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SOIL CLASSIFICATION IN SARAWAK

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PREFACE

The first soil classification for Sarawak was produced in 1966. The classification then was mainly at the soil group and family levels, and some of the criteria developed in the 7th Approximation were adopted for use. However, the soils classified were by no means complete because only less than 50% of the State was covered by soil survey. Since then a number of attempts were made to amend or improve the 1966 classification.

This publication is an updated form of the system of soil classification for Sarawak. Most of the revisions are based on the changes as agreed upon at the series of meetings by the Soil Surveyors in the last few years. It represents an approximation of a collective view of all the Soil Surveyors, although it is not necessarily entirely satisfactory to any one of them.

Many soils at all categories have been redefined, some deleted and others introduced. In considering these changes, the following factors have been taken into account: mappability and ease of field identification; possible correlation with Soil Taxonomy (USDA), World Soil Map Legend (FAO) and other regional systems of soil classification; and possible agricultural relevance.

This classification therefore reflects the present state of soil taxonomy in Sarawak. It was influenced by the early classification systems, by regional biases, by international concepts of soil classification particularly the USDA Soil Taxonomy, and by new information on soils in Sarawak. As such, it should be considered as a stage in the evolution of an improved system that will result from further knowledge of soils and improved ordering of that knowledge. Further amendments will be inevitable as new and more data become available. However, the present version will hopefully provide the framework and guidelines for future revisions.

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SOIL CLASSIFICATION IN SARAWAK

1. INTRODUCTION

The first attempt in classifying the soils of Sarawak was made by Dames (1962). He grouped the soils into the then established Great Soil Groups: Yellow Latosols, Red-Yellow Podzolic Soils, Low Humic Gley Soils, Grey Hydromorphic Soils, Ground-water Podzols, Lithosols, Alluvial Soils and Bog Soils. In the same year, a field classification system (Andriesse, 1962) was prepared to standardise, in reconnaissance soil surveys, the "soil associations" which were more or less convenient mapping units related to topography and parent material.

By 1965, more data had been accumulated to allow a formal classification of Sarawak soils at a great soil group and family level to be attempted (Soil Survey Staff, 1966). The great soil groups were formulated on the framework of Thorp and Smith (1949) and certain diagnostic horizons and features were adopted from the later USDA system (USDA, 1960). Although the system had many inadequacies and inconsistencies, it was very useful in bringing some order to the majority of Sarawak soils.

Many amendments were subsequently made but the 1966 system formed the basis on which such revisions were attempted. It was modified for West Sararwak (Andriesse, 1972) and later for Central and North Sarawak (Scott, 1973; Lim, 1975). Then, with the surveys of Northern Interior (Eilers and Loi, 1982) and Central Interior Sarawak (Louie and Lah, in prep.), and as more information was obtained (Andriesse, 1975; Tie, 1978; Loi, 1980; Teng, 1981; Lah, 1981), further modifications were deemed necessary. Many discussions were held by the Soil Survey Staff and the classification system finally adopted is described in this paper. The present system is by no means ultimate. Further amendments will be inevitable as new and more data become available.

In making these revisions, a major consideration had been to preserve as far as possible the central concepts of the 1966 system. The categories of the system had not been changed and the nomenclature had also been largely retained. Most diagnostic parameters had, however, been revised or re-defined (Section 2). Many soil families and series, and a few soil groups had been deleted, replaced or added. At the group level, for example, Regosol and Saline Gley Soil

Group had been deleted, Lateritic Group replaced by Oxisol Group, and Andisol, Arenaceous Soil and Thionic Soil Groups added. Appendix C provides a comprehensive list of all the soil series, obsolete or otherwise, found in soil survey reports, memoirs and technical papers. Appendix D correlates the present system with the current USDA and FAO Systems.

2. DIAGNOSTIC PARAMETERS

Some of the diagnostic parameters used in the present system of classification are inherited from the 1966 system and its subsequent revised versions. Many of these differentiae are adopted from "Soil Taxonomy" (USDA, 1975) and "Soil Map of the World" (FAO, 1974), some *in toto* and some with minor modifications to suit our local conditions.

2.1 Soil Group Differentiae

2.1.1 Organic Soil Materials

Organic soil materials are:

a. saturated with water for prolonged periods (unless artificially drained) and, excluding live roots, have

   (i) 30 percent or more organic matter (>18% organic carbon) if the mineral fraction has 60 percent or more clay,

   (ii) 20 percent or more organic matter (>12% organic carbon) if the mineral fraction has no clay, or

   (iii) a proportional content of organic matter for intermediate contents of clay in the mineral fraction (See Fig. 1); or

b. never saturated with water for more than a few days and have 35 percent or more organic matter (>20%) organic carbon.

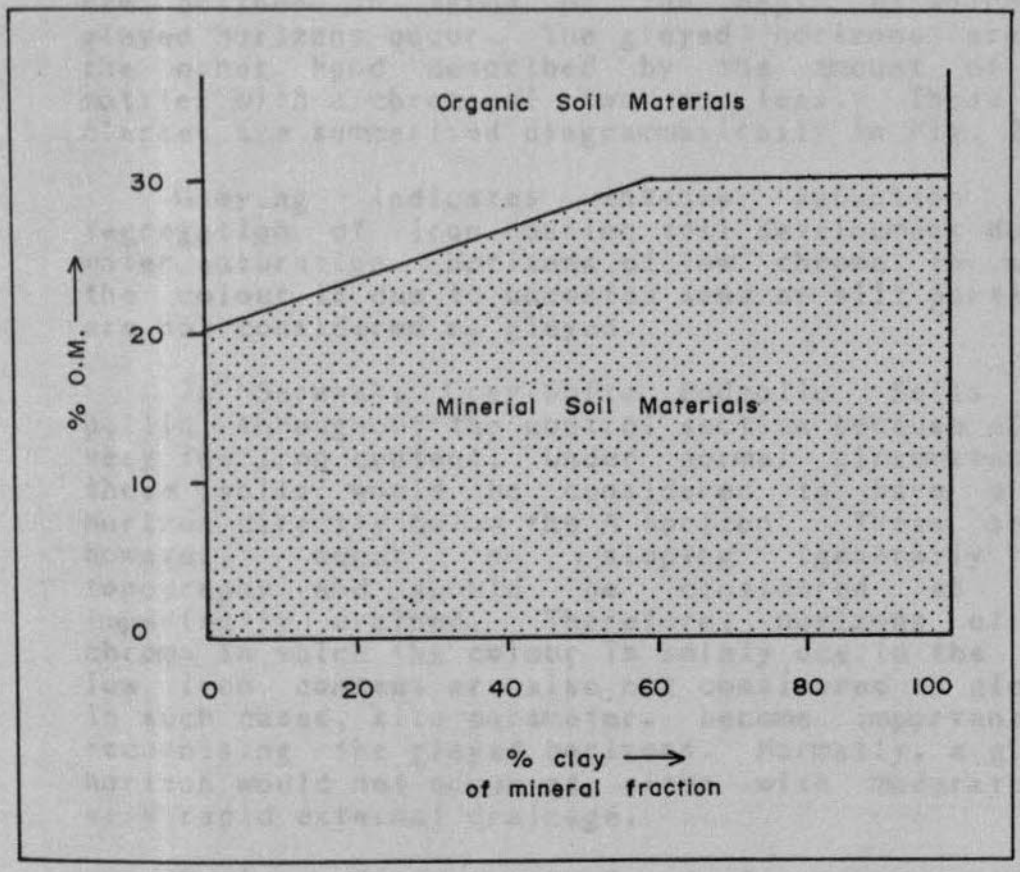


Fig. I. Organic matter requirements for saturated or artificially drained organic soil materials.

This definition is adopted in toto from "Soil Taxonomy". Item a covers materials which have been called peats and mucks. Item b is intended to include the litter or the former **O horizon***. Soil materials which do not meet the above requirements are called mineral soil materials.

* Bold type with asterisk-Refer to Appendix A for an explanation.

2.1.2. Soil Drainage Classes

The ten drainage classes developed for Malaysia (Paramananthan, in prep.) have been adopted with slight modifications in the present system. They are defined in terms of the depth at which the gleyed horizons occur. The gleyed horizons are on the other hand described by the amount of gley mottles with a chroma of two or less. These ten classes are summarised diagrammatically in Fig. 2.

Gleying indicates intense reduction and segregation of iron during soil development due to water saturation. **Horizons of low chroma in which the colour is due to uncoated sand or silt particles are not considered as gleyed.**

In Sarawak, Grey-White Podzolic Soils are pallid throughout the control section because of the very low iron content. Under normal circumstances, these soils would be considered to have a "G" horizon directly below the A horizon. These soils, however, occur on sloping (generally >5) topography and should be considered at most imperfectly drained. Therefore, **horizons of low chroma in which the colour is solely due to the very low iron content are also not considered as gleyed.** In such cases, site parameters become important in recognising the gleyed horizons. Normally, a gleyed horizon would not occur at sites with moderate to very rapid external drainage.

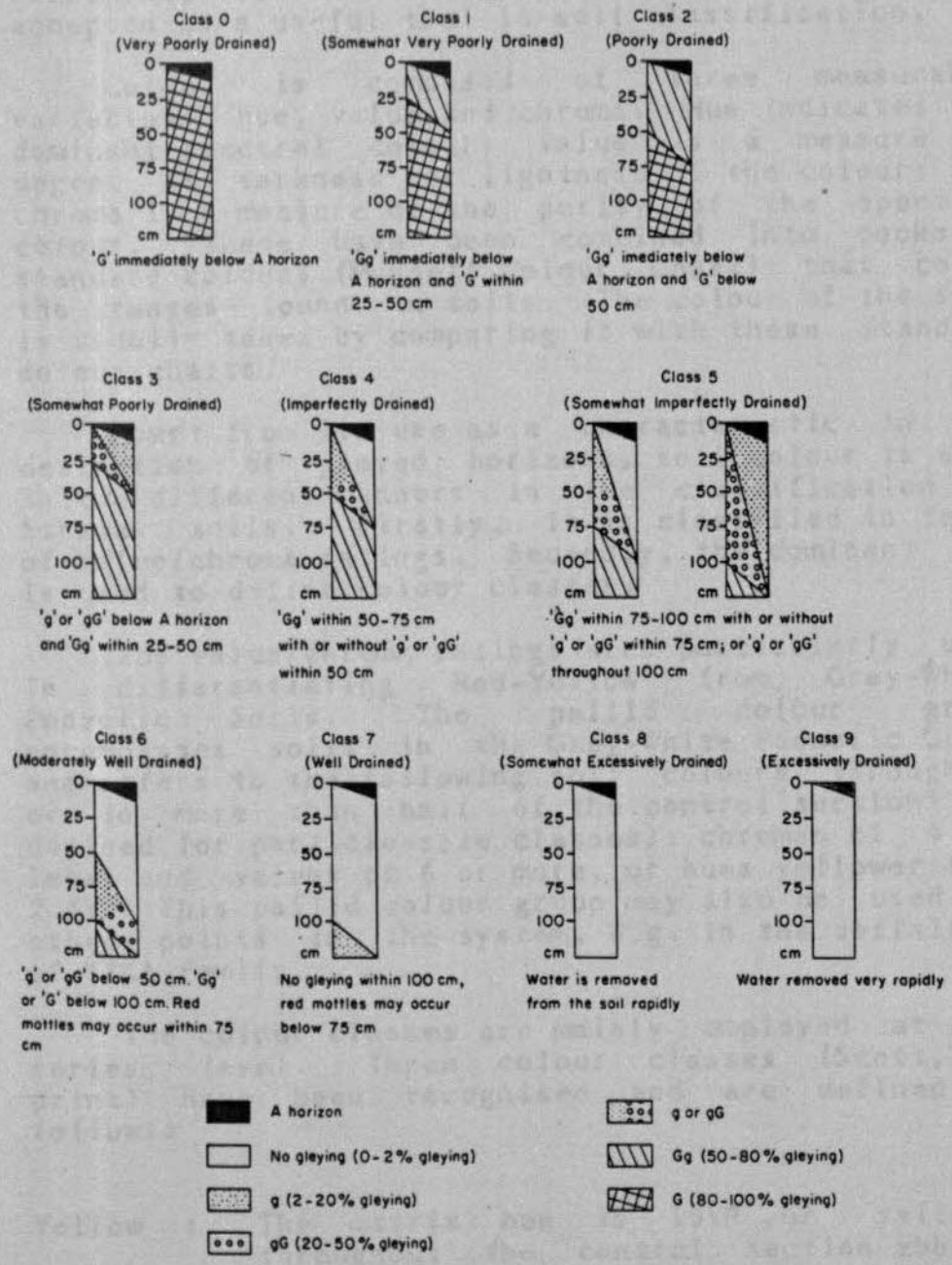
Drainage Classes of 3 or less are used to define the Gley Soil Group. Under the Skeletal Soil Group which is keyed off before the Gley Soils, Soil Drainage Classes are used as a criterion to distinguish Binatang from Kelupu Series (see 5.2.4.).

The presence of free water or a water table within the control section is also used as a series differentia in the Podzol Group. In such cases, the condition is induced by either:

a. a perched water table due to the impervious spodic horizon; or

b. the presence of a high natural groundwater table.

Fig. 2 SOIL DRAINAGE CLASSES



2.1.3. Colour

The use of colour as a parameter has always been taken with much reservation. Being very obvious, there is the danger that it may be overemphasised. Nevertheless, colour has been accepted as a useful tool in soil classification.

Colour is composed of three measurable variables: hue, value and chroma. Hue indicates the dominant spectral colour; value is a measure of degree of darkness or lightness of the colour; and chroma is a measure of the purity of the spectral colour. These have been combined into books of standard colours (Munsell Colour Chart) that cover the ranges found in soils. The colour of the soil is usually taken by comparing it with these standard colour charts.

Apart from its use as a characteristic in the definition of gleyed horizons, soil colour is used in two different manners in the classification of Sarawak soils. Firstly, it is classified in terms of value/chroma ratings. Secondly, the dominant hue is used to define colour classes.

The value/chroma ratings are particularly used in differentiating Red-Yellow from Grey-White Podzolic Soils. The **pallid colour group** encompasses soils in the Grey-White Podzolic Group and refers to the following soil colours throughout or in more than half of the **control section*** (as defined for particle-size classes): chromas of 4 or less and values of 6 or more, or hues yellower than 2.5Y. This pallid colour group may also be used at other points in the system, e.g. in the definition of TIKA Family.

The **colour classes** are mainly employed at the series level. Three colour classes (Scott, in print) have been recognised and are defined as follows:

Yellow : The matrix hue is 10YR or yellower throughout the control section above a depth of 50 cm.

Red : The matrix hue is redder than 10YR but yellower than 2.5YR in some part of the

control section above a depth of 50 cm.

Dark red: The matrix hue is 2.5YR or redder in some part of the control section above a depth of 50 cm.

Soil colour in the above discussions refers to the matrix or the dominant colour of the soil. The colour of soil profiles is seldom homogeneous throughout. Even a single layer may be uniform in colour, or it may be streaked, spotted, variegated or mottled in many ways. The presence of **abundant mottles** (>20% of the observed surface) is used as a criterion at the series level in some soil groups. In such cases, the term implies impeded drainage within the control section. As the term "variegated" usually refers to mixed colours as a result of differential weathering of the parent material, it is no longer adopted in the present system.

2.1.4. Spodic Horizon

A spodic horizon is a subsurface horizon more than 2.5 cm thick in which illuvial organic matter and aluminium with or without iron have precipitated. In Sarawak soils, most spodic horizons can be easily identified in the field by the above criterion alone from the colour contrast with the overlying **E horizon***. Where they are very weakly expressed, laboratory measurements of the illuvial carbon, iron and aluminium are needed in addition to field observations for positive identification. Various limits for the chemical characterisation of a spodic horizon are defined in "Soil Taxonomy" (p.32).

The presence or absence of iron in the spodic horizon is used as a family differentia in Sarawak. Spodols that have a spodic horizon in which the ratio of free iron (by dithionite-citrate) to carbon (both elemental) is 6 or more are classified under one family. Field identification is provisionally based on the colour of the spodic horizon. Spodic horizon that has a high illuvial iron content have dominant chromas of 3 or more; otherwise, the dominant chromas are 2 or less.

2.1.5. Oxic Horizon

An oxic horizon, exclusive of the argillic or natric horizon, is intended to characterise a mineral subsurface horizon in an advanced stage of weathering. By definition, it should be more than 30 cm thick and has more than 15 percent clay. Its **fine earth fraction*** contains only traces of **weatherable minerals***. It has a high content of hydrated iron and alluminium oxides, and the clay minerals are dominated by 1:1 lattice clay. The cation exchange capacity by ammonium acetate at pH 7.0 is 16 meq or less per 100g clay. It also has less than 10 meq of bases extractable with NH_4OAc plus aluminium extractable with 1N KCl per 100g clay. For a full definition of oxic horizon, please refer to "Soil Taxonomy" (p.39).

In Sarawak, field identification of oxic horizon is not always straight forward. There are, nevertheless, several charactistics which are useful as guidelines:

(i) The colour is usually strong brown to red with hues redder than 7.5YR and commonly as red as 2.5YR.

(ii) The soils are usually friable and porous; a fragment of a few cubic centimetres crushes easily between the fingers to fine stable granules.

(iii) Oxic horizons are generally associated with parent materials derived from coarse-grained acid igneous and intermediate to basic igneous rocks.

2.1.6. Argillic Horizon

The term is intended for subsurface horizon that contains certain stipulated amount of illuvial layer-lattice clays as shown by clay increase down the profile and the presence of **clay cutans*** on the ped faces and along the pores ("Soil Taxonomy", p. 19-27). A B horizon more than 15 cm thick that has the following clay increases within a vertical distance of 30 cm or less meets part of the requirements for an argillic horizon:

a. If the overlying horizons or layers have less than 15 percent total clay in the fine earth fraction, it must contain at least 3 percent more clay.

b. If the overlying horizons or layers have between 15 and 40 percent clay, the ratio of clay in the argillic horizon to that of the overlying horizons or layers must be 1.2 or more.

c. If the overlying horizons or layers have more than 40 percent clay, it must contain at least 8 percent more clay.

Many upland soils in Sarawak show the required increase in clay percentage in the B **horizon***. But, field evidence and micro- morphological studies on thin sections have not been very conclusive on the presence or absence of **argillans***. Supporting evidence of clay translocation by an increase in the ratio of fine clay to total clay in the argillic horizon over the eluvial horizon has not been mentioned above. However, preliminary studies (Tie, 1978b; Loi, 1980) had shown some usefulness in the use of this criterion and this issue should be actively pursued.

2.1.7. Cambic Horizon

A cambic horizon is an altered B horizon lacking properties that meet the requirements of an argillic, spodic or oxic B horizon. It has texture that is very fine sand, loamy very fine sand or finer. It also has soil structure or absence of rock structure in at least half of the volume of the horizon. Evidence of alteration is manifested in one of the following forms:

a. Stronger chroma, redder hue or higher clay content than the underlying horizon.

b. Removal of carbonates.

c. Reduction and segregation or removal of iron.

A cambic horizon does not show cementation, induration or brittle consistence when moist. It should also have enough thickness so that its base is at least 25 cm below the soil surface.

2.1.8. Sulphidic Materials and Sulphuric Horizon

Sulphidic materials are waterlogged mineral or organic soil materials that contain 0.75 percent or more of sulphur (dry weight), mostly in the form of sulphides and that have less than three times as much carbonate ($CaCO_3$ equivalent) as sulphur. Field identification usually relies on the foul smell of hydrogen sulphide gas which is normally present where there are sulphidic materials. However, this is not very reliable and usually extensive soil sampling and laboratory tests have to be carried out. Of these tests, one of the more reliable method is to measure the drop in pH upon slow air-drying. The pH (1:1 in water) which is normally near neutrality before air-drying, should drop below 3.5 if sulphidic materials are present.

Upon drainage, the sulphides oxidize and form sulphuric acid. The acid reacts with the soil to form iron and aluminium sulphates. The iron sulphate, jarosite, segregates and forms the bright-yellow mottles that characterize a sulphuric horizon. A sulphuric horizon is composed either of mineral or organic soil material that has both a pH of less than 3.5 (1:1 in water) and jarosite mottles with a hue of 2.5Y or yellower and a chroma of 6 or more.

The presence or absence of sulphidic materials and/or a sulphuric horizon within a depth of 100 cm from the mineral soil surface is used as a criterion at the soil group level. Where these materials are present, the depth at which they are found is also a very important factor agriculturally. The depth limits of 0-50 cm and 50-100 cm used in "Soil Taxonomy" to differentiate Sulphaquents from say Sulphic Fluvaquents are adopted in the family classification. At the moment, not enough sulphidic soils in Sarawak have been sufficiently drained for a sulphuric horizon to be formed. This condition of the presence of a sulphuric horizon is accommodated at the family level.

2.1.9. Particle-Size Classes

Particle-size classses coarser than very fine sand or loamy very fine sand are used as differentiae at the group level. Thus, sandy particle-size class (see Section 2.2.1.) is the basis for the definition of Arenaceous Soil Group. The occurrence at shallow depth of materials with more than 50% (by volume) of coarse fragments is also used to define the Skeletal Soil Group.

2.1.10. Exchange Complex Dominated by Amorphous Material

An exchange complex that is dominated by amorphous material shows the following characteristics:

a. The bulk density of the fine earth fraction should be less than 0.85 g per cubic cm at 1/3-bar tension, with undried sample.

b. The phosphate retention value should be more than 90%.

c. If there is enough clay to have a 15-bar water content of 15% or more in air-dried samples, the pH of a suspension of 1 g soil in 50 ml 1M NaF is greater than 9.4 after 2 minutes.

d. The variable charge (CEC at pH8.2 with $BaCl_2$ minus sum of exchange bases and Al) should be greater than 70% of the total charge (CEC at pH8.2).

e. The amount of organic carbon exceeds 0.6%.

The domination of exchange complex by amorphous material is used to define the Andisol Group (provisional). It should be noted that many spodic horizons would meet all the requirements listed above. But, in spodic horizons, the Fe and Al extracted by pyrophosphate at pH10 should be half or more of that extracted by dithionite-citrate.

2.2. Family And Series Differentiae

2.2.1. Particle-Size Classes

Particle size refers to grain-size distribution of the whole soil and is different from texture which refers to the fine-earth fraction only. Particle-size classes finer than fragmental and skeletal classes (Fig. 3) are broad groupings which cut across the textural classes and in some cases very fine sand is being treated as silt. Particle-size classes include:

a. Fragmental - More than 35% by volume of coarse fragment* and with too little fine earth to fill some of the interstices larger than 1 mm in diameter.

b. Skeletal - More than 35% by volume of coarse fragments and with enough fine earth to fill interstices larger than 1 mm. Sandy-skeletal, loamy-skeletal and clayey-skeletal are skeletal classes where the fine earth is sandy, loamy and clayey respectively.

c. Sandy - Less than 35% by volume of coarse fragments and the texture of fine earth is a sand or a loamy sand that is coarser than very fine sand or loamy very fine sand.

d. Loamy - Less than 35% by volume of coarse fragments and the texture of fine earth is very fine sand, loamy very fine sand or finer but the clay percentage is less than 35. It may be divided into four sub-classes:

   (i) coarse-loamy - By weight, 15% or more fine sand or coarser and less than 18% clay.

   (ii) fine-loamy - By weight, 15% or more fine sand or coarser and 18-34% clay.

   (iii) coarse-silty - By weight, <15% fine sand or coarser and less than 18% clay.

   (iv) fine-silty - By weight, <15% fine sand or coarser and 18-34% clay.

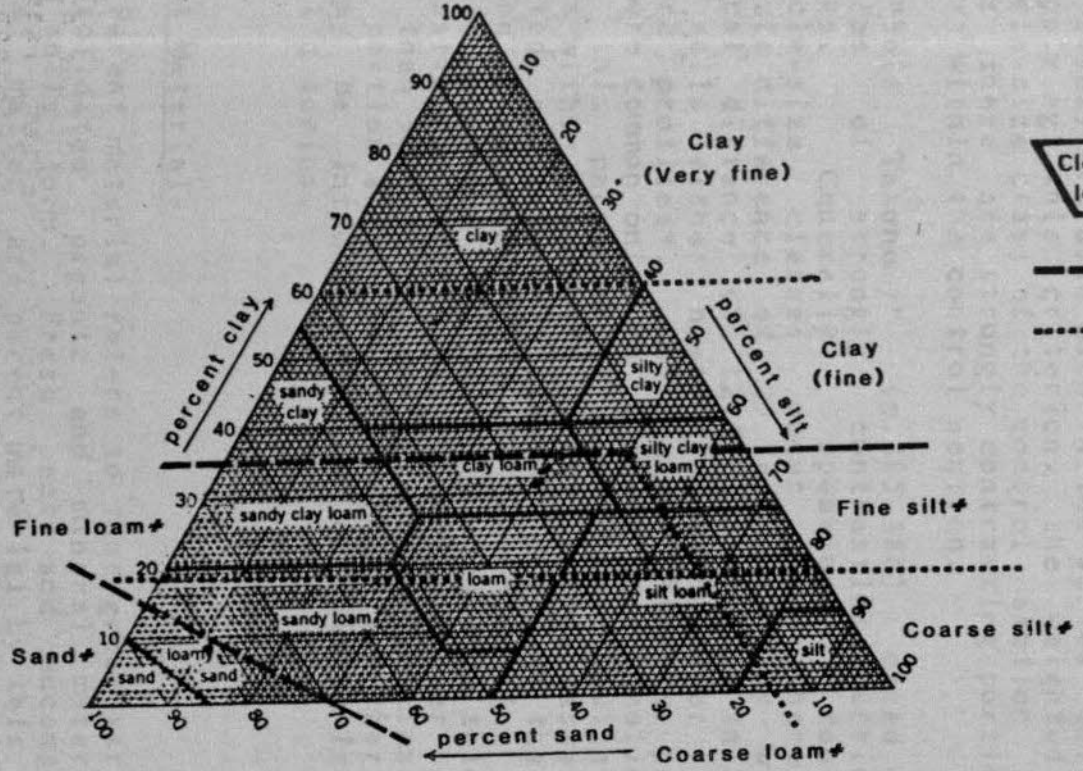


Fig. 3. PARTICLE - SIZE CLASSES AS FAMILY AND SERIES DIFFERENTIAE

e. Clayey - Less than 35% by volume of coarse fragments and the fine earth contains 35% or more clay by weight. It may be divided into two subclasses:

(i) fine - By weight, 35-60% clay.

(ii) very fine - By weight, >60% clay.

Particle-size classes finer than very fine sand or loamy very fine sand are used as the main differentia at the family level of classification in Sarawak. In some cases, they (particularly the sub-classes) are also used in the series definition. In applying this criterion, the weighted average particle-size class of the control section is used unless there are strongly contrasting particle-size classes within the control section.

"Soil Taxonomy" (p.385-386) cited forty examples of strongly contrasting particle-size classes. Generally speaking, contrasting particle-size classes occur when there is an absolute difference of 25 percent clay within a vertical distance of 12.5 cm or less. In Sarawak, most soils either have **gradational*** or **uniform texture profiles***. **Contrasting texture profiles*** are more common only in Grey-White Podzolic Soils where this parameter is used to distinguish certain series within families separated on the basis of the weighted average particle-size class of the control section or the upper part of a contrasting texture profile provided it is more than 30cm thick. In a contrasting texture profile where the upper part is less than 30cm thick, the particle-size class of the lower portion should be considered. In other soils, it may be introduced as a definitive feature in specific series.

2.2.2. Parent Materials

Parent material refers to that great variety of unconsolidated organic and mineral materials in which soils form. Fresh peat and unconsolidated mineral matter are parent material by this concept, but consolidated bedrock is not (USDA, in print).

In Sarawak, soil properties, particularly those of upland soils, commonly reflect characteristics of their parent materials but, partly due to deep chemical weathering, it is often difficult to establish the parent materials of particular profiles with any certainty in the field. Broad groupings of parent materials are used to define Alluvial Soils and Families of other groups. Further subdivisions are used at Series level. These are commonly distinctions of lesser importance, but some separations on parent material type or origin are placed at Series level because the identification cannot be made with certainty in all situations, although some of these distinctions may be quite significant and could arguably be considered appropriate at Family level. The intention in this matter is, as far as possible, to define Families by parameters which can be established consistently with little difficulty and thus construct a classification framework by which soils can be confidiently assigned to their Families even though the Series designation must remain in doubt in particular cases.

It is recognised that parent material is not a good criterion to be used in soil classification which should preferably be based on soil properties and characteristics. The fact that it is still retained in a few cases is because of the lack of sufficient data to support the direct use of soil properties and characteristics as criteria.

Different groupings of parent materials based on the types of parent rock and the modes of derivation are briefly discussed in the following paragraphs:

a. Types of Parent Rock

(i) **Igneous Rocks** - These are formed by the solidification of molten magma that originated within the earth. In Sarawak, the following four subdivisions are frequently used: acid volcanic; acid igneous; and intermediate to basic igneous rocks.

(ii) **Sedimentary Rocks** - These are formed from sediments laid down in previous

geologic ages. As a criterion for soil classification in Sarawak, they are only subdivided into calcareous and non-calcareous groups.

(iii) **Metamorphic Rocks** - These are resulted from profound alteration of igneous and sedimentary rocks by heat and pressure. Metamorphic rocks are relatively unimportant in Sarawak and so normally subdivisions are not necessary. In individual cases, a particular class such as schist (Bayur Series of Andriesse, 1972) may be used as a criterion for classification.

b. Modes of Derivation of Parent Materials

(i) **Alluvial** - Alluvium refers to that great variety of materials which have been moved and deposited by water. As a criterion for soil classification in Sarawak, it is subdivided into: accreting riverine; non-accreting riverine and marine alluvium. In the present system, the term "marine alluvium" includes true marine sediments, beach deposits and other alluvia subject to sea or brackish water influence.

(ii) **Colluvial** - Colluvium refers to materials which have been moved and deposited by gravity. It normally consists of an incoherent mass of materials at the base of a slope. Rock fragments which are usually present are angular and randomly distributed.

(iii) **Residual** - Residuum or saprolite refers to materials produced by weathering of rock *in situ*. This kind of parent material is particularly related to the nature of the original rock. Subdivisions are therefore based on the types of parent rocks.

2.2.3. Cementation

In "Soil Taxonomy", some cemented horizons, for example, a duripan, are used as differentiae in the classification in categories above the family. Others such as a continuous, cemented spodic horizon (ortstein) are however recommended for use as a family differentia. This has been adopted in Sarawak and the following classes of cementation are defined for spodic horizon:

Strongly Cemented or Indurated - All or part of the spodic horizon is sufficiently cemented into a hard to very hard massive horizon that cannot be penetrated by an Edelman auger.

Weakly Cemented - The spodic horizon is brittle and slightly hard but can be easily augered through by an Edelman auger.

Noncemented - The spodic horizon, when moist, is not cemented and usually has a loose to friable consistence.

2.2.4. Reaction Classes

Under the intense weathering and leaching processes, most upland soils of Sarawak are acidic in reaction. The pH in water (1:1) is usually less than 5.5 throughout the control section. However, some soils which have developed in calcareous parent materials (e.g. calcareous shales and limestones) can have a pH in water of 6.0 or more. The classes as defined below are therefore used as a differentia in the family classification of certain groups of soils:

Calcareous - The fine earth fraction in part of or throughout the control section defined for particle-size classes effervesces with cold dilute HCl.

Noncalcareous - The fine earth fraction does not effervesce with cold dilute HCl throughout the control section.

Nonacid - The base saturation (by sum of cations)

is 35 percent or more, and the dry pH in water (1:1) is 6.0 or more, in some horizon below a depth of 75 cm or immediately above a **lithic*** or **paralithic contact***, whichever is shallower.

Acid - Within the same depth limits as above, the base saturation is less than 35 percent and the dry pH in water (1:1) is less than 6.0.

The presence or absence of carbonates and the reaction classes are treated together because they are so intimately related. A calcareous horizon has to be nonacid; but a nonacid soil may not be calcareous.

2.2.5. Salinity

Formerly, this criterion had been used as a differentia in categories above the family. The general opinion now is that this property is very transient in character once reclamation measures are taken and as such, it should not be used at such a high level of classification. In Sarawak, salinity is only associated with marine alluvium or coastal peats subjected to tidal flooding by sea or brackish water. It is used as a series differentia amongst the Gley Soils and Thionic Soils. In Organic Soils, salinity is used at a phase level. Three classes of salinity are recognised:

Non-saline - The electrical conductivity of the soil extract at 1:5 soil:water ratio (EC_5) is less than 300 umhos/cm within a depth of 25-50cm.

Weakly Saline - EC_5 is between 300 and 1,200 umhos/cm.

Strongly Saline - EC_5 is more than 1,200 umhos/cm.

As **free water*** is normally present within the control section of these soils, the salinity of the groundwater is usually used as a useful guideline in routine soil surveys because of the ease of field testing. Groundwater conductivity readings of

<1,000, 1,000-4,000 and >4,000 umhos/cm roughly correspond to the non-saline, weakly saline and strongly saline classes respectively.

These figures can also be converted to conventional saturation extract values by multiplying them by a factor of approximately 6.48 for clay soils (Tie, 1977). An EC_5 reading between 300 and 1,200 umho/cm rated as a serious limitation to plant growth would be approximately equal to a saturation extract range of 2,000 to 8,000 umho/cm.

2.3. Family And Series Differentiae For Organic Soils

Most of the differentiae used to distinguish families and series of Organic Soils are not used in mineral soils. These are defined in this section. Like mineral soils, an arbitrary control section has also been established for the Organic Soils. In "Soil Taxonomy", it is either 130 cm or 160 cm thick depending on the kind of surface material. For simplicity, a control section of 150 cm from the surface is adopted locally, provided that no lithic or paralithic contact, or thick layer of water occurs within this limit.

2.3.1. Depth of Organic Soil Materials

This criterion is used to differentiate two main classes of Organic Soils:

Shallow - The depth of organic soil materials is 50 to 150 cm, either extending from the surface or taken cumulatively within the control section. Two depth phases may be identified for shallow organic soils, namely 1 and 2 for 50-100 and 100-150 cm of organic soil materials respectively. Where the surface organic soil materials are 20 to 50 cm thick, they become the **histic epipedon** of the underlying mineral soil.

Deep - The depth of organic soil materials is more than 150 cm. For deep peats, three depth phases are

sometimes recognised and mapped. These are depth phases 1, 2 and 3 which have 150-200, 200-250 and >250 cm of organic soil materials respectively.

2.3.2. Nature of Mineral Subsoils

Where the Organic Soils are shallow by the above definition, the nature of the mineral subsoils, as differentiated on the basis of texture and presence or absence of sulphidic materials, is an important consideration in the utilization of Organic Soils. This criterion has therefore been used to distinguish three families of shallow Organic Soils with:

Sandy Substratum - The mineral substratum has less than 15 percent clay (not further differentiated on the basis of sulphidic properties).

Clayey, Sulphidic Substratum - The mineral substratum has more than 15 percent clay and is sulphidic in nature.

Clayey, Non-sulphidic Substratum - The mineral substratum has more than 15 percent clay and is not sulphidic in nature.

2.3.3. Surface Vegetation

Botanical origin is perhaps the most widely used criterion in organic soil classification. In Sarawak, the surface vegetation as differentiated on the basis of the following categories is used at the family level of classification:

Peat Swamp Forests - These are lowland forests associated with peat swamps. They include all the sub-types described by Anderson (1963), namely Mixed Swamp Forest, Alan Forest, Alan Bunga Forest, Padang Alan Forest and Padang Keruntum (or Padang Paya) Forest.

Montane Forests - These are forests found at altitudes above 1,000 m and characterized by smaller

trees with smaller and thicker leaves. Mosses and Nepenthaceae are very common.

2.3.4. Groundwater Table

Most organic soils in Sarawak, unless artificially drained, have a very high groundwater table. MULU and KAPOR Families are the only two exceptions. MULU Family, in particular, is differentiated from others on the basis of the absence of a groundwater table:

Present - Unless artificially drained, the groundwater table is present within the control section.

Absent - The groundwater table is not present within the control section although the organic soil materials may still be saturated due to their spongy nature.

2.3.5. Ash Content

The ash content of the organic soil materials as determined by 100 percent minus the percentage loss on ignition (at 800°C for 1 hour) is used as a criterion at the series level. Formerly, this differentiation is based on the recognition of peat and muck as defined on the basis of loss on ignition. Presently, it is felt that confusion may arise on the use of the terms "peat" and "muck" which are more often defined on the basis of the degree of decomposition. Therefore, ash content has been adopted and is differentiated on the basis of the following two classes:

High Ash Content - The weighted average of the ash content of the soil materials within the top 50 cm is 10 percent or more (i.e. loss on ignition is 90% or less).

Low Ash Content - The weighted average of the ash content of the soil materials within the top 50 cm

is less than 10 percent (i.e. loss on ignition is more than 90%).

It should be noted that the above definitions take into account the occurrence of lenses of mineral soil materials within the top 50 cm, whose presence would push up the weighted average of the ash content. For example, if 5 cm of clay lense(s) with a loss on ignition of 2% occur within the top 50 cm of organic soil materials with a loss on ignition of 98%, the weighted average of the ash content within the top 50 cm would be about 12% (i.e. high ash content).

2.3.6. Mode of Derivation

This criterion is used at a series level. Two groupings have been recognised and they are defined as follow:

Autochthonous - The term is for peats which are derived from the gradual build-up of successive generations of plants *in situ*.

Allochthonous - Peats resulting from an alluvial accumulation of drifted plant residues or eroded peats are referred to as allochthonous deposits.

3. CATEGORIES OF THE SYSTEM AND THE HIERARCHIAL BIAS

There are three main categories in the present system. In order of decreasing rank and increasing number of differentiae and classes, the categories are group, family and series. Some series are further subdivided into phases on the basis of easily identifiable and/or agriculturally important properties not employed at higher levels of classification. The most common phases recognised are:

(a) the weakly and strongly saline phases of organic soils;

(b) the peaty phases of very poorly drained soils; and

(c) the depth phases of deep peats and upland soils (e.g. Merit 1, 2 and 3 for Merit Series soils with effective soil depths of 50-75, 75-100 and >100 cm respectively).

What Scott (in print) says about the hierarchial bias of his system still remains true for the present system. The more relevant portions are therefore quoted below:

"The Soil Series is commonly taken as the basic unit in soil taxonomy: higher-level divisions group Soil Series communities with common properties. Classification on this basis presupposes an adequate body of data on soil properties at the Series level. When regional reconnaissance soils studies are undertaken in tropical areas, such data are commonly not available. Particularly lacking are agronomic data on which lower-category taxonomic divisions can be made which have meaning in terms of rating the taxonomic unit for agricultural use,...."

"Classification of the profile forms recorded on reconnaissance investigations are nevertheless required and in the classification used .... the Soil Family is considered the pivotal tier in the system, as in the classification constructed in 1966. The Family unit identifies a set of profile forms with a conveniently narrow range of variation in easily-identifiable properties and, in most Families, common genetic features. Broad statements regarding limitations to agricultural use can be made at this level and certain parameters of particular relevance in that context, ..."

"The choice of criteria for Series differentiation is biased towards easily- identifiable properties not employed at the Family level. Some such as the particle-size subclass in upland soils which reflects parent material and bears on crop suitability and erosion hazard, have a general relevance. Others are included on less certain grounds. The degree to which minor subsoil colour contrasts in well-drained upland soils, for example, reflect parent materials, genetic process, plant growth limitations or associated profile properties

remains to be demonstrated. They are very obvious in the field, however, and can be recorded consistently with no difficulty. Some of these contrasts have therefore been incorporated in the classification structure at the Series level. As the body of knowledge grows, particularly regarding agricultural use, it is to be expected that much expansion and revision of the classification at this level will be required".

"In organising the classification at the ... Group level the practical choice has lain between continued use of a grouping on the Thorp and Smith model or redefinition within the terms of the USDA soil taxonomy or its derivative used for the World Soil Map Legend (USDA, 1975; FAO, 1974). The Thorp and Smith framework is advantageous in that previous classifications of Sarawak soils have been couched in this terminology at the Group level and that it has also been used in Malaya, Indonesia and for a general synthesis of the region's soils. The Groups are defined only by broad descriptions of their central concept and some modification can therefore be made to meet local problems: new Groups have been added in Indonesia to identify soils with particular properties, and some revision to the Group framework and nomenclature is made in the present study"

4. KEY TO SOIL GROUPS

4.1. Organic Soils (p.28-30)

Organic Soils are soils that:

a. Have 50 cm or more of organic soil materials, either taken cumulatively within the upper 100 cm of the soil or extending down from the surface; or

b. Have organic soil materials that extend from the surface to a depth within 10 cm or less of a lithic or paralithic contact, provided the thickness of the organic soil materials is more

than twice that of the mineral soil above the contact; or

c. Have any depth of organic soil materials resting on a lithic or paralithic contact, or on fragmental material (gravel, stones, cobbles) of which the interstices are filled with organic materials.

4.2. Skeletal Soil (p.31-32)

Skeletal Soils are other soils which are limited in depth within 50 cm of the surface by one of the followings:-

a. A lithic or paralithic contact; or

b. The top of a C **horizon*** or a horizon with more than 50% (by vol.) of coarse fragment and a thickness of more than 25 cm.

4.3. Thionic Soils (p.33-35)

Thionic Soils are other soils which have sulphidic materials or a sulphuric horizon, or both, within 100 cm of the base of an O horizon.

4.4. Gley Soils (p.36-38)

Gley Soils are other soils which have a drainage class of 3 or less.

4.5. Podzols (p.39-40)

Podzols are other soils having a spodic horizon within 200 cm of the surface.

4.6. Arenaceous Soils (p.41-42)

Arenaceous Soils are other soils that have a sandy particle-size class within the control section and show no diagnostic horizons other than an A horizon.

4.7. Alluvial Soils (p.43-44)

Alluvial Soils are other soils that have developed in accreting alluvium and show no diagnostic horizons other than an A or a cambic horizon.

4.8. Andisols (p.45)

Andisols are other soils which have, to a depth of 35 cm or more, one or both of:

a. a bulk density (at 1/3-bar water retention) of fine earth fraction of the soil of less than 0.85 g/cm^3 and the exchange complex dominated by amorphous material;

b. 60% or more (by weight) vitric volcanic ash, pumice, cinders, or other vitric pyroclastic materials.

4.9. Oxisols (p.46-47)

Oxisols are other soils that have an oxic horizon, not overlain by a cambic or an argillic horizon, within 200 cm of the surface.

4.10. Grey-White Podzolic Soils (p.48-49)

Grey-White Podzolic Soils are other soils that

have a pallid colour group. They may have a cambic or an argillic horizon, not overlain by an oxic horizon, within 150cm of the surface.

4.11. Red-Yellow Podzolic Soils (p.50-52)

Red-Yellow Podzolic Soils are other soils that have a cambic or an argillic horizon, not overlain by an oxic horizon, within 150 cm of the surface.

5. KEY TO SOIL FAMILIES AND SERIES

5.1. Organic Soils

5.1.1 Organic Soils that fulfil the requirements as stipulated in 4.1.b or 4.1.c above. — KAPOR F

a. KAPOR soils with organic materials resting on limestone — Kapor S

5.1.2. Other Organic soils in which a groundwater table is absent and that are associated with Montane Forest. — MULU F

a. MULU soils that are developed largely from a mossy material — Mulu S

5.1.3. Other Organic Soils that are associated with Montane Forest — BAREO F

a. BAREO soils that have more than 150 cm of organic materials — Bareo S

b. Other BAREO soils that have 50-150 cm of organic materials — Umor S

5.1.4. Other Organic Soils that have 50-150 cm of organic soil materials resting on sandy substratum — IGAN F

a. IGAN soils that have autochthonous organic soil materials with a low ash content — Igan S

5.1.5. Other Organic Soils that have 50-150 cm of organic soil materials resting on clayey, non-sulphidic substratum — MUKAH F

a. MUKAH soils that have autochthonous organic soil materials with a low ash content — Mukah S

b. Other MUKAH soils that have autochthonous organic soil materials with a high ash content — Epai S

5.1.6. Other Organic Soils that have 50-150 cm of organic soil materials resting on clayey, sulphidic substratum — MERAPOK F

a. MERAPOK soils that have autochthonous organic soil materials with a high ash content — Merapok S

b. Other MERAPOK soils that have autochthonous organic soil materials with a low ash content — Patok S

c. Other MERAPOK soils that have allochthonous organic soil materials (irrespective of the ash content) — Mahat S

5.1.7. Other Organic Soils that have more than 150 cm of organic materials (irrespective of the nature of mineral substratum) — ANDERSON F

a. ANDERSON soils that have autochthonous organic soil materials with a low ash content — Anderson S

b. Other ANDERSON soils that have autochthonous organic soil materials with a high ash content — Gadong S

c. Other ANDERSON soils that have allochthonous organic soil materials (irrespective of the ash content) **Luk S**

5.2. Skeletal Soils

5.2.1.	Skeletal soils that are limited in depth within 50 cm of the surface by a lithic or paralithic contact	MELUAN F
	a. MELUAN soils that are limited in depth within 25 cm	Meluan S
	b. Other MELUAN soils that are limited in depth within 25-50cm	521b S
5.2.2.	Other Skeletal soils that have developed in colluvium	TUTOH F
	a. TUTOH soils derived from non-calcareous sedimentary rocks	Tutoh S
	b. Other TUTOH soils derived from acid igneous rocks	Lundu S
5.2.3.	Other Skeletal soils that have developed in residuum	KAPIT F
	a. KAPIT soils derived from non-calcareous sedimentary rocks	Kapit S
	b. Other KAPIT soils derived from acid igneous rocks	Buri S
	c. Other KAPIT soils derived from intermediate to basic igneous rocks	Sedong S
5.2.4.	Other Skeletal Soils that have developed in alluvium or alluvium overlying residuum	BINATANG F

a.	BINATANG soils that have a drainage class of 4 or more	Binatang S
b.	Other BINATANG soils that have a drainage class of 3 or less	Kelupu S

5.3. Thionic Soils

Thionic Soils may or may not have an histic epipedon. Where the histic epipedon is present, the soil is mapped as a peaty phase (e.g. Rjn-P is the peaty phase of Rajang Series).

5.3.1. Thionic soils with a sulphuric horizon present within 100 cm of the base of an O horizon are to be keyed out first. At the moment, however, very few Thionic Soils with a sulphuric horizon have been identified in the field. Therefore, the family and series classifications of these soils have not been keyed out. They will, however, conform with groupings as follows based on the particle-size classes and the depth at which the sulphuric horizon occurs.

5.3.2. Other Thionic Soils which have a **sandy** particle-size class and have sulphidic materials within 0-50 cm of the base of an O horizon — **BELAT F**

a. BELAT soils which are strongly saline — **Belat S**

b. Other BELAT soils which are weakly saline — **Pandak S**

c. Other BELAT soils which non-saline — **Mersan S**

5.3.3. Other **sandy** Thionic Soils which have sulphidic materials within 50-100 cm of the base O horizon — **533 F**

a. 533 soils which are strongly saline — **533a S**

b. Other 533 soils which are weakly saline — **533b S**

c. Other 533 soils which are non-saline — **533c S**

5.3.4. Other Thionic Soils which have a **loamy** particle-size class and have sulphidic materials within 0-50 cm of the base of an O horizon — **PALOH F**

a. PALOH soils which are strongly saline — **Paloh S**

b. Other PALOH soils which are weakly saline — **Nagor S**

c. Other PALOH soils which are non-saline — **Nangka S**

5.3.5. Other **loamy** Thionic Soils which have sulphidic materials within 50-100 cm of the base of an O horizon — **535 F**

a. 535 soils which are strongly saline — **535a S**

b. Other 535 soils which are weakly saline — **535b S**

c. Other 535 soils which are non-saline — **535c S**

5.3.6. Other Thionic Soils which have a **clayey** particle-size class and have sulphidic materials within 0-50 cm of the base of an O horizon — **RAJANG F**

a. RAJANG soils which are strongly saline — **Rajang S**

b.	Other RAJANG soils which are weakly saline	Rampangi S
c.	Other RAJANG soils which are non-saline	Punda S

5.3.7.	Other clayey Thionic Soils which have a clayey particle-size class and have sulphidic materials within 50-100 cm of the base of an O horizon	KLUANG F
a.	KLUANG soils which are strongly saline	537a S
b.	Other KLUANG soils which are weakly saline	537b S
c.	Other KLUANG soils which are non-saline	Kluang S

5.4. Gley Soils

5.4.1. Gley Soils that have a **sandy** particle-size class — **TATAU F**

a. TATAU soils that have developed in marine alluvium and are non-saline — **Tatau S**

b. Other TATAU soils that have developed in marine alluvium and are weakly saline — **Telok S**

c. Other TATAU soils that have developed in marine alluvium and are strongly saline — **Nonok S**

d. Other TATAU soils that have developed in accreting riverine alluvium — **Plan S**

e. Other TATAU soils that have developed in colluvium. — **Bokah S**

5.4.2. Other Gley Soils that have a **loamy** particle-size class — **PAKAN F**

a PAKAN soils that have developed in accreting riverine alluvium — **Pakan S**

b. Other PAKAN soils that have developed in marine alluvium and are non-saline — **542b S**

c. Other PAKAN soils that have developed in marine alluvium and are weakly saline — **Piasau S**

d. Other PAKAN soils that have developed in marine alluvium and are strongly saline — **Sirik S**

e. Other PAKAN soils that have developed in non-accreting

riverine alluvium — Gong S

5.4.3. Other Gley Soils that have developed in marine or accreting riverine alluvium and have a clayey particle-size class — BIJAT F

a. BIJAT soils that have developed in riverine alluvium derived from non-calcareous sedimentary rocks and have a white to grey colour within 50 cm of mineral soil surface — Bijat S

b. Other BIJAT soils that have developed in riverine alluvium derived from non-calcareous sedimentary rocks and have a greenish grey colour (dominant hue 5GY) within 50 cm of mineral soil surface — Samarahan S

c. Other BIJAT soils that have developed in riverine alluvium derived from non-calcareous sedimentary rocks and have a dark grey colour (value of 4 or less) within 50 cm of mineral soil surface — Danau S

d. Other BIJAT soils that have developed in marine alluvium and are non-saline and noncalcareous — Daro S

e. Other BIJAT soils that have developed in marine alluvium and are weakly saline and non-calcareous — Pendam S

f. Other BIJAT soils that have developed in marine alluvium and are strongly saline and non-calcareous — Beliong S

g. Other BIJAT soils that have developed in marine alluvium and are strongly saline and calcareous — Buntal S

h. Other BIJAT soils that have developed in riverine alluvium

derived from calcareous sedimentary rocks — **Mundai S**

i. Other BIJAT soils that have developed in riverine alluvium derived from intermediate to basic igneous rocks — **Kakai S**

j. Other BIJAT soils that have developed in riverine alluvium derived from acid igneous rocks — **Jiwan S**

5.4.4. Other Gley Soils that have a clayey particle-size class — **SEMADOH F**

a. SEMADOH soils that have the surface G or Gg horizon underlain by horizon(s) with a dominant chroma of 3 or more (only the surface is gleyed) — **Tumau S**

b. Other SEMADOH soils that have developed in residuum derived from non-calcareous sedimentary rocks — **Semadoh S**

c. Other SEMADOH soils that have developed in non-accreting alluvium derived from non-calcareous sedimentary rocks — **Embang S**

5.5. Podzols

Where the spodic horizon is weakly or strongly cemented, depth phases may be recognised in terms of the depths at which the spodic horizon occurs. Depth phases 1, 2, and 3 are for Podzols with a spodic horizon within 50 cm, 50-100 cm and below 100 cm of the mineral soil surface respectively.

5.5.1. Podzols that either have a histic epipedon or a water table within the control section, or both — **GRANG F**

a. GRANG soils that have a histic epipedon, with or without a water table — **Grang S**

b. Other GRANG soils that have a groundwater table within the control section for at least 9 months per year — **Penian S**

5.5.2. Other Podzols that have a spodic horizon with a dominant chroma of 3 or more (and in which the ratio of free iron to carbon is 6 or more) — **JERIJEH F**

a. JERIJEH soils in which the spodic horizon is weakly or strongly cemented — **Jerijeh S**

b. Other JERIJEH soils in which the spodic horizon is noncemented — **Stoh S**

5.5.3. Other Podzols in which the spodic horizon is noncemented or weakly cemented — **BUSO F**

a. BUSO soils which have developed in non-accreting alluvium — **Buso S**

b. Other BUSO soils which have developed in residuum — **Silantek S**

5.5.4. Other Podzols in which the spodic horizon is strongly cemented or indurated — **MIRI F**

a. MIRI soils which have developed in non-accreting alluvium — **Miri S**

b. Other MIRI soils which have developed in residuum — **Bako S**

5.6. Arenaceous Soils

5.6.1. Arenaceous Soils that have developed in marine alluvium — **KABONG F**

a. KABONG soils that have a yellow colour class; do not have a cemented shell layer; and do not have an appreciable amount of weatherable minerals — **Kabong S**

b. Other KABONG soils that have a yellow colour class and a cemented shell layer within the control section — **Chupin S**

c. Other KABONG soils that have a yellow colour class and an appreciable amount (>6%) of weatherable minerals — **Siru S**

d. Other KABONG soils that have a red or dark red colour class and show a marked increase in Mn content in upper subsoil — **Rambungan S**

e. Other KABONG soils that have a red or dark red colour class — **Sematan S**

5.6.2. Other Arenaceous Soils that have developed in accreting riverine alluvium — **KAYAN F**

a. KAYAN soils that have a yellow colour class — **Kayan S**

b. Other KAYAN soils that have a red or dark red colour class — **Siar S**

5.6.3. Other Arenaceous Soils that have a pallid colour group — **TIKA F**

a. TIKA soils that have developed in residuum — **Tika S**

5.7. Alluvial Soils

5.7.1. Alluvial Soils that have a coarse loamy or coarse silty particle-size class — **SEMILAJAU F**

a. SEMILAJAU soils that have developed in alluvium derived from sedimentary rocks — **Semilajau S**

b. Other SEMILAJAU soils that have developed in alluvium derived from acid volcanic rocks — **Julan S**

5.7.2 Other Alluvial Soils that have a fine loamy or fine silty particle-size class — **BEMANG F**

a. BEMANG soils that have developed in alluvium derived from non-calcareous sedimentary rocks — **Bemang S**

b. Other BEMANG soils that have developed in alluvium derived from mixed acid volcanic and sedimentary rocks — **Dapoi S**

c. Other BEMANG soils that have developed in alluvium derived from acid igneous rocks — **Sebat S**

d. Other BEMANG soils that have developed in alluvium derived from intermediate to basic igneous rocks — **Terbat S**

5.7.3. Other Alluvial Soils that have a clayey particle-size class — **SEDUAU F**

a. SEDUAU soils that have formed

in alluvium derived from non-calcareous sedimentary rocks and have a yellow colour class — **Seduau S**

b. Other SEDUAU soils that have formed in alluvium derived from non-calcareous sedimentary rocks — **Malang S**

c. Other SEDUAU soils that have formed in alluvium derived from calcareous sedimentary rocks — **Paku S**

d. Other SEDUAU soils that have formed in alluvium derived from acid igneous rocks — **Sekati S**

e. Other SEDUAU soils that have formed in alluvium derived from intermediate to basic igneous rocks — **Ramun S**

5.8. Andisols

5.8.1 Andisols that have a clayey particle-size class — **LINAU F**

a. Linau Soils that have developed in pumice to vesicular basalt — **Linau S**

5.9. Oxisols

5.9.1. Oxisols that have a clayey particle-size class and are formed from acid volcanic rocks — **NIBONG F**

- a. NIBONG soils having a pallid colour group — **Selio S**
- b. Other NIBONG soils having a very fine clayey particle-size class and a yellow colour class — **Nibong S**
- c. Other NIBONG soils having a yellow colour class — **Mujan S**
- d. Other NIBONG soils having a red colour class (and showing distinct greyish mottles in the B horizons) — **Ujek S**

5.9.2. Other Oxisols that have a clayey particle-size class and are formed from intermediate to basic igneous rocks — **TARAT F**

- a. TARAT soils that have a dark red colour class — **Tarat S**
- b. Other TARAT soils that have a red colour class — **Jebong S**
- c. Other TARAT soils that have a yellow colour class — **Antayan S**

5.9.3. Other Oxisols that have a clayey particle-size class — **SERIN F**

- a. SERIN soils with a pallid

colour group and a hue of 10YR or redder — **Lingga S**

b. Other SERIN soils with a pallid colour group and a hue of 2.5Y — **Rukam S**

c. Other SERIN soils that have a fine clayey particle-size class and have a yellow colour class — **Serin S**

d. Other SERIN soils that have a fine clayey particle-size class — **Jagoi S**

e. Other SERIN soils that have a very fine clayey particle-size class and have a yellow colour class — **Nyaroh S**

f. Other SERIN soils that have a very fine particle-size class — **Piring S**

5.9.4. Other Oxisols that have a fine loamy or fine silty particle-size class (including coarse loam and coarse silt with >15% clay) — **GADING F**

a. GADING soils that have a red colour class and are fine loamy — **Gading S**

5.10. Grey-White Podzolic Soils

5.10.1 Grey-White Podzolic Soils with a coarse loamy or coarse silty particle-size class, or have a contrasting texture profile where the upper part is coarse loamy or coarse silty — **SARATOK F**

a. SARATOK soils with a contrasting texture profile — **Triboh S**

b. Other SARATOK soils with abundant (>20%) mottles within 100 cm — **Penipah S**

c. Other SARATOK soils which have developed in non-accreting alluvium — **Semeba S**

d. Other SARATOK soils which are residual and have a coarse loamy particle-size class — **Saratok S**

5.10.2 Other Grey-White Podzolic Soils with a fine loamy or fine silty particle-size class, or have a contrasting texture profile where the upper part is fine loamy or fine silty — **BANDANG F**

a. BANDANG soils with a contrasting texture profile — **Merang S**

b. Other BANDANG soils with abundant (>20%) mottles within 100cm — **Timang S**

c. Other BANDANG soils which have a fine silty particle-size class and are residual — **Bandang S**

d. Other BANDANG soils with a fine loamy particle-size class and are residual — **Durin S**

e. Other BANDANG soils which have

developed in non-accreting alluvium — **Lubai S**

5.10.3. Other Grey-White Podzolic Soils with a clayey particle-size class, or have a contrasting texture profile where the upper part is clayey — **KERAIT F**

a. KERAIT soils with abundant (>20%) mottles within 100 cm but without a contrasting texture profile — **Ajoh S**

b. Other KERAIT soils which have a hue redder than 10YR; are residual; and do not have a contrasting texture profile — **Serayan S**

c. Other KERAIT soils which are residual; and do not have a contrasting texture profile — **Kerait S**

5.11. Red-Yellow Podzolic Soils

5.11.1. Red-Yellow Podzolic Soils that have a coarse loamy or coarse silty particle-size class — **NYALAU F**

a. NYALAU soils that have an albic horizon* — **Matang S**

b. Other NYALAU soils that have developed in non-accreting alluvium — **Sabangang S**

c. Other NYALAU soils that have a yellow colour class and a coarse loamy particle-size class — **Nyalau S**

5.11.2. Other Red-Yellow Podzolic Soils that have a fine loamy or fine silty particle-size class and are derived from sedimentary rocks — **BEKENU F**

a. BEKENU soils that have a yellow colour class; a fine loamy particle-size class; and are residual — **Bekenu S**

b. Other BEKENU soils that have a red colour class; a fine loamy particle-size class; and are residual — **Sarikei S**

c. Other BEKENU soils that have developed in non-accreting alluvium — **Tukau S**

5.11.3. Other Red-Yellow Podzolic Soils that have a fine loamy or fine silty particle-size class — **ABOK F**

a. ABOK soils that have, in the

major part of the B horizon, a CEC (cation exchange capacity by NH_4OAc at pH 7.0) of less than 24 meq/100g clay — **Abok S**

b. Other ABOK soils that have a yellow colour class — **Gumbang S**

c. Other ABOK soils that have a red colour class — **Arip S**

5.11.4. Other Red-Yellow Podzolic Soils that have a calcareous or nonacid reaction class — **KABULOH F**

a. KABULOH soils that have a hue of 2.5Y within a depth of 50 cm or throughout the control section — **Kabuloh S**

b. Other KABULOH soils — **Karabungan S**

5.11.5. Other Red-Yellow Podzolic Soils that have a fine clayey particle-size class — **MERIT F**

a. MERIT soils that have a drainage class of 4 or 5 — **Stom S**

b. Other MERIT soils that have developed in non-accreting alluvium — **Lupar S**

c. Other MERIT soils that have a CEC of >24 meq per 100g clay in the major part of the B horizon and have a yellow colour class — **Merit S**

d. As C above except for a red colour class — **Begunan S**

e. Other MERIT soils that have a yellow colour class — **Bedup S**

f. Other MERIT soils that have a red colour class — **Jakar S**

5.11.6. Other Red-Yellow Podzolic Soils that have a **very fine** clayey particle-size class — **SEMONGOK F**

a. SEMONGOK soils that have a drainage class of 4 or 5 — **Semongok S**

b. Other SEMONGOK soils that have developed in non-accreting alluvium — **? S**

c. Other SEMONGOK soils that have a CEC of >24 meq per 100g clay in the major part of the B horizon and have a yellow colour class — **Padawan S**

d. As C above except for a red colour class — **Stass S**

e. Other SEMONGOK soils that have a yellow colour class — **Melugu S**

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APPENDIX A

EXPLANATION OF TERMS USED

A Horizons

Mineral horizons that formed at the surface or below an O horizon and (1) are characterized by an accumulation of humified organic matter intimately mixed with the mineral fraction and not dominated by properties characteristic of E or B horizons or (2) have properties resulting from cultivation, pasturing, or similar kinds of disturbance (Ap horizons).

Albic Horizon

See E Horizons.

Argillan

Also referred to as clay cutan, clay skin, clay film or clay coating, argillan is one type of cutans consisting of mainly clay. A cutan is defined as "a modification of the texture, structure, or fabric of natural surfaces in soil materials due to concentration of particular soil constituents or *in situ* modification of the plasma".

B Horizons

Horizon that formed below an A, E, or O horizon and are dominated by obliteration of all or much of the original rock structure and by (1) illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination; (2) evidence of removal of carbonates; (3) residual concentration of sesquioxides; (4) coatings of sesquioxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons without apparent illuviation of iron; (5) alteration that forms silicate clay or liberates oxides or both and that forms granular, blocky,

or prismatic structure if volume changes accompany changes in moisture content; or (6) any combination of these.

Obviously there are several kinds of B horizon. Lower case letters are used as suffices to designate specific kinds of B horizons. The ones which are most commonly encountered include:

Bt - accumulation of silicate clay;

Bs - accumulation of sesquioxides and organic matter;

Bh - accumulation of organic matter.

C Horizons

Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack properties of O, A, E, or B horizons. Most are mineral layers, but limnic layers, whether organic or inorganic, are included. The material of C layers may be either like or unlike that from which the solum presumably formed. A C horizons may have been modified even if there is no evidence of pedogenesis.

Cr horizons are C layers consisting of sediments, saprolite, or consolidated bedrock that when moist can be dug with a spade. Roots, however, cannot enter a Cr horizon except along fracture planes.

Cr Horizons

See C Horizons

Clay Cutan

See Argillan

Coarse Fragments

Also referred to as **Rock Fragments**. As a part of the soil mass these are fragments coarser than very coarse sand (2 mm) and less than 25 cm (10") if rounded or 37.5 cm (25") along the longer axis if flat.

Contrasting Texture

See **Texture Profiles**

Control Section

Except in very shallow mineral soils, the profile is classified at family and series level on features (particularly particle-size class) expressed in an arbitrarily defined control section. It essentially comprises the **E** and **B horizons** where present. Locally, the upper limit is the base of the **A horizon** or a depth of 25 cm from the surface, whichever is deeper. It extends downwards to the top of a **lithic** or **paralithic contact**, or to the top of a **C horizon** or any continuous **stonelines** more than 10 cm thick, or to a depth of 1 m from the surface, whichever is shallower.

E Horizons

Mineral horizons in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these, leaving a concentration of sand and silt particles of quartz or other resistant minerals.

Fine Earth Fraction

It is specifically, that part of mineral material composed of particles smaller than 2 mm in diameter.

Free Water

It is the water retained by undisturbed soils at a tension of O bar or less. Depth to free water is defined as the depth to water standing in a freshly dug uncased borehole after adequate time has elapsed (about 1 day) for the water level to adjust to the surrounding soil.

Gradational Texture

See **Texture Profiles**

Lithic Contact

This is a boundary between soil and continuous coherent, underlying material

that has a hardness of >3 Moh. Cracks, if any, should be few and their average horizontal spacing should be 10 cm or more. Hand digging of the underlying material with a spade is impractical.

O Horizons

Layers dominated by organic material. Some are saturated with water for long periods or were once saturated but are now artifically drained; others have never been saturated.

Paralithic Contact

This is like **lithic contact** except the the underlying material has a hardness by Moh's scale of <3. The material can be dug with difficulty with a spade and is normally a partly consolidated sedimentary rock such as sandstone, siltstone or shale. The consolidation is such that roots cannot enter. There may be cracks but the spacing should be 10 cm or more.

Stoneline

A stoneline includes any subsurface residual accumulation of quartz gravel, iron-enriched rock brash, iron 'pipe-rock' fragment, or true concretions. Pebbles or cobble bands in stratified alluvium are not considered as stonelines for the purpose of defining the control section unless they directly overlie lithic or paralithic material.

Texture Profiles

The textural trend of a profile is called a texture profile. Five texture profiles are recognized and are defined as follows:

Uniform Texture: clay percentage increases with depth or changes erratically between horizons <u>but</u> the variation is less than 5 per cent of the average clay percentage over the control section.

Erratic Texture: clay percentage varies erratically between horizons and the variation exceeds 5 per cent of the average clay percentage over the control section in some horizon. If the variation exceeds 25 percent, it should take place over a distance greater than 12.5cm.

Gradational texture: clay percentage increases with depth but if the increase within the control section is more than 25 per cent clay (absolute) this increase takes place over a greater vertical distance than 12.5 cm.

Contrasting Texture: clay percentage increases or decreases with depth and an absolute variation of 25 per cent clay occurs within a vertical distance of 12.5 cm or less.

Decreasing texture: clay percentage decreases with depth; the variation may or may not be greater than 5 per cent of the average clay percentage over the control section. If the variation is more than 25 percent, it should not occur within a distance of 12.5cm.

Weatherable Minerals

Minerals included in the meaning of weatherable minerals are those that are unstable in a humid climate relative to other minerals such as quartz and 1:1 lattice clays, and that, when weathering occurs, liberate plant nutrients and iron or aluminium. They include:

1. Clay minerals: all 2:1 lattice clays except aluminium-interlayered chlorite. Sepiolite, talc and glauconite are also included although they are not always of clay size.

2. Silt- and sand-size minerals (0.02 mm to 0.2 mm in diameter): feldspars, feldsparthoids, ferromagnesian minerals, glasses, micas and zeolites.

APPENDIX B. TABLES SHOWING PRESENT FAMILY AND SERIES SEPARATION

TABLE B1. Organic Soils

Family	Family Criteria	Series	Depth of Organic Soil Materials	Ash Content	Other Series Differentiae
KAPOR	Any depth or more than half consists of organic soil materials above lithic or para-lithic contact	Kapor	N.D.*	N.D.	(Autochthonous)**; resting on limestone
MULU	Others: Montane Forest; groundwater table absent	Mulu	N.D.	N.D.	(Autochthonous)**; formed from mossy materials
BAREO	Others: Montane Forest; groundwater table present	Bareo	>150cm	N.D.	(Autochthonous)**
		Umor	50-150cm		
IGAN	Others with 50-150cm of organic soil materials on sandy substratum	Igan	As Depth Phases:- e.g. Mkh 1 = 50-100cm; Mkh 2 = 100-150cm; And 1= 150-200cm; And 2= 200-250cm; And 3= >250cm	Low	Autochthonous
MUKAH	Others with 50-150cm of organic soil materials on clayey, non-sulphidic substratum	Mukah		Low	Autochthonous
		Epai		High	Autochthonous
MERAPOK	Others with 50-150cm of organic soil materials on clayey, sulphidic substratum	Merapok		High	Autochthonous
		Patok		Low	Autochthonous
		Mahat		N.D.	Allochthonous
ANDERSON	Others with >150cm of organic soil materials (irrespective of nature of substratum)	Anderson		Low	Autochthonous
		Gadong		High	Autochthonous
		Luk		N.D.	Allochthonous

* *N.D. = Not differentiated.*
** *Not used in the series definition.*

APPENDIX B (cont)

TABLE B2. Skeletal Soils

Family	Family Criteria	Series	Soil Depth	Parent Material	Drainage Class
MELUAN	Limited in depth by a lithic or paralithic contact	Meluan	<25 cm	N.D.	N.D.
		521b	25-50cm	N.D.	N.D.
TUTOH	Others which have developed in colluvium	Tutoh	N.D.	Non-calcareous sedimentary rocks	N.D.
		Lundu	N.D.	Acid igneous rocks	N.D.
KAPIT	Others which have developed in residuum	Kapit	N.D.	Non-calcareous sedimentary rocks	N.D.
		Buri	N.D.	Acid igneous rocks	N.D.
		Sedong	N.D.	Intermediate to basic igneous rocks	N.D.
BINATANG	Others which have developed in alluvium	Binatang	N.D.	N.D.	4 or more
		Kelupu	N.D.	N.D.	3 or less

APPENDIX B (cont)

TABLE B3. Thionic Soils

Family	Family Criteria	Series	Salinity
?	Presence of a sulphuric horizon within 100 cm	?	-
BELAT	Others: sandy; sulphidic within 50 cm	Belat	Strongly saline
		Pandak	Weakly saline
		Mersan	Non-saline
533	Others: sandy; sulphidic between 50 and 100 cm	533a	Strongly saline
		533b	Weakly saline
		533c	Non-saline
PALOH	Others: loamy; sulphidic within 50 cm	Paloh	Strongly saline
		Nagor	Weakly saline
		Nangka	Non-saline
535	Others: loamy; sulphidic between 50 and 100 cm	535a	Strongly saline
		535b	Weakly saline
		535c	Non-saline
RAJANG	Others: clayey; sulphidic within 50 cm	Rajang	Strongly saline
		Rampangi	Weakly saline
		Punda	Non-saline
KLUANG	Others: clayey; sulphidic between 50 and 100 cm	Kluang	Non-saline

APPENDIX B (cont)

TABLE B4. Gley Soils

Family	Family Criteria	Series	Parent Material	Other Series Differentiae
TATAU	Sandy particle-size class	Tatau	Marine alluvium	Non-saline
		Telok		Weakly saline
		Nonok		Strongly saline
		Plan	Accreting riverine alluvium	-
		Bokah	Colluvium	-
PAKAN	Loamy particle-size class	Pakan	Accreting riverine alluvium	-
		Piasau	Marine alluvium	Weakly saline
		Sirik		Strongly saline
		Gong	Non-accreting riverine alluvium	-
BIJAT	Clayey; developed in marine or accreting riverine alluvium	Bijat	Riverine; non-calcareous sedimentary rocks	White to grey within 50cm
		Samarahan		Greenish grey (5GY within 50 cm
		Danau		Dark grey (value of 4 or less) within 50 cm
		Daro	Marine alluvium	Non-saline; noncalcareous
		Pendam		Weakly saline; noncalcareous
		Beliong		Strongly saline; non-calcareous
		Buntal		Strongly saline; calcareous
		Mundai	Riverine; calcareous sedimentary rocks	-
		Kakai	Riverine; intermediate to basic igneous rocks	-
		Jiwan	Riverine; acid igneous rocks	-
SEMADOH	Clayey; developed in residuum/colluvium/non-accreting alluvium	Semadoh	Residuum; non-calcaceous sedimentary rocks	Gleyed throughout
		Tumau		Only surface gleyed
		Embang	Non-accreting alluvium	-

APPENDIX B (cont)

TABLE B5. Podzols

Family	Family Criteria	Series	Series Differentiae
GRANG	Presence of histic epipedon or a water table	Grang	Presence of histic epipedon
		Penian	Presence of natural groundwater table
JERIJEH	Others having a spodic horizon with chroma of 3 or more (dominated by iron)	Jerijeh	Weak to strong cementation
		Stoh	Noncemented
BUSO	Others having a non-cemented or weakly cemented spodic horizon	Buso	Developed in non-accreting alluvium
		Silantek	Developed in residuum
MIRI	Others having a strongly cemented or indurated spodic horizon	Miri	Developed in non-accreting alluvium
		Bako	Developed in residuum

APPENDIX B (cont)

TABLE B6. Arenaceous Soils

Family	Family Criteria	Series	Colour Class	Other Series Differentiae
KABONG	Developed in marine alluvium	Kabong	Yellow	-
		Chupin	Yellow	Cemented shell layer
		Siru	Yellow	>6% weatherable minerals
		Rambungan	Red or dark red	Mn rich B horizon
		Sematan	Red or dark red	-
KAYAN	Others which have developed in accreting riverine alluvium	Kayan	Yellow	-
		Siar	Red or dark red	-
TIKA	Others with a pallid colour group	Tika	N.D.	Residual
		Kilong	N.D.	Old alluvial
PENINJAH	Others which are not pallid	Peninjau	N.D.	Residual
		Sebaya	N.D.	Old alluvial

APPENDIX B (cont)

TABLE B7. Alluvial Soils

Family	Family Criteria	Series	Parent Material	Colour Class
SEMILAJAU	Coarse loamy or coarse silty	Semilajau	Sedimentary	-
		Julan	Acid volcanic	-
BEMANG	Fine loamy or fine silty	Bemang	Non-calcareous sedimentary	-
		Dapoi	Mixed acid volcanic and sedimentary	-
		Sebat	Acid igneous	-
		Terbat	Intermediate to basic igneous	-
SEDUAU	Clayey	Seduau	Non-calcareous sedimentary	Yellow
		Malang	Non-calcareous sedimentary	Red/dark red
		Paku	Calcareous sedimentary	-
		Sekati	Acid igneous	-
		Ramun	Intermediate to basic igneous	-

APPENDIX B (cont)

TABLE B8. Oxisols

Family	Family Criteria	Series	Colour	Particle-Size Subclass
NIBONG	Clayey; acid volcanic rocks	Selio	Pallid colour group	N.D.
		Nibong	Yellow colour class	Very fine clayey
		Mujan		Fine clayey
		Ujek	Red colour class	N.D.
TARAT	Clayey; intermediate to basic igneous rocks	Tarat	Dark red	N.D.
		Jebong	Red	N.D.
		Antayan	Yellow	N.D.
SERIN	Others which are clayey	Lingga	Pallid; hue 10YR	N.D.
		Rukam	Pallid; 2.5Y or yellower	N.D.
		Serin	Yellow	Fine clayey
		Jagoi	Red/dark red	
		Nyaroh	Yellow	Very fine clayey
		Piring	Red/dark red	
GADING	Loamy excluding <15% clay	Gading	Red	Fine loamy

APPENDIX B (cont)

TABLE B9. Grey-White Podzolic Soils

Family	Family Criteria	Series	Texture Profile	Mottling	Parent Material	Particle-Size Subclass	Other Series Differentiae
SARATOK	Coarse loamy or coarse silty	Triboh	Contrasting	N.D.	N.D.	N.D.	-
		Penipah		>20% within 100 cm	N.D.	N.D.	-
		Saratok	Not contrasting	<20% within 100 cm	Residual	Coarse loamy	-
		Semeba			Old alluvial	N.D.	-
BANGANG	Fine loamy or fine silty	Merang	Contrasting	N.D.	N.D.	N.D.	-
		Timang	Not contrasting	>20% within 100 cm	N.D.	N.D.	-
		Bandang		<20% within 100 cm	Residual	Fine silty	-
		Durin				Fine loamy	-
		Lubai			Old alluvial	N.D.	-
KERAIT	Clayey	Kerait	Not contrasting	<20% within 100 cm	Residual	N.D.	Hue 10YR or yellower
		Ajoh		>20% within 100 cm			-
		Serayan		<20% within 100 cm			Hue 7.5YR or redder

APPENDIX B (cont)

TABLE B10. Red-Yellow Podzolic Soils

Family	Family Criteria	Series	Drainage Class	Parent Material	Particle-Size Subclass	CEC in most part of B	Other Series Differentiae
NYALAU	Coarse loamy or coarse silty	Nyalau	N.D.	Residual	Coarse loamy	N.D.	-
		Matang			N.D.		Albic horizon present
		Sabangan		Old alluvial			-
BEKENU	Fine loamy or fine silty; sedimentary rocks	Bekenu	N.D.	Residual	Fine loamy	N.D.	Yellow colour class
		Sarikei					Red
		Tukau		Old alluvial	N.D.		-
ABOK	Others which are fine loamy or fine silty	Abok	N.D.	Residual	N.D.	<24 meq/100g clay	-
		Gumbang				>24 meq/100g clay	Yellow
		Arip					Red
KABULOH	Clayey; calcareous or non-acid	Kabuloh	N.D.	Residual	N.D.	N.D	2.5Y hue
		Karabungan					Redder than 2.5Y
MERIT	Fine clayey; noncalcareous or acid	Stom	4 or 5	Residual	N.D.	N.D.	-
		Lupar	6 or more	Old alluvial			-
		Merit		Residual		>24 meq/100g clay	Yellow
		Begunan					Red
		Bedup				<24 meq/100g clay	Yellow
		Jakar					Red
SEMONGOK	Very fine clayey; noncalcareous or acid	Semongok	4 or 5	Residual	N.D.	N.D.	-
		Padawan	6 or more			>24 meq/100g clay	Yellow
		Stass					Red
		Melugu				<24 meq/100 clay	Yellow

APPENDIX C. LIST OF ALL SOIL SERIES (OBSOLETE OR OTHERWISE) AND THEIR STATUS THROUGH THE HISTORY OF SOIL SURVEYS IN SARAWAK

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Abat (obs.)*	Low Humic Gley/? (Series Ledger)	Recent alluvial; sedimentary rocks, clayey; gley horizon within 18-30"	-	-	-	-	-	-	(=Bijat or Seduau Series)***	-
Abok	-	-	R.Y. Podzolic/ABOK	Microgranodiorite; strong colour	-	-	R.Y. Podzolic/ Abok(S)**	Yellow colour class; low CEC	R.Y. Podzolic/ABOK	Low CEC
Abon (obs.)	Half Bog/ ABON (1964a)**	0-36" peat/ muck over light grey clay	-	-	-	-	-	-	(=Bijat or Mukah Series)	-
Ajoh	-	-	-	-	G.W. Podzolic/ KERAIT	Variegated subsoil	Hydromorphic Upland Soils/ AJOH(S)	Variegated subsoil	G.W. Podzolic/ KERAIT	Abundant mottles within 100cm
Anderson	Bog Soils/ ANDERSON (1964b)	Coarse, partly decomposed woody peats >36"	(As a Family of Peat Soils)	(O horizon >40")*	Peat Soils/ ANDERSON	Non-saline; non-sulphidic; residual	Organic Soils/ ANDERSON (S)	Residual; peat (>65% O.M.)	Organic Soils/ ANDERSON	Autochthonous; low ash content
Antayan	Lateritic/ ANTAYAN (1965)	On intermediate igneous rocks; yellow; blocky	Lateritic/ TARAT	Blocky structure; 10YR throughout	-	-	Lateritic/TARAT (L)**	As Andriesse's (1972)	Oxisols/ TARAT	Yellow colour class
Arip	-	-	-	-	Not allocated	Fine silt; redder than 10YR CEC/clay 20-40; rhyolite	R.Y. Podzolic/ ABOK (S)	Red colour class; high CEC	R.Y. Podzolic/ ABOK	Red; high CEC
Bakau (obs.)	-	-	-	-	Podzols/ SILANTEK	Residual; no peat; Bh over non-lithic material; A2 has value/chroma rating of 2	Podzols/ SILANTEK (S)	A2 has value/ chroma rating of 2 or 4; residual	(=Silantek series)	-
Bako	Podzols/ BAKO (1965)	Coarse-textured sandstones; dip slopes	(As a Family of Podzols)	(Residual; Bh strongly developed)	Podzols/ MIRI	Sedimentary parent material	Podzols/ MIRI (S)	Residual	Podzols/ MIRI	Residual

Footnotes:-

*Obs. : Obsolete - *Does not appear in the present system*

**References: 1964a - *Report No.35/2 J.R.D. Wall*

1964b - *Report No.44/1, J.P. Andriesse*

S - *Scott, I.M. (in print) Soil Memoir of Sarawak Central Lowland*

EL - *Ellers, R.G. and Loi, K.S. (1982). Soil Memoir of Northern Interior Sarawak*

*** (=....) - *Can or possibly be correlated with such soil under the present system*

** 1965 - *Report No.59, J.P. Andriesse*

Andriesse (1972) - *Soil Memoir of West Sarawak*

Scott (1973) - *Technical Paper No.3.*

L - *Lim, C.P. (1975) Notes on Soil Classification in Sarawak.*

LL - *Louie, R. and Lah, J.U. (in prep.) Soil Memoir of Central Interior Sarawak*

+ - *Diagnostic features given in bracket are for the Family, not the Series*

APPENDIX C (cont).

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Bandang	-	-	-	-	R.Y. Podzolic/ BANDANG	Fine silt; residual; pallid throughout	G.W. Podzolic/ BANDANG (S)	Fine silt; residual; low CEC	G.W. Podzolic/ BANDANG	Fine silty; absence of abundant mottles and contrasting texture; residual
Banyut (obs.)	-	-	-	-	Podzols/ SILANTEK	Like Buso Series except Bh over residuum	-	-	(=Buso Series)	-
Bareo	-	-	-	-	-	-	(As a Family of Organic Soils,EL)	(High elevation; peat >100 cm)	Organic Soils/ BAREO	>150 cm organic materials
Bawang (obs.)	Low Humic Gley/? (1964a)	Marine sands	-	-	-	-	-	-	(=Tatau Series)	-
Bayur (obs.)	R.Y. Podzolic/ NYALAU (1964a)	On schist	R.Y. Podzolic/ ABOK	On schist	-	-	R.Y. Podzolic/ ABOK(L)	As Andriesse's (1972)	(=Gumbang Series)	-
Bedup	R.Y. Podzolic/ SEMONGOK (1964b)	On Triassic shales	R.Y. Podzolic/ MERIT	Triassic shale; 10YR or yellower; quartz and concretions in subsoil.	-	-	R.Y. Podzolic/ MERIT(L)	As Andriesse's (1972)	R.Y. Podzolic/ MERIT	Low CEC; yellow
Begunan	-	-	R.Y.Podzolic/ MERIT	Red mudstone; redder than 10YR	-	-	R.Y. Podzolic/ MERIT(S)	Light clay; red colour class; residual	R.Y. Podzolic/ MERIT	Residual; CEC-clay >24; moderate to good drainage
Bekenu	-	-	(As BEKENU Family)	(Medium textured; no A2; sesquioxides <20%)	R.Y. Podzolic/ BEKENU	Fine silt; 10YR or yellower; residual	R.Y. Podzolic/ BEKENU (S)	Fine silt; yellow colour class; residual; low CEC	R.Y. Podzolic/ BEKENU	Yellow; residual; fine loamy
Belat	-	-	(As a Family of Saline Gley	(Light textured; strongly saline; no peaty O)	-	-	Gley Soils/ BELAT (S)	Strongly saline	Thionic Soils/ BELAT	Strongly saline
Belawai (obs.)	-	-	-	-	Alluvial Soils/ KAYAN	Marine origin; hue redder than 10YR	Alluvial Soils/ KABONG(S)	Red colour class	(=Sematan Series)	-
Beliong	-	-	-	-	-	-	-	-	Gley Soils/ BIJAT	Marine alluvium; strongly saline, non-calcareous
Bemang	-	-	-	-	Alluvial Soils/ BEMANG	Fine silt; hue 10YR or yellower throughout 0-50 cm	Alluvial Soils/ BEMANG (S)	Fine silt; yellow colour class	Alluvial Soils/ BEMANG	Alluvium derived from sedimentary rocks
Bentang (obs.)	Semi-Hydromorphic/ MALANG (1964b)	Basic igneous rocks; dark colour; more Mn	(As a Family of Groundwater Laterities)	(Lowland)	-	-	-	-	(=Ramun Series)	-
Biawak (obs.)	-	-	R.Y Podzolic/ BEKENU	On greywacke sandstone; light olive brown colour	-	-	R.Y. Podzolic/ BEKENU(L)	As Andriesse's (1972)	(=Bekenu Series)	-
Bijat	Low Humic Gley/? (1964a)	Like Samarahan Series except occurs along large rivers	Gley Soils/ BIJAT	Large floodplains; mixed derivation	Gley Soils/ BIJAT	Riverine; surface peat	Gley Soils/ BIJAT (S)	Light clay; non-calcareous sedimentary; no peat	Gley Soils/ BIJAT	Riverine; non-calcareous sedimentary rocks; white to grey colour

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Binatang	-	-	(As BINATANG Family	(Residual/ alluvial; good to imperfect drainage)	Skeletal Soils/ KAPIT	Thin alluvium over residuum; good to imperto imperfect drainage	Skeletal/ BINATANG (L)	Good to imperfect drainage	Skeletal Soils/ BINATANG	Well to imperfectly drained
Bintulu (obs.)	-	-	-	-	G.W. Podzolic/ TIKA	Alluvial; pallid	Regosols/ TIKA (S)	Alluvial; no Bh below control section	(=Kilong Series)	-
Bokah	-	-	Gley Soils/ TATAU	Colluvial; bisequent;	-	-	Hydromorphic Upland/ PENIPAH (S)	Coarse loam; strongly gleyed subsoil	Gley Soils/ TATAU	Colluvial
Bukit Batu (obs.)	-	-	Lateritic/ TARAT	On basalt; gibbsitic; crumbly	-	-	Lateritic/ TARAT(L)	As Andriesse's (1972)	(=Jebong Series)	-
Buntal	-	-	-	-	-	-	-	-	Gley Soils/ BIJAT	Marine alluvium; strongly saline; calcareous
Buri	Skeletal Soils/ SEDONG (1965)	On acid and intermediate igneous rocks	Skeletal Soils/ KAPIT	On acid igneous rocks	-	-	Lithosols/ KAPIT (S)	On acid igneous rocks; clayey	Skeletal Soils/ KAPIT	On acid igneous rocks
Buso	-	-	(As BUSO Family)	(Alluvial; Bh weakly developed)	Podzols/ SILANTEK	A2 has value/ chroma rating of 3; alluvial no peat; Bh over alluvium	Podzols BUSO (L)	Alluvial	Podzols/ BUSO	Alluvial origin
Butan (obs.)	-	-	Podzols/ SILANTEK	On tertiary sandstone	-	-	-	-	(=Silantek Series)	-
Changgang (obs.)	-	-	-	-	No allocated	Fine loam; redder than 10YR; CEC/clay <16; granite or granodiorite	R.Y Podzolic/ GADING (S)	Red colour class; low CEC	(=Gading Series	-
Chupak (obs.)	Podzolic intergrade/ SEMILAJAU (1964b)	(Juvenile; weak A2; on sandy terrace materials)	-	-	-	-	-	-	(=Sabangan Series)	-
Chupin	-	-	Recent Alluvial/ SEMATAN	With petricalcic horizon	-	-	Recent Alluvial/ SEMATAN (L)	Cemented shell layer	Arenaceous Soils/ KABONG	Yellow colour class; with cemented shell layer
Danau	-	-	-	-	-	-	Gley Soils/ BIJAT (L)	Riverine; non-calcareous; dark grey within 50 cm	Gley Soils/ BIJAT	Riverine; non calcareous; dark grey within 50 cm
Dapoi	-	-	-	-	-	-	Alluvial/ BEMANG (EL)	Mixed sedimentary and volcanic origin	Alluvial Soils/ BEMANG	Derived from mixed pyroclastic and sedimentary materials
Daro	-	-	Gley Soils/ BIJAT	Not defined	Gley Soils/ BIJAT	Marine alluvium; no peat	-	-	Gley Soils/ BIJAT	Marine alluvium; non-saline
Daup (obs.)	-	-	-	-	Podzols/ SILANTEK	Residual/ colluvial; no peat; value/ chroma ratings of A2 and Bh are 3 and 2	-	-	(=Silantek Series)	-
Dras (obs.)	Low Humic Gley/? (Series Ledger)	Like Abat Series but gley horizon within 12"	-	-	-	-	-	-	(=Bijat Series)	-

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Durin	-	-	-	-	G.W. Podzolic/ SARATOK	Fine loam; residual; pallid	G.W. Podzolic/ SARATOK (S)	Fine loam; residual; low CEC	G.W. Podzolic/ BANDANG	Fine loam; residual; absence of abundant mottles and contrasting texture
Embang	Low Humic Gley/? (Series/ Ledger)	Recent over old alluvium; gley clay over humus stained sands	Gley Soils/ SEMADOH	Old alluvial	-	-	Hydromorphic Upland/ AJOH (S)	Light clay; strongly gleyed subsoil	Gley Soils/ SEMADOH	Non-accreting alluvium from non-calcareous sedimentary rocks
Entebar (obs.)	-	-	Recent Alluvial/ RAMUN	Derived from mudstone	-	-	Recent Alluvial/ SEDUAU(L)	From red mudstone	(=Malang Series)	-
Epai	-	-	-	-	Peat Soils/ MUKAH	Muck; residual; non-saline; non-sulphidic	Organic Soils/ MUKAH (S)	Non-sulphidic; residual; muck	Organic Soils/ MUKAH	High ash content
Gading	-	-	R.Y. Podzolic/ ABOK	Strongly coloured; on granites	-	-	R.Y. Podzolic/ GADING (S)	Yellow colour class; residual; high CEC	Oxisols/ GADING	Red colour class
Gadong	-	-	-	-	-	-	Organic Soils/ ANDERSON (S)	Residual; muck	Organic Soils/ ANDERSON	Autochthonous; high ash content
Gerawat	-	-	(As GERAWAT Family)	(Heavy textured; residual/old alluvial; peaty O <10")	-	-	Gley Soils/ SEMADOH (L)	Residual; peat present	(=Semadoh Series - peaty phase)	-
Gong	-	-	Gley Soils/ TATAU	Old riverine/ colluvial; bottomlands; no peat	-	-	Gley Soils/ PAKAN (L)	Old alluvium; coarse loam; no peat	Gley Soils/ PAKAN	Formed in non-accreting alluvium
Grang	-	-	-	-	Podzols/ SILANTEK	Alluvial; peaty top	-	-	Podzols/ GRANG	Presence of histic epipedon
Gumbang	-	-	R.Y. Podzolic/ ABOK	Strongly coloured; tonalites, hornfels	-	-	R.Y. Podzolic/ ABOK (S)	Yellow colour class; residual; high CEC	R.Y. Podzolic/ ABOK	Yellow colour class; high CEC
Igan	-	-	(As a Family)	(Topogenic; O horizon 10-40"; sandy subsoil)	(As a Family)	-	(As a Family)	-	Organic Soils/ IGAN	Autochthonous; low ash content
Jagoi	-	-	R.Y. Podzolic/ ABOK	Light colour; coarse-grained granite	-	-	R.Y. Podzolic- ABOK (L)	As Andriesse's (1972)	Oxisols/ SERIN	Fine clayey; red or dark red colour class
Jakar	-	-	-	-	R.Y. Podzolic/ MERIT	Residual; hue redder than 10YR	R.Y. Podzolic/ MERIT (S)	Light clay; red colour class; residual; high CEC	R.Y. Podzolic/ MERIT	Red; low CEC
Jebong	-	-	Lateritic/ TARAT	Gibbitic; blocky; gabbro	-	-	Lateritic/ TARAT (L)	As Andriesse's (1972)	Oxisols/ TARAT	Red colour class
Jerijeh	-	-	(As JERIJEH Family)	(Alluvial; weakly developed Bir)	-	-	-	-	Podzols/ JERIJEH	Bh is weakly or strongly cemented
Jiwan	-	-	-	-	-	-	Gley Soils/ JIWAN (EL)	Volcanic materials	Gley Soils/ BIJAT	Riverine; acid igneous rocks
Jol (obs.)	-	-	(As a Family of Saline Gley)	(Heavy textured; weakly saline; peaty O <10")	Gley Soils/ PENDAM	Surface peat present	Saline Gley/ PENDAM (L)	Surface peat present	(=Pendam Series - peaty phase)	-

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Julan	-	-	-	-	-	-	Gley Soils/ JULAN(EL)	Volcanic materials	Alluvial/ SEMILAJAU	Derived from acid volcanic rocks
Kabong	-	-	Recent Alluvial/ KABONG	Without weatherable minerals	Alluvial/ KAYAN	Marine; hue 10YR or yellower	Alluvial/ SEMATAN (L)	Hue 10YR or yellower in upper 50 cm; present storm beach	Arenaceous Soils/ KABONG	Yellow; absence of cemented shell and weatherable minerals
Kabuloh	R.Y. Podzolic/ NYALAU (1964a)	On calcareous shale and marl	(As a Family of Brown Forest Soils)	(Heavy textured)	R.Y. Podzolic/ KABULOH	Hue 2.5Y or yellower; CEC/ clay <30; base saturation >80%	Brown Forest/ KABULOH (L)	As Scott's (1973) plus pH >6.0 within 50 cm	R.Y. Podzolic/ KABULOH	Hue 2.5Y
Kakai	Low Humic Gley/ SAMARAHAN (1964b)	Derived from basic igneous rocks	Gley Soils/ BIJAT	Inland valleys; basic igneous rocks	-	-	Gley Soils/ BIJAT (S)	Light clay; igneous rocks	Gley Soils/ BIJAT	Riverine; basic to intermediate igneous rocks
Kapit	(As a Family of Regosols, 1965)	(On sedimentary rocks)	(As KAPIT Family)	(Residual; C within 10"; <500 ppm P)	Skeletal Soils/ KAPIT	Residual; clay; non-calcareous sedimentary rocks	Lithosols/ KAPIT (S)	Hill flank; sedimentary; clay	Skeletal Soils/ KAPIT	Non-calcareous sedimentary rocks
Kapor	(As a Family) (Wall's Thesis)	-	-	-	-	-	-	-	Organic Soils/ KAPOR	On limestone
Karabungan	-	-	-	-	R.Y. Podzolic/ KABULOH	Hue 10YR or redder; CEC/ clay >30; base saturation <50% in upper subsoil	Brown Forest/ KABULOH (L)	As Scott's (1973) plus pH >6.0 in lower subsoil	R.Y. Podzolic/ KABULOH	Hue 10YR or redder
Kayan	Recent Alluvial/ UNDUP (1964b)	Sandy; mixed parent materials	Recent Alluvial/ KAYAN	Light textured; riverine; hue 10YR or yellower	Alluvial/ KAYAN	Riverine; hue 10YR or yellower	Alluvial/ KAYAN (S)	Yellow colour class	Arenaceous Soils/ KAYAN	Yellow colour class
Kedadum (obs.)	Tropical Mull/ KEDADUM (1964b)	On limestone	(As a Family of Brown Forest Soils)	(Light textured)	-	-	-	-	(=Kapor Series)	-
Keladan (obs.)	-	-	R.Y. Podzolic/ ABOK	Red; tuffaceous materials	-	-	R.Y. Podzolic/ SERIN (S)	Heavy clay; dark red colour class; low CEC	(=Piring Series)	-
Kelupu	-	-	(As KELUPU Family)	(Residual/ alluvial; poor to very poor drainage)	Skeletal Soils/ KAPIT	Alluvium over residuum; poorly to very poorly drained	Skeletal/ BINATANG (L)	Poor to very poor drainage	Skeletal Soils/ BINATANG	Poorly to very poorly drained
Kemunyang (obs.)	-	-	-	-	G.W. Podzolic/ TRIBOH	Residual	G.W. Podzolic/ TRIBOH(L)	As Scott's (1973)	(=Triboh Series)	-
Kerait	Podzolic Intergrade/ KERAIT (1964b)	White clays; without humus B	G.W. Podzolic/ KERAIT	On carbonaceous shales	G.W. Podzolic/ KERAIT	Pallid; residual	G.W. Podzolic/ KERAIT (S)	Residual; low CEC	G.W. Podzolic/ KERAIT	Without abundant mottles, and contrasting texture; 10YR or yellower
Kilong	-	-	Skeletal Soils/ GAYA	Deep old marine sand	-	-	Regosols/ TIKA (S)	Alluvial; Bh below control section	Arenaceous Soils/ TIKA	Non-accreting alluvium
Kluang	-	-	-	-	-	-	Gley Soils/ BIJAT (L)	Sulphidic below 50 cm; surface peat	Thionic Soils/ KLUANG	Non-saline

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Koran (obs.)	R.Y. Podzolic/ MATANG (1964b)	On Triassic sandstone	-	-	-	-	-	-	(=Matang Series)	-
Krian (obs.)	-	-	Gley Soils/ SEBANDI	With oolitic iron concretions in subsoil; high calcium	-	-	Gley Soils/ BIJAT (S)	Calcareous; peat present	(=Mundai Series Peaty Phase)	-
Labang (obs.)	R.Y. Podzolic/ NYALAU (1964a)	On Tertiary shales and fine sandstones; fine sandy loam to sandy clay loam over clay loam to clay; subsoil mottled	-	-	-	-	-	-	(=Bekenu or Sarikei Series)	-
Lalis (obs.)	-	-	-	-	Intergrade/ MERIT-KAPIT	Intermediate between Merit and Kapit Series	Lithosols/ LALIS (S)	Hill flank; sedimentary rocks; clay	(=Tutoh Series)	-
Likau (obs.)	R.Y. Podzolic/ NYALAU (1964a)	Sandstone; brownish yellow sandy loam grading to sandy clay loam or sandy clay	-	-	-	-	-	-	(=Bekenu or Nyalau Series)	-
Limbang (obs.)	-	-	(As a Family of Saline Gley)	(Organic)	Organic Soils/ ANDERSON	Residual; saline; non-sulphidic	Peat Soils/ ANDERSON (L)	Alluvial; non-sulphidic; saline	(=Luk Series)	-
Linau	-	-	-	-	-	-	Lateritic/ TARAT(LL)	From pumice to vesicular basalt	Andisols/ LINAU	From pumice to vesicular basalt
Lingga	-	-	G.W. Podzolic/ SARATOK	On iron-poor granite	-	-	G.W. Podzolic/ KERAIT(L)	Microgranite; pallid	Oxisols/ SERIN	Pallid with a hue of 10YR
Luak (obs.)	R.Y. Podzolic/ NYALAU (1964a)	Fine sandstone; yellow to yellowish brown clay loam on clay	-	-	-	-	-	-	(=Bekenu or Merit Series)	-
Lubai	-	-	(As LUBAI Family)	(Old alluvial; fine textured)	G.W. Podzolic/ LUBAI	Alluvial; upper subsoil fine silt	G.W. Podzolic/ LUBAI (L)	Old alluvium; upper subsoil fine silt	G.W. Podzolic/ BANDANG	Non-accreting alluvium; absence of abundant mottles and contrasting texture
Luis (obs.)	-	-	-	-	Gley Soils/ TATAU	Riverine; surface peat	Gley Soils/ PLAN (L)	Surface peat	(=Plan Series Peaty Phase)	-
Luk	-	-	-	-	Organic Soils/ ANDERSON (L)	Alluvial; sulphidic; saline	Peat Soils/ ANDERSON	Alluvial; sulphidic; saline	Organic Soils/ ANDERSON	Allochthonous organic materials
Lundu	-	-	Skeletal Soils/ GAYA	Boulder fans granite/ sandstone derived	-	-	Skeletal Soils/ GAYA (L)	Colluvium; granite/ sandstone	Skeletal Soils/ TUTOH	From acid igneous rocks
Lupar	-	-	(As LUPAR Family)	(Old alluvial; heavy textured)	R.Y. Podzolic/ MERIT	Alluvial; hue 10YR or yellower	R.Y. Podzolic/ MERIT (L)	As Scott's (1973)	R.Y. Podzolic/ MERIT	Non-accreting alluvium; moderate to good drainage

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Lutong (obs.)	R.Y. Podzolic/ SEMONGOK (Series Ledger)	Gley mottles throughout subsoil; clay loam over clay; distinct textural B	-	-	-	-	-	-	(=Stom Series)	-
Mahat	-	-	-	-	Organic Soils/ MUKAH	Alluvial; saline; sulphidic	Peat Soils/ MUKAH (L)	Alluvial; peat; saline; sulphidic	Organic Soils/ MERAPOK	Allochthonous organic materials
Malang	Semi-Hydromorphic/ MALANG (1964a)	Mixed parent materials	Recent Alluvial/ SEDUAU	Mixed origin; intergrade to Gley Soils	Alluvial/ SEDUAU	Redder than 10YR; riverine	Alluvial/ SEDUAU (S)	Red colour class	Alluvial/ SEDUAU	Red colour class
Mas (obs.)	R.Y. Podzolic/ MATANG (1964b)	On coarse cretaceous sandstones	-	-	-	-	-	-	(=Matang or Nyalau Series)	-
Matang	(As MATANG Family, 1964b)	(Yellow coloured B; well developed textural B)	(As a Family of R.Y. Podzolic)	(Residual; A2 present)	-	-	R.Y. Podzolic/ NYALAU (L)	Weak A2 present	R.Y. Podzolic/ NYALAU	With an albic horizon
Matu (obs.)	-	-	-	-	Gley Soils/ TATAU	Marine; surface peat	Gley Soils/ TATAU (L)	Marine; surface peat	(=Plan Series Peaty Phase)	-
Meluan	-	-	(As a Family of Skeletal Soils)	(R present within 10")	(As a Family)	(Lithic within 25 cm)	Lithosols/ MELUAN(S)	Hill flank; sedimentary rocks	Skeletal Soils/ MELUAN	Soil depth less than 25 cm
Melugu	-	-	R.Y. Podzolic/ MERIT	Well drained; on hard shale; high sesquioxides	-	-	R.Y. Podzolic/ MERIT (S)	10YR or yellower; Group III oxides 20-25%	R.Y. Podzolic/ SEMONGOK	Residual; low CEC; yellow; good drainage
Merang	-	-	G.W. Podzolic/ LUBAI	Bisequent	-	-	G.W. Podzolic/ LUBAI (L)	Old alluvium; surface fine silt	G.W. Podzolic/ BANDANG	With contrasting texture
Merapok	-	-	-	-	Organic/ MUKAH	Muck; saline; non-sulphidic	Peat Soils/ MUKAH (L)	Residual; muck; saline; non-sulphidic	Organic Soils/ MERAPOK	Autochthonous organic materials; high ash content
Merit	(As MERIT Family, 1965)	(No A2; clayey; on shales and fine sandstones)	-	-	R.Y. Podzolic/ MERIT	Residual; 10YR or yellower	R.Y. Podzolic/ MERIT (S)	Light clay; yellow colour class; residual	R.Y. Podzolic/ MERIT	Residual; CEC clay >24; good drainage
Mersan	-	-	-	-	-	-	-	-	Thionic Soils/ BELAT	Non-saline
Metading (obs.)	-	-	-	-	Podzols/ SILANTEK	Alluvial; no surface peat	Podzols/ SILANTEK (S)	As Scott's (1973) plus A2 with value/chroma rating of 2 or 4	(=Buso Series)	-
Miri	Humus Podzol/ MIRI	Alluvial; not on beaches and without groundwater table	(As a Family	(Alluvial; B2 well developed)	Podzols/ MIRI	Alluvial	Podzols/ MIRI (S)	Alluvial	Podzols/ MIRI	Not developed in residuum
Mujan	-	-	-	-	-	-	Lateritic/ NIBONG (EL)	Hyperthene dacite; 10YR, 7.5YR at depth	Oxisols/ NIBONG	Fine clayey; yellow
Mukah	Half Bog Soils/† (1964a)	Like Abon Series but subsoil more bluish	(As a Family of Peat Soils)	(Topogenic; O horizon 10-40"; clayey subsoil)	Organic/ MUKAH	Peat; non-saline; non-sulphidic	Peat Soils/ MUKAH (L)	Residual; peat; non-saline; non-sulphidic	Organic Soils/ MUKAH	Low ash content

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Mulu	-	-	(As a Family of Peat Soils)	-	-	-	-	-	Organic Soils/ MULU	From mossy materials
Mundai	Low Humic Gley/PLAH (1964b)	Sands over clays	Gley Soils/ TATAU	Riverine; rich in calcium	-	-	Gley Soils/ BIJAT (L)	Riverine; sandy clay; calcium rich	Gley Soils/ BIJAT	Riverine; calcareous sedimentary derived
Nagor	-	-	-	-	-	-	-	-	Thionic Soils/ PALOH	Weakly saline
Nangka	-	-	-	-	-	-	-	-	Thionic Soils/ PALOH	Non-saline
Nibong	-	-	-	-	-	-	Lateritic/ NIBONG (EL)	Hyperthene dacite; 10YR throughout	Oxisols/ NIBONG	Very fine clayey; yellow
Nonok	-	-	(As a Family of Saline Gley)	(Light textured; weakly saline; with surface peat)	-	-	(As a Family of Saline Gley (L)	-	Gley Soils/ TATAU	Strongly saline; marine
Nyabu (obs.)	-	-	Gley Soils/ TATAU	Riverine; basic igneous rock derived	-	-	Gley Soils/ PAKAN (S)	Fine silt; igneous rocks; no surface peat	(=Pakan Series)	-
Nyalau	R.Y. Podzolic/ NYALAU (1964a)	Fine sandy loam over sandy clay loam; bright reddish yellow B	(As a Family)	-	R.Y. Podzolic/ NYALAU	Fine loam; residual	R.Y. Podzolic/ NYALAU (L)	10YR or yellower; no A2	R.Y. Podzolic/ NYALAU	No albic horizon; not in old alluvium; yellow
Nyaroh	-	-	-	-	Not allocated	Heavy clay; 10YR or yellower; CEC clay >16	R.Y. Podzolic/ SERIN (S)	Heavy clay; residual; yellow; low CEC	Oxisols/ SERIN	>60% clay; yellow colour class
Padawan	-	-	R.Y. Podzolic/ MERIT	Pale coloured; on variegated shale	-	-	R.Y. POdzolic/ MERIT (L)	Yellower than 10YR; heavy clay	R.Y. Podzolic/ SEMONGOK	Residual; moderate to good drainage; yellow; high CEC
Pakan	-	-	-	-	Gley Soils/ PAKAN	Riverine; fine silt; no no peat	Gley Soils/ PAKAN (L)	Alluvial/ colluvial; coarse loam; no surface peat	Gley Soils/ PAKAN	Riverine alluvium
Paku	-	-	Recent Alluvial/ SEDUAU	With oolitic iron concretions	-	-	Alluvial/ SEDUAU (L)	Calcareous; redder than 10YR above 50 cm	Alluvial/ SEDUAU	Calcareous sedimentary derived
Paloh	-	-	-		Gley Soils/ PALOH	Marine; fine silt; no peat	Saline Gley/ PALOH (L)	Fine silt; no peat; strongly saline; sulphidic within 25 cm	Thionic Soils/ PALOH	Strongly saline
Pandak	-	-	-	-	-	-	-	-	Thionic Soils/ BELAT	Weakly saline
Pantis (obs.)	R.B. Lattertic (Series Ledger)	Intermediate igneous rock; 2.5Y	-	-	-	-	-	-	(=Antayan Series)	-
Pasai (obs.)	R.Y. Podzolic/ NYALAU (1964a)	Like Labang Series but sandier subsoils and strongly mottled	-	-	-	-	R.Y. Podzolic/ NYALAU (S)	Red; residual; low CEC	(=Sarikei Series	-

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Patok	-	-	-	-	Organic/ MUKAH	Residual; saline; sulphidic	Peat Soils/ MUKAH (L)	Residual; peat; saline; sulphidic	Organic Soils/ MERAPOK	Autochthonous; low ash content
Paya Megok (obs.)	Low Humic Gley/ SAMARAHAN (1964b)	Mixed parent materials; peaty sub-soils; floored by limestone	Gley Soils/ BIJAT	Inland valleys; on limestone	-	-	Gley Soils/ BIJAT (L)	Riverine; high Ca, BSI and C%	(=Mundai Series)	-
Pendam	Low Humic Gley/ PENDAM (1965)	Leached clayey deltaic/estuarine deposits	Saline Gley/ PENDAM	Nonok Peninsula; artificially drained	Gley Soils/ PENDAM	No surface peat	Saline Gley/ PENDAM (L)	No surface peat	Gley Soils/ BIJAT	Marine; weakly saline
Penian	Podzols/ MIRI (Series Ledger)	On recent beaches; with groundwater table	-	-	-	-	-	-	Podzols/ GRANG	Presence of groundwater table
Peninjau	R.Y. Podzolic/ NYALAU (Series Ledger)	Sand to sandy loam; yellow or yellow brown	-	-	R.Y. Podzolic/ PENINJAU	Residual	Regosols/ PENINJAU (S)	Residual	Arenaceous Soils/ PENINJAU	Residual
Penipah	-	-	-	-	G.W. Podzolic/ SARATOK	Coarse loam; residual; variegated	Hydromorphic/ Upland/ PENINJAU (S)	Coarse loam; variegated	G.W. Podzolic/ SARATOK	Abundant mottles within 100 cm; no contrasting texture
Piasau	-	-	-	-	-	-	-	-	Gley Soils/ PAKAN	Marine; weakly saline
Pintasah (obs.)	R.Y. Podzolic/ NYALAU (1964a)	On shale; clay loam over clay; 10YR in upper 50 cm	-	-	-	-	-	-	(=Merit Series)	-
Piring	-	-	-	-	Not allocated	Heavy clay; redder than 10YR; CEC/clay <16; acid igneous rocks	R.Y. Podzolic/ SERIN (S)	Heavy clay; red; residual; low CEC	Oxisols/ SERIN	>60% clay; red or dark red
Plan	-	-	Gleys Soils/ TATAU	Riverine; sedimentary rock derived	Gley Soils/ TATAU	Riverine; no surface peat	Gley Soils/ PLAN (S)	Riverine; non-calcareous sedimentary; no peat	Gley Soils/ TATAU	Riverine alluvium
Pueh (obs.)	-	-	Podzols/ JERIJEH	Continuous Bir	-	-	Podzols/ JERIJEH (L)	Marine sand; pallid A2; Bhir is 7.5YR or redder	(=Jerijeh Series)	-
Punda	-	-	Gley Soils/ BIJAT	Inland valleys; with 'catclay'	-		Gley Soils/ BIJAT (L)	Riverine; dark grey and sulphidic below 50cm	Thionic Soils/ RAJANG	Non-saline
Rajang	-	-	(As a Family of Saline Gley)	(Strongly saline; no peat)	Gley Soils/ RAJANG	Saline	Saline Gley/ RAJANG (L)	Sulphidic; no peat; strongly saline	Thionic Soils/ RAJANG	Strongly saline
Rambungan	-	-	Recent Alluvial/ SEMATAN	Not rubified; Siru/Sematan Series intergrade	-	-	Alluvial/ SEMATAN (L)	Redder than 10YR; Mn rich B	Arenaceous/ Soils KABONG	Red or dark red; Mn rich B horizon
Rampangi	-	-	-	-	-	-	-	-	Thionic Soils/ RAJANG	Weakly saline

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Ramun	Recent Alluvial/ TERBAT (1964b)	Basic igneous; gravelly and bouldery	Recent Alluvial/ RAMUN	Light textured; basic igneous rocks	-	-	Alluvial/ RAMUN (L)	Basic to intermediate igneous; redder than 10YR	Alluvial/ SEDUAU	Derived from basic to intermediate igneous rocks
Rapak (obs.)	-	-	R.Y. Podzolic/ MERIT	With thick concretionary layer in subsoil	-	-	R.Y. Podzolic/ MERIT (L)	Redder than 10YR; iron concretion stoneline	(=Jakar Series)	-
Ri'i' (obs.)	R.Y. Podzolic/ NYALAU (1964a)	On Triassic shales; like Pintasah Series except for better structure	-	-	-	-	-	-	(=Merit or Bedup Series)	-
Rukam	-	-	G.W. Podzolic/ KERAIT	On chert and phyllites	-	-	G.W. Podzolic/ KERAIT(L)	On chert and phyllites; bluish grey	Oxisol SERIN	Pallid; 2.5Y or yellower
Sabangan	-	-	(As a Family of R.Y. Podzolic)	(Old alluvial; light textured)	R.Y. Podzolic/ NYALAU	Coarse loam; old alluvial	R.Y. Podzolic/ NYALAU (L)	Old alluvial; 10YR or yellower	R.Y. Podzolic/ NYALAU	Old alluvial
Salitut (obs.)	Low Humic Gley/ PLAN (1964a)	Riverine; sandstones/ shales derived; mainly sandy loam to loamy sand; greyish	-	-	-	-	-	-	(=Plan Series)	-
Samarahan	Low Humic Gley/ SAMARAHAN (1964a)	Sandstones/ shales derived; peaty topsoil over grey clay; riverine	Gley Soils/ BIJAT	Inland valleys; sedimentary rocks derived	-	-	Gley Soils/ BIJAT (L)	Non-calcareous; riverine; hue GY within 50 cm	Gley Soils/ BIJAT	Like Bijat Series except greenish grey within 50 cm
Saratok	-	-	(As a Family of G.W. Podzolic)	(Residual; coarse textured)	G.W. Podzolic/ SARATOK	Residual; pallid; coarse loam	G.W. Podzolic/ SARATOK (L)	Coarse loam; pallid throughout; residual	G.W. Podzolic/ SARATOK	Residual; without contrasting texture and abundant mottles
Sarikei	-	-	-	-	R.Y. Podzolic/ BEKENU	Hue redder than 10YR	R.Y. Podzolic/ BEKENU (L)	Sedimentary, non-calcareous; residual; redder than 10YR	R.Y. Podzolic/ BEKENU	Fine loam; not in old alluvium; red
Sebandi (obs.)	-	-	(As a Family of Gley Soils)	(Heavy textured; recent alluvial; peaty top)	Gley Soils/ BIJAT	Riverine; surface peat present	Gley Soils/ BIJAT (L)	Like Bijat Series but with surface peat	(=Bijat Series Peaty Phase)	-
Sebat	-	-	Recent Alluvial/ SEDUAU	Micaceous; granite derived	-	-	Alluvial/ BEMANG/ (L)	Biotite granite; 10YR or yellower; abundant mica	Alluvial/ BEMANG	Acid igneous rocks derived
Sebaya	-	-	-	-	R.Y. Podzolic/ PENINJAU	Old alluvial	Regosols/ PENINJAU (S)	Old alluvial	Arenaceous Soils/ PENINJAU	Not residual
Sedong	Skeletal Soils/ SEDONG (1964b)	Juvenile; shallow; basic igneous rocks	(As a Family of Skeletal Soils)	(C within 10"; residual; >500 ppm P)	(As a Family)	(On basic igneous rocks)	Lithosols/ KAPIT (S)	Hill flank; basic igneous rocks	Skeletal Soils/ KAPIT	Intermediate to basic igneous rocks
Seduau	-	-	Recent Alluvial/ SEDUAU	Argillaceous rocks derived	Alluvial/ SEDUAU	Riverine; 10YR or yellower	Alluvial/ SEDUAU (L)	10YR or yellower; sedimentary rocks	Alluvial/ SEDUAU	Yellow; non-calcareous sedimentary rocks derived
Sejinkat (obs.)	-	-	Lateritic/ TARAT	Blocky; on silicified basic igneous rocks	-	-	Lateritic/ TARAT (L)	On silicified basic igneous rocks; redder than 10YR	(=Jebong Series)	
Sekati	-	-	Recent Alluvial/ SEDUAU	Micaceous; granite derived; intergrade to gley soils	-	-	Alluvial/ SEDUAU (L)	Biotite granite; abundant Mn and mica; 10YR or yellower	Alluvial/ SEDUAU	Acid igneous rocks derived

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Selio	-	-	-	-	-	-	G.W. Podzolic/ SELIO (EL)	Hyperthene dacite; high elevation; silt loam over clay	Oxisols/ NIBONG	Pallid
Semadoh	-	-	Gley Soils/ SEMADOH	Residual	-	-	Gley Soils/ SEMADOH (L)	Residual; sedimentary rocks; no peat	Gley Soils/ SEMADOH	Residual; non-calcareous sedimentary; gleyed throughout
Sematan	-	-	Recent Alluvial/ SEMATAN	Leached; rubified	-	-	Alluvial/ SEMATAN (L)	Redder than 10YR; sub-recent beach	Arenaceous Soils/ KABONG	Red colour class; no Mn rich B
Semeba	-	-	-	-	-	-	-	-	G.W. Podzolic/ SARATOK	No contrasting texture; good drainage; old alluvial
Semilajau	Y.B. Hydromorphic/ SEMILAJAU (1964a)	Recent riverine; sandstones derived; yellowish sandy loam mainly	(As a Family of R.Y. Podzolic Soils)	(Recent deposit; light-textured)	Alluvial/ BEMANG	Coarse loam; hue 10YR or yellower	Alluvial/ BEMANG (S)	Coarse loam; yellow	Alluvial/ SEMILAJAU	Sedimentary rocks derived
Semongok	R.Y. Podzolic/ SEMONGOK (1965)	Carbonaceous shales; grey mottles below A1	R.Y. Podzolic/ MERIT	Strongly mottled; on variegated shales	-	-	R.Y. Podzolic/ MERIT (L)	Heavy clay; 10YR or redder; grey mottles in subsoil	R.Y. Podzolic/ SEMONGOK	Imperfect drainage
Serayan	-	-	G.W. Podzolic/ KERAIT	On chert	-	-	G.W. Podzolic/ KERAIT (L)	On chert; pallid-pinkish	G.W. Podzolic/ KERAIT	Hue redder than 10YR
Serin	R.Y. Podzolic/ NYALAU (1964b)	On Triassic arkose	R.Y. Podzolic/ ABOK	On arkose	-	-	R.Y. Podzolic/ SERIN (S)	Light clay; yellow; residual; low CEC	Oxisols/ SERIN	Yellow; <60% clay
Siar	-	-	Recent Alluvial/ TERBAT	Granite derived	-	-	Alluvial/ KAYAN (L)	Adamellite/ gabbro; redder than 10YR over 10YR or yellower	Arenaceous Soils/ KAYAN	Red or dark red colour class
Silantek	-	-	(As a Family of Podzols)	(Weak Bh; residual)	Podzols/ SILANTEK	Residual; no surface peat; Bh over non-lithic materials	Podzols/ BUSO (L)	Residual	Podzols/ BUSO	Residual
Simuja (obs.)	Low Humic Gley/BYAT (1964b)	Clayey; mixed parent materials	-	-	-	-	-	-	(=Bijat, Mundai or Kakai Series)	-
Siong (obs.)	Podzolic Soils/? (Series/ Ledger)	2.5Y hue; sandy loam mainly; residual/old alluvial	-	-	-	-	-	-	(=Nyalau or Sabangang Series)	-
Sirik	-	-	-	-	Gley Soils/ SIRIK	Fine silt; marine; no surface peat	Saline Gley/ SIRIK (L)	Fine silt; no peat; weakly saline	Gley Soils/ PAKAN	Marine; strongly saline
Siru	-	-	Recent Alluvial/ KABONG	With weatherable minerals	-	-	Alluvial/ SEMATAN (L)	10YR or yellower in upper 50cm; high mica and hornblende	Arenaceous Soils/ KABONG	Yellow; with weatherable minerals; no cemented shell

APPENDIX C (cont)

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Slabi (obs.)	Low Humic Gley/BYAT (1964b)	Sandy; mixed parent materials	-	-	-	-	-	-	(=Plan Series)	-
Stass	-	-	R.Y. Podzolic/ MERIT	Well drained; on variegated shales	-	-	R.Y. Podzolic/ MERIT (L)	10YR or redder; heavy clay; on shale with limestone influence	R.Y. Podzolic/ SEMONGOK	Red; moderate to good drainage; high CEC; residual
Stoh	-	-	Podzols/ JERIJEH	Incipient Bir	-	-	Podzols/ JERIJEH (L)	Pallid A; Bir is 10YR	Podzols/ JERIJEH	Bir non-cemented
Stom	-	-	R.Y. Podzolic/ MERIT	Well drained; on mudstone	-	-	R.Y. Podzolic/ MERIT (L)	Light clay; 10YR with variegated subsoil; on mudstone	R.Y. Podzolic/ MERIT	Imperfect drainage
Suka (obs.)	R.Y. Podzolic/ NYALAU (1964b)	On acid volcanic tuffs	Skeletal/ SEDONG	Immature; basic to intermediate igneous rocks	-	-	Lithosols/ LALIS (S)	Hill flank; clay; acid igneous	(=Sedong Series)	-
Tangap (obs.)	-	-	-	-	(Provisional)	(Karabungan/ Merit Intergrade)	B. Forest Soils/ KABULOH (L)	Calcareous shales; BS <30%; pH <6.0	(=Begunan or Stom Series)	-
Tarat	R.B. Lateritic/ TARAT (1964b)	Red; well structured	Lateritic/ TARAT	Kaolinitic; crumbly	-	-	Lateritic/ TARAT (L)	Mainly 5YR or redder basic-intermediate igneous	Oxisols/ TARAT	Dark red
Tatau	Regosols/ TATAU (1965)	Marine; sandy; weak hydromorphic	Gley Soils/ TATAU	Marine origin	-	-	Gley Soils/ TATAU (S)	Quartz sand; no peaty O	Gley Soils/ TATAU	Marine; non-saline
Tebakang (obs.)	R.Y. Podzolic/ NYALAU (1964b)	Shales/sandstones; sandy loam or sandy clay loam over sandy clay	-	-	-	-	-	-	(=Bekenu Series)	-
Telok	-	-	-	-	-	-	-	-	Gley Soils/ TATAU	Weakly saline; marine
Terbat	Recent Alluvial/ TERBAT (1964b)	Basic igneous rocks derived; rich in bases and Fe	Recent Alluvial/ RAMUN	Heavy texture	-	-	Alluvial/ TERBAT (L)	Intermediate basic igneous rocks; 10YR over 7.5YR	Alluvial/ BEMANG	Intermediate to basic igneous rocks derived
Tika	-	-	-	-	G.W. Podzolic/ TIKA	Residual; pallid	Regosols/ TIKA (S)	Residual	Arenaceous Soils/ TIKA	Residual
Timang	-	-	-	-	G.W. Podzolic/ BANDANG	Residual; variegated; fine silt	Hydromorphic Upland/ TIMANG(S)	Fine silt; variegated subsoil	G.W. Podzolic/ BANDANG	No contrasting texture; with abundant mottles
Triboh	Podzolic/ TRIBOH (1964b)	On terrace materials; with textural B	(As a Family of G.W. Podzolic)	(Old alluvial; medium texture)	G.W. Podzolic/ TRIBOH	Old alluvial; upper subsoil coarse loam	G.W. Podzolic/ TRIBOH (L)	Alluvial/ colluvial; texture contrast; upper coarse loam	G.W. Podzolic/ SARATOK	Contrasting texture
Tukau	-	-	-	-	R.W. Podzolic/ BEKENU	Old alluvial	R.W. Podzolic/ BEKENU (S)	Yellow; alluvial; low subsoil CEC	R.W. Podzolic/ BEKENU	Old alluvial
Tumau	-	-	-	-	-	-	Gley Soils/ TUMAU (Mulu Rep.)	High elevation; surface gleyed; with or without peaty O	Gley Soils/ SEMADOH	Surface gleyed

APPENDIX C (cont).

Series	Before 1966		Andriesse (1972)**		Scott (1973)**		Between 1973 & 1982		Present System	
	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria	Group/ Family	Series Criteria
Tunggal (obs.)	-	-	-	-	Podzols/ SILANTEK	Residual; no peaty O; Bh over lithic materials	Podzols/ SILANTEK (S)	Like Silantek Series but Bh on lithic contact	(=Silantek Series)	-
Tutoh	-	-	-	-	-	-	(As a Family) (EL)	(Residual/ colluvial; juvenile; red-yellow; non-calcareous)	Skeletal Soils/ TUTOH	On non-calcareous sedimentary rocks
Ujek	-	-	-	-	-	-	Lateritic/ NIBONG (EL)	Hyperthene dacite; clay; grey mottles in B	Oxisols/ NIBONG	Red colour class; greyish mottles in B
Umor	-	-	-	-	-	-	(As a Family of Organic Soils)	(High elevation; residual; bottom lands)	Organic Soils/ BAREO	Peat 50-150 cm

The following series were mapped in Central Interior Sarawak (Louie and Lah, in prep.). However, these soils have not been incorporated into or correlated with the present system.

Binio	-	-	-	-	-	-	Organic Soils/ ANDERSON	Associated with sedge vegetation	-	-
Latan	-	-	-	-	-	-	C.W. Podzolic/ LATAN	High elevation; Quarternary basalt	-	-
Penara	-	-	-	-	-	-	Gley Soils PENARA	High elevation; residual/alluvial; basalt	-	-
Selidang	-	-	-	-	-	-	Lateritic/ SELIDANG	Basalt; clay; 10YR to 7.5 YR; high elevation	-	-
Talingan	-	-	-	-	-	-	Lateritic/ TARAT	Low elevation; hypersthene dacite tuff/dacite	-	-

APPENDIX D. TENTATIVE CORRELATION WITH SOIL TAXONOMY (USDA, 1975) AND WORLD SOIL MAP LEGEND (FAO, 1974)

SOIL GROUP	FAMILY	SERIES	WORLD SOIL MAP LEGEND	SOIL TAXONOMY
Organic Soils	KAPOR	Kapor	Eutric Histosols	Euic, isohyperthermic/isothermic, Lithic Tropofolists
	MULU	Mulu	Dystric Histosols	(Clayey/loamy), (mixed/siliceous), dysic, isothermic, Hemic/*Sapric (Terric)** Sphagnofibrists
	BAREO	Bareo		Dysic, isothermic, Typic Tropofibrists[1]
		Umor		Clayey/loamy, mixed/siliceous, dysic, isothermic, Terric Tropofibrists[1]
	IGAN	Igan		Sandy, siliceous, dysic, isohyperthermic, Terric Tropofibrists[1]
	MUKAH	Mukah		Clayey/loamy, mixed/siliceous, dysic, isohyperthermic, Terric Tropofibrists[1]
		Epai		Clayey/loamy, mixed/siliceous, dysic, isohyperthermic, (Hemic/Sapric) Terric Tropofibrists[1]
	MERAPOK	Merapok		Clayey/loamy, mixed/siliceous, dysic, isohyperthermic, Terric Sulfihemists
		Patok		
		Mahat		
	ANDERSON	Anderson		Dysic, isohyperthermic, Typic/Fluvaquentic Tropofibrists[1]
		Gadong		Dysic, isohyperthermic, Fluvaquentic Tropofibrists[1]
		Luk	Dystric Histosols, some Eutric	Dysic (some Euic), isohyperthermic, Fluvaquentic Tropofibrists[1]/ Tropohemists
Skeletal Soils	MELUAN	Meluan	Lithosols; Dystric Regosols, some Calcaric or Eutric	Lithic Troporthents
	TUTOH	Tutoh	Dystric Regosols	Clayey-/loamy-skeletal, mixed, acid, isohyperthermic (some isothermic), Typic Troporthents
		Lundu		
	KAPIT	Kapit		
		Suri		
		Sedong		
	BINATANG	Binatang		Clayey, mixed, acid, isohyperthermic, Lithic Tropofluvents
		Kelupu		Clayey, mixed, acid, isohyperthermic, Lithic Fluvaquents
Thionic Soils	BELAT	Belat	Thionic Fluvisols	Isohyperthermic, Quartzipsammentic (Histic) Sulfaquents
		Pandak		
		Mersan		
	PALOH	Paloh		Loamy[2], mixed/siliceous, isohyperthermic, Typic/Histic Sulfaquents
		Nagor		
		Nangka		
	RAJANG	Rajang		Clayey[2], mixed, isohyperthermic, Typic/Histic Sulfaquents
		Rampangi		
		Punda		
	KLUANG	Kluang		Clayey[2], mixed, isophyperthermic, Tropic Sulfic (Histic) Fluvaquents

Footnotes:-

- *A slanting stroke (/) means either one.*
- ** *Parenthesis means the Subgroup is either the one before the parenthesis or both; e.g. Aquic (Oxic) Dystropepts means some soils may be Aquic Dystropepts while others could be Aquic Oxic Dystropepts.*

1 *Would change to Hemists or Saprists upon drainage.*

2 *Could be any of the subclasses.*

SOIL GROUP	FAMILY	SERIES	WORLD SOIL MAP LEGEND	SOIL TAXONOMY
Gley Soils	TATAU	Tatau	Dystric Fluvisols	Isohyperthermic, Quartzipsammentic Tropaquents
		Telok		
		Nonok		
		Plan		
		Bokah	Dystric Gleysols	
	PAKAN	Pakan	Dystric Fluvisols	Loamy[2], mixed/siliceous, acid, isohyperthermic, Tropic (Histic) Fluvaquents
		Piasau		
		Sirik		
		Gong	Dystric Gleysols	
	Bijat	Bijat	Dystric Fluvisols	Clayey[2], mixed, acid, isohyperthermic, Tropic (Histic) Fluvaquents
		Samarahan		
		Danau		
		Daro		
		Pendam		
		Beliong		
		Buntal	Calcaric Fluvisols	Clayey[2], mixed, calcareous, isohyperthermic, Tropic (Histic) Fluvaquents
		Mundai	Eutric Fluvisols	Clayey[2], mixed, isohyperthermic, Tropic (Histic) Fluvaquents
		Kakai	Dystric Fluvisols	Clayey[2], mixed, acid, isohyperthermic, Tropic (Histic) Fluvaquents
		Jiwan		
	SEMADOH	Semadoh	Dystric Gleysols	Clayey[2], mixed, acid, isohyperthermic/isothermic, Typic Tropaquents
		Tumau	Humic or Dystric Gleysols	Clayey[2], mixed, acid, isothermic, Histic/Typic Tropaquents
		Embang	Dystric Gleysols	Clayey[2], mixed, acid, isohyperthermic, Typic Tropaquents
Podzols	GRANG	Grang	Gleyic Podzols	Sandy/coarse loamy, siliceous, isohyperthermic, ortstein, Histic Tropaquods
		Penian	Humic Podzols	Sandy, siliceous, isohyperthermic, Typic Tropaquods
	JERIJEH	Jerijeh	Ferric Podzols	Sandy/coarse loamy, siliceous, isohyperthermic, ortstein, Ferrods[3]
		Stoh		Sandy/coarse loamy, siliceous, isohyperthermic, Ferrods[3]
	BUSO	Buso	Humic Podzols	Sandy/coarse loamy, siliceous, isohyperthermic, (ortstein), Tropohumods[4]
		Silantek		
	MIRI	Miri		Sandy/coarse loamy, siliceous, isohyperthermic, ortstein, Trophumods[4]
		Bako		
Arenaceous Soils	KABONG	Siru	Dystric Fluvisols	Siliceous/mixed, isohyperthermic, coated/uncoated, Typic Tropopsamments
		Kabong		Isohyperthermic, coated/uncoated, Typic/Orthoxic Quartzipsamments
		Chupin	Cambic Arenosols	
		Rambungan		
		Sematan		
	KAYAN	Kayan	Dystric Fluvisols	
		Siar		
	TIKA	Tika	Cambic Arenosols	
		Kilong	Albic Arenosols	
	PENINJAU	Peninjau	Cambic Arenosols	
		Sebaya		

3 *Classification at Great Group and Subgroup levels not yet developed by USDA.*

4 *Classification at Subgroup level not yet developed by USDA.*

APPENDIX D (cont)

SOIL GROUP	FAMILY	SERIES	WORLD SOIL MAP LEGEND	SOIL TAXONOMY
Alluvial Soils	SEMILAJAU	Semilajau	Dystric Fluvisols	Coarse loamy, siliceous, acid, isohyperthermic, Tropofluvents[4]
		Julan		
	BEMANG	Bemang	Dystric Fluvisols, some Ferralic/ Dystric Cambisols	Fine loamy/silty, siliceous/mixed, acid, isohyperthermic, Tropofluvents[4]. Some Typic/Oxic Dystropepts
		Dapoi		
		Sebat		
		Terbat		
	SEDUAU	Seduau	Dystric Fluvisols, some Gleyic/Ferralic/ Dystric Cambisols	Fine/very fine clayey, mixed, acid, isohyperthermic, Tropofluvents[4] Some Typic/Aquic/Oxic Dystropepts
		Malang		
		Ramun		
		Sekati		
		Paku	Eutric Fluvisols (some Cambisols)	Fine/very fine clayey, mixed, isohyperthermic, Tropofluvents[4]. Some Typic/Aquic Eutropepts
Andisols	LINAU	Linau	Ochric Andisols	Andisols (proposed but yet to be developed)
Oxisols	NIBONG	Nibong	Xanthic Ferralsol	Clayey, kaolinitic, isothermic, Typic Haplorthox
		Mujan		Clayey, kaolinitic, isohyperthermic, Aquic Haplorthox
		Ujek		
		Selio	Orthic Ferralsol	Clayey, kaolinitic, isothermic, Aquic Haplorthox
	TARAT	Tarat	Orthic/Rhodic Ferralsol	Clayey, oxidic, isohyperthermic, Typic Haplorthox
		Jebong	Orthic/Xanthic Ferralsol	Clayey, kaolinitic, isohyperthermic, Typic/Tropeptic Haplorthox
		Antayan	Xanthic Ferralsol	Clayey, kaolinitic, isohyperthermic, Tropeptic Haplorthox
	SERIN	Serin		Clayey, kaolinitic, isohyperthermic, Typic/Tropeptic Haplorthox
		Jagoi	Xanthic/Orthic Ferralsol	
		Nyaroh	Xanthic Ferralsol	Clayey, kaolinitic, isohyperthermic, Typic Haplorthox
		Piring	Xanthic/Orthic Ferralsol	
		Lingga	Orthic Ferralsol	Clayey, kaolinitic, isohyperthermic, Typic/Tropeptic Haplorthox
		Rukam		
	GADING	Gading	Xanthic/Orthic Ferralsol	Fine loamy, mixed/siliceous, isohyperthermic, Typic/Quartzipsammentic Haplorthox
Grey-White Podzolic Soils	SARATOK	Saratok	Dystric Nitosols[5] or Ferralic/ Dystric Cambisols	Coarse loamy, siliceous, isohyperthermic, Typic/(Orth)Oxic Paleudults/ Dystropepts
		Semeba		
	BANDANG	Bandang		Fine silty, mixed/siliceous, isohyperthermic, Typic/(Orth)Oxic Paleudults/ Dystropepts
		Durin		Fine loamy, mixed/siliceous, isohyperthermic, Typic/(Orth)Oxic Paleudults/ Dystropepts
		Lubai		Fine loamy/silty, mixed/siliceous, isohyperthermic, Typic/(Orth)Oxic Paleudults/Dystropepts
	KERAIT	Kerait		Clayey[6], mixed, isohyperthermic, Typic/(Orth)Oxic Paleudults/ Dystropepts
		Serayan		
	SARATOK	Penipah	Gleyic Cambisols or Dystric Nitosols[5]	Coarse loamy, siliceous, isohyperthermic, Aquic (Orthoxic/Oxic) Paleudults/Dystropepts
	BANDANG	Timang		Fine loamy/silty, mixed/siliceous, isohyperthermic, Aquic (Orthoxic/Oxic) Paleudults/Dystropepts
	KERAIT	Ajoh		Clayey[6], mixed, isohyperthermic, Aquic (Orthoxic/Oxic) Paleudults/ Dystropepts
	SARATOK	Triboh	Mostly Gleyic, some Ferralic or Dystric Cambisols; or Dystric Nitosols[5]	Coarse loamy over clayey, siliceous, isohyperthermic, Aquic (Orthoxic/ Oxic) Paleudults/Dystropepts
	BANDANG	Merang		Fine loamy/silty over clayey, mixed/siliceous, isohyperthermic, Aquic (Orthoxic/Oxic) Paleudults//Dystropepts

APPENDIX D (cont)

SOIL GROUP	FAMILY	SERIES	WORLD SOIL MAP LEGEND	SOIL TAXONOMY
Red-Yellow Podzolic Soils	NYALAU	Nyalau	Dystric Nitosols[5] or Ferralic/Dystric Cambisols	Coarse loamy, siliceous, isohyperthermic, Typic/(Orth)Oxic Paleudults/ Dystropepts
		Matang		
		Sabangan		
	BEKENU	Bekenu		Fine loamy, mixed/siliceous, isohyperthermic, Typic/(Orth)Oxic Paleudults/Dystropepts
		Sarikei		
		Tukau	As above or Gleyic Cambisols	Fine loamy/silty, mixed/siliceous, isohyperthermic, Typic/Aquic/(Orth) Oxic Paleudults/Dystropepts
	ABOK	Abok	Dystric Nitosols[5] or Ferralic Cambisols	Fine loamy/silty, mixed/siliceous, isohyperthermic, Orthoxic Paleudults/ Oxic Dystropepts
		Gumbang	Dystric Nitosols[5] or Dystric Cambisols	Fine loamy/silty, mixed/siliceous, isohyperthermic, Typic Paleudults/ Dystropepts
		Arip		
	KABULOH	Kabuloh	Eutric Nitosols[5] or Gleyic/Eutric Cambisols	Clayey[6], mixed, isohyperthermic, Typic/Aquic Tropudulfs/Eutropepts
		Karabungan		
	MERIT	Merit	Dystric Nitosols[5]/ Cambisols	Clayey[6], mixed, isohyperthermic, Typic Paleudults/Dystropepts
		Begunan		
	SEMONGOK	Stass		
		Padawan		
	MERIT	Jakar	Dystric Nitosols[5] or Ferralic Cambisols	Clayey[6], mixed, isohyperthermic, Orthoxic Paleudults/Oxic Dystropepts
		Bedup		
	SEMONGOK	Melugu		
	MERIT	Stom	Dystric Nitosols[5] or Gleyic Cambisols	Clayey[6], mixed, isohyperthermic, Aquic (Orthoxic/Oxic) Paleudults/ Dystropepts
	SEMONGOK	Semongok		
	MERIT	Lupar	Dystric Nitosols[5] or Gleyic/Ferralic/ Dystric Cambisols	Clayey[6], mixed, isohyperthermic, Typic/Aquic/(Orth)Oxic Paleudults/Dystropepts

5 *These soils are correlated with Nitosols on the basis of the clay distribution pattern. However, many of these soils have a low CEC (<24 meq/100g clay). Therefore, such soils are actually not equivalent to the present Nitosols nor Acrisols. Correlation with Ferric Acrisols may be more appropriate.*

6 *Can be any of the subclasses for Dystropepts.*