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Mineralogy of Kentucky Soils

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MINERALOGY OF KENTUCKY SOILS

A. D. Karathanasis

Very few mineralogical data have been published for soils in Kentucky. As an initial attempt to classify mineralogy of the subsoil, a general mineralogy map of the state was constructed based on currently available information (Fig. 1). The map suggests that quartz, mica, and feldspars are the dominant minerals of the sand and silt size fractions and that illite, smectite, kaolinite and hydroxyinterlayered vermiculite or smectite dominate the clay size soil fraction. Soils of the Western Coalfields, Eastern Coalfields, and Eastern Pennyrile regions generally contain more quartz in the sand and silt fraction than soils of the Purchase, Western Pennyrile, and Bluegrass regions. The sand and silt fractions of the latter regions, although still dominated by quartz, contain significant amounts of potassium feldspars and mica. The feldspar component is generally more prominent in soils of Western Kentucky, with mica being more prominent in central and eastern parts of the state. Soils with high feldspar or mica content are considered to have adequate water-soluble, exchangeable, and non-exchangeable K-supplying capacity because of the potassium released from their mineral structure during weathering. However, muscovite-type micas are more resistant to weathering than feldspars, with a rate of K-release not fast enough to replenish the solution K as it is removed by plants. Furthermore, not all mica-type minerals contain the same amount of K in their crystal structure (muscovite 11%, glauconite 5%, biotite 8%). Potassium availability to plants in these soils also depends on the rate and duration of ion exchange reactions, the nature of which is affected by soil mineralogical composition, K-specificity for certain exchange mineral sites and the nature of other ions in solution.

To date no definite regional trends have been established for the mineralogical composition of the clay size fraction of Kentucky soils. Generally, however, there is a tendency for both Eastern and Western Coalfield regions to contain less smectite and more prominent amounts of hydroxyinterlayered clay minerals than other regions. Smectite soils are most often found in some floodplain areas of the Mississippi, Ohio and Green rivers. Although when acid, these soils require more lime to raise pH because of their high cation exchange capacity, most do not have very low base saturation. Most of the soils in other regions contain variable quantities of illite, smectite/vermiculite, kaolinite and hydroxyinterlayered clay minerals. Amounts of lime needed to neutralize excessive acidity in these soils will be determined by the original acidity present and the buffering capacity of the mineral mixture.

Some soils of the Outer Bluegrass region formed from shaly parent materials are

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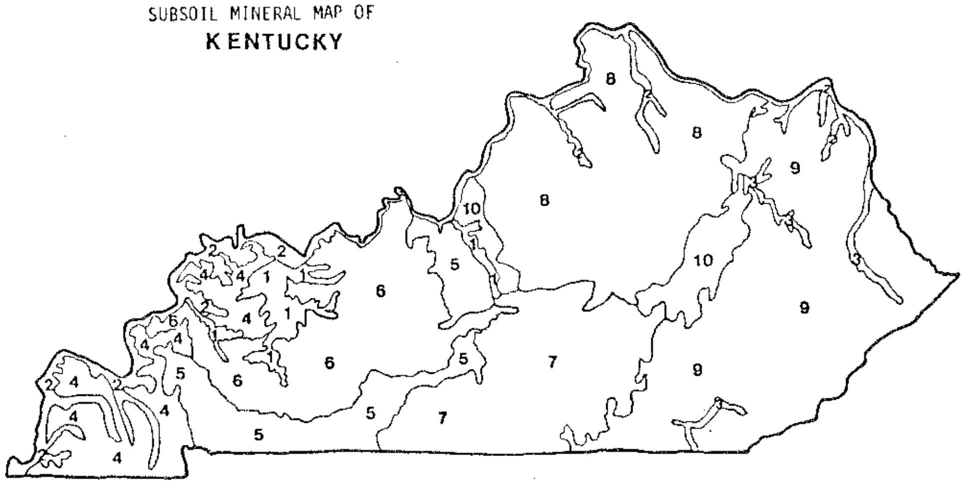
relatively high in vermiculite and interstratified minerals that exhibit a significant K-fixation capacity. Higher rates of K-fertilization may be required for such soils. Soils of the Hills of the Bluegrass, however, contain significant amounts of readily available potassium and require smaller rates of K-fertilization. Bluegrass soils developed from phosphatic limestone are likely to maintain relatively high P levels in the soil solution even without fertilization, depending on the solubility of the phosphate minerals present. Liming acid soil surfaces improves P availability because it decreases phosphate fixation by Al and Fe hydroxyoxides. Unless limed adequately, however, higher rates of P fertility are required for optimum crop growth.

There is still much to be learned about physico-chemical reactions controlling soil behavior. Some of these reactions are triggered by various types of physical or chemical soil management imposed by man. To successfully quantify them and predict how soils will respond, a quantitative knowledge of the mineralogical composition of the soil system will be necessary.

SUBSOIL MINERAL MAP OF
KENTUCKY



DOMINANT MINERALOGY

Area	Sand and Silt Fraction	Clay Fraction†
1.	<60% quartz; mica	smectite > illite > kaolinite
2.	40-80% quartz; mica	illite > kaolinite > smectite > HEX
3.	40-80% quartz; feldspars	illite > HEX > kaolinite
4.	40-80% quartz; feldspars	HEX > illite > kaolinite
5.	40-80% quartz; mica	kaolinite > illite > smectite > HEX
6.	40-80% quartz; mica; feldspars	HEX > kaolinite > illite
7.	40-80% quartz; mica; feldspars	illite > smectite > kaolinite > HEX
8.	40-80% quartz; mica; feldspars	illite > HEX > kaolinite > smectite
9.	40-80% quartz; mica	illite > kaolinite > HEX
10.	<60% quartz; mica	kaolinite > smectite > HEX > illite

† HEX - hydroxyinterlayered minerals