Geochemistry of 1.9 Ga gunflint formation in Canada: Unique oceanic environments and microbial activities

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Geochemical analyses were performed on the ca. 1.9 Ga Gunflint Formation, Canada in order to constrain the microbial ecosystem of Paleoproterozoic oceanic environments. The examined samples are divided in shallow- and deep-water sequences based on their lithologies. Hematitic oolites were the representative lithology for the shallow-water sequence and the deep-water sequences contain sideritic banded iron formation. Such contrast in water depth is corresponded to stratified oxic-anoxic ocean situation deposition of the Gunflint Formation.

Kerogens were extracted from 50 samples. Their stable carbon isotope compositions were ranging from -33.6 to -25.1 ‰ (PDB). 2α-methyl hopane were identified by GC-MS analyses of lipid-biomarker. These results suggest that cyanobacteria were the major primary producers to support the ecosystem both in oxic and anoxic parts of the Gunflint ocean. The productivity of cyanobacteria was extremely high forming thick microbial mats on the shallow part of oceans. Intensive carbon recycling was occurring in such mats, supporting anaerobic life, including methanogens.

S(pyr)/C(org) ratios of examined samples were higher than the results of previous studies. The stable sulfur isotope compositions of pyrites were range from -1.1 to +26.9 ‰ (CDT). These results indicate that ca. 1.9 Ga Gunflint ocean was sulfate-rich ocean, promising high activity of sulfate reducers in particular thick microbial mats in the shallow part of the Gunflint ocean.

H/C and N/C atomic ratios of kerogens were distinctive between oxic and anoxic conditions. As a result, oxic-water dominant kerogens were more enriched in nitrogen than anoxic-water dominant kerogens, implying that the different nitrogen-fixation pathway between the shallow- and deep-water ecosystems. Such difference is most likely related to extremely high productivity of cyanobacteria in the shallow part.

All of data suggest that ecosystem at ca.1.9 Ga was more-strongly concealed with (1) local tectonics (thus, rifiting environments), (2) atmospheric chemistry (relatively high CO_2), (3) temporal supply of elements (supply of iron and phosphate) and (4) redox conditions of oceans.

Re-Os isotopes and platinum-group elements in a peridotite-pyroxenite hybrid mantle

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Melting of a peridotite-pyroxenite hybrid source has been proposed to explain varied petrological and geochemical characteristics of mantle-derived magmas. Re-Os isotope systematics in OIB provide strong evidence for the presence of recycled components in their sources. However, Os isotope variations in OIB ($^{187}Os/^{188}Os < 0.16$) are restricted relative to the predicted compositions for recycled crust ($^{187}Os/^{188}Os$ ~9 for 1 Ga basalt). It is unclear whether this observation reflects lesser contributions from recycled components as a result of effective reaction with ambient peridotite shortly before eruption, or if it is due to modification of Re-Os budgets in recycled crust during subduction and mantle convection [1]. We present Re-Os isotope systematics and platinum-group element (PGE) abundances for a xenolith suite of 8 garnet clinopyroxenites and 7 garnet orthopyroxenites from Malaita, Solomon Islands. Geological, petrochemical, and thermobarometric evidence indicate that they represent a series of melting residues of a hybrid source located within the oceanic asthenosphere [2]. Neoproterozoic formation of the protolith has been suggested on the basis of Sr-Nd-Hf-Pb isotopes of garnet clinopyroxenites [3]. Thus, the primary aim is to test whether recycled pyroxenites are capable of preserving large Os isotope anomalies in the convective mantle. In addition, we address the origin of clino- and ortho-pyroxenites using PGE characteristics.

The two lithologies display contrasting $^{187}Os/^{188}Os$ ratios and PGE patterns. Clinopyroxenites possess highly radiogenic $^{187}Os/^{188}Os$ ratios ranging from 0.17 to 5, and are characterized by basalt-like, positively sloped PGE patterns. In contrast, most orthopyroxenites have unradiogenic $^{187}Os/^{188}Os$ ratios extending as low as 0.12, and tend to show peridotite-like, unfractionated PGE patterns. This suggests that these two contrasting lithologies largely retain the memory of their respective sources because of the relative immunity of PGE signatures to post-crystallization disturbance such as dehydration in the subducting slab, diffusion in the convective mantle, and even melt-mediated hybridization in upwelling mantle.

[1] Dale *et al.*, (2009) *GCA* **73**, 1394-1416. [2] Ishikawa *et al.*, (2004) *J. Petrol.* **45**, 2011-2044. [3] Ishikawa *et al.*, (2007) *EPSL* **259**, 134-148.