Ti-Bearing Phases in the Huber Formation, an East Georgia Kaolin Deposit

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Abstract: Six kaolin samples from the Lower Tertiary Huber Formation near Wrens, Georgia were analyzed using transmission electron microscopy (TEM), electron diffraction (ED), powder X-ray diffraction (XRD), chemical analysis, and magnetic susceptibility to characterize the Ti-bearing phases. Selected samples were treated with 5 M NaOH to remove kaolinite and concentrate the Ti-bearing phases for additional analysis. TiO_2 content in the bulk fraction ranges from 1.2 to 5.4 wt. %. There are at least three Ti-bearing phases, including anatase, rutile, and a poorly defined nanocrystalline form. Anatase is most abundant and is commonly found with {010} faces in association with kaolinite edge and basal faces. The nanocrystalline form occurs at $0-1$ wt. %, and rutile occurs in trace amounts. Bulk XRD analysis correlates well with the bulk TiO_2 chemical measurements. Average anatase unit-cell parameters are $a = 0.37908 \pm 0.0002$ nm and $c = 0.951 \pm 0.001$ nm. These parameters indicate an approximate chemical formula of $Fe^{3+}_{0.05}Ti^{4+}_{0.95}O_{1.95}(OH)_{0.05}$.

The distribution of TiO_2 content as a function of depth may be useful to obtain original grain-size variations associated with relative sea-level changes responsible for the deposition of the Huber Formation. Evidence for original depositional sediment properties can be seen in the occurrence of pseudomorphic replacement of micas and fecal pellets by kaolinite. Additional evidence for post-depositional changes includes the sub-micrometer euhedral character and low Fe content of the anatase (relative to soil-derived anatase). These observations for the Huber Formation are consistent with a previously published theory for kaolin genesis that includes biomineralization of originally coarser-grained aluminosilicates into a kaolinite-rich ore body.

Key Words: Anatase • Georgia • Huber Formation • Kaolinite • Rutile • TiO_2 • Titanium • X-ray Diffraction

Clays and Clay Minerals; April 2000 v. 48; no. 2; p. 151-158; DOI: 10.1346/CCMN.2000.0480201

Clay Minerals Society (www.clays.org)