American Mineralogist, Volume 95, pages 348–361, 2010

Factors responsible for crystal-chemical variations in the solid solutions from illite to aluminoceladonite and from glauconite to celadonite

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Abstract

Several finely dispersed low-temperature dioctahedral micas and micaceous minerals that form solid solutions from (Mg,Fe)-free illite to aluminoceladonite via Mg-rich illite, and from Fe^{3+}-rich glauconite to celadonite have been studied by X-ray diffraction and chemical analysis. The samples have 1*M* and 1*Md* structures. The transitions from illite to aluminoceladonite and from glauconite to celadonite are accompanied by a consistent decrease in the mica structural-unit thickness (2:1 layer + interlayer) or *c*sinβ. In the first sample series *c*sinβ decreases from 10.024 to 9.898 Å, and in the second from 10.002 to 9.961 Å. To reveal the basic factors responsible for these regularities, structural modeling was carried out to deduce atomic coordinates for 1*M* dioctahedral mica based on the unit-cell parameters and cation composition. For each sample series, the relationships among *c*sinβ, maximum and mean thicknesses of octahedral and tetrahedral sheets and of the 2:1 layer, interlayer distance, and variations of the tetrahedral rotation angle, α, and the degree of basal surface corrugation, Δ*Z*, have been analyzed in detail.

The transitions from illite to aluminoceladonite and from glauconite to celadonite are accompanied by a slight increase in the mean thickness of the 2:1 layers and a steady decrease in the α angles, whereas the interlayer distance becomes smaller. These results are consistent with the generally accepted model where tetrahedral rotation is the main factor for the interlayer contraction in muscovite-phengite structures: the smaller the rotation angle (α) the larger the ditrigonal ring of the tetrahedral sheet and the interlayer pseudo-hexagonal cavity, allowing the interlayer cation to sink and thus shorten the *c* parameter.

A new insight into the interpretation of the contraction of the mica layer thickness in dioctahedral micas has been achieved with the discovery that micas with the same or close mean interlayer distance, on one hand, have the same or nearly the same substitution of Al for Si; and on the other hand, they may have significantly different parameters of the interlayer structure, such as tetrahedral rotation, basal surface corrugation, Δ*Z*, and minimum and maximum interlayer distance. These results show that in dioctahedral 1*M* micas, the mean interlayer distance is determined by the amount of tetrahedral Al because the higher the Al for Si substitution, the stronger the repulsion between the basal O atoms and the larger the interlayer distance and *c*sinβ parameter.

Keywords: Illite, aluminoceladonite, glauconite, celadonite, modeling, structural features, XRD