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

BCG28-09 Room:105 Time:May 26 15:45-16:00

Spatial distribution of chromium enrichment in 3.2 Ga Moodies BIF, Barberton Greenstone Belt, South Africa

ISHIKAWA, Ko[1*] ; OTAKE, Tsubasa[1] ; SATO, Tsutomu[1] ; KAKEGAWA, Takeshi[2]

[1]Division of Sustainable Resource Engineering, Graduate School of Engineering, Hokkaido University, [2]Department of Earth Science, Graduate School of Science, Tohoku University

Geochemical data for ferruginous chemical sedimentary rocks (e.g., Banded Iron Formation: BIF) have been used to understand surface environments on early Earth. For example, enrichment of Cr relative to Ti in BIFs that occurred ~2.48 billion years ago has been considered as a result of the chemical mobilization of Cr in acidic aqueous environments due to sulfide oxidation after the oxygenation of atmosphere [1]. While the Archean sedimentary environments studied in most previous works are limited to deeper settings, the 3.2 Ga Moodies BIF in the Barberton Greenstone Belt, South Africa also indicated that Cr was enriched in the BIF and was therefore chemically mobile in a shallow marine environments [2]. This finding could be significant because it may indicate the oxidation of, at least, some parts of the ocean and therefore, imply the emergence of oxygenic photosynthesis. However, spatial distribution of Cr enrichment in the BIF has not been well understood because the data were obtained from an outcrop and an underground mine. Therefore, the objective of this study is to investigate sedimentary environments and Cr enrichment of the Moodies BIF at another locality.

Stratigraphic correlation within the Moodies group was confirmed by the 3 quartzite marker beds and 1 basaltic flow underlying MdS2. In the previous study, geological survey was conducted MdS2 at Moodies Hills (MH MdS2). We conducted new geological surveys at 4 sections of the Moodies Group: a stratigraphically upper section than the previous study at Moodies Hills (MH MdS3), and 3 sections at a different locality, called Gate of Paradise in the Eureka syncline located ~10 km northeast of Barberton (GP MdS1~3). BIFs were recognized and sampled at all the sections, where the predominant rock types are sandstone and siltstone. Whereas the BIF at MH MdS2 and GP MdS1 are overlain by silty sandstone and sandstone, the BIF at MH MdS3, GP MdS2 and MdS3 are overlain by siltstone. BIFs in MdS2 were the most developed, composed of thick ($>$5cm) and continuous Fe-rich layers. Petrographic observation of the Fe-rich layers shows that the reddish layers are composed of microcrystalline quartz and fine grains of hematite (~15μm), and that the black layers are composed of large grains of magnetite (~50μm). These observations indicate that they are typical oxide-type BIF and therefore were originally formed as precipitates from seawater. Although chromite, which is a host mineral for Cr, was found in both BIF and clastic sedimentary rock (e.g., silty sandstone) samples, chromite in the BIF was always overgrown by magnetite. This observation is also consistent with results from previous studies. Bulk chemical compositions of the samples were analyzed by WD-XRF or ICP-AES. The Cr/TiO2 ratios show that BIF at GP MdS1 was enriched in Cr while BIF at GP MdS2~3 and MH MdS3 were not enriched in Cr. MH MdS2 is more enriched in Cr than GP MdS1, which corresponds with the enrichment of Fe in the BIFs. The results suggest that both Cr and Fe were chemically supplied and co-precipitated from the ancient seawater. The results may also imply that oxic ocean were limited at very shallow parts such as sedimentation level of sandstone.

[1] Konhauser et al. (2011) Aerobic bacterial pyrite oxidation and acid rock drainage during the Great Oxidation Event, Nature, 478, 369-373.
[2] Otake et al. (2013) Chromium enrichment in sedimentary rocks deposited in shallow water in the 3.2 Ga Moodies Group, South Africa, Mineralogical Magazine, 77, 1901.

Keywords: Banded Iron Formation, chromium, chromite, Barberton Greenstone Belt, surface environments on early Earth