Proceedings of

First International Soil Classification Workshop

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA VINCULADA AO MINISTÉRIO DA AGRICULTURA
SERVIÇO NACIONAL DE LEVANTAMENTO E CONSERVAÇÃO DE SOLOS

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vinculada ao Ministério da Agricultura
SERVIÇO NACIONAL DE LEVANTAMENTO E CONSERVAÇÃO DE SOLOS

FIRST INTERNATIONAL

SOIL CLASSIFICATION WORKSHOP

Proceedings of a Workshop held in Rio de Janeiro, Brazil from June 20 to July 1, 1977 with soil study tours in the States of Rio de Janeiro, Paraná, Sergipe, Alagoas and Pernambuco

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FOREWORD

Since 1975 a group of pedologists comprised in the International Committee on the Classification of Alfisols and Ultisols with Low Activity Clays (ICOMLAC) has been working on the redefinition of select tropical soils. At the same time, the University of Puerto Rico was concerned with the improvement of Soil Taxonomy relative to tropical soils under a grant from the U.S. Agency for International Development (AID) within the framework of the Consortium on Soils of the Tropics. It seemed logical, therefore, for both entities to join efforts.

Preliminary discussions with Professor F. R. Moormann, Chairman of ICOMLAC, and Mr. E.G. Braun of the Serviço Nacional de Levantamento e Conservação de Solos (SNLCS) of the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) led to the notion of holding a workshop and field tour in Brazil. The idea was presented to Dr. T. S. Gill of AID who concurred with the workshop and its financial support with funds from grant AID/csd-2857 to the University of Puerto Rico. EMBRAPA/SNLCS graciously agreed to co-sponsor the event and absorbed many of the expenses, notably those for bus transportation and publication of the Proceedings. The financial support of the workshop by AID and EMBRAPA is gratefully acknowledged.

The duties of host were assumed by SNLCS-EMBRAPA which, in cooperation with the University of Puerto Rico, developed the program, organized the workshop, prepared a tour guide, and conducted the field trips. The University of Puerto Rico arranged the travel for invited participants. The editing, preparation and distribution of the Proceedings were the joint responsibilities of SNLCS-EMBRAPA and the University of Puerto Rico.

Special recognition is accorded to Dr. M. Camargo and the staff of SNLCS-EMBRAPA for performing a complex task with diligence and zeal, and for a multitude of helpful services and individual courtesies.

In addition to the authors of papers and reports, many persons and institutions have significantly contributed to the workshop and the contents of the Proceedings. SNLCS-EMBRAPA provided profile and site descriptions and analytical data for all pedons studied in the field. The National Soil Survey Laboratory of the USDA-Soil Conservation Service supplied companion data for several soils. Fundação Instituto Agronômico do Paraná (IAPAR) and Unidade Experimental de Pesquisa de Itapirema-EMBRAPA provided facilities for profile descriptions, sampling and study of pedons during the field trip. Dr. A. Perraud of the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) provided the placement in the French system of soil classification. Dr. H. Ikawa of the University of Hawaii furnished clay and silt mineralogic data. Dr. A. Van Wambeke of Cornell University computed soil moisture and temperature regimes. Dr. H. Eswaran of the University of Ghent contributed the micromorphological information. And Professor F. R. Moormann of the University of Utrecht summarized the discussions in the field on the basis of notes taken by Brazilian colleagues. Sincere appreciation is due to each of them for their important contributions.

Thanks to the effective collaboration of all parties involved in the workshop, the Proceedings contain a wealth of reliable analytical and pedological data. They are, therefore, an excellent reference publication on tropical soils.

F. H. BEINROTH

PREFACE

The decision of the Serviço Nacional de Levantamento e Conservação de Solos to co-sponsor the First International Soil Classification Workshop resulted from the knowledge that the subject matter of the event is of great relevance to Brazil, apart from providing the opportunity to host some of the world's formost pedologists.

The greater part of Brazil is located in the tropics where soils about which little is known occur. The opportunity to discuss the problems of these soils and to exchange more recent information among soil scientists was, therefore, most fortunate and welcome.

The increase of world population calls for an increase in food production. Soil potential in Brazil is enormous, but more information about the adequate realization of this potential is needed. To accomplish this, it is necessary to intensify research, especially in relation to management aiming at higher productivity levels.

Meetings where the subject to be discussed is tropical soils are, for various reasons, scarce; thus the great interest in this workshop that provided an advantageous interchange of information and has fostered closer relationships among soil scientists concerned with the same problems.

We are confident that the workshop has achieved its objectives and will be a landmark that will lead to similar events, in order that a better utilization of the potential of tropical soils of the world may contribute effectively and decisively to free mankind from hunger.

ABEILARD F. DE CASTRO

PART I -- PAPERS, REPORTS AND RECOMMENDATIONS

OPENING ADDRESS

F. H. Beinroth

It is a distinct pleasure and privilege to welcome to this workshop some of the world's best talent on the issue of soil classification. More than a dozen countries from all continents are represented here today - - a truly international constituency. We are extremely pleased that each of you has been able to come and thank you for your participation.

Since we meet in beautiful Rio de Janeiro, I suspect that some ignorant outsiders will consider our workshop another one of those paid-vacation junkets in the disguise of a professional conference. Well, you will soon find out that this is not the case; as the term "workshop" implies we are here to work. And we convened in Brazil not because of the exotic beauty of this country but for other compelling reasons.

First, the Serviço Nacional de Levantamento e Conservação de Solos (SNLCS) of EMBRAPA has graciously agreed not only to host and organize this workshop but also to bear part of its cost, clearly an offer we simply could not afford to refuse. We are grateful indeed for EMBRAPA's concurrence to co-sponsor and support this workshop and we appreciate the tremendous amount of work by the staff of the SNLCS that made it possible. Second, we are meeting in Brazil because there probably is no other country where we could see the variety of soils under discussion at this workshop in the field with the guidance of competent local soil scientists.

Quite obviously, then, Brazil is an ideal venue for this workshop. But why do we need to hold a workshop in the first place? The evident significance of the objectives of this meeting will conclusively settle this question. They are:

1. To examine the adequacy of Soil Taxonomy with respect to tropical soils,
2. To propose pertinent changes in Soil Taxonomy, and to identify relevant knowledge gaps and research needs,
3. To finalize new definitions for certain taxa of Alfisols and Ultisols, and
4. To study critical examples of these soils in the field.

The overall purpose of this workshop is thus to improve Soil Taxonomy. Moreover, by holding the workshop we want to demonstrate to the world that the U.S. is not only interested in improving Soil Taxonomy but also concerned about the problems soil scientists in the tropics are having with using the system.

The U.S. Agency for International Development (AID) is supporting this endeavor with about $50,000. Clearly, AID, has no direct interest whatsoever in differentiae, nomenclature of soil taxa, and the like. However, AID is, among other things, concerned with agricultural development in LDC's and it recognizes that soils and soil classification are of central importance in this context.

AID's involvement in the study of tropical soils is perceptive. Yet, it also reflects and is, at least in part, the result of the growing interest of U.S. universities in the tropics. The universities developed proposals, designed research programs and persistently persuaded AID for financial support. Over the years there emerged what I believe to be a mutually beneficial interaction between academia and government. For example, at this time AID is supporting research on various aspects of tropical soils through grants to five universities. These are comprised in the Consortium on Soils of the Tropics (CST) and include Cornell University, the University of Hawaii, the University of Minnesota, North Carolina State University, Prairie View University and the University of Puerto Rico. The present workshop is essentially made possible through the grant to the University of Puerto Rico. In addition, AID has awarded research contracts to most CST universities. In the area of soil classification, two similar contracts were issued to the Universities of Hawaii and Puerto Rico that have jointly become known as the Benchmark Soils Project. The primary objective of this project is to test the transferability of soil management practices on the basis of soil classification, specifically at the family level of Soil Taxonomy. AID's involvement in and commitment to the study of tropical soils and their classification is thus very substantial, both in terms of scope and funds.

AID regards soil classification as a means to an end, namely, to expedite agricultural development and increase food production in the tropics. There are good reasons for this viewpoint. Many statements can be found in the literature that allude to the fact that soil classification facilitates knowledge transfers. Cline, for example, points out that "classification performs the extremely important function of organizing, naming and defining the classes that are the basic units used... to formulate generalizations... and to apply these generalizations to specific cases that have not been studied directly" -- a clear reference to knowledge transfers. Another example is the FAO-Unesco Soil Map of the World, one objective of which is "to supply a scientific basis for the transfer of experience between areas with similar environments ..(as)..with the tremendous amount of knowledge and experience gained in the management and development of different soils throughout the world, the hardship perpetuated in some areas by methods of trial and error is no longer justified." A similar theme of technology transfer is also expressed in a brochure describing the goals of EMBRAPA: "Evitar duplicações e aproveitar o imenso conhecimento científico já desenvolvido no país e no exterior" (to avoid duplications and take advantage of the immense scientific knowledge already developed in the country and abroad).

However, notwithstanding the confidence and authority with which such statements have been made, it is not beyond reason to wonder if and how soil classification can, in fact, perform the task of knowledge transfers, particularly in the agricultural sector. True, we now have general soil maps covering the whole world and detailed soil surveys of many areas. But most of the soil classifications used in soil surveys are essentially genetic systems. It follows that the information on the soil maps is also in large measure pedogenetic. We are, therefore, faced with the very real challenge to translate this soil genetic information into soil agronomic data. However, it is not at all self-evident that soil genetic data per se are the best criteria to effectuate this process. Although these considerations are beyond the scope of our present workshop, I think we owe it to our main sponsor, AID, not to lose sight of the pragmatic aspects of soil classification. For, to paraphrase a statement by Dr. Dudal, soil survey and classification should help answer the decisive question if a given tract of land is arable and if so for what, for how long, at which level of technology and at what cost.

Soil Taxonomy should be very useful in this respect since it was contrived with this end in mind, hence the title "Soil Taxonomy - A Basic System of Soil Classification for Making and Interpreting Soil Surveys". As it says in the foreword of the book "at each step the all-important question was asked, Do these groupings permit us to make precise predictions of soil behavior? But, is the answer to this question affirmative in all instances? With respect to agricultural predictions that should be so, at least at the level of the soil family. Families, it will be recalled, have been conceived with the intent to group soils having similar physical and chemical properties that affect their response to management and which are important to the growth of plants. Nonetheless, it should also be remembered that these differentiae are applied in the control section that starts below the plowed layer. Consequently, much less precise statements can be made about the surface soil than about the subsoil for most taxa. From the point of view of soil fertility and crop production this is a handicap. This also seems to reflect the dichotomy that traditionally existed between the disciplines of soil survey and fertility. As Dr. Buol has stated it: Pedologists and agronomists really see two different soils while examining the same pedon.

Somehow this gap must be bridged if we are to meet the challenge mentioned above, i.e., to convert soil survey data into meaningful agronomic information. I believe this may be achieved through viable technical systems of land evaluation. Soil Taxonomy should be the basis of such systems because soil productivity is ultimately controlled by subsoil characteristics, both chemical and physical, that limit root development, and moisture and nutrient utilization. But useful fertility appraisals require additional knowledge of the chemical fertility status of the surface soil and relevant parameters defining this condition could, therefore, be used as modifiers of Soil Taxonomy classes. Thus, I am not suggesting that Soil Taxonomy be changed to conform to the need of agronomists. Rather, I am advocating the development or refinement of a technical system that, on the basis of Soil Taxonomy, will allow reliable and specific interpretations and predictions of land potential and soil fertility. As most of you know, Dr. Buol and his colleagues have already developed a first approximation to a fertility capability classification. Again, this and other technical systems should complement, but not substitute, Soil Taxonomy in order to meet the practical needs that a taxonomic system, by intent and design, cannot satisfy. We may want to keep this in mind when we discuss desired changes in Soil Taxonomy.

Another and more immediate concern of this workshop is a critical analysis of Soil Taxonomy with respect to tropical soils. We all realize that Soil Taxonomy is not a "zero defect" system for the very simple reason that, at this point in time, a perfect system cannot exist because the knowledge of soils is still incomplete. But not only is our knowledge incomplete, it is also unequally distributed. Examining Soil Taxonomy, we find that 51 pages are dedicated to Mollisols. By contrast, a mere 10 pages deal with Oxisols. This points to the fact that, as a group, tropical soils are comparatively less well known than temperate region soils. Hence their classification is less complete and more subject to change. The constitution of an International Committee on the Classification of Alfisols and Ultisols with Low Activity Clays reflects such a need to re-define tropical soil taxa. It is a major objective of this workshop to discuss relevant new definitions and test the concepts in light of the real world of soils during the field trips. The key members of the Committee are present at the workshop. I trust that under the able leadership of the Committee Chairman, Dr. Frank R. Moormann, much progress will be made in the days ahead.

However, the mentioned Alfisols and Ultisols are not the only incidents where changes in Soil Taxonomy are needed to better accommodate tropical soils. Under a grant from AID, the University of Puerto Rico is, therefore, in the process of conducting a study on the applicability of Soil Taxonomy in the tropics. Later today Dr. Guerrero will explain this study and present some preliminary results. The primary purpose of this study is to note the adequacy and determine deficiencies of Soil Taxonomy relative to tropical soils and to propose remedial steps and actions. I should like to invite your active participation in the discussions on this subject. Your comments and reactions will not only be most useful to Dr. Guerrero; they should also indicate existing problems and needed research that could be subject matter areas for future research proposals.

We in CST are quite enthusiastic about developing new proposals as the prospects to receive funds are good. Recently, a piece of legislation was passed by the U.S. Congress as the Findley-Humphrey Amendment of the Foreign Assistance Act that subsequently became known as Title XII. The purpose of this new law is to help "prevent famine and establish freedom from hunger by increasing world food production... in agriculturally developing nations." The scope of Title XII is utilization-oriented research of relevance to food production in LDC's. Funds will be administered by AID and the policy is to assign the universities an active role in the decision-making process, meaning that we can, to some extent, determine what will be done. CST will be involved in preparing a proposal for a comprehensive program in tropical soils and soil classification will, of course, form a central part of this proposal. We envision our activities in this area to be multinational efforts, carried out under the administrative umbrella of and with financial support from CST, that will involve many institutions and individuals concerned and familiar with the classification of tropical soils. In other words, we want to capitalize on the expertise existing worldwide, much the same way as we are tapping talents at this meeting. At this stage, however, we are still in the early planning phase. But we hope that this workshop will generate some of the base data and the perspective needed for outlining future activities of substance and consequence.

I believe that with these remarks I have covered the main objectives and expectations of the workshop. I think it also became obvious that we have quite a lot to accomplish. While this will consume most of our time and energy, I hope you will have enough of both left to savour the delights of Rio de Janeiro and the scenic beauty of the great country that is Brazil.

CHEMISTRY OF SOILS WITH MIXTURES OF pH-DEPENDENT AND PERMANENT CHARGE MINERALS

G. Uehara

The net surface charge density of soil colloids containing mixtures of pH-dependent and permanent charge minerals is treated as the sum of two forms of the Gouy-Chapman equation. The permanent charge component is assumed to be constant in magnitude and negative in sign, and the pH-dependent component is permitted to change in sign and magnitude with pH. Based on these assumptions, relations are developed which show that there are two zero points of charge. The zero point of charge of the mixture as a whole is designated ZPC and the zero point of charge of the pH-dependent component is designated pH_o. ZPC can be determined by ion adsorption measurements and pH_o by potentiometric titration. In mixtures, ZPC is always less than pH_o. The magnitude of the permanent charge component can be unambiguously determined by measuring cation retention at the pH corresponding to pH_o.

Introduction

The limiting form of the Gouy-Chapman double layer equation, modified to describe pH-dependent charge minerals, may be employed to explain field and laboratory results. The equation has the form

$$\sigma_v = \frac{K\varepsilon}{4\pi}\ 0.059(pH_o - pH) \qquad (1)$$

in which σ_v is the variable surface charge density, K is the inverse of the double layer thickness, ε is the dielectric constant of water, pH_o is the pH corresponding to the zero point of charge, and pH is the pH of the soil solution. This equation applies when soil pH is within 0.5 pH units of the zero point of charge. For pH values much greater than 0.5 units on either side of pH_o, σ_v increases rapidly following a hyperbolic sine function.

Equation 1 does not adequately describe soils which contain significant amounts of permanent charge minerals. The electrochemistry of minerals with permanent charge can be described by the Gouy-Chapman equation

$$\sigma_p = \left(\frac{2n\varepsilon kT}{\pi}\right)^{\frac{1}{2}} \sinh\frac{ze}{2kT}\Phi \quad (2)$$

where σ_p is the permanent surface charge density which arises from isomorphous ion substitution in the interior of mineral crystal lattice, n is the concentration of the equilibrium solution in number of ions per cm^3, ε is the dielectric constant of the medium, k is the Boltzman constant, T is the absolute temperature, z is the valence of the counter ion, and Φ is the surface potential.

Equation 1 is derived from the Gouy-Chapman equation with the assumption that Φ<<25mV. In equation 1, this assumption is met when soil pH is within 0.5 units of pH_o. Since pH_o is a point of stability, most soil pH's cluster near and around pH_o. As a consequence, tropical soils with pH-dependent charge minerals characteristically possess low cation retention capacities and, frequently, good structure.

Equation 1 and 2 are chemical models which represent two very different groups of soils. Oxisols and Andepts are examples of soils which can be chemically represented by equation 1. Vertisols are better described by equation 2.

Pedologists will agree that in general, Oxisols and Andepts on one hand and Vertisols on the other, while vastly different in character, are well-defined chemically and physically. They impose very different constraints on land use, and these constraints differ not only in degree but in kind. Soils which can be represented by equation 1 or 2 have well-defined properties and therefore are well-defined taxanomically.

Most soils are not properly represented by equation 1 or 2. This large group of soils must be represented by a hybrid model. The purpose of this paper is to present such a model and to report some predicted consequences from an analyses of this model.

Theory

In soils which contain mixtures of pH-dependent and permanent charge minerals, the total net charge σ_T can be expressed as the sum of the components thus:

$$\sigma_T = \sigma_v - \sigma_p \tag{3}$$

$$\sigma_T = \frac{K\varepsilon}{4\pi}\, 0.059(pH_o - pH) - \sigma_p \tag{4}$$

where the negative sign preceding σ_p indicates and assumes a negative sign for the permanent charge component. The pH-dependent charge component can be negative, zero, or positive, depending on whether (pH_o - pH) is negative, zero, or positive.

In equation 4, pH_o is no longer the zero point of charge of the soil but the zero point of charge of the pH-dependent component. Now, $\sigma_T = -\sigma_p$ when pH_o = pH, and the zero point of charge of the mixture would be necessarily lower than pH_o.

To distinguish between the two zero points of charge, it is convenient to designate the zero point of charge of the mixture as ZPC. At the pH corresponding to ZPC, $\sigma_T = 0$, and

$$0 = \sigma_v - \sigma_p$$

or

$$\sigma_p = \frac{K\varepsilon}{4\pi}\, 0.059(pH_o - pH) \tag{5}$$

If equation 5 is written explicitly in terms of pH, we have

$$ZPC = pH = pH_o - \frac{4\pi\sigma_p}{0.059K\varepsilon} \tag{6}$$

Equations 4, 5 and 6 are graphically illustrated in Fig. 1.

Discussion

In equation 6, ZPC = pH_o only when p = 0, in which case equation 1 applies. And in equation 4, $\sigma_T = -\sigma_p$ when pH = pH_o, in which case equation 2 applies. The latter immediately suggests a logical basis for determining permanent charge in soils containing mixtures of pH-dependent and permanent charge minerals. Note also in equation 4 that when pH = pH_o, the dielectric constant ε has no effect on σ_T, σ_v or σ_p. This allows the analyst to use alcohol to wash out excess salt in a laboratory procedure. In equation 2, alcohol is not a factor in measurement of σ_p. In equation 4, alcohol can be used only when pH = pH_o, and alcohol should never be used in a procedure to measure σ_v in equation 1. In addition, when pH = pH_o, electrolyte concentration has no effect on σ_v.

If at pH_o = pH, a soil is saturated with an indifferent electrolyte, the me. of cation adsorbed will be equal to or greater than the me. of permanent charge. The me. cation adsorbed can be and is normally greater than permanent charge because the pH-dependent charge component adsorbs equal amounts of cations and anions even when $\sigma_v = 0$. Permanent charge can be computed by subtracting the me. of anions adsorbed from the me. cations adsorbed.

pH_o can be located by potentiometric titration curves as shown by Van Raij and Peech (1972) and Keng and Uehara (1973). ZPC can be measured by ion adsorption measurement. Van Raij and Peech (1972) determined pH_o and ZPC for two Oxisols and an Alfisol from Brazil. Both topsoil and subsoil samples were analyzed. In all but one sample, ZPC < pH_o. If the supporting electrolyte used in the determination of pH_o is the same as the electrolyte used to determine ZPC, ZPC should be less than pH_o if a soil contains permanent charge minerals. This is predicted by equation 6. Equation 6 also predicts that as the proportion of permanent charge minerals decreases in a sample, the difference between ZPC and pH_o also decreases. The data of Van Raij and Peech show that this difference was greater in the Alfisol than Oxisols. This is consistent with the view that Alfisols in general contain more permanent charge minerals than Oxisols. In one sample (Oxisol), ZPC was greater than pH_o.

This is due to experimental error or suggests an intriguing possibility that permanent positive charge exists in soils.

This simple model also predicts that ZPC, unlike pH_o, is not a unique value but varies with salt concentration.

Conclusion

The predicted results discussed in this paper can be readily tested in the laboratory. Synthetic mixtures or soils with known mineral composition may be used as test materials. Equations 4, 5 and 6 are linear equations and will deviate markedly from experimental data at high negative and positive surface potentials. The model is accurate near pH_o.

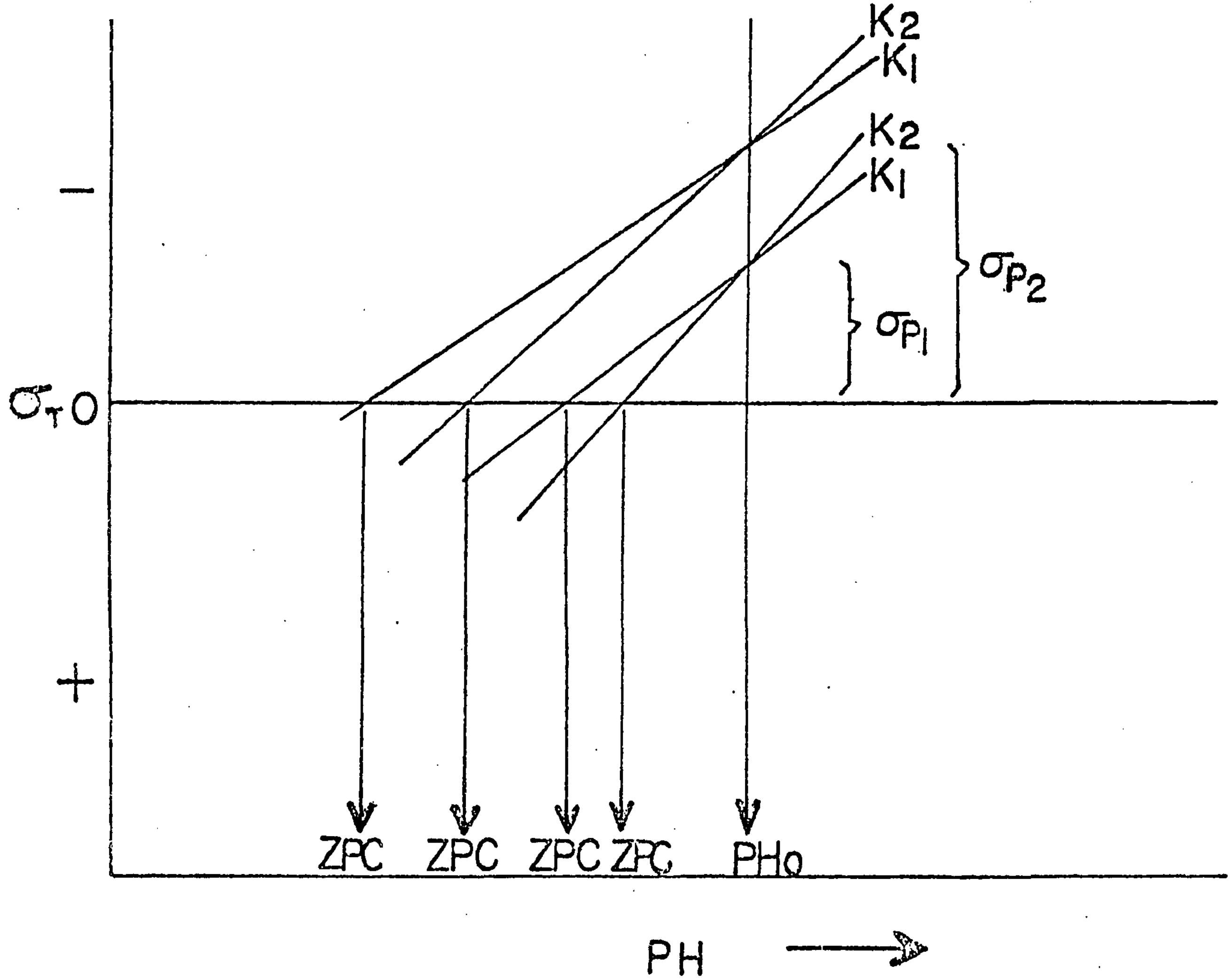

Fig. 1 - Dependence of total net surface charge (σT) on the magnitude of permanent charge (σp), salt concentration (K), and pH. ZPC and pHo are the zero points of charge of the mixture and the pH-dependent charge component, respectively.

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COMPARISON OF ANALYTICAL DATA FROM FOUR SOIL LABORATORIES ON THREE SOILS OF THE KINDARUMA AREA IN KENYA

W. G. Sombroek

Introduction

In order to compare the laboratory methods of the Kenya Soil Survey (KSS) in Nairobi with those of some well-known soil laboratories elsewhere, samples of three similar soils from the Kindaruma area in Kenya were analyzed at the following laboratories:

(a) the national soils laboratory of Brazil, SNLCS, Rio de Janeiro (request by KSS),

(b) the soils laboratory of the University of Hawaii, Benchmark Soils Project (request by Hawaii), and

(c) the soils laboratory of the IITA in Ibadan, Nigeria (request by IITA).

The three soils analyzed included one Dystropept and two Haplustox, with dark red to dusky red colors. The altitude is about 1300 m and the moisture regime is ustic, though not pronounced.

Not all three profiles were analyzed by all four laboratories. The data from Hawaii, IITA and KSS are partly incomplete. The data from SNLCS concern only one horizon of one profile. Samples for the various laboratories were taken at different times of the year and not always at exactly the same depth.

Discussion

Notwithstanding the above mentioned limitations in materials and procedures, the differences in the data from the four laboratories are striking so that a discussion seems pertinent even at this early state.

A. Textural analysis: The SNLCS data (dispersion with NaOH-calgon) are very much comparable with the KSS data. Pre-treatment of the samples by boiling with HCl+H2O2 at KSS yielded substantially more clay in the case of one profile. IITA and Hawaii will be asked to carry out their standard mechanical analysis, before fuller comment is given on the effect of pre-treatment.

B. Clay mineral analysis by X-ray and mineral counting of the sand fraction:

The results compare well.

C. Chemical analysis: It is in these aspects that large differences occur, in a rather inconsistent way.

1. pH data: These vary rather widely considering the simplicity of the methods involved. Especially the Hawaii data are quite different from the KSS ones, resulting in much larger delta pH values for the former (important for classification, e.g. Acrorthox and Andepts).

2. P-total and P-available: Further analysis will be requested from KSS, IITA and Hawaii, in view of the fact that trends of C/P ratios within a profile may be of use in classification.

3. Percentage of C: Clearly lower data were obtained at KSS which is only partly due to a different method. The methods employed were:

   KSS: Walkley-Black

   SNLCS: Thiurin

   Hawaii: Acid dichromate digestion with Fe2SO4 titation. (See page 485 of Soil Taxonomy for brief descriptions of the Hawaii methods, and "Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples" by SCS for elaborate description.)

   A uniform methodology is needed to avoid classification problems (limits of mollic epipedon, factor of activity of the organic matter). Data from IITA (also Walkley-Black) will be requested.

4. Exchangeable cations: Especially the Ca and Mg values from the SNLCS and IITA laboratories are much higher (sometimes double) than those from KSS, in particular for the topsoils. The Hawaii data, however, are the same or lower than those of KSS. The methods used were:

KSS: For Ca, a EEL flame photometer with addition of Lanthanum chloride (if available), after leaching with ammoniumacetate of pH 7.0; for Mg, colorimetric with thiazol-yellow reagent.

SNLCS: For both Ca and Mg, EDTA titration

IITA: Extraction with neutral 1N ammoniumacetate

Hawaii: For Ca, oxalate-cerate, after ammonium acetate extraction; for Mg, phosphate titration after acetate extraction. K and Na data are less divergent (K somewhat higher in the case of IITA). Clearly some check is needed on what are realistic figures (through atomic adsorption - method Van Rosmalen?)

5. Exchange acidities: Much higher values were reported from IITA as regards Al, much higher from SNLCS as regards H. Hawaii and KSS data were again comparable. Part of the difference is due to different methodology:

KSS: Al + H in a leacheate of 0.6 N BaCl2, unbuffered, titration at pH 8.3

SNLCS: Al with 1N KCl, followed by decantation and titration with NaOH 0.1N in the presence of brome-thymol blue; H extraction with 1N CaOAc at pH 7 (and subtraction of Al)

IITA: Extraction of both (?) with 1N KCl

Hawaii: Al with KCl extraction and fluoride titration; H with BaCl2-trimethanolamine 11 and back-titration with HCl

Because of its influence on base saturation percentage, Al-"toxicity" ("alic" subgroup proposal etc.), standardization is obviously essential.

6. CEC - "sum of cations": There are substantial differences because of (4) and (5). Does the Hp determination of KSS indeed include both Al and H (and all of it)? Determination of H by Hawaii is needed in this respect.

7. CEC-NH4OAc at pH 7.0: This was determined separately only by Hawaii and KSS. IITA data are missing. SNLCS states that its CEC-"sum-of-cations" (T value) should be about equivalent to CEC-NH4OAc at pH 7.0 because of its determination of H at a fixed pH of 7.0.
Hawaii comes out far higher than KSS.

   KSS: 1N NH4OAc at pH 7.0, washing with 96% ethylalcohol and leaching with acidified CaC12, NH^+ determination by steam destillation and titration,

   Hawaii: 1N NH4OAc at pH 7.0 and direct destillation.

8. CEC-NaOAc at pH 8.2: This was only determined by KSS. Difference with CEC at pH 7.0 in these profiles is small, but is often quite large in "intergrades" Ferralsols - Luvisols/Acrisols of the same area.

9. Base saturation percentages: These are quite varied, because of the aforementioned divergencies.

10. CEC-clay calculation: A separation was made between "total" CEC (i.e., with the activity of the organic matter included) and "carbon-corrected" CEC. The latter value is taken as a criterion by SNLCS and KSS, but this correction is not mentioned as a prerequisite in Soil Taxonomy (nor in the FAO legend if one wants to read it that way). Apart from everything else (see above points), a decision is needed on what value to use if one intends to apply the CEC-clay as an important criterion for high-level separation in

the classification system as the Moormann Committee proposes. In "oxic" profiles there is often a very gradual decrease of organic matter in the profiles and even minor percentages of 0.2-0.5% have a considerable effect if the clay mineral is mainly kaolinite.

The only statement to be made right now is that in the subsoils all CEC-clay values, C-corrected or not, are below the limit of 16.0 meq. and therefore all three profiles fulfill this particular requirement for Oxisols/Ferralsols.

11. Ki and Kr values: There was rather good agreement between the SNLCS and the KSS data, considering that SNLCS does it on the fine earth fraction and KSS on the clay fraction. Also, in view of the fact that formerly in East Africa these values were determined as a routine (Tanzania), it seems worthwhile for correlation purposes with Brazil to continue the practice (with a less elaborate method?). The same holds for free Fe (and total P, Ti and Mn).

General Conclusion Relative To Soil Classification

More comparative analyses by international laboratories on some characteristic profiles of major classification units are needed.

The divergence in the values of exchangeable cations, acidity, CEC and therefore base saturation percentage between the four laboratories would illustrate the problem that may arise if CEC and base saturation are taken as important criteria in international soil correlation work. For the time being, field characteristics, with simple laboratory confirmation, should be the main guide.

THE CHEMISTRY AND PHYSICS OF LOW ACTIVITY CLAYS

G. Uehara

All soil minerals can be categorized as being of either the constant surface charge or constant surface potential type. Without exception, all soils are mixtures of these two types of minerals, but their proportions differ considerably among soils. Soils with low activity clays are those in which constant surface potential minerals predominate in the fine earth fractions.

It is helpful at this point to discuss and/or define a number of terms.

1. Clay or colloid. Any particle with a Stoke's diameter equal to or less than 2 microns.

2. Constant surface charge colloid (CSC). Any colloid in which surface charge arises, for the most part, from isomorphous ion substitution in the interior of crystal lattices. Examples of ~~SCS~~ CSC minerals are smectite, vermiculite, mica, attapulgite-palygorskite, sepiolite and zeolite. These minerals are also referred to as permanent charge minerals.

3. Constant surface potential colloid (CSP). Any colloid in which surface charge arises from adsorption of potential determining ions (pdi). Examples of CSP colloids are organic matter, kaolin group minerals, oxides and hydrous oxides of Fe, Al, Mn, Si, amorphous oxides, hydrous oxides, alumino-silicates, and imogolite. These minerals are also referred to as pH-dependent charge or variable charge minerals.

4. Potential determining ions (pdi). The most important pdi's in soils are H^+ and OH^-. The potential on a colloid of the CSP type is determined by the expression

$$\psi_o = \frac{RT}{F} \ln \frac{H^+}{H^+_o} \qquad (1)$$

$$= 0.059\ (pH_o - pH) \qquad (2)$$

where: ψ_o = surface potential in volts

R = gas constant

T = absolute temperature

F = Faraday constant

pH_o = pH at the zero point of charge

5. Zero point of charge or point of charge. This point corresponds to the pH at which net charge is zero. The pH corresponding to net zero charge on the pH-dependent component is designated pH_o (pH-subzero). In a mixed system containing pH-dependent and permanent charge minerals, the pH corresponding to net zero charge is designated (ZPC). Clay activity is lowest at or near the zero point of charge.

6. Low activity clay (LAC). Low activity clays are those with a high proportion of constant surface potential colloid for which pH is very near pH_o. When pH is within one unit of pH_o, cation retention capacity (CRC) is low.

7. Cation retention capacity (CRC). CRC is equal to the product of specific surfaces (cm^2 of surface per gram of clay) and surface charge density σ, (meq per gm clay).

$$CRC = S\,\sigma$$
$$meq/gm = \frac{cm^2}{gm} \times \frac{meq}{cm^2} \qquad (3)$$

8. Surface charge density (σ). The surface charge density of a colloid is related to the surface potential through the Gouy-Chapman equation for the electrical double layer.

$$\sigma = \left(\frac{2n\varepsilon RT}{\pi}\right)^{\frac{1}{2}} \sinh\frac{ze}{2kT}\,\psi o \qquad (4)$$

where:

σ = csu per cm^2 or meq per cm^2

η = electrolyte concentration in number of ions per cm^3

ε = dielectric constant of water

k = Boltzmann constant

T = absolute temperature

z = counter ion valence

e = electron charge

ψ_o = surface potential

Equation ~~1~~ 2 and ~~6~~ 4 can be combined to give

$$\sigma = \left(\frac{2\eta\varepsilon kT}{\pi}\right)^{\frac{1}{2}} \sinh z(1.15)\ (pH_o - pH) \qquad (5)$$

If equation 5 is substituted into equation 3, we have

$$CRC = S\left(\frac{2\eta\varepsilon kT}{\pi}\right)^{\frac{1}{2}} \sinh z\ (1.15)\ (pH_o - pH) \qquad (6)$$

which describes the cation retention capacity of low activity clay or colloids of the constant surface potential variety as a function of pH. Equation 6 is synonymous with pH-dependent charge. Note that CRC of equation 6 will vary with pH, pH_o, counter ion valence (z), electrolyte concentrations (η), and dielectric constant (ε) of the solvent. In the conventional procedure for measuring cation exchange capacities with neutral, one normal NH_4OA_c, pH is adjusted to 7, pH_o is lowered by adsorption of acetate ions, counter ion valence is chosen to be one, the displacing and saturing solution are varied from one normal to near zero concentration with solvents of very different dielectric constants (water and alcohol).

9. Isoelectric weathering. This term used by Sante Mattson refers to the tendency of pH in equation 6 to drift to pH_o. Prolonged leaching under warm and humid conditions leads to "weathering out" of constant surface charge minerals, and the pH of the soil solution drifts to pH_o of the insoluble residue.

10. Limiting form of Gouy-Chapman equation. When in equation 6 pH is within one unit of pH_o (one-half unit if $z = 2$), the hyperbolic sine (sinh) may be removed. This is because $\sinh x \simeq x$ when $x < 1$. Equation 6 then reduces to

$$\sigma = 1.64 \times 10^{-6}\sqrt{\eta}\ (pH_o - pH) \qquad (7)$$

Equation 7 is the limiting form of the Gouy-Chapman equation and can be used to describe the surface charge characteristics of Acrustox and Acrorthox. In these Great group categories, pH is so close to pH_o (isoelectric weathering) that cation retention capacity is virtually zero.

When an Acrorthox or Acrustox is intensively cultivated, it is generally limed and fertilized. Liming raises pH and adds a cation for which z = 2. Fertilization raises the salt concentration and lowers pH_o (phosphorus is especially effective in lowering pH_o). The net result is a significant increase in σ and therefore CRC. When this condition is attained, sinh x >>x and equation 7 must be abandoned and replaced by equation 6.

11. The Stern model. When the electrolyte concentration exceeds 0.01N, the major counter ion is calcium or magnesium and the solution pH exceeds pH_o by more than one unit; even equation 6 fails to describe surface charge on soil colloids of the constant surface potential type. Under these circumstances, five expressions are required to characterize surface charge. They are:

$$\sigma_0 = \sigma_1 + \sigma_2 \qquad (8)$$

$$\sigma_1 = \frac{NCZ}{1 + (A\rho/Mn)\exp\{\frac{-(ze\psi_o + \phi)}{RT}\}} \qquad (9)$$

$$\sigma_2 = \left(\frac{2\eta\varepsilon RT}{\pi}\right) \sinh \frac{ze}{2RT}\psi_d \qquad (10, \text{ also see } 4)$$

$$\sigma_0 = \frac{\varepsilon'}{4\pi\delta}(\psi_o - \psi_d) \qquad (11)$$

$$\sigma_o = \frac{RT}{F} \ln \frac{H^+}{H^+_o} = 2 \times 10^{-4} (pH_o - pH) \qquad (\text{see } 1)$$

where:

σ_0 = surface charge density in the potential determining layer

σ_1 = charge in the Stern layer

σ_2 = charge in the diffuse layer

N = number of adsorption sites on 1 cm^2 of surface

A = Avogadro's number

ρ = density of water

M = molecular weight of water

ψ_d = potential on the plane between the Stern and diffuse layer

ϕ = specific adsorption energy

ε' = dielectric constant in the Stern layer

δ = thickness of the Stern layer

12. Specific adsorption. Certain counter ions, particularly Ca^{++}, Mg^{++} and Al^{++}, may be held in the surface by forces additional to those of purely electrostatic origin. These additional forces (energies) are called specific adsorption energies. In some instances, the quantity of adsorbed calcium may exceed the number of negative charge on the surface, resulting in charge reversal.

13. Charge reversal. A soil with net negative charge may be super-saturated with the counter ions. This may be best seen by using equation 8.

$$\sigma_0 = \sigma_1 + \sigma_2$$

In equation 8, σ_0 is the charge on the potential determining layer, σ_1 is the charge in the Stern layer and σ_2 the charge in the diffuse layer. If σ_1 exceeds σ_0, σ_2 must take on a sign opposite from σ_0. In acid soils $Al(OH)^{++}$ or $Al(OH)^{+}$ is frequently the dominant ion in σ_1.

14. The effective charge. The charge which has the greatest influence on soil physical properties such as swelling and solute transport is σ_2. The charge in the diffuse layer is sometimes called the effective charge.

15. The isoelectric point. The isoelectric point (IEP) is the pH at which the effective charge is zero or when $\sigma_0 = \sigma_1$. When there is no charge in the Stern layer, $\sigma_0 = \sigma_2$ so that when $\sigma_0 = 0$, σ_2 is also zero,

and IEP = ZPC. IEP = ZPC only when $\sigma_0 = \sigma_2 = 0$.

16. Delta pH or ΔpH. Delta pH is defined as

$$\Delta pH = pH_{KCl} - pH_{H_2O}$$

or the difference in pH measured by 1NKCl and water suspensions. ΔpH = 0 when $pH_o = pH$

17. Swelling. Swelling potential is low when $\psi_d = 0$. When $\psi_d = 0$, effective charge (σ_2) = 0.

18. Water dispersible clay. Water dispersible clay is low when ψ_d is low. Water dispersible clay is minimal when $\psi_d = 0$.

19. Clay activity. Clay activity is defined as the Plasticity Index to clay content ratio. Low activity clays are characterized by low ratio. This ratio should be minimal when $\psi_d = 0$.

IMPORTANCE OF MINERAL CONSTITUENTS IN PEDOLOGY

P. Segalen

Introduction

Mineral constituents of all kinds play a leading role in soils. They represent, in most cases, more than 95 percent of the soil itself. They are responsible for a number of soil properties. They reflect the soil-forming conditions. They contain many of the elements which are necessary for plant-growth and contribute greatly to soil fertility.

Yet, in the identification and classification of soils other constituents such as the organic ones, although present in much smaller amounts and identified with much more difficulty, are often preferred. So are secondary effects of these constituents such as, for instance, translocation of clays, color and exchange capacity, rather than the constituents themselves. It seems that ever since the beginning of pedology, a tendency to enter into the soils through their morphology has prevailed and that soil mineral constituents have been unduly overlooked. Presently, soil mineral constituents are, though very slowly, gaining the importance they really deserve.

I wish to advocate here their utility and shall emphasize a few points that I believe are the most important ones.

What Are the Main Mineral Constituents ?

There are plenty of them and it is customary to divide them in primary, e.g. the rock forming minerals, and secondary, e.g. the soil-formed ones. But, the separation is not so clear-cut. Some minerals can be found on both sides.

Among the rock forming minerals, some are very frequent and belong to the silicates : mostly peridots, pyroxenes, amphiboles, micas and feldspars. All these minerals supply to the soils, besides silica, aluminium and iron, alcaline and earthalcaline bases. There are also oxides such as quartz and various titanium oxides and salts of different solubilities. All these minerals can be weathered and dissolved or broken down in the soil. But some others are not or hardly modified, such as zircon, tourmaline, and various anhydrous aluminium silicates; they remain unchanged in the soil. On account of its very low solubility, quartz can be very often considered as an unweatherable mineral.

Many of the soil-formed minerals are alumino-silicates. Zeolites are known to form in soils, but very rarely. Clay minerals, such as fibrous or lattice ones, are the more frequent. They can be distinguished by their basal spacings. Inside the octahedral layers, aluminium, iron and magnesium are plentiful along with calcium, potassium and sodium. The thinner and simpler the lattice, the scarcer the bases.

Iron and aluminium sesquioxides are normal constituents, sometimes in high amounts. Titanium and manganese oxides are also usually present but in much lower amounts. Salts such as sodium chloride, sulfides, calcium sulfate or carbonate and various magnesium salts, may appear in very high amounts.

Most of the above mentioned constituents appear as crystallized minerals, but some of them may be considered amorphous material (e.g. X-ray amorphous). In addition to oxides and hydroxides, amorphous aluminium silicates known as allophanes often occur. Some of these products are very closely associated with organic matter, as in Andosols and Podzols.

Moreover, a number of constituents can be found in rocks but also be formed in soils, such as a number of salts and clays. Some clay minerals are formed in soils, carried away through erosion processes to lake or sea bottoms, incorporated in sediments and afterwards supplied to soils. It is not always easy to know whether a constituent was formed in the soil or supplied by the parent material.

How Do Mineral Constituents Appear in Soils ?

Three main general processes can be taken into account : inheritance, transformation and synthesis.

1. Some minerals are not, or very little, influenced by weathering. This is often the case for quartz which is abundant in many parent rocks. This may happen also in some sediments such as marls or limestones which contain various amounts of clay minerals which are delivered untouched to the soil.

2. Some lattice minerals are partially modified in soils. The lattice is not broken down; the basal spacing may be altered, some ions may be expelled or may change place. The transformation of micas to smectite through vermiculite and interstratified minerals is well known.

3. A great number of minerals are broken down to ions or very simple compounds. These can combine anew to form constituents that did not exist in the rocks and the lattice of which is completely different from the primary ones. Feldspars having a tridimensional framework weather, for instance, to lattice clay minerals.

Water is responsible for the breaking down of most minerals. This acts through the H_2O molecules, but also through the protons, electrons and organic anions water conveys.

By solution, salts, amorphous silica, and various alcaline and earthalcaline cations may be carried away. Protons result from dissociation of a few water molecules, but also from that of carbonic acid and various organic acids originating from the atmosphere or the evolution of organic matter.

Formation of H^+ ions:

$$H_2O \rightleftharpoons HO^- + H^+$$

$$CO_3H_2 \rightleftharpoons CO_3H^- + H^+$$

$$R\ CO_2H \rightleftharpoons R\ CO_2^- + H^+$$

The protons will expell alcaline and earthalcaline cations and consequently they will affect the linkages in the primary minerals and lead to the separation of silica, aluminium and iron. Water can either deliver electrons or fix them and act as a reductor or as an oxydant.

Water as an oxidizing or reducing agent:

$$2\ H_2O \rightleftharpoons O_2 + 4\ H^+ + 4E \quad \text{(oxydation)}$$

$$2\ H_2O + 2E \rightleftharpoons H_2 + 2\ OH^- \quad \text{(reduction)}$$

The movement of electrons will change the valencies of some ions and facilitate their removal. The anions (carbonic or organic) play an effective part in the removal of basic ions and will pull out some of the iron or aluminium.

This part of weathering is a true destruction of the primary minerals. It does not seem to be really dependant on the environment. Provided there is enough water, high or low temperatures will act the same way but faster or more slowly. But what happens to the destruction products is surely controlled by the environment. If drainage is very strong, all the soluble products are eliminated, even silica, leaving residues of metallic (Al, Fe, Ti...) oxides or hydroxides. If drainage is moderate, bases are carried away but iron oxides precipitate, while silica and aluminium combine to form 1/1 or 2/1 clay minerals. If drainage is poor, bases are not completely carried away nor is silica. So, other more complicated 2/1-2/2/1 clay minerals with iron in octahedral sites are formed. If drainage is still more impeded, fibrous clays or zeolites may appear as well as various salts.

All these compounds are crystallized ones. They are sometimes supposed to appear after going through an amorphous stage. When organic matter is abundant, it enhances or delays crystallization and this is why allophanes are always closely associated with organic products.

Therefore, each set of mineral products can give quite a clear notion of the conditions prevailing when it was formed. But, of course, very few, if any, constituents can be considered as unweatherable. With time, they can be altered again by transformation or synthesis. A 2/1 mineral may be replaced by a 1/1 one; kaolinite, usually considered as a very stable mineral, can lose its silica and leave behind aluminium hydroxides.

Determination of Soil Mineral Constituents

It seems that for a long period, the difficulty to identify rapidly and accurately mineral soil constituents hindered their use in soil genesis and classification, as in petrography at its beginning. Total chemical analysis was the only means to know what was inside a soil. But quickly, when the size of the minerals was large enough, optical microscopy helped the identification of mineral species. Unfortunately, this technique was not of much help in soil science, in the beginning at least; the size of particles was much too small. So, soil chemists did their best with what they had available. The works of Harrasowitz, Harrison and Lacroix, among others, were significant in this field.

But, especially in postwar years, tremendous progress was accomplished with the help of physical techniques such as differential thermal analysis, infrared absorption, electron microscopy and, above all,X-ray diffraction.A good identification of species was now possible. The number of iron oxides was drastically reduced. As far as clay minerals were concerned, it appeared that the 1/1 ones did not present many problems. On the other hand, 2/1 and 2/1/1 ones showed many difficulties. While the determination of the lattice type was possible, the chemical constitution was very complicated with the numerous substitutions, variety of interfoliar ions, and the abundance of interstratified minerals. But clay mineralogists were able to identify minerals according to their behavior.

In other respects, significant progress was made in the extraction of salts and free iron oxides and hydroxides, as well as of amorphous materials. New reagents and new analytical techniques were proposed and provided relevant information. The determination of some properties, such as exchange capacity, also showed particular progress.

So, the delay accumulated was rapidly resorbed. Of course, there was, and still is, no single method available to give quickly a definite answer to all identification problems. The quantitative aspect can be solved only by the combination of various methods. This is, of course, time-consuming but strictly necessary, not for all the sampling units under study, but for some of them considered as representative.

Influence of Soil Mineral Constituents on Soil Properties

Soil mineral constituents are responsible for a great number of soil properties and it seems worthwhile recalling some of them here.

Color is one of the most conspicuous soil properties related to constituents. That yellow is due to goethite and red to hematite seems quite familiar to most soil scientists now. But that amorphous oxides can also determine soil color is not so widespread a notion. Grey or whitish colors and mottles are due to the absence or the concentration of iron compounds, but also to organic matter, and distinction here is of importance.

Structure is influenced by mineral constituents, but many of them do not offer characteristic features. The mixture of various oxides and clay minerals give structures which are often difficult to describe accurately and therefore lack specificity. However, some prismatic or cubic structures seem to be associated with specific 2/1 swelling clay minerals. This is often, but not always, the case in Vertisols.

Consistency depends very often on the accumulation of particular mineral components. The aluminium and iron oxide crusts widespread in the tropics are well known. The accumulation of other oxides such as silica, or of various salts (calcium carbonate or sulfate) may lead to drastic changes of consistency. Many clay minerals, too, can modify this property.

Often bulk density is quite uniform except for some soils as the Andosols where allophanes are responsible for a sharp drop (down to 0.8).

Exchange capacity is one of the properties which depends most on the nature of constituents. Everyone knows the differences, in this respect, between 1/1 and 2/1 lattice clay minerals, and that allophanes have most variable pH-dependent base exchange capacities.

Exchangeable bases can also give good information on the nature of soils. Of course, most soils have what can be called "anonymous" exchangeable cations where calcium and magnesium are dominant. But, when aluminium or sodium becomes predominant, it is quite a different picture.

Relations Between Soil Forming Factors and Soil Constituents

1. Climate and vegetation. If the world is considered as a whole and at a very small scale, the correlation between these factors and constituents seems pretty close and maps may be drawn to show it. In the warm and more rainy parts of the world, soils are bright-colored due to amounts of iron sesquioxides and 1/1 clay minerals are often abundant. In the drier parts, warm or not, salts show a marked tendency to accumulate, along with more or less complicated clay minerals. Between these extremes, many intermediates may be encountered with or without iron oxides and with various types of

clay minerals gradually changing one into another. This broad pattern was determinant in the establishment of what is called the zonality law. But one is never sure that the present-day climate and vegetation are always responsible for the soil and other factors may interfere also.

2. Parent rocks are too often overlooked as many of them show great likeness all over the world. But some of them have quite a definite impact on soil constituents, irrespective of bioclimatic conditions. For instance, very sandy material accentuates formation of the organic sesquioxidic material of Podzols in hot as well as in cold climates as long as rainfall is high enough; ultrabasic rocks, devoid of aluminium, are altered essentially to iron sesquioxidic material after the loss of silica and magnesium; limestones (with sufficient silicate impurities) can be altered to form Rendzinas in any wet climate; volcanic ashes weather to allophanes (in Andosols) near the equator as well as near the polar circle.

3. Drainage is also very important. It is responsible for the redox potentials in the soil which bear influence on the behavior of iron, manganese and sulfur. It is also responsible, as shown above, for for the synthesis of clay minerals and sesquioxides.

4. Time is often overlooked in this respect. Things never stay at a standstill when soils are concerned. Rapid or slow changes always occur. Minerals change from one to another and sometimes, as it seems, irreversibly as in the formation of aluminium or iron oxide crusts. But, this aspect must be completed with soil history. All the above mentioned factors have been changing many times during the Tertiary and Quaternary, and very differently in many parts of the world. At higher latitudes, glaciations have disturbed completely the normal evolution of soils and mixed up all the constituents and added minute or large pieces of the underlying rocks; they were also repeatedly covered by sea invasions. At lower latitudes, weathering went on undisturbed in many places

(at least by glaciations) for entire geological periods and were seldom affected by marine transgressions. In many places, the upraising of mountain ridges was responsible for important changes in local climates. It also resulted in powerful alluvium discharges in the surrounding areas.

Relations Between Soil Mineral Constituent and Soil Classification

The introduction, or not, of soil mineral components in soil classification deserves some attention and a few systems will be reviewed.

Of course, in the earlier systems hardly anything has been said of constituents and this can be easily understood due to the lack of knowledge. Until more or less the early sixties, no reference was made to soil constituents except to salts in general which were rather easy to determine and evaluate. In Kubiena's SOILS OF EUROPE, for instance, the word "clay" bears only a granulometric meaning and the word "sesquioxides" appears very seldom.

Most of the pre-1960 genetic classifications have the same attributes, whatever the country. Pedologists in the U.S.S.R., United States, Australia, for instance, referred very frequently to soils through their color, due to organic or mineral compounds, but not to their nature. Tropical soils were referred to as lateritic; but, at least in the beginning, the definition of the soil, as far as the mineral components were concerned, was not very clear.

As time went on, this tendency to define soils partly on organic matter, or various morphological criteria, and partly by mineral components was accentuated. This can be observed in the French classification (CPCS 1967) and in the U.S. Soil Taxonomy.For instance,in the "Sols isohumiques" and "Mollisols" emphasis is laid on organic matter, which is usually under 10 percent, and hardly anything is said about the mineral constituents, except limestone and salts in general. When one speaks of a "cambic horizon", in Soil Taxonomy as well as in the FAO

Soil Units, rather negative features are given and nothing is said about clay minerals. On the other hand, mineralogical details are provided when "Sols Ferrallitiques", "Oxisols" or "Andosols" are examined. So it seems that some coherence is indeed lacking in the characterization of the soils.

However, the importance and the generalization of soil mineral and organic constituents has been known for quite a long time especially by those soil scholars whose names were mentioned previously. In soil classification, a forerunner seems to have been De Sigmond who, as far back as 1938, based the upper levels of his classification on soil constituents and not on soil forming factors nor processes nor soil characteristics. He proposed a new terminology, due to chemical determinations, which was very much used afterwards. In spite of criticisms, some Soviet authors like Volobuyev or Zonn, use these new words. Different attempts were made later on, but it seems that Fieldes, who is responsible in 1968 for a constitutional soil classification, went a very long way in this direction.

Conclusion

It seems to me that we are still in a situation which is more or less inherited from the past, when most of the soil constituents were not well known and could not be identified safely. This forced us to rely only on characteristics like color, structure, and consistency among others. But now, important progress has been made, other new techniques are being generalized, like the use of the scanning electron microscope, or of the Mössbauer diagrams and this allows us to know much more.

Soil identification and classification must keep in pace with scientific progress. Soil mineral constituents are actually well known and it is expected that in a near future, organic ones will be known better. It is time they should be given the place they deserve. It has been already announced years ago by Kelley (1946) and many others. Recently (1974), Van Der Plas and Van Reewijk wrote: "Because classification of soils is mainly a field activity, and mineralogical analysis done in the laboratory, the influence of mineralogy in classification has always been kept as small as possible. However, since mineralogy has a such strong bearing on many soil properties, it has been realized that ignoring mineralogy is unrealistic in many cases."

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CHARACTERISTICS AND PROCESSES OF FERRALLITIC SOILS

Alain Perraud

Introduction

Following the work of a party of French soil scientists, a mimeographed booklet appeared in 1967 which contained the main soil classes of what was called thereafter the French Soil Classification. One of the most important classes is that of "Ferrallitic Soils". It is defined as follows:

1. Complete weathering of primary minerals with the possible exception of some inherited minerals, mostly quartz; the washing out of alkaline and earthalkaline bases and of the greater part of silica.

2. Presence of the following compounds synthetized in the soil : 1/1 lattice clay minerals, and hydroxides and oxides of aluminium and iron, both in crystallized and amorphous forms.

3. These materials are organized in a ABC or A(B)C profile where the B horizon is thick and contains the essential soil-formed minerals. The A horizon is usually rather thin with a low organic matter content. The C horizon is of variable thickness and contains completely weathered minerals. It resembles the parent rock but can be easily crushed with the fingers.

4. The following characteristics are associated with this morphology : low cation exchange capacity, low sum of exchangeable bases, variable degree of saturation, and low pH.

The above morphology and the associated characteristics are used to define a typic ferrallitic soil.

Horizons of Ferrallitic Soils

However, the examination of ferrallitic soil profiles showed that many differences can appear:

1. As far as morphology is concerned, a number of characteristic horizons could be identified. Chatelin and Martin in 1972, gave a list of the horizons with special names in relation to their main features.

   The simplest is called "structichron". It is a mineral horizon from the C horizon by color and structure.

   An "impoverished" horizon shows a regular decrease of clay content without clay skins and without the bulge usually observed in a Bt horizon.

   An "argillic" horizon has a clay accumulation that can be recognized through clay skins and a bulge in the clay content.

   An "indurated" horizon is hard enough to be broken only with a hammer.

   A "gravelly" horizon can be made up either of detritus of quartz or crusts, or of local concentrations of iron and aluminium oxides.

   A "mottled" horizon shows a more or less regular network of grayish and yellow or red streaks.

   Below one or several of these horizons, "alterite" can be observed. All these horizons, but seldom all together, can be observed in soils of ancients surfaces. On the other hand, on recent geomorphic surfaces, the profile is much simpler.

2. A closer examination of the profiles was made to try to find out what their specific characteristics are.

   In the humic horizon, it was observed that organic matter is quickly decomposed and that the contents were seldom higher than 3 percent. However, in certain situations, e.g. lower temperatures sometimes associated with high humidity, the contents may be somewhat higher.

In most circumstances, this organic matter can be called "tropical mull", very similar to the mull of temperate areas.

In the mineral horizons, texture is generally clayey with very little silt. The sand fractions contain very few weatherable minerals. The presence of pseudo particles is responsible for difficulties in the correct evaluation of the different fractions. No particular structure is really characteristic. However, very small aggregates are frequent and structure is then called "aliatic" (similar to flour) and in Brasil "pô de café". Various other forms, more or less blocky, in relation with halloysitic clay minerals are known.

As far as consistency is concerned, friability, even if it is difficult to express, is an important criteria for ferrallitic soils.

A more thorough examination of the absorbing complex showed the extreme variability of the degree of saturation and of the sum of exchangeable bases. These could be strongly influenced by the environment and also by the history of the soil.

The mineralogical contents showed to be in most cases very simple with 1/1 lattice clay minerals and sesquioxides. However, more accurate determinations allowed to identify small amounts of 2/1 lattice clay minerals (normally inherited illite, chlorite and various intergrade clay minerals).

Taxonomy of Ferrallitic Soils

At this stage, ferrallitic soils appeared as a very important soil class, the members of which all had in common the same set of mineral constituents. But even if the morphology could present great variations, none could be considered specific. That is why the definition of the class was strictly mineralogic, whereas the morphological and physico-chemical properties were used to differentiate the lower levels (sub class, group and subgroup) of the class.

1. It seems worthwhile now to compare these soils with their neighbors in the French classification system. The closest are fersiallitic soils which differ from the ferrallitic soils by the mineralogical content. The former contain significant amounts of 2/1 lattice clay mineral in such a manner that the silica/alumina ratio is always higher than 2.0. When the entire profile is marked with the effects of a high water table, permanent or not, then the soils belong to the hydromorphic class.

2. In the comparison with other systems, especially with Soil Taxonomy and the FAO Soil Units, the following differences occur:
   - the argillic horizon appears at the group level whereas in Soil Taxonomy this horizon places the soil in the Ultisol or Alfisol orders,
   - a ferrallitic soil with a CEC higher than 16 me/100 g remains ferrallitic, while in Soil Taxonomy the soil is an Inceptisol,
   - the Oxisols of Soil Taxonomy represent only a small part of the ferrallitic soils,
   - in the FAO Soil Units, the differences are about the same : Ferralsols on one hand, Acrisols and some Luvisols on the other hand. Some of the Nitosols can be related with ferrallitic soils.

However, in the classification of soils in the French system, the ferrallitic and fersiallitic and a few other soils were classified in this manner: first, the definition of soil constituents and next the morphology. In the other classes, other criteria were taken into account. For instance, the profile development, the presence of high amounts of calcium, the distribution of organic matter and so forth.

New Approach to Soil Classification

Recently, a group of French soil scientists has tried to extend this mineralogy-morphology scheme to the whole classification. But, very quickly they became conscious that precise definitions of horizons in general, and of soil characteristics were lacking. A review of the main horizons encountered in soils was made and new definitions were proposed. Of course, those already laid down in the Soil Taxonomy and the FAO Soil Units were taken into account every time it was possible.

The aim is to give up soil-forming factors and soil-forming processes which were referred to in the preceding system and to rely only on soil characteristics that can be observed and/or measured, so as to prepare an objective soil classification. The main classes are to be built on the same scheme in such a manner that consistency will be obtained.

The classification is meant to be universal and should apply to any soil in any part of the world. Our knowledge of the main soils is now sufficient to enable us to start a soil classification on a world scale.

Another characteristic is that the scheme is an open one and any soil still to be known should find its place in it.

1. Different families of soil constituents have been inventoried and listed in a sequential manner : salts, mineral amorphous material, various combinations of clay minerals and iron sesquioxides, oxides and organic matter and metal complexes constitute the backbone of the system and are used to define the main classes and subclasses, and therefore constitute the first level.
2. The second level is devoted to morphology. Great groups and groups will take into account the main characteristic horizons that can be observed from the top downwards in the first two meters. The subgroups are meant to associate all the horizons of the profile.

3. It has been felt necessary to introduce a particular level, the genus, which will contain information on some measurable characteristics such as CEC, S, V, pH, exchangeable Al, etc. With this information, it seems quite possible to identify the soil and to give it a name.

4. But it seems necessary to go further and complement this information with other data concerning the possible use of the soil. So, a third level is necessary to give additional soil characteristic such as texture, thickness of horizons and especially data on the present environment such as slopes, relief, water and thermic regimes.

5. With this view, an attempt of the classification of ferrallitic soils has been already started and seven main groups have been listed and are going to be tested. The number of subgroups is probably larger. As far as genus are concerned, strict definitions need to be prepared and are not available yet.

At the same time, when a soil is thoroughly investigated, it seems quite appropriate to go back from the characteristics to the explanation, especially to identify the soil-forming processes.

Of course, weathering is the main and first soil-forming process. It goes on after the formation of soil horizons. The time factor and also the history of soil are most important. It is through the study of landscapes that relevant information can be obtained in this respect.

Other soil forming processes occur such as pedoplasmation, hydromorphy, induration, reworking, impoverishment, translocation of clay, and even cheluviation can modify the morphology. But nevertheless, none of the processes, except the very last one, can modify the mineralogical content of the ferrallitic soils and the unity of the class.

REPORT ON THE BRAZIL MEETING OF THE COMMITTEE ON THE CLASSIFICATION OF ALFISOLS AND ULTISOLS WITH LOW ACTIVITY CLAYS

F. R. Moormann

Introduction

In the preface of Soil Taxonomy it is emphasized that the classification presented, although in principle a universal system, is far from complete and not equally well developed in all parts. The classification of soils of the tropics is mainly based on studies in restricted areas, especially in the State of Hawaii, Puerto Rico and the U.S. Virgin Islands. Soil taxa definitions for the tropical region at large are hence in a lesser state of perfection and require further attention.

In 1975, the Deputy Administrator for Soil Survey, SCS-USDA, established an international committee with members from many countries to test the established differentiae and classes of tropical soils against the existing knowledge of these soils, their behavior and the relevancy of the classification with respect to geographic distribution and broad management properties of the existing taxa. After an initial review of the numerous aspects of revision of Soil Taxonomy for tropical regions, the committee opted for a specific mandate, i.e., the review of those Alfisols and Ultisols in which the diagnostic argillic horizon is dominated by "low activity clays", mainly 1:1 lattice kandites and/or hydrous oxides of iron (and aluminum). In the present classification of the two orders, soils with low activity clays are mainly recognized as Oxic (plus Ustoxic and Orthoxic) subgroups. However, for instance in the case of Hapludults and Paleudults, the only possible but incomplete recognition is at the family level.

The three main arguments for upgrading the low activity clay property of these soils are

- geographic: the extent of the low activity clay taxa in the intertropical zone is considerable; they are dominant among the Alfisols and Ultisols in this region.
- taxonomic: the distinction of these taxa at a low categorical level leaves little or no freedom to make meaningful further subdivisions. Thus, in the dry forest and savannah zone of West Africa, a considerable portion of the well drained upland soils should, at present, be classified as Oxic Paleustalfs and, to a lesser extent, as Oxic Hapustalfs, limiting such a wide range of soils to two subgroups. This is clearly not in balance with the subdivision of most taxa in the better known temperate zone of, e.g., the continental U.S. Moreover, in several international systems, such as the CPCS (French) system and national systems, such as that of Brazil, the dominance of low activity clay soils in the intertropical zone has been recognized and mapped at a much higher categorical level. This, too, seems a reason to upgrade the particular diagnostic characteristic under discussion.
- management: the dominance of low activity clays in so many soils of the tropics has a profound influence on the management properties of these soils which, most commonly, are less favorable as regards the chemical and physico-chemical behavior of such soils.

The deliberations of the committee since its inception were mainly by correspondence. Opinions and proposals of the members were collated in a series of circular letters edited by the chairman. Personal contacts between a few members took place from time to time, but the Brazil workshop, reported here, offered the first occasion for discussions between a larger section of the committee participants, and for a confrontation of individual and group opinions during the study of relevant pedons in the field.

The present report attempts to summarize the discussions, dealing both with items on which a reasonable consensus of opinion could be reached and with items which remain, as yet, controversial.

Summary of Discussions

A. Level of Classification in Soil Taxonomy

The present level, allowing distinction of Alfisols and Ultisols dominated by low activity clays is the subgroup. In a number of great groups no further distinction is foreseen except at the family level for clayey pedons. In the committee's circular letters, the trend has been to upgrade these taxa to the great group level, using the prefix "Kandi" (from kandites, 1:1 lattice clays) in the nomenclature, as in Kandiudalf, Kandiustult, etc.

A leading argument for placement at this level is that the changes required, both as regards the overall structure of Soil Taxonomy and in terms of (re-)definition of existing and new taxa, would be kept to a minimum. The suborder level, which uses criteria mainly based on soil moisture regime (except for Boralfs and Humults), was found to be less suitable because at this level a two-way split of most existing suborders would be required except for Boralfs, Xeralfs and Xerults. Alternative proposals, more or less well documented, include:

1. Introduction of a new order, characterized by low activity clays. An order of this kind would not only include the Kandi Alfisols and Ultisols, but also the oxic subgroups of other orders e.g., Inceptisols and Mollisols, as well as the present Oxisols. In this proposal, the diagnostic criteria for orders of the present scheme (as the presence of a mollic epipedon combined with a high base saturation; the presence of argillic, cambic, oxic horizons; base saturation; and the soil moisture regime as in Aridisols) would have to be relegated to a lower category level. This proposal would require a complete reorganization of Soil Taxonomy.

The proposal would approximate the French approach as regards classification of soils of the tropics. The soils in the "low-activity-clay order" would be mainly the Ferrallitic Soils, but would include part of the soils of other classes, such as certain Ferruginous Tropical Soils and Hydromorphic Soils. Moreover, this order would fit in the new approach to soil classification of P. Segalen where the mineralogical soil constituents are determinant at the highest categorical level.

2. Change of definition of Alfisols and Ultisols. Two variants with respect to this proposal were discussed:
- To define Alfisols and Ultisols as soils with an argillic horizon, as in Soil Taxonomy, but with, respectively, a dominance of high and low activity clays. The present criterion for distinction based on base saturation would be dropped at the order level. This proposal was previously discussed in the early circular letters as presented by C. Sys (Ghent). It is also the basis of the present classification in Brazil, where soils with an argillic horizon and dominated by low activity clays are grouped as Red-Yellow Podzolic Soils which are subdivided in eutrophic and dystrophic groups according to base saturation.
- To exclude from the Alfisols, as defined at present, all soils dominated by low activity clays. Such soils would, q.q., become Ultisols which order would therefore contain soils with high activity clays and low base saturation as well as soils with low activity clays irrespective of base saturation.

Both proposals have adherents among the committee members. Both, however, require considerable changes in the present Soil Taxonomy, and regrouping and revision of the existing taxa. Key questions in this respect are which of the two properties, notably base saturation or clay activity, is the more meaningful one in terms of implied management properties and genetic soil development.

Moreover, some other points which require an answer are: which of the two properties can be defined with greatest precision, based on analytical work, and which of the two properties gives the best geographic-taxonomic separation of the pedons for which sufficient data are available.

In summary, the upgrading of Alfisols and Ultisols with low activity clays can be made at different categorical levels. The introduction of a new order incorporating all soils with low activity clays, irrespective of their present classification, would require a major overhaul and rewriting of Soil Taxonomy. The proposals for changing the present order definitions and to group all Kandi soils with Ultisols also require important revision, but should be further studied. The proposal to introduce the low activity clay property at the great group level, though requiring the least changes, is believed by part of the discussants to be insufficient in terms of taxonomic-genetic importance of this property.

The SCS, responsible for eventual introduction of modifications, generally requires that changes must accommodate the soils considered, but should affect others least. Thus, changes should be tested first at lower levels and only if this is not satisfactory, higher category changes should be proposed. Obviously, this philosophy favors the changes we are concerned with to be kept at the great group level.

B. The Argillic Horizon as a Diagnostic Property

In the correspondence, which was dealt with in various circular letters, a recurrent theme of discussion has been the definitions and the diagnosis of argillic horizons as one of the principal diagnostic properties in Alfisols and Ultisols.

In many soils with a kaolinitic-sesquioxidic clay mineralogy, the diagnosis based on the properties as set forth in Soil Taxonomy (p. 19-27) is difficult. Clay skins in such soils are frequently difficult to diagnose in the field. In micromorphological studies, the shiny coatings are often found to be stress-cutans rather than oriented-clay argillans. Determination of clay content in many of these soils is often problematic due to poor dispersion properties which diminishes the diagnostic value of the clay ratio between the alleged illuvial and eluvial horizons as a determinant for the presence of an argillic horizon.

In many of these soils, the B horizon satisfies the chemical and mineralogical properties of an oxic horizon; but they cannot be called Oxisols due to the presence of a "textural" argillic horizon, with or without clay skins. Thus, in the field, distinction between Oxisols and low activity clay Alfisols/Ultisols may become vague and rather arbitrary.

Possible solutions to the problems which these poorly expressed argillic horizons pose for the taxonomic classification include, according to Ray Isbell (Australia):
- widen the definition of Oxisols by admitting an argillic horizon,
- widen the required clay ratio between A and B if no or no distinct clay skins or oriented clay are observable.

The loss of clay from the upper horizons does not necessarily result in an accumulation in the underlaying horizons. Lateral selective erosion of the fine fraction, clay breakdown by, e.g., ferrolysis and the process of "appauvrissement" recognized by the French (e.g., vertical clay movement without concurrent accumulation) can result in a texturally differentiated profile, without a clear process of accumulation as specified in Soil Taxonomy.

While such alternative processes leading to a textural differentiation are not specified in Soil Taxonomy, part of the discussants were of the opinion that the morphologically easily recognizable clay increase from A to B should be the norm. The clay ratio requirement of the Soil Taxonomy definition (p. 27) may be increased for those soils where clay skins are not easily recognized in the field. A ratio of 1.4 for such soils with 15-40 percent clay in the eluvial horizon (p. 21) and corresponding values for more sandy and more clayey soils was proposed but not unanimously accepted.

A proposal was made to fill the gap between the oxic horizon and the well developed argillic horizon by introducing a "lixic" or "luvic" horizon (Sombroek). This horizon is discussed below.

C. The "Thin Oxic Horizon"

In conjunction with the discussion of the argillic horizon, difficulties arising from the presence of a "thin oxic" horizon were mentioned. In the current definitions, the presence of an oxic horizon of more than 30 cm is sufficient to classify a soil as an Oxisol. In many of the soils with a Pale clay distribution, the upper part of the argillic horizon has all properties of an oxic horizon. This is especially true in Paleudults and may occur even when a distinct A2 or E horizon is present. It was the opinion of most discussants that in cases where a thin oxic horizon is underlain by an argillic horizon with distinct clay skins, the depth requirement of the oxic horizon for classifying such pedons as Oxisols should be increased. It is proposed that the thickness of the oxic horizon should be 50 or 60 cm, and that no clear cutans should occur above 100 or 125 cm. The definition of Oxisols should be amended in this respect, as well as the pertaining section of the definition of Ultisols and, possibly, of Alfisols.

D. Diagnostic Properties of Kandi Taxa

These properties were discussed on the assumption that the low activity clay properties in Alfisols and Ultisols will be distinguished at the great group level (see A.). For distinction at a higher level, most but not all of these diagnostic properties would retain their validity.

1. Soil temperature regime. While Kandi Alfisols and Ultisols are most widespread in the humid and subhumid tropical zone, they are

not exclusively tropical; important surfaces occur in the warm temperate zones. It is recommended that the soil temperature regime should not be a diagnostic criterion in the definition of the Kandi taxa, as distinct from the Trop taxa.

2. Cation exchange capacity. In the original proposal for Kandi great groups, the CEC value diagnostic for the present Oxic subgroups in Soil Taxonomy was recommended, i.e. less than 24 meq per 100 g clay by NH_4OAc (determination 5A1a, USDA-Soil Survey Investigation Report No. 1, 1972) and a cation retention capacity from NH_4Cl of less than 12 meq per 100 g clay. In correspondence, referring to the circular letters of the committee and to the discussions during this workshop, the difficulties in the determination and the lack of precision of this criterion were highlighted. In materials dominated by low activity clays, the permanent charge is low relative to the pH-dependent charge, while the total charge is low. The consequence is, among others, that slight abberations in determination may lead to considerable divergence of values, both for CEC and for the related value of base saturation. Physico-chemical aspects of the CEC determination were discussed during the workshop. An alternate value to be used as a diagnostic characteristic can be the ECEC, i.e. the sum of cations plus exchangeable Al and H, as determined at the pH of the soil. Correlation between CEC by NH_4OAc at pH7 and ECEC are mostly significant at the low CEC values in question where soils with a similar clay mineralogy are considered so that both values may be used, provided that correlations are established in "benchmark" profiles.

Whereas the NH_4OAc method is in widest use, and because no inherently superior methods are available for determining clay activity as a diagnostic taxonomic criterion no changes in the present definition of Oxic subgroups can be proposed. For the present report, the CEC by NH_4OAc at pH7 per 100 g clay is maintained, unless mentioned otherwise.

Accessory properties would pertain to characteristics such as structure (weak), consistency, etc. A distinct disadvantage of introducing such an "intermediate" horizon would be that two sets of differentiating properties will have to be defined instead of the present single set. While most of these properties are difficult to pin down in the field, it is not certain whether the introduction of the luvic horizon would be an advantage.

For the diagnostic value of CEC of Kandi great groups, several alternatives were discussed:

a. Maintain the limit of 24 meq, as in the present Oxic subgroups.
b. Introduce the limit of 16 meq, parallel to the value used for defining an oxic horizon (Soil Taxonomy, page 39,) and use the range of 16-24 meq for defining "Kandic" subgroups.
c. Use both 16 and 24 meq as a break; for example 16 meq for Ultisols and 24 meq for Alfisols.
d. Use a single value, intermediate between 16 and 24 meq, e.g. 18.

Solution (a) would require least changes, but has as the disadvantage that 2:1 lattice clays could be present in the clay fraction in measurable quantity. North Carolina research showed that 10% montmorillonite in the (kaolinitic) clay fraction would cause the CEC to be 18 meq or higher, which would considerably change engineering properties of the soils, e.g. in respect to septic tank construction (S. W. Buol). Solution (b) would cause the Kandi great group to be more pure in the sense that admixture of 2:1 lattice clays would be negligible in most cases. A disadvantage would be that for certain soil regions, especially in low activity clay Alfisol areas, the Kandi groups and subgroups would be intricately mixed. For that reason, solution (c) may be preferable as was found in studies in Nigeria (F. Moormann). Solution (d) is supported by North Carolina data, but insufficient information is available from elsewhere.

The use and usefulness of ECEC as a diagnostic tool was discussed.

Preliminary research seems to indicate that the value of 14 meq per 100 g clay would separate the low activity clays from those which have a measurable admixture of 2:1 lattice clays with a higher activity. Part of the discussants would prefer ECEC as the standard for separation of the Kandi groups and the Kandic subgroup. An NH_4OAc-CEC per 100 g clay of 16 meq would correspond approximately with an ECEC of 12, while 24 meq would give an ECEC of about 18 meq in soils from Puerto Rico (Eswaran). Other but similar values are found in other areas with variations according to parent material, pH, base saturation, and, possibly, other parameters. A possible solution is to use ECEC instead of the cation retention capacity from NH_4Cl, and change the definition of Kandi, and Kandic as follows: "have CEC of more than 16 (resp. 24) meq per 100 g clay (by NH_4OAc) <u>or</u> an ECEC of 12 (resp. 18) per 100 g clay".

The word "or" is underlined, and would replace "and" in the present definition. While this alternate choice would weaken the precision of the definition, the number of cases in which low activity clays according to the NH_4OAc-CEC would become high activity clays according to ECEC or vice versa is probably low. Correlations found in the literature between the two values and provided in the framework of the committee's work are mostly good to excellent. In practical terms, the main advantage of ECEC is that this analysis is uncomplicated and well reproducible; contrary to the NH_4OAc-CEC determination.

Besides these two types of CEC determination, other analytical procedures are used in various countries. Such other data are not directly usable in the "translation" of various national classifications into Soil Taxonomy units. In order to do so, correlations between the "national"analyses and NH_4OAc-CEC and ECEC should be made on a sufficient number of samples. Work in Brazil (see circular letter no. 8, appendix 5) may serve as an example in this respect.

In Soil Taxonomy, the diagnostic CEC values are measured on the whole soil and include the CEC of organic matter which is essentially determined by pH dependent charges. In the Brazil classification, the diagnostic CEC is determined on the mineral fraction. The Soil Taxonomy approach leads to considerable higher CEC/100 g clay values in soils where the C content of the argillic horizon is high, e.g. in many Humults and/or where the clay content is low (coarse loamy or coarser families) so that the contribution of the CEC of organic matter is relatively high. In other cases, the contribution of organic matter to the CEC of the argillic horizon is relatively unimportant. Further studies are required to show whether the CEC of the mineral fraction is preferable to the CEC of the total soil. A priori, for low activity clays, the CEC of the mineral fraction seems to be a better diagnostic value.

The diagnostic depth of the argillic horizon, or its substitute, dominated by low activity clay was generally accepted to be the upper 50 cm of this horizon. The weighted average CEC of this layer is determinant. It should be noted, however, that a relatively sandy and/or humiferous B1t horizon may increase the level of the weighted average CEC, unless the CEC of the organic matter is discounted, as is done in the Brazilian system of soil classification. In this case, the decrease of the clay CEC in the lower horizons with less organic C should be taken into account.

3. Weatherable minerals (as listed in Soil Taxonomy, p. 64). A point of discussion was if taxa with "Kandi" characteristics should be required to have less than 10% weatherable minerals in the 20-200 micron fraction. The present situation is that this requirement does not occur in Alfisols, but only in the Pale great groups of Ultisols, i.e. Paleaquults, Palehumults, Paleudults, Paleustults and Palexerults.

For great groups in Ultisols, which key out after the Pale great groups, the content of weatherable minerals is not an exclusive characteristic but is linked with the textural profile, e.g.: Tropudults

(p. 367) have either or both a) a "non-Pale" clay distribution and b) more than 10 percent weatherable minerals in the 20-200 micron fraction. Thus, these great groups may have a low content of weatherable minerals, provided that the percentage of clay decreases from its maximum amount by more than 20% within 1.5 m from the soil surface.

The present Oxic subgroups, which are mainly the precursors of the Kandi great groups, and subgroups, do not need to have a low content of weatherable minerals in the 20-200 micron fraction. This trend in Soil Taxonomy appears contrary to the general assumption in the literature (e.g. the French definition of Ferrallitic Soils, CPCS 1967), whereby dominance of low activity clays and lack of weatherable minerals in the sand fractions are given as linked properties. Recent research, e.g. in Southern Nigeria by IITA, favors the Soil Taxonomy principles.

While it is true that in most Kandi soils, especially those on parent materials derived from sedimentary rocks poor in such minerals, the properties "low activity clay" and "low content of weatherable minerals in the 20-200 micron fraction" coincide, exceptions are found. Soils derived from weathered crystalline rocks, mainly in the intermediate range, such as granites and gneisses, may have a dominantly kaolinitic clay mineralogy while at the same time the amount of weatherable minerals in the coarser fraction may be well above the limit of 10%.

It may be concluded that the possible diagnostic property of "less than 10% weatherable minerals in the 20-200 micron fraction in the upper 50 cm of the argillic horizon" is controversial and should not be introduced "across the board" in the Kandi taxa. For Alfisols, where this property is not diagnostic above the family level, it appears that its introduction is undesirable. For Ultisols, the present diagnostic use of the criterion for the existing Pale great groups may be followed, which would mean that Kandi groups in all suborders would be required to have a low content of weatherable minerals in the upper 50 cm of the argillic horizon. The consequences of this, however, have to be tested.

The discussions on the subject indicate that at present no general opinion can be presented, there being few firm data available. A more general concensus was reached regarding the presence of muscovite-micas. Especially in soils derived from crystalline rocks, but also in some which developed on micaceous sedimentary materials, amounts of muscovite-micas in excess of 10% can be present in the 20-200 micron fraction. Because most forms of muscovite present in soils should be classified as slowly to very slowly weatherable minerals, it is agreed that a higher content of this mineral should be admitted in soil materials of Kandi taxa characterized by a low content of weatherable minerals. No specific upper limit was proposed.

E. Content in the Clay Fraction of Non-Crystalline Hydrous Oxides and Specific Surface Area

Attention was given to soils with high content of Fe hydrous oxides. These soils are mainly (but not exclusively) developed from parent materials rich in dark-colored minerals such as hornblende, amphioles, augite and biotite. Soils on most basalts and gabbros, with low value colors which are mostly reddish, are in this category.

At present, Soil Taxonomy provides no specific taxa for such soils, unless at the family level (oxidic, subs. ferritic families). A considerable proportion of these soils belong to Rhodic taxa, with separation either at the great group or the subgroup level. The definition of the Rhodic property is, however, strictly on soil color and not on the mineralogical composition of the clay fraction.

Soils with a high content of Fe oxides with a high specific surface area and dominance of low activity clays have pedological and edaphological characteristics which clearly set them apart from Kandi groups developed from more acidic parent materials, e.g. higher structural stability, lower erodability, and better moisture characteristics. Comparatively, these soils are better in terms of production, both of perennial and of most annual foodcrops in tropical and subtropical regions. A possible diagnostic characteristic is the high specific surface area of the (clay) fraction, but the determination is difficult and costly and cannot be expected to be introduced as a routine analysis in most service laboratories.

The general opinion was that these soils should be separated, if possible at the great group level, from the Kandi taxa. The behavior of the soil material in respect to soil silica (silica sorption/desorption) may possibly be used (Juo, Herbillion). These determinations have, however, been tested on too few pedons to recommend at the present time their use for separating these soils at a higher categorical level. Further research on the subject is necessary though it is clear that the present exclusive color differentiae for the Rhod great groups and subgroups is not sufficient to obtain a satisfactory separation of these soils, which are mainly formed on parent materials from basic rocks high in ferro-magnesium minerals.

F. The Place of Kandi Great Groups of Alfisols and Ultisols in the Keys of Soil Taxonomy

While the place of the Kandi taxa in the great groups will be variable according to the suborders, the general opinion was in favor to give a high priority to these great groups. Most attention, both in the circular letters and in the workshop discussions, was given up to now to keying out the Kandi great group in Udults, and to a lesser extent in Ustalfs, based on work in West Africa.

1. Relationship of Plinth and Kandi great groups. Many, but certainly not all pedons with plinthite that key out as a Plinth great group, are dominated by low activity clays. Therefore, if the presence of such plinthite is to have priority over the Kandi characteristic in the keys, provision may have to be made for distinction at the subgroup level of low and high activity clay dominance in the Plinth great groups. Low activity of the clay would most probably have to

become a diagnostic property of the Typic subgroup.

In case the Kandi characteristics would be given priority over the presence of plinthite, provision would have to be made at the subgroup level in the Kandi taxa for the presence of plinthite. There would be two subgroups required:

- one with plinthite that constitutes more than half the matrix of some subhorizon in the upper 1.25 m of the soil, and
- one that has a subhorizon within 1.5 m of the soil surface that has more than 5% but less than 50% plinthite.

A third possible solution is to relegate the presence of plinthite to a lower level in the classification, i.e. the subgroup level. There are arguments in favor of cancelling the Plinth great groups, one of them being that the presence of plinthite does not seem to negatively influence root growth, as is the case in soils with a fragipan. Plinthite at the subgroup could be dealt with in conjunction with the hardened forms (petroplinthite or lithoplinthite, and petroferric).

The discussion on the importance of plinthite in Soil Taxonomy is as yet incomplete. Further study is needed in tropical areas; in the U.S. only two series were found in Plinth great groups.

<u>2. Relationship of Pale and Kandi great groups.</u> The initial trend in the committee was to key out the Kandi great groups before the Pale great groups in those suborders where Pale taxa occur. A general rule could, however, not be worked out in view of the varying diagnostic sets of properties for the different Pale taxa.

In Alfisols, Kandi taxa can be keyed out before Pale taxa without affecting too many established series especially because Paleudalfs are excluded from the intertropical zone with an iso soil temperature regime. The main taxon affected is that of Oxic Paleustalfs which occur over considerable areas, e.g. in West Africa.

As regards the kind of soils grouped under Paleustalfs and Palexeralfs, several discussants pointed out that the inclusion of soils characterized only by an abruptic upper boundary of the argillic horizon is not satisfactory (see Soil Taxonomy, p. 142, Definition 3 c, and p. 151, Definition 1 d). For Ultisols, the Kandi great groups can be keyed out before the Pale great groups, but the consequences are more far-reaching than in the case of Alfisols.

Only in the Palehumult great group, oxic subgroups are foreseen which means that at present no distinction is made at any level above that of the family between, e.g., Paleudults with high activity clays and Paleudults with low activity clays. Smith has already proposed Oxic subgroups for the Paleudults, based on data from soils in Zaire. In the context of the present Soil Taxonomy, the need for such Oxic or low activity clay taxa was felt appropriate for the other suborders as well.

The keying out of the Kandi great group prior to the Pale great group in Udults has, however, an undesirable effect in such areas where virtually only Udults dominated by low activity clays occur. In Malaysia, for instance, most freely drained low activity clay Ultisols, at present belonging to three great groups (Paleudults, Rhodudults and Hapludults), would have to be united in one great group of Kandiudults. Therefore, at least as regards Udults, the desirability and feasibility of keying out the Pale great group before the Kandi great group should be further explored.

3. Relationships Trop and Kandi great groups. Trop great groups in Soil Taxonomy are mainly used to differentiate taxa that have an isomesic or warmer iso climate, and that do not belong to other great groups such as Pale, Plinth, etc. Moreover, no Trop great groups have been introduced in suborders with an ustic or xeric soil moisture regime, with the possible exception of the Humult suborder. Trop great groups were introduced on the specific suggestion of European pedologists working in the tropical zone of Africa (G. Smith). As pointed out by several committee members, the Trop notion is neither very useful nor does it give satisfactory taxonomic and cartographic

information. Thus, for instance, Paleudults and Tropudults may occur side by side in almost identical physiographic and environmental conditions. Moreover, and this is particularly true for South America, the border between Trop great groups and great groups which do not have an iso soil temperature regime may be very difficult to establish.

Kandi great groups will key out before Trop great groups in all suborders. Because most Trop pedons in the intertropical zone are dominated by low activity clays, the extent and relevance of the Trop great groups would be further diminished.

G. Subgroups of the Kandi Great Groups

Few general rules for defining subgroups can be made; those rules vary between orders or even between suborders. Moreover, not enough firm data are available to envisage at this time anything more than a sketchy and preliminary listing of subgroups. Even the definition of the Typic subgroup will depend on the place to which the Kandi taxa will be assigned in the keys. Thus, while there was a fairly general concensus that the Typic in the Kandi taxa should be soils with a deep Pale argillic horizon, this rule cannot be generalized if, in the Udult suborder, the Pale great group would be keyed out prior to the Kandi great group (see F.1.). However, if it is assumed that the Kandi great groups would have priority over Pale and Trop great groups, a general characteristic of the Typic subgroup would be as follows:

"have a clay distribution such that the percentage of clay does not decrease by more than 20 percent of that maximum within 1.5 m of the soil surface, or the layer in which the percentage of clay is less than the maximum has skeletans on ped surfaces or has 5 percent or more plinthite by volume".

This requirement of the Typic subgroup would lead to the general introduction of a "thin subgroup", either with a lithic, paralithic, petroferric contact at less than 150 cm from the surface or with a clay content in the argillic horizon diminishing by more than 20 percent from its maximum at less than 150 cm depth, and there should be no distinct clay skins in the layers with less clay at a depth of 150 cm. Preliminary, this thin subgroup would be called Leptic.

Most subgroups occurring under Kandi taxa have their parallels in other great groups. Thus, subgroups like Aquic, Arenic, Grossarenic, Spodic, etc. can be "borrowed" from other taxa and defined accordingly. Some subgroups may be required which are specific for the Kandi taxa, but extensive testing is required.

In the Kandi taxa of Alfisols, of which a fairly extensive study was made in West Africa (mainly Ustalfs), there is a distinct need to separate Kandiustalfs with a high content of weatherable minerals from those, where this level is distinctly less than 10 percent. The former are mainly developed on parent materials derived from weathered crystalline rocks; the latter are from arenaceous sedimentary materials, and have the type of pedon which falls under the notion of "appauvri" of the French literature. It may be proposed that a content of less than 10 percent weatherable minerals would be a requirement of the Kandi taxa in Alfisols, while those containing more than 10 percent would become a separate subgroup for which at present no name is proposed. In the Kandi taxa of Ultisols, most attention during this workshop was given to Udults. The following tentative requirements were presented:

- A separation between Kandiudults with a high Al saturation (Al^{3+}/Al^{3+}+ sum of bases x 100 more than 50(?)) and those with a low saturation. High Al saturation (i.e. the "Alic" taxa of the Brazilian classification) may be proposed as a requirement for the Typic subgroup. No nomenclature was proposed for the subgroup with low Al saturation.
- Distinction of a subgroup with very low CEC/100 g clay values, parallel to the Acri great groups in Oxisols. A tentative definition of an Acric subgroup would include: ECEC of less than 5 meq per 100 g

clay in the major part of the argillic horizon and exchangeable Al constant or diminishing with depth. The diagnostic value of 5 meq should be tested and may well be too high.

- Distinction of a subgroup with characteristics, similar to the present Epiaquic subgroups, i.e. mottling in the lower part of the A and the upper part of the argillic horizon. The possible nomenclature for such soils with superficial mottling may be "Planic" (Beinroth).
- Distinction of a subgroup with distinct reticulate mottling without the low-chroma colors required for aquic, and without the hardening upon exposure to alternate drying and wetting, required for plinthite. The possible nomenclature for the subgroup would be "Ferric". This term has a similar connotation in the FAO-Unesco Legend (Ferric Acrisols).

REPORT ON A STATE-OF-THE-ART (SOTA) STUDY ON SOIL TAXONOMY IN THE TROPICS

Ramiro Guerrero

Most of the LDC's in the tropics are carrying out large and expensive national soil survey programs in which the systems of soil classification used are either Soil Taxonomy, Soil Taxonomy plus another parallel system, or other schemes. However, until now no information has been systematically compiled to show which are the main systems used in the various countries and how adequate they are to classify tropical soils.

Today we need soil surveys that employ soil classification systems that allow agricultural interpretations and can be used to transfer agrotechnology. For this purpose and to provide data to the Benchmark Soils Project, this SOTA study is compiling information under a project conducted by the University of Puerto Rico - Mayaguez Campus and sponsored by the Agency for International Development. The nature of the study and preliminary results are presented in this progress report.

Outline for the State-of-the-Art (SOTA) Study on Soil Taxonomy in the Tropics

The initial chapters introduce the subject and explain the goals of the study in relation to the agricultural development in LDC's, agrotechnology transference, and improvement of Soil Taxonomy as a source of information and as a means of national and international communication.

Central chapters are focused on the utilization of soil classification in tropical America and also on a critical evaluation of the adequacy of Soil Taxonomy to classify tropical soils. Final chapters draw conclusions and present recommendations regarding soil classification, the use of Soil Taxonomy to classify tropical soils, and, additionally, some specific guidelines and general recommendations. A summary and the literature cited are finally given and, as appendices, the list of questionnaires received from each country and the individuals questionned are included, and the total answers to each question are condensed in one questionnaire.

Preliminary Information On The Answers Obtained

As stated above, the main purpose of the questionnaire is to compile information for the SOTA study. The questions were oriented toward collection of data, procedures and systems of soil classifications, the utilization of Soil Taxonomy as a system and the adequacy of the scheme for national programs in each country.

The analysis and evaluation of the answers obtained in relation to the soil survey programs indicated that there exist: no clear specifications for different "types" (orders) of surveys; several grades in the intensity of photo-interpretion studies to complement the soil survey; and large variations from country to country in the selection of field scales, cartographic material, mapping units, number of pedons analyzed and minimum delineated areas. Regarding present utilization, the study indicates that the Soil Survey Manual and Soil Taxonomy are widely used; that a revision of the Soil Survey Manual is needed; that different soil classification systems are difficult to correlate; that Soil Taxonomy is efficiently used for classification, soil surveys, communication, and general soil survey interpretation, but less commonly employed for technology transference, intensive land use, planning and teaching. The main constraints to achieve better and wider use of the system are related to insufficient knowledge, inadequate facilities, and lack of official support.

In reference to the adequacy of Soil Taxonomy, most of the correspondents thought that its basic principles, its hierarchical structure, and its new nomenclature were appropriate. In general, the operational definitions, differentiating criteria, and the diagnostic surface and subsurface horizons were usually considered appropriate and recognized as the most valuable characteristics of the system. However, some problems with making interpretations, specific recommendations and generalized land use maps were pointed out. Also, for particular classes, opinions were expressed on the inadequacy of several definitions, the methodology, the nomenclature of some taxa, and gaps in the scheme with reference to tropical soils.

RECOMMENDATIONS OF THE WORKSHOP

During the Closing Session of the workshop in Recife on 1 July 1977, a number of problem areas relative to the classification of tropical soils in Soil Taxonomy were discussed. In addition to the redefinition of taxa of Alfisols and Ultisols with low activity clays, ten topics were identified. The proposals formulated were unanimously recommended by the participants for future action.

Summaries of the propositions are listed below, not necessarily in order of importance or priority, and the chief proponents are indicated.

1. Re-evaluation of the Soil Moisture Regimes
R. Tavernier and J. Bennema

The present Soil Taxonomy definitions of soil moisture regimes, particularly the ustic regime, do not permit rational interpretations for land use in the intertropical and subtropical regions. Also, the boundary between different moisture regimes in well or excessively drained soils can in many instances not be properly placed because (i) two or more exceptional dry or moist years will result in a shift of the boundary and (ii) not enough pertinent soil or related climatic data are available in tropical regions.

It is recommended that a committee be established to study and propose more appropriate definitions of the moisture regimes in general and of the ustic regime in particular. The committee should further study soil characteristics that are related to moisture regimes.

2. Review of the "Trop" Concept in Soil Taxonomy
R. Dudal

The "Trop" concept as presently applied in Soil Taxonomy presents a number of difficulties for soil classification in tropical regions. The stated rationale of the "Trop" element in Soil Taxonomy is to group soils which are isothermic and have an annual soil temperature which is mesic or warmer. However, this grouping does not seem to be carried through systematically:

- in the Inceptisols, "Trop" soils are separated at the suborder level, though excluding the Andepts for which no "Trop" groups are foreseen;
- in the Alfisols and Ultisols, the "Trop" element is included at the group level although no Tropustalfs or Tropustults are foreseen;
- in the Alfisols and Ultisols, the "Trop" element keys out after "Pale" and "Fragi" so that for these soils the "Trop" grouping does not apply;
- in two orders, Mollisols and Vertisols, the "Trop" grouping has been omitted throughout;
- at subgroup level, the qualifications for Tropeptic do not require an isothermic temperature regime;
- at the family level, isotemperature criteria duplicate to a certain extent the "Trop" qualification at the higher level of generalization.

If Kandi groups are recognized in the Ultisols without temperature limits, the Tropudults virtually lose their significance.

It is suggested that the adequacy of the "Trop" concept in Soil Taxonomy be reviewed and that:

- either it be used more systematically (e.g. at the suborder level),
- or be relegated to the family level,
- that the range of annual temperature (8°C to more than 22°C) be narrowed;
- or that it be dropped altogether.

3. Revision of the Andepts
J. Bennema

In the chapter entitled "Amorphous Material Dominant in the Exchange Complex", Soil Taxonomy (p. 47) states that certain specified conditions are associated with the dominance of amorphous material in the exchange complex. However, this is not always the case. It would, therefore, be better to list these conditions in the pertinent definitions of

Andepts.

In the proposed redefinition of Andepts it should be considered to include soils with a bulk density between 0.85 and 0.95 g per cc in this suborder if the other conditions are met. For soils dominated by amorphous materials but do not qualify for Andepts, more Andeptic subgroups should be established. It may also be considered to upgrade the Andepts to a new order of Andisols.

4. Review of the "Rhod" Concept in Soil Taxonomy
W. G. Sombroek

Rhodic subgroups of Alfisols and Ultisols presumably have high activity oxides and a high specific surface area and are commonly developed on basic rocks. Scrutiny of the "Rhod" concept may reveal that the separation of "Nitosols" from Alfisols and Ultisols might be preferable to placing them in Pale and Rhodic subgroups of the latter.

5. Review of the Color Criteria in Vertisols
J. A. Comerma

"Chrom" and "Pell" are supposed to separate better drained from poorly drained Vertisols at the great group level. However, there occur extensive areas of Chromusterts that are recurrently flooded for periods of 4 to 7 months. The introduction of mottles in the upper 30cm as a differentiae should be evaluated as a possible solution of this problem.

6. Redefinition of Cambic Horizons with Aquic Soil Moisture Regimes
R. Schargel

The present definition of the cambic horizon does not allow irregular decreases of organic matter or levels of organic carbon of more than 0.2% in Aquepts, except if some special conditions are met. Consequently, some soils with well developed structural cambic horizons have to be included with Aquents. In Venezuela, better drained soils associated with the former have the organic carbon distribution indicated above and are thus classified as Ustropepts.

To amend this predicament, it is suggested to allow irregular decreases of organic carbon and levels of 0.2% or more at 1.25 m depth in wet Inceptisols.

7. Revision of Oxisols
H. Eswaran, S. Paramananthan, J. Bennema et al.

The work of the International Committee on Alfisols and Ultisols with Low Activity Clays and increasing evidence from various parts of the world strongly indicate that a thorough revision of the taxonomy of Oxisols is needed. It is recommended to constitute an international committee which should develop a clear concept of an Oxisol, redefine the oxic horizon, examine the validity of present taxa, and propose pertinent amendments.

8. Evaluation of Plinthite and Related Features
H. Eswaran

To decide on the basis of the present definitions whether a soil material is plinthite or not is difficult and subjective. A new set of operational criteria should be developed that can be objectively applied in the field. Also, the effect of plinthite on root growth needs to be established. The Plinth taxa should be evaluated in the light of these findings.

9. Establishment of a Lixic or Luvic Horizon
W. G. Sombroek, R. F. Isbell, R. W. Arnold et al.

It is proposed to consider the establishment of a new diagnostic horizon tentatively named "lixic" or "luvic". This horizon is considered a weakly expressed argillic horizon with some characteristics of the oxic horizon and would fill the transition zone between oxic horizons and well developed argillic horizons.

The concept of the proposed horizon is one that is at least 75 cm thick and/or extends to a depth of 1.25 m; has no or only a few ped cutans; has an appreciable increase of clay that is neither abruptic nor diffuse; and that has more than 15% clay in at least one subhorizon.

Soils with such weak argillic horizons are apparently common in many parts of the tropics, e.g. in Australia, Malaysia, East Africa, the Sudan belt of West Africa, Zaire, and Venezuela.

10. Application of Soil Taxonomy in Land Use Planning
R. Dudal

A major application of soil classification and soil survey is to supply basic information for making optimum use of available land resources. In order to do so, the relationships between soil characteristics and the requirements of crops need to be carefully established. It is recommended that the diagnostic criteria used in Soil Taxonomy be tested and investigated in terms of their significance for plant growth in general and for a number of major crops in particular. Such a study would make it possible to determine soil parameters which are required for land evaluation and for the assessment of the potential of new areas for agriculture. From a soil classification point of view, this study would also point to possible adjustments in the criteria used in Soil Taxonomy.

PART II -- SOILS STUDIED IN THE FIELD TOUR - PEDOLOGIC, ANALYTICAL AND MICROMORPHOLOGICAL DATA AND GENERAL INFORMATION

ROUTE MAP AND LOCATION OF PEDONS

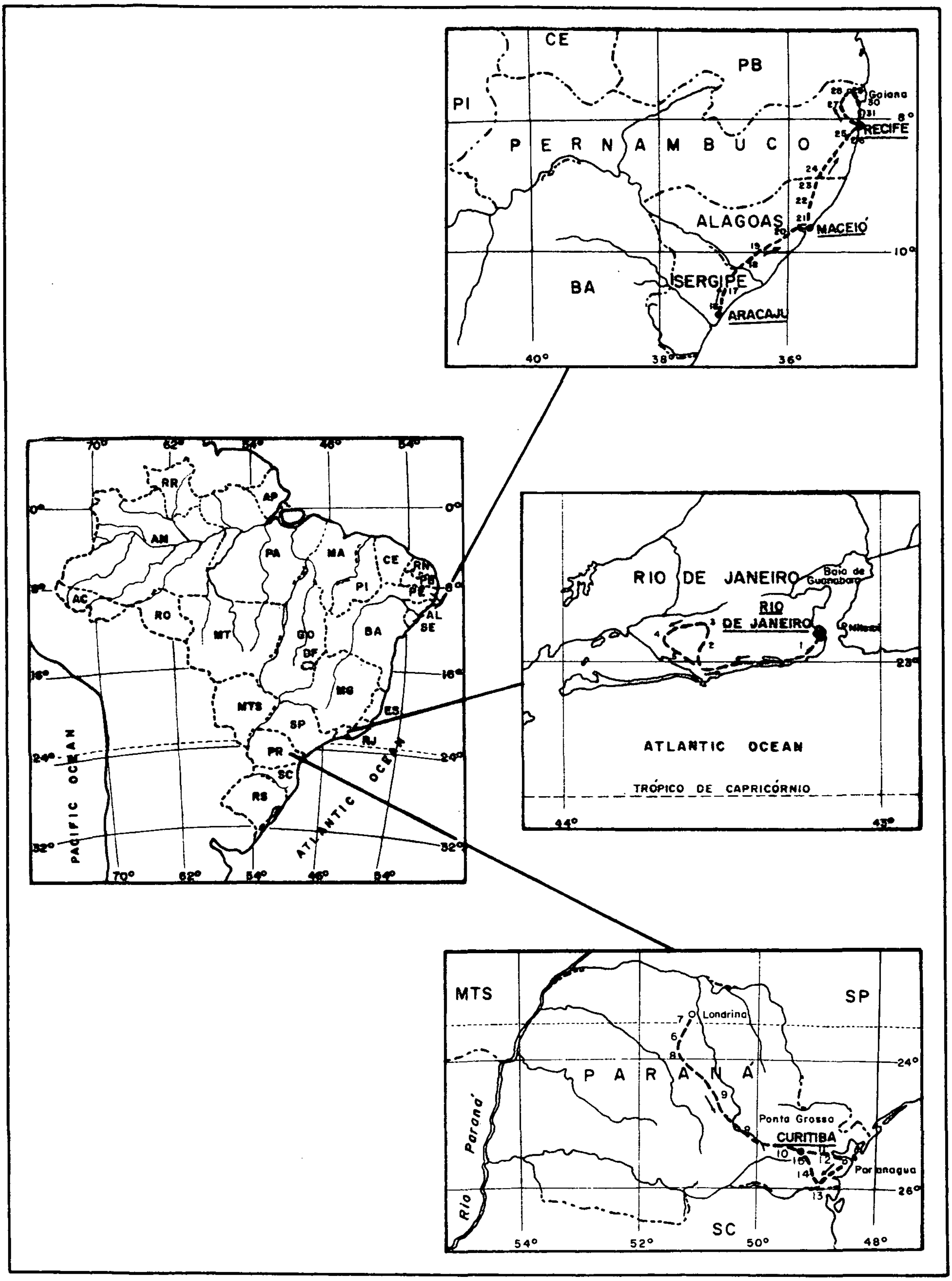

Fig. 2 - Soils tour itinerary and approximate location of pedons studied.

LABORATORY METHODS OF ANALYSES

ANALYTICAL METHODS

SNLCS

Particle size analysis: NaOH or occasionally Calgon as dispersing agent, high speed stirring sedimentation, sands by sieving and clay measured in supernatant by modified hydrometer method (Vettori et alii, 1968); no pre-treatment to destroy organic matter.

Water dispersible clay: same as above except no dispersing agent used.

Bulk density clay: measurements of two core samples 50 cc each collected with Kopecky ring (cillinder) sampler.

Particle density: pycnometer etillic alcohol.

Porosity: calculated from bulk density and particle density.

pH H2O and N KCl: suspension soil-liquid 1:2.5, contact for not less than half hour, stirring immediately before reading.

Extr. Ca, Mg and Al: extraction with N KCl proportion 1:20; determination of Al by titration of acidity using bromotimol blue as indicator; Ca and Ca + Mg determined by EDTA.

Extr. K and Na: extraction with 0.05 N HCl and determination by flame photometer.

Extr. H + Al: extraction with Ca(OAC)2 pH 7.0 and determination by titration of acidity with 0.0606 N NaOH using fenolftaleine as indicator.

H: calculated from H + Al minus Al.

Extr. bases: calculated as sum of Ca + Mg + Na + K determined as above (results comparable to NH4)AC pH 7.0).

Cat. Exch. - CEC: calculated as sum of extr. bases as above plus extractable H + Al by Ca(OAC)2 pH 7.0 as above.

Base saturation (%): calculated from extr. bases and CEC as above.

"Aluminum sat.": calculated from extr. Al and sum extr. as above.

P "available": extraction with 0.05 N HCl and 0.025 N H2SO4 solution (North Carolina).

C: wet oxidation with 0.4 N K2Cr2O7 (Tiurin method).

N: Kjeldahl.

Attack by H_2SO_4 density 1.47 and Na_2CO_3 5% (boiling solubilization): silica and titanium determined colorimetrically; aluminum and iron complexometrically; results are generally comparable to composition of clay fraction.

SiO_2/Al_2O_3 (Ki), SiO_2/R_2O_3 (Kr), Al_2O_3/Fe_2O_3: calculation on molecular basis.

Optical mineralogic analysis: mineralogical components identified by optical methods (Fry, 1933; Winchell and Winchell, 1959) using polarizing microscope and binocular microscope; counting of minerals is made on millimetric plate or paper. When necessary, chemical microtests (Feigl, 1954) are used for some opaques or weathered minerals.

In coarser than 2 mm separates, qualitative determination is made and dominance of mineralogical species is estimated. In the sand separates (coarse + fine) qualitative and semi-quantitative determinations of mineralogical species are made and results are expressed by percentage of the total sand (coarse + fine).

Conventions: tr : trace

blank : analysis not run

\- : analysis run but none detected

INDEX TO METHODS

U.S. Department of Agriculture, Soil Conservation Service,
National Soil Survey Laboratory

Lincoln, Nebraska, U.S.A.

INDEX NOS. FROM SOIL SUR. INVEST. RPT. NO. 1, USDA, SCS,
REV. APRIL 1972

CONVENTIONS

2A1 All data reported on less than 2mm (LT 2MM) size fraction base

2B Data sheet symbols

.0 not detected

TR detected, less than minimum reported amount

PARTICLE SIZE ANALYSIS

3A1 Pipette analysis, alkaline sodium polyphosphate (hexametaphosphate) dispersant

8D1 Ratio of 15-bar water to measured clay

WATER RETAINED AT 15-BARS (1.5 MEGAPASCALS)

4B2 Crushed sample, saturated and desorbed on membrane

ION-EXCHANGE ANALYSES

5A6A Cation exchange capacity, ammonium acetate, pH 7, syringe extractor, direct distillation

5A3A Cation exchange capacity, sum of cations (bases + acidity at pH 8.2)

5B4A Extractable bases from 5A6A extraction

6N2E Ca, atomic absorption

6O2D Mg, atomic absorption

6P2B Na, atomic absorption

6Q2B K, atomic absorption

6H1A Acidity, $BaCl_2$-TEA, pH 8.2

6G1E Al, N KCl extractable, syringe extraction, atomic absorption

8D1 Ratio ammonium acetate CEC: clay

8D3 Ratio extractable Ca:extractable Mg

5F1 Percent extractable Ca/ammonium acetate CEC

5C1 Base saturation, ammonium acetate CEC

5C3 Base saturation, sum of cations CEC

OTHER CHEMICAL ANALYSES

8C1A pH in water, 1:1 soil:water

8C1C pH in N KCl, 1:1 soil:solution

8C1E pH in 0.01 N $CaCl_2$, 1:2 soil solution

8C1B pH in saturated paste

6A1A Organic carbon, acid-dichromate digestion

6B1A Total nitrogen, Kjeldahl

6C2B Fe, dithionite-citrate extractable, atomic absorption

8E1 Resistivity of saturated paste (corrected to 15.6°C)

SAND MINERALOGY

7B1 Mineral counts of very fine sand (grain mounts in petropoxy, petrographic analysis)

X-RAY DIFFRACTION ANALYSIS

The soil samples for X-ray diffraction were prepared, with modifications as noted, according to the procedures of Jackson (1956 and Jones (1977). A few grams of the fine earth fraction, the fraction passing through a 2-mm sieve, were dispersed with 5 percent Calgon solution. The suspension was then passed through a 325-mesh sieve to separate the sand fraction from the silt and clay fraction. The silt in turn was separated from the clay fraction by centrifugation at 750 rpm for 3 minutes by means of a International Centrifuge, Universal Model UV. After saturating the clay fraction with Mg and K ions, preferentially-oriented slides were prepared by allowing the clay suspension to air-dry on standard 2.5 x 4.5 cm microscope glass slides. The mineralogical composition of the clay fraction was then determined by means of a Norelco Philips X-ray diffractometer with CuK_a radiation aided by a focusing monochromator. Various heat or glycolation treatments were made to obtain additional information. The silt fraction was analyzed to determine the mineralogy of that particular fraction. Mineral identification is based on standards described or listed by Brown (1961), and the dominant mineralogy of the clay and silt fractions are presented in Table 1 .

PROFILE AND SITE DESCRIPTIONS, ANALYTICAL DATA, AND SUMMARY OF DISCUSSIONS

PROFILE ISCW-BR 1 DESCRIBED AND SAMPLED - 9 May 1977

CLASSIFICATION - LATOSSOLO VERMELHO-AMARELO ÁLICO A moderado textura argilosa fase floresta tropical subperenifólia relevo montanhoso (RED-YELLOW LATOSOL ALIC, moderate A horizon, clayey, semi-evergreen tropical forest montainous phase).

Tropeptic Haplorthox; clayey, kaolinitic, hyperthermic.

Humic Ferralsol.

Sol ferralitique; fortement désaturé, rajeuni, avec érosion et remaniement, dérivé de gneiss acide.

LOCATION - Rio de Janeiro, RJ. Alto da Boa Vista-Corcovado road, 2.8 km from Av. Edison Passos, 20 m right side; 22°58'50" S 43°14'00" W.

TOPOGRAPHIC POSITION - Trench at upper third of mountain side, 40% slope, under semi-evergreen tropical forest (primary disturbed); mountainous; 560 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Acidic gneissic rocks, Precambrian Complex; colluvial material derived from stated bedrock.

DRAINAGE - Well drained.

PRESENT LAND USE - National Park

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	24.7	24.4	23.6	21.2	19.5	18.8	18.1	19.2
P mm	308	257	328	301	166	101	152	68
	Sept	Oct	Nov	Dec				
T°C	19.5	20.3	21.3	22.6	Mean	21.5		
P mm	169	176	230	206	Total	2462		
		Hyperthermic			Udic			

O1 - 5 - 0 cm, leaves and branches in decomposition.

A1 - 0 - 15 cm, brown (10 YR 4/3, moist); sandy clay loam; moderate to strong very fine to medium granular and single grains; very friable, plastic and sticky; clear and smooth boundary.

A3 - 15 - 25 cm, brown (7.5 YR 5/5, moist); sandy clay loam; moderate fine to medium granular and weak fine to medium subangular blocky breaking easily to granular; very friable, plastic and sticky; gradual and smooth boundary.

B1 - 25 - 40 cm, strong brown (7.5 YR 5/6); sandy clay; weak and moderate fine to coarse subangular blocky appears massive in place breaking easily to granular; very friable, plastic and sticky;

diffuse and smooth boundary.

B2 - 40 - 125 cm, strong brown (7.5 YR 5/8); sandy clay; weak and moderate medium to coarse subangular blocky appears massive in place breaking easily to granular; very friable, plastic and sticky; diffuse and smooth boundary.

IIB31 - 125 - 220 cm, strong brown (6.5 5/8); sandy clay; weak medium to coarse subangular blocky appears massive in place braking easily to granular; very friable, plastic and sticky.

IIB32 - 220 - 260 cm^+, yellowish red (6 YR 5/6); sandy clay; very friable, plastic and sticky.

REMARKS - Abundant roots in A1 and A3, common in B1, few in B2, very few in IIB31.

Stones and boulders up to 20 cm in diameter in IIB31; mica flakes in IIB31 and IIB32.

Trench 2 m deep, bucket auger downward to 60 cm due to the presene of boulder. Profile moist.

PROFILE Nº ISCW-BR 1

SAMPLE Nº 77.0839/44 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 15	tr	14	86	43	15	11	31	19	39	0.35
A3	- 25	-	17	83	41	15	10	34	20	41	0.29
B1	- 40	-	10	90	38	14	11	37	-	100	0.30
B2	- 125	tr	9	91	33	17	10	40	-	100	0.25
IIB31	- 220	1	12	87	33	18	11	38	-	100	0.29
IIB32	- 260+	1	20	79	35	17	13	35	-	100	0.37

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.1	3.8	0.3		0.09	0.04	0.4	3.0	6.6	10.0	4	88
4.1	3.9	0.1		0.06	0.03	0.2	2.7	4.9	7.8	3	93
4.2	4.0	0.1		0.04	0.03	0.2	2.6	4.0	6.8	3	93
4.4	4.1	0.1		0.03	0.04	0.2	1.8	3.2	5.2	4	90
4.5	4.2	0.1		0.02	0.04	0.2	1.4	2.7	4.3	5	88
4.5	4.3	0.1		0.02	0.05	0.2	1.0	2.4	3.6	6	83

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
1.95	0.18	11	10.1	13.3	5.8	0.70	1.29	1.01	3.59	2
1.26	0.14	9	11.1	14.5	6.5	0.76	1.29	1.00	3.50	1
0.92	0.12	8	12.4	16.7	7.4	0.89	1.26	0.98	3.54	1
0.57	0.08	7	12.8	17.2	7.8	0.92	1.27	0.98	3.45	1
0.39	0.06	7	13.5	18.2	8.3	0.93	1.26	0.98	3.44	1
0.25	0.05	5	12.5	17.2	8.1	0.87	1.24	0.95	3.33	1

Clay B/A - 1.2 Weighted - 1.3

PROFILE Nº ISCW-BR 1
SAMPLE Nº 77.0839/44

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE	CN ARG	WE GR	SL	WE BT & MS	IL	HN	OF				
SANDS (2-.05 mm)													
A1	85%	tr	5%	5%	3%	2%	tr	tr	tr				
A3	85%	tr	5%	5%	3%	2%	tr	tr	tr				
B1	85%	tr	5%	5%	3%	2%	tr	tr	tr				
B2	87%	tr	5%	2%	3%	3%	tr	tr	tr				
IIB31	83%	tr	5%	5%	3%	4%	tr	tr	tr				
IIB32	81%	tr	5%	5%	5%	4%	tr	tr	tr				
GRAVELS (>2 mm)													
	78%	15%	tr	5%	tr	2%°							
	55%	20%	20%	5%		tr							
	85%	10%	tr	5%		tr							
	45%	30%	10%	10%		5%°							
	48%	30%	10%	10%		2%							
	45%	30%	10%	10%	tr	5%							

Mineral Code: QZ - quartz; CN FE - iron concretions; CN ARG - argillaceous concretions; WE GR - weathered garnet; SL - sillimanite; WE BT - weathered biotite; MS - muscovite; IL - ilmenite; OF - organic fragments

Remarks: Stones analysed together with gravels

° Muscovite only

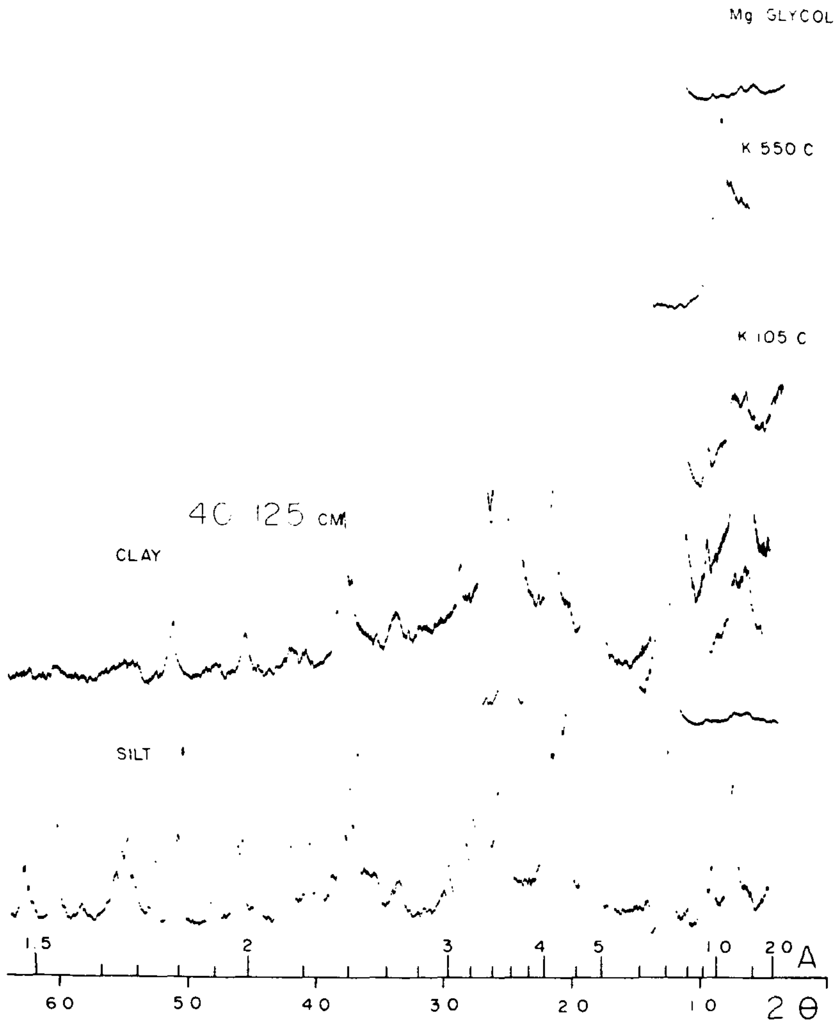

Fig. 3 - X-Ray diffraction patterns of the clay and silt from B2 horizon of the Profile BR-1.

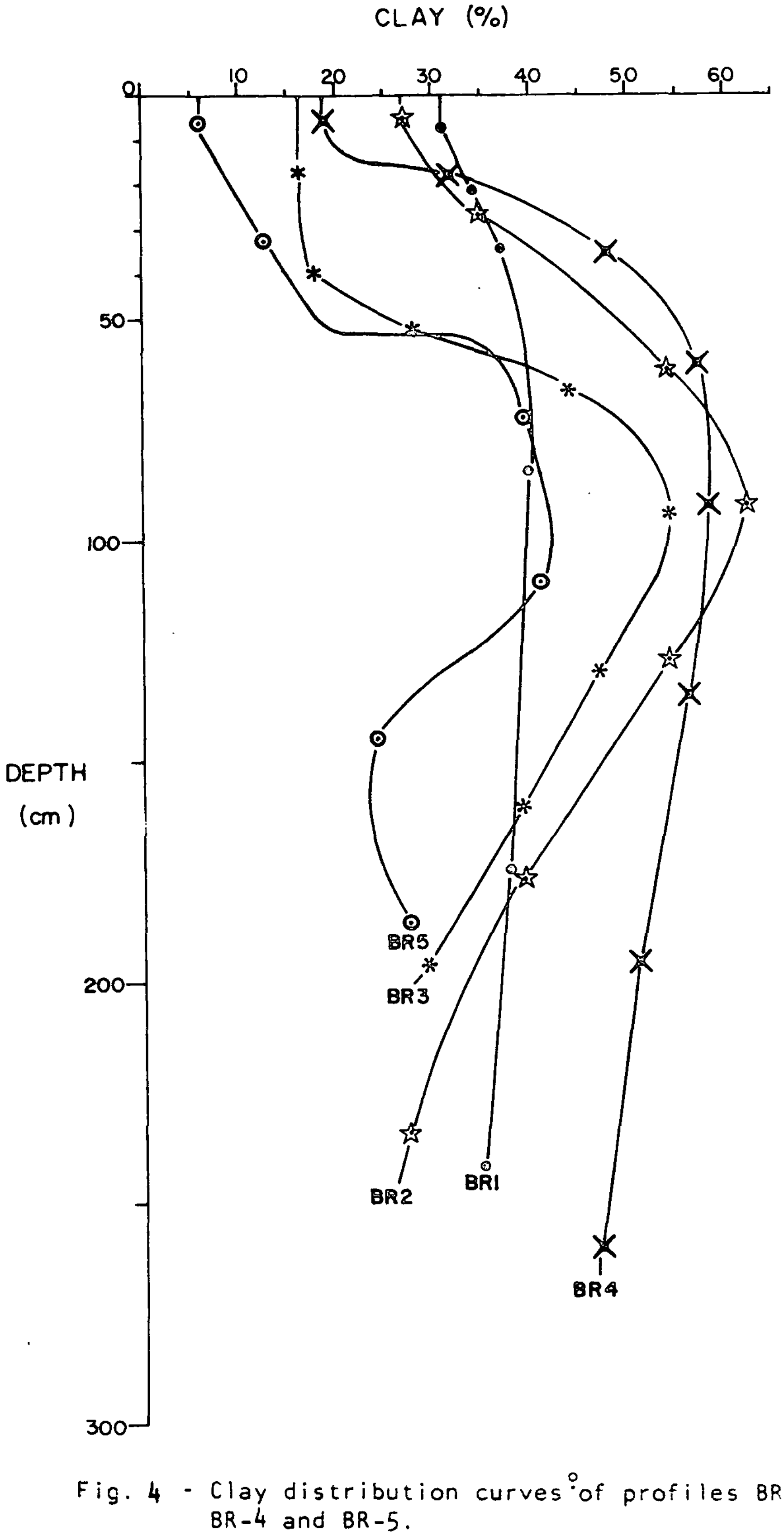

Fig. 4 - Clay distribution curves° of profiles BR-1, BR-2, BR-3, BR-4 and BR-5.

° All clay distribution curves at same scale.

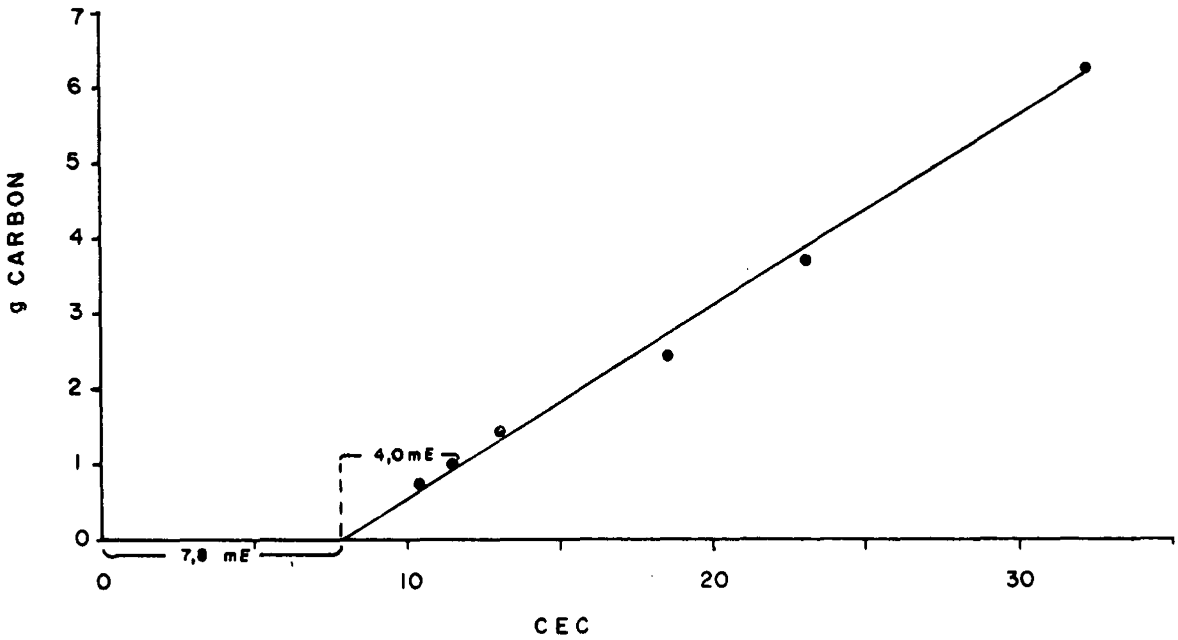

Fig. 5 - Carbon and CEC relation to 100g clay, by graphic method (Bennema, 1966). Profile BR-1.

Discussion

1. Questions were raised about the occurrence of Oxisols in a youthful landscape on slopes of 40 percent and formed in colluvial parent material that appears not highly weathered as indicated by gneiss fragments and boulders in the subsoil (Beinroth and others). Camargo pointed out that all Oxisols in this area are on transported materials and that they are associated with Inceptisols.

2. Schargel noted some clay illuviation and proposed that a thin section be made. In view of the moderate soil structure, the lack of depth of the oxic horizon, and the fairly high silt : clay ratio, this soil should be classified as a Tropeptic rather than a Typic Haplorthox.

PROFILE ISCW-BR 2 DESCRIBED AND SAMPLED - 6 May 1971

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO EUTRÓFICO argila de atividade baixa A moderado textura média/argilosa fase floresta tropical subcaducifólia relevo ondulado (RED-YELLOW PODZOLIC EUTROPHIC, low clay activity, moderate A horizon, loamy/clayey, semi-deciduous tropical forest rolling phase).

Oxic Haplustalf or Oxic Paleustalf; clayey, kaolinitic, hyperthermic.

Eutric Nitosol.

Sol ferrallitique; faiblement désaturé, typique , faiblement appauvri, dérivé de migmatite.

LOCATION - Rio de Janeiro, RJ. Cachamorra road, 200 m S of junction to Iraquara, road at left side; 22°56'00"S 43°33'25" W.

TOPOGRAPHIC POSITION - Trench on top of elevation, 26% slope, under grass vegetation; rolling;60 meters.

PRIMARY VEGETATION - Semi-deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Migmatite, Precambrian Complex; weathering residues of stated rock with slight surface reworking.

DRAINAGE - Well drained.

PRESENT LAND USE - Guava, mango and orange yard.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.5	26.6	25.7	23.7	21.7	20.5	19.8	20.7
P mm	193	164	184	1201	79	44	34	42

	Sept	Oct	Nov	Dec		
T°C	21.5	22.7	23.6	25.1	Mean	23.2
P mm	61	90	115	154	Total	1280
		Hyperthermic			Ustic/udic	

Ap - 0 - 10 cm, dark brown (7.5 YR 3/2, moist), gray (10 YR 5/1, dry); sandy clay loam; weak very fine to fine granular; many very fine, common medium and some coarse pores; friable, slightly plastic and sticky; gradual and smooth boundary.

A3 - 10 - 40 cm, dark brown (7.5 YR 4/2, moist), brown (10 YR 4/3, dry); sandy clay loam; weak fine to coarse subangular blocky; few weak clay films; many very fine and fine, common medium and coarse pores; hard, friable, plastic and sticky; gradual and smooth boundary.

B1t - 40 - 80 cm, brown (7.5 YR 4/4, moist); clay; moderate to strong fine to medium subangular blocky; continuous strong clay films; many very fine and fine, common medium and some coarse pores; very hard, friable, plastic and sticky; gradual and smooth boundary.

B21t - 80 - 103 cm, yellowish red (5 YR 4.5/6, moist); clay; strong fine to medium subangular blocky; continuous strong clay films; common fine and medium pores; very hard, friable, plastic and sticky;

diffuse and smooth boundary.

B22t - 103 - 150 cm, red (2.5 YR 4/6, moist); clay; strong fine to medium subangular blocky; continuous strong clay films; common very fine and medium pores; very hard, friable, plastic and sticky; diffuse and smooth boundary.

B31t - 150 - 200 cm, red (10 R 4/6, moist); clay loam; weak fine to medium subangular blocky; continuous strong clay films; many very fine and fine, and common medium pores; hard, friable, plastic and sticky.

B32t - 200 - 260 cm$^+$, red (10 R 4/6, moist); sandy clay loam.

REMARKS - Abundant roots in Ap, common in A3 and few in B1t.
Trench 180 cm deep, bucket auger downward. Profile moist.

PROFILE Nº ISCW-BR 2

SAMPLE Nº 7120/26 SNLCS

HORIZON	DEPTH cm	GRVL 20-2 mm %	FINE EARTH <2 mm %	PARTICLE SIZE ANALYSIS NaOH % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY	BULK DNST	PRTCL DNST	TOTAL POROSITY %
Ap	0- 10	10	90	49	12	12	27	22	19	0.44	1.39	2.57	46
A3	- 40	4	96	43	12	10	35	31	11	0.29			
B1t	- 80	6	94	30	8	8	54	-	100	0.15			
B21t	-103	3	97	24	6	8	62	-	100	0.13			
B22t	-150	1	99	26	6	14	54	-	100	0.26	1.42	2.64	46
B31t	-200	2	98	31	9	21	39	-	100	0.54			
B32t	-260+	3	97	33	15	25	27	-	100	0.93			

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
6.7	5.8	6.6	0.8	0.19	0.08	7.7	-	1.6	9.3	83	-
6.9	5.9	4.1	0.4	0.03	0.06	4.6	-	1.2	5.8	79	-
6.8	5.8	3.8	0.6	0.02	0.06	4.5	-	1.2	5.7	79	-
6.5	5.6	3.5	0.9	0.02	0.08	4.5	-	1.4	5.9	76	-
6.4	5.5	2.5	1.0	0.02	0.07	3.6	-	1.3	4.9	73	-
6.2	5.3	1.7	0.9	0.03	0.05	2.7	-	1.1	3.8	71	-
6.0	5.2	1.6	1.4	0.03	0.21	3.2	-	1.0	4.2	76	-

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
1.06	0.12	9	12.8	10.0	3.8	0.72	2.18	1.75	4.12	38
0.44	0.06	7	15.1	12.7	8.2	0.86	2.02	1.43	2.43	6
0.29	0.04	7	21.2	18.4	5.4	0.98	1.96	1.65	5.34	2
0.29	0.04	7	25.9	21.2	6.6	0.97	2.08	1.73	5.03	3
0.21	0.03	7	26.3	22.2	7.8	1.04	2.01	1.65	4.46	4
0.13	0.02	7	25.6	20.9	8.2	1.22	2.08	1.67	3.99	2
0.13	0.02	7	25.4	21.6	7.5	0.82	2.00	1.64	4.51	1

Clay B/A - 1.8 Weighted - 1.7

PROFILE Nº ISCW-BR 2
SAMPLE Nº 7120/26

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	MS	BT	MC	MG & IL	CN FE	OF	ST	RU	OP	ZR	RF	
SANDS (2-.05 mm)													
Ap	99%	tr	1%	tr	tr		tr	tr			tr		
A3	100%	tr	tr		tr	tr	tr	tr		tr	tr		
B1t	100%	tr	tr	tr	tr	tr		tr		tr	tr		
B21t	100%	tr	tr	tr	tr	tr	tr	tr			tr		
B22t	98%	2%		tr	tr				tr		tr		
B31t	100%	♀		tr	tr	tr			tr		tr		
B32t	100%	♀		tr	tr	tr			tr		tr		
GRAVELS (>2 mm)													
	100%		tr	tr		tr						tr	
	100%			tr			tr						
	100%												
	100%												
	100%												
	100%												
	100%												

Mineral Code: QZ - quartz; MS - muscovite; BT - biotite; MC - microcline; MG - magnetite; IL - ilmenite; OF - organic fragments;CN FE - iron concretions; ST - staurolite; RU - rutile; OP - opal material; ZR zircon; RF - rock fragments

♀ Muscovite occurs jointly with quartz

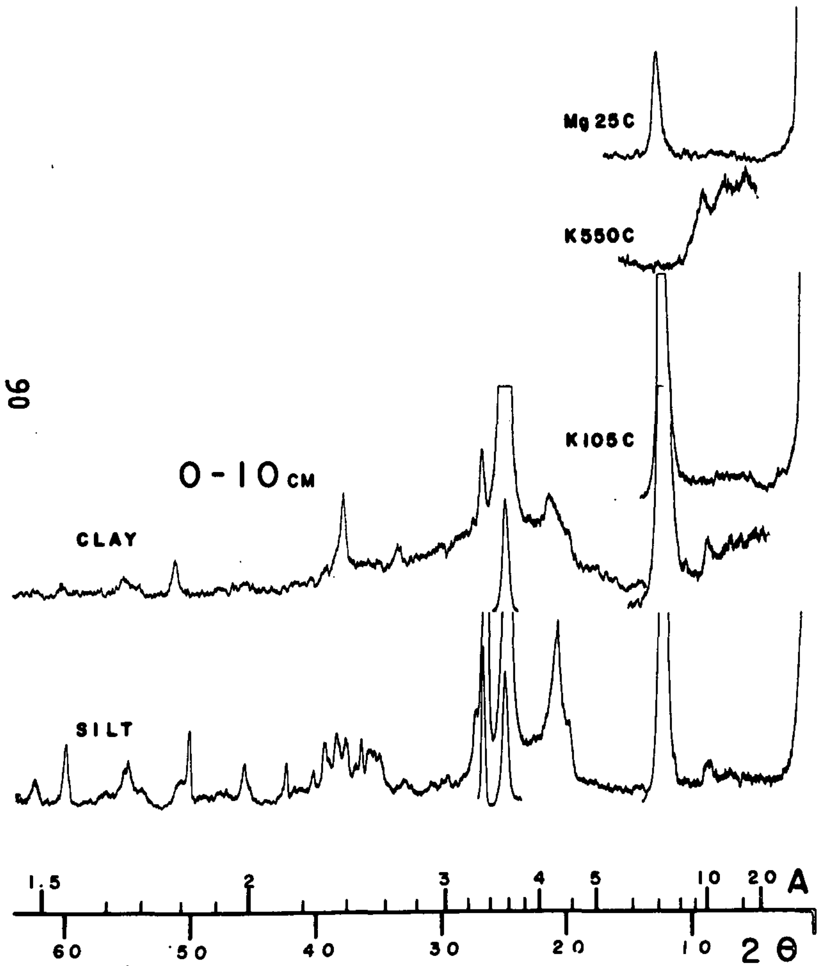

Fig. 6 - X-Ray diffraction patterns of the clay and silt from Ap horizon of the profile BR-2

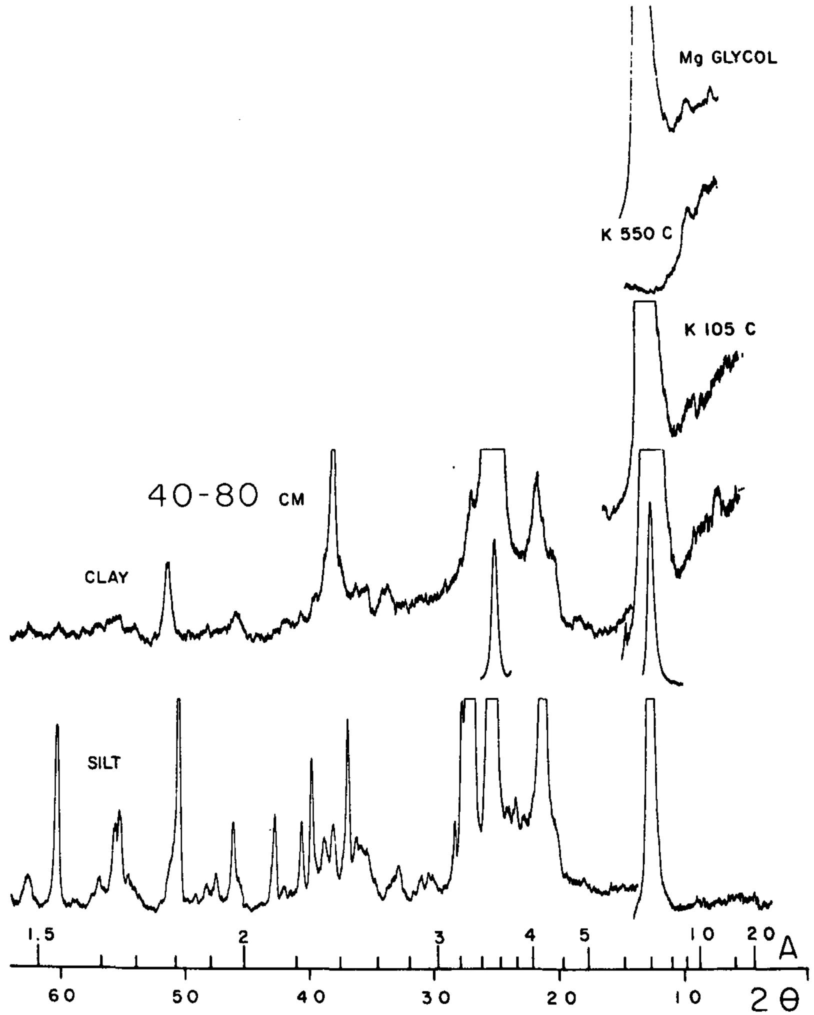

Fig. 7 - X-Ray diffraction patterns of the clay and silt from Blt horizon of the profile BR-2.

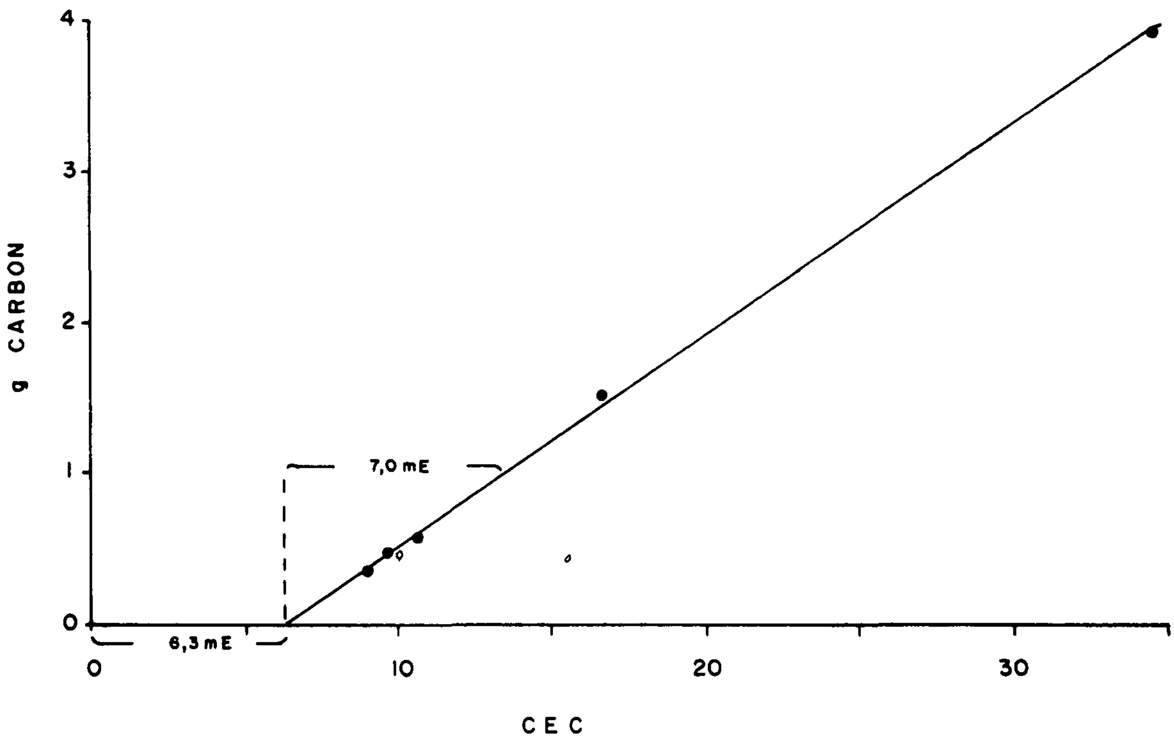

Fig. 8 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-2.

Discussion

1. Questions arose regarding the soil moisture regime, soil temperature regime and depth. According to Tavernier, an analysis of the climatic data indicates ustic and isohyperthermic regimes.

2. Referring to fig. 4 (clay distribution), Bertoldo pointed out that the clay content drops from a maximum of 62 percent to approximately 47 percent at 150 cm, i.e. slightly more than permitted in Paleustalfs. This however is subject to verification.

3. According to Camargo and Bennema the native vegetation of this area (semi-deciduous tropical forest) is indicative of an ustic soil moisture regime. No water balance studies were made for this particular area.

Assuming an ustic soil moisture regime, the options for classifying this pedon are Oxic Haplustalf or Oxic Paleustalf. In the committee's nomenclature it would be a Leptic or Typic Kandiustalf. Dudal indicated that the profile fits the Nitosol concept of FAO.

PROFILE ISCW-BR 3 DESCRIBED AND SAMPLED - 23 Apr 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO argila de atividade baixa A moderado textura média/argilosa fase floresta tropical subcaducifólia relevo suave ondulado (RED-YELLOW PODZOLIC ALIC, low clay activity, moderate A horizon, loamy/clayey, semi-deciduous tropical forest gently undulating phase).

Oxic Haplustult; clayey, kaolinitic, hyperthermic.

Ferric Acrisol.

Sol ferrallitique; moyennement désaturé, appauvri, faiblement remanié et hydromorphe, dérivé de gneiss acide.

LOCATION - Campo Grande, RJ. Cachamorra road, 1.2 km N of the juction to Iraquara, at right side; 22°56'55" S 43°33'30" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at middle slope, about 8%, under idle grassland; gently undulating; 30 meters.

PRIMARY VEGETATION - Semi-deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Acidic gneissic rocks, Precambrian Complex; weathering products of stated rock covered by reworked material.

DRAINAGE - Moderately well drained.

PRESENT LAND USE - Poor pasture.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.5	26.6	25.7	23.7	21.7	20.5	19.8	20.7
P mm	193	164	184	120	79	44	34	42
	Sept	Oct	Nov	Dec				
T°C	21.5	22.7	23.6	25.1	Mean	23.2		
P mm	61	90	115	154	Total	1280		
		Hyperthermic			Ustic/udic			

Ap1 - 0 - 33 cm, dark grayish brown (10 YR 3.5/2, moist), light brownish gray (10 YR 6/2, dry); sandy loam; weak fine to medium subangular blocky and moderate very fine to fine granular; slight hard, friable, plastic and sticky; gradual and smooth boundary.

Ap2 - 33 - 45 cm, brown (10 YR 5/3, moist), pale brown (10 YR 6.5/3, dry); sandy loam; weak fine to medium subangular blocky and weak fine granular; slightly hard, very friable, slightly plastic and slightly sticky;gradual and smooth boundary.

A2 - 45 - 57 cm, pale brown (10 YR 6/3.5, moist), very pale brown (10 YR 7/4, dry); sandy clay loam; moderate fine to coarse subangular blocky; slightly hard, friable, plastic and sticky; gradual and wavy boundary (10-15 cm).

IIBlt - 57 - 73 cm, yellowish brown (10 YR 5/6), common medium and prominent mottles of red (3.5 YR 4/5); clay; moderate to strong fine to coarse subangular and angular blocky; few weak clay films; hard, friable to firm, plastic and sticky; gradual and smooth boundary.

IIB21t- 73 - 113 cm, yellowish red (5 YR 5/6); clay; strong fine to coarse subangular and angular blocky; common moderate clay films; hard, firm, plastic and sticky; diffuse and smooth boundary.

IIB22t- 113 - 143 cm, reddish yellow (5 YR 6/6); clay; moderate to strong fine to coarse subangular and angular blocky; common moderate clay films; hard, friable to firm, plastic and sticky; gradual and smooth boundary.

IIB3t- 143 - 173 cm, brownish yellow (10 YR 6/8); clay loam; moderate fine to medium subangular blocky; hard, friable, plastic and sticky; gradual and smooth boundary.

IICl - 173 - 210 cm, variegated color of yellow (2.5 Y 8/6), olive yellow (2.5 Y 6/8) and white (2.5 Y 8/2); horizon constituted of rock highly weathered.

REMARKS - Abundant roots in Apl and Ap2, common in A2, few in IIBlt and very few in IIB21t.

Occurrence of angular quartz gravels on top of IIBlt.
Profile moist, cloudy day.

PROFILE Nº ISCW-BR 3

SAMPLE Nº 77.0831/38 SNLCS

HORIZON	DEPTH cm	GRVL 20-2 mm %	FINE EARTH <2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ %				WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY	BULK DNST	PRTCL DNST	TOTAL PORO-SITY %
				CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm						
Ap1	0- 33	5	95	52	22	10	16	12	25	0.63	1.65	2.60	37
Ap2	- 45	6	94	49	21	12	18	17	6	0.67	1.66	2.53	34
A2	- 57	10	90	41	20	11	28	21	25	0.39	1.70	2.60	35
IIB1t	- 73	10	90	32	14	10	44	-	100	0.23	1.52	2.56	41
IIB21t	-113	3	97	25	5	16	54	-	100	0.30	1.56	2.63	41
IIB22t	-142	3	97	28	6	19	47	-	100	0.40	1.63	2.56	36
IIB3t	-173	4	96	32	6	23	39	-	100	0.59	1.65	2.60	37
IIC1	-210	3	97	33	11	27	29	-	100	0.93			

pH (1:2.5)		EXTRACTABLE BASES mE/100g					EXTB ACTY mE/100g		CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
H2O	KCl N	Ca++	Mg++	K+	Na+	SUM EXTR	Al+++	H+			
4,7	3.9	0.6		0.04	0,02	0.7	0.9	2.0	3.6	19	56
4.7	3.9	0.5		0.03	0.02	0.6	1.0	1.6	3.2	19	63
4.7	3.8	0.5		0.03	0.03	0.6	1.4	1.5	2.5	24	70
4.8	3.9	0.7		0.03	0.03	0.8	1.9	2.0	4.7	17	70
4.8	3.9	0.8		0.02	0.05	0.9	2.5	1.9	5.3	17	74
4.8	3.9	0.7		0.03	0.05	0.8	2.8	1.7	5.3	15	78
4.7	3.8	0.9		0.04	0.04	1.0	2.4	1.7	5.1	20	71
4.7	3.8	0.6		0.04	0.04	0.7	2.3	0.9	3.9	18	77

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) %				SiO2 / Al2O3	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
			SiO2	Al2O3	Fe2O3	TiO2	MOLECULAR RATIO			
0.64	0.07	9	6.9	5.2	1.4	0.68	2.25	1.92	5.80	1
0.50	0,06	8	8.5	6.2	1.7	0.46	2.33	1.98	5.74	1
0.46	0.06	8	12.7	10.3	2.4	0.82	2.10	1.83	6.73	1
0.46	0.06	8	20.3	16.5	3.6	0.85	2.09	1.84	7.19	<1
0.40	0.05	8	20.8	24.3	3.7	0.64	1.99	1.82	10.31	<1
0.30	0.05	6	28.2	24.0	3.1	1.48	2.00	1.85	12.13	1
0.24	0.04	6	25.2	21.6	2.4	0.33	1.98	1.85	14.12	1
0.21	0.04	5	23.7	19.2	1.8	0.23	2.10	1.98	16.65	1

Clay B/A - 2.3 Weighted - 2.6

PROFILE Nº ISCW-BR 3
SAMPLE Nº 77.0831/38

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	WE BT & MS	CN FE	MC	MC + OG	IL & MG	MS	SL	CN ARG	ZR & RU	OF	ST
SANDS (2-.05 mm)												
Ap1	96%		tr	2%		2%				tr	tr	tr
Ap2	96%		tr		2%	2%				tr		
A2	98%	tr	tr	2%	tr	tr				tr		
IIB1t	96%		tr		2%	2%				tr		
IIB21t	93%		1%	4%			2%	tr		tr		
IIB22t	90%	7%	tr	3%		tr		tr		tr		
IIB3t	85%	10%	tr	4%				tr	1%	tr		
IIC1	77%	20%	tr	3%				tr		tr		
GRAVELS (>2 mm)												
	100%		tr							tr		
	100%											
	100%		tr									
	90%		10%									
	99%		tr				tr	1%				
	98%						2%	tr				
	99%						1%	tr				
	99%						1%	tr				

Mineral Code : QZ - quartz; WE BT - weathered biotite; MS - muscovite; CN FE - iron concretions; MC - microcline; OG - oligoclase; IL - ilmenite; MG - magnetite; SL - sillimanite; CN ARG - argillaceous concretions; RU - rutile; ZR - zircão; OF - organic fragments; ST - staurolite

L CLASSIFICATION-INTERNATIONAL SOIL ·· FICATION WORKSHOP
BRAZILIAN SOIL
IE⁽ - - - - - - - -

L NO - - - - - - - ISCW-BR3 COUNT - -

ERAL METHODS- - -1A,1B1B,2A1,2B SAMPLE NOS. 77P1250-77P125· DECEMBER 1977

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, MTSC
NATIONAL SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA

PTH M	HORIZON	SAND 2-.05	SILT .05-.002	CLAY LT .002	FIN C·/ ·· .0(	VCOS 2-1	CORS 1-.5	MEDS .5-.25	FNES .25-.10	VFNS .10-.05	COSI .05-.02	FNSI .02-.002	VFSI .005-.002	SAND 2-.1	INTR II .2-.02	FINE CLAY TO CLAY PCT	NON-CO3-CLAY PCT	RATIO 8D1 15-BAR TO CLAY
		(- - - - - - - - - - -				- - - - - - - PCT LT 2MM - -									- - -)			
-33	AP1	74.6	12.3	13.1		7.8	17.9	16.1	24.0	8.8	2.5	9.8		65.8				.53
-45	AP2	71.0	12.7	16.3		7.5	15.5	15.4	24.3	8.3	2.9	9.8		62.7				.48
-60	A2	62.9	12.7	24.4		5.9	15.4	14.9	19.8	6.9	2.5	10.2		56.0				.45
-73	2B1	48.3	12.1	39.6		6.1	12.8	10.4	14.1	4.9	1.5	10.6		43.4				.39
-113	2B21	31.2	19.7	49.1		7.7	11.1	4.9	5.3	2.2	3.7	16.0		29.0				.42
-210	2C1	45.7	30.7	23.6		13.7	14.4	5.4	7.0	5.2	5.5	25.2		40.5				.56

PTH	(PARTICLE SIZE ANALYSIS, MM, 3B. VOL. GT 2 PCT	GT 75 PCT	WEIGHT 75-20	20-5	5-2	.07	3B2) 20-2 PCT LT20	BULK DENSITY 4A1D 1/3-BAR G/CC	4A1H OVEN DRY G/CC	4D1 COLE	WATER CONTENT 4B1C 1/10 BAR PCT	4B1C 1/3-BAR PCT	4B2 15-BAR PCT	4C1 WRD CM/CM	PH 8C1C 1/1 KCL	CARBONATE 6E1B LT 2 PCT	3A1A LT .002 PCT	PH 8C1A 1/1 H2O	8C1E 1/2 CACL
			(- - - PCT LT 75 -																
-33													6.9		3.8			4.6	4.0
-45													7.9		3.8			4.4	3.9
-60													11.1		3.7			4.3	3.8
-73													15.6		3.7			4.4	3.9
-113													20.5		3.7			4.6	3.9
-210													13.2		3.6			4.5	3.9

TH M	ORGANIC MATTER 6A1A ORGN CARB PCT	6B1A NITG PCT	C/N	IRON 6C2B EXT FE PCT	PHOS TOTL PCT	EXTRACTABLE BASES 5B4A 6N2E CA	6O2D MG	6P2B NA	6Q2B K	SUM EXTB	ACTY 6H1A BACL TEA	AL 6G1E KCL EXT	CAT EXCH 5A3A EXTB ACTY	5A6A NHAC	RATIO 8D1 NHAC TO CLAY	RATIO 8D3 CA TO MG	CA 5F1 SAT NHAC PCT	BASE SAT 5C3 EXTP ACTY PCT	5C1 NHAC PCT
					(- - - - - - - - - - - -MEQ / 100 G- - - - - - - - - - - - -)														
-33	.68	.040	17	.7		.2	.1	.0	TR	.3	4.0	.9	4.3	4.4	.34	2.0	5	7	7
-45	.54	.037	15	.7		.1	.1	.0	TR	.2	4.1	1.1	4.3	4.3	.26	1.0	2	5	5
-60	.47	.038	12	1.0		.2	.2	.0	.2	.6	4.7	1.4	5.3	5.2	.21	1.0	4	11	12
-73	.41			1.4		.3	.4	.0	.1	.8	6.4	1.9	7.2	6.1	.15	.8	5	11	13
-113	.33			1.7		.1	.6	.0	TR	.7	7.6	2.8	8.3	8.2	.17	.2	1	8	9
-210	.10			.6		.0	.4	.0	.1	.5	4.8	2.5	5.3	4.5	.32			9	11

TH M	SATURATED PASTE 8E1 REST OHM-CM	8C1B PH	8A H2O PCT	NA 5D2 ESP PCT	NA 5E SAR	SAL 8D5 TOT. SOLU PPM	GYP 6F1A PCT	SATURATION EXTRACT 8A1 8A1A EC MMHOS/CM	6N1B CA	6O1B MG	6P1B NA	6Q1B K	6I1A CO3	6J1A HCO3	6K1A CL	6L1A SO4	6M1A NO3	ATTERBERG 4F1 LQID LMIT PCT	4F2 PLST INDX
									(- - - - - - - - - - MEQ / LITER - - - - - - - - - - - -)										
-33	20000	4.5																	
-45																			
-60																			
-73																			
-113																			
-210	26000	4.5																	

D MINERALOGY (7B1)
45-060 VFNS - RE86 QZ80 OP4 PO. ZR1 FK13 PR1 MI RU.
ELATIVE AMOUNTS: AS PERCENT
INERAL CODE: RE = RESISTANT MINERALS OP = OPAQUE PO = PLANT OPAL PR = PYROXENE QZ = QUARTZ ZR = ZIRCON
FK = POTASSIUM FELDSPAR RU = RUTILE MI = MICA.

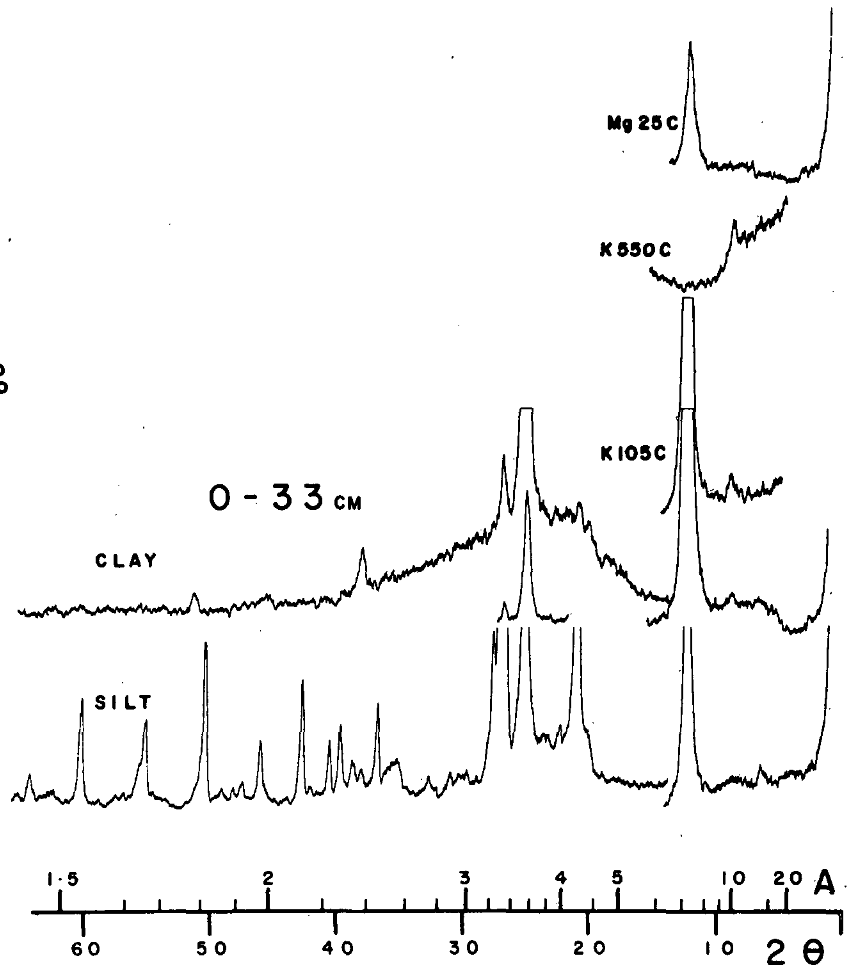

Fig. 9 - X-Ray diffraction patterns of the clay and silt from Ap1 horizon of the profile BR-3

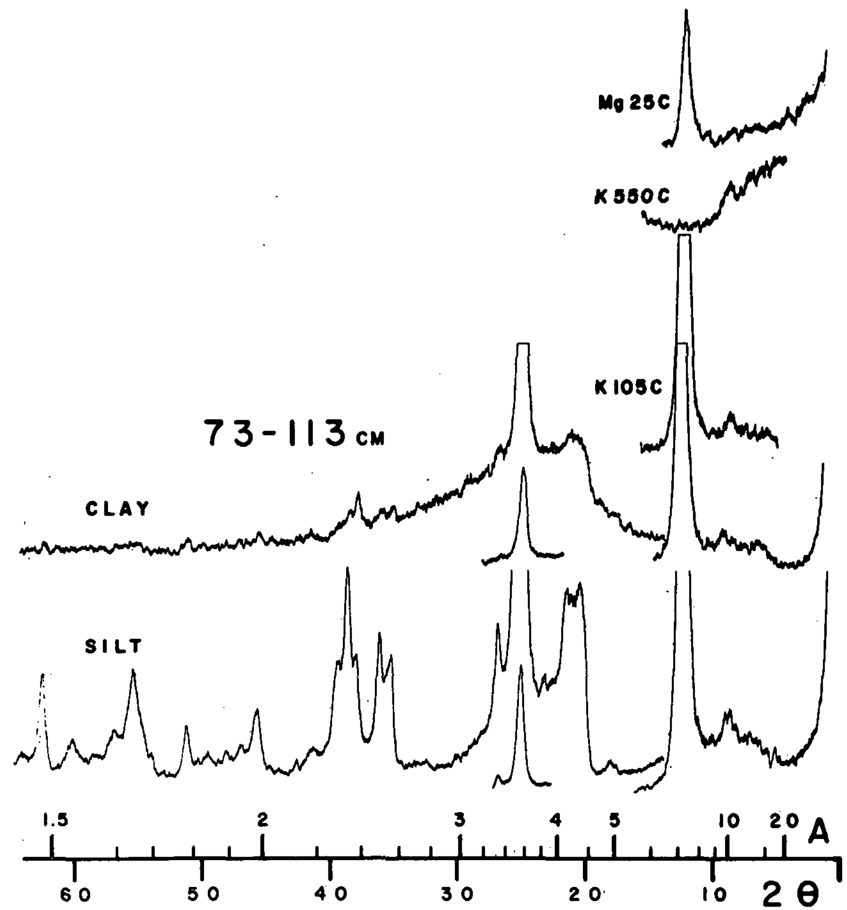

Fig. 10 - X-Ray diffraction patterns of the clay and silt from IIB21t horizon of the profile BR-3

Discussion

1. There existed the same uncertainty regarding the soil moisture and soil temperature regime as for profile BR 2.

2. The "alic" characteristic and its place in classification was discussed. Bennema stated that a ratio of 100 Al : Al + S of more than 50 in the major part of the B is unfavorable for growth of certain crops and should be recognized, at least at the family level. Buol remarked that total soluble Al may be higher in montmorillonitic families of Alfisols and hence doubted the management validity of the alic property. He therefore questioned the necessity for an alic subgroup. Moreover, reaction of various crops and cultivars to Al is very different. Rather than to create an alic subgroup, it may be possible to accept the "alic" as normal or typic and to establish an "alfic" subgroup for those Ultisols with less than 50 percent Al saturation. Eswaran pointed to the possibility of using pH-KCl for determining the alic character, but did not indicate a diagnostic value. Uehara thought that the amount of exchangeable Ca may be more important. Camargo felt that it is not certain that 50 percent Al saturation is the best limit (it may e.g., be 60 percent, and that anyhow the distinction cannot be made in the field. He further observed that the "non-alic" subgroup is common in Paraná. Sombroek mentioned that many soils of this general category have high Al saturations. It was concluded that insufficient data are available at this time to establish the limit between alic and non-alic subgroups, but that the 50 percent (or higher) Al saturation level should be tested.

3. Beinroth observed that the epiaquic subgroups distinguished in Puerto Rico have a more marked color contrast. Technically this pedon qualifies marginally as an Epiaquic Haplustult. However, the color change coincides with a lithologic discontinuity and may, therefore, be sedimentary rather than pedogenetic in nature.

Since no equiaquic oxic subgroups are provided it seems better to classify this pedon as an Oxic Haplustult. In the terminology of the committee, it would be a Leptic or Leptic Alic Kandiustult.

PROFILE ISCW-BR 4 DESCRIBED AND SAMPLED - 11 May 1971

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO DISTRÓFICO latossólico A moderado textura média/argilosa fase floresta tropical subcaducifólia relevo suave ondulado (RED-YELLOW PODZOLIC DYSTROPHIC, latosolic, moderate A horizon, loamy/clayey, semi-deciduous tropical forest gently undulating phase).

(Typic)* Paleustult (no consensus); clayey, kaolinitic, hyperthermic.

Dystric Nitosol.

Sol ferrallitique; moyennement désaturé, appauvri, jaune, dérivé de gneiss acide.

LOCATION - Rio de Janeiro, RJ. Radiobras area, Sepetiba; 22°57'30" S 43°40'12" W.

TOPOGRAPHIC POSITION - Trench on top of hill, 1.5% slope, under coconut orchard and colonial grass; gently undulating; 40 meters.

PRIMARY VEGETATION - Semi-deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Acidic gneissic, Precambrian Complex with a sandy clay detrital mantle.

DRAINAGE - Well drained.

PRESENT LAND USE - Coconut orchard.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	25.8	26.0	25.3	23.8	22.1	21.1	20.0	21.0
P mm	171	160	180	115	72	42	42	44
	Sept	Oct	Nov	Dec				
T°C	21.4	22.0	23.3	24.5	Mean	23.0		
P mm	65	103	107	171	Total	1272		
		Hyperthermic			Ustic/udic			

Ap - 0 - 11 cm, very dark grayish brown (10 YR 3/2, moist); slightly gravelly sandy loam; weak very fine to medium granular and single grains; many very fine,fine and medium and some coarse pores; very friable, plastic and slightly sticky; clear and smooth boundary.

A3 - 11 - 27 cm, dark brown (10 YR 4/3, moist); slightly gravelly sandy clay loam; weak very fine to fine granular and subangular blocky; many very fine and fine, common medium and coarse pores; very friable, plastic and sticky; gradual and smooth boundary.

B1t - 27 - 46 cm, brown (7.5 YR 4.5/4, moist); slightly gravelly clay; weak very fine to fine subangular blocky; common weak clay films; common very fine and fine, some medium and coarse pores; friable, plastic and sticky; gradual and smooth boundary.

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* Subgroup not established.

B21t - 46 - 77 cm, brown (7.5 YR 4/4, moist); slightly gravelly clay; weak to moderate very fine to medium subangular blocky; common and moderate clay films; common very fine, fine and medium pores; friable, plastic and sticky; gradual and smooth boundary.

B22t - 77 - 110 cm, brown (7.5 YR 4/4, moist); slightly gravelly clay; moderate fine to medium subangular blocky; common moderate clay films; common very fine and fine, and medium pores; friable, plastic and sticky; gradual and smooth boundary.

B23t - 110 - 160 cm, brown (7.5 YR 5/5, moist), few fine and distinct mottles of red (10 R 4/8, moist); slightly gravelly clay; weak to moderate fine to medium subangular blocky; common moderate clay films; many very fine and fine, common medium pores; friable, plastic and sticky; gradual and smooth boundary.

B31t - 160 - 230 cm, red (10 R 4/8, moist); slightly gravelly clay; weak very fine to fine subangular blocky; common weak clay films; friable, plastic and sticky.

B32t - 230 - 290 cm^+, slightly gravelly clay; plastic and sticky.

REMARKS - Abundant roots in Ap and A3, common in B1t, decreasing downward. A few lateritic concretions, ± 1 cm in diameter, rounded, throughout the profile.

Trench 1.80 m deep, bucket auger downward. Profile moist.

PROFILE Nº ISCW-BR 4

SAMPLE Nº 7133/40 SNLCS

HORIZON	DEPTH cm	GRVL 20-2 mm %	FINE EARTH <2mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY	BULK DNST	PRTCL DNST	TOTAL PORO-SITY %
Ap	0- 11	15	85	60	11	10	19	13	32	0.53	1.54	2.60	41
A3	- 27	15	85	46	12	10	32	27	16	0.31			
B1t	- 46	10	90	34	9	9	48	-	100	0.19			
B21t	- 77	9	91	29	7	7	57	-	100	0.12			
B22t	-110	10	90	30	7	5	58	-	100	0.09	1.65	2.67	37
B23t	-160	7	93	28	7	9	56	-	100	0.16			
B31t	-230	12	88	21	6	22	51	-	100	0.43			
B32t	-290+	12	88	27	4	22	47	-	100	0.47			

pH (1:2.5) H2O	KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.6	4.4	1.1	0.7	0.25	0.04	2.1	0.1	3.2	5.4	39	5
5.4	4.2	1.1	0.6	0.07	0.03	1.8	0.3	2.6	4.7	38	
5.2	4.2	1.2	0.7	0.02	0.03	2.0	0.4	2.2	4.6	43	17
5.1	4.2	1.2	0.8	0.02	0.03	2.1	0.6	2.9	5.6	38	22
5.1	4.2	1.0	0.8	0.02	0.03	1.9	0.7	2.4	5.0	38	27
5.0	4.1	0.9	0.7	0.02	0.03	1.7	0.7	2.5	4.9	35	29
5.4	4.9	0.6	1.3	0.01	0.03	1.9	-	1.6	3.5	54	-
5.4	5.0	0.4	1.3	0.01	0.01	1.7	-	1.4	3.1	55	-

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3	SiO2 / R2O3	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
0.99	0.09	11	7.8	6.7	2.2	0.51	1.98	1.64	4.76	<1
0.62	0.07	9	13.2	11.2	3.2	0.73	2.00	1.69	5.49	<1
0.57	0.07	8	19.3	17.2	5.7	0.94	1.91	1.58	4.74	<1
0.47	0.05	9	22.0	19.7	6.7	0.94	1.90	1.56	4.61	<1
0.43	0.05	9	23.0	19.9	6.8	0.99	1.96	1.61	4.59	<1
0.39	0.05	8	23.4	21.3	7.0	1.05	1.87	1.54	4.77	<1
0.20	0.03	7	28.0	25.1	9.8	1.20	1.90	1.52	4.01	<1
0.16	0.02	8	27.1	22.5	6.8	0.87	2.05	1.72	5.19	<1

Clay B/A - 2.1 Weighted - 1.8

PROFILE Nº ISCW-BR 4
SAMPLE Nº 7133/40

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE	MG & IL	OF	IL & CN MG	AP	MS	ZR	RU	OP			
SANDS (2-.05 mm)													
Ap	100%	tr	tr	tr	tr	tr		tr					
A3	100%	tr	tr	tr	tr	tr		tr					
B1t	100%	tr			tr	tr	tr	tr	tr				
B21t	100%	tr	tr	tr				tr					
B22t	100%	tr	tr	tr				tr					
B23t	100%	tr	tr	tr				tr					
B31t	85%	15%	tr					tr					
B32t	100%	tr						tr		tr			
GRAVELS (>2 mm)													
	100%	tr											
	100%	tr											
	100%	tr											
	100%	tr											
	100%	tr											
	100%	tr											
	100%	tr											
	100%												

Mineral Code : QZ - quartz; CN FE - iron concretions; MG - magnetite; IL - ilmenite; AP - apatite; MS - muscovite; ZR - zircon; RU - rutile; OP - opal material

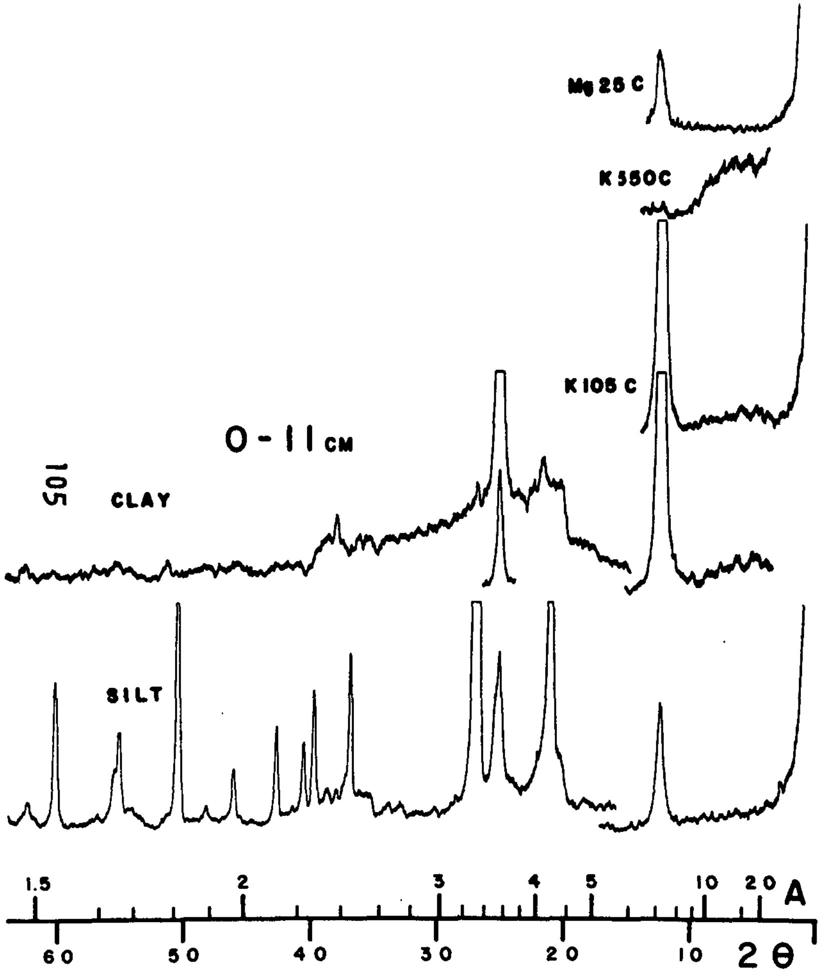

Fig. 11 - X-Ray diffraction patterns of the clay and silt from Ap horizon of the profile BR-4.

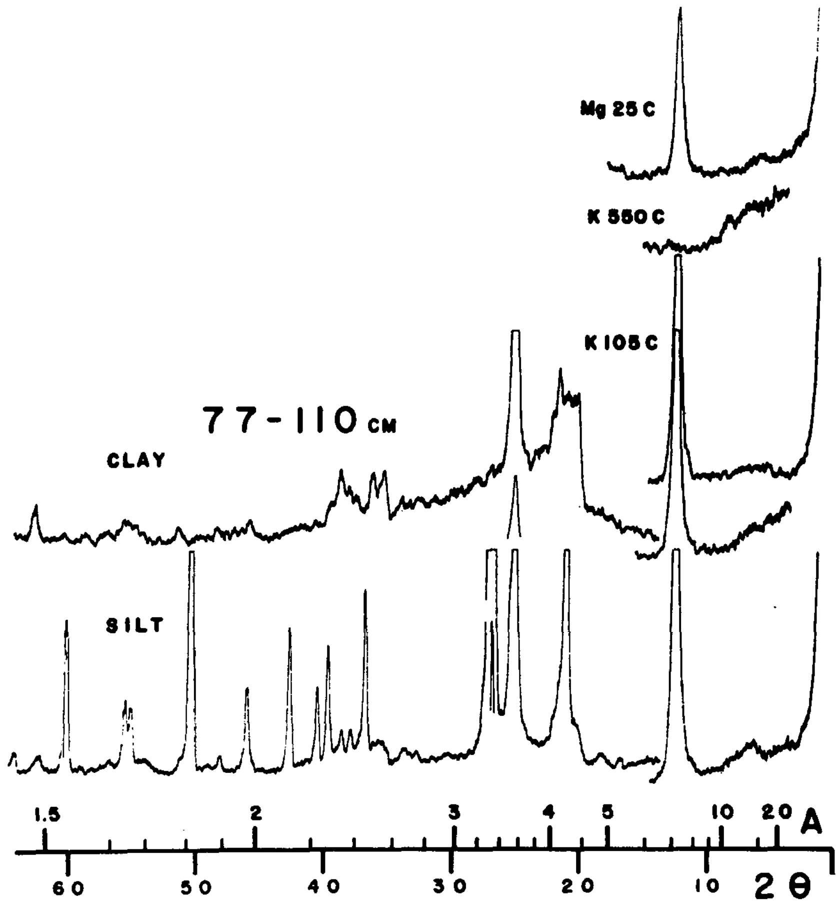

Fig. 12 - X-Ray diffraction patterns of the clay and silt from B22t horizon of the profile BR-4.

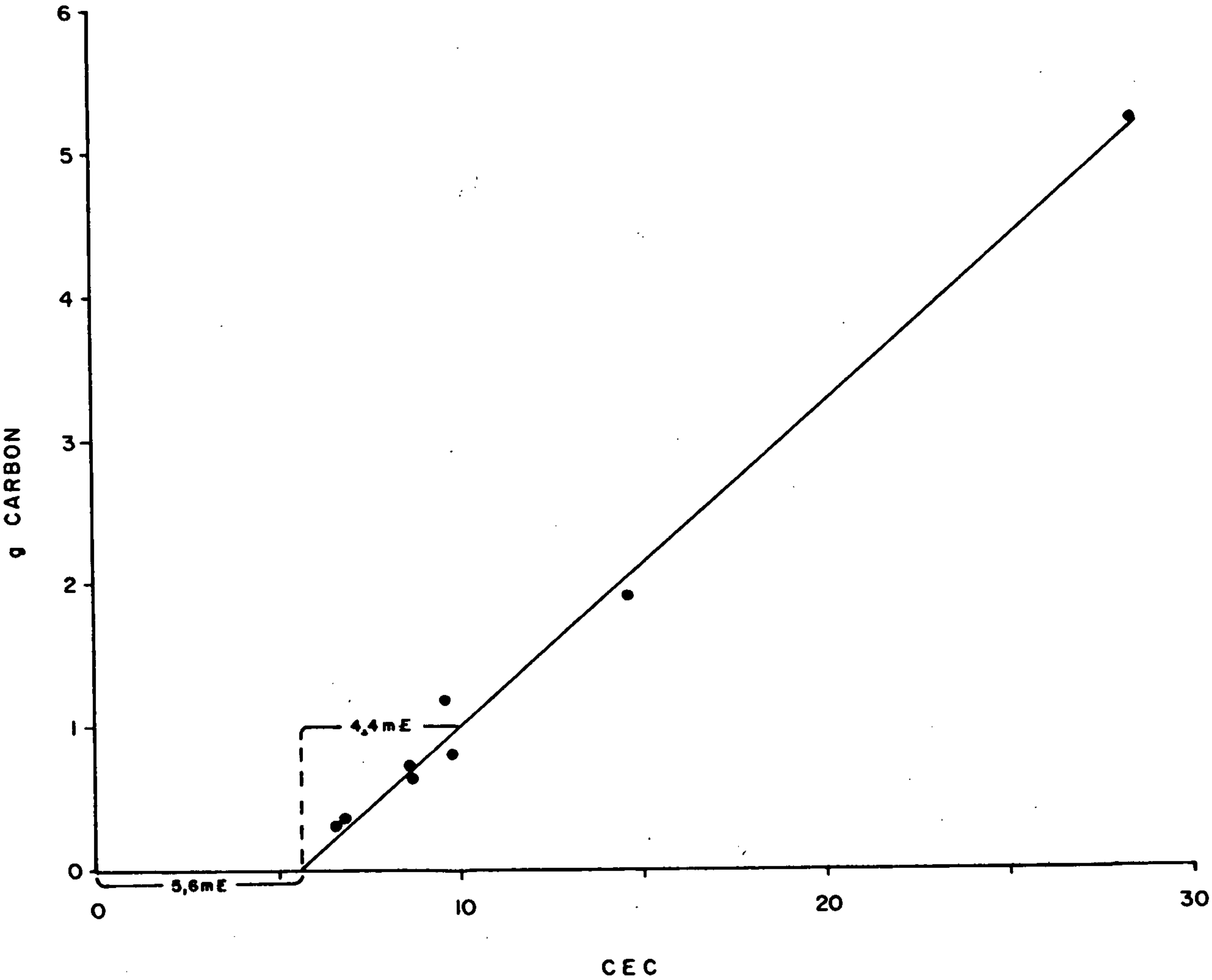

Fig. 13 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-4.

Discussion

1. There is a marked increase in clay from the Ap to the B21t horizon (ratio 1:3) and clear "leaching" as evidenced by bleached quartz grains. The surface horizon appears structurally unstable and susceptible to splash and surface erosion.

2. No clear clay skins were found by field examination with binocular microscope (Smith).

3. The lower part of the B horizon shows "chicken pox" or clay balls, typical for oxic horizons (Eswaran). However, it appears that this oxic horizon is below a lithogic discontinuity.

4. Base saturation is low at 150 cm depth and in most of the Bt horizons (23-38 percent, calculated on NH_4OAc-CEC), but Al saturation is also low. Hence this pedon is not "alic".

5. Consistence in the exposed Bt horizon is hard when dry which would be atypical for an Oxisol (Sombroek).

6. The soil temperature regime is probably isohyperthermic (Tavernier); the soil moisture regime may be marginally ustic.

About two years ago, Guy Smith proposed an ultic subgroup of Oxisols for similar profiles. But, if the textural profile (ratio 1:1.4 or more) is accepted as a diagnostic criterion for the Kandi great groups, the present pedon would become a Kandiustult. It was generally agreed that this profile is a key soil transitional between Oxisols and Ultisols with a marked clay increase but without distinct accompanying clay cutans. With few exceptions, the participants opted for classification as Kandiustult. The subgroup would depend on the definition of the Typic Kandiustults.

PROFILE ISCW-BR 5 DESCRIBED AND SAMPLED - 21 Oct 1971

CLASSIFICATION - PLANOSSOLO ÁLICO argila de atividade baixa A moderado textura média/argilosa fase floresta tropical subcaducifólia relevo plano (PLANOSOL ALIC, low clay activity, moderate A horizon, loamy/clayey, semi-deciduous tropical forest level phase).

Typic Albaquult; clayey, kaolinitic, hyperthermic.

Dystric Planosol.

Sol hydromorphe; peu humifère à pseudo gley.

LOCATION - Rio de Janeiro, RJ. Magarça, Cachimbau road; 22°58'10" S 43°36'10" W.

TOPOGRAPHIC POSITION - Trench 10 m from the road, 1% slope, under pasture; level; 20 meters.

PRIMARY VEGETATION - Semi-deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Sandy and clayey sediments of Quaternary Age.

DRAINAGE - Somewhat poorly drained.

PRESENT LAND USE - Poor pasture.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.5	26.6	25.7	23.7	21.7	20.5	19.8	20.7
P mm	193	164	184	120	79	44	34	42

	Sept	Oct	Nov	Dec		
T°C	21.5	22.7	23.6	25.1	Mean	23.2
P mm	61	90	115	154	Total	1280

Hyperthermic Aquic

A1 - 0-12 cm, very dark grayish brown (10 YR 3/2, moist), gray (10 YR 5/1, dry); loamy sand; weak very fine to fine granular; many very fine to fine pores; soft, very friable, nonplastic and nonsticky; gradual and smooth boundary.

A2g - 12 - 51 cm, dark gray (10 YR 4/1, moist), dark gray (10 YR 4.5/1, dry); sandy loam; massive; many very fine and fine pores; soft, very friable, nonplastic and nonsticky; abrupt and smooth boundary.

B21tg - 51 - 90 cm, gray (10 YR 5/1), few fine and prominent mottles of red (2.5 YR 4/6), and common medium and distinct mottles of yellowish red (10 YR 5/6); sandy clay; moderate fine to medium subangular blocky; few very fine pores; hard, firm, plastic and sticky; gradual and smooth boundary.

IIB22tg - 90 - 124 cm, dark gray (10 YR 4/1), common medium and prominent mottles of red (2.5 YR 4/6), and common fine and distinct mottles of strong brown (7.5 YR 5/6); slightly gravelly sandy clay; moderate fine to medium subangular blocky; few very fine pores; hard, firm, plastic and sticky; clear and smooth boundary.

IIB3g - 124 - 160 cm, gray (10 YR 5/1), common medium and prominent mottles of red (2.5 YR 4/6), and common fine and distinct mottles of strong brown (7.5 YR 5/6); slightly gravelly sandy clay loam; moderate fine to medium subangular blocky; common very fine pores; hard, firm, plastic and sticky; clear and smooth boundary.

IIC1g - 160 - 205 cm^{+}, variegated color of gray (10 YR 5/1), red (2.5 YR 4/6), strong brown (7.5 YR 5/6); slightly gravelly sandy clay loam; plastic and sticky.

REMARKS - Abundant roots in A1, few in A2, very few in B21tg and IIB22tg.

Trench 1.60 m deep, bucket auger downward.

NOTE - Since the profile studied in the field was not the same one described in the tour guide, discussion is omitted.

For the pedon seen, P. Segalen subsequently provided the following mineralogical data: metahalloysite, gibbsite, hematite, some interstratified chlorite-vermiculite and magnetite.

PROFILE Nº ISCW-BR 5

SAMPLE Nº 7806/11 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 12	-	3	97	72	12	10	6	4	33	1.67
A2g	- 50	-	3	97	56	15	17	12	10	17	1.42
B21tg	- 90	-	6	94	36	10	15	39	30	28	0.38
IIB22tg	-124	-	10	90	37	9	13	41	8	80	0.32
IIB3 g	-160	-	11	89	54	10	12	24	4	17	0.50
IIC1g	-205+	-	9	91	49	10	14	27	-	100	0.52

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.1	3.9	0.6		0.12	0.05	0.8	0.4	1.8	3.2	25	33
4.9	3.9	0.3		0.07	0.05	0.4	1.2	1.6	3.2	13	75
4.6	3.5	0.6		0.07	0.09	0.8	4.5	1.9	7.2	11	85
4.5	3.5	0.5		0.07	0.07	0.6	5.0	1.4	7.0	9	89
4.6	3.5	0.5		0.08	0.06	0.6	3.0	0.7	4.3	14	83
4.6	3.5	0.5		0.08	0.06	0.6	3.4	0.3	4.3	14	85

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
0.66	0.06	11	2.8	1.6	1.0	0.67	2.97	2.12	2.49	4
0.29	0.03	10	4.6	3.1	1.6	1.00	2.52	1.90	3.04	1
0.30	0.04	8	17.5	13.4	3.1	1.12	2.22	1.93	6.77	1
0.23	0.04	6	17.7	13.6	3.4	0.90	2.21	1.91	6.26	1
0.13	0.03	4	11.2	8.1	2.3	0.77	2.35	1.99	5.51	1
0.07	0.01	7	13.2	9.5	3.1	0.92	2.36	1.96	4.80	1

Clay B/A - 4.4 Weighted - 3.6

PROFILE Nº ISCW-BR 5
SAMPLE Nº 7806/11

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	MC	IL	ZR & RU	MS	BT	OF						
SANDS (2-.05 mm)													
A1	100%	tr	tr	tr			tr						
A2g	98%	1%	1%	tr	tr								
B21tg	98%	1%	1%	tr									
IIB22tg	94%	5%	1%	tr									
IIB3g	87%	12%	1%	tr		tr							
IIC1g	95%	4%	1%	tr									
GRAVELS (>2 mm)													
	100%	tr											
	100%	tr											
	100%	tr											
	100%	tr											
	100%	tr											
	100%	tr											

Mineral Code : QZ - quartz; MC - microcline; IL - Ilmenite; ZR - zircon; RU - rutile; MS - muscovite; BT - biotite; OF - organic fragments

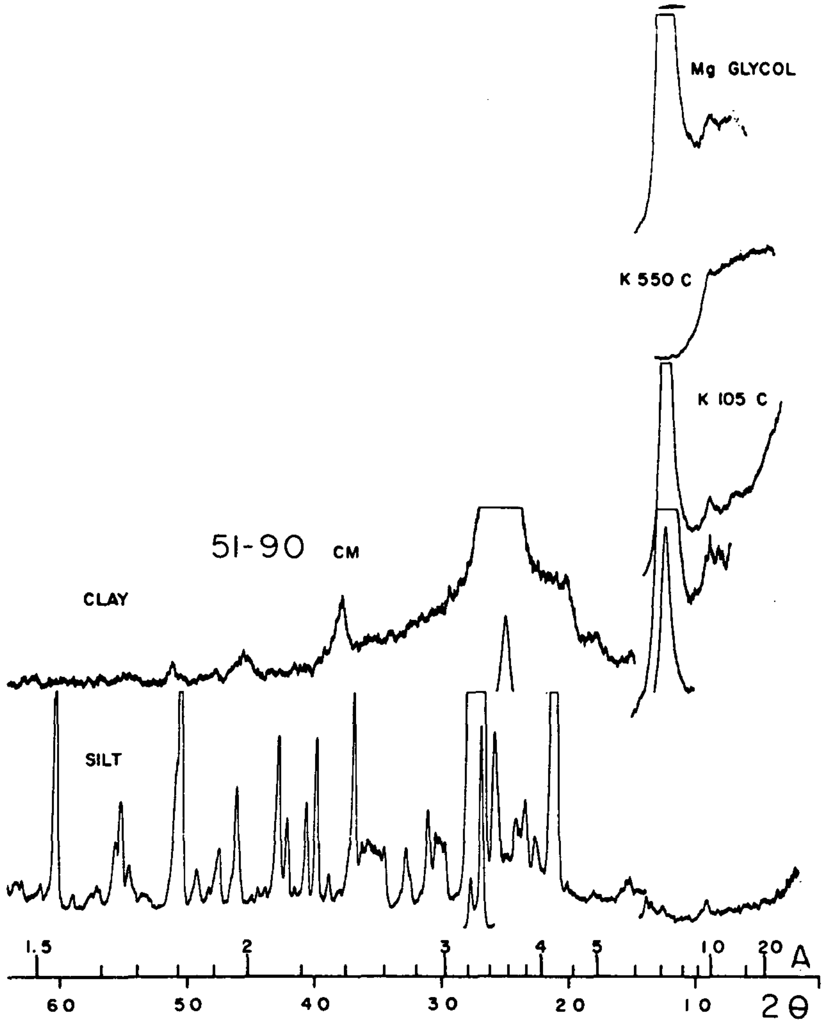

Fig. 14 - X-Ray diffraction patterns of the clay and silt from B21tg of the profile BR-5.

PROFILE ISCW-BR 6 DESCRIBED AND SAMPLED - 26 March 1977

CLASSIFICATION - TERRA ROXA ESTRUTURADA EUTRÓFICA A moderado textura argilosa fase floresta tropical subperenifólia relevo ondulado (TERRA ROXA ESTRUTURADA EUTROPHIC*, moderate A horizon, clayey, semi-evergreen tropical forest rolling phase).

Rhodic Paleudalf; clayey, kaolinitic, hyperthermic.

Eutric Nitosol.

Sol ferrallitique; faiblement désaturé, typique, humique, dérivé de diabase.

LOCATION - Londrina, PR. 34 km from Londrina in the highway to Ponta Grossa, 20 m left side; 23°40'00" S 51°10'00" W.

TOPOGRAPHIC POSITION - Trench at middle of slope, 15% slope, under colonial grass; rolling; 480 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Diabase, Upper Triassic; weathering residues of stated rock, possibly reworked.

DRAINAGE - Well drained.

PRESENT LAND USE - Semi-evergreen tropical forest.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	23.9	23.9	22.9	21.1	18.1	16.8	16.9	18.7
P mm	226	176	127	116	93	86	57	56
	Sept	Oct	Nov	Dec				
T°C	20.2	21.4	22.7	23.2	Mean	20.8		
P mm	101	171	105	171	Total	1485		
		Hyperthermic			Udic			

Ap - 0 - 15 cm, dusky red (2.5 YR 3/2, moist), dusky red (2.5 YR 3/3, dry); clay; strong fine to medium granular and subangular blocky; many very fine to medium and some coarse pores; hard firm, plastic to very plastic and very sticky; gradual and smooth boundary.

B1t - 15 - 32 cm, dark reddish brown (1.5 YR 3/4, moist), dark reddish brown (1.5 YR 3/4, dry); clay; moderate medium prismatic breaking easily to strong fine to medium subangular and angular blocky;common moderate clay films; common very fine and some coarse pores; hard, firm, plastic and sticky; diffuse and smooth boundary.

B21t - 32 - 74 cm, dark red (1.5 YR 3/5); clay; moderate coarse prismatic breaking easily to strong medium to coarse subangular and angular blocky; continuous strong clay films; common very fine to fine pores; hard, firm, plastic and sticky; diffuse and smooth boundary.

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* Low clay activity implied.

B22t - 74 - 154 cm, dark red (10 R 3/6); clay; moderate coarse prismatic breaking easily to strong medium to coarse subangular and angular blocky; continuous strong clay films; common very fine to fine pores; hard, firm, plastic and sticky; diffuse and smooth boundary.

B3t - 154 - 227 cm, weak red (10 R 4/4), few fine and diffuse mottles of red (10 R 4/8), few fine and prominent mottles of light yellowish brown (10 YR 4/4) and black (N 2/); clay; moderate medium to coarse subangular and angular blocky; common strong clay films; many very fine and fine pores; slightly hard to hard, friable, plastic and sticky; diffuse and smooth boundary.

C1 - 227 - 317 cm, variegated color of black (N 2/), yellowish brown (10 YR 5/6), reddish brown (5 YR 5/4), red (2.5 YR 4/5); clay; saprolite mixed by the bucket auger; plastic and sticky.

C2 - 317 - 370 cm^{+}, variegated color of black (N 2/), yellowish brown (10 YR 5/6), reddish brown (5 YR 5/4), red (2.5 YR 4/6); clay; consisting in saprolite mixed by bucket auger; plastic and sticky.

REMARKS - Abundant roots in Ap, plentiful in B1t, common in B21t and B22t, and few in B3t.

Trench 1.80 m deep, bucket auger downward.

PROFILE Nº ISCW-BR 6

SAMPLE Nº 77.0706/12 SNLCS

HORIZON	DEPTH cm	GRVL 20-2 mm %	FINE EARTH <2mm %	PARTICLE SIZE ANALYSIS ~~NaOH~~ CALGON % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY	BULK DNST	PRTCL DNST	TOTAL PORO-SITY %
Ap	0- 15	tr	100	3	4	34	59	52	12	0.58	1.19	2.82	58
B1t	- 32	tr	100	2	3	25	70	63	10	0.36	1.26	2.86	56
B21t	- 74	tr	100	1	2	14	83	-	100	0.12	1.20	2.86	58
B22t	-154	tr	100	1	2	18	79	-	100	0.23	1.25	2.86	56
B3t	-227	tr	100	1	2	26	71	-	100	0.37	1.22	2.86	57
C1	-317	tr	100	1	4	29	66	1	98	0.44			
C2	-370+	tr	100	4	6	31	59	2	97	0.53			

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
6.1	5.1	11.6	2.8	0.38	0.09	14.9	-	4.3	19.2	78	-
6.0	5.2	9.4	2.4	0.39	0.08	12.3	-	4.1	16.4	75	-
5.5	4.5	7.5	2.1	0.15	0.05	9.8	0.2	4.2	14.2	69	2
5.6	4.9	6.9	2.6	0.28	0.06	9.8	-	3.7	13.5	73	-
5.4	4.2	8.3	3.9	0.62	0.10	12.9	0.5	3.6	17.0	76	4
5.2	3.9	7.2	5.8	0.62	0.10	13.7	1.7	3.2	18.6	74	11
5.2	3.8	9.0	10.6	0.51	0.10	20.2	2.7	3.2	26.1	77	12

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
2.49	0.32	8	23.0	16.5	26.1	6.90	2.37	1.18	0.99	1
1.08	0.16	7	25.8	18.9	26.3	6.28	2.32	1.23	1.13	1
0.78	0.14	5	29.3	22.0	23.9	4.43	2.26	1.34	1.44	2
0.41	0.08	5	30.2	22.5	23.9	4.38	2.28	1.36	1.48	2
0.28	0.05	6	34.8	21.9	22.6	4.04	2.70	1.63	1.52	2
0.22	0.04	6	35.4	21.2	22.7	4.23	2.84	1.69	1.46	2
0.12	0.04	3	37.8	19.7	22.7	4.05	3.26	1.88	1.36	2

Clay B/A - 1.3 Weighted - 1.3

PROFILE Nº ISCW-BR 6
SAMPLE Nº 77.0706/12

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	CN FE & CN MN	CL	QZ	ZL	OP - CD	MG & IL	OF	AL AR	PL
SANDS (2-.05 mm)									
Ap	20%	1%	55%	tr	2%	10%	12%	tr	tr
B1t	30%	5%	41%	tr	10%	14%	tr	tr	tr
B21t	30%	2%	48%	tr	10%	10%		tr	tr
B22t	30%	2%	43%	10%	5%	10%		tr	tr
B3t	40%	10%	10%	27%		10%		3%	tr
C1	30%	30%	2%	23%		10%		5%	tr
C2	30%	40%	3%	20%		5%		2%	tr
GRAVELS (>2 mm)									
	56%	2%	19%	23%			tr		
	65%	3%	15%	17%					
	55%	4%	21%	20%					
	40%	tr	50%	10%					
		85%	15%						
	100%								
	50%	40%		10%					

Mineral Code: CN FE - iron concretions; CN MN - manganose concretions; CL - chlorite; QZ - quartz; ZL - zeolite; OP - opal; CD - chalcedony; MG - magnetite; IL - ilmenite; OF - organic fragments; AL AR - argillitic aggregates; PL- plagioclase

SOIL CLASSIFICATION-INTERNATIONAL SOIL CLASSIFICATION WORKSHOP
BRAZILIAN SOIL
SERIES - - - - - - -

SOIL NO - - - - - - ISCW-BR6 COUNT - - -

GENERAL METHODS- - -1A,1B1B,2A1,2B SAMPLE NOS. 77P1256-77P1261

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, MTSC
NATIONAL SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA

DECEMBER 1977

DEPTH CM	HORIZON	SAND 2-.05	SILT .05-.002	CLAY LT .002	FINE CLAY LT .0002	SAND VCOS 2-1	SAND CORS 1-.5	SAND MEDS .5-.25	SAND FNES .25-.10	SAND VFNS .10-.05	SILT COSI .05-.02	SILT FNSI .02-.002	SILT VFSI .005-.002	SAND 2-.1	INTR II .2-.02	FINE CLAY TO CLAY PCT	NON-CO3-CLAY PCT	RATIO 8D1 15-BAR TO CLAY
		(- - - -	PARTICLE SIZE ANALYSIS, LT 2MM, 3A1, 3A1A, 3A1B	PCT LT 2MM											- - -)			
0-15	AP	7.4	38.3	54.3		.4	.5	1.2	2.9	2.4	10.5	27.8		5.0				.46
15-32	B1T	5.4	35.6	59.0		.2	.4	.7	2.3	1.8	7.4	28.2		3.6				.45
32-74	B21T	3.6	22.1	74.3		.2	.3	.5	1.4	1.2	6.1	16.0		2.4				.42
74-154	B22T	4.3	30.2	65.5		.1	.3	.4	1.4	2.1	7.1	23.1		2.2				.49
154-227	B3T	5.8	37.5	56.7		.0	.3	.4	1.4	3.7	9.2	28.3		2.1				.54
227-317	C1	7.9	41.8	50.3		.1	.4	.6	2.0	4.8	9.7	32.1		3.1				.60

DEPTH CM	(PARTICLE SIZE ANALYSIS, MM, 3B, 3B1, 3B2) VOL. GT 2 PCT	GT 75 PCT	WEIGHT 75-20 PCT LT 75	WEIGHT 20-5	WEIGHT 5-2	LT .074	20-2 PCT LT20	BULK DENSITY 4A1D 1/3-BAR G/CC	BULK DENSITY 4A1H OVEN DRY G/CC	4D1 COLE	WATER CONTENT 4B1C 1/10 BAR PCT	4B1C 1/3-BAR PCT	4B2 15-BAR PCT	4C1 WRD CM/CM	PH 8C1C 1/1 KCL	CARBONATE 6E1B LT 2 PCT	CARBONATE 3A1A LT .002 PCT	PH 8C1A 1/1 H2O	PH 8C1E 1/2 CACL
0-15													25.2		5.1			5.9	5.5
15-32													26.7		5.1			5.9	5.5
32-74													31.1		4.6			5.3	4.9
74-154													32.1		5.0			5.5	5.1
154-227													30.8		4.2			5.2	4.7
227-317													30.3		3.9			5.1	4.5

DEPTH CM	(ORGANIC MATTER) 6A1A ORGN CARB PCT	6B1A NITG PCT	C/N	IRON 6C2B EXT FE PCT	PHOS TOTL PCT	EXTRACTABLE BASES 5B4A 6N2E CA	6O2D MG	6P2B NA	6Q2B K	SUM EXTB	ACTY 6H1A BACL TEA	AL 6G1E KCL EXT	(CAT EXCH) 5A3A EXTB ACTY	5A6A NHAC	RATIO 8D1 NHAC TO CLAY	RATIO 8D3 CA TO MG	CA 5F1 SAT NHAC PCT	(BASE SAT) 5C3 EXTB ACTY PCT	5C1 NHAC PCT
						(- - - -	- - - -	- - - -	- - - -	-MEQ / 100	G- - - -	- - - -	- - - -	- - - -)					
0-15	2.69	.289	9	8.2		12.8	2.6	.0	.5	15.9	12.7		28.6	23.2	.53	4.9	44	56	69
15-32	1.12	.120	9	8.5		9.1	2.5	.0	.5	12.1	11.0		23.1	18.9	.40	3.6	38	52	64
32-74	.82	.069	12	8.9		7.3	2.3	.0	.2	9.8	13.2	.2	23.0	19.6	.26	3.2	37	43	50
74-154	.39			8.9		6.8	2.2	TR	.6	9.6	10.9	TR	20.5	17.9	.27	3.1	38	47	54
154-227	.20			7.1		7.7	4.0	TR	.9	12.6	10.8	.8	23.4	21.8	.38	1.9	35	54	58
227-317	.14			6.6		6.9	5.5	TR	1.0	13.4	11.7	2.1	25.1	23.9	.48	1.3	29	53	56

DEPTH CM	(SATURATED PASTE) 8E1 REST OHM-CM	8C1B PH	8A H2O PCT	NA 5D2 ESP PCT	NA 5E SAR	SALT 8D5 TOTL SOLU PPM	GYP 6F1A PCT	SATURATION EXTRACT 8A1 8A1A EC MMHOS/CM	6N1B CA	6O1B MG	6P1B NA	6Q1B K	6I1A CO3	6J1A HCO3	6K1A CL	6L1A SO4	6M1A NO3	ATTERBERG 4F1 LQID LMIT PCT	4F2 PLST INDX
									(- - - -	- - - -	- - - -	MEQ / LITER	- - - -	- - - -	- - - -	- - - -	- - - -)		
0-15	2700	5.7																	
15-32																			
32-74																			
74-154																			
154-227																			
227-317																			

SAND MINERALOGY (7B1)
032-074 VFNS - RE82 QZ24 OP54 AR4 FK3 BT8 CL7
RELATIVE AMOUNTS: AS PERCENT
MINERAL CODE: RE = RESISTANT MINERALS AR = AGGREGATES BT = BIOTITE CL = CHLORITE OP = OPAQUE QZ = AUARTZ
FK = POTASSIUM FELDSPAR

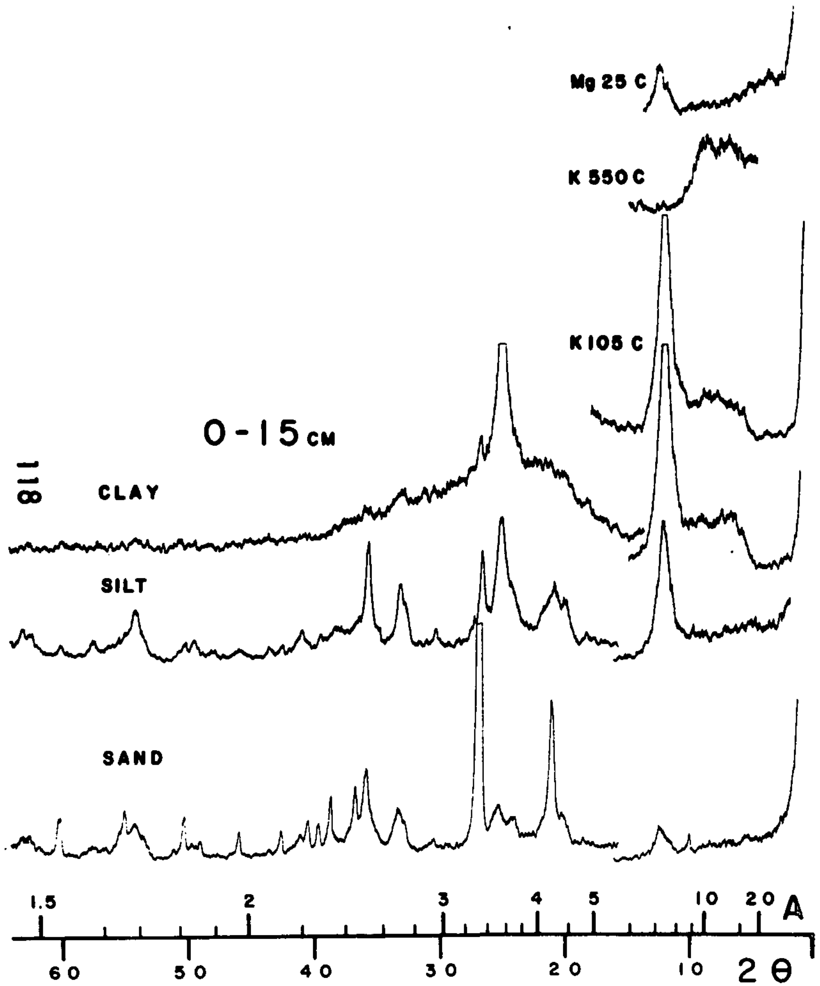


Fig. 15 - X-Ray diffraction patterns of the clay, silt and sand from Ap horizon of the profile BR-6.

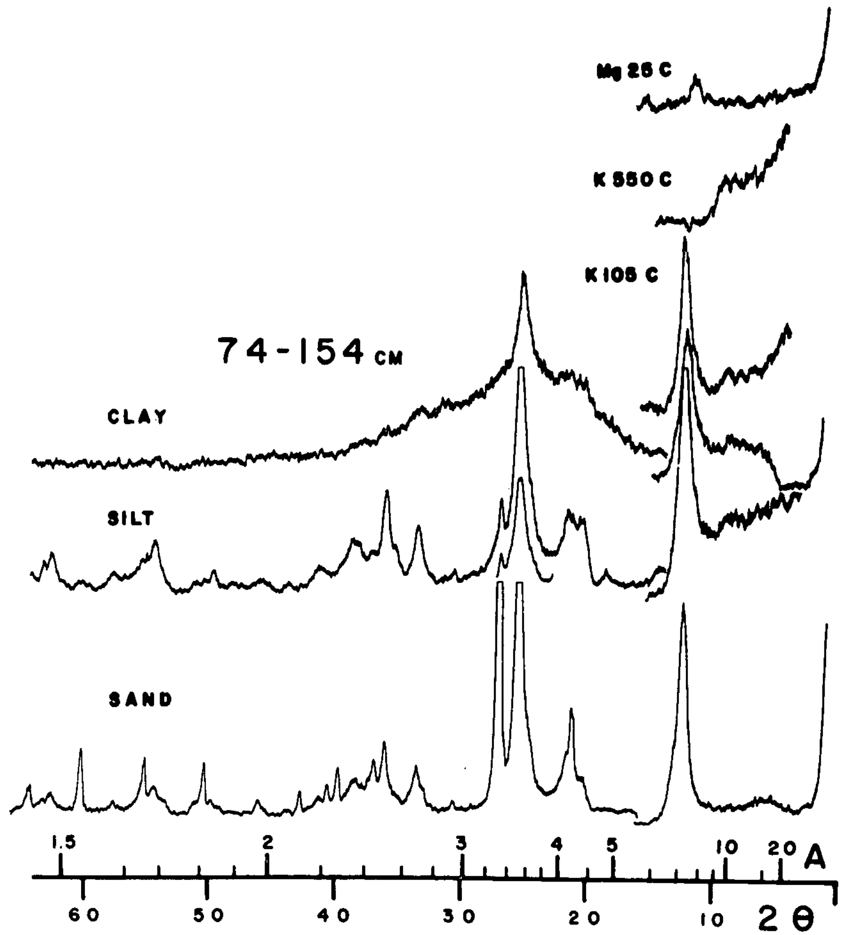
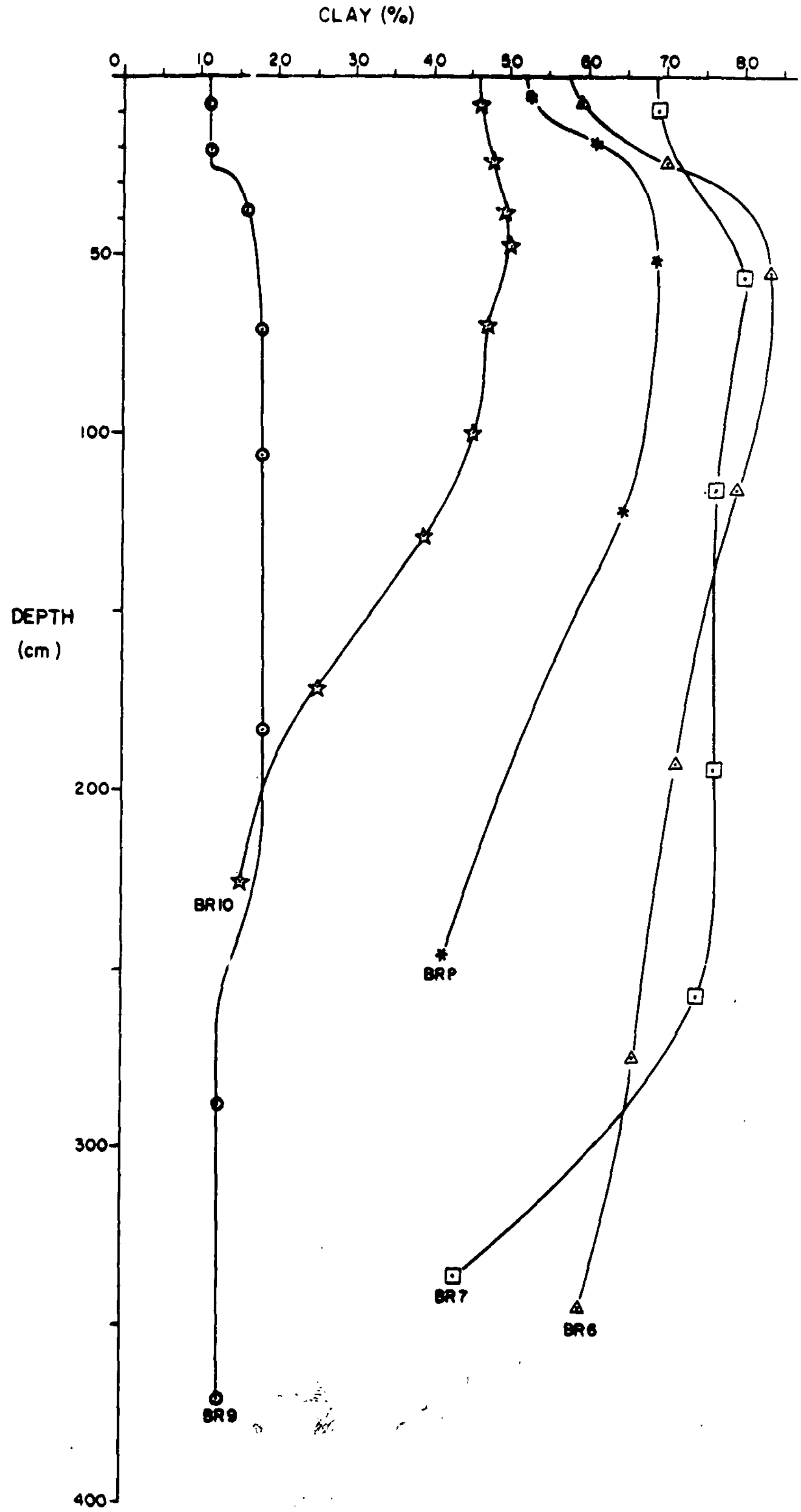


Fig. 16 - X-Ray diffraction patterns of the clay, silt and sand from B22t horizon of the profile BR-6.



400

Fig. 17- Clay distribution curves° for profile BR-6, BR-7, BR-8, BR-9 and BR-10.

° All clay distribution curves at same scale.

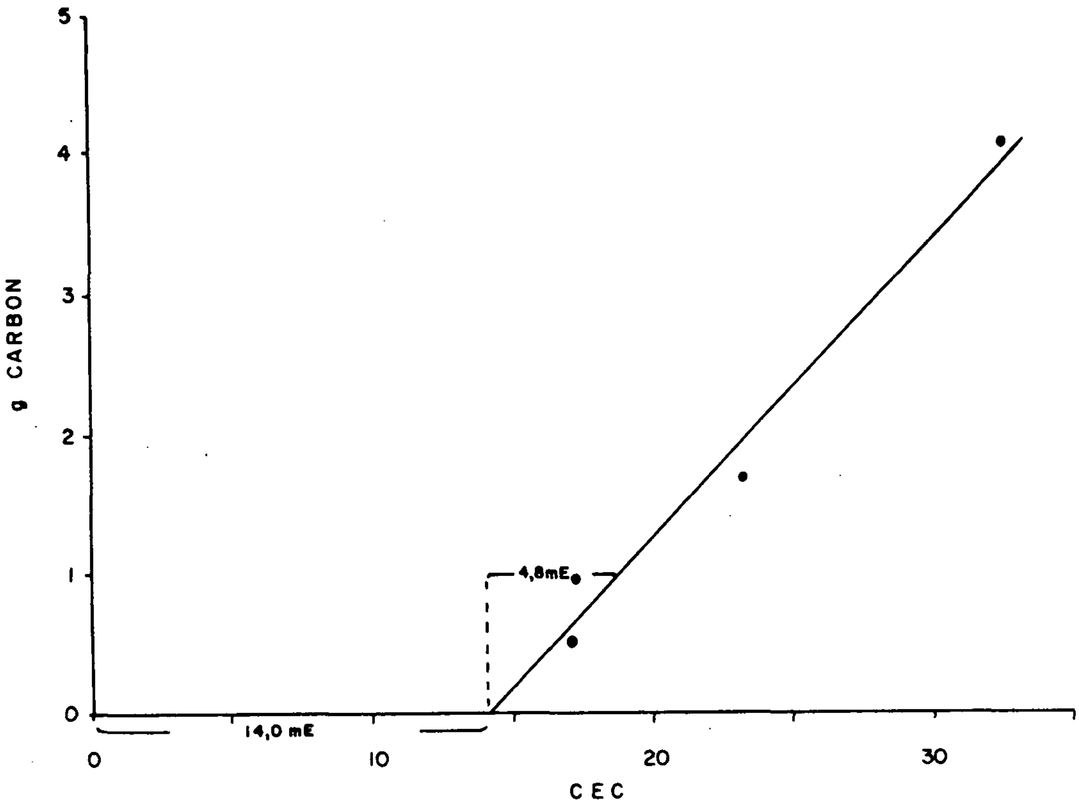


Fig.18 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-6.

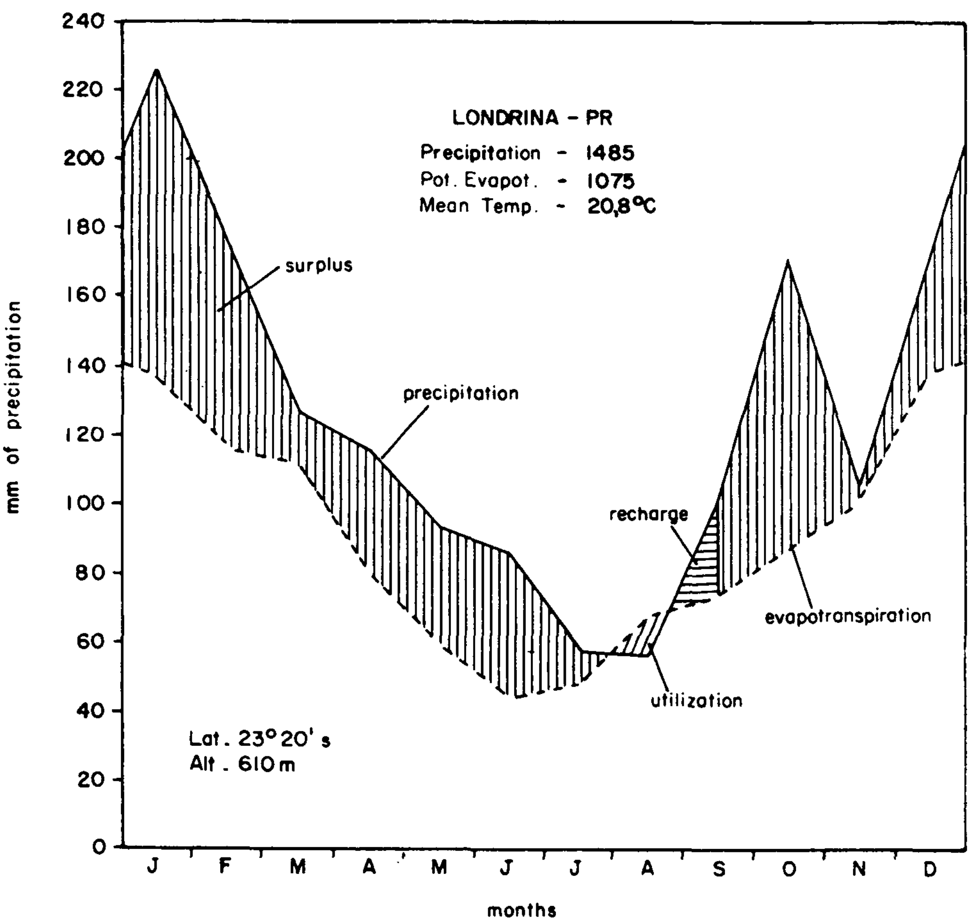


Fig. 19 - Water balance according to Thornthwaite & Mather, 1955 (125 mm), for geographic region related to profiles BR-6 and BR-7

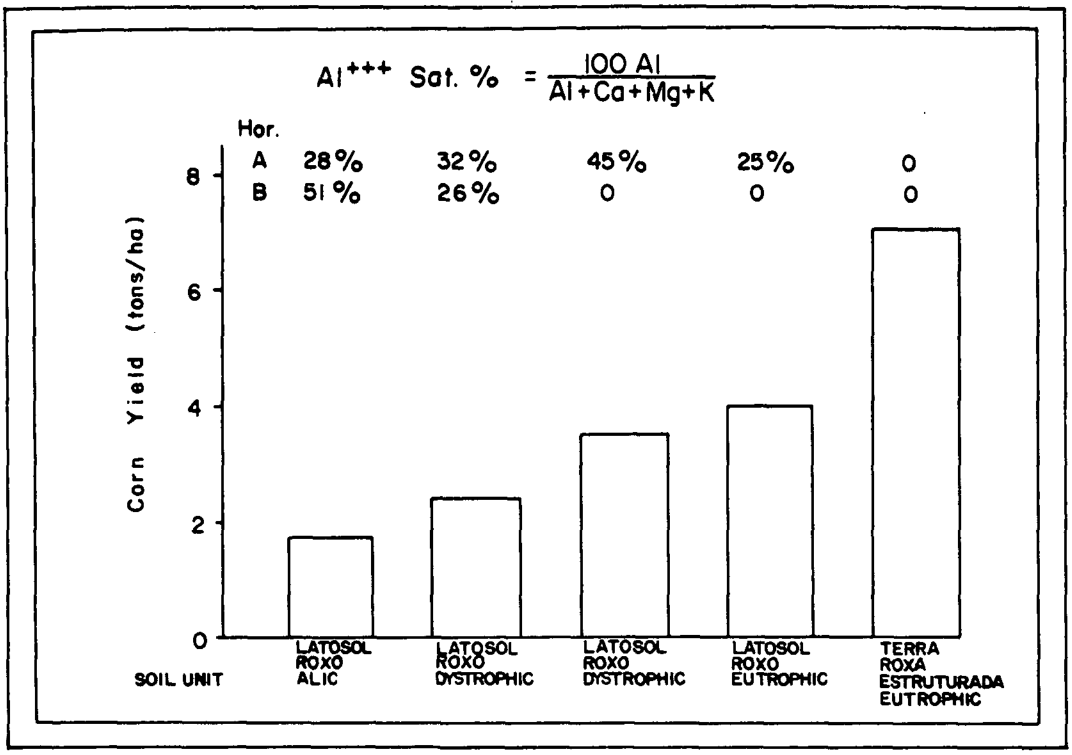


Fig. 20- Indication of distinction in behaviour between Latosol Roxo Eutrophic and Terra Roxa Estruturada Eutrophic (also other varieties of LR), as expressed by difference in crop performance. Yield results refer to best fertilizers treatment.

After Olmos I.L., Scotti, C. A., Muzilli, O., Turkiewicz, L. 1971. Estudo comparativo da produtividade de alguns solos álicos e não álicos do Estado do Paraná. Bol. Univ. Fed. do Paraná, Agronomia nº 6. Curitiba.

Discussion

1. Texturally, this soil has an argillic horizon, i.e. an increase in clay of more than 8 percent over a distance of 30 cm. Most participants agreed on the presence of cutans (Bennema).

2. The SCS data indicate a base saturation ($BaCl_2$) of more than 35 percent and a base saturation (NH_4OAc) of barely more than 50 percent.

3. While NH_4OAC-CEC of the B1t is above 24 meq per 100 g clay, even if correction is made for organic C, the values for the underlying B21t and B22t horizons are either slightly above or below 24 meq, depending on which clay data, SCS or SNLCS, are used.

4. According to Nichols this soil is transitional to a Mollisol, but the thickness of the mollic epipedon (15 cm) would exclude it from that order as the B1t horizon does not meet the color requirements.

The classification of this pedon as a Rhodic Paleudalf was agreed upon by Buol and others. Dudal and Isbell pointed to the similarities of this soil with Krasnozems.

Note

According to analyses subsequently performed by P. Segalen, the mineralogical composition is characterized by metahalloysite, hematite and some gibbsite. The peaks for the clay minerals were very clear.

PROFILE ISCW-BR 7 DESCRIBED AND SAMPLED - 21 Jan 1977

CLASSIFICATION - LATOSSOLO ROXO EUTRÓFICO A chernozêmico textura argilosa fase floresta tropical subperenifólia relevo suave ondulado (DUSKY RED LATOSOL EUTROPHIC, chernozemic A horizon, clayey, semi-evergreen tropical forest gently undulating phase).

Typic Eutrorthox; clayey, oxidic, hyperthermic.

Rhodic Ferralsol.

Sol ferrallitique; faiblement désaturé, typique, humique, dérivé de basalte.

LOCATION - Londrina, PR. Wheat experimental field, IAPAR Headquarters; 23º23'00" S 51º09'00" W

TOPOGRAPHIC POSITION - Trench in the experimental field (fallow), 5% slope; gently undulating; 560 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Melaphyres and basalts, Upper Triassic; weathering residues of stated rocks.

DRAINAGE - Somewhat excessively drained.

PRESENT LAND USE - Soybean, wheat, corn, coffee, banana and bean crops.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
TºC	23.9	23.9	22.9	21.1	18.1	16.8	16.9	18.1
P mm	226	176	127	116	93	86	57	56
	Sept	Oct	Nov	Dec				
TºC	20.2	21.4	22.7	23.2	Mean	20.8		
P mm	101	171	105	171	Total	1485		
		Hyperthermic			Udic			

Ap - 0 - 18 cm, dusky red (1 YR 3/3, moist), dusky red (1 YR 3/3, dry); clay; moderate medium to fine granular; many very fine and fine pores; hard, friable, very plastic and sticky; clear and smooth boundary.

A3 - 18 - 30 cm, dusky red (1 YR 3/3, moist and dry); clay; weak medium prismatic and weak fine to medium subangular blocky; common very fine and fine pores; very hard, friable, plastic and sticky; clear and smooth boundary.

B1 - 30 - 80 cm, dusky red (1 YR 3/4); clay; weak fine subangular blocky and strong "ultra" fine granular appears massive in place; many very fine and fine pores; slightly hard, very friable, plastic and sticky; diffuse and smooth boundary.

B21 - 80 - 150 cm, dusky red (1 YR 3/5); clay; strong "ultra" fine granular very slightly coherent appears massive in place; many very fine and fine pores; soft, very friable, plastic and sticky; diffuse and smooth boundary.

B22 - 150 - 235 cm, dusky red (1 YR 3/5); clay; weak fine subangular blocky slightly coherent appears massive in place; many very fine and fine pores; slightly hard, very friable, plastic and sticky; diffuse and smooth boundary.

B23 - 235 - 275 cm, dark red (1 YR 3/6); clay; slightly plastic to plastic and sticky.

B3/C - 275 - 325 cm, dark red (1 YR 3/6), few fine and prominent mottles of strong brown (7.5 YR 5/6); horizon constituted of B23 like material mixed with basic rock fragments.

C - 325 - 345 cm^{+}, strong brown (7.5 YR 5/8), dark red (1 YR 3/6), predomi_ nanting the brown color; rock fragments increase with depth.

REMARKS - Plentiful roots in Ap, decreasing gradually downward.

Some quartz crystals (from geode) throughout the profile.

Trench 2.30 m deep, bucket auger downward. In two trials auger reached a bedrock and/or boulder at 3.45 meters. Profile moist.

PROFILE Nº ISCW-BR 7

SAMPLE Nº 77.0529/36 SNLCS

HORIZON	DEPTH cm	GRVL 20-2 mm %	FINE EARTH <2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY	BULK DNST	PRTCL DNST	TOTAL PORO-SITY %
Ap	0- 18	tr	100	5	7	19	69	48	30	0.28	1.23	2.94	58
A3	- 30	tr	100	5	7	17	71	54	24	0.24	1.28	2.96	56
B1	- 80	tr	100	4	5	11	80	1	99	0.14	1.10	2.90	62
B21	-150	tr	100	4	6	14	76	-	100	0.18	1.00	2.90	66
B22	-235	2	98	4	6	14	76	-	100	0.18	1.05	2.94	64
B23	-275	6	94	5	7	14	74	-	100	0.19			
B3/C	-325	23	77	9	10	21	60	-	100	0.35			
C	-345+	1	99	12	12	33	43	-	100	0.77			

pH (1:2.5) H2O	pH KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
6.8	5.7	8.9	2.1	0.48	0.03	11.5	-	3.1	14.6	79	-
6.5	5.4	7.2	2.1	0.44	0.03	9.8	-	3.0	12.8	77	-
6.4	5.4	4.9	1.1	0.09	0.03	6.1	-	2.8	8.9	69	-
5.9	5.4	2.9	1.3	0.02	0.03	4.3	-	2.8	7.1	61	-
5.0	5.4	2.3	0.8	0.04	0.03	3.2	-	2.5	5.7	56	-
5.4	5.6	2.5	0.9	0.06	0.04	3.5	-	2.1	5.6	63	-
5.6	5.7	2.4	0.8	0.11	0.03	3.3	-	2.0	5.3	62	-
5.8	6.0	2.1	0.5	0.13	0.04	2.8	-	1.9	4.7	60	-

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	MOLECULAR RATIO SiO2 / Al2O3	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
2.25	0.22	10	21.2	22.7	30.3	4.91	1.59	0.84	1.12	3
1.60	0.21	8	21.7	23.3	29.6	4.64	1.58	0.87	1.23	1
0.76	0.11	7	24.3	26.1	27.6	3.91	1.58	0.95	1.48	2
0.49	0.07	7	22.9	25.3	28.9	4.25	1.54	0.89	1.37	2
0.32	0.06	5	22.4	26.2	29.1	4.23	1.49	0.87	1.41	1
0.24	0.04	6	23.4	25.6	29.6	4.19	1.55	0.89	1.36	1
0.19	0.04	5	23.9	25.4	30.4	3.92	1.60	0.91	1.31	2
0.13	0.04	3	17.1	27.2	31.2	4.66	1.07	0.62	1.37	3

Clay B/A - 1.1 Weighted - 1.1

PROFILE Nº ISCW-BR 7
SAMPLE Nº 77.0529/36

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	CN FE & CN MN	MG & IL	QZ	CD + OP + QZF	CH & OF	CL	OF	RU					
SANDS (2-.05 mm)													
Ap	20%	75%	4%		1%	tr							
A3	8%	89%	3%	tr		tr	tr						
B1	20%	75%	5%	tr		tr	tr						
B21	5%	91%	3%	1%		tr	tr	tr					
B22	10%	84%	5%	1%		tr							
B23	38%	51%	10%	1%		tr	tr						
B3/C	58%	40%	2%	tr		tr	tr						
C	70%	30%		tr		tr	tr						
GRAVELS (>2 mm)													
	90%		10%	tr		tr							
	97%		3%	tr		tr							
	95%		5%										
	97%		3%										
	99%		1%	tr									
	90%		10%				tr						
	100%		tr										
	100%		tr										

Mineral Code : CN FE - iron concretions; CN MN - manganose concretions; MG - magnetite; IL - ilmenite; QZ - quartz; CD - chalcedony; OP - opal; QZF - quartz fragments; CH - charcoal; OF - organic fragments; CL - chlorite; RU - rutile

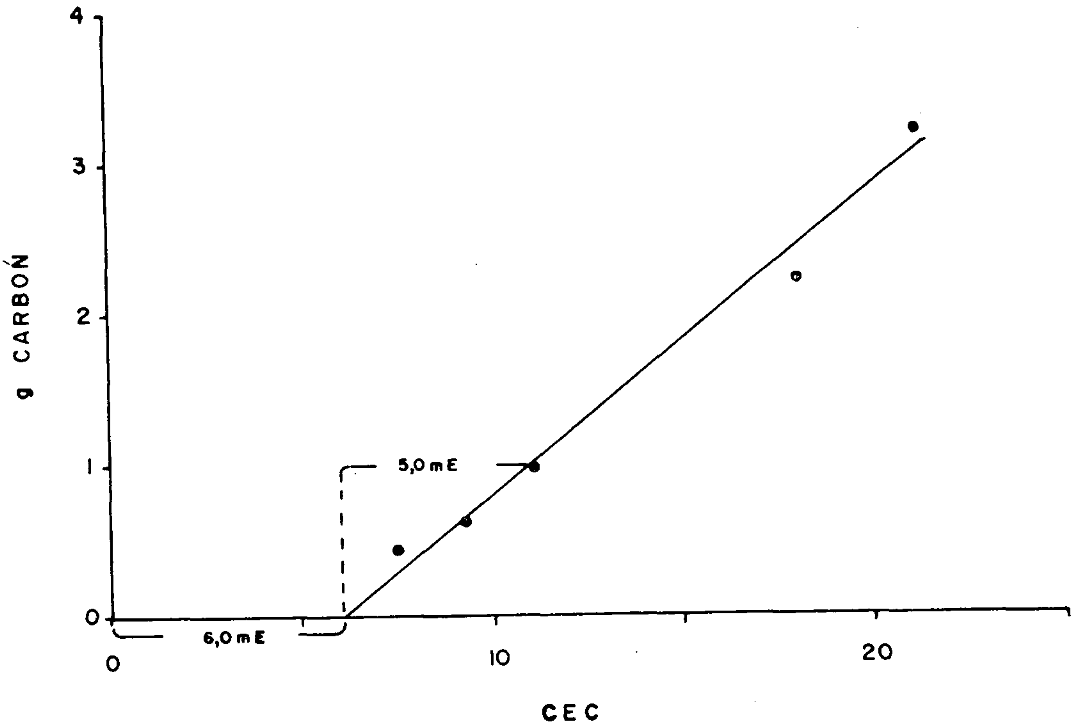


Fig. 21 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-7.

Discussion

The profile described in the tour guide was not shown. The profile studied instead was generally classified as a Typic Eutrorthox, assuming that the base saturation is high enough.

PROFILE ISCW-BR 8 DESCRIBED AND SAMPLED - 5 Mar 1977

CLASSIFICATION - TERRA ROXA ESTRUTURADA DISTRÓFICA A moderado textura argilosa fase floresta subtropical perenifólia relevo ondulado (TERRA ROXA ESTRUTURADA DYSTROPHIC* moderate A horizon, clayey, evergreen subtropical forest rolling phase).

Orthoxic Palehumult or (Rhodic) Palehumult or Tropeptic Haplorthox; clayey oxidic, thermic.

Humic Nitosol.

Sol ferrallitique; moyennement désaturé, typique, humique, dérivé de diabase.

LOCATION - Ortigueira, PR. 144 km from Londrina in the highway to Ponta Grossa, right side; 24°20'00" S 50°49'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at upper third of slope, 10% slope, under grass vegetation; rolling; 850 meters.

PRIMARY VEGETATION - Evergreen subtropical forest.

GEOLOGY AND PARENT MATERIAL - Diabase, Upper Triassic; weathering residues of stated rock.

DRAINAGE - Well drained.

PRESENT LAND USE - Pasture and reforestation.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	23.1	23.0	21.8	19.1	16.0	14.6	14.6	16.2
P mm	157	124	122	104	94	124	95	78
	Sept	Oct	Nov	Dec				
T°C	17.8	19.6	21.1	22.3	Mean	19.1		
P mm	150	182	136	183	Total	1549		
		Thermic			Udic			

Ap - 0 - 10 cm, dark reddish brown (5 YR 3/4, moist), reddish brown (5 YR 4/4, dry); clay; moderate fine to coarse granular and weak fine to medium subangular blocky; many very fine and fine, and some coarse pores; slightly hard, friable, plastic and sticky; clear and smooth boundary.

B1t - 10 - 23 cm, dark reddish brown (4 YR 3/5); clay; moderate prismatic breaking easily to strong fine to medium subangular and angular blocky; common moderate clay films; common very fine, fine and some coarse pores; hard, friable, plastic and sticky; gradual and smooth boundary.

B21t - 25 - 73 cm, dark red (2.5 YR 3/6); clay; moderate prismatic breaking easily to strong medium to coarse angular and subangular blocky; common moderate clay films; common very fine and fine pores; very hard, friable, plastic and sticky; diffuse and smooth boundary.

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* Low clay activity implied.

B22t - 73 - 168 cm, dark red (2.5 YR 3.5/6); clay; moderate prismatic breaking easily to strong medium to coarse angular and subangular blocky; common moderate clay films; common very fine and fine pores; very hard, friable, plastic and sticky; diffuse and smooth boundary.

B23t - 165 - 229 cm, red (2.5 YR 4/6); clay; weak fine to coarse subangular blocky appears massive porous slightly coherent in place; few weak clay films; many very fine and fine pores; hard, friable, plastic and sticky; gradual and smooth boundary.

B3t - 229 - 260 cm$^+$, red (2.5 YR 4/8), few fine and prominent mottles of white (5 YR 8/1), black (N 2/) and yellowish brown (10 YR 5/6); clay; weak fine to coarse subangular blocky appears massive porous in place; many very fine and fine pores; slightly hard, very friable, slightly plastic to plastic and sticky.

REMARKS - Plentiful roots in Ap, common in B1t and B21t, few in B22t and very few in B3t.

Some brown and black spots, ± 1 mm in diameter of weathered parent material in B23t.

Profile moist.

PROFILE Nº ISCW-BR 8

SAMPLE Nº 77.0713/18 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS ~~NaOH~~ CALGON % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 10	-	tr	100	6	12	30	52	40	15	0.58
B1t	- 25	-	tr	100	6	11	22	61	50	15	0.36
B21t	- 73	-	tr	100	4	8	19	69	-	100	0.27
B22t	-168	-	tr	100	4	9	22	65	-	100	0.34
B23t	-229	-	tr	100	6	11	34	49	-	100	0.69
B3t	-260+	-	-	100	7	12	39	42	-	100	0.93

pH (1:2.5) H2O	pH KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.9	5.0	6.7	2.1	0.36	0.07	9.2	-	5.0	14.2	65	-
5.3	4.4	3.4	1.3	0.09	0.04	4.8	0.3	5.1	10.2	47	6
5.3	4.4	1.5	0.9	0.03	0.05	2.5	0.4	4.7	7.6	33	14
5.5	4.4	0.6	0.8	0.03	0.05	1.5	0.4	3.8	5.7	26	21
5.5	4.2	0.7		0.05	0.05	0.8	1.8	3.1	5.7	14	69
5.2	4.0	0.7		0.06	0.05	0.8	2.2	3.4	6.4	13	73

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
2.50	0.27	9	19.9	16.4	19.5	3.85	2.06	1.17	1.33	
1.41	0.16	9	20.6	18.8	20.9	3.79	1.86	1.09	1.41	
0.93	0.11	8	23.3	21.3	20.0	3.16	1.86	1.16	1.67	
0.48	0.07	7	24.0	21.3	19.9	3.01	1.92	1.20	1.68	
0.20	0.04	5	24.5	20.9	21.0	3.44	1.99	1.21	1.56	
0.13	0.03	4	24.8	20.3	21.1	3.80	2.08	1.25	1.51	

Clay B/A - 1.2 Weighted - 1.2

PROFILE Nº ISCW-BR 8
SAMPLE Nº 77.0713/18

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	CN FE & CN MN	QZ	MG & IL	MG	IL	OF	MS & BT	CL	FK	CN ARG	RF	WE BT	
					SANDS (2-.05 mm)								
Ap	5%	59%		30%	4%	2%							
B1t	4%	54%		40%	2%	tr		tr				tr	
B21t	10%	45%	45%			tr		tr				tr	
B22t	15%	40%	43%				2%	tr		tr			
B23t	20%	30%	50%			tr	tr						
B3t	30%	30%		40%		tr			tr			tr	
					GRAVELS (>2 mm)								
	100%	tr											
	100%	tr											
	100%	tr									tr		
	100%					tr					tr		
	100%										tr		
	100%												

Mineral Code : CN FE - iron concretions; CN MN - manganose concretions; QZ - quartz; MG - magnetite; IL - ilmenite; OF - organic fragments; MS - muscovite; BT - biotite; CL - chlorite; FK-potassium feldspar; CN ARG - argillaceous concretions; WE BT - weathered biotite; RF - rock fragments

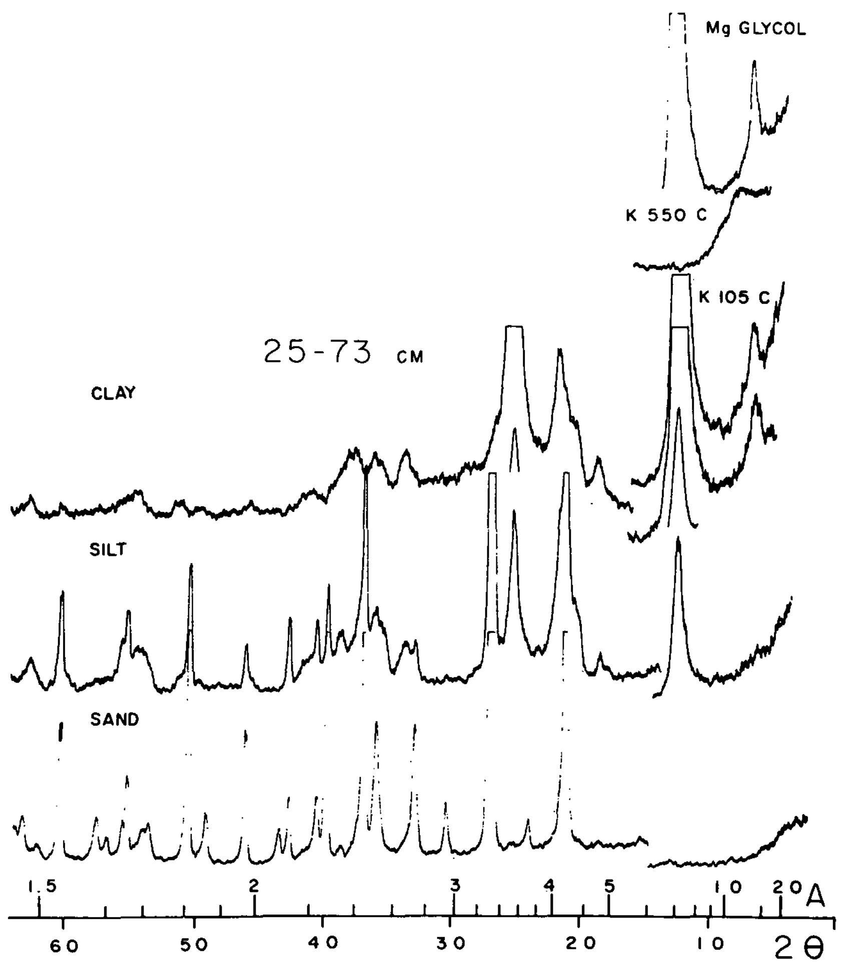

Fig- 22 - X-Ray diffraction patterns of the clay, silt and sand from B21t horizon of the profile BR-8.

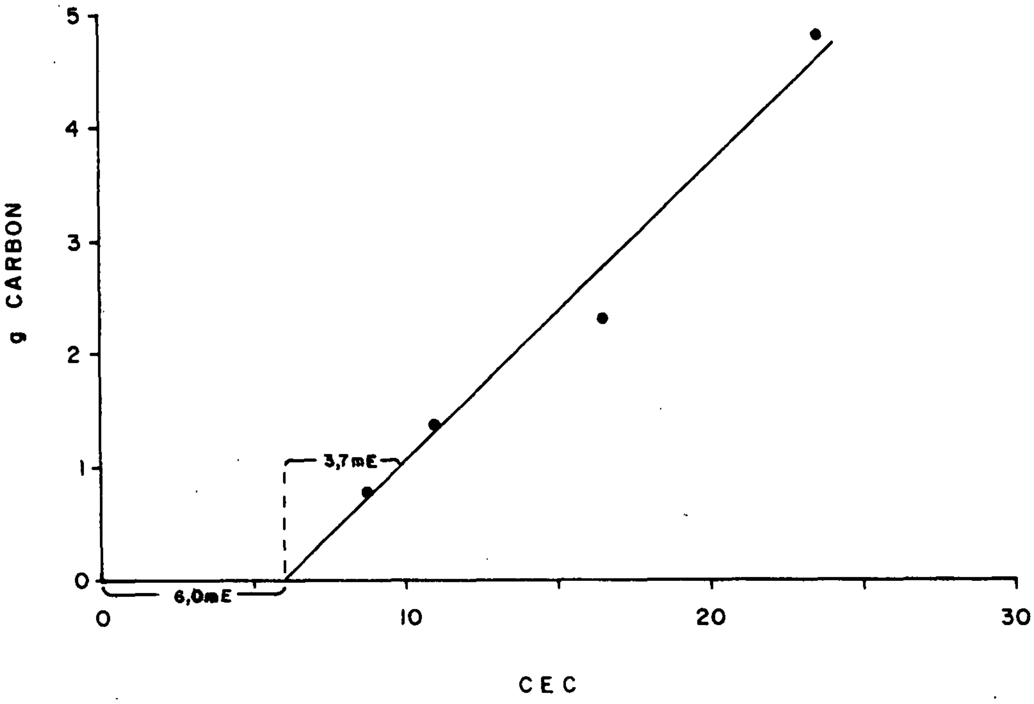

Fig.23 - Carbon and CEC relation to 100g clay, by graphic method (Bennema, 1966). Profile BR-8.

Discussion

1. The calculated NH_4OAc-CEC per 100 g clay is around 16 or somewhat higher for most of the B horizon. Only the horizon from 73 to 168 cm has a distinctly lower CEC.

2. There is an increase of more than 8 percent clay from the Ap to the B1t horizon. The presence of clay skins was noted by Smith, but not accepted by Isbell and Eswaran. A sample for a thin section was taken by Sombroek.

3. Assuming a bulk density of 1.2 g/cm^3, the pedon would have 12.4 kg organic C per m^3. It also has more than 0.9 percent organic C in the B horizon to a depth of 73 cm.

The alternatives for classification are: Tropeptic Haplorthox or Orthoxic (or Rhodic) Palehumult. If an Ultisol, it would be a "deep" subgroup with low Al saturation of Kandihumults as proposed by the committee. However, the management properties of this soil are favorably influenced by the high specific surface of Fe oxides and the classification should reflect this (Moormann, Juo, Uehara). The separation of this kind of soils developed from fine grained basic rocks like basalt, diabase, etc. and with the ensuing high specific surface of Fe oxides was discussed. It was proposed to consider the introduction of a new great group parallel to the "Kandi" great group.

PROFILE ISCW - BR 9 DESCRIBED AND SAMPLED - 24 Mar 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO argila de atividade baixa abrúptico A moderado textura arenosa/média fase floresta subtropical subperenifólia relevo ondulado (RED-YELLOW PODZOLIC ALIC*, low clay activity, abruptic, moderate A horizon, sandy/loamy, semi-evergreen subtropical forest rolling phase).

Typic Paleudult; coarse loamy, mixed, thermic.

Dystric Nitosol. ?

Sol ferrallitique; fortement désaturé, appauvri, modal, dérivé de grès.

LOCATION - Tibagi, PR. 63 km from Ponta Grossa in the highway to Londrina, about 300 m from Capivari Mirim river, 50 m right side; 24°47'00" S 50°30'00" W.

TOPOGRAPHIC POSITION - Trench at lower third of hillside, 10% slope, under pasture; rolling; 780 meters.

PRIMARY VEGETATION - Semi-evergreen subtropical forest with Araucaria pines, intermingled with natural grassland.

GEOLOGY AND PARENT MATERIAL - Sandstone, Devonian; weathering residues of stated rock.

DRAINAGE - Well drained.

PRESENT LAND USE - Pasture, soybean, corn and bean crops.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	21.4	21.1	20.3	17.4	15.2	13.9	13.5	15.1
P mm	167	162	114	80	92	81	80	

	Sept	Oct	Nov	Dec		
T°C	16.2	17.8	19.2	20.5	Mean	17.6
P mm	121	140	123	145	Total	1401
		Thermic			Udic	

Ap1 - 0 - 16 cm, grayish brown (10 YR 5/2, moist), pale brown (10 YR 6/3, dry); loamy sand; weak very fine to fine granular and single grains; many very fine and fine, common medium and some coarse pores; loose, slightly plastic and slightly sticky; gradual and smooth boundary.

Ap2 - 16 - 27 cm, brown (10 YR 5/3, moist), light gray (10 YR 7/2, dry), few fine and distinct mottles of white (10 YR 8/2); loamy sand; weak very fine to fine granular, subangular blocky and single grains; many very fine to fine, medium and some coarse pores; loose, slightly plastic and slightly sticky; abrupt and wavy boundary (7-15 cm).

B21t - 27 - 47 cm, yellowish red (5 YR 5/6); sandy loam; weak fine to medium subangular blocky and very fine granular appears massive porous in place; many very fine and fine pores; very friable, plastic and sticky; diffuse and smooth boundary.

* Epieutrophic (some fertilizer applied).

B22t - 47 - 78 cm, yellowish red (4 YR 5/8); sandy loam; weak fine to medium subangular blocky and very fine granular appears massive porous in place; many very fine and fine pores; very friable, plastic and sticky; diffuse and smooth boundary.

B23t - 78 - 117 cm, red (3.5 YR 4/7); sandy loam; weak fine to medium subangular blocky and very fine granular appears massive porous in place; many very fine to fine pores; very friable, plastic and sticky; diffuse and smooth boundary.

B24t - 117 - 230 cm, red (3 YR 4/7); sandy loam; weak fine to medium subangular blocky appears massive porous in place; discontinuous weak clay films in some pores; many very fine and fine pores; very friable, plastic and sticky.

B3 - 230 - 330 cm, yellowish red (5 YR 5/6), common distinct mottles of yellow (10 YR 7/6) and reddish yellow (7.5 YR 6/6); sandy loam; slightly plastic and slightly sticky.

C - 330 - 390 cm+, variegated color of yellow (10 YR 7/6), light yellowish brown (10 YR 6/4), light red (3.5 YR 6/6), red (2.5 YR 4/6); sandy loam; nonplastic and nonsticky.

REMARKS - Abundant roots in Ap1 and Ap2, common in B21t and few in B22t, B23t and B24t.

Scattered spots of washed sands in Ap2.

Coatings of organic matter in B21t, B22t and B23t.

Trench 1.70 m deep, bucket auger downward. Profile moist.

PROFILE Nº ISCW-BR 9
SAMPLE Nº 77.0719/26 SNLCS

HORIZON	DEPTH cm	GRVL 20-2 mm %	FINE EARTH <2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY	BULK DNST	PRTCL DNST	TOTAL PORO-SITY %
Ap1	0- 16	tr	100	14	67	8	11	7	36	0.73	1.52	2.60	42
Ap2	- 27	tr	100	15	66	8	11	7	36	0.73	1.62	2.60	38
B21t	- 47	tr	100	14	58	12	16	13	19	0.75	1.51	2.60	42
B22t	- 78	tr	100	14	57	11	18	16	11	0.61	1.56	2.60	40
B23t	-117	tr	100	12	58	12	18	15	17	0.67	1.49	2.63	43
B24t	-230	tr	100	12	58	12	18	-	100	0.67	1.46	2.63	44
B3	-330	tr	100	24	52	12	12	-	100	1.00			
C	-390+	tr	100	24	52	12	12	-	100	1.00			

pH (1:2.5) H2O	KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
6.1	5.2	1.6	0.4	0.13	0.05	2.2	-	1.3	3.5	63	-
6.2	5.3	1.4	0.5	0.09	0.05	2.0	-	1.2	3.2	63	-
5.9	4.6	0.6	0.8	0.08	0.05	1.5	-	1.9	3.4	44	-
5.0	4.0	0.4		0.06	0.05	0.5	1.0	1.7	3.2	16	67
5.0	4.1	0.1		0.06	0.04	0.2	1.0	1.8	3.0	7	83
5.0	4.0	0.1		0.06	0.04	0.2	0.8	1.0	2.0	10	80
4.9	4.1	0.1		0.04	0.04	0.2	1.2	0.5	1.9	11	86
4.8	4.1	0.1		0.03	0.04	0.2	1.2	0.5	1.9	11	86

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
0.66	0.07	9	3.4	3.5	1.0	0.08	1.65	1.40	5.44	12
0.61	0.07	9	3.7	4.0	1.0	0.08	1.57	1.27	6.22	4
0.44	0.05	9	5.6	6.3	1.5	0.13	1.51	1.31	6.51	1
0.32	0.04	8	6.0	6.8	1.7	0.13	1.50	1.29	6.29	1
0.24	0.04	6	6.3	7.4	1.8	0.13	1.45	1.25	6.42	1
0.14	0.04	4	7.1	7.6	1.7	0.11	1.59	1.39	7.03	1
0.06	0.03	2	8.1	6.8	1.3	0.05	2.02	1.80	8.23	1
0.05	0.03	2	8.1	6.4	1.4	0.03	2.15	1.89	7.13	1

Clay B/A - 1.6 Weighted - 1.6

PROFILE Nº ISCW-BR 9
SAMPLE Nº 77.0719/26

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE	OF	IL	TM	MS	ZR	FK	RU	CL	BT	MG	
SANDS (2-.05 mm)													
Ap1	98%	tr	2%	tr	tr	tr	tr	tr					
Ap2	100%	tr	tr	tr	tr		tr		tr				
B21t	100%	tr	tr	tr	tr		tr		tr				
B22t	100%	tr	tr		tr		tr			tr			
B23t	100%	tr	tr	tr	tr		tr		tr	tr			
B24t	100%	tr	tr	tr	tr	tr	tr		tr				
B3	100%	tr	tr	tr	tr	tr	tr		tr		tr		
C	100%	tr					tr						
GRAVELS (>2 mm)													
	tr	100%	tr									.tr	
	5%	95%											
	50%	50%	tr										
	50%	50%	tr										
	30%	70%	tr										
	10%	90%											
	50%	50%											
	tr	100%											

Mineral Code : QZ - quartz; CN FE - iron concretions; OF - organic fragments; IL - ilmenite; TM -tourmaline; MS - muscovite; ZR - zircon; FK - potassium feldspar; RU - rutile; CL - chlorite; BT - biotite; MG - magnetite

SOIL CLASSIFICATION-INTERNATIONAL SOIL CLASSIFICATION WORKSHOP
BRAZILIAN SOIL
SERIES - - - - - - -

SOIL NO - - - - - - - ISCW-BR19 COUNTY - - -

GENERAL METHODS- - -1A,1B1B,2A1,2B

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, MTSC
NATIONAL SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA

SAMPLE NOS. 77P1262-77P1266 DECEMBER 1977

DEPTH CM	HORIZON	SAND 2-.05	SILT .05-.002	CLAY LT .002	FINE CLAY LT .0002	VCOS 2-1	CORS 1-.5	MEDS .5-.25	FNES .25-.10	VFNS .10-.05	COSI .05-.02	FNSI .02-.002	VFSI .005-.002	SAND 2-.1	INTR II .2-.02	FINE CLAY TO CLAY PCT	NON-CO3-CLAY PCT	RATIO 8D1 15-BAR TO CLAY
		(- - - - PARTICLE SIZE ANALYSIS, LT 2MM, 3A1, 3A1A, 3A1B - - - -			FINE (- - - SAND - - -)(- - -SILT- - -)													
		(- - - - PCT LT 2MM - - - -)																
0-20	A1	66.3	21.6	12.1		7.1	10.3	10.6	22.3	16.0	8.7	12.9		50.3				.62
20-38	A2	59.1	22.4	18.5		12.4	10.3	7.6	14.7	14.1	10.1	12.3		45.0				.50
38-52	2B2TP1	30.2	21.3	48.5		4.2	7.0	4.7	7.1	7.2	6.8	14.5		23.0				.42
52-82	2B3TP1	33.0	25.5	41.5		4.2	6.6	4.8	9.2	8.2	7.0	18.5		24.8				.43
82-100	2CP1	62.4	15.7	21.9		10.0	15.6	8.7	17.6	10.5	4.8	10.9		51.9				.43

DEPTH CM	VOL. GT 2 PCT	WEIGHT GT 75 PCT	75-20	20-5	5-2	LT .074	2C-2 PCT LT20	4A1D 1/3-BAR G/CC	4A1H OVEN DRY G/CC	4D1 COLE	4B1C 1/10 BAR PCT	4B1C 1/3-BAR PCT	4B2 15-BAR PCT	4C1 WRD CM/CM	PH 8C1C 1/1 KCL	CARBONATE 6E1B LT 2 PCT	3A1A LT .002 PCT	PH 8C1A 1/1 H2O	PH 8C1E 1/2 CACL
	(PARTICLE SIZE ANALYSIS, MM, 3B, 3B1, 3B2)		(- - - PCT LT 75 - - -)					(BULK DENSITY)			(- - - -WATER CONTENT-)								
0-20													7.5		3.9			4.8	4.2
20-38													9.3		3.8			4.9	4.1
38-52													20.4		3.9			4.9	4.3
52-82													18.0		4.3			5.1	4.5
82-100													9.5		4.5			5.4	4.9

DEPTH CM	(ORGANIC MATTER) 6A1A ORGN CARB PCT	6B1A NITG PCT	C/N	IRON 6C2B EXT FE PCT	PHOS TOTL PCT	6N2E CA	6O2D MG	6P2B NA	6Q2B K	SUM EXTB	ACTY 6H1A BACL TEA	AL 6G1E KCL EXT	(CAT EXCH) 5A3A EXTB ACTY	5A6A NHAC	RATIO 8D1 NHAC TO CLAY	RATIO 8D3 CA TO MG	CA 5F1 SAT NHAC PCT	(BASE SAT) 5C3 EXTB ACTY PCT	5C1 NHAC PCT
						(- -EXTRACTABLE BASES 5B4A- -)													
						(- - - - -MEQ / 100 G- - - - -)													
0-20	1.64	.094	17	.9		.9	1.1	.0	.3	2.3	7.2	.8	9.5	7.9	.65	.8	11	24	29
20-38	.93	.062	15	1.4		.3	1.0	.0	.2	1.5	6.7	1.3	8.2	7.9	.43	.3	4	18	19
38-52	.78	.062	13	6.1		.1	3.4	.1	.2	3.8	9.5	1.1	13.3	11.1	.23		1	29	34
52-82	.34			6.3		.1	3.3	.1	.3	3.8	7.0	.4	10.8	9.1	.22		1	35	42
82-100	.14			1.5		.1	2.3	.2	.2	2.8	3.0	TR	5.8	5.5	.25		2	48	51

SAND MINERALOGY (7B1) PLACEMENT:
038-052 VFNS - RE69 QZ47 OP41 TM1 FK1 MI10 PR PO.
RELATIVE AMOUNTS: AS PERCENT
MINERAL CODE: RE = RESISTANT MINERALS OP = OPAQUE PO = PLANT OPAL PR = PYROXENE QZ = QUARTZ TM = TOURMALINE
FK = POTASSIUM FELDSPAR MI = MICA.

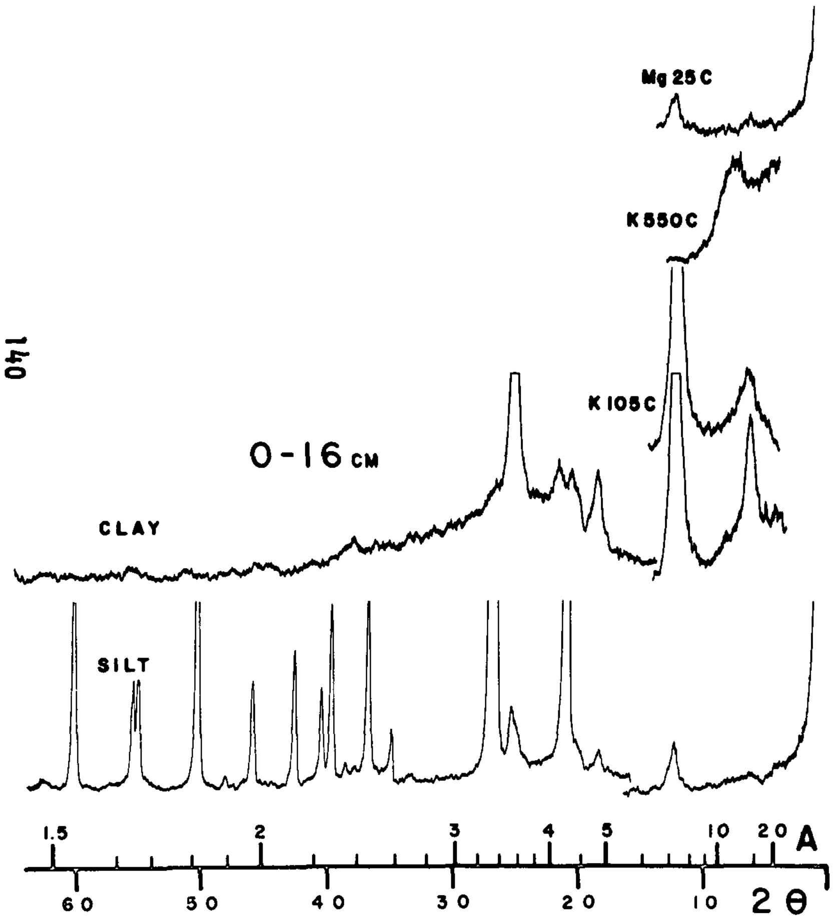

Fig. 24 - X-Ray diffraction patterns of the clay and silt from Ap1 horizon of the profile BR-9.

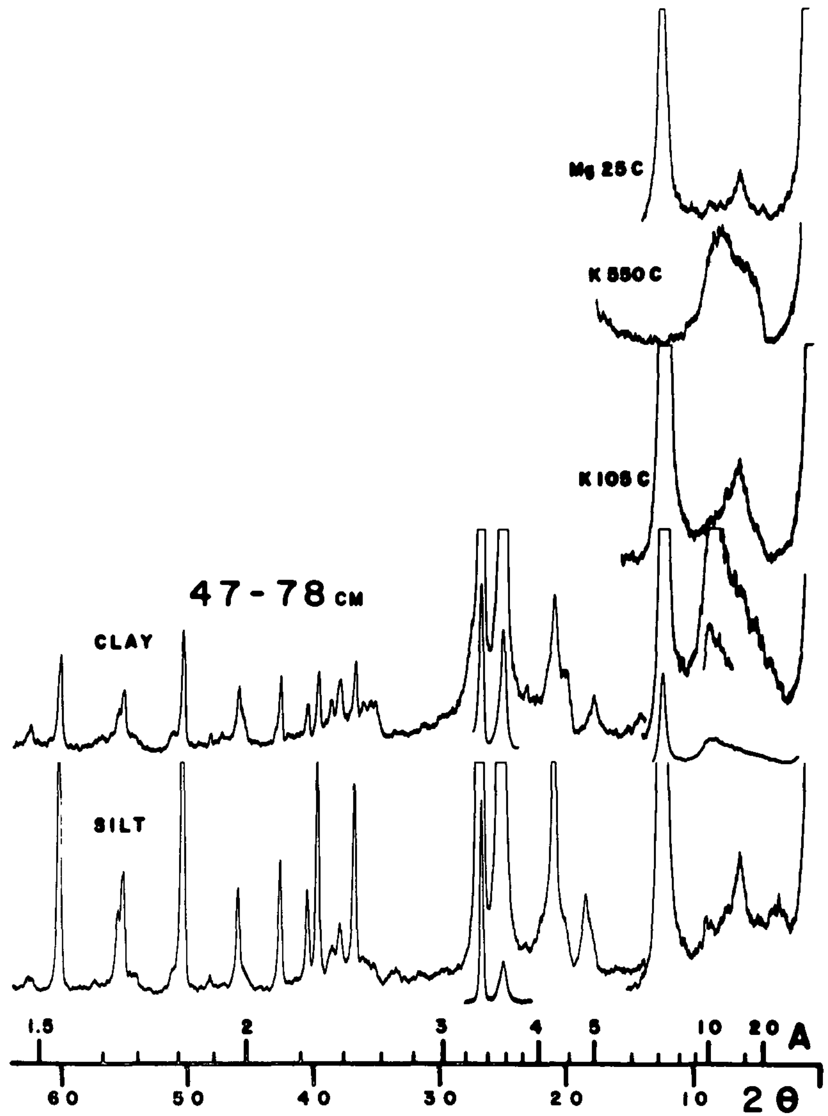

Fig. 25 - X-Ray diffraction patterns of the clay and silt from B22t horizon of the profile BR-9

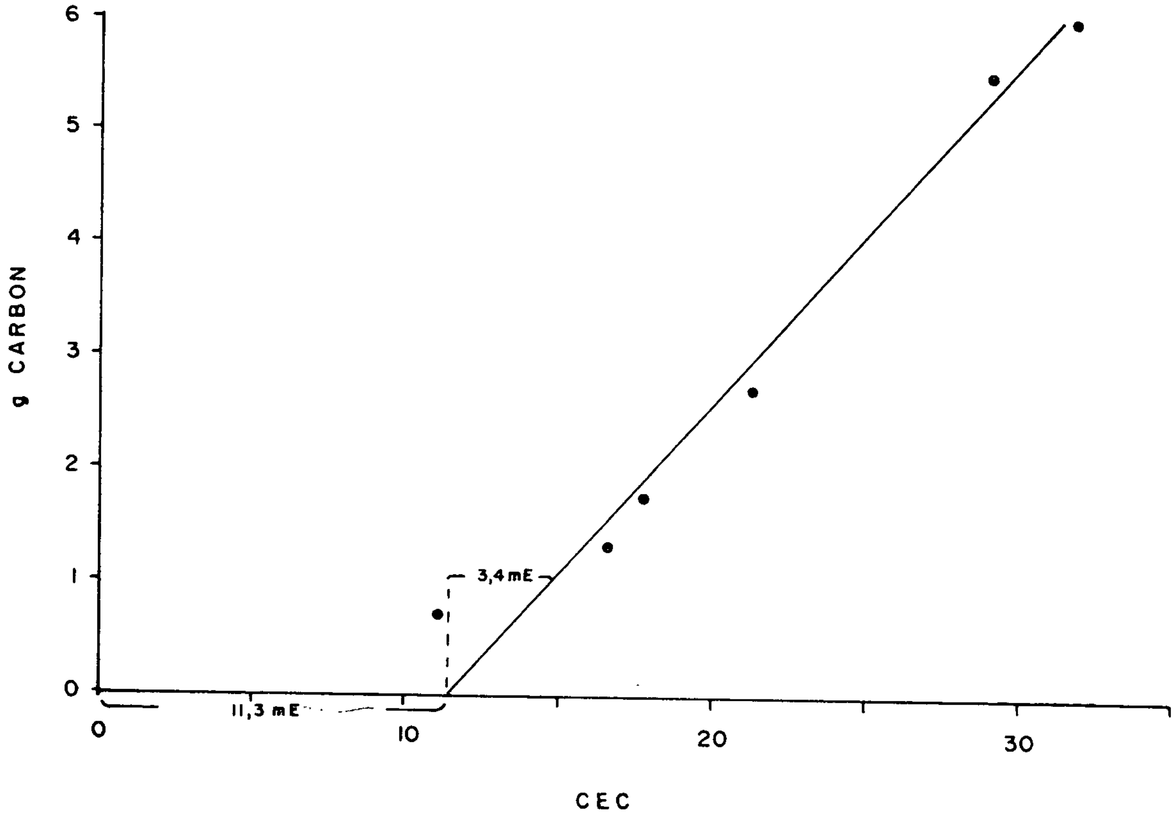

Fig. 26 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-9.

Discussion

1. The calculated NH_4OAc-CEC per 100 g clay is well above 24 meq for the B21t horizon and slightly more than 24 meq for the B22t horizon; it is lower in the horizons below 78 cm. This excludes this pedon from the Oxisols and also from the Kandi-groups, if a diagnostic depth of the major part of the upper 50 cm of the argillic horizon is accepted.

2. It is generally agreed that an argillic horizon is present in this profile (Isbell, Dudal and others).

3. The soil, although belonging to a coarse loamy family, is not sandy enough for placement in a psammentic subgroup (Buol, Nichols, Schargel).

4. The pedon has a mixed mineralogy, bordering on kaolinitic (Ikawa).

5. The Al saturation in the B horizon is high, hence the designation as alic in the Brazilian system.

The classification of this soil as Typic Paleudult, coarse loamy, mixed, isohyoerthermic would not be affected by the proposals of the committee.

PROFILE ISCW-BR 10 DESCRIBED AND SAMPLED - 1 Apr 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO argila de atividade baixa câmbico A moderado textura argilosa fase floresta subtropical perenifólia relevo ondulado (RED-YELLOW PODZOLIC ALIC, low clay activity, cambic, moderate A horizon, clayey, evergreen subtropical forest rolling phase).

Typic Haplohumult; clayey, kaolinitic, thermic.

Humic Cambisol ?

Sol ferrallitique; fortement désaturé, typique, humique, dérivé de roches métamorphiques acides.

LOCATION - Campo Largo, PR. km 27 from Curitiba in the highway to Ponta Grossa, left side; 25°27'00" S 49°35'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at medium third of hillside, 14% slope, under grass vegetation; rolling and hilly; 940 meters.

PRIMARY VEGETATION - Evergreen subtropical forest.

GEOLOGY AND PARENT MATERIAL - Acidic metamorphic rocks, phyllites or gneisses with quartzites, Precambrian Complex; transported material derived from stated bedrock.

DRAINAGE - Well drained.

PRESENT LAND USE - Pasture, corn and peach crops.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	20.1	20.1	19.2	16.8	14.5	13.2	12.5	14.0
P mm	198	173	124	78	85	87	81	83
	Sept	Oct	Nov	Dec				
T°C	14.8	16.2	17.4	18.9	Mean	16.5		
P mm	119	130	105	147	Total	1410		
		Thermic			Udic			

Ap1 - 0 - 15 cm, dark brown (10 YR 4/3, moist); clay; weak very fine and fine granular and weak fine to medium subangular blocky; very fine medium and some coarse pores; very friable, plastic and sticky; gradual and smooth boundary.

Ap2 - 15 - 30 cm, dark grayish brown (10 YR 4/2, moist); clay; weak very fine to fine granular and weak fine to medium subangular blocky; many very fine to medium and some coarse pores; very friable, plastic and sticky; gradual and smooth boundary.

A3 - 30 - 43 cm, dark yellowish brown (10 YR 4/4, moist); clay; weak fine to medium subangular blocky; many very fine and fine, and common medium pores; very friable, plastic and sticky; clear and smooth boundary.

IIB1t - 43 - 52 cm, dark yellowish brown (10 YR 4/4); very gravelly clay; moderate fine to medium subangular blocky; common moderate clay films; many very fine to medium pores; friable, plastic and sticky; clear and smooth boundary.

IIIB21t - 52 - 84 cm, brown (8.5 YR 5/4); silty clay; moderate to strong prismatic breaking easily to strong medium to coarse subangular and angular blocky; continuous and moderate to strong clay films; common very fine and fine, some medium to coarse pores; friable, plastic and sticky; diffuse and smooth boundary.

IIIB22t - 84 - 113 cm, yellowish red (5 YR 5/6); silty clay; moderate prismatic breaking easily to strong medium and coarse subangular and angular blocky; continuous and moderate to strong clay films; common very fine and fine, and some medium to coarse pores; friable, plastic and sticky; gradual and wavy boundary (26-34 cm).

IVB3t - 113 - 142 cm, yellowish red (4.5 YR 4/6); silty clay loam; weak prismatic breaking easily to moderate medium to coarse subangular and angular blocky; few weak to moderate clay films; many very fine and fine pores; very friable, plastic and sticky; gradual and wavy boundary (17-41 cm).

IVC1 - 142 - 190 cm, reddish brown (2.5 YR 5/4), few fine and prominent mottles of very pale brown (10 YR 8/3), yellowish brown (10 YR 5/6) and few fine diffuse mottles of weak red (2.5 YR 4/2); silt loam; weak fine to medium subangular blocky appears massive in place; very friable, slightly plastic and slightly sticky.

IVC2 - 198 - 250 cm^{+}, variegated color of reddish brown (2.5 YR 5/4), very pale brown (10 YR 8/3), yellowish brown (10 YR 5/6), weak red (2.5 YR 4/2), white (10 YR 8/1); silt loam; appears structureless exposing phyllitic or gneissic strucutre of metamorphic rock in variable degrees of decomposition; many very fine and fine pores; very friable, slightly plastic and nonsticky.

REMARKS - Plentiful roots in Ap1 and Ap2, common in A3 and IIB1t, few in IIIB21t and IIIB22t, and very few in IVB3t.

Stone line in IIIB1t and between IIIB22t and IVB3t.

Darker color channel fillings with material from upper horizons in IIIB21t.

Profile wet after rain.

PROFILE Nº ISCW-BR 10
SAMPLE Nº 77.0753/61 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~SALCON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap1	0- 15	1	1	98	4	13	37	46	27	41	0.80
Ap2	- 30	2	-	98	5	12	35	48	29	40	0.73
A3	- 43	-	3	97	6	12	33	49	31	37	0.67
IIB1t	- 52	4	3	97	6	11	33	50	43	14	0.66
IIIB21t	- 84	-	8	92	3	9	41	47	-	100	0.87
IIIB22t	-113	1	5	94	3	10	42	45	-	100	0.93
IVB3t	-142	-	7	93	2	8	51	39	-	100	1.31
IVC1	-198	-	-	99	1	8	66	25	-	100	2.64
IVC2	-250+	-	tr	100	tr	21	64	15	-	100	4.27

pH (1:2.5) H2O	pH KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.5	3.8		0.4	0.29	0.04	0.7	4.7	9.9	15.3	5	87
4.6	3.9		0.2	0.16	0.04	0.4	4.4	8.8	13.6	3	92
4.7	3.9		0.1	0.13	0.05	0.3	3.8	7.2	11.3	3	93
4.8	3.9		0.1	0.12	0.06	0.3	3.3	6.1	9.7	3	92
5.0	4.0		0.1	0.07	0.04	0.2	2.9	3.7	6.8	3	94
5.1	4.0		0.1	0.06	0.04	0.2	2.2	3.0	5.4	4	92
5.2	4.0		0.1	0.05	0.04	0.2	2.0	2.2	4.4	5	91
5.3	4.0		0.1	0.04	0.04	0.2	1.9	2.0	4.1	5	90
5.3	4.1		0.1	0.03	0.04	0.2	1.5	1.4	3.1	6	88

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
2.72	0.21	13	18.6	17.1	6.9	1.14	1.85	1.47	3.89	1
1.98	0.18	11	18.7	17.6	7.3	1.24	1.81	1.43	3.78	1
1.27	0.12	11	19.0	18.1	7.3	1.28	1.78	1.42	3.89	1
0.95	0.10	10	19.4	18.7	7.7	1.25	1.76	1.40	3.81	1
0.40	0.07	6	22.5	19.5	7.6	1.17	1.96	1.57	4.03	1
0.19	0.06	3	24.8	20.6	8.1	1.14	2.05	1.64	3.99	1
0.09	0.05	2	23.5	19.8	8.1	0.99	2.02	1.60	3.94	1
0.05	0.05	1	23.5	18.7	8.0	1.03	2.14	1.61	3.67	1
0.02	0.04	1	19.1	15.6	7.1	0.89	2.08	1.61	3.44	1

Clay B/A - 1.0 Weighted - 1.0

PROFILE Nº ISCW-BR 10
SAMPLE Nº 77.0753/61

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	OF + CH	RF	CN FE & CN MN	IL	BT & MS	BT	TM	PY	MS	CN MG & MG	ZR	CN HU
SANDS (2-.05 mm)													
Ap1	82%	15%		1%	2%			tr			tr		
Ap2	93%	4%		1%	1%			1%			tr		
A3	96%	1%		1%	1%			1%		tr	tr		tr
IIB1t	97%	1%		1%	1%		tr	tr			tr		
IIIB21t	96%	tr		2%	1%			1%		tr	tr	tr	
IIIB22t	96%	tr		2%	1%			1%		tr	tr	tr	
IVB3t	97%			1%				1%		1%	tr	tr	
IVC1	93%		3%	1%	1%	1%		tr	1%		tr°	tr	
IVC2	93%	tr	3%	1%		2%		tr	1%		tr°		
GRAVELS (>2 mm)													
	100%	tr		tr									
	99%			1%									
	100%	tr		tr					tr				
	100%			tr				tr					
	100%	tr		tr							tr		
	100%	tr		tr									
	100%	tr		tr									
	100%			tr									
	96%	tr	2%	2%					tr				

Mineral Code : QZ - quartz; OF - organic fragments; CH - charcoal; RF - rock fragments; CN FE - iron concretions; CN MN - manganose concretions; IL - ilmenite; BT - biotite; MS - muscovite; TM - tourmaline; PY - pyrite; CN MG - magnetitic concretions; MG - magnetite; ZR - zircon; CN HU - humous concretions

° Magnetite

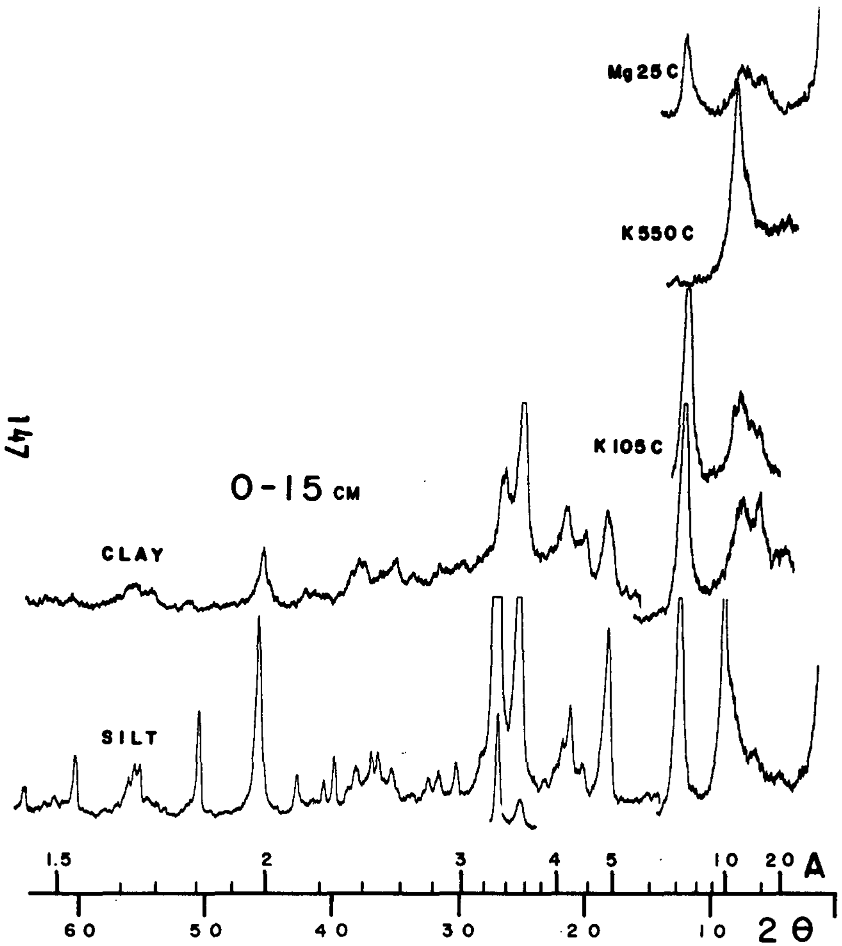

Fig. 27 - X-Ray diffraction patterns of the clay and silt from Ap1 horizon of the profile BR-10.

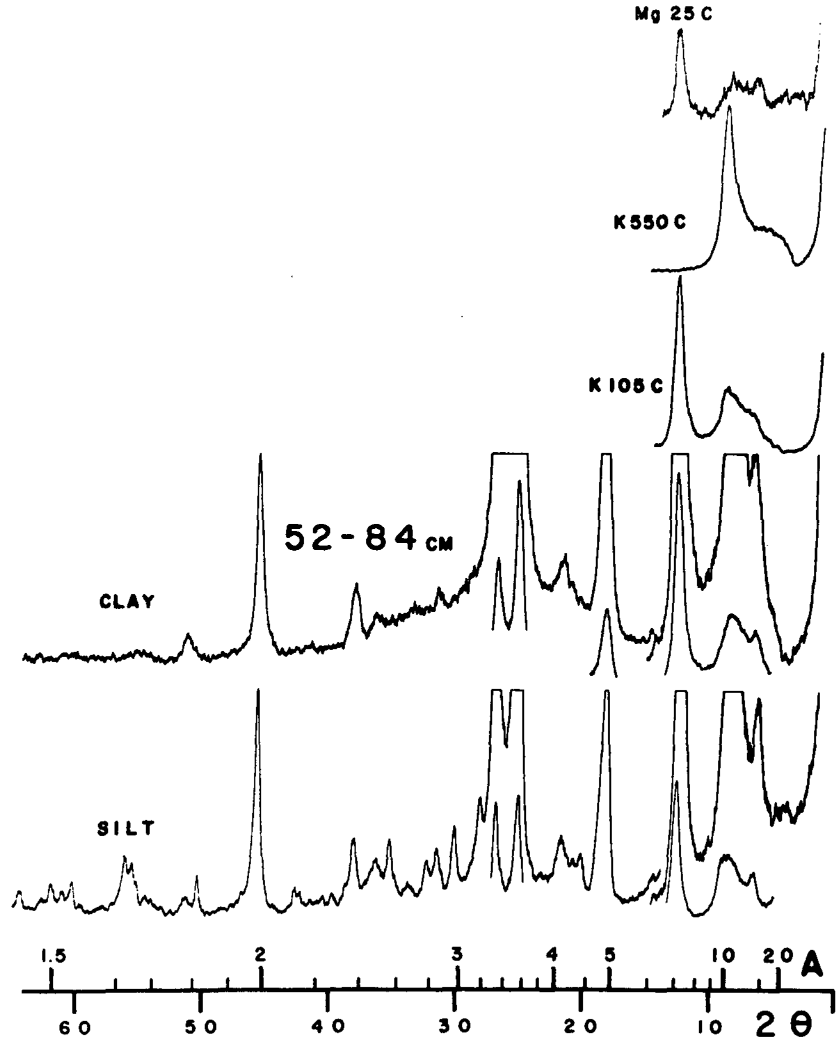

Fig. 28 - X-Ray diffraction patterns of the clay and silt from IIIB21t horizon of the profile BR-10.

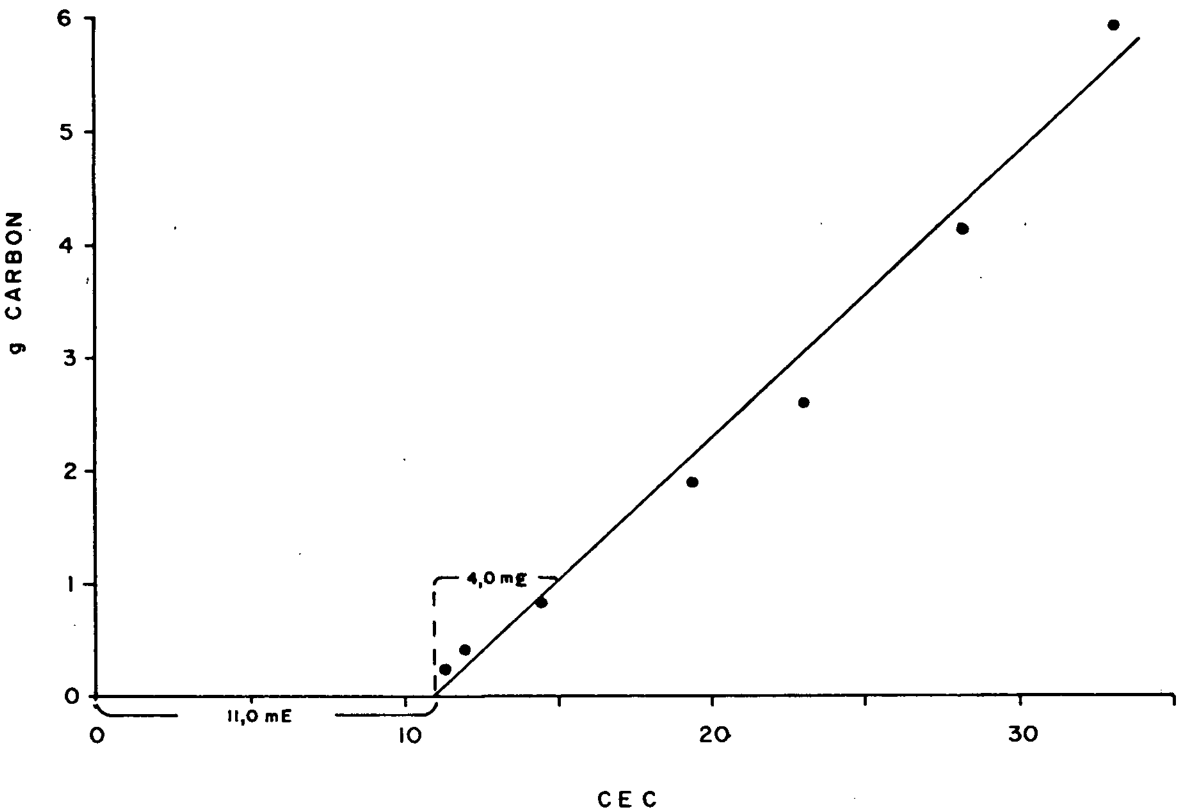

Fig. 29 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema,1966). Profile BR-10.

Discussion

This profile was not seen in the field. The following remarks are based on the data in the tour guide.

1. The classification as Ultisols appears correct in view of the cutans described.

2. The weighted average of the calculated NH_4OAc-CEC for the upper 50 cm of the B horizon is approximately 22 meq per 100 g clay. This soil would, therefore, belong to a Kandi great group if the limit is 24 meq, but not if it is 16 meq as proposed by Buol. According to the present definitions of Soil Taxonomy, it must be classified as a Typic Haplohumult as no oxic subgroups are recognized in this great group.

3. Assuming a bulk density of 1.2 g/cm^3, the organic C content in the upper m^3 is 13.2 kg. This pedon thus qualifies for a Humult.

4. The very high Al saturation should be noted.

PROFILE ISCW-BR 11 DESCRIBED AND SAMPLED - 30 Mar 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO argila de atividade baixa A moderado textura argilosa fase floresta tropical perúmida relevo forte ondulado (RED-YELLOW PODZOLIC ALIC, low clay activity, moderate A horizon, clayey, wet evergreen tropical forest hilly phase).

Typic Hapludult; clayey, kaolinitic, hyperthermic.

Ferric Acrisol.

Sol ferrallitique; fortement désaturé, typique, jaune, dérivé de migmatites.

LOCATION - Morretes, PR. Road Morretes-Curitiba, 1.8 km from the junction to Paranaguá, 50 m right side; 25°31'00" S 48°45'00" W.

TOPOGRAPHIC POSITION - Trench at lower third of hillside, 30% slope, under 2nd and 3rd grow forest; hilly; 50 meters.

PRIMARY VEGETATION - Wet evergreen forest.

GEOLOGY AND PARENT MATERIAL - Migmatites or gneisses, Precambrian Complex; weathering residues of stated rocks with surface reworking.

DRAINAGE - Moderately well drained ?

PRESENT LAND USE - Pasture, cassava and corn crops.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	24.9	24.8	24.2	22.0	19.7	18.1	17.1	17.7
P mm	281	331	250	168	115	92	59	79
	Sept	Oct	Nov	Dec				
T°C	18.5	20.0	21.6	23.4	Mean	21.0		
P mm	131	162	145	175	Total	1988		
		Hyperthermic			Perudic			

01 - 3 - 0 cm, leaves partially decomposed.

A1 - 0 - 10 cm, dark grayish brown (10 YR 4/2, moist); clay loam; moderate fine to medium granular; many very fine and fine, common medium and some coarse pores; very friable, plastic and sticky; clear and smooth boundary.

A3 - 10 - 23 cm, dark brown (8.5 YR 4/4); clay loam; weak fine to medium subangular blocky; many very fine and fine, common medium and some coarse pores; very friable, plastic and sticky; gradual and smooth boundary.

B1t - 23 - 40 cm, strong brown (7.5 YR 5/6); clay; prismatic breaking easily to moderate fine to medium subangular blocky; common moderate clay films; common very fine, fine and some medium pores; friable, plastic and sticky; diffuse and smooth boundary.

B21t - 40 - 70 cm, yellowish red (6 YR 5/6); clay; prismatic breaking easily to strong medium and coarse subangular and angular blocky; continuous moderate clay films; common very fine, fine and some medium pores; friable, plastic and sticky; diffuse and smooth boundary.

B22t - 70 - 130 cm, yellowish red (5 YR 5/6), few fine and distinct mottles of red (3 YR 4/6); clay; prismatic breaking easily to strong medium to coarse angular and subangular blocky; continuous moderate clay films; common very fine and fine pores; friable, plastic and sticky; gradual and smooth boundary.

IIB31t - 130 - 188 cm, red (3 YR 4/6), few fine and distinct mottles of strong brown (7.5 YR 5/6); clay; prismatic breaking easily to strong medium to coarse angular and subangular blocky; common very fine and fine pores; friable, plastic and sticky; gradual and smooth boundary.

IIB32t - 188 - 260 cm, red (3 YR 4/6), few fine and prominent mottles of black (N 2/), white (5 YR 8/1) and few fine distinct mottles of red (2.5 YR 4/6); clay loam; moderate medium to coarse subangular blocky; few moderate clay films; common very fine and fine pores; friable, plastic and sticky.

IIC1 - 260 - 320 cm, light reddish brown (5 YR 6/4), few fine and distinct mottles of light yellowish brown (10 YR 6/4), few fine and prominent mottles of white (10 YR 8/2); silt loam; plastic and slightly sticky.

IIC2 - 320 - 430 cm+, red (2.5 YR 5/6), few fine and diffuse mottles of red (2.5 YR 5/6), few fine and distinct mottles of reddish yellow (7.5 YR 6/6); silt loam; plastic and slightly sticky.

REMARKS - Abundant roots in A1, common in A3 and B1t, few in B21t and B22t, very few in IIB31t and IIB32 t.

Stone line between B22t and IIB31t.

Profile wet after rain.

PROFILE Nº ISCW-BR 11

SAMPLE Nº 77.0734/42 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 10	-	tr	100	26	16	23	35	23	34	0.66
A3	- 23	-	tr	100	24	14	23	39	36	8	0.59
B1t	- 40	-	tr	100	20	14	24	42	39	7	0.57
B21t	- 70	-	tr	100	18	12	17	53	-	100	0.32
B22t	-130	-	1	99	16	10	17	57	-	100	0.30
IIB31t	-188	-	tr	100	11	9	35	45	-	100	0.78
IIB32t	-260	-	tr	100	13	9	42	36	-	100	1.17
IIC1	-320	-	tr	100	12	9	52	27	-	100	1.93
IIC2	-430+	-	tr	100	10	13	58	19	-	100	3.05

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.5	3.4		0.6	0.18	0.19	1.0	5.3	6.0	12.3	8	84
4.6	3.5		0.2	0.07	0.11	0.4	5.4	4.0	9.8	4	93
4.6	3.5		0.1	0.04	0.07	0.2	6.0	2.5	8.7	2	97
4.7	3.6		0.1	0.02	0.05	0.2	6.4	2.3	8.9	2	97
4.7	3.6		0.1	0.02	0.04	0.2	6.6	1.6	8.4	2	97
4.8	3.7		0.1	0.06	0.04	0.2	5.5	1.4	7.1	3	96
4.9	3.8		0.1	0.02	0.04	0.2	4.6	1.0	5.8	3	96
4.9	3.8		0.1	0.02	0.04	0.2	3.6	0.4	4.2	5	95
4.9	3.9		0.1	0.02	0.04	0.2	3.1	1.3	4.6	4	94

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	MOLECULAR RATIO SiO2 / Al2O3	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
2.14	0.21	10	18.1	13.3	4.6	1.13	2.31	1.90	4.53	3
1.12	0.12	9	19.0	14.5	5.2	1.14	2.23	1.81	4.38	2
0.58	0.08	7	20.3	15.6	5.8	1.18	2.21	1.79	4.21	1
0.41	0.07	6	23.0	18.8	6.8	1.13	2.08	1.69	4.34	1
0.38	0.07	5	24.6	20.2	7.3	1.10	2.07	1.68	4.34	1
0.26	0.05	5	28.7	24.2	8.9	1.05	2.02	1.63	4.27	1
0.17	0.04	4	27.5	23.0	7.7	0.93	2.03	1.68	4.69	1
0.14	0.03	5	27.4	23.1	8.8	1.04	2.02	1.62	4.12	1
0.11	0.03	4	26.1	22.5	10.9	1.53	1.97	1.51	3.24	1

Clay B/A - 1.4 Weighted - 1.4

PROFILE Nº ISCW-BR 11
SAMPLE Nº 77.0734/42

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN MN & CN FE	RF	IL & MG	OF	ZR	RU						
SANDS (2-.05 mm)													
A1	95%	2%		1%	2%	tr							
A3	95%	2%		1%	2%	tr	tr						
B1t	95%	2%		3%		tr	tr						
B21t	95%	2%		3%		tr	tr						
B22t	95%	2%		3%		tr	tr						
IIB31t	93%	2%	2%	3%		tr	tr						
IIB32t	90%	5%	3%	2%		tr							
IIC1	96%	2%				tr							
IIC2	89%	1%	10%			tr							
GRAVELS (>2 mm)													
	90%	10%											
	90%	10%											
	95%	5%											
	95%	5%											
	100%												
	93%	7%											
	50%	50%											
	80%	20%											
	70%	10%	20%										

Mineral Code : QZ - quartz; CN MN - manganose concretions; CN FE - iron concretions; RF - rock fragments; IL - ilmenite; MG - magnetite; OF - organic fragments; ZR - zircon; RU - rutile

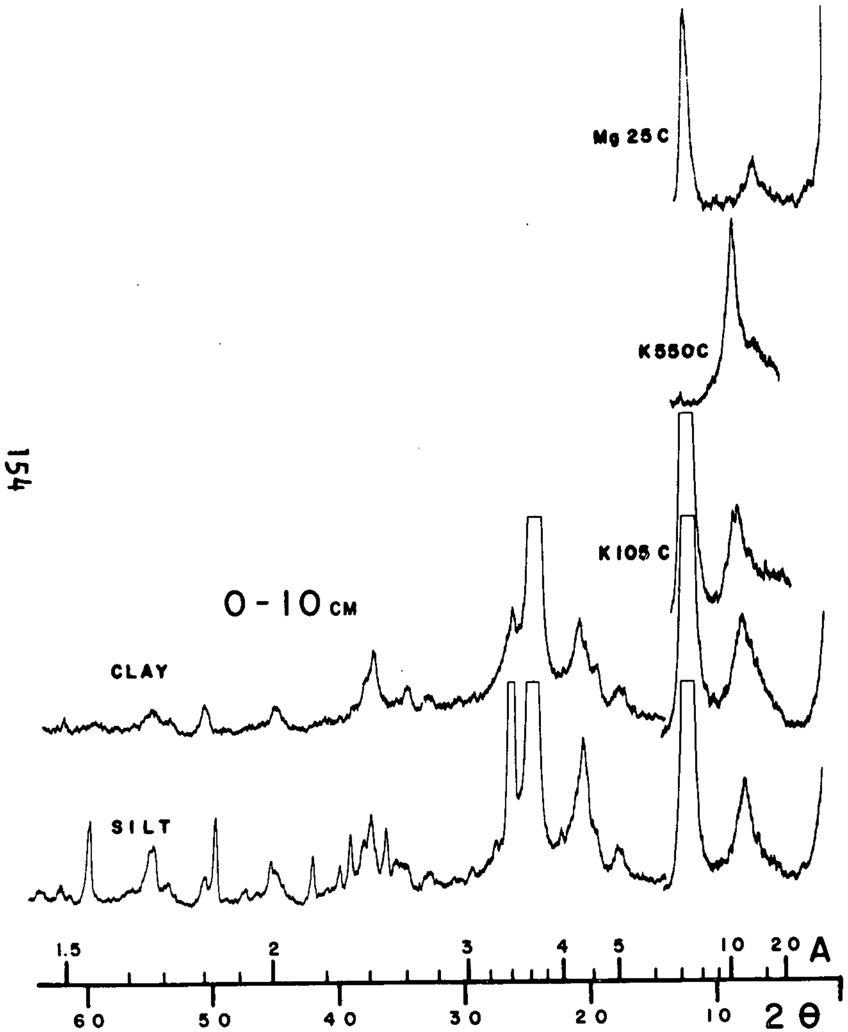

Fig. 30 - X-Ray diffraction patterns of the clay and silt from A1 horizon of the profile BR-11.

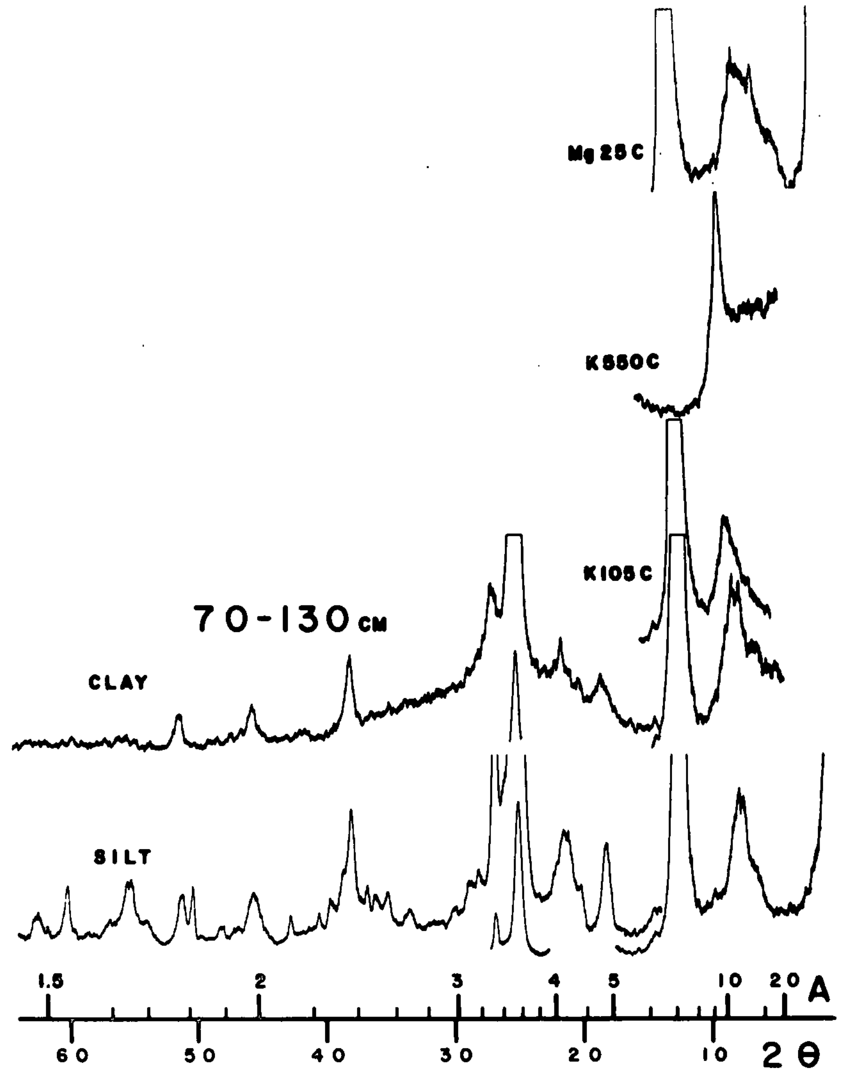

Fig. 31 - X-Ray diffraction patterns of the clay and silt from B22t horizon of the profile BR-11.

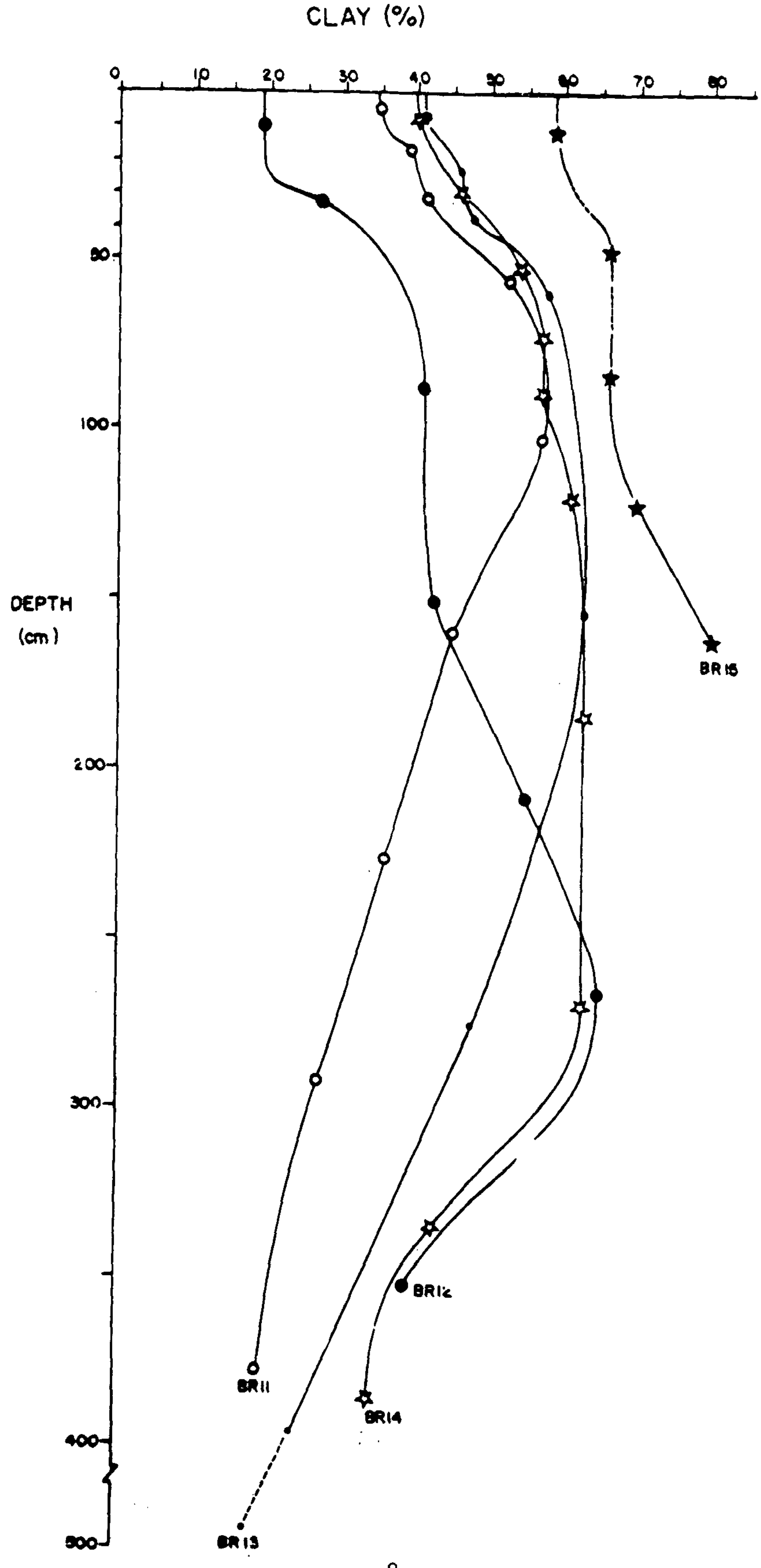

Fig. 32 - Clay distribution curves° for profiles BR-11, BR-12, BR-13, BR-14 and BR-15.

° All clay distribution curves at same scale.

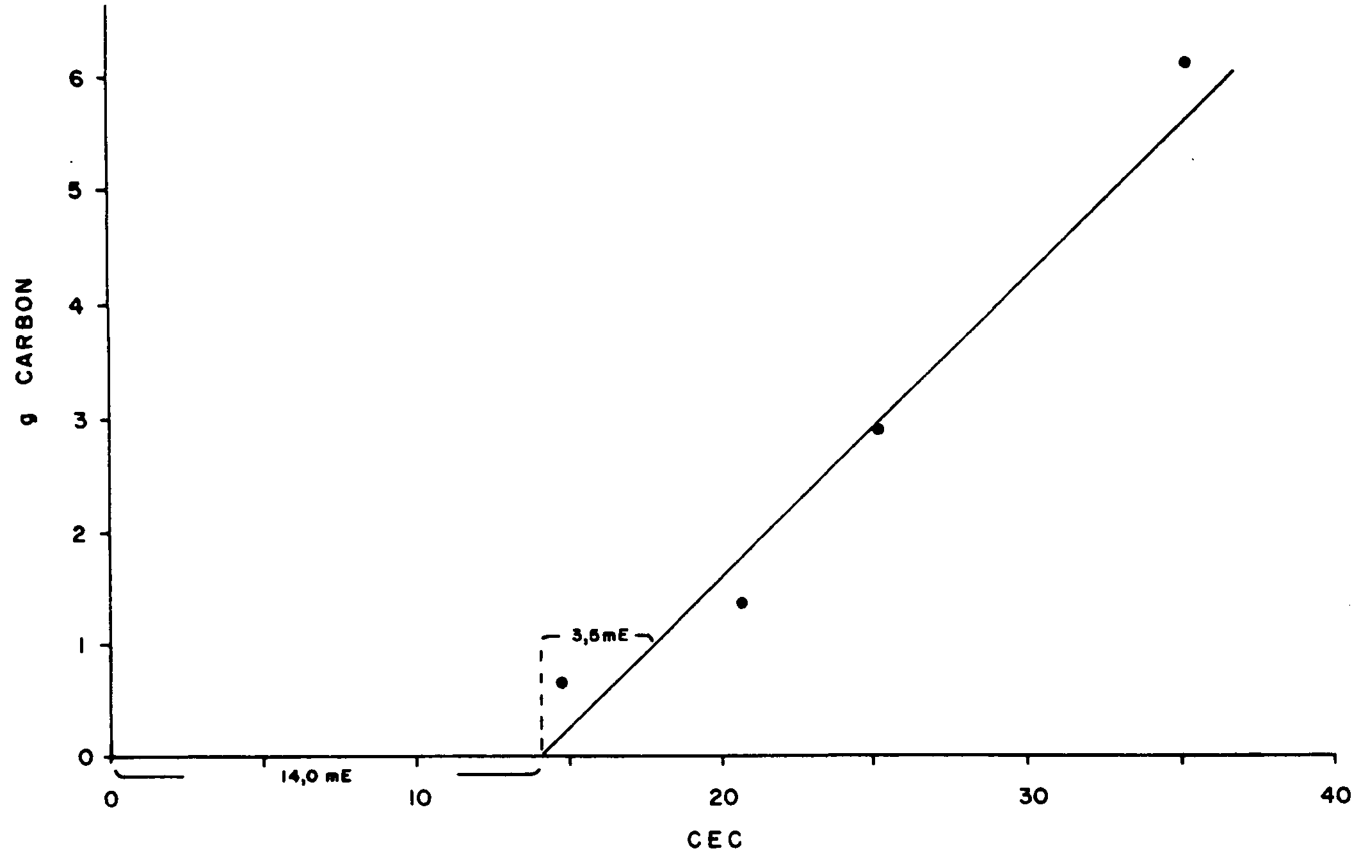

Fig. 33 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-11.

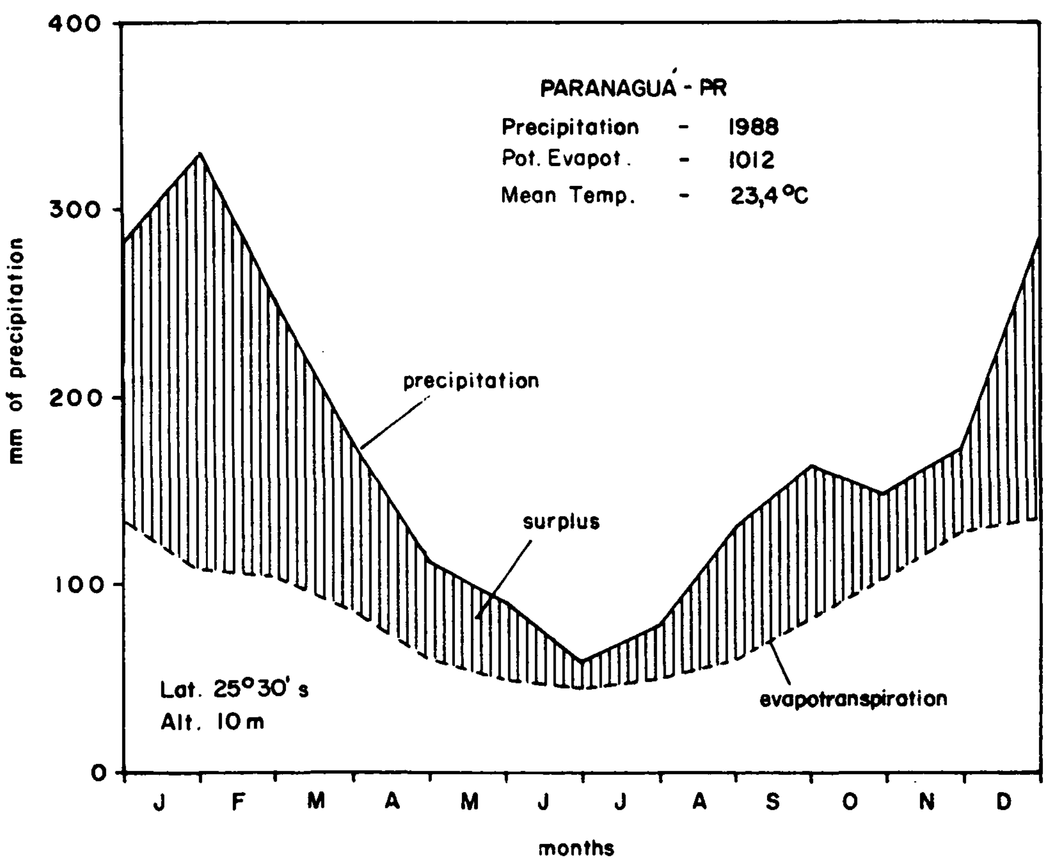

Fig. 34 - Water balance according to Thornthwaite & Mather, 1955 (125 mm), for geographic region related to profiles BR-11 and BR-12.

Discussion

1. On the basis of the presence of an argillic horizon and cutans, the classification as Ultisol was generally accepted

2. Although clay diminishes with depth, the data and graph indicate a decrease from the maximum clay content in the argillic horizon of less than 20 percent at 150 cm depth (Buol, Camargo). However, the pedon does not fit the Pale great group because of the high content of weatherable minerals in the upper 50 cm of the argillic horizon (Ikawa, Smith).

3. It was discussed whether "weatherable minerals" as defined in Soil Taxonomy should exclude muscovite-mica. If muscovite-mica is considered a non-weatherable mineral, the classification of this profile might change to a Typic Paleudult.

4. This soil has a high Al saturation combined with appreciable amounts of 2:1 lattice clay.

5. Like similar profiles in the U.S., the consistency of the B horizon is firm (Nichols). However, when moist, these soils have a friable consistency (Palmieri).

6. The weighted average of the calculated NH_4OAc-CEC of the upper 50 cm of the argillic horizon is 24.8 meq per 100 g clay, i.e. slightly higher than allowed for Kandi great groups and oxic subgroups. This corroborates the mineralogical data from Hawaii which indicate appreciable amounts of 2:1 clay minerals.

7. Assuming a non-iso temperature regime (questioned by Tavernier), the pedon should be classified as a Typic Hapludult; if the temperature regime is iso, it would be a Typic Tropudult.

PROFILE ISCW-BR 12 DESCRIBED AND SAMPLED - 26 Mar 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO latossólico A moderado textura média/argilosa fase floresta tropical perúmida relevo ondulado (RED-YELLOW PODZILIC ALIC, latosolic moderate A horizon, loamy/clayey, wet evergreen tropical forest rolling phase).

Typic Paleudult; clayey, mixed, hyperthermic.

Dystric Nitosol.

Sol ferrallitique; fortement désaturé, typique, faiblement appauvri et hydromorphe, dérivé de migmatites.

LOCATION - Morretes, PR. Road Morretes-Paranaguá, ± 1 km from the junction to Curitiba highway, about 30 m left side; 25°32'00" S 48°47'00" W.

TOPOGRAPHIC POSITION - Trench at lower third of hillside, 15% slope, under idle shrub and molasses grass; rolling; 25 meters.

PRIMARY VEGETATION - Wet evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Migmatites or gneisses, Precambrian Complex; weathering residues of stated rocks.

DRAINAGE - Moderately well drained ?

PRESENT LAND USE - Pasture, banana and cassava crops.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	24.9	24.8	24.2	22.0	19.7	18.1	17.1	17.7
P mm	281	331	250	168	115	92	59	79
	Sept	Oct	Nov	Dec				
T°C	18.5	20.0	21.6	23.4	Mean	21.0		
P mm	131	162	145	175	Total	1988		
		Hyperthermic				Perudic		

Ap - 0 - 20 cm, dark grayish brown (10 YR 4/2, moist); sandy loam; moderate very fine to fine granular; many very fine and fine, common medium pores; very friable, plastic and sticky; clear and smooth boundary.

B1t - 20 - 44 cm, yellowish brown (10 YR 5/4); heavy sandy clay loam; weak fine to medium subangular blocky; common pores; friable, plastic and sticky; gradual and smooth boundary.

B21t - 44 - 130 cm, yellowish brown (10 YR 5/6); clay; moderate fine to coarse subangular blocky; common moderate clay films; common pores; friable, plastic and sticky; gradual and smooth boundary.

B22t - 130 - 168 cm, yellowish brown (9 YR 5/6), few fine and distinct mottles of strong brown (7.5 YR 5/6); clay; moderate fine to coarse subangular blocky; common moderate clay films; common pores; friable, plastic and sticky; diffuse and smooth boundary.

B23t - 168 - 245 cm, strong brown (7.5 YR 5/6), common fine and distinct mottles of yellowish brown (10 YR 5/6); clay; moderate fine to coarse subangular blocky; continuous moderate to strong clay films; common pores; friable, plastic and sticky.

B3t - 245 - 284 cm, brownish yellow (10 YR 6/6), few fine and diffuse mottles of yellow (10 YR 8/6), and few fine and distinct mottles of reddish yellow (5 YR 6/6); clay; plastic and sticky.

C - 284 - 420 cm$^+$, variegated color of red (2.5 YR 5/6), brownish yellow (10 YR 6/6), yellow (10 YR 8/6), white (10 YR 8/2) and reddish brown (5 YR 4/4); clay loam; plastic and sticky.

REMARKS - Abundant roots in Ap, common in B1t, few in B21t and very few in B22t.

Profile wet after rain.

PROFILE Nº ISCW-BR 12
SAMPLE Nº 77.0727/33 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 20	-	tr	100	34	23	24	19	13	32	1.26
B1t	- 44	-	tr	100	32	20	21	27	20	26	0.78
B21t	-130	-	tr	100	25	17	17	41	-	100	0.41
B22t	-168	-	tr	100	24	17	16	43	-	100	0.37
B23t	-245	-	tr	100	20	12	13	55	-	100	0.24
B3t	-284	-	tr	100	11	6	18	65	-	100	0.28
C	-420+	-	tr	100	13	7	41	39	-	100	1.05

pH (1:2.5) H2O	pH KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.7	3.8	0.7		0.09	0.07	0.8	1.7	4.1	6.6	12	68
4.8	3.8	0.2		0.03	0.04	0.3	2.0	3.1	5.4	6	87
4.8	3.8	0.1		0.02	0.04	0.2	3.0	2.1	5.3	4	94
4.8	3.7	0.1		0.02	0.04	0.2	2.8	2.4	5.4	4	93
4.8	3.8	0.1		0.02	0.05	0.2	3.0	2.3	5.5	4	94
4.8	3.8	0.1		0.01	0.04	0.2	3.4	1.6	5.2	4	94
4.8	3.8	0.1		0.02	0.04	0.2	3.9	1.1	5.2	4	95

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2/Al2O3 (MOLECULAR RATIO)	SiO2/R2O3	Al2O3/Fe2O3	AVLB PHOS ppm
1.57	0.15	10	7.7	5.0	2.2	0.99	2.62	2.04	3.55	3
0.57	0.09	6	10.9	8.1	3.1	1.17	2.29	1.84	4.09	1
0.39	0.07	6	16.0	13.3	4.5	1.23	2.05	1.68	4.64	1
0.31	0.06	5	17.2	14.6	4.9	1.31	2.00	1.65	4.68	1
0.31	0.06	5	21.3	18.6	6.1	1.34	1.95	1.61	4.79	1
0.27	0.05	5	29.6	26.1	8.5	1.12	1.93	1.60	4.82	1
0.14	0.04	4	29.7	25.6	6.2	1.03	1.97	1.71	6.47	1

Clay B/A - 2.2 Weighted - 2.4

PROFILE Nº ISCW-BR 12
SAMPLE Nº 77.0727/33

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	BT	CN FE	IL	OF	ZR	ST	MS	FK
				SANDS (2-.05 mm)					
Ap	98%		tr	1%	1%	tr	tr		
B1t	99%		tr	1%	tr	tr	tr		
B21t	99%		tr	1%	tr	tr			
B22t	99%		tr	1%	tr	tr	tr		
B23t	98%	tr	tr	2%	tr	tr			
B3t	98%		1%	1%	tr	tr		tr	tr
C	90%	5%	5%	tr					
				GRAVELS (>2 mm)					
	100%		tr		tr				
	100%		tr		tr				
	100%		tr		tr				
	100%		tr		tr				
	100%		tr		tr				
	100%		tr	tr	tr				
	99%		1%		tr				

Mineral Code : QZ - quartz; BT - biotite; CN FE - iron concretions; IL - ilmenite; OF - organic fragments; ZR - zircon; ST - staurolite; MS - muscovite; FK - potassium feldspar

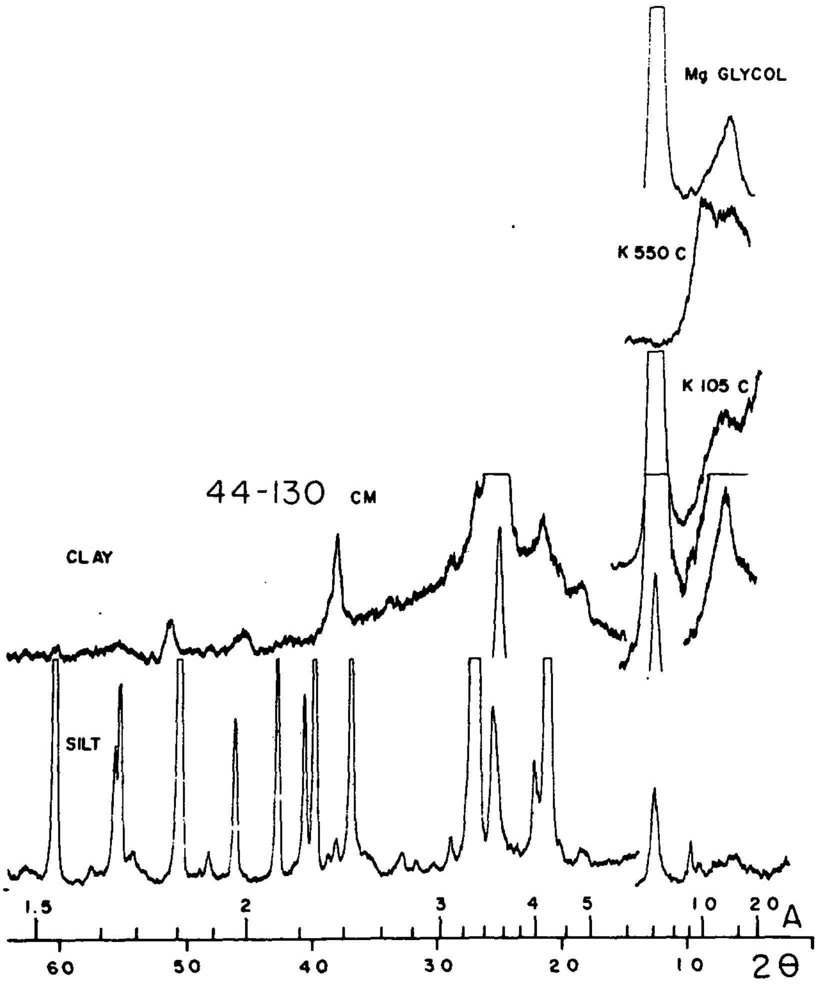

Fig. 35 - X-Ray diffraction patterns of the clay and silt from B21t horizon of the profile BR-12.

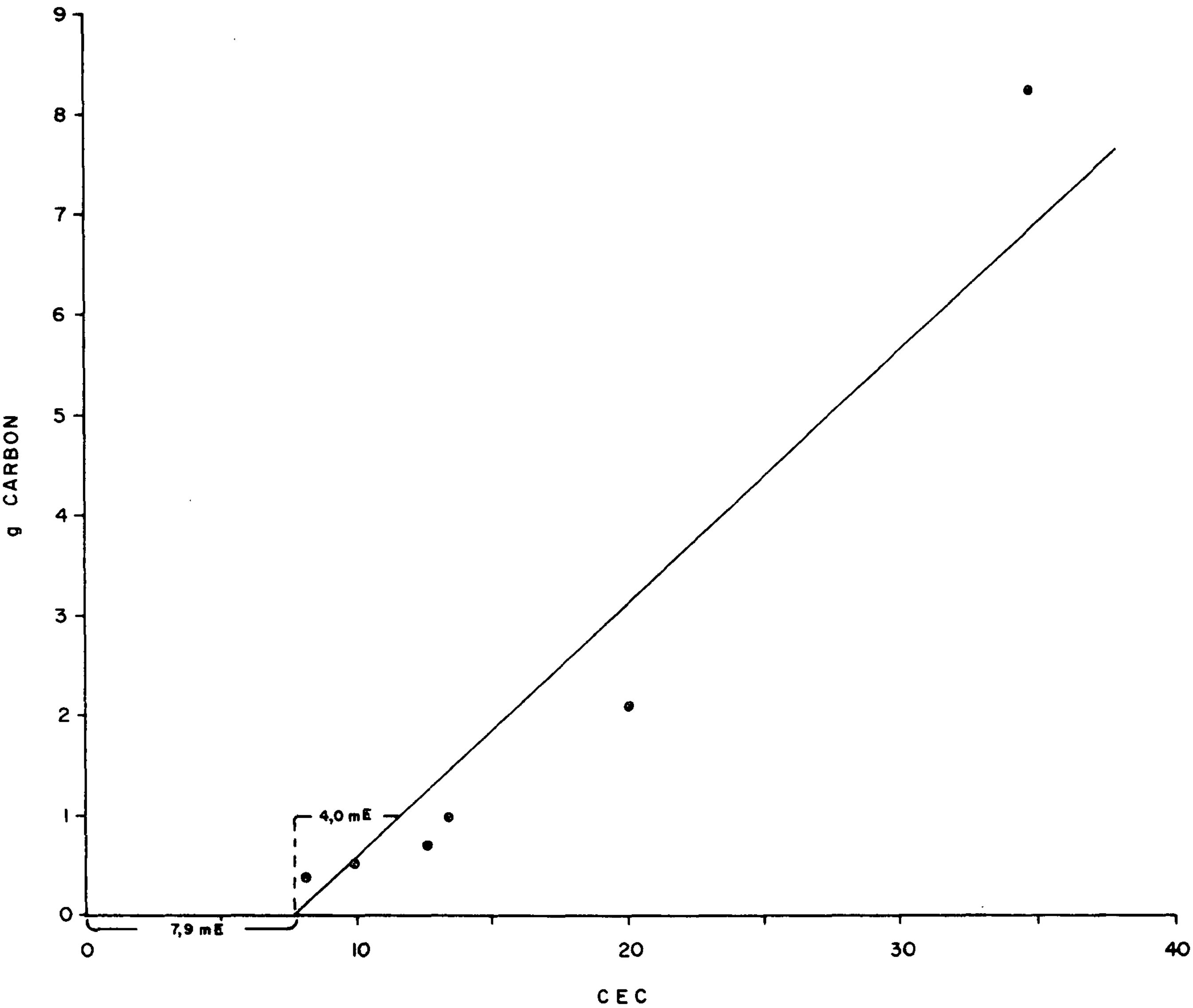

Fig. 36 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-12.

Discussion

1. The clay increase from the Ap to the B21t horizon is well within the requirements for Kandi great groups proposed by Smith (ratio 1.4 or more within 30 cm). Most participants found cutans, but Isbell was not certain. Classification as a Typic Paleudult is generally accepted. In view of the calculated clay activity of the upper 50 cm of the argillic horizon (more than 16 meq), this would not qualify for a Kandi taxon if the diagnostic limit is set at 16 meq (Buol's limit), but it would be a Kandi great group if the limit of 24 meq (Moormann's limit) is accepted.

2. Discussion arose about the Al saturation of the argillic horizon and about the eventual distinction, at the subgroup level, between high and low Al saturation.

a. What should be the diagnostic limit of Al saturation? It could be 50 percent, but no chemical or management criteria for this specific value are available at this time.

b. Which should be the diagnostic depth at which the Al saturation is determined for distinction of subgroups. Bennema favored the diagnostic depth in the upper 50 cm. Buol and Smith pointed out that at such depth the effect of liming would readily change the Al saturation, thereby resulting in a change of subgroups. According to Smith, this management dependency was the main reason that Ultisols are defined on the basis of their low base saturation in the subsoil. He agreed, however, that in tropical countries, where no or little lime is used, the shallow depth as proposed by Bennema may be interesting. Buol remarked that even small applications of lime can rapidly change Al and base saturation in these low activity clay soils. Dudal was in favor of maintaining the diagnostic depth already established to distinguish Alfisols from Ultisols. This appeared to be the opinion of the majority, so that the diagnostic depth would remain as stated in Soil Taxonomy.

McClelland noted that the definition on page 349 of Soil Taxonomy (second column, third line) the word "within" should read "at", i.e. "less than 35 percent at the following depths".

3. Should the typic subgroup of Kandiudults be required to have a high Al saturation? Tavernier and others felt that this should indeed be the case.

In summary, it was the consensus that the definition of a Typic Kandiudult should include, among others:

- an argillic horizon with the clay distribution as defined for the present Pale great groups. Thinner argillic horizons would give rise to "leptic" subgroups.

- an Al saturation of more than 50 percent (?) at the depths as presently defined for the base saturation of Ultisols (Soil Taxonomy, page 349). No name for a subgroup with lower Al saturation was proposed, but an "alfic" subgroup might be introduced for such soils.

Notes

1. Among the Udults and Ustults of the tour guide, the diagnostic depth for Al saturation (50 percent) would affect the subgroup classification in the following cases:

Pedon	Al saturation in the upper Bt horizon	Al saturation at the diagnostic depth of Ultisols
BR9	0	80
BR 21	50	31
BR 23	54	13
BR 25	19	83
BR 30	45	55

For the other profiles in the "Kandi" taxa, the Al saturation in the argillic horizon and the underlaying horizon is usually remarkably uniform.

2. According to analyses by P. Segalen, this soil is mineralogically characterized by Kaolinite, goethite and traces of gibbsite.

PROFILE ISCW-BR 13 DESCRIBED AND SAMPLED - 15 Jan 1977

CLASSIFICATION - LATOSSOLO VERMELHO-AMARELO ÁLICO podzólico A moderado textura argilosa fase floresta tropical perúmida relevo forte ondulado (RED-YELLOW LATOSOL ALIC, podzolic, moderate A horizon, clayey, wet evergreen tropical forest hilly phase).

Tropeptic Haplorthox (no consensus); clayey, kaolinitic, hyperthermic.

Dystric Nitosol.

Sol ferrallitique; fortement désaturé, typique, jaune, dérivé de migmatites.

LOCATION - Garuva, SC. 10.7 km from Garuva, in the road to Guaratuba; 25°59'00" S 48°43'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at lower third of hillside, 35% slope, under disturbed remains of primary forest; hilly; 50 meters.

PRIMARY VEGETATION - Wet evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Migmatites, Precambrian Complex; weathering residues of stated rock with slight reworking.

DRAINAGE - Well drained.

PRESENT LAND USE - Remains of natural vegetation and scattered crops of banana, corn, pineapple and beans.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	24.5	24.4	23.9	21.5	19.5	18.0	16.6	17.1
P mm	228	282	236	150	122	86	78	94

	Sept	Oct	Nov	Dec		
T°C	18.1	19.6	21.2	23.0	Mean	20.6
P mm	126	155	134	136	Total	1827
		Hyperthermic			Perudic	

A1 - 0 - 16 cm, very dark grayish brown (10 YR 3/2, moist), brown (10 YR 5/3, dry); clay; strong medium granular; many very fine to medium and some coarse pores; hard, friable, plastic and sticky; clear and smooth boundary.

A3 - 16 - 32 cm, dark yellowish brown (10 YR 4.5/4, moist); clay; moderate fine to medium subangular blocky and granular; many very fine to medium and some coarse pores; hard, friable, plastic and sticky; clear and smooth boundary.

B1 - 32 - 45 cm, yellowish brown (10 YR 4.5/6, moist); clay; weak fine to medium subangular blocky many very fine to medium and some coarse pores; hard, friable, plastic and sticky; gradual and smooth boundary.

B21 - 45 - 75 cm, strong brown (7.5 YR 5/6); clay; moderate fine to medium subangular blocky; few weak clay films; common fine to very fine and some medium pores; slightly hard, friable, plastic and sticky; diffuse and smooth boundary.

B22 - 75 - 230 cm, strong brown (6.5 YR 5/6); clay; moderate medium to coarse subangular blocky; common weak clay films; common very fine to fine pores; slightly hard, friable, plastic and sticky; gradual and wavy boundary (150-175 cm).

B31 - 230-350 cm, yellowish red (4 YR 4.5/6), few medium and prominent mottles of brownish yellow (10 YR 6/8); clay; weak medium subangular blocky; few weak clay films, mainly on the faces surrounding quartz grains; slightly hard, friable, plastic and sticky.

B32 - 350 - 440 cm, red (3 YR 4/7), brownish yellow mottles.

C - 440 - 470 cm^{+}, variegated color of red, yellow and white.

REMARKS - Abundant roots in A1 and A3, plentiful in B1, common in B21 and few in B22.

B32 and C sampled with bucket auger. Profile moist.

PROFILE Nº ISCW-BR 13

SAMPLE Nº 77.0537/44 SNLCS

HORIZON	DEPTH cm	GRVL 20-2 mm %	FINE EARTH <2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY	BULK DNST	PRTCL DNST	TOTAL PORO-SITY %
A1	0- 16	2	98	27	16	16	41	26	37	0.30	0.94	2.44	61
A3	- 32	6	94	25	14	15	46	36	22	0.33	1.24	2.60	52
B1	- 45	1	99	28	12	12	48	32	33	0.25	1.26	2.60	52
B21	- 75	2	98	22	10	10	58	-	100	0.17	1.32	2.63	50
B22	-230	3	97	19	7	11	63	-	100	0.17	1.30	2.67	51
B31	-350	11	89	22	8	22	48	-	100	0.46	1.37	2.67	49
B32	-440	9	91	23	16	37	24	-	100	1.54			
C	-470+	9	91	21	18	43	18	-	100	2.39			

pH (1:2.5) H2O	KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.3	3.6	1.0	0.5	0.15	0.09	1.7	2.8	9.9	14.4	12	62
4.5	3.8	0.6		0.04	0.04	0.7	2.1	5.1	7.9	9	75
4.6	3.8	0.4		0.03	0.04	0.5	2.0	4.0	6.5	8	80
4.5	3.8	0.4		0.03	0.04	0.5	2.2	3.6	6.3	8	81
4.6	3.8	0.2		0.03	0.04	0.3	1.9	2.9	5.1	6	86
4.6	3.8	0.2		0.03	0.04	0.3	1.5	2.1	3.9	8	83
4.6	3.8	0.2		0.05	0.05	0.3	2.0	1.3	3.6	8	87
4.6	3.8	0.3		0.07	0.05	0.4	2.3	0.9	3.6	11	85

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
2.12	0.25	8	15.4	13.5	4.8	1.06	1.94	1.58	4.41	4
1.09	0.13	8	18.2	16.7	4.9	1.24	1.85	1.56	5.35	2
0.84	0.10	8	18.4	17.1	5.8	1.10	1.83	1.50	4.62	1
0.64	0.10	6	21.9	20.1	7.0	1.05	1.85	1.52	4.50	1
0.36	0.07	5	24.0	22.3	7.2	1.03	1.83	1.52	4.86	1
0.15	0.04	4	23.9	23.6	7.4	0.99	1.72	1.43	5.00	1
0.10	0.03	3	24.4	21.3	7.2	0.99	1.95	1.60	4.64	1
0.06	0.03	2	24.8	19.3	7.2	0.92	2.18	1.76	4.20	1

Clay B/A - 1.3 Weighted - 1.4

PROFILE Nº ISCW-BR 13
SAMPLE Nº 77.0537/44

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	BT	CN FE	OF	IL	ZR	CN MN	TN	MS	TM
SANDS (2-.05 mm)										
A1	98%	tr	tr	2%	tr	tr		tr		
A3	97%	tr	tr	2%	1%	tr				tr
B1	98%	tr	1%	1%	tr	tr				tr
B21	96%	tr	2%	1%	1%	tr				tr
B22	98%	tr	1%	tr	1%	tr			tr	
B31	96%	2%°	2%	tr	tr	tr				tr
B32	83%	15%°	2%	tr	tr	tr	tr			tr
C	79%	20%	1%	tr	tr	tr	tr			
GRAVELS (>2 mm)										
	100%		tr							
	100%		tr							
	100%		tr	tr						
	100%		tr	tr						
	100%		tr							
	100%		tr							
	100%	tr°	tr				tr			
	100%		tr	tr						

Mineral Code : QZ - quartz; BT - biotite; CN FE - iron concretions; OF - organic fragments; IL - ilmenite; ZR - zircon; CN MN - manganose concretions; TN - titanite; MS - muscovite; TM - tourmaline

° - weathered

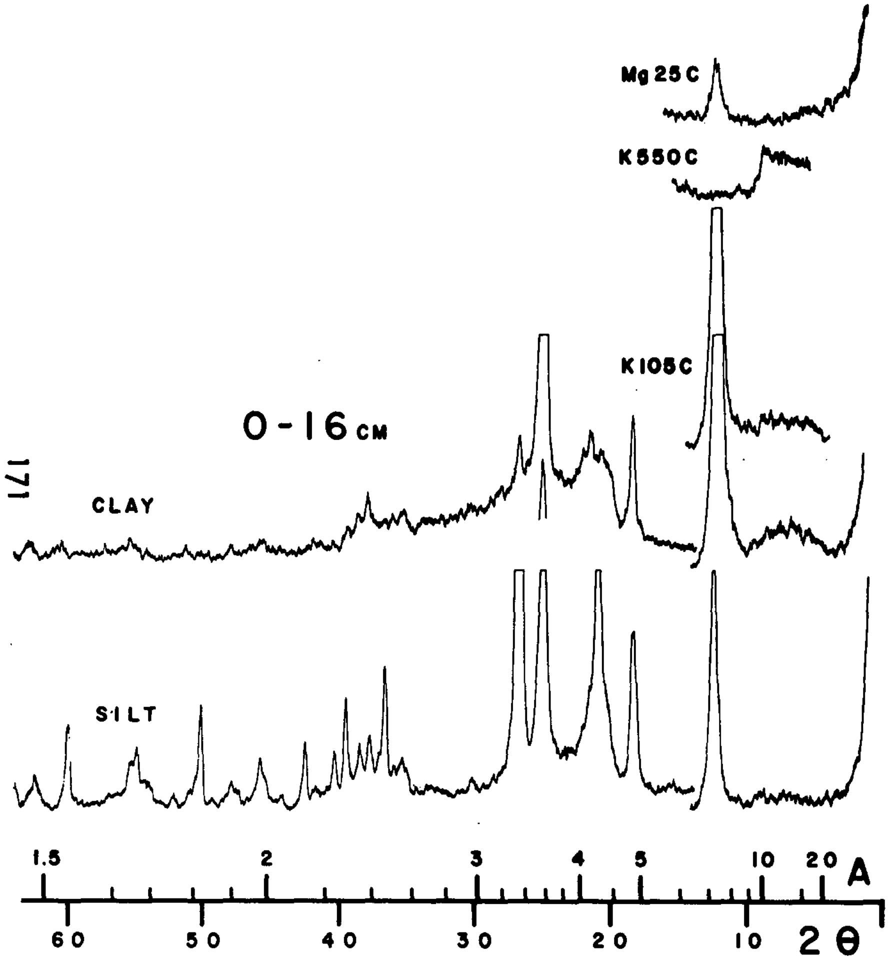

Fig. 37 - X-Ray diffraction patterns of the clay and silt from A1 horizon of the profile BR-13.

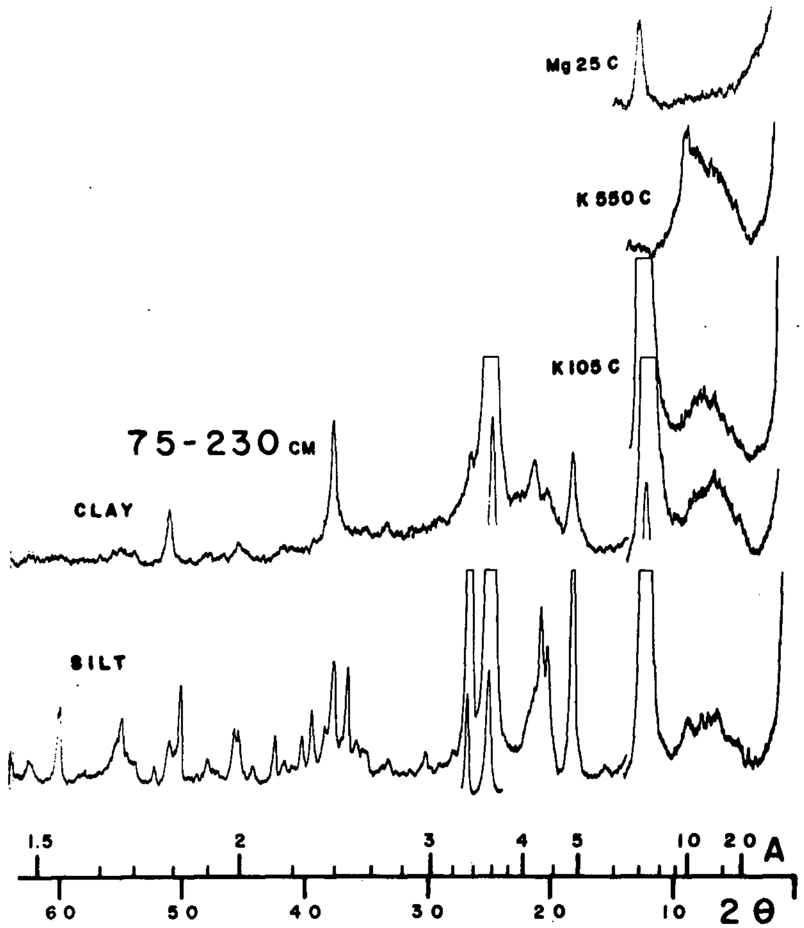

Fig. 38 - X-Ray diffraction patterns of the clay and silt from B22 horizon of the profile BR-13.

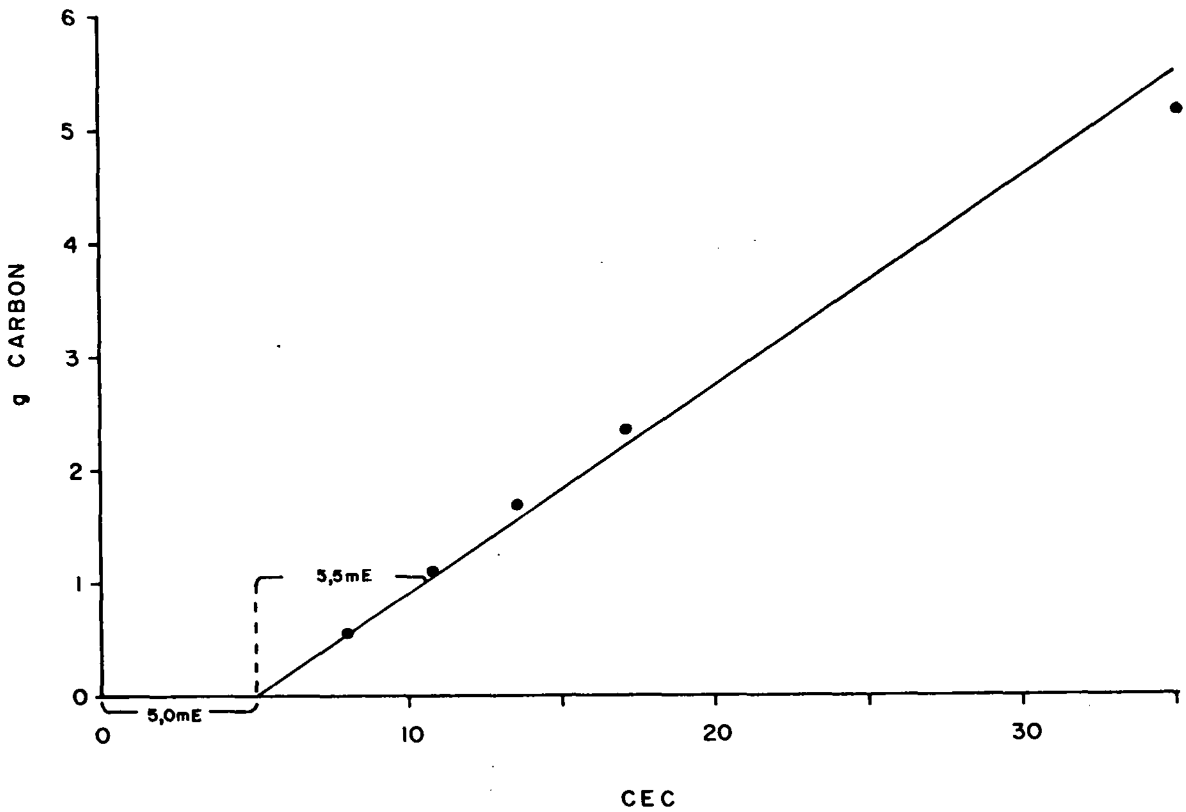

Fig. 39 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-13

Discussion

1. No consensus was reached on the classification of this pedon. Those who observed clay skins (or thought they did) would classify this soil as a Typic Paleudult or Typic Kandiudult (Buol, Moormann, Paramananthan).

Those who did not observe clay skins, and who took into account the gradual clay increase with depth and the low SiO_2 : Al_2O_3 ratio of less than 2, would classify this soil as a Tropeptic Haplorthox (Camargo, Eswaran, Isbell).

2. Nichols and Bennema commented on the transitional character of this pedon which seems to be found in many similar soils of the humid tropics.

3. The following properties of this soil seem to be atypical for a modal Oxisol : rather well developed structure in the exposed B horizon (possibly weaker, or absent, in a fresh pit), the distinct cracks possibly due to amorphous material, the predominance of bleached quartz grains in the A1 horizon, and the presence of unspecified 10-18 A clay minerals reported by Hawaii.

PROFILE ISCW-BR 14 DESCRIBED AND SAMPLED - 21 Mar 1977

CLASSIFICATION - LATOSSOLO HÚMICO VERMELHO-AMARELO DISTRÓFICO textura argilosa fase floresta subtropical perenifólia relevo plano. (HUMIC RED-YELLOW LATOSOL DYSTROPHIC*, clayey, evergreen subtropical forest level phase).

Typic Acrohumox; clayey, kaolinitic, thermic.

Humic Ferralsol.

Sol ferrallitique; fortement désaturé, humifère, modal, dérivé de roches métamorphiques.

LOCATION - São José dos Pinhais, PR. 24 km from Curitiba in the highway to Joinville, 50 m right side; 25°40'00" S 49°09'00" W.

TOPOGRAPHIC POSITION - Trench on level topography, 2% slope, under subtropical forest; level; 910 meters.

PRIMARY VEGETATION - Evergreen subtropical forest.

GEOLOGY AND PARENT MATERIAL - Acidic igneous and metamorphic rocks, Precambrian Complex; possibly a sandy clay detrital mantle related to Pleistocene deposits of Curitiba Basin.

DRAINAGE - Well drained.

PRESENT LAND USE - Corn, cassava crops and pasture.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	20.1	20.1	19.2	16.8	14.5	13.2	12.5	14.0
P mm	198	173	124	78	85	87	81	83
	Sept	Oct	Nov	Dec				
T°C	14.8	16.2	17.4	18.9	Mean	16.5		
P mm	119	130	105	147	Total	1410		
		Thermic			Udic			

O1 - 3 - 0 cm, leaves and branches in decomposition.

A11 - 0 - 16 cm, very dark gray (10 YR 3/1, moist); clay loam; moderate very fine to fine granular and weak very fine to fine subangular blocky; many very fine and fine, medium and some coarse pores; very friable, plastic and sticky; gradual and smooth boundary.

A12 - 16 - 42 cm, black (10 YR 2.5/1, moist); clay; weak fine to medium subangular blocky and moderate very fine to fine granular; many very fine, fine, medium and some coarse pores; very friable, plastic and sticky; diffuse and smooth boundary.

A13 - 42 - 64 cm, very dark gray (10 YR 3/1.5, moist); clay; weak fine to medium subangular blocky and moderate very fine to fine granular; many very fine, fine medium and some coarse pores; very friable, plastic and sticky; gradual and smooth boundary.

* Epialic.

A3 - 64 - 81 cm, dark brown (10 YR 4/3, moist); clay; weak fine to medium subangular blocky appears massive in place; many very fine, fine and common medium pores; friable, plastic and sticky; gradual and smooth boundary.

B1 - 81 - 101 cm, yellowish red (5 YR 4.5/6); clay; weak fine to medium subangular blocky appears massive moderately coherent in place; common very fine and fine pores; friable, plastic and sticky; diffuse and smooth boundary.

B21 - 101 - 140 cm, red (3.5 YR 4/6); clay; weak medium to coarse subangular blocky appears massive moderately coherent in place; common very fine and fine pores; friable, plastic and sticky; diffuse and smooth boundary.

B22 - 140 - 230 cm, red (1.5 YR 4/6); clay;weak medium to coarse subangular blocky appears massive moderately coherent in place; common very fine and fine pores; firm, plastic and sticky; diffuse and smooth boundary.

B3 - 230 - 310 cm, red (10 YR 4/6), few fine and distinct mottles of yellowish red (5 YR 5/6); clay; plastic and sticky.

C - 310 - 360 cm, red (2.5 YR 5/6), many fine and distinct mottles of yellowish red (5 YR 5/6), common fine and prominent mottles of white (10 YR 8/2), and few fine and distinct mottles of red (10 R 4/6); clay; plastic and sticky.

C2 - 360 - 410 cm$^+$, variegated color of yellowish red, yellowish brown and white; sandy clay loam; plastic and sticky.

REMARKS - Plentiful roots in A11, A12 and A13, common in B1, and few in B21 and B22.

Trench 2.30 m deep, bucket auger downward. Profile very moist after rain.

NOTES - 1. The discussion at this profile was not recorded.

2. P. Segalen subsequently provided the following mineralogical characterization: metaholloysite, considerable gibbsite, and some interstratified chlorite-vermiculite and hematite.

PROFILE Nº ISCW-BR 14
SAMPLE Nº 77.0743/52 SNLCS

HORIZON	DEPTH cm	GRVL 20-2 mm %	FINE EARTH <2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY	BULK DNST	PRTCL DNST	TOTAL POROSITY %
A11	0- 16	tr	100	15	18	27	40	7	83	0.68	0.72	2.45	71
A12	- 42	tr	100	13	19	22	46	11	76	0.48	0.73	2.35	69
A13	- 64	tr	100	13	18	15	54	11	80	0.28	0.94	2.50	62
A3	- 81	1	99	13	15	15	57	11	81	0.26	1.00	2.53	60
B1	-101	1	99	13	15	15	57	4	93	0.26	1.02	2.53	60
B21	-140	1	99	12	15	12	61	1	98	0.20	1.20	2.60	54
B22	-230	tr	100	10	15	12	63	1	98	0.19	1.21	2.60	53
B3	-310	1	99	8	14	15	63	-	100	0.24			
C1	-360	tr	100	20	22	15	43	-	100	0.35			
C2	-410+	1	99	31	20	15	34	-	100	0.44			

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.3	3.8	0	3	0.10	0.08	0.5	6.6	18.5	25.6	2	93
4.7	4.0	0	1	0.07	0.09	0.3	5.2	15.9	21.4	1	95
4.8	4.1	0	1	0.05	0.08	0.2	4.0	12.4	16.6	1	95
4.9	4.2	0	1	0.03	0.06	0.2	2.5	10.6	13.3	2	93
5.0	4.4	0	1	0.03	0.05	0.2	1.1	6.0	7.3	3	85
5.4	5.3	0	1	0.02	0.04	0.2	-	3.3	3.5	6	-
5.4	5.0	0	1	0.03	0.04	0.2	-	3.1	3.3	6	-
5.1	4.0	0	1	0.02	0.04	0.2	3.0	2.0	5.2	4	94
5.0	4.0	0	1	0.03	0.05	0.2	3.2	1.4	4.8	4	94
5.0	4.1	0	1	0.03	0.04	0.2	3.0	0.9	4.1	5	94

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
6.39	0.44	15	12.8	19.2	5.6	0.90	1.13	0.96	5.38	1
4.15	0.25	17	13.0	20.7	6.2	0.99	1.07	0.90	5.23	1
2.50	0.15	17	13.9	22.8	7.5	1.17	1.04	0.86	4.77	<1
2.19	0.14	16	13.4	23.6	7.9	1.23	0.96	0.80	4.68	<1
1.18	0.09	13	13.3	24.6	7.2	1.11	0.92	0.77	5.36	<1
0.63	0.06	11	14.6	26.1	7.7	1.11	0.95	0.80	5.32	<1
0.31	0.05	6	18.2	27.1	7.7	1.11	1.14	0.97	5.52	<1
0.15	0.04	4	26.4	27.9	5.4	0.92	1.61	1.43	8.09	<1
0.16	0.03	5	21.5	19.1	3.7	0.89	1.91	1.70	8.11	<1
0.11	0.03	4	18.1	16.0	3.1	0.61	1.92	1.71	8.09	<1

Clay B/A - 1.2 Weighted - 1.3

PROFILE Nº ISCW-BR 14
SAMPLE Nº 77.0743/52

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE	CN HU	OF & CH	IL	MS	TM	RU	ZR				
SANDS (2-.05 mm)													
A11	83%		15%	2%	tr								
A12	89%		10%	1%	tr								
A13	95%		5%	tr	tr	tr			tr				
A3	95%		4%	1%	tr			tr	tr				
B1	96%	3%		tr	1%		tr	tr	tr				
B21	97%	3%		tr	tr		tr		tr				
B22	95%	5%			tr				tr				
B3	79%	20%		tr	1%		tr	tr	tr				
C1	94%	5%		tr	1%				tr				
C2	98%	2%		tr	tr	tr			tr				
GRAVELS (>2 mm)													
	90%	10%											
	80%	20%		tr									
	75%	25%											
	90%	10%		tr									
	80%	20%		tr									
	80%	20%		tr									
	50%	50%		tr									
	tr	100%											
	40%	60%		tr									
	95%	5%		tr									

Mineral Code: QZ - quartz; CN FE - iron concretions; CN HU - humous concretions; OF - organic fragments; CH - charcoal; IL - ilmenite; MS - muscovite; TM - tourmaline; RU - rutile; ZR - zircon

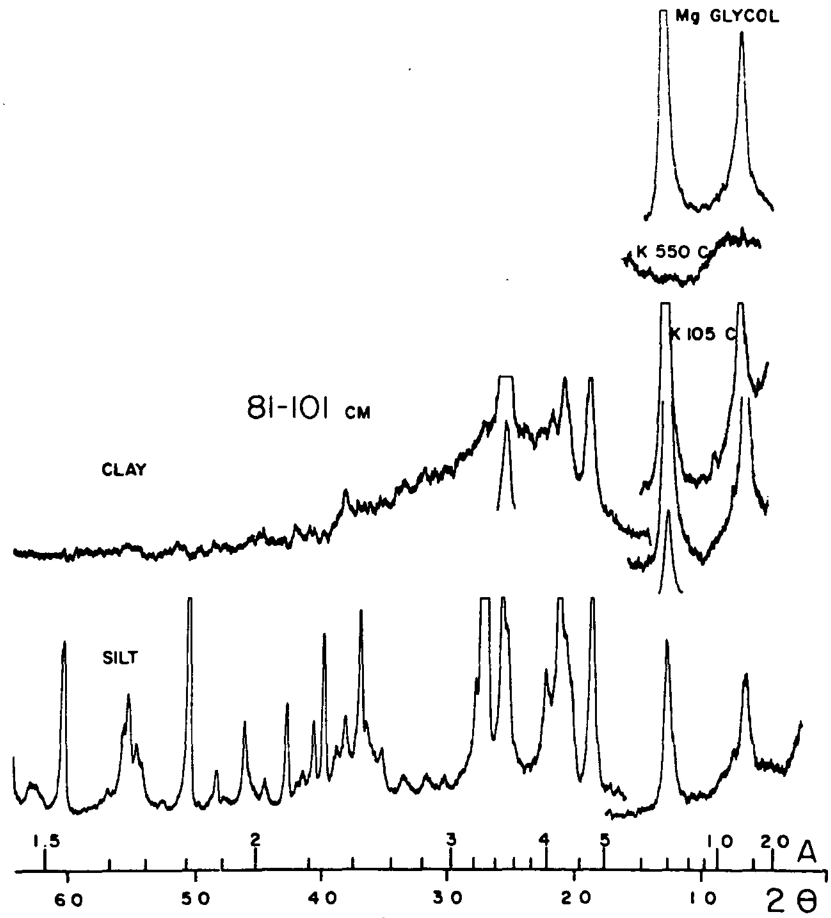

Fig. 40 - X-Ray diffraction patterns of the clay and silt from B1 horizon of the profile BR-14.

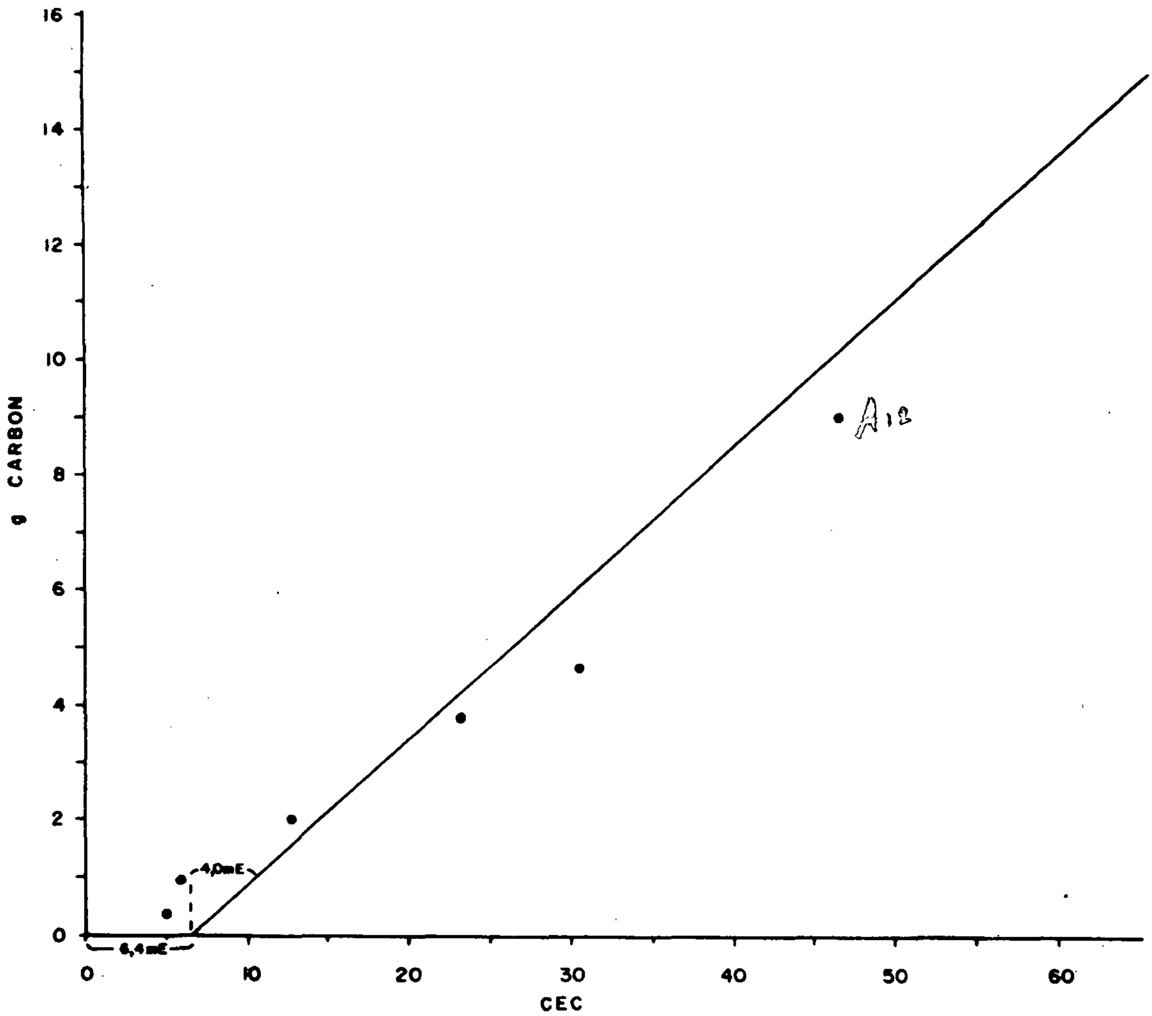

Fig. 41 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR_14.

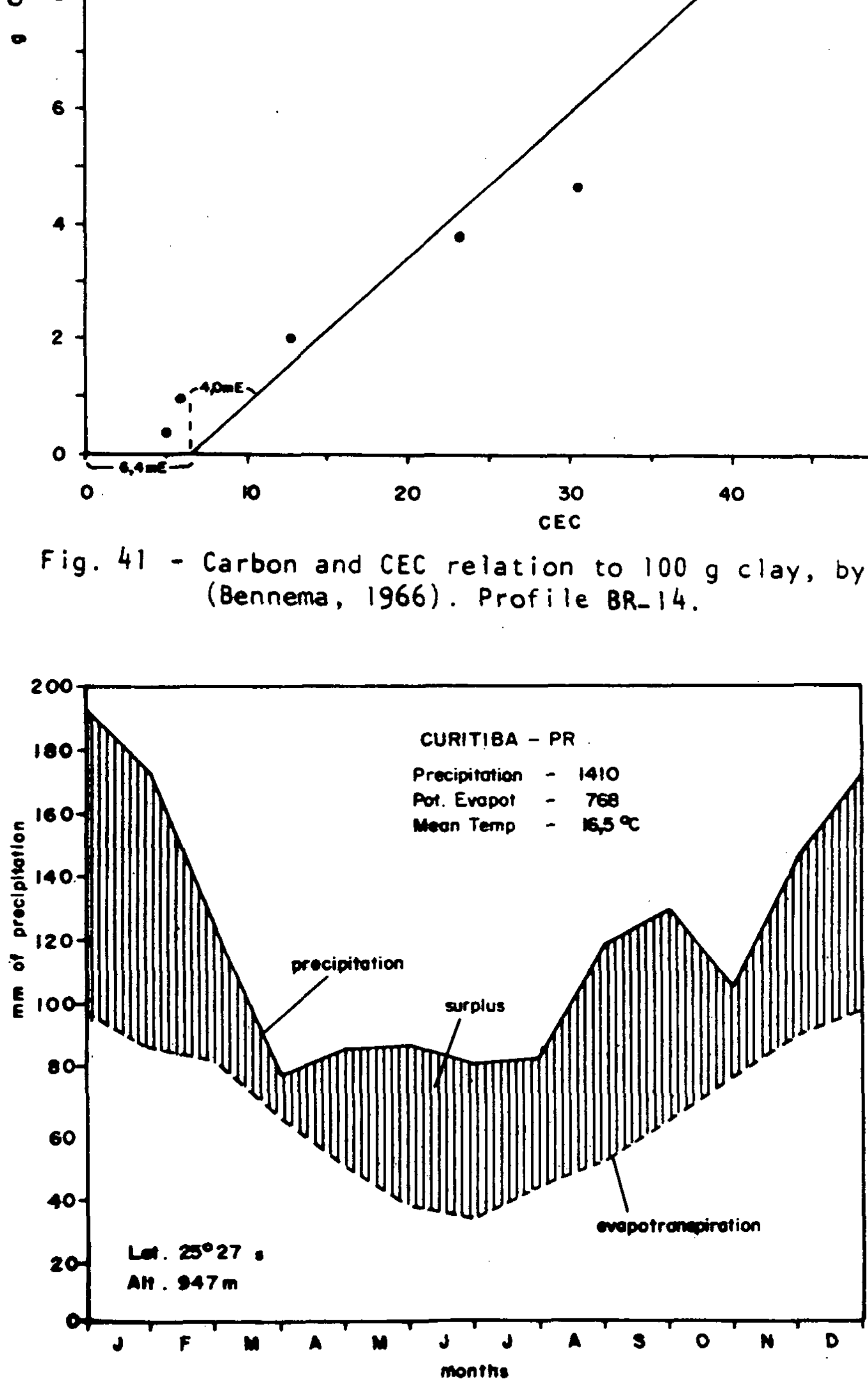

Fig. 42 - Water balance according to Thornthwaite & Mather, 1955 (125 mm), for geographic region related to profiles BR-14 and BR-15.

PROFILE ISCW-BR 15* DESCRIBED AND SAMPLED - 1974

CLASSIFICATION - RUBROZEM textura argilosa fase campo subtropical relevo suave ondulado (RUBROZEM**, clayey, subtropical grassland gently undulating phase).

Typic Haplumbrept; clayey, mixed, thermic.

Humic Cambisol.

Sol isohumique; Brunizem à B textural, dérivé d'argillites.

LOCATION - Curitiba, PR. Vila Paraíso. 25°28'00" S 49°17'00" W.

TOPOGRAPHIC POSITION - Trench at upper third of hillside, 10% slope, under grass vegetation; gently undulating; 910 meters.

PRIMARY VEGETATION - Grassland with disjunctions ("islands") of mixed Araucaria pine forest.

GEOLOGY AND PARENT MATERIAL - Pleistocene deposits (lacustrine and fluviatile) of Curitiba Basin, variably argillites, arkoses, argillaceous conglomerates and fanglomerates; weathered argillites.

DRAINAGE - Moderately will drained.

PRESENT LAND USE - Idle pasture.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	20.1	20.1	19.2	16.8	14.5	13.2	12.5	14.0
P mm	198	173	124	78	85	87	81	83
	Sept	Oct	Nov	Dec				
T°C	14.8	16.2	17.4	18.9	Mean	16.5		
P mm	119	130	105	147	Total	1410		
		Thermic			Udic			

A1 - 0 - 24 cm, very dark brown (10 YR 2/2, moist), dark brown (10 YR 3/3, crushed), very dark grayish brown (10 YR 3/2, dry); clay; strong medium granular; many coarse pores; slightly hard, friable, slightly plastic and slightly sticky; clear and smooth boundary.

A3 - 24 - 37 cm, very dark grayish brown (10 YR 3/2, moist), dark brown (10 YR 3/3, crushed), dark brown (10 YR 3/3, dry); clay; moderate medium granular; many coarse pores; slightly hard, friable, slightly plastic and sticky; clear and smooth boundary.

B1t - 37 - 56 cm, yellowish red (5 YR 4/8, moist), yellowish red (5 YR 4/6, dry); clay; moderate coarse subangular blocky; few weak clay films; common fine pores; hard, firm, plastic and sticky; clear and smooth boundary.

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* After COSTA LIMA, V. 1974. Estudo Pedológico de Perfis de Solos do Grande Grupo RUBROZEM da Bacia de Curitiba - PR. M.Sc. Thesis. Piracicaba, São Paulo

** Alic, high clay activity and prominent A horizon implied.

IIB21t - 56 - 71 cm, red (10 R 5/6, moist), yellowish brown (10 YR 5/4, dry); clay; strong medium subangular blocky; common moderate clay films; common very fine pores; very hard, very firm, plastic and sticky; clear and smooth boundary.

IIB22t - 71 - 95 cm, red (10 R 5/6, moist), weak red (10 R 5/4, dry); clay; strong medium subangular blocky; common moderate clay films; common very fine pores; very hard, very firm, plastic and sticky; clear and wavy boundary.

IIB3t - 95 - 107 cm, red (10 R 5/6, moist and dry), many fine and prominent mottles of very dark gray (10 YR 3/1) and gray (N/5); clay; moderate medium subangular blocky; common very fine pores; very hard very firm, plastic and sticky; clear and wavy boundary.

IIC1 - 107 - 135 cm, red (2.5 YR 4/6, moist), red (2.5 YR 5/6, dry), many medium and prominent mottles of very dark gray (10 YR 3/1) and gray (N/5); clay; strong medium angular blocky; common very fine pores; very hard, firm, plastic and sticky; clear and wavy boundary.

IIC2 - 135 cm^{+}, argillites.

REMARKS - Abundant roots in A1 and A3, common in B1 and IIB21t, few in IIB22t, and very few in IIB3t and IIC1.

Few, small, hard, spheric, black and ferruginous nodules till IIB3t.
Stone line (quartz and quartzite) at 54 cm depth.

Mineralogy of Clay Fraction

Horizon	Mica	Vermic.	Montm.	Kaol.	Amorphous	Gibbsite
A1	22	13	18	45	10	1
IIB1t	23	8	25	43	9	1
IIB22t	25	12	28	34	8	
IIC1	23	13	22	37	9	
IIC2	21	15	20	38	10	

Mineralogy of Sand Fraction

Predominance of quartz - more than 90%. Some of the quartz grains are subangular. The other particles are constituted of opaque minerals and ferruginous concretions. Concretions are possibly magnetite, ilmenite and hematite. Feldspar occurs occasionally as trace.

PROFILE Nº ISCW-BR 15

SAMPLE Nº --

SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 24				8	18	15	59	8	86	
A3	- 37										
B1t	- 56				8	15	11	66	1	99	
IIB21t	- 71										
IIB22t	- 95				2	18	14	66	1	99	
IIB3t	-107										
IIC1	-135				1	19	10	70	1	99	
IIC2	-135+				1	9	10	80	1	99	

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.9	3.8	3.0	1.0	0.30		4.3	8.6	12.0	24.9	17	67
--											
5.2	3.8	0.9	0.7	0.27		1.9	10.9	7.1	19.9	10	85
--											
5.1	3.6	3.7	1.8	0.08		5.6	14.8	3.0	23.4	24	73
--											
5.0	3.6	8.9	2.2	0.08		11.2	12.9	2.7	26.8	42	54
5.1	3.6	13.6	1.6	0.08		15.3	8.9	2.9	27.1	56	37

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
5.24							2.4			
--										
1.53							2.9			
--										
0.41			31.7	18.6	7.5	0.47	2.9	2.30	3.89	
--										
0.10							2.9			
0.06							3.1			

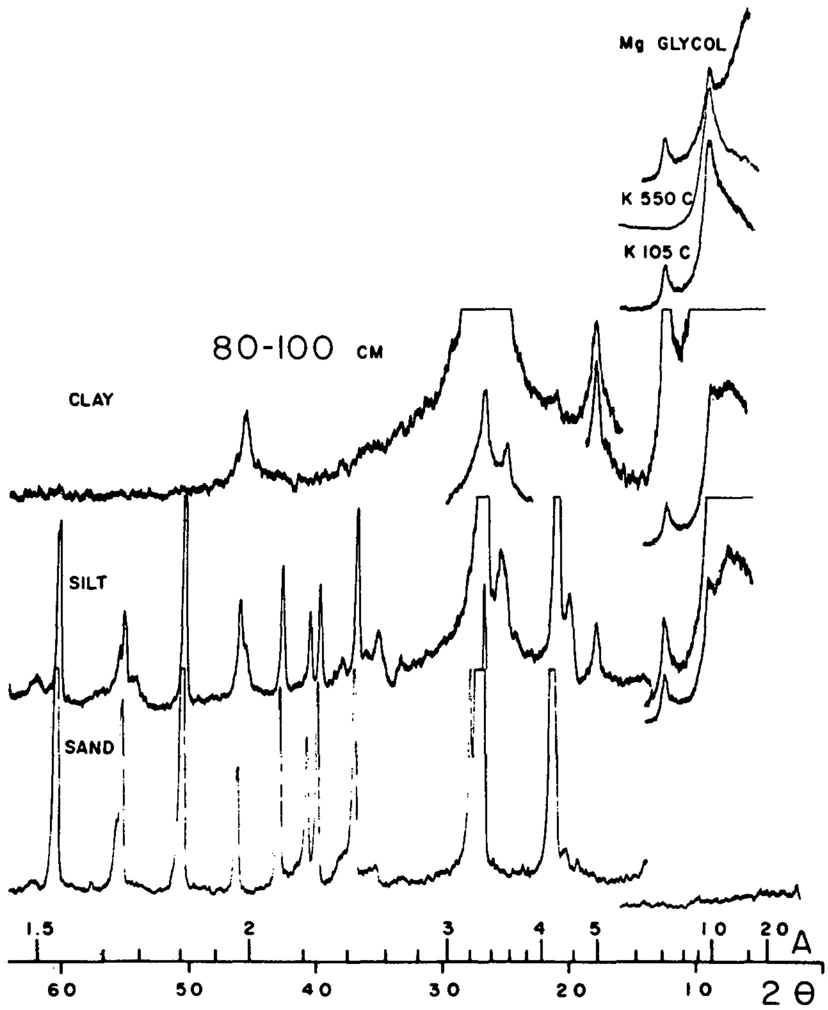

Fig. 43 - X-Ray diffraction patterns of the clay, silt and sand from B2 horizon of the profile BR-15.

Note

The profile seen in the field was not the profile recorded in the tour guide. The profile studied had questionable clay skins, no argillic horizon and sufficient organic carbon for an Umbrept, according to Smith. The pedon examined should be classified as a Cumulic Haplumbrept.

This soil was previously classified as a Typic Palehumult on the basis of weatherable minerals in the 20-200 micron fraction in the upper 50 cm of an assumed argillic horizon. The clay activity of this soil is high, amounting to more than 40 meq per 100 g clay. This excludes this pedon from the Kandi great group.

PROFILE ISCW-BR 16 DESCRIBED AND SAMPLED - 16 Feb 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO argila de atividade baixa A moderado textura argilosa fase floresta tropical subcaducifólia relevo suave ondulado (RED-YELLOW PODZOLIC ALIC, low clay activity, plinthic, moderate A horizon, clayey, semi-deciduous tropical forest gently undulating phase).

(Plinthic)* Paleustult; clayey, mixed, isohyperthermic.

Ferric Acrisol.

Sol ferrallitique; fortement désaturé, typique, induré et hydromorphe, dérivé de formation Barreiras.

LOCATION - Socorro, SE. Road Aracaju-Itabaiana, 1.600 m from BR-101; 10º53'00" S 37º08'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at medium third of hillside, under grass and shrub vegetation; gently undulating; 40 meters.

PRIMARY VEGETATION - Semi-deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Sandy clay sediments, Barreira Group, Tertiary; weathered sediments with thin cover of reworked material.

DRAINAGE - Moderately well drained.

PRESENT LAND USE - Poor pasture.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
TºC	26.6	26.9	26.9	26.6	25.7	24.7	24.0	24.1
P mm	38	51	92	162	253	186	162	120
	Sept	Oct	Nov	Dec				
TºC	24.7	25.5	26.0	Mean	25.7			
P mm	70	53	53	35	Total	1275		
		Isohyperthermic			Ustic/udic			

A1 - 0 - 26 cm, dark grayish brown (10 YR 4/2, moist), light brownish gray (10 YR 6/2, dry), common fine and prominent mottles of strong brown (7.5 YR 5/6, moist); gravelly sand clay; moderate fine subangular blocky and fine to medium granular; common fine and medium, and few coarse pores; slightly hard, firm, plastic and sticky; clear and smooth boundary.

IIA3 - 26 - 40 cm, brown (10 YR 4/3, moit), pale brown (10 YR 6/3, dry), many fine and prominent mottles of strong brown (7.5 YR 5/6, moist); clay; weak fine subangular and angular blocky; common fine and few medium pores; hard, friable, plastic and sticky; clear and smooth boundary.

IIB1t - 40 - 60 cm, yellow (10 YR 7/6, moist), common coarse and prominent mottles of reddish yellow (7.5 YR 6/8, moist); clay; weak fine subangular and angular blocky; common fine and few medium pores; very hard, firm, plastic and sticky; clear and wavy boundary (12-22 cm).

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* Subgroup not established.

IIB2t - 60 - 88 cm, brownish yellow (10 YR 6/6, moist), many coarse and prominent mottles of red (2.5 YR 5/8, moist); clay; weak fine subangular and angular blocky; common fine and few medium pores; very hard, friable, plastic and sticky;abrupt and wavy boundary (22-34 cm).

IIIB3tpl - 88 - 168 cm, variegated color of very pale brown (10 YR 7/4, moist) and red (2.5 YR 5/8, moist); clay; weak fine and medium angular and subangular blocky; few fine and medium pores; hard and extremely hard, firm and extremely firm, plastic and very sticky; gradual and wavy boundary (74-82 cm).

IIICpl - 168 - 258 cm$^+$, variegated color of light gray (2.5 YR 7/2, moist) and weak red (10 R 4/3, moist); clay; weak fine subangular and angular blocky; few fine and medium pores; very hard and extremely hard, firm and extremely firm, plastic and sticky.

REMARKS - Common roots in Al, few in IIA3 and very few in IIBlt and IIB21t.

Occurrence of quartz cobbles in Al and IIIB3tpl.

Iron concretions up to 5 cm in diameter in IIIB3tpl and Cpl.

Profile dry.

PROFILE Nº ISCW-BR 16

SAMPLE Nº 77.0762/67 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 26	8	2	90	24	23	17	36	27	25	0.47
IIA3	- 40	-	3	97	21	20	16	43	33	23	0.37
IIB1t	- 60	-	2	98	20	16	14	50	39	22	0.28
IIB2t	- 88	-	1	99	19	14	16	51	8	84	0.31
IIIB3tpl	-168	24	16	60	15	14	28	43	-	100	0.65
IIICpl	-258+	25	4	71	7	13	38	42	-	100	0.90

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.0	4.1	1.6	0.7	0.14	0.06	2.5	0.6	4.3	7.4	34	19
5.0	4.0	0.9	0.5	0.07	0.05	1.5	1.2	3.6	6.3	24	44
4.8	3.9	0.6		0.03	0.05	0.7	1.6	2.4	4.7	15	70
4.8	3.9	0.4		0.02	0.04	0.5	1.7	1.6	3.8	13	77
4.9	3.9	0.4		0.03	0.04	0.5	2.3	1.5	4.3	12	82
4.9	3.8	0.7		0.03	0.06	0.8	2.9	1.4	5.1	16	78

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
1.24	0.13	10	15.0	12.5	1.7	0.57	2.04	1.88	11.56	4
0.78	0.09	9	19.8	16.5	1.9	0.73	2.04	1.90	13.60	2
0.37	0.06	6	22.6	19.2	1.9	0.80	2.00	1.88	15.82	1
0.22	0.04	6	24.6	20.2	1.7	0.82	2.07	1.97	18.68	1
0.20	0.04	5	21.5	17.6	3.1	0.71	2.08	1.87	8.89	1
0.09	0.03	3	23.9	19.6	3.3	0.71	2.07	1.87	9.33	1

Clay B/A - 1.3 Weighted - 1.3

PROFILE Nº ISCW-BR 16
SAMPLE Nº 77.0762/67

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE	MG, TM & IL	ZR	CN ARG	RU & ST	OF	CN HU	GR				
SANDS (2-.05 mm)													
A1	97%	2%	1%	tr	tr	tr	tr	tr					
IIA3	100%	tr	tr	tr	tr	tr	tr		tr				
IIB1t	98%	2%	tr	tr	tr	tr							
IIIB2t	100%	tr	tr	tr	tr	tr							
IIIBtpl	75%	25%	tr	tr	tr								
IIICpl	100%		tr	tr	tr								
GRAVELS (>2 mm)													
	95%	5%			tr								
	95%	5%											
	95%	5%											
	95%	5%											
°	50%	50%											
°	3%	97%											

Mineral Code : QZ - quartz; CN FE - iron concretions; MG - magnetite; TM - tourmaline; IL - ilmenite
ZR - zircon; CN ARG - argillaceous concretions; RU - rutile; ST - staurolite; OF - organic fragments; CN HU - humous concretions; GR - garnet

° 100% of iron concretions in faction > 20 mm

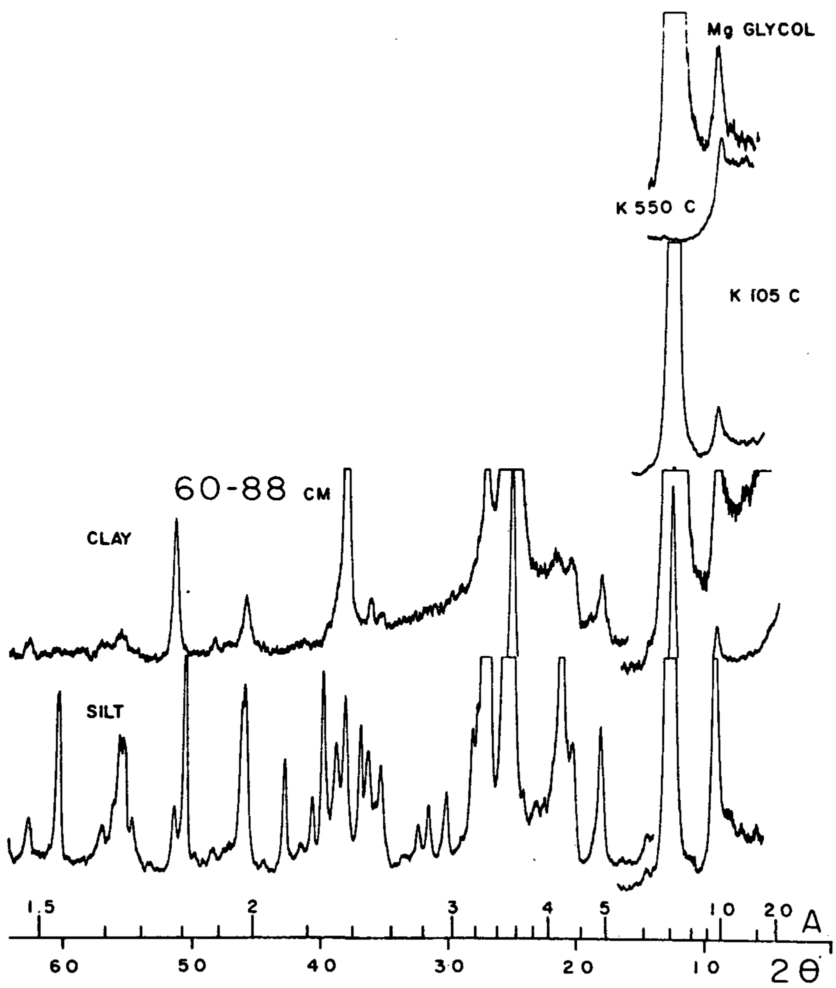

Fig. 44 - X-Ray diffraction patterns of the clay and silt from IIIB2t horizon of the profile BR-16.

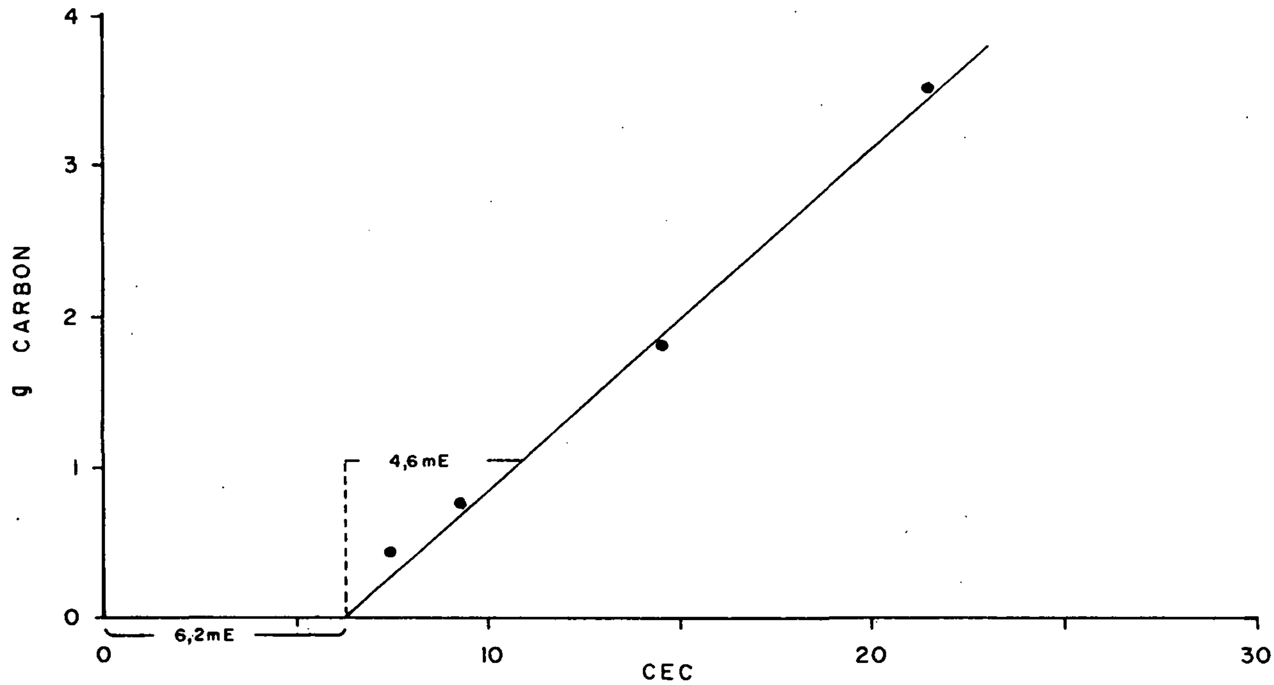

Fig. 45 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-16.

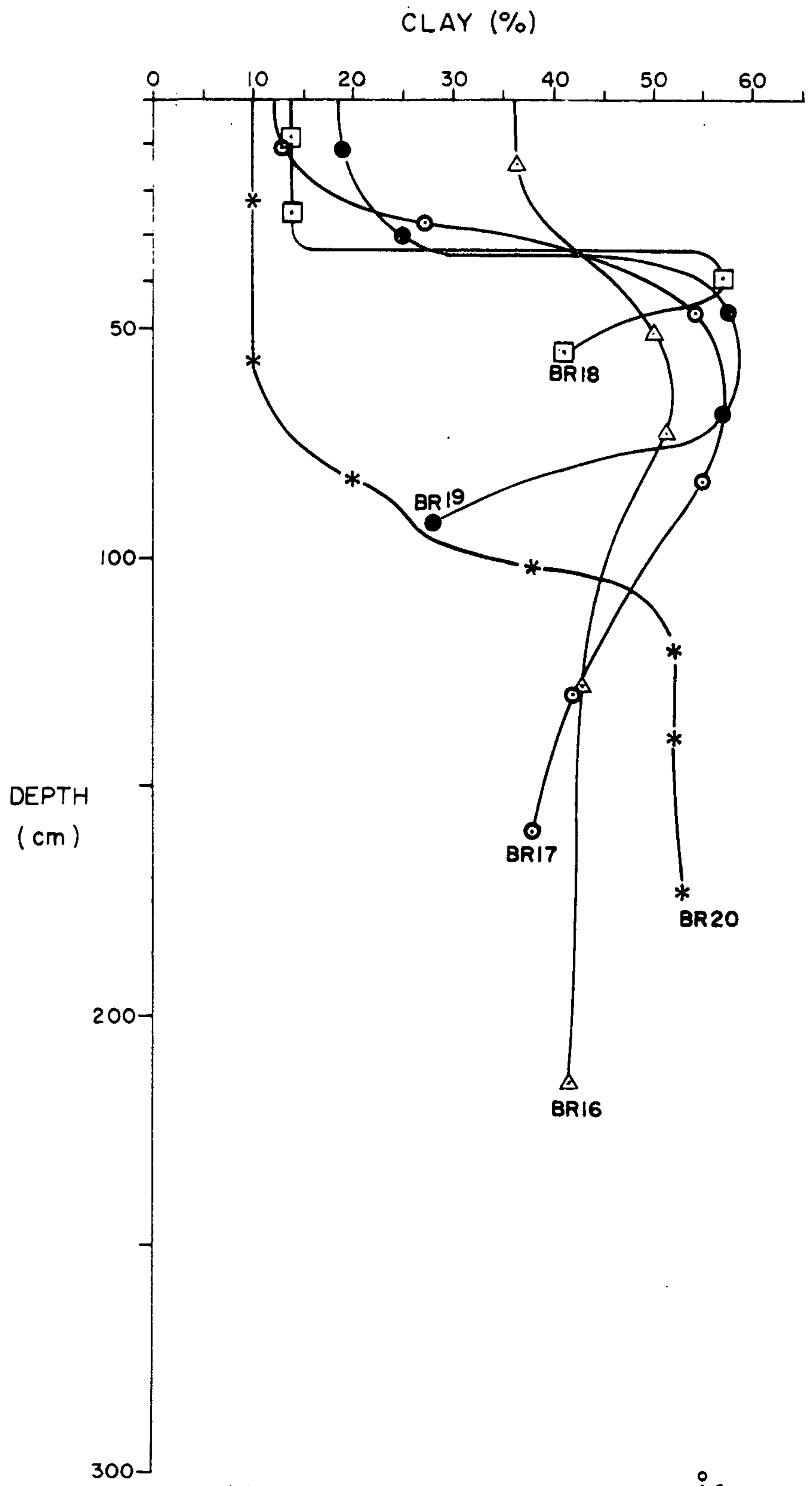

Fig. 46 - Clay distribution curves° for profiles BR-16, BR-17, BR-18, BR-19 and BR-20.

° All clay distribution curves at same scale.

Discussion

Based on the data presented and admitting the presence of cutans and less than 10 percent weatherable minerals in the 20-200 micron fraction of the upper 50 cm of the argillic horizon, this profile would be a Palustult or a Kandiustult in the terminology proposed by the committee.

A discussion was held on the material designated as plinthite in the description (III B3tpl, 88-168 cm). While no distinct hardening of the mottled material in the long-exposed roadcut was observed, there appeared enough plinthite or petroplinthite present for a plinthic subgroup. No such subgroup is presently provided for Paleustults but should be introduced.

The presence, in the III B3tpl horizon, of a high percentage of gravel may, according to Bennema, be a reason to introduce a "leptic" subgroup. Based on total soil, rather than on fine earth alone, the clay content would decrease more than 20 percent from its maximum. This proposal does, however, not conform with the present "Pale" definition, both as regards the clay distribution in the fine earch and the absence of cutans and/or plinthite in the layer below the horizon of maximum clay accumulations (Soil Taxonomy, page 371).

PROFILE ISCW-BR 17 DESCRIBED AND SAMPLED - 16 Feb 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO argila de atividade baixa abrúptico A moderado textura média cascalhenta/argilosa cascalhenta fase floresta tropical subcaducifólia relevo forte ondulado (RED-YELLOW PODZOLIC ALIC, low clay activity, abruptic, moderate A horizon, gravelly loamy/clayey, semi-deciduous tropical forest hilly phase).

Typic Haplustult; clayey, mixed, isohyperthermic.

Ferric Acrisol.

Sol ferrallitique; moyennement désaturé, typique, faiblement appauvri, dérivé de formations argileuses crétacées.

LOCATION - Carmópolis, SE. 3.0 km from Carmópolis, in a side road of Petrobrás near the junction to old Carmópolis-Aracaju road; 10°41'00" s 36°59'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at upper third of hillside, under second grow forest; hilly; 30 meters.

PRIMARY VEGETATION - Semi-deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Sandy clay and clay sediments, Cretaceous; weathering residues of stated sediments overlain by coarser material.

DRAINAGE - Well drained.

PRESENT LAND USE - Natural pasture and cassava crop.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.6	26.6	26.9	26.6	25.7	24.7	24.0	24.1
P mm	37	34	86	151	222	182	165	112

	Sept	Oct	Nov	Dec		
T°C	24.7	25.5	26.0	26.4	Mean	25.7
P mm	62	50	36	36	Total	1173

Isohyperthermic Ustic/udic

01 - 2 - 0 cm, leaves, roots and branches in decomposition.

A1 - 0 - 20 cm, dark brown (7.5 YR 4/3, moist); grayish brown (10 YR 5/2, dry); gravelly sandy loam; moderate fine to medium granular; many very fine and fine, few medium and coarse pores; soft, friable, slightly plastic and slightly sticky; gradual and smooth boundary.

A3 - 20 - 32 cm, reddish brown (5 YR 4/3, moist), brown (7.5 YR 4/4, moist); slightly gravelly sandy clay loam; weak fine angular and subangular blocky; common very fine and fine, few medium pores; hard, firm, plastic and sticky; clear and smooth boundary.

IIB1t - 32 - 60 cm, reddish brown (2.5 YR 4/4, moist); clay; strong fine subangular and angular blocky; common very fine and fine, few medium pores; common moderate clay films; firm, very plastic and sticky; gradual and smooth boundary.

IIB2t - 60 - 105 cm, red (2.5 YR 4/6, moist); clay; strong fine subangular and angular blocky; common very fine and fine, few medium pores; common moderate clay films; firm, very plastic and very sticky; gradual and smooth boundary.

IIB3t - 105 - 150 cm, red (2.5 YR 4/6, moist), many coarse and prominent mottles of light yellowish brown (10 YR 6/4, moist); sandy clay; moderate fine subangular and angular blocky; common very fine and fine, few medium pores; few weak clay films; firm, plastic and sticky; diffuse and smooth boundary.

IIC - 150 - 160 cm^+, variegated color of red (2.5 YR 4/6, moist) and reddish yellow (7.5 YR 6/6, moist); sandy clay; weak fine subangular and angular blocky; very fine and fine pores; friable, plastic and sticky.

REMARKS - Abundant roots in A1, common in A3, IIB1t and IIB2t, few in IIB3t, and very few in IIC.

Termites and ants activity in A1 and A3.

Quartz gravels in A1 and A3.

Profile dry.

PROFILE Nº ISCW-BR 17
SAMPLE Nº 77.0769/74 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 20	11	37	52	46	28	13	13	10	23	1.00
A3	- 32	1	2	97	34	25	14	27	23	15	0.52
IIB1t	- 60	-	1	99	19	15	12	54	38	30	0.22
IIB2t	-105	-	1	99	21	14	10	55	42	24	0.18
IIB3t	-150	-	1	99	40	10	8	42	3	93	0.19
IIC	-160+	-	1	99	45	9	8	38	13	66	0.21

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.1	4.2	1.2	1.1	0.40	0.08	2.8	0.3	3.8	6.9	41	10
4.7	3.8	0.6	0.4	0.25	0.07	1.3	1.9	3.8	7.0	19	59
4.7	3.7	0.6	0.8	0.31	0.09	1.8	4.5	4.0	10.3	17	71
4.7	3.7	0.3	0.9	0.32	0.09	1.6	4.5	3.8	9.9	16	74
4.7	3.8	0.3	0.9	0.16	0.10	1.5	3.3	2.5	7.3	21	69
4.7	3.9	1.0		0.16	0.06	1.2	2.8	2.2	6.2	19	70

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
1.22	0.13	9	6.5	4.2	1.0	0.32	2.63	2.49	6.54	3
0.82	0.10	8	12.3	8.6	2.1	0.44	2.43	2.10	6.44	2
0.59	0.08	7	25.0	18.3	4.9	0.60	2.32	1.98	5.86	1
0.55	0.08	7	25.1	18.7	4.9	0.58	2.28	1.96	5.99	1
0.21	0.05	4	20.7	15.4	3.3	0.41	2.28	2.01	7.33	1
0.17	0.05	3	19.4	15.1	3.0	0.39	2.18	1.94	7.87	1

Clay B/A - 2.8 Weighted - 3.1

PROFILE Nº ISCW-BR 17
SAMPLE Nº 77.0769/74

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CH & OF	IL	TM	RU	CN FE	BT & MS	OF
SANDS (2-.05 mm)								
A1	98%	2%	tr	tr	tr	tr	tr	
A3	98%	1%	1%	tr	tr	tr	tr	
IIB1t	99%		1%	tr	tr	tr	tr	tr
IIB2t	99%		1%	tr	tr	tr	tr	tr
IIB3t	100%		tr	tr	tr	tr	tr	tr
IIC	99%		1%	tr	tr	tr	tr	tr
GRAVELS (>2 mm)								
	100%							
	100%					tr		tr
	100%							tr
	100%							tr
	100%							tr
	100%							tr
	100%					tr		

Mineral Code : QZ - quartz; CH - charcoal; OF - organic fragments; IL - ilmenite; TM - tourmaline; RU - rutile; CN FE - iron concretions; BT - biotite; MS - muscovite

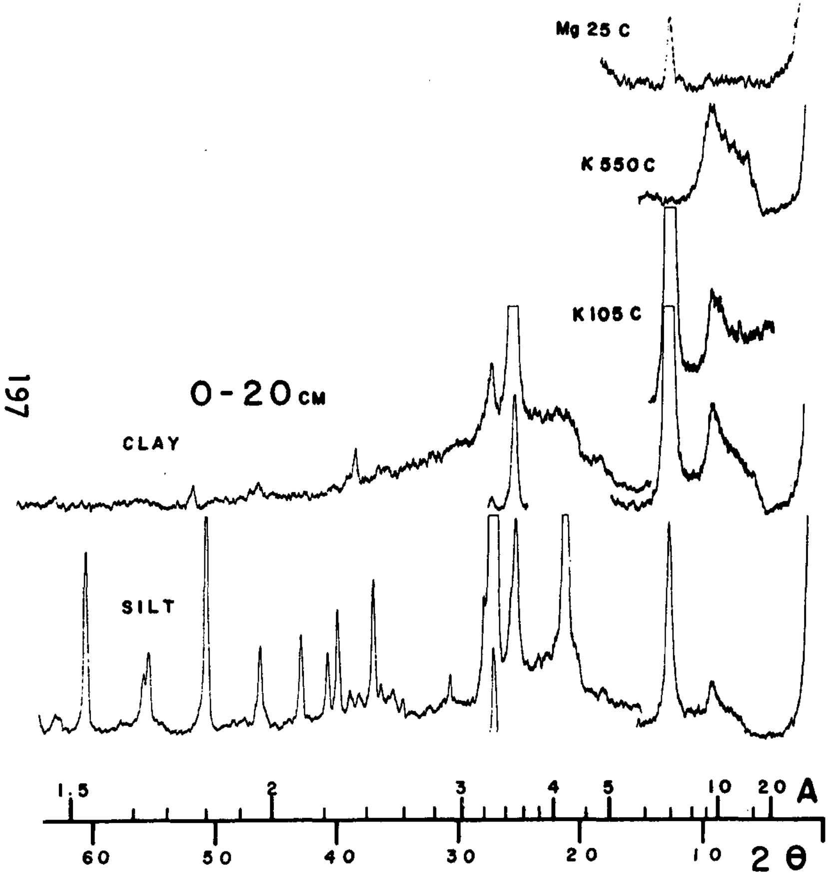

Fig. 47 - X-Ray diffraction patterns of the clay and silt from Al horizon of the profile BR-17.

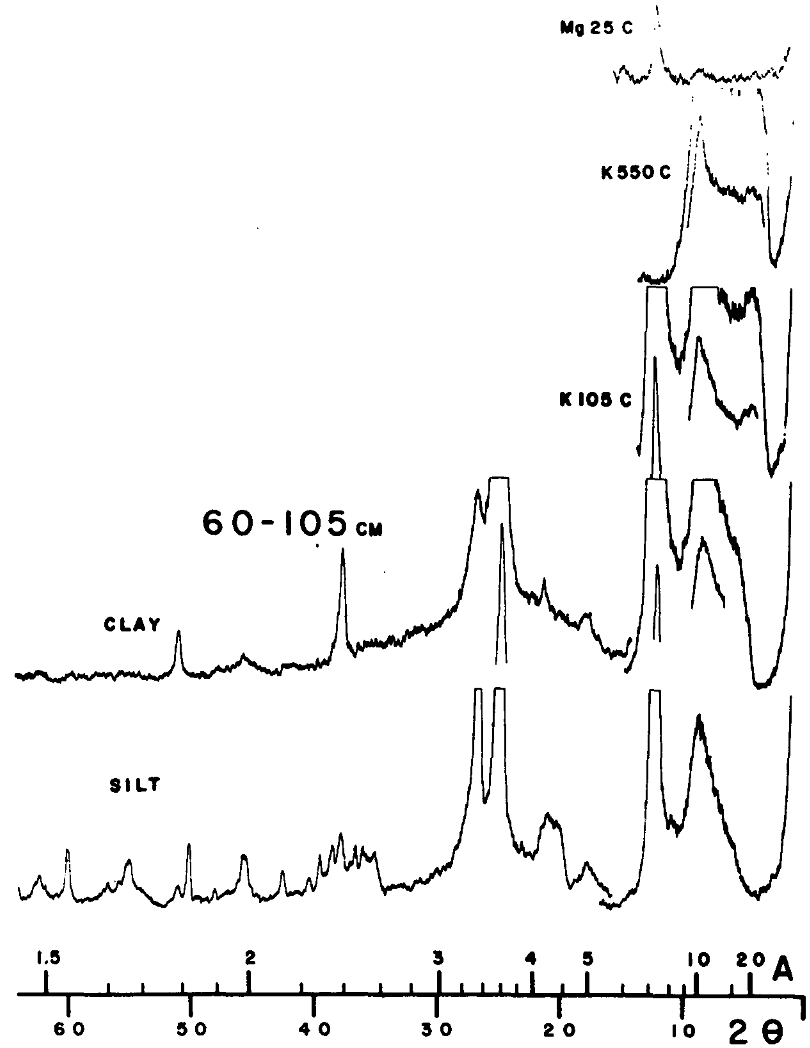

Fig. 48 - X-Ray diffraction patterns of the clay and silt from IIB2t horizon of the profile BR-17.

Discussion

1. This pedon does not qualify for a Kandi great group as the calculated clay activity in the upper 50 cm of the argillic horizon is 26 meq per 100 g clay. According to the X-ray data from Hawaii, the mineralogy of the IIB2t is mixed, with considerable 10-20 A minerals.

2. The soil does not have a "Pale" clay distribution. The transition from the A to the IIB1t horizon is clear but not abrupt (less than 25 percent clay increase over 7.5 cm). Even if there were an abrupt transition, this is not diagnostic for Pale great groups of Ultisols but only for Alfisols. This pedon is clearly an Ultisol.

3. There existed uncertainty whether the soil moisture regime is ustic or udic. Buol considered it a borderline case. In the absence of precise data, an ustic moisture regime is assumed for the purpose of the discussion.

4. Several participants observed a paralithic contact at less than 150 cm depth which also would exclude this pedon from a Pale great group. The discussion revealed that the notion of "paralithic" requires further precision. In the present instance some roots were found in the presumed paralithic layer which is not allowed according to the definition.

5. The Al saturation is more than 50 percent throughout which is characteristic for "alic" and would eventually be a requirement for the typic subgroup in various Kandi great groups of Ultisols. This issue is still under discussion.

6. Uehara commented on the apparent discrepancy between CEC and clay mineralogy. The CEC appears too low in view of the relatively high amount of 10-14 A minerals. According to Moormann, some Ultisols developed from acid crystalline rocks (Basement Complex) in Nigeria have a CEC of 10-15 meq per 100 g clay in the argillic horizon but 10 to 30 percent vermiculite in the clay fraction.

The work of Herbillon (Louvain) indicates that blocking of the exchange sites by intermediate Al-silicates may be the cause of the discrepancy between low CEC and relatively high contents of "high activity clays". If this is so, there would be mixed mineralogies in the Kandi groups, regardless whether the limit is set at 16 or 24 meq per 100 g clay. This appears to weaken Buol's claim that the 16 meq limit is better because it correlates with the mineralogy class : it does not, at least not in all cases.

7. Based on the data and observations, this pedon can be classified as a Typic Haplustult but not as a Kandiustult.

PROFILE ISCW-BR 18 DESCRIBED AND SAMPLED - 23 Nov 1969

CLASSIFICATION - BRUNO NÃO CÁLCICO abrúptico A moderado textura média/argilosa fase floresta tropical caducifólia relevo ondulado (NON-CALCIC BROWN*, abruptic, moderate A horizon, loamy/clayey, deciduous tropical forest rolling phase).

Ultic Paleustalf; clayey, mixed, isohyperthermic.

Chromic Luvisol.

Sol brun eutrophe tropical; ferrugineux, dérivé de schiste à biotite.

LOCATION - Porto Real do Colégio, AL. BR-101, 8 km N of Porto Real do Colégio, right side; 10°17'00" S 36°47'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at upper third of hillside, 10% slope, under grass and shrub vegetation; rolling to hilly; 120 meters.

PRIMARY VEGETATION - Deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Biotite schist, Precambrian Complex; weathering residues of stated rock overlain by coarser material.

DRAINAGE - Moderately well drained.

PRESENT LAND USE - Mainly pasture of colonial grass (sempre-verde) in about 60-75% of the area.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	27.2	27.9	27.8	26.8	25.2	23.8	23.0	22.9
P mm	30	24	47	90	158	123	111	80
	Sept	Oct	Nov					
T°C	24.3	25.8	26.8	27.4	Mean	25.7		
P mm	40	25	36	22	Total	786		
		Isohyperthermic			Ustic/udic			

A1 - 0 - 17 cm, dark brown (10 YR 3/3, moist), brown (10 YR 5/3, dry); slightly gravelly sandy loam; massive; many very fine and fine, and common medium pores; slightly hard, friable, slightly plastic and slightly sticky; clear and smooth boundary.

A2 - 17 - 33 cm, dark yellowish brown (10 YR 4/4, moist), light yellowish brown (10 YR 6/4, dry), common medium and diffuse mottles of yellowish brown (10 YR 5/7, moist); slightly gravelly sandy loam; massive; many very fine and fine, and common medium pores; hard, friable, slightly plastic and slightly sticky; abrupt and wavy boundary (13-20 cm).

IIBt - 33 - 50 cm, dark yellowish brown (10 YR 4/4, moist), many fine and diffuse mottles of strong brown (7.5 YR 5/6, moist) and common fine and prominent red (2.5 YR 4/8, moist); clay; weak to

* Eutrophic, high clay activity implied.

moderate fine coarser angular and subangular blocky; many very fine and fine, and few medium pores; continuous and moderate clay films; extremely hard, friable, plastic and sticky; clear and wavy boundary (15-25 cm).

IIC - 50 - 60 cm, mixed colors of dark yellowish brown (10 YR 4/4, moist and dry) and yellowish brown (10 YR 5/6, moist and dry); clay; moderate fine to medium angular and subangular blocky; many very fine and fine, and few medium pores; few weak clay films; very hard, firm, plastic and sticky; clear and wavy boundary (8-15 cm).

IIR - 60 - 100 cm^+, semi-decomposed rock.

REMARKS - Plentiful roots in A1, common in A2 and few in IIBt and IIC.

Stones and gravels mainly in A2. Some stones and gravels scattered on the surface.

Profile dry.

PROFILE Nº ISCW-BR 18

SAMPLE Nº 5825/28 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 17	2	7	91	8	52	26	14	8	43	1.86
A2	- 33	19	11	70	8	50	28	14	11	21	2.00
IIBt	- 50	-	2	98	3	20	19	58	48	17	0.33
IIC	- 60	-	1	99	4	29	26	41	36	12	0.63

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
6.1	5.0	3.6	2.6	0.48	0.12	6.8	-	2.4	9.2	74	-
6.3	4.5	2.4	2.4	0.32	0.12	5.2	0.1	1.4	6.7	78	2
6.2	4.2	3.8	14.1	0.12	0.36	18.4	0.2	2.3	20.9	88	1
6.6	4.2	3.2	16.9	0.11	0.48	20.7	0.1	1.4	22.2	93	1

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
1.69	0.17	10	7.2	4.4	3.6	0.78	2.78	1.83	1.92	3
0.63	0.08	8	7.5	4.9	3.7	0.75	2.60	1.76	2.08	1
0.61	0.08	8	25.9	17.4	9.6	0.81	2.53	1.87	2.84	< 1
0.40	0.07	6	23.4	15.4	10.0	0.73	2.58	1.83	2.42	< 1

Clay B/A - 4.1 Weighted - 4.1

PROFILE Nº ISCW-BR 18
SAMPLE Nº 5825/28

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	WE BT	RF	CN FE & CN MN	IL & MG	CN ARG	ZR	MS	OF	MC & PL	ST	RU & TM	
SANDS (2-.05 mm)													
A1	98%	tr		tr	2%		tr	tr	tr				
A2	94%	tr		3%	2%	1%	tr	tr	tr			tr	
IIBt	84%	10%		3%	3%		tr	tr			tr		
IIC	56%	40%		1%	tr	3%	tr	tr		tr	tr	tr	
GRAVELS (>2 mm)													
	88%	tr	2%	10%									
	92%			8%									
	79%		5%	15%	1%								
	50%		35%	10%	5%								

Mineral Code: QZ - quartz; WE BT - weathered biotite; RF - rock fragments; CN FE - iron concretions; CN MN - manganose concretions; IL - ilmenite; MG - magnetite; ZR - zircon; MS -muscovite; OF - organic fragments; MC - microcline; PL - plagioclase; ST - staurolite; RU - rutile; TM - tourmaline; CN ARG - argillaceous concretions

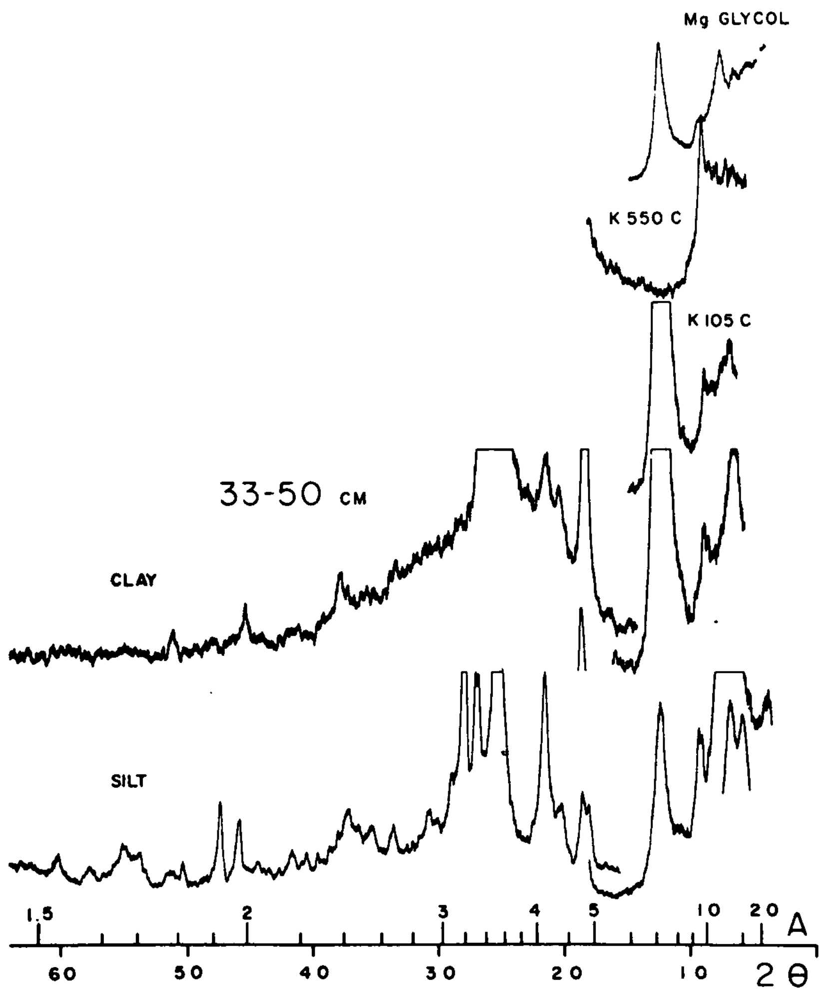

Fig. 49 - X-Ray diffraction patterns of the clay and silt from IIBt horizon of the profile BR-18.

Discussion

1. This soil is distinctly outside the Kandi sphere, both because of the high CEC (more than 55 meq per 100 g clay in the argillic horizon) and the high content of weatherable minerals. It is an Alfisol because the calculated base saturation is about 67 percent in the horizon immediately above the paralithic contact. While the clay distribution is not "Pale", the pedon qualifies for a Pale great group because of the abrupt transition from the A to the B horizon. Assuming an ustic rather than an aridic soil moisture regime, this soil would key out as an Ultic Paleustalf (Soil Taxonomy, pp. 142-143).

2. The present definition of Pale great groups of Alfisols were discussed where, in certain cases, only the sharp clay increase in the upper part of the argillic horizon is diagnostic (20 percent increase, absolute, with 7.5 cm or 15 percent, absolute, within 2.5 cm). Several participants, especially Bennema, felt this to be unfortunate because very different soils are lumped together.

Note from F. R. Moormann

During a recent field tour in California, I found that a similar objection is made by some US soil scientists who would like to return to the original classification in which the "abrupt" transition was recognized at the subgroup level. Because this particular subject does not appear directly relevant to the committee's work, the above opinions are passed on to SCS for consideration.

PROFILE ISCW-BR 19 DESCRIBED AND SAMPLED - 17 Feb 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO EUTRÓFICO argila de atividade baixa abrúptico plíntico A moderado textura média cascalhenta/argilosa fase floresta tropical caducifólia relevo ondulado (RED-YELLOW PODZOLIC EUTROPHIC, low clay activity, abruptic, plinthic, moderate A horizon, gravelly loamy/clayey, semi-deciduous tropical forest rolling phase).

Oxic Haplustalf; clayey, oxidic, isohyperthermic.

Ferric Luvisol.

Sol ferrallitique; faiblement désaturé, rajeuni, avec érosion e remaniement, dérivé de schiste à biotite.

LOCATION - São Sebastião, AL. BR-101 N of Porto Real do Colégio, roadsign km 217; 9°58'00'' S 36°30'00'' W.

TOPOGRAPHIC POSITION - Trench on slightly sloping top of hill, under grass and shrub vegetation; rolling and hilly; 150 meters.

PRIMARY VEGETATION - Deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Biotite schist with quartz veins, Precambrian Complex; weathering residues of stated rock overlain by coarser material.

DRAINAGE - Moderately well drained.

PRESENT LAND USE - Pasture of pangola grass and small crops of cassava.

	Jan	Feb	Mar	Apr	May	jun	Jul	Aug
T°C	26.0	26.0	26.0	25.5	25.0	24.0	23.5	23.0
P mm	41	47	72	127	209	173	155	107
	Sept	Oct	Nov	Dec				
T°C	23.5	24.0	25.0	25.5	Mean	24.8		
P mm	54	29	29	34	Total	1077		
		Isohyperthermic			Ustic			

A1 - 0 - 20 cm, dark grayish brown (10 YR 4/2, moist), brown (10 YR 5/3, dry); sandy loam; weak fine to medium angular and subangular blocky; few medium and coarse, common very fine and fine pores; slightly hard, friable, slightly plastic and slightly sticky; clear and smooth boundary.

A2 - 20 - 38 cm, dark brown (10 YR 4/2, moist), pale brown (10 YR 6/3, dry); very gravelly sandy clay loam; common fine and very fine pores; nonplastic and nonsticky; clear and smooth boundary.

IIB2tpl - 38 - 52 cm, variegated color of red (10 R 4/8, moist) and strong brown (7.5 YR 5/6, moist); clay; moderate fine subangular and angular blocky; common very fine and fine pores; common moderate clay films; very hard and extremely hard, friable and firm; plastic and sticky; gradual and wavy boundary (12-18 cm).

IIB3tpl - 52 - 82 cm, variegated color with predominance of red (10 R 4/6, moist) and brown (7.5 YR 5/4, moist); clay; moderate fine subangular and angular blocky; few fine and very fine pores; common moderate clay films; extremely hard, firm, plastic and sticky; clear and wavy boundary (20-35 cm).

IICpl - 82 - 100 cm, variegated color with predominance of reddish yellow (7.5 YR 6/6, moist), red (10 R 4/6, moist); clay loam (micaceous); common very fine and fine pores; extremely hard, firm and friable, plastic and slightly sticky.

REMARKS - Common roots in A1, few in A2 and IIB2tpl and very few in IIB3tpl.

A2 consists predominantly of gravels stones impeding examination of structure and consistence. These angular and subangular quartz fragments also occur in lesser quantity in lower A1.

Profile dry.

PROFILE Nº ISCW-BR 19

SAMPLE Nº 77.9775/79 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 20	2	13	85	29	34	18	19	14	26	0.95
A2	- 38	7	61	32	29	24	22	25	19	24	0.88
IIB2tp1	- 52	-	8	92	15	11	16	58	35	40	0.28
IIB3tp1	- 82	1	10	89	13	11	19	57	1	98	0.33
IICp1	-100	-	13	87	26	28	18	28	2	93	0.64

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.2	4.0	1.0	1.1	0.20	0.06	2.4	0.7	4.0	7.1	34	23
5.2	4.0	0.3	1.0	0.17	0.05	1.5	1.1	3.4	6.0	25	42
5.5	4.1	0.4	3.2	0.13	0.14	3.9	0.9	3.3	8.1	48	19
5.7	4.4	0.4	3.8	0.16	0.16	4.5	0.3	2.4	7.2	63	6
5.8	4.7	0.3	2.2	0.09	0.18	2.8	-	0.9	3.7	76	1

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	MOLECULAR RATIO SiO2 / Al2O3	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
1.34	0.12	11	7.6	5.6	2.2	0.46	2.31	1.84	3.98	1
0.85	0.08	11	10.6	8.2	3.0	0.55	2.20	1.78	4.28	1
0.74	0.09	8	25.0	20.7	11.0	0.82	2.05	1.53	2.95	<1
0.39	0.07	6	25.6	21.0	11.3	0.84	2.07	1.54	2.92	<1
0.21	0.04	5	15.3	12.3	2.8	0.23	2.11	1.85	6.89	<1

Clay B/A - 2.6 Weighted - 2.7

PROFILE Nº ISCW-BR 19
SAMPLE Nº 77.0775/79

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	MS	CN FE	PL & OG	WE BT & MS	IL, TM & RU	FK						
SANDS (2-.05 mm)													
A1	98%				2%	tr	tr						
A2	98%	tr	2%			tr	tr						
IIB2tpl	84%	5%	10%			1%							
IIB3tpl	74%	10%	15%			1%							
IICpl	66%	30%		4%		tr							
GRAVELS (>2 mm)													
	100%		tr										
	100%												
	90%		10%										
	90%		10%										
	85%	10%	5%										

Mineral Code : QZ - quartz; MS - muscovite; CN FE - iron concretions; PL - plagioclase; OG - oligoclase; WE BT - weathered biotite; MS - muscovite; IL - ilmenite; TM - tourmaline; RU - rutile; FK - potassium feldspar

SOIL CLASSIFICATION-INTERNATIONAL SOIL CLASSIFICATION WORKSHOP
BRAZILIAN SOIL

SERIES - - - - - - -

SOIL NO - - - - - - - ISCW-BR19 COUNTY - - -

GENERAL METHODS- - -1A,1B1B,2A1,2B SAMPLE NOS. 77P1262-77P1266

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, MTSC
NATIONAL SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA

DECEMBER 1977

DEPTH CM	HORIZON	SAND 2-.05	SILT .05-.002	CLAY LT .002	FINE CLAY LT .0002	VCOS 2-1	CORS 1-.5	MEDS .5-.25	FNES .25-.10	VFNS .10-.05	COSI .05-.02	FNSI .02-.002	VFSI .005-.002	SAND 2-.1	INTR II .2-.02	FINE CLAY TO CLAY PCT	NON-CO3-CLAY PCT	RATIO 8D1 15-BAR TO CLAY
		(- - - PARTICLE SIZE ANALYSIS, LT 2MM, 3A1, 3A1A, 3A1B - - -)																
		(- - - PCT LT 2MM - - -)																
0-20	A1	66.3	21.6	12.1		7.1	10.3	10.6	22.3	16.0	8.7	12.9		50.3				.62
20-38	A2	59.1	22.4	18.5		12.4	10.3	7.6	14.7	14.1	10.1	12.3		45.0				.50
38-52	2B2TP1	30.2	21.3	48.5		4.2	7.0	4.7	7.1	7.2	6.8	14.5		23.0				.42
52-82	2B3TP1	33.0	25.5	41.5		4.2	6.6	4.8	9.2	8.2	7.0	18.5		24.8				.43
82-100	2CP1	62.4	15.7	21.9		10.0	15.6	8.7	17.6	10.5	4.8	10.9		51.9				.43

DEPTH CM	VOL. GT 2 PCT	WEIGHT GT 75 PCT	75-20	20-5	5-2	LT .074	20-2 PCT LT20	BULK DENSITY 4A1D 1/3-BAR G/CC	4A1H OVEN DRY G/CC	4D1 COLE	WATER CONTENT 4B1C 1/10 BAR PCT	4B1C 1/3-BAR PCT	4B2 15-BAR PCT	4C1 WRD CM/CM	PH 8C1C 1/1 KCL	CARBONATE 6E1B LT 2 PCT	3A1A LT .002 PCT	PH 8C1A 1/1 H2O	8C1E 1/2 CACL
	(PARTICLE SIZE ANALYSIS, MM, 3B, 3B1, 3B2)		(- - - PCT LT 75 - - -)																
0-20													7.5		3.9			4.8	4.2
20-38													9.3		3.8			4.9	4.1
38-52													20.4		3.9			4.9	4.3
52-82													18.0		4.3			5.1	4.5
82-100													9.5		4.5			5.4	4.9

DEPTH CM	ORGANIC MATTER 6A1A ORGN CARB PCT	6B1A NITG PCT	C/N	IRON 6C2B EXT FE PCT	PHOS TOTL PCT	EXTRACTABLE BASES 5B4A 6N2E CA	6O2D MG	6P2B NA	6Q2B K	SUM EXTB	ACTY 6H1A BACL TEA	AL 6G1E KCL EXT	CAT EXCH 5A3A EXTB ACTY	5A6A NHAC	RATIO 8D1 NHAC TO CLAY	RATIO 8D3 CA TO MG	CA 5F1 SAT NHAC PCT	BASE SAT 5C3 EXTB ACTY PCT	5C1 NHAC PCT
						(- - - MEQ / 100 G - - -)													
0-20	1.64	.094	17	.9		.9	1.1	.0	.3	2.3	7.2	.8	9.5	7.9	.65	.8	11	24	29
20-38	.93	.062	15	1.4		.3	1.0	.0	.2	1.5	6.7	1.3	8.2	7.9	.43	.3	4	18	19
38-52	.78	.062	13	6.1		.1	3.4	.1	.2	3.8	9.5	1.1	13.3	11.1	.23		1	29	34
52-82	.34			6.3		.1	3.3	.1	.3	3.8	7.0	.4	10.8	9.1	.22		1	35	42
82-100	.14			1.5		.1	2.3	.2	.2	2.8	3.0	TR	5.8	5.5	.25		2	48	51

SAND MINERALOGY (7B1) PLACEMENT:
038-052 VFNS - RE69 QZ47 OP41 TM1 FK1 MI10 PR PO.
RELATIVE AMOUNTS: AS PERCENT
MINERAL CODE: RE = RESISTANT MINERALS OP = OPAQUE PO = PLANT OPAL PR = PYROXENE QZ = QUARTZ TM = TOURMALINE
FK = POTASSIUM FELDSPAR MI = MICA.

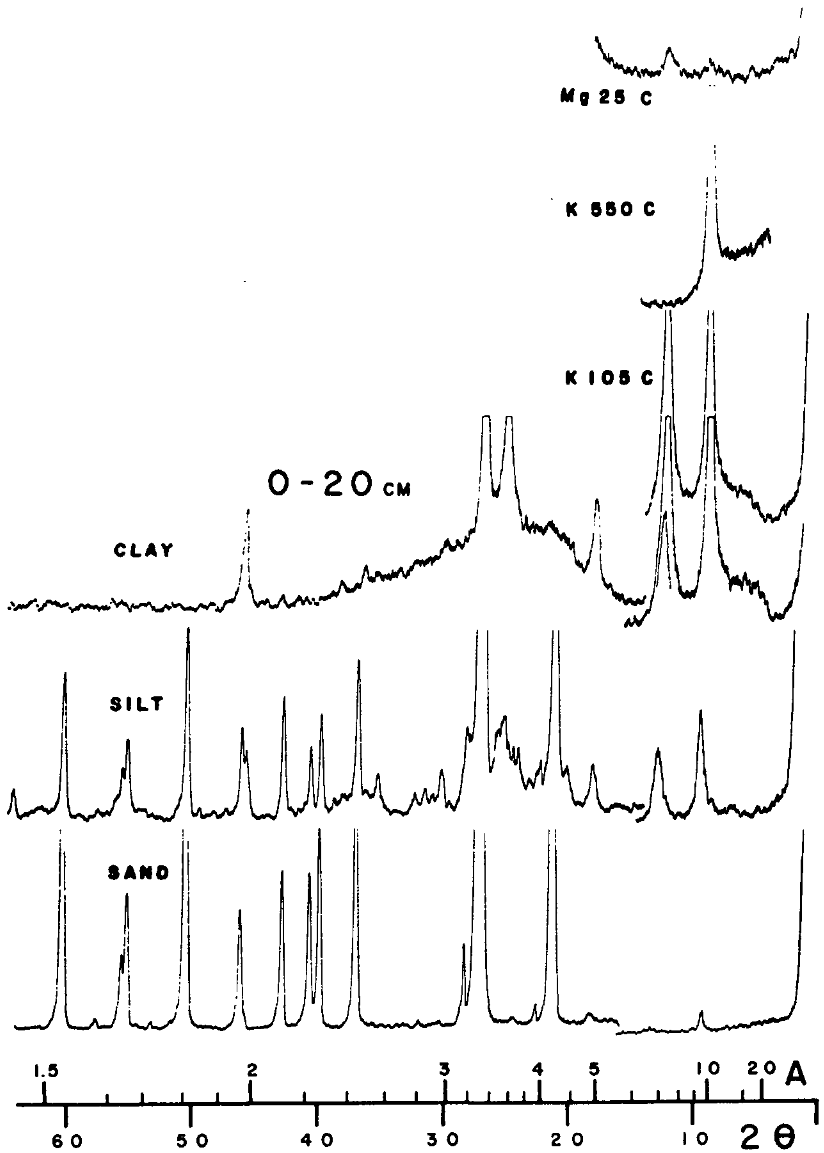

Fig. 50 - X-Ray diffraction patterns of the clay, silt and sand from A1 horizon of the profile BR-19.

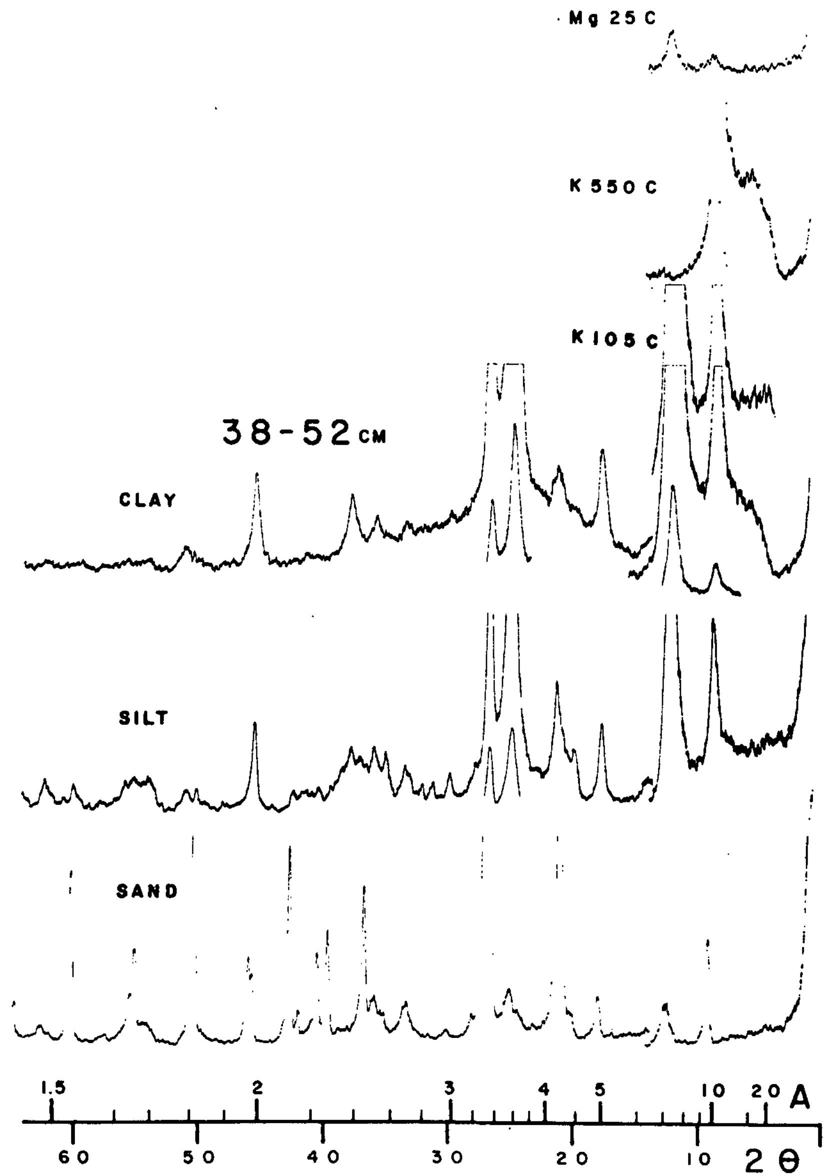

Fig. 51 - X-Ray diffraction patterns of the clay, silt and sand from IIB2tp1 horizon of the profile BR-19.

Discussion

1. This soil can be classified as an Ustalf. The base saturation (NH_4OAc) at 100 cm is 51 percent and the base saturation ($BaCl_2$-TEA at pH 8.2) is 48 percent, with a tendency to increase with depth and hence to be higher at 150 cm (not determined).

2. No distinct plinthite was observed, but Eswaran thought that the red parts of the mottled matrix in the argillic and C horizons will harden as in plinthite. Some participants felt there was enough plinthite for placement in a plinthic subgroup. Others considered the material "mottled clay" which is normal for weathering of acid crystalline rocks. In the present instance it is present at shallow depth because of erosion of the landscape and truncation of the profile (Segalen). The mottled aspect of the material may be recognized as a separate subgroup ("ferric" was proposed) where such non-plinthite material is present at shallow depth. Further discussion concerned the diagnostic characteristics of irreversable hardening upon exposure to repeated wetting and drying, and the time required. Smith indicated that induration should occur in approximately one year.

3. The clay distribution is not "Pale", but there was some question about the abruptness of the A to B horizon transition. If abrupt, the pedon may be classed in a Pale great group (see discussion for preceding profiles). It was observed, however, that the transition cannot be called abrupt which conforms to the SNLCS description.

4. The NH_4OAc-CEC per 100 g clay of the argillic horizon (44 cm) is approximately 17 meq. This seems to agree with the considerable content of 10 A micas in the clay fraction (Hawaii data). The pedon would fit the Kandi great group if the diagnostic limit is 24 meq.

Buol defended a limit of 16 meq for Ultisols. But would this limit be also useful for Alfisols? Moormann thought not.

5. The pedon can be classified as an Oxic (Plinthic?) Haplustalf according to present criteria. It would become a Kandiustalf in the committee's parlance with a rather wide choice of subgroups : leptic, leptic plinthic, or leptic ferric if the mottled aspect is considered.

PROFILE ISCW-BR 20 DESCRIBED AND SAMPLED - 17 Feb 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO DISTRÓFICO argila de atividade baixa frágico A proeminente textura arenosa/argilosa fase floresta tropical subperenifólia relevo plano (RED-YELLOW PODZOLIC DYSTROPHIC, low clay activity, fragic, prominent A horizon, sandy/clayey, semi-evergreen tropical forest level phase).

Arenic Fragiudult; clayey, kaolinitic, isohyperthermic.

Dystric Planosol

Sol ferrallitique; fortement désaturé, lessivé, podzolisé, dérivé de formation Barreiras.

LOCATION - Campo Alegre, Al. km 163 of the BR-101 highway, São Sebastião farm; 9°50'00" S 36°12'00" W.

TOPOGRAPHIC POSITION - Trench on level top of low plateau (tableland), under sugarcane field.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Sandy and sandy clay sediments, Barreiras Group, Tertiary; weathered sediments.

DRAINAGE - Moderately well drained.

PRESENT LAND USE - Sugarcane cultivated since 1967.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.0	26.0	26.0	25.5	25.0	24.0	23.5	23.0
P mm	50	60	110	200	230	200	200	135
	Sept	Oct	Nov	Dec				
T°C	23.5	24.0	25.0	25.5	Mean	24.8		
P mm	70	50	45	35	Total	1385		
		Isohyperthermic			Ustic/udic			

Ap - 0 - 45 cm, very dark grayish brown (10 YR 3/2, moist), dark grayish brown (10 YR 4/2, dry); loamy sand; weak fine to medium granular and subangular blocky; many very fine and fine, and few medium and coarse pores; soft, very friable, nonplastic and nonsticky; gradual and smooth boundary.

A2 - 45 - 70 cm, brown (10 YR 4/3, moist); pale brown (10 YR 6/3, dry); loamy sand; weak fine subangular blocky and fine medium granular; many very fine and fine, and few medium and coarse pores; slightly hard, very friable, nonplastic and nonsticky; gradual and smooth boundary.

A3 - 70 - 95 cm, brown (10 YR 5/3, moist), light brownish gray (10 YR 6/2, dry); sandy loam; weak fine angular and subangular blocky; common very fine and fine, and few coarse pores; hard, friable, nonplastic and nonsticky; clear and wavy boundary.

B1t - 95 - 112 cm, brown (10 YR 5/3, moist); sandy clay; weak fine angular and subangular blocky; common very fine and fine, and few medium pores; very hard, firm and friable, plastic and sticky.

B21tx - 112 -133 cm, mixture of light yellowish brown (10 YR 6/4, moist) and light brownish gray (10 YR 6/2, moist)colors; clay; weak fine platy and weak fine to medium angular blocky; few very fine and fine, and few medium pores; extremely hard, firm, slightly plastic and slightly sticky;abrupt and wavy boundary (15-25 cm).

B22tx - 133 - 145 cm, mixture of brownish yellow (10 YR 6/6, moist) and brown (10 YR 5/3, moist) colors; clay; weak fine platy and weak fine angular blocky; few very fine and fine; extremely hard, very firm, slightly plastic and slightly sticky; gradual and smooth boundary.

B23t - 145 - 200 cm$^+$, light yellowish brown (10 YR 6/4, moist), few fine and medium distinct mottles of yellowish brown (10 YR 5/8, moist); clay; weak fine subangular blocky; few very fine and fine pores; extremely hard, firm, slightly plastic and nonsticky.

REMARKS - Abundant roots in Ap, common in A2 and A3 and upper part of B1t, few in lower part of B1t and very few downward.

Plaqûic? layer of Fe_2O_3 with average thickness of 1 cm, predominantly with red color (2.5 YR 4/8, moist) in B22tx.

Portions of darker material intermingled in B21tx, B22tx and B23t, being mostly horizontal in B21tx, seemingly after the direction of roots or other biological activity.

Reticular pattern of colors in B21tx being less evident in B22tx.

Ants and termites acitivity from the surface down to B21tx.

Profile dry.

PROFILE Nº ISCW-BR 20
SAMPLE Nº 77.0780/86 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 45	-	tr	100	66	22	2	10	5	50	0.20
A2	- 70	-	tr	100	64	23	3	10	7	30	0.30
A3	- 95	-	1	99	51	24	5	20	13	35	0.25
B1t	-112	-	1	99	36	22	4	38	31	18	0.11
B21tx	-133	-	tr	100	28	14	6	52	30	42	0.12
B22tx	-145	-	1	99	27	14	7	52	35	33	0.13
B23t	-200+	-	tr	100	26	14	7	53	5	91	0.13

pH (1:2.5) H2O	pH KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.2	4.2	1.0	0.2	0.07	0.05	1.3	0.2	2.8	4.3	30	13
5.2	4.2	0.8		0.04	0.03	0.9	0.2	2.6	3.7	24	18
4.6	4.0	0.6		0.03	0.03	0.7	0.6	2.4	3.7	19	46
4.8	4.1	0.6		0.03	0.04	0.7	0.6	2.2	3.5	20	46
5.1	4.5	0.9		0.03	0.03	1.0	0.5	2.3	3.8	26	33
5.1	4.5	1.0		0.03	0.04	1.1	0.4	2.1	3.6	31	27
5.2	4.5	1.0		0.03	0.03	1.1	0.4	2.0	3.5	31	27

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
0.63	0.06	11	4.1	3.3	0.5	0.41	2.11	1.92	10.45	1
0.38	0.04	10	4.5	3.7	0.5	0.45	2.07	1.90	11.71	1
0.39	0.04	10	8.8	7.6	0.7	0.69	1.97	1.86	16.93	1
0.37	0.04	9	16.1	14.4	1.2	1.01	1.90	1.80	18.83	1
0.38	0.04	10	22.0	20.2	1.9	1.33	1.85	1.75	16.64	1
0.28	0.04	7	22.6	21.1	2.0	1.28	1.82	1.72	16.55	1
0.23	0.03	7	23.4	21.5	2.2	1.29	1.85	1.74	15.28	1

Clay B/A - 3.8 Weighted - 3.8

PROFILE Nº ISCW-BR 20
SAMPLE Nº 77.0780/86

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE	CN MG & CN ARG	IL & MG	MS & BT	ST, RU & ZR	OF	TM
				SANDS (2-.05 mm)				
Ap	99%	1%	tr	tr	tr	tr	tr	
A2	99%	1%	tr	tr	tr	tr	tr	
A3	99%	tr	tr	1%		tr	tr	
B1t	98%	1%	tr	1%		tr	tr	
B21tx	99%		tr	1%		tr		
B22tx	99%		tr	1%		tr		
B23t	99%		tr	1%		tr		tr
				GRAVELS (>2 mm)				
	90%	10%	tr	tr				
	100%	tr	tr	tr				
	100%	tr		tr				
	99%	1%						
	60%	10%	30%					
	45%	30%	25%					
	90%	10%						

Mineral Code: QZ - quartz; CN FE - iron concretions; CN MG - magnetitic concretions; CN ARG - argillaceous concretions; IL - ilmenite; MG - magnetite; MS - muscovite; BT - biotite; ST- staurolite; RU - rutile; ZR - zircon; OF - organic fragments; TM - tourmaline

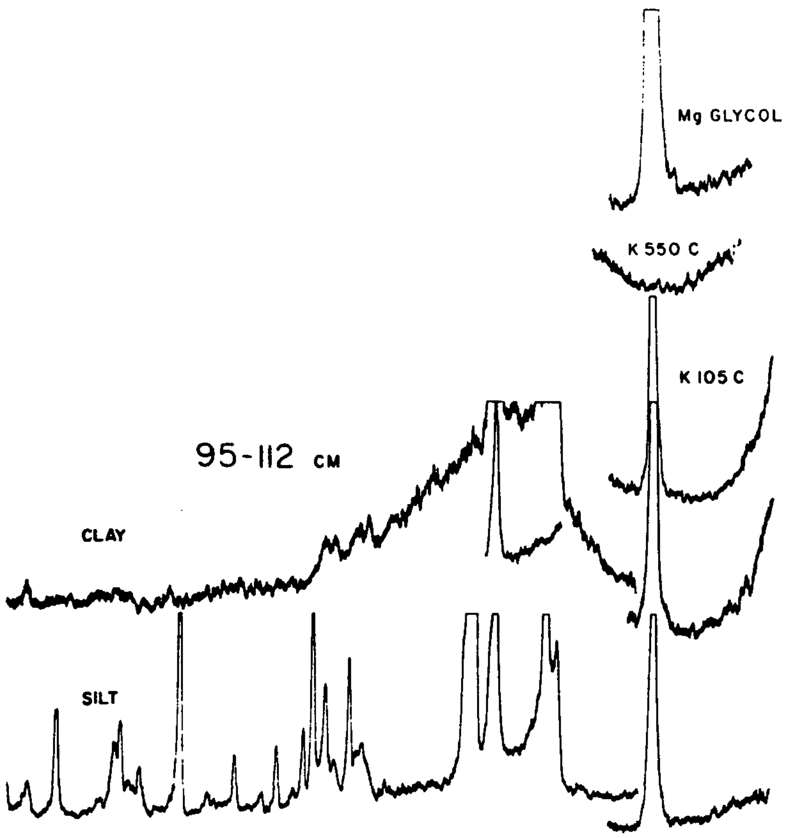

Fig. 52 - X-Ray diffraction patterns of the clay and silt from Blt horizon of the profile BR-20.

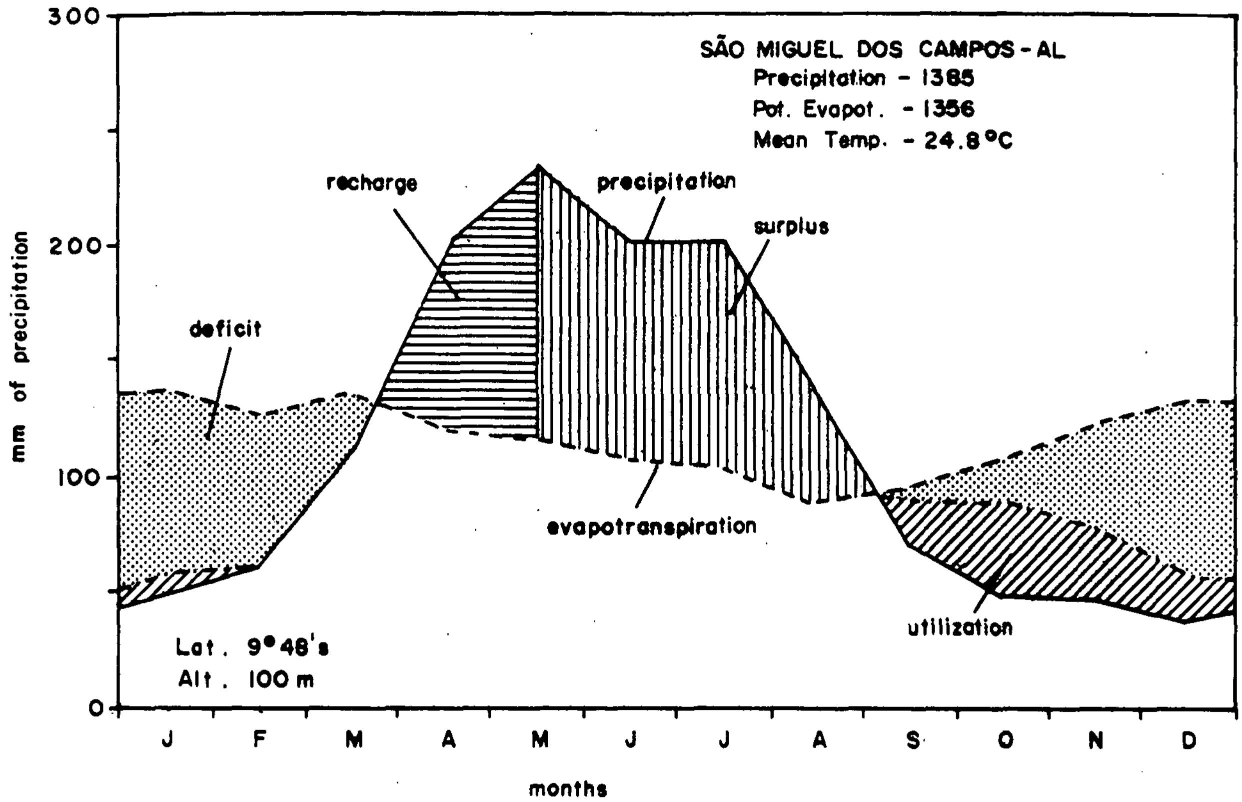

Fig. 53 - Water balance according to Thornthwaite & Mather, 1955 (125 mm) for geographic region related to profile BR-20.

Discussion

1. The profile was observed when it was nearly dark. Assuming a udic soil moisture regime, the classification as an Arenic Fragiudult was accepted.

2. The low clay activity of less than 16 meq per 100 g clay is not recognized by this classification.

3. Remarkable for these sandy lowland soils is their productivity for sugarcane : 60-80 t/ha/year, with 4 ratoons.

PROFILE ISCW-BR 21 DESCRIBED AND SAMPLED - 28 May 1963

CLASSIFICATION - LATOSSOLO AMARELO DISTRÓFICO A proeminente textura argilosa fase cerrado (tropical) subperenifólio relevo plano (YELLOW LATOSOL DYSTROPHIC*, prominent A horizon, clayey, semi-evergreen tropical cerrado level phase).

Typic Haplorthox; clayey, kaolinitic, isohyperthermic .

Xantic Ferralsol.

Sol ferrallitique; fortement désaturé, typique, jaune, dérivé de formation Barreiras.

LOCATION - Maceió, AL. km 10 of the highway Maceió-Recife, 2 km in a side road at right; 9°45'00" S 35°48'00 W

TOPOGRAPHIC POSITION - Trench on level top of low plateau (tableland), 0-1% slope, under disturbed cerrado; level; 80 meters.

PRIMARY VEGETATION - Semi-evergreen tropical cerrado.

GEOLOGY AND PARENT MATERIAL - Sandy and sandy clay sediments, Barreira Group, Tertiary; weathered mantle of stated sediments.

DRAINAGE - Well drained.

PRESENT LAND USE - In many areas it has been introduced sugarcane cultivation with large use of fertilizer.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	25.8	25.9	25.7	25.2	24.1	23.0	22.4	22.4
P mm	57	79	114	174	318	281	268	157
	Sept	Oct	Nov	Dec				
T°C	23.2	24.2	25.1	25.6	Mean	24.4		
P mm	96	69	32	33	Total	1678		
		Isohyperthermic			Udic			

A1 - 0 - 25 cm, very dark grayish brown (10 YR 3/2, moist); sandy clay; weak fine to medium granular; common fine pores; friable, plastic and sticky; clear and level boundary.

A3 - 25 - 40 cm, dark grayish brown (10 YR 4/2, moist), continuous fine and prominent mottles of yellowish brown (10 YR 5.5/5, moist); sandy clay; weak fine subangular blocky; common fine pores; friable, plastic and sticky; gradual and level boundary.

B1 - 40 - 90 cm, yellowish brown (10 YR 5.5/5, moist), common fine and distinct mottles of dark grayish brown (10 YR 4/2, moist); clay; weak fine subangular blocky structure; common fine pores; firm, plastic and sticky; gradual and level boundary.

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* Epialic.

B2 - 90 - 130 cm^+, brownish yellow (10 YR 6/5, moist); clay; fine subangular blocky appears massive porous in place; many very fine and fine pores; friable, plastic and sticky.

REMARKS - Plentiful roots in A1, few in A3 and very few in B1.

Profile moist.

PROFILE Nº ISCW-BR 21

SAMPLE Nº 6805/08 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 25	-	tr	100	31	16	4	49	10	80	0.08
A3	- 40	-	t	99	29	14	4	53	13	75	0.08
B1	- 90	-	-	99	29	11	3	57	-	100	0.05
B2	-130+	-	tr	100	25	9	2	64	-	100	0.03

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.6	3.8	0.3	0.1	0.06	0.05	0.5	1.2	5.8	7.5	7	71
4.6	3.9	0.2	0.1	0.05	0.08	0.4	0.9	4.7	6.0	7	69
4.9	4.0	0.3	0.2	0.05	0.08	0.6	0.6	4.0	5.2	12	50
5.0	4.1	0.5	0.3	0.04	0.08	0.9	0.5	3.2	4.6	20	36

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
1.16	0.09	13	21.3	18.3	1.1		1.98	1.91	26.00	
0.77	0.06	13	22.6	19.9	1.3		1.93	1.85	24.09	
0.58	0.05	12	24.1	21.1	1.5		1.94	1.86	22.19	
0.40	0.04	10	27.2	24.8	1.0		1.86	1.82	38.59	

Clay B/A - 1.2 Weighted - 1.2

PROFILE Nº ISCW-BR 21
SAMPLE Nº 6805/08

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN HU	CN FE	MG & IL	ST	TM
SANDS (2-.05 mm)						
A1	94%	4%	1%	1%		
A3	94%	4%	1%	1%		
B1	99%	tr	1%	tr	tr	tr
B2	99%	tr	1%	tr	tr	tr
GRAVELS (>2 mm)						
	100%	tr	tr			
	100%	tr	tr			
	100%	tr	tr			
	100%	tr	tr			

Mineral Code : QZ - quartz; CN HU - humous concretions; CN FE - iron concretions; MG - magnetite; IL - ilmenite; ST - staurolite; TM - tourmaline

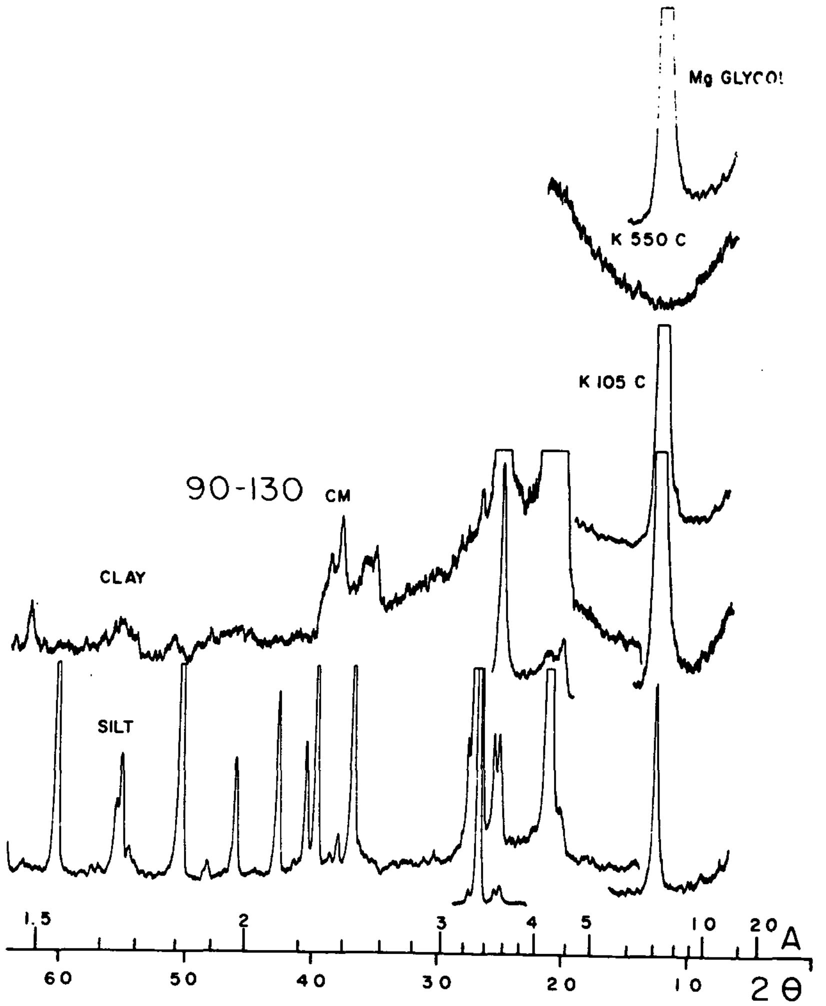

Fig. 54 - X-Ray diffraction patterns of the clay and silt from B2 horizon of the profile BR-21.

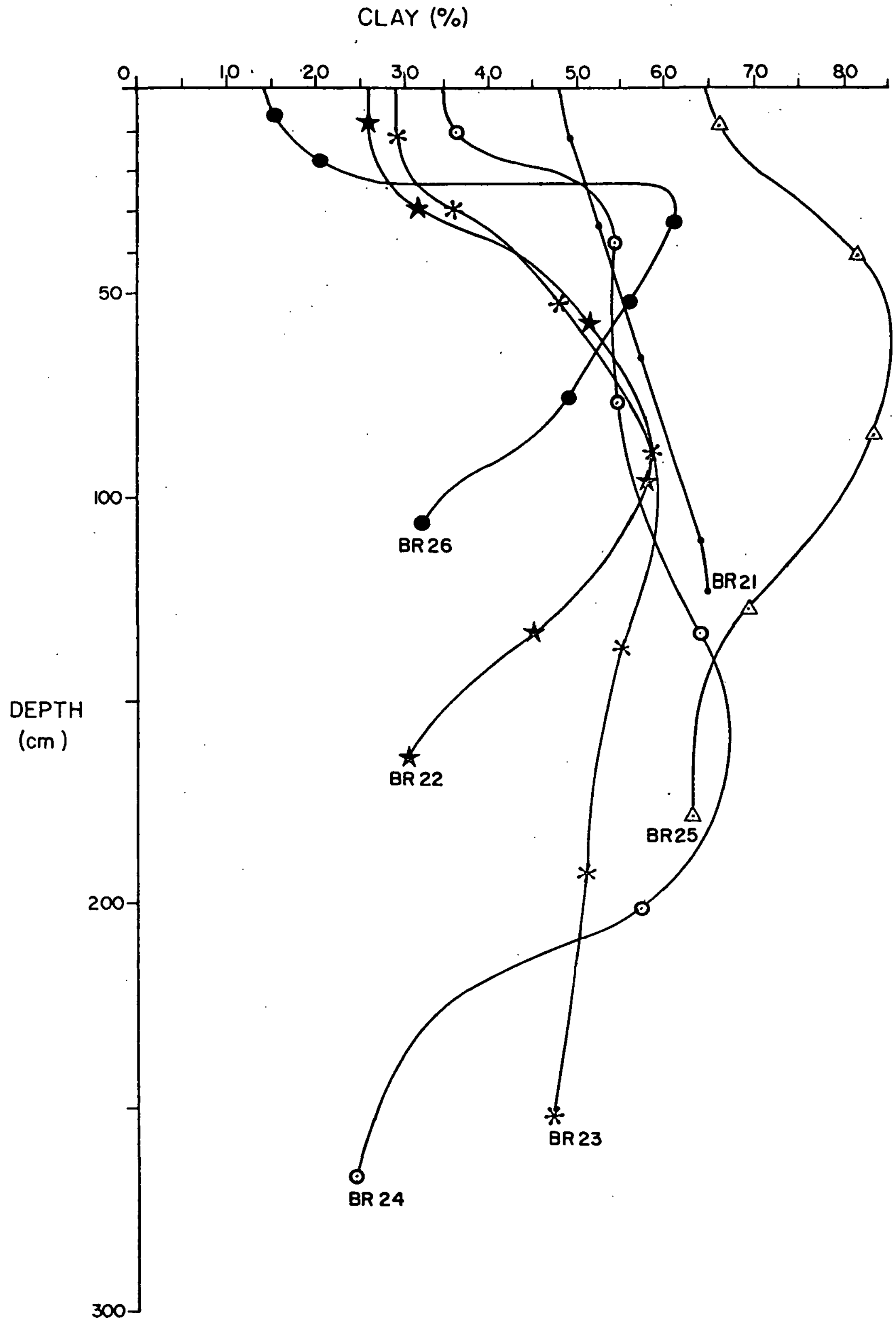

Fig.55 - Clay distribution curves° for profiles BR-21, BR-22, BR-23, BR-24, BR-25 and BR-26.

° All clay distribution curves at same scale.

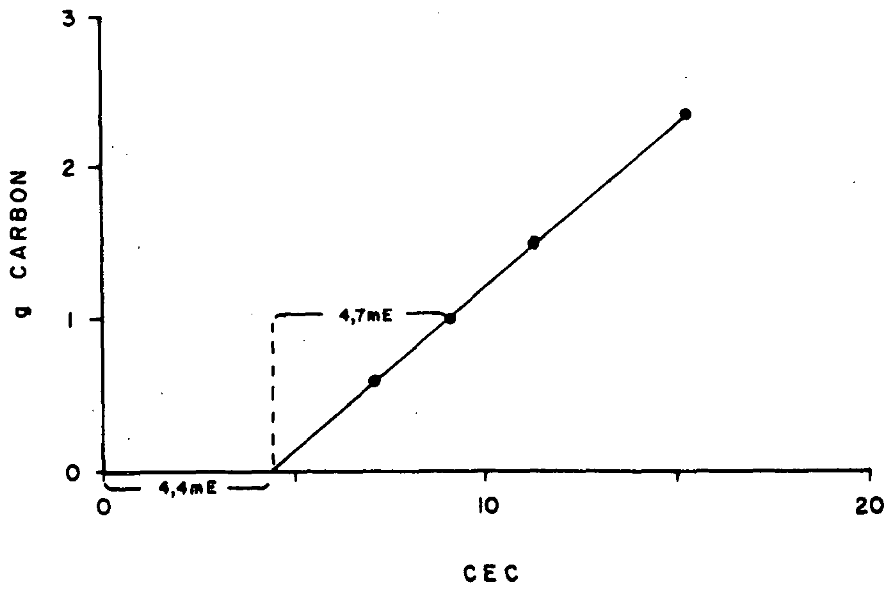

Fig. 56 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-21.

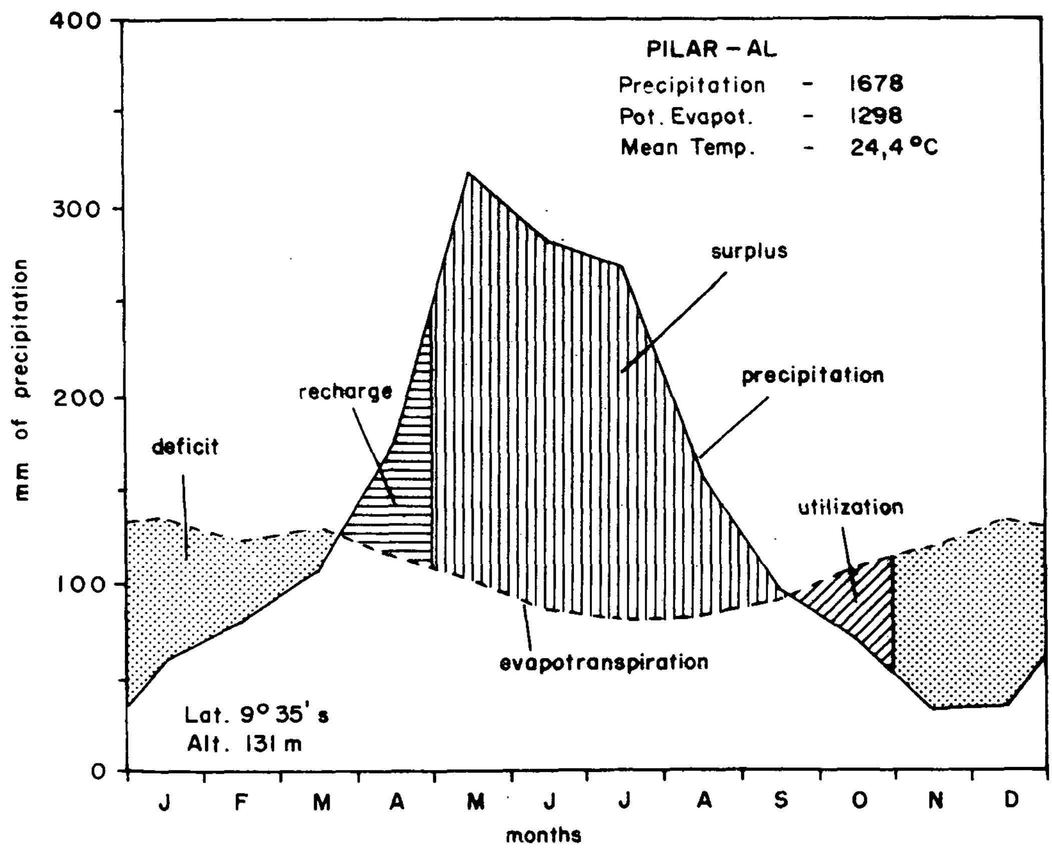

Fig. 57 - Water balance according to Thornthwaite & Mather, 1955 (125 mm), for geographic region related to profile BR-21.

Discussion

1. The profile studied in the field was not the profile described and analyzed by SNLCS. The latter has an umbric epipedon, but the colors in the profile viewed are too light.

2. The clay increase from the A horizon downward is small and gradual with an increase of 8 percent (ratio 1.16) over more than 50 cm. The clay increase requirements for an argillic horizon are, therefore, not met.

3. Clay cutans were observed in the B horizon at a depth of 110-120 cm only (Eswaran, Isbell and others).

4. "Clay balls" typical for an oxic horizon were noted by Ikawa.

5. The calculated NH_4OAc-CEC per 100 g clay is low.

6. The pedon described in the tourguide would key out as an Acrorthox according to the data available (less than 1.5 meq of extractable bases plus Al per 100 g clay, very weak or no discernable structure). The profile viewed was generally classified as a Typic Haplorthox, but some preferred a tropeptic subgroup.

7. Soils of this general morphology developed on unconsolidated sedimentary materials are widespread in the humid tropics and were mentioned to occur in Amazonia (Camargo, Sombroek, Rosateli), West Africa and the Cameroons (Moormann), and the Congo Basin (Smith et al., Pedology, 1975 :5-24). They present difficult and ill-defined transitions between Oxisols (Haplorthox and others) and Ultisols (Paleudults or Kandiudults). They may or may not have a "textural" or argillic horizon, cutans are frequently present but at greater depth

so that an oxic horizon as defined in Soil Taxonomy is present above an argillic horizon. Discussion on the Oxisol-Ultisol transition in various circular letters often pertained to this kind of soil and included the notion of "thin oxic horizons" as developed in Malaysia. The observed pedon has such a "thin oxic horizon" underlain by an argillic horizon. It was agreed that this soil is on the Oxisol side of the borderline.

PROFILE ISCW-BR 22 DESCRIBED AND SAMPLED - 8 Mar 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO DISTRÓFICO argila de atividade baixa A moderado textura média/argilosa fase floresta tropical subperenifólia relevo ondulado (RED-YELLOW PODZOLIC DYSTROPHIC*, low clay activity, moderate A horizon, loamy/clayey, semi-evergreen tropical forest rolling phase).

Orthoxic Tropudult; clayey, kaolinitic, isohyperthermic.

Ferric Acrisol.

Sol ferrallitique; moyennement désaturé, typique, faiblement appauvri et faiblement pénévolué, dérivé de gneiss à biotite.

LOCATION - Murici, AL. Left side of the highway connecting BR-101 to Murici, at roadsign km 68; 9°20'00" S 35°53'00" W.

TOPOGRAPHIC POSITION - Trench at lower third of hillside, 13-15% slope, under grass and shrub vegetation, area formerly cultivated with sugarcane; rolling; 80 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Biotite-gneiss, Precambrian Complex; weathering residues of stated rock with some surface reworking.

DRAINAGE - Well drained.

PRESENT LAND USE - Sugarcane crop and pasture.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.5	26.0	25.5	25.0	24.5	23.5	23.0	23.0
P mm	57	56	89	150	220	219	193	148
	Sept	Oct	Nov	Dec				
T°C	24.0	25.5	25.5	25.5	Mean	25.6		
P mm	84	37	30	43	Total	1326		
		Isohyperthermic			Udic			

Ap - 0 - 20 cm, dark brown (7.5 YR 4/4, moist), brown (7.5 YR 5/4, dry); gravelly sandy clay loam; weak very fine and fine subangular blocky and fine granular; many very fine and fine, and few medium and coarse pores; firm, plastic and sticky; clear and smooth boundary.

B1t - 20 - 40 cm, reddish brown (2.5 YR 4/4, moist); slightly gravelly sandy clay loam; weak fine subangular and angular blocky; common very fine and fine, and few medium coarse pores; few weak clay films; firm, plastic and sticky; gradual and smooth boundary.

B21t - 40 - 75 cm, red (2.5 YR 5/6, moist); clay; moderate fine subangular and angular blocky; common very fine and fine, and few medium and coarse pores; common moderate clay films; firm, plastic and sticky; gradual and smooth boundary.

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* Intergrade to eutrophic.

B22t - 75 - 115 cm, yellowish red (5 YR 5/6, moist), common medium and prominent mottles of reddish yellow (7.5 YR 6/6, moist); clay; strong fine subangular and angular blocky; common very fine and fine, and few medium and coarse pores; common moderate to strong clay films; firm, plastic and sticky; diffuse and wavy boundary (32-45 cm).

B3t - 115 - 150 cm, red (2.5 YR 4/6, moist); clay (micaceous); moderate fine subangular and angular blocky; common very fine and fine, and few medium and coarse pores; common moderate clay films; firm, slightly plastic and slightly sticky; gradual and wavy boundary (20-40 cm).

C - 150 - 170 cm^+, red (2.5 YR 4/6, moist); slightly gravelly sandy clay loam (micaceous); weak fine subangular and angular blocky; common very fine and fine pores; firm, slightly plastic and non-sticky.

REMARKS - Common roots in upper Ap, few in lower Ap and B1t,and very few in B21t, B22t and B3t.

Earthworms and termites activity in Ap and B1t, ants activity down to B22t.

PROFILE Nº ISCW-BR 22
SAMPLE Nº 77.0787/92

SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 20	1	12	87	40	20	14	26	18	31	0.54
B1t	- 40	2	11	87	35	19	13	33	25	24	0.39
B21t	- 75	-	2	98	25	12	12	51	-	100	0.24
B22t	-115	1	4	95	18	10	14	58	-	100	0.24
B3t	-150	-	7	93	19	18	18	45	-	100	0.40
C	-170+	tr	15	85	31	19	19	31	-	100	0.61

pH (1:2.5) H2O	pH KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.0	4.0	1.1	0.7	0.14	0.06	2.0	0.5	3.5	6.0	33	20
5.0	4.1	1.0	0.6	0.08	0.07	1.8	0.5	2.9	5.2	35	22
5.1	4.2	1.0	1.1	0.06	0.05	2.2	0.3	2.3	4.8	46	12
5.4	4.6	0.9	2.1	0.06	0.06	3.1	0.1	2.3	5.5	56	3
5.3	3.9	0.3	2.6	0.08	0.07	3.1	1.1	2.2	6.4	48	26
5.2	3.9	0.2	2.2	0.09	0.06	2.6	1.2	2.1	5.9	44	32

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	MOLECULAR RATIO SiO2 / Al2O3	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
0.87	0.10	9	11.5	8.9	3.0	0.60	2.20	1.81	4.64	2
0.62	0.08	8	14.9	11.8	4.1	0.75	2.15	1.76	4.52	
0.46	0.06	8	21.5	18.7	6.8	0.97	1.95	1.59	4.31	
0.31	0.05	6	26.8	22.5	8.6	1.07	2.02	1.63	4.10	
0.20	0.04	5	28.4	22.3	9.5	1.12	2.17	1.70	3.68	
0.17	0.03	6	25.4	20.2	7.2	0.83	2.14	1.74	4.40	

Clay B/A - 1.8 Weighted - 1.9

PROFILE Nº ISCW-BR 22
SAMPLE Nº 77.0787/92

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	MS & BT	CN ARG	MG & IL	CN FE	MC	ZR	HN	OF	TM	RU		
SANDS (2-.05 mm)													
Ap	99%	tr		1%	tr								
B1t	98%	1%		1%	tr		tr				tr		
B21t	85%	15%		tr	tr	tr	tr	tr	tr	tr			
B22t	75%	25%	tr	tr	tr	tr	tr	tr	tr	tr			
B3t	30%	70%	tr	tr	tr	tr	tr						
C	20%	80%	tr	tr	tr	tr	tr						
GRAVELS (>2 mm)													
	100%												
	100%												
	100%	tr											
	100%	tr											
	95%	5%											
	85%	10%	5%										

Mineral Code : QZ - quartz; MS - muscovite; BT - biotite; CN ARG - argillaceous concretions; MG -magnetite; IL - ilmenite; CN FE - iron concretions; MC - microcline; ZR - zircon; HN - hornblende ; OF - organic fragments; TM - tourmaline; RU - rutile

REMARKS: Mica adherent to quartz.
Rock fragment (quartzite?) in fraction > 20mm in B22t.

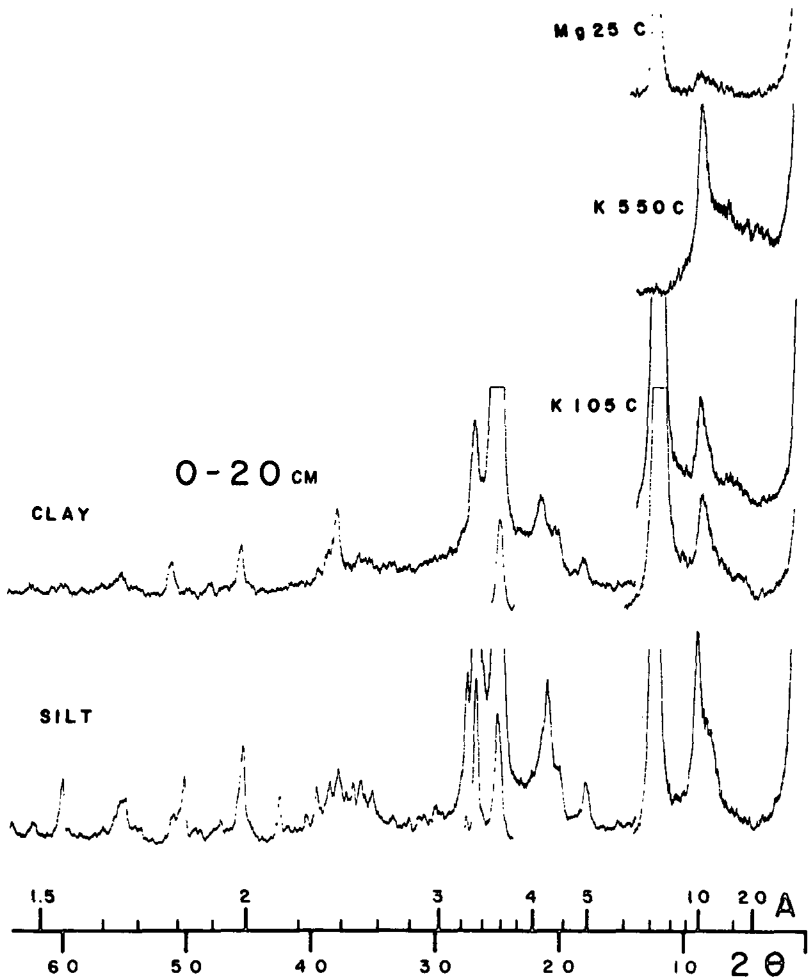

Fig. 58 - X-Ray diffraction patterns of the clay and silt from Ap horizon of the profile BR-22.

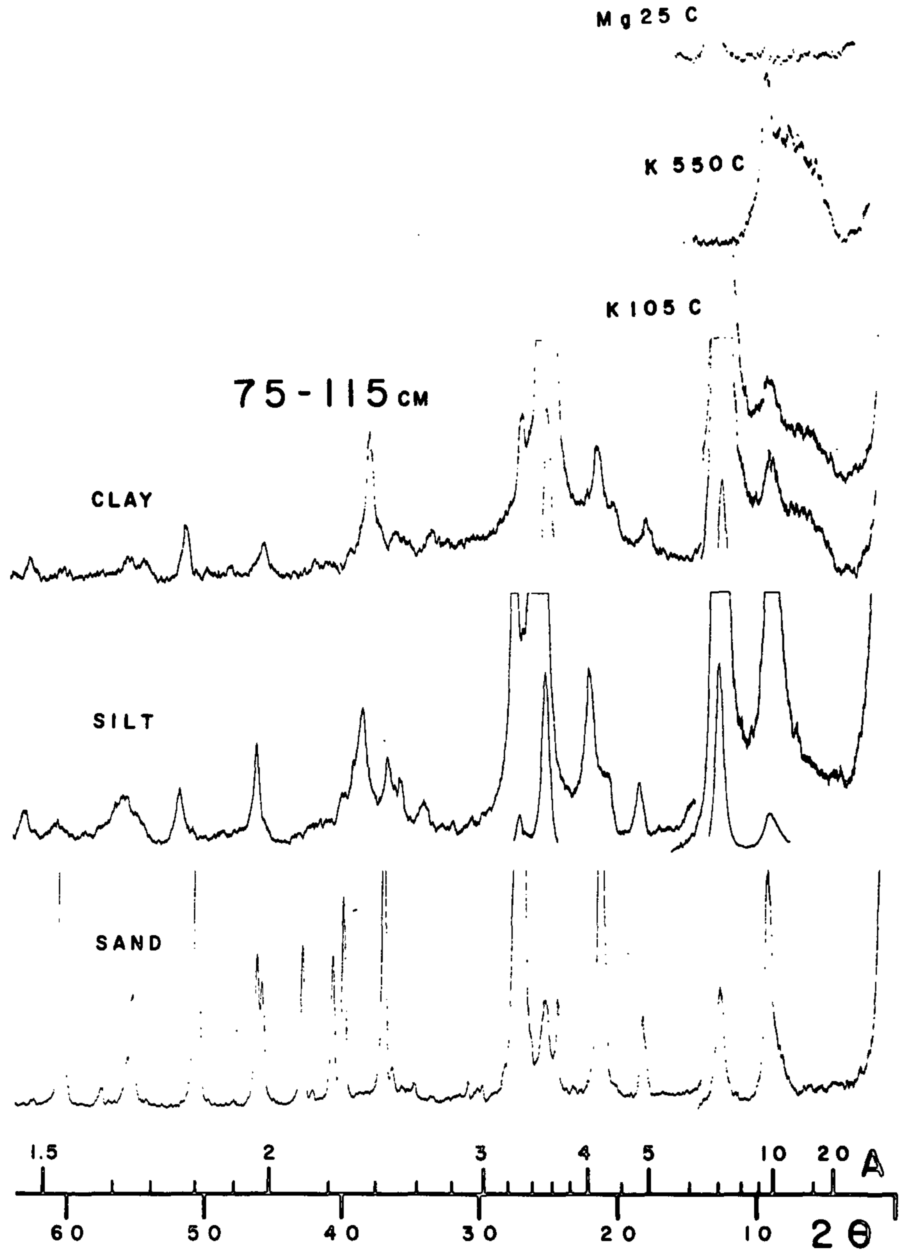

Fig. 59 - X-Ray diffraction patterns of the clay, silt and sand from B22t horizon of the profile BR-22.

Discussion

1. The base saturation (calculated NH_4OAc-CEC) is less than 50 percent throughout the profile and around 35 percent in the B3t horizon between 115 and 150 cm, dropping to 30 percent or less in the C horizon (150-170 cm). This soil is, therefore, an Ultisol of the "alfic" subgroup with less than 50 percent Al saturation throughout the argillic horizon.

2. The textural profile is "leptic", having a clay decrease of over 20 percent of the maximum within 150 cm (from 58 to approximately 35 percent at 150 cm according to SNLCS data).

3. The weighted NH_4OAc-CEC in the upper 50 cm of the argillic horizon is about 17 meq per 100 g clay. It should be noted that the presence of measurable amounts of mica and 10-17 A minerals (Hawaii data) pertain to the B22t horizon from 75-110 cm. Here, the calculated NH_4OAc-CEC is less than 14.5 meq per 100 g clay. The presence of higher activity clays in this horizon is hence not well reflected in the CEC. The B22t horizon has a mineralogy approaching mixed (Ikawa).

Further discussion centered around the presence of weatherable minerals since the pedon has more than 10 percent mica in the sand fraction (0.5 - 2 mm) of the upper 50 cm of the argillic horizon. Visually, these micas are all muscovite. There was a tendency among participants to permit this high percentage in Kandiudults. From this and other discussions a preference surfaced to consider muscovite mica in the sand fraction as less weatherable (Bennema) and to admit a higher percentage than 10 in the 20-200 micron fraction. Some (Leamy, Moormann) would like a review of the value of weatherable minerals as a diagnostic criterion as now used in Ultisols.

4. This pedon keys out as an Orthoxic Tropudult. By committee criteria, it would be a Kandiudult if the 24 meq limit were adopted; if not, it would be Tropudult or Hapludult bordering on a Kandiudult. At the subgroup level of Kandiudults it could be "Leptic" because of the clay distribution, or "alfic" because of the low Al saturation.

Note

P. Segalen subsequently characterized the mineralogy as follows : kaolinite, some illite and goethite, and traces of vermiculite.

PROFILE ISCW-BR 23 DESCRIBED AND SAMPLED - 9 Mar 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO DISTRÓFICO latossólico A moderado textura média/argilosa fase floresta tropical subperenifólia relevo forte ondulado (RED-YELLOW PODZOLIC DYSTROPHIC*, latosolic, moderate A horizon, loamy/clayey, semi-evergreen tropical forest hilly phase).

Typic Paleudult; clayey, kaolinitic, isohyperthermic.

Dystric Nitosol.

Sol ferrallitique; moyennement désaturé, typique, modal et faiblement appauvri, dérivé de gneiss.

LOCATION - Frexeiras, AL. Highway BR-101, roadsign km 57.8; 9º13'00" S 35º47'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at lower third of hillside, in a sugarcane trail, right side of the highway, 27-30% slope, under sugarcane; hilly; 130 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Gneiss, Precambrian Complex; weathering residues of stated rock with some detrital cover.

DRAINAGE - Well drained.

PRESENT LAND USE - Sugarcane crop.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
TºC	23.9	23.9	24.2	23.7	22.9	22.7	21.4	21.2
P mm	52	71	129	187	248	242	185	134
	Sept	Oct	Nov	Dec				
TºC	21.6	22.4	23.3	23.6	Mean	25.4		
P mm	72	36	34	48	Total	1438		
		Isohyperthermic			Udic			

Ap - 0 - 22 cm, dark grayish brown (10 YR 4/2, moist), grayish brown (10 YR 5/2, dry); sandy clay loam; moderate fine granular and very fine and fine subangular blocky; many fine and very fine, and few medium and coarse pores; firm, plastic and sticky; clear and smooth boundary.

A3 - 22 - 37 cm, dark brown (10 YR 4/3, moist), yellowish brown (10 YR 5/4, dry); sandy clay; weak fine subangular and angular blocky; common very fine and fine, and few coarse pores; firm, very plastic and sticky; clear and smooth boundary.

B1t - 37 - 68 cm, strong brown (7.5 YR 5/6, moist), common fine and distinct mottles of brownish yellow (10 YR 6/8, moist); clay; weak fine angular and subangular blocky; common very fine and fine, and

* Epialic.

few coarse pores; few weak clay films; firm, plastic and sticky; gradual and smooth boundary.

B21t - 68 - 102 cm, strong brown (7.5 YR 5/8, moist), common medium and distinct mottles of yellowish red (5 YR 5/8, moist); clay; weak medium prismatic and moderate fine subangular and angular blocky; common very fine and fine, and few coarse pores; common weak clay films; firm, plastic and sticky; diffuse and smooth boundary.

B22t - 102 - 154 cm, red (2.5 YR 4/6, moist), few medium and prominent mottles of reddish yellow (7.5 YR 6/8, moist); clay; moderate medium prismatic and strong fine subangular and angular blocky; common very fine and few coarse pores; common weak clay films; firm, plastic and sticky; gradual and wavy boundary (48-60 cm).

B23t - 154 - 214 cm, red (2.5 YR 5/6, moist) and strong brown (7.5 YR 5/8, moist); clay; weak medium prismatic and moderate fine subangular and angular blocky; common very fine and fine pores; few weak clay films; firm, plastic and sticky; diffuse and wavy boundary (40-62 cm).

B3t - 214 - 270 cm^{+}, red (2.5 YR 4/6, moist); clay (micaceous); weak medium prismatic and moderate fine subangular and angular blocky; firm, slightly plastic and slightly sticky.

REMARKS - Common roots in Ap, few in A3 and B1t, and very few in B21t, B22t and B23t.

Termites and ants activity in Ap, A3, B1t and B21t.

Occurrence of coal in Ap and fine iron concretions in A3, B1t and B22t.

Profile moist.

PROFILE Nº ISCW-BR 23
SAMPLE Nº 77.0793/99 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 22	-	2	98	47	12	12	29	21	28	0.41
A3	- 37	-	3	97	42	12	10	36	24	33	0.28
B1t	- 68	-	1	99	32	10	10	48	2	96	0.21
B21t	-102	-	1	99	22	6	13	59	-	100	0.22
B22t	-154	-	1	99	20	7	18	55	-	100	0.33
B23t	-214	-	2	98	28	8	13	51	-	100	0.25
B3t	-270+	-	1	99	22	8	23	47	-	100	0.49

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.9	4.0	0.8		0.14	0.05	1.0	1.1	4.3	6.4	16	52
4.7	4.0	0.3		0.08	0.04	0.4	1.1	3.4	4.9	8	73
4.9	4.1	0.5		0.06	0.04	0.6	0.7	2.6	3.9	15	54
5.2	4.6	0.4	0.7	0.04	0.05	1.2	0.2	2.0	3.4	35	14
5.3	4.8	0.5	0.8	0.04	0.06	1.4	0.1	1.7	3.2	44	7
5.3	4.8	0.6		0.05	0.05	0.7	0.1	1.7	2.5	28	13
5.2	4.3	0.4		0.06	0.05	0.5	0.6	1.6	2.7	19	55

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
1.37	0.11	12	13.9	12.0	2.7	0.94	1.97	1.72	6.96	5
1.10	0.10	11	15.9	13.6	3.1	0.93	1.99	1.74	6.87	2
0.71	0.08	9	21.1	18.4	4.4	1.00	1.95	1.69	6.56	1
0.52	0.06	9	26.5	23.9	6.0	1.05	1.89	1.63	6.25	<1
0.27	0.04	7	28.2	25.2	6.5	1.03	1.90	0.63	6.09	<1
0.19	0.03	6	22.6	20.2	5.0	0.99	1.90	1.64	6.33	<1
0.17	0.03	6	26.6	23.9	6.6	1.16	1.89	1.61	5.67	<1

Clay B/A - 1.6 Weighted - 1.7

PROFILE Nº ISCW-BR 23
SAMPLE Nº 77.0793/99

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE & CN HU	WE BT	OF	CN MG & CN FE	MG & IL	WE MC	MS	ZR	OP	TM	RU	PY
SANDS (2-.05 mm)													
Ap	98%			2%	tr		tr	tr	tr	tr			
A3	99%		tr	1%	tr	tr		tr	tr			tr	
B1t	99%		tr	tr	1%	tr		tr	tr		tr		
B21t	99%		tr		1%		tr	tr	tr				tr
B22t	97%		tr		3%			tr	tr				
B23t	98%		tr		2%			tr	tr				tr
B3t	83%		15%		1%	1%			tr				tr
GRAVELS (>2 mm)													
	80%	20%											
	80%	20%											
	80%				20%								
	85%				15%								
	80%				20%								
	80%				20%								
	95%				5%		tr						

Mineral Code : QZ - quartz; CN FE - iron concretions; CN HU - humous concretions; WE BT - weathered biotite; OF - organic fragments; CN MG - magnetitic concretions; MG - magnetite; IL - ilmenite; MS - muscovite; ZR - zircon; OP - opal; TM - tourmaline; RU - rutile; PY - pyrite

OIL CLASSIFICATION-INTERNATIONAL SOIL CLASSIFICATION WORKSHOP
BRAZILIAN SOIL
ERIES - - - - - - -

OIL NO - - - - - - - ISCW-BR23 COUNTY - - -

ENERAL METHODS- - -1A,1B1B,2A1,2B SAMPLE NOS. 77P1267-77P1272

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, MTSC
NATIONAL SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA

DECEMBER 1977

DEPTH CM	HORIZON	SAND 2-.05	SILT .05-.002	CLAY LT .002	FINE CLAY LT .0002	VCOS 2-1	CORS 1-.5	MEDS .5-.25	FNES .25-.10	VFNS .10-.05	COSI .05-.02	FNSI .02-.002	VFSI .005-.002	SAND 2-.1	INTR II .2-.02	FINE CLAY TO CLAY PCT	NON-CO3-CLAY PCT	RATIO 8D1 15-BAR TO CLAY
		(- - PARTICLE SIZE ANALYSIS, LT 2MM, 3A1, 3A1A, 3A1B - - PCT LT 2MM - -)																
0-22	AP	60.3	11.4	28.3		9.0	19.8	11.9	14.1	5.5	2.7	8.7		54.8				.46
22-37	A3	55.7	9.6	34.7		11.6	18.2	9.8	11.0	5.1	4.2	5.4		50.6				.45
37-68	B1T	42.5	11.0	46.5		7.6	14.8	7.6	8.5	4.0	2.4	8.6		38.5				.44
68-102	B2T	28.8	13.4	57.8		7.6	8.9	4.3	5.0	3.0	1.9	11.5		25.8				.45
02-154	B22T	29.4	19.6	51.0		8.4	8.7	3.8	5.0	3.5	3.7	15.9		25.9				.48
14-270	B3T	34.2	23.5	42.3		8.6	9.6	4.3	6.4	5.3	4.0	19.5		28.9				.51

EPTH CM	(PARTICLE SIZE ANALYSIS, MM, 3B, 3B1, 3B2) VOL. GT 2 PCT	WEIGHT GT 75 PCT	75-20	20-5	5-2	LT .074	20-2 PCT LT20	(BULK DENSITY) 4A1D 1/3-BAR G/CC	4A1H OVEN DRY G/CC	4D1 COLE	(WATER CONTENT) 4B1C 1/10 BAR PCT	4B1C 1/3-BAR PCT	4B2 15-BAR PCT	4C1 WRD CM/CM	PH 8C1C 1/1 KCL	CARBONATE 6E1B LT 2 PCT	3A1A LT .002 PCT	(PH) 8C1A 1/1 H2O	8C1E 1/2 CACL
0-22													13.1		3.9			4.6	4.0
22-37													15.5		3.9			4.4	3.9
37-68													20.3		4.0			4.5	4.1
68-102													25.8		4.5			5.1	4.6
02-154													24.5		4.8			5.4	4.7
14-270													21.6		4.2			5.2	4.4

EPTH CM	(ORGANIC MATTER) 6A1A ORGN CARB PCT	6B1A NITG PCT	C/N	IRON 6C2B EXT FE PCT	PHOS TOTL PCT	(EXTRACTABLE BASES 5B4A) 6N2E CA	6O2D MG	6P2B NA	6Q2B K	SUM EXTB	ACTY 6H1A BACL TEA	AL 6G1E KCL EXT	(CAT EXCH) 5A3A EXTB ACTY	5A6A NHAC	RATIO 8D1 NHAC TO CLAY	RATIO 8D3 CA TO MG	CA 5F1 SAT NHAC PCT	(BASE SAT) 5C3 EXTB ACTY PCT	5C1 NHAC PCT
						(- - MEQ / 100 G- - -)													
0-22	1.60	.094	17	1.6		.3	.5	.0	.2	1.0	8.0	1.3	9.0	7.6	.27	.6	4	11	13
22-37	1.27	.075	17	1.9		.1	.2	.0	.1	.4	7.4	1.2	7.8	6.3	.18	.5	2	5	6
37-68	.85	.053	16	2.7		.1	.5	.0	.1	.7	6.6	.7	7.3	6.8	.15	.2	1	10	10
68-102	.56			3.5		.1	.9	.0	.2	1.2	5.8	.2	7.0	4.8	.08	.1	2	17	25
02-154	.25			3.7		.1	1.2	.0	.1	1.4	5.2	.1	6.6	4.4	.09	.1	2	21	32
14-270	.14			3.6		TR	.4	.0	.1	.5	5.3	.9	5.8	4.7	.11			9	11

EPTH CM	(SATURATED PASTE) 8E1 REST OHM-CM	8C1B PH	8A H2O PCT	NA 5D2 ESP PCT	NA 5E SAR	SALT 8D5 TOTL SOLU PPM	GYP 6F1A PCT	(SATURATION EXTRACT 8AI) 8A1A EC MMHOS/CM	6N1B CA	6O1B MG	6P1B NA	6Q1B K	6I1A CO3	6J1A HCO3	6K1A CL	6L1A SO4	6M1A NO3	ATTERBERG 4F1 LQID LMIT PCT	4F2 PLST INDX
									(- - MEQ / LITER - -)										
0-22																			
22-37																			
37-68																			
68-102	21000	5.0																	
02-154																			
14-270																			

AND MINERALOGY (7B1) PLACEMENT:
037-068 VFNS - RE84 QZ80 OP2 ZR2 FK14 MI2.
RELATIVE AMOUNTS: AS PERCENT
MINERAL CODE: RE = RESISTANT MINERALS OP = OPAQUE QZ = QUARTZ ZR = ZIRCON FK = POTASSIUM FELDSPAR MI = MICA.

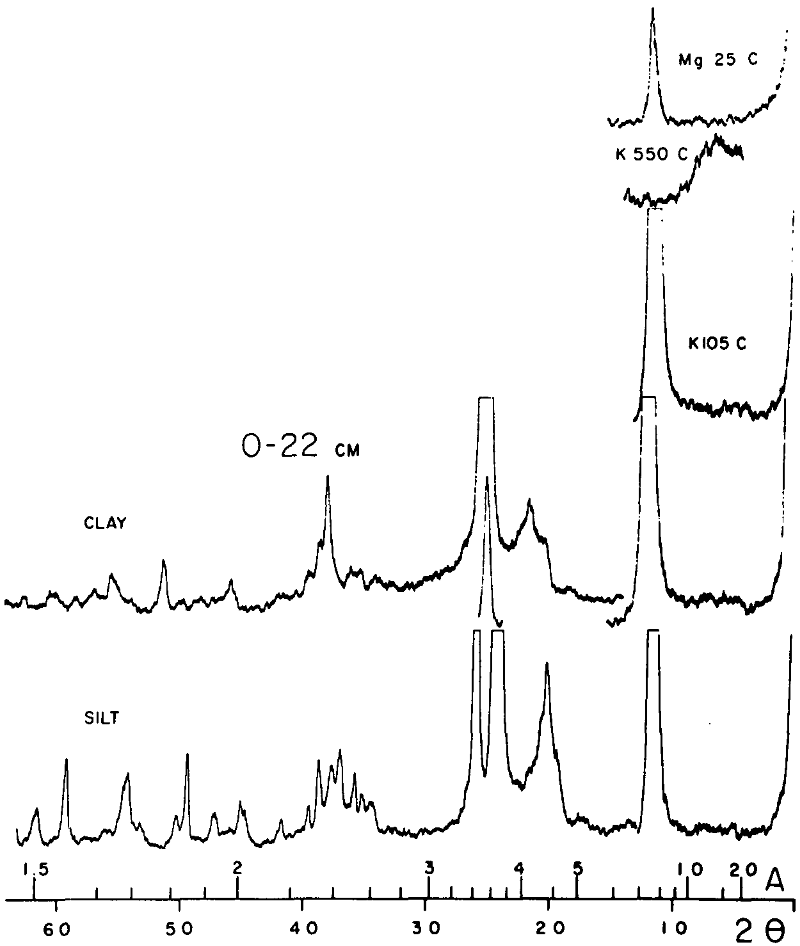

Fig. 60 - X-Ray diffraction patterns of the clay and silt from Ap horizon of the profile BR-23.

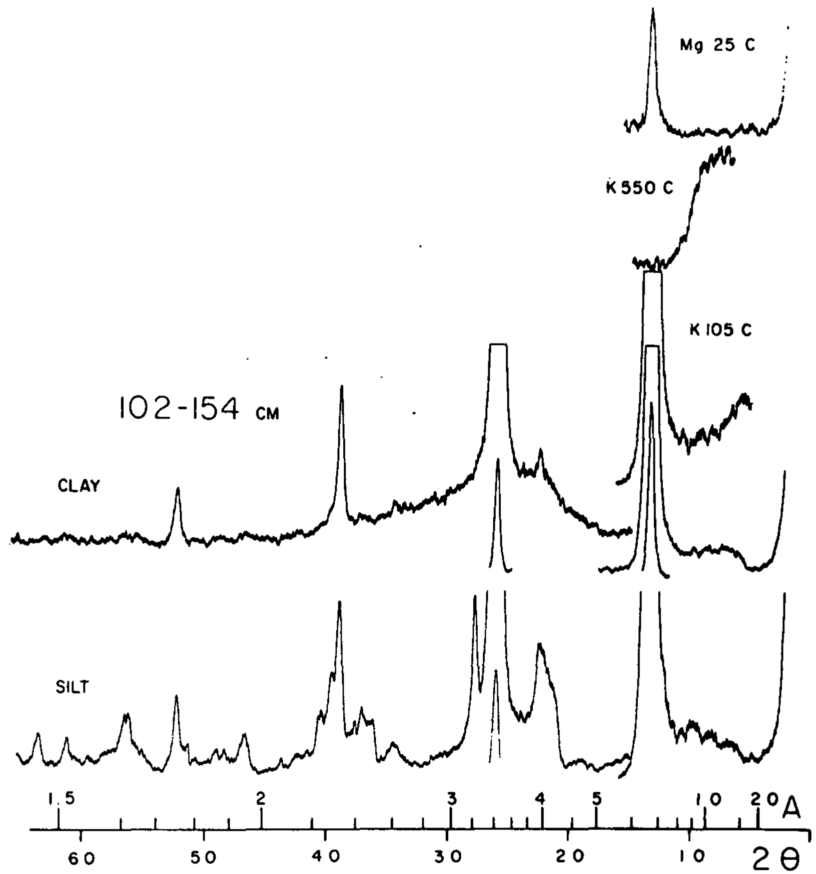

Fig. 61 - X-Ray diffraction patterns of the clay and silt from B22t horizon of the profile BR-23.

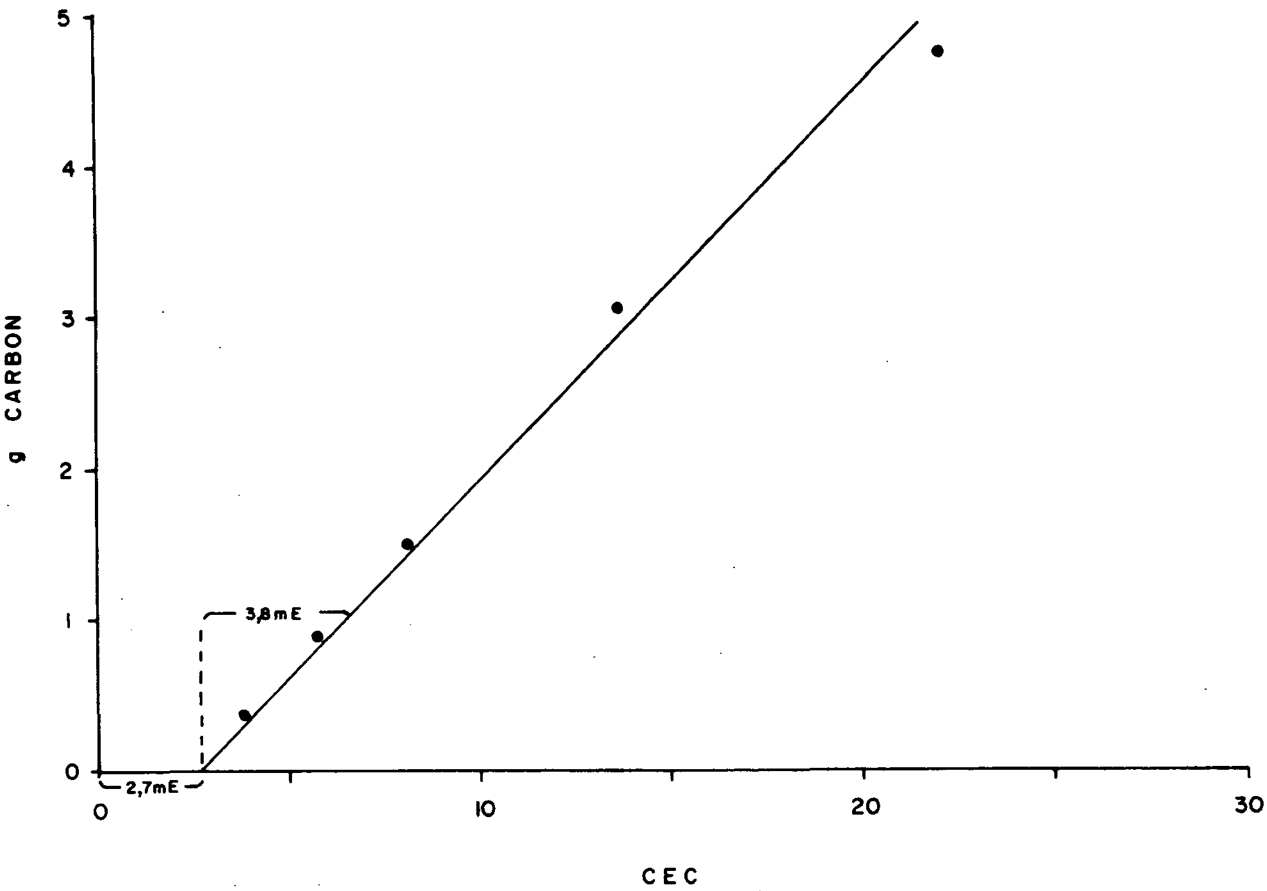

Fig. 62 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-23.

Discussion

1. The profile shows both a distinct clay increase from the A to the Bt horizon (more than 1.4 over 30 cm) and clay skins in the argillic horizon. NH_4OAc base saturation is 31 percent in the 102-154 cm horizon, decreasing with depth. This is therefore an Ultisol with a "Pale" profile.

2. CEC of the upper 50 cm of the argillic horizon is low, making the profile eligible for "Kandi". This is corroberated by the clay minerology: it is in a kaolinitic family (Ikawa).

3. While the Al saturation is high in the upper Bt horizon, it is low at 150 cm. As discussed under profile BR 12, this soil would either go in the "alic" (typic) subgroup, if the upper Bt is considered (Bennema) or in the "alfic" subgroup (Smith, Moormann, et al.) if the diagnostic depth for Ultisols of 150 cm is accepted.

4. Uehara submitted the possibility of introducing an "acric" subgroup for this pedon in which the ZPC increases with depth. In analogy with an Acrorthox, there are less than 1.5 me extractable bases plus aluminum per 100 g clay.

5. Although this soil was generally considered close to the central concept of a Kandiudult, there are several option for classification at the subgroup level. If the acric property is not taken into account and the Al saturation of the upper B horizon is considered, it would be a Typic Kandiudult. It would be an Alfic Kandiudult if the Al saturation at 150 cm is considered. It could also be an Acric Kandiudult if such a subgroup were established in analogy with

Acrorthox and the lack-of-structure requirement of the Acrorthox were waived. Moormann was not in favor of the latter possibility.

6. According to the present definitions of Soil Taxonomy, this soil is a Typic Paleudult since there is currently no provision for an oxic subgroup.

PROFILE ISCW-BR 24 DESCRIBED AND SAMPLED - 10 Mar 1977

CLASSIFICATION - LATOSSOLO VERMELHO-AMARELO ÁLICO podzólico A moderado textura argilosa fase floresta tropical subperenifólia relevo ondulado (RED-YELLOW LATOSOL ALIC, podzolic, moderate A horizon, clayey, semi-evergreen tropical forest rolling phase).

Typic Paleudult or Tropeptic Haplorthox; clayey, kaolinitic, isohyperthermic.

Dystric Nitosol.

Sol ferrallitique; moyennement désaturé, typique, modal, dérivé de gneiss.

LOCATION - Palmares, PE. Section Palmares-Recife of BR-101 highway, about 500 m from the bridge over Una river; 8º40'00" S 35º32'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at medium third of hillside, 12-13% slope, under grass and shrub vegetation; rolling; 140 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Gneiss or schist, Precambrian Complex; sandy clay detrital mantle covering stated bedrock.

DRAINAGE - Well drained.

PRESENT LAND USE - Pasture and sugarcane crop.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
TºC	23.9	23.9	24.2	23.7	22.9	22.7	21.4	21.2
P mm	52	71	129	187	248	242	185	134

	Sept	Oct	Nov	Dec		
TºC	21.6	22.4	23.3	23.6	Mean	25.4
P mm	72	36	34	48	Total	1438
		Isohyperthermic			Udic	

Ap - 0 - 22 cm, dark brown (10 YR 4/3, moist), yellowish brown (10 YR 5/4, dry); sandy clay; weak fine subangular blocky and fine to medium granular; many very fine and few coarse pores; friable, plastic and sticky; clear and smooth boundary.

B1 - 22 - 55 cm, yellowish brown (10 YR 5/5, moist); clay; weak fine subangular and angular blocky; many very fine and fine pores;slightly hard, friable, plastic and sticky; diffuse and smooth boundary.

B21 - 55 - 100 cm, strong brown (7.5 YR 5/6, moist); clay; weak fine subangular and angular blocky; many very fine and fine pores; hard, friable, plastic and sticky; diffuse and smooth boundary.

B22 - 100 - 170 cm, yellowish red (5 YR 5/6, moist); clay; weak to moderate fine subangular and angular blocky; many very fine and fine pores;

very hard, friable, plastic and sticky; diffuse and smooth boundary.

B3 - 170 - 234 cm, red (2.5 YR 4/6, moist); clay; weak fine subangular and angular blocky; many very fine and fine pores; hard, friable, plastic and sticky; clear and wavy boundary (50-70 cm).

C - 234 - 300 cm^+, rotten rock residues, loam.

REMARKS - Common roots in Ap, few in B1 and very few in B21 and B22.

Termites and ants acitivity in Ap, B1 and B21.

Few quartz gravels and stones in B3. Occurrence of krotovinas in B22.

PROFILE Nº ISCW-BR 24

SAMPLE Nº 77.0800/05 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 22	-	1	99	29	25	10	36	22	39	0.28
B1	- 55	-	1	99	20	18	7	55	-	100	0.13
B21	-100	-	1	99	21	17	7	55	-	100	0.13
B22	-170	-	1	99	15	13	8	64	-	100	0.13
B3	-234	1	1	98	15	13	15	57	-	100	0.26
C	-300^+	-	1	99	23	25	28	24	-	100	1.17

pH (1:2.5) H2O	pH KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.8	3.9	0.6		0.18	0.04	0.8	1.2	4.1	6.1	13	60
4.7	4.0	0.2		0.08	0.03	0.3	1.6	2.7	4.6	7	84
4.8	4.1	0.5		0.03	0.03	0.6	1.1	2.4	4.1	15	65
4.9	4.1	0.9		0.02	0.03	1.0	0.7	2.2	3.9	26	41
5.0	4.1	0.4		0.02	0.04	0.5	0.7	1.9	3.1	16	58
5.1	4.2	0.2		0.02	0.03	0.3	0.4	1.1	1.8	17	57

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
1.00	0.09	11	13.7	12.2	3.7	1.13	1.91	1.60	5.18	1
0.54	0.08	7	21.6	19.3	5.9	1.12	1.90	1.59	5.13	1
0.44	0.06	7	21.9	19.1	5.9	1.07	1.95	1.63	5.08	1
0.38	0.05	8	24.9	22.5	6.9	1.10	1.88	1.57	5.12	1
0.31	0.05	6	23.9	20.6	6.8	1.01	1.97	1.63	4.75	1
0.18	0.04	5	12.3	10.5	4.7	0.50	1.99	1.55	3.59	1

Clay B/A - 1.6 Weighted - 1.6

PROFILE Nº ISCW-BR 24
SAMPLE Nº 77.0800/05

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	RF	BT & MS	IL & MG	CN FE	CN ARG	TM & ZR	OF	RU & SL	CN HU			
SANDS (2-.05 mm)													
Ap	98%	tr	tr	2%	tr	tr	tr	tr		tr			
B1	98%	tr	tr	2%	tr	tr	tr	tr		tr			
B21	96%	tr	tr	2%	2%	tr	tr						
B22	94%	2%	tr	2%	2%	tr	tr						
B23	96%	2%	tr	2%	tr		tr		tr				
C	60%	20%°	15%	5%	tr		tr		tr				
GRAVELS (>2 mm)													
	91%	2%		2%	5%			tr					
	88%	5%			5%	2%							
	98%	tr			2%	tr							
	95%	tr		tr	5%	tr							
	88%	10%			2%	tr							
	70%	30%			tr	tr							

Mineral Code : QZ - quartz; RF - rock fragments; BT - biotite; MS -muscovite; IL - ilmenite; MG - magnetite; CN FE - iron concretions; CN ARG - argillaceous concretions; TM - tourmaline; ZR - zircon; OF - organic fragments; RU - rutile; SL - sillimanite; CN HU - humous concretions

° Rock fragments with > quantity of opaques

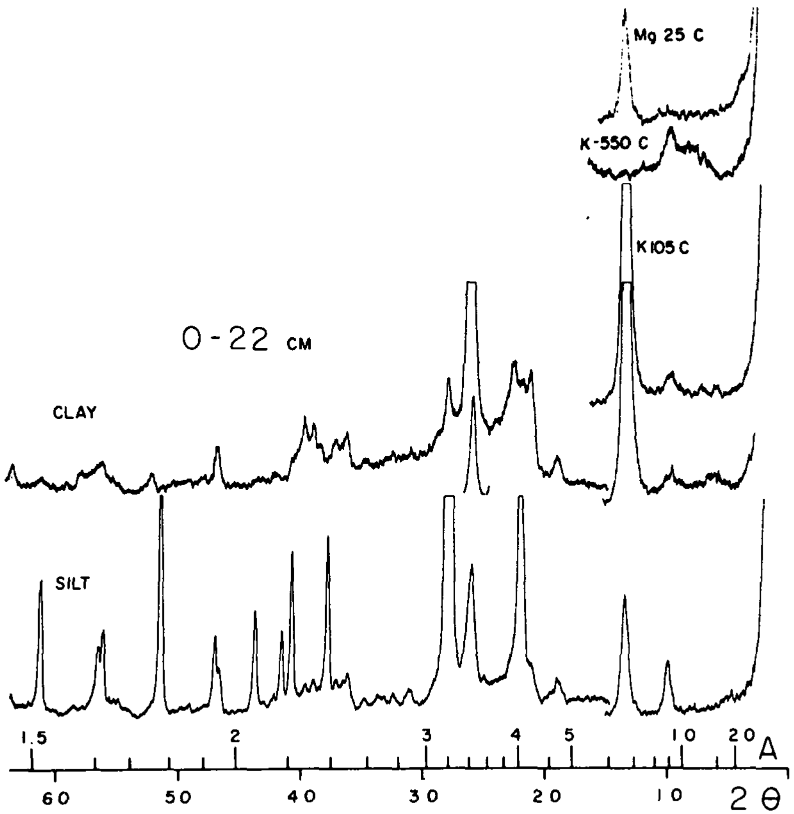

Fig. 63 - X-Ray diffraction patterns of the clay and silt from Ap horizon of the profile BR-24.

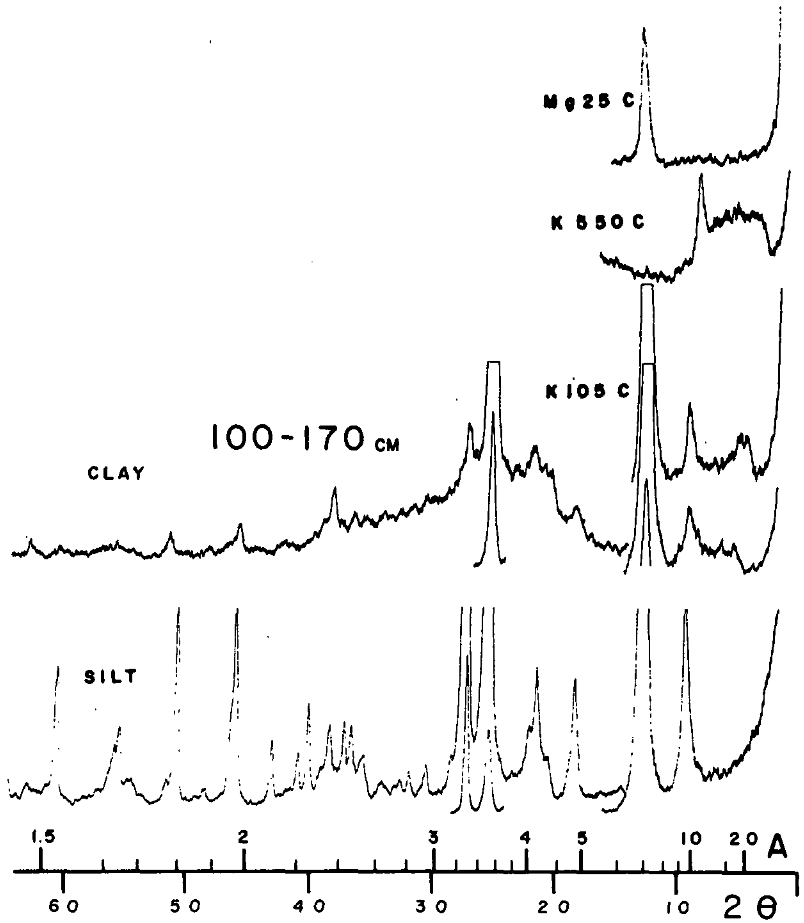

Fig. 64 - X-Ray diffraction patterns of the clay and silt from B22 horizon of the profile BR-24.

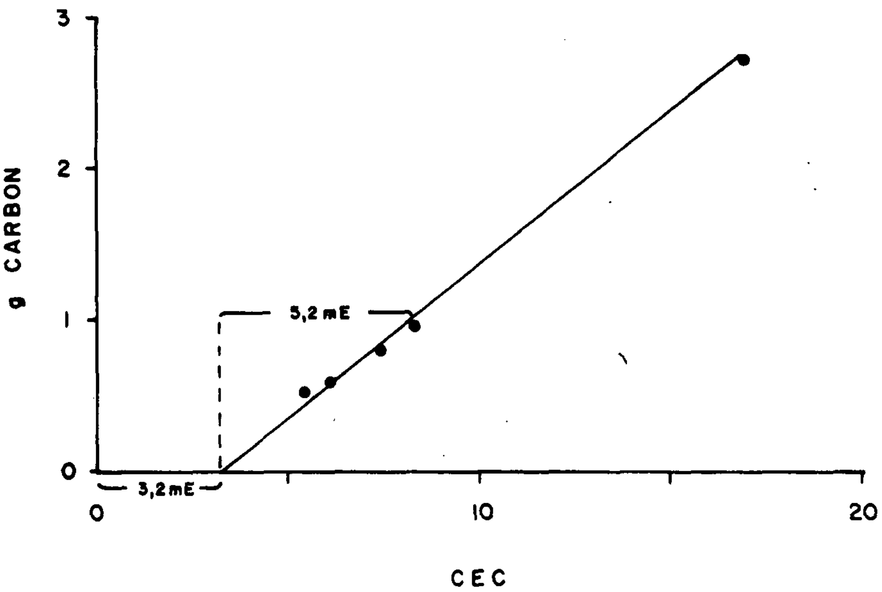

Fig. 65 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-24

Discussion

1. This pedon is similar to the previous one as regards a distinct increase in clay from the A to Bt horizon (ratio 1.5) and having some visible cutans (Smith). The mineralogy is kaolinitic with a measurable amount of amorphous material (Ikawa). Most participants considered this soil a Kandiudult close to an Oxisol.

2. The pedon differs from the previous one in that Al saturation is more than 50 percent. It was pointed out that at these low levels of CEC, the Al saturation becomes less meaningful. The preference for this soil, as for BR 23, is for an acric subgroup.

3. Further discussions pertained to the definition of an acric subgroup. Buol wanted to see a delta pH close to zero, or positive, which is not the case in this profile. Schargel did not agree with an ECEC boundary as high as 4 to 5 meq per 100 g clay for the definition of acric; this seems too high for Venezuelan conditions where 1.5 meq gives a better separation.

4. At this profile remarks were made again on the limit between Ultisols and Oxisols. However, there was no consensus of opinion. This particular point is indeed difficult to resolve even when confronted with specific conditions in the field.

PROFILE ISCW-BR 25 DESCRIBED AND SAMPLED - 10 Mar 1977

CLASSIFICATION - TERRA ROXA ESTRUTURADA ÁLICA A moderado textura argilosa fase floresta tropical subperenifólia relevo ondulado (TERRA ROXA ESTRUTURADA ALIC*, moderate A horizon, clayey, semi-evergreen tropical forest rolling phase).

Rhodic Paleudult; clayey, oxidic, isohyperthermic.

Humic Nitosol.

Sol ferrallitique; moyennement désaturé, typique, modal, dérivé de roches volcaniques basiques.

LOCATION - Cabo, PE. Cabo-Barreiros road, 100 m to the right, in a side road at Engenho Rosário; 8°18'00" S 34°59'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at upper third of hillside, 8% slope, under sugarcane; rolling; 40 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Basic volcanic rocks, mostly andesine-basalt with some trachyte, Upper Cretaceous; weathering residues of stated rocks.

DRAINAGE - Well drained.

PRESENT LAND USE - Sugarcane crop.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	27.1	27.1	27.0	26.6	25.9	25.0	24.3	24.4
P mm	40	89	197	248	335	318	224	146
	Sept	Oct	Nov	Dec				
T°C	25.3	26.2	26.6	26.9	Mean	26.0		
P mm	62	37	25	40	Total	1761		
		Isohyperthermic			Udic			

Ap - 0 - 20 cm, dark reddish brown (5 YR 3/3, moist and dry); clay; strong fine to medium granular and fine subangular blocky; many very fine and fine, and few coarse pores; friable, plastic and sticky; gradual and smooth boundary.

B1t - 20 - 65 cm, dark reddish brown (2.5 YR 3/4, moist); clay; moderate medium prismatic and strong fine subangular and angular blocky;many very fine and fine, and few coarse pores; continuous moderate clay films; friable, plastic and sticky; diffuse and smooth boundary.

B21t - 65 - 105 cm, dark red (2.5 YR 3/6, moist); clay; moderate medium prismatic and strong fine subangular and angular blocky; many very fine and fine pores; continuous moderate clay films; friable, plastic and sticky; diffuse and smooth boundary.

B22t - 105 - 150 cm, dark reddish brown (2.5 YR 3/5, moist); clay; moderate

* Endoalic.

medium prismatic and strong fine angular and subangular blocky; many very fine and fine pores; continuous moderate clay films; firm, plastic and sticky; gradual and smooth boundary.

B3t? - 150 - 205 cm$^+$, dark reddish brown (2.5 YR 3/4, moist); clay; moderate medium prismatic and strong fine subangular and angular blocky; many very fine and fine pores; continuous moderate clay films; firm, plastic and sticky.

REMARKS - Common roots in Ap, B1t, few in B21t and B22t.

Termites activity in Ap and B21t.

Profile moist.

PROFILE Nº ISCW-BR 25
SAMPLE Nº 77.0806/10

SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 20	-	tr	100	6	5	23	66	45	32	0.35
B1t	- 65	-	tr	100	4	2	12	82	-	100	0.15
B21t	-105	-	tr	100	2	2	13	83	-	100	0.16
B22t	-150	-	-	100	1	4	26	69	-	100	0.38
B3t?	-205+	-	tr	100	1	3	33	63	-	100	0.52

pH (1:2.5) H2O	pH KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.9	4.2	2.0	1.3	0.15	0.17	3.6	0.5	6.2	10.3	35	12
5.0	4.4	1.1	0.8	0.07	1.10	2.1	0.5	4.5	7.1	30	19
4.9	4.2	0.5	0.7	0.04	0.07	1.3	1.3	4.2	6.8	19	50
4.9	4.0	0.3	0.8	0.04	0.08	1.2	3.1	3.1	7.4	16	72
4.9	3.9	0.9		0.07	0.09	1.1	5.4	2.6	9.2	12	83

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
1.73	0.17	10	22.9	20.5	22.4	6.16	1.90	1.12	1.44	1
0.80	0.11	7	27.1	24.5	21.9	4.64	1.88	1.20	1.75	2
0.54	0.08	7	29.8	27.1	21.7	3.63	1.87	1.24	1.96	1
0.32	0.05	6	30.7	26.5	22.9	4.06	1.97	1.27	1.82	1
0.28	0.05	6	30.0	25.5	24.1	4.91	2.00	1.25	1.66	

Clay B/A - 1.2 Weighted - 1.2

PROFILE Nº ISCW-BR 25
SAMPLE Nº 77.0806/10

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	CN FE	QZ	MG & IL	CN ARG	OP & CD
SANDS (2-.05 mm)					
Ap	20%	63%	12%	5%	
B1t	20%	65%	15%	tr	tr
B21t	40%	50%	10%	tr	tr
B22t	65%	15%	20%	tr	tr
B3t?	55%	20%	20%	5%	
GRAVELS (>2 mm)					
	20%	60%		20%	
	50%	40%	10%		tr
	70%	30%	tr		
	--				
	90%	10%			

Mineral Code: CN FE - iron concretions; QZ - quartz; MG - magnetite; IL - ilmenite; CN ARG - argillaceous concretions; OP - opal; CD - chalcedony

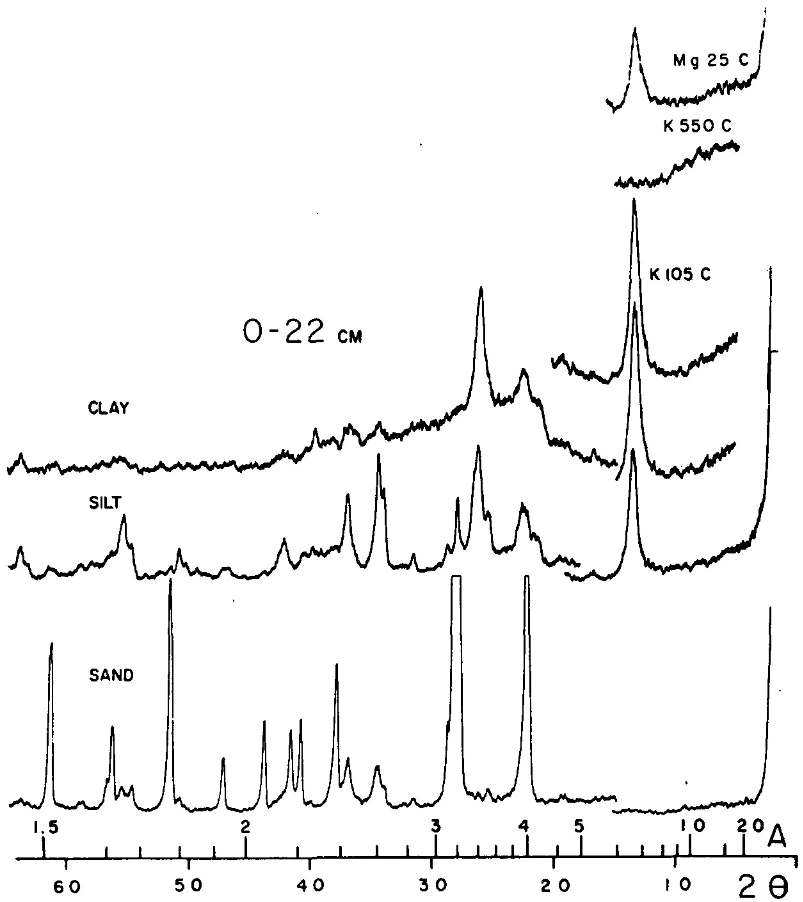

Fig. 66 - X-Ray diffraction patterns of the clay, silt and sand from Ap horizon of the profile BR-25.

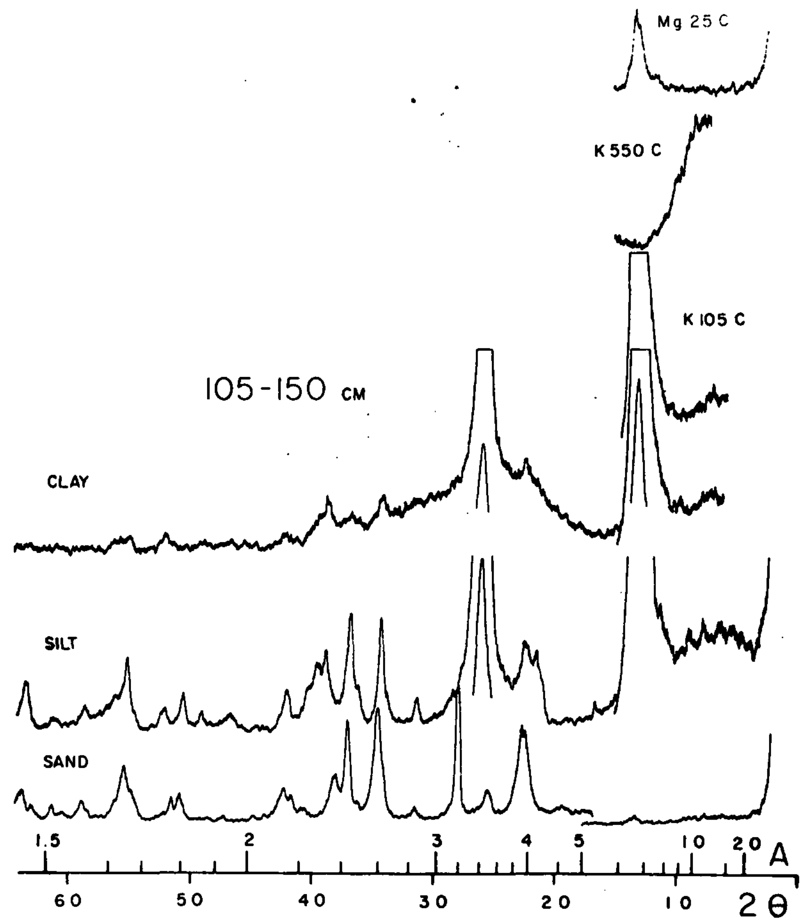

Fig. 67 - X-Ray diffraction patterns of the clay, silt and sand from B22t horizon of the profile BR-25.

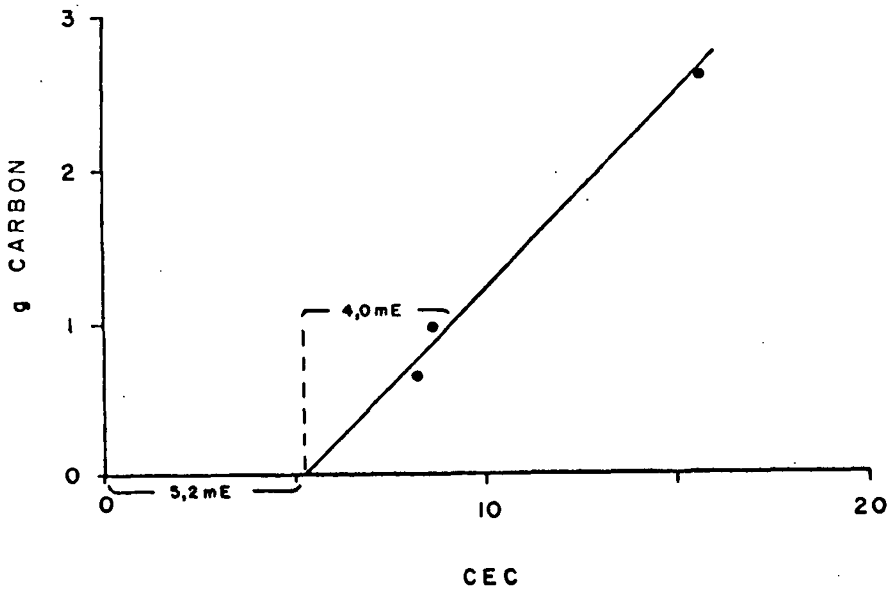

Fig- 68 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-25.

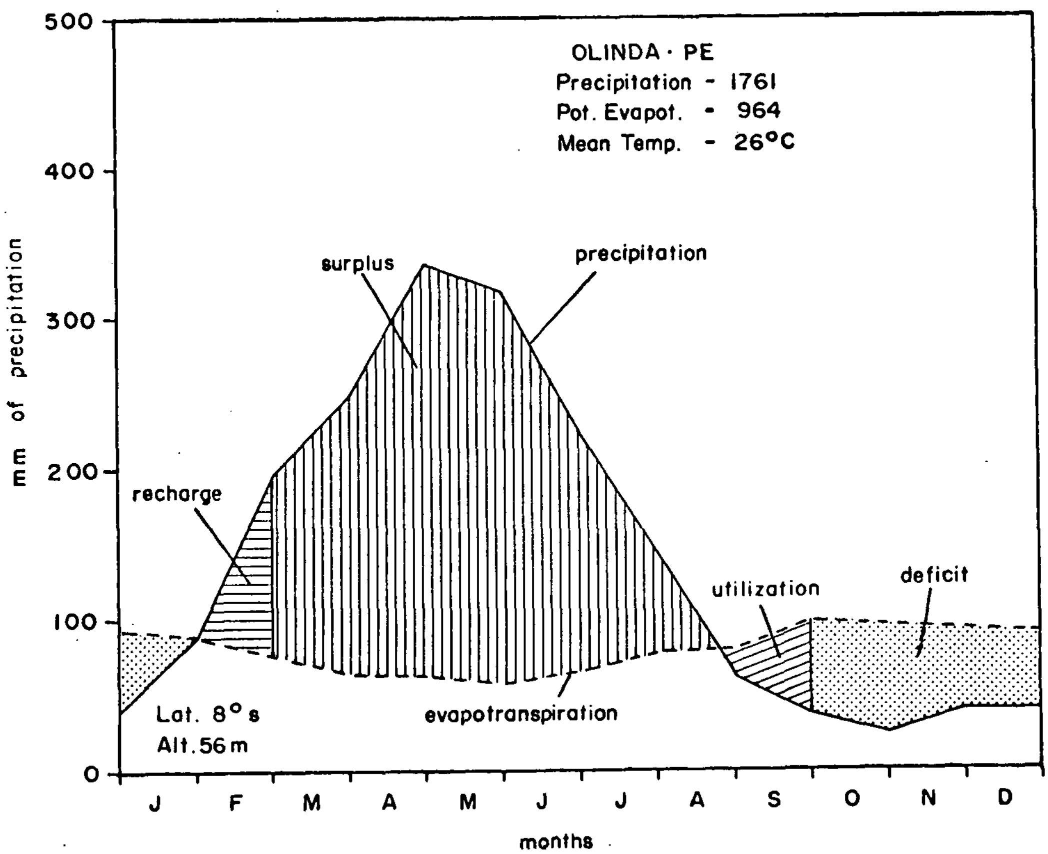

Fig. 69 - Water balance according to Thornthwaite & Malher, 1955 (125 mm), for geographic region related to profile BR-25.

Discussion

1. This soil has:

   (a) a clay distribution in which the clay diminishes with more than 20 percent from the maximum at a depth of 150 cm (see, however, 2 below),

   (b) most probably, less than 10 percent weatherable minerals in the 20-200 micron fraction in the upper 50 cm of the argillic horizon, but,

   (c) according to the profile description has skeletons on ped faces in the horizon where clay is less than the maximum (B22t at 105-150 cm, and B3t? at 150-250 cm).

According to the key for Udults (Soil Taxonomy, p. 360 and 364), this soil is therefore a Rhodic Paleudult.

2. The high figures for silt may be apparent; part of this silt is aggregated clay, as can be proven when treated with H_2SO_4 (Bennema). Thus, the clay distribution mentioned above may be more apparent than real.

3. Contrary to what is found in Oxisols of Hawaii, this profile does not show an increase in pH and a decrease in Al with depth. Hence it should not be classified as an Oxisol (Uehara).

4. This profile has the same morphology as typic Krasnozems in Australia (Isbell). In the latter, no clay cutans were found. Typical for such profiles is a kind of "tubular" structure arrangement in the B, which is somewhat visible here.

5. Different from the Ultisols developed from more acidic rocks, this kind of soil has excellent management properties, believed to be related, at least partly, to a higher specific surface of the non-cyrstalline Fe compounds (Juo). It therefore seems appropriate to eventually establish specific great groups for such soils separate from the "Kandi". An alternative would be to redefine the present "rhod" greatgroups in such a way that the high specific surface of the Fe oxides forms part of the definition, and to place the "rhod" in the key before the Kandi and Pale greatgroups.

6. The behaviour of Si (ISS ISR) in these profiles, as well as P-fixation may be diagnostic (Juo, and others), but not enough data are available at present.

7. In committee parlance, this soil would be a Rhodic Kandiudult, but the general feeling was that this is a "special" kind of soil, which would merit destinction at the great group level, at least. The profile appears to have the "shiny ped surfaces", characteristic for a "Nitosol sensu stricto" of the FAO/Unesco legend. (Sombroek, Dudal).

PROFILE ISCW-BR 26 DESCRIBED AND SAMPLED - 8 Nov 1963

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO argila de atividade alta abrúptico A moderado textura média/argilosa fase floresta tropical subperenifólia relevo ondulado (RED-YELLOW PODZOLIC ALIC, high clay activity, abruptic, moderate A horizon, loamy/clayey, semi-evergreen tropical forest rolling phase).

Epiaquic Tropudult; clayey, mixed, isohyperthermic.

LOCATION - Cabo, PE. 11 km from Cabo in the road to Ipojuca, left side. 8°21'00" S 35°01'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at upper third of hill side, 8-10% slope, under secondary forest; rolling; 560 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Conglomerate, occasionally arkosic, Cabo Formation, Lower Cretaceous; weathering residues of stated sediments.

DRAINAGE - Moderately well drained.

PRESENT LAND USE - Sugarcane crop.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	21.1	27.1	27.0	26.6	25.9	25.0	24.3	24.4
P mm	40	89	197	248	335	318	224	146
	Sept	Oct	Nov	Dec				
T°C	25.3	26.2	26.6	26.9	Mean	26.0		
P mm	62	37	25	40	Total	1761		
		Isohyperthermic			Udic			

A1 - 0 - 12 cm, dark brown (10 YR 3/3, moist); slightly gravelly sandy loam; moderate medium granular; many fine pores; slightly hard, firm, slightly plastic and slightly sticky; clear and smooth boundary.

A3 - 12 - 22 cm, dark brown (10 YR 4/3, moist), few fine and distinct mottles of strong brown (7.5 YR 5/6, moist); sandy clay loam; weak fine subangular and angular blocky; common fine pores; hard, firm, plastic and sticky; clear and smooth boundary.

B1t - 22 - 40 cm, yellowish brown (10 YR 5/4, moist), common fine and distinct mottles of red (2.5 YR 4/6, moist); clay; compound weak fine prismatic and moderate medium and coarse subangular blocky; common fine pores; very hard, very firm, very plastic and very sticky; gradual and smooth boundary.

B21t - 40 - 60 cm, yellowish brown (10 YR 5/4, moist), many medium and distinct mottles of red (2.5 YR 4/6, moist); clay; moderate medium subangular and angular blocky; common fine pores; few weak clay films; very hard, firm, plastic and very sticky; diffuse and smooth boundary.

B22t - 60 - 90 cm, red (2.5 YR 4/6, moist), many medium and distinct mottles of yelowish brown (10 YR 5/4, moist); clay; moderate fine to medium subangular blocky; common fine pores; few weak clay films; hard, firm, plastic and sticky; gradual and wavy boundary (20-40 cm).

C - 90 - 120 cm$^+$, red (2.5 YR 4/6, moist); clay loam; weak fine to medium subangular blocky and massive; common fine pores; slightly hard, firm, plastic and sticky.

REMARKS - Plentiful roots in A1, common in A3, few downward.

Earthworms activity in A1.

Light color mottling of weathered parent material and primary minerals in C.

NOTE - This profile was not seen in the field tour.

PROFILE Nº ISCW-BR 26

SAMPLE Nº 7086/91 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 12	-	3	97	33	27	25	15	5	67	1.60
A3	- 22	-	6	94	32	24	24	20	11	45	1.20
B1t	- 40	-	3	97	13	8	18	61	31	49	0.29
B21t	- 60	-	5	95	14	10	20	56	27	51	0.36
B22t	- 90	-	3	97	15	9	27	49	1	98	0.55
C	-120+	-	3	97	21	13	33	33	-	100	1.00

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.7	3.7	0.7	1.4	0.13	0.12	2.4	1.2	5.8	9.4	26	33
4.6	3.5	0.5	0.6	0.10	0.10	1.3	2.2	5.4	8.9	15	63
4.5	3.5	0.4	0.8	0.12	0.20	1.5	7.1	11.3	19.9	8	83
4.7	3.7	0.4	0.8	0.13	0.12	1.4	6.6	9.9	17.9	8	82
4.8	3.6	0.3	0.9	0.09	0.20	1.5	6.9	11.8	20.2	7	82
4.6	3.6	0.3	0.9	0.08	0.12	1.4	7.1	9.5	18.0	8	84

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	MOLECULAR RATIO SiO2 / Al2O3	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
1.42	0.11	13								
0.92	0.09	10								
0.89	0.09	10								
0.68	0.07	10								
0.39	0.05	8								
0.29	0.03	10								

Clay B/A - 3.3 Weighted - 3.4

PROFILE Nº ISCW-BR 26
SAMPLE Nº 7086/91

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	FK	BT	CN FE	MS	MG & IL	OF	ZR	ST
SANDS (2-.05 mm)									
A1	100%			tr		tr	tr	tr	
A3	100%			tr		tr	tr	tr	
B1t	98%	tr	tr	1%	tr	1%		tr	tr
B21t	92%	5%	tr	2%	tr	1%	tr		
B22t	99%	tr	tr	1%	tr	tr			
C	87%	5%	4%	2%	2%	tr		tr	
GRAVELS (>2 mm)									
	100%			tr					
	100%								
	100%						tr		
	100%	tr		tr			tr		
	100%			tr			tr		
	100%								

Mineral Code: QZ - quartz; FK - potassium feldspar; BT - biotite; CN FE - iron concretions; MS - muscovite; MG - magnetite; IL - ilmenite; OF - organic fragments; ZR - zircon; ST - staurolite

PROFILE ISCW-BR 27 DESCRIBED AND SAMPLED - 27 Aug 1964

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO DISTRÓFICO argila de atividade baixa abrúptico A proeminente textura média/argilosa fase floresta tropical subcaducifólia relevo ondulado (RED-YELLOW PODZOLIC DYSTROPHIC, low clay activity, abruptic, prominent A horizon, loamy/clayey, semi-deciduous tropical forest rolling phase).

(Epiaquic)* Paleustult; clayey, kaolinitic, isohyperthermic.

Ferric Acrisol.

Sol ferrallitique; moyennement désaturé, rajeuni, hydromorphe, dérivé de gneiss/migmatite.

LOCATION - Nazaré da Mata, PE. Carpina-Nazaré da Mata road, 1 km from Tracunhaém; 7°47'00" S 35°14'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank on top of hillside, 4 to 6% slope, under high shrub vegetation; rolling; 130 meters.

PRIMARY VEGETATION - Semi-deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Gneiss or migmatite, Precambrian Complex; weathering residues of stated rocks overlain by transported material.

DRAINAGE - Moderately well drained.

PRESENT ALND USE - Small cultures of cassava, corn, sugarcane and natural pasture.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.4	26.5	26.2	25.6	24.7	23.5	22.9	22.9
P mm	38	64	109	151	197	197	129	77
	Sept	Oct	Nov	Dec				
T°C	23.7	24.8	25.6	26.1	Mean	24.9		
P mm	40	21	27	33	Total	1083		
		Isohyperthermic			Ustic			

A1 - 0 - 35 cm, dark reddish brown (5 YR 3/2, moist); sandy clay loam; weak fine granular and weak fine subangular blocky; many fine and few coarse pores; firm, plastic and sticky; clear and smooth boundary.

A3 - 35 - 45 cm, dark reddish brown (5 YR 3/2, moist), common few and distinct mottles of dark red (2.5 YR 3/6, moist); weak fine to medium subangular blocky; common fine pores; firm, very plastic and very sticky; abrupt and wavy boundary (8-30 cm).

* Subgroup not established.

IIBt - 45 - 110 cm, red (2.5 YR 4/6, moist), few medium and prominent mottles of strong brown (7.5 YR 5/6, moist); clay; moderate fine to medium subangular blocky; few and common fine pores; common weak clay films; extremely hard, firm, plastic and sticky; clear and wavy boundary (50-70 cm.

IIC1 - 110 - 260 cm, variegated color of very pale brown (10 YR 8/3) and dark red (2.5 YR 3/6, moist); clay loam (micaceous); massive; common fine pores; very hard, friable, slightly plastic and slightly sticky; diffuse and wavy boundary.

IIC2 - 260 - 460 cm$^+$, semi-decomposed rock.

REMARKS - Abundant roots in A1 and A3, few in IIBt and very few in IIC1.

Stone line consisting of angular and subangular quartz gravels in A or at the boundary to IIBt.

Intense biological activity in A1.

Darker color channels fillings with material from upper horizons in IIBt, IIC1 and IIC2. Krotovinas also occur.

PROFILE Nº ISCW-BR 27

SAMPLE Nº 7982/85 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
A1	0- 35	-	3	97	46	18	14	22	11	50	0.64
A3	- 45										
IIBt	-110	-	-	100	15	7	25	53	-	100	0.47
IIC1	-260	-	3	97	27	5	31	37	-	100	0.84
IIC2	-460+	-	4	96	37	4	34	25	-	100	1.36

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
4.3		0.6	0.3	0.11	0.12	1.1	1.3	5.7	8.1	14	54
--											
4.5		0.8	1.6	0.05	0.12	2.6	1.6	4.3	8.5	30	38
4.4		0.8	1.0	0.05	0.38	2.2	1.9	4.1	8.2	27	46
3.9		0.5	0.6	0.05	0.74	1.9	2.9	5.3	10.1	19	60

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	MOLECULAR RATIO SiO2 / Al2O3	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
0.78	0.07	11	10.1	7.8	0.3		2.20	2.15	4.10	
--										
0.28	0.03	9	30.3	26.0	5.1		1.98	1.76	8.00	
0.23	0.03	8	30.0	24.8	2.1		2.06	1.95	18.54	
0.14	0.02	7	27.4	25.8	0.3		1.81	1.79		

Clay B/A - 2.4 Weighted - 2.4

PROFILE Nº ISCW-BR 27
SAMPLE Nº 7982/85

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE	WE BT	FK	MG & IL	MS	OF
SANDS (2-.05 mm)							
A1	98%			tr	2%	tr	tr
A3°							
IIBt	80%	18%	tr		1%	1%	
IIC1	85%		15%		tr		
IIC2	85%	tr	10%	5%	tr		
GRAVELS (>2 mm)							
A1	>%	°°					
A3°							
IIBt	>%						
IIC1	>%			°°			
IIC2	>%			°°			

Mineral Code : QZ - quartz; CN FE - iron concretions; WE BT - weathered biotite; FK - potassium feldspar; MG - magnetite; IL - ilmenite; MS - muscovite; OF - organic fragments

° A3 horizon not sampled
°° Occur jointly with quartz, but the latter in >%

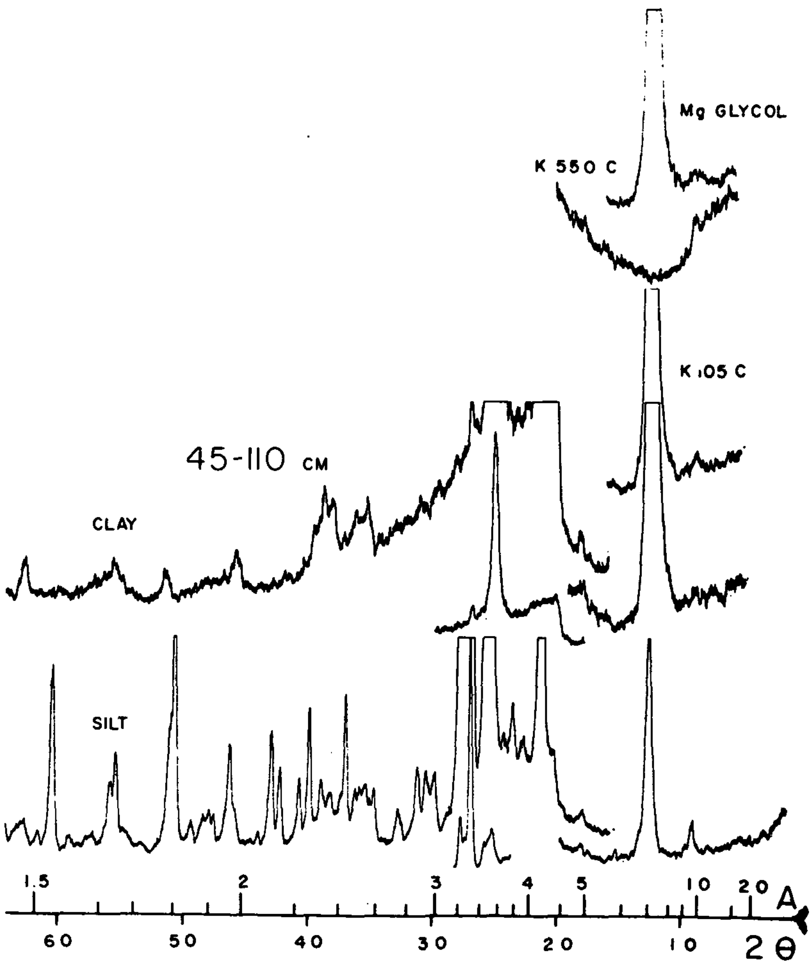

Fig. 70 - X-Ray diffraction patterns of the clay and silt from IIBt horizon of the profile BR-27.

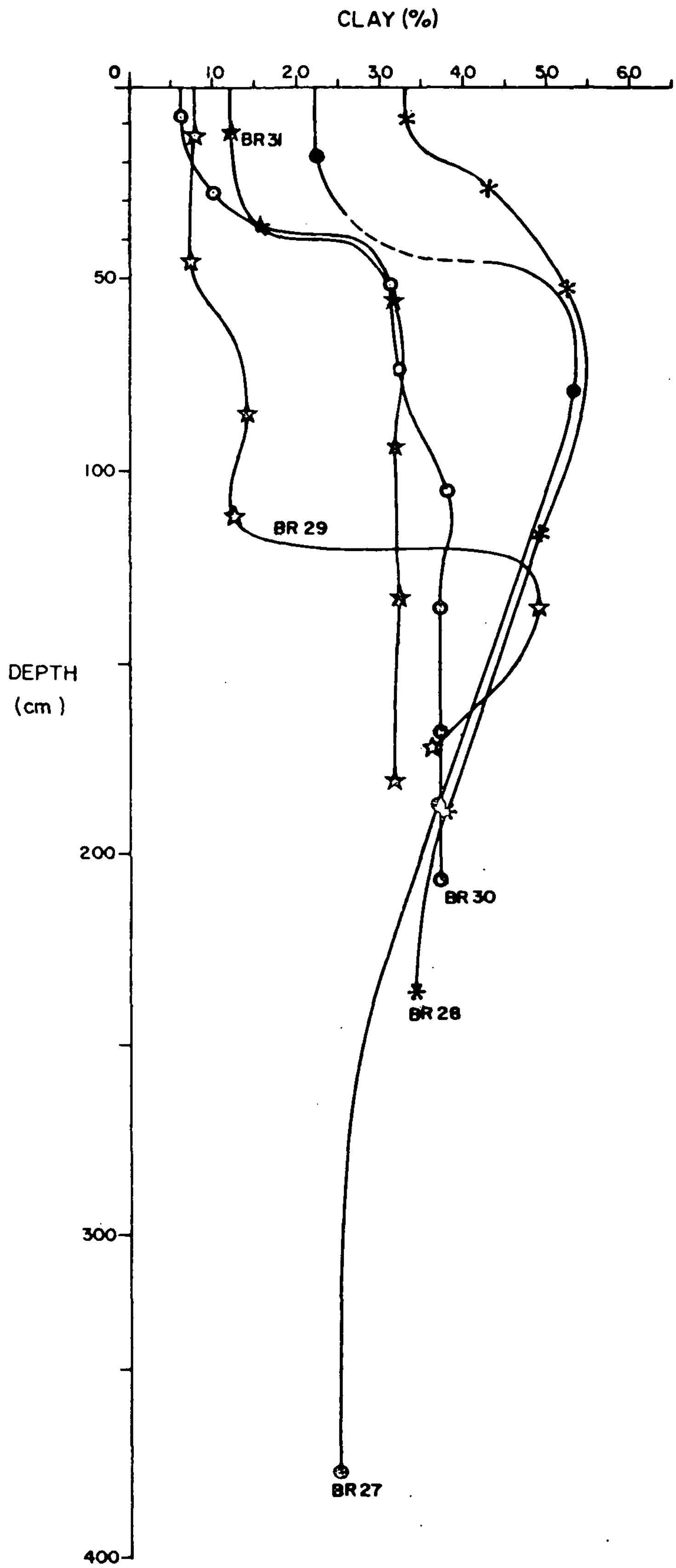

Fig.7b - Clay distribution curves° for profiles BR-27, BR-28, BR-29, BR-30 and BR-31.

° All clay distribution curves at same scale.

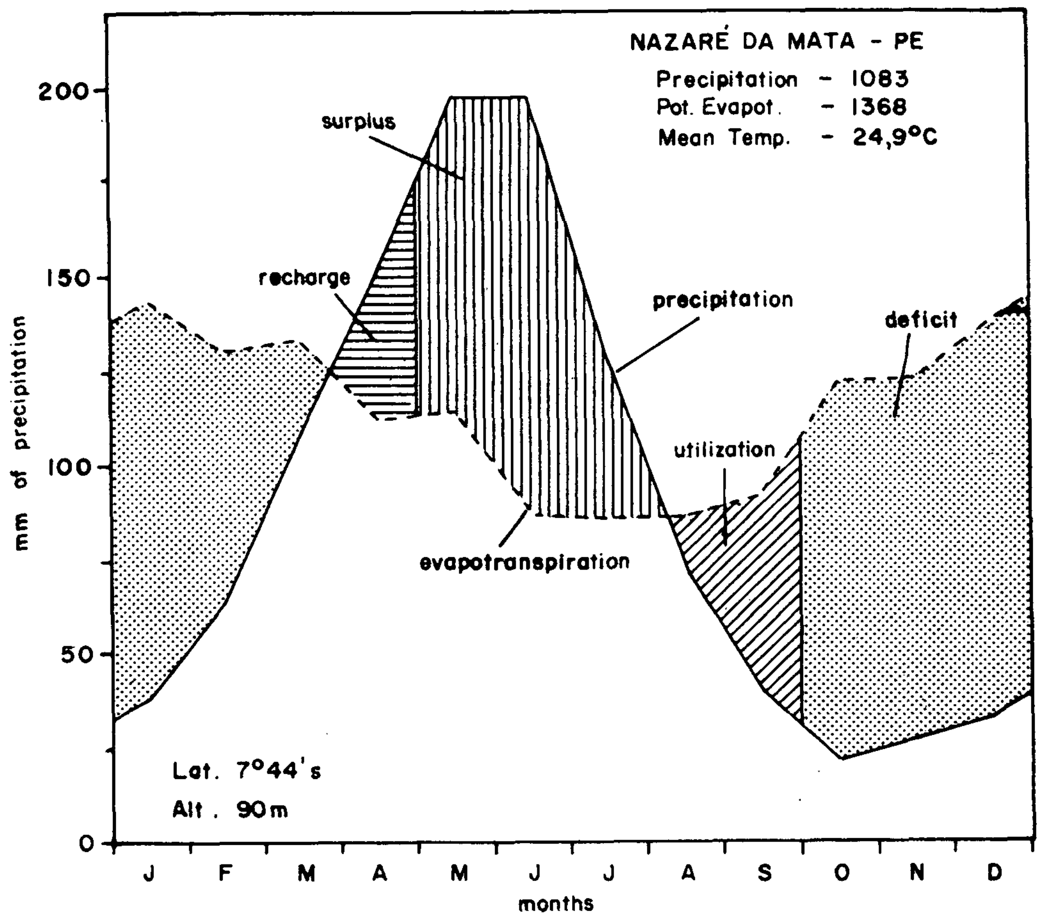

Fig. 72 - Water balance according to Thornthwaite & Mather, 1955 (125mm), for geographic region related to profile BR-27.

Discussion

1. This pedon is comparable to BR 1º as regards the reticulate red mottles. However, the mottled material is clearly not plinthite as it does not show signs of hardening (Beinroth, Smith and others). The presence of strong iron segregation may be indicated in a ferric subgroup.

2. The soil is an Ustult with a NH_4OAc-CEC in the upper 50 cm of the argillic horizon of less than 24 meq per 100 g clay. Depending on whether 16 or 24 meq would be diagnostic, this soil may or may not be a Kandiustult. From the data available it appears probable that there are less than 10 percent weatherable minerals (minus muscovite) in the 20-200 micron fraction of the upper 50 cm of the argillic horizon.

3. The clay distribution is typical for a leptic subgroup. The Al saturation is less than 50 percent at any of the two alternative depths (upper Bt or at 150 cm). The soil may, therefore, be in an alfic subgroup. Thus there are three possible subgroups : leptic, ferric and alfic.

4. The profile has an abrupt transition from the A3 to the IIB1t horizon according to the description. All this shows that it is easy enough to suggest subgroup criteria but that it is difficult, as in this case, to choose between several diagnostic characteristics for the definition of subgroups.

5. The soil has epiaquic characteristics. While no epiaquic subgroup is presently recognized in Paleustults, it should be introduced in analogy to Haplustults.

PROFILE ISCW-BR 28 DESCRIBED AND SAMPLED - 10 Oct 1968

CLASSIFICATION - TERRA ROXA ESTRUTURADA SIMILAR EUTRÓFICA A moderado textura argilosa fase floresta tropical subcaducifólia relevo forte ondulado (TERRA ROXA ESTRUTURADA SIMILAR EUTROPHIC*, moderate A horizon, clayey, semi-deciduous tropical forest hilly phase).

Oxic Paleustalf ; clayey, kaolinitic, isohyperthermic.

Eutric Nitosol.

Sol ferrallitique; moyennement désaturé, typique, modal, dérivé de gneiss à biotite.

LOCATION - Aliança, PE. Right side of the highway Recife-Aliança (in a side road, 200 m from the highway), 300 m from the junction to Vicência; 7°36'00" S 35°12'00" W.

TOPOGRAPHIC POSITION - Description and sampling in a roadbank at medium third of hillside, 25% slope, under grass and shrub vegetation; hilly; 140 meters.

PRIMARY VEGETATION - Semi-deciduous tropical forest.

GEOLOGY AND PARENT MATERIAL - Biotite-gneisses and migmatites with associated mica-schists, Precambrian Complex; weathering residues of stated rocks slightly reworked.

DRAINAGE - Well drained.

PRESENT LAND USE - Sugarcane crop in great part of the area, besides small areas with corn, cassava, cotton and bean crops.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.4	26.5	26.2	25.6	24.7	23.5	22.9	22.9
P mm	38	64	109	151	197	197	129	77
	Sept	Oct	Nov	Dec				
T°C	23.7	24.8	25.6	26.1	Mean	24.9		
P mm	40	21	27	33	Total	1083		
		Isohyperthermic			Ustic			

Ap - 0 - 15 cm, dark brown (7.5 YR 3/2, moist); clay loam; moderate medium granular and moderate fine subangular blocky; common fine pores; hard, firm, very plastic and sticky; clear and smooth boundary.

AB - 15 - 35 cm, yellowish red (5 YR 4/6, moist);clay; weak fine subangular blocky; common fine pores; hard, friable, very plastic and very sticky; gradual and smooth boundary.

B21t - 35 - 70 cm, yellowish red (3.5 YR 4/6, moist); clay; moderate fine subangular blocky; common fine pores; common weak clay films; hard, friable, very plastic and very sticky; diffuse and smooth boundary.

* Endoeutrophic.

B22t - 70 - 160 cm, red (2.5 YR 4/6, moist); clay; strong fine subangular blocky; common fine pores; continuous moderate clay films; very hard, firm, plastic and very sticky; diffuse and wavy boundary (75-90 cm).

B3t - 160 - 220 cm, red (2.5 YR 4/8, moist); clay loam; moderate fine to medium subangular blocky; common fine pores; continuous moderate clay films; very hard, firm, plastic and sticky; diffuse and wavy boundary (50-65 cm).

C - 220 - 250 cm^+, red (2.5 YR 4/8, moist); clay loam; weak fine to medium subangular blocky; common fine pores; common weak clay films; hard, friable, slightly plastic and sticky.

REMARKS - Plentiful roots in Ap, common in AB and B21t, decreasing downward.

Ap mostly eroded in intensively cultivated areas.

PROFILE Nº ISCW-BR 28
SAMPLE Nº 7062/67

SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 15	-	1	99	18	15	34	33	18	45	1.03
AB	- 35	-	1	99	15	9	33	43	15	65	0.76
B21t	- 70	-	1	99	11	7	30	52	-	100	0.57
B22t	-160	-	1	99	13	8	30	49	-	100	0.61
B3t	-220	-	2	98	16	9	37	38	-	100	0.97
C	-250+	-	2	98	18	10	38	34	-	100	1.11

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.2	4.2	2.0	1.6	0.54	0.05	4.2	0.1	4.9	9.2	46	2
4.6	3.8	1.0	0.9	0.35	0.05	2.3	0.5	3.4	6.2	37	18
4.9	4.1	0.5	1.9	0.22	0.08	2.7	0.2	2.5	5.4	50	7
5.1	4.6	0.3	2.5	0.17	0.08	3.1	0.1	1.8	5.0	62	3
5.2	4.8	0.6	2.2	0.22	0.10	3.1	0.1	1.3	4.5	69	3
5.5	4.8	0.6	2.1	0.31	0.10	3.1	0.1	1.3	4.5	69	3

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3	Al2O3 / Fe2O3	AVLB PHOS ppm
1.56	0.17	9	14.6	11.4	3.1		2.18	1.85	5.77	
0.67	0.09	7	19.9	17.0	5.8		1.99	1.63	4.60	
0.42	0.06	7	22.8	20.3	7.9		1.91	1.53	4.03	
0.25	0.05	5	25.6	21.3	8.5		2,03	1.62	3.95	
0.15	0.03	5	25.0	20.8	9.7		2.04	1.57	3.37	
0.15	0.03	5	23.1	19.4	7.7		0.01	2.02	3.95	

Clay B/A - 1.5 Weighted - 1.5

PROFILE Nº ISCW-BR 28
SAMPLE Nº 7062/67

OPTICAL MINERALOGIC ANALYSIS.

SNLCS

HORIZON	QZ	FK	RF	BT	MS	CN FE & CN MN	CN HU	MG & IL	TA	ZR & TM	OF		
						SANDS (2-.05 mm)							
Ap	98%	tr		tr	tr	1%	1%	tr		tr	tr		
AB	99%	tr		tr	tr	1%	tr	tr		tr	tr		
B21t	98%	tr	tr	tr	tr	1%	1%			tr	tr		
B22t	92%	5%		tr	2%	tr		1%		tr	tr		
B3t	90%	8%	tr	tr	1%	tr	1%	tr		tr			
C	86%	4%	6%	3%	1%	tr				tr	tr		
						GRAVELS (>2 mm)							
	< %					♀	♀						
	< %		♀			♀	♀		♀				
	< %	♀	♀			♀			♀				
	< %	♀	♀			♀			♀				
	♀♀		< %						♀♀				

Mineral Code : QZ - quartz; FK - potassium feldspar; RF - rock fragments; BT - biotite; MS - muscovite; CN FE - iron concretions; CN MN manganose concretions; CN HU - humous concretions; MG - magnetite; IL - ilmenite; TA - talc; ZR - zircon; TM - tourmaline; OF - organic fragments

♀ Occur jointly with quartz
♀♀ Occur jointly with rock fragments

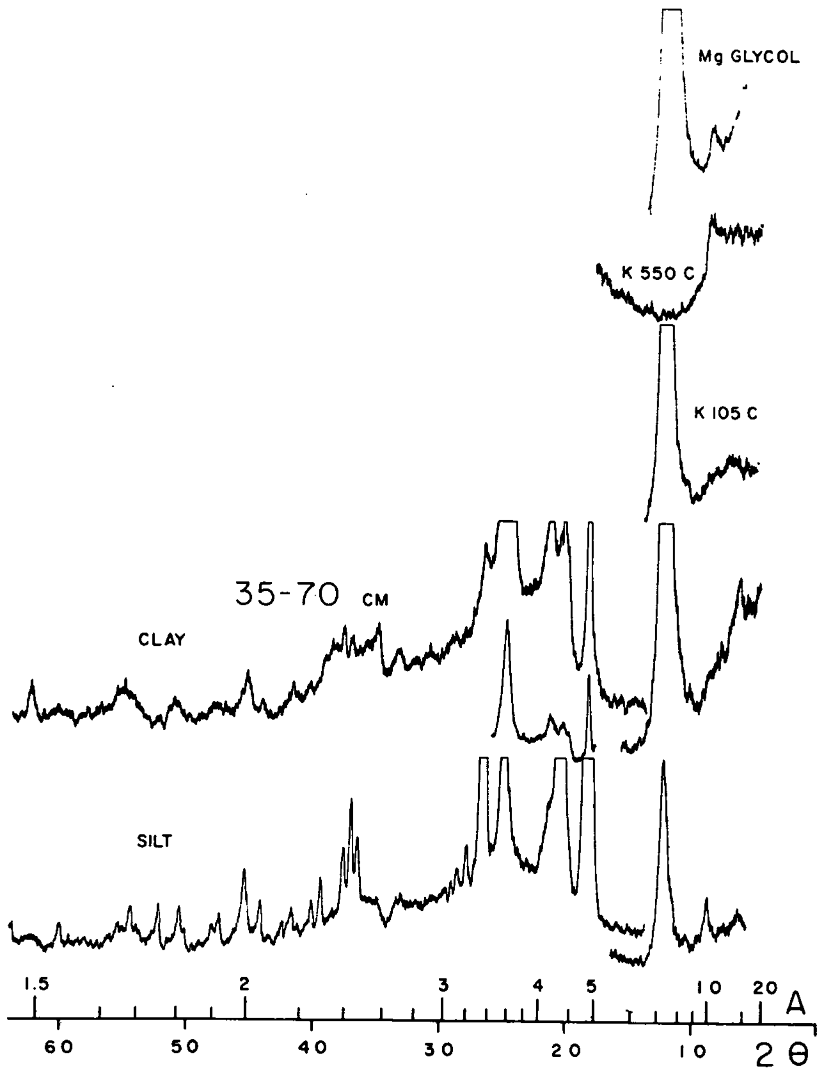

Fig. 73 - X-Ray diffraction patterns of the clay and silt from B21t horizon of the profile BR-28.

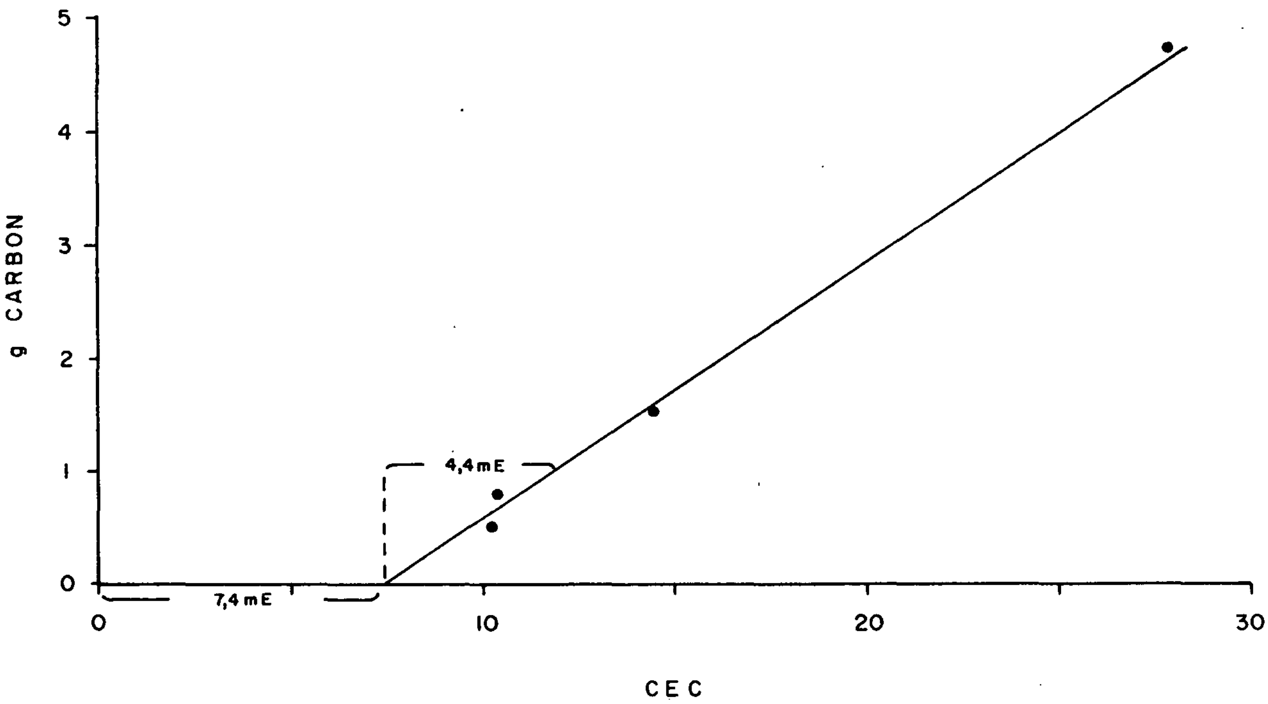

Fig. 74 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-28.

Discussion

1. The calculated NH_4OAc base saturation for the B22t horizon (70 - 160 cm) is less than 50 percent. Although it increases slightly with depth, it does not reach 50 percent. Therefore, this soil would probably be an Ultisol rather than an Alfisol. The subgroup would have to indicate the low Al saturation (alfic).

2. The weighted NH_4OAc-CEC per 100 g clay is 17 meq, i.e. more than 16 (Buol's limit) and less than 24 (Moormann's preference). This soil could thus be a Kandiustult or a Paleustult. If, for soils with ustic moisture regimes, the "alfic" is normal, one might drop this proposed subgroup and this pedon could be a Typic Kandiustult (Moormann).

3. Dudal expressed some doubt about the ustic moisture regime in view of the good performance of sugarcane and bananas in this area.

4. If not rhodic, this soil is close it (Isbell). However, the moist color values determined in the field are 4 and thus may be too high.

5. The relatively high silt content of this soil (Segalen) may be related to the micaceous parent material (Moormann).

6. As in Haplustults, a oxic subgroup should be recognized in Paleustults.

PROFILE ISCW-BR 29

CLASSIFICATION - LATERITA HIDROMÓRFICA ? DISTRÓFICA argila de atividade baixa abrúptica A proeminente textura arenosa/argilosa fase floresta tropical subperenifólia relevo plano (GROUND WATER LATERITE ? DYSTROPHIC, low clay activity, abruptic, prominent A horizon, sandy/clayey, semi-evergreen tropical forest level phase).

Typic (?) Dystropept; coarse loamy, mixed, isohyperthermic.

Luvic Arenosol.

Sol ferrallitique; moyennement désaturé, lessivé, induré/hydromorphe, dérivé de formation Barreiras.

LOCATION - Goiana, PE. Road Goiana-Timbaúba, 700 m from the junction to the new highway Recife-João Pessoa; 7°34'00" S 35°03'00" W.

TOPOGRAPHIC POSITION - Trench on the right side of the road, 0-1% slope (house backyard); level; 40 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Sandy and sandy clay sediments, Barreiras Group, Tertiary; sandy cover underlain by weathered sediments.

DRAINAGE - Somewhat poorly drained.

PRESENT LAND USE - Corn, cassava and beans small crops (backyard) with some fruit trees.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.0	26.0	25.9	25.4	24.8	23.8	23.3	23.3
P mm	95	163	196	256	287	364	240	152
	Sept	Oct	Nov	Dec				
T°C	24.5	25.2	25.7	25.7	Mean	25.0		
P mm	61	39	43	55	Total	1951		
		Isohyperthermic			Udic			

Ap - 0 - 25 cm, very dark grayish brown (10 YR 3/2, moist), grayish brown (10 YR 5/2, dry); loamy sand; weak fine to medium granular; many very fine and few medium and coarse pores; soft, very friable, nonplastic and nonsticky; clear and smooth boundary.

A2 - 25 - 65 cm, dark brown (10 YR 3/3, moist) and pale brown (10 YR 6/3, dry); loamy sand; massive; many very fine and fine, and few medium and coarse pores; soft, very friable, nonplastic and nonsticky; clear and wavy boundary (35-45 cm).

A2 ? A2+Bh? - 65-103 cm, dark brown (10 YR 3/3, moist) and pale brown (10 YR 6/3, dry) with lamellae dark brown (7.5 YR 3/3, moist) and dark brown (10 YR 3/3, dry); sandy loam; massive; common very fine and fine, and few medium and coarse pores; soft, very friable, hard and firm lamellae, nonplastic and nonsticky; clear and wavy boundary (35-43 cm).

A'2 - 103 - 118 cm, brown (10 YR 4/3, moist) and very pale brown (10 YR 7/4, dry); sandy loam; massive; many very fine and fine, and few medium and coarse pores; soft, very friable, nonplastic and nonsticky; abrupt and wavy boundary (5-17 cm).

IIB'2t - 118 - 158 cm, variegated color of dark red (2.5 YR 3/6, moist) and light reddish brown (2.5 YR 6/4, moist); clay; weak medium prismatic and moderate fine angular and subangular blocky; few moderate clay films; few very fine, fine and medium pores; extremely hard, firm, very plastic and very sticky; diffuse and smooth boundary.

IIB'3t - 158 - 200 cm$^+$, variegated color of dark red (2.5 YR 3/6, moist) and light reddish brown (2.5 YR 6/4, moist); sandy clay; weak medium prismatic and weak fine subangular and angular blocky; few very fine and medium pores; extremely hard, firm, plastic and sticky.

REMARKS - Abundant roots in Ap, common in A2, A2+Bh? and A'2, few in upper IIB'2t and avery few downward.

In A2+Bh? were found seven lamellae with average thickness of 1 cm.

Presence of coal in Ap and A2 and ants activity downward to A'2.

Penetration of dark material from the surface in IIB'2t and IIB'3t.

PROFILE Nº ISCW-BR 29

SAMPLE Nº 77.0817/22 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 25	-	1	99	46	32	14	8	4	50	1.75
A2	- 65	-	1	99	48	32	13	7	6	14	1.86
A2? A2 + Bh?	-103	-	1	99	38	32	16	14	10	29	1.14
A'2	-118	-	tr	100	39	31	18	12	10	17	1.50
IIB'2t	-158	-	2	98	22	17	12	49	-	100	0.24
IIB'3t	-200+	-	tr	100	29	24	10	37	1	97	0.27

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.9	5.2	2.5	0.4	0.14	0.20	3.2	-	1.8	5.0	64	-
5.8	4.5	0.8	0.2	0.10	0.03	1.1	-	1.5	2.6	42	-
5.6	4.2	0.9	0.2	0.24	0.05	1.4	0.3	1.3	3.0	47	18
5.8	4.4	0.9	0.4	0.14	0.04	1.5	0.2	1.4	3.1	48	12
4.8	4.0	2.0	1.1	0.22	0.09	3.4	1.5	1.5	6.4	53	31
4.8	3.9	1.2	0.6	0.21	0.08	2.1	2.3	1.2	5.6	38	52

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
0.69	0.07	10	3.6	1.9	1.1	1.01	3.23	2.35	2.70	29
0.25	0.04	6	3.0	2.0	1.3	0.54	2.55	1.81	2.42	31
0.28	0.05	6	5.4	4.0	1.7	0.62	2.30	1.81	3.70	11
0.20	0.04	5	5.1	3.8	1.7	0.67	2.28	1.77	3.52	6
0.18	0.05	4	20.6	16.4	5.9	0.81	2.13	1.74	4.36	1
0.14	0.04	3	17.5	13.4	4.3	0.63	2.22	1.84	4.88	1

Clay B/A - 4.9 Weighted - 4.9

PROFILE Nº ISCW-BR 29
SAMPLE Nº 77.0817/22

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE	MS	MG	IL & TM	MC	RU & ZR	CN ARG	TN	HN	ST	CN HU
SANDS (2-.05 mm)												
Ap	100%	tr		tr	tr	tr	tr	tr	tr	tr		
A2	99%	1%		tr	tr		tr					
A2? A2+Bh?	99%	tr		tr	1%	tr	tr				tr	
A'2	100%	tr		tr	tr	tr	tr					
IIB'2t	100%	tr		tr	tr	tr	tr					tr
IIB'3t	100%	tr		tr	tr	tr	tr	tr				
GRAVELS (>2 mm)												
	90%	10%	tr									
	90%	5%		5%								
	97%	2%			1%							
	100%	tr										
	95%	5%										
	80%	10%	10%									

Mineral Code: QZ - quartz; CN FE - iron concretions;MS - muscovite; MG - magnetite; MC - microcline;
RU - rutile; ZR - zircon; CN ARG - argillaceous concretions; TN - titanite; HN - hornblende;
ST - staurolite; CN HU - humous concretions

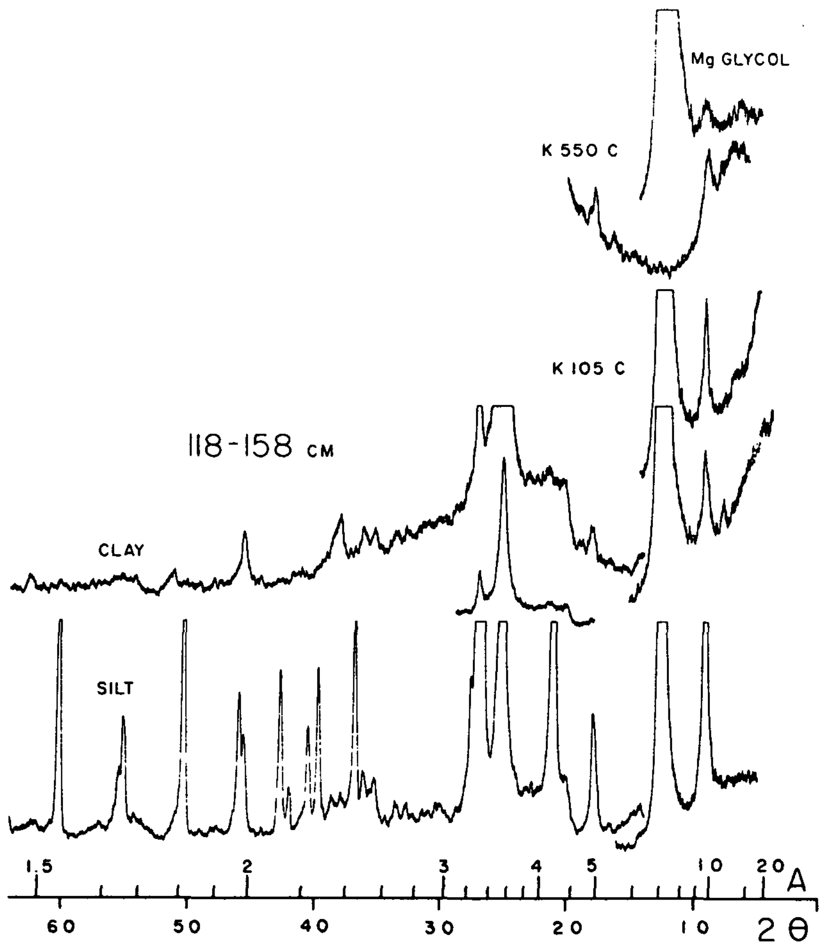

Fig. 75 - X-Ray diffraction patterns of the clay and silt from IIB'2t horizon of the profile BR-29.

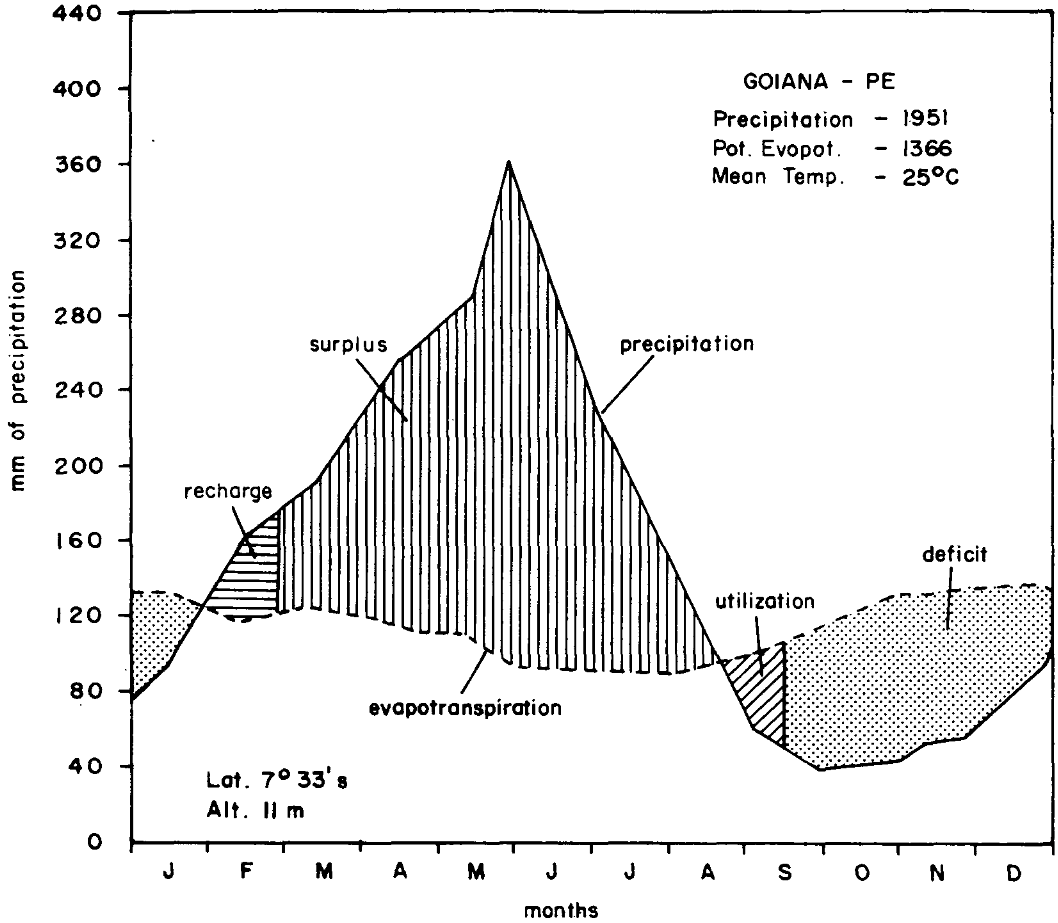

Fig. 76 - Water balance according to Thornthwaited & Mather, 1955 (125 mm), for geographic region related to profiles BR-29 BR-30 and BR-31.

Discussion

1. The profile studied by the group was not at exactly the same location as the profile described.

2. The mottled horizon with variegated colors in the subsoil is not plinthite but has the "ferric" characteristics of pedons BR 19 and 27 (Comerma).

3. A major point of discussion was the presence of a thick, sandy to coarse loamy epipedon. The question was raised whether the thick, coarse-textured layer froms a pedogenetic continuum with the underlying clayey horizon, or whether it is a younger deposit over a buried argillic horizon. Arnold, Paramananthan, Moormann, Juo, Dudal and others saw a lithologic discontinuity and would hence classify the pedon on the basis of the upper layer. Buol, Nichols and McClelland thought that the coarse layer and the clayey subsoil are genetically related and that the classification should be based on the deep argillic horizon. The deep, coarse textured epipedon would be recognized as an arenic subgroup. A similar discussion has been going on in the U.S. with respect to arenic and grossarenic subgroups of, e.g., Paleudults in the southeastern U.S.

4. The alternatives for classification based on the discussion are:

   (a) If there is <u>no</u> discontinuity : Arenic Ferric Paleudult or Arenic Ferric Kandiudult (Comerma) depending which limit for CEC per 100 g clay is taken as diagnostic

(b) If there is a discontinuity : Dystropept with no satisfactory subgroup as presently defined in Soil Taxonomy (p. 258). The subgroup might be "alfic" in analogy to Alfic Udipsamments (Soil Taxonomy, p. 206) in view of the presence of lamellae with clay illuviation.

5. In the FAO/Unesco legend this soil would be a Luvic Arenosol or an Acric Arenosol if such a unit is to be established (Dudal).

PROFILE ISCW-BR 30 DESCRIBED AND SAMPLED - 11 Feb 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO argila de atividade baixa abrúptico A moderado textura arenosa/média fase floresta tropical subperenifólia relevo plano (RED-YELLOW PODZOLIC ALIC*, low clay activity, abruptic, moderate A horizon, sandy/loamy, semi-evergreen tropical forest level phase).

Typic Paleudult (no consensus); fine loamy, mixed, isohyperthermic.

Dystric Planosol.

Sol ferrallitique; moyennement désaturé, appauvri, hydromorphe intergrade avec lessivé-podzolisé, dérivé de formation Barreiras.

LOCATION - Goiana, PE. Itapirema Experimental Station - Cashew experimental field; 7°37'30" S 34°57'30" W.

TOPOGRAPHIC POSITION - Trench on level top of low plateau (tableland), under recently plowed field; level; 80 meters.

PRIMARY VEGETATION Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Sandy and sandy clay sediments, Barreiras Group, Tertiary; weathered sediments.

DRAINAGE - Moderately well drained.

PRESENT LAND USE - Cashew and sugarcane experimental field.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.0	26.0	25.9	25.4	24.8	23.8	23.3	23.3
P mm	95	163	196	256	287	364	240	152
	Sept	Oct	Nov	Dec				
T°C	24.5	25.2	25.7	25.9	Mean	25.0		
P mm	61	39	43	55	Total	1951		
		Isohyperthermic			Udic			

Ap - 0 - 15 cm, dark grayish brown (10 YR 4/2, moist); sand; weak fine to medium granular; many fine and very fine, and few coarse pores; very friable, nonplastic and nonsticky; clear and smooth boundary.

A2 - 15 - 38 cm, brown (10 YR 5/3, moist); loamy sand; weak fine subangular blocky; many very fine and fine, and few coarse pores; very friable, nonplastic and nonsticky; clear and smooth boundary.

B21t - 38 - 62 cm, pale brown (10 YR 6/3, moist), abundant fine to medium and prominent mottles of yellowish red (5 YR 5/6, moist); sandy clay loam; weak fine subangular and angular blocky; common very fine and fine, and few coarse pores; firm, slightly plastic and slightly sticky; clear and wavy boundary (18-28 cm).

* Endoeutrophic.

B22t - 62 - 82 cm, light yellowish brown (10 YR 6/4, moist); sandy clay loam; weak fine subangular and angular blocky; many very fine and fine pores; firm, friable, slightly plastic and slightly sticky; abrupt and wavy boundary (18-25 cm).

B23t - 82 - 125 cm, brownish yellow (10 YR 6/6, moist), few medium and distinct mottles of brownish yellow (10 YR 6/8, moist) and in the upper part of the horizon prominent spots dark reddish brown (2.5 YR 3/4, moist) corresponding to iron concentration; sandy clay; weak fine subangular and angular blocky; many very fine and fine pores; friable, slightly plastic and slightly sticky; enclosed in this matrix are found slightly porous, firm nodules; clear and wavy boundary (42-48 cm).

B24 - 125 - 142 cm, reddish yellow (7.5 YR 6/6, moist), few medium and coarse prominent mottles of dark reddish brown (2.5 YR 3/4, moist) corresponding to semi-hardened iron concretions; sandy clay; weak fine subangular and angular blocky; many very fine and fine pores; friable, slightly plastic and slightly sticky; enclosed in this matrix are found slightly porous, firm to extremely firm nodules; clear and wavy boundary (10-18 cm).

B25 - 142 - 190 cm, reddish yellow (7.5 YR 6/6, moist); sandy clay; very weak fine subangular and angular blocky; many very fine and fine pores; friable, slightly plastic and slightly sticky; enclosed in this matrix are found slightly porous, firm nodules; diffuse and smooth boundary.

B26 - 190 - 220 cm^+, reddish yellow (5 YR 6/6, moist), few medium and prominent mottles of dark red (2.5 YR 3/6, moist); sandy clay; very weak fine subangular and angular blocky; friable, slightly plastic and slightly sticky.

REMARKS - Common roots in Ap, A2, few in B21t and very few downward.

Presence of coal in Ap and A2.

Profile fairly moist.

PROFILE Nº ISCW-BR 30
SAMPLE Nº 77.0823/30 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2 mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 15	-	1	99	69	22	3	6	4	33	0.50
A2	- 38	-	1	99	64	22	4	10	6	40	0.40
B21t	- 62	-	1	99	43	22	4	31	24	23	0.13
B22t	- 82	-	1	99	43	21	4	32	27	16	0.13
B23t	-125	-	tr	100	40	17	4	38	26	32	0.13
B24	-142	-	2	98	41	17	5	37	14	62	0.14
B25	-190	-	1	99	39	18	6	37	-	100	0.16
B26	-220+	-	1	99	40	17	6	37	-	100	0.16

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.7	4.7	0.9	0.2	0.03	0.03	1.2	-	1.5	2.7	44	-
5.4	4.3	0.5		0.03	0.03	0.6	0.2	1.1	1.9	32	25
5.0	4.2	0.5		0.02	0.03	0.6	0.5	1.8	2.9	21	45
5.0	4.2	0.5		0.03	0.03	0.6	0.5	1.6	2.7	22	45
5.1	4.3	0.6		0.03	0.04	0.7	0.8	1.8	3.3	21	53
5.0	4.3	0.6		0.03	0.03	0.7	0.7	1.9	3.3	21	50
5.0	4.3	0.4		0.02	0.04	0.5	0.6	1.4	2.5	20	55
5.0	4.3	0.2		0.02	0.03	0.3	0.6	1.2	2.1	14	67

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
0.53	0.06	9	3.1	2.5	0.6	0.44	2.11	1.83	6.45	1
0.41	0.04	10	4.5	3.4	0.6	0.51	2.25	2.02	8.76	1
0.39	0.04	10	12.6	11.2	1.6	1.06	1.91	1.75	10.98	1
0.37	0.04	9	12.7	11.5	1.4	1.08	1.88	1.74	12.81	<1
0.37	0.04	9	15.9	14.6	1.7	1.23	1.85	1.72	13.50	1
0.35	0.04	9	16.1	14.9	2.2	1.14	1.84	1.68	10.59	<1
0.30	0.03	10	16.8	15.3	1.7	1.10	1.87	1.74	14.15	<1
0.21	0.03	7	17.1	15.6	1.7	1.11	1.86	1.74	14.42	<1

Clay B/A - 4.2 Weighted - 4.3

PROFILE Nº ISCW-BR 30
SAMPLE Nº 77.0823/30

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE	CN ARG	TM	MG & IL	RU, ZR & ST	OF	MS & BT	CN HU
SANDS (2-.05 mm)									
Ap	99%		tr	1%	tr	tr	tr	tr	
A2	99%	tr	tr	1%	tr	tr	tr		
B21t	99%	tr	tr	1%	tr	tr	tr		
B22t	99%	tr	tr	1%	tr	tr	tr		
B23t	99%		tr	1%	tr	tr			
B24	96%	2%	tr	1%	1%	tr			
B25	99%	tr	tr	1%	tr	tr			
B26	99%		tr	1%	tr				
GRAVELS (>2 mm)									
	95%	5%			tr				tr
	95%	5%	tr	tr					
	95%	5%	tr		tr				
	95%	5%	tr						
	93%	7%	tr						
	15%	85%	tr						
	79%	1%	20%						
	98%	1%	1%						

Mineral Code : QZ - quartz; CN FE - iron concretions; CN ARG - argillaceous concretions; TM - tourmaline; MG - magnetite; IL - ilmenite; RU - rutile; ZR - zircon; ST - staurolite; OF - organic fragments; MS - muscovite; BT biotite; CN HU - humous concretions

SOIL CLASSIFICATION-INTERNATIONAL SOIL CLASSIFICATION WORKSHOP
BRAZILIAN SOIL
SERIES - - - - - - -

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, MTSC
NATIONAL SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA

SOIL NO - - - - - - - ISCW-BR30   COUNTY - - -

GENERAL METHODS- - -1A,1B1B,2A1,2B   SAMPLE NOS. 77P1273-77P1277   DECEMBER 1977

DEPTH CM	HORIZON	SAND 2-.05	SILT .05-.002	CLAY LT .002	FINE CLAY LT .0002	VCOS 2-1	CORS 1-.5	MEDS .5-.25	FNES .25-.10	VFNS .10-.05	COSI .05-.02	FNSI .02-.002	VFSI .005-.002	SAND 2-.1	INTR II .2-.02	FINE CLAY TO CLAY PCT	NON-CO3-CLAY PCT	RATIO 8D1 15-BAR TO CLAY
		(- - - PARTICLE SIZE ANALYSIS, LT 2MM, 3A1, 3A1A, 3A1B - - -) PCT LT 2MM				SAND					SILT							
0-15	AP	91.4	2.9	5.7		4.4	23.9	26.6	30.9	5.6	1.3	1.6		85.8				.53
15-38	A2	86.0	3.1	10.9		4.2	20.5	22.2	30.6	8.5	3.1	TR		77.5				.39
38-62	B21T	65.6	1.8	32.6		3.5	16.9	16.4	21.7	7.1	1.8	TR		58.5				.34
62-82	B23	58.0	6.9	35.1		3.6	15.5	14.5	16.6	7.8	4.5	2.4		50.2				.36
190-220	B3	59.9	8.9	31.2		3.4	15.4	14.2	18.8	8.1	5.7	3.2		51.8				.37

DEPTH CM	VOL. GT 2 PCT	GT 75 PCT	75-20	20-5	5-2	LT .074	20-2 PCT LT20	4A1D 1/3-BAR G/CC	4A1H OVEN DRY G/CC	4D1 COLE	4B1C 1/10 BAR PCT	4B1C 1/3-BAR PCT	4B2 15-BAR PCT	4C1 WRD CM/CM	PH 8C1C 1/1 KCL	CARBONATE 6E1B LT 2 PCT	CARBONATE 3A1A LT .002 PCT	PH 8C1A 1/1 H2O	PH 8C1E 1/2 CACL
	(PARTICLE SIZE ANALYSIS, MM, 3B, 3B1, 3B2)	(- - - WEIGHT - - -)	(- - - PCT LT 75 - - -)					(BULK DENSITY)			(- - - WATER CONTENT -)								
0-15													3.0		4.5			5.4	4.6
15-38													4.2		4.2			5.2	4.4
38-62													11.1		4.0			4.7	4.2
62-82													12.6		4.1			4.8	4.3
190-220													11.6		4.2			5.0	4.3

DEPTH CM	ORGANIC MATTER 6A1A ORGN CARB PCT	ORGANIC MATTER 6B1A NITG PCT	C/N	IRON 6C2B EXT FE PCT	PHOS TOTL PCT	EXTRACTABLE BASES 5B4A 6N2E CA	6O2D MG	6P2B NA	6Q2B K	SUM EXTB	ACTY 6H1A BACL TEA	AL 6G1E KCL EXT	CAT EXCH 5A3A EXTB ACTY	CAT EXCH 5A6A NHAC	RATIO 8D1 NHAC TO CLAY	RATIO 8D3 CA TO MG	CA 5F1 SAT NHAC PCT	BASE SAT 5C3 EXTB ACTY PCT	BASE SAT 5C1 NHAC PCT
						(- - - MEQ / 100 G - - -)													
0-15	.69	.035	20	.2		1.1	.1	.0	.1	1.3	2.0	TR	3.3	3.4	.70	11.0	28	39	38
15-38	.47	.025	19	.2		.5	.1	.0	TR	.6	2.2	.1	2.8	3.2	.29	5.0	16	21	19
38-62	.40	.017	24	.8		.4	.3	.0	.1	.8	4.1	.4	4.9	4.8	.15	1.3	8	16	17
62-82	.35			.7		.4	.3	.0	.1	.8	5.2	.8	6.0	4.8	.14	1.3	8	13	17
190-220	.20			.8		.1	.1	.0	TR	.2	3.4	.6	3.6	3.5	.15	1.0	2	6	6

DEPTH CM	SATURATED PASTE 8E1 REST OHM-CM	SATURATED PASTE 8C1B PH	8A H2O PCT	NA 5D2 ESP PCT	NA 5E SAR	SALT 8D5 TOTL SOLU PPM	GYP 6F1A PCT	8A1A EC MMHOS/CM	6N1B CA	6O1B MG	6P1B NA	6Q1B K	6I1A CO3	6J1A HCO3	6K1A CL	6L1A SO4	6M1A NO3	ATTERBERG 4F1 LQID LMIT PCT	ATTERBERG 4F2 PLST INDX
								(- - - SATURATION EXTRACT 8A1 - - -)	(- - - MEQ / LITER - - -)										
0-15	15000	5.3																	
15-38																			
38-62																			
62-82																			
190-220	29000	4.9																	

SAND MINERALOGY (7B1)   PLACEMENT: SILICEOUS.
038-062 VFNS - RE97 QZ97 MI1 KY1 HN1
RELATIVE AMOUNTS: AS PERCENT
MINERAL CODE: RE = RESISTANT MINERALS HN = HORNBLENDE QZ = QUARTZ MI = MICA KY = KYANITE.

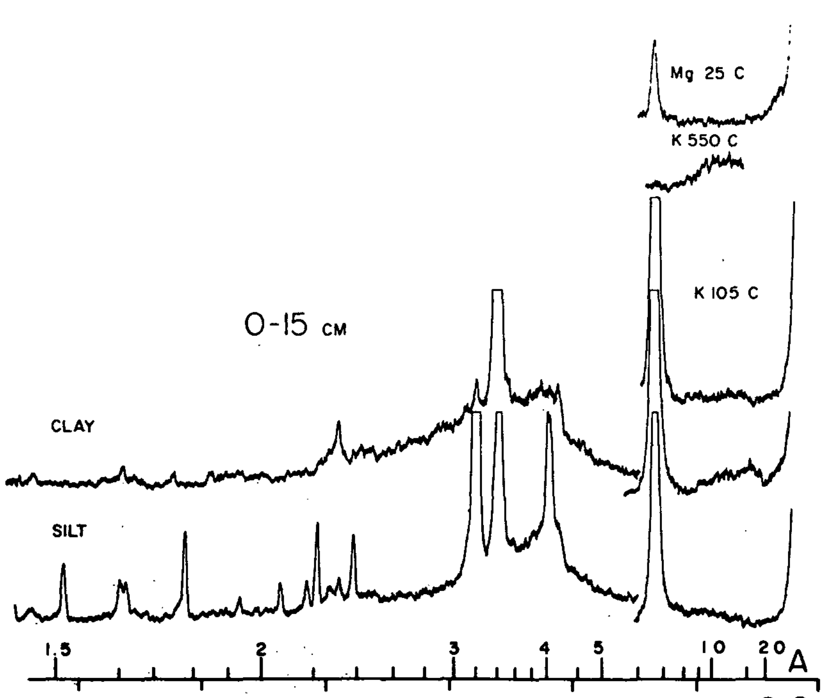

Fig. 77 - X-Ray diffraction patterns of the clay and silt from Ap horizon of the profile BR-30.

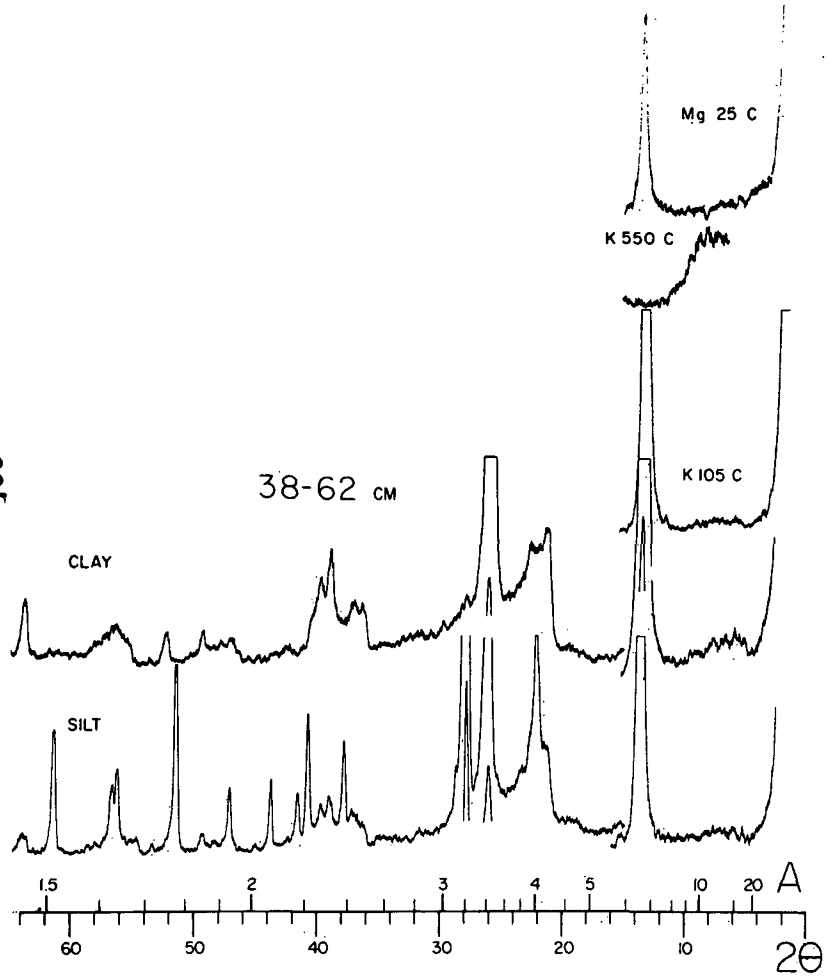

Fig. 78 - X-Ray diffraction patterns of the clay and silt from B21t horizon of the profile BR-30.

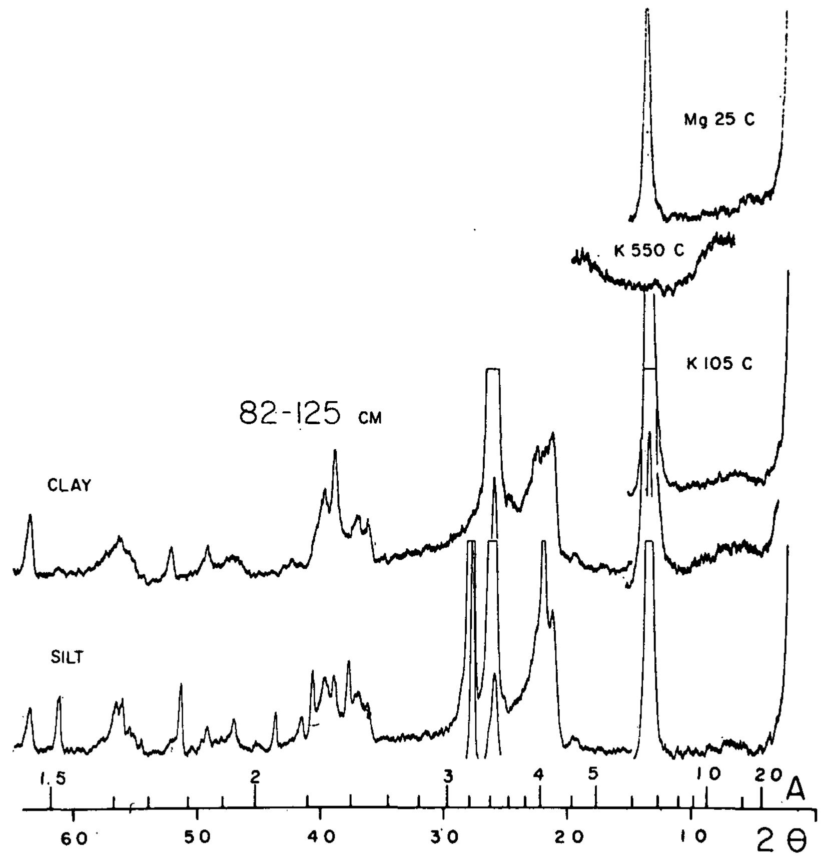

Fig. 79 - X-Ray diffraction patterns of the clay and silt from B23t of the profile BR-30.

Discussion

1. This soil and pedon BR 31 are developed in sandy to clayey sediments and show great similarities with soils found elsewhere in warm humid climates. There they are formed on late Tertiary to early Pleistocene sediments which at their time of deposition already had low contents of weatherable minerals. Such soils were reported to occur in the coastal plains of the southeastern U.S. (Buol) and southeastern Nigeria (Moormann); they possibly also occur in the Congo Basin and on older terraces in Southeast Asia.

2. The profile has an increase in clay from the A to B horizon of more than 1.4 and a low CEC of the clay fraction throughout the profile. No cutans or clay bridges were visible in the field. In the committee's parlance this soil would still be a Kandiudult, with the annotation that it is clearly on the borderline to Oxisols.

3. There was considerable discussion on the pedegenetic development of the upper horizons and the formation of a poorly permeable layer below the A horizon, characterised by a thin layer of Fe accumulation which, however, is not sufficiently consolidated to be called a placic horizon. The influence on soil quality and management for sugarcane is considerable; this particular soil is less productive and has drainage problems.

4. The possibility of clay breakdown (ferrolysis) in the upper horizon was discussed. Bennema was of the opinion that, genetically, this soil is a degraded Oxisol with a "leached" albic horizon and a thin horizon of Fe accumulation superimposed on the original Oxisol profile. It was agreed that the Fe segregation in this pedon is insufficient for a plinthic subgroup, even as regards the B24 horizon which has

many semi-hardened Fe concretions.

5. No consensus was reached regarding the subgroup. Buol and McClelland favored a typic subgroup while others felt that the superficial changes are, at least in part, management induced and should be recognized at a lower level (e.g., series). The Al saturation at 150 cm depth is more than 50 percent which, according to some participants, should be required for the typic subgroup. The clay activity in the upper part of the B horizon is low enough for Buol's concept of "Kandi". Others felt that the impeded permeability due to alteration in the surface and subsurface horizons should be reflected at the subgroup level. This soil may be in an epiaquic subgroup (Camargo, Bennema, Dudal, Leamy, Moormann) on the condition that the definition include the characteristics of this pedon. Another possibility is to recognize the ferrolysis process in the subgroup nomenclature but no name was proposed. Sombroek opined that if there is distinct ferrolysis, it should be recognized at a higher categoric level. Smith remarked that ferrolysis is, in fact, reflected at higher levels of Soil Taxonomy, e.g. in Albolls and Albaqualfs.

6. Dudal mentioned the similarities of this soil with the Planosols of the FAO/Unesco legend and classified the pedon as a Dystric Planosol.

PROFILE ISCW-BR 31 DESCRIBED AND SAMPLED - 6 apr 1977

CLASSIFICATION - PODZÓLICO VERMELHO-AMARELO ÁLICO argila de atividade baixa abrúptico A moderado textura arenosa/média fase floresta tropical subperenifólia relevo plano (RED-YELLOW PODZOLIC ALIC, low clay activity, abruptic, moderate A horizon, sandy/loamy, semi-evergreen tropical forest level phase).

Typic Paleudult (non consensus); fine loamy, mixed isohyperthermic.

Dystric Planosol.

Sol ferrallitique; fortement désaturé, appauvri, hydromorphe intergrade avec léssivé-podzolisé, dérivé de formation Barreiras.

LOCATION - Goiana, PE. Itapirema Experimental Station, extreme N of area (EMBRAPA); 7°37'30" S 34°57'30" W

TOPOGRAPHIC POSITION - Trench on level top of low plateau (tableland), 0-2% slope, recently plowed field; level; 55 meters.

PRIMARY VEGETATION - Semi-evergreen tropical forest.

GEOLOGY AND PARENT MATERIAL - Sandy and sandy clay sediments, Barreiras Group, Tertiary; weathered sediments.

DRAINAGE - Moderately well drained ?

PRESENT LAND USE - Field plowed for experiment.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
T°C	26.0	26.0	25.9	25.4	24.8	23.8	23.3	23.3
P mm	95	163	195	256	287	364	240	152
	Sept	Oct	Nov	Dec				
T°C	24.5	25.2	25.7	25.9	Mean	25.0		
P mm	61	38	43	55	Total	1951		
		Isohyperthermic			Udic			

Ap - 0 - 25 cm, dark brown (10 YR 3/3, moist), grayish brown (10 YR 5/2, dry); loamy sand; weak fine to medium granular; many very fine and fine, and few medium and coarse pores; soft, friable, nonplastic and nonsticky; clear and level boundary.

A3 - 25 - 46 cm, dark brown (10 YR 4/3, moist), pale brown (10 YR 6/3, dry); sandy loam; weak fine subangular and angular blocky; many very fine and fine, and few medium and coarse pores; slightly hard, very friable, nonplastic and nonsticky; clear and wavy boundary (20-23 cm).

B1t - 46 - 65 cm, brownish yellow (10 YR 6/5, moist), many fine and prominent mottles of strong brown (7.5 YR 5/6, moist) and many fine and medium distinct mottles of yellowish brown (10 YR 5/4, moist); sandy clay loam; weak fine subangular and angular blocky; common very fine and few fine and medium pores; extremely hard, firm, plastic and slightly sticky; gradual and level boundary.

B21t - 65 - 110 cm, yellowish brown (10 YR 5/4, moist); sandy clay loam; weak fine subangular and angular blocky; common very fine and few fine medium and coarse pores;very hard, friable, plastic and slightly sticky; diffuse and smooth boundary.

B22 - 110 - 155 cm, yellowish brown (10 YR 5/5, moist), few medium and prominent mottles of dark reddish brown (2.5 YR 3/4, moist) corresponding to semi-hardened iron concretions; sandy clay loam; very weak fine subangular and angular blocky; common very fine and fine, and few medium and coarse pores; very friable, plastic and slightly sticky; diffuse and smooth boundary.

B23 - 155 - 200 cm$^+$, brownish yellow (10 YR 6/7, moist); sandy clay loam; very fine subangular and angular blocky and very fine subangular blocky appears massive porous in place; many very fine and fine pores; very friable, plastic and slightly sticky.

REMARKS - Common roots in Ap, few in A3 and very few downward.

Presence of coal mainly in Ap, and also in Bit, B21t and B22.

Intense ants activity in Ap.

PROFILE Nº ISCW 31

SAMPLE Nº 77.0811/15 SNLCS

HORIZON	DEPTH cm	GRAVEL >20 mm %	GRAVEL 20-2mm %	FINE EARTH < 2mm %	PARTICLE SIZE ANALYSIS NaOH ~~CALGON~~ % CORS 2-.20 mm	FNES .20-.05 mm	SILT .05-.002 mm	CLAY <.002 mm	WATER DISP CLAY %	FLOC DEGREE %	SILT / CLAY
Ap	0- 25	-	1	99	62	23	3	12	6	50	0.25
A3	- 46	-	1	99	59	23	3	15	8	47	0.20
B1t	- 65	-	tr	100	44	21	4	31	22	29	0.13
B21t	-110	-	tr	100	43	21	5	31	20	35	0.16
B22	-155	-	tr	100	42	21	5	32	4	88	0.16
B23	-200+	-	tr	100	46	19	4	31	-	100	0.13

pH (1:2.5) H2O	pH (1:2.5) KCL N	EXTRACTABLE BASES mE/100g Ca++	Mg++	K+	Na+	SUM EXTR	EXTB ACTY mE/100g Al+++	H+	CAT EXCH mE/100g	BASE SAT %	100.Al+++ / Al+++ +S
5.0	4.2	0.8		0.03	0.03	0.9	0.3	2.4	3.6	25	25
4.8	4.2	0.2		0.03	0.03	0.3	0.3	2.3	2.9	10	50
4.8	4.1	0.2		0.02	0.03	0.3	0.7	2.3	3.3	9	70
4.8	4.1	0.2		0.03	0.04	0.3	0.7	2.2	3.2	9	70
4.8	4.2	0.3		0.03	0.04	0.4	0.6	1.8	2.8	14	60
4.9	4.3	0.3		0.03	0.04	0.4	0.5	1.4	2.3	17	56

ORG C %	N %	C / N	ATTACK BY H2SO4 (d=1.47) Na2CO3 (5%) % SiO2	Al2O3	Fe2O3	TiO2	SiO2 / Al2O3 (MOLECULAR RATIO)	SiO2 / R2O3 (MOLECULAR RATIO)	Al2O3 / Fe2O3 (MOLECULAR RATIO)	AVLB PHOS ppm
0.64	0.07	9	4.8	4.2	1.2	0.52	1.94	1.64	5.49	3
0.44	0.06	7	6.3	5.6	1.0	0.66	1.91	1.72	8.71	2
0.38	0.05	8	12.9	11.6	1.8	1.01	1.89	1.72	10.06	1
0.32	0.04	8	12.6	11.5	1.7	1.00	1.86	1.70	10.63	1
0.26	0.03	9	13.3	12.2	2.0	1.06	1.85	1.68	9.57	1
0.19	0.03	6	13.5	12.5	1.8	1.01	1.84	1.68	10.84	1

Clay B/A - 2.2 Weighted - 2.4

PROFILE Nº ISCW-BR 31
SAMPLE Nº 77.0811/16

OPTICAL MINERALOGIC ANALYSIS

SNLCS

HORIZON	QZ	CN FE & CN ARG	MC	TM, IL RU & ZR	IL	OF	ST & KY	BT & MS
				SANDS (2-.05 mm)				
Ap	100%			tr	tr	tr		tr
A3	100%	tr		tr	tr	tr	tr	tr
B1t	99%	tr		1%	tr		tr	tr
B21t	99%	tr		1%			tr	tr
B22	99%	tr		1%		tr		tr
B23	99%			1%				
				GRAVELS (>2 mm)				
	96%	2%	2%			tr		
	96%	2%	2%					
	98%	2%						
	98%	2%	tr					
	65%	35%				tr		
	100%	tr						

Mineral Code: QZ - quartz; CN FE - iron concretions; CN ARG - argillaceous concretions; MC - microcline;
TM - tourmaline; IL - ilmenite; RU - rutile;; ZR - zircon; OF - organic fragments;
ST - staurolite; KY - kyanite; BT - biotite; MS - muscovite

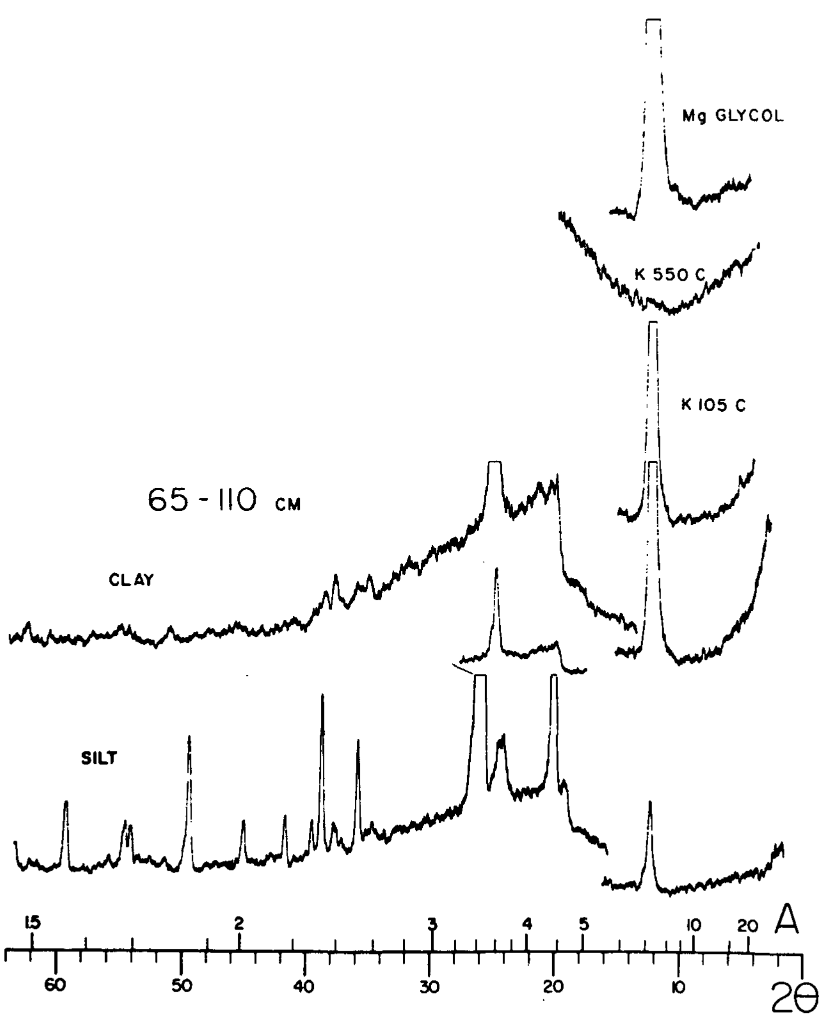

Fig. 80 - X-Ray diffraction patterns of the clay and silt from B21t horizon of the profile BR-31.

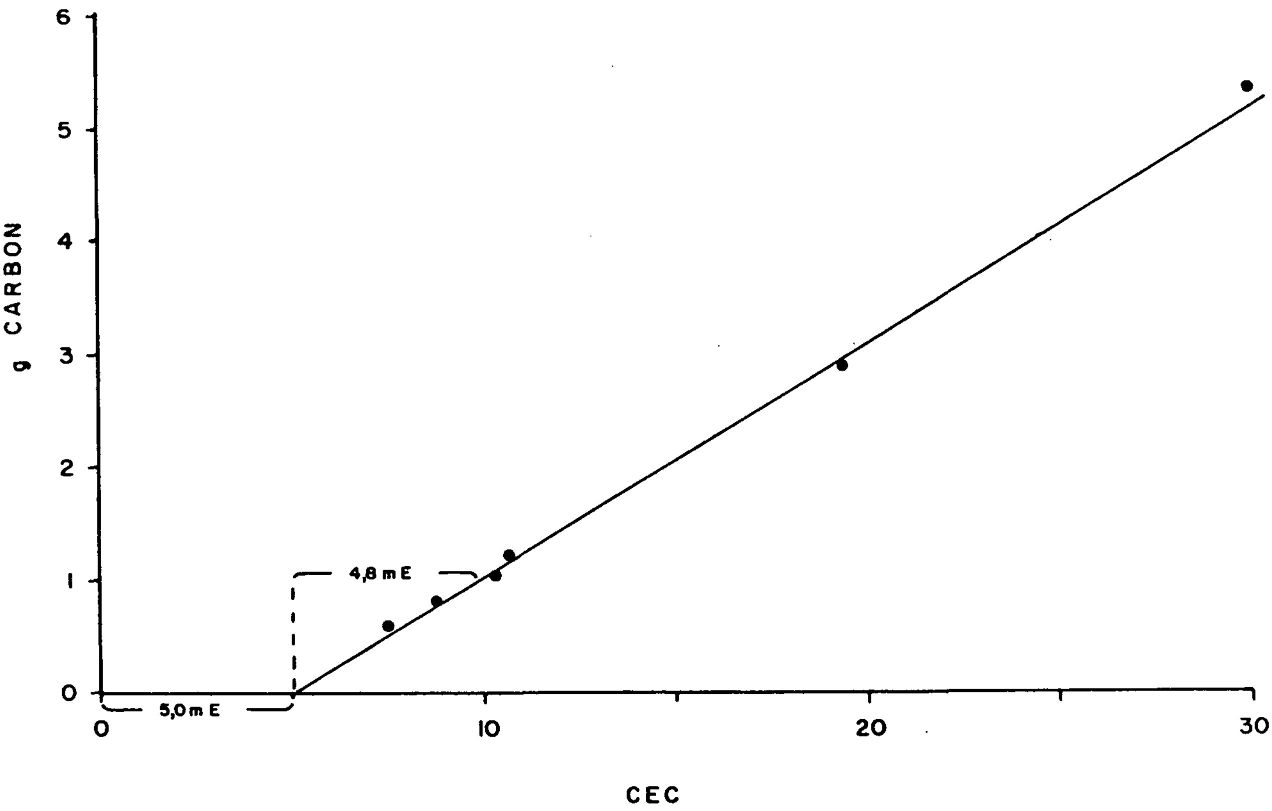

Fig. 81 - Carbon and CEC relation to 100 g clay, by graphic method (Bennema, 1966). Profile BR-31.

Discussion

1. This soil has a somewhat thicker, sandy to coarse loamy epipedon and a less abrupt transition from the A to B horizon. The accumulation of Fe is less clear. The management of this soil is somewhat easier than that of pedon BR 30 and crop performance is better. In places outside the station, where no dense B1 horizon is present, sugarcane produces up to 50 percent more under the same level of management.

2. Discussion at this pit followed the same lines as at the preceding one. Leamy proposed a tentative classification as Epiaquic Kandiudult for this soil and for BR 30.

3. Beinroth suggested the introduction of a "planic" subgroup in view of the fact that epiaquic subgroups are already defined on different rationales and because of the similarity with Planosols.

4. No firm consensus regarding the genesis and the classification of the last two pedons was reached. The salient points of the discussion were:

- are these soils Ultisols or (degraded) Oxisols,
- is the degradation of the surface soil due to the process of ferrolysis and, if so, should this be recognized in the classification,
- is there an abrupt transition the A horizon to the B or an albic horizon and, if so, at what level of classification should the "planosolic" characteristic be reflected, and

- are there sufficient indications of impeded surface drainage to assume an "epiaquic" condition and, if so, can the definition of the epiaquic subgroups be changed to cover the present situation.

TABLE 1 . DOMINANT MINERALOGY OF THE CLAY AND SILT FRACTIONS OF SOME SOILS OF BRAZIL
SUMMARY DATA

ISCW Profile	Horizon	Depth	Kaolinite		Mica		Inter-stratified		X-ray amorphous		Quartz	
		cm	clay	silt	clay	silt	clay	silt	clay	silt	clay	silt
BR-1	B2	40-125	4x	2x	1x	1x	2x	1x	1x	--	tr	2x
BR-2	Ap	0-10	4x	3x	1x	1x	1x	tr	1x	--	tr	1x
	A3	10-40	4x	3x	tr	--	1x	--	1x	--	--	1x
	B1t	40-80	4x	2x	1x	tr	1x	--	1x	--	--	2x
BR-3	Ap1	0-33	4x	2x	1x	1x	1x	1x	2x	--	--	2x
	IIB21t	73-113	4x	3x	tr	1x	1x	1x	2x	--	--	tr
BR-4	Ap	0-11	3x	1x	--	--	1x	1x	1x	--	--	2x
	B22t	77-110	3x	2x	--	--	tr	1x	1x	--	--	2x
BR-5	B21tg	51-90	4x	--	1x	1x	1x	--	1x	--	--	2x
BR-6	A p	0-15	3x	2x	tr	--	1x	--	2x	--	--	--
	B22t	74-154	3x	3x	tr	--	1x	--	2x	--	--	--
BR-7	Ap	0-18										
	B21	60-150	2x	2x	--	--	1x	tr	3x	--	--	--
BR-8	B21t	25-73	4x	3x	--	--	1x	--	1x	--	--	3x
BR-9	Ap1	0-16	4x	1x	--	--	1x	--	2x	--	--	3x
	B22t	47-78	3x	3x	--	--	1x	1x	1x	--	2x	3x
BR-10	Ap1	0-15	3x	2x	2x	2x	1x	1x	1x	--		
	IIIB21t	52-84	3x	2x	2x	2x	1x	1x	2x	--		

TABLE 1. DOMINANT MINERALOGY OF THE CLAY AND SILT FRACTIONS OF SOME SOILS OF BRAZIL (CONTINUED).
SUMMARY DATA

ISCW Profile	Horizon	Depth	Kaolinite		Mica		Inter-stratified		X-ray amorphous		Quartz	
		cm	clay	silt	clay	silt	clay	silt	clay	silt	clay	silt
BR-11	A1	0-10	3x	2x	2x	2x	1x	1x	1x	--		
	B22t	70-130	3x	2x	2x	2x	1x	1x	2x	--		
BR-12	B21t	44-130	3x	1x	--	--	2x	1x	2x	--	--	3x
BR-13	A1	0-16	4x	3x	--	--	tr	--	1x	--	tr	2x
	B22	75-230	3x	3x	--	--	1x	tr	1x	--	tr	2x
BR-14	B1	81-101	3x	2x	--	--	2x	2x	2x	--	--	3x
BR-15	B2	80-100	2x	tr	2x	2x	3x	3x	3x	1x	--	3x
BR-16	IIIB2t	60-88	3x	2x	2x	3x	2x	1x	2x	--	--	2x
BR-17	A1	0-20	3x	2x	2x	1x	2x	tr	2x	--	--	2x
	IIB2t	60-105	3x	2x	2x	2x	2x	1x	2x	--	--	tr
BR-18	IIBt	33-50	3x	2x	2x	2x	2x	3x	2x	--	--	tr
BR-19	A1	0-20	3x	1x	2x	1x	2x	--	2x	--	--	2x
	$IIB2_{tpl}$	38-52	3x	2x	2x	1x	2x	--	2x	--	--	tr
BR-20	B1t	95-112	3x	3x	--	--	--	--	3x	--	--	2x
BR-21	B2	90-130	3x	3x	--	--	--	--	3x	--	--	2x
BR-22	Ap	0-20	4x	3x	2x	3x	1x	tr	1x	--	--	--
	B22t	75-115	4x	3x	2x	2x	1x	--	1x	--	--	--

TABLE 1 . DOMINANT MINERALOGY OF THE CLAY AND SILT FRACTIONS OF SOME SOILS OF BRAZIL (CONTINUED).
SUMMARY DATA

ISCW Profile	Horizon	Depth	Kaolinite		Mica		Inter-stratified		X-ray amorphous		Quartz	
		cm	clay	silt	clay	silt	clay	silt	clay	silt	clay	silt
BR-23	Ap	0-22	4x	4x	--	--	1x	--	1x	--	--	1x
	B22t	102-154	4x	4x	--	--	1x	1x	2x	--	--	1x
BR-24	Ap	0-22	4x	1x	1x	1x	1x	--	1x	--	--	2x
	B22	100-170	4x	3x	1x	2x	1x	--	2x	--	tr	2x
BR-25	Ap	0-20	3x	4x	--	--	1x	--	2x	--	--	--
	B22t	105-150	4x	4x	--	--	1x	1x	1x	--	--	--
BR-27	IIBt	45-110	4x	3x	tr	tr	tr	--	2x	--	--	2x
BR-28	B21t	35-70	4x	3x	tr	tr	2x	2x	2x	--	--	tr
BR-29	IIB2tpl	118-158	4x	3x	1x	2x	1x	--	2x	--	--	2x
BR-30	Ap	0-15	3x	3x	--	--	1x	--	2x	--	--	1x
	B21t	38-62	3x	3x	--	--	1x	--	1x	--	--	1x
	B23t	82-125	3x	3x	--	--	1x	--	1x	--	--	1x
BR-31	B21t	65-110	3x	1x	--	--	--	--	3x	3x	--	2x

TABLE 1. DOMINANT MINERALOGY OF THE CLAY AND SILT FRACTIONS OF SOME SOILS OF BRAZIL (CONTINUED).
SUMMARY DATA

Remarks:

1. X-ray diffraction, including the preparation of the diffraction traces, was performed by S. P. Periaswamy, former Research Associate, Department of Agronomy and Soil Science, University of Hawaii, Honolulu.

2. Kaolinite may include small to moderate amounts of halloysite or disordered kaolin.

3. Interstratified minerals include vermiculite and the expanding 2:1 clay mineral(s) but not montmorillonite.

4. X-ray amorphous material is estimated by the degree of "hump" in the region of 15 through 40° 2θ (or approximately 2.2 through 6 A).

5. Estimate of the amount of minerals: 4x = dominant, 3x = large amount, 2x = moderate amount, 1x = small amount, tr = trace, and -- = not detected or not identified.

REPORT ON THE MICROMORPHOLOGY OF SELECTED BRAZILIAN PEDONS

H. Eswaran

To provide for a more complete characterization of the pedons studied in the field tour, favoring a better consideration of problems concerning diagnostic characteristics and taxonomy of the soils, core samples of upper and lower B horizon of selected pedons were collected for required micromorphological analysis.

Brief descriptions of the thin sections and interpretations pertaining to questions on classification are presented below.

PROFILE BR-4. TYPIC* PALEUSTULT (no consensus)

Micromorphological description

Sample 40 cm. B1t

The normal related distribution pattern (NRDP) is porphyric. Grains are medium to coarse sand sized quartz, heavily fractured. Some are runi-quartz with bright red sesquioxidic plasma infilling the grains. No other kinds of grains are present. Plasma is yellowish brown and plasmic fabric is essentially isotic with local inseptic.

Illuviation argillans (fig. 82) are very well expressed and occupy about 4% of the area. They are well oriented and thick. Some fine voids are completely plugged up by translocated clay.

Sample 150 cm. B23t

The NRDP is porphyric; quartz is still the only kind of grain and does not differ in morphology from the overlying horizon. Plasma is yellowish brown and locally there are few fine reddish staining with

* Subgroup not established.

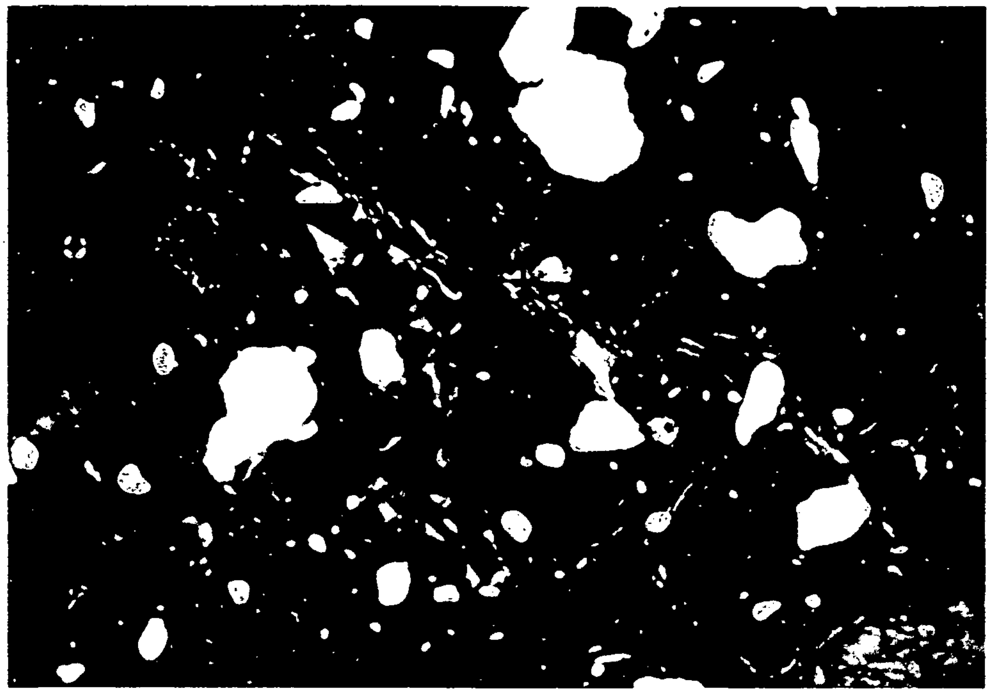

Fig. 82 - Thin section micrograph from Blt - sample 40 cm of profile BR-4 (crossed polarizers).

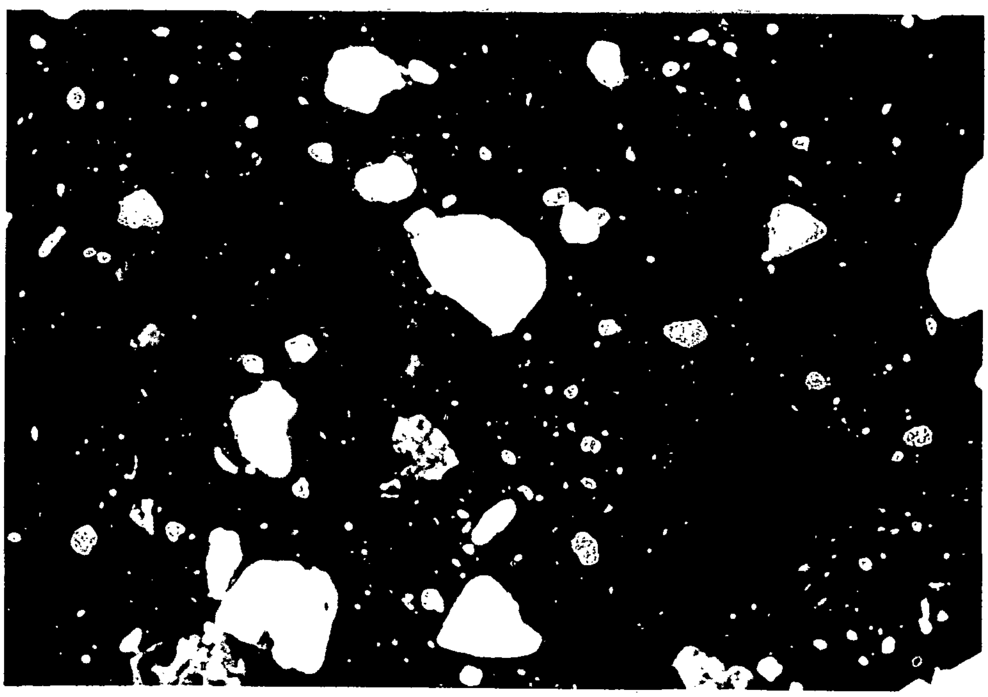

Fig. 83 - Thin section micrograph from B23t - sample 150 cm of profile BR-4 (crossed polarizers).

iron. Plasmic fabric is argillasepic, isotic (fig. 83).

There is very little evidence of accumulations of translocated clay. A few, very fine papules are present. The larger voids are free of argillans or have a very thin coating (fig. 83).

Interpretation

The two samples do not differ in fabric characteristics indicating similar material and so there is no micromorphological evidence for a lithological discontinuity. The material is essentially oxic as shown by the plasmic fabric. However, clay movement has or is taking place in this oxic material.

This is possibly recent as cutans are well formed, thick, and show no signs of disruption.

This is perhaps a case of an argillic horizon formed in oxic material. The lower horizon is essentially oxic and so the pedon is bisequual.

PROFILE BR-6. RHODIC PALEUDALF

Micromorphological description

Sample 65 cm. B21t

The NRDP is plasmic. Grains are very few and dominantly silt size quartz. Plasma is reddish brown and clearly distinguished from the cutans which are yellowish red. Plasmic fabric is argillasepic.

Illuviation argillans occupy about 8% of the area (fig. 84). They are thick and orientation is moderate. At high magnification they show a grainy appearance. In plain light and high magnification, they show splitting and other evidence of destruction.

Two kinds of papules are present. The first one due to clay illuviations plugging up fine voids. These occupy about 6% of the area and have similar morphology as the argillans. Stages of destruction are also evident. The second kind are present as small pseudomorphs of biotite. These are present as small white flakes (fig. 84) and are quite frequent.

Sample 145 cm. B22t

This horizon is actually saprolite. Relict rock structure is very evident (fig. 85). The matrix is composed of kaolinite pseudomorphs of biotite which are white in color (fig. 85) with reddish plasma around. The NRDP is grani-porphyric. However, the pseudomorphs will disperse in water to clay size material and so the material will have high apparent clay content. The color of the plasma is variegated white and red.

Voids within the saprolite material are infilled with argillans. These are thick (fig. 85) and the orientation is slightly better than the overlying horizon. The grainy nature is still evident. The argillans occupy about 12% of the area. Papules are also frequent and occupy about 6% of the area. The papules are found both in very fine and very large voids indicating intense illuviations.

Interpretation

Clay illuviation is or was an intense process in this profile. Characteristically, the saprolite has more illuviation features than the solum. The nature of the argillans and papules clearly indicate that they are in a sense relict features. Beginning stages of fragmentation, the grainy appearance of the cutans and the absence of more yellowish argillans indicate that translocation was terminated some time ago and the cutans are beginning to be altered. This interpretation does not invalidate the presence of an argillic horizon.

The relatively high CEC of the soil could come from the pseudomorphs composed of completely or partially altered biotites. The pseudomorphs from the thin section study were considered to be kaolinitic, but could be halloysite as shown by the XRD of the silt (4.6 Å) and also by the study of Eswaran et alii (1976) on biotite weathering.

The profile also presents a conceptual problem. The B22t horizon has been shown to be saprolite. Does the clay decrease requirement for "Pale" also apply if the lower material is saprolite? As the saprolite is at shallow depths, clearly the soil is different from a Paleudalf which has

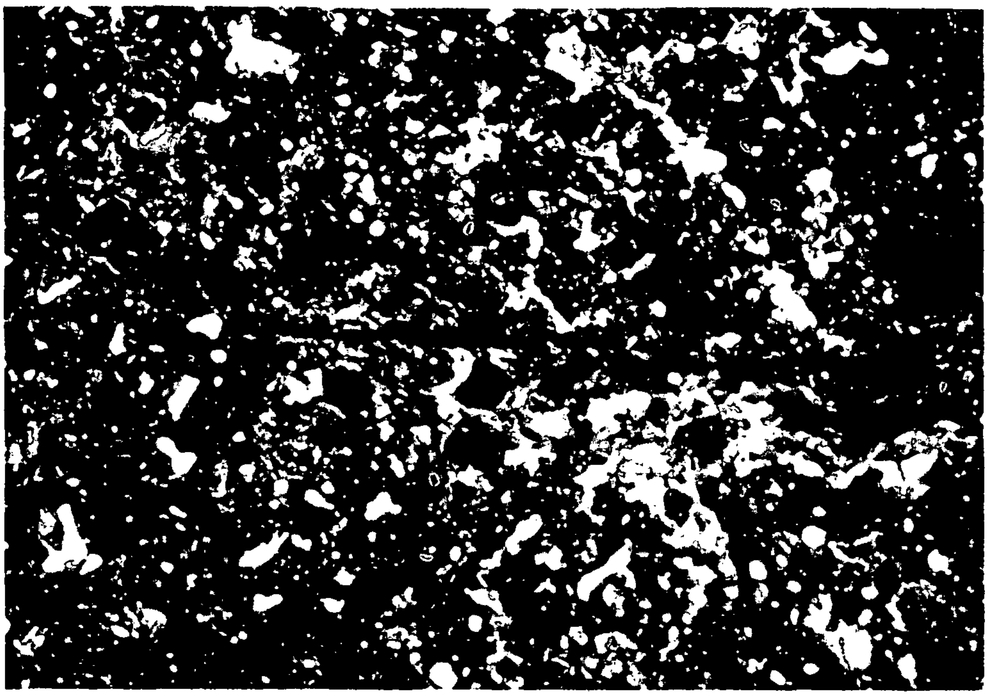

Fig. 84 - Thin section micrograph from B21t - sample 65 cm of profile BR-6 (crossed polarizers).

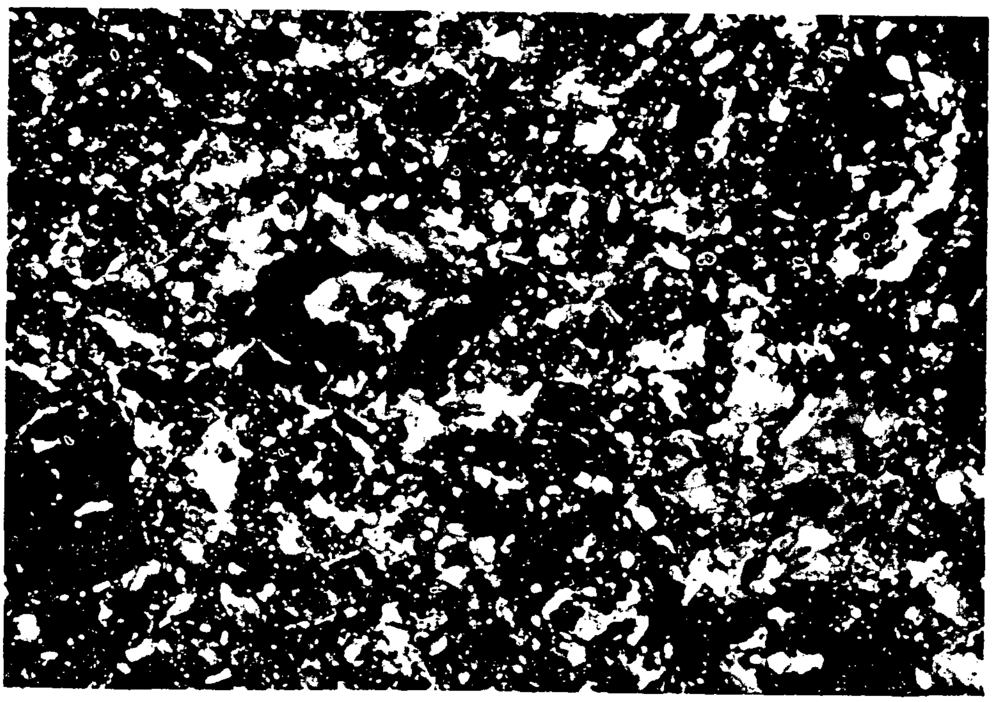

Fig. 85 - Thin section micrograph from B22t - sample 145 cm of profile BR-6 (crossed polarizers).

a deep argillic horizon. Nevertheless, the core sample was taken at 145 cm, coming near the transition B22t-B3t.

PROFILE BR-8. ORTHOXIC PALEHUMULT or RHODIC* PALEHUMULT or TROPEPTIC HAPLORTHOX

Micromorphological description

Sample 35 cm. B21t

The NRDP is porphyric. Plasma is brownish yellow and plasmic fabric is insepic-argillasepic. Under plain light, the plasma has a spongy aspect and there is a strong tendency to aggregation.

Most of the vughs and channels are free of coatings. In some vughs there is a thin layer of argillan (fig. 86). These are yellow in color and are not well oriented. The total area by point counting is 0.8% Incorporation of fragments of argillans into the s-matrix has taken place. These are also few and localized.

Few, fine sesquioxidic nodules are present. They have sharp boundaries and are probably inherited.

Sample 110 cm. B22t

The NRDP is plasmi-porphyric (fig. 87). The grains are dominantly quartz with few reddish pseudomorphs of some ferro-magnesium mineral, probably augite. Few, fine muscovite flakes are scattered in the s-matrix. The plasma is reddish yellow. The plasmic fabric is in-skelsepic, argillasepic. There is a slight tendency for the plasma to aggregate together.

Very thin coatings on a few voids are the only evidence of clay translocation. There are no papules. Few, fine sesquioxidic nodules are the only other pedological feature.

Interpretation

The upper horizon appears to have some admixtures. Clay translocation is not an important process and there is nothing to suggest that

* Subgroup not established.

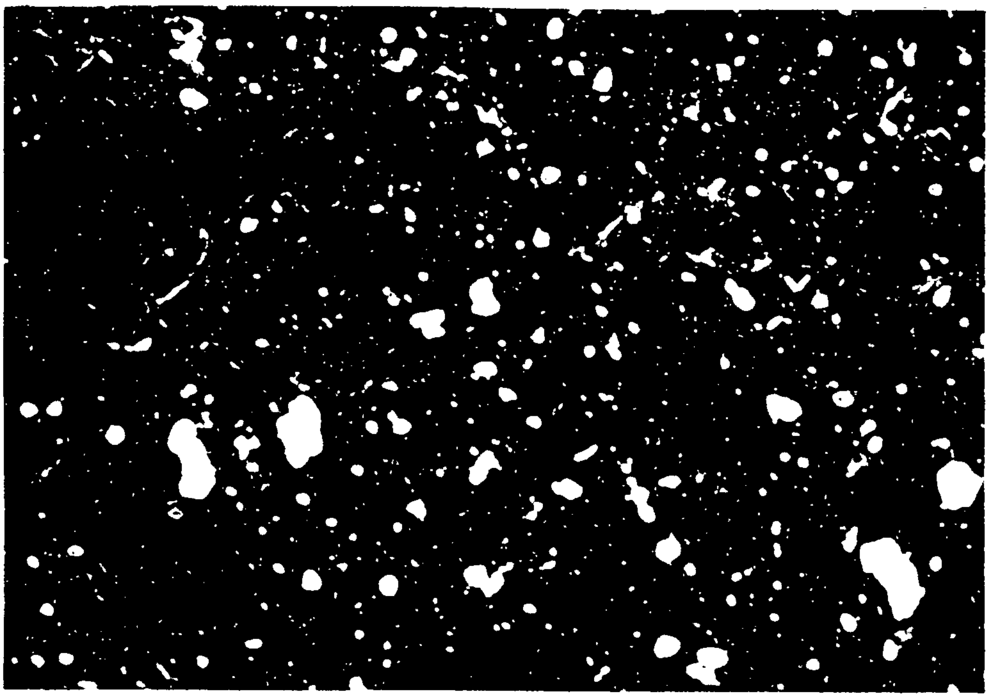

Fig. 86 - Thin section micrograph from B21t - sample 35 cm of profile BR-8 (crossed polarizers).

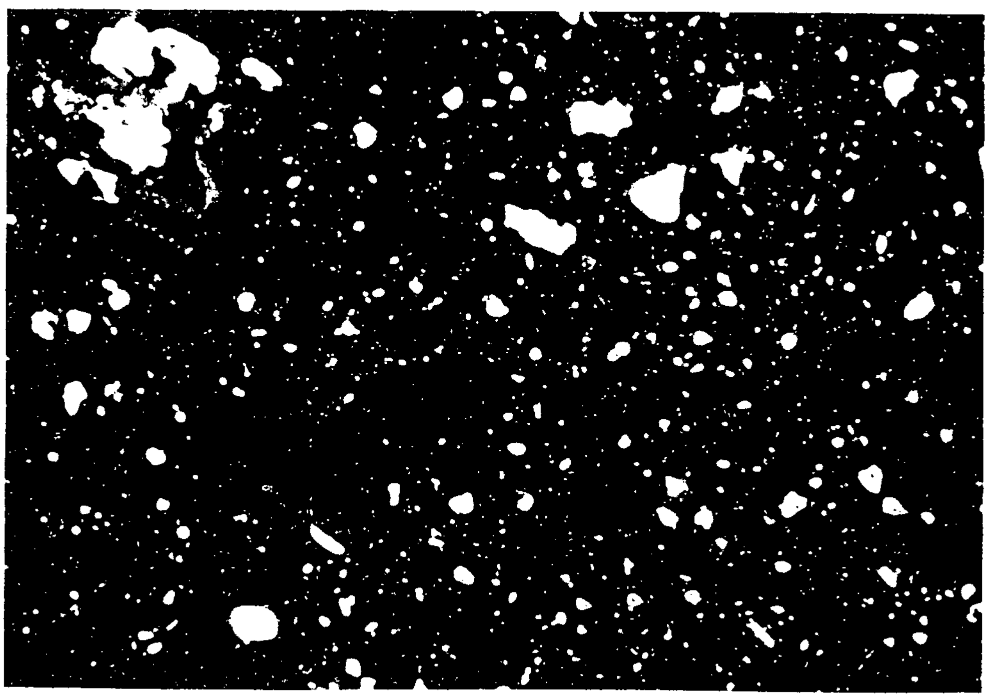

Fig. 87 - Thin section micrograph from B22t - sample 110 cm of profile BR-8 (crossed polarizers).

it is current. The material has sufficient oxic properties. The plasmic fabric indicated that there is discernable structure.

From micromorphology, the soil is classified as a Haplorthox belonging to the Tropeptic subgroup.

PROFILE BR-10. TYPIC HAPLOHUMULT

Micromorphological description

Sample 65 cm. IIIB21t

The NRDP is grani-porphyric (fig. 88). The grains are dominantly fine sand and coarse silt sized quartz. Large amounts of muscovite flakes are also present in the latter size. The plasma is pale yellow in color and plasmic fabric is in-skel-omnisepic (fig. 88). Voids are dominantly orthovughs.

There is no evidence of clay illuviation in this horizon.

Sample 130 cm. IVB3t

The quantity of muscovite shows a large increase. Most of the crystals are silt-sized (fig. 89). Apart from this, there is no basic changes in the s-matrix. Illuviation argillans are absent.

Interpretation

The soil is at a very recent stage of soil formation. There is no clay translocation in the profile. The very well expressed plasmic fabric associated with the high amount of micas are indicative that the 'B' horizon is cambic. The low CEC despite the very high mica content is due to the fact that the mica is muscovite.

From the micromorphology, the soil is classified as an Umbric Oxic* Dystrochrept. Besides the clay increase in the profile being small, the mere variation in clay content from A to B horizon does not qualified for an argillic horizon.

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* Subgroup not established.

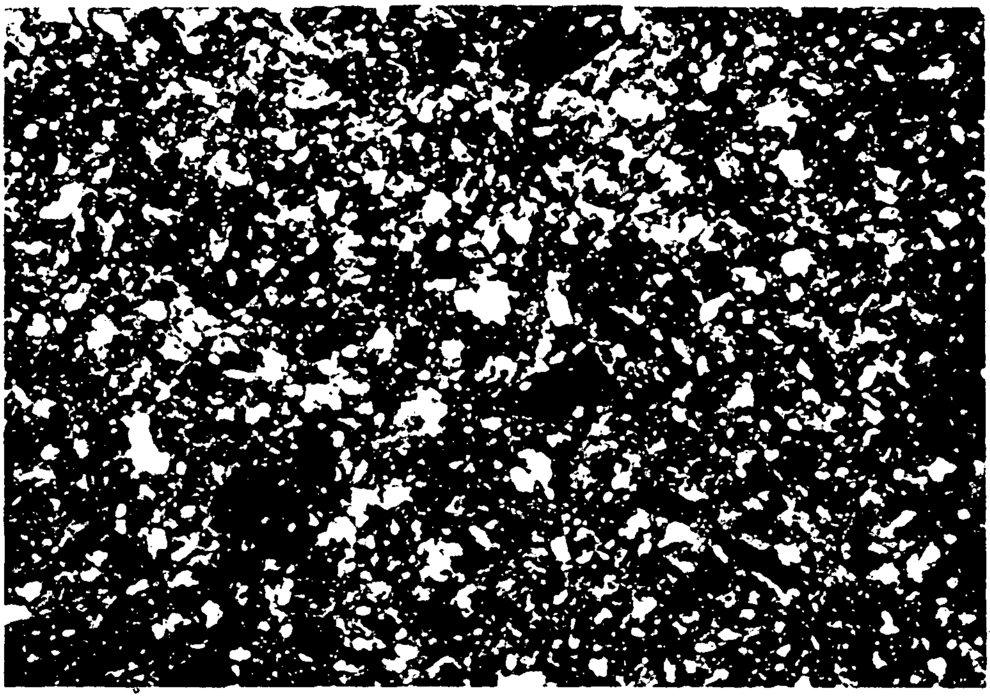


Fig. 88 - Thin section micrograph from IIIB21t - sample 65 cm of profile BR-10 (crossed polarizers).

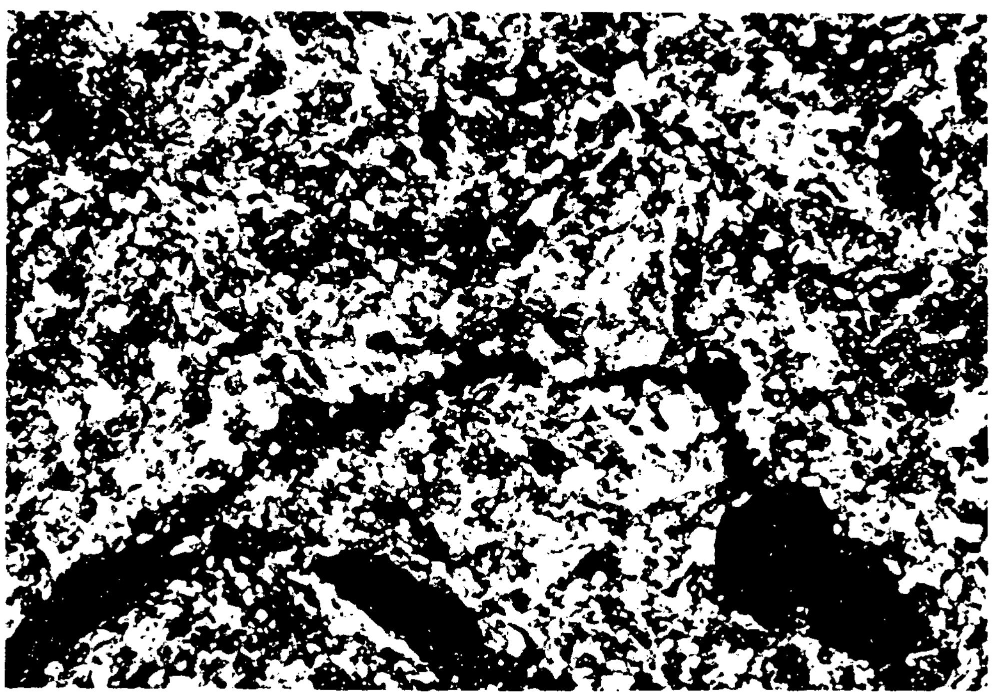


Fig. 89 - Thin section micrograph from IVB3t - sample 130 cm of profile BR-10 (crossed polarizers).

PROFILE BR-12. TYPIC PALEUDULT

Micromorphological description

Sample 25 cm. B1t

The NRDP is grani-porphyric. The fragmented and angular quartz grains range from fine to coarse sand size. Plasma is brownish yellow and plasmic fabric is insepic. There are few fine papules of translocated clay (fig. 90). These occupy less than 0.5% of the area. They are generally well oriented with good continuous extinction indicating recent translocation. Most of the channels and vughs are free of coatings. There are no other pedological features.

Sample 145 cm. B22t

The NRDP is grani-plasmic as can be seen in fig. 91. There is a distinct change in the fabric as compared to the overlying horizon indicating a lithological discontinuity. Plasmic fabric is a complex omni-insepic. Grains are dominantly quartz and a few, very fine flakes of muscovite are present. The voids are free of coatings and there are no papules.

Interpretation

Comparing the fabric of the two horizons it is evident that the lithological discontinuity is the reason for the clay increase in the solum. Translocation is minimal and is confined to the top 25 cm or so of the soil. The B horizon has all oxic characteristics, and so, from the micromorphology, the soil is classified as a Tropeptic Haplorthox.

PROFILE BR-13. TROPEPTIC HAPLORTHOX (no consensus)

Micromorphological description

Sample 35 cm. B1

The NRDP is porphyric. There are no other grains apart from angular medium sand sized quartz. The plasma is brownish yellow and plasmic

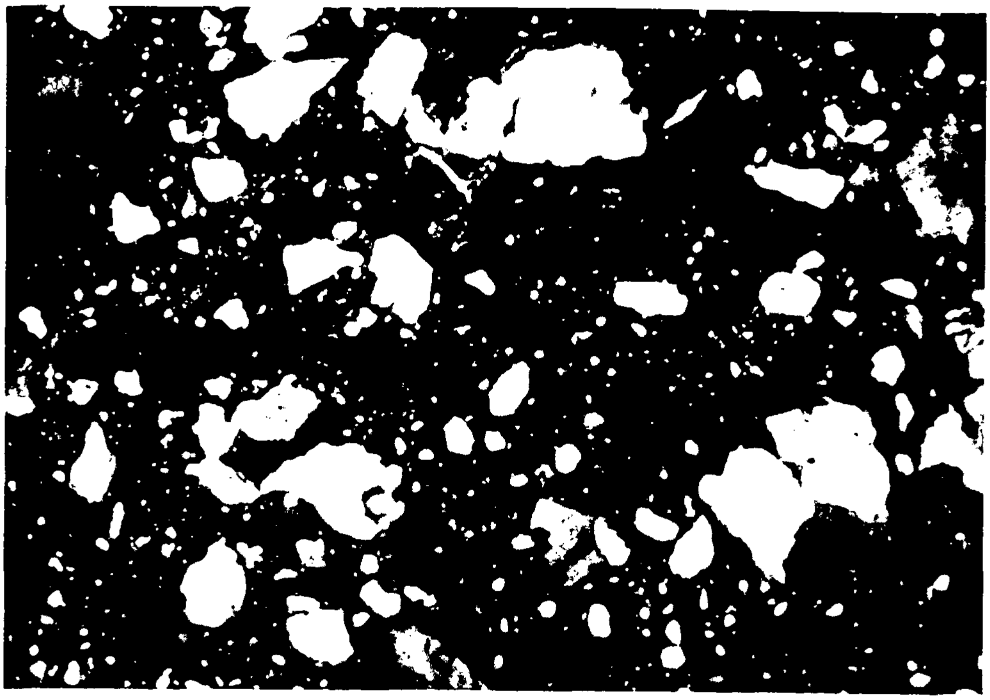


Fig. 90 - Thin section micrograph from B1t- sample 25 cm of profile BR-12 (crossed polarizers).

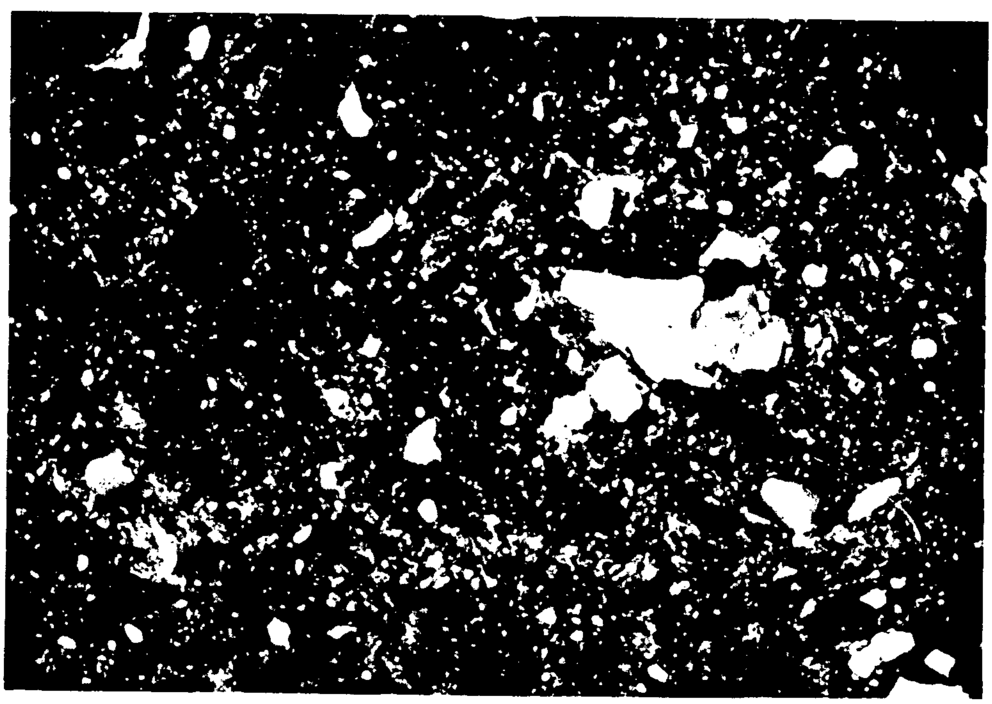


Fig. 91 - Thin section micrograph from B22t - sample 145 cm of profile BR-12 (crossed polarizers).

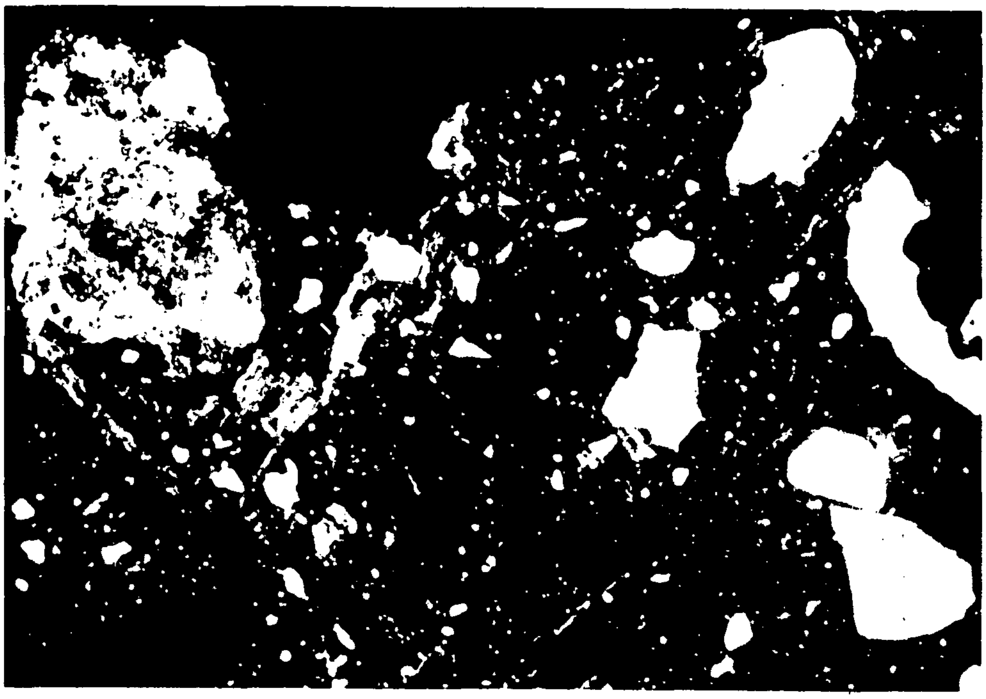


Fig. 92 - Thin section micrograph from B1 - sample 35 cm of profile BR-13 (crossed polarizers).

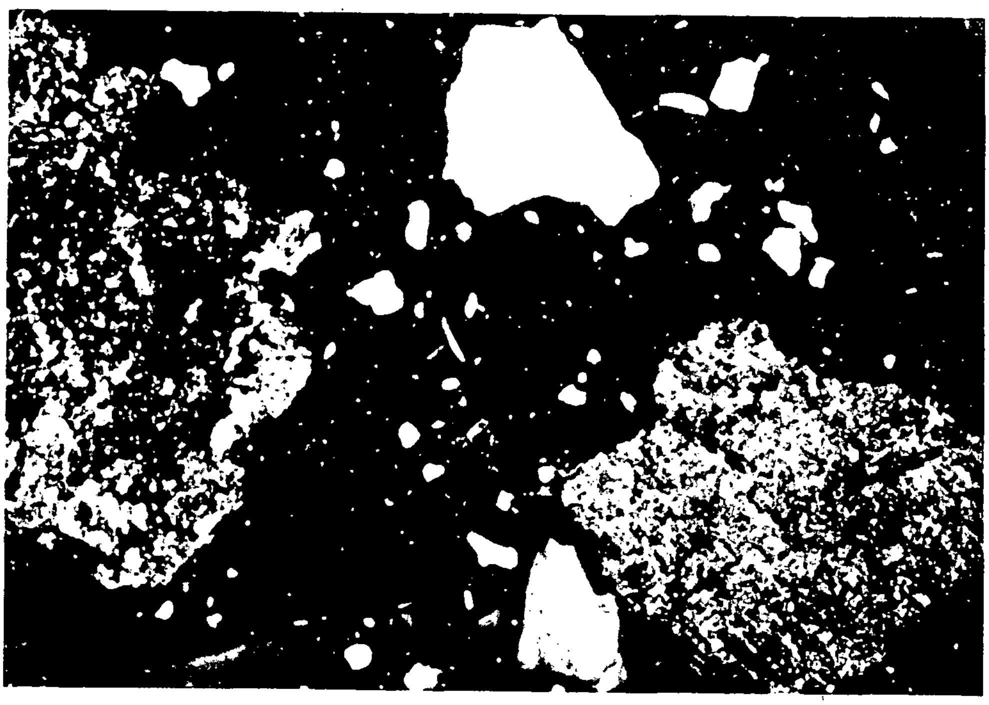


Fig. 93 - Thin section micrograph from B22 - sample 150 cm of profile BR-13 (crossed polarizers).

fabric is insepic-argillasepic. Locally some masepic is present (fig. 92). Thin, weakly oriented illuviation argillans are present in some of the vughs but these occupy less than 0.5% of the area. Large gibbsite nodules (fig. 92) are present. As shown by the XRD, the gibbsite is also present in the clay fraction.

Sample 150 cm. B22

There is very little change, apart from a slight increase in plasma, in the fabric. Illuviation argillans are fewer and sepic features are less distinct (fig. 93) and some indicate that they are direct transformations from feldspars.

Interpretation

There is very little doubt that the material is oxic. The presence of the gibbsite is further evidence of the advanced state of weathering and soil formation. There is some clay translocation in this material but insufficient to consider the subsurface as an argillic horizon.

From the micromorphology, the soil is classified as a Tropeptic Haplorthox.

PROFILE BR-15. TYPIC HAPLUMBREPT

Micromorphological description

Sample 35 cm. A3

The NRDP is plasmi-porphyric. The plasma is reddish brown and quite heavily stained with organic matter. The staining and the rather high sesquioxide content has a masking effect on the plasmic fabric which is insepic-argillasepic. Apart from a very thin coating on the finer vughs, most of the vughs and channels are free of coatings (fig. 94). Grains are fine sand sized quartz, few plagioclases and some fine micas. Although the general fabric characteristics suggest oxic material, the presence of the weatherable minerals will preclude such a horizon.

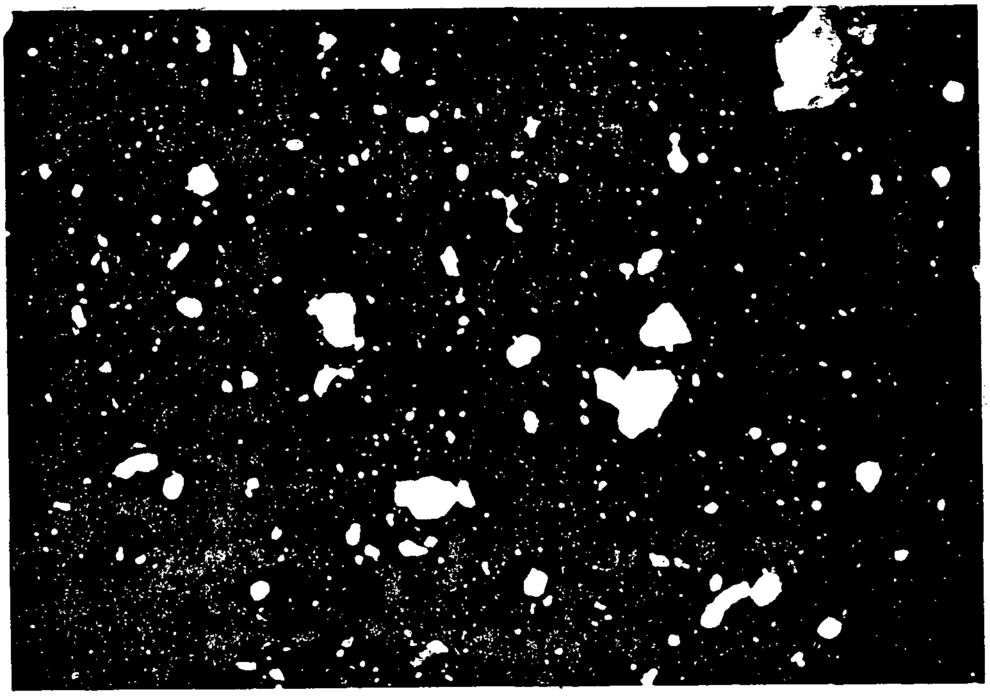


Fig. 94 - Thin section micrograph from A3 - sample 35 cm of profile BR-15 (crossed polarizers).

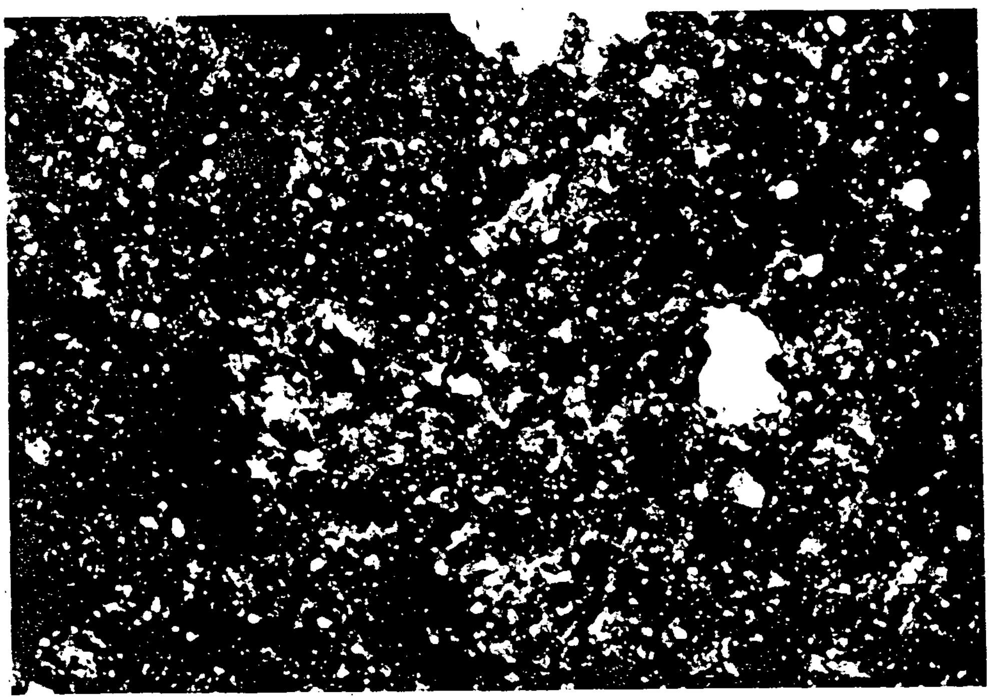


Fig. 95 - Thin section micrograph from IIB22t- sample 75 cm of profile BR-15 (crossed polarizers).

Sample 75 cm. IIB22t

This horizon has slight saprolite aspect. In the iron free zones, plasmic fabric is a complex ma-skelsepic. In the iron rich parts it is inomni-skelsepic. No evidence of clay translocation can be seen (fig. 95). There is some iron segregation to form diffuse nodules. The horizon would be better designated as B3.

Interpretation

This profile is another example where a small clay increase is insufficient justification for an argillic horizon. The B is definitely a cambic horizon. The soil is also shallow. There is sufficient clay in the B3 and C to give an apparent 'Pale' characteristic to the soil.

From the micromorphology , the soil is classified as a Typic Haplumbrept.

PROFILE BR-16. PLINTHIC* PALEUSTULT

Micromorphological description

Sample 50 cm. IIB1t

The NRDP is grani-porphyric. The angular quartz grains range in size from coarse silt to coarse sand. Very few, fine muscovite flakes are present. The plasmic fabric is insepic-argillasepic. The dominant voids are ortho-vughs. Illuviation argillans (fig. 96) are present in some of the vughs and occupy about 2% of the area. They are well oriented though in general they only form a thin-coating.

Sample 150 cm. IIIB3tpl

There is a considerable increase in the amount of fine-grained muscovite. There is also an increase in the amount of coarse sand relative to the other fractions. The presence of the fine muscovite gives a lattisepic tendency to the otherwise similar plasmic fabric. Illuviation

*Subgroup not established.

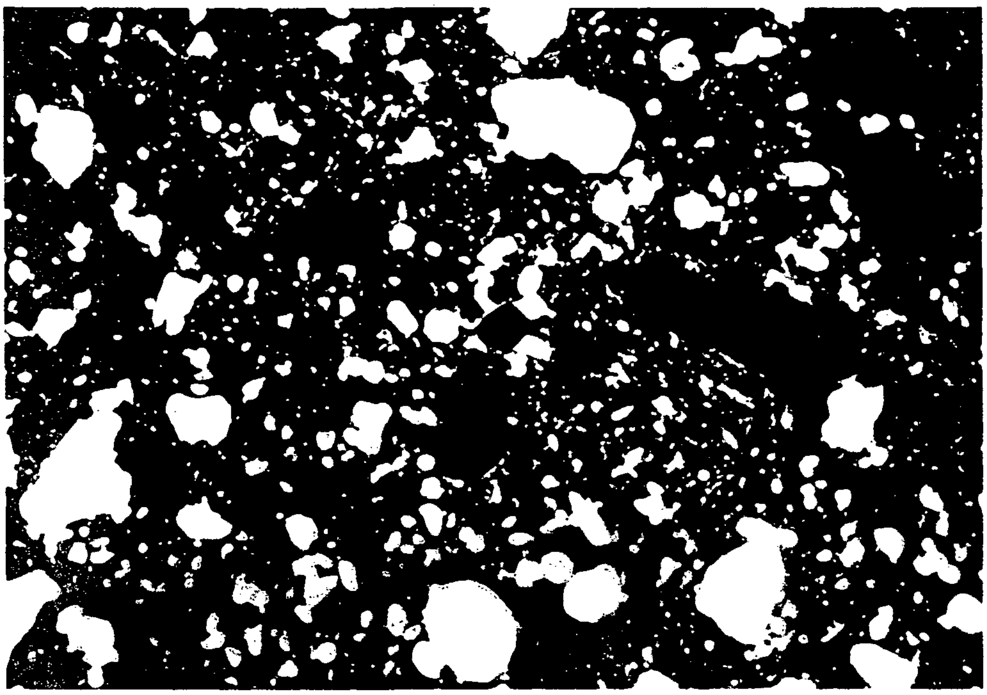


Fig. 96 - Thin section micrograph from IIBlt - sample 50 cm of profile BR-16 (crossed polarizers).

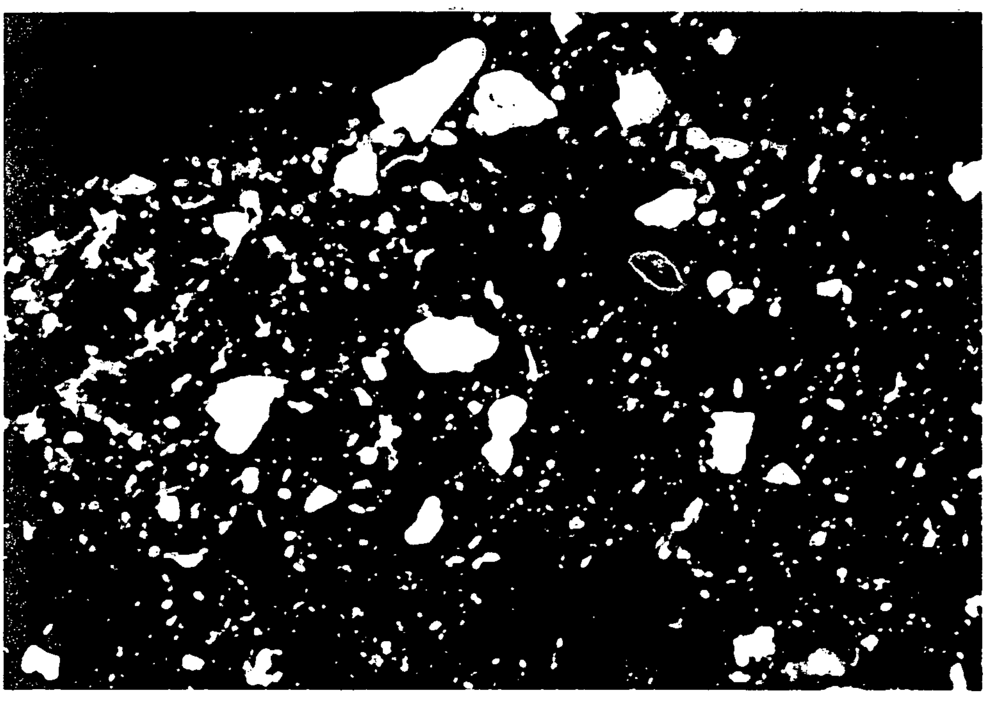


Fig. 97 - Thin section micrograph from IIIB3tpl - sample 150 cm of profile BR-16 (crossed polarizers).

argillans are few and occupy less than 1% of the area. Much of these are heavily iron stained (fig. 97) due to the plinthite forming processes. Small parts of the matrix have features of plinthite - with diffuse ferrans alternating with kaolinite rich parts of the s-matrix.

Interpretation

The profile has features of an Oxisol. However, there is sufficient amount of argillans to qualify for an argillic horizon. The profile is clearly a transitional case. Samples of the plinthic materials were not taken for the study. Parts of the s-matrix of the lower samples have features of plinthite.

PROFILE BR-19. OXIC HAPLUSTALF (no consensus)

Micromorphological description

Sample 50 cm. IIB2tpl

The NRDP is plasmi-porphyric. The s-matrix is variegated. There are parts which are yellow and others bright reddish due to iron staining. Plasmic fabric is latti-in-omnisepic with local argillasepic. Grains are dominantly fine silt to medium sand sized quartz. There are also few large biotite flakes partially altered and many fine silt sized muscovite.

Illuviation argillans are very well expressed (fig. 98). They are thick and well oriented and occupy about 10% of the area. Diffuse iron nodules are frequent. The segregation of the iron also causes some of the cutanic material to be coated with iron (fig. 98).

Sample 80 cm. IIB3tpl

There is a considerable increase in the amount of weatherable minerals especially biotites and some feldspars (fig. 98). Illuviation argillans are thicker and better defined. They occupy about 8% of the area.

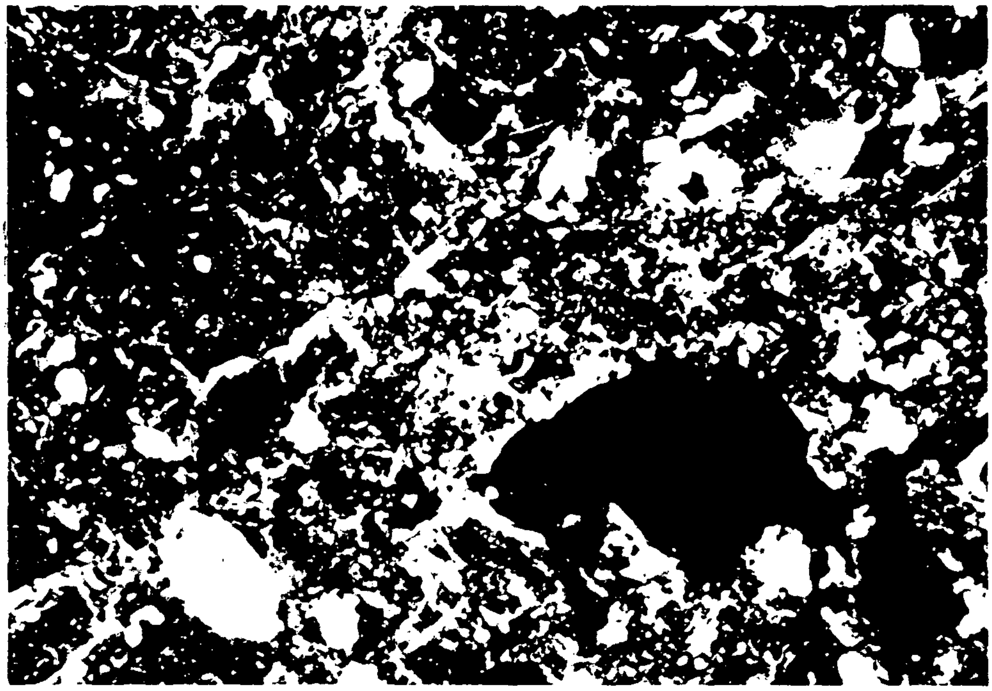


Fig. 98 - Thin section micrograph from IIB2tpl - sample 50 cm of profile BR-19 (crossed polarizers).

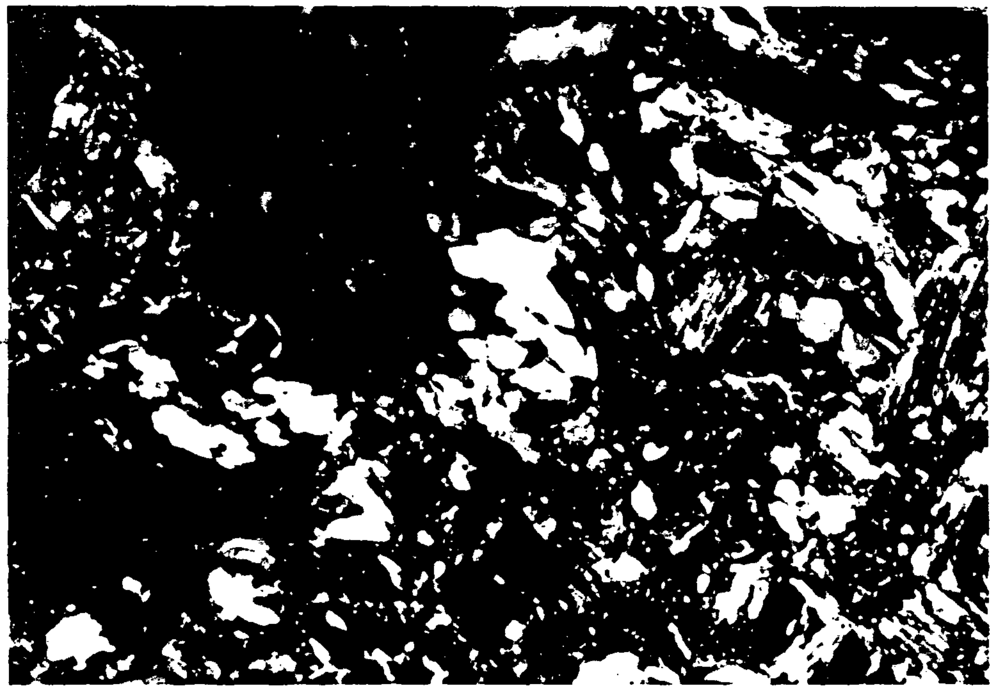


Fig. 99 - Thin section micrograph from IIB3tpl - sample 80 cm of profile BR-19 (crossed polarizers).

The most significant feature is the segregation of iron. Reallocation of iron results in iron rich and poor parts, very characteristic for plinthite (fig. 99). The iron even penetrates cracks in quartz leading to runlquartz formation.

Interpretation

There is no problem with an argillic horizon in this profile. The question is if there is plinthite. There is segregation of iron and in addition evidence to indicate that there is or was an influence of a ground water-table. In other words, the segregation is not due merely to weathering of the biotite. Consequently the material is called plinthite and so, from the micromorphology, the soil is classified as a Plinthustalf.

PROFILE BR-22. ORTHOXIC TROPUDULT

Micromorphological description

Sample 50 cm. B21t

The NRDP is grani-porphyric. Grains are medium to coarse sand sized quartz and sand size flakes of biotite (fig. 100). However, much of the biotite will come into the silt fraction during particle size analysis. Plasma is reddish yellow and plasmic fabric is latti-omnisepic. Voids are few large ortho-vughs. Most of the voids have no clay coatings (fig. 100). No papules were also detected in the whole thin section.

Sample 150 cm. B3t

Apart from a higher amount of unweathered micas (fig. 101), there is little difference with the previous sample. Again there is no evidence of clay translocation.

Interpretation

The profile is less developed than profile BR-19. The s-matrix is in some respects similar. Profile BR-22 is also not subject to

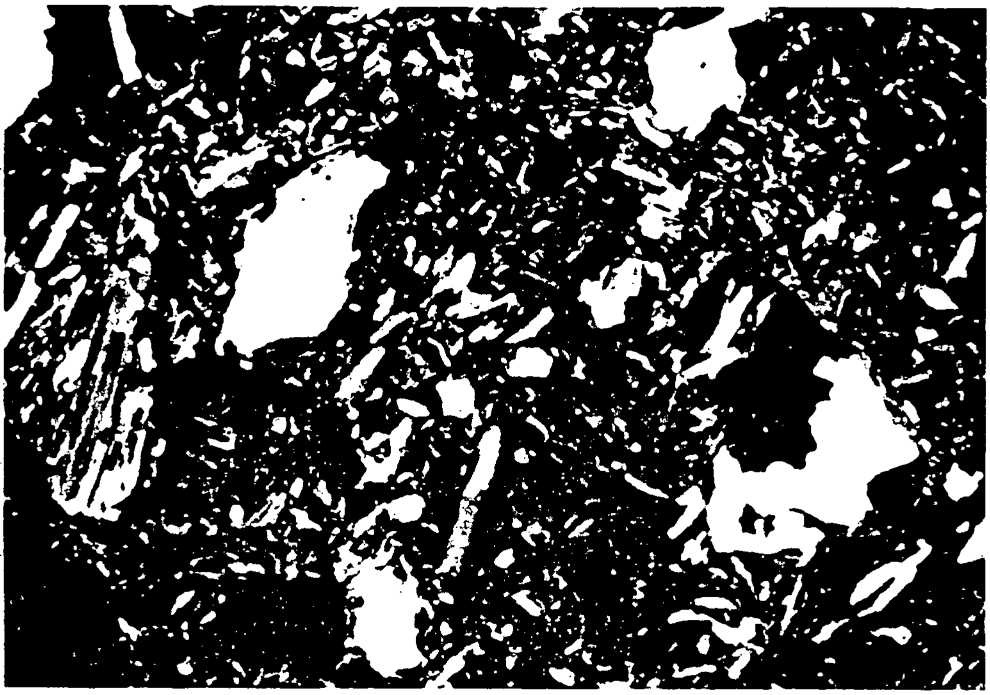


Fig. 100 - Thin section micrograph from B21t - sample 50 cm of profile BR-22 (crossed polarizers).

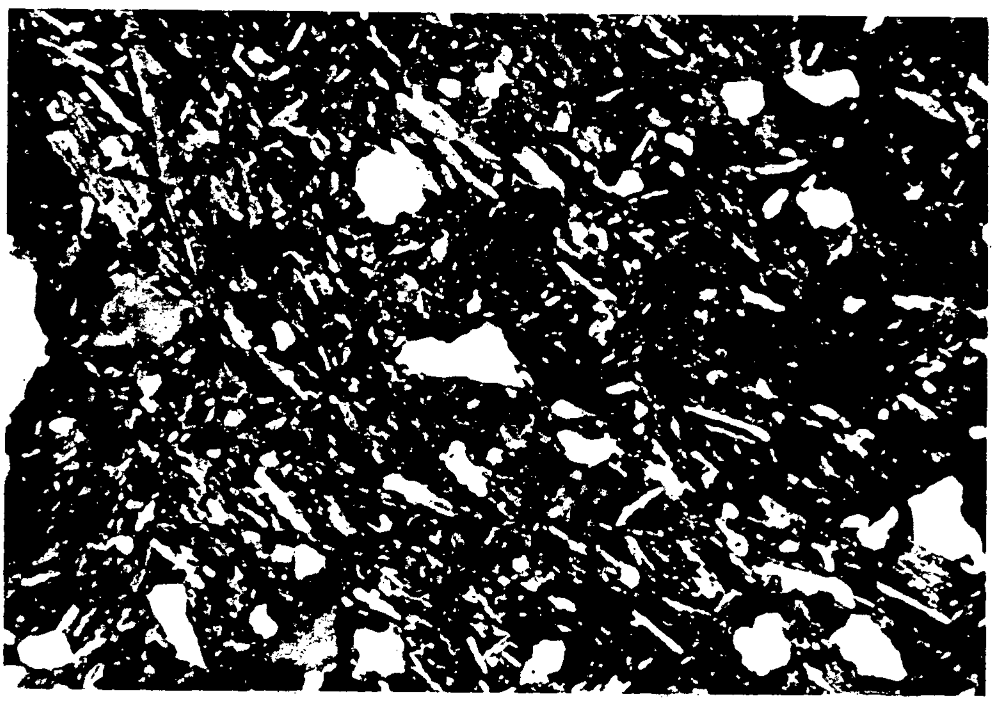


Fig. 101 - Thin section micrograph from B3t - sample 150 cm of profile BR-22 (crossed polarizers).

hydromorphism as was the case in BR-19 leading to formation of plinthite.

This profile is another illustration of the fact that a clay increase by itself is misleading. In this profile there is no evidence of clay translocation. The 'B' horizon is thus a cambic horizon and so, from the micromorphology, the soil should be classified as an Oxic Dystropept.

PROFILE BR-23. TYPIC PALEUDULT

Micromorphological description

Sample 50 cm. B1t

The NRDP is porphyric. Grains are fine to medium sand sized quartz. Very few, fine flakes of muscovite are present. The plasma is yellow and plasmic fabric is argillasepic tending to isotic. Few illuviation argillans and few papules are present and both occupy less than 1% of the area (fig. 102). The color of the cutanic material and the soil is similar indicating recent illuviation.

Sample 150 cm. B22t

The related distribution is similar in this horizon. Plasmic fabric is better expressed and is omnisepic (fig. 102). Apart from the quartz grains there are few large pseudomorphs of biotite. Illuviation argillans occupy less than 0.5% of the area.

Interpretation

Clay illuviation is clearly an insignificant process in this profile. The material is essentially oxic and some clay movement has taken in this material. There is insufficient argillan for an argillic horizon. From the micromorphology, the soils is thus Haplorthox. It is a Typic Haplorthox as indicated by the absence of distinct sepic fabric in the upper part of the oxic.

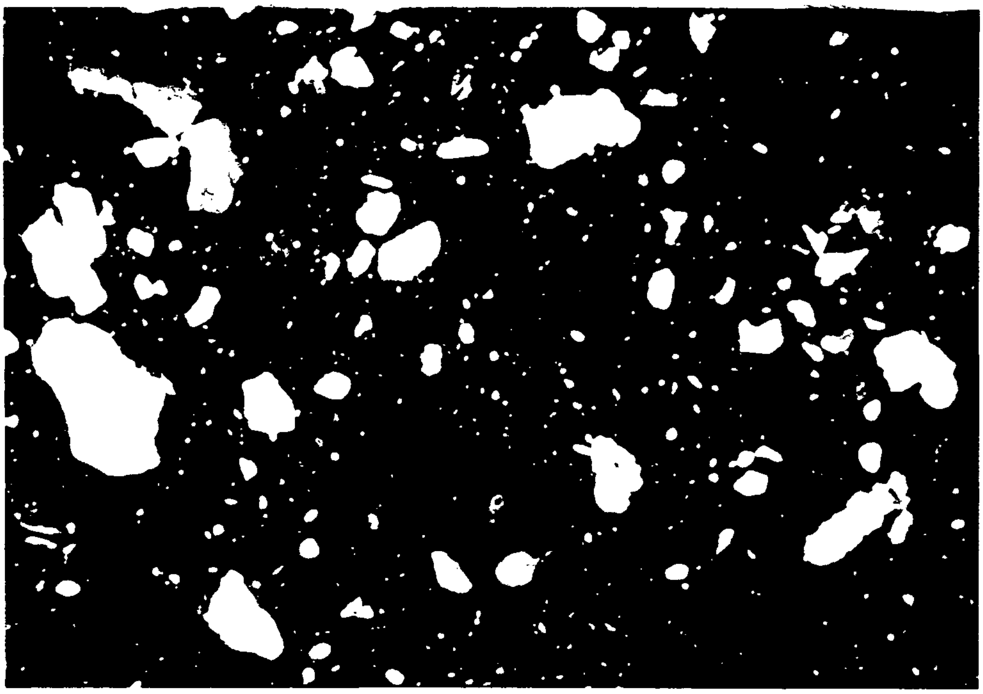


Fig. 102 - Thin section micrograph from B1t - sample 50 cm of profile BR-23 (crossed polarizers).

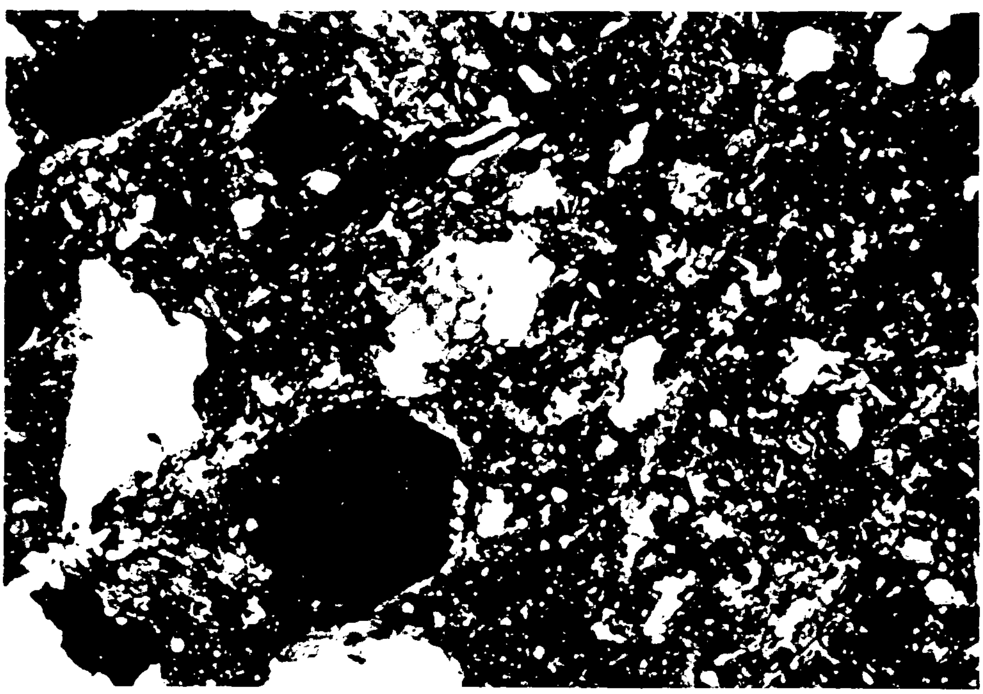


Fig. 103 - Thin section micrograph from B22t - sample 150 cm of profile BR-23 (crossed polarizers).

PROFILE BR-24. TYPIC PALEUDULT or TROPEPTIC HAPLORTHOX

Micromorphological description

Sample 50 cm. B1.

The NRDP is grani-porphyric. The s-matrix is very similar to profile BR-23 (fig. 104). As in the previous, illuviation argillans are scarce and point counting does not give more than 0.2% of cutans. There are no weatherable minerals present.

Sample 150 cm. B22

The s-matrix is very similar except that it is slightly redder (fig. 105). There is also a slight increase in the amount of fine muscovite flakes. There are no illuviation argillans.

Interpretation

The profile has all oxic characteristics. It appears to show some epiaquic features. This may be taken into account in the classification. From the micrmorphology, the soils is a Haplorthox and may be considered as belonging to the epiaquic subgroup if this is introduced.

PROFILE BR-25. RHODIC PALEUDULT

Micromorphological description

Sample 20 cm. B1t

The NRDP is plasmic. The plasma is brownish red under plain light. Few grains of quartz are present. Most of the grains are fine silt sized ilmenite. The matrix is very homogenous (fig. 106). There is a high amount of vughs but they are generally free of cutans. Few, fine papules are present and occupy less than 0.5% of the area. Plasmic fabric is isotic to argillasepic.

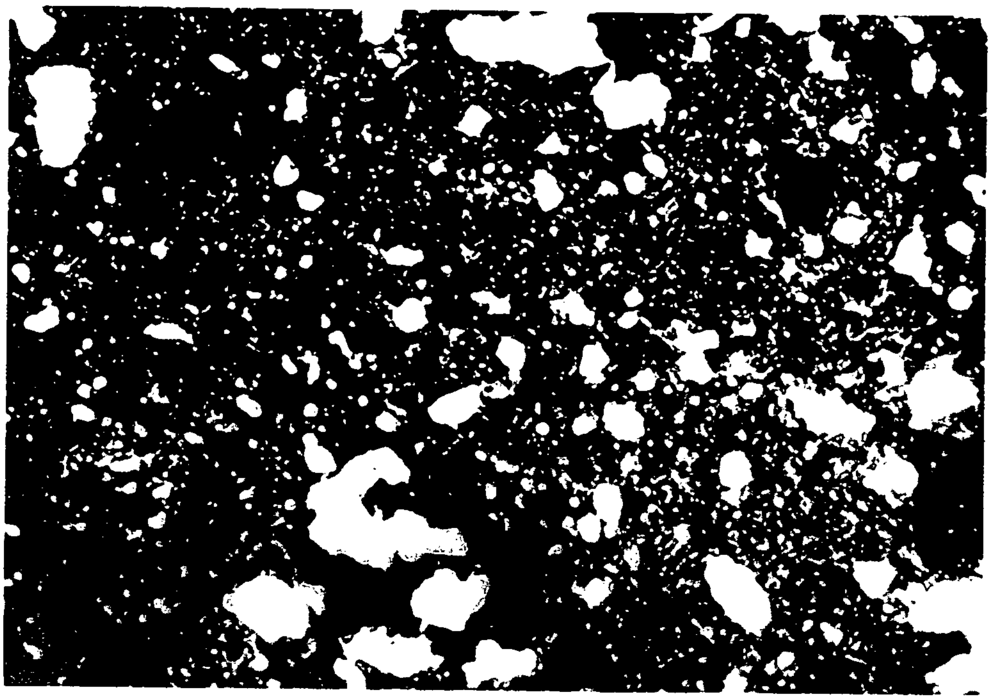


Fig. 104 - Thin section micrograph from B1 - sample 50 cm of profile BR-24 (crossed polarizers).

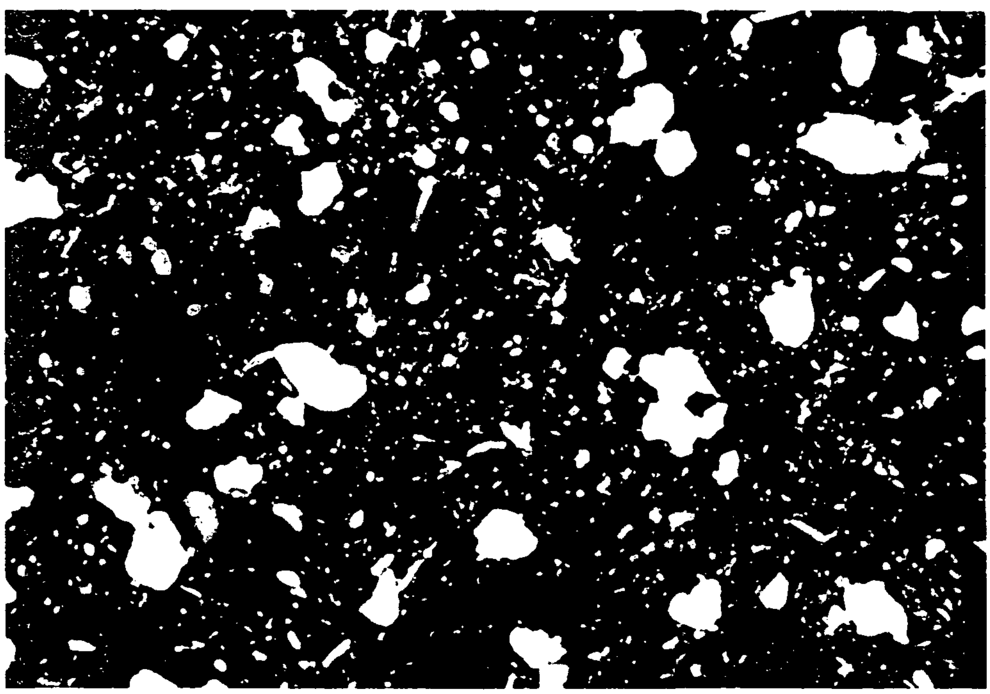


Fig. 105 - Thin section micrograph from B22 - sample 150 cm of profile BR-24 (crossed polarizers).

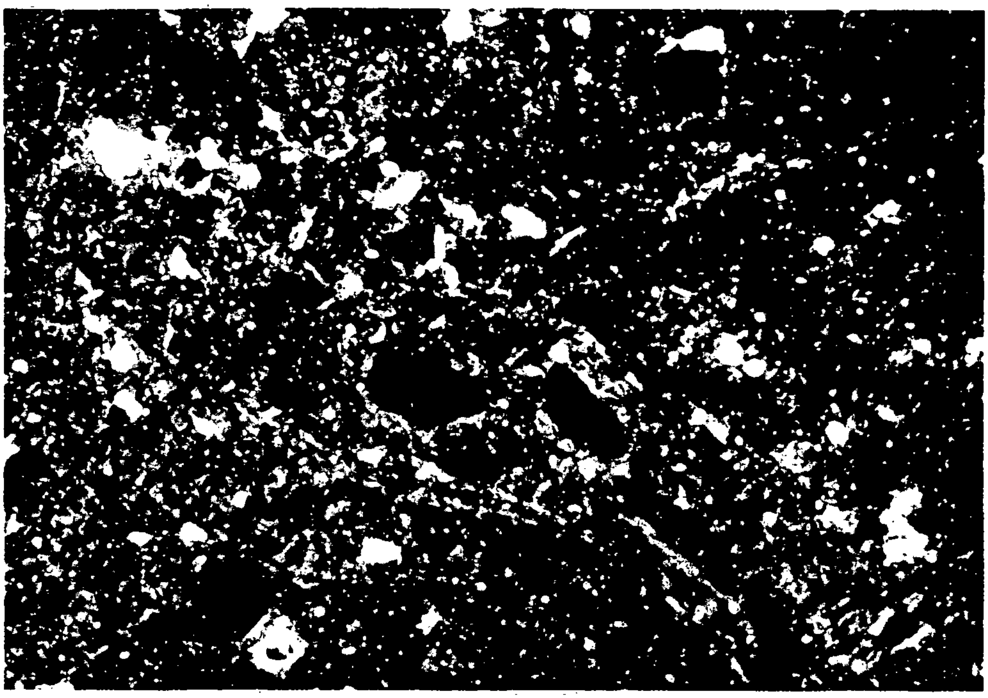


Fig. 106 - Thin section micrograph from Blt - sample 20 cm of profile BR-25 (crossed polarizers).

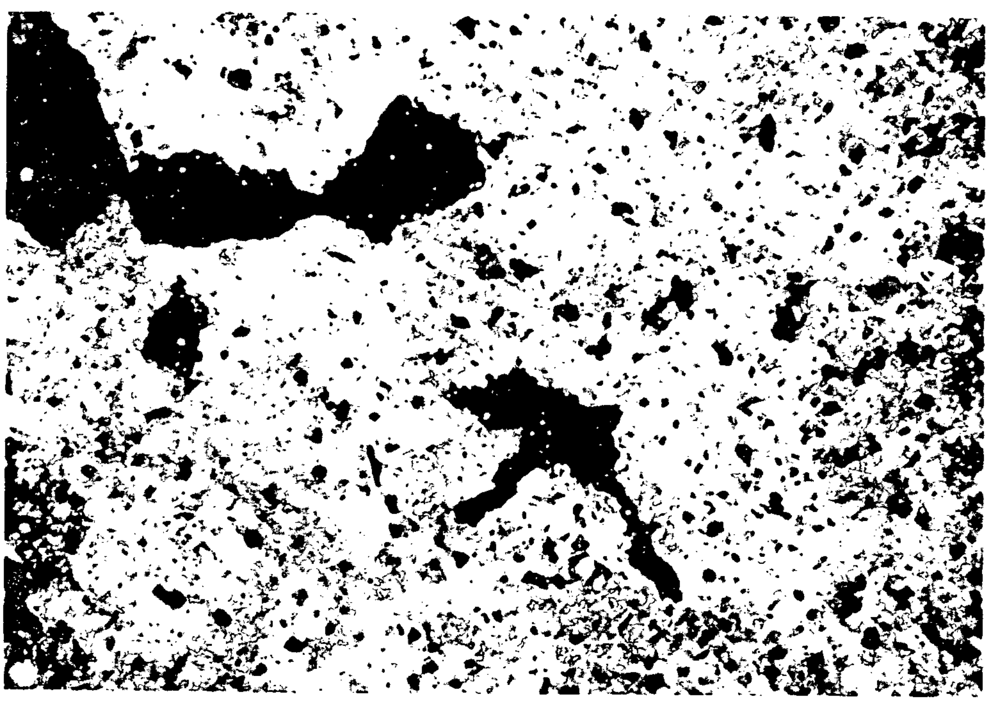


Fig. 107 - Thin section micrograph from B22t - sample 120 cm of profile BR-25 (crossed polarizers).

Sample 120 cm. B22t

There is a marked decrease of quartz giving the NRDP a plasmic aspect. However, under plain light, there is a considerable increase in ilmenite and in addition there is also magnetite. Both these minerals are in the silt fraction as a result of which there is a marked increase in this fraction. This increase is also seen in the particle size analyses. Consequently the observation in the field (Bennema, Moormann) that the particle size data for the lower horizons is incorrect due to poor dispersion is not supported here.

There are absolutely no argillans in this horizon (fig. 107). Plasmic fabric is isotic. There is also a tendency for the plasma to aggregate together.

Interpretation

The profile presents all characteristics of an Oxisol. There is little evidence for clay translocation. From the micromorphology, the soil is classified as a Tropeptic Haplorthox.

PROFILE BR-28. OXIC PALEUSTALF

Micromorphological description

Sample 20 cm. AB

The grains are dominated by medium to fine, sand sized quartz with few or no weatherable minerals. The NRDP is grani-plasmic. The plasma is reddish yellow and plasmic fabric is poorly expressed. It is essentially argillasepic with local insepic. Illuviation argillans (fig. 108) occupy about 3% of the area. They are thin and well oriented; in some places they are fragmented and partly incorporated in the s-matrix.

Sample 150 cm. B22t

The finer sized quartz grains are less frequent in this horizon (fig. 109). There is a much higher amount of plasma giving a plasmic NRDP. Plasmic fabric is not better expressed in this horizon. Illuviation argillans occupy about 5% of the total area. They are generally thicker and better oriented than the overlying horizon.

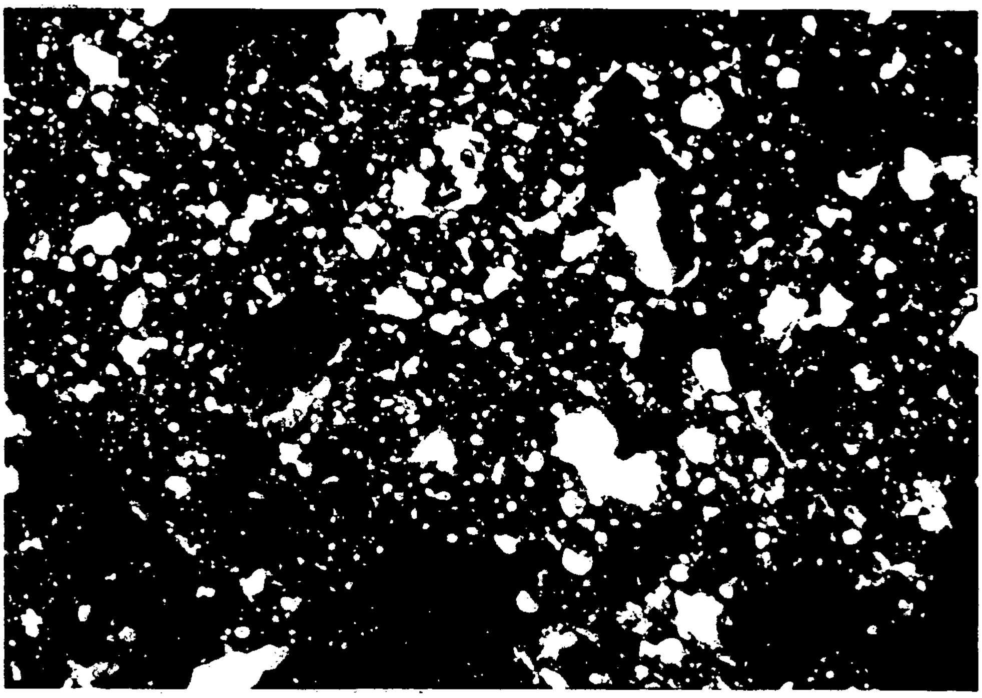


Fig. 108 - Thin section micrograph from AB - sample 20 cm of profile BR-28 (crossed polarizers).

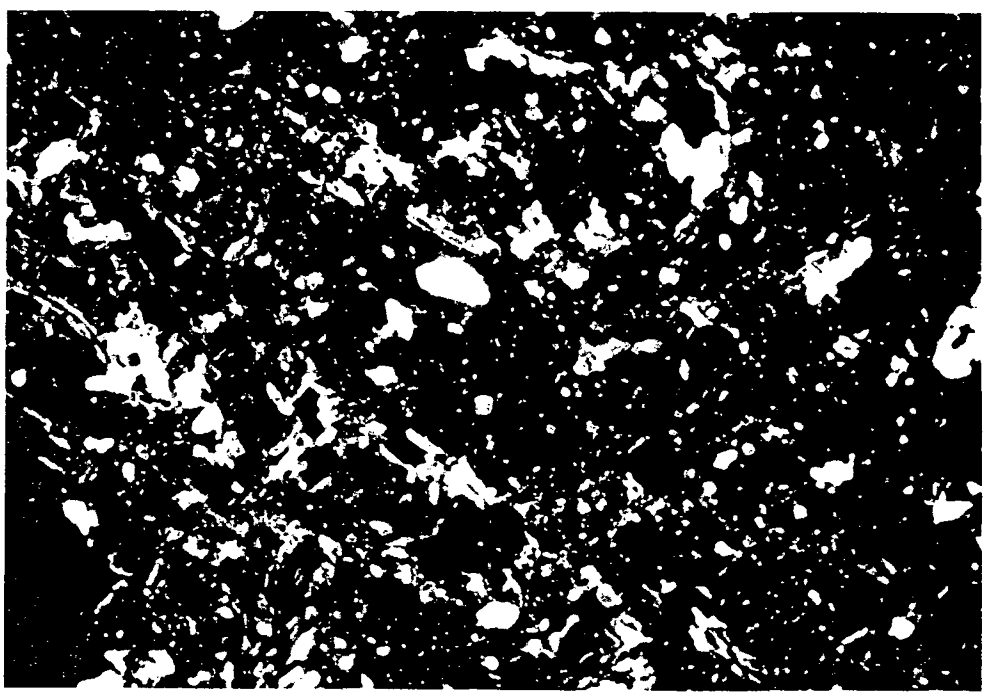


Fig. 109 - Thin section micrograph from B22t - sample 150 cm of profile BR-28 (crossed polarizers).

Interpretation

A comparison of the fabrics of the two horizons clearly indicates that the reason for the clay increase is mainly due to a discontinuity with a lighter textured surface material. Clay translocation has, however, taken place and clay skins are well developed. The lack of well expressed plasmic fabric indicates the oxic characteristics: The soil shows all micromorphological characteristics of a Paleustalf.

PROFILE BR-30. TYPIC PALEUDULT (no consensus)

Micromorphological description

Sample 50 cm. B21t

The horizon has a high amount of coarse sand sized quartz grains with lesser amount of plasma. The fabric, is as a result, loose and not ideal for cutans to form. However, some argillans are present (fig. 110) in this material with a plasmi-granic (NRDP). Although the plasma is pale yellow in color, indicating a less amount of free iron, the plasmic fabric is almost isotic. Even the argillans show a low anisotropicity. In low iron materials, such features result when the plasma is halloysitic or allophanic. Both these are probably absent and so one has to allude to the degraded kaolinite which may be the result of 'ferrolysis'.

The horizon has also few, fine, reddish sesquioxide nodules. These are inherited and indicate the sedimentary nature of the soil.

Sample 150 cm. B25

With the exception of higher amounts of argillans, the horizon is similar to the overlying. As in the other horizons, the argillans have a low birefringence and a grainy aspect. They are also broken. The plasma of the s-matrix is also poorly organized. All these suggest degradation (fig. 111).

Interpretation

The plasma shows all symptoms of degradation. The argillans also show these conditions. The cause may be the fluctuating water table. The soil shows the results of 'ferrolysis'.

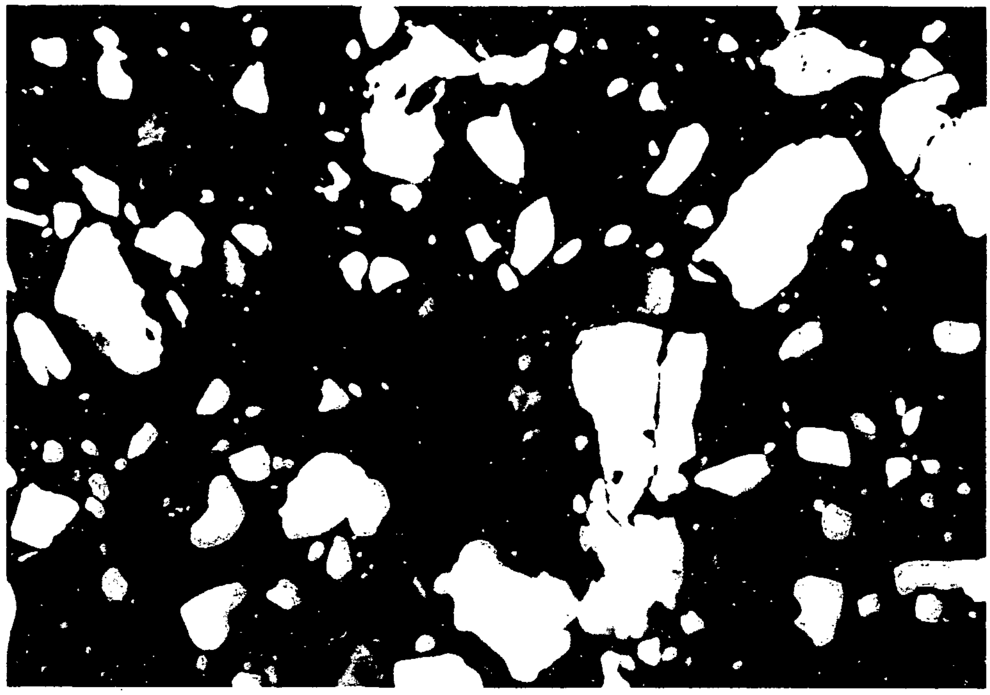


Fig. 110 - Thin section micrograph from B21t - sample 50 cm of profile BR-30 (crossed polarizers).

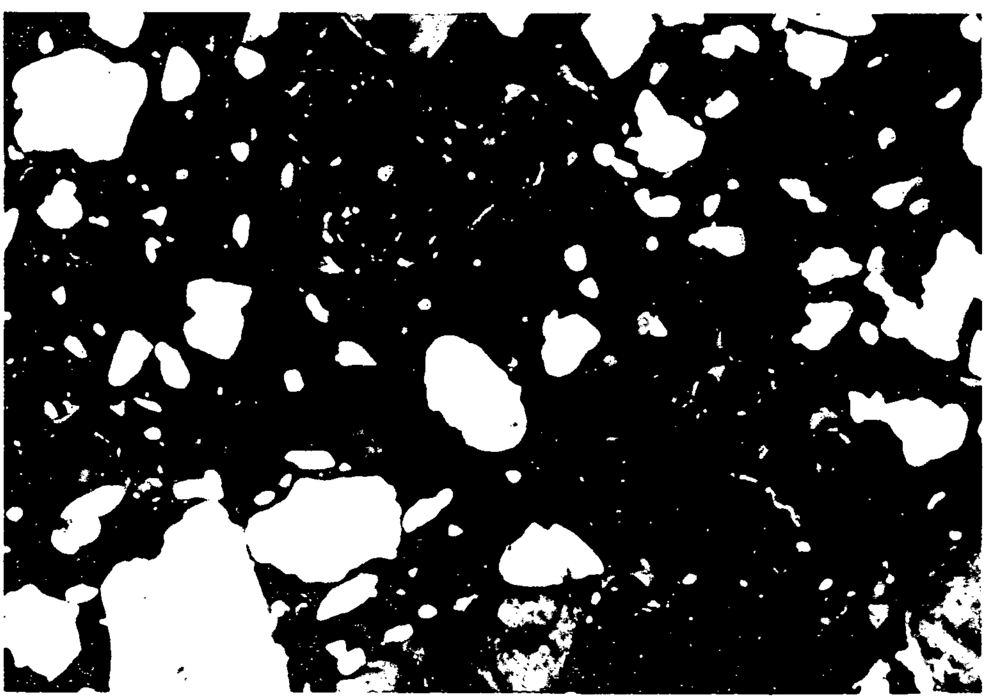


Fig. 111 - Thin section micrograph from B25 - sample 150 cm of profile BR-30 (crossed polarizers).

CORRELATION OF SELECTED DATA FOR SOME BRAZILIAN SOILS PROVIDED BY BRAZIL AND SCS-USDA LABORATORIES

H. Ikawa

In the tour guide book of the International Soil Classification Workshop held in Brazil in June and July of 1977, 31 soil profiles are characterized to provide the classification of these soils according to the Brazilian System, the Soil Taxonomy, and the FAO Legend. These soils were characterized by the Brazil laboratory*according to procedures cited in the guide book. In addition, 5 of the 31 pedons (samples BR-3, BR-6, BR-19, BR-23, and BR-30) were characterized by the National Soil Survey Laboratory of the Soil Conservation Service (SCS), USDA, according to procedures codified in the data of that laboratory.**

Because the analytical procedures differ between and amongst laboratories, the differences that may exist in the data should be compared. Furthermore, even though there may be a significant positive correlation between the data, there may not be a "one-for-one correlation," and a regression analysis must be used to understand the results. Thus, with the aid of the computer, the data obtained by the Brazil laboratory were related to the results obtained by the SCS Laboratory.

Although a comparison of the data of the 5 pedons as determined by the two laboratories represents only a limited number, a comparison of the data of the horizons of the profiles provides as much as 28 observations in most cases. That is, for 13 comparisons of variables, 10 variables have 28 observations, while 3 have 27, 15, and 7 observations, respectively.

The variables of the 5 pedons, including the number of soil horizons, and the regression equation to predict the data according to results similar to those obtained by the SCS laboratory are presented in Table 2 .

* SNLCS Soils Laboratory.
**see laboratory methods of analyses.

The results show that the correlation coefficient is over .95 in 9 of the variables, over .85 but less than .94 in 3 of the variables, and .36 in only one of the variables. The latter is due to lack of data and the correlation as well as the regression equation should be ignored. In the other cases, however, the results show either (1) that the results of the two laboratories are quite similar or (2) that the precision within a laboratory is such that a good comparison of the data of the two laboratories may be made.

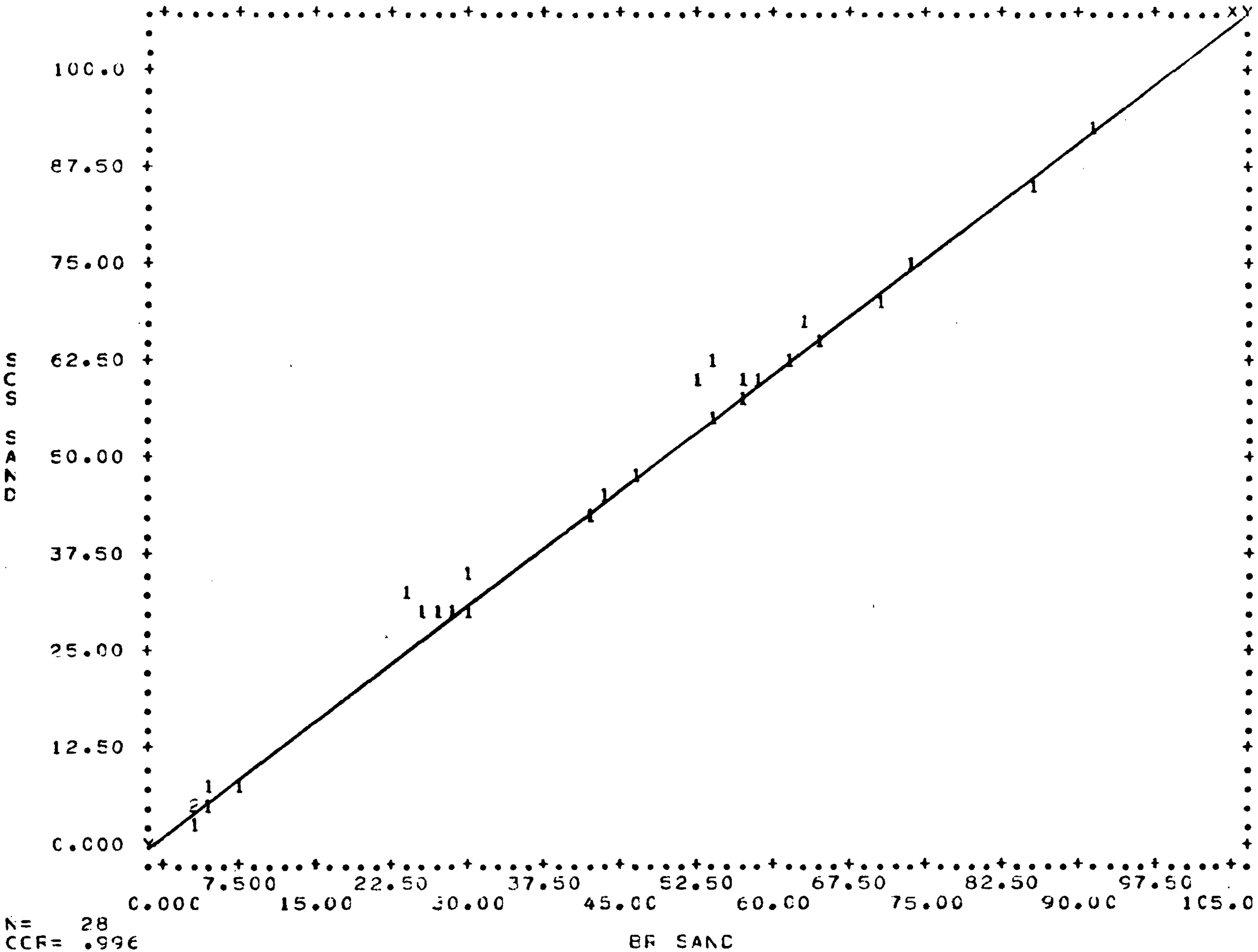
In the figures, the numbers 1, 2, 3, and so on represent the number of observations at that particular point in the chart. In utilizing the regression equation, only the $Y = mX + b$ should be used for meaningful comparison. Y represents the SCS laboratory, and X represents the Brazil laboratory.

TABLE 2 . VARIABLES, NUMBER OF HORIZONS, CORRELATION COEFFICIENTS, AND REGRESSION EQUATIONS USED IN THE STUDY OF THE SCS AND BRAZIL* LABORATORY DATA.

Variables	No. of Horizons	Correlation Coefficients	Regression Equations**
Sand	28	.996	Y = .99065X + 2.6718
Silt	28	.948	Y = 1.2972X - 1.3355
Clay	28	.977	Y = .84803X + 1.1844
Organic C	28	.993	Y = 1.1552X - .05814
N	15	.983	Y = .92984X - .02084
pH_{CaCl_2} vs pH_{KCl}	28	.859	Y = 1.0003X + .08429
pH_{H_2O}	28	.927	Y = .99750X - .23340
Na	7	.364	
K	27	.939	Y = 1.3733X + .03574
Ca + Mg	28	.998	Y = .99487X - .06826
Al	28	.990	Y = 1.0998X + .00732
CEC	28	.990	Y = 1.3923X + .83331
Base Saturation	28	.975	Y = .70735X - 2.9177

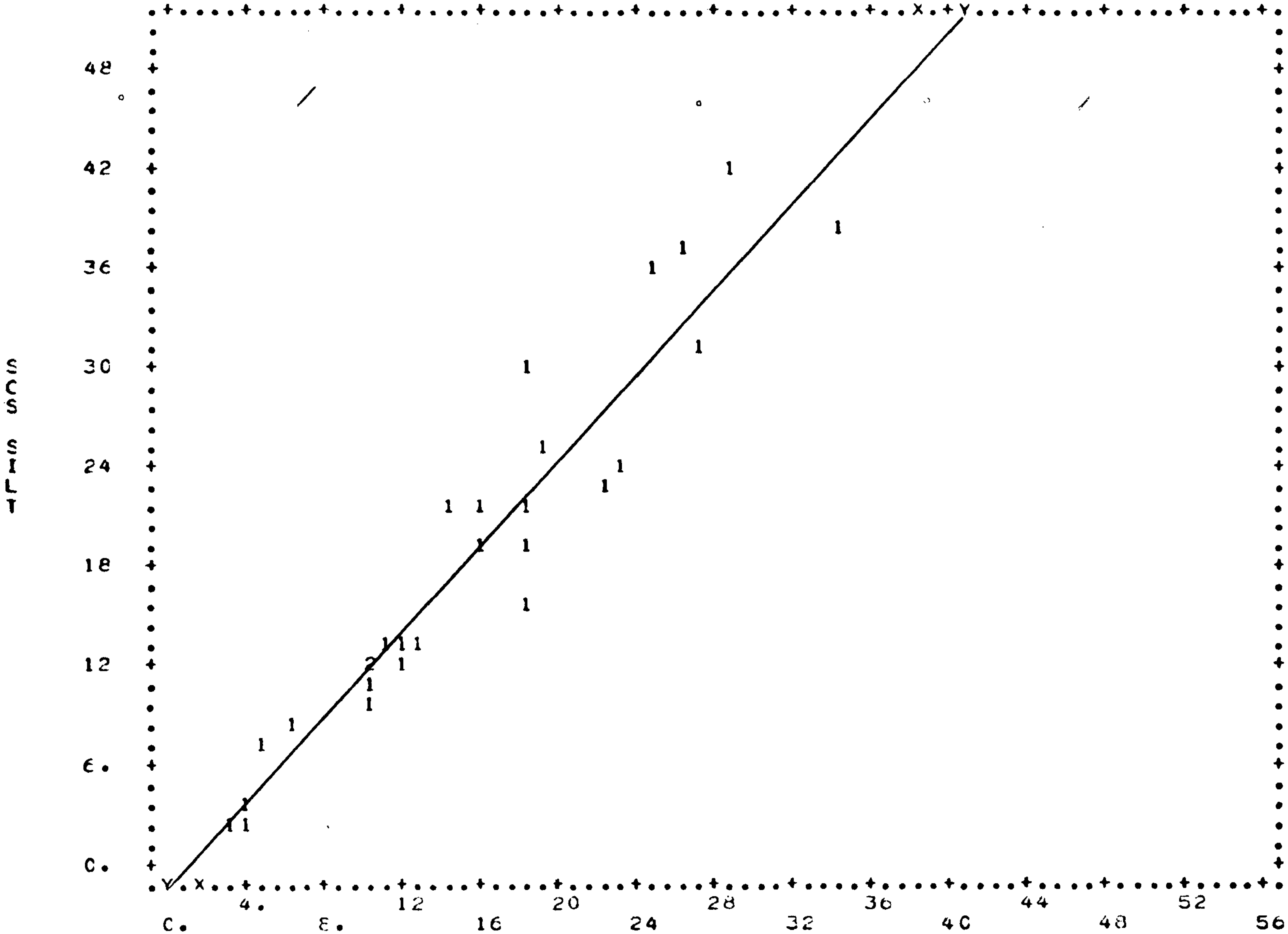
* SNLCS Soils Laboratory

** Y = SCS data; X = Brazil data.



	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	41.678	26.145	X= 1.0016*Y-2.3521	5.5182
Y	43.961	26.002	Y= .99065*X+ 2.6718	5.4573

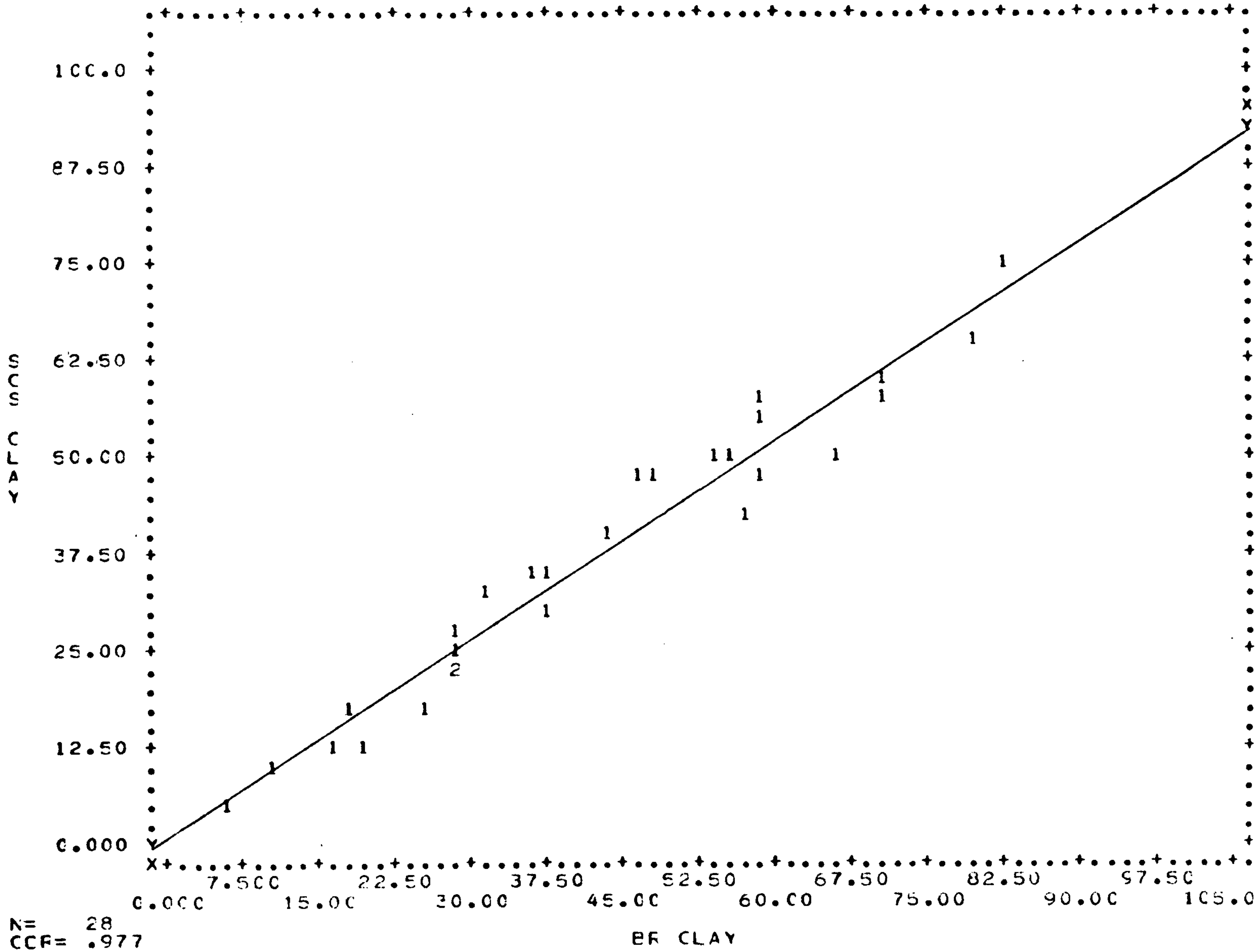
Fig. 112 - Percent sand according to SNLCS and SCS analyses.



N= 28
COR= .948

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	15.464	8.1399	X= .69327*Y+ 2.4829	6.9277
Y	18.725	11.135	Y= 1.2972*X-1.3355	12.963

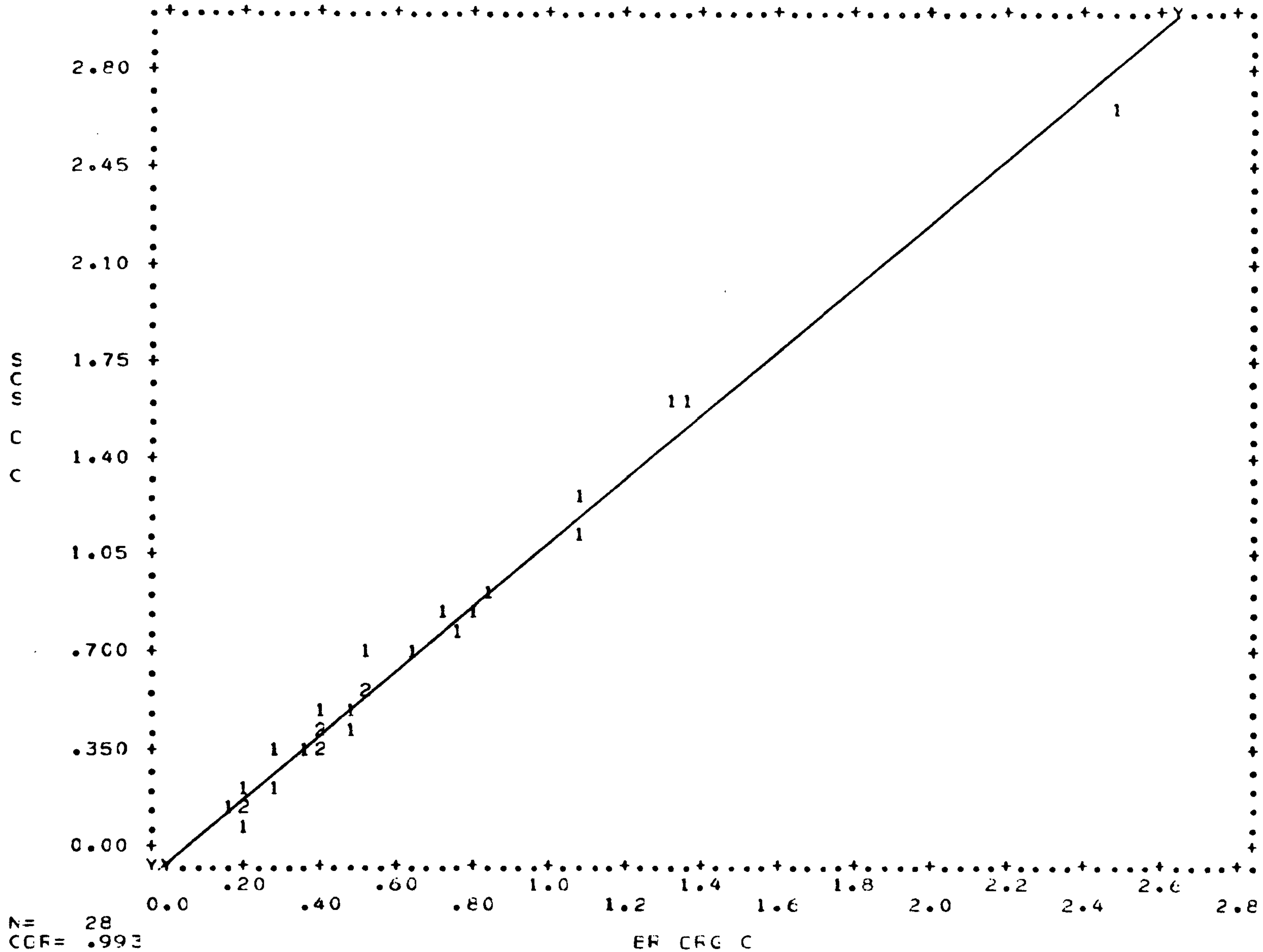
Fig. 113 - Percent silt according to SNLCS and SCS analyses.



N= 28
CCF= .977

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	42.857	21.069	X= 1.1265*Y+ .58304	20.622
Y	37.528	18.281	Y= .84803*X+ 1.1844	15.525

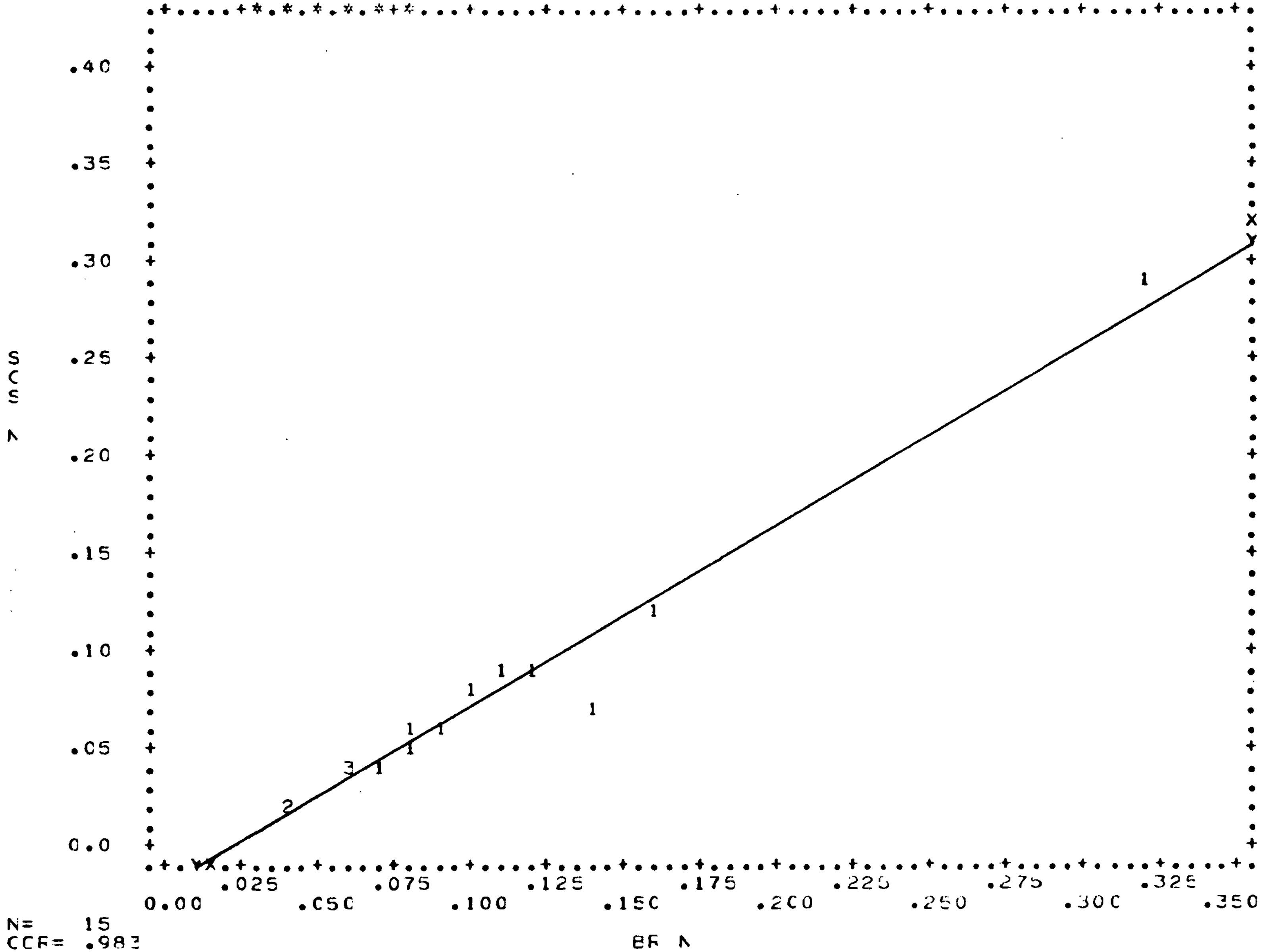
Fig. 114 - Percent clay according to SNLCS and SCS analyses.



N= 28
COR= .993

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.62536	.49493	X= .85374*Y+ .05823	.00349
Y	.66429	.57573	Y= 1.1552*X-.05814	.00473

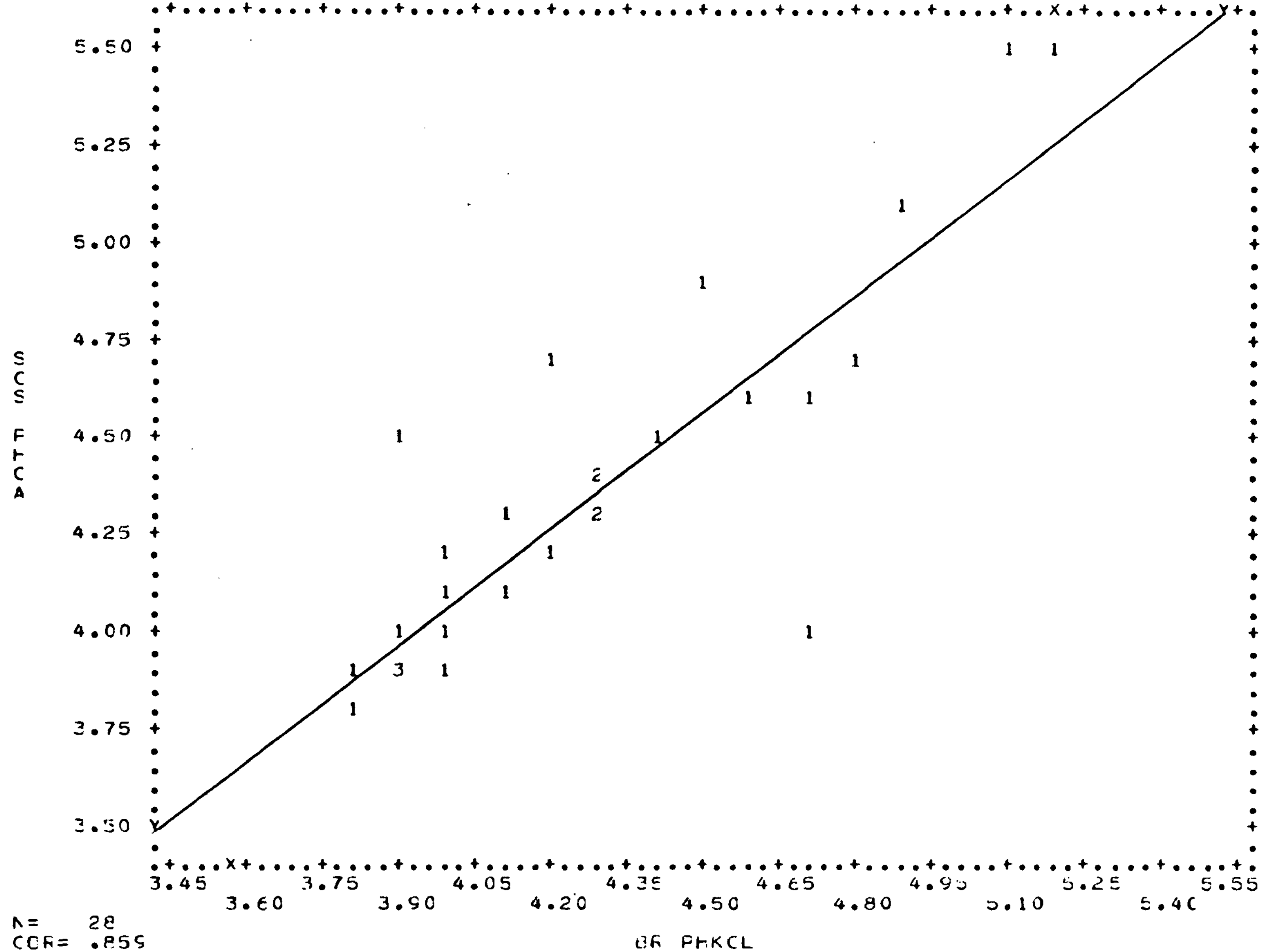
Fig. 115 - Organic Carbon according to SNLCS and SCS analyses.



N= 15
CCR= .983

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.10200	.06961	X= 1.0382*Y+ .02517	181E-6
Y	.07400	.06588	Y= .92984*X-.02084	162E-6

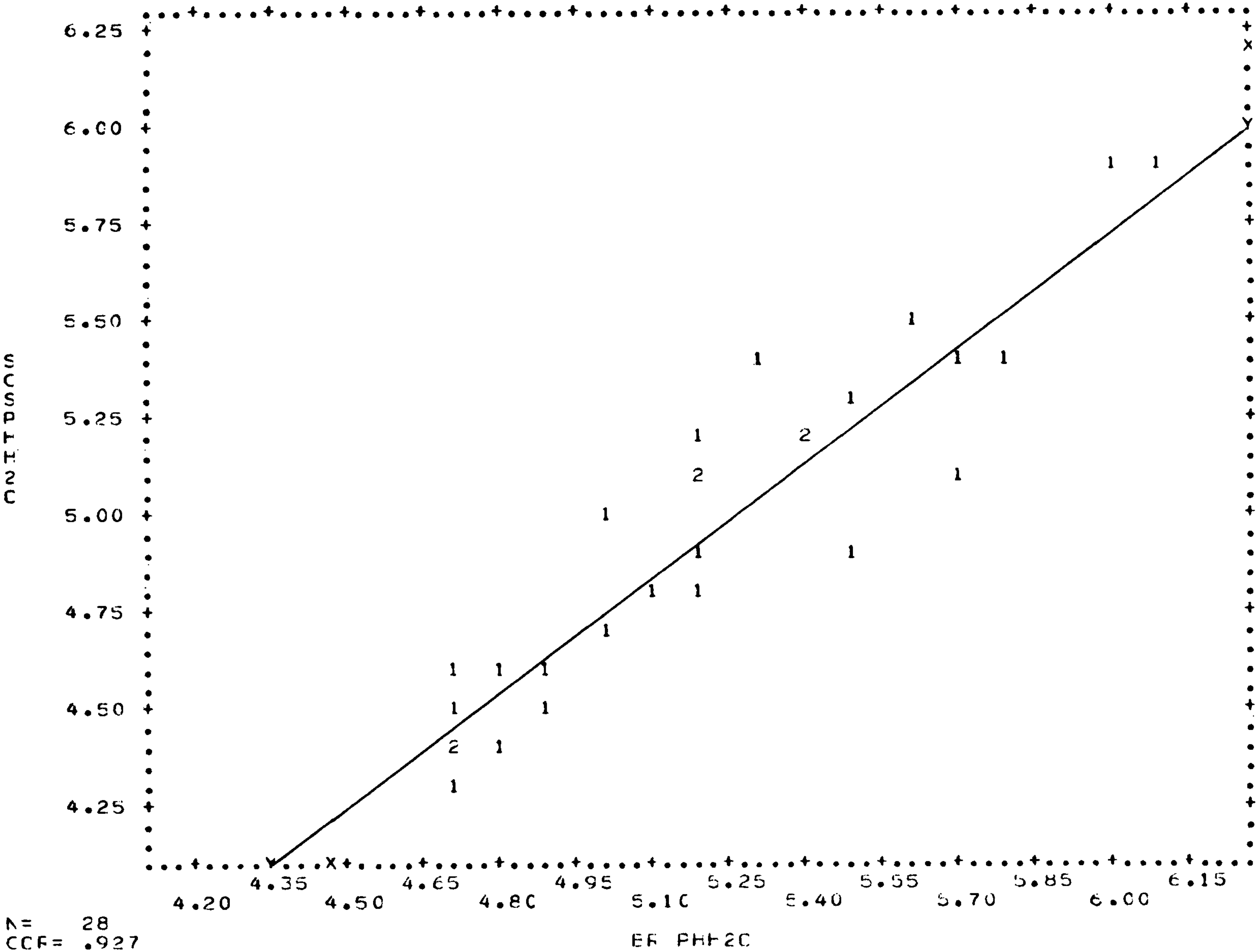
Fig. 116 - Nitrogen according to SNLCS and SCS analyses.



N= 28
COR= .859

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	4.2786	.39755	X= .73796*Y+ 1.0579	.04297
Y	4.3643	.46285	Y= 1.0003*X+ .08429	.05824

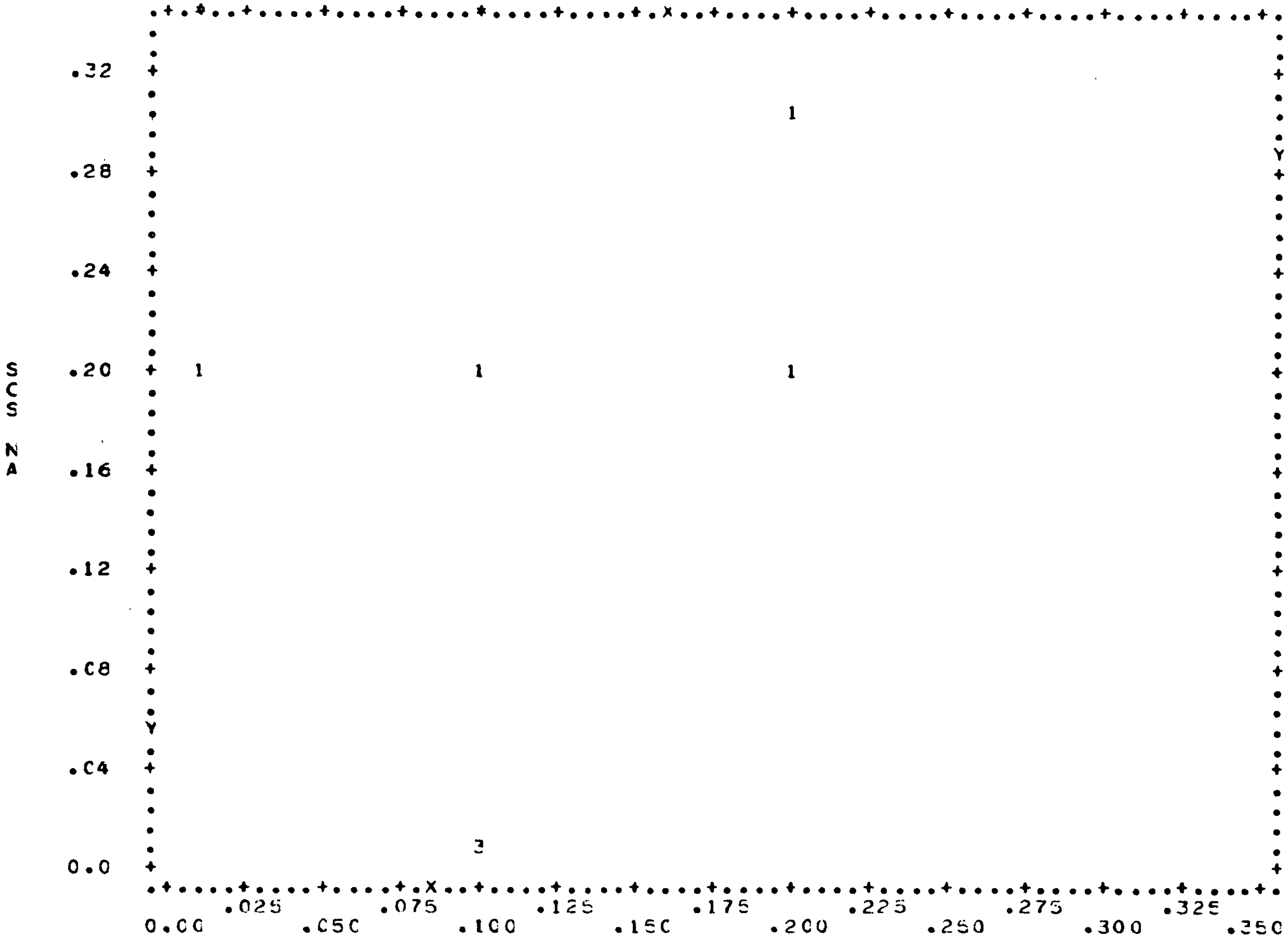
Fig. 117 - SCS pH $CaCl_2$ determination versus SNLCS pH KCl.



N= 28
CCF= .927

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	5.2143	.41160	X= .86074*Y+ .93824	.02488
Y	4.9679	.44310	Y= .99750*X-.23340	.02883

Fig. 118 - pH H_2O according to SNLCS and SCS determinations.

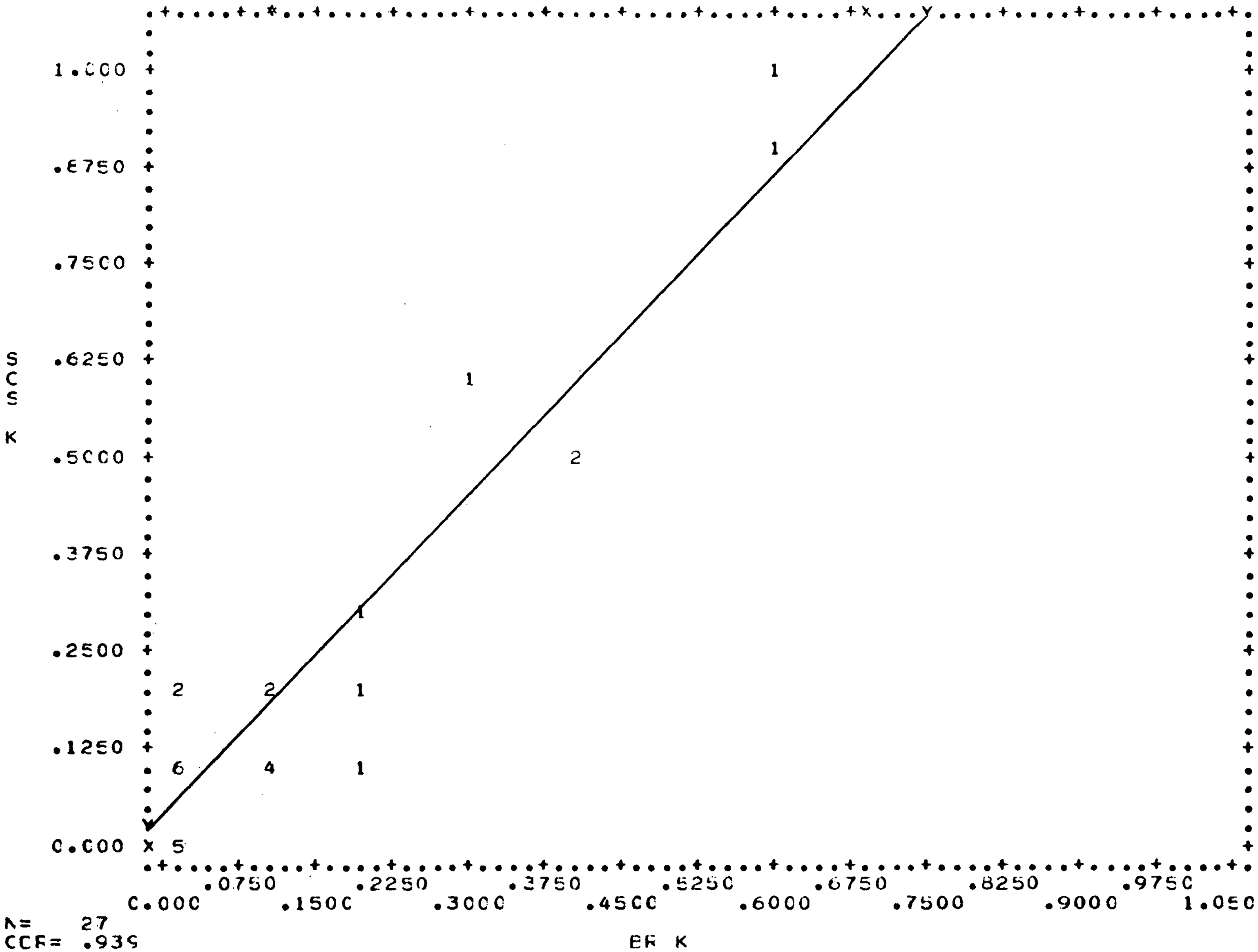


N= 7
CCF= .364

BF NA

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.11571	.06630	X= .20043*Y+ .08909	.00458
Y	.13266	.12024	Y= .65926*X+ .05657	.01506

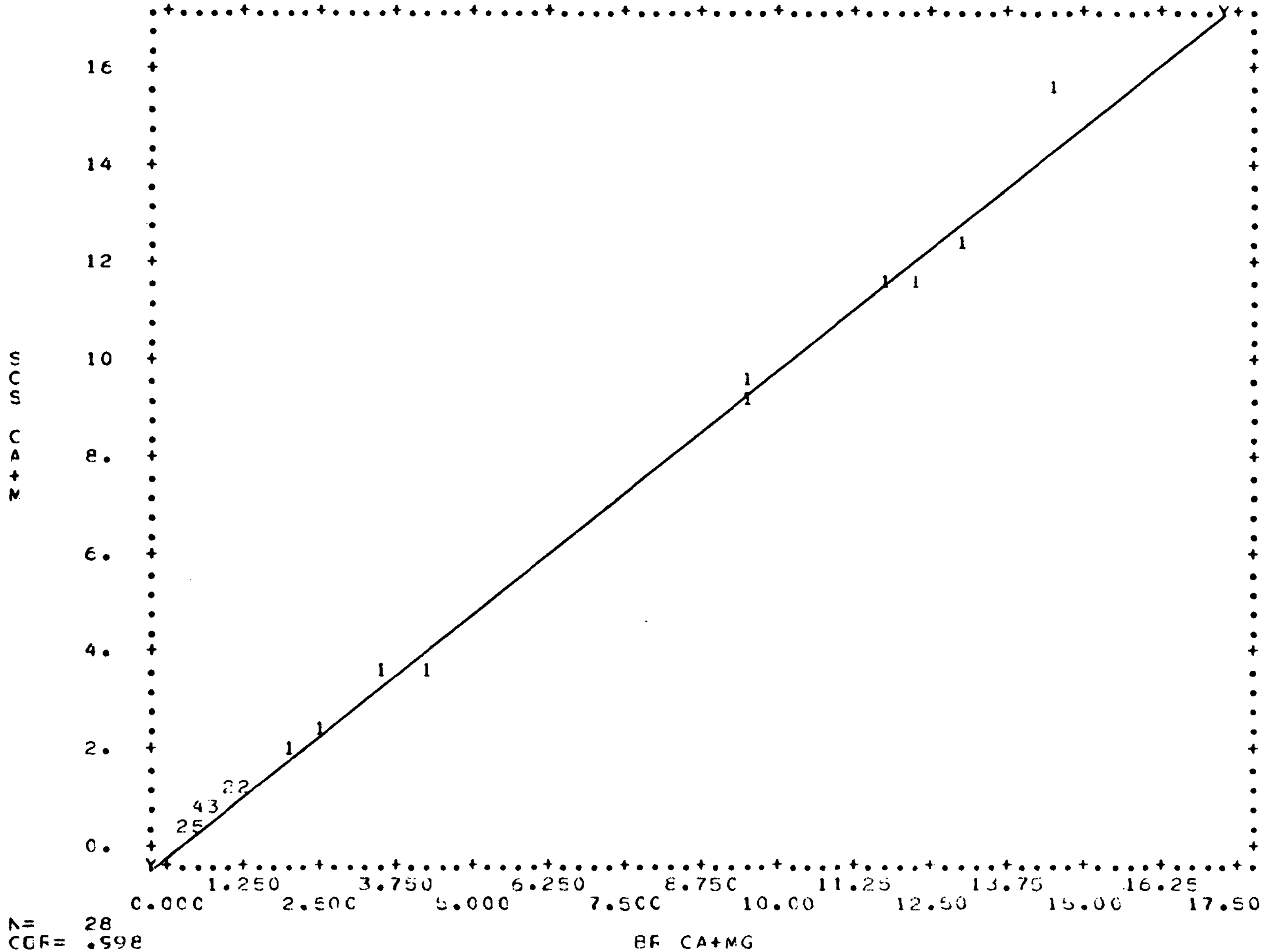
Fig. 119 - Extractable Na according to SNLCS and SCS analyses.



N= 27
CCR= .939

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.13444	.17794	X= .64262*Y-.00717	.00387
Y	.22037	.26012	Y= 1.3733*X+ .03574	.00827

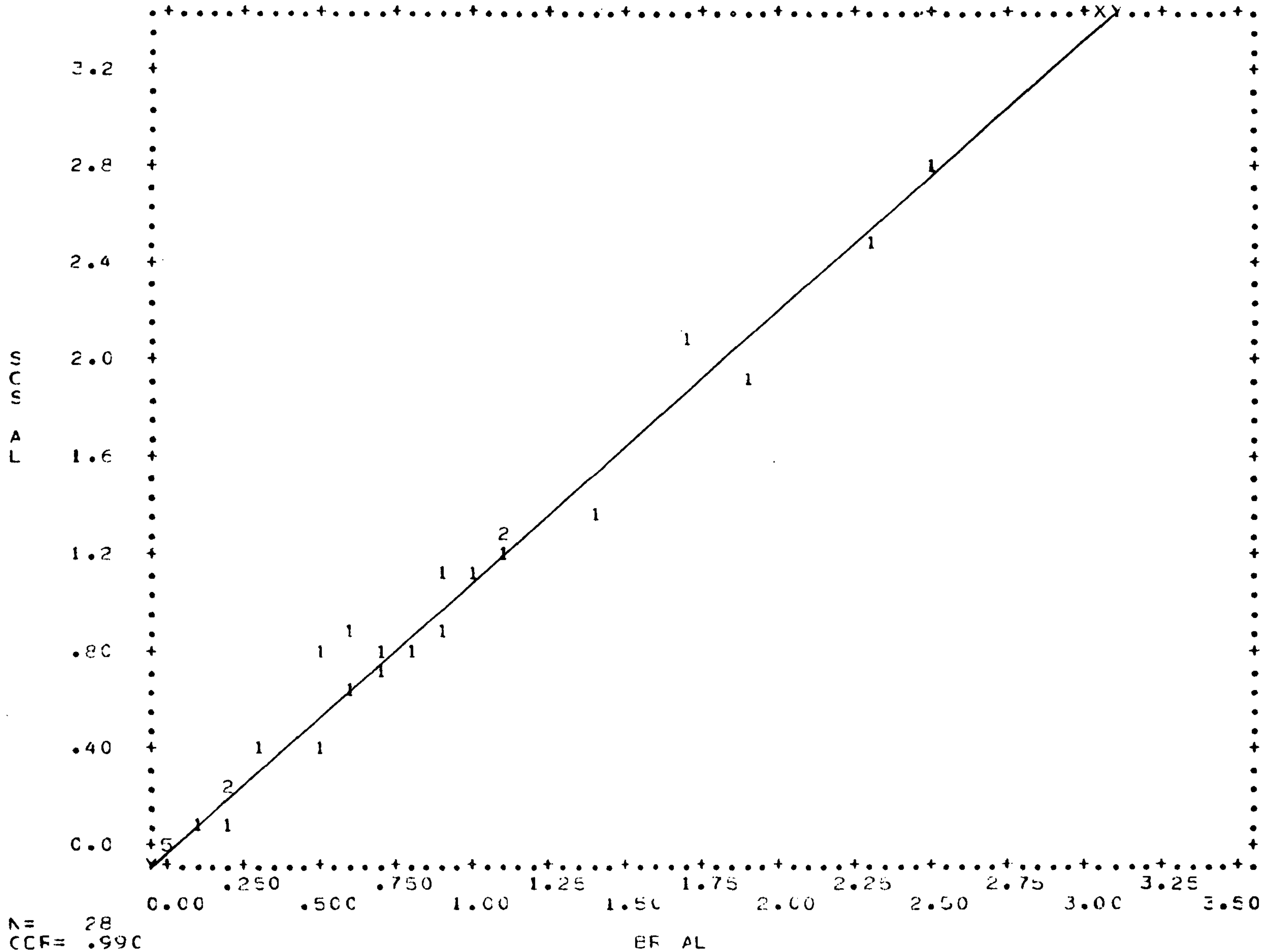
Fig. 120 - Extractable K according to SNLCS and SCS analyses.



N= 28
COR= .998

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	3.4000	4.6133	X= 1.0004*Y+ .08423	.10364
Y	3.3143	4.6004	Y= .99487*X-.06826	.10305

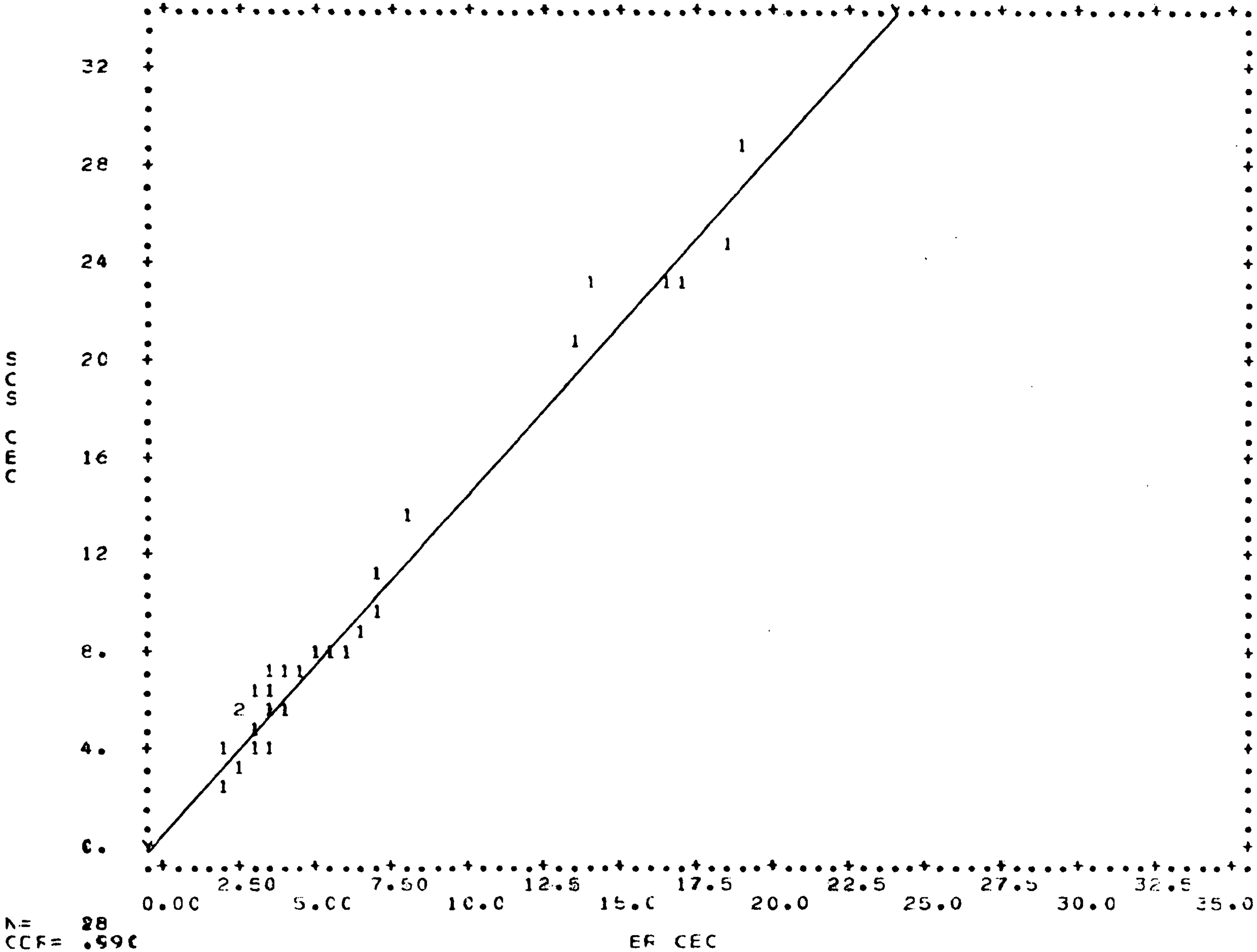
Fig. 121 - Extractable Ca + Mg according to SNLCS and SCS analyses.



N= 28
CCF= .990

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	.76071	.69673	X= .89097*Y+ .00880	.01016
Y	.84392	.77407	Y= 1.0998*X+ .00732	.01254

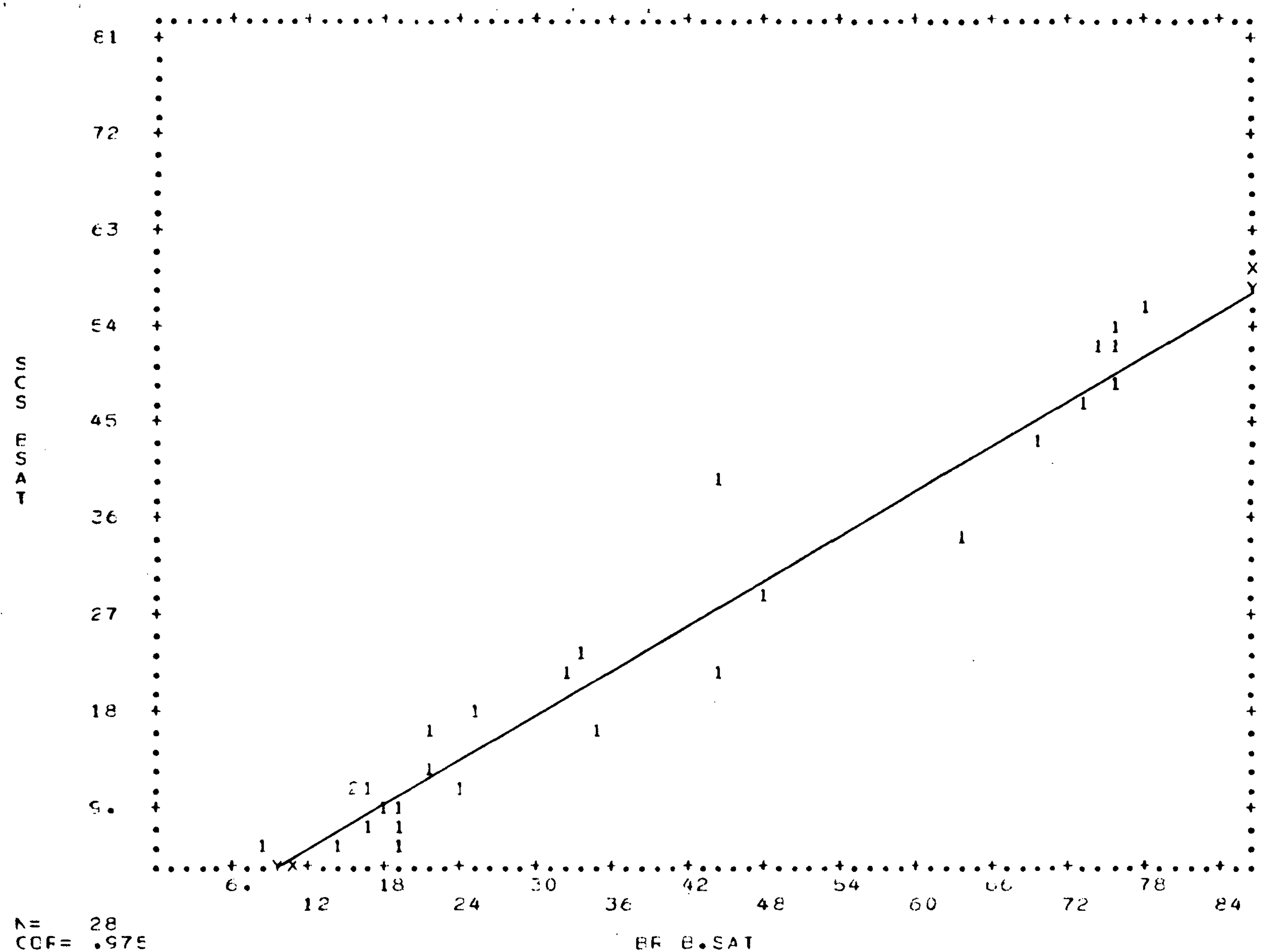
Fig. 122 - Extractable Al by N KCl according to SNLCS and SCS analyses.



N= 28
CCF= .590

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	6.8428	5.4488	X= .70447*Y-.45600	.59046
Y	10.361	7.6602	Y= 1.3923*X+ .83331	1.1670

Fig. 123 - SCS cation exchange capacity by sum of cations (bases + acidity at pH 8.2) versus SNLCS by sum of cations (bases + acidity at pH 7.0).



N= 28
COR= .975

	MEAN	ST.DEV.	REGRESSION LINE	RES.MS.
X	28.357	24.336	X= 1.3439*Y+ 5.8166	30.394
Y	24.214	17.656	Y= .70735*X-2.9177	15.998

Fig. 124 - SCS base saturation as per sum of cations (bases + acidity at pH 8.2) versus SNLCS as per sum of cations (bases + acidity at pH 7.0).

CALCULATED CATION EXCHANGE CAPACITIES FOR SOME BRAZILIAN SOILS

F. R. Moormann

The T-value as determined by the Serviço Nacional de Levantamento e Conservação de Solos (SNLCS) has been compared with other CEC determinations in several studies (see **Bragantia,** 34-21, p. 312). The following relation was found between NH_4OAc-CEC in meq at pH 7 (CEC 7) and the Brazilian T-value in meq (TBr):

$$CEC\ 7 = 1.39\ TBr - 0.01,\ r = 0.98 \qquad (1)$$

Another regression was developed using NH_4OAc-CEC in meq per 100 g clay calculated from the data provided by the Soil Conservation Service (SCS) of the U.S. Department of Agriculture for pedons BR 3,6,19,23 and 30, and the corresponding T-values in meq per 100 g clay calculated from the SNLCS data. The regression equation is:

$$CEC\ 7/100\ g\ clay = 1.23\ (TBr/100\ g\ clay) + 2.72,\ r = 0.95 \qquad (2)$$

In the table below, the calculated NH_4OAc-CEC values are presented for the B and C horizons of pedons BR 1 through 31. The columns contain the following data:

(1) Horizon designation

(2) Depth of horizon in cm

(3) SNCL CEC (TBr) per 100 g clay in meq

(4) NH_4OAc-CEC in meq per 100 g clay as determined by SCS

(5) NH_4OAc-CEC in meq per 100 g clay, calculated by equation (1) and related to clay content data by SNLCS

(6) NH_4OAc-CEC in meq per 100 g clay according to equation (2)

TABLE 3 - Comparison of CEC/100g clay SNLCS determinations by sum of cations (bases + acidity pH 7.0) with SCS determinations in some paired samples by NH_4OAc pH 7.0 and calculated values by regression equations (1) and (2).

(1)	(2)	(3)	(4)	(5)	(6)
Br 1					
B1	25-40	18.4	-	25.5	25.3
B2	40-125	13	-	18.0	18.7
II B31	125-220	11.3	-	15.7	16.6
II B32	220-260 +	10.3	-	14.3	15.4
Br 2					
B1t	40-80	10.6	-	14.7	15.8
B21t	80-103	9.5	-	13.2	14.4
B22t	103-150	9.1	-	12.6	13.9
B31t	150-200	9.7	-	13.5	14.7
B32t	200-260	15.6	-	21.6	21.9
Br 3					
II B21t	57-73	10.7	15.4	14.8	15.9
II B21t	73-113	9.8	16.7	13.6	14.8
C1	173-210	13.4	19.1	18.6	19.2
Br 4					
B1t	27-46	9.6	-	13.3	14.5
B21t	46-77	9.8	-	13.6	14.8
B22t	77-110	8.6	-	12.0	13.3
B23t	110-160	8.8	-	12.2	13.5
B31t	160-230	6.9	-	9.6	11.2
B32t	230-290 +	6.9	-	9.2	10.8
Br 6					
B1t	15-32	23.4	32.0	32.5	31.5
B21t	32-74	17.2	26.4	23.9	23.8
B22t	75-154	17.1	27.3	23.8	23.8
B3t	154-227	23.9	38.5	33.2	32.7
Br 7					
B1	30-80	11.1	-	15.4	16.4
B21	80-150	9.3	-	12.9	14.2
B22	150-235	7.5	-	10.4	12.0
B23	235-275	7.6	-	10.5	12.1
B3C	275-325	8.8	-	12.2	13.5

(1)	(2)	(3)	(4)	(5)	(6)
<u>Br 8</u>					
B1t	10-25	16.7	-	23.2	23.3
B21t	25-73	11.0	-	15.3	16.2
B22t	73-168	8.8	-	12.2	13.5
B23t	168-229	11.6	-	16.1	17.0
B3	229-260	15.2	-	21.1	21.4
<u>Br 9</u>					
B21t	27-47	21.3	-	29.6	28.9
B22t	47-78	17.8	-	24.7	24.6
B23t	78-117	16.7	-	23.2	23.3
B24t	117-230	11.1	-	15.4	16.4
B3	230-330	15.8	-	22.0	22.2
C	330-390 +	15.8	-	22.0	22.2
<u>Br 10</u>					
II B1t	43-52	19.4	-	27.0	26.6
III B21t	52-84	14.5	-	20.2	20.5
III B22t	84-113	12.0	-	16.7	17.3
IV B3t	113-142	11.2	-	15.6	16.5
IV C1	142-198	16.4	-	22.8	22.9
IV C2	198-250 +	20.7	-	28.8	28.2
<u>Br 11</u>					
B1t	23-40	20.7	-	28.8	28.2
B21t	40-70	16.8	-	23.4	23.4
B22t	70-130	14.7	-	20.4	20.8
II B31t	130-188	15.8	-	22.0	22.2
II B32t	188-260	16.1	-	22.4	22.5
II C1	260-320	15.6	-	21.7	21.9
II C2	320-430 +	24.2	-	33.6	32.8
<u>Br 12</u>					
B21t	44-130	12.9	-	17.9	18.6
B22t	130-168	12.6	-	17.5	18.2
B23t	168-245	10.0	-	13.9	15.0
B3t	245-285	8.0	-	11.2	12.6
C	285-420 +	13.3	-	18.5	19.1

(1)	(2)	(3)	(4)	(5)	(6)
<u>Br 13</u>					
B1	32-45	13.5	-	18.8	19.3
B21	45-75	10.9	-	15.2	16.1
B22	75-230	8.1	-	11.3	12.7
B31	230-350	8.1	-	11.3	12.7
B32	350-440	15.0	-	20.9	21.2
C	440-470 +	20.0	-	27.8	27.3
<u>Br 14</u>					
B1	81-101	12.8	-	17.8	18.5
B21	101-140	5.7	-	7.9	9.7
B22	140-230	5.2	-	7.2	9.1
B3	230-310	8.3	-	11.5	12.9
C1	310-360	11.2	-	15.6	16.5
C2	360-410 +	12.1	-	16.8	17.6
<u>Br 15</u>					
II B22t	71-95	35.6	-	49.5	46.5
II C1	107-135	38.3	-	53.2	49.8
II C2	135 +	33.9	-	47.1	44.6
<u>Br 16</u>					
II B1t	40-60	9.4	-	13.1	14.3
II B2t	60-88	7.5	-	10.4	11.9
III B3tpl	88-168	10.0	-	13.9	15.0
III C pl	168-258 +	12.1	-	16.8	17.6
<u>Br 17</u>					
II B1t	32-60	19.1	-	26.5	26.2
II B2t	60-105	18.0	-	25.0	24.9
II B3t	105-150	17.4	-	24.2	24.1
II C	150-160 +	16.3	-	22.7	22.8
<u>Br 18</u>					
II Bt	33-50	36	-	50	47
II C	50-60	54	-	75	69

(1)	(2)	(3)	(4)	(5)	(6)
Br 19					
II B2t pl	38-52	13.9	22.9	19.3	19.8
II B3t pl	52-82	12.6	21.9	17.6	18.2
II C pl	82-100	13.2	25.1	18.3	19.0
Br 20					
B1t	95-112	9.2	-	12.8	14.0
B21tx	112-133	7.3	-	10.1	11.7
B22tx	133-145	6.9	-	9.6	11.2
B23t	145-200 +	6.6	-	9.1	10.8
Br 21					
B1	40-90	9.1	-	12.6	13.9
B2	90-130 +	7.2	-	10	11
Br 22					
B1	20-40	15.8	-	22.0	22.2
B21t	40-75	9.4	-	13.11	14.3
B22t	75-115	9.5	-	13.2	14.4
B3t	115-150	14.2	-	19.7	20.2
C	150-170 +	19.0	-	26.4	26.0
Br 23					
B1t	37-68	8.1	18.1	11.3	12.7
B21t	68-102	5.8	14.6	8.1	9.9
B22t	102-154	5.8	8.3	8.1	9.9
B23t	154-214	4.9	8.6	6.8	8.7
B3t	214-270 +	5.7	11.1	7.9	9.7
Br 24					
B1	22-55	8.4	-	11.7	13.1
B21	55-100	7.5	-	10.4	11.9
B22	100-170	6.1	-	8.5	10.2
B3	170	5.4	-	7.5	9.4
C	234-300 +	7.5	-	10.4	11.9

(1)	(2)	(3)	(4)	(5)	(6)
Br 25					
B1t	20-65	8.7	-	12.1	13.4
B21t	65-105	8.2	-	11.4	12.8
B22t	105-150	10.7	-	14.9	15.9
B3t	150-205 +	14.6	-	20.3	20.7
Br 27					
II Bt	45-110	16.0	-	22.2	22.4
II C1	110-260	22.2	-	30.8	30.0
Br 28					
B1t	15-35	14.4	-	20	20.4
B21t	35-70	10.4	-	14.5	15.5
B22t	70-160	10.2	-	14.2	15.3
B3t	160-220	11.8	-	16.4	17.2
C	220-250 +	13.2	-	18.3	19.0
Br 29					
II B12tpl	118-158	13.1	-	18.2	18.8
II B13tpl	158-200	15.1	-	21.0	21.3
Br 30					
B21t	38-62	9.4	14.7	13.1	14.3
B22t	62-82	8.4	13.7	11.7	13.1
B23t	82-125	8.7	-	12.1	13.4
B24t	125-142	8.9	-	12.4	13.7
B25	142-190	6.8	-	9.5	11.1
B26	190-220 +	5.7	11.2	7.9	9.7
Br 31					
B1t	46-65	10.6	-	14.7	15.8
B21t	65-110	10.3	-	14.3	15.4
B22	110-155	8.8	-	12.2	13.5
B23	155-200	7.4	-	10.3	11.8

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APPENDIX

CONTRIBUITONS TO DESCRIPTIONS, SAMPLING AND ANALYTICAL CHARACTERIZATION

SNLCS STAFF RESPONSIBLE FOR THE IDENTIFICATION, DESCRIPTION AND SAMPLING OF SOILS, ANALYTICAL CHARACTERIZATION BY SNLCS, AND PREPARATION OF THE SOIL STUDY TOUR GUIDE

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ANALYTICAL CHARACTERIZATION OF PAIRED SAMPLES OF SELECTED PEDONS

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X-RAY DIFFRACTION ANALYSIS OF SELECTED HORIZONS OF THE PEDONS STUDIED

H. Ikawa, Department of Agronomy and Soil Science, University of Hawaii

WORKSHOP PROGRAM

19 Jun 77	Sunday		Participants convene in Rio de Janeiro, Hotel Everest, Ipanema
20 Jun 77	Monday	0900	OPENING SESSION Chairman: E. H. Gross Braun, Chief of SNLCS Welcome -- A. Blumenschein, Executive Director, EMBRAPA Opening address -- F. H. Beinroth
		1030	SESSION I: Soil Taxonomy and the Soils of the Tropics Chairman: F. H. Beinroth UPR's "state-of-the-art" studies in soil classification -- R Guerrero
		1400	Proposals for changes in Soil Taxonomy and related research
21 Jun 77	Tuesday	0900	SESSION II: Classification of Alfisols and Ultisols with Low Activity Clays Chairman: F. R. Moormann Status and progress of Committee work -- F. R. Moormann
		1400	Chemistry of soils with mixtures of pH-dependent and permanent charge minerals -- G. Uehara Comparison of analytical data from four soil laboratories on three soils of the Kindaruma area in Kenya -- W. G. Sombroek Reports by Committee members and discussion
22 Jun 77	Wednesday	0830	Field trip in the vicinity of Rio de Janeiro, approx. 160 km Soils: BR 1 - Tropeptic Haplorthox BR 2 - Oxic Haplustalf BR 3 - Oxic Haplustult

			BR 4 - (Typic) Paleustult BR 5 - Typic Albaquult
23 Jun 77	Thursday	0830	SESSION III: Chemical, Physical and Mineralogical Properties of Low Activity Clays Chairman: G. Uehara
			The chemistry and physics of low activity clays -- G. Uehara
			Panel discussion
		1530	Lv. Rio de Janeiro by air
		1930	Ar. Londrina
			Overnight in Londrina, Hotel Bourbon
24 Jun 77	Friday	0830	SESSION IV: Pedogenetic Processes in Soil Classification Chairman: R. Tavernier
			Importance of mineral constituents in pedology -- P. Segalen
			Characteristics and processes of ferrallitic soils -- A. Perraud
			Discussion
		1330	Field trip in the vicinity of Londrina, approx. 80 km
			Soils: BR 6 - Rhodic Paleudalf
			Overnight in Londrina, Hotel Bourbon
25 Jun 77	Saturday	0700	Field trip, Londrina-Curitiba, approx. 440 km Soils: BR 7 - Typic Eutrorthox BR 8 - Orthoxic Palehumult BR 9 - Typic Paleudult BR10 - Typic Haplohumult
			Overnight in Curitiba, Hotel Lancaster

26 Jun 77	Sunday	0730	Field trip, Curitiba-Guaratuba-Curitiba, approx. 340 km <u>Soils</u>: BR 11 - Typic Hapludult BR 12 - Typic Paleudult BR 13 - Tropeptic Haplorthox Overnight in Curitiba, Hotel Lancaster
27 Jun 77	Monday	0900	Field trip in the vicinity of Curitiba, approx. 50 km <u>Soils</u>: BR 14 - Typic Acrohumox BR 15 - Typic Haplumbrept
		1220	Lv. Curitiba by air
		1735	Ar. Aracaju Overnight in Aracaju, Hotel Beiramar
28 Jun 77	Tuesday	0730	Field trip, Aracaju-Maceió, approx. 320 km <u>Soils</u>: BR 16 - (Plinthic) Paleustult BR 17 - Typic Haplustult BR 18 - Ultic Paleustalf BR 19 - Oxic Haplustalf BR 20 - Arenic Fragiudult Overnight in Maceió, Hotel Beiramar
29 Jun 77	Wednesday	0700	Field trip, Maceió-Recife, approx. 260 km <u>Soils</u>: BR 21 - Typic Haplorthox BR 22 - Orthoxic Tropudult BR 23 - Typic Paleudult BR 24 - Typic Paleudult BR 25 - Rhodic Paleudult BR 26 - Epiaquic Tropudult Overnight in Recife, Hotel Miramar

30 Jun 77	**Thursday**	0730	Field trip, Recife-Aliança-Goiana-Recife, approx. 240 km
			<u>Soils</u>: BR 27 - Epiaquic Paleustult BR 28 - (Oxic) Paleustult BR 29 - Typic Dystropept BR 30 - Typic Paleudult BR 31 - Typic Paleudult
			Overnight in Recife, Hotel Miramar
1 Jul 77	**Friday**	0900	<u>FINAL SESSION</u> Chairmann: E. H. Gross Braun
			Committee work and progress in perspective -- F. R. Mormann
			Summary of proposals for changes in Soil Taxonomy and recommendations -- F. H. Beinroth
			Closing remarks -- F. H. Beinroth
			Vote of thanks -- F. R. Moormann
		1200	Adjourn

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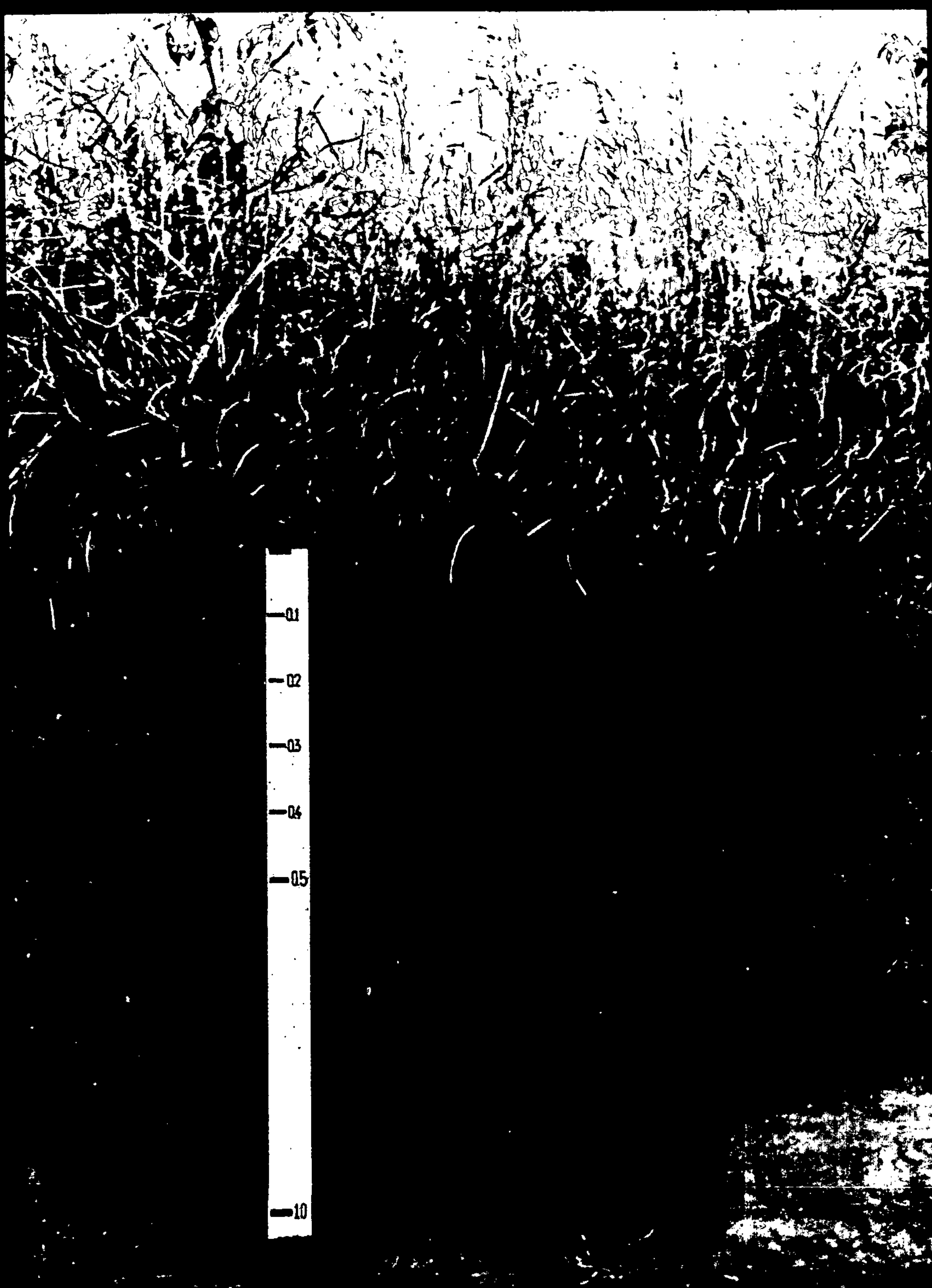
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