DYNAMIC SOIL CLAYS

BAIN, D. C.
Macaulay Institute, Craigiebuckler, Aberdeen, AB15 8QH, UK
E-mail: d.bain@macaulay.ac.uk

Soil clays, particularly expansible phases such as smectite and vermiculite, are very sensitive to the environment in which they occur and to any changes which occur to that environment. Because of the nature of the interlayer region, hydroxy-interlayered vermiculite and smectite are highly variable and changes in environmental conditions can be reflected in the degree of interlayer filling and in the relative stability of the interlayer components. The degree of interlayering in these phases is pH-dependent (Bain et al., 1990) and lowering of the soil pH by acid precipitation or change of land-use such as planting of trees on former arable land can result in the interlayer material being removed from hydroxy-interlayered phases. Modifications to hydroxy-interlayered clays are easily detected by conventional X-ray diffraction (XRD) techniques but more sophisticated XRD peak analyse routines are needed to detect more subtle changes in soil clay mineralogy. Application of such techniques to soils has shown that soil clays are dynamic systems which can change in quite short periods of time, as little as 30 years. Some examples of such changes will be presented.

Two weathering trends were established in a series of three brown forest soils in close proximity but under different land-uses in Scotland (Bain and Griffen, 2002): (1) an increasing proportion of vermiculite in interstratified mica-vermiculite in the upper horizons of the arable and forested soils; (2) formation of high charge corrensite by weathering of chlorite in all three profiles but least pronounced in the arable soil. The differences in clay mineralogy amongst the profiles are minor, but these two different weathering trends may be due to the effects of different land-use.

Research using methods to decompose XRD patterns of soil clay fractions from soils taken between 1913 and 1996 from agricultural experimental plots in the USA suggests that there is a significant influence of cropping method on the soil clays (Velde and Peck, 2002). Little change in clay mineralogy was seen in the rotation plot but there was a significant loss of illitic material from different phases for the plots with continuous corn cultivation. Use of NPK fertiliser since 1955 appears to have restored the clay mineralogy for the soils in continuous cropping compared to that for the 1913 samples.

Loss of K-bearing clay minerals such as discrete illite and interstratified mica layers and an increase in the formation of chlorite have been recorded in clayey red soils in flood irrigated Chinese rice paddies cultivated for 3, 10, 15, 30 and 80 years (Li et al., 2003). These changes occur over 30 years or less, a rather rapid, irreversible transformation of soil clay minerals.

In a chronosequence of poldered sediments in France, the natural mineral suite of kaolinite, mica, illite and two disordered illite-smectite phases have changed gradually but significantly over time under the influence of pasture development to a more smectitic clay assemblage (Velde et al., 2003).

These examples indicate that clay minerals in soils are dynamic systems that are affected by changes to their environment. Some changes to the clays are reversible but other changes can be irreversible.

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