Aid to the Laboratory Determination of the Soil Type

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1. INTRODUCTION

For laboratory personnel it is often difficult to see directly from the soil sample itself which type of soil it is. Sometimes however, a decision should be made for a choice of a certain analytical method or a check on results. A scheme has been made based on: pH, OM, EC, $CaCO_3$ and Exchangeable Na which may serve as a guide.

2. PRINCIPLE

With the help of non-time consuming determinations like pH, Electrical conductivity, $CaCO_3$ and Organic matter a scheme has been made to obtain an idea of the soil type (analytically seen). These determinations can be done on the sample itself without pretreatment. The scheme is extended with results of exchangeable Na to enable its use for checking of analytical data. Results of determinations of different samples are used to construct the scheme.The following entrance sequence is used:

1. pH

The pH is measured in a soil-water suspension (ratio 1:2.5). It can either be < 7.0 or > 7.0. This division is based on the absence of $CaCO_3$ in an acid medium.

2. $CaCO_3$

The $CaCO_3$ content can be determined with a detection limit (for the method used) of 0.5%. This 0.5% is used to make the division on the presence or absence of $CaCO_3$.

3. Electrical Conductivity

The electrical conductivity (EC) is measured in a soil-water suspension (ratio 1:2.5).The EC can be low or high. Results of samples are used to obtain a more absolute indication.

4. Exchangeable Sodium

If these results are available they can be used for checking of the results. The value can be low or high in relation to exchangeable Potassium. In a "normal" soil the Na concentration is lower than K. For obtaining an idea of the soil type in advance, Na is of no use because the determination is rather time consuming.

5. Organic matter

The Organic matter content can be low or high. Results of samples are used to obtain a more absolute indication.

6. Soil type number

Finally all soil types are numbered, named and a remark is given.

3. USE of THE SCHEME

The results of the determinations of a sample are introduced in the scheme. As a result one or more numbers are obtained

If one or more numbers are obtained the name(s) of the type can indicate what will happen with the sample, when determinations are done without any pretreatment. If necessary certain treatments can be chosen, to overcome analytical interferences.

Possibilities of used names:

Saline

Free salt is present in the soil and if no pretreatment of the sample is done, the exchangeable cations will be influenced by the corresponding cation from the dissolving free salt (normally the effect is mainly noticed for Sodium, occasionally Potassium when fertilizer has recently been added to the soil).

Calcareous

$CaCO_3$ is present in the sample in an amount which influences the exchangeable Calcium determination.

Humic

Organic matter is present and will release Hydrogen ions and hardly any exchangeable cations. As result the sum of the exchangeable cations (Ca, Mg, K and Na) will be lower than the CEC.

Saturated

The sum of the exchangeable cations (Ca, Mg, K and Na) is equal to the CEC.

Non saturated

- The sum of the exchangeable cations is lower than the CEC. This can be caused by Organic matter, which contributes to the CEC but does not contribute to the exchangeable Ca, Mg, K and Na. Hydrogen ions may be released but they are not included in the sum of the cations.
- Soils, containing Iron and/or Aluminium and other kinds of metals with a variable charge. The pH of the soil generally differs from the pH by which the CEC is determined. Also exchangeable Al and H are not included in the sum of the cations.

This scheme may only serve as a guide in determining the soil type. Its use is limited to the Soils Laboratory. It is theoretically constructed with the help of laboratory data of soil samples. Some of the types are theoretically and no sample has been noticed to establish the soil type number as yet.
The words saline, humic and calcareous do not have any relation with similar terms used in soil classification (USDA).

SOIL TYPE SCHEME

Sample	pH 2.5	$CaCO_3$ %	EC 2.5 mmho/cm	Na meq	OM %	No.
SOIL	<7.0	<0.50	low <0.3	low	low <2.7	1
					high 9.3	2a
			high >0.8	low	high 10.2	2b
				high	high 1.4	3
					low 0.5	4
	>7.0	<0.50	low <0.5	low	low + high	5
				high	(low + high)	6
			high >0.50	high	low + high	7
				(low)	(high)	(8)
					(low)	(14)
		>0.50	low <0.50	low	low + high	9
				high	low + (high)	10
			high >0.8	high	low + high	11
				(low)	(high)	(12)
					(low)	(13)

see overleaf

No.	Soil type	Remarks
1	Non saturated	Possibilities for non saturation are: 1) Influence of Organic matter. 2) Soil with Exchangeable acidity and variable charges.
2a	non saturated	see No. 1
2b	non saturated	see No. 1
3	saline humic	see No. 4, but with less Humus
4	saline	see also No 7; difference: pH
5	(non) saturated	pH between 7 and 7.5
6	saturated (slightly saline)	see also No. 7; difference in salt content
7	saline	
(8)	(non)saturated humic	see also No. 1, difference in pH. Seldom seen.
9	calcareous	depending on the EC it may contain some salt
10	slightly saline calcareous	
11	(humic) saline calcareous	
(12)	calcareous humic	
(13)	theoretically	If Organic matter is low and no free salts, what causes the EC?
(14)	theoretically	If the EC is high then free salt is present, normally free salt contains Na, but then Na exch. is also high. This type only exists if free soluble non-Na salt is present in the soil.

4. CHECKING ANALYTICAL RESULTS

When all results from the laboratory are available their relation can be checked. No fixed rules or system exists because soil is a too complex material. Nevertheless a number of relations can be checked with the following notes:

<u>pH < 7.0</u>

A. In an acid soil the Base Saturation Percentage (BSP) may be less then 100%. This is the case when Hydrogen ions are released from the soil but it can also be caused by the presence of Organic matter. The Organic matter contributes to the CEC but hardly to the exchangeable Ca, Mg, K and Na (Soil No. 1. 2a and 2b).

B. Another cause of a BSP < 100% is due to the presence of Aluminium in the soil. In these soils the Exchangeable Acidity (Hydrogen and Aluminium) is determined when the pH < 5.5. The sum of Ca, Mg, K, Na, H and Al is then called the Effective Cation Exchange Capacity (ECEC). The ECEC will be equal or lower than the CEC (Soil No. 1, 2a and 2b).

C. Soils with an Electrical conductivity > 0.8 mmho/cm. This $EC_{2.5}$ can be caused by the release of only Hydrogen (Soil No. 2b) but also by dissolved salt (soil No. 3 and 4).If the Na and Organic matter content is high the soil is No. 3. The more Na in the soil generally means less Organic matter and the soil is real saline (Soil No. 4).

D. In an acid soil, no Carbonates (most as Ca) are present. Carbonates are only determined in soils with a pH > 7.0 Sometimes a small amount is found in soil with a pH > 6.7 or 6.8. In these samples (where no $CaCO_3$ determination has been done) a check can be made with the help of the CEC and exchangeable cations. The base saturation percentage then will be > 100% (± 101 - 110%). Normally when Calcium carbonate is determined afterwards, the result will be < 0.5%.

pH > 7.0

E. pH > 7.0 without $CaCO_3$ and free salts.

In these soils the BSP is normally 100%. There is no influence of Organic matter because at pH > 7.0 no Hydrogen is released. The $EC_{2.5}$ will be < 0.5 mmho/cm (Soil No. 5 and 6).

F. pH > 7.0 with $CaCO_3$ and without free salts.

In these soils the BSP > 100%. The exchangeable Ca is high because it is influenced by the Ca from the dissolved $CaCO_3$ (especially with NH_4Ac Percolation). The total of the Ca Ca value will not be reproducible, because of the different amounts of $CaCO_3$ which will dissolve during percolation of the sample. The $EC_{2.5}$ < 0.5 mmho/cm. There is no influence of the Organic matter content on the results (Soil No. 9 and 10).

G. $EC_{2.5}$ > 0.5 mmho/cm and without $CaCO_3$

The BSP will be > 100% due to the dissolved (mostly) Na salts. The exchangeable Na will be high (Soil No. 7 and 14 and sometimes No. 6).

H. $EC_{2.5}$ > 0.5 mmho/cm and with $CaCO_3$

The BSP will be > 100%. These soils are difficult to interpret. The high $EC_{2.5}$ value can be caused by dissolved salts as well as the dissolved $CaCO_3$, although $CaCO_3$ alone does not give values > 0.5 mmho/cm. All different combinations in contents of salts and $CaCO_3$ may be possible. The Na will be equal, but very often, higher than the K. The higher the $EC_{2.5}$, the higher the Na (Soil No. 10 and 11, but beware of No. 7 and 9).

I. Fertilizers

- Fertilizers can interfere with the scheme, depending on the type used. Potassium fertilizers will cause a higher $EC_{2.5}$ as well as a raise in exchangeable K. In these soils the salinity is not caused by Na, which will have a normal value. When soil samples arrive information on the fertilizer status could be asked and taken into consideration while checking results.

- To raise the pH of acid soils $CaCO_3$ can be used. This will influence the results. It is often used as coarse material and will not affect the pH measurements at the laboratory, because it will not dissolve in water. However, it will have an effect on the exchangeable Ca, because particles will dissolve in the percolation liquid. The BSP may be > 100%. The exhangeable acidity can be determined, if H and/or Al is measured then it is definitly sure that $CaCO_3$ has been added but that the effect of the latter on the soil is still not completed.

J. High Sodium but BSP = 100%.
Sometimes the BSP = 100% but the exchangeable Na is high. The first impression from the results especially because of the high exchangeable Na content is a saline soil (there may be a $EC_{2.5}$ of e.g. 0.5 mmho/cm). But if the BSP = 100% the soil might have been saline in the past but the free salts have just been leached. However, the relatively high Na has not been exchanged as yet.