

The redox condition of late Paleoproterozoic shallow marine environment: The Cape Smith Belt, Canada

*Kento Motomura¹, Shoichi Kiyokawa¹, Minoru Ikehara², Takashi Sano⁴, Kentaro Tanaka³, Tsubasa Miki³, Yuji Sano³

1. Kyushu University, 2. Kochi University, 3. University of Tokyo, 4. National Museum of Nature and Science

The oceanic redox condition strongly affects the chemical compositions of seawater, especially, redox-sensitive elements such as Fe and Mo. Although it is suggested that bio availability of these bio-essential elements have restricted the biological development through Precambrian ocean, the redox conditions and the trigger of its transition at late Paleoproterozoic era are poorly constrained.

In this study, we reconstructed 50 m lithostratigraphy and chemostratigraphy including major and trace element compositions and C-N-S isotopes ($\delta^{13}\text{C}_{\text{org}}$, $\delta^{15}\text{N}$, $\delta^{34}\text{S}$) in order to clarify the sedimentary environment and the trigger of its change.

A part of the drilled hole from the Northern Povungnituk Group, Cape Smith belt of Canada is used for geochemical analyses. The sequence consists of the alteration of sandstone and black shale deposited at northern margin of the Superior province at ~1.9 Ga. Two lithological units, lower and upper units, are identified based on sedimentary sequence. The lower unit is characterized by the transition from coarse sandstone dominant to black shale dominant sequence, while, the upper is fine sandstone dominant sequence.

Vanadium concentrations normalized by total organic carbon (TOC) shows clear evidence for the transition of the redox condition. Although V/TOC at the bottom of the sequence (<~50 ppm/%) is lower than that of black shale from the Bravo Lake Formation of Buffin island in which a previous work cleared the black shale deposited under euxinic condition (H_2S -rich), the value increased and reaches the mean of the black shale (~105ppm/%) from the Formation at lower coarse sandstone dominant portion. These increase of V/TOC suggests ocean redox conditions changed from anoxic (weak-reducing) to euxinic (strongly-reducing). This inference is consistent with redox-sensitive element behavior confirmed from the correlation between the V concentration and TOC.

$\delta^{15}\text{N}$ of the sequences (~+7 –+9 ‰) are comparable with that of the modern ocean and that indicates nitrification, denitrification and NH_3 assimilation keep $\delta^{15}\text{N}$ of dissolved N species high. $\delta^{13}\text{C}_{\text{org}}$ and $\delta^{34}\text{S}$ change at the same interval ($\delta^{13}\text{C}_{\text{org}}$: -30.6 --33.2 ‰, $\delta^{34}\text{S}$: +11.9 --4.1 ‰) and that suggests some trigger which affects $\delta^{13}\text{C}_{\text{org}}$ and $\delta^{34}\text{S}$ caused development of strongly-reducing condition. $\delta^{13}\text{C}_{\text{org}}$ and $\delta^{34}\text{S}$ transition are likely to represent input of isotopically light HCO_3^- and SO_4^{2-} . The activity of large igneous provinces and oxidative weathering of black shale which relates regression suggested by the change of lithofacies are plausible for these isotope change.

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