2.5 Ga seafloor hydrothermal alteration in the Beasley River area, Hamersley, Pilbara Craton, Western Australia

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Hydrothermal carbonatization in the Archean greenstones have studied in order to estimate the CO2 concentration of the hydrothermal fluid and CO2 flux between seawater and oceanic crust, because it has been long believed that the atmospheric CO2 level in the Archean was much higher than today, and the CO2 greenhouse effect compensated for the faint solar luminosity of the young sun. It was suggested that the CO2 concentration of hydrothermal fluid circulating through the Archean upper oceanic crust was much higher than that of today on the basis of the secondary mineral assemblages of greenstones and thermodynamic calculation in the 3.5 Ga North Pole area, Pilbara Craton, Western Australia (Kitajima et al., 2001). Hydrothermal carbonatization of the oceanic crust is suggested to play an important role as a sink of surface CO2 in the Early Archean (Nakamura and Kato, 2004). However, it is necessary to investigate the secular change of the hydrothermal alteration of oceanic crust from Archean to present. In this study, we show the concentration of the greenstones in the 2.5Ga Beasley River area, Hamersley, Pilbara Craton, Western Australia.

The study area is located in the southwest of the Pilbara Craton, Western Australia. The lower part consists of mainly basalt and komatiite corresponding to the Fortescue Group. The upper part conformably overlies the Fortescue Group and consists of mainly sedimentary rocks of banded iron formation, chert, and tuff, interlayered with igneous rocks, which corresponds to the Hamersley Group. The depositional environment of the study area is interpreted as a sedimentary basin in an open rift valley (Thorne and Seymour, 1991). The volcanic rocks of the lower part was formed by magmatism at a spreading center, followed by the deposition of thick BIF due to active hydrothermal activities near the spreading center. Active plume volcanism resulted in bimodal volcanism of komatiite and rhyolite through the remelting of oceanic crust. Minor hydrothermal circulation on the hotspot resulted in the deposition of the BIF with tuffaceous and monolithic chert layers (Komiya, 2004).

The greenstones in the study area underwent various extents of carbonatization and modal amount of carbonate minerals ranges from 0 to 30 %. However, the modal amount strongly correlates with stratigraphy. Modal amount of carbonate in dacite, basalt and komatiite in the upper part (stratigraphically upper than thick BIF) is much less than that of basalts and komatiite in the lower part. In the greenstones, stratigraphically lower than thick BIF, modal amount of carbonate minerals in decreases stratigraphically downward. This indicates that the study area did not undergo severe carbonatization after the deposition of thick BIF. Therefore, greenstones in the lower part are suggested to be carbonatized before the deposition of thick BIF, namely during hydrothermal alteration at spreading center. Based on the modal amount of carbonate in greenstones, total mass of CO2 in the greenstones in the study area is 8.2E5mol/m2. This value is lower than that of 3.2 Ga by a order of magnitude, and several times higher than that of modern. It is, therefore, suggested that CO2 concentration of the hydrothermal fluid circulating through oceanic crust decreases from 3.2 Ga to 2.5 Ga.