalies, with $\Delta^{33}S$ values ranging from -1.18‰ to 2.04‰, with most of the studied deposits showing a sulfur signature that is consistent with a crustally derived source. Unlike smaller deposits, which may form with sulfur derived from a single sedimentary sulfur source, hence providing a coherent Archaean atmospheric signal in their $\Delta^{33}S$-$\Delta^{36}S$ slope (~0.9 – 1.5), the formation of giant deposits may require sourcing of a wider range of sulfur reservoirs, as reflected in their apparently random $\Delta^{33}S$ – $\Delta^{36}S$ slopes.

[1] Tomkins (2013), Geology, 41, 1255–1256. [2] Xue et al. (2013), Geology, 41, 791–794. [3] Hronsky et al. (2012), Mineralium Deposita, 47, 339–358.