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Exchangeable Cations
Cation Exchange Capacity

Analyse des Sols, Des Eaux et des Plantes

Damas

LE CENTRE ARABE
POUR LES ETUDES DES ZONES ARIDES ET DES TERRES SECHES
(ACSAD)

The Arab Center
For the Studies of Arid Zones
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ACSAD

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- Soil Division -

No. 3401

Exchangeable Cations
Cation Exchange Capacity

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•• ACSAD

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CODE : 3401-02/45-47-54-c/80

ORDR : 0348

Authors : ABDEL-AAL (S.H) & BERGSETH (H)
Title : Ion Exchange removal of carbonates from saline calcareous soil prior to determination of Cation Exchange Capacity using ^{89}Sr .
Public : Soil Science 120 - 5 - 1975
Pages/ref : Page 349 - 353 / 15 ref.

Summary:

A mixed ion exchange resin is used to remove calcium carbonate from soils. CEC is then measured by ^{89}Sr retention. Results are very close to ammonium acetate method, and precipitation of strontium carbonate is avoided. The Method is tested on two calcareous profiles.

Method: Removal of calcium carbonate: 0.1gr. soil, grinded to 0.1m/m, is shaken 24 hours with (0.3 - 0.9m/m) mixed resin. Soil and resin are separated by sieving. CEC is then measured by a 0.2N strontium chloride solution spiked with 0.6 millicurie/ ^{89}Sr .

For the six samples treated, ranging from 5 to 16mS cm (electric conductivity of saturated extract) the method gave a sum of exchangeable cation greater than CEC. Agreement with ammonium acetate method as an average of three replicates for each sample was within 1%.

In all cases sodium acetate method gave results higher than both other methods.

Application: Cation Exchange Capacity.

Precision :- When compared to 1N ammonium acetate pH 7, strontium-mixed-resin method gave CEC results within 1% (range 30-35meq/100gr.) ammonium acetate gave CEC 10% higher.
- Strontium method without treatment gave CEC in excess of 33 to 100meq/100gr. depending on calcium carbonate content of samples.

Tables :- Properties and mineralogical composition of soils samples.
- Comparison of CEC determination, sodium acetate, ammonium acetate, strontium chloride and sum of EC.
- CEC with and without resin treatment.

Material : Scintillation counter.

Chemicals : Stable strontium chloride. Radio active strontium chloride. Ammonium acetate. Sodium acetate.

Key Words : ECEC / RESIN / PHYS / CARB / RADIO /

Authors : ABROL (I.P)- DAHIYA (I.S) & BHUMBLA (D.R)
Title : On the method of determining gypsum requirement of soils.
Public : Soil Science 120-(1)-1975.
Pages/ref: (30-36)/ 7 ref.

Summary:

The classical method of determination of the gypsum requirement of saline soils consists in shaking a known quantity of soil with a saturated gypsum solution (soil/solution ratio 1/20 about) and to measure the decrease in calcium concentration of the solution.

When soils contain sodium carbonates (saline sodic soils) CaCO_3 precipitates during the analysis, and the excess of exchangeable sodium is overestimated. Experiments on a saline sodic soil (salonatric calciorthid) were made in leaching columns to determine the effect of the nature of the amendment (gypsum or calcium chloride) and the system of application on the precipitation of carbonates during leaching. The results were in favor of surface application in the field. In the laboratory; it is suggested to eliminate soluble carbonates by washing it with 60% ethanol. When used under similar conditions gypsum produced a lower carbonate precipitation than calcium chloride.

Tables :- Characteristics of the soil sample.
- Effect of different treatments on carbonate precipitation, on exchangeable calcium and on hydraulic conductivity of soils.
- Changes in hydraulic conductivity in respect to different soil treatments (in laboratory).
- Gypsum requirement of soils containing varying quantities of soluble carbonates.

Chemicals: Gypsum - Ethanol.

Key Words: SALI / GYPS / Na-ECHAN / Ca-ECHAN /.

Author : ABRUKOVA (L.P)
Title : Determination of exchangeable bases in calcareous soils.
Public : Soviet Soil Science - 1964.
Pages/ref: (977-980) / 17 ref.

Summary:

Three methods are compared for determining exchangeable cations in soil containing 3 to 35% of calcium carbonates, with special mention to exchangeable calcium and magnesium. the morphology of calcium carbonate appears to be an important factor leading to different solubilities in various extractants. Methods based on assumption of constant solubility of carbonates in successive extractions are suspected.

Methods: a) EC are displaced by 1N NaCl solution (up to 500ml) correction for dissolved carbonates is made by titrating carbonates passed into solution.

b) Exchangeable calcium is bound by oxalate ions and calculated from the difference in oxalate concentration before and after saturation. The reagent involved is a mixture of ammonium salts kept at 10°C.

c) Soil is saturated by two times the same volume of 1N NaCl. The first is supposed to contain exchangeable and soluble (Ca, Mg), the second only soluble (Ca, Mg).

All methods gave similar results when calcium carbonate (3%) was in latent, invisible form. CEC values differed widely when calcium carbonate was either mycelium or visible cristalline form (5%). The method (a) gave the most reliable results.

Figures :- Determination of exchangeable calcium by three methods.
- Determination of ECa and EMg in calcareous chernozems by three methods.

Chemicals: Method 1 : Sodium chloride - Hydrochloric acid.
Method 2 : Ammonium oxalate - Ammonium acetate - Ammonium carbonate . (plus chemicals for titration of oxalate).
Method 3 : Sodium chloride.

Key Words: ECEC / CALC / .

CODE : 3401-04/46-47-54-60-c/80

ORDR : 0350

Authors : ADAMS (J.M) & EVANS (S)
Title : Determination of the cation exchange capacity (layer charge)
of small quantities of clay minerals by nephelometry.
Public : Clay & Clay Mineral 2-27-1978.
Pages/ref : (137-139) / 7 ref.

Summary:

Irreversible cation fixation on clay prevents the determination of CEC of clay when less than 30mg of sample is available and only layer charge may be measured directly. A fusion with NaOH is recommended to extract completely the saturating cation(either Ba or Ca). Nephelometry technique of Barium sulfate(or calcium oxalate monohydrate) in the range of 0-30 ppm. Ba or Ca is described.

Method: 30mgr. of Ca or Ba saturated clay is fused with 0.7g NaOH to red heat 10min. and dissolved in HCl (final conc.:4%).

Nephelometry of Barium: To 5ml of the clay solution, 5ml of glycerol/ethanol mixture and 2.5ml of 1.5M H₂SO₄ are added, then volume is made up to 25ml. Turbidity is measured after 10 minutes.

Nephelometry of calcium: To 5ml of the clay solution add 4.0ml of the glycerol/ethanol mixture, 1.5ml 3M NH₄OH and 4.0ml oxalic acid solution(20 g/l)turbidity is measured after 25min. Authors suggest that barium may be fixed on surface of clay particles and propose to use Ca saturated samples even if the quantity of available clay is only 5 to 30 mgr.

Tables : Comparison of nephelometric and others determination of CEC (on Ba and Ca saturated clays) for bentonite, montmorillonite and beidellite samples.

Precision : For 30mgr. samples having a CEC 70-100meq/100 gr. duplicate measurements agreed within 10% and comparison with other methods was better than 5%.

Chemicals : NaOH . NaCl . Glycol . Ethanol . Amonia . Oxalic acid .

Key Words : CEC / MINE / Ba / Ca /.

Author : ALLEN (S.E)
Title : Metallic elements in soils: Determination of Ca, Mg, Mn,
K and Na in soils.
Public : Pye Unicam Ltd. / AA5 / 2757 /1978.
Pages ref: 3 pages / 1 ref.

Summary:

Soils is extracted either with amonium acetate N or 2,5% acetic acid. Lanthanum was added to overcome interference from aluminium, silicon, phosphorus in the determination of (Ca,Mg). Preparation of standard solution is described.

Manganese, Potassium and Sodium standard solutions are prepared as a mixture of each element (range 0-2,5-5,0mgr/l) in amonium acetate or acetic acid.

Calcium and Magnesium standards are prepared in mixed solutions (0 to 10 ppm Ca and 0 to 0,5 ppm Mg) in 1% sulfuric acid, and either / M amonium acetate or acetic acid.

Addition of sulfuric acid to unknown reduces the amount of lanthanum required.

Sodium and Potassium are determined by flame emission. Calcium at 422,7 nm, Magnesium at 285,2 nm, and Manganese at 279,5 nm. Instrumental conditions are given in detail.

Tables :- Dilution tables for stock solutions of Ca and Mg.
- Instrumental settings.
- Comparison of duplicate determination with reference values on three samples. (Extraction of exchangeable plus labile, plus soluble Ca, Mg, Na, K, Kn was done with amonium acetate N and with acetic acid 2,5%).

Material : AA Spectrophotometer.Ca, Mg, Mn Hollow Cathod Lamp.

Chemicals: Calcium carbonate. Mg ribbon . Mn metal . Sodium chloride .
HCl . Potassium chloride . Lanthanum 0,4% . Acetic acid .
Amonium acetate . Sulfuric acid .

Key Words: CALCIUM / MAGNESIUM / MANGANESE / POTASSIUM /
SODIUM / AAS /

Author : AMER (F)
Title : A comparison of Ammonium acetate, Sodium acetate, and Ca⁴⁵ equilibration methods for determining the cation exchange capacity of calcareous soils.
Public : 7th Int. Congr. of Soil Sci. Madison (U.S.A) 1960.
Pages/ref: (53-58) / 8 ref.

Summary:

Three methods of determination of CEC are compared on seven Egyptian surface soils. The soils contain 2 to 19% CaCO₃ ; 0,6 to 2,2% MgCO₃ and soluble cations ranging from 1,2 to 2 me/100g.

Methods: Calcium carbonate are determined by the difference: (total Ca - soluble Ca - exchangeable Ca). Ditto for magnesium carbonate.

The reference value for comparing the three determinations of CEC is the sum of exchangeable Ca, Mg, Na and K obtained by three different methods, i.e:

Exch. Ca : by Ca⁴⁵ equilibration corrected by 0,005 x CaCO₃% .

Exch. Mg : by N sodium acetate corrected by the solubility of dolomite in the extractant.

Exch.Na+K: by N ammonium acetate corrected for soluble Na and K found in the soil (sic).

The three methods of CEC determination compared are: a) Ammonium acetate replacement, washing out by NH₄Cl and then ethanol and distillation of ammonium. b) Sodium acetate method c) Ca⁴⁵ equilibration.

Results:As compared to the sum of exchangeable cations(average 31,5me/100g),the NH₄OAc method gave the closest results(average 29,5) The two others gave significantly higher results,(i.e 34,4 for the 45Ca method and 35,2 for the sodium acetate method.).

Exchangeable Ca extracted by ammonium acetate was higher than when extracted by sodium acetate (averages 20,0 and 18,4 respectively.).

Tables :- Alkaline-earth carbonates and soluble cations of the investigated soils.
- Exchangeable cations and calcium extracted by sodium acetate.
- CEC as determined by the sum of exchangeable cations and the three methods tested.

Key Words: ECEC /.

CODE : 3401-18/c-47-54-c-c/80

ORDR : 0583

Auteur : XXX / ARIANA

Titre : Détermination de la capacité d'échange des argiles
par une microméthode.

Public : DRES - Tunis - 1975.

Pages/ref: 4 pages / 2 ref.

Résumé:

Méthode:- Sécher l'argile sous vide à 40°C pendant 48 heures.
peser 20mg, ajouter 15ml d'acetate d'ammonium, agiter, laisser
en contact 12h, centrifuger. Laver par trois fois 5ml d'éthanol
vérifier l'absence d'ammonium au reactif de Nessler. Ajouter 15ml
de chlorure de sodium 10% agiter, laisser en contact une nuit,
centrifuger.

Mesure : Prélever 1 à 2,5ml de surnageant, compléter à 3ml par
NaCl 10% ajouter 15ml d'eau distillée, 2ml de solution de phenate
de sodium, 0,5ml d'hypochlorite de sodium, mesurer la coloration
bleue à 62 nm. On peut mesurer ainsi des CEC jusqu'à 125 me/100g
d'argile. Les résultats sont rapportés à l'argile calcinée à 900°C.

Précision: Reproductibilité 4% pour une valeur de 10 me/100g.

Tables :- Capacités d'échange de quelques argiles pures.
- Dessin du système d'extraction-centrifugation.
- Préparation des solutions étalons de colorimétrie .

Mots Clés: MINE / ECEC / ANPHYS /.

Auteur : XXX / ARIANA
Titre : Dosage du calcium et du magnesium dans les eaux, les extraits de sols et les bases échangeable à l'aide du complexon III.
Public : Méthodes d'analyse des sols et des eaux appliquées au laboratoire de l'Ariana - DRES Tunis.

Résumé:

Le calcium est déterminé à pH12 par EDTA M/50 (virage murexide du violet au rose) la somme (calcium + magnesium) est dosée à pH10 jusqu'à virage au bleu du colorant noir d'ériochrome. La fin du virage peut être suivie par une cellule voltaïque et un filtre 530nm (calcium). La concentration en magnesium est obtenue par différence.

Les ions gênants sont complexés par du cyanure de potassium ou de la triethanolamine.

Méthode: Calcium

25 ml prise d'essai plus 2 ml triethanolamine + 3 gouttes murexide 0.2% dans méthanol + 8 ml NaOH 2.5 N virage du rose au violet.

Calcium + Magnesium:

25 ml prise d'essai plus 2 ml triethanolamine (ou cyanure de K) plus 6 gouttes d'indicateur plus 2 ml tampon pH10. Titrer avec EDTA M/100 jusqu'au bleu cobalt.

Indicateur (Ca + Mg):

0.2 gr noir d'ériochrome T, 2 gr chlorhydrate d'hydroxylamine ajuster à 50 ml par méthanol.

Tampon pH 10: 67.5 gr de chlorure d'ammonium dissous 200 ml H₂O, ajouter 570 ml d'ammoniaque concentré, compléter à 1000 ml. Verifier le pH.

Figures :- Montage pour détection photométrique de la fin de virage.
- Table de calcul des concentrations.

Précision: Titrage valable pour n'importe quel milieu.

Produits : Murexide - Méthanol - Triethanolamine - Chlorure d'ammonium - Ammoniaque - Chlorhydrate d'hydroxylamine - Noir d'ériochrome - Sulfate de magnesium.

Mots Clés: CALCIUM / MAGNESIUM / EAUX / SOLS / TOTAUX / ECHAN /.

CODE : 3401-18/c-c-54-60-c/80

ORDR : 0351

Auteur : XXX / ARIANA

Titre : Mesure de la capacité d'échange et des cations échangeables d'un sol.

Public : Roneo - D.R.E.S - Tunis.

Pages/ref: 11 pages /.

Résumé:

La méthode décrite, utilise la saturation par l'acetate d'ammonium pH 8,2, le rincage a l'éthanol, et le remplacement par le chlorure de sodium. La méthode est applicable aux sols neutres.

La technique utilisée, est la percolation a niveau constant (vase de Mariotte).

Les cations échangeable sont mesurés par absorption atomique ou photometrie de flamme et la capacité d'échange déterminée par la concentration en ammonium dans le percolat NaCl mesuré par colorimetrie a l'indophenol.

Une correction est faite pour tenir compte des cations solubles lorsque la somme des cations échangeables dépasse la capacité d'échange. Cette correction est ponderée pour le calcium et le magnesium.

Application: Cations échangeables et capacité d'échange.

Materiel : Colorimetre - Photometre a flamme ou spectrophotometre d'absorption atomique.

Produits : Acetate d'ammonium - Acide acetique - Chlorure de sodium - HCl - Reactif de Nessler - Ethanol.

Mots Clés : ECEC /.

Authors : BAKER (J) BURNS (W.T)
Title : The determination of exchangeable cations and cation
exchange capacity of soils using dilute Nickel chloride.
Public : Can. J. Soil Sci. 44 - 1964.
Pages/ref : (360-365) / 10 ref.

Summary:

60 ml of neutral 0-25 normal Nickel chloride-extracting solution is added to 5g oven-dry soil 2mm mesh. The mixture is then centrifuged, after 15 minutes shaking. The supernatant is decanted and filtered. The filter is washed with distilled water and chloride is detected; the extraction is repeated 6 times. Exchangeable Ca, Mg, Mn, Na, and K were determined using flame photometer and complexometric titration. The method was tested on acid soils.

For the determination of CEC, Nickel-saturated soil were agitated with 60 ml 0,5 N ammonium-sulfate for 15 min., and centrifuged. The extracting procedure was repeated 6 times. Nickel concentration were determined using flame photometer and polarography. Also Cl^- ions were determined by back-titration as Vogel, the method was described as follow: an excess of EDTA was added to ammonium sulfate (pH=6,5), then the pH was adjusted to 9 with ammonium hydroxide-ammonium chloride buffer. EDTA was back-titrated with standard MgCl_2 using Eriochrome black T as the indicator.

For determining chloride, the Volhard's method was used.

Tables :- Some properties of the soils used in this study.
- Exchangeable cation and CEC values for soils as obtained the proposed method and by N pH7 ammonium acetate.
- A comparison of the efficiency of NH_4 , Ca and Ni as displacing cations in the determination of the CEC of a clay and a silty clay-loam.

Material : Photometer - polarography titrator - filter - centrifuge.

Chemicals : Nickel chloride - Ammonium sulfate - Sulfate - EDTA - Ammonium hydroxide - Ammonium chloride buffer - MgCl_2 - Eriochrome black T - Ammonium thiocyanate.

Key Words : ECEC /.

CODE : 3402-01/c-47-54-60-c/80

ORDR : 0283

Author : BASCOMB (C.L)
Title : Rapid method for the determination of cation-exchange capacity of calcareous and non calcareous soils.
Public : J. Sci. Fd. Agric. vol 15. - 1964.
Pages/ref: (821-823) / 5 ref.

Summary:

Procedure: to 5 gr of soil, add 100 ml of 1N BaCl_2 triethanolamine pH8.1, shake 1 hour. Centrifuge (r.c.f 415) 15 min. discard the supernatant. Leave overnight with another (200ml) portion of the reagent. Centrifuge, wash by 200ml water. Centrifuge. Add exactly 100ml MgSO_4 about N/20 shake 2 hours, Centrifuge, collect supernatant in a volumetric flask. Titrate by EDTA using catechol violet as indicator. The correction for BaCl_2 remaining by capillarity after washing is done by differential weighing.

The method was tested on 6 synthetic soil mixtures (clay + washed sand + chalk). The results are compared for the samples containing 40 and 5% clay with ammonium acetate/ethanol/distillation method ; agreement is around 5%.

Tables :- CEC of synthetic soil mixture versus clay content at 0 and 25% CaCO_3 levels.

Reagents : Triethanolamine (commercial) - BaCl_2 - $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ - EDTA - Catechol violet indicator.

Key Words: ECEC /.

CODE : 3402-05/c-47-57-59-c/80

ORDR : 0352

Author : BECKETT (P.H.T)
Title : The cation-exchange equilibria of calcium and magnesium.
Public : Soil Science 100 (2) : 1965.
Pages/ref: (118-123) / 24 ref.

Summary:

Ion exchange affinities for exchange sites of soils and ion exchange Ca/Mg constant was studied on a natural acid soil (clay 7.5% , organic matter 3.1% , pH 5.2 , NH_4Cl extractable cations $\text{Ca} = 6.8$, $\text{Mg} = 0.7$, $\text{K} = 0.5$, $\text{Na} = 0.11$ meq/100 g), clay was montmorillonite with moderate illite. In the presented study, the soil was equilibrated with solutions having a $\text{Mg} / (\text{Mg} + \text{Ca})$ concentration ratio ranging from 0.07 to 0.94 in 23 different experiments.

Results:

It was shown that except at specific sites Ca and Mg are held with similar attraction by exchange sites, the number of sites available for Ca being however greater than for Mg. The difference between Ca and Mg fixation is therefore pronounced only at low level of activities.

Tables :- Ion exchange equilibrium between Ca and Mg for $(\text{Ca} + \text{Mg}) = 4.2$ meq/l.
- Quantity - Intensity relation for labile and exchangeable Mg & Ca.

Key Words: ECEC / Ca-LABIL / Mg-LABIL /.

Authors : BERGSETH (H) HAGEBO (F.A) LIEN (H) & STEENBERG (K)
Title : Determination of cation exchange capacity in colloidal
soil material by means of radio strontium.
Public : Soil Science 95 - 2 - 1963.
Pages/ref : (97-100 / 6 ref.

Summary:

CEC is measured on a suspension of dispersed colloidal (less than 1 micron) by flocculation with 0.2 N radio-strontium chloride. Excess strontium is washed out until free of chloride. Adsorbed strontium is determined by counting the ^{89}Sr beta emitted by the precipitate.

Method:

To 50 mgr of dispersed colloid, 0.2 ml radio-strontium chloride is added. Flocculation is made overnight, suspension is decanted, saturated again with radio-strontium chloride, agitated one hour (two times). Precipitate is washed until free of chlorine and dried. A set of radio-strontium standards are prepared and activity of precipitate is compared to standard curve.

Application: Cation Exchange Capacity of Clays.

Tables :- Centrifuge table assembly with removable aluminium counting dish.
- Self absorption of radio-strontium beta emission in soil sample.
- Effect of added CaCO_3 to the sample.
- Comparison with flame photometric method.
- Results of CEC from Kaolin (4 meq/100 gr), to Montmorillonite (103 meq/10 gr).
- Effect of addition of calcium carbonate on CEC determination (0 to 30% added CaCO_3).

Precision :- Self absorption is negligible below 50 mgr/cm² of soil spread in aluminium counting dish.
- Excess of added Sr should be 20 times estimated CEC of the sample.
- Radio-strontium method compares with Sr flame emission within 1% from 4 to 105 meq/100gr of clay material.

Material : Beta counting equipment - centrifuge.

Chemicals : Radio-strontium chloride - Silver nitrate - Nitric acid - HCl.

Key Words : ECEC / MINE / ASPEC /.

CODE : 3402-12/41-47-54-60-c/80

ORDR : 0814

Authors : BLAKEMORE (L.C) METSON (A.J)
Title : Micro-determination of cation exchange capacity and
total exchangeable bases.
Public : Soil Science 84 - 1960.
Pages/ref : (202-208) / 20 ref.

Summary:

20 mgr of clay (or soil) are leached with four portions of 0.5 ml N NH_4OAc rinsed with two 0.5 ml portions of ETOH. The soil is then placed in a Conway unit in which ammonia is measured by microdiffusion method. Another method is proposed for samples of 2 to 5 mgr by using Conway's HCl - $\text{Ba}(\text{OH})_2$ procedure for ammonia determination. It is recommended to carry out the analysis in triplicate.

The experimental details are explained. The values found are compared with the NH_4OAc macro-method. The micro-method for total exchangeable bases is also described.

Precision : The mean values of 5 replicates by micro-method, compared with the mean values of triplicate determinations for 10 samples by the macro-method (CEC 5 to 40 meq/100 gr.) differed by less than 1%.

Figures : Leaching assembly and method of filling, leaching tube in which the soil should be placed.

Tables :- Comparison of CEC data for 10 soils and 6 clays by micro and by macro-methods.

Key Words : ECEC / MINE /.

BLAK

Authors : BOWER (C.A) REITEMEIER (R.F) & FIREMAN (M)
Title : Exchangeable cation analysis of saline and alkali soils.
Public : Soil Science 73 - 4 - 1952.
Pages/ref : (251-261) / 16 ref.

Summary:

The determination of exchangeable cations (EC), and cation exchange capacity (CEC) is considered with the evaluation of soluble salts (SS) in saturation extract.

EC are determined on 5 gr of soil by three times 33 ml of 1N pH7 ammonium acetate. Soluble cations in a saturated paste from 200 gr of soil. For CEC, 5 gr of soil is saturated by four 33 ml portions of 1N pH8.2 sodium acetate, washed with 95% ethanol. Efficiency of washing is controlled by electric conductivity (less than 40 micro S/cm). Replacement step is done by N ammonium acetate. CEC is proportional to sodium extracted in this last solution.

The paper details experimental conditions as optimum number of acetate extractions to remove (EC + SS) on saline, calcareous and saline soil samples. Data indicate that three extractions are sufficient to remove all soluble and exchangeable cations. Four treatments with sodium acetate are sufficient to saturate exchangeable sites with sodium.

Hydrolysis of exchangeable sodium upon washing treatment is investigated.

Tables :- Amounts of various cations removed by successive ammonium acetate extractions of soils.
- Amounts of Ca plus Mg removed by sodium acetate extraction.
- pH value of successive acetate extracts of soils.
- Removal of excess salts hydrolysis of exchangeable Na upon washing a sodium-treated soil with ethanol.
- CEC of soils by Na at various pH values.
- Influence of CaCO_3 upon values obtained for the CEC by saturation with normal sodium acetate solution of pH 8,2.

Material : Flame photometer - pH-meter.

Chemicals : Ammonium acetate - Sodium acetate - Ethanol.

Key Words : ECEC / SALI /.

Authors : CARPENA (O) LAX (A) & VAHTRAS (K)
Title : Determination of exchangeable cations in calcareous soils.
Public : Soil Science 3 - 113 - 1972.
Pages/ref : (194-199) / 6 ref.

Summary:

A modification of the Mehlich-Piper procedure is proposed to eliminate solubilization of carbonates as a source of errors in exchangeable cation determination. A soil sample is treated twice with the same volume of extracting solution. The first fraction is supposed to contain soluble and exchangeable cations. The second only cations from soluble carbonates. The solution used is barium-chloride-triethanolamine 0.2N, pH8.1. The method is applied to dolomitic soils of Spain (pH7.6 to 8.2 ; O.M 0.3 to 6% ; Clay 5 to 18%). The technique used is percolation on 5 gr sample.

Correction for dissolved carbonates is based on HCO_3^- determination, care being taken to prevent CO_2 contamination from air and correction being made for exchanged H^+ and TEA reaction with acid. The amounts of carbonates dissolved during the second extraction is smaller than in the first one (the rate of dissolution of carbonate is not constant with respect to time).

Tables :- Analysis scheme . Titration curve for HCO_3^- .
- Relationship between ECH (Ca + Mg) calculated and true exch. cations.
- Intermediate data used to calculate dissolved carbonates.

Precision : The method is tested for soils containing 5 to 55% CaCO_3 and 5 to 18% clay.

Material : AA Spectrophotometer.

Chemicals : Barium chloride - HCl - TEA - Ammonium sulfate - EDTA - Eriochrome black T.

Key Words : ECEC / CARB / CALC /.

Authors : CHHABRA (R) PLEYSIER (J) & CREMERS (A)
Title : The measurement of the cation exchange capacity and exchangeable cations in soils: A new method.
Public : Proc. of Int. Clay Conf. 1975. Applied Publ. Ltd. Wilmette, Illinois 60091 - U.S.A.
Pages/ref : (439-449) / 9 ref.

Summary:

The one-step method for measuring EC and CEC of soils is based on the high affinity of silver-thiourea complex for exchange sites. Silver, Ca, Mg, Na, K are measured in a single extract. CEC is related to decrease in Ag concentration before and after saturation. The method is compared with ^{45}Ca isotopic dilution method and NH_4OAc -NaCl method, and is tested on 30 podzolic, 15 saline alkali, and 6 calcareous soils (CaCO_3 7 to 65%). Different procedures were tested with or without 1M NH_4OAc pH7 as a buffer. Direct saturation of alkali soils with silver-thiourea is impossible because of the unstability of the complex at pH above 8. All the methods are described into detail.

Results:

Silver-thiourea and ammonium acetate methods gave correlation coefficient higher than 0.98 and exhibited a similar dependance on organic matter content of samples. For exchangeable cations the best agreement appeared on Ca determination.

Tables :- Comparison of CEC values as obtained by different methods on podzolic, saline alkali and calcareous soils.
- Correlation between silver-thiourea method and NH_4OAc percolation method for exchangeable cation (Ca, Mg, K) on podzolic soils and exchangeable + soluble cations on saline alkali soils.

Precision : Reproducibility is better than 5% for 53 duplicates.

Material : AA Spectrophotometer - Centrifuge - End-over-end shaker (optional: scintillation counter).

Chemicals : For Ag-Thiourea method only: NH_4OAc - AgNO_3 - Thiourea (optional Ag gamma tracer).

Key Words : ECEC / ASPEC /.

Authors : COFFMAN (C.B) & FANNING (D.S)
Title : Vermiculite determination on whole soils by cation exchange capacity methods.
Public : Clay & Clay Minerals 22 - 1974.
Pages/ref: (271-283) / 17 ref.

Summary:

A modified version of Alexiades' and Jackson's method for estimating vermiculite percentage of soil without size fractionation is presented. The method relies on the fixation of K on interlayer cation exchange sites of vermiculite and measuring CEC by Ca saturation, (CaEC) then by K saturation (KEC). The content of vermiculite may be estimated, providing the vermiculite has a constant interlayer exchange capacity of 154 meq/100gr. The parameters of Alexiades' procedure are reviewed and results compared with X-ray diffraction patterns. The authors conclude that assumptions on which the method is based are subject to criticism. Namely: 1) 154 meq/100gr value is an average value only. 2) vermiculite may not fix K if the layers are " propped open by hydroxy islands " in some chlorite-vermiculite types. 3) some others minerals may also fix K (beidellite-beidellitic-montmorillonite).

Experiments were made on 0.5gr samples saturated with 1N pH5 NaOAc at 80°C for 30-60 min. ; Excess acetate is removed by centrifuging ; organic matter is destroyed by overnight heating with 0.5ml H₂O₂. Soils are saturated on two subsamples by KOAc and NaOAc. The volume of excess saturating solution is measured by weighing.

Tables :- CaEC , KEC and vermiculite % of 13 soils.
- Some properties of particle size fractions of saprolite.
- Effect of free iron removal ; effect of different drying treatments ; effect of coarse versus fine crushing of chlorite and micas-derived vermiculites.
- X-ray diffraction pattern of some vermiculite soils.

Chemicals: KOAc - CaOAc - NaOAc - NH₄OAc.

Key Words: ECEC / MINE / FE / X-RAY /.

CODE : 2803-15/c-47-54-c-c/80

ORDR : 0635

Auteur : COUTINET (S)
Titre : Méthodes d'analyses utilisables pour les sols salés, calcaires et gypseux.
Public : Agronomie Tropicale 12-1965.
Pages/ref: (1242-1251) / 7 ref.

Résumé:

Les analyses des sols salés, calcaires et gypseux son détaillées.

Analyse mécanique: a)- Sols salés: 40g sol/300ml H₂O à ébullition avec H₂O₂ et lavages successifs à l'eau jusqu'à disparition des ions chlore puis mise en suspension avec 20ml Na-hexametaphosphate 40 g/l.

b)- Sol gypseux(moins de 25%): 40g sol/300ml H₂O+5g (NH₄)₂C₂O₄. Bouillir une heure, décanner, recommencer jusqu'à disparition des ions Ca en solution, puis mise en suspension avec 20ml Na-hexameta comme précédemment.

c)- Sol gypseux(plus de 25%): 40g sol/300ml NaCl à 130g/l, decanter 12 heures et recommencer jusqu'à disparition des ions Ca. Laver jusqu'à disparition des ions Cl⁻ et mettre en suspension comme précédemment.

d)- Sol calcaire: 40g de sol+5ml silicate sodium commercial, bouillir deux heures (ne pas agiter mécaniquement).

Dosage de gypse: 50g sol 0,2m/m: bouillir 15 minutes avec 100 ml carbonate ammonium 5%, filtrer, acidifier le filtrat à chaud, ajouter BaCl₂ 10%, décanner, secher 100° et calciner 900°C.

Sels solubles: extrait systematique 1/10^e méthodes classiques de dosage.

Cations échangeables sols salés: Ca et Mg: 25g de sol extrait par 2 fois 1000 ml NaCl N: Ech. Ca=Ca(extrait 1)-Ca(extrait 2)(idem pour Mg).

: Na et K : 25g de sol extrait par 1 fois 50 ml NH₄Cl N et 1 fois 50 ml H₂O Ech. Na=Na(extrait 1) - Na(extrait 2)(idem pour K).

Cations échangeable sols gypseux: comme précédemment, mais ajouter 30g gypse pur pour Ca et Mg échangeables.

CEC: 10g sol Sels solubles lessivés par NH₄OAc 1N pH7 jusqu'à disparition ions Cl⁻. Saturation par 500 ml CaCl₂ N et 150 ml CaCl₂ N/10. Percolation avec 500 ml KNO₃ N. Dosage de Ca et Cl. (CO₃, HCO₃ dans sols calcaires et SO₄ dans sols gypseux pour faire les corrections nécessaires).

Mots Clés: SALI / GYPSE / ECEC / GRAN /.

Authors : CRUZ-ROMERO (G) COLEMAN (N.T)
Title : Reactions responsible for high pH of Na saturated soils
and clay.
Public : J. Soil Sci. 26-2-1975.
Pages/ref : (169-175) / 7 ref.

Summary:

Sodium hydrolysis and desorption were studied on three different materials: a) strong-acid cation exchange resin. b) montmorillonite. c) soils. The materials were first saturated at different percentages of Na and Ca then equilibrated with and without CaCO_3 present as solid phase.

It was found in most cases that values of pH higher than 9 existed only when both conditions: CaCO_3 and high exchange sodium percentage (ESP) were realized.

An experiment was made with strong-acid cation exchange resin at 20, 50, 100% ESP equilibrated with CaCO_3 and water. Na concentration and pH was measured and calculated. The calculation was made from calcite solubility, hydrolysis constant of Na_2CO_3 , and Na, Ca ion-exchange coefficient. The values of Na exp. and Na calc. agreed within 3% in the range of 5 to 55 meq/l. The measured pH was systematically lower than calculated.

Tables :- pH and Na concentrations of soil and clay solutions (ratio 1 ml CEC/100 ml water) with and without addition of CaCO_3 .
- Composition of the solution phase for a system containing cationic resin and 200 mg calcite in 20 ml boiled dist. water.

Key Words : SALI / ECEC / CALC / Na ECHAN / RESIN /.

CODE : 3403-21/c-47-57-c-c/80

ORDR : 0358

Authors : CURTIN (D) & SMILLIE (G.W)
Title : Estimation of components of soil cation exchange capacity
from measurements of specific surface and organic matter.
Public : Soil Science Society of America proceeding 40 - 1976.
Pages/ref : (461-462) / 13 ref.

Summary:

CEC was correlated with specific surface measured by the ethylene glycol monoethyl ether retention method. The correlation coefficient with CEC was $r=0.81$. The study was made on 51 samples of 10 profiles with a CEC ranging 6 to 63 meq/100gr, clay 0.4 to 55%, organic matter 0.2 to 15% and specific surface 5 to 250 m²/g. Most of the samples were acid soils.

A multiple regression analysis with two factors gave a value $r^2(1)=0.97$ when specific surface was combined with organic matter and $r^2(2)=0.58$ when clay percentage was combined with organic matter.

The difference between $r(1)$ and $r(2)$ is attributed to the counting of phyllosilicates in silt and sand fractions when making specific surface measurements.

Tables : Summary of laboratory data for the soils and estimates of organic and mineral components of CEC.
- Simple correlation coefficients between CEC and various soil properties.
- Multiple regression equations relating CEC with (i) organic matter (O.M) and clay and (ii) O.M and specific surface.

Precision : CEC was measured at pH 8.2 using barium chloride with triethanolamine without washing step.

Chemicals : (CEC only) barium chloride - Triethanolamine.

Key Words : MINE / ANPHYS /.

CURT

CODE : 3404-02/c-47-54-60-c/80

ORDR : 0478

Auteur : DABIN (B)
Titre : Dosage des bases échangeables et de la capacité d'échange dans les sols salés. (d'après la méthode SOGREAH).
Public : Non publié.
Pages/ref: (3-7) /.

Résumé:

Deux méthodes sont utilisées: a) Sols calcaires non salés: on extrait les cations échangeables(CE) par NH_4OAc on dose seulement Na, K, Mg.

b) Sols calcaires salés: le schéma d'opération dépend de la conductivité de l'extrait saturés: (EC en mScm^{-1}).

1)- EC compris entre 1 et 2: lavage à l'ethanol presque à ce que la resistivité de l'alcool soit supérieure à 250 Ohm/cm extraire K et Na par NH_4OAc 1N, pH7.

$\text{Na éch.} = \text{Na}(\text{acetate}) - \text{Na}(\text{extrait saturé}) + \text{Cl}(\text{extrait saturé})$
(même calcul pour K éch.).

2)- EC supérieure à 2: lavage au methanol jusqu'à une resistivité supérieure à 1 K Ohm/cm, puis à l'ethanol comme précédement. Tout le Na soluble est éliminable (si Na est inférieure à Cl) sauf lorsqu'il y a d'autres sels de sodium dans le sol (Na est inférieure à Cl dans l'ex. sat.) dans ce dernier cas seulement:

$\text{Na éch.} = \text{Na}(\text{acetate } \text{NH}_4) - \text{Na}(\text{extrait saturé})$
(même calcul pour K éch.).

3)- $\text{Ca éch.} = \text{Ca}(\text{acetate Na}) - \text{Ca}(\text{extrait 1/30})$
(même calcul pour Mg éch.).

Mots Clés: ECEC /.

Auteurs : DEWIS (J) & FREITAS (F)
Titre : Capacité d'échange cationique saturation par le lithium.
Public : Méthodes d'analyse physique et chimique des sols et des eaux:
FAO Bulletin Pedologique No.10 - 1972.
Pages/ref : (112-117) et (125-127) .

Résumé:

La capacité d'échange cationique est mesurée en deux temps:

- Solution saturante: LiOAc 0.1N / LiCl 0.4N, Cl servant d'ion indicateur.
- Solution de déplacement: Ca(OAc)₂ 0.2N.

Le pH des deux solutions est tamponné soit à pH 8.2 (sols calcaires et alcalins) soit à pH 7.0 (sols neutres et acides) On dose le lithium entraîné dans l'acetate et le chlore qui mesure l'excès de solution saturante retenue par capillarité.

La méthode et les calculs sont décrits en détail, y compris l'appareillage et le matériel nécessaire. La méthode peut convenir pour doser les cations échangeables dans l'extrait au chlorure-acetate de lithium. Il faut dans ce cas précipiter le Ca sous forme de tungstate et doser Mg seul avec l'EDTA si on veut utiliser la complexometrie.

Matériel : Photomètre à flamme (ou Spectrophotometre AA).

Produits : LiCl - HOAc - LiOAc.2H₂O - Ca(OAc)₂.H₂O
et (pour dosage des chlorure): nitrate mercurique, diphenyl-carbazone, éthanol, EDTA, Tungstate de Na..

Mots Clés : ECEC /.

CODE : 3404-05/42-47-54-60-c/80

ORDR : 0361

Auteurs : DEWIS (J) & FREITAS (F)
Titre : Capacité d'échange cationique-saturation par le baryum.
Public : Méthodes d'analyse physique et chimique des sols et des eaux:
FAO Bulletin Pedologique No.10 - 1972.
Pages/ref : (109-111) / 3 ref.

Résumé:

- Les sites d'échange sont saturés par du chlorure de Ba 0.5N tamponné à la triethanolamine, puis par du chlorure de Ba seul.
- L'excès de solution saturante est lavé rapidement à l'eau.
- Le baryum est déplacé par une solution de chlorure d'ammonium N pH8.0 .

Le baryum est dosé sous forme sulfate à l'aide d'acide sulfamique à chaud. La méthode n'est pas applicable telle quelle aux sols gypseux mais convient aux sols peu calcaires; le déplacement du baryum fixé par de l'ammonium, qui a une affinité moindre pour les sites d'échange n'est pas sans problème pour les sols argileux.

Matériel : Creusets filtrants en porcelaine.

Produits : Chlorure de baryum - Triethanolamine - Chlorure d'ammonium -
Acide sulfamique - HCl.

Mots Clés : CEC / Ba /.

CODE : 3404 -19/42-47-57-59-c/80

ORDR : 0315

Authors : DOLCATER (D.L), LOSTE (E.G); SYERS (J.K) & JACKSON(M.L)
Title : Cation exchange selectivity of some clay rigid minerals and
soil materials.
Public : SSSAP. 32-1968.
Pages/ref: 795-798 / 20 ref.

Summary:

The cation selectivity on soil exchange material depends not only on pH, temperature, ion size, ion valence, ion hydration, ion concentration of equilibrating solution but also on structural and charge properties of micaceous vermiculites. Cation exchange selectivity (CES) was measured for montmorillonite, vermiculite, muscovite, biotite. CES was measured by a modified version of Schachtschabel's method:

- A Na saturated clay sample is equilibrated with a solution having a ratio of (K/Ca/2) concentration equal to 0.10. Adsorbed K and Ca were displaced by Mg. Excess saturating solution was determined by weighing. The hypothesis that the high K/Ca selectivity of micas as compared to montmorillonite was due to steric hindrance of hydrated divalent cation such as Ca and Sr was tested.

- Tables : 1 : Mineralogical analysis of samples.
2 : Flow sheet for the determination of CEC and EC of fine grained material.
3-4: K/Ca , K/Sr , K/Ba , CES of Na saturated exchange material.
5 : Mg/Ca , Sr/Ca , Ba/Ca , CES of Na saturated exchange material.
6 : CEC of original samples as given by different saturating cations.
7-8: Diagramatic cross-sections of micaceous vermiculite showing K selectivity mainly in the wedge sites and of muscovite showing K selectivity both in wedge sites and on cleavage surface.

Key Words: CLAY MINE. / CEC /

Auteurs : DROUBI (A) FRITZ (B) TARDY (Y)
Titre : Equilibres entre minéraux et solutions: programmes de calcul appliqués à la prédiction de la salure des sols et des doses optimales d'irrigation.
Public : Cah. ORSTOM ped. vol XIV No. 1, 1976.
Pages/ref : (13-38) / 16 ref.

Résumé: Inventaire des réactions chimiques regissant l'évolution d'un assemblage minéral en équilibre avec une eau naturelle.

a- Réactions d'équilibre: de l'énergie libre ΔG on déduit la constante d'équilibre K d'une réaction. Connaissant les concentrations des ions en solution par l'analyse on en déduit leur activité à l'aide de formules approchées (Debye-Hückel) par un calcul itératif: $I_1 \rightarrow \gamma_1 \rightarrow C_{i1} \rightarrow I_2 \rightarrow \gamma_2 \rightarrow C_{i2}$ jusqu'à $I_n + 1 \approx I_n$, une fois I et l'activité des espèces en solution connus, on calcule l'activité des espèces complexes (ions) et la concentration des espèces neutres à partir des constantes de dissociation. On connaît ainsi les produits ioniques Q que l'on compare pour un minéral donné au produit de solubilité P_s . On juge ainsi de l'état de sous ou sur-saturation d'un minéral en équilibre avec une solution. D'autre part, en système ouvert, pour connaître la distribution des espèces carbonatées en solution il faut connaître la fugacité de CO_2 atmosphérique et le pH. Ceux-ci interviennent également dans l'équilibre de calcite. C'est donc tout le système (calcite $\leftrightarrow$ solution $\leftrightarrow$ air) qui est inclus dans les calculs. Lorsque la concentration en espèce oxydables (ferreux-sulfures) est importante il faut introduire la fugacité de l'oxygène que l'on peut calculer à partir du potentiel redox de la solution.

b- Les phénomènes de concentration par évaporation, précipitation ou d'équilibre avec les argiles sont expliqués sur des exemples simples. On considère les équilibres argiles-solution comme une suite d'équilibres dis-continus (comprenant 24 phases intermédiaires pour la montmorillonite).

c- Les programmes simulant les équilibres, les degrés de saturation les dissolutions et précipitations sont expliqués et deux exemples pratiques sont donnés pour les eaux du Lac Tchad. L'un pour lequel la suite des précipitations est: Montmorillonite Mg- Calcite - Silice amorphe-Trona. (système ouvert). L'autre est un exemple de dissolution du mélange calcite - trona par lessivage (système fermé).

Tables :- Très nombreuses tables de constantes.

Mots Clés : SALI / THEOR /.

Auteurs : DUFEY (J.E) PETIT (C.M) GOBLET (Y) LAUDELOUT (H)
 Titre : Modélisation des équilibres physico-chimiques d'échange
 et de précipitation dans les systèmes sol-eau-électrolyte.
 Public : Ann. Agron 30 - 1 - 1979.
 Pages/ref: (53-62) / 11 ref.

Résumé: Présentation d'un programme de simulation mathématique du mouvement des sels dans la solution du sol applicable à tout transport convectif. Modèle utilisable pour traiter les données analytiques obtenues en laboratoire.

Données du modèles a) pCO_2 b) Ca^{++} , Mg^{++} , Na^+ , H_3O^+ , Cl^- , SO_4^{--} , CO_3^- , HCO_3^- , OH^- , $CaSO_4^o$, $MgSO_4^o$, $CaCO_3^o$, $MgCO_3^o$ c) $CaSO_4$, $2H_2O$, $CaCO_3$ d) Ca^{++} , Mg^{++} , Na^+ échangeables.

Equation à résoudre: huit constantes d'équilibre thermodynamique, cinq de concentration, une d'électroneutralité.

Etape 1): calcul des concentrations à l'équilibre entre solution de sol et phase gazeuse (approximations successives et à pCO_2 fixe on essaie différents pH pour obtenir l'électroneutralité).

Etape 2): calcul de $(Ca^{++})(SO_4^{--})$ et $(Ca^{++})(CO_3^{--})$, puis des concentrations réelles (après précipitation ou dissolution de Ca, SO_4 .. On les renvoie à l'étape 1 jusqu'à ce que les produits de solubilité trouvés soient corrects.

Etape 3): calcul de Ca^{++} , Mg^{++} , Na^+ échangeables à l'équilibre. On suppose: 31) le complexe échangeable saturé: 32) que le coefficient de sélectivité $Na/Ca^{++} Mg^{++}$ ainsi que sa variation sont connus: 33) que le rapport Ca/Mg est le même en solution et sur le complexe absorbant.

Vérification expérimentale sur 3 sols de la Medjerda (Tunisie):

a) CEC, Ca, Mg, échangeables sont déterminés par NH_4OAc et par $NaOAc$. Les résultats concordent sauf Ca(de $ACONH_4$) qui est beaucoup plus grand que $Ca(NaOAc)$.

b) Pour quatre systèmes sol/eau 2/1 1,3/1 1/1 0,7/1 on détermine Na_s , Mg_s en solution et Na_t , Mg_t totaux on a:

$$Na_{ech.} = Na_t - Na_s \text{ on peut déterminer}$$

$$Ca_{ech.} = C.E.C - (Na_e + Mg_e)$$

La comparaison entre les valeurs expérimentales et les valeurs calculées est excellente. La méthode de calcul présente l'avantage de ne pas nécessiter l'étude des cations échangeables directement.

Mots Clés: SALI / ELEC / GYPSE / THEOR /.

Author : EDWARDS (A.D)
Title : An ion-exchange resin method for the determination on cation exchange capacity.
Public : Canadian Journal of Soil Science 47 - 140 - 1967.
Pages/ref: (140-142) / 5 ref.

Summary:

A method using saturation by ammonium ion from a cation exchange resin (ammonium form) instead of ammonium salt is described. It is convenient for micro soil samples. A home-made sieving arrangement made from a distillation flask is shown.

Method: 0.2 to 0.5 gr of sample is mixed with NH_4 -resin in small glass vials (5 ml) and shaken 16 hours. Resin is removed by sieving into a distillation flask with a proper home-made adaptor. Separation of resin and soil is achieved by 25 ml of water if suction is applied to the mixture. Steam distillation is carried out after addition of sodium chloride and magnesium oxide. Titration of distilled ammonia is made by a 5 ml microburette and 0.029 N acid.

Tables :- Sieving arrangement for transferring saturated soil to steam distillation flask while removing the cation exchange resin.
- CEC values by three methods on five soils and soil properties (pH, Clay, Organic matter).

Precision: Relative standard deviation of 6 replicates is around 1% from 18 to 62 me/100 g of CEC and 3% at 3 me/100 g.

Material : Distillation flask fitted with filter funnel and 80 mesh stainless steel screen (removable).

Chemicals: Sodium chloride - Magnesium oxide - Cation exchange resin (40 mesh minimum size).

Key Words: CEC / RESIN /.

Authors : ELSEEWI (A.A) ELATTAR (H.A) DAOUD (A.M)
Title : Relationship between soluble and exchangeable sodium in some
soils of the Nile Delta: an examination of the SAR concept.
Public : Soil Sci. 124 - 4 - 1977.
Pages/ref : (249-264) / 8 ref.

Summary:

The SAR parameter (sodium adsorption ratio, or $1.41\text{Na}/(\text{Ca}+\text{Mg})^{1/2}$ where concentrations are expressed in meq/l in the saturation extract is an easy way to estimate ESP, (exchangeable sodium percentage) providing the relationship between ESP and SAR is general. This relationship is examined in 31 surface-soils from the Nile Delta and compared with data obtained earlier with different soils. Soluble plus exchangeable cations are measured in NH_4OAc pH 7.0 for Na and K and NaOAc pH 8.2 for Ca and Mg; results of exchangeable cations are given after subtracting the corresponding values found in saturation extract.

Regression equations are calculated first between SAR and ESR and then between SAR and ESP ($\text{ESR} = \text{ES}/(\text{CEC} - (\text{ES} + \text{EK}))$) over a wide range of ESP values.

Observed values (from soil analysis) and calculated values are compared and discussed for 31 soils.

Tables : 1. Location of sampling sites in the Nile Delta.
2. Chemical and physical characteristics of the soils studied.
3. Relationship between SAR and ESR.
4. SAR in relation to calculated ESR and to observed ESP.

Precision : $\text{ESR} = 0.0273 + 0.01457 \text{ SAR}$ ($r = 0.934$) Author's.
 $\text{ESR} = 0.0126 + 0.01475 \text{ SAR}$ ($r = 0.923$) U.S.Sal.
 $\text{ESR} = 0.0057 + 0.0173 \text{ SAR}$ (Bower's).

Chemicals : Those necessary for CEC and for Na, K, Ca, Mg analysis and extraction.

Key Words : SALI / ECEC / Na / ECHAN

CODE : 3406-05/43-47-56-59-c/80

ORDR : 0364

Authors : FERNANDO (M.J) BURAU (R.G) ARULANANDAN (K)
Title : A new approach to determination of cation exchange capacity.
Public : Soil Sci. Soc. Am. J. 41 - 818 - 1977.
Pages/ref : (818-820) / 8 ref.

Summary:

The CEC of artificial clay-sand mixture was related to dielectric dispersion (i.e; the difference between the dielectric constant of a soil sample at 3 and 75 megahertz respectively). Different regression equations were found for kaolinite, illite and montmorillonite-enriched samples: The relationships found were tested on natural soils and linear equation was found though the slope was different, the difference being attributed to organic matter, iron oxides and carbonates which cement colloid particles decreasing the dielectric dispersion.

Tables : 1. Elec. dispersion of different types of silica-flour/clay mixtures.
2. Effect of clay type on magnitude of dielectric dispersion.
3. Relationship between dielectric dispersion of CEC.
4. Composition and properties of studied soil samples.

Material : Radiofrequency bridge.

Chemicals : None.

Key Words : ELEC / ECEC / SOL /.

Authors : FRANCIS (C.W) GRIGAL (D.F)
Title : A rapid and simple procedure using Sr 85 for determining
CEC of soils and clays.
Public : Soil Sci. 112 - 1 - 1971.
Pages/ref : (17-21) / 20 ref.

Summary:

A method for measuring CEC of small samples (15mg to 3gr) is presented. Sample was saturated with strontium acetate spiked with Sr⁸⁵ in order to give 25 to 50 thousand counts per minute and per ml of solution. Counting was made by a NaI crystal gamma spectrometer. Excess saturating solution was washed out. Washing centrifuging and counting were done in 25 x 150 mm test tubes.

Several washing solvent were tested and methanol was found to be the most suitable. The method is not applicable to soils containing dolomite or calcite. The method was tested on soils (no data were given) and clay samples (Kaolinite, Bentonite).

Table :- Influence of sample size and washing on CEC of bentonite (about 100 meq/100g), kaolinite and metabentonite.

Material : Gamma spectrometer . Centrifuge.

Key Words : ECEC / RADIO / MINE /.

Author : FRINK (C.R)
Title : The effects of wash solvents on cation exchange capacity measurements.
Public : Soil Sci. Soc. Am. proc. 28 - (506-511) - 1964.
Pages/ref: (506-511) / 31 ref.

Summary:

The effect of different solvents used to remove the excess electrolyte saturating a soil sample in CEC determination is studied in relation to different index cations (Na, NH_4 , Ca, Al). The material studied was: 1) a strong acid-exchange resin (Amb. 1R-120), 2) four clays (montmorillonite-vermiculite-Illite-Kaolinite) and 3) surface soils.

The solubility of saturating solutions was studied in water different alcohols, acetone and dioxane.

Results: For the resin, if no precipitation occurs during the process CEC may be determined by any combination of cation and solvent; for the clay high speed centrifugation is necessary to avoid the loss of soil during washing step, but washing with a 0,001N portion of the saturation solution gave essentially the same result. Washing with non aqueous solvent is then unnecessary; for soils, it is demonstrated that NH_4OAc method give low results due to solubilisation of organic matter in alcohols. Washing with 0,001N NH_4OAc solution and applying correction for the volume of occluded salt is also recommended.

Tables-Figures:

- Permissible normalities of occluded salt solution when diluted 1/10 with various solvents.
- CEC of Amberlite 1R-120 saturated with 3 different cations and washed with different solvents. (ditto for montmorillonite).
- CEC of four clays by the proposed 0,01N wash method and a conventional method.
- CEC of muck saturated with NH_4OAc and washed different solvents.

Key Words: ECEC / MINE / RESIN /.

CODE : 0406-18/45-c-54-c-c/80

ORDR : 0029

Authors : FRITZ (J.S) WAKI (H) GARRALDA (B)
Title : Anion exchange separation of Calcium and Strontium.
Public : Analytical Chemistry 4 - 36 - 1964.
Pages/ref : (900-903) / 8 ref.

Summary:

Separation of calcium, magnesium, strontium is achieved through anion exchange resin. Elution by 0.25 M nitric acid-95% methanol (or 95% ethanol).

Method:

Anion exchange resin (60 to 100 mesh) is converted to nitrate form by nitric acid. Resin column is 22 cm by 1 sq.cm section. Resin is poured in 95% methanol. Column is pretreated by passing 40 ml 0.25M nitric acid in 95% ETOH (solution E), then 30 ml sample. Elution with 0.5 to 0.6 ml/min solution E. Magnesium is eluted in the first 80 ml. Eluent is changed to 0.25M nitric acid in 95% MeOH and calcium is eluted by 70 to 100 ml (depending of Ca/Sr ratio). Strontium is then eluted by 50 ml MeOH (or water). Column is washed by dilute nitric acid..

A 10 ml column is sufficient for separation of magnesium and calcium only.

Tables :- Elution curve for Ca, Sr in ethanol.
- Elution curve for Ca, Sr in methanol.
- Comparison of various effluents.
- Quantitative separation of Sr from Ca and Mg.
- Elution behavior of Mg and Ca in heavy loading (1 millimole).
- Elution curve for Mg, Ca, Sr separation.

Precision : Error on recovery is 0.5 to 1.2% of the original concentration in the range of 8 to 40 meq/l.

Material : Ion exchange column.

Chemicals : Methanol - EDTA - Anion exchange resin - Amberlyst XN-1002 - Magnesium nitrate - Calcium nitrate - Strontium nitrate - Nitric acid.

Key Words : CALCIUM / MAGNESIUM / WATER / RESIN /.

CODE : 2707-01/c-47-54-59-c/80

ORDR : 0262

Authors : GARMAN (M) HESSE (P.R)
Title : Cation Exchange Capacity of Gypsic Soils.
Public : Plant & Soil 42 - 1975.
Pages/ref : (477-480) / 1 ref.

Summary:

The method relies on saturation of exchange sites by barium at pH8.1 . Barium is exchanged with magnesium using a standard magnesium sulfate solution. The CEC is determined by calculating the loss of magnesium from the added standard solution of magnesium sulfate. The method is appreciable for soil containing up to 70% of gypsum providing some precautions:

- 1- A great excess of barium ions is used in saturation step.
- 2- EDTA titration of magnesium is corrected for calcium.

It was demonstrated that 1) even an excess of barium chloride does not dissolve all gypsum when present in quantities superior to 3% (overnight treatment). 2) pH 5.5 $MgSO_4$ treatment removes barium sulfate coating and an appreciable amount of remaining gypsum is dissolved during the second step of the procedure.

Tables :- CEC (me/100 g soil) of gypsic soil using the original and a modified version of the Bascomb's method.
- Calcium content of final magnesium sulfate extract of soils during determination of CEC by Bascomb's method.

Chemiclas : Barium chloride - Magnesium sulfate - Solochrome dark blue.

Key Words : ECEC / GYPS / CALC /.

GARM

CODE : 3407-09/c-47-54-c-c/80

ORDR : 0365

Author : GILTRAP (D.J)
Title : Determination of cation exchange capacity of soils by indirect estimation of reference cation retention.
Public : New Zealand Journal of Soil Science 15 - 2 - 1972.
Pages/ref: (156-164) / 9 ref.

Summary:

A one step method for CEC consists of saturating the soil with $(\text{OAc})_2\text{M}$ and measuring the difference in concentration of M before and after saturation. The washing step is not necessary providing the soil sample is weighed before and after saturation to estimate salt retention by capillarity in the sample. The precision of the method is usually poor since only 1 to 5% of the original concentration of M cation is adsorbed on exchange sites. The author proposes to improve the precision by precipitating an equal amount of M cation in both solutions before measuring M.

Method: 1. Calcium acetate:

Mix 1g soil with 5g silica sand, leach with 90ml 0.0375 M calcium acetate. Collect the leachate in a 100ml volumetric flask. Run a blank with sand only. To a 15ml aliquot, precipitate calcium by adding 15ml of 0.035 M calcium oxalate, centrifuge. Ca is determined in this solution by flame emission at 422 nm.

2. Barium acetate:

The same method may be used with barium acetate (precipitated by ureadichromate. Ba is measured by EE at 487 nm.

3. A third method using barium acetate/barium chloride mixture is also detailed, but was found unacceptable.

Tables : 1. Some properties (pH, % clay, clay mineralogy), of seven soil samples used. (All of them being acidic soils).
2. Results of cation exchange measurements by four different methods (ammonium acetate and the three proposed).

Precision: The precision is limited by the reproducibility of the volumes of precipitating solution. The standard error for the CEC by barium and calcium methods is 0.8 me/100g corresponding to a coefficient of variation of about 5% as on soils ranging from 5 to 70 me/100g CEC.

Chemicals: Method 1: Calcium acetate - Ammonium oxalate - Strontium chloride.
Method 2: Barium acetate - Urea dichromate - Strontium chloride.

Key Words: EC - CEC /.

CODE : 0407-18/43-c-54-c-c/80

ORDR : 0030

Auteurs : GRETHER (C) BRUTTEL (P)
Titre : Titrage du Ca et Mg en presence individuelle ou commune par
voie de complexation à l'aide d'électrodes polarisées.
Public : Metrohm No. 56f.
Pages/ref : 3 pages / 5 ref.

Résumé:

La fin de réaction des dosages complexométriques de Ca et Mg à l'aide de réactifs comme EDTA ou EGTA est déterminée par méthode voltamétrique et par électrodes polarisées à courant alternatif imposé.

Méthode 1: Titrage voltamétrique:

20 ml d'échantillon + 10 ml tampon(6.1 gr d'éthanolamine/l dans HNO₃ dilué à pH 10,5). On titre le calcium par la solution EGTA et le sodium par EDTA, avec un courant de polarisation de 1 micro A.

Méthode 2: Électrodes polarisées à courant alternatif:

Les électrodes sont polarisées à courant alternatif par le conductisque E 365B à 10 microampère. Le rapport Mg/Ca peut aller de 10 à 100.

Précision : Méthode 1: sensibilité 0.1 ppm Ca et 0.6 ppm Mg (avec une erreur de 5%), l'erreur est inférieure à 1% pour des teneurs élevées.
Méthode 2: Chiffres comparables, la méthode est légèrement plus sensible.

Materiel : Méthode 1: Potentiographe avec polariseur.Électrode d'argent ou de platine (double) amalgamées.
Méthode 2: (en plus de méthode 1) conductisque.

Produits : Ethanolamine - EGTA - NaOH - EDTA - Acide nitrique - Mercure - Nitrate de mercure - KCN.

Mots Clés : CALCIUM / MAGNESIUM / ELEC / VOLUM /.

Author : GRIFFIN (G.F)
Title : Automated determination of Magnesium in soil extracts by
Atomic Absorption Spectrometry.
Public : Soil Sci. Soc. Am. Proc. vol. 32 - 1968.
Pages/ref: (803-805) / 5 ref.

Summary:

A procedure for determination of Mg by automated AAS is described . The sample is diluted in a peristaltic pump and fed into the spectrophotometer by a "well" device specially built for this purpose. The flow rates of the manifold used to dilute the sample are as follows:

Sample (0.32) / Diluent (3.90) / Air (1.20) / Double mixing coil/
Waste (4.62) / Resampler (0.8) / Diluent (2.90) / Air (0.8) /
Double mixing coil / Debubler / Waste (1.10) / Resampler (3.40) /
Well specially designed / AA Spectrophotometer.

Magnesium is extracted from soils by shaking 4 g of soil with 20 ml (NH₄OH - CH₃COOH) pH4.8 for 15 min.

Chemical interferences of Si, Al and P are studied. 100 ppm Al causes a slight reduction of the absorbance, suppressed by 1500 ppm Sr. Silicate does produce significant interference only when Ca is absent from the solution.

- Tables :- Flow diagram.
- Drawing of well device through which spectrophotometer picks up the sample from the manifold.
 - Analysis of variance for two levels of Mg with different levels of Al, P, Si with and without 1500 ppm Sr.
 - Comparison with manual procedure.

Precision: r.s.d is 2% at 10 ppm Mg level for sampling time greater than 60 sec. Precision decreases if the sampling time is reduced.

Key Words: MAGNESIUM / AUTOANALYSE /.

CODE : 3408-05/c-47-54-c-c/80

ORDR : 0367

Author : HESSE (P.R)
Title : Cation exchange Capacity and Exchangeable Cations.
Public.in: Methods of Soil Analysis. FAO/AGON/8F/SYR/67/522 - 1974.
Pages : (11-13).

Summary:

Two methods are presented:

- 1)- Sodium as saturating ion (with washing by 95% ethanol and replacing by ammonium acetate)
- 2)- Barium as saturating ion.

The sodium method uses the conventional batch-centrifuge sequence. The barium method is the following:

To 1g soil add 20 ml 1N barium chloride (buffered to pH8.1 by the same vol. of TEA), shake, centrifuge, wash quickly with 40 ml water, centrifuge. Add 20.0 ml of magnesium sulfate 6.2gr/l) shake two hours, centrifuge. Titrate Ca in the supernatant by EDTA with Eriochrome black T as indicator and (Ca + Mg) on another aliquot. Calculate CEC from loss of Mg during saturation.

Chemicals: (Barium method only)

Triethanolamine - Barium chloride - Magnesium sulfate hexahydrate -
EDTA (disodium) - Eriochrome black T - Solochrome dark blue -
Sodium hydroxide - Polyvinyl alcohol.

Key Words: ECEC /.

HESS

CODE : 3408-15/c-47-54-c-c/80

ORDR : 0368

Authors : HOLMGREN (G.G.S) NELSON (R.E)
Title : A field procedure for base saturation using KCl-Triethanolamine pH8.1 .
Public : Soil Sci. Soc. of Am. J. , vol 41 - 1977.
Pages/ref : (824-827) / 5 ref.

Summary:

The test for rapid measurement of base saturation uses two syringes. The first contains 1 gr. soil sample, the second KCl-TEA leaching solution. Extractable acidity (1) is first measured, then exchangeable calcium plus magnesium (2). Percent base saturation is given by $(2) \times 100 / ((1) + (2))$.

Results: The KCl-TEA extracted acidity is lower than the BaCl₂-TEA laboratory procedure; The CEC given by the field procedure closely approximates the N pH7 ammonium acetate values except for one sodic sample. The critical point for applying correctly the method is the measuring of buffer solution volume and the acid titration volume. The method allows separation of Alfisols and Ultisols orders of the Soils Taxonomy.

Tables :- Figure of saturating device (syringe-bottle).
- Field and lab. exchangeable cations and base saturation data.

Precision : Correlation of the percent base saturation by the proposed method and NH₄OAc laboratory method was: $r=0.99$ slope 1.13 for 25 samples.

Material : Syringes - Field burette.

Chemicals : KCl - Triethanolamine - HCl - NaOH - EDTA - Bromocresol green - Ethanol - Eriochrome black T.- NH₄Cl - NH₄OH .

Key Words : ECEC /.

Author : KITTRICK (J.A)
 Title : The separation factor applied to some soil in ion exchange equilibria.
 Public : Soil Sci. Soc. of Amer. J. 40-1976.
 Pages/ref: (147-148) /.

Summary:

The use of the separation factor $\alpha = C_A c_b / C_B c_a$ (1)
 (where c and C are concentrations in soil solution (ml^{-1}) and in soil (eq.K^{-1} respectively) is investigated. For montmorillonite, the data from others authors (cf table 1) agreed well with equation (1). Data for 198 samples of arid zones calculated for Na and Ca resulted in equation (2):

$$\log C_{\text{Na}} / C_{\text{Ca}} = 0,79 \log a_{\text{Na}} / a_{\text{Ca}} - 1,41 \quad (2)$$

(a = concentrations in saturation extracts and C values of exchangeable Na and (Ca,Mg) respectively, exchangeable Ca being calculated as $\text{CEC} - \text{exch. Na} - \text{exch. K}$).

were a stands for activities in saturation extract. Author note that there is some question as to whether the ionic activities in the saturation extract are in equilibrium with exchangeable ions. The intercept - 1,41 cannot be considered to be the logarithm of the separation factor because the slope of eq.(2) is not equal to 1.

Tables :- 1 exchange data of Vanselow (1932) and Eliason (1966) for montmorillonite plotted according to eq. (1)

Precision: $r = 0,98$ between $\log a_{\text{Na}} / a_{\text{Ca}}$ in saturation extract and $\log C_{\text{Na}} / C_{\text{Ca}}$ an exchange sites (NH_4OAC extraction) for 198 soils of arid zones.

Key Words: CEC / Na - LABIL / Ca - LABIL / SALI /.

CODE : 0411-18/42-48-54-58-c/80

ORDR : 0035

Auteurs : KREMPE (G) MILLION (D)
Titre : Dosage du Calcium et du Magnesium.
Public : Méthodes de dosage utilisées au Centre de Sedimentologie.
Université Louis Pasteur, Strasbourg.
Pages/ref : (33-36) /.

Résumé:

Dosage du calcium et du magnésium par absorption atomique avec utilisation d'une pompe proportionnante pour préparer les solutions.

Le diagramme est le suivant: Echantillon (2 x 2.0)/Tampon A ou B (0.42)/ Double bobine / Spectrophotomètre.

- Le tampon d'ionisation A, utilisé pour le calcium est une solution à 13.4 gr/l de chlorure de césium (ou 11.2 gr/l d'oxyde de césium meilleur marché).
- Le tampon spectral pour Mg est une solution à 118 gr d'oxyde de lanthane dissous dans 300 ml d'HCl concentré et ramené à 1 litre.

Les longueurs-d'onde sont 422.7 (Ca) et 285.2 (Mg).

Figures :- Diagramme de flux continu.
- Courbe concentration/précision.

Précision : Pour Ca, l'écart type relatif est: 10% à 0.020 meq/l.
2.5% entre 0.2 et 1 meq/l.
Pour Mg, l'écart type relatif est: 10% à 0.020 meq/l.
5% à 0.06 meq/l.
1% entre 0.1 et 0.2 meq/l.

Materiel : Spectrophotomètre AA - Pompe proportionnante - Echantillonneur.

Produits : Oxyde de lanthane - Oxyde de Césium.

Mots Clés : CALCIUM / MAGNESIUM / EAUX / ASPEC /.

CODE : 3413-01/46-47-54-59-c/80

ORDR : 0374

Authors : MAC LEOD (S) ZARCINAS (B)
Title : The determination of ammonium and chloride by an autoanalyser
for the measurement of cation exchange capacity of soils.
Public : Communication in Soil Science and Plant Analysis 7 - 8 - 1976.
Pages/ref : (743-750) / 8 ref.

Summary:

A continuous flow colorimetric method is developed for the simultaneous determination of ammonium and chloride from ammonium chloride used to saturate the exchangeable complex of soils.

Method:- Salts are removed by a glycol-ethanol wash.
- Soil is saturated with 1N ammonium chloride pH 8.5 in 60% ethanol. Ammonium adsorbed is replaced by a mixture of calcium nitrate/potassium nitrate (0.25M/1.5M).

Colorimetry: Ammonium is determined by Berthelot's sodium phenate-hypochlorite reaction and chloride by mercury (II) thiocyanate, ferric ions being provided by a ferric nitrate solution. Diagrams (shown here separately) are:

1. Sample (1.6)/air(3.4) / water(1.6) / single mixing coil / iron(III) nitrate 20 gr/l in nitric acid(1.6) / single mixing coil / Hg (II) thiocyanate 0.8 gr/l (1.6) / single mixing coil / colorimeter 480nm/ repump to waste 2.9 /.
2. Sample (1.2)/air(3.9) / EDTA (disodium) M/60 (3.9) / sodium phenate (2.0) / single mixing coil / sodium hypochlorite (3% free chlorine) (2.0) / single mixing coil / bath 95°C (10 m) / cooling coil / colorimeter 620 nm / repump to waste (2.9) /.

Correction for free ammonium used to adjust the pH of saturating solution to 8.5 is made by applying a constant correction factor to ammonium results when high retention of saturating solution is suspected (swelling clays). Analysis of variance was made on 23 soil samples. The results for manual and automatic determination of chloride was the same. Standard deviation of ammonium determination was higher than in manual titrimetric method.

Precision : R.s.d is 2% at 48 me/100g ammonium level and 0.7% at 15 meq/100g level of chloride.

Chemicals : Glycol - Ethanol - Sodium hypochlorite - Phenol sodium hydroxyde - EDTA (disodium) Mercury (II) - Thiocyanate - Iron (III) nitrate - Ammonium chloride - Calcium nitrate - Potassium nitrate.

Key Words : CL / N-NO₃ / COLOR / ECEC /.

MACL

CODE : 3413-01/44-47-54-59-c/80

ORDR : 0375

Auteurs : MARCOEN (J.M) LACROIX (J.P)
Titre : Mesure de la capacité d'échange cationique de la fraction argileuse des sols par ^{85}Sr .
Public : Annales de Gembloux 83.- 277 - 1977.
Pages/ref : (277-281) / 6 ref.

Résumé:

La CEC des argiles est mesurée par scintillation liquide et par spectrométrie gamma du radio strontium. La méthode par analyse d'amplitude permet de mesurer la radioactivité du strontium directement sur le sol.

Mode opératoire:

- 15 à 75 mg d'argile est saturée par 7 ml de chlorure de strontium, 0.1N dopé avec ^{85}Sr , on centrifuge après deux fois, quatre heures d'agitation.
- On lave avec 3 ml de méthanol.

On mesure la radioactivité soit sur les surnageants de centrifugation successifs et sur les lavages (par scintillateur liquide) soit à l'aide d'un analyseur d'amplitude multicanaux équipé d'une sonde NaI de 8 x 8 cm.

Figures : Activité du radiostrontium au cours des différentes phases d'équilibre avec la solution saturante.

Précision :- La technique s'applique à des échantillons de 15 mg à 8 g.
- La CEC d'une montmorillonite est mesurée à 10% près pour une valeur de 85 me/100 g.

Matériel : Analyseur d'amplitude NaI (on scintillateur liquide).

Produits : Chlorure de strontium - Chlorure de strontium radioactif.

Mots Clés : ECEC / MINE / RADIO /.

MARC

CODE : 3413-15/c-47-54-59-c/80

ORDR : 0376

Authors : MOLODSTOV (V.A) IGNATOVA (V.P)
Title : Determination of the composition of adsorbed bases in Saline
Soils.
Public : Soviet Soil Science 3 - 1976.
Pages/ref : (364-367) / 3 ref.

Summary:

It is proposed to determine exchangeable cations of saline soils, especially those with sulfate and chloride salinization after dissolving the salts in water (20 to 40% water/soil ratio) and washing them out by 70% ethanol; up to 10% by weight of soluble salts in soil may be eliminated. Data are presented on 15 samples with 0.6 to 3% water soluble salts, 0 to 30% gypsum and 5 to 12% carbonates.

Method: Wet 5g of soil to field capacity, leave overnight. Add 10-15ml 70% ethanol, mix, centrifuge. Repeat until no sulfate is detected in washings. Add 25 ml of 0.1N NH_4Cl in 70% alcohol, mix, allow to stand 1 hour, centrifuge. Repeat three times, collect supernatant in a porcelain dish, evaporate, dissolve in water. Determine Ca, Mg, K and Na.

The method is tested on a chloridic-sulfatic solonchak and a sierozem with sulfate salinization. In none of the soil samples soluble calcium was found in the 70% alcohol extracts. Sulfate of sodium and magnesium were not removed by washing out with alcohol alone.

Tables :- Composition of adsorbed bases in me/100g after removal of soluble salts with water alone, with alcohol alone according to the proposed method.
- Content of ions in 70% alcohol solutions and composition of exchangeable cations as a function of the degree of wetting before analysis (for 20% and 40% water/soil ratio).
- Sodium content in various extracts and soil solutions.
- Content of ions in extracts and soil solution (1/5 water extracts: 70% alcohol extract after wetting; soil solution).

Chemicals : Ethanol - Ammonium chloride.

Key Words : ECEC / SALI / Na /.

CODE : 3413-15/43-47-54-60-c/80

ORDR : 0585

Authors : MORTLAND (M.M) MELLOR (J.L)
Title : Conductometric titration of soils for cation-exchange capacity.
Public : Soil Sci. Soc. Proceedings - 1954.
Pages/ref : (363-364) / 8 ref.

Summary:

The soil CEC is determined by titrating with a sulfate salt a barium saturated soil and following the titration by conductometry.

Method: 4 to 10gr. of soil are leached with 150ml 1N BaCl₂ during 4 hours. The soil is washed with distilled water until free of chloride and transferred into a beaker with 150ml ethanol 50%. The suspension is titrated with 0,2N Magnesium sulfate and the titration is followed by conductometry. Values at the beginning and end of titration are discarded.

Results: The method has been tested on 11 soils (1 to 7% CaCO₃ ; pH 7,5 to 8,0). No significant difference was found between the results by the NaOAc method and the proposed one. (average 14,3 for NaOAc and 14,6 for BaCl₂ - MgSO₄).

Precision : The standard error of the difference between duplicate determinations was better than 0,5 me/100g of soil at the 14,6 me/100 level.

Tables :- Comparison of CEC by two methods on alkaline soils and on acid soils.
- Conductometric titration of a barium saturated soil with MgSO₄ (example on acid soil and on alkaline one).

Key Words : ECEC / ECEC /.

Authors : OKAZAKI (Rose) SMITH (H.V) MOODIE (C.D)
Title : Some problems in interpreting cation exchange capacity data.
Public : Soil Science 3 - 97 - 1964.
Pages/ref : (202-208) / 9 ref.

Summary:

The effect of washing step during CEC measurement is discussed. The effect of washing out excess saturating cation is found to be the most important source of error, without regard to change of index cation used in saturating solution.

The value of CEC is not affected by the choice of divalent (Ba in a mixture of barium acetate/barium chloride) or monovalent (Na in a mixture of acetate/chloride also) saturating ion.

It is also demonstrated that the number of washings necessary to remove excess saturating solution without loss by hydrolysis varies from sample to sample.

The batch technique, which involves mixing sample with saturating solution and centrifuging is reconsidered as far as washing step, which necessitates complete resuspension of soil material is concerned. Difficulties were encountered with Ba saturated sample. Resuspension problems may lead to results differing from those obtained by leaching.

Control of washing step by use of a tracer anion, as chloride (in nonsaline samples) is not free of errors, and control by limiting the number of washings is not applicable to all samples.

Tables :- Identification of four samples (mineralogy) choosed for experiment.
- Effect of washing number on apparent CEC of samples.
- Effect of centrifuging and leaching techniques on apparent CEC as measured by Ba and Na saturating cations respectively.
- Effect of extent of shaking during washing for achieving resuspension of samples (batch technique) used for experiment mostly kaolinic.

Material : Clay type had a CEC varying from 4 to 15 me/100g (four soil samples).

Equipment : Centrifuge - Leaching columns.

Products : Sodium and Barium salts as chloride and acetate - Ethanol.

Key Words : ECEC / ECHAN /.

CODE : 0415-18/43-48-56-c-c/80

ORDR : 0036

Author : XXX / ORION
Title : Divalent cation activity electrode, model 92 - 32.
Calcium ion activity electrode model 92 - 20.
Public : ORION Research Incorperation 1967.
Pages/ref: (4 p + 4 p)/.

Summary:

An electrode responding to divalent cation may be used to determine water hardness and end point titration in EDTA titrations. The electrode is calibrated in standardized solutions of known activity or known concentration at constant ionic strength.

Tables : First Publication:

- Typical potential electrode versus calcium ion activity and calcium chloride concentration, (range 0.1 to 1000 millimoles/l also printed in the second publication).
- Electrode potential behavior versus solution pH. (pH 2 to 11) for magnesium and calcium chloride at different concentrations.
- Approximate divalent cation selectivity constants at pH 6 for Zn, Fe, Cu, Ni, Ba, Sr (based on Ca/Mg = 1,00).

Second Publication:

- Divalent cation selectivity table (Ca 1,00): Zn^{++} , Fe, Pb, Cu, Ni, Sr, Mg (Mg = 0.014) Ba.
- Electrode potential behavior versus solution pH (pure calcium chloride solutions 0.1 to 1000 millimoles Ca/l).

Material : Divalent selective electrode - Calcium ion selective electrode - pH-ionmeter.

Chemicals: Calcium activity standard - Water hardness activity standard.

Key Words: CALCIUM / MAGNESIUM / ELEC / VOLUM /.

CODE : 3415-19/43-47-57-59-c/80

ORDR : 0378

Authors : OSTER (J.D) SHAINBERG (I)
Title : Exchangeable cation hydrolysis and soil weathering as affected
by exchangeable sodium.
Public : Soil Sci. Soc. of Am. J. , 43 - (1) - 1979.
Pages/ref : (70-75) / 14 ref.

Summary:

Exchangeable and cristalline cations are released form soil minerals as a result of hydrolysis and weathering. Rates of hydrolysis and the resultant changes in the cation exchange composition of three lime free arid zones soils for different values of Ech. Na.

Methods:

Lime was removed by 1N NaCl/HCl at constant pH4 to 5; (contact time 24 to 72 hours). Then soils were equilibrated with solutions having a S.A.R of 5.20 and " infinite " (chloride of Na, Mg, Ca). PH and Electric Conductivity were measured during the equilibration period (7 to 14 days). The initial CEC was measured by Na-NH₄OAc method and EC by NH₄OAc pH7.

Results:

The conductance of aqueous suspensions plotted versus the square root of time exhibited two linear segments. Authors conclude that the release of Ca, Mg, K from silicate minerals is more rapid than the hydrolysis of exchangeable Na and Ca for the three soils considered. The removal of CaCO₃ was suspected to produce intermediate products controlling release of Ca, Mg, K. The rate of exchangeable Ca hydrolysis and release from silicate materials was sufficient to saturate the solution with respect to lime for the calcic haploxeralf.

Tables :- General properties of soils (CEC, CaCO₃, Clay, Silt-clay minerals).
- EC composition before and after the treatments.
- Relation between specific conductance and time for aqueous suspensions of three soils.
- Total initial and final EC and changes in exchange ion composition.

Material : AA Spectrophotometer (for Ca, Mg, Na, K) - Chloride titrimeter -
(for Cl) Potentiometric titrator - (for carbonates and bicarbonates)
Centrifuge.

Key Words : ECEC / SALI / SODIUM / LABIL /.

Author : PAPANICOLAOU (E.P)
Title : Determination of Cation Exchange Capacity of Calcareous Soils
and their percent base saturation.
Public : Soil Science 2 - 121 - 1976.
Pages/ref: (65-72) / 19 ref.

Summary:

Soil is saturated by CaCl_2 solution using mixing-centrifuging technique. Adsorbed Ca is removed, with excess calcium chloride by sodium or potassium nitrate (eight times). Cation exchange capacity is expressed as total (Ca + Mg) minus total(chloride + carbonate + bicarbonate). Hydrolysis of adsorbed calcium is limited by choosing a washing solution 5 meq/l and washing only once.

Chloride of Na, K, Cs used as replacing solution instead of sodium nitrate gives the same results, though the benefit of having chloride as index ion is lost.

The paper investigates also the percent base saturation which is difficult to determine in calcareous soils.

- Exchangeable Ca, Mg are measured in various extractions (chlorides of lithium, sodium, potassium, ammonium) correction is made for dissolved carbonates and bicarbonates. Lithium chloride and ammonium chloride are found unsuitable as replacing solutions, the first because it does not achieve complete replacement, the second because it is unstable gives carbonates.
- Exchangeable K and Na are determined in 1N pH7 ammonium acetate.

Tables :- CEC of calcareous soil samples using saturation by calcium chloride and removal by chlorides of Na, K, Ca and nitrates of K, Na, Mg. comparison with isotopic dilution ^{133}Ba , and ammonium acetate saturation is also included in the same table.
- Effect of various extractants and different numbers of leachings in carbonate dissolution.

Chemicals: Calcium chloride - Sodium or potassium nitrate - Sodium and potassium nitrate.

Key Words: ECEC / CALC /.

Auteur : PELLOUX (P)
Titre : Méthodes de détermination des cations échangeable, de la capacité d'échange dans les sols courants calcaires ou non, mais ni salés, ni gypseux.
Public : Service des Sols, ORSTOM - 1963.
Pages/ref: 55 pages / 7 ref.

Résumé:

Une méthode permettant la détermination de la capacité d'échange des sols peu calcaires utilisant le calcium comme ion saturant et le chlorure comme ion traceur est décrite. Les risques d'hydrolyse sont évités en éliminant l'étape de lavage.

Méthode:

Percoler 10g de terre par 500ml de chlorure de calcium tamponné à pH7 par de la triethanolamine, puis par 150ml de chlorure de calcium N/10. On déplace le calcium par 500ml de nitrate de potassium N. On dose dans le percolat Ca et l'anion Cl qui permet d'évaluer l'excès de chlorure de calcium retenu par capillarité. On titre les carbonates et bicarbonates par acidimétrie pour connaître la quantité de calcium dissoute par le réactif utilisé. On peut également doser dans l'extrait au chlorure de calcium, le sodium et le potassium échangeable.

Le calcium est dosé par colorimétrie en flux continu (BRION) par le montage.

(Echantillon (0.23) / Air (0.32) /) // (Tampon diethylamine) (1.2) / Cresolphthaleine 0.05% dans HCl 0.25N (0.32) / Agitateur magnétique // Bobine mélange 10 tours / Colorimétrie 15mm, 570nm.

Figures :- Schéma de montage des colonnes de percolation.
- Système de percolation automatique.

Produits : Chlorure de calcium - Triethanolamine - Nitrate de potassium - Helianthine - HCl - Diethylamine - Gamme de potassium.

Mots Clés: ECEC / CALCIUM / COLOR / ECHAN /.

Authors : POLEMIO (M) RHOADES (J.D)
Title : Determination Cation Exchange Capacity: A new procedure for calcareous and gypsiferous soils.
Public : Soil Science Society of Am. J. 41 - 3 - 1977.
Pages/ref : (523-528) / 23 ref.

Summary:

A two steps method for CEC is presented:

- First step: 4-5 gm of soil is treated by successive equilibration with 33 ml increments of 0.4N NaOAc - 0.1N NaCl solution (at pH8.2 in 60% ethanol) to obtain saturation of cation exchange sites.
- The second step is the saturation with three 33 ml increments of 1N MgNO₃ (pH7). Chloride is used as index cation so that no washing step is necessary. Lower CEC values were obtained with the newly developed method, as compared with ammonium acetate method (Bower).

As there is no absolute reference method for CEC, the values were correlated with saturation percentage and air-dry water content. The method is proposed for calcareous and gypsiferous soils, though it necessitates a preliminary washing out of soluble chlorides.

Tables :- Properties of soils and CEC as determined by the Bower & Al(1952) and the newly developed method.
- Relation between CEC and air-dry water content of soils.
- Comparison of CEC of soils as determined by the new and Bower methods.

Material : AA Spectrophotometer - Centrifuge.

Chemicals : Ethanol - NaOAc - NaCl - MgNO₃.

Key Words : ECEC / CALC / GYPSUM /.

Authors : PRATT (P.F) GROVER (B.L)
Title : Monovalent-Divalent Cation Exchange Equilibria in Soils
in relation to organic matter and type of clay.
Public : Soil Science Society of Am. Proc. 26 - 1 1964.
Pages/ref : (32-35) / 11 ref.

Summary:

The cation exchange equilibria. Na-Ca, Li-Ca, Mg-Ca, ions pairs was studied on 10 slightly acid soils in relation to clay type (mostly montmorillonite and illite with always some kaolinite) but also amorphous material. The purpose was to find agreement between the double-layer equation and experimental data through a correction factor to be applied to surface charge density.

Correction factor are given as well as the ratio adsorbed Na/Ca when soils were equilibrated with solutions having a $(Na) / (Ca)^{1/2}$ ratio equal to 100, (conc. expressed in millimoles). Soil were equilibrated with solutions buffered at pH7. At this SAR organic matter free soils with montmorillonite and illite as dominant clays had ratio Na/Ca (adsorbed) of 1,66 to 1,94. Equation relating exchangeable sodium percentage and SAR fit better for soils poor in organic matter. Two different regression equations may be calculated: (i) for montmorillonite-illite and (ii) for kaolinite and / or amorphous clays soils.

Tables :- CEC, dominant minerals in the fine clay, clay content and parent material for 10 soil samples used in cation exchange equilibria measurements.

- Relation between ratio of mono to divalent cation adsorption in the solid phase and in the liquid phase 3 ion pairs for each of 4 soils.
- Relation between M^+/M^{++} adsorbed and surface charge density for 10 soils for each of 3 ion pairs.
- Na/Ca adsorbed ratio from solutions having a SAR equal to 100.
- Relation between Na/Ca (adsorbed) and $Na/(Ca)^{1/2}$ in solution for soil treated and untreated with sodium peroxide.

Chemicals : Not mentioned.

Key Words : ECEC / MINE /.

CODE : 0417-21/46-47-54-60-c/80

ORDR : 0038

Auteur : QUANTIN (A)

Titre : Automation des dosage des principaux ions échangeables du sol.

Public : Fascicule de Botanique No.3 - Université de Besançon 1966.

Pages/ref: 6 pages /.

Résumé:

Les principales méthodes de dosage en flux continu des cations échangeables sont passées en revue. Dans tous les cas, les dosages sont en milieu acetate ammonium N. Pour Ca sont présentés: la colorimétrie à la murexide de photométrie de flamme en flamme propane-oxygène (2775°C) et la fluorométrie à la calceine. La méthode murexide donne des résultats peu reproductibles. La fluorométrie se fait à 485 nm (excitation 405 nm).

Diagramme (ml / min):

Echantillon (0.16) / NaCl 0.9% (3 x 3,9) / Air (1.2) / bobine double / calceine 0.004% dans NaOH 2,5% (2.5) / 2 bobines doubles / fluorométrie / repompage (2.5) /.

Lavage à l'acetate d'ammonium entre chaque échantillon.

Figures : Diagrammes de flux continu (murexide, photomètre à flamme et fluorométrie).

Précision: Gamme de 0.1 à 7.5 meq/l de Ca pour fluorométrie.

Materiel : Pompe peristaltique multi-canaux, fluoromètre - (photomètre à flamme - colorimètre).

Produits : Acetate ammonium - Calceine - Soude - Carbonate de calcium - Acide chlorhydrique - NaCl.

Mots Clés: CALCIUM / FLUOROMETRIE / SOL / ECHAN / COLOR /.

Auteur : QUANTIN (A)
Titre : Dosage du Magnesium échangeable.
Public : Université de Besançon - Fascicule de Botanique No.3 - 1966.
Pages/ref: (7-9) /.

Résumé:

L'auteur présente deux méthodes en flux continu pour le dosage du magnesium:

1- Une méthode colorimétrique utilisant le Jaune de titane à 550 nm qui permet le dosage de 1 à 5 meq/100 gr de Mg échangeable dans le sol. Le diagramme est le suivant:

Echant. (0.6) / Air (1.6) / H₂O (2.9) / Bobine simple/Débul-
lage/Reprise (1.6) / Air (1.6) / Solution compensatrice (2.2)/
Jaune de titane (1.6) / NaOH (2N) /.

2- Une méthode fluorimétrique utilisant le 8-hydroxyquinoléine dans l'éthanol. La fluorescence du Mg est activée par une lumière de 420 nm. Dans le montage décrit on utilise une excitation à 405 nm.

La fluorescence émise étant mesurée à 485 nm, le montage est le suivant :

Echant. (0.42) / Air (1.6) / Tris (0.6) / Bobine simple/Ethanol
(3.9) / Bobine simple / Hydroxyquinoléine (2.5) / Bobine simple/
Débullage / Reprise (2.9) / Fluoromètre /.

Produits : Méthode 1. Jaune de titane - Chlorydrate d'hydroxylamine -
EGTA - NaOH - HCN - Chlorure d'aluminium - KCN -
Alcool polyvinylique.

Méthode 2. Tris - Hydroxyquinoléine - Méthanol - NH₄OAc -
Ethanol.

Mots Clés: MAGNESIUM / COLOR / FLUOROMETRIE /.

Auteur : RENJIFO (C.H.A)
Titre : Comparación de cinco metodos para determinar capacidad de intercambio cationico en suelos alcalinos.
Public : A-Agronomica 24 - 1 - 1974.
Pages/ref: (61-85) / 28 ref.

Résumé:

L'auteur débute par l'étude des facteurs du sol determinant la valeur de la CEC aussi qu'une bibliographie des travaux réalisés puis cinq méthodes sont comparées 1) et 2) NH_4OAc 1N pH7 - 3) CaCl_2 4) NaOAc 1N pH8.2 - 5) sommation des cations échangeables. Chaque méthode est décrite en détail. 15 sols sont utilisés dans l'étude: pH 1/1 de 7.1 à 8.7 ; C.E extrait saturé de 0.4 à 7.3 (moyenne 1.1) mScm^{-1} . Texture argileuse, CEC de 10 à 50 me/100gr (moyenne 28). $\text{CaCO}_3\%$ n'est pas indiqué.

Résultats: Les résultats sont traités par analyse de variance. La méthode (4) est celle qui donne la meilleure précision et la meilleure exactitude (comparée à la somme des cations échangeables). La méthode au chlorure de calcium surestime la CEC par rapport à la méthode (4) alors que la méthode à l'acetate de NH_4 la sous-estime.

Seule la CEC obtenue par CaCl_2 donne des valeurs qui augmentent avec le pH des sols alors que les 3 autre méthodes donnent des valeurs qui diminuent, l'écart devenant très important à pH supérieur à 7.5 (dans la méthode CaCl_2 le calcium est remplacé par l'acetate d'ammonium N pH7 et dosé par complexometrie).

Tables :- Ordre de séléctivité des cations pour quelques groupes d'argiles.
- Caracteristiques chimiques des sols étudiés.
- Tables de traitement statistiques des résultats de CEC par les cinq méthodes.
- Valeur de CEC pour 15 sols en fonction du pH des sols pour les cinq méthodes.

Mots Clés: ECEC /.

Authors : RHOADES (J.D) KRUEGER (D.B)
Title : Extraction of cations from silicate minerals during the
determination of exchangeable cations in soils.
Public : Soil Science Society of Am. Proc. vol.32 - 1968.
Pages/ref : (488-492) / 21 ref.

Summary:

The release of Ca, Mg, Na by silicate minerals during the process of EC determination by 1N, neutral, ammonium acetate was investigated on 15 standard minerals commonly found in arid zones. The CEC was determined by three methods namely:

1): NaOAc - ethanol - NH_4OAc . 2): NaOAc - ETOH - $\text{Mg}(\text{OAc})_2$. 3): radioactive Na. The samples being contaminated by carbonate, correction for dissolved calcite and/or magnesite is presented. The extent of cation extraction for the mineral type was: ortho-silicate pyroxene, feldspathoid, amphiboles, plagioclase feldspars, K feldspars and the proportion of extracted cations was Ca, Mg, Na, K (both sequences in decreasing order of importance).

Conclusions: Determination of exchangeable sodium may be subject to errors under special condition (zeolitic, containing soils, pH above 9...). The problem of exchangeable Ca and Mg is more general and the release of these cations from minerals is a constant problem in the analysis of soils of arid zones.

Tables : 1-2 : Contamination of samples with carbonate (type, amount)
3-4-5: Cations extracted in neutral NH_4OAc and in neutral NaOAc (with and without correction for dissolved carbonates), and water.
6-7 : Apparent exchangeable cations and apparent CEC of the silicate minerals.

Chemicals : Ammonium acetate - Sodium acetate - Magnesium sulfate - Ethanol (excluding chemicals used in artificial sample preparation).

Key Words : ECEC / LABIL / CALC / SALI /.

CODE : 1318-09/c-47-54-59-c/80

ORDR : 0110

Authors : RICE (H.B) KAMPRATH (E.J)
Title : Availability of exchangeable and non-exchangeable Mg in
sandy coastal plain soils.
Public : Soil Sci. Soc. Am. Proc. vol 32 - 1968.
Pages/ref :

Summary:

The paper studies the release of non-exchangeable Mg by chemical extraction and plant uptake. This release was found to be the highest for soils containing expansible clay minerals (as measured by the ethylene glycol method). The soils studied were sandy soils with clay content of 3 to 10% and CEC lower than 4 meq/100 gr. The CEC of soils was determined by neutral NH_4OAc . Exchangeable Mg was extracted by shaking 10 gr of soil with 50 ml NaCl 0.1N for 30 min. twice. To estimate the proportion of non-exchangeable Mg two extractions were made. The first with 1N, pH7 NaOAc was supposed to contain only exchangeable Mg while the second made with 1N, pH1.0 NaOAc was supposed to contain exchangeable plus some non-exchangeable magnesium.

Tables :- Soil properties and estimated clay mineral in the Coastal Plain Soils (5 soils).
- Exchangeable and total Mg content of soils studies.
- Mg released by 1N, NaOAc solution at pH1 and pH7.
- Plant uptake of Mg from exchangeable and non-exchangeable sources.
- Mg uptake by corn as related to the initial Mg content.

Mots Clés : MAGNESIUM / ECHAN / PRECIS /.

RICE

Auteur : RIEU (Michel)
Titre : Sodium Adsorption Ratio et estimation du pouvoir
alcalinisant des eaux.
Public : Cah. ORSTOM, serie pedo., vol. XVIII, No 2, 1980-1981.
Pages/ref: (123-128) / 7 ref.

Résumé:

Le SAR calculé à partir des activités des ions dissociés permet de déterminer le pouvoir alcalinisant des eaux, quelque soit l'anion dominant. Des échantillons de sol argileux (60% à 80% montmorillonite.) sont percolés en laboratoire par des eaux naturelles (SAR 0,4 à 19). Pour tous les équilibres sol/eau-d'irrigation réalisés, les relations $EFR = f(SAR)$ sont calculées. Pour interpreter les resultats, on suppose que le coefficient de sélectivité Na/Ca du système montmorillonite/solution de sol reste constant pendant l'expérience. On suppose aussi que Ca et Mg ont un comportement identique vis à vis de l'échange. On arrive à la relation:

$EFR = 0,01 SAR_a$ avec $SAR_a = Na^+((Ca+Mg)/2)^{-1/2}$ $r=0,99$ $n=17$
avec SAR_a calculé à partir des activités des ions en solutions, et $EFR = Na/CEC (1-Na/CEC)^{-1/2}$ ou les concentrations sont données en me/100gr de sol.

Cette relation, conduit à la valeur $K=10,2$ pour le coefficient de sélectivité de la montmorillonite vis à vis de Na/Ca.

Tables :- Données analytiques du sol et des solutions de percolation initiales.
- Relations $EFR = f(SAR)$ et $f(SAR)_a$ pour un système à bicarbonate dominant et un système à sulfate dominant.

Mots Clés: SALI / Na-ECHAN /.

Authors : ROBBINS (C.W) JURINAK (J.J) WAGENET (R.J)
 Title : Calculating cation exchange in a salt transport model.
 Public : Soil Sci. Soc. Amer. J. 44-6-1980.
 Pages/ref : (1195-1200) / 22 ref.

Summary:

The paper describes a cation exchange model including K exchange. It assumes that CEC of soil is constant, and relies on the mathematical solving of equations:

$CEC = E_{Ca} + E_{Mg} + E_{Na} + E_K$ (E for exchangeable meq/100gr.). (1)
 and $k_1 = (Ca, Mg)$ coefficient of selectivity.
 $k_2 = (Na, Ca)$ coefficient of selectivity and so on.

The model solves $E_{Ca} = f(CEC, k_1, k_2, k_3, S_{Ca}, S_{Mg}, S_{Na}, S_K)$. (2)
 (where S_{Ca} means activity of Ca in true soil solution) by taking E_{Mg} from k_1 , E_{Na} from k_2 and substituting them in (1) it gives also E_{Mg} , E_{Na} , and E_K .

Thus a permanent relation exists between exchangeable and soluble cations. One or the other parameter can be followed during exchange reaction, salt precipitation, or salt dissolution.

In order to test the model, the authors choosed to calculate k_1 , k_2 , k_3 from CEC, E_{Ca} , S_{Ca} and to compare with values of k_1 , k_2 , k_3 given in another study for system containing 50% illite/50% kaolinite as exchange material.

S_{Ca} , S_{Mg} , were calculated from saturation extract after allocation for ion-pair. E_{Ca} , E_{Mg} were taken as the difference between concentrations in ammonium acetate extract and in saturation extract.

Results :- Values of k_1 for 16 soils ranged between 0,5 and 1,1.
 - Values of k_2 between 5,6 and 7,1.

The model was then included as a subroutine of a complete salt-movement model including dissolution-precipitation. This model was tested on lysimeters with irrigation water having three different concentrations in $CaSO_4$.

Key Words : ECEC / SALI /.

Authors : ROUTSON (R.C) WILDUNG (R.E) SERNE (R.J)
Title : A column cation exchange capacity procedure for low
exchange capacity sands.
Public : Soil Science 115 - 2 - 1972.
Pages/ref : (107-112) / 11 ref.

Summary:

The procedure consists of saturating 0.5 to 2.5 gr of soil with a mixture of strontium chloride and acetate (1N Sr), then by 0.01N/0.04N of the same mixture, traced with 5000 cpm/ml of radio strontium. Excess solution is removed by vacuum, the sample is washed by methanol-polyelectrolyte mixture. Concentration of Sr is measured in the final equilibration solution by AAS at 460,7 nm and 85 - strontium activity is determined by a gamma-analyser fitted with a 8 cm NaI well crystal into which the soil column may be fitted directly.

The procedure is tested on calcareous sandy samples (1 to 26% calcium carbonate ; 1 to 5% clay) with CEC averaging 4 me/100 gr.

Application: CEC for sandy soils around 4 me/100 gr.

Tables :- Properties of four soil samples used in experiments (pH - clay-silt - calcium carbonate).
- Illustration of column system.
- Measured gamma activity in leaching column.
- Equilibration of soil with 85 Sr as related to leaching volume for sands, bentonite, kaolin and humic acid(50 micrograms each).
- Measured CEC as a function of the volume of wash solution.
- Comparison of proposed procedure with non washing procedure.

Material : AA Spectrophotometer - Gamma counting equipment.

Chemicals : Radio strontium chloride - Strontium acetate - Strontium chloride - Non ionic polyelectrolyte (Magnifloc 905)- Ascarite.

Key Words : ECEC / CARB / RADIO /.

CODE : 3418-21/c-47-53-60-c/80

ORDR : 0385

Auteurs : RUELLAN (A) DELETANG (J)
Titre : Les phenomenes d'échange de cations et d'anions dans les sols.
Public : ORSTOM.Initiations et Doc. Technique No.5 - 1967.
Pages/ref : 123 pages / 330 ref.

Résumé:

Les phenomenes d'échange dans les sols sont analysés en cinq parties: 1): théorie de la capacité d'échange, facteurs agissant sur l'échangeabilité des cations. 2): comportement particulier de Al, Fe, Mg, acidité du sol. 3): lois réagissant l'échange des cations, lois qualitatives, quantitatives. 4): échange des anions causes et principaux facteurs, mesure de la capacité d'échange en anion. 5): méthodes d'analyse du complexe absorbant. Cette cinquième partie est divisé en deux: a) détermination des cations échangeables: sols neutres, sols calcaires, sols salés, sols gypseux. b) détermination de la capacité d'échange: cas général (théorie et pratique), sols calcaires, sols gypseux.

Outre toutes les techniques qui sont passées en revue, l'article contient quelques remarques relatives aux choix d'une méthode de mesure de la capacité d'échange qui prennent en compte différents paramètres du sol: le pH à utiliser, la valence des ions saturants en fonction de la nature de l'argile prédominante, la matière organique, les sols à allophanes; la bibliographie comprend 330 références.

Figures : 37 figures touchant tous les aspects du problème.

Mots Clés : ECEC / MINE / TRAIN /.

RUEL

Authors : SAYEGH (A.H) KHAN (N.A) KHAN (P) RYAN (J)
Title : Factor affecting gypsum and cation exchange capacity determination in gypsiferous soils.
Public : Soils Science 125 - 5 - 1978.
Pages/ref : (294-300) / 15 ref.

Summary:

The effect of soil fineness, and soil/water ratio on gypsum and soluble salts determinations was investigated in a first part of the paper. In a second part, pretreatment of soil sample prior to determination of cation exchange capacity by sodium acetate/ammonium acetate method is shown and a procedure for CEC determination in soils containing gypsum is proposed.

Results: Dissolution of gypsum increased with soil fineness from 5% to 12% at 1/500 soil/water ratio and for particle size 2 m/m down to 50 microns. At fixed soil water ratio (1/100) solubility increased from 4% to 7% with soil fineness.

For cation exchange capacity satisfactory results were obtained only when gypsum was removed or complexed prior to CEC procedure, without regard to procedure used. When the soil (100 microns) was pretreated by shaking with a solution of sodium oxalate during two days, an acceptable value of CEC was found by the conventional sodium acetate, isopropanol/ammonium acetate method.

Tables :- Distribution of total gypsum in soil profiles.
- Effect of soil/water ratio and particle size on total gypsum and soluble (Ca + Mg).
- CEC values as determined by various procedure with and without pretreatment (1 day of shaking).
- CEC as affected by variable time of pretreatment with different reagents (1 to 6 days treatment).

Material : Centrifuge - Shaker . .

Chemicals : (For the recommended method only)
Ammonium acetate - Sodium oxalate - Isopropanol - Sodium acetate - Acetone - ETPA (or EDTA).

Key Words : ECEC / GYPS / SALI / PRETR / ECHAN /.

CODE : 1519-03/c-47-57-60-c/80

ORDR : 0122

Authors : SCHULZ (R.K) OVERSTREET (R) BARSHAD (I)
Title : Some unusual ionic exchange properties of sodium in certain
salt-affected soils.
Public : Soil Science 99 - 3 - 1964.
Pages/ref : (161-165) / 7 ref.

Summary:

For some soils containing zeolithic mineral, the authors propose to consider as acceptable exchangeable sodium the sodium removed from the soil by exchange for Ca^{++} ion. In their experiment, a soil sample was equilibrated with Na22 and then labeled-samples were extracted by CaCl_2 , NaCl_2 , NaCl , KCl , NH_4OAc and HCl solutions. Na22 remaining fixed on exchange sites of soils was minimum after NaCl extraction (0.3 meq/100 gr for an initial value of 20.5 meq/100 gr), and maximum after CaCl_2 extraction. This unusual behavior led to an x-ray diffraction study of clay material which revealed apart from 35% illite, 15% montmorillonite, some 35% of analcime, or $\text{NaAl}(\text{SiO}_3)$, H_2O . This zeolithic mineral may be responsible of the fixation of sodium in such a way that it may be removed more easily by K^+ or NH_4^+ than by Ca^{++} .

Tables :- Exchangeable Na content of soil determination by isotopic dilution experiments.
- Effect of various extractants on Na22 labeled soil.
- Diagnostic x-ray spacings for the identification of analcime.

Material : Radioisotope counter.

Chemicals : NH_4OAc - CaCl_2 - KCl - Na22.

Key Words : EXCH. Na / X-RAY / RADIO / SALINITY /.

CODE : 1319-21/42-47-54-c-c/80

ORDR : 0111

Author : S.C.S
Title : Chemical Analysis - Magnesium - pg. 45.
Public : Soil Survey Laboratory Methods and procedure for collecting
soil samples, SSI Report No.1 .
Pages/ref: (45-47) / 3 ref.

Summary:

Six different procedures for total or exchangeable magnesium are presented :

- 1- Mg in saturation extract by EDTA titration using Eriochrome black T as indicator.
- 2- Mg in NH_4OAc extract by the same method after evaporation of NH_4OAc - alcoholic solution.
- 3- Precipitation with Diammonium hydrogen phosphate, dissolution of the precipitate by H_2SO_4 and backtitration with NaOH . Alternative: by gravimetry of $\text{Mg}_2\text{P}_2\text{O}_7$ precipitate.
- 4- From KCl -triethanolamine extracts and EDTA titration.

Chemicals: 1- EDTA titration: NH_4OH - NH_4Cl /EDTA/
Hydroxylamine hydrochloride - Mg-versenate (EDTA-Mg-Na_2)-
Eriochrome Black T.

2- Phosphate titration: NaOH - H_2SO_4 / NH_4OH /
Diammonium hydrogen phosphate - Bromocresol green -
hydrochloride acid.

Key Words: MAGNESIUM / TITRIMETRY / GRAVIMETRY /.

CODE : 3419-15/c-47-54-c-c/80

ORDR : 0388

Author : XXX
Title : Soil Survey Laboratory methods and procedures for collecting soil samples.
Public : USDA - Soil Conservation Service, Soil Survey Inv. Dep. No.1, 1972.
Pages/ref: (22-35) / 4 ref.

Summary:

Three procedures for cation exchange capacity (CEC) are described: a) NH_4OAc pH7 , washing with 95% ETOH direct distillation of ammonia ; this method is suitable for exchangeable cations (EC) and CEC of neutral soils. b) NaOAc pH8.2 , washing with 95% ETOH, replacement by NH_4OAc . CEC is directly calculated from the quantity of Na replaced. c) BaCl_2 - triethanolamine pH8.2, washing with methanol, replacement by $\text{Mg}(\text{NO}_3)_2$ solution. This method gives extractable acidity and CEC. Extractable bases are presumed to be equal to the exchangeable bases if the sample does not contain soluble salts. If it does, the amount of soluble salts is calculated from the saturation extract , except in the case of soils containing carbonates.

Chemicals: Method a) Ammonia - Acetic acid - ETOH Nessler's reagent.
Boric acid - Methylene blue - Bromocresol green - H_2SO_4 .
Method b) ETOH - Acetic acid - Sodium hydroxide - Ammonia.
Method c) MeOH - Barium chloride - Triethanolamine - Magnesium nitrate.

Key Words: ECEC /.

Authors : SHIELDS (L.G) MEYER (M.W)
Title : Carbonate clay: Measurement and relationship to clay distribution and cation exchange capacity.
Publi : Soil Sci. Soc. Am. Proc. 3 - 28 - 1964.
Pages/ref : (416-419) / 6 ref.

Summary:

The clay-sized carbonate of soil is calculated by measuring the loss of CO₂ from an aliquot of the clay suspension.

Method: To an aliquot of clay suspension 6N HCl is added. the loss of weight is measured. The values obtained may be corrected for any Na₂CO₃ present in the dispersing solution. Eighty four samples were studied, six of them only had a clay-sized carbonate exceeding two-third of the total. Five kinds of possible clay percentage calculations for calcareous materials were discussed: 1) total clay calculated percentage. 2) clay-sized carbonate. 3-4) true clay as a percentage of total soil and carbonate free soil. 5) measured true clay as a percentage of soil after removal of carbonates by NaOAc treatment.

CEC of 28 samples (CaCO₃% 10 to 25), as measured after removal of carbonates by NaOAc pH5 and CEC calculated on a carbonate-free soil basis were nearly equal showing that clay-sized carbonate has no exchange capacity.

Tables/Figures:

- Tot. carbonate vs clay-sized carbonate for 84 soils.
- Clay distribution curve for total clay and non carbonate clay / different kinds of clay percentages / CEC and carbonate values of a profile containing 0 to 20% clay-carbonate.

Key Words : CARB / MINE / CEC / GRAN /.

Authors : SMART (R.ST.C) THOMAS (A.D) DROVER (D.P)
Title : Selective ion electrode measurements of chloride concentrations in the determination of cation exchange capacity of soils.
Public : Comm. in Soil Sci. and Plant Analysis 5 - 1 - 1974.
Pages/ref : (1-11) / 5 ref.

Summary:

Comparison of two procedures for the determination of chloride ions. The first method was electrometric titration using a quinhydrone silver-silver chloride electrodes and silver nitrate as titrant. The second method uses a Cl selective ion electrode connected to an pH-ion meter calibrated against standards of known chloride ion concentration (1, 10 and mM in equimolar sodium chloride, sodium sulfate solution 0.5M solution).

The possibility of applying the method to measurement of CEC in soils using ammonium chloride was investigated.

Method: For CEC determination, soil was leached with 1N ammonium chloride, fixed ammonium was displaced by 0.5M sodium sulfate. CEC is proportional to ammonium ion in sodium sulfate provided excess ammonium is corrected for by measuring chloride as index ion the method is not suitable for saline soils. Soil samples investigated had pH values from 5 to 6.6. Interference of ammonia was shown. Calibration of electrode with ammonium chloride instead of sodium chloride reduced ammonia interference to 5% at ammonium concentration less than 20 millimoles. Application of systematic activity coefficient (0.75) for index chloride ion in extracts gave results within

Tables : Comparison of Ion Selective Electrode and titration method for 12 CEC leachates.

Material : 1. Titration method: Quinhydrone electrode - Silver-silver chloride electrode - Null point galvanometer (or potentiometric recorder).
2. Selective electrode: Chloride selective electrode - PH-ionmeter.

Chemicals : Ethanol - Ammonium chloride - Ammonia - Sodium sulfate - Sodium chloride - Silver nitrate.

Key Words : CL / N-NO₃ / ECEC / ELEC /.

CODE : 3419-13/c-47-55-c-c/80

ORDR : 0387

Authors : SMITH (H.W) MOODIE (C.D) OKAZAKI (Rose) ELLSWORTH (Norma)
Title : Hydrolysis and salt retention errors in conventional cation
exchange capacity procedures: II.
Public : Soil Science 102 - 2 - 1966.
Pages/ref : (94-106) /.

Summary:

Salt removal and index-cation hydrolysis during CEC measurement were studied with emphasis upon the effect of washing liquid. The reference method choosed was the measure of the net charge (extractable index cation minus extrac. anion) which is equal to CEC for the sample studied. Four index cations (Na, Ca, NH_4 , Ba) were used and gave good agreement as for CEC values. Effect of washing was studied with ETOH, 95% MEOH, isopropanol, and distilled water. For the sample studied, salt retention was the most difficult problem to control, index cation hydrolysis was not serious and loss of sample by dispersion was eliminated by high speed centrifuging. Removal of NH_4OAc , isopropanol was inadequate, methanol and ethanol were less efficient than water. Two of the studied samples contained amorphous material as major clay component, the third one was montmorillonitic. All of them were neutral samples.

Tables :- Properties of samples. CEC (net charge) determined with different index cations on three soils (CEC 10, 14, 99 me/100gr respectively).
- Apparent CEC of samples vs extent and technique of washing.
- CEC determined by several washing procedure vs reference CEC.
- Effect of isopropanol washing.

Chemicals : NaOAc - NH_4OAc - NH_4Cl - Isopropanol - Ethanol - Methanol.

Key Words : ECEC /.

Auteurs : SUSINI (J) & ROUAULT.
Titre : Utilisation d'une électrode spécifique pour le dosage du Sodium dans les eaux et les extraits de sol.
Public : Cah. ORSTOM Pedo. vol.X, No.3 - 1972.
Pages/ref : 12 pages / 8 ref.

Résumé:

L'article commence par un bref rappel théorique sur le fonctionnement des électrodes ioniques spécifiques et des interférences à craindre. L'appareillage pour le dosage du sodium est décrit en détail. La pente moyenne de la courbe d'étalonnage est de 59 mV avec l'appareillage utilisé.

L'effet de la température est étudié et une variation de $\pm 5^{\circ}\text{C}$ produit une erreur décroissant de 20% pour 1ppm Na à 7.5% pour 10^3 ppm (l'erreur est négligeable au niveau de 10^4 ppm de Na).

L'influence du pH et des cations Cl^- , CO_3^- , SO_4^- est étudié à un pH constant de 10 obtenu par barbotage d'ammoniac.

L'effet du gypse est étudié également, l'interférence n'existe que pour Na inférieur à 3ppm, ce qui est une valeur rare dans les extraits de sols gypseux. L'utilisation de l'électrode spécifique à la mesure du sodium dans les extraits de sols et les eaux salées est comparée avec la photométrie de flamme.

Figures :- Etalonnage de l'électrode (-6 à +11 mV).
- Variation de pente avec la température pour des concentrations de 1 à 10^4 ppm Na.
- Variation absolue en mV suivant le pH (pH=5 à pH=10).
- Interférence des sulfates, carbonates, gypse.
- Etendue des mesures: de 23.000 à 0.23 mgr/l en Na (soit pNa 0 à 5).

Précision :- L'écart-type calculé sur 10 mesures ne dépasse pas 3mV de 1 à 5.10^4 ppm en Na.
- Pour des eaux de pH compris entre 7.7 et 8.4 l'erreur relative par rapport à la mesure en spectrophotométrie de flamme est
- 1% au niveau de 100ppm Na
- 2% au niveau de 400ppm Na
- de 4 à 8% pour des valeurs inférieurs à 60ppm Na.

Mots Clés : SODIUM / SALI / GYPSE /.

CODE : 1319-23/67-47-54-58-c/80

ORDR : 0112

Authors : SWANSON (R.A) HOVLAND (D) FINE (L.O)
Title : Fluorometric determination of Magnesium in soil extracts.
Public : Soil Science 102 - 4 - 1966.
Pages/ref : (244-247) / 8 ref.

Summary:

Some azo compounds are known to form Ca and Mg derivatives emitting a fluorescence which can be used in analysis. Such a compound is O-O'-dihydroxy-azobenzene. Authors study the interference of foreign ions by artificial solutions of Al, PO₄, Na, SO₄, Cl... simulating soil extracts. Interference of Ca is studied with Ca/Mg ratio varying from 1/30 to 1/2 and partially overcome by adding a Ca buffering solution to standard and samples. Recovery of Mg added to saturation extracts of soils containing 5 to 23 ppm Mg was within 10% (in the range of 5 to 10ppm Mg added).

Fluorometric analysis is compared to AAS and Thiazol yellow colorometry in ammonium acetate and saturation extracts of soils. The fluorometric analysis was found as reliable as AAS for the 8 soil samples.

Tables :- Effect of added Ca on the Mg found using two different working solutions to develop the fluorescence.
- Recovery of Mg added to saturation extracts.
- Comparison of fluorometric analysis with atomic absorption and thiazol yellow colorimetry.

Chemicals : O-O'-dihydroxy-azobenzene / Ethanol / Ethylenediamine / HCl / Triethanolamine / CaCO₃ / Mg standard /.
Thiazol yellow method: reagents are not given.

Key Words : MAGNESIUM / COLOR /.

SWAN

CODE : 3420-21/42-47-54-60-c/80

ORDR : 0389

Author : TUCKER (B.M)
Title : Laboratory procedures for cation exchange measurements of soils.
Public : CSIRO Div. of Soils, Tech. Paper No.23 - 1974.
Pages/ref: (1-46) / 25 ref.

Summary:

The paper gives full details on EC extraction and CEC estimation after removal of soluble salts. The procedure is essentially the following:

- Soluble salts are removed by an ethylene-glycol/ethanol mixture (prealably passed though mixed-bed resin to remove ions).
- Basic exchangeable cations are extracted by pH 8.5 NH_4Cl /60% ETOH.
- CEC replacement step is made by a 15% KNO_3 ; 60% $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ solution.

Equipment is reviewed for leaching procedure and extraction-centrifuge method as well. A so called flaming solution is used in AAS to eliminate interferences in Ca and Mg determination. Removal of soluble ions, alternative reagent for displacing ammonium and AAS interferences are reviewed.

Tables :- 14 tables covering results of each analytical parameter involved in the described procedures.
- Description of extracting and leaching devices.

Material : AA Spectrophotometer - Leaching equipment - Soil shaker extractor.

Chemicals: 1-2 ethanediol - ETOH - Mixed-bed ion exchange resin - NH_4Cl - KNO_3 - $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ - Formaldehyde - Methanol - Acetone - Flaming solution: LiCl - Tween 80 - Isopropanol - Perchloric acid - Urea.

Key Words: ECEC / SALI / ASPEC - PRECIS /.

TUCK

Author : VERIGINA (K.V)
Title : A comparison of methods of determining exchangeable calcium and magnesium in calcareous and gypsiferous soils.
Public : Soviet Soil Science 1964.
Pages/ref: (969-976) / 12 ref.

Summary:

Four methods are compared:

Method (a) Relies on NaCl solution to leach out exchangeable calcium and exchangeable magnesium. Correction is made for soluble Ca assuming that calcium carbonate dissolution is proportional to the volume of leaching solution. Method (b) uses also a NaCl solution but the amount of calcium carbonate dissolved is estimated by measuring the alkalinity of the filtrate. Method (c) uses a single 3N NaCl treatment. Method (d) uses a mixture of ammonium, acetate oxalate, carbonate which is said to dissolve no carbonate.

For gypsic soils, two methods (e) and (f) are compared: in method (e) $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ is changed into calcium carbonate by treating the soil (10 gr), with barium (1 gr), and then as proposed in methods (a) to (d). In method (f) soil is treated with an alcoholic solution of sodium sulfate in which neither calcium carbonate nor gypsum are dissolved. Exchangeable calcium is precipitated as CaSO_4 and estimated from the decrease in SO_4 concentration.

After having tested all the methods, the author conclude that method (a) gives results too low by 10-15% method (b) is not applicable to dolomite soils, but is convenient for calcareous soils, in method (e) calcium carbonate is dissolved, method (d) gives only exchangeable calcium, method (e) gives good results providing the soil is shaken with barium carbonate during 24 hours, method (f) underestimates exchangeable Ca.

Tables :- A comparison of values of adsorption capacity and methods (a), (b) and (c) chernozem and sierozem (three tables).
- Solubility of calcium carbonate in NaCl, CaCl_2 mixtures (two tables).
- Effect of time of reaction of CaSO_4 with BaCO_2 , on completeness of reaction.

Chemicals: Sodium chloride - Ethanol - Calcium chloride - Ammonium carbonate - Ammonium oxalate - Barium carbonate - Sodium sulfate.

Key Words: GYPSUM / ECEC /.

Authors : WARD (D.A) BICHLER (D.G)
Title : Rapid, direct determination of calcium in natural waters by Atomic Absorption Spectrometry.
Public : Atomic Absorption Newsletters 1 - 14 - 1975.
Pages/ref : (29-31) / 3 ref.

Summary:

A sodium ionization suppressant was studied for calcium determination by AAS at 422,7 nm in nitrous oxide/acetylene stoichiometric flame for water containing 0.05 to 200 ppm sodium ion. The enhancement of calcium absorbance due to ionization suppression is reached at level 500 - 200 ppm added Na.

Aluminium at concentration greater than 100 ppm produced a negative interference even when Na ion suppressant was used. The same was true for silicon whereas phosphates and sulfate did not produce any interferences.

A 1/2 sample dilutor is used to dilute sample with the 2000 ppm Na solution. A capillary T is described.

Tables :- Photograph of capillary diluting device.
- Graph of absorbance of 50 ppm Ca versus Na concentration.
- Influence of Fe, Zn, Mg, K, Al, on 50 ppm Ca solutions in N₂O / C₂H₂ flame.
- Influence of sulfate and phosphate ions on solutions when aspirated with 2000 ppm Na.

Precision : Comparison of EDTA titration with AAS used with Na suppressant on eleven results of Ca in natural water. For values of 70 to 120 ppm Ca, a difference of less than 2% between the two methods is reported.

Material : AA Spectrometer - Capillary plastic tube.

Chemicals : Calcium standard - Sodium chloride.

Key Words : CALCIUM / AAS-PRECISION /.

CODE : 0423-15/46-51-54-c-c/80

ORDR : 0042

Auteur : WOLF (S)

Titre : Détermination de la teneur en Ca et Mg par un titrage photométrique automatique en prenant comme exemple L'analyse du ciment.

Public : Metrohm - bulletin No. 22f.

Pages/ref: 2 pages /.

Résumé:

Ca et Mg sont déterminées par complexométrique avec détermination photométrique de la fin de réaction en utilisant un potentiographe relié à un colorimètre à 620 nm.

Méthode: Calcium:

A 50 ml d'échantillon, ajouter NaOH 2N jusqu'à pH 12,5 (pH-mètre), 1 pincée murexide (1% dans NaCl solide), placer le récipient de titrage dans le colorimètre et titrer en enregistrant la courbe d'absorption.

Calcium + Magnesium:

A 50 ml d'échantillons, ajouter 10 ml tampon pH10 (chlorure d'ammonium à 5,4% dans ammoniaque concentré, dilué à 35%). La triéthanolamine est utilisée seulement en présence de Fe, Ti, Al et Mn.

La méthode photométrique est meilleure que la méthode potentiométrique (avec électrode indicatrice à cupule au mercure) lorsqu'on emploie le complexant triéthanolamine.

Matériel : Potentiographe - Colorimètre - Equipement de titration automatique - PH-mètre - Électrode de verre.

Produits : Murexide - EDTA - NaOH - Triéthanolamine - Chlorure d'ammonium - Ammoniaque.

Mots Clés: CALCIUM / ELEC / EAUX /.

WOLF

- INDEX DES AUTEURS CITES -

ABDEL-AAL (S.H) & BERGSETH (H)

ABROL (I.P)- DAHIYA (I.S) & BHUMBLA (D.R)

ABRUKOVA (L.P)

ADAMS (J.M) & EVANS (S)

ALLEN (S.E)

AMER (F)

XXX / ARIANA

" " "

" " "

BAKER (J)- BURNS (W.T)

BASCOMB (C.L)

BECKETT (P.H.T)

BERGSETH (H) - HAGEBO (F.A)- LIEN (H) & STEENBERG (K)

BLAKEMORE (L.C)- METSON (A.J)

BOWER (C.A)- REITEMEIER (R.F) & FIREMAN (M)

CARPENA (O)- LAX (A) & VAHTRAS (K)

CHHABRA (R)- PLEYSIER (J) & CREMERS (A)

COFFMAN (C.B) & FANNING (D.S)

COUTINET (S)

CRUZ-ROMERO (G)- COLEMAN (N.T)

CURTIN (D) & SMILLIE (G.W)

DABIN (B)

DEWIS (J) & FREITAS (F)

DEWIS (J) & FREITAS (F)

DOLCATER (D.L)- LOSTE (E.G)- SYERS (J.K) & JACKSON (M.L)

DROUBI (A)- FRITZ (B)- TARDY (Y)

DUFY (J.E)- PETIT (C.M)- GOBLET (Y)- LAUDELOUT (H)

EDWARDS (A.D)

ELSEEWI (A.A)- ELATTAR (H.A)- DAOUD (A.M)

FERNANDO (M.J)- BURAU (R.G)- ARULANANDAN (K)

FRANCIS (C.W)- GRIGAL (D.F)

FRINK (C.R)
FRITZ (J.S)- WAKI (H)- GARRALDA (B)
GARMAN (M)- HESSE (P.R)
GILTRAP (D.J)
GRETHER (C)- BRUTTEL (P)
GRIFFIN (G.F)
HESSE (P.R)
HOLMGREN (G.G.S)- NELSON (R.E)
KITTRICK (J.A)
KREMPF (G)- MILLION (D)
MAC LEOD (S)- ZARCINAS (B)
MARCOEN (J.M)- LACROIX (J.P)
MOLODSTOV (V.A)- IGNATOVA (V.P)
MORTLAND (M.M)- MELLOR (J.L)
OKASAKI (Rose)- SMITH (H.V)- MOODIE (C.D)
XXX / ORION
OSTER (J.D)- SHAINBERG (I)
PAPANICOLAOU (E.P)
PELLOUX (P)
POLEMIO (M)- RHOADES (J.D)
PRATT (P.F)- GROVER (B.L)
QUANTIN (A)
" " "
RENJIFO (C.H.A)
RHOADES (J.D)- KRUEGER (D.B)
RICE (H.B)- KAMPRATH (E.J)
RIEU (Michel)
ROBBINS (C.W)- JURINAK (J.J)- WAGENET (R.J)
ROUTSON (R.C)- WILDUNG (R.E)- SERNE (R.J)
RUELLAN (A)- DELETANG (J)
SAYEGH (A.H)- KHAN (N.A)- KHAN (P)- RYAN (J)
SCHULZ (R.K)- OVERSTREET (R)- BARSHAD (I)
S.C.S
XXX
SHIELDS (L.G)- MEYER (M.W)

SMART (R.ST.C)- THOMAS (A.D)- DROVER (D.P)

SMITH (H.W)- MOODIE (C.D)- OKAZAKI (Rose)- ELLSWORTH (Norma)

SUSINI (J) & ROUAULT

SWANSON (R.A)- HOVLAND (D)- FINE (L.O)

TUCKER (B.M)

VERIGINA (K.V)

WARD (D.A)- BICHLER (D.G)

WOLF (S)

