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Analysis of the mechanism of hydrothermal carbon dioxide fixation into serpentine with estimation of equilibrium of chemical species

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Abstract (less than 300 words)

Developing CO_2 storage technology is attracting attention as a reduction of the concentration of greenhouse gases. Serpentinite ($Mg_3Si_2O_5(OH)_4$) is widely distributed in the ground and one of the agents for CO_2 capture because CO_2 can be immobilized as magnesite ($MgCO_3$) in hydrothermal condition. In this study, we examined the fixation of CO_2 in serpentine under hydrothermal condition. The equilibrium composition of species in this system under hydrothermal condition was calculated and the effect of temperature and pH on CO_2 fixation is discussed [1].

CO_2 fixation experiment was conducted with batch type reactor by introducing the serpentine powder, water and pressurizing with CO_2. A certain concentration of nitric acid and sodium hydroxide aqueous solution was used for changing pH of solution. After the reaction, the recovered powder was analyzed with TG-DTA and XRD. The equilibrium composition was calculated using PHREEQC software with llnl.dat database [2]. The initial amount of gas, liquid (solvent) and solid species, initial temperature and pressure was given. Thermodynamically stable species were determined at each temperature to satisfy the mass balance. In the experiment, the yield of magnesite was below 15% based on magnesium atom and once decreased and increased with initial pH of solution at 7.1 MPa of initial pressure of CO_2 for 6 h. The reaction mechanism was proposed by the main species in the calculated equilibrium composition. The dissolution of serpentine was enhanced by the contribution of H^+ in low pH region and synthesis of magnesite was enhanced by OH^- in high pH region based on the mechanism and these factors probably promoted the formation of magnesite.

References

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