Clay Minerals in the MacAdams Sandstone, California: Implications for Substitution of H_3O^+ and H_2O and Metastability of Illite*

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Abstract: Clay minerals from the MacAdams Sandstone, Kettleman North Dome, California, have been studied by electron microscopy. The clay minerals fill pore space associated with fractured and brecciated clasts of K-feldspar. Curved packets of muscovite and kaolinite are caused by deformation of detrital muscovite that resulted in opening of fissures subsequently filled with dominant kaolinite and minor intergrown mixed-layer illite/smectite (I/S). Regions of authigenic R1 I/S (rectorite) with characteristic ~20 Å periodicity are intergrown with kaolinite in microfissures within K-feldspar or detrital muscovite. Clusters of small grains of muscovite with nearly ideal composition occur as stacks and intergrown with kaolinite and are tentatively inferred to be authigenic. Contrary to previous reports, no illite was found in these samples.

Electron microprobe analyses previously obtained on Kettleman Dome "illite" and subsequently used as a prime example of analyses of illite rich in excess interlayer water (H_2O) and hydronium ion (H_3O^+) are shown to have been obtained on mixtures, and are not representative of the actual clay mineral compositions. Previous conclusions regarding significant H_3O^+ and H_2O contents of illite are invalid because of inaccuracies inherent in bulk and EMPA analyses of illite, and do not affect arguments regarding the metastability of illite. Hydronium substitution should be favored via the reaction $H_2O + H^+ = H_3O^+$ only in highly acidic fluids. Ordinary illite forming in sedimentary environments with carbonates and iron oxides is unlikely to have significant H_3O^+ substituted for K^+.

Key Words: Electron microscopy • Hydronium • Illite • Kaolinite • Muscovite • Rectorite

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