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Papers.

THE INFLUENCE OF ELECTROLYTES ON THE ABSORPTION OF HYDROGEN IONS.

by B. Aarnio.

In a former article (1) a description is given of some experiments made to ascertain how electrolytes affected the absorption of ions of ammonium (*antagonistic* action of ions). These experiments showed that electrolytes very considerably reduce the absorption of ammonium ions, the strong acids the most (50-60 %), the neutral and acid reacting salts less, and least of all the alkali reacting salts, which in some cases increase the absorption (Table 1). The latter probably depends on the fact that the alkali reacting electrolytic solutions increase the dispersion of the basic particles.

The H ions have therefore very great supplanting properties, which correspond to the extremely weak hydration of H ions. As it was expected that the electrolytes would only have a feeble influence on the absorption of H ions, the following experiments were made :—

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(1) B. Aarnio. Die Adsorption des Ammonium-ions aus Lösungen verschiedener Ammoniumsalze und die Einwirkung von Elektrolyten auf dieselbe. *Zeitschrift für Pflanzenernährung und Düngung*, Part A., Year 1, No. 5, 1922.

TABLE I. — *Absorption of NH_4 ions from a 0.1 N. solution, by clay soil.*

100 gm. soil absorb:					
from 0.1 N. $(NH_4)_2SO_4$ – solution			from 0.1 N. $(NH_4)_2HPO_4$ – solution		
without addition	absorbs 0.4154 gm. NH_4	without addition	without addition	absorbs 0.6465 gm. NH.	without addition
+ HCl 0.1 N.	0.1824 »	— 56.09 %	+ HCl 0.1 N.	0.2546 »	— 60.62 %
+ HNO_3 »	0.1896 »	— 54.36 »	+ HNO_3 »	0.2546 »	— 60.62 »
+ H_2SO_4 »	0.2258 »	— 45.64 »	+ H_2SO_4 »	0.2799 »	— 56.71 »
+ $Al_2(SO_4)_3$ »	0.2456 »	— 40.87 »	+ $Al_2(SO_4)_3$ »	0.3856 »	— 40.39 »
+ Mg SO_4 »	0.3449 »	— 16.97 »	+ $CaCl_2$ »	0.4623 »	— 28.49 »
+ $CaCl_2$ »	0.3598 »	— 13.57 »	+ $NaNo_3$ »	0.5129 »	— 20.66 »
+ $NaNo_3$ »	0.4038 »	— 12.57 »	—	—	—
+ Na_2CO_3 »	0.4812 »	— 15.84 »	+ Na_2CO_3 »	0.6014 »	— 6.98 »

Experiment I. — 10 gm. of heavy, neutral, glacial clay were treated with 100 gm. 0.01 N. HCl or H_2SO_4 respectively, and the concentration of hydrogen was determined electrometrically (according to L. MICHAELIS). In solutions of 0.01 N. HCl — and H_2SO_4 — employed, the P_H was 2.12 or 2.16. Then so many electrolytes were added (NaCl, K_2SO_4, $CaCl_2$) that the solution with respect to electrolytes was also 0.01 N.; 10 gm. of clay were treated with this solution, and the P_H determined.

TABLE II. — *Absorption of H ions from 0.01 N. HCl and from H_2SO_4 solution, by glacial clay from S. W. Finland.*

	P_H		P_H
0.01 N. HCl (without addition)	4.04	0.01 N. H_2SO_4 (without addition)	4.00
» » + 0.01 N NaCl	4.04	» » + 0.01 N NaCl	3.96
» » + » » K_2SO_4	4.09	» » + » » K_2SO_4	4.05
» » + » » $CaCl_2$	3.89	» » + » » $CaCl_2$	3.85
» » + » » $MgCl_2$	3.81	» » + » » $MgCl_2$	4.00
Originally 0.01 N. HCl	2.12	Originally 0.01 N. H_2SO_4	2.16

Absorption of OH ions from 0.01 $Ca(OH)_2$ solution, by neutral glacial clay from S. W. Finland.

	P_H
0,01 N. $Ca(CH)_2$ (without addition)	9.03
» » + 0,01 n KCl	9.03
» » + » K_2SO_4	9.35
» » + » $CaCl_2$	8.84
Originally 0,01 N. Ca $(OH)_2$	11.34

Table 2 shows that the clay absorbs H ions very freely from solution 0.01 N., so that the concentration of the solution falls to about 0.0001 N. The elctrolytes used have hardly any antagonistic influence on the absorption of H ions. The H ions behave, therefore, very differently from the NH_4 ions with regard to absorption; this might have been foreseen in the experiments with NH_4 ion absorption (Table I). From these experiments it appears that H ions are absorbed the most, and therefore supplant the other absorbed ions.

Experiment II. — 5 gm. of soil (neutral clay, sphagnum peat and acid clay) were treated with 50 cc. or 0.1, 0.001, 0.001, 0.0001, and 0.00001 normal HCl and NaOH, and the concentration of H ions determined.

TABLE III. — *Neutral clay from S. W. Finland (5 gm. soil + 50 cm. solution)*

	P_H		P_H
H_2O	7.19	H_2O	7.19
0.00001 N. HCl	7.15	0,00001 N. NaOH	7.19
0,0001 N. »	7.03	0,0001 N. »	7.15
0,001 N. »	6.64	0.001 N. »	7.34
0,01 N. »	4.48	0,01 N. »	10.04
0,1 N. »	1.59	0,1 N. »	12.18

TABLE IV. — *Sphagnum peat from S. W. Finland (5 gm. soil + 50 cc. solution).*

	P_H		P_H
H_2O	4.73	H_2O	4.73
0.00001 N. HCl	4.62	0,00001 N. NaOH	4.73
0.0001 N. »	4.69	0.0001 N. »	4.78
0,001 N. »	4.58	0,001 N' »	4.97
0.01 N. »	3.60	0.01 N. »	5.36
0.1 N. »	1.69	0.1 N. »	7.59

TABLE V. — *Acid clay from S. W. Finland*
(*5 gm. soil + 50 cc. solution*).

	P_H		P_H
H_2O	3.79	H_2O	3.79
0,00001 N. HCl	3.87	0,00001 N. NaOH	3.91
0,0001 N. »	3.75	0,0001 N. »	3.84
0,001 N. »	3.66	0,001 N. »	3.84
0,01 N. »	3.04	0,01 N. »	5.20
0,1 N. »	1.63	0,1 N. »	12.09

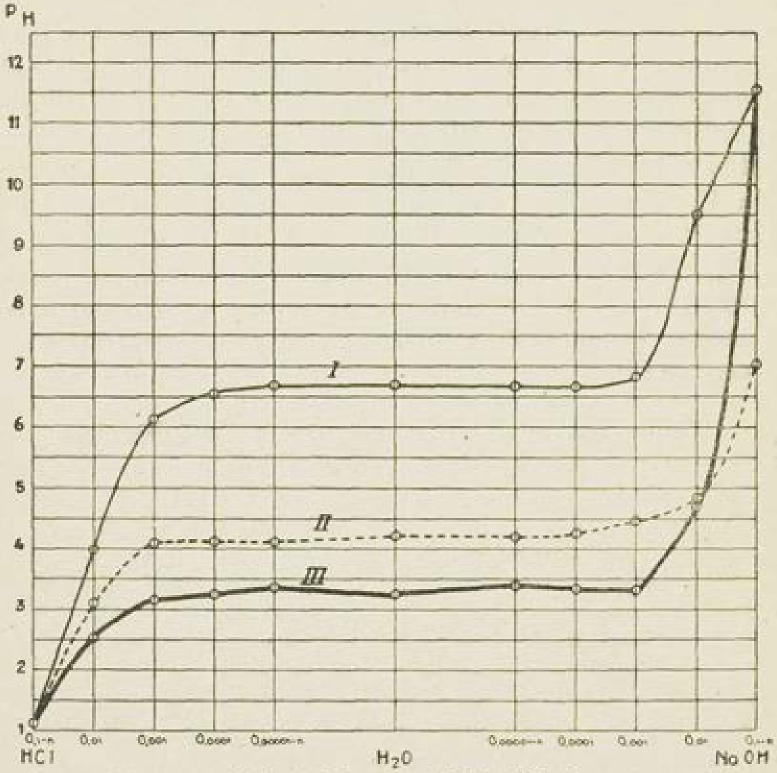

FIG. 1. — I. Neutral clay from S. W. Finland.
II. Sphagnum peat from S. Finland.
III. Acid clay (Litorina) from S. W. Finland.

As appears from tables 3-5 and figure 6, the P_H remains almost constant on both sides of the water solution, independently of whether the clay is acid or neutral, until the concentration of the added acids or alkalis becomes 0.001 N. A 0.01 N. acid or alkaline has a strong effect on the clay; on the sphagnum peat the acid has a considerable effect, but the alkali very little. A 0.1 N. acid solution reduced the P_H in all soils alike (P_H about 1.6). 0.1 N. alkaline also has an equally strong effect on the clay, so that the P_H becomes about 12. Sphagnum peat behaves quite otherwise, for with 0.1 N. alkali, the P_H only rises to 7.59. It may be assumed that the relatively strong alkali disintegrates the organic matter.

Experiment III. — The sphagnum peat was treated respectively with 0.1, 0.01, 0.001 and 0.0001 N. HCl and NaOH as before, with the addition of 0.01 N. KCl and $CaCl_2$ (the solution was therefore in relation to KCl and CaCl, 0.01 N.); the P_H was measured electrometrically. The results are shown in figure 7.

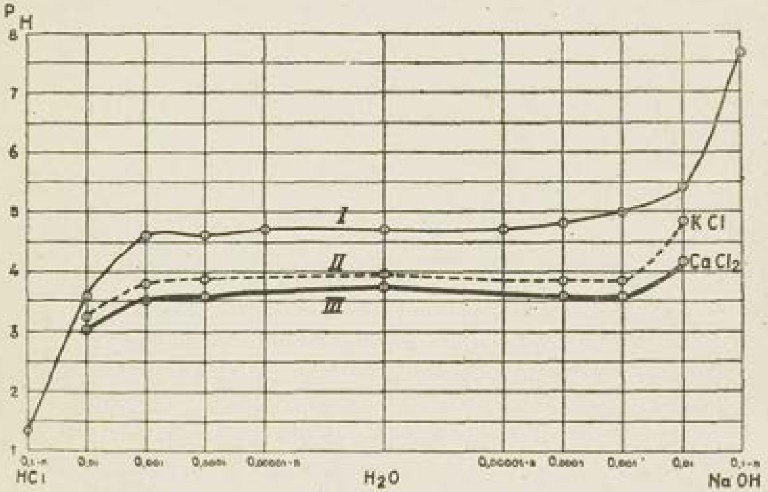

FIG. 2. — Sphagnum peat from S. Finland.

If curve I (without addition) be compared with curve II (HCl and NaOH + KCl) and curve III (HCl + $CaCl_2$ and NaOH + $CaCl_2$) it is seen that the electrolytes (0.01 N. KCl and $CaCl_2$) are almost entirely without influence on the H ions, because the pure KCl — and $CaCl_2$ — solutions exert an influence on the P_H equal to that of the 0.001, 0.001 N. HCl — and NaOH — solution with 0.01 N. KCl or $CaCl_2$.

Experiment IV. — Acid Litorina clay, paimio and silkkila were treated as in experiment III. From the results it appears that the 0.01 N. KCl and $CaCl_2$ solution had no influence on the absorption of H ions.

Experiment V. — Neutral glacial clay and loam were treated as in experiments III and IV.

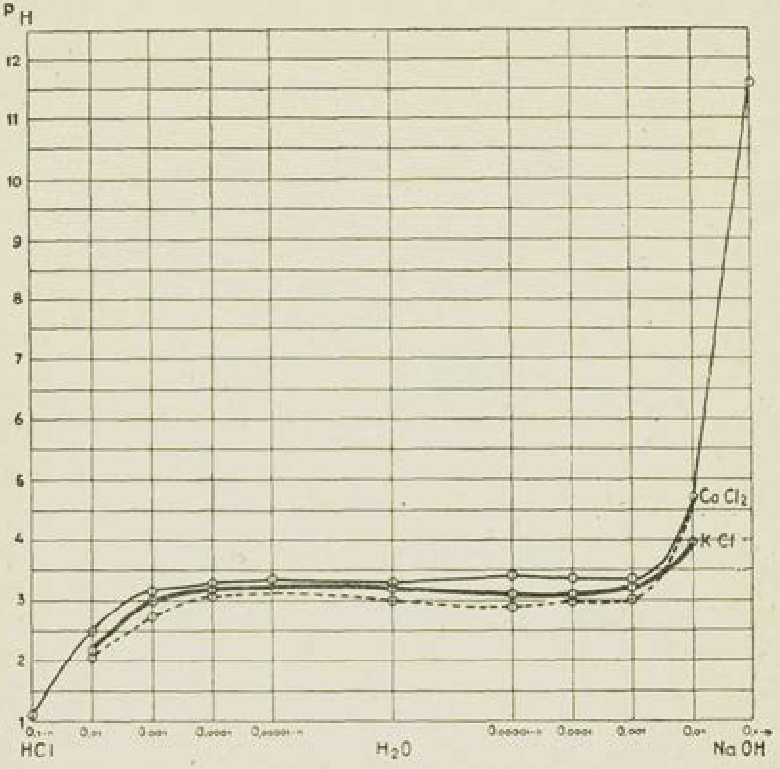

FIG. 3. — Acid clay (Litorina clay) from S. W. Finland.

With regard to these experiments, the conditions are the same as in experiments III and IV. The influence of pure 0.01 N. KCl and $CaCl_2$ solution on P_H is about the same; the rather weaker action of $CaCl_2$ solution is probably to be explained by the greater content of Ca ions of the neutral clays.

From the experiments it is shown that the electrolytes (0.01 N. KCl and $CaCl_2$) cannot expel the H ions from the clay. The phenomenon observed that the KCl solution gives rise to an increase of acidity in the soil solution (as compared with pure water solutions) cannot be caused by the K ions being interchanged with H ions, but that the K ions are interchanged with Al ions, and consequently the resulting aluminium compounds are hydrolysed.

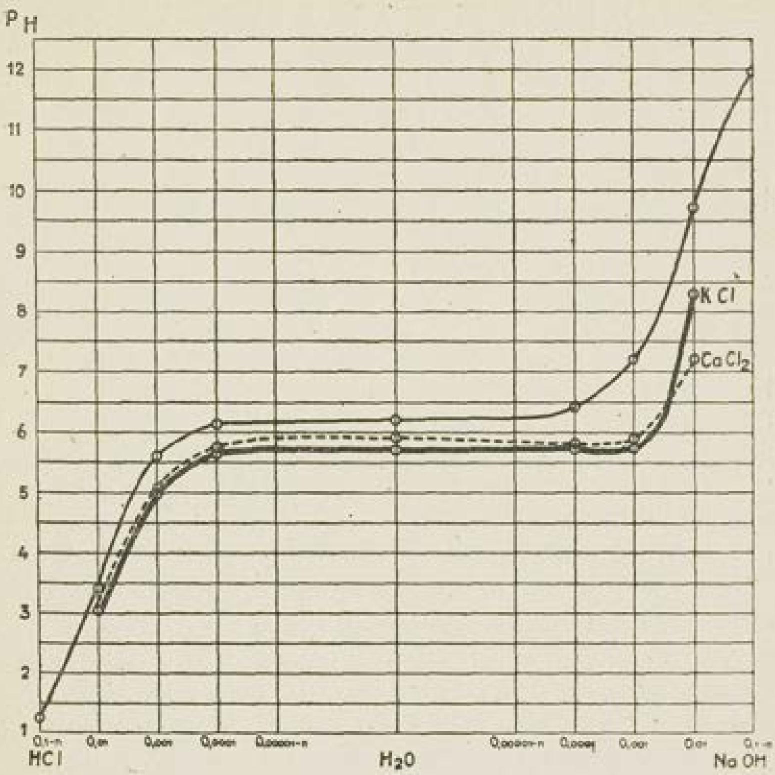

FIG. 4. — Neutral clay from S. W. Finland.

It is also clear that if the ions absorbed in a soil are to be determined, an acid must be used, because the H ions very strongly displace other ions (1).

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(1) Compare G. WIEGNER : Dispersität und Basenaustausch. *Zsigmondy Festschrift, Jubelband der Kolloid-Zeitschrift*, p. 341, 1925.

METHODS OF PRACTICAL APPLICATION OF RESEARCH ON SOIL PHYSICS (1)

by A. NOSTITZ,
Technical High School, Munich.

Soil, in conjunction with climate, forms the basis of all agriculture. For example, the choice of plants to be cultivated, rotation of crops, preparation of the ground, etc. will vary according as there is a light sandy soil, or a heavy clay soil. Consequently the soil, in the end, becomes the deciding factor in farm management and in financial success.

According to the proportion of the mixture of stones, sand, silt and clay, soils change from light soils rich in sand to heavy and very heavy clay soils. Different methods of examination, as for example those of KOPECKY, and KRAUSS, also the simpler ones of KUEHN, etc., make it possible to determine numerically the constituent parts of a soil. But to appreciate the important bearing which the values obtained have with regard to the dimensions of the particles, demands great experience and special knowledge, such as cannot yet be expected everywhere from the practical farmer. It is therefore desirable to find suitable methods, which would enable the farmer not acquainted with soil science to understand the results of the physical examination of the soil, and draw from them the conclusions bearing on his husbandry.

The author believes now, with Th. L. HENKEL, to have found a method which, taking as a basis the OSANN·triangle modified by KOEHNE, facilitates bringing the results of physical examinations of soil into close connection with agricultural practice.

In the angles of the triangle (Fig. 10) lie the three extreme types of soil. As the soils, as a result of their composition, approach more nearly to the middle of the triangle, denoted by the circle, they become more and more like each other, and form the group of medium soils included in the large square. But of course even the medium soils are not all of the same value, and hence the recognition of the differences is an absolute necessity in practice. Therefore the medium soils in the large square are divided by the vertical dividing line into two

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(1) See *Landw. Jahrbuch für Bayern VII-VIII*, p. 328, 1925.

groups, of which the left contains the lighter, and the right the heavier types of soil. The inserted arrow line points out in what manner the transmission from the lighter to the heavier soils is gradually accomplished. The upper part represents the most similar soils, whilst both ends of the arrow line approach the extremes, of sand and clay.

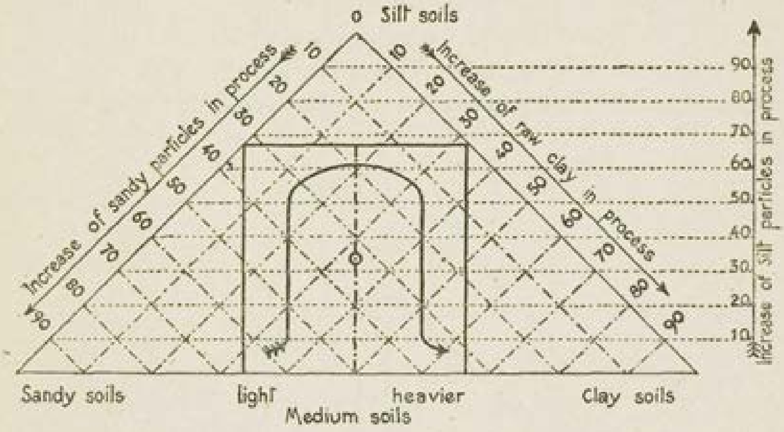

FIG. 5. — Diagram showing the results of the physical examination of a soil in practical agriculture.

This division of the soils into individual groups makes it possible to draw conclusions as to properties and applicability, if it is realised that specific properties are associated with sand, silt and raw clay. Figure 11. shows these, as also their effect on the transitional forms of the three types of soil.

Here again the best conditions lie on the centre line, which becomes the resultant of the play of forces of the different properties of soil.

Let it now be assumed that the soil consists of 60 % sand, 20 % silt, and 20 % clay. Figure 10. shows that this soil lies in the left lower point of the triangle, but still is no longer very far removed from the square of the medium soils. It still belongs, therefore, to the group of sandy soils, but comes very near to the medium soils. The extreme properties of the sand are still predominant, but are already modified. Its affinity to the sandy soils implies that it is fairly easy to till, that it will become warmed comparatively quickly in the spring, but as is shown by its nearness to the medium soils, it is perceptibly influenced by the action of the clay and silt. The soil will therefore be able to exert some power of absorption on fertiliser salts, the permeability of water is no longer of such great account, etc. In the choice of crops to be cultivated it is still necessary to take into consideration those for light types of soil, but these will, with suitable cultivation, give good yields. It may already have been attempted, by careful preparation of the ground according to the conditions of the subsoil, to bring more important plants into cultivation, but with the heavy medium soils no very great success can be expected. This, after all, poor soil will not allow of expensive working equipment and intensive cultivation.

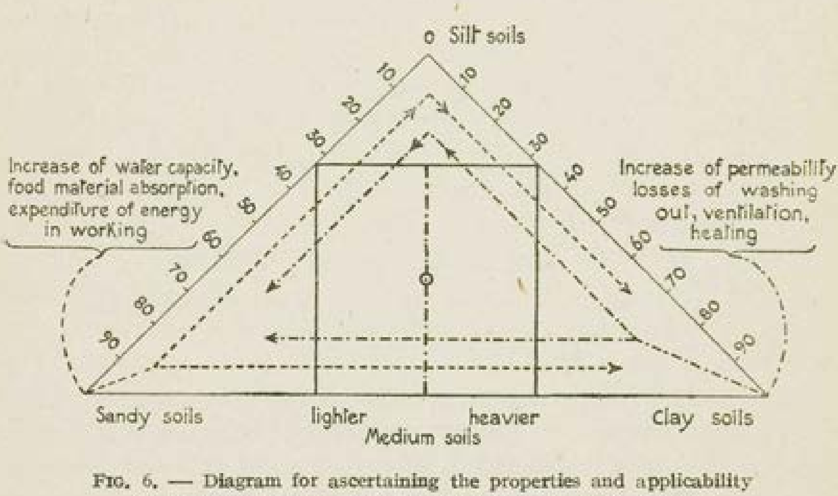

FIG. 6. — Diagram for ascertaining the properties and applicability of soils on the basis of a physical examination of the soil.

On the other hand, a soil which contains, for example, 30 % sand, 20 % silt and 50 % clay, lies in the lower part of the region of heavy medium soils. This soil, as the result of its proximity to clay, perhaps already possesses too much water-holding power, and in springtime will be rather later in getting warmed, on the other hand it has an exceptional capacity for absorption of plant food material, is considerably more easy to till than the true clay soils, etc. By proper cultivation it can also be made to give good crops, even with the more important plants. It can therefore be valued considerably higher than the soil of the first example.

A soil uniform in section has until now been taken as a basis. Many soils, however, show various layers to a depth of 1 m., particularly when they are considered for agricultural purposes. Thus a *sandy soil* may remain uniform to the depth mentioned, or may, below 50 cm., have a sub-layer of clay. In the first case the disadvantages, such as permeability, washing out of food material, etc., are more prominent than in the second. By *evenness* of the upper and lower soils, therefore, the extreme qualities are strengthened. In the second case, on the contrary, by the *opposite* conditions of the upper and lower soils, the extreme properties are mitigated. If a uniform *clay profile* continues unaltered, then the impermeability to water of the upper layer will also continue in the subsoil, whereas an under layer of sand carries off the deposit more easily. Here also, therefore, uniformity of profile strengthens the properties, whilst dissimilarity weakens them. *Silt soils* come between sand and clay, and therefore possess compensating physical and chemical properties ; consequently a uniform profile is *most valuable* here, for it will be understood that a substratum of one of the two other kinds of soil affects the silt soil less favourably. The medium soils comprised in the square are expressed by dashes — likewise more or less even. The underlaying of a medium soil by another can therefore exert no important influence, at all events it is much less than in the case of the above examples with regard to sand and clay. If one of the lighter medium soils, on the contrary, has a substratum of one of the soils found to the left of the middle dashes, then it will be of less value, the further away the subsoil lies from the middle line towards the left angle. The same applies similarly for the right half of the square of medium soils.

In Fig. 12. it is sought to make clear the far-reaching (therefore area-dimensional) conditions described here.

If the upper and lower soils fall on the left, sandy, or the right, clayey angle, then the conditions are extreme ; if they lie together at the point or in the middle square, then they are more or less even. To the extent in which the upper or lower soils are removed from the centre line or the angles, the whole of the properties of the soils alter, now towards the bad, now towards the good side, as expressed by the arrows.

The examples given with reference to figure 10. can now be completed. If in the first example the soil lies in the sand angles, then the less favourable natural tendencies of the upper soil, inclining towards dryness, washing away of plant food material, etc., will be still further strengthened ; the soil will be reduced in value. If,

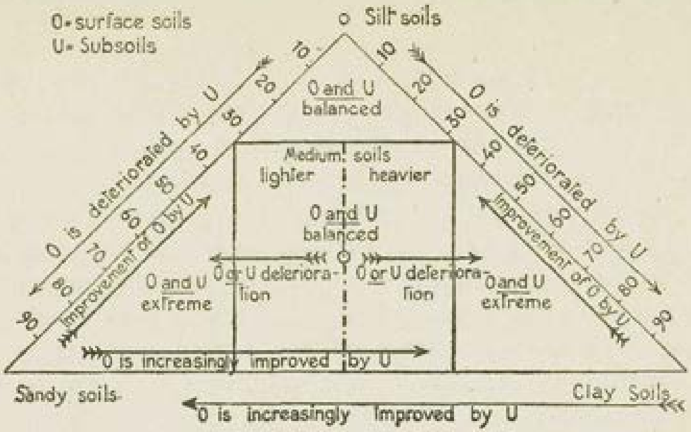

FIG. 7. — Diagram to explain the results of the physical examination of a soil for practical agriculture, in the case of soils with different layers.

however, the subsoil lies for example, in the right half of the square of medium soils, then it may be of considerably higher value.

Until now one constituent part of the soil has not been considered, namely, the stone content. In valuing this, the sizes of the stones must be taken into account. Thus, for example, the influence of a stone about the size of the fist cannot be compared with the same weight of stones of only the size of peas scattered through the soil. With a rising stone content, the soil, generally speaking, should be moved from the position in the triangle which its other physical analyses would give it, towards the left, lighter side.

Like all attempts to estimate the value of a soil according to a scheme, the foregoing has certain defects; still, the system here proposed may help even the practical farmer to inform himself quickly, on the basis of a simple examination, concerning any soil, and to recognise quickly its possibilities of usefulness.

THE INFLUENCE OF ELECTROLYTES ON DIFFERENT TYPES OF SUSPENSIONS OF CLAY.

by F. Wityn.

The literature on the influence of electrolytes on suspensions of clay is relatively extensive. An exhaustive survey of the literature is given by Prof. K. Gedroiz (1) in his treatise which appeared in 1915, in which the literature is divided into ancient and modern. In the first group Gedroiz included the works which were published up to the year 1893, that is, those periods in which the colloidal substances of the soil were only slightly known. Here appear the works of Fr. Schulze (2), Scheerer (3), Ch. Schloesing (4), A. Mayer (5), E. Hilgard (6) and G. Bodlaender (7). In these works important data were already collected, which gave a general idea of the influence of electrolytes on suspensions of clay, and also enabled certain of the suspensions to be more closely characterised.

Of the modern investigations Gedroiz cited : the works of Rohland (8), Maschhaupt (9) and Wiegner (10), Rohland considers the hydroxyl-ion as the most important factor in causing coagulation, which is contrary to the theory of Freundlich (11), and which the last two named authors point out in their works. Prof. Gedroiz is also of ths same opinion, which is based on his numerous tests. As the above-mentioned work by Gedroiz may be considered as a continuation and amplification of the earlier investigations, it will be more closely considered, and also the method of the work.

I. Important conclusions drawn from the investigations of Gedroiz.

For the investigations, suspensions of red clay were used, which in the course of three days had not been deposited from water 7.5 cm. in depth. One litre of water contained 0.22 gm. of the clay particles. The tests were carried out in Nessler's cylinders, and for these were used 50 cc. of the suspension, and 50 cc. of the corresponding electrolytic solution, of which the influence on the clay suspension was to be investigated. The duration of the test was 48 hours, but already after 24 hours important results were obtained. In the tests the highest concentrations were observed which produced no coagulation — these are termed by GEDROIZ, rising values — and the lowest concentrations were noted at which complete coagulation took place, *i. e.*, the particles of clay had all coagulated and had been deposited.

The results obtained by GEDROIZ are given in Table I, where the concentrations are expressed in relation to normal solutions.

TABLE I.

	Concentrations with which no coagulation is produced (rising values)	Concentration with which further complete coagulation is produced.
Chloride of mercury $HgCl_2$	0.5 – 0.00025 Normal	— Normal
Acetic acid	0.25 – 0.125 »	0.5 – 0.25 »
Citric acid	0.05 – 0.0125 »	0.125 – 0.05 »
Sodium hydrate	about 0.0225 »	about 0.05 »
Oxalic acid	under 0.025 »	under 0.5 »
Litium chloride	0.025 – 0.0125 »	0.125 – 0.050 »
Ammonium chloride	0.025 – 0.0125 »	0.125 – 0.050 »
Chloride of sodium	0.015 – 0.0125 »	0.125 – 0.050 »
Cloride of potassium	0.025 – 0.0125 »	0.125 – 0.050 »
Rhubidium chloride	0.0125 – 0.005 »	0.050 – 0.025 »
Formic acid	0.0125 – 0.005 »	0.1 – 0.050 »
Nitrate of silver	0.005 – 0.0025 »	0.025 – 0.0125 »
Orthophosphoric acid	0.005 – 0.0025 »	0.025 – 0.005 »
Nitric acid	0.0015 – 0.0005 »	0.005 – 0.0025 »
Sulphuric acid	0.0015 – 0.0005 »	0.005 – 0.0025 »
Magnesium chloride	0.00125 – 0.0005 »	0.005 – 0.0025 »
Chloride of manganese	0.00125 – 0.0005 »	0.005 – 0.0025 »
Calcium chloride	0.00125 – 0.0005 »	0.005 – 0.0025 »
Strontium chloride	0.00125 – 0.0005 »	0.005 – 0.0025 »
Chloride of nickel	0.00125 – 0.0005 »	0.005 – 0.0025 »
Chloride of cobalt	0.00125 – 0.0005 »	0.005 – 0.0025 »
Chloride of cadmium	0.00125 – 0.0005 »	0.005 – 0.0025 »
Chloride of barium	0.00125 – 0.0005 »	0.005 – 0.0025 »
Hydrochloric acid	0.001 – 0.0005 »	0.005 – 0.0025 »
Hydroxide of calcium	0.001 – 0.0005 »	0.004 – 0.0020 »
Protochloride of copper $CuCl_2$ . . .	0.0005 – 0.00025 »	0.0025 – 0.00125 »
Perchloride of iron, $FeCl_2$	about 0.000125 »	0.0005 – 0.00025 »
Chloride of aluminium, $AlCl_2$	» 0.000125 »	about 0.00025 »

The table shows that the organic acids in general possess very weak coagulative capacity ; the phosphoric acids, among the mineral acids, also possess only a weak coagulative capacity, whereas the so-called strong acids, *i. e.*, the strong dissociated mineral acids, such as sulphuric acid, nitric acid and hydrochloric acid possess a strong coagulative capacity.

Of the hydrates only the sodium and calcium hydroxides were examined. The coagulation capacity of the former is very weak (complete deposition can only be attained by a concentration of 0.5 N) whilst the latter possesses an exceptionally strong coagulative capacity; even concentrations of 0.004 bring about complete coagulation of the clay suspension.

If we leave on one side the chloride of mercury, then the coagulative capacities of the acids stand in close association with the atomicity of the cations. The acids of the non-atomic cations produce coagulation only with relatively high concentrations; the acids of the di-atomic cations are effective in more dilute concentrations; but the coagulative capacity is especially strong with the tri-atomic cations — iron (12) and aluminium salts.

In addition to the investigations mentioned, Prof. GEDROIZ has examined the influence of sulphuric acid on the coagulative capacity of salts. It has been found that very weak concentrations of sulphuric acid, which of themselves can cause no coagulation of the clay suspensions, strengthen the coagulative capacity of the salts in a high degree. Such concentrations of chloride of sodium and chloride of potassium were investigated, which of themselves cause no coagulation of the clay suspensions. Thus, for example, a solution of chloride of sodium of the concentration of 0.0125 N. gave no coagulation of the clay suspensions in 48 hours, but if to the same solution sulphuric acid in the concentration of 0.001-0.000075 N. were added, then the clay suspension after 20 minutes was already flocculated and deposited. No coagulation was caused by weaker concentrations of sulphuric acid. The same result was obtained with chloride of potassium solution, with which also the concentration of chloride of potassium (0.0005 N.) by itself alone could cause no flocculation in 48 hours.

The influence of sodium hydrate on the flocculation of clay suspensions, with the presence of neutral salts in the solution at the same time, is much more complicated. With low concentrations of sodium hydrate (0.005 N.) the coagulation which was caused by higher concentration of chloride of sodium (0.15 N.) was strengthened; the same concentration of sodium hydrate, however, with weaker concentrations of chloride of sodium, of 0.1 N. onwards, caused a noticeable retardation of coagulation. The solution of chloride of sodium of the concentration 0.015 N. caused by itself relatively great coagulation and a deposit in 48 hours. If, however, sodium hydrate were present in the solution at the same time, then the coagulation with concentrations of sodium hydrate of 0.05-0.0125 N. could still be observed, whilst weaker concentrations of sodium hydrate (0.005-0.00025 N.) much retarded the coagulation, and only with concentrations of NaOH of 0.000025 N. was no retardation to be observed.

The soda solution exercised a still greater retarding action on the coagulation of the clay suspensions by the chloride of sodium. A concentration of 0.015 N. still caused comparatively strong coagulation, but if to this chloride of sodium solution was added soda in the concentration of 0.0125-0.00005 N., then no coagulation could be noticed.

The influence of the sodium hydrate on the flocculation brought about by chloride of potassium was the same, in the experiments of GEDROIZ, as he had shown with chloride of sodium solutions.

The influence of the sodium hydrate on the flocculating capacity of the chloride of potassium was different. The chloride of potassium solutions in the concentration of 0.001 N. in 48 hours already caused considerable coagulation; by the addition of sodium hydrate in the concentrations 0.001-0.00025 N. the coagulation was strengthened. Coagulation was retarded by the addition of sodium hydrate in weaker concentrations (0.000125-0.0000125 N.), but the retarding action was no longer noticed with a concentration of 0.000005 N. By the addition of sodium hydrate to a chloride of potassium solution, therefore, with weak concentrations of the sodium hydrate, the coagulation is still further strengthened, and only concentrations of sodium hydrate of 0.000125 N. retard coagulation, or exert no further influence.

In the further experiments of GEDROIZ on the influence of sodium hydrate on the coagulation of clay suspension by $Ca(OH)_2$ no retarding action was observed. GEDROIZ draws from his experiments the conclusion that coagulation is caused principally by the cation, the anion operates in an opposite direction, with which the operation of the OH' ions is especially strong. The latter is especially active in solution with mon-atomic cations, whereas the coagulation capacity of the diatomic cations (*e. g.* $Ca\,(OH)_2$) is stronger than the stabilised action of the OH' ions.

GEDROIZ has also investigated the coagulative capacity of NaOH, Na_2CO_3 and $NaHCO_3$, and found that the greatest coagulative capacity of the first becomes the weakest of the last, as is seen from the following data.

	No coagulation betwen	Complete coogulation
$NaOH$	— 0.023 — 0.020 N.	0.100 — 0.050 N.
Na_2CO_3	— 0.05 — 0.025 »	0.125 »
$NaHCO_3$	— 0.125 — 0.05 »	0.125 »

The $NaHCO_3$ is considered by GEDROIZ as diatomic.

The influence of various calcium salts on clay suspensions was almost equally great; quick-lime had the highest coagulative capacity amongst them. The concentrations of the calcium salts, with which no coagulation was brought about (the electrolytic rising-value) were as follows :—

$CaCl_2$	0.00125 — 0.0005 N.
$Ca(NO_3)_2$	under 0.00125 »
$Ca(OH)_2$	0.001 — 0.0005 »
$CaSO_4$	under 0.000125 »
$Ca(HCO_3)_2$	» 0.00125 »

The following experiment of GEDROIZ is of interest, characterising in detail the influence of electrolytes on the coagulated clay particles. After the deposition of the coagulated particles of clay, the clear solution was poured off, and in its place pure distilled water added. If coagulation were produced by chloride of sodium, then the coagulation, by reducing the concentration of the salts, was again broken off.

If the coagulation was produced by hydrochloric acid, chloride of potassium and chloride of barium, then, by reduction of the concentration of the coagulator to such an extent that no further coagulation took place, only a small part of the coagulated particles were again made free.

If, however, the coagulation was produced by $FeCl_3$, then the coagulation could no longer be arrested, even though the liquid over the coagulated deposit were poured off 5 times and replaced with pure distilled water.

It has therefore been shown that the dispersed particles, under the influence of the mon-atomic Na' ions as coagulator, have not lost their capacity for increasing dispersiveness, that is, by reducing the concentration of the coagulator, all the coagulated particles are again dispersed, and coagulation can therefore be made reversible.

If coagulation is brought about by the H ion (hydrochloric acid) or the diatomic cations Ca" and Ba ", then the dispersiveness in the distilled water is indeed increased, but in a much less degree than in the first case. The influence of the triatomic cations is much greater in this respect ; the coagulation can scarcely be made reversible by distilled water.

GEDROIZ further took into consideration the relations between the size of the particles and the concentration of the coagulator. With this he has established that, the finer the particles, the higher must be the concentration of the coagulator in order to bring about coagulation. However, the relations with high concentrations of the electrolytes, which in a very short time produce coagulation, are rather different — the finer particles are flocculated out with lower concentrations than the coarser particles.

Also, the concentration of the clay particles in the solution has a certain significance ; coagulation takes place considerably more quickly with a higher content of dispersed particles. This condition has been observed both with high and low concentrations of electrolytes.

Prof. RAMANN (13) quotes some data on the coagulation of quartz suspensions, which unfortunately are not comparable with the data of GEDROIZ. Quick-lime has also been shown by the experiments of Prof. RAMANN to be a very quick coagulator, having caused coagulation with a concentration of 0.00035 N., that is, with a content of 0.013 gm. to the litre. The influence of quick-lime was 300 times greater than the influence of sodium oxide, and 245 times as great as the influence of carbonate of soda. Prof. RAMANN is also of the opinion that the physical qualities of the soils are in intimate relation with the coagulation phenomena.

Some data relative to the influence of $Ca(OH)_2$ on the finest particles of soil are found in the investigation of Prof. O. LEMMERMANN and L. FRESENIUS (14), in which it is shown that in weaker concentrations $Ca(OH)_2$ can also have a retarding action on the coagulation of suspensions.

The above investigations, including the exhaustive investigations of GEDROIZ, give no explanation why the physical qualities of soils, even with the podsol formation of clay soils, are so quickly altered. According to the investigations of GEDROIZ, podsol clay soils contain extremely small quantities of absorbed cations, apart from the H ion, but the coagulation capacity of the latter is comparatively high. Moreover, it must also be assumed that a certain quantity of H ions are formed in podsol clay soils by washing out reaction, which has in fact been observed from many methods of determining the lime requirements of the soil. Even very small concentrations of H_2SO_4 of 0.000075 N. and over, have assisted coagulation in the investigations of Prof. Gedroiz. From other investigations of Prof. Gedroiz it has been shown that the dispersiveness of the soil is very much raised by replacing Ca'' by H'.

The properties of clay which has been exposed for a long time to the action of water are quite unexplained. It is known from practice that even the physical qualities of marl clay become very bad after the continued action of water, quite apart from loams having no $CaCO_3$, which at the same time contain the absorbed H' ions of clay-loam. Gedroiz points out finally that water saturated with $CaCO_3$, but containing no CO_2, exerted no influence on the coagulation of the clay suspension which was obtained from the clay investigated. Theoretical considerations, however, show that if $CaCO_3$ is contained in the clay particles, with at the same time other electrolytes which assist or retard the dissociation of the $CaCO_3$, this influence must be very great.

It is well known from practice that even from the poor soils of Lettland with acid reaction, very light clay suspensions can be obtained. Such soils usually require larger quantities of manure, and require manuring more often than the neutral soils, which are also associated with the properties of the finest particles of these soils and their relation to electrolytes.

I. EXPERIMENTS WITH CLAY SUSPENSIONS MADE FROM THE LOAMS OF LETTLAND.

The main object of the investigation was:

(1) To ascertain the concentrations of electrolytes which cause coagulation of the suspensions of different kinds of clay, under the influence of Na' and Ca'' salts, sulphuric acid, carbonic acid, and also various mixtures of salts.

(2) To determine in detail the association of the related clay suspensions, especially in regard to the cations absorbed.

Various causes of delay occurred, however, in carrying out the investigation, consequently it could not be carried out so completely as was intended. As in the results obtained the influence of the acid reaction of the soil, and the importance of the calcium carbonate with regard to the phenomena of coagulation, were clearly shown, the investigation will probably be of interest to those who study soil structure.

The experiments were carried out with clay suspensions of the following soils :—

(1) Clay-loam formed under the influence of excessive wet. It contains no calcium carbonate, shows very strong acid reaction, and has very inferior physical qualities.

The three following horizons of a podsol clay soil, formed on heavy rubble-loam :

(2) Upper level *A*, of bright grey colour and strong acid reaction.

(3) Brown loam, level *B*, especially rich in the finest particles. It contains no $CaCO_3$ and has a weak acid reaction with litmus paper.

(4) Marl loam, has a feeble alkaline reaction with litmus paper. Level *C*.

(5) Suspensions of original chalk — a relatively pure $CaCO_3$ suspension.

A detailed account of the testing materials will be given below after the description of the experiments.

The particles of clay used in the experiments were obtained from air-dry soil, dried in the room, without baking, or the application of any reagents. The soil was pulverized, granulated through a 1mm. sieve, and then various fractions of clay obtained by cleaning. First that fraction was recovered which had not been deposited in 24 hours from water 10 cc. in depth. At the same time several beakers were filled, each with 100 gm. soil and 500 cc. water, and decantation was carried out 8-10 times. From the fraction of clay obtained in this manner, particles of clay were isolated, which had not deposited from water 10 cc. in depth in the course of 72 hours. This somewhat complicated process had to be followed on account of the marl loam, as this at first supplied no portion which could be cleared of mud, and the original chalk showed the same condition. After the marl loam and original chalk had been treated longer with water, particles susceptible of being cleared of mud were obtained, which, however, deposited comparatively quickly, that is, in the course of 4-5 days. The examination of the clear liquid over the deposited fractions of clay of this kind of soil showed that in the liquid fairly large quantities of $Ca\ (HCO_3)_2$ had formed, which had also caused coagulation. The experiments lasted several months. Also, the finest products of the marl loam had deposited several times during this period, and each time the clear liquid was poured off, and replaced by distilled water. The following experiment shows how great is the influence of the water, which had already been standing for a long time over the finest products of the marl loam, on the mechanical composition of the fraction of clay (finest products).

From those clay fractions of the marl loam which had not yet deposited in the course of 10 days, the clear liquid was poured off; the residue was freed from mud, and each 25 cc. pipetted three times. This volume of the clay fraction contained 2.21 gm. of dry residue. With this clay fraction, without drying it, the mechanical analysis was carried out. For the analysis there were used (1) distilled water, (2) water which had stood for 10 days over the clay fraction of the marl clay, and (3) water which had stood as long as 60 days over the clay fraction and had become relatively harder.

Mechanical composition.

	Deposits in 6 hours	Deposits in between 6-24 hours	Deposits in 24 hours
I.	21.2 %	40.4 %	38.4 %
II.	53.1 %	46.7 %	0.2 %
III.	96.2 %	3.7 %	0.1 %

It is seen that the alteration of the mechanical composition proceeds proportionately in stages—first the finest products disappear, and afterwards, when the water has become harder, the quantity of those particles which deposited in between 6-24 hours, is quickly reduced. From this test we see that the finest products of the marl clay cannot be obtained by mechanical analysis, even with distilled water, if the deposit of the products requires several days. A part of the finest products becomes no more dispersive by the use of the distilled water, since even in the first experiment 21.2 % of particles were available, which deposited in the course of 6 hours.

An analysis of the water used for experiments II and III, for its content of $Ca(HCO_3)_2$ and $NaHCO_3$ (16), showed:

II.

$Ca(HCO_3)_2$ . .	0.0009 N	0.073 gm. per litre
$NaHCO_3$ . . .	0.0002 »	0.017 » » »

III.

$Ca(HCO_3)_2$ . .	0.0015 »	0.121 » » »
$NaHCO_3$ . . .	0.0003 »	0.025 » » »

It should be remarked that $Ca(HCO_3)_2$ is reckoned as a diatomic, but $NaHCO_3$ as a mon-atomic salt, since the number of the $CO'_3{}'$ ions at the dissociation is very small, we have in the solution mainly the mon-atomic HCO_3' anion. It is shown later that concentrations of this salt, of the amount found, can already exert considerable coagulating influence on the finest products.

The recovery of the finest products of the original chalk was also difficult. Only one out of several samples of original chalk gave such fine products that they did not deposit in the course of about 10 days, but even in this sample the deposit was complete after the expiration of 20 days, and only by the removal of the clear liquid standing over it, and the addition of fresh distilled water, was the suspension obtained again.

An attempt was also made to obtain suspensions of the finest particles from calcium precipitate. Although the mechanical composition in a few samples of chalk showed a relatively high content of the finest products, yet complete deposit in all the samples was very quick, and lasted no longer than one hour from a layer of water 15 cm. deep. A thorough examination showed that a fairly energetic hydrolytic decomposition of $CaCO_3$ takes place, and fairly large quantities of $Ca(OH)_2$ form in the solution. The concentration of $Ca(OH)_2$ was in some cases even 0.0016 N. which must also be taken as the main reason why, from $CACO_3$ precipitate, no suspension of the finest particles could be obtained. In another article I will go more closely into the question of the hydrolytic decomposition of $CaCO_3$, and especially as to the factors which are favourable to the decomposition, and those which retard it, because this phenomenon also may have great influence on the physical qualities of the soil.

The concentration of clay suspensions of the above-mentioned soils was as follows :—

(1)	Loam-clay soil	4.43 gm. per litre
(2)	Podsol clay soil, level A	2.76 » » »
(3)	» » » » B	1.56 » » »
(4)	» » » » C	3.24 » » »
(5)	Original chalk	0.34 » » »

The experiments were carried out in test tubes of Jena glass. For each test 10 or 15 cc. of the suspension were used, and the same, or twice as great a volume added of the solution to be examined; the concentration of the solution is expressed in terms of normal solutions, which occur according to the mixture of the solution with the suspension. I have not considered it important to have the concentration of the suspension equally great in all the experiments, as according to the investigations of GEDROIZ, it is not the concentration of the suspension, but rather the degree of dispersiveness, which has the greatest significance.

The observations were made at short intervals during the first 6 to 8 hours, and afterwards after 24 and 28 hours. The general formation was already quite clear after 24 hours, just as in the experiments of GEDROIZ, but in rare cases alterations were observed after the expiration of 24 hours. In several cases I have thoroughly shaken the tubes after 2 and several days, and repeated the observations, but very rarely found any difference. In all the experiments also, clay suspensions were used without any reagent, diluted with corresponding quantities of distilled water. In the great majority of cases two similar cylinders were used. It should be mentioned that the clay suspension, which had not deposited any particles of soil in 2 hours, after 24 hours, however, gave a small deposit at the bottom of the control cylinder. If the clay suspension is flocculated, however, even though slightly, then the deposit covers the whole of the bottom.

I shall here give only the most important results, that is, only the lowest concentrations, which produce complete flocculation in 24 hours, and the highest concentrations, which cause no flocculation (electrolytic rising value).

(1) *Sulphuric acid.*

Concentrations of 0.0001 N-0.005 N. were examined. The action was strong, the results were quite definite after 6 hours; after 24 hours no alterations were to be observed. The suspended particles of original chalk all passed over into solution with concentrations of sulphuric acid of 0.002 N. and higher. The results can be seen from table III.

Concentration of normal sulphuric acid :

	Complete coagulation	No coagulation
Clay suspension of Loam-clay soil	0,002 N and over	0,0005 N, and under
Podsol clay soil, Horizon A	0.002 » » »	0,0005 » » »
» » » » B	0,001 » » »	0,0003 » » »
» » » » C	0.005 » » »	0,0001 » » »
Original chalk	0.001 » » »	0.0003 » » »

The data quoted show that the clay suspension of the marl loam (horizon C) is especially sensitive to sulphuric acid.

The following tests were also made with the clay suspension of the loam-clay soil and the upper horizon (A) of the potter's clay soil : 10 gm. of the dry soil were mixed directly with 10 cc. of sulphuric acid of different concentrations. The concentration of sulphuric acid with which complete flocculation took place was in this case rather higher — for both soils 0.003 N. ; after 24 hours, however, the action was almost complete even with the concentration of 0.002 N. To the same cylinder, after flocculation, another 20 cc. of distilled water was added, which reduced the concentration of the acid by a third, and now began an increase of dispersiveness of the coagulated particles. In the cylinders with sulphuric acid of the concentration 0.0007 and lower, the quantity of dispersed particles was approximately the same as in the tubes with soil in distilled water. The coagulation and peptisation of the suspension is therefore a reversible process in the soils mentioned. GEDROIZ, in his investigations with hydrochloric acid, could only bring about incomplete peptisation.

(2) *Experiments with carbonic acid gas* (CO_2).

Distilled water containing 0.98 gm. CO_2 to the litre was used. If to 15 cc. of the clay suspension 15 cc. of the water containing carbonic acid were added, then the concentration of carbonic acid was 0.44 gm. to the litre, or say 0.01 N, if we assume that the CO_2 in the more dilute solution is dissociated from H'-HCO_3'. The clay suspension of the loam-clay soil and of the upper horizon (A) of the podsol clay soil gave no deposit with the 0.01 N. solution of carbonic acid ; the clay suspension of horizon B, with the same solution, gave a weak deposit, but with the concentration of 0.005 N. no deposit. The other two samples of clay suspension showed the following results :—

	Complete flocculation	No flocculation
Suspension of horizon C. of the podsol clay soil	0.001 N. and over	0.001 N. and under
Suspension of original chalk	0.002 N. » »	0.0003 N. » »

The suspension of the finest particles of original chalk went completely into solution in this case also with concentrations which were greater than 0.0003 N. It is very characteristic that the clay suspension of the marl clay is much more sensitive to carbonic acid than the suspension of the pure original chalk. This phenomenon must be connected with the suspension — the concentration of the suspension of the marl clay was much greater.

To the cylinders with the clay suspensions of the loam-clay soil and horizons A and B of the podsol clay soil were added, after 24 hours, 0.5 gm. $CaCO_3$, as original chalk. Although the concentration of the carbonic acid had become weaker, the influence of the carbonic acid was considerably raised by this addition. With it the coagulation of the clay suspension of the loam-clay soil was almost complete, as can be seen from the following data :—

	Camplete coagulation	Nc coagulation
Clay suspension of loamclay soil	over 0.01	0.003 N. and under
» » » horizon A.	» 0.01	0.002 N. » »
» » » » B.	» 0.004	0.0005 N. » »

10 gm. loam-clay soil and 10 gm. of the horizon A were each mixed with 1.0 gm. $CaCO_3$ in other cylinders, and distilled water without CO_2 added. The coagulation of the clay particles in this case also proceeded quickly — in six hours. After renewing the distilled water, no peptisation of the finest particles was observed.

From the experiments on the influence of distilled water containing carbonic acid, it can further be remarked that the deposit of the finest particles shows near relationship to the chalk contents of the soil : if no $CaCO_3$ is available in the soil, then either no, or an incomplete flocculation and deposit takes place. Such water can therefore be used as a reagent in the qualitative testing of the lime requirements.

It is characteristic that the concentration of carbonic acid, which produces a complete flocculation of the clay suspension of the marl-loam (0.001 N.), is only twice as low as the corresponding concentration of sulphuric acid, yet the electrolytic rising-value for both these acids is equally high (with the concentration 0.0001 N.). If we take into consideration that the carbonic acid has expelled sulphuric acid from the $CaCO_3$, then it follows from this that the action of the carbonic acid is not weaker, but stronger, than that of the sulphuric acid.

(3) *Experiments with* $Ca(OH)_2$.

The experiments were carried out with concentrations of 0.0001 N.-0.005 N. In all these experiments the results were quite definite after 6 hours, and no further differences occurred between 6-48 hours.

The following results were obtained :—

	Complete flocculation	No flocculation
Clay suspension of loam-clay soil	0.005 N and over	0.002 N and under
» » » podsol clay soil horizon A	0.003 » » »	0.005 » » »
» » » » » » » B	0.002 » » »	0.0003 » » »
» » » » » » » C	0.002 » » »	0.0005 » » »
Suspension of original chalk	0.002 « « «	0.0003 » » »

It is surprising that with the flocculation caused by $Ca(OH)_2$ no great differences of the operating concentration could be observed, as with the other electrolytes examined. The clay suspension of horizon B is even rather more sensitive to $Ca(OH)_2$ than the clay suspension of the marl loam.

The clear liquid over the deposit in the test cylinders was almost completely poured off, and distilled water again added. The clay suspension of the loam-clay soil in this case gave no deposit at all ; the deposit in all the other test tubes was fairly large, but complete flocculation only took place in the cylinders with clay suspension of marl loam and horizon B, in which the original concentration of the $Ca(OH)_2$ amounted to 0.005 N. and over. Complete peptisation, however, could not be observed in any of the soils used, except in the clay suspensions of loam-clay soil, even after the addition of larger quantities of water.

(4) *Experiments with NaOH.*

The experiments were carried out with concentrations 0.003 N.—0.5 N., and the following results were obtained :—

	Complete flocculation	No flocculation
Clay suspension of loam-clay soil.	0.3 N and over	0.05 N and under
» » » potter's clay soil level A.	0.2 » » »	0.02 » » »
» » » » » » » B.	0.03 » » »	0.005 » » »
» » » » » » » C.	0.02 » « »	0.003 » » »
» » of level C of another sampler of soil	0.02 » » »	0.003 « « «

From the data quoted it appears that flocculation of the loam-clay soil and of horizon A of the podsol clay soil occurs with 10-15 times higher concentrations than does the flocculation of the clay suspensions of the marl loam. In order to prove the results obtained, clay suspensions of marl loam were also prepared from another sample of soil, which also proved to be equally sensitive to NaOH. It is probable that in this case the Na' ion is not of such great importance as the calcium ion passed over from the marl loam. It is also characteristic that the clay suspensions of loam-clay soil with concentrations of NaOH of 0.3 N.-0.05 N., viz. : suspensions of horizon A of the podsol clay soil, of 0.2 N.-0.02 N., in other words with those concentrations with which coagulation was in no way complete, showed a graded distribution of the solid particles, with respect to which 3 to 4 stages could be distinguished. This result was not obtained with the incomplete flocculation of the clay suspensions of the marl loam.

(5) *Experiments with* $NaHCO_3$.

As already stated above, the $NaHCO_3$ is considered as a monatomic salt. Ths experiments were carried out with concentrations of 0.001 N.-0.5 N., and the following results were obtained :—

	Complete flocculation	No flocculation
Clay suspension of loam-clay soil.	0.4 N and over	0.05 N and under
» » » horizon A	0.3 » » »	0.01 » » »
» » » » B	0.1 » » »	0.02 » » »
» » » » C	0.03 » » »	0.002 » » »
» » original chalk	0.03 » » »	0.005 » » »

It may be remarked that $NaHCO_3$ acts less strongly than NaOH which is also confirmed by the experiments of Gedroiz.

In comparing the results it must be borne in mind that the $NaHCO_3$ of Prof. GEDROIZ is assumed to be diatomic. The action of the $NaHCO_3$ is much stronger on the clay suspensions of marl loam and original chalk than on the other clay suspensions examined. The clay suspension of the loam-clay soil demands especially high concentrations for complete flocculation. After 48 hours, therefore, and the completion of the experiment, there was added to each of these clay suspensions 0.5 gm. $CaCO_3$ in a test tube. The flocculation capacity of the $NaHCO_3$ on the loam-clay suspension was not strengthened in this case, as was the case in the experiment with water containing carbonic acid. A closer examination of this phenomenon showed that the hydrolytic decomposition of the $CaCO_3$ was very much reduced by $NaHCO_3$, as both salts have the same anions.

(6) *Experiments with NaCl.*

Concentrations of 0.0005-0.5 N. were examined, and the following results obtained :—

	Complete flocculation	No flocculation
Clay suspension of loam-clay soil.	0.2 N. and over	0.02 N. and under
» » » horizon A.	0.2 » » »	0.005 » » »
» » » » B.	0.02 » » »	0.003 » » »
» » » » C.	0.01 » » »	0.0005 » » »
» » » original chalk.	0.02 » » »	0.002 » » »

Here also the strong action of the chloride of sodium on the clay suspensions of the marl loam, and especially the great difference between the concentrations which cause complete flocculation and no flocculation, is striking. In the experiments with chloride of sodium, the deposition proceeded much more slowly than with the other electrolytes tried ; during 24-48 hours considerable alterations could still be observed, which in the clay suspensions of the loam-clay soil and horizon A of the podsol clay soil were not nearly so great as in the clay suspension of the marl loam. The explanation of this result must be sought in the influence of the NaCl on the hydrolytic decomposition of the $CaCO_3$ and the further dissociation of the products of this decomposition. NaCl contains no ions common to $CaCO_3$ consequently the hydrolytic decomposition of the $CaCO_3$, under the influence of the NaCl, proceeds more quickly. If $CaCO_3$ precipitate alone is added to with a chloride of sodium solution, then perceptible quantities of the $Ca(OH)_2$ in a short time go into solution according to the equation :

$$CaCO_3 + 2\ H_2O = Ca\ (OH)_2 + H_2CO_3$$

The $Ca(OH)_2$ is strongly dissociated into Ca'' and OH' ; ions H_2CO_3, however, dissociates very easily into H_2O and CO_2 and only forms small quantities of ions $H' + HCO_3'$ therefore a strong alkaline reaction in the solution can be shown with phenol-phtaline as indicator, and it can be easily shown that the solution contains $Ca(OH)_2$, and only very small quantities of Na_2CO_3, $NaHCO_3$ and $Ca(HCO_3)_2$. As, however, the hydrolytic decomposition in this case belongs to the slowly-progressing reactions (heterogeneous system), then probably on this account the difference in the concentrations which produce complete and no coagulation may be dissimilar ; the former concentration is about 20 times greater than the latter, which was not the case with the electrolytes observed previously. The balance, in this case, can only be established after a long time.

(7) *Experiments with* $CaSO_4$.

The experiments were carried out with concentrations of 0.0003 N. -0.01 N.

TABEL VIII.

	Complete flocculation	No flocculation
Clay suspension of loam-clay soil	0.005 N. and over	0,001 N. and under
» » » horizon A of podsol clay soil	0,005 » » »	0.0005 » » »
» » » » B » » »	0,003 » » »	0,0003 » » »
» » » » C » » »	0,001 » » »	?
» » » original chalk	0,002 » » »	0,0003 » » »

The clay suspension of the marl loam, with a concentration of gypsum of 0.0003 N., in 6 hours gave no deposit ; after 24 hours there was a slight deposit, and after 48 hours a fairly heavy one. Therefore, the concentration which produces no deposit is less than 0.0003. N., probably 0.0001 N.

The lowest concentrations of gypsum, which will cause a complete flocculation of the clay suspensions, are about twice as high as the corresponding concentrations of sulphuric acid — the action of the latter is therefore stronger.

(8) *Experiments with* $Ca(HCO_3)_2$

The experiments were carried out with concentrations of 0.0001 N.-0.01 N., in which the $Ca(HCO_3)_2$ is considered as diatomic. The solution also contained free carbon dioxide — in the 0.02 N.-$Ca(HCO_3)_2$ solution moreover 0.01 N.-CO_2 — which might still further strengthen the action of the solution on the marl loam. The results were as follows :—

TABEL IX.

	Complete flocculation	No flocculation
Clay suspension of loam-clay soil	0,005 N. and over	0.002 N. and under
» » » horizon A of podsol clay soil	0,004 » » »	0,0005 » » »
» » » » B » » » »	0,002 » » »	0,0003 » » »
» » » » C » » » »	0,0005 » » »	0.0001 » » »
» » » original chalk.	0,002 » » »	0,0005 » » »

Hence, it is seen, that the clay suspensions of the marl loam are much more sensitive to $Ca(HCO_3)_2$ than the clay suspensions of the loam-clay soil and the upper horizon of the podsol clay soil. Here also are found considerable differences in the behaviour of the clay suspension of the loam-clay soil and that of the upper horizon of the podsol clay soil — the latter is flocculated by lower concentrations of $Ca(HCO_3)_2$, but especially low are those concentrations which cause no coagulation (electrolytic rising-value).

(9) *Experiments with* $Ca(HCO_3)_2$ and $NaHCO_3$.

The analyses of numerous water extracts from various soils show that certain quantities of $Ca(HCO_3)_2$ and $NaHCO_3$ pass over into the water-extract, which is even found to be the case with very acid soils. The same salts are also found in the composition of the subsoil water. Even the so-called surface waters, for instance those flowing on the surface from woods and fields, contain certain quantities of these salts; the $NaHCO_3$ contents are in many cases perceptibly high, possibly exceeding 0.001 N. The contents of $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ in the surface waters are always relatively small, often even considerably less than the contents of the first-named salt. These salt contents can of course influence the flocculation process, and at the same time, therefore, the physical properties of the soil also. The experiments of GEDROIZ showed that NaOH and Na_2CO_3, even in concentrations of 0.00005 N., can completely stop the flocculation produced by 0.015 N. NaCl solutions.

In the homogeneous system $Ca(HCO_3)_2 + NaHCO_3$ both salts have common anions, which strongly influences the solubility of the $Ca(HCO_3)_2$. In a 0.02 N. solution of $Ca(HCO_3)_2$, the $NaHCO_3$ in a concentration of 0.06 N., in 24 hours already causes complete deposition of the chalk $CaCO_3$; in 5 days, however, the concentration of the $Ca(HCO_3)_2$ solution is considerably reduced by even such weak solutions of $NaHCO_3$ as 0.001 normal.

The experiments with the clay suspensions were carried out with various concentrations of salts; we will therefore consider separately the experiments with the clay suspensions of one of each kind of soil.

a) Clay suspensions of loam-clay soil.

These experiments were carried out about two months later than the experiments with the $Ca(HCO_3)_2$ alone. In this time the clay suspension of the loam-clay soil had already considerably changed its properties, and had become less sensitive to $Ca(HCO_3)_2$. At the beginning of the experiments the clay suspension, with 0.003 N. solution of $Ca(HCO_3)_2$, in 24 hours gave a comparatively large deposit; at the time of carrying out the experiments about to be described, the clay suspension in 24 hours gave no deposit with a $Ca(HCO_3)_2$ solution of concentrations 0.003 N. and 0.004 N., and also no deposit when at the same time, in addition to $Ca(HCO_3)_2$, there was also present in the solution $NaHCO_3$ in concentrations of 0.000002 N. up to 0.15 N.

The clay suspension of the loam-clay soil at the commencement of the experiments gave a fairly large deposit with 0.1 and 0.2 N. solution of $NaHCO_3$.

Exhaustive experiments could not be made, on account of the lack of provision of testing material and want of time. With clay suspensions of loam-clay soil, experiments could only be carried out with the assistance at the same time of a 0.007 N. solution of

$Ca(HCO_3)_2$ and the following concentrations of $NaHCO_3$ solution: 0.01 N., 0.005 N., 0.002 N., 0.001 N., 0.0005 N., 0.0002 N., 0.0001 N., 0.000005 N., 0.000002 N., 0.000001 N., 0.0000005 N.

The deposit was complete in all the test tubes in 24 hours. Now, however, the tubes were interchanged and the observation repeated, when considerable differences in the condition of the tubes could be shown: after 40 minutes there was a fairly large deposit in the tubes with $CA(HCO_3)_2$ without $NaHCO_3$, but the deposit in all other tubes with $NaHCO_3$ was very small. The deposit after an hour was much smaller in the tubes with $NaHCO_3$ in concentrations of 0.002 N.-0.01 N., 0.0002 N.-0.0005 N. and 0.000005 N.-0.0005 N., than in the tubes with $NaHCO_3$ in the other concentrations examined (0.001 N., 0.00001 N. and under 0.000005 N.) the general formation after 1 ½ hours was more uniform; although the deposit was still not at all complete, the deposits in the tubes with $NaHCO_3$ in concentrations 0.01 N.-0.002 N. were notably smaller. The repetition of this experiment was unfortunately not possible.

b) Clay suspensions of horizon A of the podsol clay soil.

The experiments with these clay suspensions were only carried out with $Ca(HCO_3)_2$ in the concentrations 0.003 N. and 0.007 N.

In the first series of experiments without $NaHCO_3$ coagulation was almost complete in 24 hours, as also in the experiment three months before; the properties of the clay suspensions were therefore not altered, as was the case with the clay suspensions of the loam-clay soil. The concentrations of $NaHCO_3$ which were used, were between 0.15 N. and 0.00001 N. Complete deposit after 24 hours could only be obtained with the concentrations 0.01 N.-0.002 N. of the $NaHCO_3$, there was hardly any deposit in the same time with the concentrations 0.15 N.- 0.02 N., but again almost complete deposit, similar to those without $NaHCO_3$, began to be seen with concentrations of 0.001 N. of $NaHCO_3$ and even under that strength. The concentration of $NaHCO_3$ between 0.02 N.-0.15 N. also very much retarded the coagulation; the deposit in these tubes also was very small after 72 hours. After thoroughly shaking the tubes, an interesting phenomenon was observed in the tubes with the concentration of $NaHCO_3$ of 0.01 N. After the first 24 hours the deposit in these tubes was complete; after shaking, however, the deposit in these tubes proceeded much more slowly than in the tubes with lower $NaHCO_3$ concentrations, in which deposit was by no means complete in 24 hours.

This phenomenon can be explained by the fact that 0.01 N.-$NaHCO_3$ solution considerably assists the deposit of $CaCO_3$ from the solution of $Ca(HCO_3)_2$, as I was able to prove by special experiments; the solution of the soda itself of the concentrations mentioned, on the contrary, exerts no influence at all on the coagulation of the clay suspension of horizon A. The deposit of the $CaCO_3$ from a 0.003 N.-$Ca(HCO_3)_2$ solution by a 0.01 N. $NaHCO_3$ solution also progresses relatively quickly.

$NaHCO_3$ in concentrations between 0.000005 N. and 0.01 N. was tested with 0.007 N. $Ca(HCO_3)_2$ solution. In all the test tubes with these concentrations the deposit was complete in 2 hours. After repeated mixing, and standing for 15 minutes, considerable differences could be observed here also: flocculation was especially small with concentrations of soda solution of 0.005 N.-0.01N., 0.0005 N.-0.001 N. and 0.00002 N.-0.00005 N.; after an hour the flocculation in nearly all the test tubes was complete and equally great.

c) Clay suspensions of horizon B of podsol clay soil.

The experiments were carried out with concentrations of 0.001 N., 0.002 N. and 0.007 N. of $Ca(HCO_3)_2$. The concentrations of $NaHCO_3$ were in the first two series between 0.15 N. and 0.00001 N.

The influence of the $NaHCO_3$ was, in the first series (0.001 N. -$Ca(HCO_3)_2$ solution) as follows: The deposit was much greater in the test tubes with 0.15 N., 0.10 N. and 0.01 N. $NaHCO_3$ than in the tubes with pure $Ca(HCO_3)_2$ solution; the concentrations of 0.05 N. and 0.02 N. of $NaHCO_3$ much retarded flocculation; in all the other tubes, *i. e.*, with concentrations of $NaHCO_3$ of 0.005 N. and lower, there was, in comparison with the pure $Ca(HCO_3)_2$, solution, no influence to be observed.

In the second series the investigations were more exhaustive. After an hour a deposit could only be observed in the tubes with concentrations of $NaHCO_3$ which lay under 0.00005 N., and even in these tubes none were so great as in the test tubes without any $NaHCO_3$. The difference disappeared after 4 hours, still the deposits, in the tubes with 0.02 N., 0.05. N., 0. 10 N. and 0.15 N. — $NaHCO_3$ — solution, were notably smaller. After 72 hours the deposit was complete in all the tubes except those with 0.02 N. and 0.05 N., — $NaHCO_3$ — solution. After 72 hours all the tubes were thoroughly shaken, and after 1 ½ hours the observations were repeated. A comparatively larger deposit was present in the test tubes without $NaHCO$, and in the tubes with concentrations of $NaHCO_3$ under 0.00005 N., with concentrations of $NaHCO_3$ between 0.00005 N. and 0.005 N. the deposit was small, and between the concentrations of $NaHCO_3$ of 0.005 N. and 0.15 N. there was no deposit.

In the third series, with concentrations of 0.005 N. $Ca(HCO_3)_2$, a heavy deposit began after an hour. Half an hour after shaking, it was observed that with concentrations of $NaHCO_3$ between 0.001 N.-0.01 N. and between 0.00001 N.-0.00002 N. flocculation was retarded, but after 1 hour the difference disappeared. This difference could be thoroughly investigated only by quantitative determination, which, however, is difficult to carry out.

d) Clay suspensions of marl loam (horizon C). The experiments were carried out with concentrations of $Ca(HCO_3)_2$ of 0.0003 N., 0.001 N. and 0.007 N. The general formation was in this case still more developed than in the experiments described above. The investigation was also made more difficult because some of the clay suspensions of the marl clay change even in a solution such as $Ca(HCO_3)_2$, and therefore also $NaHCO_3$, which, in the case of experiments lasting a long time, greatly alters the general formation. It can only be said that the flocculation of the marl clay by the addition of $NaHCO_3$ is not so much retarded as was the case in the above-mentioned experiments. A most unfavourable influence on the speed of flocculation and deposit is exerted by the concentrations of $NaHCO_3$ of 0.01 N.-0.05 N. with concentrations of $Ca(HCO_3)_2$ of 0.0003 N and 0.001 N.; with concentrations of $Ca(HCO_3)_2$ there was the same effect, also some of the weak concentrations of $NaHCO_3$, but to investigate this phenomenon in detail, new and exhaustive experiments would have to be undertaken.

10. *Experiments with $CaSO_4+NaHCO_3$.*

These salts also react on each other by the extravasion of $CaCO_3$, and there then remains an equivalent quantity of Na_2SO_4 in the solution. This can easily be determined by the usual titration methods; the concentration of the $NaHCO_3$ becomes weaker, and there is a deposit of $CaCO_3$. The concentration of the $CaSO_4$ solution is very much reduced by the concentrations of the $NaHCO_3$ of 0.1 N., but a deposit of $CaCO_3$ is also observed with lower concentrations of $NaHCO_3$ (0.01 N.).

(a) Experiments with clay suspensions of loam-clay soil. The properties of the clay suspension of loam-clay soil were much less altered by the solution of $CaSO_4$ than was the case with the Ca $(HCO_3)_2$ solutions. Several experimental tests showed that very small concentrations of $NaHCO_3$ greatly retarded the flocculation of the clay suspensions, even with those higher concentrations of $CaSO_4$ which cause complete deposit without the addition of $NaHCO_3$. The results are summarised in tabular form, where the degree of deposit is calculated according to the 5 grade system: 5 — complete deposit, the liquid over the solid mass is perfectly clear; 4 — almost complete deposit, the liquid over the deposit is slightly opalescent; 3 — heavy deposit, particles of clay are still contained in the liquid, the liquid is muddy; 2 — the deposit is small, the liquid very muddy; 1 — the deposit very slight; 0 — no deposit.

TABLE X. — *Concentration of* 0.004 *N.* $CaSO_4$.

$NaHCO_3$ normal solution	6 hours	24 hours	48 hours	72 hours
0	2	3	4	4
0.1	0	0	0	0
0.05	0	0	0	0
0.02	0	0	0	0
0.01	0	1	1	1
0.005	0	1	1	1
0.002	0	1	1	1
0.001	0	1	1	1
0.0005	0	1	1	2
0.0002	0	2	2	2
0.0001	0	3	3	3
0.00005	3	4	4	4
0.00002	3	4	4	4
0.00001	3	4	4	4
0.000005	3	4	4	4

The data quoted show that that all higher concentrations of the $NaHCO_3$ from concentrations 0.0002 onwards greatly retard flocculation, but the weaker concentrations, of 0.00005 onwards, rather hasten flocculation. The unfavourable influence was very marked of the higher concentrations of $NaHCO_3$ with which the decomposition of the $CaSO_4$ occurred by the deposit of $CaCO_3$. Thorough observations, with repeated shakings, were made with the concentration of $CaSO_4$ of 0.01 N.

TABLE XI. — *Concentration of* 0.01 *N.* $CaSO_4$.

Concentration of normal solution $NaHCO_3$	40'	1 h	4 h	20 h		1,25 h	2 h	4 h	24 h	72 h		1 h	2 h	5 h
0	1	3	4	5	First shaking	3	4	4	5	5	Second shaking	1	3	4
0.2	0	0	0	1		0	0	0	1	2		0	0	0
0.15	0	0	0	1		0	0	0	1	2		0	0	0
0.05	0	0	0	1		0	0	0	1	2		0	0	0
0.02	2	3	4	5		0	0	2	3	4		0	0	0
0.01	3	4	5	5		2	4	4	5	5		0	2	3
0.005	2	3	4	5		2	4	4	5	5		2	4	4
0.002	0	0	3	5		0	2	3	4	5		1	2	4
0.001	0	0	3	4		0	1	2	4	5		1	2	3
0.0005	0	0	3	4		0	1	2	4	5		0	1	3
0.0002	0	0	3	4		0	1	2	4	5		0	2	3
0.0001	0						(destroyed)							
0.00005	0	2	4	5		1	3	4	5	5		0	3	4
0.00002	0	1	4	5		2	4	4	5	5		0	3	4
0.00001	0	2	4	5		2	4	4	5	5		1	3	4
0.000005	0	2	4	5		2	4	4	5	5		1	3	4

The data given are obtained by simple observations, therefore a certain personal equation error is not out of the question. Without going into details, a few interesting results may be mentioned. The influence of the higher concentrations of $NaHCO_3$ was also unfavourable in these experiments, in which the deposit of $CaCO_3$ could be observed in individual experiments. The concentration of the $NaHCO_3$ of 0.02 N. is particularly interesting. At the beginning of the experiment the deposit in this tube was nearly complete in 4 hours, in 20 hours complete, but after the first shaking the deposit was by no means complete after 72 hours; after the second shaking, however, there was no more deposit present after 5 hours. Almost the same result is seen with the concentration of $NaHCO_3$ of 0.01 N. — at the commencement this concentration, in comparison with the test tube without any $NaHCO_3$, influenced flocculation favourably, but later retarded it somewhat strongly. After the shaking, a favourable influence on the flocculation was only observed with the concentration of $NaHCO_3$ of 0.015 N., the lower concentrations exercised no influence or a negative one.

b. Clay suspensions of horizon A. — The concentration of $CaSO_4$ of 0.001 N. and the concentration of $NaHCO_3$ between 0.15 N.-0.0001 N. were investigated. An inconsiderable deposit was observed only with the concentration of the $NaHCO_3$ of 0.15 N., the other concentrations of $NaHCO_3$ investigated completely retarded the coagulation.

With the concentration of the $CaSO_4$ of 0.003 N. which by itself causes an almost complete deposit in 48 hours, the influence of the $NaHCO_3$ was somewhat different; the concentration of $NaHCO_3$ of 0.1 N. retarded flocculation; the concentrations of 0.05-0.005 N., however, assisted flocculation in the first 48 hours, but after the shaking a favourable influence was only to be observed with the concentrations of 0.005; with the other concentrations there was no influence, or a negative influence, which stands in relation to the alteration of the concentration of $CaSO_4$ by the depositing of $CaCO_0$.

All the low concentrations of $NaHCO_3$ (0.00005 N.-0.002 N.) retarded the deposit in the first 24 hours, but after 72 hours the difference was made up; a retarding influence was only to be observed with the concentrations of 0.0002 N.-0.002 N.

The concentration of $NaHCO_3$ of 0.00002 N. exerted no retarding influence.

c. Clay suspensions of horizon B. — The experiments were only carried out with $CaSO_4$ concentration of 0.001 N., which by itself gave a fairly considerable deposit in 48 hours. Here also the higher concentrations of $NaHCO_3$ (0.005 N.-0.1 N.) favoured deposit in the first 48 hours; after the shaking, however, the hastening influence could only be observed with the concentrations of $NaHCO_3$ (0.0001N.-0.0002 N.) exercised a markedly unfavourable influence on flocculation. With still lower concentrations of $NaHCO_3$ (0.0001 N.-0.00002 N.) no retarding influence on the coagulation was observed.

d. Clay suspensions of marl loam (horizon C). — The experiments were only carried out with a concentration of $CaSO_4$ of 0.0005 N., which by itself produces almost complete flocculation in 48 hours. The concentrations of $NaHCO_3$ used were between 0.1 N.-0.00002 N. A pronounced retarding influence was only to be observed with the concentration of $NaHCO_3$ of 0.01 N. and with that not in the first 48 hours, but only after the shaking and long standing.

CHARACTERISTICS OF THE SAMPLES OF SOIL USED FOR PRODUCING THE CLAY SUSPENSIONS.

The experiments described show that the clay suspensions of the loam-clay soil and of horizon A of the podsol clay soil are particularly insensitive to electrolytes.

The clay suspensions of horizon B show a greater sensitiveness, whilst the greatest sensitiveness is peculiar to the horizon C (marl loam). The last were even more sensitive than the clay suspensions of the original chalk, *i. e.*, the almost pure $CaCO_3$ of the highest dispersiveness. The last-named effect is probably connected with the concentration of the suspension, as in a litre about 10 times less was contained in the chalk suspension than in the suspension of the marl loam.

The retarding influence of the $NaHCO_3$ is especially great with the suspensions with $CaSO_4$ and $Ca(HCO_3)_2$, which produce no complete coagulation in 24 hours ; this influence is much greater on the suspensions of the loam-clay and of horizon A than on the clay suspensions of horizon B and C. This circumstance is of especially great importance in practical agriculture. Prof. GEDROIZ, in his publications, has already pointed out several times that manuring has a very great influence on the coagulation of the finest mechanical particles of the constituents of the soil. Prof. RAMANN also, in his above-mentioned work, calls attention to the great importance of the process of flocculation, and considers it in connection with the structure of the soil.

In practice I have never observed good soils, which on mechanical analysis without preliminary preparation — baking, treating with NH_3, NaOH solutions — have given large quantities of particles which were finer than 0.01 mm. Both the soils used — loam-clay soil and horizon A of the podsol clay soil — belong to the poor, infertile soils with relatively high chalk requirement.

The podsol clay soil was more closely examined, and in the examination samples of soil were used from two neighbouring fields. The first field lay fallow in the year 1924, had received manure and 150 kg. of superphosphate per 1 ha., the other field had not been manured for four years. With the usual mechanical analysis, both the soils gave 40 % of fractions finer than 0.01 mm., and about 10 % of fractions finer than 0.001 mm., but the mechanical analysis without any preparation of the analysing materials gave the following results :

	Manured soil		Unmanured soil	
	I	II	I	II
Fractions finer than 0,01 mm	5.32 %	1.15 %	7.72 %	1.53 %
Fractions finer than 0,01 mm	0.37 %	0.07 %	0.64 %	0.14 %

The first samples of soil (I) remained 20 days under water, the second (II) were dried at room-temperature, and only had water poured on them a day before the analysis; but on the addition of water for the second time, only very small quantities of the finest fractions were present.

In practice it is often found that soils which contain a large amount of fine clay particles require much heavier and often repeated manuring to obtain satisfactory yields.

Both the so-called productive and unproductive years are related to the flocculation and peptisation of the soil colloids. Productive years, according to the predictions of old people and the observations of practical men, are to be expected, in the zone of temperate climate, after hard winters, when the soil has been well frozen through, and after dry summers when the soil has been thoroughly dried to a great depth. Experiments I and II show how great can be the influence of drying on the quantity of finest fractions in the soil. Even very poor soils in productive years may give good results by the usual manuring, but unfortunately productive years occur very seldom.

A sufficiently high chalk content of the soil assists considerably the flocculation of the finest fractions of the soil, but cannot of itself alone produce the flocculation of these particles, since even the marl loam gave a suspension of clay particles for the experiments carried out. Practical work also shows that even the soils in the upper horizon containing $CaCO_3$, in the temperate zone, require manuring, although at greater intervals of time and in smaller doses than the poor infertile soils. Also pure marl loam, which has been brought to the surface of the soil by the carrying out of large works, such as the building of roads or railways, is at first only very slowly covered with vegetation, therefore it is, in itself alone, not so fertile as might be expected. This result is connected with the finest particles of soil, which in the marl loam are not completely flocculated and may become peptonized.

In order to explain the influence of various electrolytes on the coagulation of the clay suspensions of the samples of soil examined, we must be acquainted with the genesis of these soils. The effects observed, in the temperate zone, are in close relationship with the transformation of the upper level of the soil, since formerly the upper levels in Lettland contained $CaCO_3$, and the alteration of the qualities of the finest particles could only occur by time, with the washing out of the $CaCO_3$ from the upper levels.

The soil profiles had the following appearances.

(1) *Profile of loam-clay soil.*

The loam-clay soil was taken from a low lying marsh converted into a field.

A_1 (0-20 cm.) vegetable mould, contains 8.2 % comparatively well decomposed organic matter, reaction acid to litmus, the chalk requirement, determined according to the method of HUTCHINSON and MCLENNAN and expressed as $CaCO_3$, amounts to 0.76 %.

A_2 (20-50 cm.) grey loam, reaction acid to litmus, chalk requirement 0.21 %. In a damp state the loam is very sticky, in a dry state very hard.

B (60-70 cm.) bluish grey loam; the physical qualities are very bad, but it reacts neutrally to litmus. From 70 cm. onwards is found typical, unstratified, stony soil.

For the experiments the upper part — 20-35 cm. — of horizon A_2 was used, in which the poor physical qualities were particularly well marked.

From the high content of organic matter and the poor physical qualities, the conclusion may be drawn that the soil has developed under the influence of excessive moisture. In this district also the subsoil water lies comparatively high, at a depth of about 80 cm. In comparison with other similar soil profiles, it must be pointed out that the horizon containing $CaCO_3$ is very deep; usually, however, this horizon lies at lesser depths, about 20-30 cm. below the level of the vegetable mould. Probably the explanation of this appearance is that the loam horizon in this case was somewhat sandy, the content of particles finer than 0.01 mm. only amounted to 45.1 %.

In the development of the upper level of this soil the following phases can be distinguished :—

1. The whole of the $CaCO_3$ is washed out by the action of the deposit and the carbonic acid.

2. The acid reaction of the soil shows that noticeable quantities of Ca'' ions are washed out, even those absorbed in the organic and mineral matter. At the same time, the quantity of salts in the ground water is reduced, which in its turn might increase the dispersiveness of the finest particles of soil.

3. The small salt-content of the water, and the high degree

of dispersiveness of the finest particles of soil, have hastened the transformation of the sodium and calcium silicate. In the zeolitic class of products there appeared at the same time larger quantities of K' and Na' ions, which would exercise a deteriorating influence on the zeolitic products, especially in the case where no Ca'' ions are contained in the solution, which could reduce this injurious influence.

A complete chemical analysis of the loam and its suspensions could not be made.

The following quantities of CaO were dissolved in hot 10 % hydrochloric acid :—

A_1 0-15 cm.	0.571 %
A_2 20-35 cm.	0.224 %
B_1 60-70 cm.	0.414 %
C_1 70-80 cm.	1.420 %

The chalk contents of the upper level were obviously inadequate for obtaining a neutral reaction of the soil. The chalk contents of level A_1 are fairly high, but the contents of organic matter of the same horizon are also high ; for the saturation of this matter considerable quantities of Ca'' are necessary.

A few more details are given relative to the contents of K_2O and Na_2O, which may be of great importance in explaining the properties of the loam-clay soil :

	K_2O	Na_2O
Dissolved in hot 10 % hydrochloric acid	0.240 %	0,055 %
» » cold 0,05 N. » »	0.012 %	0.012 %
» » 1 litre $Ca(HCO_3)_2$ solution from 100 gm. soil	0,0020 gm.	0,0016 gm.
» » 1 litre clay suspension deposited by $Ca(HCO_3)_2$	0.0060 gm.	0,0085 gm.

It must be pointed out that considerable quantities of K_2O are dissolved from hot 10 % hydrochloric acid solutions, although the loamclay soils always require much potash manuring.

According to Prof. Gedroiz, the quantities of K_2O qnd Na_2O dissolved by cold 0.05 N. hydrochloric acid may be taken as suitable zeolitic bases for exchanging with other cations. The quantities of Na_2O found are small in comparison with the corresponding quantities from salt soils ; if, however, these are exchangeable in solution, particularly as $NaHCO_3$, then they can without doubt deteriorate the physical qualities of the soil and the development of the plants. This effect is frequently observed in agricultural practice when applying lime to stiff soils, and also in plant growth experiments (17).

The quantities of exchangeable K_2O and Na_2O in a litre of 0.02 N.-$Ca(HCO_3)_2$ solution on filtration through a thin (1 cm.) layer of soil, are small, but the concentration of the solution reaches about 0.0001 N., which is sufficient to exercise a retarding influence on the flocculation of the clay suspensions. The same experiments have been repeated with other loam-clay soils, and it has been shown that the amount of K_2O exchanged from very poor loam-clay soils is 10 times greater, but the quantities of Na_2O 5 times greater.

It would have been of special interest to determine the quantities of K_2O and Na_2O in the liquid of the clay suspension, especially because it had an acid reaction to litmus. Until now I have not been able to do this, as the liquid could not be separated from the clay particles, I have, however, determined those quantities of K_2O and Na_2O which were contained in the liquid after deposit of the clay particles with small amounts of $Ca(HCO_3)_2$, as a part of the K' and Na' absorbed in the clay particles could pass over into the liquid. This experiment gave considerable quantities in 1 litre of the liquid : K_2O — 0.0060 gm. and Na_2O — 0.0085 gm.

The clay suspension contained 4.43 gm. of clay particles in 1 litre and the percentage content of the clay particles was K_2O — 0.14 and Na_2O — 0.19 %, which are noticeable amounts and are characteristic of soils containing alkaline salts (salt soils). With regard to the details given, it must be remarked that the clay suspension was kept in a glass vessel for about 3 months, and during this time some K_2O and Na_2O might pass into solution from the glass, consequently the data obtained may contain a slight error. It seems probable that fairly large amounts of the mon-atomic cations might be found in distilled water or rain water after it has remained for a few months in glass vessels. As, however, equally large amounts of the same cations are found in other soils which have been examined, it may be assumed that if the amount found is not quite accurate, it is very near to the actual value. This investigation, however, will be repeated, when the tests will be carried out in glass vessels lined with lacquer.

The investigations carried out justify the conclusion that *the finest fractions of the loam-clay soil must not only be assumed to be unsaturated, i. e., requiring a greater or lesser amount of lime* (*containing H' ions*), *but also contain absorbed K' and Na' ions : the same must* *also be considered as amongst the most important factors, which raise the degree of dispersiveness of these soils, and reduce the sensitiveness of the clay suspensions of these soils to electrolytes.*

It must also be pointed out that by treating the sample 4-5 times with 1.0 N. NaCl solution, by which the Na' contents of the zeolitic products are increased, the dispersiveness of the loam-clay soil can be considerably raised, although the loam-clay soil, even after such treatment, has an acid reaction to litmus paper. After the washing out of the NaCl, the loam-clay soil gives a much greater quantity of clay suspension.

In the case of a sample of soil from the Kubanj district (Caucasus), after treatment with NaCl solution, and after washing out this solution, Prof. GEDROIZ was successful in reducing almost 50 % of the original weight of the soil in colloidal solution (18) (the diameter of the particles was less than 0.28 μ).

2. *The section of the podsol clay soil.*

The following horizons can be differentiated in the soil section.

$A_1 + A_2$ (0-18 cm.) Upper horizon much metamorphosed, of bright grey colour, the content of slightly decomposed organfic matter amounts to 2.52 %, it has an acid reaction to litmus paper.

B_1 (18-22 cm.) Loam of yellow colour with very poor physical properties ; acid reaction.

B_2 (22-52 cm.) Brown loam containing no $CaCO_3$, and which after being well dried splits up into sharp fragments ; when dry, it is firm, when damp, sticky ; weak acid reaction.

C (52 cm.) Stony unstratified loam with 16.2 % $CaCO_3$ (The $MgCO_3$ is also reckoned as $CaCO_3$).

In the experiments the horizons $A_1 + A_2$, B_2 and C were used, which are described briefly as A, B and C.

The mechanical composition of the soil, passed through a 1 mm. sieve, was as follows :—

TABLE XII. — *Mechanical Composition of Podsol Soils.*

Description	Coarse particles	A	B	C
	mm.	%	%	%
Coarse sand	1 − 0.25	3.43	3.25	6.13
Fine sand	0.25 − 0,05	34.30	32.70	42.34
Coarse silt	0,05 − 0,01	23.54	11,66	14.03
Medium silt	0.01 − 0.005	21.70	19.15	17.11
Fine silt	0.005 − 0.001	6,45	8,87	5.76
Clay particles	< 0.001	10,58	24.36	14.63

The samples of soil were prepared for the mechanical analysis by drying in the oven, a few drops of ammonia being added. The content of fractions coarser than 1 mm., in the levels named, were as follows:

A	B	C
20.1 %	6.6 %	17.2 %

The coarser fractions of the first two horizons consisted of particles of the primary rock, those of the last horizon, however, in addition to the primary rock contained large quantities of limestone of the Silurian formation, and some dolomite, presumably of the Devonian formation. It is seen from the mechanical composition that the upper horizon A has not only lost all the $CaCO_3$, but also large quantities of the finest fractions (clay particles), which were washed out and collected in horizon B.

The lime requirement according to HUTCHINSON, as $CaCO_3$, and the quantity of CaO released from hot 10 % hydrochloric acid, were as follows:—

	Level A.	Level B.
Lime requirement as CaCO3	0.25 %	0.16 %
Lime content CaO	0.069 %	0.930 %

Although the CaO content of horizon B is high, the clay suspensions of this horizon, a few hours after the production of the suspension, showed a distinct acid reaction, but after standing for about 3 months the concentration became neutral. It may be assumed that in this time a certain quantity of cations had become separated from the silicates, which altered the reaction.

The total content of K_2O and Na_2O were only determined in the marl loam (horizon C) and in the fraction of the mechanical analysis of the sample:—

TABLE XIII. — *K_2O content of Marl Loam.*

		K_2O	Na_2O
		%	%
Marl clay	—	2.28	0.77
Fractions of marl loam	1 — 0.25 mm.	1.28	0.73
» » »	0.25 — 0.05 » »	1.22	0.74
» » »	0.05 — 0.01 » »	2.67	0.60
» » »	0.01 — 0.005 » »	4.58	1.32
» » »	0.005 - 0.001 » »	4.60	0.73
» » »	< 0.001 » »	3.60	0.10 (19)

The data given show that the silicates with specially high contents of the cations mentioned are contained in the comparatively coarse fractions (0.01-0.001 mm.) ; in the finest fractions they are present in much smaller quantities.

Fractions given as finer than 0.001 mm. are those products which did not deposit from a bed of water 10 cm. deep in 10 hours. In the tests clay particles were used which had not deposited in the course of 3 days. The content of K_2O and Na_2O of these particles has not been determined. Here also, as with the loam-clay soil, the amounts of K_2O and Na_2O were determined which, (I) were set free from hot 10 % hydrochloric acid ; (II) from cold 0.05 N. hydrochloric acid ; (III) set free in 1 litre of 0.02 N. $Ca(HCO_3)_2$ solution by filtering the solution through 100 gm. soil in a layer 1 cm. thick (the filtration lasted 48 hours) ; (IV) were contained in 1 litre of the solution with the clay particles which were to be examined. The determination gave the following results :

TABLE XIV. — *Estimation of K_2O and Na_2O in Marl Loam.*

	A		B		C	
	K_2O	Na_2O	K_2O	Na_2O	K_2O	Na_2O
I.	0,165 %	0.021 %	0.555 %	0,050 %	0.390 %	0.150 %
II.	0,010 %	0.013 %	0.015 %	0,019 %	0.019 %	0,021 %
III.	0 0026 gm.	0.0042 gm.	0,0042 gm.	0.0043 gm.	0.0038 gm.	0,0085 gm.
IV.	0,0070 gm.	0,0030 gm.	0,0040 gm.	0,0110 gm.	0,0030 gm.	0,0080 gm.

An especially large quantity of potash soluble in hot 10 % hydrochloric acid is contained in horizon B, about 3 times as much as in horizon A. Cold 0.05 N. hydrochloric acid also only dissolves small quantities of the cations mentioned from this soil, but considerably more from the marl loam than from the upper levels. Considerably smaller quantities of these cations are abstracted in the $Ca(HCO_3)_2$ solution. For the last determinations, IV, the clay particles of horizons A and B had to be flocculated with the smallest possible quantities of $Ca(HCO_3)_2$, which could, however, take over in solution a part of the K_2O and Na_2O absorbed by the clay particles. Here the especially high content of K_2O of the clay particles of horizon A is striking, but the Na_2O content is very small. The highest Na_2O content is observed in the clay particles of horizon B — 0.0110 gm. to the litre.

It must also be pointed out that the amount of K_2O and Na_2O

passed over in solution from the clay particles of the marl loam are very near to the content of these compounds in the subsoil water; even in the subsoil water are found in 1 litre about 0.0022-0.026 gm. of K_2O and 0.0060-0.0087 gm. of Na_2O, if the subsoil water contains Cl' and SO_4''.

If the figures of the last group (IV) are calculated on the content of the clay particles to the litre even higher figures are obtained.

		A	B	C
Weight of clay particles per litre		2.76 gm.	1.56 gm.	3.24 gm.
Content of clay particles in	K_2O	0.26 ⅓	0.26 %	0.09 %
	Na_2O	0.11 %	0.65 %	0.25 %

These figures may perhaps be too high, since a certain amount of mon-atomic cations might have passed over into the solution from the glass vessels in which the clay suspensions had been stored for about 3 months before the tests. Still, the relatively great differences which were found in the contents of these cations in the different horizons, show that this error cannot be very great. If the content of K_2O and Na_2O in the clay particles is so high, then they stand very near to the alkaline salt soils, that is, the finest particles of the soil contain K' and Na' ions which may exert an injurious influence on the physical qualities of the soil. It has been pointed out that the physical qualitites of the marl loam cannot be considered as good, although the chalk content of the marl loam is high. The content of $CaCO_3$, however, increases the sensitiveness of the finest fractions of the marl loam to the ordinary elctrolytes examined, and also to the solution of CO_2 in water.

These experiments also afford an explanation of the phenomenon that the soil requires no dung manuring after liming, the finest fractions of the soil, after liming, are flocculated with very small quantities of salt, the clay particles of the upper horizon are not so easily peptonised and the pores of the soil are not so easily stopped up by percolation of the deposits through them, the air can therefore penetrate more easily even to the deepest levels, in which the roots of the plants can more easily develop.

As regards the injurious influence of liming, in addition to the experiments of P. Kossowitsch and L. Althausen quoted above, there may be mentioned the experiments of Gedroiz (20), according to whom the injurious influence of heavy liming can be considerably reduced by carbon dioxide in the plant vessels or by supplying the plants with water containing carbonic acid. By such treatment the Na_2CO_3 is converted into $NaHCO_3$, which has a less injurious effect on the plants. The following sample of loam-clay soil from the neighbourhood of Hasenpoth in Latvia shows that the strong acid soils really contain considerable quantities of absorbed mon-atomic cations :

	K_2O	Na_2O
Dissolved in hot 10 % hydrochloric acid	0.500 %	0.015 %
» » cold 0.05 N. hydrochloric acid.	0.032 %	0.019 %
» from 100 gm. soil in 1 litre of 0.02 N. $Ca(HCO_3)_2$ solution.	0.0108 gm.	0.0175 gm.

In the district mentioned it is found that the liming of similar soils has an injurious effect, although the lime requirements of the soil are very high — 0.34 % as $CaCO_3$. With this loam-clay soil thorough tests were made as to the permeability of water, and in some cases was found in the percolating water not only $NaHCO_3$, but also Na_2CO_3. This experiment will be more closely considered in a special treatise.

3. *Characteristics of the original chalk.*

The original chalk, from which the suspensions of the finest particles were obtained for the experiments, differs considerably from other original or field chalk, since on thorough drying no loose chalk is obtained, but fairly hard pieces. It contains no coarse crystalline $CaCO_3$ and hardly any organic matter. On filtering a 0.02 N. $Ca(HCO_3)_2$ solution through this lime, from 1 litre was obtained 0.0054 gm. K_2O, and no Na_2O.

The suspensions of the finest particles of this sample of lime were deposited completely in about 10 days, as fairly large quantities of $Ca(HCO_3)_2$ passed over into the solution ; if, however, the solution was replaced by distilled water, then the dispersiveness of the finest products was increased, and a suspension again obtained.

GENERAL CONCLUSIONS.

We will not consider here FREUNDLICH's theory concerning the general laws of the flocculation of negative suspensions, concerning which much has already been written in the treatises of the abovementioned author, and which HAGER G. (21) treats exhaustively in a recently published treatise; attention will be drawn only to the most important factors, which as can be concluded from the experiments quoted, reduce or increase the influence of electrolytes of the flocculation of clay suspensions.

Very great importance is attached to those cations which are absorbed by the finest products, and which can pass into solution by diffusion; this can very greatly alter the sensitiveness of the suspension to different electrolytes. It also explains why the clay suspension of soils with high lime requirements are much (about 10 times) less sensitive to all the Na' compounds examined than are the clay suspensions of marl loam.

If those concentrations of the electrolytes examined are compared which produce complete flocculation of the clay suspensions of the marl loam and of the loam-clay soil, then the difference between these concentrations is least with $Ca(OH)_2$-0.002 N. and 0.005 N. The explanation is probably to be sought in the properties of the $Ca(OH)_2$: first, the dissolving out of the Ca'' from the marl loam, and secondly the solution of the K_2O and Na_2O, are delayed, as was shown by Prof. O. LEMMERMANN and L. FRESENIUS (22) in a number of experiments. By the influence of the $Ca(OH)_2$ the differences in the properties of both clay suspensions were compensated for.

The greatest difference to be recorded in the behaviour of the two clay suspensions mentioned is with regard to NaCl (20 times) and against NaOH (15 times). This result can be explained, as the clay suspensions of the loam-clay soil, having a high lime requirement, could not yield a great amount of Ca'' ions to the solution, whilst the clay suspensions of the marl loam yielded considerable amounts of these ions, at all events under the action of the NaCl solution, which moreover assisted the hydrolytic decomposition of the $CaCO_3$. A specially great difference is also to be noted in those concentrations of NaCl solution which produce no further flocculation; with the clay suspensions of the loam-clay soil this is a 0.02 N. solution, whereas with the clay suspensions of the marl loam it is a 0.00005 N. solution, the difference being, therefore, 40 times as great.

An important factor also is the hydrolytic decomposition of the combined silicates; the cations which become free by this decomposition will influence flocculation. That such hydrolytic decomposition occurs has been shown, with the clay suspensions of horizon B, which at the beginning had an acid reaction against litmus paper, but after some time became neutral. The acid soils requiring lime differ in this respect from the neutral soils. The composition of the upper horizon of the podsol clay soil, in which the content of Na_2O is noticeably reduced, already points to this. Also the disintegrated layer of the primary rock loses very much of its Na_2O in acid soils, whereas in neutral soils the primary rock shows no disintegrated layer. The brown-coloured forest water also has a fairly high content of Na_2O although it has an acid reaction to litmus paper. All these results point to the fact that with insufficient chalk content, fairly large quantities of Na_2O pass over into solution, which can influence the properties of the suspensions of the finest articles.

I would also point out that the retarding effect of $NaHCO_3$ on the coagulation of the suspensions is especially great in those cases where the soil requires lime. Usually the explanation of the retarding effect of the $NaHCO_3$ is that this compound is dissolved in the solution with the formation of Na_2CO_3 which is hydrolytically decomposed into the strongly dissociated NaOH and the weakly dissociated carbonic acid, which latter further decomposes into $H_2O + CO_2$; OH' ions are also formed in the solution, and these have a stabilizing action on the suspensions. This explanation may be correct in those cases where Na_2CO_3 and higher concentrations of $NaHCO_3$ are used which, after some time have an alkaline reaction. The lower concentrations of the $NaHCO_3$, below 0.002 N. however, after a few days show no alkaline reaction against phenolphtaline, whilst the stabilizing influence of the $NaHCO_3$ is observed in much more dilute solutions.

In this case the explanation must probably be sought in the intermingling reaction between the $NaHCO_3$ solution and the clay suspension. If the clay suspension contains absorbed H' ions which are capable of intermingling with Na' ions, then the dispersiveness of the suspension, according to the investigations of GEDROIZ, is considerably increased, the H' ions pass over into the solution, where, with the HCO_3 ions, they form H_2O and CO_2. I have already mentioned above that, according to the investigations of GEDROIZ, the suspensions of higher dispersiveness are only flocculated by higher concentrations of electrolytes. That is probably also the chief reason why the action of the $NaHCO_3$ solution is comparatively small on the clay suspensions of the marl loam, and the action of this solution is equally small on the clay suspensions of acid soils when at the same time they are under the influence of higher concentrations of $Ca(HCO_3)_2$ and $CaSO_4$.

estimated as $Ca(HCO_3)_2$ and the $KHCO_3$ as $NaHCO_3$; in the titration methyl orange was used as indicator.

(17) P., KOSSOWITSCH. Arbeiten des landw. chem. Labor. in Petersburg. Part 1905. L. ALTHAUSEN, *ibidem*, Part VI. 1909.

(18) *Rus. Journ. f. experim. Landwirtschaft*, pp. 27-48. 1923.

(19) These figures are actually greater, as in the chemical analysis NH_3 on the deposition of the clay particles ($>$ 0,001 mm.) was replaced by $KAl(SO_4)_2$, which could reduce the contents of mon-atomic cations in the clay particles.

(20 *Russ. Journ. f. experim. Landwirtschaft*, pp. 705-720. 1905.

(21) G. HAGER. Bodenstruktur und Kolloidchemie (Soil structure and colloidal chemistry). *Zeitschrift f. Pflanzenernähr. u. Düngung*. Part II, pp. 292-311. 1923.

(22) L. FRESENIUS. *Zeitschr. f. Pflanzenernähr u. Düngung*. Part III, pp. 4-7. 1924.

(23) RAMANN, *Zeitschrift f. Pflanzenernähr. u. Düngung*, A. Part III, p. 269, 1924.

Abstracts and Literature.

Soil Physics.

The Preliminary Treatment of Soils with Ammonia before an Atterberg Slime Analysis.

BLANCK, E. and ALTEN, P. Ein Beitrag zur Frage nach der Vorbehandlung der Böden mit Ammoniak für die Atterberg Schlämmanalyse. *Journal für Landwirtschaft*, Vol. 72, No. 3, p. 152, 1924.

The method recommended by H. KAPPEN of heating all soils, which are suspected of having been influenced by absorbed iron hydroxide or aluminium hydroxide, on the waterbath with 2.5 % ammonia, before carrying out an ATTERBERG slime analysis, cannot be recommended by the authors unreservedly for all soils in view of their experience.

NIKLAS.

Soil Chemistry.

Base Exchange in Soils.

A general discussion held by the Faraday Society, December 1924.

The separate subjects, reprinted in this book, have been already dealt with in separate abstracts in this journal. The book is composed of the following papers.

HISSINK, D. J. Introductory paper.

Comber, N. M. The role of electro-negative ions in the reactions between soils and electrolytes.

Page, H. J. and Williams, W. Studies on base exchange in Rothamsted soils.

Robinson, G. W. and Willams, R. Base exchange in relation to the problems of soil acidity.

Saint, S. J. The relation between the P_H, the lime requirement, and the thiocyanate colour of soils.

Fisher, E. A. Base exchange in relation to adsorption.

Fisher, E. A. Base exchange in relation to swelling of soil colloids General discussion. L. G.

Estimation of Titanium in Minerals, Ores and Industrial Products.

Barneby, O. L. and Ishan, R. M. *Zeitschrift für analytische Chemie*, Vol. 65, No. 9, 1925.

The paper deals with the gravimetric, volumetric and colorimetric methods for the estimation of titanium in different substances, as suggested by various authors, and quotes the corresponding literature.

Niklas.

An Inquiry on Liming and into the Best Means of Extending the Practice.

Enquête sur le chaulage et les moyens propres à developper la pratique de cet amendement. *Bulletin de l'Office de Renseignements agricoles*, Ministère de l'Agriculture. Paris, August, 1925.

VIII Region: South.

Two parts: East of the Rhône (Cévennes). West of the Rhône (Provence).

A. *Cévennes and Languedoc.*

Ardèche Department: Consists on its central massive of granitic, Jurassic, Cretaceous and volcanic beds, and has large valleys running down to the Rhône.

Important lime-burning kilns exist at Teil and at Viviers, but, very little liming is done in the Vivarais.

Gard Department: The granite Cévennes are the home of the calcifuge chestnut-trees. On descending into the valleys alluvium is found; Gardons, Cèze are poor in lime, but quite fertile notwithstanding.

The Pliocene deposits in the South of the department are completely lacking in lime. Despite this the practice of liming is very much neglected in this vine-growing department.

Aude Department: the tertiary calcareous strata are neither vine-growing nor limed. They do not lime regularly, in this district, because it requires about 1500-2000 kgs. per hectare every 4-5 years for the granites, schists and mica-schists of the Black Mountains.

Department of the Pyrénées. East: the soils are of very varied composition, and the practice of liming is neglected.

B. *Provence.*

Vaucluse Department. Entirely calcareous.

Department Bouches-du-Rhône. Generally rich in limes, nearly 20-25 % in the alluvium of the Rhône.

Only the stony plain of Crau (diluvium) is lacking in lime. But it is not intensively cultivated except the parts irrigated by the water of the Durance, which also contains lime.

The magnesian lime (dolomite) and calcium cyanamide give good results in the Durance valley.

Drôme-Department: only a small portion is granitic, the rest is sufficiently calcareous. Except on the molasse or Pliocene plateau often clayey and in the low valleys of the Drôme, Valloire, Galaure, Bancel, Herbasse and Isère, the practice of liming is neglected.

Basses-Alpes Department: the cultivated areas are generally provided with sufficient lime.

Var Department: there is a lack of lime in the Maure and the Esterel massives. The scarcity of manure causes liming to "scorch" the soil. The lime-kilns are disappearing.

In the market-gardens of Hyères basic slag is used.

Alpes-Maritimes Department: No liming is done. To the east of Cannes the granite-triassic massive is planted with the calcifuge mimosa bushes. The soils all over the department are sufficiently calcareous for the cultivation of flowers or for large-scale farming, which is not carried out beyond the tertiary marl plateau or in the alpine valleys.

Corsica.

Nearly all districts are deficient in lime. Everywhere liming is so far no more than an experiment.

It must be added that under the Mediterranean climate the practice of liming is generally neglected; in humid climates, however, lime supplements the sun and helps nitrification. Pierre Larue.

Methods of Estimation of Humus in Soil.

Collins, O. *Engelhardtsche Versuchsstation.* No. 2.

The application of Ischtscherekoff's method of humus estimation in soils in the agrochemical laboratory of the Engelhardt experimental station did not yield accurate results. Better results were obtained by using 1-2 grams of soil instead of 0.5 gram. for an analysis and heating this to boiling point with 50 cc. of water and 20-25 cc. of 10 % sulphuric acid. To this is then added the required quantity of potassium permanganate and the whole is boiled for an hour. The humus content of a soil can be estimated with great accuracy by heating the soil with permanganate and sulphuric acid and absorbing the evolved carbon dioxide by means of caustic potash. The mixture of caustic potash and soda is analysed by Winkler's method. Author.

Manual of Mineralogical Chemistry.

Doelter, C. and Leitmeier, H. *Handbuch der Mineralchemie.* With many illustrations, tables and diagrams. Four volumes. Theodor Steinkopf, Dresden and Leipzig, 1925.

This already reviewed and well known work is continued with the two volumes now published. Vol. II, 11 (iron ores) and Vol. IV, 2 (copper and iron sulphides, silver sulphide, ores and tetrahedrite).

Sch.

The Estimation of the Very Small Quantities of Iodine.

Fellenberg, v. Th. Die Bestimmung Kleinster Mengen Jod. *Zeitschrift für analytische Chemie,* Vol. 65 (1925), No. 8, pp. 326-332.

The author who studied the occurrence of minute quantities of iodine in nature and the question of iodine metabolism in general at the request of the Swiss Crop Commission, gives in this paper a number of methods which can be used in estimating very small quantities of iodine, as they are found almost everywhere. Quantities from 0.01 gm. to the 10 millionth part of a gram can be estimated. The author deals with the quantitative estimation, the colorimetric estimation, the separation of organically and inorganically combined iodine, as for example iodine in water (sea-water) in salts (rock salt) in minerals, in soils, in plant and in animal substances, etc. He also investigates the content of iodine in the case of iodised salts. For further particulars see *Biochem. Ztschrft, 142,* 246 (1923); *152,* 116, 128, 132, 135, 141, 153, 172, 185 (1924). *Mitt. Lebensmitteluntersuchung u. Hyg., 14,* 161, 305 (1923); *14,* 185 (1923). *Biochem. Ztschrift, 152,* 116 (1924).

Niklas.

The Determination of the Cations found Adsorbed in Soils by the Hydrochloric Acid Method.

Gedroiz, K. Die Bestimmung der im Boden in adsorbiertem Zustande befindlichen Kationen nach der Salzsäurmethode. *Journal f. Experim. Agronomie,* 1924.

I worked out a method for the determination of the cations found adsorbed in the organic and inorganic parts of the soil, namely by their displacement by the ammonium ion from ammonium chloride (see my work in *Journal Experim. Agronomie,* vol. XIX, (1918), p. 226). As the result of further experimental work a new method is now proposed which by using cold hydrochloric acid of low concentration is not only much simpler and much more convenient than the former one, but what is also of great importance, much cheaper. This new method is based on the observation that, on treating a soil with hydrochloric acid of concentration not higher than 0.05 N., an exchange of cations takes place between the hydrochloric acid and the zeoliths of the soil, but there is no dissolving.

The course of an analysis with this method is as follows: The soil sample (5-25 gms. according to its content of adsorbed bases and the completeness of the analysis) is treated in the cold with 25-50 cc. of 0.05. HCl (special accuracy is not required) in a porcelain basin of moderate size, then filtered through a filter paper (hardness 602) and washed with the same acid until the washings show a negative tests for calcium. The filtrate is then treated in the manner usual for hydrochloric acid extracts. AUTHOR.

The Ultramechanical Composition of the Soil and its Dependance upon the Adsorption of its Occurring Cations. Liming as a Means of Improving the Ultramechanical Composition of the Soil.

GEDROIZ, K. Die ultramechische Zusammensetzung des Bodens und ihre Abhängigkeit von der Art des im Boden in adsorbiertem Zustande befindlichen Kations. *Journal f. Experim. Agronomie*, 1924.

In a previous paper the author has shown that the colloid nature of a soil, as estimated by its swelling, is in close relation to the adsorption of its cation. In this paper an account is given of experimental work which proves that the mechanical and especially the ultramechanical composition of a soil (the fraction < 0.001 mm.) is changed according to which cation saturates the adsorption complex of a soil. Investigations were carried out with reference to the action of Na, NH_4, K, Mg, Ba, Al, Fe and H in replacing the naturally adsorbed bases (Ca and Mg).

All soils investigated by the anthor which contained as adsorbed bases only Ca and Mg, and even the most loamy types of soil, did not show the presence of particles of colloidal size (0.25 micron); and even after the application of methods recommended for the preparation of soils for mechanical analysis the soils did not show more than 1 % of such particles. The substitution of the adsorbed Ca and Mg by the cations of Mg, H, K, NH_4 and Na increased the number of colloidal particles present in the order indicated, i. e. least on substitution by Mg and most on substitution of Ca and Mg by Na. The supplying of the soil with the cations of Ba, Al or Te on the other hand decreased the number of these colloidal particles. The author deals very exhaustively with the question of pentration of Na and H cations into the adsorbed soil complex and the influence of that penetration mainly in view of the occurrence of such penetration in nature (alkaline soils or solonetz, which contain adsorbed Na by unsaturated bases, podsol soils which contain H). The aggregates of colloidal soil particles (secondary particles) which occur in soils containing adsorbed Ca or Mg, and which are quite or almost undecomposed by water, become decomposable into primary particles on substitution of Ca or Mg by other cations. The action of the hydrogenion is very weak in this respect. However, soils saturated with repect to the hydrogen-ion contain quantities of colloidal particles which influence profoudly the physical properties of the soils. On the other hand, the action of Na in this respect is extraordinarily strong. Thus while an analysis of a loamy soil sample in its natural condition, i. e. the adsorbed bases being Ca and Mg, gave 39.9 % of the particles as being < 0.001 mm. and from among those only 1.3 % particles of 0.22 micron, the substitution of the adsorbed Ca and Mg by Na gave 59.8 % of particles as being < 0.001 mm., while from among the latter as much as 45.3% were of 0.22 micron. The cause of this phenomenon is that, while the ions in a solution of a soil saturated by Ca are Ca and OH, in a solution of a soil saturated by Na the ions are Na and OH. In the latter case the stabilising action of the hydroxyl-ion on the organic and aluminium silicate soil particles is much greater than the coagulating action of Ca. Solutions of soils saturated by the hydrogen-ion and which contain in the soil solution hydrogen-ion, but, of low concentration, and whose coagulating action with Ca is also low, occupy an intermediate position and are much nearer to the soils saturated by Ca and Mg.

The same causes also bring about the different structure and unequal stability of the different soils saturated by Ca and Mg (e. g. black-earth soils), Na (Solonetz soils) and H (Podsol soils). AUTHOR.

Soils Deficient in Bases. Methods of Determination of Hydrogen-ions present in an Adsorbed Condition. The Requirement by Soils of Lime to neutralise Unsaturation.

GEDROIZ, K. Von Basen nicht gesättigte Böden. *Journal f. Experim. Agronomie*, 1924.

Experiments on washing soils with cold hydrochloric acid of different concentrations until the washings no longer give the characteristic Ca test proved that,hydrochloric acid af 0.05N. and lower concentration, has almost no action or very little on the organic part of the soil, or on the aluminium silicate part. It does not decompose them and the only reaction is to exchange its hydrogen for the bases adsorbed by the soil, which then pass into solution. The hydrochloric acid has in this case the same action as a solution of a neutral salt, e.g. of ammonium chloride. The hydrogen ion has the same capacity as other metallic cations of penetration into the adsorbed soil complex (into the zeolitic and humous part of the soil) and of displacing the adssorbed bases present. Correspondingly all cations are equivalent in this respect and their penetration into a soil displaces from the latter equivalent amounts of adsarbed soil bases.

These investigations enable a deeper insight to be obtained into the nature and origin of soils which are deficient in bases, and to devise a more scientific method of determination of the degree of unsaturation of such soils with regard to bases. A soil unsaturated by bases is a soil whose adsorption complex contains a hydrogen-ion, the latter having the property of being able to be displaced by any other metallic cation. For the determination of the amount of hydrogen-ion present in the soil, i. e. its degree of unsaturation by bases, the same methods of displacement may be used, which are in use in the determinations of the other adsorbed cations which may be found in soils. The most suitable salt for the displacement of the hydrogen-ion is $BaCl_2$ (1-0.5N.). The soil is treated on a filter-paper with such a solution until the displacement of the hydrogen-ion is complete — as shown by methyl orange. The amounts of free hydrochloric acid in the washings is determined by titration. This method of determination of the degree of unsaturation of a soil with regard to bases, serves at the same time as a determination of the lime requirements of the soil, as a neutraliser.

The investigations of soils, when all adsorbed bases have been displaced, by treating them with 0.05 N.HCl show that: (1) the adsorbed hydrogen-ion can again be displaced by any desired cation;

(2) the decomposing and dissolving action of water on the organic and aluminium silicate adsorption complexes of the soil is considerably greater in the case of soil saturated by hydrogen-ions than in those saturated by bases,

(3) the process of podsol formation in soils is, from a chemical point of view, characterised by two stages: (*a*) the atmospheric water trickling through the soil displaces in the end all the bases present in the adsorbed soil complex by its hydrogen-ions; the presence in the water of free acids increases that displacing action of water, while, on the other hand, the presence in the soil of easily soluble salts or carbonates of Ca and Mg (in greater or smaller quantities) prevents this exchange of hydrogen-ions for the bases present in the soil; these salts protect the soil against podsol formation by the action of atmospheric water, and only when these salts are removed can the podsol formation begin.

(*b*) Simultaneously with the formation — in the above described manner — of organic and mineralogical adsorption complexes deficient in bases — proceeds an energetic washing-out action of these complexes from the soil; the soil becomes deficient in zeolitic and humous components.

The lime which serves as a means of decomposing and neutralising the unsaturated basic compounds, at the same time protects the soil against the destruction and removal of its most valuable part the adsorption complexes. AUTHOR.

The Disintegration of Beton by the Chemical Action of Soil Water.

GESSNER, H. Betonzerstörung durch chemische Einwirkung des Grundwassers. Agrochemical laboratory of the E.T.H. *Schveizerische Zeitschrift fur Strasservesen*, Nos. 5 and 6, Zurich 1925.

The author hopes that this short abstract of his work will be forgiven him in view of the enormous practical importance of the problem and with which the soil-scientist has occasionally to deal, and in view of its importance in the use of cement drain pipes in soil improvements.

The author, as a chemist to the Swiss Commission for the Investigation of Cement Pipes in Improved Soils, has studied a large number of cases of disintegration and has carried out analyses. The analyses included soil sections, soil solution as well as drainage water, and beton in very different stages of disintegration. The abstracted work is written mainly for the building expert and contains therefore as few chemical references as possible.

As a result of two years study the following conclusions are drawn; Injurious to cement are:

(1) Strong acids- these do not occur in nature, but are found in the industrial refuse-waters;

(2) Weak acids, carbonic acid, "humic" acid, i. e. organic complexes found in the soil and reacting as acids — found often in soils free of lime and in soil waters;

(3) Acid action of apparently neutral soils, liberated by neutral salts. Found very often in peat soils and much more seldom in mineral soils (soils whose water extract has a neutral reaction, which, however, show a degree of acidity by the BAUMANN-GULLY method).

(4) Sulphates found in flat moor land as gypsum, more rarely in mineral soils, gypsum waters and chimney gases;

(5) Magnesium salts- found in mineral soils, very often in soils rich in lime, more rarely in peat.

The chemical action of acids is quite clear in view of the alkaline character of Portland cement. Large amounts of carbonic acid may lead to complete destruction, and the same result can be brought about by the acid reaction of apparently neutral soils, which is due to the cation exchange — H-ion against the alkali-ion or alkaline earth-ion and which is caused by the neutral salt.

Sulphate disintegrations have been known for a long time under the name of "gypsum drive", due to the crystallisation in the cement of the cal ium-sulpho-aluminate which has a very high water of crystallisation.

The action of the magnesium salts, which are present in soils rich in lime mainly in the form of the carbonate, is probably due to the exchange of the Mg-ion for the Ca-ion of the cement gel, and on account of their higher hydration have a softening action on the beton. In general, the most dangerous and the most injurious conditions for any beton object are those brought about through the change in the soil water level, which causes the object that at one time was surrounded by water, at another time to be under dry conditions.

A number of examples from the literature and from the author's own practice are quoted and treated in greater detail and explained by means of two photographs.

As precautionary measures are suggested the production of a particularly dense beton (by pressing, stamping, fat mixing), together with a careful working and long storing of cement objects. There is not enough experience available about special forms of cements or of special coating as preventives. AUTHOR.

The Disperse Systems of the Soil.

GLINKA, K. Die dispersen Systeme im Boden. Leningrad, pp. 1-75.

The author gives a short account of the Russian and western work dealing with disperse systems and their relation to soil Science. The object of the work is to give an explanation of the origin of the different soil types. This brief work contains the following chapters:

1. The conception of disperse systems.
2. Soil suspensions.
3. Soil colloids
4. Adsorption phenomena in suspensions and colloids.
5. Electric adsorption and coagurlation.
6. Mutual coagulating action of colloids.
7. Protective action of the humus-soils.
8. Chemical adsorption in soils.
9. Adsorption of gases and liquids (water).
10. Soil solutions.
11. Origin of different soil types in the light of dispersoid chemistry:
    - (*a*) Origin of the laterite type
    - (*b*) » » » podsol »
    - (*c*) » » » steppe »
    - (*d*) » » » solonetz »
    - (*e*) » » » moor and solontschak type.

AUTHOR.

Investigations on the Acidity of Soils in the Neighbourhood of Leningrad.

GLINKA, K. Kurzer Bericht über die Untersuchung der Azidität der Böden. *Annals of the State Institute of Experimental Agronomy*, Part III, No. 1, 1925, Leningrad.

The author has investigated the active acidity and exchangeable acidity of the podsol, gley-podsol, moor and Bendzina soils. The active acidity was determined by means of indicator methods as well as by electrometric methods (with quinhydron electrode). For the active acidity the following conclusions can be drawn:

(1) The upper soil surface (A) has the maximum acidity.

(2) The low-land moor soils generally have a P_H value of 5.5-6.0.

(3) The podsol and gley-podsol soils give a maximum value for acidity when the soil sample is taken from forests. The P_H value is then 4.5 (very seldom 4.8). Arable soils of similar morphology show lower acidity (P_H 5.5-5.8-6.0-6.2).

(4) The gley soils are the least acid, and their deeper layers may even show a neutral or weakly alkaline reaction.

(5) The bendzina soils are almost neutral in their upper laxers, while their lower levels may even show an alkaline reaction (P_H 7. 7-7.8-8.0).

For the exchange-acidity using the method of Prof. GEDROIZ the following results were obtained:

(1) The upper soil surface (A) has the maximum acidity.

(2) The non-moor soils have a very slight acidity, which may be for the upper layers 0.0004 % H.

(3) The maximum exchange-acidity for the soils taken from forests was 0.002-0.0035 % H for the upper layers. AUTHOR.

A Simplified Method for the Determination of Lime in Soils.

GROSSFELD, J. Vereinfachte Verfahren zur Kalkbestimmung in Ackerböden. *Zeit. f. Pflanzenernährung und Düngung*, Vol. No. 1-2, pp. 93-103. Leipzig, 1925.

The author describes for the determination of limes in soils an indirect and a direct method which both give good results.

The first consists in evaporating to dryness in a platinum capsule the soil solution obtained by mixing 150 gm. of air-dried soil with 300 cc. of hydrochloric acid (S. g. 1.15), then heating the mixture for an hour to boiling point. After allowing to cool, it is heated to redness and 20 cc. of a 2 % solution of ammonium oxalate are added and a certain amount of soda, and then oxalate of lime; it is evaporated to 100 cc., filtered through a fine filter paper and the excess of oxalate determined by means of a solution of permanganate.

With the direct method, the soil solution is made almost neutral and 4 % ammonium oxalate added and, afterwards, 25 % sodium and ammonium acetate. The solution is filtered through fine filter paper, and is first washed with cold and then with hot water; the precipitate is dissolved in hot 10 % nitric acid and then washed with water and titrated with permanganate solution. With this method the most exact results are obtained with clay soils. A. F.

The Physical Properties of Forest Soils and their Relation to Soil Acidity.

NEMEC, A. and KOAPIL, K. Einige physikalische Eigenschaften der Waldböden. (From the Biochemical Institute of the State Experimental Station for Forestry Investigations, Prague). *Zeitschrift für Forst- und Jagdwesen*, Year 57, pp. 540-567, tables 6.

Continuing their investigations on the influence of pure coniferous and pure deciduous trees and of mixed coniferous and deciduous stands on mineral soils, the authors have investigated certain Bohemian forest soils, of very different geological origin, but they have restricted their investigations to the active acidity and to some of the physical properties of the soils. They thus investigated alluvial sandy-clay and clay soils, chalk formation sand soils, primary formation sandy loam-soils and (Sozän) sandstone clay soils. Space does not admit reproduction of the tables appended to the original paper, but the general conclusions given by the authors are as follows:

The unfavourable physical properties of soils of dense *purely coniferous* tree stands result in an accumulation of strongly acid humus (upper surface humus) which cause a diminishing air capacity and these two causes together, strong acidity and lower air capacity, are the main reasons for the failure of the natural rejuvenation. Timely removal of the upper layer, by bringing about an accelerated litter decomposition will counteract these unfavourable conditions. More openly grown stands show therefore always a lower acidity and a higher air capacity. The absolute water capacity is in general inversely proportional to the absolute air capacity.

Also, close *purely deeciduous* tree stands show a relatively small air capacity, although the soil ventilation is usually in this case much more favourable than in the case of purely coniferous tree stands. The relation, acidity-air capacity, is in the case of purely deciduous tree stands not so close as in the case of purely coniferous stands, although there is a resemblance.

In soils of *mixed tree stands* the air capacity undergoes considerable variation. A direct relation between it and acidity could not be traced, even approximately. In humus-covered, vegetation-free forests, with mixed tree stands, a much higher air capacity was found than in the case of dense coniferous or deciduous stands when grown on soils of corresponding formations.

The absolute air capacity is, in the case of mixed tree stands, in general much smaller than in the case of loose, well lighted deciduous formations.

The authors then study the relation between their results and the most important CAJANDERS forest vegetation types. The *oxalis* type has a moderately acid soil reaction and a fairly high air capacity, the *Myrtillus* type has its optimum at a somewhat higher degree of acidity and lower air capacity, and the *Calluna* type has its optimum at the highest degree of acidity and lowest air capacity.

GROHSKOPF.

Modern Methods of Soil Investigation with Respect to the Biochemical Methods of Nutritive Content Estimation of Soils and the Effect of Inoculation.

NIKLAS, H. Die moderne Bodenuntersuchung insbesondere zur Ermittlung des Nährstoffgehaltes der Boden und des Verhaltens der Boden bei der Impfung. *Tonindustriezeitung*, No. 14, 1925.

After a short consideration of the results obtained in the soil reaction investigations at the Agrochemical Institute of the High-School of Weihenstephan, the author gives an account of the stage reached by him and his collaborators in the biochemical investigations, begun at the suggestion of CHRISTIANSEN and STOKLASA, on the nutritive-content estimation of soils and their behaviour towards inoculation. The question of the inoculation of soils, especially with nitrogen fixing bacteria, seems to depend primarily upon the conditions, and only investigations concerning this point, together with the employment of biochemical methods, will enable us to say with certainty what are the conditions for making bacteria-free soils capable of inoculation.

AUTHOR.

Determination of the Reaction and the Lime Requirements of the Pfalz Soils.

Niklas, H. and Hock, A. Bestimmung der Reaktion und der Kalkbedürftigheit von Böden der Pfalz. *Praktische Blätter der Bayerischen Landesanstalt für Pflanzenbau und Pflanzenschutz*, 1923, No. 8-9-10.

A number of soil samples taken from very different geological formations of the Bavarian Rhine-Pfalz have been investigated by various methods, and the results obtained are shown in tabular form. It was proved that the geological conditions are of primary importance in determining the reaction and the lime requirements of a soil, but within the same formation local influences and the particular cultivation of the soil may also be of greater or less importance. Niklas.

Colorimetric Reaction Investigations of Soils in Agricultural Practice.

Niklas' and Hock, A. Die Reaktionsuntersuchungen der Böden mit kolorimetrischen methoden in der landwirtschaftlichen Praxis. *Tonindustriezeitung* 1925, No. 33.

The authors report on the results obtained in tests carried out with an apparatus made by the firm of E. Merck, Darmstadt, for field investigations of soil reactions. From consideration of the results obtained they conclude that the field method is unsuitable and that soil reaction, investigations must be carried out in scientific institutions. Niklas.

The Nature of Soil Acidity in Forests Soils.

Niklas, H. and Hock, A. Zur Frage der Bestimmung der Formen der Bodensäure in Waldböden. *Forstwissenschaftliches Zentralblatt*, 47, 1925.

The authors point out that, just as in the case of arable soils so in the case of forest soils we should not only determine the actual acidity, but the titrational and exchange acidities as well. Using electrometric titration methods and making the ordinates to represent the values of P_H thus obtained and the abscissae to represent the quantities of alkali used, a series of characteristic reaction curves results in the case of forest soils, from which the manner of their acidification can be derived. Strongly dissociated acids, e. g. the exchange acids conditioned by aluminium salts, gave a slowly rising curve, which on completed neutralisation by addition of a very small quantity of alkali, rose very steeply from the neutral point, through several P_H values, to a quite considerable P_H value. From other experiments the author showed that soils with exchange acids contain mainly acid aluminium salts, which give curves very similar to the above, and hence from the curves resulting on soil titration it can be easily shown whether the soil contains exchange acid or humous acids The latter acids are also shown, in a table appended to this paper, to give very characteristic curves. The paper does not say how far it is possible by using electrometric titration to determine the buffer properties of a soil and also to find whether a neutral soil contains sufficient buffer substances to permit the development of bacterial life.

NIKLAS.

The Importance of Carbonic Acid as a Fertiliser.

NIKLAS, H., SCHARRER, K. and STROBEL, A. Die Bedeutung der Kohlensäure als Düngemittel. *Zeitschrift für angewandte Chemie*, 38, 251, 1925.

The previous work on this question is exhaustively reviewed and discussed. The experiments described were carried out with carbonic acid fertilisers produced by the chemical works Bayern at Reichertshofen near Ingolstadt. This fertiliser consisted of 50 % peat, 45 % wood charcoal and 5 % lignite. It had a very favourable influence on many plants, especially potatoes. As to the question of fertilisation with carbonic acid, it is necessary to continue the investigations for a number of years to settle finally the effectiveness or otherwise of carbonic acid fertilisers.

K. SCHARRER.

Investigations on the Reactions and Lime Requirements of Soils, Carried out by the Institute of Agricultural Chemistry of the High-School of Weihenstephan during 1923-24.

NIKLAS, H. and VOGEL, F. Bodenuntersuchungen auf Reaktion und Kalkbedarf durch das agrikulturchemische Institut der Hochschule Weihenstephan. *Landwirtschaftliches Jahrbuch für Bayern* 1925, Nos. 5-6.

After a short description of the methods applied an account is given of the results obtained from 2255 soil investigations carried out by the Institute. Of those investigated, 50 % have been found to be weakly to strongly acidic, 15 % neutral and 35 % alkaline. Of 1285 soils samples sent in by official Bavarian stations, and investigated by various methods by A. HOCK, 34 % were found to be absolutely lime deficient, 23 % required only a limited lime supply and 43 % required no lime. It could also be shown that the geological conditions of the soil were of primary importance in determining the character and the lime requirements of a soil. It was further proved that quantitative methods by themselves give a very superficial, and in most cases very erroneous idea of the true condition, and a warning is given as to their use in actual practice. In an appendix, tables are given of the reactions shown by the different solis sent in from official and private sources, and they also show the total acidity of the soils. Also, the soils belonging to the different geological formations are arranged according to the same scheme. In addition, a description is given of the methods used in taking samples, an example of the questionnaire used is given, and an explanatory note is given relative to the informations published by the Intitute.

NIKLAS.

An Account of Experiments from the Unpublished Work of the late Alfred Koch. A Contribution to the Knowledge of the Nitrogen Activity of Arable Soils.

RIPPEL, A. Versuche aus dem Nachlass von ALFRED KOCH. *Journal für Landwirtschaft*, 72, No. 1, 17, 1924.

The experiments described briefly in this paper include experiments on fallow land as well as continuous cultivation experiments with winter crops and pastures, experiments with buried cylinders on fallow soil, on spontaneous growth experiments, pot experiments on the nitrogen activity of soils from different depths, and finally experiments to determine the influence of various organic substances on the nitrogen capacity of different soils. The author does not share the late A. ROCY's view as to the considerable evolution of nitrogen during a crop root fallow, and he believes himself to be supported in his opposite views by the experience gained from the twenty years' fallow land experiments carried out on the land of the Institute of Agricultural Bacteriology of the University of Göttingen. He admits that A. KOCH probably had in mind the possibility, but not the fact, of a nitrogen fixtion during a fallow. He does not go deeper into details or into less important questions, neither does he review the literature on the subject. NIKLAS.

The Preparation of Magnesium-Ammonium Phosphate in the Estimation of Phosphoric Acid or Magnesium.

SCHMITZ, B. Ein Beitrag zur Herstellung des Magnesia-Ammoniumphosphatnie derschlages für die Bestimmung der Phosphorsäure bezw des Magnesiums. *Zeitschrift für analytische Chemie*, vol. 65, Nos. 1 and 2, pp. 46-53, 1924.

The author bases his investigations on the previous work of H. NEUBAUER, an abstract of which was published in the Journal in 1894.
NIKLAS.

The Organic Substances of the Soil.

SCHMUCK, A. *Transactions of the Kuban Agricultural Institute*, Part I, No. 2, 1923, pp. 1-92, Krassnodar.

In the first part of his work the author gives a review of the literature on the nature of soil organic substances and particularly on humic acid. The following conclusions were drawn:

(1) The organic compounds in the soil form a complex mixture consisting of very different organic substances. The greater part of the organic substances isolated from the soil by American workers are not invariably present, but are in close relation to the former cultivation of the soil.

(2) The greater part is of a different nature and forms a characteristic organic compound, whose content varies in different soils.

(3) A considerable part can be separated by solution in alkalies and precipitation by acids as humic acid.

(4) Chemically, it represents a nitrogen containing substance of an acid type.

(5) The acid character is due ,partly to adsorption by the colloidal humic acid and partly to the presence of carboxyl groups.

(6) The salts of humic acid are not true salts formed in stoichiometric proportions, but, complicated chemical and adsorption compounds.

(7) The solubility of humic acid in water is slight, and the transition from the soil-state depends upon the presence of suitable protective colloids. Under suitable conditions, the formation of a stable colloidal solution is fairly easy, that solution then showing all the properties of organic emulsions.

(8) The nitrogen containing part of the humic acid resembles albuminous substances and gives similar hydrolytic decomposition products.

(9) The albumin of the organic substances of the soil are not exclusively plasm-albumin, since they ar not accompanied in the soil by glycosamine.

(10) Humic acid contains benzene ring compounds.

(11) The unsaturated character of the compound is shown by its easy combination with halogens and its easy oxidation with alkaline $KMnO_4$.

(12) The hydroxyl groups enter, most probably, the side chains in the benzene ring of the humic acid.

(13) The ash of humic acid is mainly the ash of the albumin.

In the second part the author describes experimental work on humic acid. He isolated from the soil 300 gm. of a substance usually regarded as humic acid. The substance had a somewhat complex composition and gave besides slight amounts of substances soluble in ether benzene, ligroin and chloroform, about 14 % colophonic acid and calophonic ester and about 80 % of a specific substance to which the name humusic acid was given.

This substance had a decidedly acid character and contained both hydroxyl and carboxyl groups. It is colloidal and may occur in two forms, soluble and insoluble in water. When freshly precipitated from alkaline solution it is fairly soluble in water, but does not diffuse through membranes.

Analysis gave the following percentage results, calculated as ash-free substance, C-61.8, H-4.2, N-3.2. The ash is not organically combined with the substance and is only a difficultly separable admixture. There is no doubt that the nitrogen contained in it is in the form of ordinary albumin compounds. On prolonged hydrolysis a part of the substance goes into solution, and the insoluble residue contains only small amounts of nitrogen. The author believes that a chemical analogy indeed exists between the albumin, the artificial humic bodies and the humusic acid of the soil.

These compounds are remarkable for their low H and N content and their high C and O content. A further analogy consists in the fact that all of them correspond approximately to the composition $(C_5\ H_4O_2)_n$ With such a structure they must contain a large number of double forms and should give condensation products. The author considers that from very different complex organic compiunds, by the splitting off of coater, and condensation, similarly constituted substances can be obtained, and hence, that humic acid can be obtained from many widely differing substances. AUTHOR.

Methods of Estimation of Phosphoric Acid in Soils.

SCHTSCHEPONOWSKY, A. Zur Methodik der Bestimmung des Phosphorsäuregehaltes im Boden. *Engelhardt's Versuchsstation*, No. 2.

The SONNENSCHEIN method for phosphoric acid estimation in soils so largely used by agricultural chemists, is unsuitable for two reasons. Firstly, its use in volumetric analysis is very inconvenient, and secondly it does not yield sufficiently accurate results, because the treatment of the soil with the common acids — H_2SO_4 and HNO_3 — introduces impurities.

The purpose of this work was to find a method which would yield, in volumetric analysis, better results than SONNENSCHEIN'S method and after a large number of experimenrs this was found in NIESSEN'S method. The phosphate in the soil is precipitated once with a molybdate solution and after dissolving in standard caustic potash solution, the solution thus obtained is titrated with H_2SO_4. But, since the solution must be pure, i an attempt was made to oxidise and dissolve the phosphate by first treating every 10 gm. of soil with 50 cc., or more, of 0.1N. permanganate solution, acidified with sulphuric acid, and then boiling for half an hour. The residue left in the permanganate is then decomposed with oxalic acid and the solution diluted with water to 250 cc. For the phosphate estimation by NIESSEN'S method 50 cc. of solution are taken. AUTHOR.

On the Adsorption of P_2O_5 by Soils.

SOKOLOW, A. Ueber die Adsorption des $P_2\ O_5$ durch den Boden. *Engelhardt'sche Versuchstation*, No. 2.

The author estimated the adsorption of P_2O_5 in relation to the amount of combined lime. For that purpose he increased the lime content an: then displaced it byNH_4. 100 gm. absolutely dry soil contained in mgm.:

	Combined lime —	Adsorbed P_2O_5 —
Original soil	411	341
Soil treated with $CaCl_2$	588	609
» » » $NH_4\ Cl$	—	11

AUTHOR.

The Origin of Alkaline Soils (from the Russian).

VILENSKI. *La Pédologie*, 36-58 pp., 1924.

Alkali soils differ from acid soils by the fact that their upper surfaces show an almost complete absence of easily soluble salts, while deeper down is a solid surface nearly impermeable to water. Below this surface are found NaCl, Na_2SO_4 and Na_2CO_3. From his investigations and studies, the author arrives at the following conclusions: The salt soils were formed in those places where the ground water through capillary attraction reached the upper soil surface and evaporated. Alkali soils were formed from the salt soils when rain-water again reached the lower layers and washed out the salts. They then affected the undersoil. This theory agrees with the views of geologists on the question of climate after the ice-age. According to those views the then higher temperatures brought about the formation of deserts and hence also of salt soils further North, which soils were later by the above process converted into alkaline soils. HELLMERS.

Salt Soils, their Origin, Composition and Methods of Improvement (from the Russian).

VILENSKI. (New Village), Moscow, 153 pages, 1924.

This work deals with the Russian salt soils of the region of the lower Volga and distinguishes between wastes and half wastes, the dry steppes and black-earth, the forest steppes and forest zones. The author has carried out analyses of all these different types and of samples taken from different depths, and made also both total analyses as well as analyses of water and hydrochloric acid extracts. In the next chapter, in greater detail, the flora of the salt soils is dealt with and an interesting table is given showingwhat salt concentrations of NaCl, Na_2SO_4, Na_2CO_3, $NaHCO_3$ and $MgIO_4$ the different cultivated plants can tolerate. Then follows a chapter on the origin of the salt soils and their place in the general soil classification, and it is shown that there exists no sharp line of demarcation between salt soils and alkaline soils. In conclusion the author points out the importance of salt soil investigations on the general question of the history of the earth in the post-glacial period. HELLMERS.

The Importance of Gypsum in Agriculture (from Latvian).

VITINS, J. (WITYN, J.). Riga, pp. 44, 1925.

The author draws attention to the very numerous gypsum deposits found in Latvia. They are found in the Devonian loam deposits, and in some places reach a thickness of 3-4 metres. In some places the deposits are found almost on the surface. The water of many springs contains dissolved gypsum. Thus for example, the main springs at Kemmern yield annually about 700 cc. of dissolved gypsum, and the whole neighbourhood of Kemmern yields about 2000 cubic metres. Even the sea at Kemmern is richer in gypsum than anywhere else in the Baltic.

The author discusses the questions of fertility and of exhaustion of the soil, the question of the profitable and unprofitable years on different soils in the temperate climatic zone, and arrives at the conclusion that in the temperate zone the coagulation of the fine soil products under the influence of electrolysis is of paramount importance.

The soils in the temperate zone contain usually only inappreciable amounts of divalent cations. Rich crops are obtained especially after severe winters, when the soil gets frozen through, or in in dry summers. The coagulating capacity of the divalent cations must be increased by the frost and by the dryness. The unprofitable years are a common experience on acid podsol soils and are due to a lack of divalent cations (particularly of Ca). But unprofitable years occur also on neutral soils, when the soil has not been manured for several years in succession, when the amount of precipitation was considerable and when no freezing through or drying out of the soil has taken place. To illustrate his statements the author gives several examples which show an increase in the degree of dispersion produced by precipitation. From this point of view gypsum is an important and a cheap means for keeping the fine soil particles in a state of coagulation. According to the author, 1 part of gypsum to 10 000 parts of water suffices to bring about a settling of the fine particles of a soil in 24 hours, while a 3-4 times stronger concentration is necessary to cause the settling of the fine particles of a more acid soil.

The author next considers sulphur as a plant food and the quantities of sulphur which are supplied to the soil by the atmosphere and through dung manuring. Hence he concludes that sulphur may be present in podsol soils in minimum quantities even without their being manured with superphosphate, especially if it is cultivated with hoed crops or Papilionaceae. Also in these cases gypsum may be of importance. Finally, he points out the importance of gypsum as a mean of removing the alkaline reaction of a soil caused by the presence in it of sodium and potassium carbonate. This was known for a long time in the case of solonetz soils, but it is of special importance in gley and podsol soils, where excessive liming gives negative results. The author mentions the types of soil on which the experiments with gypsum should be tried, and assumes that the doses of phosphoric acid fertilisers could have been diminished if gypsum had been used.

In the opinion of the author, gypsum should be of great importance in the case of loamy soils when potatoes, rye and certain types of hoed crops, which require loose soils, are cultivated on them. Certain experiments with clover have shown that when using gypsum in the case of heavy very acid soils, the amount of phosphoric acid present may be a minimum. The use of gypsum in the case of clover on light, acid soils, which are available for the deeply rooted plants have yielded very good results.

L. FREY.

I. The Principal Phases of the Podsol-Forming Process. — II. The Fertility of the Soil in its Relations to Soil Acidity.

(A summary of some soil investigations in Latvia).

WITYN, J. An address given at the IV International Soil Science Congress, Rome, 1924, pp. 32, illustrated, Riga, 1924.

I. The author considers briefly the phases of podsol formation in Latvia, and the subsoils, and different heights of the ground water level. With regard to the ground water the author distinguishes three cases (1) where the water level lies very deep ; (2) where water level lies near the upper surface ; (3) where the water passes to the upper surface. In the first case the author considers in greater detail the soil development on the following subsoils (1) loams with 20 % $CaCO_3$, silt content 20-30 % ; (2) sandy loams with about 10-15 % $CaCO_3$ and about 10-20 % silt, (3) moraine detritus with high $CaCO_3$ content ; (4) Sand. In the second case he deals in detail with soils whose subsoil is (1) marl-clay, (2) sand. For the third case the formation of the different deposits is closely dependent on, and is characterised by the composition of the ground water. All the cases mentioned are illustrated by soil sections.

II. The second part is a brief summary of the principal conclusions arrived at by the author in his second work (see J. VITINS (J. WITYN) "*The richess and the Fertility of Soils*". Riga, 1924). L. FREY.

Soils and Vegetation.

The Influence of Titanium on Plant Production.

BLANCK, E. and ALTEN, F. Ein Beitrag zur Frage nach der Einwirkung des Titans auf die Pflanzenproduktion. *Journal für Landwirtschaft*, 72, No. 2, p. 103, 1924.

The authors tested the results obtained by ANTONIN NEMEC and VACLAV KÁŠ, who obtained by the use of Titanium a considerable increase in the yields of mustard, peas and lucerne, and who therefore ascribed to it specific functions in the process of assimilation. Increasing admixtures of Titanium to the fertilisers gave increasing yields and a maximum yield was obtained on addition of 0.5 gm. of sodium titanate. BLANCK and ALTEN were unable, with the same experimental arrangement, to confirm the above results, and even the application of colorimetric methods did not show that any ascertainable amounts of Titanium had been taken up by the plants. No secondary effects could also be shown, hence they conclude that Titanium, at least in the form of sodium titanate, has no influence on the production of plants.

NIKLAS.

A Plant Test with "Asahi-Promoloid".

BLANCK, E. and ALTEN, F. Ein Vegetationsversuch mit « Asahi-Promoloid ». *Journal für Landwirtschaft*, 72, No. 3, p. 139, 1924.

The authors have made pot tests with this preparation which is an artificially prepared product and consists probably of a magnesium compound containing also silicic acid, the action of which seems to be catalytic. To the soil fertiliser were added three known and increasing amounts of "Promoloid", which resulted in increasing yields of grain, but no increased yield of straw; the total crop was not increased. The authors intend to test these results in actual practice. NIKLAS.

Experiments on the Disintegrating Effect of Liquid Manure on the Mineral Components of the Soil.

BLANCK, E. and ALTEN, F. Versuche mit Jauchedrill bei Häfer über den aufschliessenden Einfluss des Jauche auf die Mineralbestandteile des Bodens. *Journal für Landwirtschaft*, 18, No. 3, p. 129, 1924.

The application of the PLATH liquid manure treatment in the case of rape had a much better effect than the ordinary application of liquid manure. Repeated experiments in the case of oats prove that the liquid manure treatment will not bring about an action similar to that of either nitrate of soda or of ammonium sulphate. However, other experiments with fresh pig urine on loamy soils indicate that a solvent action on the mineral components of the soil may be attributed to liquid manure. NIKLAS.

The Effect of Zeotokol (Ground Dolerite) on Plant Production.

BLANCK, E. and ALTEN, E. Zur Wirkung des Zeotokols. *Journal für Landwirtschaft*, 72, No. 3, p. 146, 1924.

In 24 zinc vessels, tests were made with Zeotokol on three different soils, maize being selected as the experimental plant. The effect of Zeotokol on the dry substance was somewhat unfavourable, while its influence on account of its supposed colloidal properties was noticeable. Hence the authors conclude that this preparation is of no value.
NIKLAS.

The Effect of Depth of Covering on the Sprouting and Early Development of Pine (*Pinus sylvestris*) Seed.

DENGLER, A. (Researches from the Möller Institute of the Forestry High-School, Eberswalde). *Zeitschrift für Forst- und Jagdwesen*, Year 57, pp. 385-468, 4 tables and 10 illustrations.

The following is a summary of the chief results:

The sprouting numbers decrease with increasing depth of covering in the case of all soils; 0.5-1 cm. of covering depth found to be the most favourable. The time necessary for sprouting increases with increasing covering depth and with the soil hardness. The percentage decrease of germintion is especially marked in depths above 2 cms. The depth of covering determines the type of sprouting. Four types of sprouting can be distinguished:

(1) Hook type; (2) claw type; (3) etiolated, stunted forms; (4) killed. GROSSKOPF.

Investigations on the Acidity of Brandenburgian Beech and Scots Pine (*Pinus Sylvestris*) Habitats, taking Typical Habitat Growths as a Standard.

HARTMANN, F. K. Untersuchungen zur Azidität märkischer Kiefern- und Buchenstandorte unter Berücksichtigung typsischer Standortsgewächse als Weiser, *Zeitschrift für Forst- und Jagdwesen*, Year 57, pp. 321-350.

The author has rendered service in showing the relation of soil acidity to the different floral habitat (arranged mainly according to CAJANDER).

From the large, partly graphic tables it is evident that the habitat growths, beginning with the most acid heather (P_H -4 and under) to sweet grass (P_H -7 and over) which prefers a neutral reaction, extend within fairly wide acidity limits, but that their optima are found within narrower and narrower limits. The same is true of the beech, although its optimum lies within much wider acidity limits, more towards the neutral side. On the other hand the Scots pine occupies a region which extends from alkaline to a very marked acidic reaction and its optima are found to occupy similar, fairly wide regions. The titrational acidity was determined by the DAIKAHARA method; the P_H values were determined by the method of GILLESPIE using different indicators, and by the method of WHERRY using a general indicator. In the P_H determinations special attention was paid to the root depths.

GROSSKOPF.

The Development of Roots of Different Potato Varieties as shown at the Göttingen Experimental Station.

KLÄSENER, O. Wurzelentwicklung verschiedener Kartoffelsarten nach den Verhältnissen des Göttinger Versuchsfeldes. *Journal für Landwirtschaft*, 72, Nos. 1-2, 1924.

The author discusses the scanty literature on the subject, and, since the development of roots is conditioned to a large extent on the physical and chemical properties of the soil, he then describes the properties of the soil of the Göttingen Experimental Station. A description is given of the method of investigation as applied to four different potato varieties. The number of both primary and secondary roots was ascertained, their length, depth of penetration, lateral expansion and water content. It is of interest to note that both the field-plants and the pot-plants had the same number of roots. The author could not confirm the conclusions arrived at by SEELHORST and KRAUS that the worm holes do not influence the depth of penetration of the roots of a plant, but is inclined to support the opposite view of JENSEN. From his work he concluded that the potato, like all other plants, in the development of its roots, attempts to develop a definite plan as it does in the development of its aerial part. He shows also that the roots of the four potato varieties investigated, even without lupins, penetrate to a depth of 120 cm. The lateral roots seek especially the upper soil layers, which are the most favourable for their development. The upper roots have a specific function still unknown to us.

NIKLAS.

The Fertilisation of Pasture by Liquid Manure, with Relation to the Utilisation of the Nitrogen of Liquid Manure for Green Fodder Production.

LIECHTI, P. and RITTER, E. Ueber die Wesendüngung mit Gülle. *Landwirtschaftliches Jahrbuch der Schweiz*, Vol. 35, p. 1, 1921.

The authors have studied a problem of paramount importance for the Swiss agricultural industry. The first point to settle was to find the most suitable yearly application of liquid manure for a soil. A light, to medium heavy, lime-deficient, sandy soil, was divided into a number, of meadow plots each of an area of 50 sq. metres and each manured. The exhaustive results are arranged in 13 tables, each table of several pages, and the following are the main conclusions:

(1) In a liquid manure fertilisation of grassland only larger amounts of manure give a good yield of nitrogen, smaller amounts, even if repeated several times, give comparatively high losses of the nitrogen by evaporation.

(2) When using large amounts of liquid manure large amounts of lime also reach the soil, but these can only be utilised if at the same time large quantities of phosphatic manure are supplied.

(3) Large amounts of liquid manure produce a lime-deficient fodder, and this unfavourable action of the manure can be counteracted by a heavy application of lime.

(4) Liming of the soil brings about both an improvement in the quality of the fodder and an increase in the crop.

(5) Potassium phosphate manuring alone, resulted always in diminished crop, but potassium phosphate and liquid manure gave an increased yield.

(6) Each addition of fertiliser brings about a simplification in the botanical constituents, the clover varieties are repressed, but the albumin content of the fodder does not suffer.

(7 Fertiliser conditions or weathering conditions influence the water content of the grass but little; the grass has the lowest water content on unfertilised plots.

(8) Non-nitrogenous fertilisers give a grass of better quality, but nitrogen containing fertilisers give a much heavier crop. The profits from nitrogenous manuring are considerable.

(9) If it is not possible to apply a nitrogenous fertiliser, a high nitrogen crop can be obtained by a simple potassium phosphate manuring. In these experiments the crop per hectare per year was 40-200 kg. on non-limed plots and 70-230 kg. on limed plots.

GESSNER.

The Influence of Climate and Soil on Plant Life.

LUNDEGARDH, A. Klima und Boden in ihrer Wirkung auf das Pflanzenleben. 113 figures and 2 charts, pp. 319. Publisher Gustav Fischer, Jena, 1925.

This book originated from a series of lectures delivered by the author in the winter 1923-24 at the University of Brünn. It gives an exhaustive review of the Science of ecology and of causal plant geography, and described the author's investigations and the results of experimental work carried out at the ecological station " Hallands Vädero " (Sweden) established by the author. The various problems are studied from a physiological standpoint, and the author attempts to formulate certain general physiological laws, especially the law of the relativity of factor action.

It is impossible to render full justice to this exhaustive book in a short space. After a historical introduction the principal chapters deal with the factors of light, temperature, water, the soil according to its structure and general ecological properties, the physical character and the ventilation of the soil, the chemical factors of the soil, the micro-organisms of the soil, the carbonic-acid factor, the main principle of experimental ecological investigation. Each one of these chapters is subdivided into a large number of sections.

The criticism of a scientific work, like the present, cannot and must not have for its object the picking out, from the whole mass of material, of one or other view of the author with which one does not agree ; on the contrary such a work must be looked upon as a whole. Taking that view, it may be concluded that this is a work of great scientific value, which should not be missing from the library of any soil-science, geographical, botanical or other Institute. The whole book, and also the illustrations and figures are excellent.

SCHUCHT.

The Afforestation of Calcareous Soils especially by the Speckled Alder and the Black Spruce, in the Forest District of Göttingen.

STASSEN and BEIJRISCH. Uber Aufforstungen ueber Kalködland. *Zeitchrift für Forst- und Jagdwesen.* Year 57. pp. 483-494.

From the chemical part of the paper, particularly from the data relating to the hydrochloric acid soil extracts, the following conclusion can be drawn that, the soils covered by the speckled alder are much richer in nitrogen than those covered by the black spruce. These results probably have some relation to the well known fact of the enrichement of the alders in nitrogen by nodule bacteria, and it is of interest to have some quantitative results. Amongst the nitrogen data given are the following :

Nitrogen content.

Rock	Bare land	Covered by black spruce	Covered by speckled alder
—	—	—	—
Muschelkalk 0.020	5 cm. depth 0.103 5-20 cm. depth 0.637	5 cm. depth 0.167 5-20 cm. depth 0.092	5 cm. depth 0.345 5-20 cm. depth 0.178

GROHSKOPF.

The Fertility of the Soil in Relation to Soil Acidity.

VITINS, J. (WITYN, J.), Riga, 1924, pp. 80. (Latvian).

The author discusses the importance of the factors of growth of plants, air, water and mineral foodstuffs. As a result of numerous investigations he concludes that these factors by changing the reaction character of the soil from neutral to acid, impair the growth conditions of the plant. Thus, e. g. the minimum water capacity (KOSSOWITSCH) of " podsol " upper layers is much smaller than the minimum water capacity of the lower layers. The minimum water capacity of very fine grained " *Gleys* " was only 30 %, while the minimum water capacity of the very loose marl was, in one case, as high as 46 %. Also, the capillary water rise in podsol layers is smaller even than the rise in the case of the very finely grained marl-loams. Plants suffer from a water shortage mostly when growing on podsol soils, when the latter become acidic. The acid reaction of the soil injures particularly the ability of the plant to utilise phosphoric acid and nitrogen, as GEDROIZ proved again and again in his plant experiments. Numerous field experiments show that the Latvian soils contain only minimum quantities of phosphoric acid and nitrogen and the main cause is the lime shorttage. The acid soils contain larger quantities of difficultly decomposable organic substances andof phosphoric acid than those soils, which, formerly strongly acid lost their acidity through cultivation. The author mentions several very fertile soils which at present contain only 0.03-0.05 % of P_2O_5 and which without any phosphoric acid fertiliser whatsoever give very high yields, although the very same soils were previously strongly acid. In the acid soils the P_2O_5 content is 0.1-0.2 %.

The K_2O absorption also is impaired in acid soils, as can be seen best in the so called " *Gley* " soils rich in lime. In the case of these soils also, cases are known in which liming causes an improved utilisation of potassium (as determined by the grain weight without lime fertiliser).

The author mentions gypsum as the cheapest source of sulphur. It is probable that podsol soils suffer from a sulphur deficiency, since cases are known where superphosphate fertilisers gave much better results than basic slag, although the investigated soils belonged to that type on which crude phosphates act very beneficiently.

In the opinion of the author the so-called " active " acidity can impair the growth of a plant only to a very slight extent and only when it is growing on a light, lime-deficient soil. The lime content of heavy soils and of low moors is relatively high and hence their active acidity cannot be very high (buffer action). However, on these soils the roots of plants suffer from a nitrogen deficiency, even when the soil shows a low acidity. The author concludes that the yield from a plant is not determined by the abundance of food material in the soil, but by the physical and chemical properties of the soil. The same conditions determine the amounts of fertilisers required. To secure better crops from poor soils special attention must be paid to liming. By diminishing acidity of these poor soils and even with the same quantities of fertilisers the crops can be increased from two to five times.

L. FREY.

The Decline in Growth of Pines in the Middle and Lower Levels of the State Forests of Saxony.

WIEDEMANN. E. Zuwachsrückgang und Wachstumsstockung der Fichte in den mittleren und unteren Höhenlagen der sächsischen Staakforsten. Akademische Buchhandlung W. Laux. Tharandt, 1925.

The book is subdivided into three main sections and deals with the causes of the decline in growth of the pine, its relation to weathering, and finally with the means to overcome the stoppage of growth. The bock is subdivided into the following sections:

A. The causes of the growth decline in the Saxonian pine forests. (1) The proof of a growth decline; (2) the growth stoppage in the investigated region; (3) climatic causes of the growth decline; (4) changes in the soil conditions and the humus layer; (5) other injurious causes.

B. Single investigations. (1) The sensitiveness to dryness of other wood varieties; (2) The growth of pines in the period 1911-22, and weathering.

C. The experiments in Saxony on overcoming the decline in growth of pines. (1) General. (2) Precautions taken by the felling authorities in Saxony. (3) Other curative measures. Conclusions.

L. G.

Regional Soil Science.

Analyses of Soil Types of Troup County.

Bulletin of the Georgia State College of Agriculture, Vol. IV, No. 2, pp. 28. Athens. Georgia, 1915.

The soils of Troup County belong wholly to the Piedmont Plateau. The following types of soils occur: sandy loams of the Durham, Congaree and Cecil series, and loams and clays of the Cecil, Louisa, Irdell, Congaree and Altavista series. Food material and acid analyses were made of all soils.

HELLMERS.

Analyses of Soils of Dougerthy County.

Bulletin of the Georgia State College of Agriculture, Vol. 5, No. 17, pp. 37, 3 illustrations. Athens, Georgia. 1919.

Dougerthy County lies wholly in the coastal plain. Only a narrow strip in the East belongs to the Grey Sandy Loam division and the rest belongs to the Red Belt. The soil is composed of the gravel and sandy loams of the Greenville, Orangeburg, Tifton, Norfolk, Sesquehanna, Grady, Cahaba and Thompson series, of the sands of the Norfolk series and of the clays of the Greenville and Grady series. In addition are found large swamps, especially along the Coolewahee river and the Chickasawhackee river. The soils of these swamps are coloured black by large masses of organic matter to a depth of 9-12 inches. In appended tables are given the results of food material analyses of all soils.

HELLMERS.

Analyses of Soils of Polk County.

Bulletin of the Georgia State College of Agriculture, Vol. 5, No. 18 pp. 55, figs. 5. Athens, Georgia, 1924.

The greater part of the soil of the Polk County belongs scientifically to the limestone valleys of the north-west of Georgia, a small part in the East belongs to the Appalachian's and a part in the South to the Piedmont-Plateau. Among its soils the Talladega series are represented by shale, gravel and clay limes, the Louisa series by gravel and fine sandy loams, the York series by loam, the Decatur series by clay and stoney loams, the Hagerstown series by gravel, fine sandy and ordinary loam, the Clarcksville series by stoney, gravel and ordinary loam, the Colbert series by fine sandy loam, and the Christian, Arnuchee, De Kalb, Hanceville, Elk, Holston, Huntington and Gongaree series by gravel, stoney and sandy loams. In appended tables are given the results of plant food material analyses of these soils, together with the results of acid analyses.

HELLMERS.

Analyses of Soil of Jasper County.

Bulletin of the Georgia State College of Agriculture, Vol. 7, No. 6, pp. 46, plates 3. Athens, Georgia, 1918.

The soils of the Jasper county belong wholly to the Piedmont Plateau type. Among the soils are represented the Davidson series by loam, the Cecil series by stoney-sandy loam, sandy loam and sandy-clay loam, the Durham, Appling and Wilkes series by sandy loam, the De Kalb series by stony-sandy loam, the Louisa series by clay loam, the Molena series by sandy loam and the Congaree series by fine sandy loam and slimy-clay loam. All soils were examined for plant food material content and acidity.

HELLMERS.

Analyses of Soils of Crisp County.

Bulletin of the Georgia State College of Agriculture, Vol. 8, No. 3, pp. 30, 1 map. plates 3. Athens, Georgia, 1919.

Crisp County belongs wholly to the coastal plain. The main part of its soil belong to Grey Sandy Loam, a sub-division of the coastal plain, and only a narrow strip in the West belongs to the Red Belt. The Norfolk and the Tifton series are represented by sand and sandy loam, and the Greenville and Orangeburg series are represented by sandy loam. The Auston series is represented by loamy sand and sandy loam, the Sesquehanna, Plummer and Grady series are represented by sandy loam, the Kalmia and Myatt series by fine sandy loam and the Congaree series by silt loam. Appended tables give the potash, phosphoric acid, nitrogen and-lime content of these soils as well as the results of acid analyses. HELLMERS.

Analyses of Soils of Pierce County.

Bulletin of the Georgia State College of Agriculture, Vol. IX, No. 9, pp. 36, 1 map, 3 plates. Athens, Georgia, 1921.

Pierce County lies wholly in the region of soils of the coastal plain. The soils in the north-west belong to the Grey Sandy Loams type, the remaining soils belong to the "Flatwood" type. Sands are found in the Norfolk, Plummer, Blanton and Leon series and sandy loams in the above mentioned series and also in the Myatt, Kalmia, Susquehanna and Tifton series. Besides these soils large tracts of the County are occupied by swamps, especially along the rivers. Appended are the results of food material and acidity analyses of all soils except the swamps.
HELLMERS.

Analyses of Soils of Wilkes County.

Bulletin of the Georgia State College of Agriculture, Vol. IX, No. 10, pp. 39. plates 2. Athens, Georgia, 1920.

All soils of the Wilkes County belong to the Piedmont Plateau type. The Cecil series is represented by sandy and stonsy loams and clays. the Appling series is represented by sandy loams and the Congaree series by sandy and clay loams. All soils were analysed as to their potash, phosphoric acid, nitrogen and lime contents and also a determination of the acidity of each soil was carried out. HELLMERS.

Analyses of Soils of Floyd County.

Bulletin of the Georgia State College of Agriculture, Vol. XI, No. 15, pp. 70, Athens, Georgia, 1923.

Floyd County lies wholly in the region of limestone valleys. The soil consists mainly of loams. Clay loams are represented by the Decatur, Hagerstown, Frederick, Christian, Monterallo, Greenville and

Cumberland series, while gravel and stony loams are represented by the Huntington, Jefferson, Allen, Norfolk, Greenville, Hanceville, De Kalb, Shackelton, Monterallo, Frederick and Clarcksville series. Fine sandy loams are found in almost every one of the above mentioned series. In the northerly and north-westerly parts are found in addition pure stony soils. Appended are results of plant food material analyses of all the above soils.
HELLMERS.

Analyses of Soils of Burke County.

Bulletin of the Georgia State College of Agriculture, Vol. XIII, No. 5, pp. 39, 1 map, 2 plates. Athens, Georgia, 1924.

The soil of Burke County in its greater part belongs geologically to the coastal plain. Only the most northerly point belongs to the Piedmont Plateau. The soils of the coastal plain are in the north, the Red Belt soils and in the South Grey Sandy Loams. The varieties of sands found belong to the Norfolk, Austen and Kalmia series, while the sandy loams are represented by the above mentioned three series, together with the Tipton, Orangeburg, Greenville, Susquehanna, Grady, Kalmia, Leaf and Myatt series. A fine sandy loam of the Congaree series is also found. Along th rivers and brooks are found swamps. A series of tables gives the results of food material analyses of the above soils.

HELLMERS.

The Upper Rock Strata of White-Russia.

AFANASIEW, J. *Mem. de l'Institut agronomique à Gorky*, Vol. II, pp. 140-154. Gorky, 1924.

General survey of the rock strata:

(1) Upper beds composed of different types of rocks: siliceous or non-siliceous sands (1 metre), loamy sand (Latvia) — 1 metre; coarse-sandy loam (1 metre); loess-sandy loam (30 cms.-1 metre); loess (10 metres); loams free of siliceous material (up to 0.5 metre).

(2) Middle bed: Sand, free from pebbles, coarsely stratified (from 10 cms.-1 metre).

(3) Lower bed: Moraines, the upper layers of which are usually an accumulation of siliceous detritus; in loess regions, however, they contain humus (0.5-1 metre). In the latitude of Gorky there are found two horizontal strata of moraines, but in the neighbourhood of Wilabsk there are three strata, separated from each other by layers of sand (12-15 metres thick).

The soil forming layers consists of alluvium which overlies the moraines. From these alluvium deposits depend the different horizontal layers, the properties of the different soil varieties and the division into principal agricultural regions

All strata overlying the moraines are regarded as products separated from the moraines by the glacier waters of the regions.

Evidently the glacier streams, like the rivers of the present day, separated out the material and deposited and accumulated it on the extensive and very varied moraine beds, adjusting themselves naturally to the topographic and hypsometric conditions of that time.

However, to get a clear picture of the whole process of deposition we must take into account the various, chronologically separated, rock beds of the different periods, as they correspond to the separate and consequent stages of the glacial period. In this respect we can distinguish the following important stages:

After the deposition of the upper layers of the moraines there followed in the latitude of Gorky, just as on the high plateau, a stationary period with predominating damp conditions. Then there were formed on the upper surface of the moraines, humus containing swampy soils, and in the low lands between them peaty masses. In lower lying districts no traces of this stage have been preserved.

Next followed a general rock forming period, the so-called alluvial-sea period, when a certain amount of rock was deposited; on higher lying flat parts loess and sandy soils of a loess character and in lower lying areas, sandy pebble varieties.

The next period is connected with the appearance of the last ice-period, which ended in the north-westerly parts of White-Russia and left behind beds of end-moraines together with the accompanying deposits. The other parts of White-Russia were at the same period subject to the action of glacier water. This action was of a twofold character, both erosive and accumulative.

The last of the retreating ice-masses have left behind traces, particularly on lower lying parts, of sandy strips of old alluvium.

The beginning of the agricultural period, when sands in the form of hills and dunes appeared, has been characterised by the wearing away and consequent removal of the sandy deposits. In regions with soils of a fine-grained character, however, especially in those with soils of a loess type the erosion processes have been continued even to the present time. AUTHOR.

The Soil Division of South-Eastern Russia.

GLINKA, K. (Rostov-on-the-Don), pp. 1-7, 1924.

The author subdivides south-eastern Russia into the following regions:

(1) The region of *ordinary* black-earths (the northern part of the Don territory and perhaps the south-western parts of the District of Stavropol).

(2) The region of *southern* black-earths (the middle parts of the Don territory and the north-eastern parts of the District of Stavropol).

(3) The region of the *Azov* and of the *Lower Caucasian* black-earths (the south-western parts of the Don territory, the main parts of the Kuban territory, a large part of the District of Stavropol and part of the Terskaya territory).

(4) The region of *chestnut coloured* soils (the south-eastern parts

of the Don territory, the northern and the middle parts of the District of Astrakhan and the Government of Stavropol near Matysch).

(5) The region of *brown* soils (the limestone quarries of Astrakhan, etc.).

(6) Foothills with podsol soils (lower Caucasus). AUTHOR.

The Soil of the Kirghis Republic.

GLINKA, K. pp. 1-85. Orenburg, 1923.

After a short historical introduction on the data obtained by the scientific soil investigations of the Kirghis Republic, the author gives a description of the soils and characterises, morphologically and chemically the local black-earth, chestnut, coloured soils, Solonetz and Solontschak soils. AUTHOR.

Chemical Characteristics of the Loess of the Former Cherson Province.

KROKOS, W. *Proceedings of the Scientific Research Institute of Odessa*, Vol. I, August-October, No. 10-11, pp. 1-17, 1924.

In the following report are given the humus CO_2 and SiO_2 content of the different loess varieties and of the moraines.

The loess is poor in humus with the exception of the soil surface. Its content varies between tenths and hundredths of one per cent, but sometimes is nil. The fossil soil contains little humus. The first upper layer of fossil soil, contains 10-0.78 %, the second layer 0.33-0.45 %, and the third 0.62 %.

The low humus content is explained by later decomposition processes.

The carbonate levels of the fossil soils show an increasing CO_2 content. Considerable variations are found in the SiO_2 content, from 63.35 % to 84.56 % in the case of the second loess type, which is the most sandy. All loess layers get less and less sandy as the distance increases from the Dnieper. In the same geological section the loess and the moraine cannot be distinguished from each other by the SiO_2 estimation. This indicates a close connection between the loess and the moraine deposits.

Each loess variety is related to the corresponding glacial epoch, and the four loess varieties of the Cherson Government indicate four glaciations on the Russian plain.

The loess of wind-borne origin could not have been formed during the glacial retreat, since the first, or uppermost loess variety is separated from the moraines by a fossil soil. The second loess variety lying underneath the moraine cannot be separated from its fossil soil. The loess may have been formed in the second half of a glaciation period, or during its stationary state, as a result of the deterioration of its fluvo-glacial deposits.

The glaciation of the Dnieper basin was the third, i. e. the last but one, and it led to the formation of the second, more sandy, loess variety.

The first loess variety was formed during the fourth glaciation, i. e. the last, which affected mainly the north-western parts of Russia and did not reach the Ukraine. AUTHOR.

The Characteristics of the Soils of the Provinces of Odessa and Nikolaew (formerly Kerson.).

KROKOS, W. Part I. *District Board of the Experiment Station*, 1922, Section I, pp. 1-38. Odessa, 1923.

The different kinds of loess of the Provinces of Nikolaew and Odessa were studied principally by means of artificial borings and diggings on the plateau and the upper parts of the slopes.

It was thus proved that on the investigated territory four kinds of loess can be distinguished. The first and principal variety is the wind-borne loess. In the region of development of chrystalline minerals sharp fragments of these are found, and on the terraces of the Dniester near the town of Tiraspol are found sharp fragments of Carpathian fine gravel. These facts can be explained by the action of whirlwinds which may have taken place during the deposition of the loess. The second variety is loess with intermediate layers of dune-sands; the third variety is diluvial loess, and the fourth is fresh-water loess containing residues of fresh-water molluscs.

The sections at Voznesensk and Migaewo represent four varieties of loess with three dividing layers of fossil bodies. The different stages of loess reckoned from the top are marked by the letter L. Thus L_1 represents the first loess stage, L_2 the second loess stage, etc. The existing surface layer or the fossil soils are indicated by the letter *a*. Thus the first loess stage with overlying soil is denoted L_{1a}, the second L_{2a} etc. Moraines are denoted by M.

The loess overlying the moraines is separated from the latter by an intermediate layer of fossil soil. This points to the absence of any relationship between the loess and the moraines, and indicates that this region after the disappearance of the glaciers became covered with plants which helped in the formation of the fossil soil, and that only later conditions arose which were favourable to the formation of the loess.

The depth of L_1 is half that of L_2, L_3, L_4, each taken separately, and from this the conclusion, may be drawn that the time taken in its formation was only half that of each of the separate other and older stages.

The fossil soils which separate the different loess varieties have the character of black-earth, while the soil in L_2 shows pale humus soil; the soil in L_2 and in L_3 is coloured deep black and has a much greater thickness. These facts together with a morphological study of the loess show that on the territory of both districts a steppe was formed not later than the period of deposition of L_4 and existed uninterruptedly up to the present times. Judging from the fossil remains the steppe was originally moist (L_{3a}, L_{4a}) and became drier and drier.

At a depth of 2-4 metres the loess becomes chocolate brown and is traversed by yellow veins, branching vertically, which contain concretions, incrustations and small tubes of manganese salts, and it shows a wedge-shaped clearage the surfaces of which have a brilliant almost lacquered appearance.

This chocolate-brown loess has been formed owing to water logging of the lower surfaces of the loess layer, and the subsequent articulation of the district through river-valley and ravine formation, has effected a partial drainage of it (the district) and a considerable lowering of the soil water content.

The investigations of 1920-1921 proved that L_1 of the Odessa District Province were formed in the after-loess period through an inclination of the continent towards the Black Sea. AUTHOR.

The Lime Requirements of Latvian Soils and their External Characteristics.

J. VITIŅŠ (J. WITYN), pp. 88 + 32, illustrated, Riga, 1924 (in Latvian).

The author discusses the importance of liming for plants and soils, the peculiarities of the podsol-forming process on different subsoils and the external characteristics of lime-requirement. The most important characteristics are:

(1) the colour of the soil, (2) the white weathering crust on the primary rocks found in the soil, (3) the texture of the soil, (4) the nature of the organic substances found in the soil, (5) the effects of dung manuring, (6) the nature of the soil section, (7) the cracking and handening of soils on drying, (8) the permeability of the soil to water, (9) rising of water, (10) the drying of the upper layers of the soil, (11) the development of the Leguminoseae and especially of clover, (12) the weeds. The extermination of weeds is particularly difficult on acid soils.

The author treats in greater detail the following liming materials: (1) burnt lime and its preparation in Latvia from dolomite; not suitable for liming and too costly. (2) Spring lime is found in many places (more than 150 are known) among which are some containing 150,000 cubic metres of lime or more. The lime is of 95 % purity and in many cases reaches 99 % purity. In cases where this spring lime is found at higher altitudes it is hardened and transformed into tufaceous limestone; in the lower levels the lime is very loose, very fine grained and can be used without grinding.

(3) Sea-marl contains 50 % $CaCO_3$, but, is seldom found.

(4) Grey marl-loams contain 20-50 % $CaCO_3$ are found on the seacoast between Windau and Libau.

(5) Light sandy boulder-clay, very common in Northern Latvia on the Devonian sandstones, contains 10-15 % $CaCO_3$, very seldom 20 % $CaCO_3$. The upper layers are lixivated and "podsoled"; found at a depth of 1-1.5 metres

(6) Heavy boulder- clays are only found in the southern and southeastern parts of Latvia. Theupper layers are "podsoled"; found at a depth of 60-70 cm.a nd contain 15-30 % $CaCO_3$ in the upper surface, and 20 % in the middle and lower levels 4 % $MgCO_3$. The boulder-clays have been subjected to inundation and subsidiary products have been

formed. Among the latter $CaCO_3$ is found only in striated clays and garnet deposits.

(7) Garnet deposits are found only in osars and in isolated round masses. Lime is found only in a coarse form (grains larger than 1 mm.) and may reach sometimes 81 %; the grains of Silurian limestones from Estonia are rounded and polished. Before use the garnet should be ground although it is being used quite successfully without previous grinding.

8) Striated clays. Their thickness reaches in some cases 1-3 metres. They contain 15-36 % $CaCO_3$ and the $CaCO_3$ content is highest in clays with grains of 0.005-0.05 mm. in diameter. In the heavy finely-grained red clays the $CaCO_3$ content reaches only 15 %. The striated clays are found very often over large areas. These striated clays are especially useful in the case of light, sandy soils and pastures, since they contain besides the lime, 2.5-3.0 % of K_2O. Their use on light soils is equivalent to a complete manuring, as the liming helps in the utilisation of the phosphoric acid and nitrogen.

The author gives many examples of the use of the above liming materials; in many cases the liming has been brought about unintentionally while making deeper cultivation.

In conclusion the author mentions cases when liming brings about unfavourable results, when (1) the materials used contain FeS or FeS_2; (2) on account of the small humus-content of the soil very little carbonic acid is evolved so that the $CaCO_3$ cannot be converted into $Ca(HCO_2)_2$; (3) too much marl has been applied to the soil; (4) the soil suffers from a deficiency of other plant foods, mainly sulphur and phosphoric acid; (5) the soil is excessively moist.

The publication contains 32 photographs and 18 figures.

L. FREY.

The Sands and Sandy Soil of Latvia.

J. VITIŅŠ (J. WITYN), pp. 122 + 25 of German text, 50 illustrations, 6 soil sections (coloured) and 1 map. Riga, 1924.

The sand deposits occupy about $^1/_3$ of Latvian territory. The greater part of these deposits was formed during the ice-age, during the retreat of the ice; a part however, was formed at a later period by the depositing action of the rivers. Also the moraine loams of Latvia contain large masses of sand, which was brought about by the admixture of the sands of the Silurian and Devonian formations during the ice-age.

Large masses of sand are found in the neighbourhood of Riga and of Mitau, and where, even at the present time, the three greatest Latvian rivers, the Dvina, the Liv and the "Kurland" Aa, deposit large amounts of sand. Large deposits are found also in the neighbourhood of Windau, on the sea coast and also further inland.

The mechanical composition of the sand is characterised by the presence of a large proportion of grains of 0.05-0.25 mm. size. In some sands about 98 % of the grains are of that size, and in no case is the percentage smaller than 80. Clay particles (0.01 mm.) occur in the sands very seldom and never to a greater proportion than 6-8 %.

The chemical composition of the sands is quite different from that of the Finnish sands or of the sands of the district of St. Petersburg. The Latvian sands were derived from the latter sands. The Latvian Sands are characterised by a much smaller K_2O and Na_2O content; thus the K_2O content of Finnish sands is 2.05 % (FROSTERUS), of the sands of the district of St. Petersburg (WITYN) is 2.61 % and of the Latvian sands is 1.02-1.38 % The corresponding Na_2O contents are 2.69 %, 1.85 % and 0.20-0.52 %. They do not contain $CaCO_3$, which is explained by the lower resistance of limestone to crushing and grinding forces. The P_2O_5 content of the deeper lying sands is 0.05 %, and only in a single case was 0.0027 % found.

The sandy soils are mostly covered by forests of classes I-V, the central part being of class III, and heaths are found where the growth of forests would be too difficult.

The quality of the forests, as well as the usefuloness of the soil for agriculture is related very closely to the degree and the character of the podsol forming process. The development of the forests is mainly conditioned by the depth of the local rock level; with a rock depth of 30-50 cm. the forest development is still satisfactory, but with a depth of 5-15 cm. it is very poor. In such cases the roots of pines do not grow to any depth, but develop horizontally. The mother rock contains about 0.4-0.6 % $CaCO_3$ and has a thickness of about 1 cm.

It is not probable that these soils will improve without liming, as the CaO content of the sand and of the subsoil, soluble in hot 10 % hydrochloric acid, is barely 0.01-0.05 %. Even the soils under forests of the first class are strongly "podsoled." The author is of opinion that a slight diminution in the acidity of the soils would have a very beneficial effect on the pines. The solution of this question in practice is of great difficulty, since account has to be taken of the presence in the soil of various organic substances and of the changes undergone by them, as they and their changes influence profondly the acidity of the soil. Probably good results could be obtained by the application of small quantities of $CaCO_3$, in any case by smaller quantities than those used in Jutland for the heath soils (60,000 kgs. $CaCO_3$ per hectare). The author recommends spring lime as the most suitable liming material for forests soils, and striated clay, on account of its large K_2O content, for agricultural soils.

L. FREY.

Nomenclature and Classification.

The Division of Bavaria into Economic Units on the Basis of its Geological and Soil-scientific Conditions.

NIKLAS, H. and POLT, H. Die Einterlung Bayern in Wirtschaftsgebiete auf Grund der geologisch-bodenkundlichen Verhältnisse. *Zeitschrift des Bayerischen statistischen Landesamtes.* Nos. 3 and 4, 1924.

The authors have divided Bavaria, from a geological point of view, into 33 economic units and these are subdivided into 434 seed-sowing units. From tables it can be seen how many districts fall into every one of the units, what the average climatic conditions are for each unit and what the current conditions for cultivation in each unit are. Finally they determine for each unit the average crop for five years in the case of the more important varieties. Of primary importance for the work were, the soil map of Bavaria prepared by H, NIKLAS and published by the *Zeitschrift des Bayerischen Statistische Landesamtes*, and the atlas: " *Bayerns Bodenberwitschaftung unter Berücksichtigung der geologischen und klimatischen Verhältnisse* ", prepared by the same author and published in 1917 by the " Statistisches Landesamt ". NIKLAS.

The Districts of the Department of the Isère.

ROY, H. The district round Grenoble, pp. 501-520, Grenoble, 1925.

I. The alpine district of the Haut-Dauphiné. The crystalline and Liass beds of Oisans and Valbonais carry fertile pastures. Only rye and potatoes are grown at altitudes above 1000 metres.

The districts of Beaumont, Mateysine and triéves are formed of Liass-schists and carboniferous strata, covered more or less by glaciers, but the marl soils are suitable for the cultivation of cereals and fodder. Oats, tares and fodder grasses are especially grown. The extensive, bare plains are occupied by sheep.

The Lower Alps of Villars de Lans and of Grande Chartreuse are composed mainly of calcareous rocks and carry pastures up to an altitude of 1000-1200 metres.

Grésivaudan. A fertile valley of the Isère, is like a well-watered garden.

II. The Outer-Alpine district or Bas-Dauphiné.

The height declines from 500 to 200 metres from the Alps in the direction of the Rhône

The Crémière at an altitude of 250-400 metres, is a Jurassic calcareous, glacial plateau; polyculture is being practised.

The Lyon plain with its fluvio-glacial ferruginous loams carries only extensive crops.

The cold siliceous, and heavy clay soils at an altitude of 500 metres, are muddy in winter and very dry in the summer and form the animal breeding and forestry districts.

The plateau of Chambarans, from 600 to 700 metres in altitude; is not agricultural, but carries forests and is a breeding district especially of goats and oxen.

The plains of Bièvre and of Valloise, a dry ravine of fine yellow-coloured sandy-clay soil contains enclosing rounded pebbles of the Rhône Alps. Except in the valleys, the yield of wheat and of stock is low, but the quality is exceptionally high.

The marshes of Bourgoin, rich in humus, are partly drained, and grow poplars and industrial crops.

The Balmes are the hills dominating the Rhône and bear Liass and glacial soils and is a fruit growing and dairy district.

The Roussillon terrace, has the same character and is a vine and peach growing district.

The Rhône sands are occupied by market gardening on account of the very rich soil and the climate; altitude 140 metres. The chief crops are of vines, peaches and apricots.

La Voyeraine extends on a fluvio-glacial terrace at a height of 60-70 metres above the Isère. The sandy soils are used particularly for the growing of nuts for export to the United States.

On the Isère the same phenomenon is observed as in many other places, a falling off in the area of arable land and an increasing area given over to pasture, in the humid climate, especially on clay, and sandy clay soils.

The best potatoes are grown in the Alps in Trièves, Valbonnais and Oisans. The slopes exposed to the north as well as the cold soils of a schistose origin are stated to give better seed than the warm soils, such as those of a sandy nature. PIERRE LARUE.

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General Notices.

Murgoci. — On March 5, 1925, Rumania lost her most renowned geologist and agrogeologist, by the sudden death of Prof. G. Murgoci, who by his varied and important research work and original ideas placed himself in the front rank of the leaders of science.

George Muntean Murgoci was born in 1872 at Braila. His secondary education was received at Braila and Bucharest at which latter place he also attended the University. Originally he studied Mathematics, Physics and Chemistry, and then turned exclusively to the study of the natural sciences. After the completion of his University career he went to Vienna and Munich where, under G. Tschermak, I. Becke I. V. Groth and E. Weinschenk he devoted himself principally to the study of petrography, and in 1899 at Munich gained the doctorate, with "magna cum laude". Returning to Rumania he joined the Rumanian Geological Institute as a geologist and made a detailed geological map of the south-eastern Carpathians. His love of the mountains excelled even his scientific enthusiasm for the study of geology, but his great interest in soil problems led to his very successful agrogeological studies.

In 1905 the Rumanian Geological Institute established an agrogeological section of which he was Director. In 1909 he was appointed Professor of Mineralogy, Petrography and Geology at the Technical High-School of Bucharest.

Agrogeology is a science which can be studied with success only if the specialist has the opportunity to travel extensively, so as to be able to know and study on the spot, soil conditions and relations under the most varying climatic conditions. Even at the present time we do not yet possess such a description of the different soil types as would enable us to study regional soil science from books. MURGOCI satisfied these demands to the fullest extent and there are very few scientists who can possibly undertake so many journeys for study. As a student he travelled over a part of Germany and in the next year visited France and England. In 1904 in London, he married Dr. AGNES KELLY, a highly educated lady with whom he had worked under Prof. WEINSCHENK. He leaves two children, a daughter Helene, who is studying medicine, and a son RADU, who a short time ago gained a prize at Cambridge. After marriage he travelled across the United States, and worked under Prof. A. C. LAWSON and Prof. E. W. HILGARD at the Universities of Leland and Berkeley. In the various countries of Europe, he studied and learned the different methods of mapping in use. However, his repeated travels for the purpose of study, to Hungary and Russia, had a decisive influence on his soil-mapping methods, and made hin an adherent of the Russian school. The soil survey map of Rumania which be submitted to the 1st International Agrogeological Congress in 1909 was constructed on general natural-science lines. On it the different soil-types are grouped in zones, which form an uninterrupted continuation of the different Russian soil zones.

The journeys undertaken by us together in 1907 and 1908 in south Russia and Rumania led to the calling together of the first International Agrogeological Congress at Budapest. MURGOCI was one of the four whose efforts brought about the holding of agrogeological congresses (1).

At the 2nd International Agrogeological Congress at Stockolm the *Internationalen Mitteilungen für Bodenkunde* were founded and he was chosen as one of the editors, which honorary position he occupied until the journal ceased to appear. After the war he was one of the first who helped to reestablish the broken relations between the scientists of the different countries, and his efforts brought about the re-establishment of the International Congress.

At the 3rd International Congress he was elected president of the 5th International Commission for Soil Mapping, and devoted himself to this honorary office with great enthusiasm and was the author of the famous "*Memoires de la Cartographie du sol*".

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(1) The letter for the assembling of an International Agrogeological Congress was signed by J. NAMOGLICH, Odessa, G. MURGOCI, Bucharest, O. TREITZ, J. TIMKO, Budapest, Director L. V, LOGGY, at the Congress which took place at Budapest.

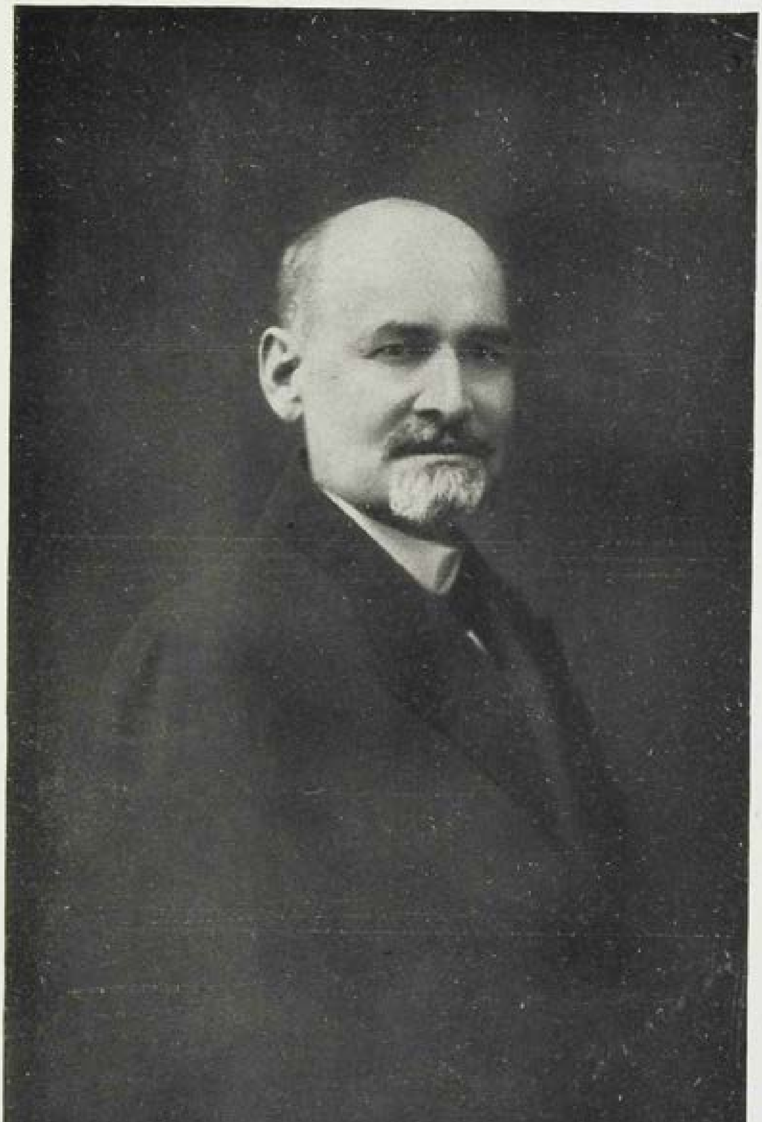

FIG. 8. — MURGOCI. Born at Braila 1872, died at Bucharest May 5, 1925.

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Although already ill he devoted all his strength and energy to the edition of the "*Memoires*" and continued this work even during his illness.

He planned several volumes of the "*Memoires*" in which he intended to deal with all the different types of soil and description current in the different countries, but succeeded in publishing only one volume, so that the work was left unfinished. However, even this one volume is of lasting value as an example for future similar work. We also owe to him the first carefully worked out scientific soil nomenclature, which will serve as a basis for future developments.

The 4th International Soil-science Congress decided on the making of a soil-survey map of the whole world. For that purpose a small executive committee was formed of which he was elected Director. And again he put all his energy into the work, hoping to have the work finished before the next Congress. He prepared a sample map as an example. He did not spare his health and his illness was no hindrance to his strenuous work.

In his life, work follows work, with only short intervals for rest and even these were taken only from necessity. However, fate prevented the completion of his great work and early death overtook him in the fullness of his restless activity. His tireless efforts found recognition in his election to membership of numerous scientific societies, among others to the French Academy of Science of Paris. His was one of the best known figures at all the international geological and agrogeological conferences, and owing to his knowledge of languages te always took a prominent part, his opinion in many cases being decisive. Also at the last Soil-Science Congress at Rome, in 1924, he, as Chairman, although in pain, led the discussions. We all known how, owing to his co-operation and to his able chairmanship, that Congress concluded with such valuable results.

It will be difficult to replace this dear colleague whose restless activity exerted such a profound influence on our science and which won him the respect of all who could appreciate it.

He will never be forgotten by those who knew him and his work will have a lasting value. PETER TREITZ.

Prof. Ramann, President of the Soil Science Research Institute, died at Munich on the 19th of January 1926. An obituary notice will be published in the next number of this *Review*.

Communication of the Executive Committee. — As appears from the list of members published in this number the membership is now 671. This obviously involves a heavy claim on the time of the General Secretary, who is also the Treasurer. I wish therefore to repeat my appeal to members for their collaboration. Members can effectually lighten my work if they will reply at once to my enquiries whether made by letter or circular, and especially if they will send annual subscriptions without delay and, if possible in Dutch florins, enclosing the entrance fee if payable. Remittances should be sent by Post Office, Order or by payment to the "Geldersche Credit Vereeniging", Groningen (Holland), on account of the International Society of Soil Science.

But as I already suggested in the previous number (Vol. III, No. 3, p. 759), it is absolutely necessary that part of my work be undertaken by the National Sections. I therefore desire to urge members once more to found National Sections and to report to me the composition of the executive committees. My idea is that the secretaries (or the treasurers) of these National Sections should in future assist me by being responsible for receiving new applications for membership, payment of annual subscriptions, the change of addresses, etc., reporting to me on these points and sending me the annual subscriptions in a single account.

Moreover I should like to remind the members that:

(1) The annual subscription for 1926 has been fixed at 6.50 Dutch florins (10 Dutch florins = about 4 Dollars).

(2) The entrance fee for new members amounts to 2.50 Dutch florins (= 1 American Dollar).

Members are requested to send the annual subcription for 1926 before 1 April 1926, with the entrance fee payable.

(3) New members for 1926 who wish to obtain the four numbers of the first volume (1925) of our Journal, must apply to Dr. Borghesani, International Institute of Agriculture, Villa Umberto I, Rome.

(4) In this number, the list of members has been inserted. Kindly inform me in *typescript* of any errors.

(6) The Journal appears in 5 languages; members are asked to inform me, if necessary, in which of these 5 languages they desire to receive the Journal.

(6) In Vol. III, No. 2, the rules of the Society were given. Reprints may be obtained or application to myself.

(7) Members intending to join one or several commissions, are requested to apply at once to the chairmen of the respective commissions. As tc the composition of these commissions, see Vol. III No. 2 (April-June 1925).

(8) Members who wish to receive the Proceedings of the Fourth International Soil Science Conference (Rome, May 1924) at the reduced price of 6 American Dollars in accordance with the new arrangements for 1926, are asked to let me know, without, however, sending the money. The sums already sent by a considerable number of members have been forwarded to the International Institute of Agriculture, Villa Umberto I, Rome (Italy).

(9) Finally, I must ask members to be so good as to write in German, English, French or Dutch. I regret that I am not acquainted with Italian and Spanish.

A communication has just reached me from the President Dr. J. G. Lipman, to the effect that, the Organising Committee for the first International Soil Science Congress has resolved that this Congress shall be held at Washington at the beginning of June 1927. Further details will be in future communicated by the American Organising Committee.

Groningen, December 1925.

Dr. D. J. Hissink,
Acting First President
and General Secretary.

IV International Soil Science Conference, Rome. — The Organisation Committee met, with Prof. G. de Angelis d'Ossat in the chair, on 30 December in Rome, to discuss the subject of the publication of the " Proceedings ". The first volume will be issued shortly by the International Institute of Agriculture, which has undertaken the publication; the other two volumes will follow. The Committee fully recognise and appreciate the interest shown by the President, the General Secretary, Count R. Perotti and the active co-operation of the Bureau of Agricultural Science of the International Institute of Agriculture, as regards the publication of these " Proceedings ".

List of Members of the International Society of Soil Science.

(Dated 1 January, 1926).

The countries are arranged in the French alphabetical order; the addresses are as far as possible quoted in the original language. The Colonies follow in each case immediately after the mother country. Under the separate countries, libraries are shown first, then institutions, societies, etc., and last of all, names of individuals; each of these groups is arranged alphabetically.

Germany.

Bibliothek der Landwirtschaftlichen Hochschule. Invalidenstrasse 42. Berlin, N. 4.
Bibliothek der Landwirtschaftlichen Institute der Universität. Ludwig Wuchererstr. 2. Halle a/Saale.
Bibliothek der Technischen Hochschule. München.
Bibliothek der Universität. Universitätsstr. 25. Marburg a/Lahn.
Bibliothek des Deutschen Kalisyndikates, G. m. b. H. Dessauerstrasse 28-29. Berlin, S. W.
Bücherei der Biologischen Reichsanstalt für Land- und Forstwirtschaft, Berlin. Dahlem.
Bücherei der Forstlichen Hochschule. Tharandt. (Freistaat Sachsen).
Staats- und Universitäts-Bibliothek. Breslau.
Universitätsbibliothek. Kiel.
Universitätsbibliothek. Beethovenstrasse, 6. Leipzig.
Universitätsbibliothek. München.

Agrikulturchemisches Institut der Hochschule für Landwirtschaft und Brauerei (Direktor: Prof. Dr. H. NIKLAS). Weihenstephan bei München.
Agrik. Chem. Kontrollstation. Karlstrasse 10. Halle (Saale).
Agrikulturchemische Versuchsstation der Landwirtschaftskammer für die Prov. Schleswig-Holstein. (Vorsteher: Dr. Sieden). Kronshagener Weg 3, Kiel.
Badische Geologische Landesanstalt. Eisenbahnstr. 62a. Freiburg i. Baden.
Bayerische Biologische Versuchsanstalt für Fischerei. Veterinärstrasse 6. München.
Deutsches Kalysindikat G. m. b. H. (Agrikultur-Abteilung). Dessauerstrasse 28-29. Berlin, S. W. 11.

Geologische Landesuntersuchung des Bayer. Oberbergamtes. München.
Geologisches palaeontologisches Institut der Universität. Talstrasse 35. III. Leipzig.
Hessische Geologische Landesanstalt. Darmstadt.
Institut für Geologie der Landwirtschaftlichen Hochschule. Invalidenstrasse 42. Berlin, N. 4.
Kulturtechnisches Institut der Universität. Tragh. Kirchenstr. 74. Königsberg i. Pr.
Landwirtschaftliche Hochschule. Meckenheimer Allee 102. Bonn-Poppelsdorf.
Landwirtschaftliche Versuchsstation. Hornerweg 104. Hamburg. Horn.
Landwirtschaftliche Versuchsstation Limburgerhof der Badischen Anilin- und Soda Fabrik. Mutterstadt II. (Rheinpfalz).
Mineralogisch-Geologisches Institut der Technischen Hochschule. Neptunstrasse 14. Danzig-Langfuhr.
Preussische Geologische Landesanstalt. Invalidenstrasse 44. Berlin, N. 4.
Preussische Moor-Versuchsstation. Neustadtswall. Bremen.
Sächsisches Geologisches Landesamt. Talstrasse 35. Leipzig.
Staatliche Landwirtschaftliche Versuchsanstalt. (Direktor: Prof. Dr. NEUBAUER). Stübel-Allee 2. Dresden, A.
Stickstoff-Syndikat G. m. b. H. Neustädtlische Kirchenstrasse. Berlin, N. W. 7.
Untersuchungsamt der Landw. Kammer in Königsberg i. Pr. Königsberg.

ALBERT, Prof. Dr. R. Forstakademie. Brummstr. 10. Eberswalde
BLANCK, Prof. Dr. Agrikulturchemisches Institut. Nikolausburgerweg 7. Göttingen.
BÖHM, Prof. Dr. A. Enzianstrasse 1. Berlin. Lichterfelde.
BÜLOW, Dr. Kurt von. Preussische Geologische Landesanstalt. Invalidenstrasse 14. Berlin.
BUNGERT, Dr. I. Oberförster. Kaiser-Friedrich-Ring 82. Wiesbaden.
DENSCH, Prof. Dr. Alfred. Direktor des Institutes für Bodenkunde und Pflanzenernährung der Preuss. Landwirtschaftlichen Versuchs- und Forschungsanstalten. Theaterstrasse 25. Landsberg a. W.
EHRENBERG, Prof. Dr. Paul. Hansastrasse 24. Breslau.
FAUSER, Oberbaurat Otto. (Ministerium des Innern.). Sporerstrasse 5. Stuttgart.
FISCHER, Dr. Hermann. Herzogstrasse 58 III. München.
GANSSEN, Prof. Dr. R. Königsallee 9. Berlin-Grünewald.
GEHRING, Dr. A. Landw. Versuchsstation. Braunschweig.
GÖRBING, Johannes. Dipl. Nahrungsmittelchemiker, Laboratorium für Bodenkunde und Pflanzenernährung. Borsteler-Chaussée 128. I. Hamburg, Grossborstel.
GÖRZ, Dr. R. Diplomierter Landwirt. Jagowstrasse 19. Berlin-Grünewald.
HALLER, Chemiker Dr. Hans. (Geologische Landesanstalt). Invalidenstrasse 44. Berlin, N. 4.
HÄRTEL, Dr. Fritz. (Geologe). Talstrasse 35. Leipzig.

Harrassowitz, Prof. Dr. Hermann. O. Prof. der Geologie und Paleontologie, Direktor des geologischen Instituts der Universität Giessen. Ludwigstrasse 23. Giessen.

Helbig, Prof. Dr. M. Freiburg (Breisgau).

Hellmers, Dr. Hans. (Institut für Geologie). Invalidenstrasse 42. Berlin, N. 4.

Hohenstein, Dr. Viktor. Neustädtische Kirchstrasse 9. Berlin, N. W. 7,

Krauss, Dr. G. Privatdozent der Bodenkunde an der Universität München. Amalienstrasse 52-0. München.

Krüger, Prof. Dr. h. c. E. Geheimer Regierungsrat. Alleestrasse 1. Hannover.

Kuhse, F. Technische Hochschule, Geologisches Institut. Danzig. Langfuhr.

Lang, Prof. Dr. Richard. Universitätsprofessor. Wilhelmstrasse 7. Halle a. d. Saale.

Lemmermann, Prof. Dr. O. Direktor des Institutes für Agrikulturchemie und Bakteriologie der Landwirtschaftlichen Hochschule. Albrecht - Thaerweg 1. Berlin. Dahlen.

Mach, Prof. Dr. F. Landwirtschaftliche Versuchsanstalt. Post Grötzingen i. B. Augustenburg.

Meyer, Dr. Diedrich, Direktor der Landw. Chem. Untersuchungsanstalten der Landwirtschaftskammer Schlesien. Matthiasplatz 6. Breslau.

Mitscherlich, Prof. Dr. E. A. Pflanzenbau-Institut der Universität. Tragheimer Kirchenstrasse 83. Königsberg i. Pr.

Münichsdorfer, Dr. F. Landesgeologe. Ludwigstrasse 14. München.

Nellzenbrecher, Dr. R. Rudmannstrasse 16. Salzwedel.

Pfeiffer, Prof. Dr. H. Geologische Landesanstalt. Invalidenstrasse 44. Berlin, N. 4.

Puchner, Prof. Dr. H. Landwirtschatliche Hochschule. Weihenstephan bei Müncken.

Ramann, Prof. Dr. E. Amalienstrasse 52. München.

Reihling, Dr. rer. nat. Karl, Regierungsrat, Vorstand der Bodenkundlichen Abteilung der Württembergischen Forstlichen Versuchsanstalt. Arminstrasse 6. Stuttgart.

Schnarrenberger, Dr. Carl. Landesgeologe. Badische Geologische Landesanstalt. Eisenbahnstr. 62 a. Freiburg i. Baden.

Schucht, Prof. Dr. F. Güntzelstrasse 59. Berlin. Wilmersdorf.

Stremme, Prof. Dr. H. Mineralogisch-Geologisches Institut der Technischen Hochschule. Neptunstrasse 14. Danzig, Langfuhr.

Trénel, Chemiker Dr. M. Geologische Landesanstalt. Invalidenstrasse 44. Berlin, N. 4.

Utescher, Chemiker Dr. K. Hasenmarkt 23. Spandau bei Berlin.

Vageler, Dr. Pflanzenzuchtstation der Landwirtschaftskammer für die Provinz Ostpreussen. Ramten, Ostpreussen.

Vater, Prof. Dr. Dr. h. c. H. Geh. Forstrat. Tharandt.

Wiessmann, Dr. Hans, Privatdozent. Werftstrasse 18. Berlin, N. W. 52.

Wolff, Prof. Dr. W. Abt. Direktor Geologische Landesanstalt. Invalidenstrasse, 44. Berlin, N. 4.

Zunker, Prof. Dr. Ing. F. Direktor des Kulturchemischen Institutes. Hansastrasse 25. Breslau, 116.

Austria.

Bodenkundliches Laboratorium des Landes-Meliorationsamtes. Vertreter Dr. Ing. Bernhard Ramsauer, Landespedologe. Müllnerhauptstrasse 54. Salzburg.

Leiningen - Westerberg, Dr. Wilh. Graf zu. Lehrkanzel für forstliche Bodenkunde und forstliche chemische Technologie an der Hochschule für Bodenkultur. Hochschulstrasse 17. Wien, XVIII.

Stiny, Prof. Dr. J. Höhere Forstlehranstalt. Bruck a. d. Mur.

Till, Prof. Dr. Alfred. Lehrkanzel für landwirtschaftliche Bodenkunde an der Hochschule für Bodenkultur. Piaristengasse 62. Wien.

Belgium.

Comptoir Belge du Sulfate d'ammoniaque. Société Anonyme. Rue Berckmans 8. Bruxelles.

Simoens, W. Staatslandbouwkundige. Poperinghe. West - Vlaanderen.

Sys, Maurice. Staatslandbouwkundige. Dixmuiden. West - Vlaanderen.

Cuba.

Anderson, E. L. Cuban Sugar Club. Apartado 1973. Habana.

Fortun, Ir. Gonzalo M. Ingeniero Agrónomo, Director Estación Experimental Agronómico de Cuba. Santiago de las Vegas.

Rapalje, E. H. Manager, American Agricultural Chemical Company. 553 Banco Nacional de Cuba. Habana.

Thurston, F. R. Manager, Central " Oriente ". Oriente.

Walker, E. S. Superintendent of Agriculture. Central Preston. Preston, Province of Oriente.

Zell, J. R. Finca " El Conde " Hershey, Province Habana.

Denmark.

Den Kgl. Veterinaer - og Landbohøjskoles. Bibliothek. Bülowsvej 13. København, V.

Afdeling for Landbrugets Plantedyrkning. Den Kgl. Veterinaer - og Landbohøjskoles. (Director : Prof. K. A. Bondorff og Prof. E. Linhard. Rolighedsvej 23. København,

Danmarks Geologiske Undersøgelse. (Director : Victor Madsen). Gammelmønt 14. København, K.

Den Kgl. Veterinaer - og - Landbohøjskoles, plantefysiologiske Laboratorium, (Director : Professor Dr. H. Weis). København, V.

Det danske Hedeselskab. Viborg.

Det Kgl. danske Landhusholdningsselskab. Vestre Boulevard 34. København, B.

Ladel und Landbrugsskoles Kemiske Laboratorium. Brørup.

Landbrugsraadet. Vestre Boulevard 4. København, B.

Statens Forsøgsstation i (Director: C. IVERSEN). Askov, pr. Vejen.

Statens forstlige Forsøgsvaesen. (Director: Prof. Dr. A. OPPERMANN). Springforbi, ved København.

Statens Havebrugs-Forsøgsstation. (Director: N. ESBJERG). Blangsted, pr. Odense.

Statens Marskforsøg. (Director: C. J. CHRISTENSEN). Ribe.

Statens Planteavls Laboratorium. (Director: CHRISTENSEN, Dr. H. C.) Lyngby.

Statens Plantepatologiske Forsøg. (Director Prof. Dr. C. FERDINANDSEN). Lyngby.

BILLMANN, Prof. Dr. E. Direktor des chemischen Laboratoriums der Universität. København.

LUND, cand. polyt. Augusta Landbohøjskolen. Bülowsvej 13. København, V.

OLSEN, Dr. Phil. Carsten. Carlsberg Laboratorium. København, Valby.

RORDAM, Prof. Dr. K. Landbohøjskoles. Bülowsvej 13. København, V.

Egypt.

ABDEL-VAHID FAHMY, Effendi. Inspecteur au Ministère Egyptien de l'Agriculture. Le Caire.

MOSSÉRI, Victor M. Président de l'Institut d'Egypte. 25, Rue Cheik Aboul-el-Sebaa. Le Caire.

Spain.

Estación Agronómica - Instituto Agrícola de Alfonso XII. Director Ing. Guillermo QUINTANILLA. La Moncloa. Madrid.

ALCARAZ, Excmo Sr. D. Enrique. Ingeniero Agrónomo - Profesor de la Escuela de Ingenieros Agrónomos. Juan de Mena 15, pral. A. Madrid.

ARGÜELLES, Sr. D. Ernesto de Canedo. Ingeniero de Montes y Geógrafo. Director de la Biblioteca del Instituto Geográfico. Villanueva, 43. Madrid.

BILBAO y SEVILLA Ing. Francisco, Délégué de l'Espagne dans l'Institut International d'Agriculture. Villa Umberto I. Roma (10).

DALDA de TORRE, Sr. D. Adolfo Ingeniero de Montes. De la Sección de Montes del Ministerio de Fomento. San Bartolomé 6. Madrid.

H. del VILLAR, Sr. D. Emilio. Lista 62, 3º der. Madrid.

ITURRALDE, Sr. D. Julián. Ingeniero de Montes - Profesor de la Escuela de Ingenieros de Montes. Arenal 8. Madrid.

MARCILLA, Sr. D. Juan. Ingeniero Agrónomo - Profesor de la Escuela de Ingenieros Agrónomos. La Moncloa. Madrid.

MUÑOZ, Sr. D. Juan Diaz. Ingeniero Agrónomo - Profesor de la Escuela de Ingenieros Agrónomos. Rodriguez San Pedro, 29. Madrid.
SANZ, Sr. D. José Lillo. Ingeniero de Montes. Villanueva 43 pral. Madrid.

Esthonia.

Bodenkundliches und Agrikulturchemisches Kabinett. (Leiter: A. NOMMIK). Vene uul. 28. Tartus.

United States.

Library of the Los Baños College F. O. Los Baños, Philippines.
Soil Improvement Committee of the National Fertilizer Association. Insurance Building. Washington, D. C.
AGEE, Director H. P. Director Experiment Station of the Hawaiian Sugar Planters Association. Honolulu, Hawaii.
ALBRECHT, W. A. College of Agriculture. Columbia. Missouri.
ALLEN, H. B. Experiment Station. New Brunswick. New Jersey.
ALLISON, Dr. F. E. Fixed Nitrogen Research Laboratory, Department of Agriculture. Washington, D. C.
ALLISON, Robert V. c/o Cuban Sugar Club. Tropical Plant Research Foundation Central Office, 1350 B Street, Southwest. Washington, D. C.
ALWAY, F. J. University of Minnesota. St. Paul. Minnesota.
ANDERSON, Dr. M. S. Bureau of Soils, United States Department of Agriculture. Washington, D. C.
BALDWIN, Mark. Bureau of Soils, United States Department of Agriculture. Washington, D. C.
BARNES, E. E. Ohio State University Soil Department. Columbus. Ohio.
BARNETTE, R. M. Experiment Station. Gainesville. Florida.
BARRETT, Rollin H. Vermont State School of Agriculture. Randolph Center. Vermont.
BATES, H. R. Manager Manufacturing Department. P. O. Box 1725. Atlanta. Georgia.
BAYLOR, H. B. Sales Manager. P. O. Box 1752. Atlanta. Georgia.
BEARER, E. V. Experiment Station. New-Brunswick. New Jersey.
BECKWITH, Charles, S. Browns Mills. New Jersey.
BENNETT, H. H. Bureau of Soils, United States Department of Agriculture. Washington, D. C.
BIZZELL, J. A. College of Agriculture. Cornell University. Ithaca. New York.
BLACKWELL, C. P. 614, Rhodes Building. Atlanta. Georgia.
BLAIR, A. W. Experiment Station. New-Brunswick. New-Jersey.
BLINN, Philo K. Rocky Ford. Colorado.
BRADFIELD, Richard. College of Agriculture. Department of Soils, University of Missouri. Columbia. Missouri.
BREWSTER Benjamin H. III. 25 South Calvert Street. Baltimore. Maryland.

BROWN, B. E. Bureau of Soils United States Department of Agriculture. Washington, D. C.

BROWN, P. E. Iowa State College. Ames. Jowa.

BUCKMANN, H. O. College of Agriculture. Cornell University. Ithaca. New York.

BURGESS, P. S. University of Arizona. Tucson. Arizona.

BUTLER, Edward, jr. 20 South Delaware Avenue. Philadelphia. Pennsylvania.

BUSHNELL, T. M. Agriculture Experiment Station. Lafayette. Indiana.

CALLISTER, George J. Potash Importing Corporation of America. 81 Fulton Street. New-York, City.

CARROLL, John S. Potash Importing Corporation of America. 81 Fulton Street. New York, City.

CHAPMANN, J. E. Agricultural College. 1010 12th Avenue North. Fargo. North Dakota.

COBB, Prof. Wm. B. Associate Professor of Geology and Soils. North Carolina State College. Raleigh. North Carolina.

COLE, John S. Bureau of Plant Industry, United States Department of Agriculture. Washington, D. C.

COLLINGS, Gilbert H. Clemson College. South-Carolina.

CONNER, S. D. Agricultural Experiment Station. Lafayette. Indiana.

CONREY, Cuy W. Ohio State University. Columbus. Ohio.

COX, H. R. Experiment Station. New-Brunswick. New-Yersey.

DAVIS, Dr. R. O. E. Bureau of Soils, United States Department of Agriculture. Washington, D. C.

DENISON, I. A. Bureau of Soils, United States Department of Agriculture. Washington, D. C.

DULEY, F. L. College of Agriculture. University of Missouri. Columbia. Missouri.

ENGLE, Mr. E. B. University of Nebraska.College of Agriculture. Lincoln. Nebraska.

EMERSON, Paul. Iowa State College. Ames. Iowa.

ERDMAN, Lewis W. Iowa State College. Ames. Iowa.

FRED, E B. University of Wisconsin. Madison. Wisconsin.

FRENCH, Albert. International Agricultural Corporation. Room 3018, 61 Broadway. New-York, City.

FRY, W. H. Bureau of Soils, United States Department of Agriculture. Washington, D. C.

FUDGE, B. R. Experiment Station. New-Brunswick. New-Jersey.

GARDNER, Willard. Utah Experiment Station. Logan. Utah.

GILE, Philip L. Bureau of Soils-United States Department of Agriculture. Washington, D. C.

GINSBURG, J. M. Experiment Station. New-Brunswick. New-Jersey.

GLADDEN HUTTON, Prof. J. State College. Brookings. South Dakota.

GRABER, L. F. University of Wisconsin, Madison, Wisconsin.

GRAUL, E. I. University of Wisconsin. Madison. Wisconsin.

GREAVES, J. E. Utah Agricultural Experiment Station. Logan. Utah.

Harper, J. N. Department of Crop Fertilization. 910 Citizens and Southern Bank Building. Atlanta. Georgia.

Haskell, S. B. Massachusetts Agricultural College. Amherst. Massachusetts.

Hayes, P. A. Bureau of Soils, United States Department of Agriculture. Washington, D. C.

Hearn, W. R. Bureau of Soils. United States Department of Agriculture. Washington, D. C.

Heukelekian, H. Experiment Station. New-Brunswick. New-Jersey.

Hibbard, P. L. University of California. Berkeley. California.

Hoagland, D. R. University of California. Berkeley. California.

Holmes, Robert S. Bureau of Soils, United States Department of Agriculture. Washington, D. C.

Horton, H. E. Casco Mercantile Trust Company. Portland. Maine.

Jennings, D. S. Utah Experiment Station. Logan. Utah.

Joffe, J. S. Experiment Station. New-Brunswick. New-Jersey.

Jones, C. D. Experiment Station. New-Brunswick. New-Jersey.

Jones, J. S., Oregon Experiment Station, Corwallis, Oregon.

Jordan, H. V. State College. New-Mexico.

Karunaker, P. D. ?

Kelley, W. P. University of California. Berkeley. California.

Kezer, Alwin. Experiment Station. Fort Collins. Colorado.

Krauss, F. G., University of Hawaii. Honolulu, Hawaii.

Kriege, Herbert F. Ohio State University. Columbus. Ohio.

Krusekopf, H. H. College of Agriculture. Columbia. Missouri.

Lapham, Macy H. Bureau of soils U. S. Dept. of Agriculture. Washington, D. C.

McLean, H. C. Experiment Station. New-Brunswick. New-Jersey.

Lee, H. R. Union Carbide and Carbon Research. Laboratories. 30. East 42nd Street. New-York, City.

Lee, Linwood L., Inc. Box 192. Moorestown. New-Jersey.

Lefevre, Henry E. Société Commerciale des Potasses d'Alsace. City 25 West 43rd. Street. New-York.

Lesh, F. R. University of Missouri. Columbia. Missouri.

Lipman, J. G. Prof. Dr. Experiment Station. New-Brunswick.. New-Jersey.

DeLoach, R. J. H. Armour Fertilizer Works. 209. West Jackson Boulevard Chicago. Illinois.

Long, D. D. Director Agricultural Research and Service Department. P. O. Box 1725. Atlanta. Georgia.

Lowry, R. B. Experiment Station. Knoxville. Tennessee.

Lyon, T. L. College of Agriculture. Cornell University. Ithaca. New-York.

Marbut, Prof. C. F. Bureau of Soils. United States Department of Agriculture. Washington, D. C.

Mattson, Dr. Sante E. Bureau of Soils. United States Department of Agriculture. Washington, D. C.

McCall, A. G. University of Maryland. College Park. Maryland.

McClure, George M. Ohio State University. Soils Department. Columbus. Ohio.

McDowell, H. C. Armour Fertilizer Works. 209 West Jackson Boulevard. Chicago. Illinois.

McIntire, W. H. Experiment Station. Knoxville. Tennessee.

Meulen, P A. van der. Rutgers University. New-Brunswick. New-Jersey.

Meyer, A. H. University of Wisconsin. Madison. Wisconsin.

Michel, Paul. Kiowa. Colorado.

Middleton, Dr. Howard. Bureau of Soils. United States Department of Agriculture. Washington, D. C.

Miller, M. F. College of Agriculture. Columbia. Missouri.

Mooers, C. A. Experiment Station. Knoxville. Tennessee.

Musgrave, G. W. Experiment Station. New-Brunswick. New-Jersey.

Myers, W. Lambert. 1128 Hurt Building. Atlanta. Georgia.

Myers, William S. 25 Madison Avenue. New York, City.

Noer, O. J. University of Wisconsin. Madison. Wisconsin.

Ober, Gustavus, Jr. Ober Fertilizer Company. Baltimore. Maryland.

Olmstead, Dr. L. B. Bureau of Soils. United States Department of Agriculture. Washington, D. C.

Orton, Dr. W. A. Tropical Plant Research Foundation. 1350 B Street, S. W. Washington, D. C.

Pearson, H. S. Nitrate Agencies Company. 104 Pearl Street. New York, City.

Pendleton, Prof. Robert L. College of Agriculture, University of the Philippines. Los Baños. Philippines.

Perkins, Alfred T. College of Agriculture. Manhattan. Kansas.

Pierre, W. H. University of Wisconsin. Madison. Wisconsin.

Powers, W. L. Oregon Experiment Station. Corvallis. Oregon.

Pranke, E. J., American Cyanamid Company, 511, Fifth Avenue, New York, City.

Prince, A. L. Experiment Station. New-Brunswick. New-Jersey.

Reed, E. P. Ohio State University. Columbus. Ohio.

Rice, T. D. Bureau of Soils. United States Department of Agriculture. Washington, D. C.

Robbins, W. R. Experiment Station. New-Brunswick. New-Jersey.

Robertson, David W. Experiment Station. Fort-Collins. Colorado.

Robinson, William O. Bureau of Soils. United States Department of Agriculture. Washington, D. C.

Ruprecht, R. W. Experiment Station. Gainesville. Florida.

Russel, J. C. University of Nebraska. College of Agriculture. Lincoln. Nebraska.

Salter, Robert M. Ohio State University. College of Agriculture. Columbus. Ohio.

Sampson, H. O. Experiment Station. New-Brunswick. New-Jersey.

SCHREINER, Oswald. Soil Fertility Investigations, Bureau of Plant Industry. United States Department of Agriculture. Washington, D. C.

SHAW, Prof. Chas. F. 320, Hilgard Hall. Berkeley. California.

SHAW, W. M. Experiment Station. Knoxville. Tennessee.

SHIVE, J. W. Experiment Station. New-Brunswick. New-Jersey.

SHOREY, R. C. Bureau of Plant Industry. United States Department of Agriculture. Washington, D. C.

SILBERT, Doroty. West 7th. Street 954. Plainfield. New-Jersey.

SKUDERNA, A. W. Rocky-Ford. Colorado.

SMALLEY, H. R. Soil Improvement Committee National Fertilizer Association, 616 Investment Building. Washington, D. C.

SMITH, A. M. University of Maryland. College Park. Maryland.

SMITH, R. S. Department of Agronomy, University of Illinois. Urbana. Illinois.

SNIYDER, Robert Miflin. College of Agriculture. East-Lansing. Michigan.

SPRAGUE, H. B. Experiment Station. New-Brunswick. New-Jersey.

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