Analysis and Implications of the Edge Structure of Dioctahedral Phyllosilicates

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Abstract: Crystal growth theory was applied to describe edge sites of phyllosilicates. Three face configurations were found to exist. One face has one tetrahedral site per tetrahedral sheet and two octahedral one-coordinated sites per crystallographic area $ac \sin \beta$, where a and c are layer dimensions and β is the angle between them. The other two faces are similar except that they have one less octahedral site which is replaced by one Si^{IV}-O-Al^{VI} site in this same $ac \sin \beta$ area. A transfer of bonding energy from the remaining octahedral site to the Si^{IV}-O-Al^{VI} site is believed to neutralize all edge charge on faces containing these latter sites at normally encountered pHs (pH 3 – 9). A similar charge rearrangement along the edges results in an apparent decrease in the permanent charge of the mineral with an increase in edge area.

On the basis of such an analysis, lath-shaped illite can be described as a very fine grained dioctahedral mica in which the apparent deficient occupancy of the octahedral sheet, presence of excess water, and measurable cation-exchange capacity may in part be the result of a large ratio of edge area to total volume, with no other chemical or structural change in the mica layers. The increasing importance of edge charge relative to layer charge produces erroneous formulae for 2:1 phyllosilicates in very fine grained samples containing fewer than 2 of 3 octahedral sites occupied by cations, on the basis of a 22-charge half cell.

Key Words: Celadonite • Edge structure • Illite • Muscovite • Octahedral site • Phengite

Clays and Clay Minerals; April 1988 v. 36; no. 2; p. 141-146; DOI: 10.1346/CCMN.1988.0360207

Clay Minerals Society (www.clays.org)