SOME CHARACTERISTICS OF THE SOILS OF THE SUGAR-CANE GROWING AREAS AROUND MALELANE-KOMATI-POORT, EASTERN TRANSVAAL

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Introduction

Except for the soils around Nelspruit on which citrus has been cultivated for a considerable time, relatively little information is available regarding the physical and chemical properties of the soils in this region of the lowveld into which the South African sugar industry has recently expanded.

The object of the present paper is to remedy this situation in some degree by providing basic information about the soils of these new sugarcane growing areas. It must be emphasised, however, that the results presented here, for the most part represent determinations on single soils only. The soils used, however, were chosen as representative of each type of soil occurring in the area. Hence these figures should be used as a general guide only, as it is possible that other seemingly similar soils may vary quite considerably as regards their properties and characteristics.

Location

The area under consideration extends at intervals along the Crocodile River from the vicinity of Schagen in the west to Komatipoort in the east. In addition further areas of development are located south and southwest of Komatipoort on the Komati and Lomati Rivers.

A very hilly tract of granite terrain east of Nelspruit conveniently divides the valley of the Crocodile River into upper and lower portions. The upper valley around Nelspruit comprises an area of extensive citrus cultivation, the only area in this portion of the Crocodile Valley scheduled for sugarcane production being a relatively small area around Schagen, some ten miles west of Nelspruit.

The lower Crocodile Valley, however, is a major area of sugarcane production. This area until recently has also been one of citrus cultivation and winter vegetable production. The area of cane production extends eastward as a long narrow belt from Kaapmuiden in the west, past Malelane and Hectorspruit to Komatipoort. It is confined to the south bank of the Crocodile River as this river here forms the southern boundary of the Kruger National Park. The main Johannesburg-Lourenço Marques railway line runs through the area, with the sugar mill to serve the region currently being built at Impala siding between Malelane and Hectorspruit.

In the east, sugarcane growing is also being undertaken adjacent to the Komati and Lomati Rivers, above the confluence of the Komati and Crocodile Rivers. On the Lomati River the area of cultivation extends into a region of higher rainfall in the hills south of Malelane, in the Kaalrug area.

A further relatively small area of sugarcane production is located in the valley of the Kaap River and some of its tributaries, south of Kaapmuiden.

Elevation in the sugar growing areas varies from some 500 ft. above sea-level in the east around Komatipoort, to about 2,500 ft. in the west at Schagen.

Climate

The climate of the region is important in that in addition to playing a major part in the determination of the types of soil that are found, it also is a factor of major agronomic significance. The region is one of summer rainfall characterised by relatively high temperatures but relatively low rainfall. Thus nearly all sugarcane in the region has to be irrigated. Temperatures generally increase eastwards but rainfall decreases. To the south, rainfall increases very markedly with altitude in the Swaziland mountain lands while temperatures correspondingly decrease.

The mean monthly distribution of temperatures at four localities in the region is given in Table I. In Table II is given the mean monthly distribution of rainfall at three localities, while in Table III is given the mean annual rainfall at a number of localities in the region. (Weather Bureau, 1954).

Table I

Mean Monthly Distribution of Temperature °C

Locality	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Nelspruit	23.7	23.8	22.8	20.8	17.8	15.2	15.0	17.0	19.3	21.3	22.3	23.4	20.2 (68.4°F)
Kaapmuiden	25.9	25.6	24.8	22.3	19.2	16.8	16.6	18.7	21.1	23.5	24.4	25.6	22.1 (71.8°F)
Hectorspruit	25.4	25.3	24.2	22.2	19.4	16.9	16.9	18.9	21.2	23.1	23.9	25.3	21.9 (71.4°F)
Komatipoort	26.9	26.6	25.7	23.7	20.3	17.3	17.5	19.8	22.1	24.3	25.2	26.8	23.8 (73.4°F)

Table II

Mean Monthly Distribution of Rainfall (mm.)

Locality	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Nelspruit	130	119	109	43	17	10	10	9	26	59	103	124	759 (29.8 ins.)
Kaalrug	171	156	147	59	14	13	17	6	36	69	123	146	957 (37.7 ins.)
Komatipoort . . .	131	114	114	38	17	7	10	8	19	45	88	93	684 (26.9 ins.)

Table III

Mean Annual Rainfall (mm.)

Schagen	786 (30.9 ins.)	Malelane	675 (26.6 ins.)
Kaapmuiden	667 (26.3 ins.)	Hectorspruit	569 (22.4 ins.)
Louw's Creek	704 (27.7 ins.)	Lomati	855 (33.7 ins.)

Vegetation

The natural vegetation of the region is typically that of the lowveld and comprises the "Lowveld-Type, (10)", of Acocks, (1953). It consists typically of open *Acacia nigrescens — Sclerocarya — Themeda* savannah. With increasing elevation and rainfall this gives way either to open parkland with tall well-spaced trees in tall grassveld, or else bushveld dotted with big trees. These constitute the "Lowveld Sour Bushveld, (11)", of Acocks, (1953).

Geology and Geomorphology

As is the case over much of Southern Africa, the geology and geomorphology of the region have had a very marked effect on soil formation. Therefore in the consideration of the soils of the region it is also necessary to pay some consideration to the geology and geomorphology of the area.

Oldest rocks in the region are those of the Swaziland System which are some 3,000 million years old, and which are therefore some of the oldest rocks on the earth. The System is subdivided into the Onverwacht Series consisting mainly of highly altered lavas, and the upper Fig-tree Series which consists mainly of altered shales. The Swaziland System is overlain by the Moodies System which comprises an alternating sequence of shales and quartzites. Associated with, but somewhat younger than these rocks, are the intrusive rocks of the Jamestown Igneous Complex. These consist mainly of altered lavas and comprise various types of basic schists, amphibolites, pyroxenites and serpentines. As will be discussed later, the rocks of the Jamestown Igneous Complex yield fairly extensive areas of characteristic soil in the region.

These ancient rocks are all highly folded and trend north-eastwards in a broad belt out of Swaziland towards Malelane, Hectorspruit and Oorsprong. Many horizons in these rocks, especially the quartzites of the Moodies System, because of their resistance to weathering, have given rise to the very hilly country south of Malelane, Kaapmuiden and Barberton. In this region the rocks stand almost vertically and hence there are narrow deep aligned valleys between the high-standing resistant hills. The basic schists and amphibolites of the Jamestown Igneous Complex, however, are not resistant to weathering and the Crocodile River has utilized this fact in determining its course between Kaapmuiden and Hectorspruit. The river in this sector flows roughly on the contact of these rocks with the granite to the north, and hence there is a relatively broad valley on the south bank of the river on these rocks. In addition to this main area of rocks of the Swaziland and Moodies Systems and the Jamestown Igneous Complex, another smaller area of these rocks trends eastward from beneath its covering of younger Transvaal System rocks in the west of the region, to the vicinity of Schagen. West of Schagen the Transvaal System rocks give rise to the very eroded face of the Great Escarpment.

Somewhat younger than the rocks of the Swaziland and Moodies Systems and the Jamestown Igneous Complex and intruded into it are a number of granites of slightly different types. Thus areas of coarse crystalline granite-gneiss occur very extensively around Nelspruit, west of Barberton, around Hectorspruit and south along the Lomati River. There are a number of types and ages of these granites. These types of granite usually weather quite readily forming lowlands. Another type of granite characteristically more basic and of the migmatite type occurs east of Nelspruit and extends northwards into the Kruger National Park. This granite gives rise to very rugged country because of its resistance to erosion. In places the granite-gneiss is much intruded by dykes of diabase.

Although in the west of the region rocks of the Transvaal System make the escarpment, the next youngest rocks in the area are the Karroo sandstones, some 150 million years old, which occur as a narrow north-south trending belt in the east of the region. The Karroo sandstones, of Ecca and Beaufort age do not have any marked effect on the topography but give rise to a number of rocky aligned ridges.

These sandstones are overlain in turn by the Stormberg lavas, some 100 million years old. These consist of a lower basalt member, and an upper andesitic rhyolite member. The basalt overlies the Karroo sandstones with the intervention of a narrow band of Cave sandstone, which usually gives rise to a quite prominent ridge. The basalt however, is readily weatherable and gives rise to a broad virtually featureless plain. The rhyolite by contrast is extremely resistant to weathering and thus gives rise to the Lebombo range north and south of Komatipoort.

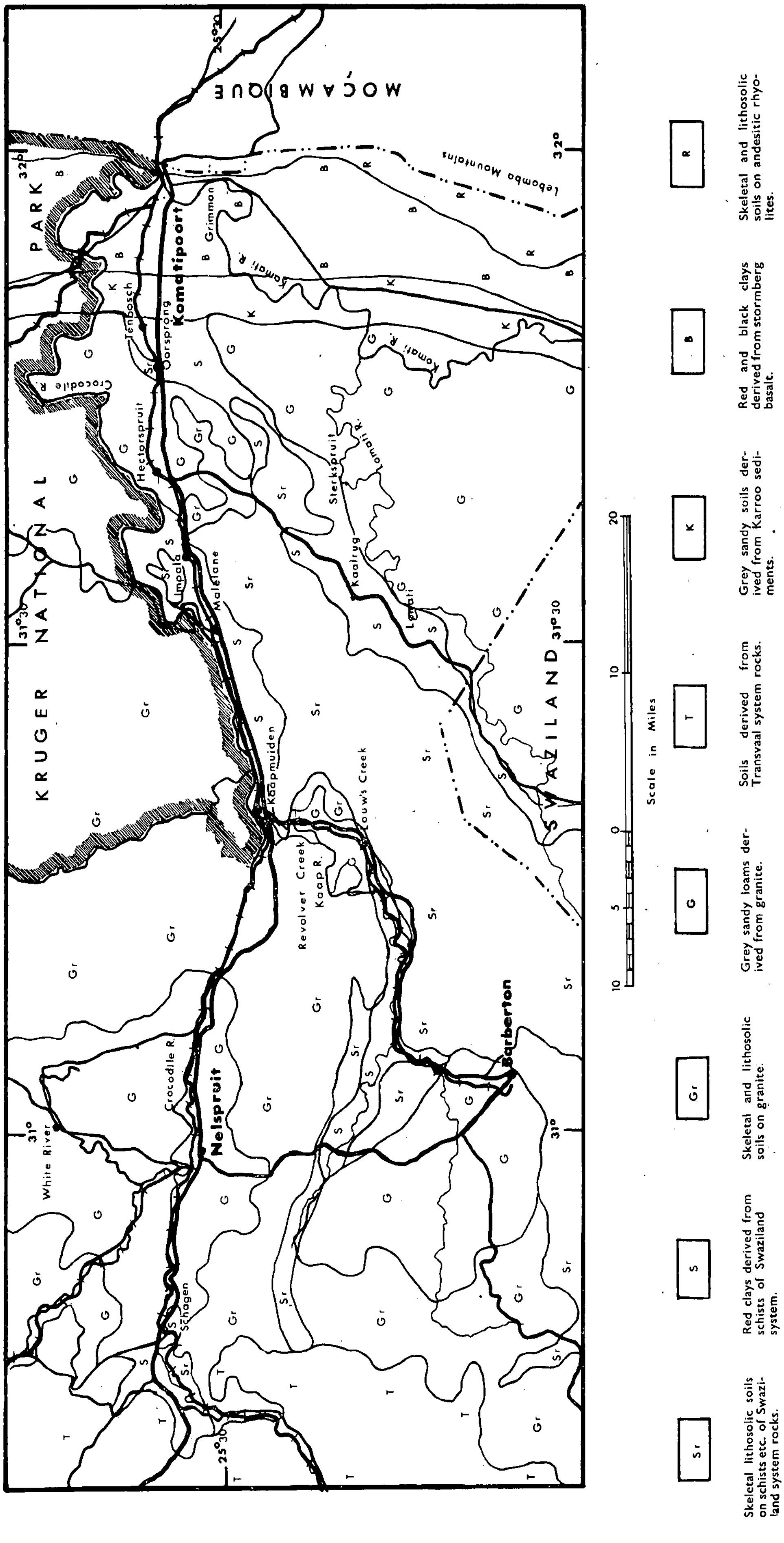

Fig. 1: Map showing the general distribution of soils around the Malelane - Komatipoort areas.

All these rocks of Karroo age and younger dip eastwards and the preferential weathering of the sandstones and basalt has given rise to the broad meridional lowland in the east of the region. This Lebombo structure very probably forms part of the Great Rift Valley system of Africa.

Erosion of the pre-existing rocks has been effected by the rivers of the region which have selectively removed and thereby lowered areas of the less resistant rock types. Much of this process has been achieved within the last 2 million years but it has not always been constant. It has been influenced by such things as climatic changes and the occurrence of areas of resistant rocks athwart the courses of the rivers which slows down erosion upstream temporarily. These periods of stillstand in the down cutting of the rivers are reflected in the terraces which flank the major rivers of the region. They are especially marked along the course of the Crocodile River in its lower valley. The alluvial soils deposited on these terraces have now largely been removed by erosion subsequently, but the continuing presence of abundant waterworn cobbles and gravel attest to their former widespread existence. The youngest terraces, however, survive as sandy alluvia in the immediate vicinities of the larger rivers. River terraces are best preserved in the relatively broad flat valley bottoms of the Crocodile, Komati and Lomati Rivers. In the narrow valley of the Kaap River, however, much of the older terraces has been lost and only the very youngest terraces survive to any extent.

Nature and Occurrence of Soils

Soils derived from basic schists and amphibolites

In the mountain lands formed by the rocks of the Swaziland System, soils are skeletal and lithosolic except in lower slopes and in the valley bottoms where they tend to be somewhat deeper. These soils tend to be reddish in colour and of sandy loam to loam texture for the most part. In a few localities, as in the tributary valleys of the Kaap River, above Louw's Creek, these soils are being cultivated for sugarcane.

Fairly extensive areas of reddish-brown clay soils developed on rocks of the Jamestown Igneous Complex occur along the south bank of the Crocodile River from Kaapmuiden past Malelane to about the vicinity of Impala siding where they give way to granite-derived soils. The depth of these soils varies considerably from a few inches to a number of feet. In general the depth of the soil increases towards the bottom of the valley. These soils may or may not have varying amounts of river-terrace gravel incorporated in them, usually as a stoneline above the weathering rock. In the immediate vicinity of the river, the soils become progressively sandier due to alluvial influence, and lime concretions may appear in the subsoil on lower slopes. The overall proportion of soils having these latter characteristics is, however, small.

These reddish brown clay soils are derived for the most part from the various basic schists and amphibolites of the Jamestown Igneous Complex. The serpentines occur as a narrow band along the foothills of the highlands on the southern margin of the valley and have very shallow lithosolic soils developed on them.

A further area of schist-derived soils occurs near Schagen but again much of this area is hilly with shallow soils, but deeper soils occur on the more moderate slopes.

Figure 1 is a generalised map of the region showing the distribution of the soils.

Particle size distribution and chemical characteristics of these schist-derived soils are given in Appendices 1 and 2.

Soil No. 1 is a very shallow soil, Soil No. 2, one of moderate depth and Soil No. 3 one of considerable depth, all from Mhlati section, Malelane. Soil No. 4 is a deep soil from near Schagen.

Consideration of the cation exchange data indicates that these are generally very fertile soils, although depth, of course, will be a limiting factor in some instances in their agronomic usage. It is of interest to note the slightly lower base status and pH of the soil from Schagen, probably the result of the slightly increased rainfall there.

This influence of increasing rainfall on the cation status of soils is also very well marked in the case of similar soils from the higher rainfall area of Kaalrug. Soil No. 5 is a very deep red soil derived from schists at Kaalrug and occurs on a middle-slope, while Soil No. 6 is a similar soil from a lower-slope at Lomati. The somewhat higher base status of this latter soil may be due either to the somewhat lower rainfall prevailing where it occurs than is the case at Kaalrug, or it may be that because of its position on a lower-slope it has not been leached to the same degree. In its physical characteristics however this soil resembles the more leached soils.

In spite of its lower base status the Kaalrug soil is nevertheless a moderately fertile soil.

Soils derived from granites

Extensive areas of soils derived from granite occur around Nelspruit and west of Barberton. Other areas of similar soils occur in the vicinity of Hectorspruit, the Lomati River near the Sterkspruit and in the Kaap River valley.

The soils derived from these granites are usually greyish brown to grey loamy sands and sandy loams. They are of variable depth but shallow soils with a depth of 18 inches or less predominate. In places sometimes because of long-continued irrigation, some of the granitic soils have developed marked hydromorphic characteristics. This may lead in time to the development of saline and alkali soils. In the neighbourhood of soils developed on the basic schists and amphibolites and the diabase dykes the granitic soils become more reddish-brown in colour due to migration of iron.

Soil No. 7 is a shallow granitic soil from Hectorspruit while Soil No. 8 is a similar soil from near the Sterkspruit. Soil No. 9 is a granite soil with marked hydromorphic characteristics from the Kaap River valley, while Soil No. 10 is a similar but deeper soil from near Schagen. Soil No. 11 is a soil developed on mixed granite-schist colluvium near Schagen.

The particle size distributions and chemical properties of a number of these granite-derived soils are again given in Appendices 1 and 2.

The cation exchange status of these soils reveals that they are considerably less fertile than the soils derived from schists and amphibolites. In general these granitic soils are only of moderate to low fertility. Nevertheless, with correct agronomic practice, these soils can be made to yield good crops.

Soils derived from Stormberg Basalts

Although a narrow area of Karroo sandstones occurs immediately to the west of the basalt in the east of the region, the soils developed on them are usually shallow and of little agronomic importance as it is unlikely that they will ever be cultivated to any extent. For this reason soils of this type have not been included in the present study.

The Stormberg basalt underlies a zone some eight to ten miles wide that trends north-south in the east of the region around Komatipoort. Soils developed on it are a characteristic assemblage of red, chocolate and black coloured clays. In places the soils have been influenced by former river terraces, and especially in the case of the red soils, may contain variable amounts of river terrace gravel.

Depths of these soils vary considerably, but the red soils tend to be rather shallow. Thus the average depth to the basalt saprolite at Tenbosch, north of Komatipoort is some 18 to 22 inches. The chocolate and black soils are usually somewhat deeper. Some of the red soils may contain nodular ironstone gravel in places, and in others may have diffuse calcium carbonate in the subsoil and weathering rock. The chocolate clays are intermediate between the red and black soils. The black clays if they are deeper than 3 ft. usually exhibit the phenomenon of "self-ploughing" or "self mulching". This is caused by the great activity of the clay mineral montmorillonite under conditions of varying moisture. In these soils lime concretions occur throughout the soil profile, but in the case of shallower black soils this is not always the case.

Intrusions of Karroo dolerite of the same age as the basalt into granitic areas to the west, as around the Sterkspruit, give rise to similar red, chocolate and black coloured clay soils.

The andesitic rhyolites which give rise to the Lebombo range, have for the most part only skeletal or very shallow soils developed on them because of the topography to which these rocks give rise. For this reason they are not cultivated.

In the appendices Soil No. 12 is a shallow red basaltic clay from Tenbosch, Soil No. 13 is a somewhat deeper similar soil from south of Komatipoort, Soil No. 14 is a chocolate coloured clay from the farm Grimman south of Komatipoort on the Komati River, whilst Soil No. 15 is a very heavy "self-mulching" clay from the same area. Soil No. 16 is a black clay derived from Karroo dolerite in the Sterkspruit area.

Consideration of the cation exchange status of all these soils reveals that they are very fertile, the black soils even more so than the red. This feature is offset, however, by the more undesirable physical properties of the black soils such as extreme plasticity when wet. The good base status of the red soils may also be offset to some degree by their tendency to shallowness.

Alluvial soils

Areas of alluvial soils are not reflected on the generalised soil map of the region because of their impersistence and relatively small areas of occurrence. It is not possible to delineate these soils at the scale of the map.

These alluvial soils are always located in the immediate vicinities of the larger rivers of the region and are usually a relatively narrow zone associated with the youngest of the river terraces. These alluvial soils are characteristicallly brown to reddish in colour and are deep and sandy. They may or may not exhibit depositional layering, sometimes with clayey horizons. In the valley of the Kaap River, however, there occur in places reddish brown more clayey alluvial soils associated with a slightly older river terrace, as well as the youngest sandy alluvia.

In the appendices Soil No. 17 is a sandy alluvial soil from near Hectorspruit, while Soil No. 18 is the more clayey alluvial soil from Revolver Creek in the Kaap valley.

The cation exchange status of the sandy alluvial soils tends to be low and hence these soils are ordinarily of low fertility. In the case of the clayey alluvial soil, however, the moderate to good base exchange status indicates that these soils are fertile.

Possible development of salinisation and alkalisation (brak)

As the soils of the region will all be irrigated in order to produce sugarcane, their tendency to salinisation with time as a result of irrigation has to be considered.

It is unlikely that any salinisation will be induced in the soils as a result of the quality of the applied irrigation water, as this is for the most part of very good quality containing only small amounts of dissolved salts. Of the soils occurring in the region the most susceptible to salinisation are undoubtedly those derived from granite. It is unlikely that under normal agronomic conditions these soils will become saline, but should in places there be consistent over-irrigation and lack of provision of drainage in these soils, salinisation will very likely occur. This will be more marked in the hydromorphic bottomland soils than those on slopes. It is very unlikely that salination would ever develop to any degree on any of the other soils of the area because of their cation status in some cases, and their drainage characteristics in others. Nevertheless even on these soils irrigation water should be controlled as far as possible by the lining of canals and accurate metering of irrigation applications. In addition adequate provision should be made for drainage where necessary.

Soil Series

More specific definition of the soils of the region than is possible on the broad genetic grouping is in terms of soil series. Soil series are defined in terms of the soil profile alone and are named after the locality where they are first described. All soils with similar profile characteristics are given the same series name. Soil series, however, may be modified by "phase" differences, which indicate that while the essential characteristics of the series remain, they may be modified by such features as depth, stoniness, etc.

In order to avoid duplication of series names for the same soil recognised in different places, in South Africa there has been adopted a system of registration of soil series. All soils have to be checked against the series register to ascertain whether similar soils have already been described and named. Only if a series' properties differ from those already registered can a new series be named and subsequently added to the register.

The register of South African soil series has been compiled by Macvicar, Loxton and van der Eyk (1965), and the characteristics of all series named thus far are contained therein. In addition in the sugar belt of Natal, the soil series occurring there have been described by Beater, (1957, 1959, 1962), many of the soils occurring there also having been included in the soil series register.

In the region under consideration, the red clay soils derived from the basic schists and amphibolites are referable for the most part to the Glendale series. The characteristic sand content of these soils serves to differentiate them from the seemingly similar soils developed on the Stormberg basalt. There are a number of phases of the Glendale series present in the region, including shallow, deep and stony phases. The shallow stony phase appears to predominate. The lower cation status of the Kaalrug upper and midslope soils resulting from the higher rainfall of this area, is however, more characteristic of the Bellevue series.

The major soil series of the granite-derived soils is the Glenrosa. This series is typically shallow. In places however, as on lower slopes, it may become deeper and sandier and it then assumes the characteristics of the Grovedale series. A hydromorphic soil developed on granite has not as yet been registered, but the Eldorado series of the sugar belt described by Beater (1959), does have hydromorphic characteristics. The shallow hydromorphic granite soils then can provisionally be assigned to this series. The deeper hydromorphic soil resembles in some respects the Grovedale series. No name has been established as yet for the soil developed on mixed granite-schist colluvium. In the present region the area of such soils is limited and consequently the introduction of a new name is not warranted until its occurrence elsewhere together with its characteristics have been proved.

The red clay developed on Stormberg basalt and dolerite is referable to the Shortlands series, for the most part the shallow phase. In the present region subsoils are non-calcareous as is typical of the Shortlands, but where calcium carbonate occurs in the lower profile a new series will have to be named if extensive areas of such a soil are proved to exist. The intermediate chocolate coloured clays are referable to the Kiora series, while the calcareous black clay belongs to the Arcadia series. Non-calcareous black clays are referable to the Rydalvale series. Waterlogged clayey calcareous bottomland and vlei soils belong to the Rensburg series.

Ordinarily alluvial soils because of their youth and absence of genuine profile development are not defined as soil series. In the Natal sugar belt, however, an alluvial soil exists which is sufficiently constant in characteristics and of widespread occurrence to warrant definition as the Shorrocks series. The sandy river terrace alluvial soils of the present region resemble the Shorrocks series to some degree but are not as red in colour and appear to be more sandy. Again, because of its seemingly limited occurrence the reddish clayey alluvial soil of the Kaap valley has not been ascribed a series name as a similar soil has not as yet been found to occur extensively elsewhere. Waterlogged acid alluvial and vlei soils are ascribed to the Katspruit series.

Because of the similarity of some of the soils of the present region with those occurring in and described from neighbouring Swaziland, mention is necessary about the correlation of similar soils from these two areas. Thus the Glendale series of the present area closely resembles the Lesibovu series of Swaziland (Murdoch and Andriesse, 1964), whilst the Bellevue has its counterpart in the Malkerns series of that territory. Similarly the Glenrosa series has as its equivalent the Otandweni series of Swaziland, whilst the hydromorphic Eldorado series is evidently paralleled by the Habelo series. Of the soils derived from basalt, the Shortlands series has as its equivalent the Rondspring series of Swaziland, the Kiora is paralleled by the Canterbury series, whilst the Arcadia has as its equivalent the Kwezi series. The sandy alluvial soil of the present area resembles the Bushbaby series of Swaziland, although the redder Shorrocks soils are referable to the Winn series described by Murdoch and Andriesse, (1964).

In summary, the soil series found thus far to occur in the region under consideration are:

Soils derived from basic schists and amphibolites, Glendale, (Bellevue).

Soils derived from granites, Glenrosa, Eldorado, (Grovedale).

Soils derived from Karroo dolerites and Stormberg basalt, Shortlands, Kiora, Arcadia, (Rydalvale).

Soils derived from alluvial sediments, (Shorrocks), (Katspruit), (Rensburg).

Physical Properties of the Soils

(Moisture Characteristics)

The moisture characteristics and bulk densities of the soils described from the region are given in Appendix 3.

Field capacity was determined on single undisturbed cores drained at 100 cms. tension. This value has been found to correspond very closely with field capacities determined in the field for most soils of the Natal sugar belt. Triplicate, disturbed samples were used for wilting point determinations in a pressure membrane apparatus. In Appendix 3, available moisture (ins./ft.) is given for each soil horizon, these values then being used on a *pro rata* basis to calculate the total available moisture in the first two feet of the soil profile. These figures do not constitute an inflexible guide in the determination of the actual amount of moisture available to the plant as rooting depth, for example, varies considerably in different soils. Thus in soil Nos. 3, 4, 5, 6, 10 and 17, rooting may take place to a depth in excess of 4 ft., whilst on shallower soils as Nos. 1, 7, 8 and 12, it may be little more than 1 ft.

Glendale series:—These soils have in general relatively high available moisture characteristics, although this is not the case in soil No. 1. Data from the first horizon only of this soil is presented as the stoniness of the underlying horizon precluded the taking of undisturbed samples. In the estimation of the total available moisture of this soil, however, data from disturbed samples were used as a guide.

Bellevue series:—These rather more weathered soils have a slightly lower available moisture status than do those of the Glendale series. This is marked in the case of soil No. 6 with its very high clay content in the second horizon. This high clay content together with the relatively high bulk density would probably restrict rooting depth to some extent in this soil.

Glenrosa series:—Soils of this series have generally lower available moisture characteristics than those described above. In the case of soil No. 7, undisturbed samples could not be taken from the second horizon of this profile because of its shallowness and hence the figure for total available moisture has been estimated from data for the disturbed soil. Because of considerations of effective rooting depth the available moisture in these soils of the Glenrosa series may in practice be less than the amount given in Appendix 3.

Eldorado and Grovedale series:—In the case of soils of these series the relatively high total available moisture value of 2.7 ins. per 2 ft. may have to be used with caution, bearing in mind the tendency of these soils to waterlogging.

Shortlands series:—These soils have in general relatively high available moisture characteristics. Again, shallowness of soil as in the case of soil No. 12 may be a limiting factor.

Kiora series:—The moisture properties of this soil are intermediate between those of the Shortlands and Arcadia series.

Arcadia series:—Soils of this series have very high available moisture characteristics due to their content of the clay mineral montmorillonite. As was the case with their very good cation exchange status, their high available moisture characteristics are offset by other undesirable physical properties.

Alluvial soils:—These soils naturally vary very widely in their characteristics both chemical as well as physical and the two examples included in this study provide some measure of the variability in the properties of these soils that may be expected. Consequently the application of the data given herein would have to be made with great caution in its extension to other alluvial soils.

Although the range in moisture characteristics of the soils of this region is considerable, provided cognisance is taken of soil depth and possible waterlogging in some soils, the data presented here should provide a reasonable guide for irrigation practice.

Conclusions

It has been shown that the soils of the region vary quite widely with regard to both their chemical and physical characteristics. The better soils can be expected to provide excellent crops of sugarcane in view of the climatic conditions that prevail. There is no reason, however, why the poorer soils with correct agronomic practice should not also yield very good crops of cane in the light of the results of the present investigation.

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Summary

The soils of the Malelane-Komatipoort region reflect very closely the geology of the area and vary considerably in their chemical and physical properties. Soil series have been established for the area and data with regard to the cation exchange status and moisture characteristics of these soils are presented with a view to their forming a general guide in agricultural practice.

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APPENDIX 1

PARTICLE SIZE DISTRIBUTION OF SOILS

No.	Soil Series	Description	Locality	Depth (ins.)	Percentage				Texture*
					Coarse sand	Fine sand	Silt	Clay	
1	Glendale	Shallow red schist	Malelane	0–6	12	21	18†	49	Clay
				6–16	12	18	13	57	Clay
2	Glendale	Moderate red schist	Malelane	0–9	10	30	14	46	Clay
				9–30	9	26	11	54	Clay
3	Glendale	Deep red schist	Malelane	0–9	6	23	17†	54	Clay
				9–20	4	15	9	72	Clay
				20–30+	4	10	10	76	Clay
4	Glendale	Deep red schist	Schagen	0–8	7	14	3	76	Clay
				8–19	6	11	12	71	Clay
				19–30+	35	33	7	25	Sandy clay loam
5	Bellevue	Deep red schist	Kaalrug	0–11	16	29	12	43	Clay
				11–32	11	24	9	56	Clay
				32+	11	21	18†	50	Clay
6	(Bellevue)	Deep red schist	Lomati	0–25	6	16	10	68	Clay
				25–40+	4	8	6	82	Clay
7	Glenrosa	Shallow grey granite	Hectorspruit	0–4	35	34	7	24	Sandy clay loam
				4–12	38	33	7	22	Sandy clay loam
				12–30	30	19	8	43	Sandy clay
8	Glenrosa	Shallow grey granite	Sterkspruit	0–9	38	46	5	11	Loamy sand
				9–21	33	53	11	4	Loamy sand
				21–29	35	49	7	9	Loamy sand
9	Eldorado	Hydromorphic grey granite	Revolver Creek	0–13	44	39	7	10	Sandy loam
		(shallow)		13–19	53	26	6	15	Sandy loam
10	(Grovedale)	Hydromorphic grey granite	Schagen	19–32	43	21	3	33	Sandy clay loam
		(deep)		0–9	33	46	6	15	Sandy loam
				9–20	32	47	5	16	Sandy loam
				20–26	34	42	7	17	Sandy loam
				26–35	43	43	6	8	Loamy sand
				35–52+	47	42	5	6	Loamy sand
11	—	Reddish mixed granite	Schagen	0–6	42	41	5	12	Sandy loam
		— schist		6–18	38	42	5	15	Sandy loam
				18+	33	49	7	11	Sandy loam
12	Shortlands	Shallow red basalt	Tenbosch	0–10	4	18	23†	55	Clay
				10–22	4	18	13	65	Clay
13	Shortlands	Moderate red basalt	Komatipoort	0–9	4	16	13	67	Clay
				9–15	4	12	11	73	Clay
				15–25	8	12	12	68	Clay
14	Kiora	Chocolate basalt	Grimman	0–10	10	19	19†	52	Clay
				10–22	7	17	15†	61	Clay
				22+	13	16	15†	56	Clay
15	Arcadia	Black basalt	Grimman	0–12	3	14	11	72	Clay
				12–30+	4	12	4	80	Clay
16	Arcadia	Black dolerite	Sterkspruit	0–15	5	13	9	73	Clay
				15–30	9	14	24†	53	Clay
				30–44	4	10	8	78	Clay
				44–60+	4	13	7	76	Clay
17	—	Brown sandy alluvial	Hectorspruit	0–9	17	63	6	14	Sandy loam
				9–29	18	65	10	8	Loamy sand
				29–60	16	63	9	12	Sandy loam
				60+	15	67	9	9	Sandy loam
18	—	Reddish clayey alluvial	Revolver Creek	0–8	21	26	9	44	Clay
				8–18	32	22	9	37	Sandy clay
				18–33	37	24	3	36	Sandy clay
				33+	44	24	3	29	Sandy clay loam

*Textures from diagram of Loxton, (1961). †High silt figure probably due to incomplete dispersion.

APPENDIX 2

CHEMICAL CHARACTERISTICS OF SOILS

No.	Soil Series	Description	Locality	Depth (ins.)	Exchangeable Cations m.e.q. %					Per-cent-age Base Satu-ration	pH 1:25 H_2O
					K	Na	Ca	Mg	Cation Ex-change Capa-city		
1	Glendale	Shallow red schist	Malelane	0–6	0.32	0.83	24.00	9.44	23.32	100	7.7
				6–16	0.22	0.41	13.50	10.28	28.96	84	7.4
2	Glendale	Moderate red schist	Malelane	0–9	0.29	0.38	11.50	7.52	18.07	100	6.9
				9–30	0.63	0.44	9.50	7.22	17.57	100	6.8
3	Glendale	Deep red schist	Malelane	0–9	0.78	0.78	10.50	6.78	18.18	100	6.3
				9–20	0.26	1.26	9.50	10.28	24.14	88	7.3
				20–30+	0.25	1.35	22.50	14.44	25.18	100	7.9
4	Glendale	Deep red schist	Schagen	0–8	0.15	0.28	15.50	7.37	25.96	90	6.6
				8–19	0.20	0.34	14.50	6.99	23.29	95	6.6
				19–30	0.21	0.38	12.00	7.52	22.00	91	6.9
5	Bellevue	Deep red schist	Kaalrug	0–11	0.25	0.24	1.80	3.29	10.43	54	6.0
				11–32	0.12	0.19	0.60	1.85	7.54	37	5.5
				32+	0.12	0.33	0.65	1.85	6.29	47	5.4
6	(Bellevue)	Deep red schist	Lomati	0–25	0.50	0.38	12.50	5.30	20.06	93	6.0
				25–40+	0.10	0.29	6.00	4.48	18.43	59	6.1
7	Glenrosa	Shallow grey granite	Hectorspruit	0–4	0.45	0.23	5.50	2.89	11:07	82	5.9
				4–12	0.36	0.35	10.25	2.71	10.86	100	6.1
				12–30	0.18	0.42	6.00	4.65	14.32	79	5.7
8	Glenrosa	Shallow grey granite	Sterkspruit	0–9	0.36	0.18	1.80	1.20	5.09	70	6.3
				9–21	0.41	0.40	4.70	3.59	4.06	100	5.8
				21–30	0.10	0.20	1.20	1.35	3.43	83	5.8
9	Eldorado	Hydromorphic grey granite (shallow)	Revolver Creek	0–13	0.54	0.23	2.70	1.85	6.54	81	7.4
				13–19	0.32	0.27	2.10	2.43	7.46	69	8.0
				19–32	0.49	1.30	5.00	5.16	11.86	100	7.4
10	(Grovedale)	Hydromorphic grey granite (deep)	Schagen	0–9	0.14	0.14	1.20	0.58	4.93	42	5.2
				9–20	0.10	0.20	1.35	0.66	3.57	65	5.6
				20–26	0.08	0.23	1.70	0.84	7.79	36	6.0
				26–35	0.04	0.10	0.60	0.36	1.59	69	6.1
				35–52	0.04	0.08	0.50	0.36	0.84	100	7.3
11	—	Reddish mixed granite — schist	Schagen	0–6	0.18	0.10	1.60	0.90	3.59	77	6.6
				6–18	0.09	0.19	1.30	0.44	3.25	62	6.5
				18+	0.05	0.13	2.13	1.44	4.18	90	7.3
12	Shortlands	Shallow red basalt	Tenbosch	0–10	0.84	0.41	16.50	4.11	23.57	93	7.0
				10–22	0.49	1.00	13.00	5.16	27.46	72	7.5
13	Shortlands	Moderate red basalt	Komatipoort	0–9	0.63	0.26	8.50	4.32	31.00	44	5.1
				9–15	0.20	0.85	12.00	8.06	29.43	72	5.3
				15–25	0.19	1.22	15.00	8.47	29.54	84	6.1
14	Kiora	Chocolate basalt	Grimman	0–10	0.23	1.09	18.00	8.72	38.04	74	6.6
				10–22	0.18	1.61	19.50	9.67	37.50	83	6.7
				22+	0.15	2.22	27.00	10.51	36.36	100	7.5
15	Arcadia	Black basalt	Grimman	0–12	0.43	1.57	36.00	17.43	56.10	99	7.9
				12–30+	0.31	2.26	37.00	19.34	61.00	97	7.7
16	Arcadia	Black dolerite	Sterkspruit	0–15	0.32	0.78	16.00	21.02	55.39	69	5.8
				15–30	0.18	0.78	14.00	21.88	56.86	65	6.2
				30–44	0.22	1.07	19.50	18.22	58.89	66	6.6
				44–60	0.19	1.22	24.50	18.55	50.61	88	8.0
17	—	Brown sandy alluvial	Hectorspruit	0–9	0.54	0.21	10.00	1.61	7.68	100	7.9
				9–29	0.27	0.36	17.50	1.56	5.79	100	8.0
				29–60	0.16	0.30	16.00	1.20	7.29	100	8.0
				60+	0.13	0.30	10.25	1.56	5.91	100	8.5
18	—	Reddish clayey alluvial	Revolver Creek	0–8	0.13	0.14	1.50	0.84	14.68	18	6.8
				8–18	0.24	0.40	7.50	4.50	14.57	87	6.3
				18–33	0.29	0.78	12.50	3.90	13.57	100	7.0
				33+	0.29	0.83	8.50	3.06	11.50	100	7.3

APPENDIX 3

SOIL MOISTURE CHARACTERISTICS

No.	Soil Series	Description	Locality	Depth (ins.)	F.C. %	W.P. %	B.D. (g/cc.)	A.M. (ins. /ft.)	T.A.M.* (ins/2ft surface)	Texture
1	Glendale	Shallow red schist	Malelane	0–6	20.2	13.4	1.44	1.2	2.4	Clay
2	Glendale	Moderate red schist	Malelane	0–9	23.2	13.1	1.42	1.7		Clay
				9–30	24.3	16.3	1.45	1.4	3.0	Clay
3	Glendale	Deep red schist	Malelane	0–9	28.4	16.1	1.33	2.0		Clay
				9–20	29.3	19.0	1.39	1.7	3.6	Clay
4	Glendale	Deep red schist	Schagen	0–8	31.7	19.6	1.31	1.9		Clay
				8–19	32.6	22.4	1.29	1.6	3.4	Clay
5	Bellevue	Deep red schist	Kaalrug	0–11	20.2	10.8	1.42	1.6		Clay
				11–32	24.3	13.5	1.23	1.6	3.2	Clay
6	(Bellevue)	Deep red schist	Lomati	0–25	27.8	18.1	1.28	1.5		Clay
				25–40+	29.9	23.1	1.31	1.1	3.0	Clay
7	Glenrosa	Shallow grey granite	Hectorspruit	4–12	12.4	7.7	1.77	1.0	2.0	Sandy clay loam
8	Glenrosa	Shallow grey granite	Sterkspruit	0–9	11.3	2.1	1.50	1.7		Loamy sand
				9–21	10.8	3.0	1.44	1.4	3.0	Loamy sand
9	Eldorado	Hydromorphic grey granite (Shallow)	Revolver Creek	0–13	11.9	3.4	1.49	1.5		Sandy loam
				13–19	9.6	3.6	1.47	1.2	2.7	Sandy loam
10	(Grovedale)	Hydromorphic grey granite (Deep)	Schagen	0–9	12.4	4.5	1.46	1.4		Sandy loam
				9–20	11.4	4.9	1.66	1.3	2.7	Sandy loam
11		Reddish mixed granite-schist	Schagen	0–6	10.1	3.9	1.56	1.2		Sandy loam
				6–18	10.2	3.4	1.48	1.2	2.4	Sandy loam
12	Shortlands	Shallow red basalt	Tenbosch	0–10	34.4	19.5	1.14	2.0		Clay
				10–22	32.3	20.4	1.16	1.7	3.7	Clay
13	Shortlands	Moderate red basalt	Komatipoort	0–9	30.6	20.6	1.22	1.5		Clay
				9–15	30.0	20.9	1.27	1.4	2.9	Clay
14	Kiora	Chocolate basalt	Grimman	0–10	32.2	19.8	1.25	1.9		Clay
				10–22	34.2	23.0	1.24	1.7	3.5	Clay
15	Arcadia	Black basalt	Grimman	0–12	47.0	28.9	1.20	2.6		Clay
				12–30+	46.7	31.6	1.16	2.1	4.7	Clay
16	Arcadia	Black dolerite	Sterkspruit	0–15	47.6	27.9	0.99	2.4		Clay
				15–30	49.4	32.3	1.06	2.2	4.6	Clay
17		Brown sandy alluvial	Hectorspruit	0–9	14.2	5.5	1.45	1.5		Sandy loam
				9–29	14.4	4.3	1.45	1.8	3.3	Loamy sand
18		Reddish clayey alluvial	Revolver Creek	0–8	16.9	11.6	1.57	1.0		Clay
				8–18	18.6	11.2	1.63	1.4	2.6	Sandy clay

F.C. = Field Capacity. W.P. = Wilting point. B.D. = Bulk density. A.M. = Available moisture.

*Total available moisture in surface 2 ft. of soil. *N.B.* Allowance must be made in regard to depth of shallow soils in the application of these figures.

Mr. Halse: I understand that cane is growing very well on gravelly basalt soils in Swaziland although you say that this would not be the case on the Transvaal soils.

Dr. Maud: At Ubombo Ranches in Swaziland the pebbles and gravel comprise mainly weathered and porous basalt whereas the Transvaal soils contain very hard, unweathered and non-porous gravels.

Mr. Turck: At Ubombo Ranches the gravels are of weathered basalt and the underlying rock is also porous.

Mr. von der Meden: We did not suggest that cane would not grow well on these stony Transvaal soils, but rather that rooting will be restricted to a degree and total available moisture appreciably reduced.