Mineral chemical aspects of hydrothermalism in the mid-upper oceanic crust: Chloritization of the isotropic gabbro/dolerite from the northern Oman ophiolite

N. YOSHITAKE AND S. ARAI*

Department of Earth Sciences, Kanazawa University,
Kanazawa 920-1192, Japan
(*correspondence: ultrasa@kenroku.kanazawa-u.ac.jp)

Introduction

Hydrothermalism in the oceanic lithosphere deeper than the uppermost crust is difficult to make an access except on ophiolites. We examined detailed mineral chemical characteristics of chlorite rocks that metasomatically replaced isotropic gabbro and dolerite as network-like veins in northern Oman ophiolite in order to understand the chemical budget of hydrothermal alteration of the oceanic lithosphere. The chlorite rocks comprise chlorite (> 99 %) and traces of Ti-rich minerals (ilmenite, rutile and titanite) and apatite.

Geochemistry

During chloritization of the mafic rocks, Si, Ca, Na and K decreased in amount, while Fe dramatically increased. REE (slightly lower than REE_N = 10) (subscript N, chondrite-normalized), except Eu, which shows a strong depletion in the chlorite rocks, were almost immobile during chloritization. All the minerals in the chlorite rocks display strong negative Eu anomalies. The chlorites are low in Mg# (= Mg/(Mg + total Fe) atomic ratio), 0.24 to 0.73, as compared with precursory pyroxenes, of which Mg# is 0.7 to 0.8, and show very low REE (REE_N = <1, except Eu_N =<0.1). The Ti-rich minerals and apatite show high REE abundances (REE_N =1000 to 10000, except Eu_N = 100 to 1000).

Discussion and Suggestions

The chloritization was possibly due to downward recharge flow of circulated seawater. A portion of Fe was possibly supplied from overlying mafic extrusives, especially through alteration of their plagioclases. The Ti-rich minerals acted as the reservoirs of most REE in the chlorite rocks. The negative Eu anomaly of the chlorite rocks indicates selective leaching of divalent Eu possibly as a chlorine complex, which is comparable with the positive Eu anomaly of the seafloor vent fluids. The residual fluid after chloritization can produce the diopsidite, which is rich in Ca and Si and shows a positive Eu anomaly, within deeper gabbros/peridotites.

Carbon isotope analyses of kerogen from Tumbiana Formation, Fortescue Group shown possibility of the environmental redox changes

K. YOSHIYA[1], R. SAKURAI[1], M. NISHIZAWA[1],
Y. UENO[1], T. KOMIYA[1], N. YOSHIDA[1], H. WADA[2],
AND S.MARUYAMA[1]

[1]Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Japan. (yoshiya.k.aa@m.titech.ac.jp)
[2]Institute of Geoscience, Shizuoka University, Japan.

Carbon isotope compositions of Precambrian carbonaceous material exhibit a negative excursion yielding up to -60‰ at *ca.* 2.8Ga [1, 2, 3]. This negative excursion of carbon isotope ratio was caused biologically (aerobic or anaerobic methanotrophic bacteria) or abiologically[4]. But exact timing and the transition from the anaerobic to aerobic condition, and the relationship between the $\delta^{13}C$ and lithologies are still unknown. We analyzed 117 carbon isotope composition of organic carbon ($\delta^{13}C_{org}$: -10.25 to -51.84‰) and inorganic carbon ($\delta^{13}C_{carb}$: 0.60 to -6.08‰) in lithologically varied samples based on the description of lithology of the Fortescue Group in Redmont area, Western Australia. The high resolution analyses of carbon isotope ratio and detailed stratigraphy of sedimentary rocks revealed that two large negative excursions are found in mudstone beds in Mingah Tuff Member and stromatolite beds in Meentheena Carbonate Member. In addition, $\delta^{13}C_{carb}$ progressively increases from the Mingah Tuff to Meentheena Carbonate Member. Considering the relationship between lithology and their $\delta^{13}C$ values, we conclude the cause of these excursions might have different origin. The negative excursion in the Mingah Tuff Member results from activities of anaerobic methanotrophic bacteria, whereas that in the Meentheena Carbonate Member results from activities of aerobic methanotrophic bacteria. The former is consistent with the suggestion of Hinrichs [5] and the latter is also consistent with the biomarker data from stromatolite in Hamersley Province[6]. The fact accounts for the presence of extremely low-$\delta^{13}C$ kerogen in ca. 2.8Ga sediments.

[1] Schoell & Wellmer (1981) *Nature* **290**, 696-699. [2] Schidlowski *et al.* (1983) in *Earth's Earliest Biosphere*, 149-185. [3] Hayes (1994) in *Early Life on Earth*, 220-236. [4] Pavlov (2001) *Geology* **29**, 1003-1006. [5] Hinrichs (2002) *Geochem. Geophys. Geosyst.* **3**. [6] Eigenbrode *et al.* (2008) *EPSL* **273**, 323-331