Is a coherent picture of Earth's early oxygenation emerging from sedimentary metal isotope records?

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Over the past decade, there has been a surge in the amount of metal isotope data collected from Precambrian sedimentary rocks with the aim of tracking Earth's protracted oxygenation. This work has been essential in moving forward our views of marine and atmospheric evolution. Typically, however, these studies have focused on single isotope systems, often within a single sedimentary facies. We will present case studies in which records compiled from multiple metal isotope systems in multiple facies provide a coherent view of ambient redox state. Specifically, we will present work from paleosols and sedimentary rocks from the ca. 2.9 Ga Pongola Supergroup where a multi-proxy approach provides strong evidence for the rise of oxygenic photosynthesis almost half a billon years before the Great Oxidation Event.

Secondarily, we will focus, more broadly, on addressing whether metal isotope proxies (foremost U and Cr isotopes) applied to different sedimentary facies (e.g., shales vs. carbonates) yield a consistent signal, and whether we can discern clear temporal trends through the Precambrian. We will highlight cases where proxy records from different facies appear to yield conflicting results. Although some apparent discrepancies can be resolved by considering the influence of disparate depositional environments, we will highlight certain conflicts in need of resolution. Addressing apparent contradictions within proxy records will, in the future, be an essential step to ensure that metal isotopes can continue to shape our view of Earth's redox history.