
Surface Properties of Allophane, Halloysite, and Imogolite

B. K. G. Theng, M. Russell, G. J. Churchman and R. L. Parfitt

Soil Bureau, Department of Scientific and Industrial Research Lower Hutt, New Zealand

Abstract: The adsorption of sodium, chloride, and phosphate ions by allophane, imogolite, and halloysite has been studied in relation to the surface structure of the mineral samples. The high adsorption of phosphate ($>200 \mu\text{mole/g}$) and chloride ($10\text{--}30 \text{ meq/100 g}$ at pH 4) by allophane is ascribed to the small particle size of allophane, its high surface area ($\sim 800 \text{ m}^2/\text{g}$), and the presence at the surface of Al-OH-Al groups and defect sites. In contrast, halloysite has a relatively large particle size and a Si-O-Si surface. Accordingly, the adsorption of phosphate ($5\text{--}10 \mu\text{mole/g}$) and chloride (1 meq/100 g) by halloysite is very much lower as compared with allophane. Phosphate adsorption by halloysite is also related to particle morphology and the number of edge sites. Thus, a sample consisting entirely of spheroidal particles adsorbed only $5 \mu\text{mole/g}$ at a solution concentration of $1 \times 10^{-4} \text{ M}$, whereas the tubular types of comparable surface area adsorbed $7\text{--}10 \mu\text{mole/g}$ at the same concentration. This is because spheroidal halloysite particles have few, if any, edge sites at which phosphate can adsorb. The relative degree of order and hydration of halloysite, as indicated by infrared spectroscopy, also affects phosphate adsorption. However, this factor is apparently less important than particle morphology and surface structure. Although imogolite also has an Al-OH-Al surface, it contains relatively few defect sites where phosphate can adsorb. Consequently, much less phosphate ($120 \mu\text{mole/g}$) was adsorbed as compared with allophane.

Key Words: Adsorption • Allophane • Halloysite • Imogolite • Infrared spectroscopy • Phosphate • Surface charge

Clays and Clay Minerals; April 1982 v. 30; no. 2; p. 143-149; DOI: [10.1346/CCMN.1982.0300209](https://doi.org/10.1346/CCMN.1982.0300209)

© 1982, The Clay Minerals Society

Clay Minerals Society (www.clays.org)
