Geophysical Research Abstracts, Vol. 8, 04906, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04906

The use of NanoSIMS to critically test claims of early (3.5 billion-year-old) life

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Questions concerning the origin of life and our place in the universe are fundamental to modern science and society. Investigations of the earliest purported microfossils and their geochemical traces require high resolution technology on account of their small size and typically poor preservation and, despite many claims, compelling evidence for life on earth before ~3 billion years is not yet available. The resolution of this fundamental question depends upon acquiring multiple lines of evidence for biogenicity including a plausible geological context, biological morphology and biogeochemical evidence for metabolic pathways.

A recent discovery of micron scale mineralized tubes in 3.48 billion year old pillow lavas from the Barberton Greenstone Belt, South Africa [1], together with suggested modern analogues in ocean crust basalts [2] has once again highlighted the need for greater spatial resolution in the field of biogeochemistry. Whilst the quality of data presented by Furnes et al [1] using conventional microprobe x-ray element mapping and bulk rock carbon isotope analysis is not disputed it lacks the spatial resolution to be compelling evidence for biogenicity.

We have recently discovered a potentially important assemblage of partially mineralized microtubes (5-10 microns in diameter) in ~3.5 billion year old siliceous sediments from Western Australia. We here use the high spatial resolution of the NanoSIMS 50 to geochemically map the minerals within the tubes, linings of the walls of the tubes and zonations within their mineral host, analyzing for biologically important elements (e.g. C, N, P, S, K, Fe) as well as carbon isotope variations between the phases. The advantage of the NanoSIMS 50 is that it allows us to build up a 3D

geochemical map of the microtubes at nm scale resolution and helps us to eliminate surface contamination.

[1] H. Furnes, N.R. Banerjee, K. Muehlenbachs, H. Staudigel, M. de Wit, Science 304, 578-581 (2004)

[2] H. Furnes, H. Staudigel, I. Thorseth, T. Torsvik, K. Muehlenbachs, O. Tumyr, G^3, Vol 2, No 8 (2001)