

Geological study of carbonation of the 3.8 Ga in greenland and the occurrence of the graphites

yoko ohtomo[1]; Takeshi Kakegawa[2]

[1] IMPE, Tohoku Univ; [2] IMPE., Tohoku Univ.

It is known that the 3.8Ga Isua Supracrustal belt (ISB), southern West Greenland was significantly carbonated. Such carbonation was caused by CO₂-rich metasomatic fluids at ~3.7 Ga. But its geological extension, nature of associated metasomatic fluids and detailed chemical reactions are poorly understood.

It is thought that atmosphere of the early Earth had rather high CO₂ concentration level than present (Kasting,1993). Under such conditions, activity of bicarbonates increased in the contemporary oceans. This further caused progressive carbonation of oceanic basalts and precipitation of carbonate-rich BIF. These rocks may have proceeded to become a part of continental crusts. This indicates that the large amounts of atmospheric CO₂ were fixed into oldest continental crusts. With a growth of continents, de-volatilization may have occurred releasing CO₂ from the primary rocks, forming CO₂-rich metasomatic fluids. It reacted with surrounding metamorphic rocks and generated secondary carbonate.

These carbonation phenomena inside of ancient continental crusts may have played an important role for the global carbon cycle. In order to understand this process geologically and geochemically, field survey of ISB was performed. X-ray analyses and EDS analysis on collected samples were conducted in this study.

Field observation indicates that massive siderite ore was developing inside or around BIF. Mafic rocks around BIF are also hosting siderite ores. Around the siderite ores, carbonation becomes significant with variety of appearances and thickness even in one single formation. It is found that the carbonation is spatially associated with felsic intrusive rocks, suggesting intrusive event was driving force for the CO₂-rich metasomatic fluids. By using X-ray analyzing microscope (XAM), this massive siderite ore is found to be chemically zoned in Mg and Fe contents, probably reflecting the different degree of metasomatism or progressive chemical change of reacted fluids.

Abundant graphite is also found in the massive siderite ore: graphite was most likely generated by decomposition of siderite: graphite contents are ranging 0.21 wt % to 0.30 wt %. We propose that (1) carbonation of oceanic basalts and precipitation of carbonated BIF stored large amounts of CO₂ on the 3.8 Ga oceanic crusts; (2) these CO₂ were recycled in the continental crusts associated with the magmatic activity inside of the ancient crust; (3) these CO₂ were preferentially distributed into around Fe-rich formations (thus, banded iron formations); and (4) some of the Fe-carbonates were decomposed and then formed abiogenic graphite. This phenomenon further indicates that large amounts of abiogenic graphite had formed in the Early Earth and probably influenced onto the early global carbon cycle.

On the other hand, we found the graphite inside BIF as thin layers (the thickness is a few mm-cm). The layers of graphite continue in a few hundred meters. Concentrations of graphite ranges from 0.21 wt % to 1.14 wt %. This is the first report for graphite layers interbedded in banded-iron formation in ISB; previously reported ones are now identified veined graphite not interbedded ones. There is the possibility that this graphite was sedimentary origin and most likely biogenic.