The silicate minerals are a major constituent of a large number of soils. These minerals contain many elements, particularly bases, that are essential to plant growth. In recent years both quantitative and qualitative methods of mineralogical analyses of mineral mixtures have been improved. However, further research is still required before mineralogical analyses can be used to the best advantage in the study of soils. The problem of interpreting mineralogical data is complicated by the lack of a uniform particle size distribution of the minerals in soils and differences in the stages of weathering of the various minerals present. Different conditions within soils may also affect the rates with which minerals weather. This study was undertaken to determine what effects time, temperature, particle size, and degree of calcium saturation of the soil colloid, have on the release of bases from some of the commoner soil-forming minerals.

EXPERIMENTAL METHODS

Pure mineral samples of some of the commoner minerals found in soils were obtained from Wards Natural Science Establishment of New York. These consisted of an orthosilicate (olivine), two metalisilicates (hornblende and augite), four polysilicates (albite labradorite, microcline, and anorthoclase), and three micas (muscovite, biotite, and phlogopite). The minerals were crushed or cut up into small pieces and pulverized in a porcelain ball mill with quartzite balls. The ground minerals were fractionated in water at the following approximate diameters, 20, 15.5, 11.0, 6.5, 2.0, and 0.2 μm. The latter separation was effected in a supercentrifuge. Clean separations could not be obtained as all of the minerals appeared to undergo some mechanical breakdown due to shaking. The minerals were shaken in water and decanted or supercentrifuged until the breakdown appeared to be constant. No dispersing agent was required although labradorite flocculated until it was washed a few times. Hornblende would not disperse, and only two separations could be effected.

The minerals were treated using a modification of a method outlined by Graham (8) which more closely approached conditions which prevail in soils. Four grams of each mineral fraction studied were mixed with 4 grams of H-bentonite and 6 grams of acid-washed, 11 to 50 μm quartz. The quartz was necessary as a filtering aid. “Volclay” bentonite was obtained from the American Colloid Company, purified, and saturated with H-coated clay change resin (amberlite). The mixtures were placed in porcelain filtering crucibles. The leaching experiments were run in duplicate.

The mineral-bentonite-quartz mixtures used in an experiment showing the effect of particle size on the rate of release of bases from minerals were leached with neutral, ammonium acetate (400 ml), saturated with H using 0.05 M acetic acid (400 ml), washed with distilled water, and kept standing in a humid incubation chamber. These treatments were repeated at intervals.

To study the relationship between the rate of release of bases from minerals and different degrees of Ca saturation of the exchange complex a similar experiment was set up using the coarse clay fraction of the minerals. The treatments used were the same as those used in the particle size experiments with the substitution of one of the following leaching solutions for the 0.05 M acetic acid: (1) 0.05 M acetic acid and 0.10 M calcium acetate solution, (2) 0.05 M acetic acid and 0.05 M calcium acetate solution, (3) 0.05 M calcium acetate solution. These treatments will be referred to hereafter as the 2:1 Ca:H, and Ca saturated treatments respectively.

To evaluate bentonite as a weathering agent 4 grams of coarse clay fractions of the minerals were mixed with 10 grams of silt size quartz and treated as in the particle size experiments. The leaching intervals were the same in all of these experiments.

The effect of temperature was observed on the coarse clay fractions of microcline and muscovite. The samples were the same as in the particle size experiment except for the temperature and time of incubation. Duplicate samples of microcline and muscovite were incubated at 7, 16, and 41° C for 5 weeks. Immediately before electrodialysis they were desiccated partially filled with distilled water. This experiment appeared to have a higher moisture content than the samples contained in the metal lined, wooden desiccators used in the former experiments.

The coarse clay fractions of microcline, muscovite, and olivine were electrodialyzed at a potential of 100 volts for 5 weeks. Immediately before electrodialysis they were treated with neutral M ammonium acetate. The cathode chambers used in the former experiments.

ANALYTICAL METHODS

To determine total bases the 2.0 to 0.2 μm fraction of the minerals and an un fractioned portion were treated with HF (12, p. 276) and Fe, Al, and Mn removed (13, p. 394). Mg was precipitated from an aliquot portion by the standard Ca was precipitated from an aliquot portion by