地質学的産状と化学組成を用いたグリーンランド・イスア表成岩帯の変成炭酸塩岩の起源の解明と初期太古代海洋環境の復元

Occurrence and chemical composition of metamorphic carbonate rocks in the Isua supracrustal belt, West Greenland: Implications for the origin of carbonate rocks and compositions of the Eoarchean seawater.

*吉田 聡[1]、安川 和孝[2]、加藤 泰浩[2]、澤木 佑介[3]、小宮 剛[3]
*Yoshida Satoshi[1], Kazutaka Yasukawa[2], Yasuhiro Kato[2], Yusuke Sawaki[3], Tsuyoshi Komiya[3]

1. 東京大学理学系研究科地球惑星科学専攻、2. 東京大学大学院工学系研究科システム創成学専攻、3. 東京大学総合文化研究科広域科学専攻
1. Department of Earth & Planetary Science, Graduate School of Science, The University of Tokyo, 2. Department of Systems Innovation, Graduate School of Engineering, University of Tokyo, 3. Department of Earth Science & Astronomy Graduate School of Arts and Sciences, The University of Tokyo

The Earth is a unique planet where liquid water and life exist through the geologic time. Therefore, reconstruction of the surface environment of the early Earth is an important issue to consider early life. However, we know little about the early Earth, because the first 500 million years record of the Earth was almost lost.

In recent decades, many studies has been done on the reconstruction of surface environment of the early Earth and early life (c.f. Schidlowski et al., 1979; Ueno et al., 2002; Tashiro et al. 2017). Especially, research on the origin of metamorphic rocks derived from banded iron formation (BIF), carbonate rock and chert in the 3.81 Ga Isua supracrustal belt (ISB), southern West Greenland has been actively carried out in order to reconstruct the surface environment of the early Earth (c.f. Rose et al., 1999; Bolhar et al., 2004; Friend et al., 2008; Nutman et al., 2010).

Recent geochemical studies suggested that the meta-carbonate rock in the ISB originated from a chemical sedimentary rock based on their Post-Archean Average Shale (PAAS)-normalized rare earth element (REE) patterns (Friend et al., 2008; Nutman et al., 2010). They argued that the meta-carbonate rocks have positive La ($[La/La^*]_{PAAS}$; La* = 2 Ce - 2 Pr), Eu ($[Eu/Eu^*]_{PAAS}$; Eu^* = 0.5 Sm + 0.5 Gd) and Y (Y/Ho) anomaly. In the ISB, the carbonate rocks occur with one of three types following rocks: meta-chert, meta-conglomerate and meta-basalt. However, the relationship between the occurrence and the chemical compositons of meta-carbonate rocks is still ambiguous.

We estimated origin of the meta-carbonate rocks with different occurrence, and reconstructed chemical composition of the Eoarchean seawater from geochemistry of the meta-carbonate rocks in the northern part of the ISB. The meta-carbonate layers accompanying the meta-chert are several centimeters thick, and interlayered with meta-chert layer. The meta-carbonate rocks accompanying the meta-conglomerate rock occur as matrix of meta-conglomerate or layer formed centimeter thick. Previous workers considered that those meta-carbonate rocks originated from shallow water sediments (e.g. Dimorth, 1982; Nutman et al., 1984), whereas others interpreted that they formed through metasomatic alteration (e.g. Appel et al., 1998); thus the origin of the meta-carbonate rock are still controversial. The meta-carbonate rocks accompanying meta-basalt occur as veins in the meta-basalt and their thickness are centimeter to tens of

centimeters. Those differences in the occurrence are related to their origin.

We analyzed major and trace element (e.g. REE and Zr) contents of the whole rocks of the carbonate rocks with X-ray Fluorescence (XRF) for major elements and High-Resolution Inductively Coupled Plasma Mass Spectrometry (HR-ICP-MS) for trace elements at the University of Tokyo, respectively. Some carbonate rocks have high SiO_2, TiO_2, Al_2O_3, and Zr contents, possibly due to involvement of detrital and volcanic materials with/without silicification. We selected the carbonate rocks with low SiO_2, TiO_2, Al_2O_3, and Zr contents in order to remove influence of the silicification and contamination of the detrital materials.

The PAAS-normalized REE patterns of meta-carbonate rocks interlayered with the meta-chert show LREE-depleted patterns with positive La (La/La*: 1.18-1.40), Eu (Eu/Eu*: 1.80-5.50) and Y (Y/Ho: 34.9-45.3) anomaly and without Ce anomaly. The meta-carbonate rocks accompanying with meta-conglomerate rocks show LREE-depleted patterns with positive Eu (Eu/Eu*: 1.43-1.91) anomaly, and lack La, Ce and Y anomaly. The meta-carbonate rocks accompanying with the meta-basalt possess LREE-depleted pattern with Eu (Eu/Eu*: 1.35-1.91) anomaly, and lack La, Ce and Y anomaly.

The positive La and Y anomaly indicates that the meta-carbonate rocks were originate from chemical sediments precipitated from seawater (e.g. Webb and Kamber, 1999; Bolhar et al., 2004), and the lack of the Ce anomaly indicates that the Eoarchean seawater was anoxic as many previous works suggested. In addition, the positive Eu anomaly suggests that the meta-carbonate rocks was precipitated from seawater, influenced by hydrothermal activity.
We classified the meta-carbonate rocks in the ISB into two groups based on the occurrence and REE patterns: chemical sedimentary rock and metasomatized rock. The former includes the meta-carbonate rocks interlayered with meta-chert, whereas the latter comprises those accompanied with meta-conglomerate and meta-basalt.

キーワード：イスア表成岩帯、炭酸塩岩、初期太古代、希土類元素、遷移金属元素
Keywords: Isua supracrustal belt, Carbonate rock, Eoarchean, Rare earth element, Transition metal element

