

In situ observation of Cs^+ adsorption on phyllosilicate mineral surfaces by liquid-FM-AFM

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Ion exchange ability of phyllosilicate minerals works as soil condition, water purification, etc. While the exchange tendency has been understood well, the microscopic phenomena such as cation distribution and their diffusion have not been revealed. Recent progress of Frequency modulation atomic force microscopy (FM-AFM) working in liquids allows us to visualize the surface structure with an atomic/molecular resolution (Fukuma et al., 2005). In this study, we investigated Cs^+ adsorption processes on phyllosilicate minerals with 2:1 layer type (montmorillonite and muscovite mica) by using FM-AFM. The surfaces are negatively charged due to divalent cations (Mg^{2+} , Ca^{2+}) in Al-O octahedral layer and Al^{3+} in Si-O tetrahedral layer of the montmorillonite and the muscovite mica, respectively. Therefore, the depth of the negative charge sources in the silicate sheets is different between these minerals (Fig.1). To clarify the mechanism of the cation adsorption the difference in the adsorption and diffusion properties of Cs^+ between these two minerals have been explored. Topographic images of the montmorillonite and the muscovite mica in CsCl solution (Fig.2) showed some protrusions, which appear brighter in the images, with a height of 0.1 nm measured from the topmost surface. The density of these protrusions were in good agreement with the surface charge density of the samples estimated from the chemical component analysis. Therefore, we concluded that these protrusions were adsorbed Cs^+ . The adsorbed Cs^+ formed a one-dimensional row on the montmorillonite surface. On the other hand, the Cs^+ formed hexagonal islands on the muscovite mica surface. While the Cs^+ on the montmorillonite surface was stable after 10 minutes, the Cs^+ islands on the muscovite mica disappeared in 20 seconds, suggesting the Cs^+ diffusion on the surface. In our presentation, we will discuss the behavior of exchangeable cations at these mineral surfaces.

Keywords: ion adsorption, clay, phyllosilicate, FM-AFM

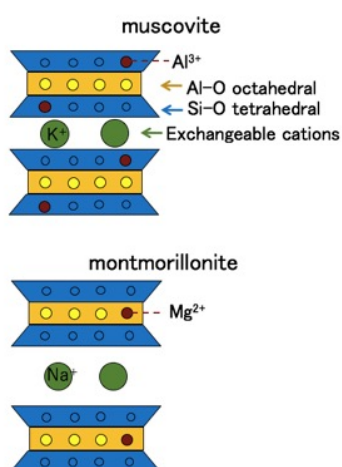


Fig. 1: Crystal models of muscovite and montmorillonite.

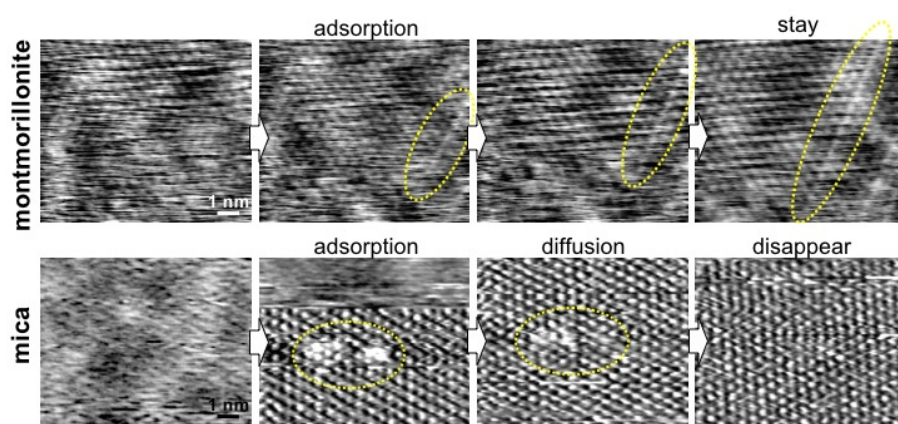


Fig. 2: Sequential images of montmorillonite (upper) and muscovite (lower) surfaces taken in CsCl solution. The adsorbed Cs^+ cations appear as brighter dots in each dotted oval.