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A RAPID METHOD TO DETERMINE A CEC DELTA VALUE OF SOILS

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All soils, to a greater or lesser extent, show a pH-dependence of the CEC ("variable charge"). Especially soils developed in volcanic parent material have characteristically high CEC delta values due to allophane and related poorly ordered silicates. Also organic matter may contribute significantly.

Perhaps less prominent but not less important variable charge is exhibited by soils with low activity clays, highly weathered Oxisols and Podzols.

Knowledge of the extent of the variable charge is important with respect to the behaviour, characteristics, management, and agricultural potential of the soils.

Because the appreciation of the variable charge is relatively young, only few attempts have been made to measure its extent fully. Certainly a suitable routine method has not yet been available.

The existing methods (1, 4) are either too cumbersome or erroneous or both. They involve harsh chemical treatment and several consecutive washings causing intolerable loss of components and uncertainty as to the environment of adsorption.

We found that the recently introduced method to determine the CEC with the silver thiourea complex (AgTU) as saturating cation (2, 3) can be made to good use for a rapid and convenient determination of the CEC at any pH value up to 9.

The method is based on the extremely high affinity of $AgTU^+$ for negatively charged colloids. Even in the presence of considerable amounts of "normal" cations a nearly complete saturation of the exchange complex can be achieved. The tedious and erroneous washings can thus be omitted.

The procedure involves a conditioning of the sample with an "indifferent" buffer at the desired pH prior to adding AgTU. After equilibration the amount of silver drawn from solution is measured versus a blank.

PROCEDURE

1. Weigh out 0.5 to 2.0 gram of sample into 100 ml shaking flask.
2. pH 9: Add 40 ml 0.25 N Na-carbonate buffer pH 9.10.
   pH 4: Add 400 ml 0.20 N Na-acetate buffer pH 3.99.
3. Shake for 20 hrs.
4. pH 9: Add 40 Ml 0.25 N Na-carbonate buffer containing 0.02 M AgTU.
   pH 4: Add 40 ml 0.02 M AgTU.
5. Shake for 4 hrs.
6. Centrifuge the suspension.
7. Transfer 2 ml aliquot to 100 ml volumetric flask (pH 9 flasks acidify with 5 ml 1 N HNO_3.
8. Measure Ag with AAS in 0-25 ppm range (include a blank).
9. Calculate

$$CEC = \frac{ppmblank - ppmsample}{samplewt} = 3.71$$

Table of some results

Country	Soil/ Location/ Name	Classification	CEC (me/100g) pH 4	CEC (me/100g) pH 9	Δ CEC (me/100g)	Δ CEC ratio[1] (%)	Org.C (%)	Clay[2] (%)	15bar moist (wt%)
Colombia	Narino	vitric Ando/Vitrandept	10	70	60	86	9.3	19	34
"	same profile	"	7	52	45	87	1.9	40	44
Colombia	Narino	placic Ando/Placandept	28	159	131	82	28.5	7?	114
Hawaii	Hilo	humic Ando/Hydrandept	4	69	65	94	3.5	46	106
Hawaii	Kikoni	mollic Ando/Eutrandept	13	84	71	85	8.6	32	48
Hawaii	Kukaiau	humic Ando/Dystrandept	7	79	72	91	7.9	45	61
Italy	--	vitric Ando/Vitrandept	7	61	54	89	5.9	15	19
"	same profile	"	2	25	23	92	1.4	3?	30
Japan	Hino City	humic Ando/Dystrandept	8	45	37	82	5.8	30	27
Japan	Kumamoto	humic Ando/Hydrandept?	10	94	84	89	9.5	32	211
Kenya	Kijabe	mollic Ando/Eutrandept	36	89	53	60	9.8	20	29
"	same profile	"	10	44	34	77	2.5	16	36
N.Zealand	Tirau	ochric Ando/Dystrandept	4	25	21	84	1.8	12	34
Tanzania	Larale	Kastanozem/Argiustoll[3]	21	39	18	46	0.6	28	11
Jamaica	Hope Pen	Ferralsol/Acrortox[4]	2	16	14	88	1.7	76	--
Kenya	Busia	Acrisol/Paleudult	3	8	5	63	0.7	15	2.4
Kenya	Magarini	Ferralsol/Eutrustox	2	5	3	60	0.7	15	3.5
Kenya	Nairobi	Nitosol/Palehumult[3]	12	36	24	67	2.8	66	22
Netherlands	Yvonnite	allophane	28	103	71	69	0	--	--
U.K.	Cornwall	kaolinite	5	8	3	38	0	--	--
N.Zealand	Naike	halloysite	7	17	10	59	tr.	--	--
U.S.A.	Wyoming	bentonite	77	104	27	26	tr.	--	--

[1] $\Delta CEC\ ratio = \frac{\Delta CEC}{CEC9} \times 100\%$. [2] All clay data are suspect by nature. [3] Ash-influenced. [4] Gibbsitic.

OBSERVATIONS

Procedure

- The pH 4 buffer dissolved, at worst, up to 2% of the sample, in most cases the loss was less than 1%. The pH 9 buffer dissolved less than % in all cases.
- Of many samples, especially at pH 9, part of the humus is extracted (dark coloured extract) but this is not excluded from the CEC determination.

Data

- Δ CEC values of Andisols are high but erratic. Obviously they depend on clay-type, clay content and humus content. The present limited number of samples does not allow the establishment of consistencies with particular types of Andisols.
- To reduce the wide variation in γ CEC values, Quantin (5) proposed to use the "Δ CEC ratio" as differentiating criterion. The present results indicate that this value might not be sensitive enough for this purpose.
- Comparison of Andisols with other variable charge soils suggests that Andisols are characterized by:

  CEC 9 > x 5 x CEC 4

  or Δ CEC > 20 me/100 g

  or both

CONCLUSIONS

The AgTU CEC method can be used at pH values up to pH 9 and facilitates a rapid and convenient determination of the pH-dependence of the CEC of soils. The proposed method is very mild in causing damage to samples and in formation of artefacts.

It is proposed that this method is used to determine the CEC at pH 4 and 9 on a routine basis as a better alternative for all other methods used to determine the variable charge of soils.

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