Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

BPT23-15 会場:104 時間:5 月 25 日 14:30-14:45

In-situ iron isotope analysis of pyrite and organic carbon/nitrogen isotope ratios from the Middle Proterozoic sediments

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Oxygenation of Earth's surface is deeply linked to evolution of life. Independent evidence suggests that the Earth's atmospheric oxidation state is increased in two steps: (1) from 2,400 to 2,300 million years ago, and (2) around 600 million years ago (Holland, 2002; Holland, 2006). In contrast, the ocean was mostly reducing during the Archean, whereas the Phanerozoic was as oxygenated as it is now. Compared with Archean and Phanerozoic time, the redox status of middle Proterozoic (1.8-1 billion years ago) ocean remains little known. Canfield considered that the middle Proterozoic deep ocean was globally sulfidic condition (Canfield, 1998). On the other hand, Planavsky and others considered that deep-ocean was globally iron-rich anoxic condition, and sulfidic conditions are restricted to biologically productive ocean margin and restricted marginal basin (Planavsky et al., 2011).

Here we show iron isotope analysis of individual pyrite grains and whole rock carbon/nitrogen isotope analyses of middle Proterozoic sediments, mainly mudstones and black shales, from four drillcore samples (Mount Young 2, McArthur River 2, Urapunga 4 and 5) in McArthur Basin, Northern Australia.

Pyrites from the Wollogorang Formation of the Tawallah Group show the wide variation of δ^{56}Fe values from -2 to +2 ‰ . It suggests that the occurrence of partial oxidation, so their depositional environment of the Wollogorang Formation was ferruginous condition. $\delta^{15}N_{TN}$ values of the black shale in the Wollogorang and Barney Creek formations are from +4 to +7 ‰ , relatively high values. The high $\delta^{15}N_{TN}$ values suggest the occurrence of partial denitrification in the water-column. $\delta^{15}N_{TN}$ values of black shale in the Wollogorang and Barney Creek Formations suggested that middle proterozoic sulfidic condition did not persist for long periods as previous studies insisted.

Keywords: Middle Proterozoic, pyrite, nitrogen isotope, iron isotope, McArthur Basin