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S-cycle characterization in the Paleoproterozoic Kuruman iron formation, Transvaal Supergroup, South Africa.

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The Great Oxygenation Event (GOE) is a drastic change of the atmosphere's composition occurring at the end of the Archean. This major transition is currently constrained within ~200 Ma depending the basin and is traceable by the disappearance of the mass-independent fractionation of sulfur preserved in sedimentary rocks. Constraining the duration and the evolution of the GOE have been the focus of numerous studies, some suggesting an abrupt shift while others proposed a series of repetitive and reversible oxidation events.

We present new in-situ triple-S isotope SIMS measurements performed on pyrite grains from black shales extracted from the Kuruman iron-Formation, Griqualand West Basin, South Africa, that span the interval of the GOE. This drillcore has been already studied in great detail by [1] who calculated a sedimentation age model using high-precision geochronology. Pyrites are present under various crystalline phases but no correlation between their morphology, locations, and S isotope compositions has been observed. However, theses diagenetic pyrites have been formed through the mixing of several S sources, two atmospheric, elemental S-pool (S^8) and sulfate aeresol (SO_4) and seawater sulfate reduced by microbial sulfate reduction (MSR). Particularly, a clear mixing pattern which we interpret as an oxygenation pulse is particularly evident in the Kleine Naute Shale (2483.6±0.34 Ma; [1]). The following black shale ~3 m above shows a complete different signal. Furthermore, we notice a common overlap between different textures. Based on previous work, the estimated lapse between shales with different S-signals would be less than 5 Ma. This drillcore represents by far the highest temporal resolution ever achieved at the transition between Archean mass-independent to Proterozoic/modern-day mass-dependent fractionation of S. In consequence, we believe that we have found pulses of oxygenation at a basinal scale at million years timescale of duration, possibly one of the latest Archean-oxygenation-event as proposed by [2].

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[2] Ostrander, C., Johnson, A., & Anbar, A. (2021). Earth's First Redox Revolution. Annual Review of Earth and Planetary Sciences, 49, 337-366.