REPUBLIC OF ANGOLA

DEVELOPMENT OF A SOIL AND TERRAIN MAP/DATABASE FOR ANGOLA

VOLUME I REPORT

Technical Report No.

by

F.R. BEERNAERT

for

Institute for Land and Water Management
Catholic University of Leuven (Belgium)

Food and Agriculture Organization of the United Nations

De Pinte, June, 1997

TABLE OF CONTENTS

SUMMARY ***1***

RECOMMENDATIONS ***2***

1. Recommendations for Angola 2

2. Recommendations for digitalization and database construction 3

INTRODUCTION ***5***

1. ACKNOWLEDGEMENTS 5

2. TERMS OF REFERENCE 7

3. BACKGROUND 8

4. IMPLEMENTATION AND WORKING METHOD 9

4.1. Literature study 9

4.2. Soil map 9

4.3. Terrain unit map 9

4.4. Database for Angola 10

MAIN FINDINGS AND CONCLUSIONS ***11***

PART I NATURAL RESOURCES OF ANGOLA 11

1. Area and population 11

2. Climate 12

3. Land use 15

4. Physiography 17

4.1.1. Coastal plateau I 18

4.1.2. Coastal terraces A and B 18

4.1.3. Coast 18

4.1.4. Namib (Moçâmedes) desert 19

4.2.1. Plateau II 20

4.2.2. Plateau III 20

4.2.3. Canzanga mountains (Uige Province) 21

4.3. Marginal Mountain Chain (Cadeia Marginal de Montanhas) 21

4.3.1. The Great Escarpment 21

4.3.2. Plateau V remnants 22

4.4. High Plain IV (Planalto Antigo) 23

4.5. Kalahari Basin 24

4.5.1. Zaire Basin (Bacia do Zaire) 25

4.5.2. Upper Cuanza Basin (Bacia do Alto Cuanza) 26

4.5.3. Zambeze and Cubango basins 26
5. Vegetation 30
5.1. (1) Tropical wet evergreen forest 30
5.2. (2) Tropical deciduous and semi-deciduous forests 31
5.3. (3.) Tropical inundated coastal formations 32
5.4. (4) Savanna 33
5.5. (7.) Steppe 35
5.6. (8.) Semi-desert formations 35
5.7. (9.) Desert formations 36
5.8. Montane formations 36
6. Geology of Angola 37
6.1. Old Massif - Maciço Antigo 37
6.1.2.1.Oendolongo Group 40
6.1.2.2.Bembe Group 40
6.1.3. Igneous intrusions 41
6.2.1. Karroo 42
6.2.1.1.Lutôe Group 42
6.2.1.2.Cassange Group 43
6.2.1.3.Post-Karroo igneous intrusions 43
6.2.2. Continental Cretaceous, or Calonda Group 43
6.2.3. Tertiary to Quaternary Kalahari Sequence and related deposits 44
6.2.4. Lower and Upper Cretaceous rocks (coastal belt) 46
6.2.5. Eocene (Coastal Belt) 47
6.2.6. Oligo-Miocene (coastal belt) 47
6.2.7. Plio-Pleistocene (coastal belt) 47
6.2.8. Holocene alluvium 47
6.2.8.1.Pan sediments and evaporites 48
7. Soils 48
7.1. Soil correlation and classification 49

Part II Database for Angola **60**

1. Introduction 60

2. Terrain units 61
2.1. Main Land Regions 61
2.2. Specific subdivisions 61
2.3. SOTER terrain unit characterization 62

3. Natural vegetation 62

4. Land Use 63
4.1. IGADD Crop Production System Zones "CPSZ" 63
4.2. Thermal zones 64
4.3. Crop codes 64

5. TERRAIN UNITS OF ANGOLA 65
---

6. Bibliography 190

VOLUME II SOIL PROFILE DESCRIPTIONS

1. Soil profile descriptions

2. Soil map legend

MAP APPENDICES

1. Base map ("Cartographia", reduced to a scale of 1/2,500,000), with reference map zones (A1...F7).

2. Terrain unit map of Angola (to a scale of 1/2,500,000)

3. Soil map of Angola; FAO classification (1990)

(to a scale of 1/2,500,000)

4. Location map of soil profiles
(to a scale of 1/2,500,000)

List of figures

1. Contours of mean annual rainfall in Angola
2. Mean annual temperatures in Angola
3. The Great Escarpment and the Kalahari Basin
4. Geology of Angola
5. NW-SE transect, south of Benguela.
6. Terrain unit 103/1: typical vegetation on Coastal terrace A, along the Namibe-Tombua road (60 m a.s.l.).
7. Terrain unit 0309/1; succulent-thorn bush near Sumbe (Novo Redondo).
8. Terrain unit 309/2: coastal plateau I, on sedimentary rocks, near Porto Amboim (140 m a.s.l.)
9. Terrain unit 0311/1: coastal plateau I on crystalline rocks near Vila Nova de Seles.
10. Terrain unit 311/2: coastal plateau I on crystalline rocks.
11. Terrain unit 401/3: granite inselberg landscape at Rio Nhia; Gabela-Humbi plateau IIa
12. Terrain unit 401/3: soil profile of the inselberg landscape at Rio Nhia, on the Gabela-Humbi plateau IIa.
13. Terrain unit 0414: Cubal plateau II; soil profile on lower slopes of Rio Hanha-Cubal.
14. Terrain unit 0414/2: plateau II near Catengue; succulent-thorn bush steppe.
15. Terrain unit 0414/3: inselberg plain on Cubal plateau II.
16. Terrain unit 0414/3: inselberg plain on plateau II, N of Caimbambo.
17. Terrain unit 0414/4: Quilengues plateau II; a soil developed in biotite granite.
18. View towards the SE, near Amboiva, over plateau II towards the Marginal Mountains with High Plain IV.
19. Terrain unit 0418/2: dissected inselberg plain near Vila Nova de Seles.
20. Terrain unit 0418/3: view, from the SE, over Plateau II to the Humbi Mountains, or Serra da Rianga.
21. Terrain unit 418/3: plateau II, in between Gabela and Quibala; a tall grass - dwarf tree steppe.
22. Terrain unit 0418/4: Luati plateau IIb, with granitic inselbergs (Libolo highlands).
23. Terrain unit 419/2: inselberg plain on plateau II, along the Lubango-Namibe road.
24. Terrain unit 419/2: the Western Munhino plateau II at Pedra Grande; an open thorn-shrub steppe.
25. SW-NE/WNW-ESE transect from Dondo, to N'Dalatando and

Malanje.

26. Terrain unit 0504/1: low dry forest at the foot of Mount Dumbi.
27. Terrain unit 0504/1: Rio Queve plain on Plateau III, near Dumbi.
28. Terrain unit 504/3: Rio Balombo plateau III; a soil developed on porphyritic gneiss.
29. Terrain unit 0504/4: footplain of plateau III, with the escarpment to plateau V, east of the road Ganda-Chicuma.
30. Terrain unit 0504/4: Cuma granitic inselberg plain inlier, part of plateau III, along the Ganda-Huambo road.
31. Terrain unit 0504/4: inselberg plain on plateau III, near Ganda; high dry forest.
32. Terrain unit 0505/1: plateau IIIa (1,350 m a.s.l.) and Mount Bonga, seen from Cacula-Quilengues road.
33. Terrain unit 0601/1: Bailundo inselberg High Plain IV, seen from the southern escarpment of Bimbe plateau V.
34. Terrain unit 0602/1: Humbi Mountains, seen from the W on Luimbale High Plain IV.
35 Terrain unit 602/2: road Huambo-Luimbale on the granitic Huambo High Plain IV , with Bonga Mountains.
36. Terrain unit 0602/2: soil profile developed in granite, on the Huambo High Plain IV.
37. Terrain unit 0603/1: soil profile on shales; Caconda High plain IV.
38. Terrain unit 0603/1: Caconda High Plain IV; a transect through a slightly dissected valley.
39. Terrain unit 603/4: Chibia-Cangolo High Plain IV, with the escarpment to the Humpata plateau V.
40. Terrain unit 707/2: Luimbale-Balombo plateau V; soil profile on mica-quartzite.
41. Terrain unit 0707/3: Galanga High Plain IV, with inselfelsen.
42. Terrain unit 0707/4: the Cassongue mountain chain, above High Plain IV.
43. Terrain unit 0707/6: the Lepi-Caala plateau V, with Mount Holocoso; Ganda-Huambo road.
44. Terrain unit 0709/2: Bimbe plateau V; park-like mountain vegetation on deep soils.

List of tables

1. Agriculture production of Angola in 1989 (PC Globe, 1992)

2. Soil phases

3. Tentative soil correlation: Portuguese Oversees Classification (1965) - FAO (1990)

4. Soil mapping units of Angola (FAO classification, 1990)

ABBREVIATIONS and CONVERSIONS

a.s.l.	altitude in metre above sea level
AWC	available water holding capacity
CEC	cation exchange capacity
CPSZ	crop production system zones (IGADD)
EC	electrical conductivity
Ex. Ac.	Exchangeable acidity
FAO	Food and Agriculture Organization
IGADD	Inter-Governmental Authority on Drought and Development (East Africa)
SOTER	World SOils and TERrain Digital Data Base
WCS	Western Congo System (rocks)

SUMMARY

The "development of a soil, terrain unit map and database for Angola" presents a revised soil map and a terrain unit map (to a scale of 1/2,500,000). The report (volume I) contains a description terrain units, according to the principles of the SOTER manual; soil mapping units are classified in the FAO soil classification (1990). Available information on land use and vegetation has been collected, following the principles of the IGADD database.

Major constraint is that this study has been based only on existing literature and reports.

Volume II produces an adaptation and translation of typical, geo-referenced, soil profile descriptions.

The report provides FAO with basic data on Angola's natural resources, fundamental data needed for multi-layered GIS-supported information systems and essential for land use planning decisions.

RECOMMENDATIONS

1. Recommendations for Angola

There is no up-to-date soil map of Angola. The previous war situation in the country has resulted in an absence of detailed soil, land use and vegetation studies. Appropriate information on soils and soil properties is lacking and makes it difficult to assess the land use potentials for specific areas.

The fragile nature of soils and vegetation increases the risks of environmental degradation, due to population pressure and/or mismanagement of natural resources, such as overgrazing, deforestation for fuelwood production and land clearing.

Land resources inventarisation, as initiated by this project, is urgently needed. It should be based on systematic collection of all physical data which influence land use.

The information presented in this report is fragmental. More fundamental and recent information is needed on major land regions, land units, soil types, climatic data (risk factors), land suitability potentials, farming systems, importance of soil erosion and soil conservation measures.

It is important to identify (map/describe) and stop land degradation: soil, soil water and soil fertility losses. Effective measures are needed, such as management of soil and water conservation and soil fertility restoration, crucial to reduce land degradation and increase productivity.

Climatic data need incorporation into agro-ecological zones. Studies of socio-economic factors should also be included.

The matching of all collected data should lead to formulation of sound advices for National Land Use Planning, on a scientific basis.

Databases need to be supplied with reliable, recent field observations and laboratory analyses. Land evaluation is needed to formulate recommendations of appropriate types of land use

and soil conservation.

- It is recommended to refine the national terrain unit and soil map. More old soil profile data may be available in Angola, or in Portugal, but it is evident there is a demand for recent field observations and practical training courses of Angolan technicians.

- The first objective would be to finalize an updated soil map to a scale of 1:1 Million, for incorporation in a digital soil map, as has been done for the east African IGADD countries. At that level, terrain units could be subdivided into clearly defined terrain components. Field work, satellite image and aerial photograph interpretation would be essential at that stage. During reconnaissance soil surveys, combined with training courses, representative soils could be mapped and sampled for each terrain unit.

- In a second phase, more detailed soil and land unit mapping could be foreseen for critical agriculture, pasture or conservation areas.

2. Recommendations for digitalization and database construction

The SOTER programme is a useful tool to handle terrain and soil data. The user of the programme should, however, be advised that the stored information is simplified and restricted. It could give a false impression, that enough field data are available for any kind of land use planning decision.

- At the terrain unit level, the programme permits ONE entry only for each topic; e.g. lithology of an area is often complex and composed of contrasting rocks, such as layers of limestone and sandstone. The SOTER programme will accept one entry only. This over-simplification may lead to erratic decisions. The same problem exists at the terrain component level. More detailed information may be found in

the written text of this report.

- SOTER permits a description of quantity and size of gravels, but not of gravel composition; e.g. a soil with weathered schist gravels will store water and provide nutrients to the plants, which is not the case for ironstone or inert quartz gravels.

- There is no entry available for ironstone pans or crusts, which cause important temporary water stagnation problems and damage to coffee and other crops on the Angolan plateaus.

- SOTER permits to describe soil structure, but there is no entry to describe the large and deep cracks, as in case of Vertisols.

- There is no entry for mottling, important to define drainage problems.

It must be repeated that, no matter how impressive GIS and computerized systems might be, outputs will be of inferior quality, as long as basic data (field observations) supplied to these system are of poor quality.

INTRODUCTION

1. ACKNOWLEDGEMENTS

First of all, I am grateful to Dr. F. Nachtergaele, Dr. P. Koohafkan and Dr. R. Brinkman at FAO HQ/Rome for their support and for the opportunity to undertake this study.

In Belgium, I would like to thank Prof. Dr. Jan Feyen and Prof. Dr. J. Deckers of the University of Leuven (B) for their confidence. Full support was received from Dr. G. Baert at the University of Ghent (B).

I wish to thank my brother in law Fernando Bessa, captain of the UN peace keeping mission in Angola, for sending me valuable information.

2. TERMS OF REFERENCE

Development of a Soil and Terrain map/database for Angola

The Soil and Terrain Database for the IGADD countries, developed by FAO in 1996, will be expanded with soil, terrain and related information (geology) for Angola.

The database will contain the following:

1. A physiographic layer with terrain and slope information at an equivalent scale of 1:5 Million, according to the principles used in the SOTER manual (FAO, 1995).
2. A soil map at the same scale giving information on the soil unit composition in each unit, surface conditions and the soil phase if required.
3. A selection of geo-referenced typical soil profiles characterizing the major SOTER units in the country, classified in the FAO revised Legend (1990).
4. Available information on geology and vegetation following the principles used in the IGADD database.

Language : English

Adaptation of the terms of reference

The amount of data allowed to work at a scale of 1:2.5 Million instead of 1:5 Million.

3. BACKGROUND

The digital soil map of the east African IGADD countries, to a scale of 1:1,000,000, has recently been complemented with a wealth of related information on geology, landform, agro-climate, land use, vegetation... and the material has been used for a one-time baseline study for the Global Information and Early Warning System.

Together with soil information, it has been built into an easily accessible, multi-layered GIS-supported information base, suitable for national and sub-national level agro-ecological zoning, improving irrigation capability interpretation and environmental impact studies, with a view to support the land use planning facilities of the countries concerned.

The success of this system and the availability of similar data in other countries in the region have led to an international demand for a completely updated soil and terrain database for all Africa. Such data are available for Angola and the present agreement has collected, compiled and stored the land resources information in an orderly manner to make them easy retrievable.

Outputs of this agreement will be of direct utility to the AFRICOVER project and the ongoing global SOTER update.

Agriculture plays a large role in the economy of Angola. It is by far the greatest source of employment for the majority of the population. There is a need to increase the productivity of agriculture, to improve the livehood, of the rural poor.

Development planning depends heavily on sufficient data inputs. Land use planning in Angola, is up to now, rarely based on natural resources information. There is a growing awareness that a sound perspective of Angola's agricultural potential is needed. Essential is the preparation of a systematic inventory of natural factors determining the agricultural potential, e.g. land forms and soils.

The objectives of this study are to collect basic data of the natural resources of Angola, for procession of those data by computer and to release conclusions on the optimal use of land to decision makers

The ultimate goal is to provide essential information for land use planning to decision makers, in order to improve the living conditions of rural communities and to establish systems for sustainable management and protection of both the renewable natural resources and the physical environment.

4. IMPLEMENTATION AND WORKING METHOD

4.1. Literature study

The consultant gathered information in the libraries of the University of Gent (Belgium). Valuable data were collected on geology and soils of Angola, Namibia and South Africa. Recent literature on the Kalahari was obtained from Dr. Florias Mees of the Geological Institute of Ghent University.

Detailed information on soils, vegetation, land use and landscapes could be extracted from the work of O. Jessen (1936).

4.2. Soil map

Many soil studies have been done in Angola, in the period 1950-1965, by the Junta de Investigações do Ultramar. The main source for this work has been the soil map o9Angola, to a scale of 1/3,000,000 (1965). This map had been used already to prepare the soil map of the world in 1974. During this study the original map has been reviewed and adapted to the revised FAO soil classification of 1990.

4.3. Terrain unit map

The terrain unit map has been based on the step-like plateau nature, which characterize most of the country. The plateaus are separated by low or steep escarpments and each step brings about a change of climate, vegetation and soil types.

Terrain units were subdivided according to geology of the

substratum, geomorphology and vegetation. A comparison with the available soil information was useful to understand the physiography of the country.

4.4. Database for Angola

The reader is referred to part II: database for Angola. According to the terms of reference, each terrain unit has been coded and described, taking into account the objective of informatisation.

MAIN FINDINGS AND CONCLUSIONS

PART I NATURAL RESOURCES OF ANGOLA

1. Area and population

Angola is a vast, relatively scarcely populated country. It is located in south western Africa, between the parallels of 4 to 18 ^{o} S and the meridians of 12 to 24 $_{o}$ E. The country has roughly a rectangular shape and a surface of 1,246,700 km^2. Angola is bordered, from N to S, by the Congo Republic, Zaire, Zambia, Namibia and by the Atlantic Ocean in the west.

There is an extreme diversity of landscapes. Relief is dominated by step-like plateaus. Two-thirds of the country is situated at an altitude of 1,000-1,300 m a.s.l.

A marginal mountain chain (Moco 2,620 m a.s.l.) separates the coastal stepped plateau zone from the extensive "Interior African Plateau", "High Plain" or "Planalto Antigo", which towards the east gradually slopes to the Kalahari and Zaire basins.

The central High Plain is the source area for many affluents of the Zaire, Cubango and Zambeze rivers. Streams descend the western stepped plateaus in many waterfalls, with an enormous hydro-electrical potential.

Population is about 8,700,000 inhabitants (1991), or 7 per square kilometre. Population growth is 2.7 % and the number of

inhabitants is doubling every 26 years. Settlements are mainly concentrated in the western centre, on the highlands (54%) and in the northern coastal region, from Benguela to Luanda.
Main towns are Luanda (1,500,000 inh.), Lubango (105,000 inh.), Namibe (100,000 inh.), Huambo (62,000 inh.)... (PC Globe, 1992).

2. Climate

Due to the 1,600 km distance between N and S, altitude differences, and due to the influence of the cold Benguela stream, climates are very diverse: equatorial in Cabinda, tropical humid on the northern part of the central plateau; tropical dry on the high regions of the south; temperate humid in the northern part of the coastal plateau; semi-arid in the southern part.

Climatic zones are roughly parallel to the Atlantic Ocean and to the Namibian border. Climate becomes colder and more humid with altitude. According to Thornthwaite's classification, two-thirds of Angola has a humid climate.

The lowest mean annual temperatures (15-20^{o}C) are found on the High Plain and along the Namib coast. The highest values (25-27^{o}C) occur at the Zaire river and on a sub-coastal strip in the north.

Mean annual rainfall decreases towards the south and increases with altitude and distance from the sea. The highest annual rainfall is 1,700 mm and the lowest less than 100 mm (Namib).

On the higher parts, the rainy season is found between November and April, while the dry and cool season occurs from May to October.

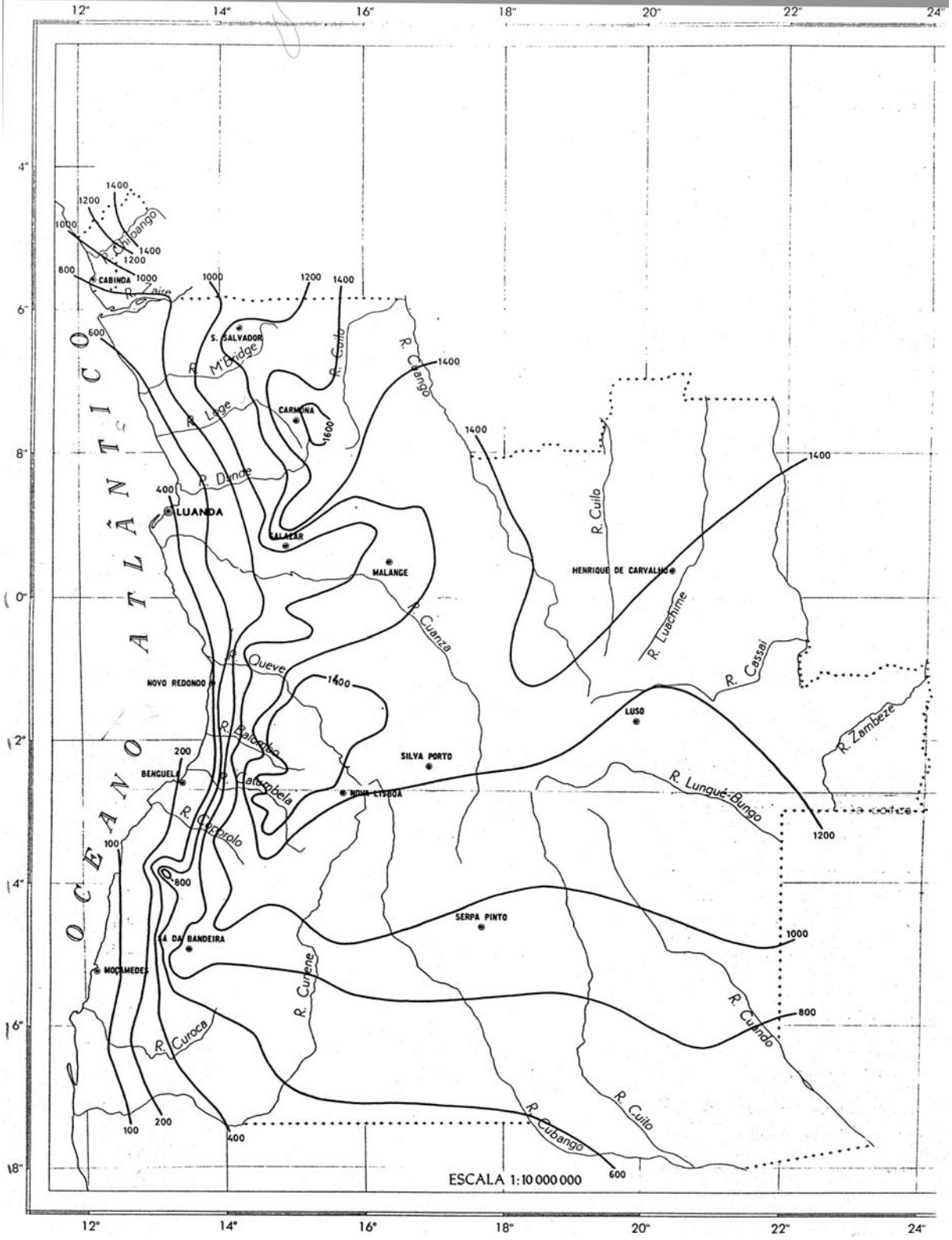


Fig. 1. Mean annual precipitation (mm) in Angola (Missão de Pedologia, 1965)

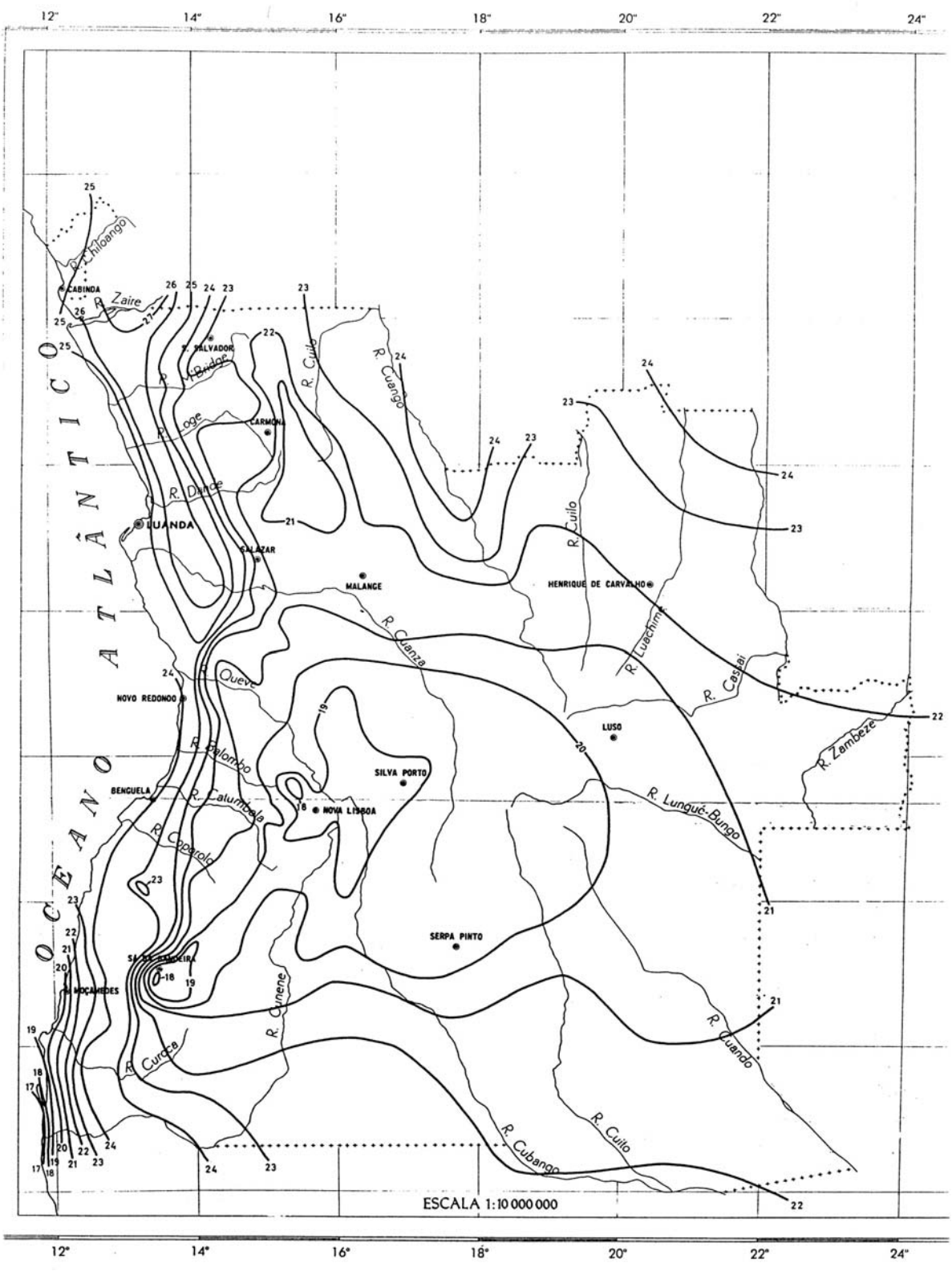


Fig. 2. Mean annual temperatures (°C) in Angola (Missão de Pedologia, 1965)

3. Land use

Most important food crops in Angola are: cassava in the north, beans and maize in the centre, and millets and sorghum in the dry south and eastern regions.

In 1968, 525,000 ha were covered by coffee plantations. Originally concentrated in the areas of Uige and Malanje, coffee has progressed towards the south, to the latitude of Lobito. Angola was, in 1971, the fifth world productor (210,000 ton) and coffee represented 35 % of the export values.

Cotton is grown in the region of Luanda, Malanje and Cuanza Sul; in the same region as coffee, but also more to the E. In Malanje province it made up to 60 % of all harvests. Cotton is also cultivated in the south. Production was 86,013 ton of cotton grain and 35,478 ton cotton (1971).

Sugar cane plantations are concentrated in the coastal region, on wide valley floors, as near Lobito, Benguela and Luanda (764,000 tons in 1971).

Sisal plantations occur at some distance from the coast: near Porto Amboim, Namibe and Benguela (90 % of the production, formerly 60,000 ton/year).

Oil palm and groundnuts are grown in the coastal regions.

Forests cover 42 million ha, mainly in the mountainous parts in the N and NE.

Pasture is concentrated almost completely in the southern provinces: Huila, Cunene, Huambo and Benguela.

Table 1. Agriculture production of Angola in 1989 (PC Globe, 1992)

Error! Reference source not found.crop	metric tons
coffee	27,000
maize	260,000
cotton	11,000
meat	77,000
milk	148,000
potatoes	40,000
rice	22,000
sugar	30,000
tobacco	3,000
wheat	10,000

4. Physiography

Angola belongs to the "African Interior Plateau", also called "High Plain", "Planalto Antigo", or "planation surface IV". It is bordered in the west by high mountains and the Great Escarpment, overlooking the step-like coastal plateaus (I-III) zone.

Towards the east, the African Interior Plateau is depressed and forms the Kalahari Basin. Incision of valleys started during the Cretaceous and further deepening took place following the Miocene tectonical upheaval.

One of the most characterizing elements of African geomorphology are the different planation surfaces. These pediplains, nowadays plateaus, represent the final stage of individual cycles of erosion and are separated from each other by escarpments.

4.1. Coastal Belt (Faixa Litoral) coastal terraces and coastal plateau I

This area has a maximal width of 200 km (Cuanza valley). It includes some low escarpments and recent beaches, with spits (restingas), e.g. Baía dos Tigres and at Lobito. River incision formed wide valleys in soft rocks and canyons in hard rocks. Cliffs are common at the coast.

The coastal Belt extends over Meso-Cenozoic sedimentary rocks (marl, limestone, sandstone...) and part of the Precambrian soccle (frequently gneiss).

Some limestone platforms are characterized by karst phenomena, e.g. at Sumbe (Novo Redondo).

A cuesta relief has developed in mesozoic formations in the region of Dondo, Porto Amboim and Quicombo.

4.1.1. Coastal plateau I

This pediplain remnant cuts rocks from the Precambrian Basal Complex to the Tertiary and must have formed during the Miocene or Pliocene. In southern Angola it has a width of 35-55 km, but at Rio Cuanza it reaches 180 km. It maximal elevation varies from 500 m in the south, 300 m at Lobito and 400 m N of Rio Cuanza at the base of the Cazengo mountains.

The step, or escarpment, from plateau I to the higher and older surfaces becomes more important from S to N: it is almost unnoticeable in the south, its altitude is 280 m in the interior of Benguela, 600 m at Lobito, 700 m at Gabela, and it decreases to 400 m, N of Rio Cuanza at N'Dalatando.

In some areas a distinction can be made between a lower level, or plateau Ia and a higher level, plateau Ib.

4.1.2. Coastal terraces A and B

Plateau I terminates directly at the coast at Luanda. In Porto Amboim and Benguela Velha, however, a first, lower marine terrace appears at 40-60 m a.s.l.. From Lobito to Namibe town (Moçâmedes), two terraces can be distinguished: higher terrace A at 80-130 m a.s.l. and lower terrace B, at 40-75 m a.s.l.. These marine terraces are dated Late Tertiary-Early Quaternary. Their surface slopes 0.8 % towards the W.

4.1.3. Coast

a. Coast N of Lobito

N of Lobito, the Namib desert becomes transitional. The Cretaceous and Tertiary plateau I, at 120 to 150 m a.s.l. is sparsely covered with desert grasses and succulents; where sands occurs it is generally covered with grasses or thorn scrubs.

b. Lobito-Punta Albina coast

From Lobito to a few kms S of the low, sandy, Punta Albina, the coastline is generally sandy and backed by cliffs, mainly of Tertiary and Cretaceous sandstones and limestones, rising to altitudes of 120-150 m a.s.l.. In places, however, as between Punta das Salinas and Cabo de Santa Maria, and behind the low coastal flat on which Benguela stands, these height rise to 300-450 m a.s.l., within 7 to 9 km of the coast.

c. Punta Albina-Cunene coast

South of Punta Albina, the coast becomes low and sandy and is backed by the sandy surface of the northern Namib which, behind Baia dos Tigres, receives a constant supply of wind-blown sand from the beaches to the N of the Cunene river mouth.
Deposits by currents along this coast form sand-spits at Baia dos Tigres, at Tombua (Porto Alexandre) and at Lobito.

4.1.4. Namib (Moçâmedes) desert

The Angolan part of the Namib desert is covered with alluvial and eolian deposits, originating from weathering of Cretaceous to Tertiary deposits. It is mainly a "dune Namib", with typical barchan dunes and sand ridges.

The area with shifting dunes and rocky desert floors, rises up to 300 m a.s.l. At Tombua (Porto Alexandre) the sand desert widens to 45 km.

Northwards from there, although sand covers considerable areas behind the coastal strip, the dominant surface type is the sandy and clayey flat, formed by weathering of Tertiary and Cretaceous beds, stony surfaces from the weathering of conglomerates and bare outcrops of more resistant sandstone and limestone covering large areas.

4.2. Transition zone (Zona de Transição) plateaus II and III

The transition zone occurs in between the Marginal Mountains and the coastal belt; it includes plateaus II and III.
Streams are draining directly towards the Atlantic ocean. All plateaus (I, II, III and IV) are bordered by escarpments.

4.2.1. Plateau II

This planation surface, or pediplain, reaches a width of 100 km at Namibe (Moçâmedes). It has been cut during Senonian to Eocene times and it slopes towards the W. Altitude varies from 500 m a.s.l. in the south to 800-1,200 m a.s.l. in the north.

Inselbergs and inselfelsen are common, especially in the marginal areas, near the escarpments. The step from plateau II to the higher and older Plateau III is very reduced.

In some regions a distinction can be made between a lower level, or plateau IIa and a higher level, or plateau IIb.

4.2.2. Plateau III

North of Rio Cuanza, plateau III is found at an altitude of 1,200 m. It reaches 1,500 m at Sanga (Cuanza Sul Province), from

where it descends to the base of the Serra da Chela (850-900 m a.s.l.) in the south. This pediplain probably formed during the Lower Cretaceous.

The general inclination is towards the W and the step which separates plateau III from the higher surfaces is very irregular. A maximal altitude difference is found at Serra da Chela, where an abrupt escarpment reaches 1,000 m; at Lépi the step between plateau III and V is 250 m high; in the region of Luimbale it is 350 m and at Bimbe 500 m.

4.2.3. Canzanga mountains (Uige Province)

These mountainous area is topped by plateau III remnants. The Zaire stream and its affluents are responsible for its dissection.

4.3. Marginal Mountain Chain (Cadeia Marginal de Montanhas)

The Marginal Mountains, bordered in the west by the Great Escarpment, separate the coastal belt and transition zone (plateaus I, II and III) from the extensive "African Interior Plateau" or "High Plain", in Angola called "planation surface IV".

4.3.1. The Great Escarpment

The Great Escarpment is one of the most important physical features of southern Africa. It borders the depressed interior plateau with Kalahari basin. It runs parallel to the Atlantic Ocean and has a steep relief.

North of the Cunene river, the Great Escarpment is imperceptible for some 30 km in a 'Mountain Belt', dissected by the Cunene river and its affluents (dambas, or dry water courses). This intensely broken area is known as the Chamalindi mountains, a dissected outlier of the Ovashimba plateau.

At about Ondambo, the Escarpment becomes sharply defined in the horizontal Otavi-Chela quartzites and limestones of the Serra da Chela forming the 'Tunda'. North of the Caroca river, the Chela Escarpment becomes progressively steeper and higher, attaining an altitude of 2,200 m a.s.l. on the edge of the Humpata Plateau, west of Lubango.

From here the escarpment trends NE as the watershed between the Cunene basin and the coastal drainage. Lacking a hard sedimentary rock cover, the granite substratum in most places does not form a well-defined escarpment, but it can be traced to the Benguela railway, which it crosses between Lepi and Robert Williams, and then west of north to the granite peaks Capanga (2,500 m) about 20 km N of Lepi.

At the plateau edge, quartzite and ironstones of the Oendolongo System form a hard protective covering the granites. Several granite peaks rise to over 2,100 m. The highest is the Moro Moco (2,620 m) about 25 km SW of Luimbale (Wellington, 1955).

4.3.2. Plateau V remnants

Planation surface V can be found as isolated remnants, or as flat shoulders (terraces) on the mountain slopes (S of Rio Cuanza only).

- Bimbe Plateau (1,830 m)
- Cassongue (1,800 m)
- Luimbale and Moco (1,800 m)
- Chicuma (1,830 m)
- Humpata (2,000 m)

The narrow Humpata plateau, near Lubango, is a horizontal quartzite and limestone area on the eastern edge of the marginal chain; the western edge of the plateau is formed by the Great Escarpment, or Serra da Chela.

Many times remnants of older planation surfaces rise above plateau V: these phases were called Vb and Vc.

Below and W of the Great Escarpment, fragments of plateaus V and IV remained as outliers or inselbergs; evidences of headward erosion which has been in progress since the formation of the coastline in Cretaceous times.

In the south, peaks and ridges of Bembe Group quartzites, folded in the west, form the mountain features between the river valleys. North of this area, quartzites and ironstones of the Oendolongo Group cap the basement rocks (granite, gneiss), forming isolated peaks and ridges of great height and prominence. The naturally excessively irregular topography resulting from vigorous dissection of massive granite-gneiss, with sporadic capping of hard quartzite and ironstone. The fragmental relicts of the plateau decrease in height with increasing distance from the plateau edge (Wellington, 1955).

4.4. High Plain IV (Planalto Antigo)

East of the Marginal Mountains occurs the Interior African Plateau, or "African Pediplain"; in Angola called "planation Surface IV" or "Planalto Antigo".

It is an extensive, slightly undulating plateau or plain. It is covered by poor ferralic soils, usually with a thick ironstone crust in the subsoil.

In the W, near the Marginal Mountains, the High Plain reaches an altitude of 1,600-1,700 m a.s.l., culminating on the main water divide between Huambo and Bié (Chinguar, 1,800 m a.s.l.).
From here the High Plain descends towards the Kalahari in the east, reaching 1,350 m a.s.l. at Rio Cuanza.

- 1,650-1,750 m at Congolo
- 1,800-1,850 m at Cutato-Capeio (Bié Province)
- 1,200-1,400 m in the south

Inselbergs are abundant on the western part of the High Plain. They become more rare towards the E. At Rio Cuanza, the plateau has been cut over Karroo rocks, consequently a Lower Jurassic age has been proposed.

The surface is mainly formed of granite; a great deal of the surface is flat and well suited to cultivation (Wellington, 1955).

4.5. Kalahari Basin

The Kalahari in Angola has a much more humid climate than in Namibia/Botswana and it does not look like a desert. It is not a sea of shifting sand dunes and it generally possesses a significant natural vegetation cover. The Kalahari is, however, notable for its lack of permanent, and even seasonal, water courses.

The Kalahari is probably the largest continuous sand surface in the world. Only locally the sand is broken by rock or boulder surfaces. The area lacks surface water. Vegetation is mostly steppe and savanna, but some forests occur in the north.

Its basal structure is an ancient plain upon which terrestrial Cretaceous sediments accumulated upon a Gondwana erosion surface. Although in places the Kalahari sand is obviously of alluvial origin, it was deposited on the basin floor by wind transportation under desert conditions. The Kalahari System consists of 3 groups:

(1) the basal group or Botletle beds (chalcedonic sandstone and grits);

(2) the Kalahari limestone group, with limestones, calcareous sandstones, marl and calcareous tuff;

(3) and the Kalahari sands, with secondary calcretes, ferricretes and silcretes.

The Kalahari Basin is surrounded by a belt of peripheral highlands. The flatness of the basin surface is mainly due to its sedimentary infill.

The basin formed by the uplifting of the surrounding highlands. There are three major internal drainage basins: the Etosha pan plain in S. Angola and N. Namibia, the Okavango plain in Botswana and the Molopo-Nossob basin in S Namibia.

In Angola, the Kalahari contains parts of the Okavango (Cubango) and Linyanti (Cuando) river valleys, which form extensive marches and papyrus swamps. In S Angola, a flat area slope towards the Namibian Etosha Pan; it is a partly saline, sandy clay plain.

The precise origin of the Kalahari sands is unknown, but they probably originated from Karroo or Stormberg sandstone sediments, transported by ancient rivers and distributed over the basin floor by wind action is later arid periods.

Six dune types are found in the Kalahari: (1) parabolic dunes, (2) blowouts, (3) barchan dunes, (4) transverse ridges, (5) linear dunes (dominant) and (6) seif dunes.

The eastern and northern dune fields are dominated by linear dunes, but differ markedly from the southern dune field, as they occur in a wetter climate and support considerably more vegetation.

The northern dune field consists almost exclusively of linear ridges with subdued and rounded crests. The ridges support a mixed savanna woodland vegetation, which aids their distinction from the grass- and shrub-covered interdune straats.
The presence of vegetation on most dunes indicates they are no longer active.

4.5.1. Zaire Basin (Bacia do Zaire)

This is an undulating region in NE Angola, draining towards the Zaire river. It consists of tilted, middle to late Tertiary planation levels, well represented in the Uíge, Malanje and Lunda provinces. The plateaus are covered by a Kalahari

sandsheet. Most rivers have cut deep valleys through the sandsheet into the underlying rocks (e.g. northern Lunda province).

4.5.2. **Upper Cuanza Basin** (Bacia do Alto Cuanza)

The Kalahari sandsheet covers the entire dissected upper Cuanza river basin, draining directly to the Atlantic Ocean.

4.5.3. Zambeze and Cubango basins (Bacias do Zambeze e Cubango)

The Cubango river has an almost not dissected valley, which is not the case for the Zambeze and its affluents.

a. Cameia Plain (Anhara da Cameia)

This region is located south of Rio Cassai (Moxico province). It is an extensive plain called the Anhara da Cameia. It is a flat, sandy area, partly inundated during the rainy season.

b. Dissected valley region of W Moxico

In the W of the Zambeze basin, in the upstream areas of the Cuando, Lungué-Bungo and Cuito rivers, occurs a region with dissected to steep valley sides.

c. Southern Angolan Etosha Plain

The Etosha plain is featureless even surface, broken only by the occurrence of a vast network of sallow flood channels (called mulolas in Angola, or oshanas in Namibia), trending N-S. The Cuvelai river is dry during the dry season.

The Cunene river is a typical Kalahari stream, with a gradient of less than 20 cm/km, a tranquil flow and ox-bow back-waters lined with reeds and water lilies

4.6. Cassange depression (Baixa de Cassange)

This SSE-NNW oriented, Plio-Pleistocene depression developed on Karroo formations, with equally SSE-NNW oriented fault lines.
It is an amphitheatre structure, bordered in the W by a high escarpment.

4.7. High Zambeze Massif (Maciço do Alto Zambeze)

This mountainous massif is built of Precambrian rocks and more recent basic igneous rocks. A high escarpment borders it in the

W.

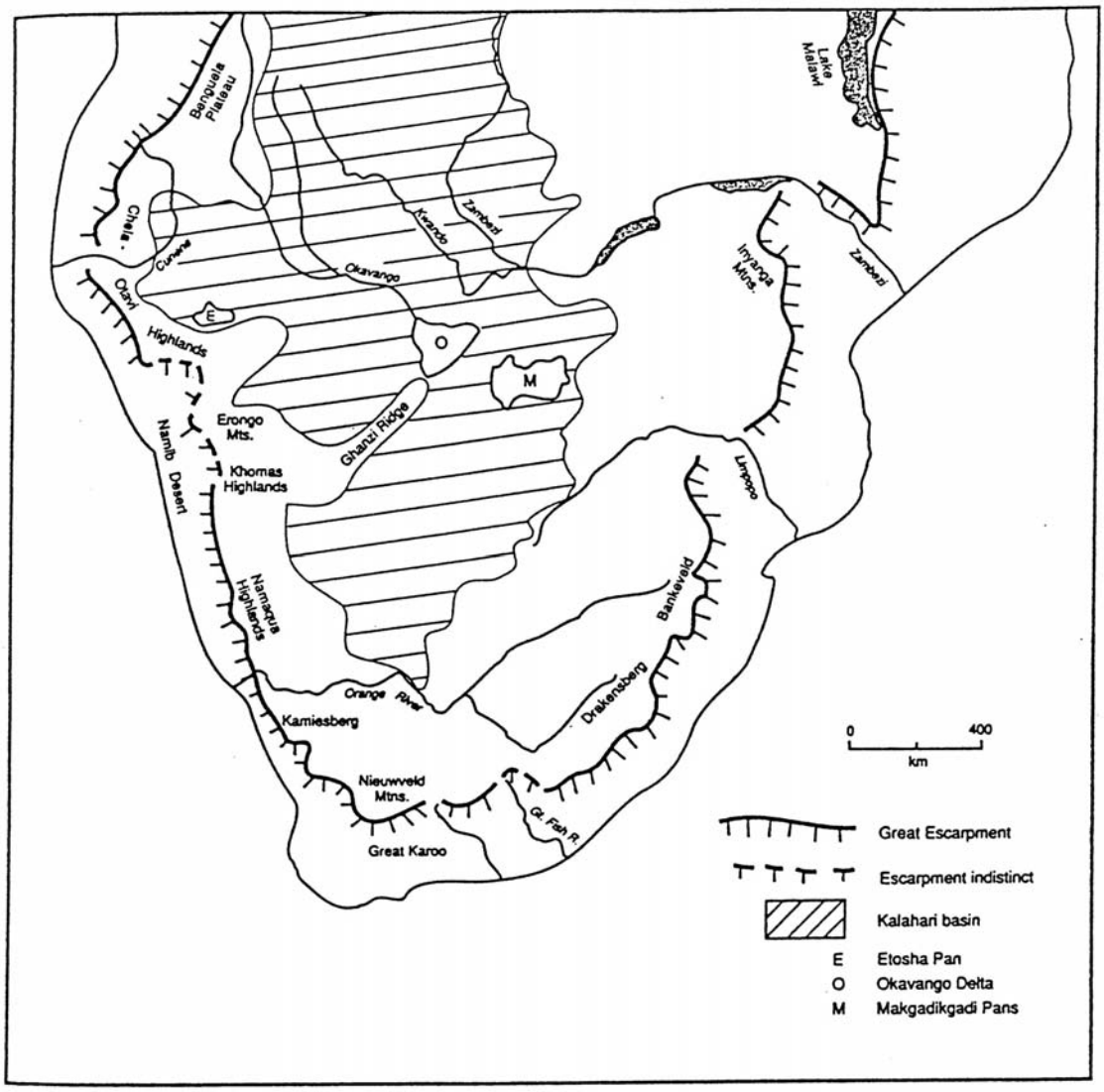


Fig. 1. The Great Escarpment and the Kalahari Basin (Thomas and Shaw, 1991)

5. Vegetation

Almost the entire territory of Angola is included in the Zambezian domain of the Sudan-Zambezian geo-botanic region. Minor areas of the Guinean region, with evergreen forests, are found in the north. Xerophile steppes grow on the coast and on the low plateaus of the south.

The numbers below (..) refer to the vegetation regions of FAO (1977).

5.1. (1) Tropical wet evergreen forest

Along the Mayombe Mountains, tropical forest extends south into Angola, because of deep soils, mist and clouds over the area (influence of the cold Benguela stream).

(1.a.) Tropical lowland rain forest (Cabinda uplands and NW Angola)

The tropical forest is never leafless. It consists of several strata, including an upper strata of large trees, which may be 40-60 m high. It is very heterogenous and among its numerous species are Brachystegia laurentii, Gilbertiodendron dewevrei, Diogoa zenkeri, Scorodophloeus, Oxystigma oxyphyllum and Celtis soyauxii. The underwood includes Alchornea floribunda, Geophila obvallata and Scaphopetalum thonneri. The forest has in many places been degraded and secondary forests are composed of fast growing light-wood species, such as Ricinodendron heudelotii, Albizzia ealaensis, Irvingia grandifolia and especially the umbrella tree (Musanga cecropoides or Musanga smithii).

These forests keep the soil almost permanently moist, shelter an intense biological life, maintain a rather constant temperature and suffer practically no erosion. Nevertheless, they live a virtually closed life cycle in which decomposing dead matter nourishes the living matter. This equilibrium is precarious and is upset by deforestation and cultivation.

5.2. (2) Tropical deciduous and semi-deciduous forests

(2.a.) Tropical semi-deciduous rain forests (northern Zaire and Uige Provinces)

Rain forest species are intermixed with deciduous species. Semi-deciduous rain forests grow especially along rivers and in groves on hills and plateaus. Climate differs little from that of rain forests and it seems that the presence of savanna is due to degradation or to various ecological conditions, especially the insufficient water-holding capacity of sandy soils. These tall grass savannas are composed of Pennisetum purpureum, Loudetia arundinacea and Imperata cylindrica, together with a number of fire-tolerant shrubs, such as Hymenocardia acida. The grass steppes are frequently burned off by farmers and hunters.

(2.c.) **Large-leaved rain-green dry forest or Myombo forest** (Kalahari and High Plain)

Trees in the upper storey belong to the Isoberlinia and Brachystegia genera, which retain their leaves during part of the dry season. The lower storey is composed of Uapaa, which lose only some of their broad leaves. Brachystegia and Julbernardia are dominant, but Monotes, Terminalia, Combretum and Acacia occur at the limit between Myombo and valley grasslands.
This formation subsists on a low rainfall. In drier regions, especially on Kalahari sands, there are distinctive species, such as Marquesia acuminata, Cryptosepalum pseudotaxus and Guibourtia coleosperma, as well as a few dense dry forests of Baikiacea. Treeless steppes are found on the plateaus.

Wellington (1955) classified this zone as "Brachystegia-Isoberlinia savanna".

Although the general appearance is that of parkland, there is a variation in tree density from almost open grassland to almost closed forest. With the dominant trees Brachystegia spiciformis (also known as B. randii and B. hockii, or 'Panda' tree) and Isoberlinia globiflora are associated many other species of Faurea, Monotes, Strychnos, Swartzia, Albizzia, Combretum...

(2.d.) Small-leaved rain-green forest with umbrella

trees (southern Angola)

This area represents a transition from woodland to Acacia wooded steppe in a warmer and drier climate (< 750 mm) than that of the preceding formation. Acacia predominates and associations of Combretum ad Terminalia and Adansonia digitata and Sclerocarya also occur.

The valleys are dominated by a tall grass alluvial savanna, with Acacia polyacantha and Acacia sieberiania, and especially woodlands of Colopospermum mopane, which has a fire-tolerant bark and can subsist on poorly drained soils. These forests usually reach heights of 15 m or more, but my be low and stunted in regions subject to frost.

Wellington (1955) called this zone "Mopaniveld".

The presence of baobab (Adansonia digitata) indicates low air humidity and high temperatures. The mopane tree (Colophospermum mopane) is dominant in these areas, occurring in places as almost pure forest association, especially on clayey soils, but thinning out to form almost open grassland in the areas of loose sandy soils. The mopani tree is deciduous, its bark is fire-resisting. Unlike most of the other savanna trees it can survive in temporarily waterlogged soils, but it develops best in well drained soils, where it may grow to about 18 m.

5.3. (3.) Tropical inundated coastal formations

(3.a.) Mangroves

Extensive mangrove forests are found on saline loamy soils, exposed directly to the tides along the coast, down to the Longa river. They occur at the estuaria of following rivers: Zaire, Catumbela, Chiloango, Mebridge, Loge, Dande, Bengo, Cuanza and are less developed along the other rivers more to the south.
The stands are dominated by Rhizophora racemosa, R. harrisonni and R. mangle. Avicennia nitida sometimes occurs behind the areas of Rhizophora.

5.4. (4) Savanna

The density of these stands varies greatly, but is generally open, leaving the grass cover visible. The savanna extends south of the forest zone into regions of marked dry season and often merges imperceptibly with semi-desert steppe where the grassy ground cover is exposed.

(4.a.) Large-leaved semi-deciduous tree savanna
(northern and central plateau region)

This type of savanna is fairly humid and stages range from woodland to grassy savanna. Tree cover density varies greatly with edaphic conditions and the nature and extend of human activity. Grass heights varies from 80 cm to 3-4 m; the trees tend to be of the C. oliveri, Lophira lanceolata and Combretum, Anogeissus, Khaya and Pterocarpus genera. The grasses are mainly of the Hyparrhenia genus.

In Angola, Hyparrhenia bracteata, H. rufa and H. dissoluta, Panicum maximum and Chloris occur with an open savanna of Brachystegia, Isoberlinia and Combretum.

(4.c.) Moist savanna
(northern and central plateau region)

This formation is often found in association with large-leaved, semi-deciduous, tree savanna (4.a.). Although Isoberlinia doka and Isoberlinia dalzielli woodlands are intermixed with clumps of Uapaca togoensis characterize this type, these species are often replaced on eroded slopes by Monotes kerstingii and in poorly drained clay depressions by Terminalia macroptera and laxiflora. Tall-grass savannas, sometimes with Borassus palms, occur in wide valleys.

(4.d.) Inundated savanna
(Wet Kalahari)

These areas are covered by sandy soils, which are inundated during the rainy season. In Angola, vegetation is called 'anhara', being a steppe-like landscape with grasses, herbs and some shrubs; e.g. Anhara da Cameia (Moxico Province)

(4.e.) Dry savanna
(northern-central coastal zone and SE Kalahari)

Acacia dominate in this wooded savanna, but many broad-leaved trees (Combretum and Terminalia) occur in association with Adansonia digitata, Sclerocarya, Celtis, Ziziphus and Gymosporia.
Medium to tall grasses predominate: Hyparrhenia hirta, Themeda triandra, Heteropogon contortu and Trachypogon spicatus. Setaria, Sehima and Ischaemum occur on Vertisols.

Wellington (1955) classified this zone as "Mixed savanna".

In SE Angola, in between Rio Cuando and Cubango (Okavango), the mixed savanna includes trees of the genera Acacia, Sclerocarya, Commiphora and Hyphaene, with Hyparrhenia and Andropogon as dominant grasses.

The Angolan extension of the Barotse Plain, on the Zambian border, N of Rio Cuando, was classified as tropical grassland.

5.5. (7.) Steppe

(7.b.) Temperate dry short-grass steppe (Eastern Namibe Province)

This steppe consists of Eragrostis, Aristida, Urochloa, Panicum and Vetiveria nigritana in poorly drained areas. Grass cover of this type is associated with a few wooded areas of Colophospermum mopane and Adansonia digitata. The annual grasses dry up and disappear almost completely during the dry season. There are also Aristida steppes with Welwitschia mirabilis.

5.6. (8.) Semi-desert formations

(8.c.) Tropical and subtropical semi-desert low vegetation (Namibe Province)

This is a true steppe, with very widely spaced grasses. The most common of the many genera of shrubs and shrublets are Pentzia, Chrysocoma, Euryops and, on saline soil, Salsola, Suaeda and Atriplex. Welwitschia bainessii often occurs in association with Zygophyllum stapfii.

5.7. (9.) Desert formations

(9.b.) Desert with isolated bushes
(Southern Namib coast)

Here and there, there are small patches of 'steekriet' or pickle reed (Eragrostis cyperoides) or 'voelsstruisgras', ostrich grass (E. spinosa).

5.8. Montane formations

High mountain vegetation is found on the Moco Massif and the Humpata plateau; it is scarce and formed by evergreen forests of Podocarpus milanjianus (small areas), by low grass/herblands, or by wooded communities with shrubs and trees; Protea sp. and Philippia sp. Wellington (1955) classified the Humpata plateau, S of Lubango, as a tropical grassland.

6. Geology of Angola

6.1. Old Massif - Maciço Antigo

6.1.1. Basement complex - Complexo de Base (Precambrium)

The African Basement comprises:

(1) a lower series; an igneous, granitized, migmatized complex of Lower Precambrian age, injected with intrusives and

(2) an upper series of Middle Precambrian, non-fossiliferous, sedimentary, more or less metamorphized rocks.

The lower Series is composed of:

- granitic gneisses
- albitic, calco-sodic, feldspatic gneisses
- migmatites

the Upper Series contains:

- schists
- slates
- quartzites

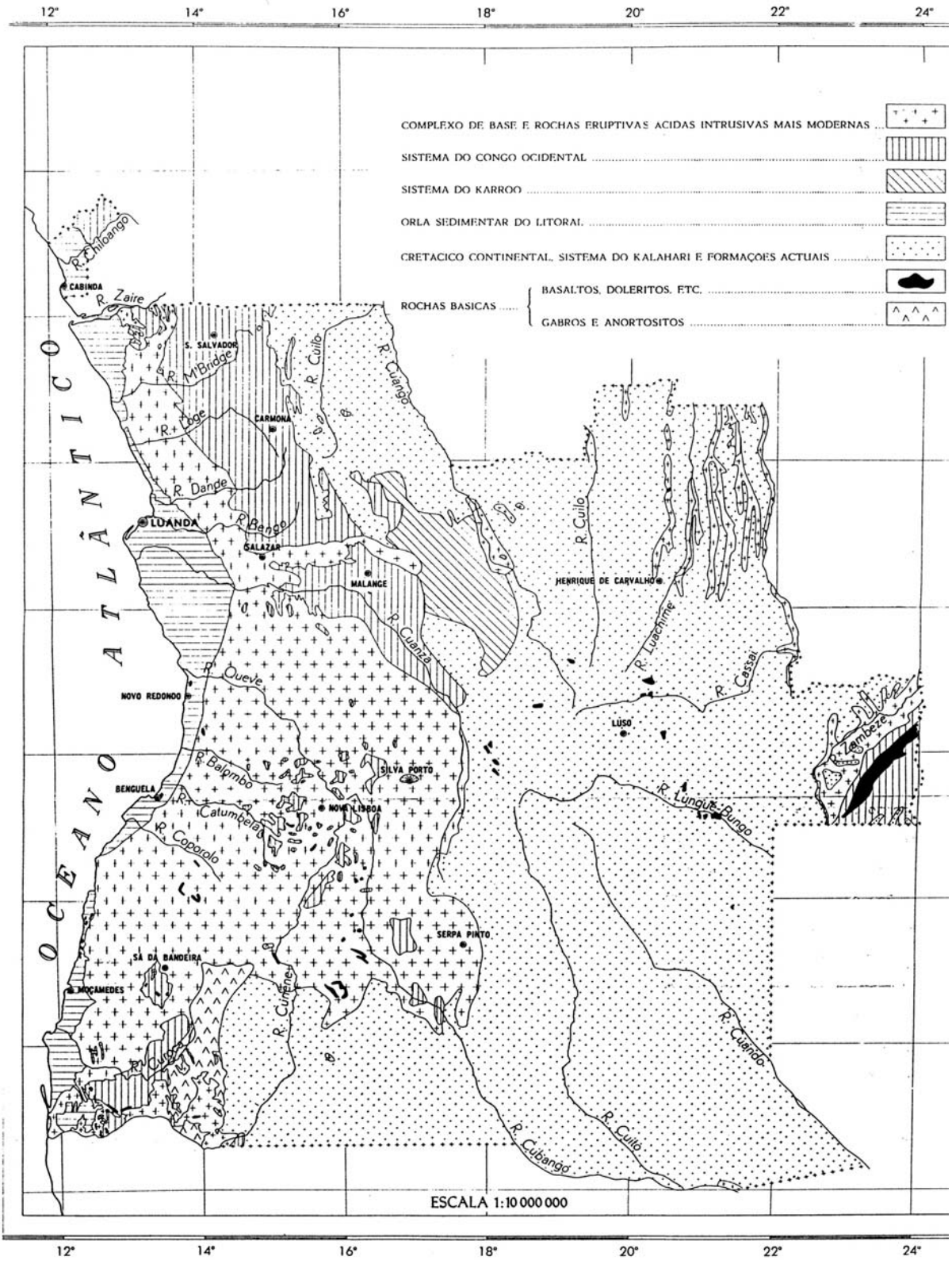


Fig. 4. Geology of Angola (Missão de Pedologia, 1965)

6.1.2. Western Congo System - Sistema do Congo Occidental (Upper Precambrian - Devonian)

A mega-cycle of sedimentation, which started in the Upper Precambrian, discordantly overlies Basal complex rocks. The System consists of sedimentary rocks of the Oendolongo and Bembe groups.

6.1.2.1. Oendolongo Group (Upper Precambrian)

a. Sansícua Series

- arkoses
- quartzites
- clayey schists
- limestones

b. Alto Chiloango Series

- lower tillites
- clayey schists
- quartzites
- stromatolitic limestones

6.1.2.2. Bembe Group

a. Limestone-Schist Series (Upper Precambrian-Cambrian)

- upper tillites
- schists

- stromatolitic limestones
- dolomitic limestones

b. Sandstone-Schist Series (Cambrian-Devonian)

- basal conglomerates
- graywackes
- clayey schists
- coarse arkoses
- cross-bedded graywackes

6.1.3. Igneous intrusions

a. Precambrian intrusions

- calco-alkaline granites
- grano-diorites
- quartzo-diorites
- grano-dioritic porphyrites

(Zaire Province and south of Rio Cuanza)

- gabbros
- anorthesites

(S. Angola)

b. Post Western Congo - Ante Karroo intrusions

- pink granites (Sambo-Cuíma, Capelongo, Cassinga, Caiundo)
- porphyrites (Cassinga and Capelongo)
- andesites
- dacites
- dolerites

6.2. Cover formations (Formaçoes de Cobertura)

The cover formations overlie the old massif. They are composed of shales, sandstones (sometimes with calcareous intercalations), conglomerates and eolian sands; dolorite and kimberlite intrusions are frequent (Post-Karroo).

6.2.1. Karroo
(Upper Carboniferous-Triassic)

The Karroo deposition begun with an ice age and ended with a volcanic episode. These rocks are mainly shallow fresh water and terrestrial deposits. Basal glaciogene rocks of the Dwyka Formation are overlain by shales, sandstones, mudstones and coal-bearing shales of the Ecca Group.

6.2.1.1. Lutôe Group
(Upper Carboniferous-Triassic)

- red basal conglomerate (tillite)
- red, ferruginous, coarse sandstone
- sandy schists
- black clayey schists, sometimes coal-bearing (Lunda)

6.2.1.2. Cassange Group
(Triassic)

- thick sandy schists, with calcareous intercalations
- fossiliferous micro-sandstones
- fine sandstones

6.2.1.3. Post-Karroo igneous intrusions

- dolorite (Moxico and Lunda)
- kimberlite (Lunda)
- volcanic ring structures, with carbonatites (Huambo and Bié)

6.2.2. Continental Cretaceous, or Calonda Group (formerly Lunda Series)

The Calonda Group is the equivalent of the Cuango Series in Zaire.

- basal conglomerate
- cross-bedded, purple, fine sandstone
- sandstone, with fine conglomerate layers

6.2.3. Tertiary to Quaternary Kalahari Sequence and related deposits

The Kalahari Sequence, of Tertiary to Recent age, forms an extensive cover of terrestrial origin in the east of Angola. A lime-cemented sand and conglomerate at its base is followed by a green sandy clay, white partly-calcareous sand and calcrete. Unconsolidated aeolian sand covers most of the Kalahari succession.

Six major lithological components can be identified within the Kalahari Group: (1) conglomerate and gravel; (2) marl; (3) sandstone, mainly secondary duricrusts; (4) alluvium and lacustrine deposits (swamp and pans); (5) Kalahari sand and (6) duricrusts.

A division into three groups can also been made:

(1) basal gravels, or Botletle deposits, composed of chalcedonic sandstone and grits, overlain by

(2) the Kalahari limestone group, composed of limestone, calcareous sandstone, pipe sandstone, overlain by salt, marl and calcareous tuff, in most places is covered by

(3) a mantle of sand, almost completely hiding the underlying rocks. In some places the Kalahari sands are 100-150 m thick. Usually sands are red, with iron-oxide coatings on sand grains; white sands have lime coatings. Sands are composed of quartz, but feldspar, epidote, chalcedony and mica also occur. These deposits have many accretions of secondary calcrete, silcrete and ferricrete.

Of all these units the Kalahari sands and the duricrusts (silcrete, calcrete and ferricrete) are most significant in terms of extend.

The term Kalahari Sand is not applied to a homogeneous deposit but to one which varies markedly in colour, composition, thickness and even age. Towards the Kalahari fringes it becomes mixed up with and indistinguishable from the weathering products of the underlying Karroo and Precambrian rocks. In the south western Kalahari the sands form a distinct aeolian deposit, 20-30 m thick, resting on an extensive calcrete surface. In northern Namibia, 200-300 m of sands lie uninterrupted on lower Kalahari gravels and marl, or directly on Karroo rocks.

The colour of the sand is commonly described as red, though in fact it is frequently ochreous and surface layers are sometimes bleached, particularly when the sand has been reworked in water. Colouring resulted of sand particles being coated by a pellicle of precipitated iron-oxide, derived from weathering of iron-rich minerals within the sand matrix. Little of environmental significance can currently be gained from attempting to interpret the regional scale colour variations (Thomas and Shaw, 1991).

The Kalahari sand is largely composed of quartz grains (90 % or more by weight) with accessory heavy minerals. Much of the sand is of local origin, including weathering products of the pre-Kalahari rocks, with additions derived from sources in an easterly direction.

Secondary formations are duricrusts, mostly in the calcrete-silcrete spectrum, which are among the most extensive in the world. Much difficulty is experienced in identifying and distinguishing between calcrete and silcrete without chemical or petrological analysis. This has led to much confusion in field identification. There exist a large number of intermediate forms, termed cal-silcretes and sil-calcretes.

Calcrete profiles of 60 m thick have been reported from the Mokolo valley and of 100 m thick at Khakaea in the southern Kalahari (Thomas and Shaw, 1991). The processes of alteration are complex and include gradual diagenesis of Kalahari strata, chemical weathering of underlying rock, particularly the removal in solution of base elements, the addition of aeolian silica and calcium and the continual precipitation and re-solution of calcium carbonate and silica under a wide pH range.
Although much of the duricrust is pedogenetic and has formed within the range of soil moisture fluctuation, other parts have formed, and continue to form, as a result of ground water activity.

Duricrusts are usually assumed to form prominent features in the landscape. In erosional landscapes this is generally true, but in a depositional setting, such as the Kalahari, such resistant features are encountered only where the duricrust has been exposed to sub-aerial processes, as in fossil valleys, escarpments, pan rims and surface pavements.

Calcretes and silcretes have developed from a wide variety of host materials in the Kalahari, including Karroo sedimentary rocks and basalts, Kalahari sands, beach gravels, alluvium, pan and lacustrine sediments, including shell beds, diatomaceous earths, as well as pre-existing duricrusts.

Late Tertiary tectonic movements have tilted the middle Tertiary pediplain on polymorphic sandstone, towards the N, in the direction of the Zaire Basin. Eolian sands were later on deposited (probably during the Pliocene). Also rolled gravels layers were deposited, probably during the Plio-Pleistocene.

A tilting towards the N occurred of the not yet completed late Tertiary Pediplain and a new dry phase provoked the silicification of the Plio-Pleistocene coarse sandstones.

6.2.4. Lower and Upper Cretaceous rocks (coastal belt)

The Cretaceous rocks of the coastal belt are conglomerates, gypsiferous marls, calcarenites, oolitic and marly limestones, dolomitic and fossil-bearing limestones.

In southern Angola (Benguela), lagunar deposits are characterized by gypsum, gypsiferous clays, micaceous calcareous and clayey sandstones.

Aptian: limestone of Tshipanga (Zaire basin)

coal-bearing sandstones of Quilungo and Calucala, limestone of Libongos, Dondo Formation: continental sandstone and conglomerates, bitumous limestones of Libongos (Cuanza basin)

sands and conglomerates (S. Angola)

Albian: limestone of Dombe Grande (S. Angola)
limestone of Cabo Ledo (Cuanza basin)

Senonian: limestone of Ponta Negra (Zaire basin)

Intrusions of basalts, dolerites and porphyrides also date from the Cretaceous.

6.2.5. Eocene (Coastal Belt)

The Eocene is represented by mainly somewhat silicified marl deposits.

6.2.6. Oligo-Miocene (coastal belt)

Deposits are gypsiferous marls, sandy limestones, clays, silty marls and arenites. Near Namibe (Moçâmedes) occur mesas or table mounts of Miocene rocks.

Near Benguela some trachyte intrusions of Miocene or younger age are found.

6.2.7. Plio-Pleistocene (coastal belt)

Hard sandstones, sands and conglomerates cap the older Tertiary marl layers.

6.2.8. Holocene alluvium

Holocene alluvium has been deposited, mainly in the coastal sections of the main river valleys.

6.2.8.1. Pan sediments and evaporites

Pans are frequently the sites of deep weathering, which permits the formation of tens of metres of duricrusts and laminated sands and clays. Aeolian deflation is controlled by groundwater tables and surface moisture content. Evaporite deposits occur in closed basins where saline waters are found close to the surface. Surface efflorescence of halite (NaCl) and of trona ($Na_2CO_3.NaHCO_3.2H_2O$) occur, with an absence of calcium and magnesium carbonates, already precipitated out of the system. The pans form a major source of eolian dust.

7. Soils

There is no up to date soil map of Angola. The low agriculture potentials of some regions, such as the Kalahari, has resulted in an absence of detailed soil and vegetation studies. Appropriate information on soils and soil properties is lacking and makes it difficult to assess the land use potential for specific areas.

The soil distribution in the country is mainly influenced by climate and topography.

Most of eastern Angola is covered by Kalahari sands, with a low nutrient status and water retention. Clayey alluvial soils are found on valley floors, such as the Kunene and Cubango.

Table 2 shows a tentative correlation between the Portuguese Oversees Soil Classification System (1965) and the FAO revised soil classification (1990).
The soil mapping units of the revised soil map (to a scale 1/2,500,000) are presented in table 3.

The soil mapping symbols in the data base of this report refer to the FAO revised soil classification (1990). Textural classes and slope classes are those of the FAO soil map of the world legend of 1974 (e.g. LXh - 2a: Haplic Lixisols, medium textured, slope class 0-8 %).

Textural classes

1 = coarse textured: sand, loamy sand and sandy loam with less than 18 % of clay and more than 65 % sand;

2 = medium textured: sandy loam, loam, sandy clay loam, silty loam, silt, silty clay loam and clay loam with less than 35 % clay and less than 65 % sand; the sand fraction may be as high as 82 % if a minimum of 18 % clay is present;

3 = fine textured: clay, silty clay, sandy clay, clay loam and silty clay loam with more than 35 % clay.

Slope classes

a = level to gently undulating: dominant slopes range between 0 and 8 %

b = rolling to hilly: dominant slopes range between 8 and 30 %

c = steeply dissected to mountainous: dominant slopes are > 30%

7.1. Soil correlation and classification

This chapter presents a soil correlation between the Portuguese Oversees Soil Classification and the revised FAO system (table 3). Table 4 shows the composition of the soil mapping units.

Several FAO soil phases were distinguished (table 2). These were NOT drawn on the soil map, as it could be interpreted that ALL soils of a mapping unit are characterized by that phase.
In many cases, a particular soil phase (e.g. petroferric phase) only affects part of the soils of that unit.

Table 2. Soil phases (FAO).

phase	description
inundic	an area is flooded during more than 10 days, during the growing period
petroferric	a continuous ironstone crust occurs at < 1 m from the surface
phreatic	a groundwater table occurs at depth of < 5 m
rudic	stones and gravels in the topsoil and at the surface restrict mechanized agriculture
salic	the soils have an electrical conductivity of > 4 dS/m at a depth of < 1 m
skeletic	a layer of > 25 cm thick, with > 40 % ironstone concretions, or fragmented ironstone crust, occurs at a depth of < 50 cm
sodic	the soils have an exchangeable sodium percentage (ESP) of > 6, in some horizon, within 1 m of the surface
yermic	soils in a desert environment (see FAO, 1990, p. 63)
lithic	hard rock occurs at a depth of < 50 cm

Table 3. Tentative soil correlation
Portuguese Oversees Classification (1965) - FAO (1990)

Portuguese classification	translation	FAO soil symbols (1990)
Dunas do deserto	desert dunes	ARh
Xero-Litossolos e/ou Solos Xero-litólicos	Xero-Lithosols and/or Xero-litholic soils	LPe
Udo-Litossolos e/ou Solos Udo-litólicos	Udo-Lithosols and/or Udo-litholic soils	LPd
Psamo-Regossolos e/ou Solos Psamo-rególicos	Psammo-Regosols and/or Psammo-regolic soils	ARh, ARa, RGu
Aluvionais fluviais	Alluvial fluvial soils	FLe
Aluvionais marinhos	Alluvial marine soils	SCn FLe, salic phase
Calcários pardos e/ou Calcários vermelhos	Brown and/or red calcareous soils	CLh
Barros negros litomórficos	Lithomorphic black heavy clays	VRk, VRe
Barros pardos e/ou pardo-avermelhados litomórficos	Lithomorphic brown and/or reddish brown heavy clays	VRk, VRe
Barros negros topomórficos	topomorphic black heavy clays	VRk, VRe
Arídicos pardo-cinzentos	Greyish brown arid soils	CLl, LVk, sodic phase
Arídicos pardo-avermelhados - rochas eruptivas básicas	Reddish brown arid soils - basic eruptive rocks	LVx, LVk - CMv, CMx
Arídicos halomórficos	saline arid soils	SCn, SCh
Arídicos com crosta calcária	petrocalcic arid soils	CLp
Lito- e/ou Topo-Calsiálicos de regiões sub-húmidas e húmidas	Litho- and/or Topo-calsiallitic soils of sub-humid and humid regions	LVh, sodic phase
Oxisiálicos pardo-cinzentos	greyish brown oxysiallic soils	CMu, ALh
Oxisiálicos pardo-avermelhados	reddish brown oxysiallic soils	ALf, ALh
Oxipsâmicos pardacentos	brownish Oxipsammic soils	ARb
Eutro-Fersialícos pardacentos	brownish Eutro-Fersiallitic soils	CMe, LVh
Eutro-Fersialícos crómicos	Chromic Eutro-Fersiallitic soils	LXh
Portuguese classification	translation	FAO soil symbols

		(1990)
Tipo-Fersialícos pardacentos -rochas eruptivas basicas - outras rochas	brownish Typo-Fersiallitic soils - basic eruptive rocks - other rocks	 - LVf, LVh - ALh, LVh
Tipo-Fersialícos crómicos	Chromic Typo-Fersiallitic soils	LXf, LXh
Psamo-Fersialícos pardacentos	brownish Psamo-Fersiallitic soils	ARo, ARb, FRx, FRh
Psamo-Fersialícos crómicos	Chromic Fersiallitic soils	ARo, FRh
Solos fracamente podzolizados	weakly podzolized soils	PZh
Eutro-Paraferrálicos crómicos	Chromic Eutro-Paraferrallitic soils	ACh, CMo
Tipo-Paraferrálicos pardacentos	brownish Typo-Paraferrallitic soils	NTh
Tipo-Paraferrálicos crómicos	Chromic Paraferrallitic soils	NTh, ACh
Braqui-Paraferrálicos crómicos	Brachy-Paraferrallitic soils	CMo
Psamo-Paraferrálicos crómicos	Psammo-Paraferrallitic soils	ARb, RGu
Fracamente Ferrálicos pardacentos - rochas eruptivas básicas	brownish weakly Ferrallitic soils - basic eruptive rocks	FRh FRh, ACf
Fracamente Ferrálicos amarelos - rochas eruptivas básicas	yellow weakly Ferrallitic soils - basic eruptive rocks	FRx FRx, ACh
Fracamente Ferrálicos vermelhos - rochas eruptivas básicas	red weakly Ferrallitic soils - basic eruptive rocks	ACh, FRh FRr
Ferrálicos Típicos amarelos	yellow Typic Ferrallitic soils	FRx
Ferrálicos Típicos vermelhos	red Typic Ferrallitic soils	FRr
Ferrálicos Típicos vermelhos e/ou Ferrálicos Típicos Húmicos vermelhos	red Typic Ferrallitic soils and/or red Humic Typic Ferrallitic soils	FRr, FRu
Psamo-Ferrálicos amarelos	yellow Psammo-Ferrallitic soils	ARo
Psamo-Ferrálicos vermelhos	red Psammo-Ferrallitic soils	ARo, RGu
Solos Glei	Low Humic Gley soils	GLe

Portuguese classification	translation	FAO soil symbols (1990)
Psamo-Hidromórficos	Psammo-Hydromorphic soils	ARg, ARa
Solos Glei-Húmicos, Glei-Turfosos e/ou Solos Turfosos	Humic Gley, peaty Gley and/or Peat soils	GLu, GLm, HSf
Solos Cromopsâmicos de regiões secas	Chromo-psammic soils of dry regions	ARo, ARb
Solos diversos com materiais lateríticos próximo da superfície	diverse soils with lateritic material near to the surface	FRp, PT
Litossolos e/ou solos litólicos e afloramentos rochosos	Lithosols and/or litholic soils and rock outcrops	LP

Table 4. Soil mapping units of Angola
(FAO classification, 1990)

Associated soils cover > 20 %, inclusions < 20 % of the soil mapping unit.

map zone	mapping unit	assoc. soils	inclusions	phases, properties (part of the soils)
B6	ACf 1 - 2a	FRh, FRx	VRe, ARb	petroferric/skeletic ph.
B3	ACh 1 - 2bc	FRh, ACf	FRr, FRx, LP	petroferric/skeletic ph.
C3	ACh 2 - 1/2bc	LPd	FRh	
C4	ACh 3 - 2bc	CMo, FRh	FRr, LP	
A1	ACh 4 - 1/2a	ARo	LVk, FLd, GLd	
D3	ARb 1 - 1a	-	ARh, LV, FR	
F4	ARb 2 - 1a	ARg	PZ, ACh, FRh	
F5	ARb 3 - 1a	ARo, ARh	PT	
F5	ARb 4 - 1a	ARg	FRh	
C5	ARb 5 - 1a	PT	ARg	
E5-E6	ARb 6 - 1a	ARh	ARo, ARg, PZ	
B6-C6	ARb 7 - 1a	ARh	ARa	
B7	ARb 8 - 1a	LXf, ARh	ARg	ferric properties
B7	ARb 9 - 1a	ARa, CLl	SC, VR, ARh	
C7	ARb 10 - 1a	ARh, CLl	PT	
C7-D7	ARb 11 - 1a	LXf	CLl, ARh, CMc	
D7	ARb 12 - 1a	ARg, LXf	CLl, CMe, PLe	
E-F7	ARb 13 - 1a	ARg, PZc	VR, SNg, ARh	
E-F7	ARb 14 - 1a	ARg, LVh	PZ	
D6	ARb 15 - 1a	PZc	ARg, ARh	
C7	ARb 16 - 1a	LXf, ARh	FRh	ferric properties
D7	ARb 17 - 1a	-	ARh, LXf, FR	
E4	ARg 1 - 1a	ARa	ARh, GLu, PT	inundic/phreatic phase
D5-C6	ARg 2 - 1a	GLu, HSf	PZ	inundic/phreatic phase
E5	ARg 3 - 1a	ARh, ARb	HSf, PZc	inundic/phreatic phase
C7	ARg 4 - 1a	-	ARh, GLu, PT	inundic/phreatic phase
E6	ARg 5 - 1a	ARb	PZc, ARh	inundic/phreatic phase
A1	ARg 6 - 1a	-	ARh, GLu, PT	inundic/phreatic phase

F7	ARg 7 - 1a	CMe	GLu, HS, FLe	inundic/phreatic phase
map zone	mapping unit	assoc. soils	inclusions	phases, properties (part of the soils)
C2	ARh 1 - 1a	ARo, RGu	PZc	
C3	ARh 2 - 1ab	PT, ARa	ARo, FRh, FRx	
A6	ARh 3 - 1ab	-	takyric SCn	shifting dunes
A1	ARo 1 - 1a	ARl, ARb	CMo, FRx	
A1	ARo 2 - 1a	LXh	FRx, ACh	
A2	ARo 3 - 1a	ARh	FRh, ACh	
B2	ARo 4 - 1a	ARh	-	
B2-C2	ARo 5 - 1/2ab	FRh	ARh, RGu, GL	
D2-D3	ARo 7 - 1a	ARh, ARa	GL, PZ	
D2-E2	ARo 8 - 1a	ARl	ARh, FRh, FRr	
D2	ARo 9 - 1a	FR	-	
B3	ARo 10 - 1a	-	-	
B3-C4	ARo 11 - 1a	PT, RGu	FRh, LXf	
C3	ARo 12 - 1a	ARl	ARh	
C3-C4	ARo 13 - 2ab	LPd	FR, LVh, LVx	
C3-D3	ARo 14 - 2a	FR	ARh	
C3-D3	ARo 15 - 1a	ARl	ARh, FRh, ACh	
B4-C4	ARo 16 - 1a	PTd	GLd, AR	
C4	ARo 17 - 1a	PT	ARh, ARg	petroferric phase
D4-D5 C5-C6	ARo 18 - 1a	ARl	ARh, FRh, ACh, ARg	
D4-E6	ARo 19 - 1a	ARh, ARb	GL, ARa, PZ	
C5	ARo 20 - 1a	FRh, FRx	ARg	
E5	ARo 21 - 1a	ARl	ARh, FRh, ACh	
B6	ARo 22 - 1a	ARb	FRh, LV	
C6-D6	ARo 23 - 1a	ARh, ARa	ARb, PZ	
A3	ARo 24 - 1a	-	GLe, ARh, VRe	
A1	ARo 25 - 1a	FRx, NTh	ARb, ACh	
B6	ARo 26 - 1/2ab	FRh	ARh, ARg	
A3	CLh 1 - 2/3a	VRk	LPe, LVx	rudic phase
A4-B4	CLh 2 - 2/3ab	VRk	GLe, VRe	
A4	CLh 3 - 2/3ab	VRk	FLe	
A4	CLh 4 - 2/3a	CMx, GYp	LVx, ARb, VRk	rudic phase and

				petrogypsic horizons
C7-D7	CLh 5 - 1/2a	CMe, FLe	Ple, GLe	
map zone	mapping unit	assoc. soils	inclusions	phases, properties (part of the soils)
D7-E7	CLh 6 - 1/2a	PLe	FLe, GL, CMe	
A2	CLl 1 - 2ab	LPe, LVk	SC, ARb	
A5-A6	CLl 2 - ab	SCn	Lpe	sodic phase
A6	CLl 3 - 1/2a	CMc	CMv	yermic phase, gypsic
A6-A7	CLl 4 - 1/2a	-	ARh, LPe	rudic and yermic phase
B6-B7	CLl 5 - ab	VRe, VRk	ARb	
B7	CLl 6 - 1/2a	-	VRe, LXh	
B7	CLl 7 - 1/2a	LXh, ARb	ARh	sodic and/or salic phase
B7	CLl 8 - 2ab	CMc, LPe	LVx, ARb	rudic/lithic phase
B7-C7	CLl 9 - 1/2a	-	LV, AR, SC	sodic and/or salic phase
A5-A6	CLl 10 - 2ab	LPe, SCn	-	sodic/salic/rudic phase
A6	CLp 1 - 1/2a	GYk	CMv, SCn	salic/rudic/yermic phase and gypsic horizon
A7	CLp 2 - 1/2 a	ARc	-	rudic and yermic phase
A1	CMo 1 - 2bc	FRx, CMo	LP, GLd, FRp	
A2-A3	CMx 1 - 1/2ab	ARo, LXf	LPe	lithic and rudic phase, ferric properties
A3-B3	CMx 2 - 1/2ab	CMe	LPe	skeletic/petroferric/ rudic phase
A2	FLe 1 - 2/3a	RG	-	salic/sodic/inundic/ phreatic phase
A2...	FLe 2 - 2/3a	-	-	salic/inundic/phreatic phase
C3	FLe 3 - 1/2a	-	GLe	inundic/phreatic phase
D7-E7	FLe 4 - 2a	CLl, PLe	ARg, VRe	inundic/phreatic phase
E7-F7	FLe 5 - 2/3a	CMe, GLe	PL, HS, CMc	inundic/phreatic phase
B2	FRh 1 - 2a	-	FRr	
E2	FRh 2 - 2/3b	FRr	FRx, ARo, LP	
B3	FRh 3 - 2/3bc	NTh	FRr, NTu	
B3	FRh 4 - 2bc	ACh	LP	
C3	FRh 5 - 2b	ACh	FRr, ARo, ARh	
C3	FRh 6 - 2/3b	ARo	FRr, LXh	
C3-D3	FRh 7 - 2b	ACh, CMo	LP, LVh	
C3-C4	FRh 8 - 2ab	FRx	ARo, ACh	

C3-B3	FRh 9 - 2ab	FRx	ARb, FRp	
map zone	mapping unit	assoc. soils	inclusions	phases, properties (part of the soils)
C3-C5	FRh 10 - 2a	ALh	FRx, FRp, GL, ARh	
C3-D3	FRh 11 - 2a	-	FRp, PT, ARh	
D3	FRh 12 - 2/3b	FRx	FRr, AR, LP	
C4-D4	FRh 13 - 2ab	LPd, CMo	FRx	
B4-C4	FRh 14 - 2ab	FRr, FRx	CMo, ACf, LP	petroferric/skeletic ph.
C4	FRh 15 - 2ab	FRr	ACh, FRx	
C4-C5	FRh 16 - 2ab	FRr	FRx, ANh	
C4-C5	FRh 17 - 2ab	FRr	ACh, FRx	petroferric phase
C4-D4	FRh 18 - 2a	FRx	FR, LX	
D4	FRh 19 - 2b	FRr, FRx	LVh, PT	
D3-D4	FRh 20 - 2ab	AR	-	
E4-E5	FRh 21 - 2/3a	FRr, FRx	FRp, ARo	
F4-F5	FRh 22 - 2ab	FRx, FRr	ARb, GL, FRp	
F4-F5	FRh 23 - 2a	FRx	FRp, FRr	
F4-F5	FRh 24 - 2/3b	ARo, ACh	FRx, LP, FRr	
A5-B5	FRh 25 - 2ab	FRr, FRx	ARo, FRp, ACf	petroferric phase
B5	FRh 26 - 2ab	FRr, FRx	-	
B5	FRh 27 - 2bc	ACh	FRx, LP	
B5	FRh 28 - 2ab	FRx, LP	FRr	petroferric phase
B5	FRh 29 - 2ab	CMo, FRx	LP	
B5	FRh 30 - 2ab	LPe	ARb, FRp, PT	petroferric phase
B5	FRh 31 - bc	ACf	FR, LP	petroferric phase
B6-C5	FRh 32 - 2ab	FRx	ARo	petroferric phase
B5-B6	FRh 33 - 2a	FRx	ARb	
D5	FRh 34 - 2/3b	FRr	FRx, ARo, LP	
E5	FRh 35 - 2a	FRr, FRx	FRp, ARb	
A6	FRh 36 - 2ab	LPe	LXf	ferric properties
B6-C6	FRh 37 - 2ab	FRx, ARb	ARg, FRp	
C6	FRp 1 - 2/3a	FRx, LXf	LPe, FRr, VR	
B6-C6	FRp 2 - 2a	FRh, FRx	FRr	

B2-B3	FRr 1 - 2/3a	FRu, FRh	ACh, FRp	
F4-F5	FRr 2 - 2ab	FRp	Lp, ACh, FRx	
E5	FRr 3 - 2/3a	FRx	LXh, PT	
map zone	mapping unit	assoc. soils	inclusions	phases, properties (part of the soils)
B6	FRr 4 - 2/3a	ACf, FRh	PT	
B6-C6	FRr 5 -2ab	FRp	LPe, ACh, FRx	
A2	FRx 1 - 2/3b	CMo, FRr	FRh, LXf, LPd	
A2-B3	FRx 2 - 2/3ab	NTh	FRh, FRp	
B2	FRx 3 - 2/3a	GLu	GLe	
B3-C3	FRx 4 - 2a	FRh, FRp	FRr, ARo	
C4	FRx 5 - 2a	-	FRh, FRp	
F4	FRx 6 - 2a	FRp	FRh, GL	
F4	FRx 7 - 1/2a	ARg, ARa	GLd	
B5	FRx 8 - 2b	FRh	ACf, FRr	petroferric phase
B4-B5	FRx 9 - 2ab	FRh	-	petroferric phase
B5-C5	FRx 10 -2a	-	FRh, FRp	petroferric phase
B5-C5	FRx 11 - 2a	FRh	FRp, LP, ARb	
C5-C6	FRx 12 - 2ab	FRh, FRr	FRp	
A6-B6	FRx 13 - 2a	FRp	FRh, ARb	petroferric phase
B6	FRx 14 - 3a	FRh	LXf, VR	skeletic phase (gabbro)
C6	FRx 15 - 2a	LPe	FRh, LV	
C6	FRx 16 - 2a	FRp	FRh, GL	
C6	FRx 17 - 2a	FRh, FRp	FRr, AR	
A1	FRx 18 - 2bc	CMo, ACh	LP, FRp	
C4	FRx 19 - 2ab	-	PT	
B4	GLe 1 -1/2a	GLu	HSf	
C3	LP-ACh-NT-c			lithic/rudic phase
C3	LP-LV-ab			lithic/rudic phase
F4	LP-FR-c			lithic/rudic phase
A5-A6	LP-CL-c			lithic/rudic phase
A6-A7	LPe-CL-c			lithic/rudic phase
B3-B4	LPe 1 - 2a	LVh	-	lithic/rudic phase
A6-A7	LPe 2 - ab	SCk, LVk	ARb, ARc	lithic/rudic/sodic/ salic phase
A5-A6	LVf 1 - 1/2ab	CLl	LPe, ARb	

A5-A6	LVf 2 - 1/2ab	CMe, LVh	LPe	
	LPq 1 - 2 c	LPq	RK	rock debris properties
map zone	mapping unit	assoc. soils	inclusions	phases, properties (part of the soils)
B3	LVh 1 - 2a	LVg, PT	FRr, FRp	
C3	LVh 2 - 1/2a	GLe, GLu	ARh, LPd	sodic phase
B6-B7	LVh 3 - 1/2a	CLl	LPe	
A2-B3	LXf 1 - 1/2bc	LPe, LXh	FRx, CMe, ARo	
A2	LXf 2 - 1a	LXh	ACh, CMe	
A4-B4	LXf 3 - 1/2ab	LXg, LXv	LPe, LXh VRe (basalt)	petroferric/skeletic phase
A5-A6	LXf 4 - 2b	LXh	FRx, LPe	petroferric/skeletic ph.
B5	LXf 5 - 2b	ACh, LXh	FRx, FRh, LPe	petroferric phase
A5	LXf 6 - ac	LP, FR	ACf, LXh	
A2	LXf 7 - 1a	ARo, LXh	CMe, ACh, LVa	
A1	NTh 1 - 3c	CMo	ACh, ACu	
C2	NTh 2 - 2/3a	FRh, ARb		
B2	NTh 3 - 2/3ab	FRx	ACp, FRp	
B2	NTh 4 - 3c	-	NTu, ACh	
B2	NTh 5 - 2/3bc	FRx	ACh	
B2	NTh 6 - 2/3bc	FRx	FRr, NTu	
B2	NTh 7 - 2/3ab	FRx	FRr, FRp	
C3	PTd 1 - 1a	ARh	ARo, LP, FR	
A6	PT - 1a		GLd, AR	
D6	PZc 1 - 1a	-	ARg, ARo, HSf	
A6	SCn 1 - 1/2a	LP	CL, FLe	rudic phase
A6	SCn 2 - 1/2a	CLl, LPe, SCk	CMv	rudic and yermic phase
A6	SCn 3 - 1/2a	LPe, SCk	SCy	yermic, rudic phase and petrogypsic crusts
A6-A7	VRe 1 - a	-	LPe	
A6-B6	VRe 2 - a	FRr	FRx, ACh	
A6-B6	VRe 3 - a	LVf	FRr	
A6-B7	VRe 4 - a	-	LVf, LPe	
B7	VRk 1 - a	CLl	FLe	

7.2. Comments

7.2.1. Sandy soils of the Kalahari

Soil profile development is virtually absent, though variations in texture with depth have been observed. In many areas soils have a very low content of organic matter (0.2-0.55 %) and nutrients. Soils developed in Kalahari sands are classified as Ferralic or Cambic Arenosols. They have a poor profile development and are moderately acid. The presence of the underlying calcrete leads to calcic and petrocalcic horizons. The tendency exist for finer-textured soils to develop in depressions of all types, particularly in pans and fossil valleys, where calcium, magnesium and phosphorus levels are significantly higher.

Soils in hollows, including interdune ridges, are usually Calcic Luvisols or Gleysols, dependent on drainage.

Where the pre-Kalahari substratum appears at the surface Calcisols or Arenosols derived from sandstone or granitic rocks appear. The latter are sometimes indistinguishable from Kalahari Sand.

Vertisols occur in large depressions of probably lacustrine origin. These soils have a high fertility, but are extremely intractable; a large portion of the soil moisture is held at tensions above 15 bars, making it unavailable to most plants.

Pans contain gleysols or gleyic Solonchaks, with frequent silcrete duricrust development.

7.2.2. Solonchaks

Solonchaks are soils with free salts, in Angola usually NaCl or Na_2SO_4. Usually a crust is present at the surface.
These soils are found where capillary rising water reaches the surface: pans, dry river beds... Halophytic vegetation is common.

7.2.3. Solonetz

In Solonetz soils more than 15 % of the cation exchange capacity is occupied by sodium. Free salts are not available. When Na is washed out, a Solod soil forms. Solonetz soils are slippery and sticky in the rainy season, but in the dry season they are extremely hard. pH may reach values of 10.

7.3. Soil data input in the SOTER programme

The SOTER programme is a useful tool to handle terrain and soil data, the user of this programme should however be advised that the stored information is simplified and restricted:

- at the terrain unit level, the programme permits only ONE entry for each information level; e.g. lithology of an area is often complex and composed of contrasting rocks, such as layers of limestone and sandstone; the SOTER programme will only accept ONE entry; this over-simplification may lead to erratic decisions when the programme is used for land use planning purposes; the same problem exists at the terrain component level; more information may be found in the text of the report.

- SOTER permits description of quantity and size of gravels, but not of gravel composition. A soil with weathered schist gravels will store water in the rotten rock and also provide nutrients to the plants, which is not true for ironstone or quartz gravels.

- There is no entry available for ironstone crusts, which cause temporary water stagnation problems and damage to coffee and other crops.

- SOTER permits to describe soil structure, but there is no entry to describe large and deep cracks, which occur in some soils, as in Vertisols.

- There is no entry available for mottling, important to define drainage problems.

During the entering of soil information in the SOTER programme some difficulties were encountered.

SOTER demands cation exchange capacity (CEC) values at pH 7, but usually only CEC values at pH 8.1 are available. The latter have been entered in the programme.

The fine earth fraction subdivision, into silt and sands, used by SOTER, is not the same in the Portuguese Oversees System.

PART II DATA BASE FOR ANGOLA 50

1. Introduction 50

2. Terrain units 52

2.1. Main Land Regions 52

2.2. Specific subdivisions 52

2.3. SOTER terrain unit characterization 53

3. Natural vegetation 53

4. Land Use 53

4.1. IGADD Crop Production System Zones "CPSZ" 54

4.2. Thermal zones 54

4.3. Crop codes 55

5. TERRAIN UNITS OF ANGOLA 55

6. BIBLIOGRAPHY 180

PART II DATA BASE FOR ANGOLA

1. Introduction

This chapter gives a description of each terrain unit. Terrain units were coded and described according to the SOTER programme. Land use data were coded and structured following the principles of the IGADD system.

As the SOTER programme does only allow one entry, even in complex regions, a more accurate description of the terrain units can be found in following chapter.

Information has been structured as follows:

number Terrain unit code (SOTER), geographical name and
0000 minimum to maximum altitude (SOTER)

(1) -geological and geomorphological information (SOTER)
(2) -soil units (FAO classification, 1990), textural classes and slope classes (see page 46)
(3) -vegetation (Atlas of Angola, 1982, and other sources)
(4) -land use: crop production system zones or "CPSZ", thermal zones and main crops of the area (IGADD system)

Notes

- "WCS"

  is an abbreviation for "Western Congo System" in the geological description,

- "'ngote, ongote or lingote"

  Typical vegetation type in Angola; it is composed of low grasses, leguminoses and herbs, with a dense wooden rooting system at the surface. It is usually found on lower valley slopes on the High Plain.

2. Terrain units

Terrain units have not been numbered at random, but according to the major land regions to which they belong.

2.1. Main Land Regions

0000	Beaches and sand spits
0100	Coastal terraces on sedimentary rocks
0200	Alluvial plains
0300	Coastal plateau I
0400	Plateau II
0500	Plateau III
0600	High Plain or Planalto IV
0700	Marginal mountains, plateau V and High Plain IV
0800	Kalahari Basin
0900	Dissected valleys of the Kalahari
1000	Cassange depression
1100	Continental and desert dunes
1200	Alto Zambeze Massif

2.2. Specific subdivisions

0100	Coastal terraces
----	----------
0101	on Cretaceous rocks
0102	on Tertiary rocks

0300	Coastal plateau I
----	----------
0301-0310	on sedimentary rocks
0311	on crystalline rocks
0312	Higher coastal plateau Ib and escarpments

2.3 SOTER terrain unit characterization

In the following descriptions, codings (see SOTER manual) are presented for:

4	minimum elevation
5	maximum elevation
8	major landform
6	dominant slope
9	regional slope
10	hypsometry
12	general lithology

3. Natural vegetation

Natural vegetation has been classified, based on the land use map (scale 1/3,000,000) of the atlas of Angola (1982). For each terrain unit, an estimation of the surface cover has been given.

More detailed information on vegetation types has been added, where available.

E	desert
ST	semi-arid steppe vegetation
GH	grass/herb - lands or "chana and anhara"
SW	dry savanna with trees or shrubs, or dry tropical woodland
OF	open forest
HF	dense humid forest
FS	mosaic of forest and savanna

4. Land Use

4.1 IGADD Crop Production System Zones "CPSZ"

Based on the principles of the IGADD programme, following Crop Production System Zones, or CPSZ, have been defined

AR	Arid and hyper-arid areas
ML 1 2 3	Marginally productive lowland(semi-arid and/or sandy lowlands-medium highland zones lowlands Plateau I and lower areas, < 400 m a.s.l low highlands Plateau II 400-800/1,100 m a.s.l medium highland zones Plateau III and Kalahari Basin 800/1,100 -1,300 m a.s.l
PL 1 2 3	Productive lowlands moist semi-arid, sub-humid and humid lowlands and medium highlands; medium to fine textures) lowlands low highlands Plateau II 400-800/1,100 m a.s.l medium highland zones Plateau III and Kalahari Basin 800/1,100 -1,300 m a.s.l
MH	Marginally productive highlands (semi-arid and/or sandy highland zones) Plateau IV, V and higher mountains 1,300-2,620 m a.s.l
PH	Productive highlands (moist semi-arid, sub-humid and humid highlands medium to fine textures) Plateau IV, V and higher mountains 1,300-2,620 m a.s.l
IR	Irrigated areas

4.2. Thermal zones

For each CPSZ, the thermal zone was determined, based on the mean annual temperature (^{o}C)

1	> 25	warm
2	20 - 25	moderately warm
3	15 - 20	moderately cool

These symbols have been added to the CPSZ code, e.g.

PL1/1 productive lowland at < 400 m a.s.l. /thermal zone 1

4.3 Crop codes

The main crops were determined for each CPSZ and coded according to the IGADD programme.

2	maize
4	millets
6	rice
7	sorghum
9	wheat
11	phaseolus bean (and other beans)
17	groundnuts
20	sunflower
22	cotton
23	sisal
25	cassava
26	sweet potato
27	white potato
30	banana
32	sugar cane
33	pineapple
35	vegetables
36	coffee
38	other narcotics and stimulants: tobacco, cacao
39	tree crops/fruits: oil palm, cocos
40	pasture

Those number codes have been added to the CPSZ/thermal zone symbol, e.g.

PL1/1 -25,06
Productive lowland at < 400 m a.s.l. /thermal zone 1;
main crops: cassava (25) and rice (06)

5. TERRAIN UNITS OF ANGOLA

0000 Beaches and sand spits

SOTER (4) 0, (8) SR, (9) DU, (10) 1, (12) UE

0001 A sand spit at Ponta das Palmeirinhas (near Luanda) has a length of 50 km; it is situated at 2-4 km from the cliff coast.
Typical Profiles: p.9c/63 (ARo) – p.279/62 (Aro) – p.82/64 (ARo)

0002 Sand spit at Baia dos Tigres

0100 Coastal terraces on sedimentary rocks

0101 Coastal terraces on Cretaceous rocks (0-115 m a.s.l.)

SOTER (8) CL, (9) RI, (10) 6, (12) SO2

- A plateau, build of sandy marl, overlain by sandstone and limestone layers, often has been dissected to a badland topography; hill tops align at the altitudes of coastal terraces A and B.
- CLh 2 - 2/3a; CLh 4 - 2/3a, partly rudic phase
  Typical Profiles: p.233c/62 (CLh) – p.299c/62 (CLh)
- ST
  Grass steppe grows on the hills; in the valleys occur mainly grasslands, with rare trees and shrubs.
- ML1/2 - 04,07
  It is a sorghum and millets zone
- IR/2 - 30,39,33
  In the irrigated Rio Cavaco valley: banana, papaya, guava, lemon, pineapple, cabbage... are grown.

0101/1 Rio Queve-Porto Amboim dissected coastal terrace (0-50 m a.s.l.)

- This area is a dissected landscape, formed in yellowish marls; the hill tops align at 40-50 m a.s.l., altitude of a former coastal terrace.

- CLh 2 - 2/3 ab

- Vegetation is formed by a patchy grass steppe on bare, yellow marls; on the valley floors grow mainly grasses.

0101/2 Sumbe (Novo Redondo) badlands (0-50 m a.s.l.)

- A bright yellow to greyish yellow sandy marl is overlain by sandstone and limestone layers. This plateau has been dissected to a badland topography. The summit remnants reach the altitude of an old coastal terrace at 20/30-50 m a.s.l.

- CLh 4- 2/3 a

- The hill slopes are covered by rare grasses; the valley floors are characterized by rare trees and shrubs.

0101/3 Lobito-Benguela coastal terraces (0-115 m a.s.l.)

- (1) Coastal terrace A is found at 60-115 m a.s.l.; it is an old abrasion platform with mollusc sandstone and breccia. The platform has been dissected by (dry) valleys.
  At Benguela, dissected badlands formed in soft yellow marl. On those hill tops (old platform remnants), sandy soils are found, with many rolled quartz and gneiss gravels.

  (2) Coastal terrace B occurs at 40 m a.s.l.. It builds steep cliffs at the coast, cutting marl and limestone layers. There are numerous dry valleys and there is no beach.

- CLh 4 -2/3 a, partly rudic phase
  Gravelly, red soils overlie weathering limestone.

- Vegetation is formed by dry short grass steppe, with herbs, few thorn shrubs (Boscia micropylla) and few trees.

- In the irrigated Rio Cavaco valley: banana, papaya, guava, lemon, pineapple, cabbage... are grown.

0102 Coastal terraces on Tertiary rocks (0-100 m a.s.l.)

SOTER (8) CL, (9) RI, (10) 6, (12) SO2

- Pliocene sandy limestone and sandstone layers overlie Miocene yellow marls.

- CLh 4 - 2/3 a
  Typical Profiles: p.233c/62 (CLh) – p.299c/62 (CLh)

- ST
  There is a dry steppe vegetation.

- ML1/2 - 04,07
  It is a millets and sorghum zone.

0102/1 Ponta do Sombreiro coastal terraces
W of Benguela

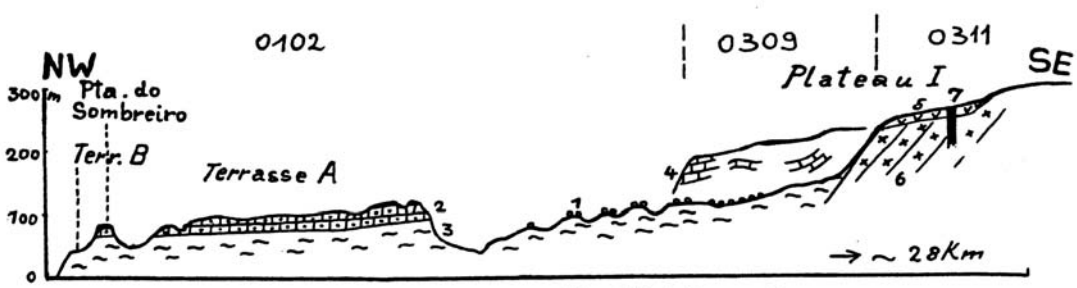
- Pliocene sandy limestone and sandstone layers overlie soft, Miocene yellow marls, with gypsum nodule layers. A SW-NE oriented depression, in direction of Rio Coporolo, is limited by steep rocky slopes:

  - on the western slopes occur Pliocene rocks, overlain by Miocene rocks;

  - the eastern slopes developed in Miocene marls.

  (1) Pliocene rocks build the coastal terrace A at 80-100 m a.s.l. Ponta do sombreiro is a witness hill capped by harder Pliocene rocks

  (2) Coastal terrace B is found at 40 m a.s.l.



Geologisches Profil südlich Benguela.

1. Schotter; 2. Pliozäne Sandsteine; 3. Miozäne tonige Mergel; 4. Unterkretazische Kalke, Mergel usw.; 5. Tone mit Gips der Unterkreide (Aptien?); 6. Biotitgneis; 7. Andesit und metamorphe Gesteine.

Fig 5. NW-SE transect, south of Benguela, with terrain units:

- 0102 dissected coastal terraces A and B on Tertiary sedimentary rocks;
- 0309 coastal plateau I on sedimentary rocks;
- 0311 coastal plateau I on crystalline rocks.

1 = rolled gravels
2 = Pliocene sandstone
3 = Miocene marl
4 = Lower Cretaceous limestone, marl ...
5 = Lower Cretaceous clays with gypsum accumulations
6 = biotite gneiss
7 = andesite and metamorphic rocks

(Jessen, 1936)

0103 Namibe coastal terraces on Tertiary rocks
(0-180 m a.s.l.)

SOTER (8) LL, (9) F, (10) 1, (12) SO2

- The coastal terraces build a partly dissected, table mount plateau on Eocene to Miocene limestone, marl and calcareous sandstone.

- CLp 1 - 1/2a, SCn 1-2-3 1/2 a, partly rudic phase.
  Typical Profile: p.185/58 (SCn)

- DE
  It is a desert area, with rare herbs and shrubs (see below).

- AR/2+3

0103/1 Namibe coastal terraces (0-180 m a.s.l.)

- (1) Coastal terrace B has, in some areas, been dissected to a table mount landscape, at 90-180 m a.s.l.; otherwise it forms a very flat plateau, with few, isolated, table mountains (remnants and outliers of plateau I); dry valleys are located slightly lower than the plateau (dambas).

  (2) Coastal terrace A occurs at 145 m a.s.l.; it forms steep cliffs (40 m high) at the coast, composed of Eocene limestone, marl and calcareous sandstone, with a Miocene capping.

- CLp 1 - 1/2a, SCn 1-2-3 1/2 a, partly salic and rudic phase.
  South of Namibe town occur saline gypsum-calcrete soils.

- Vegetation forms a desert steppe, with every 20-30 m, a sharp, 0.5 m tall, thorn shrub: Sarcocaulon mossamedense, also some grasses, herbs and Welwitschia ('n'tumbo').

0103/2 Rio Coroca coastal terrace (100-120 m a.s.l.)

(N of Tombua and N of Rio Coroca)

- This uniform, very flat plateau builds 35-40 m high cliffs at the coast; the SW part is completely covered by rolled gravels, overlying gypsic marl dust; the plateau is interrupted by the deep canyon of Rio Coroca.

- SCn 3 - 1/2a, partly rudic phase;
see profile p.52/57 (SCk)

  10-20 cm thick, dark grey, gypsic lime crusts occur at the surface; also nut-sized, polished, rounded gravels are found at the surface; salt crystals are common. Clayey marls are covered by saline dust layers of 2-4 mm thick.

- Vegetation is composed of rare Welwitschia and 3-5 cm tall Zygophyllum; in the erosion gullies of the Rio Coroca canyon grow 1.6 m high candle Euphorbia.

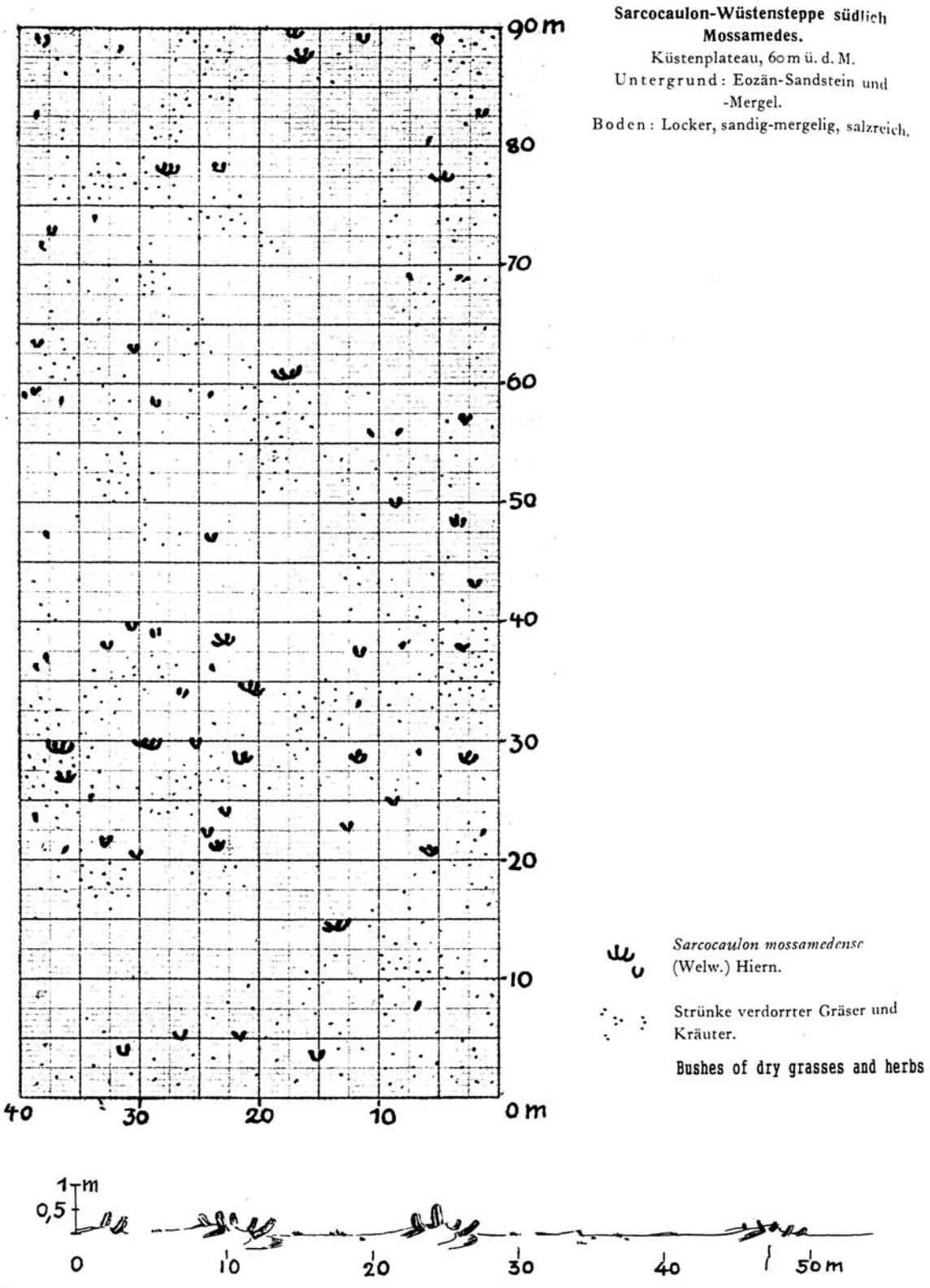


Fig. 6. Terrain unit 103/1: typical vegetation on Coastal terrace A, along the Namibe-Tombua road (60 m a.s.l.). Sarcocaulon desert steppe on a saline, gravelly, sandy marl soil on Eocene sandstone and marl (Jessen, 1936)

0200 Alluvial plains

0201 Estuarine plains (e.g. Zaire river)

SOTER (8) LV, (9) F, (10) 1, (12) UM

- Parent material is formed by saline, marine and estuarine sediments.
- FLe 1 - 2/3a, inundic, salic and/or sodic phase
- On the tidal plain grow mangroves and somewhat higher saline grasslands.

0202 Non-specified alluvial plains

SOTER (8) LV, (9) F, (10) 1, (12) UF

- Medium to fine textured alluvial sediments have filled in the valley bottoms.
- FLe 2 -2/3a, partly salic, inundic or phreatic phase
- Vegetation is characterized by temporary and permanent swamps and grasslands...
- PL, PH, IR, e.g. PL1/2 - 30,32,35,39
  The valley floors are used for planting of banana, sugar cane, vegetables, oil palm...

0203 Sumbe (Novo Redondo) - Rio Cambongo coastal alluvial plain

SOTER (4) 0, (8) LV, (9) F, (10) 1, (12) UF

- The valley floor is filled up by medium to fine alluvial sediments.
- FLe 2 -2/3a, partly salic, inundic, or phreatic phase.
- PL1-IR/2 - 30,39,40
  The plain is planted with irrigated oil palm, banana and cocos. Pasture exists on the saline grasslands.

0204 Rio Queve coastal alluvial plain

SOTER (4) 0, (8) LV, (9) F, (10) 1, (12) UF

- Alluvial sediments build a several kms wide valley floor, situated 80-100 m below the plateau level. The upper valley slopes and plateau edge are composed of hard limestone and the dissected lower slopes cut across soft yellow marls. Swamps and meanders characterize the alluvial plain. Upstream the valley becomes a narrow canyon.
- FLe 2 -2/3a, partly salic, inundic, or phreatic phase
- The valley slopes are covered by thorny shrubs and succulents.
- On the flat valley floor oil palm is grown.

0205 Rio Catumbela-Rio Cavaco coastal alluvial plain (Benguela)

SOTER (4) 0, (8) LV, (9) F, (10) 1, (12) UF

- The valley floor is filled up with alluvial sediments.
- FLe 2 -2/3a, partly salic, inundic, or phreatic phase Mainly greyish yellow loamy alluvial soils occur.
- Irrigated agriculture on the valley floor: sugar cane, oil palm, cocos, banana, papaya...

0206 Rio Bero and Rio Giraul coastal alluvial plain

SOTER (4) 0, (8) LV, (9) F, (10) 1, (12) UF

- These alluvial valleys are located near Namibe town.

- FLe 2 -2/3a, partly salic, inundic, or phreatic phase.

- These two river oases in the Namib desert are situated at 5-7 m a.s.l., and are favoured by a permanent groundwater table.

- IR/2 - 39,35,11,27,02,26,25,32,22,30...
  There are irrigated gardens with oil palm, olive, cabbage, beans, peas, tomato, carrot, potato, maize, orange, lemon, peach, apple, date palm, sweet potato, cassava, sugar cane, cotton, ricinus, mango, papaya, guava, passion fruit, banana, cocos

0207 Rio Coroca (Tombua) desert canyon

SOTER (4) 0, (8) LV, (9) F, (10) 1, (12) UF

- Alluvial sediments

- FLe 2 -2/3a; partly salic, inundic, or phreatic phase. Area composed of sandy marl or clayey alluvial soils; the valley floor has a permanent groundwater table at a depth of 0.5-2 m.

- IR/2 - 02,11,35,32,30...
  In this green oasis: maize, beans, cabbage, sugar cane, onion, date palm, ficus, and banana are grown.

0208 Rio Cuanza-Rio Mucoso-Rio Lucala mid-stream alluvial plains

SOTER (8) LV, (9) F, (10) 1, (12) UF

- Alluvial sediments have been deposited on the valley floor in the region of Dondo.

- FLe 2 -2/3a; partly salic, inundic, or phreatic phase. Soils are dark brown, with a permanent groundwater table.

- The shallow groundwater table favours the growth of moist high forest, with baobab trees and a dense shrub undergrowth, kapok (Ceiba pentandra), Anonaceae, Meliaceae, leguminoses, Moraceae...; grasslands occur in the swamps of abandoned river beds.

- Sisal, cocos, banana, oil palm and kapok zone

0209 Rio Cuanza and Rio Bengo coastal alluvial plains

SOTER (4) 0, (8) LV, (9) F, (10) 1, (12) UF

- Alluvial sediments build a wide, flat, swampy alluvial plain, with many lakes (lagunas), at those places where minor affluent valleys have been blocked by sediments of the main river.

- FLe 2 -2/3a; partly salic, inundic, or phreatic phase

- Typical banana, papaya, mango, cocos zone.

0300 Coastal plateau I
---- ----------

0301 Cabinda coastal plateau I (0-400 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 1, (12) SC

- A Plio-Pleistocene sandsheet composed of yellowish brown clayey sands, with gravel layers, almost completely overlies Cretaceous to Miocene sedimentary rocks: limestone, sandstone, clay, calcareous sandstone, tuff, marl, phosphate rock, ironstone...

- Aro 1 -1a, Aro 2 - 1a, ACh 4 - 1/2a, ARo 25 - 1a;
  Typical Profiles: P.9c/63 (ARo) – p.279/62 (ARo)-p.82/64 (ARo);
  profile p.237/59 (LXh)

- HF (50 %), SW (50 %)
  Evergreen dense humid forest (Maiombe forest) covers the plateau, with Gossweilerodendron balsamiferum, Pterygopodium oxyphyllum, Terminalia superba, Chlorophora excelsa. Undergrowth is represented by evergreen low trees and shrubs. Many parts of the forests were cleared for agriculture and degraded secondary forest of Musanga smithii.., Hyparrehnia and Andropogon grasses recolonizes these areas.
  Savanna with shrubs and trees also occurs, with Annona spp. and Hymenocardiacida. Hyphaene palms are common along the coast up to 50 m a.s.l.. Mangroves are found around lake Massabi and the estuarium of Rio Chiloanga.

- ML1/1+2 - 25,36,38;
  This is a robusta coffee, cassava and cacoa zone.

0302 **Zaire coastal plateau I** (< 400 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 1, (12) SC

- A Late Tertiary to Quaternary sandsheet covers most of the area.

- Aro 2 - 1a, Aro 3 - 1a, CLl1 - 2a;
  Typical Profiles: P.9c/63 (ARo) – p.279/62 (ARo)-p.82/64 (ARo);
  profiles p.232c/60 (RGu) and p.273c/60 (ALf)

- SW
  Vegetation is dry savanna and woodland.

- ML1/1 - 25
  This is a cassava zone.

0303 **Zaire-Castende coastal plateau I** (0-400 m a.s.l.)

SOTER (6) 8-30, (8) LL, (9) IN, (10) 1, (12) MA2

- This slightly undulating inselberg plain has formed on

rocks of the Basal complex (gneiss...).

- FRx1 -2/3b (north), LXf1 - 1/2 bc, LXf2 - 1a (south); CMx1 - 1/2ab, partly lithic and/or rudic phase; see profile p.181c/60 (FRx); Typical profile: p.237/59 (LXf)

- 50% SW (N); in the S: 10% GH, 25% FS, 15% OF

- PL1/1+2 - 25,36
  It is a cassava and robusta coffee zone.

0304 Lufico igneous intrusions in unit 0303
(< 400 m a.s.l.)

SOTER (6) 8-30, (8) LL, (9) IN, (10) 1, (12) IA

- The intrusions are composed of Precambrian granite, grano-diorite and quartzo-diorite.

- Soils here are associated soils of soil mapping unit FRx 1 -2/3b, LXf1 - 1/2bc ; profile p.304/60 (LXh); Typical profiles: p.181c/60 (FRx) – p.113c/60 (FRx) – p.159/56 (FRx).

- SW
  Vegetation is dry savanna and woodland.

- PL1/1 - 25
  It is a cassava zone.

0305 Ambriz coastal plateau I (100-400 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 1, (12) SC

- This plateau developed on continental Cretaceous sedimentary rocks.

- CMx 2 -1/2ab, partly skeletic/rudic/petroferric phase; LXf 7 - 1a; profile p.287/60 (LVa).

- SW
  Vegetation is dry savanna or woodland.

- PL1/2 - 25,30,39
  It is a cassava, banana and oil palm zone.

0306 Bengo coastal plateau I (100-450 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) U, (10) 1, (12) SC1

- This plateau area occurs on marine and continental Cretaceous sedimentary rocks.

- CMx 2 - 1/2ab, partly rudic phase, some soils have ferric properties, petroferric or skeletic phase.

- ST
  The steppe vegetation, changes to secondary savanna in the less arid eastern parts; riparian forests grow on the valley floors.

- PL1/1 - 02,40,23(39,30)
  This is a maize, sisal and pasture zone; oil palm and banana are restricted to valley floors.

0306/1 Maria Teresa plateau Ia (150-160 m a.s.l.)

- This slightly undulating plateau formed on marine Cretaceous limestones, sandstones, marls (Albian) and Senonian sandy marl (near Itombe); or on limestone (at Maria Teresa)

- CMx 2 -1/2ab

- Vegetation is a dry baobab-tree steppe, with grass floors; there are 2-5 m high shrub groups and isolated or grouped, 10-15 m high trees. Many baobab trees are present; in the W many Euphorbia are found.
  The valleys are covered by open riparian forests, with low trees and 2 m tall grasses.

- Oil palm cultivation is restricted to valley floors.

0306/2 Dondo plateau Ia (100-150 m a.s.l.)

- This wide, saddle-like plateau has formed on red clayey sandstones, red conglomerates and breccia (with gravels of Oendolongo rocks) of the Dondo Series.

The 100 m deep valley of Rio Cuanza has a valley floor at 54 m a.s.l.

- CMx 2 - 1/2 ab, partly rudic phase
  Soils are yellowish or brownish and sandy; up to 1 m thick rolled gravel soils also occur.

- Mainly secondary savanna vegetation occurs, composed of forest groups and shrub islands, with high grass floors and baobab trees; valley floors are characterized by riparian forests.

- Cassava, sisal, oil palm and banana zone.

0306/3 Cuanza plateau Ia (290 m a.s.l.)

- This is a metamorphic rock inclusion: a wide open plain, with 5-6 m deep valleys of the affluents of Rio Cuanza. The subsoil is built by purple phyllitic shales, serricite schists and quartzite.

- Soils are moderately deep and sandy, with ironstone concretions (ferric properties).

- It is a grass steppe area, with baobabs, low thorn trees and shrubs; oil palm is found in the valleys only.

0306/4 Rio Munenga valley, inlier of plateau Ia (450 m a.s.l.)

(1) Main landscape

- This wide valley is situated in between Quibala and Dondo and it forms an inlier of plateau Ia, surrounded by high mountains. The valley is composed of low plateaus (reaching level Ib altitude) and, about 100 m high, grass covered, flat-topped hills (reaching level II a altitude).

- There is a relation between lithology, soils, vegetation and landscape.

  (1) fine mica sandstone has weathered to yellowish brown sandy soils;

  (2) a granite area is characterized by a more narrow valley and more tree vegetation;

  (3) diorite has weathered to bright red soils

  On the rounded plateau ridges, ironstone crusts occur at shallow depth, often at < 0.75 m. On middle valley slopes ironstone pans are exposed at surface.
  Agriculture suffers from temporary water stagnation on top of the ironstone crusts (petroferric or skeletic phase).

- Vegetation may be classified as a 'moderately moist riparian forest steppe'.
  On the plateau grows secondary, open, high grass tree steppe with shrubs. Riparian forests, with oil palms, are found on the valley floors. Many valley bottoms are swampy during the rainy season.

- It is a sisal area, with cassava and less maize.

(2) The valley is surrounded by mountains, reaching plateau IIa and IIb altitudes (1,100 m a.s.l.). The steep, rocky slopes are bare or covered by grasses, with isolated low trees and some dark riparian palm forests in mountain valleys. Overgrazing has caused important mass movement erosion.

0307 Muceques (Luanda) coastal plateau Ia (70-170 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 1, (12) SO

- This plateau is flat and almost not dissected; it developed on Miocene and Pliocene rocks, overlain by a thick Pleistocene, reddish brown, quartz sandsheet.

Sands only occupy the plateaus and not the valleys (with soil mapping unit CLh1). Coastal cliffs are composed Miocene to Pliocene fine sands, clays and sandy limestone layers, overlain by the red Muceques sandsheet.

- ARo 24 - 1a
  Soils are sandy and reddish brown;
  Typical Profiles: P.9c/63 (ARo) – p.279/62 (ARo)- p.82/64 (ARo).

- The coastal area is covered by a Hyphaene grass steppe (ST), with isolated or grouped, 10-15 m high Hyphaene palms, Adansonia trees, 1-1.5 m tall sansevieria, 12-15 m high cashew trees (Anacardium occidentale) and 0.6-1 m tall grasses; 80 % of all shrubs are thorny (e.g. Capparis subglabra).

- ML1/2 - 40
  This is mainly a pasture zone.

0308 **Catete coastal plateau Ia on Tertiary sedimentary rocks** (70-150 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 1, (12) SO2

- This slightly undulating plateau developed on Early Tertiary marl layers (Cunga Series). Sandy and rolled gravel soils are common on the plateau; on lower valley slopes occur outcrops of bluish grey limestone, which has weathered to clayey soils.

- CLh 1 -2/3 a, partly rudic phase; see profile p.508/62 (associated soil VRk);

  Typical Profiles: p.233c/62 (CLh) – P.234c/62 (CLh) – p.299c/62 (CLh).

  This is a dense thorn-less shrub steppe (2.5-3.5 m high), with a few, 7-11 m high Euphorbia and no grasses; the so-called 'coffee bush' is composed of Tricalysia buxifolia, Strychnos lucens, Combretum exanulatum, Sterculia tomentosa...

- ML1/2 - 02,25,40
  It is a maize and cassava zone, with cotton on limestone soils.

0309 **Coastal plateau Ia on Cretaceous sedimentary rocks** (110-260 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 1, (12) SO

- This planation surface developed on marine and

continental Cretaceous rocks (limestone, marl, sandstone...).

- CLh 2 - 2/3ab; CLh 4 - 2/3a, partly rudic phase.

- ST
  The plateau has a steppe vegetation (see below).

- ML1/2 - 02,04,07,40, (35,25,26)
  Maize is mostly grown in the N; millets and sorghum in the S. Extensive pasture is important. There are a few valley floors with vegetables, cassava and sweet potato.

0309/1 Sumbe (Novo Redondo) plateau Ia (110-130 m a.s.l.)

- This flat plateau is interrupted by some steep, dry canyons (e.g. Rio Gunza); there is a cliff coast, with deep, dry, canyon-like valleys, dissecting the plateau, with limestone, marl and sandy areas.

- CLh 4 - 2/3a, see profile p.233c/62 (CLh).

  There is a relation between lithology and soils:

  (1) greyish-white clayey soils have on limestone and marl (VRk);

  (2) greyish brown sandy soils occur on sandstone; the abundant rolled quartz gravels at the surface originated from Cretaceous conglomerates;

  (3) calcrete soils (CLp) are common in the limestone area; breccia cementation of weathering material is common.

- Vegetation on this sedimentary rock area is less dry as on gneiss: there is a thin cover of 20-30 cm tall Melinis and Setaria grasses and there are groups of thorn shrubs: Acacia mellifera, Dichrostachys nutans and Aloes. In valleys and on valley slopes grows a very dense tree vegetation; close to the sea occur grass steppes.

- On the plateau occur plantations of ricinus and oil palm.

  A Rio Gunza affluent forms the border between crystalline and sedimentary plateau Ia; it has cut a 150 m deep valley in layered limestone, with dry,

stony slopes, covered by dense thorn shrubs of 4 m high and with 10-12m high Euphorbia and many aloes.

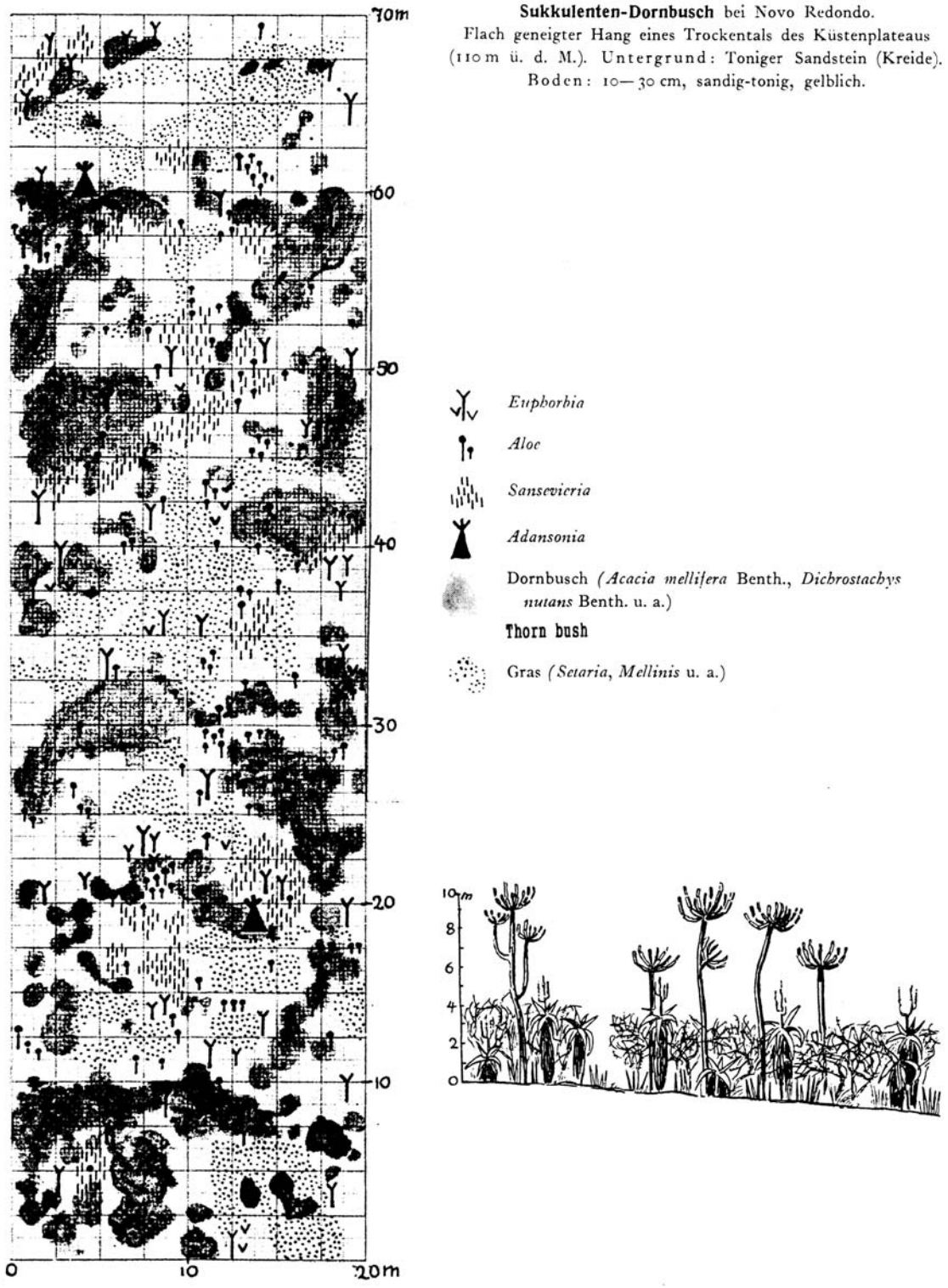


Fig. 7. Terrain unit 0309/1; succulent-thorn bush near Sumbe (Novo Redondo); slightly sloping dry valley side on coastal plateau I (110 m a.s.l.); a 10-30 cm thick, yellowish clayey sand soil overlies a Cretaceous clayey sandstone (Jessen, 1936).

0309/2 Rio Queve - Porto Amboim coastal sedimentary plateau Ia (120-200 m a.s.l.)

- At the coast occur 50-60 m high cliffs of soft sandy marl, overlain by limestone (with calcrete wherever it appears at the surface), overlain by 25-30 m hard conglomeratic sandstone.
  In the Porto Amboim region, the plateau has been dissected to a marly hilly landscape. Further inland dissection is absent and a very flat limestone-marl plateau extends towards the border with the crystalline rocks, where the landscape again has been dissected into N-S-oriented plateau ridges, with deep valleys in between.

- CLh 4 - 2/3 a; often with rolled gravels at the surface (rudic phase).

  There is a relation between soil and rock type:

  (1) reddish brown sandy soils, with rolled gravels, on sandstone;

  (2) reddish brown sandy clay loam soils on limestone profile P. 234 C/62 (CLh)

  (3) grey calcrete and black/dark brown soils on marl; see also profile p.149/58 (CLp).

  (4) deep grey-white sandy soils on limestone, with rolled quartz gravels at the surface and locally swampy points.

- ST
  Vegetation is classified as an 'open landscape grass steppe', with groups of thick thorn bushes; also 'short grass steppe'; or 'open tree steppe', with few shrubs (Gongrothamnus angolensis, Terminalia spec.), thorn shrubs (Acacia spec.) and low trees (Grewia spec.); with dense grasses of 0.5-0.75 cm: Eragrostis superba, Setaria spec.
  In the coastal area near Porto Amboim occurs a grass steppe, with Hyphaene palms and low thorn shrubs, grass bushes of 0.5-1 m and Euphorbia; also tree and shrub steppe, with many thorn bushes and giant Euphorbia.

- Mainly extensive pasture is practised on the plateaus; few valley floors are planted with vegetables, cassava and sweet potato.

0309/3 Lobito-Benguela coastal sedimentary plateau Ia (200-260 m a.s.l.)

- Near Lobito occurs a dissected limestone, gypsic marl and sandstone layer plateau, with the 160 m deep, wide valley of Hanha-Cubal and the 70-80 m deep Hanha canyon in limestone.
  Near Benguela the plateau is only a narrow and superficial strip, where Albian layered limestone forms the 100 m high step from the coastal plain to plateau I. The crystalline soccle is buried under gypsiferous, yellowish brown clays and sandstone/loam layers, but even in those areas biotite gneiss is also exposed at the surface.

- CLh 4 - 2/3 a, see profiles p.220/58 (ARh) and p.149/58 (CLp).
  Grey soils have gypsic and calcic horizons.
  On the slopes, where gypsum accumulations appear at the surface, only rare grasses grow.

- This is mainly an extensive pasture area, with some oil palm and ricinus.

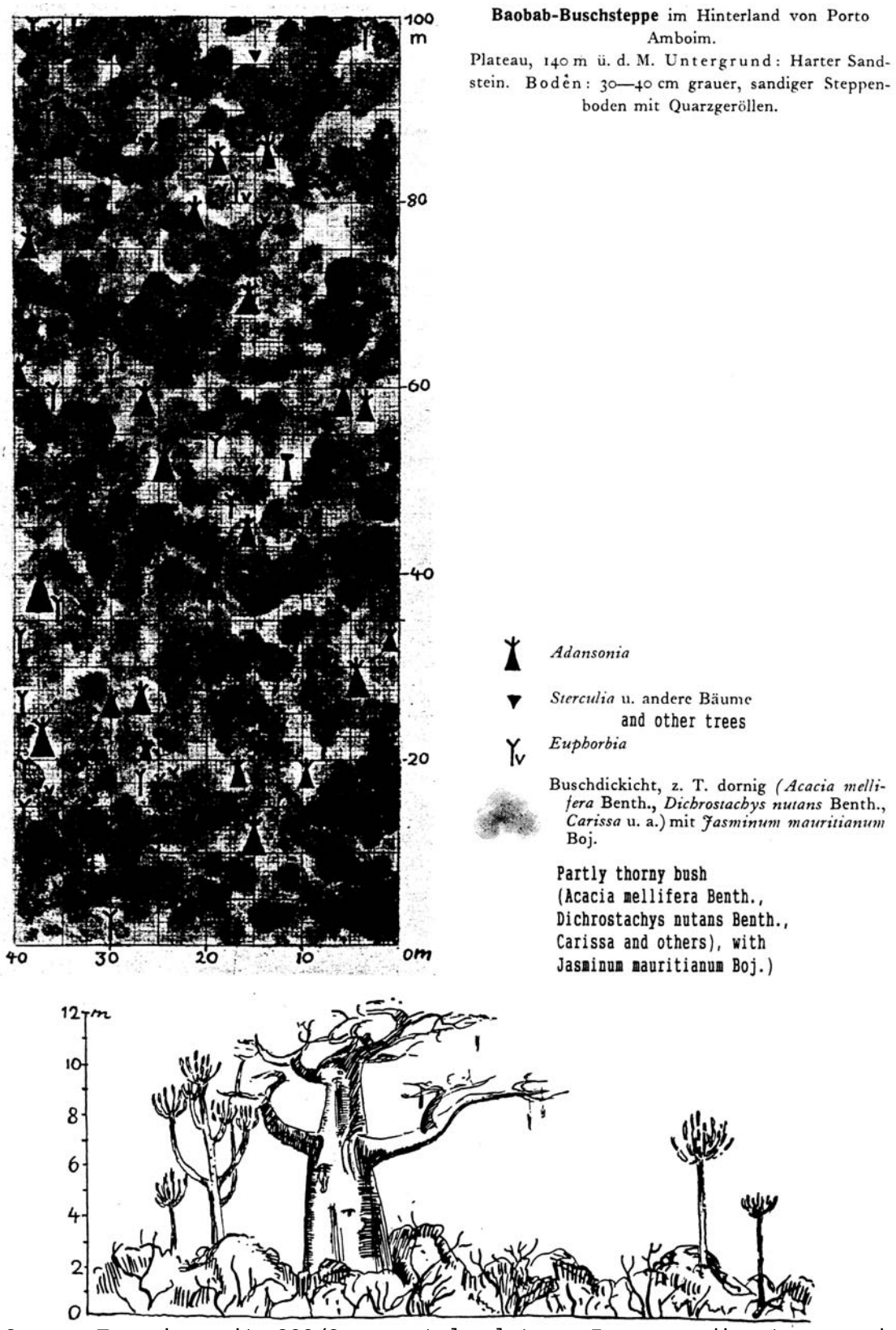


Fig. 8. Terrain unit 309/2: coastal plateau I, on sedimentary rocks, near Porto Amboim (140 m a.s.l.)
Baobab-shrub steppe on a 30-40 cm thick, grey sandy soil, with rolled quartz gravels (Jessen, 1936)

0310 Namibe coastal plateau Ia on sedimentary rocks
(180-280 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 1, (12) SC2

- This planation surface developed on Eocene marl, sandstone and calcareous sandstone, capped by a calcareous conglomerate. There are a few inclusions of Basal Complex rocks.

- CLp 1 - 1/2 a, partly salic/rudic/yermic phase;
LP-CL-c soil complex;
Typical Profile: p.149/58 (CLp).

- DE and ST; extensive plateau with semi-desert vegetation; the Rio Giraul valley bottom is a river oasis, with trees and shrubs.

- AR + IR - 02,35,32,40;
Irrigated agriculture is possible in the Rio Giraul valley: maize, vegetables, sugar cane and pasture land.

0310/1 Rio Geraul dissected coastal sedimentary plateau I (280 m a.s.l.)

- This is a very flat, but also dissected, table plateau with steep table mounts on horizontal layers of Eocene marl, sandstone and calcareous sandstone, capped by a calcareous conglomerate. The canyon of Rio Geraul is 200 m deep and the valley bottom is found at 65 m a.s.l. On the eastern slopes occur outcrops of andesite, while the western slopes are cut in Eocene rocks.

- Soils are marly and sandy, with some secondary lime and gypsum crusts (GYk soils).

- The plateau is covered by semi-desert vegetation:

  (1) marly soils are covered by grasses and herbs;

  (2) on sandy soils grow shrubs: Tribulus pechuelii, Sesuvium digynum...

  The Rio Giraul valley bottom is a river oasis, with trees and shrubs on sandy marl soils; irrigated maize, vegetables, sugar cane are grown and some pasture land exists.

310/2 Rio Buracco coastal sedimentary plateau I
(180-280 m a.s.l.)

- This very flat, not dissected plateau, is a rolled gravel covered, bare, yellow sand plain; a striated plain, with lines formed by 0.75-1 m deeper, 10-20 m wide, parallel, meandering dry valleys. The sharp plateau edge, 20-30 m high, is built of a resistant gypsum crust.
  The Rio Burraco canyon has a wide, wadi-like, valley; its steep slopes consist of conglomerate layers, reddish striated sandstone and bright sandy marls.

- There are saline and gypsic soils (CLp 1, partly salic phase), but no petrogypic crusts on the plateau.

- Vegetation is limited to single Welwitschia on the striated plain; in the meandering dry valleys grow many grasses and herbs.
  The Rio Burraco canyon vegetation is characterized by dwarf shrubs.

0311 Coastal plateau Ia on crystalline rocks
(200-480 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) IN, (10) 1, (12) MA2

- This planation surface has been cut over rocks of the Basal Complex (gneiss, granite...).

- CLl 10 - 2ab, partly sodic/salic/rudic phase;
  Typical Profile: p.53/54 (CLl)
  LXf 3 -1/2ab, partly petroferric/skeletic phase.

- ST, steppe, with or without riparian forests in the valleys

- ML1/2 - 07,04 (25,26,30,39)
  sorghum and millets zone; (valleys with cassava, sweet potato, banana, papaya)

0311/1 Sumbe-Chimboco crystalline plateau Ia (310-320 m)

- This is a slightly undulating plateau on gneiss, with many quartz veins, and solitary, slightly sloping, wide inselbergs (see figure 9). Olivine basalt and red tuff intrusions occur in the gneiss region, building low ridges and convex hills.

  There are only few, very flat, valleys. Dissected valleys occur only:

  (1) in the east, near the escarpment to plateau II;
  (2) a 150 m deep dissected area also exists in the west near the border with the sedimentary basin;

- LXf 3 -1/2 ab; CLl 10 - 2ab, profile p.296c/62 (LVx)

  There is a clear relation between soils and landscape/rock type:

  (1) on the plateau formed typical grey and yellowish brown sandy loam soils, with rolled quartz gravels;

  (2) in the valleys occur brownish red soils

  (3) on basalts formed bright red soils

- Vegetation is composed of an 'open tree and shrub steppe', with Cassia gorathensis, Terminalia prunoides, Embelia, Sterculia, candle Euphorbia, low grasses and few baobab trees. Trees become lower towards the W, as rainfall decreases (shrub-size). Evergreen shrubs and deciduous thorn shrubs are common, but also grasslands and Aloes-Euphorbia formations (of 2-3 m high) occur; the valleys lack riparian forests, but shrubs exist.

  In the Porto Amboim region grows a dense shrub steppe with trees: 4-5 m high shrubs and 20-30 m high trees. Vegetation changes gradually to the E into a high grass (2-4 m) savanna with Adansonia (baobab) and few trees (Sterculia); riparian forests are present in the valleys.

- Agriculture is mainly confined to the valleys: cassava, sweet potato, banana, papaya...

0311/2 Lobito-Benguela coastal crystalline plateau Ia (200-480 m a.s.l.)

- This is a slightly undulating plateau on gneiss, with dry valleys, without inselbergs. Plenty of quartz veins cut the gneiss and many quartz gravels have accumulated at the soil surface. There are some basalt intrusions in the E. A granitic, isolated inselberg: Cerro Sahoa, rises 300 m above plateau I, being an outlier of plateau II. It has a foot terrace of surface Ib (see figure 10).
  Near the escarpment to plateau II exists a gneiss area, with 40 m high hills and gneiss block towers.

- CLl 10 - 2ab, partly rudic phase
  Stony, grey/dark grey/yellow/brown/red soils and rock outcrops, without ironstone crusts; near the escarpment to plateau II exist stony, greyish to yellowish grey, sandy soils, with angular quartz gravels at the surface.

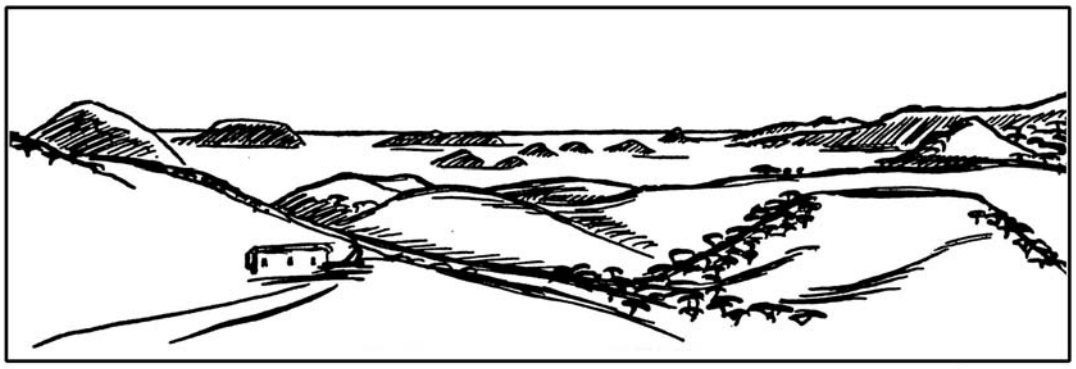
- Vegetation of the Lobito area is composed of 4-6 m high thorn shrubs (Acacia etbaica) and a few Terminalia prunioides trees, with grasses of 30-50 cm: Setaria, Melinis.

- Vegetation of the Benguela area is an open steppe with short grasses (10-20 cm), herbs and an Acacia tree steppe with open spots. The Acacias are 8-14 m high and spaced 50-60 m; the dense thorn bush vegetation is 5-8 m high.

0311/3 Namibe coastal crystalline plateau I (280-340 m a.s.l.)
Lubango-Namibe: Rio Giraul region

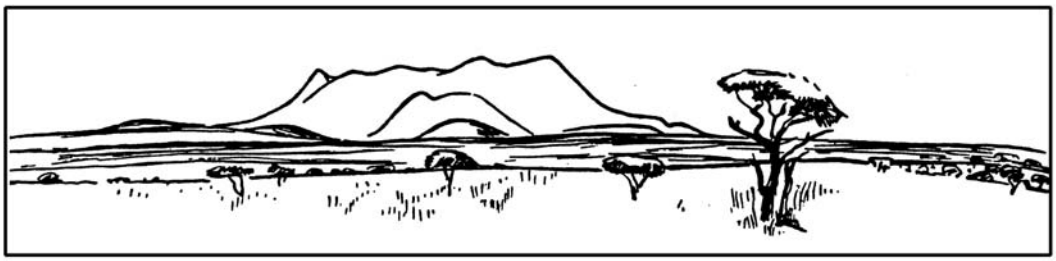
- This very flat plateau, has been canyon-like dissected by (dry) valleys. There is a 120 m high step from plateau I to II. Rocks are metamorphic schists and a layer of andesitic trachyte, with 10-30 cm angular blocks and plates at the surface. The subsoil is calcareous cemented. Towards the west exists a 2-3 m thick, lime-cemented conglomerate (overlying andesite at Rio Giraul) with polished rolled quartz, schist, andesite gravels at the surface, building a gravelly sandy plain.

- The semi-desert vegetation is characterized by dwarf shrubs, Boscia, candle Euphorbia and Hoodia. The canyon of Rio Giraul has gravelly slopes, with shrubs and dwarf Aloes.



Blick vom Abstieg hinter Vila Nova de Selles (550 m ü. d. M.) gegen Westen auf die Küstenrumpfebene (Niv. I) mit Inselbergen.

Fig. 9. Terrain unit 0311/1: coastal plateau I on crystalline rocks, with inselbergs, seen from the escarpment to Plateau II (terrain unit 0401/2), near Vila Nova de Seles (Jessen, 1936).



Der Cerro Sahoa im Hinterland von Benguela.

Fig. 10. Terrain unit 311/2: coastal plateau I on crystalline rocks (400 m a.s.l.); view towards the Cerro Sahoa (800 m a.s.l.), an isolated outlier of plateau II, with a foot terrace of plateau Ib (Jessen, 1936).

0312 **Higher coastal plateau Ib** (520-600 m a.s.l.) **and escarpment zone** (300-1,150 m a.s.l.)

SOTER (6) 0-15, (8) CL, (9) IN, (10) 2, (12) MA2

- The planation surface Ib has formed on continental Cretaceous sedimentary rocks and on rocks of the Basal complex (granite, biotite gneiss). Many isolated remnants of plateau Ib have been conserved as shoulders or terraces on escarpments.

- LPe 1, LXf 3 - 1/2ab, LXf 4 - 2b, partly petroferric or skeletic phase
  Reddish brown, partly gravelly, soils with ironstone crusts when situated on flat plateau remnants, but without crust on escarpment slopes
  Typical Profile: p.237/59 (LXf).

- 35% SW, 35% GH, 30% OF
  Vegetation is composed of high thorn shrubs, Adansonia trees and tree-size Euphorbia; moist tropical palm forest occurs on the escarpment's higher slopes (> 920 m a.s.l.), e.g. on the 'palm step'; on the escarpment's lower slopes grow low trees and high grasses.

- PL1/2 - 39,23,36
  Oil palm, sisal and robusta coffee zone.

0312/1 Fragmented remnants of plateau Ib in the Lobito-Sumbe region (520-600 m a.s.l.)

- Near the escarpment from plateau I to II, W of Vila Nova de Seles, some inselberg tops reach planation surface Ib altitude.

  The escarpment of the Bocoio plateau, in between plateaus I and II, from 300 to 915 m a.s.l. (Bocoio-Lobito) has a flat shoulder at 520 m a.s.l.; this is a remnant of plateau Ib.

- LXf 4 - 2b

- High (many thorn) shrubs, Adansonia trees and tree-size Euphorbia.

0312/2 Calandula Escarpment or 'Palm Step' (from plateau Ib at 600 m a.s.l. to plateau IIb at 1,150 m a.s.l.) (Quibala-Dondo)

(1) The upper slopes of the escarpment (920-1,150 m a.s.l.) consist of granite, weathering to reddish, sticky, soils.
Moist tropical palm forest covers the slopes;
there are abundant oil palm and coffee trees.
At 960 m a.s.l. exists a flat strip of Mussende plateau IIa (terrain unit 0401).

(2) The middle and lower slopes of the escarpment (450-920 m a.s.l.) are cut on biotite gneiss covered by reddish brown, partly gravelly, soils (LXf 3 - 1/2 ab);
Oil palm is restricted to valleys only; low trees and high grasses grow on the slopes: millettia sp., Acacia pennata, Conopharyngia, Adansonia, Combretum, Strychnos...
At 600 m a.s.l. exists a terrace remnant of plateau Ib.

(3) The Mussende-Munenga plateau Ib on the Calandula escarpment or Palm Step (600 m a.s.l.)
This planation surface remnant on gneiss, is covered with red soils on ironstone crusts (LXf3 - 1/2ab), but there are no crusts on the escarpment slopes.
Vegetation is savanna, with swampy valley floors. Crops are oil palm, sisal, maize...

0312/3 The Cazenga mountains

- This is the equivalent of the 'Palm Step'. These mountains build the escarpment between plateaus I and IIa, from 300 to 800 m a.s.l., in the Dondo-N'Dalatando region. It is a 400-500 m high step on gneiss, granite and quartzite; at 600 m a.s.l. exists a terraced remnant of plateau Ib
- LXf1 1/2 bc
- Moist dense tropical forest occurs on the slopes.

0400 Plateau II

0401 **Gabela plateau IIa** (960-1,100 m a.s.l.) **and escarpments** (280-1,000 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) IN, (10) 3, (12) MA2

- Planation surface IIa has been cut on granite, biotite-gneiss; it is a typical inselberg landscape.

- ACh 1 - 2bc, partly petroferric/skeletic phase.

  Soils are grey, yellow to yellowish brown, affected by strong water erosion problems on the escarpments
  Typical Profile: p.291/57 (ACh).

- 45% GH, 25% SW, 20% ST

  (1) The plateau vegetation is composed of savanna, or high grasses;

  (2) riparian palm forests grow in (dry) river beds;

  (3) evergreen forests cover the escarpment, with riparian forest in its valleys.

- PL2/2 - 02,36,25,40

  (1) On the plateau, crops are maize, robusta coffee, cassava and also pasture;

  (2) in the valleys of the plateau, sweet potato, vegetables, banana, papaya and oil palm are planted.

0401/1 The escarpment between plateau I and II

(1) Sumbe region escarpment (280-1,000 m a.s.l.)

- Soils are yellowish grey and developed in biotite gneiss.

- (a) On the escarpment slopes grow evergreen forests. Baobab trees and riparian forests occur in the valleys, with 30 m high trees: Pseudospondias microcarpa, Combretum racemosum and Loranthus... There is a rich undergrowth, with palms.

  (b) Plateau remnants are covered by high grasses: Setaria megaphylla and Vernonia.

- The escarpment is a robusta coffee and oil palm zone.

(2) Porto Amboim region escarpment (310-1,000 m a.s.l.)

- Very deep bright red soils overlie a yellowish white weathering zone on biotite gneiss and quartzite. Strong water erosion affect the slopes.

- The escarpment is covered by dense evergreen tropical rain forest (40-50 m high); palms grow in valleys.

- This is a robusta coffee area, with some banana and oil palm. On top of the escarpment, at the dissected rim of the plateau, maize, cassava and sweet potato are grown.

0401/2 Plateau II, west of Vila Nova de Seles

- This is a gneiss plateau, with young, very deep, valley incision in the area near the escarpment between plateau I and II

- Shallow, grey, sandy loam soils overlie rolled quartz gravels.

- High grasses grow on slopes and riparian forests, with green palm trees are found in (dry) river beds.

- (1) The plateau is planted with maize and cassava;

  (2) in the valleys: sweet potato, vegetables, banana, papaya and oil palm are grown.

0401/3 Gabela-Humbi plateau IIa (1,000-1,100 m a.s.l.)

- This dissected plateau is dominated by steep, granitic inselberg domes and towers (80-150 m high). The Rio Nhia inselberg region, in between Gabela and Quibala, is characterized by 60-80 m high inselberg towers, reaching plateau IIb altitudes (see figure 11).
- The plateau is covered by yellow to yellowish brown soils on gneiss and ironstone (see figure 12).
- Vegetation is savanna, with riparian forests in the valleys.

0401/4 Mussende plateau IIa strip (960 m a.s.l.)

- In between Quibala and Dondo occurs a narrow plateau on the step from plateau IIb (at 1,155 m a.s.l.) to plateau Ib (at 600 m a.s.l.).
- ACh 1 - 2bc
  Red loamy soils overlie bright mottled laterite.
- It is an oil palm, coffee, maize and cassava zone.

Die Inselberglandschaft am Rio Nhia.

Fig. 11. Terrain unit 401/3: granite inselberg landscape at Rio Nhia; Gabela-Humbi plateau IIa (1,200 m a.s.l.). Plateau IIa forms the plain; the original plateau IIb level is conserved on the inselberg tops; inselbergs rise 10-80 (100) m above the plain (Jessen, 1936)

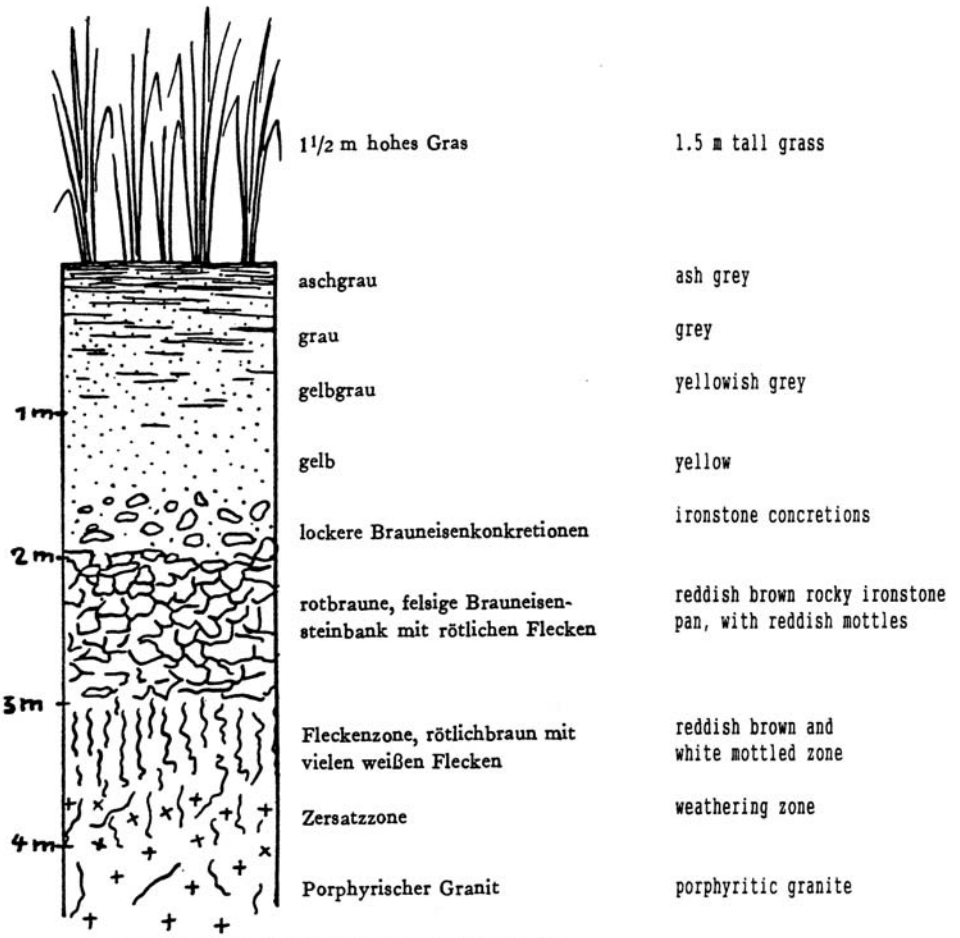


Fig. 12. Terrain unit 401/3: soil profile of the inselberg landscape at Rio Nhia, on the Gabela-Humbi plateau IIa (1,200 m a.s.l.); (Jessen, 1936)
Ferric Acrisols of soil mapping unit ACh 1

0402 Quibaxe plateau IIa (700-800 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) IN, (10) 3, (12) MA1

- Planation surface IIa has been formed on rocks of the Oendolongo Group (WCS); it is a very extensive inselberg plain, bordered in the W by the 'Bamba Step' to plateau I.
- FRx 2 - 2/3 ab; profile 299/59 (NTh)
  Typical Profiles: p.181c/60 (FRx) – p.113c/60 (FRx) – p.249/57 (FRx)
- 60% SW, 20% HF in the N; 10% GH, 10% OF in the S
- PL2/2 - 25,36
  Mainly a cassava and coffee zone.

0403 Uíge plateau IIa (700-800 m a.s.l.)

SOTER (6) 0-15, (8) CL, (9) IN, (10) 3, (12) MB2

- This very extensive inselberg plain has developed on rocks of the Bembe Group, with some inclusions of the Oendolongo Group (both WCS); rocks are frequently schists.
- FRx 2 - 2/3 ab, NTh 3 - 2/3ab, NTh 4 - 3c, NTh 5 - 2/3bc, NTh 7 - 2/3ab; profile p.113c/60 (FRx) and p.120/60 (FRr).
- 70% HF, 20% SW, 10% GH (in the S)
- PL2/2 - 25,36,39
  This a cassava, oil palm and coffee zone.

0404 **Damba plateau IIb** (1,100 m a.s.l.) **and**
Canzanga mountains (N) (1,200-1,300 m a.s.l.)

SOTER (6) 0-15, (8), LL, (9) RI, (10) 3, (12) SC

- In this dissected area, plateau III remnants have been conserved on the highest tops (1,200-1,300 m a.s.l.) The 300 m high Damba step, separates plateau IIa from plateau IIb. The area is underlain by Cretaceous rocks (Lunda Series), often covered by a Kalahari sandsheet.

- FRh 1 - 2a, NTh 7 - 2/3 ab
profile p.121/60 (FRu)
Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)

- 80% SW, 5% HF, 15% GH

- PL2+3/2 - 25,36
This is a cassava and coffee zone.

0405 **Negage plateau IIb** (1,100 m a.s.l.) **and**
Canzanga mountains (S) (1,200-1,300 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) RI, (10) 3, (12) MB2

- Planation surface IIb occurs beside dissected remnants of plateau III on the highest tops (1,200-1,300 m a.s.l.). The region formed on Bembe Group rocks, with Oendolongo Group inclusions (both WCS).

- FRr 1 - 2/3a
Typical Profiles: p.120/60 (FRr) – p.180c/60 (FRr) – p.296/58 (FRr)

- 70% SW, 30% GH

- PL2+3/2 - 25,36,40
It is a cassava, coffee and pasture zone.

0406 **N'Dalatando plateau IIa** (800 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) IN, (10) 3, (12) MA2

- This open, almost flat, inselberg landscape developed on rocks of the Basal Complex (gneiss...).

- FRh 4 - 2bc, LVh 1 - 2a, LXf 1 - 1/2 bc
  Typical Profile: p.222/63 (LVh)

- 85% OF, 15% GH
  The savanna vegetation contains many baobabs; riparian forests occur along permanent streams.

- PL2/2 - 02,22,36,38
  This is a maize, cotton, coffee and tobacco zone.

0407 **Rio Cuanza plateau IIa** (about 800 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 3, (12) MB2

- This is a sandy planation surface, cut on rocks of the "Sandstone-Schist Series" (WCS).

- ARo 10 - 1a, ARo 11 - 1a
  Typical Profiles: p.9c/63 (Aro) – p.279/62 (ARo) – p.82/64 (ARo)

- 60% OF, 30% GH, 10% SW

- ML2/2 - 02,38,40
  It is a maize, tobacco and extensive pasture zone.

0410 **Lucala plateau IIb** (about 1,100 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 3, (12) MB2

- This planation surface IIb developed on rocks of the "Sandstone-Schist Series" (WCS) and on Late Tertiary - Quaternary sediments.

- FRx 4 - 2a
  Typical Profile: p.159/56 (FRx)

- 50% GH, 25% OF, 15% HF, 10% SW

- PL2/2 - 22,25
  It is a cassava and cotton growing area.

0411 **Cacuso plateau IIb** (1,100 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 3, (12) MA2

- This planation surface IIb has formed on rocks of the Basal Complex, usually gneiss.

- LVh 1 - 2a, FRh 9 - 2ab
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)

- 80% GH, 20% SW
  Vegetation is a savanna-like dry forest, with some baobab trees and riparian forests in the valleys.

- PL2/2 - 02,25,36
  It is a maize, cassava and coffee zone.

0412 **Pungo Andongo plateau IIb** (about 1,100 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 3, (12) MA1

- This plateau formed on rocks of the "Sandstone-Schist Series" (WCS), with some inclusions of the "Limestone-Schist Series" (WCS) and Karroo rocks; frequent rocks are quartzite and schists.

- FRh 10 - 2a, ARo 10 - 1a, ARo 11 - 1a, FRh 9 - 2ab, LVh 1 - 2a, profile p.9c/63 (ARo)
  Quartzites are weathering to sandy soils.

- 50% OF, 30% SW, 20% GH

- PL2/2 - 02,22,25,38,40
  Maize, cotton and cassava are typical crops in the north; it is also a tobacco and pasture zone.

0413 **Haco plateau IIb** (about 1,100 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) G, (10) 3, (12) MA2

- This planation surface IIb formed on rocks of the Basal Complex (usually gneiss), with some inclusions of the Oendolongo group (WCS).

- ARo 11 - 1a; FRh 14 - 2ab, partly petroferric/skeletic phase; LP
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh).

- 70% SW, 20% GH, 10% OF

- PL2/2 - 02,40
  It is mainly a maize and pasture zone.

0414 **Cubal plateau IIb and dissected Serra de Korruteva** (750-1,050 m a.s.l.)

SOTER (6) 8-30, (8) LL, (9) IN, (10) 3, (12) IA1

- This planation surface, with inselbergs, has developed on Precambrian granite and some gneiss, quartzite and phyllite.

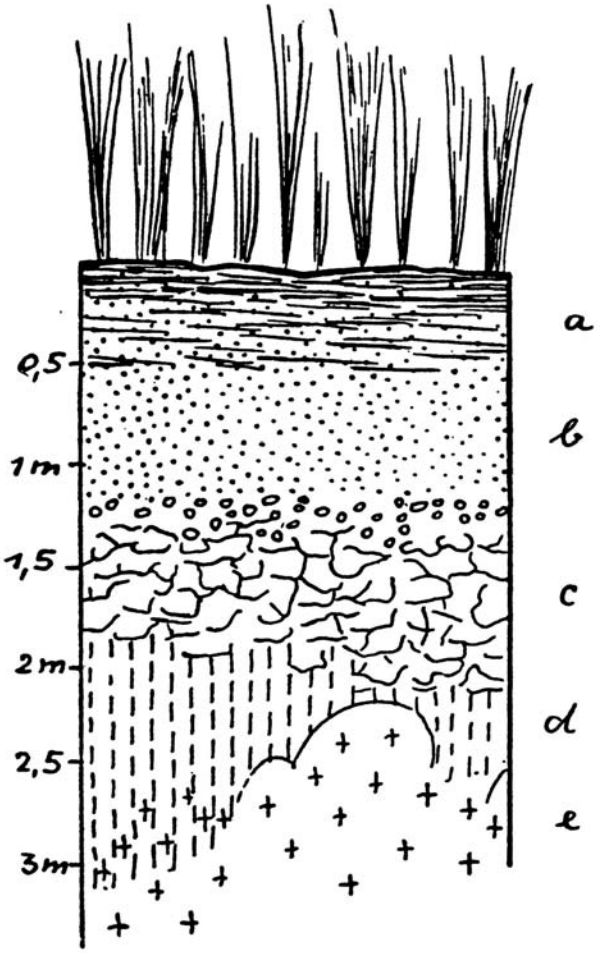
- LXf 4- 2b, partly petroferric/skeletic phase; LXf 5 - 2b, partly petroferric phase; LVf 1-2, LXf 6 - ac; LPe; see figure 13.

- 40% ST, 20% GH, 30% SW, 10% OF
  Vegetation is a shrub steppe, or park-like landscape with succulents and high grasses; the valleys are covered by grass floors, shrubs and baobabs (Adansonia).

- PL2/2 - 40,38,23,02,25,07,27

  (1) The plateau is mainly a pasture area, with some tobacco, maize, cassava, sisal and potato; the south is a sorghum ('massambala') area.

  (2) some valley floors are planted with maize, bananas, pineapple, lemon and papaya.



Bodenprofil am Hanha-Cubal.

	tall grass vegetation
0-0.5 m	dark greyish brown loamy sand
0.5-1.1 m	bleached yellowish loam
1.1-1.6/2.0 m	dark reddish brown soil, with ironstone concretions over fragmented ironstone crust
1.6/2.0-2.2/3.0 m	greyish green clay, with white mottles
> 2.2/3.0 m	rounded, weathered, amphibole granite

Fig. 13. Terrain unit 0414: Cubal plateau II (900-950 m a.s.l.); soil profile on lower slopes of Rio Hanha-Cubal (Jessen, 1936)
Ferric Lixisols

0414/1 Bocoio plateau II (915-1,000 m a.s.l.)

- This plateau is covered with inselbergs, e.g. the Lombe Mountains, 300-400 m higher than plateau II; the inselberg tops reach plateau IIIa altitudes and some higher mountains attain plateau IIIb levels, about 80-100 m higher.

- LXf 4 - 2b
  On the soils occur 3-4 m high termite hills. A basalt intrusion is characterized by red soils with a thick ironstone crust.

- The plateau is covered by thorn shrub steppe, or a park-like landscape with succulents, high grasses, tree-size Aloes and Adansonia trees near the valleys. Rocky granite ridges and hills are covered by a thin grass cover, 10-12 m high euphorbia and thorn shrubs.

- Crops are maize, cassava, ricinus, potato, banana, papaya and lemon trees, but it is mainly a pasture area.

0414/2 Serra de Korruteva and plateau II remnants

(1) At Coroteva occurs a strongly dissected Plateau II, with a plateau remnant at 790 m a.s.l.; the latter has formed on gneiss, quartzite and phyllite.

(2) Serra de Korruteva

- This impressive mountainous landscape, has been cut out of granite and pegmatite; typical are granite block deserts, towers and domes; the valley bottoms are found at 540-580 m a.s.l.

- LXf 4 - 2b, profile P.258/58 (LXh)
  Soils around granite blocks are shallow, stony, black or brown; yellow sandy soils occur on mountain slopes. At Catengue, reddish brown soils developed on biotite-granite and sandy loam soils occur in the valleys.

- Thorn shrubs, of 4-6 m high, dominate. There are also tall Sansevieria and there is a dense cover of 3-4 m high Aloes and some baobabs. In open spaces occurs a thin, 20-40 cm tall, grass cover.

(3) Rio Coporolo plateau II (760-800 m a.s.l.)

- This plateau is covered by granite blocks and towers; the Coporolo mountains form a SW-NE-oriented chain, 350-400 m higher than plateau II, with flat plateau tops (remnant of surface III) and terraced remnants of surface IIb on the slopes; inselfelsen are 60 m high, with block peaks and block-covered slopes; Rio Coporolo has cut a 50-60 m deep valley in plateau II.

- Soils are moderately deep, grey or brown, with granite gravels in the topsoil; there are also 1-1.5 m deep, reddish brown to yellow, sandy to sandy loam soils, with ironstone concretions; see profile p.291/57 (ACh).

- This is a tree steppe region with thorn shrubs, low thorn trees and moderately tall grasses; baobabs grow on western slopes of inselbergs only; valley floors are covered by 1-2 m tall grasses and some trees of 10-20 m high, with many baobabs.

(4) The western plateau area is characterized by 40-100 m higher inselbergs rising above the plateau.

- Grey and brown soils developed on granite; red soils characterize a basalt intrusion.

- Vegetation forms a dense shrubland (4-5 m high) with 90 % Rubiaceae: 'coffee-bush', with some Combretum and baobab trees and with 0.5-1 m tall shrubs of Boscia urens; there are almost no grasses.

(5) The dissected escarpment between plateau I and II (480-800 m a.s.l.)

- This area is characterized by ridges, dry valleys and granite block covered slopes; granite block towers or castles are 60-80 m high. At 540 m a.s.l. exist terraced remnants of plateau Ib.

- This is a thorny shrub-succulent steppe, with tree-size euphorbia and few baobabs; the valleys are covered by grass floors, 5-6 m tall shrubs and many baobabs.

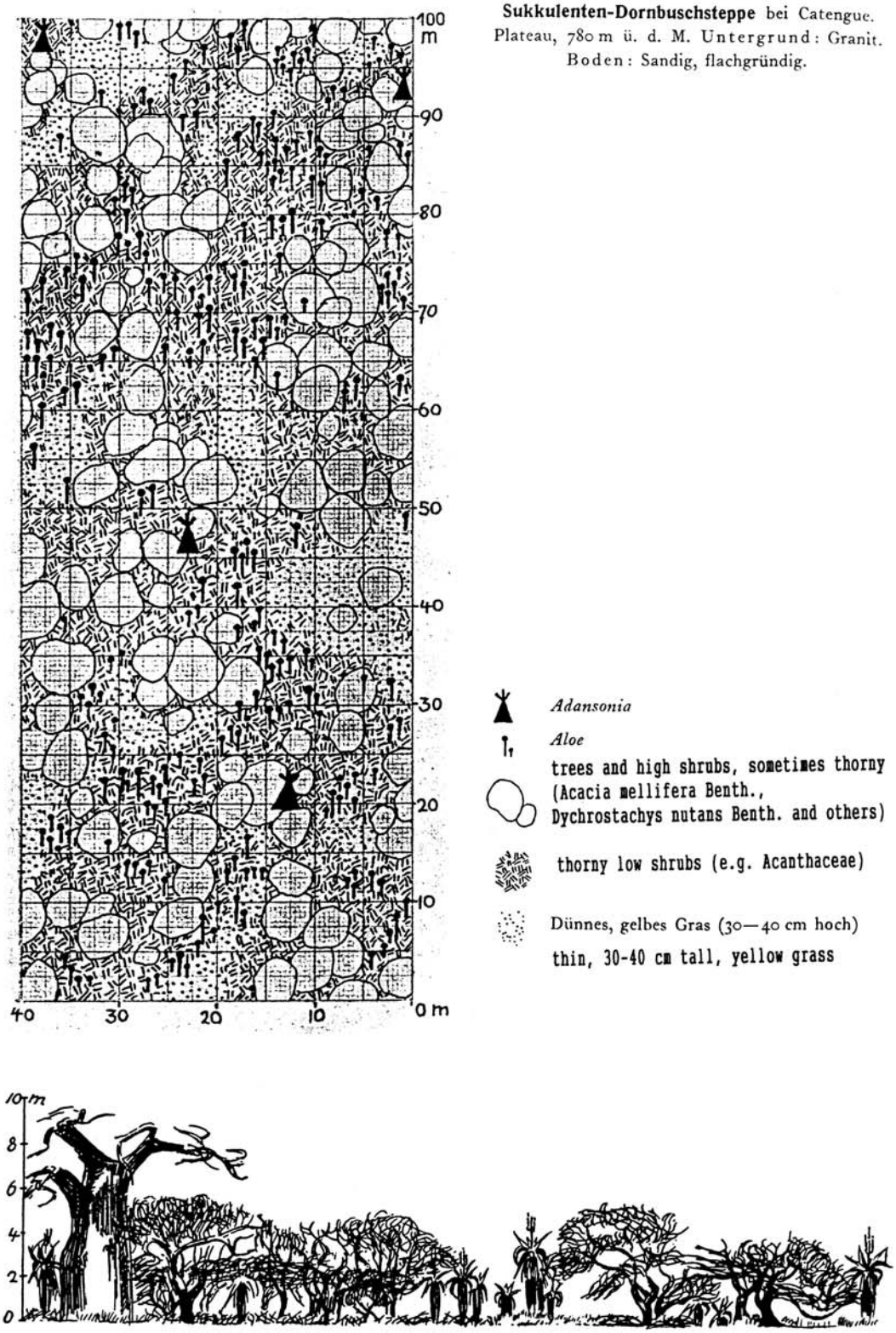


Fig. 14. Terrain unit 0414/2: plateau II (780 m a.s.l.), near Catengue; succulent-thorn bush steppe on a shallow sandy soil, developed in granite (Jessen, 1936).

0414/3 Caimbambo-Cubal Plateau II (790-950 m a.s.l.)

(1) Main landscape

- This 100 km wide, slightly undulating plateau is interrupted by wide, flat, valleys. Granite hills of 50-100 m high and granite boulder heaps characterise the plateau. There are many platy granite rock outcrops. Basalt intrusions are characterized by typical red soils.
  The Sapa granite inselberg rises 250-300 m above the plateau; it is an outlier and remnant of plateau III, 80 km to the E. Most inselbergs are 50-60 m high, building cones, towers and pillars (see figures 15 and 16). Rio Cavaco has a flat valley bottom; the river has cut a 110 m deep valley in the plateau surface.

- LXf 5 - 2b
  Deep (dark) reddish brown loamy sand soils, covered by 4-5 m high termite hills, are common. Finer soils are found in the valleys; see profiles P.244/58 (LXh) and P.291/57 (ACh).

- This is a thorny shrub steppe, with rare short grasses, 2-4 m high tree-size Aloes, baobabs and 4-6 m high trees.

(2) The landscape east of Cubal

- Ironstone crusts dominate the soils; there are giant termite mounts of 4-6 m high and 10-15 m wide, spaced every 50-60 m.

- Vegetation is composed of a park-like tree (10-12 m high) and shrub steppe, with baobabs. There is almost no shrub undergrowth, but 1-2 m tall grasses are common.

- This is a cassava and maize growing area.

(3) The swampy, flat, valley floor of Rio Cubal

- Rio Cubal has cut a 30-40 m deep valley in the plateau.

- Valley floor soils are clayey and suffer of temporary flooding problems.

- Trees are absent; high grassland covers the soils.
- Maize, banana, pineapple, lemon trees and papaya area.

(4) Escarpment between plateau II and Ganda plateau III (950 to 1,200 m a.s.l.)

- Many granite inselbergs (e.g. Nangangombi, 1,500 m a.s.l., Kiunda...) and terraced remnants of plateau III occur on the dissected escarpment.

- Vegetation is characterized by high grasses and dry forest.

- This is a sisal and Arabica coffee area.

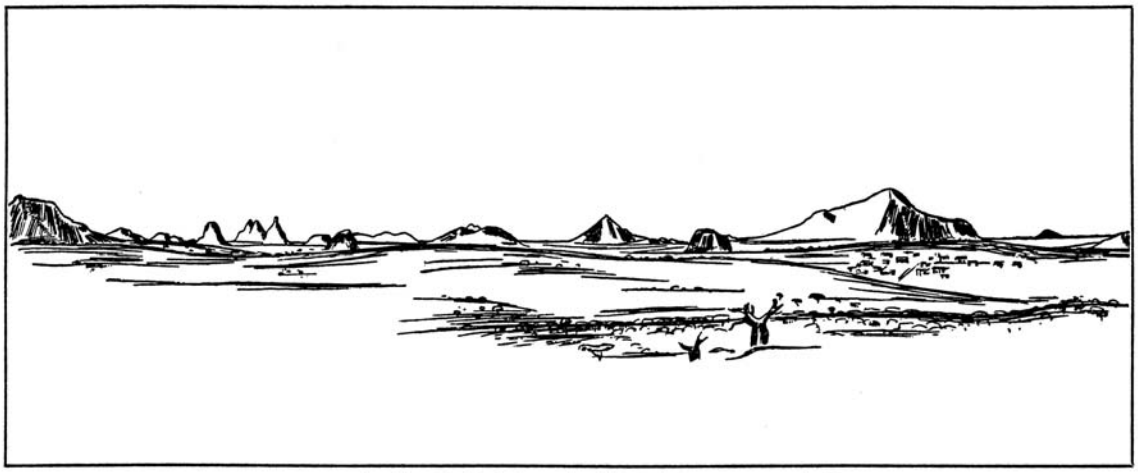
0414/4 Quilengues plateau II (860-1,010 m a.s.l.)

- Above this slightly undulating plateau, rise 300-400 m higher, NW-oriented mountain chains (remnants of plateau III and some higher domes). There are also isolated inselbergs and outliers of plateau III; all have rocky terraces or remnants of surface IIb on their slopes.
  Plateau II has been cut on granite, but there is also a SE-NW-oriented basalt intrusion ridge.
  Valleys are straight, wide and flat and have sandy valley floors, situated 50-60 m deeper than the plateau surface.

- LXf 4 -2bc, LVf 1
  Soils are usually 2-3 m deep and developed in biotite-granite; see soil profile p.313/56 (LVf) and figure 17.

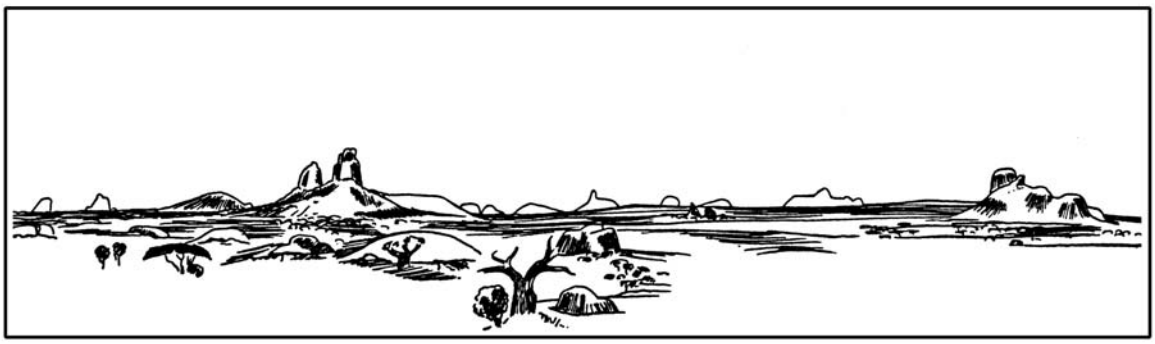
- Vegetation consists of wooded steppe with thorn shrubs and low trees. Adansonia is found only in valleys, on grass floors with bare soil patches.

- This is mainly a pasture area, with some sorghum ('massambala') and cassava.



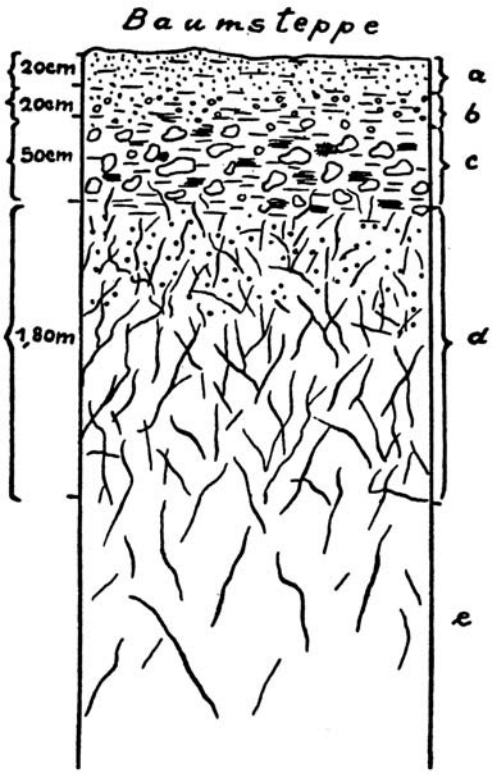
Inselberglandschaft nordöstlich Cubal. 900—950 m ü. d. M.

Fig. 15. Terrain unit 0414/3: inselberg plain on Cubal plateau II (900-950 m a.s.l.), NE of Cubal; the inselbergs rise 300 m higher, reaching plateau III levels (Jessen, 1936).



Inselberglandschaft nordöstlich Caimbambo. Links der doppelgipfelige Galunga.

Fig. 16. Terrain unit 0414/3: inselberg plain on plateau II (850 m a.s.l.), N of Caimbambo, along the road Caimbambo-Cubal; the 90 m high pillars, with at 60 m height: terraced remnants of plateau IIb (Jessen, 1936)



Bodenprofil in der Baumsteppe bei Quilengues (975 m ü. d. M.).
a) Sandig-lehmig; graugelb. b) Lehmig-sandig; gelbbraun mit weißen Körnern. c) Rotbraun mit großen weißen Flecken. Viele Brocken halb zersetzten Granits. d) Zersetzter Granit mit noch erkennbarer Gesteinsstruktur. Oben mit vielen kleinen, lockeren Brauneisenknöllchen von innen schwarzer, außen braunroter Farbe. e) Grobkörniger Biotitgranit von schwarz-weißer Farbe.

tree steppe

a greyish yellow sandy loam

b yellowish brown loamy sand with white grains

c reddish brown, with coarse white mottles, and many pieces of half-weathered granite

d weathered granite, with rock structure; in the upper part with many small ironstone concretions, black inside and reddish brown outside

e black and white, coarse grained biotite granite

Fig. 17. Terrain unit 0414/4: Quilengues plateau II (975 m a.s.l.); a soil developed in biotite granite, on the tree steppe of Quilengues (Jessen, 1936)
Ferric Lixisols of mapping unit LXf 4

0415 **Namibe plateau IIb** (250-700 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) IN, (10) 2, (12) MA2

- This inselberg plain has been cut on rocks of the Basal Complex (mainly gneiss); the inselbergs reach altitudes of > 1,200 m a.s.l.
- CLl 1 - 2a, LPe ; see profile p.39/57.
- 90% ST, 10% GH
- ML2/2 -04,07
  This is a millets and sorghum growing zone.

0416 **Cunene plateau II** (250-700 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) IN, (10) 2, (12) MB2

- This planation surface IIb, with inselbergs of > 1,200 m a.s.l., has formed on rocks of the Oendolongo group (WCS), frequently schists, and on granite.
- LPe-CL-c complex; partly rudic and lithic phase.
- ST, steppe vegetation
- ML2/2 - 04,07
  It is a millets and sorghum zone.

0417 **Cabinda uplands** (400-800 m a.s.l.)

SOTER (6) 15-50, (8) TH, (9) T, (10) 3, (12) MB2

- This steep, mountainous region, has developed on rocks of the Oendolongo Group (WCS): mica-schists, quartzites and phyllites.

- NTh 1 - 3c, FRx 18 - 2bc, CMo 1 -2bc
see profiles p.82/59 (CMo) and p.80/59 (NTh).

- HF The uplands are covered by dense, evergreen, humid forests (Maiombe forest), with Gossweilerodendron balsamiferum, Pterygopodium oxyphyllum, Terminalia superba, Chlorophora excelsa; undergrowth is composed of evergreen low trees and shrubs.
Degraded secondary forest of Musanga smithii.., Hyparrehnia and Andropogon grasses colonizes abandoned fields.

- PL2/1 - 25,36
This is a cassava and robusta coffee zone

0418 **Quibala plateau IIb** (1,000-1,250 m a.s.l.)
and mountains (< 1,500 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) IN, (10) 3, (12) IA1

- This planation surface cuts Precambrian granites and some gneisses. On the plateau occur granite rock outcrops and 350-400 m higher mountain chains; a few peaks reach surface IV altitudes.
The narrow, moderately deep valleys, become wider and plateau ridges consequently more narrow, towards the west.

- ACh1 - 2bc, FRh 14 - 2ab; partly petroferric or skeletic phase
Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh).
Soils are very deep to shallow, dark reddish brown, or bright yellow to yellowish brown.

  (1) The plateau ridges and slopes usually are covered by soils on ironstone crusts, with temporary water stagnation on top of the crusts and damage to coffee trees; soil erosion problems are common;
  (2) on lower slopes the ironstone crust appears at the surface;
  (3) on the valley floors occur deep, moist soils, without ironstone crusts.

- 50% OF, 30% SW, 20 % GH

  (1) The plateau is characterized by open, high, dry forest, with shrubs and dense tall grasses, or by dense tree steppe;
  (2) shrubs or tall grasses grow in the valleys;
  (3) Aloes colonize the inselfelsen;
  (4) on higher mountains there are rocky slopes with rare, hard grasses and some trees in valleys.

  The Luati plateau (0418/4), however, is covered by dense forest (ironstone crust absent). In areas with crusts grow low trees. Narrow riparian forests occur along streams, without grasses and dense shrub undergrowth. Inselbergs are covered with low dry forest or shrub steppe. Secondary vegetation consists of wooded savanna, or riparian forest steppe, with high grasses and shrubs.

- PL2/2 - 02,07,11,17,22,23,25,26,36,39,40

  (1) The plateaus are a maize, sorghum ('malufu'), beans, groundnuts, sisal, cotton, cassava, sweet potato, robusta coffee, oil palm and pasture zone

  (2) in the valleys: bananas, coffee, mango, papaya, pineapple, passion fruit, rosella, egg plant, oranges and vegetables are grown.

0418/1 Amboiva plateau II (1,190-1,250 m)

- This plateau is situated 260 m below planation surface III, 400 m below high plain IV and 600 m below surface V. On the plateau rise 350-400 m higher mountain chains, with a few peaks reaching surface IV levels. There are finger, pillar, dome and tower shaped inselbergs. The rare, narrow and moderately deep valleys, become wider and plateau ridges consequently more narrow, towards the west. There are many granite outcrops on the plateau.

- FRh 14 - 2ab
  Sandy topsoils overlie yellowish brown soils, with a diffuse transition to a reddish mottled weathering zone.

- Vegetation is open, high, dry forest, with Brachystegia, Syzygium, Entada abyssinica, Erythrina suberifera; there also shrubs and dense, tall grasses (1.5-2.5 m). Shrub vegetation also occurs in the valleys.

Blick vom Weg einige Kilometer hinter Amboiva gegen Südosten
über die Rumpffläche II auf die Randketten mit den Niveaus III und IV.

Fig. 18. View towards the SE, near Amboiva, over plateau II (1,200 m a.s.l.), terrain unit 0418/1; towards the Marginal Mountains with High Plain IV, terrain unit 0707 and intermediate plateau III, terrain unit 0504: (Jessen, 1936)

0418/2 Vila Nova de Seles surface II (1,070 m a.s.l.)

- This plateau is characterized by giant, rounded, granite block floors. Valleys have dissected the plateau (40 m deep) to rocky ridges, granite boulder plateaus and steep inselfelsen. The valleys have wide floors and most valley slopes are steep, with abundant rock outcrops, see figure (D1 = plateau II).

- ACh1 - 2bc; partly petroferric phase.
  On plateaus and slopes occur shallow soils, on ironstone crusts and granite boulders; valley floors are covered by deep, moist soils.

- Vegetation is composed of high grasses, trees (Cussonia angolensis) and shrubs (Gymnosporia);
  on inselfelsen grow Aloes and on valley floors high Andropogon grasses.

- Crops are maize, oil palm, banana, robusta coffee, cassava, sweet potato and also some pasture.

0418/3 Humbi-Quibala plateau IIb (1,150-1,200 m a.s.l.)

(1) Main landscape

- This plateau is covered by bright yellow soils, with ironstone crusts, on gneiss or quartzite; many termite hills occur.
  ACh1 - 2bc, FRh 14 - 2ab; partly petroferric or skeletic phase.

- Vegetation is composed of a dense, tall grass - low tree steppe; see figure 21.

- The main crops are maize, cassava and groundnuts.

(2) Humbi mountains (Serra da Rianga, 1,500 m a.s.l.)

This mountain chain has a 300-370 m high escarpment and planation surface III remnants at 1,400 m a.s.l. (see figure 20). The mountains are cut by a V-shaped break-trough of Rio Nhia. The rocky slopes are covered by rare, hard grasses; some trees occur in the mountain valleys.

(3) Dissected Quibala-Rio Longa plateau

- This area, in between Quibala and Dondo, forms the step from plateau II to III at 1,100-1,400 m a.s.l.
  It is a dissected granite dome area, with rounded, higher and lower inselbergs, with deeply weathered biotite granite and flat granite outcrops.

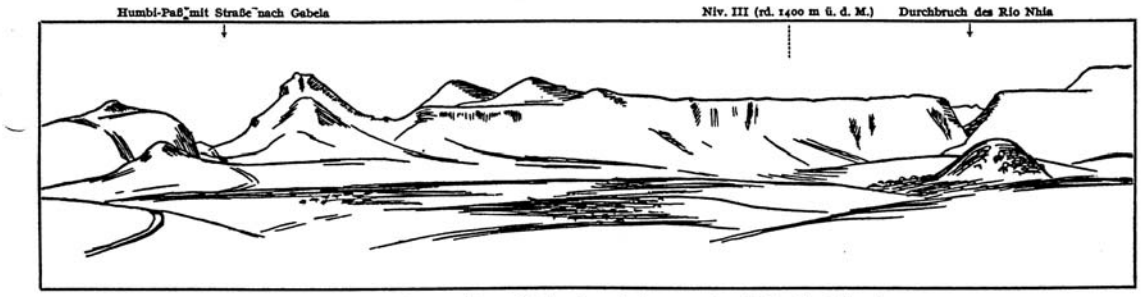
- The region is covered by reddish brown soils on granite.

- The main crops are maize, vegetables, groundnuts ('otchinguwa'), pineapple and potato.
  Rio Longa flows at 1,100 m a.s.l.. The river has a wide valley floor planted with banana, coffee, mango and papaya.

Die zertalte Inselbergfläche bei Vila Nova de Selles (schematisiert).
D_1 Alte Inselbergfläche. D_2 Neue, im Entstehen begriffene Fußflächen.
a) Entblößter Fels; b) Blockschutt; c) Feiner Verwitterungsboden.

Fig. 19. Terrain unit 0418/2: dissected inselberg plain near Vila Nova de Seles (Jessen, 1936)

D1 = old inselberg plain or Plateau II at 1,070 m a.s.l.
D2 = new footplain
a = rock outcrops
b = talus blocks
c = fine granite weathering soil



Die Humbi-Kette (Serra da Rianga) von Südost aus 1280 m M. H. (Niv. II) gesehen.

Fig. 20. Terrain unit 0418/3: view, from the SE, over Plateau II (1,280 m a.s.l.) to the Humbi Mountains, or Serra da Rianga (1,500 m a.s.l.), with flat tops, being plateau III remnants (1,400 m a.s.l.). Note the V-shaped break-through of Rio Nhia (Jessen, 1936)

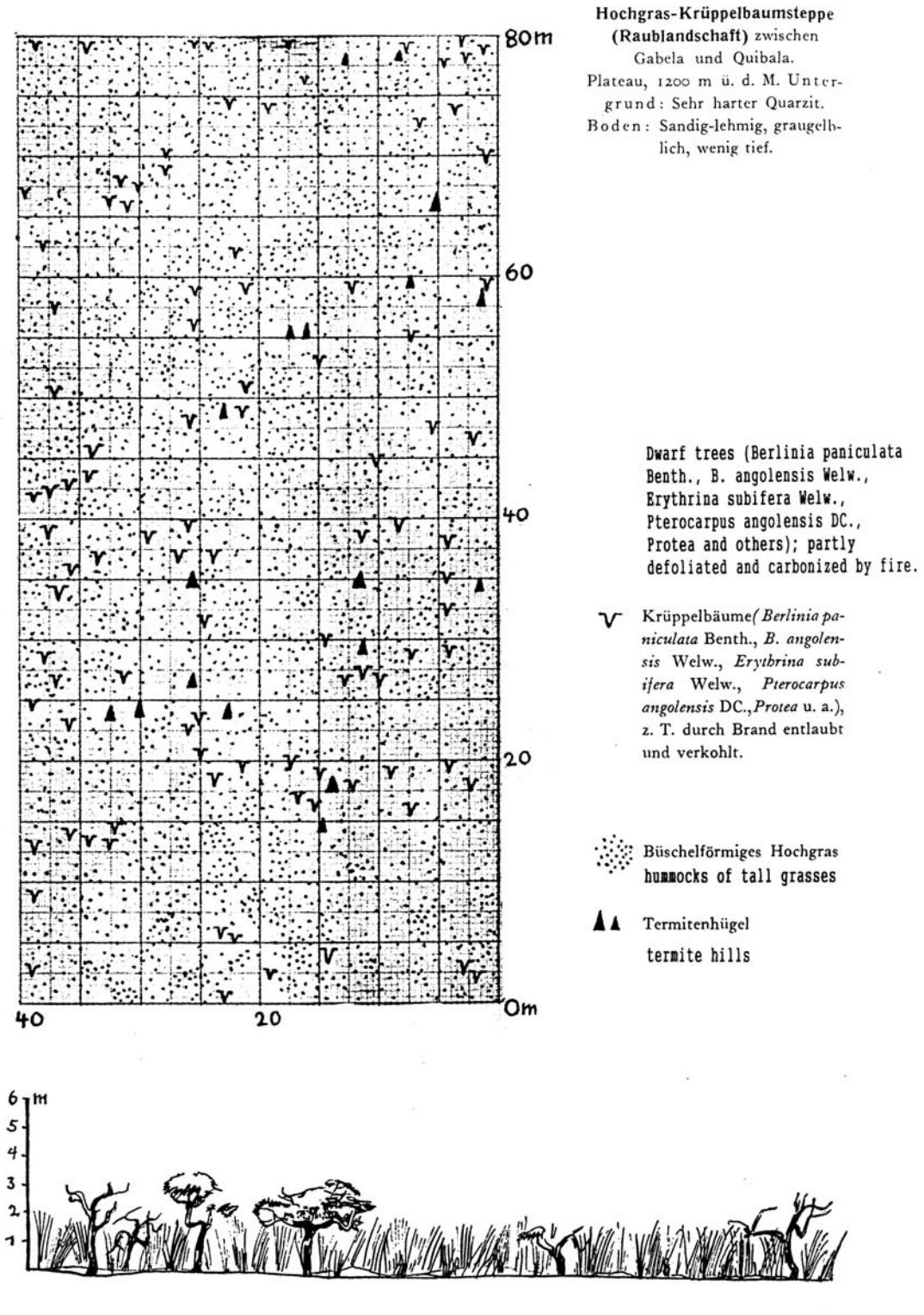


Fig. 21. Terrain unit 418/3: plateau II, in between Gabela and Quibala (1,200 m a.s.l.); a tall grass - dwarf tree steppe, on a moderately deep, yellowish grey, sandy loam soil, developed in hard quartzite (Jessen, 1936).

0418/4 Luati plateau IIb (1,100-1,180 m a.s.l.)
and Libolo highlands (1,380-1,400 m a.s.l.)

- In between Quibala and Dondo exists a granite plateau, with some rock outcrops and with impressive mountainous inselberg domes and ridges. Some of the inselbergs are topped by plateau remnants, reaching plateau III altitudes (1,380-1,400 m a.s.l.); see figure 22.

- ACh1 - 2bc, FRh 14 - 2ab; partly petroferric or skeletic phase.

  There are mainly > 3 m deep, dark reddish brown, sandy loam soils. Usually an ironstone crust is present; sometimes it is found at a depth of less than 50 cm. Some very deep plateau soils do contain ironstone concretions only.

  Temporary water stagnation problems occur on top of the ironstone pan (damage to coffee trees).
  Soil erosion is important. On lower slopes, ironstone crusts appears at the surface. Crust are absent in valley floor soils.

- Vegetation is a moderately moist savanna, with high stem trees and high grasses; its density depends on the depth of the ironstone crust:

  (1) where ironstone crusts are absent or deep grow dense forests

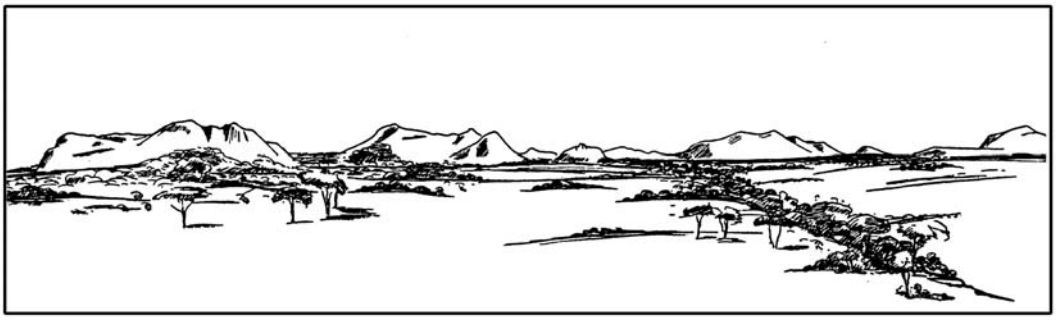
  (2) where the crust occurs at shallow depth, a low tree vegetation can be found and there are no coffee plantations, only maize and cassava;

  (3) no crusts exists in valley floor soils, covered by narrow strips of riparian forest, without grasses, but with a dense shrub undergrowth; on moist soils near streams grows 5-7 m high Cochlospermum angolense;

  (4) inselbergs are covered by low dry forest or shrub steppe.

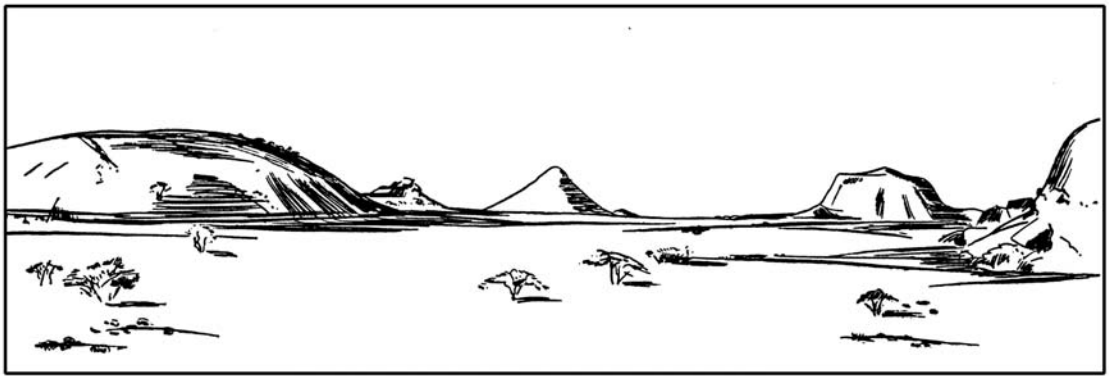
  Secondary vegetation consists of a wooded savanna or riparian forest steppe, with high grasses and shrubs.

- Crops of the area are: maize (5 month cycle), cassava, groundnuts, beans, sweet potato, sorghum ('malufu'), banana, pineapple, oil palm, mango, passion fruit, rosella, egg plant, papaya, oranges, vegetables, sisal, cassava, coffee and tobacco.



Inselberglandschaft am Luati. Blick von der Pflanzung M. gegen Osten.

Fig. 22. Terrain unit 0418/4: Luati plateau IIb (1,180 m a.s.l.), with granitic inselbergs (Libolo highlands) (Jessen, 1936).



Granitische Inselkuppen im Vorland der Chella.

Fig. 23. Terrain unit 419/2: inselberg plain on plateau II, along the Lubango-Namibe road (500 m a.s.l.); the granite inseldomes are 80-120 m higher and reach plateau IIb altitude (Jessen, 1936).

0419 **Munhino plateau II** (450-600 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) IN, (10) 2, (12) IA1

- In between Lubango and Namibe exists an inselberg-covered pediplain on granite, quartzite and schists. It is interrupted by large dry river beds with groundwater at shallow depth.

- CLl 10 - 2ab; CLl 2 -ab, partly sodic phase
  Typica Profile: p.53/54 (CLl)

- 95% ST; 5 % GH
  Vegetation is composed of a thorny shrub-low steppe, with trees in the eastern parts; riparian forests grow in the valleys.

- ML2/2 - 04,07,40
  This is a millets, sorghum and pasture zone.

  IR/2 - 02,32,38,30,35...
  The valleys are characterized by irrigated and groundwater agriculture: maize, sugar cane, tobacco, potato, peas, cabbage, banana...

0419/1 Eastern Munhino plateau (II, 450-600 m a.s.l.)

- This inselberg-covered, 100 km wide, pediplain formed on granite with diabase intrusions. The Cerro Maluco inselberg (2,100 m a.s.l.) rises steeply above the plateau; it is a granite mountain with a quartzitic sandstone and shale peak (an outlier of Humpata plateau V), with a terraced planation IV remnant at 1,800 m a.s.l. and a terrace of plateau III at 900 m a.s.l.

- CLl 10 - 2ab; CLl 2 -ab, partly sodic phase

- The region is covered by baobab-tree steppe, with high termite hills. On dry spots occur rare grasses and 6 m high Acacia mellifera, Albizzia anthelmintica, Cleistanthus ('mupapa')... Riparian forests grow along Rio Munhino, with 1-15 m high Copaifera mopane ('mutuati'), boabab, Terminalia, Ximenia ('umpeke')...

- The Rio Munhino plantations used to grow maize, coffee, potato, peas, cabbage, sugar cane and had gardens with banana, guava, orange, mandarin, lemon, ficus, grape and apple.

0419/2 Western Munhino plateau (II, 450-500 m a.s.l.)

(1) main landscape

- The region is a wide inselberg pediplain on granite and some schists. The wide, dry river beds have a groundwater table at shallow depth. Granite or quartzite inselbergs rise 80-350 m above the plain; e.g. the quartzite/marble Mocorro and Cerro Lulea inselberg ridges, reaching surface IIb (80-120 m higher) or plateau III (300 m higher) levels. The latter form plateau-shaped inselbergs, topped with still 50-100 m higher ridges and domes (e.g. Serra de Lua: quartzites, schists). Valleys are shallow and dry (mololas).

- CLl 10 - 2ab
Yellowish grey, coarse sandy soils developed on granite and sandy clay soils on schists; see profile p.282/56 (LVk, sodic phase). There is strong sheet erosion (shrubs on pedestal).

- Vegetation is a 5-7 m high thorny shrub - low tree steppe, with few higher trees. Towards the west climate becomes more arid, with a 3-3.5 m high thorny shrub steppe and less high trees, with 0.3-0.5 m tall grass and bare, gravel-covered, yellowish grey sandy granite weathering soils. Typical are dense grey shrubs of Acacia mellifera and macrostachys, Balamites angolensis, Barleria, Euphorbia ... The trees of this area are Acacia albida, Boscia, Salvadora persica, Burkea africana.... 15-25 m high riparian forests, with Acacia albida, Copaifera mopane and high grasses occur along the streams.

- Agriculture is restricted to the valleys: maize, sugar cane, tobacco ...

(2) Pedra Grande plateau II (450-540 m a.s.l.)

- The most western part of plateau II is characterized by biotite granite inselfelsen, inselbergs and granite cones. The plateau rises towards the W and the inselbergs disappear; only granite boulder packings remain.

- CLl 10 - 2ab; partly rudic phase
Stony, sandy, granite weathering soils.

- Vegetation consists of 2-3 m tall shrubs, spread each 20-30 m and bare soil spots. An open dwarf shrub steppe occurs on the plateau, with Acacia detinens, Cissus and with high euphorbia on the inselfelsen.

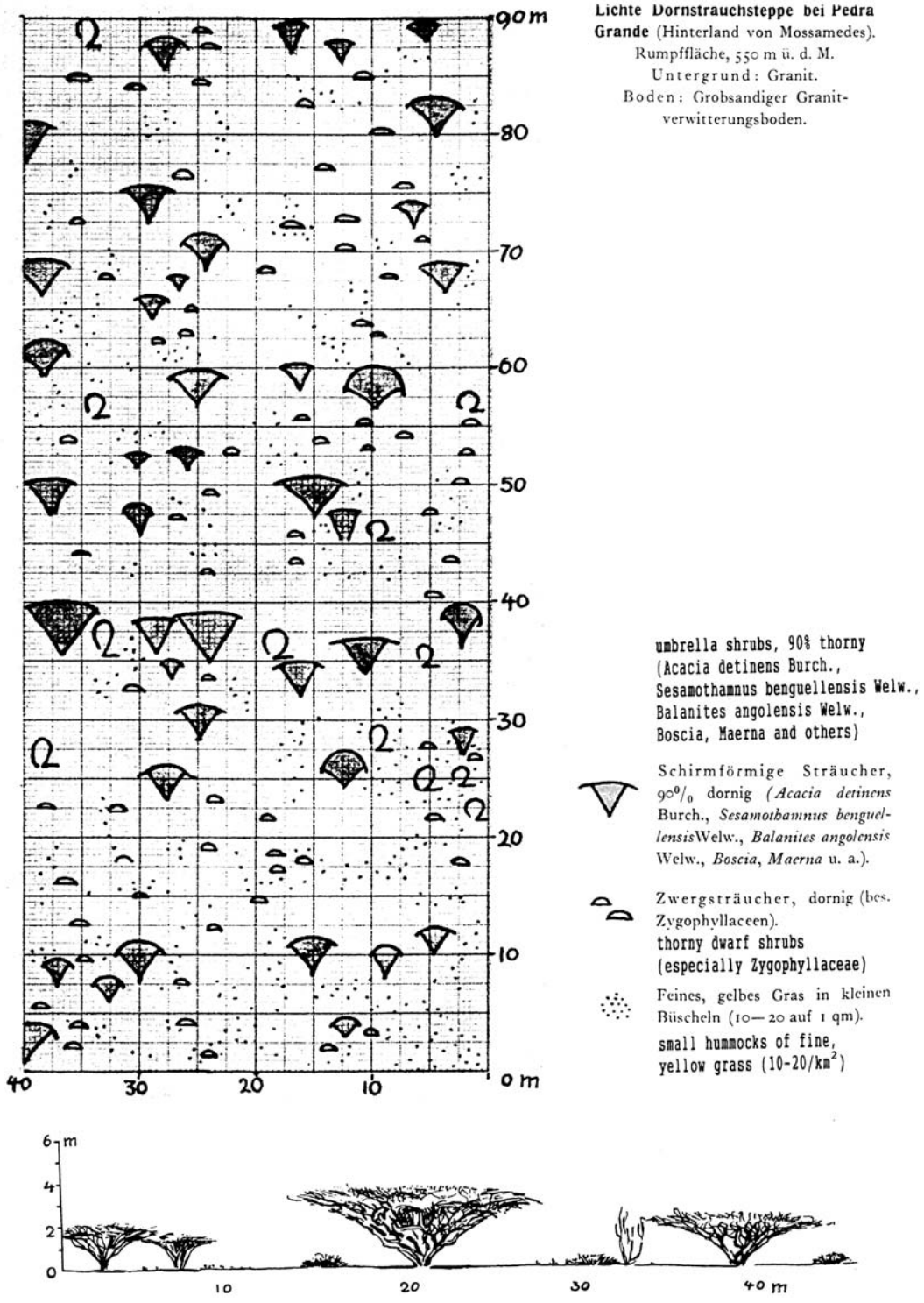


Fig. 24. Terrain unit 419/2: the Western Munhino plateau II at Pedra Grande (550 m a.s.l.); an open thorn-shrub steppe, on a coarse sandy soil, developed in granite (Jessen, 1936).

0500 Plateau III

0501 Quela plateau III (1,270 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) U, (10) 3, (12) MA2

- This planation surface formed on rocks of the Basal Complex, usually gneiss.
- FRh 8 - 2ab, FRh 9 - 2ab
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- 85% GH, 15% SW
- PL3/2 - 22,25
  This is a cassava and cotton growing area.

0502 Malanje plateau III (1,200 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) U, (10) 3, (12) MA2

- This plateau developed on rocks of the "Sandstone-Schist Series" (WCS).
- FRh 9 - 2ab, FRh 10 - 2a, (FRh 14 - 2ab, ARo 11 - 1a); see profile p.57c/63 (FRh)
- 70% OF, 20% GH, 10% SW
- PL3/2 - 06,25,36
  Land use is characterized by cassava, rice and coffee.

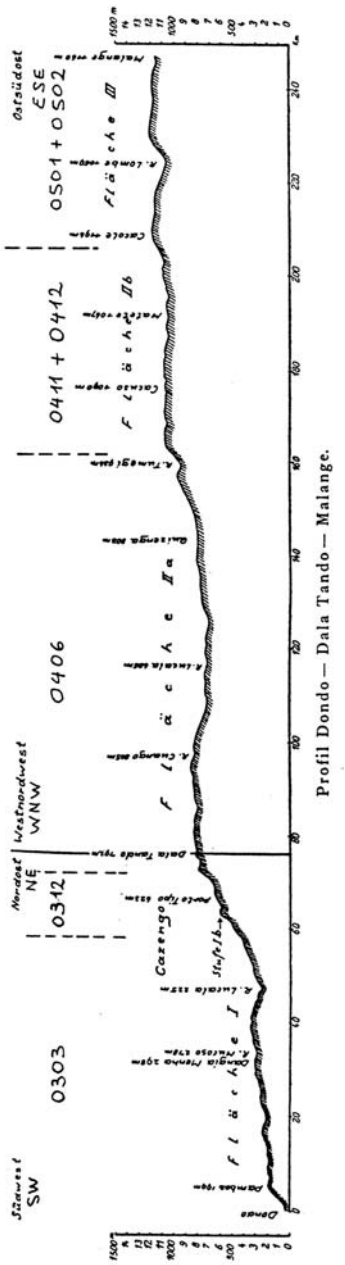


Fig. 25. SW-NE/WNW-ESE transect from Dondo, to N'Dalatando and Malanje; a typical succession of plateau I, Cazengo mountains (step), plateaus IIa and b and plateau III (Jessen, 1936).

0503 **Sanga plateau III** (1,420-1,500 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) U, (10) 3, (12) MB3

- This planation surface, with flat bottom valleys, formed on rocks of the Basal Complex (mica schists, pyroxene gneiss, quartzites).

- FRh 14 - 2ab, (ARo 11 - 1a: sandy soils on sandstone and quartzite); partly skeletic phase
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh).
  Bright yellow sandy loam soils, with a bleached zone (temporary water stagnation) overlie ironstone concretions, reddish mottled loam and bleached weathered rock.

- 45% GH, 30 % OF, 25% SW
  Vegetation is high (10-16 m) dry forest (Berlinia angolensis), with rare shrub undergrowth, but with abundant grasses (0.7-1.4 m). The valleys are covered with Pandanus forests; grasses are found on temporary swampy areas of the valley floors.

- PL3/2 - 02,25,22,32,40
  This is a maize, cassava, cotton (east), coffee (west) and pasture zone.

0504 **Ganda plateau III** (1,200-1,450 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) IN, (10) 3, (12) IA1

- This plateau developed on Precambrian granites and is covered by inselbergs. The plateau becomes hilly and dissected near the step to plateau II. Valley floors are wide and flat.

- FRh 26 - 2ab, FRh 27 - 2bc, FRh 14 - 2ab, ACh 1 - 2bc, FRx 8 - 2b, FRh 30 - 2ab; partly petroferric phase

  (1) Plateau soils are yellow or red, with or without ironstone crust/concretions. Deep red loamy soils, without concretions, are found at the footslopes of inselbergs (best soils). Termite hills are common;

  (2) yellow or yellowish brown soils occur on the slopes;

  (3) greyish white soils occupy the valley floors (inundic phase).

- 75% OF, 15% SW, 10% GH

  Vegetation is dense, high, dry forest, with high grasses, with or without shrubs; or a tree steppe/open steppe forest, with high grasses. The wide, flat valleys are swampy in the rainy season and are covered by dense high grasses, without trees. These are pasture areas.

- PL3/2 - 02,23,36,38,40,25,11, 26

  This is a maize, Arabica coffee, sisal, tobacco, cassava, beans, sweet potato and pasture area.
  In gardens, potato, lettuce, radish, peas, strawberries, melons, citrus, mango, papaya, banana, guava, apple are grown.

0504/1 Dumbi-Cassongue plateau III (1,350-1,450 m a.s.l.)

- In between Cassongue and Amboiva occurs a granite plain with convex, steep-sloping, rocky, flat-topped, 130-150 m higher inselbergs. Many inselberg tops align at similar altitudes (planation surface IV).
  Rio Queve has dissected plateau III. Also near the step to plateau II, surface III has been dissected to an inselberg landscape (see figure 27).

- ACh 1 - 2bc

- An area with dense, high forests, with high grasses and high shrubs (see figure 26).

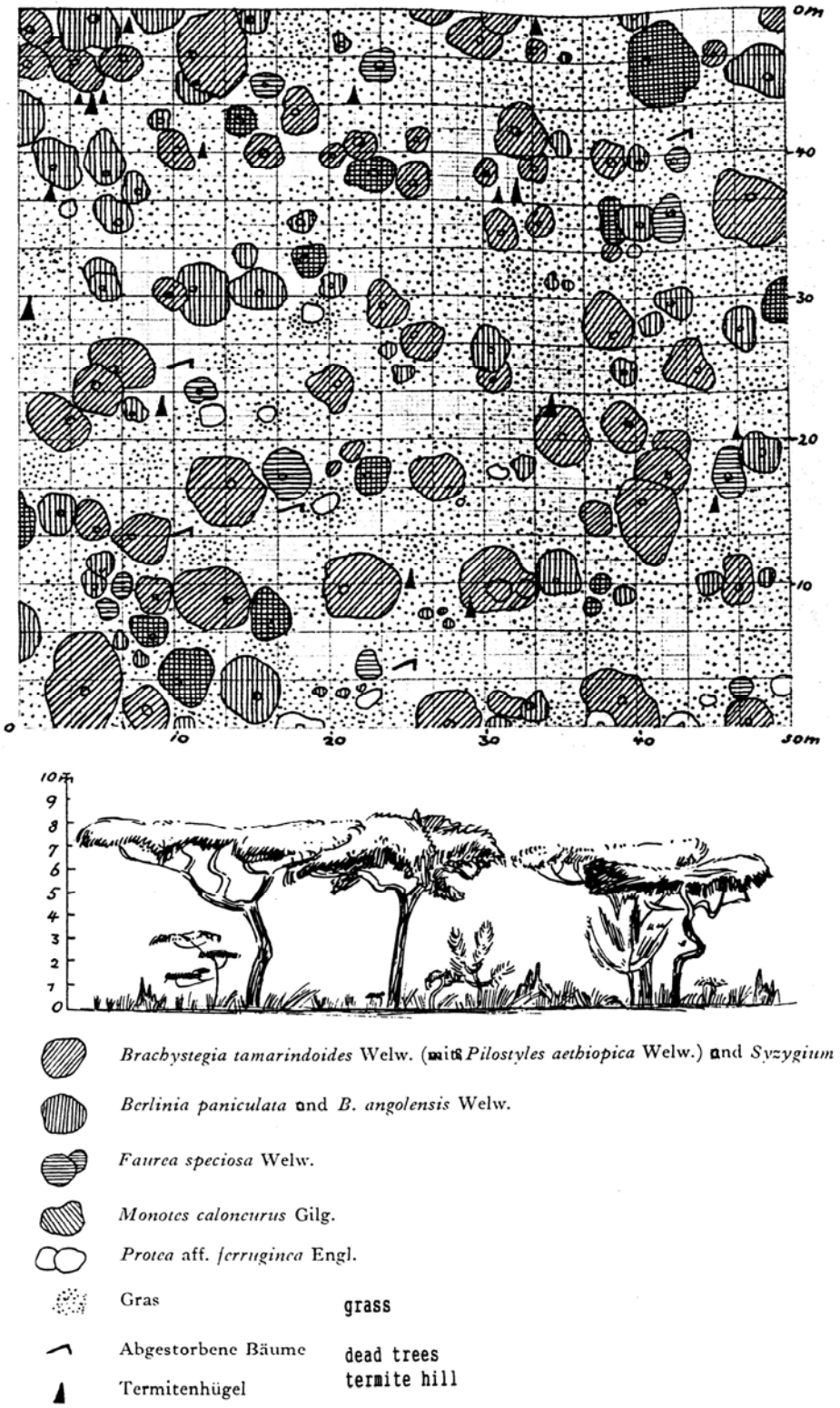
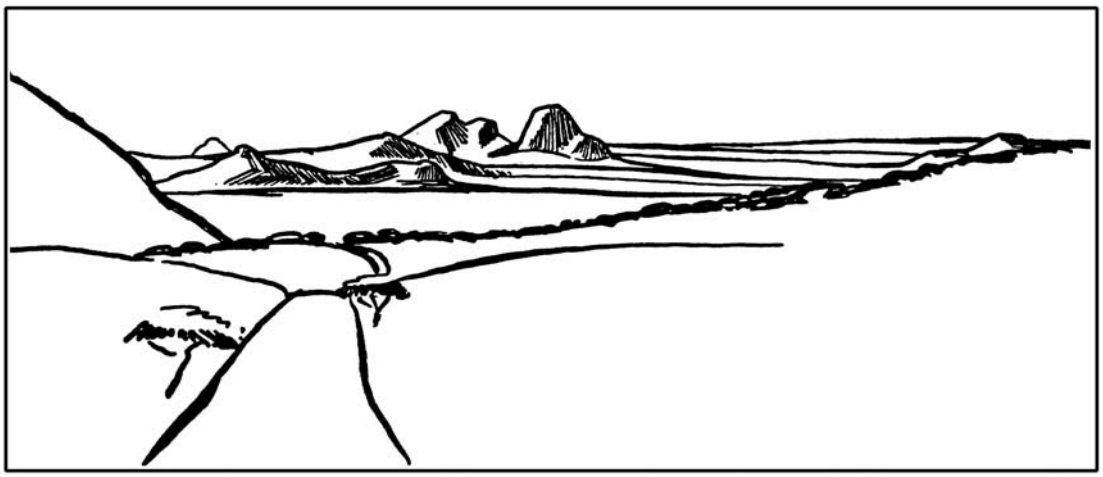


Fig. 26. Terrain unit 0504/1: low dry forest at the foot of Mount Dumbi; the undulating plateau III (1,580 m a.s.l.) is covered with a 2-3 m thick, red soil, with ironstone concretions (LXf), on porphyritic gneiss (Jessen, 1936).



Blick vom Abstieg hinter Ndumbi auf die Queve-Niederung (Niv. III), mit Inselbergen (Niv. IV).

Fig. 27. Terrain unit 0504/1: Rio Queve plain on Plateau III, near Dumbi (1,350-1,450 m a.s.l.); the inselberg tops reach planation level IV altitudes (Jessen, 1936).

504/2 Dissected Quibala-Sanga plateau III strip

(1) Main landscape

- This is a hilly area with dissected plateau III remnants.

- FRh 14 - 2ab

(1) On the plateaus occur yellow to dark red soil on granite, with termite hills;

(2) in the valleys exist greyish white soils.

- This is a region with tree steppe or open steppe forest, with up to 4 m tall grasses, trees of 6 m (rarely 10-15 m) high.

(2) Rio Capuche dissected inlier of plateau III (1,410-1,430 m a.s.l.)

- In between Sanga and Bimbe exists a 25 km wide basin, cut by many streams. They dissect plateau III and form 10-25 m deep valleys. The flat valley bottoms are covered by grasses. There are some forested ridges.

0504/3 Rio Balombo plateau (IIIa, 1,250 m a.s.l.)

(1) Main landscape

- This is an undulating plateau with hills. Slopes are covered with gneiss blocks and rock steppe. The hill tops reach planation level III b altitudes (1,360-1,389 m a.s.l.), about 100-200 m above plateau IIIa (e.g. Londumbu, Maepo mountains). Rio Balombo flows in a flat bottom valley.

- Soils: see figure 28.

- Vegetation is high (10-15 m) dry forest, without undergrowth. Towards the W conditions are more arid and low steppe forest, shrub steppe, or open tree steppe, with high grasses occurs.

- Typical rainfed and irrigated crops are maize, cassava, beans, sweet potato, banana, sugar cane, papaya and tobacco.

(2) Balombo-Bocoio plateau IIIa (1,250-1,260 m)

- This is a slightly undulating, 40 km wide, plateau, with large rounded gneiss/granite blocks and steep, bare granite inselbergs and inselberg chains. The valleys have a dense high grass cover and are swampy in the rainy season.

- FRx 8 - 2b, ACh 1 - 2bc

  (a) 2-3 m deep, bright red soils characterize the plateau;

  (b) on the slopes occur > 1.5 m deep, yellow or yellowish brown soils, without large boulders;

  (c) greyish-white soils are found on the valley floors.

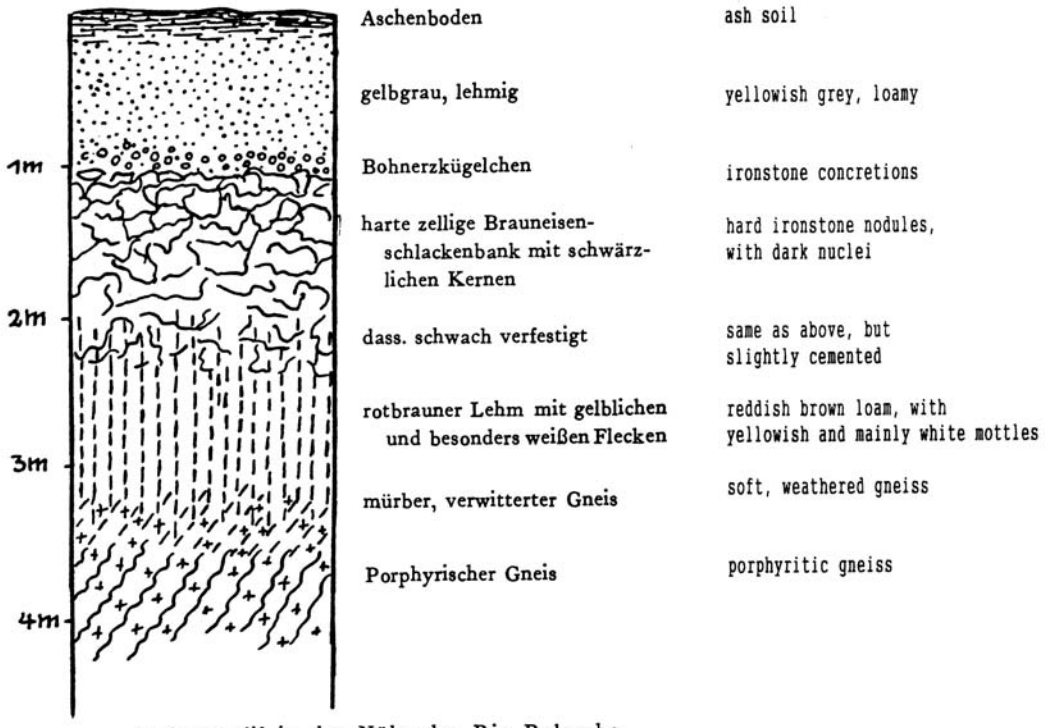
- Vegetation is dense forest (12-15 m), without undergrowth; it is less abundant according to soil depth:

  - 100-150 cm: low trees
  - 20-30 cm: 2-3 m tall grasses, single shrubs and low trees
  - 3-5 cm : 4-5 cm tall grasses
  - shield-like rock outcrops without grasses

- Crops are maize, cassava, sweet potato...

(3) escarpment between plateaus II and III (260 m high)

- The escarpment has rocky slopes; riparian forests are found in the valleys; there are high euphorbia and Aloes.



Bodenprofil in der Nähe des Rio Balombo.
1200 m ü. d. M. Hoher Trockenwald.

Fig. 28. Terrain unit 504/3: Rio Balombo plateau III (1,200 m a.s.l.); a soil developed on porphyritic gneiss, covered by high dry forest (Jessen, 1936).
Ferric Acrisols, petroferric phase; mapping unit ACh1.

504/4 Ganda - Cuma plateau III (1,200-1,350 m a.s.l.)

(1) Main landscape

- The slightly undulating biotite granite plateau is interrupted by the 500 m higher Ganda mountains; also granitic inselfelsen are rising 40-100 m above the plateau.

- FRh 30 - 2ab, partly petroferric or skeletic phase; see profile p.229/57 (FRh)

  There are moderately deep soils, on ironstone crusts and/or concretions. 15 m deep red loamy soils, without ironstone concretions are found on mountain footslopes (best soils). Termite hills, of 3-5 m high, are spaced each 40-50 m.

- Vegetation is dense, high stem, leguminoses forest (8-15 m), with Bauhinia recticulata ('Ombanka'), 10-12 m high Pterocarpus angolensis ('Onguva'), Cryptosepalum, Uapaca, Terminalia sericea, Strychnos, Brachystegia goetzei; there is almost no shrub undergrowth; tall grasses grow in the forest (Andropogon, Hyparrhenia of 2-3 m).

- Agriculture includes maize, cassava, sweet potato, sisal, Arabica coffee and some pasture.
  In gardens, potato, lettuce, radish, peas, strawberries, melons, citrus, mango, papaya, banana, guava and apple are grown.

(2) The kms wide Rio Cubal valley floor is characterized by 6-7 m deep, yellow-red mottled clayey soils, without ironstone crust. The flat bottom is swampy in the rainy season (inundic phase); it is covered by grasses (Pennisetum) and no trees.

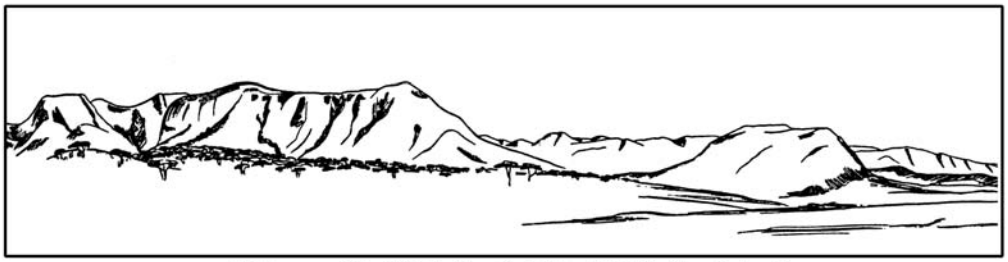
(3) Cuma inlier of plateau III (1,430-1,500 m a.s.l.)

- The Cuma inlier is a 15 km wide basin, surrounded on three sides by uplands of plateau V: the 600-700 m higher quartzitic Oendolongo mountains in the south, the Uirala mountains in the north, and the 400 m higher quartzitic sandstone Elendi mountain chain (1,900 m a.s.l.).
  The area is a granite plateau, with wide flat valley floors, interrupted by some plateau IV remnants and granite inselbergs (e.g. Mt. Tschimba); see figure 30.

- FRh 26 - 2ab, FRh 27 - 2bc
  The granite inselberg footslopes are covered by deep, red, fine loamy soils and have a slope of 3-4^{o}. There is a sharp break to the 40^{o} mountain slopes. The northern escarpment to plateau V is covered by 4 m deep, red loamy soils, without ironstone crusts.

- This is an open dry forest (10-15 m high) area, with large termite hills. Tree-less grasslands occur in the wide flat valleys. These are traditional pasture areas.

- The main crops are maize and Arabica coffee, some oranges are also grown.



Die 600—700 m hohe Stufe des Camatia-Hochlands östlich des Weges Ganda—Chicuma.

Fig. 29. Terrain unit 0504/4: footplain of plateau III (1,300 m a.s.l.), with the 600-700 m high escarpment to plateau V (Camatia highland; terrain unit 0707), east of the road Ganda-Chicuma (Jessen, 1936).

Die Hochlandstufe (Niv. IV u. V) mit vorgelagerter Inselbergebene (Fläche III) am Rio Cuiva.

Fig. 30. Terrain unit 0504/4: Cuma granitic inselberg plain inlier, part of plateau III, at Rio Cuiva, along the Ganda-Huambo road, (1,430-1,500 m a.s.l.). In the distance, the 400-600 m high quartzitic escarpment to High Plain IV and plateau V (Jessen, 1936).

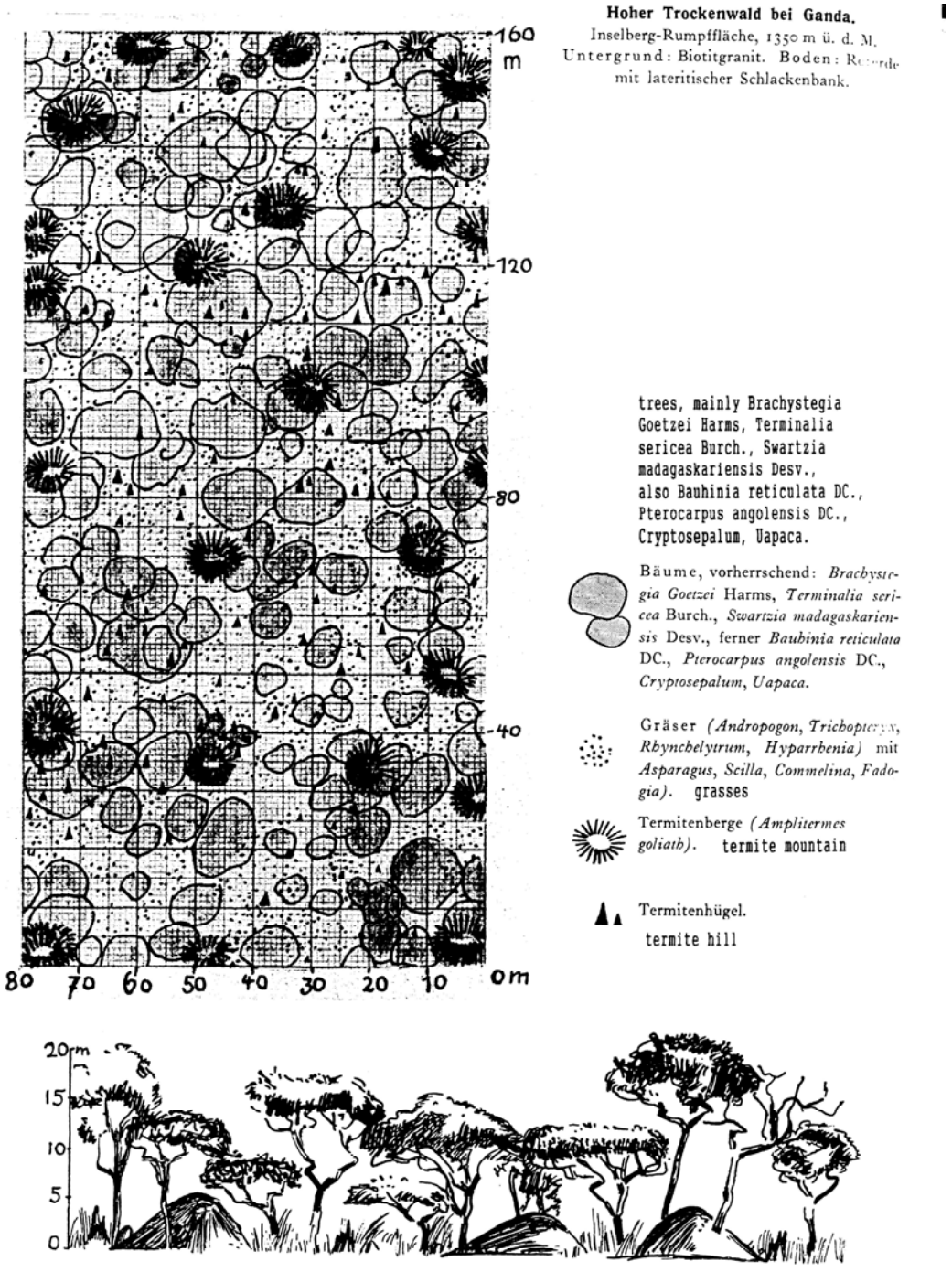


Fig. 31. Terrain unit 0504/4: inselberg plain on plateau III (1,350 m a.s.l.) near Ganda; high dry forest grows on a red soil with an ironstone crust, developed on biotite granite (Jessen, 1936).

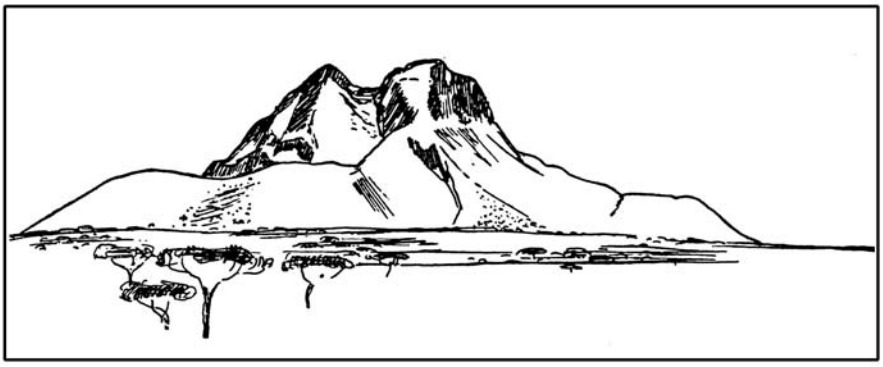
0505 Bibala (Vila Arriaga) plateau III (940-1,320 m a.s.l.)

SOTER (6) 0-30, (8) LL, (9) IN, (10) 3, (12) IA1

- This inselberg plain developed on Precambrian granites.
- LXf 4 - 2b, partly petroferric/skeletic phase;
  LXf 5 - 2b, partly petroferric phase; LVf 2 - 1/2ab;
  see profile p.289/56 (LVh)
  Typical Profile: p.237/59 (LXf).
- 30% GH, 35% ST, 35% SW
  Vegetation is a baobab and tree steppe, or a shrubland with baobab trees.
- PL3/2 - 04,07,23,38,40,02
  This is mainly a pasture area, with some millets, sorghum, sisal, maize and tobacco. area

0505/1 Mapupa plateau III (1,200-1,320 m)

- South of Cubal occurs a granite plateau with inselbergs, e.g. Chivila and Bonga mountains (remnants of planation surface IV, with terraced shoulders of surface IIIb; see figure 32). In the northern part of the plateau (south of Cubal) exists a 300 m high escarpment between plateaus III and IV.
- LXf 5 - 2b
  Soils rarely contain ironstone crusts, but usually ironstone concretions.
- Vegetation is classified as a moderately dry, open park-like baobab and tree steppe, with tree- and shrub-size Aloes, minor grass floors (0.5 m tall grasses and thorn trees). The vegetation is differentiated from the Ganda plateau (unit 0504) by the absence of the high grass dry forest.
- This is mainly pasture area.



Der Bonga-Berg (rd. 1600 m) von Osten mit Terrasse (IIIb) und Fußfläche (IIIa).

Fig. 32. Terrain unit 0505/1: plateau IIIa (1,350 m a.s.l.) and Mount Bonga (1,600 m a.s.l.), with terraced remnants of plateau IIIb, seen from the E on the Cacula-Quilengues road (Jessen, 1936).

0505/2 Bibala plateau III s.s. (940-960 m a.s.l.)

- This area is a slightly undulating granite plateau, with inselbergs reaching 1,500 m a.s.l.. There are a few quartz-diabase intrusions, forming sharp ridges. The 100-150 m deep (dry) valley of Rio Munhino breaks through a granite-porphyre mountain chain. There is a 200 m high escarpment, descending to plateau II in the west.

- LXf 4 - 2b; LVf 2 - 1/2 ab; profile p.289/56
  Typical are sandy clay loam, granite weathering soils; platy granite rock outcrops also occur.

- This is a shrubland with 3-5 m high Tricalysia buxifolia and baobab trees of 15-20 m.

- Crops are maize, Arabica coffee, banana, papaya and also pasture.

0506 **Cainde plateau III** (700-1,100 m a.s.l.)

SOTER (6) 0-30, (8) LL, (9) IN, (10) 3, (12) IA1

- This plateau is located in the Namibe Province; it was cut on Precambrian granites; it is an inselberg plain, with tops of > 1,200 m a.s.l. There are some gabbro intrusions.

- LPe, CLl 1 - 2ab;
  Ferric Luvisols (LVf) occur on gabbro intrusions; see profile p.223/54.

- 70% GH, 30% ST

- ML3/2 - 04,07,40
  This is a millets, sorghum and pasture zone.

0507 **Nova Gaia plateau III** (1,200-1,457 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) U, (10) 3, (12) MB2

- This planation surface in Malanje Province developed on rocks of the Cassanje Series (Karroo, mainly schists).

- FRh 8 - 2ab, FRh 13 - 2ab, FRh 19 - 2b
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)

- 70% OF, 15% GH, 15% SW

- PL3/2 - 22,25
  It is a cassava and cotton growing zone.

0508 **Capunda plateau III** (1,200-1,457 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) U, (10) 3, (12) MB2

- This plateau in the southern Malanje Province has formed on Late Tertiary-Quaternary sediments and Karroo rocks (mainly schists).
- FRh 10 - 2a, FRh 18 -2a; see profile p.101c/63 (FRh)
- 70% OF, 15% GH, 15% SW
- PL3/2 - 06,22,25
  It is a cassava, rice and cotton zone.

0509 **Iona highlands** (700-1,500 m a.s.l.)

SOTER (6) > 30, (8) TM, (9) T, (10) 3, (12) SC

- This dissected area occurs on tillites of the Bembe and Oendolongo Groups (WCS) and also on Precambrian granites.
- LPe - CL - c, lithic/rudic phase.
- ST, steppe vegetation
- ML3/2 - 04,07
  This is a millets and sorghum zone.

0600 High Plain or Planalto IV

0601 Kuito High Plain IV (1,450-1,850 m a.s.l.)

SOTER (6) 0-15, (8) LP, (9) U, (10) 4, (12) MA2

- This planation surface developed on rocks of the Basal Complex: gneiss, granitic gneiss and some quartzite. The landscape is composed of plateaus and slightly undulating ridges, with wide, flat, swampy (rainy season) valleys. Inselbergs only occur in the western parts (0601/1). Dissect areas are the sandy Chinguar and Kuito plains (0601/4-5).

- FRh 14 - 2ab, partly petroferric phase; ARo 17 - 1a, partly petroferric phase; FRh 15 - 2ab; FRh 16 - 2ab; FRh 10 - 2a, FRh 17 - 2ab, partly petroferric phase; ACh 3 - 2bc
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh).

- 60% GH, 25% OF, 15% SW

  (1) The plateaus are covered by open, low, dry forest, with or without shrubs, with grasses (important pasture area);

  (2) on the valley slopes grow herb formations with crawling roots ('ngote' or lingote, ongote) and low trees due to the shallowness of the soils over ironstone crust;

  (3) the swampy valley floors are tree-less; there is a frost hazard for crops.

- HP/3 - 02,40,06,36,25,26,11

  (1) land use on the plateaus is dominated by: maize, pasture, rice, Arabica coffee, cassava and beans;

  (2) in gardens the population grows tobacco, banana, sugar cane and oil palm;

  (3) on valley floors occur: beans, potato, rice, wheat, lemon, oranges, mandarin, banana, peach and vegetables.

0601/1 Bailundo High Plain IV (1,450-1,580 m a.s.l.)

- This high plain formed on gneiss and granite-gneiss; it is interrupted by inselberg ridges and cones. The plain is composed of a succession of plateaus and slightly undulating ridges, with many wide and flat, swampy (rainy season) valleys.

- FRh 14 - 2ab, FRx 9 - 2ab; partly petroferric phase
  There is a relation between topography and soils:

  (1) plateau ridges are covered by red and yellow to yellowish brown soils of more than 3 m deep, overlying thick ironstone crusts on top of a reddish brown and purple weathering zone; termite hills are common; the most fertile soils are found at the inselberg footslopes;

  (2) ironstone crusts are exposed, or near surface, on the lower valley slopes;

  (3) the valley floors are occupied by greyish white clayey soils, with a black topsoil (poor in organic matter); e.g. Rio Cusso.

- There is also a relation between vegetation type, soil and topography:

  (1) The plateaus are covered by open, low, dry forest of 8-10 m high, with many shrubs, and 0.5-0.75 m tall grasses (mainly pasture area)

  (2) less trees grow where shallow soils overlie ironstone crusts;

  (3) on valley slopes occur herb formations with crawling roots at surface (''ngote, ongote, lingote') and low trees, due to shallow ironstone crusts;

  (4) the tree-less valley floors are covered by swamp vegetation, with Aeolanthus floribundus; there is an important frost hazard.

- This is a maize, Arabica coffee, cassava, sweet potato, tobacco, pasture and cassava area.

Blick vom Rand der Bimbe-Hochfläche (Niv. V) gegen Süden auf die Inselbergebene von Bailundo (Niv. IV).

Fig. 33. Terrain unit 0601/1: Bailundo inselberg High Plain IV (1450-1580 m a.s.l.), seen from the 260 m high, southern escarpment of Bimbe plateau V (terrain unit 0709/3) (Jessen, 1936).

0601/2 Rio Capuche plateau strip IV (1,650 m a.s.l.)

- In between Sanga and Bimbe exists a 10 km wide gneiss plateau; it is a narrow strip of High Plain IV, without inselbergs, situated about 125 m above plateau III.
- FRh 14 - 2ab, ARo 17 - 1a
- Vegetation is low dry forest (8-10 m), with rare short grasses; there is no shrub undergrowth.

0601/3 Bela Vista High Plain IV (1,800-1,850 m a.s.l.)

- In between Huambo and Kuito occurs a high plain, without inselbergs, on biotite gneiss and gneiss-granite, overlain by quartzitic sandstone. There are wide, tree-less flat valleys.

- FRh 14 - 2ab, FRx 10 - 2a; partly petroferric phase; see profiles p.159/56 (FRx) and p.113c/60 (FRx)

- The plateaus are covered with less trees, due to shallow soils overlying ironstone crusts.

- This is a maize, beans and wheat zone, with pasture lands in the valleys.

0601/4 Chinguar High Plain IV, or 'Bulum Vulu' (1,800 m a.s.l.)

- In between Huambo and Kuito occurs a sandy plain, without inselbergs, on gneiss, quartzite, diorite, but overlain by a layer of quartz sandstone. There are soft valley slopes, with some biotite gneiss or quartzite outcrops.

- ARo17 - 1a
Soils are eolian-reworked and fine sandy soils; a black A horizon overlies a 1-3 m deep, bleached fine sand on a quartz sandstone, or on a yellowish clay (weathered gneiss); there are no ironstone crusts in this area. Some rounded pan depressions of 100-200 m diameter are fossil blowouts; they are swampy in the rainy season and contain peaty soils, without sand cover, overlying a 1 m thick kaolinite clay layer.
The wide, flat, tree-less, often swampy, valley floors, have dark grey to black peaty soils.

- (1) On the sandy plateaus grow forests and grasslands; the soft valley slopes are covered by Acacia shrubs;

  (2) the valley floors are tree-less and swampy.

- In valleys: beans, potato and wheat are grown.

0601/5 Kuito High Plain IV (1,720 m a.s.l.)

- This is a uniform, undulating, sandy plateau, without inselbergs, developed on deep weathered quartzitic sandstones. The valleys are 30-40 m deep and have swampy valley floors.

- FRh 17 - 2ab; ARo 17 - 1a; partly petroferric phase

  (1) On the plateaus occur deep, eolian-reworked sandy soils (ARo17), sometimes with quartzite and conglomerate gravels, always overlying ironstone crusts;

  (2) in the valleys, black soils are found, with a reduced subsoil and without ironstone crusts.

- The plateaus are covered with 4-6 m high dry forest.

- The valleys produce rice, wheat, lemon, oranges, mandarin, banana, peach, vegetables and are pasture lands.

0601/6 Camacupa High Plain IV (1,270-1,500 m a.s.l.)

(1) Main landscape

- In between Kuito and Cuanza occurs a plateau with flat valley bottoms, at 50-100 m below the plateau level.

- FRh 17 - 2ab, FRh 10 - 2a
  Soils are deep, red, loamy and gravel-free. There are no more sandy plains such as in units 0601/4-5. There are no rock outcrops, but giant termite mounds of Amplitermes goliath.

- The plateau is covered by 20-30 m high dry forest.

- (1) On the plateau one finds maize, cassava, beans, sweet potato and some pasture land.

  (2) In gardens, the population grows tobacco, banana, sugar cane and oil palm.

(2) At Rio Cuanza occur forested plateaus and flat ridges. There are some raphia palms. Rio Cuanza has no alluvial plain or steep valley slopes; on its left bank granite blocks rest on granite; on its right bank granite is overlain by Karroo red clayey sandstone.

0602 Huambo High Plain, with Humbi Mountains
(1,400-2,200 m a.s.l.)

SOTER (6) 0-15, (8) LP, (9) IN, (10) 4, (12) IA1

- This is a slightly undulating planation surface on Precambrian granites and inclusions of Oendolongo group rocks (WCS). Streams have cut 50-150 m deep valleys in the plateau.

- FRh 28 - 2ab, FRx 9 - 2ab, FRh 14 - 2ab, FRx 10 - 2a; all with partly a petroferric or skeletic phase
Typical Profile: p.159/56 (FRh).
Deep soils, with ironstone concretions and crusts, are common; the crusts are exposed on the valley slopes.

- 60% SW, 15% OF, 25% GH
This is an open, low, dry forest area, with many shrubs; the swampy flat valley floors are covered by grasses and 'lingote'.

- PH/3 - 02,36,40,11,25,38,26,27,(09)
In this area: maize, Arabica coffee, beans, cassava, tobacco, sweet potato and potato are grown; it is also a pasture zone; irrigated wheat is grown in the valleys.
There are gardens with cabbage, sweet potato, peppers, banana, papaya, mango, lemon, orange, mandarin, apple, peach, pineapple and strawberry.

0602/1 Luimbale High Plain IV (1,450-1,580 m a.s.l.)
and Humbi Mountains (2,200 m a.s.l.)

(1) Main landscape

- This is a slightly undulating plateau on Precambrian granites and inclusions of Oendolongo (WCS) quartzites; with wide, flat, grassland valley floors and grey termite hills. Streams have cut 150 m deep valleys in the plateau, with river terraces at 50 m above the alluvial plain. Near the Humbi mountains, the plateau IV surface has been dissected to many domes of equal altitudes.

- FRh 28 - 2ab, FRx 9 - 2ab; partly petroferric phase.
Soils on the plateaus are usually more than 3 m deep, with ironstone concretions and ironstone crusts. The ironstone crusts are exposed at the surface on the valley slopes.

- Vegetation is composed of open, low, dry forest of 8-10 m high, with many shrubs. The valley floors are treeless and covered by grasses, herbs (Lingote) and swamp vegetation.

- This productive region has been growing: maize, cassava, tobacco, sweet potato, Arabica coffee, potato, pineapple, papaya, mango, bananas, peach, apple, sisal, ricinus, beans and strawberries.

(2) Humbi Mountains, with Mount Lovili (2,200 m a.s.l.)

- These NE-oriented, reddish quartzite and mica sandstone mountains have rounded tops and steep slopes; they rise 400-500 m above High Plain IV. At 1,800 m a.s.l., a terraced remnant of planation surface V has been conserved; see figure 34.

- Vegetation is open forest of 6-10 m high and short grasses.

0602/2 Huambo High Plain IV (1,600-1,700 m a.s.l.) and Bonga Mountains (2,200 m a.s.l.)

(1) Main landscape

- It is an area of slightly undulating, rounded granite plateau ridges, with some weathered granite blocks. Some granite pillars/towers rise above the plain. Streams have cut 60-100 m deep, wide, flat valleys in the plateau. Water flow is permanent and slow. The streams flow somewhat below the alluvial floor. Granite block floors exist on the plateau limits and on the upper valley slopes.

- FRh 14 - 2ab, FRx 10 - 2a; partly petroferric phase.

  (1) Deep, poor, reddish brown, sandy loam soils occur on the plateaus, see figure 36;

  (2) outcrops of ironstone crusts characterize the lower valley slopes;

  (3) no crusts exist in the valley bottom soils, but sandy loam topsoils overlie yellowish brown sandy clay.

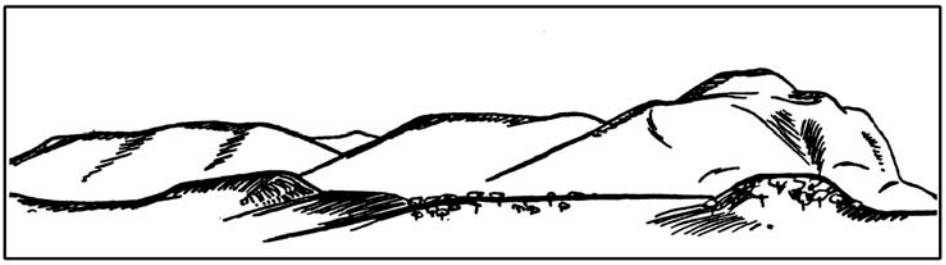
- Vegetation is composed of low dry forest with Combretum, leguminoses and Strychnos schumaniana (6-7 m high).

- Crops are maize, beans, sesame, irrigated wheat (in valleys), cassava, tobacco and also pasture.
  In gardens grow cabbage, sweet potato, peppers, banana, papaya, mango, lemon, orange, mandarin, apple, peach, pineapple and strawberry.

(2) Bonga mountain chain (2,200 m)

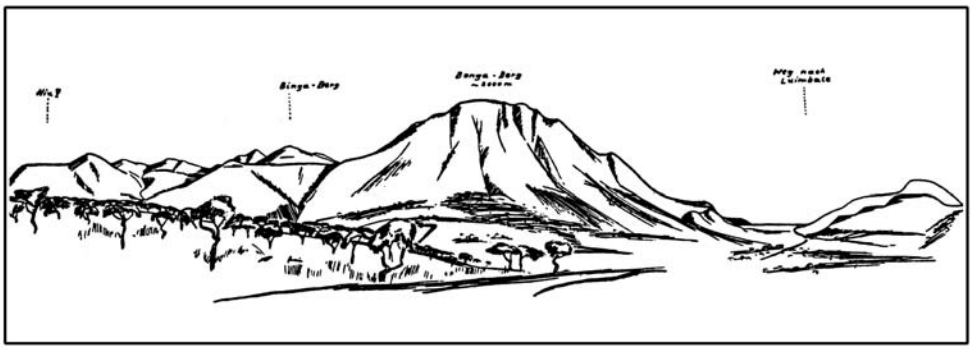
- These mountains are located in between Huambo and Luimbale; they are built of reddish and whitish mica-quartzite of the Oendolongo Group. Terraced shoulders occur at 1,800 m a.s.l.; these are remnants of planation surface V.

- The mountains are covered by low trees and shrubs; more green vegetation is found in the valleys.



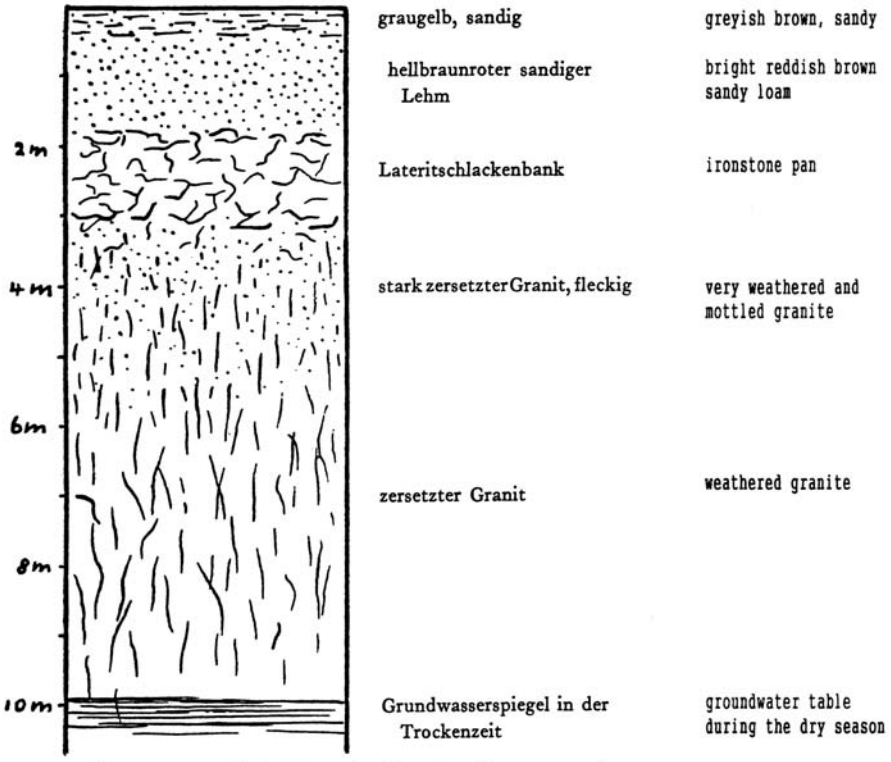
Die Humbi-Kette von Westen mit Verebnungen (Niv. V). Hochland von Luimbale.

Fig. 34. Terrain unit 0602/1: Humbi Mountains (2,200 m a.s.l.), with terraced plateau V remnants at 1,800 m a.s.l., seen from the W on Luimbale High Plain IV (1,450-1,580 m a.s.l.) (Jessen, 1936).



Blick vom Weg Huambo-Luimbale gegen Südwesten auf das Bonga-Gebirge.

Fig. 35 Terrain unit 602/2: SW view, along the road Huambo-Luimbale, of the granitic Huambo High Plain IV (1,600-1,700 m a.s.l.), towards the quartzitic Bonga Mountains (2,000 m a.s.l.), with terraced remnants of plateau V at 1,800 m a.s.l. (Jessen, 1936).



Brunnenprofil in Huambo (Casa Americana, 1700 m).

Fig. 36. Terrain unit 0602/2: well and soil profile developed in granite, on the Huambo High Plain IV (1,600-1,700 m a.s.l.); (Jessen, 1936).
Xanthic Ferralsols, petroferric phase; soil mapping unit FRx 10 or 14.

0603 Caconda High Plain IV (1,300-1,780 m a.s.l.)

SOTER (6) 0-15, (8) LP, (9) IN, (10) 4, (12) IA1

- This planation surface, with inselbergs formed on Precambrian amphibole granites, some mica-schists, gneiss, quartzite...

- FRh 32 - 2ab, partly petroferric phase; FRh 33 - 2a; FRh 37 - 2ab; FRx 11 - 2a; FRx 12 - 2ab; FRx 13 - 2a; ACf1 - 2a, partly petroferric phase; LVf 3 - 2ab, partly petroferric phase
Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh).

  Usually soils are deep on the plateaus; ironstone crusts are often exposed on the valley slopes.

- 35% GH, 35% SW, 30% OF
Vegetation is a dense, 10-15 m high, dry forest; there is no shrub undergrowth; 'ngote' occurs on the lower slopes; swampy grasslands characterize the valley floors.

- PH/2+3 - 40,02,11,25,07,26,35
This is an important pasture area, but neither pasture, nor agriculture occurs on lingote ('n gote): being low herbs and grasses of 10-20 cm, with leguminoses.

  The plateau is a productive maize zone; other crops are beans, cassava, sorghum, sweet potato, peppers, cabbage and tomato; wheat is grown in the valleys.

0603/1 Caconda High Plain IV s.s. (1,620-1,780 m a.s.l.)

- This slightly sloping to flat, uniform highland formed on amphibole granite, shales, mica schists, gneiss, and some basic (diabase) intrusions with bright red soils. Bare granite hills and forested granite ridges rise above the plateau (e.g. Sumi inselberg). Slow streams flow in flat valleys, 20 m below the plateau level. Rio Que has cut a 120 m deep valley. The step from plateau IV to V occurs near Chicuma (1,825-1,630 m a.s.l.).

- FRh 32 - 2ab; partly petroferric phase
  There is a relation between soils and topography:

  (1) On the upper slopes occur 1-2 m deep, yellowish brown to reddish brown, sandy loam soils over ironstone crust;

  (2) on the lower slopes, ironstone crusts are at/near the surface, covered by lingote (n'gote) vegetation;

  (3) the wide, permanent swampy, peaty and clayey valley bottoms are bordered by granite blocks.

- There is also a relation between vegetation and topography/soils:

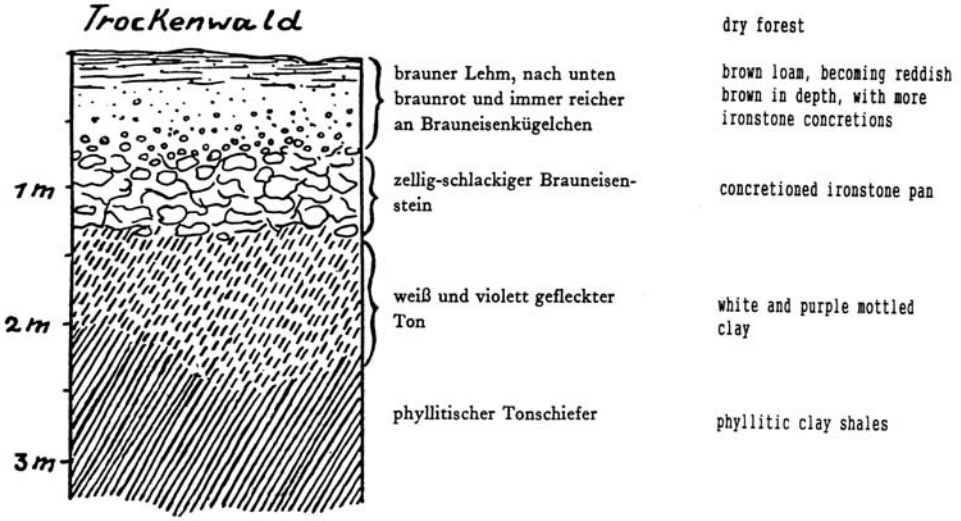
  (1) On the plateau grows dry forest with 10-15 m high Brachystegia, 5-10 m high Acacia caffra, 10 m high Erythrina suberifera, 10-20 m high Parinarium curatellifolium; there is no shrub undergrowth, but a 0.5-1 m tall grass cover.

  (2) the upper valley slopes are covered with shrub-like Brachystegia, Berlinia, 'lingote' and grasses;

  (3) on the lower valley slopes one finds the ironstone crusts at/near surface, with 'lingote' vegetation;

  (4) the swampy valley floors are characterized by swamp vegetation: Cyperus and grasses.

- This is a productive maize zone; other crops are beans, cassava, sorghum, sweet potato, peppers, cabbage and tomato; wheat grows in the valleys. Pasture is important, but neither pasture nor agriculture is found in the 'lingote' zone.



Bodenprofil auf dem Chicuma-Hochland.

Fig. 37. Terrain unit 0603/1: soil profile on shales; Caconda High plain IV (1,630-1,650 m a.s.l.) (Jessen, 1936). Haplic Ferralsols, petroferric phase (FRh 32).

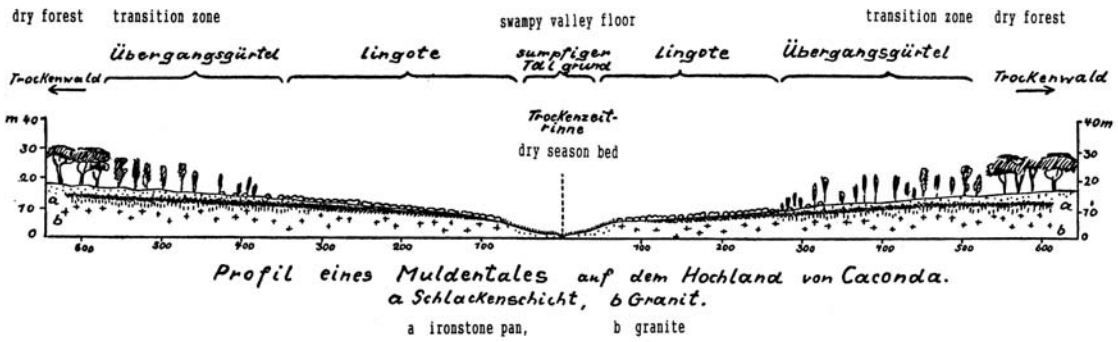


Fig. 38. Terrain unit 0603/1: Candueo (Gandu), in between Ganda and Caconda, on the Caconda High Plain IV (1,650 m a.s.l.); a transect through a slightly dissected valley: ironstone crust soils on granite (Jessen, 1936).
The soils on the plateau are Haplic Ferralsols, petroferric phase (FRh 32)

0603/2 Caluquembe-Negola High Plain IV (1,700 m a.s.l.)

- On this uniform, rounded plateau there are no rock outcrops. The flat valley bottoms are situated 30-40 m deeper than the plateau level. The isolated and steep N'Gola inselbergs rise 120-180 m high above the plateau; these are remnants of surface V. The plateau formed on layered sandstone and quartzite, phyllite, and sericite shales; there are some granite inclusions.

- FRh 32 - 2ab, FRh 37 - 2ab
  Plateau and slopes are characterized by deep (< 20 m), reddish brown or grey, somewhat sandy soils of poor fertility, on sandstone and quartzite; ironstone crusts are rare; sandy loam soils occur on the valley floors.

- Vegetation is dense, 10-15 m high, forest; there is no shrub undergrowth; narrow lingote strips are found in between valleys and forest.

- This is mainly a pasture area.

0603/3 Kipungo (Quipungo) High Plain IV (1,340 m a.s.l.)
E of Lubango

- It is a slightly undulating plateau on granite.

- FRh 32 - 2ab, ACf 1 - 2a
  Most soils are deep and yellowish.

- There are patches of high thorn shrubs and trees, with tall grasses, or dry forest.

0603/4 Chibia-Cangolo High Plain IV (1,450-1,530 m a.s.l.)

- This plain occurs SE of Lubango on granite. Some granite block castles rise above it. In the west occur olivine basalt and porphyre intrusions. Most valleys are dry, except Rio Cangolo, which is flooding its wide valley floor during the rainy season.

- LVf 3 - 2ab, Frx 13 - 2a, FRh 32 - 2ab; partly petroferric phase.

  Soils are moderately deep, over ironstone crusts (exposed on the valley slopes).

- On the dry somewhat sandy plateaus grow thorn shrubs. On the loamy valley slopes occur dry forest with grasses. Trees are e.g. the 15-20 m high Berlinia baumii ('mumue') and Burkea africana ('mukalati'). The valley bottoms are covered by grasslands.

- On the plateau grows maize, but pasture is also important. The valley bottoms are wheat production areas, but also used for pasture.

Blick über die bewaldete Planalto-Fläche (IV) gegen Nordwesten auf den Rand des Humpata-Hochlands (Fl. V).

Fig. 39. Terrain unit 603/4: Chibia-Cangolo High Plain IV (1,530 m a.s.l.); in the NW, the 250 m high escarpment to the Humpata plateau V (Jessen, 1936).

0604 **Pocolo High Plain IV** (about 1,400 m a.s.l.)

SOTER (6) 0-8, (8) LP, (9) F, (10) 4, (12) IB

- This planation surface, in the SW of Huíla Province, occurs on Precambrian granites, norites, gabbros, and peridotites. It is characterized by Vertisol plains.

- VRe 1 - a, VRe 2 - a, VRe 3 - a, (CLl 5 - ab); see profile P.127/54 (VRe).

- 50% SW, 30% OF, 20% GH

- PH/2 - 04,07,02,40
  It is a millets, sorghum and pasture zone; more maize is grown in the NE.

0605 **Rio Chicungo High Plain IV** (1,450 m a.s.l.)

SOTER (6) 0-8, (8) LP, (9) U, (10) 4, (12) IB1

- This planation surface, in the Huíla Province, has developed on norites, gabbros and peridotites.

- ACf 1 - 2a, FRx 14 - 3a
  Typical Profies: p.181c/60 (FRx) – p.113c/60 (FRx) – p.249/57 (FRx)
  Soils are deep yellowish brown and loamy, with ironstone concretions. There are rare to common termite hills.

- 40% GH, 40% OF, 20% SW
  Vegetation is a thorn bush with grass floors, or a park-like tree landscape. The valley floors are swampy in rainy season and are covered by short grasses.

- PH/2+3 - 02,40,07
  This is a maize, sorghum and pasture zone.

0605/1 Eastern Chicungo High Plain IV (1,450 m a.s.l.)

- Along the road from Kipungo to Lubango road exists a flat plain on gabbro, with many weathered gabbro rock outcrops; these are mainly smooth, black domes, block castles or 10-20 m high towered walls.

- ACf 1 - 2a; see profile p.217c/52 (ACf)
  Soils are yellowish loamy, without ironstone pans; but with rounded gabbro boulders; there are rare termite hills.

- Vegetation is thorn bush, with many 7-8 m high Acacia woodii trees, grass floors and Aloes and Peltophorum africanum trees. Towards Rio Chicungo exists a park-like (15 m high) tree landscape. The valley floors are swampy in the rainy season and are covered by short grasses.

- The area is mainly a sorghum zone.

0605/2 Western Chicungo High Plain IV (1,450 m a.s.l.)

- More to the west, along the Kipungo-Lubango road, an undulating plateau on gabbro is found, without gabbro hills.

- FRx 14 - 3a; partly skeletic phase
  Soils are yellowish brown to brownish yellow, with 0.3-0.7 m thick layers of ironstone concretions. Termite hills are common.

0606 Rio Muculo High Plain IV (about 1,400 m a.s.l.)

SOTER (6) 0-15, (8) LP, (9) U, (10) 4, (12) MA2

- In the SE Huíla Province occurs a planation surface on rocks of the Basal Complex, mainly gneiss.

- FRh 37 - 2ab
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)

- 60% SW, 40% OF

- PH/2 - 02,40
  It is a maize and pasture zone.

0607 **Cussava High Plain IV** (about 1,400 m a.s.l.)

SOTER (6) 0-15, (8) LP, (9) U, (10) 4, (12) MB

- In the eastern Huíla Province, this planation surface formed on rocks of the Oendolongo group (WCS), frequently schists and also volcanic diabases and dolorites.

- FRh 37 - 2ab; ACf 1 - 2a; FRx 11 - 2a; ARo 26 - 1a
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh).

- 80% OF, 20% GH

- PH/3 - 02,40
  This is a maize and pasture zone.

0700 Marginal mountains and plateau V

0701 **Southern Serra da Chela mountains** (1,522 m a.s.l.)

SOTER (6) > 30, (8) TE, (9) T, (10) 4, (12) SO1

- This mountainous area is found on the Namibe-Cunene province border; it formed on rocks of the 'Limestone-Schist Series' (WCS).
- LPe-CL-c, complex of mainly shallow soils: rudic and/or lithic phase...
- 25% SW, 15% GH, 60% ST
- MH/2+3 - 04,07,40
  It is a millets, sorghum and pasture zone.

0702 **Chitado mountains** (about 1,500 m a.s.l.)

SOTER (6) > 30, (8) TM, (9) T, (10) 4, (12) MA2

- This mountain area, in the western Cunene Province, developed on rocks of the Basal Complex, frequently gneiss.
- LPe-CL-c soil complex; CLl 8 - 2ab, rudic and/or lithic phase.
- 80% ST, 20% GH
- MH/2+3 - 04,07,40
  It is a millets, sorghum and pasture zone.

0703 **Uncócua mountains** (about 1,500 m a.s.l.)

SOTER (6) > 30, (8) TM, (9) T, (10) 4, (12) IA1

- Located in the western Cunene Province, these mountains are composed of Precambrian granites, granodiorites and quartzo-diorites.
- LPe-CL-c: shallow soil complex: rudic and/or lithic phase...
- 60% ST, 40% SW
- MH/2+3 - 04,07,40
  It is a millets, sorghum and pasture zone.

0704 **Otchinjau mountains** (1,413 m a.s.l.)

SOTER (6) > 30, (8) TM, (9) T, (10) 3, (12) IB1

- These mountains, in the western Cunene Province, are built of norite, gabbro, peridotite and granite inclusions.
- LPe-CL-c: shallow soil complex: rudic and/or lithic phase...
- MH/2+3 - 04,07,40
  It is a millets, sorghum and pasture zone.

0705 **Northern Humpata plateau V and mountains** (2,000-2,385 m a.s.l.)

SOTER (6) > 30, (8) TE, (9) T, (10) 4, (12) IA1

- The narrow Humpata plateau occurs on the border of the Huíla and Namibe provinces. It is an area of horizontal quartzite and limestone layers, on the eastern edge of the marginal mountain chain, overlying Precambrian granites, granodiorites and quartzo-diorites. The western edge of the plateau forms the Serra da Chela.
- LP-ACh-NT-c shallow soil complex: rudic and/or lithic phase...
- 80% GH, 20% ST
- PH/3 - 02,40
  It is a maize and pasture zone.

0706 **Southern Humpata plateau V** (2,000 m a.s.l), **higher mountains** (2,250 m a.s.l.) **and western escarpment**

SOTER (6) 0-15, (8) CL, (9) U, (10) 4, (12) MA1

- On the border of the Huíla and Namibe provinces occurs a distinct high plateau, with stepped table mountains. Granite is overlain by rocks of the 'Limestone-Schist Series' (WCS): quartzitic sandstone, mica sandstone and shales.

- FRh 36, LP-ACh-NT-c, rudic and/or lithic phase...

- 50% GH, 10% SW, 40% ST
  Vegetation was originally low dry forest, but it has degraded to secondary shrub land. Herb-grasslands occur on the wide, flat valley floors and on the lower valley slopes. High forest is found on the western escarpment.

- PH/3 - 02,04,07,09,11,27,40,(09,38,35)
  Crops on the plateau are maize, millets, sorghum, wheat, beans, potato, alfalfa and also pasture.
  On the valley bottoms, wheat, tobacco and vegetables are grown.

0706/1 Humpata table plateau V (1,980-2,040 m a.s.l.) and table mountains (< 2,250 m a.s.l.)

- Granite is overlain by quartzitic sandstone and clayey fine mica sandstone, overlain by purple, silicified clay shales. There are also porphyre and diabase intrusions. The area is an open landscape, with a soft relief. The higher table mountains are stepped, rocky, with angular boulders of sandstones; shales are found on the slopes, with little vegetation. Some remnants of an older planation surface Vb are found on the mountain slopes.

- FRh 36 - 2ab
  Mountain valleys have yellow or red, somewhat sandy soils, often with ironstone concretions.

- Herb-grasslands occur on wide, flat valley floors and on lower valley slopes. Ongote (lingote), a typical herb layer with dense wooden roots, is found on the higher valley slopes. On the plateaus occur low dry forest (6-7 m high) of Burkea africana, Brachystegia, Parinarium curatellifolium, Berlinia panculata...; most of it has been replaced by secondary 1-1.5 m tall shrubs.
- On the plateau area, wheat, maize, beans, potato and alfalfa are grown; it is also a pasture zone.

0706/2 Escarpments of Humpata plateau V (1,982 m a.s.l.) and Chela mountains

- The escarpments are cut by steep valleys. Granite is overlain by quartzitic sandstone and clayey fine mica sandstone, overlain by purple, silicified clay shales. A mountain pass on surface V is covered by 50 m high granite hills. The 1,000 m high Chela escarpment (step from plateau III to V) is characterized by 10-15 m deep weathered biotite granite on its slopes. At 1,200-1,245 m a.s.l. occurs a terraced remnant of surface IIIb (Humbia station), with boabab trees of 15-20 m high.
- LVf 2 - 1/2 ab
- Vegetation is high forest with Peltophorum africanum, Psorospermum albidium, Terminalia, Berlinia and Brachystegia, with spots of thorn shrubs: Protea, Combretum...
- On the valley bottoms: wheat, tobacco and vegetables are grown.

0707 Oendolongo high plain IV, high plateau V and higher mountains (1,550-2,620 m a.s.l.)

SOTER (6) 0-15, (8) LP, (9) IN, (10) 4, (12) IA1

- In this area, High Plain IV forms a slightly undulating plateau, with swampy wide flat valley floors, inselbergs and higher remnants of surface V, also covered by inselbergs. The region has formed on Precambrian granites, gneiss and inclusions of Oendolongo quartzite and mica sandstone (WCS).
- FRh 31 - bc; partly petroferric phase; FRh 27 - 2bc; FRh 25 - 2ab, partly petroferric phase; ACh 1 - 2bc; FRh 14 - 2ab, partly petroferric phase; FRx 10 - 2a, partly petroferric phase
  Typical Profiles: p.229/57 (FRh) - p.208/56 (FRh).

- 80% OF, 10% SW, 10% GH

  Vegetation is open dry forest, with leguminoses and no undergrowth, or also tree and shrub steppe with low or high grasses, or grassland with patches of dry forest. At an altitude of > 1,800 m a.s.l. occurs a short grass steppe with some trees and shrubs, and with riparian forests in the mountain valleys.

- PH/3 - 02,40,27,36,06,09,11

  This is a maize, potato, Arabica coffee, upland rice, wheat, beans and pasture zone. Irrigated agriculture produces orange, peach, pineapple, banana, ficus, lemon, citrus, apple, peach, guava, papaya, strawberry, red beet and radish.

0707/1 Luimbale High Plain IV, high plateau remnants V and higher mountains

- Above High Plain IV (1,560-1,600 m a.s.l.) rise remnants of surface V (1,850-1,900 m a.s.l.) and W-E oriented inselbergs. Planation surface IV is composed of slightly undulating wide plateau ridges, with wide flat valley floors. There are some flat gneiss-granite rock outcrops on top of the plateau ridges and on the lower valley slopes.

- FRh 25 - 2ab
  Soils are sandy loamy and hard.

- Vegetation is open dry forest with leguminoses and no undergrowth. Combretum trees have a density of 4-5 trees/100 m^2 and a height of 8-10 m. Grasslands with low grasses also exist.

- Crops are maize, upland rice, wheat, potato and Arabica coffee.

0707/2 Luimbale-Balombo high plateau V (1,730 m (E)- 1,910 m (W)) and higher mountains

(1) main landscape

- This plateau surface formed on gneiss and porphyre; inselberg chains rises 200-400 m above it. The latter have terraced remnants of older planation surfaces Vb (Mount Okongo). In the west occur the rocky steep peaks of the Elongo mountains (200-300 m higher). These are rounded, moderately steep, elongated and terraced (planation surface Vc) mountains, covered by dry forest, riparian forests and bare rock outcrops.

- FRh 25 - 2ab, ACh 1 - 2bc; partly petroferric phase; see profile p.249/57 (FRx)

  On the plateaus occur reddish brown soils on thick ironstone crusts; see figure 40.

- Vegetation is a park-like tree and shrub steppe with low grasses. Above 1,800 m, a short grass steppe with some trees and shrubs is found.

- This is a maize, upland rice, wheat, potato and Arabica coffee zone.

(2) Elongo mountains

- This mountain chain forms the 700 m high western escarpment, with at 1,570-1,600 m a.s.l. a dissected remnant of plateau IV and at 1,370 m a.s.l. a remnant of surface IIIb.

- Yellow sandy soils formed in quartzite on top of the plateau, while reddish brown soils developed in granite on the slopes; see profile p.249/57 (FRx).

- Vegetation is composed of grass steppe with low trees; at an altitude of < 1,450 m occurs open dry forest with high grasses.; trees are 12-15 m high. High termite hills are common.

(3) Moco Massif (2,620 m a.s.l.)

- The highest massif of Angola is characterized by rounded, moderately steep, elongated, porphyre mountains. Terraced remnants of older planation surfaces Vb (2,000-2,100m) and Vc (2,450 m) are common.
- Soils are shallow and stony.
- Vegetation is open dry forest; riparian forests occur in mountain valleys. Bare outcrops rise to 2,620 m a.s.l.. The forest boundary is found at 2,400 m; higher occur Barbacenia shrubs, herbs and 20-30 cm tall shrubs.

(4) undulating granite plateau V, south of the Moco massif (1,830 m a.s.l.)

This area is characterized by wide flat valleys and WNW oriented mountain ridges. The 3-5^{o} sloping foot slopes rise with a concave transition to the 25-35^{o} convex mountain slopes. On the mountains, one or two terraced levels of older planation surfaces Vb and Vc can be observed. Mountain tops are flat.

- The often swampy valleys are occupied by shallow, dark grey to black, clayey soils. The mountain footslopes have deep, gravel-free, yellowish brown to bright reddish brown, loamy to sandy loam soils on ironstone crusts.
- lingote vegetation builds the transition between the swamp vegetation of the valley floors and the dry forest on footslopes. On mountains occur forested slopes with boulders and also bare rock.
- This is a maize, tobacco, potato, sorghum and pasture area.

0707/3 Gallanga High Plain

(1) main landscape

- High plain IV is found at 1,650-1,690 m a.s.l. It is a 1-2 % sloping, gneiss-granite, inselberg plain, with tree-less, wide, flat, clayey valleys and with N-W oriented mountain chains (300-500 m higher). The latter expose at 1,850 m a.s.l. remnants of planation surface V. Mount Chipepe (1,966 m) is built of sandstone and conglomerate; the Namba mountain chain rises 400-500 m above surface IV.

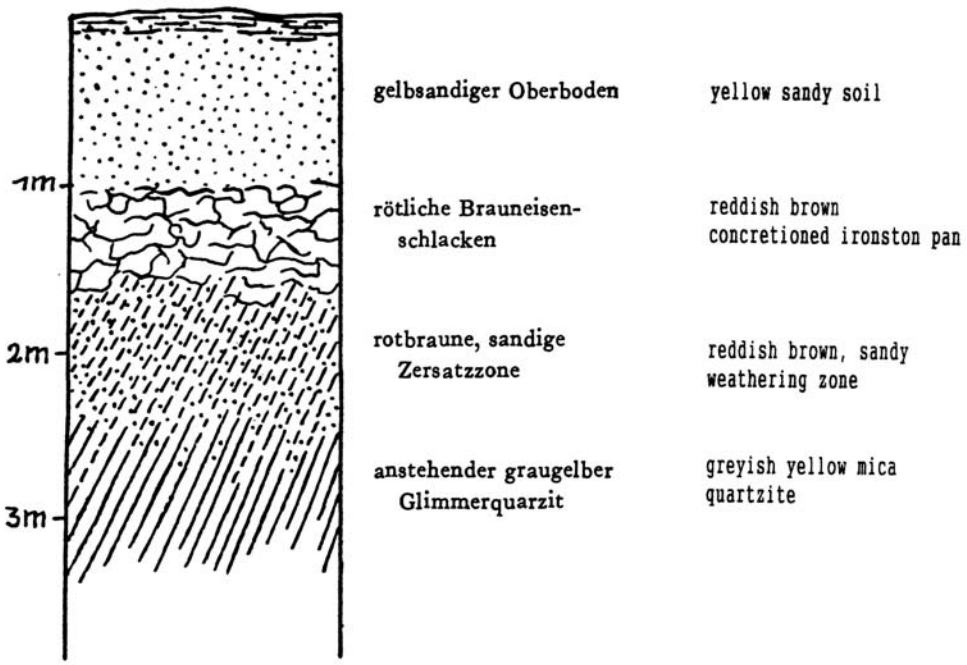
- FRh 25 - 2ab; partly petroferric phase;
see profile P.296/58 (FRr)
Ironstone crusts are exposed on the lower slopes of the valleys.

- The area has an open landscape, with grasslands and rare patches of dry forests. On the mountains grow low shrubs and grasses, but in mountain valleys, with deep soils, (at > 1,680 m a.s.l.) evergreen riparian forest is found.

- Irrigated oranges, peaches, pineapples and potato are grown.
This is an Arabica coffee, maize, beans and pasture zone.

(2) Rio Cahula mountains (1,850 m a.s.l.)

These mountains are located in between Luimbale and Gallanga. The mountain tops are remnants of plateau V. Two ENE-oriented chains of granite rise 200-300 m above planation surface IV.

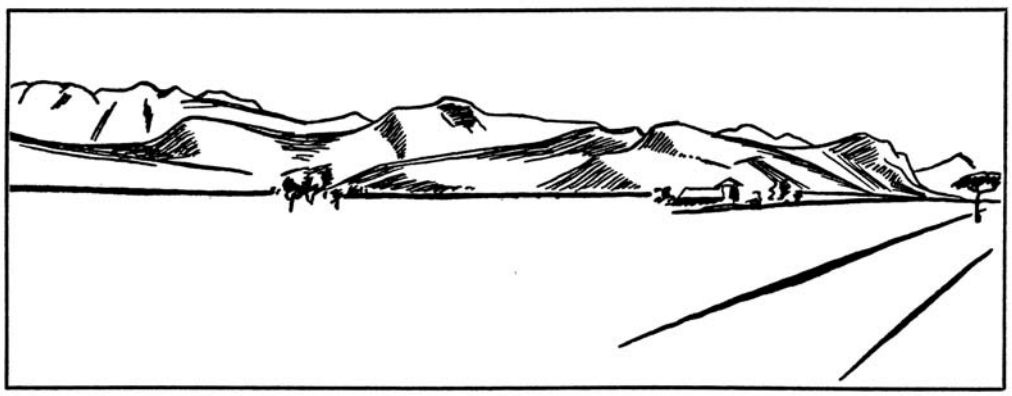


Bodenprofil zwischen Luimbale und Balombo in 1800 m M. H. (Niv. Va). Höhensteppe mit Büschen und Bäumen.

Fig. 40. Terrain unit 707/2: Luimbale-Balombo plateau V (1,800 m a.s.l.); soil profile on mica-quartzite, covered by mountain shrubs and tree steppe (Jessen, 1936).
Ferric Acrisols, petroferric phase; soil mapping unit ACh1.

Die Hauptrumpffläche hinter Galanga mit Inselfelsen
(schematisiert).

Fig. 41. Terrain unit 0707/3: Galanga High Plain IV (1,650 m a.s.l.), with inselfelsen (Jessen, 1936).



Die Cassongue-Kette von Süden.

Fig. 42. Terrain unit 0707/4: the Cassongue mountain chain (2,350 m a.s.l.) seen from the south, over High Plain IV (1,330-1,600 m a.s.l), (Jessen, 1936).

0707/4 Cassongue High Plain IV (1,530-1,600 m) and higher mountains (2,350 m)

(1) Main landscape

- This is a slightly undulating gneiss plateau, with wide, tree-less, swampy valleys; except for the deeper dissected Rio Cuchi, an affluent of Rio Cubal.
- Deep, reddish brown soils are found on the gneiss plateaus and bright brown soils in valleys.
- Vegetation is an open dry forest, with a moderately tall, thin grass cover (0.5-0.75 m).
- Sisal and banana are grown here.

(2) Cassongue mountains (Serra de Lombamba, 2,300-2,350 m a.s.l.); these rise 700-750 m above surface IV

See figure 42.

(3) Ndumbi mountain

- This is an isolated gneiss cone, with at 1,830 m a.s.l., a wide shoulder of planation surface V.
- Vegetation is open dry forest; there is no shrub undergrowth, but grasses of 0.6-0.7 m.

0707/5 Casseque high plateau V (1,825 m a.s.l.) and higher mountains

(1) Main landscape

- In between Ganda and Caconda exist rounded and wide plateaus, with wide valleys. Mountains rise 150-200 m higher (Mount Mejo, 1,986 m a.s.l.).

- FRh 31 - bc, FRh 29 - 2ab

  (a) Deep, greyish loam soils occur in the valleys;

  (b) yellowish brown soils overlie red mottled sandy material on slopes;

  (c) porphyrite blocks cover the convex top slopes.

- Vegetation is a 0.5 m tall grass steppe on slopes and valleys. The original dry forest, of 8-10 m, is composed of Brachystegia, Barbacenia...

- Rainfed and irrigated agriculture produce: Arabica coffee, ficus, lemon, citrus, apple, peach, guava, pineapple, papaya, banana, strawberry, red beet, radish and potato.

(2) Casseque escarpment (step from plateau III to V, 600-700 m high, top at 1,825 m a.s.l.)

- The Camatia mountains (1,960 m a.s.l.) and Serra do Chilengue, along the Ganda-Caconda road, are built of quartzo-porphyre, porphyrite. The flat-rounded mountain tops rise above planation surface III. The mountain slopes are an escarpment, dissected to ridges, with important mass movement erosion. At 1,600 m a.s.l. existed a terraced shoulder of surface IV.

- Vegetation is open, short grassland, with few trees (Brachystegia spiciformis of 4-5 m, also called 'M'panda'). Dense riparian forests, with 20-30 m high trees, occupy the mountain valleys, with high Barbacenia and low Aloes.

0707/6 Lepi-Caala mountains and plateau V (1,820-1,845 m a.s.l.)

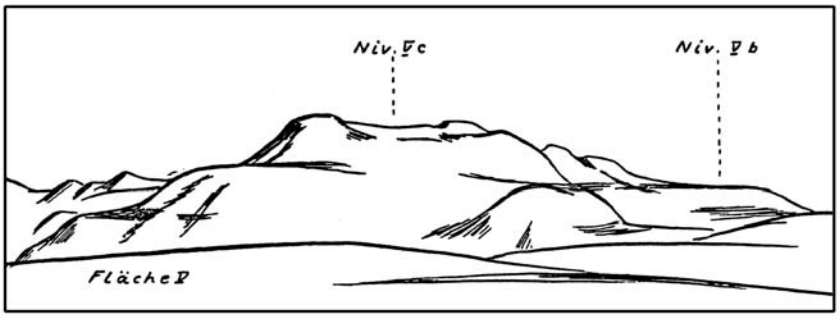
- In between Ganda and Huambo occurs the dissected and forested escarpment between plateaus III and V (1,400-1,820 m a.s.l.), developed on quartzite, with at 1,720 m a.s.l., a terraced remnant of surface IV. Plateau V has developed on sandstone, quartzite and clayey shales. Remnants of an older planation surface are found 40 m higher. There are intrusions of basalt and porphyrite. NNE-oriented mountain chains (Holocoso massif, see figure) are characterized by two older planation remnants: Vb (2,000-2,100 m a.s.l.) and Vc (2,450 m a.s.l.).

- FRh 14 - 2ab, FRx 10 - 2a, FRh 32 - 2ab; partly petroferric phase.

  The area is covered by deep yellow soils on ironstone crusts.

- Vegetation is low dry forest. Valleys are flat, treeless, with grasses and herbs.

- This is a maize growing zone.



Der Holocoso (etwa 2500 m) bei Lepi, von Osten.

Fig. 43. Terrain unit 0707/6: the Lepi-Caala plateau V (1,820 m a.s.l.), with Mount Holocoso (2,500 m a.s.l.), characterized by older planation remnants Vb (2,000-2,100 m a.s.l.) and Vc (2,450 m a.s.l.); Ganda-Huambo road (Jessen, 1936).

0708 **Western Bimbe high plateau V** (about 1,800 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) U, (10) 4, (12) IA1

- This planation surface V developed on Precambrian granites, grano-diorites and quartzo-diorites.
- FRx 9 - 2ab, FRh 14 - 2ab, parts of both units have a petroferric phase
  Typical Profiles: p.159/56 (FRx) – p.249/57 (FRx).
- 50% SW, 40% OF, 10% GH
- PH/3 - 02,40
  It is a maize and pasture zone.

0709 **Eastern Bimbe high plateau V**
1,760 m (north) to 1,850 m a.s.l. (south)

SOTER (6) 0-15, (8) LL, (9) IN, (10) 4, (12) MA2

- This planation surface V formed on rocks of the Basal Complex. It is an extensive plain, with gneiss block towers and wide, clayey valleys, with slow streams (swampy in the rainy season).
- FRh 14 - 2ab; partly petroferric phase; ARo 16 - 1a.
  Bright yellow soils overlie ironstone crusts.
- 50% SW, 40% OF, 10% GH
  Dense high forest grows on the escarpments. The plateau is characterized by open dry forest, with a thin grass cover; or a park landscape with low grass bushes, shrubs and low trees.
- PH/3 - 02,40
  It is a maize and pasture zone.

0709/1 The northern escarpment (1,430-1,760 m a.s.l.)

- The escarpment is covered by many towers and block towers of biotite gneiss. A terraced remnant of plateau IV is conserved at 1,630 m a.s.l.
- FRh 14 - 2ab, profile P.208/56 (FRh)
  On the escarpment occur reddish brown soils, with abundant termite hills.
- Vegetation is dense, high forest.

0709/2 Bimbe plateau V (1,760 m (N), 1,850 m a.s.l. (S))

- The plateau looks like an extensive plain (27 km wide); 10-20 m high gneiss block towers rise above it. The wide, grey clayey valleys have slow streams; valley floors are swampy in rainy season.

- FRh 14 - 2ab; partly petroferric phase.

  Bright yellow soils overlie ironstone crusts, above a purple to dark reddish brown weathering zone of gneiss.

- Vegetation is open dry forest (6-7 m), with a thin, 0.5-0.75 m tall, grass cover.
  Around Bimbe town exists a park-like landscape, with low grass bushes, shrubs and low trees (4-5 m): Syzygium ('Olumbala'), Uapaca, Berlinia paniculata...; see figure 44.

- This is a maize and pasture zone.

0709/3 The southern escarpment (1,600-1,850 m a.s.l.)

- The Bimbe plateau is bordered in the south by a 200-260 m high, granitic escarpment.

- Soils are red and developed in weathering granite.

- Vegetation is characterized by 5-7 m high Swartzia madagaskariensis trees.

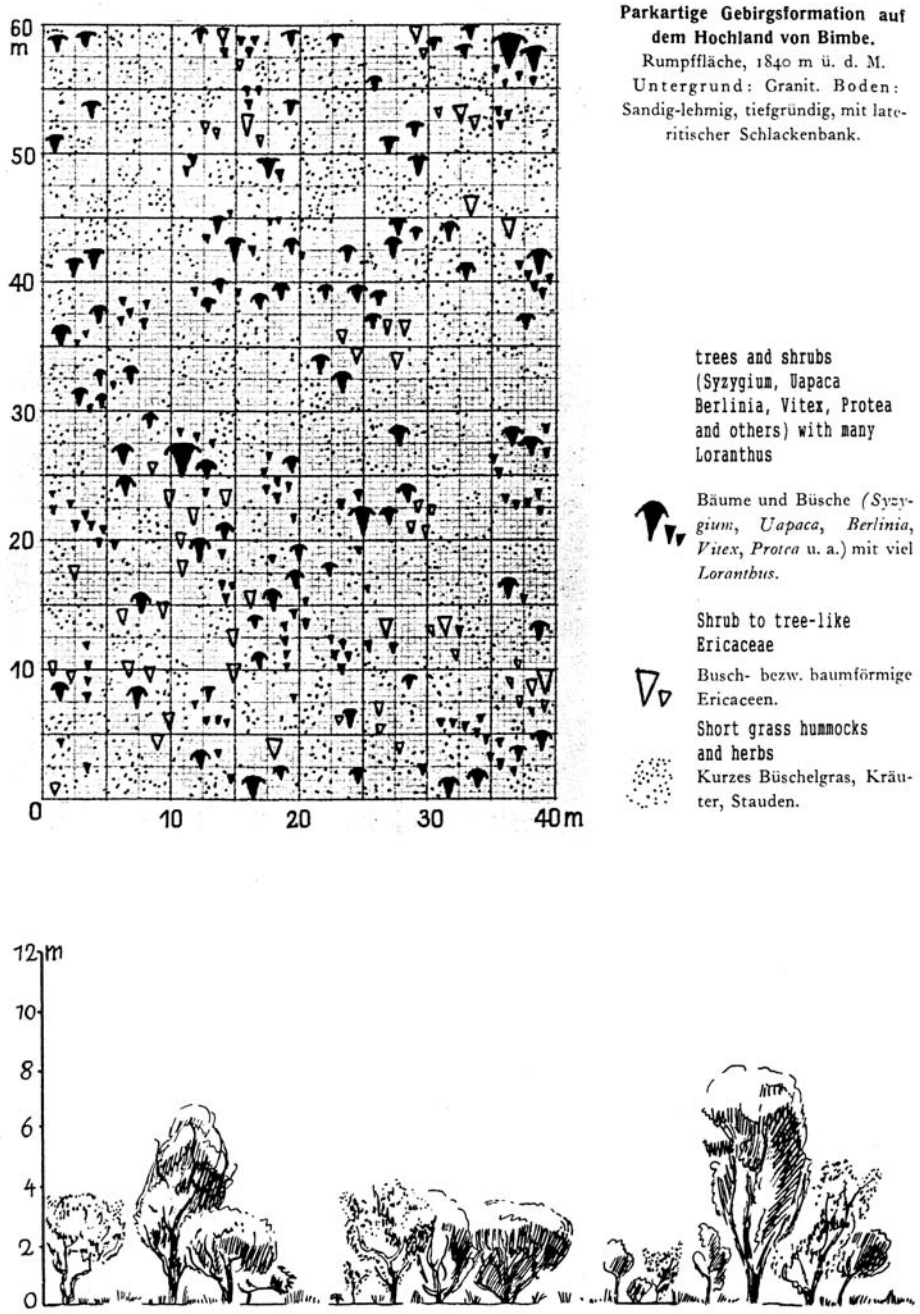


Fig. 44. Terrain unit 0709/2: Bimbe plateau V (1,840 m a.s.l.); park-like mountain vegetation on deep soils, with an ironstone crust, developed on granite (FRh 14) (Jessen, 1936).

800 Kalahari basin

0801 Zaire Basin or Northern Kalahari
(about 700-1,200 m a.s.l.)

SOTER (6) 0-8, (8) LP, (9) U, (10) 3, (12) UE

- The area is composed of undulating Kalahari sand plateaus. Deeper valleys have cut through the sandsheet into the underlying rocks (terrain units 0900).
- ARo 4, ARo 5, ARo 6, ARo 7, ARo 8, ARo 14, ARo 15, ARo 19, ARb 1; see profiles P.61/60 and P.97/60, both RGu; and also profile p.32/60 (PZc)
  Typical Profiles: p.9c/63 (ARo) – p.279/62 (ARo) – p.82/64 (ARo).
- 50% GH, 10% FS (N and E), 30% SW, 10% OF
- ML3/2 - 25,06,(39)
  This is a cassava and rice zone; oil palm is grown only in the extreme NW (Uige province).

0802 Upper Cuanza Basin or Western Kalahari
(about 1,000-1,300 m a.s.l.)

SOTER (6) 0-8, (8) LP, (9) U, (10) 3, (12) UE

- This undulating region is covered by the Kalahari sandsheet.
- ARo 18, ARo 19 - 1a; see profile P.279/62 (ARo)
- 85% OF, 10% SW, 5% GH
- ML3/2 - 06,40
  This is a pasture zone, with some rice production.

0803 **Zambeze-Cubango basins or Southern Kalahari**
(about 1,000-1,200 m a.s.l.)

SOTER (6) 0-8, (8) LP, (9) U, (10) 3, (12) UE

- The area is covered by a thick layer of Kalahari sands.
- ARo 18-19-21-22 - 1a; Arb 7-8-11-12-13-15-16 - 1a, PZc 1 - 1a; see profile p.423/63 (ARb)
- 48% OF, 2% HF, 30% SW, 20% GH
- ML3/2 - 06,25,02,04,07

  This region is very extensive and as precipitation decreases to the south, three E-W oriented land utilization zones can be distinguished:

  north : cassava and rice zone
  central: maize zone
  south : millets and sorghum zone

0804 **Cuando Wet Kalahari** (about 900-1,100 m a.s.l.)

SOTER (6) 0-8, (8) LP, (9) W, (10) 3, (12) UE

- This area is covered by the Kalahari sandsheet, but a groundwater table is found at shallow depth. Many places are flooded during the rainy season.
- ARg 2-3-4-5; partly inundic or phreatic phase;
  see profile p.146/64
- 50% GH, 30% SW, 20% OF
- ML3/2 - 04,07,02
  Millets, sorghum and maize zone.

0805 **Kalahari wet valley floors**
(about 1,000-1,100 m a.s.l.)

SOTER (6) 0-2, (8) LV, (9) W, (10) 3, (12) UF

- These wide valley floors in the Kalahari sandsheet, have a groundwater table at shallow depth.
- Arg 7 - 1a, partly inundic or phreatic phase
- 70% SW, 25% OF, 5% GH
- ML3/2 - 02,40
  It is a maize and pasture zone.

0806 **Kalahari calcareous valley floors**
(about 1,000-1,100 m a.s.l.)

SOTER (6) 0-2, (8) LV, (9) F, (10) 3, (12) UF

- These valleys are found in the Kalahari sandsheet area, but are characterized by calcretes and silcretes in the subsoil.
- CLh 5 - 1/2a, CLh 6 - 1/2a
  Typical Profile: p.234c/62 (CLh)
- 40% SW, 30% OF, 30% GH
- ML3/2 - 40
  These are mainly pasture zones.

0807 **Calcareous plain of N'Giva-Cunene**
(about 1,200 m a.s.l.)

SOTER (6) 0-3, (8) LP, (9) F, (10) 3, (12) SO1

- This is an extensive plain in the Kalahari, with calcretes and silcretes in the subsoil.
- CLl 7 - 1/2a; CLl 9 - 1/2a, partly salic and/or sodic phase; see profile P.475/55 (SCn) and profile p.53/54 (CLl, sodic phase).
- 70% GH, 20% SW, 10% OF
- ML3/2 -04,07,40
  It is a millets, sorghum and extensive pasture zone.

0808 **Rio Caculuvar-Cunene plain** (about 1,200 m a.s.l.)

SOTER (6) 0-2, (8) CV, (9) F, (10) 3, (12) UF

- The area is composed of old, clayey, alluvial terraces.
- VRk1 -a; see profile 65/54 (VRk)
- 50% OF, 50% SW
- ML3/2 - 04,07,40
  It is a millets, sorghum and pasture zone.

0809 **Moxico Wet Kalahari** (about 1,100-1,200 m a.s.l.)

SOTER (6) 0-8, (8) LP, (9) F, (10) 3, (12) UE

- This area is covered by Kalahari sandsheet, but a groundwater table is found at shallow depth. Many places are flooded during the rainy season.
- ARg 1-3; partly inundic or phreatic phase;
  see profile p.58/64 (ARa)
- 50% OF, 25% GH, 25% SW
- ML3/2 - 06,25
  The northern parts are more humid and are a cassava and rice zone; the southern parts are drier and are a millets, sorghum zone.

0900 Dissected valleys in the Kalahari

These valleys occur in the Kalahari sandsheet region. River dissection has cut through the sandsheet, into the underlying hard rocks. These valley slopes have been considered as separate terrain units.

0901 **Lunda dissected valleys (1)** (about 600-800 m a.s.l.)

SOTER (6) 8-30, (8) CV, (9) R, (10) 6, (12) MA2

- These valleys have cut rocks of the Basal Complex, mainly gneiss.
- FRh 2 - 2/3 b
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- 80% SW, 20% GH
- PL3/2 - 06,25
  It is a cassava and rice zone.

0902 **Lunda dissected valleys (2)** (about 600-800 m a.s.l.)

SOTER (6) 8-30, (8) CV, (9) R, (10) 6, (12) IA

- The valley slopes are formed by various igneous rocks.
- FRh 2 - 2/3b
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- 70% SW, 30% GH
- PL3/2 - 25
  This is a cassava growing zone.

0903 **Lunda dissected valleys (3)** (about 600-800 m a.s.l.)

SOTER (6) 8-30, (8) CV, (9) R, (10) 6, (12) MB2

- River dissection has exposed rocks of the Oendolongo Group (WCS), frequently schists.
- FRh 2 - 2/3b
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- GH, grass and herb land
- PL3/2 - 06/25
  It is a cassava and rice zone.

0904 **Rio Uovo valley** (about 900 m a.s.l.)

SOTER (6) 8-30, (8) CV, (9) R, (10) 6, (12) MB2

- This valley is located in the northern Lunda Province. Its valley has cut into Karroo rocks, frequently schists.
- FRh 12 - 2/3b
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- 65% SW, 25% FS, 10% GH
- PL3/2 - 25
  This is a cassava zone.

0905 **Cuembe outcrops** (about 1,000-1,300 m a.s.l.)

SOTER (6) 8-30, (8) CV, (9) R, (10) 6, (12) SC2

- The Cuembe outcrops, in the Kalahari sandsheet of the Bié province, expose rocks of the Cretaceous Lunda Series (mainly sandstones) and some dolorites.
- FRh 34 - 2/3b
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- GH - The region is a grass/herbland.
- PL3/2 - 06,40
  It is a pasture and rice growing zone.

0906 **Rio Cullo dissected valleys**
(about 1,100-1,200 m a.s.l.)

SOTER (6) 2-15, (8) CV, (9) R, (10) 6, (12) SC2

- These valleys have exposed rocks of the Cretaceous Lunda Series (mainly sandstones).

- FRh 20 - 2ab
Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)

- 80% OF, 20% GH

- PL3/2 - 06,25
It is a cassava and rice zone.

0907 **Cassai dissected valleys** (about 900 m a.s.l.)

SOTER (6) 0-8, (8) CV, (9) U, (10) 6, (12) MA2

- These valleys have cut through the Kalahari sandsheet into rocks of the Basal Complex, frequently gneiss.

- FRx 6 - 2a
Typical Profiles: p.159/56 (FRx) – p.249/57 (FRx)

- GH, grass/herbland.

- PL3/2 - 25
This is a cassava zone.

0908 **Alto Zambeze incision zone** (1,000-1,200 m a.s.l.)

SOTER (6) 0-15, (8) LP, (9) U, (10) 3, (12) MA2

- In the eastern Moxico Province, the Kalahari sandsheet has been removed and rocks of the Basal Complex, frequently gneiss, are exposed.

- FRh 22 - 2ab
Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)

- 40% GH, 35% OF, 15% HF, 10% SW

- PL3/2 - 06,25
It is a cassava and rice zone.

0909 **Lucusse outcrops** (1,100-1,200 m a.s.l.)

SOTER (6) 0-8, (8) LP, (9) U, (10) 3, (12) IB3

- These outcrops in the northern Moxico Province expose dolorites.

- FRh 21 - 2/3a
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)

- 60% SW, 30% OF, 10% GH

- ML3/2 - 06,25
  It is a cassava and rice zone.

1000 **Cassange depression** (about 800-1,000 m a.s.l.)
---- ----------

1001 **Western Cassange depression**

SOTER (6) 8-30, (8) CD, (9) R, (10) 3, (12) SC2

- The western part of the depression has been cut on rocks of the 'Sandstone-Schist Series' (WCS) and the Cretaceous Lunda Series (mainly sandstone).

- FRh 6 - 2/3b, ACh 2 - 1/2bc, (ARh 2 - 1ab)
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)

- 50% SW, 25% OF, 25% GH

- PL3/2 - 25
  This is a cassava growing zone.

1002 **West Marimba region, Cassange depression**

SOTER (6) 0-8, (8) CD, (9) G, (10) 3, (12) SC2

- This area, west of Marimba village, exposes rocks of the Cretaceous Lunda Series (mainly sandstones) and of the Cassanje Series (Karroo).

- LVh 2 - 1/2a, sodic phase
  Typical Profile p.222/63 (LVh)

- 50% SW, 50% GH

- ML3/2 - 25
  This is a cassava zone.

1003 **Central Cassange depression**

SOTER (6) 0-8, (8) CD, (9) G, (10) 3, (12) SC2

- This extensive part of the depression formed on rocks of the Cassanje Series (Karroo).

- LVh 2 - 1/2 a, sodic phase; see profile p.222/63 (LVh, sodic phase)

- 35% SW, 30% GH, 25% OF

- ML3/2 - 22,25
  It is a cassava and cotton zone.

1004 SE Cassange depression

SOTER (6) 0-15, (8) CD, (9) U, (10) 3, (12) SC2

- The SE part of the depression has developed on rocks of the Cassanje Series (Karroo) and other undifferentiated Karroo rocks.
- FRh 11 - 2a, FRh 13 - 2ab
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- 65% OF, 15% GH, 15% SW, 5% FS
- PL3/2 - 22,25
  It is a cotton and cassava zone.

1005 NE Cassange depression

SOTER (6) 8-30, (8) CD, (9) R, (10) 3, (12) MA2

- The NE part of the depression exposes rocks of the Basal Complex, frequently gneiss.
- FRh 7 - 2b
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- 95% SW, 5% OF
- PL3/2 - 22,25
  It is a cotton and cassava zone.

1006 N Cassange depression

SOTER (6) 0-8, (8) CD, (9) G, (10) 3, (12) SC2

- In the N of the depression one finds rocks of the Lutôe Series (Karroo), undifferentiated Karroo and Sandstone-Schist Series (WCS).
- PTd 1 - 1a
- 65% SW, 30% GH, 5% OF
- ML3/2 - 22,25
  It is a cotton and cassava zone.

1100 Continental dunes

1101 **Namib desert dunes** (0-250 m a.s.l.)

SOTER (6) 0-30, (8) LP, (9) DU, (10) 6, (12) UE

- The Namib desert is characterized by shifting sand dunes, sand plains and gravel-covered plains.
- ARh 1 - 1ab, partly rudic phase; shifting dunes
  Typical Profile: p.220/58 (Arh).
- DE, desert
- AR/2+3

1102 **Tombua sand dune and gravel plain** (0-100 m a.s.l.)

SOTER (6) 0-8, (8) LP, (9) DU, (10) 1, (12) UE

- This part of the coastal Namib desert is characterized by rolled gravel floors and sand dunes; it is separated by a 65 m high step from the higher Namib sandy plains.
- CLl 4 - 1/2a, partly rudic phase; shifting dunes
  Typical Profile: p.53/54 (CLl).
- DE, desert
- AR/3

1103 **Rio Zambeze dunes** (1,100-1,200 m a.s.l.)

SOTER (6) 0-30, (8) LP, (9) DU, (10) 6, (12) UE

- Reworked Kalahari sands form dunes along the Zambeze river.
- Arb 2 - 1ab
- 90% HF, 10% SW
- ML3/2 - 25,40
  It is mainly a pasture zone.

1200 Alto Zambeze Massif

1201 NW Alto Zambeze Massif and escarpment (1,100-1,500 m a.s.l.)

SOTER (6) 0-8, (8) LL, (9) U, (10) 3, (12) MB2

- This high plateau developed on rocks of the Oendolongo group (WCS), frequently schists.
- FRh 23 - 2a
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- 50% HF, 20% OF, 20% SW, 10% GH
- PL3/2 - 06,25
  It is a cassava and rice zone.

1202 SE Alto Zambeze Massif (1,300-1,500 m a.s.l.)

SOTER (6) 0-15, (8) LL, (9) U, (10) 3, (12) IB

- This part of the high plateau is built of volcanic diabases.
- FRr 2 - 2ab
  Typical Profiles: p.120/60 (FRr) – p.296/58 (FRr)
- 90% SW, 5% GH, 5% OF
- PL3/2 - 06,25
  It is a cassava and rice zone.

1203 E Moxico outcrops (1,100-1,200 m a.s.l.)

SOTER (6) 8-30, (8) LP, (9) R, (10) 3, (12) SC1

- The eastern Moxico outcrops are characterized by conglomerates and rocks of the Mwashya Series (Bembe Group, WCS).
- FRh 24 - 2/3b, profile p.82/64 (ARo)
  Typical Profiles: p.229/57 (FRh) – p.208/56 (FRh)
- 70% GH, 20% HF, 10% SW
- PL3/2 - 06,25
  It is a cassava and rice zone.

6 BIBLIOGRAPHY

FAO-UNESCO. 1977. Soil map of the world, 1:5,000,000. Vol VI, Africa. Paris

FAO-UNESCO. 1974. Soil map of the world, Volume I, Legend, 59 pp., Paris

FAO-UNESCO. 1990. Soil map of the world, revised legend, 119 pp., Rome

FAO. 1990. Guidelines for soil profile description; 3rd edition. Land and Water Development Division, 70 pp., Rome

FAO. 1991. Guidelines: Land Evaluation for extensive grazing. FAO Soils Bulletin 58, 158 pp., Rome

FAO, 1993. Global and National Soils and Terrain Databases (SOTER), Procedures manual; World Soil Resources Reports 74, Rome, 122 pp.

Geological Survey 1982. The Geology of South West Africa/ Namibia; Windhoek; 5 pp.

Haughton, S. 1969. Geological History of Southern Africa. Geological Society of south Africa; Cape Town; 535 pp.

IGADD and FAO, 1994. Crop production system zones of the IGADD sub-region; IGADD Early Warning and Food Information System for Food Security, GCPS/RAF/256/ITA; Agrometeorology Working Papers, Series N.10, FAO, Rome, 90 pp.

Jessen, O. 1936. Reisen und Forschungen in Angola; Berlin, Verlag von Dietrich Reimer/ Andrews & Steiner, 397 pp.

Ministério da Educação, 1982. Atlas Geográfico, República Popular de Angola, volume 1, Esselte Map Service, Stockholm, 49 pp.

Missão de Pedologia de Angola, 1963. Carta geral dos solos de Angola. 3. Distrito de Moçâmedes; Memórias da Junta de Investigações do Ultramar No 45 (2da Série); Lisboa, 192pp.

Missão de Pedologia de Angola e Moçambique, e Centro de Estudos de Pedologia Tropical. 1965. Carta generalizada dos solos de Angola (3a approximação); Ministério do Ultramar, Junta de Investigações do Ultramar; Lisboa, 341 pp.

Missão de Pedologia de Angola e Moçambique, 1968. Carta geral dos solos de Angola. 4. Distrito de Moçâmedes; Memórias da Junta de Investigações do Ultramar No 57 (2 Série); Lisboa, 227 pp.

Mouta, F. and O'Donnell, H. 1933. Carte Géologique de l'Angola (1/2,000,000); Notice Explicative, Ministério das Colónias, 87 pp.

Mouta, F. 1954. Notícia explicativa do esboço geológico de Angola (1:2,000,000); Lisboa, Ministério do Ultramar, Junta de Investigações do Ultramar; 148 pp.

Munsell Soil Color Charts, 1975. Munsell Color, Macbeth division of Kollmorgen Corporation, Baltimore, USA

PC Globe, 1992. PC Globe Inc,. Tempe, AZ, USA.

Pelletier, R. 1964. Mineral Resources of South-Central Africa. Oxford University Press; 277 pp.

Rust, U. 1985. Die Enstehung der Etoschapfanne im Rahmen der Landschaftsentwicklung des Etoscha Nationalparks (nördliches Südwestafrika/Namibia). Namaqua, vol. 14, No.3, pp. 197-266.

South African Committee for Stratigraphy (SACS) 1980. Stratigraphy of South Africa; Part 1 (Comp. L.E. Kent): Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Bophuthatswana, Transkei and Venda; Handb. geol. Surv. S. Afr.; 8; Pretoria, 690 pp.

Telles Antunes, M. 1964. O Neocretácico e o Cenozóico do Litoral de Angola; I Estratigrafia, II Répteis; Junta de Investigações do Ultramar, Lisboa, 253 pp.

Thomas, D. 1988. The nature and depositional setting of arid and semi-arid Kalahari sediments, Southern Africa; Journal of Arid Environment 14, pp. 17-26.

Thomas, D. and Shaw, P. 1991. The Kalahari Environment; Cambridge University Press, 284 pp.

Van Chi-Bonnardel, Régine. 1973. Grand Atlas du Continent Africain; éditions Jeune Afrique, Paris, 335 pp.

Wellington J. 1955. Southern Africa. A Geographical Study; vol.I: Physical Geography; Cambridge University Press; 528 pp.

Worthington, P. 1977. Geophysical investigations of groundwater resources in the Kalahari Basin. Geophysics, vol. 42, No 4; pp. 838-849.