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Single pulse of significant O_2 increase during the Great Oxidation Event – geochemical, isotopic and stratigraphic evidence from the Duitschland and Rooihoogte formations (South Africa)

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Identifying the nature and temporal evolution of the Great Oxidation Event (GOE) as either an oscillating or sudden atmospheric change relies heavily on the correlation of sedimentary formations recording the loss of mass independent fractionation of sulfur isotopes (MIF-S) [1,2]. Two critical formations in this regard are the Duitschland and Rooihoogte formations in the Transvaal Basin (South Africa), which both record the loss of MIF-S, but have an unsettled stratigraphic relationship. A synchronous deposition of the Duitschland and Rooihoogte formations would indicate a sudden loss of a significant MIF-S signal in South African strata [3]. Contrary, a decoupled deposition, with the Duitschland Formation predating the Rooihoogte Formation, would point towards an oscillating nature of the GOE [4]. Here we present lithological, stratigraphic, major and trace element data as well as Sr and Nd isotope data from four drill cores intersecting critical strata of both the Duitschland and the Rooihoogte formations to answer this discrepancy. All collected data point to a contemporaneous deposition for the two formations and thus a sudden loss of MIF-S and an abrupt GOE, much in contrary to the oscillation model. Furthermore, bulk rock T_{DM}(Nd) from the Duitschland and Rooihoogte formations show old (consistently Archean) model ages compared to the youngest zircon ages of 2342±18 and 2353±18 Ma respectively [5], and hence changes our understanding of key sediment sources to these formations.

[1] Guo et al. 2009 Geology, 399-402; [2] Luo et al. (2016) Science Adv. 2.5; [3] Schröder et al. (2016) Precamb. Res. 278, 362-393; [4] Gumsley et al. (2017) PNAS 114, 1811-1816; [5] Zeh et al. (2020), Precambrian Research 345, 105760