American Mineralogist, Volume 90, pages 85–89, 2005

Determination of defect structures in kaolin minerals by high-resolution transmission electron microscopy (HRTEM)

TOSHIHIRO KOGURE[1,*] AND ATSUYUKI INOUE[2]

[1]Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

[2]Department of Earth Sciences, Faculty of Science, Chiba University, 1-33 Yayoi-cho, Inage-ku, Chiba 263-8522, Japan

ABSTRACT

Near-atomic resolution TEM imaging has been successfully applied to determine the stacking defect structures in kaolin minerals, especially kaolinite. The specimen studied is from the middle stage of the depth-related kaolinite-to-dickite transformation in a sandstone reservoir. Several high-quality images were recorded on films in which the tetrahedral and octahedral positions in the kaolinite unit layers are clearly resolved, despite the obstacle of electron radiation damage. Electron diffraction and high-resolution imaging of dickite showed that few stacking defects exist in this polytype. On the other hand, kaolinite crystals contain a high density of stacking defects. These defects or stacking disorders are formed by a mixture of two kinds of lateral interlayer shifts, $\boldsymbol{t}_1$ (approximately $-\boldsymbol{a}/3$) and $\boldsymbol{t}_2$ ($-\boldsymbol{a}/3 + \boldsymbol{b}/3$), between adjacent layers. Disorder due to the coexistence of B and C layers (dickite-like stacking sequence) was never observed. These results provide not only an unambiguous settlement for the long-standing controversy of the defect structures in kaolinite, but also a new clue to understanding the kaolinite-to-dickite transformation mechanism.