SOIL SURVEY OF SONOP RESEARCH STATION

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ABSTRACT

A semi-detailed soil survey of Sonop Research Station north-east of Grootfontein in northern Namibia was carried out by staff of the Ministry of Agriculture, Water and Rural Development in April 1998. It covered an area of ±11 000 ha. The method used to delineate mapping units was a combination of aerial photo-interpretation and free survey. The final map scale was 1:25 000.

Three main soil types (A, B, C) were identified according to depth and underlying material. These were further subdivided into five soil mapping units (A1, A2, A3, B1, C1) according to the colour of B-horizons and geomorphological phases.

The best soil, in terms of agricultural potential, is B1: shallow to moderately deep brown, non-calcareous sandy soils occurring on interdunes and overlying hard calcrete, or weathered calcrete on hard calcrete.

INTRODUCTION

A semi-detailed soil survey of Sonop Research Station was carried out in April 1998 by J. T. Kutuahupira and H. D. Mouton from the Agro-Ecological Zoning Programme of the Ministry of Agriculture, Water and Rural Development. The objective was to collect basic information on soils as an agricultural resource, as to their capabilities and constraints.

DESCRIPTION OF THE AREA

Location and Extent

The survey locality is in Grootfontein District, Otjozondjupa Region, Namibia, 120 kilometres north-east of Grootfontein. It covers an area of approximately 11 000 hectares, confined by latitudes 18°59' and 19°06' and longitudes 18°51' and 18°56'. Sonop Research Station consists of the farms Sonop No. 903 (5458 ha) and Moedhou No. 902 (5541 ha).

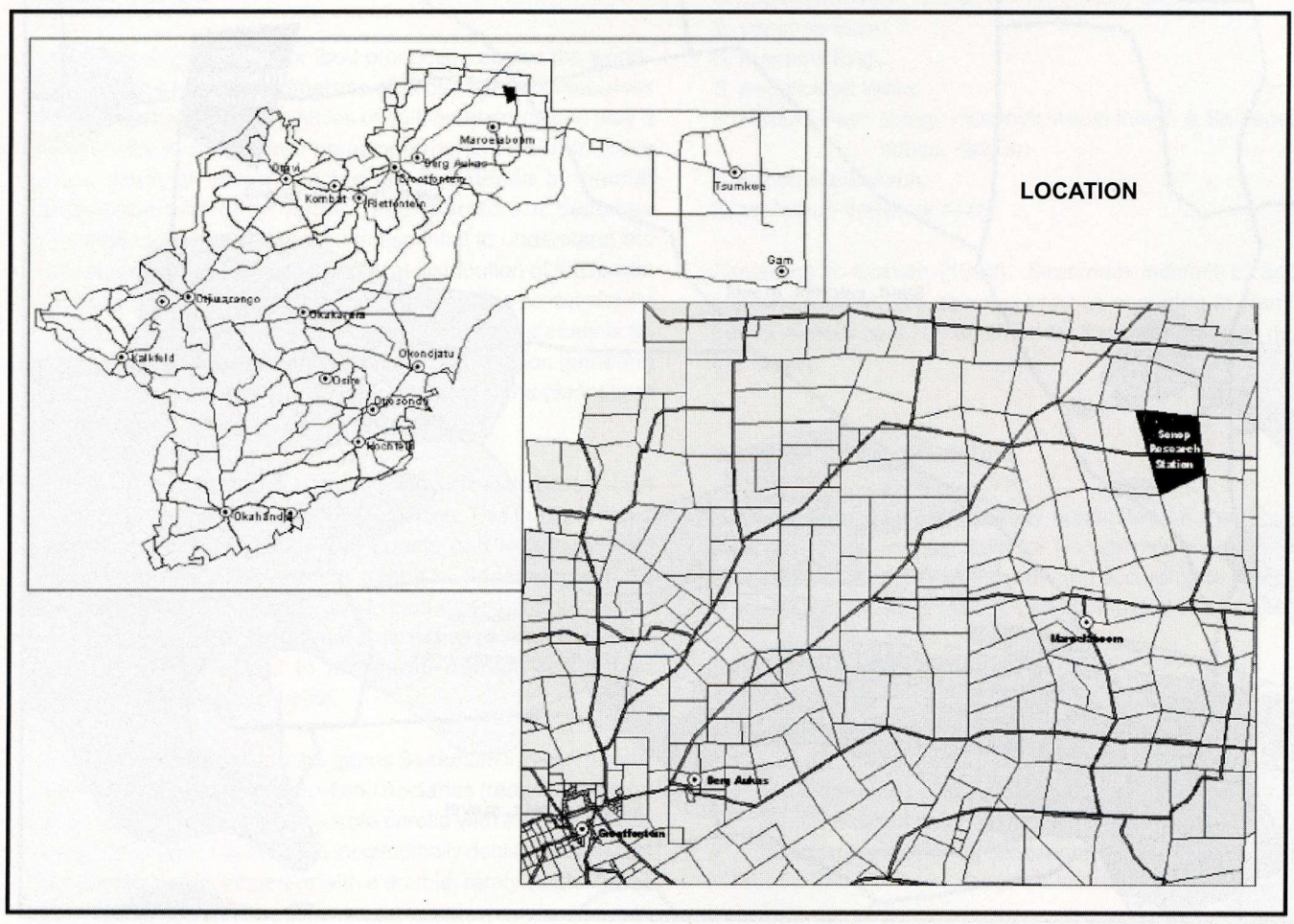

Figure 1. Location of Sonop Research Station in northern Namibia.

Climate

The mean annual precipitation is 534.5mm. Precipitation is concentrated in summer, from November until April, and generally occurs in the form of intense, scattered, erosive thunderstorms.

The mean annual temperature is approximately 19.6°C. The absolute minimum temperature measured in the area is -5.3°C and the absolute maximum 38.5°C.

Geology, Geomorphology and Agro-Ecology

The survey area is mainly covered by material of Tertiary to Quaternary age known as the Kalahari Sequence. This forms an extensive cover of terrestrial origin in the eastern part of Namibia. Unconsolidated aeolian sand covers most of the Kalahari succession and form stationary longitudinal dunes in much of the eastern part of the country. Silcrete, calcrete and gravels also date from this period (Geological Survey of Namibia, 1980). On Sonop, silcrete does not occur within the upper 125 cm, while calcrete has been observed in interdunes at a depth of 125 cm or less.

The general altitude of the survey area ranges between 1190m and 1220m. The area is characterised by four landforms: dunes, interdunes (narrow longitudinal relatively flat surfaces between dunes, locally known as 'streets'), sandplains and depressions ('pans'). The dunes are longitudinal, also known as 'alab' or 'seif' dunes. Their orientation is approximately 280°, with wide flat tops. They have been formed by easterly winds.

The topsoil is generally fine to medium sand of reddish brown colour, but it becomes paler or browner toward the footslopes. The dunes are separated by interdunal depressions. The sandplains are flat to gently undulating landforms resulting from aeolian sand accumulation.

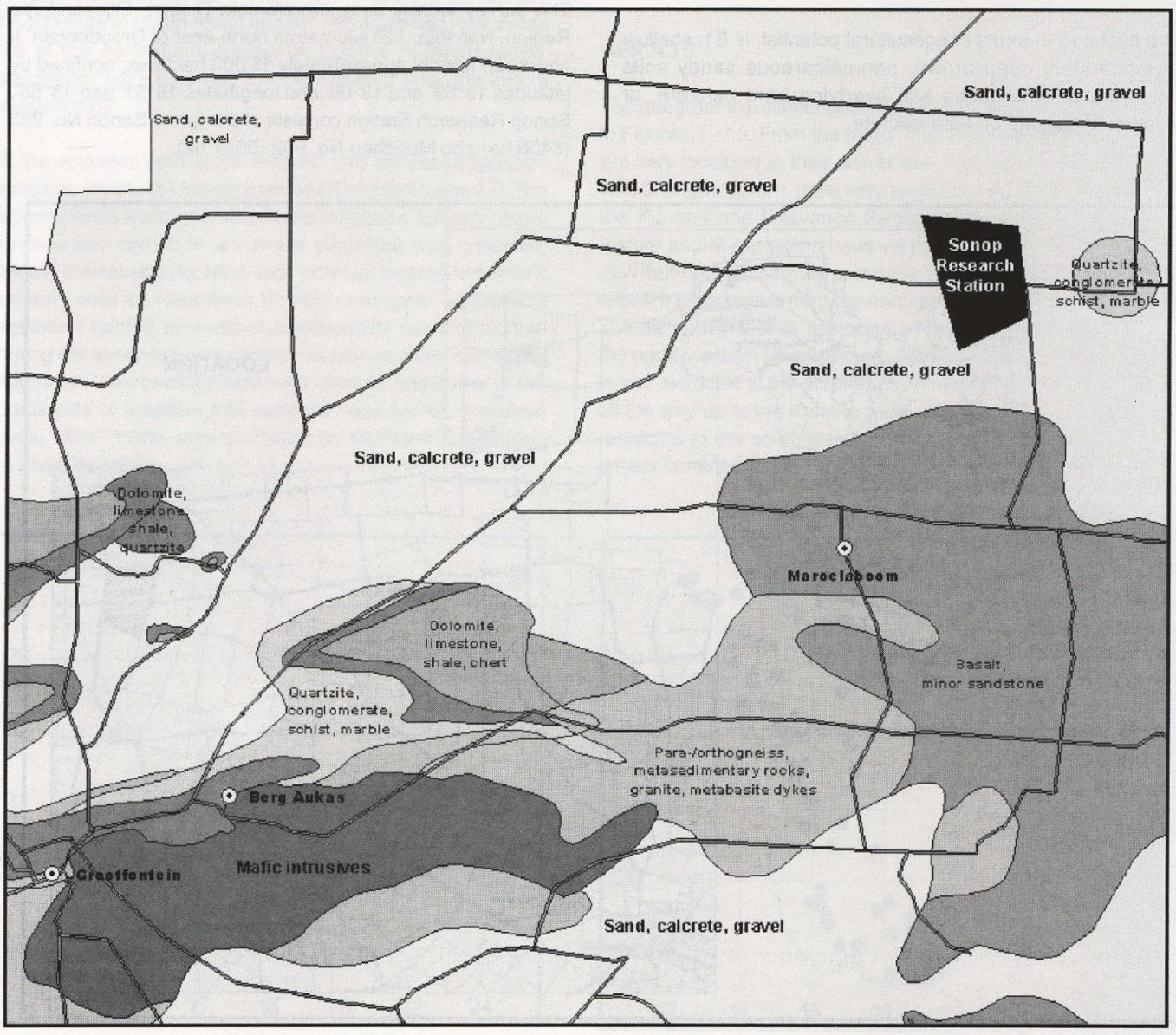

Figure 2. Lithology in the vicinity of Sonop Research Station (from the Geological Map of Namibia, Geological Survey of Namibia, 1980).

On the National Agro-ecological Zones map of Namibia (AEZ Programme, MAWRD, 1999), Sonop Research Station belongs to the 'Kal 8' zone: Kalahari Sands Plateau, omuramba-dune association with an average growing period of 105 days, dependable growing period of 86 days (80% of the average). The general slope range of Kal 8 is 0-2%, the absolute relief interval is 10-30m and the drainage pattern is strongly oriented and parallel. This agro-ecological zone has a ranking of second, out of eleven, for agricultural potential. A major agricultural limitation is sandy textured soil with low moisture holding capacity. It is highly suitable for livestock grazing, but unsuitable to marginally suitable for short-maturing crops only.

According to the 1:5 million scale FAO-UNESCO Soil Map of Africa (1977), the dominant soils are Ferralic Arenosols, associated with Petric Calcisols and Luvic Arenosols, with inclusions of Haplic Arenosols and Gleyic Solonetz.

Vegetation

There is a good correlation between vegetation and main landform units:

Dunes are covered by a dense shrub savannah tending to an open tree savannah. The most common trees are *Pterocarpus angolensis, Burkea africana, Lonchocarpus nelsii, Terminalia sericea and Combretum collinum*. The most common shrubs are *Glewia flava, Croton gratissimus, Commiphora glandulosa, Combretum collinum, Bauhinia petersiana, Lonchocarpus nelsii, Terminalia sericea, Ochna pulchra* and *Baphia massaiensis*. The poisonous plant *Dichapetalum cymosum* occurs on the footslopes of dunes. The following grass species are common on dunes: *Aristida stipitata, Stipagrostis uniplumis, Schmidtia pappophoroides, Digitaria seriata, Panicum kalaharense, Eragrostis pallens* and *Mellinus repens (glandiflora).*

The interdune vegetation type is generally a dense shrub savannah tending to an open thorny tree savannah. The dominant trees are *Acacia erioloba*, *Acacia mellifera* and *Acacia reficiens. Peltophorum africana* is widely scattered. The most common bushes are *Catophractes alexandri, Ziziphus mucronata, Acacia mellifera, Acacia reficiens and Dichostrachys cinerea*. A good standing crop of perennial and annual grasses occurs on interdunes. Common grasses are *Stipagrostis uniplumis, Anthephora pubescens, Eragrostis rigidior, Aristida stipitata, Chloris virgata,* and *Urochloa brachyura.*

Dense shrub savannah and savannah are the most common vegetation types of the sandplains. The dominant trees are *Lonchocarpus nelsii, Burkea africana, Acacia erioloba, Rhus tenuinerves* and *Mundulea sericea*. The dominant shrubs are *Acacia mellifera, Bauhinia petersiana, Acacia erioloba, Baphia massaiensis, Dichostachys cinerea, Commiphora angolensis, Terminalia sericea, Grewia flava, Grewia flavenses and Rhus tenuinervis*. The following grass species are common: *Eragrostis trichophora, Stipagrostis uniplumis, Triraphis schinzii, Aristida meridionalis, Panicum kalaharense, Enneapogon cenchroides, Eragrostis rigidior, Stipagrostis uniplumis, Schmidtia pappophoroides, Eragrostis superba, Aristida stipitata, Aristida meridionalis, Anthephora pubescense, Digitaria seriata* and *Heteropogon contortus.*

Land Use and Human Activity

Sonop Research Station is a state-owned farm devoted to agricultural research, mostly on cattle and game. It is also used to breed indigenous Nguni's and Sanga's for sale to private farmers and to conserve genetic material.

Sonop is surrounded by privately owned cattle farms. Some crop cultivation (maize, millet, sorghum, cotton, groundnuts, pastures) is practised in the area. As a rule, this is secondary to cattle husbandry, on account of the variable rainfall and sandy nature of soils.

METHODOLOGY

Normal visual and stereoscopic interpretation of aerial photographs (APR Photography 1973, Job No 723/25, Run 1 No 1202-1205, Run 2 No 663-665) was done to delineate distinctive features. The Geological Map of Namibia (Geological Survey of Namibia, 1980) to a scale of 1:1 million was evaluated. Relevant literature on climate, vegetation, geology, geomorphology, soils and land use of the survey area was also studied.

Pre-delineated land mapping units and land cover units were verified by driving along transects. Soil boundaries were drawn based on a compromise between free survey and the aerial photograph unit sampling method. Landforms and vegetation assisted with delineation of soil mapping units.

Forty-six soil augerings in different land mapping units were carried out for routine identification purposes. During this process, each soil horizon was described according to FAO terminology (FAO, 1990) in terms of colour, texture (finger method), consistency, pH, stoniness, presence of carbonates, landform and position in the landscape. Samples for physical and chemical analyses were taken from some augerings.

Three soil profile pits were dug at representative sites and described (FAO, 1990). Samples from each horizon were collected for physical and chemical analyses at the Agricultural Laboratory in Windhoek. The depth of the profiles ranged between 80cm and 130cm. Photographs were taken of the profiles. The exact location of all soil profiles and augerings were recorded with the aid of a global positioning system.

Soils were classified according to the system developed for Etosha/Northern Namibia (Beugler-Bell *et al.*, 1993), based on the updated FAO-UNESCO world soil map legend (FAO-UNESCO, 1988), and described in accordance with the FAO Guidelines for Soil Description (FAO, 1990) and the Revised Standard Soil Colour Charts (Eijkelkamp, 1993). Arenosols were grouped into mapping units by the colour of the B-horizons, which reflects differences in pedogenesis.

After ground truthing, lines on aerial photographs were corrected where necessary and transferred to topographical maps that were used as base maps. The final map was produced at a scale of 1:25 000.

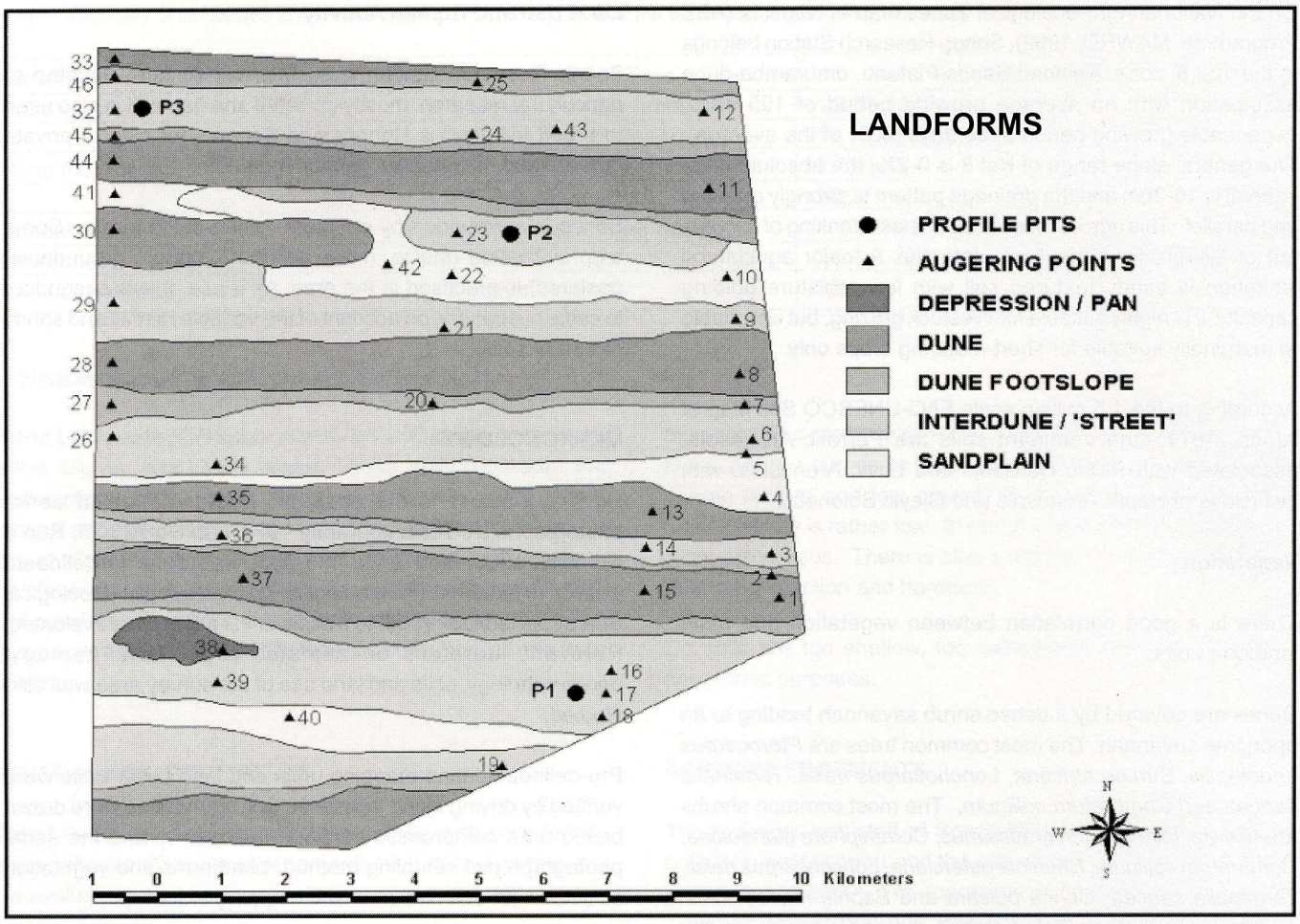

Figure 3. Landforms found on Sonop Research Station.

SOILS

The survey identified four landforms:

- dune crests,
- dune footslopes,
- interdunes ('streets'), and a
- depression / pan,

and three main soil types in close association with the landforms:

A Soils from deep sandy substrata,
B Shallow to moderately deep sandy soils, and
C Shallow soils abruptly overlying hard calcrete.

The main soil types were further subdivided into five soil mapping units, according to the colour of B-horizons, geomorphological phases, depths and types of underlying material:

A1 Chromi Ferralic Arenosols,
A2 Xhanti Ferralic Arenosols,
A3 Eutric Arenosols,
B1 Eutric Arenosols, and
C1 Eutric Leptosols.

A: Soils and Soil Associations from Deep Sandy Substrata

Arenosols developed in deep (>1metre) sandy substrata from aeolian origin. Although very uniform in most properties, these more or less carbonate-free soils with fine to medium sandy texture can be distinguished mainly by the colour of the B-horizon (e.g. Cambic Arenosols with moist hues of 10YR, Xanthi Arenosol with hues of 7.5YR, Chromic Arenosols with hues of 5YR).

Chromi Ferralic Arenosols (A1) occur on the crests of dunes, normally at elevations of ±1296m. These are deep to very deep, well to excessively drained, reddish brown (5YR 4/6-4/8) fine to medium sands, covered by a thin layer (<4cm) of aeolian sand. These soils are non-calcareous.

Xhanti Ferralic Arenosols (A2) occur on the lower dunes, at the footslopes of dunes and on the sandplains. These soils show less intensive colouring, of dull reddish brown to brown B-horizons with hues of 7.5YR. These soils are non-calcareous, deep to moderately deep, well to somewhat excessively drained and consist of fine to medium sand.

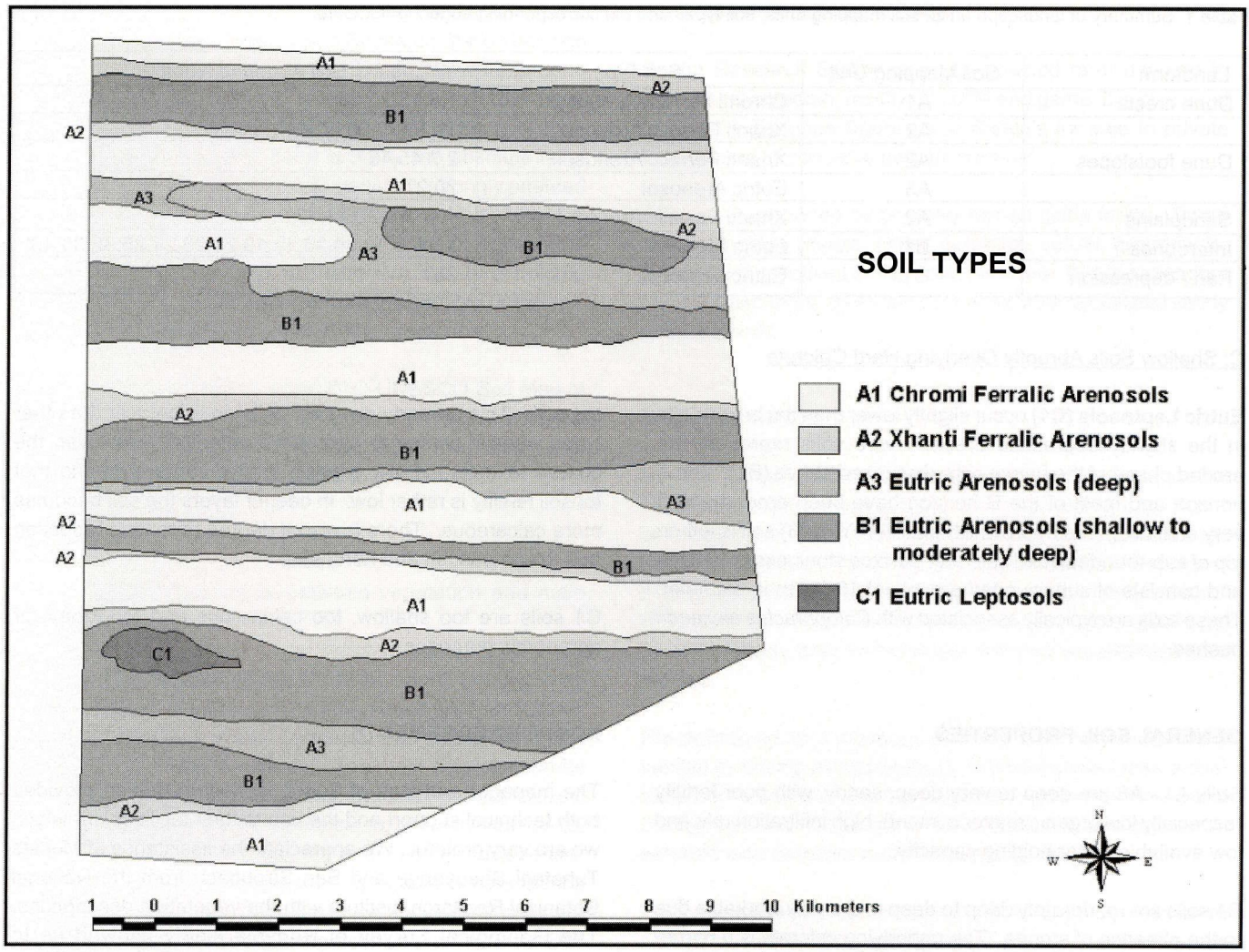

Figure 4. Soil types found on Sonop Research Station.

Eutric Arenosols (A3) occur mainly on the sandplains and sometimes at the footslopes of dunes. These soils show less intensive colouring (B-horizons with hues of 10YR) than the soils described above. They are deep to moderately deep, well to somewhat excessively drained, fine to medium sand, and non-calcareous. The physical and chemical characteristics of the Eutric Arenosols are very similar to those described above. The colour of the B-horizon implies a less intensive pedogenesis compared to Arenosols on dunes.

B: Shallow to Moderately Deep Sandy Soils

The interdunal depressions are mainly composed of Eutric Arenosols. These soils are browner and richer in clay than the Arenosols from dunes and sandplains. They probably developed in colluvium.

Eutric Arenosols (B1) are brown soils occurring on interdunes. These soils are non-calcareous and abruptly overlie hard calcrete, or weathered calcrete on hard calcrete, at depth. These brown soils did not develope *in situ* due to weathering of calcrete, but formed in reworked colluvial sediments. They are classified as Eutric Arenosols, when having a base saturation of more than 50 percent. As these are the higher potential soils, they are described in somewhat more detail:

- Sometimes an A1 horizon, a thin layer of <5cm of aeolian sand, is present. The moist soil colour is dull brown (7.5YR 5/3-5/4) to dark brown (7.5YR 3/3). The horizon is non-calcareous.
- The A2 horizon is 5-60cm thick. Texture is sand to loamy sand. The moist soil colour is brown (7.5YR 4/4) to dark brown (7.5YR 3/3). The horizon is non-calcareous.
- The Bw horizon starts at a depth of 5-60cm and it has a sandy to loamy sand texture. The moist soil colour is brown (7.5YR 4/3-4/6), dark reddish brown (5YR 3/3-3/4) or very dark reddish brown (5YR 2/3). The Bw horizon is non-calcareous.
- The C-horizon is ±10cm thick. It overlies hard calcrete at a depth of <1.25m. It includes ±40% non-weathered, sub-rounded calcrete gravels of 2-5cm. This horizon is calcareous.
- The Rk horizon is a layer of continuous calcrete at a depth of >1.25m.

Table 1. Summary of landscape units, soil mapping units, soil types and the corresponding augering numbers.

Landform	Soil Mapping Unit	Soil Type	Soil Augering Number
Dune crests	A1	Chromi Ferralic Arenosol	1,8,15,25,28
	A2	Xhanti Ferralic Arenosol	11,13,30,33,35,44
Dune footslopes	A2	Xhanti Ferralic Arenosol	2,7,45,46
	A3	Eutric Arenosol	20,27
Sandplains	A2	Xhanti Ferralic Arenosol	4,10,18,22,41,42
Interdunes	B1	Eutric Arenosol	3,5,6,9,12,14,16,17,19,21,23,24,26,32,36,43
Pan / depression	C1	Eutric Leptosol	38

C: Shallow Soils Abruptly Overlying Hard Calcrete

Eutric Leptosols (C1) occur slightly lower than the brown soils in the slightly depressed areas. These soils represent the eroded phase of the brown soils discussed above (B1). The A horizon and most of the B horizon have been eroded and a very shallow (<15cm) brownish black (10YR 3/3) soil is left on top of sub-rounded, hard calcrete. Surface stoniness is 10-15% and consists of sub-rounded gravels of 10-20cm in diameter. These soils are typically associated with *Catophractus alexandri* bushes.

GENERAL SOIL PROPERTIES

Soils A1 - A3 are deep to very deep, sandy, with poor fertility (especially low organic matter content), high infiltration rate and low available water holding capacity.

B1 soils are moderately deep to deep and easily workable due to the absence of stones. The underlying calcrete is a barrier to infiltration of water, improving the water storage capacity of the soils. This property gives B1 soils an edge over the other types when it comes to agronomic potential. However, the coarse texture and low organic matter content means that topsoil fertility is rather low. In deeper layers the soil becomes more calcareous. There is also a degree of rooting reduction due to compaction and hardness.

C1 soils are too shallow, too calcareous and too stony for agronomic purposes.

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