# AN INTEGRATED SYSTEM FOR SOIL INDENTIFICATION IN THE SOUTH AFRICAN SUGAR INDUSTRY

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**Abstract**

Soils of the South African sugar industry were first mapped on the basis of soil parent material and were subsequently grouped into forms and series in the binomial system. An integrated system incorporating both these methods has now been developed to enable the cane grower to identify his soils without difficulty.

## Introduction

In South Africa, sugarcane is grown under a range of climatic and soil conditions and soils in particular, differ widely in their physical and chemical properties, their ability to produce crops and their management requirements. It is also not uncommon to find a number of soils differing in these characteristics on one farm.

For three decades soil scientists have been identifying and classifying the sugarbelt soils. The Soils Bulletin No. 19 (SA Sugar Association Experiment Station[14]) was the result of surveys of the soils on a geological basis Beater.[2,3,4,5] A soil parent material map and key is useful and convenient for identifying soil series for young soils near the coast but is not always reliable in detecting differences in soil series resulting from changes in parent material, particularly in the Natal Midlands. Another limitation is that soils with very different properties are derived from the same parent material, eg granite, alluvium, Dwyka tillite, Middle Ecca sediments and Table Mountain Sandstone all give rise to a number of different soil forms.

The Department of Agriculture and Fisheries subsequently introduced the more precise binomial system of classification (MacVicar *et al*[9]) which involves grouping soils into soil forms and series without necessarily knowing the soil parent material. This has been accepted as the standard system of soil identification for South Africa and it would be advantageous for cane growers to be familiar with this system.

The revised edition of the Experiment Station's soils bulletin[15] to be published in 1984, will describe both classification systems. The main features of the two classification systems and their integration are described in this paper.

**TABLE 1**

**The nature and extent of soil parent materials in the South African sugar industry**

| SOIL PARENT MATERIAL | MAP COLOUR GUIDE | PERCENTAGE DISTRIBUTION OF TOTAL AREA SURVEYED | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | OVERALL | SOUTH COAST | MIDLANDS | NORTH COAST | ZULULAND | PONGOLA | EASTERN TRANSVAAL |
| Amphibolite | Red cross hatched | 0,21 | 0,21 | – | – | – | – | – |
| Pre-Granite quartzite | Red dotted | 0,07 | 0,03 | – | – | 0,04 | – | – |
| Tugela schist | Red hatched | 2,31 | 0,73 | 0,16 | 0,15 | 1,25 | 0,02 | – |
| Swaziland Basic Rocks (Eastern Transvaal only) | Red hatched | 0,65 | – | – | – | – | – | 0,65 |
| Granite | Red | 9,62 | 7,54 | 0,19 | 0,36 | 1,19 | – | 0,34 |
| Table Mountain Sandstone (TMS) - Mistbelt | Blue with white dots | 4,96 | 0,71 | 1,37 | 2,74 | 0,14 | – | – |
| Table Mountain Sandstone (TMS) - Ordinary | Blue | 24,90 | 7,10 | 8,76 | 7,59 | 1,45 | – | – |
| Dwyka tillite | Red-brown | 9,35 | 3,68 | 1,89 | 3,29 | 0,50 | – | – |
| Lower Ecca shale | Dark brown | 6,19 | 0,98 | 1,86 | 2,42 | 0,93 | – | – |
| Middle Ecca shales and sandstones | Yellow-brown | 6,62 | 0,03 | 1,30 | 1,67 | 3,22 | 0,40 | – |
| Beaufort shales and sandstones | Grey | 2,01 | – | – | – | 2,01 | – | – |
| Cave sandstone | Pink | 0,06 | – | – | – | 0,06 | – | – |
| Dolerite-Basalt-Diabase | Light green | 12,22 | 0,72 | 4,89 | 2,69 | 3,19 | 0,26 | 0,47 |
| Cretaceous sediments | Yellow hatched | 0,29 | – | – | – | 0,29 | – | – |
| Recent Sands - Red | Orange | 4,58 | 0,28 | – | 1,66 | 2,64 | – | – |
| Recent Sands - Grey | Yellow | 5,61 | 0,32 | – | 0,89 | 4,40 | – | – |
| Alluvium | Dark green | 10,42 | 0,53 | 3,51 | 1,29 | 4,05 | 0,83 | 0,21 |
| Total | | 100 | 22,86 | 23,93 | 24,75 | 25,36 | 1,51 | 1,67 |

**Note:** The area under cane in the South African sugar industry was about 392 000 ha in 1982.
Total area surveyed amounted to 587,865 ha.

## The Soil Parent Material System

The first recorded attempt at identifying soils in parts of the sugarbelt was by Rosentrauch[12] in 1937. The soils were so diverse that the classification system used at that time (van der Merwe[17]) was not satisfactory. The soils were therefore described simply in terms of colour, texture, depth and fertility. Although this classification was simple it was subjective and cumbersome and led Beater[1] to devise an alternative method, based on the early American use of geological formations (Marbut[10]). Initially, eight major soil parent materials were identified, viz: granite, Table Mountain Sandstone, Dwyka tillite, Ecca sediments, basalt, dolerite, Recent Sands and alluvium. Many soil profiles were examined, mainly in coastal cane land, and the findings were that dolerite always weathered to form heavy, deep red or shallow black clay; shale produced dark coloured base rich clays and granite and Table Mountain Sandstone produced shallow coarse grained, loamy sands and somewhat deeper grey medium grained sandy soils respectively. Initially, individual soil series were described and named after the farm or locality at which they were first found but later it was decided that soil associations, each consisting of soils derived from one parent material, would be the best mapping unit. Virtually the whole industry has been surveyed in this way to a scale of 1:6 000. The nature and extent of the soil parent materials that have been mapped for different parts of the industry are shown in Table 1.

MacVicar[7] later introduced the principle of soil systems which refers to an association of soils that coincide with areas of similar climate, topography and age of the land surface. The five systems described are the Nottingham, Umzinto (subdivided into the coast lowlands, midlands and river valleys), the Komatipoort, Nelspruit and Berea systems.

The Nottingham system, for example, comprises strongly weathered, red and yellow acid soils of mid- and late-tertiary land surfaces, those with thick humic horizons occupying the older of the two surfaces. This system is situated in a region known as the midlands mistbelt which has a cool humid climate. The main features of each system in terms of climate, altitude and soil properties are summarized in Table 2. The northern irrigated lowveld areas comprise mainly the Komatipoort and Nelspruit systems while the rainfed areas of Natal are represented by the other three systems.

The various systems were subsequently combined with the 16 soil parent materials into a key so that the predominant soil series associated with a particular soil parent material/soil system combination could be identified quickly. This soil parent material key (see Appendix I) formed the basis of the Experiment Station's Bulletin No. 19 entitled 'Soils of the Sugar Industry'[14] first published in 1973.

## Binomial System

During the 1960's the most recent United States soil classification system (Soil Survey Staff[13]) was applied to local conditions but was rejected because the diagnostic horizons nomenclature was not suitable and the class boundaries for

**TABLE 2**

**Summary of main features of the five soil systems within the sugar industry**

| Soil system | Natural region | Geomorphological history | Climate | Representative localities |
|---|---|---|---|---|
| Nottingham | Midlands Mistbelt (310–1200 m) | Remnants of the mid-tertiary surface. | Warm summers cool winters (mist is common) Mean ann. rainfall (925–1250 mm) | Paddock Powerscourt Kloof, Eshowe |
| | | Remnants of the late-tertiary surface | | Ixopo Richmond Windy Hill Seven Oaks Melmoth |
| Umzinto | Midlands (Coast hinterland) (310–950 m) | Remnants of late tertiary surface reduced by post-tertiary erosion cycles | Warm summers cool winters (frost not uncommon) Mean ann. rainfall (730–1000 mm) | Harding Highflats Eston Camperdown |
| | River Valleys (60–730 m) | Rejuvenated by post-tertiary erosion cycles | Hot semi-arid in dry sub-humid Mean ann. rainfall (650–800 mm) | Umkomaas Umvoti Lower Tugela |
| | Coast Lowlands (< 310 m) | Rejuvenated by post-tertiary erosion cycles | Hot summers mild winters Mean ann. rainfall (925–1300 mm) | Port Edward Umzinto Shakaskraal Amatikulu Empangeni |
| Berea | Coast Lowlands (< 310 m) | Recent coastal sand deposits | Hot summers mild winters Mean ann. rainfall (1020–1340 mm) | Port Edward Umhlanga Rocks Felixton Makatini Flats (part of) |
| Komatipoort | Lowveld (< 310 m) | Rejuvenated by post-tertiary erosion cycles | Very hot summers mild winters Mean ann. rainfall (590–730 mm) | Pongola Malelane Komatipoort Kaapmuiden Mhlume |
| Nelspruit | Lowveld (usually) (> 310 m) | Rejuvenated by post-tertiary erosion cycles | Hot summers Mild winters Mean ann. rainfall (760–900 mm) | Nelspruit Kaalrug |

separating soils were not applicable locally (MacVicar[6]). However the principles of this system of classification, which defined diagnostic horizons, did provide the stimulus for the systematic development of the national binomial system of soil classification, the prototype of which first appeared in 1969 (Van der Eyk *et al*[16]).

The binomial system has a general category of soil forms and a specific category of soil series. There are 41 soil forms each made up of a vertical sequence of diagnostic top- and subsoil horizons. The properties of the five topsoil and 15 subsoil horizons are defined and summarised in Appendix II. The definitions of these horizons must be thoroughly understood for successful identification. Each form is subdivided into a number of series which have a common prescribed horizon sequence for that particular form but which differ mainly in texture and base status. Of the 41 soil forms and more than 500 soil series that are provided for by the binomial system, 33 soil forms and about 130 soil series are known to occur in the sugar industry.

By determining the presence, sequence and depth of the diagnostic horizons the appropriate soil form may be determined by referring to the soil form key (given in Appendix III) in which form names are arranged in terms of the defined topsoil and subsoil horizons. For example, a soil with an orthic A over a red apedal B horizon will be classified as the Hutton form. Another soil profile with the same topsoil but a red structured B subsoil will be classified as the Shortlands form.

In many ways, the binomial system of classifying soils is analogous to that of classifying plants and animals according to their generic and specific names. Thus soils are classified by being allocated first to the appropriate soil form and then to the series, so a number of soil series belonging to the same soil form is like a family of soils.

Series are usually named after geographical locations and forms usually take their names from the most commonly distributed series within that form. For example, a heavy black shallow clay soil, derived from Lower Ecca shale, is called the Milkwood series because it was first described and identified on Milkwood Estate on the Natal North Coast. Soils which are very similar in appearance but lighter in texture are called the Dansland series because the soil was first identified on Dansland Estate on the south coast. Because of their similarity, these soils have been grouped in the same form or family. As the Milkwood series is more widespread than the Dansland series in South Africa, the form has been named the Milkwood form. To identify a soil a profile must first be exposed in the field by digging a pit and then proceeding as follows:

- demarcating the master horizons in the profile (A, E, B, C, G and R)
- identifying the diagnostic horizons (see Appendix II)
- establishing the soil form from the soil form key (see Appendix III)
- establishing the appropriate soil series by using various criteria such as texture, grade of sand, colour or base status.

Full details on the use of this system are in the prescribed handbook on the binomial system (MacVicar *et al*[9]).

### The Integrated System

There are a number of reasons why maps based on soil forms and series should not be made without regard to the information on soil parent material. First, the relationships Beater found between parent materials and soil series can be extended to certain diagnostic horizons and a number of soil forms. In general, soils derived from siliceous parent materials in the coastal areas (eg TMS (ordinary), Recent Sands, granite) will tend to be associated mainly with orthic A horizons and usually weakly developed subsoil horizons (eg lithocutanic B, regic sand). On the other hand, basic parent materials such as amphibolite, Lower Ecca shale and often dolerite, will produce black blocky clays which qualify for either melanic or vertic A horizons. The relationships with parent materials will therefore influence the nature of the resulting soil forms. One can infer that forms with vertic A (eg Arcadia) or melanic A (eg Milkwood) horizons will not occur on TMS (ordinary). Likewise, there is no likelihood of finding the Cartref form on dolerite.

A second reason concerns the effect of the geological time factor in soil formation. Soils with humic A horizons (eg Inanda form) will occur only in the Nottingham soil system. It is also not possible to obtain soils with vertic A horizons in this soil system.

Thirdly, the toposequence (catenary) effect has an influence on the forms that will be found on different parts of the landscape above various parent materials. This effect is illustrated in Figure 1 for soils on a granite landscape in the Eastern Transvaal Lowveld.

Depending on slope, soil forms such as Mispah, Glenrosa or Cartref occur on the crest or upland positions, the Longlands, Kroonstad and Estcourt forms on the mid to lower slopes and the Katspruit form on the lower slope or bottom lands. For basic parent materials such as dolerite and shale, the Milkwood or Arcadia form will usually be found in the upland position, the Bonheim or Tambankulu forms on the mid to lower slopes, and the Willowbrook or Rensburg forms in the bottom lands.

These environmental relationships are important and useful in identifying soils and have therefore, where possible, been incorporated into the modified soil parent material key (see Appendix I). The advantage of using this key is that the choice of soil form is reduced from 33 to 4 or 5 forms. As has been demonstrated, parent material, topography and soil system will indicate the predominant soil series associated with any particular form. This is especially so for soil forms such as the Hutton, Clovelly, Griffin and Avalon where it is sometimes difficult to establish the soil series according to the binominal system because a chemical analysis is required. Knowing that

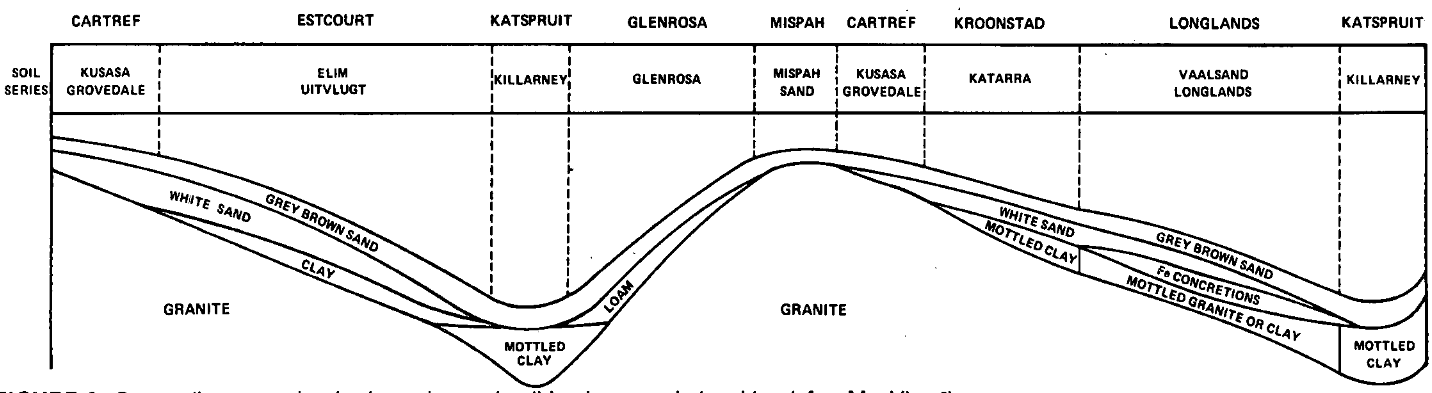


**FIGURE 1** Grey soils on granite: horizonation and soil-landscape relationships (after MacVicar[8]).

the soil occurs in the Nottingham system will immediately indicate that the soil is 'dystrophic', or if it occurs in the Komatipoort system, it will be 'eutrophic'.

Thus, an integrated approach to identifying soils has been developed, the procedure for which is as follows:

Step 1 : Identify the soil parent material on a particular site using the colour code index on the map of soil parent materials which is obtainable from the Experiment Station for most farms in the cane belt.

Step 2 : Identify the soil system from the maps in bulletin No. 19 published by the Experiment Station.

Step 3 : Use this information to make a list of the possible soil forms by consulting the parent material key to soils (see Appendix I).

Step 4 : Obtain a simple profile description either by augering or by exposing a fresh face in a pit and then match the description with the soil form that corresponds best with that in the parent material key. If the description cannot be matched or if no parent material map is available, use the binomial system. This requires a detailed examination of the profile to identify the diagnostic topsoil and subsoil horizons or materials (see Appendix II). Name the soil form by consulting the binomial system key to the soil forms (see Appendix III).

Step 5 : Refer to the identified soil form in bulletin No. 19 or the binomial system handbook and select the appropriate series name using criteria such as texture, grade of sand, colour, base status or soil system.

**Example** Field 10 — Komatidraai, Eastern Transvaal

| | |
|---|---|
| Step 1 : Parent material | : Swazi Basic Rocks |
| Step 2 : Soil system | : Komatipoort |
| Step 3 : Short list from key | : Shortlands, Hutton, Arcadia, Rensburg, Milkwood |
| Step 4 : Profile | : B horizon is a red blocky clay |
| From parent material key | : Identification gives Shortlands form or |
| using binomial system | : Diagnostic horizons — Orthic A over red structured B (from Appendix II) identification gives Shortlands form (from Appendix III) |

Step 5 : Short list gives Glendale or Sunvalley series and identification gives Glendale series because soil is not calcareous.

## Discussion

The integrated system of soil identification takes into account the fact that soil properties are not random and that the pattern is orderly and governed by the interaction of climate, vegetation and topography (environmental factors), parent material and time (inherited factors). In the key, primary consideration has been given to parent material and thereafter also to climate and time factors (soil system) and where possible, to topography. In bulletin No. 19 the forms have, where possible, been arranged according to their position in the landscape, from the highest (crest) to the lowest point (bottom land). In practice, the forms occurring in any toposequence will depend on the soil system and nature of the underlying parent material. The list of soil forms contained in bulletin No. 19 is summarised in Appendix IV.

In time, consideration should be given to the establishment of mapping units based on *soil form associations*, which would comprise soil forms with similar agronomic qualities and therefore capable of being managed in the same way. The Longlands, Kroonstad, Westleigh and Katspruit forms for example, all have poor internal drainage and water intake and a high erosion hazard. Even if these forms have different soil parent materials, a mapping unit to combine them would be of practical value to the agriculturalist. The importance of considering soil as a factor in the management of sugarcane production has been considered in detail by Moberly & Meyer.[11]

## Conclusions

It is hoped that the integrated system will make it possible for growers to identify their soils on a field by field basis. Most growers have access to soil parent maps and these, together with the revised soils bulletin, will provide the information needed to determine the nature and distribution of soils to soil form level. The advantage of the new soil parent material key is that the selection is restricted to four or five forms instead of the 33 in the binomial system. Until resources become available to survey the soils of the sugar industry on the basis of soil forms and series, the integrated system can be used to identify soils in any part of the sugar industry.

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## APPENDIX I

### PARENT MATERIAL KEY TO THE SOIL FORMS

**1. Swaziland Basic Rocks**

KOMATIPOORT AND NELSPRUIT SYSTEMS

*Red clays:*
- blocky structured clay: Shortlands
- non-structured clay loam: Hutton

*Black blocky structured:*
- shallow cracking clay on soft rock (upland): Arcadia
- heavy cracking clay on waterlogged pot clay (bottomland): Rensburg
- non-cracking clay on hard rock (upland): Milkwood

**2. Swaziland Shale/Limestone**

KOMATIPOORT SYSTEM

*Brown loams:*
- shallow soil on hard rock (upland): Mispah

**3. Amphibolite**

UMZINTO SYSTEM

*Black blocky structured:*
- shallow, non-cracking clay on hard rock (upland): Milkwood
- yellow mottled waterlogged pot clay subsoil (bottomland): Willowbrook

**4. Pre-Granite Quartzite**

*Grey sand:*
- subsoil contains light bleached horizon with clay tongues into rock: Cartref

**5. Tugela Schist**

UMZINTO SYSTEM

*Red clays:*
- blocky structured clay: Shortlands
- non-structured clay loam: Hutton
- shallow brown cracking clay on rock: Arcadia

*Black clays:*
- shallow cracking clay on soft rock (upland): Arcadia
- heavy cracking clay on waterlogged pot clay (bottomland): Rensburg

**6. Granite**

UMZINTO, KOMATIPOORT AND NELSPRUIT SYSTEMS

*Grey coarse sands:*

*upland*
- shallow sandy subsoil with clay tongues into deep weathered rock: Glenrosa
- subsoil contains light bleached horizon with clay tongues into rock: Cartref

*lower slope (mainly in Komatipoort and Nelspruit Systems)*
- heavy clay subsoil with strong prismatic structure: Sterkspruit
- bleached sand on heavy prismatic structured clay: Estcourt

*bottomland*
- subsoil contains bleached sand on ouklip: Longlands
- bleached sand on yellow mottled clay (usually wet): Kroonstad
- yellow mottled waterlogged pot clay: Katspruit

*Black gritty loams:*
- Shallow blocky clay subsoil with clay tongues into rock: Mayo

*Red gritty loams (Komatipoort and Nelspruit Systems only)*
- non-structured porous loam: Hutton

**7. Table Mountain Sandstone (TMS)**

NOTTINGHAM SYSTEM

*TMS Mistbelt*

*Dark brown fluffy humic loams:*
- shallow subsoil with clay tongues into rock: Nomanci
- deep non-structured orange/red subsoil: Inanda
- deep non-structured yellow over red subsoil: Kranskop

*TMS 'Ordinary'*

*Dark grey loams:*
- brown clayey subsoil with clay tongues into rock (upland): Glenrosa
- yellow non-structured subsoil: Clovelly
- yellow over red non-structured subsoil: Griffin
- yellow non-structured subsoil on ouklip: Avalon
- heavy mottled pot clay (bottomland): Katspruit

*Deep red clays:*
- porous non-structured subsoil: Hutton

UMZINTO SYSTEM

*TMS 'Ordinary'*

*Grey sands with a bleached sandy horizon:*
- sandy subsoil with clay tongues into rock: Cartref
- with ouklip layer on mottled subsoil: Longlands
- yellow mottled clay (bottomland): Kroonstad

*Grey loamy sands without a bleached layer:*
- sandy subsoil with clay tongues into rock: Glenrosa
- ouklip layer in grey subsoil: Westleigh
- yellow subsoil waterlogged mottled pot clay: Katspruit

*Red loams (midlands):*
- deep non-structured subsoil: Hutton

**8. Dwyka Tillite**

NOTTINGHAM SYSTEM

*Dark brown humic loams:*
- yellow over red non-structured subsoil: Kranskop

*Brown non-structured clays:*
- yellow above red subsoil on rock: Griffin
- yellow subsoil on rock: Clovelly
- yellow-brown subsoil with clay tongues into rock: Glenrosa

*Red loams:*
- deep non-structured subsoil: Hutton

UMZINTO SYSTEM

*Grey fine sandy loams with a bleached sandy horizon:*
- sandy subsoil with clay tongues into rock: Cartref
- with ouklip on yellow mottled subsoil: Longlands

*Grey fine sandy loams without a bleached horizon:*
- sandy subsoil with clay tongues into yellow decomposed rock: Glenrosa
- ouklip layer in yellow mottled subsoil: Westleigh

*Brown clay:*
- yellow-brown subsoil with clay tongues into rock: Glenrosa

KOMATIPOORT SYSTEM

*Grey fine sandy loams:*
- yellow subsoil with dark clay tongues into rock: Glenrosa
- ouklip layer in yellow mottled subsoil: Westleigh
- olive-brown strong blocky clay subsoil: Sterkspruit
- bleached sandy horizon on blocky clay subsoil: Estcourt
- yellow mottled waterlogged pot clay: Katspruit

**9. Lower Ecca Shale**

NOTTINGHAM SYSTEM

*Brown clays:*
- shallow clay on shale: Mispah
- yellow non-structured subsoil on rock: Clovelly
- yellow above, red non-structured subsoil: Griffin

UMZINTO SYSTEM

*Coast lowlands and river valleys*

*Dark grey to black blocky clays:*
- shallow rubbly clay on shale: Milkwood
- yellow-brown blocky clay subsoil: Bonheim
- yellow heavy mottled waterlogged pot clay: Willowbrook
- heavy cracking; yellow mottled waterlogged pot clay: Rensburg

*Midlands*

*Grey brown clays:*
- shallow stoney clay on shale: Mispah

**10. Middle Ecca Sediments (Sandstones and Shales)**

NOTTINGHAM SYSTEM

*Dark brown fluffy humic loams:*
- yellow above, red non-structured subsoil: Kranskop

*Brown clays on shale and grey loams on sandstone:*
very shallow shaley subsoil: Mispah
yellow non-structured subsoil: Clovelly
yellow above, red non-structured subsoil: Griffin

*Red clays:*
porous non-structured subsoil: Hutton

UMZINTO SYSTEM

*Grey sands to fine sandy loams:*
shallow shaley subsoil: Mispah
shallow blocky clay subsoil: Swartland
ouklip layer in yellow mottled subsoil: Westleigh
bleached sandy horizon on ouklip: Longlands
yellow mottled clay (usually wet): Kroonstad
yellow heavy mottled waterlogged pot clay: Katspruit

*Dark blocky clays on shale:*
*(Coast lowlands and river valleys)*
shallow rubbly clay on rock: Milkwood
yellow-brown blocky clay subsoil: Bonheim
yellow heavy mottled waterlogged pot clay: Willowbrook
heavy cracking waterlogged pot clay: Rensburg

KOMATIPOORT SYSTEM

*Grey sands to loams:*
shallow shaley or rocky subsoil: Mispah
shallow blocky clay subsoil: Swartland
ouklip layer in yellow subsoil: Avalon
strong blocky brown clayey subsoil: Sterkspruit
bleached sandy horizon on brown blocky clay subsoil: Estcourt
bleached sandy horizon on ouklip: Longlands
yellow mottled clay subsoil layer (usually wet): Kroonstad
yellow mottled waterlogged pot clay: Katspruit

*Black blocky clays:*
shallow non-cracking clay on shale: Milkwood
yellow mottled waterlogged pot clay: Willowbrook
heavy cracking waterlogged pot clay: Rensburg

**11. Beaufort Sediments**

KOMATIPOORT AND UMZINTO SYSTEMS

*Grey loams on sandstone:*
very shallow loam on rock: Mispah
bleached sand layer on blocky clay subsoil: Estcourt

*Dark loams and clays on shale:*
shallow brown blocky clay subsoil: Swartland
black blocky clay subsoil: Milkwood
yellow mottled waterlogged pot clay subsoil: Willowbrook

**12. Cave Sandstone**

KOMATIPOORT SYSTEM

*Grey loamy sands:*
very shallow soil on rock: Mispah

*Red loams:*
deep non-structured subsoil: Hutton

**13. Dolerite-Basalt-Diabase**

NOTTINGHAM SYSTEM

*Deep red non-structured clays:*
thick dark brown fluffy topsoil (> 45 cm): Inanda
brown shallow topsoil (< 45 cm): Hutton

UMZINTO AND KOMATIPOORT SYSTEMS

*Red blocky structured clays:*
deep porous non-cracking clay on weathered rock: Shortlands
shallow brown cracking clay on rock: Arcadia

*Black blocky structured clays:*
shallow cracking clay on rock (upland): Arcadia
yellow-brown blocky clay subsoil (lower slope): Bonheim
heavy cracking waterlogged pot clay (bottomland): Rensburg

*Red non-structured clays (Umzinto Midlands only):*
deep porous subsoil on weathered rock: Hutton

**14. Cretaceous Sediments**

UMZINTO AND KOMATIPOORT SYSTEMS

*Black blocky structured clays:*
shallow cracking clay on rock (upland): Arcadia
yellow-brown blocky clay subsoil (lower slope): Bonheim

*Dark grey loams:*
shallow brown blocky clay subsoil: Valsrivier

**15. Recent Sands**

BEREA SYSTEM

*Red sands to sandy loams:*
deep non-structured subsoil: Hutton
bleached grey sand on red subsoil: Shepstone

*Grey sands (no watertable):*
deep loose sandy subsoil: Fernwood
yellow sandy subsoil: Clovelly

*Grey sands (wet and low-lying areas):*
sandy subsoil with abundant mottling: Fernwood
sandy subsoil with ouklip layer: Westleigh
bleached sandy subsoil with ouklip layer: Longlands
bleached sandy subsoil on mottled clay: Kroonstad

*Dark peat:*
humus rich topsoil on sand: Champagne

**16. Alluvium**

ALL SYSTEMS

*Grey sands:*
alternating layers of sand and clay: Dundee
deep loose sandy subsoil: Fernwood

NOTTINGHAM SYSTEM

*Grey sands:*
reddish structureless clay subsoil with dark clayskins: Oakleaf
yellow mottled waterlogged pot clay: Katspruit

*Black peat:*
humus rich topsoil on mottled pot clay: Champagne

UMZINTO AND KOMATIPOORT SYSTEMS

*Red soils:*
deep porous non-structured: Hutton
red blocky structured: Shortlands

*Grey soils with yellow-brown subsoils:*
deep sandy subsoil: Clovelly
non-structured subsoil with dark clayskins: Oakleaf
blocky structured clay subsoil: Valsrivier

*Grey soils with a bleached sandy horizon:*
on ouklip: Longlands
heavy block clay subsoil: Estcourt
yellow mottled clay: Kroonstad

*Grey soils without bleached sandy horizon:*
yellow mottled waterlogged pot clay: Katspruit

*Black blocky structured clays:*
yellow-brown blocky clay subsoil: Bonheim
clayey subsoil with ouklip layer: Tambankulu
alternating layers of sand and clay in subsoil: Inhoek
non-cracking yellow mottled pot clay: Willowbrook
cracking yellow mottled pot clay: Rensburg

*Black peat:*
humus rich topsoil on yellow mottled waterlogged pot clay: Champagne

NELSPRUIT SYSTEM

*Red loams:*
deep non-structured subsoil: Hutton

*Black clays:*
blocky structured on yellow mottled pot clay: Willowbrook

*Grey soil:*
bleached sand on wet mottled clay: Kroonstad

## APPENDIX II

### SUMMARY OF MAIN PROPERTIES OF TOP AND SUBSOIL DIAGNOSTIC HORIZONS USED IN THE BINOMIAL SYSTEM OF SOIL CLASSIFICATION

## TOPSOIL HORIZONS

**Humic**

- Rich in organic matter.
- More than 2% organic carbon throughout a depth of 450 mm.
- Does not overlie a gleyed material.
- Found mainly in TMS (mistbelt) derived soils.

**Vertic**

- Black cracking clay.
- Strong blocky structure.
- Has one or more of the following:
  - clearly visible slickensides;
  - cracks more than 25 mm;
  - self-mulching in the surface material.
- Found mainly in dolerite and heavy alluvial derived soils.

**Melanic**

- Black non-cracking clay.
- Lacks slickensides, self-mulching and cracks.
- Has blocky structure.
- Less organic carbon than Humic.
- Contains at least 15% clay.
- Is at least 300 mm thick if it overlies a B horizon with a red or yellow colour.
- Found mainly in Lower Ecca shale derived soils.

**Orthic**

- Topsoil which does not qualify as Humic, Melanic, Vertic or Organic.
- Usually grey to brown non-structured sands to sandy loams.
- Most common soil found mainly in TMS (ord), Dwyka, Granite and Recent Sands.

**Organic O**

- Rich in organic matter.
- Also known as peat.
- At least 10% organic carbon throughout a vertical distance of 300 mm.
- Overlies gleyed material.
- Very rare, found in reclaimed swampland.

## SUBSOIL HORIZONS

### NON-STRUCTURED

**Red Apedal**

- No structure.
- Structure weaker than moderate blocky
- Directly underlies diagnostic topsoil horizon, yellow-brown or E horizon.

**Yellow-Brown Apedal**

- No structure.
- Directly under topsoil.
- Mottling permissible.

**Regic Sand**

- Little or no structure; may be massive or single grained.
- May contain clay fibres or lamellae.
- Usually grey.
- Directly under a topsoil horizon.
- Is at least 250 mm thick.
- Common to Recent Sands and Recent Alluvium.

**Lithocutanic**

- Underlies a topsoil or an E.
- Merges into underlying weathering rock.
- Characteristics (50%) of material in stages of alternation from rock to soil.
- Has cutanic character expressed usually as tongues.
- Found on crest to midslope position.

**Neocutanic**

- No structure.
- Has formed in recent sediment.
- Presence of Cutans or clayskins.
- Non-uniform colour – variegation may be absent if colour is a uniform dark brown.
- Lacks evidence of wetness.
- Has no evidence of saprolite in B2 or B3.

### STRUCTURED

**Red Structured**

- Colour same as apedal - must be uniform
- Directly under orthic.
- No abrupt transition from A with respect to structure or texture.

**Pedocutanic**

- Underlies a topsoil directly or via a stone line.
- Has transition with overlying horizon which is non-abrupt (abrupt transition allowed if there is no indication of prismatic or columnar structure).
- Structure more developed than red apedal when its upper boundary is not abrupt.
- Has clearly expressed cutanic character. Does not qualify as :
  G (lacks wetness) as gley, prisma or plinthic (no accumulation of iron and manganese oxides);
  red structured (colour non-diagnostic or not uniform).

**Prismacutanic**

- Has *abrupt* transition with E or A with respect to two of the following:
  *Texture* – if clay percent of overlying material is more than 20% then below must show an increase of 20%.
  *Structure* - one grade stronger than red structured B.
  *Consistence* - at least two grades firmer than overlying horizon.
- Has prismatic or columnar structure (usually coarse). Occasionally primary blocky structure is more pronounced than prismatic or columnar.
- Lacks evidence of wetness. If there is wetness then the vertical faces of prisms have continuous clay coatings of uniform dark colours.
- Has colour contrast beween clay skins and ped interiors.

### POORLY DRAINED

**E Horizon**

- Bleached greyish sandy layer.
- Overlies: gleycutanic, prismacutanic, lithocutanic, neocutanic, plinthic, yellow-brown or red apedal.
- May contain mottling or streaking.
- Is non-plastic - may set hard when dry
- Occurs immediately below a diagnostic topsoil horizon, except where mixing has occurred.

**Gleycutanic**

- Directly underlies an E or yellow-brown horizon.
- Colour variegation in a random pattern comprising grey, low chroma colours (as for E). Has high chroma mottling - usually dark colouration due to Cutans.
- Has any type or degree of development of structure *except* well developed prismatic or columnar with uniformly coloured dark ped exteriors.

**Hard Plinthic**

- Also known as ouklip or ngubane.
- Cannot be cut with a spade.
- Occurs as the 3rd sequence of horizons provided 2nd horizon is E or yellow-brown.
- Non-diagnostic if it occurs:
  - at the surface
  - immediately beneath a topsoil;
  - beneath the 3rd horizon of a profile.

**Soft Plinthic**

- Has mottling and/or concretions from iron or manganese oxides. Mottle colours are usually red, yellow, dark grey and black. Matrix colours always include grey from gleying.
- Can be cut with a spade.
- Occurs as 2nd or 3rd sequence of a horizon. If 3rd, then 2nd horizon must be E, yellow-brown or red.

G HORIZON

- Similar to a pot clay.
- Does not overlie: gleycutanic, prismacutanic.
- Saturated with water for most of the year.
- Directly underlies topsoil; horizon.
- Firm or plastic consistence.
- At least 250 mm thick.
- Same colour as E but may have blue or green tints, with or without mottling. Can be yellowish-brown, olive-brown, red or black.

## APPENDIX III

BINOMIAL SYSTEM KEY TO SOIL FORMS

| SUBSOIL DIAGNOSTIC HORIZONS | TOPSOIL DIAGNOSTIC HORIZONS | | | | |
|---|---|---|---|---|---|
| | ORGANIC | HUMIC | VERTIC | MELANIC | ORTHIC |
| Hard rock | | | | Milkwood | Mispah |
| Soft rock (saprolite) | | | Arcadia | | |
| Lithocutanic B | | Nomanci | | Mayo | Glenrosa |
| Pedocutanic B/saprolite | | | | Bonheim | Swartland |
| Pedocutanic B/unconsolidated material | | | | | Valsrivier |
| Prismacutanic B | | | | | Sterkspruit |
| Soft plinthic B | | | | Tambankulu | Westleigh |
| E horizon/red apedal B | | | | | Shepstone |
| E horizon/lithocutanic B | | | | | Cartref |
| E horizon/soft plinthic B | | | | | Longlands |
| E horizon/prismacutanic B | | | | | Estcourt |
| E horizon/gleycutanic B | | | | | Kroonstad |
| G horizon (firm gley) | Champagne | | Rensburg | Willowbrook | Katspruit |
| Red structured B | | | | | Shortlands |
| Red apedal B | | Inanda | | | Hutton |
| Yellow apedal B | | Magwa | | | Clovelly |
| Yellow apedal B/red apedal B | | Kranskop | | | Griffin |
| Yellow apedal B/soft plinthic B | | | | | Avalon |
| Neocutanic B | | | | Inhoek | Oakleaf |
| Regic sand | | | | | Fernwood |
| Stratified alluvium | | | | Inhoek | Dundee |

## APPENDIX IV

LIST OF SOIL FORMS CONTAINED IN THE REVISED SOILS BULLETIN

*Forms with Humic A or Organic O horizons*

| | |
|---|---|
| 1. Humic A over hard rock | Nomanci |
| 2. Humic A over red apedal B | Inanda |
| 3. Humic A over yellow-brown apedal over red apedal B | Kranskop |
| 4. Humic A over yellow-brown apedal | Magwa |
| 5. Organic O over G | Champagne |

*Forms with Vertic A horizons (crest to valley bottom)*

| | |
|---|---|
| 6. Vertic A on soft rock (saprolite) | Arcadia |
| 7. Vertic A over G (firm gley) | Rensburg |

*Forms with Melanic A horizons (crest to valley bottom)*

| | |
|---|---|
| 8. Melanic A over hard rock | Milkwood |
| 9. Melanic A over lithocutanic B | Mayo |
| 10. Melanic A over pedocutanic B | Bonheim |
| 11. Melanic A over soft plinthic B | Tambankulu |
| 12. Melanic A over G (firm gley) | Willowbrook |
| 13. Melanic A over neocutanic B or stratified alluvium | Inhoek |

*Forms with Orthic A horizons over rock or lithocutanic B (mainly crest or upland)*

| | |
|---|---|
| 14. Orthic A over hard rock | Mispah |
| 15. Orthic A over lithocutanic B | Glenrosa |
| 16. Orthic A over E over lithocutanic B | Cartref |

*Forms with Orthic A horizons over pedocutanic or prismacutanic B horizons (midslope to bottom land)*

| | |
|---|---|
| 17. Orthic A over pedocutanic B on saprolite | Swartland |
| 18. Orthic A over pedocutanic B on unconsolidated material | Valsrivier |
| 19. Orthic A over prismacutanic B | Sterkspruit |
| 20. Orthic A over E over prismacutanic B | Estcourt |

*Forms with Orthic A horizons over E and/or soft plinthic B or G horizons (foot slope to bottom land)*

| | |
|---|---|
| 21. Orthic A over E over soft plinthic B | Longlands |
| 22. Orthic A over soft plinthic B | Westleigh |
| 23. Orthic A over E over gleycutanic B | Kroonstad |
| 24. Orthic A over G (firm gley) | Katspruit |

*Forms with an Orthic A over red or yellow B horizons (mainly upland to foot slope)*

| | |
|---|---|
| 25. Orthic A over red structured B | Shortlands |
| 26. Orthic A over red apedal B | Hutton |
| 27. Orthic A over yellow-brown apedal B | Clovelly |
| 28. Orthic A over yellow-brown apedal B over red apedal B | Griffin |
| 29. Orthic A over yellow-brown apedal B over soft plinthic B | Avalon |

*Forms with an Orthic A over recently formed subsoil material (footslope to bottom land)*

| | |
|---|---|
| 30. Orthic A over neocutanic B | Oakleaf |
| 31. Orthic A over E/red apedal B | Shepstone |
| 32. Orthic A over regic sand | Fernwood |
| 33. Orthic A over stratified alluvium | Dundee |