Weathering of Chlorite to a Low-Charge Expandable Mineral in a Spodosol on the Apennine Mountains, Italy

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Abstract: The clay fraction of a Spodosol and its parent rock in the Apennine mountains of central Italy were studied by powder X-ray diffraction (XRD) and infrared (IR) spectroscopy, to evaluate the possibility of transformation of chlorite into low-charge expandable minerals. Results indicated that the main phyllosilicate in the rock was a slightly weathered trioctahedral chlorite, rich in both Mg and Fe, together with dioctahedral mica and minor amounts of kaolinite. In the BC horizon, chlorite has undergone partial transformation into 2 vermiculitic components, in 1 of which the interlayer could be removed by hot Na-citrate treatment; the presence of a regular interstratified mineral (high-charge corrensite) was also observed. Further changes in the structure of chlorite were detected in the Bsl horizon, becoming more evident towards the soil surface. The first stage of weathering of chlorite involved Fe oxidation and partial expulsion of Mg from the hydroxide sheet, followed by deposition of Al in the interlayer space. Iron is also removed from the interlayer sheet, possibly remaining, in the oxidized state, in the 2:1 octahedral sheet, and so contributing to the lowering of layer charge and transformation to a dioctahedral structure. When approaching the surface, Al removal from the interlayers is enhanced by complexing agents, and further charge reduction leads to the formation of 2:1 minerals with a smectite nature. Illite, because of its low content in the soil clay fraction, contributes marginally to this weathering sequence, forming the high charged expandable component observed in the Bhs horizon. At the soil surface, a randomly inter-stratified vermiculite/illite was detected, which probably originated from K fixation by the higher-charged expandable minerals. This study of weathering in a natural soil strongly supports the hypothesis, previously ascertained by laboratory experiments, that chlorite can transform into a low-charge expandable mineral.

Key Words: Chlorite • Hydroxy-interlayers • Smectite • Spodosols

Clays and Clay Minerals; February 1997 v. 45; no. 1; p. 28-41; DOI: 10.1346/CCMN.1997.0450104

Clay Minerals Society (www.clays.org)