

42456

631.473
(911.14)

Report No.38

Report on a Detailed Reconnaissance

Soil Survey of the Mukah Area.

by

J.R.D. Wall

THIRD DIVISION

October 1961

REPORT ON A DETAILED-RECONNAISSANCE

SOIL SURVEY OF THE MUKAH AREA.

by

J.R.D. Wall

CONTENTS

Location map facing page 1.

1. INTRODUCTION	Page
1. General	1
2. Purpose of the Survey	1
2. GENERAL CHARACTER OF THE AREA	
1. Geology	1
2. Geomorphology and Drainage	2
3. Vegetation and Land Use	2
3. SOILS OF THE AREA	
1. Soil Classification	4
2. Soil Description	5
3. Soil Capability	9
4. CONCLUSIONS	
Appendix A. Chemical Analyses	
Soil Map enclosed (Soil Survey Drawing No.59)	
Soil Capability Map enclosed (Soil Survey Drawing No.60).	

1. INTRODUCTION.

1.1* General. The area surveyed totals approximately 74,700 acres covering Mukah and neighbouring areas in the 3rd Division. Very simply, the area consists of a narrow sandy coastal belt backed by an extensive peat swamp. This is broken by the narrow alluvial plain of the Batang Mukah and associated tributaries.

The population is predominantly Melanau except in Mukah town where shop-owning Chinese are dominant. The economy of the Melanau is based on sago production supplemented mainly by fishing. There are a few, small Melanau-owned rubber gardens, a negligible acreage of rice and scattered attempts at vegetable growing, none of which supply sufficient extra cash. The sago processing equipment is crude and resultant flour poor. In fact, this is an area showing depressed economic conditions.

1.2 Purpose of the Survey. In order to help improve this undesirable state of affairs the Soils Division was asked to investigate soil conditions in the area and to give indications for better soil use, especially with a view to introducing coconuts.

2. GENERAL CHARACTER OF THE AREA.

2.1 Geology. The whole area is covered by Quaternary deposits, either alluvium or peat. The alluvium is of three types; riverine, estuarine and marine.

2.1a) The riverine alluvium, as the name suggests, is found alongside Btg. Mukah and extending beneath the peat deposits of the south. There is also, for Sarawak conditions, an unusually large amount of riverine alluvium with shallow peat cover in the Sg. Tillian - Petanak area.

2.1b) The estuarine alluvium, deposited under brackish conditions, covers comparatively small areas around the mouths of Btg. Mukah and Sg. Penipah and the narrow river-bank strips on the lower reaches of coastal streams. This material is probably present, however, beneath much of the adjacent riverine alluvium.

2.1c) Marine alluvium is extensive and occurs as a band from $\frac{1}{2}$ to $2\frac{1}{2}$ miles wide on the coast and beneath the backing peat. This band is broken in places by rivers and streams where marine alluvium has been replaced by either riverine or estuarine material.

2.1d) Peat is characteristically found in the badly drained inter-river areas overlying either riverine alluvium, where it is usually deep, or marine alluvium where it is more often shallow.

*This report includes information from field notes, maps and the initial report on the same area compiled by C.J. Grant.

2.2 Geomorphology and Drainage. Four groups of land-form occur associated respectively with riverine, estuarine, marine and peat deposits. That is land-form and soil forming material (described in section 2.1) are strongly related, also vegetational types as will be indicated in section 2.3.

2.2a) Riverine landforms include levees and basins. The levees are very low, discontinuous and grade back quickly into the basins. They have low watertables for parts of the year but are frequently topped by flood water especially during the landas.

The basins behind the levees are quite extensive especially in the Tillian-Petanak area. They are almost permanently waterlogged with high watertables for most of the year due to the surrounding peat and levees which obstruct natural drainage.

There are many small streams present which originate from the peat. The water is fresh but acid and peaty. Many of the seaward flowing streams show straight courses, possibly indicating steepish gradients.

2.2b) Estuarine land-forms in the area surveyed are not particularly well-developed. They are here the result of the infilling of lagoons as at Kuala Mukah or the infilling of abandoned meanders of Btg. Mukah. Micro topography is very hummocky as a result of activity by the crab 'ketam nguang'.

All water supplies in this type of land-form are brackish.

2.2c) Coastal land-forms are here the result of long-continued movement of sandy material up and down the coast which builds up a series of beach lines and sand bars parallel to the shore. Tidal currents at Kuala Mukah, however, have built up a complicated pattern of beach lines with an equally confused drainage pattern. The heights of older beach lines are in general lower than those of more recent ones.

Small streams crossing this coastal belt from the riverine and peat areas behind tend to do so in a rectilinear pattern being strongly influenced by former beach alignment. The stream water is fresh but usually peaty except near the mouths where salt water occurs. Some streams may dry up temporarily in the dry season but most maintain a steady, small flow being fed by the backing peat swamps.

2.2d) The peat swamps, in the larger areas at least, have a domal development as indicated by the radial stream pattern. Streams are permanent but short and confined to the shallow peat fringes. The boundary between the basins and deep peat is very sharp, especially in cultivated parts. The step in depth of peat from 2 feet to 10 feet plus may take place in as little as 300 to 400 feet.

2.3 Vegetation and Land Use. Rather than enumerating the different kinds of vegetation and land use and describing where they occur, it is more convenient to use the land-form divisions of section 2.2 and describe the kinds of vegetation and land use associated with each. In fact, land-form and vegetation type are closely associated.

2.3a) Riverine areas are practically all covered by Melanau-owned sago gardens except on river banks where kampongs and gardens occupy the low levees. The sago is said to grow well in these areas taking from 10 to 14 years to mature. The crop is not very well kept, and there seems to be no attempt to replant in blocks and so economise in labour at harvesting times. It is really semi jungle cropping rather than an organised plantation system.

2.3b) Estuarine areas are conversely almost all under natural vegetation of mangrove and nipah. Riverbank fringes have in some places been 'reclaimed' for kampong settlement while inland fringes are occasionally used for sago and coconut gardens, but not very successfully.

2.3c) The coastal belt as a whole has a moderate amount of natural vegetation left. The thin coastal margin where the beachsand has not a peat cover has been reclaimed originally for cultivation, but now it has reverted to coarse grasses and scrub. Where shallow peat tops the beachsand there is much primary Mixed Swamp forest, frequently with thick undergrowth. West of Sg. Petanak the forest growing on shallow peat above beachsand has been removed by Chinese for rubber gardens which cover a considerable acreage. In the same area there are occasional attempts at market gardening.

2.3d) The edges of the peat areas (less than 10 feet deep) have been cleared and planted with sago. Palms take longer to mature on peat, the average being 10 years. Quality is similar to palms grown on riverine soils. Beyond this limit is mainly primary Mixed Swamp forest, which to the south shows Alan and Padang Paya development. Small areas have been seen planted with pineapples and vegetables on the shallower peat.

3. SOILS OF THE AREA

3.1 Classification. The soils are divided into four Soil Associations which correspond to the four land-form divisions made in section 2.2.

MAIN SOIL GROUPS	SOIL ASSOCIATION	MAPPING UNIT	
SEDIMENTARY	A. RIVERINE	1. Mainly grey to brownish grey clay to silty clay. Up to 3 feet peat as topsoil.	
	B. ESTUARINE	2. Mainly mottled grey brown silty clay over dark grey silty clay.	
	C. COASTAL	3. Sand, ranging from undifferentiated to humus podsol. Water table below 24".	
		4. As for 3. Water table above 24" and up to 3 feet peat as topsoil.	
ORGANOGENIC	D. PEAT	5. 3-6' peat	a) Mainly clay subsoil b) mainly sand subsoil
		6. 6-10' peat	a) mainly clay subsoil. b) mainly sand subsoil
		7. More than 10' peat	a) mainly clay subsoil b) mainly sand subsoil.

Each Association may contain several soils differing in e.g. drainage, texture, degree of development etc., but within each Association all soils are strongly related topographically, genetically and in fertility. In detailed surveying the several soils within an Association could be mapped separately but with reconnaissance surveys the aim is to present a generalised picture except in certain cases, as here with the Peat Association depth phases.

3.2 Soil Descriptions.

3.2a) Riverine Association. The soils of this Association are in fact derived from a layer of freshwater alluvium deposited during floods, lying over a sub-layer of old brackish estuarine alluvium. The latter alluvium is of significance in the development of 'cat@lay' as will be indicated later.

On the whole the soils are fairly uniform except near such localities where disturbance by estuarine or coastal influences can be expected, e.g. within abandoned meanders near Mukah and near the coastal sand belt. In such places variations from the average can be expected.

The typical soil is deep, impervious, heavy-textured and has a high water table. Physically, soil conditions are ideal for padi and sago.

A typical profile, this from a sago garden, would be:

- 3 - 0" : Damp peaty litter.
- 0 - 4" : Very dark greyish brown peaty loam; abundant fibrous roots.
- 4 - 19" : Light grey clay loam to silty clay loam with strong brown mottling; wet, sticky and plastic; common fine roots.
- 17 - 37" : Gray silty clay with light gray and strong brown mottling; wet, slightly sticky and plastic; few roots.
- 37 - 45"+: Dark grey silty clay with few greenish grey mottles; wet, slightly sticky and plastic; no roots.

Water table 4".

Chemically the peaty material appears to be more fertile than the soil beneath as regards nutrients but the peat is very acid and this alone is sufficient to make it an unfavourable medium for growth for many crops. In most nutritional aspects however this soil is above average for Sarawak conditions.

At lower depths, coincident with the occurrence of old estuarine alluvium, there are indications of 'catclay'. On drying out this material is very acid and sulphurous and in this condition toxic to plant growth. Fortunately this material is generally at depths too great to affect plant growth. Only towards the present estuarine alluvium does it come near the surface; elsewhere it is mainly below 36", especially upstream where depths of overlying freshwater alluvium become greater.

Levees are poorly developed and very similar to the basin soils described above. In fact they should be considered as better drained versions of the basin soils. Variations towards the coast are mainly in texture when sandy clay loams and sandy clays occur. The peat in this mapping unit varies from C - 36" deep and also varies in quality with type and length of cultivation. The few small areas left under primary swamp forest have a woody, coarse, little decomposed peat, while under long continued sago cultivation the peat becomes partially aerated. This allows accelerated decomposition and results in well decomposed peaty loam, at least in the top 12" or so. Towards rivers where flooding is common the peat may be mixed with mineral matter to give mucks.

Approximate acreage mapped - 10,600 acres.

3.2b) Estuarine Association. The soils of this Association are quite uniform and characterized by excessive amounts of salts, sodium in particular, for satisfactory cultivation. Deposition of material is normally at high tide and at such times the salinity of the water will be maximal.

The soil surface is broken by innumerable crab cones that may reach heights of 3 and 4 feet. The burrowing and building of such cones has resulted in a thorough mixing of the topsoil.

A typical profile would be:

- 0 - 8" : Grayish brown silty clay loam mixed with many strong brown and gray patches; moist, slightly sticky.
- 8 - 18" : Gray silty clay with strong brown mottles; wet, much fine organic matter.
- 18 - 50"+: Gray to dark gray silty clay; wet with abundant undecomposed organic matter.

Water table 10".

Variations are mainly in texture towards the Coastal Association where sandy clay loams and sandy clays are common.

Approximate acreage mapped - 1,600 acres.

3.2c) Coastal Association. Soils within this Association are variable and for mapping purposes have been split into

- (i) beachsand 'dry'; water table below 24".
- (ii) beachsand 'wet'; " " above 24" and up to 3 feet peat as topsoil.

3.2c) (i) Beachsand 'dry'. This soil occurs as a narrow fringe along the coastal margin varying in width from less than 100 feet to almost half a mile. It varies in degree of development from completely undifferentiated sand through semi-humus podsol of humus podsol, - all with gleyed subsoil.

The normal situation is for the degree of podsolization to increase with increasing distance from the shore, i.e. from the younger to the older soils. Frequently however the true humus podsol can be found on the present shore line while further inland the degree of podsolization appears to be much less. The latter can possibly be explained by the fact that with present equipment, augering is only possible to a depth of 4 feet. This whole depth may be the eluviated horizon while the 'pan' lies somewhere below 4 feet in the region of the water table. The former is harder to explain but may just be due to coastal erosion exposing older sand, or long-continued stagnation of shore line sand accumulation which has allowed podsolization to continue unimpeded on the shore line itself.

The undifferentiated sand is confined mainly to river mouths where currents are constantly eroding and depositing new material.

The gleyed humus podsol and semi-podsol occupy the remaining bulk of this mapping unit. As explained above it is not always easy to determine whether what appears to be a semi-humus podsol is one or not; thus even the approximate acreage it covers cannot be estimated.

The gleyed humus podsol is described below. Natural vegetation cleared to leave 'lallang' 'rumput melay' and 'engkadok' as an incomplete surface cover. No humus.

- 0 - 4" : Dark grey loamy sand; moist; abundant fine roots.
- 4 - 10" : Light brownish grey fine-medium sand; moist, very friable, roots as above.
- 10 - 18" : Very dark brown fine sand to loamy sand with few pale brown mottles; moist, firm, many fine to medium roots.
- 18 - 32" : Brown to dark brown fine to medium sand; moist, friable, no roots.
- 32 - 40" + : Olive brown sand to loamy sand; moist, friable, no roots.

Water table 50" (non saline).

The semi-podsol shows characteristics ranging between the extremes of undifferentiated sand and the humus podsol. The sand is excessively drained until either the 'pan' or water table is reached, there being practically no clay or humus to retain water or nutrients - especially when the natural forest cover is removed. Rain water seeps straight through the profile; normal drainage is along the surface of the water table rather than along the ground. The top of the 'pan' and the water table level are frequently coincident.

Chemically the sand is initially very poor since it has been transported up and down the coast and subjected to weathering for a considerable number of years leaving mainly quartz. Both the podsol and undifferentiated sand are extremely poor. The newer sand has a high pH and greater amount of total bases, but is still extremely deficient. Nutrients are very low in all types except where topsoil is present. Under primary forest the loss of nutrients by leaching is made good by the return of leaves and litter to the topsoil thus retaining a soil horizon of reasonable fertility. After clearing and burning, crops may be good for one or two years but subsequent regeneration during fallow becomes progressively poorer and very little is returned to the soil.

Approximate acreage - 3,400 acres.

- 3.2c) (ii) Beachsand 'wet'. Soil conditions are dominated by the water table which is at, or rises to, the surface several times during a year, especially during the "landas" and after storms.

This soil is found behind the 'dry' beachsand as a belt from a few feet to a mile in width.

Where peat occurs as topsoil the water table is usually near the surface: the sand beneath tends to be undifferentiated in colour and texture - mainly light grey to yellow or brown wet sand. The peat may be woody under natural vegetation or a peaty loam if exposed to the drying effect of sun by clearing. The nutrient status of the wet sand is very low. That of the peaty material above appears to be appreciably higher, though not all the bases indicated by analyses are necessarily available for plant nutrition. The peat is also very acid. Where peat is absent as topsoil and the water table is below the surface, podsolization occurs and consequently soil qualities are similar to those of the 'dry' beachsand.

Approximate acreage - 9,200 acres.

- 3.2d) Peat Association. This soil occupies by far the greater part of the area. The bulk of the peat is more than 10 feet deep, often approaching 30 feet towards the swamp centres. The morphology of the swamps appears to be biconvex with rather abrupt edges especially in areas

/adjoining

adjoining cultivation. This sudden decrease in depth towards the edges may be due to the long - continued effect of cultivation allowing drying, humification and shrinking, or it may be a natural sub peat feature connected with fluvial deposition; more probably it is due to both.

The peat is woody and coarse under primary forest with the water table at or near the surface. Under sago, or other cultivated parts it is finer and loamier in the topsoil. Occasionally, near rivers, there may be interstratified layers of alluvium, relics of former floods.

Chemically, as explained before, the peat is very acid but certainly contains more nutrients than most other peats in Sarawak: those however may be out of balance i.e. antagonistic.

Approximate acreage 3 - 6 feet deep -	5,500
6 - 10 feet deep -	4,900
more than 10 feet deep -	39,000
	<hr/>
	49,400 acres
	<hr/>

3.3 Soil Capability. The enclosed Soil Capability map should be referred to in this section. The map and the comments below give an indication of where different types of agriculture can be carried out with soil conditions as they are at the moment, and possible future use providing certain measures of soil improvement are carried out.

a) Intensive Cultivation - 'wet'. This is only possible on soils of the Riverine Association. Under present soil conditions of very poor drainage, impervious, deep soil and moderate fertility both sago and padi farming recommend themselves. The former, as undertaken now, can be improved substantially by simply intensifying the planting in a more orderly manner. Very little is known of the nutrient requirements of the plant but it does seem to grow satisfactorily in more or less permanently water logged conditions. Thus if there are any patches of this soil difficult to drain they could be planted or left to Sago.

Padi cultivation should be possible over much of the area. If drainage is needed on a large scale however it is essential to take accurate levels over the land beforehand because of the possibility of brackish water flooding after soil and peat shrinkage.

If needed there are areas which can be fairly easily drained to allow cultivation of 'dry foot' crops such as coconuts, citrus, oil palm, vegetables and many other fruits. These areas are near rivers and streams where incipient levee formation gives slightly better soil drainage. There is the possibility here however of meeting 'catclay' at shallow depth, especially where the water in streams is still brackish.

Although intensive cultivation is indicated the soil is not so rich that manuring can be ignored. On the contrary the more intense the farming is the more liberal and frequent should the manuring be, depending of course on the requirements of the respective crops and what is available in the soil.

b) Extensive Cultivation. This is possible on soil from the Coastal Association - beachsand 'wet' - and shallower peat.

(i) At present little of the beachsand 'wet', is cultivated but providing suitable measures are taken, shallow rooted crops such as vegetables, bush fruit, coconuts, pineapple, papaya etc. should grow satisfactorily. Yields will be lower than on (a) above.

The peat is moderately fertile but very acid and the sand beneath is poor in plant food; so cultivation measures should aim at conserving the peat as long as possible. Frequent shallow drains will be necessary to keep the water table below 12 - 18" and so allow aeration. If drains are over deep, peat may dry irreversibly; there is also the small possibility of tidal flooding which in the sandy soil would be difficult to control.

Drain alignment on the peat should be towards the coast or rivers, but where the peat is very shallow or absent, drains in the sand should be aligned parallel to the coast until a natural drainage line is met. Drains should not exit at the coast unless through natural streams otherwise the exit will be blocked within days by drifting sand.

Crop requirements in the way of fertilizer should be met regularly since the natural supply in the peat is not large.

(ii) The margins of the large peat swamps are indicated as suitable for extensive cultivation - mainly because sago is being grown there quite satisfactorily at the moment. On still deeper peat, i.e. exceeding depths of 10 feet, sago should still grow satisfactorily, though for all other crops this 'soil' would be marked as unsuitable for cultivation.

c) Unsuitable for Cultivation. Soils included here are those of the brackish mangrove and nipah swamps, the main deep peat areas and the 'dry' beachsand which would require too much fertilizer too often for economical crop growth on a large scale. On the latter soil however vegetables can be grown if the topsoil is improved and conserved by addition of organic manures, burnt earth, night soil and possibly moist peat. Addition of almost any type of organic matter would improve this poor soil since in its present condition there is extremely little absorption or adsorption complex and any mineral fertilizers applied would be washed down by the first heavy rain.

4. CONCLUSIONS

4.1 The basic problem in this area is that the Melanau

/depends

APPENDIX A.

Chemical Analyses

N.B. At the time of preparing this report only a few analyses were available. Three examples have been picked out showing soils of the Riverine and Coastal Associations, also an example of peat taken from the vicinity of Oya.

1. Riverine Association. Auger sample from ulu Sg. Petanak in old sago garden. Musky topsoil lying on silty clay.

Lab. No.	Depth (in.)	pH	ppm P	Organ. C %	Total N %	C/N	CATION EXCHANGE in m.e. %						
							Exch. capacity	Total Bases	% Base Satn.	Ca	Mg	K	Na
5011	0-20	3.3	41	19.61	1.50	13	68.6	5.87	9	.56	3.79	.38	1.14
12	20-48	3.3	14	16.08	0.73	22	50.6	5.45	11	.91	3.18	.19	1.17
13	48+	4.1	17	3.91	0.16	24	13.2	6.93	53	.25	6.06	0.10	.52

2. Coastal Association

- a) Beachsand, 'wet'. Auger sample in wet sand in newly planted rubber garden near Sg. Petanak. Soil too wet to sample below 30".

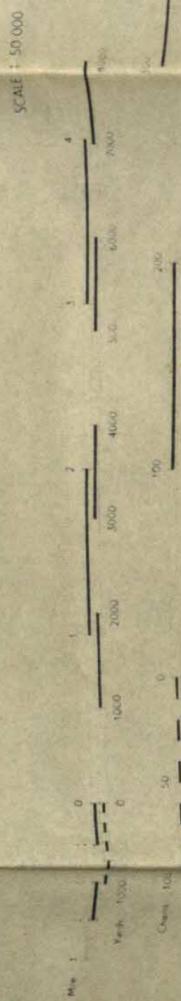
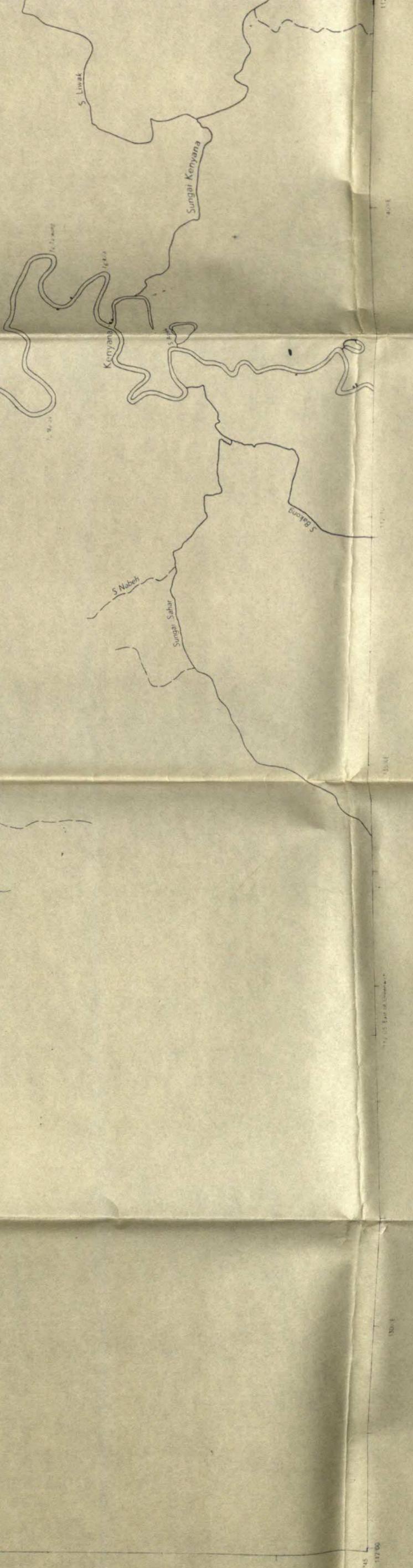
Lab. No.	Depth (in.)	pH	ppm P	Organ. C%	Total N%	C/N	CATION EXCHANGE in m.e. %						
							Exch. capacity	Total Bases	% Base Satn.	Ca	Mg	K	Na
5017	0-27	3.4	33	30.3	1.27	24	48.9	5.69	12	.86	3.74	.31	.78
18	27-30+	4.6	7	2.19	0.03	73	3.5	0.95	27	.39	0	.02	.54

- b) Beachsand 'dry'. Pit sample near Kuala Mukah under coarse, poor grazing land.

Lab. No.	Depth (in.)	pH	ppm P	Organ. C%	Total N%	C/N	CATION EXCHANGE in m.e. %						
							Exch. Capacity	Total Bases	% Base Satn.	Ca	Mg	K	Na
4925	0-7	4.6	2	0.54	0.03	18	1.8	0.81	45	0.49	0	.09	0.23
26	7-13	5.0	1	0.18	0.02	9	0.9	0.68	76	0.49	0	.03	0.16
27	13-23	4.9	2	0.16	Trace	-	1.0	0.68	68	0.49	0	.03	0.16
28	23-28	4.9	2	0.11	Trace	-	1.2	0.64	53	0.49	0	.03	0.12
29	28-42	4.9	3	0.14	Trace	-	1.3	1.33	100	0.78	0.39	.03	0.13
30	42-46	4.9	2	0.12	Trace	-	1.4	0.96	69	0.54	0.24	.03	0.15
31	46-50	2.7	Trace	33.40	0.92	36	25.6	11.69	46	8.79	2.66	.02	0.22
32	50+	6.8	7	0.14	Trace	-	1.4	3.51	100	3.12	0.18	.03	.18

3. Peat Association. Deep peat near Oya. Auger sample.

Lab. No.	Depth (in.)	pH	ppm P	Organ. C %	Total N %	C/N	CATION EXCHANGE in m.e.%						
							Exch. capacity	Total Bases	% Base Satn.	Ca	Mg	K	Na
5033	0-25	3.5	57	63.06	1.88	34	83.4	11.5	14	2.38	7.25	.73	1.14
34	25+	3.7	41	61.70	1.08	57	81.2	8.76	11	2.00	5.04	.36	1.36



LEGEND

SOIL CATEGORY	SOIL ASSOCIATION	MAPPING UNIT
SEDIMENTARY	A. RIVERINE	1. Grey to brownish grey clay to silty clay. Up to 3 feet peat as topsoil. Poor to very poor drainage; deep, impervious. Liable to flooding.
	B. ESTUARINE	2. Mainly mottled grey brown silty clay lying over dark grey silty clay. Poor to very poor drainage; brackish, frequently flooded.
	C. COASTAL	3. Light grey to brownish yellow sand, ranging in podsolization from undifferentiated to humus podsol. Water table below 24". Excessively drained above water table; extremely pervious, deep. Not flooded. 4. As for C.3. Water table above 24" and up to 3 feet peat as topsoil. Imperfect to very poor drainage. Rarely flooded.
ORGANOGENIC	D. PEAT	5. 3-6' peat subsoil mainly sand 6-10' peat subsoil mainly clay > 10' peat

KEY

	Pit sample location
	Auger sample location
	Laboratory ref. numbers of samples
	Rentis
	Soil boundary uncertain
	Very tentative sub peat sand-clay boundary
	Soil type uncertain

