Comments on “Sericites in Feldspars as Source of 2:1 Phyllosilicates in Selected Sandy Soils”

Arocena et al. (1993) have presented an interesting discussion on feldspar weathering and a highly plausible hypothesis that associated 2:1 phyllosilicates are weathering products of feldspars. I take issue, however, with the authors’ interpretations of x-ray diffraction (XRD) patterns for the alkylammonium treated 2:1 phyllosilicates.

Based on XRD analyses of alkylammonium-treated samples, Arocena et al. (1993) identified four 2:1 phyllosilicate phases in their soils: (i) a 1.0-nm nonexpanding phase, (ii) a low-charge [0.34 mol, mol(OH)2] expanding phase, (iii) a high-charge [0.6 mol, mol(OH)2] expanding phase, and (iv) an interstratified high-charge/low-charge phase. The evidence presented does not prove that either the high-charge phase or the interstratified phase exists in the studied soils, and in my judgement, the results are artifacts of the alkylammonium treatments.

Vermiculite (or high-charge smectite), if present in soil clays, will expand on treatment with alkylammoniums and yield low-angle XRD peaks. But, low-angle XRD peaks are not diagnostic for the existence of a high-charge phase, because micaceous soil minerals (illites, sericites, etc.) also react with alkylammoniums, yielding similar low-angle XRD peaks. The only means of distinguishing low-angle XRD peaks for vermiculite and degraded mica is by measuring the amount of K released from the clay on reaction with alkylammonium cations. Arocena et al. (1993) did not report K released from their samples, and thus, their interpretations are suspect.

A considerable body of evidence exists that alkylammonium cations react with micas yielding a vermiculite-like product (Weiss, 1963; Mackintosh and Lewis, 1968; Mackintosh et al., 1971; Mackintosh et al., 1972; Laird et al., 1987; Ross and Kodama, 1987). To the contrary, Ghabour et al. (1989) suggested, based on analysis of one (100–250 μm) sample, that only micas damaged by grinding “repotassified” vermiculites would expand on treatment with alkylammoniums. Ghabour et al. (1989) suggested, however, is inconsistent with the release of substantial amounts of K from reference illites (Mackintosh and Lewis, 1968; Laird et al., 1987) that were never ground and were clearly not repotassified vermiculite. Crystal defects introduced by grinding may facilitate K release from specimen micas but cannot explain release of more than 90% of K from coarse (53–75 μm) Ontario biotite after a 10-d reaction with dodecylammonium (Mackintosh et al., 1971). Furthermore, grinding cannot explain the clear relationship between crystal structure and the extent of reaction for reference micas (e.g., biotites > phlogopites > muscovites > lepidolites) when all of the micas received the same grinding treatments (Mackintosh et al., 1971). The vast majority of evidence clearly indicates that micaceous minerals react with alkylammonium cations; however, the extent of reaction depends on both mineral properties (layer charge, particle size, crystal structure, defects) and reaction conditions (C chain length of the alkylammonium cation, K/alkylammonium activity ratios in solution, temperature, contact time, etc.).

Random interstratification of 1.0-nm and alkylammonium-expanded layers yield broad diffuse first order XRD reflections, whereas fully expanded alkylammonium-vermiculites yield sharp well-defined first order XRD reflections and a series of rational higher order reflections. Layer charge estimations should not be based on first order reflections of randomly interstratified minerals, because apparent basal spacings are intermediate between those of the expanded and contracted phases. Due to incomplete reaction, random interstratification is likely for alkylammonium degraded micas. The 2.05-nm peak shown by Arocena et al. (1993) as representing the “high-charge component” is both broad and diffuse and thus appears to represent a randomly interstratified phase. Unfortunately, rational higher order reflections can be neither identified nor ruled out because mica is also present in the sample. Random interstratification, however, could well account for the apparent charge of the high-charge phase being 0.6 [mol, mol(OH)2] rather than >0.8 [mol, mol(OH)2] as might be expected for micaceous minerals.

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References

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In Arocena et al. (1993), we indicated the presence of the high-charge 2:1 phyllosilicate based on (i) reflection around 2.0 nm for the dodecylamine hydrochloride-treated (AC-12) sericite and (ii) strong x-ray microdiffraction (XRMD) reflection around 1.76 nm of AC-12-treated sericite in soil thin section. We did not show any x-ray diffraction (XRD) pattern because of (i) but presented an XRD pattern for the AC-12-treated bulk clay sample showing the reflections at 2.05- and 1.8-nm regions. We do not preclude the concern that extraction

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