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Botswana

THE SOILS OF THE MPANDAMATENGA PLAINS

FOOD & AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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REPUBLIC OF BOTSWANA

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THE SOILS OF THE PANDAMATENGA PLAINS

by

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United Nations Development Programme

Republic of Botswana

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The conclusions given in this report are those considered appropriate at the time of its preparation.
They may be modified in the light of further knowledge gained at subsequent stages of this project.

ABSTRACT

This report presents results for the soil survey and mapping of the Pandamatenga lacustrine clay plains in the Chobe district.

The report has three chapters covering the following subjects:

Chapter 1 gives a general description of the area covering such aspects as the location, population, communication, climate, geology, geomorphology, natural vegetation and land use.

Chapter 2 gives a systematic description of the soils, soil classification systems, soil legend and soil units. In chapter 3, the physiography of these lacustrine plains is described with some cross sectional illustrations.

Finally, there are two appendices one for soil chemical and physical analyses and the other for selected representative soil profile descriptions and analytical data.

INTRODUCTION

The Pandamatenga plains are of lacustrine origin and cover and extensive area in eastern Chobe. There are three plains , the most extensive being the northern plain (Kakulwane Seloko), which extends eastwards into Zimbabwe. The central plain is located a few kilometres west of Pandamatenga village, whilst the southern plain lies just south of the Botswana Defence Force camp.

These plains were surveyed and mapped by the FAO/MOA soil survey team at reconnaissance scale (Kasane sheet 1:250 000) in 1984 and at semi detailed scale (1:50 000) in 1988. The surveys were initiated by the Botswana Government's interest in developing the area into commercial arable agriculture land. A total of eight fieldworks of 2 - 3 weeks duration were conducted with the result that 350 observations were made most of which are analysed soil profiles. Few of such profiles are listed in appendix 2 and the rest are available from the Botswana Soil Database. The report does not provide any data on land evaluation.

SUMMARY OF CONCLUSIONS

The predominant soil type in the plains is the Pellic Vertisol (Black cotton Soil), which is chemically fertile but poses physical problems. This soil unit strongly cracks when dry, has irregular surface and a poor drainage.

The predominant underlying lithology is basalt, most of which outcrops along the eastern fringe of the central and southern plains. This fringe is an erosional landscape characterized by some strong dissection with relatively shallow soils.

The lacustrine plains have minor but important elevation differences which eventually dictates the waterflow directions and flooding hazard of the lowest positions. The southern plain is gently tilted towards the southwest, whereas the central plain is gently tilted towards the north. The northern plain has an overall landform which is much more flat. It has, however, numerous gravelly islands which might interfere with tillage implements, once the area is put under commercial arable agriculture.

ACKNOWLEDGMENTS

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1 GENERAL DESCRIPTION OF THE AREA

1.1 Location; Population and Communication

1.1.1 Location

The Survey area is located within latitudes 18^{o} 07' South - 18^{o} 45' South and longitudes 25^{o} 05' East - 25^{o} 47' East.

The main village in the area is Pandamatenga which is located at about 100 km south of Kasane and 6 km east of the Nata-Kasane main road.

1.1.2 Population

According to the housing and population census of 1981, the population of Pandamatenga was 684. The last five years has seen the face of this area quickly changing due to the population influx borne by commercial farm operations started in the mid 1980's the military base which is continuously inhabited and the establishment of the Botswana Agricultural Marketing Board (BAMB) complex. The Pandamatenga development study consultancy estimated the core population at 1400. This means that the total population of the area is about 2000 which calls for a lot of essential amenities for the community.

1.1.3 Communication

Pandamatenga area is linked to Kasane, 100 km to the north and Francistown, about 400 km to the south east by a good tarmac road. The village itself, is linked to the tarmac road by a 6km gravel road. The 200 km stretch of the road between Pandamatenga and Nata village in the south has numerous emergency landing strips for small aircrafts. There are few trafficable tracks from the main road to the west across the flat vertisol plains. It is envisaged that a lot more tracks will come into being as more and more farms become operational. This will indeed enhance the accessibility of the area which was one of the biggest limitations during the survey.

1.2 Climate

The climate in the Chobe district and Pandamatenga in particular is semi-arid, with hot and moist summers and dry, mild winters. The north eastern part of the district which includes Kasane and Pandamatenga receives the highest rainfall (-+ 600mm) in Botswana. This area is part of the agro-climatic zone 1B1 (Figure 3). This zone has in more than 75% of years, a growing season of 101 to 120 days with 11-20 dry days and 41-60 humid days within the season.

The soil climate of Pandamatenga is characterized by a ustic moisture regime and an isohypertermic temperature regime (SMSS, 1987 technical monograph No 6). An aquic moisture regime occurs in poorly drained parts of the lacustrine area.

1.3 Geology

The Pandamatenga lacustrine plains are underlain by the Stormberg lava stage basalt of karoo age. This basalt occurs subordinately with the sandstones of the same age. The basalts are mostly exposed around Pandamatenga village and extends eastwards across the border into Zimbabwe. The plains are bordered by

superficial deposits of Kalahari sands which partly occur as east-west orientated longitudinal dunes. These dunes seem to have been deposited before the lake was formed and later became submerged and eroded. Tectonic activity seems to have occurred after the lake was formed, resulting in the different levels and opposite direction tilting of the lake bottom. The present consequence of this phenomenon is susceptibility to flooding of the lowest positions of the lake bottom.

1.4 Geomorphology

This area is very flat with minor elevation differences. Refer to chapter 3 for the detailed physiographic description of the Pandamatenga lacustrine plains.

1.5 Natural Vegetation

In addition to the extensive grassland savanna vegetation on the vertisol plains, is an association of Colophosphermum mopane with Acacia species. Colophospermum mopane tolerates alkaline and poorly drained soils better than most other species. Often mopane forms pure stands, giving rise to the name (shrub-) woodland. On heavy clay soils, with poor drainage, mopane remains a short shrub. In contrast, it occurs as a tree on better drained clay and sandy soils and in association with a wide range of other species. i.e. Terminalia Sericea, Acacia spp, Combretum spp, and Grewia spp.

1.6 Land Use

At the moment, Commercial dryland farming is being practiced in the central and southern clay plains, with sorghum as the main crop. Small scale dryland farming and traditional grazing are practiced around the Pandamatenga village, and in the northern plain along the main road to Kasane, where the farmers were attracted by the opportunity to use boreholes which were left over by the company which built the Nata - Kazungula road. These two land use types in one area could be a recipe for future conflict between livestock owners and commercial farmers. It has to be borne in mind that fencing would be very expensive in this area as it needs seasonal maintenance due to the swelling-shrinking character of the vertisols which easily collapses the fence poles.

REPUBLIC OF BOTSWANA

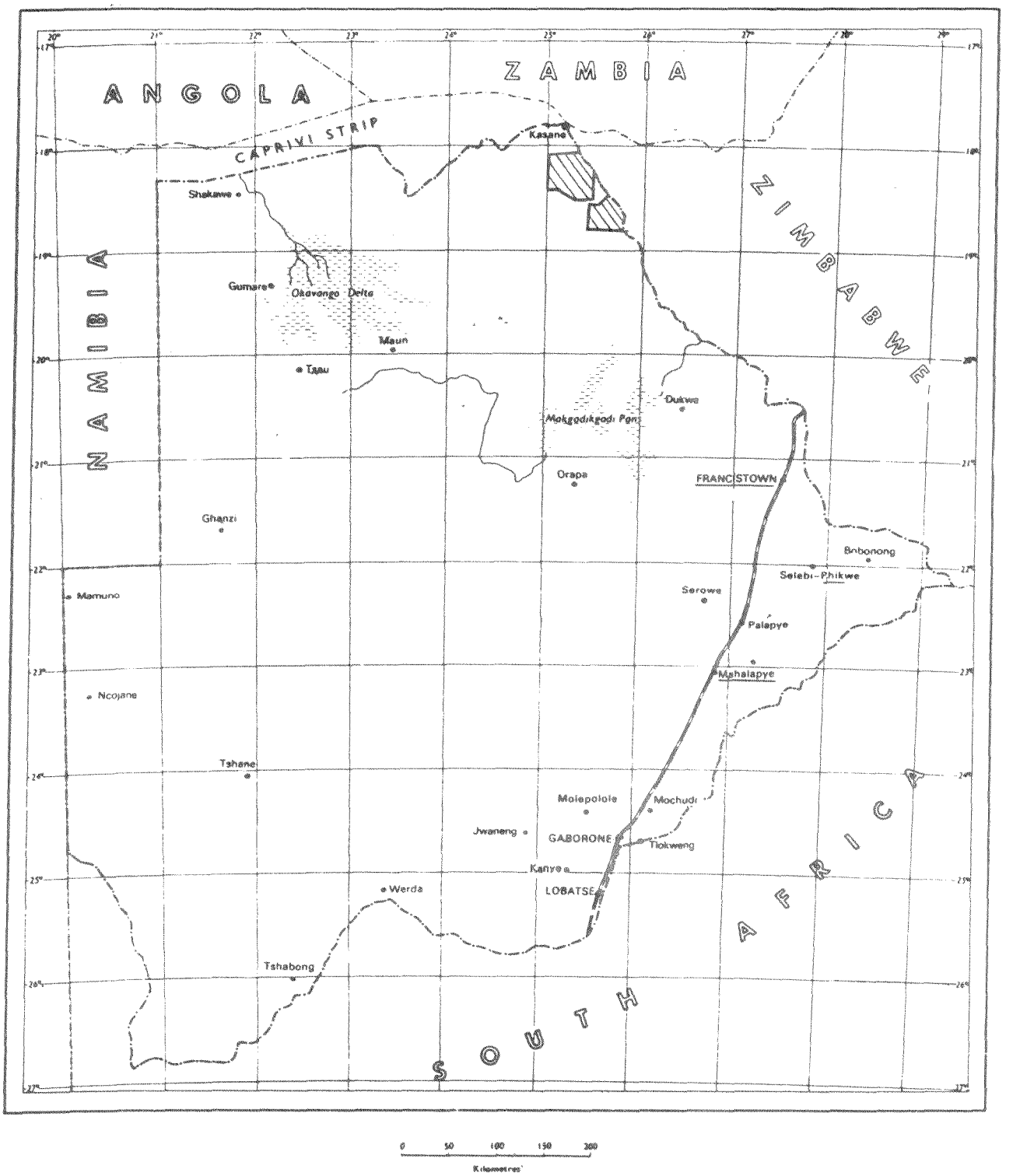
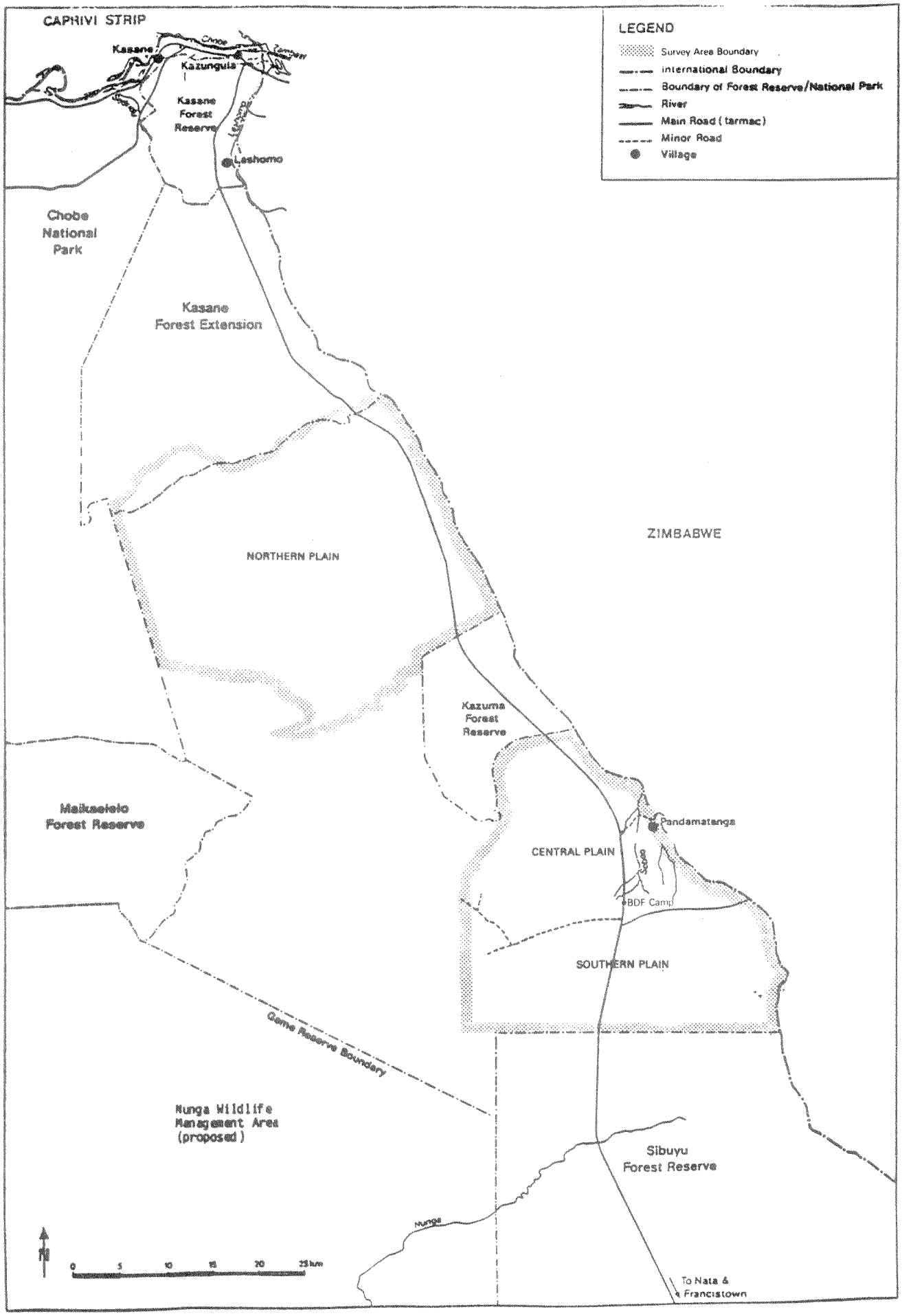


Fig. 1 Location Map

Fig. 2: MPANDAMATENGA CLAY PLAINS



REPUBLIC OF BOTSWANA

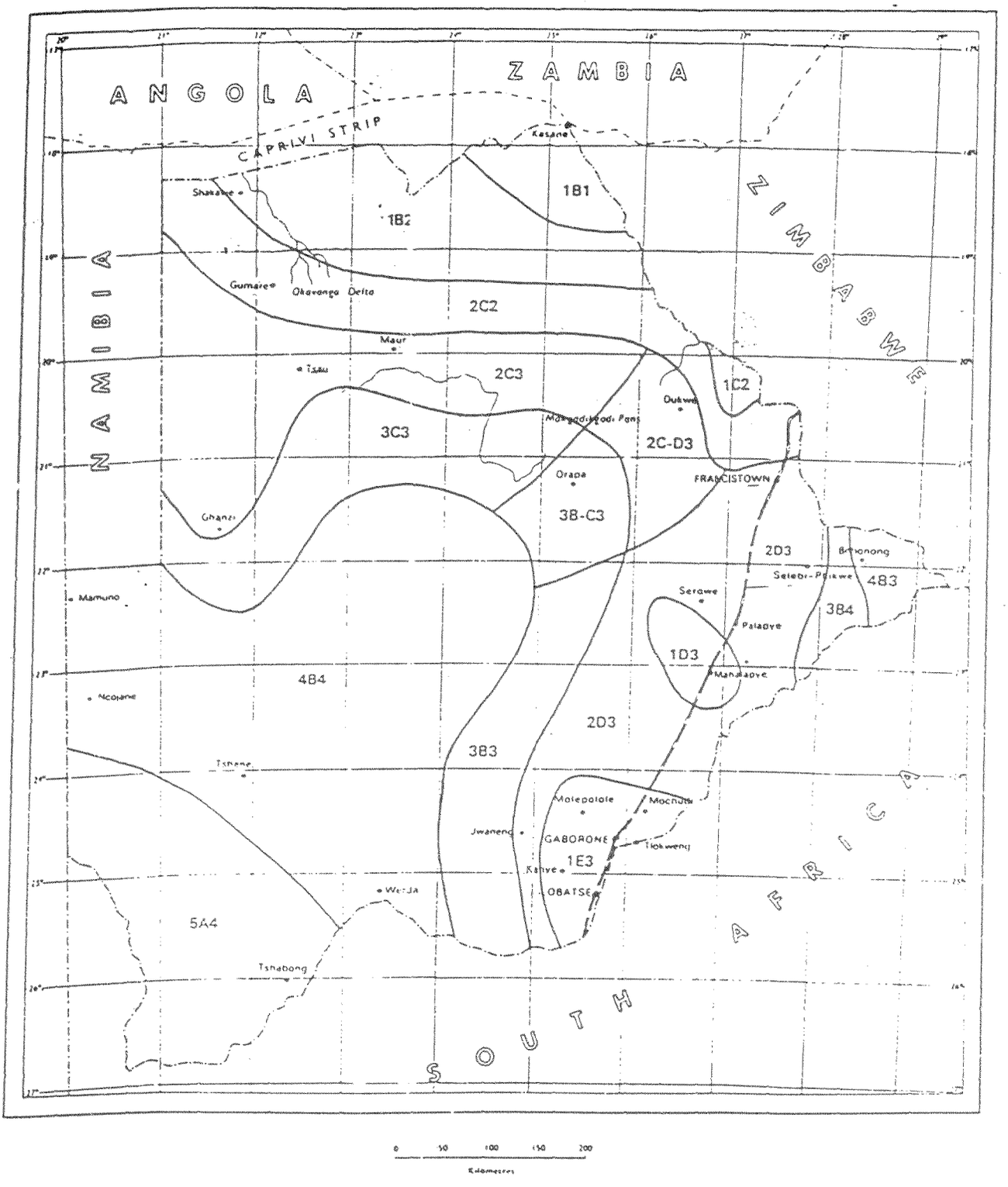


Fig. 3 : AGRO-CLIMATIC ZONES OF BOTSWANA (Dambe, 1987)

Length of Season

	Duration (days)	Frequency (%)
1	101-120	75-100
2	81-100	75-100
3	61-80	75-100
4	41-60	75-100
5	41-60	50-74

Number of Dry Days within the Season

A	0-10
B	11-20
C	21-30
D	31-40

Length of Humid Period

	Duration (days	Frequency (%)
1	41-60	75-100
2.	20-40	50-74
3	20-40	25-49
4	20-40	25

2 SOILS

2.1 INTRODUCTION

For general concepts and survey methods reference is made to Remmelzwaal (1988b).
For mapping purposes landsat imagery was used on scale 1:250 000. The most used dates were 25-3-83 and 2-7-81 (colour composites, enhanced). In addition black and white air photos (August, 1985) on scale 1:50 000 and photo maps were used. Field observations were carried out according to the Botswana Guidelines for Soil Profile Description (Remmelzwaal & Van Waveren, 1988). The point observations were done mainly from soil pits, with additional augerings. Almost all the pits were sampled and subsequently analysed. The soil analytical methods used are given in Appendix 1. In total about 350 soil profiles were described.
Physical properties of Pellic Vertisols and Ferralic Arenosols in the Pandamatenga area are described by Joshua (1988).

Pellic Vertisols

Pellic Vertisols are by far the dominant soil type on the lacustrine clay plains. These soils strongly crack when dry and form an irregular micro relief (gilgai). When wet, they are highly impermeable and external factors, such as slope and relative position, determine largely the drainage characteristics. By definition these soils have a high clay content (>30%). On the Pandamatenga plains the clay content is generally >50%, and they have a very dark colour (chroma <1.5).

Based on structural differentiation an A1, A2, B1 and B2 horizon are generally recognized. When dry, the structural development of most Pellic Vertisols can be described as follows:

A1 Strong, medium and coarse granular structure (upper 2-8cm)

A2 Moderate, medium to very coarse angular and subangular blocky structure

B1 Moderate, very coarse prismatic falling apart into moderate to strong angular blocky. Wedge shaped aggregates may occur in the lower part of the horizon. Predominantly non intersecting slickensides.

B2 Weak to moderate very coarse prismatic falling apart into a strong mostly wedge shaped angular blocky structure. Continuous, mostly intersecting, slickensides. This horizon usually starts at a depth of 40-60 cm.

The consistence is invariably very or extremely hard when dry and (very) plastic when wet.

The Pellic Vertisols on lower receiving sites may have a calcic, or a petrocalcic horizon and may be sodic.

2.2 SOIL CLASSIFICATION

Soils are classified according to the Legend of the Soil Map of the World (FAO/Unesco, 1974). The Soil Taxonomy (Soil Survey Staff, 1987 and 1975) is used as a second classification system. It is not used for general mapping purposes. Soils are also correlated with the Revised Legend of the Soil Map of the world (FAO/Unesco/ISRIC, 1988).

A full description of the soils of Botswana and correlation between the above mentioned classification systems is given in the General Soil Legend of Botswana (Remmelzwaal, 1988). In this legend, new soil units and modifications of the FAO system are introduced. Relevant changes and interpretations for the Chobe area are given in the following sections.

2.2.1 Legend of the Soil Map of the World (1974)

Soil phases

Of several phases a shallow variety, occurring within 50cm of the surface, is introduced (petric, petrocalcic, petroferric).

Diagnostic horizons

Mollic horizon The part of the definition "Soil structure is strong enough that the major part of the horizon is not both massive and hard, or very hard when dry" is interpreted as such that epipedons having a very hard consistency and coarse blocky structure are excluded from mollic horizons, considering the general concept as given in Soil Taxonomy (Soil Survey Staff, 1975).

Calcic and petrocalcic horizons Petrocalcic horizons are considered diagnostic horizons with the same taxonomic value as calcic horizons. Both horizons were given diagnostic value to enter Arenosols and Cambisols.

Albic horizons The complete Soil Taxonomy definition is used.

Diagnostic properties

Albic material. The diagnostic property albic material was replaced by albic horizon

Ferralic and ferric properties. For the calculation of the CEC clay values, a correction is applied for organic carbon, 400me per 100g carbon. In sandy soils the calculated CEC clay is a rather meaningless figure, as the CEC is relatively strongly influenced by the components sand and silt. Therefore an additional criterion for the definition of ferralic properties is introduced, namely the CEC of the total fine earth fraction, which should be lower than 4meq/100g to qualify for ferralic properties.

Hydromorphic properties. The corresponding full Soil Taxonomy definitions are used, as there appeared to be some errors in the FAO (1974) definition.

Vertic properties. The definition was replaced by the Soil Taxonomy definition as used for subgroups: ' having cracks at some period in most years that are 1cm or more wide at a depth of 50cm, that are at least 30cm long in some parts and that extend upwards to the surface of the Ap (A) horizon, if not irrigated'.

Soil Units

The soil units are subdivided at second level and some at third level. The soil units at third level have the additional characteristics of another soil unit at second level. The only exception is the third level addition **Arenic**, defined as having a texture of loamy fine sand or coarser in the upper 50 cm from the surface.

The soil units have their upper boundary at the surface or at less than 30 - 50 cm below the surface. When covered with a thicker layer of new material, the diagnostic horizons no longer have diagnostic value for classification. The variable thickness of 30 - 50 cm is following the concept of buried soils in Soil Taxonomy (Soil Survey Staff, 1987). In practice this means that clay covers on sandy soils may not be thicker than 30 cm, as the sand normally does not have diagnostic subsurface horizons. Sand covers on loam or clay may be up to 50 cm thick if the diagnostic horizons in the buried soil are 1 m or more in thickness.

Gleysols Calcaric Gleysols were renamed Calcic Gleysols since in Botswana these soils always have a calcic horizon or soft powdery lime.

Arenosols The definition of Arenosols was not considered useful in the mapping of Botswana soils and was changed for the following reasons:

1. All deep sandy soils should be grouped together.
2. The present boundary of coarse texture allows soils with a high clay percentage of up to 18 percent and in addition silt. The boundary used in Soil Taxonomy, basically between loamy and sandy loam is considered more appropriate.
3. Gravelly soils should be excluded.
4. Redistribution or enrichment of carbonates, even in the form of a calcic or petrocalcic horizon, should be permitted.
5. For reasons of correlation with Soil Taxonomy and other practical reasons as to include soils on non-gravelly sandstone, lithic and petroferric contacts (phases) should be permitted.
6. There should be no restriction as to the soil moisture regime.

The revised key reads as follows:

Other soils which are coarser than sandy loam and having less than 35 percent of rock fragments or other coarse fragments in all sub-horizons to a depth of at least 100 cm from the surface or to a lithic or petroferric contact, having no diagnostic horizons other than an ochric A horizon, an albic E horizon, a calcic or petrocalcic horizon.

Arenosols having an albic E horizon to a depth of at least 50 cm below the surface.

Albic Arenosols

Other Arenosols having a petrocalcic horizon within 125 cm of the surface.

Petrocalcic Arenosols

Other Arenosols having a calcic or petrocalcic horizon or soft powdery lime within 125 cm of the surface.

Calcic Arenosols

Other Arenosols which are calcareous at least between 20 and 50 cm below the surface.

Calcaric Arenosols

Other Arenosols showing a clay increase of 3% or more or lamellae of clay accumulation within 125 cm of the surface.

Luvic Arenosols

Other Arenosols showing colouring and ferralic properties within 125 cm of the surface.

Ferralic Arenosols

Other Arenosols showing colouring. **Cambic Arenosols**

Other Arenosols having a base saturation (by NH4OAc) of less than 50 percent, at least in some part of the soil between 20 and 50 cm below the surface.

Dystric Arenosols

Other Arenosols. **Eutric Arenosols**

Notes

- Ferralic should include colouring in order to distinguish from recent sands (beach, dune) which may have ferralic properties.
- Cambic should exclude other alteration than colouring. This could only be structure (or decalcification), which often is a questionable property.
- Some very weak structure alone should not lead to classification as Cambic Arenosol or Ferralic Arenosol.

Planosols The abrupt textural change is recognized as a unique property of Planosols, and is an essential diagnostic criterion. The word 'abruptly' was added to the text of definition and key between "E horizon" and "overlying". The requirements of hydromorphic properties in at least part of the E horizons is interpreted with some liberty, as mottling or other evidence does hardly or not appear in deferrated material (see also FAO, 1988).

Nitosols The same colour requirement as for Paleustalfs is applied to Nitosols, which means that if the colour is not redder than 10YR, in general classification as Orthic Luvisols is applicable.

2.2.2 The Revised Legend of the Soil Map of the World (1988)

The Revised Legend of the Soil Map of the World (FAO/UNESCO/ISRIC, August 1988) is applied in all standard routine soil descriptions. A general correlation with the 1974 Legend for Botswana soils is given in Remmelzwaal (1988). The following interpretations or modifications are made:

Mollic horizon See remark section 2.2.1

Cambic horizon The definition is different from the definition in Soil Taxonomy, which may lead to confusion. In soils with gleyic or stagnic properties the "gray color requirement" may be the difference in recognizing a cambic horizon or not. See also under Cambisols.

Salic properties Depth within 100 cm of the surface.

Soft powdery lime Significant is quantified as follows: at least few (5-15%) by volume, or covering at least 50% of the ped surfaces.

Vertic properties Definition used see Section 2.2.1

Prevalence of diagnostic B horizons General rule of upper B horizon is not observed in the case of cambic horizon overlying argic horizon (within 125 cm of the surface).

Leptosols Other diagnostic horizons permitted: calcic and petrocalcic horizons, as these are difficult to distinguish from highly calcareous material. New soil unit introduced **Calcaric Leptosols** (following Umbric Leptosols in key) which are calcareous at least from 20 to 50 cm below the surface, in order to separate Leptosols on soft calcareous materials.

Vertisols Pellic and Chromic Vertisols are kept at second level, as defined in 1974 edition. Calci- is used at third level. The key is as follows:

Gypsic Vertisols
Dystric Vertisols
Pellic Vertisols
Chromic Vertisols.

Arenosols The key as given in section 2.2.1 is changed as follows:
Gleyic Arenosols are added, Petrocalcic Arenosols are deleted (petri- distinguished at third level), Dystric Arenosols are deleted and Eutric changed into Haplic. It should be noted that the requirement of less than 8% clay is not observed.

Calcisols The following definition for the key applies: "Other soils having a calcic or a petrocalcic horizon, or a concentration of soft powdery lime within 125 cm of the surface; having no other diagnostic horizon than an ochric horizon, a cambic B horizon, or an argic B horizon underlying a calcic horizon, or overlying a calcic or petrocalcic horizon which occurs within 50 cm of the surface". New soil unit introduced: **Stagnic Calcisol** (following Luvic Calcisol in the key) which has stagnic properties within 100 cm of the surface.

Ferric properties As with Alisols, Acrisols, Luvisols, Lixisols, occurrence is within 125 cm of the surface.

Luvisols The defined cation exchange capacity occurs throughout the B horizon to a depth of 125 cm.

Lixisols The defined cation exchange capacity occurs in at least some part of the B horizon within a depth of 125 cm.

Cambisols New soil unit introduced **Stagnic Cambisol** (following Gleyic Cambisol in the key) showing stagnic properties within 50cm of the surface. Soils which have stagnic properties but not a cambic horizon do not key out.

Soil Subunits (third level and lower level codes)

The third level was introduced to indicate intergrades between major soil groupings at the first or second level, or to further characterise or specify the second level soil groupings. Definitions of soil subunit connotatives as used in Botswana are given in Remmelzwaal (1988).

The rule normally followed is that definitions at the third level correspond with second level definitions, and do not represent weaker expressions of the relevant phenomenon.

2.2.3 Soil Taxonomy

Soil Taxonomy (Soil Survey Staff, 1975, 1987) is used as the second classification system and applied to all standard routine soil descriptions. Soil Taxonomy definitions are normally followed when FAO uses identical diagnostic criteria, but defined in abbreviated form. For remarks on interpretation of diagnostic horizons and criteria see Section 2.2.1

The subdivision of certain great groups appears to be insufficient. Therefore a number of subgroups has been introduced, defined as identical subgroups already identified with comparable other great groups (e.g. petrocalcic, petroferric, ustalfic, calciorthidic, arenic). Also some new compound subgroups were added, e.g. Arenic Kandic Rhodic, Arenic Petrocalcic. Completely new soil units were not defined (see Remmelzwaal, 1988).

2.3 SOIL LEGEND

2.3.1 Legend Construction

The legend consists of two components, Main Units and Soil Units. For Chobe district the following main units are relevant:

C Soils on highly calcareous rocks and materials. Contains all highly calcareous materials, such as calcrete and nodular calcareous materials, as well as minor limestone and dolomites, which have a calcium carbonate content of 40 percent or more equivalent, occurring within a depth of 50 cm of the surface. The unit is indicated as LC when occurring in lacustrine deposits.

L Soils on lacustrine deposits. Comprises all lake and pan deposits.

A Soils on alluvial deposits. Exclusive of lacustrine sediments but includes alluvial reworked lacustrine, indicated as LA; as well as deltaic deposits.

S Soils on coarse grained sedimentary rocks. Occurs on coarse-grained sedimentary rocks, whether consolidated or unconsolidated. When the sediment consists of unmixed Kalahari sand the unit is indicated as KS. The general criterion is that the texture is loamy fine sand or coarser to a depth of 50 cm from the surface and not finer than fine sandy loam at a depth of 100 cm. However, occasional exceptions are made for aeolian features such as dunes which are allowed to have slightly finer textures. Sands with a lacustrine influence are indicated as LS.

B Soils on basic igneous and metamorphic rocks Related to the Karoo basalts, various dolerite/diabase intrusions and ultrabasic rocks

2.3.2 Soil Units

Soil units recognized in the survey area and represented on the maps are listed below.

Details are given on occurrence, soil characteristics and vegetation. pH (water) and CEC are average values of the subsoil, unless stated otherwise. The soil units occur on the map either as single mapping or together with other soil units as complex mapping units.

Selected profiles are given in Appendix 2, with standard analytical results, and if available, soil physical data. Information on all other profiles is available from the Botswana Soil Database.

SOILS ON ALLUVIAL DEPOSITS

A1.1 FAO: Pellic Vertisols (1974)
Grumi-Pellic Vertisols/Calci-Grumi-Pellic Vertisols (1988)
ST : Typic Pellusterts

Description: Deep to very deep imperfectly to poorly drained very dark gray to dark grayish brown clay
Topography: Flat to almost flat
Site: Water receiving in central parts of valleys, normal on valley sides.
Profiles: PA74, PA87, PA88, PA89, PA103, PA359
Occurrence: Valley floors in dissected eastern parts of Central and Southern Pandamatenga plains.
Characteristics: Drainage conditions vary according to position, relatively better drained Vertisols occur on the valley sides while poorly drained Vertisols are found in the lowest, central parts. In general low gilgai.
In places with calcic horizon. Average clay content in subsoil 50-60%; pH 8-9; CEC 50-55 meq/100gr soil; Organic C ranges from 1.2% (topsoil) to 0.5% (lower subsoil); non sodic.
Vegetation: Open savanna with Colophospermum mopane, Combretum imberbe, Acacia nilotica. Grassland in poorly drained positions.

A1.2 FAO: Pellic Vertisols (1974)
Grumi-Pellic Vertisols (1988)
ST : Typic Pellusterts

Description: Deep to very deep poorly to imperfectly drained very dark gray to dark grayish brown clay
Topography: Flat
Site: Water receiving
Profiles: PA38, PA280, PA318, PA319, PA350
Occurrence: Alluvial flats in Northern Pandamatenga plain
Characteristics: Alluvial reworked lacustrine clays. Transitional between alluvial fans and lacustrine deposits. Medium and low gilgai. Strongly developed granular 5 -8 cm deep A1 horizon.
Average clay content in subsoil >70%; pH 6.5-8; CEC 40-60 meq/100 gr soil; Organic C content decreases only slightly with depth, with average values of 0.6% (subsoil); non sodic; non calcic.
Vegetation: Shrub to tree savanna with predominantly Colophospermum mopane.

A1.3 FAO: Pellic Vertisols, partly sodic (1974)
Grumi-Pellic Vertisols, partly sodic (1988)
ST : Typic Pellusterts

Description: Deep to very deep poorly drained very dark gray to dark grayish brown clay
Topography: Flat
Site: Water receiving
Profiles: PA42, PA43, (PA279)
Occurrence: Alluvial fans in Northern Pandamatenga plain
Characteristics: Alluvial reworked lacustrine clays. Water is likely to collect in this unit due to its geomorphologic characteristics. High and low gilgai. Strongly developed granular, 5 - 8 cm thick, A1 horizon.
Average clay content in subsoil >70%; pH 7-8; CEC 45-50 meq/100gr soil; Organic C content decreases only slightly with depth, with average values varying from 0.5% to 0.8% (subsoil); partly sodic; non calcic.
Vegetation: Tree savanna and woodland with Colophospermum mopane as predominant species.

A2 FAO: Chromic Vertisols (1974), partly petric
Chromic Vertisols/Calci-Chromic Vertisols, partly petric (1988)
ST : Typic Chromusterts

Description: Deep to very deep imperfectly drained very dark grayish brown to reddish brown clayloam to clay
Topography: Flat to gently undulating
Site: Normal to slightly water receiving
Profiles: PA82, PA107, PA358
Occurrence: Minor unit in dissected parts of Central and Southern Pandamatenga plains. On lower valley slopes; transitional to Pellic Vertisols (A1.1) in poorer drained positions (valley floors and undissected lacustrine plains) and shallow Eutric Regosols and Chromic Luvisols (B1a/5a) on higher valley slopes.
Characteristics: Moderately deep clay soils on weathered basalts. Average clay content in subsoil 55-65%; pH 7.5-8.5; CEC 50-65 meq/100gr soil; Organic C content varies from 1.5% (topsoil) to 0.5% (subsoil); non sodic; non calcic.

Vegetation: Open savanna with Colophospermum mopane and Acacia nilotica as dominant species.

A34 FAO: Eutric Regosols, shallow petric (1974)
Eutric Leptosols/Eutric Regosols (1988)
ST : Lithic Ustorthents/Typic Ustorthents

Description: Moderately deep to deep well to somewhat excessively drained dark brown to reddish brown loamy sands to sandy loams
Topography: Flat to gently undulating
Site: Normal
Profiles: None
Occurrence: Minor unit in dissected eastern part of Central Pandamatenga plain. Eroded valley bottoms of incised valleys.
Characteristics: Very shallow to moderately deep clayey, stony soils on weathered basalts.
Vegetation: Open savanna with Colophospermum mopane and Acacia nilotica as dominant species.

B SOILS ON BASIC IGNEOUS AND METAMORPHIC ROCKS

B1 FAO: Eutric Regosols, lithic (1974)
Eutric Leptosols/Eutric Regosols (1988)
ST : Lithic Ustorthents

Description: Very shallow to shallow well to somewhat excessively drained reddish brown to dark brown sandy loams to clayloam
Topography: Undulating
Site: Normal to shedding
Profiles: PA80, PA104, PA106
Occurrence: Minor unit; steeper slopes in dissected eastern part of Central Pandamatenga plain.
Characteristics: Very shallow and (very) stony eroded soils on basalts. Field estimates show considerably higher clay content.
Vegetation: Savanna and woodland. Combretum apiculatum found in better drained positions, other species as on adjacent lacustrine plain (Colophospermum mopane, Acacia nilotica, A. nigrescens, A. gerrardii, Combretum imberbe, C. hereroense).

B1a FAO: Eutric Regosols, shallow petric (1974)
Eutric Regosols, skeletic (1988)
ST : Typic Ustorthents

Description: As B1
Topography: Almost flat to gently undulating
Site: Normal, flooding risk moderately low
Profiles: PA5, PA6
Occurrence: On eroded slopes in dissected eastern part of Central Pandamatenga plain, with Chromic luvisols (B5a) in less eroded parts of complex.
On eroded central part of Northern Pandamatenga plain in complex with better developed Orthic Luvisols (L22b).
Characteristics: Shallow, clayey, eroded soils, within 50cm overlying weathered parent rock (mainly basalts). Average clay content 40-50%;

Organic C of topsoil upto 1.5%; CEC 25 meq/100gr soil;non sodic.
Vegetation: Woodland with Colophospermum mopane and Acacia nigrescens.

B5a FAO: Chromic Luvisols, shallow petric (1974 and 1988)
ST : Lithic/Typic Ustorthents

Description: Shallow to moderately deep well drained reddish brown to strong brown sandy clayloam to sandy clay
Topography: Almost flat to gently undulating, slope gradient upto 3%
Site: Normal
Profiles: PA102, PA108, PA360
Occurrence: On slopes and interfluves in dissected eastern part of Central Pandamatenga plain, in complex B1 and B1a on more eroded parts.
Characteristics: Predominantly well drained sandy clayloam to sandy clay within 50cm overlying weathered basalts. Weak subangular blocky structure, hard to very hard consistence.
pH 6.2-6.6; average clay content 30-50%; Organic C varying from 1% (topsoil) to 0.5% (subsoil); CEC 30-35 meq/100gr soil;non sodic.
Vegetation: Woodland and savanna with Colophospermum mopane, Acacia nigrescens and Combretum apiculatum.

B5b FAO: Chromic Cambisols, shallow petric/lithic (1974)
Eutric leptosols/Chromic Cambisols, petric (1988)
ST : Dystric eutrochrepts

Description: as B5
Topography: Almost flat to gently undulating, slope gradient upto 3%
Site: Normal
Profiles: PA377
Occurrence: Minor unit; on valley slopes in dissected eastern part of Central Pandamatenga plain, Intermediate between Chromic Vertisols (A2) on lower slopes and Eutric Regosols (A1a) on more eroded parts.
Characteristics: Moderate subangular blocky structure, hard to very hard consistence. Clay increase with depth considered insufficient for argillic horizon.
pH 6.8; CEC 34 meq/100gr soil; non sodic.
Vegetation: Savanna with Colophospermum mopane, Combretum imberbe, Burkea africana.

(L)C Soils on highly calcareous materials

LC8 FAO: Gleyic Luvic Chernozems, shallow petrocalcic (1974)
Epi-Petrocalci-Stagni Luvic Chernozems (1988)
ST : Petrocalcic Calciaquolls

Description: Shallow to moderately deep poorly to imperfectly drained very dark gray to gray sandy clay to clay
Topography: flat
Site: slightly receiving, flooding risk moderately high
Profiles: PA54
Occurrence: Minor unit; northern, lower part of N. Pandamatenga plain bordering with sandveld. In association with Calcic Gleyic Luvisols (mainly higher parts) and Pellic Vertisols (in depressions).
Characteristics: Topsoil shows admixture of sands from nearby sandveld. Moderate to strong prismatic structure, very hard consistence.

Clay content subsoil 37%; pH 7.3; CEC 32 meq/100gr soil; Organic C decreases with depth from 0.9 to 0.2%; non sodic.
Vegetation: Savanna with Combretum imberbe as dominant species.

SOILS ON LACUSTRINE DEPOSITS

L6 FAO: Calcic Gleysol, partly sodic (1974)
Stagni Calcisols/Sodi-Stagni Calcisols (1988)
ST : Typic Haplaquepts

Description: Very deep poorly to imperfectly drained very dark gray to gray sandy clay to clay
Topography: flat
Site: Receiving, flood risk high
Profiles: PA56, PA202, PA264
Occurrence: Lower parts of lacustrine plains adjacent to sandveld. In northern complex (N. Pandamatenga plain) in association with Calcic Gleyic Luvisols (mainly higher parts) and Pellic Vertisols (in depressions). In Central Pandamatenga plain subordinate unit in complex with Vertic Calcic Gleysols and Pellic Vertisols. May occur on mounds of large scale gilgai patterns.
Characteristics: Moderate to strong subangular blocky structure, hard and very hard consistence. With calcic horizon, partly strongly sodic (ESP >50%).
Clay content subsoil 50-75%; pH 7-10; CEC 50-65 meq/100gr soil; Organic C decreases with depth from 0.6 to 0.2%.
Vegetation: (Open) Tree savanna, dominant species Colophospermum mopane, Combretum imberbe.

L7 FAO: Eutric Gleysol (1974)
Stagnic Cambisol (1988)
ST : Typic/Mollic Haplaquepts

Description: Very deep poorly to imperfectly drained very dark gray to gray sandy clay to clay
Topography: flat
Site: Receiving (N.Pandamatenga plain), flood risk high;
Normal (S. Pandamatenga plain), flood risk moderately low
Profiles: PA67, PA221, PA290, PA363
Occurrence: In northern complex (N. Pandamatenga plain) in association with Calcic Gleyic Luvisols (L28/28a mainly higher parts). In northern, higher part of S. Pandamatenga plain adjacent to sandveld in association with Pellic Vertisols (subordinate in lower positions).
Characteristics: Moderate to strong (sub)angular blocky structure often with weak very coarse overall prismatic structure. hard and very hard consistence. Non calcic, non sodic.
Clay content subsoil 35-50%; pH 6-7.5; CEC 25-30 meq/100gr soil; Organic C decreases with depth from 1 to 0.3%.
Vegetation: (Open) savanna types, dominant species Colophospermum mopane (S.Pandamatenga plain), Combretum imberbe (N.Pandamatenga plain).

Organic C of topsoil upto 1.5%; CEC 25 meq/100gr soil;non sodic.
Vegetation: Woodland with Colophospermum mopane and Acacia nigrescens.

B5a FAO: Chromic Luvisols, shallow petric (1974 and 1988)
ST : Lithic/Typic Ustorthents

Description: Shallow to moderately deep well drained reddish brown to strong brown sandy clayloam to sandy clay
Topography: Almost flat to gently undulating, slope gradient upto 3%
Site: Normal
Profiles: PA102, PA108, PA360
Occurrence: On slopes and interfluves in dissected eastern part of Central Pandamatenga plain, in complex B1 and B1a on more eroded parts.
Characteristics: Predominantly well drained sandy clayloam to sandy clay within 50cm overlying weathered basalts. Weak subangular blocky structure, hard to very hard consistence.
pH 6.2-6.6; average clay content 30-50%; Organic C varying from 1% (topsoil) to 0.5% (subsoil); CEC 30-35 meq/100gr soil;non sodic.
Vegetation: Woodland and savanna with Colophospermum mopane, Acacia nigrescens and Combretum apiculatum.

B5b FAO: Chromic Cambisols, shallow petric/lithic (1974)
Eutric leptosols/Chromic Cambisols, petric (1988)
ST : Dystric eutrochrepts

Description: as B5
Topography: Almost flat to gently undulating, slope gradient upto 3%
Site: Normal
Profiles: PA377
Occurrence: Minor unit; on valley slopes in dissected eastern part of Central Pandamatenga plain, Intermediate between Chromic Vertisols (A2) on lower slopes and Eutric Regosols (A1a) on more eroded parts.
Characteristics: Moderate subangular blocky structure, hard to very hard consistence. Clay increase with depth considered insufficient for argillic horizon.
pH 6.8; CEC 34 meq/100gr soil; non sodic.
Vegetation: Savanna with Colophospermum mopane, Combretum imberbe, Burkea africana.

(L)C Soils on highly calcareous materials

LC8 FAO: Gleyic Luvic Chernozems, shallow petrocalcic (1974)
Epi-Petrocalci-Stagni Luvic Chernozems (1988)
ST : Petrocalcic Calciaquolls

Description: Shallow to moderately deep poorly to imperfectly drained very dark gray to gray sandy clay to clay
Topography: flat
Site: slightly receiving, flooding risk moderately high
Profiles: PA54
Occurrence: Minor unit; northern, lower part of N. Pandamatenga plain bordering with sandveld. In association with Calcic Gleyic Luvisols (mainly higher parts) and Pellic Vertisols (in depressions).
Characteristics: Topsoil shows admixture of sands from nearby sandveld. Moderate to strong prismatic structure, very hard consistence.

Clay content subsoil 37%; pH 7.3; CEC 32 meq/100gr soil; Organic C decreases with depth from 0.9 to 0.2%; non sodic.
Vegetation: Savanna with Combretum imberbe as dominant species.

SOILS ON LACUSTRINE DEPOSITS

L6 FAO: Calcic Gleysol, partly sodic (1974)
Stagni Calcisols/Sodi-Stagni Calcisols (1988)
ST : Typic Haplaquepts

Description: Very deep poorly to imperfectly drained very dark gray to gray sandy clay to clay
Topography: flat
Site: Receiving, flood risk high
Profiles: PA56, PA202, PA264
Occurrence: Lower parts of lacustrine plains adjacent to sandveld. In northern complex (N. Pandamatenga plain) in association with Calcic Gleyic Luvisols (mainly higher parts) and Pellic Vertisols (in depressions). In Central Pandamatenga plain subordinate unit in complex with Vertic Calcic Gleysols and Pellic Vertisols. May occur on mounds of large scale gilgai patterns.
Characteristics: Moderate to strong subangular blocky structure, hard and very hard consistence. With calcic horizon, partly strongly sodic (ESP >50%).
Clay content subsoil 50-75%; pH 7-10; CEC 50-65 meq/100gr soil; Organic C decreases with depth from 0.6 to 0.2%.
Vegetation: (Open) Tree savanna, dominant species Colophospermum mopane, Combretum imberbe.

L7 FAO: Eutric Gleysol (1974)
Stagnic Cambisol (1988)
ST : Typic/Mollic Haplaquepts

Description: Very deep poorly to imperfectly drained very dark gray to gray sandy clay to clay
Topography: flat
Site: Receiving (N.Pandamatenga plain), flood risk high;
Normal (S. Pandamatenga plain), flood risk moderately low
Profiles: PA67, PA221, PA290, PA363
Occurrence: In northern complex (N. Pandamatenga plain) in association with Calcic Gleyic Luvisols (L28/28a mainly higher parts). In northern, higher part of S. Pandamatenga plain adjacent to sandveld in association with Pellic Vertisols (subordinate in lower positions).
Characteristics: Moderate to strong (sub)angular blocky structure often with weak very coarse overall prismatic structure. hard and very hard consistence. Non calcic, non sodic.
Clay content subsoil 35-50%; pH 6-7.5; CEC 25-30 meq/100gr soil; Organic C decreases with depth from 1 to 0.3%.
Vegetation: (Open) savanna types, dominant species Colophospermum mopane (S.Pandamatenga plain), Combretum imberbe (N.Pandamatenga plain).

L22 FAO: Orthic Luvisols (1974)
Haplic Luvisols (1988)
ST : Typic Haplustalfs

Description: Deep to very deep imperfectly drained dark grayish brown to olive brown sandy clayloam to clay
Topography: flat
Site: Normal (N. Pandamatenga plain), flood risk moderately low;
Slightly receiving (Pans)
Profiles: PA284, PA347, (PA288)
Occurrence: On littoral deposits in N.Pandamatenga plain in complex with Calcic Luvisols (L24a) and Planosols (L41), L22 mainly in higher postions.
In interdunal depressions and pans in sandveld in complex with L24/24b and L31.
Characteristics: Loamy sands over sandy clayloam, weak to moderate coarse prismatic or columnar structure to massive, very hard consistence. Non calcic, non sodic. Soils often become calcic at depth (>120cm).
Clay content subsoil 15-30%; pH 5.5-7; CEC 15-20 meq/100gr soil; Organic C < 0.5%.
Vegetation: In N.Pandamatenga plain woodland and savanna with Brachystegia Boehmii, Combretum imberbe, C.hereroense and C.fragrans. In pans predominantly dense shrub savanna and shrubland with Colophospermum mopane Terminalia sericea, Combretum spp. and Lonchocarpus nelsii.

L22a FAO: Arenic Orthic Luvisols (1974)
Areni-Haplic Luvisols (1988)
ST : Arenic Haplustalfs

Description: Deep to very deep imperfectly to moderately well drained dark grayish brown to brown loamy sands to sandy clayloam
Topography: flat
Site: Normal to slightly receiving
Profiles: PA47, PA138, PA156, PA161, PA236, PA237
Occurrence: Minor unit; in pans in sandveld
Characteristics: very weak subangular structure to massive, very hard consistence in places with compacted subsoil. Transitional to Albic Luvisols and Planosols; predominantly non sodic.
Clay content subsoil 7-20%; pH 6-8; CEC 10-15 meq/100gr soil; Organic C < 0.5%.
Vegetation: Structure variable, main species Combretum imberbe, Croton gratissimus, Colophospermum mopane and Terminalia sericea.

L22b FAO: Orthic Luvisols, shallow petric (1974)
Haplic Luvisols, skeletal (1988)
ST : Typic Haplustalfs

Description: as L22
Topography: flat
Site: Normal, flood risk low
Profiles: PA336, PA354
Occurrence: Minor unit; eroded higher parts of N.Pandamatenga plain in complex with Eutric Regosols (B1a)
Characteristics: Predominantly sandy clays within 50cm overlying fragmented weathered rock (mainly basalts); non sodic.

Clay content subsoil 30-60%; pH 6-7; CEC 15-25 meq/100gr soil; Organic C < 0.4%.
Vegetation: Woodland and tree savanna with Colophospermum mopane.

L23 FAO: Gleyic Luvisols (1974)
Stagnic Luvisols (1988)
ST : Mollic Ochraqualfs

Description: Deep to very deep poorly to imperfectly drained dark gray to grayish brown sandy clayloam to clay
Topography: flat
Site: Receiving, flooding risk moderately high
Profiles: PA185, PA196, PA197, PA198, PA212, PA235, PA302, PA355
Occurrence: Littoral deposits in transition lacustrine plains and sandveld; On central and southern Pandamatenga plains in association with Calcic Gleyic Luvisols (higher positions).
Characteristics: Moderate and strong (sub)angular blocky often with very coarse prismatic primary structure. Sandy dark coloured topsoils transitional to mollic horizons but lacking high organic C contents. Non calcic; non sodic.
Clay content subsoil 20-45%; pH 5-7; CEC 15-30 meq/100gr soil; Organic C < 0.7%.
Vegetation: Woodland and tree savanna with Brachystegia Boehmii, Colophospermum mopane, Combretum imberbe and Baikaea plurijuga. Dominant species on N.Pandamatenga plain is Colophospermum mopane.

L23a As L23 but petric. Minor unit in central eroded part of N.Pandamatenga plain. In complex with B1a.

L24 FAO: Calcic Luvisols (1974 and 1988)
ST : Typic Haplustalfs

Description: Very deep imperfectly drained very dark grayish brown to brown sandy clayloam to clay
Topography: flat
Site: Normal, flood risk moderately low
Profiles: PA217, PA218, PA291
Occurrence: Higher parts of lacustrine plains: in transitional zone to sandveld, and on mounds ('tree islands').
Characteristics: Weak to moderate subangular blocky often with coarse prismatic primary structure. Non sodic.
Clay content subsoil 20-50%; pH 7-8; CEC 15-30 meq/100gr soil; Organic C < 1.0%.
Vegetation: Savanna with Colophospermum mopane.

L24a FAO: Calcic Luvisols, sodic partly saline (1974)
Sodi-Calcic Luvisols (1988)
ST : Typic Haplustalfs

Description: As L24
Topography: flat
Site: Normal, flood risk moderately low
Profiles: PA28, PA263, PA286, PA294, PA320, PA372
Occurrence: Slightly elevated positions in N.Pandamatenga plain and S.

Pandamatenga plain ('tree islands') and in pans in sandveld.
Characteristics: Weak subangular blocky to massive, strongly calcareous and strongly sodic subsoil. Lacking the structural characteristics of Natric B horizon. Non saline on lacustrine Pandamatenga plains, partly saline in pans. Clay content subsoil 15-50%; pH 9-10; CEC 15-30 meq/100gr soil; Organic C < 0.6.
Vegetation: Tree savanna and woodland with Colophospermum mopane, Acacia nigrescens, Combretum imberbe and Adansonia digitata. Grasscover genrally less than 10%.

L25.1 FAO: Pellic Vertisols (1974)
Grumi-Pellic Vertisols (1988)
ST : Typic Pellusterts

Description: Deep to very deep imperfectly drained very dark gray to dark grayish brown clay
Topography: Flat, slope 0.25-0.5%
Site: Normal, flood risk relatively low
Profiles: PA3, PA4, PA9, PA36, PA37, PA61-66, PA134, PA139, PA153, PA192, PA193, PA216, PA281, PA328
Occurrence: Higher parts of lacustrine Pandamatenga plains with a relatively high slope gradient.
Characteristics: Drainage relatively good due to position and slope. Medium gilgai. Non sodic and predominantly non calcic.
Average clay content in subsoil 60-70%; pH (water) in subsoil 7-8; CEC in subsoil 45-60 meq/100soil; Organic C ranges from 0.7% (topsoil) to 0.4% (lower subsoil).
Vegetation: Open savanna and grassland with Colophospermum mopane, Combretum imberbe, Acacia nilotica, A.gerrardii.

L25.2 FAO: Pellic Vertisols (1974)
Grumi-Pellic Vertisols/Calci-Grumi-Pellic Vertisols (1988)
ST : Typic Pellusterts

Description: Deep to very deep imperfectly drained very dark gray to dark grayish brown clay
Topography: Flat, slope 0.15-0.25%
Site: Normal, flood risk relatively low
Profiles: PA11, PA12, PA9, PA33, PA52-53, PA57, PA59-60, PA69, PA83-86, PA88, PA190-92, PA94, PA112-114, PA133, PA222-223, PA329, PA364-367
Occurrence: Intermediate and higher parts of lacustrine Pandamatenga plains with a slope gradient between 0.15 and 0.25%.
Characteristics: Drainage relatively good due to position and slope. Medium to low gilgai. Partly calcic in lower parts of unit; Non sodic.
Average clay content in subsoil 60-80%; pH (water) in subsoil 7-8; CEC in subsoil 40-60 meq/100soil; Organic C ranges from 0.8% (topsoil) to 0.4% (lower subsoil).
Vegetation: Open savanna types with Colophospermum mopane, Acacia nilotica, A.gerrardii.

L25a1 FAO: Pellic Vertisols (1974)
Grumi-Pellic Vertisols/Grumi-Calci-Pellic Vertisols (1988)
ST : Typic Pellusterts

Description: Deep to very deep poorly to imperfectly drained very dark gray to dark grayish brown clay
Topography: Flat, slope <0.15%
Site: slightly receiving, flood risk moderate
Profiles: PA2, PA13, PA27, PA30, PA34-35, PA39, PA233, PA234, PA266, PA269, PA271, PA321, PA327, PA330, PA334, PA348, PA361
Occurrence: Flat, intermediate parts of lacustrine Pandamatenga plains.
Characteristics: Medium to low gilgai. In lower parts of unit with a strongly calcareous subsoil or calcic horizon; Non sodic.
Average clay content in subsoil 60-80%; pH 6.5-8; CEC 45-60 meq/100gr soil; Organic C ranges from 1% (topsoil) to 0.4% (lower subsoil).
Vegetation: Open savanna types with Colophospermum mopane, Acacia nilotica, A.gerrardii, Combretum imberbe.

L25a2 FAO: Pellic Vertisols, partly sodic (1974)
Grumi-Pellic Vertisols/Grumi-Calci-Pellic Vertisols, partly sodic (1988)
ST : Typic Pellusterts

Description: Deep to very deep poorly to imperfectly drained very dark gray to dark grayish brown clay
Topography: Flat, slope <0.15%
Site: Normal, flood risk moderately low
Profiles: PA214, PA332, PA311
Occurrence: Flat, highest parts of lacustrine N.Pandamatenga plain.
Characteristics: Flooding risk low due to position, ponding may occur caused by very limited run-off. Low to medium gilgai. In northern part of N.Pandamatenga plain strongly sodic. Partly calcic.
Average clay content in subsoil 55-60%; pH 7.5-9; CEC 30-45 meq/100 gr soil; Organic C ranges from 0.5 (topsoil) to 0.2 (lower subsoil).
Vegetation: Open savanna with Colophospermum mopane and Acacia nilotica.

L25b1 FAO: Pellic Vertisols, partly sodic (1974)
Grumi-Pellic Vertisols/Grumi-Calci-Pellic Vertisols, partly sodic (1988)
ST : Typic Pellusterts

Description: Deep to very deep poorly drained very dark gray to dark grayish brown clay
Topography: Flat, drainage ways
Site: Receiving, flood risk high
Profiles: PA1, PA31, PA40-41, PA115, PA132, PA274, PA276, PA295, PA300, PA349, PA368
Occurrence: Flat, drainage ways in lacustrine Pandamatenga plains.
Characteristics: Flooding risk high due to position. Medium to low gilgai. In northern part of N.Pandamatenga plain often with calcic horizon. Partly sodic.
Average clay content in subsoil 50-80%; pH 7-8; CEC 40-60 meq/100gr soil; Organic C ranges from 0.9% (topsoil) to 0.3% (lower subsoil).
Vegetation: Predominantly open savanna types with Colophospermum mopane and Acacia nilotica, A. gerrardii, Combretum imberbe.

L25b2 FAO: Pellic Vertisols, partly sodic (1974)
(Sodi-)Grumi-Calci-Pellic Vertisols/Grumi-Pellic Vertisols (1988)

ST : Typic Pellusterts

Description: Deep to very deep poorly drained very dark gray to dark grayish brown clay
Topography: Flat, depressions
Site: Receiving, flood risk very high
Profiles: PA51, PA206, PA207, PA227
Occurrence: Closed depressions in lacustrine Pandamatenga plains.
Characteristics: Flooding risk very high due to position. Medium to high gilgai. In N.Pandamatenga plain very clayey (>80%), non calcareous; non sodic. In Central Pandamatenga plain strongly calcareous and (partly) strongly sodic.
Average clay content in subsoil >75%; pH 6.5-9; CEC 45-60 meq/100gr soil; Organic C ranges from 1.5% (topsoil) to 0.5% (lower subsoil).
Vegetation: Grassland/Arable land

L25c FAO: Pellic Vertisols, petric/petrocalcic (1974)
Grumi-Calci-Pellic Vertisols/Grumi-Pellic Vertisols/
Grumi-Petrocalci-Pellic Vertisols (1988)
ST : Typic Pellusterts

Description: Deep to very deep poorly to imperfectly drained very dark gray to dark grayish brown clay
Topography: Flat
Site: Normal, flood risk moderately low
Profiles: PA9, PA335, PA379, PA380
Occurrence: Eroded higher parts of N and Central Pandamatenga plains.
Characteristics: Imperfectly drained moderately deep Vertisols over weathered basalts or massive petrocalcic. Medium gilgai. non sodic. Average clay content in subsoil >65%; pH 5-8; CEC 50-75 meq/100gr soil; Organic C ranges from 1.5% (topsoil) to 0.5% (lower subsoil).
Vegetation: Open savanna and tree savanna with Combretum imberbe and Acacia nilotica.

L26 FAO: Vertic Calcic Gleysols, petric/petrocalcic (1974)
Verti-Stagnic Calcisols (1988)
ST : Vertic Haplaquepts/Haplaquolls

Description: Moderately deep to deep poorly to imperfectly drained very dark gray to dark gray clay
Topography: Flat
Site: Receiving, flood risk very high
Profiles: PA50, PA100, PA127-128, PA210-211, PA306, PA356, PA367
Occurrence: Lowest parts of lacustrine plains adjacent to sandveld, such as NW part of Central Pandamatenga plain and Kazuma depresion, and N. complex (NE part of N. Pandamatenga plain).
Characteristics: Weak to moderately coarse prismatic primary structure falling apart into moderate and strong angular blocky structure. Moderate cracks in subsoil, mostly overlying calcrete within 120cm, non sodic, non saline. pH 6.5-8; CEC 25-40 meq/100gr soil; Organic C ranges from 1% (topsoil) to 0.1% (lower subsoil); Clay content subsoil 40-55%.
Vegetation: Open savanna with Colophospermum mopane and Combretum imberbe; Grassland.

L28 FAO: Calcic Gleyic Luvisols, partly petrocalcic (1974)
Calci-Stagni Luvisols/Petrocalci-Stagni Luvisols (1988)
ST : Typic/Petrocalcic Ochraquepts

Description: Deep to very deep poorly to imperfectly drained dark gray to grayish brown sandy clayloam to clay
Topography: Flat
Site: (Slightly) Receiving, flood risk moderately high
Profiles: PA260, PA285, PA201, PA268, PA278, PA331, PA371, PA374
Occurrence: Lower parts of littoral zone in lacustrine N. Pandamatenga plain. Also on mounds in complex area with Vertic Calcic Gleysols and Gleyic Luvisols.
Characteristics: Weak to moderately coarse prismatic primary structure with an angular blocky sub structure. Very hard consistence. Partly (nodular) petrocalcic. Non sodic, non saline. pH 6-7.5; CEC 20-30 meq/100gr soil; Organic C < 0.7% (topsoil); Clay content subsoil 20-50%.
Vegetation: Open savanna types with Colophospermum mopane, Combretum imberbe and C.hereroense as dominant species.

L28a FAO: Calcic Gleyic Luvisols, sodic (1974)
(Sodi-)Calci-Stagnic Luvisols (1988)
ST : Typic/Mollic Ochraquepts

Description: as L28
Topography: Flat
Site: Receiving, flooding risk moderately high
Profiles: PA289, PA298, PA301, PA303, PA337, PA373
Occurrence: Lower parts of littoral zone in lacustrine N. Pandamatenga plain.
Characteristics: Deep to very deep, moderately to strong coarse prismatic structure. Very hard consistence. Sodic and partly strongly sodic, non saline.
pH 9-10; CEC 15-30 meq/100gr soil; Organic C < 0.8%; Clay content subsoil 30-50%.
Vegetation: Open savanna types with Colophospermum mopane.

L29 FAO: Vertic Gleyic Luvisols, partly petric (1974)
Verti-Stagnic Luvisols (1988)
ST : Vertic Ochraqualfs

Description: Moderately deep imperfectly drained dark gray to grayish brown sandy clay to clay
Topography: Flat
Site: (Slightly) Receiving, flood risk moderate
Profiles: PA215, PA3338, PA340-341, PA343-344
Occurrence: On moderately deep lacustrine deposits over weathered rock. Often as transitional soil between Pellic Vertisols and shallow soils.
Characteristics: Subsoil with coarse prismatic primary and angular blocky sub-structure and moderate cracks, very hard consistence. Sandy topsoil. Partly sodic, non saline.
pH 6.5-8; CEC 25-30 meq/100gr soil; Organic C < 0.6% (topsoil); Clay content subsoil 35-50%.
Vegetation: Predominantly open savanna with Colophospermum mopane.

L31 FAO: Eutric Nitosols (1974)
Areni-Chromic Luvisols (1988)
ST : Arenic Paleustalfs

Description: Very deep imperfectly to moderately well drained yellowish brown to yellowish red loamy sands to sandy clayloam
Topography: Flat to gently undulating
Site: Normal
Profiles: PA175
Occurrence: Minor unit; Valleysides in northern complex (NE part of N.Pandamatenga plain). In association with Orthic Luvisols (L22) on valley bottoms.
Characteristics: Sandy topsoils, clay increase only at depth. Very weak structure, non calcic.
pH 5.5-6; CEC 5-10 meq/100gr soil; Organic C less than 0.4 (topsoil); Clay content subsoil 10-15%.
Vegetation: Savanna types with Combretum spp., Terminalia sericea, Colophospermum mopane, Pterocarpus angolensis.

L32 FAO: Arenic Ferric Luvisols (1974)
Areni-Haplic Lixisols (1988)
ST : Arenic Kandic Paleustalfs

Description: Very deep moderately well to well drained brown to yellowish red loamy sands to sandy clayloam
Topography: Gently undulating
Site: Normal
Profiles: PA22, PA23, PA24
Occurrence: Lower, lacustrine influenced dunes in northern complex (NE part of N.Pandamatenga plain). On upper slopes and tops of dunes. In complex with Arenic Ferric Acrisols.
Characteristics: Sandy topsoils, clay increase only at depth. Very weak structure. Comparable with L31 but with lower CEC (ferric).
pH 5.5-6; CEC <4 meq/100gr soil; Organic C less than 0.3 (topsoil); Clay content subsoil 10-15%.
Vegetation: Woodland with Bauhinia petersiana, Brachystegia boehmii, Terminalia sericea, Colophospermum mopane.

L33 FAO: Arenic Ferric Acrisols (1974)
Areni-Kandic Acrisols (1988)
ST : Arenic Paleustults

As L32 but with low PBS (<50%) in subsoil

L34 FAO: Ferric Luvisols, partly petroferric (1974)
Ferric/Haplic Lixisols (1988)
ST : Kanhaplic/Petroferric Haplustalfs

Description: Moderately deep to deep imperfectly to moderately well drained brown to yellowish red sandy clayloam to clay
Topography: Flat to gently undulating
Site: Normal
Profiles: PA21, PA353
Occurrence: Lower, lacustrine influenced dunes in northern complex (NE

part of N.Pandamatenga plain). In lower positions as compared to L32/33.
Characteristics: Very weak subangular blocky to massive, sandy clay overlying petroferric material.
pH 5.5-6; CEC 10-15 meq/100gr soil; Organic C less than 0.4 (topsoil); Clay content subsoil 25-35%.
Vegetation: Dense savanna with Brachystegia boehmii and Colophospermum mopane as dominant species.

L35 FAO: Luvic Chernozems (1974)
Calci-Luvic Chernozems (1988)
ST : Typic Argiustolls

Description: deep to very deep imperfectly to moderately well drained dark gray to grayish brown sandy loam to clay
Topography: Flat
Site: Normal
Profiles: PA370, PA375
Occurrence: Minor unit; SE part of S.Pandamatenga plain bordering sandveld. In slightly higher positions in complex with Calcic Gleyic Luvisols.
Characteristics: Dark coloured sandy topsoil with weak to moderate subangular blocky structure and hard consistence over sandy clayloam, partly strongly calcareous. with calcic horizon at depth. Non sodic.
pH 7.5-8.5; CEC 15-20 meq/100gr soil; Organic C in topsoil 0.8 to 0.6% (topsoil); Clay content subsoil 20-30%.
Vegetation: Savanna with Colophospermum mopane as dominant species.

L35a FAO: Gleyic Luvic Chernozems (1974)
Stagni-Luvic Chernozems (1988)
ST : Aeric Calciustolls/Typic Argiustolls

Description: deep to very deep poorly to imperfectly drained very dark gray to dark gray sandy clayloam to clay
Topography: Flat
Site: Receiving, flood risk moderate
Profiles: PA137, PA141, PA267, PA313, PA323
Occurrence: Pan complex in NW part of N.Pandamatenga plain transitional to sandveld. In lower parts of association with Calcic Luvisols. In complex with Calcic Gleyic Luvisols.
Characteristics: Imperfectly drained. With dark sandy topsoil with weak to moderate subangular blocky structure and a hard consistence. With calcic horizon at depth. Predominantly non sodic.
pH 6-8.5; CEC 15-35 meq/100gr soil; Organic C in topsoil <1.5%; Clay content subsoil 20-40%.
Vegetation: Savanna with Colophospermum mopane as dominant species.

L36 FAO: Calcic Chernozems, sodic (1974)
Sodi-Calcic Chernozems (1988)
ST : Typic Calciustolls

Description: deep to very deep poorly to imperfectly drained very dark gray to dark gray sandy clayloam to clay
Topography: Flat
Site: Normal
Profiles: PA26

Occurrence: Minor unit; Transition lower dune slopes to lacustrine plain.
Characteristics: Moderately deep massive lacustrine clays over gravel layer. With calcic horizon; strongly sodic.
Vegetation: Dense tree savanna with Colophospermum mopane, Acacia nigrescens.

L37 FAO: Mollic Gleysol (1974)
Stagnic Phaeozem (1988))
ST : Typic Haplaquoll

Description: Very deep poorly to imperfectly drained black to very dark gray loam to clay
Topography: Flat
Site: Receiving
Profiles: none
Occurrence: SW part of S. Pandamatenga plain; lower parts (drainage ways) in association with Calcic Gleyic luvisols.
Characteristics: Predominantly sandy clays
Vegetation: Arable land/Grassland to open savanna

L37b FAO: Calcic Mollic Gleysol (1974)
Stagni-Calcic Chernozem (1988)
ST : Typic Calciaquoll

Description: Very deep poorly to imperfectly drained black to very dark gray loam to clay
Topography: Flat
Site: Receiving
Profiles: none
Occurrence: Slightly higher, more sandy parts of S. Pandamatenga plain. In lower positions as compared to associated sodic (Calcic) Gleyic Luvisols.
Characteristics: Predominantly sandy clays, with calcic horizon, partly sodic.
Vegetation: Grassland to open savanna

L37c FAO: Vertic Mollic Gleysol (1974)
Verti-Stagnic Phaeozems (1988)
ST : Vertic Haplaquoll

Description: Very deep very poorly to imperfectly drained black to very dark gray clay
Topography: Flat
Site: Receiving, flood risk moderately high
Profiles: PA346, PA312, PA359
Occurrence: Minor unit; In pan complex in N. part of N.Pandamatenga plain bordering sandveld. With Pellic Vertisols in depressions.
Characteristics: Sandy clayloam to sandy clay, moderate coarse and very coarse prismatic structure, moderate cracks in subsoil. non calcic, non sodic.
Vegetation: Grassland to savanna, dominant species Colphospermum mopane, Combretum imberbe, Combretum hereroense and Acacia nigrescens.

L37d as L37c, but shallow petric. Minor unit in N.Pandamatenga plain on moderately deep lacustrine deposits over weathered rock. In association with L24a.

L41 FAO: Eutric Planosols (1974 and 1988)
ST : Mollic/Typic/Arenic Albaqualfs

Description: Deep to very deep imperfectly drained dark yellowish brown to brown sandy clayloam to clay
Topography: Flat
Site: Slightly receiving, flood risk moderately high
Profiles: PA219, PA239, PA261, PA307, PA308, PA351
Occurrence: On littoral deposits in N.Pandamatenga plain. Occupies lower positions in complex with Orthic Luvisols. Also in pans, towards edge of sandveld, often in complex with Calcic Gleyic Luvisols.
Characteristics: Sandy topsoil abruptly overlying slowly permeable, massive, sandy loams to sandy clayloam. Non sodic, non saline. In pans locally overlying petrocalcic material.
Clay content in subsoil 15-25%; CEC 10-20 meq/100gr soil; pH 5.5-6.5; Org C. in topsoil <0.3%.
Vegetation: Open savanna types; dominant species Kirkia acuminata, Combretum imberbe, C. hereroense and Protea gaguedi (shrub only)

L42 FAO: Solodic Planosols (1974)
Albi-Abrupti-Stagnic Solonetz (1988)
ST : Aeric/Arenic Albaqualfs

Description: Deep to very deep poorly to imperfectly drained very dark gray to dark grayish brown sandy clayloam to clay
Topography: Flat
Site: Slightly receiving, flood risk moderate
Profiles: PA270, PA339
Occurrence: On littoral deposits in N.Pandamatenga plain. Occupies lower positions in complex with Orthic Luvisols.
Characteristics: Sandy topsoil abruptly overlying sandy clayloam to clay. Subsoil with weak to moderate angular blocky structure, with or without a prismatic primary structure. Non saline. With calcic or petrocalcic horizon.
Clay content in subsoil 20-40%; CEC 10-20 meq/100gr soil; pH 7.5-9; Org C. in topsoil <0.6%.
Vegetation: Open savanna; dominant species Colophospermum mopane, Acacia nilotica and Combretum imberbe.

L43 FAO: Albic Luvisols (1974)
Abrupti-Albic Luvisols (1988)
ST : Arenic/Typic Haplustalfs

Description: Deep to very deep imperfectly to moderately well drained gray to light brownish gray fine sands abruptly overlying dark grayish brown to pale brown massive loamy sands to sandy loams
Topography: Flat
Site: Normal, flooding risk moderate
Profiles: PA146, PA262, PA297
Occurrence: Minor unit; on sandy littoral deposits in N.Pandamatenga

plain. Occupies lower positions in association with Calcic Luvisols (on mounds).
Characteristics: Compacted, weakly cemented subsoil. Non saline, partly sodic.
Vegetation: Open tree savanna, trees mainly on mounds (L24); dominant species Terminalia sericea and Colophospermum mopane.

L44 FAO: Ferralic Arenosols (1974 and 1988)
ST : Typic Quartzipsamments

Description: Deep to very deep somewhat excessively drained dark grayish brown to pale brown fine-medium sand to loamy sands, overlying petroferric material
Topography: Almost flat to gently undulating
Site: Normal, flooding risk low
Profiles: PA277
Occurrence: Lower, lacustrine influenced dunes in N.complex (NE part of N. Pandamatenga plain). Found in higher positions in association with Ferric Luvisols and petroferric Ferric Arenosols (L44a)
Characteristics: Medium and fine-medium sands to loamy sands, with very weak subangular blocky structure overlying petroferric material at depth (>125cm).
Clay content in subsoil <10%; CEC <4 meq/100gr soil; pH 5-5.5; Org C. in topsoil <0.4%.
Vegetation: Woodland; dominant species Brachystegia boehmii, Bauhinia petersiana, Colophospermum mopane, Pterocarpus angolensis, Baikiaea plurijuga.

L44a FAO: Ferralic Arenosols,petroferric (1974)
Ferri-Ferralic Arenosol (1988)
ST : Petroferric Quartzipsamments

Description: Shallow to moderately deep somewhat excessively drained dark grayish brown to pale brown fine-medium sand to loamy sands
Topography: Almost flat to gently undulating
Site: Normal, flooding risk low
Profiles: PA273, PA357
Occurrence: See L44
Characteristics: As L44, but with overlying petroferric material within 1m.
Vegetation: Dense savanna

L45 FAO: Eutric Regosols, shallow petric (1974)/skeletic (1988)
ST : Typic Ustorthents

Description: Shallow imperfectly to moderately well drained very dark grayish brown to yellowish brown sandy loams to clay
Topography: Almost flat
Site: Normal, flooding risk low
Profiles: PA229
Occurrence: Minor unit; in eroded parts of N.Pandamatenga lacustrine plain.
Characteristics: Shallow lacustrine clays overlying weathered basalts.
Vegetation: Open savanna with Combretum imberbe, Combretum hereroense, Terminalia sericea, Brachystegia boehmiii.

SOILS OB COARSE GRAINED SEDIMENTARY ROCKS

KS3 FAO: Ferralic Arenosols (1974 and 1988)
ST : Ustic Quartzipsamments

Description: Deep to very deep well to somewhat excessively drained yellowish brown (with chroma 5 or more) to yellowish red fine and fine-medium sands
Topography: Flat to gently undulating
Site: Normal
Profiles: PA71, PA143, PA147-148, PA170, PA178-179, PA181, PA183, PA187, PA225, PA230, PA231, PA314, PA362
Occurrence: Sand plains; not in lowest positions.
Characteristics: Very deep, somewhat excessively drained, fine-medium and medium sands. Clay content <6%; CEC <4meq/100gr soil; pH 5-5.5; Org C <0.5%.
Vegetation: Woodland to savanna; dominant species: Pterocarpus angolensis, Lonchocarpus capensis, Terminalia sericea, Baikiaea plurijuga, Burkea africana.

KS5 FAO: Ferralic Arenosols (1974)
Luvic Arenosols (1988)
ST : Ustic Quartzipsamments

Description: Deep to very deep well to somewhat excessively drained yellowish brown to red fine and fine-medium sand to loamy fine sand.
Topography: Flat to gently undulating
Site: Normal
Profiles: PA23, PA68, PA116, PA118, PA121, PA164, PA194-195, PA220, PA283, PA293
Occurrence: Sand plains; not in lowest positions.
Characteristics: Very deep, somewhat excessively drained, fine-medium and medium sands to loamy sands. With a slight clay increase with depth (upto 3%). Clay content subsoil 7-9%; CEC <4meq/100gr soil; pH 5-6; Org C <0.3%.
Vegetation: Woodland to dense savanna; dominant species: Pterocarpus angolensis, Lonchocarpus capensis, Terminalia sericea, Baikiaea plurijuga, Burkea africana.

KS5a FAO: Luvic Arenosols (1974)
Lamelli-Luvic Arenosols (1988)
ST : Alfic Quartzipsamments

Description: as KS5, but showing lamellae of clay accumulation
Topography: Flat to gently undulating
Site: Normal
Profiles: PA245
Occurrence: Sand plains.
Characteristics: As KS5 but with clay bands in subsoil
Vegetation: As KS5

KS6 FAO: Ferralic Arenosols (1974)
Luvic/Ferralic Arenosols (1988)
ST : Ustic Quartzipsamments

Description: Deep to very deep somewhat excessively to excessively drained yellowish brown to red fine and fine-medium sand to loamy fine sand.
Topography: (Gently) undulating
Site: (slightly) watershedding
Profiles: PA32, PA122, PA362
Occurrence: Dunes
Characteristics: Fine-medium and medium sands to loamy sands. Often with a slight clay increase with depth (upto 3%). Clay content subsoil 7-9%; CEC <4meq/100gr soil; pH 5.5-6; Org C <0.3%.
Vegetation: Woodland; dominant species: Pterocarpus angolensis, Kirkia acuminata, Baikiaea plurijuga.

KS16 FAO: Dystric Arenosols (1974)
Dystri-Haplic Arenosols (1988)
ST : Ustic Quartzipsamments

Description: Deep to very deep somewhat excessively drained dark grayish brown to light yellowish brown fine and fine-medium sand to loamy fine sand.
Topography: Flat to gently undulating
Site: Normal
Profiles: PA166, PA190, PA315-316
Occurrence: Sand plains
Characteristics: Pale medium sands. Clay content <4%; CEC <2meq/100gr soil; pH 5-5.5; Org C <0.3%.
Vegetation: Tree savanna and woodland; dominant species: Burkea Africana, Terminalia sericea.

KS17 FAO: Eutric Arenosols (1974)
Eutri-Haplic Arenosols (1988)
ST : Ustic Quartzipsamments

Description: Deep to very deep somewhat excessively drained dark grayish brown to light yellowish brown fine and fine-medium sand to loamy fine sand. Non calcareous between 50-100cm
Topography: Flat to gently undulating
Site: Normal
Profiles: PA144-145, PA157, PA162, PA172, PA315
Occurrence: Sand plains
Characteristics: Pale medium and fine medium sands. Clay content <4%; CEC <2meq/100gr soil; pH 5.5-6; Org C <0.4%.
Vegetation: Dense savanna types; dominant species: Burkea Africana, Terminalia sericea, Acacia fleckii, A. erioloba, A. luederitzii.

3 PHYSIOGRAPHY

The Pandamatenga plains can be subdivided into flat lacustrine clay plains, undulating dissected plains and almost flat complex areas. A cross section through the plains and adjacent sandplains is given in section 3.2.

3.1 Lacustrine plains

Flat clay plains with minor, but important differences in slope and elevation, which largely control drainage conditions and other soil characteristics. Detailed altitude data are available from recent topographical surveys of the northern and central plains, and from the construction plan of the Nata-Kazungula road.
Pellic Vertisols are by far the dominant soil type in the lacustrine clays. Transitional to the sandveld zones with littoral deposits are found Calcic Gleyic Luvisols which are in general more sandy, and often sodic. The vegetation of the lacustrine clay plains is best described as open (tree) savanna, with Colophospermum mopane, Acacia nigrescens and A. gerrardii. It should be remarked that the trees are not evenly distributed throughout the plain, but mainly occur in small clusters. Important grass species are Cymbogon spp., Sectaria spp. and Hypharrenia spp. In places Mopane woodland occurs, often in slightly better drained parts, although this is not always the case, as woodland also occurs on the poorly drained alluvial fans in the northern plain. Pure mopane stands are also found on sodic soils.

3.1.1 The Southern plain is slightly tilted to the SSW with an average slope of 0.2% measured along the road (see 3.2 cross section 1). The east part of the plain is very homogeneous and consists of lacustrine clays (Pellic Vertisols). In the western part the parent material gradually becomes more sandy, and a drainage pattern is recognizable. This drainage system has formed an almost flat topography with sandy higher parts and clayey drainage ways, soils in higher positions are often sodic. It seems to be related to the pan system SW of the Southern plain. To what extent the plain still drains into this pan system is questionable, since no topographical data of this part are available. Due to the general slope of the plain, water collects in the southern part. Here the Vertisols are poorly drained and generally calcic and partly sodic.

3.1.2 The central plain slopes from the central higher part towards the sandveld. In northern direction the average slopes are approximately 0.2%, in western direction slope gradients are upto 0.5%. The lowest part of the plain is found adjacent to the northern sandveld. The soils in this part are poorly drained Calcic Gleysols with a petrocalcic phase (see 3.2 cross section 2). The central part of the plain is imperfectly drained. Transitional to the eroded plain, moderately deep Pellic Vertisols with a petric phase (L25c) are found. A detailed toposequence is given in 3.2, cross section 2.

3.1.3 The northern plain has its highest part located in the SE. From there the major part of the plain slopes approximately 0.2% in NW direction. The upper slopes are eroded and are characterized by shallow soils (Regosols and Orthic Luvisols) over basalts and related tuffaceous deposits. These soils are in association with deeper Pellic Vertisols with a petric phase. Lacustrine clays derived from this eroded part are redeposited as alluvial fans further to the north.

These alluvial fans are extremely clayey (>80%), and poorly drained. A major drainage way runs north of the alluvial fans along the sandveld towards the west into the Ngwezumba river.
The southern part of the plain drains into a large pan adjacent to the southern sandveld. A toposequence is given in section 3.2., cross section 3.

3.1.4 Dissected gently undulating plains

The east parts of the central and southern Pandamatenga plains are being dissected by tributaries of the Zambesi. Soils on these erosional plains are generally shallow to moderately deep Eutric Regosols and Chromic Luvisols over basalts. The valley floors mainly consist of alluvial reworked lacustrine clays (Pellic vertisols). In transitional positions Chromic Vertisols may occur. A toposequence is given in section 3.2, cross section 2.

3.1.5 Complexes

The northern complex in the NW part of the Northern plain is formed by lacustrine reworked remnants of the longitudinal dune system. The material is mixed sandy and loamy resulting in clearly different soils. In the former interdunal valleys lacustrine deposits are found. The most northern part adjacent to the sandveld is the lowest part with clearly lacustrine soils. Due to a large influx of sand, Vertisols no longer occur. A toposequence is given in 3.2, cross section 4. In the southern part of the southern plain, part of the longitudinal dune system (physiographic unit 1b) has been lacustrine reworked. In lower positions clayey hydromorphic soils have formed (Gleysols), in intermediate positions lacustrine reworked sands are associated with Orthic Luvisols. Reddish Kalahari sands are preserved on the highest parts (longitudinal dune remnants).

3.2 CROSS SECTIONS

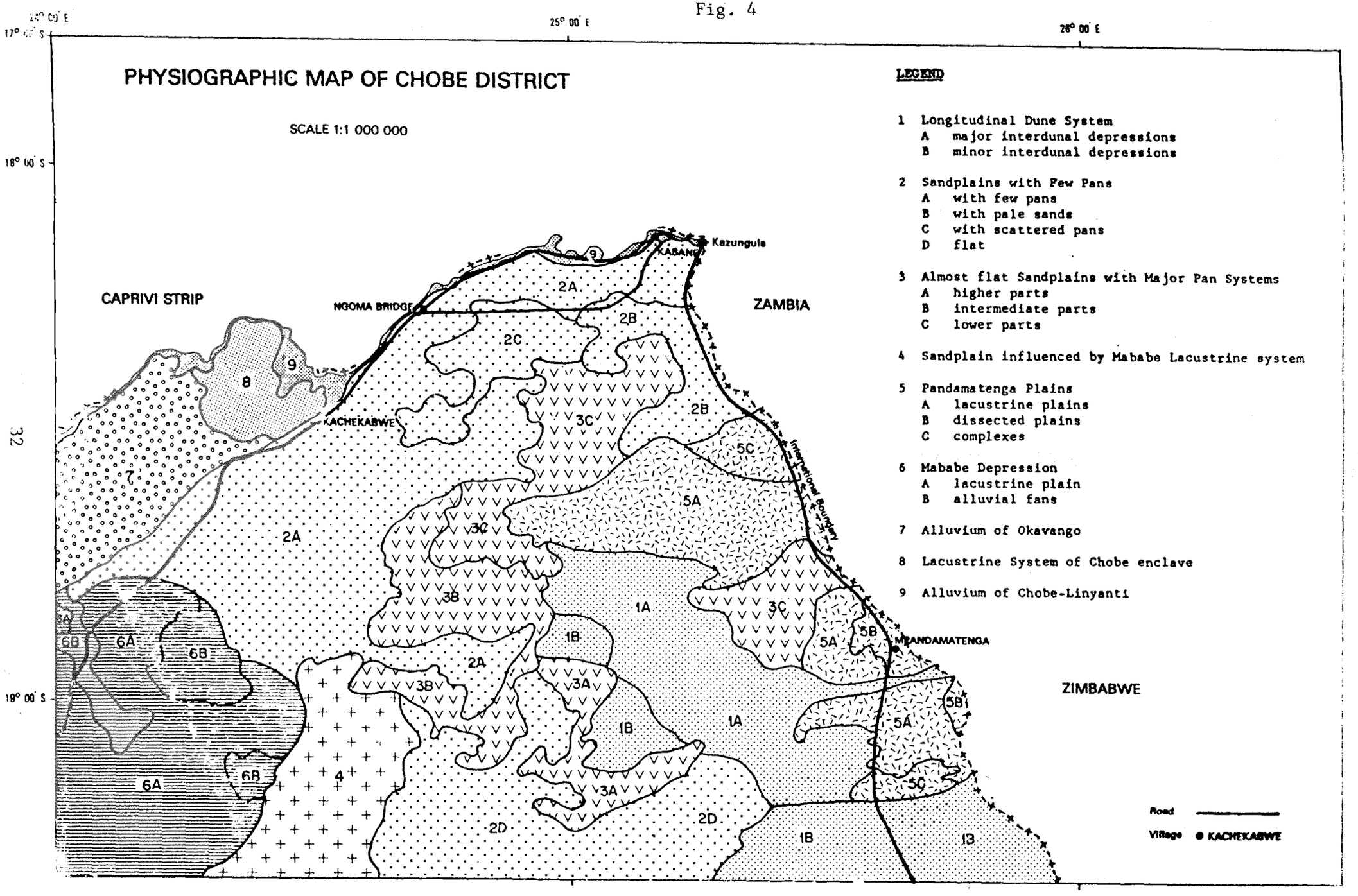
Cross sections 1,2,3 and 4 form a continuous section along the Kasane-Kazungula road, starting from the Kibuyu Forest Reserve boundary 21km S of Pandamatenga, and ending 57km N of Pandamatenga at the Kasane forest Reserve boundary. This section crosses the three lacustrine Pandamatenga plains and the adjacent sandveld. Besides the physiographic relationships, it gives an accurate picture of the differences in elevation within the lacustrine plains as well as between the lacustrine plains and the adjacent sandveld.

Cross section 1. Southern Pandamatenga Plain

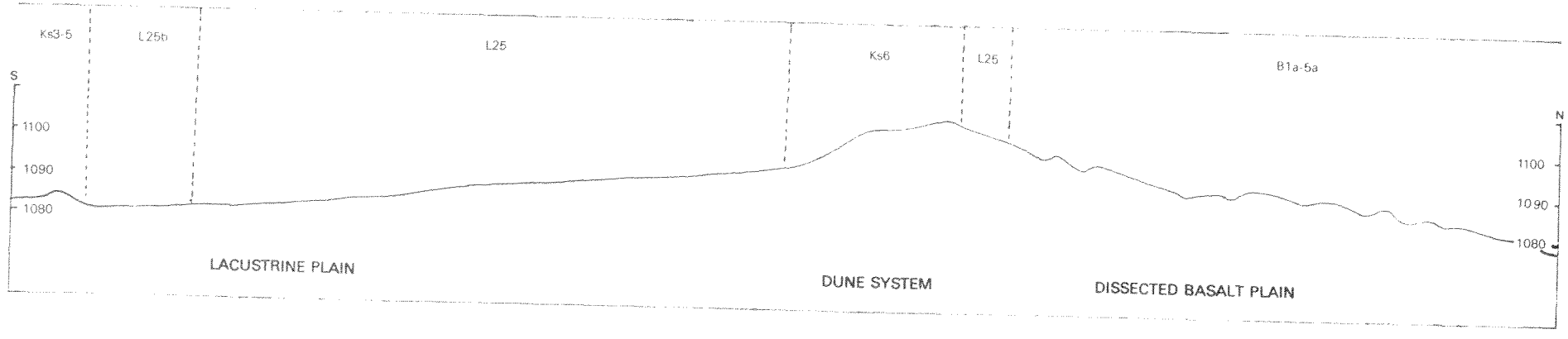
This cross section runs S-N across the southern lacustrine plain, starting at the Kibuyu Forest Reserve Boundary, and ending 20km further north, just before the Pandamatenga junction. It includes the following physiographic units: Longitudinal dune system (Unit 1B), lacustrine plain (5A) and dissected basalt plain (5B).

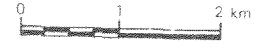
The longitudinal dunes consist mainly of reddish aeolian Kalahari sands, with Ferralic Arenosols as predominant soil type. The mapping unit is a complex of KS3, sands without clay increase with depth, and KS5 (with gradual clay increase with depth).

Fig. 4

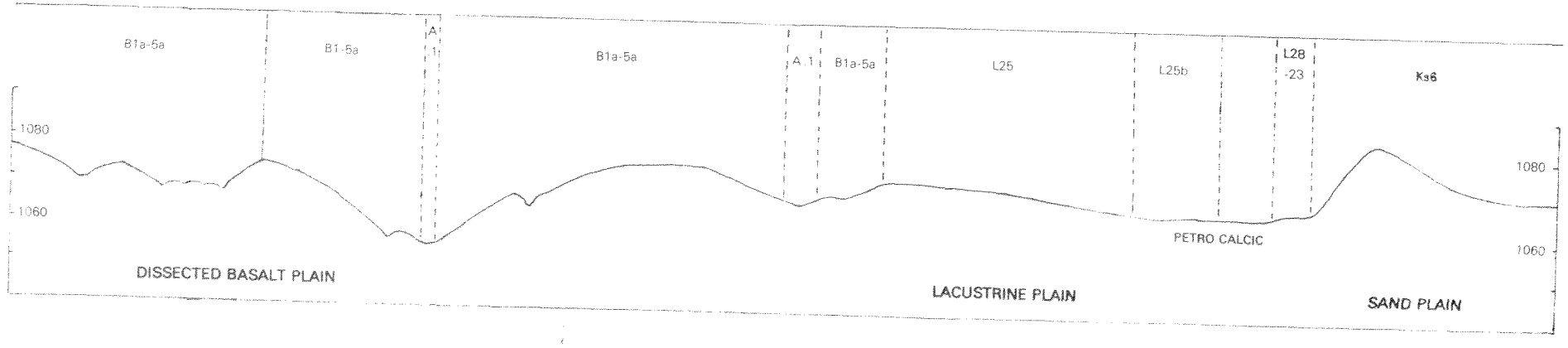

PHYSIOGRAPHIC MAP OF CHOBE DISTRICT
SCALE 1:1 000 000
25° 00' E
26° 00' E
18° 00' S
19° 00' S
CAPRIVI STRIP
ZAMBIA
ZIMBABWE
NGOMA BRIDGE
KASANE
Kazungula
KACHEKABWE
MTANDAMATENGA
International Boundary
Road
Village
KACHEKABWE
LEGEND
1 Longitudinal Dune System
A major interdunal depressions
B minor interdunal depressions
2 Sandplains with Few Pans
A with few pans
B with pale sands
C with scattered pans
D flat
3 Almost flat Sandplains with Major Pan Systems
A higher parts
B intermediate parts
C lower parts
4 Sandplain influenced by Mababe Lacustrine system
5 Pandamatenga Plains
A lacustrine plains
B dissected plains
C complexes
6 Mababe Depression
A lacustrine plain
B alluvial fans
7 Alluvium of Okavango
8 Lacustrine System of Chobe enclave
9 Alluvium of Chobe-Linyanti

CROSS SECTION 1 S. MPANDAMATENGA PLAIN

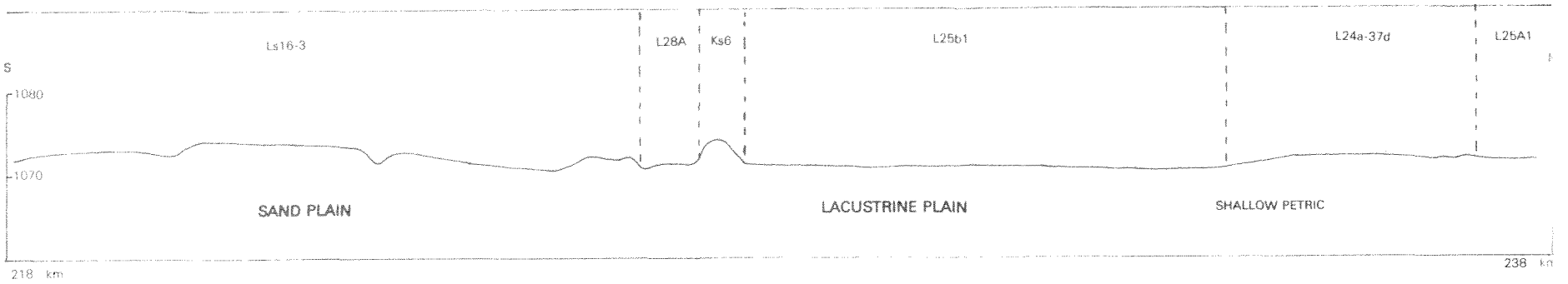




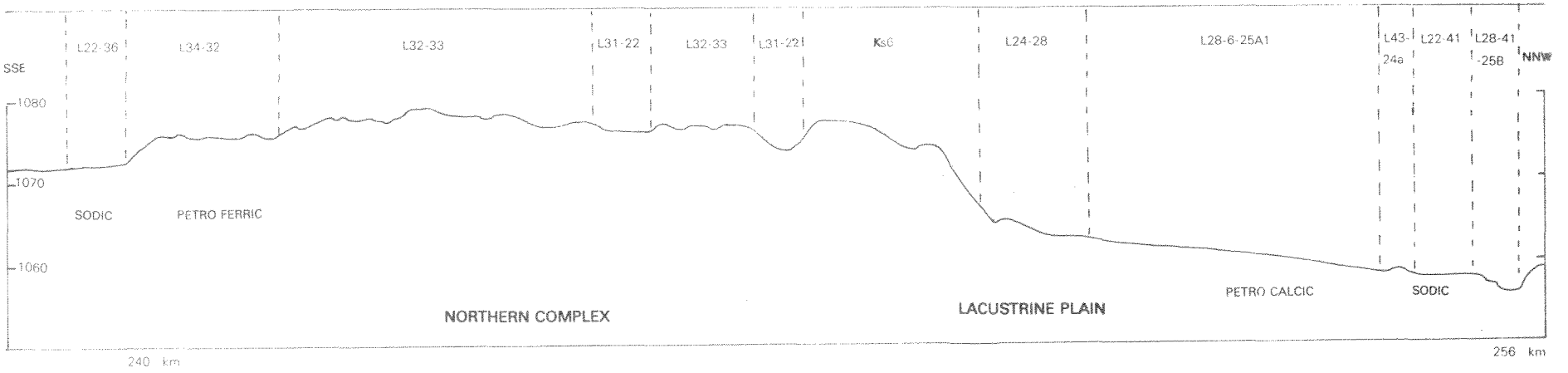
CROSS SECTION 2 CENTRAL MPANDAMATENGA PLAIN



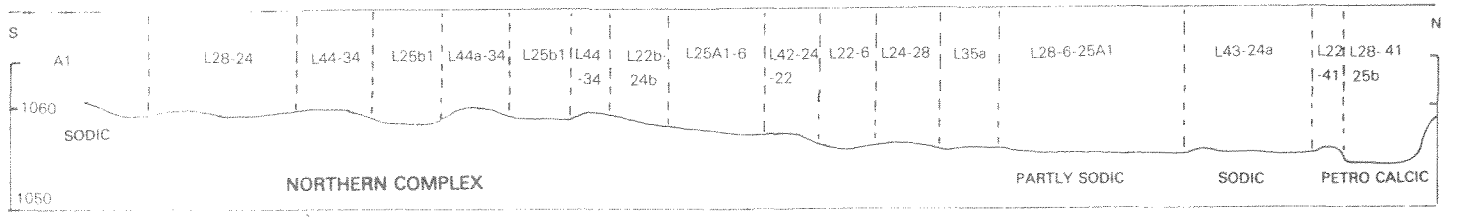
CROSS SECTION 3 N. MPANDAMATENGA PLAIN (South)



CROSS SECTION 4A N. MPANDAMATENGA PLAIN (North)



CROSS SECTION 4B N. MPANDAMATENGA PLAIN (North)



The lacustrine plain is slightly tilted (0.2%) in a southern direction. In the lowest part, transitional to the sandveld, Calcic gleyic Luvisols are found. These soils are characterized by a sandy topsoil with an admixture of aeolian sands, and a clayey prodominantly lacustrine subsoil. Due to their position these soils are calcic and often sodic.
The major part of the plain consists of homogeneous lacustrine clays (Pellic Vertisols). The lowest parts (drainage ways), mapped as L25b, are characterized by a poor drainage, a high flooding risk and often a calcareous or calcic subsoil. The drainage on the higher parts (L25) is relatively good due to runoff.

A longitudinal dune divides the southern and the central lacustrine plain. This dune is the highest point in the Chobe district. It consists of reddish Kalahari sands, predominantly Ferralic Arenosols with a gradual clay increase with depth (see profile PA902).

The dissected basalt plain forms part of the central Pandamatenga plain and is further discussed under crosssection 2.

Cross section 2. Central Pandamatenga Plain

Cross section 2 runs SE-NW over the Central Pandamatenga plain along the main road, starting at the Pandamatenga junction and ending 20km further north. It includes the following physiographic units: dissected basalt plain Unit 5B), lacustrine plain (5A) and lacustrine influenced sandplain (3C).

The dissected basalt plain, which is the eroded part of the central lacustrine plain, is incised by a valley system draining towards the east. Soils are shallow to moderately deep over basalts, predominantly Eutric Regosols, Chromic Luvisols occur on relatively flat parts (interfluves). In places remnants of the old lacustrine deposits are found (L25c). The valley floors consist mainly of alluvial reworked lacustrine clays (A1, Pellic Vertisols).
Chromic Vertisols is found as a minor unit on the lower valley slopes transitional to the Pellic Vertisols.

The lacustrine plain tilts slightly (0.25%) to the north and west and consists of clayey soils, mainly Pellic Vertisols. Drainage conditions depend on relative position rather than on soil type.
Pellic Vertisols on the higher central part are imperfectly drained (L25), flooding risk in this unit is relatively low. These Vertisols are predominantly non calcic and non sodic.
Soils in the lower part of the plain are poorly drained and often petrocalcic due to lateral enrichment of carbonates. Predominant soil types are Pellic Vertisols (L25b), with Vertic Calcic Gleysols (L26) in the lowest part of the plain, closer to the sandveld. Here the development to vertisols is limited by the occurrence of petrocalcic material high in the profile, and by the admixture of aeolian material from the sandveld. The flooding risk in these units is very high.
The littoral zone, transitional to the sandveld, is characterized by (Calcic) Gleyic Luvisols, with a clear textural differentiation with depth due to admixture of aeolian sands in the upper part of the soil.

A dune separates the central Pandamatenga plain from the sandplain. It consists of reddish Kalahari sands. The major soil type is Ferralic Arenosol with a slight and gradual clay increase with depth (KS6).

The lacustrine influenced sandplain should be considered as part of the Northern lacustrine plain system and is further discussed under crossection 3.

Cross section 3. Northern Pandamatenga plain (south).

This cross section runs 20km N along the main road from the Kazuma forest Reserve boundary up to the northern complex, in the Northern Pandamatenga plain. It includes the following physiographic units: lacustrine influenced sandplain (Unit 3C) and lacustrine plain (5A).

Lacustrine influenced sandplain: This is an almost flat sandplain with a number of large pans. The highest parts of the plain are at most 2-3m above the level of the adjacent lacustrine plain and are characterized by reddish sands (Ferralic Arenosols, LS3). The lower sandplain consists mainly of pale sands with a low PBS in the upper 50cm (Dystric Arenosols, LS16).
Predominant soil types in the pans are Eutric Planosols (L41) and Vertic Calcic Gleysols (L26). The Planosols occur towards the margins of the pans where aeolian sands are overlying clayey lacustrine pan deposits. Vertic Calcic Gleysols are found in the center of the pans.

The SE part of the northern **lacustrine plain** is flat and non tilted. The littoral zone, transitional to the sandveld, is characterized by sodic and calcic soils with a clear textural differentiation within the profile (Calcic Gleyic Luvisols, L28a). An isolated dune separates the transitional zone from the lacustrine clays. The lacustrine plain in this part is relatively low (drainage way), and water is likely to collect here. Pellic Vertisol is the predominant soil type. These Vertisols are poorly drained and calcic or calcareous.
In places the lacustrine deposits are shallow and overlying basalts, the predominant soils in these areas are Vertic Mollic Gleysols, with petric phase and in higher positions Calcic Luvisols (L37d and L24a).

Cross section 4. Northern Pandamatenga plain (north)

Cross section 4a runs SSE-NNW along the main road. It starts at the beginning of the Northern complex 39km N of Pandamatenga and ends at the Kasane Forest Reserve boundary 59km N of Pandamatenga.
Cross section 4b runs more or less parallel with 4a, about 10km further west.

The main physiographic units are: Complex of lacustrine reworked longitudinal dunes (Unit 5C), lacustrine plain (5A), sandplain (2B).

The longitudinal dune system is tilted to the west. The highest eastern parts are approximately 5m above the present level of lacustrine plain, towards the west the dune system gradually merges into the lacustrine plain (see 4b). Major soil units are related to the elevation and delineated by a fault system of which the major faults run SW-NE, which correlates with the major fault direction in the Chobe region.
On higher parts of the dune system the dominant soils are Arenic Ferric Luvisols and Arenic Ferric Acrisols, the amount of clay in the subsoils (sandy loam/sandy clayloam) strongly suggests lacustrine influences.
Reddish aeolian Kalahari sands are found on the highest isolated part of the system (KS6).

In lower parts (see 4b) the topsoils become less sandy, and Ferric Luvisols are found, often overlying petroferric material (L34).

Interdunal depressions in the higher eastern part are sandy, with Arenic Eutric Nitosols on the valley slopes and Orthic Luvisols in the center of the depressions. Towards the west the interdunal depressions become more clayey, and Gleysols and Vertisols gradually become the dominant soil types (see 4b).

The transitional zone towards **the lacustrine plain** consists of Calcic Luvisols and Calcic Gleyic Luvisols. The first occur in slightly higher positions, the so-called tree islands. Further north soils become more hydromorphic and clayey and Calcic Gleysols and Pellic Vertisols are found in lower positions. The soils in this unit often overly petrocalcic material due to accumulation of carbonates. The soils in the lowest positions are strongly sodic, and due to the influence of the nearby sandveld often show an abrupt textural change (sandy topsoil over clayey subsoil). The main units are Eutric Planosols, with Orthic Luvisols and Calcic Gleyic Luvisols in higher positions.

The significantly lower level of this part of the lacustrine plain as compared to the SE part, clearly illustrates the occurrence of (a) phase(s) with tectonic activity after the lacustrine phase.

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APPENDIX 1 METHODS

Soil Chemical Analysis

Methods of soil chemical analysis are fully described and discussed by Breitbart (1987). Short description of the methods used are as follows:

pH determination
Two pH values are determined, pH-H_2O and pH-$CaCl_2$. For the latter a 0.01N solution is used. Soil suspension ration is 1:2.5. Values are determined electrometric with an "onion" Ag/AgCL electrode and a Zeiss 300 pH meter.

Electric conductivity
EC is determined in a soil/water suspension of 1:5, only for samples with a pH>7. A Philips PW9506 conductivity meter is used.

Phosphorous
Extractable phosphorous is determined following the Bray and Kurtz (1945) method. The extracting solution is 0.03N NH_4F in 0.025N HCL. P concentration is determined colorimetrically with a modification of the molybdenum blue method of Diekmann and Bray (1940) at 660nm.

Oxidizable organic carbon (organic matter)
In order to obtain results with a better reproducibility, the original Walkley and Black (1934) method was modified. A solution of 3.4N sodium dichromate ($Na_2Cr_2O_7$) in 10N H_2SO_4 is added to the soil and heated for 1h to 150$\pm$5^{o}C. The green colour of Cr^{3+} is determined colorimetrically at 570nm. A standard curve is prepared with glucose.

CEC by ammonium acetate method pH 7.0
This procedure is based on the method of Peech et al. (1947). It has been modified by the USDA National Soil Survey Laboratory for use with 24 place automatic extractors. Soil is leached with ammonium acetate to remove exchangeable cations and to saturate the exchange sites with the ammonium ion. The excess ammonium is removed by leaching with ethanol and the remaining exchangeable ammonium ion is removed by distillation and determined by titration.

Exchangeable cations
Na, K, Ca and Mg are determined with a Varian atomic absorption spectrometer.

Particle-size determination

Clay and silt fraction: For the particle-size distribution of the clay and silt fractions both the pipette method and the hydrometer method are used. The pipette method is more accurate than the hydrometer method, but the output is much higher with the latter. 24 analyses versus 6 are possible per day, for this reason the routine analyses is carried out with the hydrometer method.

Sand fraction: Particles coarser than 50mu are segregated by dry sieving. The sandfraction is divided into five subfractions, following the USDA system: 2000-1000mu, 1000-500mu, 500-250mu, 250-100mu, 100-50mu. Clay and silt are separated from the sand fraction by wet sieving through a 50mm sieve. The sand fraction is dryed in an oven before sieving. With the pipette method, the

clay and silt fraction is washed into sedimentation cylinders for determination. With the hydrometer method, clay and silt are determined within the complete sample. The sand fraction is separated. After the determination, clay and silt are discarded.

Pretreatement and dispersion: Soils which contain considerable amounts of organic matter, soluble salts or gypsum, may not disperse adequately. These components are removed first by treating the soil with hydrogenperoxide to destroy the organic matter and, if applicable, filtration and washing with enough water to dissolve soluble salts and gypsum. For dispersion, samples are shaken for more than 12 hours in a dilute alkaline solution of sodium hexametaphosphate. According to Tyner (1940) and Kilmer and Alexander (1949), mixtures of sodium hexametaphosphate and sodium carbonate have proved to disperse also calcareous soils without prior removal of alkaline earth carbonates.

Pipette method: This method was adopted in 1929 by the International Society of Soil Science (Intern. Soc. Sci, 1929). The pipette method for particle-size analyses is a sedimentation procedure which utilizes pipette sampling at controlled depths and times, calculated with Stokes' equation. The determination is performed in a constant temperature waterbath controlled to $\pm 0.5^{o}C$.

Hydrometer method: The hydrometer method is a sedimentation procedure for clay and silt, introduced by Bouycous (1926, 1927). The hydrometer method, like the pipette method, depends fundamentally upon Stokes' equation. The determination is performed in a constant temperature bath controlled to $\pm 0.5^{o}C$.

Soil physical analyses

Infiltration

The double ring infiltration method is used to measure the water intake characteristics of soils. Open ended cylinders of diameter 25-35 cms and height 30cms are driven into the soil to a depth of 15cms. Around each cylinder, another cylinder larger in diameter is driven concentrically into the soil to the same depth. The intake of water in the inner cylinder is measured for progressively increasing time intervals while keeping the space between the inner and outer cylinder always ponded with water. At each site three to five replicate measurements are made (for detailed procedures see reference No 1).

Bulk density

Bulk density is determined by obtaining an undisturbed soil sample of known volume (100cc) and dividing the oven dry soil mass by the field volume of the sample. Stainless steel cylinders of diameter 5cms and height 5 cms are driven into the soil by a heavy hammer to obtain the cylindrical undisturbed core samples. Five replicate measurements are made for each soil horizon. (for detailed procedure see reference No 1).

Soil moisture retention

Soil moisture characteristics (moisture retention) are done on undisturbed soil core samples for tensions between 0.03 bar and 1.0 bar and on 2mm sieved samples for tensions between 5 bars and 15bars. For tensions of 0.03 bar and 0.05 bar, hanging water column technique, using a sand table is used.

For higher tensions, a pressure plate apparatus is used. Generally moisture contents are measured at 0.03, 0.05, 0.1, 0.3, 1.0, 3.0, 5.0 and 15. bar tensions in duplicate.

Structural stability index

The relative structural stability of soils to wetting is assessed by comparing the degree of collapse of samples of air dried soils when rapidly wetted as opposed to slow wetting under a tension. The degree of collapse is estimated by the relative change in pore-size distribution which in turn is determined from the moisture release characteristics.

Air dry sieved soil samples of 50cc volume and size range between 1mm and 2mm are placed in two sintered glass Buchner funnels connected to burettes by flexible tubing. One sample is wetted slowly at a tensions of 10cms of water for 24 hours. The second sample is wetted fast by raising the water level in burette to saturate the soil. After both samples have been equilibrated at zero tension, moisture release at different tensions are measured by lowering the burettes and noting the increase in volume of water in the burettes (for detailed procedures see reference No 2).

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APPENDIX 2. SELECTED REPRESENTATIVE SOIL PROFILE DESCRIPTIONS AND ANALYTICAL DATA

Profile	Unit	FAO classification
PA22	L32	Arenic Ferric Luvisol
PA50	L26	Vertic Calcic Gleysol
PA116	KS5	Ferralic Arenosol
PA170	KS3	Ferralic Arenosol
PA218	L24	Calcic Luvisol
PA227	L25b	Pellic Vertisol
PA264	L6	Calcic Gleysol
PA270	L42	Solodic Planosol
PA278	L28	Calcic Gleyic Luvisol
PA279	A1	Pellic Vertisol
PA300	L25b	Pellic Vertisol
PA313	L35a	Gleyic Luvic Chernozem
PA315	KS16	Dystric Arenosol
PA348	L25a	Pellic Vertisol
PA358	A2	Chromic Vertisol
PA360	B5a	Chromic Luvisol
PA362	KS6	Ferralic Arenosol
PA901	KS9	Arenic Ferric Acrisol
PA902	L25	Pellic Vertisol

Information on all other soil profiles are available from the Botswana Soil Database.

SOIL PROFILE DESCRIPTION — Profile: PA 0022 Unit: L32 Status: 2

SHEET : 1825A2
LOCATION : Kakulwane N.complex (N.plain) Traverse 1, 15.5km N.
AUTHOR(S): A.Remmelzwaal G.J.Rhebergen T.D.Mafoko K.Kgatlwane
CLASSIFICATION FAO: Arenic Ferric Luvisol (1974)
ST : Arenic Paleustalf
LANDFORM : plain
TOPOGRAPHY: almost flat
SURF. CHAR: slight sealing, no cracks,
LAND USE: no apparent management system
SPECIES : Trees - Brachystegia boehmii (dom.)
: Shrubs - Bauhinia petersiana (dom.) Euclea undulata Brachystegia boehmii
: Grasses/forbs-
PARENT MATERIAL: lacustrine reworked aeolian
MOIST. COND: moist 0 - 60 , dry 60 - 160 cm
SURF.STONES: none
EROSION : nil

GRID : LK-334-845
COORD: 18-18-25-S 25-25-32-E
DATE : 04/04/84

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: even

VEGETATION: woodland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1076 m

SMR: ustic

POSITION: intermediate part
SLOPE : 0 - 1 %

GRASSCOVER: 30 - 70 %

GEOL.UNIT:
DRAINAGE : well drained

HUMAN INF: nil

REMARKS: Augering from 120cm. Pit 400 m W main road.

SAMPLES: A: 0 - 20 B: 40 - 60 C: 80 - 100 D: 140 - 160

A 0 - 25 cm 10YR 3.5/2.5 (moist) and 10YR 4.5/2.5 (dry), sand, very weak fine and medium subangular blocky structure, very friable, common fine and medium pores, non calcareous, common roots, clear smooth boundary.

Bt1 25 - 70 cm 10YR 4/4 (moist) and 10YR 5/4 (dry), loamy sand, very weak very coarse subangular blocky structure, slightly hard very friable, few fine and medium pores, non calcareous, few roots, gradual smooth boundary.

Bt2 70 - 160 cm 9YR 4/5 (moist) and 9YR 5/6 (dry), sandy loam, very weak very coarse subangular blocky structure, slightly hard friable, continuous thin clay cutans, few fine and medium pores, non calcareous, few roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0022

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	6.4	5.9	0.0	14	0.3	3.7	1.6	0.6	0.1	0.0	0.0	62	0.0	0	12	48	26	6	1	0	6	40	H	
B	40	60	6.1	5.6	0.0	15	0.1	2.7	0.9	0.5	0.2	0.0	0.0	59	0.0	0	12	46	26	5	1	0	9	24	H	
C	80	100	5.6	5.4	0.0	22	0.1	3.9	1.5	0.7	0.2	0.0	0.0	62	0.0	0	12	44	25	4	1	0	13	26	H	
D	140	160	6.0	5.5	0.0	12	0.0	3.5	1.1	0.8	0.2	0.0	0.0	60	0.0	0	12	40	25	4	2	1	17	21	H	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0050 Unit: L26 Status: 2

SHEET : 1825B3
LOCATION : Pandamatenga plain, 0.4km S of Kazuma forest.
AUTHOR(S): A.Remmelzwaal K.Kgatlwane
CLASSIFICATION FAO: Vertic Calcic Gleysol (1974)
ST : Vertic Haplaquept
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt,
LAND USE: no apparent management system
SPECIES : Trees - Combretum imberbe (dom.) Erythrophleum africanum Bauhinia petersiana Combretum hereroense
: Shrubs - Combretum imberbe (dom.) Bauhinia petersiana
: Grasses/forbs- Hyparrhenia filipendula
PARENT MATERIAL: lacustrine
MOIST. COND: slightly moist 0 - 110 cm
SURF.STONES: none
EROSION : nil

GRID : LK-468-598
COORD: 18-26-51-S 25-33-00-E
DATE : 06/04/84

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: even

VEGETATION: open savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1065 m

SMR: aquic

POSITION: lower part
SLOPE : 0 - 1 %

GRASSCOVER: 30 - 70 %

GEOL.UNIT:
DRAINAGE : poorly drained

HUMAN INF: nil

REMARKS: Ploughed farmland 20 years ago. Strong decrease or structure in B horizon at 60cm.

SAMPLES: A: 0 - 20 B: 40 - 60 C: 80 - 100

A 0 - 20 cm 10YR 3/2- (moist), sandy clay loam, moderate medium to very coarse subangular blocky structure, very hard friable to firm, common fine and medium pores, non calcareous, common roots, clear smooth boundary.

B 20 - 70 cm 10YR 4-/0.5 (moist) and 10YR 5/1 (dry), clay, strong very coarse angular blocky falling apart into strong medium wedge shaped angular blocky structure, very hard firm, continuous partly intersecting slickensides, few fine and common medium pores, non calcareous, few fine roots, abrupt smooth boundary.

Cck 70 - 110 cm clay (30% clay), weakly cemented, very frequent medium irregular soft calcareous white nodules, strongly calcareous, very few roots,

STANDARD SOIL ANALYSIS RESULTS

PROFILE: PA 0050

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	meq/100gr soil						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	7.3	6.4	0.0	2	0.5	14.2	6.8	5.2	0.4	0.0	0.0	87	0.0	0	19	36	19	6	2	3	16	75	H	A
B	40	60	7.4	6.7	0.0	1	0.2	27.5	13.7	11.3	0.6	0.1	0.0	93	0.0	0	13	20	11	4	3	2	46	58	H	A
C	80	100	8.1	7.8	0.2	0	0.1	17.0	46.7	7.0	0.5	0.1	0.0	100	0.0	2	9	14	10	5	3	6	51	33	H	A

Soil Survey of Botswana FAO/BOT/85/011 Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0116 Unit: KS05 Status: 2

SHEET : 1825D1
LOCATION : Sandveld south, 8.9km S of Cogefar ridge.
AUTHOR(S): A.Remmelzwaal G.J.Rhebergen K.Kgatlwane
CLASSIFICATION FAO: Haplic Arenosol(1988) Ferralic Arenosol (1974)
ST : Ustoxic Quartzipsamment
LANDFORM : dune field
TOPOGRAPHY: almost flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt,
LAND USE: no apparent management system
SPECIES : Trees - Baikiaea plurijuga (dom.) Pterocarpus angolensis Afzelia quanzensis Burkea africana
: Shrubs - Terminalia sericea Bauhinia petersiana Combretum fragrans
: Grasses/forbs-
PARENT MATERIAL: aeolian sand
MOIST. COND: dry 0 - 130 cm
SURF.STONES: none
EROSION : nil

GRID : LK-531-304
COORD: 18-42-52-S 25-36-24-E
DATE : 11/06/84

LAND ELEMENT : dune
MICRO TOPOGRAPHY: even

VEGETATION: woodland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1084 m

SMR: ustic

POSITION:
SLOPE : 0 - 1 %

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : somewhat excessively drained

HUMAN INF: nil

REMARKS:

SAMPLES: A: 0 - 20 B: 30 - 50 C: 110 - 130

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A 0 - 25 cm 10YR 3/3 (moist) and 10YR 4/3 (dry), fine-medium sand, very weak medium subangular blocky structure, soft, common fine pores, non calcareous, common burrows, common roots, clear smooth boundary.

B1 25 - 60 cm 10YR 4/4 (moist) and 10YR 5/4 (dry), fine-medium sand, very weak medium subangular blocky to weakly coherent massive structure, soft, common fine pores, non calcareous, common burrows, common roots, gradual smooth boundary.

B2 60 - 130 cm 10YR 5/8 (moist) and 10YR 6/8 (dry), fine-medium sand, weakly coherent massive structure, soft to slightly hard, non calcareous, common burrows, few roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0116

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)							CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil				----------ù	%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	6.7	5.8	0.0	5	0.4	2.8	1.2	0.4	0.1	0.0	0.0	61	0.0	0	18	41	25	10	2	1	5	24	H	A
B	30	50	5.7	4.7	0.0	2	0.2	2.4	0.3	0.1	0.1	0.0	0.0	21	0.0	0	18	38	24	11	1	1	6	28	H	A
C	110	130	5.8	4.7	0.0	2	0.1	1.7	0.4	0.1	0.1	0.0	0.0	35	0.0	0	18	35	26	11	1	1	7	20	H	A

Soil Survey of Botswana FAO/BOT/85/011 Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0170 Unit: KS03 Status: 2

SHEET : 1824B4
LOCATION : 81.8km from Nata road to Ngwezumba.
AUTHOR(S): B.Kopelo C.I.Ketlogetswe
CLASSIFICATION FAO: Ferralic Arenosol(1988) Ferralic Arenosol (1974)
ST : Ustoxic Quartzipsamment
LANDFORM : plain
TOPOGRAPHY: almost flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt,
LAND USE: game reserve
SPECIES : Trees - Terminalia sericea (dom.)
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: aeolian sand
MOIST. COND: dry 0 - 160 cm
SURF.STONES: none
EROSION : nil

GRID : - -
COORD: 18-23-30-S 24-54-48-E
DATE : 31/08/85

LAND ELEMENT :
MICRO TOPOGRAPHY: even

VEGETATION: tree savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: ustic

POSITION:
SLOPE : 0 - 1 % straight

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : somewhat excessively drained

HUMAN INF: nil

REMARKS: Augering from 100cm

SAMPLES: A: 0 - 10 B: 20 - 40 C: 80 - 100 D: 140 - 150

A 0 - 15 cm 10YR 2.5/2 (moist) and 10YR 3/2 (dry), sand, very weak fine and medium subangular blocky structure, soft, common fine pores, non calcareous, many fine and medium roots, gradual smooth boundary.

AB 15 - 45 cm 10YR 3.5/3 and 10YR 4.5/3 (dry), sand, weakly coherent massive structure, soft, common fine pores, non calcareous, common very fine and fine roots, gradual smooth boundary.

B1 45 - 110 cm 10YR 4.5/5 (moist) and 10YR 5.5/5 (dry), sand, weakly coherent massive structure, soft, few fine pores, non calcareous, few fine roots, gradual smooth boundary.

B2 110 - 160 cm 7.5YR 4.5/6 (moist) and 7.5YR 5.5/6 (dry), sand, non calcareous,

PROFILE: PA 0170

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	meq/100gr soil						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	10	6.5	6.5	0.0	4	0.4	2.9	2.2	0.3	0.1	0.0	0.0	90	0.0	0	8	60	23	3	1	1	5	26	H	
B	20	40	5.1	4.7	0.0	1	0.1	1.9	0.1	0.1	0.1	0.0	0.0	16	0.0	0	4	44	36	10	1	3	3	48	H	
C	80	100	4.9	4.7	0.0	1	0.1	1.8	0.0	0.2	0.1	0.0	0.0	17	0.0	0	9	53	26	5	1	1	5	27	H	
D	140	150	5.2	5.1	0.0	1	0.0	1.9	0.3	0.2	0.2	0.0	0.0	37	0.0	0	10	56	24	4	1	1	5	38	H	

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION

Profile: PA 0218 Unit: L24 Status: 2

SHEET : 1825A4
LOCATION : Kakulwane Seloko (N.plain) South.
AUTHOR(S): G.J.Rhebergen C.I.Ketlogetswe E.Van Waveren
CLASSIFICATION FAO: Calcic Luvisol (1974)
ST : Aquic Haplustalf
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: moderate sealing, no cracks, nil evidence of salt,
LAND USE: forest reserve
SPECIES : Trees - Colophospermum mopane (dom.)
: Shrubs - Colophospermum mopane (dom.)
: Grasses/forbs- Hyparrhenia filipendula Setaria sphacelata
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 60 , slightly moist 60 - 110 cm
SURF.STONES: none
EROSION : nil

GRID : LK-283-624
COORD: 18-25-06-S 25-22-34-E
DATE : 24/06/87

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: even

VEGETATION: savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: ustic

POSITION: intermediate part
SLOPE : 0 - .5 % straight

GRASSCOVER: > 70 %

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

REMARKS: Approx. half of pit has no calcaric nodules.

SAMPLES: A: 0 - 5 B: 5 - 15 C: 15 - 35 D: 40 - 60 E: 90 - 110

A1 0 - 5 cm 10YR 3.5/1.5 (moist) and 10YR 4/1.5 (dry), sandy clay, moderate fine and medium granular structure, hard, frequent medium irregular hard calcareous white nodules, slightly calcareous, field pH: 7.0, clear smooth boundary.

A2 5 - 15 cm 10YR 3.5/1.5 (moist) and 10YR 4/1.5 (dry), few fine faint clear reddish-brown mottles, sandy clay, weak medium prismatic falling apart into moderate medium and coarse subangular blocky structure, very hard, broken pressure faces, common very fine and fine pores, frequent medium irregular hard calcareous white nodules, non calcareous, common fine and medium roots, field pH: 8.0, clear wavy boundary.

Btk1 15 - 35 cm 10YR 3.5/1.5 (moist) and 10YR 4/1.5 (dry), clay, moderate coarse prismatic falling apart into strong coarse and very coarse angular blocky structure, very hard, broken pressure faces and patchy thin clay cutans on pedfaces, few very fine and fine pores, frequent medium irregular hard calcareous white nodules, non calcareous, few fine and medium roots, field pH: 8.0, clear wavy boundary.

Btk2 35 - 70 cm 10YR 3.5/1.5 (moist) and 10YR 4/1.5 (dry), clay, weak to moderate very coarse prismatic falling apart into moderate to strong coarse and very coarse wedge shaped angular blocky structure, hard to very hard, continuous intersecting slickensides, few very fine and fine pores, frequent medium irregular hard calcareous white nodules, non calcareous, few medium and very few fine roots, field pH: 8.0, gradual wavy boundary.

Btk3 70 - 110 cm 10YR 3.5/1.5 (moist) and 10YR 4/1.5 (dry), clay, weak very coarse prismatic falling apart into weak to moderate very coarse wedge shaped angular blocky structure, very firm, continuous intersecting slickensides, few very fine and fine pores, frequent medium irregular hard calcareous white nodules, non calcareous, very few fine and very few medium roots, field pH: 8.5,

STANDARD SOIL ANALYSIS RESULTS

PROFILE: PA 0218

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	5	6.9	6.4	0.1	6	0.3	15.6	8.2	6.0	0.3	0.1	0.0	94	0.0	0	2	26	38	12	2	2	18	79	H	
B	5	15	7.3	6.9	0.1	2	0.5	26.9	22.6	7.1	0.2	0.1	0.0	100	0.0	0	4	28	24	1	5	2	35	71	H	
C	15	35	7.3	6.9	0.1	1	0.3	27.9	24.3	8.0	0.1	0.2	0.0	100	0.0	0	5	27	21	6	1	2	38	71	H	
D	40	60	7.7	7.0	0.1	1	0.2	31.8	25.0	10.9	0.1	0.5	0.0	100	0.0	0	4	25	22	6	3	1	40	78	H	
E	90	110	8.1	7.4	0.2	1	0.1	34.0	22.3	14.2	0.2	1.2	0.0	100	0.0	1	4	18	12	4	8	6	47	71	H	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0227 Unit: L25b2 Status: 2

SHEET : 1825A4
LOCATION : Kakulwane seloko (N.plain) South.
AUTHOR(S): A.Remmelzwaal C.I.Ketlogetswe E.Van Waveren
CLASSIFICATION FAO: Pellic Vertisol (1974)
ST : Entic Pellustert
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: no sealing, cracks 5 cm wide, nil evidence of salt,
LAND USE: no apparent management system
SPECIES : Trees -
: Shrubs -
: Grasses/forbs- Sporobolus spicatus
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 60 , slightly moist 60 - 140 cm
SURF.STONES: none
EROSION : nil

GRID : LK-228-603
COORD: 18-26-29-S 25-19-21-E
DATE : / /

LAND ELEMENT : pan
MICRO TOPOGRAPHY: high gilgai

VEGETATION: grassland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1068 m

SMR: aquic

POSITION: intermediate part
SLOPE : 0 - %

GRASSCOVER: > 70 %

GEOL.UNIT:
DRAINAGE : poorly drained

HUMAN INF: nil

REMARKS:

SAMPLES: A: 0 - 5 B: 5 - 12 C: 12 - 40 D: 50 - 70 E: 110 - 130

A1 0 - 5 cm 2.5Y 4/0 (moist) and 2.5Y 4/0 (dry), clay, strong medium and coarse granular structure, hard, non calcareous, abrupt wavy boundary.

A2 5 - 12 cm 2.5Y 4/0 (moist) and 2.5Y 4/0 (dry), clay, strong medium and coarse angular and subangular blocky structure, very hard, common very fine and fine pores, non calcareous, many very fine and fine roots, clear wavy boundary.

B1 12 - 40 cm 2.5Y 4/0 (moist) and 2.5Y 4/0 (dry), clay, moderate very coarse prismatic falling apart into strong medium to very coarse angular blocky structure, extremely hard, broken partly intersecting slickensides, few very fine and fine pores, non calcareous, many very fine and fine roots, clear wavy boundary.

B2 40 - 140 cm 2.5Y 4/0 (moist) and 2.5Y 4/0 (dry), clay, moderate to strong very coarse prismatic falling apart into strong medium to very coarse wedge shaped angular blocky structure, extremely hard, broken partly intersecting slickensides, few very fine and fine pores, non calcareous, few very fine and fine roots, gradual wavy boundary.

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0227

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	5	6.3	6.1	0.2	22	1.4	54.5	25.5	22.0	3.3	0.1	0.0	93	0.0	2	1	4	4	2	4	6	77	64	H	
B	5	12	6.3	6.1	0.2	7	0.9	50.9	27.7	20.3	2.8	0.3	0.0	100	0.0	2	1	4	3	1	0	4	85	56	H	
C	12	40	6.2	6.1	0.2	10	0.8	51.0	28.4	20.0	2.9	0.3	0.0	100	0.0	2	3	4	3	1	0	4	83	57	H	
D	50	70	6.4	6.3	0.2	14	0.7	51.9	28.8	19.2	3.2	0.4	0.0	99	0.0	0	1	4	3	1	3	5	83	59	H	
E	110	130	6.8	6.7	0.2	11	0.6	51.1	29.0	18.6	3.7	0.4	0.0	100	0.0	0	3	3	2	1	1	8	83	59	H	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0264 Unit: L06 Status: 2

SHEET : 1825A2
LOCATION : Kakulwane N.complex (N.plain) traverse 2, 33.5km N.
AUTHOR(S): E.Van Waveren T.D.Mafoko D.Kwape
CLASSIFICATION FAO: Calcic Gleysol (1974) sodic phase
ST : Typic Haplaquept
LANDFORM : lacustrine plain
TOPOGRAPHY: almost flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: no apparent management system
SPECIES : Trees - Colophospermum mopane (dom.)
: Shrubs - Ziziphus mucronata (dom.)
: Grasses/forbs- Hyparrhenia filipendula
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 30 , slightly moist 30 - 130 cm
SURF.STONES: common gravel
EROSION : nil

GRID : LK-251-930
COORD: 18-08-56-S 25-20-59-E
DATE : 16/10/87

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: even

VEGETATION: open tree savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: aquic

POSITION: higher part
SLOPE : 0.2 - 0.5% straight

GRASSCOVER: 10 - 30 %

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

REMARKS: Pa 264 on a woodland spot, stones concentrated in places. Medium roots stop at 60cms. Deep 5mm wide cracks with bleached sand washed in wider cracks from top of B horizon. - Occur in complex with LK unit L24 (see profile PA 265

SAMPLES: A: 0 - 0 B: 0 - 0 C: 0 - 0 D: 0 - 0

A 0 - 5 cm 2.5Y 3.5/1- (moist) and 1.5Y 3.5/ 1- (dry), clay, weak fine and medium granular structure, slightly hard, common very fine and fine pores, very few medium rounded strongly weathered chert rock fragments, frequent irregular soft calcareous white concretions, slightly calcareous, many fine and medium roots, abrupt wavy boundary.

Ak 5 - 30 cm 2.5Y 4/1- (moist) and 2.5Y 4/1- (dry), clay, strong medium to very coarse subangular blocky structure, extremely hard, common very fine and fine pores, frequent irregular soft calcareous white soft segregations, strongly calcareous, many fine and medium roots, abrupt wavy boundary.

Bk 30 - 110 cm 2.5Y 4.5/1- (moist) and 2.5Y 4.5/1- (dry), clay, weak coarse and very coarse angular and subangular blocky structure, firm, common very fine and fine pores, frequent irregular soft calcareous white soft segregations, strongly calcareous, common medium and common very fine roots, clear wavy boundary.

Ck 110 - 130 cm 2.5Y 4/1- (moist) and 2.5Y 4/1- (dry), clay, weak coarse angular and subangular blocky structure, extremely firm, common very fine and fine pores, dominant coarse irregular soft calcareous white soft segregations, strongly calcareous,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0264

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	meq/100gr soil						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	0	8.1	7.9	0.4	2	0.5	46.9	53.9	22.7	4.5	3.0	0.0	100	0.0	1	3	20	14	2	2	4	54	84	H	
B	0	0	8.8	8.3	0.6	1	0.4	50.8	49.2	36.1	4.3	18.8	0.0	100	0.0	1	3	22	13	3	1	1	56	88	H	
C	0	0	9.1	8.6	0.7	1	0.3	41.1	32.2	34.6	0.5	20.4	0.0	100	0.0	0	3	23	17	3	2	0	51	78	H	
D	0	0	9.2	8.7	0.6	1	0.1	30.5	31.7	30.5	2.9	17.0	0.0	100	0.0	1	4	25	16	3	0	2	48	62	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0270 Unit: L42 Status: 2

SHEET : 1825A2
LOCATION : Kakulwane N.complex (N.plain) traverse 2, 29.1km N.
AUTHOR(S): A.Remmelzwaal P.Jamagne J.Huesken
CLASSIFICATION FAO: Solodic Planosol (1974)
ST : Aeric Albaqualf
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: no apparent management system
SPECIES : Trees - Colophospermum mopane (dom.) Acacia nilotica
: Shrubs - Colophospermum mopane (dom.) Euclea undulata Terminalia sericea
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 50 , slightly moist 50 - 120 cm
SURF.STONES: none
EROSION : slight sheet erosion

GRID : LK-248-889
COORD: 18-11-04-S 25-20-44-E
DATE : 15/10/87

LAND ELEMENT :
MICRO TOPOGRAPHY: even

VEGETATION: savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: aquic

POSITION: intermediate part
SLOPE : 0 - 1 % straight

GRASSCOVER: > 70 %

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

REMARKS: Land element is eroded dune base. Few termite hills. Vegetation structure in places dense savanna to woodland.

SAMPLES: A: 0 - 15 B: 15 - 20 C: 20 - 30 D: 50 - 70 E: 90 - 110

A 0 - 15 cm 10YR 2.5/2 (moist) and 10YR 3/2.5 (dry), sand to loamy sand (10% clay), weak medium and coarse subangular blocky structure, soft, many very fine and fine and few medium pores, non calcareous, many very fine and fine roots, clear smooth boundary.

E 15 - 20 cm 10YR 3/1.5 (moist) and 110YR 5/1.5 (dry), many fine distinct clear brownish mottles, sand to loamy sand (10% clay), massive structure, very hard, common very fine and fine and few medium pores, non calcareous, few very fine and fine roots, abrupt wavy boundary.

Bt 20 - 45 cm 10YR 4.5/3 (moist) and 10YR 5/3 (dry), common fine faint diffuse brownish mottles, sandy clay (40% clay), weak very coarse subangular blocky falling apart into weak medium and coarse angular and subangular blocky structure, very hard, broken moderately thick clay cutans on pedfaces, many very fine and fine pores, non calcareous, few fine and medium roots, gradual wavy boundary.

Btk1 45 - 70 cm 10YR 5/3 (moist) and 10YR 5/3 (dry), many fine distinct clear reddish-brown mottles, sandy clay to clay (50% clay), weak to moderate medium and coarse prismatic falling apart into moderate medium and coarse angular and subangular blocky structure, very hard, broken moderately thick clay cutans on pedfaces, many very fine and fine pores, few medium irregular soft calcareous white soft segregations, moderately calcareous, few fine and medium roots, clear wavy boundary.

Btk2 70 - 120 cm 10YR 4.5/2.5 (moist) and 10YR 5/5 (dry), common fine distinct clear reddish-brown mottles, sandy clay to clay (50% clay), moderate coarse and very coarse angular and subangular blocky falling apart into moderate fine and medium angular and subangular blocky structure, very hard, broken moderately thick clay cutans on pedfaces, many very fine and fine and few medium pores, frequent medium irregular hard and soft calcareous white nodules, moderately calcareous, few fine and medium roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0270

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	15	6.1	5.9	0.0	4	0.6	4.4	2.6	1.3	0.3	0.0	0.0	95	0.0	0	10	51	20	3	1	0	14	14	H	
B	15	20	6.3	5.7	0.1	1	0.4	8.0	3.9	2.4	0.5	0.8	0.0	95	0.0	0	8	43	21	4	1	1	23	27	H	
C	20	30	6.8	6.2	0.1	1	0.4	12.0	5.8	3.7	0.7	1.4	0.0	97	0.0	0	7	36	17	3	1	1	36	29	H	
D	50	70	7.6	7.2	0.4	1	0.5	20.4	12.8	7.0	0.8	3.2	0.0	100	0.0	0	7	36	16	3	1	2	35	53	H	
E	90	110	8.0	7.4	0.6	1	0.4	20.6	17.9	6.5	0.4	3.7	0.0	100	0.0	0	4	21	23	5	2	3	42	45	H	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0278 Unit: L28 Status: 2

SHEET : 1825A2
LOCATION : Kakulwane N.complex (N.plain) traverse 2, 23.8km N.
AUTHOR(S): R.Kelebemang J.Huesken
CLASSIFICATION FAO: Calcic Gleyic Luvisol (1974)
ST : Typic Ochraqualf
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: moderate sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: no apparent management system
SPECIES : Trees - Colophospermum mopane (dom.) Acacia nigrescens
: Shrubs - Colophospermum mopane (dom.) Combretum fragrans
: Grasses/forbs- Hyparrhenia filipendula
PARENT MATERIAL: aeolian reworked lacustrine
MOIST. COND: dry 0 - 120 cm
SURF.STONES: none
EROSION : slight sheet erosion

GRID : LK-247-835
COORD: 18-14-05-S 25-20-46-E
DATE : 13/10/87

LAND ELEMENT :
MICRO TOPOGRAPHY: low hummocks

VEGETATION: tree savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: aquic

POSITION: intermediate part
SLOPE : 0 - 0.2% straight

GRASSCOVER: 30 - 70 %

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

REMARKS:

SAMPLES: A: 0 - 15 B: 15 - 30 C: 40 - 60 D: 80 - 100

A 0 - 15 cm 10YR 2.5/1.5 (moist) and 10YR 3.5/2 (dry), few fine faint diffuse brownish mottles, loamy sand, very weak medium and coarse subangular blocky structure, soft, many very fine and fine pores, non calcareous, many very fine and fine and few medium roots, clear wavy boundary.

Btg1 15 - 30 cm 10YR 3.5/2 (moist) and 10YR 4.5/2 (dry), common fine faint diffuse brownish mottles, sandy loam (6% clay), very weak coarse and very coarse prismatic structure, hard, patchy thin clay cutans on pedfaces, common very fine and fine and few medium pores, non calcareous, common very fine and fine and few medium roots, clear wavy boundary.

2Btg2 30 - 60 cm 2.5Y 4.5/2 (moist) and 2.5Y 4.5/2 (dry), many fine distinct clear brownish mottles, sandy clay, very weak coarse and very coarse prismatic falling apart into moderate medium to very coarse angular and subangular blocky structure, extremely hard, broken pressure faces, few very fine and fine pores, non calcareous, few insect activity, few fine roots, clear wavy boundary.

2Btk 60 - 120 cm 5Y 4/1 (moist) and 5Y 4.5/1 (dry), sandy clay, weak medium and coarse subangular blocky structure, very hard, patchy thin clay cutans on pedfaces, few very fine and fine pores, very frequent fine irregular hard and soft calcareous white concretions, strongly calcareous, very few very fine and fine roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0278

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	meq/100gr soil						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	15	5.8	5.6	0.0	0	0.3	6.1	2.9	0.8	0.3	0.1	0.0	67	0.0	0	9	46	25	7	2	3	8	65	H	
B	15	30	5.5	4.8	0.0	0	0.2	7.0	3.4	1.0	0.1	0.2	0.0	67	0.0	0	11	50	21	4	1	2	10	61	H	
C	40	60	6.3	5.9	0.1	0	0.1	23.1	14.2	6.0	0.5	0.9	0.0	94	0.0	0	7	33	17	5	1	1	36	63	H	
D	80	100	7.8	7.2	0.2	0	0.1	20.5	36.5	5.9	0.5	0.9	0.0	100	0.0	0	7	33	18	5	2	2	33	61	H	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0279 Unit: A01.3 Status: 2

SHEET : 1825A2
LOCATION : Kakulwane N.complex (N.plain) traverse 2, 22.4km N.
AUTHOR(S): B.G.Moganane R.Kelebemang J.Huesken
CLASSIFICATION FAO: Pellic Vertisol (1974) sodic phase
ST : Entic Pellustert
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: slight sealing, cracks 5 cm wide, nil evidence of salt, bleached sand on surface
LAND USE: no apparent management system
SPECIES : Trees - Colophospermum mopane (dom.)
: Shrubs -
: Grasses/forbs- Hyparrhenia filipendula
PARENT MATERIAL: fluvial reworked lacustrine
MOIST. COND: dry 0 - 60 , moist 60 - 120 cm
SURF.STONES: few stones
EROSION : nil

GRID : LK-242-821
COORD: 18-14-49-S 25-20-26-E
DATE : 11/10/87

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: low gilgai

VEGETATION: open tree savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1060 m

SMR: ustic

POSITION: intermediate part
SLOPE : 0 - 0.2% straight

GRASSCOVER: 30 - 70 %

GEOL.UNIT:
DRAINAGE : poorly drained

HUMAN INF: nil

REMARKS: Grass cover occurs in patches, in places class 0. Vertisol appears darker than vertisols to the N. but is not. Thick mulch covers wide (5cm)cracks.

SAMPLES: A: 0 - 8 B: 8 - 15 C: 20 - 40 D: 50 - 70 E: 80 - 100

A1 0 - 8 cm 10YR 4.5/0.5 (moist) and 10YR 4.5/0.5 (dry), clay, strong medium and coarse granular structure, very hard, slightly calcareous, abrupt wavy boundary.

A2 8 - 15 cm 10YR 4.5/0.5 (moist), clay, strong medium and coarse subangular blocky structure, very hard, patchy slickensides, few very fine and fine pores, very few medium angular slightly weathered chert rock fragments, very few fine irregular hard calcareous white concretions, slightly calcareous, common very fine roots, clear wavy boundary.

B1 15 - 40 cm 10YR 4.5/0.5 (moist), clay, moderate very coarse prismatic falling apart into weak coarse and very coarse angular blocky structure, extremely hard, broken slickensides, few very fine and fine pores, few medium angular slightly weathered chert rock fragments, very few fine irregular hard calcareous white concretions, slightly calcareous, very few very fine and fine roots, clear wavy boundary.

B2 40 - 80 cm 10YR 4.5/0.5 (moist), clay, moderate very coarse prismatic falling apart into moderate to strong coarse and very coarse wedge shaped angular blocky structure, extremely hard very firm, continuous intersecting slickensides, few very fine and fine pores, few medium angular slightly weathered chert rock fragments, very few fine irregular hard calcareous white concretions, slightly calcareous, very few very fine roots, gradual wavy boundary.

Bk 80 - 120 cm 10YR 4.5/0.5 (moist), clay, weak very coarse prismatic falling apart into moderate medium and coarse angular and subangular blocky structure, very hard, few very fine and fine pores, few medium angular slightly weathered chert rock fragments, few fine irregular hard calcareous white concretions, slightly calcareous, few very fine roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0279

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	8	6.8	6.4	0.1	0	0.5	46.8	29.2	21.4	1.4	0.3	0.0	100	0.0	0	3	15	10	3	2	4	64	70	H	
B	8	15	6.9	6.5	0.1	0	0.5	45.3	27.9	17.5	0.9	0.5	0.0	100	0.0	0	4	17	12	3	1	3	60	72	H	
C	20	40	7.5	7.1	0.2	0	0.4	50.0	32.6	21.3	1.2	1.4	0.0	100	0.0	0	3	15	10	3	2	4	63	77	H	
D	50	70	7.8	7.3	0.2	0	0.4	50.8	28.7	22.3	1.1	2.6	0.0	100	0.0	0	3	14	10	3	1	6	62	79	H	
E	80	100	8.0	7.4	0.3	0	0.5	51.4	34.1	29.1	1.2	4.5	0.0	100	0.0	1	3	11	7	2	2	3	71	69	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0300 Unit: L25b1 Status: 1

SHEET : 1825C2
LOCATION : Pandamatenga plain, Agr.Research farm at Met.Stati.
AUTHOR(S): A.Remmelzwaal D.Kwape J.Maembolwa
CLASSIFICATION FAO: Pellic Vertisol (1974)
ST : Entic Pellustert
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: no cracks, nil evidence of salt,
LAND USE: commercial dryland farming
SPECIES : Trees -
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 60 , moist 60 - 85 , slightly moist 85 - 160 cm
SURF.STONES: none
EROSION :

GRID : LK-391-424
COORD: 18-36-16-S 25-28-34-E
DATE : 20/10/87

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: medium gilgai

VEGETATION:

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1081 m

SMR: aquic

POSITION: lower part
SLOPE : 0.1 - 0.3% straight

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : poorly drained

HUMAN INF: nil

REMARKS: Due to moist condition prismatic structure not optimal. Expected to develop up to 1 class stronger.

SAMPLES: A: 0 - 5 B: 5 - 23 C: 33 - 55 D: 50 - 85 E: 85 - 120 F: 120 - 150

A1 0 - 5 cm 10YR 4/0.5 (moist) and 10YR 5/0.5 (dry), clay (55% clay), strong medium and coarse granular structure, hard, sticky slightly plastic, non calcareous, abrupt wavy boundary.

A2 5 - 23 cm 10YR 4/0.5 (moist) and 10YR 5/0.5 (dry), clay (60% clay), weak very coarse prismatic falling apart into weak to moderate coarse and very coarse subangular and angular blocky structure, very hard, sticky slightly plastic, patchy pressure faces, few medium pores, non calcareous, common fine and medium and few coarse roots, clear wavy boundary.

B1 23 - 50 cm 10YR 4/0.5 (moist) and 10YR 5/0.5 (dry), clay, moderate to strong very coarse prismatic falling apart into moderate to strong coarse and very coarse angular blocky structure, extremely hard, sticky to very sticky plastic, continuous partly intersecting slickensides, common medium and coarse and few fine pores, non calcareous, very few medium roots, clear wavy boundary.

B2 50 - 85 cm 10YR 4/0.5 (moist), clay, moderate very coarse prismatic falling apart into strong medium to very coarse wedge shaped angular blocky structure, very firm, sticky to very sticky plastic, continuous intersecting slickensides, few fine and medium pores, non calcareous, very few medium roots, gradual wavy boundary.

B3 85 - 120 cm 10YR 4/0.5 (moist), clay (70% clay), weak very coarse prismatic falling apart into moderate to strong medium to very coarse wedge shaped angular blocky structure, very firm, sticky to very sticky plastic, continuous intersecting slickensides, few fine and medium pores, very few fine spherical hard calcareous white nodules, slightly calcareous, very few medium and few coarse roots, gradual wavy boundary.

Bk 120 - 150 cm 10YR 4/0.5 (moist), clay (70% clay), weak to moderate medium to very coarse angular blocky structure, very firm, sticky plastic, broken slickensides, few fine irregular hard calcareous white nodules, moderately calcareous, very few medium and few coarse roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0279

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	8	6.8	6.4	0.1	0	0.5	46.8	29.2	21.4	1.4	0.3	0.0	100	0.0	0	3	15	10	3	2	4	64	70	H	
B	8	15	6.9	6.5	0.1	0	0.5	45.3	27.9	17.5	0.9	0.5	0.0	100	0.0	0	4	17	12	3	1	3	60	72	H	
C	20	40	7.5	7.1	0.2	0	0.4	50.0	32.6	21.3	1.2	1.4	0.0	100	0.0	0	3	15	10	3	2	4	63	77	H	
D	50	70	7.8	7.3	0.2	0	0.4	50.8	28.7	22.3	1.1	2.6	0.0	100	0.0	0	3	14	10	3	1	6	62	79	H	
E	80	100	8.0	7.4	0.3	0	0.5	51.4	34.1	29.1	1.2	4.5	0.0	100	0.0	1	3	11	7	2	2	3	71	69	H	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0300 Unit: L25b1 Status: 1

SHEET : 1825C2
LOCATION : Pandamatenga plain, Agr.Research farm at Met.Stati.
AUTHOR(S): A.Remmelzwaal D.Kwape J.Maembolwa
CLASSIFICATION FAO: Pellic Vertisol (1974)
ST : Entic Pellustert
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: no cracks, nil evidence of salt,
LAND USE: commercial dryland farming
SPECIES : Trees -
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 60 , moist 60 - 85 , slightly moist 85 - 160 cm
SURF.STONES: none
EROSION :

GRID : LK-391-424
COORD: 18-36-16-S 25-28-34-E
DATE : 20/10/87

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: medium gilgai

VEGETATION:

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1081 m

SMR: aquic

POSITION: lower part
SLOPE : 0.1 - 0.3% straight

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : poorly drained

HUMAN INF: nil

REMARKS: Due to moist condition prismatic structure not optimal. Expected to develop up to 1 class stronger.

SAMPLES: A: 0 - 5 B: 5 - 23 C: 33 - 55 D: 50 - 85 E: 85 - 120 F: 120 - 150

A1 0 - 5 cm 10YR 4/0.5 (moist) and 10YR 5/0.5 (dry), clay (55% clay), strong medium and coarse granular structure, hard, sticky slightly plastic, non calcareous, abrupt wavy boundary.

A2 5 - 23 cm 10YR 4/0.5 (moist) and 10YR 5/0.5 (dry), clay (60% clay), weak very coarse prismatic falling apart into weak to moderate coarse and very coarse subangular and angular blocky structure, very hard, sticky slightly plastic, patchy pressure faces, few medium pores, non calcareous, common fine and medium and few coarse roots, clear wavy boundary.

B1 23 - 50 cm 10YR 4/0.5 (moist) and 10YR 5/0.5 (dry), clay, moderate to strong very coarse prismatic falling apart into moderate to strong coarse and very coarse angular blocky structure, extremely hard, sticky to very sticky plastic, continuous partly intersecting slickensides, common medium and coarse and few fine pores, non calcareous, very few medium roots, clear wavy boundary.

B2 50 - 85 cm 10YR 4/0.5 (moist), clay, moderate very coarse prismatic falling apart into strong medium to very coarse wedge shaped angular blocky structure, very firm, sticky to very sticky plastic, continuous intersecting slickensides, few fine and medium pores, non calcareous, very few medium roots, gradual wavy boundary.

B3 85 - 120 cm 10YR 4/0.5 (moist), clay (70% clay), weak very coarse prismatic falling apart into moderate to strong medium to very coarse wedge shaped angular blocky structure, very firm, sticky to very sticky plastic, continuous intersecting slickensides, few fine and medium pores, very few fine spherical hard calcareous white nodules, slightly calcareous, very few medium and few coarse roots, gradual wavy boundary.

Bk 120 - 150 cm 10YR 4/0.5 (moist), clay (70% clay), weak to moderate medium to very coarse angular blocky structure, very firm, sticky plastic, broken slickensides, few fine irregular hard calcareous white nodules, moderately calcareous, very few medium and few coarse roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0300

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	5	6.2	5.9	0.1	4	0.5	37.8	25.8	13.8	0.4	0.2	0.0	100	0.0	0	10	18	6	3	4	1	58	62	H	
B	5	23	6.3	5.8	0.1	1	0.5	38.8	25.2	14.6	0.1	0.3	0.0	100	0.0	0	8	15	6	3	2	9	56	66	H	
C	33	55	6.4	5.8	0.1	1	0.3	37.7	25.0	14.2	0.1	0.5	0.0	100	0.0	0	9	16	6	3	2	9	56	66	H	
D	50	85	6.8	6.1	0.1	1	0.4	40.4	24.2	14.1	0.1	0.8	0.0	97	0.0	1	7	13	5	3	3	5	65	60	H	
E	85	120	7.6	7.2	0.3	1	0.3	45.7	35.1	18.1	0.1	1.3	0.0	100	0.0	1	6	10	4	2	2	6	69	64	H	
F	120	150	7.7	7.4	0.3	0	0.3	47.9	40.5	20.1	0.1	1.4	0.0	100	0.0	3	4	8	3	2	1	4	75	62	H	

Soil Survey of Botswana FAO/BOT/85/011 Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

INFILTRATION

No.	Basic (cm/hr)	a	n
1	0.0	0.00	0.00
2	0.0	0.00	0.00
3	0.0	0.00	0.00

METHODS. Infiltration: double ring infiltrometer for cumulative time of 4 hrs 'a' and 'n' are constants in equation $F=at^n$ where F = cumulative infiltration (cm) and t=elapsed time (min)
Bulk Density: oven dry, mean of 5 measurements - CL = clod; CO = core
Moisture Retention: Tension <=1bar on core or clods; Tension > 1bar on <2mm crushed samples
Structural Stability Index: on >1mm seived samples <2mm of surface soil, relative collapse larger pores on slow & fast wetting

SURFACE STRUCTURE STABILITY INDEX: 0.42

	DEPTH (cm)		BULK DENSITY (g/cc)	WATER CONTENT (weight %) 0.03bar	0.05bar	0.1bar	0.3bar	1.0bar	3.0bar	5.0bar	15.0bar
A	5	23	1.30	37.90	35.11	31.61	30.26	27.4	24.3	23.1	22.1
B	23	50	1.35	37.49	35.40	31.65	30.68	27.8	24.5	28.7	22.7
C	50	85	1.37	36.82	35.67	35.06	30.44	27.8	24.3	23.7	22.7

REMARKS:*vertisols being cracking, swelling and shrinking clays, no infiltration measurements were done. *bulk densities were estimated bya method using 15 bar moisture percentage allowing for overburden pressure.

SOIL PROFILE DESCRIPTION — Profile: PA 0313 Unit: L35a Status: 2

SHEET : 1825A1
LOCATION : Kasane forest reserve extension.
AUTHOR(S): A.Remmelzwaal B.G.Moganane R.Kelebemang D.Kwape
CLASSIFICATION FAO: Gleyic Luvic Chernozem (1974)
ST : Typic Argiaquoll
LANDFORM : lacustrine plain
TOPOGRAPHY: almost flat
SURF. CHAR: moderate sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: forest reserve
SPECIES : Trees - Lonchocarpus capassa (dom.) Combretum mossambicense Terminalia prunioides Acacia nigrescens
: Shrubs - Colophospermum mopane (dom.) Combretum hereroense Combretum imberbe Ziziphus mucronata
: Grasses/forbs- Hyparrhenia filipendula
PARENT MATERIAL: lacustrine reworked aeolian
MOIST. COND: dry 0 - 130 cm
SURF.STONES: none
EROSION : nil

GRID : LK-045-888
COORD: 18-10-49-S 25-09-12-E
DATE : 21/10/87

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: termite mounds

VEGETATION: savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: aquic

POSITION: lower part
SLOPE : 0 - 1 % straight

GRASSCOVER: 30 - 70 %

GEOL.UNIT:
DRAINAGE : moderately well drained

HUMAN INF: nil

REMARKS: Not clear wether dune depression or lacustrine plain.

SAMPLES: A: 0 - 18 B: 20 - 40 C: 50 - 70 D: 75 - 95 E: 100 - 120

A1	0 - 18 cm	10YR 2/1 (moist) and 10YR 3/1 (dry), sandy loam (8% clay), weak to moderate medium to very coarse subangular blocky structure, slightly hard, common fine and few medium pores, very few fine spherical soft calcareous white nodules, non calcareous, many fine and medium roots, clear wavy boundary.
AB	18 - 45 cm	10YR 3/1 (moist) and 10YR 3.5/1 (dry), sandy clay loam (25% clay), very weak very coarse angular blocky structure, hard, patchy moderately thick cutans, common fine and medium pores, very few fine spherical soft calcareous white nodules, non calcareous, many fine and medium roots, gradual smooth boundary.
Btg	45 - 70 cm	10YR 3.5/1 (moist) and 10YR 4.5/1 (dry), sandy clay loam (32% clay), weakly coherent massive structure, hard, patchy moderately thick cutans, few fine and medium pores, few coarse irregular soft calcareous white soft segregations, non calcareous, common fine and medium and few coarse roots, clear wavy boundary.
Ck1	70 - 95 cm	10YR 5/2 (moist) and 10YR 6.5/2 (dry), sandy clay (40% clay), massive structure, hard, patchy moderately thick clay and humus cutans, frequent coarse irregular soft calcareous white soft segregations and few medium spherical soft calcareous white nodules, extremely calcareous, few fine and medium and few coarse roots, clear wavy boundary.
Ck2	95 - 130 cm	10YR 6/2 (moist) and 10YR 7.5/1 (dry), sandy clay (40% clay), massive structure, hard, very frequent coarse irregular soft calcareous white soft segregations and few medium spherical soft calcareous white nodules, extremely calcareous, no roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0313

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù-----	meq/100gr soil				----------ù	%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	18	9.0	8.1	0.1	1	1.0	12.8	20.1	0.5	0.2	0.1	0.0	100	0.0	0	7	38	31	7	1	2	13	68	H	
B	20	40	7.4	6.2	0.1	2	0.7	11.6	20.2	0.0	0.2	0.0	0.0	100	0.0	0	3	42	30	6	1	1	18	49	H	
C	50	70	7.6	7.0	0.1	16	0.4	13.2	16.3	0.6	0.3	0.1	0.0	100	0.0	0	6	38	32	7	1	2	14	81	H	
D	75	95	8.5	7.4	0.1	5	0.3	12.3	53.9	0.8	0.3	0.0	0.0	100	0.0	0	7	36	27	6	2	2	20	56	?	
E	100	120	9.1	7.6	0.1	4	0.3	9.4	54.9	0.8	0.2	0.0	0.0	100	0.0	0	6	28	23	6	2	7	29	28	?	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0315 Unit: KS16 Status: 2

SHEET : 1825A1
LOCATION : Kasane forest reserve extension.
AUTHOR(S): A.Remmelzwaal R.Kelebemang P.Jamagne
CLASSIFICATION FAO: Dystric Arenosol (1974)
ST : Ustoxic Quartzipsamment
LANDFORM : sand plain
TOPOGRAPHY: flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: no apparent management system
SPECIES : Trees -
: Shrubs - Terminalia sericea (dom.) Acacia fleckii Dialium engleramum
: Grasses/forbs-
PARENT MATERIAL: aeolian sand
MOIST. COND: slightly moist 0 - 20 , dry 20 - 120 cm
SURF.STONES: none
EROSION : slight wind erosion/deposition

GRID : LK-329-00
COORD: 18-10-13-S 25-08-26-E
DATE : 21/10/87

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: medium hummocks

VEGETATION: shrub savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: ustic

POSITION: lower part
SLOPE : 0 - 0.5%

GRASSCOVER: 30 - 70 %

GEOL.UNIT:
DRAINAGE : somewhat excessively drained

HUMAN INF: nil

REMARKS:

SAMPLES: A: 0 - 20 B: 25 - 45 C: 50 - 70 D: 90 - 110

A 0 - 20 cm 10YR 5/2 (moist) and 10YR 6.5/2 (dry), sand (4% clay), very weak fine to coarse subangular blocky structure, soft very friable, many very fine and fine pores, non calcareous, few insect activity, common fine and medium and common coarse roots, gradual smooth boundary.

B1 20 - 45 cm 10YR 5.5/2.5 (moist) and 10YR 7/2.5 (dry), sand (4% clay), very weak fine to coarse subangular blocky structure, soft very friable, non calcareous, few insect activity and common burrows, common fine and medium and common coarse roots, diffuse smooth boundary.

B2 45 - 70 cm 10YR 5.5/3 (moist) and 10YR 7/3 (dry), sand (5% clay), weakly coherent massive structure, soft, non calcareous, common burrows, few fine and medium and few coarse roots, diffuse smooth boundary.

B3 70 - 120 cm 10YR 5.5/4 (moist) and 10YR 7/5 (dry), sand (6% clay), weakly coherent massive structure, soft, non calcareous, few fine and medium and few coarse roots,

STANDARD SOIL ANALYSIS RESULTS

PROFILE: PA 0315

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)							CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	meq/100gr soil						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	6.1	4.1	0.0	2	0.2	1.7	1.1	0.1	0.1	0.0	0.0	76	0.0	0	9	44	34	9	0	1	3	30	?	
B	25	45	4.9	4.3	0.0	2	0.0	1.4	0.2	0.1	0.1	0.0	0.0	29	0.0	0	8	42	35	10	1	0	4	35	?	
C	50	70	4.9	4.4	0.0	3	0.0	1.7	0.3	0.1	0.1	0.0	0.0	29	0.0	0	12	47	30	7	1	1	2	85	?	
D	90	110	4.9	4.3	0.0	2	0.0	1.4	1.0	0.2	0.1	0.0	0.0	93	0.0	0	8	40	36	11	1	2	2	70	?	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0348 Unit: L25a1 Status: 2

SHEET : 1825A2
LOCATION : Kakulwane N.complex (N.plain).
AUTHOR(S): B.G.Moganane E.Van Waveren J.Huesken
CLASSIFICATION FAO: Pellic Vertisol (1974)
ST : Typic Pellustert
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: slight sealing, cracks 5 cm wide, nil evidence of salt,
LAND USE: no apparent management system
SPECIES : Trees - Acacia nilotica (dom.) Acacia gerrardii Colophospermum mopane
: Shrubs - Kirkia acuminata (dom.) Acacia nilotica Albizia anthelmintica
: Grasses/forbs- Cymbopogon plurinodes Hyparrhenia filipendula
PARENT MATERIAL: lacustrine
MOIST. COND: moist 0 - 20 , slightly moist 20 - 100 cm
SURF.STONES: few gravel
EROSION : nil

GRID : LK-341-820
COORD: 18-14-49-S 25-25-34-E
DATE : 28/11/87

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: low gilgai

VEGETATION: open savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1071 m

SMR: aquic

POSITION: intermediate part
SLOPE : 0.1 - 0.2% straight

GRASSCOVER: > 70 %

GEOL.UNIT:
DRAINAGE : poorly to imperfectly drained

HUMAN INF: nil

REMARKS: Higher parts (<10%) with COI, no cracks, probably Gk/Ge and imperfectly drained. Augering from 100cm. Medium gilgai and semi-lineair gilgai observed close to pit

SAMPLES: A: 0 - 3 B: 3 - 10 C: 30 - 50 D: 70 - 90

A1 0 - 3 cm 10YR 3.5/0.5 (moist), clay, weak to moderate fine and medium granular structure, friable, non calcareous, many very fine and fine roots, abrupt wavy boundary.

A2 3 - 10 cm 10YR 3.5/0.5 (moist) and 10YR 3.5/0.5 (dry), clay, moderate medium to very coarse angular and subangular blocky structure, very friable, many very fine and fine and few medium pores, non calcareous, many very fine and fine roots, clear wavy boundary.

B1 10 - 60 cm 10YR 3.5/0.5 (moist) and 10YR 3.5/0.5 (dry), clay, moderate very coarse prismatic falling apart into moderate to strong coarse and very coarse angular blocky structure, very friable, broken slickensides, common very fine and fine pores, non calcareous, few very fine and fine roots, clear wavy boundary.

B2 60 - 120 cm 10YR 3.5/0.5 (moist) and 10YR 3.5/0.5 (dry), clay, very weak very coarse prismatic falling apart into moderate to strong medium and coarse angular blocky structure, very friable, broken partly intersecting slickensides, common very fine and fine pores, non calcareous, very few very fine and fine roots,

Bk 120 - 150 cm 10YR 4/0.5 (moist) and 10YR 4/0.5 (dry), clay, broken cutans, common very fine and fine pores, non calcareous, very few very fine and fine roots,

Cck 150 cm + few medium irregular hard and soft calcareous white nodules, moderately calcareous,

STANDARD SOIL ANALYSIS RESULTS

PROFILE: PA 0348

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	3	6.5	6.1	0.2	15	0.8	47.7	39.6	12.5	1.9	0.2	0.0	100	0.0	0	3	12	9	3	2	8	64	70	H	
B	3	10	7.1	6.8	0.5	5	0.6	43.3	47.5	8.7	1.4	0.2	0.0	100	0.0	1	5	14	10	3	2	5	61	68	H	
C	30	50	7.0	6.4	0.1	2	0.4	47.0	35.2	9.5	2.0	0.4	0.0	100	0.0	0	4	12	10	3	2	6	62	73	H	
D	70	90	7.3	6.7	0.1	2	0.5	46.4	41.4	11.3	2.0	0.9	0.0	100	0.0	1	4	11	7	3	2	6	66	67	H	

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0358 Unit: A02 Status:

SHEET : 1825D1
LOCATION : Pandamatenga plain East of main road.
AUTHOR(S): P.Jamagne O.Dikinya
CLASSIFICATION FAO: Chromic Vertisol (1974)
ST : Typic Chromustert
LANDFORM : lacustrine plain
TOPOGRAPHY: almost flat
SURF. CHAR: slight sealing, cracks 1 cm wide, nil evidence of salt,
LAND USE: traditional grazing
SPECIES : Trees - Colophospermum mopane
: Shrubs - Colophospermum mopane (dom.) Acacia nigrescens
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: dry 0 - 15 , moist 15 - 100 cm
SURF.STONES: none
EROSION :

GRID : LK-569-455
COORD: 18-34-47-S 25-38-36-E
DATE : 10/06/88

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: low gilgai

VEGETATION: savanna

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: ustic

POSITION: higher part
SLOPE : 0 - 0.2% straight

GRASSCOVER: 30 - 70 %

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: nil

REMARKS: in Bk2 concentration of calcium carbonate nodules in former root channels

SAMPLES: A: 0 - 15 B: 15 - 35 C: 40 - 60 D: 80 - 100

A 0 - 15 cm 10YR 3/2.5 (dry) and 10YR 3/3 (moist), clay (50% clay), moderate coarse and very coarse subangular blocky falling apart into moderate fine and medium subangular blocky structure, hard, few very fine pores, very few fine rounded slightly weathered basalt rock fragments, very few fine irregular hard calcareous white nodules and very few medium irregular hard calcareous white nodules, strongly calcareous, common very fine and fine roots, clear wavy boundary.

Bk1 15 - 35 cm 10YR 3.5/3 (moist), clay (55% clay), weak to moderate medium to very coarse prismatic falling apart into weak to moderate fine to coarse subangular blocky structure, friable to firm, broken pressure faces, few very fine and fine pores, very few fine rounded slightly weathered basalt rock fragments, few fine irregular hard calcareous white nodules and very few medium irregular hard calcareous white nodules, strongly calcareous, few very fine and fine roots, clear wavy boundary.

Bk2 35 - 70 cm 10YR 3.5/3 (moist), clay (55% clay), weak to moderate coarse and very coarse prismatic falling apart into weak to moderate medium and coarse wedge shaped angular blocky structure, firm, patchy intersecting slickensides, few very fine and fine pores, very few fine rounded slightly weathered basalt rock fragments, few fine irregular hard calcareous white nodules, strongly calcareous, very few very fine and fine roots, clear wavy boundary.

Bck 70 - 100 cm 10YR 4/3 (moist), clay (45% clay), very weak coarse and very coarse angular blocky structure, firm, patchy pressure faces, few very fine and fine pores, very few fine rounded slightly weathered basalt rock fragments, frequent fine irregular hard calcareous white nodules, strongly calcareous, very few very fine and fine roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0358

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	meq/100gr soil						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	15	7.7	7.5	0.4	2	1.6	48.7	52.8	2.3	1.1	0.2	0.0	>100	0.0	1	4	4	6	6	5	20	54	78	H	A
B	15	35	8.3	7.5	0.3	2	1.1	48.9	52.8	3.1	0.8	0.2	0.0	>100	0.0	5	3	3	4	4	0	20	63	71	H	A
C	40	60	8.4	7.6	0.2	2	0.9	50.9	51.9	3.9	0.8	0.2	0.0	>100	0.0	5	2	2	4	4	3	16	63	75	H	A
D	80	100	8.5	7.6	0.2	2	0.6	42.7	79.8	4.1	0.7	0.3	0.0	>100	0.0	9	5	4	4	4	3	23	49	82	H	A

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0360 Unit: B05a Status: 1

SHEET : 1825D1
LOCATION : Pandamatenga plain - E of main road.
AUTHOR(S): P.Jamagne O.Dikinya
CLASSIFICATION FAO: Chromic Luvisol (1974) petric (skeletic) phase
ST : Typic Haplustalf
LANDFORM : plain
TOPOGRAPHY: almost flat
SURF. CHAR: slight sealing, no cracks, nil evidence of salt,
LAND USE: traditional grazing
SPECIES : Trees - Colophospermum mopane Bauhinia petersiana
: Shrubs - Colophospermum mopane
: Grasses/forbs-
PARENT MATERIAL: in situ weathered
MOIST. COND: dry 0 - 60 cm
SURF.STONES: none
EROSION : nil

GRID : LK-597-432
COORD: 18-36-04-S 25-40-23-E
DATE : 10/06/88

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: even

VEGETATION: savanna

ROCK TYPE: basalt

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: ustic

POSITION: intermediate part
SLOPE : 0.2 - 1 % straight

GRASSCOVER: 10 - 30 %

GEOL.UNIT:
DRAINAGE : well drained

HUMAN INF: nil

REMARKS: C is weathered basalt

SAMPLES: A: 0 - 10 B: 10 - 30 C: 35 - 55

A 0 - 10 cm 7.5YR 3/3 (moist) and 7.5YR 4/5 (dry), clay loam (35% clay), weak to moderate coarse and very coarse subangular blocky structure, very hard, few very fine and fine pores, non calcareous, common medium and coarse and common very fine and fine roots, clear wavy boundary.

Bt1 10 - 35 cm 7.5YR 3.5/3 (moist) and 7.5YR 4/4 (dry), clay (45% clay), weak coarse and very coarse subangular and angular blocky structure, slightly hard to hard, patchy thin clay cutans on pedfaces, few very fine and fine pores, non calcareous, few open burrows, few fine and medium roots, gradual wavy boundary.

Bt2 35 - 60 cm 7.5YR 3/5 (moist) and 7.5YR 4/5 (dry), clay (45% clay), very weak coarse and very coarse subangular and angular blocky structure, slightly hard to hard, patchy thin clay cutans on pedfaces, few very fine and fine pores, non calcareous, few termite/ant activity and few open burrows, few very fine and fine roots, abrupt wavy boundary.

Cr 60 cm +

STANDARD SOIL ANALYSIS RESULTS

PROFILE: PA 0360

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	meq/100gr soil						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	10	6.7	6.2	0.1	32	1.1	24.3	13.9	4.1	0.9	0.1	0.0	78	0.0	0	8	12	16	10	13	21	21	96	H	A
B	10	30	6.6	6.1	0.1	6	0.9	30.7	19.3	4.1	0.4	0.2	0.0	78	0.0	3	6	10	16	9	9	19	28	97	H	A
C	35	55	7.1	6.5	0.2	7	0.9	30.2	22.7	3.6	0.4	0.2	0.0	89	0.0	4	6	9	16	6	5	22	33	82	H	A

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0362 Unit: KS06 Status:

SHEET : 1825D1
LOCATION : Sandridge N. of southern plain.2.5km W Zimb border.
AUTHOR(S): E.Van Waveren B.G.Moganane A.Markus E.Telekelo
CLASSIFICATION FAO: Ferralic Arenosol (1974)
ST : Ustic Quartzipsamment
LANDFORM : plain
TOPOGRAPHY: almost flat
SURF. CHAR: no sealing, no cracks, nil evidence of salt, bleached sand on surface
LAND USE: no apparent management system
SPECIES : Trees - Kirkia acuminata (dom.) Baikiaea plurijuga Burkea africana Pterocarpus angolensis
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: aeolian sand
MOIST. COND: dry 0 - 140 cm
SURF.STONES: none
EROSION : nil

GRID : LK-668-420
COORD: 18-36-51-S 25-44-32-E
DATE : 10/06/88

LAND ELEMENT : dune
MICRO TOPOGRAPHY: even

VEGETATION: woodland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION :

SMR: ustic

POSITION: crest
SLOPE : 0 - 1 % straight

GRASSCOVER: > 70 %

GEOL.UNIT:
DRAINAGE : somewhat excessively drained

HUMAN INF: nil

REMARKS:

SAMPLES: A: 0 - 20 B: 25 - 45 C: 70 - 90

A 0 - 20 cm 10YR 3/3 (moist) and 10YR 4/3 (dry), sand, weak medium and coarse subangular blocky structure, soft, many very fine and fine pores, non calcareous, few fine and medium roots, clear smooth boundary.

B1 20 - 50 cm 7.5YR 4/5 (moist) and 7.5YR 5/5 (dry), sand, very weak coarse and very coarse subangular blocky structure, soft, many very fine and fine pores, non calcareous, few fine and medium roots, gradual wavy boundary.

B2 50 - 100 cm 5YR 4/6 (moist) and 5YR 5/6 (dry), sand, very weak coarse and very coarse subangular blocky structure, slightly hard, many very fine and fine pores, non calcareous, very few very fine and very few coarse roots,

STANDARD SOIL ANALYSIS RESULTS

PROFILE: PA 0362

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	20	6.3	5.1	0.0	20	0.6	4.6	1.1	0.5	1.0	0.2	0.0	61	0.0	0	12	39	25	12	3	1	9	26	H	A
B	25	45	5.1	4.4	0.0	6	0.4	3.0	0.3	0.3	0.1	0.1	0.0	27	0.0	0	14	40	24	11	1	2	9	16	H	A
C	70	90	5.3	4.4	0.0	4	0.2	3.2	0.4	0.5	0.1	0.1	0.0	34	0.0	2	8	43	21	9	3	2	12	21	H	A

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PROFILE DESCRIPTION — Profile: PA 0901 Unit: KS09 Status: 1

SHEET : 1825D1
LOCATION : Sandridge 10km S of Pandamatenga.
AUTHOR(S): A.B.Price M.D.Mays A.Remmelzwaal
CLASSIFICATION FAO: Dystri-Argi-Luvic Arenosol(1988) Arenic Ferric Acrisol (1974)
ST : Psammentic kandic Paleustult ; sandy siliceous hyperthermic
LANDFORM : dune field
TOPOGRAPHY: undulating
SURF. CHAR: no sealing, no cracks, nil evidence of salt,
LAND USE: no apparent management system
SPECIES : Trees - Baikiaea plurijuga (dom.) Pterocarpus angolensis Kirkia acuminata Burkea africana
: Shrubs - Bauhinia petersiana (dom.) Combretum apiculatum Baphia massaiensis Terminalia sericea
: Grasses/forbs-
PARENT MATERIAL: aeolian sand
MOIST. COND: moist 0 - 166 cm
SURF.STONES: none
EROSION : slight sheet erosion

GRID : LK-554-408
COORD: 18-37-11-S 25-37-41-E
DATE : 26/03/86

LAND ELEMENT : longitudinal dune
MICRO TOPOGRAPHY: even

VEGETATION: woodland

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1103 m

SMR: ustic

POSITION: middle slope
SLOPE : 3 - 4 %

GRASSCOVER: 30 - 70 %

GEOL.UNIT:
DRAINAGE : somewhat excessively drained

HUMAN INF: borrow pit

REMARKS: USDA Pedon no.8 Moist profile showing little structure.

SAMPLES: A: 0 - 18 B: 18 - 31 C: 31 - 55 D: 55 - 95 E: 95 - 140 F: 140 - 166

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A 0 - 18 cm 6YR 3/3 (moist) and 6YR 4/3 (dry), fine sand, very weak medium subangular blocky structure, soft very friable, non sticky non plastic, common very fine pores, non calcareous, common very fine and fine and few medium roots, gradual smooth boundary.

AB 18 - 31 cm 5YR 3/4 (moist) and 5YR 4/4 (dry), fine sand to loamy fine sand, very weak coarse subangular blocky structure, soft very friable, non sticky non plastic, common very fine pores, non calcareous, common very fine and fine roots, gradual wavy boundary.

Bt1 31 - 55 cm 4YR 3/5 (moist) and 4YR 4/5 (dry), fine sand to loamy fine sand, very weak coarse and very coarse subangular blocky structure, slightly hard very friable, non sticky non plastic, patchy thin cutans on pedfaces, common very fine pores, non calcareous, few fine and medium roots, diffuse smooth boundary.

Bt2 55 - 95 cm 2.5YR 3/6 (moist) and 2.5YR 4/6 (dry), loamy fine sand, very weak very coarse subangular blocky structure, slightly hard very friable, non sticky non plastic, broken thin cutans on pedfaces, common very fine and few medium pores, non calcareous, few very fine and few coarse roots, diffuse smooth boundary.

Bt3 95 - 140 cm 2.5YR 3/6 (moist) and 2.5YR 4/6 (dry), loamy fine sand, very weak very coarse subangular blocky structure, slightly hard very friable, non sticky non plastic, broken moderately thick cutans on pedfaces, common very fine and few medium pores, non calcareous, few very fine and few coarse roots, diffuse smooth boundary.

Bt4 140 - 166 cm 2.5YR 3/6 (moist) and 2.5YR 4/6 (dry), loamy fine sand to fine sandy loam, very weak very coarse subangular blocky structure, slightly hard very friable, non sticky non plastic, continuous moderately thick cutans on pedfaces, common very fine and few medium pores, non calcareous, few very fine and few coarse roots,

STANDARD SOIL ANALYSIS RESULTS

PROFILE: PA 0901

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	ù----- meq/100gr soil ----------ù						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	18	5.2	4.4	0.0	12	0.5	2.4	0.9	0.5	0.1	0.1	0.0	67	0.0	0	24	50	14	4	1	1	5	8		
B	18	31	5.0	4.4	0.0	4	0.3	2.3	0.2	0.6	0.1	0.1	0.0	43	0.0	0	18	52	14	4	1	2	9	12		
C	31	55	4.6	4.2	0.0	5	0.2	2.6	0.5	0.6	0.1	0.1	0.0	50	0.0	1	32	48	7	3	1	1	9	20		
D	55	95	5.7	4.1	0.0	1	0.2	2.2	0.5	1.0	0.1	0.1	0.0	77	0.0	0	37	44	6	1	1	1	11	13		
E	95	140	5.3	3.8	0.0	2	0.2	3.2	0.3	1.2	0.2	0.1	0.0	56	0.0	1	25	46	13	3	0	1	11	22		
F	140	166	5.3	3.9	0.0	1	0.2	3.1	0.3	0.8	0.2	0.3	0.0	52	0.0	0	18	49	13	3	2	1	13	18		

Soil Survey of Botswana FAO/BOT/85/011

Print date: 22/06/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

INFILTRATION

No.	Basic (cm/hr)	a	n
1	0.0	0.00	0.00
2	0.0	0.00	0.00
3	0.0	0.00	0.00

METHODS. Infiltration: double ring infiltrometer for cumulative time of 4 hrs 'a' and 'n' are constants in equation $F=at^n$ where F = cumulative infiltration (cm) and t=elapsed time (min)
Bulk Density: oven dry, mean of 5 measurements - CL = clod; CO = core
Moisture Retention: Tension <=1bar on core or clods; Tension > 1bar on <2mm crushed samples
Structural Stability Index: on >1mm seived samples <2mm of surface soil, relative collapse larger pores on slow & fast wetting

SURFACE STRUCTURE STABILITY INDEX: 0.00

	DEPTH (cm)		BULK DENSITY (g/cc)		WATER CONTENT (weight %) 0.03bar	0.05bar	0.1bar	0.3bar	1.0bar	3.0bar	5.0bar	15.0bar
A	0	18	1.73	CL			7.60	6.40				1.9
B	18	31	1.73	CL			6.60	5.30				2.1
C	31	55	1.72	CL			7.30	5.70				2.1
D	55	95	1.59	CL			6.40	5.40				3.6
E	95	140	1.62	CL			7.40	6.10				3.6
F	140	166	1.66	CL			8.60	7.20				3.6

REMARKS:used clods for moisture retention

SOIL PROFILE DESCRIPTION — Profile: PA 0902 Unit: L25.2 Status: 1

SHEET : 1825B3
LOCATION : Pandamatenga plain, 2.9km S of Kazuma forest.
AUTHOR(S): A.B.Price M.D.Mays A.Remmelzwaal
CLASSIFICATION FAO: Pellic Vertisol(1988) Pellic Vertisol (1974)
ST : Typic Pellustert ; very fine montmorrilonitic hyperthermic
LANDFORM : lacustrine plain
TOPOGRAPHY: flat
SURF. CHAR: no sealing, cracks 5 cm wide, nil evidence of salt,
LAND USE: commercial dryland farming, crops: sorghum
SPECIES : Trees -
: Shrubs -
: Grasses/forbs-
PARENT MATERIAL: lacustrine
MOIST. COND: moist 0 - 105, slightly moist 105 - 150 cm
SURF.STONES: none
EROSION : slight sheet erosion

GRID : LK-486-581
COORD: 18-27-47-S 25-34-01-E
DATE : 27/03/86

LAND ELEMENT : not applicable
MICRO TOPOGRAPHY: medium gilgai

VEGETATION:

ROCK TYPE:

ROCK OUTCROP: none

AGRO CLIM.ZONE: 1B1
ELEVATION : 1068 m

SMR: aquic

POSITION: intermediate part
SLOPE : 0.1 - 0.3% straight

GRASSCOVER:

GEOL.UNIT:
DRAINAGE : imperfectly drained

HUMAN INF: ploughing

REMARKS: USDA Pedon no.9 with modifications by A.Remmelzwaal 27-06-86; revisiting profile when dry.

SAMPLES: A: 0 - 17 B: 17 - 38 C: 38 - 61 D: 61 - 105 E: 85 - 105 F: 110 - 150

Ap1 0 - 3 cm 10YR 3/1- (moist) and 10YR 3.5/1 (dry), clay (60% clay), strong medium and coarse granular structure, hard firm, very sticky very plastic, few very fine pores, non calcareous, no roots, abrupt wavy boundary.

Ap2 3 - 17 cm 10YR 3/1- and 10YR 3.5/1 (dry), clay (60% clay), moderate medium subangular blocky structure, very hard firm to very firm, very sticky very plastic, patchy slickensides on pedfaces, few very fine pores, non calcareous, common very fine and few medium roots, clear wavy boundary.

B1 17 - 38 cm 10YR 3/0.5 (moist) and 10YR 3.5/0.5 (dry), clay (65% clay), moderate very coarse prismatic falling apart into moderate medium and coarse angular blocky structure, extremely hard very friable, very sticky very plastic, broken slickensides on pedfaces, few very fine pores, non calcareous, common very fine roots, clear wavy boundary.

B2 38 - 61 cm 10YR 3/0.5 (moist) and 10YR 3.5/0.5 (dry), clay (70% clay), moderate very coarse prismatic falling apart into moderate medium and coarse wedge shaped angular blocky structure, extremely hard very friable, very sticky very plastic, continuous partly intersecting slickensides on pedfaces, non calcareous, few very fine roots, diffuse wavy boundary.

B3 61 - 105 cm 10YR 3/0.5 (moist) and 10YR 3.5/0.5 (dry), clay (70% clay), weak very coarse prismatic moderate medium and coarse wedge shaped angular blocky structure, extremely hard very friable, very sticky very plastic, continuous partly intersecting slickensides on pedfaces, non calcareous, very few very fine roots, gradual irregular boundary.

Bck 105 - 150 cm 10YR 3/0.5 (moist) and 10YR 3.5/0.5 (dry), clay (70% clay), moderate very coarse wedge shaped angular blocky structure, extremely hard very firm, very sticky very plastic, broken partly intersecting slickensides on pedfaces, few fine spherical hard calcareous white nodules, non calcareous, very few very fine roots,

S T A N D A R D S O I L A N A L Y S I S R E S U L T S

PROFILE: PA 0902

SAMPLE	DEPTH		pH		EC	P	C	CEC	Ca	Mg	K	Na	Exac	PBS	Carbo	Particle size (weight %)								CECclay	METH	PRETR
			H2O	CaCL2	mS/cm	ppm	weight %	meq/100gr soil						%	%	vcS	cS	mS	fS	vfS	cSi	fSi	Clay	meq/100gr		
A	0	17	7.1	6.6	0.0	4	0.9	74.3	54.1	14.8	1.8	0.3	0.0	97	0.0	1	3	4	4	3	1	7	76	93		
B	17	38	7.9	7.2	0.0	1	0.5	71.5	54.1	14.5	1.6	1.0	0.0	>100	0.0	1	3	4	4	3	2	3	81	86		
C	38	61	8.1	7.4	0.3	1	0.5	70.9	54.3	14.8	1.7	1.9	0.0	>100	0.0	0	0	0	2	1	4	6	86	80		
D	61	105	8.1	7.3	0.2	2	0.6	77.5	51.5	14.9	1.6	2.6	0.0	91	0.0	1	2	3	3	3	4	2	82	92		
E	85	105	8.2	7.5	0.3	1	0.7	73.4	52.7	15.7	1.7	3.5	0.0	100	0.0	3	2	3	3	2	2	4	81	87		
F	110	150	8.3	7.5	0.3	1	0.7	80.4	59.6	17.5	1.8	4.3	0.0	>100	0.0	1	2	3	3	2	3	8	79	98		

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PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, * = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

INFILTRATION No.	Basic (cm/hr)	a	n
1	0.0	0.00	0.00
2	0.0	0.00	0.00
3	0.0	0.00	0.00

METHODS. Infiltration: double ring infiltrometer for cumulative time of 4 hrs 'a' and 'n' are constants in equation $F=at^n$ where F = cumulative infiltration (cm) and t=elapsed time (min)
Bulk Density: oven dry, mean of 5 measurements - CL = clod; CO = core
Moisture Retention: Tension <=1bar on core or clods; Tension > 1bar on <2mm crushed samples
Structural Stability Index: on >1mm seived samples <2mm of surface soil, relative collapse larger pores on slow & fast wetting

SURFACE STRUCTURE STABILITY INDEX: 0.00

	DEPTH (cm)		BULK DENSITY (g/cc)		WATER CONTENT (weight %) 0.03bar	0.05bar	0.1bar	0.3bar	1.0bar	3.0bar	5.0bar	15.0bar
A	0	17	7.00	CL		57.30		54.30				37.8
B	17	38	1.02	CL		56.70		54.00				37.7
C	38	61	1.05	CL		56.10		53.00				38.6
D	61	84	1.09	CL		53.40		50.30				38.5
E	84	105	1.04	CL		56.60		53.60				39.1
F	105	150	0.99	CL		62.00		56.40				38.8

REMARKS:used clods for moisture retention

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