TRAINING PROJECT IN PEDOLOGY

KISII - KENYA

DIFFERENCES IN SOIL PROFILE DEVELOPMENT AS A RESULT OF A LOCAL SPRING

BY J.H.M.SCHOLTEN

~~PRELIMINARY REPORT~~ Scriptie

AGRICULTURAL UNIVERSITY OF THE NETHERLANDS - WAGENINGEN

CONTENTS

Preface

In this report the results are represented of a research on soils in the Kisii District in Kenya.
The writer of this report participated in the Training Project in Pedology in Kisii in order to do practical work during his study in tropical soil science on the Agricultural University of the Netherlands in Wageningen.
After finishing a soil survey in the Magombo market area,North East of Kisii town,a research on a special subject- the differences in soil profile development as a result of a local spring - was carried out in the same area.
The fieldwork was carried out in the months february and march 1975,during which soil samples were taken which have been studied on the Agricultural University of Wageningen in 1975 and 1976.
The fieldwork was supervised by ir W.G.Wielemaker and ing H.W.Boxem, and the study in Wageningen by professor J.Bennema;all of them are staff members of the Agricultural University.

Introduction

In the Magombo market area - the area in which a detailed soil survey had been carried out - springs were commonly seen.
Since the rainfall was rather high (an average of about 1800 mm a year), the infiltration speed of the soils about 14 m/24 h, and the underlying hardrock quite impermeable, it was expected that the water was moving laterally over the rock through the under part of the soil profile in the direction of the springs, causing a subsurface water erosion.
The water, carrying ions and possibly soil particles, should have an impact on the soils around the springs.
Apart from the possible influence on the soils, it was easily seen that the springs had a strong impact on the landscape. They were cutting backwards the valleys or, when they occurred in the transition zone hill-valleybottom, they were the cause of steep linear slopes.
Initially, a kind of round pits of 10- 20 m diameter and 1 to 5 m deep, frequently occurring in clusters on the hill slopes, were taken for old spring locations, but later on they seemed to be originating from human beings livung there long before the Kisii people came.
The springs are very important for the people living in the area because most of the springs provide water of excellent quality for drinking and cooking and thus keep the area clear of diseases like for instance cholera.
In this study the research on the soils is stressed, but also some geomorphological data of some valleys, typical for the area, have been added.

Acknowledgements

I am grateful indepted to the project managers ir W.G.Wielemaker and ing H.W.Boxem for their help,suggestions and discussions during the fieldwork in Kenya.
Many thanks are also going to professor J.Bennema,who attended the research,dr L.van der Plas,dr ir B.Slager and ing T.Jongmans for all their discussions,especially at the thin sections.
The research wouldn't be possible without the help and the analyses of the laborants of the department of Soil Science and Geology of the Agricultural University of Wageningen and,last but not least,without the help of my companions in the field : Charles Faniaco,Charles Ongera,Joni Atambo and Nelson Orandi,in digging the two soil profile pits of 7.50 m depth.

1. Methods and Material

First of all a number of springs and their valleys and a number of a kind of "round pits" were selected from aerial photographs and subjected to investigations including geomorphology,soils and occurrance of rock.
Than one spring was selected and the soils around it checked by augerhole observations;one augering has been carried out by motor auger until a depth of 11.00 m.
Two profile pits were dug to about 7.50 m depth : one on the watershed near the top of the hill (profile 3S) and one about 150 m downwards just above the spot where the water flew out of the rock (profile 1S).
Detailed soil profile descriptions were made and the following samples were taken :
a.mixed samples from every horizon for chemical analyses.
b.undisturbed samples for thin sections from some important horizons.
c.unditurbed ring samples from every 10 cm,starting from the surface to a depth of 4 m (profile 1S) and 3 m (profile 3 S),for organic carbon and bulk density research.
d.undisturbed ring samples for pF research.
e.water samples from profile 1S,taken from groundwater which flew into the pit,from the spring near profile 1S and from some springs in the neighbourhoud.
f.some samples,disturbed and undisturbed and for thin sections,have been taken from the place where the water was flowing out of the rock.These samples have been indicated by the word "spring".

The ring samples for pF research and for organic carbon and bulk density research have been analyzed in the laboratory of the Training Project in Pedology in Kisii,Kenya.
The organic carbon content has been determined according the method of Walkley and Black.
The other samples were send to Holland for further analyses.
That analyses included :
grain size distribution (texture)

mineralogy of clay fraction,by x-ray diffraction method.

pH : pH-H_2O , pH-KCl , pH-$CaCl_2$.

pF : soil moisture tension - soil moisture content

free iron and aluminium } method: Schwertmann 1964 and Duchaufour
amorphous iron } et Souchier 1966

cation exchange capacity(CEC) } NH_4-acetate pH 7 method
exchangeable bases }

oxides (12) by x-ray fluorescention method (XRFS) except :

sodium : emission spectometrically (ES)

magnesium : atomic adsorption (AAS)

ferro-ferri : by HF method

thin section research

The analyses of the water samples included :

amounts of cations (Ca,Mg,K,Na)

amount of SiO_2

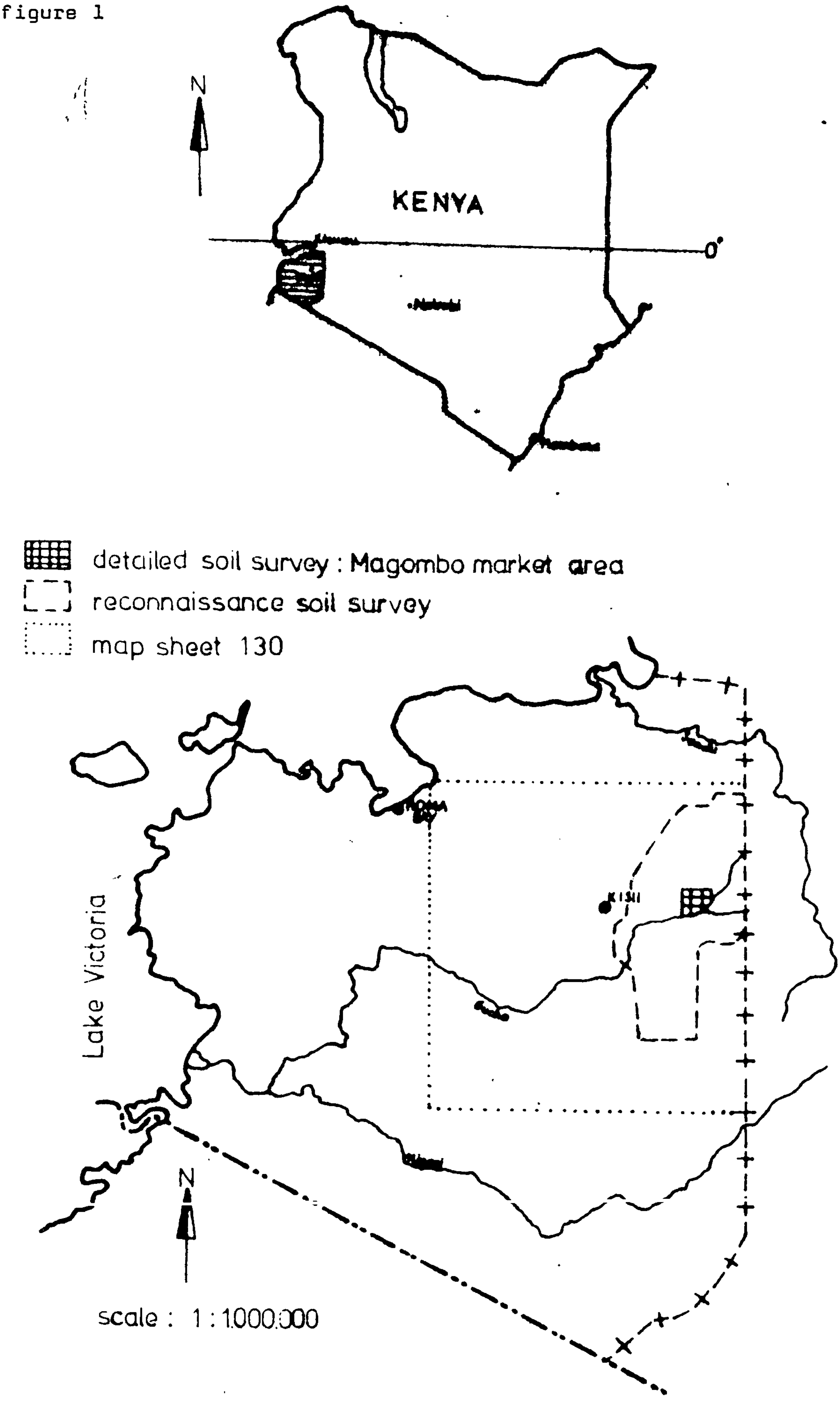
pH

The percentages of the oxides were used in norm calculations. A goethite norm of the clay fraction and a epinorm of the non-clay fraction were calculated by computer programme and a katanorm calculation of the non-clay fraction was carried out by hand.

Finally the soils ewre classified according Soil Taxonomy (1975).

LOCATION OF THE AREA

figure 1



2. The Environment

2.1. Location of the Area

The research has been done within the Magombo market area in the Kisii district in Kenya,where previous to the research a detailed soil survey had been carried out.
see location map on previous page
The two profile pits were situated about 2 km East of Magombo market,300 m North from the point where the road from Magombo market to Kenyenya passes the bridge near Kenyerere School,on the left side of the stream. (see also point 3.1.)
Topographical map (1962),scale 1 : 50 000 ,sheet 130/2 Kisii , 714.7 E , 9926.3 N .
The altitude varies from about 1800 m in the valleys to about 1900 m on the hilltops.
The altitudes of profile pit 1S and 3S are 1865 and 1880 m above sealevel respectively.

2.2. Geology

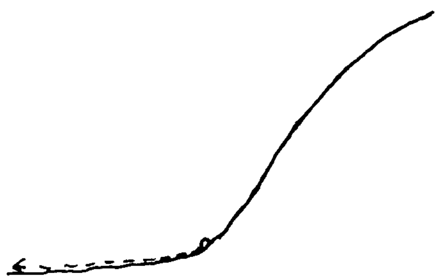
The parent material in the area includes mainly - according to the geological map - andesite rock of the Bukoban system of late Precambrium age.However,it is quite possible that over the Bukoban system younger materials - mainly volcanic ash - have been deposited.
The rocktype has also been a subject of this research.Thin sections from the two profile pits and from a piece of rock showed that the parent material was arcose sandstone or indurated tuff,indurated tuff being the most likely.
It is not yet clear whether all the parent material in the area is indurated tuff or partly andesite.
In the rock a layering can be recognized with a dip of 10-12 % to the East-South East.
Locally conglomerate rock is found.

2.3. Geomorphology

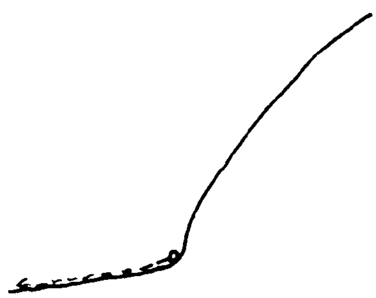
The rock in the area is dipping 10-12 % to the East -South East and the consequence is that the mainstreams are running from the North East to the South West (roughly).
Another result of the dip of the rock is the tendency of the streams to a slightly movement eastwards in the valleys, leaving steep slopes (15-30 %) on the valleysides facing West and sloping to moderately steep slopes (5-15 %) on the valleysides facing East.
Another explanation for the mentioned differences in slope can be found in the way of deposition of the volcanic ash coming from the East.
Two types of springs can be distinguished :
a. springs in the transition zone hill-valleybottom. They are the cause of steep linear slopes on the valleyside, and have the tendency to widen the valleybottom. Locally landslides have been found, probably caused by this type of spring.
b. springs on the hill slopes. Water flowing out of this type of spring will gradually remove material and erode backwards and/or headwards into the hill side. This process, known as spring sapping, can produce quite large valley heads and is in some places even branching the valleys.

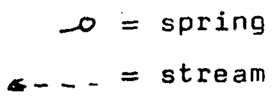
a number of springs and their valleys have been drawn :
figure 2
type a. in the transition zone hill-valley bottom

cross sections :

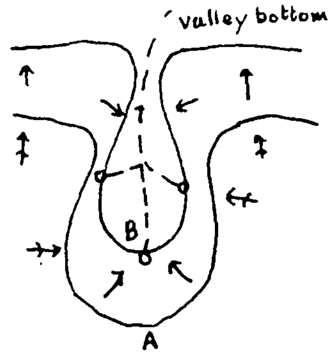


or :





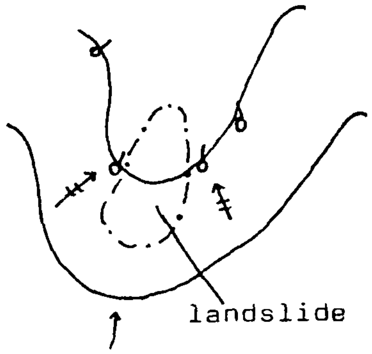
valley forms produced by springs of type a. :
figure 3



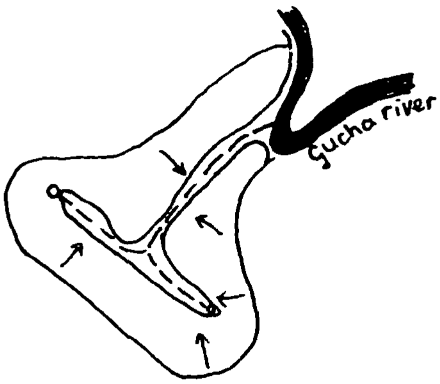
aerial view

cross section A-B

= linear slope
= convex slope
= concave slope



aerial view

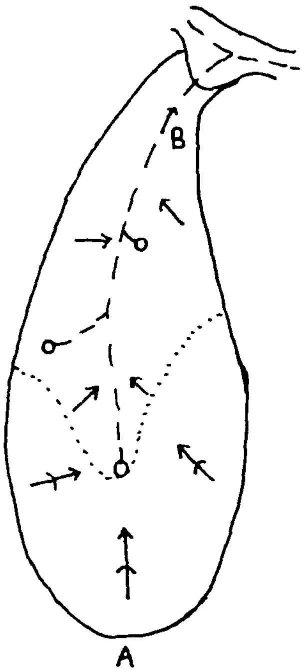


aerial view

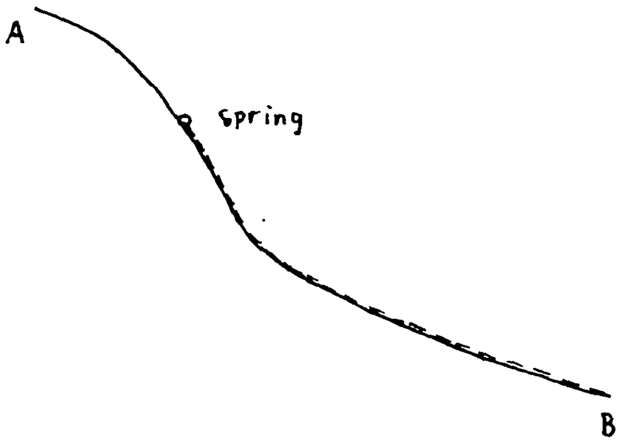
spring type b. on the hill slopes :

b.1. occurring on the lower convex hills as well in the higher steeply dissected area.

figure 4



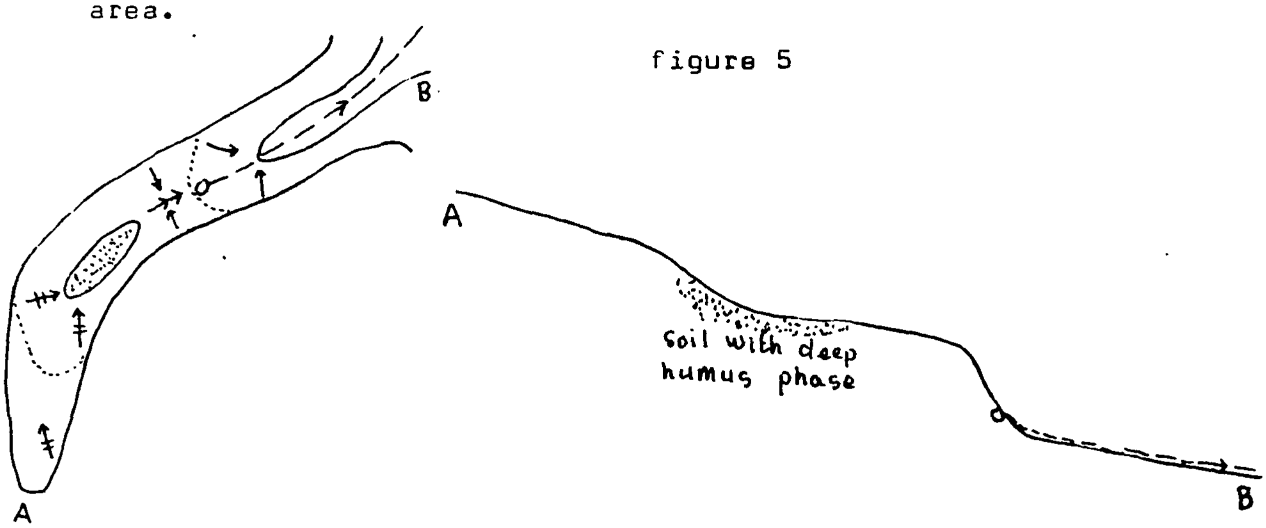
aerial view



cross section A-B

b.2. occurring in the transition zone steeply dissected area-hilly area.

figure 5

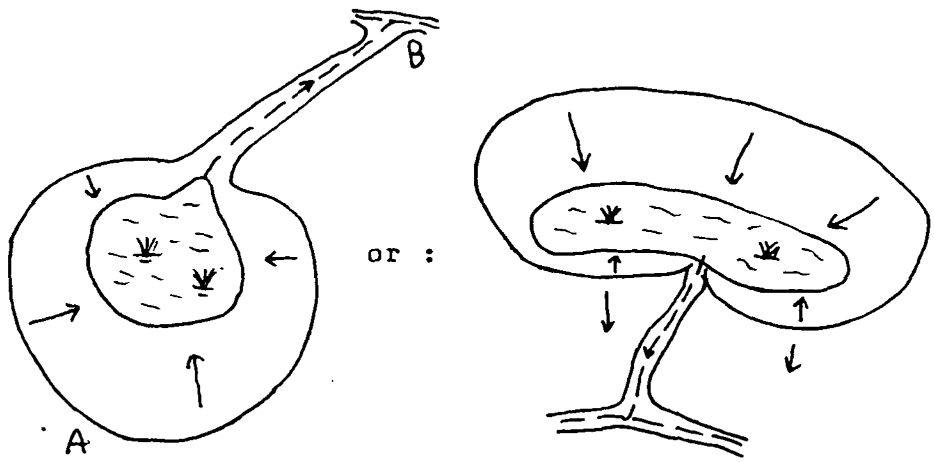


aerial view

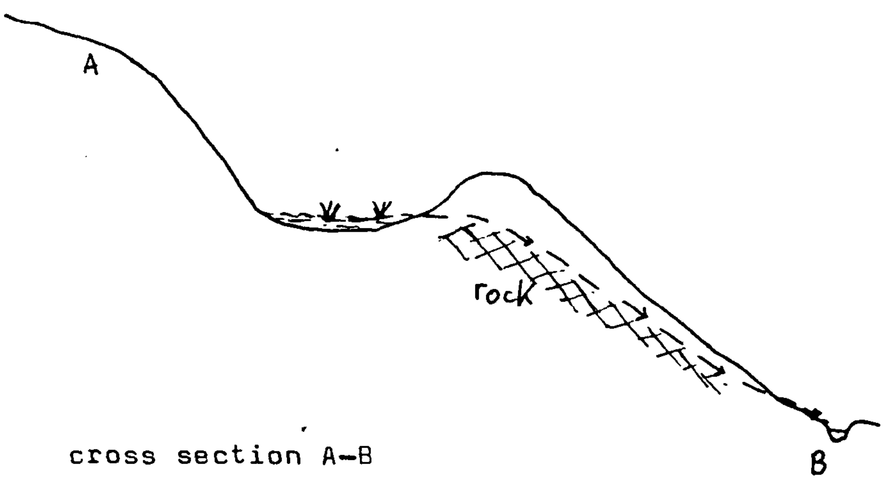
cross section A-B

b.3. occurring in steeply dissected area (slopes 20-40 %) :

figure 6

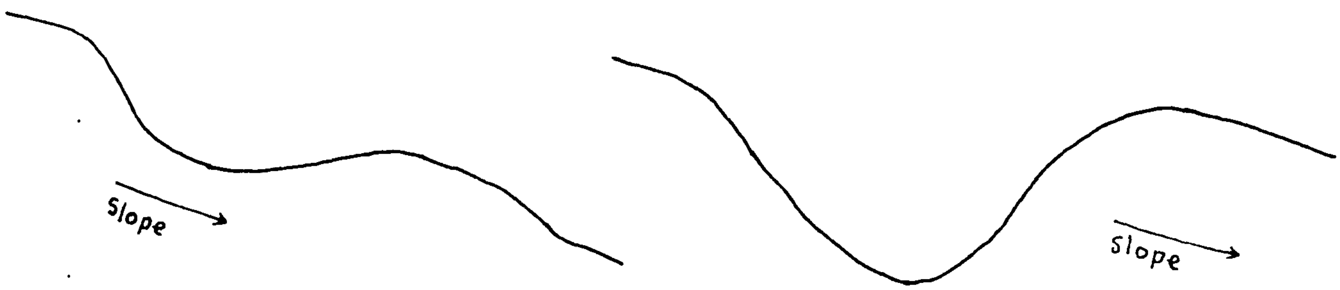


aerial views



cross section A-B

A point of discussion is the appearance of big rounded pits on the hill slopes.Usually they have a diameter of 5-15 m and a depth of 1-5 m.They occur separate or in clusters.
The shape of the "pits" is showed in the next cross sections :



shape of shallower pits shape of deeper pits

figure 7

The origin of these pits is not clear;initially they were taken for old spring locations,probably of iron age.
In a pyrethrum field,just a few meters from such a pit,East of Magombo market,iron slacks,pot sherds and pieces of a grinding stone have been found by the writer.Probably this was formerly a smelting site.

photograph : banana plants and maize standing in a "pit" near Nyambaria School.

The possibility of landslides is not ruled out for a number of these pits,but especially for the deeper pits this is not likely. By dr Sombroek (oral consultation) they were thought to be caused by subsidences of underlying rock,but in my opinion are those subsidences not likely in view of the type of rock.
People living around the pits don't know exactly how the pits came there.Some of them said that formerly elephants came to drink there,and others said that these pits were cattle boma's (a kind of corral where they kept the cattle at night) where some soil was moved out while removing the manure.
the latter explanation seems to me quite fair.
In Kisii history nothing is known about the pits.
Archaeological research in the area has been done by John R.F.Bower.
He found numerous sites with archaeological remains,and mentions a concentration of sites near Nyambaria School - the place where writer found a concentration of pits and numerous pot sherds - but doesn't speak about the pits.
Anyway,it seems the most likely that the pits originate from human activity.

2.4. Hydrology

The area in which the research has been done is a part of the catchment area of the Gucha river.
Although in the dry season the precipitation is very low,the main streams in the wider valleys are never dry.
Important are the "dams" of mostly conglomerate rock at the end of the flat bottomed,wet valleys.On these places the valleys are narrowing,and the streams running through have rapids,sometimes over a length of 50-500 m with a height difference of 10-30 m.
In the lower part of the flat valley bottoms swamps are found.
Two types of groundwater table occur and coherent with them two types of springs :

a. The main groundwater table of the valley bottoms.Connected with this water table are the springs in the transition zone hill-valley bottom.
b. The perched groundwater table above the rock in the hills. Connected with this water table are the springs on the hill slopes.

All over the area man can find springs;a number of them will be dry at the end of the dry season.
The drainage direction of the minor streams is from North West to South East,of the bigger streams from North East to South West.
The infiltration in the soil is very rapid;near the profiles 1S and 3S an infiltration speedhas been measured of 12-14 m/24 hrs.

2.5. Climate

There is no meteorological station siruated in the surveyed area.
Figures of rainfall,evapotranspiration and temperature are estimated from figures of neighbouring stations.
These stations are :
Nyanturubo , registration number : 90 34 031,altitude : 1680 m
Murumba , " " : 90 34 032, " : 1890 m
altitude profile pits :1865 and 1880 m

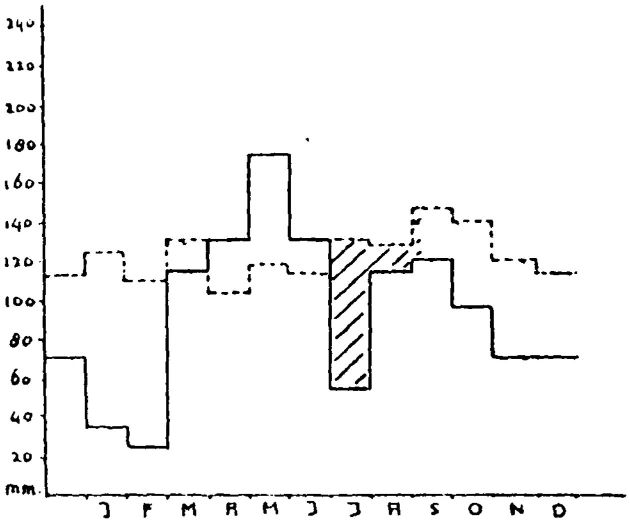
Mean minimum temperatures are about 10 °C and maximum temperatures can reach 29 °C in Magombo.
The yearly rainfall amounts three out of four years more than 1600 mm (statist. v.Maurik).

The diagrams on page 15 show the rainfall and evapotranspiration figures of Nyanturubo (South West of Magombo) and Murumba (North West of Magombo).
We can notice that there is :
- a dry spell during december,january and february
- a rainy season during march,april,may and june
- a drier month july
- a second rainy season during august,september and october

Rainfall and Evapotranspiration Diagrams.

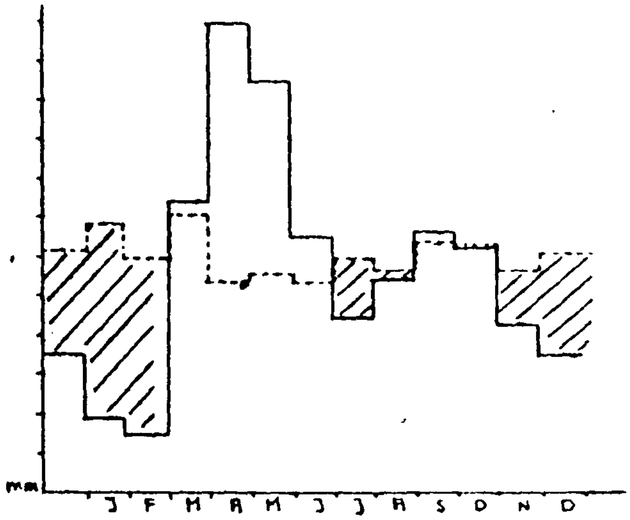
graph 1

Kisii,Nyantorubo 90 34 031
1670 m above sealevel



graph 2

Kisii,Murumba 90 34 032
1890 m above sealevel



= monthly rainfall in mm

= E_{po} : the mean consumptive water use of a crop at the end of the vegetative period with optimal water availability.
(e.g. a fully closed tea crop)

= estimate of the available stored water for a crop in full production throughout the year,e.g. tea.

E_{po} = 0.82 x the evaporation of an open water surface.
The storage capacity is calculated for a soil with a rootable depth of 1 m and a moisture content of 20 % between PF 2 and PF 4.

A more detailed study about the climate of the area can be found in preliminary report no 8 : D.van Maurik (1974) The landquality water availability for some soils in the Kisii and South Nyanza Districts in Kenya.

2.6. Vegetation and Landuse

vegetation

The area is belonging to the Western moist forest zone (WM , 1 : 250 000 Climate and Vegetation Map of South West Kenya)
The original vegetaion has been a moist montane forest;eventhough the settlement of the area is quite recent there are not even secondary forests present,but remniscant elements of these forests can be found,mostly on very steep slopes.
On the steeper hills small forest plantations of Cupressus sp. and Eucalyptus sp. can be found,the latter on the valley bottoms also.
On the wet valley bottoms swamps occur with typical swamp shrubs as Sesbania keniensis and Gomphocarpus semilunatus.

landuse

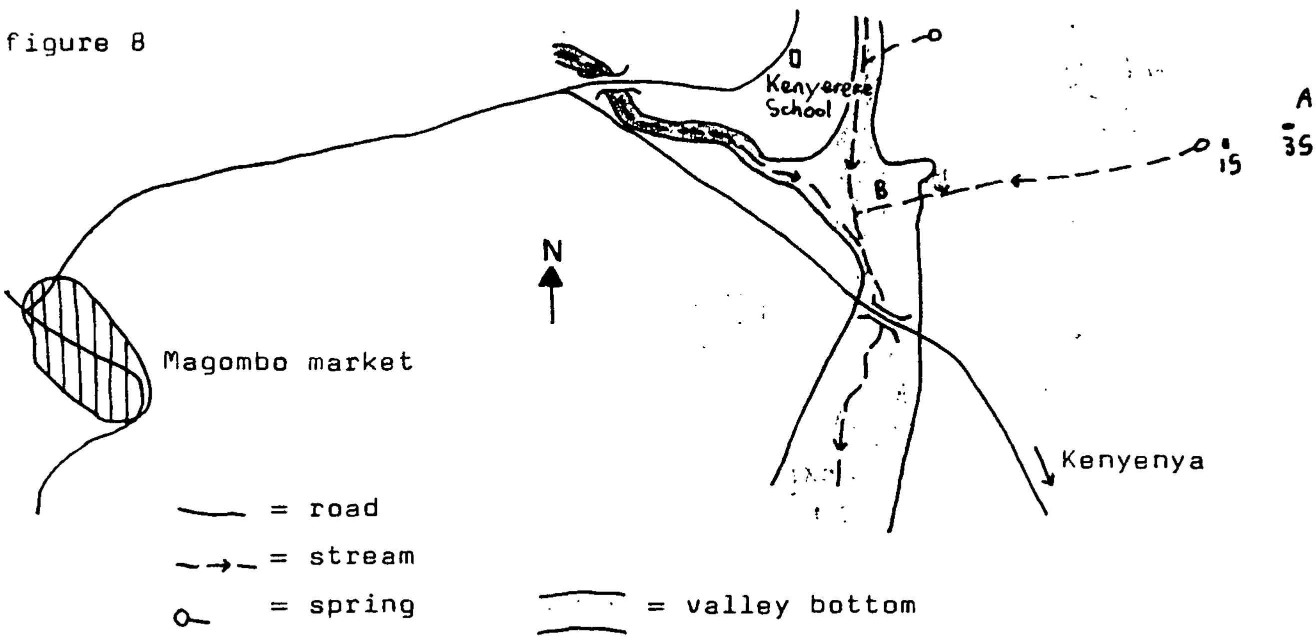
Nearly all the land has been taken into cultivation;looking at the landscape man can distinguish a pattern of narrow strips from the valley bottoms to the hilltops,separated and divided into small plots by hedges,commonly of Mauritius thorn.
The population density accounts about 450 persons/km^2.
The type of farming is smallholder-farming with farmsizes varying from 1 to 10 ha,and the following crops are the most important : maize,grass (grazing),tea and pyrethrum.
Other crops are :
vegetables,passion fruits,fingermillet,Irish patatoes,sweet patatoes,pineapples,bananas,sugar cane(for chewing),beans,fruit trees (avocado,orange).
The wood of the small forest plantations of Cypress and Eucalyptus is used for timber and charcaol.
The tough,thin,low feeding-value grass from the shallow soils (Loudetia kagerensis) and from the valley bottoms (Imperata cylindrica) is used for thatching.

3. SOILS

3.1. Situation of the profile pits and short description of the soil profiles.

The two profile pits were situated about 2 km East of Magombo market :

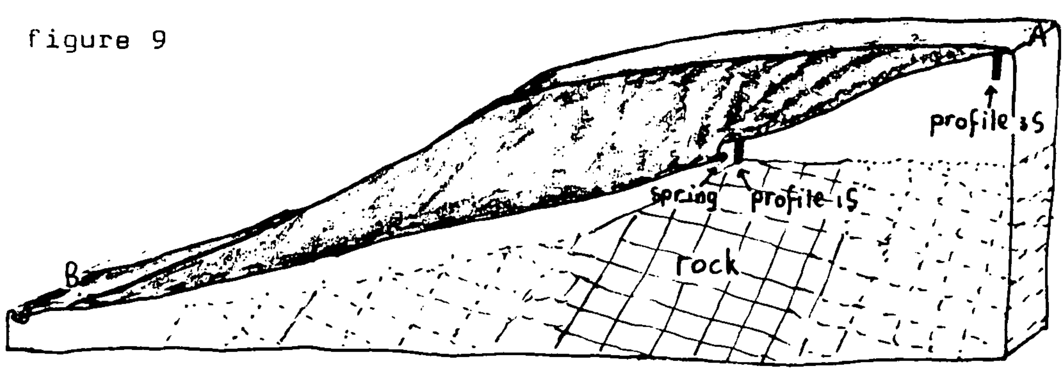
figure 8



Soil profile 3S is on the watershed near the top of the hill,and profile 1S is about 150 m downwards just above the spot where the water flows out of the rock.

cross section A-B :

figure 9



photograph on front page : spring and site of profile pit 1S.

Short description of the soil profiles.

Profile 1S

A very deep,dark reddish brown,very fine clayey soil with a good structure and a high biological activity.
A B_{2t} horizon is present.
One of its main characteristics is the great thickness of the A-horizon.
This soil occurs on the bottom of smaller valleys running down larger slopes.

Profile 3S

A very deep,dark reddish brown to yellowish red,very fine clayey soil with a good structure and a high biological activity.
A B_{2t} horizon is present.The thickness of the A horizon is not so great as in profile 1S.
This is the far most important soil in the area : it covers 67 % of the surface on the detailed soil map of the Magombo market area.

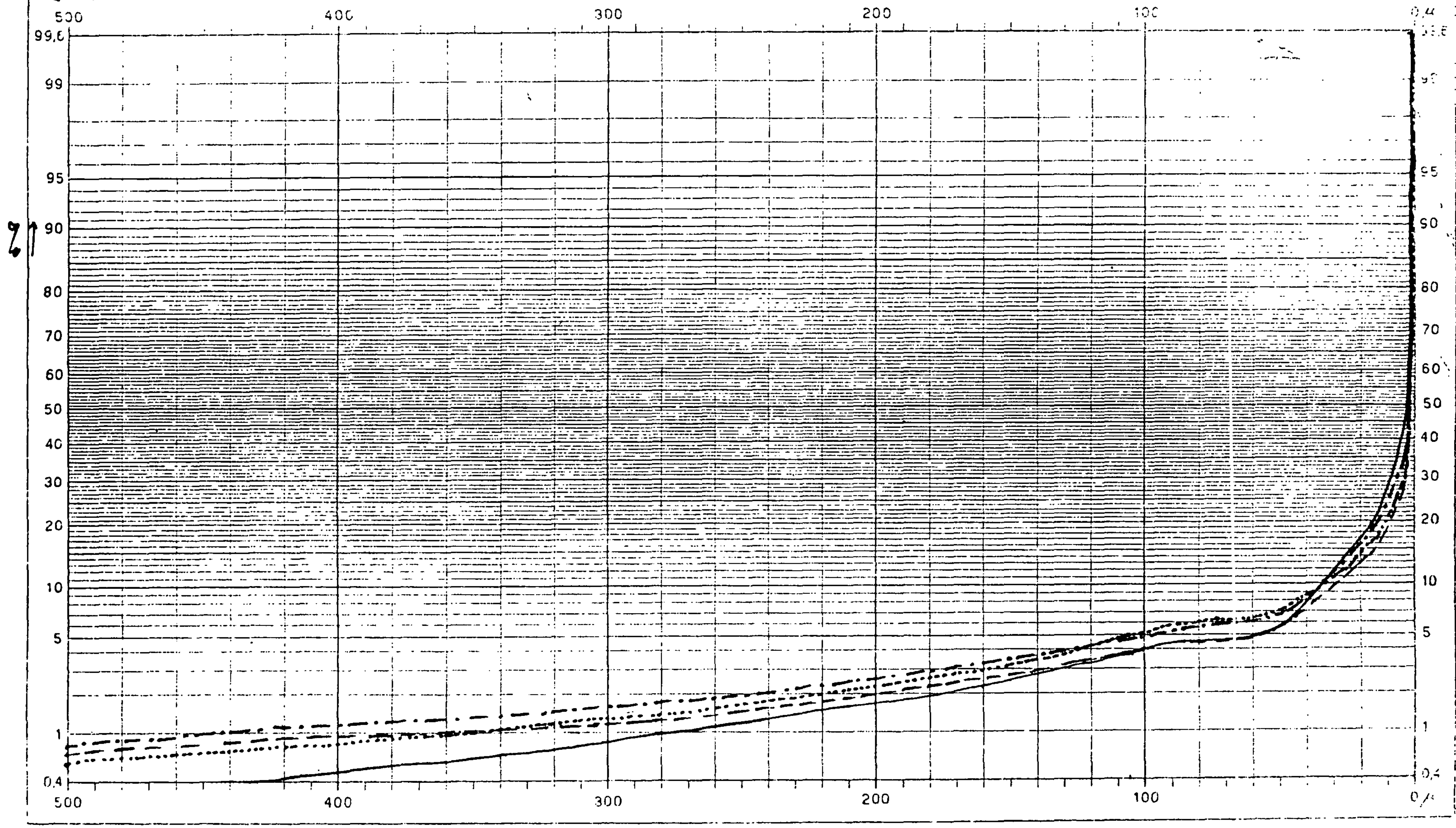
Spring

Some samples have been indicated by the word "spring".These samples have been taken from the surface of the spot where the water was flowing out of the rock.

-19a-

graph 3

Grain Size Distribution



profile 1S :

——— = $A_{1,1}$ 35-40 cm depth.

- - - - = $B_{2,3}$ 320-325 cm "

profile 3S

-·-·-·- = $A_{1,1}$ 40-45 cm depth.

·········· = $B_{2,2}$ 340-345 cm "

3.2. Results and Discussion

3.2.1. Texture

Profile 1S has a clay content (%< 2μ) of 50 % of the fine earth fraction in the A_1 horizon,and 60-70 % in the B_2 horizon.Beginning from the top of the B_3 horizon the clay content is gradually decreasing downwards (from 50 to 29 %).
The clay content in the $B_{2,1}$ is low (29 %) because in this layer iron concretions are present in the sand fraction.
The requirements for an argillic horizon are present :
The argillic horizon contains about 20 % more clay than the A horizon (must be at least 8 % more),and it has oriented clay in 1 % or more of the cross section.(see thin section research)

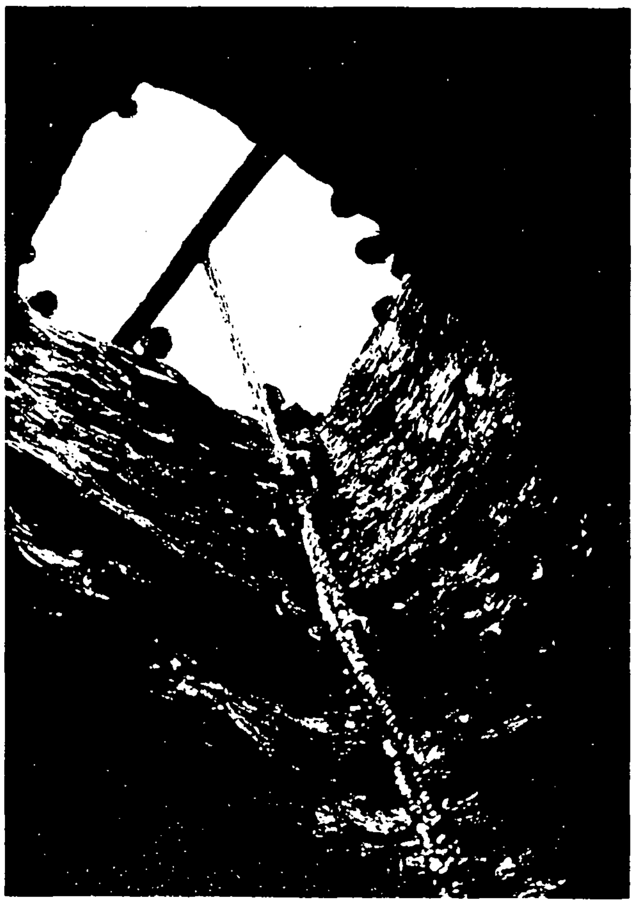
At the surface of the spot where the water is flowing out of the rock,the clay has been washed out.This sample has a clay content of only 10 % and should have about 40 % clay,which is the content of the corresponding layer in profile 1S.

Profile 3S
The percentage of clay in the A_1 is 62 %,in the B_2 73 % and a decrease downwards was not yet obvious on the bottom of the profile pit : still 70 % on 740 cm depth.
The B_2 meets some requirements for an argillic horizon : it has oriented clay in 1 percent or more of the cross section (see thin section research).However it is not clear whether the B_2 horizon meets the requirements for clay content of an argillic horizon or not,because the percentage of fine clay has not been determined. If the total clay content exceeds 60 % in the eluvial horizon,the argillic horizon must have at least 8 % more fine.clay.
On account of the oriented clay in future the B_2 will be considered as an argillic horizon.

The graph on previous page shows the grain size distributions of two horizons of profile 1S and two corresponding horizons of profile 3S.
It can easily be seen that the plotted grain size distribution

of all horizons are quite similar.

for graph : clay content - depth ,see point 3.2.7.
for detailed results of texture analysis,see appendix.



photograph : view from the bottom of profile pit 1S

3.2.2. Mineralogy of the clay fraction

Mineralogical research has been done on the clay fraction of a number of samples by means of the x-ray diffraction method.

preparation of the samples :
The cations on the clay were exchanged by Mg^{++} ions.After x-ray diffraction records some samples were treated with glycerol,and some with K^{+} ions and heatened till 600 °C.

Profile 1S
The 7 Å clay mineral kaolinite is present all over the profile, and it is dominant from the surface to a depth of 650 cm.
On 500-650 cm depth some montmorillonite clay is present,and the amount of it is increasing downwards to be dominating from a depth of 750 cm.
There is a little bit of illite (10 Å) and possibly some chlorite.
Concerning the non-clay minerals : all samples contain a small amount of quartz and feldspars and goethite is also present.

Profile 3S
Kaolinite is dominant in all samples.
Small amounts of quartz and feldspars occur.

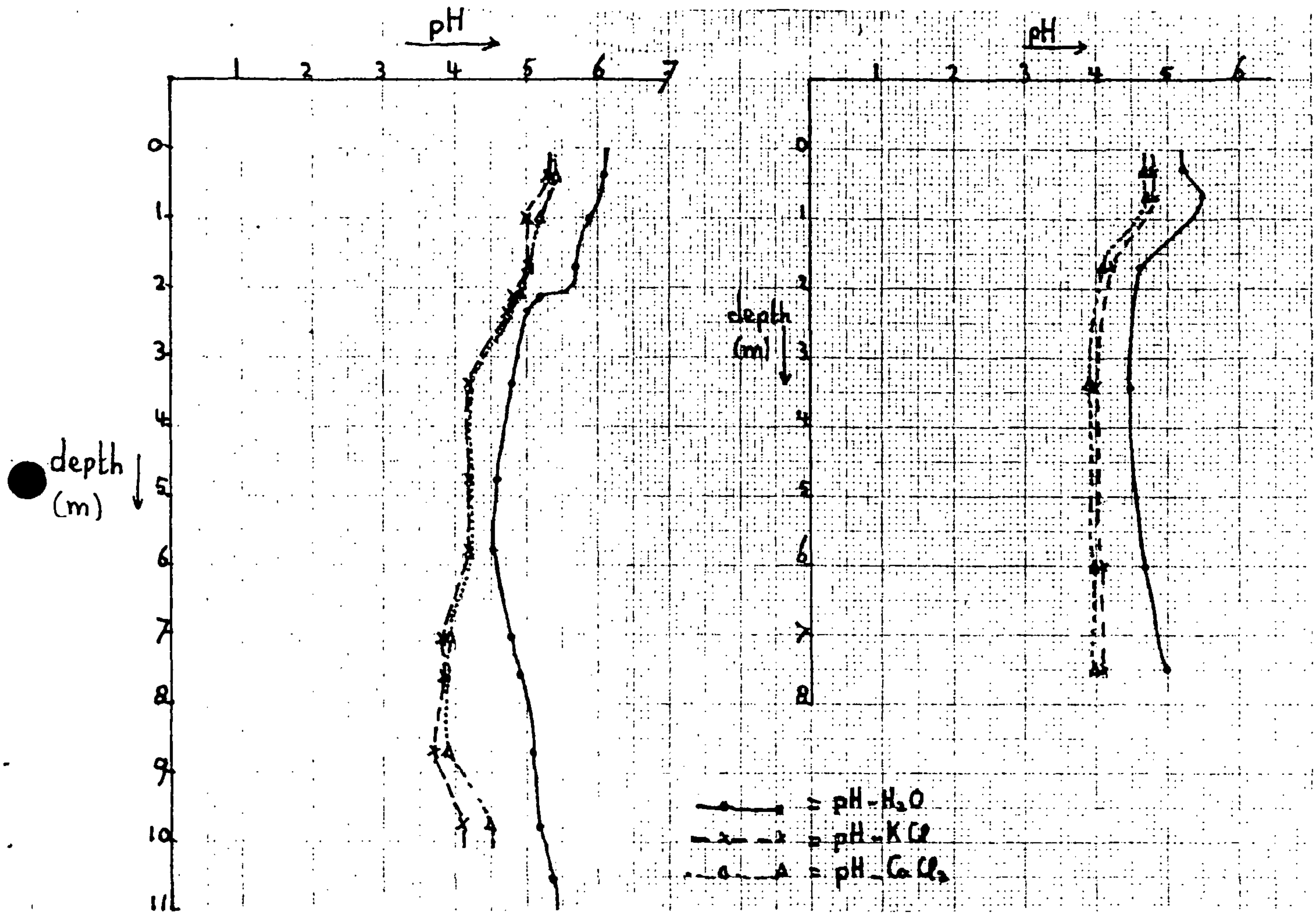
Summary of the results :
In the samples from profile 3S the clay mineral kaolinite is dominant,while in profile 1S a transition kaolinite-montmorillonite occurs.

for more detailed report : see appendix.

3.2.3. pH

The pH-H_2O , pH-KCl and the pH-$CaCl_2$ of all samples have been determined.
The graphs on page 22 show the results.
From 0 to about 600 cm depth the pH of profile 1S is higher than that of profile 3S;below 600 cm there is not much difference in pH.

Graphs : pH - depth (m)



graph 4 ; profile 1S

graph 5 : profile 3S

Remarkable is the quick decrease in pH-H_2O in profile 1S on 210-215 cm depth;on this depth a discontinuous iron pan is present. Another point of interest is ΔpH (pH-H_2O - pH-KCl).
In profile 1S ΔpH is relatively small between 2 m,the under boundary of the A_1 horizon,and 6 m depth from where montmorillonite clay is going to dominate.In profile 3S where a transition kaolinite-montmorillonite doesn't occur,ΔpH is nearly constant untill 5 m depth from where it is increasing.

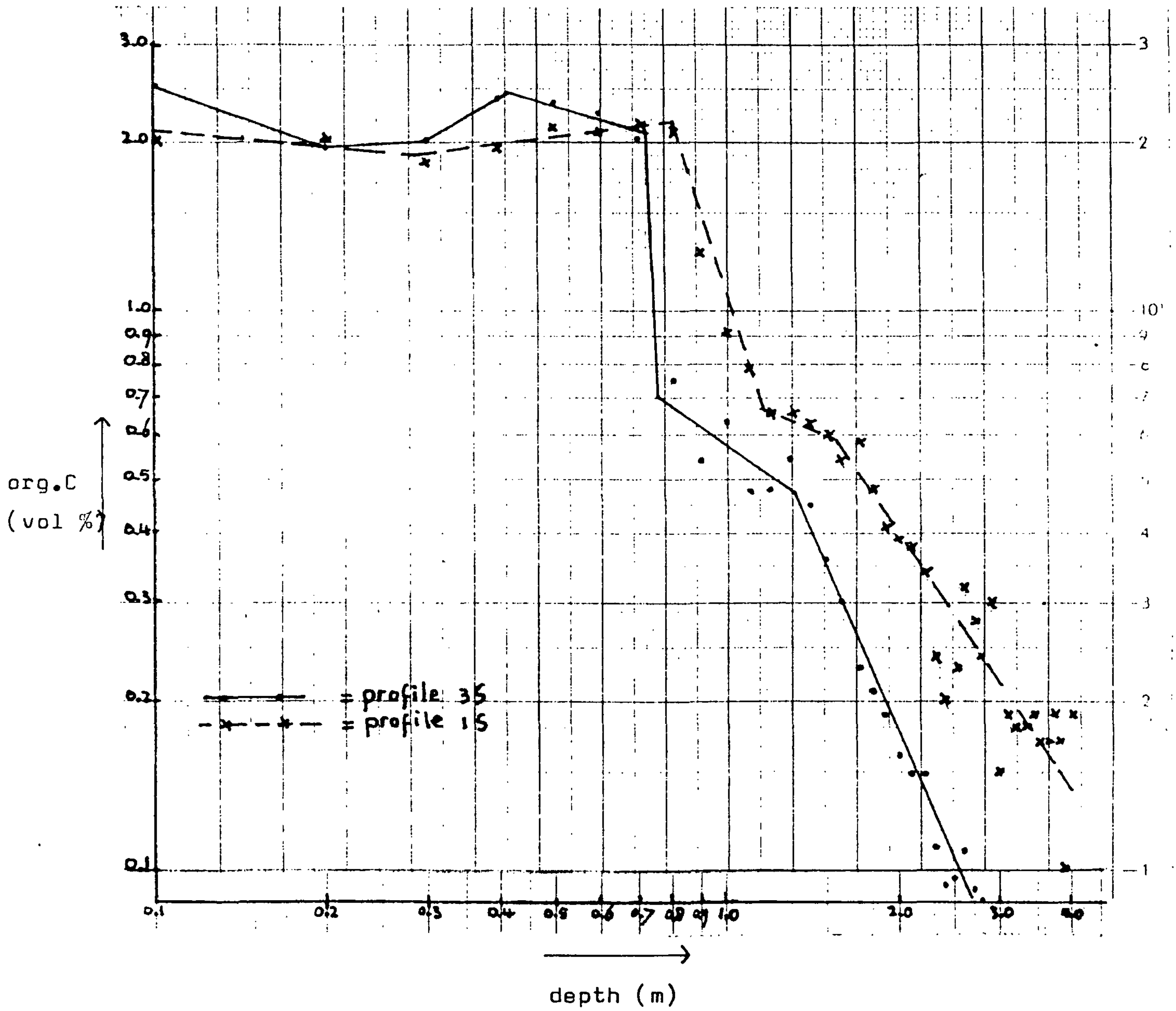
see appendix for analysis results.

3.2.4. Organic Carbon and Bulk Density

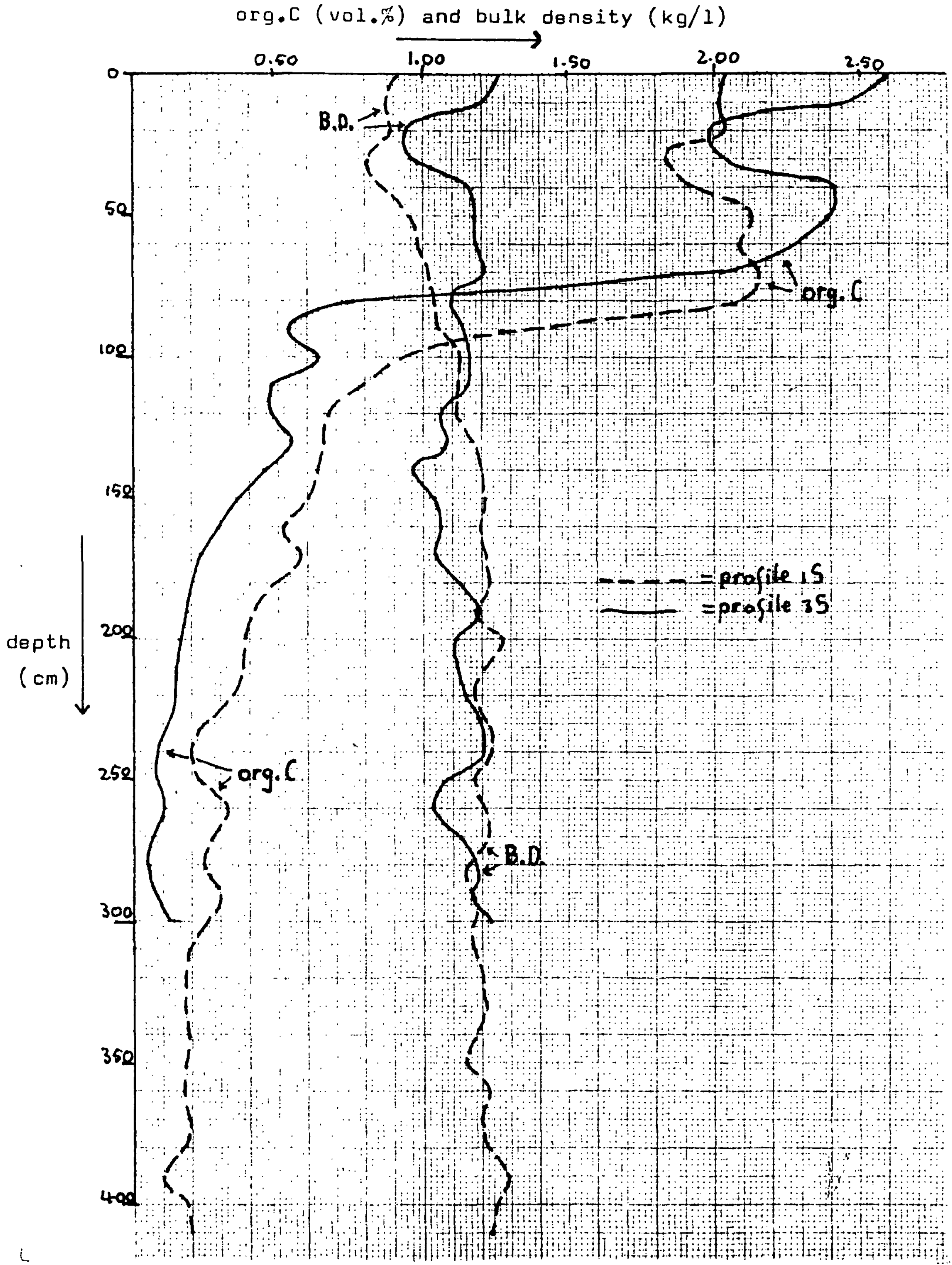
From each profile ring samples were taken every 10 cm up to a depth of 410 cm for profile 1S and to 300 cm for profile 3S. The bulk density (kg/l) and the organic carbon content of each sample have been determined;the organic carbon according the method of Walkley and Black.

The results are shown in the next two graphs.

Graph 6.depth (m) - organic carbon (vol %),on logarithmic scale.



Graph 7. depth (cm) - organic carbon content (vol.%)
depth (cm) - bulk density (kg/l)



The two graphs on page 23 and 24 show the quite similar organic carbon profile of the two soils.From 0 to 60 cm profile 3S has more organic C than 1S;below 60 cm profile 1S is higher in carbon content.

The bulk density of profile 1S tends to decrease towards the surface,while the b.d. of profile 3S doesn't show such a trend.

Both profiles show a significant decrease in organic carbon content in a layer just below the surface(profile 1S : 20-40 cm depth; profile 3S : 10-30 cm depth),accompanied by a decrease in bulk density while one should expect an increase in bulk density.This layer wasn't visible in the field.

Below the layer mentioned above the org.C content is higher,in profile 1S even higher than at the surface.In the graph depth-organic carbon on logarithmic scale(page 23) it can be seen that roughly between 20 and 100 cm depth there is more organic carbon than one should expect from the slope gradient of the straight lines just above and just beneath these depths.This could be an indication of a sombric horizon,but the layer doesn't fit the requirements for soil colour of the sombric horizon (lower value or chroma or both than the overlying horizon).However,also the possibility of a buried A_1 horizon should be kept in mind.because the appearance of ash rains in the past is not ruled out.

Because of the irregularity of the organic carbon content the soils have to be classified on subgroup level as "cumulic" instead of "pachic".

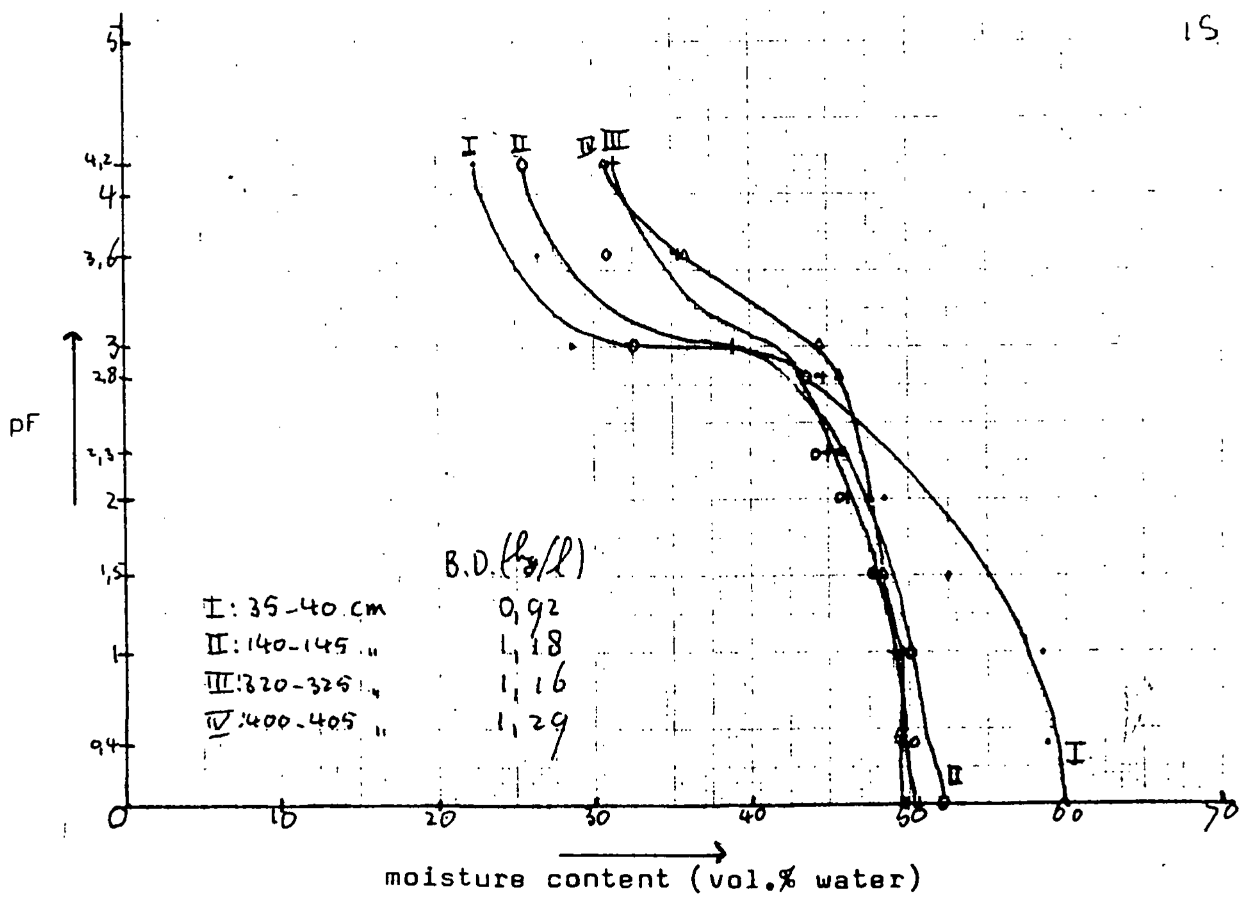
The A_1 horizons of both profiles meet the requirements for a mollic epipedon.However profile 3S is not a Mollisol because in some part of the argillic horizon the base saturation is less than 50 %.

For analysis results,see appendix.

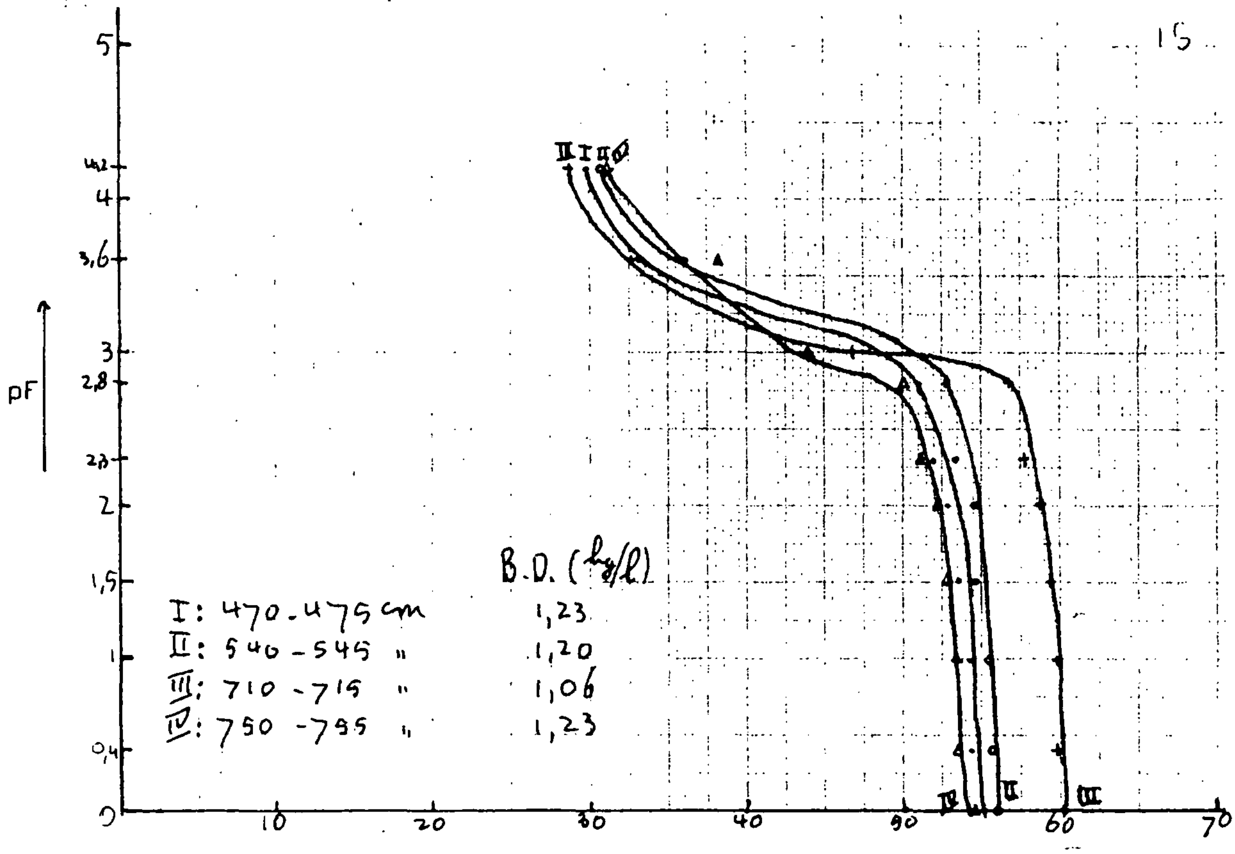
3.2.5. pF

In graph 8,9 and 10 the negative logarithm of the soil moisture tension (pF)has been plotted against the soil moisture content for various depths of the two profiles.
The moisture content at the permanent wilting point (pF 4.2) is still 20-35 %,consequently about one third of the soil moisture is not available for plant growth.
At the point of saturation (pF 0) the water content will be rather high : 50-60 %.
In profile 1S a relatively large amount of the water is held at about pF 3 and,except for the epipedon,only 5-10 % of the soil moisture is held in between pF 0 and pF 3.However,the big leap in soil moisture content at pF 3 could be caused by an analytical error due to different determination methods of pF 2.8 and pF 3.
The moisture content at field capacity (pF 2) in profile 1S is 45-55 % for the upper horizons and 52-60 % for the lower horizons.
Profile 3S shows a more gradually release of the soil moisture.
The moisture content at field capacity in profile 3S is 45-52 %.

Graph 8. :Profile 1S pF - soil moisture content

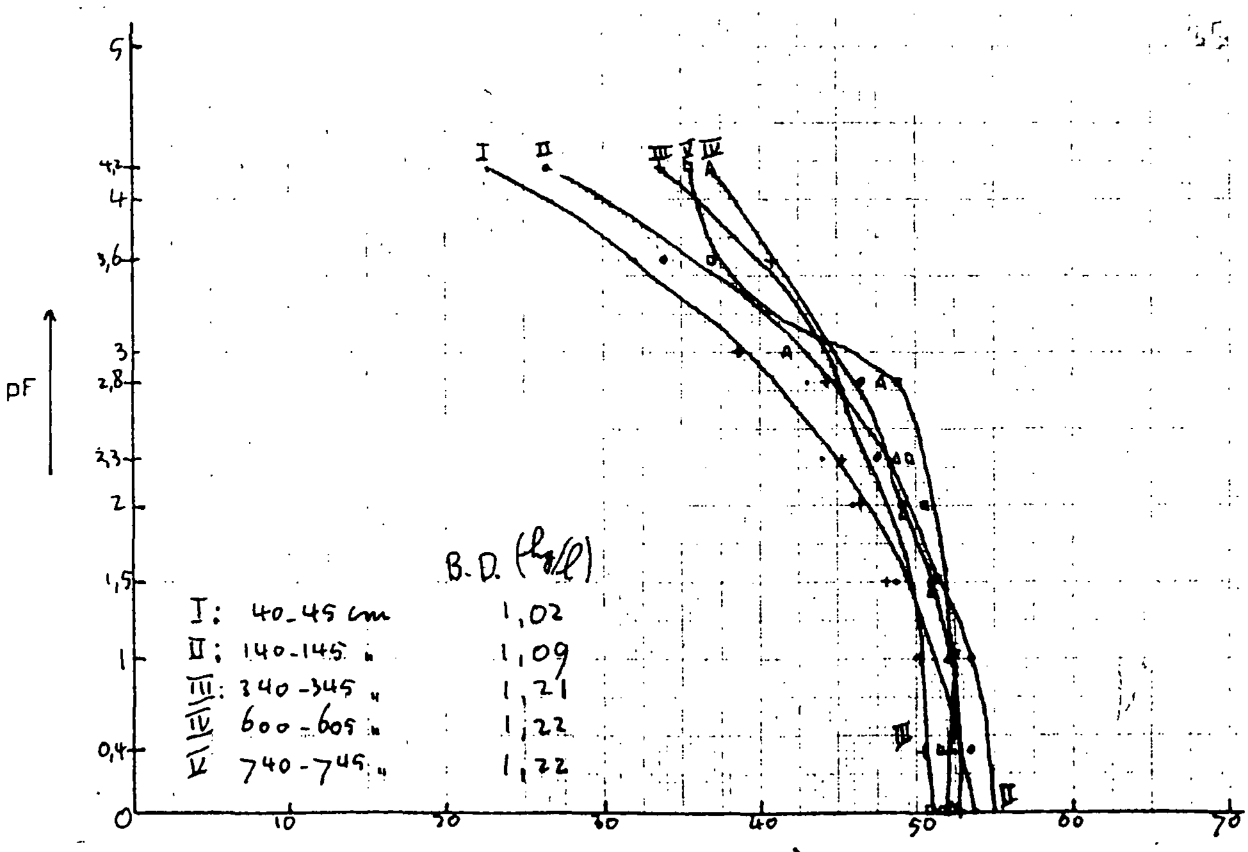


Graph 9:Profile 1S pF - soil moisture content



soil moisture content (vol.% water)

Graph 10 : Profile 3S pF - soil moisture content

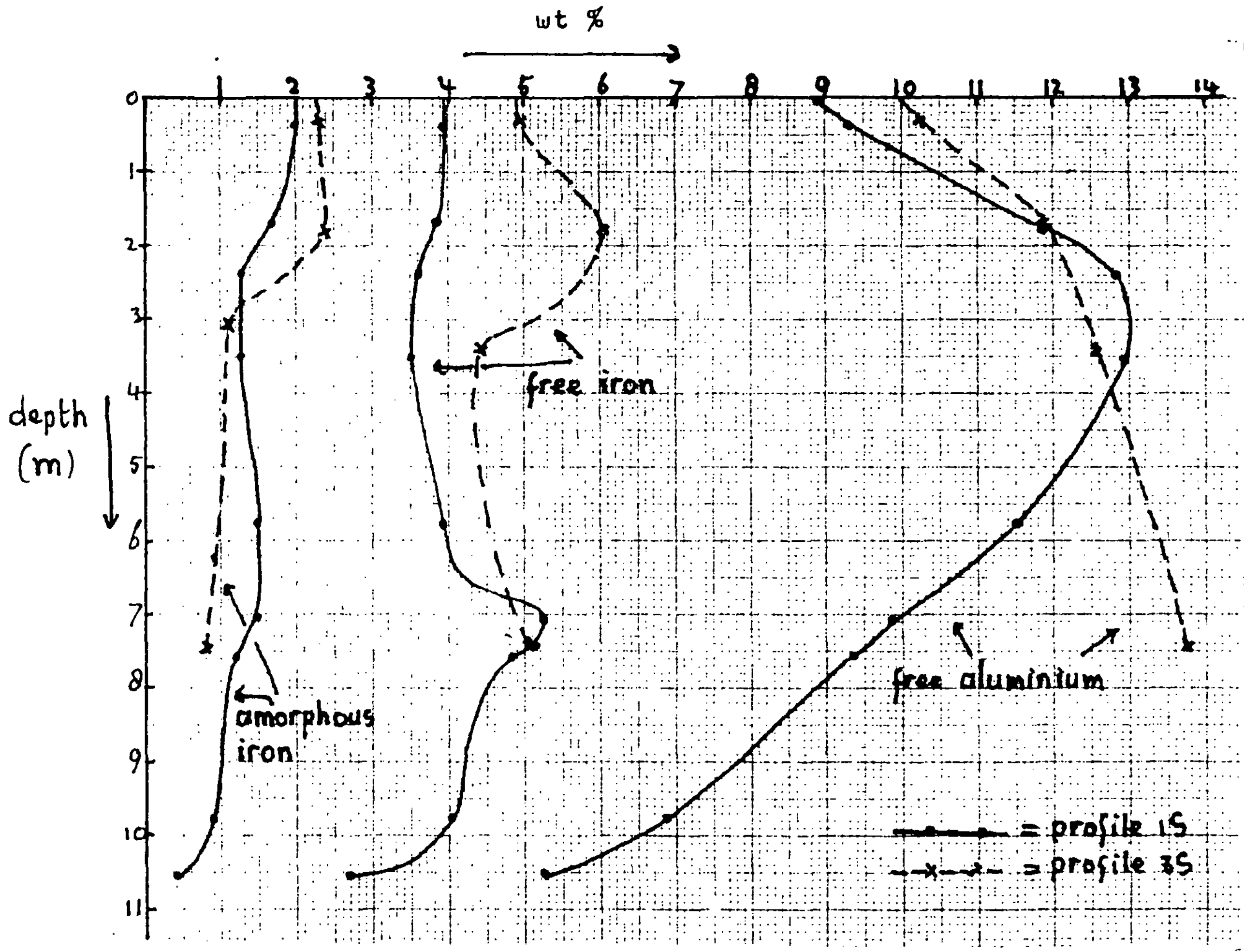


soil moisture content (vol.% water)

3.2.6. Free Iron and Aluminium and Amorphous Iron

On a number of samples the content on free iron and aluminium and on amorphous iron has been determined,using a Tamm solution according the method of Duchaufour et Souchier (1966) and Schwertmann (1964).
In the next graph all the results have been plotted against the depth below the surface.

Graph 11 : Free iron and aluminium and amorphous iron - depth.



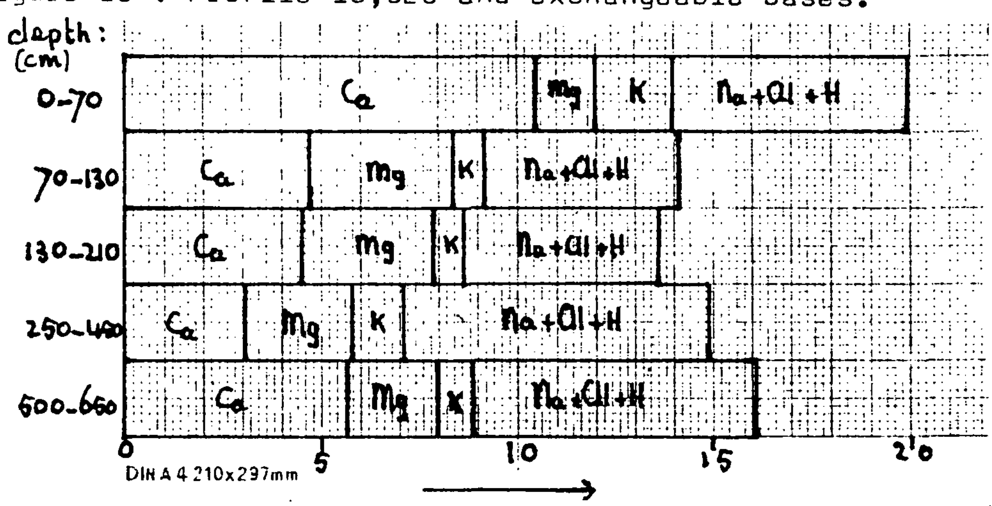
Both profiles show a decrease of amorphous iron with increasing depth.The free iron content of profile 1S is rapidly increasing in the zone of "rotten rock" on 650-730 cm depth;below this zone it is decreasing gradually.
In profile 3S the free iron content is first increasing untill 200 cm,than decreasing untill 350 cm depth and than increasing again downwards.

The conduct of free aluminium is quite opposite in the two profiles. Both contents increase untill 350 cm depth but downwards the content in profile 1S is strongly decreasing(from 13 to 5 %) while the content in profile 3S is still gradually increasing.
Norm calculations mostly indicated more than 15 % free iron (hematite + goethite),and chemical analysis maximal 6 %,consequently one of the two methods must be wrong.It is not ruled out that in the chemical analysis too little free iron has been determined.

3.2.7. CEC and Exchangeable Bases.

The CEC and exchangeable bases have been determined by means of the NH_4-acetate-pH 7 method.
In the next diagrams the values for the CEC and the exchangeable bases have been plotted.

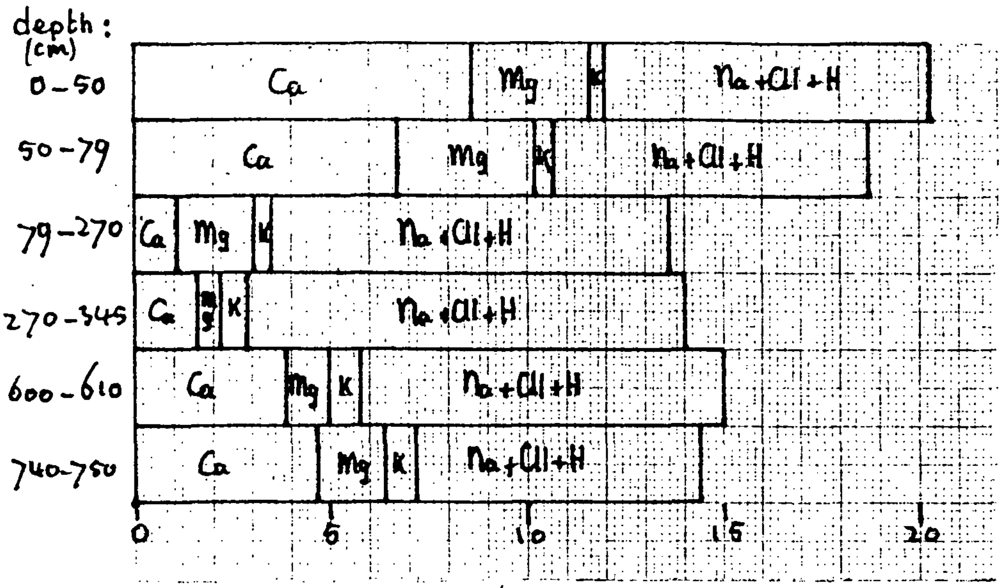
figure 10 : Profile 1S,CEC and exchangeable bases.



meq/100 g dry soil

The figures of CEC don't differ very much between the two profiles, but the figures of exchangeable bases do.
In profile 1S the amounts of exchangeable Ca,Mg and K of most horizons are higher than those of profile 3S,consequently the base saturation of profile 1S is higher than that of 3S (see table 1).

figure 11 : Profile 3S,CEC and exchangeable bases.



meq/100 g dry soil

table 1 : base saturation (%).

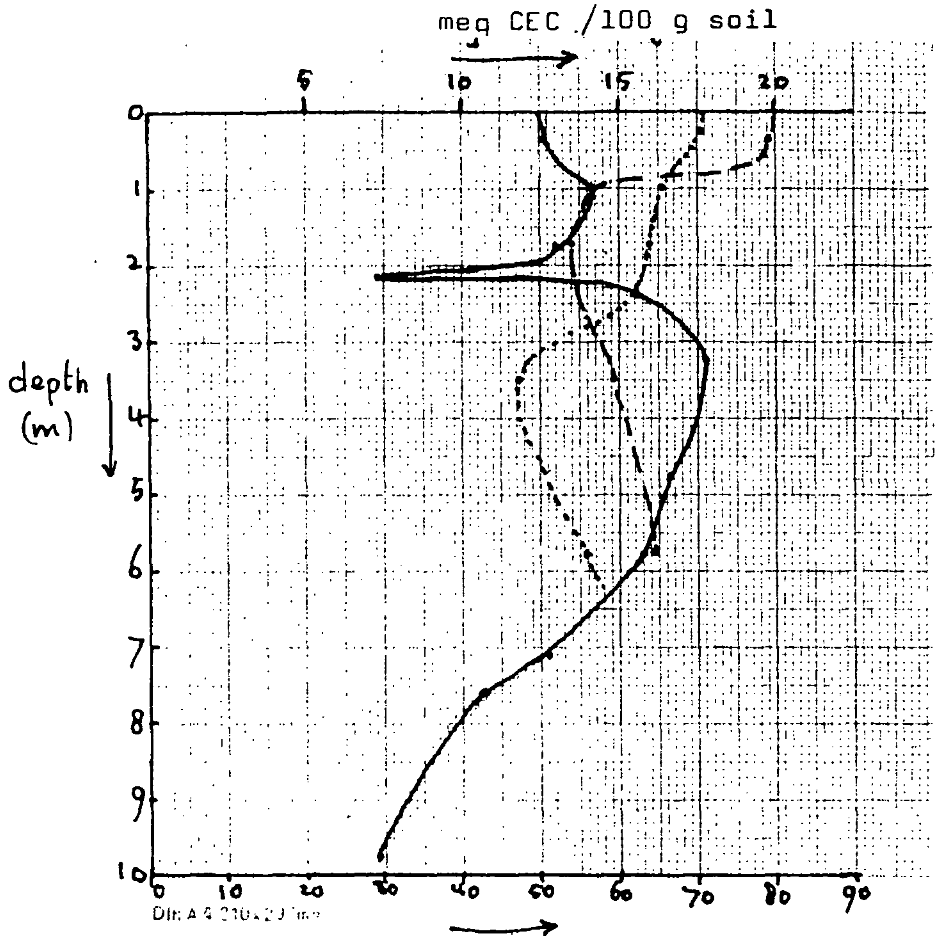
profile 1S			profile 3S		
depth	horizon	base sat.(%)	depth	horizon	base sat.(%)
0- 70	$A_{1,1}$	70.3	0-50	$A_{1,1}$	59.1
70-130	$A_{1,2}$	65.2	50-79	$A_{1,2}$	57.2
130-210	$A_{1,3}$	63.9	79-270	$B_{2,1}$	25.7
250-450	$B_{2,3}$	47.6	270-345	$B_{2,2}$	20.7
500-650	$B_{2,5}$	55.2	600-610	$B_{2,2}$	38.6
			740-750	$B_{2,3}$	50.0

The base saturation is very important for the classification of the soils.

Because profile 1S has an argillic horizon and the base saturation is more than 35 %,this soil belongs to the order of the Alfisols.

Profile 3S has also an argillic horizon but because the base saturation is less than 35 % within 180 cm below the surface of the soil (or within 125 cm below the upper boundary of the argillic horizon,whichever is least),it belongs to the order of the Ultisols.

Graph 12 : Percentages of clay and base saturation and CEC as a function of depth.Profile 1S



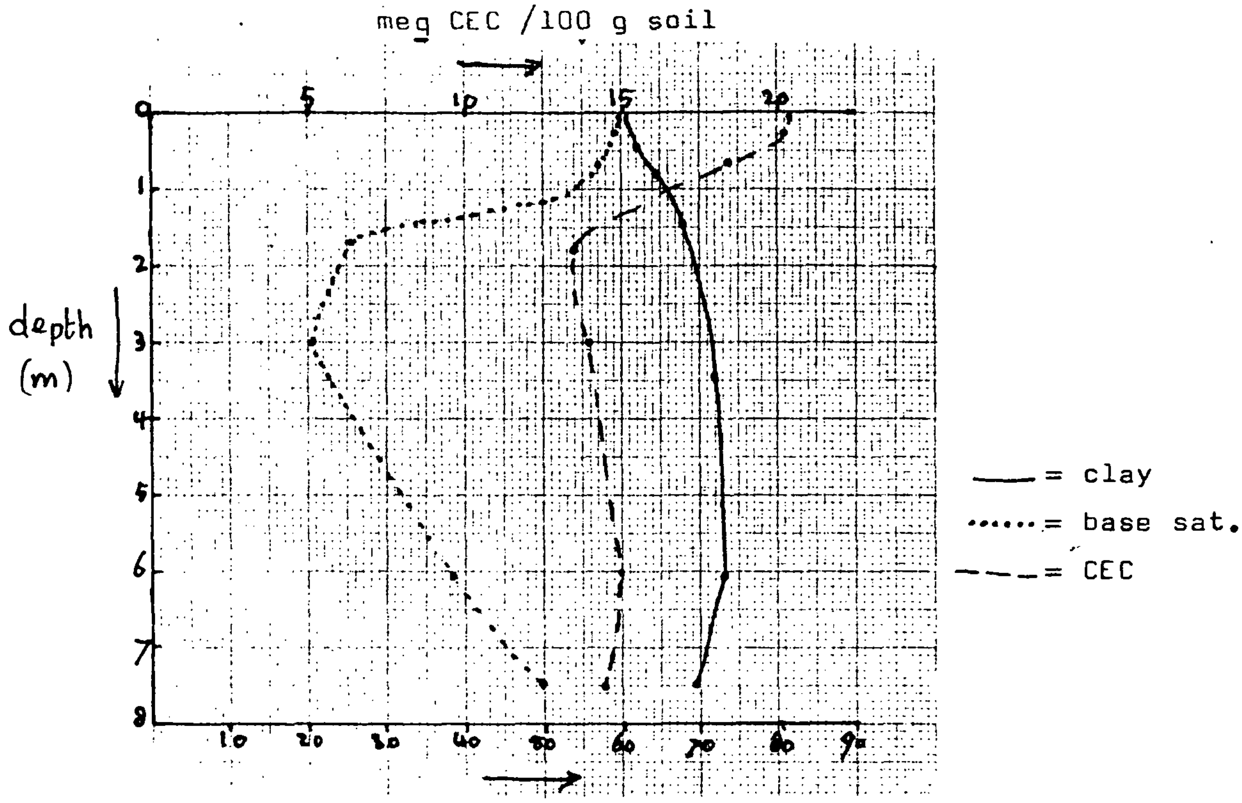
% clay and % base saturation

——	= clay
······	= base saturation
— — —	= CEC

Graph of profile 3S on next page.

For clay percentages see also point 3.2.1. texture.

Graph 13 : Percentages of clay and base saturation and CEC as a function of depth.Profile 3S

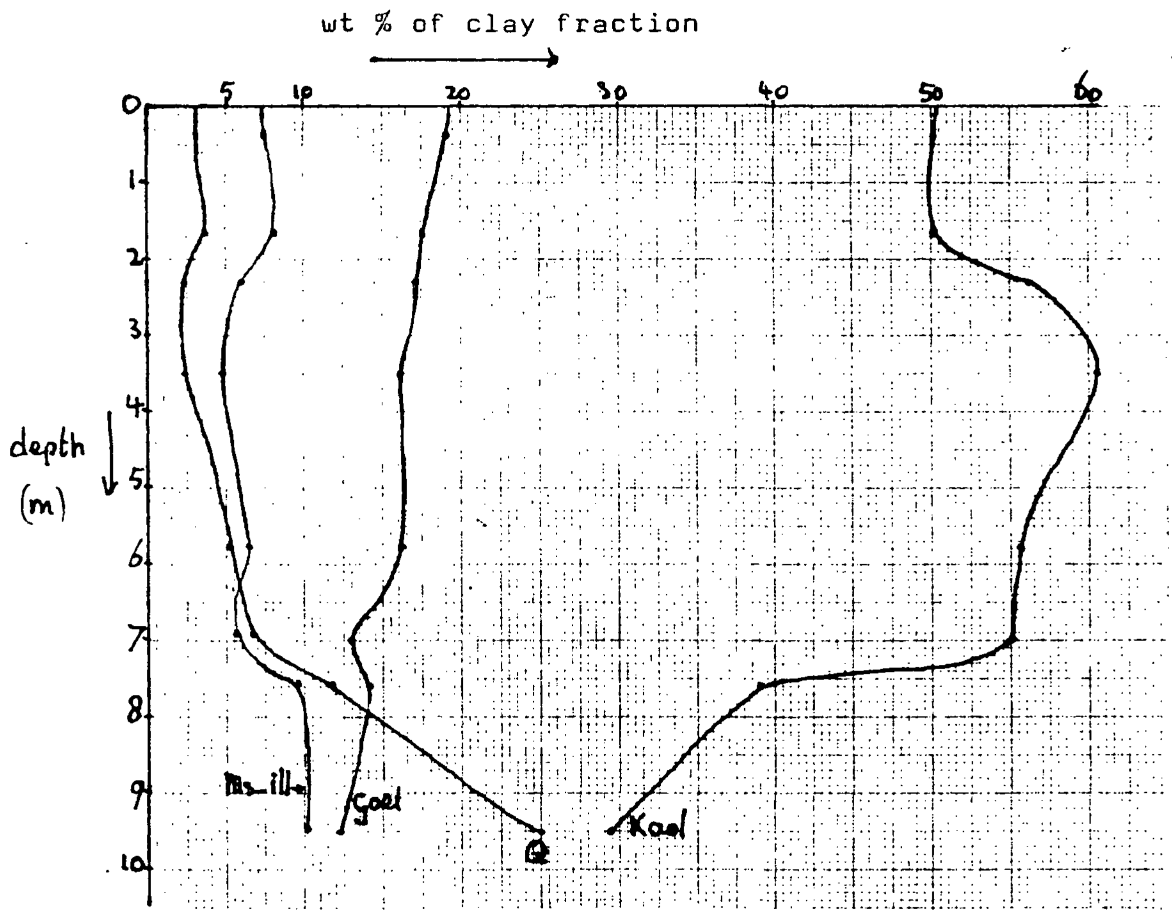


The pattern of the base saturation as a function of depth of profile 3S (graph 13) is typical for an Ultisol.The decrease in base saturation with depth untill about 350 cm reflects cycling of bases by plants or additions in fertilizers.
The high base saturation and CEC in the upper horizons of both profiles can also be explained by deposition of volcanic ash by ash rains in the past.An early product in the weathering of volcanic ash is allophane which has a high exchange capacity in a system buffered at pH 7.
Both soils have a mollic epipedon,but profile 3S cannot be classified as a Mollisol because the base saturation in the argillic horizon is less than 50 % within 180 cm depth(or within 125 cm below the upper boundary of the argillic horizon,whichever is least).

3.2.8. Oxides and Norm Calculation

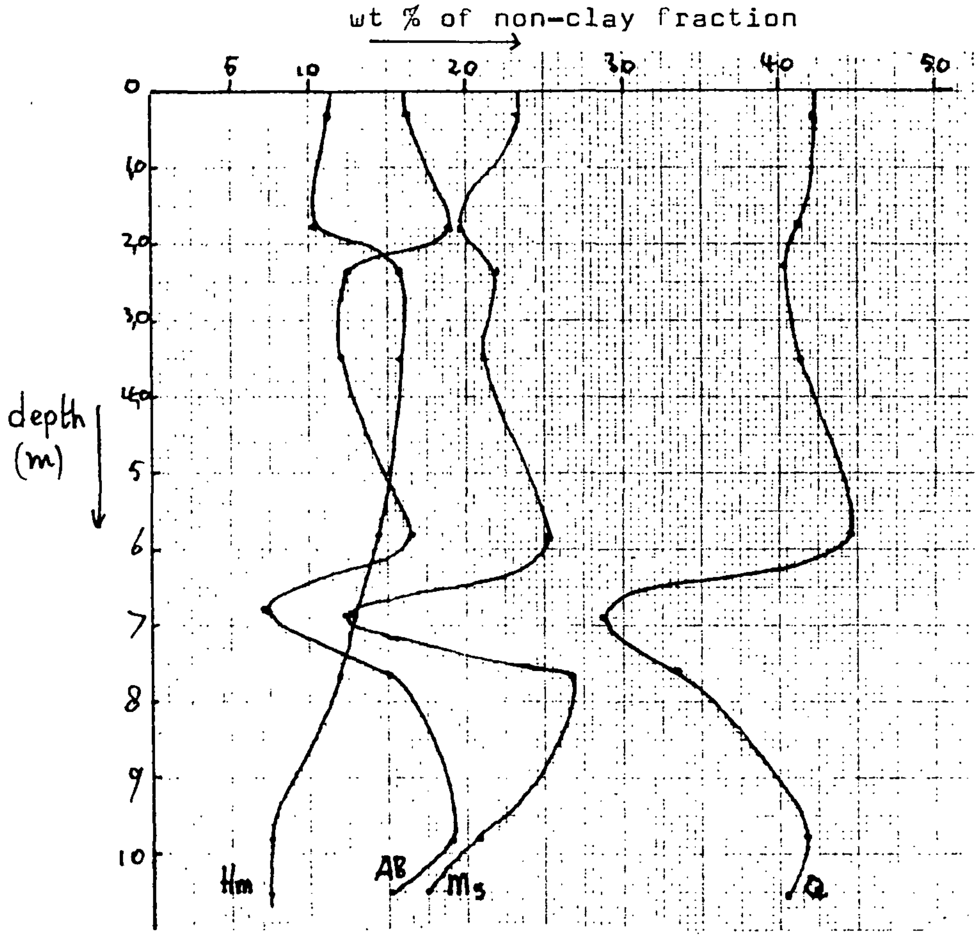
On a number of samples the percentages of twelve oxides have been determined (see appendix).
The percentages of the oxides have been used in norm calculations.
The goethite norm calculation of the clay fraction and the epinorm calculation of the non-clay fraction were carried out by the computer;the kata norm calculations of the non-clay fraction were carried out by hand.
Graph 14,15,16 and 17 show the profiles of the most important norm-minerals of each soil.

Graph 14 : Profile 15,most important goethite norm minerals of clay fraction.

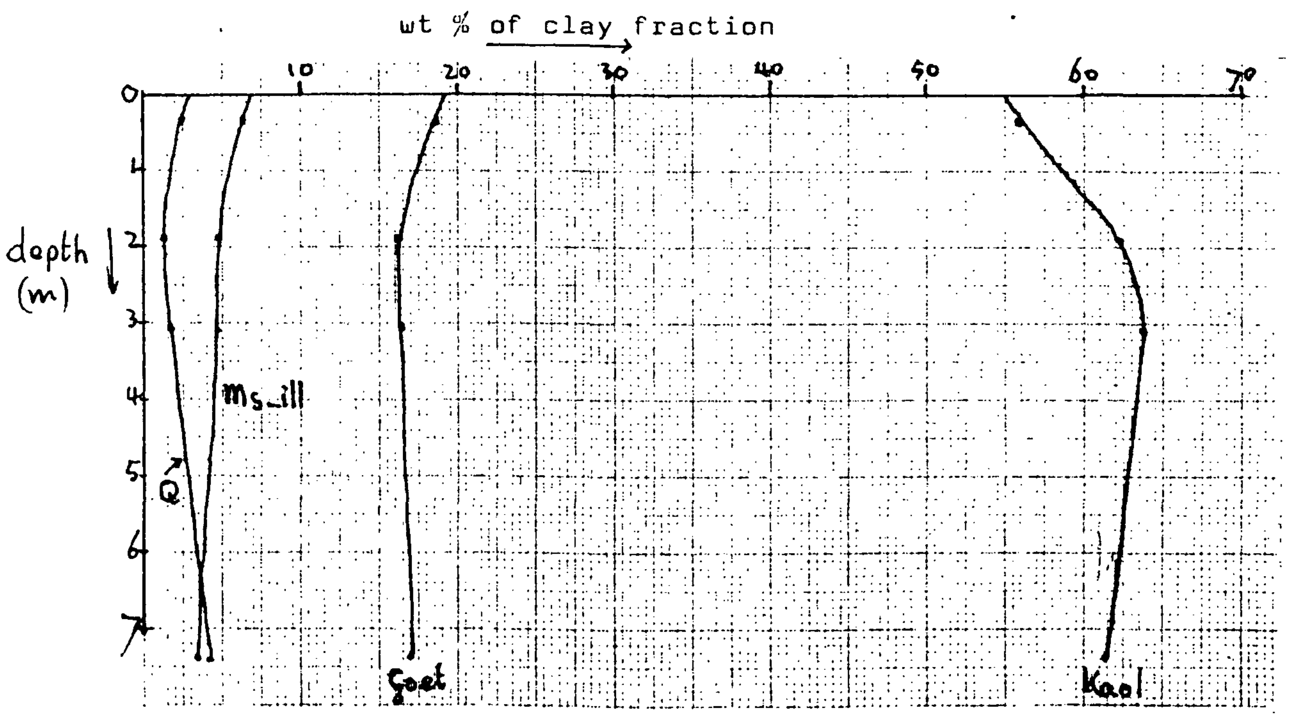


For explanation of the symbols used,see page 35.

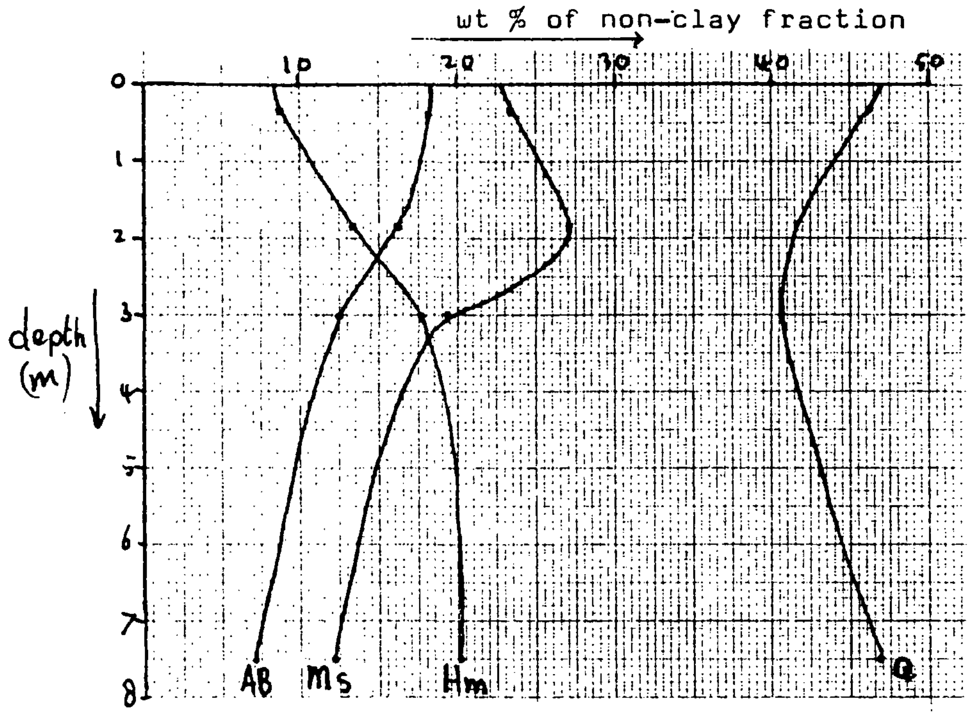
Graph 15 : Profile 1S, most important epi-norm minerals of non-clay fraction.



Graph 16 : Profile 3S, most important goethite norm minerals of clay fraction.



Graph 17 : Profile 3S,most important epi-norm minerals of non-clay fraction.



Explanation of the symbols :

AB	= Albite	MM	= Montmorillonite
Aug	= Augite	Ms	= Muscovite
C	= Corundum	Ms-ill	= Muscovite (illite)
CP	= Ca-Phosphate	Or	= Orthoclase
F	= Feldspars(AB+Or)	Q	= Quartz
Goet	=Goethite	Ru	= Rutile
Hm	= Hematite	Str	= Strengite
Kaol	= Kaolinite		

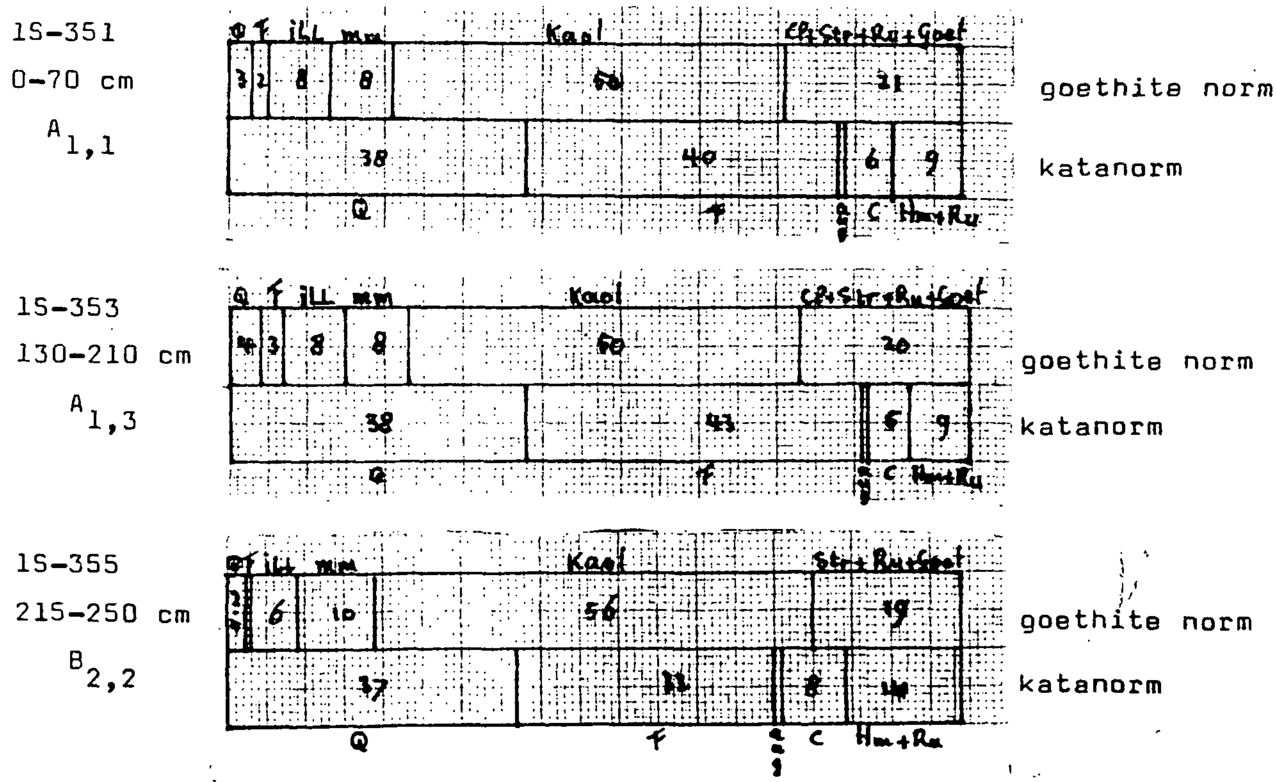
In the epi-norm as in the goethite norm an excess of water of 2-6 % occurs.
Since the soils were influenced by volcanic ash(see thin section research) a kata-norm calculation was carried out.
The diagrams in figure 12 and 13 show the percentages of kata-norm and goethite norm minerals for a number of samples.
The kata-norm would give a probable mineral composition of volcanic ash.
From the kata-norm can be concluded :

Without soil forming processes the ash would probably have a composition of : 30-40 % Feldspars (F);30-40 % quartz;0.5-4 % Augite.
There is a shortage of Calcium for the formation of Augite.
An excess of aluminium (C = Al_2O_3) occurs.

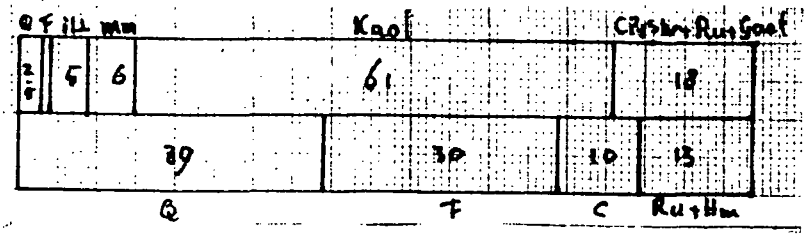
Comparison of the katanorm with the goethite norm gives :
SiO_2 has been build in in clay minerals.
All the available iron from Augite has been transformed into goethite.
The Feldspar content decreases to just a few percentages as the result of building in of Potassium in illite.
In the katanorm an excess of Carborundum (Al_2O_3) occurs;in the goethite norm this has been partly bound,together with quartz,into Kaolinite.

Amorphous Allophane can occur,especially in the under part of the soil profiles,by addition of volcanic ash.The norm analyses don't indicate such an occurrance.
With x-ray diffraction analysis amorphous Allophane cannot be proved,however in the thin section research some amorphous material has been reported.

figure 12 : Profile 1S,diagrams comparing the percentages of katanorm minerals with percentages of goethite norm minerals.

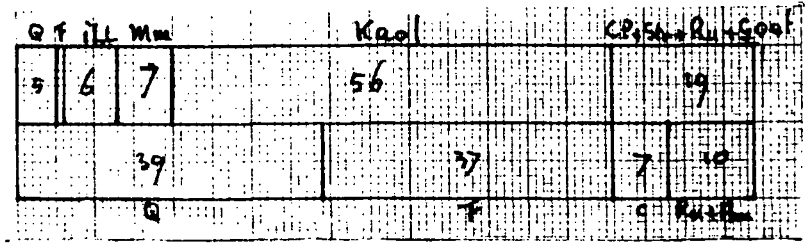


1S-356
250-450 cm
$B_{2,3}$



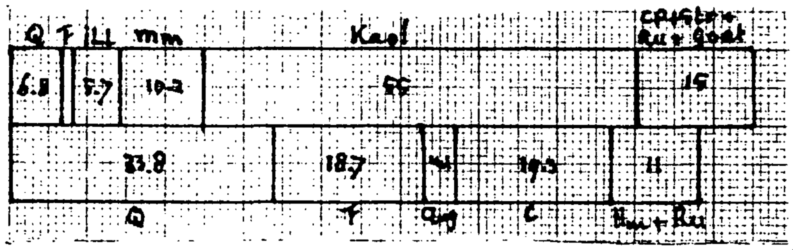
goethite norm
katanorm

1S-358
500-650 cm
$B_{2,5}$



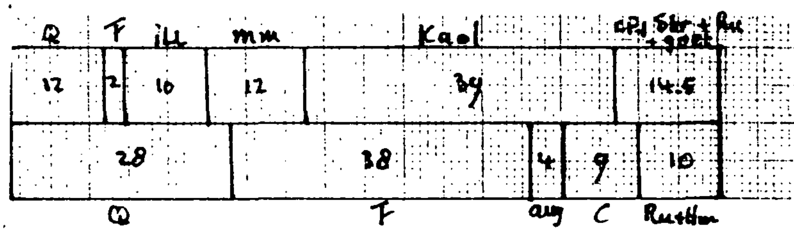
goethite norm
katanorm

1S-359
650-710 cm
$B_{3,I}$



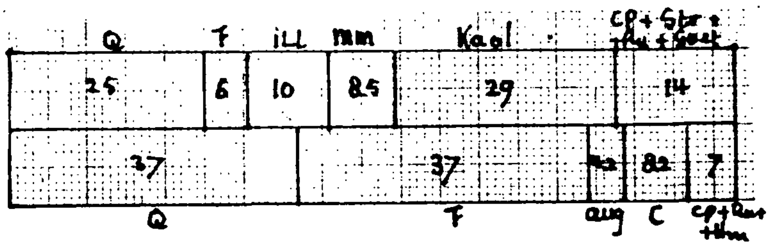
goethite norm
katanorm

1S-360
750-760 cm
$B_{3,2}$



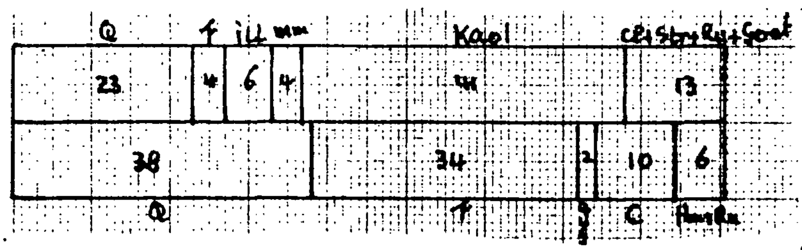
goethite norm
katanorm

1S-361
950-1000 cm
B_3



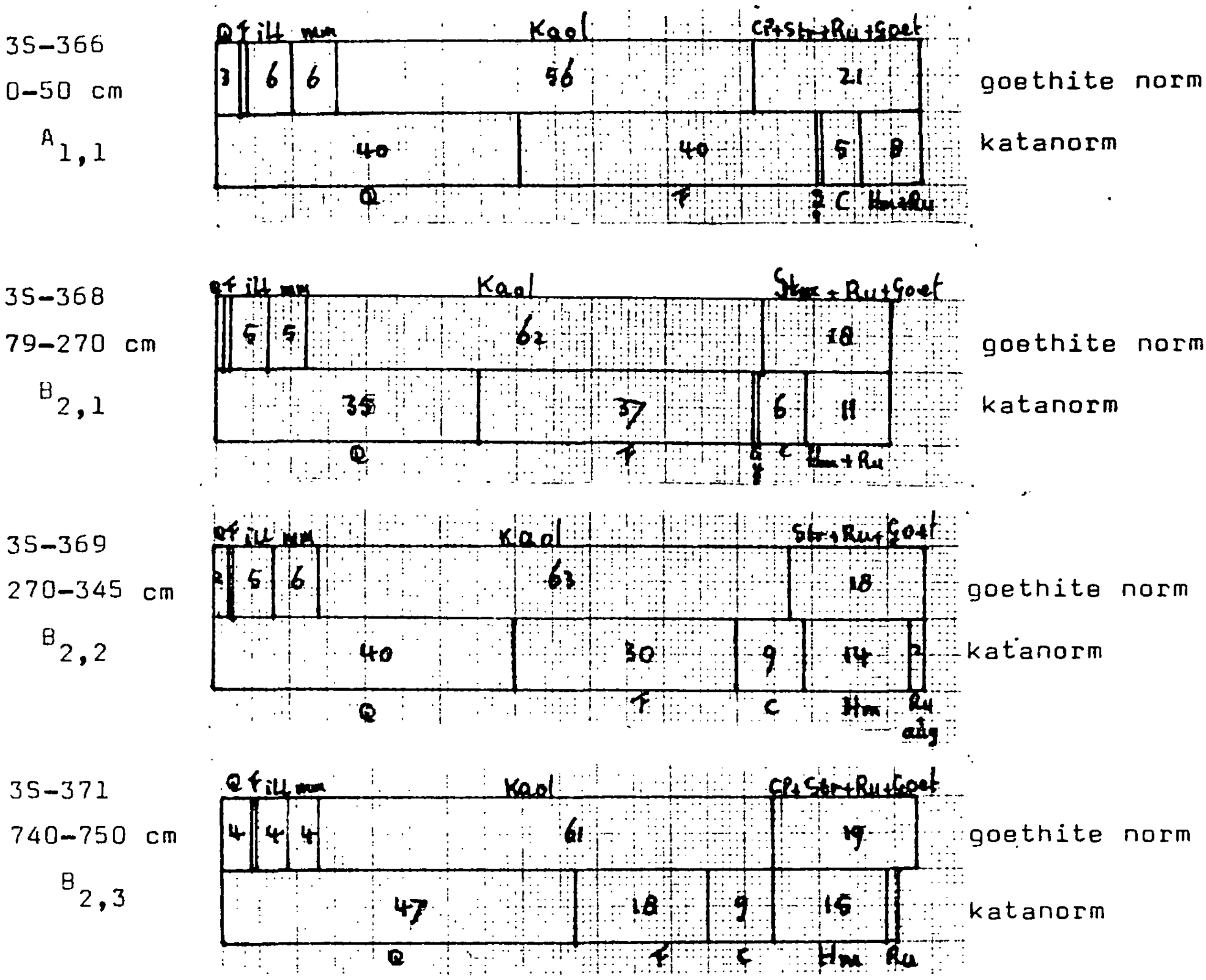
goethite norm
katanorm

364
surface
spring



goethite norm
katanorm

figure 13 : Profile 3S ,diagrams comparing the percentages of katanorm minerals with percentages of goethite norm minerals.



3.2.9. THIN SECTION RESEARCH

thin sections nr. : 75/284 - 291 Kisii,Kenya

contents :

3.2.9.1.

SUMMARY

Profile 1S

The plasma of soil material consists of clayminerals and iron. Grains of chert,quartz,quartzite and feldspars occur in the soil material;they are possibly deposited by ash rains.
The rotten rock has the structure of sandstone;according to van der Plas the most likely parent material of this profiles is a comprimated and indurated tuff layer.
The biological activity is still high on 390 cm depth(thin section 75/284)but is then gradually decreasing with the depth;on 700 cm there is only a few biological activity.
On 700 cm depth the groundmass consists of two components: a. soil material b. pieces of rotten rock ; the number of pieces of rotten rock is increasing from that depth and the rotten rock is going to dominate on 760 cm from the surface.
Three types of clay cutans occur in this profile:
a. clay-iron cutans caused by illuviation,mainly in soil material.
b. clay cutans caused by weathering,mainly in pieces of rotten rock.
c. Very thick "waxy" cutans occur on 700 and 760 cm depth(thin section 75/285,286 and 287)probably originating from dissolved volcanic ash.
If the cutan types a. and b. occur together, a. is always covering b.
Throughout the profile cutans of iron and manganese occur and formation of these hydromorphic features seems to be the last process.

Thin section 75/287,sampled from the surfaçe of a spring cutting is essentially the same as 75/286 (profile 1S),but the clay has been washed out.

The shape of the iron and manganese nodules is an indication for displacement,possibly as the result of biological activity,of soil material.

Profile 3S

The plasma consists of clayminerals and iron;the grains have the same mineralogical composition as in profile 1S.
There is no rotten rock found in the under part of the profile like in profile 1S,so it is not obvious what the parent material is but it is very likely that the parent material is the same as in profile 1S :indurated tuff.

The biological activity is high;plant roots are found on 400 cm depth. Only clay-iron cutans are found in the profile;in 289 "waxy"diffuse cutans were found,they are not so thick like in profile 1S but probably they have the same origin:from dissolved volcanic ash. Cutans of iron and manganese occur and their formation seems to be the last process here also.

The shape of nodules of iron and manganese indicates displacement of soil material;this displacement can be caused by biological activity.

3.2.9.2.

PROFILE 1S

thin sections:	horizon:	depth(cm):
75/284	B2,3	381-396
75/285	B3,1	695-710
75/286	B3,2	750-765
75/287	B3	surface(spring)

DESCRIPTION OF THE THIN SECTIONS

A Groundmass

284 :soil material

285 :soil material and pieces of rotten rock.

286 :rotten rock showing rock structure with heavy weathering.

287 :idem as 286.

Skeleton grains:

size			mineralogical composition :
:284	30-800	micron	many feldspars;chert fragments;
285	30-1000	"	quartz.
286	30-100	"	
287	30-200	"	

Angular,low spherecity,in a random distribution pattern,286 locally in a banded distribution pattern,most of them weathered,some of them covered with iron oxides.Thin section 285 has only a few skeleton grains, 287 is very rich on silt sized grains.

Plasma :

284 :The plasma consists for the greater part of pedorelicts in different stages of soil forming (see pedorelicts),and is porfyroskelic basic fabric,asepic-undulic.
mineralogical composition :clay minerals and iron.

285 :The groundmass has two components: a. soil material b. pieces of rotten rock.
plasma soil material:asepic,clay minerals and iron.
rock :papulic fabric,clay minerals.

286 :asepic and papulic,clay minerals.

287 :papulic , clay minerals.

Plasma Reorientations

284 : weak ; gleesepic,skelsepic,channel vosepic and masepic.

285 : planar vosepic,skelsepic.

286 : skelsepic,masepic,glaesepic,planar and channel vosepic.

287 : locally a little bit channel vosepic.

Voids

284 and 285 : compound packing voids,channels,vughs,interconnected vughs,skew planes,craze planes.

286 : channels,vughs,interconnected vughs,skew planes, craze planes.

287 : idem as 286 except for the interconnected vughs.

B. Special Features

(Ferri-)argillans;papules;quasicutans.

284 :Distinct,moderately strong continuous orientated,channel and plane ferri-argillans,10-50 micron thick,sharp outer boundary and derived papules and identical quasicutans.
Some ferri-argillans have a much higher iron content and consequently a much lower birefringens.

285 ;Distinct,strong continuous orientated ferri-argillans and argillans,10-400 micron thick,in channels and planes.The argillans mostly don't show any sign of layering.
In rotten rock : normal void argillans and ferri-argillans.
The illuviation of red ferri-argillans seems to be the last process,because if they occur together they cover the white argillans.
Papules from argillans,10-300 micron diameter,most frequently occurring in patches with silt rich material.

286 :Distinct,strong continuous orientated ferri-argillans and argillans,10-500 micron thick,ferri-argillans locally up to 5000 micron thick;the argillans occur in a flecked orientation pattern.
Papules,10-200 micron thick,derived from the (ferri-)argillans, are most frequently occurring in bands of silt-rich material.

287 :Distinct,strong continuous orientated,ferri-argillans and argillans,10-200 micron thick;argillans often cover ferri-argillans.

Other Illuviations :

285,286 and 287 : Very thick,50-5000 micron, "waxy"cutans ,probably proceeded from dissolved volcanic ash.

Matrans

284 :Matrans in channels and planes;they cover ferri-argillans, and sometimes the ferri-argillans cover the matrans.

286 and 287 : A few matrans in channels.

Pedotubules

284 : Distinct ortho-matric aggrotubules,1-5 mm diameter.

285 : Distinct ortho-matric isotubules.

C. Hydromorphic Features

Quasi- and/or neoferrans/mangans

284,285 and 286 : Distinct channel and plane neoferrans/mangans in a clustered distribution pattern and locally covering the ferri-argillans,thickness : 284 : 10-50 micron;285 and 286 : 10-200 micron;they have a sharp outer boundary.

287; idem,but with diffuse outer boundary and 10-100 micron thick.

Sharp Nodules

284 : Sharp rounded ferric/manganiferous nodules,30-3000 micron diameter,with high spherecity.

285 : Sharp rounded,subrounded and angular ferric/manganiferous nodules,30-1500 micron diameter,with high sphericity.They occur most frequently in patches which are rich on papules and silt sized materials.

286 : idem as 284 but with 1-5 mm diameter,and : sharp angular ferric/manganiferous nodules,30-200 micron diameter,with high sphericity.

287 : idem as 284 but 100-5000 micron diameter and with high and low sphericity.

Diffuse Nodules

284 : Diffuse ferric/manganiferous nodules 10-100 micron diameter with high sphericity.

285 : idem but with diameter 30-1000 micron,and in a clustered distribution pattern.

286 : idem as 284 but diameter 30-400 micron.

287 : " " " " " 30-300 " .

Iron rich patches

285 and 286 : Iron rich patches along planes and channels.

284 and 287 : not present.

D. Other Biogenic Features

284 : Distinct welded matric fecal pellets,30-100 micron diameter.
In the other thin sections are fecal pellets not present.

E. Relicts

Pedorelicts

284 : Subrounded matric nodules with skelsepic and which are moreless red than the groundmass.
Sharp subangular matrix nodules with plasma reorientation, 100-300 micron diameter,probably originally rock pieces which are weathered in situ.

LIthorelicts

284 : Pieces which are grey and rich on secundary silica and richer on silt sized grains than the other soil material,containing a lot of yellow papules,rounded sharp nodules,and locally rounded matric nodules.They occur in a banded distribution pattern and sometimes show a little layering.

285 : In this thin section the groundmass consists of two components:
a. soil material b. pieces of rotten rock

CONCLUSIONS

284 : The biological activity is high(channels,fecal pellets),but not very high.
The sharp rounded ferric/manganiferous nodules are an indication of displacement,possibly as the result of biological activity,of soil material.

Formation of neoferrans/mangans seems to be the last process because they mostly cover ferri-argillans.

285 : There is not much biological activity;the presence of channels can possibly be caused by fossile biological activity.
The sharp rounded nodules : idem as 284.
In pieces of rotten rock : ferri-argillans cover argillans if they occur together;this indicates two phases:argillans - weathering, ferri-argillans -illuviation.Locally the argillans show a layering.
The papules of the papulic plasma in pieces of rotten rock are caused by weathering.
Pieces rich on silt-sized grains and on papules.What is their origin? possibilities:
1. Angular rock pieces are weathered,displaced,weathered again,and the voids are filled up with other materials,rich on silt-sized grains. This possibility is the most likely.
2. The concentration of silt-sized grains and papules is caused by erosion by subsoil waterstreams.

286 : This thin section is essentially the same as 285,but in the under part of the thin section rotten rock is going to dominate.
In the rotten rock,rock structure is present with signs of weathering: argillans with flecked orientation patteern in planes.
Some channels are filled up with silt-rich material,and nodules occur in the rotten rock.

287 : This thin section is originating from the surface of a spring cutting on 5M distance from profile 1S and consists mainly of rotten rock.
It is essentially the same as the rotten rock of section 286 but the clay has been washed out (about 10% clay left).
Sharp rounded ferric/manganiferous nodules indicate displacement of the material.
Just as in thin sections 285 and 286 "waxy" cutans occur that probably have been proceeded from dissolved volcanic ash.
Some silica-aluminium gels have filled up channels and voids;this is possibly the explanation for the high CEC.This allophane-like material can be a product of weatherimg.

The whole matrix is permeated with secundary silica that is present in big quantities.
Formation of argillans after formation of neoferrans/mangans.

3.2.9.3.

PROFILE 35

thin sections:	horizon:	depth(cm):
75/288	B2,1	140-155
75/289	B2,2	395-410
75/290	B2,3	710-725

DESCRIPTION OF THE THIN SECTIONS

A. Groundmass

Skeleton grains

size : 288 : 20-400 micron,the greater part 20-40 micron.
       289 : 20-400 " .
       290 : 20-700 " ,many silt-sized grains in a banded distribution pattern.

Angular,low sphericity,in a random distribution pattern;most of them weathered,some of them covered with iron oxides.
Mineralogical composition :feldspars,quartz and chert.

Plasma

The plasma consists of clay minerals and iron,arrangement:asepic.
288 consists for the greater part of pedorelicts(see pedorelicts).

Plasma reorientations

288 : glaesepic,masepic,weak channel vosepic and weak skelsepic.
289 : " , " ,planar vosepic and skelsepic.
290 : " , " , " " ,channel vosepic and skelsepic.

Voids

All thin sections : compound packing voids,channels,skew planes, craze planes,vughs and interconnected vughs.

B. Special features

Ferri-argillans

288 : Only in darker parts,probably originating from other horizons the following ferri-argillans :
distinct,strong continuous orientated,channel and plane ferri-argillans 10-40 micron thick with sharp outer boundary,and idem : very few ped ferri-argillans,20-60 micron thick.

289 : Distinct,strong continuous orientated,channel ferri-argillans, locally covered by iron oxides and locally with a lower bi-refringens,10-100 micron thick with a sharp outer boundary,and : idem plane and ped ferri-argillans 5-100 micron thick.
Diffuse ferri-argillans locally covered by iron oxides,10-100 micron thick with a sharp outer boundary.

290 : Distinct,strong continuous orientated,channel and plane ferri-argillans,10-1000 micron,locally up to 2500 micron thick, with sharp outer boundary.
Sometimes the ferri-argillans are laying against sharp nodules.

Papules

288 : Distinct,strong continuous orientated,ferri-argillan papules, 10-40 micron thick,some of them covered by iron oxides.

289 : idem papules 10-50 micron thick.

290 : idem papules 10-50 micron thick. In tubes which are more rich on silt-sized skeleton grains than the surrounding soil material,many papules are found,and in parts of the tubes that show a slight layering the papules are smaller than on other places.

Pedotubules

288 and 289 :Distinct, ortho matric aggrotubules,1-5 mm diameter.

290 : idem,but with neoferrans/mangans.
Tubes which are less red and which have more skeleton grains of silt size and papules than the surrounding soil material,and in which man locally a layering can recognize.Secundary silica and sometimes very thick(up to 2500 micron) ferri-argillans are found in this tubes.

C. Hydromorphic features

Quasi- and/or neoferrans/mangans

288 : not present.

289 : Distinct channel, plane and ped neoferrans/mangans,10-200 micron thick,plane and ped neoferrans/mangans locally up to 500 micron thick,with a sharp outer boundary and occurring in a clustered distribution pattern.
On some places neoferrans/mangans are covering ferri-argillans.

290 : Distinct channel and plane neoferrans/mangans,10-400 micron thick,with sharp outer boundary,in a clustered distribution pattern and mostly covering the ferri-argillans.

Distinct channel and plane quasiferrans/mangans 10-50 micron thick, sharp inner and outer boundary.

289 idem quasiferrans/mangans.

Nodules and concretions

288 : Sharp ferric-manganiferous nodules,10-2000 micron thick,low as well as high sphericity.

Diffuse ferric-manganiferous nodules,10-1000 micron thick,high sphericity.

289 : Sharp ferric-manganiferous nodules 20-2500 micron thick,high sphericity and idem diffuse nodules 30-200 micron thick.

A few partly sharp partly diffuse ferric-manganiferous nodules, 30-100 micron thick.

290 : sharp and diffuse nodules idem as 288 but both 20-2000 micron thick.

A few concretions 100-200 micron thick.

Iron-rich patches

289 : patches which are more red,caused by iron movement.

D. Other biogenic features

288 :Faint single and strengly welded matric fecal pellets,50-300 micron in diameter and in a clustered distribution pattern.

A great part of the soil consists of fecal pellets

289 : idem fecal pellets,but obviously less than in the previous thin section.

290 : no fecal pellets.

E. Relicts

288 : The plasma consists for a greater part of pedorelicts :

faint subrounded pedorelicts with a high sphericity,in different stages of soil formation,50-1000 micron diameter and in a random distribution pattern;they contain plasma and skeleton grains and are in general more red than the surrounding soil material.

Bigger matric pedorelicts which are darker reddish brown than the surrounding material and in which ferri-argillans are present;they have a diameter of 0.5-2 cm and are seen by the naked eye in the thin section.

289 : Faint subrounded pedorelicts in different stages of soil formation,with a low sphericity,30-1000 micron diameter and in a random distribution pattern.They are generally darker reddish brown than the surrounding soil material and they don't contain skeleton grains.

290 :pedorelicts idem as 289,but 100-1000 micron diameter and the colours are often more greyish red than the surrounding soil material.

CONCLUSIONS

288 : The biological activity is high but not very high because there are many voids and cutans only occur as papules;ferri-argillans are only occurring in darker parts which are originating from other horizons.
The sharp ferric nodules indicate displacement,possibly as the result of biological activity,of soil material.the darker parts are another indication for displacement of soil material.
The ferri-argillans tend to become more red by enrichment of iron oxides caused by weathering.

289 : The biological activity is less than in the previous thin section,but still plant roots are found on this depth.
Undisturbed ferri-argillans aed neoferrans/mangans are present.
Formation of neoferrans/mangans seems to be the last process because they frequently cover ferri-argillans.
Sharp ferric-manganiferous nodules with a high sphericity indicate displacement of soil material.
Diffuse ferric nodules and patches which are more red indicate movement of iron oxides.

290 : there is some biological activity - the presence of channels is an indication for that - but significantly less than the previous thin sections.In the groundmass are only a few papules present.
Many undisturbed ferri-argillans and neoferrans/mangans are present.
Sharp ferric/manganiferous nodules indicate displacement of soil material.

Clay-iron illuviation must have taken place after displacement because ferri-argillans are laying against sharp nodules.
Formation of neoferrans/mangans seems to be the last process because they frequently cover ferri-argillans.
Tubes are occurring which are rich on silt-sized grains and papules and which locally show a layering.Very thick clay cutans (up to 2500 micron) in voids,secundary silica and omnisepic arrangements seem to be assiociated with these tubes.Probably these tubes are lithorelicts : weathered pieces of rotten rock.

3.2.9.4.

THIN SECTION 75/291 <u>rock sample</u>

This thin section is made from a piece of rotten rock found on a spot along the stream on the valley bottom downwards the slope on which profile 1S and 3S are situated.

According to van der Plas this rock is an arcose sandstone or indurated tuff,with plagioclase as a component,and is not andesite as was expected.

3.2.9.5.

<u>PARENT MATERIAL</u>

In the soil profile 3S are components present of the sandstone of thin section 291,but no pieces of sandstone,consequently it is not obvious what the parent material of profile 3S was.
In thin sections 284 and 285 chert fragments,feldspars,quartzite and angular and rounded quartz is present.
In 286 are many feldspars originating from igneous rocks and pyrophyllite with a high birefringens present,and in 288 and 289 the quartz and chert grains are rounded while the feldspars are angular.
The rotten rock of 286 and 287 has the structure of a sandstone.
According to van der Plas the parent material of the two profiles is a comprimated and indurated tuff layer.In the andesite ash layers can appear,caused by ash rains during the eruptions.

3.2.10. Water Samples

The following water samples have been taken :
(A+B means : the sample consists of two bottles)

1S A+B	: groundwater from profile pit 1S	date	: 25-3-1975
1 A+B	: water from spring near profile pit 1S	"	: 5-3-1975
2 A+B	: water from spring in transition zone hill-valleybottom near Kenyamware	"	: 5-3-1975
3 A+B	: water from spring in tea field near Kenyerere School	"	: 1-4-1975
4 A	: idem as 2 A+B except for sampling date :	"	: 1-4-1975

The total amount of cations was very small : 0.3 meq/100 g for all samples.
The analysis results are shown in table 2.

table 2 : Analysis results of water samples.

sample nr	pH	cations (meq/100 g)					SiO_2 (mmol/100 g)	sampling date
		Ca	Mg	Na	K	total		
1S A+B	5.3	0.01	0.01	0.13	0.03	0.18	0.57	25-3-1975
1 A+B	6.7	0.02	0.01	0.13	0.03	0.19	0.62	5-3-1975
2 A+B	6.4	0.03	0.02	0.11	0.04	0.20	0.55	5-3-1975
4 A	5.2	0.02	0.01	0.11	0.04	0.18	0.57	1-4-1975
3 A+B	5.7	0.02	0.01	0.12	0.04	0.19	0.55	1-4-1975

It is not sure whether the elements in the water originate from solution of salts or from solution of minerals.
Assumed they originate from minerals,the figures can be plotted in stability diagrams.
The figures of K,pH and SiO_2 plotted in the stability diagram of minerals in the system $Al_2O_3 - SiO_2 - K_2O - H_2O$ at 25 °C and 1 atm total pressure,indicate that the mineral kaolinite is stable.
The figures of Mg,pH and SiO_2 plotted in the stability diagram of minerals in the system $Al_2O_3 - SiO_2 - MgO - H_2O$ at 25 °C and 1 atm total pressure,give the same result.

4. Conclusions and Final Classification of the Soil Profiles.

Springs have a strong impact on the geomorphology,and especially on the valley forms,in and around the Magombo market area.
The pH of the water from the springs varies between 5.2 and 6.7; the amount of cations in the water is very small : about 0.3 meq/100 g.
The origin of a kind of round pits with a diameter of 5-15 m and a depth of 1-5 m is still a point of discussion,but likely is that they are archaeological remains.
The differences in soil between a point near the top of a hill (profile 3S) and a point just above a spring on the bottom of a small valley (profile 1S) have been studied.
The most probable parent material of both profiles is indurated tuff.
Addition of volcanic ash to the soil by ash rains in the past is not ruled out.
Profile 1S was shallower (however still more than 8 m deep),but was higher in base saturation throughout the profile,less acid in the A_1 horizon,and the thickness of the A_1 horizon was far more than that of profile 3S.
The percentage of clay ($< 2\mu$) in both profiles is about 50-60 % in the A_1 and about 65-75 % in the B_2 horizon.
In the samples from profile 3S the clay mineral kaolinite is dominant,while in profile 1S a transition kaolinite - montmorillonite clay occurs.
According the norm calculations the origin of both profiles could be : weathering of volcanic ash.

Classification

Both profiles have a mollic epipedon and an argillic horizon.
The base saturation is the crucial point.
Final classification :

Profile 1S :
very fine clayey,kaolinitic,isothermic,cumulic Paleudoll
Nyambaria series

Profile 3S :
very fine clayey,kaolinitic,isothermic,cumulic,mollic Palehumult
Magombo series

reference : Soil Taxonomy (december 1975)

LITERATURE

1 Bennema J. 1974 Organic carbon profiles in Oxisols. Pedologie XXIV-2 p 119-146 Ghent

2 Bolt G.H.,Janse A.R.P.,Koenigs F.F.R. 1970 Algemene Bodemkunde part II,Bodemnatuurkunde.syllabus kandidaatscollege.Agric.Univ. Wageningen. chapter I-1

3 Bolt G.H. and Bruggenwert M.G.M. 1976 Soil Chemistry,part A basic elements.Elsevier,Amsterdam . p 150-151 point 8.2.2.

4 Bower John R.F. 1973 Early pottery and other finds from Kisii District.Azania,journal of the British Institute in Eastern Africa.VIII : 131-141

5 Brinkman R.1975 Using the computer for goethite and epinorm calculations. Department of Soil Science and Geology,Agric. Univ. Wageningen.

6 Carson M.A. and Kirkby M.J. 1972 Hillslope,form and process. Cambridge University Press. chapter III-9

7 Duchaufour Ph. et Souchier B. 1966 Note sur une méthode d'extraction combinée de l'aluminium et du fer libres dans les sols. Science du sol 1966 p17-29

8 Guidelines for soil description.FAO 1967

9 Huddleston A. 1951 Geology of the Kisii District.Geological Survey of Kenya,report no 18.Govt.Printer,Nairobi.

10 Juo A.S.R.,Moormann F.R. and Maduakor H.O. 1974 Forms and pedogenetic distribution of extractable iron and aluminium in selected soils of Nigeria. Geoderma, 11 : 167-179

11 Mourik D.van 1975 The landquality water availability for some soils in the Kisii and South Nyanza Districts in Kenya. Preliminary report no 8,Training Project in Pedology,Kisii,Kenya. Agricultural University of the Netherlands,Wageningen.

12 Munsell soil colour charts.

13 Ogot B.A. History of the Southern Luo.vol.1 : Migration and settlement. East African Publishing House,Nairobi.

14 Oliver R. 1961 The dawn of African History.
Oxford University Press,London.

15 Plas L.van der and Schuylenborgh J.van Petrochemical calculations applied to soils.Dep. of Soil Science and Geology,Agric.Univ. of Wageningen,the Netherlands.

16 Robinson H. 1969 Morphology and Landscape.
University Tutorial Press ltd,London. chapter 8 and 12

17 Scholten J.H.M.,ter Maat S.E.,Torren K.van der and Vuyk D.H. 1976.
A detailed soil survey of the Magombo market area.Preliminary report no 9 Training Project in Pedology,Kisii,Kenya.
Agric. Univ. of Wageningen,the Netherlands.

18 Schwertmann M. 1964 Differenzierung der eisenoxide des bodens durch extraction mit ammoniumoxalate-löserung.
Zeitschr.Pfl.ern. Düng.Bodenk. 105 : 194-202

19 Small R.J. 1972 The study of landforms.
Cambridge,at the University Press. chapter 4 and 7.

20 Topographical Map (1962),sheet 130/2 Kisii,scale 1 : 50 000 .
Survey of Kenya,Nairobi.

21 U.S.Dept.of Agriculture : Handbook no 18 : Soil Survey Manual.
Govt.Printing Office,Washington.

22 U.S.Dept.of Agriculture 1975 Agriculture Handbook no 436 :
Soil Taxonomy. Govt.Printing Office,Washington.

APPENDIX

Detailed soil profile descriptions

Analysis results

Norm calculations

SOIL PROFILE DESCRIPTION

profile nr.:15
Nyambaria series
classification:7^{th}:very fine clayey,kaolinitic,isothermic,cumulic Paleudoll

date:25-3-1975,beginning wet season
author:J.H.M.Scholten
location:sheet 130/2 kisii,kenya ,714.7E, 9926.3N,Magombo market area.
elevation:+1865 M above sealevel.
landform:upper valley bottom,just above spring.
" surrounding country:hilly.
geol.formation:Bukoban
slope:concave,100 M length,slope gradient:8%
landuse:grass
climate:isothermic,rainfall:about 2000 mm a year.

parent material:andesite
drainage:well drained-somewhat excessively drained
moisture conditions in the soil:0-650 cm moist,from 650 cm wet
groundwaterlevel:7.30 M
erosion:only in bare soil very slight sheet erosion.
rock outcrops:some rotten rock in spring cutting
root distribution:well distributed till concretionlayer on 210-215 cm depth.
infiltration:very rapid (+_14 m/day)
human influences:some paths,50 cm incised

This soil occurs on the bottom of smaller valleys running down larger slopes, and contains a lot of humus-rich soil material which is washed down from the valleysides.Particularly in the wet season this soil can bebe rather wet.

SOIL PROFILE

$A_{1,1}$	0-70 cm	Dark reddish brown(5YR2/2 moist)very fine clay;moderate very fine subangular blocky;very friable moist,slightly sticky slightly plastic wet;many fine and very fine,common medium pores;clear wavy boundary. samples:1 bag(mixed)and rings 53+54(35-40 cm) 351
$A_{1,2}$	70-130 cm	Dark reddish brown(5YR3/2 moist)very fine clay;moderate fine subangular blocky;friable moist,slightly sticky slightly plastic wet;many fine and very fine,common medium pores; clear smooth boundary. 1 mixed sample : 352
$A_{1,3}$	130-210 cm	Dark reddish brown(5YR 3/3 moist)very fine clay;moderate fine subangular blocky;friable moist,slightly sticky slightly plastic wet;many fine and very fine,common medium pores;abrupt wavy boundary. samples:1 mixed,rings 55+57 (140-145 cm) 353
$B_{2,1}$	210-215 cm	Yellowish red(5YR 5/8 moist)and black,discontinuous nodular ironpan.Stagnating water on this layer. abrupt wavy boundary. samples:1 bag mixed samples. 354
$B_{2,2}$	215-250 cm	Dark reddish brown(5YR 3/4 moist)very fine clay;moderate fine angular blocky;firm moist,slightly sticky slightly plastic wet;continuous moderately thick clay cutans; patchy thin coatings of probably iron and manganese; many fine and very fine pores;gradual smooth boundary. 1 mixed sample. 355

$B_{2,3}$ 250-450 cm Yellowish red(5YR 4/6 moist) ~~xxxx~~ very fine clay;moderate ~~xxxx~~ fine angular blocky;firm moist,slightly sticky slightly plastic wet;broken thin clay cutans;continuous thick cutans of probably iron and manganese;many fine and very fine pores; diffuse smooth boundary.
samples:1 mixed sample,320-325 rings 58+59,381-396 tin BM172, 400-405 rings 60+61. 356

$B_{2,4}$ 450-500 cm Dark reddish brown(5YR 3/4 moist) very fine clay;moderate very fine angular blocky;firm moist,slightly sticky slightly plastic wet;continuous thin clay cutans,broken thin cutans of probably iron and manganese;many fine and very fine pores; gradual smooth boundary.
samples:1 mixed sample,470-475:rings 62+63. 357

$B_{2,5}$ 500-650 cm Dark brown(7.5YR 4/3 moist)very fine clay;moderate fine angular blocky;firm moist,slightly sticky slightly plastic wet;broken thin clay cutans and cutans of probably iron and manganese;many fine and very fine pores;abrupt irregular boundary.
samples:1 mixed sample,540-545 cm:rings 64+65. 358

$B_{3,1}$ 650-730 cm Multicolored (mainlydark browm7.5YR4/4 and pale yellow 2.5Y 7/4) rotten rock;moderate fine angular blocky;hard dry, friable moist,slightly sticky slightly plastic wet;locally broken moderately thick clay cutans,broken thick cutans of probably iron and manganese in pores and locally on ped faces;many fine and very fine,common medium pores;diffuse smooth boundary.
samples:695-710:tin,700-710:500 cc,710-715:rings 71+2. 359

$B_{3,2}$ 730-800 cm Multicoloured (mainly pale yellow 2.5Y 7/4)"rotten rock"; moderate fine angular blocky;hard dry,firm moist,slightly sticky slightly plastic wet;broken thick cutans of probably iron and manganese,broken moderately thick clay cutans, thick clay cutans in larger pores;many fine and very fine, common medium and coarse pores;groundwater level at 730 cm;
samples:750-755:rings 11+12,750-760:500 cc,750-765:tin. 360

Observatios with motor auger just besides of the pit site :

800-950 cm Light yellowish brown(10YR 6/4 wet) sandy clay?;sticky, non plastic;saturated with water.
samples:2 plastic bottles. 363

950-1000 cm Multicoloured(maincolour pale yellow 2.5Y 7/4)"rotten rock"; slightly sticky,non plastic;more dry than horizon above.
samples:1 mixed sample. 361

1000-1100 cm Pale yellow (5Y 7/3 moist)"rotten rock";friable moist;rather dry.
samples:1 mixed sample. 362

SOIL PROFILE DESCRIPTION

profile nr.:35
Magombo series
classification : 7^{th}:very fine clayey,kaolinitic,isothermic,cumulic mollic Palehumult.
FAO:humic Nitosol.
date:22-3-1975,beginning wet season.
author:J.H.M.Scholten
Location:sheet 130/2 Kisii,Kenya,714.9 E,9926.3 N,Magombo market area.
elevation :about 1880 M above sealevel.
landform:saddle between hilltops
landform of surrounding country:hilly.
slope:linear slope of 500 M length;gradient:5%
landuse:pasture
climate:isothermic ,rainfall:about 2000 MM/year.

parent material:andesite
drainage:well drained
moisture conditions in the soil:moist throughout the profile
groundwaterlevel:-----
infiltration:very rapid,K= ±12 M/24hrs.
rootdistribution:fine and very fine grassroots well distributed throughout the profile up to a depth of 4M.

Very deep,red,very fine clayey soil,with a good structure and a high biological activity,formed by weathering of andesite rock.This is the most important soil series of the area.

SOIL PROFILE:

A1,1	0-50 CM	Dark reddish brown (5YR 3/2 moist)very fine clay;moderate ~~xxxx~~ fine subangular blocky;very friable moist,slightly sticky slightly plastic when wet;many fine and very fine,common mediumand few coarse pores;clear smooth boundary. samples:bag and cores49+50 (40-45 cm). 366
A1,2	50-79 cm	Dark reddish brown (5YR 3/3 moist) VERY FINE CLAY;moderate fine subangular blocky;friable moist,slightly sticky,slightly plastic wet;many fine and very fine,common medium pores; gradual smooth boundary. samples:bag. 367
B2,1	79-270 cm	Dark reddish brown (5YR 3.5/4 moist)very fine clay; moderate fine angular-subangular blocky;friable moist, slightly sticky slightly plastic wet;moderately thick, broken clay cutans;many fine and very fine pores,few medium pores;from 205-210 cm very many,small soft manganese concretions;clear smooth boundary. samples:1 bag,1 tin and from 140-145 cm rings 51+52. 368 140-155 cm: 75288
B2,2	270-700 cm	Yellowish red (5 YR 4/6 moist) very fine clay;moderate medium angular blocky;firm moist,slightly sticky slightly plastic wet;common fine and very fine pores;thick broken clay cutans;black continuous coatings from iron and manganese; gradual smooth boundary. 75289 samples:1 bag,1 tin(395-410 cm)and rings 67+68(340-345 cm). 600-605:rings 69+70,600-610:500 cc. 369, 370
B2,3	700-750 cm	Yellowish red (5YR 4/6 moist)very fine clay;moderate medium--coarse prismatic;firm moist,slightly sticky slightly plastic wet;patchy thick clay cutans,continuous thick cutans of iron and manganese;common fine and very fine pores; samples:710-725:tin,740-745:rings 13+15,740-750:500 cc. 371 75290

table 3

NUMBERS OF SOIL SAMPLES

PROFILE 1S

number	depth	horizon	thin section no.	depth
75/351	0-70	A1,1		
352	70-130	A1,2		
353	130-210	A1,3		
354	210-215	B2,1		
355	215-250	B2,2		
356	250-450	B2,3	75/284	381-396
357	450-500	B2,4		
358	500-650	B2,5		
359	700-710	B3,1	75/285	695-710
360	750-760	B3,2	75/286	750-765
361	950-1000	B3		
362	1000-1100	B3		
363	800-950	B3		
364	spring surface	B3	75/287	surface
365	rock samples	R	75/291	----
A	weathered part			
B	unweathered part			

PROFILE 3S

75/366	0-50	A1,1		
367	50-79	A1,2		
368	79-270	B2,1	75/288	140-155
369	270-345	B2,2	75 /289	395-410
370	600-610	B2,2		
371	740-750	B2,3	75/290	710-725

----

table 4 TEXTURE RESEARCH MAGOMBO MARKET AREA KENYA
BY HANS SCHOLTEN

profile:	(cm) depth	horizon	% < 2	2–16	16–50	50–74	74–105	105–2000 micron
1S	35–40	$A_{1,1}$	50.7	30.0	13.8	0.7	1.0	3.8
	130–210	A1,3	52.1	27.2	13.9	0.7	1.1	5.0
	210–215	B2,1	29.0	22.9	17.9	0.9	2.2	27.1 1)
	215–250	B2,2	62.5	18.7	12.3	0.8	1.0	4.7
	320–325	B2,3	71.1	14.1	9.2	0.7	1.0	3.9
	450–500	B2,4	66.5	16.8	10.9	0.6	0.9	4.3
	700–710	B3,1	50.9	22.0	11.8	1.0	1.5	12.8
	750–760	B3,2	42.8	28.3	14.9	1.4	2.1	10.5
	950–1000	B3,4	29.3	30.4	19.5	1.7	2.3	16.8
	spring	B3	10.0	33.9	31.0	2.3	3.0	19.8 2)
3S	40–45	A1,1	62.1	19.6	11.6	0.8	1.1	4.8
	140–145	B2,1	68.1	14.9	11.2	0.7	0.9	4.2
	340–345	B2,2	72.0	11.7	9.3	0.9	1.2	4.9
	600–610	B2,2	73.1	10.5	8.8	0.7	1.1	5.8

1) 600–2000 :12.7%
2) 600–2000 : 8.0%

[illegible] (Scholten)
24-02-05

appendix

table 5 : grain size distribution

BEDRIJFSLABORATORIUM VOOR GROND- EN GEWASONDERZOEK, MARIËNDAAL, OOSTERBEEK

[...]rzoek- [...]mer	Merk en nadere aanduiding van het monster		Laag in cm	pH KCl	Hoofdbestanddelen in % van de grond: Humus Glv.	Humus EL	CaCO₃	Afslibbaar	Grof zand	in % van minerale delen: Afslibbare delen <2	2–4	4–8	8–16	Zand 16–25	25–35	35–50	50–75	75-105	105-150	150-210	210-300	300-420	420-600	600-850	850-1200	1200-1700	M	U
		horizont																										
143	75/352-1S	$A_{1,2}$	70-150	5,0	2,7			79,3	[illegible]	56,1	8,7	7,9	8,7	5,6	3,8	1,7	1,4	1,2	1,5	1,1	0,8	0,7	0,4	0,2	0,2		<2	
144	75/358-1S	$B_{2,5}$	500-550	4,2	1,4			82,3	[illegible]	63,1	7,9	6,3	6,2	3,4	3,1	1,2	1,4	1,3	1,7	1,4	0,9	0,7	0,5	0,3	0,3	0,3	<2	
145	75/367-3S	$A_{1,2}$	50-79	4,8	4,8			80,8	14,4	54,7	6,2	7,2	6,8	3,9	3,0	1,3	1,2	1,1	1,3	1,0	0,8	0,6	0,4	0,3	0,2		<2	
146	75/371-3S	$B_{2,3}$	[illegible]-750	4,1	1,6			80,2	18,2	69,7	5,6	3,5	2,7	1,9	2,5	1,1	1,5	1,8	2,5	1,7	1,1	1,1	0,9	1,0	0,8	0,6	<2	

RAPPORT VAN ONDERZOEK

BETREFT: Mineralogisch onderzoek aan de klei-fractie (<2µ) van een aantal monsters uit projekt W 74-02-05 (Kenia, Hr. Scholten)

MONSTERS: Profiel 1S : 75/351-353-355-356-358-359-360-361-362 en364.
Profiel 3S : 75/366-368-369 en371.

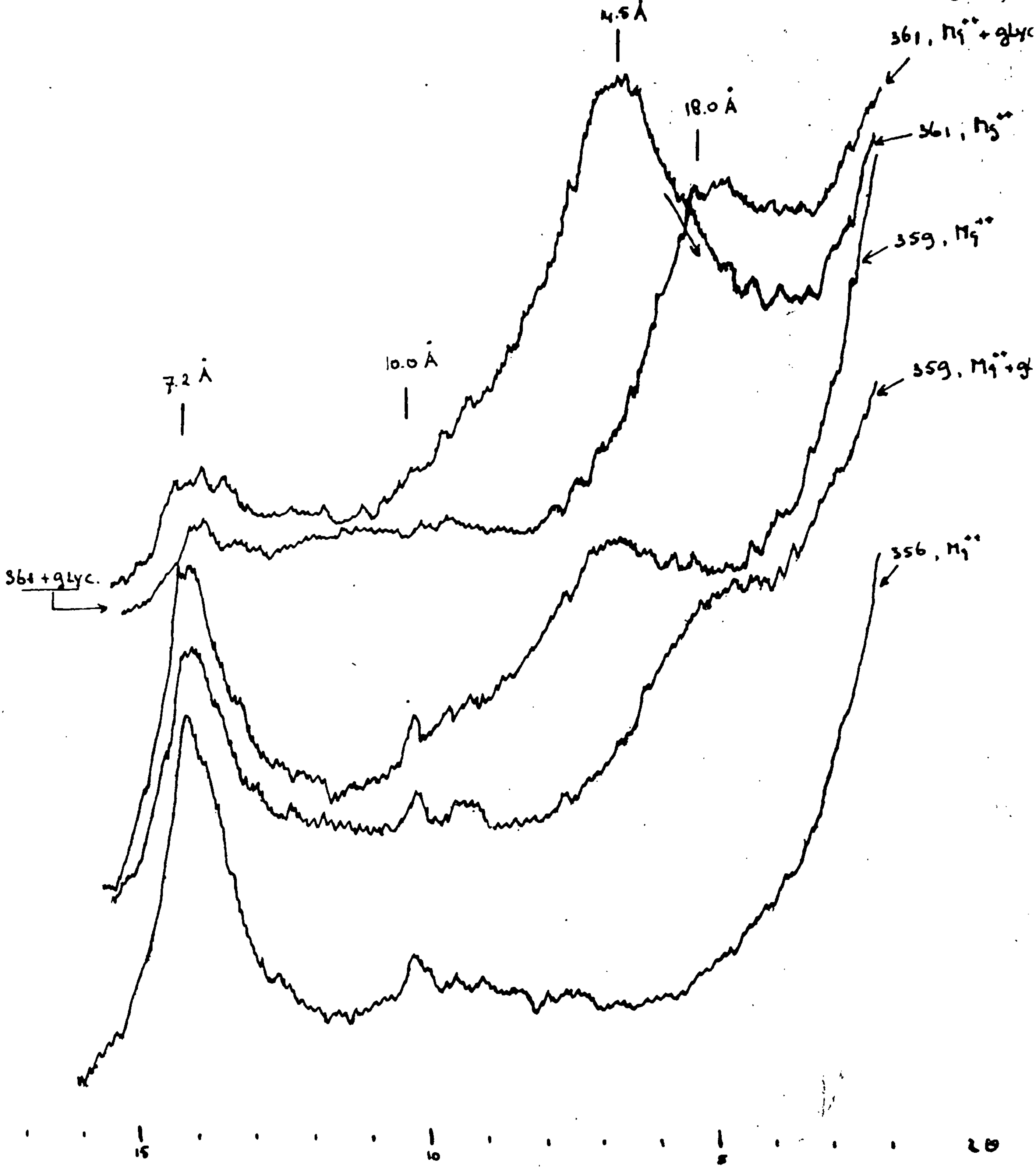
VOORBEHANDELING: Alle monsters werden gesedimenteerd op een keramisch plaatje, waarna de klei bezet werd met Mg^{++}-ionen. Na Röntgendiffractie-opname werden enkele monsters met glycerol* behandeld; ook werden sommige monsters met K^{+}-ionen bezet en verhit tot 600 °C.

RESULTAAT: In de eerste vijf monsters van profiel 1S is het 7 Å-kleimineraal kaoliniet zeer duidelijk dominant. Verder een zeer weinig illiet (10 Å) en mogelijk wat chloriet (een nauwelijks te zien piekje verandert niet na verhitting). Een verhoging van de ondergrond tussen 7 en 10 Å ,resulterend in een klein piekje bij ca. 10.7 Å kan wijzen op een interstratificatie van illiet en chloriet.
In monster 358 is in geringe mate montmorilloniet aanwezig, welke hoeveelheid sterk toeneemt in de volgende monsters: in 360, 361 en 362 is montmorilloniet zeer duidelijk dominant, om in 364 weer af te nemen. In alle monsters blijft kaoliniet duidelijk aanwezig, zij het natuurlijk in mindere mate dan in de eerste monsters van dit profiel. Voor de rest geldt voor deze monsters hetzelfde als voor de eerste monsters van dit profiel.
Wat de niet-klei-mineralen betreft: alle monsters bevatten een geringe hoeveelheid kwarts en veldspaten. Wat dit laatste betreft: in de monsters 353, 361, 362 en 364 meer dan in de rest van de monsters. Ook goethiet is aanwezig (niet of nauwelijks in 360 & 364)

Voor de vier monsters van profiel 3S geldt hetzelfde als voor de eerste vier monsters van profiel 1S: kaoliniet zeer duidelijk dominant.Verder een weinig kwarts en veldspaten.

* Montmorilloniet (ca. 14 Å) expandeert m.b.v. glycerol naar ca. 18 Å

SAMENVATTING RESULTATEN: In de monsters van profiel 3S is het klei-mineraal <u>kaoliniet</u> dominant, terwijl we in profiel 1S een overgang zien van <u>kaoliniet</u> naar <u>montmorilloniet</u>. Hieronder enkele diffractogrammen die representatief zijn: 356 voor de "kaoliniet-monsters" (7Å)
359 voor overgang "kaoliniet ⟶ montm."
361 voor de "montmorilloniet-monsters" (14Å)



J.D.J. van Doesburg

Appendix,table 6

Research J.H.M.Scholten

PH RESEARCH PROFILE 1S AND 3S

profile nr. <u>1S</u>

horizon	depth(cm)	PH-H20	PH-KCl	PH-CaCl2
351 $A_{1,1}$	0-70	6.1	5.3	5.4
352 $A_{1,2}$	70-130	5.9	5.0	5.2
353 $A_{1,3}$	13 0-210	5.7	5.0	5.0
354 $B_{2,1}$	210-215	5.2	4.8	4.9
355 $B_{2,2}$	215-250	5.0	4.7	4.7
356 $B_{2,3}$	250-450	4.8	4.2	4.2
357 $B_{2,4}$	450-500	4.6	4.2	4.2
358 $B_{2,5}$	500-650	4.5	4.2	4.2
359 $B_{3,1}$	700-710	4.8	3.8	3.9
360 $B_{3,2}$	750-760	4.9	3.8	3.8
[illegible]3 $B_{3,3}$	800-950	5.1	3.7	3.9
361 $B_{3,4}$	950-1000	5.2	4.1	4.5
362 $B_{3,5}$	1000-1100	5.4	---	---
364 B_3	spring	5.0	3.7	3.8

profile nr. <u>3S</u>

horizon	depth(cm)	PH-H20	PH-KCl	PH-CaCl2
366 $A_{1,1}$	0-50	5.2	4.8	4.7
367 $A_{1,2}$	50-79	5.5	4.8	4.7
368 $B_{2,1}$	79-270	4.6	4.2	4.1
369 $B_{2,2}$	340-345	4.5	4.0	3.9
370	600-610	4.7	4.1	4.0
371 $B_{2,3}$	740-750	5.0	4.1	4.0

Appendix table 7

ORGANIC MATTER RESEARCH MAGOMBO market AREA

Profile no.: 15 by J.H.M.Scholten

depth cm	vol.% water	B.D. kg/l	org.C vol.%
0-10	44.6	0.87	2.01
10-20	43.8	0.89	2.03
20-30	44.6	0.81	1.84
30-40	47.6	0.86	1.94
40-50	46.2	0.96	2.12
50-60	43.8	0.98	2.09
60-70	44.2	1.02	2.16
70-80	44.7	1.04	2.09
80-90	42.7	1.05	1.27
90-100	46.4	1.13	0.91
100-110	49.2	1.12	0.79
110-120	39.3	1.11	0.66
120-130	42 .8	1.17	0.66
130-140	40.0	1.20	0.63
140-150	39.8	1.21	0.60
150-160	38.6	1.20	0.52
160-170	36.5	1.22	0.58
170-180	38.7	1.23	0.48
180-190	41.2	1.18	0.41
190-200	36.8	1.27	0.39
200-210	35,9	1.21	0.38
210-220	37.5	1.15	0.34
220-230	39.5	1.22	0.24
230-240	37.6	1.23	0.20
240-250	37,1	1.17	0.23
250-260	37.0	1.21	0.32
260-270	40.0	1.22	0.28
270-280	33.7	1.15	0.24
280-290	46.7	1.17	0.30
290-300	44.3	1.17	0.15
300-310	46.2	1.18	0.19
310-320	49.8	1.20	0.18
320-330	48.7	1.22	0.18
330-340	46.8	1.18	0.19
340-350	45.7	1.14	0.17
350-360	48.5	1.22	0.17
360-370	48.5	1.20	0.19
370-380	47.4	1.22	0.17
380-390	48.2	1.29	0.10
390-400	51.1	1.25	0.19
400-410	48.9	1.23	0.20

table 8 appendix

ORGANIC MATTER RESEARCH MAGOMBO market AREA

profile nr.:3S by J.H.M.Scholten

depth cm	vol.% water	B.D. kg/l	vol.% org.C
0-10	27	1.20	2.52
10-20	32	0.94	1.99
20-30	40	0.97	2.03
30-40	36	1.17	2.41
40-50	25	1.17	2.39
50-60	29	1.18	2.28
60-70	25	1.21	2.03
70-80	27	1.10	0.76
80-90	25	1.14	0.54
90-100	27	1.16	0.64
100-110	34	1.15	0.48
110-120	41	1.05	0.48
120-130	42	1.08	0.55
130-140	40	0.97	0.45
140-150	42	1.04	0.36
150-160	42	1.06	0.30
160-170	40	1.04	0.23
170-180	43	1.12	0.21
180-190	45	1.19	0.19
190-200	41	1.11	0.16
200-210	41	1.11	0.15
210-220	43	1.14	0.15
220-230	44	1.20	0.11
230-240	46	1.20	0.08
240-250	43	1.08	0.09
250-260	41	1.03	0.11
260-270	41	1.13	0.07
270-280	42	1.18	0.05
280-290	42	1.17	0.09
290-300	44	1.23	0.14

research J.H.M.Scholten

FREE IRON AND ALUMINIUM MAGOMBO MARKET AREA,KENYA

profile nr. 1S

horizon	depth(cm)	$\%Al_2O_3$	$\%Fe_2O_3$
$A_{1,1}$	0-70	3.94	9.27
$A_{1,3}$	130-210	3.89	11.85
$B_{2,2}$	215-250	3.64	12.89
$B_{2,3}$	250-450	3.53	12.92
$B_{2,5}$	500-650	3.94	11.54
$B_{3,1}$	700-710	5.25	9.86
$B_{3,2}$	750-760	4.81	9.36
$B_{3,5}$	1000-1100	2.69	5.23
$B_{3,4}$	950-1000	4.02	6.89
B_3	spring	3.34	6.03

profile nr. 3S

$A_{1,1}$	0-50	4.99	10.23
$B_{2,1}$	79-270	6.03	11.85
$B_{2,2}$	340-345	4.44	12.57
$B_{2,3}$	740-750	5.04	13.77

code 35,15   Sender Hielimakee, Scholten Project Kisii, Kenia   -70-   no. W 74-

..75	351	354	357					
fraction: µm	%	%	%	%	%	%	%	%
>2000								
-2000		12,7						
-1000	4,8		5,2					
-600		16,6						
~~50~~-74	0,7	0,9	0,6					
-~~16~~50	13,8	17,9	10,9					
-~~50~~16	30,0	22,4	16,8					
	50,7	29,0	66,5					

1975	352	353	355	356	358	359	360	36.
fraction: µm	%	%	%	%	%	%	%	%
1650-2000								
1200-1700		0,6	0,8	0,6	0,3	1,9	1,8	4,
850-1200	0,2				0,3			
600-850	0,2				0,3			
420-600	0,4	0,4	0,4	0,3	0,5	1,8	1,2	2,
300-420	0,7	0,7	0,5	0,4	0,7	2,2	1,5	2,
210-300	0,8	0,9	0,8	0,6	0,9	2,4	1,6	2,
150-210	1,1	1,0	0,9	0,8	1,4	2,0	1,7	2,
105-150	1,5	1,4	1,3	1,2	1,7	2,5	2,7	3,
75-105	1,2	1,1	1,0	1,0	1,3	1,5	2,1	2,
50-75	1,4	0,7	0,8	0,7	1,4	1,0	1,4	1,
35 ~~32~~-50	1,7				1,2			
~~25-35~~ 16-~~22~~ 25	3,6	13,9	12,3	9,2	3,4	11,8	14,9	19,
8-16	8,7				6,2			
4-8	7,9	27,2	18,7	14,1	6,3	22,0	28,3	30,
2-4	6,7				7,9			
< 2	56,1	52,1	62,5	71,1	63,1	50,9	42,8	29,3

19	classification

1975			351		353		355		356		358		359		360		361	
mm	< 2 µm																	
org. matter	giv	%	2,7								1,4							
nitrogen	N	%	(352)															
C/N																		
free iron	Fe_2O_3	%	9,3		11,9		12,9		12,9		11,5		9,9		9,4		6,9	
carbonates	$CaCO_3$	%																
[illegible] iron	Fe_2O_3	%	2,0		1,7		1,3		1,3		1,5		1,5		1,2		0,9	
aluminium	Al_2O_3	%	3,9		3,9		3,6		3,5		3,9		5,3		4,8		4,0	
pH	~~H_2O~~	1975→		352		354				357								
	$CaCl_2$	0.01M	5,4	5,2	5,0	4,9	4,7		4,2	4,2	4,2		3,9		3,8		4,5	
	KCl	1N	5,3	5,0	5,0	4,8	4,7		4,2	4,2	4,2		3,8		3,8		4,1	
vocht	H_2O^-	%	5,0	*	3,8	*	4,0		8,6		5,1		16,6		13,1		7,2	
exchangeable, NH_4-acetate	Ca	me/100 g [illegible]	10,5	4,7	4,5				3,1		5,7							
	Mg		1,5	3,7	3,4				2,7		2,3							
	Na		nd	nd	nd				nd		nd							
	K		2,0	0,8	0,8				1,3		0,9							
	Al																	
	H																	
	Σ																	
c.e.c.			19,9	14,1	13,6				14,9		16,1							
soil solution	Ca	me/100 g																
	Mg																	
	Na																	
	K																	
	Σ																	
	CO_3	me/l																
	HCO_3																	
	Cl																	
	SO_4																	

appendix

		357		358		359		380		350		354		360		361	
weight percentage		< 2 mm	< 2 µm	< 2 mm	< 2 µm	< 2 mm	< 2 µm	< 2 mm	< 2 µm	< 2 mm	< 2 µm	< 2 mm	< 2 µm	< 2 mm	< 2 µm	< 2 mm	< 2 µm
2		40,06	36,55	52,02	38,33	46,70	38,18	44,78	37,16	49,75	39,08	48,82	42,67	52,40	44,50	63,81	52,9
O3		10,06	24,80	18,98	25,26	21,56	26,73	23,58	27,23	21,71	26,06	23,39	26,36	19,18	22,33	16,48	18,2
O3		13,46	16,70	13,44	16,47	15,95	15,98	15,12	14,79	14,74	14,98	12,59	12,20	12,59	13,37	8,69	11,35
		0,24	0,21	0,22	0,21	0,14	0,43	0,16	0,07	0,13	0,12	0,30	0,04	0,25	0,07	0,26	0,0
)		0,92	0,46	0,71	0,47	0,79	0,43	0,78	0,40	0,89	0,45	0,65	0,33	0,71	0,56	0,12	0,1
)		0,26	0,31	0,29	0,34	0,31	0,30	0,28	0,29	0,28	0,32	0,38	0,38	0,75	0,66	0,46	0,4
)		0,36	0,02	0,17	0,01	0,11	—	0,08	0,01	0,16	0,01	0,46	0,01	0,85	0,02	0,74	0,0
)	< 2 µm Ba-clay	1,01	0,22	1,25	0,34	0,60	0,06	0,45	0,05	0,76	0,05	0,49	0,14	1,16	0,28	1,82	0,60
		2,02	0,91	2,14	0,97	1,43	0,72	1,17	0,59	1,63	0,77	1,07	0,67	2,31	1,16	2,11	1,2
2		1,36	1,57	1,33	1,43	1,82	1,51	1,47	1,33	1,52	1,54	1,05	1,24	0,75	0,99	0,65	0,9
5		0,20	0,53	0,11	0,37	0,13	0,34	0,11	0,33	0,10	0,34	0,07	0,37	0,04	0,41	0,03	0,2
		0,19	3,14	0,17	2,30	0,23	2,99	0,23	4,27	0,22	3,67	0,17	3,93	0,20	5,20	0,12	4,8
+		13,38	12,97	9,24	12,88	10,37	13,23	11,21	13,57	9,55	13,15	11,13	12,99	8,65	11,00	6,85	9,4
Σ		100,12	96,47	100,07	99,38	99,84	100,96	99,42	100,09	101,44	100,54	100,57	101,33	100,12	100,55	102,14	100,7

	percentage	2 µm-2 mm	< 2 µm
lica			
linite			
ite			
ctite			
thite			
ile			
engite			
c.			

	estimation	< 2 mm	< 2µm
ctite			
ite/verm.			
r.mica			
linite			
rtz			
dspar			
marks			

ction	weights	50-420 µm
		50-105 µm
ction		105-210µm
		210-420µm

	numerical percentages	50-420 µm	50-105 µm	105-210 µm	210-420 µm
rmaline					
con					
net					
ile					
tase					
okite					
anite					
urolite					
thene					
alusite					
limanite					
ase					
oritoid					
dote					
regates					
ssurite					
ende gr.					
lende br.					
ite					
sthene					
tite					
ticmatter					
a					
tite					
covite					
marks					

code 30, 10 Sender Nieuwenhuis, Wageningen Project Kisii, Kenia -72- no. W 74-0.-0.

table 11 appendix

ion: µm	%	%	%	%	%	%	%	%
>2000								
-2000								
-1000								
-500								
-250								
-100								
-50								

19	classification

1975	366	364	367	368	369	371	370	
fraction: µm	%	%	%	%	%	%	%	%
1650-2000								
1190-1700	0,8	8,0		0,3	0,4	0.6	0,9	
850-1200			0.2			0.8		
600-850			0.3			1.0		
420-600	0,3	1,9	0.4	0,4	0,4	0.9	0,5	
300-420	0,6	2,1	0.6	0,7	0,6	1.1	0,7	
210-300	0,8	2,1	0.8	0,8	0,9	1.1	1,0	
150-210	0,9	2,1	1.0	0,8	1,0	1.7	1,1	
105-150	1,4	3,6	1.3	1,2	1,6	2.5	1,6	
75-105	1,1	3,0	1.1	0,9	1,2	1.8	1,1	
50-75	0,8	2,3	1.2	0,7	0,9	1.5	0,7	
35-50			1.3			1.1		
~~25-35~~			3.0			2.5		
16-25	11,6	31,0	3.9	11,2	9,3	1.9	8,8	
8-16			6.8			2.7		
4-8	19,6	33,9	7.2	14,9	11,7	8.5	10,5	
2-4			6.2			5.6		
< 2	62,1	10,0	64.7	68,1	72,0	69.7	73,1	

1975			362		364		366		368		369		371			
mm	< 2 µm															
org. matter	C	%					4.8 (367)						1.6			
nitrogen	N	%														
C/N																
free iron	Fe_2O_3	%	5.2		6.0		10,2		11,9		12.6		13.8			
carbonates	$CaCO_3$	%														
amorphous iron	Fe_2O_3	%	0.4		0.8		2,3		2.4		1,1		0.8			
aluminium	Al_2O_3	%	2.7		3.3		5,0		6,0		4,4		5,0			
pH	H_2O	1975→		363				367				370				
	$CaCl_2$	0.01M	nd	3,9	3.8		4.7	4.7	4.1		3.9	4.0	4.0			
	KCl	1N	nd	3.7	3.7		4.8	4.8	4.2		4.0	4.1	4.1			
vocht	H_2O^-	%	7.7		6.9		5,1	*	5.4		4.5	↓	12.2			
exchangeable cations NH_4-acetate	Ca	me/100 g dry soil					8.6	6.7	1.1		1,6	3.9	4.7			
	Mg						3.0	3.5	2.0		0.6	1.1	1.7			
	Na						nd	nd	nd		nd	nd	nd			
	K						0,4	0,5	0,4		0,7	0,8	0,8			
	Al															
	H															
	Σ															
c.e.c.							20,3	18.7	13.6		14.0	15,0	14,4			

soil solution		me/100 g	me/1							
	Ca									
	Mg									
	Na									
	K									
	Σ									
	CO_3									
	HCO_3									
	Cl									
	SO_4									

appendix

				362		304		366		600		309		377		Kors		Kors 2
SiO_2	weight percentage	< 2 mm	< 2 µm Ba-clay	65,73	56,13	65,22	51,22	47,52	36,01	46,53	36,98	44,26	37,84	45,38	37,67	80,74		81,35
Al_2O_3				16,32	17,77	16,39	20,49	20,21	25,92	24,05	23,93	23,90	20,29	22,23	26,77	6,99		7,89
Fe_2O_3				7,44	9,67	7,74	11,65	18,53	17,22	14,43	14,40	15,87	15,18	17,00	15,68	4,65		3,70
FeO				0,17	0,07	0,24	–	0,28	–	0,29	0,07	0,14	0,10	0,24	0,03	nd		nd
MnO				0,10	0,12	0,13	0,18	0,78	0,53	0,54	0,37	0,76	0,42	0,43	0,26	0,05		0,02
MgO				0,49	0,55	0,29	0,24	0,25	0,32	0,22	0,27	0,25	0,27	0,26	0,24	0,76		0,14
CaO				0,67	0,07	0,47	0,07	0,29	0,02	0,06	–	0,05	–	0,12	0,01	0,10		0,16
Na_2O				1,80	0,79	1,36	0,53	0,86	0,14	0,70	0,14	0,45	<0,05	0,29	<0,05	nd		nd
K_2O				2,00	1,31	2,19	0,76	1,65	0,75	1,43	0,88	1,06	0,56	0,78	0,46	3,62		4,39
TiO_2				0,63	0,66	0,60	0,78	1,41	1,87	1,39	1,42	1,45	1,35	1,54	1,37	0,34		0,32
P_2O_5				0,02	0,15	0,02	0,28	0,17	0,47	0,13	0,36	0,09	0,29	0,13	0,33	0,09		0,07
BaO				0,11	4,16	0,10	3,93	0,20	3,40	0,20	2,82	0,21	2,61	0,23	3,29	0,07		0,11
H_2O^+				6,77	4,11	6,83	10,98	13,32	13,76	11,18	13,72	11,49	12,99	11,27	13,11	2,12		1,35
Σ				102,33	100,16	102,08	100,46	100,47	100,11	101,15	99,56	100,08	99,90	99,90	99,22	99,53		100,53

Silica	percentage	2 µm-2 mm	< 2 µm
Kaolinite			
Illite			
Smectite			
Goethite			
Rutile			
Strengite			
misc.			
Smectite	estimation	< 2 mm	< 2 µm
chlorite/verm.			
hydr.mica			
kaolinite			
quartz			
feldspar			
remarks			
fraction	weight%	50-420 µm	
		50-105 µm	
fraction		105-210 µm	
		210-420 µm	

	numerical percentage	50-420 µm	50-105 µm	105-210 µm	210-420 µm
tourmaline					
zircon					
garnet					
rutile					
anatase					
brookite					
titanite					
staurolite					
disthene					
andalusite					
sillimanite					
topase					
chloritoid					
epidote					
aggregates					
saussurite					
hornblende gr.					
hornblende br.					
augite					
hypersthene					
apatite					
oriticmatter					
mica					
biotite					
muscovite					
remarks					

table 12 appendix

Kata Norm of non-clay fraction

Sample nr.	depth (cm)	Hor.	Q	Or	AB	Clay	Hm	C	Sill	Fe conc	Conc
351	0-70	$A_{1,1}$	38,2	21,0	19,0	0,5	8,5	6,0	7,6	1,3	1,5
353	100-210	$A_{1,3}$	38,0	21,5	21,7	0,4	7,7	5,2	7,6	1,1	0,7
355	215-260	$B_{2,2}$	37,5	17,4	15,2	1,3	12,4	8,2	11,5	—	2,[illegible]
356	250-450	$B_{2,3}$	39,4	15,9	13,9	—	12,0	10,3	15,4	1,7	0,5
358	500-650	$B_{2,5}$	39,3	18,5	18,5	—	9,1	7,0	10,5	0,7	0,7
359	650-710	$B_{3,1}$	33,8	10,0	8,7	4,1	10,3	19,4	26,7	1,3	3,3
360	750-760	$B_{3,2}$	27,6	20,7	17,7	4,1	9,1	8,9	10,9	1,8	6,6
361	950-1000	B_3	36,6	15,3	21,7	4,2	5,5	8,2	9,9	1,5	3,7
[illegible]4	surface spring		38,1	15,0	19,5	2,3	5,6	10,4	14,3	1,3	2,4
profile 55:											
366	0-50	$A_{1,1}$	40,4	20,2	20,0	0,4	6,5	5,4	7,9	3,5	—
368	79-270	$B_{2,1}$	35,3	19,5	17,3	0,4	9,6	5,4	13,4	3,3	—
369	270-545	$B_{2,2}$	39,6	15,0	14,8	0,1	14,0	8,6	12,7	1,1	1,3
371	740-750	$B_{2,3}$	47,3	9,5	8,3	—	15,3	8,8	15,2	3,3	1,6

Table 13 Appendix

Goethite and Epinorm Calculations

DATA FOR GOETHITE AND EPINORM PROGRAMME

NR I	OXIDE NAME CN(I)	BASIS NAME BN(I)	G-NORM NAME GN(I)	G-NORM FACTOR GF(I)	EPINORM NAME EN(I)	EPINORM FACTOR FF(I)
1	SIO2	RU	CP	.0620	CP	.0620
2	AL2O3	CP	STR	.0934	STR	.0934
3	FE2O3	STR	VAR	.0790		.0000
4	FEO	VAR	Q	.0601	Q	.0601
5	MNO*	KP	RU	.0799	RU	.0799
6	MGO	KS	GOET	.0888	HM	.0798
7	CAO	NE	CC	.1001	CC	.1001
8	NA2O	NS	MGS	.0843	MGS	.0843
9	K2O	CAL	SID	.1158	SID	.1158
10	H2O+	CS		.0000		.0000
11	H2O-*	SP	NAOH	.0400	NSX	.0455
12	TIO2	FO	KOH	.0561	KSX	.0536
13	P2O5	HZ	TC	.0567	MS	.0569
14	BAO*	FA	HIN	.0651	AB	.0524
15	SRO*	FS	AB	.0524	OR	.0556
16	NIO*	Z	OR	.0556	XON	.0626
17	CR2O3*	C	GIBB	.0780	TREM	.0554
18	ZRO2*	Q	KAOL	.0645	ANT	.0554
19	CO2	CO2	MS_ILL	.0569	FE ANT	.0743
20	S*	H2O+	MM 1	.0592		.0000
21		H2O-	FEMM 1	.0619	ZO	.0568
22			MM 2	.0584	AT	.0557
23			MGMM 2	.0579	FE AT	.0683
24			SAP	.0535	MG OT	.0551
25			FE SAP	.0670	OT	.0630
26				.0000	KAOL	.0645
27			CO2	.0440	CO2	.0440
28			H2O+	.0180	H2O+	.0180
29			H2O-	.0180	H2O-	.0190
30	TOTAL	TOTAL	TOTAL	.0000	TOTAL	.0000

table 13 appendix

MAGOMBO 1S 351 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 50,7 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	1,746	2,501	5,789	2,315

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	36.55	18.53	RU	19.6	CP	0.6	0.6	0.04	0.02	0.04
AL2O3	24.80	12.57	CP	0.6	SIR	14.5	14.5	1.35	0.68	1.39
FE2O3	16.78	8.51	STR	14.5	VAR	0.0	0.0	0.00	0.00	0.00
FEO	0.21	0.11	VAR	0.0	Q	107.7	54.6	3.28	1.66	3.37
MNO*	0.46	0.23	KP	58.0	RU	19.6	19.6	1.57	0.80	1.61
MGO	0.31	0.16	KS	0.0	GOET	202.9	202.9	18.02	9.14	18.53
CAO	0.02	0.01	NE	21.3	CC	0.0	0.0	0.00	0.00	0.00
NA2O	0.22	0.11	HS	0.0	MGS	0.0	0.0	0.00	0.00	0.00
K2O	0.91	0.46	CAL	0.0	SID	0.0	0.0	0.00	0.00	0.00
H2O+	12.97	6.58	CS	0.0		0.0	0.0	0.00	0.00	0.00
H2O-*	0.00	0.00	SP	23.1	NAOH	7.1	0.0	0.00	0.00	0.00
TIO2	1.57	0.80	FO	0.0	KOH	0.0	0.0	0.00	0.00	0.00
P2O5	0.53	0.27	HZ	8.8	TC	17.9	0.0	0.00	0.00	0.00
BAO*	0.00	0.00	FA	0.0	MIN	6.8	0.0	0.00	0.00	0.00
SRO*	0.00	0.00	FS	304.4	AB	0.0	35.5	1.86	0.94	1.91
NIO*	0.00	0.00	Z	0.0	OR	0.0	0.0	0.00	0.00	0.00
CR2O3*	0.00	0.00	C	438.5	GIBB	0.0	0.0	0.00	0.00	0.00
ZRO2*	0.00	0.00	Q	480.4	KAOL	857.3	779.1	50.25	25.48	51.68
CO2	0.00	0.00	CO2	0.0	MS_ILL	135.2	135.2	7.70	3.90	7.91
S*	0.00	0.00	H2O+	705.5	MM 1	0.0	92.3	5.46	2.77	5.62
	0.00	0.00	H2O-	0.0	FEMM 1	0.0	35.1	2.17	1.10	2.23
	0.00	0.00		0.0	MM 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	MGMM 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	FE SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0		0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	H2O+	145.6	173.9	3.13	1.59	3.22
	0.00	0.00		0.0	H2O-	0.0	0.0	0.00	0.00	0.00
TOTAL	95.33	48.33	TOTAL	1369.4	TOTAL	1369.4	1369.4	94.83	48.08	97.52

EXCHANGEABLE CATIONS, WT PERC OF	CLAY FRACTION	FINE EARTH
	0.50	0.25

table 13 appendix

MAGOMBO 1S 351 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	5.651	8.848	15.642	1.768
IN TOTAL SOIL:	3.106	4.583	9.632	2.101

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS. THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION.

COMPO- SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	66.83	32.01	RU	16.0	CP	0.0	0.00	0.00
AL2O3	12.82	6.14	CP	0.0	STR	0.0	0.00	0.00
FE2O3	11.36	5.44	STR	0.0		0.0	0.00	0.00
FEO	0.30	0.14	VAR	0.0	Q	702.9	42.25	20.24
MNO*	1.50	0.72	KP	210.5	RU	16.0	1.28	0.61
MGO	0.17	0.08	KS	0.0	HM	142.2	11.35	5.44
CAO	0.12	0.06	NE	189.0	CC	0.0	0.00	0.00
NA2O	1.95	0.94	NS	0.0	MGS	0.0	0.00	0.00
K2O	3.30	1.58	CAL	6.5	SID	0.0	0.00	0.00
H2O+	7.66	3.67	CS	0.0		0.0	0.00	0.00
H2O-*	0.00	0.00	SP	12.6	MSX	0.0	0.00	0.00
TIO2	1.28	0.61	FO	0.0	NSX	0.0	0.00	0.00
P2O5	-0.13	-0.06	HZ	12.4	MS	414.0	23.56	11.28
BAO*	0.00	0.00	FA	0.0	AB	314.9	16.50	7.90
SRO*	0.00	0.00	FS	213.3	OR	55.1	3.06	1.47
NIO*	0.00	0.00	Z	0.0	XON	1.0	0.06	0.03
CR2O3*	0.00	0.00	C	97.3	TREM	12.6	0.70	0.33
ZRO2*	0.00	0.00	Q	909.0	ANT	0.0	0.00	0.00
CO2	0.00	0.00	CO2	0.0	FE ANT	6.7	0.51	0.25
S*	0.00	0.00	H2O+	425.3		0.0	0.00	0.00
	0.00	0.00	H2O-	0.0	ZO	0.0	0.00	0.00
	0.00	0.00		0.0	AT	0.0	0.00	0.00
	0.00	0.00		0.0	FE AT	0.0	0.00	0.00
	0.00	0.00		0.0	MG OT	0.0	0.00	0.00
	0.00	0.00		0.0	OT	0.0	0.00	0.00
	0.00	0.00		0.0	KAOL	0.0	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.00	0.00
	0.00	0.00		0.0	H2O+	362.4	6.52	3.12
	0.00	0.00		0.0	H2O-	0.0	0.00	0.00
TOTAL	107.19	51.31	TOTAL	1665.6	TOTAL	1665.6	105.79	50.67

table 13 appendix

MAGOMBO 1S 353 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 52.1 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	1.819	2.575	6.185	2.402

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. FR	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	38.33	19.97	RU	17.9	CP	0.3	0.3	0.02	0.01	0.02
AL2O3	25.26	13.16	CP	0.3	STR	10.2	10.2	0.95	0.50	1.04
FE2O3	16.47	9.58	STR	10.2	VAR	0.0	0.0	0.00	0.00	0.00
FEO	0.21	0.11	VAR	0.0	Q	127.3	63.7	3.83	2.00	4.17
MNO*	0.47	0.24	KP	61.8	RU	17.9	17.9	1.43	0.75	1.56
MGO	0.34	0.18	KS	0.0	GOET	201.2	201.2	17.86	9.31	19.43
CAO	0.01	0.01	NE	32.9	CC	0.0	0.0	0.00	0.00	0.00
NA2O	0.34	0.18	NS	0.0	MGS	0.0	0.0	0.00	0.00	0.00
K2O	0.97	0.51	CAL	0.0	SID	0.0	0.0	0.00	0.00	0.00
H2O+	12.88	6.71	CS	0.0		0.0	0.0	0.00	0.00	0.00
H2O-*	0.00	0.00	SP	25.3	NAOH	11.0	0.0	0.00	0.00	0.00
TIO2	1.43	0.75	FO	0.0	KOH	0.0	0.0	0.00	0.00	0.00
P2O5	0.37	0.19	HZ	8.3	TC	19.7	0.0	0.00	0.00	0.00
BAO*	0.00	0.00	FA	0.0	MIN	6.8	0.0	0.00	0.00	0.00
SRO*	0.00	0.00	FS	301.8	AB	0.0	54.9	2.87	1.50	3.13
NIO*	0.00	0.00	Z	0.0	OR	0.0	0.0	0.00	0.00	0.00
CR2O3*	0.00	0.00	C	441.2	GIBB	0.0	0.0	0.00	0.00	0.00
ZRO2*	0.00	0.00	Q	505.9	KAOL	867.1	777.3	50.14	26.12	54.53
CO2	0.00	0.00	CO2	0.0	MS_ILL	144.2	144.2	8.20	4.27	8.92
S*	0.00	0.00	H2O+	704.8	MH 1	0.0	101.2	5.99	3.12	6.52
	0.00	0.00	H2O-	0.0	FEMH 1	0.0	35.1	2.17	1.13	2.36
	0.00	0.00		0.0	MH 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	MGMH 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	FE SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0		0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	H2O+	136.8	172.2	3.10	1.61	3.37
	0.00	0.00		0.0	H2O-	0.0	0.0	0.00	0.00	0.00
TOTAL	97.08	50.58	TOTAL	1405.9	TOTAL	1405.9	1405.9	96.57	50.31	105.03

EXCHANGEABLE CATIONS, WT PERC OF	CLAY FRACTION	FINE EARTH
	0.27	0.11

table 13 appendix

MAGOMBO 1S 353 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	6.034	9.238	17.409	1.884
IN TOTAL SOIL:	3.207	4.659	10.302	2.212

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN SET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION.

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	68.01	32.58	RU	15.6	CP	0.0	0.00	0.00
AL2O3	12.49	5.98	CP	0.0	STP	0.0	0.00	0.00
FE2O3	10.39	4.98	STR	0.0		0.0	0.00	0.00
FEO	0.23	0.11	VAR	0.0	Q	689.0	41.41	19.84
MNO*	0.98	0.47	KP	217.3	RU	15.6	1.25	0.60
MGO	0.10	0.05	KS	0.0	MU	130.1	10.36	4.97
CAO	0.08	0.04	NE	219.0	CC	0.0	0.00	0.00
NA2O	2.26	1.08	NS	0.0	MGS	0.0	0.00	0.00
K2O	3.41	1.63	CAL	4.4	SID	0.0	0.00	0.00
H2O+	3.64	1.74	CS	0.0		0.0	0.00	0.00
H2O-*	0.00	0.00	SP	7.2	NSX	0.0	0.00	0.00
TIO2	1.25	0.60	FO	0.0	KSX	0.0	0.00	0.00
P2O5	-0.17	-0.08	HZ	9.9	MS	348.7	19.84	9.50
BAO*	0.00	0.00	FA	0.0	AB	365.0	19.13	9.16
SRO*	0.00	0.00	FS	135.1	OR	113.1	6.29	3.01
NIO*	0.00	0.00	Z	0.0	XON	1.0	0.06	0.03
CR2O3*	0.00	0.00	C	95.4	TREM	7.2	0.40	0.19
ZRO2*	0.00	0.00	Q	921.1	ANT	0.0	0.00	0.00
CO2	0.00	0.00	CO2	0.0	FE ANT	5.1	0.40	0.19
S*	0.00	0.00	H2O+	201.9		0.0	0.00	0.00
	0.00	0.00	H2O-	0.0	ZO	0.0	0.00	0.00
	0.00	0.00		0.0	AT	0.0	0.00	0.00
	0.00	0.00		0.0	FE AT	0.0	0.00	0.00
	0.00	0.00		0.0	MG AT	0.0	0.00	0.00
	0.00	0.00		0.0	OT	0.0	0.00	0.00
	0.00	0.00		0.0	KAOL	0.0	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.00	0.00
	0.00	0.00		0.0	H2O+	149.2	2.69	1.29
	0.00	0.00		0.0	H2O-	0.0	0.00	0.00
TOTAL	102.68	49.18	TOTAL	1675.2	TOTAL	1675.2	101.34	48.78

table 13 appendix

MAGOMBO 1S 355 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 52,5 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	1,754	2,424	6,350	2,620

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO- SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	38,18	23,86	RU	18,9	CP	0,0	0,0	0,00	0,00	0,00
AL2O3	26,73	16,71	CP	0,0	STR	9,6	9,6	0,89	0,56	1,49
FE2O3	15,98	9,99	STR	9,6	VAR	0,0	0,0	0,00	0,00	0,00
FEO	0,43	0,27	VAR	0,0	Q	93,2	40,1	2,41	1,51	4,02
MNO*	0,43	0,27	KP	45,9	RU	18,9	18,9	1,51	0,94	2,52
MGO	0,30	0,19	KS	0,0	GOET	195,3	195,3	17,35	10,84	28,91
CAO	0,00	0,00	NE	5,8	CC	0,0	0,0	0,00	0,00	0,00
NA2O	0,06	0,04	LS	0,0	MGS	0,0	0,0	0,00	0,00	0,00
K2O	0,72	0,45	CAL	0,0	SID	0,0	0,0	0,00	0,00	0,00
H2O+	13,23	8,27	CS	0,0		0,0	0,0	0,00	0,00	0,00
H2O-*	0,00	0,00	SP	22,3	NAOH	1,9	0,0	0,00	0,00	0,00
TIO2	1,51	0,94	FO	0,0	KOH	0,0	0,0	0,00	0,00	0,00
P2O5	0,34	0,21	HZ	18,0	TC	17,4	0,0	0,00	0,00	0,00
BAO*	0,00	0,00	FA	0,0	MIN	14,0	0,0	0,00	0,00	0,00
SRO*	0,00	0,00	FS	293,0	AB	0,0	9,7	0,51	0,32	0,85
NIO*	0,00	0,00	Z	0,0	OR	0,0	0,0	0,00	0,00	0,00
CR2O3*	0,00	0,00	C	480,2	GIBB	0,0	0,0	0,00	0,00	0,00
ZRO2*	0,00	0,00	Q	520,5	KAOL	956,9	872,5	56,28	35,17	93,79
CO2	0,00	0,00	CO2	0,0	MS_ILL	107,0	107,0	6,09	3,81	10,15
S*	0,00	0,00	H2O+	724,8	MS 1	0,0	89,3	5,29	3,30	8,81
	0,00	0,00	H2O-	0,0	FEMU 1	0,0	71,8	4,44	2,77	7,40
	0,00	0,00		0,0	MU 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	MGMU 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	FE SAF	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0		0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	CO2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	H2O+	123,5	148,7	2,68	1,67	4,46
	0,00	0,00		0,0	H2O-	0,0	0,0	0,00	0,00	0,00
TOTAL	97,91	61,19	TOTAL	1414,2	TOTAL	1414,2	1414,2	97,44	60,90	162,39

table 13 appendix

MAGOMBO 18 355 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	4,475	7,984	10,180	1,275
IN TOTAL SOIL:	2,496	3,676	7,782	2,117

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN ST TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION,

COMPO-SITION	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH	BASIS	MEQ, NR	NORM	MEQ, NR	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH
SIO2	60,90	22,84	RU	19,2	CP	0,0	0,00	0,00
AL2O3	12,94	4,85	CP	0,0	STR	0,0	0,00	0,00
FE2O3	15,90	5,96	STR	0,0		0,0	0,00	0,00
FEO	-0,34	-0,13	VAR	0,0	Q	671,0	40,33	15,12
MNO*	1,39	0,52	KP	166,4	RU	19,2	1,54	0,58
MGO	0,33	0,12	KS	0,0	HM	139,1	15,69	5,96
CAO	0,29	0,11	NE	145,2	CC	0,0	0,00	0,00
NA2O	1,50	0,56	NS	0,0	MGS	0,0	0,00	0,00
K2O	2,61	0,98	CAL	15,7	SID	0,0	0,00	0,00
H2O+	5,60	2,10	CS	0,0		0,0	0,00	0,00
H2O-*	0,00	0,00	SP	21,3	NSX	0,0	0,00	0,00
TIO2	1,54	0,58	FO	0,0	KSX	0,0	0,00	0,00
P2O5	-0,22	-0,08	HZ	0,0	MS	388,4	22,10	8,29
BAO*	0,00	0,00	FA	0,0	AB	242,0	12,68	4,76
SRO*	0,00	0,00	FS	208,7	OR	0,0	0,00	0,00
NIO*	0,00	0,00	Z	0,0	XON	0,0	0,00	0,00
CR2O3*	0,00	0,00	C	123,3	TREM	0,0	0,00	0,00
ZRO2*	0,00	0,00	Q	810,1	ANT	0,0	0,00	0,00
CO2	0,00	0,00	CO2	0,0	FE ANT	0,0	0,00	0,00
S*	0,00	0,00	H2O+	311,0		0,0	0,00	0,00
	0,00	0,00	H2O-	0,0	ZO	20,7	1,19	0,45
	0,00	0,00		0,0	AT	0,0	0,00	0,00
	0,00	0,00		0,0	FE AT	0,0	0,00	0,00
	0,00	0,00		0,0	MG CT	32,4	1,79	0,67
	0,00	0,00		0,0	OT	0,0	0,00	0,00
	0,00	0,00		0,0	KAOL	30,0	1,93	0,72
	0,00	0,00		0,0	CO2	0,0	0,00	0,00
	0,00	0,00		0,0	H2O+	231,2	4,16	1,56
	0,00	0,00		0,0	H2O-	0,0	0,00	0,00
TOTAL	102,44	38,42	TOTAL	1603,0	TOTAL	1603,0	101,50	38,10

table 13 appendix

MAGOMBO 1S 356 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 71.1 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	1.719	2.316	6.678	2.884

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	37.16	26.42	RU	16.6	CP	0.3	0.3	0.02	0.01	0.05
AL2O3	27.23	19.36	CP	0.3	STR	9.1	9.1	0.85	0.60	2.08
FE2O3	14.79	10.52	STR	9.1	VAR	0.0	0.0	0.00	0.00	0.00
FEO	0.07	0.05	VAR	0.0	Q	73.4	40.3	2.42	1.72	5.95
MNO*	0.40	0.28	KP	37.6	RU	16.6	16.6	1.33	0.95	3.27
MGO	0.29	0.21	KS	0.0	GOET	160.7	160.7	16.05	11.41	39.48
CAO	0.01	0.01	NE	4.8	CC	0.0	0.0	0.00	0.00	0.00
NA2O	0.05	0.04	NS	0.0	MGS	0.0	0.0	0.00	0.00	0.00
K2O	0.59	0.42	CAL	0.0	SID	0.0	0.0	0.00	0.00	0.00
H2O+	13.57	9.65	CS	0.0		0.0	0.0	0.00	0.00	0.00
H2O-*	0.00	0.00	SP	21.6	NAOH	1.6	0.0	0.00	0.00	0.00
TIO2	1.33	0.95	FO	0.0	KOH	0.0	0.0	0.00	0.00	0.00
P2O5	0.33	0.23	HZ	2.9	TC	16.8	0.0	0.00	0.00	0.00
BAO*	0.00	0.00	FA	0.0	MIN	2.3	0.0	0.00	0.00	0.00
SRO*	0.00	0.00	FS	271.1	AB	0.0	8.1	0.42	0.30	1.04
NIO*	0.00	0.00	Z	0.0	OR	0.0	0.0	0.00	0.00	0.00
CR2O3*	0.00	0.00	C	503.6	GIBB	0.0	0.0	0.00	0.00	0.00
ZRO2*	0.00	0.00	Q	514.0	KAOL	993.1	940.9	60.69	43.15	149.30
CO2	0.00	0.00	CO2	0.0	MS_ILL	87.7	87.7	4.99	3.55	12.27
S*	0.00	0.00	H2O+	744.2	MH 1	0.0	86.3	5.11	3.63	12.57
	0.00	0.00	H2O-	0.0	FERM 1	0.0	11.7	0.72	0.51	1.78
	0.00	0.00		0.0	MH 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	MGMH 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	FE SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0		0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	H2O+	138.5	154.5	2.78	1.98	6.94
	0.00	0.00		0.0	H2O-	0.0	0.0	0.00	0.00	0.00
TOTAL	95.82	68.13	TOTAL	1381.6	TOTAL	1381.6	1381.6	95.37	67.81	234.64

EXCHANGEABLE CATIONS, WT PERC OF	CLAY FRACTION	FINE EARTH
	0.16	0.11

table 13 appendix

MAGOMBO 1S 356 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	4.366	7.408	10.632	1.435
IN TOTAL SOIL:	2.290	3.227	7.882	2.443

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION.

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	63.74	18.42	RU	22.7	CP	0.0	0.00	0.00
AL2O3	14.60	4.22	CP	0.0	STR	0.0	0.00	0.00
FE2O3	15.93	4.60	STR	0.0		0.0	0.00	0.00
FEO	0.38	0.11	VAR	0.0	Q	688.8	41.40	11.96
MNO*	1.71	0.50	KP	158.7	RU	22.7	1.81	0.52
MGO	0.07	0.02	KS	0.0	HM	199.5	15.92	4.60
CAO	-0.05	-0.01	NE	138.8	CC	0.0	0.00	0.00
NA2O	1.43	0.41	NS	0.0	MGS	0.0	0.00	0.00
K2O	2.49	0.72	CAL	0.0	SID	0.0	0.00	0.00
H2O+	5.40	1.56	CS	0.0		0.0	0.00	0.00
H2O-*	0.00	0.00	SP	5.0	MSX	0.0	0.00	0.00
TIO2	1.81	0.52	FO	0.0	KSX	0.0	0.00	0.00
P2O5	-0.43	-0.12	HZ	15.9	MS	370.2	21.06	6.09
BAO*	0.00	0.00	FA	0.0	AB	231.4	12.12	3.50
SRO*	0.00	0.00	FS	299.3	OR	0.0	0.00	0.00
NIO*	0.00	0.00	Z	0.0	XON	0.0	0.00	0.00
CR2O3*	0.00	0.00	C	173.3	TREM	0.0	0.00	0.00
ZRO2*	0.00	0.00	Q	861.8	ANT	0.0	0.00	0.00
CO2	0.00	0.00	CO2	0.0	FE ANT	0.0	0.00	0.00
S*	0.00	0.00	H2O+	300.0		0.0	0.00	0.00
	0.00	0.00	H2O-	0.0	ZO	0.0	0.00	0.00
	0.00	0.00		0.0	AT	0.0	0.00	0.00
	0.00	0.00		0.0	FE AT	0.0	0.00	0.00
	0.00	0.00		0.0	MG OT	6.7	0.37	0.11
	0.00	0.00		0.0	OT	21.2	1.34	0.39
	0.00	0.00		0.0	KAOL	135.0	8.71	2.52
	0.00	0.00		0.0	CO2	0.0	0.00	0.00
	0.00	0.00		0.0	H2O+	172.6	3.11	0.90
	0.00	0.00		0.0	H2O-	0.0	0.00	0.00
TOTAL	107.09	30.95	TOTAL	1675.5	TOTAL	1675.5	105.84	30.59

table 13 appendix

MAGOMBO 1S 358 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 63.1 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	1.862	2.545	6.934	2.725

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	MEQ. NR	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH	WT PERC OF: NON-CLAY
SIO2	39.08	24.66	RU	19.3	CP	0.3	0.3	0.02	0.01	0.03
AL2O3	26.06	16.44	CP	0.3	STR	9.3	9.3	0.87	0.55	1.49
FE2O3	14.98	9.45	STR	9.3	VAR	0.0	0.0	0.00	0.00	0.00
FEO	0.12	0.08	VAR	0.0	Q	126.4	88.0	5.29	3.34	9.04
MNO*	0.45	0.28	KP	49.0	RU	19.3	19.3	1.54	0.97	2.63
MGO	0.32	0.20	KS	0.0	GOET	182.9	182.9	16.25	10.25	27.78
CAO	0.01	0.01	NE	4.8	CC	0.0	0.0	0.00	0.00	0.00
NA2O	0.05	0.03	NS	0.0	MGS	0.0	0.0	0.00	0.00	0.00
K2O	0.77	0.49	CAL	0.0	SID	0.0	0.0	0.00	0.00	0.00
H2O+	13.15	8.30	CS	0.0		0.0	0.0	0.00	0.00	0.00
H2O-*	0.00	0.00	SP	23.8	NAOH	1.6	0.0	0.00	0.00	0.00
TIO2	1.54	0.97	FO	0.0	KOH	0.0	0.0	0.00	0.00	0.00
P2O5	0.34	0.21	HZ	5.0	TC	18.5	0.0	0.00	0.00	0.00
BAO*	0.00	0.00	EA	0.0	HIN	3.9	0.0	0.00	0.00	0.00
SRO*	0.00	0.00	FS	274.4	AB	0.0	8.1	0.42	0.27	0.72
NIO*	0.00	0.00	Z	0.0	OR	0.0	0.0	0.00	0.00	0.00
CR2O3*	0.00	0.00	C	474.0	GIBB	0.0	0.0	0.00	0.00	0.00
ZRO2*	0.00	0.00	Q	541.0	KAOL	924.3	663.4	55.69	35.14	95.23
CO2	0.00	0.00	CO2	0.0	MS-ILL	114.4	114.4	6.51	4.11	11.13
S*	0.00	0.00	H2O+	720.6	MM 1	0.0	95.3	5.64	3.56	9.64
	0.00	0.00	H2O-	0.0	FEMM 1	0.0	20.0	1.24	0.78	2.12
	0.00	0.00		0.0	MM 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	MGMM 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	FE SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0		0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	H2O+	143.4	161.9	2.91	1.84	4.98
	0.00	0.00		0.0	H2O-	0.0	0.0	0.00	0.00	0.00
TOTAL	96.87	61.12	TOTAL	1401.0	TOTAL	1401.0	1401.0	96.38	60.81	164.81

EXCHANGEABLE CATIONS, WT PERC OF	CLAY FRACTION	FINE EARTH
	0.24	0.15

table 13 appendix

MAGOMBO 18 358 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	5.207	6.849	12.650	1.430
IN TOTAL SOIL:	2,756	3,975	8,984	2,260

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS. THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION.

COMPO-	WT PERC OF:		BASIS	MEQ. NR	NORM	MEQ. NR	WT PERC OF:	
SITION	FRACTION	FINE EARTH					FRACTION	FINE EARTH
SIO2	68.20	25.17	RU	18.6	CP	0.0	0.00	0.00
AL2O3	13.08	4.83	CP	0.0	STR	0.0	0.00	0.00
FE2O3	14.33	5.29	STR	0.0		0.0	0.00	0.00
FEO	0.15	0.05	VAR	0.0	Q	747.4	44.92	16.57
MNO*	1.64	0.61	KP	193.8	RU	18.6	1.49	0.55
MGO	0.09	0.03	KS	0.0	HM	179.5	14.32	5.28
CAO	-0.02	-0.01	NE	191.1	CC	0.0	0.00	0.00
NA2O	1.97	0.73	MS	0.0	MGS	0.0	0.00	0.00
K2O	3.04	1.12	CAL	0.0	SID	0.0	0.00	0.00
H2O+	3.39	1.25	CS	0.0		0.0	0.00	0.00
H2O-*	0.00	0.00	SP	6.4	NSX	0.0	0.00	0.00
TIO2	1.49	0.55	FO	0.0	KSX	0.0	0.00	0.00
P2O5	-0.31	-0.11	HZ	6.1	MS	448.8	25.54	9.42
BAO*	0.00	0.00	FA	0.0	AB	318.5	16.69	6.16
SRO*	0.00	0.00	FS	269.2	OR	2.5	0.14	0.05
NIO*	0.00	0.00	Z	0.0	KOM	0.0	0.00	0.00
CR2O3*	0.00	0.00	C	119.3	TREM	0.0	0.00	0.00
ZRO2*	0.00	0.00	O	917.0	ANT	3.6	0.20	0.07
CO2	0.00	0.00	CO2	0.0	FE ANT	3.4	0.25	0.09
S*	0.00	0.00	H2O+	188.4		0.0	0.00	0.00
	0.00	0.00	H2O-	0.0	ZO	0.0	0.00	0.00
	0.00	0.00		0.0	AT	0.0	0.00	0.00
	0.00	0.00		0.0	FE AT	0.0	0.00	0.00
	0.00	0.00		0.0	MG CT	0.0	0.00	0.00
	0.00	0.00		0.0	CT	0.0	0.00	0.00
	0.00	0.00		0.0	KAOL	0.0	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.00	0.00
	0.00	0.00		0.0	H2O+	121.5	2.19	0.81
	0.00	0.00		0.0	H2O-	0.0	0.00	0.00
TOTAL	107.05	39.50	TOTAL	1722.2	TOTAL	1722.2	105.73	39.01

table 13 appendix

MAGOMBO 1S 359 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 50,9 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	2,120	2,747	9,296	3,384

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR.	NORM	MEQ. NR	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	42,67	21,72	RU	15,5	CP	0,3	0,3	0,02	0,01	0,02
AL2O3	26,36	13,42	CP	0,3	STR	10,2	10,2	0,95	0,48	0,39
FE2O3	12,20	6,21	STR	10,2	VAR	0,0	0,0	0,00	0,00	0,00
FEO	0,34	0,17	VAR	0,0	Q	174,2	113,3	6,81	3,47	7,06
MNO*	0,33	0,17	KP	42,7	RU	15,5	15,5	1,24	0,63	1,29
MGO	0,38	0,19	KS	0,0	GOET	147,7	147,7	13,12	6,68	13,60
CAO	0,01	0,01	NE	13,6	CC	0,0	0,0	0,00	0,00	0,00
NA2O	0,14	0,07	NS	0,0	MGS	0,0	0,0	0,00	0,00	0,00
K2O	0,67	0,34	CAL	0,0	SID	0,0	0,0	0,00	0,00	0,00
H2O+	12,99	6,61	CS	0,0		0,0	0,0	0,00	0,00	0,00
H2O-*	0,00	0,00	SP	28,3	NAOH	4,5	0,0	0,00	0,00	0,00
TIO2	1,24	0,63	FO	0,0	KOH	0,0	0,0	0,00	0,00	0,00
P2O5	0,37	0,19	HZ	14,2	TC	22,0	0,0	0,00	0,00	0,00
BAO*	0,00	0,00	FA	0,0	MIN	11,0	0,0	0,00	0,00	0,00
SRO*	0,00	0,00	FS	221,5	AB	0,0	22,6	1,18	0,60	1,23
NIO*	0,00	0,00	Z	0,0	OR	0,0	0,0	0,00	0,00	0,00
CR2O3*	0,00	0,00	C	470,0	GIBB	0,0	0,0	0,00	0,00	0,00
ZRO2*	0,00	0,00	Q	617,6	KAOL	948,8	854,8	55,13	28,06	57,15
CO2	0,00	0,00	CO2	0,0	MS_ILL	99,6	99,6	5,67	2,98	5,87
S*	0,00	0,00	H2O+	710,9	MM 1	0,0	113,1	6,70	3,11	6,94
	0,00	0,00	H2O-	0,0	FEMM 1	0,0	56,8	3,51	1,79	3,64
	0,00	0,00		0,0	MM 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	MGMM 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	FE SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0		0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	CO2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	H2O+	135,7	157,1	3,01	1,53	3,12
	0,00	0,00		0,0	H2O-	0,0	0,0	0,00	0,00	0,00
TOTAL	97,70	49,73	TOTAL	1433,8	TOTAL	1433,8	1433,8	97,33	49,54	100,90

table 13 appendix

MAGOMBO 1S 359 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	3.274	4.611	11.289	2.448
IN TOTAL SOIL:	2.636	3.542	10.306	2.910

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION.

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ, NR	NORM	MEQ, NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	55,20	27,10	RU	10,7	CP	0,0	0,00	0,00
AL2O3	20,31	9,97	CP	0,0	STR	0,0	0,00	0,00
FE2O3	12,99	6,38	STR	0,0		0,0	0,00	0,00
FEO	0,26	0,13	VAR	0,0	Q	478,2	28,74	14,11
MNO*	0,98	0.48	KP	94,6	RU	10,7	0,85	0.42
MGO	0,38	0,19	KS	0,0	HM	162,7	12,99	6,38
CAO	0,93	0,45	NE	92,6	CC	0.0	0,00	0,00
NA2O	0,85	0,42	NS	0,0	MGS	0,0	0,00	0,00
K2O	1,48	0,73	CAL	49,6	SID	0.0	0,00	0,00
H2O+	9,20	4,52	CS	0,0		0,0	0,00	0.00
H2O-*	0,00	0,00	SP	28,3	NSX	0,0	0,00	0,00
TIO2	0,85	0,42	FO	0,0	KSX	0,0	0,00	0,00
P2O5	-0,24	-0,12	HZ	10,8	MS	220,6	12,55	6,16
BAO*	0,00	0,00	FA	0,0	AB	137,6	7,21	3,54
SRO*	0,00	0,00	FS	244,1	OR	0,0	0,00	0,00
NIO*	0,00	0,00	Z	0,0	XON	0,0	0,00	0,00
CR2O3*	0,00	0,00	C	260,3	TREM	0,0	0,00	0,00
ZRO2*	0,00	0,00	Q	778,2	ANT	0,0	0,00	0,00
CO2	0,00	0,00	CO2	0,0	FE ANT	0,0	0,00	0,00
S*	0,00	0,00	H2O+	510,3		0,0	0,00	0,00
	0,00	0,00	H2O-	0,0	ZO	66,1	3,75	1,84
	0,00	0,00		0,0	AT	0,0	0,00	0,00
	0,00	0,00		0,0	FE AT	0,0	0,00	0,00
	0,00	0,00		0,0	MG OT	37,7	2,08	1,02
	0,00	0,00		0,0	OT	14,4	0,91	0,45
	0,00	0,00		0,0	KAOL	451,0	29,09	14,28
	0,00	0,00		0,0	CO2	0,0	0,00	0,00
	0,00	0,00		0,0	H2O+	236,6	4,26	2,09
	0,00	0,00		0,0	H2O-	0,0	0,00	0,00
TOTAL	103,20	50,67	TOTAL	1579,0	TOTAL	1579,0	102,43	50,29

table 13 appendix

MAGOMBO 1S 360 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 42.8 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	2.446	3.382	8.846	2.616

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	44.50	19.05	RU	12.4	CP	0.6	0.6	0.04	0.02	0.03
AL2O3	22.33	9.56	CP	0.6	STR	11.1	11.1	1.03	0.44	0.77
FE2O3	13.37	5.72	STR	11.1	VAP	0.0	0.0	0.00	0.00	0.00
FEO	0.07	0.03	VAR	0.0	Q	279.5	197.8	11.89	5.09	8.90
MNO*	0.56	0.24	FP	73.9	RU	12.4	12.4	0.99	0.42	0.74
MGO	0.66	0.28	KS	0.0	GOET	161.9	161.9	14.38	6.15	10.76
CAO	0.02	0.01	NE	27.1	CC	0.0	0.0	0.00	0.00	0.00
NA2O	0.28	0.12	NS	0.0	MGS	0.0	0.0	0.00	0.00	0.00
K2O	1.16	0.50	CAL	0.0	SID	0.0	0.0	0.00	0.00	0.00
H2O+	11.00	4.71	CS	0.0		0.0	0.0	0.00	0.00	0.00
H2O-*	0.00	0.00	SP	49.1	NAOH	0.0	0.0	0.00	0.00	0.00
TIO2	0.99	0.42	FO	0.0	KOH	0.0	0.0	0.00	0.00	0.00
P2O5	0.41	0.18	HZ	2.9	TC	38.2	0.0	0.00	0.00	0.00
BAO*	0.00	0.00	FA	0.0	MIN	2.3	0.0	0.00	0.00	0.00
SRO*	0.00	0.00	FS	242.9	AB	0.0	45.2	2.37	1.01	1.77
NIO*	0.00	0.00	Z	0.0	OR	0.0	0.0	0.00	0.00	0.00
CR2O3*	0.00	0.00	C	369.7	GIBB	0.0	0.0	0.00	0.00	0.00
ZRO2*	0.00	0.00	Q	626.0	KAOL	728.3	605.1	39.09	16.73	29.25
CO2	0.00	0.00	CO2	0.0	MS_ILL	172.4	172.4	9.81	4.20	7.34
S*	0.00	0.00	H2O+	599.5	MM 1	0.0	196.5	11.63	4.98	8.70
	0.00	0.00	H2O-	0.0	FEMM 1	0.0	11.7	0.72	0.31	0.54
	0.00	0.00		0.0	MM 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	MGMM 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	FE SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0		0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	H2O+	113.7	156.2	2.81	1.20	2.10
	0.00	0.00		0.0	H2O-	0.0	0.0	0.00	0.00	0.00
TOTAL	95.35	40.81	TOTAL	1415.6	TOTAL	1415.6	1415.6	94.76	40.56	70.91

tablel 13 appendix

MAGOMBO 1S 360   NON-CLAY FRACTION,   EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	4.111	5.984	13.132	2.195
IN TOTAL SOIL:	3.303	4.687	11.184	2.386

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION.

COMPO- SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	59.33	33.93	RU	7.1	CP	0.0	0.00	0.00
AL2O3	16.82	9.62	CP	0.0	STP	0.0	0.00	0.00
FE2O3	12.01	6.87	STR	0.0		0.0	0.00	0.00
FEO	0.38	0.22	VAR	0.0	Q	567.0	33.76	19.32
MNO*	0.82	0.47	KP	201.9	RU	7.1	0.57	0.33
MGO	0.82	0.47	KS	0.0	HM	150.4	12.00	6.86
CAO	0.95	0.54	NE	176.0	CC	0.0	0.00	0.00
NA2O	1.82	1.04	NS	0.0	MGS	0.0	0.00	0.00
K2O	3.17	1.81	CAL	59.6	SID	0.0	0.00	0.00
H2O+	6.89	3.94	CS	0.0		0.0	0.00	0.00
H2O-*	0.00	0.00	SP	60.8	MSX	0.0	0.00	0.00
TIO2	0.57	0.33	FO	0.0	KSX	0.0	0.00	0.00
P2O5	-0.24	-0.14	HZ	16.1	MS	471.2	26.81	15.34
BAO*	0.00	0.00	FA	0.0	AB	293.4	15.37	8.79
SRO*	0.00	0.00	FS	225.6	OR	0.0	0.00	0.00
NIO*	0.00	0.00	Z	0.0	XON	0.0	0.00	0.00
CR2O3*	0.00	0.00	C	119.0	TREM	0.0	0.00	0.00
ZRO2*	0.00	0.00	Q	786.2	ANT	0.0	0.00	0.00
CO2	0.00	0.00	CO2	0.0	FE ANT	0.0	0.00	0.00
S*	0.00	0.00	H2O+	382.5		0.0	0.00	0.00
	0.00	0.00	H2O-	0.0	ZO	67.5	3.83	2.19
	0.00	0.00		0.0	AT	18.0	1.00	0.57
	0.00	0.00		0.0	FE AT	0.0	0.00	0.00
	0.00	0.00		0.0	MG OT	52.3	2.88	1.65
	0.00	0.00		0.0	OT	21.4	1.35	0.77
	0.00	0.00		0.0	KAOL	0.0	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.00	0.00
	0.00	0.00		0.0	H2O+	285.4	5.14	2.94
	0.00	0.00		0.0	H2O-	0.0	0.00	0.00
TOTAL	103.34	59.11	TOTAL	1643.4	TOTAL	1643.4	102.74	58.77

table 13 appendix

MAGOMBO 1S 361 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 29,3 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	3,520	4,915	12,404	2,524

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO- SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ, NR	NORM	MEQ, NR	MEQ, NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	52,97	15,52	RU	11,3	CP	2,1	2,1	0,13	0,04	0,05
AL2O3	18,29	5,36	CP	2,1	STR	6,2	6,2	0,58	0,17	0,24
FE2O3	11,35	3,33	STR	6,2	VAR	0,0	0,0	0,00	0,00	0,00
FEO	0,05	0,01	VAR	0,0	Q	506,3	417,2	25,07	7,35	10,39
MNO*	0,17	0,05	KP	78,3	RU	11,3	11,3	0,90	0,26	0,37
MGO	0,47	0,14	KS	0,0	GOET	139,0	139,0	12,35	3,62	5,12
CAO	0,07	0,02	NE	65,8	CC	0,0	0,0	0,00	0,00	0,00
NA2O	0,68	0,20	NS	0,0	MGS	0,0	0,0	0,00	0,00	0,00
K2O	1,23	0,36	CAL	0,0	SID	0,0	0,0	0,00	0,00	0,00
H2O+	9,46	2,77	CS	0,0		0,0	0,0	0,00	0,00	0,00
H2O-*	0,00	0,00	SP	35,0	NAOH	21,9	0,0	0,00	0,00	0,00
TIO2	0,90	0,26	FO	0,0	KOH	0,0	0,0	0,00	0,00	0,00
P2O5	0,29	0,08	HZ	2,1	TC	27,2	0,0	0,00	0,00	0,00
BAO*	0,00	0,00	FA	0,0	MIN	1,6	0,0	0,00	0,00	0,00
SRO*	0,00	0,00	FS	208,6	AB	0,0	109,7	5,75	1,68	2,39
NIO*	0,00	0,00	Z	0,0	OR	0,0	0,0	0,00	0,00	0,00
CR2O3*	0,00	0,00	C	296,0	GIBB	0,0	0,0	0,00	0,00	0,00
ZRO2*	0,00	0,00	Q	764,0	KAOL	560,8	442,8	28,56	8,37	11,84
CO2	0,00	0,00	CO2	0,0	MS_ILL	182,8	182,8	10,40	3,05	4,31
S*	0,00	0,00	H2O+	518,9	MM 1	0,0	139,9	8,28	2,43	3,43
	0,00	0,00	H2O-	0,0	FEMM 1	0,0	8,4	0,52	0,15	0,21
	0,00	0,00		0,0	MM 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	MGMM 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	FE SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0		0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	CO2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	H2O+	123,6	177,1	3,19	0,93	1,32
	0,00	0,00		0,0	H2O-	0,0	0,0	0,00	0,00	0,00
TOTAL	95,92	28,10	TOTAL	1459,4	TOTAL	1459,4	1459,4	95,73	28,05	39,67

table 13 appendix

MAGOMBO 18 361 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	5,633	7,369	23,925	3,247
IN TOTAL SOIL:	4,916	6,571	19,516	2,970

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION,

COMPO-SITION	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH	BASIS	MEQ, NR	NORM	MEQ, NR	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH
SIO2	68,30	48,29	RU	6,8	CP	0,0	0,00	0,00
AL2O3	15,73	11,12	CP	0,0	STR	0,0	0,00	0,00
FE2O3	7,59	5,36	STR	0,0		0,0	0,00	0,00
FEO	0,35	0,25	VAR	0,0	Q	696,4	41,85	29,59
MNO*	0,10	0,07	KP	157,6	RU	6,8	0,55	0,39
MGO	0,46	0,32	KS	0,0	HM	95,0	7,58	5,36
CAO	1,02	0,72	NE	221,9	CC	0,0	0,00	0,00
NA2O	2,29	1,62	NS	0,0	MGS	0,0	0,00	0,00
K2O	2,47	1,75	CAL	54,4	SID	0,0	0,00	0,00
H2O+	5,77	4,08	CS	0,0		0,0	0,00	0,00
H2O-*	0,00	0,00	SP	33,9	NSX	0,0	0,00	0,00
TIO2	0,55	0,39	FO	0,0	KSX	0,0	0,00	0,00
P2O5	-0,07	-0,05	HZ	14,5	MS	367,8	20,93	14,79
BAO*	0,00	0,00	FA	0,0	AB	369,9	19,36	13,70
SRO*	0,00	0,00	FS	142,5	OR	0,0	0,00	0,00
NIO*	0,00	0,00	Z	0,0	KOM	0,0	0,00	0,00
CR2O3*	0,00	0,00	C	113,5	TREM	0,0	0,00	0,00
ZRO2*	0,00	0,00	Q	962,7	ANT	0,0	0,00	0,00
CO2	0,00	0,00	CO2	0,0	FE ANT	0,0	0,00	0,00
S*	0,00	0,00	H2O+	320,2		0,0	0,00	0,00
	0,00	0,00	H2O-	0,0	ZO	72,6	4,12	2,91
	0,00	0,00		0,0	AT	0,0	0,00	0,00
	0,00	0,00		0,0	FE AT	0,0	0,00	0,00
	0,00	0,00		0,0	MG OT	45,2	2,49	1,76
	0,00	0,00		0,0	OT	19,3	1,22	0,86
	0,00	0,00		0,0	KAOL	34,9	2,25	1,59
	0,00	0,00		0,0	CO2	0,0	0,00	0,00
	0,00	0,00		0,0	H2O+	229,5	4,13	2,92
	0,00	0,00		0,0	H2O-	0,0	0,00	0,00
TOTAL	104,55	73,92	TOTAL	1708,0	TOTAL	1708,0	104,51	73,89

tabel 13 appendix

MAGOMBO 1S 362 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	5,294	6,835	23,481	3,436

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	65.73	0.00	RU	7,9	CP	0,7	0,04	0,04
AL2O3	16.32	0.00	CP	0,7	STR	0,0	0,00	0,00
FE2O3	7.44	0.00	STR	0,0		0,0	0,00	0,00
FEO	0.17	0.00	VAR	0,0	Q	672,2	40,40	40,40
MNO*	0.10	0.00	KP	132,5	RU	7,9	0,63	0,63
MGO	0.49	0.00	KS	0,0	HM	93,2	7,44	7,44
CAO	0.67	0.00	NE	174,3	CC	0,0	0,00	0,00
NA2O	1.80	0.00	NS	0,0	MGS	0,0	0,00	0,00
K2O	2.08	0.00	CAL	34,6	SID	0,0	0,00	0,00
H2O+	6.77	0.00	CS	0,0		0,0	0,00	0,00
H2O-*	0.00	0.00	SP	36,5	NSX	0,0	0,00	0,00
TIO2	0.63	0.00	FO	0,0	KSX	0,0	0,00	0,00
P2O5	0.02	0.00	HZ	7,1	MS	309,1	17,59	17,59
BAO*	0.00	0.00	FA	0,0	AB	290,4	15,22	15,22
SRO*	0.00	0.00	FS	139,8	OR	0,0	0,00	0,00
NIO*	0.00	0.00	Z	0,0	XON	0,0	0,00	0,00
CR2O3*	0.00	0.00	C	165,8	TREM	0,0	0,00	0,00
ZRO2*	0.00	0.00	O	945,1	ANT	0,0	0,00	0,00
CO2	0.00	0.00	CO2	0,0	FE ANT	0,0	0,00	0,00
S*	0.00	0.00	H2O+	375,3		0,0	0,00	0,00
	0.00	0.00	H2O-	0,0	ZO	46,1	2,62	2,62
	0.00	0.00		0,0	AT	0,0	0,00	0,00
	0.00	0.00		0,0	FE AT	0,0	0,00	0,00
	0.00	0.00		0,0	MG OT	48,6	2,68	2,68
	0.00	0.00		0,0	OT	9,5	0,60	0,60
	0.00	0.00		0,0	KAOL	166,5	10,74	10,74
	0.00	0.00		0,0	CO2	0,0	0,00	0,00
	0.00	0.00		0,0	H2O+	231,0	4,16	4,16
	0.00	0.00		0,0	H2O-	0,0	0,00	0,00
TOTAL	102.22	0.00	TOTAL	1644,1	TOTAL	1644,1	102,10	102,10

table 13 appendix

MAGOMBO 1S 364 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 10,0 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	3,155	4,242	12,320	2,904

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	51,22	5,12	RU	9,8	CP	2,1	2,1	0,13	0,01	0,01
AL2O3	20,49	2,05	CP	2,1	STR	6,2	6,2	0,58	0,06	0,06
FE2O3	11,05	1,10	STR	6,2	VAR	0,0	0,0	0,00	0,00	0,00
FEO	0,00	0,00	VAR	0,0	Q	142,6	386,6	23,23	2,32	2,58
MNO*	0,18	0,02	KP	48,4	RU	9,8	9,8	0,78	0,08	0,09
MGO	0,24	0,02	KS	0,0	GOET	135,3	135,3	12,01	1,20	1,33
CAO	0,07	0,01	NE	51,3	CC	0,0	0,0	0,00	0,00	0,00
NA2O	0,53	0,05	NS	0,0	MGS	0,0	0,0	0,00	0,00	0,00
K2O	0,76	0,08	CAL	0,0	SID	0,0	0,0	0,00	0,00	0,00
H2O+	10,93	1,09	CS	0,0		0,0	0,0	0,00	0,00	0,00
H2O-*	0,00	0,00	SP	17,9	NAOH	17,1	0,0	0,00	0,00	0,00
TIO2	0,78	0,08	FO	0,0	KOH	0,0	0,0	0,00	0,00	0,00
P2O5	0,28	0,03	HZ	0,0	TC	13,9	0,0	0,00	0,00	0,00
BAO*	0,00	0,00	FA	0,0	MIN	0,0	0,0	0,00	0,00	0,00
SRO*	0,00	0,00	FS	202,9	AB	0,0	85,5	4,48	0,45	0,50
NIO*	0,00	0,00	Z	0,0	OR	0,0	0,0	0,00	0,00	0,00
CR2O3*	0,00	0,00	C	356,8	GIBB	0,0	0,0	0,00	0,00	0,00
ZRO2*	0,00	0,00	Q	751,6	KAOL	707,0	637,1	41,09	4,11	4,57
CO2	0,00	0,00	CO2	0,0	MS_ILL	112,9	112,9	6,43	0,64	0,71
S*	0,00	0,00	H2O+	600,5	MM 1	0,0	71,4	4,23	0,42	0,47
	0,00	0,00	H2O-	0,0	FEMM 1	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	MM 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	MGMM 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	FE SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0		0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	CO2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	H2O+	150,7	186,3	3,35	0,34	0,37
	0,00	0,00		0,0	H2O-	0,0	0,0	0,00	0,00	0,00
TOTAL	96,53	9,65	TOTAL	1446,9	TOTAL	1446,9	1446,9	96,32	9,63	10,70

table 13 appendix

MAGOMBO 1S 364 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	5.490	7.111	24.073	3.385
IN TOTAL SOIL:	5.188	6.753	22.395	3.317

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION,

COMPO-SITION	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH	BASIS	MEQ, NR	NORM	MEQ, NR	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH
SIO2	66,78	60,10	RU	7,3	CP	0,0	0,00	0,00
AL2O3	15.93	14,34	CP	0,0	STP	0,0	0,00	0,00
FE2O3	7.37	6.64	STR	0,0		0,0	0,00	0,00
FEO	0.27	0.24	VAR	0,0	Q	680,3	40,88	36,80
MNO*	0.12	0,11	KP	149,6	RU	7,3	0,58	0,52
MGO	0.30	0.27	NS	0,0	MT	92,3	7.37	6,63
CAO	0.51	0,46	NE	194,4	CC	0,0	0,00	0,00
NA2O	2,01	1,81	MS	0,0	MGS	0,0	0,00	0,00
K2O	2.35	2.11	CAL	27,5	SID	0,0	0,00	0,00
H2O+	6.37	5.74	CS	0,0		0,0	0,00	0,00
H2O-*	0.00	0.00	SP	22,0	NSX	0,0	0,00	0,00
TIO2	0.58	0.52	FO	0,0	KSX	0,0	0.00	0,00
P2O5	-0,01	-0.01	HZ	11,1	MS	349,1	19.86	17,88
BAO*	0.00	0,00	FA	0,0	AB	323,9	16.97	15,28
SRO*	0.00	0.00	FS	138,5	OR	0,0	0.00	0,00
NIO*	0.00	0.00	Z	0,0	XON	0,0	0,00	0.00
CR2O3*	0.00	0.00	C	157,5	TREM	0,0	0.00	0,00
ZRO2*	0.00	0.00	Q	959,5	ANT	0,0	0.00	0.00
CO2	0.00	0,00	CO2	0,0	FE ANT	0,0	0.00	0,00
S*	0.00	0,00	H2O+	353,8		0,0	0,00	0.00
	0.00	0,00	H2O-	0,0	ZO	36,7	2.08	1.88
	0.00	0,00		0,0	AT	0,0	0,00	0.00
	0.00	0,00		0,0	FE AT	0,0	0,00	0,00
	0.00	0.00		0,0	MG OT	29,3	1,62	1,45
	0.00	0.00		0,0	OT	14,8	0,94	0,84
	0,00	0,00		0,0	KAOL	124,6	8,04	7,24
	0.00	0,00		0,0	CO2	0,0	0,00	0,00
	0.00	0,00		0,0	H2O+	228,3	4,11	3,70
	0.00	0.00		0,0	H2O-	0,0	0,00	0,00
TOTAL	102,59	92,33	TOTAL	1658,4	TOTAL	1658,4	102,45	92,21

table 13 appendix

MAGOMBO 3S 366 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 62.1 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	1.655	2.358	5.558	2.357

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	36.01	22.36	RU	19.6	CP	0.6	0.6	0.04	0.02	0.06
AL2O3	25.92	16.10	CP	0.6	STR	12.8	12.8	1.19	0.74	1.95
FE2O3	17.22	10.69	STR	12.8	VAR	0.0	0.0	0.00	0.00	0.00
FEO	0.00	0.00	VAR	0.0	Q	80.3	42.2	2.53	1.57	4.15
MNO*	0.53	0.33	KP	47.8	RU	19.6	19.6	1.57	0.97	2.57
MGO	0.32	0.20	KS	0.0	GOET	209.3	209.3	18.58	11.54	30.45
CAO	0.02	0.01	NE	13.6	CC	0.0	0.0	0.00	0.00	0.00
NA2O	0.14	0.09	NS	0.0	MGS	0.0	0.0	0.00	0.00	0.00
K2O	0.75	0.47	CAL	0.0	SID	0.0	0.0	0.00	0.00	0.00
H2O+	13.76	8.54	CS	0.0		0.0	0.0	0.00	0.00	0.00
H2O-*	0.00	0.00	SP	23.8	NAOH	4.5	0.0	0.00	0.00	0.00
TIO2	1.57	0.97	FC	0.0	KOH	0.0	0.0	0.00	0.00	0.00
P2O5	0.47	0.29	HZ	0.0	TC	18.5	0.0	0.00	0.00	0.00
BAO*	0.00	0.00	FA	0.0	MIN	0.0	0.0	0.00	0.00	0.00
SRO*	0.00	0.00	FS	313.9	AB	0.0	22.6	1.18	0.74	1.94
NIO*	0.00	0.00	Z	0.0	OR	0.0	0.0	0.00	0.00	0.00
CR2O3*	0.00	0.00	C	472.1	GIBB	0.0	0.0	0.00	0.00	0.00
ZRO2*	0.00	0.00	Q	474.2	KAOL	921.3	864.7	55.77	34.63	91.38
CO2	0.00	0.00	CO2	0.0	MS_ILL	111.5	111.5	6.34	3.94	10.39
S*	0.00	0.00	H2O+	751.0	MT 1	0.0	95.3	5.64	3.50	9.24
	0.00	0.00	H2O-	0.0	FEMM 1	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	MM 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	MGMM 2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	FE SAP	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0		0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.0	0.00	0.00	0.00
	0.00	0.00		0.0	H2O+	162.3	182.3	3.28	2.04	5.38
	0.00	0.00		0.0	H2O-	0.0	0.0	0.00	0.00	0.00
TOTAL	96.71	60.06	TOTAL	1378.4	TOTAL	1378.4	1378.4	96.13	59.70	157.52

EXCHANGEABLE CATIONS, WT PERC OF	CLAY FRACTION	FINE EARTH
	0.34	0.21

table 13 appendix

MAGOMBO 3S 366   NON-CLAY FRACTION,   EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	6,503	9,352	21,345	2.283
IN TOTAL SOIL:	2,801	3,999	9,355	2,339

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION,

COMPO- SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ, NR	NORM	MEQ, NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	71.75	27.19	RU	16.3	CP	0.0	0.00	0.00
AL2O3	13.02	4.93	CP	0.0	STR	0.0	0.00	0.00
FE2O3	8.93	3.39	STR	0.0		0.0	0.00	0.00
FEO	0.77	0.29	VAR	0.0	Q	770.2	46.29	17.54
MNO*	1.27	0.48	KP	296.6	RU	16.3	1.30	0.49
MGO	-0.00	-0.00	KS	0.0	HM	111.9	8.93	3.38
CAO	0.10	0.04	NE	206.4	CC	0.0	0.00	0.00
NA2O	2.13	0.81	NS	0.0	MGS	0.0	0.00	0.00
K2O	3.28	1.24	CAL	5.4	SID	0.0	0.00	0.00
H2O+	3.31	1.25	CS	0.0		0.0	0.00	0.00
H2O-*	0.00	0.00	SP	0.0	MSX	0.0	0.00	0.00
TIO2	1.30	0.49	FO	0.0	KSX	0.0	0.00	0.00
P2O5	-0.30	-0.11	HZ	32.1	MS	409.7	23.31	8.84
BAO*	0.00	0.00	FA	0.0	AB	344.0	18.02	6.83
SRO*	0.00	0.00	FS	167.8	OR	55.1	3.06	1.16
NIO*	0.00	0.00	Z	0.0	XON	3.6	0.23	0.09
CR2O3*	0.00	0.00	C	92.0	TREM	0.0	0.00	0.00
ZRO2*	0.00	0.00	Q	999.9	ANT	0.0	0.00	0.00
CO2	0.00	0.00	CO2	0.0	FE ANT	17.8	1.33	0.50
S*	0.00	0.00	H2O+	183.5		0.0	0.00	0.00
	0.00	0.00	H2O-	0.0	ZO	0.0	0.00	0.00
	0.00	0.00		0.0	AT	0.0	0.00	0.00
	0.00	0.00		0.0	FE AT	0.0	0.00	0.00
	0.00	0.00		0.0	MG CT	0.0	0.00	0.00
	0.00	0.00		0.0	CT	0.0	0.00	0.00
	0.00	0.00		0.0	KAOL	0.0	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.00	0.00
	0.00	0.00		0.0	H2O+	117.0	2.11	0.80
	0.00	0.00		0.0	H2O-	0.0	0.00	0.00
TOTAL	105.55	40.00	TOTAL	1728.6	TOTAL	1728.6	104.58	39.63

table 13 appendix

MAGOMBO 3S 368 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 68,1 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	$SIO_2/(AL_2O_3+FE_2O_3)$	SIO_2/AL_2O_3	SIO_2/FE_2O_3	AL_2O_3/FE_2O_3
IN THIS FRACTION:	1,676	2,247	6,596	2,936

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPOSITION	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH	BASIS	MEQ, PR	NORM	MEQ, NR	MEQ, PR	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH	WT PERC OF: NON-CLAY
SIO2	36,98	25,18	RU	17,6	CP	0,0	0,0	0,00	0,00	0,00
AL2O3	27,93	19,02	CP	0,0	STR	10,1	10,1	0,95	0,65	2,02
FE2O3	14,90	10,15	STR	10,1	VAR	0,0	0,0	0,00	0,00	0,00
FEO	0,07	0,05	VAR	0,0	Q	57,4	20,2	1,21	0,83	2,59
MNO*	0,37	0,25	KP	36,9	RU	17,8	17,8	1,42	0,97	3,03
MGO	0,27	0,18	KS	0,0	GOFT	181,5	181,5	16,12	10,98	34,41
CAO	0,00	0,00	NE	13,6	CC	0,0	0,0	0,00	0,00	0,00
NA2O	0,14	0,10	NS	0,0	MGS	0,0	0,0	0,00	0,00	0,00
K2O	0,58	0,39	CAL	0,0	SID	0,0	0,0	0,00	0,00	0,00
H2O+	13,72	9,34	CS	0,0		0,0	0,0	0,00	0,00	0,00
H2O-*	0,00	0,00	SP	20,1	NAOH	4,5	0,0	0,00	0,00	0,00
TIO2	1,42	0,97	FO	0,0	KOH	0,0	0,0	0,05	0,00	0,00
P2O5	0,36	0,25	HZ	2,9	TC	15,6	0,0	0,00	0,00	0,00
BAO*	0,00	0,00	FA	0,0	MIN	2,3	0,0	0,00	0,00	0,00
SRO*	0,00	0,00	FS	272,3	AB	0,0	22,6	1,18	0,81	2,53
NIO*	0,00	0,00	Z	0,0	OR	0,0	0,0	0,00	0,00	0,00
CR2O3*	0,00	0,00	C	515,7	GIBB	0,0	0,0	0,00	0,00	0,00
ZRO2*	0,00	0,00	Q	507,9	KAOL	1021,8	966,8	62,36	42,46	133,12
CO2	0,00	0,00	CO2	0,0	MS_ILL	66,2	66,2	4,90	3,34	10,47
S*	0,00	0,00	H2O+	751,4	MN 1	0,0	80,4	4,76	3,24	10,16
	0,00	0,00	H2O-	0,0	FEMN 1	0,0	11,7	0,72	0,49	1,54
	0,00	0,00		0,0	MN 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	FGMN 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	SAF	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	FE SAF	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0		0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	CO2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	H2O+	130,1	149,6	2,69	1,83	5,75
	0,00	0,00		0,0	H2O-	0,0	0,0	0,00	0,00	0,00
TOTAL	96,74	65,88	TOTAL	1397,3	TOTAL	1397,3	1397,3	96,32	65,59	205,63

EXCHANGEABLE CATIONS, WT PERC OF	CLAY FRACTION	FINE EARTH
	0,07	0,05

table 13 appendix

MAGOMEO 3S 368 NON-CLAY FRACTION, EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	4.672	7.212	13.265	1.839
IN TOTAL SOIL:	2.375	3.285	8.576	2.610

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION,

COMPO- SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ, NR	NORM	MEQ, NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	67.01	21.38	RU	16.6	CP	0.0	0.00	0.00
AL2O3	15.77	5.03	CP	0.0	STR	0.0	0.00	0.00
FE2O3	13.43	4.28	STP	0.0		0.0	0.00	0.00
FEO	0.76	0.24	VAR	0.0	Q	694.2	41.72	13.31
MNO*	0.90	0.29	KP	204.8	RU	16.6	1.33	0.42
MGO	-0.01	-0.00	KS	0.0	HM	168.2	13.42	4.28
CAO	0.09	0.03	NE	183.5	CC	0.0	0.00	0.00
NA2O	1.90	0.60	NS	0.0	MGS	0.0	0.00	0.00
K2O	3.22	1.03	CAL	4.9	SID	0.0	0.00	0.00
H2O+	5.76	1.84	CS	0.0		0.0	0.00	0.00
H2O-*	0.00	0.00	SP	0.0	NSX	0.0	0.00	0.00
TIO2	1.33	0.42	FO	0.0	KSX	0.0	0.00	0.00
P2O5	-0.36	-0.12	HZ	31.7	MS	477.8	27.19	8.67
BAO*	0.00	0.00	FA	0.0	AB	305.8	16.03	5.11
SRO*	0.00	0.00	FS	252.2	OR	0.0	0.00	0.00
NIO*	0.00	0.00	Z	0.0	XON	0.0	0.00	0.00
CR2O3*	0.00	0.00	C	155.4	TREM	0.0	0.00	0.00
ZRO2*	0.00	0.00	Q	901.8	ANT	0.0	0.00	0.00
CO2	0.00	0.00	CO2	0.0	FE ANT	0.0	0.00	0.00
S*	0.00	0.00	H2O+	319.6		0.0	0.00	0.00
	0.00	0.00	H2O-	0.0	ZO	6.5	0.37	0.12
	0.00	0.00		0.0	AT	0.0	0.00	0.00
	0.00	0.00		0.0	FE AT	0.0	0.00	0.00
	0.00	0.00		0.0	MG CT	0.0	0.00	0.00
	0.00	0.00		0.0	OT	42.3	2.66	0.85
	0.00	0.00		0.0	KAOL	39.5	2.55	0.81
	0.00	0.00		0.0	CO2	0.0	0.00	0.00
	0.00	0.00		0.0	H2O+	220.6	3.97	1.27
	0.00	0.00		0.0	H2O-	0.0	0.00	0.00
TOTAL	109.78	35.02	TOTAL	1750.9	TOTAL	1750.9	109.23	34.85

table 13 appendix

MAGOMBO 3S 369 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 72,0 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	1,691	2,270	6,625	2,919

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH	NON-CLAY
SIO2	37,84	27,24	RU	16,9	CP	0,0	0,0	0,00	0,00	0,00
AL2O3	28,22	20,37	CP	0,0	STR	8,2	8,2	0,76	0,55	1,96
FE2O3	15,18	10,93	STR	8,2	VAR	0,0	0,0	0,00	0,00	0,00
FEO	0,10	0,07	VAR	0,0	Q	64,1	31,2	1,87	1,35	4,82
MNO*	0,42	0,30	KP	35,7	RU	16,9	16,9	1,35	0,97	3,47
MGO	0,27	0,19	KS	0,0	GOET	186,0	186,0	16,52	11,89	42,48
CAO	0,00	0,00	NE	4,8	CC	0,0	0,0	0,00	0,00	0,00
NA2O	0,05	0,04	HS	0,0	MGS	0,0	0,0	0,00	0,00	0,00
K2O	0,56	0,40	CAL	0,0	SIO	0,0	0,0	0,00	0,00	0,00
H2O+	12,99	9,35	CS	0,0		0,0	0,0	0,00	0,00	0,00
H2O-*	0,00	0,00	SP	20,1	NAOH	1,6	0,0	0,00	0,00	0,00
TIO2	1,35	0,97	FO	0,0	KOH	0,0	0,0	0,00	0,00	0,00
P2O5	0,29	0,21	HZ	4,2	TC	15,6	0,0	0,00	0,00	0,00
BAO*	0,00	0,00	FA	0,0	MIC	3,2	0,0	0,00	0,00	0,00
SRO*	0,00	0,00	FS	279,0	AB	0,0	6,1	0,47	0,30	1,09
NIO*	0,00	0,00	Z	0,0	OR	0,0	0,0	0,00	0,00	0,00
CR2O3*	0,00	0,00	C	525,2	GIBB	0,0	0,0	0,00	0,00	0,00
ZRO2*	0,00	0,00	Q	523,3	KAOL	1038,5	986,7	63,64	45,82	163,66
CO2	0,00	0,00	CO2	0,0	MS_ILL	83,2	83,2	4,74	3,41	12,18
S*	0,00	0,00	H2O+	712,9	MU 1	0,0	80,4	4,76	3,43	12,24
	0,00	0,00	H2O-	0,0	FEMU 1	0,0	15,7	1,03	0,74	2,65
	0,00	0,00		0,0	MU 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	MGMU 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	FE SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0		0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	CO2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	H2O+	82,5	95,4	1,77	1,28	4,56
	0,00	0,00		0,0	H2O-	0,0	0,0	0,00	0,00	0,00
TOTAL	97,34	70,08	TOTAL	1417,1	TOTAL	1417,4	1417,4	96,87	69,75	249,10

EXCHANGEABLE CATIONS, WT PERC OF

CLAY FRACTION	FINE EARTH
0,07	0,05

table 13 appendix

NAGOUBO 38 369   NON-CLAY FRACTION,   EPI NORM

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	4.284	8.183	8.985	1.097
IN TOTAL SOIL:	2.204	3.144	7.370	2.344

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN ET TO ZERO AFTER,
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE EPINORM CALCULATION.

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ, NR	NORM	MEQ, NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	60.86	17.04	RU	21.4	CP	0.0	0.00	0.00
AL2O3	12.61	3.53	CP	0.0	STR	0.0	0.00	0.00
FE2O3	18.00	5.04	STR	0.0		0.0	0.00	0.00
FEO	0.24	0.07	VAP	0.0	Q	677.3	40.70	11.40
MNO*	1.63	0.46	KP	145.7	RU	21.4	1.71	0.48
MGO	0.16	0.04	KS	0.0	HM	225.5	17.99	5.04
CAO	0.02	0.01	NE	143.1	CC	0.0	0.00	0.00
NA2O	1.48	0.41	NS	0.0	MGS	0.0	0.00	0.00
K2O	2.29	0.64	CAL	1.0	SID	0.0	0.00	0.00
H2O+	7.63	2.14	CS	0.0		0.0	0.00	0.00
H2O-*	0.00	0.00	SP	11.6	MSX	0.0	0.00	0.00
TIO2	1.71	0.48	FO	0.0	KSX	0.0	0.00	0.00
P2O5	-0.42	-0.12	HZ	10.1	MS	339.9	19.34	5.41
BAO*	0.00	0.00	FA	0.0	AB	236.6	12.50	3.50
SRO*	0.00	0.00	FS	338.2	OR	0.0	0.00	0.00
NIO*	0.00	0.00	Z	0.0	XON	0.0	0.00	0.00
CR2O3*	0.00	0.00	C	136.0	THEM	0.0	0.00	0.00
ZRO2*	0.00	0.00	Q	803.2	ANT	0.0	0.00	0.00
CO2	0.00	0.00	CO2	0.0	FE ANT	0.0	0.00	0.00
S*	0.00	0.00	H2O+	423.7		0.0	0.00	0.00
	0.00	0.00	H2O-	0.0	ZO	1.3	0.07	0.02
	0.00	0.00		0.0	AT	0.0	0.00	0.00
	0.00	0.00		0.0	FE AT	0.0	0.00	0.00
	0.00	0.00		0.0	MG CT	15.4	0.85	0.24
	0.00	0.00		0.0	CT	13.5	0.85	0.24
	0.00	0.00		0.0	FAOL	78.1	5.04	1.41
	0.00	0.00		0.0	CO2	0.0	0.00	0.00
	0.00	0.00		0.0	H2O+	328.8	5.92	1.66
	0.00	0.00		0.0	H2O-	0.0	0.00	0.00
TOTAL	106.20	29.74	TOTAL	1610.9	TOTAL	1610.9	104.97	29.39

table 13 appendix

MAGOMBO 3S 371 CLAY FRACTION, GOETHITE NORM

CLAY FRACTION 69,7 PER CENT OF FINE EARTH

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	1,738	2,388	6,365	2,674

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH	BASIS	MEQ, NR	NORM	MEQ, NP	MEQ, MP	WT PERC OF: FRACTION	WT PERC OF: FINE EARTH	WT PERC OF: NON-CLAY
SIO2	37,67	26,26	RU	17,1	CP	0,3	0,3	0,02	0,01	0,04
AL2O3	26,77	18,66	CP	0,3	STR	9,1	9,1	0,85	0,59	1,95
FE2O3	15,68	10,93	STR	9,1	VAR	0,0	0,0	0,00	0,00	0,00
FEO	0,03	0,02	VAR	0,0	Q	93,4	66,8	4,01	2,80	9,23
MNO*	0,26	0,18	KP	29,3	RU	17,1	17,1	1,37	0,95	3,15
MGO	0,24	0,17	KS	0,0	GOET	191,8	191,8	17,04	11,87	39,19
CAO	0,01	0,01	NE	4,8	CC	0,0	0,0	0,00	0,00	0,00
NA2O	0,05	0,03	NS	0,0	MGS	0,0	0,0	0,00	0,00	0,00
K2O	0,46	0,32	CAL	0,0	SIL	0,0	0,0	0,00	0,00	0,00
H2O+	13,11	9,14	CS	0,0		0,0	0,0	0,00	0,00	0,00
H2O-*	0,00	0,00	SP	17,9	NAOH	1,6	0,0	0,00	0,00	0,00
TIO2	1,37	0,95	FO	0,0	KOH	0,0	0,0	0,00	0,00	0,00
P2O5	0,33	0,23	FZ	1,3	TC	13,9	0,0	0,00	0,00	0,00
BAO*	0,00	0,00	FA	0,0	MIC	1,0	0,0	0,00	0,00	0,00
SRO*	0,00	0,00	FS	287,8	AE	0,0	8,1	0,42	0,29	0,97
NIO*	0,00	0,00	Z	0,0	OF	0,0	0,0	0,00	0,00	0,00
CR2O3*	0,00	0,00	C	501,0	GIBB	0,0	0,0	0,00	0,00	0,00
ZRO2*	0,00	0,00	Q	519,6	KAOL	991,6	960,2	61,26	42,72	140,95
CO2	0,00	0,00	CO2	0,0	MS_ILL	68,4	68,4	3,89	2,71	8,95
S*	0,00	0,00	H2O+	718,7	ILL 1	0,0	71,4	4,23	2,95	9,73
	0,00	0,00	H2O-	0,0	FEM 1	0,0	5,0	0,31	0,22	0,71
	0,00	0,00		0,0	MT 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	MGM 2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	FE SAP	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0		0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	CO2	0,0	0,0	0,00	0,00	0,00
	0,00	0,00		0,0	H2O+	112,1	125,1	2,25	1,57	5,18
	0,00	0,00		0,0	H2O-	0,0	0,0	0,00	0,00	0,00
TOTAL	95,98	66,90	TOTAL	1388,2	TOTAL	1388,2	1388,2	95,67	66,68	220,08

EXCHANGEABLE CATIONS, WT PERC OF	CLAY FRACTION	FINE EARTH
	0,19	0,12

table is appendix

[illegible] 3S 371 NON-CLAY FRACTION, [illegible]

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	4.371	9.116	8.39[illegible]	[illegible].921
IN TOTAL SOIL:	2.331	3.16[illegible]	7.[illegible]	2.04[illegible]

CO2, H2O+ AND H2O- EXCLUDED FROM [illegible] TOTALS
OXIDES MARKED WITH ASTERISKS [illegible] CALCULATION
COMPOSITION SHOWS NEGATIVE CONTENTS, THESE HAVE BEEN [illegible] ZERO [illegible]
CALCULATING RELATIONS OF SESQUIOXIDES AND BEFORE [illegible]

COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MOL. OF	[illegible]	[illegible]	WT PERC OF: FRACTION	FINE EARTH
SIO2	63.32	19.1[illegible]	[illegible]	2[illegible].2	CP	[illegible]	[illegible]	0.00
AL2O3	11.79	3.57	CP	[illegible]	STR	[illegible]	[illegible]	[illegible]
FE2O3	20.04	6.07	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
FEO	0.72	0.22	VAR	[illegible]	[illegible]	[illegible]3.1	[illegible]	14.26
[illegible]*	0.82	0.25	[illegible]	22.6	[illegible]	[illegible].2	[illegible].93	0.59
MGO	0.19	0.06	[illegible]	[illegible]	[illegible]	25[illegible]	20.02	6.07
CAO	-0.06	-0.02	[illegible]	[illegible]	CC	[illegible]	[illegible]	[illegible]
NA2O	0.84	0.26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00
K2O	1.45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00
H2O+	7.0[illegible]	2.13	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
H2O-*	[illegible]	[illegible]	[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	0.00
TIO2	1.[illegible]	[illegible].59	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
P2O5	-[illegible].33	-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.73
BAO*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].12	2.16
SRO*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]*	[illegible]	[illegible]	Z	[illegible]	Y	[illegible]	[illegible]	[illegible]
CR2O3*	[illegible]	[illegible]	[illegible]	1[illegible].5	[illegible]	[illegible]	[illegible]	[illegible]
ZRO2*	[illegible]	[illegible]	[illegible]	[illegible].3	[illegible]	[illegible]	[illegible]	[illegible]
CO2	[illegible]	[illegible]	CO2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
S*	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]		[illegible]	[illegible]	1[illegible]	1.[illegible]	[illegible].32
	[illegible]	[illegible]		[illegible]	[illegible]	[illegible].3	2.[illegible]	[illegible].77
	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	3.[illegible]
	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]		[illegible]	[illegible]	[illegible].2	[illegible]	[illegible].44
	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	1[illegible]7.75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	32.51

table 13 appendix

MAGOMBO RA 365 NON-CLAY FRACTION, [illegible]

MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	13.758	19.6[illegible]	46.1[illegible]	2.354

CO2, H2O+ AND H2O- EXCLUDED FROM NORM TOTALS
OXIDES MARKED WITH ASTERISK NOT USED IN NORM CALCULATION

COMPO-SITION	WT PERC OF FRACTION	WT PERC OF FINE EARTH	BASIS	EQU. [illegible]	NORM	EQU. [illegible]	WT PERC OF FRACTION	WT PERC OF FINE EARTH
SIO2	80.74	0.00	[illegible]	[illegible]	[illegible]	3.[illegible]	[illegible]	[illegible]
AL2O3	6.97	0.00	CP	3.0	[illegible]	[illegible]	[illegible]	0.01
FE2O3	1.65	0.00	STI	[illegible]		[illegible]	[illegible]	[illegible]
FEO	0.00	0.00	VAR	[illegible]	[illegible]	110[illegible]	[illegible].15	66.15
MNO*	0.05	0.00	[illegible]	2[illegible]	[illegible]	4.3	[illegible]	0.34
MGO	0.76	0.00	KS	[illegible]	[illegible]	59.2	[illegible]	1.64
CAO	0.1[illegible]	0.00	[illegible]	0.0	CC	[illegible]	[illegible]	[illegible]
NA2O	0.00	0.00	NS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K2O	3.62	0.00	CAL	.0	[illegible]	[illegible]	[illegible]	[illegible]
H2O+	2.12	0.00	CS	[illegible]		[illegible]	[illegible]	[illegible]
H2O-*	0.00	0.00	SE	50.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TIO2	0.34	0.00	FO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
P2O5	[illegible]	0.00	[illegible]	[illegible]	[illegible]	71[illegible]	12.[illegible]	12.[illegible]
BAO*	0.00	0.00	FA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SRO*	0.00	0.00	FS	[illegible]7.[illegible]	[illegible]	233.[illegible]	[illegible]	12.[illegible]
NIO*	0.00	0.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CR2O3*	0.00	0.00	C	[illegible]2.5	[illegible]	[illegible]	[illegible]	[illegible]
ZRO2*	0.00	0.00	Q	12[illegible]	[illegible]	31.[illegible]	1.7[illegible]	1.74
CO2	[illegible]	[illegible]	CO2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
S*	[illegible]	0.00	H2O+	11[illegible]		[illegible]	[illegible]	[illegible]
	[illegible]	0.00	H2O-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	0.00		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	0.00		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0.00	0.00		[illegible]	[illegible]	[illegible]	[illegible]	0.00
	0.00	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	0.00		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0.00	[illegible]		[illegible]	[illegible]	0.0	[illegible]	[illegible]
	[illegible]	[illegible]		[illegible]	H2O+	74.[illegible]	1.35	1.35
	[illegible]	[illegible]		[illegible]	H2O-	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	TOTAL	1642.[illegible]	[illegible]	1642.1	[illegible]	[illegible]

table 13 appendix

MAGOMBO RB 365 NON-CLAY FRACTION, EPI NORM

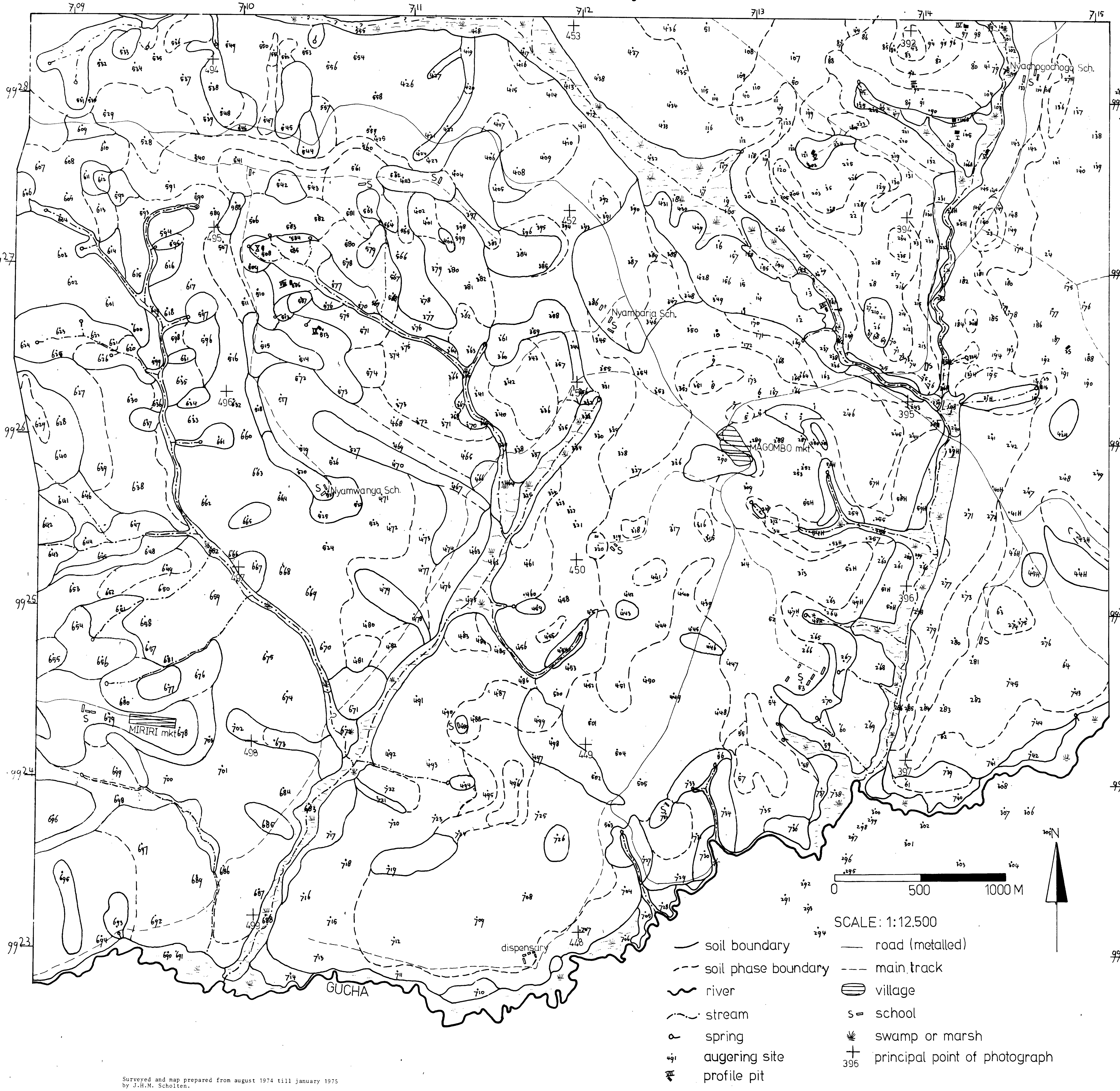
MOLAR RELATIONS OF THE SESQUIOXIDES

	SIO2/(AL2O3+FE2O3)	SIO2/AL2O3	SIO2/FE2O3	AL2O3/FE2O3
IN THIS FRACTION:	13.470	17.503	58.457	3.340

CO2, H2O+ AND H2O- EXCLUDED FROM MEQ TOTALS
OXIDES MARKED WITH ASTERISK* NOT USED IN NORM CALCULATION

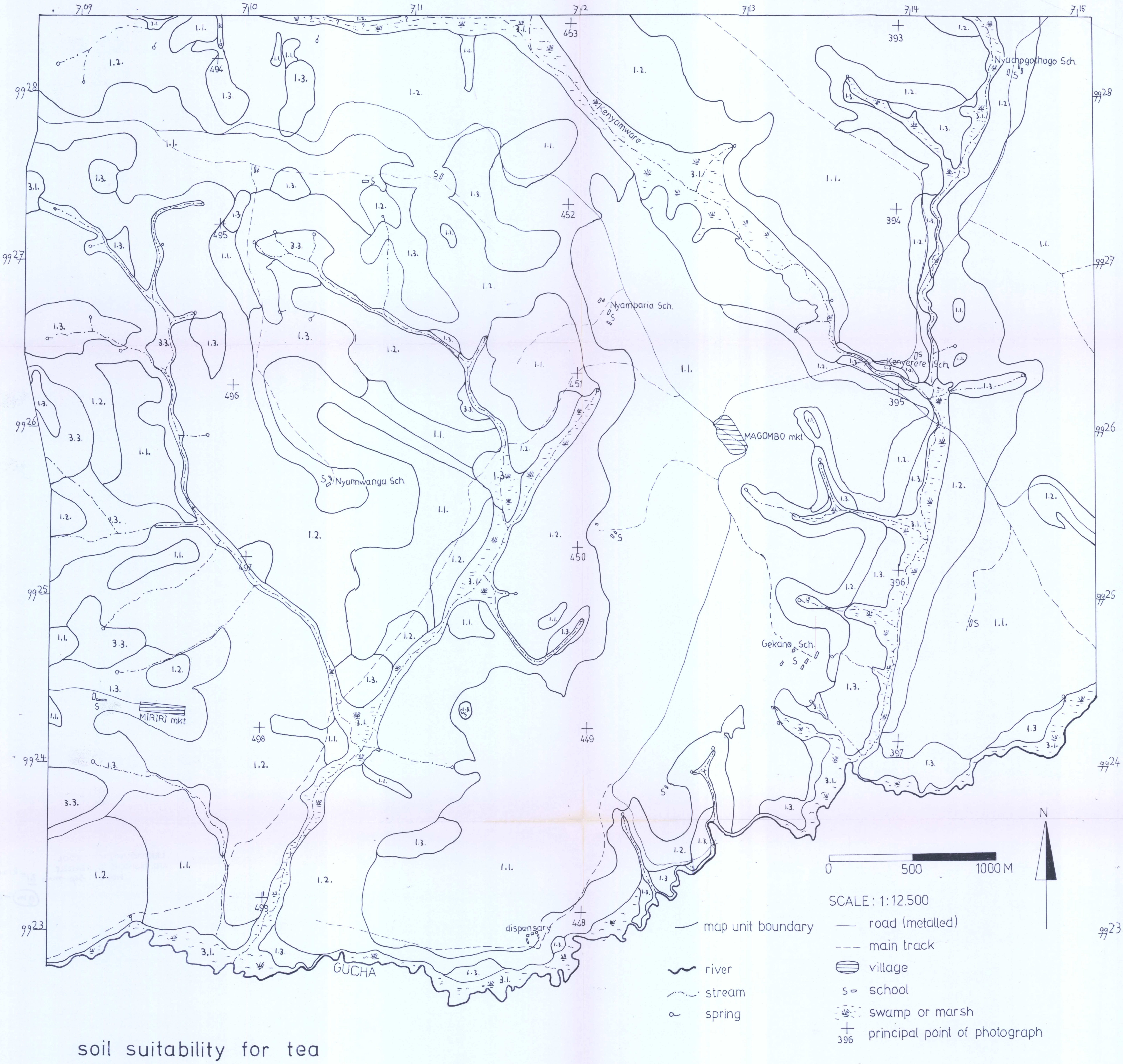
COMPO-SITION	WT PERC OF: FRACTION	FINE EARTH	BASIS	MEQ. NR	NORM	MEQ. NR	WT PERC OF: FRACTION	FINE EARTH
SIO2	81.36	0.00	RU	4.0	CP	2.5	0.15	0.15
AL2O3	7.89	0.00	CP	2.5	STR	0.0	0.00	0.00
FE2O3	3.70	0.00	STR	0.0		0.0	0.00	0.00
FEO	0.00	0.00	VAR	0.0	Q	1069.3	64.26	64.26
MNO*	0.02	0.00	KP	279.6	RU	4.0	0.32	0.32
MGO	0.14	0.00	KS	0.0	HM	46.3	3.70	3.70
CAO	0.16	0.00	NE	0.0	CC	0.0	0.00	0.00
NA2O	0.00	0.00	NS	0.0	MGS	0.0	0.00	0.00
K2O	4.39	0.00	CAL	4.1	SID	0.0	0.00	0.00
H2O+	1.35	0.00	CS	0.0		0.0	0.00	0.00
H2O-*	0.00	0.00	SP	10.4	NSX	0.0	0.00	0.00
TIO2	0.32	0.00	FO	0.0	KSX	0.0	0.00	0.00
P2O5	0.07	0.00	HZ	0.0	MS	215.5	12.26	12.26
BAO*	0.00	0.00	FA	0.0	AB	0.0	0.00	0.00
SRO*	0.00	0.00	FS	69.5	OR	312.1	17.35	17.35
NIO*	0.00	0.00	Z	0.0	XON	0.0	0.00	0.00
CR2O3*	0.00	0.00	C	51.9	TREM	10.3	0.57	0.57
ZRO2*	0.00	0.00	O	1236.0	ANT	0.1	0.00	0.00
CO2	0.00	0.00	CO2	0.0	FE ANT	0.0	0.00	0.00
S*	0.00	0.00	H2O+	74.9		0.0	0.00	0.00
	0.00	0.00	H2O-	0.0	ZO	0.0	0.00	0.00
	0.00	0.00		0.0	AT	0.0	0.00	0.00
	0.00	0.00		0.0	FE AT	0.0	0.00	0.00
	0.00	0.00		0.0	MG OT	0.0	0.00	0.00
	0.00	0.00		0.0	OT	0.0	0.00	0.00
	0.00	0.00		0.0	KACL	0.0	0.00	0.00
	0.00	0.00		0.0	CO2	0.0	0.00	0.00
	0.00	0.00		0.0	H2O+	43.4	0.78	0.78
	0.00	0.00		0.0	H2O-	0.0	0.00	0.00
TOTAL	99.42	0.00	TOTAL	1660.0	TOTAL	1660.0	99.40	99.40

Location of augerings and profile pits Magombo market area, Kenya.



Surveyed and map prepared from august 1974 till january 1975 by J.H.M. Scholten.

SOIL SUITABILITY MAP FOR TEA — MAGOMBO MARKET AREA, KENYA



soil suitability for tea

LEGEND

order 1. suitable

- 1.1. 1.1. optimal suitable
- 1.2. 1.2. suboptimal suitable
- 1.3. 1.3. marginal suitable

order 3. unsuitable

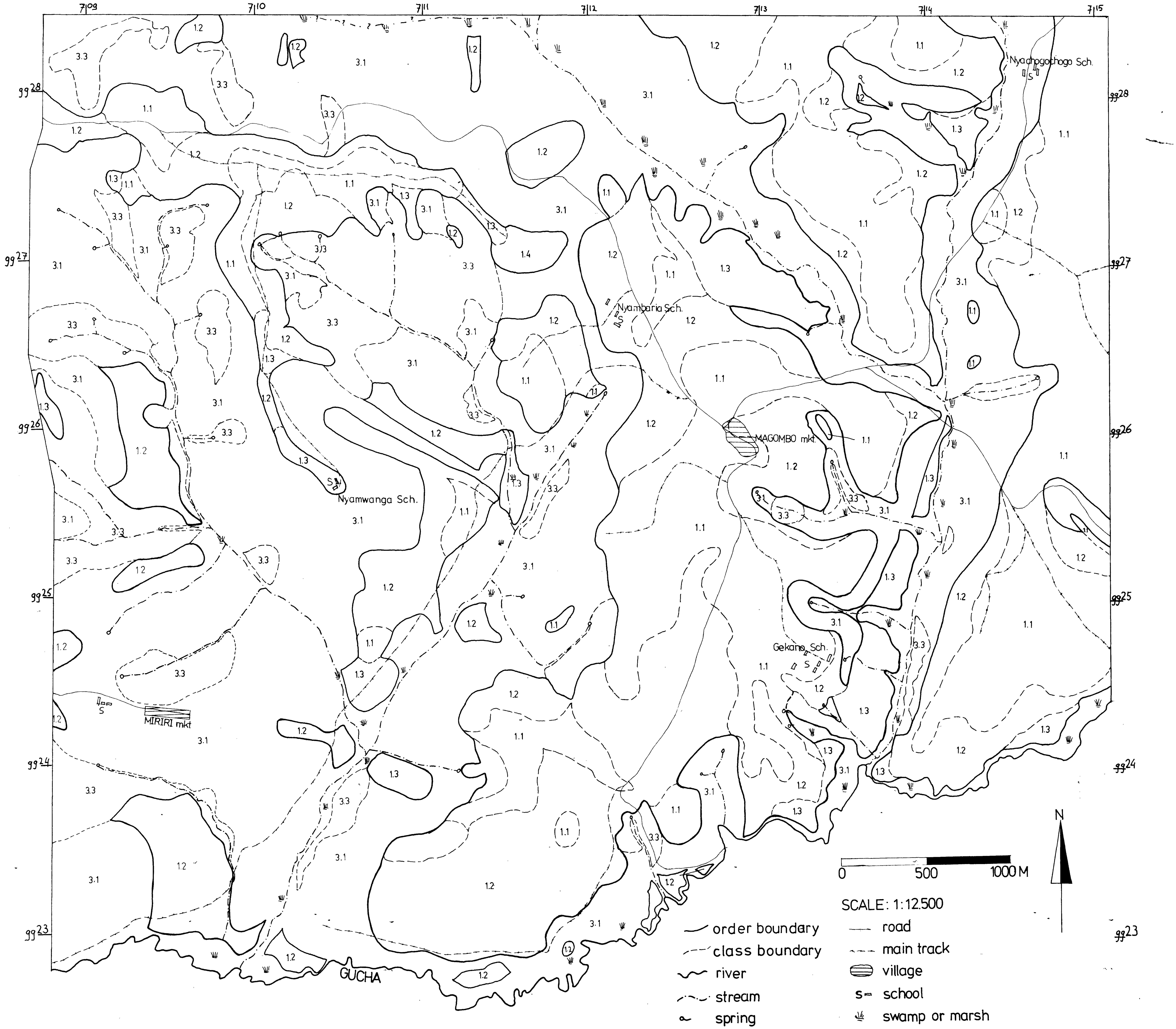
- 3.1. 3.1. presently unsuitable
- 3.3. 3.3. permanently unsuitable

Trainingproject in Pedology, Kisii, Kenya

map prepared by J.H.M. Scholten

MAIZE 2789 b

PRESENT LAND SUITABILITY MAP of the MAGOMBO AREA.



MAIZE — 2789 a

FUTURE LAND SUITABILITY MAP of the MAGOMBO AREA.