Petrographic and geochemical characteristics of monazite and zircon associated with biogenic graphite in > 3.7 Ga metasedimentary rocks, Isua Supracrustal Belt, West Greenland

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Biogenic graphite in > 3.7 Ga Isua metasedimenrary rocks, West Greenland, has been reported as the oldest remnants of life (Rosing, 1999; Ohtomo et al., 2014). Geochemical characteristics of minerals containing redox-sensitive rare earth elements (REE) associated with biogenic graphite may constrain microbial habitat environments in the > 3.7 Ga ocean. However, metamorphic fluids could also precipitate secondary REE-containing minerals or modify the geochemistry of primary minerals. Here, we investigated the petrographic and geochemical characteristics of monazite and zircon in the >3.7 Ga Isua schists containing biogenic graphite (reported by Ohtomo et al., 2014) to clarify relationship of these minerals and metamorphic events.

Graphite-rich schist sample (4.3wt% $C_{graphite}$) consists of graphite-chlorite- and quartz-cummingtonite-dominated microlayers, containing high amounts of REE compared to samples showing low graphite content (0.5wt% $C_{graphite}$). The graphite-rich sample contains euhedral monazite, zircon and minor xenotime 2-10 μm in diameter as REE host minerals, which are concentrated in graphite-chlorite microlayers, whereas most of the monazite in samples showing low graphite content are anhedral. Monazite is sometimes overgrown on zircon and accompanied by large graphite crystals (~10 μm in diameter), whereas the surrounding graphite grains not associated with monazite are a few hundreds nm in diameter. The petrographic characteristics and chemical compositions suggest that monazite and zircon were partially associated with metamorphic fluids, which precipitated large secondary graphite in a quite limited scale in proximity to the monazite.

[1] Rosing, M. T. (1999) *Science* **283**, 674–676.
[2] Ohtomo *et al*. (2014) *Nature Geoscience*, **7**, 25–28.