Report No. 22

Report on The Reconnaissance Soil Survey

of

BINTULU - TATAU AREA

4 th DIVISION

by

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HUNTING TECHNICAL SERVICES

Contents

Soil Maps enclosed (Soil Survey Drawings, Nos. 70 a) & b)).

I. INTRODUCTION

This survey was proposed by the 4th Division Development Committee. The purpose of it was to find the extent of areas suitable for agriculture, and if possible to indicate a road route between Bintulu and Tatau within the area shown on the accompanying map.

The survey was started in early April and field work was completed in 5 weeks. On completion of the field work it was learned that the road building project had been more or less abandoned due to an unfavourable timber reconnaissance report by a group of Philippine Forest Surveyors. The results of this soil survey support the view that a road between Bintulu and Tatau would be difficult to construct and would be far less useful than constructing two feeder roads from the two towns direct to the north-south trunk road, aligned tentatively across the ulu Tatau and Kemena rivers.

The area shown on the map totals approximately 450 square miles (290,000 acres)*. Of this amount 160 square miles (102,000 acres) were surveyed in 1961, namely the coastal swamps. This coastal land has been included to make available more information and to make a convenient shaped block for reporting purposes. Of the total area an estimated 160 square miles (102,000 acres) are thought to be suitable or marginal for agricultural development with the systems in use at present. Technically, far larger areas could be developed if the pressure for land was strong enough and if agricultural practises were correspondingly improved. The following paragraph summarises the types and distribution of soils present.

Peat soils are dominant in the Segan swamp and to the north of the hilly land behind the coast. They are mainly unsuitable for development. Alluvial soils occur in scattered areas largely on the swamp fringes and in upland valleys; these are agriculturally important. The residual hill soils belong mainly to the Nyalau, Merit and Penrissen Associations+ and are partly unsuitable for development due to excessively steep slopes and shallowness. There are however quite large areas with lowlying Merit, Kapit and Nyalau Associations that are suitable for agriculture, but as is the usual case the bulk of these soils is already in use for shifting cultivation. The main restriction to the development of the hill land is not so much the low fertility of the soils but the degree of dissection which produces very steep slopes and shallow soils.

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* Areas measured by planimeter from 1:50,000 maps. Figures are therefore most accurate on flat land, and least accurate on the most rugged dissected land where errors exceeding 100% are possible.

+ Andriesse, J.P. (1962) 'Field Classification of Sarawak Soils' (1st Approximation), Technical Paper No.1, 1962.

2. METHOD OF SURVEY

The standard method for reconnaissance soil surveying in this country was adopted. Air photographs were studied stereoscopically in the laboratory in conjunction with geological and land use maps. By these means broad soil types were delimited as between alluvium and peat and residual hill soils. Maps showing different geomorphological types were then prepared, especially of the hill areas in the hope that soil differences would coincide with them. Sample areas were selected to study in detail in the field and from which information could be interpolated to other similar areas.

Field work consisted of following paths and of cutting straight rentises across country at pre-selected bearings, that traverse the geological strike of rock formations, so that during soil examinations the maximum number of probable soil boundaries could be crossed. Finally, a reinterpretation of the air photographs was made and soil boundaries drawn on the photographs taking into account all the available information.

Soil boundaries are transferred onto 1:50,000 topo sheets, and are reduced in the process by approximately 50%. By means of this reduction some of the cartographical errors are avoided. Inevitably however some errors occur especially in the manual transferring of photo data to map. These errors at this time are unavoidable and therefore soil association boundaries are only claimed to be approximate, and acreage figures should be treated with reserve, both for this reason, and also for that mentioned in the footnote on page 1.

3. GENERAL CHARACTER OF THE AREA

1. <u>GEOLOGY</u>*.+. Sedimentary rocks of Miocene and Oligocene age underly the hills and continue beneath the Quaternary alluvium and deep accumulations of peat which occur particularly around the margins of the area. The sedimentary rock formations consist mainly of weakly resistant shales and fine sandstones: medium and coarse textured sandstones are rare. Small outcrops of conglomerate, limestone and calcareous sandstone occur locally near Tatau while coal has been reported from the Bintulu district near Sebauh+.

For details see:

* Wolfenden, E.B. (1960). The Geology and Mineral Resources of the Lower Rejang and Adjoining Areas, Sarawak: Brit. Borneo Geol. Survey Mem. 11, 1960.

+ Kirk, H.J.C. (1957). The Geology and Mineral Resources of the Upper Rejang and Adjacent Areas: Brit. Borneo Geol. Survey Mem. 8, 1957.

Structural events have been responsible for folding, the main trend being to the north and northeast. Dip of strata varies from less than 10° to more than 80° in places: the main directions of dip are to the west, east and north. Faulting is also evident, in particular in the Tatau and Sg. Sebauh areas where cliffing has resulted and stream alignment has been strongly influenced.

Low terrace remnants occur around the fringes of large swamp areas. The low hills at the same height or lower than the terraces in the Sg. Saparai area contain quartz conglomerate and limestone: these may be suitable for roadstone. There are also outcrops of hard fine sandstone in the Sg. Sap valley, Tatau.

2. TOPOGRAPHY. Briefly the area consists of a central block of hills in a rough 'U' shape, the two arms of which point northeast and enclose the Segan swamp. Extensive peat swamps occur between the hills and the coast, and in smaller embayments south of Sg. Sebauh.

The peat swamps have accumulated in alluvial basins containing mixed marine and riverine material. There is no direct evidence of doming of the peat surface, although in view of the large areas and great depths, especially towards Btg. Tatau, this morphological characteristic is likely. The drainage pattern shows a radial development in places, though a more typical pattern is shown by streams crossing the deeper swamps in straight lines from hills to main rivers or coast. This is probably due to the uniform (on a macro scale) structural weakness of the peat and the regular gradient of the surface tilted in one direction. Since the streams have gradually been lifted by peat accumulation they can be considered as a type of antecedant drainage.

The coast is fringed by a belt of marine sands of variable width whose probable origin was from both the hills north of Bintulu and from ulu Btg Tatau and Btg Kemena. At present little coarse sediment reaches the coast via rivers but formerly the Btg. Tatau must have brought down considerable amounts of sandy alluvium. This appears to have spread over the clayey basins east and west along an advancing shoreline. The river levees at that time must also have been considerably higher than the low ones which occur now, to judge by the comparatively steep gradient from river banks to sub-peat basin clay. These sandy sediments alongside Btg Tatau are now in the process of being drowned by the combined advancing of peat swamps and a suspected regional lowering of the land surface here. The drainage pattern is markedly rectilinear along parts of the coast where sand bars and lagoons alternate.

The hills have been subject to structural deformation and peneplanation, followed by dissections, Rapid differential erosion in the more recent geological history under a wet tropical climate has led to exploitation of and headward erosion in weaker strata. The resultant dissection is marked, and 'knife-edge' strike ridges and single and grouped cuestas are the rule. The topography appears to be in the late youthful to mature stage in the cycle of erosion.

There appear to be relics of two former erosion surfaces. The older level lies at an estimated 500-700 feet in the southeast and consists of isolated, flat, levelled cuesta summits. This surface tilts fairly steeply to the north, and just south of Bt. Buan appears as wide flat-bottomed valleys drained by streams which plunge over knick points to the level of the present day alluvium, lying near sea level. Further north it is seen mainly by accordant summit levels at an estimated height of 150-200 feet near Bintulu. Isolated hills and ridges (monadnocks) protrude from this surface and culminate in Bt. Buan (2098'), Bt. Setiam and Bt. Kapal (719').

The lowest (Jerdong*) erosion surface can be seen by terrace remnants occurring in many places at the junction of swamps and hills. The general level is 15-30 feet above local base level; remnants are not extensive, in general less than $\frac{1}{4}$ mile square. Accordant summits of this surface spread far into the hills especially in the Sg. Segan, Sg. Sebauh, Sg. Silas and Sg. Salitut areas. Joining up the remnants of this surface it can be seen that the sea at that time surrounded the whole of this area which consisted of one or two large islands.

3. VEGETATION AND LAND USE. The central hills are covered by primary forest, mainly lowland Dipterocarp grading to Kerangas. It is understood that a recent report to a Chinese timber company by Philippine Forest Surveyors gives low figures over most of the area for commercial timber, and that timber extraction is not likely to be started due to the excessively dissected topography and consequent difficulty in the building of extraction routes. Some higher hills, in particular near waterways, are used for hill padi where slopes exceed 60°. Surface erosion in such places is rapid, often in the form of landslides and gullying. The lower marginal hills are mainly used for shifting cultivation for hill padi, while peat swamps have been left under primary swamp forest except for the shallower margins near rivers and the coast. Riverine areas are used for rubber, wet padi and for the collection of belian: little primary Riparian forest remains. Settlements are predominantly on the river levees.

The population consists mainly of Iban in the rural areas. Chinese are predominant in Bintulu (Foochow and Teochew) and Tatau (Teochew); Malays are present in Bintulu (Melanau origin?) Tatau and near Sebauh. The Chinese depend on commerce for a livelihood,

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* Wilrod, G.E. (1960). Brunei and Adjacent Parts of Sarawak: Brit. Borneo Geol. Survey Mem. 10, 1960.

also

Liechti, P. et al. (1960). The Geology of Sarawak, Brunei and the Western part of North Borneo: Brit Borneo Geol. Survey Bull. 3, 1960.

ranging from the small town shopkeepers to the wealthy timber firms. A more recent trend is the planting of high yielding rubber, in particular around Bintulu. In a few years time this will be a major export of this area. The Malays prefer living on the outskirts of the towns and along the coast. At Bintulu fishing and farming are practised on a small scale, at Tatau mainly farming. The Ibans keep to the more accessible areas drained by navigable rivers and practise shifting cultivation with a lucrative sideline of belian working, also the collecting of engkabang in season. In many places however the belian is already worked out near the longhouses and is becoming increasingly difficult to transport due to the longer distances involved. Usually, belian is the main source of cash since the Ibans have planted very little rubber as yet; in the near future this may become a serious economic problem unless measures are taken to encourage the planting of cash crops.

It is worth noting that most land suitable for agriculture appears to have been used already by cultivators. If land that is at all accessible by stream, river or foot is not used it can generally be said that it is of low agricultural value. On the other hand if land is cultivated that appears to be difficult of access then it must be of above average value for that neighbourhood: in the latter case it is usually alluvial flats among rugged dissected hills.

4. SOILS

1. CLASSIFICATION AND MAPPING. In this section reference is made to the 'Field Classification of Sarawak Soils'*, in which soil associations are named and their characteristics and crop suitability outlined. The list below divides the associations found in this area into three basic groups - organic, alluvial and residual soils.

It will be seen that some associations are mapped together in the same unit on the attached soil map, particularly in the areas with residual hill soils. This is because it is often impossible to map individual associations in a reconnaissance survey when they do not coincide with topographic types. As will be realised from reading section 2 above, the mapping of topographic units by the use of air photographs is in fact the main means by which the reconnaissance surveys are so rapidly effected.

The grouping of associations is equally necessary where soils occur as a complex. For example where sandstones and shale succeed each other rapidly, each strata may give basically different soils

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* Andriesse, J.P. (1962) 'Field Classification of Sarawak Soils, (1st Approximation), Technical Paper No.1, 1962.

These basic differences may then be obscured by slope which causes soil mixing, and drainage, texture; and colour changes: the result is a complex of soils that cannot be sorted out except on the most detailed basis.

Comments on soil fertility are from field examination and by comparison with similar soils already analysed. Altogether 230 samples were taken of which 93 have been submitted for analysis: these are in addition to those taken during 1961 in the coastal swamp areas.

ORIGIN		ASSOCIATION NUMBER	ASSOCIATION NAME	APPROX. ACREAGE
ORGANOGENIC		311	ANDERSON 1	1,300
		312	" 2	20,000
		313	" 3	33,600
ALLUVIAL	Marine	11	TATAU	500
		111	IGAN	3,400
		12	OYA	200
		121	EDIN	1,600
		122	KABONG	1,600
		14	MIRI	200
		15	TANAH PUTEH	
	Riverine	23	SADONG	8,000
		21	UNDUP	
		211	SEMILAJAU	
		34	PANTU	
		221	BIJAT	2,000
		222	NYABOR	3,800
		352	PAYA MEGOK	100
	Estuarine	33	RAJANG	400
RESIDUAL		44	PENRISSEN	2,600
		441	MATANG	71,200 (+29,200)
		442	BAKO	
		444	NYALAU	
		452	KAPIT	24,100 (+2,700)
		453	SEMONGO	
		455	MERIT	
MIXED		51		4,000
		24	BUSO	9,300
		222/221		8,400
		44/444/455		7,600
		444/455/452		45,600
		23/444/455/452		4,900
Acreage figures approximated to nearest 100 acres.			Total	286,300

2. SOIL ASSOCIATION DESCRIPTIONS. This section deals with the main associations in the area, gives some characteristics of the soils and explains how each occurs in relation to others and in which mapping units. Some associations are grouped together below for descriptive convenience. Numbers in brackets are code numbers of associations.

A. ORGANOGENIC SOILS

1. Anderson Association (31). On the soil map this peat association has been divided into depth phases, that is Anderson 1, 2 and 3. This association is widespread in the Segan swamp where depths exceed 12 feet and the subsoil, where found, is clay. The peat also occurs to depths of more than 20 feet between the foothills in the north and the coast, except alongside riverine stretche ; the subsoil is sand towards Btg. Kemena and alongside Btg Tatau where the depths tend to be shallower, and clay between these two rivers where the peat is deepest. South of Sg. Salitut there is comparatively shallow peat lying over sand. Elsewhere peat occurs in small swamps as in the Sebauh valley and in the tanjongs of Btg. Tatau where depths exceeding 10 feet are common: such areas commonly have a covering, or contain lenses, of alluvial clay especially near rivers and streams; their subsoil is invariably clay.

The peat is usually a dark brown woody watery accumulation of plant debris, occasionally mixed with mineral matter near streams in particular after cultivation. This acid and waterlogged soil provides a poor medium for growth in its natural state to all but especially tolerant crops such as sago and jelutong.

The deeper peats, (more than 6 feet deep, Anderson 2 and 3) are rarely used for cultivation, the shallower swamp margins however, (3-6 feet deep, Anderson 1) are in places planted with wet padi. With suitable drainage and manuring they could probably be used for annual crops, in particular pineapple, semangka and bandong and probably for citrus and dwarf coconut. Sago grows successfully and would provide fodder for pigs and poultry.

B. ALLUVIAL SOILS

1. Tatau (11), Igan (111) and Oya (12) Associations.

These associations are related to each other by mode of deposition. They are marine sands with minor occurrences of clay and occur mainly north of the hills near Bintulu, along the coastline, alongside Btg. Tatau, and between Sg. Salitut and the low hills to the south of that river. The Oya Association consists of very pale brown fine sands with a low water table. The sand has in places been leached to such an extent that it is now a true humus podsol, that is a soil of the Miri Association (described under B2 below). This association is limited in extent and is of low agricultural value since the soil contains little plant food except where topsoil remains.

The Tatau and Igan Associations are rather more extensive. They are also less podsolized on the whole since the water table is high and leaching is consequently restricted; they are mainly pale brown to dark brown sands and loamy sands (Tatau), with up to 3 feet of peat as topsoil (Igan). If drainage is possible and with appropriate manuring, since the sand is inherently poor and the peat acid, shallow rooted crops could probably be grown such as vegetables, bush fruit and coconuts. Small stretches of the Edin and Kabong Association occur on the coast where saline and fresh water lagoons alternate with sand bars.

2. Miri (14) and Tanah Puteh (15) Associations. These are essentially marine terrace associations. Such terraces occur intermittently along the northern foothills between Btg. Kemena and Btg. Tatau, also sporadically on the inner margins of the Segan swamp and in the Sg. Silas valley. The main terrace height is between 15 and 30 feet above local base level and the main soil is a podsol of the Miri Association. The podsols consist of very poor. leached fine quartz sands whose fertility depends almost completely on the presence of topsoil humus. Where it has been removed or consumed by burning and cultivation the resultant secondary growth is very poor; this may be aggravated by sun scorch killing off micro-organisms in the bare sand exposed to the sun. Natural vegetation is kerangas. A humus pan is present at a depth of between two and three feet usually and this tends to form a perched water table. Podsols also occur near the present swamp level at Bintulu and Sg. Balau: these are possibly older terraces being 'drowned' by rapid peat accumulation.

The Tanah Puteh Association occurs in small patches on the terraces, for example near Sg. Mas, and consists of pale coloured fine sandy to silty clays. Crops seen to be growing quite well on these soils were sugar cane, pineapple and rubber; other vegetables, bush and tree fruits may also do well.

The soils of both associations are usually deep and lie either directly on sandstone and shale or on a pale coloured (quartzose) sandy clay. The latter could be either weathered and gleyed parent material or possibly alluvium deposited as a sandy clay, or a sandy alluvium later enriched by illuviated clay. In other reports this soil has been named Saratok soil (vide Saratok-Jakar road survey and Siong-Pasai-Sekuau survey by J.P. Andriesse). Laterally these soils change rapidly into either normal hill soils or recent alluvium. In the former case there is commonly a small gully or stream separating the two; it is not usual for the terrace top to give way directly to a hillside.

At Sg. Saparai a terrace surface with Miri Association soils is broken in places by quartz conglomerate boulders. This apparently is not a soil feature but is a geological outcrop of the Liang Formation. An interesting feature is that the B_2

of the podsol lies directly on and follows closely the very uneven conglomerate surface. This area is also described below under D. Dissected Old Coastal Landscape (51).

3. Undup (21), and Semilajau (211) Associations.

The Undup and Semilajau Associations are the soils developing on high levees and flooded during the landas. They can be found along most of the middle and upper courses of streams and rivers. The Semilajau Association soils are the sandy types and are found mainly in upper courses while the Undup Association soils are texturally more mixed and occur in middle river courses. The sandy material testifies to the presence of much sandstone in the hills.

Both associations occur as a narrow strip alongside water courses, rarely more than 300 feet wide. Their height above stream level usually exceeds 10 feet and often 15 to 20 feet. This indicates that when flooding does occur it must be a rapid increase in water level which is probably short lived. The soils are well-drained for at least 2 feet and though not rich, since their material is derived from poor sedimentary rocks, they are replenished with a certain amount of plant food during floods. These soils are ideal for the siting of settlements and for the production of most vegetables, tree and bush fruits.

4. Sadong (23), Pantu (34) Bijat (221), and Nyabor (222) Associations.

These soils are associated with the low-lying alluvial land between the levees and the swamps of the Anderson Association, and with the narrower valleys among the hills. The Pantu Association in this area is mainly a poorly drained clay to sandy clay loam found in the valleys leading up into the hills. It does not cover large areas. Upstream it gives way to Undup or Semilajau soils, downstream to Sadong, Bijat and Nyabor soils. It is subject to flooding and since the water table is permanently within about two feet of the surface, crops are limited to those which like or are tolerant of wet subsoil conditions. Under natural conditions wet padi is the obvious choice, while if drained satisfactorily most vegetables, bush and tree fruit should grow well. Sadong Association soils tend to be very mixed and frequently have peaty topsoils; they occur in valleys among the dissected low lying hills.

The Bijat and Nyabor Associations are predominantly light grey to pale yellow clays (Bijat) with up to 3 feet of peat or muck as topsoil (Nyabor). These soils are widespread on the swamp margins and in the larger hill valleys. They are permanently very poorly drained under natural conditions and are frequently flooded; a natural crop choice is therefore wet padi. If it is desirable and possible to drain these soils oil palm, coffee, coconut, citrus and vegetables should do well. Care should be taken in some areas near swamp margins

where there is only a thin skin of alluvial clay overlying deep peat. Where such alluvium is less than one foot thick it should be included in the Anderson Association since it would be similarly difficult to cultivate and drain.

5. Paya Megok (352) Association. Small outcrops of limestone and calcareous sandstone occur in the Sg. Saparai valley among a rather clayey alluvial soil which is probably slightly richer than normal alluvium. Associated with this soil in the same neighbourhood is a soil developing on a calareous sandstone. This particular soil is rather unusual in that the topography consists of flat alluvium (?) among 'hills' about 2 to 4 feet high. The soil develops uniformly to a depth of 6 to 12 inches abruptly changing to weathering rock. The soil itself strongly resembles young alluvium being a yellow heavy clay. Old rubber is growing but not particularly well. In view of the shallowness and possibly high pH of the soil it would be better to restrict usage to vegetables and bush fruit. Flooding occurs intermittently but to no great depth.

C. RESIDUAL SOILS

1. Penrissen (44), Matang (441) and Bako (442) Associations.

These associations are restricted usually to the higher hills and mountains where the underlying parent material is hard coarse sandstone. In this area however they also occur on quite low hills with moderately hard, fine to medium sandstone. The usual topography is cuesta country where the scarp slope has Matang soils and the gentle dip slope Bako soils. Where they cannot be mapped separately they are conveniently classified together as the Penrissen Association.

On the higher and very steep sides hills such as Bt. Kapal and Bt. Buan these soils are together predominant, also in the central block of hills where they occur with Nyalau soils. They are shallow, yellow to pale yellow sandy loams on sandy clay loams (Matang) in places becoming true podsols (Bako). Neither Matang nor Bako soils are suitable for cultivation due to shallow depths, low fertility level and their frequent occurrence on steep slopes.

2. Nyalau (444) Association. This is a very common soil found on the hills and is a typical red yellow podsolic, developed from very fine to medium, soft sandstone, somtimes mudstone. The textures are mainly sandy clay loams on sandy clays though finer sand and silt grades are common. It is found on both the very high and on the very low hills. Slopes and the attitude and type of underlying sandstone are apparently the main controlling factors. Optimum conditions are slopes between 10^{o} and 40^{o} with soft fine to medium sandstone as parent material dipping quite strongly. The harder and the coarser the sandstone, the steeper the slope and often the more gently the beds dip, the more the soil changes towards Matang and eventually Bako soils.

This is the situation in the large central block of hills which is covered by a mixture of Bako, Matang, Nyalau and minor occurrences of Merit soils, a mixture whose component soils could only be mapped separately by a detailed survey; the Nyalau Association covers an estimated 1/3 of this area.

The Nyalau Association soils though nutritionally poor are physically good, being well-drained, moderately deep and unencumbered by stones. Similar soil at Tg. Kidurong (North of Bintulu and near to this survey area) on 10°-15° slopes was growing good crops of vegetables and fruit, especially pineapple, citrus and mango; young coconuts were also thriving. The fertiliser being used was cave guano. Rubber also grows well on these soils near Bintulu, though with slopes exceeding 20° to 25° the topsoil is very prone to erosion.

3. Merit (455), Kapit (452) and Semongo (453) Associations.

These soils are mainly derived from siltstones, mudstones and shales with minor occurrence of sandstone. The Merit Association soils are by far the most common in this group and occur on both low to high hills and on gentle to steep slopes. In general however they are predominant on hills lower than 300 feet and on slopes less than 40°. The nutrient content below the topsoil is low and the drainage is not usually good due mainly to the heavy textures, (clay loams on clays): frequently the soil may be shallow. The Semongo soils occur with the Merit Association but only in very small areas. In the mixed Merit-Nyalau area the proportion of each is approximately 50-50.

The Kapit Association occurs with the Merit and Semongo Associations, but appears to be confined to the very low hills, in particular around the south-east of the Segan swamp and in parts near Btg. Tatau. It is usually shallow and contains iron coated rock fragments at depths of less than 2 feet. It is more poorly drained than the Merit soil, is shallower and consists of a heavy clay throughout.

Where these soils occur on slopes of less than 35° they are normally suitable for cultivation. Rubber should be the first choice though other tree crops with suitable manuring would probably grow satisfactorily, except where the Kapit soils are very shallow.

D. SOILS OF MIXED ORIGIN

1. Association (51)

The soils in these areas are very mixed and occur on dissected erosion surface remnants; in particular they were noted in the Sg. Salitut area and at Sg. Mas. There are many other small areas, around the margins of the Segan swamp and in ulu Sg. Sebauh especially. Soils present can include the Miri (14), Tanah Puteh (15), Ridgeway (16), Nyalau (444), Merit (455), Kapit (452),

/Bijat

Bijat (221), Nyabor (222), Sadong (23), Pantu (34), Paya Megok (352), Anderson (31) and possibly Tatau (11) and Igan (111) Associations. The main types however are the residual hill soils and terrace soils.

2. Buso (24) association

This association occurs in ulu Sg. Sekabai covering a long narrow stretch of low flat topped hills and apparently giving way westwards to shallow residual soils of a podsolic nature. The soil appears to be riverine terrace material. It is a podsolized pale yellow sandy loam on a pale yellow sandy clay containing no gravel: in places true podsol soils occur of limited extent. Primary kerangas vegetation covers the area which indicates that the soil is poor. The soils of the erosion surface remnants have been included in this group since they probably give a similar podsolic soil under a kerangas vegetation, although their origin is probably marine and not riverine.

3. Rajang Association. These saline soils occur in limited stretches on the coast in lagoons and alongside those rivers and streams that contain saline to brackish water, namely Btg. Kemena, Btg. Tatau and Sg. Segan. The silty clay to clay soil is potentially suitable for agriculture since the nutrient content, although unbalanced, is high. Reclamation however would be both difficult and expensive, and there is the additional possibility of 'catclay' complications.

5. DISCUSSION AND CONCLUSIONS

1. Agriculture

Approximately 450 square miles are shown on the map: of these an estimated 290 square miles are thought to be unsuitable for agriculture. These areas include deep peat (Anderson Association), saline soils (Rajang Association), infertile sands (Buso and Miri Associations) and land that is steeply sloping with shallow soils (Penrissen Association). The remaining areas (160 square miles) consist of shallow peat on sand and clay, alluvial sands and clays, and those hills which are generally less than 300 feet high and with slopes not exceeding 35°.

The cultivable areas can be put to far better use than they are at the moment. Apart from in the Bintulu district where high yielding rubber is being grown on terraced slopes, little of the hill land is being planted with anything more ambitious than hill padi. These hill soils are probably of low fertility to judge by analyses of similar soils but physically they are a good medium for plant growth. In this respect they are suited to the requirements of many tropical crops - provided they have regular appropriate manuring. This can be born out by an example from Tg. Kidurong just north of this area. The soil is similar to the Nyalau Association, a yellow sandy clay loam on a yellow sandy clay derived

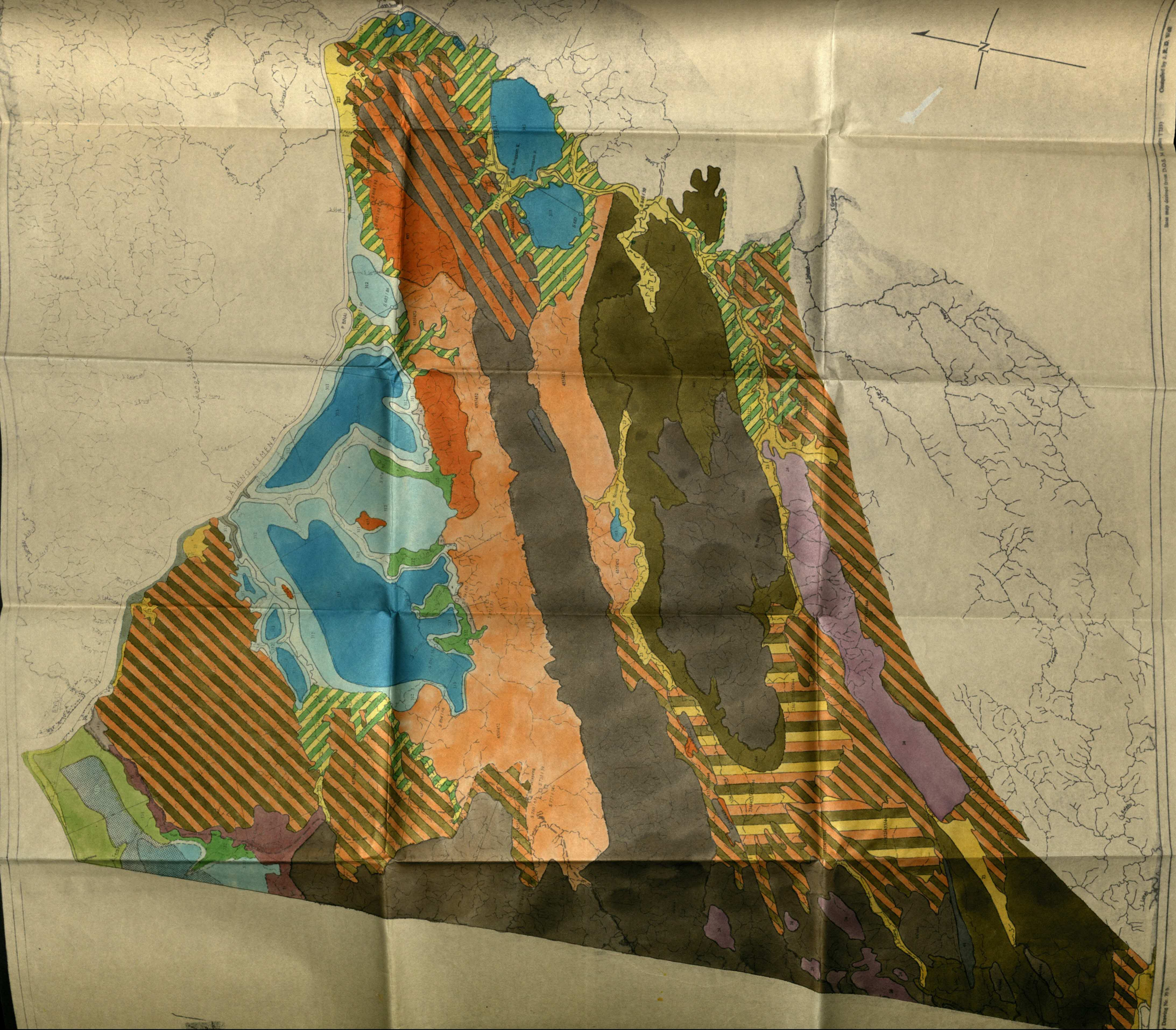
/from

from white soft sandstone; the slope of the hillside is between 10 to 15°. Malays from Bintulu have been rncouraged to plant coconuts on the hills, this in itself being unusual for Sarawak. But not only have coconuts been planted they have also planted a great variety of vegetables, citrus, pineapple, banana, papaya, mango, semangka etc. as catch crops. It is noticeable that unmanured gardens are more retarded in most respects than those receiving guano fertiliser. The more fortunate owners have access to guano deposits in caves at Sg. Semilajau, and they are already finding that although coconuts (1 year old) do not respond particularly well to guano so far on this soil, pineapple, citrus and mango do respond and fruit very well indeed. One bad problem in this particular area is the wild pig which can only effectively be kept out by expensive barbed wire fencing; a further danger is that of surface soil erosion, which is evident on a bare surface on a 10° slope after one year only. This implies that terracing is desirable on this Nyalau soil even on low gradients. The conclusion to be drawn is that if this kind of intensive agriculture succeeds at Kidurong there seems to be no reason why it should not succeed on similar Nyalau soils in the area being discussed.

2. Roads. The building of a road between Bintulu and Tatau would seem to be a costly project since at least 10 miles of the route must pass through badly dissected country, with many hills to cross exceeding 200 feet above the nearby valley. For information the easiest route has been plotted on the soil map, though such a road would open up little land worthwhile developing in the central block. It would however make moderately good land around the margin of the Segan swamp more accessible from Bintulu, although if this lowlying land is to be developed a small feeder road from Bintulu would serve this purpose equally well. Little good land near Tatau would be made available since steeper and more dissected country is the main type of topography there.

Regarding direct communication between Bintulu and Tatau the following alternative to the Sg. Segan route has been suggested. The trunk road should be aligned not too far to the south, for example along the Sg. Minah valley towards Sebauh, so that feeder roads from Bintulu and Tatau could be connected to it, and it would then take little longer to travel between Bintulu and Tatau by road than it does to travel by sea now.

Providing that there are no overriding reasons other than agricultural development for constructing the direct Bintulu-Tatau road, it is felt that the proposal should be dropped and the central block of land with Penrissen and Nyalau Association soils be made into a Forest Reserve.



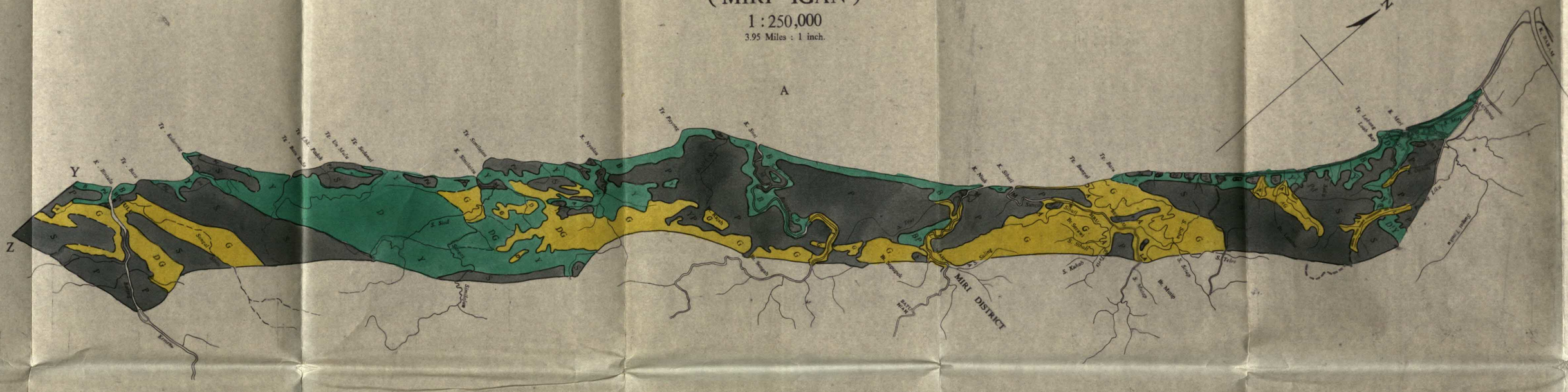
Compiled by J.R.D. Wall
BATANG KEMENA

SOIL CAPABILITY MAP
(MIRI - IGAN)

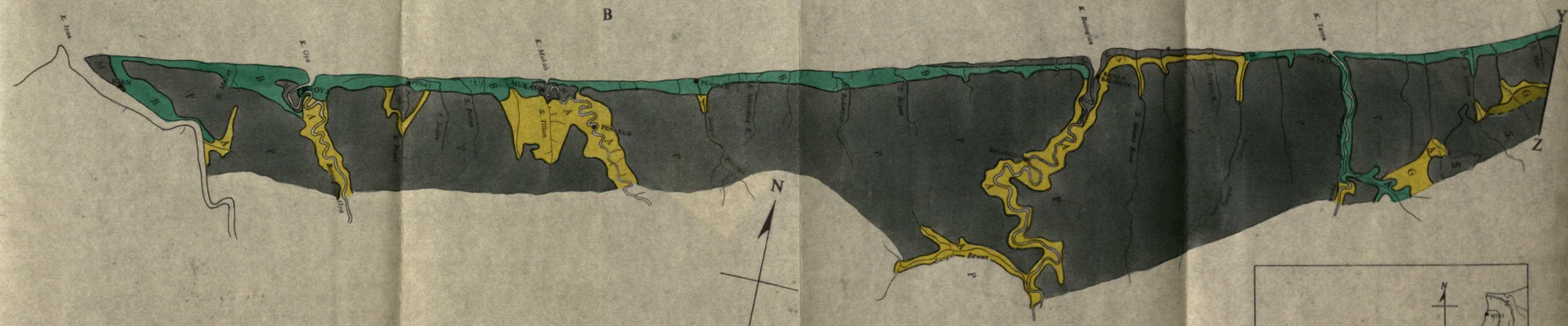
1 : 250,000

3.95 Miles : 1 inch.

A



B



AREAS UNSUITABLE FOR CULTIVATION

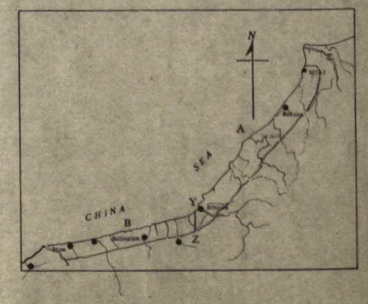
- *P* - Deep peat
- *Pd* - Podsol
- *S* - Steep, dissected hills
- *M* - Saline swamp

AREAS SUITABLE FOR CULTIVATION

- *A* - Riverine alluvium
- *L* - Levees
- *G* - Lower hills; gentler slopes

MARGINAL FOR CULTIVATION

- *B* - 'Wet' and 'dry' beachsand
- *D* - Low, moderately dissected poor hills
- *Y* - Mixed : Parts Suitable; Parts Unsuitable

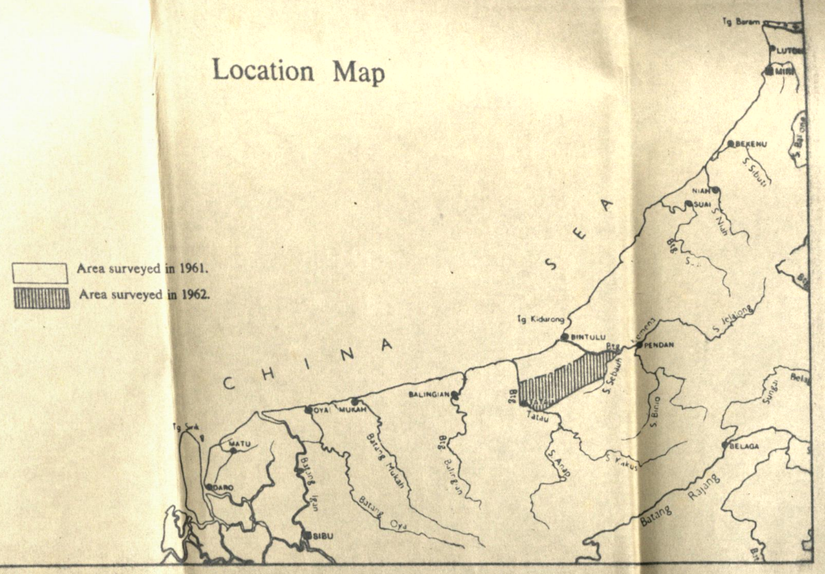


Soil Survey Drawing No.64

Compiled by : J.R.D. Wall. Drawn by Sebli Mohd.Ap.

Reconnaissance Soil Map
BINTULU - TATAU
4 th DIVISION

Location Map



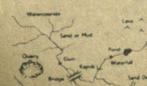
KEY TO SOILS

ORIGIN	MAPPING UNITS	ASSOCIATION NUMBER	ASSOCIATION NAME	APPROX ACREAGE	MAIN SOIL TYPE	TOPOGRAPHIC TYPE	TENTATIVE AGRICULTURAL SUITABILITY
ORGANOGENE		311	ANDERSON 1	4,300	3 to 6 feet peat, sometimes muck topsoil.	Flat and badly drained swamps.	Very marginal : sago when undrained ; shallow rooted annual crops when drained.
		312	ANDERSON 2	20,000	6 to 10 feet peat.		Only suitable for sago, jelutong.
		313	ANDERSON 3	33,600	More than 10 feet peat.		Only suitable for sago, jelutong.
MARINE		11	TATAU	500	Pale brown to dark brown sands. High water table, poorly drained.	Beaches and swamp margins.	Low fertility : when water table below 2 feet suitable for coconuts, vegetables and other nondemanding shallow rooted crops.
		111	IGAN	3,400	As TATAU with up to 3 feet peat as topsoil; badly drained.	Swamp margins	Variable fertility : when drained as for TATAU.
		12	OYA	200	Very pale brown sands, frequently podsolized. Low water table, excessively drained.	Beaches.	Marginal; low fertility.
		121	EDIN	1,600	Mixed TATAU, OYA and NYABOR.	Sand bars and lagoons.	Refer to individual associations
		122	KABONG	1,600	Mixed TATAU, OYA and RAJANG.		
ALLUVIAL		14	MIRI	200	Humus podsol; excessively drained.	Dissected marine terrace.	Unsuitable for cultivation.
		15	TANAH PUTEH		Pale, fine sandy and clayey soils; poorly drained.		Medium fertility : vegetables, bush and tree fruit, rubber.
RIVERINE		23	SADONG	8,000	Mixed UNDUP and SEMILAJAU.	High river levees.	Medium fertility : vegetables, bush and tree fruit, rubber, coconut.
		21	UNDUP		Mixed sandy and clayey soils; well drained.		
		211	SEMILAJAU		Yellow sandy soils; well drained.		
		34	PANTU		Pale coloured sandy clay loam to clay; shallow peat in patches; poorly drained.	Lowlying flat land in small hill valleys.	
		221	BIJAT	2,000	Light gray clays; badly drained.	Lowlying flat land on swamp margins and in large valleys.	Low to medium fertility ; undrained - wet padi and sago; drained - vegetables, bush and tree fruit, coconut, oil palm.
		222	(NYABOR) MUKAH	3,800	As BIJAT but with up to 3 feet peat or muck as topsoil; badly drained.		As for BIJAT.
		352	PAYA MEGOK	100	Very shallow yellow clay on limestone; moderately drained.	Limestone and marls covered by shallow alluvium.	Probably medium fertility, but restricted to shallow rooted crops.
ESTUA RINE		33	RAJANG	400	Gray to dark gray saline silty clay to clay, muck topsoil; poorly drained.	Mangrove, nipah swamp.	Potentially fertile : of low agricultural value until reclaimed.
RESIDUAL		44	PENRISSEN	2,600	Mixed BAKO and MATANG.	Highest and steepest ridges.	Refer to individual associations.
		441	MATANG	71,200	Shallow pale yellow sandy loam to sandy clay loam on crumbly sandstone; moderately to well drained.	Long and short steep slopes.	Low fertility: marginal for cultivation.
		442	BAKO		Shallow pale podsolic sandy loam on sandstone; well drained.	Gentle slopes.	Low fertility : unsuitable for cultivation.
		444	NYALAU	(+29,200)	Yellow sandy loam on red yellow sandy clay loam; well drained.	Mainly medium to high hills. Steep and gentle slopes.	Low fertility : where slopes less than 30° suitable for most crops including coconut; terracing on slopes more than 15°.
		452	KAPIT	26,700	Yellow clay with iron accumulation at shallow depth; moderately drained.	Mainly low to medium height hills, gentle to steep slopes.	Low fertility : mainly on slopes less than 35° and suitable for rubber.
		453	SEMONGO		Yellow clay on white clay subsoil; poorly drained.	Low and high hills, gentle and steep slopes.	Low fertility : on slopes less than 35° suitable for rubber.
		455	MERIT	(+2,700)	Yellow clay loam on red yellow clay; moderately drained.		As for SEMONGO.
MIXED		24	BUSO	9,300	Mixed (marine) riverine terrace podsolised sands, with BAKO and NYALAU.	Dissected riverine terrace	Mainly poor soils, low agricultural value.
		51		4,000	Mainly MIRI or BAKO, NYALAU, MERIT and PANTU associations.	Low hills, gentle to moderately steep slopes.	Refer to individual associations.
		44/444/455		7,600	Refer to individual associations.		
		455/452/444		45,600			
		222/221		8,400			
		234/455/452/444		4,900			

All soils are probably of medium to low fertility. Each crop will therefore need appropriate and regular manuring to obtain best results.

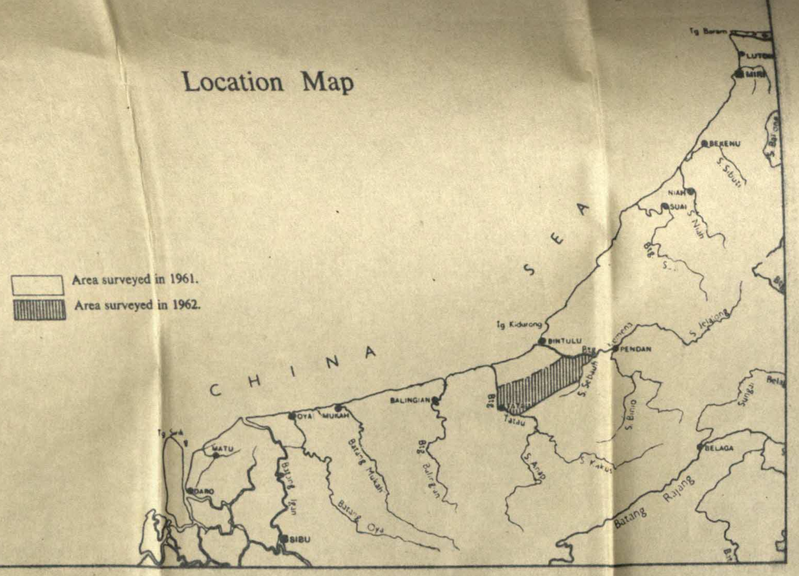
LEGEND

- The easiest road route between Bintulu and Tatau.
- Foot paths used for soil investigations.
- Cut line of soil investigations.
- Soil sample pit and laboratory number.
- Tentative subpeat sand-clay boundary.



Reconnaissance Soil Map
BINTULU - TATAU
4 th DIVISION

Location Map



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LEGEND

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- Foot paths used for soil investigations.
- Cut line of soil investigations.
- S 815 / 20 — Soil sample pit and laboratory number.
- S 697 / 701 — Auger sample site.
- Long house.
- Tentative subpeat sand-clay boundary.