Graphitic microfossils in apatite from the Paleoproterozoic Michigamme Formation

DOMINIC PAPINEAU

London Centre for Nanotechnology and Department of Earth Sciences, University College London, London, UK

Precambrian phosphorites preserve evidence for past microbial activity and as such, they constitute a proxy repository for the kinds of microbial communities that evolve in changing paleoenvironments. A hypothesis is that diverse environments continued to host high levels of primary production, but preserve different evidence depending on water depth. Phosphorite deposits from the Paleoproterozoic started forming at around 2.0 Ga, such as in the Zaonega Formation where concretionary phosphatic organic-rich shales preserve evidence for methanotrophic and sulphur-oxidizing microorganisms (Lepland et al., 2014).

For comparison, the Michigamme formation from the Baraga Group preserves phosphate-rich layers in finely laminated organic-rich shaly banded iron formation, from deep marine setting (Papineau et al., 2010). The organic matter (TOC = 2-3%wt) has $\delta^{13}C$ values between -21.3 and -22.9‰. Nitrogen and other trace elements can be detected *in situ* in this graphite with Raman I_D/I_G = 0.1 to 0.3 and *d*-spacing of 3.40-3.53Å. A micro-fabricated lamellae from this graphite has C-XANES spectra characteristic of graphite, with intense peaks for the 1s-π* and 1s-σ* transitions at 285.2 and 291.5eV. Acid-insoluble organic matter has similar characteristics, but also a resolvable peak at 287.5 eV, which suggests small levels of aliphatic carbon. Micron size curved and filamentous graphitic ribbons ressemble microbial mats.

In the shallow marine occurrences of phosphatic granules in the Michigamme formation, including in stromatolitic cherts, there are organic microbial fabrics, euhedral grains sometimes rimed with nanoscopic pyrite, microscopic filamentous organic structures composed of apatite, and millimetric elongated organic structures. Bulk organic matter (TOC = 0.3 %wt) has $\delta^{13}C$ values between -35.3 and -26.7‰. The C-XANES spectrum of acid-insoluble organic matter has peaks at 285.3, 287.6, 288.5 and 291.7 eV, which indicates organic matter with aliphatic carbon, but also carboxilic acid.

Comparisons on the composition of organic matter between deep ferruginous and shallow marine apatite-rich rocks from the Bijiki member of the Michigamme formation in the Baraga Group will be discussed, and placed in the petrographic context of associations between apatite and graphitic carbon, occurrences of early diagenetic phases, and the taphonomy of microfossils.