

Surface conditions at 2.47 Ga as constrained by triple oxygen isotope system

MARTIN HUGO SENGER¹ AND ILYA N. BINDEMAN²

¹University of Arizona

²University of Oregon

Presenting Author: martinsenger@arizona.edu

The oxygen stable isotope system measured in the sedimentary record is a robust approach to understand the temperature and environmental conditions at the time of formation deposition [1]. However, the traditional approach of $\delta^{18}\text{O}$ values may not discern between the following two scenarios: a) seawater temperature and b) secular changes of $\delta^{18}\text{O}$ in the range of 10-20 ‰ [1,2]. Instead, the use of triple oxygen isotopes allows recognition of these factors through an extra temperature-dependent mineral-water fractionation equation provided by $\Delta^{17}\text{O}$, potentially allowing the disentanglement of the temperature of formation and $\delta^{18}\text{O}_{\text{seawater}}$ [3].

We present a comprehensive stable isotopic dataset ($\Delta^{17}\text{O}$ - $\delta^{18}\text{O}$) of a drillcore intersecting the entire depositional environment of the marine-deposited Kuruman Formation (Transvaal Supergroup, South Africa). The Kuruman Formation, dated to ~2.47 Ga, is of critical importance in the geologic record because it predates the GOE and the first Snowball event in the earliest Paleoproterozoic [4]. Another remarkable feature of the Kuruman Formation is that it records an entire cross-section of the Paleoproterozoic seawater, from deeper to shallower facies. We thus sampled the black shales that are interbedded in between the characteristic banded iron formation of this iconic unit. Isotopic variations expressed as $\Delta^{17}\text{O}$ - $\delta^{18}\text{O}$, range between -0.05 ‰ and -0.36 ‰ and 8.7 to 21 ‰ respectively and variations are aligned along a single fractionation line representing a single value of parental water with low- $\delta^{18}\text{O}$ values. The $\delta^{18}\text{O}$ values in lutites are among the heaviest values measured for the Neoproterozoic/Paleoproterozoic transition recording low-mid temperature of precipitation. This data is currently being interpreted to evaluate the temperature of formation as well as the $\delta^{18}\text{O}$ composition of participating seawater, with a subtle influence from the participating mineralogies, and the effects of chemogenomic precipitation and alteration. Notably, our new results provide valuable evidence that is crucial to our understanding of the Paleoproterozoic oceans.

[1] Shields, G. & Veizer, J. (2002). *Geochemistry, Geophysics, Geosystems*, 3(6).

[2] Muehlenbachs, K. (1998). *Chemical Geology*, 145(3-4), 263-273.

[3] Bindeman, I. N. (2021). *Reviews in Mineralogy and Geochemistry*, 86(1), 241-290.

[4] Lantink, M. L., Davies, J. H., ... & Hilgen, F. J. (2019). *Nature geoscience*, 12(5), 369-374.