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# Infrared Spectra of Frozen Clay-Water System

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Infrared spectra of 0.12 mm thick frozen clay-water system were obtained at sub-zero temperature with a FTIR spectrometer. The absorbances at the frequency of 2700 $cm^{-1}$ decreased gradually with increasing temperature. The freezing point depression determined by the absorbance increased with clay and salt concentrations.

Infrared spectroscopy method is useful for studies on the structure of absorbed water on clay particles.[1] However, infrared is absorbed so intensively by water that the method is normally used for the sample containing less water. Mizoguchi et al.[2] have measured infrared spectra of 0.12 mm thick NaCl frozen solution and determined ice fraction in the solution by using the absorbance at 2700 $cm^{-1}$. In this study the spectra of frozen clay-water system are given at sub-zero temperature and the temperature dependence of the absorbance at 2700 $cm^{-1}$ is described.

The clays used in this experiment were (1) Volclay and (2) Wyoming Bentonite. Each clay was mixed with distilled water and 1% NaCl solution by weight. Water content of the sample was about 500%. For the measurement of IR spectrum, a specially designed apparatus, a variable temperature unit (Beckman VLT-2), was used[2] with a FTIR spectrometer (Perkin Elmer Model 1800). After the sample

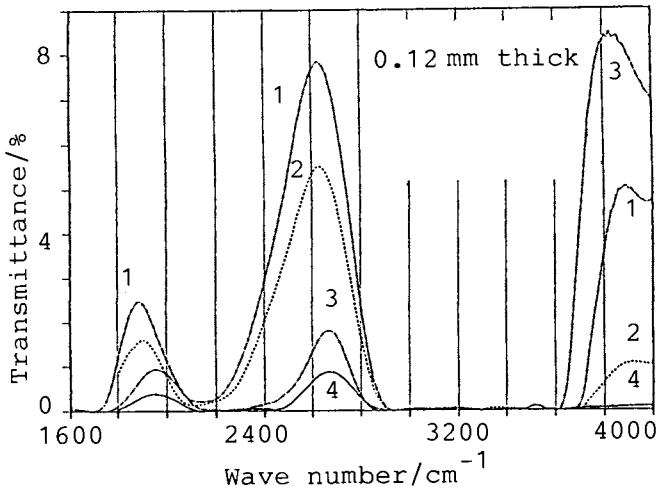


Fig. 1. Transmittance of frozen clay-water system.
1:Liquid (7.8 °C) 3:Ice (-1.0 °C)
2:Unfrozen clay-water (7.5 °C)
4:Frozen clay-water (-1.0 °C)

was frozen with liquid nitrogen, the temperature was upwards in increment, then the IR spectrum was obtained for every 2 $cm^{-1}$ from 1800 to 4000 $cm^{-1}$ at each temperature.

Figure 1 shows transmittances versus frequency. The transmittances of the clay-water system around 1900 and 2700 $cm^{-1}$ were lower than those of the system without clay because clay particles absorbed infrared. Figure 2 shows absorbances as a function of sub-zero temperature at 2700 $cm^{-1}$. In the sample without NaCl, the absorbances of the frozen clay-water system decreased gradually whereas that of pure water decreased abruptly. As the sample contained NaCl, the absorbances decreased more gradually than those without NaCl. These results mean that the freezing point depressed due to both clay particles and solute. The freezing point depression, as shown in Table 1, was determined from an intersection of frozen and unfrozen absorbances in Fig.2. The freezing point of the clay-water system decreased with clay and salt concentrations.

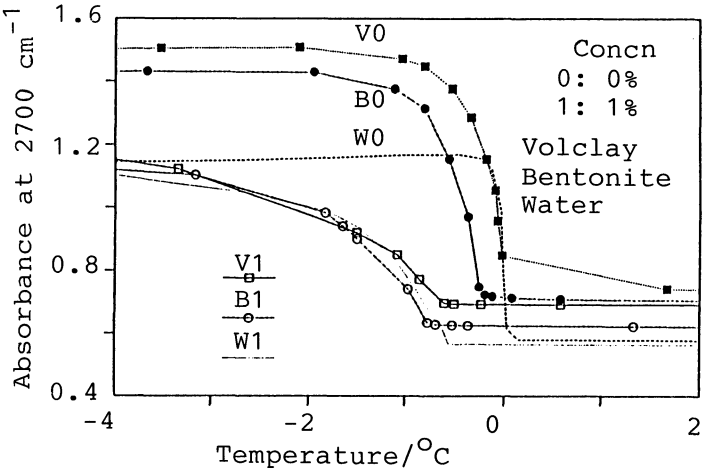


Fig. 2. Absorbance of frozen clay-water system.

**Table 1. Freezing point depression determined from absorbance**

| C | H | W[3)] | V | B | |
|---|---|---|---|---|---|
| 0% | 0.0 | 0.0 | 0.02 | 0.24 | /°C |
| 1% | 0.59 | 0.57 | 0.61 | 0.75 | |

C=Concentration (g NaCl/g water)
H=Handbook data for NaCl solution
W=Water: V=Volclay: B=Bentonite

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