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Report for 1948

Full Table of Content

Rothamsted Experimental Station
Harpenden

LAWES AGRICULTURAL TRUST

REPORT
for
1948

Pedology Department

Anon

Anon (1949) *Pedology Department ;* Report For 1948, pp 33 - 35 **- DOI: https://doi.org/10.23637/ERADOC-1-70**

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PEDOLOGY DEPARTMENT

The general programme of work outlined in the 1947 report has been continued. Professor Mannkopff and Mr. Albrecht completed their work in the spectrographic section and during the summer Professor Mannkopff held a very successful course in spectrography which was attended by several workers from other laboratories.

It is with deep regret that we record the death of Dr. J. B. Hale, who was in charge of the spectrographic section.

Dr. E. M. Chenery, formerly at Trinidad, is continuing and extending his study of aluminium accumulator plants.

Weathering of Rocks and Minerals

The examination of the Malvern rocks and soils described in last year's report is continuing. The Malvern Hills region is particularly well suited to the study of the magnesium-iron mica biotite, as rock types very rich in biotite occur in the crystalline complex. The weathering of this mineral can best be studied by taking a compact block of the rock, and dissecting it so as to show the transition from the fresh core specimen to the outer weathering crust. X-ray diagrams of the biotite flakes in the fresh, the slightly weathered and the highly weathered condition have been obtained. Thin sections provide supplementary evidence of the stages of decomposition. As revealed by these two methods the main trend of weathering is primarily towards a chloritic product. A characteristic feature of a residual soil profile derived from highly weathered biotitic rock is the presence in the sand fraction of yellowish-brown micaceous minerals with a golden or bronzy lustre. All stages in the transition from the chloritic weathering product of biotite to this mineral are traceable. Its identity with vermiculite is suggested by both X-ray and optical determinations, as well as by its ready exfoliation by H_2O_2 in the cold.

Particular attention is being given to characterizing by X-ray analysis the clay fractions (<2 microns) separated from the soils. A point of interest is that a trioctahedral mica occurs both as a weathering product and as a component of the clay fractions of soils derived from the more basic members of the rock complex. This is paralleled by G. F. Walker's work in Aberdeenshire (*Clay Min. Bull.*, 1947, No. 1, 5–7).

Clay Mineral Studies

Adsorption complexes of α-zinc hydroxide. A series of complexes of α-zinc hydroxide with anionic dyestuffs (especially Naphthol Yellow) has been discovered, having partially ordered layer lattices with characteristic basal spacings. The degree of order in the random packing of layers in the complexes is a direct function of the concentration of the dyestuff present during the precipitation of the α-zinc hydroxide. There is a critical dye concentration at which the layer lattice changes from the non-expanding to the expanding type.

The primary complex of the "expanding" type forms secondary complexes with water, the hydroxy compounds (primary alcohols, glycols, glycerol and aqueous solutions of the saccharides) and the nitriles of the aliphatic series showing a corresponding increase in

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the basal spacing. This behaviour is similar to that of kaolinite and montmorillonite but only qualitatively. In addition, no complexes could be obtained with organic liquids of high dipole moment (e.g. nitromethane, nitrobenzene) which are so strongly taken up by the clay minerals.

Location of adsorbed ions and molecules of montmorillonite. The investigation of the montmorillonite/nitrile complexes has been completed. The results show that the amount of water present in the clay has an appreciable effect on complex formation by these liquids.

A detailed Fourier investigation of the (000) reflections of montmorillonite and hectorite, saturated with various exchangeable cations, has been undertaken to elucidate the structure of these minerals and especially to find the positions occupied by these ions in the lattice. A Kipp recording microphotometer has been set up and adjusted for use in this work.

In addition to these special investigations a number of clays from soils and clay deposits have been examined. A sample of brick-making clay from the Keuper Marl, near Birmingham (supplied by the Building Research Station) has been examined in detail. It contains what is believed to be a new type of clay mineral, a hydrated chlorite. Further work is being done on related materials.

A series of English soil clays (nine complete profiles) of interest in connection with the Summer Excursion of the Commonwealth Conference on Tropical Agriculture has been examined.

Spectrographic Work

The glass spectrograph designed by Professor Mannkopff was completed and is now in operation. The other instruments have also been set up and some preliminary work is being carried out with both the glass and large quartz spectrographs, but not as much has been done so far as had been hoped, owing to the sad loss of Dr. Hale. The dispersion curves of both instruments have now been obtained and standard photographs have been made indicating the positions of the principal lines of most of the elements. Some work has also been done on the relative characteristics of different types of photographic plates.

The medium quartz spectrograph is now in routine operation using the Lundegårdh flame method.

Gleying in Soils

The study of the gleying process has been continued mainly as a laboratory problem. It is hoped that by the summer this side of the investigation will be sufficiently far advanced to permit a profitable extension to cover field conditions.

A soil may be gleyed artificially in the laboratory by anaerobic incubation in a sugar medium, the process being usually completed in about two weeks. The fermentation produces a marked change in the appearance of the clay, and starting with clays of different colours the final colour is a light slate-blue. The colour change begins at isolated places throughout the body of the clay, and gradually extends until finally the whole mass is a uniform blue colour. In addition to the colour change, considerable solution of iron occurs, the clay is flocculated and is impregnated with a gummy material which may be responsible for the blue colour

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since treatment with hydrogen peroxide quickly destroys the organic material and leaves an almost white clay. At the end of such a fermentation the supernatant solution contains much ferrous iron in the form of the lactate, propionate, etc. The solution oxidizes rapidly on exposure to air, and unless the pH has fallen to a very low value this is accompanied by hydrolysis and the precipitation of bulky yellowish-red basic ferric compounds.

It has been found by experiment that it is possible to remove iron from clay by incubation under less anaerobic conditions. In such cases the solution is dark red-brown in colour, contains no ferrous iron, and does not give a precipitate on prolonged exposure to air. This degree of stability may be due either to complex formation, or to the development of too low a pH to permit hydrolysis.

(If reducible sulphur compounds are present, hydrogen sulphide is almost invariably formed and the clay is blackened by a precipitate of ferrous sulphide.)

The bleaching of the surfaces of structural elements in heavy textured subsoils is also a reduction effect. The associated rusty mottling is due to the hydrolysis of the iron-organic complexes and precipitation of a hydrous oxide. In addition soluble iron compounds which diffuse to the surface of the bleached layer would tend to be removed from the system by fresh water percolating down the profile. Thus it seems that the overall tendency of the process is the complete removal of the iron, and this suggests a strong affinity with the process of podzolization.

From a consideration of the products of bacterial fermentation of sugars it is obvious that the formation of complexes with ferric, and possibly ferrous, iron is highly probable. It is well known that many ferric organic complexes suffer reduction on exposure to light (cf. Schofield's work on the oxalate treatment of clays). Ignatieff has reported an increase in the ferrous iron content of gleyed soils on exposure to light, which tends to confirm that such ferric complexes are found in natural gleys. In addition, the energy required to reduce ferric iron to the ferrous form, in the ionic state, is considerable so that it does not seem feasible that the process can occur as such under natural conditions. It therefore seems possible that the process actually occurs via complex formation with organic compounds. This aspect of the problem is being studied. Preliminary work suggests that the formation of ferrous complexes is not likely to occur extensively. The hydrolysis of inorganic ferric salts is so pronounced that considerable difficulty is experienced in investigating the ferric complexes conductimetrically, since attempts to increase the pH of the solution, to values at which complex formation is possible, by the addition of a base result in such a large increase in the conductance that the relatively small changes in conductance being sought are completely masked. A potentiometric method is therefore being used.

Investigations on the Bio-geochemistry of Aluminium

A survey of the occurrence of aluminium in the plant world has been completed. In this over 2,000 strongly accumulating species were brought to light. The significance of these plants in tropical ecology is being studied.

https://doi.org/10.23637/ERADOC-1-70