

CO₂ sequestration into geothermal fields: (2) Experimental study of CO₂/water/rock interaction at hydrothermal temperatures

K. KATO¹, A. UEDA¹, A. GOTO¹, Y. ODASHIMA¹,
T. OHSUMI², T. YAJIMA², M. SORAI², H. ITO³ AND
H. KAIEDA³

¹Central Research Institute, Mitsubishi Materials Corp., 1-297 Kitabukuro, Omiya-ku, Saitama, Japan (a-ueda@mmc.co.jp; aykgoto@mmc.co.jp; koikato@mmc.co.jp; yodasima@mmc.co.jp)

²Research Institute of Innovative Technology for the Earth, 9-2 Kizugawa-dai, Kizu, Soraku-gun, Kyoto, Japan (ohsumi@rite.or.jp; tyajima@rite.or.jp; sorai@rite.or.jp)

³Central Research Institute of the Electric Power Industry, 1646 Abiko, Abiko-shi, Chiba (ito_hisa@criepi.denken.or.jp; kaieda@criepi.denken.or.jp)

Experiments on CO₂-water-rock interaction at hydrothermal temperatures have been performed to investigate dissolution and precipitation phenomena during Ca extraction from rocks.

Experimental procedures

The rock samples used were granodiorites composed of quartz, plagioclase, K-feldspar, mica, epidote, chlorite, anhydrite, pyrite and calcite. They were collected at 1061m depth from a drill core (OGC-2) that was obtained from the Ogachi hot/dry rock field, Akita, Japan. Each sample was sealed with distilled water and CO₂ gas at 7 MPa in a teflon beaker covered by a SUS reaction vessel. The reaction vessel was then heated and kept at 150 °C for between one and 30 days while rotating (1 rpm). After reaction, the solution was collected directly into a sample collector (SUS) through a valve and analyzed for its chemical composition. The rock samples were examined by SEM-EDX and XRD after cooling the reaction vessel to room temperature.

Results and discussion

Initially, concentrations of chemical constituents in the solutions reacted with the Ogachi rocks at 150 °C increased with increasing reaction time, but after 5 days Ca and SO₄ concentrations decreased (Fig.1). In this experiment, Ca can be released from both anhydrite (CaSO₄) and silicates such as plagioclase. To calculate the concentrations of Ca released from silicates, the observed Ca concentrations are corrected on the basis of the Ca/SO₄ mole ratios in the solutions (Fig.2). These results indicate that Ca can be released easily from rocks (silicates) and might be removed as CaSO₄ and/or carbonate during CO₂ sequestration into geothermal fields.

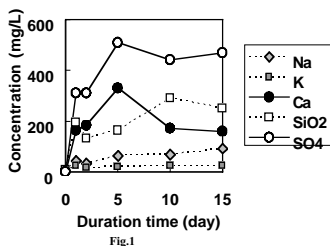


Fig.1

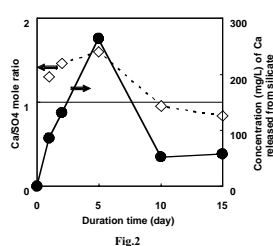


Fig.2

Banded iron formations: Their genesis and implications for Precambrian Earth

YASUHIRO KATO¹

¹Department of Geosystem Engineering, University of Tokyo, Tokyo, Japan (ykato@geosys.t.u-tokyo.ac.jp)

Banded iron formations (BIFs) that occur in many cratons of 3.8 to 1.9 Ga sequences are chemical sedimentary rocks deposited in marine environments. Ultimate sources of iron and silica for BIFs are submarine hydrothermal emanations, mostly from a mid-ocean ridge (MOR) (e.g., Jacobsen and Pimentel-Klose, 1988; Kato et al., 1998). Recently, it is recognized that global magmatism is considered to have been responsible for BIF deposition (e.g., Barley et al., 1997; Isley and Abbott, 1999). The BIF precipitation is most likely genetically related to the evolution of mantle. Based on geochemical and geological estimates by Komiya (1999), the Archean-Early Proterozoic upper mantle had constantly higher FeO content (10 wt%) than today. The potential mantle temperature of the Archean upper mantle was hotter by 150-200 °C than the modern mantle and the temperature decreased episodically.

The conditions of the Archean-Early Proterozoic upper mantle are considered to have been of great advantage to produce huge amounts of BIFs. The hotter potential mantle temperature probably brought about much larger quantities of circulating water at MORs and hence added greater amounts of Fe into oceans. The higher temperature water/rock interaction is very likely to have given rise to higher dissolved Fe content in hydrothermal fluids. In addition, the higher FeO content of the upper mantle must have also played an important role in providing large volume of Fe. This scenario for BIF deposition is consistent with geochemical features of BIFs. Some elements such as P, V, Ni, Zn, Y, Mo and REEs are positively correlated with Fe, like modern MOR hydrothermal Fe-Mn sediments, suggesting that Fe-oxyhydroxide particulates scavenged these elements from ambient seawater. However, these element/Fe ratios of the BIFs are generally lower than modern Fe-Mn sediments by one order of magnitude. This is probably because more abundant Fe-oxyhydroxide particulates competitively scavenged these elements in the Precambrian oceans.

References

- Barley, M.E, Pickard, A.L. and Sylvester, P.J. (1997), *Nature* **385**, 55-58.
 Isley, A.E. and Abott, D.H. (1999), *J. Geophys. Res.* **104**, 15461-15477.
 Jacobsen, S.B. and Pimentel-Klose, M.R. (1988), *Earth Planet. Sci. Lett.* **87**, 29-44.
 Kato, Y., Ohta, I., Tsunematsu, T., Watanabe, Y., Isozaki, Y., Maruyama, S. and Imai, N. (1998), *Geochim. Cosmochim. Acta* **62**, 3475-3497.
 Komiya, T. (2001), *AGSO-Geoscience Australia Record* **2001/37**, 54-56.