Toward Constraining Agnostic Biosignatures in Rocks by Investigating the Abiotic 'Background'

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A considerable portion of life detection research in recent decades has focused on defining and characterizing biosignatures. More recently, there has been a drive towards investigating agnostic, or universal signs of life. Yet, in order to establish features that can be considered universal signs of life, we first need to understand the 'background' signal of physical and chemical processes in a system *sans* life. This is particularly difficult to do, even within highly controlled laboratory settings, as life is everywhere on Earth.

One way to minimize this 'life is everywhere' effect is to focus on rocks – particularly, those from a time when life was relatively simple and was not necessarily saturating every aspect of the environment. Here we present research methodology and preliminary results of a study that interrogates the relationship between biotic and abiotic features in rocks from the early Paleoproterozoic Turee Creek Group in Western Australia.

Our aim is to identify features and/or relationships within these rocks that are attributable to abiotic processes. To do this, both textural features and elemental/mineralogical compositions will be analyzed within three sets of carbonate rocks from the same locality: 1) samples that preserve features of definitively biological origin (i.e., demonstrably biogenic stromatolites, Fig. 1A); 2) samples of mixed origin (i.e., microbial mats interlayered with sediment, Fig. 1B); and 3) rocks that preserve abiogenic sediments (i.e., thinly bedded carbonates, Fig. 1C).

The depositional, diagenetic, and metamorphic history of the studied unit is well constrained, with the necessary contextual information available (e.g., Barlow et al., 2016; Barlow & Van Kranendonk, 2018; Nomchong, 2021; Nomchong & Van Kranendonk, 2020; Soares et al., 2019) to be able to select samples that have been subject to the same conditions during sediment deposition and subsequent rock formation. Thus, the samples should essentially be the 'same' except for where features have been directly influenced by biology, allowing us to tease apart textural, elemental and mineralogical features and/or relationships representative of each sample category (i.e., biogenic, mixed, abiogenic).

By improving our understanding of the 'background' processes represented in rocks from this system, we will be a step closer to revealing candidate features for universal signs of life in rocks.

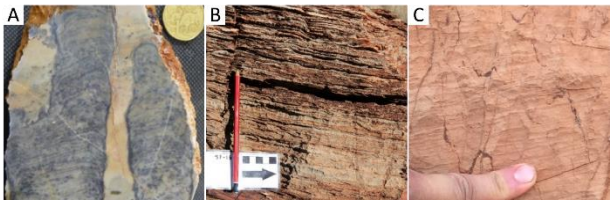

Figure 1. Examples of sample categories. A) Biogenic origin: columnar stromatolites (blue) with inter-column sediment (tan). B) Mixed origin: microbial mat, interlayered with sediment. C) Abiogenic origin: thinly bedded carbonate. Photo credit: Barlow et al. (2016) (A, B); B. J. Nomchong (C).

References:

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