GENESIS AND FORMATION OF CLAY LAYERS IN ALKALI SOILS AND ITS BEARING ON THEIR RECLAMATION

BY

MOHAMED EL - TAHER EL - SAYED ABBAS
B. Sc. (Soils) Cairo Univ. 1967
M. Sc. (Soils) Azhr Univ . 1976

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INTRODUCTION

In addition to over increasing population in Egypt the country is suffering greatly from the loss of its very fertile agricultural land due to the gradual attack of building and industrial establishments. One of the best solution for that problem is either to occupy desert cultivable areas or to reclaim soils, whether sandy or salt affecteds.

Salt affected soils occupy a vast area in the country as its acreages range between 1.2 and 1.5 million feddan. Fine textured salt-affected soils have a common feature among them, heavy texture subsurface or clayey layer in their profile interfere with their reclamation. Knowledge of the pattern and the nature of these layers is essential to solve the problems of high water table, nutritive condition, run-off and installation of the proper drainage system.

The extent of clay accumulation in the subsurface layer to form a diagnostic horizon depends mainly on the degree of soil development under equilibrium set of soil forming factors. According to soil taxonomy, the subsurface horizons which are characterized by clay accumulation are argillic, cambic and agric horizons. Different mechanisms have been proposed for clay accumulation in these horizons such as :

Physical translocation from the upper horizons, weathering of minerals in situ, and resynthesis of the eluviated soluble oxides. In a given soil one or two of these processes may predominate in forming the clay horizon, though each process would be associated with certain morphological or micropedological features. Thus, if a clayey horizon is formed mainly by clay translocation, clay skins or argillans are indicative to that process in most cases. However if the clay is being formed in situ, evidence of alteration or some weatherable minerals should be present in that horizon.

Under soil forming factors prevailing in Egypt, formation of such diagnostic horizons is questionable, simply because of the Torric moisture regime. However, in some areas excessive amounts of water have been applied, since thousands of years, through irrigation. Under such conditions of moisture regime on a uniform sediment could any diagnostic horizon (argillic, cambic or agric) develop in the soils of Egypt ??. This is the main purpose of this investigation.

To achieve this, soil profiles of clayey subsurface were collected from different locations, after thorough the morphological study, different samples were subjected to, physical, chemical, micromorphological and mineralogical analyses. Results were discussed in the light of the criteria given for diagnostic horizons (argillic, cambic and agric), in a trial to find out a descriptive nomenclature of more qualitative nature, if possible' to our soils.

2. REVIEW OF LITERATURE

2.1. Clay Migration in Soil :

Clay migration is an important process in the formation of a soil profile, which develops by illuviation and eluviation of the different constituents. In part, the profile is affected by differential weathering in response to different conditions of moisture and temperature encountered in several layers of the solum. It is believed that percolating water causes the migration of the more mobile constituents from the upper layers and their deposition in the lower ones.

Studies on the migration of clay in strongly podzolized gray, dark gray forest and chernozems, according to relief and parent rock were carried out by Sorochkin (1965), who found that the variations in the contents of clay fraction, SiO_2, Al_2O_3 and Fe_2O_3 were greater in the C than in the B and A horizons. He added that in all soils, the clay fractions, SiO_2 and sesquioxides have migrated from A to B horizon and sometimes even lower.

Leon and Yacobazzo (1967), studied the distribution of free iron in some highly leached soils of uruguarg. They showed that, the migration of clay and free iron oxides occurred in all soils.

Gile and Grossman (1968), in their study on the morphology of argillic horizon in desert soils of southern New Mexico, found that the prominent argillic horizons occur only in soils formed primarily during the Pleistocene, clay skins occur on ped surfaces in pipes of over thick-ened argillic horizons in buried Pleistocene soils.

Oberholster (1969), studied the genesis of two different soils on basalt, he found that these soils contained larger amounts of transported material. Also, he stated that clay distribution pattern appeared to be the result of pseudo accumulation of clay caused by argi-llipedoturbation that effectively incorporated transported materials into soils.

Rowell and Dillon, (1972), showed that the ability of clay to move in an ice-liquid interface depends on the rate of freezing, while a freezing rate of 1 cm. per hour did not move flocculated clay, but moved dispersed clay up to 0.7 cm. They added that the coarse material of illite and vermiculite has no migration at any temperature.

Bullock et al. (1974), found that the zone of degradation formed in the udalf soils of New York state is largely a result of eluviation of clay from the zone. Fine clay appears to have been moved preferentially from the zone of degradation to the lower part of the solum, and the development of the zone appears to be caused primarily by eluviation of clay.

Sehgal et al. (1976), studied the clay migration in soil groups of NW India, developed under varying soil moisture and temperature regimes, using thin sections for illuviation cutans. The results reveal a very low effective clay mobility in udic soils having thick, continuous and strongly oriented argillans, and moderate to high clay mobility in ustic soils where clay cutans are either not observed or are weakly oriented. The potentially mobile, however, is the dispersible, clay which is the highest in ustic and the lowest in udic soils having optimum conditions for clay translocation suggesting that the highly birefringent argillans in udic soils are not a definite proof for present day illuviation but could be taken as indicat ion to the past illuviation process.

Horlan et al. (1977), studied the effect of loess thickness and natural soil drainage on profile distribution of clay and free oxides of Fe, Al, Mn and Si in 14 soils in south western Indiana. They found that in all soils Fe and Al profiles followed clay profiles, suggesting that oxides are adsorbed on clays and move with them.

Abd El-Hamid (1979), showed that the high saline water increased the quantity and depth of clay migration more than the non saline water. He found that the movement decreased by increasing the clay content due to the blocking of the pores by high amount of clay and this depends on clay types and their expansion (bentonite $>$ kaolinite $>$ illite).

Kussmaul and Niederbudde (1980), studied the balances between the formation and movement of clay and clay transformation in loessial parabraunerde. They found that the clay movement has apparently involved 42-51 kg/m^2 of $< 2\mu$ clay and 25-39 kg/m^2 of $< 0.1\mu$ clay. During Holocene soil formation and average of 21 kg/m^2 of illite, 16 kg of vermiculite, and 11 kg/m^2 of kaolinite were calculated to have been formed in the $< 2\mu$ clay and 68 kg/m^2 of smectite to have been lost from it. The greatest changes in clay mineral composition appear in the $< 0.1\mu$ fraction and indicate a transformation of smectite into illite.

2.2. Evidences of clay translocation :

As mentioned in Soil Taxonomy (1975), the subsurface horizon may be finer in texture than the overlying horizons without being an argillic one. The finer texture may be the result of stratification in the parent material, of loss of clay from the upper horizons without significant illuviation, or possibly of differential formation or destruction of clay.

Clays that have moved usually do not differ in mineralogy from the clay of the same size that has not moved. In mixtures that contain montmorillonite it seems that montmorillonite, due to its fines, is more completely removed from the A horizon than the other types of clays. Elemental and mineralogical analyses of the clay fraction of soils that have argillic horizon, normally show little or no difference between the clays of the various horizons. The constancy of SiO_2 to R_2O_3 ratio of the clay fraction and the uniformity in clay mineralogy in the various horizons of each soil attest to the absence of large differences between the clays of the horizons. In contrast to the constancy of SiO_2 to R_2O_3 ratio of the clay fraction, the ratio of the fine earth differs between horizons. These differences are attributable to changes in the percentage of clay. As the clays have a lower SiO_2 to R_2O_3 ratio than the silt and sand, the SiO_2 to R_2O_3 ratio of the fine earth decreases as the proportion of clay increases. The dependence of SiO_2 to R_2O_3 ratio on the percentage of clay in a given pedon lends support to the hypothesis that the differences in the amount of clay in the A and B horizons are largely the result of clay movement. The amount of clay is a function of parent material, climate, relief, vegetation and time. The movement of clay can take place from one horizon to another or within a horizon. Since, water is the agent that moves the clay, the translocated clay tends to form coatings of oriented clay particles on the channels through which or into which water moves or in which water stands.

An argillic horizon may be formed and later destroyed. Clay skins are absent from the ped surfaces, and skeletans, which are bleached coatings of silt or sand, are left. (Brewer, 1964). Oriented clay within the peds persists for a time. It is common in a degrading argillic horizon that the clay skins on ped surfaces or in pores are most abundant in the lower part of the argillic horizon and in the zone of transition to the next underlying horizon. In advanced stages of degradation of an argillic horizon there may be no clay skins in or on the peds in the upper part. A degrading argillic horizon has other indications of degradation in addition to the absence of clay skins. It has an irrigular upper boundry that is marked by narrow or broad penetration of the eluvial horizon. Small, nodular remnants of the argillic horizon commonly are in the lower part of the present eluvial horizon.

Agric horizon :

According to the Soil Taxonomy (1975) the agric horizon is an illuvial horizon formed under cultivation that contains significant amounts of illuvial silt, clay and humus. After a long-continued cultivation changes in the horizon immediately below the plough layer became apparent and cannot be ignored in classifying the soil. The large pores in the plough layer and the absence of vegetation immediately after ploughing permit turbulent flow of muddy water to the base of the plough layer. Here the water can enter wormholes or fine cracks between peds, and the suspended materials are deposited as the water is withdrawn into capillary pores. The worm and , root channels, or ped surfaces become coated with a dark-coloured mixture of organic matter, silt, and clay. The