Study of behavior of supercritical CO_2 at mineral surface by FT-IR spectroscopy

Shunsuke Furukawa[1]; Nobuo Hirano[1]; Noriyoshi Tsuchiya[1]

[1] Environmental Studies, Tohoku Univ.

Recently, CO_2 geological storage is attracted as one of the provision against the global warming. For example, in CO_2 injection and storage in aquifer, it is said that the injected CO_2 dissolves in the groundwater of aquifer and reacts slowly with the surrounding rocks to be fixed to the rocks as carbonate. However, the interaction between rock and CO_2 is not revealed. In this study, we have observed the interfacial area of the mineral and CO_2 by FT-IR spectroscopy. We try to investigate the interaction and the behavior of CO_2 under supercritical condition.

In the experiments, we used the high temperature-pressure visible cell. The cell has a disk-shaped window made of artificial single crystal diamond and the infrared light goes through the window. There is a metal reflector in the sample chamber, and the infrared light from the diamond window goes through the fluid and is reflected by metal reflector, and then goes through the fluid and window. Mineral samples are quartz and calcite plates which are main rock minerals. The plate is placed between diamond window and metal reflector, and after CO2 injection into the sell, we measured the IR spectra of CO_2 on the minerals. The condition of temperature and pressure is 25 to 50 deg C and 0.1 to 20MPa that is almost the same as that of underground where we attempt to inject CO_2.

By infrared spectroscopic measurement, two absorption bands of CO_2 are observed at 667cm-1, assigned to the bending vibration, and at 2349cm-1, assigned to the anti-symmetric stretching vibration. In this study, we consider the band around 2349cm-1, which showed an apparent change.

As a result of experiments, each peak position of interfacial CO_2 on mineral shifted to lower wavenumber with pressure increasing. But the change of peak position is different for different minerals. It is supposed that the interaction between CO_2 molecules and mineral substrate is different for different minerals, and stability of CO_2 like adsorption strength on minerals is also different from mineral to mineral. And it was observed that the higher the temperature became, the higher the peak wavenumber shifted. It would appear that the vibration of CO_2 molecule becomes stronger at higher temperature and CO_2 molecules are adsorbed poorly. In addition, there was a marked change of peak position at the saturation pressure at 25 deg C. On the other hand, at 40 and 50 deg C, at which CO_2 becomes supercritical state over 7.4MPa, peak wavenumber changed significantly not at supercritical pressure but above that pressure. It suggests that there are the liquid-like region and the gas-like region in the same supercritical condition, and it is considered that the adsorption strength of CO_2 on minerals is different in several regions.