

The nature, formation, and stability of end-member illite: A hypothesis

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ABSTRACT

The nature and stability of end-member illite (I), $K_{0.88\pm 0.01}/O_{10}(OH)_2$, a K-deficient mica, has been a subject of much controversy. Evidence for the metastability of “illite” with respect to ideal muscovite (Ms) + pyrophyllite (Py) has been discussed in the literature but conflicting evidence from studies of natural and synthetic systems point to the stability of K-deficient micas with respect to Ms below ~ 360 °C. Py coexists with K-deficient micas in natural assemblages thought to have formed between 300 and ~ 360 °C.

Available evidence suggests that end-member illite (I) has an ordered, domain structure. Structural strain due to K-deficiency in micas may be accommodated by the creation of Py domains. The resulting structure could be stable with respect to Ms + Py at low temperatures only if the domains are ordered. Recent FTIR studies have established the presence of local Py domains and molecular water in Al-rich illite. Py stability (~ 360 °C at 1 kbar) limits the stability of the domain structure; Ms coexists with andalusite + water at 400 °C.

The prograde, stepwise transformation of S (smectite) \rightarrow I-S \rightarrow I probably leads to a metastable, compositional end-member (I_w) containing “excess,” interlayer water. Dehydration of I_w results in the formation of a metastable, disordered K-deficient mica (I_d) that may recrystallize to form a stable, ordered, Py domain structure (I_o). I_w may persist metastably but solid-state alteration of Ms can only yield I_o . Fine-scale, Py domains have not been observed in K-deficient micas by TEM as yet, but available evidence suggests that end-member illite (I_o) is a distinct, ordered, domain structure, stable below ~ 360 °C.