Swelling Pressure of Montmorillonite Layers versus H-O-H Bending Frequency of the Interlayer Water

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Abstract: The in-depth perturbation of vicinal water by the surfaces of montmorillonite layers was investigated by relating the swelling pressure, Π, of the montmorillonite layers to the H-O-H bending frequency, ν_2, of the interlayer water. For this purpose, an oriented montmorillonite gel was deposited on a porous filter in an environmental chamber. On its underside the filter was in contact with a solution maintained at atmospheric pressure. By admitting nitrogen gas at a known pressure to the environmental chamber, water was squeezed from the gel into the solution until equilibrium was reached and Π equalled the applied pressure. Then the gel was divided into 2 parts. One part was used for the gravimetric determination of the water content, m_w/m_c. It was possible, therefore, to determine m_w/m_c as a function of Π. The other part of the sample was transferred to an FTIR spectrometer where the ν_2 of the water within it was measured by attenuated total reflectance. Thus, the same samples were used to determine the dependence of both Π and ν_2 on m_w/m_c. It was found that Π and ν_2 were both exponential functions of m_c/m_w and so a linear relation was found between $\ln(\Pi + 1)$ and $\ln(\nu_2/\nu_2^\circ)$, where $\nu 2^\circ$ is the H-O-H bending frequency of bulk water. These results strongly support the conclusion that the in-depth perturbation of the water by the surfaces of the montmorillonite layers is primarily responsible for both the development of Π and the departure of ν_2 from ν_2°.

Key Words: Bending Frequency • Hydration • Infrared Spectroscopy • Interlayer Force • Interlayer Water • Montmorillonite • Swelling Pressure

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