REVISED CLASSIFICATION OF THE SOILS OF BELIZE

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Summaries

SUMMARY

The soil classification of Belize is revised and updated, starting from the system devised for 'Land in British Honduras' by A. C. S. Wright and his colleagues in the 1950s, the only previous country-wide survey of soils and land resources. The revised classification is a three-tiered system consisting of soil suites, subsuites and series. The suites are based on rock type, and the subsuites on soil profile characteristics. The main groups of soils, the soil suites, and the soil subsuites are described separately at progressively increasing levels of detail. There are insufficient data to describe soil series as yet, but guidelines for the definition and naming of new series are indicated. The classes of the revised system are correlated with all of the soil classifications previously used in Belize, and with the two main international systems of soil classification. Important chemical features of the main soil groups are summarized and compared. The comparisons vindicate the revised classification.

RESUMEN

La clasificación de suelos de Belice es revisada y actualizada aparte del diseñado sistema por el trabajo hecho por A.C.S. Wright y sus colegas y llamadó 'Land in British Honduras' en el año de los 1950s, el único estudio previo de suelos y recursos terrenales en todo el paí. La clasificación revisada es un sistema de tres nivels consistiendo de serie de suelos, subseries, y nivels. Las series son basadas en el tipo de roca, y los subseries segun las características del perfil de los suelos. Los grupos principales de suelos, las series, y los subseries de tierra se describen separadamente, aumentando progresivaments niveles de detalle. Aúu existe información insuficiente para describir las series de suelos, pero el guía para la definición y nombramiento de nuevas series se indican. Las clases del sistema revisadas se correlaciona con toda las clasificación de suelos previamente usadas en Belice, y con dos sistemas internacionales principales de clasificación de suelos. Las características quimicas importantes de los grupos principales del suelo se sumarisan y se comparan. Las comparaciones vindican la clasificación revisada.

Part 1

Introduction

PROJECT BACKGROUND

Since 1986 the Natural Resources Institute (NRI), and its predecessors in the Overseas Development Administration (ODA) of the UK Government, has carried out a series of land resource assessments (LRA) at the request of the Government of Belize. These have been done as three self-contained projects, each reported separately:

1986	Toledo District	(King *et al.*, 1986)
1988	Stann Creek District	(King *et al.*, 1989)
1989-90	Northern Belize	(King *et al.*, 1992)

The assessments have been multidisciplinary, taking account of demographic, social, economic and institutional aspects of agricultural development as well as physical land resources.

Although the projects were organized separately, with considerable intervening gaps, the team involved with the assessment of the physical aspects of land resources has remained unchanged virtually throughout:

R. B. King	Geomorphology, remote sensing and team leader
A. C. S. Wright	Soils agriculture and land-use advisor
M. A. Holder	Formerly Government of Belize counterpart, latterly soils and agricultural advisor
I. C. Baillie	Soil surveyor
J. Chen	Farming advisor, field ecologist and field assistant.

They were joined by E. A. FitzPatrick, soil classification consultant, for this revision project in 1991. Despite the continuity of personnel and general field methods, there were inevitably some changes in approach as the projects progressed and knowledge accrued. Soil classification was one of the areas where a number of inconsistencies and anomalies crept in, to the extent that there are several mentions in the Northern Belize LRA report (King *et al.*, 1992) of the need for a revision and rationalization of the Belizean system of soil classification. The current project was therefore set up by the British Development Division in the Caribbean and the Government of Belize to meet that need. It was run in conjunction with projects to review rural physical planning (King *et al.*, 1993) and to prepare a general and accessible account of the land resources of Belize (Wright *et al.*, 1993).

PROJECT AIMS

This project aims to:

(i) Revise, rationalize and simplify the system of soil classification in Belize down to subsuite level

(ii) Correlate the revised system with earlier Belizean classifications, and with the international systems of soil classification

(iii) Summarize the morphological and chemical features of the main soils of Belize.

PRINCIPLES AND ASSUMPTIONS

The revision starts from the following principles and assumptions:

(i) The revised system is basically a simplification and update of the classification of Belizean soils formulated by Wright *et al.* (1959) in the only previous country-wide survey of land resources. The system has worked well, and many of the more important soil names are widely used by agriculturalists and farmers.

(ii) Where possible, the soil classes and names formulated in the semi-detailed soil survey of the Belize Valley, covering about one-seventh of the country (Jenkin *et al.*, 1976; Birchall and Jenkin, 1979), have been accommodated.

(iii) The adoption and development of a local system implies that neither of the international systems - the 'Soil Taxonomy' of the US Department of Agriculture (USDA, 1975; SMSS, 1990) nor the 'Legend of the Soil Map of the World' (FAO/UNESCO 1974; 1988) - has been used as the basis for Belizean soil classification. They are both difficult to apply in Belize, as is discussed further in Part 7, which also contains full correlations of the local soil classes with the international systems. However, for the benefit of readers familiar with the international systems but not with Belize, the approximate FAO/UNESCO and Soil Taxonomy equivalents of the soil suites and subsuites are given in the descriptions in Parts 3 and 4.

(iv) The revised system permits a degree of flexibility for additions and developments in the future. In particular the classes are defined in terms of their central concepts rather than by interclass boundaries.

(v) At all levels the classes are, as far as possible, defined in terms of morphological features or environmental and ecological relationships that are apparent in the field. It is rarely necessary to have laboratory data to assign a soil to a class in the revised system.

STRUCTURE AND PRESENTATION OF THE SYSTEM

The revised classification is a three-tiered hierarchical system of suite-subsuite-series. The first two levels more or less correspond with the suites and subsuites of Wright *et al.* (1959), who adapted the New Zealand approach (Taylor and Pohlen, 1962) to Belizean conditions.

The suites are defined mainly in terms of the parent materials. This is appropriate in geomorphologically active landscapes like Belize, where landform and hence drainage and hydrology are greatly influenced by the lithology of the regolith. It also affects the mineralogy and nutrient status of the soils, and hence the vegetation. In addition to the main lithological groups, the soils overlying limestone are divided into a number of suites on the basis of the age of the rocks. This was originally done in order to divide up a large group of soils that spanned wide geographical, climatic and ecological ranges. Parent material age was therefore acting as an indicator for a number of other important pedogenic factors. The soil analyses later indicated that the different limestones are also geochemically distinct and give rise to soils with characteristic chemical properties and nutrient status (see Part 8).

The soil subsuites are differentiated on morphological characteristics, environmental setting and ecological relationships. Some subsuites encompass considerable variation. For instance the clays overlying limestone are separated into subsuites primarily on the basis of colour. This is usually associated with a range of chemical, physical and biological properties, but it does mean that a single subsuite can range from shallow soils on interfluves to deep cracking clays on the margins of swamps.

The classes of the third level, the soil series, are also defined on morphology and ecological relationships. They are relatively homogeneous in terms of their morphological and chemical properties and should be amenable to uniform soil management.

In this report the classes are defined and described only down to soil subsuite level. The soils are presented in stages of successively increasing detail. Part 2 describes nine main soil groups in Belize in fairly general terms. These are physiographic groups of soils rather than profile types. Part 3 outlines the soil suites and Part 4 the soil subsuites. The detail and assumed familiarity with pedological concepts and terminology increases at each stage. This incremental presentation permits the reader to progress through to the level of detail required, and not to be bogged down by unwanted complexity at an early stage.

No attempt is made to define or describe soil series. There are likely to be several hundred of these but they will be clarified only when many more detailed (at mapping scales of 1:25 000 or greater) soil surveys have been conducted in different parts of the country. However the general considerations and procedures for defining and naming new series are discussed in Part 5.

Part 2

Main soil types of Belize

INTRODUCTION

For general purposes and for those not interested in the technical intricacies of the full classification, the soils of Belize can be grouped into nine categories as listed in Table 1. These correspond roughly with land regions or important groups of land systems in the recent land resource assessments (King *et al.*, 1986, 1989, 1992).

This generalized division describes the main soils in physiographic groups. More details of soil variations that are important for agriculture and other land uses are included in the descriptions of the soil suites, subsuites and series in Parts 3 to 5.

Table 1 The main soil types of Belize

Category	Soil type/group
1	Soils of the Maya Mountains (a) Soils of the Mountain Pine Plateau (b) Soils of the rugged land systems
2	Clays of the limestone uplands and foothills
3	Grey and brown soils of the Toledo Beds
4	Pine ridge soils of the coastal plain
5	Dark limestone soils of the Northern Coastal Plain
6	Reddish limestone clays of the Northern Coastal Plain
7	Swamp soils
8	Young soils on river alluvium
9	Young coastal soils

SOILS OF THE MAYA MOUNTAINS

Soils of the Mountain Pine Plateau

The Maya Mountains form the geological and topographic core of the country. They consist of fairly hard Paleozoic metamorphic and volcanic rocks, into which a number of granitic bodies have been intruded. The granites form a considerable part of the Mountain Pine Plateau. This is thought to be a relatively old landscape, and the soils appear to have been weathered and leached for a long period, although they are not especially deep by tropical standards. Beneath a darkish topsoil they are normally brightly coloured, ranging from yellow to red, grading into yellow, grey and pinkish weathering granite. They vary in texture from sandy loam to sandy clay but invariably contain angular quartz grit. They are acid and have very low contents of available plant nutrients. There are also some soils derived from metamorphic rocks in the Mountain Pine Plateau. They resemble the granitic soils in the bright reddish and yellow colours, acidity and low contents of plant nutrients, but lack the quartz grit and often have subsoil layers of ironstone gravel. They mostly occur on the steeper and higher ground in the east and south of the area. They tend to be shallower than the granitic soils, often with hard rock within a metre of the surface.

Soils of the rugged land systems

The rest of the Maya Mountains consist of steep slopes covered with various kinds of broadleaf forest. The soils are mostly derived from metamorphic rocks and are shallow and stony. They vary in colour from grey, brown and yellow to red. Textures range from stony sand loam to clay. Despite the shallowness and apparent youth of the soils, they are acid and leached with few available plant nutrients. There are a number of rolling basins in the mountains formed on granite. Their soils tend to be deeper, but are also of variable colour, acid and leached of nutrients.

CLAYS OF THE LIMESTONE UPLANDS AND FOOT-HILLS

Except on the east, the mass of metamorphic and granitic rocks forming the Maya Mountains are flanked by hills of Cretaceous limestone. Much of the topography is karstic with towers, cliffs, sinkholes, caves, underground rivers and little surface water. The soils are formed from the relatively few impurities left when the limestone dissolves. They are generally shallow and stony, black or very dark clays, but there are also brown and reddish clays. In some of the bigger interkarstic basins hillwash clay accumulates, giving deep soils with dark cracking tops and plastic yellowish clay subsoils. All of these limestone soils are of slightly acid reaction and well supplied with calcium and magnesium, but the contents of other nutrients are often only moderate.

SOILS OF THE TOLEDO BEDS

South of the limestone foothills Toledo district is mostly underlain by the relatively flat-bedded mudstones and siltstones with minor sandstones and limestones. In the rolling landscape of the Toledo Uplands and the coastal lowlands these rocks give rise to a range of brown, grey and sometimes red soils. They are generally rather shallow, but deeper and redder soils occur in the south and west. Most of these soils are clays, but they are mostly fairly well drained. Because of the thin limestone bands in the rock, the soils are moderately well supplied with calcium and magnesium, and are only moderately acid.

PINE RIDGE SOILS OF THE COASTAL PLAIN

The plain of the coastal pine ridge stretches from Deep River in Toledo District to Tower Hill in Orange Walk District. It is a striking feature of the Belize lowlands, with characteristic pine savanna and woodland vegetation. The soils are also quite distinctive. The most prominent feature is the brightly mottled red and white sandy clay subsoil, known locally as 'corned beef'. This has formed in coastal alluvium, laid down several million years ago. The topsoil is usually much sandier and paler, but yellowish colours and loamy textures also occur. These soils are acid and have extremely low contents of plant nutrients, and are even less fertile than those of the Mountain Pine Plateau. They impose extreme moisture regimes on their vegetation, with the sandy topsoils alternating between droughtiness in the dry season, and prolonged periods of saturation in the wet season, due to the low permeability of the underlying 'corned beef'. This combination of disadvantages makes the natural vegetation rather sparse and susceptible to fire. Repeated burning appears to be an important factor in maintaining the open savanna of the lowland pine ridge.

DARK LIMESTONE SOILS OF THE NORTHERN COASTAL PLAIN

Most of Belize north of the Maya Mountains is underlain by limestones that get progressively younger northwards. The main soils are black and very dark grey clays which crack and crumble when dry. Many of these are quite shallow but deeper soils are found close to swamp margins. In places where there is sand in the limestone or a sandy deposit overlying it, the soils appear similarly dark but have coarser textures and crack less. All of these dark soils are neutral or alkaline and are well supplied with calcium and magnesium, and some of them also have moderate potassium and phosphorus supplies.

REDDISH LIMESTONE CLAYS OF THE NORTHERN COASTAL PLAIN

There are considerable areas of red and brown clays over limestone around Corozal town, east of Progesso Lagoon and in the Hill Bank-Gallon Jug area. They tend to be quite shallow and stony, and crack when dry, but not as much as the dark clays. They are neutral or alkaline and well supplied with calcium and magnesium. The availability of nitrogen and phosphorus is lower than in the dark soils.

SWAMP SOILS

The soils of swamps are wet for all or part of the year but are otherwise quite varied. Those near the coasts tend to be flooded with saline or brackish water and often support mangroves. Those inland are mostly flooded with fresh water and carry a variety of swamp forest and herbaceous communities. Textures vary from coarse sand to heavy clay. Colours tend to be grey, sometimes with rust brown mottling. Because the flooding and poor aeration inhibit the decomposition of plant litter, these soils often accumulate wet organic matter on the surface, sometimes deep enough to be classified as peat.

RIVERINE ALLUVIAL SOILS

Some of the most fertile and manageable soils in the country are formed in the alluvial deposits of the main rivers. These are most extensive in the centre of the country, from the Belize River southwards to Monkey River, but there are also floodplains along the rivers in Toledo District. The soils of the lowest and most recent deposits are young, and are little leached or weathered. They are grey, brown yellow or red in colour, and may be wet at depths of a metre or more. They are well supplied with plant nutrients from the weathering of the fresh minerals, and also from periodic augmentation by floods. The terraces that flank the sides of some of the main valleys are formed in deposits laid down when the river flowed at higher levels than now. The deposits have been left behind by subsequent drops in river level and are no longer replenished by flooding, so the soils are older than those on the lower and more recent floodplains. They are more weathered and reddish in colour, more leached and acid, and less well supplied with plant nutrients. Although needing lime and fertilizers, they are still productive and flexible soils, and are favoured by the citrus industry.

YOUNG COASTAL SOILS

Many of the soils on young marine deposits along the coast are poorly drained and wet, and are included with the swamp soils. However there are also drier deposits that have weakly developed soils, which vary accordingly to the source of the material and its mode of deposition. The beach sands in the north are calcareous, comprised of fragments of limestone, coral and modern shells. Further south, the Maya Mountains are the main source of sand, so that the beaches are mainly quartz sand. Also included in this group of soils are the thin, raw sand and mud deposits over recently emerged coral.

Part 3

Soil suites

INTRODUCTION

The soil suites are the highest category in the three-tiered classification. Except for the wet soils in swamps, they are differentiated mainly on the lithology or age of the parent materials. Problems in the use of parent materials as criteria for differentiation include:

(i) Difficulties of recognition due to the obliteration of parent material by deep and intense weathering. Fortunately this is rare in Belize.

(ii) The distinction of limestones of different ages. This is achieved mainly by reference to the most recent geological maps (Cornec, 1985).

(iii) Difficulties in classifying soils formed in layered, polysequent parent materials. Where a particular combination is sufficiently widespread, it can be taken out as a separate parent material type. For instance, the sequence of sand over Tertiary/Pleistocene 'corned beef' alluvium is taken as the parent material for Puletan Suite, and sand overlying calcareous material is taken as the parent material of Revenge Suite. For less common combinations of layered parent materials, soils are assigned to suites in the following way:

- When the upper layer is more than 1 m thick, it is assumed to be the greatly dominant component of the parent material and the soil is placed in its corresponding suite.

- When the upper layer is less than 30 cm thick, it is assumed to be only a minor influence, and the soil is assigned to the suite corresponding to the underlying material. The influence of the surface material can be recognized at series level.

- When the upper layer is between 30 and 100 cm thick, it determines the suite of the soil, but the important influence of the underlying material is recognized by setting up a separate subsuite, e.g. Sennis Subsuite is assigned to Melinda Suite in Tables 2 and 17 because of the 30-100 cm overlay of fresh, fertile riverine alluvium. However the infertile underlying Tertiary/Pleistocene 'corned beef' alluvium is recognized as being important in the ecological relationships and agricultural potential of the soils - sufficient to warrant differentiation at subsuite level.

- There are also soils formed in compound materials which have been intimately mixed rather than layered. This is particularly evident in contact areas between calcareous and siliceous rocks. Because of the solution of the limestone, the bulk of the residual mineral material is siliceous, but the limestone greatly affects the composition of the soil solution and the general chemical ambience for weathering and pedogenesis. These soils are normally placed in the suite determined by the siliceous component but the calcareous influence is recognized at subsuite or series level. For example, the bulk of the parent material on the flanks of the Grano de Oro Hills is derived from the metasediments and the soils are assigned to Ossory Suite. However their properties are considerably affected by the proximity of the limestone, warranting separation as Granodoro and Machiquila Subsuites.

Table 2 Soil suites of Belize

Suite	Parent material	General characteristics and distribution	Previous LRA suites incorporated	Component subsuites	Table number for subsuite details
Ossory	Santa Rosa metasediments	Red and yellow leached soils in Maya Mountains; many shallow and stony	-	Cabbage Haul Curassow Pippen Borrowpit Cooma Baldy Granodoro Machiquila	3
Richardson	Bladen volcanics	Red and yellow; very acid and leached soils on main divide of Maya Mountains	-	Doyle Ramos	4
Stopper	Granite	Red, yellow and grey gritty loams and clays of rolling and rugged basins in Maya Mountains, and granitic outwash deposits in foothills	Parts of Hiccattee	Silkgrass Powder Hill Mayflower Canada Hill Pinol	5
Toledo	Toledo Beds clastic sediments	Brown grey and reddish clays and loams in uplands and coastal low-lands of Toledo District	Jacinto, Parts of Hiccattee	Cimin Aguacate Temash Machaca Jacinto	6
Chacalte	Cretaceous limestone	Shallow and stony dark slightly acid clays, with some brownish and reddish; in karstic foothills flanking Maya Mountains	Vaca	Cabro Xpicilha Cuxu	7, 8
Yaxa	Early Tertiary limestone	Dark and reddish neutral clays in N Cayo and Belize, S Orange Walk Districts	-	Yalbac Jolja Chacluum	7, 9
Pembroke	Late Tertiary limestone	Dark and reddish alkaline clays of N Orange Walk and Corozal Districts	-	Louisville Xaibe	7, 10
Guinea Grass	Siliceous Late Tertiary limestone	Dark loamy and sandy soils of N Orange Walk District	-	Lazaro Pixoy	7, 11
Altun Ha	Late Tertiary flinty limestone	Flinty dark and brownish loams and clays of Old Northern Highway area	-	Jobo Rockstone	7, 12
Bahia	Pleistocene limestone	Shallow clay over coastal coral, and clays and mucks over coastal gypsiferous limestone	-	Consejo Remate	13
Revenge	Sand over Late Tertiary limestone	Pale sand over sticky and mottled sandy clay and clay over limestone	-	Felipe Tok	14
Puletan	Tertiary - Pleistocene coastal alluvium, possibly with later sandy wash	Pale coloured sands or loams over acid and impermeable brightly mottled 'corned beef' sandy clay-clay	Parts of Hiccattee	Crooked Tree Boom Bladen Ben Lomond Haciapina Buttonwood	15

Suite	Parent material	General characteristics and distribution	Previous LRA suites incorporated	Component subsuites	Table number for subsuite details
Tintal	Poorly drained alluvium and hillwash	Poorly drained grey mottled loams, clays and peats of swamps	Caway	Sibal Ycacos Pucte Chucum	16
Melinda	Riverine alluvium	Brown, grey and reddish loams and clays of floodplains and terraces	Parts of Hiccattee	Monkey River Quamina Hondo Canquin Governor Croja Sennis	17
Turneffe	Coastal deposits	Raw, deep calcareous and siliceous sands, and shallow sands and muds over coral	-	Shipstern Ambergris Hopkins Matamore	18

Three suites defined in the Toledo LRA report (King *et al.*, 1986) and one from Northern Belize (King *et al.*, 1992) have been dropped. The freshwater hydromorphic soils of Toledo District were placed in Caway Suite. They have now been grouped with the other permanently freshwater wet soils in Sibal Subsuite of Tintal Suite. Jacinto Suite was defined as being formed in a bisequent parent material of a thin Tertiary-Pleistocene marine alluvial overwash on top of Toledo Beds clastic sediments. Re-examination of these soils in 1987 (Baillie and Wright, 1988) and in 1991 indicated that they mostly form by prolonged weathering, leaching and some gleying of Toledo Beds material. They have therefore been reclassified as Jacinto Subsuite in Toledo Suite. Hiccattee Suite was defined as a minor and heterogeneous group of soils formed round the fringes of Cretaceous limestones, often in parent materials that included siliceous components from the Toledo Beds, the old coastal alluvium and fresh riverine alluvium. A feature common to all of these soils is the abundance of black manganiferous 'buckshot' rounded concretions. It is felt that separation of these soils as a suite contravenes the lithological basis, and that they are best distinguished as series in the appropriate siliceous suites and subsuites.

Vaca Suite was defined in the Northern Belize LRA report to accommodate the soils over the pinkish, hard, microcrystalline Cretaceous limestones that occur close to the northern boundary of the Maya Mountains massif and elsewhere in the Vaca Hills land system. The only subsuite - Cuxu - is retained but is now included in Chacalte Suite with the other soils over Cretaceous limestone.

It is thought that Table 2 is a definitive list of the soil suites of Belize. No parent material combination of any extent is likely to have evaded notice during the fieldwork for Wright *et al.* (1959) and the recent LRA surveys. The most likely circumstances for the creation of new suites are where future soil surveyors or taxonomists in Belize feel that existing suites are too broad, and need to be subdivided at suite level.

OSSORY SUITE

The most extensive soils in the Maya Mountains belong to Ossory Suite (Cambisol, Acrisol; Tropept, Udult). The main parent materials are meta-argillites and quartzites, both of which are hard and slow to weather. They therefore give a high proportion of shallow, stony and poorly developed soils on steep slopes. Features common to all of the soils in the suite include low content of available nutrients, high acidity, and high contents of total potassium and magnesium. Morphologically the soils are very variable, ranging from shallow grey and brown stony sands over quartzite, through red and yellow deep clays in hillwash deposits on lower slopes, to the yellowish, columnar, stony clays of the Bald Hills.

RICHARDSON SUITE

The soils of Richardson Suite (Cambisol, Ferralsol; Tropept, Perox) are not extensive, being confined to the outcrops of the Bladen Volcanics on the Main Divide of Maya Mountains. The limited data from these soils indicate that they are reddish, very leached and acid loams and clays. Under undisturbed forest they seem to be resistant to erosion and able to develop to considerable depths, even on very steep slopes.

STOPPER SUITE

Stopper Suite (Cambisol, Acrisol, Planosol; Inceptisol, Ultisol) includes all of the soils developed on granite. They occupy extensive areas on the Mountain Pine Plateau, and in the rolling granite basins at lower altitude, such as the Cockscomb. A feature common to all of the soils of this suite is the high content of angular quartz grit and coarse sand and their susceptibility to erosion, especially gullying. All of these soils are acid, highly leached and have low contents of available nutrients. In contrast to Ossory Suite they also have low or, at best, moderate total contents of nutrients, including potassium and magnesium. The suite includes considerable morphological heterogeneity, ranging from pale yellow and grey loamy sands to bright red sandy clays. The suite covers a wide range of depths but the proportion of shallow and stony soils is lower than in Ossory Suite.

TOLEDO SUITE

The soils of Toledo Suite (Cambisol, Acrisol, Luvisol; Tropept, Udult, Udalf) have developed over the clastic sedimentary rocks of the Toledo Beds in the uplands and coastal lowlands of Toledo District. These rocks are mainly fine grained, but are much softer than the meta-argillites of the Maya Mountains, so that slopes are much gentler and the soils less stony than in Ossory Suite. However deep weathering is not widespread and most of the soils are shallow. Because there are thin bands of limestone in the Toledo Beds most of these soils are only moderately acid. The contents of available nutrients are variable, but the total contents of potassium and magnesium are quite high. Textures are variable, with clays and loams predominant. Greys and browns are the main colours in the shallow soils, but there are also deeper, redder and more leached soils.

LIMESTONE SOILS

The soils over mainly non-siliceous limestones are divided into four suites according to the geological age of the rock. There are significant geochemical differences in the limestones, but the age distinction was initially made to separate soils occurring in distinctly different topographic and climatic regimes.

CHACALTE SUITE

Chacalte Suite (Leptosol, Vertisol; Tropept, Vertisol, Mollisol) includes all of the soils formed on the karst hills on the hard Cretaceous limestones that flank the Maya Mountains. The suite includes the reddish and brownish stony and shallow clays of the Vaca Hills. These were separated out as Vaca Suite in the Northern Belize LRA (King *et al.*, 1992), but are now incorporated into Chacalte Suite, although distinguished at subsuite level (Cuxu Subsuite). Many of the soils of this suite on the predominantly steep slopes are very shallow and stony black clays. There are patches of brown and reddish clays, distributed without any obvious topographic pattern and probably related to ferruginous impurities that were either incorporated into the original limestones or later deposited on their surfaces. All of the shallow soils are neutral or alkaline. They have strong structures, and shrink and crack when dry. On the more gently graded lower slopes and in the interkarstic basins, the clays washed off the hills accumulate to give deeper soils. Some are black or very dark coloured throughout their depth, but most of them have dull brown or yellowish subsoils. These are heavy and sticky clays, often with dark iron and manganese concretions resembling bird- or buckshot.

YAXA SUITE

The soils of the Yaxa Suite (Cambisol, Vertisol; Tropept, Mollisol, Vertisol) are found on the Early Tertiary limestones in the rolling country of western Belize, north of the Belize River. This area has some karstic topography, with subterranean drainage and sinkholes, but the relief is insufficient to give many steep slopes except along the scarps, such as north-west of Rio Bravo, but the soils are nonetheless mostly shallow. The main soils are dark coloured blocky clays overlying limestone. They are neutral or alkaline and well supplied with calcium and magnesium but have only moderate contents of other nutrients. The soils are often deeper and more alkaline on the lower slopes and close to the edges of the swamps and bajos. They differ from the deeper soils in Chacalte Suite in that they often contain gypsum, and tend to be grey rather than dull yellowish in colour. This suite also includes the flinty dark clays found in the north-western corner of the country, and the reddish clays of the Yalbac Ranch-Hill Bank area.

PEMBROKE SUITE

The soils of Pembroke Suite (Cambisol, Vertisol; Tropept, Mollisol, Vertisol) are found on the Late Tertiary limestones that underlie Corozal and parts of Orange Walk Districts. The upper part of the limestone appears quite weathered and friable and is known as sascab which, is often capped by a thin crust of hard limestone (Quinones and Allende, 1974; Darch, 1981). The commonest soils are black clays of moderate depth on the upper and middle slopes. These are quite fertile, with moderate supplies of potassium and phosphorus as well as ample calcium and magnesium. Downslope the hillwash clays are deeper and more alkaline and suffer from impeded drainage. The suite also includes red clays in Corozal District, which tend to be shallower and stonier than the black clays, but are still moderately fertile.

BAHIA SUITE

The Bahia Suite (Leptosol, Cambisol; Tropept, Entisol) includes soils developed in limestones which have only recently emerged from the sea around the shores of Chetumal Bay. Some of these soils are shallow, dark coloured, moist peaty loams and clays over gypsiferous limestone in the Consejo area. There are also very shallow and stony dark and reddish clays overlying emergent hard coral on the southern shores of the bay.

GUINEA GRASS SUITE

Two suites are distinguished on the basis of siliceous non-layered additions to predominantly limestone parent materials. The first is Guinea Grass Suite (Luvisol, Planosol; Tropept, Alfisol), the soils of which occur in northern Orange Walk District. The siliceous component is quartz sand, either an impurity in the original limestone or a later mixed-in surficial deposit. The soils are dark coloured throughout with topsoil textures ranging from rare loamy sands to the predominant sandy clays. Clay contents increase with depth until the underlying limestone is reached. The medium-textured soils are more or less neutral and moderately endowed with plant nutrients especially at depth, but the nutrient contents of the sandier topsoils are low.

ALTUN HA SUITE

The second suite of mixed siliceous/calcareous lithology is Altun Ha Suite (Leptosol, Cambisol, Luvisol, Vertisol; Tropept, Alfisol, Vertisol). These soils occur on either side of the old Northern Highway. The main siliceous components are flint and chert, fragments of which range in size up to boulders. There is also siliceous sand, some derived from abrasion of the flints but some may also come from old beach deposits. The soils range in colour from reddish brown through black to light grey. Topsoil textures are also variable, from loamy sand to clay loam. Clay contents generally increase with depth, but this is not always easy to discern because of the high stone contents. All of the soils are stony, and many are shallow to the hard microcrystalline limestone. These soils are of about neutral pH, and may be only moderated supplied with plant nutrients, as well as being rather droughty.

REVENGE SUITE

The soils of Revenge Suite (Planosol; Alfisol) are also formed from a combination of siliceous and calcareous parent materials. In this case the parent materials have not been mixed and the soils are highly layered. In some soils the siliceous cover is over a metre deep, so that the soil is effectively acid and naturally supports a type of Pine Ridge vegetation. In others the acid sandy top is quite thin and overlies a mottled, plastic and sticky calcareous clay. This also supports Pine Ridge vegetation but with poorer tree growth and often with a high proportion of calabash trees.

PULETAN SUITE

The main soils of the lowland Pine Ridge are those of Puletan Suite (Arenosol, Planosol, Acrisol; Ultisol, Entisol). They consist of coarse- or medium-textured topsoils abruptly overlying brightly mottled red and white 'corned beef' sandy clay or clay. The topsoil can vary from shallow yellowish loam to deep white coarse sand. These soils are acid throughout and have very low contents of plant nutrients. They have the additional disadvantages of being droughty in the dry season and poorly drained in the wet season. Their normal vegetation is Pine Ridge, although more closed woodland can develop in areas protected from frequent fires.

TINTAL SUITE

Tintal Suite (Gleysol, Histosol; Aquept, Mollisol, Entisol, Histosol) is the only suite that is defined in terms of profile characteristics rather than its parent material. It includes all soils that are wet to the surface for all or a substantial part of the year. It includes the soils of perennial and seasonal, freshwater, brackish and saline swamps. Texturally the soils range from sand to clay, and many have marked textural layering inherited from depositional stratification of alluvial parent material. Apart from wetness and consequent tendencies to softness, plasticity and stickiness, the features common to all of the mineral soils in the suite are grey colours, with or without venose rust brown mottling along current and previous root channels, and a tendency to accumulate organic matter at the surface. The inhibition of decomposing microbes may lead to the build-up of enough litter for the soil to qualify as muck or peat. This suite now includes the swamp soils of Toledo District, which were originally designated as Caway Suite in the Toledo LRA report (King *et al.*, 1986). This name has been dropped because of its similarity to, and possible confusion with, Kaway - the series name given to a quite different soil in the Belize Valley survey (Birchall and Jenkin,

MELINDA SUITE

Melinda Suite (Fluvisol, Gleysol, Cambisol, Acrisol, Planosol; Entisol, Tropept, Ultisol, Alfisol) contains some of the most productive and flexible agricultural soils in the country. It includes all of the well and imperfectly drained soils formed in river alluvium. Really poorly drained soils are excluded, and are grouped with the swamp soils of Tintal Suite. The soils of Melinda Suite include the young soils that have formed in the fresh or recent alluvium of current river floodplains. They are grey or brown and often have some mottling in the subsoil. Their textures vary from gritty sand to clay according to the vagaries of alluvial deposition. As river courses and regimes change, so do deposition conditions at any one place, with the result that these soils often inherit marked textural layering. A feature found in many of these soils is muscovite, the silvery mica which gives the soils a characteristic glinting appearance. These soils are well supplied with nutrients from the weathering of the freshly deposited minerals, and also from the dissolved nutrients in the waters of periodic floods.

This suite also includes the more mature soils on the older deposits of the river terraces on the sides of the valleys. These soils are more weathered and better drained that those of the current floodplains, and are predominantly reddish in colour. Their textures are generally fine, with high silt contents inherited from the alluvium. They have also been leached more freely and for longer than the floodplain soils, so that they tend to be acid and rather low in plant nutrients such as phosphorus, calcium and magnesium. Total potassium levels tend to be moderately high, due to the muscovite in the alluvium.

TURNEFFE SUITE

Turneffe Suite (Leptosol, Arenosol, Luvisol, Acrisol; Entisol, Udalf, Udult) includes all of the well and imperfectly drained soils on young coastal deposits. The really wet soils of mangrove swamps are excluded, and are grouped in Tintal Suite. Turneffe Suite soils form in deep quartzose beach sands in the south and centre of the country, deep calcareous beach sands in the north, and in shallow sand and mud deposits over coral. They are very young and immature, and have hardly developed any profile morphology. They tend to be very droughty, and the quartz sands are also very deficient in all of the main plant nutrients. The calcareous sands are well supplied with calcium and magnesium but have very low contents of nitrogen, phosphorus and potassium.

Part 4

Soil subsuites

INTRODUCTION

The suites are divided into subsuites on the basis of morphological characteristics and ecological relationships apparent in the field. The criteria for subsuite differentiation vary between suites. Texture, colour, topographic location and natural vegetation are used in the soils on siliceous parent materials. Colour is the main criterion for wholly calcareous soils and the subsuites of limestone soils encompass considerable variations in depth and drainage. They cover all of the non-swamp elements of toposequences from interfluve crest to lower slope, and are therefore similar to the associations in the Canadian and Scottish systems of soil classification.

The subsuites are discussed and tabulated separately by suites. The relevant table numbers are indicated in the final column of Table 2; (an alphabetical list of the subsuites is given in Table 19).

Except for soils found only in Toledo District, the subsuites have been described in the Stann Creek and Northern Belize LRA reports (King *et al.*, 1989, 1992). The descriptions are only summarized here, with stress on the characteristics that make the subsuite distinct. For details of the subsuite, and for detailed descriptions and analyses of individual profiles, reference should be made to the LRA reports, as indicated in the tables.

OSSORY SUITE

The subsuites of Ossory Suite are summarized in Table 3. This suite has been simplified by the removal of two subsuites. The former Dancing Pool Subsuite included the deep hillwash soils at low altitudes (see Stann Creek and Northern Belize LRA reports). These are now assigned to Curassow and Pippen Subsuites according to the predominant soil texture. This excision is because the hillwash soils appear to be areally insignificant. The deeper soils can still be differentiated, at series level within Curassow and Pippen Subsuites if required. Chiquibul is the other subsuite dropped (see Northern Belize LRA report). The shallow Ossory soils on the Mountain Pine Plateau are now incorporated into Cooma Subsuite. This avoids the name Chiquibul which has been used for soils in several slightly different senses (e.g. Wright *et al.*, 1959; King *et al.*, 1986, 1992). It also acknowledges the intricate intermixture of the predominant shallow and less extensive deeper soils of this suite on the Mountain Pine Plateau. The depth classes can still be differentiated as series if required. There is an element of inconsistency in the subsuite differentiation as the shallow soils at low altitudes are still recognized as the Cabbage Haul Subsuite. However there are very extensive broadleaf forest steepland areas, and these soils still appear to warrant separate subsuite status.

Cabbage Haul Subsuite

The other three subsuites occur widely in the steeplands. The shallow and stony grey and brown soils of Cabbage Haul Subsuite (Dystric Cambisol; Dystropept) are probably the most extensive. They vary in texture from loamy sand to clay loam. Their shallowness is attributed to the slow weathering of the very competent metasediments and the tendency to profile truncation by erosion on

Table 3 Subsuites in Ossory Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*	Previous LRA* subsuites included
Cabbage Haul	Shallow grey and brown stony sands and loams over hard rock; acid and leached; steep slopes and broadleaf forest and scrub	SC 1989	SC31, SC36 (SC1989)	-
Curassow	Moderate and deep red and yellow clay loams and clays over weathering rock; leached and acid; moderate slopes and broadleaf forest	SC 1989	SC6, SC8, SC34 SC35, SC59 (SC 1989)	Dancing Pool (fine textured) (SC 1989)
Pippen	Moderate and deep sandy loams, sandy clay loams over weathering rock; leached and acid; moderate slopes and broadleaf forest	SC 1989	SC32, SC54 (SC 1989)	Dancing Pool (coarse textured) (SC 1989)
Borrowpit	Loams and clays with abundant subsoil ferruginous gravel or massive ferricrete; leached and acid; lower eastern footslopes of Maya Mountains	SC 1989	SC11, SC12 SC23, SC26 (SC 1989)	-
Cooma	Red and yellow soils, often with ferrugnious stone lines of Mountain Pine Ridge; very leached and acid; pine woodland and savanna	NB 1992	OZ 39, OZ 42 OZ 74 (NB 1992)	Chiquibul (NB 1992)
Baldy	Yellow and grey clays with marked prismatic or columnar structures in Bald Hills; very leached and acid; grassland and scattered pine savanna	NB 1992	OZ 43 (NB 1992)	-
Granodoro	Red and yellow; loams and clays of Grano de Oro Hills; moderately shallow; slightly leached and acid; Broken Ridge and Broken Pine Ridge forest.	NB 1992	OZ 86, OZ 87 (NB 1992)	-
Machiquila	Deep; red and yellow loams and clays over limestone;moderately leached and acid; metasedimentary outwash south of Grano de Oro Hills; broadleaf forest	NB 1992	OZ 88 (NB 1992)	-

* LRA reports: SC 1989 = King *et al.*, 1989
NB 1992 = King *et al.*, 1992

steep slopes. The soils are very droughty, which renders their forest cover susceptible to fire, either natural or anthropogenic. Severe or repeated burning leads to the replacement of the broadleaf forest with tiger bush (*Dicranopteris pectinata)* scrub or broken Pine Ridge. Although apparently immature, these soils are very acid and leached, and have low contents of plant nutrients.

Curassow and Pippen Subsuites

The soils on gentler slopes, and now including hillwash accumulation sites, are deep and reddish. They are subdivided according to texture. The heavier-textured soils (with subsoils that are clay loam or finer) are in Curassow Subsuite, whereas those with lighter textures qualify as Pippen Subsuite. Both of these subsuites are mostly Haplic Acrisols or Kandiudults. In both subsuites there is a tendency for soil colour to go from reddish yellow to red and for clay content to increase with depth. These tendencies are less pronounced in soils where hillwash accumulation is rapid and masks pedogenic horizonation. Both subsuites are leached and acid, and have low available and moderate total contents of nutrients. The soils of these subsuites also occur on narrow, relatively uneroded strips along the sharp ridge crests of this terrain. They are often associated with the tall, Cuban-affined palm *Coplothrinax cooki*, especially at high altitudes.

Borrowpit Subsuite

There are now four subsuites of soils under mainly broadleaf forest in the steeplands of the Maya Mountains. The soils of Borrowpit Subsuite (Plinthosol; Plinthic Hapludox) appear to occur only on the lower eastern toe-slopes of the mountains, close to the 40 m contour and along the junction of metasedimentary material with the old alluvium of the coastal Pine Ridge. The dominant feature is the occurrence of large quantities of ferruginous gravel, often cemented to form massive sheets of ferricrete. This is assumed to be a seepage formation, enriched by ferriferous throughflow and return flows from upslope. It was probably deposited at a time when water-tables were at or close to the present 40 m contour. It is tempting to correlate its formation with the marine transgression that deposited the higher levels of the Tertiary/Pleistocene coastal alluvium.

Cooma Subsuite

Cooma Subsuite (Halplic Acrisol; Udult) includes most of the Ossory soils on the Mountain Pine Plateau, especially those under pine woodland or savanna. They occupy the broad arc of high land that runs from the Thousand Foot Falls turn-off on the Cooma Cairn Road right round past Cooma Cairn and along the Brunton Trail as far as the Quartz Ridge. Because of their greater competence, the metasedimentary rocks overlook the rolling and rugged granitic basins at the centre of the Mountain Pine Plateau. The soils of Cooma Subsuite are brightly coloured, with reddish yellow topsoils grading to intensely red subsoils. Textures are medium or fine, usually reaching clay loam or clay in the subsoil. There is often much ferruginous gravel, frequently formed round cores of partially weathered meta-argillite. The gravel is frequently concentrated into subsoil stone lines, apparently marking the lower limit of faunal sorting and excavation. These soils are very leached and acid, and have even lower contents of exchangeable and available nutrients than the Ossory Suite soils under broadleaf forest at lower altitudes. However the argillitic influence ensures that total contents of potassium and magnesium are moderate or high. The intense leaching and weathering of the upper part of the profile suggests that these soils are old. However they are not particularly deep, with fairly hard rock normally found within the top metre, and often much less on the steep connecting slopes down to the granite basins or to the valleys of the Macal River and its tributaries. In the Northern Belize LRA survey (King *et al.,* 1992) the shallow soils were separated as the former Chiquibul Subsuite but, as noted above and in Table 3, they have now all been amalgamated into Cooma Subsuite.

Baldy Subsuite

The soils of the Bald Hills are quite different from those of the rest of the Mountain Ridge Plateau. The soils of Baldy Subsuite (Haplic Acrisol; Hapludult) are pale in colour, with greys and yellows predominating. Textures are generally fine with the subsoils reaching clay loam or clay. The surface often has a marked quartz stone pavement, with the grasses and sedges poking through. The most distinctive feature of these soils is the strong coarse prismatic or columnar structure which stretches from the surface down to the weathering argillite. Some of them are truly columnar with rounded caps that are dusted with bleached sand. Exchangeable sodium levels are slightly higher than in the Cooma Subsuite soils at lower altitudes, but the exchangeable sodium percentage in OZ 43, the only profile analysed, does not exceed 7% in any horizon. The sodicity necessary to produce truly columnar structures may be transient, being injected in the rainfall and then rapidly leached, but residing long enough to influence soil morphogenesis. Analysis of rainfall suggests that there are significant quantities of sodium being deposited from the atmosphere on to the Mountain Pine Plateau (Kellman and Carty, 1986). Similar situations have been noted in New Zealand. In places, the soils of Baldy Subsuite overlie massive ferricrete rather than grading directly into weathered rock. This may be a formation dating from a period of prolonged stillstand and high water-tables, and may be very old.

Granodoro Subsuite

The soils of Ossory Suite on the Grano de Oro Hills have been separated as Granodoro Subsuite (Cambisol, Acrisol; Tropept, Halpludult). In appearance they are not greatly different from the shallower soils of Curassow and Pippen Subsuites, with reddish yellow medium- and coarse-textured topsoils becoming redder and finer with depth. Some of these soils are thought to be leached and acid. However a feature of the lower slopes of the Grano de Oro Hills is the former capping of Cretaceous limestone. This has been but barely stripped off, and there are still a few remnant boulders. These and other less visible calcareous influences mean that some of these soils may be moderately acid but have moderately eutric base status especially in the topsoil, e.g. Profile OZ 86 in the Northern Belize report (King *et al.*, 1992). This significant but patchy calcareous influence justifies keeping this as a separate subsuite. The vegetation on these hills confirms a variable nutrient status, with Mountain Pine Ridge over Cooma soils at the eastern, San Pastor end, and a mosaic of Broken Ridge, Broken Pine Ridge and rosewood-rich, rather stunted broadleaf forest on the Granodoro soils further west.

Machiquila Subsuite

To the south of the hills there is an area of deep metasedimentary outwash overlying Cretaceous limestone. This gives rise to the light reddish and yellowish, medium- and fine-textured soils of Machiquila Subsuite (Luvisol; Kandiudalf). Their chemical characteristics also show a calcareous influence but, in contrast to Granodoro soils, this is more pronounced in the subsoils than in the surface horizons, e.g. Profile OZ 88 in King *et al.*, 1992.

RICHARDSON SUITE

The subsuites of Richardson Suite are summarized in Table 4. Compared with the Northern Belize LRA report (King *et al.*, 1992) the suite has been simplified by the amalgamation of Palmasito and Doyle Subsuites, under the name of Doyle. Palmasito has been dropped as a name because it was used for soils on different parent materials by Wright *et al.*, 1959. The two subsuites remaining are differentiated on depth and profile development.

Doyle Subsuite

The soils of Doyle Subsuite (Ferrasol, Acrisol; Acroperox, Kandihumult) are deep and show considerable pedogenetic maturity. They are mainly reddish yellow and red with reddish colours intensifying with depth. Textures are fairly uniformly medium or fine. The subsoils tend to be friable with open porous crumb structures. There are a number of distinctive features of these soils. They

Table 4 Subsuites in Richardson Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*	Previous LRA* subsuites included
Doyle	Deep; reddish; loams and clays over weathered volcanics; some with surface micro-podzols; ridge crests and stable slopes; very acid and leached; tall broad-leaf forest with many tall palms	NB 1992	OZ 26, OZ 27 OZ 28, OZ 29	Palmasito (NB 1992)
Ramos	Shallow and stony; red, yellow and brown; loams and clays; leached and acid; steep slopes; broadleaf forest	NB 1992	-	-

* LRA report: NB 1992 = King *et al.*, 1992

appear to be very stable on steep slopes under undisturbed forest, so that the profiles are surprisingly deep. The stability, combined with the high rainfall of the high mountainous areas and the free through-drainage, enables these soils to be very intensively leached. The soils are very acid and of low base status. A further indication of the prolonged and intensive leaching is the development of shallow podzolic features in the surface layers of deeply weathered profiles, e.g. Profile OZ 26 in King *et al.*, 1992. This was originally taken as a distinctive criterion at subsuite level. However the micropodzolic features appear to be of very limited distribution, being found only on the highest ridge crests, so the distinction has been dropped. It can be retained at series level if required. The broadleaf forest on these soils contains a high proportion of Santa Maria. The forest on the ridge crests also has a high proportion of the tall palm *Coplothrinax cooki*.

Ramos Subsuite

Ramos Subsuite (Cambisol; Dystropept) has been set up to allow for shallow soils on the Bladen volcanic rocks. However none of these soils were seen in the course of the limited LRA fieldwork in this part of the Maya Mountains. The soils are likely to be red, yellow and brown, medium and fine textured, shallow and stony, and leached and acid. Exchangeable base status may be slightly higher than in the deeper and older soils of Doyle Subsuite.

STOPPER SUITE

The granite soils of Stopper Suite are divided into five subsuites, on depth, texture, colour, topographic location and ecological relationships, as summarized in Table 5.

Silkgrass Subsuite

The soils of Silkgrass Subsuite (Arenosol; Quartzipsamment) occur as a series of discontinuous bodies in places where large volumes of granitic sediment have been dumped by high-energy streams slowing down as they debouch from the mountains and meet the coastal plain. The sediments are mostly relict features, dating from periods when erosion base levels were higher than at present. In many places these deposits are now being dissected, fairly gently, by modern streams. The main feature of these soils is the deep, grey and yellow loamy sand or sandy loam surface layers. These may be underlain by compact red and white mottled 'corned beef' sandy clay but only at depths of well over a metre. The soils are effectively well drained and permit deep rooting. Prior to their grubbing out to make way for citrus, the well-grown pines at Mile 7 junction on the Stann

Table 5 Subsuites in Stopper Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses LRA report)*
Silkgrass	Deep, pale sands and loams on granitic outwash along eastern footslopes of Maya Mountains; leached and acid; Broken Pine Ridge and some broadleaf forest	SC 1989	SC18, SC19 SC21 (SC 1989)
Powder Hill	Shallow and stony grey, brown and yellow sands and loams over fairly land granite; fairly leached and acid; steep slopes	SC 1989	SC37 (SC 1989)
Mayflower	Deep, yellow, grey and pinkish sands and loams over weathering granite; moderately leched and acid broad-leaf forest on gentle-moderate slopes	SC 1989	SC38, SC60 (SC 1989)
Canada Hill	Deep, red, fiable loams and sandy clays; moderately acid and leached; gentle-moderate slopes; broadleaf forest; erodible	SC 1989	SC20, SC39 (SC 1989)
Pinol	Red, yellow and grey soils on Mountain Pine Plateau; very leached and acid; pine wood-land savanna; erodible	NB 1992	OZ 38, OZ 40 OZ 41, OZ 79 OZ 80 (NB 1992)

* LRA reports: SC 1989 = King *et al.*, 1989
NB 1992 = King *et al.*, 1992

Creek Road were characterized by deep, straight and unfanged taproots. These soils are acid and leached, and have low contents of most plant nutrients. Their natural vegetation is Broken Pine Ridge or Broken Ridge forest.

Powder Hill Subsuite

The granitic soils of the broadleaf forest steeplands of the Maya Mountains are subdivided into three subsuites. Powder Hill Subsuite (Cambisol; Dystropept) contains the shallow and stony soils. These are grey, yellow or pinkish in colour. Textures vary from loamy sand to sandy clay loam, but are all characterized by high contents of angular quartz coarse sand or grit. They are weakly structured and appear to be easily eroded. They are proportionally less extensive than their analogues in Cabbage Haul Subsuite on the metasedimentary rocks. This is attributed to the greater erodibility and generally gentler and lower topography of the granites. These soils are slightly acid but are fairly intensively leached. The combination of coarse texture and shallow depths makes them droughty.

Mayflower and Canada Hill Subsuites

The deeper soils are divided on colour and texture. Mayflower Subsuite (Acrisol; Udult) includes grey, yellow, pink and light red soils of coarse to medium texture. They tend to become redder and finer with depth. They are moderately acid but fairly intensively leached with low contents of most plant nutrients. The soils of Canada Hill Subsuite (Acrisol, Ferralsol; Udult, Udox) are deep and bright red in colour. They are medium textured, going as fine as sandy clay. The sand fraction is coarse grained and mostly consists of angular quartz. The clay content changes little with depth which, with the porous crumb structures in the subsoil, suggests that there is little clay translocation. The chemical characteristics of these soils are variable but they are mostly moderately acid and strongly leached. The distribution of the soils of these two subsuites suggests that they are more determined by mineralogical variations in the granite than by site stability and soil age. There does not appear to be a consistent pattern of red Canada Hill soils on interfluves and less rubefied Mayflower Subsuite soils on the connecting slopes down to the dissecting drainage lines.

Pinol Subsuite

Pinol Subsuite (Acrisol, Planosol; Kandiudult) includes all of the granite soils of the Mountain Pine Plateau. It covers a wide variation in morphology, ranging from bright red sandy and gritty clays to pale yellow and light grey loamy sands and grits. They are mostly well drained, but there are imperfectly drained soils in the lower western sections of the Mountain Pine Plateau. The clay contents of the well-drained soils mostly increase with depth, but not to the extent or with the abruptness of the coastal Pine Ridge soils. Colours generally become redder with depth, but the underlying weathering granite is often brightly mottled red and white. These soils are extremely leached and acid. This and the high degree of rubefaction indicates that they are quite old and stable. Nonetheless they are not particularly deep, and weathering granite is often encountered within a metre or so.

TOLEDO SUITE

The soils of Toledo Suite are divided into five subsuites as summarized in Table 6. Since the Toledo LRA report (King *et al.*, 1986), three subsuites have been removed by incorporation into others. The former Santa Cruz Subsuite is now part of Aguacate Subsuite, the former Waika Subsuite is now in Cimin Subsuite, and the former Topco Subsuite is in Machaca Subsuite.

Cimin Subsuite

The fairly well-drained soils of the rolling and hilly Toledo Uplands are divided between the shallow brownish soils of Cimin Subsuite and the deeper reddish soils of Aguacate Subsuite. The topsoils of the Cimin Subsuite (Cambisol, Luvisol; Eutropept, Udalf) are very dark coloured and worked into strong crumb structures by worm action. Textures vary from sandy loam to clay, with finer textures predominating. This horizon grades into a blockier, finer-textured subsoil that ranges in colour from dark brown, through grey to reddish colours. This grades into weathering mudstone or other clastic sediments at quite shallow depths, generally within 60 cm. There are narrow strips of deeper hillwash soils on the lower slopes and in drainage lines. These tend to be dark coloured and fine textured with some subsoil mottling in the bottomland soils.

Aquacate Subsuite

Towards the western end of the Toledo Uplands the soils are deeper and redder, and are classified in Aguacate Subsuite (Acrisol, Luvisol; Tropudult, Tropudalf). The more developed of these soils have deep, bright red subsoils over brightly mottled red and white saprolite often at well over a metre deep. In the less developed soils, the subsoil is less brightly rubefied and grades straight into weathering rock. Clay textures predominate in this subsuite, often with an increase in clay content with depth.

Both the Cimin and Aguacate soils of the uplands are less acid and have higher exchangeable base status than the in morphological equivalents in the Toledo coastal lowlands. Aguacate is slightly acid and has high base saturation in the

Table 6 Subsuites in Toledo Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*	Previous LRA* subsuites included (possible future series)
Cimin	Mostly shallow; grey and brown soils over weathered sediments; neutral slightly acid; high base status; eastern Toledo Uplands; broadleaf forest	TL 1986	TL10/15/5 TL10/32 (TL 1986)	Waika (TL 1986)
Aguacate	Deep; red or brown soils over weathered rock; slightly acid and leached; western Toledo Uplands; broadleaf forest	TL 1986	TL10/14/3 TL10/14/2 TL10/20 TL10/31 TL10/13/1A (TL 1986)	Santa Cruz (TL 1986)
Temash	Moderately deep; grey clays, usually with bright red upper sub-soil, over flat-bedded weathered mudstone; imperfectly drained; very leached and acid; southern Toledo coastal lowlands; broadleaf forest with melastomes	TL 1986	TL11/1 TL12/13 TL12/2 (TL 1986)	-
Machaca	Shallow; grey and brown soils over weathered rock; moderately leached and acid; northern Toledo coastal lowlands; broadleaf forest	TL 1986 (and Topco (1988))	TL13/8 TL13/13 TL13/3,TL13/11 TL13/4,TL13/2 (TL 1986) plus many in Topco (1988)	Topco (TL 1986)
Jacinto	Brownish loam or clay topsoils over fairly deep and compact grey clay subsoils with red mottling; flat inter-fluves in Toledo coastal lowlands; Broken Ridge or patchy Pine Ridge	TL 1986 (and Topco (1988))	TL13/6 TL13/32 plus several in Topco (1988)	Parts of Machaca (TL 1986)

* LRA report: TL 1986 = King *et al.*, 1986
and: Topco (1988) = Baillie and Wright, 1988

topsoils. There is some aluminium in the subsoils but it does not dominate the exchange complex. The rolling or steeper topography gives most of these soils free drainage. Combined with the high base status, this makes these soils productive and stable enough to support milpa farming with longer cropping and shorter fallow phases than is normal in tropical shifting cultivation. However the pressure cannot be intensified indefinitely without eventual severe soil deterioration and possibly erosion.

Temash Subsuite

The soils of Temash Subsuite (Acrisol; Udult, Aquult) are mainly found in the southern part of the Toledo coastal lowlands, especially south of the Moho River. They tend to be moderately deep, usually with bright red but mottled upper subsoils grading into grey mottled clay, which overlies weathered mudstone, with subordinate thin-banded siltstone and fine sandstone. The thick clay horizons and the more or less horizontal bedding of the sediments somewhat impede the drainage of these soils. However they are old enough to be well leached and they are mostly acid and have low exchangeable base status.

Machaca Subsuite

The soils of Machaca Subsuite (Cambisol, Acrisol; Tropept, Udult) cover most of the northern part of the Toledo coastal lowlands. They are shallow and moderately deep, brown, red and grey and fairly well drained. They are generally less acid- and base-depleted than the soils of Temash Subsuite. However, some sandstones that have been subject to secondary enrichment with silica give rise to very acid soils (see Part 8 and Baillie and Wright, 1988). Soils over conglomerates and arkoses with substantial volcanic components are of higher base status and apparent fertility than others in the subsuite, and were originally separated as Topco Subsuite. However it is now known that they do not occur in the Topco area and they appear to be of very limited extent. They have therefore been incorporated into Machaca Subsuite but can be differentiated at series level if required.

Jacinto Subsuite

On the broader interfluves in the undulated sections of the Southern Coastal Plain there are the deep grey clays with reddish mottling that are classified as Jacinto Subsuite (Gleyic Acrisol; Aquult). These are thought to be old sedentary soils, developed by prolonged argilluviation. They have brownish, well-structured and freely draining topsoils which range in texture from loam to clay. The main subsoil horizon is a thick grey clay, which eventually grades into weathering rock. The grey clay is often split between an upper section, which has a bluish tinge in the matrix and dark red haematitic-looking mottles, giving an overall mauve-purple impression, and a lower section which tends to have a greenish tinge in the matrix and bright brown and yellowish mottles. These soils are acid and leached but not generally as much as those of Temash Subsuite. The Jacinto soils have poor internal drainage, probably partly due to the clogging up of the subsoil macropores by clayskins. External drainage is also limited on the flat wide interfluves and the soils are intermittently saturated. The deterioration in soil drainage is accompanied by decreases in the stature and productivity of the forest, which grades from Broken Yemeri Ridge, through low Broken Ridge and eventually to low seasonal swamp forest with many rosewood trees. In places pines become established - probably after fires - and the succession is diverted through Broken Pine Ridge to patchy Pine Ridge. Jacinto was recognized as a separate suite in the Toledo LRA report (King *et al.*, 1986), because it was thought to occur only where shallow Pleistocene coastal alluvium overlay Toledo Beds. It is now appreciated that these soils and their characteristic vegetation can develop directly from Toledo Beds parent material (Baillie and Wright, 1988).

LIMESTONE SOILS

The subdivision of the suites of the soils on limestones and siliceous limestones follows a common pattern, with variations, as shown in Table 7. The subsuites are differentiated on colour (in the non-siliceous limestone soils) or texture and stones (for the siliceous limestones). Most of the subsuites stretch from interfluve crests to the margins of swamps and have a range of depth, structure and drainage characteristics. The only distinction made on depth and/or topography is the separation of the very shallow Cabro soils on rugged karst terrain within Chacalte Suite.

For the dark coloured soils, this subsuite structure is similar to the LRA reports (King *et al.*, 1986, 1989, 1992). Previously however, deep, mottled and imperfectly drained soils on the lower slopes below the red and brown clays were separated at subsuite level. Inclusion of these soils in the subsuites with the reddish clays upslope has led to the removal of the former Puluacax (now in Xaibe), Irish Creek (now in Chacluum) and San Lucas (now in Xpicilha) Subsuites. Another former subsuite to be relegated is Concepcion, the brown clays of Corozal District. These have now been incorporated with the red soils of Xaibe Subsuite. Similarly the former Ramgoat Subsuite, the reddish soils with yellowish

Table 7 Subsuites in the main limestone soils

Topographic position		*Steep karst*	*Low interfluve*	*Midslope*	*Lower slope*	*Swamp*
	Soil features	Shallow, stony, discontinuous pockets	Shallow, well drained	Moderate depth, crumbly over blocky, well drained	Deep, cracking and blocky, mottled, imperfectly drained	Wet, gleyed
Suite	Subsuite criterion					
Chacalte	Mainly dark clay	Cabro		Xpicilha		
	Mainly red and brown clay	Cabro		Cuxu		
Yaxa	Dark clay	(Yalbac)		Yalbac		
	Dark flinty soil	Rare (Jolja)		Jolja		
	Red clay	Rare (Chacluum)		Chacluum		
Pembroke	Dark clay	Not found		Louisville		
	Red and brown clay	Not found		Xaibe		Tintal Suite
Guinea Grass	Medium-textured topsoil	Not found		Lazaro		
	Coarse-textured topsoil	Not found		Pixoy		
Altun Ha	Medium-textured flinty soil	Not found		Jobo		
	Coarse-textured flinty soil	Not found		Rockstone		

red fragic clay subsoils in the Hill Bank area have been incorporated into the reddish clays of Chacluum Subsuite.

All of these former subsuites are soils worth distinguishing, both pedologically and edaphically, in detailed studies and surveys. It is hoped that they will be used as series in future work.

Although these are designated as limestone soils and, although most of the parent materials are undoubtedly of calcareous origin, there is some question as to how many of the soils are actually sedentary. Many of the soils, especially the deeper profiles on lower slopes, appear to have developed in calcareous, smectitic transported materials. The extent to which these are of marine origin, deposited in shallow bays and lagoons when the relative sea levels were some metres higher than at present, or are just local hillwash accumulation, is still uncertain. This is an area where archaeological evidence may help.

The details of previous descriptions, location of profile data, and previous subsuites incorporated are summarized in Tables 8 to 12.

CHACALTE SUITE

The inclusion of all of the clays in the karst terrain on the Cretaceous limestones flanking the crystalline rocks of the Maya Mountains into one suite, Chacalte, follows the precedent of Wright *et al.* (1959). However, they delineated a considerable number of different subsuites and soil sets. Reducing these to three subsuites, each with considerable variability, reflects the problems of separating, both taxonomically and cartographically, the intricate mixture of deep and shallow, dark and reddish clays in the jumbled karst topography.

Table 8 Subsuites in Chacalte Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*	Previous LRA* subsuites included (possible future series)
Cabro	Shallow and stony clays in pockets between boulders on steep slopes in rugged karst; slightly acid-neutral and base saturated; broad-leaf forest	TL 1986 SC 1989 NB 1992	TL8/21 (TL 1986) SC57 SC58 (SC 1989) OZ 77 (NB 1992)	-
Xpicilha	Moderate deep and deep dark clays; many reddish or brownish subsoil colours, olive yellow subsoils common in deeper profiles; slightly acid; gentler lower slopes and basins in karst; broadleaf forest	TL 1986 SC 1989 NB 1992	TL8/12 TL8/13 TL12/5 TL8/22 (TL 1986) SC17 (SC 1989) OZ 64, OZ 76 (NB 1992)	San Lucas (TL 1986 SC 1989 and NB 1992)
Cuxu	Moderately deep and deep brown and reddish clays; lower slope profiles may have olive brown subsoils; slightly acid; Vacá Hills and southern footslopes of Belize Valley; broadleaf forest	NB 1992	OZ 37 OZ 78 OZ 81 (NB 1992)	-

* LRA reports: TL 1986 = King *et al.*, 1986
SC 1989 = King *et al.*, 1989
NB 1992 = King *et al.*, 1992

Cabro Subsuite

Cabro Suite (Leptosol; Eutropept) includes all of the stony clays that are shallower than about 50 cm. Many of them are much less, consisting of pockets of soil between bare boulders and outcrops. Most of the clays are black or dark grey, but browns and reddish colours also occur, particularly in the Vaca Hills and Belize Valley. They mostly have crumb structures and there is much evidence of faunal working, particularly by worms. They are of slightly acid-neutral pH, and more or less fully base saturated. Their shallowness and the porosity of the underlying limestone means that droughtiness is the main constraint on natural vegetation and crops. On the whole these are quite stable soils. Nonetheless if the vegetation is stripped off, some soil erosion will occur. Although small in absolute terms, the resulting losses can be serious in soils which are already thin (Furley, 1987).

Xpicilha Subsuite

The Xpicilha Subsuite (Cambisol, Vertisol; Eutropept, Udoll, Udert) includes most of the deeper soils. It has been expanded to include the deeper soils of intrakarstic basins, formerly San Lucas Subsuite. This means that the subsuite now includes a considerable depth range. The slope soils tend to be 50-100 cm deep and have dark grey blocky subsoils under the dark crumb topsoil. Reddish and brownish subsoils also occur. In the basins some soils remain dark grey throughout their depth, but most tend to go to olive yellow clay in the lower subsoil. The colour is indicative of intermittently impeded drainage, confirmed by the presence of many black iron-manganese stains and concretions. Whether dark or yellow, the subsoils are massive and plastic when wet but crack widely in the dry season to give coarse blocks with shiny pressure faces. The soils are neutral or slightly acid, are well supplied with nitrogen, and have moderate total and available contents of phosphorus and potassium.

Cuxu Subsuite

Cuxu Subsuite (Cambisol; Eutropept, Udoll) includes all except the shallowest of the predominantly reddish and brownish soils of the Vaca Hills and the foothills that flank the southern side of the Belize Valley. They are similar to the Xpicilha soils in many ways except colour, which is due to the presence of significant quantities of free iron oxide. These appear to have originated from impurities in the limestones, and may be related to the distribution of these soils close to the Northern Boundary Fault. They make the soils more tractable and flexible than the darker soils for cultivation, but this may be offset by increased phosphate fixation and lower potassium and nitrogen levels.

YAXA SUITE

Yaxa Suite is divided into three subsuites, as summarized in Table 9. This represents a considerable simplification on the subdivision used in the North Belize LRA report (King *et al.*, 1992). It has been effected by amalgamating the former Ramgoat and Irish Creek Subsuites into the Chacluum Subsuite.

Yalbac Subsuite

By far the commonest soils in the suite are the dark clays of Yalbac Subsuite (Cambisol, Vertisol; Eutropept, Udoll, Udert). They are probably the most extensive soils in the country, stretching from the Belize Valley near Benque almost to Orange Walk Town. In the south-west they occur on rolling terrain in which moderate karst landforms have developed. Many of the soils in this region are shallow dark grey clays. They tend to be less black, less crumbly and more blocky than the equivalent soils in Chacalte Suite and the underlying limestone

Table 9 Subsuites in Yaxa Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*	Previous LRA* subsuites included (possible future series)
Yalbac	Dark clays; crumb and shallow, ranging through crumb over blocky moderate depth, to deep grey cracking blocky clay on lower slopes, possibly with gypsum in deep subsoil; rolling-undulating limestone hills; broadleaf forest.	NB 1992	OZ 15, OZ 16 OZ 33, OZ 34 OZ 70 (NB 1992)	-
Jolja	Similar topographic and morphological range to Yalbac but with many flints; rolling-undulating flinty limestone above and NW of Rio Bravo escarpment; broadleaf forest	NB 1992	OZ 11, OZ 12 OZ 50, OZ 66 (NB 1992)	-
Chacluum	Shallow and moderate reddish and brownish clay over limestone; also with deeper yellowish red fragic subsoil with many iron-manganese concretions; also mottled red and grey deep clay on lower slopes; undulating plain near Hill Bank; broadleaf forest	NB 1992	OZ 35, OZ 47 OZ 67, OZ 68 OZ 69 (NB 1992)	Ramgoat, Irish Creek

* LRA reports: NB 1992 = King *et al.*, 1992

is often more weathered and crumbly. In the more undulating country of the Northern Coastal Plain, running north-eastwards towards Orange Walk, a higher proportion of soils are deeper and have pronounced grey blocky subsoils. In all areas the soils of the lower slopes and close to the margins of swamps are much deeper. Beneath the black or very dark grey crumbly topsoils they grade to grey or light grey clay subsoils which crack widely in the more severe dry seasons. They have a range of pale yellow and brown mottles, indicating impeded drainage during the wet season, when the cracks close up and the subsoil becomes massive, plastic, sticky and impermeable. There may be small quantities of gypsum crystals in the deeper layers of some of these subsoils. These soils are neutral or slightly alkaline and are well supplied with calcium and magnesium. Nitrogen, phosphorus and potassium contents are variable, but tend to be lower than the equivalent soils in Louisville Subsuite on the younger limestones further north, and in the Xpicilha soils on the older Cretaceous limestone to the south.

Jolja Subsuite

The Early Tertiary limestone that outcrops above and to the north-west of the Rio Bravo fault scarp contains many flints. It weathers to give the dark flinty clays of Jolja Subsuite (Cambisol, Vertisol; Eutropept, Udoll, Udert). These are similar to Yalbac Subsuite in that they grade from dark, crumbly, shallow soils on interfluves to deep, mottled, cracking soils along swamp margins. The flints may be scattered or concentrated as a stone line. They are often associated with some fine siliceous material so that fine earth textures tend to be slightly coarser than in the Yalbac clays, with sandy clay quite common in subsoils. The flints also affect the cracking pattern, so that coarse blocks and prisms are less apparent in the subsoils of the deep, lower slope soils than in Yalbac soils. The presence of so much silica, even if much of it is in insoluble forms, tends to reduce the soil pH and exchangeable base status slightly, so that some of these soils are slightly acid and less than fully base saturated.

The soils of Yalbac and Jolja Subsuites carry broadleaf forests of calcicole species. These have been subdivided into various forest types in the Rio Bravo Conservation and Management area of the Programme for Belize. It would be interesting to know how much the distribution of these forest types relates to soil variation and how much is the result of stochastic biological processes, Ancient Maya deforestation, and logging over the past century and a half.

Chacluum Subsuite

Chacluum Subsuite (Chromic Cambisol, Luvisol; Eutropept, Rhodudalf) has been expanded by the incorporation of the former Ramgoat and Irish Creek Subsuites. It now includes all of the reddish clays in the Yalbac Ranch-Hill Bank area. The soils vary from fairly shallow, reddish clays that grade into weathering limestone within 30-70 cm to deep, grey clays with reddish mottles on lower slopes and close to swamps. An extensive intermediate soil type has reddish crumbly clays at the surface, grading into a bright orange coloured (reddish yellow-yellowish red) clay subsoil. This has high contents of iron-manganese concretions which suggest intermittently impeded drainage, either now or in the past. This horizon is also characterized by a very brittle consistence when dry. The horizon is extremely difficult to auger or dig through when in situ, but crumbles readily in the hand once removed from the pit face. This characteristic may also be a result of intermittent saturation. As far as can be seen, it does not affect root or faunal penetration, which presumably occur mostly when the soil is moist.

The reddish soils of this subsuite on slopes appear to be fairly easily cultivated, with less tendency to produce clods than the darker soils of Yalbac Subsuite. They are neutral or slightly acid and are well supplied with calcium and magnesium. There may be problems of phosphate fixation and deficiency when the soils are intensively cropped. The deep grey clays on the lower slopes (the former Irish Creek Subsuite) do not appear to be extensive. They may have been used for swamp margin wetland agriculture by the Ancient Maya.

PEMBROKE SUITE

Pembroke Suite on the younger Tertiary limestones in the north of Belize is divided into two subsuites, mainly on colour, as summarized in Table 10. The former Northern Belize LRA subsuites Concepcion and Puluacax (King *et al.*, 1992) have been incorporated into Xaibe Subsuite, which also includes parts of the former Remate Subsuite from the Bahia Suite.

Louisville Subsuite

Louisville Subsuite (Cambisol, Vertisol; Eutropept, Udoll, Udert) includes all of the black and very dark grey clays. Many of the topsoils have intense black colours, more pronounced than in the Yalbac Subsuite (Yaxa Suite) and similar to those found in some Chacalte Suite soils. The Louisville soils cover a wide topographic range in the north Belize limestone plain from low, broad interfluve crests to swamp margins. The interfluve soils consist of black, crumbly and intensely worm-worked clays over dark grey, slightly blocky clays over limestone. The underlying limestone is often soft and crumbly to some depth, and can be hand textured to give a loam or clay texture, often gritty or gravely. It is known locally as sascab. It is often capped by a layer that is distinctly harder. This may form an intact lithified layer, known as carapace, or it may be fragmented to give a stone line. Both sascab and carapace occur in the dark Yalbac Subsuite clays of Yaxa Suite on the older limestones to the south, but are not as extensive or pronounced. Both features are very extensive and well developed in the Mexican state of Yucatan, further north.

In the shallower soils the carapace is found within some 50 cm of the surface. There are similar but deeper profiles with up to 80 cm of stone-free soil. These tend to occur downslope but the correlation between depth and topographic position is not strong.

Table 10 Subsuites in Pembroke Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*	Previous LRA* subsuites included (possible future series)
Louisville	Black and very dark grey crumbly clay over grey clay over weathering limestone; often less than 60 cm deep on interluves; deeper on mid-slopes; deep cracking clays with grey subsoils, often with mottles and occasionally with gypsum on lower slopes; gently undulating plains; formerly broadleaf forest, now sugar-cane	NB 1992	OZ 2, OZ 46 OZ 51, OZ 52 (NB 1992)	-
Xaibe	Shallow red and brown clays over limestone with ridges of coral rubble, with some deeper grey and yellow mottled clays on lower slopes; very gently undulating plain; low broadleaf forest with calcicole species	NB 1992	OZ 7, OZ 8 OZ 19, OZ 20 OZ 24, OZ 53 (NB 1992)	Concepcion, Puluacax, Remate (part) (NB 1992)

* LRA report: NB 1992 = King *et al.*, 1992

Further downslope, the swamps fringing the soils of this subsuite are mostly well over a metre deep. They have black, crumbly, worm-worked clay topsoils, similar to those upslope. The subsoils grade through dark grey, blocky clays to grey clay with coarse blocky or prismatic structures which have shiny pressure faces or slickensides. This merges into light grey or pale brown, sticky, blocky clay. There may be patches of soft secondary lime but this horizon rarely has gypsum crystals. There may be some faint brownish mottling, but it is not pronounced. This horizon grades into soft weathering sascab.

The subsuite therefore encompasses a considerable range of depths and drainage status. This was apparently reflected in the former natural vegetation which ranged from high broadleaf forest with many cohunes on the shallower, freely drained soils to a lower broadleaf forest with many botan palms on the deeper more slowly draining soils downslope. However virtually all of the vegetation has been removed and most Louisville soils are now under sugar-cane.

Xaibe Subsuite

Xaibe Subsuite (Cambisol; Eutropept, Rhodudalf) includes all of the reddish, brownish and yellowish soils of the suite. It incorporates the former Concepcion (brownish clays) and Puluacax (mottled yellowish clays) Subsuites. It also includes the very stony shallow red and brown clays of the former Remate Subsuite. The dominant profile form is a shallow reddish clay over limestone. The topsoil is dark reddish brown and has good crumb structures produced by worm and ant action. It grades into bright red clay which has a moderately blocky structure. This overlies sascab (weathering limestone), usually within 50 cm of the surface. The soft sascab is usually capped by a continuous or fragmented carapace of harder limestone. These carapaces tend to be more pronounced than in the dark Louisville clays. In places these shallow clays occupy gentle swales, separated by intervening low banks of coral limestone gravel in interstitial red clay. The banks were originally separated at suite and subsuite level, as part of the Remate Subsuite, but are now regarded as the extremely stony variant of the Xaibe Subsuite. In places the bright red colours grade into reddish browns and dark browns. These were separated as the Concepcion Subsuite in the Northern Belize LRA report (King *et al.*, 1992) but are now incorporated as brownish variants of Xaibe.

There are places where the red clays accumulate by weathering and inwash, and reddish profiles up to a metre deep are found. However most of the deeper clays that accumulate on lower slopes have yellowish or yellowish brown matrix colours. They may also have greyish, reddish and rust-brown mottling in the subsoils. The subsoils tend to have blocky structures and patches of soft secondary lime, but gypsum is rare. These yellow clays are not extensive because there are fewer declivities and swamps than in the Louisville dark clay areas. The soils were classified as the former Puluacax Subsuite in the Northern Belize LRA (King *et al.*, 1992).

Like Louisville, Xaibe Subsuite now includes a considerable range of profile morphologies. These can be separated at series levels if required. The variations are reflected to some extent in the natural vegetation with broadleaf forest of medium height and many sapote trees on the better drained clays, grading to a lower stature broadleaf forest with some pucte trees and many botan palms on the deeper and more slowly drained yellowish clays.

GUINEA GRASS SUITE

Guinea Grass Suite on the sandy Late Tertiary limestones of northern Orange Walk District is divided into two subsuites as summarized in Table 11.

Table 11 Subsuites in Guinea Grass Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*
Lazaro	Black or very dark grey crumbly loam over dark grey sandy clay over weathering sascab, sometimes with capping of harder stones (carapace); undulating plain with broadleaf forest	NB 1992	OZ 3, OZ 5 OZ 9, OZ 10 (NB 1992)
Pixoy	Black or very dark grey loamy sand or sandy loam over dark grey or grey sandy clay loam or sandy clay, over weathering sascab, sometimes with a capping of harder stones (carapace); undulating plain with broadleaf forest	NB 1992	OZ 1, OZ 23 OZ 65, OZ 72 (NB 1992)

* LRA report: NB 1992 = King *et al.*, 1992

Lazaro Subsuite

The soils of Lazaro Subsuite (Cambisol, Luvisol; Eutropept, Udalf) are the more extensive, and are the main soils for sugar-cane and mechanized cereal production in the northern part of Orange Walk District. They have very dark medium-textured topsoils with good crumb structures. The sand is mostly fine or medium grained. The subsoil is lighter in colour but is still dark grey. It shows an increase in clay content, and sandy clay textures are most common. The structure is moderately blocky and shows signs of worm activity. The soil grades into sascab (weathering limestone), often with a capping of harder fragments of limestone or carapace.

As in the other subsuites of limestone soils in northern Belize, Lazaro includes a range of depths and drainage status. The most widespread soils are shallow or moderately deep with the limestone at 80 cm or less. However on the lower slope, close to the margins of swamps, the profiles are deep, with sascab often below one metre. These profiles often have a lower subsoil horizon of light grey or very pale brown sandy clay. This may be faintly mottled and have soft patches of secondary lime, but gypsum is very rare. Drainage of the subsoils of these deeper lower slope soils is slow, but not so impeded as to prevent their cultivation for sugar-cane or mechanized cereals.

Pixoy Subsuite

The soils of Pixoy Subsuite ((Luvisol, Planosol; Udalf, Aqualf) are coarser-textured analogues of Lazaro. The topsoil is black or very dark grey, loamy sand or sandy loam. This has a good crumb structure in the loams, but tends to be weak and crumbles to single grain in the sandier soils. The subsoil is dark grey or grey. There is a marked increase in clay content with depth; sandy clay loam is the commonest texture but some sandy clays also occur. Structures are moderately blocky. In the predominant shallow and moderately deep soils, this horizon overlies sascab, often with a stone line of harder limestone fragments, by about 80 cm. On lower slopes and in other sites of accumulation the profiles are deeper. These deeper soils have a lower subsoil horizon which is light grey or pale, has sandy clay loam or sandy clay textures, and has moderate blocky structure. It may be weakly or moderately mottled but secondary lime is rare, and gypsum has not been seen. Pixoy therefore encompasses a considerable range of depth and drainage. The natural vegetation of most of the subsuite is broadleaf forest, which can be of very diverse composition including both species normally associated with neutral soils over limestone, such as sapote, and acidiphilous species, such as pine and oak. This reflects the varied chemical characteristics of these soils which range from full base saturation to acidity and base deficiencies. However, much of the natural vegetation has been cleared for sugar-cane and cereal cultivation.

ALTUN HA SUITE

The soils of Altun Ha Suite are derived from the flinty siliceous Late Tertiary limestones of northern Belize District and small areas in neighbouring parts of Orange Walk and Corozal Districts. They are divided into two subsuites as summarized in Table 12.

Jobo Subsuite

Jobo Subsuite (Cambisol, Luvisol; Eutropept, Udalf) is the more extensive and important. It is morphologically variable with fine earth textures from loam to clay, and colours from grey through brown to reddish brown. Consistent features are an increase in clay content with depth and the presence of flints. The flints may be concentrated, on the surface or as a subsoil stone line, or may be scattered throughout the profile. A common position is as a stone line overlying the limestone. This is usually fairly shallow, between 50 and 100 cm. It differs from most other limestones in northern Belize in being microcrystalline and hard, fracturing to give hard planar or subconchoidal faces. It tends to form a thick carapace of hard rock over the slightly weathered material beneath. The competence of this carapace gives rise to the 'pitted plain' appearance of this landscape, with numerous small solution holes and hollows, surrounded by rims of hard intact rock.

As in the other limestone soils, there is a tendency to deeper and slightly imperfectly drained profiles on the margins of larger swamps and in other accumulation sites. These deeper soils have pale coloured lower horizons with moderate blocky structures and weak or moderate mottling, but gypsum is rare.

Rockstone Subsuite

The soils of Rockstone Subsuite (Leptosol, Cambisol; Eutropept) are not extensive. The profile consists of a dark grey or brownish coarse-textured topsoil overlying a grey or brown medium-textured subsoil. A feature of these soils is the very high contents of flints which are usually found throughout the profile. Textures therefore tend to grade from stony loamy sand or sandy loam to very stony sandy loam or sandy clay loam. The stones dominate the structure of the soil. The soil overlies the same hard microcrystalline limestone as the Jobo soils. In some of these soils there appears to be a thin layer of slightly sulphidic-smelling clay over the limestone. If this is a remnant of a subrecent mangrove deposit, it

Table 12 Subsuites in Altun Ha Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*
Jobo	Dark greyish or brownish loams and clays with or without flintstones, over grey and brown stony clay, over hard flinty limestone	NB 1992	OZ 22, OZ 25 OZ 49, OZ 55 OZ 56, OZ 57 OZ 58 (NB 1992)
Rockstone	Greyish or brownish stony sandy loam or loamy sand over grey very stony sandy loam or sandy clay over flinty limestone	NB 1992	OZ 89 (NB 1992)

* LRA report: NB 1992 = King *et al.*, 1992

suggests that at least some of the sand in these soils is derived from Quaternary beach deposits, and not from the underlying flinty limestone.

BAHIA SUITE

Bahia suite encompasses a heterogeneous but not very extensive group of soils, the common feature of which is that they occur on very recent limestones close to sea level, fringing Chetumal Bay. It is divided into two subsuites as summarized in Table 13.

Consejo Subsuite

The soils of Consejo Subsuite (Leptosol, Cambisol; Eutropept) are found on the northern shore of Corozal Bay. The profile consists of shallow black or very dark grey clay, loam, muck or peat over gypsiferous limestone. There is usually a pronounced stone line of hard coral fragments over the gypsiferous material. The substrate is not very permeable and these soils tend to be wet, possibly accounting for the tendency to peatiness. These soils support low broadleaf forest which must be adapted to the high gypsum levels.

Remate Subsuite

Remate Subsuite (Leptosol; Eutropept) includes the shallow and stony clays found on recently emergent coral limestone, mostly in patches along the southern shore of Chetumal Bay. Colours vary from black, through brown and reddish brown to red. The limestone usually occurs within 30 cm of the surface. This subsuite has been reduced since the Northern Belize LRA report (King *et al.*, 1992). It used also to include the very shallow and stony red clays on low ridges of coral rubble at higher levels. These have now been included as a very strong variant of Xaibe red clays, with which they are intricately intermixed.

REVENGE SUITE

The soils of Revenge Suite are formed in compound parent materials in which siliceous sands and loams overlie limestone. The depth of siliceous material varies from a few decimetres to over two metres, but the limestone is shallow enough for biological cycling of calcium and, therefore, can influence the chemistry of the upper solum. The sandy material is some kind of alluvial deposit, laid down by former rivers or in shallow marine conditions. In some of these soils there appears to be a deposit of calcareous marine clay between the sand and the limestone.

Table 13 Subsuites in Bahia Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*
Consejo	Black or dark grey clay muck or peat, over hard coral stone line, over weathered limestone, usually gypsiferous	NB 1992	OZ 45 (NB 1992)
Remate	Dark grey, black or brown very stony clay over shallow hard coral limestone, usually within 30 cm of surface	NB 1992	OZ 18 (NB 1992)

* LRA report: NB 1992 = King *et al.*, 1992

Although not extensive, the soils of this suite are very heterogenous. They are divided into only two subsuites, as summarized in Table 14, each of which encompasses a considerable range of variation.

Felipe Subsuite

The soils of Felipe Subsuite (Eutric Planosol; Albaqualf) are formed where there is a considerable depth of sandy material, at least one metre and often more than two. The profile somewhat resembles that of the acid duplex soils (planosols) of Puletan Suite. There is a shallow, dark grey or black sandy-sandy loam topsoil over a pale-coloured upper subsoil of similar texture. This changes fairly abruptly to a sandy clay-sandy clay loam, with a compact consistence and prominently contrasting mottling of red, yellow, light grey and pale brown. This eventually grades into weathering limestone but is rarely seen in ordinary augerings or profile pits as it is often more than 2 m deep. However, it manifests itself in the subsoil exchangeable and total calcium levels, which are considerably higher than in the superficially similar soils of Puletan Suite (see Table 32). The general nutrient levels and physical conditions in the upper horizons, where rooting is concentrated, in Felipe Subsuite are too dystrophic to support broadleaf forest, and the natural vegetation is Pine Ridge savanna. These soils occur in the isolated areas of Pine Ridge in the north of Orange Walk District, such as around Chan Pine Ridge, and stretching north and south from August Pine Ridge. Some of the soils on the high alluvial deposits in the central Belize Valley, such as Erindale and Rough Mile series (Birchall and Jenkin, 1979), also qualify for this subsuite.

Tok Subsuite

In the soils of Tok Subsuite (Eutric Planosol; Albaqualf) the siliceous sandy topsoil is rarely more than 50 cm deep. It is dark grey at the surface, and grades to grey or light grey below. It abruptly overlies a grey sandy clay or clay. This is mottled with reds, browns and yellows but does not achieve the striking colour contrasts of the 'corned beef' subsoils of Felipe Subsuite or Puletan Suite. It is quite calcareous, and the lower sections may contain patches of secondary lime and considerable quantities of gypsum crystals. A feature of this horizon in some profiles is its extraordinary stickiness and plasticity when moist or wet. Digging a profile in it can be a frustrating and comical exercise, scraping soil from spade to machete to shovel and back to spade again. This horizon often has as much as ten times as much clay as the sandy surface material, and it overlies sascab at depths from about one to well over two metres.. Clay contents within the horizon may further increase with depth. Like those of Felipe Subsuite, these soils support a rather scrubby Pine Ridge savanna despite moderate subsoil levels of exchangeable and total calcium. The pine trees are scattered and stunted-looking. There is also a high proportion of calabash trees. Some Erindale and

Table 14 Subsuites in Revenge Suite

Subsuite	Distinctive features and environment	Detailed description (LRA report)*	Profile descriptions and analyses (LRA report)*
Felipe	Dark coarse-textured topsoil over pale coarse-textured topsoil, over red, yellow and grey mottled sandy clay or sandy clay loam, over limestone at depths greater than about 2 m	NB 1992	OZ 4 OZ 25 (NB 1992)
Tok	Shallow grey coarse-textured topsoil over mottled plastic calcareous clay or sandy clay over limestone, usually within 2 m	NB 1992	OZ 21 OZ 60 (NB 1992)

* LRA report: NB 1992 = King *et al.*, 1992

Rough Mile series soils probably qualify for this subsuite (Birchall and Jenkin, 1979), although the possibility of establishing a separate subsuite for the calcareous-influenced alluvial soils of the central Belize Valley also needs to be considered.

PULETAN SUITE

The soils of Puletan Suite develop in deep, siliceous, old alluvium on the coastal plain. They are extensive soils, stretching from Deep River in Toledo District almost to Tower Hill Ferry in Orange Walk District, and inland as far as Ramgoat Creek. They are subdivided into six subsuites, as summarized in Table 15, four of which are distinguished on differences within the coarser upper horizons.

The soils of this suite have some striking profile features in common. They all have subsoils that are brightly mottled with strongly contrasting red and white blotches. In places these have a laminar arrangement, possibly dating from their original deposition. Others have a more vertical alignment, possibly due to burrowing by marine worms (B. Holland, 1991, personal communication). Others have a lattice structure possibly due to the weathering of very old corestones or to a combination of horizontal layering and vertical burrowing. The strong colour contrast is quite distinctive and is locally referred to as 'corned beef'. It is a well-developed example of the flambon horizon of FitzPatrick (1988). The textures of this horizon vary from sandy clay loam to clay with sandy clay predominant. These horizons are generally densely packed with high bulk densities and low porosities. They are of compact consistence, tending to plinthic and ferricrete induration in the red patches. They have low permeability to water and poor penetrability by roots. They are very base deficient, although only moderately acid (pH about 5 in water). The age of this material is unknown. In previous LRA reports it was assigned to the Pleistocene, but several observers have since suggested that it may be older, dating from the Late Tertiary, possibly the Miocene (B. Holland, 1991, personal communication). It is certainly quite thick and the underlying rocks, mainly limestones, play no part in soil processes except in a few places where relict pinnacles protrude close to, or through, the surface.

The overlying material is always of coarser texture, pale colour, looser consistence and high permeability and root penetrability. It is also moderately acid and very base deficient. It varies considerably in depth, colour and texture, but its lower boundary with the 'corned beef' is always very distinct and usually abrupt.

The mottled 'corned beef' subsoil is treated as a constant and homogenous feature of all the subsuites except for Ben Lomond which has much ferruginous gravel. In the Toledo and Stann Creek LRA reports, distinctions were made on subsoil consistence, but these have been abandoned as this property varies with moisture content. However, there are other differences in these horizons, especially in the quantity, group size and angularity of the quartz sand components and in the mineralogy of the clays, the investigation of which is likely to help unravel the sedimentology of the alluvium and the pedogenesis of the soils. In particular the occurrence of bodies of virtually sandless smectoid-looking clays, as at Mile 59 on the Southern Highway, needs to be investigated.

Another crucial pedogenetic query in these soils is the relationship between the coarse upper layers and the mottled subsoils. Are they derived from the same source, with the upper horizons having had their clays depleted by vertical eluviation, weathering and solution, and selective lateral erosion by surface and subsurface lateral runoff? Or are the surface layers the results of later deposition by tidal beach sorting, wind or post emergence hillwash? The occasional occurrence of stone lines between the upper layers and the mottled subsoils suggests that they may be of different sedimentary origins and ages, but the stones may indicate the lower limit of soil faunal excavation and sorting, and may therefore be relatively modern pedogenic features.

Table 15 Subsuites in Puletan Suite

Subsuite	Distinctive features and environment	Detailed descriptions (LRA report)*	Profile descriptions and analyses (LRA report)*	Previous LRA* subsuites included (possible future series)
Crooked Tree	Shallow or absent dark sandy topsoil over deep brilliant white sand; this may have weak podzolic illuvial horizonsof brown or dark brown organic matter or yellowish brown illuvial iron sesquioxides; in other profiles the white sand is non-podzolized; the lower subsoil is brightly mottled red, white and yellow compact 'corned beef' sandy clay loam or sandy clay, at depths of over 50 cm, usually over 1 m	NB 1992	OZ 54, OZ 59 (NB 1992)	(Some Savannah) (SC 1989)
Boom	Dark sandy topsoil over light grey, white or pale yellow sand, sometimes going bright yellow at base, abruptly over brightly mottled red and white compact 'corned beef' sandy clay or sandy clay loam	TL 1986 (as Savannah) SC 1989 (as Savannah and Serpon) NB 1992	TL14/14 TL14/15 (TL 1986) SC14, SC29 SC30, SC33 SC53 (SC 1989) OZ 13, OZ 14 (NB 1992)	Savannah (TL 1986) Savannah and Serpon (SC 1989)
Bladen	Shallow, dark loamy topsoil over yellow, or pale brown loam, abruptly over bright and red mottled compact sandy clay 'corned beef' subsoil.	TL 1986 SC 1989 (as Regalia) NB 1992 (as Backlanding)	TL14/4,TL14/5 (TL 1986) SC27, SC42 SC50 (SC 1989)	Regalia (SC 1989) Backlanding (NB 1992)
Ben Lomond	Upper profiles mostly loamy like Bladen, but also some Boom and Crooked Tree-type topsoils; distinctive feature is abundant ferricrete in 'corned beef' subsoil, as gravel or continuous slabs; found only on moderately high and older deposits in Central Belize	NB 1992	SC53 (SC 1989) OZ 83, OZ 84 (NB 1992)	Part of Serpon (SC 1989) Bocatora (NB 1992)
Haciapina	Shallow grey sandy surface over deep, pale wet sand, abruptly over brightly mottled red and white sandy clay loam-sandy clay compact 'corned beef'; found on lower slopes, fringing palmetto wet spots	TL 1986 SC 1989	SC48 (SC 1989)	-
Button-wood	Profile form variable; distinctive feature is salinity, which may give topsoil reddish colours and puffy consistence; limited distribution near coast or saline/brackish springs inland; distinctive silver buttonwood bush	SC 1989 NB 1992	SC 41 (SC 1989)	-

* LRA reports: TL 1986 = King *et al.*, 1986
SC 1989 = King *et al.*, 1989
NB 1992 = King *et al.*, 1992

Crooked Tree Subsuite

The upper layers of the profiles of Crooked Tree Subsuite (Arenosol, Planosol; Quartzipsamment, Albaquult) are very coarse textured, usually sand and only occasionally loamy sand. They differ from those of Boom in that they are deeper than 50 cm and often more than one metre. The sandy horizons are very permeable, freely drained and tend to have very pale colours, often dazzling white. In some of the deeper sands there is incipient podzolization. Because of the lack of iron in the quartzose parent material, it is usually organic matter that has been mobilized, transported and deposited. This shows as brown or dark brown horizons in the middle sections of the sandy layers making these soils weak humic podzols. Occasionally there is sufficient iron for a weak ferri-humic podzol to have started. The soils of this subsuite can only form where there is deep sand, and they are mainly found north of the Belize River, particularly on the upper slopes of the Pine Ridge interfluve that runs northwards from Ramgoat Creek through Lemonal and almost to Carmelita. However, patches are found as far south as Gales Point. A feature of these soils is the vigour of their Pine Ridge vegetation, with well-grown pines, oaks and common wild cashew.

Boom Subsuite

The most extensive soils are those of Boom Subsuite (Dystric Planosol; Albaquult). They have coarse-textured topsoils, never finer than sandy loam and usually sand or loamy sand. The colour sequence is normally shallow black or very dark grey topsoil, overlying white, light grey or pale yellow subsoil. In the south this horizon often grades to bright yellow at the base, lying abruptly above the mottled 'corned beef' subsoil. The total depth of the sandy upper layers is less than about 50 cm. This subsuite incorporates the former Savanna Subsuite of Toledo LRA and the former Savannah and Serpon Subsuites of Stann Creek (King *et al.*, 1986, 1989). The vegetation is typical Pine Ridge.

Bladen Subsuite

The upper horizons of the soils of Bladen Subsuite (Dystric Planosol; Tropaquult) are medium textured, ranging from sandy loam to silty clay loam. They are known locally as the 'clay Pine Ridge' soils. There is still an abrupt increase in clay content at the lower boundary between the topsoil and the 'corned beef' subsoil, commonly doubling or more over a depth interval of a decimetre or so. The medium-textured upper layers tend to be shallow, always less than 60 cm, and usually less than 40 cm. They also tend to be less pale coloured than those of the sandier subsuites, mainly ranging from pale yellow through yellow to pale brown. They often have moderate or better crumb structures and considerable remnants of worm casts at the surface. The vegetation of these soils is typical Pine Ridge. These soils occur throughout the coastal plain but appear to be more widespread in the south, possibly reflecting variations in the provenance and grain size of the alluvium.

Ben Lomond Subsuite

Ben Lomond Subsuite (Planosol, Plinthosol; Albaquult, Plinthaquult, Plinthudult) is distinguished on the characteristics of the 'corned beef' subsoil rather than the overlying horizons. The topsoils vary in texture, colour and depth, but Bladen-type shallow, yellowish loams are the most common. The distinctive feature of the subsoil is the presence of substantial quantities of ferruginous gravel, sometimes cemented into ferricrete slabs and sheets. This is an intensification of a tendency for the red patches to indurate in all of the Puletan subsoils. Its further development in this subsuite appears to require considerable time and special topographic/hydrological conditions, as these soils only occur on remnants of high-intermediate alluvial terraces, especially between the Manatee and Sibun rivers. Similar soils are found on higher alluvial remnants around the Zoo and La Democracia on the Western Highway. However, some of the ferricrete fragments there are well polished, suggesting that they formed elsewhere and have been imported during the deposition of the alluvium. This subsuite was called Bocatora in the Northern Belize LRA report (King *et al.*, 1992), but has been renamed to avoid confusion with the Bocatora Series in Bladen Subsuite in the Toledo LRA (King *et al.*, 1986).

Haciapina Subsuite

The upper layers of the soils of Haciapina Subsuite (Planosol, Gleysol; Albaquult, Umbraquult) are coarse textured. However they differ from those of Crooked Tree and Boom Subsuites in being wet for most of the year. They are pale coloured, usually light grey or pale yellow. They are very poorly structured, forming a single grained semi-fluid sludge when saturated. They abruptly overlie compact, brightly mottled 'corned beef' sandy clay or sandy clay loam at variable depths, but normally between 50 and 100 cm.

Buttonwood Subsuite

The sixth subsuite is Buttonwood (Salic Eutric Planosol; Salic Albaquult). These soils are not extensive, occurring in strips and patches along the coast and as small pockets near saline or brackish springs inland. Their distinctive feature is that they are saline. Their profiles have variable morphologies with a range of coarse and medium textures of various depths for the upper layers. They often have a reddish tinge and puffy, loose consistence when dry - a consequence of their salinity. The salinity appears to come from saline groundwater or windblown spume. These soils have a distinctive natural vegetation that is dominated by the shrub silver buttonwood.

TINTAL SUITE

The swamp soils of Tintal Suite are divided into four subsuites as summarized in Table 16. They are distinguished mainly on their drainage regimes and therefore each covers a considerable range of morphological variation.

Sibal Subsuite

Sibal Subsuite (Gleysol, Histosol; Aquent, Histosol) includes all of the soils of perennially wet freshwater swamps. The mineral soil profiles are gleyed and wet to the surface, with grey matrix colours, sometimes with bluish or greenish tinges in the subsoils, and rust mottling. Textures vary from sand to clay and often show signs of layering inherited from the alluvial deposition. Because of the perennial wetness, the decomposition of organic litter is retarded. These soils often accumulate organic matter at the surface, building up into muck or even peat layers. These soils occur in inland swamps throughout the country and are most extensive in the larger depressions in the undulating terrain of northern Belize. This subsuite incorporates the former Laguna, Silver Creek and Curocoa Subsuites of the now-defunct Caway Suite from the Toledo LRA report (King *et al.*, 1986). These were differentiated on texture and degree of textural layering. The distinctions may serve for series definitions in the future, if required.

Ycacos Subsuite

Ycacos Subsuite (Gleysol, Histosol; Aquent, Fibrist, Hemist) includes all perennially wet soils deeper than 50 cm in mangroves and other saline swamps. They are gleyed and wet to the surface and are texturally heterogeneous. The soils are formed in recent marine alluvium, which may overlie hard coral but this is at depths greater than 50 cm. The soils tend to be less mottled and peaty than the freshwater swamp soils of Sibal Subsuite. They tend to be of soft raw consistence. They are saline and often contain abundant gypsum crystals, almost to the surface.

Table 16 Subsuites in Tintal Suite

Subsuite	Distinctive features and environment	Detailed descriptions (LRA report)*	Profile descriptions and analyses (LRA report)*	Previous LRA* subsuites included (possible future series)
Sibal	Perennially wet peats and soils of freshwater swamps; gleyed and mottled to surface; textures variable with some layering but clays predominant; swamp forests and sedge communities	TL 1986 SC 1989 NB 1992	TL15/4,TL15/2 TL18/1 (TL 1986) (SC 48) (SC 1989) (OZ 85) (NB 1992)	Laguna Silver Creek Curocoa (TL 1986)
Ycacos	Perenially wet peats and soils of saline and brackish swamps; gleyed to surface; textures variable; may have hard coral at depths more than 50 cm; saline mangrove forest or savanna	TL 1986 SC 1989 NB 1992	OZ 30, OZ 32 (NB 1992)	-
Pucte	Gleys of seasonally wet margins of freshwater swamps; brown crumb top-soil over grey calcareous mottled clay, over pale plastic calcareous clay often with gypsum crystals; swamp forest	NB 1992	OZ 48, (OZ 85) (NB 1992)	-
Chucum	Gleys of seasonally wet depressions in undulating limestone terrain; dark clays, with occasional sandy clay, to more than 1 m; wide cracking to give coarse blocks or prisms in dry season, closing to give massive sticky plastic clay in wet; usually gypsum crystals in subsoil; low akalche bush, often with logwood	NB 1992	OZ 71 (NB1992)	-

* LRA reports: TL 1986 = King *et al.*, 1986
SC 1989 = King *et al.*, 1989
NB 1992 = King *et al.*, 1992

Pucte Subsuite

The soils of Pucte Subsuite (Gleysol; Aquept, Aquoll) occur in seasonally wet sites around the margins of the larger swamps in the undulating terrain of north Belize. They carry a characteristic broadleaf forest with many pucte and chechem broadleaf trees and botan palms. The surface often has a marked hummocky micro-relief, possibly initiated by clay shrink-swell but apparently accentuated by surface runoff and stabilized by small-scale variations in worm activity and plant rooting. The topsoil is often brown clay, intensively worked by worms to give a very friable, well-developed crumb structure. At about 20-30 cm, this grades into grey mottled blocky clay, which is often soft and plastic when wet but dries quite hard. In some profiles the plastic grey clay rests directly on sascab within a metre, often capped with a fragmented carapace of harder stones. In others it grades into light grey or very pale brown clay with faint mottles. This is massive when wet, as it is for most of the year, but cracks to give very coarse blocks when dry. It often contains many gypsum crystals, sometimes concentrated in clumps.

Chucum Subsuite

The soils of Chucum Subsuite (Gleysol; Aquept) occur in internally drained and seasonally flooded depressions in the undulating limestone plain of north Belize.

They carry a characteristic low stunted bush with a high proportion of sclerophyllous tree and shrub species, including logwood. The profile consists of grey or dark grey clay, which becomes slightly lighter in colour with depth. In the wet season the clay is massive, plastic and sticky almost to surface. In the dry season these soils dry out to depths of a metre or more, and crack to give very pronounced coarse prismatic structures, with some oblique surfaces and well-developed slickensides. These soils usually have gypsum at depths below 50 cm. In places close to areas of pine ridge, these soils may contain some inwashed sand but retain their characteristic colour, structure, gypsum and vegetation.

MELINDA SUITE

Melinda Suite includes all of the moderately and well-drained soils derived from river alluvium. It encompasses considerable variability of parent material grain size and age. The soils are divided into six subsuites as summarized in Table 17.

Monkey River Subsuite

Monkey River Subsuite (Fluvisol; Fluvent) includes all of the young soils on floodplains on wholly siliceous alluvia. Beneath dark grey or dark brown topsoils, the predominant colours are grey, brown or yellowish brown. The colours are often banded according to the layering of the alluvium. Matrix colours are predominantly grey in the subsoils of profiles in low-lying areas where water-tables are intermittently high. The youth of these soils shows in marked textural layering inherited from the alluvium, and so far only slightly homogenized and redistributed by pedogenetic processes. Silt contents are high in some layers, and are often associated with high contents of fine, glinting muscovite flakes. These soils are only slightly acid- and base-deficient because of their youth and despite their siliceous provenance. Two former subsuites were distinguished in the Stann Creek LRA report (King *et al.*, 1989) that are now incorporated into the Monkey River Subsuite. The soils of the former Sarawina Subsuite develop in a layer of young Monkey River-type alluvium overlying wet granitic hillwash/fan material. They are of restricted extent, believed to occur only on the southern flank of the floodplain of the lower section of North Stann Creek. The soils of the former Waha Leaf Subsuite are developed in coarse quartzose and muscovitic alluvium derived from granite. They are greyish brown in colour but appear to be well drained. They are of limited extent, being restricted to the floodplains of minor rivers draining wholly granitic catchments in the eastern Maya Mountains.

Quamina Subsuite

The soils of Quamina Subsuite (Fluvisol; Fluvent) are morphologically very similar to those of Monkey River Subsuite in their grey and brown colours, textural range and layering, and high silt and muscovite contents. They are also young soils developed in recent alluvium and occur in floodplain deposits. They differ in that the alluvium is of mixed siliceous and calcareous origins, or it is mainly siliceous but is regularly inundated and suffused with hard water from calcareous catchments. The result is that the soils have higher pH and exchangeable bases, especially Ca and Mg, than the Monkey River soils.

Hondo Subsuite

The soils of Hondo Subsuite (Fluvisol; Fluvent) are not extensive. They develop in the limited patches of calcareous alluvium deposited by the few and generally sluggish streams in the undulating limestone terrain of the Northern Coastal Plain. They are inextensive because the limestone weathers by solution, and most infiltration percolates down through the porous rock to groundwater, so that there is little surface runoff and such as there is carries little alluvium. The soils are dark clays, varying from black to grey. The subsoils may be faintly or moderately mottled and contain some gypsum crystals. Textures vary from clay

Table 17 Subsuites in Melinda Suite

Subsuite	Distinctive features and environment	Detailed descriptions (LRA report)*	Profile descriptions and analyses (LRA report)*	Previous LRA* subsuites included (possible future series)
Monkey River	Young, grey and brown soils on siliceous alluvium of floodplains in central and southern Belize; textures variable according to deposition; high silt and mica contents; may be mottled in subsoils; broad-leaf riparian forest	TL 1986 SC 1989 NB1992	SC3, SC4 SC10, SC24 SC40, SC43 SC45, SC46 SC47 (SC 1989)	Waha Leaf, Sarawina (both SC 1989)
Quamina	Young, grey and brown soils on mixed siliceous and calcareous alluvium of floodplains of central Belize; textures variable according to alluvial deposition; high silt and mica contents; broadleaf riparian forest	SC 1989 NB 1992	SC16, SC17 (SC 1989) OZ 61, O Z62 OZ 63 (NB 1992)	-
Hondo	Dark and grey layered clays in calcareous alluvium of north Belize; may be mottled and contain gypsum in subsoil; calicole broadleaf forest	NB 1992	-	Pasmore (NB 1992)
Canquin	Brown and reddish loams and clays in siliceous old alluvium of terraces; some textural layering from alluvium but also some argilluviation; may have seasonally fragic subsoil; calcifuge broadleaf forest	TL 1986 SC 1989 NB 1992	TL16/10, TL16/4 (TL 1986) SC5, SC7 SC13, SC44 SC51, SC52 (SC 1989)	Logan Bank. (TL 1986) Old Bank (TL 1986 and SC 1989) Pomona (SC 1989)
Governor	Brown and reddish loams and clays in mixed granitic and metasedimentary old alluvium on low-angle fans flanking the eastern foothills of Maya Mountains; some argilluviation; intensely fragic consistense in subsoil when dry; broadleaf forest	TL 1986 SC 1989	TL6/10 (TL 1986) SC28 (SC 1989)	-
Croja	Variable grey or brown sandy-loamy topsoil over compact brightly mottled red, white and yellow loam-clay; discontinuous strips of high-level alluvium on some streams in southern and central Belize; Broken Ridge forest	TL 1986 SC 1986	TL6/3 TL6/7 (TL 1986) SC22, SC25 SC36, SC61 (SC 1989)	Sirin Trio (TL 1986)
Sennis	Between 30 and 100 cm of grey and brown layered micaceous loams and clays as in Monkey River, over-lying compact red and white 'corned beef' sandy clay of Puletan type; alluvium of minor creeks coming out of Maya Mountains and crossing coastal plain; broadleaf forest, tending to Broken Ridge and Broken Pine Ridge in places	TL 1986 SC 1989 NB 1992	SC15, SC49 SC50 (SC 1989) OZ 82, (NB 1992)	-

* LRA reports: TL 1986 = King *et al.*, 1986
SC 1989 = King *et al.*, 1989
NB 1992 = King *et al.*, 1992

loam, through silty clay to heavy clay. Clay contents may vary with depth, due more to alluvial stratification than to argilluviation. Weak and discontinuous stone lines of subrounded limestone fragments may occur; they are stratigraphic rather than pedogenic features. The soils are slightly alkaline and fully base saturated.

Canquin Subsuite

Canquin Subsuite (Cambisol, Acrisol; Dystropept, Udult) includes all of the well-drained and imperfectly drained soils on older alluvium of river terraces. These vary considerably in age and height above current base levels. Three distinct levels of terraces above the current floodplain were noted in the Belize Valley (Jenkin *et al.*, 1976). There appear to be several distinct terrace levels in the Stann Creek Valley (King *et al.*, 1989) and along the Sibun (Wagner *et al.*, 1987). The soils therefore vary considerably in their pedological maturity and the extent to which alluvial features are still discernible. The topsoil is generally dark brown, and the subsoils are red or reddish yellow usually with yellowish mottling. In the soils on the highest and oldest terraces, the mottling increases in intensity with depth, eventually becoming an almost 'corned beef'-like strongly contrasting mixture of red and white at depths below two metres. Textures are loamy or clay. The inherited layering is much less marked than in young soils, but the alluvial origin is still obvious in the layers of rounded stones or boulders that occur in these soils in the upstream reaches of some valleys. Argilluviation has clearly occurred, with a tendency for clay contents to increase with depth and with well-developed clayskins on the subsoil structure faces. Although weathering and pedogenesis appear to have progressed considerably, there are still substantial silt contents and some fine muscovite flakes. These soils are quite firm and compact in the subsoils. The mottling appears to indicate some impedance of vertical drainage. This may contribute to the fragic consistence apparent in the subsoils of some profiles. This feature appears to be most marked in the soils on the terraces along the rivers of southern Stann Creek and northern Toledo Districts, such as the Swasey and Bladen. In the Toledo and Stann Creek LRA reports the former Old Bank and Logan Bank Subsuites were separated on the basis of fragipan development (King *et al.*, 1986, 1989). However, subsequent fieldwork suggests that the fragipan may be a seasonal feature, fading when the soils are thoroughly moistened. There is also doubt about how serious a barrier it is to rooting and, therefore, how significant it is edaphically and agriculturally. These subsuites have therefore now been incorporated into Canquin. The fragipan may serve as a criterion for differentiation at series level.

The high terraces of the Belize Valley are wider than those on other rivers. They appear to have retained a trace of the reverse slope topography inherited from their time as active floodplains. There are therefore patches of soils with restricted external drainage at the back of the terraces. Their inclusion makes this a very variable subsuite. As can be seen in Table 24 (in Part 6), nine soils series have already been identified and named in this subsuite, and that is just in the Belize River Valley.

Governor Subsuite

The soils of Governor Subsuite (Cambisol, Acrisol; Dystropept, Udult) are not extensive. They form in a series of discontinuous low-angle alluvial fans where some rivers issue from the mountains onto the coastal plain. The largest areas are at Trio and Waha Leaf Creeks. The soils are reddish loams or sandy clays, with a moderate increase in clay with depth. Their most striking and distinctive feature is the very pronounced fragipan development in the subsoil. The fragipan is reddish in colour, with silty or sandy clay loam texture, and it has moderate permeability and moderately high bulk density (about 1.5). However it is extremely indurated in situ and very difficult to auger or dig. These soils are thought to have both metasedimentary and granitic components in their parent materials.

The taxonomic placement of these soils in the LRA reports has been inconsistent. The subsuite was placed in Melinda Suite of alluvial soils in the Toledo report (King *et al.*, 1986). For Stann Creek, the granitic provenance was considered more important and they were put in Stopper Suite (King *et al.*, 1989). For this revision, demotion to series was considered, with the soils being included in the granitic outwash soils of Silkgrass Subsuite in Stopper Suite. However their finer texture, reddish colours, better base status and, above all, the fragipan make them considerably different from the main soils of Silkgrass which are deep, pale, coarse textured, friable and acid. They have therefore been left as a separate subsuite, and relocated back in Melinda Suite on account of their alluvial origin.

Croja Subsuite

As noted above the deeper horizons in Canquin profiles may be strongly mottled. There are also soils developed in old alluvium which have strongly contrasting, almost 'corned beef'-like, mottling within the top metre. They have been grouped together as Croja Subsuite (Planosol; Aquult). The upper horizons are varied, ranging from greyish, coarse loamy sands to brownish clay loams. These soils seem to be various pedogenetic origins. Some appear to result from prolonged and intensive argilluviation and mottling of originally fairly homogeneous alluvium. Others seem to have formed in compound and layered materials in which young riverine or hillwash deposits overlie older alluvium. These soils are not extensive and occur as discontinuous patches on the higher terraces of rivers in the south and centre of the country. There is a fairly large expanse of these soils in the upper Dry Creek - St Margaret's Creek catchment. These soils are quite acid and normally carry a rather stunted Broken Ridge-type of forest. This subsuite incorporates the former Sirin and Trio Subsuites in the Toledo LRA (King *et al.*, 1986).

Sennis Subsuite

Sennis Subsuite (Planosol, Fluvisol; Albaquult, Fluvent) includes soils formed where fresh alluvium has been deposited over 'corned beef' old alluvium of the Puletan type. The profile usually consists of Monkey River-type grey and brown layered sands, silts, loams and clays of 30-100 cm depth abruptly overlying compact, brightly mottled red and white sandy clay. The upper horizons are slightly to moderately acid and of good exchangeable base status. The mottled subsoil is acid and has low base status. These soils appear rather similar to those of Croja Subsuite but are found along the courses of intermediate streams that drain out of the Maya Mountains and cross the coastal plain. The larger rivers deposit thicker layers of fresh alluvium and their topsoils form in very young alluvium; the soils are classified in Monkey River Subsuite. Most small streams are ephemeral and originate in the coastal plain and therefore have no source of fresh fertile alluvium. Sennis soils carry broadleaf gallery forest, often quite low and dense, but forming very distinctive strips in the pine-grass savanna of the Puletan soils of the interfluves. These soils have been recognized as a separate subsuite in all the LRA reports: in the Toledo report they were classified as part of Puletan Suite on account of the mottled subsoil. However, it is now felt that a topsoil of fresh alluvium more than 30 cm deep is edaphically and agriculturally more important than the subsoil, and that the proper place for this subsuite is in Melinda Suite. Soils with less than 30 cm of fresh alluvium are part of Puletan Suite, probably best differentiated at series level within Bladen Subsuite.

There are limited areas of a variant of Sennis Subsuite in the north, particularly along the streams that drain westwards from wide limestone interfluves, across Pine Ridge and into the Booth River Lagoon and swamp. There the fresh alluvium is more of the Hondo type, so that the upper horizons consist of dark grey and grey calcareous clays, often with discontinuous stone lines of rounded limestone fragments. The subsoil is brightly mottled sandy clay, similar to that of the surrounding Pine Ridge soils.

TURNEFFE SUITE

The well-drained soils developed in young coastal deposits are classified as Turneffe Suite. The poorly drained soils on these deposits are classified as Tintal Suite, mostly in the Ycacos Subsuite. The soils of Turneffe Suite are divided into five subsuites as summarized in Table 18.

Shipstern and Ambergris Subsuites

The soils of the calcareous coastal deposits of northern Belize and the clays are subdivided according to the depth to hard coral. The distinction is based on limited field and laboratory data, and is therefore somewhat theoretical and tentative. Soils with less than about 50 cm of calcareous sediments are assigned to Shipstern Subsuite (Leptosol; Entisol), the deeper soils to Ambergris Subsuite (Arenosol; Psamment). The profile of soils of Shipstern Subsuite consists of pale-coloured sands and silts, mostly comminuted coral over hard coral. There may also be some clay. The soils of Ambergris consist of deep, pale sands made up of comminuted coral and limestone.

Hopkins Subsuite

The beaches of central and southern Belize mostly consist of quartz sands, originally derived from the Maya Mountains, and then rounded and sorted by river and coastal transport processes. The raw soils found on them are classified as the Hopkins Subsuite (Arenosol; Quartzipsamment). They consist of deep, pale, coarse or medium sands with little profile development except some topsoil melanization.

Table 18 Subsuites in Turneffe Suite

Subsuite	Distinctive features and environment	Detailed descriptions (LRA report)*	Profile descriptions and analyses (LRA report)*
Shipstern	Raw shallow sandy and muddy sediments usually calcareous over recently emergent coral; northern Belize and cays; scrubby white mangrove or stunted beach forest	NB 1992	OZ 31 Auger 38 (NB 1992)
Ambergris	Raw pale coarse soils in deep calcareous sands of modern or recent beaches of north Belize and cays; beach forest	NB 1992	OZ 32 (NB 1992)
Hopkins	Raw pale coarse soils in deep quartzose sands of modern or recent beaches in central and southern Belize; beach forest	SC 1989 NB 1992	-
Matamore	Young and slightly developed pink or yellow sands on relict subrecent coastal deposits; broadleaf forest	TL 1986 SC 1989 NB 1992	SC25 (SC 1989)
Barranco	Moderately leached red and yellow loams and clays on old coastal deposit in Toledo District; broadleaf forest	TL 1986	TL18/5 (TL 1986)

* LRA reports: TL 1986 = King *et al.*, 1986
SC 1989 = King *et al.*, 1989
NB 1992 = King *et al.*, 1992

Matamore Subsuite

There are a number of very low ridges inland from the modern coast, mainly in central Belize, that appear to be relict coastal deposits. The soils that have developed, so far only to a limited extent, form Matamore Subsuite (Arenosol; Psamment). They are of limited extent but are rather heterogeneous. Some are pale coarse-textured soils that appear to be descendants of former Hopkins-type soil, developed in wholly quartzose beach deposits. Despite their age, there is little reddening or clay formation as there are very few non-quartz minerals in the parent material available for weathering. The soils in the All Pines area appear to be of this type. Other Matamore soils are also very coarse textured, but do show some rubefaction, and some formation and translocation of clay. The sand fraction in these soils contains a considerable proportion of quartz grit that is quite angular, suggesting that these deposits have not been transported over great distances. Their location in the Silkgrass-Hopkins area suggests that they may be derived from the granitic outwash soils of Silkgrass Subsuite, that have been further reworked and redeposited by coastal processes when sea levels were higher and the coast further inland than at present.

Barranco Subsuite

The soils of Barranco Subsuite (Acrisol, Luvisol; Udult, Udalf) develop on discontinuous patches of old coastal alluvium from Seven Hills southwards to Barranco in Toledo District. The alluvium is derived from catchments of Toledo Beds sedimentary and Cretaceous limestone rocks. It is less quartzose than that originating in the granites and quartzites of the Maya Mountains. The soils are reddish yellow loams and clays, often with an increase in clay content with depth, and with compact but not fragic subsoils. They often have bright reticulate red and yellow mottling in the lower subsoil, indicating considerable age and impeded drainage. The vegetation is broadleaf forest but much of it has been cleared and many of these soils are now cropped for cassava and pineapples by Garifuna farmers.

FURTHER SUBSUITES

The above tables and descriptions include all the subsuites so far defined: Table 19 lists them alphabetically. However, unlike the soil suites, we do not see the current list as definitive. We can envisage circumstances in which future soil workers will need to define further subsuites. For instance, it may be felt that the subsuites defined above are too broad, and should be subdivided at subsuite level. In some cases this may involve no more than reviving subsuites that have disappeared by amalgamation in the current revision. For example, the current reconstruction on the Hummingbird Highway is opening up new cuttings through the lower spurs of the Maya Mountains and revealing many pockets of recent or active deep hillwash of metasedimentary material. There may therefore be a case for bringing back Dancing Pool Subsuite for deep colluvial soils in Ossory Suite (for its euphonious name amongst other reasons).

There are also soils which are not adequately covered in the subsuites described. They are likely to be of fairly limited extent. We know of some of them but have not had time to sort out their properties, distribution, and environmental and ecological relationships. For instance, the soils of the higher deposits of the coastal alluvium in the Belize River Valley are not adequately classified as either Puletan Suite or Tok Subsuite. Similarly the small area of red sandy soils in the Chiwa Lagoon area (see Profile OZ 23 in the Northern Belize LRA report) is not a comfortable fit in any of Xaibe, Jobo or Pixoy Subsuites. There are no doubt others waiting to be revealed by detailed surveys.

If subsuites are revived or created, it is essential that other workers should know about them. The names and definitions should be lodged with the Register of Soil Names at the Ministry of Agriculture (Central Farm) and at the Belize Center for Environmental Studies in Belize City.

Table 19 Alphabetical summary of soil subsuites

Subsuite	Suite	Table
Aguacate	Toledo	6
Ambergris	Turneffe	18
Baldy	Ossory	3
Ben Lomond	Puletan	15
Bladen	Puletan	15
Boom	Puletan	15
Borrowpit	Ossory	3
Buttonwood	Puletan	15
Cabbage Haul	Ossory	3
Cabro	Chacalte	8
Canada Hill	Stopper	5
Canquin	Melinda	17
Chacluum	Yaxa	9
Chucum	Tintal	16
Cimin	Toledo	6
Consejo	Bahia	13
Cooma	Ossory	3
Croja	Melinda	17
Crooked Tree	Puletan	15
Curassow	Ossory	3
Cuxu	Chacalte	8
Doyle	Richardson	4
Felipe	Revenge	14
Governor	Melinda	17
Haciapina	Puletan	15
Hondo	Melinda	17
Hopkins	Turneffe	18
Jacinto	Toledo	6
Jobo	Altun Ha	12
Jolja	Yaxa	9
Lazaro	Guinea Grass	11
Louisville	Pembroke	10
Machaca	Toledo	6
Matamore	Turneffe	18
Mayflower	Stopper	5
Monkey River	Melinda	17
Pinol	Stopper	5
Pippen	Ossory	3
Pixoy	Guinea Grass	11
Powder Hill	Stopper	5
Pucte	Tintal	16
Quamina	Melinda	17
Ramos	Richardson	4
Remate	Bahia	13
Rockstone	Altun Ha	12
Sennis	Melinda	17
Shipstern	Turneffe	18
Sibal	Tintal	16
Silkgrass	Stopper	5
Temash	Toledo	6
Tok	Revenge	14
Xaibe	Pembroke	10
Xpicilha	Chacalte	7
Yalbac	Yaxa	9
Ycacos	Tintal	16

Part 5

Soil series

INTRODUCTION

The soil series form the third tier in the classification. Soil series should be fairly homogeneous with respect to morphological, chemical and physical properties. The soils of a series should be amenable to uniform agricultural management, and they should have similar edaphic and ecological relationships. Within these constraints a soil series may be allowed to encompass some variability, particularly if this permits the delineation of simple single-series mapping units. It is possible to subdivide the series further into phases if necessary. This is normally done on the basis of topsoil textures, but is usually only necessary for detailed surveys preceding heavy investment in intensive irrigation.

The definition of soil series requires substantial field data. Soil series are only needed for surveys and studies at semi-detailed (1:50 000 mapping scale) or more intensive levels. Soil series were tentatively defined in the Toledo LRA report (King *et al.*, 1986). Subsequent detailed studies suggested that the attempt was premature (Baillie and Wright, 1988). For the reconnaissance level mapping (1:100 000 scale) of the subsequent LRA reports, series definitions were not attempted, and the soils were classified only to subsuite level (King *et al.*, 1989, 1992).

However there have been a number of surveys and studies detailed enough for series definitions and mapping. The most important is the semi-detailed survey of the Belize River Valley (Jenkin *et al.*, 1976; Birchall and Jenkin 1979). Others that cover smaller areas and more restricted ranges of soils include the surveys for the Toledo Research Development Project (Jenkin *et al.*, 1978; Walker and Anderson, 1983), Topco National Land (Baillie and Wright, 1988), and Hummingbird Hershey (Wagner *et al.*, 1987). Other studies of small areas that have defined and named soil series include surveys in the Yalbac-Hill Bank area (McCormack, 1987; Jacob, 1989).

Charter (1940 and 1941) named a considerable number of series. He did not define them in detail, and there are no profile descriptions or analyses. However, he described field relationships very clearly and includes graphic depictions of the profile morphology of the more important series. It is therefore possible to follow his series nomenclature to some extent. The names of all series so far described and named are listed in Table 20.

It is not yet possible to draw up a comprehensive list of soil series in Belize. This will require more detailed studies in different parts of the country. Future soil surveyors and pedologists will probably need to define many new series in such studies.

It is clear from Table 20 that there have been instances when soil surveyors and consultants have named series with insufficient attention to precedent use of names. This is unfortunate and negligent, and results in ambiguity and confusion for following workers.

Table 20 Existing soil series names (July, 1991)

Series	Source
Akalche	1
Almond Hill	2
Alta Vista	10
Arena	3, 4
Arenal	2
Baker	2
Banana Bank, Barton Ramie	1
Beaver Dam	1, 2
Belize	2
Bemudian Landing	1
Big Fall	5, 6
Big Pond	1
Blancaneau	2
Blue Creek	3, 4, 5
Bocatora*	5
Boden	5, 6
Boom, Boston	2
Burdon*, Butcher Burns	1, 2
Cadena Creek	1
Calcutta	2
Camelote	1
Canada	2
Canop	5
Cara Blanca	1
Cave	2
Caves Branch	7
Cayo, Ceiba	2
Central Farm	1
Chacluum	8, 9
Chalillo, Chial, Chiquibul	2
Chorro, Colonel English	1
Consejo	2
Corazon	5
Cornhouse	2
Cox's, Crabcatcher	1
Croja	2
Cutting Grass	6
Dog Creek	2
Domingo	3, 4
Double Head Cabbage	1
Douglas	2
Dry Creek*	2, 7
Duck Run	1
Dump	3, 4
Ellen Broaster	1
English Creek	2
Erindale	1
Esperanza	1
Estero, Estrela	2
Freetown	1
Fresco	2
Garbutt	1
Gracie Rock	2
Hachac Luum	8
Hattieville	1
Haulover	2
Hawaii, Hellgate	5
Hershey	7
Hinchasones	5
Hishilha	6
Hokeb	5
Hummingbird*	1, 7
Iguana	1
Indian Creek	2
Jolantunich	9
Jordan	5
Kates Lagoon	2
Kaway	1
Kinloch	2
Kramer	5
La Flore	2
La Perla, Lemonal, Listowel, Little Creek	1
Louisville	2
Lomitas, Lubaantun	5
Macaroni	2
Machaca, Mafredi	3, 4
Makal, Manatee, Marie, Maskall	2
Meditation	1
Melinda	2, 7
Melvin	5
Mico, Middlesex	2
Moho	5
Morning Star, Mount Hope	1
Mountain Cow, Mullin	2
Mumble de Peg	1
Naranjo	2
Nimli Punit	5
Norland	1
Orange Walk	2
Otoxha	5
Papinshaw	6
Patchacan, Pelly	2
Piedra	3, 4, 5, 6
Piedregal, Pucte	1
Pueblo Viejo, Quam	5
Rancho Dolores	1, 9
Roaring Creek	2
Robateau	5
Rockstone Pond	2
Rosewood	6
Rough Mile	1
St Margaret's	2
St Thomas*	2, 7
San Pablo, San Pastor	2
San Pedro	3, 4, 5
Santos Pine Ridge	1
Sarawe	2
Savannah Bank	7
Sayab Camp, Seven Mile	1
Sibun, Silk Grass (also Silk Grass Creek)	2
Sinche	5
Soccotz	2
Society Hall, Spanish Lookout	1
Stevenson	2
Sunday Wood	5
Tambos	1
Tigerbush	6
Tillet and Potts	1
Tipperary	10
Tower Hill, Turner	2
Vaca	2
Warrie	5, 6
Wetziltok	5
Willowbank	1
Wood	2
Xaibe	2
Yaha*	2, 5
Yaxcal	5
Yemeri	5, 6
Yo Creek	2
Young Girl	1

* Name has been used later for different soils. Best avoided, or used in the sense defined in the underlined source. Other series appearing in more than one source have been used with similar definitions

Source:
1 Jenkin *et al.*, 1976; Birchall and Jenkin 1979
2 Charter, 1940 and 1941
3 Jenkin *et al.*, 1978
4 Walker and Anderson, 1983
5 King *et al.*, 1986
6 Baillie and Wright, 1988
7 Wagner *et al.*, 1987
8 McCormack, 1987
9 Jacob, 1989
10 Darcel, 1952

PROCEDURE FOR ESTABLISHING SERIES

It is recommended that the procedure for naming a new soil series in future should be:

1. Check if the soil in question has been already described, defined and named at series level. Use existing series if possible.
2. If the soil series is new, and not as yet defined and named, avoid the name of existing series, or any name that could be confused with one (see Table 20 for the series known to us in 1991).
3. Also avoid using names that have previously been used for soil taxa other than series. This includes the soil set names of Wright *et al.* (1959) and the suite and subsuite names of the LRA reports (King *et al.*, 1986, 1989 and 1992). The names known to us that should be avoided are listed in Table 21. The names of former subsuites that have been lost by amalgamation in the current revision can be revived as series, provided that the series more or less corresponds in properties, distribution and general environmental and ecological relationships with the former subsuite.
4. Choose a place name from the type locality, or the name of a plant or animal characteristic of the soil or its environment. Avoid inappropriate names like Alta Vista for a valley floor alluvial soil or Arena for soils that have clay textures throughout. Use names of one or, at most, two words. Three word names are unnecessarily cumbersome. There is a wealth of colourful names in Belize, and time and attitudes have changed since Charter cautioned that,

   > "... locality names..., such as for example, 'Pull-Trouser Swamp' and 'Go to Hell Camp', whilst being both picturesque and descriptive are hardly suitable as soil series designations."
   >
   > (Charter, 1941, p7)

   In abbreviated form, these would now be welcome as series names, perhaps to be joined by Foulgut, Sale-se-Puede, Despair, Gallon Jug and others. Avoid ubiquitous place names like Black Creek and San Antonio, which recur quite frequently in different parts of Belize.
5. Once the series has been defined and named, leave details of the soil and copies of any supporting data with the Register of Soil Names in the Ministry of Agriculture (Central Farm) and at the Belize Centre for Environmental Studies (Belize City).

Table 21 Names to be avoided when defining new soil series

Aguacate, Altun Ha, Ambergris

Bahia, Baldy, Barranco, Bladen, Bobo, Borrowpit, Buttonwood

Cabbage Haul, Cabro, Canada Hill, Canquin, Caway, Chacalte, Chapayal, Chiquibul (also spelt as Chequibul), Chucum, Cimin, Cooma, Copetilla, Crooked Tree, Cumbre, Currasow, Cuxu

Doyle

Felipe

Governor, Granodoro, Guinea Grass

Haciapina, Hiccattee, Hondo, Hopkins

Jacinto, Jobo, Jolja

Lazaro

Manfredi, Matamore, Mayflower, Monkey River

Ossory

Quamina

Palmasito, Pembroke, Pinol, Pippen, Pixoy, Pomona, Powder Hill, Puletan, Puluacax, Punta Negra

Ramgoat, Ramos, Raspacula, Remate, Redbank, Retiro, Revenge, Richardson, Rockstone

Sanjuanilha, Sarawina, Sarstun, Savannah, Sennis, Shipstern, Sirin, Stopper, Swamp, Swazey

Temash, (also spelt as Temax), Tiger, Tintal, Tok, Toledo, Turneffe, Tziminkax

Vaqueros

Yalbac, Yaxa, Ycacos, Yobo

Xpicilha, Xunantunich

Part 6

Correlation with previous Belizean systems of soil correlation

INTRODUCTION

Some soil workers from overseas have been prepared to accept and work with existing soil classes. McCormack (1986), Christiansen (1986), and Fedick and Ford (1990) amongst others have found the classification of Wright *et al.* (1959) quite satisfactory. Others have felt it necessary to modify it or invent new names. Correlation of all of the main previous soil classifications and names with the revised system should help clarify the linkages between the various studies and surveys, and reduce future confusion and duplication.

WRIGHT *et al.* (1959)

This is the most important and the most widely used of all of the previous systems, and the only one that covered the whole country. As the classification presented here is basically its revision and updating, correlation is fairly straightforward. Wright and his co-workers classified soils into suites and subsuites along New Zealand lines (e.g. Taylor and Pohlen, 1962), with the suites primarily determined by the lithology of the parent material. However they described the soils mainly in soil sets, which were mappable subdivisions of the subsuites. The correlation between their soil sets and the revised classification is summarized in Table 22. The main differences are in the shallow and stony soils in the Maya Mountains and flanking limestone foothills, which they subdivided into many sets. In the revision, all those derived from metasediments on steepland topography and under broadleaf forest are classified in the Cabbage Haul Subsuite. All those over Cretaceous limestone are in the Cabro Subsuite. Otherwise the differences are fairly minor. For most of the main soils the names in the two systems correspond, usually, at subsuite level.

CHARTER (1940, 1941)

Although now half a century old, Charter's work is not only of historical interest. It is clear that he did extensive fieldwork throughout the country north of the Chiquibul River and had a perceptive eye for soil features and their relationships with landscape and vegetation. His descriptions are very brief and general, sometimes a little cryptic, but are generally clear. Although no detailed profile descriptions and analyses are now available, he does have clear profile diagrams of some of the more important soils in northern Belize.

He erected a complicated multi-tiered classification system consisting of:

- (i) Division - determined by whether flatland or mountain
- (ii) Group - determined by the permeability of the parent material
- (iii) Fax - determined by internal and external drainage
- (iv) Suite - soils of similar profiles on lithologically similar parent materials

(v) Series - fairly homogeneous profile morphology on almost identical parent materials

(vi) Types - subdivisions of series based on fairly minor textural variations

In addition there were phases, which could be subdivisions of any class below the rank of suite, usually series, based on characteristics such as depth and stoniness.

In his report he greatly simplified the classification, using only suites and series. These are correlated as far as possible with the revised classification in Table 23. The main difficulties are with the limestone soils and some of the old alluvial soils. He has differentiated a number of limestone soils on profile morphological criteria which appear to overlap somewhat. He has named many of them after former logging and chicleiro camps in the Vaca-Chiquibul area, and his descriptions imply that this is where the soils occur. They therefore appear to correspond more or less with our Chacalte Suite. However his very small and generalized map shows these soils stretching up to the north-west of the country, so that they clearly include many of our Yaxa soils. The other difficult group of soils are those on older alluvial deposits, especially those in the Upper Belize Valley. The equivalents in the revised system of his Roaring Creek and Butcher Burns series are therefore only tentative.

Table 22 Correlations with Wright *et al.*, 1959

Wright *et al.*, 1959		1993 Revised classification	
Set		Suite	Subsuite
1	Turneffe sand	Turneffe	Ambergris
1a	Turneffe coarse sand	Turneffe	Hopkins
1b, 1c	Shipstern	Turneffe	Shipstern
2-2c	Monkey River (all)	Melinda	Monkey River
3 ,3c	Hondo Clays	Melinda	Hondo
4	Consejo loam	Bahia	Consejo
5, 5c, 5d	Remate (dark)	Bahia	Remate
5a ,5b	Remate (brown)	Pembroke	Xaibe
6-6c	Louisville (all)	Pembroke	Louisville
7-7b	Puluacax (all)	Pembroke	Xaibe
8-8c	Xaibe (all)	Pembroke	Xaibe
9-9d	Yaxa	Yaxa	Yalbac
10-10c	Ramgoat (all)	Yaxa	Chacluum
11-11c	Chacluum (all)	Yaxa	Chacluum
12-12b	Lazaro (all)	Guinea Grass	Lazaro
13-13d	Jolja (all)	Yaxa	Jolja
14-14a	Cuxu (all)	Chacalte	Cuxu
15 15a	Hummingbird clay	Chacalte	Xpicilha, Cuxu
15H	Hummingbird hill soil	Chacalte	Cabro
16	Tziminkax clay	Chacalte	Cuxu
16H	Tziminkax hill soil	Chacalte	Cabro, Cuxu
17, 17a, 17b	Chacalte clays	Chacalte	Xpicilha
17H, 17c, 17cH	Chacalte gravelly and hill soils	Chacalte	Cabro
18, 18a	Xpicilha clays	Chacalte	Xpicilha
18H	Xpicilha hill soils	Chacalte	Cabro
19, 19a	Cumbre clay and sandy clay loam	Chacalte	Xpicilha
19H, 19aH	Cumbre hill soils	Chacalte	Cabro
20-20b	Pixoy (all)	Guinea Grass	Pixoy
21-21f	Jobo (all)	Altun Ha	Jobo
22-22b	Rockstone (all)	Altun Ha	Rockstone
23	Felipe	Revenge	Felipe
24	Tok	Revenge	Tok
25-25h	Aguacate (all)	Toledo	Aguacate
26-26H	Manfredi (all)	Toledo	Aguacate
27	Temax Complex (all)	Toledo	Temash
28	Sanjuanilha	Melinda	Canquin
29-29H	Cimin (both)	Toledo	Cimin
30	Hiccattee	Toledo	Temash
31-31b	Machaca Complex brownish clays	Toledo	Machaca
31c-31d	Machaca Complex grey clays	Toledo	Jacinto

Wright *et al.*, 1959		1993 Revised classification	
Set		Suite	Subsuite
32-32a	Jacinto (both)	Toledo	Jacinto
33	Stopper sandy clay loam	Stopper	Canada Hill
33H	Stopper cobbly soil	Stopper	Powder Hill
33a	Stopper gritty loam	Stopper	Mayflower
33b	Stopper loam	Melinda	Canquin
34-34b	Quamina (all)	Melinda	Quamina
35, 35a, 35b	Curassow clays and loams	Ossory	Curassow
35H ,35aH	Curassow hill soils	Ossory	Cabbage Haul
36, 36b, 36c	Ossory loams	Ossory	Pippen
36H, 36aH	Ossory hill soils	Ossory	Cabbage Haul
37-37a	Governor (all)	Melinda	Governor
38-38e	Canquin (all)	Melinda	Canquin
39, 39a, 39b	Chiquibul clays	Ossory	Curassow
39H, 39aH	Chiquibul hill soils	Ossory	Cabbage Haul
39c	Chiquibul sandy loam	Ossory	Pippen
40	Sirin gritty loam	Stopper	Silkgrass
40H	Sirin hill soil	Stopper	Powder Hill
41	Sennis	Melinda	Sennis
42H-42aH	Copetilla hill soils (both)	Ossory	Cabbage Haul
43	Palmasito sandy clay	Ossory	Curassow
43H-43aH	Palmasito hill soils	Ossory	Cabbage Haul
44-44a	Melinda (all)	Melinda	Canquin
45H	Esperanza hill soil	Richardson	Ramos
46-46a	Matamore (all)	Turneffe	Matamore
47	Silkgrass sand	Stopper	Silkgrass
47a, 47b	Silkgrass loam and clay	Ossory	Curassow
48-48a	Machiquila (all)	Ossory	Machiquila
49-49b	Barranco (all)	Turneffe	Barranco
50-50a	Haciapina (all)	Puletan	Haciapina
51, 51H ,51a, 51aH	Granodoro sands, loams and hill soils	Ossory	Granodoro
51b	Granodoro fine sand	Stopper	Mayflower
51c-51e	Granodoro loam and clay	Melinda	Canquin
52, 52H, 52d, 52e			
52a, 52aH, 52b	Pinol	Stopper	Pinol
52bH, 52c, 52cH	Pinol	Ossory	Cooma, Baldy
52f	Pinol cherty sand	Puletan	Boom
53, 53a, 53d	Puletan sands	Puletan	Boom
53b	Puletan coarse sands	Puletan	Crooked Tree
53c,53e-f	Puletan sands and loams	Puletan	Bladen
54	Bobo	Chacalte	Xpicilha
55-55b	Pucte (all)	Tintal	Pucte
56-56a	Chucum (all)	Tintal	Chucum
57-57a	Caway (all)	Tintal	Sibal
58-58e	Sibal (all)	Tintal	Sibal
59	Ycacos	Tintal	Ycacos
60-60a	Xunatunich (all)	Chacalte	Cabro
61-61a	Dry Creek (all)	Chacalte	Cabro
62-62c	Cabro (all)	Chacalte	Cabro
63-63b	Wetziltok (all)	Toledo	Cimin
64	Swasey	Stopper	Powder Hill
65-65c	Raspacula (all)	Ossory	Cabbage Haul
66-66a	Chapayal (all)	Ossory	Cabbage Haul
67-67b	Cockscomb (all)	Ossory	Cabbage Haul
68	Richardson	Richardson	Ramos

BELIZE VALLEY

This was a survey of the soils and agricultural potential of 3170 km^2 in the valley of the Belize River. The soils were mapped at 1:50 000 scale and examined at thousands of auger holes. Over 200 profiles were described in detail and samples from many of them were comprehensively analysed. It was therefore by far the largest semi-detailed soil survey done so far in Belize. The soils were classified in a three-tiered hierarchy of suite-subsuite-series, which followed the taxa and names of Wright *et al.* (1959) quite closely.

Researchers doing detailed field studies in the area find their classes meaningful and their mapping accurate (e.g. Fedick and Ford, 1990). However the criteria for distinguishing the series, and the general spatial, environmental, ecological

Table 23 Correlations with Charter (1940, 1941)

Charter (1940, 1941)		1993 Revised classification	
Suite	Series	Suite	Subsuite
Stevenson	Stevenson	Melinda	Monkey River, Quamina, Canquin
	Mullin	Melinda	Monkey River, Quamina, Canquin
	Dog Creek	Melinda	Monkey River, Quamina, Canquin
	Manatee	Melinda	Monkey River, Quamina, Canquin
Pelly	Pelly	Melinda	Canquin
	Middlesex	Melinda	Canquin
Yaha	Yaha	Melinda	Canquin
	Almond Hill	Melinda	Canquin
Kate's Lagoon	Kate's Lagoon	Revenge	Tok, Felipe
Melinda	Melinda	Melinda	Monkey River, Canquin
	Indian Creek	Melinda	Monkey River, Canquin
Fresco	Fresco	Melinda	Canquin
	Wood	Melinda	Canquin, Quamina
Sibun	Sibun	Tintal	Ycacos
Burdon	Burdon	Tintal	Ycacos
Xaibe	Xaibe	Pembroke	Xaibe
	Calcutta	Pembroke	Xaibe
	Maskall	Pembroke, Altun Ha	Xaibe, Jobo
Louisville	Louisville	Pembroke	Louisville
	Estero	Pembroke	Louisville
	Boston	Pembroke, Guinea Grass, Altun Ha	Louisville, Lazaro, Jobo Louisville, Lazaro, Jobo
	Mountain Cow	Chacalte	Xpicilha
	San Pablo	Guinea Grass	Lazaro
Douglas	Douglas	Pembroke, Tintal	Louisville, Pucte
	Cave	Tintal	Chucum
Consejo	Consejo	Bahia	Consejo
Yo Creek	Yo Creek	Tintal	Sibal
Haulover	Haulover	Tintal	Ycacos
Sarawe	Sarawe	Tintal, Melinda	Sibal, Monkey River
	English Creek	Tintal, Puletan	Sibal, Bladen
	Butcher Burns	Tintal, Puletan	Sibal, Bladen
Baker	Baker	Puletan	Boom, Haciapina
	Tower Hill	Revenge	Tok
Roaring Creek	Roaring Creek	(Melinda	Canquin)
Belize	Belize	Puletan	Boom
Turner	Turner	Tintal	Chucum
	Kinloch	Tintal	Chucum, Pucte
	Cayo	Chacalte, Tintal	Xpicilha, Chucum
	Chial	Chacalte	Cuxu
	Estrela	Pembroke, Tintal	Louisville, Pucte
	Patchacan	Pembroke, Tintal	Xaibe, Pucte
	Orange Walk	Guinea Grass	Pixoy
	Rockstone Pond	Altun Ha	Jobo
Boom	Boom	Melinda	Quamina
	Beaver Dam	Melinda	Quamina
St Thomas	St Thomas	Chacalte	Xpicilha
Ceiba	Ceiba	Chacalte, Yaxa	Xpicilha, Cuxu, Yalbac
	Naranjo	Chacalte, Yaxa	Xpicilha, Yalbac
Chiquibul	Chiquibul	Chacalte	Xpicilha, Cuxu
	San Paster	Ossory	Machiquila
	St Margarets	Ossory	Machiquila
	Cornhouse	Chacalte	Xpicilha

Charter (1940, 1941)		1993 Revised classification	
Suite	Series	Suite	Subsuite
Marie	Marie	Stopper	Mayflower, Canada Hill
	Vaca	Ossory	Cabbage Haul, Pippen, Curassow
	Macaroni	Ossory	Cabbage Haul, Pippen, Curassow
	Mico	Ossory	Granodoro
Gracie Rock	Gracie Rock	Chacalte	Cabro
La Flore	La Flore	Chacalte	Cabro
Soccotz	Soccotz	Chacalte	Cuxu
Arenal	Arenal	Chacalte, Yaxa	Xpicilha, Yalbac
Croja	Croja	Ossory	Pippen
	Challilo	Ossory	Cooma
	Silk Grass Creek	Ossory	Pippen, Cooma
	Canada	Ossory	Pippen, Cooma
	Blancaneau	Stopper	Pinol
Dry Creek	Dry Creek	Ossory	Cooma, Baldy
	Makal	Ossory	Cooma, Baldy

and pedogenetic relationships of the soils are discussed only briefly. This has hampered correlations especially for the soils of their Yobo and Haciapina Subsuites. These are developed on what appear to be very variable old alluvia in the upper parts of the Belize River valley, which are unlike those in other parts of the country. The correlation of Erindale and Rough Mile series with Felipe and Tok Subsuites in Revenge Suite is therefore rather tentative. It may be necessary to formulate a further subsuite in Revenge Suite to accommodate these soils.

The correlations, summarized in Table 24, are based on their published reports and on the archive of their profile description field cards that was transferred from NRI to Central Farm in 1989.

KING *et al.* (1986, 1989, 1992)

The revised classification presented here is basically a tidying up and rationalization of the system used in the 1986-91 LRA studies. It is not strictly correct to talk of 'correlation' between systems that are so closely related and similar. However it is useful to summarize the changes that have been made, and particularly to indicate the revised taxonomic placement of soil names which appear in some or all of the LRA reports but have since been dropped. The changes are summarized in Table 25. If a soil suite or subsuite name does not appear in Table 25, its meaning is more or less unchanged throughout the LRA studies and this revision. The soil series named in the Toledo LRA study are not listed in Table 25. Their placement in the revised classification can be determined from their subsuites.

OTHER SURVEYS

Other surveys and studies that have named soils were done for specific properties or projects and cover only restricted areas and few soils. The correlations of their units with the revised classification are summarized in Table 26.

Table 24 Correlations with Belize Valley survey

Belize Valley*			1993 Revised classification	
Suite	Subsuite	Series	Suite	Subsuite
Melinda	Quamina	Garbutt	Melinda	Quamina
		Branch Mouth	Melinda	Quamina
		Young Girl	Melinda	Quamina
		Barton Ramie	Melinda	Quamina
		Freetown	Melinda	Quamina
	Redbank	Listowel	Melinda	Canquin
		Esperanza	Melinda	Canquin
		Meditation	Melinda	Canquin
		Morning Star	Melinda	Canquin
		Central Farm	Melinda	Canquin
		Banana Bank	Melinda	Canquin
		Bermudian Landing	Melinda	Canquin
		Lemonal	Melinda	Canquin
	Creek	Norland	Melinda	Canquin
		Iguana	Melinda	Hondo
		Cox's	Melinda	Hondo
Yaxa	Yalbac	Piedregal	Yaxa	Yalbac
		Chorro	Yaxa	Yalbac
		Tambos	Yaxa	Yalbac
		Spanish Lookout	Yaxa	Yalbac
		Beaver Dam	Yaxa, Tintal	Yalbac, Chucum
		Seven Mile	Yaxa	Yalbac
		Cadena Creek	Yaxa, Tintal	Yalbac, Chucum
	Chucum	Cara Blanca	Tintal	Chucum
		Akalche	Tintal	Chucum
	Cuxu	Mount Hope	Chacalte	Cuxu
		Camelote	Chacalte	Cuxu
		Society Hall	Chacalte	Cuxu
		Hummingbird	Chacalte	Cuxu, Xpicilha
		Sayab Camp	Chacalte	Cuxu
	Chacluum	Mumble de Peg	Yaxa	Chacluum
		Rancho Dolores	Yaxa	Chacluum
		Tillett and Potts	Yaxa	Chacluum
Puletan	Boom	Santos Pine Ridge	Puletan	Crooked Tree
		Double Head Cabbage	Puletan	Boom, Crooked Tree
		Colonel English	Puletan	Boom
		Hattieville	Puletan	Bladen, Boom
	Yobo	Duck Run	Altun Ha	Rockstone
		Erindale	Revenge	Tok
		Rough Mile	Revenge	Tok
	Haciapina	Willows Bank	Revenge, Melinda	Tok, Sennis
		La Perla	Melinda	Sennis
		Little Creek	Puletan	Haciapina
		Butcher Burns	Tintal	Pucte
		Crabcatcher	Puletan (Tintal)	Haciapina (Pucte)
		Ellen Broaster	Tintal	Chucum
Swamp	Sibal	Pucte	Tintal	Sibal
	Ycacos	Big Pond	Tintal	Sibal
		Burdon	Tintal	Ycacos

* Source: Jenkin *et al.*, 1976; Birchall and Jenkin, 1979

Table 25 Renamed LRA soil units

LRA study and soil unit	Now part of 1993 Revision unit
Toledo 1986	
Santa Cruz Subsuite	Aguacate Subsuite
Waika Subsuite	Cimin Subsuite
Topco Subsuite	Machaca Subsuite
San Lucas Subsuite	Xpicilha Subsuite
Hiccattee Suite	
Poite Subsuite	Xpicilha Subsuite
Joshua subsuite	Xpicilha, Temash or Machaca Subsuite
Trio Subsuite	Croja Subsuite
Jacinto Suite (including both Couton and Flour Camp Subsuites)	Jacinto Subsuite
Savannah Subsuite	Boom Subsuite
Old Bank Subsuite	Canquin Subsuite
Logan Bank Subsuite	Canquin Subsuite
Sirin Subsuite	Croja Subsuite
Caway Suite (including Laguna, Siver Creek, and Curocoa Subsuites)	Sibal Subsuite
Stann Creek 1989	
Waha Leaf Subsuite	Monkey River Subsiute
Pomona Subsuite	Canquin Subsuite
Old Bank Subsuite	Canquin Subsuite
Sarawina Subsuite	Monkey River Subsuite
Savanna Subsuite	Boom (and some Crooked Tree) Subsuites
Serpon Subsuite	Boom Subsuite
Regalia Subsuite	Bladen Subsuite
San Lucas Subsuite	Xpicilha Subsuite
Dancing Pool Subsuite	Curassow, Pippen Subsuites
Chiquibul Suite	Ossory Suite
North Belize 1991	
Pasmore Subsuite	Hondo Subsuite
Bocatora Subsuite	Ben Lomond Subsuite
Backlanding Subsuite	Bladen Subsuite
Concepcion Subsuite	Xaibe Subsuite
Puluacax Subsuite	Xaibe Subsuite
Ramgoat Subsuite	Chacluum Subsuite
Irish Creek Subsuite	Chacluum Subsuite
San Lucas Subsuite	Xpicilha Subsuite
Vaca Suite	Cuxu Subsuite
Dancing Pool Subsuite	Curassow, Pippen Subsuites
Chiquibul Subsuite	Cooma Subsuite
Palmasito Subsuite	Doyle Subsuite

Table 26 Other correlations

Previous survey			1993 Revised classification	
Reference	Survey area	Soil unit	Suite	Subsuite
Darcel (1952)	Stann Creek Valley	Alta Vista Series	Melinda	Monkey River
		Tipperary Series	Stopper	Canada Hill
		Upper bench soil	Melinda	Canquin
Jenkin *et al.* (1978)	Toledo District	Dump Series	Melinda	Monkey River
		Domingo Series	Tintal	Sibal
		Mafredi Series	Melinda	Monkey River
		Arena Series	Chacalte	Xpicilha
		Blue Creek Series	Chacalte	Xpicilha
		Piedra Series	Toledo	Machaca, Temash
		San Pedro Series	Toledo	Machaca
Walker and Anderson (1983)	Blue Creek, Toledo District	Piedra Series	Toledo	Machaca
		Dump Series	Melinda, Tintal	Monkey River, Xpicilha
		Arena Series	Chacalte	Xpicilha
		Mafredi Series	Melinda	Monkey River
		Machaca Series	Toledo	Machaca, Temash
McCormack (1987)	Yalbac Ranch, Orange Walk District	Chacluum Series	Yaxa	Chacluum
		Hachac Luum Series	Yaxa	Chacluum
Wagner *et al.* (1987)	Hummingbird Hershey, Upper Sibun Valley	Dry Creek Series	Chacalte	Cabro
		Hummingbird Series	Chacalte	Xpicilha
		Melinda Series	Melinda	Canquin
		St Thomas Series	Melinda	Canquin
		Caves Branch Series	Melinda	Canquin
		Hershey Series	Melinda	Quamina
		Savanna Bank Series	Melinda	Quamina
		Alluvial land	Melinda	Quamina, Monkey River
Baillie and Wright (1988)	Topco National Land, Toledo District	Warrie Series	Toledo	Machaca
		Piedra Series	Toledo	Machaca
		Big Fall Series	Toledo	Machaca
		Boden Series	Toledo	Machaca
		Hishilha Series	Toledo	Machaca
		Yemeri Series	Toledo	Machaca
		Cutting Grass Series	Toledo	Jacinto
		Rosewood Series	Toledo	Jacinto
		Papinshaw Series	Toledo	Jacinto
		Monkey River Subsuite	Melinda	Monkey River
		Caway Suite	Tintal	Sibal
Jacob (1989)	Yalbac Ranch, Orange Walk District	Chacluum clay	Yaxa	Chacluum
		Jolatunich clay	Yaxa	Chacluum
		Rancho Dolores clay	Yaxa	Yalbac
		Yaxa clay	Yaxa	Yalbac

Part 7

Correlation with international systems of soil classification

INTRODUCTION

A number of countries have rejected the option of creating or developing local soil classification systems. Instead they have adopted one or other of the international systems, usually the 'Soil Taxonomy' formulated by the staff of the US Department of Agriculture (USDA, 1975; SMSS, 1990). When the recent series of LRA studies began in 1986 this option was not taken up because local farmers, foresters and agricultural workers in Belize were already familiar with, and using, the more important soil names in the system of Wright *et al.* (1959). Most succeeding soil surveys had based their mapping units on it, and researchers in other disciplines had found it workable. In addition there are drawbacks to the use of 'Soil Taxonomy' in the humid tropics in general and Belize in particular including:

(i) Insufficient weight is given to the lithology of the parent material.

(ii) Insufficient allowance is made for compound layered parent materials.

(iii) There is an over-emphasis on processes of vertical transfers within profiles and insufficient emphasis on lateral transfers between them.

(iv) There is an over-emphasis on the properties of 'diagnostic' horizon and insufficient emphasis on overall profile morphology.

(v) There is an over-emphasis on exchangeable cations and insufficient emphasis on their total contents and on the anionic plant nutrients.

(vi) The nomenclature is user-hostile especially to non-pedologists. It includes redundant information, such as soil moisture status (usually guessed at from rainfall data) and location in the tropics.

The other international system, the FAO/UNESCO 'Legend of the Soil Map of the World', has similarities with 'Soil Taxonomy' and therefore shares some of its defects. However it takes more note of the morphology of the whole profile, and makes more reference to parent materials. It also has a more traditional and international nomenclature (FAO/UNESCO, 1974, 1988).

Although not used as the basis for the revised Belizean classification, the international systems have a role as a common yardstick and a channel of communication, by which locally defined and named soils in different countries can be compared and information on them exchanged. The correlations between the international systems and the revised soil suites are summarized in Table 27. This gives an indication of the diversity of Belize's soils, despite its small area. Thirteen (or 15 if there are andosols in Richardson Suite and podzols in Crooked Tree Subsuite) of the 28 major units of the World are represented (FAO/UNESCO, 1988). In 'Soil Taxonomy' at least eight, possibly 10, of the 11 soil orders of the world are found, with only the Aridisols definitely excluded (SMSS, 1990). This partly reflects the small number of orders and the consequent width of their definitions in the 'Soil Taxonomy'.

Table 27 Main correlations of soil suites with international systems

Suite	Soil Map of the World*	Soil Taxonomy†
Ossory	Leptosol, Cambisol, Acrisol, Plinthosol, Luvisol, (Ferralsol)	Inceptisol, Ultisol, (Oxisol), Entisol, Alfisol
Richardson	Ferralsol, Cambisol, Acrisol, (Andosol?)	Oxisol, Inceptisol, Ultisol, (Andisol?)
Stopper	Cambisol, Acrisol, Ferralsol, Planosol, Leptosol	Ultisol, Oxisol, Inceptisol, Entisol
Toledo	Cambisol, Acrisol, Luvisol	Inceptisol, Ultisol, Alfisol
Chacalte	Leptosol, Cambisol, Vertisol, Phaeozem	Inceptisol, Vertisol, Mollisol
Yaxa	Cambisol, Vertisol, Phaeozem, Leptosol	Inceptisol, Mollisol, Vertisol
Pembroke	Cambisol, Vertisol, Phaeozem	Inceptisol, Mollisol, Vertisol
Guinea Grass	Cambisol, Luvisol, Planosol	Inceptisol, Alfisol
Altun Ha	Cambisol, Luvisol, Leptosol, Vertisol, Phaeozem	Inceptisol, Alfisol, Vertisol, Mollisol
Bahia	Leptosol, Cambisol	Inceptisol, Entisol
Revenge	Planosol	Alfisol
Puletan	Planosol, Arenosol, Gleysol, (Podzol)	Ultisol, Entisol, Aquept, (Spodosol)
Tintal	Gleysol, Histosol	Aquent, Aquept, Histosol
Melinda	Fluvisol, Cambisol, Acrisol	Entisol, Inceptisol, Ultisol
Turneffe	Arenosol, Regosol, Cambisol	Entisol, Inceptisol

* (FAO/UNESCO, 1974, 1988)
† (USDA, 1975; SMSS, 1990)

Table 28 summarizes the correlations at revised subsuite level. The lack of exact equivalence and the need to name several groups is partly due to the considerable variability within each subsuite. However it is also partly caused by the rigidity of the international systems, and the inappropriateness of their criteria to Belizean soils. Compilation of Table 28 was extremely laborious, and vindicated the decision to stick with a local system of classification rather than go over to the 'Soil Taxonomy'.

Table 28 Correlations of soil subsuites with international systems

Suite	Subsuite	Soil Map of the World*	Soil Taxonomy†
Ossory	Cabbage Haul	Dystric Leptosol, Dystric Cambisol	Lithic Dystropept, Lithic Troporthent
	Curassow	Haplic Acrisol, Ferric Acrisol	Typic Rhodudult, Typic Kandiudult
	Pippen	Haplic Acrisol, Ferric Acrisol, Dystric Cambisol	Typic Kandiudult, Oxic Dystropept
	Borrowpit	Plinthosol	Plinthic Hapludox
	Cooma	Haplic Acrisol, Dystric Cambisol	Typic Hapludult, Plinthudult, Plinthic Dystropept
	Baldy	Haplic Acrisol	Typic Hapludult
	Granodoro	Haplic Acrisol, Dystric Cambisol, Eutric Cambisol	Typic Hapludult, Typic Dystropept, Eutric Dystropept
	Machiquila	Chromic Luvisol, Eutric Cambisol	Typic Kandiudalf
Richardson	Doyle	Humic Ferralsol, Haplic Ferralsol, Humic Acrisol, Haplic Acrisol (?Andosol)	Humic Acroperox, Typic Acroperox, Typic Kandihumult, Kandiudult (?Andisol)
	Ramos	Ferralic Cambisol, Dystric Cambisol	Oxic Dystopept, Typic Dystropept
Stopper	Silkgrass	Cambic Arenosol	Typic Quartzipsamment
	Powder Hill	Dystric Leptosol, Dystric Cambisol	Lithic Dystropept, Lithic Troporthent

Suite	Subsuite	Soil Map of the World*	Soil Taxonomy†
	Mayflower	Dystric Cambisol, Haplic Acrisol	Typic Dystropept, Typic Hapludult
	Canada Hill	Haplic Acrisol, Haplic Ferralsol	Typic Kandiudult, Typic Hapludox
	Pinol	Haplic Acrisol, Gleyic Acrisol, Dystric Planosol	Typic Kandiaquult, Rhodic Kandiudult
Toledo	Cimin	Eutric Leptosol, Eutric Cambisol, Haplic Luvisol, Vertic Luvisol	Typic Eutropept, Typic Tropudalf Vertic Tropudalf
	Aguacate	Dystric Cambisol, Haplic Acrisol, Ferric Acrisol, Haplic Luvisol, Ferric Luvisol	Typic Tropudult, Typic Tropudalf
	Temash	Gleyic Acrisol, Haplic Acrisol	Typic Tropaquult, Typic Tropudult
	Machaca	Haplic Acrisol, Haplic Luvisol, Eutric Cambisol, Dystric Cambisol	Typic Tropudult, Typic Tropudalf, Typic Eutropept, Typic Dystropept
	Jacinto	Gleyic Acrisol, Gleyic Luvisol	Typic Tropaquult, Typic Tropaqualf
Chacalte	Cabro	Rendzic Leptosol, Lithic Leptosol	Lithic Rendoll, Lithic Eutropept
	Xpicilha	Eutric Cambisol, Vertic Cambisol, Gleyic Cambisol Eutric Vertisol, Haplic Phaeozem	Vertic Eutropept, Rendollic Eutropept, Typic Pelludert,Typic Chromudert, Typic Hapludoll, Vermic Hapludoll
	Cuxu	Mollic Leptosol, Eutric Leptosol, Eutric Cambisol Vertic Cambisol, Eutric Vertisol, Haplic Phaeozem	Rendollic Eutropept, Chromudertic Eutr--opept, Typic Chromudert, Typic Hapludoll, Vermic Hapludoll
Yaxa	Yalbac	Rendzic Leptosol, Eutric Cambisol, Mollic Cambisol, Haplic Phaeozem, Pelleutric Vertisol	Lithic Eutropept, Rendollic Eutropept, Typic Hapludoll, Typic Pelludert
	Jolja	Eutric Leptosol, Eutric Cambisol, Haplic Phaeozem Pelleutric Vertisol	Skeletal Eutropept, Skeletal Hapludoll, Typic Pelludert
	Chacluum	Chromic Cambisol, Chromic Luvisol, Chromeutric Vertisol, Eutric Gleysol	Typic Eutropept, Typic Rhodudalf, Typic Chromudert, Eutric Tropaquept
Pembroke	Louisville	Eutric Cambisol, Vertic Cambisol, Eutric Vertisol, Haplic Phaeozem	Vertic Eutropept, Vertic Hapludoll Typic Pelludert
	Xaibe	Rendzic Leptosol, Eutric Cambisol, Chromic Cambisol, Vertic Cambisol, Eutric Vertisol	Typic Eutropept, Lithic Eutropept, Vertic Rhodudalf, Eutric Tropaquept
Guinea Grass	Lazaro	Eutric Cambisol, Haplic Luvisol, Vertic Luvisol, Haplic Phaeozem	Typic Eutropept, Typic Tropudalf, Vertic Tropudalf, Vertic Haplaqualf Typic Hapludoll
	Pixoy	Haplic Luvisol, Eutric Planosol	Typic Tropudalf, Typic Albaqualf
Altun Ha	Jobo	Rendzic Leptosol, Eutric Cambisol, Haplic Luvisol, Eutric Vertisol, Vertic Luvisol	Rendollic Eutropept, Lithic Eutropept, Typic Tropudalf, Typic Chromudert, Typic Pelludert, Vertic Tropudalf
	Rockstone	Lithic Leptosol, Eutric Leptosol, Mollic Cambisol, Haplic Luvisol	Rendollic Eutropept, Lithic Eutropept, Typic Tropudalf
Bahia	Consejo	Lithic Leptosol, Eutric Leptosol, Eutric Cambisol, Gypsic Cambisol, Humic Cambisol	Lithic Eutropept, Gypsic Eutropept, Lithic Troporthent, Typic Humitropept
	Remate	Lithic Leptosol, Eutric Leptosol, Umbric Leptosol	Lithic Eutropept, Typic Eutropept
Revenge	Felipe	Eutric Planosol	Typic Albaqualf
	Tok	Eutric Planosol	Typic Albaqualf
Puletan	Crooked Tree	Albic Arenosol, Dystric Planosol, (Carbic Podzol)	Typic Albaquult, Typic Quartzipsam-ment, (Grosserenic Tropohumod)
	Boom	Dystric Planosol	Typic Albaquult
	Bladen	Dystric Planosol	Arenic Hapludult, Typic Tropaquult
	Ben Lomond	Dystric Planosol, Plinthic Planosol	Typic Albaquult, Typic Plinthaquult, Typic Plinthudult, Typic Kandiudult
	Haciapina	Dystric Planosol, Gleyic Acrisol	Typic Albaquult, Typic Umbraquult, Typic Psammaquent
	Buttonwood	Salic Eutric Planosol	Salic Albaquult
Tintal	Sibal	Dystric Gleysol, Eutric Gleysol, Fibric Histosol, Terric Histosol	Typic Hydraquent, Tropaquent, Terric Tropofibrist, Terric Tropohemist
	Ycacos	Eutric Gleysol, Thionic Gleysol, Fibric Histosol, Terric Histosol, Thionic Histosol	Typic Hydraquent, Tropaquent, Terric Tropofibrist, Terric Tropohemist, Typic Sulfaquent, Typic Sulfihemist
	Pucte	Mollic Gleysol, Eutric Gleysol	Typic Tropaquept, Typic Haplaquoll, Vertic Haplaquoll
	Chucum	Eutric Gley	Typic Tropaquept

Suite	Subsuite	Soil Map of the World*	Soil Taxonomy†
Melinda	Monkey River	Eutric Fluvisol, Dystric Fluvisol, Dystric Gleysol, Eutric Gleysol	Tropic Fluvaquent, Tropic Fluvaquept, Eutric Tropofluvent, Dystric Tropofluvent
	Quamina	Eutric Fluvisol, Eutric Gleysol	Tropic Fluvaquent,Tropic Fluvaquept, Eutric Tropofluvent
	Hondo	Mollic Fluvisol, Eutric Fluvisol Vertic Fluvisol, Eutric Gleysol	Eutric Tropofluvent, Tropic Fluvaquent
	Canquin	Dystric Cambisol, Haplic Acrisol	Fluventic Dystropept, Typic Paleudult, Typic Kandiudult
	Governor	Dystric Cambisol, Haplic Acrisol	Fluventic Dystropept,Typic Kandiudult, Typic Fragiudult
	Croja	Haplic Acrisol, Dystric Planosol	Typic Kandiudult, Typic Albaquult
	Sennis	Eutric Planosol, Dystric Planosol, Eutric Fluvisol	Typic Albaqualf, Typic Albaquult, Eutric Tropofluvent
Turneffe	Shipstern	Lithic Leptosol, Eutric Leptosol	Lithic Troporthent
	Ambergris	Calcaric Arenosol	Typic Tropopsamment
	Hopkins	Dystric Arenosol, Gleyic Arenosol	Typic Quartzipsamment, Aqueptic Quartzipsamment
	Matamore	Haplic Arenosol, Cambic Arenosol	Typic Tropopsamment
	Barranco	Haplic Luvisol, Haplic Acrisol, Ferric Luvisol	Typic Tropudalf, Typic Tropudult

* FAO/UNESCO, 1974, 1988
† USDA, 1975; SMSS, 1990

Part 8

Some chemical characteristics of Belizean soils

INTRODUCTION

The recent series of LRA reports includes 187 profile descriptions most of which are supported by analyses. The analyses were all done at the Tropical Soils Analysis Unit of the Natural Resources Institute, Chatham, UK, using standard methods (King *et al.*, 1986, 1989, 1992). These data are supplemented by 25 profiles in Baillie and Wright (1988), of which 15 were fully analysed at the same laboratory using the same methods.

This is a substantial body of methodologically homogeneous data and it is used here to compare some of the chemical features of the main soil groups. These summaries and comparisons are fairly tentative. Soil analysis uses tested procedures that have been empirically found to indicate, more or less, the chemical aspects of the ecological and edaphic behaviour of soils. Nonetheless they cannot unravel the intricate and dynamic complex of interactions going on between the mineral, organic, biotic, solution and gaseous components of the soil. The present comparisons are based on data gathered from subjectively sited points, and the number of profiles for the individual groups is small and unequal. They are therefore presented only as medians and ranges, with no attempt at statistical significance testing.

SOILS OF SILICEOUS PALEOZOIC ROCKS

Table 29 summarizes some chemical aspects of the soils developed on the siliceous rocks of the Maya Mountains massif.

General points that emerge include:

(i) Low-activity clays predominate with cation exchange capacities (CECs) in the subsoil about 10-20 milliequivalents/100 g clay; CECs are higher in the topsoils because of the organic matter. The CEC of the calcareous-influenced subsoil of Machiquila Subsuite is quite high, suggesting that there are some 2:1 clays present.

(ii) The soils are all base deficient, with base saturations less than 50% at all depths except in the soils with calcareous inputs in Granodoro and Machiquila subsuites.

(iii) Most of the soils are acid but not extremely so, often with pH values of around 5. The exceptions are the deep and apparently very leached soils of Richardson Suite on the rhyolitic and andesitic volcanic rocks. Most of these are very acid, with topsoil pH values at or below 4.

(iv) The topsoils in the metasedimentary Ossory Suite appear to be slightly more acid- and base-depleted than those in the granitic Stopper Suite. This is true in the steepland soils under broadleaf forest and in the dissected plateau soils of the Mountain Pine Plateau. The difference persists in the subsoils but is less marked. It may be due to the less prolonged leaching in the granitic soils. The granites are generally more erodible than the metasedimentary rocks so that the profiles of their soils tend to be more rapidly truncated and rejuvenated.

Table 29 Chemical characteristics of soils on siliceous Paleozoic rocks - median values *(and ranges)*

Parent material	Metasedimentary						Volcanic		Granite			
Suite	Ossory						Richardson		Stopper			
Topography and vegetation	*Steepland, broadleaf forest*		*Mountain Pine Plateau*		*San Pastor - Chiquibul*		*Maya divide, broadleaf forest, palm*		*Steepland, broadleaf forest*		*Mountain Pine Plateau*	
Subsuite	Cabbage Haul, Curassow Pippen		Cooma, Baldy		Granodoro, Machiquila		Doyle		Silkgrass, Powder Hill Mayflower, Canada Hill		Pinol	
No.of profiles	6		4		2		4		5		3	
0-10 cm												
% clay	33	*(25-38)*	24	*(13-38)*	24	*(22-38)*	32	*(23-38)*	26	*(5-39)*	44	*(12-48)*
pH	5.4	*(4.6-6.9)*	4.7	*(4.5-5.4)*	5.0	*(4.9-5.0)*	3.8	*(3.6-4.3)*	5.4	*(4.3-6.2)*	5.5	*(4.9-5.9)*
Total N %	0.25	*(0.13-0.39)*	0.20	*(0.09-0.39)*	0.20	*(0.17-0.22)*	0.32	*(0.14-1.97)*	0.28	*(0.11-0.3)*	0.14	*(0.08-0.18)*
C:N	10	*(8-12)*	16	*(12-17)*	11	*(11)*	14	*(10-34)*	13	*(10-15)*	16	*(16-21)*
Exchangeable K*	0.2	*(0.1-0.4)*	0.1	*(0.1-0.2)*	0.1	*(0.1)*	0.1	*(0.1-0.6)*	0.1	*(0.0-0.1)*	0.1	*(0.1-0.2)*
CEC*	10.8	*(7.2-11.4)*	10.0	*(4.6-13.9)*	10.3	*(7.3-13.3)*	20.5	*(8.8-29.4)*	10.7	*(3.5-13.9)*	10.5	*(4.5-10.6)*
Base saturation %	33	*(13-100)*	8	*(2-17)*	68	*(65-72)*	7	*(3-12)*	40	*(6-77)*	22	*(12-40)*
Exchangeable Al*	0.8	*(0-3.3)*	2.7	*(1.1-4.6)*	0.0	*(0.0)*	9.8	*(5.5-13.9)*	0.4	*(0.0-3.8)*	1.5	*(0.0-3.3)*
Total K†	11 400	*(3 200-16 800)*	11 700	*(9 800-13 500)*	6 400	*(1 000-11 800)*	6 450	*(3 150-11 600)*	3 300	*(400-8 850)*	1 650	*(1 150-4 400)*
Total Mg†	1 200	*(950-1 850)*	650	*(300-650)*	2 000	*(1 100-2 950)*	1 400	*(1 300-2 150)*	1 400	*(150-3 000)*	550	*(350-800)*
Available P†	3	*(2-11)*	1	*(1-3)*	1	*(1-2)*	2	*(1-3)*	4	*(2-74)*	2	*(2-6)*
Total P†	325	*(160-570)*	195	*(170-530)*	150	*(130-170)*	370	*(160-550)*	300	*(60-990)*	110	*(50-190)*
ca 50-60 cm												
% clay	36	*(27-47)*	25	*(19-46)*	57	*(51-64)*	28	*(20-48)*	24	*(7-46)*	38	*(19-64)*
pH	4.8	*(4.6-5.2)*	5.1	*(4.9-5.3)*	4.7	*(4.6-4.8)*	4.5	*(4.3-4.9)*	5.1	*(4.8-5.7)*	5.7	*(5.2-5.7)*
Exchangeable K*	0.0	*(0.0-0.1)*	0.0	*(0.0-0.1)*	0.2	*(0.2-0.3)*	0.0	*(0.0)*	0.0	*(0.0-0.1)*	0.0	*(0.0-0.2)*
CEC*	4.2	*(2.7-6.7)*	2.0	*(1.3-4.9)*	20.0	*(13.3-26.6)*	3.8	*(3.2-6.6)*	4.1	*(0.8-10.6)*	4.0	*(2.3-6.1)*
Base saturation %	7	*(4-35)*	13	*(0-15)*	74	*(71-77)*	2	*(1-4)*	20	*(7-63)*	26	(1-57)
Exchangeable Al*	1.8	*(0.5-3.5)*	0.3	*(0.0-2.1)*	1.2	*(0.9-1.6)*	5.8	*(2.0-8.0)*	2.0	*(0.5-3.7)*	0.0	*(0.0-1.9)*
Total K†	15 650	*(4 750-17 100)*	19 150	*(15 800-26 400)*	13 050	*(3 300-23 800)*	8400	*(4 850-17 100)*	3 400	*(400-15 900)*	2 000	*(1 200-12 100)*
Total Mg†	1 480	*(800-2 300)*	450	*(450-850)*	5 500	*(3 800-7 150)*	1650	*(1 250-3 050)*	1200	*(150-4750)*	450	*(250-2 450)*
Available P†	1	*(1-2)*	0	*(0-1)*	2	*(1-3)*	1	*(1-3)*	2	*(1-3)*	1	*(1)*
Total P†	210	*(100-760)*	200	*(170-530)*	170	*(70-270)*	380	*(180-490)*	160	*(30-390)*	100	*(80-150)*

* milliquivalents/100 g air-dried fine earth
† µg/kg

Note: Single values for range indicate all contributing values are identical

(v) The situation is reversed when total, rather than exchangeable, contents of cations of the soils are compared. The argillaceous components of the metasediments give the Ossory soils high values for total K, especially in the subsoils, and also for Mg. However the values in the granitic Stopper soils are not particularly low, presumably because there are still some partially weathered feldspars and micas in the lower horizons. It is important to stress that the high total contents of K in the Ossory soils appear to be almost entirely unavailable to plants and that exchangeable K levels are low.

(vi) The soils of the steepland broadleaf forests are slightly but clearly more fertile than those of the Mountain Pine Plateau. This is true in both Ossory and Stopper Suites. The difference is most apparent in the topsoils, for which the Mountain Pine Plateau soils have lower pH and base saturation, higher exchangeable Al, and P levels only about one-third to one-half of those of the steepland soils. These differences influence the relative nitrogen status, with the Mountain Pine Plateau soils having lower total N but wider C:N ratios, and therefore slower rates of N mineralization.

TOLEDO SUITE

Table 30 summarizes the chemical characteristics of the five subsuites in Toledo Suite. In general the soils of the suite are moderately weathered and leached. The cation exchange capacities indicate quite high activity clays, thought to be mixtures of primary micas, illites, interlayered vermiculites and kandites. The micas and illites, derived from the argillaceous parent materials, account for the high K status of these soils. Both exchangeable and total K contents are moderate-high. Fertilizer trials on dry-season matahambre corn in the uplands gave responses to small doses of N and P but not to K. The micaceous parent materials may also account for the fairly high Mg status. Exchangeable Mg ranges from 0.5 to 8 milliequivalents/100 g air-dried fine earth. The exchangeable Mg:Ca ratio is always above 0.3 and often exceeds unity in the more leached soils. The total Mg contents are also high, usually above 1000 µg/kg, and sometimes above 10 000 (=1%).

A feature of the soils of the suite is the lability of aluminium at higher than usual pH levels. In most tropical soils, KCl-extractable Al is normally negligible above pH 5. In these soils however several milliequivalents/100 g of Al occur in soils with pH (in water) above 5. However the high activity of the clays and CEC values indicate that Al is dominant only in the more acid and leached soils.

Within these generalizations it is possible to discern distinct differences between the chemical characteristics of the various subsuites. In general, the soils of the Toledo Uplands are slightly more fertile than those of the lowlands. Aguacate and Cimin Subsuites tend to have higher pH, base saturation, exchangeable and total K, and slightly better available and total P than the other subsuites. Their topsoils also appear to be of better N status, with moderate total N contents combined with fairly narrow C:N ratios.

It is also possible to pick out geographical trends within each of the physiographic regions. In the uplands, the deeper and redder soils of Aguacate Subsuite in the south-west are more acid, less base saturated, and of lower P status than the shallower, darker soils of Cimin Subsuite in the north-east. A similar trend is apparent in the comparison between the deeper and redder soils of Temash Subsuite in the southern part of the coastal lowlands and shallow grey-brown soils of Machaca Subsuite further north. These tend to be less acid, have better base status and possibly have slightly better total P contents. The picture in the lowlands is complicated by the occurrence of the older, deep grey clay soils of Jacinto Subsuite on undissected flat interfluves in the northern section. These appear to have been intensively leached and weathered, with low pH, low base status, and the lowest total P and K contents in the whole suite.

Table 30 Chemical characteristics of Toledo Suite - median values *(and ranges)*

Subsuite No. of profiles	Aguacate 3		Cimin 2		Temash 3		Machaca 15		Jacinto 6	
0-10 cm										
pH	5.9	*(5.8-6.2)*	6.3	*(6.2-6.4)*	5.2	*(4.8-5.7)*	5.3	*(4.0-6.2)*	5.0	*(4.6-5.8)*
Total N	0.40	*(0.36-0.56)*	0.48	*(0.44-0.51)*	0.19	*(0.19-0.21)*	0.28	*(0.21-0.49)*	0.25	*(0.10-0.36)*
C:N	11	*(11-12)*	9	*(9)*	9	*(8-11)*	10	*(8-19)*	10	*(9-14)*
Exchangeable K	0.6	*(0.3-0.7)*	1.3	*(1.1-1.5)*	0.2	*(0.1-0.8)*	0.3	*(0.1-0.5)*	0.2	*(0.0-0.3)*
CEC	21.9	*(21.9-49.1)*	46.6	*(43.8-49.4)*	19.1	*(8.4-26.9)*	16.7	*(12.0-29.0)*	13.4	*(4.3-17.8)*
Base saturation	78	*(70-90)*	90	*(88-93)*	22	*(7-71)*	63	*(5-98)*	42	*(14-57)*
Exchangeable Al	0.0	*(0.0-0.1)*	0.1	*(0.0-0.1)*	2.4	*(0-6.6)*	0.7	*(0-4.7)*	1.6	*(0.3-5.9)*
Available P	4	*(3-7)*	5	*(4-6)*	4	*(3-7)*	3	*(2-6)*	3	*(2-4)*
Total P	210	*(190-430)*	430	*(400-460)*	140	*(130-380)*	240	*(140-360)*	150	*(50-250)*
Total K	3 400	*(2 900-6 100)*	8 220	*(7 900-8 550)*	3 150	*(2 300-5 550)*	2 250	*(500-4 850)*	1 200	*(500-3 650)*
10-30 cm										
pH	5.6	*(5.4-5.7)*	5.7		4.9	*(4.8-5.3)*	5.3	*(3.8-6.2)*	5.0	*(4.8-5.3)*
Exchangeable K	0.3	*(0.3-1.0)*	0.7		0.3	*(0.1-0.3)*	0.3	*(0.0-0.5)*	0.3	*(0.1-0.4)*
CEC	21.6	*(10.7-51.4)*	40.9		22.6	*(7.3-24.7)*	24.4	*(2.8-36.3)*	23.0	*(12.8-28.4)*
Base saturation	44	*(24-86)*	75		7	*(7-47)*	66	*(3-80)*	40	*(26-72)*
Excheable Al	3.9	*(0.8-8.2)*	4.3		5.9	*(4.7-16.3)*	2.3	*(0.1-13.7)*	7.1	*(1.5-9.4)*
Available P	3	*(2-3)*	4		2	*(2)*	3	*(1-4)*	2	*(2-3)*
Total P	140	*(100-280)*	200		130	*(100-200)*	160	*(100-470)*	80	*(40-110)*
Total K	5 700	*(3 450-6 600)*	9 350		4 100	*(3 850-6 100)*	3 050	*(650-8 850)*	2 500	*(2 150-4 700)*
30+ cm										
pH	5.3	*(5.2-6.1)*	5.5	*(5.4-5.6)*	5.0	*(5.0-5.3)*	5.1	*(3.7-6.9)*	4.9	*(4.8-5.2)*
Exchangeable K	0.4	*(0.3-0.5)*	0.6	*(0.6)*	0.5	*(0.1-0.9)*	0.2	*(0.0-0.5)*	0.3	*(0.1-0.5)*
CEC	22.4	*(19.1-43.0)*	46.9	*(46.1-47.8)*	35.4	*(11.1-48.8)*	27.5	*(2.3-46.1)*	24.9	*(15.7-32.7)*
Base saturation	14	*(8-89)*	64	*(54-73)*	13	*(4-40)*	64	*(2-100)*	36	*(7-69)*
Exchangeable Al	12.6	*(0.9-17.3)*	10.7	*(6.9-14.5)*	22.3	*(8.8-25.0)*	3.0	*(0.3-21.0)*	10.8	*(2.6-14.7)*
Available P	2	*(2-4)*	4	*(3-4)*	2	*(2-3)*	3	*(1-4)*	2	*(2-3)*
Total P	80	*(70-160)*	155	*(110-200)*	90	*(80-90)*	110	*(70-190)*	50	*(40-90)*
Total K	7 500	*(7 350-7 650)*	10 625	*(10 600-10 650)*	6 150	*(5 700-15 250)*	6 150	*(1 100-11 400)*	4 000	*(2 350-9 800)*

Note: Units as in Table 29. Single values for range indicate that all contributing values are identical; absence of range indicates only one sample

The detailed study of Topco national land and Big Fall Plantation (Baillie and Wright, 1988) indicated considerable variability within the subsuites, thereby cautioning against undue generalizations. In particular two series - Tigerbush and one as yet unnamed - that develop over siliceous sandstones in the Toledo Beds are considerably more acid and weathered than the rest of Machaca Subsuite. The unnamed series has a dark umbric topsoil, pH values about 4, base saturations of about only 5%, and an exchange complex that is about 90% saturated by labile Al. Detailed studies of other areas will probably show that other subsuites are of similar chemical heterogeneity.

LIMESTONE SOILS

Table 31 summarizes some chemical features of the main groups of soils derived from non-siliceous limestones. The data confirm the validity of separating these soils on the stratigraphic age of the limestones. The three groups have distinctive combinations of chemical characteristics. Common features include high activity clays, mainly smectoid, and dominance of the exchange complex by Ca together with Mg where the limestone is dolomitic.

The dark soils of the Chacalte suite are slightly acid with the pH about 6.5 in topsoils, dropping to below 6 in the deeper subsoils. Some of them have base saturations of less than 100%. They have good nitrogen status with high total contents and low C:N ratios. Available P levels are moderate but total contents are quite high. Potassium levels are only moderate, which indicates probable deficiencies because of the dominance of the exchange complex by calcium.

The dark Yaxa soils are of about neutral pH and are wholly base saturated. Total nitrogen levels are only about half of those in the Chacalte soils in the wetter areas further south. Total contents of both P and K tend to be lower than in the Chacalte soils, but these nutrients appear to be in slightly more available forms.

There are only two profiles in the dark clays of Pembroke suite, but their data accord with general fertilizer experience on the Louisville soils. They are distinctly alkaline at about pH 8, and values of almost 9 are known. They are fully base saturated. Their nitrogen status is very similar to that in the Yaxa soils, with only about half of the total N levels of the Chacalte soils. However with respect to P and K these are clearly the most fertile of the dark limestone clays. Their available P contents are high but total contents are only moderate. Exchangeable K levels are high, as are the total K contents, considering that these soils overlie limestone.

In general the red soils in each suite are more acid and of lower fertility than the dark subsuites, although there are apparent exceptions. Thus Cuxu has lower total N, P and K contents than the dark soils of Xpicilha and Cabro Subsuites, but has equal or higher pH, available P and exchangeable K. The red soils of Chacluum Subsuite are clearly more acid and less fertile than the dark soils in Yaxa Suite. Similarly in Pembroke Suite the red Xaibe clays are generally of lower pH and nutrient status than the black Louisville clays, except for total K contents. In general the data vindicate the milpero's and sugar-cane farmer's preferences for the dark over the red soils.

PINE RIDGE SOILS OF THE COASTAL PLAIN

Table 32 summarizes the chemical characteristics of the soils under pine-grass savanna in the coastal plains.

The data for the Puletan soils indicate the impoverishment of the Tertiary-Pleistocene alluvium. Even in the 'corned beef' subsoils, with substantial clay contents, the contents of exchangeable bases, total P and total Ca are very low. In the sandy or loamy upper horizons, the contents are even lower, making these extremely infertile soils even poorer than the soils of the Mountain Pine Plateau (of Table 29), especially with respect to total P. Although very base deficient, these soils are not very acid. Their pH values are around 4.5-5, nothing like as

Table 31 Chemical characteristics of limestone soils - median values *(and ranges)*

Suite	Chacalte (Cretaceous)				Yaxa (Early Tertiary)				Pembroke (Late Tertiary)			
Subsuite	Xpicilha, Cabro (dark)		Cuxu (red and brown)		Yalbac, Jolja (dark)		Chacluum (red and brown)		Louisville (dark)		Xaibe (red and brown)	
No. of profiles	6		2		7		5		2		3	
0-10 cm												
Total N	1.08	*(0.51-1.29)*	0.71	*(0.61-0.81)*	0.48	*(0.17-0.68)*	0.49	*(0.23-0.65)*	0.44	*(0.44-0.48)*	0.48	*(0.38-0.60)*
Available P	3	*(2-7)*	3	*(3-4)*	5	*(2-45)*	3	*(2-3)*	48	*(12-84)*	6	*(2-17)*
Total P	720	*(360-820)*	400	*(270-540)*	200	*(110-390)*	210	*(180-360)*	500	*(320-680)*	210	*(190-480)*
Exchangeable K	0.3	*(0.2-0.4)*	0.4	*(0.4-0.5)*	0.5	*(0.2-3.0)*	0.1	*(0.1-0.8)*	1.3	*(0.2-2.5)*	1.8	*(1.5-2.3)*
Total K	1 000	*(500-2 650)*	770	*(750-800)*	800	*(200-3 000)*	650	*(150-800)*	4 450	*(850-8 050)*	8 625	*(7 850-8 900)*
pH	6.4	*(5.8-7.9)*	7.2	*(6.3-8.0)*	7.2	*(6.0-8.2)*	6.1	*(5.6-6.8)*	8.0	*(8.0)*	7.4	*(6.7-7.6)*
10-30 cm												
Total N	0.20	*(0.17-0.68)*	0.25	*(0.25-0.26)*	0.14	*(0.10-0.35)*	0.15	*(0.07-0.21)*	0.24	*(0.15-0.33)*	0.20	*(0.17-0.36)*
Available P	3	*(2-7)*	3	*(3)*	4	*(2-23)*	2	*(2-3)*	10	*(9-12)*	3	*(1-5)*
Total P	290	*(150-660)*	200	*(180-220)*	110	*(60-170)*	140	*(90-230)*	340	*(100-580)*	130	*(130-170)*
Exchangeable K	0.1	*(0.1-0.2)*	0.1	*(0.1)*	0.2	*(0.1-1.0)*	0.1	*(0.1-0.2)*	0.9	*(0.2-1.7)*	1.4	*(0.5-2.6)*
Total K	650	*(400-1 550)*	580	*(550-600)*	750	*(150-1 800)*	420	*(400-900)*	4 220	*(600-7 850)*	9 350	*(4 750-12 750)*
pH	6.3	*(5.2-8.2)*	6.6	*(6.5-6.6)*	7.2	*(5.5-8.3)*	6.2	*(4.7-7.4)*	8.1	*(8.1)*	8.3	*(5.7-8.4)*
40+ cm												
Available P	3	*(2-3)*	3		3	*(1-7)*	2	*(1-2)*	12		3	*(2-4)*
Total P	130	*(90-140)*	120		60	*(30-130)*	85	*(80-250)*	260		90	*(80-90)*
Exchangeable K	0.2	*(0.2-0.3)*	0.2		0.1	*(0.1-0.2)*	0.1	*(0.0-0.1)*	0.6		1.6	*(1.0-3.2)*
Total K	1 800	*(1 650-1 850)*	1 050		600	*(200-1 550)*	450	*(400-500)*	4 300		10 600	*(9 350-13 800)*
pH	5.6	*(5.1-6.6)*	8.5		6.6	*(5.1-8.0)*	5.9	*(4.6-6.1)*	8.2		7.2	*(6.2-8.1)*

Note: Units as Table 29; ranges as Tables 29 and 30

Table 32 Chemical characteristics of Pine Ridge soils of the coastal plain - median values *(and ranges)*

Suite	Puletan				Revenge			
Subsuite	Boom, Crooked Tree (sandy)		Bladen, Ben Lomond (loamy topsoil)		Felipe (deep siliceous cover)		Tok (shallow siliceous cover)	
No. of profiles	6		4		3		2	
Topsoil								
Clay	4	*(0-19)*	28	*(9-47)*	3	*(2-6)*	3	*(2-4)*
pH	5.0	*(4.5-5.3)*	5.2	*(4.7-5.2)*	6.2	*(5.1-6.9)*	6.7	*(6.3-7.1)*
Organic C	1.07	*(0.46-4.16)*	3.18	*(2.54-5.65)*	1.17	*(0.60-1.36)*	0.40	*(0.28-0.52)*
Total N	0.07	*(0.03-0.26)*	0.20	*(0.14-0.45)*	0.11	*(0.05-0.13)*	0.04	*(0.02-0.06)*
Exchangeable K	0.0	*(0.0)*	0.1	*(0.1-0.2)*	0.1	*(0.0-0.1)*	0.1	*(0.0-0.1)*
CEC	2.8	*(1.6-14.6)*	11.2	*(7.4-21.5)*	3.4	*(3.2-6.0)*	2.6	*(1.1-4.2)*
Base saturation	12	*(3-57)*	15	*(7-23)*	97	*(56-100)*	95	*(91-100)*
Exchangeable Al	0.7	*(0.1-3.6)*	2.6	*(1.1-4.5)*	0.0	*(0.0-0.1)*	0.0	*(0.0)*
Total K	1 025	*(50-5 200)*	950	*(650-2 000)*	50	*(50-100)*	75	*(50-100)*
Total Ca	75	*(25-500)*	175	*(100-250)*	300	*(250-1 300)*	600	*(25-1 200)*
Available P	2	*(1-3)*	2	*(2-3)*	2	*(2-5)*	2	*(1-2)*
Total P	50	*(20-130)*	95	*(70-210)*	40	*(20-120)*	15	*(5-20)*
Upper subsoil								
Clay	4	*(0-38)*	45	*(21-67)*	22	*(1-24)*	32	*(26-38)*
pH	5.1	*(4.8-5.3)*	5.1	*(4.2-5.2)*	5.5	*(5.1-6.2)*	6.7	*(6.2-7.1)*
Exchangeable K	0.0	*(0.0)*	0.0	*(0.0)*	0.0	*(0.0-0.1)*	0.1	*(0.1)*
CEC	0.5	*(0.2-2.7)*	4.2	*(2.4-7.9)*	6.5	*(0.4-11.8)*	14.5	*(9.6-19.3)*
Base saturation	28	*(0-100)*	12	*(8-18)*	54	*(50-85)*	97	*(93-100)*
Exchangeable Al	0.1	*(0.0-1.0)*	1.4	*(0.9-3.4)*	0.2	*(0.0-2.4)*	0.0	*(0.0)*
Total K	1 700	*(50-6 550)*	1 400	*(750-10 700)*	200	*(25-200)*	675	*(500-850)*
Total Ca	25	*(25-50)*	40	*(25-50)*	350	*(25-1 300)*	2 850	*(1 050-4 700)*
Available P	1	*(1-3)*	1	*(1-3)*	2	*(0-3)*	3	*(3)*
Total P	45	*(10-90)*	65	*(40-120)*	40	*(10-90)*	40	*(40)*
'Corned beef'								
Clay	36	*(17-64)*	62	*(35-65)*	27	*(25-32)*	42	*(29-56)*
pH	5.2	*(4.5-5.2)*	4.7	*(4.0-5.3)*	5.3	*(4.7-7.8)*	8.0	*(7.3-8.6)*
Exchangeable K	0.0	*(0.0)*	0.0	*(0.0)*	0.1	*(0.1)*	0.1	*(0.1-0.2)*
CEC	3.2	*(1.0-5.7)*	7.4	*(3.8-9.4)*	10.8	*(8.1-15.5)*	19.7	*(18.4-21.0)*
Base saturation	22	*(11-41)*	14	*(8-35)*	90	*(88-100)*	100	*(100)*
Exchangeable Al	0.8	*(0.3-3.4)*	2.9	*(2.7-4.7)*	0.3	*(0.0-1.2)*	0.0	*(0.0)*
Total K	5 700	*(1 150-15 050)*	3 150	*(1 500-17 000)*	250	*(200-250)*	1 250	*(1 200-1 300)*
Total Ca	40	*(25-100)*	40	*(25-50)*	1 300	*(1 000-1 400)*	22 100	*(6 750-38 500)*
Available P	1	*(1-2)*	1	*(1-2)*	2	*(1-4)*	3	*(3)*
Total P	80	*(50-150)*	70	*(60-100)*	30	*(30-80)*	65	*(30-100)*

Note: Units as Table 29; ranges as Tables 29 and 30

low as in the rhyolitic-andestic soils of Richardson Suite in the Maya Mountains (see Table 29). The moderate pH and low CECs account for the relatively low labile Al contents. The CEC values indicate very low activity clays, mainly sesquioxides and kanditic lattice aluminosilicates. The finer-textured soils in Bladen and Ben Lomond Subsuites are only marginally more fertile than the very sandy soils of Boom and Crooked Tree Subsuites. They have higher cation exchange capacities but these are equally base depleted. Total K and P levels are slightly higher but are still very low.

Where the siliceous alluvium thins out in northern Belize and overlies calcareous material, the soils of Revenge Suite are formed. The influence of the underlying material shows in the higher pH, base saturation and total Ca of the sandy topsoils, but otherwise they are hardly more fertile than the topsoils of Puletan. The calcareous effect increases with depth, most markedly in the shallower sandy alluvium that gives the soils of Tok Subsuite. Although pH, base saturation and total Ca levels are moderately high, the P and K status of the subsoils are still very low.

In assessing the potential of these soils it must be remembered that as well as being chemically infertile, the soils of Puletan and Revenge Suites also provide very poor physical conditions for plant roots. The underlying mottled horizons are almost impenetrable and impermeable. Rooting systems are largely confined to the coarse-textured surface horizons, which are droughty in the dry season, and saturated and poorly aerated in the wet. The combination of chemical and physical drawbacks make these soils infertile and unproductive under natural vegetation or agricultural crops.

RIVERINE ALLUVIAL SOILS

Table 33 compares the chemical characteristics of soils developed in riverine alluvial deposits. The number of profiles is small so that the comparisons have to be tentative. Nonetheless the data do show the chemical effects of increasing age of alluvium since deposition and last inundation. The soils of Monkey River and Quamina Subsuites are variable with respect to clay content, pH, base saturation, and exchangeable Al. They have high total K contents throughout the profile but this is not reflected in the exchangeable K contents which are low. Available P contents are high but total contents are mostly moderate.

The soils of Canquin Subsuite on the older alluvium are clearly more leached. This shows up in the lower pH and base saturation and higher exchangeable Al. The deposits are also considerably more weathered as shown in the lower total P and Ca, and in the lower CEC, especially when these are compared on a basis of per 100 g clay rather than per 100 g fine-earth basis. The clay minerals in the subsoils are clearly of low activity, probably mainly kandites and sesquioxides. However it is noticeable that the total K contents are still high. This accords with the field morphological evidence of the persistence of some muscovite flakes, even in quite high terrace deposits.

Comparison of the Canquin data in Table 33 with those from Tok Subsuite in the final column of Table 32 are, in some respects, such as pH, base saturation and exchangeable Al, unfavourable to the Canquin soils, although their total P contents are several-fold higher. The Canquin soils are rated as highly productive and flexible and those of Tok Subsuite as being of very low agricultural value. This highlights the importance of the physical contribution to overall fertility. The Canquin soils are deep, fairly permeable, reasonably well drained and aerated, and have substantial capacities for storing available moisture. The subsoils of Tok are virtually impenetrable by roots and are impermeable to water.

Table 33 Chemical characteristics of riverine alluvial soils - median values *(and ranges)*

Subsuite	Monkey River, Quamina (young alluvium of floodplains)		Canquin (old alluvium of terraces)	
No. of profiles	4		2	
Topsoil				
Clay	25	*(7-42)*	17	*(16-18)*
pH	5.5	*(4.7-7.8)*	5.0	*(4.8-5.1)*
Organic C	2.04	*(0.86-2.50)*	1.71	*(1.38-2.04)*
Total N	0.22	*(0.10-0.32)*	0.16	*(0.14-0.19)*
Exchangeable K	0.1	*(0.1-0.2)*	0.0	*(0.0-0.1)*
CEC	9.7	*(4.9-13.7)*	6.0	*(5.4-6.7)*
Base saturation	68	*(14-100)*	16	*(13-19)*
Exchangeable Al	0.2	*(0.0-3.5)*	1.8	*(1.2-2.3)*
Total K	14 400	*(6 200-20 300)*	6 600	*(6 550-6 650)*
Total Ca	1 700	*(250-4 800)*	250	
Available P	12	*(3-67)*	5	*(4-6)*
Total P	410	*(240-710)*	135	*(120-150)*
20-50 cm				
Clay	23	*(12-37)*	47	*(37-57)*
pH	5.4	*(4.9-7.4)*	4.7	*(4.3-5.2)*
Exchangeable K	0.0	*(0.0-0.1)*	0.0	*(0.0-0.1)*
CEC	5.5	*(3.3-9.6)*	5.8	*(3.9-7.8)*
Base saturation	42	*(13-100)*	6	*(3-10)*
Exchangeable Al	0.3	*(0.0-1.9)*	3.5	*(1.8-5.2)*
Total K	14 400	*(7 250-22 300)*	15 500	*(11 650-20 400)*
Total Ca	600	*(100-2 250)*	25	
Available P	5	*(2-18)*	2	*(1-2)*
Total P	300	*(170-580)*	115	*(100-130)*
60-100 cm				
Clay	26	*(13-40)*	48	*(45-50)*
pH	6.2	*(5.5-7.0)*	4.8	*(4.4-5.2)*
Exchangeable K	0.0	*(0.0-0.1)*	0.0	*(0.0-0.1)*
CEC	5.0	*(4.1-6.0)*	4.9	*(4.4-5.4)*
Base saturation	61	*(37-85)*	8	*(1-16)*
Exchangeable Al	0.5	*(0.0-1.0)*	3.9	*(2.3-5.5)*
Total K	17 350	*(11 600-23 100)*	18 500	*(17 050-20 000)*
Total Ca	850	*(450-1250)*	25	
Available P	15	*(2-28)*	1	*(1)*
Total P	320	*(220-420)*	145	*(140-150)*

Note: Units as Table 29; ranges as Tables 29 and 30

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