RECONNAISSANCE SOIL SURVEY—EAST COAST NEW IRELAND

By C. L. Van Wijk.*

This is a summarized account of a departmental Soil Survey report made by Mr. C. L. Van Wijk as an initial appreciation of the problem of declining plantations in New Ireland. The subsequent detailed investigations carried out, reports of which are published elsewhere in this issue, permitted the deletion of the general discussion from this report.—*Editor.*

Topography.

MOUNTAIN ranges occupy the northern and central parts of New Ireland. These reach their greatest height in the Lelet Plateau, a limestone massif of 3,000 feet to 4,000 feet. From this plateau, the ranges fall away to the south and north, although they are generally above 500 feet. The notable gap is at Namatanai, where the height is about 300 feet. The ranges end in the northern part of the island, and there are only isolated hills in the north-west of the island.

The parent material consists mainly of limestone and raised coral, so the landform is mainly determined by subterranean drainage. Although rainfall is considerable, there are no surface streams in some parts of the island.

Karst phenomena, such as a rugged surface, dolines, caves and big springs at the bases of cliffs are common.

The coastal belt consists mainly of undulating raised coral surfaces, broken by cliffs. In many places, this takes the form of terraces, usually dissected and irregular because of differential weathering.

The width of the coral fringe varies, but averages about a mile. However, the fringe is absent from the foot of the Lelet Plateau. Villages are sited mainly on flat coral-sand fringes along the foreshore. These fringes are mainly narrow belts, parallel with the shore, or isolated pockets, between the raised coral terraces and the coast. In other places, at the base of the terraces, sago swamps are found in seepages.

Alluvial deposits are mainly restricted to a few creek valleys in Central New Ireland and to the area between Namatanai and Samo.

Petrology.

Limestone and raised coral are the main parent materials from which New Ireland soils are derived. The limestone is found in association with fragments of old igneous rock, sandstones and shales, and quartzite, which apparently originates from upper tertiary rock formations.

A calcareous tuff formation, known as soapstone, is closely related to the limestone and coral. This material is of a greasy consistency and is believed to be the decomposed and structureless formation of old coral. In Northern New Ireland, calcareous tuff is found in isolated areas, mainly in steep ridges which dip away into the surrounding coral and limestone. Calcareous tuff is more extensive in Central New Ireland, from Lokon southward, where it is associated mainly with limestone and old volcanic materials. The area is badly eroded and unsuitable for agriculture.

Evidence of old volcanic activity appears in Northern New Ireland, between the northern end of the limestone range and the flat or gently undulating northern section. Volcanics are found also in Central New Ireland as narrow strips fringed by soapstone ridges. Magnetite sand deposits indicate the likelihood of old volcanic activity in the centre of New Ireland. There are also volcanic products on the west coast.

Volcanic areas are generally of easier relief than the limestone country, but they are generally inaccessible, except possibly in parts of Northern New Ireland.

Rainfall.

Reliable rainfall totals for many areas have not yet been accumulated. However, the main rainy season is from November to April, during the north-west monsoon. But

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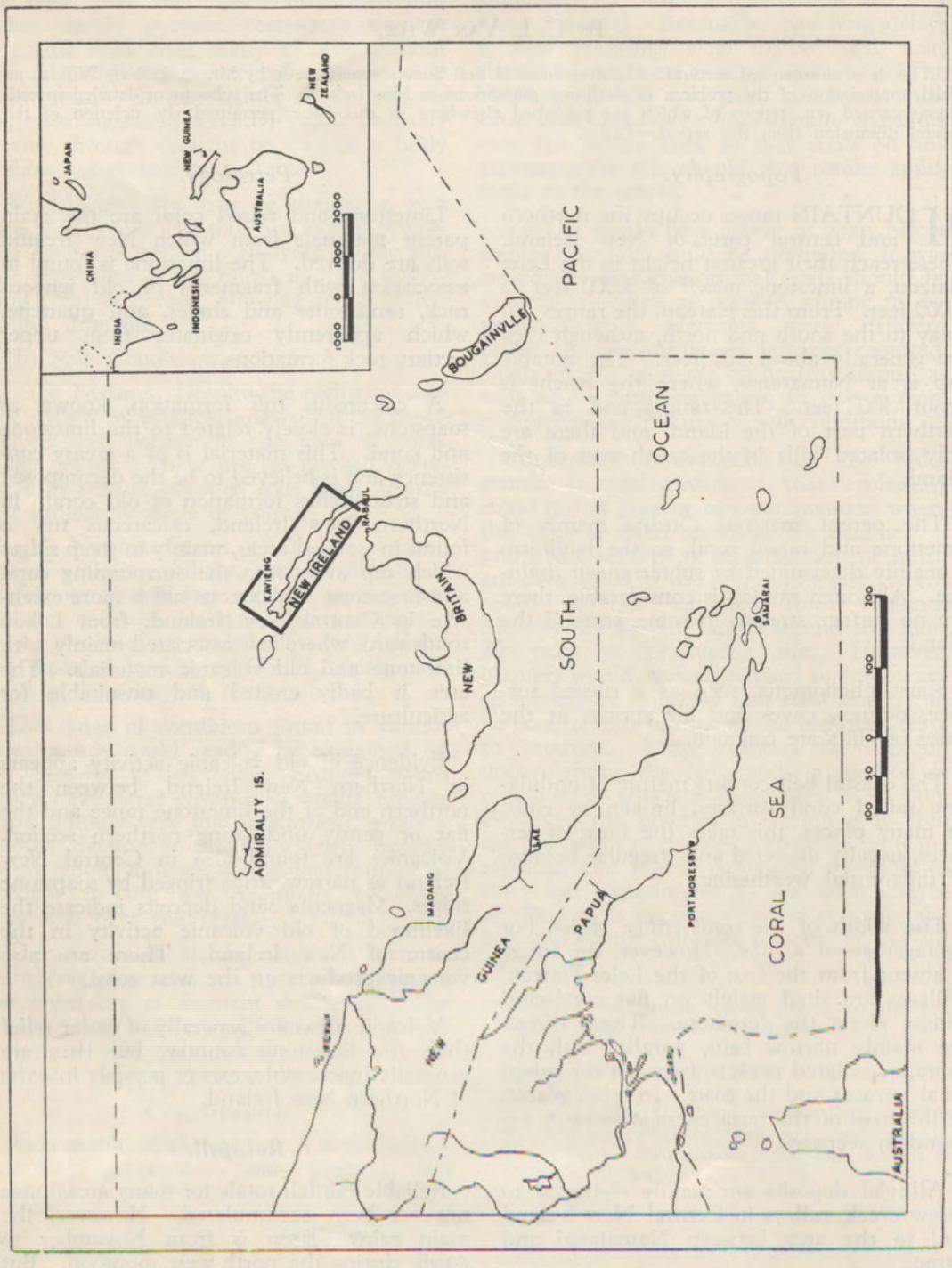
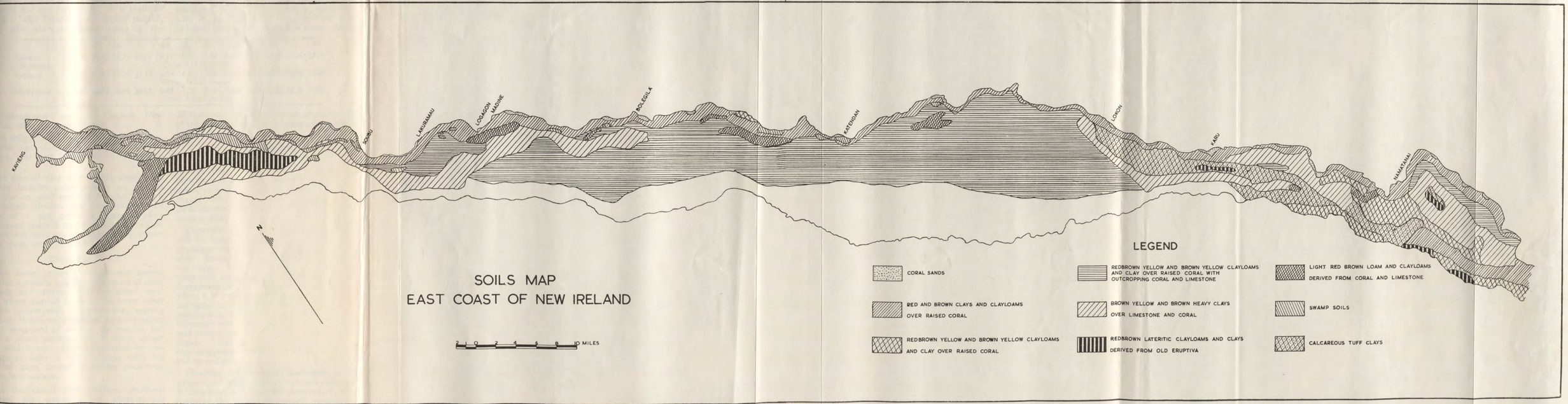


Location map of area surveyed.


KAVIENG
SOMBU
LAMUSAMAU
LOGAKON
MADINE
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KATEDOAN
LOKON
KABU
NAMATANAI
N
SOILS MAP
EAST COAST OF NEW IRELAND
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LEGEND
CORAL SANDS
RED AND BROWN CLAYS AND CLAYLOAMS OVER RAISED CORAL
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LIGHT RED BROWN LOAM AND CLAYLOAMS DERIVED FROM CORAL AND LIMESTONE
SWAMP SOILS
CALCAREOUS TUFF CLAYS

there are also showers from May to September, the period of south-east winds, along the east coast. These falls are local in character, scattered and not very heavy. It is probable that the Lelet Plateau has a higher rainfall, while falls are considerably lower in the Karu-Namatanai part of Central New Ireland, where droughts occur.

	J.	F.	M.	A.	M.	J.	Jy.	A.	S.	O.	N.	D.
Kavieng .... (10 years)	12.20	11.60	11.35	12.06	9.93	9.55	10.36	10.67	8.03	8.12	9.24	10.72
					TOTAL 123.23 inches.							
Logagon	13.96	15.85	12.35	11.13	9.54	6.51	7.03	10.08	5.50	8.55	8.89	12.86
					TOTAL 122.25 inches.							
Namatanai ..	19.68	16.87	16.61	14.72	8.80	7.04	8.55	7.39	5.93	8.99	11.39	16.87
					TOTAL 142.84 inches.							

The only rainfall figures available are from Kavieng and Logagon in Northern New Ireland, and from Namatanai in the central part.

The rainfall and its monthly distribution favours healthy palm growth on mineral soils, but on coral and limestone soils, which are mainly shallow and well-drained, the effect of a dry period is marked. More permanent water is found in hill depressions, but, where drainage is impeded by impervious clays, swamps result.

Vegetation.

Rain forest covers the mountain ranges, but this generally appears to be poor in composition and species. On the raised coral belt, where rainfall is lower, the forest cover is even poorer and, by comparison, appears stunted. It is usually replaced by a secondary forest composed of only a few species, but with a dense undergrowth of vines, ginger and wild hemp. Forest vegetation on the calcareous tuffs is often scanty, with big windfall gaps, caused by sodden conditions in the wet season.

On the raised coral terraces, grassland patches are common. A characteristic species of Pandanus has given the country a savannah-like appearance. These grasslands are probably artificial, having been formed by the few hardy species which survive the annual burns.

Swamps appear mainly where there is seepage, as on the boundary of coral sands and reefs in Northern New Ireland. From Katendan northward, mangroves and sago swamps are fairly extensive in the form of a belt half a mile or less in from the shore.

Nearly all the agricultural land is within two miles of the coast. The natives use the traditional form of bush-fallow agriculture with a rotation of a crop in one year, followed by a re-growth of five years. About 50 European and Chinese-owned plantations of coconuts alternate with many village plantings of the palm.

Soils—General.

Except for small areas of volcanic and old tertiary formations, most of Central and Northern New Ireland is composed of limestone, coral and calcareous tuffs. On this parent material, soil is formed from the inorganic constituents originating from the upper tertiary sediments and old volcanic deposits.

Generally speaking, the fertility of a soil will be higher and vegetation will be more abundant when more mineral matter is available. Excess of calcium carbonate helps in two ways. Firstly it saturates the colloidal clays with lime, and secondly it keeps the soil flocculated into a coarse dispersoid phase, when it is penetrated by water and air. This permeability causes drought in dry seasons, particularly where soils are shallow. The limestone and coral in itself is very permeable and groundwater is always at a considerable depth. Under these aerobic conditions, the iron compounds show predominantly brown-red to red colours.

However, under humid conditions, in the presence of organic matter, calcium carbonate is dissolved and leached downwards, thus lowering the pH in the topsoil, resulting in the formation of iron concretions and a bleached brown-yellow colour. The clay has a heavier texture and becomes stickier and more plastic as the fine, dispersed iron compounds transform into a course disperse condition.

Calcareous tuffs are impervious. Consequently this parent material is water-saturated during wet periods. Under these conditions hydrogen clay, which disintegrates

easily, is formed. This clay is liable to heavy erosion and creep. During the wet season, the calcium carbonate is gradually leached out, especially if organic matter is available. The soil pH does not fall below neutral and leaching is less extensive than in permeable limestone and coral. During the dry period the pH increases slightly. This soil dries more slowly than the red and brown-yellow clays.

G. W. Robinson * describes their characteristics as follows. " Soils derived from limestone belong to the group of terra rossa. They have a low base status, sometimes even in the presence of fragmentary limestone, and a type of organic matter of a light colour. Colour of the mineral soil is red or reddish-brown, associated with a type of clay having a S_1O_2/R_2O_3 ratio of two or less, in which there is a certain proportion of free sesquioxides." Other writers suggest that the reason for the change in colour from red to brown-yellow in the coral and limestone soils is caused by a difference in saturation of the clay complex.

Although the red clay is slightly acid, it seems that the clay complex shows a certain saturation with bases mainly calcium. The red clay is mostly friable and well aerated. The brown-yellow coral clays represent the less-saturated type in which calcium and bases in the clay complex have been replaced by hydrogen. These soils are heavy, plastic and impermeable. Water movement is disturbed and once the soil is saturated, anaerobic conditions and reduction processes prevail.

Volcanic soils derive mainly from old andesites and show the characteristic of lateritic weathering. They gradually increase in heaviness with depth, from loam to clay to medium clay, with a reddish-yellow mottled layer. These soils are permeable and have a favourable water-holding capacity. Unfortunately they are mainly in steep positions and are heavily eroded.

Profile Description.

1. *Coral-sand* consists of yellowish-white coarse coral fragments with no profile differentiation. The soils are porous and cannot hold water, except in the dark humic top layer. However, these flat sands have a favourable groundwater table, and tidal influences cause movements of subsoil water, which assists coconut growth. Under equatorial rainfalls, these coral-sands grow good palms, which are healthy in appearance as long as competition by shrubs and rival plants is eliminated. At present, these coral-sands represent the best palm soils on the east coast of New Ireland.

2. *Red-brown to red clay-loams/light clays over raised coral.*

Description of an average profile :—

0-1 in.—Dark-brown humic, permeable, friable and crumbling loam with numerous roots, merging into—

1-6 in.—reddish-brown, permeable, friable, crumbling to slightly sticky clay loam, gradually merging into—

12-20 in.—red-brown clay, cloddy to granular, permeable and less friable, due to increased stickiness and plasticity. Root development is favourable. Merges into—

20-36 in.—red-brown clay, friable and permeable, cloddy to granular light clay, less sticky and plastic, containing soft earthy-blue iron concretions. Roots are developed through this layer.

Variation in profile composition is caused mainly by relief. Shallow red to red-brown clay-loams are restricted to the ridges which are liable to severe erosion. Deep profiles are accumulated from the ridges. Depressions with poor drainage are often swampy during the wet monsoon. Consequently a subhydric decrease in pH takes place, accompanied by movements of soluble iron compounds and the formation of iron concretions. The sticky and plastic heavy subsoil in these localities shows a brown-yellow mottling with red streaks.

The above red clay-loams and clays are restricted to the raised coral and cliff country for a distance of half a mile to three-quarters of a mile from the coast. The topography shows no marked difference from the remaining raised coral areas further inland, which are occupied by the brown-yellow clays.

3. *Brown-yellow clays.* The average profile of this soil type has the following characteristics :—

* *Soils, their origin, constitution and classification*—1932.

0-10 in.—a brown-yellow permeable, friable, crumbling to granular slightly humic clay-loam. Slightly sticky and plastic in consistency, gradually merging into—

10-12 in.—yellow-brown, less friable and less permeable, cloddy clay with increased stickiness and plasticity, merging into—

12-36 in.—yellow-brown, cloddy, compacted, heavy impermeable clay, usually with bluish iron concretions.

This soil type tends to bogginess during the rainy season, although the soil takes a long time to become saturated. In this type, palms are alternately exposed to droughts during dry periods and to waterlogging in wet season. These heavy clays are found inland on the hilly, raised coral and extend to the lower mountain ranges.

3. (*a*) *Red-brown-yellow clay-loam to clay.* An intermediate type is the red-brown-yellow clay-loam to clay over raised coral. In physical properties this type is closely related to the red clays. However, the predominantly yellow to yellow-brown colour and the presence of blue-iron concretions indicate a chemical difference. Profile characteristics of this type are—

0-3 in.—A grey-brown, mellow permeable, humic crumbling loam, feeding roots plentiful, merging into—

3-8 in.—brown-yellow, permeable, friable, less humic loam, gradually merging into—

8-12 in.—reddish-brown-yellow, permeable, friable clay-loam, poor in humus and slightly sticky and plastic, gradually merging into—

12-36 in.—reddish-yellow, permeable, friable light clay, increasing in stickiness and plasticity and containing soft blue iron concretions. Root development in this latter is satisfactory.

Although physical properties of this type are more favourable than the brown-yellow clays, coconut palms are less healthy and productive than on the red clay/clay-loams along the foreshore. The economic life is definitely shorter. Reasons for the early decline could be the occurrence of droughts and deficiences in plant nutrients.

Grasslands developed on this soil type usually show a deteriorated topsoil, which is dark, due to the presence of fine charcoal. Water percolation is disturbed and anaerobic conditions prevail in the upper layers.

4. *Red-brown loams to clay-loams.* Soils of the best physical properties are found in small bands at the base of limestone ranges near Logagon and Magina. The soil profile generally has the following characteristics :—

0-12 in.—Red-brown loam, crumbling, friable and permeable, merging into—

12-30 in.—reddish-brown clay-loam, crumbling and permeable. Roots all through the layer.

30-34 in.—red-brown-yellow light clay, crumbling, friable, permeable, and containing a few concretions.

34-36 in.—red-brown-yellow, red-streaked clay-loam, crumbling, friable and permeable.

These light-structured loams are found also in depressions and valleys in the limestone ranges, where eroded material accumulates. These soils have a good waterholding capacity, and for this reason are preferable for native gardens. However, the areas are scattered and small. This soil is quite suitable for cocoa, as at Soubu plantation and Bolegila, five miles inland.

5. *Calcareous tuff soils.* This tuff is associated with limestone and volcanic material. Soils developed in situ are heavy, puggy, impermeable yellow-brown clays. The soil profile shows the following characteristics :—

0-4 in.—Grey-brown clay-loam, friable, crumbling and humic, suddenly changing into—

4-10 in.—impermeable, cloddy, compacted brown clay containing tuff fragments. Consistency is more or less greasy.

10-36 in.—mainly decomposing tuff fragments and impermeable, compact brown clay. Very greasy.

These shallow profiles get waterlogged after only a short period of rain. The saturated soil disintegrates and the vegetation topples. Even on deeper profiles, a common symptom is fallen trees and palms. Deep, well-drained profiles on hill sites seldom reach the stage of saturation and accordingly

support an abundant natural vegetation. Coconut palms on these soils are healthy, green and productive.

The impermeability of the parent material causes temporary waterlogging of subsoils, which is shown by a grey-brown and reddish mottling. Calcareous tuff areas have mainly a surface run-off and unlike the limestone country, small creeks are found.

6. *Volcanic soils.* There are small areas of soil over old volcanic material in Northern and Central New Ireland. Although the soil is preferable for agriculture, the areas are inaccessible and also are generally of dissected relief, which restricts their value. Profile characteristics are :—

0-8 in.—Grey-brown loam, crumbling to granular, friable, permeable and of a good water-holding capacity. This layer is reasonably well provided with humus. It merges at—

8-18 in.—into yellow-brown clay, crumbling to granular, permeable and friable. Humus content is very low, but roots develop through the area. It merges gradually at—

18-30 in.—into yellow-brown clay, granular to cloddy, less friable but permeable. Roots are less numerous. Merges into—

30-36 in.—yellow-brown medium clay, cloddy, less permeable and less friable.

The third layer usually shows a red, grey, blue and yellow mottling associated with the lateritic weathering. Soils are mainly eroded and shallow on steep slopes, where old volcanic parent material (andesite) often appears on the surface.

7. *Alluvial soils.* These are found in narrow strips along some creeks. These alluvia are mainly brown sand, to sandy loams of good permeability. At depth they are gravellish, but the soil is at least five to six feet deep. The ground water table is at a favourable depth and water movement is unimpeded. These alluvia are quite suitable for growing coconut palms, rice and cocoa, but the area is restricted and already occupied.