

The fate of smectite in KOH solutions

ANDREAS BAUER,^{1,*} BRUNO LANSON,² ERIC FERRAGE,² KATJA EMMERICH,³ HEINER TAUBALD,⁴
DIETER SCHILD,¹ AND BRUCE VELDE⁵

¹Forschungszentrum Karlsruhe, Institut für Nukleare Entsorgung, P.O. Box 3640, 76021 Karlsruhe, Germany

²Environmental Geochemistry Group, L.G.I.T., Maison des Géosciences, Université J. Fourier, B.P. 53, 38041 Grenoble Cedex 9, France

³Universität Karlsruhe, Institut für Mineralogie und Geochemie, Kaiserstrasse 12, 76128 Karlsruhe, Germany

⁴Universität Tübingen, Institut für Geowissenschaften, AB Mineralogie und Geodynamik, Lehrstuhl für Geochemie, Wilhelmstrasse 56, 72074 Tübingen, Germany

⁵Ecole Normale Supérieure, Département de Géologie, 24, rue Lhomond, 75231 Paris Cedex 05, France

ABSTRACT

The aim of the present study was to investigate the detailed evolution of the SAZ-1 smectite in 1 M KOH at 80 °C at a solid/liquid ratio of 1/80. AFM observations indicated no change in crystal size or shape. XRD measurements at 40% relative humidity revealed changes in expandability of the smectite. The (001) reflection profile of smectite was modeled using a trial-and-error approach. The results indicate that with increasing run time, the number of non-expandable layers with zero or one water layer increases and that the coherent scattering domain size of the smectite decreases. IR spectroscopy of the reacted smectite suggests that there is no change from the initial clay products. The dehydroxylation temperature showed a slight decrease from 619 to 605 °C. STA measurements demonstrated that the cis-vacant character of the octahedral sheet remained nearly unchanged throughout the experiment. Determination of the average layer charge showed a continuous increase from 0.32 to 0.42 eq/(Si/Al)₄O₁₀, whereas the layer charge distribution indicated the appearance of high charged smectite layers with a charge of ~0.6 eq/(Si/Al)₄O₁₀ and the disappearance of the low charged layers. XPS and SEM measurements indicate an increase of Al in the smectite samples. Isotope data support the theory of an internal diffusion mechanism by gradual changes in δ¹⁸O values.

From these data it appears that KOH solutions provoke a mineralogical change in the 2:1 layer of the smectite minerals that increases the layer charge by increasing the Al content. This mineralogical change does not involve dissolution/crystallization processes and then must show solid-state transformation of the clays at 80 °C.

Keywords: Smectite, illitization, solid-state transformation, KOH