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Low-temperature illitization of smectite in the late eocene and early oligocene of the Isle of Wight (Hampshire basin), U.K.

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ABSTRACT

Variegated palaeosols, which formed from weathering of clays, silts, and brackish to freshwater limestones, are present in the late Eocene-early Oligocene Solent Group of the Hampshire Basin, southern U.K. The detrital clay mineral suite is dominated by illite and illite-smectite with minor kaolinite and chlorite. In pedogenically modified (palaeosol) and evaporitic lacustrine clay-rich sediments, the proportion of illite in the illite-smectite is greater than in the non-pedogenically modified sediments, and where alteration is most intense, kaolinite and chlorite are absent. The smectite to illite transition has been investigated in the <0.5 μm fraction by XRD analysis (powder and oriented mounts), thermogravimetry (TG), analytical SEM, and chemical analysis of Fe^{2+}. Modeling of XRD data reveals that the illite-smectite is a mixture of compositions (overall 60–95% illite), *R*0, with high rotational stacking disorder. Dehydroxylation occurs mainly at 500 °C, but also at higher temperatures, indicating heterogeneous octahedral cation composition. Analytical SEM and chemical analysis of Fe^{2+} indicate that the illite to smectite transition occurs through Fe reduction in octahedral sites leading to increased layer charge, coupled with K fixation. The driving mechanism for what appears to be irreversible Fe^{3+} reduction is wetting (reducing) and drying (oxidizing) cycles in gley soil, in which reoxidation of reduced Fe is never complete.