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Biosignatures of early life in >3.8Ga Banded Iron Formations?

Matthew Dodd and Dominic Papineau

London Centre for Nanotechnology and Department of Earth Sciences, University College London, United Kingdom (matthew.dodd.10@ucl.ac.uk)

Almost all Eoarchean sedimentary rocks have undergone high grade metamorphism. However, small enclaves of Banded Iron Formations (BIFs) from the south-west margin of the Nuvvuagittuq supracrustal belt (NSB-Canada) are now the first candidate Eoarchean BIFs metamorphosed to only around the greenschist facies. Ellipsoidal ribbons of microcrystalline hematite in 1-4 micron chert and chert-hematite rosettes are preserved and largely undeformed, which point to diagenetic structures metamorphosed at low grade facies. Stilpnomelane is common as a prograde mineral in these rocks, which suggests the upper limits of metamorphic conditions where 430-500˚C at 5-6 Kbars; this is reinforced by the presence of ripidolite which is not seen in BIFs subjected to above 500˚C (Miyano & Klein, 1989). The exceptional low metamorphic grade of these Eoarchean rocks has enabled the preservation of diagenetic structures and mineral associations of disordered organic carbon with pyrite, apatite, carbonate and phyllosilicates, thus providing excellent opportunities to search for possible remains of some of the most primitive life. Noteworthy mineral assemblages include microscopic apatite and carbon inclusions in phyllosilicate and layered-pyritiferous, ring structures that contain disordered organic carbon. Raman spectra display broad D and G peaks and lack 2nd-order carbon peaks, which are indicative of disordered carbon, also raman peaks around 1440 cm-1 represent stretching of C-H bonds in the carbonaceous material. Focused ion beam milling and transmission electron microscope analysis of the milled foils reveals the structure and chemistries of these potential biosignatures down to the nanoscale and details the diverse relations of organic carbon in Earth's oldest sedimentary rocks.

References

Miyano, T. & Klein, C., 1989. Phase equilibria in the system K20 - FeO - MgO - $AIzO_3$ - SiO_2 - H20 - CO_2 and the stability limit of stilpnomelane in metamorphosed Precambrian iron-formations. Contributions to mineralology and petrology, Volume 102, pp. 478-491.