

MINERAL CONTENT AND DISTRIBUTION AS INDEXES OF WEATHERING IN THE OMEGA AND AHMEEK SOILS OF NORTHERN WISCONSIN

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ABSTRACT

Quantitative estimation of mineral concentrations was made for the clay fractions of Omega loamy sand (Brown Podzolic) and Ahmeek loam (Brown Forest). These soils are relatively young and have developed from Pleistocene (late Wisconsin) outwash and till, respectively, in northern Wisconsin. A mineral weathering depth function was found, in which illite and chlorite present at depth have weathered to vermiculite and montmorillonite nearer the surface, particularly in the clay fractions of Ahmeek loam. In the fine clay, the montmorillonite content increases from 5 percent in the C_1 horizon to 44 percent in the A_1 horizon. Conversely, chlorite decreases from 11 percent in the C_1 to virtually none in the A_1 horizon. Weathering in these soils is also reflected by distribution of minerals as a function of particle size. The occurrence of mineral-weathering depth and size functions in these young soils is attributed to accelerated leaching made possible by the coarse texture of the soils.

INTRODUCTION

The kind of minerals present and their distribution with depth in a soil profile often serve as an index of the pedogenic and weathering processes operative in soil development. That the various minerals common in soils weather at a differential rate has been recognized by many investigators in the field of soil mineralogy. Since some minerals weather more easily than others, there tends to be an accumulation of minerals of similar stability in any one soil profile or horizon which reflects the intensity of the various agencies of weathering (Jackson and others, 1948; Jackson and Sherman, 1953), and the survival of specific minerals in the finer fractions of soils is often affected by the size of the mineral particles (the "size function") and the position of the minerals in the profile (the "depth function"). The results of the present investigation illustrate both the particle-size function and the depth function of weathering as manifested by the mineral species present in the clay fractions of two relatively young, coarse-textured soils.

MATERIALS

The Omega loamy sand represents a Brown Podzolic soil developed from smooth glacial outwash under pine forest cover. The parent material and solum contain a large proportion of basic rock constituents. The Ahmeek loam represents a Brown Forest soil developed under hardwood forest from acidic glacial

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till. The till, however, contains a higher content of basic rock constituents than does most of the till of northern Wisconsin. Complete profile descriptions of the two soils are given in the U.S.D.A. Soil Survey Laboratory Memorandum no. 1, Beltsville, Maryland, 1952.

The presence of numerous unweathered rocks in the solum, the predominance of coarse-grained particles, and the lack of any appreciable evidence of translocation of clay, iron oxides, or organic matter reflect the youth of these soils developed on deposits of late Pleistocene age.

Although the clay fractions constitute only a small percentage of the total mineral portion of the two soils, only the clay was analyzed in the present study because it was felt that the changes observed in these fractions would be most indicative of the course and extent of chemical weathering in these soils.

ANALYTICAL METHODS

The coarse clay (2 to 0.2 microns) medium clay (0.2 to 0.08 micron), and fine clay (<0.08 micron) fractions of selected horizons were separated after dispersion treatments as described by Jackson, Whittig, and Pennington (1950). Each of the fractions was x-rayed by the random powder method after magnesium saturation and glycerol solvation by the procedure of White and others (outlined by Jeffries and Jackson, 1949). Parallel oriented samples of each fraction, as magnesium saturated, glycerol solvated and as potassium saturated, heated specimens, were also analyzed with a Geiger-counter diffractometer to characterize layer-silicate components present. The qualitative x-ray diffraction data have been presented previously (Whittig and Jackson, 1955). Specific-surface measurements were made by the method of Vanden Heuvel and Jackson (1953), cation-exchange capacity by the method of Swindale and Fieldes (1952), and elemental analysis as described by Corey and Jackson (1953). The general allocation procedure involved (a) allocation of sodium and calcium to plagioclase feldspars; (b) estimation of kaolinite, halloysite, and quartz from x-ray diffraction intensities; (c) approximation of orthoclase and illite by evaluation from total potassium and x-ray diffraction intensities; (d) estimation of chlorite from x-ray diffraction intensities; (e) estimation of vermiculite and montmorillonite from specific surface and diffraction data; and (f) calculation of 2:1 layer-silicate and chlorite formulas by the method described by Marshall (1935) to check the estimations of other minerals.

RESULTS

The quantitative data obtained from the Omega and Ahmeek fractions (Tables 1 and 2) include the percentage of each clay fraction and the amount of free iron oxide extracted from the soil material less than 0.40 mm diameter. In general, the amount of clay increases with proximity to the soil surface, indicating a breakdown of primary minerals into finer particles under the influence of increased weathering intensity near the surface.

The relative proportions of vermiculite and montmorillonite (identified by x-ray analysis; Whittig and Jackson, 1955) in the clay fractions of the Omega soil are shown by the mutually corroborative specific-surface and cation-exchange capacity data. The amount of glycerol sorbed by expanded layer silicates

TABLE 1. — ELEMENTAL ANALYSIS, HEATING WEIGHT LOSS, SPECIFIC SURFACE, AND CATION-EXCHANGE CAPACITY DATA FOR THE CLAY FRACTIONS OF THE OMEGA LOAMY SAND.

| Fraction, microns | Percent of soil, <2 mm | Internal glycerol sorbed, mg/50 mg | Cation-exchange capacity, meq/100 g | Elemental composition, percent as oxides | | | | | | | | | | |
|---|------------------------|------------------------------------|-------------------------------------|--|--------------------------------|--------------------------------|------|------------------|------|------|------------------|-------------------|--------------------------|--|
| | | | | SiO ₂ | Al ₂ O ₃ | Fe ₂ O ₃ | FeO | TiO ₂ | MgO | CaO | K ₂ O | Na ₂ O | H ₂ O <110° C | |
| <i>A</i> ₃ horizon, 2 to 4 inches (0.64 percent Fe ₂ O ₃ extracted ²) | | | | | | | | | | | | | | |
| 2-0.2 | 1.17 | 2.94 | 38.4 | 59.9 | 21.4 | 2.96 | 1.20 | 1.66 | 1.53 | 0.09 | 2.11 | 0.87 | 7.87 | |
| 0.2-0.08 | 0.74 | 7.99 | 72.4 | 46.8 | 31.0 | 4.01 | 0.76 | 1.12 | 1.98 | 0.10 | 1.44 | 0.32 | 11.2 | |
| <0.08 | 0.88 | 11.14 | 107.7 | 48.4 | 29.1 | 5.55 | 1.34 | 0.57 | 1.90 | 0.18 | 1.12 | 0.26 | 12.1 | |
| <i>B</i> ₂₂ horizon, 11 to 20 inches (0.64 percent Fe ₂ O ₃ extracted ²) | | | | | | | | | | | | | | |
| 2-0.2 | 1.21 | 3.33 | 34.0 | 55.9 | 22.8 | 3.54 | 1.07 | 1.27 | 1.98 | 0.12 | 1.90 | 0.69 | 8.39 | |
| 0.2-0.08 | 0.99 | 9.89 | 72.4 | 40.6 | 31.3 | 6.45 | 1.21 | 0.86 | 1.44 | 0.20 | 0.82 | 0.33 | 13.4 | |
| <0.08 | 0.41 | 10.26 | 83.1 | 40.3 | 31.6 | 5.99 | 1.01 | 0.62 | 1.09 | 0.19 | 0.56 | 0.27 | 19.0 | |
| <i>C</i> ₂₁ horizon, 26 to 35 inches (0.33 percent Fe ₂ O ₃ extracted ²) | | | | | | | | | | | | | | |
| 2-0.2 | 0.19 | 4.50 | 51.6 | 55.2 | 24.1 | 3.57 | 1.32 | 1.35 | 2.17 | 0.10 | 2.21 | 0.80 | 9.11 | |
| 0.2-0.08 | 0.38 | 10.38 | 69.3 | 43.8 | 28.0 | 11.14 | 0.81 | 1.76 | 0.82 | 0.02 | 0.95 | 0.31 | 13.3 | |
| <0.08 | 0.07 | 14.20 | 83.5 | 40.9 | 28.4 | 9.56 | 1.33 | 1.48 | 0.92 | 0.03 | 0.64 | 0.27 | 16.0 | |
| <i>C</i> ₂₃ horizon, 40 to 49 inches (0.13 percent Fe ₂ O ₃ extracted ²) | | | | | | | | | | | | | | |
| 2-0.2 | 0.06 | 6.21 | 44.8 | 49.3 | 23.2 | 6.02 | 1.57 | 2.26 | 3.86 | 0.26 | 2.07 | 0.99 | 10.1 | |
| 0.2-0.08 | 0.07 | 10.70 | 52.5 | 42.4 | 23.3 | 16.84 | 1.39 | 2.68 | 1.50 | 0.10 | 1.09 | 0.54 | 13.6 | |
| <0.08 | 0.02 | 16.84 | 78.7 | 41.7 | 26.8 | 9.06 | 2.60 | 2.34 | 1.11 | 0.09 | 0.98 | 0.26 | 15.2 | |

1 Corrected for ferrous iron oxidation.

2 Extracted from less than 0.4 mm mineral material of soil, calculated as percent of soil < 2 mm.

increases with decreasing particle size within each horizon and also increases with depth in the profile. The cation-exchange capacity also increases with decreasing particle size. The exchange capacity of the 2 to 0.2 micron fraction of the A_3 horizon, for example, was found to be 38.4 meq per 100 g while the less than 0.08 micron fraction exhibited an exchange capacity of 107.7 meq per 100 g.

A significant trend may be observed in the exchange capacity of the various fractions within each horizon. In the A_3 horizon, the highest exchange capacity was found in the 0.2 to 0.08 micron and less than 0.08 micron fractions (72.2 and 107.7 meq per 100 g, respectively) while the lowest was obtained from the 2 to 0.2-micron fraction (38.4 meq per 100 g). Similar trends were obtained in the B_{22} , C_{21} , and C_{23} horizons.

In view of the fact that the exchange capacity of vermiculite is normally much higher than that of montmorillonite (about 150 meq per 100 g as compared with about 90 meq per 100 g) and that montmorillonite is capable of adsorbing twice as much interlayer glycerol as vermiculite, it appears that vermiculite predominates over montmorillonite in the A_3 -horizon fractions. The fractions sorbed relatively small amounts of glycerol but exhibited relatively high exchange capacities. The data indicate that the proportion of montmorillonite is relatively low in the A_3 horizon.

In the B_{22} -horizon fractions, there was again a direct relation between amounts of glycerol sorbed and cation-exchange capacities. The 2 to 0.2-micron fraction, with the lower exchange capacity (34.0 meq per 100 g) sorbed the lesser amount of glycerol (3.33 mg per 50 mg of sample) while the less than 0.08-micron fraction exhibited an exchange capacity of 83.1 meq per 100 g and sorbed 10.26 mg of glycerol per 50 mg of sample. Similar trends were observed in the C_{21} and C_{23} horizon fractions.

An inverse relation between exchange capacity and glycerol sorbed is strikingly illustrated by the less than 0.08-micron fractions of the A_3 and C_{23} horizons. In the former, the less than 0.08-micron fraction sorbed 11.14 mg of glycerol per 50 mg of sample and had an exchange capacity of 107.7 meq per 100 g. The less than 0.08-micron fraction of the C_{23} horizon, on the other hand, with an exchange capacity of only 78.7 meq per 100 g sorbed 16.84 mg of glycerol. This indicates that the proportion of vermiculite to montmorillonite is higher in the A_3 -horizon fraction. The higher proportion of montmorillonite at greater depth, where weathering intensity is presumably less, suggests that there has been some translocation of fine montmorillonite particles in this sandy soil.

The amount of glycerol sorbed by expanded layer silicates was generally lower in each fraction of the Ahmeek (Table 2) than in the Omega horizons, indicating a lower concentration of these expanded minerals. Similarly, the exchange capacities of the Ahmeek fractions were lower in general than exhibited by the Omega fractions.

The amount of glycerol sorbed increased with fineness of particle size in the A_1 horizon of the Ahmeek profile. There was a linear relationship between glycerol sorbed and exchange capacity in this horizon. In the B_{22} , C_{17} , and C_2 horizons, there was also a general increase in glycerol sorption with decreasing particle size except that the 0.2 to 0.08-micron fractions from each horizon sorbed the most glycerol. The exchange capacities of the fractions from these horizons increased progressively with decrease in particle size, however, with

TABLE 2. — ELEMENTAL ANALYSIS, HEATING WEIGHT LOSS, SPECIFIC SURFACE, AND CATION-EXCHANGE CAPACITY DATA FOR THE CLAY FRACTIONS OF THE AHMEEK LOAM.

| Fraction, microns | Percent of soil, <2 mm | Internal glycerol sorbed, mg/50 mg | Cation-exchange capacity, meq/100 g | Elemental composition, percent as oxides | | | | | | | | | | |
|--|------------------------|------------------------------------|-------------------------------------|--|--------------------------------|--------------------------------|------|------------------|------|------|------------------|-------------------|--------------------------|--|
| | | | | SiO ₂ | Al ₂ O ₃ | Fe ₂ O ₃ | FeO | TiO ₂ | MgO | CaO | K ₂ O | Na ₂ O | H ₂ O <110° C | |
| <i>A</i> ₁ horizon, 0 to 2.5 inches (1.45 percent Fe ₂ O ₃ extracted ²) | | | | | | | | | | | | | | |
| 2-0.2 | 4.36 | 4.13 | 40.3 | 63.9 | 19.7 | 1.29 | 2.08 | 2.48 | 0.97 | 0.24 | 2.83 | 0.87 | 8.24 | |
| 0.2-0.08 | 1.41 | 8.26 | 93.3 | 50.2 | 26.1 | 5.47 | 1.35 | 3.19 | 2.07 | 0.07 | 2.05 | 0.27 | 9.66 | |
| <0.08 | 1.10 | 11.18 | 97.6 | 52.3 | 24.6 | 8.52 | 1.59 | 1.57 | 1.89 | 0.09 | 1.74 | 0.18 | 9.71 | |
| <i>B</i> ₂₂ horizon, 7 to 19 inches (1.54 percent Fe ₂ O ₃ extracted ²) | | | | | | | | | | | | | | |
| 2-0.2 | 4.12 | 4.31 | 45.5 | 57.3 | 24.2 | 2.52 | 2.17 | 1.72 | 1.95 | 0.73 | 2.67 | 0.90 | 8.63 | |
| 0.2-0.08 | 1.18 | 7.42 | 72.5 | 47.5 | 32.4 | 4.22 | 1.61 | 1.69 | 2.39 | 0.11 | 1.60 | 0.32 | 11.5 | |
| <0.08 | 1.33 | 3.38 | 85.9 | 48.7 | 32.8 | 5.55 | 0.41 | 1.31 | 1.78 | 0.20 | 1.32 | 0.27 | 11.4 | |
| <i>C</i> ₁ horizon, 30 to 42 inches (0.95 percent Fe ₂ O ₃ extracted ²) | | | | | | | | | | | | | | |
| 2-0.2 | 2.09 | 3.52 | 27.8 | 51.0 | 24.9 | 5.64 | 1.82 | 1.99 | 2.69 | 0.92 | 3.09 | 1.13 | 8.28 | |
| 0.2-0.08 | 0.16 | 7.90 | 38.4 | 38.8 | 29.7 | 8.36 | 2.00 | 2.77 | 2.65 | 0.13 | 1.73 | 0.43 | 14.1 | |
| <0.08 | 0.32 | 7.16 | 70.5 | 39.1 | 29.8 | 10.5 | 2.57 | 3.92 | 1.82 | 0.04 | 1.44 | 0.29 | 13.6 | |
| <i>C</i> ₂ horizon, 42 to 48 inches (1.00 percent Fe ₂ O ₃ extracted ²) | | | | | | | | | | | | | | |
| 2-0.2 | 2.75 | 4.16 | 29.7 | 51.5 | 25.7 | 4.56 | 1.52 | 1.68 | 2.38 | 1.38 | 3.04 | 1.05 | 8.28 | |
| 0.2-0.08 | 0.28 | 6.22 | 45.0 | 41.4 | 32.4 | 4.92 | 2.00 | 3.02 | 2.27 | 0.15 | 1.68 | 0.41 | 12.6 | |
| <0.08 | 0.22 | 4.93 | 80.5 | 39.2 | 31.1 | 5.92 | 1.88 | 4.96 | 1.86 | 0.09 | 1.48 | 0.28 | 12.9 | |

1 Corrected for ferrous iron oxidation.

2 Extracted from less than 0.4 mm mineral material of soil, calculated as percent of soil < 2 mm.

the highest exchange capacities shown by the less than 0.08-micron fractions. The surface data suggest that there is a higher proportion of vermiculite to montmorillonite in the fine-clay fraction than in the medium-clay fraction since the exchange capacity increases while glycerol sorption decreases. The data also indicate that the ratio of vermiculite to montmorillonite is highest in the lower horizons whereas the amount of montmorillonite increases with proximity to the surface. The increase in montmorillonite near the surface is interpreted as a result of alteration of vermiculite to montmorillonite.

Elemental analysis of the Omega fractions (Table 1) reveals several significant trends which may be interpreted in terms of the mineral composition of the fractions. The SiO_2 content decreases with depth in the profile as well as with fineness of particle size within any one horizon. Conversely, the Al_2O_3 content increases with fineness of particle size. These trends are interpreted to indicate a decrease in quartz and increase in layer silicates with depth and with decrease in size. The Fe_2O_3 content generally follows the trends shown by Al_2O_3 , being low near the surface and in the coarser fractions. MgO shows significant trends only in the C_{21} and C_{23} horizons. In these horizons, it is considerably higher in the coarse clay fraction. This is probably due to a higher content of chlorite. K_2O and Na_2O contents are relatively high in the 2 to 0.2-micron fractions of the A_3 , B_{22} , and C_{21} horizons. This is commensurate with the relatively high feldspar content as revealed by x-ray analysis.

Water content of the fractions, as revealed by heating weight loss analysis, increased markedly with decreasing particle size. This reflects the higher concentration of hydroxyl-containing layer silicates relative to quartz and feldspar in the finer fractions.

The SiO_2 content of the several fractions decreases with depth and with fineness of particles whereas Al_2O_3 increases with depth and with fineness of particles in the Ahmeek profile (Table 2). These trends indicate increasing proportions of layer-silicate minerals relative to quartz and feldspars with depth and fineness of particle size. The CaO , K_2O , and Na_2O contents are highest in the 2 to 0.2-micron fractions, which reflects a higher concentration of feldspars. Again, as in the Omega profile, there appears to have been some translocation of layer silicates from the upper horizons. The higher content of H_2O at depth corroborates the existence of a higher percentage of layer silicates in the lower horizons.

The mineral content of the Omega fractions (Table 3) shows that the concentration of montmorillonite generally increases with decrease in particle size and with depth in the profile. Vermiculite has its highest concentration in the less than 0.08-micron fraction of the B_{22} horizon (71 percent). Vermiculite increases with a decrease in size in the A_3 and B_{22} horizons. In the C_{21} and C_{23} horizons, however, the largest quantity of vermiculite is in the 0.2 to 0.08-micron and less than 0.08-micron fractions. Chlorite, most abundant in the 2 to 0.2-micron fractions, is fairly constant with depth in the profile, but decreases with decreasing particle size. Feldspars, present in the 2 to 0.2-micron fractions, were not detected in fractions finer than 0.2 micron. Quartz persists into the 0.2 to 0.08-micron fractions. Illite increases in the medium clay (less dilution with quartz) and decreases in the fine clay.

Mineral data for the Ahmeek fractions (Table 4) show that montmorillonite increases with decrease in particle size and with proximity to the surface. Ver-

TABLE 3. --- MINERAL COMPOSITION OF THE CLAY FRACTIONS OF THE OMEGA LOAMY SAND.

| Horizon | Depth | Fraction, microns | Percent of soil <2 mm | Minerals ¹ present expressed as percent | | | | | | | | | |
|-----------------|--------------|-------------------|-----------------------|--|------|----|----|----|-----|----|----|----|--|
| | | | | Ab | Anor | Or | Qr | Il | Chl | Vm | Mt | Kl | |
| A ₃ | 2 to 4 in. | 2-0.2 | 1.17 | 8 | 1 | 10 | 26 | 5 | 25 | 13 | 5 | | |
| | | 0.2-0.08 | 0.74 | 0 | 0 | 15 | 14 | 5 | 27 | 28 | 10 | | |
| | | <0.08 | 0.88 | 0 | 0 | 0 | 11 | 0 | 48 | 41 | 0 | | |
| B ₂₂ | 11 to 20 in. | 2-0.2 | 1.21 | 6 | 1 | 8 | 26 | 5 | 20 | 22 | 5 | | |
| | | 0.2-0.08 | 0.99 | 0 | 0 | 10 | 8 | 10 | 26 | 38 | 5 | | |
| | | <0.08 | 0.41 | 0 | 0 | 0 | 5 | 0 | 71 | 24 | 0 | | |
| C ₂₁ | 26 to 35 in. | 2-0.2 | 0.19 | 7 | 1 | 10 | 19 | 5 | 15 | 24 | 10 | | |
| | | 0.2-0.08 | 0.38 | 0 | 0 | 10 | 9 | 5 | 35 | 36 | 5 | | |
| | | <0.08 | 0.07 | 0 | 0 | 0 | 6 | 0 | 23 | 71 | 0 | | |
| C ₂₃ | 40 to 49 in. | 2-0.2 | 0.06 | 9 | 1 | 9 | 9 | 5 | 10 | 40 | 5 | | |
| | | 0.2-0.08 | 0.07 | 0 | 0 | 5 | 10 | 5 | 56 | 27 | 0 | | |
| | | <0.08 | 0.02 | 0 | 0 | 0 | 9 | 0 | 0 | 93 | 0 | | |

¹ Ab=albite; Anor=amorphite; Or=orthoclase; Qr=quartz; Il=illite; Chl=chlorite; Vm=vermiculite; Mt=montmorillonite; Kl=kaolinite and halloysite.

TABLE 4. — MINERAL COMPOSITION OF THE CLAY FRACTIONS OF THE AHMEEK LOAM.

| Horizon | Depth | Fraction, microns | Percent of soil <2 mm | Minerals present expressed as percent | | | | | | | | | |
|-----------------|--------------|-------------------|-----------------------|---------------------------------------|------|----|----|----|-----|----|----|----|--|
| | | | | Ab | Anor | Or | Qr | Il | Chl | Vm | Mt | Kl | |
| A ₁ | 0 to 2.5 in. | 2-0.2 | 4.36 | 8 | 1 | 10 | 35 | 10 | 10 | 13 | 0 | | |
| | | 0.2-0.08 | 1.41 | 0 | 0 | 0 | 15 | 20 | 3 | 20 | 33 | 10 | |
| | | <0.08 | 1.10 | 0 | 0 | 0 | 5 | 17 | 0 | 41 | 44 | 0 | |
| B ₂₂ | 7 to 19 in. | 2-0.2 | 4.12 | 8 | 4 | 5 | 25 | 17 | 11 | 32 | 5 | 0 | |
| | | 0.2-0.08 | 1.18 | 0 | 0 | 0 | 5 | 15 | 11 | 47 | 15 | 10 | |
| | | <0.08 | 1.33 | 0 | 0 | 0 | 0 | 12 | 0 | 46 | 46 | 0 | |
| C ₁ | 30 to 42 in. | 2-0.2 | 2.09 | 10 | 5 | 6 | 16 | 20 | 20 | 24 | 5 | 0 | |
| | | 0.2-0.08 | 0.16 | 0 | 0 | 0 | 2 | 17 | 5 | 62 | 10 | 5 | |
| | | <0.08 | 0.32 | 0 | 0 | 0 | 0 | 14 | 11 | 73 | 5 | 5 | |
| C ₂ | 42 to 48 in. | 2-0.2 | 2.75 | 9 | 7 | 5 | 20 | 20 | 17 | 6 | 16 | 0 | |
| | | 0.2-0.08 | 0.28 | 0 | 0 | 0 | 5 | 16 | 15 | 54 | 5 | 5 | |
| | | <0.08 | 0.22 | 0 | 0 | 0 | 0 | 14 | 24 | 58 | 0 | 5 | |

Ab = albite; Anor = anorthite; Or = orthoclase; Qr = quartz; Il = illite; Chl = chlorite; Vm = vermiculite; Mt = montmorillonite; Kl = kaolinite and halloysite.

miculite is in highest concentration in the C_1 horizon and in the medium and fine clay. Chlorite increases with depth in the profile.

Quartz and feldspar follow the same trends in the Ahmeek as in the Omega profile; i.e., they decrease with decrease in size of mineral particles. Quartz decreases considerably and feldspar increases slightly with depth in the profile.

A very small amount of halloysite was detected by electron microscope examination in the 0.2 to 0.08-micron and less than 0.08-micron fractions of the Ahmeek C_2 horizon.

The accumulation of vermiculite and montmorillonite near the surface of the Ahmeek profile, as contrasted with their concentration at greater depth in the Omega soil, suggests that there has been less translocation of these minerals in this finer-textured, loamy soil. That leaching action has not been as extensive in the Ahmeek soil is reflected by the wider range in layer-silicate content as a function of depth. The x-ray diagrams of the Ahmeek fractions (Whittig and Jackson, 1955) showed strong maxima for vermiculite and montmorillonite near the surface of the profile with weak manifestation at depth. The vermiculite and montmorillonite near the surface are present largely as discrete crystals, whereas they are present as members of interstratified series at depth. Interstratification of these components was more evident in the surface horizons of the Omega profile.

CONCLUSIONS

The predominant minerals in the Omega and Ahmeek profiles are representative of intermediate stages of weathering as defined by Jackson and others (1948). The high content of chlorite (stages 4 to 8, Jackson and Sherman, 1953), feldspar (stage 5), quartz (stage 6), vermiculite (stage 8), and montmorillonite (stage 9) indicate that the soils have not been weathered intensively.

The observed variation in concentrations of layer silicates illustrates the weathering effects of accelerated leaching in relatively young soils. Percolating rain waters have had free passage through these sandy profiles and as a result the minerals have been subjected to more weathering than in fine-textured soils of the same age. In a medium- or fine-textured soil, under the same environmental conditions, there would be less leaching and less weathering of layer-silicate minerals, owing to a greater water-holding capacity.

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