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A SOIL SURVEY MANUAL FOR MALAYAN CONDITIONS

by

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Soil Science Division,
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This is the first approximation of a Soil Survey Manual for Malayan Conditions. It is being circulated in this form for use and critical appraisal. It is intended eventually to publish this Manual as a book small enough to be used conveniently in the field. Some of the terminology suggested, and particularly that concerning horizon nomenclature, is put forward tentatively with the object of inviting further comment. Despite this, however, all the terminology is intended to be used on soil survey operations until there is any further official amendment.

In compiling the Manual an attempt has been made to provide the soil surveyor with all the information, whether it be technical, administrative or even medical, which he may require to carry out a soil survey in Malaya efficiently and competently. The authors would appreciate their attention being drawn to anything they may have overlooked in this regard.

Included with some copies of this first approximation are descriptions of all the soil series currently being used during the Schematic-Reconnaissance Soil Survey of Malaya. Strictly speaking these are out of place in a Manual devoted primarily to techniques and methods, and they will not appear in the final publication. For the sake of convenience they are issued with this first approximation to all soil surveyors and others who have an immediate interest in the soil series recognised in Malaya.

At this stage the Manual is not regarded as a formal publication and should not be quoted in other publications without reference to the authors, and then the reference should be to "personal communication".

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PREFACE

This is a book for practising soil surveyors working in the field. It has been prepared primarily to assist in the Schematic-Reconnaissance Soil Survey of Malaya - an ambitious programme which aims to produce a stock-taking of the soil resources of the whole of the Malayan Peninsula by 1967. The project has an international character provided by the Malaysian, Canadian, American, British and New Zealand personnel who are participating in it. This Manual has been compiled by drawing on their experience both in their own countries and in Malaysia.

Free use has been made throughout of information drawn from the United States Soil Survey Manual (1951) and from Soil Survey Method: A New Zealand Handbook for the Field Study of Soils (1962), and this data has not everywhere been acknowledged specifically in the text. Such acknowledgement is tendered here. Wherever possible the standards outlined in these documents have been adhered to in order to maintain uniformity with a nomenclature that is widely understood in other parts of the world. The modifications which have been made are necessary to meet local conditions.

Grateful acknowledgement is made to other members of the Schematic-Reconnaissance Team for their participation and help, and particularly to Inche2 Law Wei Min, Ignatius F.T.Wong and K. Selvadurai for their work on the classification of slope and terrain; to Mr. W.Null and Inche Ignatius F.T.Wong for their contribution to the soil suitability classification; to Inche Ignatius F.T.Wong for assisting with the section on landforms and Appendix 4; to Messrs. J. Dumanski and H.A. Smallwood for much of the data used in the section on horizon nomenclature; to Mr. D.A.Libby for his contributions to discussion; and to Mr. D.W.Ives for providing the diagram following p.15. Thanks for criticism and helpful suggestions are also tendered to members of the staff of the Soil Science Division, particularly to the Senior Soil Scientist, Mr. G.W.Arnott for his constant encouragement, and to Dr. Ng Siew Kee. Thanks are also extended to Mr. C.R.Jones, Geological Survey, and Dr. M.M.Guha, Rubber Research Institute, for their helpful comments on Appendices 6 and 13 respectively. The diagrams were drawn in the Soil Survey Drawing Office by Inche2 Raja Lob Sharuddin and Mohd. Ali bin Othman, to whom appreciation is extended.

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CHAPTER 1

INTRODUCTION

Soil survey activity is increasing in both scope and intensity throughout the world today. This is particularly so in many tropical countries, and Malaya is no exception. A by-product of this is the urgent need to standardise the terms and techniques associated with soil survey. Handbooks and manuals have already been produced by soil survey organisations in some countries, notably, the U.S.A., New Zealand, and the Philippines (Soil Survey Staff, 1951; Taylor and Pohlen, 1962; Barrera, 1961) and although these documents have much in common it is evident that local conditions vary sufficiently from country to country to warrant the provision of a separate guide for each individual survey organisation.

The purpose of this Manual, therefore, is to provide a ready guide to the description and mapping of soils in the field in the States of Malaya. It is thus aimed primarily at the soil surveyor, and strives to outline all the information, both scientific and administrative, that he may require in order to fulfill his function efficiently and competently. At the same time, it contains much information of interest to those who use soil maps, and it is hoped that it will be accepted as the standard authority in the field of soil survey in this country.

Soil surveys provide a foundation for land development programmes by outlining the basic soil pattern of a region, and by identifying each kind of soil occurring there. This information on soil resources reveals a rational basis for the assessment and prediction of crop responses. Similarly, on developed land soil survey information is often helpful in explaining uneven growth patterns and in providing a blueprint for remedial trials. Although the immediate purpose of soil survey is practical, it is also a scientific exercise which is not necessarily subordinated to the needs of the moment but which results in basic information

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of wide application. Although the information may be interpreted in many ways for different purposes, its inherent value lies in its fundamentally scientific nature.

Depending on the degree of detail required, soil surveys in Malaya are classed as schematic-reconnaissance, detailed reconnaissance, or detailed. The aims of schematic-reconnaissance surveys are; to obtain an indication of the broad soil distribution pattern over a given area; to assess the relative agricultural potentials of the dominant soils; to set up a working classification at the association and series level; and to draw up small scale soil maps showing the distribution of the main soils. Maps are compiled usually on a scale of 1 to 500,000 (or about 8 miles to 1 inch) but also sometimes on a scale of 4 miles to 1 inch (1 to 253,440) and even 2 miles to 1 inch (1 to 126,720) by reduction from the data collected on 2 inch to 1 mile field sheets during field traverses carried out on a reconnaissance scale. Field survey on a reconnaissance scale involves examination of soils at about $\frac{1}{4}$ mile intervals along pre-determined routes about 3 to 4 miles apart and mapping these soils as series which are later grouped and shown on the map as associations of series. Geological, topographical, and any other sources of information are referred to when the actual positions of the soil boundaries are being inferred between the traversed routes.

In Malaya, schematic-reconnaissance surveys supply at least part of the answer to some very important practical questions: namely, is a certain area worth developing for agriculture, and if so, what type of crop would be most suitable. In addition, if already developed areas are also examined, the final result is a very useful initial stock-taking of the country's soil resources. Other advantages of such a survey are that a soil classification is built up in the field and this can be used as a guide in laying down certain types of agricultural experiments, thus enabling results of these to be applied in developed or

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potential agricultural areas where the soils are similar.

The schematic-reconnaissance survey of the Malayan Peninsula is providing urgently needed information to aid investigation and planning on a regional and national scale, and at the same time it furnishes a framework within which future, more intensive soil studies can be pursued.

Detailed reconnaissance surveys, which are the normal method of surveying jungle soils at the soil series level, involve traversing lines cut at intervals of between 200 yards and 1 mile, and examining the soils very closely along these lines. The maps, which are made by plotting the soil data obtained along the rentis$_2$* and then drawing in the positions of the actual soil boundaries by inference, are usually produced on a scale of 1 mile to 1 inch (1 to 63,360). This work is very expensive and time-consuming, particularly in forested areas, but if there is some definite end in view and the terms of reference have been stated in detail before the field work begins, then such surveys can be of great value in the study of local soil problems and as a basis for assembling and distributing information in the fields of agriculture and forestry.

In both schematic-reconnaissance and detailed reconnaissance surveys, the actual position of the soil boundaries has to be inferred for most of their distance between the rentis$_2$ or other traverse routes and it is obviously impossible to produce an accurate map in jungle covered terrain by these methods. Such maps do, however, indicate the broad soil pattern in spite of the inaccuracies in detail. They should be interpreted intelligently and with full regard to their limitations.

Detailed surveys produce maps normally showing series and phases on a large scale, for small areas where detailed

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* rentis - a Malay term for a track or trace cut through the jungle. Those used in soil survey work are cut on fixed compass bearings. In Romanised script the plural of rentis is written rentis$_2$.

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knowledge of the soil pattern will be of use in various agricultural and agronomic projects. Mapping by free traversing at close intervals can sometimes be done on estates or open areas of padi land, but in jungle or thick second growth a very close rentis net must be cut and very detailed notes taken of the soils along the rentis$_2$. The usual spacing between the rentis lines is 4 to 8 chains, and the final maps are produced on scales ranging from 16 chains to 1 inch up to 1 mile to 1 inch. It is usually impractical to produce this type of map in jungle country owing to the heavy expense involved, and such maps are normally only prepared for developed lands such as agricultural stations, development schemes and estates.

Surveys of small areas carried out at a specific request are referred to as ad hoc surveys. The maps are usually at a detailed scale and aim to answer an immediate agronomic problem.

Frequently a soil scientist is called upon to examine a piece of land and to advise on the cropping potential or management requirement without producing a soil map. In order to differentiate this type of examination from a soil survey, which implies the preparation of a soil map, the term soil inspection should be used.

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CHAPTER 2

THE SOIL SITE AND PROFILE

The Geographical Setting of Malaya

Malaya occupies the extreme south easterly portion of the Asian mainland and is part of the peninsula which extends southwards from Burma to Singapore. The distance from the northern most boundary at Perlis to the southern tip at Singapore (latitude 1° 18' N.) is about 700 miles, and the country covers an area of about 51,000 square miles. The central spine of mountain ranges, rising to just over 7,000 feet, is flanked to the east and the west by extensive coastal plains. In terms of the geographic elements of climate and vegetation, Malaya is a land of striking uniformity. The dense cover of tropical jungle is continuous in the undeveloped areas, and both the rainfall (of the order of 100 inches per annum) and the mean temperature (in the vicinity of 80°F) are uniformly high. Such an environment is a challenging one for soil surveyors, and athletic prowess is often almost as important as professional ability to the surveyor working in the jungle. Many of the special techniques and methods described in this Manual have been developed to overcome the difficulties of the environment.

Soil Forming Factors

All the classic soil forming factors operate in Malaya. The soils are the products of their environment - of the parent material, of the climate under which they weather, of the kind of topography upon which they are situated, of the vegetation which grows on them, during the length of time that they have been developing. As is the case in many other regions, some factors are expressed more emphatically under Malayan conditions than are

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others. Thus, the broad scale soil pattern is dictated almost exclusively by the parent material. This is a reflection in part of the varied geology and in part of the uniform climate and vegetation. Differences in topography and time both produce important soil distinctions at a slightly lower level of abstraction. Geological information, therefore, is a necessary pre-requisite to soil survey in Malaya.

Parent Material

The more important groups of parent rocks from which parent materials of Malayan soils are derived are described below:-

1. Basalt and allied rocks

These are hard, dark coloured, finely crystalline rocks containing a high proportion of iron rich minerals which weather down to produce well-structured dark red or chocolate coloured soils with deep uniform profiles. Rocks of basaltic or related composition are formed by cooling and consolidation of molten magma which is injected from the interior of the earth into its outer crust, and in Malaya the resultant rocks occur mainly as dykes, which are thin sheets of rock cutting across the stratification of the surrounding country rocks: or as ancient lava flows interbedded with sedimentary strata and often folded by subsequent earth movements. Remnants of an extensive basalt lava flow of lower Tertiary age occur near Kuantan, Pahang.

The more commonly occurring rocks in this group are basalt, dolerite, and andesite. The basalt only occurs in the Kuantan area, but andesite rocks outcrop over small areas in several parts of Malaya. The soil developed from the andesite has a characteristic red colour, is deep and uniform and has a strongly developed structure.

Dolerite dykes and volcanic ash layers occur in the

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shales and quartzites of Central Malaya, but as they usually take the form of very narrow bands, perhaps only a foot or two in width, the soil formed from them is usually mixed with that formed from the neighbouring rock type, and the actual area of soil developed on these parent rocks is usually very small. Where a sufficient quantity of doleritic rock occurs to form a recognisable soil, this is similar to that formed from andesite, although slight differences in colour and structure can be seen. These soils are, however, only of very minor importance because of their limited extent.

2. Granite and allied rocks

Granites and rocks of similar composition including syenites and diorites outcrop over a very large proportion of the country, particularly in the mountainous regions. Soil differences caused by topographic and climatic influences are noticeable at different elevations, but most granite-derived soils are readily recognised by their characteristic colour and texture, and the number of separate series established on this type of parent material is relatively small considering the very large area involved.

Granite is an igneous rock formed from acidic magma which consolidates within the earth's crust to form large masses known as batholiths. Subsequent earth movements and removal of the overlying crust by erosion result in exposure of the granite on the surface, and this state exists over much of Malaya at the present day. On close examination, granite is seen to be a coarsely crystalline rock made up of several different minerals. The most important of these are quartz, the separate crystals of which can be recognised by their glassy and often greyish

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appearance, irregular outline and hardness; feldspars which are more evenly shaped and have an opaque, milky appearance; and micas which are the glittering, dark-coloured, finely-layered minerals which can be broken down into small flakes by splitting in one direction. Quartz is the mineral which forms the sand fraction in the resultant soil, while the other minerals weather down to form clay, and as the free quartz content of a granite rock varies from place to place, the texture of the resultant soil will reflect these changes. Granitic rocks of progressively lower free silica content are known as granodiorites and quartz diorites, and these give soils with a very much lower proportion of sand which is also usually of a finer grain size. The higher content of hornblende and other dark-coloured, iron-rich minerals also imparts a redder hue to these soils. The dominant colours match the 7.5YR and 5YR hues on the Munsell Colour Charts rather than the 10YR hue which is common to the soils derived from acid granites.

3. Quartzite

Quartzite and quartzitic sandstones are hard, highly siliceous rocks formed at depth by the action of intense heat on sandstones. They are common rocks in many parts of Malaya, and can be distinguished from un-metamorphosed sandstones by their hardness and sometimes by their glassy appearance. Malayan quartzites are seldom formed from pure sandstones with the result that soils formed from quartzite show some variation depending on the amounts and nature of any clay which may have been present in the original sedimentary rock. Soils formed from quartzite normally occur on strongly ridged terrain and usually have shallow profiles with fine sandy textures and light yellowish colours, although those on gentler topography have deep uniform loamy, well-structured profiles.

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4. Shales

A shale is a soft, laminated, fine grained rock formed by accumulation of successive layers of clay or silt under still water conditions. A very large part of the rocks of Carboniferous age shown in blue on the Geological Map (Geological Survey Staff, 1948) consists of shale. The mineral composition is extremely variable and this has an important influence on the nature of the resultant soils. Some shales are rich in iron-bearing minerals which result in the formation of red coloured clay soils with very strongly developed laterite bands close to the surface. Others consist of very siliceous clay, and weather to give stiff pale coloured soils. Some types of shales, particularly those occurring along the East Coast of Malaya, are sandier than normal and these give rise to looser, more weakly structured loamy soils. Differences in lithology are very common in most shale-bearing rock formations occurring in Malaya, so that the soil pattern is generally rather complex in such regions.

5. Limestone

Limestones are formed by accumulation of shells and corals, or by direct precipitation of calcium carbonate in salt or fresh water. Pressure of overlying rocks results in re-crystallisation of the calcium carbonate to form calcite or marble with the result that the original outlines of the shells disappear, as is the case with most Malayan limestones. Limestone weathers by solution, and the resultant soil is in fact formed from residual minerals other than carbonates which exist in small quantities within the original rock. The high iron content of many of these residual soils suggest that meteoric dust may in some cases be an important constituent, while in other cases the iron may have originated by metasomatic replacement

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connected in some way with the granite intrusions. Limestone outcrops in Malaya generally take the form of steep-sided, rugged cliff masses almost bare of soil, and impossible to cultivate; but in a few small areas of gently rolling country, deep well-structured dark red coloured soils are developed on limestone; while in other cases laterite bands may be developed at varying depth within the profiles.

6. Older Alluvium

In Johore, Singapore and possibly in other parts of the country, low dissected hills of unconsolidated clays, sands and gravels are an important element of the landscape. These materials rarely occur above 250 feet above sea level and are thought to have been deposited in early Pleistocene times. They are known collectively as "Older Alluvium" (Burton 1964). It is difficult to separate this deeply weathered material from associated deeply weathered igneous and sedimentary rocks, but the resultant soils, although similar in appearance behave very differently under agriculture. Soils formed on Older Alluvium are extremely impoverished of both major and minor plant nutrients. The following criteria are used to identify Older Alluvium in the field (Null, Acton, Wong 1965). No one of these is necessarily diagnostic by itself but the presence of several of them in any one locality is regarded as sufficient evidence for Older Alluvium:

1. The presence of rounded boulders and pebbles.
2. Signs of stratification.
3. Absence of quartz veins.
4. Absence of mica.
5. Greater susceptibility to erosion.
6. Light yellowish red vertical mottling in the subsoil.

Flat to gently undulating terraces occur in some parts

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of the country, intermediate in elevation between the Older Alluvium and Recent Alluvium. These are composed of predominantly coarse textured "Subrecent" alluvium which is approximately intermediate in age between Recent Alluvium and Older Alluvium.

7. Marine alluvium

Material eroded from the mountains of the interior is carried by the rivers to the sea where it is deposited to form new land around the mouths of the rivers and along the neighbouring coastal stretches. On the West Coast, the rivers flow very sluggishly in their lower reaches and often meander for miles through swamp land. Such rivers do not have the capacity to carry large amounts of coarse grained material so that the bulk of the detritus which reaches the sea consists of very fine particles in suspension, and this eventually settles out as mud in the shallow, relatively calm waters of the Straits of Malacca. This material is known as coastal or marine alluvium, and several extensive coastal flats including the Kedah Plain and the flat low-lying country around Kuala Selangor in West Selangor have been built up in this manner. The more recently deposited alluvium (i.e. that nearest to the coast) is usually subject to flooding by the sea with the result that the soils formed on it contain very high proportions of dissolved salts, but further inland these salts have been removed by leaching under the heavy rainfall. Chlorides are rapidly removed in this manner, but sulphates, which are often reduced to sulphides under the prevailing anaerobic conditions, may persist.

In some of the larger stretches of alluvium along the West Coast, the permanent swamp conditions in the centre prevent the total decomposition of dead plant material and this gradually accumulates to form a thick layer of peat.

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The peat is coarse and woody, has a high loss on ignition, and is usually between 5 and 20 feet in depth. Shallow peat suitable for agricultural development is usually restricted to a narrow marginal zone.

On the East Coast, the rivers are much faster flowing in their lower reaches with the result that very large amounts of coarse sand eroded from the granite mountains are carried as far as the river mouth where the wave and current action of the sea, particularly during the North-east Monsoon, washes the sand along the coast line and up on to the beaches. Very extensive beach deposits have been formed in this way all along the East Coast of Malaya. The soils developed from this coarse material are very free draining and almost devoid of nutrients.

8. River alluvium

Around the bases of all the mountain ranges of Malaya, usually at elevations of less than 100 feet above sea level, the rate of flow of Malayan rivers decreases very rapidly and this sudden change in the current speed reduces the carrying capacity of the stream very considerably and causes deposition of much of the coarse and medium grained material. This results in the formation of large areas of riverine alluvium, and the soils formed on such deposits are usually loamy in texture and with very variable drainage character. Near the river banks, the soils are likely to be very free draining but towards the valley sides the water-table approaches close to the surface and in some very poorly drained spots small pockets of inland peat may form.

Landforms

Malayan landforms bear characteristic features of both a narrow mountainous peninsula and a tropical environment. The landscape is dominated by mountain ranges and the tectonic skeleton

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of Malaya consists of a series of mountain or hill ranges separated by valley troughs (Richardson 1947). Extensive coastal plains flank this mountain complex both to the east and to the west, and these are probably the second most conspicuous feature of the Malayan landscape. Between the mountains and the coastal plains, and occupying a large tract of terrain in the central and southern part of the Peninsula is a complex of undulating, rolling, and hilly land which probably represents various stages of dissection of an ancient peneplain. Besides these three major groups of landforms, many minor features can be recognised and are often of great value to the soil surveyor in providing supplementary evidence concerning the origin and age of the soil and its site. Short descriptions of the landform units recognised for soil survey purposes are given below:-

The mountains which are steep-sided, and strongly dissected by an intricate pattern of small active streams, range in elevation from about 2,000 to about 7,000 feet. The larger streams flow through torrent tracts which are narrow V-shaped, steep-sided valleys, the floors of which are completely cluttered with large boulders.

The coastal plain can be briefly described as a plain whose seaward margin coincides with the coast. A beach ridge occurs on the coastal plain and is an essentially continuous mound of beach material located behind the beach, where it has been heaped up by wave action. Ridges may occur singly or as a series of approximately parallel deposits. They are well developed along the East Coast of Malaya. Extensive swamps are common on the wide parts of the coastal plain where they occur behind a seaward bar of alluvium or sand. Their landward margin generally coincides with the edge of the dissected peneplain.

A plain tract is the lower portion of a river course where it crosses the coastal plain. It consists, in effect,

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of a wide path cut across the marine alluvium of the coastal plain and filled in with typical riverine alluvium. A meander belt is often a very distinct feature of these plain tracts. In some parts of Malaya, particularly Kelantan, this feature may become very extensive until the landscape is dominated by features of riverine deposition. In this case, the term river basin denotes the distinction between this and the smaller plain tract. A river basin is commonly almost entirely surrounded by hills. A marine terrace is a component of the coastal plain, and the term is used to distinguish very weakly dissected remnants of a former coastal plain at a slightly higher level. In Malaya, most marine terraces range from about 5 to about 50 feet above the surrounding coastal plain. However, in the southern part of the country, dissected remnants of what were probably former coastal plains occur up to 250 feet above sea level.

A valley tract is most commonly associated with the dissected peneplain landscape, and is the middle part of a stream course characterised by a moderate gradient and a fairly wide valley. River terraces are quite common in central and southern Malaya particularly, where they are associated with the dissected peneplain. They occur at various levels and at various stages of dissection, but always consist of a plain and an accompanying escarpment, features which are sometimes partly obliterated by dissection. The lowest and most recent surface in a river valley is normally called the floodplain. A levee is the natural bank of a river formed during flood periods by the deposition of sediment. When the flood subsides, the sediment remains and the levee is thus the highest portion of the floodplain of a river.

The above are not intended as strict geomorphological definitions. They are included only to allow soil surveyors to

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describe in a reasonably consistent way an important feature of the soil site.

Slope and Terrain

The elements of the different landforms can be described in terms of slope and terrain, that is, the angle of the single slopes in the landscape and the nature of the terrain produced by a combination of the single slopes in any one place. A single slope occurs on a tract of land which is level, or flat, or having a slope in one direction only; whereas the complex slopes occur on all tracts of land which have slopes in more than one direction. At present, no allowance is made in the classification of slope and terrain to express the amplitude of relief of the landscape. Obviously, this is an important facet of the terrain, but for schematic-reconnaissance purposes the following classification is considered sufficient:-

	Terrain Classes	
Angle of Slope	Single Slopes	Complex Slopes
0 - 2°	Level or nearly level, A_1	Level or nearly level, C_1
2 - 6°	Gently sloping, A_2	Undulating, C_2
6 - 12°	Strongly sloping, A_3	Rolling, C_3
12 - 20°	Moderately steep, A_4	Hilly, C_4
20 - 25°	Steeply sloping, A_5	Steep, C_5
Greater than 25°	Very steeply sloping, A_6	Very steep, C_6

The above Table includes suggested mapping symbols for the various slope and terrain classes.

Steepland Boundary

The steepland boundary is the line which marks the sudden

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break between terrain which is predominantly steep and very steep and that which is level, undulating, rolling or hilly. It is an obvious topographical feature over large areas of Malaya, and is highly significant to land use for it very effectively marks the separation of land which is topographically suitable for agricultural development and land which is of questionable suitability for extensive cultivation owing to excessive steepness. The position of this change of slope boundary can be readily located on any contoured topographic map (1 to 63,360 or 1 to 25,000 New and Old Series Sheets) by noting the difference in spacing between adjacent contours. For a given topographic sheet or district, the boundary will usually be found to coincide with one particular contour. For instance, in the Kuala Lumpur District the boundary is generally about 300 feet above sea level; while in Central and North Kedah the line coincides with the 150 foot contour; and in the Kuala Lipis area it corresponds with the 600 foot contour. The change in altitude of this boundary between these different places is very gradual and takes place progressively on a regional scale. In general terms, the boundary rises gradually towards the centre of the country and this change in altitude is most readily apparent in the State of Pahang within the catchment of the Sungei Pahang. This suggests that the steepland boundary is coincident with the edge of a pre-existing peneplain which was a general feature of the Malayan landscape at an earlier geological period and is now being dissected to give the typical undulating to rolling terrain found in most places below the steepland boundary.

In the field, either on the ground or from the air at low altitude, the demarcation of the steepland boundary is even more obvious than it is on the map, and it is seen to separate the undulating, rolling, and hilly land of the dissected peneplain, or the level terrain of the coastal plain, from mountainous country with most slopes exceeding 25°. Above the steepland boundary, the slopes are long and continuous right to the topmost mountain ridges which may be up to 7,000 feet high. Below the

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steepland boundary, the individual small hills seldom rise to more than 250 feet above the surrounding coastal plain and their summits are commonly accordant so that the appearance of the landscape indicates that the area in question represents a strongly dissected peneplain. The slopes generally fall in the 5° to 20° slope category.

The steepland boundary in Malaya can thus be defined as a line separating land with average slopes less than 20°, and topographically suitable for tree-crop agriculture from land having average slopes exceeding 25° and better suited to permanent forest rather than to extensive agricultural development.

Erosion

The first distinction to be made in discussing this subject is that between normal erosion, which is the geological process by which the land surface is being continuously worn down, and accelerated erosion which occurs when the normal process is speeded up, sometimes catastrophically, and in most cases due to man's interference with the existing natural regime. In the humid tropics, the forces of normal erosion are operating almost universally whether they be slow mass movement on slopes, active gullying in steep terrain, or deposition on alluvial plains. Probably the only units of the landscape which are relatively immune are the level surfaces of marine and alluvial terraces which are isolated from the effects of river activity. It is important to recognise whether or not normal erosive processes are operating on any particular soil site in the tropics because under the prevailing conditions of intense weathering and leaching, the soil is rapidly impoverished unless there is constant rejuvenation by erosion, whether it be addition to the surface, or removal from the surface with the resultant addition to the soil from the underlying rock. In Malaya, the processes of normal erosion can be categorised as water erosion and mass movement erosion. The main manifestations of water erosion are:-

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1. Sheet erosion

This is the relatively uniform removal of soil from an area without the development of conspicuous water channels. It probably fulfills a minor role on undulating, rolling, hilly, and steep terrain under jungle cover where the surface of the ground is normally exposed due to the rapid decomposition of any protective litter layer.

2. Gully erosion is the removal of material by streams of running water with consequent formation of relatively large channels commonly with steep sides. Gullies are common in hilly and steep terrain under jungle cover where they provide evidence of the intensity with which the land is being dissected.

3. Deposition on floodplains by rivers and on the coastal plains by the sea completes the normal cycle of water erosion.

Mass movement under normal conditions is probably confined to soil creep, which is a slow movement downhill under the influence of gravity. The presence of stonelines tends to suggest that soil creep operates almost universally on near level and gently undulating terrain as well as on rolling, hilly, and steep land.

Accelerated erosion in Malaya most commonly and most spectacularly occurs on steep slopes which have been cleared for cultivation. The same sub-division can be made as was employed in the description of normal erosion. The processes are essentially the same, the main distinction being one of increased speed and intensity due to the disturbance of the natural protective cover. The effects of water erosion are sometimes described as rill, sheet, and gully erosion, as have been described under normal erosion. Rill erosion refers to the removal of soil by the cutting of numerous small but conspicuous channels which are minor concentrations of run-off. In many ways, rill erosion is intermediate between sheet and gully erosion. Under mass movement, soil creep is accelerated so that slip or slump erosion becomes

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characteristic and very destructive. This is the sliding or slipping of saturated soil and underlying material upon a slip surface under the influence of gravity. Slips are relatively shallow, whereas slumps are normally quite deep and spoon-shaped with a characteristic upheaval of the bottom part of the slump.

These are the main types of erosion affecting the soils of Malaya. For the purposes of the schematic-reconnaissance survey, it will probably suffice to recognise the type and the approximate severity which can be described in ordinary terms. However, a comprehensive classification of erosion classes is outlined in the U.S.D.A. Soil Survey Manual (Soil Survey Staff, 1951) and this may be used if more precise description is required.

Drainage

In a country such as Malaya which has a high rainfall and whose soils are predominantly fine textured, drainage is a most important soil characteristic and in many cases poor drainage is the chief factor limiting agricultural development.

The problem of appraising soil drainage is far more complicated than it may at first appear. The term has two distinct connotations. Soil drainage in the active sense refers to the rate and extent of the removal by surface run-off, flow through the soil, evaporation and transpiration of water which has been added to the soil by precipitation, seepage, etc. On the other hand, in a passive sense, soil drainage refers to the condition of the soil and implies the frequency and duration of periods when the soil is actually free of saturation or partial saturation. Both these conditions can be measured, but for soil survey purposes they are estimated in the field by inference. Among the internal characteristics of a soil that throw light on the soil drainage and its variations at different times of the year are:-

The soil texture; the soil structure; the pattern of cracking; the soil colour; the pattern of mottling; the kind and depth of organic matter; and the consistence of

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various horizons.

The overall concept of soil drainage is a broad one and it comprises certain narrower aspects such as surface run-off which is sometimes referred to as external soil drainage, internal soil drainage, and soil permeability.

Surface run-off is the relative rate at which water is removed by flow over the surface of the soil and it can be recorded in the following six classes:- Ponded, very slow, slow, medium, rapid, and very rapid. These classes are defined on page 167 of the U.S.D.A. Soil Survey Manual.

Internal soil drainage is that quality of the soil that permits the downward flow of excess water through it. It is reflected in the frequency and duration of periods of saturation with water. Six classes are recognised and are defined in the U.S.D.A. Soil Survey Manual, (page 169). They are none, very slow, slow, medium, rapid, and very rapid.

Soil permeability is that quality of the soil that enables it to transmit water or air. It can be measured quantitatively but it may also be gauged in the field by considering structure, texture, porosity, cracking, and other characteristics of the soil horizons in relation to local experience. It is a valuable aid in predicting how much the drainage can be improved. Thus, a rapidly permeable sandy soil and a slowly permeable clay soil may both have poor drainage because of a high water-table. If the water-table is lowered, the drainage will clearly be improved much more in the one than in the other. Seven classes of soil permeability ranging from very slow to very rapid are given on page 168 of United States Soil Survey Manual.

By combining these aspects of surface run-off, internal soil drainage, and soil permeability, the overall drainage of the soil under the prevailing conditions of the site can be indicated by soil drainage classes derived by assessing the rate at which water is removed from the soil and the time for which the soil is

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saturated. The following classes are reproduced, with slight modification, from the United States Soil Survey Manual:-

0. Very poorly drained

The water is removed from the soil so slowly that the water-table remains at or on the surface for the greater part of the time. Soils of this drainage class usually occupy level or depressed sites and are frequently ponded. They commonly have peaty surface layers and grey subsoil colours or other evidence of gleying. An example is the Linau Series.

1. Poorly drained

The water is removed so slowly that the soil remains saturated for a large part of the time. The water-table is commonly at or near the surface during a considerable part of the time. Poorly drained conditions are due to a high water-table, a slowly permeable soil, seepage or to some combination of these conditions. Grey gley colours predominate in the subsoil but reddish, brownish or yellowish mottles are common in the upper horizons. Undeveloped Selangor Series provides an example of this state of drainage.

2. Imperfectly drained

The water is removed from the soil slowly enough to keep it wet for significant periods but not all of the time. Imperfectly drained soils commonly have a slowly permeable layer within the profile, a high water-table, additions through seepage or a combination of these conditions. Reddish, brownish and yellowish mottles normally penetrate well into the subsoil but the grey gley colours are still present at depth, as in the Briah Series.

3. Moderately well drained

The water is removed from the soil somewhat slowly so that the profile is wet for a small but significant part of the time. Moderately well drained soils commonly

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have a slowly permeable layer within or immediately beneath the solum, a relatively high water-table, additions of water through seepage, or some combination of these conditions. Reddish, brownish, yellowish and greyish mottles are common in the subsoil. Akob Series is an example of a moderately well drained soil.

4. Well drained

The water is removed readily but not rapidly from the soils which consequently are not wet for a significant part of the time although they commonly retain near optimum amounts of moisture for lengthy periods. Well drained soils are commonly intermediate in texture although soils of other textural classes may also be well drained. Serdang Series is a good example of a well drained soil.

5. Somewhat excessively drained

The water is removed from the soil rapidly and many of these soils have little horizon differentiation, are sandy and very porous such as the Telemong Series.

6. Excessively drained

The water is removed from the soil very rapidly and little is retained. Excessively drained soils are commonly sandy and may be steep, very porous, or both. Shallow soils on slopes may be excessively drained. Rudua Series is a Malayan example of an excessively drained soil.

Confusion sometimes arises between the natural drainage of the soil under primitive conditions and the present state of drainage induced by man. In order to understand clearly the changes that are taking place, both conditions need to be considered.

For the purposes of the schematic-reconnaissance survey, indication of the soil drainage class alone is sufficient, but for detailed studies the permeability and the internal and external drainage may need to be described.

Vegetation

Malaya is a forested land, and at first glance vegetation

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seems too uniform a factor to have much impact on the soil pattern. This is essentially true when the separation of soils is being carried out on a schematic-reconnaissance scale. But there is evidence which suggests that vegetation/soil inter-relations do exist in detail. (See Wyatt-Smith 1964, page 203; Libby 1964, page 10)

Furthermore, vegetation is an important environmental factor and the recording of vegetation type should be an integral part of soil survey operations. A useful description of the main vegetation types found in Malaya is outlined by Wyatt-Smith in a paper entitled, "A Preliminary Vegetation Map of Malaya with Descriptions of the Vegetation Types" published in the Journal of Tropical Geography, Volume 18 August 1964; and the salient points of this are reproduced below for the guidance of soil surveyors in the field:-

For ease of reference the types are arranged in three groups, namely;

1. Lowland (dryland) vegetation.
2. Hill and mountain vegetation.
3. Swamp and low-lying vegetation.

1. Lowland (dryland) vegetation

a. Primary forests

The primary lowland forests are usually dense though comparative freedom of movement on the ground is possible. They are composed of many thousands of species of trees as well as shrubs, herbs, and woody climbers. The upper or emergent storey is usually about 100 to 150 feet high, though trees nearly 200 feet in height are often present. This storey is often discontinuous. The main storey or second tree layer which occupies a region of about 70 to 100 feet from the ground forms a continuous canopy, except immediately below the large emergent storey trees. The under storey or third tree layer consists of segments of

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the upper two storeys together with members of other families. The density of the shrub layer varies from very thick and dense to open. It contains young saplings of larger trees, shrub species, and palms. The herb layer consists mainly of young seedlings of the other layers and lianas with some ferns near streams and in moist valleys. Epiphytes are usually very poorly represented. There is usually a comparatively poor layer of litter though fallen leaves often cover the forest floor. Certain broad and rough divisions of the lowland dipterocarp forest can be made on the basis of the larger economic trees.

(1) Balau forests

These forests are mainly found in North Johore, East Negri Sembilan, West Pahang, and North Trengganu. They are characterised by a high percentage of the Balau or heavy hardwood group of Shorea of which S. atrinerbosa, S. exelliptica, and S. maxwelliana are the most common. Dipterocarpus spp. and species of the Red Meranti group of Shorea are also frequently present.

(2) Beach forests

These form a very narrow strip of woodland rarely more than 20 to 40 yards wide and frequently less along the sandy or gravelly beaches of the coast above the level of all but the highest tides. They occur along much of the length of the East Coast although often in a disturbed form, but they are comparatively rare along the muddy shores of the West Coast where mangrove forests predominate and where most of the sandy and gravelly beaches which do exist have been developed or greatly disturbed by man.

Along the accreting sandy beaches, Casuarina equisetifolia is the predominant species. Species of Calophyllum, Cycas, Desmodium, Eugenia, Pandanus,

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Planchonella, Scaebola and Terminalia also occur. Along the receding and the gravelly beaches, notably on the West Coast, the Casuarina fringe is replaced by a narrow belt of trees among which species of Barringtonia, Calophyllum, Cerbera, Desmodium, Hibiscus, Pongalia, Scaebola and Terminalia are common.

This vegetation type has been destroyed in many places along the East Coast and secondary growth is allowed to return. Owing to the demand for firewood and poles, the regrowth is very shrubby, and scrambling shrubs and woody climbers predominate. The shrub, Rhodomyrtus tomentosa, is particularly common.

(3) Chengal forest

Balanocarpus heimii or Chengal characterises this forest, and is Malaya's best known hardwood, occurring in many parts of the country. However, it is absent from North-west Malaya and Malacca, and poorly represented in much of Central Malaya and Johore. The species is found in most types of lowland and hill Dipterocarp forest but is specially common in the Bukit Goh and Lepar Forest Reserves of East Pahang and in most reserves of West Pahang. It is also found in some parts of the eastern foothills in Negri Sembilan, some foothill reserves of Selangor, and North-east Malaya, and in some foothill and lowland reserves in Perak apparently preferring a rich soil.

(4) Damah Laut Merah forest

This forest is characterised by the presence of Shorea kunsteleri (Damah Laut Merah) which is particularly common in many of the forests in foothills of South Kedah, North Perak, East Kelantan, Trengganu, and north of the Pahang River in East Pahang.

(5) Heath forest

Along the East Coast, a clear pattern is frequently

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revealed of strips of high forests inter-spaced with strips of shorter vegetation, the strips running, in general, parallel to the present coast line. This high forest is growing on old sandy beach ridges occupied largely by Rudua soils (Panton, 1958, page 29).

This type of forest was formerly, it is believed, very extensive along Malaya's East Coast and of local occurrence along the West Coast but it has largely been destroyed. A small area, however, still remains in the northern part of Tanjong Hantu Forest Reserve in the Dindings on the West Coast, and two accessible areas are known to remain along the East Coast - Jambu Bongkok Forest Reserve north of Dungun in Trengganu and Minachali Forest Reserve in the Rompin District of Pahang. All three areas however have been subject to disturbance. When the forest is clear felled, the secondary regrowth is that of very open scrub. This scrub degrades to an open grassland of tufted grasses or parkland with a few scattered trees or shrubs. The commonest of these trees and shrubs are Fagraea fragrans, Ploiarium alternifolium, and Melaleuca leucadenderon (gelam).

(6) Kapur forests

These forests characterised by the presence of Dryobalanops aromatica (kapur) are found in eastern Malaya usually never more than about 15 to 20 miles inland (except in Johore) on low hills and undulating land on well drained sandy clay loam soils. The forest structure is typically three-layer but the individuals forming the emergent or upper storey are generally taller than is usual in lowland dipterocarp forests. It is usually found mixed with other dipterocarps, both Shorea spp. and Dipterocarpus spp. and, but for its presence and predominance the forest would be

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classified as either Red Meranti - Keruing type or Balau type.

(7) Kempas-Kedondong forests

These forests often of poor timber value with the tallest trees few in number and rarely exceeding 100 feet in height occur mainly in the rather low-lying and flatter land between the Red Meranti-Keruing or Balau forests and the swamp forests. They are found principally in Central and Southern Perak, Selangor, and Johore where the forests appear to be associated with heavy white clays of poor status and old beach ridges. These forests are characterised by the comparative abundance of Koompassia malaccenis (Kempas), Canarium, and Santeria (Kedondong), Dialium patens, D. platysepalum (Keranji), Dillenia eximia and D. reticulata (Simpoh), Ixonanthes reticulata, Madhuca spp., and Palaquium (Nyatoh) and by the relative scarcity or complete absence of Dipterocarps.

(8) Keruing forests

On some of the less well drained land in North Johore, Central, East and South Pahang, East and West Negri Sembilan, the Kinta and Batang Patang Districts of Perak, and the northern part of Trengganu; extensive areas of forest are found characterised by Dipterocarpus spp. (Keruing) which are often associated with Dryobalanops oblongifolia, Hopea mengarawan, and Shorea lepidota. Other common species are Koompassia malaccenis and Palaquium spp. Much of the area is slightly water-logged at certain times of the year. The height of the upper tree layer is less than that in Red Meranti (Keruing) forest, and this layer is frequently very discontinuous with the large trees resembling true emergents.

(9) Lowland Dipterocarp forest

This is a general term including all the well

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drained primary forests of the plains, undulating land, and foothills up to an elevation of about 1,000 feet with the exception of the narrow strips of beach forests.

(10) Merbau-Kekatong forest

This type is found in the foothills of the Main Range, principally in North Malaya, and is usually very deficient in Dipterocarps and other economic tree species. It is characterised by Intsia palembanica (Merbau) and Cynometra inaequifolia (Kekatong). Sindora species are also frequently present.

(11) Nemesu forest

Shorea pauciflora (Nemesu) occurs throughout the Peninsula, except Perlis, but it is particularly common in undulating country and the foothills of North Malaya where it frequently characterises the forests.

(12) Red Meranti - Keruing forests

These forests are mainly found in South Perak, Selangor, Negri Sembilan, Malacca, North and Central Pahang, South Kelantan, and Central Trengganu. They are characterised by a high percentage in the upper storey of species of the Red Meranti group of Shorea, and of species of Dipterocarpus. The shrub and sapling layer is usually open with the palms, Eugeissona triste (mainly west of the Main Range), Licuala spp. (mainly east of the Main Range), and the shrub or woody scrambler, Agrostistachys spp. often being locally common.

(13) White Meranti-Gerutu forests

These forests have a predominantly Burmese flora and are found where there is a distinct annual dry season of about two months. They are characterised by:-

(a) the absence of the Red Meranti and Damah Hiban groups,

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(b) the paucity of the Balau group, and

(c) the relative abundance of the White Meranti group of the genus Shorea.

Parashorea lucida (Gerutu-gerutu) is perhaps the commonest of a group of characteristic Dipterocarps. These forests occur on the flat lands of the extreme north-west of Malaya (Perlis and North-west Kedah) and at a slightly higher elevation on hill slopes, and low ridges farther south in Northwest Kedah, Upper Perak, and North Kelantan.

b. Secondary forests

The lowlands of Malaya have been subject to much destruction by storms, floods, shifting cultivation, and rapid development during the past century. Secondary forest is often induced as a consequence of this disturbance, and the following is an outline of the commonest species which occur:-

Trema spp. are the most prominent early pioneer species on gently undulating land, deforested and cultivated for one or, at the most, two years before being abandoned. They are generally followed by species of Macaranga, Mallotus, Ficus, and Glochidion. If the land is cultivated for several years before being abandoned and the soil fertility is thoroughly exhausted, a Melastoma-Eupatorium-Gleichenia scrub develops. This community readily burns and is soon converted into almost pure Imperata grassland (lallang). In South Malaya on degraded land a woody community dominated by Adinandra dumosa often develops, and once established it appears to be maintained by periodic ground fires. On foothill slopes banana-ginger thickets and in the valleys of the Main Range,

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bamboo groves commonly arise after shifting cultivation by aborigines.

In North-west Malaya, much of the area formerly covered by White Meranti - Gerutu forests has long been subject to shifting cultivation and the original vegetation has given way to a type characterised by the trees, Schima noronhae and Shorea talura; and the bamboos, Gigantochloa latifolia, and G. ligulata.

2. Hill and mountain vegetation

Vegetation types in this category occur on the inland ranges above an altitude of 1,000 feet. Because they occur mostly on steepland terrain they are not of immediate interest to the schematic-reconnaissance survey, and this discussion is therefore confined to outlining the classes separated by Wyatt-Smith on page 208, 209, 210 of the article already quoted. The classes are:-

(1) Hill Dipterocarp Forests,
(2) Agathis alba,
(3) Coastal Hill Forests,
(4) Limestone Vegetation,
(5) Montane Ericaceous Forests,
(6) Upper Dipterocarp Forests,
(7) Vegetation of quartz dykes, quartzite ridges and other sterile habitats with severe drainage or lacking available moisture.

3. Swamp and low-lying vegetation

(1) Fresh Alluvial Swamp or Lopak Forests

The surface of the land covered by these forests is semi-permanently submerged in mineral-rich fresh water. Though a few inches of peat or muck may occur, they should not be confused with peat swamp forests

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which grow on deep peaty layers entered only by rain water, and which have a restricted and specialised flora. These Lopak forests are found throughout Malaya under a wide environmental range. Accordingly, their floristic composition and structure vary enormously. Stilt roots, Knee roots, and plank-like sinuous buttresses are found in some species but are not a feature of these forests. Single species often predominate over large areas, for instance., sedges, screw pines, rattans, palms, in the Rompin District on the East Coast, the Sungei Tinggi area of Selangor, and the Tasek Bera area of South-west Pahang.

(2) As a result of felling, cultivation, burning or alteration of the natural drainage, many seral and sub-seral communities evolve on land that once bore swamp forest. The most important is Gelam Forest. This consists of Melaleuca leucadendron often associated with Ploiarium alternifolium, both occurring as scattered trees in the swamp forest found between old beach ridges or more characteristically, on the seasonally wet swamps of coastal flats behind the sandy beaches and mangroves of Kedah, Malacca, Negri Sembilan, Kelantan, and Trengganu.

(3) Marine Alluvial (Mangrove) Swamp Forests

These forests are confined to muddy shores, lagoons, and the estuaries of tidal rivers. They cover an overall area of about 350,000 acres in Malaya, almost all of which is along the sheltered West Coast, mainly in the States of Perak, Selangor, and Johore. Along the East Coast, they are found within the mouths of tidal streams. Some of the principal tree species which are found nowhere outside these habitats are Rhizophora, Avicennia, Bruguiera, Sonneratia, and

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Xylocarpus.

(4) Peat Swamp Forests

These forests are of a very special type found on peats ranging from a few feet to about 20 feet in thickness, immediately behind the coast, principally, of Central and Southern Malaya. These peats evolved in permanently water-logged and anaerobic habitats where the only incoming water from rain is deficient in minerals and very acid. The forests have a three-layered tree structure. This comprises a broken upper or emergent layer, often reaching a height of 100 to 120 feet and frequently represented by scattered true emergent trees; a fairly level main layer which is often, in practice, the upper tree layer reaching a height of about 90 to 100 feet and frequently very open and discontinuous; and a fairly continuous under storey of considerable depth usually ranging from 30 to 60 feet above the ground or peat surface. Where there is standing water, there is frequently a dense thicket of stemless palms; otherwise the shrub layer is, in general, rather sparse. Ground flora is comparatively poor. There are generally few species in this vegetation type and they are not normally found outside the peat swamp environment. After clearing and cultivation an almost pure stand of Macaranga maingayi develops as an early sub-seral stage in the secondary succession.

(5) Riparian Fringes

Numerous vegetation types occur as narrow strips along the banks of estuaries, rivers, and streams throughout the country. Their width varies greatly depending on the terrain. Their composition and, hence, their structure also vary and depend on tidal

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influence, the rate of water flow, the elevation, the width of the river, the nature and aspect of the terrain, and the enrichment of the site by water or silt. At the mouths of rivers where saline influence is strongest are the mangroves which have already been described. Further upstream where the water is brackish, Nipa fruticans usually lines the banks especially those of larger and wider rivers. Still further upstream where the water is tidal but no longer brackish is found Rassau (Pandanus helicopus). Beyond tidal influence, occur the "gallery forests" of which those in Kelantan, Pahang, and Trengganu with Dipterocarpus oblongifolius are the most picturesque. In North Malaya, Hopea odorata plays a similar role; while in abandoned or seasonally occupied river beds of the East Coast in which heath forest grows, several species characteristic of peat swamp forest are found. In the foothills where the rivers become narrower, more rocky, and faster flowing, the characteristic component of the riparian fringes is Saraca species. Some bamboos (Dendrocalamus pendulus, Schizo-stachyum gracile, Gigantochloa scortechinii) are common in the larger valleys of the Main Range.

The following Table summarises these Malayan vegetation types:-

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Lowland (dryland) Vegetation	Hill and Mountain Vegetation	Swamp and Low-lying Vegetation
a. Primary Forest 1. Balau Forests 2. Beach Forests 3. Chengal Forest 4. Damah Laut Merah Forest 5. Heath Forest 6. Kapur Forests 7. Kempas Kedondong Forests 8. Keruing Forests 9. Lowland Dipterocarp Forest 10. Merbau-Kekatong Forest 11. Nemesu Forest 12. Red Meranti-Keruing Forest 13. White Meranti-Gerutu Forest b. Secondary Forest	1. Hill Dipterocarp Forests 2. Agathis alba 3. Coastal Hill Forests 4. Limestone Vegetation 5. Montane Ericaceous Forests 6. Upper Dipterocarp Forests 7. Vegetation of sterile habitats.	1. Fresh Alluvial Swamp or Lopak Forests 2. Gelam Forests (secondary) 3. Marine Alluvial (Mangrove) Swamp Forests 4. Peat Swamp Forests 5. Vegetation of the Riparian Fringes.

Describing the Soil

The expression of environmental characteristics on the body of the soil is studied by examining the soil profile - a vertical section through the soil from the surface to the underlying parent material.

"Descriptions of a soil profile should be as objective as possible and should be supplemented by interpretations of genetics. To keep the objective and interpretative descriptions in clear perspective, so that one is not confused with the other, is not so easy as it might seem. Even in the first breakdown of a soil

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profile into horizons, the pedologist is interpreting the profile, selecting the boundaries that appear most significant and considering the genetic relationships of the horizons. However, there is no substitute for good objective descriptions of the soil. These are the very basis of pedology. They become increasingly valuable as more and more laboratory information becomes available on collected samples, and without them the laboratory information loses much of its value." (Taylor and Pohlen, 1962 page 67)

In Malaya in the past, the standard of profile descriptions has been a little uneven due, in part, to the mixed backgrounds and purposes of the people describing the soil. Many countries have faced this situation in what is still a youthful science, and have resolved it by setting up fairly rigid standards or accepting those already applied in other survey organizations, by which individual features of each horizon of the soil profile are described. In the absence of a Malayan manual, the practice generally has been to adopt the standards outlined in the U.S.D.A. Soil Survey Manual. Without some such standardization, there is little scientific point in indulging in the time-consuming and, in the tropics, often uncomfortable exercise of describing a soil, because theinformation cannot readily be correlated with other soil descriptions. This, then, is a plea to soil surveyors and to others who may feel the urge to describe soils to adhere to the standards set out in this section, because they have been set upespecially to suit Malayan conditions, and they have been found acceptable by a majority of soil surveyors with Malayan experience.

1. <u>The soil examination pit</u>

Ideally, full profile descriptions should be taken from freshly dug soil examination pits. Road-side cuttings may be used but should always be regarded with a certain suspicion because they may express features which have been artificially

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induced, and also because the drying out of the soil which usually accompanies such excavations may obliterate some natural features and accentuate others. It is rarely possible to obtain a satisfactory full profile description from auger borings because the bulk of material is not sufficient and the soil is invariably disturbed. Both roadside cuttings and auger borings are, of course, extremely valuable diagnostic tools to be used in soil mapping.

The soil examination pit should, for preference, be at least five feet deep at one end, six feet long, and about two and a half feet wide. For convenience and in order to reduce the amount of work, earth steps can be left at one end of the pit as shown in the accompanying diagram (Fig. 1). Earth should not be thrown on to the surface near the deep end of the pit, and the surface soil at this side should be disturbed as little as possible so that uncontaminated samples of topsoil can be obtained. On sloping ground, the deepest end of the pit should be on the uphill side of the slope. Two men working reasonably hard should be able to dig two or even three of these pits in a normal eight-hour day, if digging in moderately friable soil without concretionary bands or a high water-table. A chop betul is a useful tool to supplement a changkol in digging pits of this type.

2. Horizon nomenclature

The designation of soil horizons by symbols is the interpretative part of what is otherwise a relatively objective description. The profile description is more useful if interpretative designations are employed to indicate the genetic relationships of the horizons. It should be stressed, however, that the common designations for horizons by letters are interpretations additional to the description and are not a substitute for it. They are understood to be a matter of probability not of certainty. Many systems of soil horizon designation are in use, including those outlined in the U.S.D.A. Soil Survey Manual, in Soil Classification (7th Approximation 1960)

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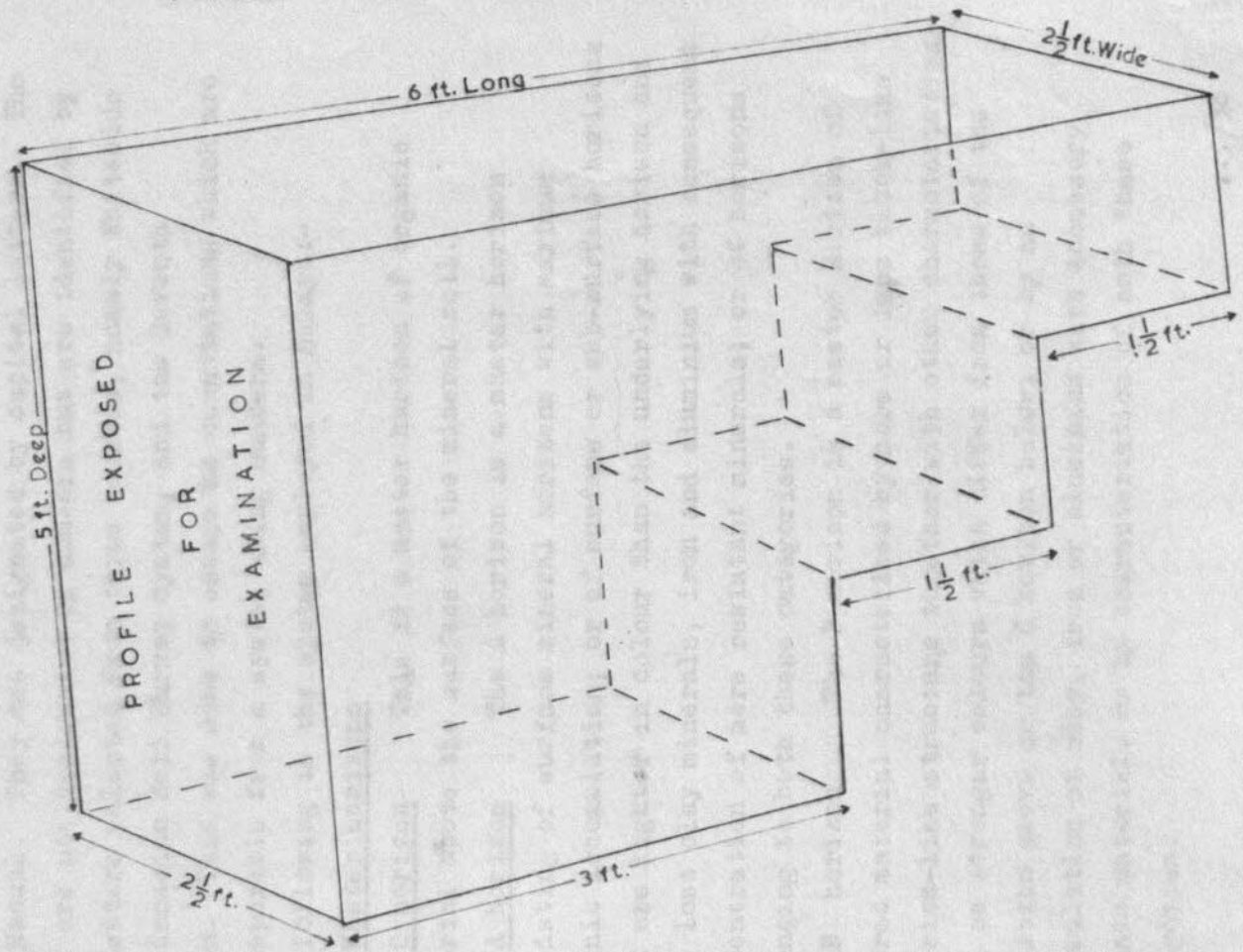
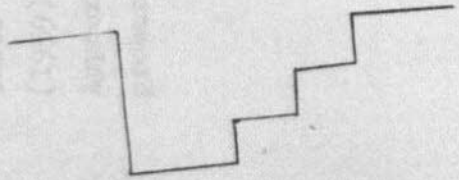
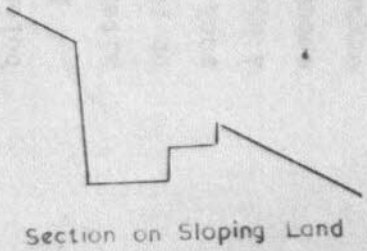
FIGURE I: SOIL EXAMINATION PIT



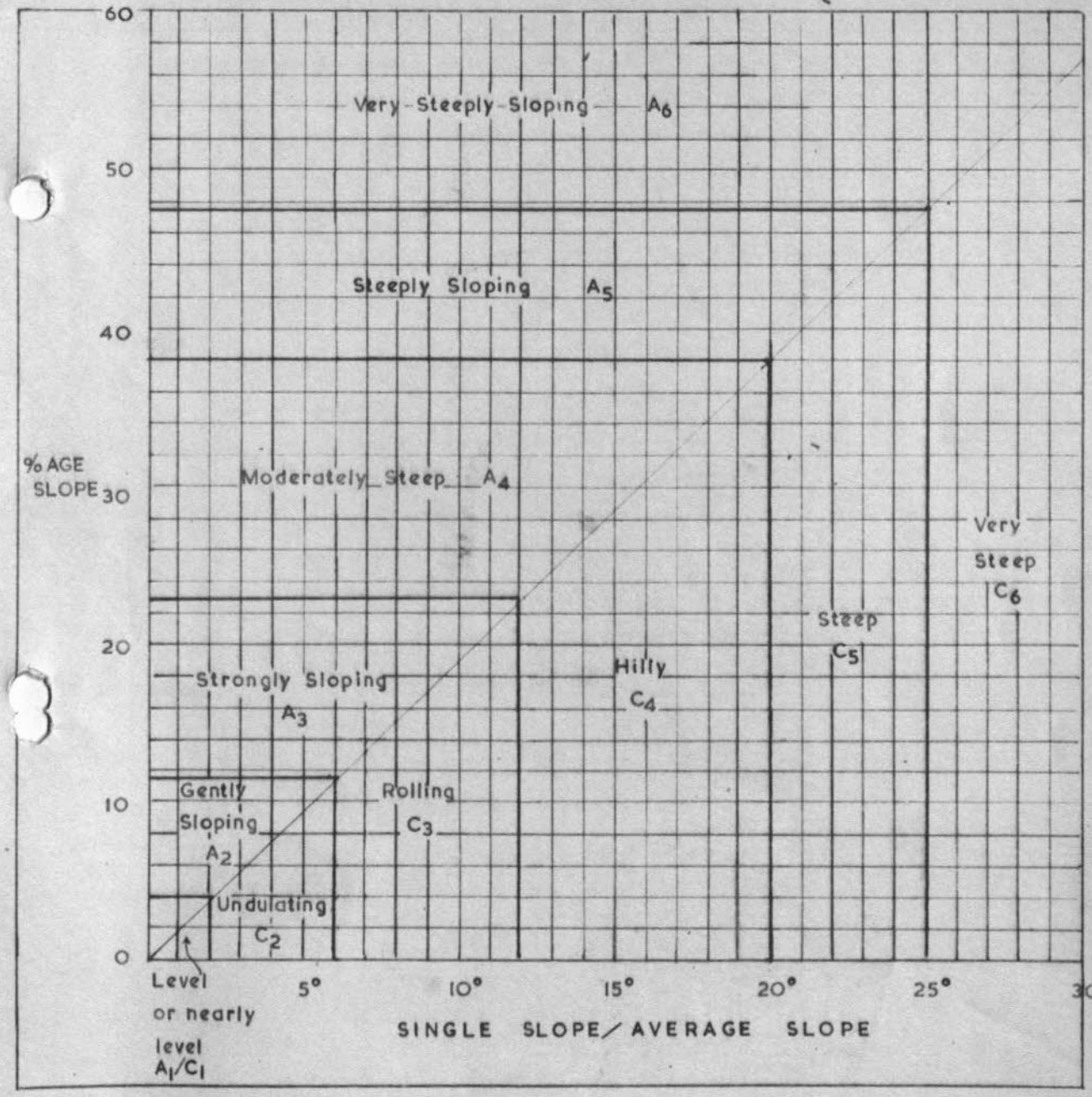


Section on Flat Land



Section on Sloping Land

DIAGRAM TO SHOW TERRAIN CLASSES AND PERCENTAGE SLOPE/SLOPE RELATIONSHIPS



by Whiteside (1959) and by the Canadian Soil Survey(1963). It has been found in practice that none of these are wholly applicable to or suitable for Malayan conditions and so a new system is proposed here to cater for the salient features of Malayan soils. This system has been entirely derived, with a little modification, by selecting pertinent features of each of the systems mentioned above. The prime aim has been to provide for those features which are most commonly characteristic of Malayan soils. The master horizons are relatively unchanged and are essentially as outlined in the U.S.D.A. Soil Survey Manual. They are designated by capital letters. The sub-horizons are not designated by numbers but are identified by lower case letters selected from three sources, namely Whiteside (1959), the Canadian Soil Survey System, and the Seventh Approximation. This was done to escape the connotations which are probably inseparable from a system using numbers.

The following is the system employed in Malaya:-

(1) Master horizons

O horizon This is a master horizon of organic material above the surface of the mineral soil.

A horizon The A horizon is a master horizon consisting of surface mineral horizons with maximum organic accumulation; or of surface or sub-surface horizons that are lighter in colour than the underlying horizon and have lost clay minerals, iron and aluminium with consequent concentration of more resistant minerals; or of horizons belonging to both these categories.

B horizon The B horizon is a master horizon of altered material characterised by more or less block-like or prism-like structure together with other characteristics such as stronger colours which differ from those of the A horizon above or the C horizon below; or by an accumulation of clay, iron or aluminium with accessory organic material; or by characteristics of both these categories.

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C horizon This is a master horizon embracing the relatively unweathered parent rock and the weathered material above this which is the parent material of the soil.

(2) Sub-horizons

Definitions of the lower case letters used to identify sub-horizons and the source from which they were taken are given below. In some cases these definitions have been modified a little to accord more closely to Malayan conditions.

c - cemented, consolidated or indurated even when moist. This embraces unaltered rock (Whiteside, 1959).

cn - accumulations of concretions or hard non-concretionary nodules rich in sesquioxides (Seventh Approximation, 1960).

d - accumulation of dead, undecomposed organic material in which the organic structures are clearly visible (Whiteside, 1959).

e - a horizon characterised by the removal of clay, iron, aluminium, or humus usually lighter in colour and texture than the layer below. The e stands for eluviated (N.S.S.C. Canada, 1963).

f - accumulation of partially decomposed plant material (Whiteside, 1959). The f stands for fermented.

g - a gleyed layer in which both mottles and grey gley colours are present (Canadian Soil Survey).

/ relatively h - a horizon /enriched with humus in which very few or no plant structures are recognisable (Whiteside, 1959; Canadian Soil Survey).

i - concentration of iron oxide usually finely disseminated (Whiteside, 1959).

j - a horizon whose characteristics are weakly expressed, from juvenile (Canadian Soil Survey). This letter

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will be used almost invariably with one of the other sub-horizon designations as a modifying adjective, e.g. a weakly developed Ae horizon would be Aej.

m - residual concentrations of minerals from the primary material. The original rock structure is not recognisable (Whiteside, 1959).

p - ploughed, puddled or other layers whose properties have been strongly influenced by man's activities (Whiteside, 1959).

r - a reduction horizon where the characteristic colours are grey, grey-green, or grey-blue. No mottles are present. (Whiteside, 1959)

t - a concentration of silicate clay taken from the English word, texture; and the German word, ton (Canadian Soil Survey, Whiteside 1959).

u - unconsolidated, uncemented materials relatively unaltered by weathering and other soil-forming processes. The original rock structure is discernible (Whiteside 1959).

v - horizons whose characteristic properties are prominently developed. The v is derived from vigour. (Whiteside 1959). This letter will be used mainly to qualify another sub-horizon designation, e.g. a strongly developed Bt horizon would be Btv.

(3) Transitional horizons

In many Malayan soils, horizon properties are not developed strongly enough to justify certain identification as one or other of the master horizons. In this case, the following transitional horizons may be used:-

AB - a horizon transitional between A and B having an upper part dominated by properties of the A, and a lower part dominated by properties of the B.

AC - a horizon transitional between A and C having subordinate properties of both A and C but not

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dominated by properties characteristic of either A or C.

BC - a horizon transitional between B and C with properties of the B dominant in the upper part, and properties of the C dominant in the lower part.

3. Horizon identification

The identification of horizons is one of the more demanding aspects of the soil surveyor's profession. He must use his judgment and experience to interpret the evidence before him in terms of soil genesis. He can obtain assistance in some cases from analysis, but in practice in the field he is out on his own. The following notes on the identification of the horizons most commonly present in Malayan soils are designed to supplement the judgment and experience of individual soil surveyors:-

Od horizon - This is the upper part of the litter layer in which the original form of most plant matter is discernible by the naked eye. It consists, in Malaya, of a very thin layer of dead leaves, twigs, etc. It corresponds to the O_1 horizon which has been used previously.

The Of horizon - This is the lower part of the litter layer which once again is commonly very thin in Malaya and consists of decomposed plant material in which the original form of the plants cannot be recognised with the naked eye. This was previously called the O_2 horizon.

The Ah horizon - This is the thin humus-stained topsoil which in most Malayan soils is only a few inches thick and which in the past has been referred to as the A_1 horizon.

The Ag horizon - This is a gleyed horizon, characterised by grey, red, brown, or yellow mottlings, and lying in an A horizon position.

Ap horizon - This is a horizon which has been disturbed

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by man's activities and which generally has a mixed appearance.

Ae horizon - This is the horizon of maximum eluviation which is most commonly identified by comparison with the B horizon below. It is lighter in colour and coarser in texture. It is usually more porous and weaker structured and commonly has a more friable consistence, but these latter three features are not invariable. A few clayskins may be present but they are not nearly as abundant as they are in the underlying horizon. This is the A_2 horizon. Weak development can be indicated by using Aej and similarly, strong development should be noted by using Aev.

The Bt horizon - This is the horizon of maximum illuviation which is enriched in clay and usually also in iron, aluminium or humus. Clayskin development is at its strongest in this horizon and normally structures are strongly developed or more strongly developed than structures above and below. Quite commonly, consistence is firmer than that above, and the colour is deeper. This horizon was formerly known as the B_2 horizon although the concept has been narrowed slightly and now emphasises the enrichment of clay. This horizon corresponds in most aspects to the argillic horizon defined in the Seventh Approximation (Soil Survey Staff 1960), and the analytical criteria used to distinguish between the illuvial and the overlying eluvial horizon can be employed here. In such a horizon the ratio of the clay content of the eluvial (Ae) horizon and illuvial (Bt) horizon is 1.2 or larger. This criterion seems to apply well to Malayan soils. For instance, the ratio of clay in the Ae and the Bt horizons of the Rengam Series from a large number of samples is 1.4, and in this Series these two horizons are normally well developed and easily recognisable. In contrast

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the Segamat Series has a ratio of 0.9 and in this Series the two horizons are not present. In this example, to obtain the ratio the figures for clay content were taken from the arbitrary depths of 1 - 6" and 12 - 24". Strong and weak development of the Bt horizon should be indicated where applicable by using Btv and Btj.

The Bi horizon - This is the B horizon where the enrichment is predominantly with iron oxides, normally disseminated throughout. These oxides impart characteristic red colours, strongly developed structures, and friable and very friable consistences. Clayskins are very rare although there are some coatings which under the hand lens appear to have a metallic glint and which, in fact, may be illuvial or weathering coatings of oxides. In some respects, this horizon is similar to the oxic horizon defined in the Seventh Approximation (Soil Survey Staff 1960) and it has been identified as an A_3, B_3 or even B_2 horizon in the past. Strong and weak development can be indicated by using Biv and Bij.

The Bcn horizon - This is the horizon where concretions are common. They are normally lateritic or bauxitic and vary in size and shape and in abundance.

Note that by definition it is possible to have an Acn or Ccn horizon because the concretions need not necessarily be formed in place, and also they may be fragments of parent material impregnated with sesquioxides.

The Bg horizon - This is a gleyed horizon in a B horizon position which is characterised by grey, red, brown and yellow mottles, and which usually has a higher content of clay and therefore a heavier texture than the overlying horizon.

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The Br horizon - This is a horizon in which gleying excludes most other soil-forming processes. The characteristic colours are grey, grey-green, or grey-blue and the horizon may be sulphurous.

The Cm horizon - This is the horizon where the chemical weathering of the parent rock is dominant. It does not have features of the B horizon and is characterised normally by weak structures and lack of clayskins. Residual minerals such as quartz, and in some cases, feldspar and mica commonly occur in this horizon but these are the only vestiges of the original parent rock.

The Cu horizon - This horizon is characterised by ghost structures of the parent rock. The rock is not indurated or cemented and is normally soft and easily broken, but the original structure is readily apparent.

The Cc horizon - This is the virtually unaltered indurated parent rock.

The following hypothetical profile description illustrates the correlation between the old horizon symbols and the new horizon symbols:-

Hypothetical Profile Description

Old Horizon Symbol	New Horizon Symbol	Profile
O_1	Od	1 - 0" dead leaves or twigs.
A_1	Ah	0-5" 2.5YR5/4 light olive brown, sandy clay loam with a weak fine crumb and subangular blocky structure, friable consistence, few fine quartz fragments, abundant animal casts, many pores, indistinct boundary.

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(cont'd) Hypothetical Profile Description

Old Horizon Symbol	New Horizon Symbol	Profile
A_2	Ae	5-16" 2.5Y7/6 yellow clay loam, moderate medium subangular blocky structure, friable to firm, many quartz fragments, few pores, few to many roots, indistinct boundary.
AB	Acn	16-20" 2.5Y7/6 yellow clay loam matrix with abundant subangular to rounded laterite concretions, boundary sharp.
B_2	Bt	20-30" 2.5Y7/8 yellow clay, moderate fine angular blocky structure, very firm, discontinuous clayskins colour 2.5Y6/4 light yellow brown, few pores, boundary indistinct.
B_3	Btj	30-40" 10YR5/8 yellowish brown clay, weak fine angular blocky structure, firm consistence, infested with termites, few pores, patchy 2.5Y7/4 pale yellow clayskins, boundary indistinct.
C_1	Cm	40-56" 10YR6/6 brownish yellow clay, weak medium and fine angular blocky structure, friable consistence, few pores, patchy clayskins, many distinct vertical streaky 2.5YR5/8 red mottles, many large quartz grains, boundary distinct.
C_2	Cu	56-71" variegated coloured soft clay in which rock structure is clearly visible.
	Cc	71"+ hard, unaltered rhyolite.

4. Main morphological features

Colour, texture, structure, consistence, and mottles are the main ingredients of any soil horizon, and the method of describing them has been well standardised in the literature

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and is generally accepted. In Malaya the description of these properties follows very closely those outlined in the U.S.D.A. Soil Survey Manual, and the following notes are intended to supplement these:-

(a) Colour

Colours are described according to the Munsell system as to hue, value and chroma. The Munsell soil colour charts which have seven charts displaying approximately 190 different standard colour chips are used in soil survey in Malaya, and are at times supplemented by a Japanese soil colour book which contains 14 charts consisting of more than 380 standard colour chips. As far as is possible the method by which the soil colour is compared with the colour chips should be standardised, for instance, the soil should always be moist although the colour may in addition be determined when it is dry or wet. The fragment of soil should be brokenaway from the rest of the soil mass with minimum disturbance although again it may be desirable at times to record the colour of the rubbed soil. Each individual will develop his own personal techniques in this matter, whether it be to record the colour comparison in the shade or with direct light or indirect light shining on the fragment of soil and the colour chip, but as long as he is consistent personal error can be eliminated as much as possible. In Malaya it is often impossible to study the colour chart in comfort in bright, direct sunlight.

(b) Texture

Soil texture is the particle size distribution of the solid inorganic constituents of the soil. It refers specifically to particles under 2 mm. in diameter. The presence of large particles and organic constituents is recognised by qualifying the textural name accordingly. The particles are classified by diameter into four main fractions according to the International Scale as follows:-

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Coarse sand,	0.2 - 2 mm.
Find sand	0.02 - 0.2 mm.
Silt	0.002 - 0.02 mm.
Clay	less than 0.002 mm.

Each of these fractions imparts particular physical qualities to the soil; the sand fractions are gritty, the silts are smooth, and most clays are plastic and sticky. By judging these qualities and making allowance for differences due to the kind of clay, the amount of organic matter, and other contributory factors the soil surveyor is able to assess the relative portions of each fraction and arrive at a close approximation of the texture of the soil as determined by mechanical analysis in the laboratory.

The textural terms used to describe the results of mechanical analysis in Malaya closely follow those outlined on the textural diagrams shown on pages 84 and 85 of Soil Survey Method (Taylor and Pohlen 1962). The common textural names used in the field in Malaya are gravel, very coarsesand, coarse sand, sand, fine sand, very fine sand, loamy coarse sand, loamy sand, loamy fine sand, sandy loam, fine sandy loam, very fine sandy loam, gravelly sandy loam, loam, gravelly loam, stony loam, silt, silt loam, clay loam, silty clay loam, sandy clay loam, fine sandy clay loam, coarse sandy clay loam, stony clay loam, sandy clay, fine sandy clay, coarse sandy clay, silty clay, clay, muck, peat, mucky peat, and peaty muck. Textures that are distinctly more sandy or clayey than average for the class may be indicated by the term light and heavy respectively.

Useful descriptions which may aid in the field identification of some of the main textural grades are given by Clark (1957 page 64, 65). They are as follows:-

Sands — Soils consisting mostly of coarse and fine sand and containing so little clay that they are loose when dry and not sticky at all when wet.

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Loamy sands consisting mostly of sand but with sufficient clay to give a small degree of plasticity and cohesion when moist.

Sandy loam Soils in which the sand fraction is still quite obvious but which mould readily when sufficiently moist without sticking appreciably to the fingers.

Loams Soils in which the fractions are blended so that the soils mould readily when sufficiently moist and stick slightly to the fingers. The sand fraction can still be readily appreciated.

Clay loams The soils are distinctly sticky when sufficiently moist but the presence of sand fractions can still be detected with care.

Sandy clay loams These soils contain sufficient clay to be distinctly sticky when moist but the sand fraction is a more obvious feature than in the clay loams.

Sandy clays These soils are plastic and sticky when moistened sufficiently but the sand fraction is still an obvious feature. They are essentially soils in which clay and sand are dominant and the intermediate grade of silt and very fine sand are less apparent.

Clays Soils which are very sticky when sufficiently moist and very hard when dry. In some cases the sand fractions are scarcely represented or entirely masked by the dominance of the clay, whilst in other cases a small proportion of sand can be detected with care.

Silts Soils in which the smooth soapy feel of silt is dominant.

Silty clays Soils which are composed almost entirely of very fine material but in which the

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smooth soapy feel of the silty fraction modifies to some extent the stickiness of the clay.

Silty clay loams — These are less sticky than the silty clays or clay loams but contain quite subordinate amounts of sand and sufficient silt to confer something of a smooth soapy feel.

Silt loams — Soils in which the fractions are blended to give moderate plasticity without being very sticky and in which the smooth soapy feel of the silt is the main feature.

A high content of organic matter tends to make both sandy soils and clay soils feel more loamy. Organic matter feels rather like silt but whereas silt leaves a smooth soapy surface when smeared between finger and thumb, organic matter tends to give a frayed appearance. The determination of textural grade is made by thoroughly working a small amount of moistened soil between the fingers and thumb. Many rough field tests are employed by individuals to provide clues to textural grade and although none of these is entirely reliable they can provide useful supplementary evidence as to the texture of the soils. Some of the better known tests are

a. Small amounts of sand can be heard as well as felt if the soil is worked close to the ear.
b. Loams (including sandy loams, clay loams, and silt loams) will usually mould into a ball if rubbed vigorously between the palms with a circular motion.
c. A clay, as distinct from a clay loam, can be formed into a long thin rod when rubbed between the palms and this rod should not break easily when bent to form a ring.

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(c) Structure

Structure is described according to the grade, size, and shape of the aggregates. These features are well defined in both the United States Soil Survey Manual and Soil Survey Method (Taylor and Pohlen, 1962, page 93). A useful distinction can be made between a ped - a natural soil aggregate which is the basis of the soil structure - and a clod which is a transient mass of soil moulded by disturbance such as digging.

In Malaya the commonest structural shape seems to be angular and subangular blocky with some prismatic, granular and crumb structures. Many granular structures can be described as cast granular, that is, spheroidal aggregates which are the result of animal activity in the soil, particularly earthworms. Crumb structures are not as common as may have been thought in the past. The term crumb was formerly used with a very broad meaning, but since the more specific definition of structural aggregates has become available it is restricted to describe porous peds similar in appearance to crumbs of bread. In most Malayan soils such structures are confined to the top few inches where the crumbs cling to roots. Many of them appear to consist of clusters of very tiny granules loosely bound together around roots or root hairs.

The simplest method of assessing soil structure in the field is to take a clod of soil and gently disrupt it by crushing between the hands. The grade or degree of development of the structure can be measured approximately by determining the amount of material which remains aggregated, compared to the amount of material which breaks down completely to single grains or unidentifiable clods of small size. The shape of the structure can be determined from the aggregated material and the size can be measured by picking out a well aggregated ped. The strength of individual peds is, strictly speaking, a property which is separate from the grade of structure. This can be described by using

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the normal consistence terms. For instance, it is possible to have a strongly developed structure, the peds of which when pressed between fingers and thumb are friable. Structureless horizons can be further qualified as either massive, if the material coheres together but does not form aggregates, or single grain as in many sandy soils which break down completely to individual sand grains.

(d) Consistence

Consistence is a measure of the resistance to deformation or rupture of the soil. It is described under different moisture conditions according to whether the soil is wet, moist or dry. The terms used are outlined in both the U.S.D.A. Soil Survey Manual (page 231 ff.) and in Soil Survey Method (Taylor and Pohlen, 1962 page 89 ff.). On page 234 of the U.S.D.A. Soil Survey Manual, and page 93 of Soil Survey Method cementation classes are defined. These could well be used to indicate the consistence of concretionary horizons in Malaya. In many soils the consistence of the soil mass when disturbed is different from the undisturbed consistence and may also differ from the consistence of the individual aggregates. To express fully consistence in this case, it may be necessary to determine not only the consistence of a clod removed from the soil; for example, friable, firm, etc.; but also the consistence of the mass in place. For describing this feature the terms weakly compact, moderately compact, or strongly compact may be used and they are usually assessed by digging or boring into the soil. Furthermore, the consistence of individual structural aggregates may need to be described separately, for example, peds firm.

(e) Mottles

Streaked, spotted or variegated colour patterns in soil horizons are usually referred to as mottles. They are commonly but not necessarily an indication of retarded drainage. They can

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be described according to abundance, size, contrast, and colour as well as by shape. Standards for such descriptions are outlined in the U.S.D.A. Soil Survey Manual (page 191 ff.) and in Soil Survey Method (Taylor and Pohlen, 1962, page 78 ff.).

5. Other important morphological features

a. Pores and channels

Many tropical soils are characterised by the presence of cavities of various sizes. Most of the larger passages are probably biological in origin and mark the activities of burrowing insects and animals or channels previously occupied by tree roots. The abundance of smaller cavities seems to increase directly with an increasing basicity of the parent material and is important supplementary evidence in classifying the soils.

An arbitrary size of 8 mm. (most pencils are about 8 mm. in diameter) is suggested here to distinguish the smaller cavities (pores) from the larger ones (channels), so that soil pores as used in Malaya are the visible cavities 8 mm. or less in diameter, and soil channels are crevices or passages occurring in the soil greater than 8 mm. in diameter.

Standards for describing soil pores are given by Johnson et al. (1960) who named and classified them according to six criteria - shape, distribution, orientation, continuity, size, and abundance. At present the attention of soil surveyors in Malaya is confined to recording the relative abundance of pores with reference to an exposed surface. The standard for this is taken from Soil Survey Method (Taylor and Pohlen, 1962, page 99) and is as follows:-

Few pores - 1 to 3 per square inch.

Many pores - 4 to 14 per square inch.

Abundant pores - more than 14 per square inch.

Soil channels usually have obvious shapes and characteristics and can best be described in normal language. Many of them are very large and in this case, the actual measured diameter and

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extent should be recorded.

b. Roots and casts

The presence of plant roots throughout the soil and any distinct concentration of roots in a particular horizon should be noted in the profile description. The relative abundance of roots can be described by using the terms, few, many, or abundant. It may also be useful to distinguish large roots from small roots and root hairs.

Casts are massesof soil material which have been processed by soil-dwelling animals during burrowing or in the course of normal feeding. Different animals produce distinctive casts and some of these are outlined in Soil Survey Method (Taylor and Pohlen, 1962, page 51). The following is a summarised description of some of commoner casts:-

Earthworm casts are smooth, rounded globules of intimately mixed organic and mineral matter, which are frequently aggregated together into a porous spongy mass. Amphipods, Isopods (woodlice), and Collembola (springtails) deposit small cylindrical pellets of finely divided plant debris. Some insect larvae deposit masses of long, narrow, cylindrical, humus-rich casts near the surface. Mites deposit very small, short, cylindrical pellets which are often found in small cavities or are scattered on the top of the soil. Ants roll soil into small compact balls. Wasps carry out soil and scatter it fairly widely over the surface. In normal profile descriptions it is sufficient to identify casts without specifying the animals responsible. Their relative abundance should be noted.

c. Clayskins

Clayskins are films of translocated clay of varying thickness which coat structural aggregates and line pores and

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channels in the soil. They provide evidence of the movement of clay within the soil and can be an important criterion in classification. Under the microscope clayskins are recognised by the orientation of their particles. In the field they can, with experience, be detected with a hand lens or, in extreme cases, with the naked eye. Characteristically they are smooth coatings which may differ from the interior of the peds in colour as well as texture. Pores emerging on the lower side of a ped often have irregular lips where the clay protrudes. The surfaces of the clayskins often have an irregular shape with channels and apparent flowlines formed by running water, and if the clayskins on ped surfaces are thick the tracings of roots are often visible. Uncertainty of recognition increases if the clayskins are thin or if the matrix material has a clay texture, both conditions which are very common in Malaya. Furthermore, in soils rich in swelling clays, as many alluvial soils in Malaya are, they may be difficult to distinguish from smooth ped surfaces generated by pressure as the clay swells on wetting, and in soils rich in iron oxides thin coatings of predominantly oxide material may be confused with clayskins.

It has been found in Malaya that most clayskins are very thin and that they are most commonly found in pores, channels, and coating the faces of peds so that the description of them is made according to their continuity and to their position. The following standards are suggested:-

Weakly developed clayskins	: Patchy clayskins on few peds and in some pores.
Moderately developed clayskins	: Discontinuous clayskins on some peds and in many pores.
Strongly developed clayskins	: Almost continuous clayskins on most peds and in most pores.

This provides three classes for describing the increasing intensity of clayskins in any horizon. Clayskins are an important characteristic of illuvial horizons but are not

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necessarily confined to such horizons. Structureless or massive soils obviously cannot have clayskins on ped surfaces since they have no peds. The clays in the illuvial horizons of these soils are usually found as coatings on the individual sand grains. Occasional pores in these horizons persist long enough to have patchy or continuous clayskins with flowlines. Because of the turbulent flow of water down wide cracks and large channels such as are quite common in Malayan soils, clayskins might be formed by a single rain in a soil having no significant illuviation. For this reason, a Bt horizon should have clayskins on most of the structural aggregates as well as in pores and channels. It is possible also to have clayskins in the surface horizons of many Malayan soils and this probably indicates a fairly rapid rate of erosion at that particular site, the clayskins being relics from a former illuvial horizon. Brewer(1960) has given a comprehensive description of colloidal coatings and related features, which he calls cutans.

d. Stones and concretions

Gravels, stones,and boulders of geological and pedological origin are common in Malayan soils. They should be described according to shapes, (rounded, angular, subangular, etc.) identification, size, and abundance. The following standards are suggested for size and abundance:-

Size

Gravel - Individual particles are less than 10 mm. (2/5 of an inch) in greatest diameter. A ready field test is provided by the fact that it is easier to throw a handful rather than individual particles.

Stones - The diameter of stones ranges from 10 mm. to 200 mm. (2/5 of an inch to 8 inches) and it is easier to throw a single stone than a handful of stones.

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Boulders - The diameter of a boulder is greater than 200mm. (8 inches) and it is not at all easy to throw a boulder.

e. Laterite

Laterite in one form or another is a very common feature of Malayan soils. It is, of course, an extremely well documented substance (e.g. Sivarajasingham, Alexander, Cady and Cline, 1962; Panton, 1956) but these notes are intended to standardise the method of describing laterite in the field, and thus no comment is made here concerning its origin or genetic significance. Some of the forms of laterite found in Malayan soils, and suggested terms for them are given below:-

1. Nodular laterite - This consists of rounded or sub-rounded individual concretions which are not cemented together. They are mostly hard and brittle and occur most commonly in B horizons although they are found in A horizons and in some places on the surface. Individual pieces of nodular laterite in the A horizon are commonly corroded into essentially rounded but irregular shapes.
2. Massive laterite - This consists essentially of nodular laterite, cemented into a coherent mass. It most commonly occurs in the B horizon but in many places occupies the whole profile from the surface to depths which may be as great as 15 or 20 feet.
3. Laterized parent material - This comprises the underlying rock which is impregnated or coated with iron. The structure and texture of the rock can still be discerned. It is confined to the C horizon.
4. Fragmental laterite includes angular, or subangular fragments of laterite or laterized parent material which probably originated as one or other of the three forms described above. It occurs indiscriminately

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throughout the profile and has almost certainly been transported away from the place where it was formed.

The cementation of lateritic horizons is a very important property in terms of plant growth and should always be described. The following scale can be used:-

Weakly cemented - The cemented mass is brittle and hard but can be broken in the hand.

Strongly cemented - The cemented mass is brittle and too hard to be broken in the hand, but is easily broken with a hammer.

Indurated, very strongly cemented - Brittle and is so extremely hard that a sharp blow with a hammer is required to break it and the hammer generally rings as a result of the blow.

Other features of laterite which should be recorded are the thickness of the horizon containing laterite, the depth below the surface at which it occurs, (these two particularly apply in the case of massive laterite), and the presence of bauxite which can be distinguished by its yellowish white colour.

f. Stonelines

Layers of stones within the soil profile are a common feature in many Malayan soils, and the characteristics of many of these lines suggests that they are not residual features of the rock from which the soil is derived, but are pedologic in origin.

These lines normally consist of angular or subangular fragments of vein quartz, quartzite, iron-stained shale, granite, or rounded concretions of laterite (limonite), or mixtures of two or more of these components. The fragments can vary in size from small pebbles to medium-sized boulders, and considerable differences in size and angularity of the stones can occur in any one stoneline. They are normally only a few inches in thickness, and not uncommonly consist of only one layer of stones. In some cases the stones may

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be several inches apart so that the line is broken and discontinuous. Stonelines may occur from within a few inches of the surface down to depths of several feet, but they are not found in the parent material horizons. They normally run parallel, or nearly parallel, to the surface, and in rare instances can be seen to outcrop on the surface.

The soil above and below the stonline is usually similar in general appearance, but a close examination often reveals slight differences in colour, texture, and consistency, indicating that the line marks a boundary between two genetically different horizons of the profile. It is not unusual to find that the horizon below the stoneline is coarser in texture and firmer in consistency than the horizon above, and that the change takes place suddenly at the line itself.

If it is accepted that these features are of pedogenic origin, which certainly appears to be the case, then two possible modes of origin can be postulated, namely that they are either layers formed as a result of soil creep along the frictional boundary separating the static from the moving part of the soil mass, or alternatively that they represent former surface accumulations which have been subsequently covered by colluvium. It is possible that stonelines in Malayan soils could have formed as a result of either process.

Soil creep could explain the presence of stonelines in the more steeply sloping areas of the country; while the colluvial explanation appears to be more applicable in the less steeply sloping lowland areas, and more particularly in those areas where gently undulating sedentary soils and Older Alluvial soils developed over eroded terraces occur in close association. In such areas the low slopes would preclude intensive soil creep, while the higher sea level conditions during the interglacial ages of the Pleistocene would have led to extensive alluvial and colluvial accumulation and sheet wash, interspaced by periods of erosion during the glacial ages, when climatic conditions may have been

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unfavourable to dense forest growth. It is of interest to note that stonelines are commonest in such low-lying sedentary soil areas below the 250 foot contour and the balance of evidence appears favourable to the colluvial explanation.

Similar stonelines occurring in the south-eastern states of the U.S.A., which are explained in similar manner, are termed carpedoliths, (Parizek and Woodroff 1957) and this name may prove acceptable in time to Malayan soil scientists.

g. Identifiable minerals

The presence of relatively unweathered minerals in the soil can give an important indication of the age of the soil and of the relative reserve of plant nutrients in it. In most cases, these mineral remnants reflect the mineralogy of the parent rock. Such minerals should be identified with the aid of a hand lens and recorded. The following brief notes may be of assistance:-

Identification can be assisted by separating colourless minerals (including pale coloured) from coloured (mainly dark coloured) minerals. The commonest colourless minerals will be quartz (which cannot be scratched with a pocket knife), feldspar (which can be scratched with a pocket knife and can usually be crushed between the fingers because of the semi-decomposed condition in which this mineral often occurs in Malayan soils) and the lighter coloured micas (which have a characteristic glitter and a platy shape). The coloured minerals will be mainly ferro-magnesian minerals and separate identification is probably not necessary apart from noting biotite, the dark coloured mica which is easily recognised by its tabular form and by the striated character of the crystal faces. The degree of decomposition of mineral fragments should also be noted.

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h. Horizon boundaries

The boundaries between horizons vary in distinctness and in shape. The distinctness of boundaries depends partly on the contrast and partly on the thickness of the transition between the horizons. It is expressed by the thickness of the transitions, and the following standards can be used:-

Sharp - almost a line.

Distinct - less than one inch.

Indistinct - one to three inches.

Diffuse - greater than three inches.

Most horizon boundaries in Malayan soils are smooth so that the shape need not be specified unless it is unusual such as wavy, irregular, or broken. Definitions of these terms oan be found on page 187 of the U.S.D.A. Soil Survey Manual.

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CHAPTER 3

SOIL SURVEY

Basically soil survey is one of the many manifestations of man's attempt to satisfy his natural curiosity about his environment, but at the same time it is a scientific exercise carried out for severely practical purposes, and the techniques of unravelling and recording the soil pattern must be as effective as resources of time, finance and manpower permit. They must also be reasonably standardised so as to avoid accumulating fragments of information which are difficult to correlate.

The main components of soil survey are the mapping of the soils in the field, the classification of the soils, and the production of soil maps and soil reports.

Units of Mapping and Classification

The grouping of like soils into units for mapping and classification purposes provides an essential framework for the survey. Art becomes entwined with science in this aspect of the profession because the analysis of the soillandscape, and the subsequent synthesis into significant soil units which can satisfy the twin demands of land use and technical taxonomy depends in considerable degree on pedological "intuition" - a distillation of learning, skill, and experience which imparts a flair for making the right choice more often than not, from a number of alternatives.

The difference between mapping units and classification units is often confused. Ideally the units of the soil classification are simple and uniform, becoming more embracing and comprehensive but still within sharply defined limits as the higher categories of the classification are approached. Much of the confusion probably arises from the fact that this ideal is seldom realised in practice, but a broad distinction on the basis of uniformity

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can be made between the mapping unit and the classification unit. The basal unit of both mapping and classification is the same, and in the schematic-reconnaissance survey of Malaya this is the soil series. Series are recognised and mapped in the field and they also represent the individual bricks by which the technical classification is built up. Mapping units other than the series are units of convenience to enable a practical soil map to be assembled. Because of the many differences within a soil landscape they allow for considerable variation, variation which in some cases is greater than would be permitted within one classification unit. But whereas such mapping units are a reasonable and practical way of depicting a complex array of natural objects on a map, they are rarely precise or uniform enough to satisfy the requirements of a technical classification, and so classification units, which are closely related to but more strictly defined than the mapping units, are erected.

In brief, the soil mapping unit is used to analyse the soil landscape to show what is there and where it occurs; whereas the purpose of the unit of classification is to synthesise this information and to arrange it into a logical and orderly system. The mapping units most commonly used in Malaya are the soil series, the soil phase, the soil complex, the soil association, and miscellaneous land units. The classification units which are most commonly recognised in Malaya are the soil series, the soil family, and the great soil group.

1. Mapping units

(a) The soil series

In the present state of soil survey in Malaya the soil series is regarded as the unit basal to mapping and to classification, and it thus forms the link between them. This situation differs from that pertaining in many other countries, where the soil type is accorded this distinction. Not enough detailed mapping has been done in this country to determine

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realistic criteria for distinguishing soil types, and the original concept for type separation - different topsoil textures - does not apply in a country where topsoils, i.e. A_1 or Ah horizons, are only a few inches thick and are commonly modified by erosion, so that textures are considerably coarser than those throughout the rest of the profile. It is interesting to note that for similar reasons the series tends to supplant the type as the basal unit in other parts of this region (e.g. Sarawak, Andriesse, 1964, page 21). The requirements of detailed soil surveys will perhaps in time cause the concept of soil type to be resurrected and redefined, possibly on the basis of the texture of the upper part of the soil, i.e. the horizons lying between the thin humified surface layer and the main B horizon.

The soil series is a grouping of soils with similar profiles, similar temperature and moisture regimes, and the same or very similar parent material. It is used on occasions as a mapping unit by itself, but is more commonly replaced by associations of series, particularly in the schematic-reconnaissance survey. The series name however provides a ready key to most of the characteristics of the soil it embraces. It is most important that series be erected on valid and uniform criteria. It is much easier to draw attention to differences than it is to stress similarities but a distinct series should satisfy the requirements of the definition outlined above. The question as to what constitutes similar profiles is not always easy to answer, and the broad criterion that is used at present is whether a morphological or analytical difference will have considerable impact on the use of the soil. The close co-variance of soil and parent material over much of Malaya tends to simplify the recognition of series.

The series is given a geographic name indicating a locality where it is well developed or where it was first recognised. The geographic name should be a well established one and should be as simple as possible. Malay names are used almost exclusively and where

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possible a single name rather than a double or triple name should be preferred. Each series should also have a defined type locality where the characteristics of the series can be inspected.

(b) The soil phase

The soil phase is commonly used as a sub-division of the series, but strictly speaking it is a sub-division of any category without itself being a category of the system of classification. It is based on any characteristic or combination of characteristics potentially significant to land use; for example, depth of the soil, presence of laterite, severe erosion, drainage, or salinity. At the series level, phases are used to show differences of lesser rank than the pedological characteristics that differentiate the soil series. They are important for some kinds of land use and may indicate transient or artificially induced changes not accompanied by significant changes in the morphology of the soil. For example, drained phases are recognised where the drainage of the series has been improved artificially. The phase names are placed after the series as follows:-

Segamat Series, lateritic phase.

(c) The soil variant

The soil variant should be clearly distinguished from the soil phase. It is a unit of convenience designed to avoid unnecessary multiplication of series names. It is closely related to the soil from which it derives its name but differs in characteristics at the same level of separation. It permits the soil surveyor to avoid establishing separate soil series for soils of minor extent. Thus, a soil may be defined as a variant in one survey and later raised to the rank of a separate series when found to be more extensive. By using the term variant, the soil surveyor tells his readers that he recognises in the profile enough criteria to justify a new series but for one reason or another it cannot be conveniently established. In Malaya

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variants have been commonly used to distinguish between profiles which have similar properties apart from colour; for instance, Serdang Series, red variant. If further mapping reveals such variants to be of sufficient extent, they will be elevated to series rank.

(d) The soil association

The soil association is a compound mapping unit consisting of a group of soils which are geographically and topographically associated in a defined proportional pattern. The term has been confined to reconnaissance maps, where there is insufficient field data available to permit of any further subdivision on the final maps. The association is essentially similar to a soil complex but the pattern is sufficiently coarse to be resolved on ordinary detailed maps, whereas the pattern within a complex cannot be resolved easily on detailed maps. The association is the commonest mapping unit in the schematic-reconnaissance survey. Although by definition, associations may show combinations of various groups of soils, in Malaya they consist almost exclusively of series, and the association is named after the most important series occurring within it, or by combining the names of component series.

(e) The soil complex

The soil complex is also a compound mapping unit containing an intimate mixture of two or more soil series that cannot be differentiated on ordinary detailed soil maps. As with associations, soil complexes do not form a category in the soil classification and it is thus not correct to give them a separate taxonomic name. They are allotted composite names derived from the names of their principal constituent units.

As is the case with an association, the soil complex can only be described in terms of its constituent units and this should always be done carefully. In addition, a description of

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the pattern including the percentage occupied by each unit should be given.

(f) Miscellaneous land units

In a rapid schematic-reconnaissance soil survey it is not always necessary to do more than delimit the boundaries of certain landscape types which are easily recognised and which are mostly of fairly low agricultural potential. These units will be categorised more precisely as the level of soil survey becomes more intense, but it has been found very convenient to make use of a number of these groupings, the names of which are almost always self-explanatory. Some typical miscellaneous land units are steepland, disturbed land, local alluvium, and peat. Sub-division on the basis of phases is sometimes done so that depth phases of peat are recognised. This mapping unit serves the somewhat specialised requirements of the schematic-reconnaissance survey because it eliminates those landscape units which are easily recognised and yet which are commonly most inaccessible. However, the unit will probably not find much further use on completion of this first time reconnaissance survey.

2. Units of classification

The soil series is the basal unit of classification as has already been mentioned under the previous section.

(a) The soil family

The soil family is a grouping together of similar series for purposes of classification at a level between the series and the great soil group. The concept of soil family has not yet been thoroughly worked out and tested in practice in Malaya, but it can be said that the series within any one family will have broad similarities of parent material; there will be no great differences in the kind and arrangement of genetic horizons within the profile; and the mineralogy of the soils will be similar.

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For instance, the Rengam family, which as constituted at present, contains some eight series and two variants, comprises series which are formed on granitic or grano-dioritic rocks, have quite a marked eluvial A/illuvial B horizon sequence and are predominantly kaolinitic with fragments of quartz and, in some cases, feldspar.

(b) The great soil group

The great soil group is, at present, the ultimate unit of classification in use in Malaya, and comprises families which have broad similarities of parent material, environmental characteristics, and horizonation. The names used are those commonly referred to in literature pertaining to the tropics. At present the higher categories of classification are under comprehensive revision and it is hoped to be able to produce a system which can be correlated easily with those used elsewhere. The Seventh Approximation (Soil Survey Staff, 1960) is also being tested under Malayan conditions.

Methods of Survey

The physical difficulties and logistical problems faced by a soil surveyor working in Malaya, particularly in the more inaccessible undeveloped forest-covered regions of the country are very different from those encountered by soil surveyors working in many other parts of the world. This is due to the almost continuous cover of high forest which restricts visibility on the ground and obscures the soil pattern from the air, accompanied in many places by difficult terrain in which steep hills alternate with deep and almost impenetrable swamps. In the gently undulating and hilly land, progress on the ground is slow and a straight line traverse for three miles through uncut jungle can be considered a good day's progress if a satisfactory examination is to be made of the soils occurring along the route. In steep mountainous country the distance covered in a straight

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line can be very much less because of the deeply incised nature of the mountain topography. The slowest rates of all, however, are those recorded in some deep peat swamps where as little as a quarter mile a day might be attained, with every inch of the way having to be cut to allow for bodily progress.

Under these conditions much of the time of a soil surveyor is taken up with logistical problems such as how many men he should employ, or how much road or riverine transport will be necessary for a large scale jungle exploration and how many days rations and other supplies will be required by his field parties. Working out the detailed answers to these problems and completing the necessary arrangements in an efficient manner are an unavoidable part of the job and are of fundamental importance to the success of any jungle survey programme. Many of these tasks can and should be carried out by reliable subordinates such as Agricultural Assistants or Junior Agricultural Assistants, but the surveyor must retain overall supervision. The work of the various labourers comprising a normal soil survey group ranges from porterage duties through rentis* cutting and pit digging to more responsible jobs such as chaining; soil sampling; and recording elementary details of topography, soil, and vegetation observed along the various exploratory routes. An average labouring force may number up to 30 persons of varying degrees of technical knowledge and these men are usually split into smaller parties of about 5 persons, each led by a literate team leader who is capable of using a prismatic compass and of keeping a running log of his observations. These teams are responsible for separate phases of the field programme such as rentis cutting, soil sampling, raft and base camp construction, and chain and compass surveys of unmapped access routes such as aborigine footpath or timber extraction tracks as well as for porterage of supplies to the various working

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* Rentis. A Malay term for a track or trace through the jungle, cut usually in a straight line. In Romanised Malay, the plural form is written rentis$_2$.

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parties.

A normal survey preliminaryis to design a rentis network which consists of a complex of inter-connecting rentis lines cut on fixed compass bearings traversing the area under examination but avoiding the steeper mountain masses and the more impenetrable swamps. The direction of the rentis lines is most important and these are normally designed to cut across the dominant geological or topographical units which may be known or suspected to exist within the survey region, as in this way, they will be likely to cut the greatest number of soil boundaries. If there is no apparent grain to the land, however, it may be found more convenient to offset the rentis line at right angles to any existing access routes, such as forest roads or navigable rivers. In fact, the actual rentis net laid down is commonly a compromise between these two alternatives. On a reconnaissance soil survey, the rentis lines are generally parallel and spaced about two miles apart. Short cross rentis$_2$ are cut between the main lines at intervals of between 5 and 10 miles in order to complete the inter-connecting network. The speed of cutting of a rentis in low-lying jungle country seldom exceeds one mile per day on average, and a rentis team of 5 men cutting a 12 mile rentis line are therefore unlikely to finish the job in much less than 2 weeks. Distance along the rentis is indicated by marker posts set at one chain intervals by the cutting party and numbered consecutively with an indelible pencil.

Normally the rentis teams are trained to carry out soil sampling at the same time as they cut and measure the rentis. Samples are taken with a six-inch post-hole auger at quarter mile intervals during a reconnaissance soil survey. The sampling is done at arbitrary depths most commonly 0-6", 6-12", 12-24", and 24-36". The samples, which are collected in polythene bags in order to retain their moist condition, are placed within numbered canvas bags which enables ready identification later, and affords better protection than the polythene under the heavy wear and tear

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of jungle travel. They are then carried either to the base camp or the office where they are arranged in sequence and examined by the soil surveyor himself before he goes into the field to examine the soils in greater detail along selected rentis$_2$. This preliminary examination gives a very useful broad picture of the area and often enables the main soil boundaries to be tied down to within a quarter mile, or whatever other unit has been chosen as the sampling distance. Occasionally the soils along some of the sampled lines may be so completely uniform and the classification so obvious and familiar that no further field examination by the soil surveyor or his field assistant may be necessary. This presupposes completely reliable rentis teams, which is not always the case. It has been found prudent in the past to keep a close check to ensure that the samples are actually collected from the points specified and that the rentis has in fact been cut to the distance stated. If the pattern of soils appears complicated from the samples and if new and unrecognisable series are emerging, or if the main boundaries must be tied down to a greater degree of accuracy, the soil surveyor himself must traverse the rentis lines to examine the soils in more detail and to record the boundaries with greater precision.

In examinations of this nature, the soil surveyor is usually accompanied by a lightly laden, fast travelling party of three or four of his fittest and most energetic labourers so that he can make fairly rapid progress and cover perhaps 5 or 6 miles of thoroughly examined rentis each day. In such inspection the soil is examined with a 1½ inch screw auger usually mounted on a 40-inch shaft with a fixed steel handle, although a 6-inch post-hole auger may be used as well, and borings are made at varying intervals depending on the complexity of the soil pattern; while soil pits down to 6 feet in depth may be dug when a very detailed examination is necessary.

Full notes are made of the soil, topography, vegetation, and other relevant features during a field examination of this

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nature and portable pocket tape-recorders are a valuable asset for this purpose. The hot, wet conditions in the jungle render writing a task which is resorted to only when unavoidable, but speaking into a microphone clipped to the shirt or held in the hand involves no discomfort whatever. The quantity and quality of recording on jungle survey has increased considerably since these machines have come into use. A constant check must be kept on the recorder to ensure that it is operating.

During the surveyor's examination of the rentis the opportunity is taken to check the depth and positioning of the borings made by the sampling teams to verify that theyhave completed their work in a satisfactory manner. When travelling along rentis lines, the soil surveyor avoids re-tracing his steps down an already examined rentis because this is both monotonous and time-wasting, and the cross rentis$_2$ cut between the main lines of the net are utilised to avoid this. They also enable a useful cross-check to be made on the direction and distance traversed by each individual rentis, thus allowing for a more accurate plotting of detail on the base map.

The information collected is recorded sometimes in the field but more often in the office or base camp immediately after each period of examination on two inches to one mile or 1 to 25,000 topographic maps whichever are obtainable. Before marking in the field data every precaution should be taken to see that the actual ground position of the rentis has been accurately fixed upon the map itself, for there is always a possibility of a faulty compass or a careless compass operator or even a deliberate attempt at under-chaining on the part of the labourers, which could result in considerable inaccuracies in the positioning of soil boundaries on the final map. Details recorded along the rentis lines are transferred to traverse sheets as in the sample shown (Fig) 2and these are filed to form a permanent record of detail observed, not all of which will appear on the final map.

The field map and notes obtained in this manner form a

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Figure 2.

SAMPLE TRAVERSE SHEET

MAP SHEET 2 K/6 & 10	W.P. Panton	19
STATE Kelantan	DATE 5.8.57	

GRID POSITION	TRAVERSE DETAILS From camp on S. Pahi along rentis Bg. 150/63 chains to S.Pas, then up short rentis leading south. Back to Post 51 on first rentis and out to Pahi Station via various jungle tracks on banks of S. Pahi.
2 K/6. 348816	Down rentis Bg 150° for 63 chains from south bank of S. Pahi. Post 0. River bank 15' high, small narrow strip of recent alluvial fine sand. Post 0-6. Gently undulating 3-4° land under good jungle with brownish yellow sandy clay loam Rengam Series.
2 K/10 349814	Post 6-6½. Rengam sandy clay loam on 12° to south slope. Post 6½-7. Alluvial swamp. Flows to west. Post 7-14½. Very nice Rengam brownish yellow sandy clay loam undulating land with slopes up to 20° at Post 13 and 14. Post 14½-15. Alluvial swamp. Flows to east. Post 15-19. Undulating land 10-20° slopes to north-west. Very nice brownish yellow to reddish yellow sandy clay loam Rengam with good jungle. Post 19-21. Hilltop, moderately undulating, old track runs to S.S.W. Post 21-28. Slopes to south, between 5 and 20°. Undulating land with brownish yellow and reddish yellow Rengam sandy clay loam. Post 28-33½. Gently undulating, 5-3° slope land. Pale brownish yellow sandy clay loam Rengam, gently undulating phase. Post 33½-34. Coarse colluvial light grey sand. Post 34-37. Gently undulating Rengam phase. Post 37-39. Edge of hillsoil (Rengam) on east, and swamp on west. Post 39-40. Alluvial swamp. Small stream flows to southwest. Post 40-44. Gently undulating rather pale yellow Rengam sandy clay loam. Post 44-45. Alluvium. Post 45-57. Gently undulating phase of Rengam sandy clay loam. About 5° slopes. Post 57-58. 15° to south slope, good Rengam sandy clay loam. Post 58-61. Gently undulating phase Rengam sandy clay loam.

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(cont'd) SAMPLE TRAVERSE SHEET

357790 approx.	Post 61-63. Recent riverine alluvium under belukar. Post 63. S.Pas, flowing W.S.W. by W. Granite rocks "in situ" in river bed forming occasional rapids. Down rentis Bg 180° for 25 chains from this position. Post 0. River bank, S. Pas. Post 0-4½. Recent alluvial free draining silty to fine sandy loams on 20' high river bank. Post 4½-9. Rentis runs up small alluvial strip with Rengam sandy clay loam on east and west sides. Post 9-16¼. Gently to moderately undulating rather pale coloured Rengam sandy clay loam. Post 16¼-19. Swamp alluvium.

most valuable record of the survey work which has been obtained at some considerable cost and every precaution should be made to preserve these records for posterity. Vertical plan filing cases and insect proof filing cabinets help to preserve such records and are a legitimate expense under the circumstances.

Aerial photographs are of restricted use in Malaya during field work in most types of forested terrain. In practice, it is found that the one inch aerial reconnaissance topographic maps as well as the more recently produced New Series topographic sheets published by the Survey Department normally reflect the relevant details which appear on the aerial photographs themselves; and this is because the maps have been compiled largely from the available photographic material and any obvious boundaries which can be seen from the air in the relatively uniform forest cover are already transferred on to the one inch scale maps. There are some recent aerial photographs available and those of good quality are useful in that they show unmapped tracks and trails such as timber extraction tracks, and furthermore, stereoscopic inspection of them prior to surveying furnishes background knowledge of the terrain, particularly where good topographic maps are not available. They are not taken into the field on jungle survey, however, because of the difficulty of locating positions on them accurately and because no convenient method of preventing rapid deterioration of photographs in the moist humid conditions of the Malayan jungle has yet been devised. Occasionally, however, a careful study of the aerial photographs may indicate a change in the vegetational pattern which might be correlated with a soil change on the ground but which may not be shown on the corresponding topographic map, and a preliminary examination of the photographs is therefore advisable before any period of field work is commenced. Sometimes a rudimentary map showing the main ecological types can be prepared at this stage. This may prove useful in the field and may later be incorporated on to the field map at the compilation stage, after a correlation

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between soil and vegetation has been proved by actual field examination.

There is in fact no reliable alternative to visual examination of the soils on the ground in undulating jungle terrain under Malayan conditions, and this explains the time-consuming nature of soil surveys in Malaya. This of course applies only to the undeveloped regions of the country, and in the more developed and open areas where access is much easier soil surveys can be carried out much more rapidly. Greater use can be made of aerial photographs and the methods are generally comparable with those practised in most other parts of the world.

The preparation for the soil survey should include a study of all the available literature pertaining to the natural features of the area to be surveyed and particularly to any geological data. Considerable geological information is available in unpublished form and can be obtained either from Field Offices of the Geological Survey or from the Headquarters in Ipoh. An understanding exists between the Director of Geological Survey and the Director of Agriculture by which a free interchange of relevant unpublished data is ratified subject to the normal acknowledgement requirements.

After consulting relevant information, a reconnaissance is made along the roads and passable tracks and the major soils are noted. Key areas are examined in some detail so that sufficient information may be gained to draw up a preliminary skeleton legend and decide on the kinds of units to be mapped. The legend, although very approximate at this stage, is an essential device for categorising the soil units which are likely to be mapped, and by the time the preliminary inspection is completed and before field mapping begins the framework of a controlled working legend of soil units as such should be drawn up. Inevitably, this preliminary legend will be incomplete but it is an essential requirement to enable the soils to be mapped in classifiable units as they are encountered, and thus to allow the

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field work to proceed systematically. It will be added to and revised as the survey progresses.

During the course of the survey, information on the various series being mapped will accumulate and from time to time this should be used to prepare standard series descriptions. These descriptions of a page or two in length should include an introduction, in which the main distinguishing features of the series are summarised; a full detailed profile description; some indication of the range in characteristics; and notes on terrain, drainage, vegetation, uses, distribution, type location, derivation of the series name, pit description numbers, sample numbers, and remarks. In selecting the profile description for inclusion in this standard description, the central concept of the series should be aimed at. These standard series descriptions provide the basis for the descriptive part of the report which will accompany the final soil map.

Soil Maps

1. Base maps available in Malaya

The soil surveyor working in Malaya is very fortunate in being able to obtain high quality topo maps for all areas of the country. Topographical surveys have been carried out extensively in Malaya since the end of the 19th century, and many areas have been mapped two or even three times during the intervening period.

As would be expected in an area the size of Malaya, the quality of the maps varies from place to place, mainly because the programme of revision mapping usually takes many years to reach finality.

Details concerning the more useful map series, and a few individual maps which are relevant to soil studies, are given below:-

1 inch to 1 mile Topographic Sheets

The standard mapping scale has always been 1 inch to 1 mile (1:63,360) and three series of maps, having very variable

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standards, comprise the most recent coverage of the Malayan peninsula.

Hind 1035 Series

The earliest of the three series is the Hind 1035 Edition, which is often referred to as the Old Series (standard mapping) edition. These sheets are the only available 1 inch maps for a large proportion of western Malaya north of the Johore border, particularly in Selangor, Perak, Province Wellesley, Kedah, and Perlis, and also parts of Pahang.

The mapping was carried out mainly between 1910 and 1940, and the maps were prepared by rigorous ground survey methods, without the aid of aerial photographs. All these maps show accurate contours at 50 foot vertical intervals. The land use detail shown on this series is now out of date, and in areas where development in recent years has been rapid, the maps can be very misleading. However, the physiography is surprisingly accurate, and stream lines in particular are very reliable. The contouring also attains a high standard of accuracy, although ridge lines do not show up as prominently as on the latest new series sheets for the same areas. (see below).

Many of the early Hind 1035 sheets have gone through several editions, and revisions to some of the sheets have been made from time to time. Much of the revision work has been undertaken by British military units since the end of the Second World War, and these revision sheets are known as 2-GSGS edition sheets. They often include the most up-to-date road and track detail, which has been included to meet present day military requirements.

Air Reconnaissance Series

The air reconnaissance series,, often referred to as the Old Series (air recce) edition, covers those parts of the country which were not covered by the Hind 1035 mapping programme, and were very quickly prepared during the early days of the Emergency, commencing in 1948. They are compiled from aerial

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photographs which were flown in haste and are therefore of very variable quality. Very little rigorous ground control was available owing to the limited amount of ground survey which had been carried out in the areas covered by this programme during the pre-war period. This edition covers large parts of Kelantan, Pahang and Trengganu.

Accurate contours are not shown on these maps. The relief is indicated by form lines which do not maintain constant height, and are drawn at approximately 500 foot vertical intervals. A further form line, which corresponds very approximately to the 250 foot contour, is also shown, and is very useful for soil survey reconnaissance mapping purposes. Streams are usually plotted with a high standard of accuracy and the relief can be interpreted with fair confidence from a study of the drainage pattern and the form lines. Occasionally mistakes in compilation occur, largely because of the poor quality of the photographs from which the maps have been compiled. The greatest confusion is likely to arise when streams are shown flowing in the wrong direction, particularly when the mistake is only discovered during a field reconnaissance.

The accuracy of the detail shown on the air reconnaissance sheets is very variable and the least accurate sheets are to be found in the north along the Thai-Kelantan border.

New Series

In the early 1950s the Topo Division of the Survey Department commenced a resurvey of the Malayan States on the 1 inch scale, based on a new projection, known as the Malayan rectified skew orthomorphic, and field work was commenced in the Johore-Malacca region and in the Trengganu and Kelantan coastal areas. To date sheets have been published for the whole of Johore, Malacca and the Langkawi Islands, and parts of Negri Sembilan, Selangor, Penang and Province Wellesley, and much of the northern part of Kelantan and the north-eastern part of Trengganu, together with a few sheets covering southeast Pahang.

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Field work is presently being concentrated in the central and eastern parts of the country, so that the air reconnaissance series maps may be replaced by the new series sheets in the shortest possible time. The programme will later continue into the west coast states where the maps will replace the sheets of the Hind 1035 Series.

The New Series sheets are extremely accurate, and are based on rigorous ground control and compiled from recent photographs which are usually of better quality than the early R.A.F. photographs. Contours and drainage lines are extremely accurate, and land use detail is very up-to-date. Because of the much better quality of these new maps, soil surveyors commencing surveys in areas not covered by published new series sheets should always enquire whether compilation sections of the new series sheets are available, as the compilation is usually a year or two ahead of the publication, and in such instances copies showing contours, if the compilation has passed the multiplex stage, and on a scale of 2½ inches to 1 mile, can be obtained from the Topo Division of the Survey Department.

New Series - 1:25,000 Maps

The compilation of the New Series sheets is carried out on a scale of 2½ inches to a mile and published sheets are available on a scale of 1:25,000 for the developed areas covered to date by this re-survey. These maps make very suitable base sheets for soil surveys and uncoloured copies, which are more convenient than the coloured edition, are usually obtainable. Unfortunately, copies of the forest covered areas are not published in this series, owing to the limited demand, but it is always possible to obtain copies of the less well finished compilation section on the similar scale of 2½ inches to a mile for such areas. These can be obtained from the Topo Division.

Photostat Enlargements

Because the Hind 1035 and Air Reconnaissance series maps are only published on the 1-inch scale, it is often

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necessary to enlarge these maps for soil survey purposes. A photostat reproduction and enlargement service is available at almost all State Survey Offices, and also at the Survey Department Headquarters in Gurney Road, Kuala Lumpur.

Enlargement from 1 inch maps up to a scale of 2 inches to a mile is usually found acceptable for soil survey purposes, and this degree of enlargement enables a standard sized 1 inch Hind or Air Reconnaissance sheet to be conveniently enlarged on to 4 photostat sheets. This is possible because a quarter of a 1 inch sheet, when enlarged to thisscale, just fits within the shorter side of a standard 18 x 24 inch photostat plate; while enlargements onto a larger scale, such as 2½ inches to a mile, will require 9 photostat copies instead of 4, thus increasing reproduction costs by a wide margin. A further disadvantage of enlarging 1 inch maps to a greater scale than 2 inches to a mile is that the enlargements will be variable in shape and for that reason inconvenient for field work.

4 inch to 1 mile Forest Reserve Map Series

The Survey Department carried out a number of surveys on this scale over certain forest reservesat the request of the Forest Department during the inter-war period. Copies of some of these maps are still available and enquiry should be made at the appropriate State Survey Office.

Cadastral Sheets

Land registration in Malaya is based on the Torrens system, which depends on very accurate ground survey of the boundary of each title area. The very accurate cadastral survey sheets for this purpose cover all the developed parts of the country. The scale is normally 8 chains to 1 inch, and copies of these sheets can be obtained with little difficulty from State or District Survey Offices.

State Maps

This collection of maps, often termed the Land Utilization series, is printed on different scales for the States

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of Malaya, as follows:-

State	Scale
Kedah and Perlis	2 miles to 1 inch
Penang and Province Wellesley	1 mile to 1 inch
Perak	2 miles to 1 inch
Selangor	2 miles to 1 inch
Negri Sembilan	2 miles to 1 inch
Malacca	1 mile to 1 inch
Johore	3 miles to 1 inch
Pahang	4 miles to 1 inch
Trengganu	3 miles to 1 inch
Kelantan	3 miles to 1 inch

The detail shown on these State land utilization sheets is compiled largely from the cadastral survey sheets and the land use groupings therefore reflect the purpose for which the land was alienated, as shown on the alienation titles, rather than the actual land use situation. For this reason the term land utilization can be misleading, while considerable changes in the land use pattern have in any case occurred since the maps were prepared. These maps, most of which were published between 1950 and 1953, can be obtained in both coloured and uncoloured editions.

4 mile to 1 inch Topographical Sheets

These sheets, printed in a military edition, each cover the same area as 16 Old Series 1 inch sheets. 21 separate sheets are available covering the whole of Malaya.

1:500,000 Map of Malaya

In recent years a useful wall map of Malaya on a scale of 1:500,000 has been published. This map can be obtained in both coloured and uncoloured editions, and the scale is very satisfactory for publication of schematic-reconnaissance soil maps. Soil maps for Trengganu and Kelantan were printed on base plates taken from this map.

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12 miles to 1 inch Map of Malaya

This smaller map, which shows very similar detail to the new 1:500,000 map, also makes a suitable wall map. It is obtainable in several editions of which the most recent was published in 1959. Copies are obtainable in colour and plain.

18 miles to 1 inch Topo Sheets Index Diagram

An index diagram showing the areas covered by the Old Series Hind and Air Reconnaissance sheets and the New Series sheets is available from the Survey Department, and is indispensable for map reference purposes.

1948 Geological Map of Malaya

This map, which has been out of print for several years, is the most up-to-date geological map showing the main geological formations on a sufficiently large scale for field study purposes. The compilation is based almost entirely on pre-war geological records.

1 inch to 1 mile Geological Maps

These maps, which are obtainable from the Geological Survey in Ipoh, are superimposed on the Hind 1035 series sheets, and the following 4 maps were published prior to the Second World War:-

$2\frac{N}{1}$; $2\frac{N}{13}$; $2\frac{N}{14}$; $3\frac{B}{4}$

The following 13 sheets, have been published since the end of the Second World War, but based largely on pre-war geological surveys:-

$2\frac{N}{5}$; $2\frac{N}{9}$; $2\frac{N}{8}$; $3\frac{B}{12}$; $2\frac{P}{13}$; $2\frac{P}{14}$; $3\frac{D}{1}$; $3\frac{D}{2}$; $2\frac{N}{8}$; $2\frac{N}{12}$; $3\frac{B}{7}$; $3\frac{B}{10}$; $3\frac{B}{11}$

Approximately 40 unpublished geological maps are also understood to be available for reference in the archives of the Geological Survey in Ipoh, and publications of these maps, with accompanying memoirs, can be expected during the next few years. These unpublished maps are almost entirely based on post World War II geological surveys.

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Forest Resources Map of Malaya

This map is really a very simple small scale land use map compiled from alienation records and incorporating boundary details of the game and forest reserves. It was published in 1951 on a scale of 12 miles to 1 inch.

1962 Vegetation Map of Malaya

This map was published in Volume 18 of the Journal of Tropical Geography in August 1964, and is on a scale of 24 miles to 1 inch.

1962 Soil Map of Malaya

This map was also published in Volume 18 of the Journal of Tropical Geography and is on the same scale as the vegetation map. Extra copies are obtainable from the Soil Science Division, Research Branch, Department of Agriculture.

Rainfall Map of Malaya

This map which is based on an analysis of rainfall records in the 1930 - 1939 period was prepared by the Meteorological Service, and was published in 1947. Dyeline copies of this map are available from the Soil Science Division.

Except where indicated in the text, copies of the above maps, if in print, are obtainable from the Map Sales Office, Survey Department, Mountbatten Road, Kuala Lumpur; or from the Survey Department Headquarters in Gurney Road. A full list of available maps can be obtained on enquiry at the Map Sales Office.

2. Methods of Compilation

In Malaya a mapping scale of between 2 and 2½ inches to a mile has been found satisfactory for schematic-reconnaissance and detailed-reconnaissance soil survey purposes, and copies of the uncoloured edition of the published 1:25,000 New Series sheets therefore make excellent base maps. Unfortunately these maps have only been published for a limited area, but in those areas for which New Series 1 inch maps have been published without an accompanying 1:25,000 edition, copies of the 2½ inch compilation

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sheets which were used in the preparation of the 1 inch maps can be obtained from the Chief Surveyor, Topo Division. Similar, but only partly completed, compilation sections can also sometimes be obtained from the same source for those areas in which new series mapping is being undertaken, although such pre-publication sheets are of little use to the soil surveyor unless the compilation shows contour detail, which will only be the case if the assembly has passed the multiplex stage.

Planetable sheets were originally prepared at a scale of $2\frac{1}{2}$ inches to 1 mile for the Hind edition of Old Series maps, and then reduced to 1 inch for publication, and copies of these old planetables can occasionally be obtained, although most of the records are believed to have been destroyed during the war. In the case, therefore, of most Hind edition, and all of the Air Reconnaissance edition Old Series sheets, no larger scale maps are obtainable than those on the 1 inch publication scale, and in order to obtain a suitable base map for reconnaissance soil survey purposes enlargements must be prepared from the published sheets. Such enlargements can most conveniently be made to a scale of 2 inches to 1 mile by photostat machine as explained in the section on base maps.

It is normal soil survey practice to obtain 2 copies, or positive prints in the case of photostat enlargements, of each base map. One of these copies becomes the field map and is used during the course of the survey to plot observed soil boundaries, soil sample and examination points, traverse routes, including rentis positions, and other relevant field data; while the other copy, which is called the data sheet, is retained in the office and used to compile a permanent record of the soil survey results in a manner suitable for ready reference.

The data sheet is not simply a fair copy of the field map, as the information drafted on to this sheet is designed to show only the factual data obtained during the field examination, and to exclude the boundary detail which is obtained by

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extrapolation from this data during the compilation of the final soil map.

This manner of recording the field data is considered desirable because of the advantage of having a visual presentation on a large scale of the soil survey results, free from the high degree of error which is inevitable when soil boundaries are extrapolated under normal Malayan reconnaissance soil survey conditions. This applies particularly to areas of undisturbed or regenerating forest, but is also applicable to most areas covered by mature tree crops, and is a consequence of the physical limitations to lateral ground observations and therefore to field sketching of soil boundaries. It is this difficulty, together with the access problems normal to most forest areas, which has brought about the evolution of the rentis examination method on which most Malayan soil surveys depend.

The information shown on the data sheet comprises all the traverse routes, including accurate plots of the rentis net, in red waterproof ink; while soil examination points, brief notes on the soil types, series names, and positions of soil boundaries observed or inferred along the line of traverse, are all plotted in blue ink.

The next stage in compilation is carried out on a transparent Ethyulon or tracing paper overlay placed over the completed data sheet, and on this the soil boundaries are extrapolated. The detail shown on the data sheet is the main source of reference for drawing in the soil boundaries, but field note books, standard traverse notes and description sheets, aerial photographs, and the field map on which tentative soil boundaries may have been drawn during the course of field work, will all be consulted during this exercise. The two sheets (data sheet and compilation sheet) are then mounted on filing strips and stored together in a vertical plan filing cabinet from which they can be readily extracted for reference.

The separation of the factual soil information on the

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data sheet from the inferred boundary detail on the compilation sheet is particularly useful for making appreciations of the development potentialities of particular areas of land from the soil survey records, which is perhaps the most important interpretation made from soil surveys in undeveloped forest areas. In making such appreciations, it is advantageous to know which areas were actually examined, and this is best determined from a study of the rentis data plotted onto the data sheet, free of extrapolated boundary detail, which is inevitably of a lower standard of accuracy.

Appreciation of the cropping potential, managements needs, and general development requirements of an area which is shown from the data sheet to have been examined in detail and actually traversed during the survey can always be made with greater confidence than is the case in the intervening areas between traverse lines, for which the soil boundaries are extrapolated and plotted separately on the compilation sheet. Comparisons between the factual data and the compilation are readily made by positioning the transparent compilation sheet over the data sheet.

Another advantage in having the results preserved on two separate sheets is that as further information is obtained about the soils of the area, either from detailed soil surveys, or from ad hoc soil and land inspections, the detail can be superimposed onto the data sheets without affecting the validity of the existing data; while revisions of the extrapolated boundary detail consequent on the new data can be incorporated onto a new compilation sheet which then replaces the original overlay. When this is done it is best to destroy the old compilation, to avoid any possibility of inadvertent reference.

Some discretion should be used in permitting access to soil survey field records preserved in this manner, and cautionary advice should be given to persons who are allowed to refer to these records and who are unlikely to appreciate the reliability of soil survey data shown on such a large scale. These records

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can be invaluable to soil surveyors, and others, with the necessary experience to make sound judgements from the technical data, but they can be dangerously misleading if they fall into the wrong hands.

For convenience it is useful to have the soil boundaries on the compilation sheets reduced to a 1 inch to 1 mile scale and superimposed on a copy of the appropriate standard 1 inch map series, and these reductions are also very useful for quick reference, for which purpose they are conveniently stored in the vertical plan filing cabinet with the 2 inch records.

A further reduction down to a scale of between 2 miles to 1 inch and 1:500,000 will normally be necessary for publication, and the final publication scale will be largely determined by the accuracy of the boundary lines. This will depend not only on the quality of the surveyor's field work and his professional judgement, but also on the time devoted to the survey, the degree of physical development and of existing access within the area, financial considerations, the quality of the base maps, and a host of other variables. Reduction is most conveniently and accurately carried out by means of a Saltzman projector.

3. Aerial Photographs

The generally high quality and extensive coverage afforded by the topographic map series for the Malayan States, and the restricted availability and only average quality of much of the aerial photography, have been instrumental in reducing the dependence on aerial photographs of soil surveyors working in Malaya to a lower degree than is common in many surrounding territories.

Limitations on the use of aerial photographs are particularly apparent in forest covered regions, where the relatively uniform and dense vegetational cover obscures most of the ground detail which is necessary for accurate soil mapping, and it is in these areas, which cover about 70 per cent of the

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country, that soil surveys have to date been most extensively carried out.

A comparison between an aerial photograph and an accurately contoured topographic map for almost any forest-covered area enables the relative advantages and disadvantages of the two base media to be readily appreciated, and the advantages of the aerial photographs, which largely depends on the small amount of extra detail, mostly vegetational differences between broad forest types, which is not reflected on the corresponding topographic maps, is outweighed by the advantages of having a clear definition of the physiography, mainly in the form of drainage lines and contours, accurately shown on a rigidly surveyed base, as is the case on the topo maps. For these reasons it has become general practice to rely mainly on the topographic base maps for reconnaissance soil surveys, and to plot soil survey data and extrapolate soil boundaries directly onto these maps, rather than onto photographs.

The use of photographs in such surveys is therefore restricted to a preliminary inspection prior to commencing field work, and to office checking of details which may be obscure on the available maps and can be cleared up under stereoscopic examination.

Field experience soon gives the surveyor a measure of the reliance which can be placed on the different media, and as a broad generalization it can be said that high quality photographs are more useful in the more detailed types of reconnaissance surveys, and are of most utility in those areas which are only mapped on the air reconnaissance edition. The quality of this edition varies enormously from sheet to sheet and the photographs are in practice most frequently consulted in the areas where ground control data at the time of compilation was of a very low order, and led to inaccurate plotting of low ridges and drainage patterns in the lower-lying areas.

A comprehensive collection of aerial photographs is held

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in the photo library of the Topo Division, Survey Department Headquarters, Gurney Road, Kuala Lumpur; and this collection consists mainly of aerial photographs taken since 1947 by the R.A.F., mainly using Eagle cameras, and reproduced on a wide variety of scales, including 1:25,000; 1:30,000; 1:40,000; 1:60,000; and 1:90,000. The whole country is covered by this collection, and some areas have been photographed 6 or 7 times, giving a wide choice of scale and quality. Copies of R.A.F. photographs may be obtained, on payment, from the O.C. JARIC (SE), R.A.F., Seletar, Singapore, in the case of flights for which the negatives are held in Singapore.

In more recent years the Survey Department has been taking photographs of areas undergoing re-survey by the Topo Division, using an R.C. 8. camera mounted in R.M.A.F. Dove aircraft. The earliest of these photographs, which are all on a scale of 1:25,000, were taken in 1959, and up to the present time almost 25 per cent of the country has been covered in this manner. Most of this coverage is of Selangor, Perak, and Negri Sembilan, together with small parts of Pahang. Copies can be borrowed, or purchased, from the Chief Surveyor (Topo) who will also prepare photo-mosaics at a small extra charge.

The Survey Department is unable to take photographs on a smaller scale owing to the restricted ceiling of the R.M.A.F. aircraft.

Photographic reconnaissance specifically for soil survey purposes may be arranged through the Survey Department, who will supply the camera and operator, and arrange for the aircraft hire, as well as carry out the film processing.

R.M.A.F. Aircraft can also be hired for reconnaissance and transportation flights necessary for soil survey purposes at special rates applicable only to government departments. De Haviland Doves, Scottish Aviation Single and Twin Pioneers, and Sud-Aviation Allouette helicopters are available, and application should be made to the Ministry of Defence, Gurney Road, Kuala

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Lumpur. A special application form giving full flight details must be submitted with each application, and the choice of aircraft must be made with due consideration for the aims of the reconnaissance. Very broad reconnaissances over wide areas, and communication flights between the main airfields are best carried out in the Doves; more detailed reconnaissances over a wide area, and communication flights between the smaller airstrips are most satisfactorily made in single or twin Pioneers; while detailed observations and short-range transportation and supply missions into the jungle can be conveniently carried out in the helicopters.

Helicopters can be brought into landing zones specially constructed by soil survey staff, if made in accordance with Ministry of Defence requirements, under special arrangements with the R.M.A.F.

4. Map Production

When preparing maps for publication it is useful to have some knowledge of the stages involved in printing, so that the difficulties faced by the printer can be better appreciated and allowed for in the final draft.

In the case of lithographic colour printing, which is the usual process followed in soil map publication, the printer first prepares a negative contact on Estar Base film from the transparent draft submitted by the publisher, and from this he prepares sufficient non-photo or ferro-prussiate blues on Cut-N-Strip film or Astrofoil to match the number of separate basic colours required in printing. After cutting out, or masking out, the unnecessary detail by hand for each colour, the prepared Cut-N-Strip or Astrofoil, as the case may be, is placed on a photosensitised coated zinc plate and the necessary printing screens are placed between the two materials, after which the pack is exposed to give the finished zinc printing plate. The printing then commences, with the plate containing the background detail, usually in grey, being run off first,followed by a black print of the soil boundary

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detail, titling and frame, and then the various colour plates until the printing operation is completed. Trimming and folding of the sheets is then carried out in accordance with the publishers or editors instructions.

The soil scientist is usually directly responsible for bringing the map to the final draft stage, and this draft is most conveniently prepared on a thick, distortion-resistant transparent film, such as Permatrace or Durafilm. Unfortunately these polyester-type materials are often difficult to write on with mapping pens and waterproof drawing inks, and this is usually caused by a greasy surface film which is inherent to this type of material. A light rubbing with dry cotton wool dipped in french chalk will often improve the quality of the surface. Mixing the waterproof ink with equal quantities of ox gall can also help the ink to adhere to the material. Very smooth and greasy patches which do not respond to this processing may be treated with methylated spirit, but this should be used cautiously as the spirit will also remove pre-existing linework, including the images on photo-sensitive copying materials.

Draft maps should wherever possible be prepared on the same scale as the final publication, provided a competent draftsman is available to carry out the work. If the draft is handed to the printer with instructions to reduce for publication, the draft should be prepared on white drawing paper and not on transparent base material, as an extra photographic stage will be necessary to bring about the reduction. Lettering is most conveniently done using clarifoil impressions, and stencilling or freehand lettering should be avoided. Similarly, Ethyulon tracing cloth and ordinary tracing paper should be avoided owing to the inferior quality of these materials and particularly to their tendency to shrink or expand under variable humidity conditions.

For soil maps a very satisfactory final print can be obtained by using a standard published map as a base plate, which

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will show all the background detail necessary for position finding. 1 inch standard topo map sheets should be ideal in this respect for detailed soil maps, while smaller scale State maps are useful for reconnaissance sheets, and these can be run off in light grey (not black) ink, after which a black ink outline of the soil boundaries, legend, titling and frame can be superimposed upon the grey background. Such a combination of grey and black ink gives a very pleasing finish to the map and the necessary emphasis to the soil detail. When both a black and a grey plate are to be used, the draft prepared on permatrace by the soil scientist should include only the detail which is necessary for printing the black plate, and an already published sheet, which represents the grey plate, should be fixed beneath the transparent film to ensure that the draftsman obtains a correct matching of the two plates.

When a pre-existing base map on the correct scale is not available, a photo-reduction, or enlargement, of the published topo sheet may be made to give the correct size grey plate, and this can then be placed beneath the transparent film to guide the draftsman. The background detail for the 1962 Soil Map of Malaya, for example, was obtained in this way, by reducing the latest 12 miles to 1 inch physical map of Malaya down to half scale. In other cases, where sensible reduction may not be possible because the detail will come out too fine and indistinct, as happens when 1 inch to 1 mile (1:63,360) New Series topo sheets are reduced to a half inch to 1 mile (1:126,720) scale, the entire map must be completely re-drafted by selecting the necessary background detail and reducing manually from larger scale originals. Such a map can usually be satisfactorily reproduced in black and colour only without the extra grey plate, as the background detail will be then limited to what is necessary for interpretation of the soil data, and will not be sufficiently great to obscure the actual soil boundaries.

When the final draft showing the black plate detail

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has been prepared the colour selection must be made, and for this the Survey Department Standard Colour Chart should be consulted. This code is built up from six basic colours known as first and second yellow, red, and blue respectively, and indicated by the numbers 3, 6, 9, 12, 15, and 18 on the chart. All other colours, numbering 757, can be prepared by appropriate combination of up to four of these basic colours, together with several types of screening in black, grey and purple, which are made up of a selection of rulings, dots, and crosses.

As a separate plate is needed for each basic colour required in the printing process, and each plate is expensive, the choice of colours in the final maps is partly governed by consideration of economy, and about ten suitably contrasting colours, which are reasonably consistent with the standard soil series colour code, can usually be obtained using three or four basic colour plates, so that, with the rather cheaper black and grey plates included, a total of five or six plates is necessary for printing a normal soil map. A very complex soil map, using perhaps 30 or 40 separate colours from the chart, would almost certainly need the maximum of eight plates.

In order to assist the printer in preparing the plates, it is advisable to prepare a hand coloured guide, matching the water colours as closely as possible to the colour selection made from the chart, and using a dyeline copy of the black plate draft. The Survey Department colour chart index number should also be written over each colour compartment on the guide, and, in addition, extra copies of the map should be prepared for <u>each of the basic colours</u> as a double check for the printer. These colour key sheets should then be very carefully checked and re-checked to ensure that no single colour compartment, including the legend, has been omitted from any sheet, as a mistake at this stage can easily pass unnoticed until after the final mp has been printed, by which time it is too late to obtain a correction without the expenditure of much time and money.

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The final drafting stage consists of drawing in the map frame, and very special care should be taken to ensure that this is correctly orientated to the latitude and longtitude lines of the base map, and that the size of the frame, together with the margin and binding edge, is related to the size of the publication in which the map is to appear. It is advisable to prepare a dummy copy, at the correct size, and check the position of the folds in relation to the map detail when the format for the colour, legend, title, etc. is being decided if an aesthetically satisfying production is desired.

For the best professional results Coates printing inks and 50 per cent Rag paper should be specified. It is also worth bearing in mind that the best results are likely to be obtained if the drafting and printing stages are not hurried. Slight errors made through hasty preparation may stand out sharply in the final print, and act as a permanent embarrassment to the author and a minor irritant to the user.

Soil Reports

Every completed soil survey must be finalised by the preparation of the soil map and a report, and in some instances it may be desirable to have one or more progress reports prepared during the course of the survey. In Malaya, soil maps and reports are either printed or duplicated depending on the size of the area surveyed and to some extent on the interest which is likely to be shown in the results of the survey. There are three main vehicles of publication:-

(a) Bulletins of the Department of Agriculture which are used for reports covering areas at least as large as individual States. These are accompanied by printed maps and are normally fairly comprehensive.

(b) Papers in the Malayan Agricultural Journal and in other locally published journals such as the Journal of Tropical Geography. These reports normally

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embrace smaller areas than those published as bulletins but are usually of considerable pedologic and land use interest.

(c) Malayan Soil Survey Reports. These reports are cyclostyled and bound with a printed cover. They may be supplemented with a printed map, or with a coloured sunprint. This type of report has been introduced to meet the requirements of the schematic-reconnaissance survey, and in general cover the area surveyed by one man in a period of about two years. They have the advantage of making technical soil survey data available promptly and yet in a reasonably elegant form.

Until the results of the soil survey are published, the information is relatively inaccessible and for the most part cannot be used without interpretation personally by the soil surveyor. Consequently the preparation for publication should be finished without delay and before the departure of essential members of the survey team. The soil report is aimed primarily at agricultural officers, scheme and estate managers and advisors, and others who require soil information. However, it should contain enough technical data to satisfy the interest of other soil scientists.

The following is an idealised framework for the preparation of a soil report. This need not be followed slavishly but should act as a guide when preparing material for publication:-

1. Introduction

Purpose of the survey; location and size of the area surveyed; general description of the area; methods of survey.

2. The environment

Physiography and terrain; geology; vegetation; climate.

3. The soils

Dominant soil-forming factors; mapping and

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classification units; legend; description of individual soils including main environmental characteristics, main profile characteristics, variations, present land use, potential crop suitability, analyses.

4. Soil classification

The arrangement of series into families and great soil groups.

5. Soil suitability

Soils classed according to suitability for agriculture.

6. Main conclusions

7. References

Literature cited in text.

8. Acknowledgements

9. Appendix

Detailed profile descriptions for the main series.

10. Soil map

11. Map showing soil suitability

Tables, figures, and photographs may be used wherever possible to summarise or emphasise certain features. Every report should include, near the beginning, a sketch map showing the situation of the area surveyed in relation to the country as a whole or the State as a whole.

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CHAPTER 4

SOIL IDENTIFICATION AND CLASSIFICATION

The identification of soils in the field is of vital importance to soil surveyors and of very real interest to many other people. Since about 1950 many workers in various parts of the country and in different organizations have established approximately 200 separate soil series. Not all these units satisfy the requirements of the series definition. Some are duplications and many are not described well enough for them to be of much practical value. The responsibility for rectifying this situation lies directly with the Soil Survey Branch of the Soil Science Division, Department of Agriculture, as the major body actively pursuing soil survey in Malaya. This can only be done in close co-operation with other organizations which use soil data and which in some instances carry out soil surveys. A free interchange of information and an acceptance of the prerogative of the Department of Agriculture to ratify the setting up of new series are essential to establish a generally acceptable soil classification.

To date all series of which there is any record have been culled to less than 100 "hard core" series which form the basis of a soil register to be built up and maintained in the Soil Science Division in Kuala Lumpur. These series are in general either firmly established by common usage, well described, or of wide extent and to assist in their identification in the field they have been arranged in key form as follows:-

Soil Series Key

I. SEDENTARY SOILS

A. On Granite

1. Subsoil colour predominantly brown.

BUKIT TEMIANG - Subsoil colour strong brown (7.5YR5/6)

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to brownish yellow (10YR6/8); red (2.5YR4/8) at depth; commonest textures gravelly coarse sandy loam and gravelly coarse sandy clay loam; surface commonly littered with boulders; normal slope range 20° - 35°; most commonly found at altitudes above 250 feet.

GUNONG PADANG - Subsoil colour pale brown, also grey, dark brown; textures are peat over coarse sandy loam over sandy clay loam; terrain rolling to hilly; altitude 4,000 feet.

2. Subsoil colour predominantly yellow.

RENGAM - Subsoil colour brownish yellow (10YR6/8) to light red (2.5YR6/8) at depths greater than 30 inches; commonest texture sandy clay loam, also some coarse sandy clay loam; normal slope range 5°-15°. Includes Lanas and Lakota mapped on gneissose granite in Kelantan.

TAMPIN - Subsoil colour pale yellow (2.5Y8/4) to very pale brown (10YR8/3); commonest texture coarse sandy loam with clayey gravel at depth; terrain mainly undulating to flat; boulders may be present, particularly on steeper slopes. Includes the Titi Akar Series mapped in Kedah.

BUKIT LUNCHU - Subsoil colour reddish yellow (7.5YR6/8 - 5YR6/8); texture coarse sandy clay loam to gravelly sandy loam; level areas in hilly and mountainous terrain; surface boulders common.

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3. Subsoil colour predominantly red.

RENGAM, red variant - Description as for Rengam except that subsoil colour is red (2.5YR5/8) within 30 inches of the surface and commonly the soil is red right to the surface. Includes Lambak mapped in Johore.

KALA - Formed on porphyritic granite and the presence of large subsoil feldspar phenocrysts is characteristic. Subsoil colour reddish brown (5YR4/3) to yellowish red (5YR4/6), brownish yellow or strong brown; texture coarse sandy or gravelly clay loam.

B. On Quartz Porphyry

HARAD - Dark yellowish brown to dark brown sandy loam to clay loam on yellowish brown to strong brown sandy clay loam with a very compact, strongly mottled horizon appearing at 32-40 inches.

CHENAIN - Subsoil mottled pale yellow to yellowish brown firm silty clay to clay loam, with a characteristic waxy feel.

C. On Granodiorite and Quartz Diorite

1. Subsoil colour predominantly red.

BUKIT AJIL - Subsoil colour yellowish red (5YR5/8); commonest textures sandy clay loam to sandy clay; surface boulders common; normal slope range 20°-35°.

KAMPONG KOLAM - Subsoil colour yellowish red (5YR4/8) to reddish brown (5YR4/4); commonest texture clay to clay loam; terrain gently sloping to moderately steep.

JERANGAU, red variant - Description as for Jerangau except that colour throughout

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is red (2.5YR5/6 - 4/6).

2. Subsoil colour predominantly brown.

JERANGAU - Subsoil colour strong brown (7.5YR5/8) to yellowish red (5YR5/6); commonest textures fine sandy clay loam and sandy clay loam; most slopes between 2° and 22°.

MASAI - Texture silty clay loam to clay loam; subsoil colour brownish yellow (10YR6/8), strong brown (7.5YR5/6) to reddish yellow; strong structure, firm consistence; close packed laterite within 12 to 24 inches.

D. On Andesite and Diorite

SEGAMAT - Subsoil colour predominantly red (2.5YR4/6, 5YR5/8, 7.5YR6/8); commonest texture clay; friable, well structured; includes Kampong Awah and Pahi Series, and a laterite phase formerly mapped as Kampong Bakah; terrain gently sloping to moderately steep; on andesite.

SENAI - Subsoil colour strong brown (7.5YR5/8) to yellowish red (5YR4/8) silty clay loam to silty clay with laterite usually within two feet of the surface, but deeper profiles are common on gently undulating terrain. On diorite or dioritic gabbro.

KATONG - Yellowish brown (10YR5/6) silty clay loam or strong brown (7.5YR5/6) clay, friable and well structured. On andesite or quartz andesite.

E. On Basalt

1. With strongly developed subsoil structure.

KUANTAN - Predominant subsoil colour reddish brown (5YR4/4) ("chocolate"); commonest texture clay; free draining; topography gently to moderately undulating (slope range 2°-10°).

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2. With weakly developed subsoil structure.

PELAWAN - Commonest texture gravelly clay; drainage slow; compact horizon at depth; unusual "greenish grey"(2.5Y4/2) topsoil colour; slope range 2° - 5°.

F. On Norite

1. Without laterite.

BUKIT PANJANG - Predominant subsoil colour reddish brown to red; commonest texture clay to sandy clay loam; strongly developed structure, friable consistence, free draining; slope range 2°-12°. A stony phase with a shallow profile is recognised.

2. With laterite.

SUNGEI KADUT - Predominant subsoil brownish red; commonest texture clay to sandy clay loam; laterite, often thick, at between 18 and 36 inches.

C. On Schist and Hornfels

1. On schist.

(a) Without laterite.

BATANG MERBAU - Subsoil colour yellowish brown (10YR5/6) to brownish yellow (10YR6/8); texture fine sandy loam to fine sandy clay loam; normal slope range 5°-25°. Kemahang North Series is included here.

(b) With laterite.

SEREMBAN - Roughly flattened laterite fragments in lower horizons; dominant subsoil colour yellow; commonest textures sandy clay loam or sandy clay.

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2. On hornfels

PATANG - Subsoil colour yellowish red; texture clay to clay loam; well developed structure; deep uniform profile.

H. On Argillaceous Sediments (Shale, argillite, mudstone, phyllite)

1. With lateritic profiles on iron-rich sediments.

(a) With massive laterite.

MALACCA - Laterite normally deeper than 2 feet; subsoil colour yellowish brown (10YR5/6) to brownish yellow (10YR6/8); commonest texture above laterite is sandy clay loam.

TANDAK - Laterite occurs within one foot of the surface; subsoil colour reddish yellow (5YR6/8);subsoil texture consists of laterite in clay matrix.

CHUNGLOON - Subsoil strong brown (7.5YR5/6) clay loam to yellowish red (5YR5/6) clay loam withmassive laterite appearing about 2 feet below surface; pea-sized black concretions are characteristic.

(b) With laterite fragments.

GAJAH MATI - Laterite concretions form a distinct diagnostic horizon within 2 feet of the surface; subsoil colour is strong brown; commonest texture clay loam.

TAVY - Subsoil colour yellowish brown to yellowish red sandy clay to clay loam; moderately thick layer of laterite pebbles at 16-40 inches. On gentle slopes laterite deeper or absent.

PADANG BESAR - Subsoil yellowish brown (10YR5/8) silt loam with yellowish red

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(5YR5/8) laterite concretions at about 8 inches from the surface. On siltstone.

2. With yellowish, brownish and reddish profiles on "normal" argillaceous sediments.

(a) Subsoil colour predominantly yellow.

DURIAN - Subsoil colour brownish yellow (10YR6/6); very firm, compact, ("stiff") subsoil consistence; commonest texture silty clay to silty clay loam; distinct mottling at depth; laterite fragments may be present. Includes Kluang Series mapped in Johore.

KUALA BRANG - Subsoil colour yellowish brown (10YR5/8) to brownish yellow (10YR6/6); friable consistence, commonest texture fine sandy loam.

BUKIT RESAM - Subsoil yellowish brown (10YR5/8) to brownish yellow (10YR6/8) sandy clay loam to clay loam; firm consistence; on reddish yellow (5YR6/8) gravelly clay packed with angular laterite concretions at about 24-48 inches.

(b) Subsoil colour predominantly brown.

MUNCHONG - Subsoil colour strong brown (7.5YR5/6) to reddish yellow (7.5YR6/8); commonest texture silty clay loam; consistence friable to firm.

BATU LAPAN - Subsoil strong brown (7.5YR5/6) silt loam to clay loam; firm consistence.

(c) Subsoil colour predominantly red.

MUNCHONG, red variant - Description as for Munchong Series except that subsoil colour is

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predominantly yellowish red (5YR5/8).

JEMPOL - Subsoil colour yellowish red (5YR5/6), mottled light grey and dark red at depth; commonest texture is clay; friable consistence; moderate structure; includes Pamol. Parent material identification is not yet certain - may be volcanic tuff of andesitic composition.

3. With pale coloured profiles on iron-poor sediments.

(a) With pale yellow mottled subsoil.

BATU ANAM - Subsoil colour pale yellow (2.5Y7/4) to light grey (2.5Y7/2) and distinctly mottled; commonest texture silty clay, to heavy clay; subsoil very firm and compact.

(b) Subsoil colour predominantly light grey.

APEK - Subsoil colour light grey (10YR7/1 - 5/1); commonest texture fine sandy clay loam to clay, weak structure.

LOK YANG - Subsoil colour light grey (2.5Y7/2) to pale yellow (2.5Y7/4) brcoming white with depth; commonest texture loam; compact, structureless subsoil.

4. With greyish or brownish profiles on carbonaceous shale.

KEMUNING - Predominant colour greyish brown (2.5Y5/2); commonest texture silty clay loam to clay; firm consistence.

POHOI - Yellowish brown (10YR5/6) clay loam, moderate structure, friable; laterite may occur.

J. On Arenaceous Sediments (Quartzite, Quartzose Sandstones, Conglomerates)

1. Subsoil colour predominantly brown.

(a) Sandy textured.

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KEDAH - Subsoil colour strong brown (7.5YR5/6) becoming yellowish red (7.5YR6/6); texture sandy loam to gravelly loam; profile shallower than 3 feet; steep slopes.

SERDANG - Subsoil colour strong brown (7.5YR5/6) to yellowish red (5YR5/8); texture sandy loam; profile deeper than 3 feet; gently sloping to moderately steep slopes.

KUALA NERANG - Subsoil brown (7.5YR5/4) fine sandy loam on yellowish red (5YR5/8) fine sandy loam to clay loam.

(b) Clayey textured.

BUNGOR - Subsoil colour yellowish brown (10YR5/6); texture fine sandy clay; deep profile with friable consistence in upper part and moderately to strongly developed structures; slope range 5°-40°; developed on quartzite and shale.

NAMI - Subsoil yellowish brown (10YR5/4) loam on reddish yellow (7.5YR6/6) loam to clay loam.

(c) With laterite.

MONG GAJAH - Clay loam of coarser texture than Gajah Mati with pisolitic laterite at about 24 inches from the surface.

POKOK SENA - Subsoil yellowish brown (10YR5/6) loam with pisolitic laterite at about 12 inches from the surface.

2. Subsoil colour predominantly grey.

MARANG - Subsoil colour light yellowish brown to pale yellow (2.5Y6/4 - 7/4); texture loamy sand; shallow profile from 2-5 feet; hilly terrain.

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3. Subsoil colour predominantly red.

SERDANG, red variant - Descriptionas for Serdang except that subsoil colours are reddish yellow (5YR6/8) and yellowish red (5YR5/8) becoming red (2.5YR5/6 and 10R4/8) with depth.

K. On volcanic tuffs, rhyolite and dacite

KULAI - Subsoil colour yellow (2.5Y7/6) to olive yellow (2.5Y6/6); subsoil texture clay to silty clay; firm to very firm consistence below one foot. On rhyolite.

YONG PENG - Friable clay loam with predominantly yellowish red (5YR5/8) subsoil colours. On dacite.

L. On Limestone

LANGKAWI - Deep uniform profile with dark red (2.5YR3/6) clay loam subsoil; well developed structure; very friable consistence.

PERLIS - A soil of very limited extent set up by Owen. It occurs around the base of limestone cliffs and consists of a very friable dark reddish brown loam overlying a more compact clay loam.

KAKI BUKIT - Yellowish red loam over red (2.5YR4/6) clay loam subsoil; moderately developed structure; few small laterite concretions in deep subsoil.

KODIANG - Red (2.5YR4/6) clay loam subsoil; moderately developed structure; dense pisolitic laterite concretions at 20 inches.

WENG - Subsoil reddish yellow (7.5YR6/8) clay; strong structure; very friable; on calcareous shale.

II. ALLUVIAL SOILS

A. On Riverine Alluvium

1. Somewhat excessively drained.

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HALU - Developed on rewashed recent rhyolitic ash, on level land in valley bottoms; predominant colour is light grey (10YR7/1); consistence very loose to friable; texture silt or very fine sand.

TELAGA - Also known as Kampong Telaga; recent soil formed on lower terraces of larger east coast rivers; predominantly yellowish brown (10YR5/8) to strong brown (7.5YR5/8) silty fine sand overlying river gravels. Susceptible to flooding.

(a) Developed on river terraces.

CHEMOR - Yellow to reddish yellow sandy loam to clay loam.

(b) Developed on floodplains and recent terraces.

TELEMONG - Recent soil common on floodplains of the main east coast rivers; predominantly yellowish brown (10YR5/4) to strong brown (7.5YR5/8) fine sandy loam to loam with moderate structure and friable consistence.

3. Moderately well drained.

(a) Developed in wide river basins.

AKOB - Characterised by a highly mottled horizon at about 3 feet; colours are dark yellowish brown to yellowish brown becoming mottled red, brownish yellow, light yellowish brown and light grey; textures fine sandy loam topsoil, clay loam subsoil.

KAMPONG CHERANG HANGUS - Occurs in the "deficiency area" Kelantan and consists of dark grey sandy clay loam over grey clay loam becoming grey clay with a

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few red brown mottles at about 2'6"; buried soils may occur.

LATI - Occurs in the "deficiency area" Kelantan and consists of dark grey brown coarse sandy clay loam on brownish yellow sandy clay loam with mottled light grey sandy clay loam at about 2'6".

(b) Developed on river terraces.

PADANG GONG CHENAK - Occurs in the "deficiency area" Kelantan and consists of very dark grey sandy loam on mottled light grey sandy clay loam, mottled brownish yellow fine sandy clay and mottled whitish grey sandy clay. Mottles appear within one foot.

4. Imperfectly drained.

(a) Developed on river terraces.

BUKIT TUKU - Occurs in the "deficiency area", Kelantan, and consists of light brown fine sandy loam on very pale brown mottled fine sandy loam, with the mottles appearing at about 6", on whitish grey mottled sandy clay loam and clay.

KAMPONG LUBOK KIAT - Occurs in the "deficiency area", Kelantan, and is an old soil on an upper terrace consisting of dark grey brown (10YR3/2) fine sandy loam on light grey (10YR7/1) sandy loam, sandy clay and clay with mottling from 2 feet.

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Some lateritic material occurs.

JARAU - Occurs in association with fresh water swamps and consists of dark grey or black (5YR2/1) sandy loam to clay loam over greyish to white (10YR7/1) sandy clay loam strongly mottled from about 2'6".

(b) Developed in river basins.

KAMPONG PUSU - Occurs in the "deficiency area", Kelantan, and consists of black sandy clay loam on mottled dark grey sandy clay, mottled light grey sandy clay loam and mottled white clay.

MERBAU PATAH - Dark greyish brown or olive grey clay loam becoming mottled between 1 and 2 feet and underlaid by a light grey or white waterlogged subsoil.

(c) Developed on valley tracts.

KAMPONG KUBOR - Formed on colluvium derived mainly from granite; consists of dark brown sand on yellowish brown sand or clayey sand over light grey loose moist mottled sand or clayey sand; water-table high.

PERAK - Consists of grey, mottled yellow, silty clay loam over blue grey silty clay loam; iron concretions may occur.

(d) Developed on plain tracts.

BRIAH - Occurs along west coast rivers where they cross the marine alluvial plain; consists of dark brown well structured silty clay over mottled light brown silty

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clay becoming light brownish grey or grey and grading into a bluish grey sticky silty clay; water-table naturally high.

5. Very poorly drained.

TIAN BAHRU - Occurs in the river basins of the east coast and consists of olive grey mottled sticky loam (plough layer) with the colour changing to mottled greyish brown or light olive grey, mottled light grey to a white, structureless water-logged horizon at 2 - 3 feet.

B. On Marine Alluvium

1. Excessively drained.

RUDUA - Formed on raised beaches on the East Coast and consists of a very freely draining loose coarse sand; dark grey or brown structureless loose coarse sand on very dark grey coarse sand, greyish or brownish coarse sand, brownish yellow coarse sand and a reddish, yellowish brown or even black horizon at 4-5 feet.

JAMBU - Developed on raised beaches now situated a few miles inland on the West Coast. Consists of dark grey (10YR4/1) to grey sand over light grey (10YR7/1), white or pale yellow sand; consistence throughout is very loose and the soil is structureless. Water-table within 3 feet.

2. Poorly drained.

(a) Developed on coastal swamps.

KRANJI - Formed under mangrove vegetation and consists of dark brown silty or fine sandy clay underlain by dark grey or black muck which is waterlogged at high tide.

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RUSILA - Formed in lagoonal swamps between sand ridges and consists of dark grey to black clayey sand to sandy clay on light grey or white mottled subsoil. There is considerable variation in these soils.

(b) Developed on the coastal plain.

SELANGOR - Naturally poorly drained but readily improved by drainage; consists of dark brown (7.5YR4/2) silty clay loam on mottled brownish grey silty clay and bluish-grey clay. In the undeveloped soil the bluish-grey horizon closely approaches the surface but in the well-drained phase it is 3 feet below the surface.

KANGKONG - Deep black topsoil on light grey to light olive grey clay; iron mottles and gypsum crystals at depth; mapped in Kedah.

3. Very poorly drained.

TELOK - Acid sulphate soil mapped in Kedah; very dark topsoil over uniform light grey subsoil.

LINAU - Formed in brackish water and consists of very dark greyish brown organic clay with moderate structure on dark brown muck over bluish grey structureless clay. Strong sulphurous odour in the subsoil and yellow sulphate deposits commonly appear when drained and oxidised.

PENOR - Developed on old marine beach sands in fresh water swamps and consists of light grey loamy sand to sandy clay loam, structureless, firm consistence, Flooded to the surface most of the year.

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C. On Subrecent Alluvium

1. Somewhat excessively drained.

HOLYROOD - Commonest texture sandy loam; subsoil colour light yellowish brown (10YR6/4) to brownish yellow (10YR6/6); weak structure; friable to loose consistence.

HOLYROOD, grey variant - Description as for Holyrood except subsoil colour light grey (10YR7/1).

SITIAWAN - Occupies a relatively high marine terrace on the West Coast and consists of greyish brown (10YR5/2) or light yellowish brown (10YR6/4); well structured silt loam to silty clay on pale yellow (2.5Y7/4) clay or clay loam with very few light red (2.5YR6/8) mottles with moderate structure and firm consistence.

SUNGEI BULOH - Coarse textured soil consisting of dark brown (10YR4/3) to yellowish brown (10YR5/4) and yellow (10YR8/6) loose, structureless sand; characterised by accumulations of iron oxide in the B horizon.

2. Poorly drained.

MANIK - Poorly structured, pale coloured sandy clays and clay loams with a strongly mottled horizon close to the surface and a fluctuating seasonal water-table.

SOGOMANA - Grey silty clay over light grey to white silty clay to clay, few mottles, with weak structure and firm consistence.

D. On Older Alluvium

1. Coarse textured.

ULU TIRAM - Commonest texture sandy loam to coarse

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sandy loam; subsoil colour brownish yellow to yellowish brown; weak structure and friable consistence but becoming very compact in the subsoil.

2. Medium textured.

(a) Compact at depth.

TAMPOI - Commonest texture sandy loam to sandy clay loam; subsoil colour yellowish red (5YR5/8) weak structure, very firm consistence; very compact subsoil.

HARIMAU - Commonest texture sandy clay loam; subsoil colour brownish yellow (10YR6/8); moderate structure and friable consistence becoming weak structure and compact at depth.

(b) Not compact at depth.

SEGARI - Grey (10YR5/1) clayey sand to loamy sand on light grey (10YR6/1) and pale yellow (2.5Y7/4) sandy clay with few mottles.

RASAU - Commonest texture sandy clay loam; subsoil colour brownish yellow (10YR6/6); weak structure and firm to very firm consistence.

3. Fine textured.

TAI TAK - Commonest texture silty clay loam; subsoil colour brownish yellow (10YR6/8); strongly developed structure and firm consistence.

Legend for the Schematic-Reconnaissance Survey

All the series and variants which have been encountered so far during the course of the schematic-reconnaissance survey have been grouped into classification units up to family level

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in the following legend. This will be extended and modified as the survey progresses but can be regarded as the general framework within which information on the soils will be built up.

I. SEDENTARY SOILS

A. On acid and intermediate igneous rocks

	Map Symbols*
RENGAM FAMILY	
Rengam Series	RGM
Rengam Series, red variant	RGM/1
Jerangau Series	JRA
Jerangau Series, red variant	JRA/1
Bukit Temiang Series	BTG
Gunong Padong Series	GPG
Tampin Series	TPN
Bukit Lunchu Series	BLU
Kala Series	KLA
Masai Series	MSI
KULAI FAMILY	
Kulai Series	KLI
Yong Peng Series	YPG
HARAD FAMILY	
Harad Series	HRD
Chenain Series	CHN
KAMPONG KOLAM FAMILY	
Kampong Kolam Series	KKM
Bukit Ajil Series	BAL

B. On intermediate and basic igneous rocks.

SEGAMAT FAMILY	
Segamat Series	SGT
Senai Series	SNI
Katong Series	KTG

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* These are standardised three letter abbreviations, using prominent letters fro the series names, which have been established for use on maps and in field not Variants are indicated by numerals following a stroke placed after the series symbol.

Jempol Series (provisional placing) JML

KUANTAN FAMILY
Kuantan Series KUN
Pelawan Series PLN
Bukit Panjang Series BPG
Sungei Kadut Series SKT

C. On schist, hornfels, and calcareous rocks

BATANG MERBAU FAMILY
Batang Merbau Series BMU
Seremban Series SBN
Patang Series PTG

WENG FAMILY
Weng Series WNG

PERLIS FAMILY
Perlis Series PRL
Kaki Bukit Series KBT
Kodiang Series KDG
Langkawi Series LKI

D. On argillaceous sediments.

MALACCA FAMILY
Malacca Series MCA
Tandak Series TDK
Gajah Mati Series GMI
Changloon Series CGL
Padang Besar Series PBR

TAVY FAMILY
Tavy Series TVY
Bukit Resam Series BRM

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DURIAN FAMILY

Durian Series	DRN
Pohoi Series	PHI
Kemuning Series	KMG
Bungor Series	BGR

MUNCHONG FAMILY

Munchong Series	MUN
Munchong Series, red variant	MUN/1
Kuala Brang Series	KLG
Batu Lapan Series	BLN

BATU ANAM FAMILY

Batu Anam Series	BTM
Apek Series	APK
Lok Yang Series	LYG
Marang Series	MRG

E. On arenaceous sediments.

POKOK SENA FAMILY

Mong Gajah Series	MGH
Pokok Sena Series	PKA

SERDANG FAMILY

Serdang Series	SDG
Serdang Series, red variant	SDG/1
Kedah Series	KDH
Kuala Nerang Series	KNG
Nami Series	NMI

II. ALLUVIAL SOILS

A. On recent alluvium.

TELAGA FAMILY

Telaga Series	TLA

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Halu Series	HLU
TELEMONG FAMILY	
Telemong Series	TMG
Chemor Series	CMR
Akob Series	AKB
BUKIT TUKU FAMILY	
Bukit Tuku Series	BTU
Kampong Cherang Hangus Series	KCH
Lati Series	LTI
Padang Gong Chenak Series	PGC
Kampong Lubok Kiat Series	KLK
Kampong Pusu Series	KGP
BRIAH FAMILY	
Briah Series	BRH
Jerau Series	JRU
Merbau Patah Series	MPH
Perak Series	PRK
Tian Bahru Series	TBU
Kampong Kubor Series (provisional placing)	KKR
RUDUA FAMILY	
Rudua Series	RDU
Jambu Series	JBU
Penor Series	PNR
RUSILA FAMILY	
Rusila Series	RSL
SELANGOR FAMILY	
Selangor Series	SLR
Kranji Series	KNJ

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Linau Series	LNU
Kangkong Series	KGG
Kampong Telok Series	KTK

B. On Subrecent Alluvium.

HOLYROOD FAMILY	
Holyrood Series	HYD
Holyrood Series, grey variant	HYD/1
Sitiawan Series	SWN
Sungei Buloh Series	SBH
MANIK FAMILY	
Manik Series	MNK
Sogomana Series	SMA

C. On Older Alluvium.

RASAU FAMILY	
Rasau Series	RSU
Segari Series	SGI
HARIMAU FAMILY	
Harimau Series	HMU
Ulu Tiram Series	UTM
Tampoi Series	TPI
Tai Tak Series	TTK

III. MISCELLANEOUS LAND UNITS

STEEPLAND	STP
DISTURBED LAND	DLD
PEAT	PET
Shallow Peat	PET/1

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Medium peat	PET/2
Deep peat	PET/3
ORGANIC CLAYS AND MUCKS	OCM
LOCAL ALLUVIUM	LAA
COLLUVIUM	COL
INLAND SWAMP	ISA

Technical Soil Classification

Technical soil classification is in a fluid state in Malaya at present and must remain so until sufficient data is available from the schematic-reconnaissance survey to erect a comprehensive classification. However, attempts have been made in the past to allocate Malayan soils to great soil groups recognised elsewhere and these are reviewed below:

Owen (1951) correlated several of his main series with the following great soil groups:-

Reddish brown latosols,
Yellow latosols,
Yellow podzolic.
Ground water laterite,
Wiesenboden/Half Bog.,
Alluvial soils.

The 1962 Soil Map (Panton) developed on this initial classification and took advantage of the knowledge of the soil pattern as revealed by reconnaissance soil surveys concluded by that date. This Map, which was produced primarily to meet the needs of the Administration and particularly those concerned with the Rural Development Drive, is of course open to considerable criticism with regard to the nomenclature, but has undoubtedly

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fulfilled its main purpose, which was to supply a relatively simple picture of the broad soil distribution pattern over the whole country.

The classification used on this Map is summarised in the following Table:-

Soil Group	Brief Description	Example
Lithosols/Shallow latosols	Steep land soils with parent material on or close to the surface.	Bukit Temiang Series.
Red and yellow latosols. Red and yellow Podzolic soils.	Undulating land soils with deep profiles.	Rengam Series. Serdang Series.
Reddish brown latosols.	Undulating land soils with deep profiles developed from basic igneous parent materials.	Kuantan Series. Segamat Series. Kampong Kolam Series.
Laterite soils.	Undulating land soils with strongly developed laterite horizons developed from iron-rich argillaceous parent materials.	Malacca Series. Gajah Mati Series.
Low humic gleys	Alluvial soils of the main plains and the river valleys.	Selangor Series. Akob Series.
Podzols	Soils with iron or humic "B" horizons, developed from highly siliceous parent materials over relatively flat topography.	Rudua Series. Sungei Buloh Series. Gunong Padang Series.
Organic soils	Peats and mucks.	
Azonal soils	Recent marine sediments.	Kranji Series

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The following further explanations are relevant to this Table:-

(1) The Lithosol/Shallow Latosol group includes shallow Red Yellow Podzolic soils and Podsols, particularly at higher altitudes.

(2) The soil within the Red and Yellow Latosol/Red Yellow Podzolic soil group were not separately shown on the Map owing to the difficulty experienced in mapping firm boundary lines between these two groups on reconnaissance surveys. It is considered that under Malayan conditions, the absence or presence of a textural B horizon would be a useful diagnostic feature for separating soils into one or other of these groups, and furthermore it seems that the more heavily textured soils tend towards the Latosolic type; while the lighter textured soils are closer to the Podzolics. Latosolic features may become more dominant towards the south of Malaya, largely as a result of the change in the climate as the Equator is approached. Certain reservations were felt with regard to the widespread recognition of the Podzolic group in view of the strong prevalence of rather sandy surface soil horizons in Malayan hill soils which is attributed to strong surface wash and solifluxion under the normal conditions of erosion.

(3) The well structured and strongly coloured soils derived from intermediate and basic igneous rocks have been classed as Reddish Brown Latosols since Owen first considered this question. More recently, suggestions have been made that some of these soils may be Reddish Brown Lateritic Soils as in the case of the Kampong Kolam Series, and Grumusols as in the case of the Kuantan Series (Moormann et al. 1964).

(4) The use of a separate group of Lateritic soils at

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the great soil group level, while not new, is not a common grouping which is generally accepted in soil literature. Nevertheless, strong arguments in favour of such a grouping can be adduced from a study of Malayan soils.

The appearance of more precise definitions of the commonly used classification units (Dudal and Moormann, 1964; World Soil Resource Report 12, 1964) and the inauguration of soil correlation with other countries in the region (Moormann et al. 1964) have encouraged further modification to these earlier classifications at the great soil group level. The advent of the Seventh Approximation (Soil Survey Staff 1960) and Amendments (Dr. Guy D. Smith, personal communication) has enabled this attempt to be extended to higher classification categories.

At present the technical soil classification is evolving slowly along these two parallel avenues and although no finality can be expected at least until 1967, the following Table shows the tentative taxonomic trends:-

Series (examples only)	Great soil groups (after Panton, 1962)	Great soil groups (World Soil Resource Report, 1964)	7th Approximation and Amendments	
			Sub-order	Order
Selangor	Low, humic gley	Alluvial soils	Aquent	Entisol
Bukit Temiang	Lithosols/shallow Latosols.	Lithosols	Udent	Entisol
Rengam	Red and Yellow Latosols/Red and Yellow Podzolic	Red Yellow podzolic soils.	Udult	Ultisol
Kampong Kolam	Reddish Brown Latosols.	Reddish Brown Lateritic Soils (low base status)	Udult	Ultisol
Segamat	Reddish Brown Latosols.	Dark Red Ferralsols.	Udox	Oxisol*

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Series (example only)	Great soil groups (after Panton, 1962)	Great soil groups (World Soil Resource Report, 1964)	7th Approximation and Admendments.	
			Sub-order	Order
Malacca	Laterite soils	Ferruginous (Tropical) Soils.	Ustalf	Alfisol**
Rudua	Podzols	Podzols	Aquod	Spodosol
Harimau	Not distinguished.	Pale Yellow Ferralsols.	Udox	Oxisol*
Peat	Organic soils	Organic soils.	-	Histosol

* According to the latest information the distinction between Dark Red Ferrasols and Pale Yellow Ferrasols will be introduced in the U.S.D.A. 8th Approximation.

** When more information is available, these soils may be better placed as Plinthudults, a great soil group of the Ultisol order.

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APPENDIX 1

Common Equivalent Measurements and Map Scales

Length

1 inch = 2.54 cm.

1 mile = 1.6 kilometers = 80 chains = 1760 yards = 5280ft
= 63,360 inches.

1 centimeter = 0.394 inch.

1 meter = 39.37 inches.

1 kilometer = 0.6214 mile.

1 chain = 66 feet = 792 inches.

Area

1 acre = 0.4047 hectares = 10 sq. chains.

1 square mile = 2.5899 sq. kilometers = 640 acres = 4840 sq.yds
= 43,560 sq.ft.

1 hectare = 2.47 acres.

1 sq. kilometer = 0.3861 sq. mile.

A 1000 yard grid square on a 1 inch map covers the equivalent of 206.61116 acres on the ground.

Land Measure (Malay)

12 inchi (inches) = 1 kaki (1 foot)

6 kaki = 1 depa (6 feet)

2 depa = 1 jemba

4 (square) depa = 1 sq. jemba (144 sq. ft.)

100 square jemba = 1 penjuru (14,400 sq. ft.)

4 penjuru = 1 lelong (1.2 acre approx.)

Volume

1 cubic inch = 16.387 cubic centimeters.

1 cubic meter = 1.308 cubic yards.

1 litre = 0.8799 quarts.

1 gallon = 4.546 litres. = 1.2009 U.S. gallons = 1 gantang(Malay)

Weight

1 lb. = 0.45359 kilogramme

1 kilogramme = 2.2046 lbs.

1 gallon of water at 62°F. (16.7°C.) weighs 10 lbs.

1 cubic foot of water at 60°F. Weighs 62.37 lbs.

Malay Weights

1 tahil = 1 1/3 oz.

16 tahils = 1 kati = 1 1/3 lb.

1,600 tahils = 100 katis.

100 katis = 1 pikul = 133 1/3 lb.

40 pikuls = 1 koyan = 5,333 1/3 lb.

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A ready rule for converting avoirdupois into pikuls is to multiply by 3 and divide by 4, e.g.

168 lb. x 3 ÷ 4 = 1 pikul 26 katis.

To convert pikuls into avoirdupois multiply by 4 and divide by 3, e.g.

250 x 4 ÷ 3 = 333 1/3 lbs. avoirdupois = 2 cwt 3 quarters 25 1/3 lbs.

Angles of slope and per cent grades

Degree	Per cent
2	3.5
4	7
6	10.5
8	14.1
10	17.6
12	21
15	26.8
20	36.4
25	46.6
30	57.7
40	84.0

Equivalent Map Scales

British Units	Fractional Scale (R.F.)
32 miles to 1 inch	1 : 2,027,520
24 miles to 1 inch	1 : 1,520,640
16 miles to 1 inch	1 : 1,013,760
12 miles to 1 inch	1 : 760,320
8 miles to 1 inch	1 : 506,880
4 miles to 1 inch	1 : 253,440
2 miles to 1 inch	1 : 126,720
1 mile to 1 inch	1: 63,360
40 chains to 1 inch	1 : 31,680
20 chains to 1 inch	1 : 15,840
10 chains to 1 inch	1 : 7,920
8 chains to 1 inch	1 : 6,336
5 chains to 1 inch	1 : 3,960

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Fractional Scale (R.F.)	British Units
1 : 2,000,000	31.57 miles to 1 inch
1 : 1,000,000	15.78 miles to 1 inch
1 : 500,000	7.89 miles to 1 inch
1 : 250,000	3.95 miles to 1 inch
1 : 100,000	1.58 miles to 1 inch
1 : 25,000	0.395 miles to 1 inch or 31.56 chains to 1 inch

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Appendix 2: Soil Description Sheet and Abbreviations

SOIL DESCRIPTION SHEET

FIELD NO.	RAINFALL	LOCATION	VEGETATION .
LAB. NO.	GRID REF.		
LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE
EROSION	PARENT MATERIAL		

HORIZONS		SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSIST-ENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	R
SYMBOL	THICK-NESS											

SPECIAL FEATURES/NOTES:

This form is used to record soil profile data in the field. The abbreviations shown overleaf may be used to economise on space.

SERIES ESTABLISHED/ TENTATIVE

PHASE | GREAT SOIL GROUP

SURVEYOR: | DATE:

UGGESTED ABBREVIATIONS

1. Texture:

gravel.....g	Very fine sandy loam .....vfsl	stony clay loam....stcl
very coarse sand ....vcos	gravelly sandy loam.....gsl	silty clay .....sic
coarse sand.....cos	loam.....l	clay.....c
sand.....s	gravelly loam.....gl	fine sandy clay....fsc
fine sand.....fs	stony loam.....stl	coarse sandy clay..cosc
very fine sand .....vfs	silt.....si	sandy clay.....sc
loamy coarse sand ...lcos	silt loam.....sil	heavy clay.....hvc
loamy sand .....ls	clay loam.....cl	muck.....m
loamy fine sand.....lfs	silty clay loam.....sicl	peat .....p
sandy loam.....sl	sandy clay loam.....scl	mucky peat .....myp
fine sandy loam.....fsl	fine sandy clay loam.....fscl	peaty muck .....pym
	coarse sandy clay loam coscl	

2. Consistence:

Wet soil -	Moist Soil -	Cementation -
non-sticky.....wso	loose .....ml	weakly cemented....cw
slightly sticky...wss	very friable.....mvfr	strongly cemented..cs
sticky.....ws	friable.....mfr	indurated.....ci
very sticky.....wvs	firm.....mfi	
non-plastic.....wpo	very firm.....mvfi	
slightly plastic..wps	extremely firm.....mefi	
plastic.....wp		
very plastic.....wvp		

3. Structure:

size -	Grade -	Shape -	
very fine.....vf	structureless....0	platy.....pl	subangular blocky.....sbk
fine.....f	weak.....1	prismatic...pr	granular.....gr
medium.....m	moderate.....2	columnar....cpr	crumb.....cr
coarse.....c	strong.....3	blocky.....bk	single grain.....sg
very coarse....vc		angular blocky....abk	massive.....m

Example: moderately to strongly developed medium and fine subangular blocky = mf2-3sbk

4. Pores:

Few	(1 - 3/sq.inch).....	1P
Many	(4- 14/sq.inch).....	2P
Abundant	(more than 14/sq.inch)....	3P

5. Clayskins:

Patchy clayskins on few peds and in some pores 1C
Discontinuous clayskins on some peds and in many pores.....2C
Almost continuous clayskins on most peds and in most pores.....3C

6. Mottles:

Abundance -	Size -	Contrast -
few.....f	fine.....1	faint.....f
many.....m	medium.....2	distinct.....d
abundant.....a	coarse.....3	prominent.....p
profuse.....p		

Example: few medium prominent strong brown mottles = f2p7.5YR5/6.

Horizon boundaries:

Sharp.....sh
Distinct.....ds
Indistinct.....id
Diffuse.....df

APPENDIX 3

The Collection and Preparation of Soil Monoliths

A Soil Monolith is a vertical section of the upper part of a soil profile, which is preserved in a suitable protective case for display, instruction, and correlation purposes. The standard monoliths in the Soil Science Division collection are 48 inches in length, 7 inches wide and 2 inches deep.

In taking a monolith a pit is first dug to a depth of about 5 feet and one vertical face is then carefully smoothed to a depth of at least 4 feet and a width of at least 1 foot, and into this is pressed a steel frame, measuring 48" x 9" x 3" until the outside edge of the frame lies flush with the smoothed profile surface. A steel backing plate is then fixed onto the edge of the frame to give extra rigidity to the frame and the enclosed soil column, after which the frame and contents are carefully separated from the surrounding soil and transported, with the minimum of vibration, to the laboratory. Detailed notes on the profile characters as seen in the pit should be made at the time the monolith is extracted, with particular care being made in noting the natural soil colour and structure, which in the case of the monolith may show a gradual change after several years of even the most careful preservation. A series of soil samples should also be taken for chemical analysis together with an extra large sample of the top 12 inches, which will be placed in a suitable container beside the monolith for determination of soil textural class by feel. If possible a sample of the parent rock or parent material should also be taken.

After leaving the soil to dry out for a few hours, or perhaps a few days in the case of a very moist heavy textured alluvial soil, the exposed surface of the monolith is very carefully smoothed and a wooden mounting board, covered with a thick layer of cellulose acetate in acetone cement, is placed over the exposed surface, and the board, frame and contents inverted. When the cement has set the steel frame is carefully lifted off the monolith and the edges of the column trimmed down until the column is a uniform width of about 7 inches. Wooden side and base pieces 2 inches deep are then fixed firmly into position around the edge of the column, and the exposed surface of the monolith is structured down to show up as well as possible the natural structural elements of the profile.

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The monolith is next carefully sprayed with a 2.5% phenol solution in water until the moisuture content approximates to average field conditions, the phenol being added to the water simply to sterilize the soil in order to prevent the growth of fungus and multiplication of soil fauna which might otherwise take place. A glass plate, the underside of which has been treated with a 1 : 2 glycerine/water mixture to reduce condensation, is then securely fixed over the prepared monolith face, and the entire monolith frame enclosed in a complete polythene envelope which is sealed to the glass with a suitable glue such as white Bostick.

Monoliths prepared in this way have been preserved intact and without undergoing any noticeable alteration for many years.

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APPENDIX 4

The Construction of Relief Models

Introduction

A relief model is a graphic way of showing the physiographic features of a region in three dimensions. It is particularly effective in translating factual resource data into terms readily comprehended by people who have not been trained in map interpretation. Such a model also assists technical personnel in their analysis of a region and, if the model is constructed with care and precision, it can emphasise facets of the geological structure which had not been obvious before.

Materials

The materials required are very simple - a topographic base map which is the source of information; plywood or cardboard to form the core of the model; plasticine to round off the angular plywood edges; plaster of paris to make a mould of the model so that it can be reproduced in durable material; and paint (poster type is most effective) to illustrate the required pattern(soils,land use,forestry,geology etc.) on the model.

Scale

The scale selected depends on the purpose of the model and on the size of the region involved. Vertical exaggeration of the scale is almost always necessary. On a model based on a 1 inch to 1 mile (1:63360) map, if the horizontal and vertical scales are the same, a 5000 ft. mountain will be a little less than 1 inch high on the model. If the model is observed by a person standing at a table, with his eyes about 30 inches above the model, the effect is the same as if the terrain is viewed from an aircraft flying at nearly 160,000 ft. ! Obviously at this height the topography will not show up very well. In practice, 30,000 ft. is a satisfactory altitude from which to observe mountainous terrain and a similar effect, from 30 inches above the model, will be obtained if the vertical scale is exaggerated 5 times i.e. 5000 ft. mountains are shown as nearly 5 inches high instead of nearly 1 inch high. A 1:5 horizontal to vertical ratio model has been found satisfactory in depicting the Malayan landscape when the horizontal scale is 1 inch to 1 mile.

It should be remembered that a model exaggerated in this way will be distorted in comparison with the view from an aircraft at 30,000 ft. and in particular slopes on the model will appear steeper than they actually are. However, the distortion is most obvious at an angle close to the horizontal, and least obvious from a near vertical, or normal, viewpoint.

On smaller scale maps an even greater exaggeration is necessary if the proper effect is to be obtained, and a 1:9.6 ratio of horizontal to vertical has been found satisfactory for 1:500,000 horizontal scale models. On such a model, Gunong Tahan, a 7000 ft. peak and the highest mountain in Malaya, is shown to be about $1\frac{3}{4}$ inches high, similar to the impression which would be gained from an aircraft flying at approximately 125,000 ft. Without this exaggeration, i.e. with horizontal and vertical scales the same and Gunong Tahan shown about 1/6th of an inch high the effect would be similar to that obtained from an artificial satellite at a height of about 230 miles above the earth - obviously unsatisfactory for demonstration purposes.

Procedure

The construction procedure is as follows :

1) Having decided on the vertical scale to be used, plywood or cardboard of a uniform thickness is chosen. The material chosen should have a thickness that represents the difference in height between two consecutive contour lines, or a convenient multiple of this.

For example, if the contour lines on the map are at 50 ft. intervals, the material should have a thickness that represents 50 ft. on the model to be constructed, or, say, 250 or 500 ft. i.e. in the case of a 1 inch to 1 mile model with a vertical exaggeration ratio of 1:5, the material should be 1/20, or $\frac{1}{2}$ or $\frac{1}{4}$ an inch thick, as the case may be.

2) The outlines of two consecutive contour lines (e.g. 50 ft. and 100 ft.) are traced onto a piece of the chosen material.
3) The plywood or cardboard is then cut along the outer contour line which, in this case, is the 50 ft. contour.
4) The outlines of the 100 ft. and 150 ft. contour lines are next traced onto another piece of material of the same thickness.
5) This second piece of plywood or cardboard is also cut along the outer tracing i.e. the 100 ft. contour.
6) After cutting, this second piece is fitted on its own outline previously drawn on the top of the first piece (see Fig. 3a).
7) When the pieces have been glued together they will ascend in very sharp steps of, say, 50 ft. intervals. These sharp steps can be evened out with plasticine filling, and if done with care this produces a realistic replica of the topography. The final product in cross section should appear as in Fig. 3b.
8) The whole model is then enclosed in a frame so that the highest point on the model is well below the top of the frame and a plaster of paris mould is made. Before pouring the plaster of paris, the model is covered with a light grease such as vaseline to prevent the plasticine from sticking to the inside of the mould. A one to three parts by weight mixture of water and plaster of paris will harden in 5 to 15 minutes. Foam rubber or plaster of paris replicas can then be run off from the mould and painted to show the desired information.

FIGURE 3 a.

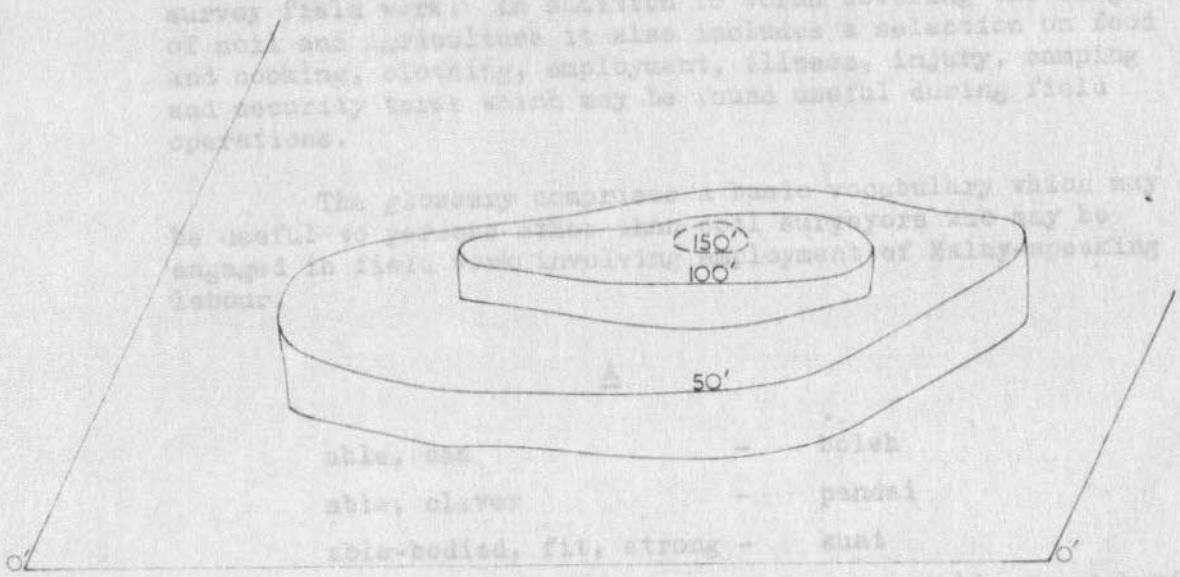
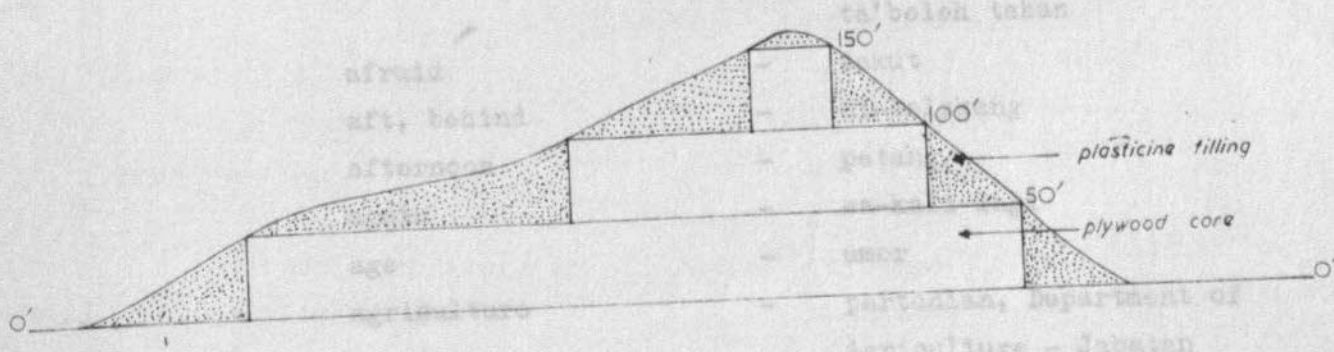


Diagram not to scale

FIGURE 3 b



APPENDIX 5

A glossary of useful Malay Words and Phrases

The following glossary includes most of the Malay words which are likely to be required in the course of soil survey field work. In addition to words covering the subjects of soil and agriculture it also includes a selection on food and cooking, clothing, employment, illness, injury, camping and security terms which may be found useful during field operations.

The glossary comprises a basic vocabulary which may be useful to persons other than soil surveyors who may be engaged in field work involving employment of Malay-speaking labour.

A

able, can	-	boleh
able, clever	-	pandai
able-bodied, fit, strong	-	kuat
aborigines	-	Orang Asli, orang bukit, orang ulu.
about, approximately	-	lebeh kurang
above	-	atas
account, bill	-	kira - kira
ache	-	sakit, headache - sakit kepala, stomach ache - sakit perut.
acid	-	asam
adequate	-	chukup
adjacent	-	dekat
aeroplane	-	kapal terbang
afford, endure	-	tahan, cannot afford - ta'boleh tahan
afraid	-	takut
aft, behind	-	di-belakang
afternoon	-	petang
again	-	sa-kali lagi
age	-	umor
agriculture	-	pertanian, Department of Agriculture - Jabatan Pertanian.

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ahead - depan, di-hadapan
aid - tolong
air - udara
air-field - padang kapal terbang
alive - hidup
all - semua
alone - sa-orang diri
also - juga
ambulance - kereta orang sakit
ambush - mengendap
ameliorate - mem-baiki
analysis - pereksa
and - dan
animal - binatang
ankle - mata kaki
annual - tiap-tiap tahun
answer - jawab
ant - semut, kerengga
ant hill - pusu
anxious - susah hati
areca nut - pinang
arm - lengan
army - tentera
aroid(a root vegetable) - keladi
around - sa-keliling
arrive - sampai
arrogant - sombong
ascend - naik
ascend a river - mudik
ask - bertanya
assistant - penolong, kaki tangan
at - di-
auger - borer, pengerek
authority - kebenaran.(noun) - lembaga
axe - kapak

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B

back	-	belakang, back bone - tulang belakang.
backwards	-	ka-belakang.
bacon	-	daging babi
bad	-	busok, kurang baik.
bag	-	beg
baggage	-	barang
bake	-	membakar
bamboo	-	buloh
banana	-	pisang
bandage	-	kain balut.
bank	-	tepi sungei, tebing, bank in padi field - batas.
bark	-	kulit kayu
barrel	-	tong
basket	-	bakul, shallow basket for carrying soil - pongkis, shoulder basket - ambong.
bat	-	kelawar, fruit bat - keluang.
bath	-	tong mandi
bathroom	-	tempat mandi
bathe	-	mandi
bay	-	telok
beach	-	pantai
bean	-	kachang
bear	-	beruang
beard	-	janggut
bed	-	tempat tidor fixed wooden sleeping platform - pangking.
bedrock	-	batu hampar

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bee - lebah
bee's nest - sarang lebah
beef - daging lembu
beetle - kumbang
before - dahulu, in front of - di-hadapan.
below - di-bawah
belt - tali pinggang
bench - bangku
bend(river or road) - sekeloh
bent - bengkok
best - baik sa-kali
better - lagi baik, lebeh baik
beware - jaga
big - besar
bird - burong.
bitter - pahit
black - hitam
blanket - selimut
bleed - keluar darah
blind - buta
blister - kelembong
blood - darah
blunt - tumpul
boat - perahu, harbour boat - sampan.
boil - rebus
bone - tulang
book - buku
boot - kasut
bore - menggerek
borrow - pinjam
bottle - bòtol
boundary - sempadan, boundary stone - batu sempadan.

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box - peti
bread - roti
bridge - jambatan, small bridge - titi.
bring - mem-bawa
broad - lebar
broken - pechah
brush - penyapu, to brush - meng-gosok
bucket - baldi
buffalo - kerbau
build - biken, mem-buat
burn - mem-bakar
but - tetapi
butter - mentega
butterfly - kupu-kupu
buy - mem-beli

C

cake - kueh
calculate - kira
camera - peti gambar
can, able to - boleh
canal - tali ayer
car - kereta
carefully - baik-baik
carry - mem-bawa
cashew - jambu, buah gajus
casuarina - pokok ru
cat - kuching
catch - tangkap
cave - gua
cement - semen
cent - sen
certain - tentu
chair - kerusi
chalk - kapor

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charcoal - kayu arang
cheap - murah
cheat - tipu
cheese - keju
chemist - ilmu kimia
chestnut - berangan
cigarette - rokok
hand made local cigarette - rokok daun
civet cat - musang
clay - tanah liat
clean - chuchi
clear(light undergrowth) - tebas
thick forest - tebang
clod - gumpal
close - tutup
cloth - kain
coast - tepi laut
coat - baju
coconut - nyior, coconut tree - pokok kelapa
cold - sejok
colour - warna
come - datang, mari
comfortable, easy - senang
compass - compas
complete - siapkan
concretion - beku
confluence (of rivers) - kuala
continually - selalu
cook - masak (verb); kuki (noun)
coral - karang
correct - betul
cough - batok
country - negara

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course - hala
cover - tutup
cow - lembu
crab - ketam
crocodile - buaya
cross (a river) - seberang, menyeberang
croton - pokok puding
cultivate - menchangkulkan
cup - chawan
curfew - perentah berkurong
current (in stream) - harus
curry - kari
cut - potong, memotong
cutoff, oxbow - ayer mati

D

daily - tiap-tiap hari
dam - empangan
danger - awas
dark - gelap
date - hari bulan
dawn - pagi-pagi
dead - mati
decayed - busok, burok
decimal - perpulohan
deep - dalam
deer - rusa, small deer - pelandok, barking deer - kijang.
defecate - buang ayer besar, pergi ka-sungei
deficient - kurang
depart - pergi, keluar
department - jabatan
descend - turun, descend a river - hilir
desk - meja tulis
destination - tempat
dew - embun

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diarrhoea	-	bera - bera
diary, logbook	-	buku hari
dibble (plant seed)	-	tugal, menugal
difficult	-	susah
dig	-	menggali, mechangkul
dinner	-	makan malam
direct, straight	-	terus
director	-	pengarah
dirty	-	kotor
dish	-	pinggan
disinfect	-	chuchi dengan ayer ubat
dispensary	-	tempat ubat
district	-	daerah
ditch	-	parit
divide	-	membahagi, divide into two - bagi dua division - bahagian, soil science division - bahagian sains tanah
doctor	-	doktor
dog	-	anjing
dollar	-	ringgit
door	-	pintu
down	-	di-bawah
drag	-	tarek, menarek
drain	-	longkang, parit
draw	-	tulis, menulis
	-	sketch a map - petakan
drawing	-	peta
dress	-	pakaian (noun), berpakai (verb).
drink	-	minum (verb), minuman (noun)
drive	-	menjalankan
driver	-	driber, sais
drop (verb)	-	titek, jatoh

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drunk - mabok

dry - kering, dry season - musim kering

duck - itek

dust - debu

E

each, every - tiap-tiap

eagle - lang

ear - teling

early - siang-siang

earth - tanah(soil), bumi (world)

east - timor

easy, relaxed - senang

eat - makan, memakan

edge - tepi

egg - telor

eight - lapan

either, or - atau

elbow - siku

elder - tua

elephant - gajah

embark (ship, boat, raft)- naik kapal, naik perahu, naik rakit

employ - pakai

employee - orang gaji

empty - kosong

end - sudahkan

ended - habis,sudah

enemy - musoh

enough - chukup

enter - masok

entire - semua

envelope - sarong surat

equal - sama

erect, upright (of marker post) - betul

... erode - memakan

estate - ladang

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estuary - kuala
Eurasian - orang serani
European - orang puteh
evening - petang
every, all - semua
examine - pereksa
excellent - baik-baik
expert - pakar
extinguish (of light) - padam
eye - mata
face - muka
fall - jatoh
far - jauh
fare, rent - sewa
fasting month - bulan puasa
fast, quick - chepat
fasten - mengikat
fat - gemok, rich soil - tanah gemok
feather - bulu
fell (jungle) - tebang
fence - pagar
fern - resam
fertile (of soil) subor, gemok, baik
fertilizer - baja, garam
festival - hari raya
fever - demam, sakit demam
few - sikit, sa-dikit
field - padang, ladang, rice field - sawah, bendang
fill - penoh
find - jumpa
finger - jari
fire - api, set fire to - pasang api
first, before - dahulu
fish - ikan

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five - lima
flat - rata
flesh - daging
flood - bah
floor - lantai
flour - tepong
flower - bunga
fly (insect) - lalat
horsefly - pikat, sandfly - agas
fly - terbang
fog - kabut
fold - lipat
follow - ikut
food - makanan
foot - kaki
forearm - tangan
foreman - mandor, kepala
forest - hutan
secondary forest - belukar tua
recent scrub forest - belukar muda
forget - lupa
fork - serampang, garfu
fort - kota
four - empat
frangipanni - bunga chempaka
Friday - hari lima, hari juma'at
friend - kawan
from - dari daripada
fruit - buah
fry - goreng, fried rice - nasi goreng
frying pan - kuali
full - penoh

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G

garden - kebun
public garden - taman

gently, slowly - perlahan-perlahan
geography - ilmu bumi
geology - ilmu kajibumi,
geological survey - jabatan kajibumi

get - mendapat
ghost - hantu
gibbon - wahwah
ginger - halia
give - bagi, kasi, memberi
go - pergi, jalan
goat - kambing
gold - emas
good - baik
graft - tut
granite - batu ubin
grass - rumput
gravel - ibu pasir
gravy - kuah
graze - makan rumput
great - besar
green - hijau
groundnut - kachang tanah
grow - bertumboh
guard - jaga
guava - buah jambu
gun - senapang

H

hair - rambut
half - sa-tengah
hall - balai, police station - balai polis

.../141

halt	-	berhenti
halve	-	potong sa-tengah
hammer	-	pemukul besi
hand	-	tangan
happen	-	jadi
happy	-	suka hati
hard	-	keras
hat	-	topi, terendak, songkok
he, she	-	dia, possessive - nya
head	-	kepala
head-ache	-	sakit kepala
headman	-	penghulu
healthy	-	sihat
hear	-	mendengar
heart	-	jantong
heat	-	panas
heavy	-	berat
hedge	-	pagar
helicopter	-	kapal terbang kipas atas
help	-	tolong
hen	-	ayam
here	-	di-sini
hibiscus	-	bunga raya
high	-	tinggi
high yielding (plant or soil)	-	subor, baik
hill	-	bukit, changkat. limestone hill - guar
him, her	-	dia
hire	-	sewa
his, her	-	-nya
hit	-	pukul
hoe	-	changkul
hold out, endure	-	tahan
hole	-	lubang, mine - lombong cave - gua

.../142

holiday - hari raya
hope - harap
horizontal - rata
hornet - tebuan
horse - kuda
hospital - rumah sakit
hot - panas, hot of food - pedas
hour - jam
house - rumah
how - macham mana, mana boleh
how far - berapa jauh

hundred - ratus
hunger - lapar
hurry - chepat

I

I - sahaja, saya
ice - ayer batu
identical - sama
if - jika, kalau
ignite - pasang api
impermeable - kedap
important - besar, mustahak
improve - membaiki
in - di-dalam
inch - inchi
incur - kena
ink - darat
inspect - pereksa, memereksa
interior (of country) - ulu
iron - besi
is - ada, ia-lah
island - pulau
jacket - baju
jackfruit - chempadak

.../143

job	-	perkerjaan
juice	-	ayer
junction (of roads)	-	simpang, junction (of rivers) - kuala
jungle	-	hutan
junior	-	muda

K

keep	-	simpan
kerosene	-	minyak gas
key	-	anak kunchi
kidney	-	buah pinggang
kitchen	-	dapor
knapsack	-	ambong
knife	-	pisau
know	-	tahu

L

ladder	-	tangga
lake	-	tasek
lame	-	tempang
lamp	-	lampu
land	-	tanah
language	-	bahasa
large	-	besar
late	-	lewat
later	-	kemudian
laterite	-	batu merah
latex	-	getah
latrine	-	jamban
lazy	-	malas
leaf	-	daun
leak	-	bochor
learn	-	belajar
leech	-	pachat, buffalo leech - lintah
left	-	kiri

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leg	-	batang kaki
let	-	memberi, kasi, bagi
letter	-	surat
level	-	rata
lid	-	penutup
lie	-	bohong
lie (down)	-	baring
lift	-	angkat
light (not heavy)	-	ringan
light (not dark)	-	terang
lightning	-	kilat
like	-	suka
lime (fruit)	-	limau nipis
limestone	-	batu kapor, limestone hill - guar
little	-	kechil
live	-	hidup
liver	-	hati
lizard	-	chichak
long	-	panjang
loris	-	kongkang
low	-	rendah
lubricate	-	minyakkan
luggage	-	barang
lunch	-	makan tengah hari

M

machine	-	enjin
made	-	buatan
magnetite	-	batu besi semberani, amang
maize	-	jagong
make	-	bikin, buat
malaria	-	sakit demam
Malaya	-	Persekutuan Tanah Melayu
male	-	laki-laki
man	-	orang

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...

manganese	-	batu kawi
mango	-	mangga
mangosteen	-	manggis
mangrove	-	bakau
manure	-	baja, tahi. verb - bajakan
many	-	banyak
map	-	peta, verb - petakan
marble	-	batu marmar
market	-	pasar
match	-	goris api
mattress	-	tilam
mature, ripe	-	masak
meat	-	daging
medicine	-	ubat
meet	-	berjumpa
melon	-	buah mendikai
mica	-	batu chermin
midnight	-	tengah malam
mile	-	batu
milk	-	susu, cream - kepala susu coconut milk - ayer nyior
million	-	juta
mince	-	chinchang
mine	-	lombong, galian
minister	-	menteri, Prime Minister - perdana menteri,
ministry	-	kementerian, ministry of Agriculture & Co-operative - kementerian pertanian dan sharikat kerjasama, ministry of lands and mines - kementerian tanah dan galian
minute	-	minit

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mirror	-	chermin
missing	-	sudah hilang
mist	-	kabut, embun asap
mistake	-	salah
mix	-	champor
monitor lizard	-	biawak
monkey	-	monyet
monsoon	-	musim hujan
month	-	bulan
moon	-	bulan
more	-	lagi
morning	-	pagi
mosque	-	masjid
mosquito	-	nyamok
most	-	kebanyakan
motor-car	-	kereta
mottled	-	borek
mountain	-	gunong
mouse	-	tikus
mouth	-	mulut
much	-	banyak
mud	-	lumpur
mushroom	-	chendawan
must	-	mesti
mustard	-	sawi-sawi
mutton	-	daging kambing
myself	-	sendiri

N

nail	-	paku
name	-	nama
narrow	-	sempit
near	-	dekat
needle	-	jarum
nest	-	sarong
		bees' nest - sarang lebeh
never	-	tidak

.../147

new	-	baharu
night	-	malam
night soil	-	tahi malam
no	-	tidak
north	-	utara
nose	-	hidong
not	-	tidak
now	-	sekarang

O

oak	-	berangan
oar	-	dayong
obstacle	-	sangkutan
obtain	-	mendapat
occur	-	ada
office	-	pekerjaan, pejabat
officer	-	pegawai
often	-	banyak kali
oil	-	minyak hitam
oil palm	-	kelapa Bali
old	-	tua
on	-	di- (place), pada (time)
once	-	sa-kali
one	-	satu
onion	-	bawang
only	-	sahaja
open	-	buka
or	-	atau
orange	-	limau manis
orchard	-	dusun
orchid	-	anggerek
ore (tin)	-	bijeh
other	-	lain
otter	-	anjing ayer
out, outside	-	luar
outboard motor	-	motor sangkut

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oven	- dapor
owl	- burong hantu

P

pack	- bungkusan, backpack - ambong
pail	- baldi
pain	- sakit
paint	- chat
pan (for heavy minerals)	- medulang (verb)
pan (frying)	- kuali
panther	- harimau kumbang
paper	- kertas, newspaper - kertas khabar
parachute	- payong terjun
paraffin	- minyak gas
parcel	- bungkusan
park	- taman, national park - taman negara
pass	- lalu
pass (in hills)	- genting
path	- jalan, path cut in forest - rentis
pay	- membayar
pea	- kachang hijau
pen	- kalam
pepper	- lada
perhaps	- barangkali
persimmon	- pisang kaki
person	- orang
perspiration	- ayer peloh
photograph	- gambar
picket, stake	- piket
picture	- gambar
piece (cut off)	- sa-potong

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pig	-	babi
pigeon	-	burong punai
pillow	-	bantal
pineapple	-	nanas
pipe	-	paip
pit	-	lobang
pitch (a tent)	-	bikin (khemah), bentang (khemah)
place	-	tempat
plan,map	-	peta
plant	-	tanam (verb), tanaman (noun)
plantation	-	ladang
planter	-	tuan tanam getah, tuan ladang
plate	-	pinggan
platinum	-	mas puteh
pleasant	-	sedap
please	-	beri suka
plough	-	tenggala
poison	-	rachun
pole	-	batang kayu
policeman	-	mata mata
pomelo	-	limau besar
pomfret	-	ikan bawal
poor	-	miskin
pork	-	daging babi
pot	-	periok
potato	-	ubi kentang
pour	-	tuang
prepare	-	siapkan
present time	-	masa ini
price	-	harga
prime minister	-	perdana menteri
profit	-	untong
proper	-	betul, benar

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pull	-	tarek
punt	-	bergalah
push	-	tolak
python	-	ular sawah

Q

quarry	-	galian batu, tempat pechah batu
quarter	-	suku
quartz	-	batu telerang
quickly	-	segera

R

radish	-	lobak
raft	-	rakit
railway	-	jalan kereta api
rain	-	hujan
rat	-	tikus
read	-	membacha
ready	-	siap
rear, behind	-	belakang
recent	-	baharu
red	-	merah
refrigerator	-	peti ayer batu, peti sejok
repair	-	membaiki
replete (after meal)	-	kenyang
reply	-	jawab
report	-	beri tahu
request	-	pinta, meminta
research	-	siasat
reservoir	-	kolam ayer
restaurant	-	kedai makan
rest house	-	rumah persinggahan, rumah rehat
return	-	balek
rhinoceros	-	badak
rhododendron (melastomaceous plants)	-	sendudok

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rice	-	padi, glutinous rice - pulut, husked rice - beras, cooked rice - nasi, rice field - sawah, bendang, paya
rich	-	kaya, rich of soil - subor, gemok
ridge pole (of tent)	-	tulang khemah
right	-	kanan
ringworm	-	kurap
ripe	-	masak
river	-	sungai
road	-	jalan
rock	-	batu
roof	-	bumbong
room	-	bilek
root	-	akar
rope	-	tali
rough	-	kasap
round	-	bulat
R.M.A.F.	-	Tentera Udara Di-Rajah tanah Melaysia.
rub	-	gosok
run	-	lari

S

sack	-	guni
sad	-	susah hati
salary	-	gaji
salt	-	garam
salty	-	masin
same	-	sama
sample	-	chontoh
sand	-	pasir, coarse sand - ibu pasir
sand fly	-	agas

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sandstone - batu pasir
sardine - ikan tamban
satisfied - puas hati
saucer - piring
say - kata
school - sekolah
science - sains, soil science - sains tanah
scissors - gunting
scorpion - kala
scrub - belukar muda
scythe (for clearing rice fields) - tajak
sea - laut
seaweed - agar-agar
seal,stamp - chop
search - menchari
season - musim
wet season - musim hujan
dry season - musim panas
seat - tempat dudok
chair - kerusi
second - kedua
see - melihat
seed - beneh
seek - menchari
select - pileh
self - sendiri
sell - menjual
shall - hendak, nak
share (verb) - membahagi
sharp - tajam
shave - menchukor
sheep - kambing
ship - kapal
boat - perahu

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shoe - kasut
shoot (with gun) - tembak
shop - kedai
shore - pantai
short - pendek
shoulder - bahu
shout - berteriak
sick - sakit
side - sa-belah
silver - perak
sit - dudok
sketch - gambar, peta, (verb) - petakan
skin - kulit
sleep - tidor
slice - sa-potong, verb - potong
slippery - lichin
slow - lambat
slowly - perlahan
sluice box (in mining) - palong
small - kechil
smoke - asap
snail - siput
snake - ular, ular sawah - python ular tedong - cobra
snare - jerat
so - macham ini, bagini
soap - sabun
socks - sarong kaki
soft - lembek
soil - tanah. undisturbed soil - tanah dara. rich, cultivated soil - tanah hidup, gemok, subor. poor, abandoned soil - tanah mati.

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soil survey - penyiasatan tanah
soldier - askar
soup - sup
sour - asam, masam
south - selatan
sow (seeds) - tabor, menaborkan
soya bean - kachang jipun
spade - penggali
speak - chakap
specimen - chontoh
spider - laba-laba
spill - titek, menitek
spinach - bayam
spoon - sudu
squirrel - tupai
stake - piket
stand - berdiri
star - bintang
starch - kanji
station (railway) - perhentian kereta api,
setesen keretapi
police station - balai polis

steal - menchuri
steam - embun
steep - churam
stew - rebuskan
stick - tongkat, kayu
sting - sengat
stir - kachau
stocking - sarong kaki
stomach - perut
stone - batu
stool - bangku
stop - berhenti
store - stor, gudang

.../155

storm	-	ribut
straight	-	turus, upright - betul truthful - benar
stream	-	anak sungai
street	-	jalan
strike (hit)	-	pukul
strike (of employee)	-	mogok
string	-	tali
strong	-	kuat
stuck	-	tersangkut
substitute (of persons)	-	ganti
sugar	-	gula sugar cane - tebu
sun	-	matahari
sure, certain	-	tentu
survey (topographical)	-	ukor, mengukor
surveyor	-	tukang ukor
swallow (down throat)	-	telan
swamp	-	paya, rice field - sawah.
sweat	-	peloh
sweep	-	sapu
sweet	-	manis
swift	-	laju, swiftly - lekas
swim	-	berenang

T

table	-	meja
tailings (in mine)	-	tahi lombong
tailor	-	tukang jahit
take	-	pegang
talk	-	chakap
tall	-	tinggi
tapioca	-	ubi kayu
tapir	-	badak
taut	-	tegang
tea	-	teh
teak	-	kayu jati

.../156

team - pasokan
tent - khemah, pitch a tent - bentang khemah
termite - anai-anai
tetanus - kaku
thank you - terima kaseh
that - itu, yang
thatch (palm leaf) - atap
then, at that time - pada masa itu
there - situ
these - ini
they - mereka
thick - tebal
thin - nipis
think - fikir
thirst - dahaga
this - ini
thorn - duri
thousand - ribu
thread - benang
throat - lehar
through - terus
throw - buang
thrust away - tolak
thumb - ibu jari
thunder - petir
thus, like this - baginii like that - bagitu
tick - kutu
tie - ikat
tiger - rimau
timber - kayu, planks - papan
tin - timah
to - ka-
tobacco - tembakau
toddy - tuak

.../157

toe	-	jari kaki
together	-	sama
tomorrow	-	besok, day after tomorrow - lusa
tongue	-	lidah
tonight	-	malam ini
tooth	-	gigi, tooth brush - berus gigi, toothpaste - ubat gigi.
top	-	atas
torch (electric)	-	lampu pichit
torn	-	koyak
tortoise	-	labi-labi
tough	-	liat
towel	-	tuala
town	-	pekan, bandar
trace (in forest)	-	rentis
trace (in drawing office)	-	petakan
track (in forest)	-	jalan hutan, game track - denai
train	-	kereta api
transparent	-	terang, tracing paper - kertas terang
transport (verb)	-	membawa
trap	-	jerat
travel	-	berjalan
tree	-	pokok
trouser	-	seluar
truck	-	lori
true	-	benar
try	-	menchuba
tub	-	tong
tuberculosis	-	batok kering
turn	-	pusing

U

ulcer	-	barah
umbrella	-	payong

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unable - tidak boleh, ta'boleh
unaccompanied - sa-orang diri
uncertain - tidak tentu
under - di-bawah
underpants - seluar dalam
up - ka-atas
upon - di-atas
uproot, pull out - menchabut

V

vacancy - kerja kosong
veal - daging anak lembu
vegetable - sayor
venison - daging rusa.
vest - baju dalam
village - kampong
vote - undi.(verb) - mengundi

W

wage - gaji
waist - pinggang
waist belt - tali pinggang
wait - nanti
wake up - bangun
walk - jalan
want - mahu
warm - panas
wash - chuchi, basoh
wasp - penyengat
watch (verb) - berjaga, watchman - jaga
watch (timepiece) - jam
water - ayer
water course in padi - tali ayer
weak - leteh
wear - pakai
weary - penat
weather - musim

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weed (verb) - merumput
week - minggu
welcome - selamat datang
well (for water) - telaga
well, fit - baik, sihat
west - barat
wet - basah
what - apa
wheel - roda
when - bila
whence, from where - dari mana
where - mana
white - puteh
caucasian - orang puteh

who - siapa
whose - siapa punya
wick - sambu
wide - lebar
will, intend - mahu, nak
wind - angin
window - jendela
wipe - sapu
wire - kawat, barbed wire - kawat duri

wish - mahu
with - dengan
within, inside - dalam
without, outside - luar
won't - tidak mahu, ta'mahu
wood, forest - hutan, timber-kayu, planks - papan

word - kata
work - kerja
workman - tukang, orang gaji
world - dunia

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worm	-	chaching
wound	-	luka
worry	-	susahkan
wrap	-	membalut, bandage - balut
write	-	tulis
wrong	-	salah

Y

yam	-	ubi
yard (measurement)	-	ela
yaws	-	puru
year	-	tahun
yellow	-	kuning
yes	-	ya
yesterday	-	sa-malam
you	-	awak
young	-	muda

Numerals

one	-	satu
two	-	dua
three	-	tiga
four	-	empat
five	-	lima
six	-	enam
seven	-	tujoh
eight	-	lapan
nine	-	sembilan
ten	-	sepuloh
eleven	-	seblas
twelve	-	duablas
thirteen	-	tigablas
twenty	-	duapuloh
twenty one	-	dua puloh satu
one hundred	-	saratus
one hundred and thirty four	-	saratus tiga puloh empat

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one thousand	-	saribu
one thousand four hundred and eighty seven	-	saribu empat ratus lapan puloh tujoh
nineteen sixty five	-	sembilanblas enam puloh lima

Days of the week

Monday	-	Ithnin; hari satu
Tuesday	-	Selasa; hari dua
Wednesday	-	Rabu; hari tiga
Thursday	-	Khamis, hari empat
Friday	-	Juma'at; hari lima
Saturday	-	Sabtu; hari enam
Sunday	-	Ahad; hari minggu

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APPENDIX 6

Aids to the Identification of Common Malayan Rocks

The following notes are designed to help soil surveyors recognise different types of parent rocks. Simple descriptive terms have been used in consideration of the fact that many soil surveyors have not had comprehensive geological training. These notes do not give precise definitions of rock types, for which the soil surveyor should refer to a textbook of petrology.

1. Igneous Rocks

A useful primary distinction of igneous rocks can be made according to their origin whether erupted (volcanic), injected (hypabyssal), or emplaced (plutonic); and their composition, whether acidic (high in felsic* and low in ferromagnesian minerals), intermediate (approximately equal amounts of felsic and ferromagnesian minerals), basic (low in felsic and high in ferromagnesian minerals or ultra-basic (predominantly ferromagnesian minerals). The broad relationship between the main igneous rocks occurring in Malaya is outlined in the following chart. It must be emphasized that this is an extremely simplified version which is hardly acceptable to modern petrologists, but it does provide a rough outline which can be readily comprehended.

	ACID		INTERMEDIATE	BASIC	ULTRABASIC
VOLCANIC	Rhyolite	Dacite, Quartz-andesite	Andesite, Trachyte	Basalt	Serpentine
HYPABYSSAL	Granite-porphyry, Quartz-porphyry, Microgranite		Andesite, Microdiorite	Dolerite	
PLUTONIC	Granite	Granodiorite, Quartz diorite	Diorite, Syenite	Gabbro, Norite	Peridotite

Granite: Granite is a predominatly light coloured, greyish, whitish or pinkish coarse grained igneous rock of relatively light weight, containing essentially quartz visible without the aid of the microscope, much feldspar, and mica or other coloured minerals. Grey porphyritic granite with large crystals of orthoclase is the commonest type of granite exposed in Malaya, and may be regarded as the typical rock of the granite suite. There are, however, many variations from this type of rock due to differences in texture and mineral composition. There is never any non-crystalline base or ground mass between the minerals as granite is typically holocrystalline (comprised entirely of crystals).

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*Felsic = quartzo-felspathic

Granite porphyry: This is a fine grained granitic rock with a holocrystalline ground mass, composed mainly of alkaline feldspar and quartz, through which are dispersed large crystals of orthoclase and plagioclase with smaller crystals of quartz, biotite, and sometimes hornblende or pyroxene. The essential difference from granite is its fine grained texture and the presence of large feldspar phenocrysts.

Quartz porphyry: This is a fine grained greyish, pinkish or brownish rock with scattered phenocrysts of quartz throughout the groundmass. The groundmass of most Malayan quartz porphyrys is crystalline but it is not possible to pick out individual crystals even under the microscope. In some cases, feldspar has crystallized out as well as the quartz giving a quartz-feldspar-porphyry.

Rhyolite: This is a pale coloured relatively light weight rock in which flow structures can be seen. Small phenocrysts of quartz are commonly scattered throughout a non-crystalline groundmass.

Granodiorite: In a true granite, orthoclase is more common than plagioclase. In granodiorite, the reverse is true The same is true of diorite but, unlike a granodiorite, there is no free quartz in a normal diorite. Thus, granodiorite is intermediate in composition between granite and diorite. In hand specimen it is very similar to granite although it tends to be slightly darker coloured. Most Malayan granites are somewhat transitional to granodiorite in composition.

Quartz diorite: This is essentially a diorite in which free quartz is present. It is holocrystalline, and outwardly resembles grey granite, but may usually be distinguished from it by the striated faces of its feldspars, and the somewhat higher proportion of dark minerals.

Dacite: Dacite and quartz andesite are the volcanic equivalents of granodiorite and quartz diorite. Dacite is darker coloured and slightly but noticeably heavier than rhyolite and contains quartz phenocrysts in a fine grained, largely non-crystalline groundmass.

Diorite: This is a dark grey coloured, moderately heavy holocrystalline rock which does not contain any free quartz, but contains a fairly high percentage of dark coloured minerals, usually hornblende and black mica.

Andesite: This is the volcanic equivalent of diorite and is a dark grey or black rock which is quite heavy in hand specimen and has a compact groundmass through which striated feldspar prisms may generally be observed. The texture of the rock ranges from finely crystalline to essentially glassy with small phenocrysts of dark coloured minerals throughout. The andesites usually contain acid plagioclase and one or more of the minerals, biotite, amphibole and pyroxene. Malayan andesites commonly have a distinct greenish coloyration.

Gabbro: This is a coarsely crystalline black or greenish black heavy rock. It consists essentially of calcic plagioclase, pyroxene and often has olivine as an accessory. There is usually no quartz.

Norite: This rock is similar to gabbro but has orthorhombic pyroxene usually hypersthene, instead of clinopyroxene (augite). In hand specimen, it is very similar to gabbro.

Basalt: This is a dark coloured, heavy volcanic rock which is very fine grained and in which it is often impossible to recognise individual crystals with the unaided eye. In some cases basalts contain

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uncrystallized material which occurs as a brown or green glass. They consist essentially of basic plagioclase, feldspars, and pyroxenes with olivine as an accessory. Many basalts are black, extremely compact, apparently homogeneous rocks which break with a splintery or conchoidal fracture.

Serpentine: This rock consists almost exclusively of the dark coloured basic mineral, serpentine. It was probably originally an eruptive ultrabasic rock which has subsequently been altered and is now composed of the serpentine group of minerals. It is a compact faintly glimmering or dull rock, easily cut or scratched, having a prevailing dirty green colour, sometimes variously streaked or flecked with brown, yellow or red. It frequently contains other minerals besides serpentine and one of the commonest is chrysotile or fibrous serpentine which, as veinings of a silky lustre, often ramifies through the rock in all directions.

2. Metamorphic Rocks

These are rocks which have been changed in mineral composition, structure or both under the influence of heat and/or pressure. The following different types of metamorphism can be distinguished:-

(a) Thermal metamorphism, which is the result of heat and gives rise mainly to mineralogical changes.

(b) Dynamic metamorphism. This is the result of stress which gives rise mainly to structual re-arrangements, the rock developing new structures while old ones are lost; and

(c) Regional metamorphism. It is difficult to heat a rock without pressure affecting it. Thus metamorphic rocks such as schist, phyllite, etc., formed under the joint influence of high temperature and powerful shearing are said to have been regionally metamorphosed. The following brief notes describe the commoner metamorphic rocks to be found in the Malayan landscape:-

Quartzite: This is a quartz rock resulting from the metamorphism of sandstone. It is a bedded, granular to compact mass of quartz, generally white, sometimes yellow or red with a characteristic lustrous fracture, sometimes possessing a sugary appearance particularly when weathered, occasionally pebbly and even accompanied by conglomerates. The finely granular structure of quartzite is distinctly visible to the naked eye and more or less distinct evidence of crushing and deformation of the grains may be observed. The particles are commonly cemented together with siliceous material. It often contains muscovite and potash feldspar as well as quartz due to impurities in the original sandstone. Quartzite is produced by the thermal metamorphism of sandstone and thus does not have any marked metamorphic structures.

Slate: This rock is produced in the first stage of dynamic or regional metamorphism of shale. It is a fairly hard dark rock with a marked cleavage developed in it. There may be some new mineral formation but there is no segregation of minerals into bands.

Hornfels: This rock represents stage in the thermal metamorphism of shale and is characterised by the appearance of new minerals such as biotite, and sometimes cordierite. Biotite hornfelses are very common in Malaya in thermally metamorphosed shales close to granite contacts. They are typically compact, close grained rocks, often characteristically spotted.

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Gneiss: Intense thermal or regional metamorphism of shale results in the disappearance of biotite and the formation of such high grade metamorphic minerals as sillimanite, garnet , spinel and corundum. In such a high grade rock the recrystallization is so complete that the rock develops a grain size coarser than that of a typical hornfels. Gneiss may in fact resemble granite and differ only in the foliated arrangement of the minerals.

Phyllite: This rock is the second stage in the regional metamorphism of shale after slate. It is characterised by the separation out along the cleavage plains of flakes of white mica or sometimes green chlorite. Phyllites are intermediate between normal slates and true mica schists and many show original bedding often well marked by colour bands and by the alternation of sandy layers.

Schist: This marks the highest grade of regional metamorphism of sedimentary rocks. Schists have been completely recrystallised. The component minerals are segregated into bands, and typical laminated schistose structures are developed. Contortions are quite common in schists.

Marble: When a limestone is heated during thermal metamorphism the calcium carbonate forms crystals of calcite which grow larger and larger as the temperature increases. Marble is a hard, pale coloured rock and the coarseness of its grain is an indication of the degree of thermal metamorphism.

3. Sedimentary Rocks

These are rocks that consist of materials which have previously existed on or beneath the surface of the earth in another form, and the accumulation, and consolidation of which gives rise to new compounds. The commonest sedimentary rocks in Malaya are shales, sandstones and conglomerates, while breccias, agglomerates and tuffs also occur.

Shale: This is a general term to describe clay that has assumed a thinly stratified or fissle structure. Included are laminated and somewhat hardened argillaceous rocks which are capable of being split along the lines of deposit into thin leaves.

Sandstone: This is a rock composed of consolidated sand. The integral grains of sandstone are chiefly quartz and the colour usually arises not so much from the quartz which is commonly white or grey, as from the film which often coats the grains and holds them together as cement. The cementing material may be ferrugeneous, argillaceous, calcareous, or siliceous.

Conglomerate: This is a rock formed of consolidated gravel or shingle. The component pebbles are rounded and water-worn and may consist of any kind of rock, though usually of some hard and durable sort, such as quartz or quartzite.

Breccia: This rock is similar to a conglomerate but is composed of angular instead of rounded fragments and has less stratification than a conglomerate. Volcanic breccia consists of material discharged from volcanoes and consolidated into masses of angular material.

Agglomerate: This rock is normally volcanic in origin and consists of an assemblage of blocks of all sizes up to several yards in diameter. The materials are commonly of volcanic rocks but include also fragments of the surrounding rocks. An agglomerate is devoid of stratification but sometimes includes portions which have a more or less

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distinct arrangement into beds of coarser and finer detritus.

Tuff: This is another rock of essentially volcanic origin which includes all the finer grades of volcanic detritus ranging from coarse, gravelly deposits to exceedingly compact fine grained rocks formed from volcanic dust. The tuffs have consolidated sometimes under water, sometimes on dry land. As a rule, they are distinctly stratified. Near the original vents of eruption, they commonly present rapid alternations of finer and coarser detritus indicative of successive phases of volcanic activity. They necessarily grade into the sedimentary formations with which they were contemporaneous.

APPENDIX 7

Extracts from Financial General Orders relating to Travelling, Subsistence and Transport Allowances

The following is an extract of those Financial General Orders which relate to travelling, subsistence and transport allowances for journeys on Government duty, together with a copy of Treasury Circular Letter No. 7 of 1960, which is complementary to the F.G.O's. A copy of FEO. 1158/28 of 5.8.64 is also attached.

It should be noted that where a claim is made for re-imbursement of expenses for board and lodging actually incurred at a hotel, only such expenses as room rent, charges for morning tea, breakfast, lunch, afternoon tea and dinner are recoverable; provided that no officer whose salary is less than $1,360.00 per mensem will be permitted to claim more than $23.50 in respect of any period of 24 hours' board and lodging. Telephone charges necessarily and unavoidably incurred at a hotel on Government business are also recoverable, provided the officer claiming so certifies on the "chits" or on the covering receipt.

All other charges, including charges for laundry, soft drinks and fruits (which are considered as refreshments), are not admissable as a charge on Government funds.

Each hotel receipt produced in support of a claim, therefore, should have endorsed on it by the officer making the claim, a summary showing total gross charges, deductions in respect of items not recoverable from Government, and balance which will represent the sum recoverable. The endorsement may be made on any available space on the receipt.

A certificate by the District Officer to the effect that rest house accommodation was not available for the period should be obtained and attached to claims for hotel receipts. *

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* This is not now necessary. According to Treasury Circular Letter No.4/1965 as from 1st May,1965 the "choice of accommodation should be left to the officer concerned and in such circumstances the officer is permitted to recover :

a) a Subsistence Allowance according to paragraph 2 above(i.e. $12.50 a night).
b) Actual lodging charges supported by receipts up to a maximum of $17.50 cents a night in the case of an officer whose salary is less than $1360/- per month in addition to the subsistence allowance as above."

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JOURNEYS ON TOUR

Extract of Financial General Orders on Travelling, Subsistence and Transport Allowances

Transport expenses

235. An officer claiming reimbursement of transport expenses under the provisions of this Chapter, should normally travel by the quickest route, provided that:

(a) he may not travel by air without special permission or as may be generally approved from time to time by the Deputy Chief Secretary in the case of officers borne on the Federal estimates, or by the Menteri Besar or Resident Commissioner in the case of the officers borne on the State or Settlement estimates

(b) he is ordinarily required to travel by the Malayan Railway rather than by steamer; and

(c) he is only entitled to travel by such means of conveyance as the head of department may certify to be expedient or necessary. Officers in Division III and IV will not be permitted to use a specially hired or chartered car unless no alternative means of transport are available.

Class of Accommodation.

236. Officers are entitled to be provided with the following accommodation for journeys by rail or steamer:

Officers in Division I and II .... First Class

Officers in Division III.... Second Class, provided that women officers whose salary is not less than $310 a month will be given first class accommodation.

Officers in Division IV.... Third Class.

Journeys on tour. Transport expenses.

245. An officer on tour is entitled, subject to the provisions of General Orders 235, 236, 252 - 258, to recover his actual transport expenses necessarily and unavoidably incurred.

246. (a) Subject to

(i) the provisions of sections (d) and (e).

(ii) the certificate of the head of department that it was necessary, and

(iii) the absence of any departmental scale of subsistence allowance approved by the Minister of Finance in the case of officers holding posts borne on the Federal Estimates or the State Secretary

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or Settlement Secretary in the case of officers borne on the State or Settlement Estimates,

an officer or employee who, in the execution of his duty, sleeps the night away from his headquarters station is entitled to subsistence allowance at such rates as may be generally approved from time to time by the High Commissioner, provided that only half of the prescribed allowance may be drawn by an officer when travelling by vessels including aircraft where the passenger fare defrayed by the Government includes messing. The full allowance may, however, be drawn by officers who provide their own food when travelling by sea. The rates at present approved are detailed in Appendix F.

(b) An additional $3 a night is payable to an officer using his own motor car for a journey on tour, if accompanied by a driver who is employed and paid by him provided that no such addition may be drawn if the officer is not entitled to draw a driver's allowance in accordance with General Order 259.

(c) The question as to what constitutes an officer's or employee's headquarters station shall, in case of doubt, be determined by the Minister of Finance in the case of officers or employees paid from provision in the Federal estimates and by the State Secretary or Settlement Secretary in the case of officers or employees paid from provision in the State or Settlement estimates.

(d) Where a Head of Department considers it necessary for an officer to stay in a rest-house or other Government quarters away from his headquarters station subsistence allowance may be drawn for a period not exceeding three months. A Head of Department may not authorise payment of subsistence allowance in excess of a period of three months to secure the performance of any duty without the prior sanction of the Minister of Finance in the case of officers holding posts borne on the Federal estimates or of the State Secretary or Settlement Secretary in the case of officers holding posts borne on the State or Settlement estimates.

Provided that in the case of

(i) officers who normally work in the field and sleep the night away from their headquarters, and

(ii) officers who are required to attend short courses of instruction at training centres,

the Minister of Finance in the case of officers holding posts borne on the Federal Estimates or the State Secretary or Settlement Secretary in

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the case of officers borne on the State or Settlement Estimates, may authorise a commuted allowance, at a rate not exceeding that payable under section (a) above, irrespective of the length of the period of their stay away from their headquarters.

(e) Subsistence allowance may be drawn by an officer on tour during a period of absence from duty through illness not exceeding seven days but may not be drawn in cases where an officer on tour is admitted to hospital except with the special sanction of the Minister of Finance in the case of officers holding posts borne on the Federal estimates or of the State Secretary or Settlement Secretary in the case of officers holding posts borne on the State or Settlement estimates.

Hotel expenses.

247. (a) An officer of Division I, II or III of the public service on tour is entitled to accommodation in a rest-house and may, if such accommodation is not in fact available, recover instead of subsistence allowance under the previous General Order the actual cost incurred in board and lodging subject to the certificate of the Head of the Department approving the charge.

(b) Where it is necessary for an officer to remain away from his headquarters station in circumstances in which accommodation in a rest-house or other Government quarters is not available he may recover the full cost of board and lodging for a period not exceeding three months. A Head of Department may not authorise payments under this General Order in excess of a period of three months to secure the performance of any duty without the prior sanction of the Minister of Finance in the case of officers holding posts borne on the Federal estimates or of the State Secretary or Settlement Secretary in the case of officers holding posts borne on the State or Settlement estimates.

Lodging expenses.

248. (a) An officer of Division I, II or III of the public service on tour is entitled to recover in addition to subsistence allowance the actual fees paid for lodging (but not board) incurred at a rest-house and garage fees.

(b) An officer or employee not entitled to use a rest-house or a leased rest-house may be paid lodging allowance at such rates as may be approved from time to time by the High Commissioner in addition to the subsistence allowance paid to him. The rates at present approved are detailed in Appendix F.

Day allowances.

249. (a) An officer or employee whose duties require him to remain continuously away from his headquarters station for a period of more than eight but less than twenty-four hours is entitled to a day allowance which will ordinarily be at

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half the rates approved for subsistence allowance. In special cases with the approval of the Minister of Finance in the case of officers or employees paid from provision in the Federal estimates or of the State Secretary or Settlement Secretary in the case of officers or employees paid from provision in the State or Settlement estimates, the full rate for a subsistence allowance may be paid.

(b) An officer on tour required to remain continuously away from his headquarters for a period exceeding thirty-two hours is eligible in addition to subsistence allowance to one day allowance in respect of any balance period of eight hours or more for which no subsistence allowance can be claimed, a subsistence allowance being reckoned as covering subsistence for a period of twenty-four hours.

Field allowance.

250. An officer or employee who, when spending the night away from his headquarters in circumstances which entitle him to subsistence allowance under General Order 246, is compelled to live under canvas or other temporary structure or in a houseboat or unfurnished halting bungalow is eligible to receive in addition to subsistence allowance a field allowance in respect of each unbroken period of 24 hours not exceeding -

Divisions I and II ..... $2.00 a day

Divisions III and IV .... $1.50 a day

Such extra allowance will not be drawn by Military Officers and other ranks when in camp for instruction or training purposes, or in the course of their normal military duties.

Allowance for daily paid employees.

251. For the purpose of relating the wage of employees on daily rates to the salaries of officers on monthly rates, in order to determine eligibility for allowances under General Orders 246 and 250, the wages of employees shall be multiplied by 26.

Mileage for duty.

252. Where it is necessary for the efficient performance of the duties attached to his post that an officer should travel by his own motor-car or motor-cycle, he may be paid mileage for journeys travelled on Government duty at such rates as may be generally approved from time to time by the High Commissioner. The rates at present in force are given in Appendix "C".

Rates of mileage.

253. The rate of mileage payable will be determined in accordance with the type of vehicle used, except that:

(a) No officer on a basic monthly salary of less than $863 may draw mileage at the rates prescribed for a Class "A" car;

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(b) No officer on a basic monthly salary of less than $710 may draw mileage at the rates prescribed for a Class "A" or Class "B" car;

(c) No officer on a basic monthly salary of less than $514 may draw mileage at the rates prescribed for a car, unless -

(i) it is shown to the satisfaction of the Financial Secretary in the case of an officer holding a post borne on the Federal estimates, or of the Mentri Besar or Resident Commissioner in the case of an officer holding a post borne on the State or Settlement estimates, that the nature of his duties necessitates the use of a car rather than of a motor-cycle; or

(ii) the officer has been certified by a Medical Board of not less than two Government Medical Officers, appointed for that purpose by the Director of Medical Services, or by the Senior Administrative Medical Officer of the State or Settlement as the case may be, to be unfit to ride a motor-cycle.

Classes of Vehicles.

254. (a) A Class "A" car is a car of cylinder capacity of not less than 1,400 c.c.

(b) A Class "B" car is a car of cylinder capacity of less than 1,400 c.c. but not less than 1,000 c.c.

(c) A Class "C" car is a car of cylinder capacity of less than 1,000 c.c.

(d) A motor-cycle means a motor-cycle of cylinder capacity of not less than 225 c.c. Mileage at special rates may be approved by the High Commissioner for motor-cycles, motor-scotters or similar vehicles of cylinder capacity of less than 225 c.c. The rates at present in force are given in Appendix "C".

Mileage Vouchers.

255. (a) Mileage will be claimed monthly on a voucher to which must be attached a detailed statement of all journeys performed on Government duty, signed by the officer making the claim, who will be required to certify and will be held responsible that the claim is made strictly in accordance with all the relevant terms of General Orders 252 to 259.

Only one mileage claim to be made in any one month.

(b) In no circumstances may an officer submit more than one mileage claim in respect of any one calendar month. An officer whose travelling is to be debited to more than one vote will submit his claim for payment from one vote only,

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and distribution to other votes will be made subsequently by normal accounting methods. Such distribution shall be made in proportion to the mileage travelled.

Conditions of payment.

256. Mileage is payable only if -

(a) the journeys in question are on Government duty;

(b) they are made in a vehicle kept and maintained by the officer making the claim, and of the class appropriate to the rate of mileage claimed. It is not permissible for two or more officers to claim mileage in respect of the same vehicle in any one calendar month (unless the vehicle has been transferred during the month from one officer to another);

(c) the distances and other particulars are correctly quoted in the statement attached to the relevant voucher.

Mileage intended to cover whole cost of transport.

257. Mileage in accordance with General Order 252 is intended to cover the whole cost of transport on duty of an officer, his servants and baggage by road, and no other charges for such transport will be passed for payment without the certificate of the head of department that it was not practicable or would have caused undue delay or unnecessary expense to the Government to have used the officer's own vehicle.

Journeys between places served by railway.

258. Officers travelling on duty who use their own cars solely as a means of transport and not inspection between places served by the railway are as a general rule not entitled to draw mileage in respect of such journeys unless the cost to the Government is thereby reduced, but may recover the amount which a railway ticket of the class by which they are entitled to travel would have cost, provided that it is clearly stated in the voucher that the officer travelled by his own car and that the railway fare claimed is not an amount actually disbursed but the equivalent of the fare to which such officer is entitled under General Order 236. Exceptions to this rule are allowed when the officer in charge of the vote certifies on the voucher that in the circumstances it was reasonable that the officer should have used his own car and not have travelled by railway.

Drivers.

259. (a) An officer to whom mileage is paid in accordance with the foregoing General Orders at the rates for a Class "A" car may, if he employs a full-time licensed driver, be paid in addition a driver's allowance at the rate of 12 cents per mile of duty travelling, subject to a maximum of $60 in any one calendar month.

(b) An officer to whom mileage is paid in

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accordance with the foregoing General Orders at the rates for a Class "B" car may, if he employs a full-time licensed driver, be paid in addition a driver's allowance at the rate of 12 cents per mile of duty travelling, subject to a maximum of $60 in any one calendar month, provided that the head of the department in the case of an officer borne on the Federal Estimates, or the Mentri Besar or Resident Commissioner in the case of an officer borne on the State or Settlement Estimates, is satisfied that the employment of driver is necessary for the efficient performance of the officer's duties.

APPENDIX C.

(General Order 252)

Rates of Mileage

Duty Travelling in each calendar month	Class "A" cents per mile	Class "B" cents per mile	Class "C" cents per mile	Motor cycles cents per mile	Light motor cycles and motor-scooters cents per mile
For the 1st 100 miles	38	36	34	16	8
" " 2nd 100 miles	33	29	25	12	6
" " 3rd 100 miles	31	26	21	10	5
" " 4th 100 miles	28	24	19	9	4.5
" " 5th 100 miles	28	23	18	9	4.5
" " 6th 100 miles	27	22	17	8	4
" " 7th 100 miles	26	21	17	8	4
" " 8th 100 miles	26	21	17	8	4
" " 9th 100 miles	25	21	17	8	4
" " 10th 100 miles	25	20	16	8	4
" " 11th 100 miles	25	20	16	8	4
For any travelling beyond the 1st 1,100 miles	25	20	16	8	4
Additional rate for duty travelling in Pahang	6	5.5	4.5	-	-
Additional rate for duty travelling in Kelantan and Trengganu	6	5	4	2	1

APPENDIX F.

GENERAL ORDERS 246 (a) and 248 (b)

Rates of Subsistence and Lodging Allowances

1. Rates of Subsistence Allowance:*

   (a) Officers of Divisions I, II and III

   Three per cent. of monthly basic salary plus cost of living allowance subject to a minimum of $4 and a maximum of $10 a night. Rates of subsistence allowance shall be rounded off to the nearest 5 cents.

   (b) Officers of Division IV and daily-rated employees

   Three per cent. of monthly basic salary plus cost of living allowance subject to a minimum of $3 and a maximum of $10 a night. Rates of subsistence allowance shall be rounded off to the nearest 5 cents.

2. Rates of Lodging Allowance $3 a night.

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* According to Treasury Circular Letter No.4/1965, effective from 1st May 1965, the maximum amount of subsistence allowance per night for all categories of officers is $12.50.

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COPY

TRY(FS) 2444/Vol.1/151.

THE TREASURY,
KUALA LUMPUR.

11th May, 1960

ALL SECRETARIES/PERMANENT SECRETARIES TO MINISTRIES/MINISTERS, HEADS OF FEDERAL DEPARTMENTS.

TREASURY CIRCULAR LETTER NO. 7 OF 1960

HOTEL ACCOMMODATION WHILE ON DUTY, ON TRANSFER, OR ON DEPARTURE OR RETURN FROM LEAVE

Where it is necessary for an officer travelling on duty to stay in a hotel he may recover instead of subsistence allowance the actual cost incurred in board and lodging, subject to the certificate of the Head of the Department that the charge is fair and reasonable in the particular circumstances; provided that in no case will an officer whose salary is less than $1,360/- p.m. be permitted to recover more than the sum of $23.50 in respect of any period of 24 hours' board and lodging. In the case of officers and their families occupying hotel accommodation when proceeding on transfer or on departure or return from leave similar principles will apply, with the addition that in no case may an officer whose salary is less than $1,360/- be permitted to recover more than $37/- for 24 hours' board and lodging in respect of two persons occupying a double room. For hotels in Singapore the existing instructions will remain in force.

(LIM KIM CHENG)
b.p. SETIA USAHA PERBENDAHARAN

Copy to:

All Hon'ble the State Secretaries.

/AC.

C O P Y

FEO.1158/28.

Federation Establishment Office,
Federal House,
Victory Avenue,
Kuala Lumpur.

5th August, 1959.

Sir,

PAHANG TREASURY CIRCULAR NO. 9/59

REST HOUSE (GOVERNMENT HOTEL) CHARGES

I am directed to forward herewith a copy of Pahang Treasury Circular No. 9/59 for your information.

2. This circular will apply to Federal officers travelling on duty in Pahang and officers staying at the Government Hotels (formerly called Rest Houses) will not be able to claim the actual fee charged for lodging in addition to subsistence allowance. They may either claim subsistence allowance under F.G.O. 246 or the actual cost of board and lodging under F.G.O. 247(a).

I am, Sir,
Your obedient servant,

Sgd: (M. NADARAJAH)
for Principal Establishment Officer.

To: All Heads of Federal Departments.

COPY

No. (103) in PHG. FIN.50/EXP/8.

PAHANG TREASURY CIRCULAR NO. 9/59

REST HOUSE (GOVERNMENT HOTEL) CHARGES

1. The policy of the Pahang Government is that Rest Houses and Halting Bungalows shall be run on an economic basis and in the interests of this policy the following decisions have been made effective 1st May 1959.

(a) Pahang Government Rest Houses shall be re-named Pahang Government Hotels;

* (b) The new charges shall be as set out in Appendix A.

(c) Government officers on duty will not be provided with free accommodation as hitherto but are eligible to claim for board and lodging under F.G.O. 247(a).

2. The implications of the decisions contained in paragraph 1 above are:-

(a) The renaming of Rest Houses as Hotels means that claims will be submitted under F.G.O.247(a) and not under 248(a).

(b) Claims in respect of accommodation charges at Halting Bungalows will continue to be made under F.G.O.248(a).

3. No additional funds will be provided for Departmental Transport and Travelling Votes as a result of these increased charges and Heads of Departments may have to economise accordingly. In actual fact the additional charge on transport and travelling votes for Pahang Government officers is likely to be very small.

4. Besides placing Government Hotels (Rest Houses) on an improved economic basis one of the reasons prompting the increased charges was the necessity to improve the standards of accommodation in the interests of the tourist trade. It is hoped therefore that District Officers will ensure that the best use is made of resources available and that a high standard of service, cleanliness and efficiency is maintained.

Sd. D.C.L.Wilson
State Financial Officer and
State Treasurer, Pahang.

* Note. This appendix is not attached.

APPENDIX 8

EMPLOYMENT OF JUNIOR SUBORDINATE STAFF & LABOURERS

According to existing regulations the following grades of junior subordinate staff and labourers should be recruited through the local Government Employment Exchange/Labour Office. They must be medically examined and certified as fit for service by a Government Medical Officer before they can be employed. Their employment will be on monthly salaries and cost of living allowances (C.O.L.A.). They are eligible to draw housing allowance if they are not accommodated in government quarters. They are eligible for 14 days vacation leave and 4 days unrecorded leave a year and leave on medical grounds:-

(1) Office boys
(2) Launch drivers
(3) Lorry, car and van drivers
(4) Outboard motor drivers
(5) Watchmen
(6) Mandores
(7) Head labourers
(8) Labourers

Their monthly salaries, allowances, etc. are shown in the attached table. These salaries are paid from the Soil Survey Vote (S.12, Subhead 21) in the case of those persons who are employed by soil survey staff, including experts, and engaged in work directly related to soil survey field operations. It is advisable to employ all staff who are continuously employed (i.e. for longer than 1 month) and who are in most cases likely to be employed for at least one entire field season, in accordance with the existing regulations and at the correct rate of salary and allowance.

Unfortunately no guarantee of continuous employment, in the above sense, can be given in the case of certain categories of labour normally engaged by soil survey units, for the reason that labour requirements fluctuate according to the weather conditions, terrain, access, and the general survey programme; and in such cases it is permissible to engage personnel on a casual basis for a specified period of time (usually less than one month) and at a negotiated wage rate which is an effective compromise between the rate considered appropriate by the soil surveyor and the employee. Labourers; head labourers; and mandores (usually referred to as field labourers; team, or crew, leaders; and head labourers in the survey units), are the categories usually employed in this way, but not infrequently watchmen and outboard motor drivers are taken on for short periods under similar arrangements.

Employment of field staff on an individual contract basis has considerable advantages for the soil surveyor, as he can in this way reduce the paper work and wage paying procedure, increase the flexibility of his work force, and effect considerable economies in the use of his available funds. For example, a soil survey casual labourer employed for a 20-day jungle trip in any one month would be paid a total of $100 if employed at $5 per day; which compares well with a regulation labourer who would earn $88.70 for his combined monthly salary, basic salary, COLA, and basic rate housing allowance, together with $60 subsistence allowance and $30 field camping allowance for 20 days in the jungle, which would bring his total pay to $178.76 (without including overtime for week days, weekly holidays, and public holidays which may be spent in the jungle).

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It is important to remember that under no circumstances should a casual employee earn more than the equivalent regulation rate, as this would lead to audit and treasury inquiries. While such a possibility is remote, it should always be borne in mind.

The procedure to be followed in employing casual labour is entirely the responsibility of the soil surveyor once he has obtained an assurance that the necessary funds are available from the appropriate O.C.A.R. Vote, which is controlled by the A.D.R.

After agreement has been reached regarding the daily rate of casual labour and the length of employment, an advance, amounting to a proportion of the total sum to be earned, can be paid to the employee from the cash-in-hand, held in the form of an advance to the Soil Surveyor for such contingencies. The balance is paid after the work period is concluded, either from the soil surveyors own cash-in-hand, or after receipt of the cheque for the total amount, which is forwarded from the Ministry after the necessary checkrolls have been submitted. Recoupment of the advance money should be made at this stage. All checkrolls must be signed by the labourers when final payments to them have been made from petty cash advances. In such cases the Paying Officer and witness must sign the certificate at the bottom right hand corner of the checkroll after payment to the labourers, and before the checkroll is forwarded to head office.

In the preparation of checkrolls, which should be on Form Gen.70, the Vote Head should be inserted after the heading "Head of Service". After "Pay List and Acquittance....." the nature and place of work must be stated and the period given also. Care should be taken to enter the names of the labourers correctly.

There are no normal hours of work for casual labourers, neither are they entitled to overtime or housing allowance.

The rate of pay is based on the classification of the labourer. For instance, a head labourer is normally paid $7 per diem, a team leader $6 and a labourer $5. But these rates will normally vary from place to place, and individual soil surveyors should do their best to negotiate fair rates of pay. Higher rates may be necessary in order to obtain willing assistance in some parts of the country, while lower rates are often possible in many central and east coast areas. There will be no E.P.F. deductions for casual labourers.

A Certificate should then be inserted on the checkroll as follows:- "Compared with checkrolls and found correct" in order to comply with Ministry requirement. Similarly the certificate at the left foot of the checkroll should also be signed by the Soil Surveyor or his assistant.

Four copies of the checkroll should be sent to the A.D.R's office where a covering voucher will be prepared and signed by the A.D.R., who is the officer responsible for expenditure, and then forwarded to the Ministry for checking. After the voucher and checkrolls have been checked, the documents and cheque are sent direct to the paying officer from the Ministry. It should be noted that under normal circumstances the cheque does not come to the A.D.R's office, which has no control over the movements of the voucher, checkroll or cheque once the voucher has been prepared and passed to the treasury section of the Ministry. Vouchers are normally forwarded to the treasury section within four to seven days of receipt, depending on the amount of work in hand. Delays are most likely to occur at the end of the month when salary sheets and subsistence vouchers are being dealt with.

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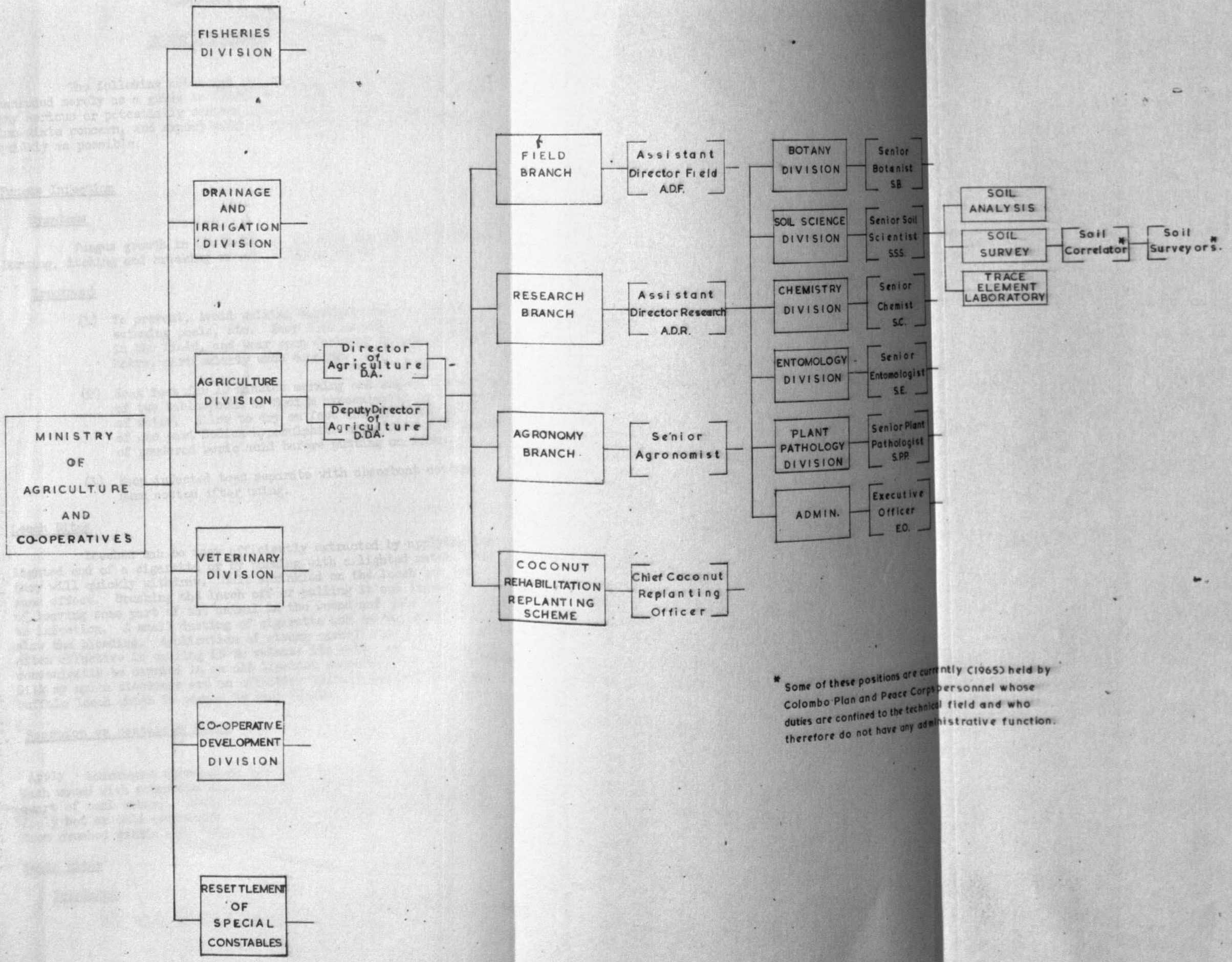
On occasions the soil surveyor may be able to recruit aborigine labourers living in the ulu on a casual basis. Separate arrangement for pay and ration allowance should be discussed with the appropriate Protector or Assistant Protector for the State concerned before direct negotiations are undertaken with the aborigines themselves.

Salaries & Allowances payable to Junior Subordinate Staff and Labourers

Junior staff/employee	Salaries & Allowances p.month				Overtime per hour			Allowances for duty away from HQ. Stn.				Remarks
	Basic salary	COLA	Housing allce. (Basic rate)	Total	Weekday @ 1¼ time	Weekly holiday @ 1½ time	Public holiday @ double time	Day allce. p.d.	Subsis. allce. p.ngt	Field camp allce. 24-hr.	Lodging allce. p.ngt.	
Div.IV staff on establishment under Personal Emoluments in the Annual Estimates:-												
(1) Office Boys (salary scale: $71x1.50-74)	$71.00	$7.07	$5.00	$ 83.07	-	-	-	$1.50	$3.00	$1.50	$3.00	Candidates for appointment must have attained 14th but not 16th birthday. Service to be terminated on 21st birthday.
(2) Launch drivers (salary scale: $96x3-120)	96.00	10.07	8.00	114.07	61¢	73¢	98¢	1.60	3.20	1.50	3.00	
Industrial & Manual Group employees on Open Votes under Other Charges, Annually Recurrent in the Annual Estimates:-												
(1) Lorry, car & van drivers	102.06	10.26	8.00	120.32	65¢	78¢	$1.04	1.70	3.35	1.50	3.00	With incremental scales ($102.06-105.84-110.16).
(2) Outboard motor drivers	86.94	7.56	5.00	99.50	55¢	66¢	88¢	1.50	3.00	1.50	3.00	Employment restricted to D.I.D.
(3) Watchmen	85.32	7.56	5.00	97.88	54¢	64¢	86¢	1.50	3.00	1.50	3.00	
(4) Mandores	90.18	7.56	5.00	102.74	56¢	67¢	90¢	1.50	3.00	1.50	3.00	
(5) Head labourers	85.32	7.56	5.00	97.88	54¢	64¢	86¢	1.50	3.00	1.50	3.00	
(6) Labourers	76.14	7.56	5.00	88.70	46¢	55¢	74¢	1.50	3.00	1.50	3.00	With incremental scales ($76.14-84.24).

APPENDIX 9: ADMINISTRATIVE STRUCTURE OF THE DIVISION OF AGRICULTURE
BY HEW MOCK SUNG, EXECUTIVE OFFICER (RESEARCH) DIVISION OF AGRICULTURE.



* Some of these positions are currently (1965) held by Colombo Plan and Peace Corps personnel whose duties are confined to the technical field and who therefore do not have any administrative function.

APPENDIX 10.

FIRST AID GUIDE

The following notes are by no means exhaustive and are included merely as a guide to immediate action in the case of injury. Any serious or potentially serious injury should be regarded with immediate concern, and expert medical assistance should be sought as quickly as possible.

Fungus Infection

Symptoms

Fungus growth in the hair, on the skin and under the nails. Burning, itching and cracking of skin usually around the toes.

Treatment

(1) To prevent. Avoid walking barefoot around showers, swimming pools, etc. Keep feet as dry as possible in the field, and wear open footwear during off-duty hours, particularly when camping.

(2) Soak feet for 10 minutes morning and night in solution of two tablespoons of Sodium hyposulphite in one quart of water. Allow to dry on feet and dust with powder of one part Sodium hyposulphite mixed with four parts of powdered boric acid before putting on socks.

(3) Keep infected toes separate with absorbent cotton. Burn cotton after using.

Leech Bites

Leeches can be most efficiently extracted by applying the lighted end of a cigarette or by burning with a lighted match, when they will quickly withdraw. Salt sprinkled on the leech has the same effect. Brushing the leech off or pulling it out incurs danger of leaving some part of the animal in the wound and this may give rise to infection. A small dusting of cigarette ash on the wound tends to slow the bleeding. Application of strong carbolic soap to a leech is often effective in causing it to release its hold, and the soap can conveniently be carried in an old lipstick container for this purpose. Silk or nylon stockings are an effective barrier against the large buffalo leech which is common in padi fields.

Scorpion or centipede bites

Apply a tourniquet above wound and suck out as in a snake bite. Wash wound with potassium permanganate solution (2.5 grains in one quart of cool water). Apply the paste of baking soda and water. Apply hot or cold compresses to relieve or reduce swelling. Juice from crushed garlic will help ease the pain.

Snake Bites

Treatment

(1) Apply tourniquet above the knee or elbow of the bitten

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limb. This should be done immediately. Use as a tourniquet, rubber, shoe string, handkerchief or anything suitable and practicable.

(2) If the bite is on the finger or toe, apply a second tourniquet around the digit.

(3) Wash the venom off the skin with a one percent solution of potassium permanganate.

(4) With a sharp knife or razor, make cross cuts in the wound.

(5) Apply solutions of potassium permanganate to the wound.

(6) Suck the wound thoroughly. Be sure you have no open wounds or sores in your mouth. Spit out frequently. Repeat continually for an hour or even up to three or four hours. Wash the wound occasionally with potassium permanganate.

(7) Should the blood refuse to flow, loosen tourniquet very slightly to increase bleeding.

(8) To delay absorption of the venom, absolute rest is necessary. Make the patient lie down.

(9) Let the patient drink quantities of water. Give liquids only, such as hot milk, tea, cocoa, coffee, or soup every half hour. Never give alcoholic drink.

(10) Wrap the patient in warm blankets and hot water bottle when symptoms of shock appear.

Ringworm

10% Salicylic acid solution applied to the affected skin has been found to be a suitable treatment for this complaint, which is quite common among labourers.

Ticks etc.

These small parasitic insects can be controlled with liberal applications of DDT powder.

Burns

Kind There are three general kinds of burns: thermal, sunburn and chemical.

Degree Burns can also be classified according to depth or degree. In first degree burns the skin is reddened; in second degree burns blisters develop; in third degree burns there is deeper destruction, the underlying growth cells that continually form new skin being destroyed.

Treatment

Thermal burns

(1) Obtain sterile dressings in sufficient quantity. If such are not available, treat clean clothes to render them as nearly sterile as possible.

(2) Apply the dressings in at least four layers, preferably six.

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(3) Then add additional covering to exclude air even more, using clean tightly woven material.

(4) Do not rupture blisters, although they may break when applying dressings.

(5) For a burn of the eye if the pain can be tolerated, irrigate the eye gently to remove any foreign material. Cover with a dry sterile gauze pad or a dry clean soft bandage and immediately seek medical aid. Do not drop oil or ointment in the eye unless necessary to relieve pain pending medical care.

(6) If the burn is of consequence have the patient lie flat. Raise the foot of the bed or stretcher about 10 inches if the burn involves more than 10% of the body. If the hand is burned, elevate above the level of the body and keep it elevated.

If medical help is not available within 20 minutes, begin giving at 15 minute intervals a half glass of a solution made by dissolving a half level teaspoon of table salt and one half level teaspoon of baking soda in a quart of water.

Sunburn

Always limit the time of initial exposure to no longer than 10 or 15 minutes.

(1) For mild sunburn, cold cream or such oil or greases as salad oil may relieve pain.

(2) Wash the hand before applying the material. Butter or margarine should not be applied.

(3) A dressing should be used if blistering appears.

(4) The injured area should not be exposed again to the sun until healing is complete.

Chemical Burns

When irritating chemicals come in contact with the skin or mucous membrane, injury usually commences instantly and first aid should be immediate. Among such chemicals are acids and alkalis, lime and cement, petroleum products, turpentine, some cleansing agents, some asphalt preparations, and some antiseptics.

(1) Wash away the chemical completely with large quantities of water.

(2) If first aid directions against the specific chemicals are available on labels or through industrial plant directions, follow them. In the absence of such directions, do not apply additional chemicals such as ammonia to an acid burn.

(3) After removing the chemical, give additional first aid just as for any similar heat burn.

(4) These injuries like all burns should not be exposed to direct sunlight until healing has occurred.

Marine life that causes skin irritation

Along the coasts many cases of severe skin irritation and

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poisoning are caused by marine animals such as Portuguese Man of War. These animals inject irritating substances. They may cause enough pain to weaken the person greatly and occasionally severe shock develops.

Treatment

(1) If an animal part such as a portion of the tentacles of the jelly fish or Man of War remains embedded in the skin, remove it at once by washing with water containing enough sand to form a soupy mixture. Otherwise wash with cold salt water and then place the involved extremity in hot water for 30 to 60 minutes.

(2) Also the application of half strength household ammonia solution followed by a paste of bicarbonate of soda and cold cream may be tried but probably emersion in hot water gives as much relief.

Cuts

Treatment

(1) Wash away dirt outside the wound with alcohol but do not try to wash out the dirt in the wound.

(2) Apply antiseptic (2% solution iodine, mercurochrome, tincture of metaphen). Apply iodine in one stroke and allow to dry before bandaging. Then apply sterile gauze and fix with tape to press cut edges together. Never apply iodine near eyes or body cavities. Never apply adhesive tape directly over iodine.

Wounds with danger of tetanus

The danger of tetanus (lock-jaw) should be considered in all wounds. Punctured wounds especially those contaminated with soil or manure probably have the highest incidence of tetanus, but many cases of tetanus result from wounds so insignificant that the patient does not recall them until specifically questioned. The particular need is for medical attention, and possible immunisation against tetanus. The danger of tetanus illustrates one of the reasons why even the most insignificant wound should be cleansed without delay.

Malaria

When you are in a malarial region, take necessary precautions against mosquito bites. Always use a mosquito net. Three weeks before going into such an area, take tablets of Atabrin or Nivaquin or some other preventative medication.

APPENDIX 11.

A SHORT HISTORY OF SOIL SURVEY IN MALAYA

Studies on the classification of Malayan soils can be traced to the early years of this century. The published works of Akhurst and Haines, Barrowcliff, Belgrave, Dennet, Grantham, Greenstreet, Hamilton, Savage and Wilshaw show how much attention this subject received between the First and Second World Wars. In all these studies the importance of parent material was recognized and repeatedly stressed, and frequent reference was made to existing geological maps. However, apart from a map of the Rubber Research Institute's Experiment Station at Sungei Buloh, prepared by Akhurst and Haines, no true soil maps were published, and the only systematic surveys known to have been made of extensive areas were those commissioned by certain large planting companies for their own properties. The unpublished works of Tommerup and Cole who worked respectively for Dunlop Malayan Estates, Ltd. and Guthrie and Co. (M) Ltd., were excellent pioneer efforts in this sphere. Interest was revived in the post World War II period and a notable advance was made in 1951, when Owen published a provisional classification of Malayan soils, in which he proposed names for a number of soil types then known to exist in the peninsula. This classification was unfortunately not accompanied by a soil map, but it marked the beginning of the classification system which is now being followed.

Later, in the nineteen-fifties, Coulter and others carried out a number of soil surveys of some of the major swamp areas along the west coast of Malaya, including the Kuala Langat (North) Forest Reserve and the trans-Perak Swamp. These surveys were designed primarily to determine the suitability of the soil for padi before planning drainage and irrigation facilities. They sampled soils at regular intervals along specially cut rentis or traverse lines; these samples were mechanically analysed, and soil maps showing the principal textural groups were produced.

During the same period a number of detailed maps of both sedentary and alluvial soil types were prepared for a few areas of developed land in several regions of the country, using profile characteristics as the basis of the classification. In the mid-fifties, reconnaissance soil surveys of some extensive padi areas were undertaken, and a schematic-reconnaissance soil survey programme for the whole country was also started. This ambitious programme was intended to elucidate the broad soil pattern for the entire country, and give a realistic appreciation of the soil suitability, and therefore of the agricultural development potentiality in both the undeveloped and developed areas. It was considered that reconnaissance soil surveys of this nature, if systematically carried out, would give a far greater return than if effort was concentrated on detailed soil surveys of restricted areas carried out largely for ad hoc purposes, although these could never be completely eliminated. For reasons of convenience, it was decided that the schematic-reconnaissance mapping programme should be carried out on a State basis, commencing with the northeast States, where the need for soil surveys was considered to be greatest, and to date soil maps on a scale of 1:500,000 with accompanying reports have been published for the States of Trengganu and Kelantan while a similar map, on a scale of 16 miles to 1 inch, has also been published, together with a report, for the state of Kedah.

Field work has since been concentrated in Perak, Pahang, and Johore, and soil maps and reports for these States are gradually becoming available. In addition, a large number of ad hoc surveys have been carried out in various parts of the country, and the

information provided by such work, as well as from other sources of a less direct nature, was used to compile a small scale map of Malayan soils which was completed in 1962.

Systematic detailed surveys were also carried out over a number of large alluvial areas particularly in Kedah and Kelantan. Unfortunately the results of these surveys have not been published, but the records are preserved in the Soil Science Division and will doubtless prove of great value during any future re-survey.

In addition to the official soil survey programme, which is undertaken by the Soil Science Division staff of the Department of Agriculture, certain private organisations have undertaken soil surveys, mainly of oil palm estates, to help with agronomic studies, while Soil Scientists on the staff of the R.R.I. have also carried out a number of detailed surveys of rubber estates in recent years, and liaison has been maintained with these organisations which have mostly adopted the soil classification of the Department of Agriculture.

References cited in this Appendix are set out in chronological order in Appendix 12.

APPENDIX 12.

A Bibliography of Malayan Soil Survey Publications, in Chronological Order.

ABBREVIATION: M.A.J., Malayan Agricultural Journal.

(1) Grantham, J. 1915: 'Some Johore soils', M.A.J., Vol. 4, pp. 114-21.

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(5) Belgrave, W.N.C. 1929: 'General considerations on a soil survey of Malaya', M.A.J., Vol. 17, pp. 175-8.

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(19) Coulter, J.K., McWalter, A.R., and Arnott, G.W. 1956: 'The Trans-Perak Swamp', M.A.J., Vol. 39, pp. 99-120.

(20) Arnott, G.W. 1957: 'The Kelantan deficiency area', M.A.J., Vol. 40, pp. 60-91.

(21) Panton, W.P. 1956: 'Types of Malayan laterite and factors affecting their distribution', Proceedings, 6th International Congress of Soil Science, Vol. 5 (Paris), pp. 419-23.

(22) Panton, W.P. 1957: 'The Federal Experiment Station, Jerangau', Trengganu, M.A.J., Vol. 40, pp. 19-29.

(23) Coulter, J.K. 1957: 'Development of the peat soils of Malaya', M.A.J., Vol. 40, pp. 188-99.

(24) Panton, W.P. 1958: 'Reconnaissance soil survey of Trengganu', Department of Agricultural Bulletin No. 105 (Kuala Lumpur).

(25) Panton, W.P. 1958: 'The Bukit Goh Forest Reserve, near Kuantan, Pahang', M.A.J., Vol. 41, pp. 3-9.

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(33) Moormann, F.R. et al 1964: 'Report on the Thai-Malayan Soil Correlation Meeting, 1964', Research Branch, Division of Agriculture, Ministry of Agriculture and Co-operatives, Kuala Lumpur, Malaysia.

(34) Libby, D.A. 1964: 'Schematic-reconnaissance soil survey of the Lepar Valley in Northeast Pahang', Soil Survey Report 1/1964. Research Branch, Division of Agriculture, Ministry of Agriculture and Co-operatives, Kuala Lumpur, Malaysia.

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APPENDIX 13.

A SOIL SUITABILITY CLASSIFICATION FOR MALAYA

One of the most important objects of soil survey is to interpret the data so as to predict the behaviour of the soil when it is used by man. Many methods of doing this are available, and the one chosen here is based on features of the soil or its environment which limit the suitability of the soil for agriculture. The term "suitability" is used in preference to the alternative terms "productivity", "capability" or "fertility" because it is felt that these alternatives infer more experimental and analytical information about the soils than in fact exists at present. This classification is erected solely on the observations made by soil surveyors combined in some cases with information concerning the performance of the main crops on different soils. Experimental confirmation in the near future would be most desirable.

The scheme is necessarily broad in approach because it is based on data obtained from the schematic-reconnaissance survey of Malaya. It is therefore aimed primarily at assessing suitabilities for the main economic crops of the country, i.e. rubber and oil palm, and does not contain enough detail to predict satisfactorily for crops with special requirements such as padi. In the case of such crops, far more detailed soil information than is at present available is required before any realistic appraisal can be made, and, even then, this should be supported by a comprehensive system of field trials.

In erecting this classification certain assumptions have been made, and the most important of these is that the plant nutrient deficiencies which, almost without exception, characterise Malayan soils, will be corrected by fertilizer application under agriculture. Fertilizer requirements are not mentioned here because the necessary information is not available for the wide range of soils considered, but it can be bluntly stated that all soils will require fertilizer application, and until this universal limitation is corrected, scheme as outlined here will have only restricted application. Some soils, however, have acute plant nutrient deficiencies in which minor as well as major nutrients are involved, and as this condition is regarded as far more difficult to diagnose and correct than the normal situation, it is included in the classification as a limitation.

The limitations to the suitability of the soils for agricultural development are divided into three groups as follows:-

Very Serious Limitations

These are impediments to development which are extremely difficult to correct; which severely reduce the productivity* of the soils; or which could result in very serious damage to the land under development. They are:-

1. Slopes steeper than 20°.

2. Massive, thick laterite at or very close to the surface.

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* The term "soil productivity" is used here as defined by Kellogg (1961 p.15) i.e. "Soil productivity is that quality of a soil that summarises its potential for producing specified plants or sequences of plants under defined sets of management practices."

3. Extreme rockiness - i.e. boulders and rocks almost entirely covering the surface.

4. Land disturbed by mining.

5. Toxicity caused by abnormally high amounts of certain elements.

The classification of slopes steeper than 20° as a very serious limitation may be controversial in view of the satisfactory techniques which have been evolved in parts of the tropics for cultivating slopes as steep and steeper than this. However, steep terrain is retained under this heading because it is considered desirable at present to direct attention to the very large areas of undeveloped land with slopes less than 20°, and also because it does not seem as if the agricultural population of Malaya is yet high enough to warrant exploiting such difficult terrain. In the future, when most land has been developed and when the population has increased considerably, development of steep land may be justified, but at present this is not so. Conversely, the case for retaining many, if not all, of these areas under permanent forest, either productive or protective, is likely to be increasingly emphasised in the future as the conservation role of forest in the steep lands becomes more readily appreciated, and as the need for water catchment, game and recreational reserves is felt.

Serious Limitations

These are impediments to development which are quite difficult to correct; or which considerably reduce the productivity of the soil; or which require the adoption of special techniques to be overcome. They are:-

1. Acute nutrient deficiencies - including trace element as well as major element deficiencies.

2. Very poor and poor drainage.

3. Moderately steep slopes (12° - 20°).

4. Massive, thick laterite within 2 feet of the surface.

5. 2 feet or more of acid peat.

6. Strong compaction.

7. Sand texture throughout.

8. Acid sulphate conditions.

9. Saline conditions.

Minor Limitations

These are impediments to development which are relatively easy to correct; or which only slightly reduce the productivity of the soil or which to a minor extent restrict the range of crops which should be grown. They are:-

1. Susceptibility to flooding.

2. [illegible]k structures within the top 4 feet.

3. [illegible]perfect or moderate drainage.

4. Acid peat less than 2 feet thick.

5. Weak or moderate compaction.

On the basis outlined above the following five classes have been established:-

Class 1: Soils with no limitations to agricultural development

These are deep, well drained, friable, well structured soils on slopes less than 12°. They are suitable for rubber and oil palm as well as a wide range of other crops.

Class 2. Soils with few minor limitations to agricultural development

These soils occur on slopes less than 12° and have no serious disability. The range of crops for which they are suitable is restricted in some cases by the type of limitation, e.g. susceptibility to flooding or up to 2 feet of peat, but apart from this most other soils in this class are suitable for a wide range of crops including rubber and oil palm.

Class 3. Soils with at least one serious limitation to agricultural development

These soils occur on a wide range of slopes up to 20° and most of them cannot be developed satisfactorily without amelioration of the limiting factors. Their suitability tends to be restricted to certain crops under specified management practices. Some will support rubber and oil palm under a high standard of management.

Class 4. Soils with more than one serious limitation to agricultural development

These soils occur on slopes up to 20° and will require a high standard of development and management to produce reasonable yields. Some will support rubber but most will be restricted to specialised crops, such as pineapples on peat. However, without question these soils would be best left in forest at present.

Class 5. Soils with at least one very serious limitation to agricultural development

The obstacles to the development of these soils are so great that they should remain in forest or be allowed to regenerate to forest.

THE COMMON SOIL SERIES OF MALAYA CLASSIFIED ACCORDING TO SUITABILITY

SOIL SUITABILITY CLASSES

CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5
RENGAM RENGAM, red variant JERANGAU JERANGAU, red variant KAMPONG KOLAM SEGAMAT SENAI KUANTAN WENG LANGKAWI MUNCHONG MUNCHONG, red variant SERDANG SERDANG, red variant NAMI SELANGOR (drained) KANGKONG (drained) JEMPOL	YONG PENG BATANG MERBAU PATANG PERLIS KAKI BUKIT POHOI KEMUNING KUALA BRANG BATU LAPAN KUALA NERANG TELEGA TELEMONG CHEMOR AKOB BRIAH SITIAWAN	RENGAM (slopes over 12°) JERANGAU (" " 12°) TAMPIN BUKIT LUNCHU KALA KODIANG MASAI KULAI HARAD CHENAIN KATONG PELAWAN KEDAH (slopes less than 20°) BUKIT PANJANG SUNGEI KADUT SEREMBAN MALACCA GAJAH MATI CHANGLOON PADANG BESAR TAVY BUKIT RESAM DURIAN (contd.)	BUKIT TUKU KG. CHERANG HANGUS LATI PADANG GONG CHENAK KG. LUBOK KIAT KAMPONG PUSU RUDUA JAMBU PENOR RUSILA KRANJI LINAU KAMPONG TELOK HOLYROOD (sandy variant) MEDIUM PEAT (2-5 ft.) DEEP PEAT (more than 5 feet) INLAND SWAMP	BUKIT TEMIANG GUNONG PADANG BUKIT AJIL MALACCA (laterite shallower than 2 ft.) TANDAK POHOI (Steep slopes) KUALA BRANG (steep slopes) KEDAH STEEPLAND DISTURBED LAND

CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5
		BATU ANAM APEK LOK YANG MARANG BUNGOR MONG GAJAH POKOK SENA HALU JARAU MERBAU PATAH PERAK TIAN BAHRU SELANGOR KANGKONG HOLYROOD HOLYROOD, grey variant SUNGEI BULOH MANIK SOGOMANA RASAU SEGARI HARIMAU ULU TIRAM TAMPOI TAI TAK SHALLOW PEAT (less than 2 feet) ORGANIC CLAYS & MUCKS LOCAL ALLUVIUM COLLUVIUM		

APPENDIX 14.

DESCRIPTIONS OF THE COMMONER SOIL SERIES.

All the series mentioned in the Soil Series Key in Chapter 4 are described in the following Appendix. The amount and reliability of the data available for each series varies widely, and because of this three different levels of series descriptions have been set up as follows:

(1) Standard Series Description - this is a comprehensive description derived from a number of observations and depicting the range covered by the series, Small amend ments will possibly be made to profile descriptions as further information becomes available from future surveys, but essentially these descriptions can be regarded as firmly established.

(2) Provisional Series Description - this is compiled from only a few, perhaps isolated observations which do not necessarily represent the actual concept of the series. In many cases it is known, or suspected, that the series described will be further encountered during future survey operations, and thus the actual concept and range cannot be defined satisfactorily at present. Profile descriptions are quoted in most provisional descriptions but are usually deficient in some morphological information. In some cases provisional descriptions are given for soils which will probably not be mapped again, but the information on record is too meagre to justify their elevation to standard series descriptions.

(3) Tentative Series Description.- this comprises only sketchy information based on limited observations, and in fact does little more than provide a broad picture of the series in question. There is however, enough information to enable separation from most other series to be made with reasonable confidence.

One aim of the schematic-reconnaissance survey is to accumulate enough information on all the series mentioned in the Key, and any new ones which may be established, to enable standard series descriptions to be compiled for each.

No analytical data is quoted at this stage, but it is the aim to incorporate this eventually.

In the following descriptions the series are arranged in alphabetical order, and the list on the next page indicates whether they are standard(S), provisional (P) or tentative (T).

List of Series Described

Akob(S) p.199
Apek(T) p.201
Batang Merbau(S) p.202
Batu Anam(S) p.204
Batu Lapan(P) p.206
Briah(T) p.207
Bukit Ajil(S) p.208
Bukit Lunchu(S) p.209
Bukit Panjang(T) p.211
Bukit Resam(S) p.212
Bukit Temiang(S) p.214
Bukit Tuku(P) p.215
Bungor(S) p.216
Chemor(T) p.218
Chenain(P) p.219
Chungloon(P) p.220
Durian(P) p.221
Gajah Mati(P) p.223
Gunong Padang(T) p.224
Halu(T) p.225
Harad(P) p.226
Harimau(S) p.227
Holyrood(P) p.229
Jambu(T) p.230
Jarau(P) p.231
Jempol(P) p.233
Jerangau(S) p.234
Kaki Bukit(P) p.236
Kala(P) p.237
Kampong Cherang Hangus(P) p.238
Kampong Kolam(S) p.239
Kampong Kubor(T) p.241
Kampong Lubok Kiat(P) p.242
Kampong Pusu(P) p.243
Kangkong(T) p.244
Katong(P) p.245
Kedah(S) p.246
Kemuning(T) p.248
Kodiang(P) p.249
Kranji(T) p.250
Kuala Brang(S) p.251
Kuala Nerang(P) p.253
Kuantan(S) p.254
Kulai(P) p.256
Langkawi(P) p.257
Lati(P) p.258
Linau(T) p.259
Lokyang(T) p.260
Malacca(T) p.261
Manik(T) p.262
Marang(T) p.263
Masai(P) p.264
Merbau Patah(T) p.266
Mong Gajah(T) p.267
Munchong(S) p.268
Nami(P) p.270
Padang Besar(T) p.271
Padang Gong Chenak(P) p.272
Patang (T) p.273
Pelawan(T) p.274
Penor(S) p.275
Perak(T) p.276
Pohoi(P) p.277
Pokok Sena(P) p.278
Rasau(P) p.279
Rengam(S) p.281
Rudua(T) p.283
Rusila(T) p.284
Segamat(S) p.285
Segari(T) p.287
Selangor(S) p.288
Senai(P) p.290
Serdang(S) p.292
Seremban(T) p.294
Sitiawan(T) p.295
Sogomana(T) p.296
Sungei Buloh(S) p.297
Sungei Kadut(T) p.299
*Tai Tak(S) p.300
Tampin(T) p.301
Tampoi(S) p.302
Tandak(S) p.304
Tavy(P) p.306
Telaga(S) p.308
Telemong(S) p.309
Telok(T) p.310
Tian Bahru(T) p.311
Ulu Tiram(S) p.312
Weng(T) p.314
Yong Peng(T) p.315

* dropped.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

AKOB SERIES.

The soils of this series, which are formed from riverine alluvium on many of the larger plains lining the main rivers along the East Coast, are characterised by the development of a highly mottled horizon in the subsoil, indicative of a seasonally fluctuating watertable close to the surface. In underdeveloped areas dry padi is the main crop, while tobacco, ground-nuts and other annuals are also common in some areas. These soils can also be used to grow wet padi if irrigation facilities are improved. The topsoil is somewhat variable in texture, yellowish brown in colour and somewhat weakly structured. It changes gradually into a mottled horizon which is usually best developed at a depth of about three feet. The soil is not easily confused with any other recognised series.

Soil Profile (Akob fine sandy loam)

Ah — 1 to 6 inches. Dark yellowish brown to yellowish brown fine sandy loam; weak medium and fine crumb structure; red iron oxide staining common along old root traces, particularly near surface. 1 to 8 inches thick.

Aej — 6 to 17 inches. Yellowish brown clay loam with weak medium subangular blocky structure; free draining. 10 to 20 inches thick.

Bgj — 17 to 55 inches. Yellowish brown clay loam with faint red mottles, becoming more variegated with depth, and mottle colours include also brownish yellow and light yellowish brown with occasional patches of light grey. Small dark manganese speckles may also be present. 24 to 48 inches thick.

Bg — 55 + inches. Gradual transition to a light grey clay loam horizon with decreasing number of light yellowish brown and light red mottles. 20 to 40 inches thick.

Range in Characteristics - The chief variation is in the depth at which the mottled horizon develops, and this is dependent on the depths of the upper and lower levels of fluctuation of the water table which may vary quite considerably over very short distances. There is a fair amount of textural variation. Fine sandy loam, loam, and clay loam types have so far been identified, and doubtless several other types would be established following detailed survey. In some places the dark manganese speckles which occur near the top of the mottled zone may be very numerous but in other cases they may be completely absent.

Relief - Level or nearly level.

Drainage - Well drained in topsoil and upper zone of subsoil and waterlogged in lower horizons. During the north-east monsoon the water table may rise almost to the surface.

Vegetation - Most areas are belukar-covered and very few patches of natural forest cover remain. Dry padi is the most widespread crop and large areas which are covered by melastomaceous scrub are cultivated at irregular intervals with this crop.

Uses - Although dry padi is the commonest crop, this soil can be used for a wide variety of annual and tree crops, including rubber, fruit trees and ground-nuts, tobacco and soya beans, and small quantities of all these crops can be seen growing in the different areas.

Distribution - Occurs in the wider valleys and inland basins or plains of the larger rivers flowing into the South China Sea from the East Coast mountain ranges, being particularly common along the lower reaches of the Sungei Trengganu and the Sungei Kelantan. It also occurs along the banks of some of the larger West Coast rivers, particularly in Perak.

Type Location - Kampong Bukit Payong, Trengganu.

Series established - Kuala Akob near Kuala Brang, Trengganu.

Remarks - This soil is very suitable for annual crops and should lend itself to continuous cultivation if a suitable rotation could be devised. It would also be very suitable for mechanical cultivation. Large areas are at present only cultivated at irregular intervals under a system of shifting cultivation.

Suitability for Agriculture - Class 2 - few, minor limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

APEK SERIES.

This soil, which has not been examined in very great detail, occurs over undulating and rolling land in Trengganu and Johore, and is well exposed in cuttings at several places along the main east coast road between Ulu Chalok and Jerteh, and Kota Tinggi and Jemaluang. The parent material consits mainly of a very soft grey silty shale. The soil is poorly structured, pale coloured, and of low fertility. The depth of subsoil above the parent material is very variable, and loose packed laterite bands may occasionally develop within a few inches of the surface.

The surface soil is most often a loose, very weakly crumbed fine sandy silt loam, or fine sandy clay loam, grey in colour (Munsell 10YR 5/1) with only moderate rooting, and this is underlain at a depth of one or two inches by a rather compact light grey fine sandy clay loam to clay loam, which is difficult to dig but breaks when disturbed to a weak angular structureRoot development is very poor, and small rounded ironstone fragments may be scattered irregularly through this horizon which may be anything between ten and thirty inches in thickness. Occasionally a few medium sized mottles, reddish yellow in colour and with diffuse boundaries may be apparent, particularly in the lower parts of the profile. This is underlain by the parent material horizon of very soft fine banded grey silty shale.

This is a soil of very low fertility which is not only unsuitable for high grade tree crops, but is even of doubtful value for rubber.

This series was first described by Panton (1958) and has subsequently been further recorded by Null, Acton and Wong (1965).

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

BATANG MERBAU SERIES.

These soils are developed from schist rocks over moderately undulating country, and have so far been found in the north of Kelantan in the area around Batang Merbau, and in parts of Johore. They are well drained, deep, loamy soils which are very similar in appearance to certain soils derived from gneiss and granite rocks. They are important agriculturally in the area close to the west bank of the Sungei Kelantan where several large rubber estates are situated on them, but only scattered development has taken place on other parts, which are still largely under forest, or scattered Kampong rubber and secondary jungle. The Batang Merbau soils are similar to the Rengam soils but can be distinguished by their very much weaker structure, particularly in the upper horizons, and by the absence of any distinct colour change to pale red in the deeper parts of the subsoil. They can also be distinguished from the Rengam series by their very much higher proportion of fine sand. They have a lighter texture and weaker structure than the Jerangau series; the Kuala Brang series may resemble the Batang Merbau, but the former are generally shallower, slightly lighter in colour, and have a lower proportion of clay.

Soil Profile (Batang Merbau fine sandy clay loam)

Ah	0 to 1 inch, dark brown (10YR 4/3) fine sandy loam; loose, weak, fine crumb structure with a well developed network of fine roots. 0 to 2 inches thick.
Ae-Bt	1 to 53 inches, yellowish brown (10YR 5/6) fine sandy clay loam possessing a weak medium granular to sub-angular blocky structure; friable; often slightly micaceous; changes gradually with depth to brownish yellow (10YR 6/8) fine sandy clay loam with a rather firmer consistency; rooting is good throughout this horizon which is very well drained and aerated. 30 to 60 inches thick.
Bt-Cu	53 inches, brownish yellow (10YR 6/5) fine sandy clay loam of much firmer consistency than overlying horizons; roots decreases rapidly with depth; fragments of soft decayed schist rock, often indistinguishable from shale, become increasingly common with depth.

Range in characteristics - These soils are fairly uniform over a wide area, and only two types, namely fine sandy clay loam and fine sandy loams have been identified. The profile is normally 6 or 7 feet deep, and decayed fragments of the parent material are very rarely seen even in road cuttings, but on steeper slopes of about 20° and over, a shallow phase development may be found in which schist rock occurs within 2 or 3 feet of surface and colour in the subsoil varies from strong brown to brownish yellow. Small quartz fragments which are the remnants of quartz veins in the parent material, may occur at any depth in the profile.

Terrain - Undulating to hilly and steep, with slopes varying from 5° to even 30°. The soil is known to occur at elevations up to 600 feet but on account of the steep slopes on the higher ground, the soil is only suitable for agriculture at altitudes below about 250 feet.

Drainage - Moderately well drained to well drained.

Vegetation - Good quality forest, which is worked in the Bukit Kemahang Forest Reserve.

Uses - Rubber is by far the most commonly grown crop, both on an Estate and small holder scale, but fruit trees, particularly Durian and Rambutan, hill padi, tapioca and pineapples are all successfully grown.

Distribution - These soils are widely distributed in the undulating country lying west of the Sungei Kelatan between Kuala Krai and Tanah Merah, and in the southern part of the Kemahang Forest Reserve north of the road between Batang Merbau and Nibong. The soils probably occur also in the eastern part of the Khan Lau district of Thailand. They also occur in small patches in south-west Johore.

Type Location - Agricultural Experiment Station, Batang Merbau.

Series Established - Batang Merbau area, Tanah Merah district, Kelantan.

Remarks - This is a good soil which is worth developing more intensively for tree crops. It is rather more accessible than many other areas of undeveloped land in Kelantan, and in fact many areas have been recently felled and planted to rubber.

Suitability for Agriculture - On undulating terrain -
Class 2 - few, minor limitations.

On hilly terrain -

Class 3 - one serious limitation.

On steep terrain -

Class 5 - one very serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

BATU ANAM SERIES.

This soil is characterised by a pale yellowish colour, rather stiff compact consistence, and heavy texture, and is particularly common in west-central Johore and parts of central Pahang around Triang and Mentakab. It is not a particularly fertile soil but rubber grows well, especially if nitrogen and phosphate fertilisers are supplied. The soil occurs most commonly on undulating terrain. Batu Anam series was first named by Owen (1951) but his description of it was meagre. The following description attempts to establish the series and limit the variations within it so that it may be more readily identified and mapped during field work. It can be distinguished from the Durian series by its lighter colour, more compact and mottled subsoil, and general heavier texture, while the Apek and Lokyang series are very much lighter in colour and even more impermeable and compact in the subsoil.

Soil Profile (Recent clearing on rubber estate)

Ah — 0 to ½ inch. Light olive brown (2.5Y 5/4) silty clay; moderate medium to coarse subangular blocky structure; firm consistence; moderately well rooted; 0 to 1 inch thick.

Ae — ½ to 5 inches. Pale yellow (2.5Y 7/4) silty clay; very firm consistence; moderate medium subangular blocky structure; patchy clay skins; moderate rooting; slow internal drainage; diffuse lower boundary; 6 to 24 inches thick.

Bt — 15 to 46 inches. Variegated horizon, light grey (2.5Y 7/2) silty clay with diffuse patches of pale yellow (2.5Y 7/4) and a few dendritic red mottles (2.5YR 5/8), particularly in lower part of horizon; only fair rooting; strong brown (7.5YR 5/6), fine root trace staining common in upper part of this horizon; a few small angular laterite concretions may occur, either separate or in a small narrow band at about 2 to 3 feet from surface; very firm consistency; discontinuous clayskins; medium to coarse moderate angular blocky structure; 24 to 48 inches thick.

Cu — 46 inches +. Decayed silty shale and siltstone bands, light grey in colour with some red and brown mottling.

Range in Characteristics - Silty clay appear to be much the commonest type, but clay or silt textures may be found in places. The main variation within the series depends on the depth below the surface at which the variegated B_2 horizon occurs. The narrow laterite band is very spasmodic in occurrence. There is generally a rapid change in the thickness of the various horizons even over very short distances, and profiles transitional to Apek, Lokyang or Durian series may be common in some areas. The colour of the Ae horizon may be as yellow as 10YR 7/6 or 10YR 6/6, and the predominent B horizon colour in some places is of 7.5YR hue.

Terrain - Mostly gently undulating, but may be found on slopes on to 15 degrees in some places.

Drainage - Imperfectly drained.

Vegetation - Normal dipterocarp rain forest.

Uses - Rubber is undoubtedly the commonest crop. Much of this series is still covered by undisturbed forest, as in the Palong and Kemasul forest reserves.

Distribution - The Batu Anam soil is found mainly in a large tongue of land stretching from Singapore through west and west-central Johore and into east Negri Sembilan and West Pahang. This distribution pattern corresponds fairly closely to the known outcrop of the Triassic sediments in the southern half of the Malayan Peninsular as shown on the latest Geological Map of Malaya.

Type Location - Sungei Kawang Estate, near Bentong, Pahang.

Series Established - Batu Anam area of Johore.

Remarks - The main distinguishing characteristics of this series are:-
(1) The compact, heavy textured B horizon.
(2) Predominantly pale colours in the Ae horizon.
(3) The "blotchy appearance and tendency towards prismatic structure in the B.

Suitability for Agricluture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

BATU LAPAN SERIES.

The Batu Lapan series is one of "the better soils of Kedah", where the total acreage amounts to approximately 13,000 acres. It is confined to the Chungloon-Kodiang-Jitra triangle in north Kedah. The Batu Lapan Series is developed on shale parent material, but unlike the other shale derived soils of Kedah, pisolitic laterite concretions are not present in the soil profile, although pieces of "laterized" shale may be present. Texture varies from silty loam to clay loam. The colour of the soil profile is very different to that of the other shale derived soils of Kedah. The soils are developed on rather variable topography but in general are found on fairly undulating to rolling country.

Typical Profile Characteristics.

Ah horizon 0-2" 10YR 6/4 Light yellowish brown silty loam.

Bt horizon 2-42" 7.5YR 5/6 Strong brown silt loam to clay loam; moderate granular structure; firm consistence; rooting moderately abundant up to 30"; but becoming less with depth.

Cu horizon Parent material very soft and easily crumbled shale.

Colour Variants.

Colour variants of the Batu Lapan series include the following:- (see colour variants confined to B horizon).

7.5YR 5/6 Strong brown silty loam to clay loam - Typical Profile.

(1) 10YR 5/4 Yellowish brown silt loam.

(2) 5YR 5/6 Yellowish red silt loam. (Joseph, 1964).

Suitability for Agriculture - Class 2 - few, minor limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

BRIAH SERIES.

The Briah series is an alluvial soil first identified and named in the Briah area of North Perak, where it occurs along the banks of the Sungei Samagaga on the inner (eastern) edge of the alluvial plain. The soil is almost certainly developed from riverine alluvium under fresh water conditions, and the same soils can be expected to occur in similar geographic situations along other west coast rivers. It has also been mapped in western Johore.

The soil is characterised by a dark brown silty clay topsoil which shows a moderate to strong medium crumb development particularly when well drained and cultivated with tree crops. The depth of this topsoil horizon may vary from about 2 inches to perhaps 6 or 7 inches. In poorly drained locations the topsoil may be black rather than dark brown and at some distance from the river may be highly organic as the soils become transitional to the muck and peat soils with which this series is often associated.

The subsoil is a light brown or light brownish grey silty clay or silty clay loam with pronounced strong brown or brownish yellow colouring along old root traces. This mottled horizon is usually about 12 to 18 inches thick and the mottling forms about 20% of the total soil volume, although occasionally it may be much more intensely developed.

The mottled horizon changes gradually with increasing depth to a light brownish gray horizon without mottles, which usually do not continue below about 24 inches. A bluish-grey sticky permanently moist silty clay horizon with a slight sulphurous odour may be apparent at depths greater that 2 feet, the depth varying with the efficiency of the drainage.

Under natural vegetation the watertable probably seldom drops below a depth of about 18 inches, and flooding is probably frequent during periods of high rainfall, but large areas of this soil are now artificially drained and the watertable more generally fluctuates between about 1 and 3 foot depth.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

BUKIT AJIL SERIES.

The Bukit Ajil soils are shallow, reddish coloured, medium textured types developed on steep slopes in mountainous country. The parent material is quartz diorite. Practically all areas are under virgin jungle in inaccessible parts of the country and the soils are never likely to be of any agricultural importance. The Bukit Ajil series can be distinguished from the Bukit Temiang series by its deeper colour and heavier texture. It is easily recognised and unlikely to be confused with any other series.

Soil Profile (Bukit Ajil sandy clay loam) under hill rice and bananas.

Ah — 0 to 4 inches, dark brown (7.5YR 4/4) sandy clay loam; very well rooted; moderate medium to fine granular structure; very friable and well drained. 0 to 5 inches thick.

Bi — 4 to 26 inches; yellowish red (5YR 5/8) sandy clay loam to sandy clay; friable; moderate medium subangular blocky structure; fair root development. 20 to 40 inches thick.

Cu — 26 to 41 inches, yellowish red (5YR 5/8) sandy clay soil filling interstics between decayed rock fragments and weathered core boulders. Solid unweathered quartz diorite rock begins at 41 inches.

Range in Characteristics - The depth of soil down to parent rock may vary considerably, but decayed boulders generally appear within 2 feet of the surface, while bouldery surface phases are common.

Terrain - Only in mountainous or steep hilly regions on slopes in the 20 - 35° range.

Drainage - Somewhat excessively drained.

Vegetation - Forest, with varieties changing according to altitude.

Uses - It has only been seen under cultivation in one or two isolated patches, where it is used to grow hill rice, bananas and durian. It appears to be a very fertile soil, but cannot be recommended for agriculture on account of the inherent erosion danger.

Distribution - Throughout the country in the steep granite mountain areas.

Type Localities - Kampong Bukit Mempelas area, Ulu Trengganu district.

Source of name - 1,000 foot mountain in Ulu Trengganu district, Trengganu.

Suitability for Agriculture - Class 5 - one very serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

BUKIT LUNCHU SERIES.

This series is a reddish yellow to yellowish red, coarse textured soil that is found in hilly and mountainous country. It is developed from granitic rocks and frequently is associated with the Bukit Temiang series. However, unlike the Bukit Temiang series which is found on steep slopes and exhibits a red hue (2.5YR) in its subsoil, this soil occupies the more level or gradual slopes as well as the summits of hills and never displays such a dark coloured subsoil. Bukit Lunchu soils support a luxuriant vegetative cover under jungle and rubber grows well in developed areas.

Soil Profile (Bukit Lunchu sandy loam - belukar)

Ah — 0 - 6 inches, dark grey brown (10YR 4/2) sandy loam; weak medium crumb structure; friable; abundantly rooted. 4 - 8 inches thick.

Aej — 6 - 8 inches, reddish yellow (7.5YR 7/8) coarse clay loam; structureless to weak medium crumb; loose; not abundantly rooted; well drained. 12 - 16 inches thick.

Ac — 18 - 30 inches, reddish yellow (5YR 6/8) very coarse sandy clay loam to gravelly coarse sandy loam; st ucture less; loose; well drained. 20 - 40 inches thick.

Cu — 30 - 60 inches, yellowish red (5YR 5/6) gravelly coarse sand with partially decomposed granite rock fragments. Clay to clay loam filling the interstic..s; loose when moist and firm when dry; gradual transition from previous horizon.

Range in Characteristics - The actual depth of the profile can vary considerably but is usually somewhat deeper than the associated, Bukit Temiang series. Huge granite boulders generally are exposed at the surface. Colours in the surface soil vary from dark grey brown (10YR 4/2) to brownish yellow (10YR 6/6) while in the upper layers of the subsoil colours may range from reddish yellow (7.5 7/8) to yellowish red (5YR 5/8). Texture is quite consistent below the surface soil where it may range from fine sandy clay loam to sandy loam.

Terrain - Commonly found in mountainous and hilly country, and at altitudes exceeding 175 feet. It does not, however occupy the steep slopes but is found on the level areas in rugged topography.

Drainage - Somewhat excessively drained.

Vegetation - Varying forest cover, as well as rubber.

Uses - Has only been under forest and rubber.

Distribution - Found associated with Bukit Temiang series in steep topography in many parts of south Johore and possibly in other States.

Type Location - Plentong area, south Johore.

Source of Name - 573 foot hill near Plentong, Johore.

Remarks - This soil should be classed as occurring with the Bukit Temiang series and thus constituting a component of the Bukit Temiang - Bukit Lunchu Association.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

BUKIT PANJANG SERIES.

This is a deep, well structured red soil developed over basic igneous rocks of noritic composition and is found in undulating and hilly country west of the Bukit Timah Road on Singapore Island. Drainage is good and roots are able to penetrate deeply into the subsoil so that it is ideal for tree crops.

A strongly structured dark brown or dark reddish-brown clay to sandy clay loam about 6 inches thick is characteristic of the surface soil, which is excellently drained and aerated. This is underlain by a reddish-brown soil of similar texture and good friable consistence which is easily dug, very well rooted, free draining and well aerated. There is a gradual colour change to red at a depth of between 18 inches and 2 feet which coincides with a drop in organic matter content as shown by analysis. However, the soil below this level is still an ideal rooting medium as judged by the profile rooting which often continues to a depth of 4 feet. Below this, the red clay becomes more sandy or even gritty and inclusions of decomposed norite rock appear. At first these are only an inch or so across and can be easily broken with a trowel or even, in some cases, crushed between the fingers, but at a depth of 6 feet hard resistant boulders of the decomposing parent material are reached, and at this depth tree roots have disappeared and further digging is impossible.

Unfortunately this soil is not very widespread and has a rather patchy distribution around the lower sides of the steeper norite hills. A gradual shallowing of the profile takes place towards the hilltops until finally the decomposing fragments of parent material appear within 6 inches of the surface.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

BUKIT RESAM SERIES.

The soils of this series occur in hilly country limited largely to a range of low hills situated a few miles west of Johore Bahru and southwest of Gunong Pulai. This hilly range is oriented in a pronounced southeast-northwest direction with parent material consisting of banded siltstones, shales, and sandstones of Triassic age. Laterite and laterized rock fragments normally occur within the first three feet of a profile. On steeper slopes these concretions and fragments appear nearer the surface... sometimes even exposed on the surface, and conversely, on the gentler slopes where erosion is negligible the laterite may be at depths greater than four feet.

This range of hills is oriented in the same manner as those on the west portion of Singapore Island, and it could be surmised that they are a continuous chain bisected only by the Johore Strait. If this conjecture could be substantiated geologically it would be highly probable that soils which were recognised in the hill country of West Singapore Island would correlate with this series.

Soil Profile (Bukit Resam Loam)

Ah — 0 - 1 inch, light yellowish brown (10YR 6/4) loam; strong medium crumb; friable.

Ae — 1 - 24 inches, yellowish brown to brownish yellow (10YR 5/8 - 6/8); sandy clay loam to clay loam; strong medium subangular blocky; firm. Incipient laterite near the lower reaches of this horizon.

Bcn — 24 - 48 inches, reddish yellow (5YR 6/8) gravelly clay packed with angular laterite concretions; structure is obscured.

Bt — 48 - 70 inches, reddish yellow (7.5YR 6/6) clay with some sand grains; moderate medium subangular blocky; firm.

Range in Characteristics - Subsurface soil colours range between the 10YR - 7.5YR Hues while much stronger hues of the 5YR -2.5YR classes may predominate below the concretionary band. Texturally, sandy clays to sandy clay loams prevail above the Bcn horizon whereas below this horizon, and depending on the amount of quartz present, clay to gravelly clay is normal. Compaction can be severe in this soil when droughty conditions appear, but under normal conditions consistence ranges between the friable and firm clases.

Terrain - Occurs over rolling, hilly and steep topography where the incidence of erosion varies from slight to severe.

Use - Rubber and dusun are the most common crops planted.

Distribution - Limited to a range of low hills in southwestern Johore.

Type Location and Establishment - 15 milestone on Gelang Patah-Johore Bahru Road.

Remarks - Owing to its rather limited distribution this series could be considered as not being of great agricultural importance.

Suitability for Agriculture - Class 3 - one serious limitation. On steep topography Class 5 - one very serious limitation.

SOIL SCIENCE DIVISION- DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

BUKIT TEMIANG SERIES.

This series occurs only on steep slopes in hilly and mountainous areas, It is developed from granite rocks and unweathered boulders often litter the surface. The profile is shallow in comparison with the deeply weathered profiles formed from similar rocks on gentler slopes, and seldom exceed three or four feet to the parent material horizon. Most areas are covered by jungle and the soil has very little agricultural value on account of the steepness of the slopes, and the high altitude at which it is generally found. The only other series with which these soils are likely to be confused is the Bukit Ajil series, but the latter soils are deeper red in colour, more heavily textured, and rather better structured.

Soil Profile (Bukit Temiang coarse sandy loam)

Ah — 0 to 1 inch, dark brown (10YR 4/3) coarse sandy loam; weak medium crumb structure; loose; very well rooted. 0 to 1 inch thick.

A-C — 1 to 35 inches, strong brown (7.5YR 5/6) coarse sandy loam; changing gradually with depth to gravelly coarse sandy loam; firm consistency; moderate medium subangular blocky structure; roots are not numerous, and diminish rapidly down the profile; very well drained; one or two rounded granite boulders up to 6 inches in diameter scattered at varying depths. 20 to 40 inches thick.

Cu — 35 + inches, red (2.5YR 4/8) gravelly coarse sand; very firm; filling spaces between large and small decaying granite boulders; gradual transition from previous horizon.

Range in Characteristics - The actual depth of the soil profile in this series may vary quite considerably over very small areas, depending on the closeness of the hard parent material to the surface. Very commonly the surface may be littered with boulders, sometimes up to 20 feet in diameter. Colours vary between strong brown (7.5YR 5/6) and brownish yellow (10YR 6/8) in the upper layers of the subsoil.

Terrain - Always found in steep/country and most commonly at altitudes exceeding 250 feet. Normal slope range between 20 and 35°.

Drainage - Somewhat excessively drained.

Vegetation - Varying forest cover, with individual varieties changing with altitude.

Uses - The lower slopes in some areas may be cultivated with hill padi, bananas, sweet potato and sometimes rubber but the greater part of this series remains under virgin jungle.

Distribution - Found wherever granite rock occurs in mountainous and steep hilly country throughout Malaya.

Type Location -Kampong Betong area, Ulu Trengganu.

Series Established - Bukit Temiang area, Marang district, Trengganu.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

BUKIT TUKU SERIES.

This soil is one of the poorest in the Kelantan "deficiency area" and it occupies 13,000 acres, mainly on the upper terrace in the central part of the area. The vegetation associated with this series is poor, mixed secondary jungle growth with frequent clumps of bamboo.

Variations in the topsoil texture, from loamy sands to sandy loams, occur within the series but mapping detail was not sufficient to differentiate the various types.

Soil Profile.

Pit situated on flat ground at top of gentle slope; spindly secondary jungle growth and a few clumps of bamboo.

0 - 1 in.	Light brown fine sandy loam with many roots; fine weak crumb structure, easily crushed; free drainage.
1 - 6 in.	As above, with lighter colour.
6 -14 in.	Very pale brown fine sandy loam with few roots; fine weak crumb structure; few faint small orange mottles.
14 -21 in.	Whitish-grey sandy clay loam matrix with few distinct small orange mottles; moist soil, slightly sticky; weak crumb structure; imperfect drainage.
21 -32 in.	As above, with orange mottling common.
32-38 in.	White sandy clay matrix with many prominent medium red-brown mottles; imperfect drainage.

This soil was first described by Arnott (1957).

Suitability for Agriculture - Class 4 - more than one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

BUNGOR SERIES.

This series is characterised by a yellowish brown colour and fine sandy clay loam texture. It has a deep profile derived mostly from quartzite and some shale parent materials and occurs on slopes ranging from 5 - 40°. It has medium to rapid internal drainage and usually 3 - 4 feet root distribution. Occasionally a band of laterite pebbles is found in the profile. This soil occurs on many of the steeper hills and mountains in the East Pahang region. It is often similar in appearance to the Munchong series but is generally coarser textured and yellower in colour.

Soil Profile

Ah — 0 - 5 inches depth, is a 10YR 4/4 dark yellowish brown fine sandy clay loam with a weak fine granular structure and very friable, gradual boundary.

Aej-Bt — 5 - 39 inches, is a 10YR 5/6 yellowish brown fine sandy clay of moderate medium subangu blocky structure and friable consistence, diffuse boundary.

Bt-Cu — 39-120 inches depth is a 10YR 5/6 yellowish brown fine sandy clay of strong medium subangular blocky structure and firm consistence. Usually no mottles and no laterite are found. A few pieces of shale and quartzite are present in this horizon.

Range in Characteristics - Depth of the profile will vary with the slope of the hill, also the colour may be paler in places (pale yellowish brown) or alternatively darker and more reddish coloured.

Terrain - Terrain varies greatly because these soils are developed on steep broken hill country of shale and quartzite. Slopes therefore range all the way from 5 - 40°. The average slopes will be around 15 - 20°.

Drainage - The soils are well drained and the internal drainage is usually rapid, or medium where the clay content is higher.

Vegetation - Most of this soil occurs in Dipterocarp rain forest.

Uses - Much care is needed in growing crops on the slopes greater than 20° because of the possible erosion harzard. These soils could probably grow rubber and fruit. Much of the land occupied by these soils might be best used as forest reserve.

Distribution - These soils are distributed all along the hill ranges running on the east side of the Belimbing new road south-west of Kampong Paya Bungor, Pahang, and probably extensively developed north and south of this region.

Type Location - ¼ milestone on the Belimbing new road where a roadside cut shows a deep development of this soil.

Series Established - On the west side of the lower Sungai Lepar Valley, in east Pahang.

Source of Name - Name is taken from the Sungai Bungor which runs through the series area.

Suitability for Agriculture - Class 3 - one serious limitation. On steep terrain - Class 5 - one very serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

CHEMOR SERIES.

This series was first described by Owen (1951) but has not been identified with certainty since. For this reason it may eventually be eliminated from the Register of Common Soil Series.

It is freely drained, of alluvial origin and consists of yellow to reddish yellow sandy loams to clay loams. Laterite concretions are usually absent.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

CHENAIN SERIES.

This soil which is developed from quartz porphyry parent rocks has been found to occur in the Sungei Siput district of Perak, east of Kampong Lasah and in patches along the New Military Road, south of Kampong Lasah. It resembles the Batu Anam series except that it is heavier textured than the latter and occasionally stronger coloured. The most characteristic feature of this soil is that it has a mottled appearance throughout the profile. Very often parallel bands of quartz rocks appear at varying depths. Another striking feature is the waxy feeling of the soil when pressed between the fingers. Often decaying quartz porphyry parent rocks are found in deep section.

The topsoil is a silty to very fine sandy clay loam with a moderate crumb structure and friable consistency. The colour varies from pale brown to brown. The topsoil changes into a mottled subsoil, the mottles often increasing with depth. The colour of the subsoil varies considerably from pale yellow to yellowish brown. The texture is often silty clay to clay loam with a rather coarse structure and firm consistence. Parallel bands of quartz rocks occur at varying depths. Below this band the soil becomes very compact and has a high percentage of mottles.

A very pale coloured variant of this soil is mainly found on more gently sloping land and it is likely that the colour change is due to the topographical differences.

Suitability for Agriculture. - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

CHUNGLOON SERIES.

This soil series is shale derived like the Gajah Mati series, although the differences between these two soils are quite marked.

An interesting feature of the Chungloon series is the presence of small black concretions throughout the profile, although this becomes more dense with depth. "Normal" lateritic concretions are also present in the profile, though this tends to be more massive when exposed. Deep planting holes will need to be dug for rubber cultivation on these soils.

Two phases of the Chungloon series, have been recognised, according to the depth of the water table.

In very flat to low-lying situations, laterite tends to be more massive and therefore less "penetrable" than in the more freely draining topographical situations.

Approximately 21,000 acres of this series is present in Kedah where it is developed north of the Batu Lapan-Kodiang road and extending northwards to the Siam border.

Typical Profile Characteristics.

Ah	horizon	0-1 in.	7.5YR 4/2 Dark brown clay loam. Very fine crumb structure.
Aej	horizon	1-9 in.	7.5YR 5/6 Strong brown clay loam. Very fine crumb structure.
Bcn	horizon	9-24 in.	5YR 5/6 Yellowish red clay loam. Extremely friable consistency with small black concretions. Moderately weak, medium subangular blocky structure. Pisolitic laterite concretions present. Fairly dense.
Bcnv	horizon	24-+ in.	5YR 5/9 Yellowish red clay loam, matrix. Laterite concretions becoming dense and massive. Difficultly penetrable.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

DURIAN SERIES.

The soils of this series are developed from either siliceous shales, phyllites, or very fine grained sandstones probably of Triassic Age. Occasionally, intruded quartz veins are also apparent. They occur intermittently over gently to strongly sloping topography in areas where Batu Anam and Malacca series exist. Texture varies considerably within the series but clay and clay loam are the commoner classes. Laterite development is not an uncommon feature but usually occurs at the three foot depth and below, hence many auger borings fail to reach this ironstone formation. The laterite band is normally quite thin and is rather loosely packed thereby not hindering root penetration. Below the laterite lies a reddish yellow clay with some sand grains and prominent red stains. The series is distinguishable from the Batu Anam and Malacca series by its more uniform colour, coarser texture, and better structure in the upper horizons than that of the former. As compared with the latter, the Durian series has a deeper as well as a less strongly pronounced laterite band.

Soil Profile.

Ah — 0 to 1 inch, dark brown (10YR 3/3); loamy fine sand; structureless; loose.

AB — 1 to 36 inches, brownish yellow (10YR 6/6); loamy clay to clay loam; strong medium subangular blocky breaking to a medium crumb; firm to very firm consistence.

Bcn — 36 to 40 inches, laterite band imbedded with quartzite and shale fragments.

Bt — 40 to 60 inches, reddish yellow (5YR 7/6) with red (2.5 YR 4/8) mottles; clay; moderate medium subangular blocky; firm.

Cu — 60+ inches, very pale brown (10YR 8/4) with the same red mottles; matrix is a firm, blocky silty clay with partially decomposed shale or phyllite and quartz.

Range in Characteristics. - Texture can range from fine sandy loam in the topsoil to silty clay and clay in the subsoil. Colour has a wide variation as well, depending on the iron content of the parent material, it may range from yellow (10YR 8/6) to yellowish red (5YR 5/8).

Firm and very firm consistences are typical and the subsoil is commonly moderately compact. The laterite band is normally present, but may be absent.

Terrain - Undulating to rolling with slopes seldom exceeding 15°.

Drainage - Imperfectly to moderately drained.

Uses - Rubber and some oil palm are being grown, but most of the area still remains under forest.

Distribution - In central Johore and Pahang.

Type Location - Kampong Gajah, along the Kluang-Jemaluang Road.

Remarks - Often mapped in association with Batu Anam and Malacca series.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

GAJAH MATI SERIES.

This is by far the most extensive soil in the State of Kedah. The total acreage of these soils amounts to approximately 360,000 acres - almost all of which are distributed in central and south Kedah.

This soil has been developed on predominantly shale parent material on fairly undulating to gently rolling terrain. Slopes are usually of the order of 5-8° and seldom exceed 15°. The soils are characterised by the presence of laterite concretions at variable depths in the soil profile, but generally at a depth of 15 - 18 inches from the surface. The "laterite" which is invariably in the form of pisolitic concretions is always fairly loose and quite "penetrable" to the roots of the rubber trees, which are grown extensively on these soils. In some places the laterite is massive and impenetrable.

The profile sequence of this soil series consists of a clay loam topsoil over a penetrable laterite zone (varying thickness) which in turn overlies a "pallid" zone of kaolinitic clay. This zone is usually over 6 feet from the surface. Drainage of the soil is good.

Typical Profile Characteristics.

Ah horizon 0-1 in. 10YR 5/4 Yellowish brown fine sandy loam. Moderate to strong fine subangular blocky structure. Fairly friable consistency.

Ae horizon 1-15 in. 7.5YR 5/8 Strong brown clay loam. Moderate to strong medium subangular blocky structure. Firm consistency. Fairly good rooting.

Bcn horizon 15-48 in. 7.5YR 5/8 Strong brown clay loam. Dense pisolitic laterite concretions. Somewhat elongated (¼ to 1 inch in size).

Range in Characteristics - The "variants" of this soil series differ from one another in colour of the subsoil (Ae horizon). All "variants" are however, texturally similar.

The colour ranges are as follows:-

7.5YR 5/8 Strong brown clay loam (typical)
10YR 5/8 Yellowish brown clay loam.
5YR 5/8 Yellowish red clay loam.

Suitability for Agriculture. - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

GUNONG PADANG SERIES.

This soil is developed on granite at altitudes of 4,000 feet and above and was first described on the Gunong Padang plateau in the mountains of central Trengganu. The cool climate and acid parent material have produced podzol characteristics in the profile, which is marked by a peat layer up to 1 foot thick, underlain by a bleached mineral horizon which grades at depth into a faint pale red band of accumulated sesquioxides.

This series was first described by Panton in Reconnaissance Soil Survey of Trengganu, bulletin 105, Department of Agriculture, 1958.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

HALU SERIES.

This is an easily recognised soil which is developed from recent rhyolitic ashes, possibly redeposited as alluvium. It has only been located so far in the Lenggong area of Perak, and in the Raub district, Pahang, where it is found over level or nearly level land in valley bottoms and other low elevations. The surface is often hummocky with small rounded hillocks up to 5 feet in height and 10 or 20 feet in diameter. The soil is very loose, silty or very fine sandy in texture, and very pale coloured (commonly 10YR 7/1, light grey, in the subsoil) and drainage is very rapid. The topsoil is loose to very friable, but the subsoil tends to pack closely causing auger spin. The subsoil is normally deep and uniform except for the occasional appearance of horizontal bedding lines in the lower horizons, which indicate the boundaries between successive layers of the parent material. It does not occur over very extensive areas, and most developments of this soil are less than 50 acres in extent.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

HARAD SERIES.

This soil, which is derived from quartz porphyry rocks, has very different characteristics from the Chenain series. It is developed on more strongly sloping land and resembles a Rengam series. The main feature is a mottled zone which varies in depth from 32" to 40". Small bits of feldspar phenocrysts are normally present in the B horizon, evenly distributed.

The top soil is a sandy loam to clay loam, dark yellowish brown with a fairly loose consistence. The colour changes gradually to a yellowish brown and sometimes strong brown, sandy clay loam, with moderate structure throughout the B horizon. The depth of the B horizon varies from 32-40" and occasionally a deeper section may occur but this is not typical of this series. Below the B horizon the soil becomes very compact, and strongly mottled. This is a very typical feature of this soil. A band of quartz rocks about 5-8" thick normally appears below the mottled zone.

Laterite phases of this series were also found. The lateritic concretions are loosely packed and distributed evenly throughout the mottled zone.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

HARIMAU SERIES.

Soils of this series are developed from fine to medium textured parent material considered to be of Older Alluvial origin. They are among the commonest of the Older Alluvial soils, and occur predominantly over gently sloping topography at elevations ranging from 50 to 200 feet A.S.L. The soils are generally characterised by weak or pale colours as well as exhibiting a general increase in compaction as soil depth increases. Frequently, they are found occupying the lower slope positions on landscapes where soils of the Rengam series occur. In this instance, it is probable that these soils could be developed over colluvial deposits of granitic origin, and in such cases boundary delineation is sometimes difficult.

Soil Profile (Harimau fine sandy clay loam)

Ah — 0 - 1 inch, dark brown (10YR 4/3) to yellowish brown (10YR 4/4); loam; weak fine crumb; friable consistency. ($\frac{1}{2}$ - 4 inches).

AB — 1 - 26 inches, brownish yellow (10YR 6/8) to yellow (10YR 7/8); fine sandy clay loam; moderately developed crumb to subangular blocky; firm to friable consistency. (18 - 36 inches).

Btj — 26 - 48 inches, brownish yellow (10YR 6/8) to yellowish brown (10YR 5/8); sandy clay loam with faint yellowish red, vertically oriented streaks appearing near the lower reaches of this horizon. Structure, when dry, tends to be coarse and blocky with a weakly compact consistency. When moist, a medium subangular blocky structure and firm consistency is apparent.

Cu — 48 - 54 inches reddish yellow (7.5YR 7/8 - 6/8); gritty clay loam; massive; friable to firm.

Range in Characteristics - Colour ranges to 7.5YR hue of the Munsell Soil Colour chart and is generally confined to the higher chroma and values. Texture is commonly in the fine sandy to sandy clay loam range and coarse sand is seldom exhibited above the 36 inch depth. Structure, on the whole, is usually poorly developed, while consistency ranges in the firm to compact classes. A diffuse band of laterite is sometimes encountered in this series.

Drainage - In the upper 2 feet of the profile, drainage is medium while below this depth drainage becomes slightly impeded owing to the compacted, poorly structured subsoil.

Uses - Rubber is the most widely grown crop on these soils, and the growth and yield is below that normally attained on granite derived soils. Some dusun is also planted.

Type Location - It was first found along the Johore Bahru - Kota Tinggi road near Harimau Estate.

Remarks - These soils occur in association with the Tampoi and Ulu Tiram series, and from verbal reports of estate managers, it would appear that they tend to be deficient in some of the major nutrients, and probably also manganese. A cautious approach should be made in the matter of recommending these soils

for agricultural development purposes.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

HOLYROOD SERIES.

General.

This soil is a brownish yellow fine sandy loam having a rapid internal drainage and developed from low terraces of Sub-recent alluvium with slopes ranging from 0-3°. It is strongly leached and is very low in the plant nutrients needed for agricultural crops. Most areas of this soil support only poor jungle vegetation and lallang at the present time. This series is found in eastern Pahang, southern Perak and southern Johore.

Soil Profile.

Od — 2 - 0" organic matter and dead leaves and twigs from scrub and lallang.

Ah — 0 - 4" depth with gradual boundary to the Ae, fine sandy loam and colour of 10YR 4/4 dark yellowish brown. Structure is weak fine granular and consistence is very friable.

Ae — 4 -45" with diffuse boundary to the B_2, 10YR 6/6 brownish yellow sandy loam; consistence friable to very friable; weak fine subangular blocky structure.

Ac — 45"+ depth, colours of 10YR 8/8 ... to 2.5Y 8/4 pale yellow sandy loam to weak fine subangular blocky structure and very friable consistence.

Range in Characteristics - This series may range from a very loose sandy loam or loamy sand ranging in colour from pale yellowish brown (10YR 6/4) to white to dark yellowish brown or yellow sandy clay or fine sandy clay loam. A grey variant, with colours predominantly light grey (10YR 7/1) in the subsoil, has been recognized in Johore.

Terrain - Terrain is flat to gently undulating with slopes usually from 0-5°. Elevations are about 25 to 100 feet.

Drainage - Internal drainage is usually rapid.

Vegetation - Vegetation generally found is natural Dipterocarp rain forest, but the tall trees are never very large. Rubber does rather poorly.

Uses - Undisturbed jungle seems to be the best use for this soil as forest reserve land. There would be a heavy fertilizer requirement if this soil were used for agriculture and the soil would tend to be droughty during the dry seasons.

Type Location - In Pahang this soil is found at the east side of the Kuantan airport just north of the highway; and south of the 7th milestone at about the 13th milestone on the Gambang to Kampong Lepar road. The type location in Johore is near the 42nd milestone from Johore Bharu on the Mersing road, and in Perak near the 19th mile from Ipoh on the Kuala Lumpur road.

Source of Name - Holyrood Estate, Perak.

Suitability for Agriculture - Sandy texture throughout - Class 4 - more than one serious limitation. Fine textured - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION -DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

JAMBU SERIES.

This soil occurs in the Simpang area between Kampong Simpang Haji Adam and Kampong Perak, several miles to the south-west of Taiping, Perak, and also in western Johore. It is developed over former raised beach deposits running parallel to the coast, but is now situated a few miles inland.

Texture of the soil is fine to medium and mixed occasionally with a variable but small percentage of clay, (roughly between about 2 and 10%). The sand in the surface layer is finer than that in the subsoil, which is usually of medium texture. In the absence of organic matter or vegetation cover, the soil exhibits a profile of light grey (10YR 7/1) to almost white sand. Where organic matter and vegetation exist the topsoil, ranging up to 10YR 6/1 to 3/1), is underlain by a grey to light grey, or more rarely, pale yellow subsoil. The condition of the subsoil is moist as the watertable generally fluctuates between 20 and 36" depth. The top soil shows a very loose consistence, and is practically structureless.. In more exposed or more recently cultivated situations the surface may be covered by a layer of white sand wash.

Soils of the Jambu series are likely to possess a very low fertility. They show several features in common with the more recent Rudua series which occurs extensively along the east coast.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

JARAU SERIES

General.

This series comprises a grey to greyish brown sandy loam to clay loam of poorly drained areas and is found in association with fresh water swamps. These soils vary in depth to the watertable and occupy terraces usually found at elevations of 30 feet or less. Generally they have a dark grey or black very thin topsoil only 2 or 3 inches thick and below is lighter coloured grey to white and usually the subsoil is mottled with yellow colours.

Soil Profile.

Ah — 0-2". Abrupt boundary to the Agj horizon. 5YR 2/1 black to grey sandy loam to clay loam of a granular structure and friable.

Agj — 2-6". Abrupt boundary to the Bg, dark grey to greyish brown sandy clay loam. It has moderate medium sub-angular blocky structure and very friable consistence. Mottles may be present.

Bg — 6-31". Diffuse and irregular to the Cr horizon, with 70% light grey 10YR 7/1 and 30% mottles of yellowish red to brownish yellow colour sandy clay or clay loam; friable consistence; waterlogged.

Cr — 31-60" + of usually white or light grey coloured coarse to fine sandy clay loam or loamy sand with no structure; very friable; waterlogged.

Range in Characteristics. - This varies very much in colours and textures and internal drainage. They may be grey coarse sandy loams, to a clay loam of nearly white to grey brown colour. Usually clay is found mixed with coarse sands, and mottles are present for varying depths. They may resemble the Akob series but lack the developed topsoil horizon of brown colour, are less well drained and have coarse sand present in the profile. They may also resemble the Penor series, but the latter has no mottling is grey coloured, highly waterlogged, and is mostly sandy clay loam with sticky clay and no developed topsoil horizon.

Terrain - Terrain is almost always flat and slopes range from 0 to 2°.

Drainage - The surface may be covered with water during monsoon seasons and they may be drained from a few inches to a few feet during the dry monsoon of the year. Generally, they are poorly drained.

Vegetation - Usually disturbed areas, vegetation is grass or sedges. Very few trees grow on these highly water-logged light soils which lack a topsoil horizon. Where natural vegetation is found, it comprises part swamp, part lowland type vegetation with no large trees.

Uses - Desirable grasses suitable for grazing may have a future on some of these soils which have been disturbed.

Distribution - These soils are distributed mostly along the edges and inside the fresh water swamps of East Pahang. They are associated with peats, Akob and Penor series. They are found mostly on the west side of the Pekan road below the 11 milestone and north of the riverine soils along the Sungei Pahang.

Type Location - The 11th milestone of Pekan-Kuantan road. 2 pits on thePulau Manis to Gambang trail also show this series. They are located just inland from the Telemong-Akob soil association and on the west bank of the Sungei Rasau where the path crosses.

Series Established - It is established on the extreme lower edge of the old terrace land towards the sea and is in association with the fresh water swamp land.

Source of Name - Name is taken from the Sungei Jarau north of Pekan on the Kuantan-Pekan road. This river runs near this series.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

JEMPOL SERIES.

General.

This is a clay textured soil of red colour derived from shale and having a small laterite pebble band at about 30 inches depth. In some places it may be derived from andesitic tuff and conglomerate, particularly near Maran, Pahang. It is moderately well drained and quite friable in consistence. This soil is probably well suited for rubber and fruit crops with good management to maintain fertility and reduce erosion.

Soil Profile.

Ah — 0 - 5" with gradual boundary to AB. The colour is 10YR 4/4 brown and texture is sandy clay loam. It has a moderate medium granular structure and is friable in consistence.

AB — 5 - 28", with abrupt boundary to Bt, 5YR 5/6 yellowish red, and has a moderate medium subangular blocky structure, consistence friable.

Bt — 28-42", with gradual boundary to C horizon. 5YR5/6 yellowish red clay with moderate medium subangular blocky structure and consistence friable. Laterite pebbles form a band in the upper part of this horizon but is rather a weak one.

C — 42 - 78" + clay consisting of 30% mottles of 10YR 7/2 light grey and 70% 2.5YR 5/6 dark red colour. Structure is moderate medium subangular blocky and is friable in consistence. Pieces of shale are present in this horizon.

Range in Characteristics. - Most of the soils are brown and yellowish red (5YR) to reddish brown (2.5YR).

Terrain - Slopes generally range from 5 to 15°; the majority being around 10°. The land is hilly to undulating.

Drainage - The internal drainage of this series is medium and it tends to hold moisture rather well. External drainage is rapid.

Vegetation - The vegetation is natural Dipterocarp tropical rain forest.

Uses - This soil can be utilised for agriculture. Due care is needed to protect it from erosion since most of the land is hilly. Rubber and fruit would probably be the best crops for this soil.

Type Location - A roadside cut at grid reference 203638 of map sheet 30/8 Pahang. The roadside cut is about ¾ miles east of the Sungei Berkelah bridge on the Kuantan-Maran highway.

Suitability for Agriculture - Class 1 - no limitations. Slopes greater than 12° - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

JERANGAU SERIES.

These soils are found in undulating country developed over acid igneous rocks of granodiorite type. They are deep, well drained soils suitable for a wide variety of crops and they have a fairly wide distribution throughout Malaya. The profile is similar to that of the Rengam series, but differs in having a finer grained and heavier texture, slightly redder colour, and more strongly developed structure. The Batang Merbau soils are slightly lighter coloured, less friable at depth, and have a higher proportion of fine sand. The Durian series differs in having a more clayey texture and a firmer, more compact subsoil.

Soil Profile. (Jerangau fine sandy clay loam).

Ah — 0 to 1 inch, dark brown (10YR 4/3) fine sandy clay loam; moderate to weak fine crumb; well rooted. 0 to 2 inches thick.

Ae/Bt — 1 to 62 inches, strong brown (7.5YR 5/8) fine sandy clay loam to fine sandy clay; deep horizon showing slight increase in clay content with depth; friable for first 2 or 3 feet and increasingly firm below; fine subangular blocky structure; very well rooted down to about 5 feet. 40 to 70 inches thick.

Cm — 62 + inches, yellowish red (5YR 5/6) sandy clay loam; firm, very few roots.

Range in Characteristics - Texture is usually fine sandy clay loam, or clay loam, but occasionally the proportion of coarse sand may exceed that of fine sand, and some difficulty may be experienced in deciding whether to map as Jerangau or Rengam series. This transitional type is rather common in some granite areas, and is due to the fact that the composition of the igneous rock, which is the chief factor governing the differences between the two series, may change very gradually from a quartz rich to a less acid variety over a very wide band. The soil commonly develops a lighter colour near the foot of a hill than on the upper slope or hill top. Laterite phases are occasionally seen, either on gently sloping hill tops, or at lower levels as fringe developments near the boundaries with waterlogged alluvial soils; it has been observed that the former phase is most common on the west side of the main range, while the latter development seems more typical along the east side of Malaya. A red variant, with colours of 2.5YR 5/4, 2.5YR 4/6, has been recognised in Johore.

Terrain - Varies from hilly to gently undulating with slopes between 2 and 20°. Elevation seldom exceeds 250 feet.

Drainage - Medium to rapid internal drainage, rapid runoff may occur in some areas in the 5 to 15° slope range if the cover is insufficient.

Vegetation - Good quality forest.

Uses - Is widely planted in different parts of the country with such crops as rubber, oil palm, and various local fruits.

Distribution - Has been mapped in Kelantan, Trengganu, Pahang and in Johore, and probably occurs in most areas where Rengam soils are known to exist. The total acreage of Rengam, however, is far greater than that of the Jerangau series.

Type Location - Federal Experiment Station, Jerangau, Trengganu.

Series Established - Ajil-Jerangau road area, Ulu Trengganu district.

Source of Name - Small kampong on edge of Sungei Dungun.

Suitability for Agriculture - Class 1 - no limitations. On slopes greater than 12° - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

KAKI BUKIT SERIES.

This soil occurs at the foot of limestone outcrops in Kedah and is regarded as being 'intermediate' in age between the 'juvenile' Langkawi and the "senile" Kodiang. It is characterised by a fine sandy loam topsoil over a clay loam subsoil, with weak structure in the topsoil becoming strong with depth. Roots are abundant within the top 2 feet.

Typical Profile.

Ah	0 - 1" 7 5YR 5/4 brown fine sandy loam with a weak fine granular structure.
Ae	1 - 14" 7.5YR 4/6 dark brown loam with a weak to moderate fine subangular blocky structure.
Bcnj	14 - 48" 2.5YR 4/6 red clay loam with a moderate to strong medium subangular blocky structure. Small angular laterite concretions appearing from 23 inches.

Suitability for Agriculture - Class 2 - few minor limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

KALA SERIES.

This soil, which is developed from certain types of porphyritic granite, has been found in North Perak, particularly in the region between Grik and Lenggong. It is best developed on steep and hilly, but deeper phases, often transitional to Rengam series, may occur on rolling to undulating land. The peculiar features of this soil are due largely to the very resistant nature of the feldspar phenocrysts in the parent material, which weather very slowly in comparison with the surrounding matrix minerals.

The topsoil is a coarse sandy or gravelly clay loam, brownish yellow to strong brown in colour, but often overlain by a loose coarse sandy or gravelly layer where erosion has recently occurred. This topsoil changes gradually to a brownish yellow, strong brown, or even yellowish red coarse sandy or gravelly clay loam in which pale coloured partly decomposed feldspar phenocrysts appear, giving a coarse mottled appearance to the subsoil. The depth of this subsoil horizon varies according to the ground slope, and the relict structure of the decayed parent material becomes more marked with increasing depth, while undecayed boulders of porphyritic granite may occur within a few feet of the surface on the shallower phase developments of this soil. The partly decayed feldspar phenocrysts can often be broken down by pressure between the fingers to a coarse angular white sand.

In the market gardening and tapioca cultivation areas to the north of Lenggong erosion has been widespread in the past, and is very obvious at the present day. Continuous cultivation and erosion has resulted in the removal of much of the finer grained material in the surface layers and the formation of a residual coarse grained surface wash. Extensive coarse colluvial dumps are also common along the bottoms of most slopes in these cultivated areas.

On the more gently sloping land where this soil occurs, a more mature profile is developed in which the feldspar phenocrysts in the surface horizon have completely broken down to clay producing a clay loam texture, but this heavier texture only persists for a few inches before the more normal profile again becomes apparent in the subsoil.

Suitability for Agriculture. - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARMENT OF AGRICULTURE

PROVISIONAL SERIES DESCRIPTION

KAMPONG CHERANG HANGUS SERIES

This series is widespread in the northern half of the "deficiency area" of Kelantan and occupies an area of 11,000 acres. Its parent material is alluvium. Patches within the series mapped are of a heavier clay loam to clay which is usually grey-to-white in colour. With the alterations in the beds of the streams this alluvium must have been deposited in strips and horizons of varying and intermixed texture. The survey was not carried out in sufficient detail to differentiate them and it is suifficient to group them together for the purpose of mapping and discussion as to land development.

Profile

Occurs in an open, hog-wallowed, uncultivated area of level slope; rumput jenaris and palas (Licuala sp.) form the main vegetation. The profile shows signs of what might be a buried organic layer, i.e. a former topsoil.

0 - 1 in. Dark grey sandy clay loam with plentiful roots; fine crumb structure; slightly plastic when wet; free drainage.

1 - 5 in. As above, with a little rust staining around the root channels.

5 -17 in. Grey clay loam with a medium, sub-angular, blocky structure; roots plentiful; free drainage; small faint rust mottles, especially around root channels.

17 -28 in. Presumably a buried topsoil consisting of a dark grey clay loam with a very good medium crumb structure; slightly moist and well rooted.

28 -33 in. Grey clay with massive structure; few faint medium red-brown mottles; patches of organic staining; slightly moist and sticky.

33 -42 in. As above, but lighter in colour; very distinct black and purple specks and splotches of bright purple which are presumably caused by manganese. The two bottom horizons are imperfectly drained and moist.

This soil type is probably formed when the jungle or gelam is cut and burnt. The surface is very much hog-wallowed (i.e., channelled and hummocky) and for agricultural use it would have to be ploughed, levelled and drained. It is not a fertile soil.

It was first described by Arnott (1957).

Suitability for Agriculture

Class 4 - more than one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

KAMPONG KOLAM SERIES.

The Kompang Kolam series is a deep well structured reddish brown heavy textured soil derived from quartz diorite, a rock which often occurs within or along the edges of the main granite masses, particularly where the surrounding country rock consists largely of shale. It is not developed over large areas of the country, and, so far, has only been identified in the east coast States, particularly Trengganu, and in small patches in north-west Pahang and south Johore. It is not likely to be confused with any other series with the exception of the Segamat clay, but can be distinguished by its lighter clay texture and the fact that it only occurs in association with granite-derived soils, and not in areas where rocks of the Pahang Volcanic Series are found, as is the case with the Segamat series.

Soil Profile (Kampong Kolam clay loam).

Ah — 0 to 1 inch, dark brown clay loam with a strong fine crumb structure and friable consistency. 0 to 2 inches thick.

Bt — 1 to 47+ inches; yellowish red to reddish brown (5YR 4/8 to 5YR 4/4) clay with a strong medium subangular blocky structure and friable consistency, very porous, becoming firm with increasing depth, good drainage and aeration and very well developed rooting. Horizon continues to an undetermined depth, but probably at least 6 feet thick.

Range in Characteristics - This is a remarkably uniform soil with very little profile differentiation, but red (2.5YR 4/6 to 4/') subsoil colours may sometimes be observed in addition to the more usual yellowish red colour, while profiles transitional to Jerangau series, with strong brown colouring and definite clay loam texture throughout the profile may also occur in some places.

Terrain - Gently sloping to moderately steep.

Drainage - Rapid to medium internal drainage; negligible surface runoff even during heavy rains.

Vegetation -Good quality forest. Some very well grown stands of seedling rubber have been seen on this soil in parts of Ulu Trengganu. Cacao has been planted on this soil near Jerangau, in Trengganu.

Uses - Should be a very suitable soil for most crops, particularly for oil palm or rubber.

Distribution - In small patches, up to about 200 acres in extent, in association with Rengam and Jerangau series soils in Trengganu, particularly along the Jerangau road, and a few miles to the west of the Kuala Trengganu-Kota Bharu road between the 20th and 35th miles from Kuala Trengganu. Small patches in Pahang and Johore.

Type Location - Federal Experimental Station, Jerangau, Trengganu.

Series Established - Small kampong near Ajil, Trengganu.

Remarks - One of the best sedentary soils so far identified in Malaya, which should be planted with crops other than rubber where practicable.

Suitability for Agriculture - Class 1 - no limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

KAMPONG KUBOR SERIES.

This colluvial soil occurs in the smaller valleys within the Rengam-Jerangau-Kampong Kolam association in Trengganu (Panton 1958) where it is formed over the accumulations of coarse material derived from the surrounding slopes as a result of soil creep and local wash. The immaturely developed profile is rather variable in appearance, but the most characteristic features are the high water table, coarse texture, and the dark topsoil colour which changes at varying depth to a pale grey or white.

The soil always occurs in small patches scattered throughout the association wherever conditions suitable for the accumulation of colluvium exist, as in any small depression; at the foot of long slopes; in the bottoms of the smaller valleys, or along the sides of some of the larger valleys which are filled in their centres with finer grained stream-borne materials.

The surface soil is a dark brown very weakly crumbed coarse sand an inch or two thick which is underlain by a sub-surface horizon of sand or clayey sand, yellowish brown in colour and with a friable weak subangular blocky structure. The subsoil is generally a light grey, loose, moist sand or clayey sand with slight red mottling and the water table may vary in depth from six inches to three or four feet. Its level fluctuates very widely according to the rainfall, and the soil may be subject to flooding followed by drought conditions at very frequent intervals.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

KAMPONG LUBOK KIAT SERIES.

This is probably one of the poorest soils occurring in the Kelantan 'deficiency area' but it is fortunately of small extent, covering some 2,000 acres on the upper terrace in the middle of the area. It has been formed on uplifted Triassic sediments and has been subjected to weathering and leaching for a long period. Little has been added to the soil and it is in an advanced senile stage.

Profile.

Slope flat; hog-wallowed surface under dense cover which includes spindly tembusu, poor bamboo and resam ('Gleichenia linearis'): thick leaf litter on surface. Horizon boundaries were generally diffuse and sub-division was made at arbitrary intervals.

0 - 1 in.	Dark grey-brown (10YR 3/2) fine sandy loam with good medium crumb structure; very thickly rooted.
1 - 6 in.	Uniform grey (10YR 6/1) loamy sand with many roots and a fine crumb structure; drainage free.
6 -12 in.	Light grey (10YR 7/1) sandy loam with fewer roots than in the 1 to 6 in. depth; structure deteriorates with increasing depth; horizon boundaries diffuse.
12 -18 in.	As above, with very faint rust mottling at 15 in.; few roots and massive structure.
18-24 in.	Light grey sandy loam which is very much compacted; massive structure, poor drainage and moist soil; very few roots.
24 -39 in.	Grey sandy clay matrix with many medium and coarse distinct yellow (10YR 8/8) mottles; firm consistency and weak coarse subangular blocky structure; few roots and imperfect drainage.
39 -54 in.	Grey clay matrix with many medium and coarse red (7.5YR 5/6) mottles; a few yellow mottles are present and mottling covers over 50% of the surface; structureless 'in situ'; cracks out on drying; roots practically non-existent; clear boundary at 39 in.
54 -69 in.	As above with less mottling at 69 in. Below 69 in. the red mottling decreases.

A few lumps of lateritic type material were found in the profile and they became hard on drying. No concretions were found 'in situ'. The profile is poorly drained and further development would tend to produce a typical laterite soil.

This soil was first described by Arnott (1957).

Suitability for Agriculture - Class 4 - more than one serious limitatio

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

KAMPONG PUSU SERIES.

This is one of the better of the deficiency type soils occurring in Kelantan and occupies 7,500 acres in the low-lying areas, mainly in the north and south.

Soil Profile.

A soil pit was dug in Field 3 at Kampong Pusu Experiment Station and the description is as follows:-

Area under rumput jenaris and the stubble of a dry padi crop; slope, flat; and profile moderately well drained.

0 - 1 in. Black sandy clay loam with weak, medium crumb structure; plenty of grass roots; free aeration and drainage.

1 - 5 in. Black sandy loam with fine subangular blocky structure; boundary with the above horizon is indistinct; friable consistence; fewer roots and drainage imperfect; faint yellow mottles at 5 in. depth.

5 -12 in. Distinct boundary at 5 in.; dark grey (5Y 4/1) sandy clay with frequent small rust mottles; fine subangular blocky structure; few roots and imperfect drainage.

12 - 23 in. Light grey (5Y 7/2) sandy clay loam with rust mottles frequent; subangular to crumb structure.

23 -35 in. White (5Y 4/8) clay matrix with medium common red (7.5R 4/8) mottles; non-structured and compact.

35 -48 in. As above with some coarse mottles; many orange and red mottles medium and prominent; structureless; drainage poor and no roots.

This soil was first described by Arnott (1957).

The soil found in the south of the area, at Padang Siam, has been included in this series because it has many basic similarities. It differs in not having such a well developed organic horizon as the Kampong Pusu type.

Suitability for Agriculture - Class 4 - more than one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

KANGKONG SERIES

This series was first described by McWalter (unpublished report) in Kedah, and has subsequently been mapped also in north-west Selangor (Acton, 1963).

It is developed on fairly recently deposited marine alluvium of clay texture on the level surface of the coastal plain. It has a coarse prismatic to blocky structure, firm rubbery consistence and light greenish grey colours in the subsoil.

The surface horizon (0 - 4 in.) consists of dark grey to black fr able clay with a moderate to strong medium crumb structure. Where the organic topsoil is shallow or absent, the surface horizon is hard, has a strongly developed coarse sub-angular blocky structure and often pronounced cracking during dry weather. The second horizon extends to 12 or 18 inches in depth and is grey, light grey or greenish grey in colour with a prismatic to blocky structure. A partial coating of topsoil, which has slumped down the cracks, often covers the prism faces. The consistence is always firm and the soil tends to dig out in slabs. Mottles of strong brown to yellowish brown commonly occur as well as concretionary yellowish-brown, olive brown or olive yellow gritty deposits. Such deposits are commonest below 24 inches imbedded in a matrix of grey to greenish grey clay. Bluish grey deposits may occur along root channels. The structure of this horizon is not strongly developed, and the consistence occasionally is somewhat looser. This horizon is generally saturated with water.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

KATONG SERIES.

This series was established in the Ulu Tembeling District of north-east Pahang. It is formed on quartz andesite rocks and is characterised by generally yellower colours and siltier textures than the Segamat soils. It has a podzolic horizonation with distinct Ae/Bt horizon development. It occurs on hilly terrain with slopes ranging from 12° - 20°. Internal drainage is medium to rapid. A profile is:-

Ah	0 - 3 in.	10YR 4/3 (dark brown) silty clay, firm consistence, moderate medium subangular blocky structure, abrupt boundary.
Ae	3 - 7 in	10YR 5/6 (yellowish brown) silty clay to clay loam, friable, moderate fine subangular blocky, few pores, patchy clayskins, distinct boundary.
Bt	7 -32 in.	7.5YR 5/6 - 5/8 (strong brown) silty clay, firm, moderate, medium to fine subangular blocky, few pores, almost continuous clayskins, indistinct boundary.
Cu	32 + in.	5YR 5/8 (yellowish red) silty clay, firm, moderate fine crumb, few pores, discontinuous clayskins, small pebbles of quartz andesite.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE

STANDARD SERIES DESCRIPTIONS.

KEDAH SERIES.

The soils of the Kedah series are developed over steep land from parent material of dominantly quartzitic composition, but with varying proportions of conglomerate and shale. The profile is shallow and roots seldom penetrate to much greater depths than about 2 feet. Kedah series soils are common in many areas where rocks of Triassic Age occur along the west and central parts of Malaya, and are particularly widespread in Selangor and Negri Sembilan. These soils usually occur in association with the Serdang series and transitional types between these two soils are common on the moderately steep slopes. This soil is unlikely to be confused with any other established series.

Soil Profile (Kedah sandy loam - immature cacao).

Ah — 0 to 6 inches. Dark brown (10YR 4/3) sandy loam, weak medium crumb structure. Well drained and with numerous ramifying roots. 1 to 6 inches thick.

AC — 6 to 24 inches. Strong brown (7.5YR 5/8) sandy loam Weak subangular structure, becoming compact at depth. Roots decrease rapidly down the profile and practically disappear at 24 inches. 12 to 30 inches thick.

Cu — 24 + inches. Strong brown (7.5YR 5/8) to yellowish red (5YR 5/8) coarse sandy and gravelly loam with much partly weathered quartzite parent material. Compact, well drained, and with practically no roots.

Range in Characteristics - The chief variation in this soil depends on the depth at which the parent material zone is found, and this varies from about 6 inches below the surface to 3 feet, depending on the ground slope and the rate at which geological or man-induced erosion has been taking place at the surface. When mapping in the field using the standard 3 feet screw type auger, the occurrence of parent material at a greater depth than 3 feet is taken as being the criterion for classifying the transitional types into either Serdang or Kedah series, and the boundary is usually found to coincide approximately with the 20° slope limit, and in most parts pf Malaya this change usually comes in at least about the 150 or 200 foot contour level. Several soil types occur within this series, with textures varying from fine sands to fine sandy clay loam.

Terrain - Steep to very steep slopes in hilly and mountainous country. Small patches may also occur in some areas of moderately steep land (12 - 20°).

Drainage - This is a fairly well drained soil and crops may easily suffer from drought conditions during short dry spells. Surface runoff may cause serious erosion if good conservation measures such as terracing and a good cover crop under rubber are not taken.

Vegetation - Normal dipterocarp rain forest. Several forest reserves are sited on soils of the Kedah-Serdang association, including the Ayer Itam Forest Reserve near Serdang, Selangor.

Uses - In addition to forest reserves, large areas

have been alienated to rubber and many estates and smallholdings have patches of this series in their more steeply sloping parts. Some of the experimental cacao plantings at F.E.S. Serdang are sited on this series.

Distribution. - A common soil in many of the hilly areas of Selangor, Negri Sembilan, Perak, Malacca, East Pahang and South Kedah, and probably also occurs in several other parts of the country.

Type Location - F.E.S. Serdang, Selangor.

Series Established - Serdang, South Kedah.

Remarks - This series was first described by Owen and the rather broad original description also covers what is now classified as the Serdang series. Detailed mapping has revealed the necessity to subdivide the original group covered by this name.

Suitability for Agriculture. - Class 5 - one very serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

KEMUNING SERIES.

This is an unusual soil first mapped in Kelantan (Panton 1960) and subsequently also in Johore (Null, Acton, Wong 1965), which is distinguished by a dark greenish grey colour throughout the uniform shallow profile. It is thought to be formed on carbonaceous shale, and has a silty clay loam to clay texture and a firm consistence.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

KODIANG SERIES.

This soil is derived from limestone, occurs in Kedah, and has a "senile" profile compared to Langkawi and Kaki Bukit Series. It is characterised by the presence of fairly dense pisolitic laterite concretions from about 20 inches. Structure is moderate to strong and texture is clay loam.

Typical Profile.

Ah	0 - 1 in.	2.5YR 3/6 dark red clay loam with a weak fine subangular blocky structure.
Aej	1 -20 in.	2.5YR 4/6 red clay loam with a moderate to strong medium subangular blocky structure and friable consistence.
Bcn	20 -48 in.	2.5YR 4/6 red clay loam matrix around dense pisolitic laterite connections ranging in size from ¼ inch to 1 inch.

Suitability for Agriculture. - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

KRANJI SERIES.

These estuarine clay soils were first identified on Singapore Island, (Panton, 1955) and are quite common near the mouths of West coast river systems. They support a mangrove swamp vegetation under brackish water or marine conditions and, apart from a few coconuts, are not used for agriculture. Fish culture and collection of mangrove for firewood are the chief uses to which the land is put at present.

A dark brown silty or fine sandy clay topsoil up to 20in. thick is underlain by a dark grey or bl ck muck. This subsoil often shows marked variations in texture and organic matter content, and bands of coarse sand may be found interbedded with dark reddish-brown peat. Generally however the soil shows a loss on ignition of between 35 and 65% and is therefore classed as muck. Decayed mangrove roots are the main source of this organic matter. The whole of the subsoil layer is waterlogged at high tide but drainage is good owing to the open texture of the muck. Profile examination down to 6 feet is easily carried out during low tide.

Owing to the relatively high salinity, this soil in its present state is unsuitable for agriculture, and coconuts are the only crop which is grown in any quantity.

Reclamation of the swamps by bunding is unlikely to be worthwhile owing to the high cost in relation to the comparatively small areas which could be drained, and fish culture appears to tb the most profitable occupation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

KUALA BRANG SERIES.

The soil of this series are brownish yellow, medium to fine textured types, derived from fine sandy shales, or mixed shale and quartzite formations, of Carboniferous age, and they occur over large parts of Trengganu and Kelantan. They are free draining and rather weakly structured, and roots normally penetrate to a depth of about three feet, below which a very much decayed parent material horizon is developed. Slopes vary from about 5° up to an much as 35°, with the depth of profile varying inversely with the steepness of slope. The Kuala Brang soils are agriculturally important in many parts of Trengganu, particularly around the Sungei Trengganu basin, where thay are cultivated with rubber, dry padi and dusun. The soils differ from those of the Setir series in the absence of any distinct zone of iron oxide accumulation, as well as in having a lighter texture and more friable consistency; they are also lighter textured and looser structured than the Durian series; soils of the Telemong series have similar profile characteristics, but have developed from alluvium over more gently undulating to flat land.

Soil Profile. (Kuala Brang fine sandy loam)

Ah — 0 to 1 inch, dark yellowish brown (10YR 4/4) fine sandy loam; very friable; medium to fine weak crumb structure; numerous roots. 0 to 3 inches thick.

Ae/Bt — 1 to 34 inches, yellowish brown to brownish yellow (10YR 5/8 to 6/6) fine sandy loam; friable; weak medium subangular blocky structure; good root development; slight increase in clay content with depth. 15 to 40 inches thick.

Cm — 34 to 37 inches, brownish yellow (10YR 6/6) fine sandy clay loam, with a few very soft decayed shale fragments and very occasional indistinct light red (2.5YR 6/8) mottles or stains along cracks and bedding planes. 0 to 4 inches thick, with indistinct upper and lower boundaries.

Cu — 37 + inches, loose decayed grey and greyish brown shale with a few irregular quartz pebbles in a fine sandy loam matrix. A few roots follow fractures in the parent material and may continue for some considerable depth.

Range in Characteristics - Over rolling and hilly land on which the slopes range from 5 to 15° the profile above the parent material horizon is about three feet deep, but on the steepest slopes this shale may occur on the surface in areas where landslides are common. Colour and texture are often surprisingly uniform over very large areas, with fine sandy loam by far the dominant texture. Although a distinct mottled or concretionary horizon does not develop, the upper part of the parent material zone may be stained various shades of red along bedding planes and exposed surfaces of the shale fragments.

Terrain - Varies from rolling with slopes of 5 to 10° up to steep ridge country in the 30 - 35° slope range.

Intermediate slopes of the order of 15 to 25° are the most common, while elevation varies from 50 to about 500 feet. The more steeply sloping ridges are generally orientated in a NNW - SSE direction, coinciding with the regional strike trend of the underlying rocks.

Drainage - Internal drainage is rapid, but surface runoff during heavy rains may be sufficient to cause serious erosion over cleared areas.

Vegetation - Moderate to good forest; large areas in Trengganu are covered by secondary jungle.

Uses - Rubber is the commonest crop in the developed areas, while a large proportion of the land under secondary jungle is periodically cleared and planted with hill padi. Many areas close to the coast in Trengganu have been worked for timber, while continuous cultivation in other parts has resulted in exhaustion and erosion of the soils, which are now covered by a low, poor scrub.growth.

Distribution - The Kuala Brang series is widely distributed throughout Trengganu, and occurs also on the Sungi Galas region of Kelantan.

Type Location - 24th mile Kuala Brang road, Trengganu.

Series Established - Kuala Brang area Trengganu

Remarks - Much of the potential agricultural land in Trengganu lying east of the East coast range is covered by these soils, which are of moderate fertility and best suited to cultivation of rubber.

Suitability for Agriculture - Class 2 - few minor limitations. On steep slopes Class 5 - one very serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

KUALA NERANG SERIES.

This soil series is a deep, well drained, light textured soil, developed on conglomerate parent material. The total acreage of the Kuala Nerang series is approximately 37,000 acres, most of which occurs in the Kuala Nerang-Padang Senai-Nakar "triangle" of north-eastern Kedah. The soils are developed on fairly flat topography and the vegetation, generally, is rather poor.

This soil would be suitable for rubber provided adequate fertilisers are applied. Apart from N.P.K., magnesium would also have to be included for these light textured soils.

Typical Profile Characteristics.

Ah horizon 0 - 2" 10YR 4/3 Dark brown fine sandy loam.

Ac horizon 2 -31" 7.5YR 5/4 Brown fine sandy loam. Moderate to weak subangular blocky structure. Good rooting.

Btj horizon 31-48" 5YR 5/8 Yellowish red fine sandy loam to clay loam.

Cu horizon below 48" Conglomerate rock fragments seen.

Range in Characteristics. - There is only one major variant of this soil, where the colour of the Ae horizon is 10YR 5/6 Yellowish brown fine sandy loam instead of the typical 7.5YR 5/4 Brown fine sandy loam.

Suitability for Agriculture. - Class 2 - few minor limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

KUANTAN SERIES.

This very well structured, deep, fertile clay soil is one of the very best sedentary soils in the country. It has, unfortunately, a rather limited distribution, occurring only in the region of the Bukit Goh Forest Reserve near Kuantan in Pahang, where it is developed from basalt and dolerite rocks over gently undulating to rolling country. It has a very characteristic reddish brown, almost "chocolate" brown colour, and the well drained, open structured subsoil permits exceptionally deep rooting of tree crops. A large proportion of this series occurs in a forest reserve but in other places the land has been alienated for rubber estates. The latex yield from these estates are surprisingly high in comparison with estates on other soils with trees of similar age and receiving similar treatment. The Kuantan series can be distinguished very easily from all other series simply by its colour and structure, and the only series that even remotely resemble it are soils of the Segamat and Bukit Panjang series, both of which have higher red colour values.

Soil Profile (Kuantan clay).

Ah — 0 to 2 inches, dark reddish brown (5YR 3/4 to 5YR 3/3) clay; strongly developed fine crumb structure; excellently drained and aerated; very friable; very well rooted. 1 to 4 inches thick.

Bij — 2 to 90 inches, extremely uniform dark yellowish brown (10YR 4/4) to reddish brown (5YR 4/4) clay; medium granular to subangular blocky structure, which when disturbed breaks to a strong fine crumb; good root development to 4 or 5 feet and intermittent rooting to 7 feet; rapid internal drainage. 60 to 100 inches thick.

Cu — 90+ inches, reddish brown (5YR 4/4) clay with hard irregular red stained very decayed basalt rock fragments, varying in size up to 6 inches diameter.

Range in Characteristics - This series displays surprising uniformity in texture, and only one type (60 - 70% clay) has been recognised. Very slight variations in colour of the subsoil may be noted, between dark reddish brown (5YR 3/4) to dark yellowish brown (10YR 5/6), but this latter colour is rarely developed. Other variations include the occurrence of occasional bauxite and laterite concretions at depths of two or more feet, and in some cases the development of a continuous band of laterite and iron stained rock fragments at depths of three or four feet. This latter phase appears to be very local and confined to the flatter areas on the tops of some of the lower ridges.

Terrain - Mainly undulating to rolling with slopes in the 2 to 10° range, with maximum elevations of about 200 feet. In one or two areas however the land is eroded into steep sided, flat topped hills, with slopes up to 25° on the sides, and elevations up to 400 feet.

Drainage - Very rapid drainage down to 7 or

more feet, but the fine peds have a good water retaining capacity, so that although drying out of the open structured topsoil may induce drought symptoms in shallow rooted annual crops after comparatively short periods without rain, deeper rooted, older established crops are not affected. Loss of structure through compaction of the surface layer along tracks can result in rapid runoff.

Vegetation - Good quality forest.

Uses - Largely forest reserve. Other areas under rubber.

Distribution - Only found in quantity in the Bukit Goh forest reserve and over the alienated land to the east and south of the reserve but may occur in very small patches in other parts of the country where basic igneous lavas are known to exist.

Type Location - Centre of Bukit Goh forest reserve.

Series established - Estate, near Kuantan.

Source of Name - Capital city of Pahang, near which this series is developed.

Remarks - These soils, which probably resemble some of the rich volcanic soils of Java, should prove ideal for most types of tree crops which are suited to the Malayan climate.

Suitability for Agriculture - Class 1 - no limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

KULAI SERIES.

The soils of this series are commonly shallow, fine textured, rather pale coloured, and have a firm subsoil consistence. They occur over rolling and hilly terrain and are derived from a mixed geological formation of rhyolites and volcanic tuffs. Development of a concretionary band of laterite or laterized rocks is not uncommon in this series, and when formed, the concretions are loosely packed; consequently, root growth is not appreciably obstructed. Soils of the Batu Anam series closely resemble those of the Kulai but difficulty should not arise in distinguishing the two as the former exhibit a more compacted, poorly structured soil and occur over gently sloping terrain whereas the latter is somewhat better structured and found on steeper land.

Soil Profile (Kulai loam).

Ah	0 to 2 inches, light olive brown (2.5Y 5/4); loam; moderate, medium, crumb; friable.
Ae	2 to 16 inches, olive yellow (2.5Y 6/6); clay loam; moderate medium subangular blocky; friable.
Bt	16 to 60 inches (10YR 5/8) yellowish brown clay; weak fine angular blocky; firm.
Btcn	60 to 64 inches, strong brown (7.5YR 5/6); silty clay with scattered, small laterite concretions; moderate, medium, angular to subangular blocky; firm.
Cu	64 + inches, (10YR 6/6) brownish yellow clay; weak medium and angular blocky; friable red mottles; weathered rhyolite.

Range in Characteristics - This series may exhibit a wide range in texture as shale, vein quartz, and granite also occur among the various other rocks as parent material. Colour, as a result of the heterogeneity and mineral composition in parent rocks, will range quite widely at times but the light paler colours are commoner. Pieces of parent material, both weathered and unweathered, are commonly found within 5 feet of the surface.

Uses - Rubber is the most common crop but oil palm is being grown on these soils in the vicinity of Kulai, Johore.

Drainage - Slow to medium

Distribution - Occurs intermittently from west-central through south-central to south-eastern Johore.

Type Location - Bukit Jinjam, north of Ayer Hitam, Johore.

Series Established - Kulai Oil Palm Estate, Johore.

Remarks - Kulai Oil Palm recognises two variants of this series i.e., Kulai Fine and Kulai Coarse which should be considered if a more detailed survey is planned in the future.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

LANGKAWI SERIES.

This soil is developed on the slopes of limestone outcrops, and has been mapped in Kedah. The profile is very deep and uniform and structure and root penetration are excellent. It has a clay loam texture throughout. It is regarded as the "juvenile" member of the sequence - Langkawi, Kaki Bukit, Kodiang.

Typical Profile.

Ah 0 - 2" 2.5YR 3/4 dark reddish brown clay loam with a moderate to strong fine crumb and granular structure.

Bi 2 -72" 2.5YR 3/6 dark red clay loam with a strong fine and medium subangular blocky structure and a very friable consistence. Excellent root distribution up to 4 feet, becoming less abundant below this, Very good drainage.

Cc 72"+ limestone rock.

Suitability for Agriculture - Class 1 - no limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

LATI SERIES.

This soil occurs mainly in the north-east part of the Kelantan "deficiency area" and occupies about 5,000 acres. It has been formed from the sandy alluvium deposited by the Kelantan river.

Soil Profile

In old rubber plantation; badly kept rubber with much secondary jungle growth; slope, flat; moderate drainage and permeability. Surface covered by a thin layer of decomposing leaves and twigs.

0 - 1 in.	Dark grey-brown, coarse sandy clay loam; more or less structureless with free drainage; roots common; friable consistence; slightly sticky when wet.
1 - 3 in.	As above with few roots.
3 -14 in.	Brownish-yellow sandy clay loam with a little organic staining and very few roots; moderately dry; massive structure.
14 -39 in.	As above, with a few, faint rust mottles.
30 -48 in.	Light grey sandy clay loam matrix with rust coloured streaks and distinct medium, light red mottles; non-sticky, slightly plastic; loose consistency. There are a few brown speckles which are probably due to manganese concretions, and small flakes of mica are common in the lower horizons.

The horizon boundaries are diffuse except at 3 in., where the boundary is abrupt and smooth. Drainage in the upper layers is free and in the lower horizons, slightly imperfect.

This soil was first described by Arnott (1957).

Suitability for Agriculture - Class 4 - more than one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

LINAU SERIES.

This series was first described in the South-West Johore Coconut Survey (Panton, unpublished report) and has subsequently been identified in north west Johore also (Small-wood, in preparation). It is a recent marine alluvial soil characterised by a very dark greyish brown (10YR 3/3) organic clay surface soil with a subsoul of dark brown muck containing considerable visible organic remains. Below these organic horizons is a structureless dark bluish grey (5B 4/1) silty clay with distinct sulphurous odour.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

LOKYANG SERIES.

This is a very poor, light coloured soil derived from Triassic shales of low iron content and rather variable textural composition. The profile is shallow and the parent material can usually be seen within 5 feet of the surface. At the present time much of this soil is derelict and carries a very poor type of scrub. It occurs on Singapore Island, where it was first described by Panton (1955). Terrain is gently undulating to almost flat.

The surface soil is a light grey to greyish-brown clay loam or sandy loam up to 6 inches deep which contrasts markedly with the light coloured subsoil. After a few years under scrub and lallang (Imperata cylindrica) this topsoil develops a good granular structure, is well drained and aerated and appears to be ideal for cultivation. Unfortunately, however, this is not the case because after clearing the structure rapidly deteriorates and the small amount of fertility accumulated over a few years is soon lost. The appearance of this soil thus varies considerably and is a reflection of its recent cropping history. The subsoil is a rather compact, almost structureless light grey or pale yellow loam which is very difficult to dig. Roots are very rare, even at a depth of one foot below the surface, and the only apparent structure consists of large shrinkage cracks, and water movement is slow and takes place almost entirely along these cracks. At a depth of 3 feet faint yellow mottles or blotches may be apparent while the predominant colour of the soil changes gradually to white or, in some cases, a peculiar shade of greenish-white which does not appear on the Munsell soil colour chart. The parent material, which begins at a depth of 4 to 6 feet often has a pronounced blocky structure due to fracturing along original bedding planes and red dendritic staining or mottling may be developed. No laterite is ever found in this soil.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

MALACCA SERIES

Although first described by Owen (1951) and for long regarded as among the "classic" soil series of Malaya, Malacca Series has not been investigated by any sort of soil survey in the region where it is best developed - Malacca State. The series has been identified in Kelantan and Johore and the following description is based largely on these occurrences. It has been thought prudent, however, to keep the status of the description as "tentative" until more information about this series is available from the schematic reconnaissance soil survey of Malacca.

The soil occurs on flat to rolling terrain and is derived from shale. It is characterised by massive laterite which usually occurs at depths greater than 2 feet. Commonly laterite boulders occur on the surface. Most profiles show a yellowish brown or dark greyish brown sandy loam an inch or two thick underlain by a sandy clay or clay loam which shows a gradual colour change with depth from yellowish brown (10YR 5/6) to brownish yellow (10YR 6/8). This horizon varies in thickness from 1½ to 2 feet, is well drained and aerated and has good structural development. A sharp change to laterite then occurs. The laterite consists of irregularly shaped ironstone concretions ranging in size up to 1½ inches which are commonly cemented together to form large rough boulders. The matrix is brownish or reddish yellow sandy clay or clay loam. The laterite is normally about 18 inches thick and is underlain with red mottles towards the base of the profile.

Malacca Series has been described further by Panton (1955), Arnott(1957), Null, Acton and Wong (1965)and Smallwood (in preparation).

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

MANIK SERIES.

This series has been identified in Perak on subrecent marine alluvium. It is developed on a marine terrace and includes poorly structured, pale coloured sandy clays and clay loams with a strongly mottled horizon close to the surface. The following profile is given by Moormann et al (1964):

Ap	0 - 4"	10YR 4.5/1 (dark grey to grey) mottled clay loam with a weak subangular blocky structure.
Btg	4 -12"	10YR 7/1 (light grey) sparsely mottled clay with strong medium subangular blocky structure and some clay movement.
Cg	12" +	10YR 8/1 (white) mottled clay with a coarse angular blocky structure.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

MARANG SERIES.

The soil is best developed in the region around Marang to the south of Kuala Trengganu where it is found over a large area of hilly country made up of sandy indurated shales and vein quartz. The soil is poorly structured, shallow, and of very low fertility. It was first described by Panton (1958).

The surface soil under virgin jungle consists of a one or two inch layer of dark greyish brown loamy sand or sand possessing a very weak fine crumb structure. Under the belukar (secondary jungle) and scrub which covers large areas of this soil, however, the topsoil is much deeper, the dark greyish brown surface layer changing gradually to a brown sub-surface layer about four or five inches thick with a slightly heavier texture and rather strong crumb structure. Rooting and drainage are generally good at this level but roots decrease rapidly in the subsoil, which varies in colour from light grey through very pale brown to yellow, and has a medium subangular blocky structure. The subsoil is rather shallow and a gradual transition to parent material may take place between depths of two and five feet, the transition zone generally being a light grey or pale yellow in colour and rather compact with very few roots, while the parent rock is a whitish or greenish grey sandy shale often with included veins and bands of quartz or quartzite. Drainage in the transition horizon between the subsoil and the parent material is often very poor and small rounded concretions of iron oxide may be found scattered through the zone.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

MASAI SERIES.

The soils of this series are developed from granodiorite. They are characterized by the presence of laterite which in some cases is exposed on the surface or may be up to 36 inches below the surface depending on the severity of erosion. Normally, however, the laterite band is within 12 to 24 inches of the surface and ranges from 2 to 5 feet in thickness. This series occurs over extensive areas of undulating and rolling terrain at elevations ranging from 50 to 200 feet A.S.L., and because of its similarities above the zone of laterization with soils of the Malacca series, difficulty sometimes arises in distinguishing the two.

Soils of the Masai series differ from those of the Malacca series in being somewhat less coarse in texture and not as well developed structurally in both the surface and subsurface layers. This series also does not possess the typical pale silty "mottled zone",lying below the laterite that is so distinctive of Malacca. In deep exposures, however, this series displays a rather dark red somewhat mottled, silty clay soil accompanied with coarse quartz below the laterite.

Soil Profile (Masai clay loam).

Ahj — 0 to ½ inch, yellowish brown clay loam. Moderately developed fine crumb structure with a friable consistency. (0 - 4 inches thick).

Ae — ½ to 12 inches, brownish yellow silty clay loam. Strongly developed medium crumb structure with a firm consistence. (12 to 36 inches thick).

Bcn — 12 to 48 inches, strong brown to reddish yellow with abundant closely packed laterite concretions varying in size from ½ to 3 inches in diameter (in some instances, boulders up to 2 feet in diameter occur). The matrix of this horizon has a silty clay texture and a firm consistence. (20 to 60 inches thick).

Cm — 48+ inches, reddish yellow to red silty clay loam with coarse quartz grains sometimes scattered throughout the matrix. This horizon not infrequently possesses yellowish red and white streaks which are more or less vertically oriented thereby affording it a variegated appearance. Structure varies from strong to moderately developed medium subangular blocky which when moist is of a firm consistence and on drying becomes quite compact.

Range in Characteristics - The colour is predominantly brownish yellow in the surface and subsurface layers but varies from brownish yellow, strong brown, reddish yellow to red in both the laterite and zones below this concretionary formation. Texture varies from fine sandy clay loam to silty clay loam above the laterite; within and below this band, textures are silty clay to silt loam with quartz grains sometimes present.

Uses - Rubber is the only crop of any importance presently being grown on this soil, however, oil palm may fare quite well where the laterite is deep enough and drainage is sufficient to prevent any root hindrance.

Drainage is slow to medium in the zone above the laterite but is impeded below this zone as a result of the poorly developed structure and firm consistence.

Series Established - Masai Town in south-central Johore.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

MERBAU PATAH SERIES.

The Merbau Patah series was first mapped in Trengganu by Panton (1958) and includes a number of soil types having somewhat variable profile features, this variation being due in part to secondary differences induced by cultivation and irrigation. Detailed survey would probably provide sufficient data for subdivision of this soil into 2 or 3 distinct but closely similar series, and while profiles corresponding to the description given below are fairly widespread, it should be remembered that a great many atypical variants exist in the field. The essential features of the profile include a brownish surface soil underlain by a mottled horizon, usually at a depth of between one and two feet, and a grey or white waterlogged subsoil. The water table fluctuates between two and three feet in the drier months, while complete flooding occurs during the north-east monsoon. The soil is extensively planted with wet padi. It occurs over flat land, usually at some distance from the river banks, in the main basin alluvium, and is widespread on both sides of the road between Bukit Payong and Kuala Trengganu.

The surface soil is a dark greyish brown or olive grey clay loam with a well developed moderate to weak crumb. The surface horizon is of variable thickness, usually about three inches, which corresponds to the plough layer in the case of long cultivated land. Drainage is normally good, but the soil becomes sticky and puddles easily when moist. Yellowish brown iron staining along root traces is a common feature. The sub-surface soil is a greyish brown or light olive brown colour, possesses a moderate subangular blocky structure, and is mottled yellowish brown to red, the mottling increasing with depth and becoming most intense between depths of one and two feet. Below this is a gradual transition to a light grey or even white subsoil which is waterlogged and structureless, contains few roots, and shows only occasional mottling in the upper layers.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

MONG GAJAH SERIES.

This series has been mapped in Kedah (Joseph 1964). It is not very extensive and consists of a clay loam of coarser texture than the Gajah Mati series; pisolitic laterite occurs at about 24 inches from the soil surface.

SOIL SCINECE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

MUNCHONG SERIES.

This soil is found in several parts of Selangor, Perak, and Johore, and probably also occurs in Malacca, Pahang, and Negri Sembilan. It is a good deep soil with a moderately heavy texture which is developed from shale, possibly sometimes interbedded with thin quartzite bands. It usually occurs in association with soils of the Serdang series, and the profile is closely similar to that of the Serdang, but differs in having a distinct heavier texture, better structure and rather deeper colour. Differentiation between these two series is based principally on colour and texture, and transitional types are common in the field due to the fact that the parent material of the Munchong series, which is shale, and the parent material of the Serdang series, which is quartzite, are often interbedded. Other soils with which this series could be confused include some of the better types of Durian series soils, but these soils have shallower profiles and a "stiffer" consistency an the subsoil, and they also tend to occur to the east of the Main Range rather than in the areas covered by the Munchong series. Jerangau series soils are sometimes similar, but are developed from igneous rocks of granodiorite composition. Some lateritic phases of this series may resemble Malacca series soils but the laterite horizon is always very much thinner and usually occurs at a greater depth in the profile.

Soil Profile (Munchong silty clay loam under rubber).

Ah — 0 to 4 inches, dark yellowish brown (10YR 4/4) silty loam with a moderate fine crumb structure, friable consistency. 1 to 6 inches deep.

Ae/Bt — 4 to 52 inches, strong brown (7.5YR 5/6) silty clay loam with a moderate subangular blocky structure and friable to firm consistency, becoming less friable with increasing depth. At least 48 inches deep, and continuing to unknown depth.

Range in Characteristics. - Colour varies from brownish yellow (10YR 6/8) through strong brown (7.5YR 5/8) to more rarely reddish yellow (7.5YR 6/8), while texture varies from fine sandy clay loam through clay loam to loamy or silty clay. Occasionally a very small but easily recognisable proportion of medium or coarse sand may occur in this series, particularly when this soil occurs close to granite outcrops. It is not unlikely that the parent material is a schist in these instances. Lateritic phases of this series sometimes occur, particularly in the case of the heavier textured types.

Drainage - Medium to slow.

Vegetation - Normal rain forest.

Terrain - Undulating to rolling.

Uses - Extensively cultivated with rubber, oil palm, dusun, etc.

Distribution - Found in Selangor in the Rawang area and on Prang Besar Estate near Serdang, and also in the area between Selama and Taiping in Perak and in the region

around Kuala Kangsar and Sungei Siput. Probably distributed also in several west coast States in areas not yet covered by field survey parties. Occurs in Johore, and small areas have been identified in west Pahang.

Type Location - Kuala Kangsar District, Perak.

Series Established - Munchong Estate, Rawang, Selangor.

Suitability for Agriculture - Class 1 - no limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

NAMI SERIES.

These soils are among the better soils of Kedah. Approximately 27,000 acres of these shale-conglomerate derived soils have been recorded.

These soils are deep and well drained, with a satisfactory moisture holding capacity. The Nami series is heavier in texture than the Kuala Nerang series. The vegetation supported by this soil is also far more dense than in the areas under the Kuala Nerang series. The soil is developed on undulating to hilly terrain.

These soils would be suitable for most tree crops, including "dusun crops".

Typical Profile Characteristics.

Ah horizon 0 - 2" 10YR 5/3 Brown fine sandy loam. Moderate to weak fine subangular blocky structure.

Ae horizon 2 -42" 10YR 5/4 Yellowish brown loam. Moderate, medium subangular blocky structure.

Bt horizon 42-60" 7.5YR 6/6 Reddish yellow loam to clay loam. Moderate, medium subangular blocky structure. Firm consistence.

Colour Variants. (Ae horizon).

10YR 5/4	Yellowish brown loam	(Typical profile)
10YR 7/8	Yellow loam	(Variant 1)
10YR 6/3	Brownish yellow loam	(Variant 2)

Suitability for Agriculture - Class 1 - no limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

PADANG BESAR SERIES.

This series was first mapped in south Kedah (Joseph 1964) where it occurs in association with the Pokok Sena series. It is derived from siltstone and is characterised by a high proportion of silt. It occupies flat to gently undulating terrain. A profile is:-

Ah	0 - 1"	dark brown (10YR 4/4) silt loam, weak structure.
Ae	1 - 6"	yellowish brown (10YR 5/8) silt loam, weak medium subangular blocky structure, very friable to loose consistence, rooting restricted to this horizon.
Bcn	6 -27"	yellowish red (5YR 5/8) pisolitic lateritic concretions in a matrix of yellowish brown silt loam.
Cm	27-44"	"pallid" zone of kaolinitic clay with red (2.5YR 4/8) mottles.
Cc		on weathered siltstone.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

PADANG GONG CHENAK SERIES.

This series occurs on gently undulating open country. It covers about 4,000 acres in the east and central parts of the Kelantan "deficiency area". It is found on the upper terrace but appears to be a younger soil than the Kampong Lubok Kiat Series.

Soil Profile.

On gently slope; sparse rumput jenaris on surface; scattered clumps of bushes; abandoned padi fields common.

0 - 1 in. Very dark grey organic-stained sandy loam with plentiful roots; weak fine crumb structure and loose consistency.

1 - 8 in. As above, with few roots and lighter colour.

8 -21 in. Light grey sandy clay loam matrix with a few organic-stained patches; frequent medium and distinct orange mottles; massive structure and moist; slightly plastic soil.

21-32 in. Brownish yellow fine sandy clay with frequent medium and distinct red-brown mottles; imperfect drainage; subangular medium blocky structure; slightly sticky soil.

32-44 in. Whitish-grey sandy clay matrix with red mottles frequent, large and prominent; poor drainage and slightly sticky soil; mottled patches are slightly hard and are probably in the process of forming concretions. Hard concretions were encountered on augering below 44 inches.

This profile bears similarities to the Kampong Lubok Kiat Series but is not in such an advanced stage of development. Other parts of the same area(which have been mapped as one series) shown variations from the profile examined. Colour is often more yellow-brown and mottling is less pronounced.

This soils was first described by Arnott (1957).

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

PATANG SERIES.

The Patang series has been found only in the Sungei Tebak valley in south Trengganu where it occurs over a long thin band about half a mile wide and at least five miles in length running in a north-westerly direction across the north-east corner of the valley. The soil is a uniform yellowish red colour, deep, reasonably well drained and well rooted in the subsoil, and except for a rather more compact structure it is in appearance similar to the Kampong Kolam series profile. However, the parent material is almost certainly a hornfels, and the soil is unlikely to be so fertile as the diorite-derived Kampong Kolam series. The known area at present amounts to only about 1,500 acres but most of this lies in gently to moderately undulating country which would be suitable for agriculture should development take place in this area in the future.

The organic stained surface layer is extremely thin in this soil, seldom exceeding half an inch in thickness and often being completely absent, so that the surface soil is a yellowish red coloured clay or clay loam which is moderately well rooted and has a good granular structure. There is very little change in the appearance in increasing depth, and except for a slight compaction in the subsoil which breaks to a subangular structure at depths of about two or three feet, the profile is extremely uniform with good drainage throughout. The compaction is sufficient to inhibit the free development of tree roots at a depth of about four feet, while very much decomposed fragments of parent material may appear below this depth. Occasionally small rounded iron oxide concretions, about quarter inch or less in diameter, may be seen scattered through the subsoil but they do not occur in a distinct band and are no hindrance to root development.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

PELAWAN SERIES.

This series was first mapped in the Bukit Goh Forest Reserve, Pahang and is described by Panton and Ang in Soil Survey Report No. 7 published in Volume 41 of the Malayan Agriculture Journal 1958. It is formed on basalt on flat to gently undulating terrain and is associated with Kuantan soils. It is subject to semi-permanent waterlogging in the lower-lying situations.

The surface soil is clay-textured and is characterised by an unusual greenish-grey colour (nearest Munsell notation 2.5Y 4/2). It has a well developed granular to subangular blocky structure, permitting good root distribution. The surface is self-mulching. The gravelly clay subsoil is between 36 and 60 inches thick and has a weak medium subangular blocky structure. This is underlain by a very moist, compact gravelly clay layer at about 38 to 62 inches, and this horizon is not penetrated by tree roots.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

PENOR SERIES.

This series is grouped in association with the peats, mucks and organic clays found in the fresh water swamps of east Pahang. It is mostly sandy clay loam, light grey coloured, and with very little, if any, mottling. It is nearly always under water and has no well developed soil profile or topsoil. It is derived from old marine beach sand deposits and occurs at elevations of 20 feet or less.

Soil Profile (Penor loamy sand).

Ar 0 - 36+inches depth is 2.5YR 7/2 light grey coloured loamy sands to sandy loams having no structure and usually quite firm consistence when moist. At all depths colour and texture etc. seem to remain the same. Mottles are rarely found in this soil, and there is no profile differentiation.

Range in Characteristics - The texture may range from loamy sands to sandy loam or sandy clay loam and is almost always light grey coloured, except that occasionally a shallow overlying layer of peat only a few inches thick will discolour the grey upper horizon to darker colours. The parent material from which this soil is formed is usually found underlying the organic soils in the surrounding areas.

Terrain - Flat - slopes 0 - 2°.

Drainage - Almost always flooded up to the surface all the year round, which results in a lack of mottling, and the usual light grey colour, with no profile development.

Vegetation - Fresh water swamp forest cover.

Uses - These soils are very poor and have a negligible agricultural value. They are too sandy, and are too waterlogged to recommend for extensive agricultural development.

Distribution - These soils are found throughout the east Pahang swamps between Kuantan and the Sungei Pahang, and are probably also common in the swamps occurring along the lower reaches of the Sungei Endau and Rompin, which have not yet been surveyed.

Type Location - Along a rentis running west of the 11th milestone on the Pekan-Kuantan road.

Series Established - Fresh water swamps in east Pahang.

Source of Name - Name taken from Sungei Penor which runs through the lower half of the east Pahang swamp between Kuantan and the Sungei Pahang.

Suitability for Agriculture - Class 4 - more than one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

PERAK SERIES.

This series was established by Owen (1957) but has not been encountered much since. It may in time become assimilated into either Briah or Akob series. It is developed under conditions of impeded drainage on riverine alluvium and consists of grey, mottled yellow, silty clay loam overlying blue-grey silty clay loam. It tends to be lighter in texture and generally less impervious than the coastal alluvial silty clays of the Selangor series. Terrain is flat to very gently undulating. Ironstone concretions are not common, although they do occur occasionally, distributed irregularly in small pockets or as a thin band at varying depths below the surface.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

POHOI SERIES.

This is a brown or olive brown coloured soil derived from dark carbonaceous shale occurring over low hills in parts of east Pahang. It is medium drained and has a root distribution of 2 to 4 feet. On slopes above 10° laterite bands often occur and the shale parent material is also close to the surface. Most areas of this soil occur under undisturbed forest but some areas have been developed for rubber.

Soil Profile. (Pohoi clay loam).

Od	1-0" dead organic layer of stems and leaves.
Ah	0-3" having gradual boundary to A_2. Is 10YR 4/3 brown colour and clay loam with weak medium blocky structure, and very friable.
AB	3-48", with gradual and irregular boundary to B_2. Is 10YR 5/6 yellowish brown coloured clay loam with moderate medium subangular blocky structure; friable.
Btj	48"+, 10YR 5/6 yellowish brown colour and clay loam texture, with moderate medium subangular blocky structure and friable consistence.

Range in Characteristics - On the more level slopes from 5-10°, this series is at least 4 feet deep and no laterite band is present, but on steeper slopes a band of laterite mixed with shale will be as close as 10 to the surface, giving rise to a shallow phase of this series.

Drainage - Internal drainage is medium and the soil holds moisture well. No mottling is present however.

Vegetation - Soils are developed to rubber in some areas, but mostly carry Dipterocarp rain forest.

Uses - This series can be used for agriculture and is best utilised for development of rubber and fruits, but good management is essential in relation to fertility and erosion.

Distribution - This series is found close to the Maran-Kuantan road near Gambang in east Pahang, mainly near the Sungei Pohoi and westwards from this point for about five miles.

Type Location - Roadside cut 1 mile west of Sungei Pohoi on Maran-Kuantan road, Pahang.

Series Established - This series was established during reconnaissance survey in east Pahang. It is very closely related to the Tavy series.

Source of Name - Sungei Pohoi which runs within the area of occurrence of this soil.

Suitability for Agriculture - Class 2 - few minor limitations. On steep slopes Class 5 - one very serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE,

PROVISIONAL SERIES DESCRIPTION.

POKOK SENA SERIES.

The Pokok Sena series was originally regarded as a fine sandy loam variant of the Gajah Mati series (Gajah Mati clay loam) but has since (after more detailed work) been regarded as a distinct and separate soil series. This soil, is not only texturally poorer but also can be distinguished from the Gajah Mati series by its colour (lighter). Unlike the Gajah Mati which is developed predominantly on shale, the Pokok Sena series is formed on quartzite parent material. It has been mapped in Kedah.

These soils are developed on fairly flat to gently undulating terrain and the slopes are usually of the order of 3 to 5°, but never exceeding 10°. Drainage in these soils is generally poorer than in the Gajah Mati series.

The characteristics of these soils are a greyish brown fine sandy loam topsoil over a yellowish brown loam subsoil.

Laterite is invariably present in the form of loose, penetrable, pisolitic concretions usually about 12" from the surface, though this varies considerably.

As in the Gajah Mati series, the profile sequence follows a similar pattern:-

Topsoil overlying a penetrable laterite zone overlying in turn a "pallid zone" overlying weathered quartzite (sandstone) parent material. The watertable, however, in these soils is generally closer to the surface than in the Gajah Mati series.

Typical Profile Characteristics.

Ah horizon 0-1" 10YR 4/3 Greyish brown fine sandy loam. Fine weak subangular blocky structure.

Ae horizon 1-12" 10YR 5/6 Yellowish brown loam. Fine moderate to weak subangular blocky structure.

Bcn horizon 12-30" Band of laterite in the form of ironstone concretions. Matrix colour as above.

Cm horizon 30-42" Kaolinitic clay with red mottling. ("Pallid Zone).

Cc horizon below 42" Sandstone. (Weathered fairly fine grained quartzite).

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

RASAU SERIES.

This soil is a sandy clay loam. The topsoil is yellowish brown in colour while the subsoil is a brownish yellow colour. It is developed on raised terraces of Older Alluvium of approximately 50 feet elevation above the sea, which are flat or almost flat with slopes ranging from 2 - 5°. Most of this soil is covered by undisturbed or only slightly disturbed forest, although some areas are developed with rubber. The agricultural potential of this series is considered only moderately good, and it appears best suited for permanent forest reservation purposes. It has a leached profile, pale in colour, and apparently low in plant nutrients. When dry the soil becomes very hard and when wet it is quite sticky. It has medium internal drainage. No erosion is evident, and stones and laterite are absent. It closely resembles the Holyrood series, but is "stiffer", and has a higher clay content and appears to occur mainly at higher elevations.

Soil Profile.

Ahj — 0 - 1½ inches, sandy loam, 10YR 6/4 light yellowish brown, with weak coarse granular structure and friable consistence.

AB — 1½ - 24 inches, sandy clay loam, 10YR 6/6 brownish yellow in colour, weak medium subangular blocky structure and firm.

Bt — 24 - 51 inches, diffuse and irregular boundaries of 10YR 6/6 brownish yellow colour and sandy clay texture with weak medium subangular blocky structure and very firm consistence.

BC — 51+ inches, diffuse boundary, sandy clay, 10YR 7/2 very pale yellow with gradual change with depth to 10YR 8/2 white. Present also are 10% mottles of 10YR 6/8 brownish yellow and some 1% mottles of 2.5Yr 6/6 light red colour. Structure is weak, medium subangular blocky and has very firm consistence.

Range in Characteristics - This soil ranges in character from a soil closely resembling the Holyrood series soils which differ by being more sandy, friable, and paler in colour, to a stiff soil with more clay and darker in colour, which generally occurs in the higher places close to the Tavy series, on the low hill country to the west of the swamps near the Kuantan-Pekan road.

Terrain - Generally on elevations of 100 feet above sea level and on slopes ranging from 2 - 60°. Sharp drops into small stream beds are evident, indicating that the streams are eroding into the terrace topography, but otherwise the land is quite flat to very gently undulating.

Drainage - Is a medium to rapidly drained soil.

Vegetation - Dipterocarp rain forest of rather poor quality. The rubber present in the developed areas is generally below average quality and appears deficient in nutrients which are most probably lacking in this soil.

Uses - A large portion is gazetted as forest reserve and State land forest; some rubber and fruit is grown but is of poor quality. This soil appears better suited for forest reserve rather than for agriculture development, as long as better land suitable for agriculture remains undeveloped elsewhere.

Distribution - The major area of distribution is south of Gambang on the flat to gently rolling country immediately east of the hills and the Sungei Lepar. Towards the east this soil series merges with the Holyrood series, although there are indications that the two soils occur at slightly different levels, and may be related to two separate terrace levels.

Type Location - Just south of the Sungei Rasau on the Gambang to Kampong Kuala Lepar new road.

Series Established - Lepar Forest Reserve area, Pahang.

Source of Name. - Sungei Rasau, which runs through the terrace on which these soils occur.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

RENGAM SERIES.

The Rengam series is probably the most widespread and well known series in Malaya. It occurs in most parts of the country, particularly in the undulating region on the west side of the main range. The soils are sandy clay loams derived from granite rocks, brownish yellow in colour, with very deep profiles, and moderately good subsoil structure which allows reasonably deep penetration of tree roots. They are suitable for a wide range of crops. Many large rubber and oil palm estates are sited on these soils. Several series derived from quartzite rocks or the more sandy iron-poor shales, may closely resemble the Rengam in certain features, particularly in colour, but the Rengam can be recognised by its very characteristic texture which is formed from a mixture of clay with almost equal parts of angular coarse and fine sand, and also the great depth of the profile which shows a gradual change to a pale red colour at lower levels. The Kuala Brang series has a lighter texture and shallower profile; the Serdang and Batang Merbau series also have finer textured subsoils with a higher proportion of fine to coarse sand, and weaker crumb structures. The Tampin can be distinguished by its very coarse texture and paler colour, while the Jerangau series is a better structured, finer textured, soil with a characteristic strong brown colour in contrast with the brownish yellow colour of the Rengam.

Soil Profile (Rengam sandy clay loam - virgin).

Ah	0 to 1 inch, dark brown (10YR 4/3) sandy clay loam; loose moderate medium to fine crumb; good root development. 1 to 2 inches thick.
Ae/Bt	1 to 47 inches, brownish yellow (10YR 6/8) sandy clay loam, moderate medium to fine sub-angular blocky structure; friable; with firmness gradually increasing with depth, root development moderate to good, to depths of 4 to 5 feet. 36 to 80 inches thick.
Cm	47+ inches, light red (2.5YR 6/8) coarse sandy clay loam; very gradual change from brownish yellow over a wide (6 to 24 inches) transitional band; very deep horizon with gradual coarsening in texture with depth; firm to very firm consistency; breaks to moderate medium angular blocky structure; roots confined to upper 2 or 3 feet and rather few in number. 40 inches to 10 feet or more thick.
Cc	Varying depth up to 60 feet, and normally only seen in deep road sections or quarries.

Range in Characteristics - Considering the wide area over which these soils are developed, they display surprisingly little variation. Textural types vary from sandy loam to fine sandy clay loam. Laterite phases do occur in places, particularly on the flatter hill tops in the more gently undulating areas, and also at the foot of slopes to the boundaries with waterlogged alluvial soils. The laterite in such cases is usually at a depth of 3 feet or more below

the surface, and is seldom more than 12 or 18 inches thick.

Terrain - Ranges from gently undulating to hilly slopes from 2 to 20°. Rolling and hilly land in the 5 - 15° range is the commonest however, and where the elevation is less than 200 feet such areas are very suitable for tree crops.

Drainage - Medium to rapid even at considerable depths.

Vegetation - Good quality jungle.

Uses - Extremely varied, used for practically every type of tree crop and short term food crop.

Distribution - Found over large areas of Johore, Malacca, Negri Sembilan and Selangor on the west side of the country, and also occurs in parts of every other State except Perlis.

Type Location - Ulu Chalok, Trengganu.

Series Established - Johore.

Source of Name. - Town in Central Johore.

Remarks - This series has a very great agricultural importance and is one of the most suitable for tree crops, particularly rubber and oil palm. Large areas in the southern and east coast States still remain covered by virgin jungle. A red variant, formerly Lambak series, has been mapped in Johore.

Suitabliility for Agriculture - Class 1 - no limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

RUDUA SERIES.

The raised beaches over which this soil develops are very gently rolling, and seldom higher than about twenty feet above sea-level. The vegetation which is secondary in character, consists mostly of rather stunted and gna led gelam ('Melaleuca leucodendron') and tembusu ('Fragraea fragrans) scattered at widely spaced intervals about the landscape, while the ground between the trees is covered with a variety of coarse grasses which seldom grow more than a foot or two in height. The soil is a very free draining loosely structured coarse sand which is extremely poor in nutrients and coconuts are the only crop of any importance. It was first described in Trengganu by Panton (1958).

While practically the whole of the series is covered by this secondary bush savanna type of vegetation, one or two small areas under natural jungle cover have been located, the largest of these being an area of about 300 acres to the west of the 38th mile on the main road between Dungun and Kuala Trengganu. Here the soil is overlain by a root mat two to four inches in thickness which is absent in the areas now covered by bush. This thick organic surface horizon under jungle represents a valuable source of fertility in an otherwise impoverished soil, and the rapid loss of this layer by oxidation following clearing of the land leads to the formation of a degraded profile capable of supporting only the poor type of vegetation described above. The profile description given below is typical of that found in the degraded areas.

The surface soil is a dark grey or brown coarse sand which is completely structureless and may be covered by a thin layer of white coarse sand wash. Rooting is very variable and may be considerable under a good grass cover beneath coconuts. This surface soil is little more than one inch thick and is underlain by a very dark grey sub-surface horizon of coarse sand about six inches deep, which merges with a greyish or brownish coloured coarse sandy subsoil which is excessively drained, loose, and structureless. At a depth of about two feet there is a gradual change to a brownish yellow coarse sand, and this in turn changes to a reddish, yellowish brown, or even black colour reminiscent of of a humus iron podzol horizon, at depths of four or five feet. Roots, particularly those of coconuts, are well distributed and numerous even as far down as six feet, but rather than being a sign of high fertility, this indicates the intense competition for the few available nutrients and the serious water shortage in the upper horizons.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

RUSILA SERIES.

On the East Coast the gradual infilling of the narrow lagoons between the sand ridges with finer grained sediments carried in by streams flowing from the coastal hill ranges eventually results in the formation of swamps in which the vegetation usually consists of a natural monostand of "gelam" (Melaleuca leucodendron). In a few places in Trengganu (Panton 1958) these swamps have been cleared and cultivated with wet padi, but yields are very low, particularly in the most recently cleared areas. The soils are of rather variable texture, have high water tables, and in some cases may be completely flooded for much of the year.

Very few detailed examinations have been carried out on these soils, but the following summary is based on observations made at several points throughout the State of Trengganu.

The texture of the soils varies from clayey sands to sandy and even silty clays but the coarser textured types are the most common, particularly in the narrower swamps. In cultivated areas there is often a considerable amount of sand in the topsoil horizons which is probably due to admixture with coarse sand brought in from the surrounding Rudua series. Flooding to a depth of one foot is common and movement of the swamp water is very slow to almost completely stagnant. The surface soil layers vary in colour from dark grey to black, while the subsoil is generally a light grey or white. Some yellow mottling may be developed in the subsoil and at greater depths a strong sulphurous smell may be apparent. From the above description it will be seen that there is a considerable variation in these soils, and detailed survey would no doubt require the setting up of several series to cover these differences.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

SEGAMAT SERIES.

This soil was first identified by Owen in the Segamat area of Johore, and it has since been recognised and mapped in several parts of the country, including Pahang, Kelantan and Selangor. It is developed from andesitic rocks of intermediate to basic composition.

The surface soil is normally very thin, particularly under forest, and consists of an inch or two of dark brown firmly crumbed clay which changes below to a very deep, uniform yellowish red or red clay. This horizon has a strong medium or fine subangular blocky structure and friable consistency and is usually very well rooted down to at least 4 feet, below which rooting decreases fairly rapidly and the consistency becomes firmer. The parent material horizon occurs at great depth, and is not normally apparent in the rooting zone. The soil is particularly suitable for tree crops including rubber, dusun and oil palm. It is unlikely to be mistaken for any other series, with the exception of the Kampong Kolam series, but this latter soil has a lower clay content and occurs only in areas of Rengam series soil.

Soil Profile (Segamat clay, under mature rubber).

Ah — 0 to 1 inch, dark brown (7.5YR 4/4) clay loam, very friable and with a fine crumb structure, 0 to 2 inches thick.

Bti — 1 to 44 inches, yellowish red (7.5YR 4/6 changing with increasing depth to 7.5YR 6/8) possessing a strong fine to medium subangular blocky structure and friable consistency. Roots are very well developed throughout the profile. Maximum thickness unknown but likely to exceed 72 inches.

Range in Characteristics - Colour may vary from red (2.5YR 4/6) to yellowish red (5YR 5/8) over quite short distance, and this is probably related to slight changes in the composition of the parent material. Occasional lateritic phases may be developed, usually on more gently sloping situations, but these developments do not normally cover very large areas. The laterite in such cases consists of irregular concretions in a clay matrix and may be several feet thick and approach to within a few inches of the surface.

Terrain - Varies from undulating to hilly with deeper soils usually developed over slopes in the medium slope range.

Drainage - Internal drainage is rapid to medium throughout the profile. The surface layers dry out rapidly during dry spells, which may be a handicap to the growth of annual crops.

Uses - Rubber, which is noted for its good growth and high yield, is the main crop, while a variety of kampong fruit trees also grow well and can be seen in most developed areas.

Vegetation - Bears a good forest cover in the virgin state.

Distribution - Occurs in patches varying in size from several thousand to less than 20 acres in several parts of the country, particularly in central Malaya in a broad band running from the Kuala Krai district of Kelantan to the Kluang area of Johore, and including extensive developments in the vicinity of Segamat and Temerloh. It has also been seen in a number of places in Selangor, and there is no doubt that other discoveries will be made in future years as soil survey work is extended into previously unsurveyed areas.

Type Location - Muar River Estate, Segamat Johore.

Series Established - Muar River Estate, Segamat, Johore.

Remarks - This is a particularly rich sedentary soil which should be brought under cultivation whenever possible. While it is not always practicable to reserve such areas for crops other than rubber, the possibility of growing an alternative crop is always worth considering in the case of newly discovered undeveloped areas. Soils belonging to this series have previously been classed as Kampong Awah series in parts of Pahang, and Pahi series in parts of Kelantan, but it is now recognised that all these soils belong to the one series and these alternative names should now be dropped.

Suitability for Agriculture - Class 1 - no limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

SEGARI SERIES.

This soil is found along the Ipoh-Damar Laut road, Perak, but is limited in area and occurs in a naroow band of half a mile to one mile wide, commencing from 52½ m.p. in the north and ending at 63½ m.p. in the south. In all probability its parent material is derived mainly from the granite hills e.g. Bukit Segari sited on the western side.

Normally the topsoil is grey (10YR 5/1) clayey sand on loamy sand averaging about 10" depth. Structure is weak medium crumb and angular blocky. Consistence is firm. There is no mottling or iron deposits.

The texture in the subsoil is sandy clay extending to about 30" depth, and below this is partly decomposed alluvium derived from the hills. Structure is moderate medium angular blocky, matrix colour is light grey (10YR 6/1 to 7/1), and quite often pale yellow (2.5Y 7/4), resembling the Holyrood series in colour and some other features but better placed as a separate series due to textural differences, the Holyrood having normally a sandy clay loam texture and the Segari a clayey sand with a gravelly subsoil. Variations in the texture and colour are brown sand, pale brown sand and yellowish brown sand. Mottling of reddish (5YR 6/8) occupied 2 - 3% of soil volume. Drainage in this soil is quite good.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE

STANDARD SERIES DESCRIPTIONS

SELANGOR SERIES

Soils of the Selangor series are found over the large marine alluvial flats along the west coast of Malaya, and they rank as possibly the most fertile soils in the country. The profile consists of a dark brown surface horizon underlain by a brownish grey horizon which becomes increasingly mottled with yellow or red at depth. Below there is a permanently moist blue-grey horizon. Texture is most commonly silty clay. The soils are suitable for practically all crops, but deep drainage is necessary if the best results are to be obtained, particularly in the case of deep rooting tree crops. Soils of the Selangor series have high nutrient reserves and crops grown show little or no response to fertilisers, although in future years continual cropping is likely to show up the need for one or more nutrients as the soils in the older cultivated areas become exhausted.

Soil Profile (Selangor silty clay under mature rubber, well drained phase).

Ah 0 to 3 inches. Dark brown (7.5YR 4/2) silty clay loam; moderate medium to fine crumb structure; friable consistency; very well rooted; diffuse boundary; 2 to 4 inches thick.

AB 3 to 23 inches. Dark greyish brown (10YR 4/2) silty clay; weak coarse prismatic structure; friable consistency; good root development; medium internal drainage; occasional small strong brown root trace stains; 12 to 25 inches thick.

Bgj 23 to 48 inches. Dark greyish brown (10YR 4/2) silty clay, very similar to previous horizon, but with weak medium angular blocky structure and with occasional yellowish brown (10YR 5/6) mottles and root trace streaks; root development still very good; 12 to 30 inches thick.

Br 40 inches +. Bluish-grey clay; structureless and often possessing a faint sulphurous odour; root penetration decreases considerably at the top of this horizon; continues to an undetermined depth

Range in Characteristics - The changes induced by cultivation and drainage result in this series having a wide variation in visual characters, the most obvious of which are the lowering of the upper level of the bluish-grey gley horizon with drainage, and the formation of a rather better structured topsoil which takes places as a result of the lowering of the water-table. It is possible to recognise several phases of this series, including an undeveloped phase, in which the bluish-grey layer comes very close to the surface; a moderately drained phase in which the gley horizon occurs at depths of between 2 and 4 feet from the surface; and a well drained phase in which the top of the gley horizon occurs at even greater depths, as a result of very efficient drainage. Texture varies very little within this series.

Terrain - Flat land on west coast alluvial plains.

Drainage - In their undeveloped state these soils are water-logged for the greater part of the year, but when developed for tree crops the watertable is kept as low as possible, usually below 3 feet, by deep ditching. In such circumstances percolation through the profile is rather slow.

Vegetation - Swamp forest.

Uses - Large areas have been opened up for rubber, oil palm, and coconut cultivation, particularly in the Selangor coastal areas. When this type of soil is developed for wet padi cultivation the seasonal wetting and drying, and sparse vegetational cover, cause far reaching changes in the physical character of the profile. It is highly likely that a large proportion of the many extensive padi areas in coastal Kedah and Perak were originally covered by soils which conformed to this general description.

Distribution - Throughout the coastal plains along the west coast of Malaya.

Type Location - Selangor River Estate, Bukit Rotan, Selangor.

Series established - West Selangor coastal plain.

Remarks - This soil is proving to be a particularly suitable type for oil palm, and the area planted with this crop is likely to increase considerably in future.

Suitability for Agriculture - Undrained, Class 3 - one serious limitation.

Drained, Class 1 - no limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE

PROVISIONAL SERIES DESCRIPTION

SENAI SERIES

These soils have been found to occur over rolling to hilly topography in the southern part of Johore and were first recognised on Mount Austin Estate. They are rather thin lateritic soils of fine texture and occur over the upper and mid-slope positions where the shallowness of the profile may be accentuated by erosion. They are believed to be derived from rocks of basic composition and it has been suggested that they are of diorite-gabbro type, however this has not been definitely confirmed. The general simillarity between these soils and some identified on Singapore Island which are of basic noritic composition is probably not coincidental and the more lateritic type of the Senai Series is similar to the Sungei Kadut Series which was established in the Singapore survey.

Soil Profile

Ah 0 - 1 inch. Brown to dark brown (7.5YR4/4), silty clay loam, well developed medium crumb structure, friable consistency. This horizon may be absent in some profiles.

BEj 1 - 14 inches. Strong brown (7.5YR5/8) to reddish yellow (5YR6/8) silty clay loam to silty clay, well developed fine crumb structure and friable consistency.

Bcn 14 - 48 inches. Penetrated only with difficulty by soil auger. Consists of abundant vesicular slabby laterite and bauxite concretions in a yellowish red (5YR5/8) silty clay matrix.

Range in Characteristics - Occasional deeper phases of this Series have been observed generally on less steeply sloping topography, or in lower positions. These are exceptionally well structured rich looking soils with reddish brown topsoils up to 4 inches in depth. This is underlain by reddish yellow silty clay loam with a well developed medium crumb structure extending to a depth of at least 36 inches where occasional laterite concretions are encountered.

Distribution - Occurring intermittently throughout South-Central Johore on developed land.

Uses - It is planted almost entirely to rubber, and considering its favourable soil structure and texture, oil palm is likely to flourish on this soil where the laterite is deep enough to prevent root hindrance.

Drainage - Medium to rapid.

Series Established - Mount Austin Estate, Johore Bahru.

Type Location and Name Source - Senai Estate, Senai, Johore.

Suitability for Agriculture - Laterite within 2 feet, Class 3 - one serious limitation.

Laterite deeper than 2 feet Class 1 - no limitations.

SOIL SCINECE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

SERDANG SERIES.

This is a common soil in many parts of Malaya. It is formed from quartzite conglomerate parent material over undulating and rolling country, and on the lower, gentler slopes of many quartzite ridges and mountain ranges. It can be used for a wide variety of crops. The profile is very uniform and quite deep, free draining, and rather loosely structured. Laterite is not found in this series and root development is normally good. The soil can be distinguished from the Telemong series by its lighter colour, more free draining subsoil, and the fact that it occurs over sloping ground in contrast to the flat alluvial sites on which the Telemong is developed. The Kuala Brang series has a shallower profile and is generally found on steeper slopes. The Kedah series, with which the Serdang series if often associated, has a very much shallower profile, with undecomposed quartzite or conglomerate fragments occurring at about 2 feet or less, and is found only on steep slopes, or at high elevations.

Soil Profile.

Ah	0 - 5"	10YR 4/4 (dark yellowish brown) friable sandy loam with a moderate fine and medium subangular blocky structure, few pores, indistinct boundary.
Ae	5 -22"	7.5YR 5/6 (strong brown) very friable sandy loam, with a weak medium subangular blocky structure, abundant pores, patchy clayskins, boundary distinct.
Bt	22-36"	7.5YR 5/8 to 6/8 (strong brown to reddish yellow) friable to firm sandy clay, moderate fine subangular blocky structure, few pores, discontinuous clayskins, boundary distinct.
BC	36-58"	5YR 5/8 (yellowish red) firm sandy clay, weak medium subangular blocky structure, many pores, patchy clayskins, boundary distinct.
Cm	58-68+"	5YR 5/8 (yellowish red) firm coarse sandy clay weak fine blocky structure, few pores, patchy clayskins.

Range in Characteristics - Apart from slight changes in texture, and colour, which varies from strong brown to yellow, this is a very uniform soil series. Textural types ecognised include the fine sandy clay loam, fine sandy loam and fine sand.

Terrain - Undulating to hilly, usually on the lower, gentler slopes of quartzite hill and mountain ranges.

Drainage - Well drained throughout the profile.

Vegetation - Normal Dipterocarp rain forest.

Uses - Extensively cultivated with rubber and various crops.

Distribution - This soil has been recognised in practically every State in the country and seems to be particularly common in Selangor and Pahang.

Type Location - Federal Experiment Station Serdang, Selangor.

Series Established - Federal Experiment Station, Serdang, Selangor.

Remarks - Soils corresponding to this description were first named Kedah series by Owen, but in the absence of a full description, and on the assumption that the Kedah series would exhibit differences in its type area (Kedah, north Malaya) from the soils seen in the first areas mapped by the Soil Science Division, the Serdang series was set up to avoid possible confusion. It now appears that the better developments of Owen's Kedah and the Department of Agriculture Serdang series are in fact much the same soils, but as subsequent reconnaissance survey has shown this soil to be more common in Selangor and other central States of Malaya than in Kedah itself, it is felt that Serdang would be a more suitable name. A red variant has been identified in Johore.

Suitability for Agriculture. - Class 1 - no limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

SEREMBAN SERIES.

This series was first described by Owen (1951) and has not been definitely identified in the field since, so that the following description is very tentative.

It occurs on schist and, according to Owen (page 37) the main criteria are: flattened laterite fragments in the subsoil, the presence of partly decomposed quartz veins at variable depths, and a yellow sandy clay loam or sandy clay over clay.

The following profile has been very tentatively identified as Seremban series in Selangor:

Soil Profile.

Ah	0 - 3" 10YR 4/4 (dark yellowish brown) friable sandy clay loam with a moderate fine subangular blocky structure, quartz fragments, few pores, patchy clayskins, abundant roots, boundary distinct.
AB	3 -12" 7.5YR 5/8 (strong brown) firm silty clay with a moderate medium and fine angular blocky structure, quartz fragments, few pores, discontinuous clayskins, many roots, boundary indistinct.
Btj	12-26" 7.5YR 5/8 - 6/8 (strong brown to reddish yellow) firm clay with a weak to moderate fine angular blocky structure, quartz fragments. many pores, discontinuous clayskins, few roots, boundary indistinct.
Bt (i)	26-40" 7.5YR 5/6 (strong brown) friable clay with a weak medium subangular blocky structure, quartz fragments, many to abundant pores, discontinuous clayskins and oxide skins, few roots.

Note: The quartz fragments throughout this profile are very small and in some cases identified only under the hand lens.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

SITIAWAN SERIES.

This alluvial soil was first located in Perak in a small area along the 42nd m.p. Bruas - Sitiawan - Lumut road but is present in considerable areas around Sitiawan, Pekan Gurney and south of Kampong Koh. It is also found in Rycroft, Cashwood, Ayer Tawar, Walbrooh and Sungei Wangi Estates. The Sitiawan lies in association with the Sogomana with the former occupying the higher terrace and the latter the lower terraces.

The topsoil is characterised by greyish brown (10YR 5/2) or light yellowish brown (10YR 6/4) silty loam or silty clay usually between 3 and 5 inches. Structure is strong fine crumb and moderate medium crumb, consistence is firm.

Subsoil has a pale yellow (2.5Y 7/4) clay or clay loam and extends to 36" depth. Light red (2.5YR 6/8) mottling occupies 2 - 5% of soil volume. Structure is moderate medium to coarse angular blocky and consistency is always firm. Drainage is always adequate in this soil as it occurs on higher ground and it is thus easy for excess water to percolate further. Variations in texture and colour often occur, for instance yellow (2.5 Y 7/6) clay and very pale yellow silty clay were encountered. Sometines a little fine to medium sand is noticed in the subsoil at about 28 - 36 inches depth.

Soils of the Sitiawan series appear to be of average fertility. However this soil requires manuring and also planting of grown cover to improve soil conditions. Rubber is a suitable crop for this soil and most of the good rubber found along Bruas-Sitiawan-Lumut road were grown on these soils.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

SOGOMANA SERIES.

This soil was originally found in Sogomana Estate, Perak, and lies in association with the Sitiawan series, the sequence being the Sitiawan occupying the higher terrace and the Sogomana the lower terrace. It is also found in various estates - Sogomana, Huntly, Rycroft, Cashwood and Ulu Ayer Tawar Estates and occurs along the areas bordering 40th m.p. to 62 m.p. Bruas-Sitiawan-Lumut road and also in small patches just to the west of Kampong Koh and Pekan Gurney. A representative profile is as follows:-

The topsoil is normally 4 to 6 inches deep of silty clay texture. Normally matrix colour is grey (10YR 5/1). Structure is weak fine to medium crumb and subangular blocky, consistence is generally firm.

The subsoil is generally very uniform light grey to white (10YR 7/1 to 8/1) colour. Texture is silty clay to clay with a weak moderate angular blocky and coarse prismatic blocky structure. Consistence is normally firm. Reddish yellow mottling (5YR 6/8) occupies 3-6% of soil volume. Normally drainage is inadequate in this soil and must be considered before agriculture can be contemplated.

On account of its occurrence in low-lying areas, this soil if adequately drained and planted with good ground cover will prove suitable for rubber, and good rubber was noticed along the Bruas-Sitiawan-Lumut road.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

SUNGEI BULOH SERIES.

The Sungei Buloh series is a free draining soil developed over coarse grained alluvial sands and gravels, and occurring in the wider valleys and along the edges of many of the hill and mountain ranges in various parts of the country. It is a soil of rather low nutrient status, but marked responses can usually be obtained to fertilisers. This soil is rather pale in colour and loosely textured, and although the upper part of the profile is generally well drained, waterlogging commonly occurs at depths below 4 or 5 feet. The Kampong Kubor series, which is a colluvial soil occurring in small valleys in granite hill country is the only series which resembles the Sungei Buloh, but can be distinguished by the immaturity of its profile and the absence of a podzolic horizon.

Soil Profile (Sungei Buloh Sand).

Ah — 0-1½ inches, dark brown (10YR 4/3) loose sand full of ramifying roots. Very free draining and structureless. Bare topsoil under mature rubber, 1 to 4 inches thick.

Ae — 1½-7 inches, yellowish brown (10YR 5/4) loose sand with much less rooting than previous horizon. 0 - 10 inches thick.

Bhi — 7-43 inches, dark brown (10YR 4/3) loose structureless sand with fair root development, 6 - 12 inches thick, underlain by a somewhat compacted yellowish brown (10YR 5/6) sandy loam with a very weak fine crumb of loose consistency, 10 - 20 inches thick. The lower boundary of this horizon is gradual and irregular and merges with a lighter coloured horizon blotched with light red (2.5YR 6/8) iron stains varying in diameter from ½ to 6 inches. These areas of iron accumulation are often harder than the surrounding soil, but crumble easily when disturbed, 3 to 10 inches thick.

C — 43+ inches, yellow (10YR 8/6) sandy loam with light grey and white patches, often with a high clay content which becomes more common with increasing depth.

Range in Characteristics - This series exhibits very considerable variation, the variations depending mainly on small changes in topography which result in marked differences in the drainage character of the profile and the depth of the watertable. Accumulations of iron oxide in the B horizon which is one of the most characteristic features of this soil are very variable in thickness and intensity, while the texture may change rapidly over very small areas. Textural types so far recognised include sands, fine sands, and sandy loams.

Terrain - Very gently undulating to almost flat land at low elevations.

Drainage - Rapid in the surface horizons, but a seasonably fluctuating watertable is usually found at depths of between 4 and 6 feet.

Vegetation - Largely cultivated with rubber. This soil probably carried a stand of moderate jungle in the virgin state.

Uses - Rubber and food crops.

Distribution - Believed to be extensively developed in the wider valleys along the west coast of Malaya.

Type Location - Rubber Research Institute Experimental Station at Sungei Buloh, Selangor.

Series Established - Sungei Buloh, Selangor.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

SUNGEI KADUT SERIES.

This is a thin, lateritic soil with a variable profile which is found over the gently and moderately undulating country to the west of the Bukit Timah Road, Singapore Island. The parent material is probably a basic rock of noritic type.

A thin, greyish-brown clay to sandy clay surface soil is underlain by a strong brown or brownish-red subsoil which changes to a reddish laterite at a depth of between 18 and 36 inches. This is often very thick and consists of concretions of various sizes from small pebbles up to large boulders. Bauxite, which can be distinguised by its whitish colour, often occurs with the laterite, and old bauxite workings can be seen on some hill tops.

This soil has probably developed from the same parent material as the Bukit Panjang series and its differences are due to the different topography. The Bukit Panjang series is a young soil developed on the steeper hills where geologic erosion is more rapid and the parent rock occurs within a few feet of the surface, while the shallow lateritic Sungei Kadut series represents a senile phase derived from this same material but formed on very much older slopes where the process of laterisation has been at work for a considerable period of time.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

TAI TAK SERIES.

The name Tai Tak series has been given to a commonly occurring group of soils in southern Johore which are believed to be of Older Alluvium origin. They consist mainly of brownish yellow silty clay loam and clay loams and are generally free of laterite, or have only small amounts of laterite present. They are much better structured than most soils of Older Alluvium origin recognised in Johore and from this aspect, as well as the fact that they occur over undulating topography, they should be better suited than the other Older Alluvial soils to most agricultural crops.

Soil Profile.

A_1 0 - 2 inches. Yellowish brown (10YR 5/6) loam, well developed coarse crumb structure, friable consistency.

AB 2 -24 inches. Brownish yellow (10YR 6/8) silty clay loam to clay loam, strong medium subangular blocky structure, firm consistency.

Btj 24-60 inches. Brownish yellow (10YR 6/8) silty clay loam to silty clay with red (2.5YR 4/5) streaks becoming more abundant with depth. Strongly developed medium crumb to subangular blocky structure, firm consistency.

Range in Characteristics - A fine sandy loam texture has been widely recognized and is very common in the undeveloped area south of the Sungei Johore. This type is similarly brownish yellow in colour with a textural range of clay loam to fine sandy clay loam in the sub-surface horizons. Soil structure is less strongly developed in this type than in Tai Tak loam.

Reddish yellow, yellow and occasionally strong brown variants of this series have been recognized but not mapped.

Type Location - East of Ulu Tiram village.

Series Established - Tai Tak Rubber Estate, at the 22nd milestone Johore Bharu-Kota Tinggi Road.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCINECE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

TAMPIN SERIES.

This series was first described by Owen (A Provisional Classification of Malayan Soils, Journal of Soil Science, Volume 2, 1951), and this description was subsequently expanded by Panton (Reconnaissance Soil Survey of Trengganu, Bulletin 105 Department of Agriculture, 1958).

It is a pale coloured, coarse grained soil derived from highly siliceous granite which occurs in several parts of Malaya and which has been mapped in Trengganu and Pahang. It is found on undulating terrain commonly associated with Rengam soils. The soil is quite deep but the compact nature of the coarse textured subsoil inhibits root development.

The thin surface horizon is greyish brown to whitish grey sandy loam with a loose consistence and a very weak crumb structure, which merges into a pale yellow coarse sandy loam or clayey sand. This subsoil horizon has a very weak crumb structure, is free draining and becomes increasingly compact with depth. Root development is poor in this zone and tree roots seldom penetrate below a depth of three feet. There is often a pronounced textural change in this horizon the proportions of both gravel and clay increasing while the coarse and fine sand percentages decrease, and at around three feet the texture may approach that of a clayey gravel. The parent material horizon is very coarse textured and may include a few rounded boulders of weathering granite.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

TAMPOI SERIES.

The soils of this series are developed from moderately coarse textured parent material considered to be of Older Alluvial origin. They occur predominantly over undulating terrain at elevations ranging from 50-150 feet A.S.L., but frequently occur at the lower end of this range, i.e. 50-100 feet A.S.L. The soils are characterized by strong colours not unlike in situ sedentary soils and difficulty may be experienced in distinguishing them from granite soils due to this fact.

Soil Profile.

Ah — 0 - 4 inches, dark yellowish brown (10YR 4/4) sandy loam with a slight concentration of medium to coarse sand on the surface due to erosion. Well developed medium crumb structure, friable consistency.

AB — 4 -48 inches, reddish yellow (7.5 YR 6/6) sandy loam to sandy clay loam texture. Coarse blocky breaking to weak crumb structure and becoming increasibly compact with depth. Consistency is friable when moist, but very firm when dry. A few laterite concretion are sometimes evident scattered throughout this horizon.

Btj — 48+ inches, reddish yellow (7.5YR 6/6) sandy clay loam with yellowish red (5YR 5/8) streaks tend to dominate the subsoil colour at depths beyond 72 inches. The structure is very compacted coarse blocky, and consistency firm. Rounded quartzite pebbles or boulders ranging in size from ½ to 3 inches in diameter are commonly found in the subsoil or at the base of an exposed and eroded section.

Range in Characteristics - The texture generally varies from sandy loam to sandy clay loam, the sand being predominantly in the fine to medium size range and with only small amounts of coarse sand. Laterite phases are not uncommon, but the concretions generally are small and diffuse, and therefore they would not interfere with root development. Where laterite occurs it is generally within 2 feet of the surface in the upper slope positions, but may be 4 - 6 feet below the surface in lower slope positions.

Drainage - Drainage is medium to rapid in the upper 2-3 feet of the profile, but is impeded below this depth due to the compacted, poorly structured subsoil.

Uses - Rubber is the most widely distributed crop occurring on these soils. To date this series has not been identified over the undeveloped areas of south Johore.

Type Location - It has been found to occur in the extreme southern part of Johore, in the vicinity of Johore Bharu. This series was first established a few miles from Johore Bharu, near Tampoi Halt on the main railway line.

Remarks - These soils occur in association with the Harimau series; the Tampoi series being confined to the more low-lying and moister positions, while the Harimau series, which is of similar texture, but is brownish yellow to yellow in colour, occurs further upslope in the better drained positions.

Suitability for Agriculture. Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

TANDAK SERIES.

The Tandak soils are developed over undulating and rolling land from shales of Carboniferous age in the north of Kelantan near the Thai border. They are shallow, heavy textured soils with a strongly developed ironstone laterite horizon which usually occurs within 6 to 8 inches of the surface. The laterite concretions are small, irregularly shaped, and closely packed, and often show a pronounced elongated or platey form. Root development is very much restricted by the laterite band, and roots are almost entirely confined to the shallow topsoil. Many areas which have been opened up for rubber and general kampong development have been seriously degraded by erosion, and ironstone pavements are a common sight in the more densely populated region near the Rantau Panjang railway line. The Tandak differs from the Malacca series in having a much shallower topsoil above the laterite, and in the size and shape of the laterite concretions. It is not unlike the Ulu Pandan series of Singapore Island but differs in colour, texture, and depth of the topsoil. It is a poor soil with a very low agricultural potential.

Soil Profile (Tandak clay)

Ah — 0 to 2 inches, dark brown (10YR 4/3) to brown (10YR 5/3) clay with a moderate to strong medium to fine crumb structure; loose; numerous worm-casts on surface; very numerous roots. 1 to 6 inches thick.

AB — 2 to 8 inches, reddish yellow (5YR 6/8) moderate to strong medium crumbed clay; well rooted; firm but friable. 3 to 8 inches thick.

Bcnv — 8 to 32 inches, close packed laterite horizon; 80% concretions in a reddish yellow (5YR 6/8) matrix. Concretions are small, irregularly shaped, and sometimes elongated and platey, usually about ¼ inch across, but some up to 2 inches diameter. Difficult to dig and very poorly rooted. 20 to 40 inches thick.

BC — 28 inches +, reddish yellow (5YR 6/8) clay with moderate coarse subangular blocky structure; compact; very few roots; occasional small indistinct reddish mottles.

Range in Characteristics - The subsoil above the laterite band varies in thickness with relief, but seldom exceeds eight inches, while very badly eroded phases are common. Texture in the topsoil varies from clay to fine sandy clay loam, the heavier textured types being most widespread. Virgin profiles can be seen under jungle in the Kenahang Forest Reserve, but in all other areas the profiles have to some extent been disturbed as a result of man's interference. The depth of the organic stained surface layer is less than one inch under virgin jungle, but may be as much as 6 inches under lallang.

Terrain - Undulating and rolling with elevation not exceeding 200 feet. Slopes commonly range from 0 to 15 degrees but may reach 20 degrees in one or two places.

Drainage - Moderate, with slow percolationiin the subsoil and rapid run-off.

Vegetation - Moderate quality forest. Abandoned areas are covered by low dense scrub.

Uses- - Except for the forest reserve, most available areas are under either permanent or shifting cultivation. Rubber and kampong fruit trees are the commonest permanent crops.

Distribution - In the northern part of the Kemahang forest reserve, Kelantan, and south of the railway line between Pasir Mas and Rantau Panjang. Probably also occurs in the Su-Ngai district of Thailand.

Type Location - Pasir Mas District, Kelantan.

Source of Name - Small hill south of Gual Perick, near the north boundary of Kemahang forest reserve.

Remarks - Development should not be encouraged on this series, which is only suitable for forest crops. Exhaustion and erosion in the older established areas will make even the replanting of rubber difficult, and the problems are likely to increase in future years.

Suitability for Agriculture. - Class 5 - at least one very serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

PROVISIONAL SERIES DESCRIPTION.

TAVY SERIES.

This is a reddish brown coloured sedentary soil of clay and sandy clay loam textures derived from shale parent material on undulating to hilly land which has been recognised in east Pahang. It has a moderately thick layer of laterite pebble usually at 16 to 40 inches depth. On the gentler slopes the laterite may be below 40 inches depth. This soil is classed as of average to above average quality for agriculture purposes, but needs good management due to its being often developed on somewhat steeply sloping land. Erosion could be a problem with these soils, They are medium drained, and are found at elevations of more than 70 feet above sea-level. The deeper, more level types, are usually of a more sandy loam texture and the laterite band may be absent or at such a depth as to be unnoticeable during normal soil survey examination.

Soil Profile (Tavy Sandy Clay Loam)

Ah — 0-2" deep with gradual boundary to Ae; 7.5YR 4/4 brown to dark brown, sandy clay loam. Structure is weak medium granular and of friable consistence.

Ae — 2-16" depth with gradual boundary beneath, 10YR 5/8 yellowish brown sandy clay to clay loam of weak medium subangular blocky structure and friable consistence.

Bcn — 16-40" depth with gradual boundary beneath of 5YR 5/8 yellowish red sandy clay or clay of weak medium subangular blocky structure, and very firm consistence with laterite pebbles of 10R 3/4 dusky red colour.

Cu — 40-48+" depth 5YR 5/8 yellowish red silty clay, no structure, very friable consistence, and contains shale of 5YR 5/3 reddish brown colour mixed with silty clay.

Range in Characteristics - Generally the series is a clay loam to sandy clay of 2 to 3 feet depth above the laterite horizon, and of reddish brown colour and firm consistence, and may extend to deeper phases on more level slopes containing sandy clay loam and very little laterite around the bases of the higher and steeper slopes.

Slopes - Normally on 5 to 10 degrees slopes. Deeper phases on 0 to 5 % shallow phases on 10 to 20 degrees land slopes.

Drainage - Soil has medium internal drainage. No mottles present.

Vegetation - Cover is good quality Dipterocarp rain forest when undisturbed, and in areas already developed for agriculture rubber does well

Uses - This soil if well managed and protected from possible erosion damage on the steeper slopes, may best be used for agriculture for crops like rubber, and

mixed dusun fruits. Root distribution is from 2 to 5 feet and laterite pebbles generally do no restrict root development. The pebbles are not cemented together to form solid concretions.

Distribution - The major area of this series is located on a range of small hills running N.W. to S.E. beginning at Sungei Pahoi near the Maran-Kuantan road in Pahang and extending south of Gambang towards the Sungei Pahang. It also occurs in Johore.

Type Location - Tavy Rubber Estate, near Gambang, Pahang.

Series Established - On range of small hills just south of Gambang, Pahang.

Source of Name - From Tavy Rubber Estate, Gambang Pahang.

Remarks - Rubber grows well on this soil in the type area, compared to the Old Alluvium terrace soils in the surrounding flatter land.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION- DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

TELAGA SERIES.

A very rich, free draining, recent alluvial soil formed on the lower, more recent, terraces of many of the larger east coast rivers. It is developed over fine sandy and silty material which has been derived from the mountains of the interior and deposited along the river banks, particularly on the inner sides of the numerous meanders. The only soil similar in appearance to the Telaga is the Telemong series, but the Telaga can be distinguished by its more silty texture, and its situation in areas very liable to flooding during the Monsoon period. In most areas where it occurs this soil is intensively cultivated with food crops during the intermonsoon season.

Soil Profile (Telaga silty fine sand under maize)

Ah — 0 to 8 inches, yellowish brown (10YR 5/4) loose silty fine sand with a weak fine crumb structure. Very free draining. Extensive development of fine roots. Very diffuse lower boundary 4 to 10 inches thick.

AC — 8 to 52 inches, yellowish brown (10YR 5/8) to strong brown (7.5YR 5/8) silty fine sand changing with increasing depth to sand. This horizon overlies a layer of coarse material consisting of water worn gravel in a sandy matrix, which are former bottom deposits of the original stream bed.

Range in Characteristics - The chief variation is in the depth of the fine sandy subsoil horizon above the gravel bed, which may range from a few inches up to several feet. The texture of the surface soil may range from sand to silt loam.

Terrain - Almost flat.

Drainage - Very rapid, but susceptible to flooding during periods of heavy rainfall.

Uses - Intensively cultivated with annual crops including dry padi, maize, tobacco and goundnuts.

Distribution - Is found in the valley and plain tracts of many of the east coast rivers where it occurs in patches up to about 100 acres in extent, but usually very much smaller, on the most recently established lower terraces of the river systems.

Type Location - Kampong Menerong, Sungei Brang, Ulu Trengganu.

Series Established - Kampong Telaga, Ulu Trengganu.

Remarks. - An ideal soil for annual cropping. Very easy to cultivate.

Suitability for Agriculture - Class 2 - few minor limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

TELEMONG SERIES.

Soils of the Telemong series are free draining alluvial types which are common on the flood plains of the main east coast rivers, and in smaller amounts along the banks of many inland streams. They are formed from medium and light textured materials which have been deposited in recent geological times by the present streams. They are yellowish brown in colour and possess rather deep, uniform profiles. They may show some resemblance to the Telaga series, but may be distinguished by their deeper, more uniform profiles and by their rather less silty texture. The Akob series soils are also rather similar but have a lighter coloured, mottled horizon, developed within a few feet of the surface.

Soil Profile (Telemong fine sandy loam under mature rubber).

Ah — 0 to 4 inches, dark yellowish brown (10YR 4/4) fine sandy loam with a moderate fine crumb structure and friable consistence. Good root development. 1 to 4 inches thick.

A^C — 4 to 72 inches, yellowish brown (10YR 5/4) fine sandy loam changing gradually with depth to strong brown (7.5YR 5/8) loam, moderate to weak medium subangular crumb and friable consistence. Good root development to about 53 inches.

Range in Characteristics - Texture shows a very wide variation in this series, from fine sand to clay loam, with the heavier textured varieties generally being the most fertile. Some profiles may show very faint pale red blotching in the lower subsoil, while the dominant subsoil colour may vary from brownish yellow to strong brown.

Terrain - Level or nearly level land in flat valley bottoms or near river banks on flood plains.

Drainage - Medium to rapid depending on texture. Watertable usually lies at least 6 feet below the surface.

Vegetation - Normal forest if undisturbed, but these soils are usually among the first to be developed in any newly settled area.

Uses - Can be used for a wide variety of tree and food crops. Dusun and house lots are very commonly situated on this soil type.

Distribution - This soil is developed in most valleys not occupied by swampy alluvium, with the best developed types usually located along the sides of rivers flowing between high banks. For this reason these soils are more common along the east coast and in central Malaya than on the west side of the Main Range.

Type Location - Telemong, Ulu Trengganu.

Series Established - Sungei Telemong, Ulu Trengganu.

Suitability for Agriculture. - Class 2 - few minor limitations.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

TELOK SERIES.

This series, originally named Kampong Telok, was first mapped in Kedah by McWalter. It has subsequently been described from north west Selangor (Acton, 1963).

This is a clay believed to be of brackish water origin and resembles the Selangor series in that it has a shallow organic clay topsoil overlying greyish brown and greenish grey clay subsoil. It is easily differentiated from the Selangor series by its abundance of iron oxide deposits accumulating in the upper portion of the profile. The subsoil structure of Telok series is rather coarse with a moderate block like development being quite common. The landscape is somewhat lower-lying than that in the Selangor series areas, with the water table occasionally approaching within one foot of the surface, and as a result undecomposed root remains commonly occur throughout the subsoil horizons. A more detailed profile description is as follows:

The surface horizon consists of organic clay to muck, dark grey to very dark greyish brown in colour which may extend to 10 inches, but averages about 4 inches in depth. It possesses moderately to strongly developed medium crumb structure with yellowish red iron oxide deposits coating parts of the structure face, as well as concentrating along root channels. This is underlaid by a horizon of greyish brown to dark greyish brown clay containing abundant deposits as above, extending to 12 to 30 inches in depth, and consisting of a weakly developed medium crumb to coarse blocky structure. In some profiles a shallow mottled horizon consisting of grey to light-grey clay with commonly occurring strong brown or reddish yellow mottles occurs below the zone of iron oxide deposition. The parent material consists of greenish grey unmottled sulphurous clay containing considerable quantities of undecomposed plant roots, and usually occurs at about 30 inches below the surface. Most subsoils exhibit weak development of blocky or prismatic structure, and have a friable, greasy consistency particularly below the level of the water table.

Acid phases of the Telok series have been separated in the Kedah survey, and similar soils have been identified in the southwest Johore coconut area. In the latter survey they have been referred to as the Linau series. Their distribution in northwest Selangor is confined to local patches occurring along with the normal phase, and large areas comprised solely of one type are uncommon. These soils are similar to the normal phase as described above but the subsoil horizons tend to be slightly darker in colour, contain larger quantities of undecomposed plant roots, and generally are highly sulphurous in this zone. Yellow deposits of sulphur often can be seen scattered throughout the subsoil horizons, and are very prominent after the soil has been exposed to the air for a period of time.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

TIAN BARRU SERIES.

This series is the most waterlogged of the four soils developed over the main basin alluvial deposits in Trengganu (Panton, 1958). Its distribution is confined to the worst drained areas usually at some distance from the rivers, and it is commonly found near the boundaries of the association close to the foothills of the various hillsoil associations. It may also occur in the many small stream courses which meander about the plains of the larger river valleys, and frequently occurs as small patches in close proximity to soils of the Telemong, Akob or Merbau Patah series. It is most common in the main basin of the Sungei Trengganu where it is extensively cultivated with wet padi.

An olive grey three inch plough layer of moist sticky loam, possessing a weak crumb structure and containing numerous yellowish brown or rust coloured root trace streaks, is underlain by a greyish brown or light olive grey sub-surface soil with yellowish brown and red mottlings. The sub-soil, which normally begins at about 12 to 15 inches, is light grey, and is often intensely mottled for the first 12 inches. Waterlogging may occur in this horizon for short periods even during the drier months. An almost white structureless permanently waterlogged horizon is generally found at a depth of two or three feet.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

STANDARD SERIES DESCRIPTION.

ULU TIRAM SERIES.

The soils of the Ulu Tiram series are developed from moderately coarse textured Older Alluvial deposits occurring over undulating topography at elevations from 30-150 feet A.S.L. They are similar in the upper 2 to 3 feet to granite soils formed in situ, however, they possess a much coarser textured subsoil and are shallower than the normal granite soils developed over similar terrain. They can also be differentiated from the Tampoi and Harimau series by their coarser textured subsoils.

Soil Profile. (Ulu Tiram sandy loam).

Ah — 0 - 4 inches, dark brown (10YR 4/4) fine sandy loam. Moderately developed medium crumb structure, friable consistence.

Btj — 4 -24 inches, brownish yellow (10YR 6/6) to yellowish brown (10YR 5/6) sandy loam to sandy clay loam. Weakly developed medium crumb structure. Friable consistence.

BC — 24+ inches, brownish yellow (10YR 6/6) coarse sandy loam to gravelly loam. Very compact medium subangular blocky crumb structure. Abundant coarse subangular quartz grains are evident in a matrix of clay which gives rise to this compact subsoil. Occasionally small rounded pebbles of bauxite have been found. At depths of 8-10 feet faint reddish streaks are observed throughout the subsoil. Rounded water worn pebbles or boulders, often in a highly decomposed condition, may be visible in this horizon.

Range in Characteristics - The colour, particularly of the subsoil, may be quite variable; ranging from brownish yellow, and possibly to yellowish red. There may be sufficient variability in this characteristic to recognise reddish as well as pale variants of this series, or possibly may even warrant establishing a new series. The texturé and structure of the subsoil generally appears to be as described above.

Pale coloured variants of this series have been recognised in a road quarry at the 13th milestone Johore B ru- Kota Tinggi Road. Yellow colours characterized the greatest part of the B horizon and a pale brown to white coarse sandy loam BC horizon was evident in this exposure to a depth of about 10 feet.

Drainage - Drainage is medium to rapid to a depth where the compacted subsoil occurs, after which it becomes restricted. This usually occurs at about a depth of 24 inches below the surface. The subsoil is apparently very impermeable, for deep gullies are evident at the base of exposures where water has been unable to infiltrate the subsoil thus causing excessive run-off and subsequent erosion. This feature was very striking at nearly all exposures examined and is not a characteristic of in situ granite derived soils. The surface soil also has a tendency to erode easily leaving a concentration of coarse sand on the surface and

Uses - Rubber is the most widely grown crop on this soil type.

Type Location - These soils were first recognised and the the series established near the village of Ulu Tiram at about the 12½ milestone Johore Bharu-Kota Tinggi road. They also occur over Tan Guan Estate and Sungei Tiram Estate in the same general vicinity, and are likely to be widespread throughout the southern part of Johore.

Suitability for Agriculture - Class 3 - one serious limitation.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

WENG SERIES.

This series has been mapped in central Kedah (Joseph 1964) and consists largely of clays derived from calcareous shales. The soils are well drained and strongly structured with very friable subsoils. A profile is:

Ah	0-1 in.	yellowish brown (10YR 5/6) silty clay with a fine crumb structure.
AB	1-36 in.	reddish yellow (7.5YR 6/8) clay with a very strongly developed fine crumb structure and a very friable consistence.
Btj	36-48 in.	reddish yellow (7.5YR 6/8) clay with a medium subangular blocky structure, firm consistence, very uniform throughout, abundant rooting.

SOIL SCIENCE DIVISION - DEPARTMENT OF AGRICULTURE.

TENTATIVE SERIES DESCRIPTION.

YONG PENG SERIES.

This soil has been mapped in Johore on dacite, and is normally associated with Kulai series. It has a dusky red to dark reddish brown (2.4YR 3/3 - 3/4) surface horizon and a predominantly yellowish red (5YR 5/8) subsoil in which are laterite bands of from 4 to 12 inches thick. It occurs on hilly and steep land. It consists of a clay loam of friable to firm consistence. It was first described by Jansen of the Chemara Research Station.

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