Geophysical Research Abstracts,
Vol. 11, EGU2009-2895-2, 2009
EGU General Assembly 2009

Carbon dioxide sequestration via olivine carbonation: Examining the formation of reaction products

H. E. King (1), O. Plümper (1,2), and A. Putnis (1)

(1) Institut für Mineralogie, University of Münster, Münster, Germany (hking_01@uni-muenster.de), (2) Physics of Geological Processes, University of Oslo, Oslo, Norway

Due to its abundance and natural ability to sequester CO_2, olivine has been proposed as one mineral that could be used in the control of CO_2 emissions into the atmosphere (Metz, 2005). Large scale peridotite deposits found in locations such as the Western Gneiss Region in Norway could provide in-situ sites for sequestration or the raw materials for ex-situ mineral carbonation. Determining the conditions under which magnesite ($MgCO_3$) forms most efficiently is crucial to conduct a cost effective process. Understanding the development of secondary minerals is particularly important for in-situ methods as these phases can form passivating layers and affect the host rock porosity. The final solution of flow-through experiments conducted at alkaline pH have been shown to be supersaturated with respect to talc and chrysotile (Giammer et al., 2005), although these phases were not found to have precipitated the formation of a passivating, amorphous silica layer has been observed on reacted olivine surfaces (Bearat et al., 2006). By studying magnesite and other products produced during the carbonation of olivine within Teflon lined steel autoclaves we have begun to form a more comprehensive understanding of how these reactions would proceed during sequestration processes. We have performed batch experiments using carbonated saline solutions in the presence of air or gaseous CO_2 from 80 to 200 ˚C. X-ray powder diffraction was used to identify magnesite within the reaction products. Crystals of magnesite up to 20 μm in diameter can be observed on olivine grain surfaces with scanning electron microscopy. Secondary reaction products formed a platy layer on olivine surfaces in reactions above 160 ˚C and below pH 12. Energy dispersive X-ray analysis of the platy layer revealed an increase in Fe concentration. The macroscopically observable red colouration of the reaction products and Raman spectroscopy indicate that hematite is present in these layers. For experiments with a duration of 4 weeks, lizardite has also been identified using X-ray powder diffraction. The Mg/Si ratio obtained from energy dispersive X-ray analysis of the secondary phases from shorter period experiments indicates that lizardite may also be present. However, the components of these platy layers are closely associated and too low in concentration to be distinguishable with X-ray diffraction analysis. We have not observed the precipitation of talc or chrysotile phases in any of our experiments. Amorphous silica has also not been identified in any of the reaction rims. Higher temperature experiments and those with an initial solution slightly undersaturated with respect to magnesite produced well formed carbonate crystals. The presence of CO_2 above the solution did not affect the final magnesite crystal shape but did increase the rate of precipitation.

References:

Bearat H., McKelvy M. J., Chizmeshya A. V. G., Gormley D., Nunez R., Carpenter R. W., Squires K. and Wolf G. H. (2006), Environ. Sci. Technol., 40 4802-4808.

Giammar D. E., Bruant R. G. and Peters C. A. (2005), Chem. Geol., 217 257-276.

Metz B. D. O., de Coninck H., Loos M. and Meyer L. (2005), IPCC Special Report on Carbon Dioxide Capture and Storage, Cambridge University Press.