American Mineralogist, Volume 96, pages 1613–1623, 2011

Early Proterozoic weathering processes under low O_2 conditions reconstructed from a 2.45 Ga paleosol in Pronto, Canada

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Abstract

We have examined a paleosol in Pronto, Canada, which formed at ~2.45 Ga and under very low O_2 conditions, to reconstruct ancient weathering processes. Chlorite, which replaced biotite in parent granite, consists of almost complete chlorite layers as revealed by high-resolution transmission microcopy. Chlorite grains were fragmented gradually with increased intensity of weathering. The fragmented chlorite grains were partly or largely replaced by sericite formed from K-metasomatism, which strongly suggests that almost complete chloritization of biotite preceded sericitization. In the upper part of the paleosol, chlorite-biotite mixed layers formed but the formation of these layers cannot be explained by mere chloritization and sericitization, which are usually considered to occur concurrently during post-weathering events. Our observations and analyses suggest that the chlorite-biotite mixed layers were formed as follows: chlorite, with no or little biotite, was formed from biotite in parent granite prior to weathering. Chlorite was then weathered by dissolution and fragmentation at ~2.45 Ga, and chlorite-vermiculite (or smectite) mixed layers were formed by layer-by-layer transformation in the weathering profile (note that vermiculite is not actually observed in the Pronto paleosol). Following burial of the weathering profile, the vermiculite layers in the chlorite-vermiculite mixed layers were converted to biotite layers, by means of K-metasomatism, to form the chlorite-biotite mixed layers. The chlorite-biotite mixed layers in the Pronto paleosol were therefore chlorite-vermiculite mixed layers at the time of weathering.

Keywords: Chlorite, mixed layers, weathering, paleosol, atmospheric evolution, alteration