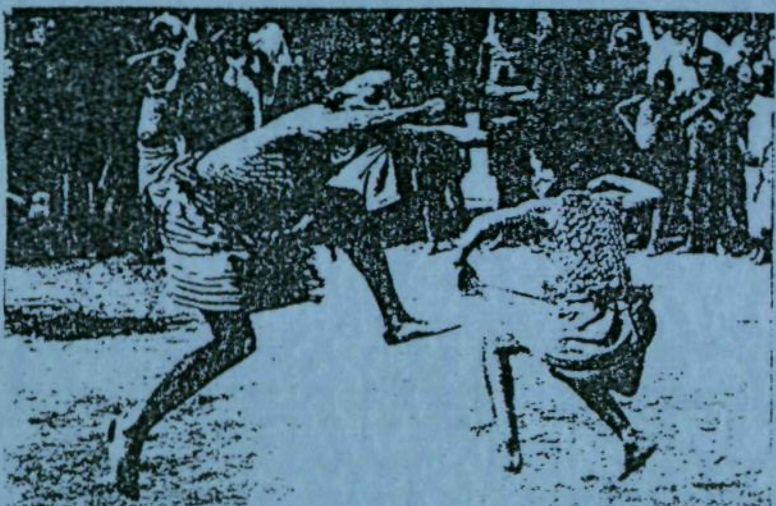
A REVIEW OF DEEP, WELL DRAINED UPLAND SOILS IN NORTHERN MOZAMBIQUE, BASED ON EXISTING SOIL REPORTS.



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A REVIEW OF DEEP, WELL DRAINED UPLAND SOILS IN NORTHERN MOZAMBIQUE, BASED ON EXISTING SOIL REPORTS.

Contents

1 INTRODUCTION.

Deep well drained soils cover vast areas of the northern half of Mozambique and constitute of one of the country's most important land reserves. As they represent a vast potential for agricultural production, the management of the deep, well drained upland soils is most important if the much needed food production is to be sustained.
From 1960 untill 1983, several soil survey reports were published describing these soils in northern Mozambique. These soil surveys have been executed by the national agricultural research institute of Mozambique (INIA, formerly IAM) and by several engineering consultancy offices like COBA, Hidrotecnica Portuguesa (both Portuguese) and Tecnosynesis (Italien).
However, never an attempt has been made to inventory the considerable amount of information, accumulated in reports over 23 years, in order to obtain an overview of those deep, well drained upland soils. By cha-racterizing these soils, information can be obtained as to how they could be managed.
In the late 1970's, this subject was broached by Mr.Kauffman, working at INIA, 'Instituto Nacional de Investigacao Agronomico' (the national agricultural research institute) in Maputo in that time. About 60 deep, well drained soil profiles from northern Mozambique were selected, and several soil characteristics were visualized in graphs. This was all done manual because of the lack of computer facilities.

From this first attempt a comprehensive study on 20 newly located, described, sampled and analysed soil profiles has been proceeded. These 20 profiles will be used as a reference base of the deep, well drained, clayey soils of northern Mozambique.
In order to examine the usefulness of soil data, resulting from old soil studies, this study arose from the previous attempt with 60 soil profiles.

The existing information on the morphological, chemical and physical properties of 140 soil profiles has been collected and is reviewed in terms of variability in soil properties, criteria for soil classification and relevant soil forming processes.

Soil analytical and morphological data obtained by old soil studies should be handled with care. There is a wide range in analytical methods and morphological observations within the 23 years timespan. From a theoretical point of view, it would be preferable to collect all soil samples once again and analyse them in one and the same laboratory at one time. But a pragmatical approach has been chosen, resulting in a reduced number of soil characteristics of which analytical methods did not change (or hardly changed) and therefore were expected to be sufficiently reliable to use for this study.

The contents of this report is the following:
Chapter 2 describes the methodology used in collecting and studying the soil profiles.
Chapter 3 contains an environmental sketch of northern Mozambique (geology, climate, vegetation and landuse) with a description of the location of the soil profiles used.
Chapter 4 gives information on the reliability of the sources of

soil analytical data (changes in soil analytical methods, reliability of soils data, omitted soil characteristics).
Chapter 5 characterizes the whole data set of deep, well drained upland soils by means of variability of soil properties.
Chapter 6 describes the criteria used for classifying soils by means of the FAO- and Soil Taxonomy- classification systems.
In chapter 7 relevant soil forming processes and functional relationships between soil characteristics are discussed.
At last, some conclusions are drawn in chapter 6.
The appendices consist of:

- the data file of all soil characteristics (appendix 1)
- the soil profile descriptions of the 20 reference profiles (appendix 2)
- the soil profile location map (appendix 3).

This report is written for the department of soil science and geology, section tropical soil science, of the agricultural university, Wageningen, the Netherlands. Its fits in with the fulfilling of the authors study in tropical soils.

At last I would like to thank Mr.Kauffman and Mr.Jordens for their support in writing this study and Mr.Bomer for drawing the location map. Compilation of this study would not have been possible without the initial work of Mr.Kauffman in Mozambique.

2 METHODOLOGY.

In May and June 1983, the soil survey reports dealing with deep, well drained upland soils of northern Mozambique, present in the library of INIA, Instituto National de Investigacao Agronomico (the national agricultural research institute) in Maputo, were investigated. Out of 20 soil surveys, who where executed from 1960 till 1983, 184 soil profiles who met the requirements of deep, well drained upland soils were selected.
The requirements were:
All mature soils

- having free or slightly impeded drainage (lacking strong hydromorphic properties),
- having a uniform subsoil color redder than 7.5YR
- which are not sandy,
- which are not shallow (rooting depth deeper than 1 m.).

The approximate equivalents on soil group level of the FAO- and on order level of the Soil Taxonomy-classification systems are given below.

FAO - Ferralsols, acrisols, luvisols, nitosols, cambisols and phaeozems.
ST - Oxisols, ultisols, alfisols and mollisols.

The analytical and morphological data of these 184 soil profiles were copied and were taken to the International Soil Reclamation and Information Centre, the ISRIC, Wageningen, the Netherlands.
In May and June 1985, analytical and morphological data of 146 soil profiles have been stored in a database, with the aid of a data base management program, called Dbase II and a Digital Rainbow personal computer at the department of soil science and geology of the Agricultural University of Wageningen.
From the original 184 profiles, 38 were rejected for this study because of the lack of essential data.
Two out of the 20 soil surveys were totally excluded from storing them. One soil report, 'Os solos de Murrupula' 1961, because of not provided analytical data. The other, a soil survey executed by the South-African consultancy office Loxton & Hunting, because of a deflecting textural division in coarse, medium and fine sand, in stead of the more common division in coarse and fine sand. Besides this, the soil samples from the latter survey were analysed in South-Africa and not in Mozambique, like all other soil surveys, bringing on deviating analytical methods.

With an unified program of multi-function 'library' of statistical analysis and support programs, called STATPAK, all further computing has been executed. An explanation of stored and excluded soil characteristics will be given in chapter 4.
Three data files have been made:

1) Soil characteristics as they were analysed at the INIA-laboratory (pH, exchangeable bases, organic matter, etc.).
2) Derived soil characteristics obtained by calculations of data of soil characteristics (CEC, C/N ratio, S/C ratio, etc.).

3) Morphological properties.

First, sandy soils, with a subsoil containing less than 15% clay, were excluded, in order to exclude soils like psamments (ST) or arenosols (FAO) to be grouped together with the deep, well drained upland soils. In fact, the remaining 140 soil profiles out of 18 soil surveys can be characterized as deep, well drained <u>clayey</u> upland soils.

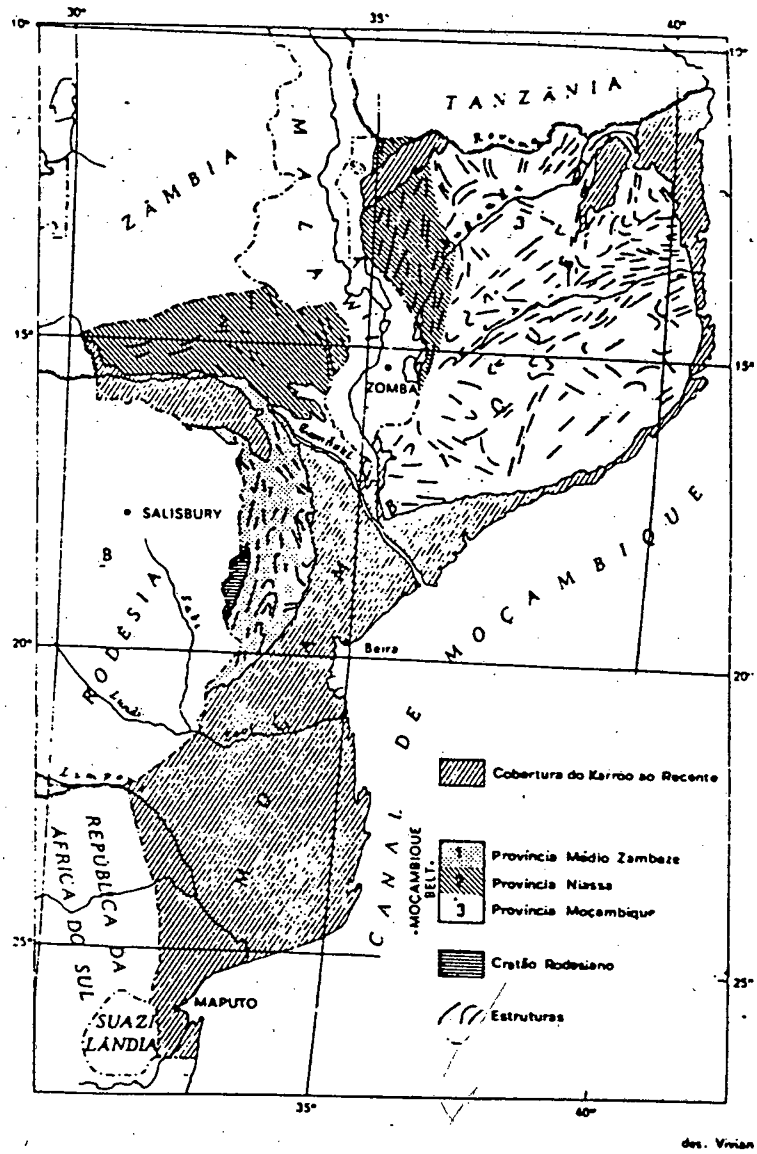


Fig. 3.1 Major geological division of Mozambique.
(after Holmes 1948)

3 ENVIRONMENTAL SKETCH AND LOCATION OF THE SOIL PROFILES.

In this chapter, a brief overview will be given of environmental factors of northern Mozambique as well as information about the location of the 140 soil profiles.
Paragraph 3.1 contains information about environmental factors like: geology, geomorphology, climate, vegetation and land use.
Paragraph 3.2 deals with the location of the soil profiles from the 18 soil surveys. A location map is appended (appendix 3).

3.1 Geology, climate, vegetation and landuse.

Geology.

A considerable part of northern Mozambique is occupied by Precambrium shields, called the Mozambican Belt or 'Socco Antigo'.
Holmes (1948) devided the precambrium shields on the main direction of faulting and their topographical height. On base of this division, three main shields can be distinguished (see Fig.3.1):

1) Zambeze shield.
2) Niassa shield.
3) Mozambique shield.

Shields no. 2 and 3 are of importancy for this study.

The Niassa shield (no.2), located on both sides of Lake Malawi, has a relative high topographical position with an altitude of about 1350 m and has a dominant N-S faulting direction. This high elevation and N-S faulting is a result of the position of the Niassa shield along the most southern part of the East African rift valley, Lake Malawi. The subsiding, uplifting and faulting activity of this rift valley originated in the uplift of the Niassa shield, causing a fault direction parallel to that of the rift valley.
The major rock types consist of bands of granites and gneisses.

The Mozambique shield (no.3) has a (lower) altitude of 200-800 m and the dominant fault direction is WSW-ENE, which is regarded to be older than the N-S fault direction of the Niassa shield.
The major rock types consist of bands of granites and gneisses alternating with bands of quartzites, schists and metamorphised marbles.

From a geomorphological point of view, these precambrium shields can be characterized as peneplains with an undulating to (sometimes) rolling topography. Striking in these landscapes is the presence of Inselbergs, remnants of resistent, non-eroded, mostly granite rocks. The undulating topography indicates that landscape-development is in a mature state.

Climate.

In general, the climate of northern Mozambique can be described as a moist savanna type climate with one wet and one dry season.
According to the Koppen classification, about 80% of northern Mozambique can be classified as Aw, which is moist savanna. Higher alti-

MOZAMBIQUE 1 : 12.000.000

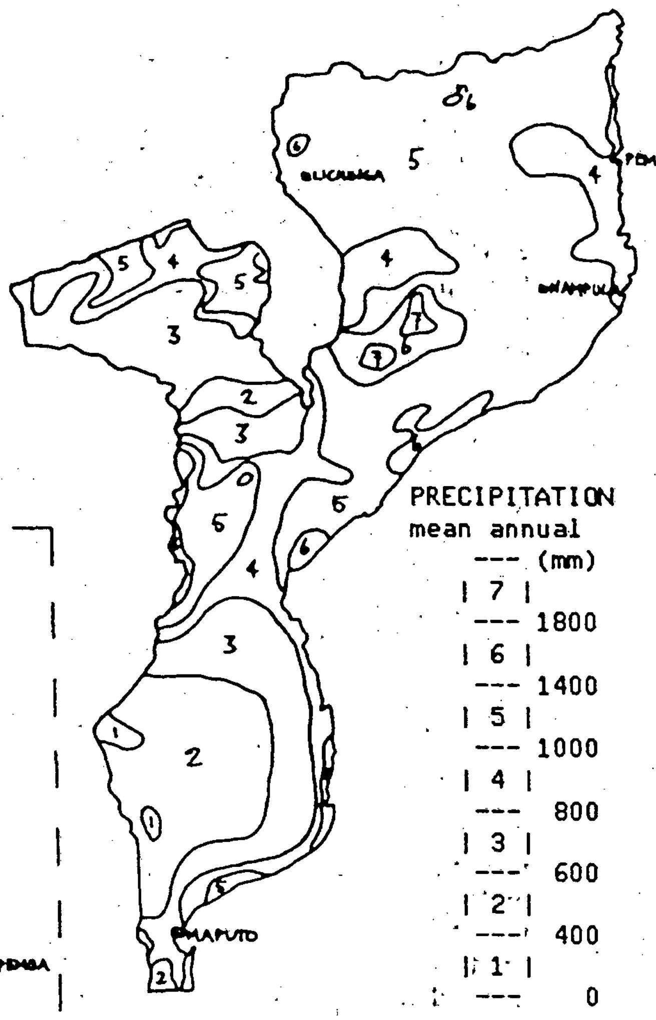


Fig. 3.2 Mean annual precipitation.

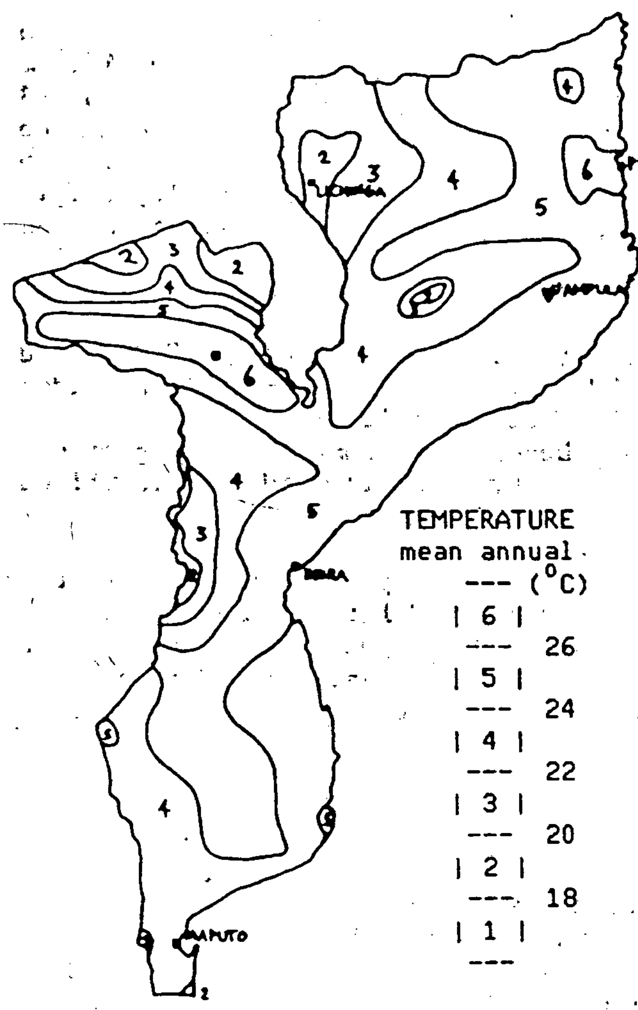


Fig. 3.3 Mean annual temperature.

tudes, such as the Niassa shield, can be classified as Cwb, which indicates tropical high altitudes.

In the cold, dry season (May - October) the monthly rainfall is less than 60 mm, whereas in the warm, wet season rainfall exceeds 200 mm in some months.
The mean annual rainfall and temperature are shown in fig.3.2 and 3.3. The mean annual rainfall ranges from 800 - 1400 mm. The mean Penmann annual evapotranspiration is about 1450 mm, but on the topographical higher positions it decreases to 1250 mm.
Precipitation only exceeds evapotranspiration in the wet season. The surplus of rainfall over evapotranspiration ranges from 250 mm in the East up to 500 mm in the West.
The soil moisture regime can be considered as mainly being ustic.

The mean annual temperature decreases with increasing altitude. Some places on the Niassa shield have a mean annual temperature of 18-20°C, whereas the mean annual temperature along the East-coast exceeds 26°C. The monthly fluctuation of the mean temperature is about 5°C between the cold and warm season.
The approximate soil temperature regimes are (iso)thermic and (iso)-hyperthermic.

Vegetation and land use.

The overall vegetation type in northern Mozambique is miomba woodland. This miomba woodland is far from homogeneous and is often interspersed with other forest associations.
On the high elevated Niassa shield, a woodland of Brachystegia species with frequent occurence of Julbernardia Globiflora is present. This type of woodland is restricted to altitudes of 900-1350 m, with an annual precipitation of 800-1100 mm.
At lower altitude (lower than 1000 m) Julbernardia Globiflora becomes more dominant. Here, the miomba woodland is interspersed with patches of Acacia species, Hyparrhenia grassland (when the drainage is impeded or as a result of burning) and bamboo forest (Oxytenanthera Abyssinica).
Towards the lower plains (200-600 m) decidious dry miomba savanna and a discontinuous dry savanna are found. The woodlands are dominated by Brachystegia species and the dryer savannas are composed of Adansonia (Baobap tree) and Sterculia.
In the lowest zones, tree savannas with Acacia species are present. (Sources: Flora Zambesiaca 1968).

The agricultural activities in northern Mozambique can be devided into three sectors:

1) Family sector.
2) Cooperatives.
3) State farms.

The family sector agriculture is based on a system of shifting cultivation with varying fallow periods.
In the Nampula and Cabo Delgado provinces the deep red clay soils are very intensively used, sometimes even for 15 consequent years without a fallow period. The most important crops are millet, maize and sorghum. The sandier soils are more extensively used. Cassave, beans and

peanuts are common crops on these soils.
This sector can be characterized as subsistence agriculture with low capital input and low technological level.
The state farms, on the contrary, have high capital input and high technological level. Mainly cash-crops like cotton and sunflower are produced, although maize and beans are grown in large areas as well.
The cooperatives are intermediate between these two sectors, with relation to capital input, technological level and crops grown.

On higher elevated places, crops like potatoes and wheat are grown, due to the lower temperature and lower evapotranspiration.

3.2 Location of the soil profiles.

The finally selected number of 140 soil profiles originate from 18 soil survey reports (see table 3.4). These soil surveys have been executed in the 5 northern provinces of Mozambique: Niassa, Cabo Delgado, Nampula, Zambezi and Tete.
The objects as well as the scale of all studies are of great variability. A number of soil surveys were focussed on the object to investigate in a detailed way the variability of soils on agricultural experimental posts (report no.6, 7, 8 and 10). Other detailed surveys aimed on the suitability of soils in a certain area for irrigation (report no.12 and 14). The large scale, reconaissance, surveys (report no.13,15,16 and 18) have been executed in order to make inventories of natural soil resources of certain areas.
Report no.1 (in preparation) is a comprehensive study of 20 deep, well drained clayey soils which are representative for large areas in northern Mozambique. Twenty locations have been selected as reference soils, covering a wide range in site characteristics such as altitude, geology, landform and vegetation. Six profiles from these 20 pedons were selected for monolith preparation and additional research. The 20 profiles are to be used as a reference base, and therefore will be indicated in this study as reference profiles.

In all surveys, morphological descriptions of soil profiles have been made. Of all samples, analysis was executed by the INIA-laboratory (formerly IICM, IAM and IIAM) in Maputo (formerly Lourenco Marques).

The appended soil profile location map indicates the location of all soil surveys by report numbers, and all soil profiles by profile numbers.
The twenty reference profiles are indicated with ▲ (a triangle).
Some single soil profile locations are not exactly known. In order to seperate them from exact known locations, the former are indicated with a + (a plus), whereas the latter are indicated as . (points).
In the soil reports no.2,4,9 and 12 the location of soil profiles is not given at all. In that case, the boundaries of the survied areas are indicated as  .

On the next page (table 3.4), all soil surveys are stated with:
1) Their complete names.
2) The number of profiles which are selected from each soil

report (not to be confused with the profile number!).

3) The publication scale of the study.
4) The row numbers in the appended data matrix of all soil characteristics.

Table 3.4

a*/ b*	c*	Name and scale of soil survey	d*
1/ 1-20	20	Deep, well drained red clayey soils of Mozambique. J.H.Kauffman (in prep).	1-141
2/21-26	6	Os solos de Muite (Imala). J.F.Casimiro. 1:500.000	142-159
3/27-28	2	Os solos de Nipende (Lalua, Ribaue). J.F. Casimiro. 1:40.000	160-165
4/29-33	5	Alguns solos de Netia (Monapo). J.F.Casimiro. 1:20.000	166-180
5/34-35	2	Alguns solos de Litunde (Vila Cabral). J.F. Casimiro. 1:50.000	181-186
6/36-38	3	Os solos do posto agronomico de Namapa. J.F Casimiro. 1:5.000	187-195
7/39-41	3	Os solos do posto agraria de Mutuali. J.F. Casimiro. 1:5.000	196-207
8/42-43	2	Os solos do posto agronomico de Nampula. J.F.Casimiro. 1:5.000	208-215
9/44-51	8	Reconhecimento dos solos da paste da bacia hidrografica do rio Malema. 1:100.000	216-248
10/52-54	3	Os solos de estacao agraria de Ribaue. A.Sa e Melo Marques. 1:40.000	249-263
1[illegible]-56	2	(published in 'Agronomia Mocambicana' Vol.7 no.1.	264-272
12/57-62	6	Regadio de Matama, estudo pedologico e interpretacao de fotografias aereas, Lichinga Niassa.A.Jansen and M.F.Vilanculos.1:40.000	273-290
13/63-83	21	The soils of Angonia district, province of Tete, Mozambique. 1:50.000	291-363
14/84-85	2	Os solos de regadio de Chipembe, avaliacao da aptidao para o arroz alagado e outras culturas. 150.000	364-372
15/86-117	32	Bacia do rio Lurio. Reconaissance survey.	373-460
16/118-128	11	" " " " " "	461-492
17/129-130	2	Aproveitamento hidraulico de bacia do rio Montepuez. 1:100.000	493-499
18/131-140	10	Estudos de avaliacao do potencial de desenvolvimento e estudos de inventariacao dos recursos hidraulicos da bacia hidrografica do rio Lugenda. 1:250.000	500-529

a* = Report number.
b* = Profile number.
c* = Number of selected profiles.
d* = Row number in the data matrix (appendix 1).

4 RELIABILITY OF THE SOURCES.

4.1 Introduction.

Using data from old soil studies can be very risky. The oldest report used in this study dates back to 1962. Within 20 years, a shift in discriptions of,for example, soil morphological properties easily takes place because of the subjectivity in judgement of morphological characteristics. Morphological descriptions more or less always will remain qualitative through which deviating description can not be proved.
Analytical data must be taken care off as well. The first problem is the great variety in analytical procedures to determine soil characteristics. The result of a determination method is strongly influenced by the method chosen. The results obtained in the 'laboratory methods and data exchange program for soil characterization', LABEX, of ISRIC, show that extremely variable analytical results are obtained all over the world:

> 'The analytical results in general show a large variability both in accuracy and precision. This strongly points to the need for standardization of analytical procedures. The results also indicate that such standardization is feasible, but that a certain level of variability has to be excepted and accounted for in the application of taxonomic criteria.'

Such estimated levels of variability, as given in the LABEX reports (15) are:

- CEC ±20%
- Clay content ±11%
- CEC of the clay ±25%
- Base Saturation ±10%
- pH ±0.2 unit.

The internal control in Mozambique on reliability of laboratory data was established only after independence by the introduction of so-called standard samples, which were regularly analyzed. The external control was introduced in 1977 through incidental analysis of standard samples abroad. From 1982 this occurred in a more regular way through the above mentioned laboratory methods and data exchange program for soil characterization.

The second problem which appears, is the change in soil analysis from 1962 untill now. Great differences in analytical procedures exist between the time before and after independence (1975).
Before independence, the procedures for chemical and physical soil analyses adopted by the laboratory of the 'Departemento de pedologia' is well described in the volume numbers 69 and 70 of 'Comunicacoes do IIAM' (4+5).
The post-independence period is characterized by changes in methods, which have been insufficiently recorded and published. One is referred to 'A review on actual and formerly used soil analyses' by A.Jansen and S.Kauffman (7), from which the description on soil analytical procedures is greatly adapted.

4.2 SOIL ANALYTICAL PROCEDURES AND CHANGED METHODS IN MOZAMBIQUE.

Preparation of soil samples.

In 1980 a soil crushing mill was introduced. This means that the laborious manual breaking of the dried soil samples in a mortar and sieving was replaced by mechanical grinding and sieving.
The consequence for soil analysis is that a substantial quantity of material larger than 2 mm will be broken and passes the 2 mm sieve, while only very hard concretions and gravel remain on the sieve.

4.2.1 Physical determinations.

After independence, especially in physical determinations, drastic changes occurred. The number of analyses was reduced and frequently the methodology of the remaining analyses were subjected to (experimental) changes. The main cause of these changes originates in the fact that before independence all determinations were executed on disturbed samples (dried and sieved 'fine earth' samples)!
Execution of many physical determinations on disturbed samples have no or very limited value, because the soil structure strongly determines the results.
The 'old report' results of the following determinations must be considered as having little value and therefore were rejected as subjects for further study in this report.

1) Cappillary rise (Alcance ascensional da agua).
2) Apparent density (Densidade aparente).
3) Porosity (Porosidade).
4) Moisture equivalent (Equivalente de humidade).
5) All pF-measures (Tudos percentagens a 0,1 0,3 etc. atmosfera).
6) Expansibility (Expansibilidade)
7) Permeability (Permeabilidade intrinseca do solo a agua).
8) Saturation percentage (Percentagem de saturacao).

Other physical determinations, like
- Liquid limit (Limite liquido)
- Plastic limit (Limite plastico)

were abandoned after independence. Because of the small amount of available data, the liquid and plastic limit data were omitted in this study.

Textural analysis.

As already has been stated in the introduction , the fraction of particles larger than 2 mm in het samples prepared for the laboratory is reduced due to the introduction of the soil mill in 1980 for the preparation of 'fine earth'.
Another important change in the textural analysis was the introduction of the use of the soil sieve of 50 μm in the beginning of 1977. This had three important consequences.
First: the size of the silt fraction changed from 2-20 μm before 1977 to 2-50 μm. As such, the old transformation of the 2-20 μm results to 2-50 μm silt with a specially constructed textural triangle diagram could be abandoned.
Second: the results of the fine sand fraction (50-200 μm) improved

considerably, because the formerly used substraction (fine sand = 100 - (coarse sand + silt + clay) was replaced by determination of the fine sand fraction.
Third: because all fractions were determined, a better control on the whole textural analysis was possible through a addition procedure. When the sum of all fractions differed more than 5% from 100% the analysis was repeated.
Up to the present, the textural analysis has been realized with HCl and H_2O_2 pretreated samples with the pipette method.

The electrical conductivity estimation has been excluded in this study because salt does not play an important role in well drained upland soils.

4.2.2 Chemical determinations.

No changes occurred in the following chemical determinations.

pH.

The determination of the pH of a soil is considered one of the most straightforward chemical analysis of a soil laboratory. It is measured potentiometrically in a 1 : 2,5 soil solution mixture. The solution is distilled water for pHH_2O or 1M KCl for pHKCl.

Organic Carbon (OC).

The organic carbon percentage continued to be analyzed according to the Walkley & Black method modified by Steyn.
The INIA laboratory gives the results as organic matter percentage. A fixed factor is used to convert organic carbon into organic matter:
Organic Matter (%) = 1,72 x Organic Carbon (%).
The Organic Carbon percentage is handled with one decimal in this study.

Total Nitrogen (Ntot).

Analysis of total nitrogen percentage according to the Kjeldahl (macro) method. Percentage is given in 2 decimals but might give a misleading impression of accuracy.

Changes since the day of independence were introduced in the following determinations.

Exchangeable bases.

The extraction of bases was executed with NH_4-acetate buffered at pH 7,0, which is the most widely used method. Before 1978 the extraction was done by leaching, thereafter by shaking.
Exchangeable Ca was determined till 1981 in the extract with an EDTA-titration. Since the end of 1981, Ca was determined by using atomic absorption.
Exchangeable Mg was not measured directly. Exchangeable Ca + Mg was analysed by a titration with NH_4OH. As such the exchangeable Mg, with known exchangeable Ca, can be calculated

Exchangeable K and Na were determined with a flame photometer during the whole period.
In this report, the values of the exchangeable bases before and after independence are considered to be the same, in spite of the changed method for exchangeable Ca estimation.
Values are given in meq/100gr soil, with one decimal.

Exchangeable acidity (AC7).

Before 1978 extraction of exchangeable acidity was realized with a barium acetate solution, buffered at pH 7 (shaking method). Since 1978 instead of barium acetate, calcium acetate has been used.
In this study, both methods are considered to be the same, because pH remained the same (pH 7).
Values are given in meq/100gr soil, with one decimal.

Sumbases (Sumb), Cation Exchange Capacity (CEC) and Base Saturation (BS).

According to 'comunicacoes no.69' (4), before independence CEC was directly determined with an extraction solution of NH_4OAc buffered at pH 7. However, according to the analytical data of the CEC in old reports, the CEC was calculated as the sum of exchangeable bases and exchangeable acidity, because differences between values of estimated CEC and calculated CEC in all reports are nil.
After 1977, direct determination (officially) has been abandoned.

In this report, all data of Sumbases, CEC and BS were calculated.
Extraction methods with $BaCl_2$ pH 8,1 known as the Mehlich method, was used in special cases like calcareous soils, through which this method is not recommended for using it on strongly weathered tropical soils.

Free iron oxides (Fef).

Before independence, free iron was determined by the method of Olsen.
After independence, this analysis has been abandoned.
Existing values of Fef have been stored in the data file, but because of the small amount, were not used.

The following determinations were not taken into account in this study:
- $CaCO_3$, because strongly weathered tropical soils do not contain $CaCO_3$.
- Available phosphorus, because its value remains without accuracy due to the difficulty of estimating phosphorus. Phosphorus can be found in organic matter, in inorganic compounds, adsorbed by clay minerals and in the soil solution.
  Before 1978 the Saunder method (with alkaline exstracting solution) was replaced by the Carolina procedure (with unbuffered acid extracting solution).
  In spite of the importance of phosphorus present in tropical soils, values of phosphorus were rejected because of its unreliability.

4.3 Reliable soil characteristics.

Summarizing, one can state that using soil data with a diversity in methodological background, from a theoretical point of view must be abandoned. However, the approach of this study is a more pragmatical than a theoretical one.
Revisiting all soil profiles in northern Mozambique and re-sampling them at defined depths and analyzing the soil samples in one and the same way would be more preferable to do this kind of study. It is clear that this involves a tremendous lot of time, only to gather all those soil samples in northern Mozambique.

Analytical data, resulting from unchanged methods during all those years, can be treated without any problems. The following soil characteristics and derived soil characteristics may be considered as having no severe limitations in using them:

- Gravel (%), Coarse sand (%) and Clay (%).
- pHH_2O, pHKCl and DpH.
- OC (%), Ntot (%), C/N and OC100.

Having 'theoretical' limitations:

- Exchangeable bases and acidity, Sumb, CEC, BS, CEC100 Sumb100, Ca/Mg and Mg/K.

Having 'severe' limitations:

- Fine sand, Silt, Sand and S/C.
- Fef.
- All other physical determinations.

Below, the furtheron in this study used soil characteristics are stated. A division is made in soil characteristics and derived soil characteristics, in which the latter are obtained through addition, subtraction, division and/or multiplying of the former.
Significant errors of the derived soil characteristics may be large, due to these calculations. Especially calculations executed with low values, rounded of at one decimal, may produce important significant errors.

SOIL CHARACTERISTICS	DERIVED SOIL CHARACTERISTICS
Ave - Average depth (cm)	DpH - pHH20 minus pHKCl
Gr - Gravel (%)	San - Sand (%)
Co - Coarse sand (%)	S/C - Silt:clay ratio
Fi - Fine sand (%)	Sumb - Sumbases (meq/100gr soil)
Si - Silt (%)	CEC - Cation exchange capacity (")
Cl - Clay (%)	BS - Base saturation (%)
pHH - pHH20	Ca/Mg - Ca:Mg ratio
pHK - pHKCl	Mg/K - Mg:K ratio
OC - Organic carbon (%)	OC100 - OC per 100gr clay
Ntot- Ntotal (%)	CEC100- CEC per 100 gr clay
Ca - Calcium -]	Sum100- Sumb per 100 gr clay
Mg - Magnesium] exchangeable	C/N - OC : Ntot ratio
Na - Sodium] (meq/100 gr	
K - Potassium] soil)	
AC7 - Acidity -]	

TABLE 5.1

Average, minimum, maximum and standard deviation values of all data, topsoil data and subsoil data.

	ALL DATA				TOPSOIL				SUBSOIL			
Charact.	Mean	Min.	Max.	S.D.	Mean	Min.	Max.	S.D.	Mean	Min.	Max.	S.D.
Ave	67,1	2	635	80,8	9,7	2	24	5,7	89,9	52	145	24,8
San>'77	50,6	12	92	22,2	58,8	13	92	20,6	43,3	12	84	21,2
Si >'77	12,0	0	38	6,8	13,3	0	29	6,7	10,9	0	33	6,4
Cl	36,4	1	87	20,8	25,9	2	85	17,4	44,7	2	87	19,8
S/C>'77	0,58	0,00	8,00	0,87	0,78	0,00	5,50	0,80	0,40	0,0	7,50	0,83
pHH	6,1	4,2	8,0	0,5	6,1	4,2	7,8	0,5	6,0	4,6	8,0	0,5
pHK	5,1	3,5	6,8	0,5	5,1	3,5	6,8	0,5	5,1	3,9	6,5	0,4
DpH	0,9	-0,4	2,1	0,4	1,0	-0,4	1,9	0,3	0,9	-0,2	2,1	0,4
Ca	3,9	0,0	27,0	3,7	5,1	0,2	27,0	4,4	3,4	0,1	14,0	2,7
Mg	1,4	0,0	10,8	1,5	1,4	0,0	6,1	1,2	1,5	0,1	8,6	1,5
Na	0,1	0,0	0,9	0,1	0,1	0,0	0,8	0,1	0,1	0,0	0,9	0,1
K	0,3	0,0	3,4	0,3	0,4	0,0	1,8	0,3	0,2	0,0	1,3	0,2
Sumb	6,0	0,4	33,5	5,0	7,3	0,9	32,1	5,4	5,3	0,9	21,6	3,9
Sumb100	23,8	0,7	190	24,3	38,8	1,9	190	30,0	14,8	1,9	105	14,7
AC7	1,8	0,0	22,2	1,9	2,1	0,0	22,2	2,1	1,6	0,0	16,8	1,7
CEC	7,8	1,5	33,8	5,4	9,4	2,2	32,3	5,8	6,8	1,5	21,6	4,4
CEC100	31,0	3,1	320	31,0	50,3	8,9	320	39,4	19,0	3,1	135	18,0
BS	74,5	9,7	100	15,7	74,6	9,7	100	16,0	76,4	14,7	100	14,2
Ca/Mg	4,1	0,0	24,2	3,6	5,0	0,2	24,2	4,2	3,5	0,1	14,7	2,9
Mg/K	6,9	0,0	107	10,1	4,7	0,2	43,0	6,0	8,3	0,5	69,0	10,3
OC	0,8	0,0	4,7	0,7	1,2	0,2	4,7	0,7	0,4	0,0	4,6	0,6
Ntot	0,07	0,01	1,00	0,08	0,10	0,01	0,34	0,06	0,05	0,01	1,00	0,09
OC100	3,7	0,0	93,3	6,3	6,8	0,3	93,3	8,6	1,0	0,0	12,2	1,4
C/N	12,1	0,0	120	9,1	14,6	2,7	120	11,8	9,8	0,0	35,4	5,8

Ave=Average depth (cm), San=Sand (%), Si=Silt (%), Cl=Clay (%), S/C= Silt:Clay ratio, pHH=pHH_2O, pHK=pHKCl, DpH=(pHH-pHK), Sumb=Sumbases (meq/100gr soil), Sumb100=Sumb (meq/100gr clay), AC7=Exchangeable acidity pH7 (meq/100gr soil), CEC=cation exchange capacity (meq/100gr soil), CEC100=CEC (meq/100gr clay), BS=Base Saturation (%), Ca/Mg=Ca:Mg ratio, Mg/K=Mg:K ratio, OC=Organic Carbon (%), Ntot=Total N (%), OC100= OC (%/100gr clay), C/N=C:N ratio.

5 CHARACTERIZATION OF THE SOILS.

In this chapter, a rough characterisation is given of the whole set of data, in order to obtain an overview of the magnitude and range of important soil characteristics and derived soil characteristics of the well drained upland soils in northern Mozambique.
The data matrix (that of all samples and all characteristics, see appendix 1) consists of 529 lines or rows, i.e. 529 soil samples from 140 soil pits, with each line representing the soil characteristics and derived characteristics of that soil sample as columns.

Characterization is done by giving the mean, minimum, maximum and standard deviation values of the most important soil (derived) characteristics in table 5.1 and by scattergrams of the different soil characteristics plotted against depth.
Mean values of a given soil property at any depth do not give sufficient information about the soil, because soil properties change with depth. Therefore, two sub-populations were made to make behaviour of soil properties more understandable:

1) topsoil - soil samples between 0 - 25 cm.
2) subsoil - soil samples between 50 - 150 cm.

The topsoil data set consists of 174 lines, i.e. 174 soil samples from 139 soil pits. The subsoil data set consists of 202 lines from 136 soil pits.
Table 5.1 shows the mean, minimum, maximum and standard deviation of important soil characteristics of both topsoil and subsoil populations.
However, within these data matrices of all samples and all characteristics and of the topsoil and the subsoil, many missing values occur. Especially Ntotal and Organic Carbon show many missing values, particularly in the subsoil, mainly because the values for these characteristics are assumed to be very small at depths between 50 - 150 cm and were therefore not analysed.
Exchangeable Acidity (AC7) and the Ca:Mg-, Mg:K-ratios show some missing values. AC7 mainly because of not being analysed in the soil survey 'Regadio de Matama' (report no.12) and the Ca:Mg- and Mg:K-ratios because values of K and Mg sometimes equal zero.
Besides, many single soil variables are missing, due to failing analysis, etc.

A statistical tiresome problem occurs when values of variables are missing. Many 'tricks' do exist to overcome this problem, of which the most widely used are:

1) Omitting all other characteristics of the same matrix row, i.e. soil sample.
2) Replacing the missing values by default values, for example the mean of that variable.

The first option has been chosen, but not all matrix rows with one or more missing values in it have been rejected. The total number of elements (n) has been maximalized for each or pair of soil characters that has been considered.

Executing calculations to obtain derived soil characteristics out of analyzed soil characteristics and drawing scattergrams by using the

Fig. 5.2 Average depth - Sand content (data from after 1977).

Collision symbol: *

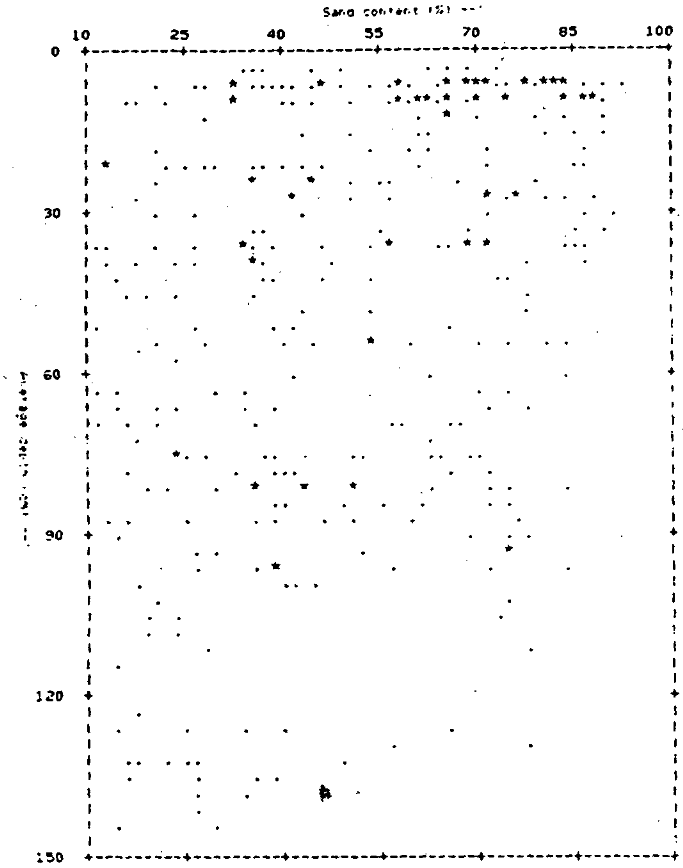
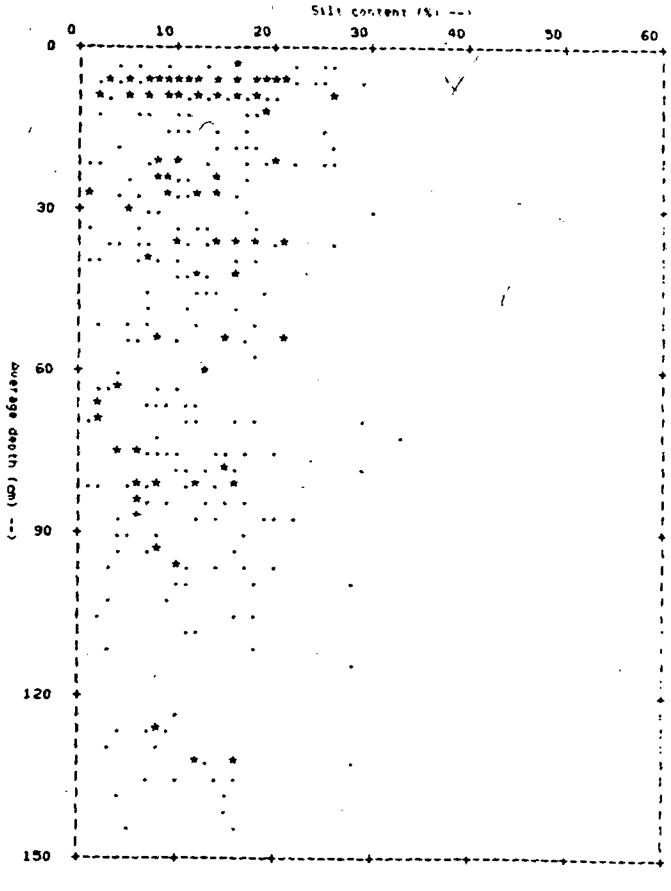


Fig. 5.3 Average depth - Silt content (data from after 1977).

Collision symbol: *



STATPAK program with many missing values in the data set involves a lot of time. Rejection of missing values for each (or pairs of) characteristic-column(s) in the data set only can be done by creating a new file for each (or pairs of) column(s). In order to save time, calculations of mean, minimum, maximum and standard deviation and drawing of scattergrams has been done by 'grouping' soil characteristics. 'Groups' that have been made are:

1) Ave, Clay, pHH, pHK, Ca, Mg, Na, K and AC7.
2) OC, Ntot, OC100 and C/N.
3) DpH, Sumb, CEC, BS, Ca/Mg, Mg/K, CEC100 and Sumb100.
4) Si, San, S/C.

Below, the number of data elements is given for each 'group'.

group / population	1	2	3	4	all characteristics
all	504	393	460	398	529
topsoil	164	165	151	133	174
subsoil	194	118	179	144	202

Consequently, the number of data elements of soil characteristic Ntot in the subsoil is 118 out of 202, due to 84 missing values in the subsoil.
As has been stated in chapter 4.2.1, only values of San, Si and S/C are given from 1977 untill now, due to changed textural analysis methods in 1977.

Below, soil characteristics from table 5.1 and soil characteristic-depth scattergrams will be discussed.

5.1 Sand, Silt and Clay content and Silt:Clay ratio.

The average sand content of 51%, decreases with depth from 59% in the topsoil to 43% in the subsoil (see table 5.1 and fig.5.2). The maximum sand content in the topsoil which equals 92% may be considered too high, but the textural limit has been set at the subsoil (<15% clay).

One should expect an increasing silt content, because the silt fraction is assumed to consist mainly of weatherable minerals, and the proportion of weatherable minerals decreases due to tropical weathering, causing destruction of silt. From table 5.1 and fig.5.3 it appears that the silt content decreases with depth, from 13,3% in the topsoil to 10,9% in the subsoil. But we have to keep in mind that the silt-analysis is a very 'noisy' one because of existence of pseudo-silt. Sesquioxide-rich tropical soils are difficult to disperse because of strong inter-particle bonds, which can be very stable (Fe). Sometimes, the clay is strongly aggregated to form silt-size particles giving rise to soils which appear to have high silt content.
Also the sand fraction may consist mainly of pseudoparticles in which the coarser silt particles are bound by strong organic bonds.
The average silt content of 12% is rather high but does not exceed 15%, which is normal for soils weathered under tropical conditions.

Fig. 5.4 Average depth - Clay content (data from after 1977).

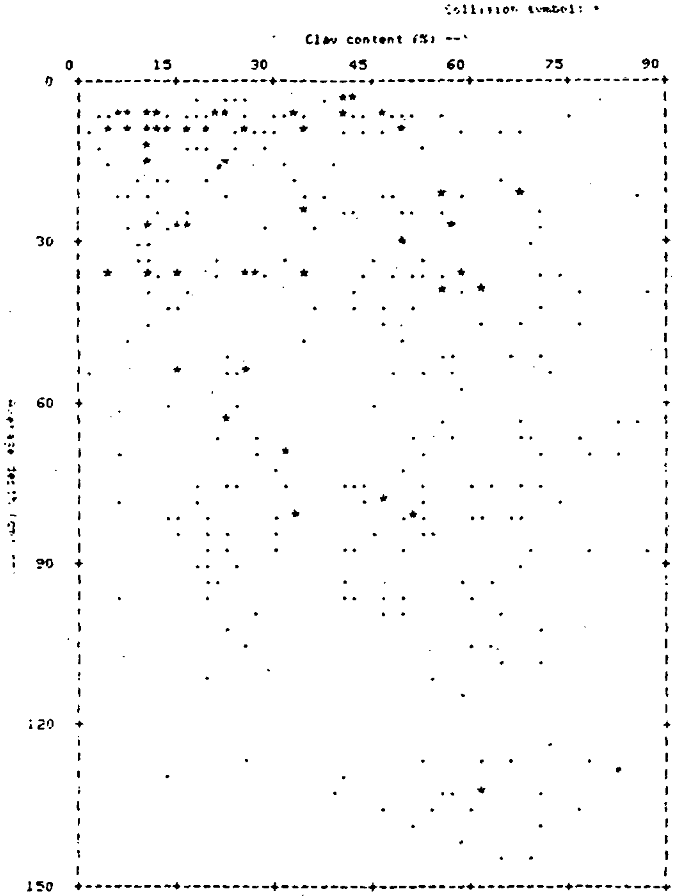
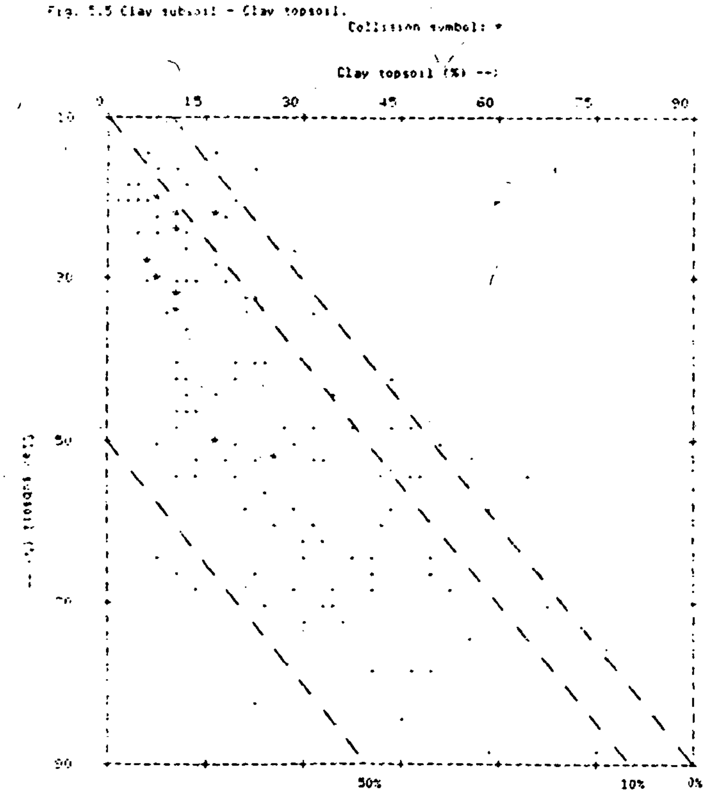


Fig. 5.5 Clay subsoil - Clay topsoil.



1962). Table 5.1 and fig.5.6 show that most of the values of this ratio do exceed 0,15. It's not clear if the 0,15 criterium should be applied to the B-horizons or to material at about 2 meters depth, but nearly all values are higher than 0,15. From this point of view, one can state that the whole data set population consists of 'younger', i.e. less highly weathered soils. But more criteria for estimating the weathering stage of soils do exist, like:

- structure,
- weatherable minerals percentage,
- CEC.

The general observed decrease in S/C ratio with depth indicates a loss of clay from the surface horizon and less weathering of the silt-size fraction in the subsoil. On the contrary, Young (18) citing Verheye (1974) reported an increase in S/C ratio with depth for some alfisols in the Central Ivory Coast. In the present case the decreasing S/C ratio with depth is almost only due to the increasing clay percentage.

To show what the influence is of changed textural analysis on sand, silt and S/C values before and after 1977, table 5.7 is appended. To enable comparison of a soil characteristic of which the analytical method has not been changed, the clay value is added.

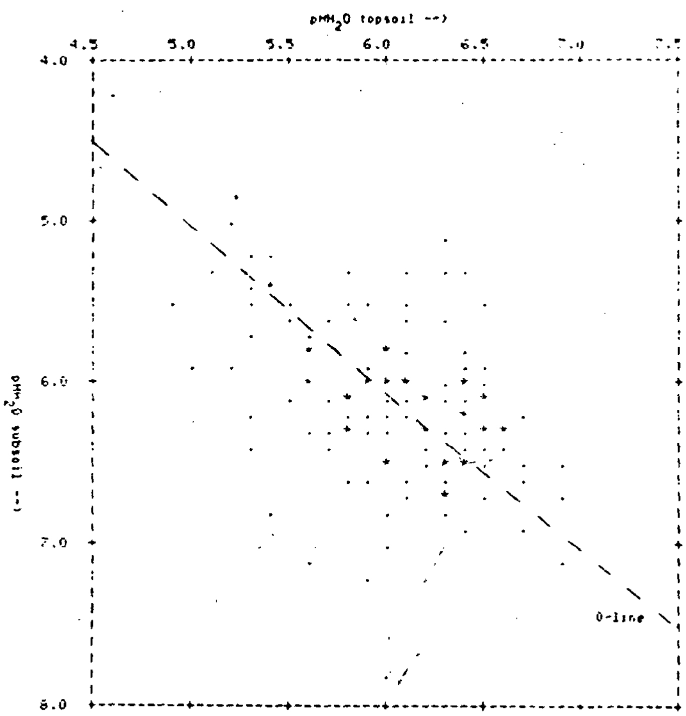
Table 5.7 Average values of sand, silt and clay content and S:C ratio, before and after 1977.

		all	topsoil	subsoil
San	all	53,8	62,5	47,3
	<77	58,1	70,3	50,1
	>77	50,6	58,8	43,4
Si	all	10,6	11,7	9,4
	<77	7,2	8,4	6,2
	>77	12,0	13,3	10,9
S/C	all	0,50	0,71	0,34
	<77	0,28	0,45	0,17
	>77	0,58	0,78	0,40
Cl	all	36,4	25,9	44,7
	<77	34,6	21,2	43,5
	>77	37,4	27,9	45,7

(San-Sand, Si-Silt, Cl-Clay (%), S/C-Silt:Clay ratio, <77-before 1977, >77-after 1977, all-before and after 1977).

The average clay content is 2.8% higher after 1977, which seems to be the result of soil sampling in areas with soils with a higher clay content. This assumption becomes truth when one looks at the average clay contents of soil study no.18, executed by Kauffman, containing 20 soil profiles, with an average clay content of 46,6%. The textural limit of soils to be within this study was set upon more than 35% clay in the subsoil. On the other hand, soil reports no. 10 - 18 (all executed after 1977) have an average clay content of 31,9% (not to be found in table 5.1).

Fig. 5.8 pH_{H_2O} subsoil - pH_{H_2O} topsoil.
Collision symbol: *



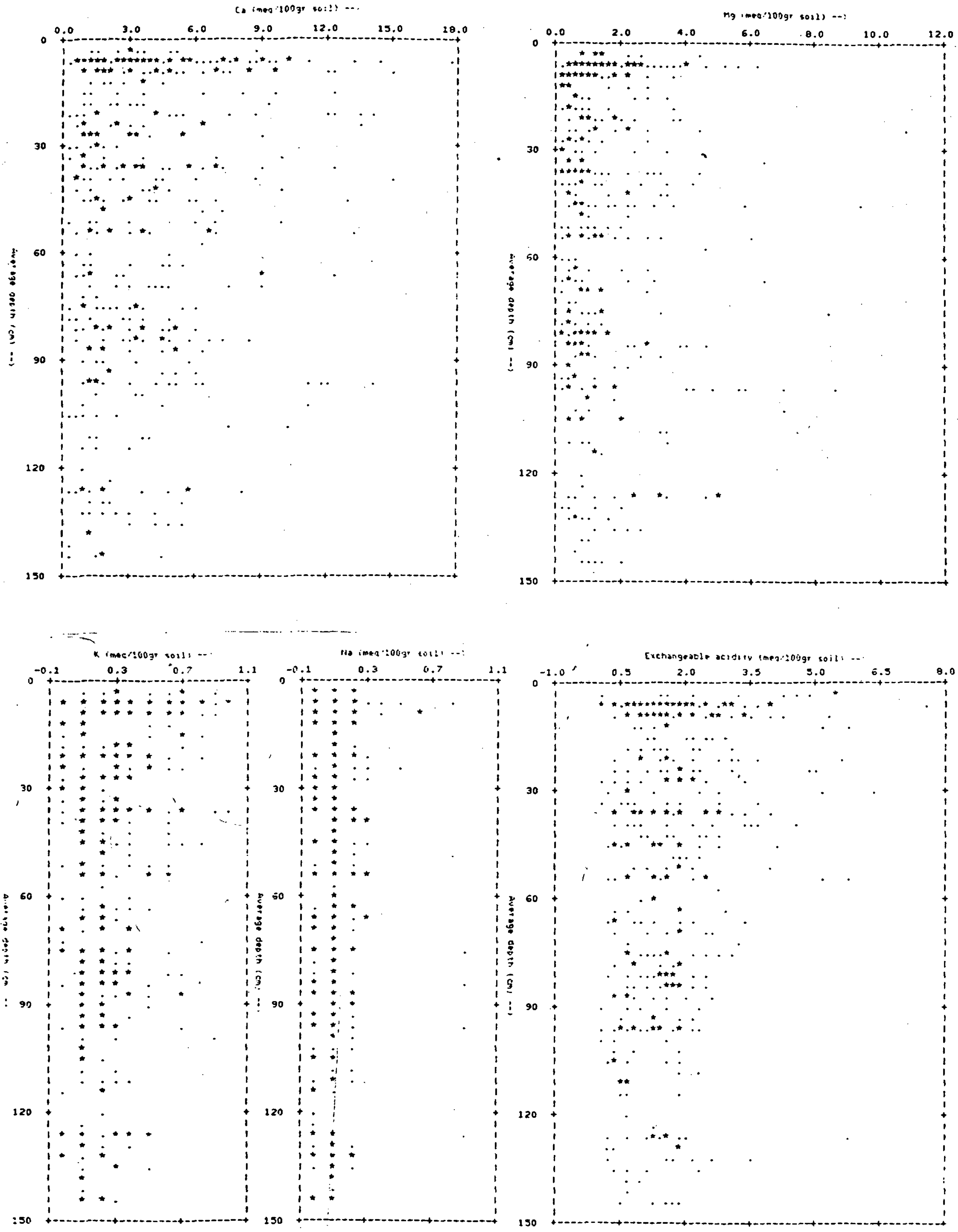
The decreasing sand percentage, ca. 15%, is due to the narrowing fine sand limits from 0,02 - 0,2 mm to 0,05 - 0,2 mm. On the other hand, the silt content increase is ca. 67% after 1977.

5.2 pHH2O pHKCl and Delta pH.

On the average, the whole population shows to be weakly acid. The pHH just exceeds a pH of 6. Most soils have a pHH between 6 and 7 in the topsoil and a small decrease in pHH values in the subsoil. This small shift in pH values is also shown in Table 5.1, where pHH-topsoil is 6,1 and pHH-subsoil is 0,1 unit lower. It is a consequence of greater leaching in the upper horizons. Fig.5.8 shows it once more. The 0-line represents no change in pHH topsoil and subsoil.
Only few soil samples have a pHH lower than 5 (strongly acid, which is important in connection with exchangeable Al^{3+} and Al-toxicity) and also few samples have a pHH above 7 (weakly alkaline, due to the presence of $CaCO_3$).
All primary and most other nutrients have their maximum availability in the pH range 6,0-7,5. At pH values below 5,5 primary and secundary nutrients become less available, this effect being most outspoken in the case of phosphorus. About 15% of all soils has a pHH below 5,5 in the subsoil and only about 11% in the topsoil, whereas the subsoil has less influence on plant growth than the topsoil because the subsoil deals with a depth deeper than 50 cm.

In general, soil genesis in particular oxisols and ultisol- and alfisol LAC's may be described as an relative increase in sesquioxides in comparision with alumino-silicate minerals, or to an relative increase in the pH-dependent component to the permanent component of the total charge. Kaolinite and sesquioxides become the primary components of many soils. These components (together with present organic colloids and possible non-crystalline inorganic constituents like allophane) are of variable charge (Young (18)).
The Zero Point of Charge (ZPC) of kaolinite according to Parks (1967) is ranging from pH<3,5 to almost pH 4,6. This means that kaolinite carries a nett negative charge at pH values above these levels. Additional data indicate that positive charges persist in kaolinites up to pH values as high as 8-10 (Schofield & Samson 1954, Smith & Emerson 1976, Bolland et al 1976).
Whatever the source of the component charges may be, the co-existence of negative and positive charges at field pH values would explain the increase of the pHK relative to the pHH in soils with high contents of kaolinite and sesquioxides in the subsoil.
According to this theory, Delta pH values (pHH-pHK) decrease are even become negative in the subsoil. This DpH behaviour is hardly to be seen here. pHH and pHK show a strong lineair correlation, as might be aspected. DpH (table 5.1) equals 0,9 on the average and is a bit higher in the topsoil than in the subsoil, due to a higher pHH in the topsoil. Notice that the small relative increase of pHK relative to pHH is due to a decreasing pHH and not due to an increasing pHK.

Fig. 5.9 Average depth - Ca, Mg, Na, K and exchangeable acidity.
Collision symbol: *



5.3 Sumbases, Exchangeable Acidity, Cation Exchange Capacity and Base Saturation.

The CEC of soils rich in kaolinite, halloysite and sesquioxides is pH-dependent. As pH values decrease, there is a substantial decrease in negeative charge (see paragraph 5.2). The conventional and in this report used method for determination of CEC is by saturation with NH_4OAc at a pH of 7,0 (see paragraph 4.2.2). Therefore, the values given for CEC are substantially above the cation-holding power of the soil under natural conditions. Values for BS are also affected.

The CEC_{100}, i.e. the CEC of the clay fraction gives an indication of the nature of the clay mineral (CEC_{100}=(CEC_{soil}/clay%)x100).The CEC_{100} is not corrected for the contribution of organic carbon to the CEC and therefore CEC_{100} has no value in the topsoil but in the subsoil only (because OC contents in the subsoil are low).

The CEC_{100} and BS are usefull as indicators of soil-forming processes and as differentiating criteria between soil types.
The cut-off value for defining highly weathered soils is usually taken as 16 meq/100gr clay, indicating dominance by kaolinite, with free sesquioxides present, but no 2:1 lattice minerals (LAC's).
BS indicates the intensity of present-leaching and depends on pH. The pH-range of 5,0-6,0 corresponds approximately to a BS-range of 25-75% (Greenland (6)). The quantities of individual bases are only of agricultural importance.
The values of individual bases from table 5.1 and fig.5.9 show a decreasing average quantity of each cation with depth, except for Mg, which quantity increases from 1,4 meq/100gr soil in the topsoil to 1,5 meq in the subsoil. This Mg-behaviour with depth is difficult to explain, because the quantity of Mg normally should decrease with depth, due to a decreasing organic carbon content with depth. One explanation could be the rather big standard deviation of Mg-values in the subsoil (1,5) in comparison to the standard deviation of the topsoil (1,2), while all standard deviations of the other individual bases are higher in the topsoil. This means that a lot of profiles have low Mg-values in the subsoil, however, a few profiles have very high Mg-values in the subsoil. In fig.5.9 this can be noticed.

Exchangeable acidity varies from 2,1 meq (mean) in the topsoil to 1,6 meq in the subsoil, which is a normal to low value in this type of soils (table 5.1 and fig.5.9). This decreasing AC7 with depth coincides with the BS-values. An average BS of 75% is not a very low value with relation to higly weathered tropical soils. Fig.5.10 gives the average sample depth plotted against BS-values. The dotted line represents the 50% limit of the BS, which is the limit between alfisols and ultisols in ST and between acrisols and luvisols in the FAO-classification. Almost all soils have a BS-value larger than 50%, which means that we deal with alfisols in ST and with luvisols according to the FAO-Legend (when, of coarse, the other requirements like an argillic-B are fulfilled).
In general, one can state that the present-day leaching isn't very intensive in most soils concerned here, because BS values are not low.

Fig. 5.10 Average depth - Base Saturation.
Collision symbol: *

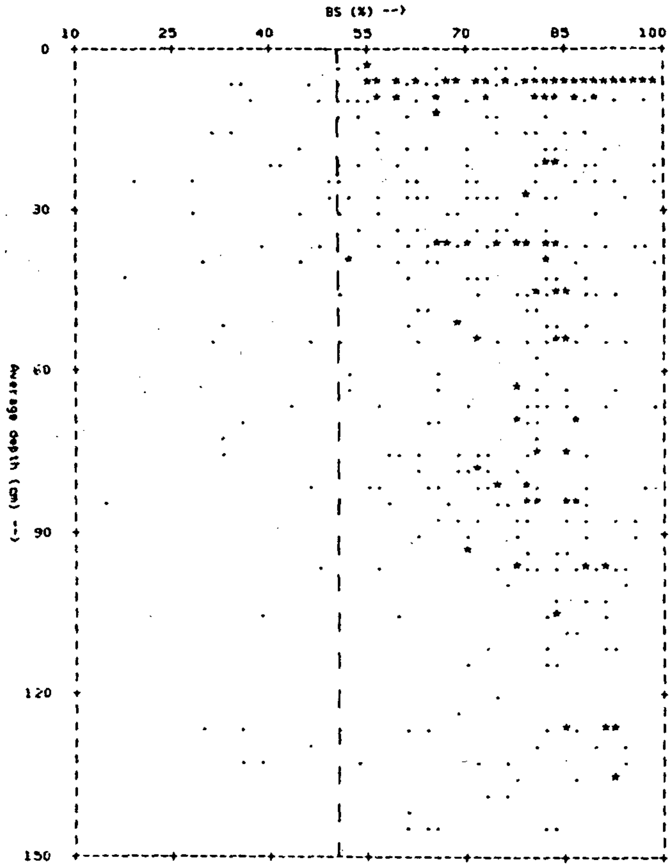
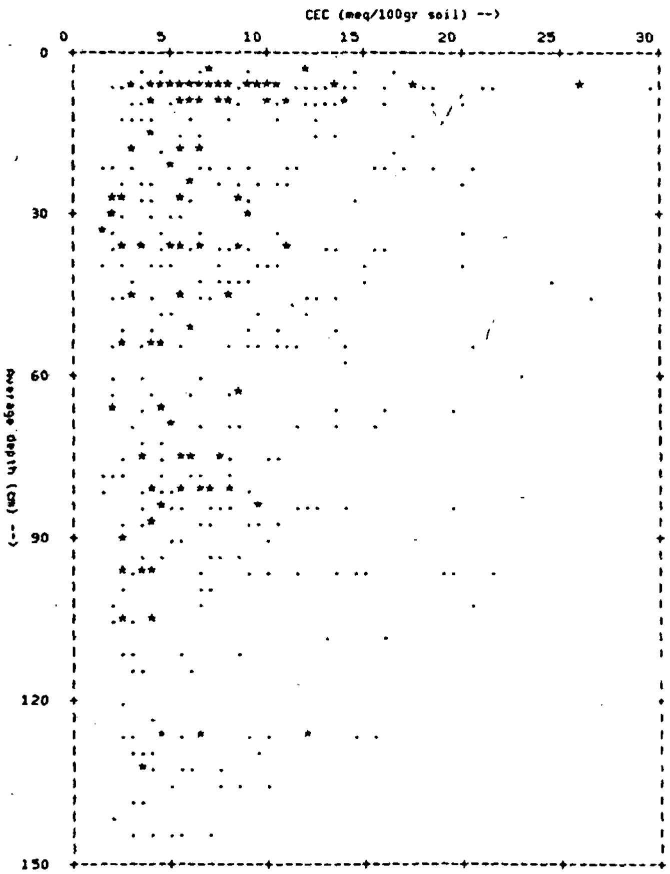


Fig. 5.11 Average depth - CEC.
Collision symbol: *



In fig.5.11 the average sample depth is plotted against the CEC of the clay.

Fig. 5.12 Average depth - CEC of the clay.
Collision symbol: *

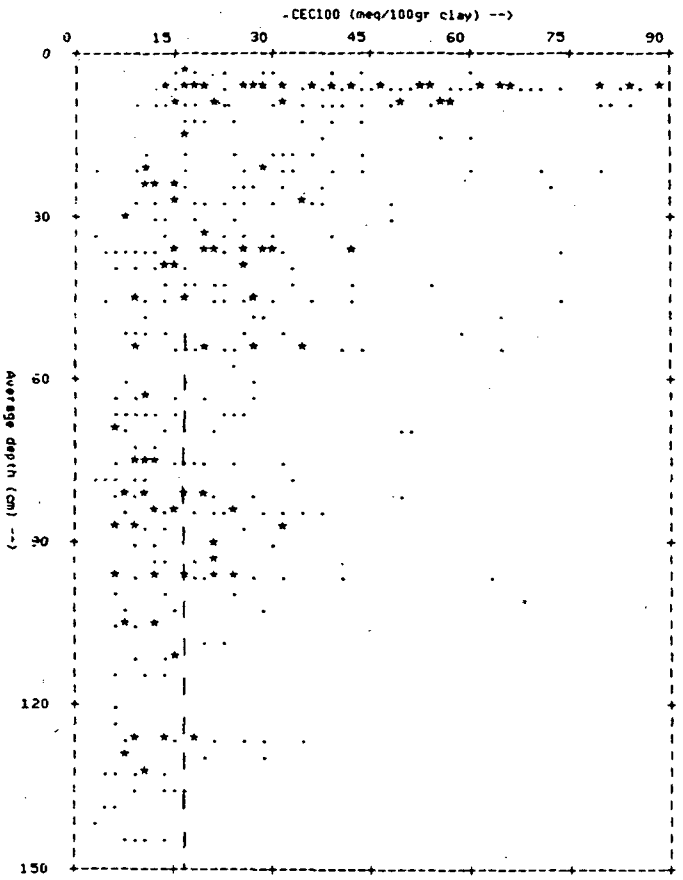
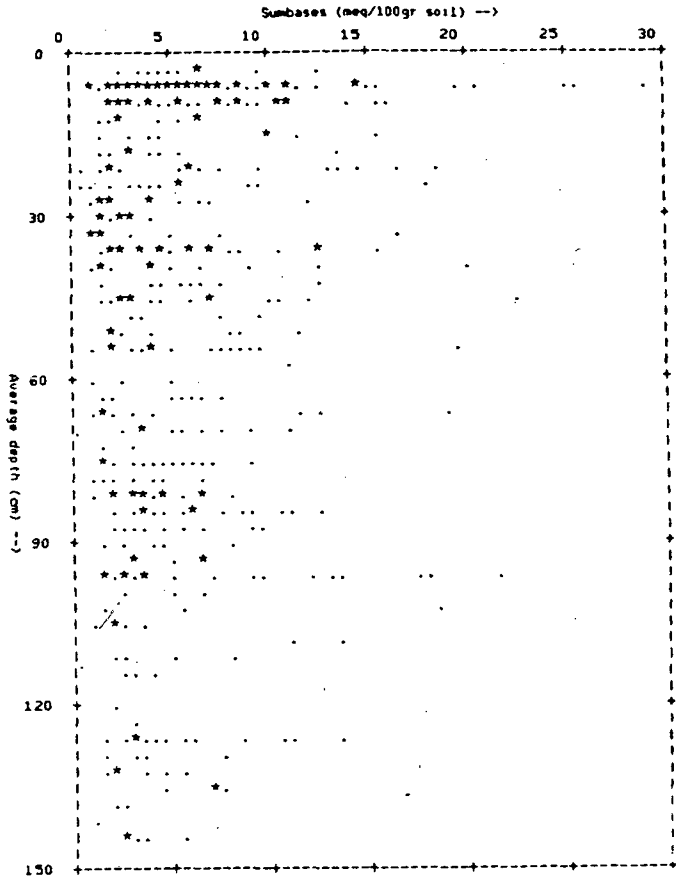


Fig. 5.13 Average depth - Sumbases.
Collision symbol: *



As could be expected, the decreasing values of all individual bases except Mg (fig. 5.13) and AC7, results in a decreasing CEC with depth. The CEC_{100} is significant in the subsoil only, because the contribution of organic matter in the topsoil to the CEC is high. Attention will be payed to this problem in paragraph 7.5.
Fig.5.12 shows that the CEC_{100} decreases with depth, due to the decreasing organic matter content and increasing clay content. The dotted line represents a value of 16 meq/100gr clay.
Almost all soils have a CEC_{100} of 30 meq or less from 50 cm to 150 cm depth, with an average of 19 meq (see table 5.1).

An estimation of the type of clay mineral based on CEC_{100} can be done only when the fine silt content is low (in some soils an appreciable portion of the CEC may reside with the fine silt).

Kaolinite	3 - 15	meq/100gr clay,
Halloysite	5 - 50	" ,
Illite,Chlorite	10 - 40	" .

From the presented values it will be evident that these clay minerals play an important role in these soils.

Fig. 5.14 Average depth - Organic Carbon and Ntotal.
Collision symbol: *

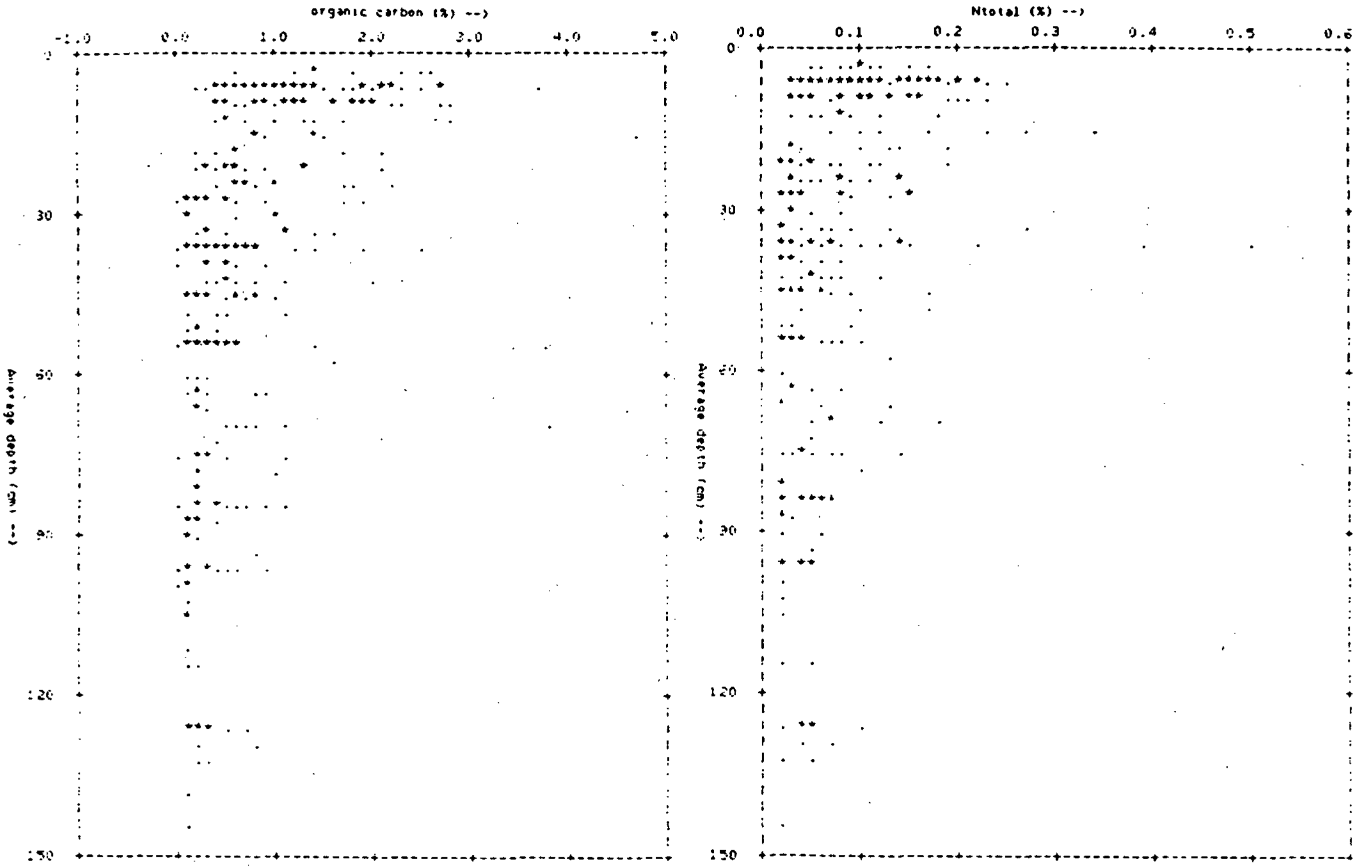
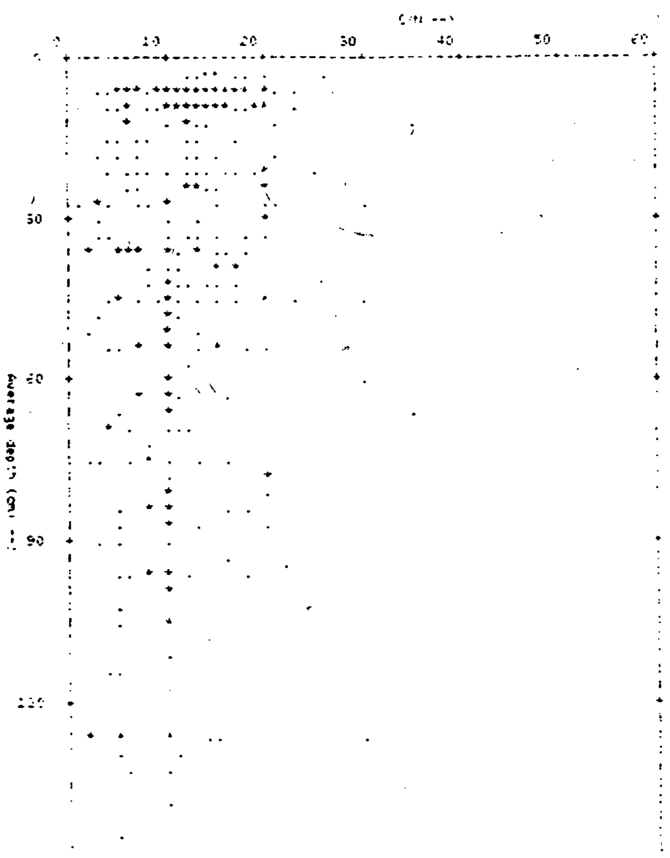


Fig. 5.15 Average depth - C/N ratio.
Collision symbol: *



5.4 Organic Carbon, Ntotal and C:N ratio.

In the following paragraph, only topsoil values of OC are considered. In converting OC-values to Organic Matter values a multiplication with a constant value is used: OM = 1,72xOC, which is the most commun used value.
Factors who influence OC content and Ntotal content are:

-climate, texture, composition of the parent material, slope, drainage, base supply, plant growth, biological activity, etc.

For example, topsoil OC and Nitrogen content increase with a drop in temperature and an increase in rainfall; low temperatures slow the rate of decomposition of humus by oxidation, high rainfall supports the humus supply from plant growth. The OM content varies directly with clay content (sandy soils contain usually less OM than clayey soils). The C/N ratio increases with increasing temperature.

Some typical values for OM content of the topsoil in the tropics on freely drained soils of medium to heavy texture under natural vegetation are (Young (18)):

	OM (%)	OC (%)
Dry savanna	1 - 2	0,6 - 1,2
Moist savanna	2 - 3	1,2 - 1,8
Lowland forest	3 - 5	1,8 - 3,0

The topsoil C/N ratio in moist savannas is sometimes 15 or above, compared with 10 in adjacent forested sites.
From fig.5.14 and table 5.1 can be seen that the OC content obviously decreases with increasing depth. The mean average of 1,2% OC in the topsoil indicates an environment of dry to moist savanna (see above), which is reliable for the climate in northern Mozambique.

The C/N ratio in fig.5.15 also indicates savanna like circumstances, with a mean value of 14,6 in the topsoil. Ntotal and C/N ratio decreases with increasing depth. Some high C/N ratios appear, i.e. C/N ratios higher than 25, which indicates an appearance of OM as straw. This is very doubtfull, especially at great depths. Reasons for this can be:

- Wrong analytical results.
- Rounding off at two decimals for Ntotal and one decimal for OC, which can produce a significant error up to 13% with low OC and Ntotal percentages.

Fig. 5.16 Average depth - Ca/Mg and Mg/K ratios.
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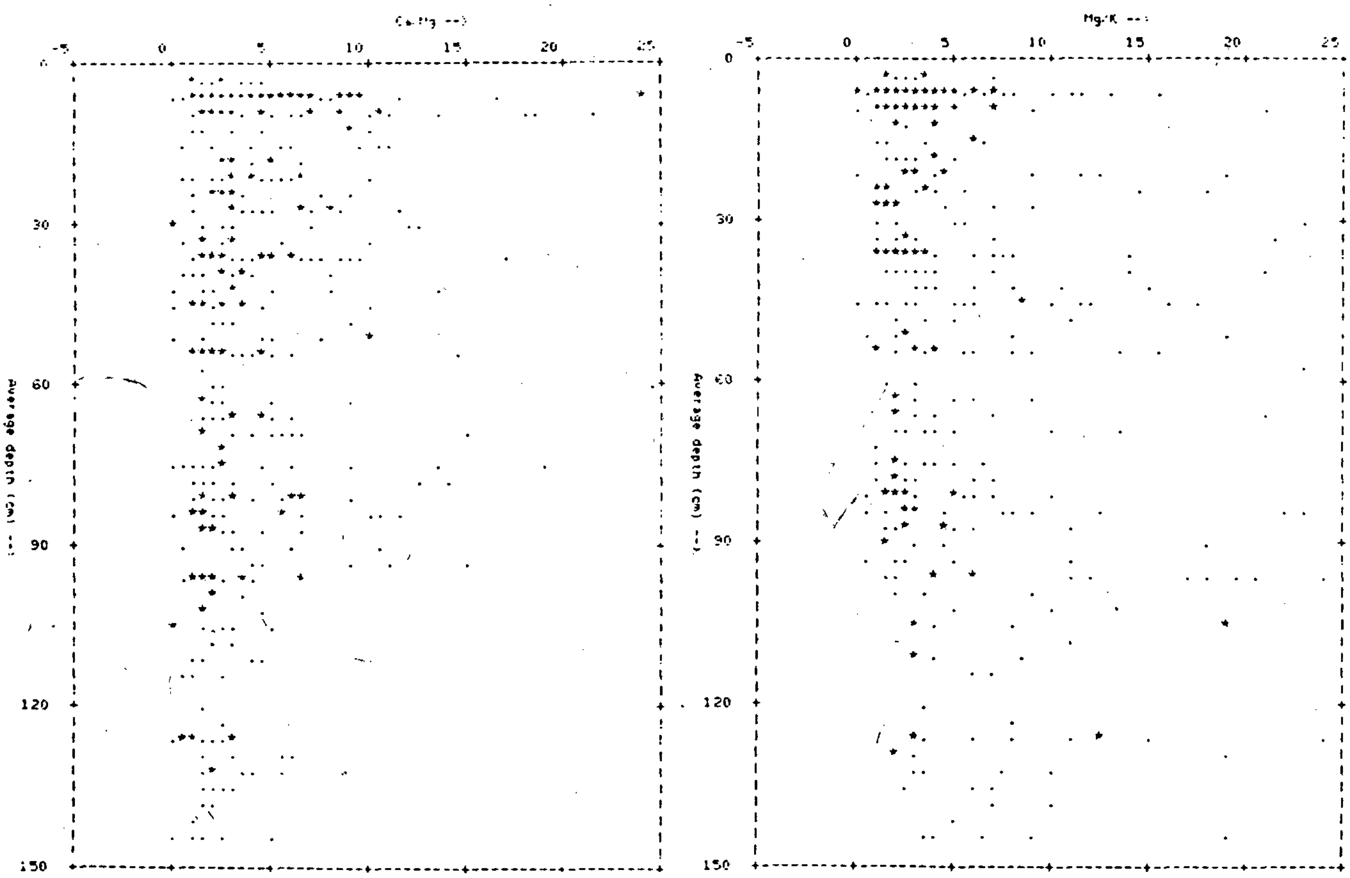


5.5 Ca:Mg and Mg:K ratios.

Calcium and magnesium play an important role with respect to the availability for plants of other elements. Mg deficiency will appear when the Mg:K ratio is too low (often as a result of burning) or when the Ca:Mg ratio is too high.
Various criteria have been used for evaluating Ca/Mg and Mg/K ratios (see table below) in Mozambique. Critical levels of these ratios depend on crops grown, which is not included in this table. Three suitability classes are given:

S1 = suitable,
S2 = moderately suitable,
S3 = marginally suitable.

Critical levels according to Woodhouse and Rendle (17):

$1 < Ca/Mg < 5$
$3 < Mg/K < 25$

Suitability classes according to Touber and Noort (14), based on the Voortman criteria:

	S1	S2	S3
Ca/Mg	> 2	1,2 - 2	< 1,2
Mg/K	< 3,5	3,5 - 7	> 7

according to Voortman (16):

	S1	S2	S3
Ca/Mg	2 - 9,9	1,2 - 1,9 10 - 24,9	< 1,2
Mg/K	1,0 - 3,4	< 1,0 3,5 - 6,9	>7

As can be seen from fig.5.16, the Ca/Mg ratio equals an average of 5,0 in the topsoil, with relative few soil samples having Ca/Mg ratios below 2 and above 10.
The Mg/K ratio equals 4,7 in the topsoil, with many soil samples exceeding the 3,5 limit.
The Ca/Mg ratio decreases with increasing depth, while the Mg/K ratio increases, due to the increasing Mg content.

6 CLASSIFICATION CRITERIA.

6.1 The FAO and Soil Taxonomy classification systems.

Natural classifications require skill to use, since they involve an understanding of soil genesis. Pedogenic scenarios do not clearly separate all soils, as they merge in a continuum. Clearly, mutually exclusive definitions are needed to facilitate placement of pedons into soil classification systems. But there will be profiles which can't be definitely allocated to a classification. Artificial systems solve such cases by a decision based on some arbitrary limiting value. Such limiting values, which are important in the present case, are stated below. It mainly deals with limiting values of CEC, Base Saturation, Organic Matter content and clay content used in the classification systems of FAO and Soil Taxonomy.

The USDA Soil Taxonomy is an 'artificial' system in which the observable soil characteristics, used to differentiate classes, are largerly chosen to reflect agriculturally significant properties. It attempts to be comprehensive in that any profile can in theory be unambiguously allocated to a class. But in order to do this, the class definitions are necessarily lengthy, complicated and legalistic. Further disadvantages are that class definitions depend too heavily on laboratory analyses, making classification in the field at best a provisional exercise only. Tropical soils are treated inadequately, but this will be improved with the introduction of the Kandic ~~sub~~ great group.

The FAO soil map of the world legend is very much simpler, and the parameters chosen for class definitions are designed to reflect natural classes. It is intended for mapping soils on a continental scale, and therefore the units are inevitably very broad.

First, the FAO-classification system as appeared in Volume 1, legend, Unesco-Paris 19741 (1), will be handled (FAO-old).
Second, the FAO-classification system as it appears in Revised legend, FAO 1985 (2), third draft (FAO-revised).
Third, the Soil Taxonomy system, as appeared in the Agricultural Handbook no.436 (11).

When no marks are added, Base Saturation (BS) is measured by NH_4OAc, pH 7.

FAO-old.

Diagnostic horizons.

Mollic A-horizon	- BS > 50% - OM > 1% - mixed surface 18 cm.
Umbric A-horizon	- as mollic, but BS < 50%.
Argillic B-horizon	- increase in clay within 30 cm If E-horizon <15% clay --> arg.B at least 3% more clay

If E-horizon 15-40% clay --> arg.B %clay/E-hor. %clay > 1,2.
If E-horizon >40% clay --> arg.B at least 8% more clay.

Cambic B-horizon - CEC >16meq/100gr clay.

Oxic B-horizon - CEC <16meq/100gr clay,
- >15% clay.

Major soil groups and soil units.

Phaeozems - mollic A-hor. (not oxic B).
Cambisols - cambic B-hor.
Luvisols - argillic B-hor. with BS >50% at least in the lower part of the B-hor. within 125 cm of the surface. Not mollic A.
Acrisols - argillic B-hor. with BS <50% at least in the lower part of the B-hor. within 125 cm of the surface. Not mollic A
Nitosols - argillic B-hor. with clay <20% within 150 cm of the surface.
Ferralsols - oxic B-hor.

Humic ... - BS <50% with depth restrictions.
Dystric .. - BS <50% " " " .
Eutric .. - BS >50% " " " .

<u>FAO-revised</u>.

Diagnostic horizons.

Argillic B-horizon - same as in FAO-old, with addition of:
luvi-arg.B - CEC >24meq/100gr clay
- no abrupt textural change between A and B.
lixi-arg.B - CEC < 24meq/100gr clay
- textural restrictions.

Mollic A, umbric A, cambic B and oxic B remain the same as they were defined in FAO-old.

Major soil groups and soil units.

Cambisols - cambic B-hor.
Eutric .. - BS >50% between 20 - 50 cm.
Dystric .. - BS <50% " 20 - 50 cm.
Phaeozems - mollic A-hor.
- CEC >16 meq/100gr clay -| - throughout 125 cm of the
- BS >50% -| surface.
Luvisols - arg.B with:
- CEC >16 meq/100gr clay
- BS >50%
Lixisols - arg.B with:
- CEC <16 meq/100gr clay
- BS >50%

Acrisols - arg.B
- CEC <16 meq/100gr clay -|
- BS <50% -| - within 125 cm of the surface.

Alisols - arg.B
- CEC >16 meq/100gr clay -|
- BS <50% -| - within 125 cm of the surface.

Nitosols - arg.B with >35% clay
- clay <20% within 150 cm of the surface.

Ferralsols - oxic B within 100 cm of the surface
- lacking arg.B above the oxic B

An important change is the extension of classification of Low Activity Clays (LAC's Lixisols and Acrisols) and High Activity Clays (HAC's Luvisols and Alisols). The difference between FAO-old and FAO-revised concerning LAC and HAC is stated below, once again.

FAO-old

BS high (>50%)	BS low (<50%)
LUVISOLS	ACRISOLS

FAO-revised

	BS high (>50%)	BS low (<50%)
CEC high	LUVISOLS	ALISOLS
low	LIXISOLS	ACRISOLS

(CEC high >16 meq/100gr clay,
CEC low <16 " ").

Soil Taxonomy.

Diagnostic (sub)surface horizons mollic, umbric, argillic, cambic and oxic are the same as FAO for the criteria regarded here.

Order

Oxisol - oxic B within 2 m.
Ultisol - argillic B,
- BS* <35% within about 1,8 m.
Alfisol - argillic B,
- BS* >35% within about 1,8 m.
Mollisol - BS >50%,
- upper 18 cm: OM >1%.

Suborder

Humox - BS <35%,
- OC >16 kg/m^3 (O-hor. excluded).
Orthox - BS >35%,
- OC <16 kg/m^3 (O-hor. excluded).
Humults - OC >0,9% in upper 15 cm of arg.B,
- OC >12 kg/m^3 (O-hor. excluded).
Ustults - OC <0,9% in upper 15 cm of afg.B,
- OC <12 kg/m^3 (O-hor. excluded).

Great group

Eutrorthox- BS >35% within 1,25 m.
Haplorthox- BS <35% " " .
Umbriorthox-BS <35% " " .
Eutrusthox- BS >50% if clayey oxic,
- BS <35% if loamy oxic.
Haplusthox- BS <50% if clayey oxic,
- BS <35% if loamy oxic.

BS* means BS measured by pH 8,2. Used here is the assumed correlation: 35% BS pH 8,2 = 50% BS pH 7,0, where BS pH 7,0 is the normal determination (used in the FAO-system) with NH_4OAc.

Oxisols/Ferralsols representing transitions from other kind of soils are difficult to recognize in the field. One of the most problematic cases is a LAC which is transitional to an Oxisol.
The term LAC has been widely accepted in order to indicate soils with a CEC of less than 24 or 16 meq/100gr clay as measured by the NH_4OAc - pH7 method. An argillic horizon can be as low in weatherable minerals and CEC as an oxic, but because the latter is a subsurface horizon exclusive of the argillic horizon, one has to prove that a horizon is not argillic, before it can be called oxic.
Nearly insoluble problems of classifying such soils as Oxisols or Ultisols - Alfisols (ST), Ferralsols or Luvisols - Acrisols (FAO-old) resulted.
One has to depend on the A/B clay ratio or on micromorphological data in order to determine whether or not an argillic or oxic horizon is present (micromorphological: in an oxic horizon, clay skins should not occupy more than 1% of the volume of any subhorizon). Clay ratios are difficult to use since the relevant laboratory results are often not sufficiently reliable because of the poor dispersion characteristics of the soil (see paragraph 5.1).

In the revised FAO legend, the classification problems of LAC's have been tried to solve. The classification criteria of the soil group Ferralsols remained the same as it was before, i.e. lacking an argillic B above the oxic B horizon. Besides the soil groups Luvisols and acrisols, two soil groups were added, namely Alisols and Lixisols.

Thus, in the present FAO-classification, the Luvisols and Alisols represent the HAC's (CEC >16meq/100gr clay) and the Lixisols and Acrisols represent the LAC's (CEC <16meq/100gr clay). Whereas on one hand Luvisols and Lixisols have high BS (>50%) and on the other hand Alisols and Acrisols have low BS (<50%). This change can be considered as a major improvement towards classification of LAC's.

Below another division in soils concerned has been made based on different criteria than the classification systems discussed above. This will be discussed hereafter.

6.2 Subpopulations.

Reasons for not using the normal FAO or ST classification criteria, but dividing the whole group of soils in another way, are:

- Not all profiles have been classified, and those that have been classified, are classified in a different way. Not only FAO-classification is used, but also the CCTA-classification (Soil map of Africa classification, D'Hoore 1964).
  Classifying all profiles according to one or more classification systems would involve cumbersome work.
- As has been stated before, classifying the soils concerned causes considerable problems. Due to the lack of essential morphological and analytical data, the soils could not be differentiated sufficiently in order to belong to an unique class.
- The huge amount of names, proceeded from 'normal' classification would not be workable for caracterizing the soils and indicating the soil forming processes.

Instead of classifying in the normal way, four subpopulations were made:

1- 'Poor sandy',
2- 'Rich sandy',
3- 'Poor clayey',
4- 'Rich clayey'.

The discriminating criteria, adopted from Kauffman, for these subpopulations are sumbases, texture and depth.

Sumbases.

A division has been made in 'poor' and 'rich' soils, with a limit of sumbases = 5 meq/100 gr soil in the subsoil. If the sumbases is below 5 meq, the soil is regarded having a poor natural fertility. It is clear that in this case, an agricultural approach has been chosen. A pedogenetic approximation would prefer a limit of 16 meq/100gr clay, which is the limit of presence of kaolinite. Anyhow, a sumbas of 5 meq/100gr soil is also used as an indication of presence of kaolinite, so actually both agricultural and pedogenetic factors are supposed to be considered.

	Rich	Poor
Subsoil (50-150cm)	Sumbas >5meq/100gr soil	Sumbas <5meq/100gr soil

Texture.

Soil profiles with <15% clay in the subsoil were excluded, i.e. the sandy soils (psamments, arenosols) are beyond the subject of this study (see chapter methodology).
The remaining soil profiles (140 profiles) were devided in a 'sandy' and a 'clayey' population. The way this has been done is based on a division of soils in coarse, medium and fine textured soils, as it is used in the FAO-soil map of the world, but in a slightly different way. In this study, only the clay content has been taken as discriminating criterium for coarse, medium or fine soils.

C (coarse) <15% clay,
M (medium) 15-35% clay,
F (fine) >35% clay.

	Sandy		Clayey		
Topsoil (0-25 cm)	C	M*	C	M	F
Subsoil (50-150 cm)	M	M	F	F	F

By M* profiles, the upper 15 cm is decisive whether it is regarded as a sandy or a clayey soil. When the topsoil is within more than 15 cm coarse, the soil is classified sandy, and when it is within less than 15 cm coarse, the soil will be handled as clayey. It appeared that only 10 soil profiles had a M/M texture.

Depth.

As mentioned in chapter 3, soil samples were devided in two ranges of depths. This has been done because throughout the years, soil samples have been taken at various depths.

1) Topsoil - soil samples between 0-25 cm.
   Samples closest to an average depth of 10 cm have been chosen.
2) Subsoil - soil samples between 50-150 cm.
   Samples closest to an average depth of 80 cm have been chosen.

On the basis of the above the following soil populations were created:

- Poor sandy - 43 soil profiles,
- Rich sandy - 13 " " ,
- Poor clayey - 37 " " ,
- Rich clayey - 37 " " .

Total 130 " " .

In the previous chapters we were dealing with 140 soil profiles. The omitted 10 profiles did not have a sample of the topsoil as well as a sample of the subsoil, therefore, they were omitted.

TABLE 7.1

Average values of soil characteristics for the subpopulations and for all data.

	Poor Sandy		Rich Sandy		Poor Clayey		Rich Clayey		All data	
	top	sub	top	sub	top	sub	top	sub	top	sub
San>'77	80.1	64.2	72.1	60.6	48.8	28.7	53.6	34.3	58.8	43.3
Si >'77	10.1	8.5	15.8	13.3	14.3	13.4	14.6	10.5	13.3	10.9
Clay	9.6	26.6	11.8	29.6	35.8	56.4	30.8	56.0	25.9	44.7
S/C>'77	1.44	0.39	1.34	0.57	0.45	0.25	0.56	0.41	0.78	0.40
pHH	6.2	6.1	6.3	6.2	5.8	5.7	6.3	6.2	6.1	6.0
pHK	5.3	5.1	5.4	5.0	4.9	5.0	5.3	5.2	5.1	5.1
DpH	0.9	1.0	0.9	1.2	0.9	0.6	1.1	1.1	1.0	0.9
Ca	2.8	1.9	6.2	5.3	3.1	2.0	9.4	6.4	5.1	3.4
Mg	0.6	0.7	0.8	1.5	1.3	0.9	2.3	2.7	1.4	1.5
Na	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1
K	0.2	0.2	0.4	0.3	0.4	0.2	0.7	0.3	0.4	0.2
Sumb	3.7	2.8	7.6	7.3	5.0	3.2	12.5	9.6	7.3	5.3
Sumb100	51.7	12.3	65.8	27.8	16.0	5.8	43.5	20.5	38.8	14.8
AC7	1.4	1.1	1.6	2.2	3.3	1.7	1.9	1.6	2.1	1.6
CEC	5.1	3.9	9.2	9.5	8.3	5.0	14.4	11.2	9.4	6.8
CEC100	71.5	16.7	80.1	35.9	26.4	9.2	50.3	24.2	50.3	19.0
BS	73.0	71.9	78.9	78.7	62.3	70.7	83.7	84.3	74.6	76.4
Ca/Mg	6.3	4.6	6.8	6.2	2.9	3.3	6.0	3.9	5.0	3.5
Mg/K	5.2	4.3	2.6	8.2	4.4	4.8	3.8	13.0	4.7	8.3
OC	0.8	0.1	1.1	0.3	1.6	0.6	1.7	0.5	1.2	0.4
Ntot	0.07	0.02	0.12	0.05	0.11	0.06	0.13	0.06	0.10	0.05
OC100	11.4	0.6	10.0	1.0	4.6	1.1	6.1	1.1	6.8	1.0
C/N	12.2	7.6	11.5	5.5	17.5	11.9	14.0	7.2	14.6	9.8

Sand, silt, clay, Base saturation, organic carbon and Ntotal - %.
Bases, sumbases, exchangeable acidity and CEC - meq/100gr soil.
Sum100 and CEC100 - meq/100gr clay (topsoil data are provided, but are not corrected for the contrubution of organic carbon).
OC100 - %/100gr clay.

7 SOIL FORMING PROCESSES AND FUNCTIONAL RELATIONSHIPS.

7.1 General considerations.

In this chapter will be looked at several soil characteristics and relations between soil characteristics as they behave in the subpopulations and in the whole population of 140 soil profiles.
PS stands for the Poor Sandy population (43 profiles), RS for Rich Sandy (13 profiles), PC for Poor Clayey (37 profiles) and RC for Rich Clayey (37 profiles), by which all populations are devided in topsoil and subsoil samples. In some cases, topsoil and subsoil, PC and RC or PS and RS are taken together in order to obtain insight in respectively the entire soil profiles in one subpopulation, the clayey population or the sandy population.

Table 7.1 gives the average values of relevant characteristics for all data and for the subpopulations. Marked differences between soil characteristic values of the subpopulations will be discussed below.

Texture.
The clay differentiation is large in all populations, especially in the clayey populations (more than 20% on the average).
The silt content does not differ much from the overall average in all populations. Silt content reaches lowest values in the PS population.
The S:C ratio of the PC population is very low relative to the other ratios. From this point of view, the soils of the PC population are by far the highest weathered soils.

pH.
The former statement with respect to the PC population is strengthened by the low pH values and the relative low Delta pH values of the PC population in the subsoil, which indicates presence of charge variability.

Bases, CEC and BS.
Also with regard to the AC7 and BS, the PC population has a special position, with the highest AC7 (3.3 meq/100gr soil) and the lowest BS (62.3%) in the topsoil. Consequently, the Ca:Mg ratio is low in the PC topsoil (2.9).
Remarkable is the high Mg:K ratio in the RC subsoil (13.0).
The observed increase of Mg with depth (chapter 5) appears in all populations, except in the PC population.

Organic carbon, Ntotal and C:N ratio.
Organic carbon content reaches highest levels in the clayey populations. Ntotal is relative low in the PS topsoil and subsoil.
The PC topsoil and subsoil have high C:N ratios, which agrees with the poor and highly weathered properties of this population.

In the following paragraphs, a couple of topics will be described in detail. Selection of these topics is principally based on assumed and actual present correlations between soil characteristics. Subjects such as the correlation between Delta pH and other characteristics (using Delta pH as a 'search factor') were omitted because significant correlations were not found.

Fig. 7.2 Organic Carbon - CEC, topsoil.
Collision symbol: *

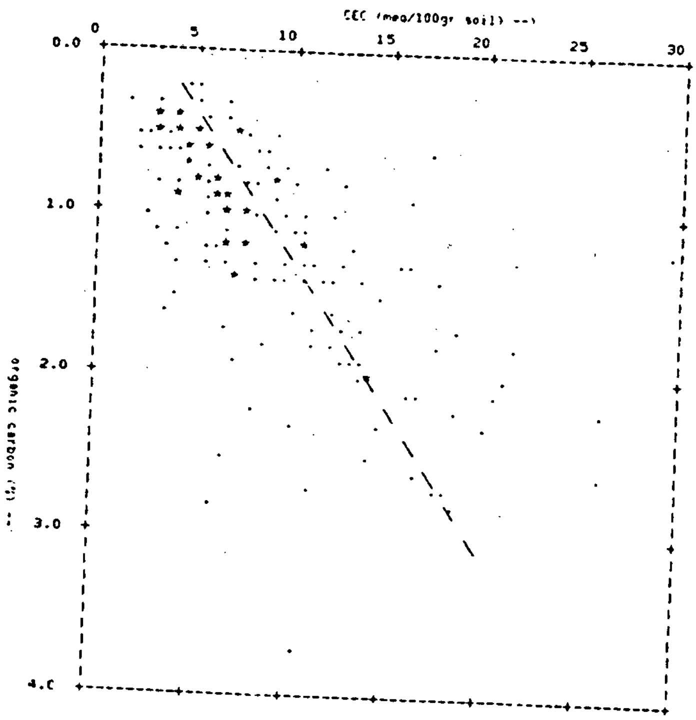


Fig. 7.3 Organic Carbon - Clay content, topsoil.
Collision symbol: *

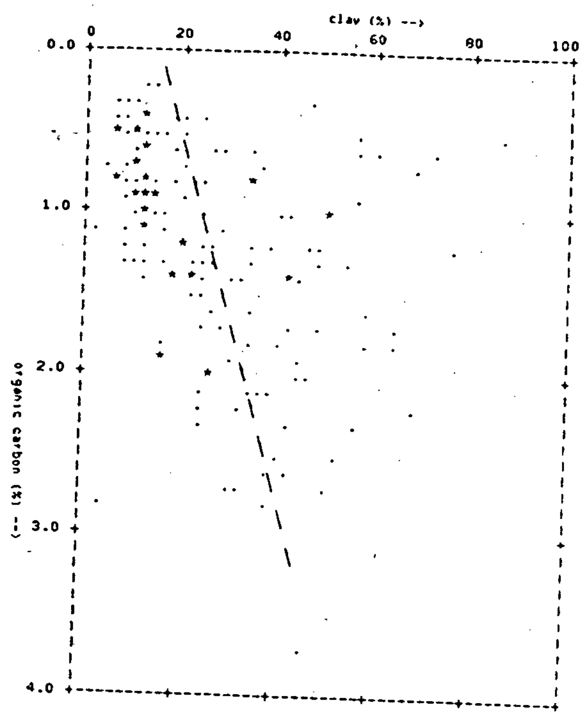
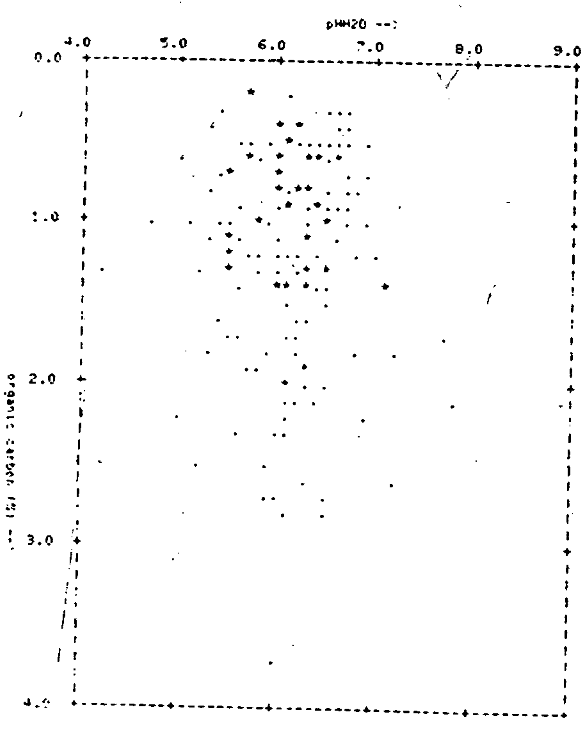


Fig. 7.4 Organic Carbon - pHH2O, topsoil.
Collision symbol: *



7.2 Organic Carbon.

Organic matter in the soil contains virtually all of the soil reserves of nitrogen for plant nutrition (and large proportions of the sulphur and phosphorus). It exerts a strongly favourable influence on physical conditions in the soil, stabilizes aggregates of soil particles and provides food for the soil fauna, which reworks the soil to produce the desired porosity. Its ability to retain cations and micronutrients is also important.
The organic matter content of a soil is not a fixed value, as it is the resultant of the simultaneous rates of addition of fresh material and decomposition of both the added material and the humified material already in the soil.
Soil factors as clay content, pH, base supply and aeration are considered to have marked effects on the rate of decomposition.

In the following considerations of organic carbon, clay content, pH and CEC, only topsoil data will be taken into account.

In the scattergrams 7.2, 7.3 and 7.4, OC (X-axis, vertically) is plotted against CEC, clay and pHH2O (Y-axis, horizontally) for all data.
It will be clear from the presented data that the OC content increases with increasing CEC and clay content. The correlation coefficients and lineair regression lines between OC and the three variables are stated below.

	corr.coeff	lin.regr.line
OC - CEC	0.68	OC(%) = 2,4 + 5,5 CEC(meq/100gr soil).
OC - Clay	0.36	OC(%) = 14,7 + 8,9 Clay(%).
OC - pHH	-0.02	OC(%) = 6,1 + -.01 pHH(unit).

The lineair regression lines from OC with CEC and Clay can be found in the scattergrams as lines, drawn by hand. Notice that the regression line of OC and Clay does not make much sense because of the low correlation coefficient.
The OC content does not depend on the pHH value, what as well can be seen from the OC - pHH scattergram. OC contents remain the same at various pHH values.

Table 7.1 shows an overall average OC content of 1.2%. The OC content of

PS (0.8%) < RS (1.1%) < PC (1.6%) < RC (1.7%)

which is obvious because OC is positively related to the CEC (see above).
The pHH of

PC (5.8) < PS (6.2) < RC = RS (6.3)

with an overall average of 6.1 shows the acidity of the Poor Clayey population relative to the Poor Sandy population.

The clay content is a discriminating criterium for dividing the subpopulations, and is therefore much lower in the sandy populations than in the clayey populations.
The Sumbas of the subsoil has been a discriminating criterium too. It is assumed that the CEC in the topsoil is related to the Sumbas of the

Fig. 7.5 Organic Carbon - Clay content, topsoil of poor sandy, rich sandy, poor clayey and rich clayey soils.
Collision symbol: *

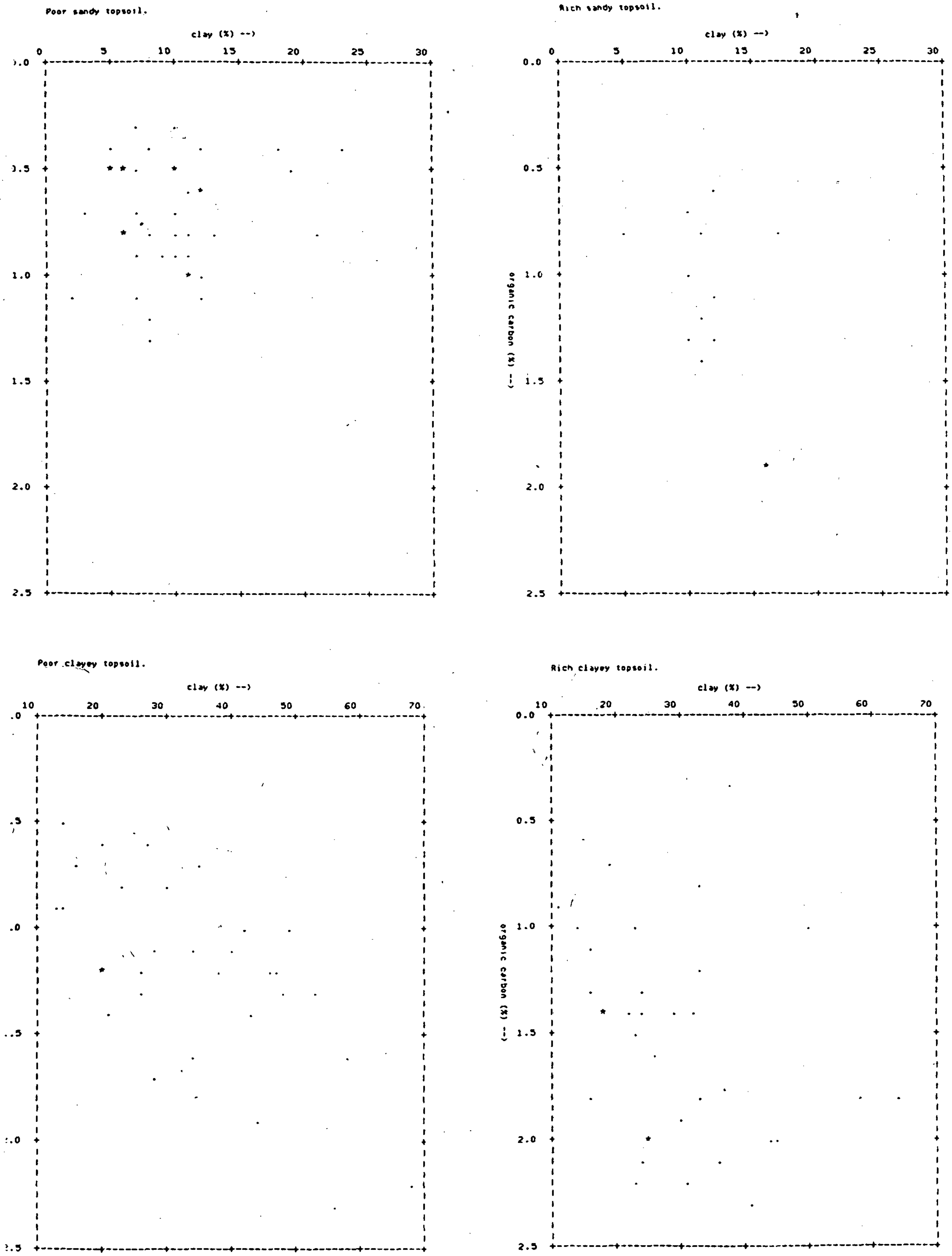


Fig 7.6 Organic Carbon - CEC, topsoil of poor sandy, rich sandy, poor clayey and rich clayey soils.
Collision symbol: *

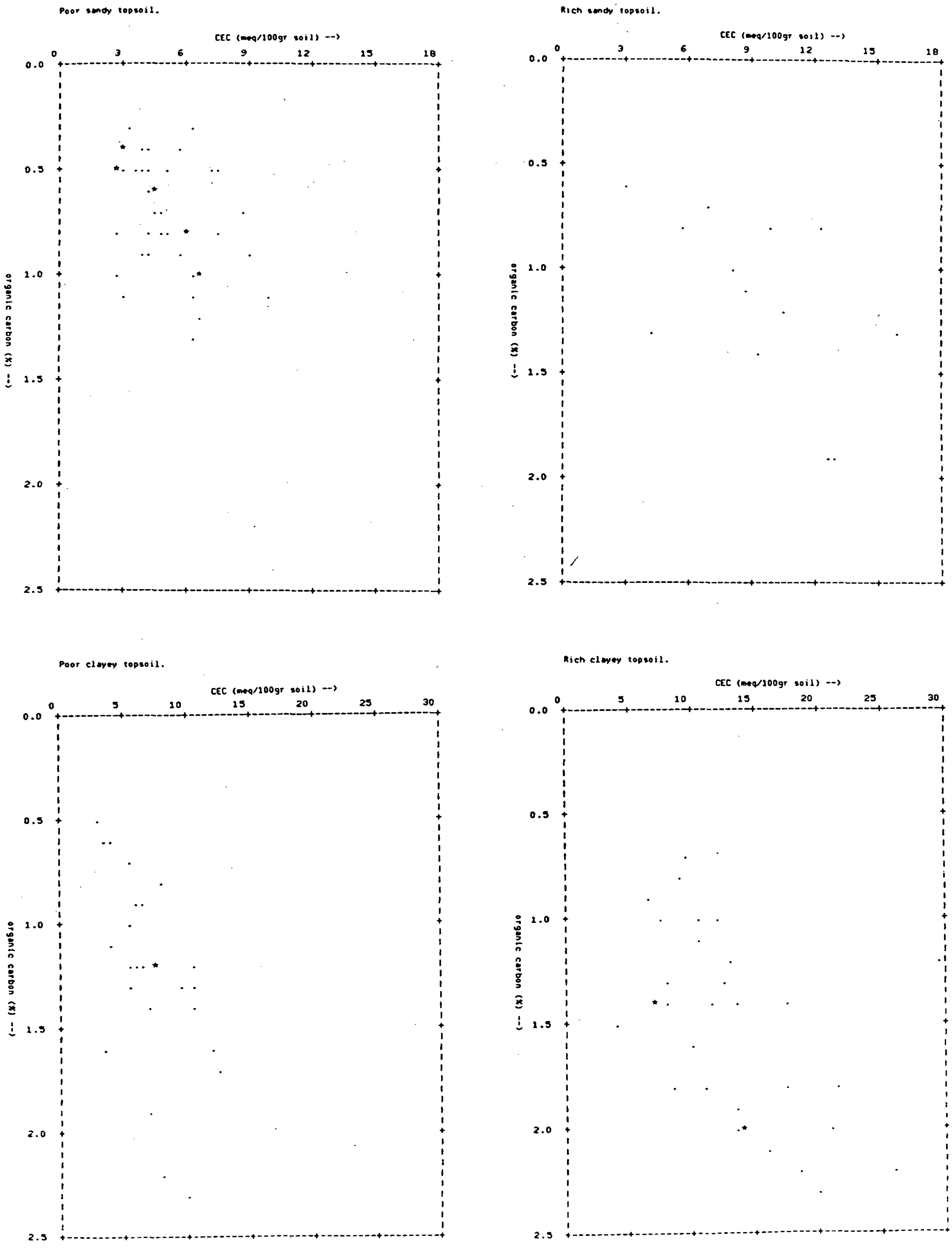
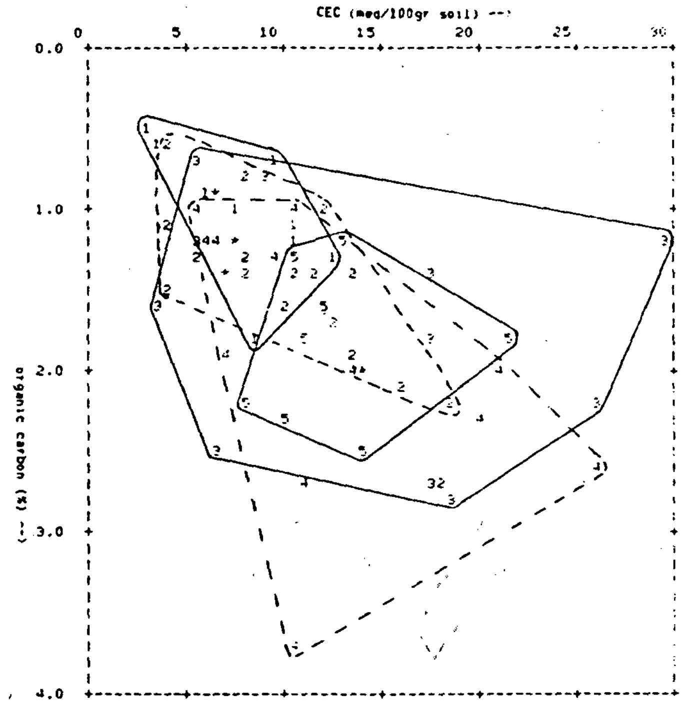


Fig. 7.8 Organic Carbon - CEC, topsoil, with clay classes.
(1 ≤ 21% clay, 2= 21-31%, 3= 31-41%, 4= 41-51%, 5 >51%)
Collision symbol: *



subsoil. Through that, it would be credible that the CEC of the poor subpopulation is lower than the CEC of the rich subpopulation. From table 7.1, one can see that the CEC of

PS (5.1) < PC (8.3) < RS (9.2) < RC (14.4)

which hierarchy is obvious. The small difference between CEC of the PC and CEC of the RS population indicates that the CEC of the topsoil of the Poor Clayey population is large relative to the CEC of the topsoil of the Rich Sandy population.

Scattergrams 7.5 and 7.6 show that the OC content depends less on CEC and Clay content in the sandy populations than in the clayey populations. And even in the clayey populations, scattering is large. (It should be noticed that the Y-axis has variable values in the case of CEC and Clay content for sandy and clayey populations).
Table 7.7 below lists the correlation coefficients between the four soil variables OC, CEC, Clay and pHH.

TABLE 7.7
Correlation coefficients of OC, CEC, Clay and pHH in the topsoil of the subpopulations and of the whole population.

		PS	RS	PC	RC	All data
OC	- CEC	0.29	0.55	0.77	0.56	0.68
	- Clay	-0.26	0.48	0.43	0.23	0.36
	- pHH	-0.15	0.03	-0.20	0.08	-0.02
CEC	- Clay	-0.32	0.49	0.18	0.36	0.38
	- pHH	-0.11	0.15	-0.09	0.62	0.28
Clay	- pHH	0.14	-0.15	-0.43	0.00	-0.30

From the correlation coefficients and the figures, it appears that in the clayey populations, the OC content increases with increasing CEC and Clay content, while in the sandy populations this tendency is not very clear. One can state that the observed increase of OC with CEC and Clay content in fig 7.2 and 7.3, is mainly due to the clayey population.

In investigating the behaviour of the three variables OC, CEC and Clay in one scattergram, five classes for the Clay content have been made in the topsoil of the clayey population (i.e. PC and RC together)

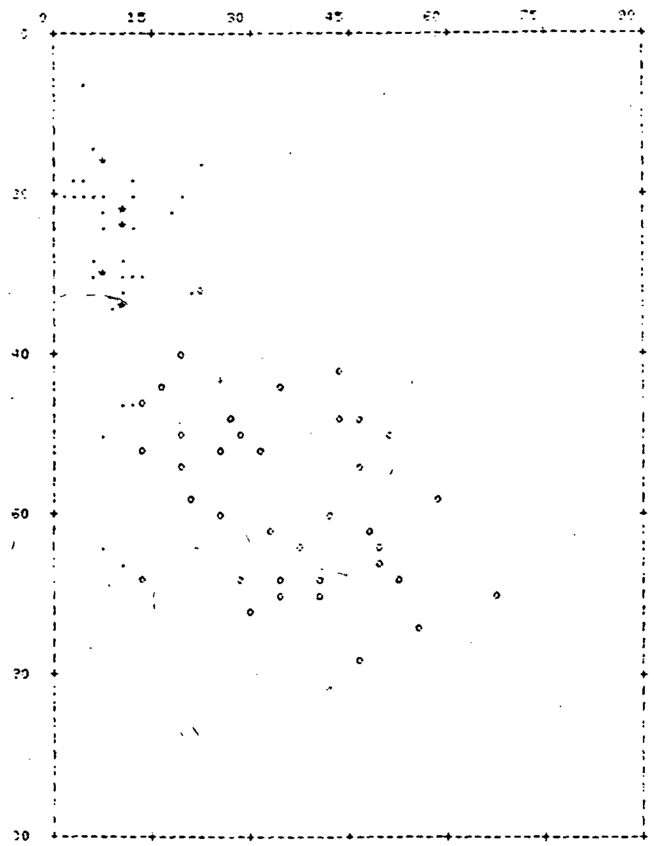
Class 1 - < 21% clay.
Class 2 - 21 - 31% " .
Class 3 - 31 - 41% " .
Class 4 - 41 - 51% " .
Class 5 - > 51% " .

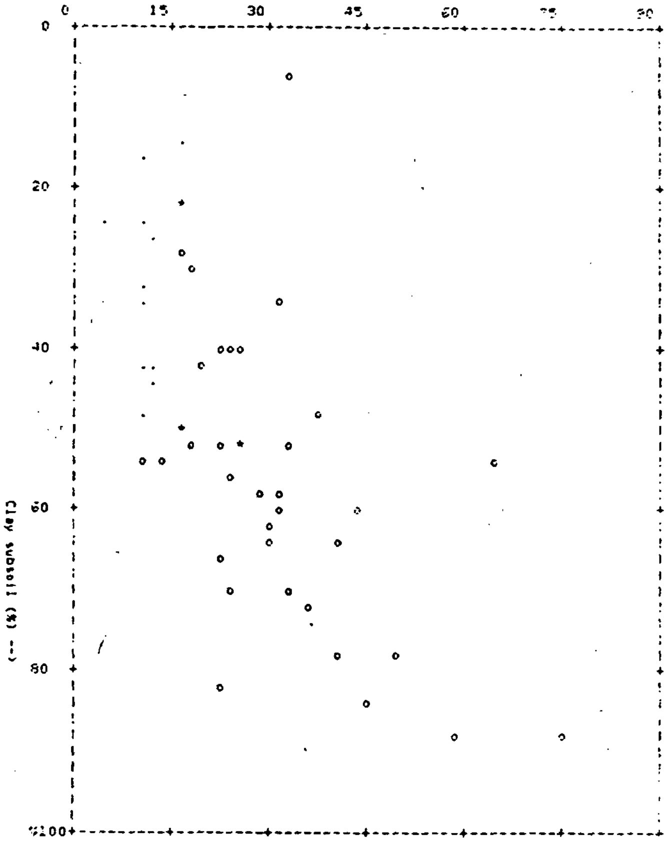
In scattergram 7.8 no.1 represents class 1, no.2 class 2, etc. The variability in OC and CEC is wide for these five classes. One should expect class 1 having the lowest OC contents and CEC and contrary class 5 having the highest values.
From the clusters can be seen that this tendency is present, although not very evident. In table 7.9 the mean values and correlation coeffi-

Fig. 7.10 Clay subsoil - Clay topsoil, in poor sandy, rich sandy, poor clayey and rich clayey soils.
Collision symbol: *

		Mean	Corr.coeff.
* = Poor sandy.	clay topsoil	3.6 %	0.07
	clay subsoil	26.5 %	
o = Poor clayey			
	clay topsoil	35.5 %	0.41
	clay subsoil	57.3 %	

		Mean	Corr.coeff.
. = Rich sandy	clay topsoil	11.8 %	-0.31
	clay subsoil	29.6 %	
o = Rich clayey			
	clay topsoil	30.8 %	0.51
	clay subsoil	56.0 %	





cients are stated for each of the five classes.

TABLE 7.9
Mean values and correlation coefficients of OC, CEC and Clay in the clayey population.

	class 1	class 2	class 3	class 4	class 5
	mean values				
Clay	16.3	25.6	34.6	45.4	60.4
OC	1.04	1.49	1.74	1.81	1.84
CEC	7.1	10.1	14.3	11.0	12.4
	correlation coefficients				
OC - CEC	0.58	0.81	0.57	0.53	-0.09
- Clay	0.18	0.10	-0.08	-0.20	-0.39
CEC _ Clay	0.19	-0.13	-0.46	-0.48	-0.18

From this table and from fig.7.8 it appears that mean OC values increase with increasing clay class, although the correlation coefficients within the classes are very low.
The CEC only increases with increasing Clay class in the first three classes (from 7.1 meq till 14.3 meq). Remarkable is the correlation coefficient of 0.81 between OC and CEC in class two, while the others have much lower values and is even negative in class 5!
So, the assumption that OC, CEC and Clay are highly correlated is far beyond the thruth. From these date, it is likely to believe that we are dealing with various types of clay and organic matter.

7.3 Topsoil - subsoil pHH2O and Clay content.

In chapter 5, paragraph 5.2 and 5.3 has been glanced at the clay content and pHH in subsoil and topsoil (fig.5.5 and 5.8).
In the case of clay content, a large textural differentiation in the soil profiles between topsoil and subsoil has been noticed. In order to estimate the contribution of the four subpopulations to this textural differentiation, scattergrams 7.10 were made.
In Fig. 5.5 clay contents in subsoil and topsoil of all data are plotted. The correlation coefficient is 0.68, which is not very high.
The lineair regression line of

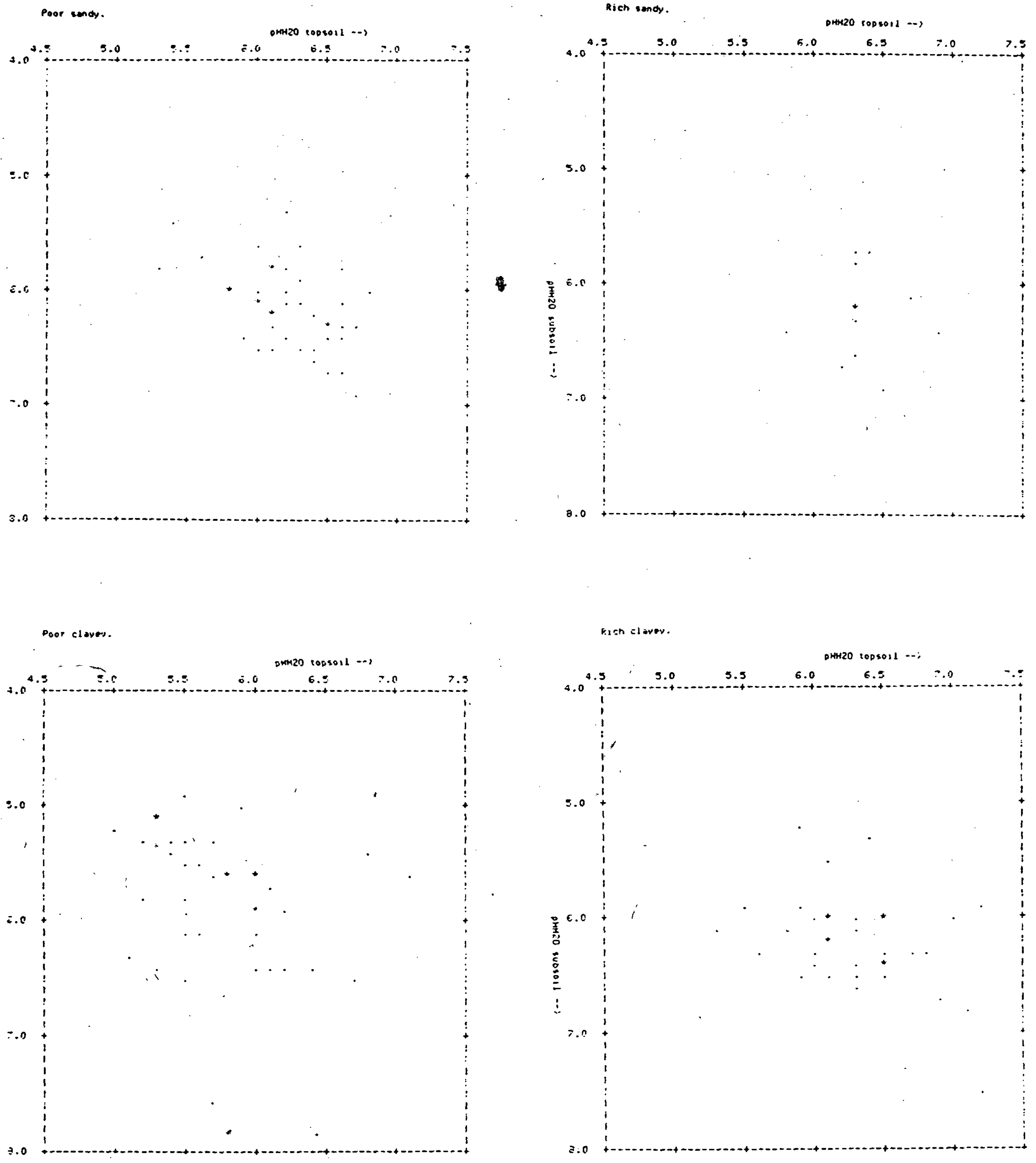
$$Clay_{top} = -0.82 + 0.55\ Clay_{sub}$$

indicates that the mean clay content in the subsoil (50-150 cm) is about 1.8 times the mean clay content in the topsoil (0-25 cm).

In the figures 7.10 the dots (.) represent the sandy population, while the nots (o) represent the clayey population. The left figure is the poor population whereas the right the rich. It is clear that a wide scattering is present, and that the correlation coefficients are low (lower than 0.68). In all subpopulations, the clay differentiation is large.

From table 7.1 it appears that in each subpopulation the pHH in the

Fig. 7.11 pHH2O subsoil - pHH2O topsoil, in poor sandy, rich sandy, poor clayey and rich clayey soils.
Collision symbol: *



topsoil is ~~one~~ 0.1 unit higher than the pH in the subsoil. This small shift in pH values towards a lower pH in the subsoil has also been noticed in chapter 5. Remarkable are the low values of the PC population (5.8 in topsoil and 5.7 in the subsoil), which can be due to a more intense weathering of this population (fig.7.11).

7.4 pHH2O, pHKCl, Delta pH, CEC and BS.

In general, the soil acidifying process can be outlined as follows (Sanchez (10)):
Hydrogen ions, mainly produced by organic matter decomposition are unstable in mineral soils, because they react with layer silicate clays, releasing exchangeable Al.
Therefore, exchangeable Al is the dominant cation associated with soil acidity, giving information about soil acidity (percent Aluminium Saturation).
Exchangeable Al is precipitated at a pH of about 5.5 to 6.0. Thus little or no exchangeable Al is found at higher soil pH values.

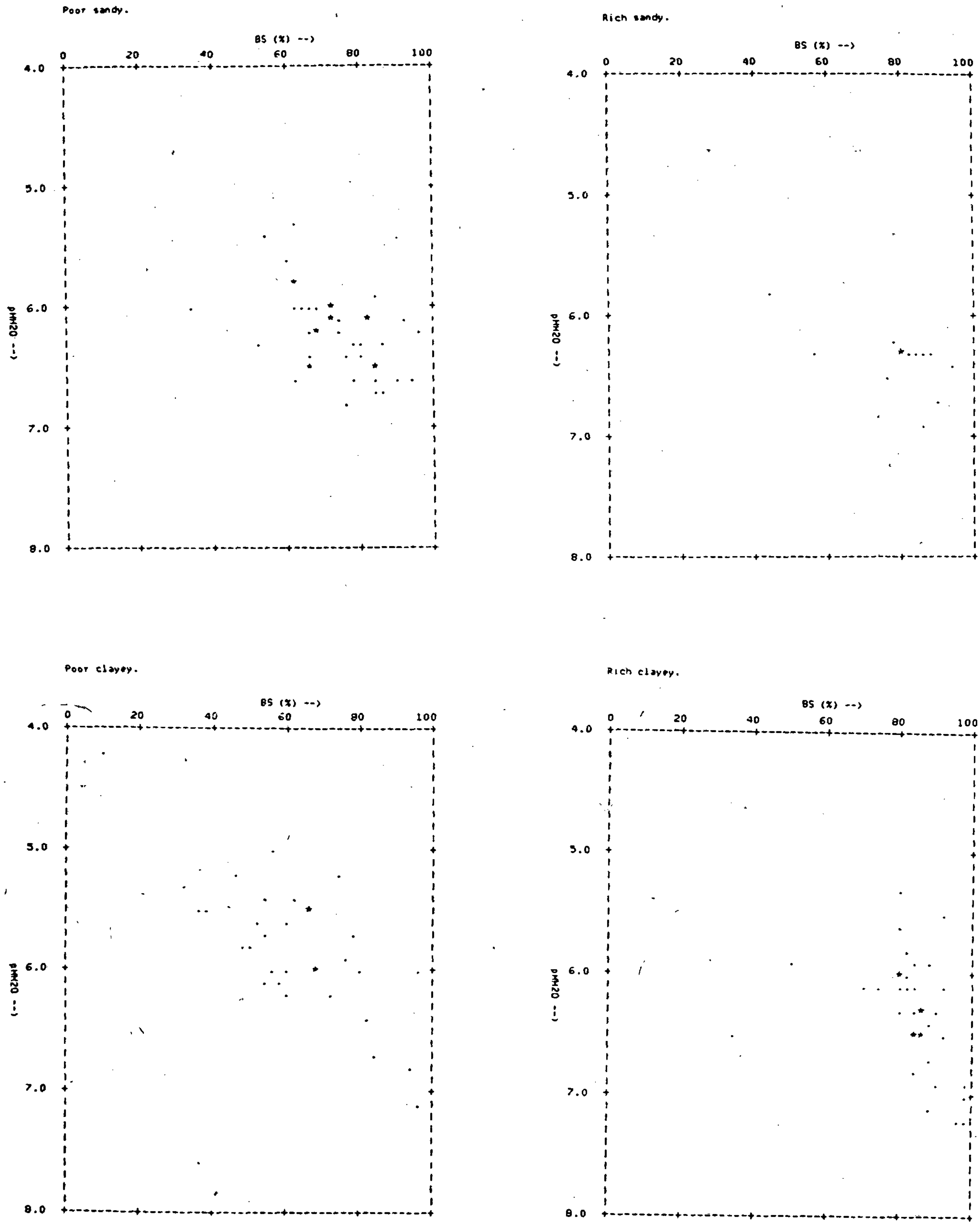
In addition to exchangeable Al values, which has not been analyzed in Mozambique, a usefull measure of soil acidity is the percent BS, which is the reciprocal of percent Al Saturation.
Since the exchangeable bases and acidity were measured by pH7, they are of low practical value, since we have to deal with pH-dependent charged soils. The BS values obtained exaggerate the actual acidity of soils that have pH-dependent charge.

BS is an important criterium in soil classification systems (see chapter 6). BS distinguishes the soil groups Luvisols and Acrisols, mollic and umbric diagnostic horizons and humic, eutric and distric soil units in the old FAO system.
In the revised FAO legend, BS discriminates the soil groups Luvisols, Lixisols, Alisols and Acrisols, mollic and umbric diagnostic horizons and eutric and distric cambisols.
In Soil Taxonomy on order level, the distinction between Ultisols and Alfisols is very important.

Greenland (6), proposed that the effective CEC (ECEC) procedure, that is CEC measured with unbuffered solution, i.e. at field pH, must be adopted as a standard CEC procedure. A percentage BS (PBS) of 70 percent or above in the diagnostic B horizon should be used for seperating Alfisols from Ultisols. (The choice of this particular PBS value also has agronomic significance: soil having a PBS value above 70 percent or exchangeable Al Saturation of less than 30 per cent, are normally suitable for most Al-sensitive legume crops without liming).

Sanchez (10), points to a correlation between BS calculated by the Ba-TEA method at pH8.2 and BS calculated from ECEC determinations of 88 soils from the USA and Puerto Rico. The indication that 35% BSpH8.2 is equivalent to 55% BS obtained with ECEC holds very well for loamy and clayey soils low in organic matter. For sandy soil or soils with more than 1% organic matter, the relationship is different. The limit for seperating Mollisols and Alfisols, 50%f BS pH7, corresponds to 90% BS using ECEC.

Fig.7.12 pHH2O - Base Saturation, topsoil of Poor sandy, Rich sandy, Poor clayey and Rich clayey soils.
Collision symbol: *



It may be clear that the interpretation of CEC and BS values depends heavily on the methods used to obtain them.
Table 7.1 shows that BS has the lowest values in the PC subpopulation (62.3% in the topsoil and 70.7% in the subsoil). In the previous paragraph has already been noticed that this PC subpopulation also has the lowest pH values.

In scattergrams 7.12 the pHH (X-axis vertically) is plotted against BS (Y-axis horizontally) for each subpopulation in the topsoil. It can be seen that there is a tendency of BS to increase with increasing pHH. This tendency is most outspoken in the PC population where the correlation coefficient equals 0.75.

Correlation coefficients of pHH and Sumbas, CEC and BS.

	PS		RS		PC		RC	
	top	sub	top	sub	top	sub	top	sub
pHH - Sumbas	0.07	0.00	0.21	-0.37	0.47	0.25	0.66	0.53
- CEC	-0.15	-0.03	0.15	0.14	-0.09	-0.15	0.62	0.47
- BS	0.50	0.15	0.62	-0.45	0.75	0.37	0.38	0.50

Remarkable is the (low) negative correlation between pHH and BS in the RS subsoil.
In general, the correlation coefficients are very low, which gives rise to the conclusion that BS is <u>not</u> an usefull measure of soil acidity according to the analyzed data set.

Fig. 7.13 pHH2O - pHKCl in subsoil and topsoil (all data).
Collision symbol: *

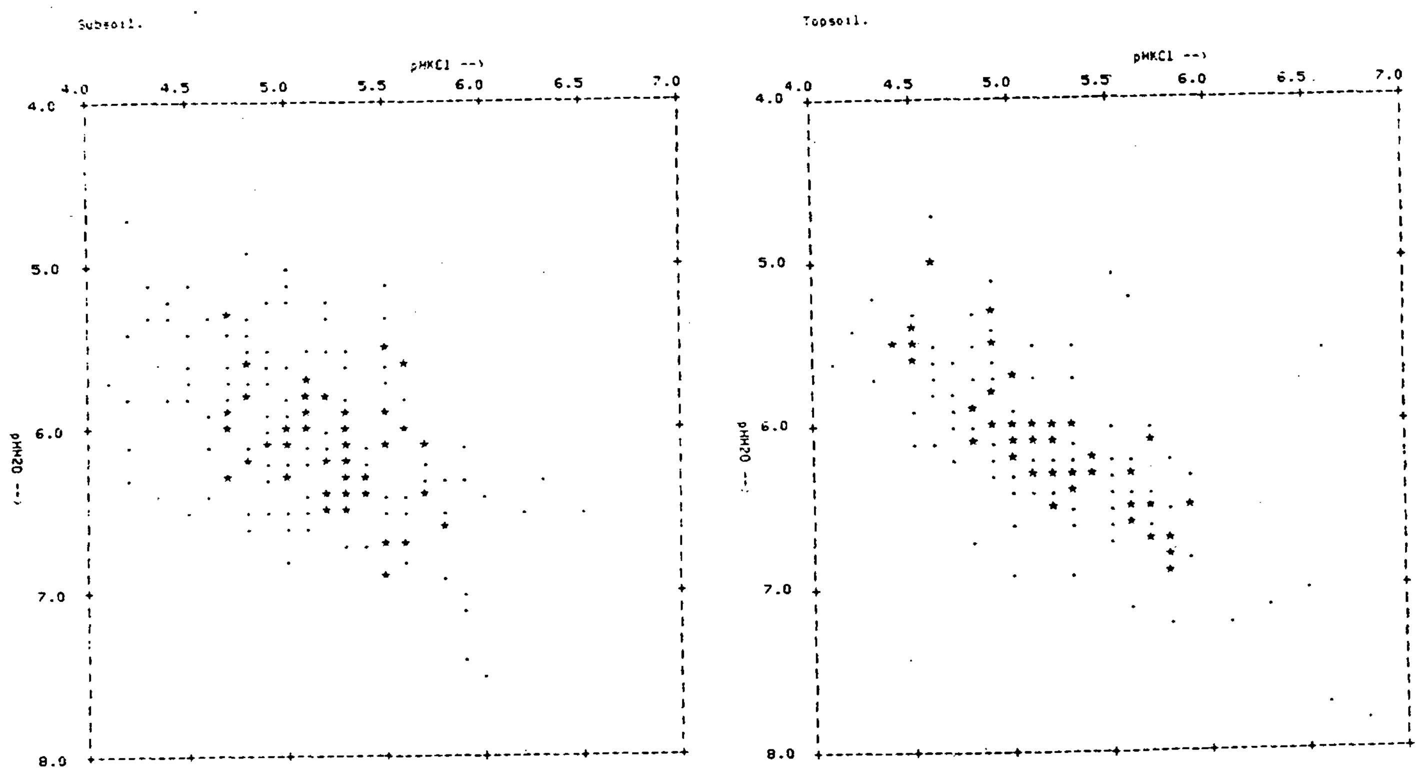
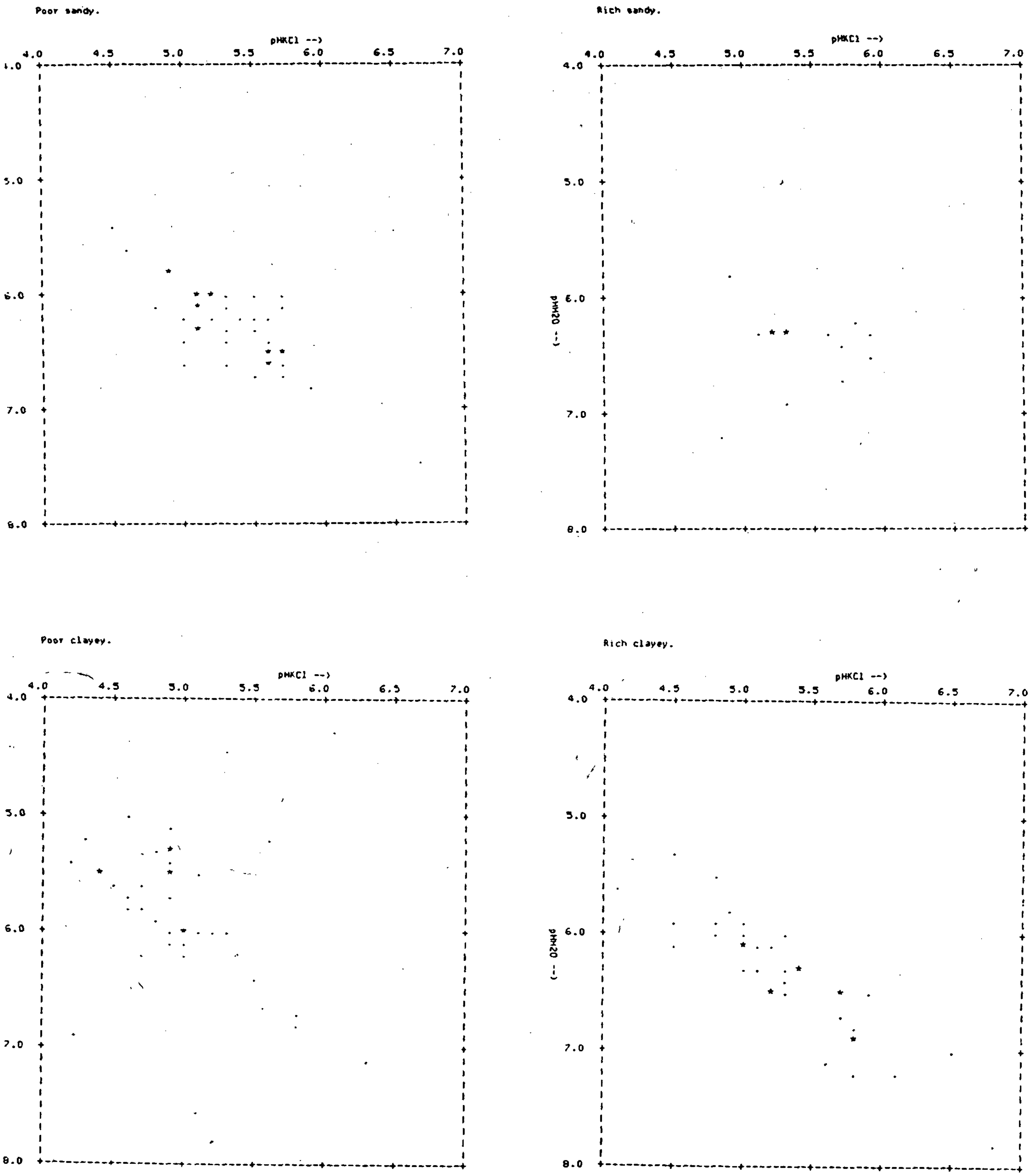


Fig. 7.14 pHH2O - pHKCl, topsoil of Poor sandy, Rich sandy, Poor clayey and Rich clayey soils.
Collision symbol: *



Soil pH depends on base supply. It is known that the pH increases due to an increase in exchangeable Ca, Mg and K after burning and decreases gradually with time because of the leaching of bases (Sanchez (10) ,page 365).
One should expect an increasing pH with increasing Sumbas. As can be seen from the correlation coefficients listed above, these two variables do not correlate at all in the sandy populations and show low correlation in the clayey populations.

In the figures 7.13,the pHH (vertically, X-axis, values 4-8) is plotted against pHK (horizontally, Y-axis, values 4-7) in the topsoil and the subsoil. They show that the tendency of pHH to decrease with decreasing pHK is more clear in the topsoil than in the subsoil. The correlation coefficient of the former is 0.79 and of the latter is 0.57.
The correlation coefficients of the four subpopulations in the subsoil have a range between 0.62 and 0.66, which indicates a wide scattering between pHH and pHK values.
The relation between both pH values in the topsoil show a more pronounced picture.
Correlation coefficients of pHH and pHK in the topsoil:

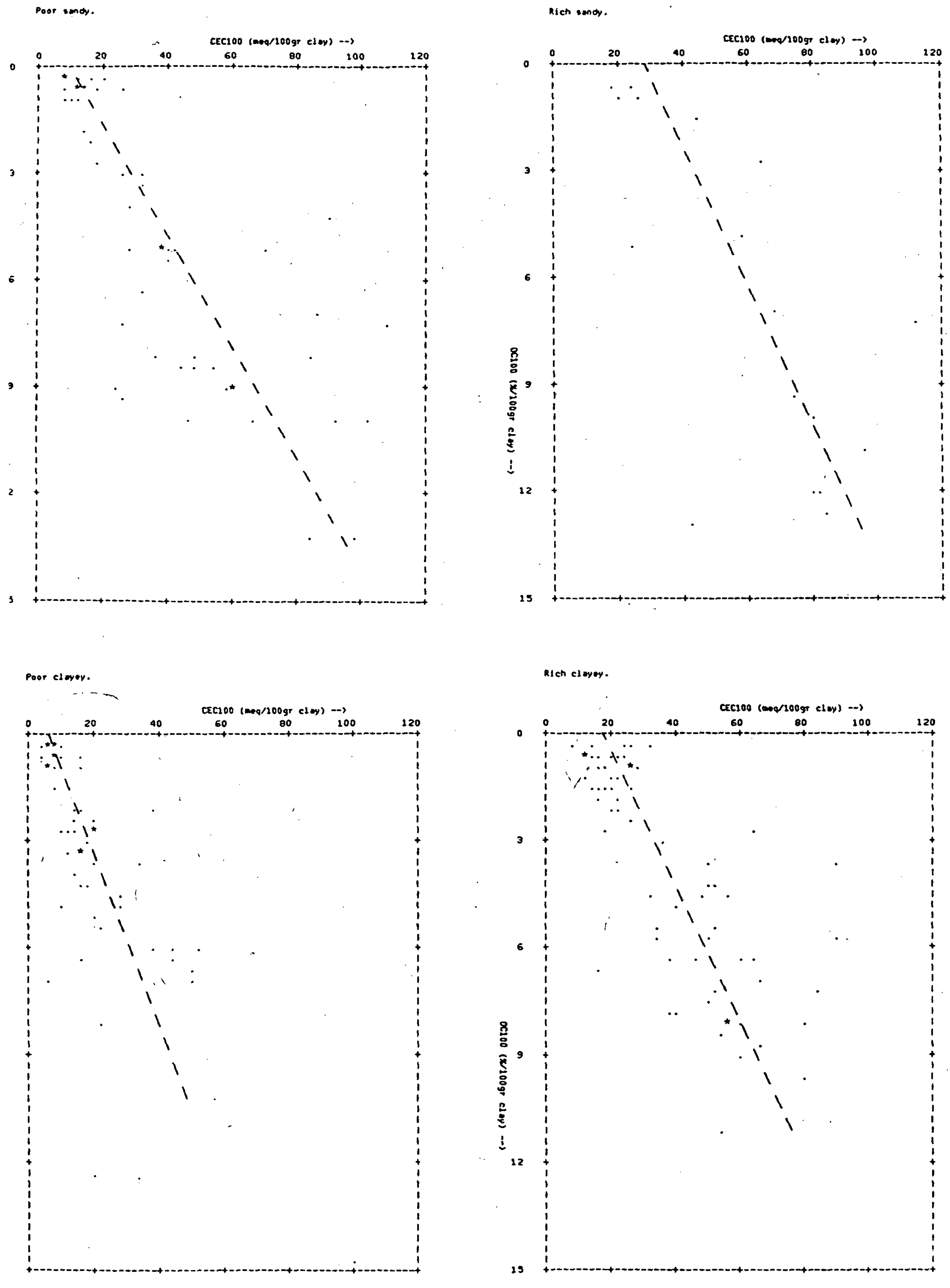
PS	RS	PC	RC	Poor	Rich	Sandy	Clayey
0.69	0.36	0.78	0.89	0.79	0.84	0.53	0.85

The general conclusion is that pHH and pHK are highly correlated in the rich clayey population. The lineair regression line in this population is: pHK = -0.81 + 0.96pHH (fig.7.14).

The charge of an oxide system can be easily determined by measuring its pHH and pHK. If DpH (defined here as pHH - pHK) is positive, there is net negative charge (cation exchange capacity). If DpH is negative, there is net positive charge (anion exchange capacity).
In layer silicat systems, DpH is always positive, whereas in oxide systems DpH can be positive are negative depending on the pH of the soil (charge variable or pH dependent CEC).

As can be seen from table 7.1, pHH and pHK decrease with depth, except for pHK in the PC population. DpH in all populations is positive. The PC population has the lowest DpH values (0.9 in topsoil, 0.6 in subsoil), which is not surprising, because the PC population can be regarded as the one most similar to the LAC-soils in which oxides play an important role.
A positive DpH does not imply a total absence of positive charge on the clay surfaces. A small number can be present, perhaps in areas isolated from the negative charges (Sanchez (10)).

Fig. 7.15 Organic Carbon per 100gr clay - CEC per 100gr clay, in Poor sandy, Rich sandy, Poor clayey and Rich clayey soils.
Collision symbol: *



7.5 <u>The calculation of CEC of the clay with correction for OC</u>.

The CEC_{100}, defined as CEC_{soil}x100/clay content, gives an indication of the nature of the clay minerals. The CEC_{100} value is significant in the subsoil only, because the contributon of OC in the topsoil to the CEC is high. Therefore, the CEC_{100} value must be corrected for OC in order to estimate the real CEC_{100}.

A method, which shows the influence of OC on the exchange complex, as well as the CEC of clay, has been developed by Bennema 1966. This method is based on the estimaton of CEC_{100} and OC_{100} of within one latosol profile. In this study, this method will be used on groups of profiles, in order to give a rough indication of the clay minerals present.

The method is based on the assumptions that:

1) The CEC is practically all located in the clay fraction and in the organic matter.
2) The clay and OC in the same subpopulation have approximately the same CEC.

For each sample of the solum

$$CEC = CEC_{clay} + CEC_{oc}$$

in which CEC is the CEC of the soil sample determined in the laboratory and

$$CEC_{oc} = OC \times CEC_{1oc}$$

in which OC is the organic carbon content and CEC_{1oc} is the CEC of 1% OC. So

$$CEC = CEC_{clay} + (OC \times CEC_{1oc})$$

By multiplying each factor with 100/clay content the equation becomes:

$$(100/clay) \times CEC = CEC_{clay100} + (OC_{100} \times CEC_{1oc})$$

or

$$Y = CEC_{clay100} + CEC_{1oc}\ X$$

$CEC_{clay100}$ and CEC_{1oc} are considered to be the same for all samples. X and Y can be calculated statistically.

Calculation is done for the four subpopulations, not devided in topsoil and subsoil. Correlation coefficients and lineair regression lines of OC_{100} and CEC_{100} for these populations are stated below. Scattergrams are given in fig.7.15.

	Corr.coeff.	Lineair regression line
PS	0.78	CEC_{100} = 9.3 + 6.5 OC_{100}
RS	0.76	" = 28.0 + 5.1 "
PC	0.76	" = 5.5 + 4.2 "
RC	0.76	" = 17.1 + 5.3 "

The correlation coefficients indicate wide scattering (see also scattergrams).
The lineair regression lines indicate (in a very rough way) the contribution of 100 gr clay ($CEC_{clay100}$) and 1% OC (CEC_{1oc}) to the total

measured CEC.

	$CEC_{clay100}$	CEC_{1oc}	$CEC_{100subsoil}$
PS	9.3 meq/100gr clay	6.5 meq/1%oc	16.7 meq/100gr clay
RS	28.0	5.1	35.9
PC	5.5	4.2	9.2
RC	17.1	5.3	24.2

In the third column the original not corrected CEC_{100} of the subsoil, as it appears in table 7.1, is stated. It is obvious that $CEC_{clay100}$ is lower than $CEC_{100subsoil}$ because the contribution of OC to the CEC has been subtracted.

CEC of some important clay minerals according to

	Sanchez (Kenya) (10)	Young (18)
Montmorillonite	118	80-150
Vermiculite	85	100-150
Illite	19	10-40
Halloysite	18	5-50
Gibbsite	5	-
Kaolinite	4	3-15
Goethite	4	-

The $CEC_{clay100}$ values show that the contribution of 100 gr clay to the total measured CEC in the PC and PS populations is very low (5.5 and 9.3 respectively). These populations to a large extend consist of kaolinite, halloysite (1:1 clay minerals), gibbsite and/or goethite only. They also do not exceed the limit of 16 meq/100gr clay, which is the limit of strongly weathered soils.
The RC population just exceeds this limit of 16 meq. Besides the above mentioned 1:1 clay minerals, 1:2 clay minerals such as illite and chlorite can be present in the RC population.
The RS population has by far the highest $CEC_{clay100}$. This is surprising because in general sandy soils are strongly weathered due to extreme leaching. The fact that only few RS profiles (13 out of 130) are in the data set, might be the origin of a wrong interpretation of the $CEC_{clay100}$.

The CEC of OC may vary with soil type: one should expect that the richer the weathering complex, the higher the CEC of the humus. From the CEC_{1oc} values, this tendency can not be seen. The population lowest in $CEC_{clay100}$ (PC) has the lowest CEC_{1oc}g, but on the contrary, the PS population has the highest CEC_{1oc} (6.5 meq/1%oc)

Finally, some remarks about this method of calculation of CEC for 100 grams clay with correction for OC must be added.

1) The first assumption that CEC is practically all located in the clay fraction and in the organic matter, is not true. An appreciable proportion of the CEC may reside with the fine silt, because of presence of pseudo-silt.

2) The second assumption that clay and OC within the same subpopulation have approximately the same CEC, introduces a big generalization (see paragraph 7.2). Even in one and the same soil profile various types of clay and organic matter can be present throughout the solum, due to different weathering conditions, lateral removal, etc.

8 CONCLUSIONS AND RECOMMENDATIONS.

The usefulness of soil data, resulting from old studies is restricted. One of the major problems is the great variety in analytical procedures used for determination of soil characteristics.

First, soil analytical methods changed considerable in Mozambique during the last 20 years. Especially great differences exist between the time before and after independence (1975). This resulted in a limited number of soil characteristics which were expected to be sufficiently reliable to use for this study.
Second, analytical procedures are not (yet) standardized all over the world, which gives rise to a large variability in analytical results.
One of these analytical methods, the estimation of the CEC, must be mentioned in particular.
The various methods used for estimation of the CEC is rather confusing. The 'normal' methods used in the FAO and Soil Taxonomy classification systems (extraction of cations with NH_4OAc, pH7 and/or with $BaCl_2$, pH8.2) overestimate the CEC of many tropical soils, especially those soils which have pH-dependent CEC (Low Activity Clays). The CEC estimated at the actual field pH, the effective CEC or ECEC, gives a better characterization of the exchange capacity of a soil.
Also BS, based on 'normal', i.e. buffered exchange methods, is effected and tends to underestimate the base status whereas total exchangeagble acidity overestimates the acidity problems of many tropical soils.
Standardization of analytical procedures is therefore urgently needed!

The selected and sufficiently reliable soil characteristics are convenient to give information about soils in terms of variability in soil properties. As all data from all soil profiles are gathered, it is impossible to consider single soil profiles. Considering single soil profiles is needed for studying criteria for soil classification and relevant soil forming processes. Besides this, the available data do not lend themselves to consider single profiles in terms of soil processes and classification criteria, due to the lack of essential morphological and analytical data.
In meeting this problem partly, a division in Poor sandy, Rich Sandy, Poor Clayey and Rich Clayey subpopulations has been made.
The results presented indicate that the deep, well drained upland soils show a large variability in soil properties. Anyhow, average values of soil characteristics and tendencies of soil forming processes and relationships between soil characteristics as stated below, give a rough characterization of the soils.

- The textural differentiation is large in the entire population of soils, as well as in all subpopulations. About 59% of the soils show a difference in clay content between topsoil (0-25 cm) and subsoil (50- 150 cm) of 20% or more!

- The average Silt:Clay ratio is high and decreases with depth. In almost all soil profiles it exceeds a value of 0.15. The poor clayey population has the lowest Silt:Clay ratios (0.45 in the topsoil and 0.25 in the subsoil), which indicates that this population is the most weathered one.

-The whole population has an average pHH_2O value of 6.1. The poor clayey population shows a moderately acid property.

-An increase of the pHKCl relative to the pHH_2O in the subsoil, indicating the presence of pH dependent CEC, does not appear in the entire population. Only in the poor clayey population this tendency is slightly present.

-The exchangeable acidity has normal to low values and almost all soils have a Base saturation larger than 50%. The poor clayey population is by far the most acid and leached one with topsoil average values of exchangeable acidity of 3.3 meq/100gr soil and a BS of 62.3%.
CEC values are low, with an average value of 9.4 meq/100gr soil in the topsoil and 6.8 meq in the subsoil.
The CEC of the clay, corrected for the contribution of organic carbon to the CEC, is very low in the poor sandy and poor clayey populations (9.3 and 5.5 meq/100gr clay respectively).

-Organic carbon, Ntotal an C:N ratios argue dry to moist savanne like circumstances, which is reliable for the climate in northern Mozambique.

-In the topsoil of the entire population, the organic carbon content is positively correlated with CEC and clay content and the CEC positively with clay content as well. Organic carbon shows a low negative correlation with pHH_2O.
In the poor sandy population, the CEC is negatively correlated with organic carbon and clay content, which is rather surprising. It also appeared that soil with a high clay content not always have a higher CEC than soils with a lower clay con-tent. It is concluded that various types of organic matter and clay are present.

In this study, many issues were not envisaged because some issues, which were intended to be considered, were omitted because of lack of time and other issues were beyond the purpose of this study. In order to stress further research on deep, well-drained clayey soils, the following topics, which are important to inventory, are mentioned:

-The geographical distribution of soil properties. The influence of altitude, parent material, rainfall and temperature on soil characteristics should be investigated, although proper climatic and geological data of northern Mozambique are hardly available.

-Morphological data, such as color, structure and consistence are, notwithstanding their subjectivity, suitable to incorpotate with the analytical data for a good characterization of the soils.

-The twenty reference soil profiles (report no.1) are assumed to be representative for large areas in northern Mozambique. By way of labeling these soils, it can be judged how far the reference soil properties are related to those of the whole population of 140 soil profiles.

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Appendix 1 : Data matrix of all soil characteristics.

SOIL CHARCTERISTICS OF ALL DATA — DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #	PROFILE		AVE	GR	CO	FI	SI	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN	S/C	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
1	1/1	a1	2		39	30	6	25	5.7	4.8	0.6	0.05	1.3	0.7	0.1	0.3	2.1	0.9	69	0.24	12.0	2.4	4.5	53.3	1.9	2.3	2.4	18.0	9.6
2		a1	9		46	20	7	27	5.7	4.6	0.6	0.04	1.0	0.8	0.1	0.2	1.8	1.1	66	0.26	15.0	2.1	3.9	53.8	1.3	4.0	2.2	14.4	7.8
3		a1	22		29	16	8	46	5.4	4.5	0.3	0.03	1.4	0.8	0.2	0.2	2.2	0.9	46	0.17	10.0	2.6	4.8	54.2	1.8	4.0	0.7	10.4	5.7
4		a1	47		47	26	16	7	5.6	4.6	0.1	0.01	1.8	0.7	0.1	0.2	1.7	1.0	77	2.29	10.0	2.8	4.5	62.2	2.6	3.5	1.4	64.3	40.0
5		a1	100		24	18	11	47	5.6	4.8	0.1	0.01	1.6	0.9	0.1	0.1	0.0	0.8	42	0.23	10.0	2.7	2.7	100.0	1.8	9.0	0.2	5.7	5.7
6		a1	225		22	18	12	47	5.9	4.9			2.0	0.6	0.2	0.2	1.0	1.0	41	0.26		3.0	4.0	75.0	3.3	3.0		8.5	6.4
7	1/2	a2	2		33	15	9	42	6.0	4.9	1.4	0.10	3.1	0.8	0.2	0.5	4.6	1.1	49	0.21	14.0	4.6	9.2	50.0	3.9	1.6	3.3	21.9	11.0
8		a2	10		29	14	9	47	5.8	4.7	1.2	0.08	1.8	0.6	0.2	0.4	3.3	1.1	44	0.19	15.0	3.0	6.3	47.6	3.0	1.5	2.6	13.4	6.4
9		a2	37		22	12	11	55	5.2	4.5	0.2	0.02	0.9	0.5	0.2	0.5	3.4	0.7	34	0.20	10.0	2.1	5.5	38.2	1.8	1.0	0.4	10.0	3.8
10		a2	77		22	16	15	47	5.6	5.5	0.2	0.01	1.1	0.4	0.1	0.2	0.8	0.1	38	0.32	20.0	1.8	2.6	69.2	2.8	2.0	0.4	5.5	3.8
11		a2	137		16	18	15	51	5.5	5.5	0.1	0.01	1.3	0.7	0.1	0.1	0.7	0.0	34	0.29	10.0	2.2	2.9	75.9	1.9	7.0	0.2	5.7	4.3
12		a2	275		15	16	19	50	5.5	5.5			1.9	0.6	0.1	0.0	1.5	0.0	31	0.38		2.6	4.1	63.4	3.2			8.2	5.2
13		a2	430		19	13	21	47	5.5	5.5			2.1	0.9	0.1	0.1	1.4	0.0	32	0.45		3.2	4.6	69.6	2.3	9.0		9.8	6.8
14	1/3	a3	2		19	18	25	38	6.3	5.6	2.6	0.17	8.8	2.5	0.1	0.9	4.3	0.7	37	0.66	15.3	12.3	16.6	74.1	3.5	2.8	6.8	43.7	32.4
15		a3	9		23	17	15	44	6.1	5.0	2.0	0.10	7.0	1.5	0.1	0.9	4.2	1.1	41	0.34	20.0	9.5	13.7	69.3	4.7	1.7	4.5	31.1	21.6
16		a3	55		16	12	15	57	6.0	4.9	1.4	0.08	6.6	1.4	0.2	0.5	5.2	1.1	28	0.26	17.5	8.7	13.9	62.6	4.7	2.8	2.5	24.4	15.3
17		a3	75		14	11	15	60	6.0	5.1	1.1	0.07	5.9	1.0	0.1	0.2	2.7	0.9	25	0.25	15.7	7.2	9.9	72.7	5.9	5.0	1.8	16.5	12.0
18		a3	92		13	12	16	58	6.1	5.3	0.8	0.05	5.1	1.1	0.0	0.1	1.2	0.8	26	0.28	16.0	6.3	7.5	84.0	4.6	11.0	1.4	12.9	10.9
19		a3	132		14	12	16	57	6.2	5.1			4.2	1.0	0.2	0.1	2.2	1.1	27	0.28		5.5	7.7	71.4	4.2	10.0		13.5	9.6
20		a3	152		59	25	11	4	6.2	5.9			1.9	0.5	0.1	0.1	0.1	0.3	85	2.75		2.6	2.7	96.3	3.8	5.0		67.5	65.0
21	1/4	11	7		20	23	10	46	5.5	4.4	1.2	0.08	0.8	1.0	0.1	0.2	3.7	1.1	44	0.22	15.0	2.1	5.8	36.2	0.8	5.0	2.6	12.6	4.6
22		11	22		11	17	13	59	5.0	4.6	0.6	0.03	0.4	0.8	0.1	0.0	0.9	0.4	28	0.22	20.0	1.3	2.2	59.1	0.5		1.0	3.7	2.2
23		11	40		10	17	18	55	5.0	4.8	0.3	0.02	0.5	0.7	0.1	0.1	3.3	0.2	27	0.33	15.0	1.4	4.7	29.8	0.7	7.0	0.5	8.5	2.5
24		11	77		10	22	15	53	5.5	5.5	0.2	0.01	0.5	0.6	0.1	0.1	0.8	0.0	32	0.28	20.0	1.3	2.1	61.9	0.8	6.0	0.4	4.0	2.5
25		11	140		9	18	15	58	5.6	5.6			0.4	0.5	0.1	0.1	0.7	0.0	27	0.26		1.1	1.8	61.1	0.8	5.0		3.1	1.9
26		11	255		9	15	18	58	5.2	4.9			0.2	0.3	0.1	0.1	1.2	0.3	24	0.31		0.7	1.9	36.8	0.7	3.0		3.3	1.2
27		11	360		7	16	24	53	5.2	4.3			0.1	0.1	0.1	0.1	1.8	0.9	23	0.45		0.4	2.2	18.2	1.0	1.0		4.2	0.8
28		11	575		17	21	38	23	5.1	4.0			0.1	0.2	0.1	0.2	3.6	1.1	39	1.65		0.6	4.2	14.3	0.5	1.0		18.3	2.6
29	1/5	12	2		15	19	26	40	6.2	5.1	1.8	0.12	3.7	2.2	0.1	0.6	5.4	1.1	34	0.65	15.0	6.6	12.0	55.0	1.7	3.7	4.5	30.0	16.5
30		12	11		12	16	19	53	5.8	4.6	1.3	0.09	2.6	2.1	0.1	0.5	5.1	1.2	28	0.36	14.4	5.3	10.4	51.0	1.2	4.2	2.5	19.6	10.0
31		12	23		9	12	8	71	6.0	4.7	0.6	0.01	3.0	1.7	0.1	0.5	3.1	1.3	21	0.11	60.0	5.3	8.4	63.1	1.8	3.4	0.8	11.8	7.5
32		12	45		7	9	7	77	5.8	5.0	0.3	0.02	2.9	0.8	0.2	0.8	1.9	0.8	16	0.09	15.0	4.7	6.6	71.2	3.6	1.0	0.4	8.6	6.1
33		12	80		8	11	14	67	5.6	5.3	0.2	0.01	1.6	1.1	0.1	0.2	2.4	0.3	19	0.21	20.0	3.0	5.4	55.6	1.5	5.5	0.3	8.1	4.5
34		12	145		5	10	16	69	5.6	5.6			1.5	1.3	0.1	0.2	1.7	0.0	15	0.23		3.1	4.8	64.6	1.2	6.5		7.0	4.5
35		12	260		13	16	19	51	5.5	5.5			1.9	1.7	0.1	0.4	0.8	0.0	30	0.37		4.1	4.9	83.7	1.1	4.3		9.6	8.0
36		12	360		8	24	26	42	5.6	5.5			2.3	2.1	0.1	0.3	0.9	0.1	32	0.62		4.8	5.7	84.2	1.1	7.0		13.6	11.4
37		12	635		27	25	33	15	5.3	4.0			0.9	0.7	0.2	1.1	4.6	1.3	52	2.20		2.9	7.5	38.7	1.3	0.6		50.0	19.3
38	1/6	13	2		13	23	22	42	6.3	4.9	1.4	0.10	4.7	1.1	0.2	0.7	5.4	1.4	36	0.52	14.0	6.7	12.1	55.4	4.3	1.6	3.3	28.8	16.0
39		13	9		12	19	18	50	5.9	4.5	1.0	0.07	4.6	0.0	0.2	0.5	5.3	1.4	32	0.36	14.3	5.3	10.6	50.0		0.0	2.0	21.2	10.6
40		13	22		9	14	10	68	5.5	4.5	0.7	0.05	5.2	0.0	0.2	0.4	5.6	1.0	22	0.15	14.0	5.8	11.4	50.9		0.0	1.0	16.8	8.5
41		13	40		6	10	7	76	5.6	4.6	0.5	0.03	4.1	0.5	0.2	0.3	4.6	1.0	17	0.09	16.7	5.1	9.7	52.6	8.2	1.7	0.7	12.8	6.7
42		13	62		5	9	4	82	5.8	4.8	0.3	0.03	2.9	2.0	0.2	0.4	2.9	1.0	14	0.05	10.0	5.5	8.4	65.5	1.5	5.0	0.4	10.2	6.7
43		13	87		5	10	6	78	5.2	5.2	0.2	0.01	2.9	1.0	0.2	0.4	2.0	0.0	16	0.08	20.0	4.5	6.5	69.2	2.9	2.5	0.3	8.3	5.8
44		13	125		5	10	7	78	6.0	5.6			1.8	3.1	0.1	0.5	1.2	0.4	15	0.09		5.5	6.7	82.1	0.6	6.2		8.6	7.1
45		13	250		6	13	12	69	5.8	5.6			3.8	1.1	0.2	0.5	1.0	0.2	19	0.17		5.6	6.6	84.8	3.5	2.2		9.6	8.1
46		14	2		39	33	4	23	5.7	5.0	1.2	0.06	1.6	1.4	0.1	0.2	0.0	0.7	73	0.17	20.0	3.3	3.3	100.0	1.1	7.0	5.2	14.3	14.3
47	1/7	14	10		34	28	2	35	5.5	4.0	0.7	0.01	0.8	1.0	0.1	0.2	3.5	1.5	63	0.06	70.0	2.1	5.6	37.5	0.8	5.0	2.0	16.0	6.0
48		14	22		22	20	1	56	5.6	4.5	0.5	0.02	0.8	0.9	0.1	0.2	3.0	1.1	43	0.02	25.0	2.0	5.0	40.0	0.9	4.5	0.9	8.9	3.6
49		14	40		20	17	1	62	5.1	4.1	0.3	0.02	0.8	0.7	0.1	0.2	2.2	1.0	37	0.02	15.0	1.8	4.0	45.0	1.1	3.5	0.5	6.5	2.9
50		14	62		16	13	4	67	5.2	4.9	0.2	0.03	1.1	0.6	0.1	0.2	1.8	0.3	29	0.06	6.7	2.0	3.8	52.6	1.8	3.0	0.3	5.7	3.0

SOIL CHARCTERISTICS OF ALL DATA DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #	PROFILE		AVE	GR	CO	FI	SI	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN	S/C	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
51		14	87		14	11	6	69	5.3	5.2	0.2	0.02	1.2	0.9	0.2	0.2	1.3	0.1	25	0.09	10.0	2.5	3.8	65.8	1.3	4.5	0.3	5.5	3.6
52		14	137		13	12	4	70	5.7	5.5			1.3	1.0	0.1	0.1	0.9	0.2	26	0.06		2.5	3.4	73.5	1.3	10.0		4.9	3.6
53		14	265		13	13	11	63	5.3	5.1			1.1	0.7	0.2	0.1	1.1	0.2	26	0.17		2.1	3.2	65.6	1.6	7.0		5.1	3.3
54		14	560		16	16	30	40	5.0	4.2			0.7	1.0	0.2	0.0	1.7	0.8	30	0.75		1.9	3.6	52.8	0.7			9.0	4.8
55	1/8	15	5		11	10	4	75	6.1	5.0	1.2	0.08	5.9	2.5	0.2	0.9	3.3	1.1	21	0.05	15.0	9.5	12.8	74.2	2.4	2.8	1.6	17.1	12.7
56		15	20		7	6	2	85	5.7	5.1	0.5	0.04	4.9	1.7	0.2	0.6	1.5	0.6	13	0.02	12.5	7.4	8.9	83.1	2.9	2.8	0.6	10.5	8.7
57		15	40		7	6	0	87	5.9	4.9	0.3	0.04	4.5	1.2	0.2	0.4	3.5	1.0	13	0.00	7.5	6.3	9.8	64.3	3.8	3.0	0.3	11.3	7.2
58		15	62		6	6	2	86	5.5	5.2	0.2	0.03	4.9	1.0	0.2	0.5	1.9	0.3	12	0.02	6.7	6.6	8.5	77.6	4.9	2.0	0.2	9.9	7.7
59		15	87		7	6	0	87	5.5	5.3	0.1	0.02	5.0	1.1	0.2	0.1	2.6	0.2	13	0.00	5.0	6.4	9.0	71.1	4.5	11.0	0.1	10.3	7.4
60		15	135		8	8	7	77	5.9	5.5			5.3	1.8	0.2	0.3	2.3	0.4	16	0.09		7.6	9.9	76.8	2.9	6.0		12.9	9.9
61		15	360		17	24	25	35	6.0	5.3			19.4	10.7	0.4	0.1	2.4	0.7	40	0.71		30.6	33.0	92.7	1.8	107.0		94.3	87.4
62	1/9	16	7		39	27	14	20	6.0	5.0	0.6	0.07	1.2	0.9	0.1	0.3	1.2	1.0	66	0.70	8.6	2.5	3.7	67.6	1.3	3.0	3.0	18.5	12.5
63		16	25		37	18	11	34	5.6	4.7	0.4	0.03	1.0	0.5	0.1	0.3	1.9	0.9	55	0.32	13.3	1.9	3.8	50.0	2.0	1.7	1.2	11.2	5.6
64		16	55		28	16	8	48	5.5	5.1	0.2	0.03	2.0	0.8	0.1	0.1	1.2	0.4	44	0.17	6.7	3.0	4.2	71.4	2.5	8.0	0.4	8.7	6.3
65		16	95		25	15	11	50	5.9	5.5	0.1	0.01	1.4	0.8	0.1	0.2	0.7	0.4	39	0.22	10.0	2.5	3.2	78.1	1.8	4.0	0.2	6.4	5.0
66		16	132		36	13	12	39	6.2	5.7			1.1	0.6	0.1	0.2	1.7	0.5	49	0.31		2.0	3.7	54.1	1.8	3.0		9.5	5.1
67		16	172		33	16	12	40	6.3	6.0			1.2	0.6	0.1	0.2	0.3	0.3	48	0.30		2.1	2.4	87.5	2.0	3.0		6.0	5.3
68	1/10	17	5		35	23	9	33	6.0	5.1			0.9	3.7	0.2	0.1	4.0	0.9	58	0.27		4.9	8.9	55.1	0.2	37.0		27.0	14.8
69		17	16		32	18	11	39	5.7	5.0			0.8	2.8	0.1	0.1	2.9	0.7	50	0.28		3.8	6.7	56.7	0.3	28.0		17.2	9.7
70		17	31		25	17	7	50	5.8	5.8			0.4	2.3	0.1	0.1	2.8	0.0	43	0.14		2.9	5.7	50.9	0.2	23.0		11.4	5.8
71		17	52		24	14	5	57	5.8	5.0			0.4	1.9	0.1	0.1	1.6	0.8	38	0.09		2.5	4.1	61.0	0.2	19.0		7.2	4.4
72		17	82		18	12	8	62	6.1	5.3			1.0	0.6	0.1	0.2	2.2	0.8	30	0.13		1.9	4.1	46.3	1.7	3.0		6.6	3.1
73		17	125		24	11	4	62	6.5	5.8			1.9	0.6	0.1	0.2	1.8	0.7	34	0.06		2.8	4.6	60.9	3.2	3.0		7.4	4.5
74	1/11	c1	2		32	30	13	24	6.1	5.2	2.3	0.09	5.1	4.3	0.1	0.1	4.9	0.9	63	0.54	25.6	9.6	14.5	66.2	1.2	43.0	9.6	60.4	40.0
75		c1	11		35	26	11	28	5.6	4.7	1.7	0.08	3.5	2.8	0.2	0.0	5.8	0.9	61	0.39	21.3	6.5	12.3	52.8	1.3		6.1	43.9	23.2
76		c1	23		28	22	10	40	5.5	4.5	1.0	0.08	2.3	2.2	0.1	0.0	4.9	1.0	50	0.25	12.5	4.6	9.5	48.4	1.0		2.5	23.8	11.5
77		c1	40		21	15	8	56	5.3	4.4	0.6	0.06	2.2	1.4	0.2	0.1	3.7	0.9	36	0.14	10.0	3.9	7.6	51.3	1.6	14.0	1.1	13.6	7.0
78		c1	75		15	13	4	68	5.5	4.8	0.3	0.04	2.1	1.4	0.1	0.0	2.2	0.7	28	0.06	7.5	3.6	5.8	62.1	1.5		0.4	8.5	5.3
79		c1	150		17	16	6	61	6.1	5.5			1.8	1.5	0.1	0.0	1.1	0.6	33	0.10	0.0	3.4	4.5	75.6	1.2			7.4	5.6
80		c1	250		16	16	13	55	6.0	5.5			0.0	2.7	0.5	0.1	1.3	0.5	32	0.24	0.0	3.3	4.6	71.7	0.0	27.0		8.4	6.0
81	1/12	c2	30		16	10	5	69	5.1	4.7	1.0	0.05	0.5	3.3	0.1	0.1	5.1	0.4	26	0.07	20.0	4.0	9.1	44.0	0.2	33.0	1.4	13.2	5.8
82		c2	75		14	9	6	71	5.2	4.4	0.5	0.04	0.4	8.4	0.2	0.0	1.5	0.8	23	0.08	12.5	9.0	10.5	85.7	0.0		0.7	14.8	12.7
83		c2	125		14	11	9	66	5.5	4.9	0.3	0.02	0.3	3.2	0.1	0.0	2.0	0.6	25	0.14	15.0	3.6	5.6	64.3	0.1		0.5	8.5	5.5
84		c2	175		14	10	7	69	5.2	4.7	0.3	0.02	0.9	2.6	0.1	0.0	3.2	0.5	24	0.10	15.0	3.6	6.8	52.9	0.3		0.4	9.9	5.2
85		c2	225		15	9	11	65	5.1	4.5			0.6	2.2	0.1	0.0	3.5	0.6	24	0.17		2.9	6.4	45.3	0.3			9.8	4.5
86		c2	275		15	10	7	68	5.0	4.2			2.0	1.5	0.2	0.3	3.3	0.8	25	0.10		4.0	7.3	54.8	1.3	5.0		10.7	5.9
87	1/13	c3	6		35	14	3	48	4.2	3.6	1.3	0.10	0.2	0.3	0.1	0.3	8.4	0.6	49	0.06	13.0	0.9	9.3	9.7	0.7	1.0	2.7	19.4	1.9
88		c3	25		33	11	5	51	4.3	3.8	0.6	0.03	0.9	0.1	0.1	0.1	5.0	0.5	44	0.10	20.0	1.2	6.2	19.4	9.0	1.0	1.2	12.2	2.4
89		c3	50		32	10	2	56	4.5	3.8	0.4	0.03	1.1	0.7	0.1	0.0	4.0	0.7	42	0.04	13.3	1.9	5.9	32.2	1.6		0.7	10.5	3.4
90		c3	75		29	8	10	53	4.6	3.9	0.3	0.05	1.0	0.4	0.1	0.0	3.1	0.7	37	0.19	6.0	1.5	4.6	32.6	2.5		0.6	8.7	2.8
91		c3	132		16	9	13	62	4.7	3.9	0.2	0.02	0.8	0.5	0.1	0.0	2.6	0.8	25	0.21	10.0	1.4	4.0	35.0	1.6		0.3	6.5	2.3
92		c3	270		16	10	9	65	4.9	3.9			0.2	0.6	0.1	0.0	2.5	1.0	26	0.14		0.9	3.4	26.5	0.3			5.2	1.4
93		c3	370		17	9	7	66	5.0	4.0			0.5	0.7	0.2	0.0	2.4	1.0	27	0.11		1.4	3.8	36.8	0.7			5.8	2.1
94		c3	470		15	11	17	56	5.5	4.2			0.9	0.9	0.3	0.0	2.0	1.3	27	0.30		2.1	4.1	51.2	1.0			7.3	3.8
95	1/14	n1	7		24	32	10	33	6.8	5.8	1.8		9.7	3.2	0.2	1.3	2.9	1.0	57	0.30		14.4	17.3	83.2	3.0	2.5	5.5	52.4	43.6
96		n1	22		17	20	10	55	6.1	4.6	0.9		8.7	3.5	0.3	0.3	3.2	1.5	35	0.18		12.8	16.0	80.0	2.5	11.7	1.6	29.1	23.3
97		n1	40		14	21	6	58	6.2	4.6	0.6		8.6	3.3	0.3	0.1	2.6	1.6	36	0.10		12.3	14.9	82.6	2.6	33.0	1.0	25.7	21.2
98		n1	65		10	14	7	69	6.3	4.7	0.5		9.1	2.9	0.3	0.1	3.4	1.6	24	0.10		12.4	15.8	78.5	3.1	29.0	0.7	22.9	18.0
99		n1	107		7	12	11	70	6.5	4.5	0.3		10.1	3.2	0.2	0.1	2.3	2.0	19	0.16		13.6	15.9	85.5	3.2	32.0	0.4	22.7	19.4
100	1/15	n2	7		17	23	18	41	7.2	6.1	2.6		20.4	3.0	0.3	1.2	1.3	1.1	41	0.44		24.9	26.2	95.0	6.8	2.5	6.3	63.9	60.7

SOIL CHARCTERISTICS OF ALL DATA

DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #	PROFILE	AVE	GR	CO	FI	SI	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN	S/C	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
101	n2	22		13	18	22	48	7.7	6.6	1.7		14.2	3.7	0.2	0.3	0.3	1.1	30	0.46		18.4	18.7	98.4	3.8	12.3	3.5	39.0	38.3
102	n2	40		10	13	16	61	7.6	6.3	1.0		15.1	4.2	0.3	0.2	0.4	1.3	23	0.26		19.8	20.2	98.0	3.6	21.0	1.6	33.1	32.5
103	n2	66		7	8	8	77	7.5	6.0	0.6		12.2	6.3	0.3	0.2	0.4	1.5	15	0.10		19.0	19.4	97.9	1.9	31.5	0.8	25.2	24.7
104	n2	103		10	11	9	70	7.4	5.9	0.4		11.2	6.9	0.2	0.1	1.9	1.5	21	0.13		18.4	20.3	90.6	1.6	69.0	0.6	29.0	26.3
105	n2	150		30	29	15	26	7.3	5.4	0.2		11.3	7.0	0.2	0.1	0.8	1.9	59	0.58		18.6	19.4	95.9	1.6	70.0	0.8	74.6	71.5
106	1/16 n3	9		70	17	2	10	6.3	5.1	0.9	0.04	1.9	0.9	0.1	0.1	2.7	1.2	88	0.20	22.5	3.0	5.7	52.6	2.1	9.0	9.0	57.0	30.0
107	n3	40		67	20	2	11	6.2	5.0	0.3	0.02	0.6	0.2	0.1	0.1	0.7	1.2	87	0.18	15.0	1.0	1.7	58.8	3.0	2.0	2.7	15.5	9.1
108	n3	65		60	11	2	27	6.1	4.8	0.2	0.02	1.0	0.2	0.1	0.1	1.9	1.3	71	0.07	10.0	1.4	3.3	42.4	5.0	2.0	0.7	12.2	5.2
109	n3	95		44	13	3	40	5.8	5.1	0.1	0.02	1.3	0.2	0.1	0.1	1.9	0.7	57	0.07	5.0	1.7	3.6	47.2	6.5	2.0	0.3	9.0	4.3
110	n3	130		47	9	3	41	6.5	6.5	0.2	0.04	1.2	0.2	0.0	0.1	1.8	0.0	56	0.07	5.0	1.5	3.3	45.5	6.0	2.0	0.5	8.0	3.7
111	n3	175		48	7	3	42	6.4	5.8			1.3	0.8	0.1	0.2	0.4	0.6	55	0.07		2.4	2.8	85.7	1.6	4.0		6.7	5.7
112	n3	255		31	8	6	55	6.5	6.0			1.3	1.1	0.1	0.4	0.4	0.5	39	0.11		2.9	3.3	87.9	1.2	2.8		6.0	5.3
113	1/17 n4	5		71	17	3	11	6.7	5.7	0.9	0.07	2.5	0.6	0.1	0.2	0.6	1.0	86	0.27	12.9	3.4	4.0	85.0	4.2	3.0	8.2	36.4	30.9
114	n4	14		80	8	0	11	6.6	5.6	0.9	0.07	2.3	0.6	0.1	0.1	1.1	1.0	89	0.00	12.9	3.1	4.2	73.8	3.8	6.0	8.2	38.2	28.2
115	n4	33		77	11	1	10	6.3	5.3	0.3	0.02	0.9	0.3	0.1	0.0	0.0	1.0	89	0.10	15.0	1.3	1.3	100.0	3.0		3.0	13.0	13.0
116	n4	63		62	12	3	23	6.3	5.0	0.2	0.03	0.9	0.4	0.1	0.2	0.4	1.3	74	0.13	6.7	1.6	2.0	80.0	2.3	2.0	0.9	8.7	7.0
117	n4	102		67	8	3	22	6.3	5.4	0.1	0.02	0.8	0.5	0.1	0.1	0.3	0.9	75	0.14	5.0	1.5	1.8	83.3	1.6	5.0	0.5	8.2	6.8
118	n4	150		65	9	3	23	6.3	5.8			0.5	0.8	0.1	0.2	0.3	0.5	74	0.13	0.0	1.6	1.9	84.2	0.6	4.0	0.0	8.3	7.0
119	n4	240		63	7	6	24	6.3	5.7			0.4	1.2	0.1	0.1	0.3	0.6	70	0.25	0.0	1.8	2.1	85.7	0.3	12.0	0.0	8.7	7.5
120	n4	335		58	8	4	30	5.8	5.5			0.3	1.2	0.1	0.1	0.2	0.3	66	0.13	0.0	1.7	1.9	89.5	0.3	12.0	0.0	6.3	5.7
121	n4	410		59	11	7	22	5.5	5.3			0.4	1.2	0.2	0.2	0.6	0.2	71	0.32	0.0	2.0	2.6	76.9	0.3	6.0	0.0	11.8	9.1
122	1/18 n5	6		50	15	8	26	6.0	5.0	1.2	0.07	3.9	0.6	0.1	0.3	2.4	1.0	66	0.31	17.1	4.9	7.3	67.1	6.5	2.0	4.6	28.1	18.8
123	n5	25		44	12	9	35	5.8	4.7	0.7	0.06	2.3	0.9	0.2	0.3	2.3	1.1	56	0.26	11.7	3.7	6.0	61.7	2.6	3.0	2.0	17.1	10.6
124	n5	47		33	10	7	50	5.7	4.7	0.4	0.04	1.9	1.0	0.2	0.2	1.9	1.0	43	0.14	10.0	3.3	5.2	63.5	1.9	5.0	0.8	10.4	6.6
125	n5	80		28	7	5	60	5.6	5.0	0.2	0.02	2.2	1.0	0.2	0.2	1.4	0.6	35	0.08	10.0	3.6	5.0	72.0	2.2	5.0	0.3	8.3	6.0
126	n5	145		22	7	5	65	5.7	5.1	0.1		1.9	1.2	0.1	0.3	1.9	0.6	30	0.08		3.5	5.4	64.8	1.6	4.0	0.2	8.3	5.4
127	1/19 n6	5		75	9	6	11	6.2	5.2	0.8		1.9	0.5	0.1	0.2	0.1	1.0	83	0.55		2.7	2.8	96.4	3.8	2.5	7.3	25.5	24.5
128	n6	17		76	11	4	9	5.9	4.7	0.5		1.2	0.4	0.1	0.1	1.4	1.2	87	0.44		1.8	3.2	56.3	3.0	4.0	5.6	35.6	20.0
129	n6	35		75	11	3	11	5.4	4.3	0.2	0.02	0.8	0.2	0.2	0.1	1.0	1.1	86	0.27	10.0	1.3	2.3	56.5	4.0	2.0	1.8	20.9	11.8
130	n6	65		66	10	2	21	5.3	4.3	0.2	0.02	0.7	0.3	0.1	0.1	0.9	1.0	77	0.10	10.0	1.2	2.1	57.1	2.3	3.0	1.0	10.0	5.7
131	n6	104		66	7	2	25	5.3	4.6	0.1	0.01	0.7	0.3	0.1	0.1	1.9	0.7	73	0.08	10.0	1.2	3.1	38.7	2.3	3.0	0.4	12.4	4.8
132	n6	152		60	7	2	31	5.3	5.2	0.1	0.01	0.7	0.3	0.1	0.1	0.6	0.1	67	0.06	10.0	1.2	1.8	66.7	2.3	3.0	0.3	5.8	3.9
133	n6	270		56	8	1	35	5.5	5.5			1.3	0.5	0.1	0.1	0.6	0.0	64	0.03		2.0	2.6	76.9	2.6	5.0		7.4	5.7
134	n6	360		56	8	1	35	6.3	5.4			1.0	0.6	0.1	0.1	0.4	0.9	64	0.03		1.8	2.2	81.8	1.7	6.0		6.3	5.1
135	1/20 n7	7		85	7	2	6	6.3	5.1	0.8	0.07	3.1	0.6	0.1	0.1	1.1	1.2	92	0.33	11.4	3.9	5.0	78.0	5.2	6.0	13.3	83.3	65.0
136	n7	26		72	15	4	8	5.8	4.7	0.2	0.02	1.4	0.2	0.1	0.1	0.6	1.1	88	0.50	10.0	1.8	2.4	75.0	7.0	2.0	2.5	30.0	22.5
137	n7	54		69	10	5	15	5.1	4.3	0.2	0.03	1.2	0.4	0.1	0.1	0.7	0.8	80	0.33	6.7	1.8	2.5	72.0	3.0	4.0	1.3	16.7	12.0
138	n7	87		62	14	4	20	5.6	4.9	0.1	0.01	1.3	0.6	0.1	0.1	0.6	0.7	76	0.20	10.0	2.1	2.7	77.8	2.2	6.0	0.5	13.5	10.5
139	n7	110		66	11	3	20	5.8	5.6	0.1	0.01	1.4	0.3	0.1	0.1	0.7	0.2	77	0.15	10.0	1.9	2.6	73.1	4.7	3.0	0.5	13.0	9.5
140	n7	167		65	10	3	23	6.0	5.3			1.0	0.5	0.1	0.1	0.5	0.7	74	0.13		1.7	2.2	77.3	2.0	5.0		9.6	7.4
141	n7	305		64	9	3	23			0.1		0.9	0.7	0.2	0.2	0.8		74	0.13		2.0	2.8	71.4	1.3	3.5	0.4	12.2	8.7
142	2/21 59/62	5	3	36	28*	6	29	6.4	5.3	1.4	0.08	7.3	2.3	0.0	0.6	1.5	1.1	65*	0.21	17.5	10.2	11.7	87.2	3.2	3.8	4.8	40.3	35.2
143	59/62	45	1	25	12	4	58	6.4	5.5	0.7	0.03	0.2	2.3	0.0	0.2	0.2	0.9	38	0.07	23.3	2.7	2.9	93.1	0.1	11.5	1.2	5.0	4.7
144	59/62	85	10	23	13	6	58	5.3	4.7	0.7	0.07	3.2	2.7	0.0	0.1	1.5	0.6	36	0.10	10.0	6.0	7.5	80.0	1.2	27.0	1.2	12.9	10.3
145	2/22 73/62	5	6	14	32	17	36	7.8	6.8	2.1	0.18	27.0	4.6	0.2	0.3	0.0	1.0	47	0.47	11.7	32.1	32.1	100.0	5.9	15.3	5.8	89.2	89.2
146	73/62	55	2	12	22	7	59	6.3	5.3	0.6	0.04	13.3	6.0	0.1	0.1	1.2	1.0	34	0.12	15.0	19.5	20.7	94.2	2.2	60.0	1.0	35.1	33.1
147	73/62	95	0	12	12	4	71	6.0	5.1	0.3	0.04	11.6	5.8	0.1	0.1	1.2	0.9	25	0.06	7.5	17.6	18.8	93.6	2.0	58.0	0.4	26.5	24.8
148	2/23 52/62	5	2	30	46	3	20	6.8	5.8	1.2	0.17	7.7	1.9	0.0	0.3	0.6	1.0	77	0.15	7.1	9.9	10.5	94.3	4.1	6.3	6.0	52.5	49.5
149	52/62	45	4	35	33	5	27	6.1	5.1	0.6	0.17	4.3	2.2	0.1	0.4	1.2	1.0	68	0.19	3.5	7.0	8.2	85.4	2.0	5.5	2.2	30.4	25.9
150	52/62	95	10	38	20	3	39	5.4	4.2	0.4	0.04	3.1	1.8	0.0	0.1	1.4	1.2	58	0.08	10.0	5.0	6.4	78.1	1.7	18.0	1.0	16.4	12.8

SOIL CHARCTERISTICS OF ALL DATA / DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #		PROFILE	AVE	GR	CO	FI*	SI*	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN*	S/C*	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
151	2 24	140/6	5	1	68	19	3	10	6.5	5.6	0.3	0.03	2.1	0.5	0.0	0.1	0.5	0.9	87	0.30	10.0	2.7	3.2	84.4	4.2	5.0	3.0	32.0	27.0
152		140/6	35	0	66	18	2	14	6.6	5.5	0.1	0.02	1.4	0.4	0.0	0.0	0.4	1.1	84	0.14	5.0	1.8	2.2	81.8	3.5	0.0	0.7	15.7	12.9
153		140/6	105	1	59	11	1	29	6.7	5.5	0.1	0.01	0.1	1.9	0.0	0.1	0.4	1.2	70	0.03	10.0	2.1	2.5	84.0	0.1	19.0	0.3	8.6	7.2
154	2/25	67/62	5	0	61	26	4	8	6.6	5.7	0.4	0.08	3.8	1.1	0.0	0.1	0.6	0.9	88	0.50	5.0	5.0	5.6	89.3	3.5	11.0	5.0	70.0	62.5
155		67/62	55	1	60	22	2	16	6.4	5.3	0.5	0.04	1.1	0.9	0.0	0.1	2.1	1.1	82	0.13	12.5	2.1	4.2	50.0	1.2	9.0	3.1	26.3	13.1
156		67/62	125	1	56	23	2	19	5.9	5.3	0.3	0.01	1.3	1.1	0.0	0.1	0.2	0.6	79	0.11	30.0	2.5	2.7	92.6	1.2	11.0	1.6	14.2	13.2
157	3/26	79/62	5	0	56	29	3	11	6.6	5.6	0.6	0.22	3.2	0.7	0.0	0.1	0.3	1.0	86	0.27	2.7	4.0	4.3	93.0	4.6	7.0	5.5	39.1	36.4
158		79/62	45	0	61	23	3	12	5.8	4.8	0.2	0.04	0.9	0.6	0.0	0.1	0.4	1.0	85	0.25	5.0	1.6	2.0	80.0	1.5	6.0	1.7	16.7	13.3
159		79/62	115	1	63	12	4	21	5.8	4.8	0.1	0.02	0.8	1.4	0.0	0.2	0.5	1.0	75	0.19	5.0	2.4	2.9	82.8	0.6	7.0	0.5	13.8	11.4
160	3/27	213/6	5	1	41	44	3	12	6.3	5.3	0.6	0.04	2.5	1.0	0.0	0.1	0.9	1.0	85	0.25	15.0	3.6	4.5	80.0	2.5	10.0	5.0	37.5	30.0
161		213/6	45	3	49	29	3	18	6.1	5.2	0.1	0.02	1.5	1.6	0.0	0.1	0.6	0.9	79	0.17	5.0	3.2	3.8	84.2	0.9	16.0	0.6	21.1	17.8
162		213/6	95	4	48	24	4	24	5.9	5.3	0.1	0.01	1.4	1.8	0.0	0.3	0.5	0.6	72	0.17	10.0	3.5	4.0	87.5	0.8	6.0	0.4	16.7	14.6
163	3/28	209/6	5	1	43	39	6	12	6.4	5.6	0.6	0.04	3.0	0.7	0.0	0.0	0.9	0.8	82	0.50	15.0	3.7	4.6	80.4	4.3	0.0	5.0	38.3	30.8
164		209/6	45	1	41	28	6	24	6.4	5.3	0.2	0.02	1.7	1.0	0.0	0.1	0.4	1.1	70	0.25	10.0	2.8	3.2	87.5	1.7	10.0	0.8	13.3	11.7
165		209/6	95	3	44	21	5	29	6.2	5.3	0.1	0.01	1.8	1.1	0.0	0.1	0.3	0.9	66	0.17	10.0	3.0	3.3	90.9	1.6	11.0	0.3	11.4	10.3
166	4/29	26506	5	0	29	38	10	23	6.3	5.4	1.0	0.08	7.2	2.6	0.0	1.0	1.2	0.9	67	0.43	12.5	10.8	12.0	90.0	2.8	2.6	4.3	52.2	47.0
167		265/6	35	0	19	25	7	48	6.3	5.2	0.7	0.39	7.3	4.4	0.1	0.6	1.3	1.1	45	0.15	1.8	12.4	13.7	90.5	1.7	7.3	1.5	28.5	25.8
168		26506	95	1	15	12	8	65	6.0	5.0	0.3	0.05	6.1	5.5	0.1	0.2	1.7	1.0	27	0.12	6.0	11.9	13.6	87.5	1.1	27.5	0.5	20.9	18.3
169	4/30	266/6	5	1	15	28	13	45	6.5	5.7	2.0	0.15	14.3	4.0	0.1	1.2	1.6	0.8	42	0.29	13.3	19.6	21.2	92.5	3.6	3.3	4.4	47.1	43.6
170		266/6	25	0	6	10	10	74	6.1	5.2	0.6	0.09	13.5	4.3	0.1	0.3	1.6	0.9	16	0.14	6.7	18.2	19.8	91.9	3.1	14.3	0.8	26.8	24.6
171		266/6	95	2	5	4	7	83	6.4	5.2	0.6	0.05	14.0	3.9	0.1	0.2	1.4	1.2	10	0.08	12.0	18.2	19.6	92.9	3.6	19.5	0.7	23.6	21.9
172	4/31	311/6	5	0	22	32	14	31	6.9	5.8	2.2	0.14	17.7	6.1	0.2	1.7	0.3	1.1	55	0.45	15.7	25.7	26.0	98.8	2.9	3.6	7.1	83.9	82.9
173		311/6	25	0	8	26	19	47	7.4	6.0	2.2	0.11	21.6	10.8	0.5	0.6	0.3	1.4	34	0.40	20.0	33.5	33.8	99.1	2.0	18.0	4.7	71.9	71.3
174		311/6	95	0	27	27	11	34	8.0	6.3	0.9	0.05	11.9	8.6	0.9	0.2	0.0	1.7	55	0.32	18.0	21.6	21.6	100.0	1.4	43.0	2.6	63.5	63.5
175	4/32	305/6	5	1	7	19	16	58	7.2	5.8	1.8	0.15	13.3	5.5	0.1	1.8	0.6	1.4	26	0.28	12.0	20.7	21.3	97.2	2.4	3.1	3.1	36.7	35.7
176		305/6	45	8	3	5	7	84	5.4	4.8	0.6	0.06	5.6	5.8	0.0	0.7	1.4	0.6	9	0.08	10.0	12.1	13.5	89.6	1.0	8.3	0.7	16.1	14.4
177		305/6	95	1	4	1	7	87	5.9	5.1	0.5	0.05	6.4	6.9	0.0	0.0	1.2	0.8	6	0.08	10.0	13.3	14.5	91.7	0.9	0.0	0.6	16.7	15.3
178		292/6	5	1	36	43	8	12	6.3	5.2	1.1	0.07	5.4	1.7	0.0	0.4	1.3	1.1	80	0.67	15.7	7.5	8.8	85.2	3.2	4.3	9.2	73.3	62.5
179	4/33	292/6	45	0	34	39	7	19	5.8	4.7	0.6	0.03	3.1	3.5	0.0	0.2	1.3	1.1	74	0.37	20.0	6.8	8.1	84.0	0.9	17.5	3.2	42.6	35.8
180		292/6	95	0	39	14	4	43	5.7	4.8	0.3	0.04	4.1	4.8	0.1	0.2	1.0	0.9	53	0.09	7.5	9.2	10.2	90.2	0.9	24.0	0.7	23.7	21.4
181	5/34	236/6	5	1	40	41	4	14	6.1	5.0	0.5	0.03	0.7	0.8	0.0	0.1	1.2	1.1	82	0.29	16.7	1.6	2.8	57.1	0.9	8.0	3.6	20.0	11.4
182		236/6	35	5	26	20	5	49	5.8	5.0	0.3	0.02	1.0	1.1	0.0	0.3	1.2	0.8	46	0.10	15.0	2.4	3.6	66.7	0.9	3.7	0.6	7.3	4.9
183		236/6	95	1	15	14	3	67	5.7	5.1	0.1	0.01	1.2	1.8	0.0	0.3	0.8	0.6	30	0.04	10.0	3.3	4.1	80.5	0.7	6.0	0.1	6.1	4.9
184	5/35	250/6	5	1	60	27	3	10	6.1	5.1	0.5	0.04	1.2	0.8	0.0	0.0	0.8	1.0	87	0.30	12.5	2.0	2.8	71.4	1.5	0.0	5.0	28.0	20.0
185		250/6	45	0	48	17	6	29	5.8	5.2	0.1	0.02	1.6	0.6	0.0	0.2	0.6	0.6	65	0.21	5.0	2.4	3.0	80.0	2.7	3.0	0.3	10.3	8.3
186		250/6	105	2	42	21	4	31	6.2	5.2	0.1	0.01	1.5	0.3	0.0	0.1	0.4	1.0	65	0.13	10.0	1.9	2.3	82.6	5.0	3.0	0.3	7.4	6.1
187	6/36	42/65	5	1	47	27	9	19	6.7	5.7	0.7	0.04	6.2	1.8	0.0	0.5	1.1	1.0	72	0.47	17.5	8.5	9.6	88.5	3.4	3.6	3.7	50.5	44.7
188		42/65	25	1	36	29	7	28	6.4	5.4	0.7	0.05	6.2	2.1	0.1	0.5	1.4	1.0	65	0.25	14.0	8.9	10.3	86.4	3.0	4.2	2.5	36.8	31.8
189		42/65	55	1	36	17	4	42	6.3	5.3	0.6	0.04	6.6	2.7	0.1	0.2	1.6	1.0	54	0.10	15.0	9.6	11.2	85.7	2.4	13.5	1.4	26.7	22.9
190	6/37	47/65	5	3	34	43	9	12	5.7	4.3	0.2	0.05	1.6	1.0	0.0	0.3	2.2	1.4	79	0.75	4.0	2.9	5.1	56.9	1.6	3.3	1.7	42.5	24.2
191		47/65	45	15	65	13	5	15	5.1	4.0	0.2	0.03	1.4	1.2	0.0	0.1	2.7	1.1	80	0.33	6.7	2.7	5.4	50.0	1.2	12.0	1.3	36.0	18.0
192	6/38	32/65	5	0	34	29	8	24	6.1	5.2	2.1	0.10	9.1	3.9	0.1	1.3	1.4	0.9	68	0.33	21.0	14.4	15.8	91.1	2.3	3.0	8.7	65.8	60.0
193		32/65	45	0	29	17	12	47	6.0	5.1	1.0	0.06	6.8	2.9	0.0	0.6	1.8	0.9	41	0.26	16.7	10.3	12.1	85.1	2.3	4.8	2.1	25.7	21.9
194		32/65	85	0	15	10	6	70	6.2	5.3	0.6	0.06	6.5	3.9	0.0	0.5	1.6	0.9	24	0.09	10.0	10.9	12.5	87.2	1.7	7.8	0.9	17.9	15.6
195		32/65	125	0	17	10	7	68	6.5	5.6	0.5	0.05	5.6	5.0	0.0	0.4	1.1	0.9	25	0.10	10.0	11.0	12.1	90.9	1.1	12.5	0.7	17.8	16.2
196	7/39	3/65	5	0	57	26	6	10	6.7	5.7	1.0	0.05	5.5	1.3	0.0	0.4	0.8	1.0	84	0.60	20.0	7.2	8.0	90.0	4.2	3.3	10.0	80.0	72.0
197		3/65	45	0	28	36	9	26	6.1	5.1	0.5	0.04	3.9	1.7	0.0	0.2	1.4	1.0	65	0.35	12.5	5.8	7.2	80.6	2.3	8.5	1.9	27.7	22.3
198		3/65	85	0	21	26	6	47	6.1	5.1	0.4	0.05	5.6	2.3	0.1	0.3	1.4	1.0	47	0.13	8.0	8.3	9.7	85.6	2.4	7.7	0.9	20.6	17.7
199		3/65	125	0	22	22	6	49	5.1	5.0	0.2	0.04	5.7	2.4	0.1	0.3	1.5	0.1	45	0.12	5.0	8.5	10.0	85.0	2.4	8.0	0.4	20.4	17.3
200	7/40	24/65	5	0	25	35	15	23	6.1	5.1	2.2	0.12	11.0	3.6	0.2	0.5	3.0	1.0	62	0.65	18.3	15.3	18.3	83.6	3.1	7.2	9.6	79.6	66.5

SOIL CHARCTERISTICS OF ALL DATA — DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #	PROFILE	AVE	GR	CO	FI*	SI*	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN*	S/C*	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
201	24/65	45	1	32	25	6	36	5.8	4.7	0.8	0.07	13.0	9.4	0.0	0.2	4.1	1.1	58	0.17	11.4	22.6	26.7	84.6	1.4	47.0	2.2	74.2	62.8
202	24/65	85	0	23	20	6	51	6.0	5.0	0.5	0.06	8.3	3.8	0.1	0.3	1.7	1.0	43	0.12	8.3	12.5	14.2	88.0	2.2	12.7	1.0	27.8	24.5
203	24/65	125	3	31	19	2	43	6.2	5.2	0.2	0.04	8.0	4.9	0.1	0.4	1.2	1.0	55	0.05	5.0	13.4	14.6	91.8	1.6	12.3	0.5	34.0	31.2
204	7/41 15/65	5	0	28	39	14	16	6.3	5.3	1.1	0.08	6.5	2.3	0.0	0.2	1.4	1.0	70	0.88	13.8	9.0	10.4	86.5	2.8	11.5	6.9	65.0	56.3
205	15/65	55	0	36	26	12	25	6.3	4.7	0.2	0.03	3.7	3.1	0.3	0.2	1.5	1.6	63	0.48	6.7	7.3	8.8	83.0	1.2	15.5	0.8	35.2	29.2
206	15/65	85	0	26	18	6	49	6.6	4.8	0.2	0.04	4.6	4.6	0.9	0.2	1.7	1.8	45	0.12	5.0	10.3	12.0	85.8	1.0	23.0	0.4	24.5	21.0
207	15/65	125	0	24	21	5	48	6.6	5.1	0.1	0.05	4.9	4.5	0.9	0.3	1.6	1.5	47	0.10	2.0	10.6	12.2	86.9	1.1	15.0	0.2	25.4	22.1
208	8/42 81/65	5	1	52	20	7	21	7.1	6.3	1.4	0.09	7.9	1.8	0.0	0.3	0.4	0.8	72	0.33	15.6	10.0	10.4	96.2	4.4	6.0	6.7	49.5	47.6
209	81/65	55	0	26	13	8	58	6.0	5.1	0.5	0.07	2.2	1.1	0.0	0.5	1.5	0.9	34	0.14	7.1	3.8	5.3	71.7	2.0	2.2	0.9	9.1	6.6
210	81/65	85	0	25	3	10	58	5.6	4.7	0.4	0.04	3.5	0.3	0.0	0.1	0.7	0.9	32	0.17	10.0	3.9	4.6	84.8	11.7	3.0	0.7	7.9	6.7
211	81/65	125	0	22	10	2	61	4.7	4.2	0.2	0.10	0.6	2.4	0.0	0.1	5.7	0.5	37	0.03	2.0	3.1	8.8	35.2	0.3	24.0	0.3	14.4	5.1
212	68/65	5	0	71	17	3	12	6.5	5.7	1.0	0.05	3.2	0.8	0.0	0.2	2.2	0.8	85	0.25	20.0	4.2	6.4	65.6	4.0	4.0	8.3	53.3	35.0
213	68/65	55	0	69	15	3	20	6.3	5.4	0.1	0.01	0.6	0.4	0.0	0.1	2.4	0.9	77	0.15	10.0	1.1	3.5	31.4	1.5	4.0	0.5	17.5	5.5
214	8/43 68/65	105	1	53	10	3	35	6.2	5.4	0.1	0.02	0.4	1.9	0.0	0.1	1.6	0.8	62	0.09	5.0	2.4	4.0	60.0	0.2	19.0	0.3	11.4	6.9
215	68/65	145	1	50	8	1	39	6.1	5.7	0.1	0.02	0.4	1.9	0.0	0.1	1.5	0.4	60	0.03	5.0	2.4	3.9	61.5	0.2	19.0	0.3	10.0	6.2
216	9/44 1321	4	0	26	23	6	43	6.1	4.9	1.4	0.08	2.5	1.1	0.0	0.3	3.2	1.2	51	0.14	17.5	3.9	7.1	54.9	2.3	3.7	3.3	16.5	9.1
217	1321	29	0	25	15	9	51	6.4	5.2			1.4	1.1	0.0	0.2	1.3	1.2	40	0.18		2.7	4.0	67.5	1.3	5.5		7.8	5.3
218	1321	70	0	22	14	14	48	6.4	5.6			1.3	1.0	0.0	0.2	0.4	0.8	38	0.29		2.5	2.9	86.2	1.3	5.0		6.0	5.2
219	1321	120	0	27	13	14	44	6.5	5.5			0.9	0.7	0.0	0.2	0.6	1.0	42	0.32		1.8	2.4	75.0	1.3	3.5		5.5	4.1
220	40	10	0	43	43	7	6	6.4	5.0	0.5	0.03	1.5	0.3	0.0	0.1	1.0	1.4	87	1.17	16.7	1.9	2.9	65.5	5.0	3.0	8.3	48.3	31.7
221	40	32	0	39	45	8	7	6.5	4.7	0.2	0.02	0.9	0.3	0.0	0.1	0.5	1.8	85	1.14	10.0	1.3	1.8	72.2	3.0	3.0	2.9	25.7	18.6
222	9/45 40	67	0	31	48	7	14	6.5	4.9			1.1	0.4	0.0	0.1	0.4	1.6	79	0.50		1.6	2.0	80.0	2.8	4.0		14.3	11.4
223	40	110	0	45	29	6	19	6.5	5.0			1.3	0.8	0.0	0.2	0.5	1.5	75	0.32		2.3	2.8	82.1	1.6	4.0		14.7	12.1
224	40	145	0	37	33	7	23	6.7	5.4			1.7	0.7	0.0	0.2	0.5	1.3	70	0.30		2.6	3.1	83.9	2.4	3.5		13.5	11.3
225	9/46 1284	7	1	27	27	6	38	6.2	4.7	1.2	0.01	2.3	0.7	0.0	0.4	2.3	1.5	56	0.16	120.0	3.4	5.7	59.6	3.3	1.8	3.2	15.0	8.9
226	1284	35	3	20	14	7	60	6.5	5.2			1.3	0.9	0.0	0.3	0.9	1.3	33	0.12		2.5	3.4	73.5	1.4	3.0		5.7	4.2
227	1284	75	1	11	17	8	64	6.4	5.3			1.4	1.3	0.0	0.2	0.7	1.1	28	0.13		2.9	3.6	80.6	1.1	6.5		5.6	4.5
228	1284	115	2	22	16	9	53	6.3	5.4			1.4	1.2	0.0	0.2	0.6	0.9	38	0.17		2.8	3.4	82.4	1.2	6.0		6.4	5.3
229	9/47 1285a	7	1	58	27	5	9	6.4	5.3	0.9	0.04	2.5	0.6	0.0	0.1	1.0	1.1	86	0.56	22.5	3.2	4.2	76.2	4.2	6.0	10.0	46.7	35.6
230	1285a	30	1	42	16	4	36	6.4	5.3			1.5	0.5	0.0	0.1	0.6	1.1	60	0.11		2.1	2.7	77.8	3.0	5.0		7.5	5.8
231	1285a	65	1	47	13	5	33	6.6	5.8			1.2	0.7	0.0	0.1	0.2	0.8	62	0.15		2.0	2.2	90.9	1.7	7.0		6.7	6.1
232	1285a	105	4	39	18	9	33	6.6	5.8			1.0	0.8	0.0	0.2	0.2	0.8	58	0.27		2.0	2.2	90.9	1.3	4.0		6.7	6.1
233	9/48 530	5	0	17	26	24	30	6.5	5.2	2.7	0.15	10.2	3.9	0.1	0.7	2.9	1.3	46	0.80	18.0	14.9	17.8	83.7	2.6	5.6	9.0	59.3	49.7
234	530	17	0	15	26	17	38	6.4	5.1	2.1	0.10	9.2	3.5	0.1	0.7	3.1	1.3	45	0.45	21.0	13.5	16.6	81.3	2.6	5.0	5.5	43.7	35.5
235	530	37	0	15	23	13	44	6.0	5.0	1.4	0.08	7.0	2.9	0.0	0.5	2.8	1.0	43	0.30	17.5	10.4	13.2	78.8	2.4	5.8	3.2	30.0	23.6
236	530	85	1	13	14	13	61	6.0	5.0			4.5	2.7	0.0	0.3	1.9	1.0	26	0.21	0.0	7.5	9.4	79.8	1.7	9.0	0.0	15.4	12.3
237	9/49 639	10	1	23	42	8	26	6.3	5.1	1.6	0.10	6.9	1.1	0.0	0.5	1.4	1.2	66	0.31	16.0	8.5	9.9	85.9	6.3	2.2	6.2	38.1	32.7
238	639 0	32	1	28	29	7	35	6.1	4.7	1.4	0.07	6.9	0.7	0.0	0.1	2.7	1.4	58	0.20	20.0	7.7	10.4	74.0	9.9	7.0	4.0	29.7	22.0
239	639 0	62	1	24	27	8	40	6.1	4.9	0.8	0.05	5.3	0.6	0.0	0.1	1.8	1.2	52	0.20	16.0	6.0	7.8	76.9	8.8	6.0	2.0	19.5	15.0
240	639 0	102	4	21	26	11	42	6.2	5.2			4.6	1.0	0.0	0.1	0.8	1.0	47	0.26		5.7	6.5	87.7	4.6	10.0		15.5	13.6
241	639 0	145	3	25	23	12	40	6.4	5.1			4.6	0.9	0.0	0.1	1.2	1.3	48	0.30		5.6	6.8	82.4	5.1	9.0		17.0	14.0
242	9/50 711	6	1	16	49	8	24	6.2	5.3	1.7	0.11	8.6	2.1	0.2	0.6	2.2	0.9	68	0.33	15.5	11.5	13.7	83.9	4.1	3.5	7.1	57.1	47.9
243	711	21	1	12	45	7	34	6.2	4.9	1.3	0.08	7.5	1.8	0.0	0.4	1.4	1.3	59	0.21	16.3	9.7	11.1	87.4	4.2	4.5	3.8	32.6	28.5
244	711	50	1	18	33	9	41	6.2	4.9			6.8	1.6	0.1	0.2	1.9	1.3	50	0.22		8.7	10.6	82.1	4.3	8.0		25.9	21.2
245	9/51 618	6	1	21	59	9	10	6.9	5.3	0.7	0.05	4.5	0.9	0.0	0.4	1.0	1.6	81	0.90	14.0	5.8	6.8	85.3	5.0	2.3	7.0	68.0	58.0
246	618	21	0	25	50	8	16	6.9	5.0	0.5	0.03	4.2	1.3	0.0	0.5	1.0	1.9	76	0.50	16.7	6.0	7.0	85.7	3.2	2.6	3.1	43.8	37.5
247	618	50	1	17	47	8	28	6.5	4.8			5.9	1.2	0.2	0.5	1.1	1.7	64	0.29		7.8	8.9	87.6	4.9	2.4		31.8	27.9
248	618	82	3	22	37	8	34	6.4	4.6			6.0	1.5	0.1	0.3	1.1	1.8	58	0.24		7.9	9.0	87.8	4.0	5.0		26.5	23.2
249	10/52 15/71	7	2	58	32	4	6	6.7	5.5	0.5	0.03	1.5	0.4	0.2	0.1	0.4	1.2	90	0.67	16.7	2.2	2.6	84.6	3.8	4.0	8.3	43.3	36.7
250	15/71	28	1	53	37	3	7	6.8	5.8	0.2	0.01	1.2	0.3	0.2	0.0	0.1	1.0	90	0.43	20.0	1.7	1.8	94.4	4.0		2.9	25.7	24.3

SOIL CHARCTERISTICS OF ALL DATA

DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #	PROFILE		AVE	GR	CO	FI*	SI*	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN*	S/C*	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
251		15/71	54	3	47	37	5	11	7.1	5.9	0.3	0.02	1.5	0.4	0.2	0.1	0.2	1.2	84	0.45	15.0	2.2	2.4	91.7	3.8	4.0	2.7	21.8	20.0
252		15/71	90	3	42	25	5	29	6.9	5.8	0.2	0.00	1.8	0.3	0.2	0.2	0.1	1.1	66	0.17	0.0	2.5	2.6	96.2	6.0	1.5	0.7	9.0	8.6
253		15/71	130	5	32	23	4	41	7.0	5.9	0.2	0.00	2.1	0.4	0.2	0.2	0.2	1.1	55	0.10	0.0	2.9	3.1	93.5	5.3	2.0	0.5	7.6	7.1
254	10/53	34/71	6	1	40	38	7	14	6.9	5.8	1.0	0.07	4.9	1.2	0.2	0.3	0.8	1.1	79	0.50	14.3	6.6	7.4	89.2	4.1	4.0	7.1	52.9	47.1
255		34/71	19	2	46	29	6	17	6.6	5.5	0.6	0.04	3.4	0.7	0.2	0.3	0.9	1.1	77	0.35	15.0	4.6	5.5	83.6	4.9	2.3	3.5	32.4	27.1
256		34/71	38	1	38	26	5	29	6.6	5.3	0.5	0.03	2.7	0.8	0.2	0.3	0.9	1.3	66	0.17	16.7	4.0	4.9	81.6	3.4	2.7	1.7	16.9	13.8
257		34/71	75	1	26	17	4	53	6.7	5.5	0.3		3.4	1.3	0.2	0.4	0.7	1.2	43	0.08		5.3	6.0	88.3	2.6	3.3	0.6	11.3	10.0
258		34/71	110	1	23	15	3	59	6.7	5.6	0.2		3.6	0.9	0.2	0.3	0.5	1.1	38	0.05		5.0	5.5	90.9	4.0	3.0	0.3	9.3	8.5
259	10/54	73/71	8	1	23	23	12	37	6.5	5.3	2.8	0.15	12.2	2.8	0.1	0.4	3.0	1.2	51	0.32	18.7	15.5	18.5	83.8	4.4	7.0	7.6	50.0	41.9
260		73/71	26	0	24	20	11	41	6.4	5.1	1.7	0.08	9.0	2.7	0.1	0.3	2.4	1.3	48	0.27	21.3	12.1	14.5	83.4	3.3	9.0	4.1	35.4	29.5
261		73/71	49	0	26	20	12	42	6.5	5.1	1.1	0.10	7.1	2.2	0.1	0.2	2.3	1.4	46	0.29	11.0	9.6	11.9	80.7	3.2	11.0	2.6	28.3	22.9
262		73/71	90	0	25	18	9	48	6.3	4.9	0.6		5.7	1.8	0.2	0.1	2.3	1.4	43	0.19		7.8	10.1	77.2	3.2	18.0	1.3	21.0	16.3
263		73/71	130	0	25	17	9	49	6.2	4.9	0.6		5.4	1.9	0.1	0.1	1.9	1.3	42	0.18		7.5	9.4	79.8	2.8	19.0	1.2	19.2	15.3
264	11/55	18	15		28	24	17	32	5.3	4.9	4.7	0.27	6.2	3.3	0.1	0.5	22.2	0.4	51	0.53	17.4	10.1	32.3	31.3	1.9	6.6	14.7	100.9	31.6
265		18	42		25	17	14	45	5.2	4.5	2.0	0.12	0.7	3.3	0.1	0.1	20.4	0.7	41	0.31	16.7	4.2	24.6	17.1	0.2	33.0	4.4	54.7	9.3
266		18	85		26	12	10	52	5.1	4.5	1.1	0.07	0.5	2.2	0.1	0.1	16.8	0.6	38	0.19	15.7	2.9	19.7	14.7	0.2	22.0	2.1	37.9	5.6
267		18	125		24	11	10	55	5.3	4.7	0.7	0.05	0.9	3.4	0.1	0.0	10.9	0.6	35	0.18	14.0	4.4	15.3	28.8	0.3		1.3	27.8	8.0
268	11/56	16	7		63	23	4	10	6.6	5.6	0.5	0.03	1.9	0.6	0.0	0.1	1.6	1.0	86	0.40	16.7	2.6	4.2	61.9	3.2	6.0	5.0	42.0	26.0
269		16	22		59	22	7	12	6.7	5.8	0.4	0.02	1.6	0.3	0.1	0.1	0.9	0.9	81	0.58	20.0	2.1	3.0	70.0	5.3	3.0	3.3	25.0	17.5
270		16	50		60	15	4	20	6.7	5.6	0.1	0.01	1.5	0.2	0.0	0.1	0.8	1.1	76	0.20	10.0	1.8	2.6	69.2	7.5	2.0	0.5	13.0	9.0
271		16	95		55	20	3	21	6.7	5.6	0.1	0.01	0.9	0.4	0.0	0.1	1.1	1.1	76	0.14	10.0	1.4	2.5	56.0	2.3	4.0	0.5	11.9	6.7
272		16	125		61	14	5	20	6.7	5.5	0.1	0.01	0.9	0.3	0.1	0.1	1.4	1.2	75	0.25	10.0	1.4	2.8	50.0	3.0	3.0	0.5	14.0	7.0
273	12/57	1	7		14	21	20	47	5.5	5.3	1.3		2.5	0.0	0.2	0.4		0.2	33	0.43		3.1				0.0	2.8		6.6
274		1	35		5	8	13	74	6.3	5.8	0.1		1.4	1.3	0.1	0.5		0.5	13	0.18		3.3			1.1	2.6	0.1		4.5
275	12/58	2	7		16	23	24	40	5.3	4.8	1.1	0.09	2.3	1.1	0.1	0.5		0.5	36	0.60	12.2	4.0			2.1	2.2	2.8		10.0
276		2	52		6	10	18	70	5.1	5.5	0.2	0.02	2.8	0.5	0.2	0.2		-.4	12	0.26	10.0	3.7			5.6	2.5	0.3		5.3
277		2	100		7	11	18	65	6.3	6.3	0.1	0.01	1.8	0.0	0.1	0.2		0.0	17	0.28	10.0	2.1				0.0	0.2		3.2
278	12/59	3	7		10	18	25	49	5.1	4.9	1.0	0.06	1.8	3.8	0.2	0.4		0.2	26	0.51	16.7	6.2			0.5	9.5	2.0		12.7
279		3	20		5	10	20	67	5.7	5.3	0.2	0.01	1.3	0.0	0.1	0.2		0.4	13	0.30	20.0	1.6				0.0	0.3		2.4
280		3	45		5	10	13	68	6.0	5.9	0.2	0.01	1.4	0.7	0.1	0.2		0.1	19	0.19	20.0	2.4			2.0	3.5	0.3		3.5
281		3	105		6	10	18	63	6.3	5.7	0.1	0.01	0.9	0.5	0.2	0.2		0.6	19	0.29	10.0	1.8			1.8	2.5	0.2		2.9
282	12/60	4	7		21	18	29	34	5.5	4.9	1.1	0.13	3.8	0.0	0.2	0.4		0.6	37	0.85	8.5	4.4				0.0	3.2		12.9
283		4	20		20	17	25	38	5.6	4.9	0.9	0.12	3.0	1.1	0.2	0.4		0.7	37	0.66	7.5	4.7			2.7	2.8	2.4		12.4
284		4	37		12	12	21	58	5.7	5.5	0.4	0.04	2.4	0.5	0.2	0.4		0.2	21	0.36	10.0	3.5			4.8	1.3	0.7		6.0
285		4	90		8	8	17	68	6.5	6.2	0.1	0.02	2.4	0.5	0.2	0.4		0.3	15	0.25	5.0	3.5			4.8	1.3	0.1		5.1
286	12/61	5	10		31	27	13	30	5.3	4.9	0.8	0.05	1.9	0.0	0.2	0.2		0.4	57	0.43	16.0	2.3				0.0	2.7		7.7
287		5	55		11	9	8	72	6.4	6.0	0.2	0.01	1.3	0.5	0.2	0.5		0.4	20	0.11	20.0	2.5			2.6	1.0	0.3		3.5
288	12/62	6	12		34	33	18	16	5.5	5.1	0.7	0.06	2.2	0.0	0.1	0.3		0.4	66	1.13	11.7	2.6				0.0	4.4		16.3
289		6	75		21	20	17	44	4.9	4.8	0.2	0.02	1.6	0.5	0.2	0.2		0.1	39	0.39	10.0	2.5			3.2	2.5	0.5		5.7
290		6	170		14	20	25	42	6.5	6.0	0.1	0.01	1.9	1.1	0.2	0.1		0.5	33	0.60	10.0	3.3			1.7	11.0	0.2		7.9
291	13/63	r028	6				12	18	6.0	4.8	1.4	0.12	3.6	1.7	0.0	0.5	1.3	1.2	70	0.67	11.7	5.8	7.1	81.7	2.1	3.4	7.8	39.4	32.2
292		r028	24				14	42	6.1	4.8	1.7	0.14	6.4	2.7	0.1	0.5	1.1	1.3	44	0.33	12.1	9.7	10.8	89.8	2.4	5.4	4.0	25.7	23.1
293		r028	70				12	52	6.3	5.0	0.8	0.07	4.4	2.7	0.1	0.2	1.1	1.3	36	0.23	11.4	7.4	8.5	87.1	1.6	13.5	1.5	16.3	14.2
294		r028	134				16	46	6.5	5.3	0.6		4.2	2.6	0.1	0.1	0.6	1.2	38	0.35		7.0	7.6	92.1	1.6	26.0	1.3	16.5	15.2
295	13/64	r027	7				10	32	5.9	4.8	2.7	0.23	9.0	5.1	0.1	0.4	2.8	1.1	58	0.31	11.7	14.6	17.4	83.9	1.8	12.8	8.4	54.4	45.6
296		r027	32				12	52	5.9	4.8	1.6	0.13	9.8	6.4	0.1	0.3	3.6	1.1	36	0.23	12.3	16.6	20.2	82.2	1.5	21.3	3.1	38.8	31.9
297		r027	57				18	58	6.1	4.6	1.6	0.13	6.2	4.6	0.1	0.2	2.8	1.5	24	0.31	12.3	11.1	13.9	79.9	1.3	23.0	2.8	24.0	19.1
298		r027	95				14	60	5.9	4.7	0.9		5.2	4.1	0.1	0.2	1.8	1.2	26	0.23		9.6	11.4	84.2	1.3	20.5	1.5	19.0	16.0
299	13/65	r018	4				16	40	5.9	4.8	2.5	0.15	2.9	1.2	0.0	0.7	1.5	1.1	44	0.40	16.7	4.8	6.3	76.2	2.4	1.7	6.3	15.8	12.0
300		r018	19				16	64	5.5	4.6	1.7	0.14	2.9	0.9	0.1	0.3	2.3	0.9	20	0.25	12.1	4.2	6.5	64.6	3.2	3.0	2.7	10.2	6.6

SOIL CHARCTERISTICS OF ALL DATA DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #	PROFILE		AVE	GR	CO	FI	SI	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN	S/C	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
301		r018	65				12	68	5.0	5.0	4.6	0.13	2.8	0.6	0.1	0.3	0.8	0.0	20	0.18	35.4	3.8	4.6	82.6	4.7	2.0	6.8	6.8	5.6
302		r018	132				12	70	6.3	5.8	0.4		2.4	0.7	0.0	0.2	0.2	0.5	18	0.17		3.3	3.5	94.3	3.4	3.5	0.6	5.0	4.7
303	13/66	r023	10				18	64	5.3	4.5	1.8	0.11	4.7	3.5	0.1	0.7	2.2	0.8	18	0.28	16.4	9.0	11.2	80.4	1.3	5.0	2.8	17.5	14.1
304		r023	41				16	70	6.0	4.9	1.1	0.08	4.0	3.1	0.1	0.4	1.5	1.1	14	0.23	13.8	7.6	9.1	83.5	1.3	7.8	1.6	13.0	10.9
305		r023	112				18	54	6.1	5.4	0.5	0.00	4.0	3.4	0.1	0.4	0.6	0.7	28	0.33	0.0	7.9	8.5	92.9	1.2	8.5	0.9	15.7	14.6
306	13/67	r015	10				10	26	5.2	4.3	1.3	0.11	2.2	0.9	0.0	0.8	1.4	0.9	64	0.38	11.8	3.9	5.3	73.6	2.4	1.1	5.0	20.4	15.0
307		r015	55				8	52	5.8	4.7	0.3	0.03	4.0	2.1	0.1	0.6	1.3	1.1	40	0.15	10.0	6.8	8.1	84.0	1.9	3.5	0.6	15.6	13.1
308		r015	125				8	52	6.4	5.4	0.3		3.7	1.8	0.1	0.5	0.6	1.0	40	0.15		6.1	6.7	91.0	2.1	3.6	0.6	12.9	11.7
309	13/68	r017	9				12	28	5.5	4.4	1.1	0.08	1.4	0.7	0.0	0.6	1.4	1.1	60	0.43	13.8	2.7	4.1	65.9	2.0	1.2	3.9	14.6	9.6
310		r017	26				14	36	5.3	4.2	0.9	0.03	1.1	0.4	0.0	0.4	1.5	1.1	50	0.39	30.0	1.9	3.4	55.9	2.8	1.0	2.5	9.4	5.3
311		r017	87				12	50	5.8	5.3	0.4	0.03	1.7	0.8	0.0	0.4	0.4	0.5	38	0.24	13.3	2.9	3.3	87.9	2.1	2.0	0.8	6.6	5.8
312	13/69	r013	11				10	24	6.1	4.5	1.4	0.12	4.4	1.6	0.0	0.6	1.5	1.6	66	0.42	11.7	6.6	8.1	81.5	2.8	2.7	5.8	33.8	27.5
313		r013	38				10	42	5.7	4.6	0.9	0.08	6.0	2.5	0.1	0.6	1.5	1.1	48	0.24	11.3	9.2	10.7	86.0	2.4	4.2	2.1	25.5	21.9
314		r013	87				14	40	6.2	5.0	0.3		6.4	2.5	0.1	0.5	0.8	1.2	46	0.35		9.5	10.3	92.2	2.6	5.0	0.8	25.8	23.8
315	13/70	m055	5				12	56	5.6	4.5	2.3	0.17	3.7	1.8	0.0	0.4	3.9	1.1	32	0.21	13.5	5.9	9.8	60.2	2.1	4.5	4.1	17.5	10.5
316		m055	26				12	70	5.8	4.7	1.9	0.13	4.0	1.4	0.0	0.2	3.3	1.1	18	0.17	14.6	5.6	8.9	62.9	2.9	7.0	2.7	12.7	8.0
317		m055	78				10	74	6.1	4.9	1.0	0.10	3.0	1.4	0.0	0.2	1.8	1.2	16	0.14	10.0	4.6	6.4	71.9	2.1	7.0	1.4	8.6	6.2
318		m055	132				16	62	5.8	5.2	1.0		2.9	1.5	0.0	0.2	1.5	0.6	22	0.26		4.6	6.1	75.4	1.9	7.5	1.6	9.8	7.4
319	13/71	m053	5				14	46	6.0	4.9	3.7	0.25	5.4	2.2	0.1	0.7	2.0	1.1	40	0.30	14.8	8.4	10.4	80.8	2.5	3.1	8.0	22.6	18.3
320		m053	25				8	56	5.9	4.5	1.8	0.14	2.4	1.1	0.0	0.7	1.8	1.4	36	0.14	12.9	4.2	6.0	70.0	2.2	1.6	3.2	10.7	7.5
321		m053	68				2	78	5.6	4.5	0.7	0.07	2.4	0.8	0.0	0.2	1.8	1.1	20	0.03	10.0	3.4	5.2	65.4	3.0	4.0	0.9	6.7	4.4
322		m053	123				10	72	5.8	5.2	0.4		2.0	0.8	0.0	0.1	1.3	0.6	18	0.14		2.9	4.2	69.0	2.5	8.0	0.6	5.8	4.0
323	13/72	m050	9				18	50	6.0	5.2	2.7	0.23	7.4	2.2	0.1	1.1	0.4	0.8	32	0.36	11.7	10.8	11.2	96.4	3.4	2.0	5.4	22.4	21.6
324		m050	36				14	52	6.0	5.2	2.5	0.22	12.3	2.1	0.1	1.0	0.4	0.8	34	0.27	11.4	15.5	15.9	97.5	5.9	2.1	4.8	30.6	29.8
325		m050	81				12	66	5.9	5.1	1.7		4.4	1.5	0.1	0.7	0.2	0.8	22	0.18		6.7	6.9	97.1	2.9	2.1	2.6	10.5	10.2
326		m050	135				14	60	6.0	5.6	0.2		2.9	1.2	0.0	0.5	0.4	0.4	26	0.23		4.6	5.0	92.0	2.4	2.4	0.3	8.3	7.7
327	13/73	m35a	6				16	30	5.8	4.9	1.9	0.14	7.4	2.8	0.1	0.8	2.5	0.9	54	0.53	13.6	11.1	13.6	81.6	2.6	3.5	6.3	45.3	37.0
328		m35a	35				14	48	5.8	4.8	1.9	0.15	8.9	3.1	0.1	0.4	2.8	1.0	38	0.29	12.7	12.5	15.3	81.7	2.9	7.8	4.0	31.9	26.0
329		m35a	109				12	64	6.1	5.0	0.8		7.4	3.3	0.1	0.3	1.8	1.1	24	0.19		11.1	12.9	86.0	2.2	11.0	1.3	20.2	17.3
330	13/74	m030	7				18	44	5.7	4.9	1.9	0.15	2.8	1.7	0.0	1.0	1.5	0.8	38	0.41	12.7	5.5	7.0	78.6	1.6	1.7	4.3	15.9	12.5
331		m030	36				16	58	5.2	4.5	0.6	0.06	1.7	0.9	0.0	0.9	1.8	0.7	26	0.28	10.0	3.5	5.3	66.0	1.9	1.0	1.0	9.1	6.0
332		m030	88				22	42	5.3	4.8	0.3		1.7	0.9	0.0	0.7	0.6	0.5	36	0.52		3.3	3.9	84.6	1.9	1.3	0.7	9.3	7.9
333	13/75	m023	9				10	20	6.1	5.1	0.9	0.08	3.0	1.7	0.1	0.7	0.6	1.0	70	0.50	11.3	5.5	6.1	90.2	1.8	2.4	4.5	30.5	27.5
334		m023	42				12	42	5.7	4.8	0.4	0.04	3.7	2.1	0.1	0.6	0.9	0.9	46	0.29	10.0	6.5	7.4	87.8	1.8	3.5	1.0	17.6	15.5
335	13/76	m020	8				10	24	5.5	4.8	1.3	0.11	4.7	2.2	0.0	0.6	0.6	0.7	66	0.42	11.8	7.5	8.1	92.6	2.1	3.7	5.4	33.8	31.3
336		m020	63				10	56	5.9	5.0	0.9	0.08	4.6	2.7	0.1	0.3	0.6	0.9	34	0.18	11.3	7.7	8.3	92.8	1.7	9.0	1.6	14.8	13.8
337		m020	135				10	54	6.1	5.3	0.6		4.7	2.1	0.1	0.3	1.1	0.8	36	0.19		7.2	8.3	86.7	2.2	7.0	1.1	15.4	13.3
338	13/77	v239	12				6	10	5.3		0.5	0.05	1.4	0.7	0.0	0.3	1.5		84	0.60	10.0	2.4	3.9	61.5	2.0	2.3	5.0	39.0	24.0
339		v239	37				4	12	5.5		0.2	0.02	1.4	0.6	0.2	0.2	1.0		84	0.33	10.0	2.4	3.4	70.6	2.3	3.0	1.7	28.3	20.0
340		v239	62				8	22	5.8		0.1	0.01	3.0	1.7	0.0	0.2	0.9		70	0.36	10.0	4.9	5.8	84.5	1.8	8.5	0.5	26.4	22.3
341		v239	125				8	26	6.2		0.1	0.01	2.8	1.0	0.0	0.2	0.7		66	0.31	10.0	4.0	4.7	85.1	2.8	5.0	0.4	18.1	15.4
342	13/78	v211	10				16	16	5.9	5.0	1.8	0.15	5.2	1.7	0.1	0.6	1.1	0.9	68	1.00	12.0	7.6	8.7	87.4	3.1	2.8	11.3	54.4	47.5
343		v211	37				10	44	6.0	4.7	0.4	0.03	3.4	1.6	0.1	0.7	0.8	1.3	46	0.23	13.3	5.8	6.6	87.9	2.1	2.3	0.9	15.0	13.2
344		v211	100				10	50	6.5	5.2	0.2		3.7	1.7	0.1	0.9	0.4	1.3	40	0.20		6.4	6.8	94.1	2.2	1.9	0.4	13.6	12.8
345	13/79	m003	6				8	10	6.1	5.3	0.8	0.08	2.8	1.3	0.0	0.3	0.4	0.8	82	0.80	10.0	4.4	4.8	91.7	2.2	4.3	8.0	48.0	44.0
346		m003	27				6	10	6.1	5.3	0.1	0.01	0.8	0.9	0.0	0.2	0.4	0.8	84	0.60	10.0	1.9	2.3	82.6	0.9	4.5	1.0	23.0	19.0
347		m003	55				6	24	5.7	4.1	0.1	0.01	2.0	1.4	0.0	0.5	0.6	1.6	70	0.25	10.0	3.9	4.5	86.7	1.4	2.8	0.4	18.8	16.3
348		m003	91				8	24	5.8	4.2	0.1	0.01	1.5	2.2	0.1	0.5	0.6	1.6	68	0.33	10.0	4.3	4.9	87.8	0.7	4.4	0.4	20.4	17.9
349		m003	130				8	14	5.9	5.1	0.8	0.07	1.9	1.1	0.1	0.4	0.4	0.8	78	0.57	11.4	3.5	3.9	89.7	1.7	2.8	5.7	27.9	25.0
350	13/80	b6	10				16	68	5.0	4.6	2.2	0.19	3.0	1.1	0.0	0.3	3.4	0.4	16	0.24	11.6	4.4	7.8	56.4	2.7	3.7	3.2	11.5	6.5

SOIL CHARCTERISTICS OF ALL DATA

DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #		PROFILE	AVE	GR	CO	FI	SI	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN	S/C	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
351		b6	35				18	70	5.0	4.6	1.2	0.12	3.2	1.4	0.1	0.1	3.1	0.4	12	0.26	10.0	4.8	7.9	60.8	2.3	14.0	1.7	11.3	6.9
352		b6	70				18	70	5.2	5.0	0.6	0.05	3.0	0.2	0.1	0.0	1.8	0.2	12	0.26	12.0	3.3	5.1	64.7	15.0		0.9	7.3	4.7
353	13/81	b26	7				12	42	5.4	4.9	1.0	0.09	1.7	0.7	0.5	0.5	2.1	0.5	46	0.29	11.1	3.4	5.5	61.8	2.4	1.4	2.4	13.1	8.1
354		b26	23				14	50	4.7	4.6	1.0	0.08	3.7	1.1	0.3	0.3	2.2	0.1	36	0.28	12.5	5.4	7.6	71.1	3.4	3.7	2.0	15.2	10.8
355		b26	45				14	62	5.0	5.0	0.2	0.02	2.8	0.8	0.3	0.3	1.2	0.0	24	0.23	10.0	4.2	5.4	77.8	3.5	2.7	0.3	8.7	6.8
356		b26	105				16	60	5.3	5.5	0.1	0.01	2.4	0.8	0.1	0.1	0.7	-.2	24	0.27	10.0	3.4	4.1	82.9	3.0	8.0	0.2	6.8	5.7
357	13/82	s198	3				16	18	5.6	4.1	1.4	0.11	3.4	1.4	0.1	0.7	1.4	1.5	66	0.89	12.7	5.6	7.0	80.0	2.4	2.0	7.8	38.9	31.1
358		s198	17				18	20	5.3	3.5	0.4	0.03	3.6	1.6	0.1	0.4	0.6	1.8	62	0.90	13.3	5.7	6.3	90.5	2.3	4.0	2.0	31.5	28.5
359		s198	36				18	28	6.2	4.2	0.3	0.03	4.6	2.7	0.1	0.7	0.4	2.0	54	0.64	10.0	8.1	8.5	95.3	1.7	3.9	1.1	30.4	28.9
360		s198	88				20	30	6.3	4.2	0.1		5.2	3.2	0.1	0.7	0.4	2.1	50	0.67		9.2	9.6	95.8	1.6	4.6	0.3	32.0	30.7
361	13/83	v236	10				16	34	5.4	4.2	1.6	0.15	0.8	0.5	0.1	0.4	1.5	1.2	50	0.47	10.7	1.8	3.3	54.5	1.6	1.3	4.7	9.7	5.3
362		v236	32				18	45	5.4	4.6	0.5	0.04	0.4	0.3	0.0	0.3	0.6	0.8	37	0.40	12.5	1.0	1.6	62.5	1.3	1.0	1.1	3.6	2.2
363		v236	77				16	44	5.4	4.8	0.2	0.01	0.4	0.3	0.1	0.3	0.4	0.6	40	0.36	20.0	1.1	1.5	73.3	1.3	1.0	0.5	3.4	2.5
364	14/84	1	7	0	14	14	21	51	5.2	5.6	2.5	0.22	4.7	1.4	0.1	0.2	7.6	-.4	28	0.41	11.4	6.4	14.0	45.7	3.4	7.0	4.9	27.5	12.5
365		1	30	0	11	9	30	50	5.2	4.3	1.0	0.08	1.7	0.7	0.1	0.0	6.4	0.9	20	0.60	12.5	2.5	8.9	28.1	2.4		2.0	17.8	5.0
366		1	72	0	10	8	33	49	5.3	4.4	0.4	0.05	1.0	0.4	0.1	0.0	3.2	0.9	18	0.67	8.0	1.5	4.7	31.9	2.5		0.8	9.6	3.1
367		1	132	0	8	8	28	56	5.7	4.5	0.3	0.05	1.7	0.3	0.2	0.0	3.5	1.2	16	0.50	6.0	2.2	5.7	38.6	5.7		0.5	10.2	3.9
368	14/85	14	9	0	12	10	20	58	6.2	5.0	1.6	0.16	6.2	2.1	0.1	0.3	3.3	1.2	22	0.34	10.0	8.7	12.0	72.5	3.0	7.0	2.8	20.7	15.0
369		14	41	0	21	17	11	51	6.2	4.9	0.6	0.05	4.2	1.5	0.1	0.1	2.5	1.3	38	0.22	12.0	5.9	8.4	70.2	2.8	15.0	1.2	16.5	11.6
370		14	115	0	7	8	28	58	5.9	4.9	0.2	0.05	2.9	1.1	0.1	0.0	1.8	1.0	14	0.48	4.0	4.1	5.9	69.5	2.6		0.3	10.2	7.1
371		14	280	0	9	11	19	61	6.0	5.3	0.1	0.02	4.1	1.3	0.1	0.0	1.4	0.7	20	0.31	5.0	5.5	6.9	79.7	3.2		0.2	11.3	9.0
372		p9	10	1	30	27	26	16	6.3	5.3	1.9	0.10	8.3	1.0	0.6	0.5	2.6	1.0	58	1.63	19.0	10.4	13.0	80.0	8.3	2.0	11.9	81.3	65.0
373	15/86	p9	35	0	35	29	21	15	6.4	5.0	0.2	0.02	3.5	0.7	0.1	0.4	1.6	1.4	64	1.40	10.0	4.7	6.3	74.6	5.0	1.8	1.3	42.0	31.3
374		p9	85	5	38	20	17	22	6.2	4.8			4.4	0.7	0.1	0.3	1.5	1.4	61	0.77		5.5	7.0	78.6	6.3	2.3		31.8	25.0
375	15/87	p102	12	0	54	35	7	3	6.1	4.8	2.8	0.08	3.6	0.4	0.2	0.1	1.5	1.3	90	2.33	35.0	4.3	5.8	74.1	9.0	4.0	93.3	193.3	143.3
376		p102	42	0	46	27	12	15	6.3	4.5	0.8	0.07	4.1	0.3	0.1	0.1	1.7	1.8	73	0.80	11.4	4.6	6.3	73.0	13.7	3.0	5.3	42.0	30.7
377		p102	90	0	57	20	4	18	6.5	4.8			3.2	0.3	0.1	0.2	1.6	1.7	78	0.22		3.8	5.4	70.4	10.7	1.5		30.0	21.1
378	15/88	p104	7	0	33	37	19	11	5.8	4.9	1.0	0.07	3.2	0.4	0.1	0.3	2.5	0.9	70	1.73	14.3	4.0	6.5	61.5	8.0	1.3	9.1	59.1	36.4
379		p104	35	0	28	27	16	27	6.2	4.7	0.5	0.07	2.6	0.6	0.0	0.4	1.6	1.5	57	0.59	7.1	3.6	5.2	69.2	4.3	1.5	1.9	19.3	13.3
380		p104	82	0	28	23	16	33	6.0	4.7			3.6	0.6	0.1	0.4	1.6	1.3	51	0.48		4.7	6.3	74.6	6.0	1.5		19.1	14.2
381	15/89	p34	7	0	56	24	12	8	5.9		1.2	0.08	4.7	0.6	0.1	0.1	1.1		80	1.50	15.0	5.5	6.6	83.3	7.8	6.0	15.0	82.5	68.8
382		p34	27	1	40	31	14	15			0.2	0.02	1.0	0.3	0.1	0.2	1.0		71	0.93	10.0	1.6	2.6	61.5	3.3	1.5	1.3	17.3	10.7
383		p34	75	0	52	18	7	24	6.4	5.3			0.8	0.4	0.1	0.2	1.1	1.1	69	0.29		1.5	2.6	57.7	2.0	2.0		10.8	6.3
384	15/90	p108	8	0	50	40	5	5	6.0	5.2	0.4	0.03	2.2	0.2	0.1	0.1	1.6	0.8	90	1.00	13.3	2.6	4.2	61.9	11.0	2.0	8.0	84.0	52.0
385		p108	38	0	43	35	7	16	5.3	4.9	0.0	0.02	1.1	0.3	0.1	0.0	0.8	0.4	77	0.44	0.0	1.5	2.3	65.2	3.7		0.0	14.4	9.4
386		p108	95	0	41	29	10	19	5.6	4.8			1.3	1.2	0.1	0.1	0.8	0.8	71	0.53		2.7	3.5	77.1	1.1	12.0		18.4	14.2
387	15/91	p112	10	1	57	25	5	12	6.0	5.3	0.4	0.03	2.0	0.2	0.1	0.2	1.3	0.7	83	0.42	13.3	2.5	3.8	65.8	10.0	1.0	3.3	31.7	20.8
388		p112	60	1	31	10	13	45	6.1	5.5	0.1	0.01	1.3	0.5	0.1	0.4	1.2	0.6	42	0.29	10.0	2.3	3.5	65.7	2.6	1.3	0.2	7.8	5.1
389	15/92	p113	10	0	52	32	9	8	6.5	5.7	0.8	0.05	5.4	0.4	0.1	0.3	1.2	0.8	83	1.13	16.0	6.2	7.4	83.8	13.5	1.3	10.0	92.5	77.5
390		p113	35	0	48	21	6	26	6.4	5.6	0.1	0.02	3.5	0.6	0.1	0.2	0.8	0.8	68	0.23	5.0	4.4	5.2	84.6	5.8	3.0	0.4	20.0	16.9
391		p113	85	0	56	16	13	15	6.4	5.7			3.4	0.6	0.1	0.2	0.8	0.7	72	0.87		4.3	5.1	84.3	5.7	3.0		34.0	28.7
392	15/93	p114	7	0	55	13	9	23	6.2	5.4	0.4	0.03	1.8	0.2	0.1	0.0	1.0	0.8	68	0.39	13.3	2.1	3.1	67.7	9.0		1.7	13.5	9.1
393		p114	27	0	45	35	9	11	6.1	4.9	0.1	0.08	0.8	0.1	0.1	0.1	1.0	1.2	80	0.82	1.3	1.1	2.1	52.4	8.0	1.0	0.9	19.1	10.0
394		p114	80	0	55	27	2	15	5.8	5.1			0.5	0.2	0.1	0.1	0.7	0.7	83	0.13		0.9	1.6	56.3	2.5	2.0		10.7	6.0
395	15/94	p46	10	0	40	21	14	25	6.3	5.0	2.0	0.10	9.5	0.9	0.1	0.6	2.7	1.3	61	0.56	20.0	11.1	13.8	80.4	10.6	1.5	8.0	55.2	44.4
396		p46	37	0	40	16	10	34	6.4	5.2	0.8	0.05	5.8	0.8	0.1	0.3	1.9	1.2	56	0.29	16.0	7.0	8.9	78.7	7.3	2.7	2.4	26.2	20.6
397		p46	82	0	32	11	6	51	6.5	5.3			5.2	0.8	0.1	0.3	1.7	1.2	43	0.12		6.4	8.1	79.0	6.5	2.7		15.9	12.5
398	15/95	p59	15	1	35	26	17	22	6.3	5.4	1.4	0.34	9.5	1.0	0.1	0.7	2.0	0.9	61	0.77	4.1	11.3	13.3	85.0	9.5	1.4	6.4	60.5	51.4
399		p59	47	1	36	18	11	35	6.3	5.1	0.5	0.17	6.2	0.7	0.1	0.4	2.0	1.2	54	0.31	2.9	7.4	9.4	78.7	8.9	1.8	1.4	26.9	21.1
400		p59	92	1	37	14	8	40	6.4	5.2			5.9	0.4	0.1	0.2	1.8	1.2	52	0.20		6.6	8.4	78.6	14.8	2.0		21.0	16.5

SOIL CHARCTERISTICS OF ALL DATA — DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #	PROFILE		AVE	GR	CO	FI	SI	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN	S/C	C/N	SUMB	CEC	BS .	CaMg	MgK	OC100	CEC100	SUM100
401	15/96	p119	7	0	19	40	20	21	6.1	5.7	1.5	0.17	10.1	1.6	0.1	0.8	1.8	0.4	59	0.95	8.8	12.6	14.4	87.5	6.3	2.0	7.1	68.6	60.0
402		p119	22	0	15	24	26	34	6.2	5.4	2.1	0.11	13.4	2.3	0.1	0.8	3.7	0.8	40	0.76	19.1	16.6	20.3	81.8	5.8	2.9	6.2	59.7	48.8
403		p119	20	0	11	15	20	55	6.3	5.1	0.6	0.05	12.2	1.9	0.1	0.1	2.7	1.2	25	0.36	12.0	14.3	17.0	84.1	6.4	19.0	1.1	30.9	26.0
404	15/97	p136	5	0	45	34	14	7	6.1	5.7	0.9	0.05	5.7	1.5	0.1	0.2	1.6	0.4	79	2.00	18.0	7.5	9.1	82.4	3.8	7.5	12.9	130.0	107.1
405		p136	233	0	49	31	12	8	6.2	5.5	0.3	0.02	3.4	0.3	0.1	0.1	1.5	0.7	80	1.50	15.0	3.9	5.4	72.2	11.3	3.0	3.8	67.5	48.8
406		p136	75	0	49	21	8	22	6.3	5.4			3.2	0.7	0.1	0.3	1.0	0.9	70	0.36		4.3	5.3	81.1	4.6	2.3		24.1	19.5
407	15/98	p65	7	0	73	17	7	3	6.0	5.7	0.7	0.08	2.9	0.3	0.1	0.1	1.3	0.3	90	2.33	8.8	3.4	4.7	72.3	9.7	3.0	23.3	156.7	113.3
408		p65	30	0	67	19	5	9	6.1	5.7	0.6	0.03	1.2	0.1	0.1	0.1	0.7	0.4	86	0.56	20.0	1.5	2.2	68.2	12.0	1.0	6.7	24.4	16.7
409		p65	92	0	59	15	7	19	6.1	5.9			2.0	0.5	0.1	0.2	0.5	0.2	74	0.37		2.8	3.3	84.8	4.0	2.5		17.4	14.7
410	15/99	p69	10	0	37	32	17	13	6.4	5.5	0.9	0.10	4.3	0.6	0.1	0.3	1.1	0.9	70	1.31	9.0	5.3	6.4	82.8	7.2	2.0	6.9	49.2	40.8
411		p69	32	0	33	22	13	32	6.3	5.5	1.1	0.06	3.7	0.7	0.1	0.3	1.5	0.8	55	0.41	18.3	4.8	6.3	76.2	5.3	2.3	3.4	19.7	15.0
412		p69	77	0	29	12	13	46	6.4	5.7			2.8	0.2	0.1	0.1	1.4	0.7	41	0.28		3.2	4.6	69.6	14.0	2.0		10.0	7.0
413	15/100	p71	7	0	56	27	5	13	6.8	5.9	0.8	0.07	2.4	0.1	0.1	0.5	1.0	0.9	82	0.38	11.4	3.1	4.1	75.6	24.0	0.2	6.2	31.5	23.8
414		p71	25	0	57	22	9	12	6.7	5.9	0.6	0.04	2.2	0.3	0.1	0.4	0.7	0.8	79	0.75	15.0	3.0	3.7	81.1	7.3	0.8	5.0	30.8	25.0
415		p71	72	0	45	16	8	30	6.0	5.3			1.5	0.6	0.1	0.8	0.7	0.7	62	0.27		3.0	3.7	81.1	2.5	0.8		12.3	10.0
416	15/101	p80	7	0	39	33	7	21	6.2	5.6	0.8	0.16	3.5	0.3	0.1	0.1	1.9	0.6	72	0.33	5.0	4.0	5.9	67.8	11.7	3.0	3.8	28.1	19.0
417		p80	27	0	40	33	10	16	6.5	5.4	0.3	0.08	3.1	0.4	0.1	0.2	1.6	1.1	74	0.63	3.8	3.8	5.4	70.4	7.8	2.0	1.9	33.8	23.8
418		p80	75	0	39	24	4	32	6.4	5.3			1.9	0.1	0.0	0.0	1.4	1.1	64	0.13		2.0	3.4	58.8	19.0			10.6	6.3
419	15/102	p85	7	2	64	18	5	12	6.5	5.7	0.5	0.11	0.7	0.1	0.1	0.2	1.1	0.8	83	0.42	4.5	1.1	2.2	50.0	7.0	0.5	4.2	18.3	9.2
420		p85	32	1	70	15	6	9	6.1	5.0	0.3	0.09	0.2	0.4	0.1	0.2	0.8	1.1	85	0.67	3.3	0.9	1.7	52.9	0.5	2.0	3.3	18.9	10.0
421		p85	315	2	53	11	9	27	6.2	5.5			3.5	0.3	0.0	0.1	1.4	0.7	64	0.33		3.9	5.3	73.6	11.7	3.0		19.6	14.4
422	15/103	p139	7	1	30	35	20	16	6.5	5.7	1.3	0.20	9.2	1.0	0.1	0.7	1.7	0.8	64	1.25	6.5	11.0	12.7	86.6	9.2	1.4	8.1	79.4	68.8
423		p139	22	1	32	28	17	22	6.5	5.5	1.3	0.19	11.9	1.2	0.1	0.5	1.7	1.0	61	0.77	6.8	13.7	15.4	89.0	9.9	2.4	5.9	70.0	62.3
424		p139	70	1	33	24	16	27	6.4	5.4	1.1	0.18	9.1	1.4	0.2	0.4	2.6	1.0	57	0.59	6.1	11.1	13.7	81.0	6.5	3.5	4.1	50.7	41.1
425	15/104	p140	12	0	50	28	2	19	6.2	5.5	0.5	0.08	2.0	0.2	0.0	0.1	1.2	0.7	79	0.11	6.3	2.3	3.5	65.7	10.0	2.0	2.6	18.4	12.1
426		p140	37	0	47	25	7	21	5.9	5.9	0.6	0.10	1.7	0.2	0.1	0.2	2.5	0.0	72	0.33	6.0	2.2	4.7	46.8	8.5	1.0	2.9	22.4	10.5
427		p140	82	0	42	29	8	20	6.0	5.0			1.4	1.2	0.0	0.2	1.5	1.0	72	0.40		2.8	4.3	65.1	1.2	6.0		21.5	14.0
428	15/105	p90	7	0	28	29	9	33	6.0	5.3	0.8	0.16	5.8	0.7	0.1	0.5	1.7	0.7	58	0.27	5.0	7.1	8.8	80.7	8.3	1.4	2.4	26.7	21.5
429		p90	27	0	23	19	1	57	5.2	5.4	0.5	0.15	5.3	0.8	0.1	0.4	1.8	-.2	42	0.02	3.3	6.6	8.4	78.6	6.6	2.0	0.9	14.7	11.6
430		p90	77	0	39	25	29	6	6.0	5.3			4.8	1.0	0.1	0.4	1.8	0.7	65	4.83		6.3	8.1	77.8	4.8	2.5		135.0	105.0
431	15/106	p141	10	0	49	24	12	14	6.0	5.3	0.9	0.16	2.8	0.4	0.1	0.3	2.5	0.7	74	0.86	5.6	3.6	6.1	59.0	7.0	1.3	6.4	43.6	25.7
432		p141	17	1	33	20	14	33	6.4	5.2	0.6	0.13	2.5	0.4	0.1	0.2	2.1	1.2	53	0.42	4.6	3.2	5.3	60.4	6.3	2.0	1.8	16.1	9.7
433	15/107	p141	67	1	25	14	11	51	6.4	5.5	0.3	0.06	2.3	0.4	0.1	0.2	1.3	0.9	38	0.22	5.0	3.0	4.3	69.8	5.8	2.0	0.6	8.4	5.9
434		p144	7	1	30	40	18	12	6.0	5.2	1.1	0.18	0.4	0.3	0.0	0.3	2.0	0.8	70	1.50	6.1	1.0	3.0	33.3	1.3	1.0	9.2	25.0	8.3
435		p144	27	1	39	37	9	15	6.5	5.4	0.6	0.09	3.4	0.4	0.1	0.2	1.5	1.1	76	0.60	6.7	4.1	5.6	73.2	8.5	2.0	4.0	37.3	27.3
436		p144	77	1	40	30	11	18	6.5	5.2			3.7	0.3	0.1	0.1	1.7	1.3	71	0.61		4.2	5.9	71.2	12.3	3.0		32.8	23.3
437	15/108	p155	10	0	56	29	7	7	6.3	5.5	0.5	0.10	4.0	2.1	0.4	0.1	1.0	0.8	86	1.00	5.0	6.6	7.6	86.8	1.9	21.0	7.1	108.6	94.3
438		p155	37	0	67	17	10	5	6.5	5.3	0.3	0.05	4.9	0.8	0.1	0.4	1.2	1.2	85	2.00	6.0	6.2	7.4	83.8	6.1	2.0	6.0	148.0	124.0
439		p155	85	1	61	13	7	19	6.5	5.1			2.8	0.5	0.1	0.2	1.1	1.4	74	0.37		3.6	4.7	76.6	5.6	2.5		24.7	18.9
440		p164	35	3	12	22	14	51	7.1	6.0	0.4		1.7	0.1	0.1	0.1	0.4	1.1	35	0.27		2.0	2.4	83.3	17.0	1.0	0.8	4.7	3.9
441	15/109	p166	25	1	26	40	17	16	7.1	6.4	0.8	0.14	0.6	0.0	0.1	0.0	1.8	0.7	67	1.06	5.7	0.7	2.5	28.0			5.0	15.6	4.4
442		p166	75	1	31	21	6	42	6.8	5.0	0.3	0.14	3.1	1.2	0.2	0.6	2.4	1.8	52	0.14	2.1	5.1	7.5	68.0	2.6	2.0	0.7	17.9	12.1
443	15/110	p172	15	3	41	40	9	11	6.3	5.1	0.8	0.17	8.2	0.8	0.1	0.8	2.4	1.2	80	0.82	4.7	9.9	12.3	80.5	10.3	1.0	7.3	111.8	90.0
444		p172	55	3	50	25	10	15	6.6	5.0	0.4	0.10	6.8	1.1	0.1	0.2	1.4	1.6	75	0.67	4.0	8.2	9.6	85.4	6.2	5.5	2.7	64.0	54.7
445	15/111	p156	17	3	48	24	17	12	5.8	4.9	0.6	0.19	1.0	0.2	0.1	0.0	1.6	0.9	71	1.42	3.2	1.3	2.9	44.8	5.0		5.0	24.2	10.8
446		p156	75	0	40	9	9	41	6.4	5.2	0.2	0.08	2.3	3.2	0.9	0.1	1.2	1.2	50	0.22	2.5	6.5	7.7	84.4	0.7	32.0	0.5	18.8	15.9
447	15/112	p173	15	0	51	34	10	5	6.2	5.8	0.8	0.10	3.6	0.6	0.1	0.1	1.2	0.4	85	2.00	8.0	4.4	5.6	78.6	6.0	6.0	16.0	112.0	88.0
448		p173	60	0	43	20	13	24	6.7	5.3	0.2	0.02	4.9	0.2	0.1	0.0	1.2	1.4	63	0.54	10.0	5.2	6.4	81.3	24.5		0.8	26.7	21.7
449	15/113	p175	12	1	36	33	19	11	6.5	5.6	1.0	0.18	1.3	0.3	0.1	0.0	0.9	0.9	70	1.73	5.6	1.7	2.6	65.4	4.3		9.1	23.6	15.5
450		p175	52	1	15	12	7	66	6.3	5.9	0.2	0.09	3.0	0.3	0.1	0.6	1.8	0.4	27	0.11	2.2	4.0	5.8	69.0	10.0	0.5	0.3	8.8	6.1

SOIL CHARCTERISTICS OF ALL DATA | DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #	PROFILE		AVE	GR	CO	FI	SI	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN	S/C	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
451	15/114	p177	7	0	12	65	16	7	6.6	5.3	1.1	0.19	3.6	3.3	0.8	0.1	2.1	1.3	77	2.29	5.8	7.8	9.9	78.8	1.1	33.0	15.7	141.4	111.4
452		p177	35	0	11	59	14	15	6.1	5.4	0.7	0.14	6.2	0.7	0.1	0.1	3.9	0.7	71	0.93	5.0	7.1	11.0	64.5	8.9	7.0	4.7	73.3	47.3
453		p177	92	0	5	25	8	63	6.1	5.2			4.4	0.5	0.0	0.1	2.1	0.9	29	0.13		5.0	7.1	70.4	8.8	5.0		11.3	7.9
454	15/115	P178	22	1	40	45	8	7	6.6	5.0	0.3	0.07	4.2	0.9	0.1	0.1	1.0	1.6	85	1.14	4.3	5.3	6.3	84.1	4.7	9.0	4.3	90.0	75.7
455		P178	80	0	28	22	1	49	6.3	5.4			1.8	0.2	0.1	0.1	1.2	0.9	50	0.02		2.2	3.4	64.7	9.0	2.0	0.0	6.9	4.5
456	15/116	p180	10	2	30	57	3	10	6.3	5.2	1.3	0.21	1.7	0.4	0.1	0.1	1.8	1.1	87	0.30	6.2	2.3	4.1	56.1	4.3	4.0	13.0	41.0	23.0
457		p180	32	2	37	32	10	21	6.0	5.4	1.1	0.27	1.7	0.7	0.1	0.3	1.9	0.6	69	0.48	4.1	2.8	4.7	59.6	2.4	2.3	5.2	22.4	13.3
458		p180	52	0	29	36	12	23	6.3	5.4			9.8	1.0	0.1	0.4	2.2	0.9	65	0.52		11.3	13.5	83.7	9.8	2.5		58.7	49.1
459	15/117	p183	15	0	25	37	14	23	6.5	5.2	1.5	0.23	1.1	0.1	0.1	0.0	2.6	1.3	63	0.61	6.5	1.3	3.9	33.3	11.0		6.5	17.0	5.7
460		p183	70	0	6	10	2	82	6.0	5.3	0.5	0.12	7.6	1.3	0.1	0.0	2.5	0.7	16	0.02	4.2	9.0	11.5	78.3	5.8		0.6	14.0	11.0
461	16/118	p9	10	1	30	27	26	16	6.3	5.3	1.9	0.10	8.5	1.0	0.6	0.5	2.1	1.0	58	1.63	19.0	10.6	12.7	83.5	8.5	2.0	11.9	79.4	66.3
462		p9	37	0	35	29	20	15	6.4	5.0	0.2	0.02	3.5	0.6	0.1	0.4	1.6	1.4	65	1.33	10.0	4.6	6.2	74.2	5.8	1.5	1.3	41.3	30.7
463		p9	87	5	38	21	19	22	6.2	4.8			4.4	0.7	0.1	0.3	1.5	1.4	59	0.86		5.5	7.0	78.6	6.3	2.3		31.8	25.0
464	16/119	p15	10	2	60	28	7	5	6.1	5.1	0.5	0.04	3.7	0.2	0.1	0.2	0.9	1.0	88	1.40	12.5	4.2	5.1	82.4	18.5	1.0	10.0	102.0	84.0
465		p15	30	2	61	29	8	1	6.4	5.2	0.1	0.01	1.4	0.2	0.1	0.0	0.2	1.2	91	8.00	10.0	1.7	1.9	89.5	7.0		10.0	190.0	170.0
466		p15	55	1	51	32	15	2	6.3	5.4			1.3	0.3	0.1	0.1	0.4	0.9	83	7.50		1.8	2.2	81.8	4.3	3.0		110.0	90.0
467		p15	95	2	59	25	10	6	6.2	5.2			1.4	0.4	0.0	0.1	0.5	1.0	84	1.67		1.9	2.4	79.2	3.5	4.0		40.0	31.7
468	16/120	p46	10	0	40	21	14	25	6.1	5.0	2.0	0.10	9.5	0.9	0.1	0.6	2.7	1.1	61	0.56	20.0	11.1	13.8	80.4	10.6	1.5	8.0	55.2	44.4
469		p46	37	1	40	16	10	34	6.4	5.2	0.8	0.50	5.8	0.6	0.1	0.3	1.9	1.2	56	0.29	1.6	6.8	8.7	78.2	9.7	2.0	2.4	25.6	20.0
470		p46	82	1	32	11	6	51	6.5	5.3			5.2	0.8	0.1	0.3	1.7	1.2	43	0.12		6.4	8.1	79.0	6.5	2.7		15.9	12.5
471	16/121	p52	7	0	41	37	11	11	6.5	5.9	1.4	0.10	6.8	0.0	0.1	0.2	2.2	0.6	78	1.00	14.0	7.1	9.3	76.3		0.0	12.7	84.5	64.5
472		p52	27	1	44	31	11	13	7.0	6.0	0.1	0.03	3.0	0.6	0.1	0.3	2.2	1.0	76	0.85	3.3	4.0	6.2	64.5	5.0	2.0	0.8	47.7	30.8
473		p52	70	1	47	20	1	32	6.9	5.5			4.2	0.8	0.1	0.4	10.1	1.4	67	0.03		5.5	15.6	35.3	5.3	2.0		48.8	17.2
474	16/122	p78	7	0	29	39	9	23	6.7	5.8	0.8	0.11	5.8	0.6	0.1	0.2	1.3	0.9	68	0.39	7.3	6.7	8.0	83.8	9.7	3.0	3.5	34.8	29.1
475		p78	27	0	37	35	12	16	6.4	5.6	0.0	0.04	3.4	0.3	0.1	0.2	1.6	0.8	72	0.75	0.0	4.0	5.6	71.4	11.3	1.5	0.0	35.0	25.0
476		p78	70	0	32	27	11	31	6.5	5.2	3.8	1.00	3.8	1.0	0.1	0.1	1.5	1.3	58	0.35	3.8	5.0	6.5	76.9	3.8	10.0	12.3	21.0	16.1
477	16/124	p84	10	0	46	28	9	17	6.3	5.6	0.8	0.20	7.2	0.4	0.1	0.4	1.7	0.7	74	0.53	4.0	8.1	9.8	82.7	18.0	1.0	4.7	57.6	47.6
478		p84	37	0	47	24	18	11	6.3	5.4	0.7	0.14	7.0	1.0	0.1	0.3	2.4	0.9	71	1.64	5.0	8.4	10.8	77.8	7.0	3.3	6.4	98.2	76.4
479		p84	82	0	50	24	11	14	6.2	5.3			4.7	0.7	0.1	0.1	1.4	0.9	75	0.79		5.6	7.0	80.0	6.7	7.0		50.0	40.0
480	16/125	p90	7	0	28	29	9	33	6.0	5.3	0.8	0.16	5.8	0.7	0.1	0.5	1.7	0.7	58	0.27	5.0	7.1	8.8	80.7	8.3	1.4	2.4	26.7	21.5
481		p90	27	0	23	19	1	57	6.2	5.4	0.5	0.15	5.3	0.8	0.3	0.4	1.8	0.8	42	0.02	3.3	6.8	8.6	79.1	6.6	2.0	0.9	15.1	11.9
482		p90	70	0	39	25	29	6	6.0	5.3			4.8	1.0	0.1	0.4	1.8	0.7	65	4.83		6.3	8.1	77.8	4.8	2.5		135.0	105.0
483	16/126	p103	12	0	31	34	17	18	6.2	5.0	0.4	0.03	1.8	0.2	0.1	0.1	0.8	1.2	65	0.94	13.3	2.2	3.0	73.3	9.0	2.0	2.2	16.7	12.2
484		p103	45	0	54	24	12	11	6.5	5.1	0.3	0.01	1.3	0.3	0.1	0.2	0.5	1.4	77	1.09	30.0	1.9	2.4	79.2	4.3	1.5	2.7	21.8	17.3
485		p103	92	0	59	16	4	21	6.1	4.2			2.2	0.2	0.2	0.4	1.3	1.9	75	0.19		3.0	4.3	69.8	11.0	0.5		20.5	14.3
486	16/127	p104	7	0	33	37	19	11	5.8	4.9	1.0	0.07	3.2	0.6	0.1	0.3	2.5	0.9	70	1.73	14.3	4.2	6.7	62.7	5.3	2.0	9.1	60.9	38.2
487		p104	35	0	30	27	16	27	6.2	4.7	0.5	0.07	2.6	0.6	0.1	0.4	1.6	1.5	57	0.59	7.1	3.7	5.3	69.8	4.3	1.5	1.9	19.6	13.7
488		p104	82	0	28	23	16	33	6.0	4.7			3.6	0.6	0.1	0.4	1.6	1.3	51	0.48		4.7	6.3	74.6	6.0	1.5		19.1	14.2
489	16/128	p143	5	0	48	35	9	8	6.0	5.5	1.3	0.20	3.7	0.6	0.0	0.1	2.0	0.5	83	1.13	6.5	4.4	6.4	68.8	6.2	6.0	16.3	80.0	55.0
490		p143	22	0	57	30	7	6	6.7	4.8	0.3	0.05	0.5	0.1	0.1	0.0	1.0	1.9	87	1.17	6.0	0.7	1.7	41.2	5.0		5.0	28.3	11.7
491		p143	42	1	45	28	13	13	5.8	4.7	0.3	0.02	1.1	0.4	0.1	0.1	1.1	1.1	74	1.00	15.0	1.7	2.8	60.7	2.8	4.0	2.3	21.5	13.1
492		p143	82	1	46	16	7	30	6.1	5.5			3.0	1.0	0.1	0.1	1.5	0.6	63	0.23		4.2	5.7	73.7	3.0	10.0		19.0	14.0
493	17/129	130v	15	0	11	31	25	32	7.1	5.6	1.4	0.12	12.4	2.3	0.1	0.7	2.1	1.5	43	0.78	11.7	15.5	17.6	88.1	5.4	3.3	4.4	55.0	48.4
494		130v	42	0	10	26	16	47	7.1	5.4	0.5	0.05	10.0	2.1	0.1	0.2	2.8	1.7	37	0.34	10.0	12.4	15.2	81.6	4.8	10.5	1.1	32.3	26.4
495		130v	65	0	11	22	9	57	6.8	5.6			9.1	2.1	0.2	0.1	2.1	1.2	34	0.16		11.5	13.6	84.6	4.3	21.0		23.9	20.2
496		130v	95	0	9	25	17	47	6.9	5.5			11.1	1.7	0.1	0.1	2.1	1.4	36	0.36		13.0	15.1	86.1	6.5	17.0		32.1	27.7
497	17/130	3b	5	0	43	35	11	11	6.5	5.9	0.9	0.09	4.9	0.3	0.4	0.1	1.0	0.6	78	1.00	10.0	5.7	6.7	85.1	16.3	3.0	8.2	60.9	51.8
498		3b	42	0	27	27	10	36	6.6	5.2	0.5	0.06	4.8	0.6	0.1	0.1	2.3	1.4	54	0.28	8.3	5.6	7.9	70.9	8.0	6.0	1.4	21.9	15.6
499		3b	85	0	22	17	6	54	6.5	5.3			4.8	0.9	0.1	0.2	2.1	1.2	40	0.11		6.0	8.1	74.1	5.3	4.5		15.0	11.1
500	18/131	66	9	0	16	41	26	12	6.3	5.9	1.3	0.13	12.1	1.4	0.1	0.6	1.8	0.4	62	2.17	10.0	14.2	16.0	88.8	8.6	2.3	10.8	133.3	118.3

SOIL CHARCTERISTICS OF ALL DATA   DERIVED SOIL CHARACTERISTICS OF ALL DATA

ROW #	PROFILE	AVE	GR	CO	FI	SI	CL	pHH	pHK	OC	Ntot	Ca	Mg	Na	K	AC7	DpH	SAN	S/C	C/N	SUMB	CEC	BS	CaMg	MgK	OC100	CEC100	SUM100
501	66	55	0	13	38	21	26	5.8	4.4	0.4	0.06	6.6	1.8	0.3	0.3	2.5	1.4	53	0.81	6.7	9.0	11.5	78.3	3.7	6.0	1.5	44.2	34.6
502	18/132 50	5	3	36	32	22	5	6.1	5.1	0.5	0.05	4.3	0.5	0.1	0.3	2.0	1.0	73	4.40	10.0	5.2	7.2	72.2	8.6	1.7	10.0	144.0	104.0
503	50	30	5	36	32	17	11	5.5	4.2	0.1	0.03	2.5	0.2	0.1	0.1	2.3	1.3	72	1.55	3.3	2.9	5.2	55.8	12.5	2.0	0.9	47.3	26.4
504	50	75	4	31	30	20	18	5.8	4.5	0.0	0.03	3.5	0.4	0.1	0.1	1.6	1.3	62	1.11	0.0	4.1	5.7	71.9	8.8	4.0	0.0	31.7	22.8
505	18/133 48	10	0	24	15	19	41	6.0	5.0	2.3	0.13	14.9	0.7	0.1	0.4	4.0	1.0	40	0.46	17.7	16.1	20.1	80.1	21.3	1.8	5.6	49.0	39.3
506	48	75	0	14	9	14	63	6.4	5.4	0.3	0.04	5.3	0.4	0.1	0.4	1.6	1.0	23	0.22	7.5	6.2	7.8	79.5	13.3	1.0	0.5	12.4	9.8
507	18/134 45	7	0	44	25	18	10	6.0	5.1	0.7	0.06	4.3	0.8	0.1	0.3	3.1	0.9	72	1.80	11.7	5.5	8.6	64.0	5.4	2.7	7.0	86.0	55.0
508	45	55	0	40	21	17	23	5.9	4.7	0.0	0.01	2.9	0.2	0.1	0.2	1.2	1.2	60	0.74	0.0	3.4	4.6	73.9	14.5	1.0	0.0	20.0	14.8
509	45	85	0	32	16	6	45	6.1	5.0	0.0	0.02	3.1	0.3	0.1	0.2	1.8	1.1	49	0.13	0.0	3.7	5.5	67.3	10.3	1.5	0.0	12.2	8.2
510	18/135 35	5	0	26	22	21	33	7.0	6.5	1.2	0.08	26.6	1.1	0.1	1.2	0.4	0.5	46	0.64	15.0	29.0	29.4	98.6	24.2	0.9	3.6	89.1	87.9
511	35	45	0	17	15	19	46	6.5	5.8	0.8	0.09	6.0	0.6	0.1	3.4	2.3	0.7	35	0.41	8.9	10.1	12.4	81.5	10.0	0.2	1.7	27.0	22.0
512	35	85	0	34	8	9	52	6.0	5.2	0.9	0.05	7.1	0.7	0.1	1.3	2.5	0.8	39	0.17	18.0	9.2	11.7	78.6	10.1	0.5	1.7	22.5	17.7
513	18/136 25	7	4	21	49	20	6	6.0	5.1	0.8	0.05	3.4	0.5	0.1	0.3	1.6	0.9	74	3.33	16.0	4.3	5.9	72.9	6.8	1.7	13.3	98.3	71.7
514	25	18	0	18	45	26	14	6.1	5.0	0.2	0.03	2.0	0.5	0.1	0.4	1.3	1.1	60	1.86	6.7	3.0	4.3	69.8	4.0	1.3	1.4	30.7	21.4
515	25	100	0	22	27	28	27	6.0	5.0	0.0	0.02	3.4	1.0	0.2	0.3	1.6	1.0	45	1.04	0.0	4.9	6.5	75.4	3.4	3.3	0.0	24.1	18.1
516	18/137 22	7	0	25	41	21	11	6.4	5.7	1.2	0.10	8.4	1.1	0.1	0.3	0.6	0.7	68	1.91	12.0	9.9	10.5	94.3	7.6	3.7	10.9	95.5	90.0
517	22	20	0	25	41	19	10	6.5	5.8	0.6	0.01	5.3	0.8	0.1	0.3	1.5	0.7	71	1.90	60.0	6.5	8.0	81.3	6.6	2.7	6.0	80.0	65.0
518	22	35	0	31	39	26	5	6.2	5.2	0.0	0.03	2.5	0.5	0.1	0.4	1.7	1.0	69	5.20	0.0	3.5	5.2	67.3	5.0	1.3	0.0	104.0	70.0
519	22	55	0	19	34	21	26	5.9	4.6	0.1	0.02	3.6	0.7	0.1	0.6	5.7	1.3	53	0.81	5.0	5.0	10.7	46.7	5.1	1.2	0.4	41.2	19.2
520	22	95	2	18	20	20	42	5.7	4.7	0.0	0.02	4.7	1.2	0.2	0.7	2.3	1.0	38	0.48	0.0	6.8	9.1	74.7	3.9	1.7	0.0	21.7	16.2
521	18/138 17	6	0	36	42	12	7	5.4	4.5	0.7	0.04	1.9	0.3	0.1	0.2	2.1	0.9	81	1.71	17.5	2.5	4.6	54.3	6.3	1.5	10.0	65.7	35.7
522	17	27	0	33	28	16	28	5.4	4.2	0.3	0.04	1.4	0.3	0.1	0.2	2.1	1.2	56	0.57	7.5	2.0	4.1	48.8	4.7	1.5	1.1	14.6	7.1
523	17	85	1	21	33	15	30	5.4	4.5	0.2	0.02	1.7	0.3	0.1	0.0	1.5	0.9	55	0.50	10.0	2.1	3.6	58.3	5.7		0.7	12.0	7.0
524	18/139 15	8	0	56	28	11	2	5.6	4.6	1.1	0.13	3.1	0.5	0.1	0.1	2.6	1.0	87	5.50	8.5	3.8	6.4	59.4	6.2	5.0	55.0	320.0	190.0
525	15	60	0	51	30	4	13	5.4	4.7	0.3	0.01	0.6	0.3	0.1	0.1	1.0	0.7	83	0.31	30.0	1.1	2.1	52.4	2.0	3.0	2.3	16.2	8.5
526	15	90	0	47	27	5	20	5.7	4.9	0.2	0.06	1.0	0.3	0.1	0.1	0.9	0.8	75	0.25	3.3	1.5	2.4	62.5	3.3	3.0	1.0	12.0	7.5
527	18/140 7	10	0	29	34	18	20	5.5	4.9	1.2	0.11	4.2	0.5	0.1	0.3	2.6	0.6	62	0.90	10.9	5.1	7.7	66.2	8.4	1.7	6.0	38.5	25.5
528	7	35	1	24	27	18	26	6.0	5.0	0.5	0.05	2.6	0.4	0.1	0.4	1.8	1.0	56	0.69	10.0	3.5	5.3	66.0	6.5	1.0	1.9	20.4	13.5
529	7	80	1	15	15	12	53	6.1	5.7	0.2	0.02	2.2	0.4	0.1	0.6	0.9	0.4	35	0.23	10.0	3.3	4.2	78.6	5.5	0.7	0.4	7.9	6.2

PROFILE = report number/profile number, number of the profile in the report
AVE = Average depth (cm)
GR = Gravel (%)
CO = Coarse sand (%)
FI = Fine sand (%)
Cl = Clay (%)
pHH = pH H2O
pHK = pH KCl
OC = Organic carbon (%)
Ntot = Total nitrogen (%)
Ca = Calcium (meq/100gr soil)
Mg = Magnesium (")
Na = Sodium (")
K = Potassium (")
AC7 = Exchangeable acidity (")

Dph = Delta pH (pHH - pHK)
SAN = Sand (%)
S/C = Silt:clay ratio
SUMB = Sum of bases (meq/100gr soil)
CEC = Cation exchangeable capacity (")
BS = Basesaturation (%)
CaMg = Ca:Mg ratio
MgK = Mg:K ratio
OC100 = Organic carbon per 100gr clay
CEC100 = CEC per 100gr clay
Sum100 = Sumbas per 100gr clay.

+ indicates a silt fraction of 0.002 - 0.02 mm and
a fine sand fraction of 0.02 - 0.2 mm.
(normal fractions are 0.002 - 0.05 mm and 0.05 - 0.2 mm).

Appendix 2: Soil profile descriptions of the 20 reference profiles.

KEY FOR INTERPRETING SOIL PROFILE DESCRIPTIONS

HORIZON CODE according guidelines FAO with additionally:

- Bt = increase of clay percentage with depth (argillic horizon)
- Bt' = weakly structured Bt horizon
- Bt" = moderately structured
- Bt"' = strongly structured
- Btg = Bt with gleying
- Bws = porous massive horizon (oxic horizon)
- BC = transition horizon

BOUNDARY		TOPOGRAPHY	
a	abrupt	s	smooth
c	clear	w	wavy
g	gradual	i	irregular
d	diffuse	b	broken

COLOUR without indication is moist soil

- D dry soil
- W wet soil

TEXTURE

S	sand	LS	loamy sand	sgr = slightly gravelly
L	loam	SL	sandy loam	
Si	silt	SCL	sandy clay loam	
C	clay	SC	sandy clay	

PEDAL STRUCTURE

GRADE		SIZE		TYPE	
w	weak	vf	very fine	gr	granular
m	moderate	f	fine	cr	crumb
s	strong	m	medium	ab	angular blocky
		c	coarse	sb	subangular blocky
				pl	platy

APEDAL STRUCTURE

TYPE		COHERENT	
sg	single grain	nc	non coherent
mp	massive porous	wc	weakly coherent
		mc	moderately coherent
		sc	strongly coherent

CONSISTENCY

DRY		MOIST		WET			
dl	loose	ml	loose	ns	non sticky	np	non plastic
s	soft	vfr	very friable	ss	slightly sticky	sp	slightly plastic
sh	slightly hard	fr	friable	s	sticky	p	plastic
h	hard	fi	firm	vs	very sticky	vp	very plastic
vh	very hard	vfi	very firm				
eh	extremely hard	efi	extremely firm				

CUTANS

QUANTITY		VISIBILITY		TYPE	
p	patchy	f	faint	C	clay
b	broken	d	distinct	ir	iron
c	continuous	p	prominent		

POROSITY

QUANTITY		SIZE	
f	few	vf	very fine
c	common	f	fine
m	many	m	medium
vm	very many	c	coarse
a	abundant	vc	very coarse

ROOTS

QUANTITY		SIZE	
f	few	vf	very fine
c	common	f	fine
m	many	m	medium
		c	coarse

/ = to; + = and; . = not described; - = not present

PROFILE: A 1

Date of examination: 15 October 1982 (end of dry season)

Author : J.H. Kauffman

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Tete, Angonia, Vila Velha

Coordinates : 14°13' S, 34°17' E

Elevation : 1.350 m

Landform : plateau, weakly undulating: smooth broad interfluves and saucer-shaped valleys ("Dambo")

Slope of site: uniform, weakly convex, gradient 1 a 2%, length > 400 m; upper slope position

Vegetation : open 'Miombo' woodland (see annex)

Land use : cutting fuelwood

Climate : unimodal, P = Ep = , 6 month dry season, L.R. = 290 mm (see annex)

General information on the soil

Parent material : Basement complex, probably felsic to intermediate gneiss

Drainage conditions : well drained

Moisture conditions : dry throughout

Ground water level : no evidence < 200 cm, probably temporarily saturated 200-250 cm

Termitaria : dome-shaped mounds, small, about 2/ha.

Surface characteristics: smooth surfaces caused by superficial lateral flow, few sand accumulated at the surface

Miscellaneous

Local soil name : KATONDE (Chinhandje/Chichewa)

Brief description of the profile

Very deep, well drained, dark red clay soil ; very porous, weakly to moderately structured up to 65 cm than massive porous.

1 - Vila Velha

ODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	CONSISTENCY M	CONSISTENCY W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-15[1]	g-s	5YR3/3	SCL	m vf/m sb	(s)h	vfr	ss+sp	-	vm vf/f	m vf	
AB	15-30	g-s	2.5YR3/3	SC	m vf/f sb	h	fr	ss+sp	b f C	vm vf/f	f vf/f	
B	30-65	g-s	2.5YR4/6	C	w vf/f sb	h	fr	ss+sp	c d C	vm vf	f vf/f	
	65-165+		2.5YR4/6	C	mp-wc	sh	vf	ss+sp	p f C	vm vf	f vf	many fine/medium hard spherical iron + Mn concretions
	Augering 165-250		2.5YR4/6	C	.	.			.	.	.	

otes

- From 0-4 cm is visible a weakly developed platy structure caused by thin sedimentation layers.
- In the massive porous subsoil the presence of cutans is discutable.
- Structure is difficult to describe; every size of "peds" can be made with slight forces, the massive porous very friable subsoil falls apart in 'coffee granules'.

		SAMPLING DEPTH			TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
1	1	0	4	2.0	38.6	30.5	5.9	25.0	5.7	4.8	1.1	91	0.05	1.3	0.7	0.29	0.13	2.06	0.04	0.07
1	2	4	15	9.5	45.6	20.4	6.8	27.2	5.7	4.6	1.1	60	0.04	1.0	0.8	0.19	0.13	1.83	0.02	0.08
1	3	15	30	22.5	29.5	16.1	8.4	46.0	5.4	4.5	0.5	66	0.03	1.4	0.8	0.25	0.18	2.21	0.01	0.08
1	4	30	65	47.5	25.6	15.7	7.1	51.6	5.6	4.6	0.2	91	0.01	1.8	0.7	0.22	0.14	1.72	0.01	0.08
1	5	90	110	100.0	23.9	17.6	11.3	47.2	5.6	4.8	0.1	15	0.01	1.6	0.9	0.10	0.15	0.00	0.01	0.01
1	6	200	250	225.0	21.9	18.5	12.5	47.1	5.9	4.9	-.1	-1	-.1	2.0	0.6	0.22	0.21	0.96	0.02	0.00

PROFILE: A 2 (MOC-1)

Date of examination: 16 October 1982 (end of dry season)

Author : J.H. Kauffman

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Tete, Angonia, south of Calomué

Coordinates : 14°27' S, 34°22' E

Elevation : 1480 m

Landform : plateau, weakly undulating; smooth interfluves and "dambo's", few bare rock inselbergs

Slope of site: uniform, weakly convex; gradient 2-3%, length > 400 m, upper slope position (see annex)

Vegetation : "Miombo" woodland, recently strongly cut for fuelwood

Land use : shifting cultivation, small farmer, maize

Climate : Unimodal, P = , Ep = , 6 months dry season, L.R. = ± 300 mm (see annex)

General information on the soil

Parent material : Basement complex; probably felsic to intermediate gneiss

Drainage conditions : well drained

Moisture conditions : 0-200 cm dry, > 200 cm moist

Ground water level : no evidence within 400 cm

Termitaria : dome-shaped mounds, medium, 1 ≤ ha

Surface characteristics: smooth planes indicate superficial lateral flow of water

Miscellaneous

Local soil name : Katonde (Chinhandje/Chichewa)

Brief description of the profile

Very deep, well drained dark red clay soil; weakly to moderately structured up to 62 cm than massive porous.

- Sul de Calomue (MOC-1)

HORIZON						CONSISTENCY						
CODE	DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
	0-15	g-s	5YR3/3	SC	m vf/f sb+cr	sh	vfr	ss+sp	-	a vf/f	m vf	
	15-25	g-s	2.5YR3/4	C	m vf/f sb	h	fr	ss+sp	-	vm vf/f	c vf/f	
	25-62	g-s	2.5YR3/6	C	w vf/f sb	h	fr	ss+sp	b d C	vm vf/f	c vf/f	
	62-170+		2.5YR3-4/6	C	mp-wc[1]	sh	vfr	ss+sp	b d C	vm vf/f	f vf/f	very few, medium, soft to hard spherical iron cemented clay nodules
	augering											
	170-400	d-.	2.5YR4/6	C	.		.		.	.	.	very few medium to large, hard, iron cemented clay nodules
	400-600		2.5YR4/6	C	.		.		.	.	.	few medium, hard, spherical, iron/mn concretions

Notes

Structure is difficult to describe, no clear ped visible, in fact every "ped" size can be made with a slight force; massive porous-weakly coherent can also be described as very weak, very fine to fine subangular blocky ('coffee granules structure').

The nodules have the same colour as the soil matrix. They differ from the soil by their coherency and the absence of pores. Their nature is probably clay indurated with iron.

Spherical termite holes with flat bottom and Ø of about 8 cm are visible in the whole soil profile with a density of 1 to 2/m²; mainly empty but sometimes filled with fungus combs.

SAMPLING DEPTH					TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H20	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
2	1	0	4	[illegible]	33.3	15.9	8.9	42.3	6.0	4.9	2.5	119	0.10	3.1	0.5	0.49	0.17	4.60	0.06	0.02
2	2	5	15	10.0	29.1	14.5	9.2	46.9	[illegible]	4.7	2.1	34	0.08	1.9	0.6	0.38	0.18	3.27	0.04	0.05
2	3	30	45	37.5	22.[illegible]	12.2	10.7	54.[illegible]	5.2	4.5	0.4	52	0.02	0.9	0.5	0.23	0.09	3.36	0.01	0.12
2	4	[illegible]	[illegible]	[illegible]	[illegible]	15.0	14.6	47.6	5.6	5.5	0.3	71	0.01	1.1	0.4	0.18	0.10	0.84	0.01	0.0
2	5	[illegible]	[illegible]	[illegible]	16.[illegible]	14.5	15.[illegible]	53.7	5.5	5.5	0.2	6	0.01	1.3	0.7	0.11	0.14	0.72	0.01	0.0
2	6	[illegible]	[illegible]	[illegible]	14.7	16.5	15.7	53.[illegible]	5.5	5.5	-.1	-1	-.1	1.9	0.6	0.04	0.12	1.46	0.01	0.0
2		400	460	[illegible]	15.9	[illegible]	21.1	47.1	5.[illegible]	5.5	-.1	-1	-.1	2.1	0.9	0.07	0.11	1.41	0.05	0.0

PROFILE: A 3

Date of examination: 18 October 1982 (end of dry season)

Author : J.H. Kauffman

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Tete, Angonia, Ulõnguê (Vila Coutinho nova)
Coordinates : 14°43' , 34°21' E
Elevation : 1.250 m
Landform : plateau, weakly undulating; smooth interfluves and 'dambo's', rock ridge/inselbergs
Slope of site: uniform, weakly convex, gradient 2-3%, length > 500 m, upper/mid slope position
Vegetation : savanna woodland (see annex)
Land use : natural grazing land at site, elsewhere intensively used by small farmers, maize .
Climate : unimodal, P = , Ep = , 6 months dry season, L.R. = 310 mm (see annex)

General information on the soil

Parent material : Basement complex, probably mafic rock
Drainage conditions : well drained
Moisture conditions : dry
Ground water level : no evidence
Termitaria : dome-shaped mounds, medium, 1 < ha.
Surface characteristics: --

Miscellaneous

Local soil name : MAKANDE (Chinhandje/Chichewa)

Brief description of the profile

Deep, well drained, dark reddish brown clay soil; moderately structured and having a thick dark coloured topsoil.

A 3 - Ulõnguê

HORIZON CODE	DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-40	d-s	5YR3/2	CL	m vf/m sb	h	fr	ss+sp	-	a vf/f	m vf/f	
AB	40-75	d-s	2.5YR3/2	C	m vf/m sb	h	fr	ss+sp	c d C	vm vf/f	m vf/f	
B	75-130	g-s	2.5YR3/4	C	m f/m sb	h	(v)fr	ss+sp	c d C	vm vf/f	f vf/f	few weathered gravel sized rock
BC	130-140	a-w	2.5YR3/4	sgrC	.	.			.	.	.	
C	145-170	rotten rock		S	.	.			.	.	.	

Notes

- *throughout the profile micas visible*
- termite holes, spherical with flat bottom, present

1	2	SAMPLING DEPTH BEG	END	AVE	TEXTURE CS	FS	SI	AG	pH H20	KCl	OM	P	N	BASES Ca	Mg	K	Na	AC7	EC	ACF
5	1	0	4	2.0	19.1	17.8	25.2	37.9	6.3	5.6	4.4	32	0.17	8.8	2.5	0.93	0.13	4.28	0.08	0.0
5	2	4	15	9.5	23.0	17.5	15.5	44.0	6.1	5.0	3.4	7	0.10	7.0	1.5	0.91	0.15	4.22	0.04	0.0
5	3	45	65	55.0	16.0	11.8	15.0	57.2	6.0	4.9	2.6	1	0.08	6.6	1.4	0.47	0.19	5.19	0.03	0.0
5	4	65	85	75.0	14.5	11.2	14.7	59.6	6.0	5.1	1.9	2	0.07	5.9	1.0	0.17	0.15	2.74	0.02	0.04
5	5	85	100	92.5	13.3	12.5	16.2	58.0	6.1	5.5	1.3	2	0.05	5.1	1.1	0.10	-0.1	1.18	0.02	0.01
5	6	120	145	132.5	14.5	14.5	13.8	57.1	6.2	5.1	-.1	-1	-.1	4.2	1.0	0.07	0.17	2.22	0.03	0.0
5	7	145	160	152.5	29.5	25.5	11.5	[illegible]	6.2	5.9	-.1	-1	-.1	1.9	0.5	0.06	0.15	0.09	0.01	0.01

PROFILE: LI (MOC 2)

Date of examination: 25 October 1982 (end of dry season); rep.: 5 April 1983 (end of rainy season)

Authors : J.H. Kauffman/M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Niassa, Lichinga, Lichinga
Coordinates : 13°18' S, 35°16' E
Elevation : 1325 m
Landform : Plateau, (weakly) undulating; smooth interfluves and dambo's
Slope of site: uniform, convex, gradient 1-2%, length ± 500 m; position: top of interfluves
Vegetation : fallow grass/herb
Land use : shifting cultivation, small farmer, maize
Climate : Unimodal, P = , Ep = , 6 months dry season, L.R. = 500 mm (see annex)

General information on the soil

Parent material : Basement complex; diorite (see annex)
Drainage conditions : well drained
Moisture conditions : 0-130 cm dry, > 130 cm moist
Ground water level : no evidence within 500 cm
Termitaria : dome-shaped mounds, very large, 1-2/ha
Surface characteristics: surface smooth by superficial lateral flow of water

Miscellaneous

Local soil name : Chicunja (Jaua language)

Brief description of the profile

A very deep, well drained dark red clay soil, weakly structured up to 58 cm then porous massive, topsoil is weakly developed.

LI (MOC-2)

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D M W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
Ap	0-15	a-s	2.5YR3/4	SC	m vf/f	sh vfr ss+sp		a vf/f	m f	
	15-58	d-s	1.25YR3/6	C	m/w vf/f	h fr ss+sp	b d C	vm vf/f	m f	
	58-180		1.25YR3/6	C	pm-wc	sh vfr ss+sp	p f C	vm vf/f	c f	very few, medium, soft spherical and irregular iron cemented clay nodules
	augering									
	180-400		1.25YR3/6	C						
	400-650		idem but with increasing percentage of minerals (rotten rock)							

Notes

- Structure is difficult to describe; every "ped" size can be formed with little force! Clear natural ped surfaces are not present in the subsoil > 58 cm. Horizon differentiation is a combined effect of structure and consistency. The subsoil > 58 cm can be described in term of "floury", "coffee granules".
- The massive soft, probably iron cemented clay nodules with same colour as soil matrix are present from about 100 cm and deeper.
- A few fine vertical cracks are visible in the profile.
- Magnetite is present in the whole profile; weatherable minerals are visible from 200 cm and deeper.
- Presence of cutans in deeper subsoil is disputable.

		SAMPLING DEPTH			TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
4	1	0	15	7.5	[illegible]	[illegible]	[illegible]	[illegible]	5.5	4.4	2.0	27	[illegible]	0.8	1.0	0.24	0.11	3.69	0.03	0.22
4	2	15	30	22.5	[illegible]	[illegible]	13.3	58.7	5.0	4.6	1.1	11	0.03	0.4	0.8	0.05	0.12	0.66	0.01	0.10
4	3	30	50	40.0	[illegible]	17.1	17.6	55.5	5.0	4.8	0.6	6	0.02	0.5	0.7	0.06	0.12	3.32	0.01	0.04
4	4	65	90	77.5	[illegible]	22.2	15.1	52.7	5.5	5.5	0.3	9	0.01	0.5	0.6	0.07	0.12	0.79	0.01	0.0
4	5	130	150	140.0	[illegible]	15.1	15.1	[illegible]	5.6	5.6	-.1	-1	-.1	0.4	0.5	0.07	0.13	0.73	0.01	0.0
4	6	240	270	255.0	9.1	15.1	18.2	57.6	5.2	4.9	-.1	-1	-.1	0.2	0.3	0.13	0.13	1.23	0.01	0.02
4	7	350	370	[illegible]	6.5	16.0	24.5	[illegible]	5.2	4.3	-.1	-1	-.1	0.1	0.1	0.12	0.12	1.73	0.01	0.47
4	8	[illegible]	[illegible]	[illegible]	[illegible]	21.2	37.5	35.5	5.1	4.0	-.1	-1	-.1	0.1	0.2	0.18	0.07	3.58	0.01	1.58

PROFILE: L 2 (MOC 3)

Date of examination: 26 October 1982 (end of dry season); re.: 7 April 1983 (end of rainy season)

Authors : J.H. Kauffman, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Niassa, Sanga, Unango
Coordinates : 12°57' S, 35°23' E
Elevation : 1075 m
Landform : Plateau, weakly undulating; smooth interfluves and dambo's, few rocks, outcrops/inselbergs
Slope of site: uniform, weakly convex, gradient 1-2%, > 500 m; position: upper slope
Vegetation : Brachystegia Woodland (see annex)
Land use : recently cleared for permanent mechanized farming, maize
Climate : Unimodal, P = , Ep = , 6 months dry, L.R. = (see annex)

General information on the soil

Parent material : Basement complex, diorite (see annex)
Drainage conditions : well drained
Moisture conditions : 0-17 moist, 17-200 dry, > 200 cm moist
Ground water level : no evidence within 600 cm
Termitaria : dome-shaped mounds, very large, < 1/ha
Surface characteristics: ± 2 cm dry litter present

Miscellaneous

Local soil name : Chicunja (Jaua language)

Brief description of the profile

A very deep, well drained, dark red clay soil, moderately structured.

L2 (MOC-3)

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-15	c-s	2.5YR3/3	C	m vf/f sb+cr	.	fr		-	vm vf/f	m f+m	
AB	15-25	g-s	2.5YR3/4	C	m vf/m sb	h	fr		b f C	vm vf/f	m f+m	
B	25-70	d-s	1.25YR3/4	C	m vf/m sb	h	fr		c p C	m vf/f	m f	...... few faint black mottling
	70-105	d-s	1.25YR3/5	C	m/w vf/f sb	(s)h	vfr		b d C	m vf/f	m f	very few medium soft iron cemented clay nodules
	105-185+		1.25YR3/5	C	w vf/f sb	sh	vfr		p d C	m vf/f	c f	
	augering											
	185-400		idem with few weatherable minerals visible									
BC	400-600		idem with increasing percentage of weatherable minerals									
C	600-670+		rotten rock									

Notes
- Magnetite is present in whole profile.
- Soft nodules has same colour as soil matrix, inner side of nodules is massive.
- Horizon boundaries in subsoil are very diffuse.

SAMPLING DEPTH 1	2	BEG	END	AVE	TEXTURE CS	FS	SI	AG	pH H2O	KCl	OM	P	N	BASES Ca	Mg	K	Na	AC7	EC	ACF
5	1	0	5	2.5	14.7	18.8	26.0	40.5	6.2	5.1	3.0	98	0.12	3.7	2.2	0.64	0.13	5.39	0.04	0.05
5	2	5	17	11.0	12.0	15.9	18.8	53.3	5.8	4.6	2.3	35	0.09	2.6	2.1	0.52	0.15	5.14	0.03	0.05
5	3	17	30	23.5	9.1	12.3	8.0	70.6	6.0	4.7	1.1	31	0.01	3.0	1.7	0.52	0.14	3.06	0.01	0.03
5	4	30	60	45.0	7.0	4.2	6.9	76.9	5.8	5.0	0.5	11	0.02	2.9	0.8	0.84	0.19	1.90	0.01	0.0
5	5	65	[illegible]	[illegible]	8.3	11.1	15.3	66.3	5.6	5.3	0.4	1	0.01	1.[illegible]	1.1	0.18	0.14	2.36	0.01	0.0
5	6	130	160	145.0	[illegible]	[illegible]	15.[illegible]	[illegible]	5.6	[illegible]	-.1	-1	-.1	1.5	1.3	0.21	0.15	1.67	0.01	0.0
5	7	250	290	[illegible]	13.1	16.4	19.2	51.3	5.5	5.5	-.1	-1	-.1	1.9	1.7	0.39	0.15	0.85	0.01	0.0
5	8	350	390	[illegible]	[illegible]	25.7	26.[illegible]	42.4	5.6	5.5	-.1	-1	-.1	2.3	2.1	0.30	0.13	0.94	0.01	0.0
5	9	600	670	635.0	26.6	25.3	32.7	15.4	5.3	4.9	-.1	-1	-.1	0.9	0.7	1.09	0.25	4.59	0.05	1.63

PROFILE: L 3

Date of examination: 27 October 1982 (end of dry season)

Authors : J.H. Kauffman, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Niassa, Sanga, Unango
Coordinates : 12°57' S, 35°25' E
Elevation : 1.075 m
Landform :
Slope of site: gradient 2-3%
Vegetation : see L 2
Land use :
Climate :

General information on the soil

Parent material : Basement complex, diorite
Drainage conditions : well drained
Moisture conditions : 0-15 moist, > 15 cm dry
Ground water level : no evidence 0-400 cm
Termitaria : dome-shaped mounds, very large, ~ 1/ha.
Surface characteristics: bare smooth surfaces present, caused by superficial flow of water

Miscellaneous

Local soil name : Chicunja (Jaua language)

Brief description of the profile

A very deep, well drained, dark red clay soil, moderately structured.

L 3 - Unango

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-15	c-s	2.5YR3/2	C	m vf/f sb+cr	.	vf		-	a vf/f	m-vf/m	
BA	15-30	g-s	2.5YR3/4	C	m vf/f sb		fr		c-p-C	m vf/f	c- f	few fine distinct blackish mottling
B	30-100	g-s	1.25YR3/4-5	C	m vf/f sb		fr		c-d-C	m vf/f	c- f	few fine distinct blackish mottling
	100-170+		1.25YR3/4-5	C	v/m vf/f sb		fr		b-d-C	m vf/f	c- f	
	Augering 170-280		1.25YR3/5	C	.		.		.	.	.	> 200 cm first weatherable mineral visible
BC	280-340		1.25YR3/5	C	.		.		.	.	.	few fine weathered minerals
C	340-400	rotten rock										

Note

- termite holes present mainly in the depth range 15-100 cm.

		SAMPLING DEPTH			TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
6	1	0	4	2.0	15.1	25.5	21.2	41.6	6.5	4.9	2.4	154	0.10	4.7	1.1	0.73	0.18	5.40	0.03	0.63
6	2	5	13	9.0	12.4	15.7	18.4	50.5	5.9	4.5	1.8	133	0.07	4.6	0.0	0.50	0.17	5.30	0.03	0.07
6	3	15	30	22.5	8.6	13.6	10.2	67.6	5.5	4.5	1.2	119	0.05	5.2	0.0	0.36	0.19	5.64	0.02	0.07
6	4	30	50	40.0	6.5	10.0	7.0	76.5	5.6	4.6	0.8	126	0.03	4.1	0.5	0.35	0.19	4.63	0.01	0.07
6	5	50	75	62.5	5.2	9.1	3.7	52.0	5.8	4.8	0.5	136	0.03	2.9	2.0	0.37	0.18	2.88	0.01	0.01
6	6	75	100	87.5	5.5	9.6	6.5	78.4	5.2	5.2	0.3	41	0.01	2.9	1.0	0.38	0.17	2.01	0.01	0.0
6	7	100	150	125.0	5.1	10.0	7.2	77.7	6.0	5.6	-.1	-1	-.1	1.8	3.1	0.46	0.13	1.20	0.01	0.0
6	8	240	280	260.0	6.5	12.7	12.0	69.0	5.8	5.6	-.1	-1	-.1	3.9	1.1	0.46	0.20	0.98	0.01	0.0

PROFILE: L 4

Date of examination: 29 October 1982 (end of dry season)

Author : J.H. Kauffman

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Niassa, Majune, Litunde
Coordinates : 13°20' S, 35°53' E
Elevation : ± 800 m
Landform : nearly level middle planation surface; low interfluves and broad "dambo" valleys
Slope of site: uniform, straight, gradient ~ 1%, length ; upper slope position
Vegetation : open woodland (see annex)
Land use : at least 20 years without cultivation
Climate : unimodal, P = , Ep = , 60 months dry season, L.R. = (see annex)

General information on the soil

Parent material : Basement complex; grainite and gneiss (see annex)
Drainage conditions : well or moderately well drained
Moisture conditions : 0-150 cm dry, > 150 cm humid
Ground water level : no evidence 0-400 cm
Termitaria : dome-shaped mounds, very large, about 1/2 ha (frequent, tiny mounds)
Surface characteristics: ± 2 cm dry litter present

Miscellaneous

Local soil name : --

Brief description of the profile

Very deep, well drained, dark red clay soil, moderately structured, hard and less porous.

L 4 - Litunde

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-5	c-s	5YR3/3	SCL	w vf/f sb+cr	sh	vfr	.	-	m vf/f	m f+c	
AB	5-15	g-s	2.5YR3/4	SC	w vf/f sb	sh	vfr	.	-	m vf/f	m f+c	
B	15-160	1	2.5YR3/6 1.25YR3/6	C	m(s) f/(m) sb+aa w/m	(v)h	fr vfr	.	c p C	c vf/f f	c f+c	mottling or concretions: few, very fine, black
	Augering											
B	160-380		1.25YR3/6	C	.		.		.	.	.	
2	380-450		1.25YR3/6	C	.		.		.	.	.	concretions: frequent, medium, hard, spherical iron+manganese?
BC	450-550		1.25YR3/6	C	.		.		.	.	.	mixed with little rotten rock
CB	>550		multicolor	SC	mainly rotten rock							

Notes

[1] Very diffuse changes in characteristics
- no magnetite present
[2] B concretions ? Bg

1	2	SAMPLING DEPTH BEG	END	AVE	TEXTURE CS	FS	SI	AG	pH H2O	KCl	OM	P	N	BASES Ca	Mg	K	Na	AC7	EC	ACF
7	1	0	5	2.5	33.4	33.3	4.3	25.0	5.7	5.0	2.0	53	0.06	1.6	1.4	0.17	0.13	-.1	0.04	0.02
7	2	5	15	10.0	34.2	28.4	2.0	35.4	5.5	4.0	1.2	-1	0.01	0.8	1.0	0.19	0.13	3.51	0.05	0.05
7	3	15	50	32.5	22.5	20.0	1.5	56.2	5.6	4.5	0.8	11	0.02	0.8	0.9	0.20	0.14	5.00	0.02	0.08
7	4	50	[illegible]	40.0	20.1	17.5	0.6	62.0	5.1	4.1	0.6	9	0.02	0.8	0.7	0.20	0.11	2.25	0.01	0.11
7	5	[illegible]	75	62.5	15.6	13.5	[illegible]	[illegible]	5.2	4.9	0.4	6	[illegible]	1.1	0.6	0.23	0.15	1.83	0.01	0.03
7	6	75	[illegible]	87.5	14.5	[illegible]	[illegible]	[illegible]	5.3	5.2	0.4	6	[illegible]	1.2	0.9	0.20	0.17	1.29	0.01	0.0
7	7	[illegible]	150	[illegible]	[illegible]	12.4	[illegible]	[illegible]	5.7	5.5	-.1	-1	-.1	1.3	1.0	0.12	0.13	0.90	0.01	0.0
[illegible]	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.1	-.1	-1	-.1	1.1	0.7	0.11	0.17	1.08	0.01	0.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-.1	-1	-.1	[illegible]	1.0	0.05	0.17	[illegible]	0.01	0.25

PROFILE: L 5

Date of examination: 2 November 1982 (end of dry season)

Authors : J.H. Kauffman, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Niassa, Mavago, M'sauize
Coordinates : 12°38' S, 36°37' E
Elevation : 500 m
Landform : middle planation surface, (weakly) undulating; smooth broad interfluves and dambos
Slope of site: uniform, convex, gradient ~ 4 to 5%, length 300 m; upper slope position
Vegetation : open woodland (see annex)
Land use : shifting cultivation at distance, at site at least 30 years without cultivation
Climate : unimodal, P = , Ep = , 6 months dry season, L.R. =

General information on the soil

Parent material : Basement; metagabbroide
Drainage conditions : well drained
Moisture conditions : dry
Ground water level : no evidence within 300 cm
Termitaria : dome-shaped mounds, very large, < 1/ha.
Surface characteristics: 2 to 3 cm litter present

Miscellaneous

Local soil name : Litumba

Brief description of the profile

A very deep, dark red clay soil, nearly strongly structured.

L 5 - M'Sauize

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-10	g-s	5YR3/3	C	w/m vf/f sb+cr	.	fr	.	-	vm f/m	m f/m	
BA	10-42	d-s	2.5YR3/6	C	m vf/f sb	.	fr	.	p d C	c vf	m f	
B	42-170		2.5YR3/6	C	s(m) vf/f sb	h	fr	.	c p C	m vf	c f	[1]common, fine to medium, distinct black mottling
	Augering											
B	170-300		2.5YR3/6	C								
CB	>300		yellowish	CL	mainly rotten rock							

Notes

[1] A part of the mottling can be considered as: few medium soft ir/mn? concretions
- magnetite not present
- termite holes present

1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.66	0.20	5.51	0.04	0.0
[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.04	[illegible]	1.7	0.58	0.19	1.50	0.02	0.0
[illegible]	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.9	0.6	[illegible]	0.04	4.5	1.2	0.45	0.17	3.53	0.01	0.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.5	5.2	0.3	[illegible]	0.03	4.9	1.0	0.46	0.17	1.93	0.01	0.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.5	5.3	0.2	2	0.02	5.0	1.1	0.11	0.17	2.64	0.01	0.0
[illegible]	[illegible]	120	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.5	-.1	-1	-.1	5.5	1.8	0.30	0.17	2.29	0.01	0.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.3	-.1	-1	-.1	19.4	10.7	0.07	0.37	2.36	0.02	0.0

PROFILE: L 6

Date of examination: 8 November 1982 (end of dry season)

Authors : J.H. Kauffman, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Niassa, Marrupa, Matiguite
Coordinates : 13'04' S, 37'37' E
Elevation : 775 m
Landform :
Slope of site:
Vegetation : secondary open woodland
Land use : shifting cultivation
Climate : unimodal, P = , Ep = , 6 months dry season, L.R. = 500 mm

General information on the soil

Parent material : probably granite
Drainage conditions : well drained
Moisture conditions : dry
Ground water level : no evidence
Termitaria : dome-shaped, very large, < 1/2 ha.; frequent tiny mounds
Surface characteristics: smooth bare surfaces present, caused by superficial waterflow

Miscellaneous

Local soil name : ithaya yoquila (Macua language)

Brief description of the profile

Deep, well drained, red clay soil, weakly structured.

L 6 - Marrupa

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D M W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-17	c-s	10YR3.5/2	SL	w vf/m sb	sh vfr ss+sp	-		m f/m	
AB	17-32	g-s	2.5YR3.5/6	SCL	w/m f/m sb	h vfr ss+sp	-	m f	m f/m	
B	32-80	g-s/w	2.5YR4/7	C	w vf/f sb	h vfr ss+sp	p f C	m vf	c f/m	
	80-110	g-s	2.5YR4/6	C	w f(m) sb	sh vfr ss+sp	p f C	m vf	c f/m	frequent, small (medium), quartz gravel
	110-175	c-w	2.5YR4/7	SC	w f/m sb	sh vfr ss+sp	p f C	m vf	c f/m	
C	>175			SCL	rotten rock					

Notes

- Termite holes visible in the whole soil profile
- Magnetite present

		SAMPLING DEPTH			TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
9	1	0	15	7.5	38.9	26.8	14.3	20.0	6.0	5.0	1.0	9	0.07	1.2	0.9	0.28	0.15	2.17	0.04	0.0
9	2	20	30	25.0	37.4	18.0	10.6	34.0	5.6	4.7	0.7	2	0.03	1.0	0.5	0.27	0.13	1.92	0.02	0.0
9	3	35	75	60.0	27.6	16.2	8.2	48.0	5.5	5.1	0.4	2	0.03	2.0	0.8	0.15	0.13	1.21	0.02	0.0
9	4	80	110	95.0	24.7	14.6	10.8	49.9	5.9	5.5	0.2	2	0.01	1.4	0.8	0.17	0.13	0.68	0.02	0.0
9	5	115	160	137.5	35.6	13.2	11.8	39.4	6.2	5.7	-.1	-1	-.1	1.1	0.6	0.25	0.13	1.67	0.02	0.0
9	6	160	185	172.5	33.0	15.8	11.6	39.6	6.3	6.0	-.1	-1	-.1	1.2	0.6	0.20	0.15	0.33	0.02	0.0

PROFILE: L 7

Date of examination: 9 November 1982 (end of dry season)
Author : J.H. Kaufman

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Niassa, Marrupa, Marrupa
Coordinates : 13°04' S, 37°35' E
Elevation : 775 m
Landform :
Slope of site:
Vegetation : regeneration of open woodland
Land use : shifting cultivation
Climate : unimodal, P = , Ep = , 6 months dry season, L.R. = 500 mm

General information on the soil

Parent material : Basement, probably granite
Drainage conditions : well drained
Moisture conditions : dry
Ground water level : no evidence
Termitaria : dome-shaped mounds, large, 1/ha
Surface characteristics: bare smooth surfaces present

Miscellaneous

Local soil name :

Brief description of the profile

Deep, well drained, dark red clay soil.

L 7 - Marrupa

HORIZON CODE	DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-10	c-s	5YR2.5/2	SCL	w/m f/m sb	(s)h			-	vm vf/m	m vf/f	
AB	10-22	c-s	2.5YR3/4	SC	m f/m sb	vh		ss+sp	-	vm vf/f	m vf/f	
BA	22-40	d-s	2.5YR3/6	C	m f/m sb	h			b d C	m vf/f	c vf	
B	40-150+		2.5YR3/6	C	m f/m sb	h			p d C	m vf/f	f vf	

Notes

- Termite holes: spherical with flat bottom, mostly empty and some with fungus cumbs, density is about 5/m²
  mainly in the depth range of 0-100 cm.
- Little magnetite is present.
- Deeper subsoil colour is slightly redder than 2.5YR3/6.

1	2	SAMPLING DEPTH BEG	END	AVE	TEXTURE CS	FS	SI	AG	pH H2O	KCl	OM	P	N	BASES Ca	Mg	K	Na	AC7	EC	ACF
10	1	0	10	5.0	34.6	25.0	9.4	33.[illegible]	6.0	5.1	-.1	-1	-.1	0.9	3.7	0.13	0.17	4.04	0.03	0.0
10	2	10	22	16.0	31.7	15.5	11.[illegible]	38.3	5.7	5.0	-.1	-1	-.1	0.8	2.8	0.10	0.13	2.91	0.03	0.02
10	3	22	40	31.0	25.1	17.5	7.3	50.1	5.8	5.8	-.1	-1	-.1	0.4	2.3	0.10	0.15	2.83	0.03	0.0
10	4	40	65	52.5	24.1	14.0	4.7	57.2	5.8	5.0	-.1	-1	-.1	0.4	1.9	0.15	0.14	1.57	0.02	0.0
10	5	65	100	82.5	15.4	12.2	7.7	61.7	6.1	5.3	-.1	-1	-.1	1.0	0.6	0.22	0.13	2.25	0.03	0.0
10	6	100	150	125.0	25.3	11.0	[illegible]	[illegible]	5.5	5.8	-.1	-1	-.1	1.9	0.6	0.17	0.13	1.81	0.03	0.0

PROFILE: C 1 (MOC 4)

Date of examination: 12 November 1982 (start of rainy season);
repeat: 30 March 1983 (end of rainy season)

Authors : J.H. Kauffman, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Cabo Delgado, Montepues, Chipembe
Coordinates : 13°09' S, 38°37' E
Elevation : 500 m
Landform : Planation surface, weakly undulating; very broad smooth interfluves
Slope of site: uniform, straight, gradient about 1%, length about 2 km, position: on upper slope or top of interfluve
Vegetation : closed Bambu forest with scattered high trees (see annex)
Land use : nearby permanent mechanized farming, maize and cotton
Climate : Unimodal, P = , Ep = , 6 months dry, L.R. = 300 mm (see annex)

General information on the soil

Parent material : Basement; probably gabro norite (see annex)
Drainage conditions : well drained
Moisture conditions : 0-25 cm moist, 25-30 cm dry
Ground water level : no evidence within 300 cm
Termitaria : dome-shaped mounds, medium/large, about 1/5 ha
Surface characteristics: about 1 cm litter (in the agricultural field few signs of sheet erosion)

Miscellaneous

Local soil name : Ithaya yoquilla (Macau language)

Brief description of the profile

A very deep, well drained, dusky red clay soil, weakly to moderately structured up to 125 cm than porous massive, with a dark coloured topsoil.

C1 (MOC-4)

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-18	c-s	5YR2.5/2	SCL	w vf/f cr	.	vfr	ns+sp	-	vm vf/m	m f/m	
AB	18-30	g-s	2.5YR3/2	SC	w vf/f sb	.	vfr	ss+sp	-	vm vf/f	m f/m	
B	30-60	d-s	1.25YR3/4	C	w/m vf/f sb	h	vfr	ss+sp	b d C	m vf/f	m f	
	60-125	d-s	10 R3/5	C	w vf/f sb	sh	vfr	ss+sp	p f C	m vf/f	c f	
	125-175+		10 R3/5	C	pm-wc	sh	vfr	ss+sp	p f C	m vf	c f	very few medium soft iron cemented clay nodules
	augering											
	175-320		10 R3/5	C	.		.		.	.	.	
	320-400		10 R3/5		.		.		.	.	.	few medium soft/hard spherical iron/mn concretions
	400-430				.		.		.	.	.	frequent medium soft/hard spherical iron/mn concretions
	430+		abrupt to hard rock or stone									

Note

- The upper horizon has few holes filled with reddish subsoil; the subsoil has few holes filled with dark coloured topsoil.
- Traces of magnetite are present from 30 cm and deeper.
- Spherical termite holes with flat botton and with a diameter of 4 to 8 cm are visible in the whole soil profile, density is about $4/m^2$.

		SAMPLING DEPTH			TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
11	1	[illegible]	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.2	[illegible]	6	0.09	5.1	4.3	0.07	0.13	4.92	0.04	0.0
11	2	5	15	[illegible]	[illegible]	25.7	11.4	[illegible]	5.6	4.7	[illegible]	2	0.08	5.5	2.8	0.04	0.17	[illegible]	0.02	0.0
11	3	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.5	1.7	1	0.08	2.3	2.2	0.03	0.15	4.92	0.03	0.04
11	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.4	1.1	1	[illegible]	2.2	1.4	0.06	0.17	3.75	0.02	-.1
11	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.5	[illegible]	1	0.04	2.1	1.4	0.02	0.11	2.17	0.01	-.1
11	6	125	175	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-.1	-1	-.1	1.8	1.5	0.01	0.13	1.08	0.09	-.1
11	7	225	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-.1	-1	-.1	2.7	0.5	0.02	0.13	1.26	0.02	-.1

PROFILE : C2 (= comparable to C1)

Date of examination :

Authors :

Higher category classification

- (FAO-UNESCO 1974)
- (Soil Taxonomy 1975)

Environmental information

Location :

Coordinates :

Elevation :

Landform :

Slope of site :

Vegetation :

Land use :

Climate :

General information on the soil

Parent material :

Drainage conditions :

Moisture conditions :

Ground water level :

Termitaria :

Surface characteristics:

Miscellaneous

Local soil name :

Brief description of the profile

		SAMPLING DEPTH			TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
12	1	20	40	30.0	15.4	10.5	4.3	65.7	5.1	4.7	1.7	1	0.05	0.5	3.3	0.07	0.14	5.06	0.02	0.01
12	2	60	90	75.0	13.6	9.2	6.2	71.0	5.2	4.4	0.9	1	0.04	0.4	8.4	0.05	0.17	1.53	0.02	0.14
12	3	110	140	125.0	14.0	10.6	9.2	66.2	5.5	4.9	0.6	1	0.02	0.3	3.2	0.05	0.15	2.05	0.02	0.15
12	4	160	190	175.0	14.0	10.3	7.1	68.6	5.2	4.7	0.5	-1	-.02	0.9	2.6	0.03	0.15	3.17	0.02	0.02
12	5	210	240	225.0	14.9	9.1	10.6	65.4	5.1	4.5	-.1	-1	-.1	0.6	2.2	0.03	0.13	3.47	0.01	0.03
12	6	260	290	275.0	14.9	9.6	7.1	68.4	5.0	4.2	-.1	-1	-.1	2.0	1.5	0.33	0.17	3.29	0.07	0.04

PROFILE: C 3

Date of examination: 19 November 1982 (end of dry season, first rains)
Authors : J.H. Kauffman, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Cabo Delgado, Montepuez, Namanhumbir
Coordinates : 13°01' S, 39°19' E
Elevation : 280 m
Landform : lower planation surface, weakly undulating; very broad smooth interfluves
Slope of site: uniform, straight, gradient 1%; middle slope position
Vegetation : dense woodland
Land use : nearby large state farmer enterprise
Climate : Unimodal, P = , Ep = , 6 months dry; L.R. =

General information on the soil

Parent material : Basement; grano-sienite
Drainage conditions : well drained
Moisture conditions : dry
Ground water level : no evidence
Termitaria : dome-shaped, middle sized, about 1/ha
Surface characteristics: on the farmland sheet erosion present

Miscellaneous

Local soil name: ithaya yoquilla ('red soil') (Macua language)
kotokwa ('dust')

Brief description of the profile

A very deep, well drained, dusky red clay soil, weakly structured; high erodability.

C 3 - Namanhumbir

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-12	c-s	2.5YR2.5/4	SC	w vf sb	s	vfr	ss+sp	-	m vf/m	m vf/f	
(AB)	12-35	d-s	1.25YR3/4	C	w vf/m sb	sh	fr	ss+sp	f C	m vf/m	m vf/f	
B	35-105	d-s	1.25YR3/4	C	w vf/m sb	sh	fr	ss+sp	b d/p C	m vf	c vf	
	105-175		1.25YR3/4	C	[1] w vf/f sb	s	vfr	ss+sp	b d/p C	m vf	c vf	very few, medium, soft, irregular iron cemented clay nodules
	Augering 175-500		10R3/4	.	.	.			.	.	.	

Notes:

- termite holes: mainly small ones with diameter 2 to 3 cm, few larger ones, diameter around 8 cm
- nodules: do not show porosity, they can be broken with the nails
- magnetite: traces present in the whole profile

[1] structure grade is very weak, can also be described as massive porous/weakly coherent.

1	2	SAMPLING DEPTH BEG	END	AVE	TEXTURE CS	FS	SI	AG	pH H2O	KCl	OM	P	N	BASES Ca	Mg	K	Na	AC7	EC	ACF
13	1	0	12	6.0	35.3	13.8	2.8	43.1	4.2	3.6	2.3	5	0.10	0.2	0.3	0.33	0.12	9.45	0.09	0.30
13	2	15	35	25.0	33.1	11.1	4.9	50.9	4.3	3.8	1.1	2	0.05	0.9	0.1	0.14	0.13	5.05	0.04	0.34
13	3	35	65	50.0	31.9	10.5	2.0	55.6	4.5	3.8	0.7	1	0.03	1.1	0.7	0.05	0.12	4.04	0.03	1.23
13	4	60	90	75.0	29.0	8.1	10.0	52.9	4.6	3.9	0.6	1	0.05	1.0	0.4	0.03	0.12	3.08	0.04	0.85
13	5	115	150	132.5	15.7	9.2	12.7	62.4	4.7	3.9	0.3	1	0.02	0.8	0.5	0.03	0.13	2.58	0.02	0.35
13	6	250	290	270.0	15.6	9.9	9.3	65.2	4.9	3.9	-.1	-1	-.1	0.2	0.6	0.03	0.13	2.55	0.02	0.67
13	7	350	390	370.0	17.5	9.4	6.5	66.5	5.0	4.0	-.1	-1	-.1	0.5	0.7	0.03	0.17	2.36	0.02	1.33
13	8	450	490	470.0	15.5	11.2	11.4	55.9	5.5	4.2	-.1	-1	-.1	0.9	0.9	0.05	0.32	2.03	0.02	0.98

PROFILE: N 1

Date of examination: 21 November 1982
Author : J.H. Kauffman

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Nampula, Erati, Mirrote
Coordinates : 13°47' S, 39°35' E
Elevation : 280 m
Landform : low planation surface, neary level to weakly undulating; dissected interfluves and dambo's, bare Inselbergs present
Slope of site: uniform, weakly convex, gradient 1-2%; top of interfluve
Vegetation : -
Land use : farmland, partially mechanized, cotton, before about 1965 shifting cultivation
Climate : Unimodal, P = , Ep = , 6 months dry, L.R. = 260 mm

General information on the soil

Parent material : Basement
Drainage conditions : well drained
Moisture conditions : dry
Ground water level : no evidence within 165 cm
Termitaria : dome-shaped, middle sized, about 1/ha
Surface characteristics: in farmland, frequent sheet and shallow rill erosion present

Miscellaneous

Local soil name : ithaya yocheria = ithaya yoquilla (Macua)

Brief description of the profile

Deep, well drained, dark reddish brown clay soil, nearly strongly structured.

N 1 - Mirrote

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
Ap	0-15		5YR3/2	SCL	m vf/f sb	sh	vfr	ss+sp	-	.	m f/m	
AB	15-50	d-s	2.5YR2.5/4	C	m/s f/m sb	vh	fr	s+p	b f C	m vf/f	c f/m	very few fine, faint, brackish mottling on exterior of peds
B	50-85	d-s	2.5YR3/4	C	m/s f/m sb	vh	fr	s+p	c d C	m vf/f	c f/m	
	85-145		2.5YR3/5	C	m/s f/m sb	vh	fr	s+p	c d C	m vf/f	f f/m	few, fine to medium, distinct blackish mottling
	Augering 145-165		2.5YR3/5	C	.	.			.	.	.	
	>165		rotten rock and few quartz gravel									

Notes:

- structure grade is nearly strongly; a part can be described as angular blocky
- consistency: clearly sticky and plastic (the "wire" can be deformed without breaking)
- traces of magnetite present
- the horizon boundaries at 50 and 85 cm are very vague, the differences are small.

SAMPLING DEPTH 1	2	BEG	END	AVE	TEXTURE CS	FS	SI	AG	pH H2O	KCl	OM	P	N	BASES Ca	Mg	K	Na	AC7	EC	ACF
14	1	0	15	7.5	24.1	32.5	10.1	33.3	6.3	5.8	3.1	16	-.1	9.7	3.2	1.30	0.19	2.59	0.16	0.07
14	2	15	50	22.5	16.[illegible]	20.1	10.[illegible]	55.[illegible]	6.1	4.6	1.6	2	-.1	6.7	3.5	0.27	0.27	3.25	0.04	0.67
14	3	50	[illegible]	[illegible]	14.1	[illegible]	[illegible]	[illegible]	6.2	4.6	1.1	1	-.1	[illegible]	3.3	0.10	0.29	2.62	[illegible]	0.06
14	4	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.3	4.7	0.[illegible]	1	-.1	[illegible]	2.9	0.07	0.28	3.4[illegible]	0.03	0.03
14	5	[illegible]	150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.5	4.5	0.6	2	-.1	[illegible]	3.2	0.07	0.25	[illegible]	0.02	0.04

PROFILE: N 2 (MOC 5)

Date of examination: 23 November 1982 (start of rains); repeat: 13 April 1983 (end of rains)

Authors : J.H. Kauffman, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Nampula, Monapo, Metochéria
Coordinates : 14°49' S, 40°05' E
Elevation : 180 m
Landform : planation surface, nearly flat to weakly undulating; dissected interfluves
Slope of site: complex, weakly convex, length < 300 m, gradient 1-2%; position: nearly on top of interfluve
Vegetation : dense grass cover with few trees (originally probably dense rich forest)
Land use : at site nearly permanently cultivated plots of small farmers, nearby large cotton estates
Climate : Unimodal, P = , Ep = , ± 6 months dry, L.R. = 275 mm (see annex)

General information on the soil

Parent material : mafic rock type, probably gabro (see annex)
Drainage conditions : well drained
Moisture conditions : 0-85 moist, > 85 cm dry
Ground water level : no evidence
Termitaria : dome-shaped mounds, density about < 1/ha
Surface characteristics: in the cultivated land rill erosion is common, mainly on the more sloping terrain towards natural drainage channels

Miscellaneous

Local soil name : -

Brief description of the profile

A deep, well drained, dark reddish brown clay soil, strongly or moderately structured; with a thick dark coloured topsoil; subsoil aggregates fall apart when wetted.

N 2 (MOC-5)

HORIZON CODE	DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-30	c-s	5YR3/1	C	m vf/f sb+cr	(s)h	vfr	ss/p	-	vm vf/m	m f/m	
AB	30-50	g-s	5YR3/2	C	s/m vf/m sb+ab	h	fr	s/p	c/b p C	m vf	m f	
B	50-95	g-s	2.5YR3/4	C	s/m f/m sb+ab	h	fr	s/p	c p C	c vf/f	c f	
	95-140	d-w	+2.5YR3/5	C	m f sb+ab	h	fr	s/p	c p C	c f	c f	very few to few fine to medium strongly weathered rock
CB	140-160+		7.5YR5/8 + 2.5YR3/4	mainly rotten rock								

Note

Soil when dry has a few cracks, width is less than ½ cm.
Soils clods falls apart in very fine angular aggregates when saturated with water.
At a depth of about 70-100 cm is present a "stone layer" with a thickness of 5 to 15 cm containing few, fine to medium iron rich, angular concretions and few quartz gravels; the layer forms no limitation for root development.

1	2	SAMPLING DEPTH BEG	END	AVE	TEXTURE CS	FS	SI	AG	pH H2O	KCl	OM	P	N	BASES Ca	Mg	K	Na	AC7	EC	ACF
15	1	0	15	7.5	16.6	23.4	13.5	41.5	7.2	6.1	4.5	133	-.1	20.4	5.0	1.19	0.29	1.26	0.03	0.02
15	2	15	30	22.5	12.3	17.7	21.6	47.9	7.7	5.6	2.3	14	-.1	14.2	3.7	0.23	0.25	0.26	0.09	0.02
15	3	30	50	40.0	9.7	13.3	15.9	61.1	7.6	6.3	1.3	1	-.1	15.1	4.2	0.16	0.23	0.44	0.06	0.03
15	4	50	82	[illegible]	[illegible]	[illegible]	[illegible]	76.3	7.5	6.0	1.1	1	-.1	12.2	6.5	0.20	0.27	0.37	0.06	0.01
15	5	82	125	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.4	5.9	0.7	1	-.1	11.2	6.3	0.10	0.20	1.93	0.04	0.0
15	6	140	160	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.5	5.4	0.3	-1	-.1	11.3	[illegible]	0.56	0.22	0.75	0.03	0.02

PROFILE: N 3 (MOC 6)

Date of examination: 28 November 1982 (start of rainy season);
repeat: 27 April 1983 (end of rainy season)

Authors : J.H. Kauffman, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Nampula, Nampula, Nova Chaves
Coordinates : 15°18' S, 39°07' E
Elevation : 450 m
Landform : middle planation surface, (weakly) undulating; irregular interfluves, bare rock inselbergs frequent
Slope of site: straight/irregular, gradient %, length m; position: upper slope
Vegetation : fallow grasses + herbs (see annex)
Land use : shifting cultivation, small farmer, cassava/cashew
Climate : Unimodal, P = , Ep = , about 6 months dry;
L.R. = 350 mm (see annex)

General information on the soil

Parent material : Basement; granite (see annex)
Drainage conditions : well drained, 0-120 cm, > 120 cm imperfectly
Moisture conditions : 0-165 cm moist
Ground water level : probably deep subsoil > 150 cm is saturated during some period in rainy season
Termitaria : dome-shaped mounds, medium/large, < 1/ha; also few chimney-shaped mounds present
Surface characteristics: -

Miscellaneous

Local soil name : -

Brief description of the profile

A deep, well drained, yellowish red sandy clay (loam), with a loamy sand topsoil and deeper than 150 cm having a strongly mottled low permeable subsoil.

N3 (MOC-6)

HORIZON CODE	DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-21	c-s	10YR3/1	LS	w f/m sb	.	1	ns+np	-	vm f	m vf	
AB	21-52	c-s	7.5YR3.5/2	LS	w m[1] sb	.	1	ns+np	-	vm f	m vf	
B	52-121	g-s(w)	5YR4/6	SCL/SC	pm-vc	.	vfr	ss+sp	p f C(?)	m vf/f	c vf/f	
Bg?	121-165+		2.5YR4/6	SC	w m ab	vh	fr	s+sp	-	m vf/f	f vf/f	many 10YR7/1 + 10YR6/6 mottling

Note

[1] Structure of topsoil can be also described as single grain or massive porous/weakly coherent.
- In topsoil are holes filled with redder coloured subsoil; in subsoil are holes filled with darker coloured topsoil.
- At 90 cm one can observe a slight increase in clay content.
- Termite holes are present, density about $2/m^2$.
- The strongly mottled subsoil is caused by temporarily stagnant water.

1	2	SAMPLING DEPTH BEG	END	AVE	TEXTURE CS	FS	SI	AG	pH H2O	KCl	OM	P	N	BASES Ca	Mg	K	Na	AC7	EC	ACF
16	1	0	16	[illegible]	79.5	17.4	[illegible]	[illegible]	6.5	5.1	1.5	5	0.04	1.9	0.9	0.12	0.11	2.68	0.03	0.03
16	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.0	6.2	5.0	[illegible]	1	0.02	0.6	0.2	0.09	0.09	0.72	0.03	0.03
16	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.1	4.	[illegible]	1	0.02	1.0	0.2	0.12	0.11	1.87	0.03	0.02
16	4	[illegible]	110	[illegible]	44.3	[illegible]	[illegible]	[illegible]	5.8	5.1	0.2	1	0.02	1.3	0.2	0.13	0.11	1.86	0.03	0.04
16	5	110	150	[illegible]	46.7	9.3	[illegible]	40.7	6.5	6.5	0.4	1	0.04	1.2	0.2	0.12	0.05	1.83	0.02	0.04
16	6	150	[illegible]	[illegible]	43.5	6.7	2.7	42.1	6.4	5.8	-.1	-1	-.1	1.3	0.8	0.17	0.10	0.37	0.06	0.02
16	7	250	[illegible]	[illegible]	31.1	[illegible]	[illegible]	34.6	6.5	6.0	-.1	-1	-.1	1.3	1.1	0.40	0.12	0.39	0.03	0.0

PROFILE: N 4

Date of examination: 26 November 1982 (start of rainy season)
Authors : J.H. Kauffmann, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Nampula, Nampula, Nova Chaves
Coordinates : 15°18' S, 39°07' E
Elevation : 430 m
Landform : middle planation surface, (weakly) undulating; irregular interfluves, bare rock inselbergs present.
Slope of site: straight/irregular, gradient %, length ; position: lower slope
Vegetation : fallow grasses + herbs (see annex)
Land use : shifting cultivation, small farmer, cassave/cashew
Climate : Unimodal, P = , Ep = , 6 months dry; L.R. = 350 mm (see annex)

General information on the soil

Parent material : Basement; probably granite (see annex)
Drainage conditions : well drained
Moisture conditions : moist
Ground water level : no evidence within 300 cm, > 300 cm probably temporarily saturated
Termitaria : dome-shaped mounds, very large to medium sized, < 1/ha
Surface characteristics: -

Miscellaneous

Local soil name :

Brief description of the profile

A very deep, well drained, yellowish red sandy clay loam, non-structured and having a thick loamy sand topsoil.

N 4 - Nova Chaves

HORIZON CODE	DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D M W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
Ap	0-10	c-s	10YR3/1	LS	sg	loose	-	very porous	m f/m	
A	10-19	c-w	10YR3/1	LS	sg	loose	-		m f/m	
AB	19-47	d-s	5YR4/4	LS	sg	loose	-		c f/m	
B	47-120	d-s	5YR4/6	SCL	mp-wc	vfr	-		c f	common dark "mottling" = holes filled with darker topsoil
	120-190		5YR4/6	SCL	mp-wc	vfr	-		f f	
	Augering									
	190-270		5YR4/6	SCL	.	.	.			
	270-320		5YR4/6	SCL	.	.	.			. few yellow mottling
	320-420		+5YR4/6	SCL	.	.	.			. many yellow mottling

Resume:

A very deep well drained yellowish red sandy clay loam, non structured and having a thick loamy sand topsoil.

		SAMPLING DEPTH			TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
17	1	[illegible]	10	[illegible]	[illegible]	16.7	2.6	[illegible]	[illegible]	5.7	1.6	6	0.07	2.5	0.6	0.21	0.08	0.57	0.04	0.0
17	2	10	19	14.5	[illegible]	[illegible]	[illegible]	11.2	[illegible]	5.6	1.5	2	0.07	2.3	0.6	0.12	0.11	1.09	0.04	0.0
17	3	19	47	[illegible]	77.2	11.2	1.4	[illegible]	[illegible]	5.3	0.6	1	0.02	0.9	0.3	0.05	0.09	0.50	0.02	0.02
17	4	47	[illegible]	[illegible]	61.5	[illegible]	2.9	[illegible]	6.3	5.0	0.4	1	0.03	0.9	0.4	0.17	0.11	0.41	0.02	0.02
17	[illegible]	[illegible]	125	[illegible]	[illegible]	[illegible]	[illegible]	22.4	6.3	5.4	0.2	1	0.02	0.9	0.5	0.14	0.07	0.35	0.02	0.0
17	6	120	150	[illegible]	[illegible]	[illegible]	[illegible]	22.6	[illegible]	[illegible]	-.1	-1	-.1	0.5	0.8	0.21	0.08	0.31	0.03	0.01
17	7	[illegible]	200	[illegible]	65.4	6.5	5.1	23.7	5.5	5.7	-.1	-1	-.1	0.4	1.2	0.14	0.11	0.27	0.02	0.0
17	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.5	-.1	-1	-.1	0.3	1.2	0.15	0.13	0.25	0.06	0.0
[illegible]	9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-.1	-1	-.1	0.4	1.2	0.18	0.17	0.57	0.02	0.0

PROFILE: N 5

Date of examination: 27 November 1982 (end of dry season)
Authors : J.H. Kauffman, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Nampula, Mecuburi, Mecu (now "7 Abril")
Coordinates : 14°29'S, 38°54'E
Elevation : 450 m
Landform : low planation surface, weakly undulating; smooth interfluves + dambos, bare rock inselbergs present
Slope of site: uniform, straight, gradient 1%; upper slope position
Vegetation : regeneration of woodland
Land use : shifting cultivation, small farmer, cotton, mandioca
Climate : Unimodal, P = , Ep = , 6 months dry; L.R. = 490 mm

General information on the soil

Parent material :
Drainage conditions : well drained
Moisture conditions : dry
Ground water level : no evidence
Termintaria : dome-shaped mounds, middle sized < 1/ha
Surface characteristics: smooth bare surfaces present

Miscellaneous

Local soil name : Kotokwa (Macua language)

Brief description of the profile

A very deep, well drained, dark red clay soil, weakly to moderately structured.

N 5 - Mecuburi

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
Ap	0-12	g-s	2.5YR3/2	SCL	w vf/f ss+sp	sh	vfr	ns+np	-	vm	m	
AB	12-35	g-s	2.5YR3/4	SCL	w vf/f ss+sp	sh	vfr	ss+sp	-	vm vf/m	f	
B	35-110	d-s	2.5YR3/4	C	w/m f/m ss+sp	h	vfr	ss+sp	b/m d/p C	vm vf/f	f	
	110-180		1.25YR3/6	C	w f(m) ss+sp	sh	vfr	ss+sp	b d C	m vf/f	f	
	Augering											
	180-250		1.25YR3/6	C	.		.		.	.	.	
	250-260		1.25YR3/6		.		.		.	.	.	frequent gravel + concretions

Notes:
- many termite holes present, mainly at a depth of 25-40 cm
- structure subsoil nearly massive porous

Resume:
A very deep, well drained, dark red clay soil, weakly to moderately structured.

SAMPLING DEPTH					TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
[illegible]	1	0	12	[illegible]	[illegible]	[illegible]	[illegible]	26.5	[illegible]	5.0	2.0	6	0.07	3.9	0.6	0.29	0.11	2.44	0.02	0.01
[illegible]	2	15	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.7	1.2	1	[illegible]	2.3	0.9	0.30	0.18	2.33	0.04	0.05
[illegible]	3	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.7	0.7	1	[illegible]	1.9	1.0	0.25	0.19	1.95	0.02	0.05
[illegible]	4	[illegible]	[illegible]	[illegible]	26.5	[illegible]	4.9	[illegible]	5.6	[illegible]	0.4	1	0.02	2.2	1.0	0.20	0.17	1.38	0.02	0.03
[illegible]	5	[illegible]	[illegible]	[illegible]	22.4	[illegible]	[illegible]	[illegible]	[illegible]	5.1	0.2	-1	-.1	1.9	1.2	0.29	0.13	1.92	0.04	0.04

PROFILE: N 6

Date of examination: 29 November 1982

Authors : Kauffman, Vilanculos, Beernaert

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Nampula, Meconta, Camuane
Coordinates : 15°04' S, 39°35' E
Elevation : 320 m
Landform : lower planation surface, weakly undulating
Slope of site: weakly convex, 1%, upper slope position
Vegetation : fallow grasses and low shrubs/trees
Land use : shifting cultivation; mandioca and cashew
Climate : Unimodal, P = , Ep = , 6 months dry; L.R. =

General information on the soil

Parent material :
Drainage conditions : well or somewhat excessively drained
Moisture conditions : dry
Ground water level : no evidence 0-400 cm
Termitaria : dome-shaped, middle < 1/ha
Surface characteristics: -

Miscellaneous

Local soil name :

Brief description of the profile

Very deep, well drained, yellowish red, sandy clay loam, with a massive porous structure and a loamy sand topsoil.

N 6 - Camuana

CODE	HORIZON DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
Ap	0-10	a-s	7.5YR3/2	LS	sg			ns+np	-	.	m vf/m	
A	10-24	c-s	7.5YR3.5/2	LS	sg	s	l	ns+np	-	.	m vf/m	
AB	24-47	g-s	7.5YR4/4	LS	sg	sh	vfr	ss+sp	-	.	v vf/m	
B	47-84	d-s	4YR4/6	SCL	mp-vc	sh	vfr	ss+sp	-	c/m vf/f	f vf/m	
	84-180		4YR4/8	SCL		sh	vfr	ss+sp	-	c/m vf/f	f vf/m	
	Augering 180-400		4YR4/8	SC(L)	.		.		.	.	.	

Notes:
- massive porous structure can also be described as very weak subangular blocky

		SAMPLING DEPTH			TEXTURE				pH					BASES						
1	2	BEG	END	AVE	CS	FS	SI	AG	H2O	KCl	OM	P	N	Ca	Mg	K	Na	AC7	EC	ACF
19	1	0	10	5.0	75.1	8.6	5.3	11.0	6.2	5.2	1.3	-1	-.1	1.9	0.5	0.21	0.10	0.14	0.01	0.0
19	2	10	24	17.0	75.6	11.1	3.8	9.5	5.9	4.7	0.8	-1	-.1	1.2	0.4	0.13	0.11	1.36	0.04	0.05
19	3	24	47	35.5	75.4	10.8	2.7	11.1	5.4	[illegible]	0.4	1	0.02	0.8	0.2	0.07	0.18	0.96	0.01	0.17
19	4	47	84	65.5	66.2	10.4	1.9	21.5	5.3	4.3	0.4	2	0.02	0.7	0.3	0.12	0.10	0.93	0.02	0.19
19	5	84	125	104.5	66.0	6.8	2.0	25.2	5.5	4.6	0.2	2	0.01	0.7	0.3	0.08	0.12	1.58	0.01	0.16
19	6	125	180	152.5	59.7	6.6	2.3	31.4	5.5	5.2	0.1	2	0.01	0.7	0.3	0.14	0.13	0.63	0.02	0.09
19	7	260	280	270.0	55.5	8.2	[illegible]	34.5	5.5	5.5	-.1	-1	-.1	1.3	0.5	0.13	0.13	0.63	0.03	0.03
19	8	[illegible]	[illegible]	[illegible]	[illegible]	8.2	1.2	[illegible]	6.3	5.4	-.1	-1	-.1	1.0	0.6	0.15	0.15	0.40	0.04	0.05

PROFILE: N 7

Date of examination: 30 November 1982

Authors : J.H. Kaufmann, M. Vilanculos

Higher category classification

- (FAO-UNESCO, 1974)
- (Soil Taxonomy, 1975)

Environmental information

Location : Mozambique, Nampula, Muecate

Coordinates : 14°54'S, 39°2'E

Elevation : 410 m

Landform : lower planation surface, weakly undulating; frequent rocky inselbergs

Slope of site: weakly convex

Vegetation : regeneration of woodland

Land use : formerly shifting cultivation, cotton

Climate : Unimodal, P = , Ep = , 6 months dry; L.R. =

General information on the soil

Parent manterial : probably granite-gneiss

Drainage conditions : well or somewhat excessively drained

Moisture conditions : slightly moist 0-300 cm

Ground water level : no evidence

Termitaria : dome-shaped mounds, large, < 1/ha

Surface characteristics: -

Miscellaneous

Local soil name : -

Brief description of the profile

Very deep, somewhat excessively drained sandy loam; with a massive porous structure and a sandy topsoil.

N 7

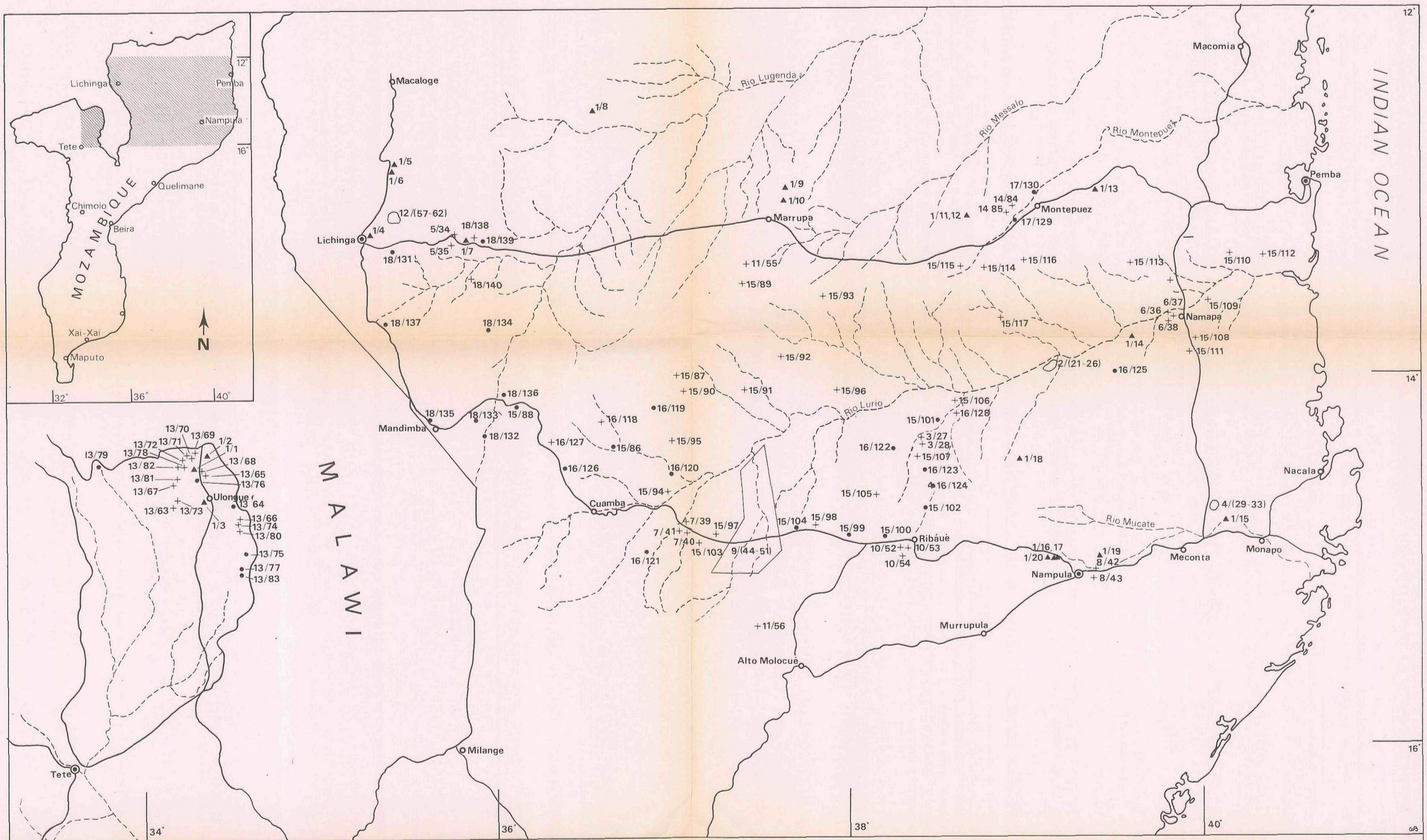
HORIZON CODE	DEPTH	BOUND	COLOUR	TEXTURE	STRUCTURE	CONSISTENCY D	M	W	CUTANS	POROSITY	ROOTS	OTHER CHARACTERISTICS
A	0-14	c-s	5YR2.5/1	S	sg	.	1	ns+np	-	m vf/f	m vf/f	
AB	14-38	g-s	5YR4/3	S	sg	.	vfr	ns+np	-	m vf/f	m vf/f	
B	38-105	g-i	5YR4/7	SL	mp-wc	.	vfr	ns+np	-	m vf/f	c vf/f	many holes filled with coloured soil
	105-135	d-s	4YR4/7	SL	mp-wc	.	vfr	ns+np	-	m vf/f	c vf/f	
	135-190		4YR4/7	SCL	mp-wc	.	vfr	ns+np	-	m vf/f	c vf/f	few to common faint yellowish mottling
	Augering 190-320		7.5YR5/6	SCL								

Notes:

- massive porous structure can also be described as very weakly subangular blocky.

1	2	SAMPLING DEPTH BEG	END	AVE	TEXTURE CS	FS	SI	AG	pH H2O	KCl	OM	P	N	BASES Ca	Mg	K	Na	AC7	EC	ACF
20	1	0	14	7.0	64.7	[illegible]	2.1	5.3	6.3	5.1	1.3	5	0.07	3.1	0.6	0.12	0.13	1.10	0.04	0.0
20	2	14	38	26.0	72.5	15.5	5.9	3.1	5.5	4.7	0.4	1	0.02	1.4	0.2	0.15	0.10	0.59	0.02	0.01
20	3	38	70	54.0	65.7	15.4	5.5	15.4	5.1	4.3	0.4	1	0.03	1.2	0.4	0.10	0.11	0.72	0.01	0.02
20	4	70	105	87.5	62.1	15.7	5.3	23.1	5.6	4.9	0.2	1	0.01	1.3	0.6	0.09	0.10	0.56	0.01	0.03
20	5	105	135	120.0	65.6	11.5	4.3	19.5	5.5	5.6	0.1	1	0.01	1.4	0.3	0.10	0.13	0.67	0.01	0.03
20	6	135	190	162.5	64.[illegible]	[illegible]	[illegible]	22.[illegible]	5.0	5.3	-.1	-1	-.1	1.[illegible]	0.5	0.09	0.11	0.54	0.09	0.03
20	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-.1	-.1	0.1	-1	-.1	[illegible]	0.7	0.17	0.19	0.76	0.04	0.12

11959 a



LEGEND

——— main road

- - - - river

◎ province capital

o village

PROFILE INDICATION

profile code	report no.	profile no.	location	quantity	sort
▲	1	1–20	exact	single	reference
•	2	21	exact	single	other
+	|	|	approximate	single	other
◯	18	140	approximate	cluster	other

Scale 1 : 2.000.000

LEGEND OF SOIL PROFILES LOCATION MAP

Report/Profile number/number		Executing agency	Publication	Year	Abbreviated name of soil survey
1	1-20	INIA	Comunic. no. 2, serie pedologia	1983	Red soils north Mozambique
2	21-26	IAM	Comunic. no. 25	1962	Os solos de Muite
3	27,28	IAM	Comunic. no. 27	1962	Os solos de Nipende
4	29-33	IAM	Comunic. no. 29	1962	Alguns solos de Netia
5	34,35	IAM	Comunic. no. 31	1962	Alguns solos de Litunde
6	36-38	IAM	Comunic. no. 41	1965	Os solos do posto agronómico de Namapa
7	39-41	IAM	Comunic. no. 41	1965	Os solos do posto agrario de Mutuali
8	42,43	IAM	Comunic. no. 41	1965	Os solos do posto agrario de Nampula
9	44-51	ARTOP	-	1971	Bacia do rio Malema
10	52-54	IIAM	Comunic. no. 76	1972	Os solos de estação agraria Ribauè
11	55,56	IIAM	Agronomia Mocam.	1973	Gomeia
12	57-62	INIA	Comunic. no. 2 serie pedologia	1978	Regadio de Matama
13	63-83	INIA	-	1979	Angonia
14	84,85	INIA	Comunic. no. 13 serie pedologia	1979	Os solos da zona de regadio de Chipembe
15	86-117	H.P.	-	1979	Bacia do rio Lurio
16	118-128	H.P.	-	1981	Bacio do rio Lurio
17	129,130	COBA	-	1982	Bacia do rio Montepuez
18	131-140	Technosyn.	DNA	1983	Bacia do rio Lugenda

Comunic. : Comunicaçoẽs
IAM : Instituto Agronómico de Moçambique
IIAM : Instituto de Investigação Agronómico de Moçambique
INIA : Instituto National de Investigação Agronómico
H.P. : Hidrotechnica Portuguesa
Technosyn. : Technosynesis

SOIL PROFILES LOCATION MAP - MOZAMBIQUE