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A perspective on life and its environment(s) during the Great Oxygenation Event from apatite and dolomite petrochronology of microbialites: the 2.4-2.2 Ga Turee Creek Group, Western Australia

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There are few well-preserved fossiliferous deposits from the time of the Great Oxygenation Event (GOE). This time period is significant to our understanding of life's co-evolution with the environment because oxygen has been linked to the complexification of life. A microbialite reef complex in the 2.4-2.2 Ga Turee Creek Group, Western Australia, provides insight into life during the GOE. A peritidal phosphorite within this reef indicates shallow water oxygenation associated with diverse and novel microbialites, suggesting life potentially flourished in oxygenated environments [1-2]. However, evidence of very near shore oxygenation does not indicate the types of environments microbialites in other sections of the reef experienced. Here we combine stratigraphic and textural relationships with geochemical data to describe and quantify the environments associated with microbialite growth. Apatite from the phosphorite and dolomite from various microbialites in the shallow to deeper water sections of the reef were analysed by Laser Ablation Split-Stream analysis in the LionChron facility at Penn State. *In situ* U-Pb isotope data (apatite), along with trace metal and rare earth element (REE) data (apatite and dolomite) were obtained from multiple samples within the reef. By combining age and trace-element data, various generations of apatite can be linked to particular trace element patterns, highlighting the data that best represents depositional information. U-Pb apatite age data indicates that the reef complex was likely deposited by ~2.3 Ga, with evidence of Pb loss events associated with later regional orogenic events at ~2.1 and ~1.8 Ga. The apatite associated with the depositional age, and shallow-water microbialites, have mostly flat REE patterns with positive La and Y anomalies, suggesting deposition within a mixed riverine-oceanic environment. Microbialites within deeper water units have sloped REE patterns with enriched heavy REEs, positive La and Y anomalies that are indicative of marine deposition. An extended study using *in situ* iodine and trace metal data in combination with U-Pb isotopes, from dolomite in both deeper and shallow water units, will be used to look at the extent of oxygenation in the reef.

[1] Soares G.G. et al. (2019)Precambrian Res., 320, 193-212.

[2] Barlow E.V. et al. (2016)Geobiology., 14, 317-343.