

## This Week's Citation Classic®

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**Greenland D J.** Interaction between clays and organic compounds in soils. Part II. Adsorption of soil organic compounds and its effect on soil properties. *Soils Fert.* 28:521-32. 1965.

[Waite Agricultural Research Institute, University of Adelaide, Australia]

A large proportion of the organic material in soils reacts with the inorganic clay particles to form the clay-organic complex. The physicochemical mechanisms of interaction are described and used to explain how the organic materials modify the physical and other properties of soils. [The SC]<sup>®</sup> indicates that this paper has been cited over 120 times, making it the most-cited paper for this journal.]

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As a research student in the Agriculture Department of the University of Oxford in 1952, I was asked to give a seminar on my research work. As I had just completed a chemistry degree, knew little of agriculture, and was working on the surface chemistry of clays, I was rather dismayed at the prospect of giving a talk to a group of agriculturists. I decided to broaden the scope of my talk to a general discussion of how organic compounds in soils might modify clay properties. Most agriculturists are aware of the fact that humus makes soils less sticky or cloddy, though rather few understand the intricacies of molecular adsorption processes at aluminosilicate surfaces. My supervisor, Walter Russell, however, did not approve and urged me to keep my seminar strictly to a discussion of the specific topic of my research, an investigation of the number of hydroxyl groups on the basal surfaces of montmorillonite. There were no questions at the seminar, even from the soil scientists present, and it remained a latent ambition of mine to describe more fully the ways in which the properties of clays can be modified by interaction with organic compounds.

Some years later I joined Quirk's group in Australia. His stimulation and interest in the subject and his awareness of the practical importance of controlling the physical properties of clays encouraged me to write the review. But I had no opportunity to do so until on sabbatical leave in England in 1964, when I was able to take advantage of the excellent facilities of the library at Rothamsted to prepare a broad discussion of the mechanisms by which clays adsorb and react with organic materials in soils, and how such interactions modify clay properties.

The paper was written from a basic physicochemical viewpoint. Part I described the behavior of well-defined chemical molecules at surfaces and provided a basis for discussion of the adsorption of humic materials whose chemistry was, and still is, poorly understood. The various mechanisms described helped to explain not only the way humus might interact with clays, and so modify their properties, but also the ways in which pesticides, whose chemical structures were of course well known, would interact with clays once they reached the soil. As the publication of the paper immediately preceded the period of intense interest in the fate and persistence of pesticides in soils, it was widely used (and quoted) as a basis for studies of the behavior of pesticides in the soil.

Work on the topic of the interaction between clays and organic compounds has grown tremendously since the paper was published, and a student who was working with Quirk and me at the time I wrote the original review, B.K.G. Theng, has since produced two books on the subject,<sup>1,2</sup> the first of which was awarded the Hilger prize as the best scientific book published in 1974. Our knowledge of the physical chemistry of adsorption processes has also increased greatly since 1965, and this has been reviewed in relation to clay-organic reactions in a book published in 1981.<sup>3</sup> A full understanding of how humus helps to make clays less sticky, soils more friable, and sands better able to hold water and less liable to blow away awaits proper elucidation of the chemical structures of humic materials.

1. Theng B K G. *The chemistry of clay-organic reactions*. London: Hilger, 1974. 343 p.

2. ...., *Formation and properties of clay-polymer complexes*. Amsterdam: Elsevier, 1979. 362 p.

3. Burchell S, Hayes M H B & Greenland D J. Adsorption of organic molecules. (Greenland D J & Hayes M H B, eds.) *The chemistry of soil processes*. Chichester, England: Wiley, 1981. p. 221-400.