X-RAY MICROTOMOGRAPHY: A POTENTIAL TOOL FOR PRECAMBRIAN PALAEOBIOLOGY.

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Introduction: The suitability of tomographic techniques[1] for assessing Earth's oldest life is yet to be investigated. We evaluated the utility of two X-ray computed microtomography (µCT) scanners in assessing the morphology and petrological context of the Precambrian cellular record[2]. Material tested originated from the Pilbara craton of Western Australia (3.49 Ga Dresser Fm., 3.46 Ga Apex Basalt and 3.43 Ga Strelley Pool Fm.) and the 1.88 Ga Gunflint Fm. of Ontario, Canada. These units chart key developments in palaeobiology: from controversial microfossil-like objects and microbial structures to definitive prokaryotes. Such a record has pivotal implications for the early evolution of life on Earth.

Detection of microfossils: Certain carbonaceous and pyritised *Gunflint* microbiota (*cf. Huroniospora*) can be visualised, as can some arcuate and vermiform *Apex* chert pseudofossils. However, both the absolute number of, and morphospace occupied by, the features detected using µCT tomograms is less than estimated from thin section observation, suggesting many remain unresolved. The recognition of regions rich in carbonate rhombs from the Gunflint Chert allows the identification of areas in which, by contrast, microfossil preservation is unlikely.

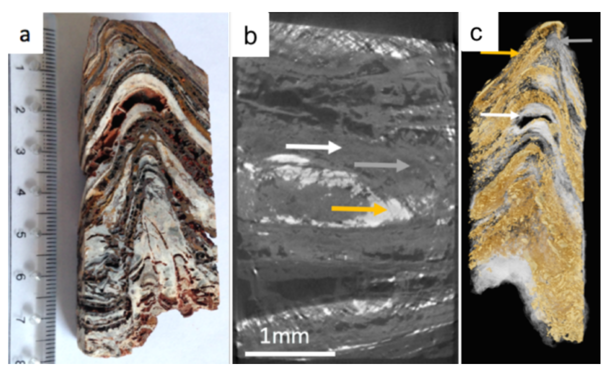
Detection of minerals: In *Strelley Pool* samples, we identified heavy mineral phases often associated with microbiota[3], though identification of the tubular and spheroidal fossils is precluded by their small size.

Detection of stromatolites: Stromatolites provide a contrasting challenge: in those studied (3.49 Ga Dresser Fm. and 1.88 Ga Mink Mountain), we were able to image and identify micron-scale compositional variation, and thus the distinction of laminae was usually possible (Fig. 1). Stacked tomograms (Fig. 1b) provide greater spatial detail than, and highlight alternative features when compared with, corresponding thin section photomicrographs, and could denote complexity in support of biogenicity[4-5]. Though the Dresser stromatolites are of questioned biogenicity, our images show recurrent patterns in complexity and preservation through multiple layers (Fig. 1c) which might support some cyclical, systematic mediation.

Detection of MISS: The Apex chert microbially induced sedimentary structures (MISS), proposed by us in a previous work[6] are confirmed as filamentous and of dimensions comparable to known biofilm-like MISS, though low density contrasts (by virtue of extreme silicification) hinder complete detection.

CT for micropalaeontology: We demonstrated that while the imaging of individual microfossils and pseudofossils currently lies at the limits of most lab-based µCT capabilities, beneficial taphonomy (mode of preservation) can ameliorate detection[2]. Ergo, microfossils preserved as thicker carbonaceous coatings or through heavy mineral phases are most easily identified. The quality of data obtained from MISS and stromatolites is controlled by their mode of preservation. In the cherts we studied, preservation by silica is a double-edged sword: although high-fidelity morphological biosignatures can preserve well, the pervasiveness of silicification reduces density contrast, making their detection challenging. Notwithstanding, X-ray CT provides a clear overview of the petrological context of many tested objects at flexible spatial scales, and could have implications both for the assessment of stromatolite and MISS biogenicity and for their archiving[2]. It could also prove to be a valuable tool in the reconnaissance of sedimentary micro-facies.

Fig. 1. (a) Dresser stromatolite. (b) µCT tomogram. (c) 3D density render; gold=dense, greys=less dense.



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