

High-resolution cryo-transmission electron microscopy of smectite

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Clay minerals are critically important components of weathered rocks and sediments as well as valuable industrial materials. Smectites are swelling clays that exhibit major changes in interlayer thickness as a function of solution chemistry. Previous high-resolution transmission electron microscope (TEM) studies of smectite have been limited by sensitivity to beam damage and the dependence of the structure on environmental conditions. Here, we adopted cryogenic TEM methods to enable morphological and structural analyses of smectite *in aqua*. Under appropriate conditions it was possible to resolve basal spacing information and, to a limited extent, cross fringes that provided information about stacking order. The approach was applied to investigate the nature of smectite in a range of solutions, including low ionic strength solutions that promoted formation of osmotic hydrates and single layer particles. The combination of high-resolution imaging, cryogenic preservation and 3D electron tomographic reconstructions is providing new insights into the nature and behavior of clay minerals in solutions of relevance under a wide range of earth surface conditions.