No 123
ISSN 0725-8526

CSIRO
AUSTRALIA

DIVISION OF SOILS

Divisional Report

Soils of the Babinda – Cairns Area, North Queensland

G.G. Murtha, M.G, Cannon and C.D. Smith

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Divisional Report No 123

National Library of Australia Cataloguing-in-Publication Entry

Murtha, G. G. (Grahame George).
Soils of the Babinda-Cairns area, North Queensland.

Bibliography.
ISBN 0 643 05861 3.

1. Soils - Queensland - Babinda Region. 2. Soils - Queensland - Cairns Region. I. Cannon, M. G. II. Smith, C.D. III. CSIRO. Division of Soils. IV. Title. (Series : Division of Soils divisional report ; no. 123).

631.499436

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INDEX TO SOIL SERIES AND MAP UNIT DESCRIPTIONS

SOILS OF THE BABINDA CAIRNS AREA, NORTH QUEENSLAND

G.G.Murtha[1] , M.G.Cannon[2] and C.D.Smith[3].

Abstract

The Babinda-Cairns area is located at about 17° 15' south latitude and 145° 50' east longitude. It forms part of what is locally known as the wet tropical coast of north Queensland. Mean annual rainfall ranges from about 1900mm to over 4500mm and has a pronounced summer dominance.

A soil survey at 1:50 000 scale has been conducted over an area of about 200 000 ha. Forty eight soil series have been recognised and characterised in terms of their field morphology and major chemical and physical properties. The mapping units are associations of soil series.

The soils of the area are formed on granite, basalt and low grade metamorphic rocks, on mixed alluvium derived from those parent materials and to a minor extent alluvium of marine origin. The major physiographic units include, precipitous mountains, granite peaks, minor basalt flow surfaces, and depositional surfaces. The depositional surfaces range from alluvial fans to riverine and marine plains and narrow beach ridge systems. The alluvial fans are often extensive, of very low angle and appear to have originated as mud flows rather than by gradual accretion. The upland soils exhibit many properties characteristic of the humid tropics such as thick sola or very deeply weathered saprolite, freely draining and friable nature, acid reaction, and low base status. The lowland soils are a much more diverse with profile wetness, which is usually site dependent being the dominant factor influencing soil morphology.

INTRODUCTION

General

The area covered by this survey (Figure 1) is bounded by the North Johnstone River in the south, Buchan Point in the north and extends from the coast to the Lamb Range in the west. It is an area of approximately 200,000ha of which about 55% is very steep rainforest-clad mountains. The survey was undertaken to provide maps at 1:50 000 scale by a free survey technique (Reid 1988). Colour aerial photographs taken in September 1983 of approximately 1:30 000 scale were used as the major aid in map unit delineation. Monochrome aerial photographs taken in 1961 at approximately 1:80 000 scale were also used to take advantage of the original vegetation patterns which assisted in the selection of inspection sites and in soil mapping.

Large areas of the coastal lowland country to the east of the Murray-Prior, Malbon-Thompson, Graham, and Seymour Ranges were inaccessible at the time of this survey and hence the map units in this area have been delineated and interpreted on the basis of air photo pattern with little or no ground truthing. There also is minimal access to the mountainous lands and they have been simply mapped as such and differentiated only on the basis of geology. A reliability diagram is given on the accompanying maps.

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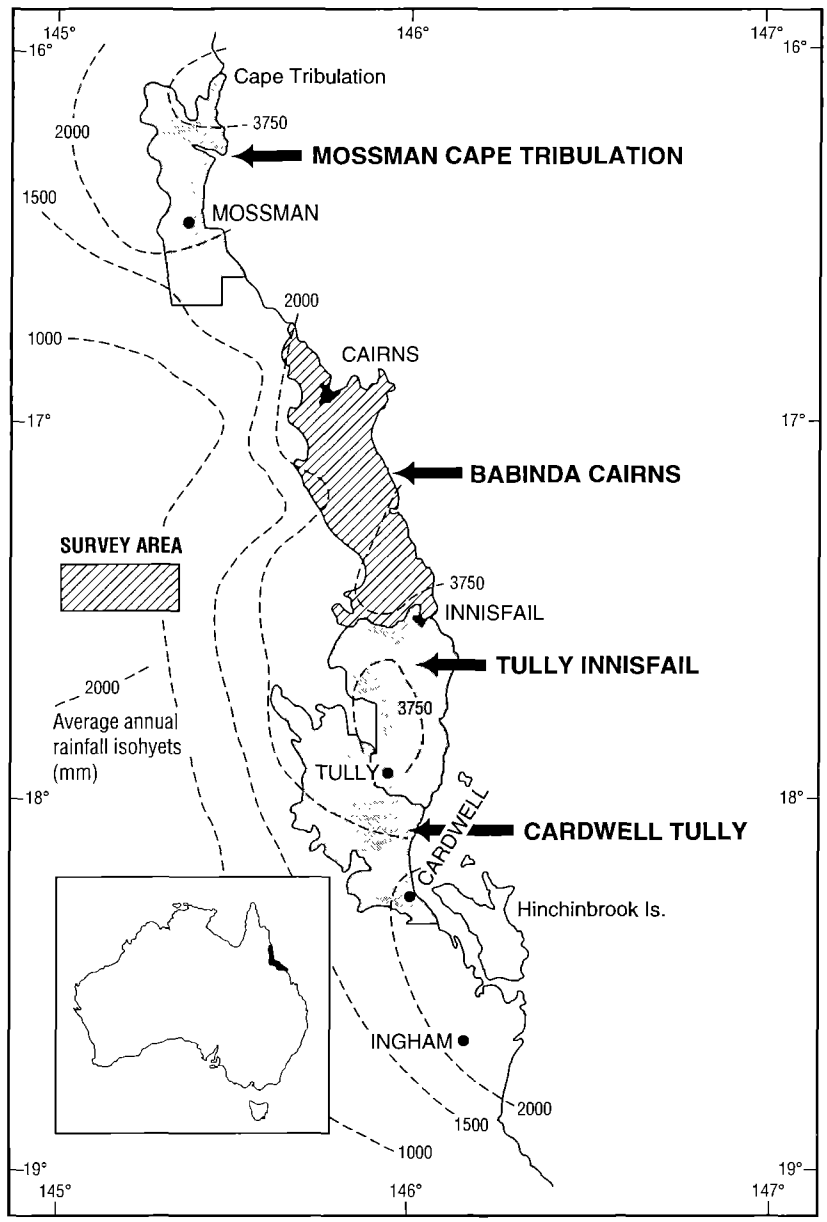


Figure 1. Locality map

This report provides a morphological description of the soil series recognised and a description of the mapping units depicted on the accompanying map. Chemical and physical data are presented for representative profiles but there is no discussion of the data. Unless otherwise stated on the table the analytical methods used are those described in the appropriate section of this report. This report should be read in conjunction with the land evaluation report of Smith et al (in press) where the soil and land suitability for a wide range of crops has been determined.

The soils have been classified in terms of the Factual Key (Northcote 1979), Great Soil Groups (Stace et al. 1968), and to the sub-group level in the new Australian Soil Classification (Isbell 1993).

A 'p' following the principal profile form (PPF) denotes soils that have an Ap horizon. All cultivated soils have an Ap horizon which is usually about 25cm thick but may be as thick as 40cm. In addition, deep ripping further disturbs horizonation and A horizon materials may occur as deep as 80cm. In many soils it is likely that deep cultivation has modified the original profile form to the extent that subsurface horizons such as A2, A3, and B1 have been destroyed. Where possible, the PPF from undisturbed sites has been recorded. For a number of soils there is no provision in the Great Soil Groups (Stace et al. 1968), and for others the classification is doubtful. The latter are identified by a question mark.

The classification given applies to the representative profile and the accompanying laboratory data. It may not necessarily apply to the range of soils that comprise an individual series.

Despite the intensive nature of agricultural industries in the region, any systematic investigation of the soil resource has been almost totally lacking until very recently. Previous soil survey information is limited to the reconnaissance mapping associated with the Atlas of Australian Soils (Isbell et.al.1968). Holz (1985) mapped part of the area in a land resource survey for the Mulgrave shire while Thompson and Cannon (1988) carried out a detailed soil survey of the coastal fringe north of the Barron River as part of a coastal management study. Wilson (1988) identified those soils suitable for tea production as part of a broader study. Numerous soil analyses have been conducted on samples to assist in farm fertilizer recommendations. These have not been collated and they would be of very limited value without a full history of the area from which they were taken and the identification of the soil within the framework of this soil survey. While there may at first glance appear to be major inconsistencies between the maps accompanying this report and those in Holz (1985) and Thompson and Cannon (1988), the differences are entirely consistent with the scale of the mapping and the time frame and method of survey. In addition, the authors of this report have had the benefit of establishing the soil framework and field relationship of the soils on a regional basis and were not constrained by the limited soil population examined by those authors.

The Environment

Climate

The climate is characterised by very humid summers and mild relatively dry winters. The mean annual rainfall over the survey area ranges from about 1900mm to over 4500mm although up to 9000mm has been recorded on Mount Bellenden Ker and this significantly higher figure probably applies to much of the Bellenden Ker Range. There is a relatively strong declining rainfall gradient from Deeral in the south to Cairns in the north as shown by the station records (Table 1) and sharp rainfall gradients are a feature of the area. The only supporting rainfall data for this comment are from the two Bellenden Ker stations. These stations are approximately five km apart and have an elevation difference of about 1470m. The rainfall at the top station is 75% greater than the low station. Altitude has the major influence on these stations as both have a similar aspect. Rain shadow effects are very noticeable in many areas as evidenced by the sharp changes in the vegetation communities. Some caution is required when trying to interprete rainfall patterns from the vegetation pattern. The major determinate for a rain forest community to persist is a soil with an adequate soil water regime and that may be determined by a number of factors such as parent material, depth to rock, amount of gravel and position on slope. The rainfall is strongly summer dominant although significant falls can occur (100mm/day) at any time of the year. The total rainfall is strongly influenced by intense tropical low pressure systems when very high recordings but often of a very localised nature may be recorded. The high winds associated with these low pressure systems may have a devastating effect on rural production particularly to the tree crops. At Cairns mean monthly temperatures range from a maximum of

32° C in January to a minimum of 16° C in July and August. The highest and lowest temperatures recorded are 43° C and 6° C respectively. Frosts have not been recorded at any of the recording stations although they will probably occur on some of the higher uplands as they are common on the adjacent Atherton Tableland. Climatic data for selected stations are given in Table 1.

Table 1. Climatic data for selected stations.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
CAIRNS A.M.O.													
MEAN RAINFALL	418	430	440	273	118	72	42	37	38	61	82	199	2208
TEMP. MAX.	32.1	31.6	30.6	29.4	27.6	26.1	25.7	26.5	28.1	29.8	31.1	32.0	29.2
TEMP. MIN.	23.4	23.3	22.5	21.1	19.0	17.5	16.2	16.2	17.7	19.7	21.4	22.7	20.0
%REL. HUM. 9am	74	77	79	79	77	75	73	71	65	64	66	69	72
%REL. HUM. 3pm	65	68	67	64	64	59	57	54	53	54	59	61	60
PAN EVAP.mm/day	6.0	5.8	5.2	4.5	3.8	3.4	3.7	4.3	5.0	5.7	5.9	6.1	4.9
PAN EVAP.	1788mm/YEAR												
MEAN RAINFALL													
BABINDA	663	737	816	514	346	209	133	108	123	110	175	294	4186
DEERAL	673	720	837	446	293	157	96	86	99	117	198	296	4019
GORDONVALE	389	402	457	220	103	46	27	28	30	49	87	156	1943
GARRADUNGA	688	689	762	447	368	210	151	113	96	95	139	280	3991
BELLENDER KER 1*	1085	1307	1259	1025	794	455	355	356	322	283	345	433	7748
BELLENDER KER 2	735	831	795	552	363	165	115	124	171	116	258	314	4452

*This station is at the summit of Mt. Bellender Ker.

Geology

The geology of the survey area has been recorded in the regional mapping of the Cairns and Innisfail 1:250 000 Sheet areas by joint parties of the Bureau of Mineral Resources and the Geological Survey of Queensland (Fardon & deKeyser, 1964; de Keyser, 1964). More recently Willmont et al. (1988) have mapped the Cairns region at a scale of 1:100 000 as part of a program to provide detailed geological information in areas where increasing urbanisation and industrialisation are occurring. Soil parent materials in the uplands include a range of granites, low grade metamorphics (which include some basic rocks) and minor basalt flows. The basalt flows have been the subject of numerous studies which are summarised in Stephenson and Griffin (1976).

The geomorphology of the lowland country is very complex. The uplands are surrounded by low angle alluvial fans, the distal end of which usually overlie riverine alluvium. The latter is usually of mixed origin and ranges from coarse sands to heavy clays and even peat and may be as thick as 100 metres. Muller (1968) describes in some detail the alluvial deposits and the development of the Mulgrave and Russell River drainage networks. The nature of the modern alluvium is dependent to some extent on the source of the material but the energy of the depositional environment is the major control. There are also extensive areas of freshwater swamps (Wyvuri, Ella Bay and Eubenangee), mangrove swamps (Admiralty Inlet, Sorensen Creek and Joyce Creek) and coastal beach ridges and dunes.

Vegetation

The vegetation of the area has been described by Tracey (1982). In simplistic terms there are four broad communities; mangrove forests, Eucalypt and Melaleuca forests and woodlands, and

vine forests. The mangrove forests are most extensive around Admiralty Inlet and Joyce Creek and to a lesser extent around the estuary of most minor streams and on sheltered sections of the coastline. The Eucalypt woodland and forests occur on the Little Mulgrave and Mulgrave Rivers and on the slopes of the Macalister Range; dominant upperstory species include narrow-leafed ironbark *(Eucalyptus drepanophylla)*, bloodwood (*E. intermedia*),stringy-bark (*E.acmenoides*), flooded gum *(E.grandis)* and an understorey of *Casaurina* and *Acacia* spp. The Melaleuca open forests and woodlands are dominated by *Melaleuca viridiflora* while the closed forests are predominantly *Melaleuca quinquenervia.* The diversity of the vegetation is due in part to soil nutrition but is largely a reflection of the soil water status and in some instances historical burning. Very little of the original vegetation remains on the lowland country. For some soils it is now impossible to determine the original vegetation.

Soil Series

The basis for the differentiation of soil series is with minor modification, the criteria specified in the Soil Survey Manual (Soil Survey Staff, 1980). Briefly, a series is a group of soils having horizons with essentially similar properties and arrangement in the profile. In the wet coast surveys the parent material and landform have also been used as differentia. With few exceptions series are confined to similar parent materials and landform. Factors such as significance in land use and ease of recognition and distinction from similar soils were also important criteria in the establishment of series. As much as is possible the aim was to simplify the complexity without comprimising the intregity of the mapping. Forty four of the fourty eight series described here were established in other survey areas or in earlier surveys of the region (Murtha 1986, 1989, Cannon Smith and Murtha 1992, Holz 1985, and Thompson and Cannon 1988). Correlation between surveys has allowed the maintenance of the original series central concept although those morphological characteristics more common to this survey are highlighted in the individual series description. Each soil series is defined by a detailed description of a single pedon (the pedon sampled for chemical analyses) and by then describing the range observed for the major properties of each horizon. A range is given only where the range observed over the survey area differs from that given in the representative profile. Chemical analysis has been carried out on selected profile samples. The most extensive series have been sampled along with the minor soils which are unique to this survey area. The soil series and mapping associations described in this report are listed in the Index.

The soil series have been placed in the seven groups used in the Tully-Innisfail area report (Murtha 1986). The groups are based on parent material or drainage status or both and serve as a simplified soil map depicting soils with generally similar agronomic constraints (Fig. 2).

Soil Mapping Units

The map units are associations of soil series and have been named after the dominant soil series. Unit purity varies considerably between unique map areas (UMA). Some of this variability is due to the difficulty of boundary delineation in cropped land (particularly pasture and sugar cane) where cultural practices can mask all evidence of soil change. More commonly, many soil series form part of a continuum in which soil changes are subtle and it is almost impractical to delineate soil boundaries at the map scale.

Use of map symbols

In an attempt to improve interpretation of the mapping, a deliberate system of single and multiple symbols has been adopted. For instance in the Mission association there are areas of almost pure Mission series - these are labelled Ms . Other areas may have Mission or Edmonton

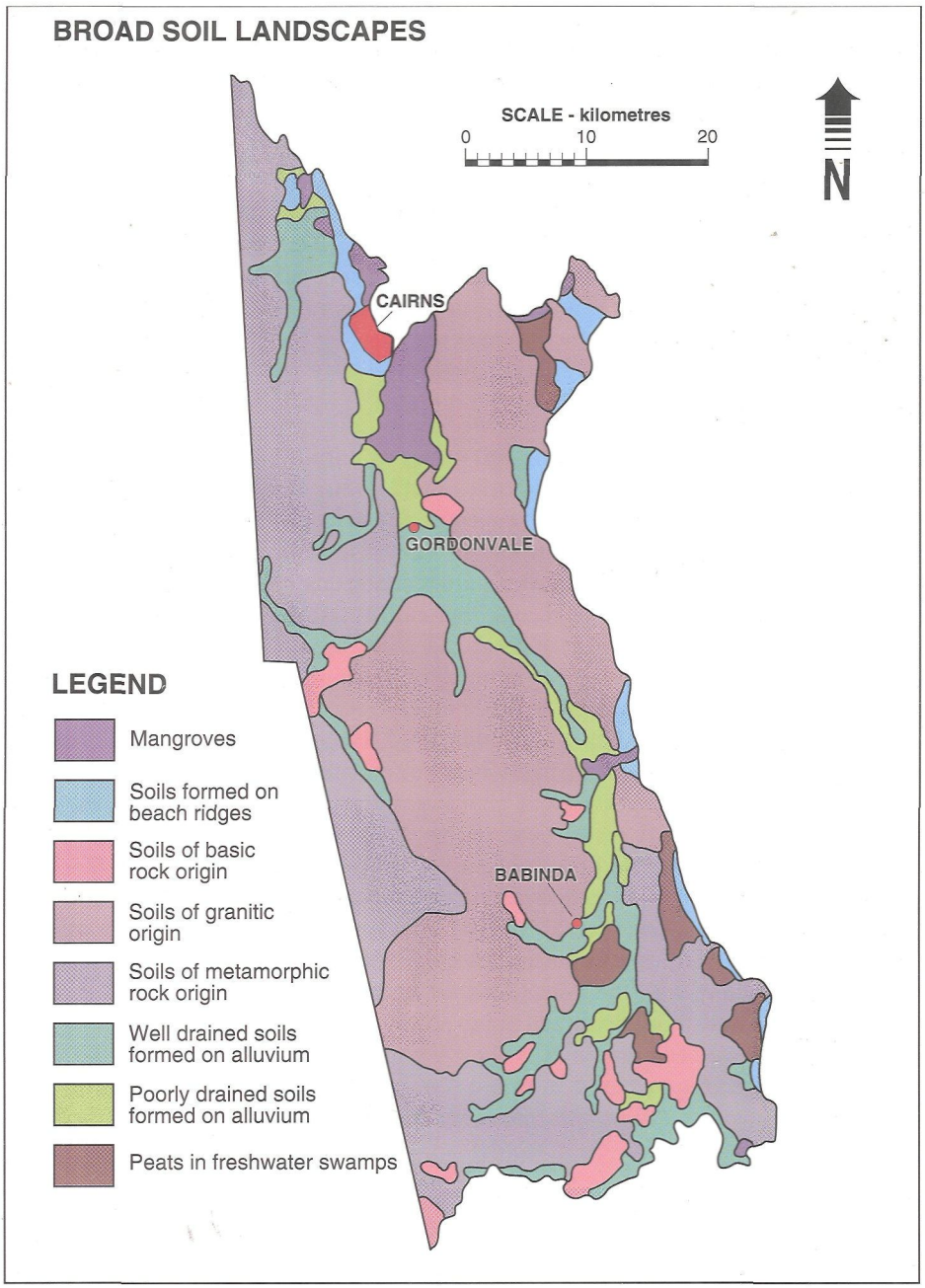


Figure 2. Generalised soil map

series as co-dominants - these are labelled Ms-Ed and Ed-Ms respectively. Two series in particular show a transition from one to the other rather than co-dominance. Canoe series is found to change from a yellow massive loamy to clayey subsoil with a sandy qualifier, to a yellow structured loamy to clayey subsoil with silty qualifiers of Tully series so a slash has been used to show this transition e.g. Cn/Tu. In addition, all these symbols may appear in the one UMA. The placement of the symbol is not arbitrary. The intention has been to place the symbol in the area of the UMA where the particular combination of soils occurs.

Solid and broken lines are used for the association boundaries. These are intended to give an indication of the confidence of boundary placement. Solid lines indicate a reasonable degree of confidance for the boundary placement, the longer the broken line the lower the confidence level.

SOILS FORMED ON BEACH RIDGES

The Malbon-Thompson, Graham, and Seymour Ranges form an almost continuous chain of mountains along the coastline. As a result the beach ridge systems are not well developed and are confined to a number of relatively small embayments. In addition the age and morphological sequences of soils are not as well represented as they are elsewhere on the wet coastal lowlands. In fact, without a prior knowledge of what to expect little order could be made of the fragmentary evidence in this area. The largest area of beach ridges is to the north and west of Trinity Inlet. All of this area is now part of Cairns suburbia and few inspections were made in this area.

Little evidence was found of the oldest ridges on which the very strongly developed podzols are formed. Thompson and Cannon (1988) identified and mapped a small area of Kaygaroo series behind Trinity Beach. Due to the urban development in the area, the presence of Kaygaroo series was not confirmed in this survey. Murtha (1986) provides a full description of Kaygaroo series. There are only minor areas of the older ridges on which the red and yellow earths have formed. One which occurs on the northern side of the Barron Delta has been considerably reworked and in part is overlain by fans from the adjacent metamorphic rock uplands. That is the only place where the beach ridge and depositional relationship has been established. The younger series of ridges and soils are reasonably well represented although there was limited access to many areas so ground inspections were sparse.

There has been some aeolian sorting and movement of the sands in the embayments between Cape Grafton and False Cape. Some embryonic crescent dunes are forming in this area and aeolian sheets overlie some of the upland soils. No attempt was made to fully characterise the soils in this area due to the difficult access.

Seven soil series have been recognised. Their major features are summarised in Table 2.

Table 2 Soils formed on beach ridges

SERIES	LANDFORM	MAJOR DISTINGUISHING FEATURES
TOOLAKEA	Frontal beach ridges	Minimal profile development beyond organic accumulation in the A horizon.
HULL	Beach ridges immediately behind frontal ridges	Very weakly developed podosol; A2 weakly developed or absent; no mottling or cementation in the B horizon
WONGALING	Beach ridges; usually immediately behind the Hull ridges	Well developed podosol: bleached A2; bright yellow and red B horizons: some cemented patches in the B horizon
GOOGARA	Older beach ridges	Deep sands with bleached A2 horizons and pale mottled B horizons
BROSNAN	Older beach ridges	Red uniform or gradational textured soils. massive B horizons
SPANOS	Older beach ridges	Yellow uniform or gradational textured soils. massive B horizons
NEEDEP	Swales or reworked beach ridge sands	Coarse sandy or loamy peat over coarse sand. Water-table is above the surface for much of the year.

HULL SERIES

CONCEPT: Very weakly developed podosol; A2 weakly developed or absent; no mottling or cementation in the B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	(Rudimentary Podzol)	Uc4.21	Fragic, Humosesquic, Aeric, Podosol

LANDFORM Beach ridge RAINFALL 2200mm
REFERENCE SITE Cairns 1:100 000 626419

Horizon	Depth m	
A1	0 to 0.15	Brown (7.5YR4/2); sandy loam ; weak 2-5mm cast; moist very weak; diffuse change to-
A2	0.15 to 0.55	Brown (7.5YR5/4); loamy sand; single grain; moist very weak; gradual change to-
B2hs	0.55 to 0.70	Brown (7.5YR5/2); sand; single grain; moist loose; diffuse change to-
B3	0.70 to 0.95	Brownish yellow (10YR6/6); sand; single grain; moist loose; diffuse change to-
BC	0.95 to 1.20	Pale brown (10YR6/3); sand; single grain; moist loose.

RANGE IN CHARACTERISTICS

A considerable area has been mapped as being dominated by this series but much of the it is not readily accessible and as a result very few observations have been made. This series will vary considerably in the degree of profile development and in particular in the degree of development of the B2hs or B2h horizons. These soils have formed on beach ridges and while there is a correlation between age of the ridge and degree of profile development, there is not necessarily any correlation between degree of development and the position of the ridge in relation to the present shoreline. In some places the beaches are rapidly aggrading while in other places there is active erosion of the frontal ridges. Where the latter situation exists the older soils in this series, i.e. those with well developed B2hs, horizons may occur on the foreshore. The B2hs horizon ranges from light brown (7.5YR6/4) to dark brown (7.5YR-10YR3/3) in colour. It is usually of loose consistence but may have some weakly coherent patches. It is never cemented. Weakly developed non-bleached A2 horizons may or may not be present and many soils have a paler rain-washed A11 above a darker A12 horizon.

ANALYTICAL DATA

The data below are from a profile sampled by Thompson and Cannon (1988).
Site No. C1 Map Reference Cairns 1:100 000 626419
HULL SERIES Sampled from *Acacia spp.* open woodland

Depth m	0-.10	.20-.30	.50-.60	.80-.90	1.10-1.20	1.40-1.50
Horizon	A1	A2	B2hs	B2hs	C1	C1
pH	5.3	5.3	5.5	5.7	5.8	5.7
E.C.dS/m^{-1}	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	0.53					
N%	0.03					
AvP ppm	4					
Tot.P%	0.005	0.003	0.003	0.003	0.003	0.004
Tot.K%	0.74	0.67	0.73	0.80	0.86	0.71
Tot.S%	0.003	0.002	0.001	<0.001	<0.001	<0.001
Exchange properties m.e./100 g soil						
Ca	0.08	<0.01	<0.01	<0.01	<0.01	<0.01
Mg	0.07	0.03	0.04	0.01	0.01	0.02
K	0.04	0.03	<0.03	<0.03	<0.03	<0.03
Na	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
CEC	2	1	1	<1	<1	5
Particle Size%						
CS	92	90	88	91	92	83
FS	6	8	8	7	7	15
SI	0.7	0.1	0.3	0.7	2	2
C	3	3	1	0.7	0.7	1
.33Bar %Water	3	2	2	2		1
15 Bar % Water	1	1	1	1		1

For methods see Bruce and Rayment (1982)

WONGALING SERIES

This soil was not described in detail or sampled in this survey area, the following is from the Tully-Innisfail report (Murtha 1986).

CONCEPT: Well developed podosol; bleached A2; bright yellow and red brown B horizons; some small cemented patches in B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Podsol	Uc2.2	Fragic, Humosesquic, Semiaquic, Podosol

LANDFORM Beach Ridge RAINFALL 3000mm
REFERENCE SITE Innisfail 1:100 000 040220

Horizon	Depth m	
A1	0 to 0.15	Dark grey (10YR4/1) (10YR6/2d); sand; single grain; dry loose; gradual change to-
A2	0.15-030/.80	Light grey (10YR7/2) (10YR8/2d); sand; single grain; dry loose; clear very irregular change to-
B2hs	0.30/.80 - 1.50	Brownish yellow (10YR6/6) with dark reddish brown (5YR3/2) and black (5YR2/1) mottles; sand; single grain; dry moderately weak, some darker mottles weakly cemented; diffuse change to-
C	1.50+	Very pale brown (10YR7/4) with 2-10%, distinct, yellowish brown (10YR5/8) mottles; sand; single grain; dry loose

RANGE IN CHARACTERISTICS

The variability in horizonation of these soils can only be seen in a section. Isolated auger holes will only give a confusing picture.

The thickness of the A2 horizon can vary from 40 to 150 cm. The boundary to the B horizon is irregular with a broad amplitude and there are no clearly defined tongues or pipes of A2 intruding into the B horizon as is common in some of the more strongly developed Podosols (eg Kaygaroo series).

B horizons tend to be more strongly developed where they occur shallow in the profile. The strength of cementation is always weak but the amount can vary from isolated patches in the upper part to an almost continuous band at the top of the B horizon.

ANALYTICAL DATA

This soil was not sampled in this survey area. The analytical data below are from the Tully-Innisfail report (Murtha 1986).

Profile T277 Map Reference Innisfail : 100 000 072466
WONGALING SERIES Sample site undisturbed Acacia-Tristania-Casuarina woodland

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.60	.60-.90	.90-1.20
Horizon	A11	A11	A12	B2hs	B2hs	BC	C
pH	4.8	5.0	5.1	5.2	5.4	5.5	5.7
E.C.dS/m^{-1}	.037	.022	.019	.017	.017	.015	.009
Org.C%	1.07		.54	.48	.33		
N%	.03		.02	.03			
AvP ppm	7	5	5	8			
Tot.P%	.006					.002	
Tot.K%	.12					.10	
Tot.S%	.018					.003	
Free Fe%	.04	.23	.27	.22			
Exchange properties m.e./100g soil							
Ca	1.11		.30	.06			
Mg	.48		.08	.01			
K	<.01		<.01	<.01			
Na	.02		.01	<.01			
H+Al	.64		1.30	.92			
ECEC*	2.26		1.70	1.01			
CEC**	3.0		1.8	.8			
Particle Size %							
Gr	tr	tr	tr	2	2	2	2
CS	88		93	93		90	93
FS	8		4	5		9	6
SI	2		1	1		0	0
C	2		2	1		1	1

* sum of basic and acidic cations ** Comp. Exch

TOOLAKEA SERIES

CONCEPT: Uniform sand with minimal profile development beyond organic accumulation in the A horizon

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Siliceous sand	Uc1.21	Basic, Siliceous,Arenic, Rudosol
LANDFORM	Frontal beach ridge	RAINFALL 3000mm	
REFERENCE SITE	Cooper Point 1:100 000 006688		

Horizon	Depth m	
A1	0 to 0 15	Greyish brown (10YR5/2); sand; single grain; moist and dry loose; diffuse change to-
B/C	0.15 to 0 60	Pale brown (10YR6/3); sand; single grain; moist loose; 2-10%, 20-60mm, rounded pumice; diffuse change to-
C	0.60 to 1.20+	Light yellowish brown (10YR6/4); sand; single grained; moist loose.

RANGE IN CHARACTERISTICS

Too few inspections were made to give any range however it is not expected that any profiles would differ significantly from that described above. Some profiles may contain shell or coral fragments and pumice may occur on the surface or in bands through the profile.

ANALYTICAL DATA

The data below are from a profile sampled by Thompson and Cannon (1988).
Site No. C4 Map Reference Cairns 1:100 000 626421
TOOLAKEA SERIES Sampled from *Casuarina spp.* low open woodland.

Depth m	0-.10	.20-.30	.50-.60	.80-.90	1.10-1.20	1.40-1.50
Horizon	A1	C1	C1	C1	C1	C2
pH	6.7	7.0	7.1	7.6	8.3	8.2
E.C.dS/m^{-1}	0.01	0.02	0.01	0.02	0.03	0.53
T.C. %	0.16					
N%	0.02					
AvP ppm	4					
Tot.P%	0.005	0.004	0.005	0.004	0.004	0.004
Tot.K%	1.27	1.50	1.21	1.15	1.20	1.17
Tot.S%	0.003	0.001	0.001	0.001	0.001	0.004
Exchange properties m.e./100 g soil						
Ca	0.40	0.40	2.60	0.24	0361	0.42
Mg	0.15	0.11	0.12	0.04	<0.02	0.63
K	<0.03	<0.03	<0.03	<0.03	<0.03	0.07
Na	<0.01	<0.01	<0.01	<0.01	<0.01	1.9
CEC	1	1	1	<1	<1	1
Particle Size%						
CS	94	95	96	96	96	94
FS	6	5	3	4	3	5
SI	2	3	3	3	3	3
C	7	2	1	1	2	2
.33Bar %Water		11	0.5	0.5		1
15 Bar %Water	0.4	0.3	0.3	0.3		0.5

For methods see Bruce and Rayment (1982)

BROSNAN SERIES

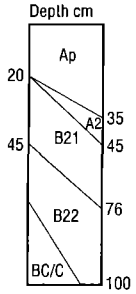
CONCEPT Red soils on beach ridges.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Red Earth	Gn2.1p	Acidic, Dystrophic, Red, Kandosol
LANDFORM	Beach ridge	RAINFALL 3000mm	
REFERENCE SITE	Bartle Frere 1:100 000 932802		

Horizon	Depth m	
Ap1	0 to 0.15	Brown (7.5YR4/2); sandy loam; massive; moist moderately weak; gradual change to-
Ap2	0.15 to 0.35	Brown (7.5YR4/3); sandy clay loam (light); massive; moist moderately weak; clear change to-
B21	0.35 to 0.75	Yellowish red (5YR4/6); sandy light clay; massive; moist moderately weak; diffuse change to-
B22	0.75 to 1.20	Yellowish red (5YR5/8); sandy medium clay; massive; moist moderately weak.

RANGE IN CHARACTERISTICS



Ap Very dark grey (10YR3/1) to brown (7.5YR4/2); loamy sand to sandy loam
A2 Brown (7.5YR4/4);loamy sand; massive; moist moderately weak
B21 Yellowish red (5YR4-5/6-8);loamy sand to sandy light clay
Only very small areas of this soil occur and no undisturbed sites were examined.
Principal profile forms encountered include Gn2.1p and Uc4.21.

ANALYTICAL DATA

Brosnan series was not sampled in this survey area. The data below are from the Tully-Innisfail report (Murtha 1986).
Profile T284 Map Reference Innisfail 1:100 000 990523
BROSNAN SERIES Site is cleared, probably cultivated at some stage.

Depth m	0-.10	.10-.20	.20-.30	.30-.60	.60-.90	.90-1.20	1.20-1.50	1.50-1.80	1.80-2.10
Horizon	A1	A2	A2	B1	B2	B2	B2	B3	B3
pH	5.4	5.3	5.0	5.1	5.0	5.0	5.0	4.6	5.2
E.C.dS/m^{-1}	.023	.023	.059	.023	.020	.017	.020	.098	.020
Org.C %	1.11	.86			.23				
N%	0.09	.07			.02				
AvP ppm	13	9	10	6	2	2			
Tot.P%	0.022				0.017				
Tot.K%	.28				.48				
Tot.S%	0.020				0.017				
Exchange properties m.e./100 g soil									
Ca	.12	<.02			<.02				
Mg	.34	.01			<.01				
K	.10	.08			.06				
Na	.04	.04			.04				
H+Al	2.00	.59			.56				
ECEC*	2.60	.74			2.9				
ECEC/100g Clay	23.6	4.9			2.9				
CEC**	3.0	1.6			2.2				
CEC/100g C.**	27.3	10.7			9.2				
Base Sat***	20	9			6				
CEC****	1.4	1.4			1.6				
Particle Size%									
GR.	2	2	2	2	2	2	2	5	7
CS	72	64	64	58	57		67		68
FS	14	16	19	14	15		11		10
SI	3	5	4	4	5		5		3
C	11	15	18	24	24		18		19

	Depth cm	ChV%	I %	Ka %	G %
Mineralogy of	15-30	5-10	5-10	30-40	50-65
the clay fraction	60-90	5-10	5-10	30-40	50-65

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$ ** NH_4 OAc **** Comp. Exch

SPANOS SERIES

CONCEPT: Yellow soils on beach ridges

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Earthy Sand	Uc4.21	Acidic, Regolithic Orthic, Tenosol

LANDFORM Beach Ridge RAINFALL 2725mm
REFERENCE SITE Cairns 1:100 000 814278

Horizon	Depth m	
A1	0 to 0.12	Dark greyish brown (10YR4/2); sand; single grain; dry loose; gradual change to-
A2	0.12 to 0.32	Yellowish brown (10YR5/4); sand; single grain; dry loose; diffuse change to-
B2	0.32 to 0.80	Brownish yellow (10YR6/5); sandy loam; moist weak; diffuse change to-
B3	0.80 to 1.25	Brownish yellow (10YR6/5) with 2-10%, 5-15mm, distinct reddish yellow (5YR6/6) mottles; sandy loam; moist moderately weak; diffuse change to-
BC	1.25 to 1.65	Olive yellow (2.5Y6/6) with 2-10%, 5-15mm, faint light grey (10YR7/2) mottles; loamy sand; moist weak

Only small areas of this soil occur in the survey area and no virgin sites were described. The sites described differ little from the profile described above. The heavy textured and the dark surface variants described in the Cardwell-Tully and the Mossman- Cape Tribulation surveys were not observed.

ANALYTICAL DATA

Spanos series was not sampled in this survey area. The data below are from the Tully-Innisfail report (Murtha 1986).
Profile T282 Map Reference Innisfail 1:100 000 998545
SPANOS SERIES Cultivated site, under cane for 50+ years.

Depth m	0-.10	.10-.20	.20-.30	.30-.40	.40-.60	.60-.90	.90-1.20	1.20-1.50
Horizon	Ap	Ap	Ap	Ap	B2	B2	BC	C
pH	5.8	5.2	5.2	5.1	5.3	5.0	5.1	5.1
E.C.dS/m^{-1}	.017	.017	.029	.020	.020	.023	.017	.023
Org.C%	.59	.65		.53		.25		
N%	.06			.05		.04		
AvP ppm	41	42				16		
Tot.P%	.027					.014		
Tot.K%	.12					.17		
Tot.S%	.010					.006		
Free Fe%	.15		.21		.23	.15		.03
Exchange properties m.e./100g soil								
Ca	.85	.12		.02		.02		
Mg	<.01	<.01		<.01		<.01		
K	.05	.05		.05		.06		
Na	.04	.03		.04		.04		
H+Al	2.40	.76		.84		1.60		
ECEC*	3.35	.97		.96		1.73		
ECEC/100g Clay	67.0	19.4		10.7		17.3		
CEC**	1.2	.9		.8		1.8		
Particle Size %								
Gr	2	4	5	4	4	8	4	5
CS	79	78	79	75	77	73		72
FS	13	13	10	13	10	14		13
SI	3	3	3	3	3	3		4
C	5	5	8	9	10	10		11

* sum of basic and acidic cations ** Comp. Exch

NEEDEP SERIES

CONCEPT: Coarse sandy or loamy peat over coarse sand.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	? Peaty podzol	Uc5.11	Peaty, Homosesquic, Semiaquic, Podosol

LANDFORM Beach ridge (swale) RAINFALL 2200mm
REFERENCE SITE Cairns 1:100 000 842313

Horizon	Depth m	
A1	0 to 0.22	Black (10YR21); coarse sandy fibric peat; massive; wet very friable very fibrous and many fine roots; gradual change to-
A3/B1	0.22 to 0.35	Dark greyish brown (10YR3/2); loamy sand; single grain; wet loose; gradual change to-
?B2	0.35 to 0.70+	Dark brown (10YR4/3); loamy sand; single grain; wet loose;.

Note; .06m of water on the surface at the time of inspection. Weak sulphide smell from about 0.40m. Only one profile was described so no range can be given.

Acid sulphate materials or potential acid sulphate materials almost certainly underlie these soils. The analytical data presented below suggests that weak acid sulphate conditions occur in that soil (Tot.S% at 0.60-0.90m = 0.12% and pH very acid at 3.6) although there is limited field evidence.

ANALYTICAL DATA

Needep series was not sampled in this survey area. The data below are from the Tully-Innisfail report (Murtha 1986).
Profile T276 Map Reference Innisfail 1:100 000 050466
NEEDEP SERIES Sample site undisturbed. Melaleuca quinquenervia heath

Depth m	0-.10	.10-.20	.20-.30	.30-.60	.60-.90
Horizon	A1	A1	A3	B	B
pH	4.1	4.4	4.7	4.4	3.6
E.C.dS/m^{-1}	.28	.086	.037	.059	.235
Org.C %	23.0	9.89	2.60	2.22	
N%	.95	.26	.05	.03	
Loss Ign%	57.8				
AvP ppm	40	15	12	3	
Tot.P%	.030				<.001
Tot.K%	.78				1.16
Tot.S%	.320				0.120
Free Fe%	.17	.01	<.01	<.01	.04
Exchange properties m.e./100 g soil					
Ca	.91		<.01	<.01	
Mg	.78		<.01	<.01	
K	1.48		<.01	<.01	
Na	.31		.02	.06	
H+Al	1.30		.92	.92	
ECEC*	4.78		.97	1.01	
ECEC/100g Clay	22.8		19.4		
CEC**	2.6		1.5	0.6	
Particle Size%					
GR.	0	*tr*	*tr*	*tr*	*tr*
C.S.	36	78	88	91	97
F.S.	17	9	6	5	2
S.I.	26	7	4	3	1
C.	21	6	5	1	1

* sum of basic and acidic cations ** Comp. Exch

GOOGARRA SERIES

CONCEPT: Deep sands with bleached A2 horizon and pale, mottled, B horizons.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Siliceous sand	Uc2.2	Melacic, Sesquic, Semiaquic, Podosol

LANDFORM Beach ridge RAINFALL 2200mm
REFERENCE SITE Cairns 1:100 000 615407

Horizon	*Depth m*	
A1	0 to 0.35	Very dark grey (10YR3/1); loamy sand; single grain; dry loose;
A2	0.35 to 0.60	Light yellowish brown (10YR6/4); light brownish grey (10YR6/2) mottles; sand; single grain; moderately moist very weak;
B2s	0.60 to 1.00	Very pale brown (10YR7/3); greyish brown (10YR5/2) mottles; sand; single grain; moist very weak;
C	1.00 to 1.20	Light grey (10YR7/2); sand; single grain; moist very weak.

Only one profile was described in this survey area so range in characteristics cannot be given. This series is of minor importance and was not sampled.

MAPPING UNITS – SOILS FORMED ON BEACH RIDGES

HULL ASSOCIATION Hu 50 UMAs 4924ha.

This is the most widespread unit on the beach ridges. The largest area is in Cairns city where the soils are all highly disturbed and few inspections could be made. Likewise the occurrences on the beaches to the north of Cairns have been highly disturbed.

The only reasonably pristine area which is accessible is in the Bramston Beach embayment. Here, Toolakea series occupies the first two or three ridges and Hull series the remainder. Hull series exhibits the classical increasing degree of profile development with the age of the beach ridge. The range is from soils with pale brown incipient B2h horizons to soils with very dark brown (almost black) B2h horizons. A2 horizons are usually present but only weakly developed. Wongaling series may occur particularly on the inland extremity of the UMA in the Cairns city area but it was not observed. Holloway series occurs in the swales in the Cairns and northern beach areas while Needep series may occur in the swales in the Bramston and Ella Beach areas.

In the U.M.A. mapped at Trinity Beach there is a small area of what may have been Kaygaroo series (Murtha 1986) but the soils have been so modified by urban development that it is difficult to be certain. The very small inland ridge at Ella Bay is also Kaygaroo series. It has been included in this association as it is the only definite occurrence in this survey area

BROSNAN ASSOCIATION Br 6 UMAs 226ha.

This association is of minor importance and has been mapped in three locations, Smithfield, Bramston Beach and Innisfail North. Much of the area to the north of the Barron Delta around Smithfield has been reworked by small streams from the adjacent uplands and is in part overlain by fans derived from the adjacent metamorphic uplands. Recent urban development has almost destroyed evidence of the ridges in this area. The presence of these ridges was not recognised in the mapping by Jones (1985).

The Bramston Beach occurrence consists of one low ridge almost completely surrounded by peat swamps. Brosnan series is dominant but most of the UMA is surrounded by a narrow band of the yellow Spanos series where there is prolonged shallow ground-water.

There may be some doubt about the area mapped at Innisfail North being of beach ridge origin. Obviously to be so they have had to have formed while the Moresby Range was an island and before the spit forming ridges of the Mourilyan area cut off wave action to this area. It is a very uniform area of red earths similar in morphology to the Brosnan series to the east of Martyville. Only deep drilling and determination of the stratigraphic relationship will confirm the origin.

SPANOS ASSOCIATION Sp 3 UMAs 127ha.

Only three small beach ridges have been mapped in this association. The largest occurs in the Smithfield area where it occupies the lower part of what is dominantly a Brosnan ridge. Recent urban development has destroyed most of the evidence of this area. Yellow sands occur on the low ridge inland of the Yarrabah settlement and in the embayment to the south of Bramston Beach. The yellow sands of Spanos series were the only soils observed in these occurrences.

GOOGARA ASSOCIATION Go 2 UMAs 124ha.

This unit occurs inland of Half Moon Bay. It is of minor significance and the soils have been highly modified by urban development. The heavy textured soils of Holloway series occurred in the swales but have been buried by land levelling operations. Jones (1985) mapped this unit and one of the Brosnan UMA's as Pleistocene beach ridges. As he described them as

deposits of quartzose sand it is assumed he was describing Googara series and not the red Brosnan series. In the Hull River eustary where these soils were first described, Googara series occurs inland of and must therefore be older than Brosnan series. The relationship is difficult to establish in this area as the remnants of the ridges are fragmented and highly disturbed.

WONGALING ASSOCIATION Wo 5 UMAs 23ha.

This association has been mapped on one small ridge in the southern portion of Ella Bay and on the low ridges occurring in the mangroves of Trinity Inlet. The latter were not examined and the mapping is based on profile remnants examined on a small ridge developed for aqua-culture

NEEDEP ASSOCIATION Ne 3 UMAs 260ha.

This association has been mapped in the low lying corridor between Cape Grafton and Grant Hill. Access was gained only at one point where the soil was difficult to examine due to surface water. Fibric or Sapric peats similar to Nind or Sumalee series probably occur towards the centre of the larger UMA.

MISCELLANEOUS UNIT M7 2 UMAs 675ha.

This unit includes the embryonic parabolic dunes that have formed in the corridors between Cape Grafton, Grant Hill, and the Murray Prior Range. Access was only gained to one point where it was clear that there had been aeolian sorting of the sand. At the time of inspection the sands were dry and they were impossible to auger but the little evidence available suggests they are pipey podosols similar to Kaygaroo series (Murtha 1986). They have strongly bleached A2 horizons at least four metres thick. Where the sands have blown over the upland soils, a very intricate B2hs horizonation occurs in bands less than one cm thick. Jones (1985) has mapped these as Pleistocene dunes and that maybe so as they have a much higher elevation (up to 40m) than any other sand ridges.

SOILS OF BASIC ROCK ORIGIN

Soils in this group have formed in situ, on alluvial fan materials derived from basic rocks, and on small alluvial plains in the basalt province. The basic rocks include basalt and amphibolite which is a weakly metamorphosed basic rock interbedded in the Hodgkinson Formation. It is only in the cultivated lands that the latter can be readily identified so a number of occurrences may be included in the metamorphic rock soil landscapes. Bingil series has formed insitu on the amphibolite while Kimberley series is formed on local fans associated with the amphibolite.

The largest extent of basalt is in the Upper Daradgee- Garradunga area. Here the basalt is from three distinct sources and is on three levels but these levels are not easy to distinguish. On the lower level are the older basalts (having a minimum age of 3.3 m.y. Stephenson pers. com.) which are part of the Mena Creek surface, the source of which is unknown but is most probably an older flow from the Atherton Tablelands. The mid-level is the end of the flow that originated on the Atherton Tablelands dated at 1.6 m.y. (Stephenson and Griffin 1976). The higher basalts are the younger vents and the limited flows associated with those vents. Warramami Hill and an un-named hill to the north east of Garradunga are the most prominent of the younger vents. These younger vents and those to the north have been dated at between 0.8 and 1.0 m.y. (Stephenson and Griffin 1976).

The basalts in the Russell and Mulgrave Valleys are clearly part of flows from the Atherton Tablelands and that is probably also the source of the small area along Babinda Creek. Green Hill is the only younger vent in the northern part of the survey area. The small area at Meringa is probably from a subsidiary vent about the same age as Green Hill. The parent material for the small area of soils mapped as Pin Gin series to the south of Hervey Creek is unknown. The soils appear to be of basaltic origin but they may have formed on amphibolite. There are some unmapped metamorphics upslope of this unit so they may be interbedded volcanics or alternatively it could be an outlier of the Babalangee amphibolite which has been mapped along the Graham Range which is just across the Russell River from this point.

Six soil series have been identified. Their major morphological features are summarised in Table 3.

Table 3. Soils of basic rock origin

SERIES	LANDFORM	MAJOR DISTINGUISHING FEATURES
PIN GIN	Undulating rises to Rolling low hills	Very deep, red, strongly structured soils, uniform or gradational texture profiles
EUBENANGEE	Gently undulating rises	Red, gradational texture profiles, massive B1 over structured B2, ferruginous or lateritic gravels throughout
BINGIL	Rolling low hills to Steep hills	Strongly structured, dark red, gradational or uniform textured soils formed on interbedded basic volcanics.
MENA	Rolling low hills to Rolling hills	Grey or grey brown uniform textured clay soils
GARRADUNGA	Alluvial plain	Red, gradational or uniform texture profiles, strongly structured B horizons
KIMBERLEY	Alluvial fan	Red, gradational or uniform texture profiles, strongly structured B horizons, may be gravelly throughout

PIN GIN SERIES

CONCEPT: Red gradational textured soils formed on basalt.

REPRESENTATIVE PROFILE

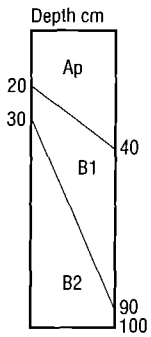
	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Krasnozem	Gn3.11	Haplic, Dystrophic, Red, Ferrosol

LANDFORM Low hills RAINFALL 3990mm
REFERENCE SITE Cooper Point 1:100 000 954706

Horizon	Depth m	
Ap1	0 to 0.15	Dark reddish brown (2.5YR3/4); clay loam; weak 10-20mm subangular blocky; moist moderately weak; 2-10% 60-200mm, rounded basalt gravel; <2% 2-6mm manganiferous concretions; common 1-2mm roots; diffuse change to-
Ap2	0.15 to 0.30	Dark reddish brown (2.5YR3/4); light clay; weak 10-20mm subangular blocky; moist moderately firm; 2-10% 2-6mm manganiferous concretions; few 1-2mm roots; diffuse change to-
B1	0.30 to 0.60	Dark reddish brown (2.5YR3/4); light clay (heavy); weak 10-20mm subangular blocky; moist moderately firm; few 1-2mm roots; diffuse change to-
B21	0.60 to 0.90	Dark reddish brown (2.5YR3/4); medium heavy clay; moderate 5-10mm angular blocky; moist very firm; few 1-2mm roots; diffuse change to-
B22	0.90 to 1.65	Dark reddish brown (5YR3/4); heavy clay; strong 2-5mm polyhedral; moderately moist moderately strong

NOTE: ON BASALT GRAVEL AT 1.65m.

RANGE OF CHARACTERISTICS



Ap Dark reddish brown (2.5YR3/4) to yellowish red (5YR4/5); clay loam; weak to moderate 5-20mm subangular blocky or cast;

B1 Dark reddish brown (2.5YR3/4- 5YR3/4);weak to moderate 2-10mm subangular blocky;

B2 Dark reddish brown (2.5YR3/4) to yellowish red (5YR4/6); moderate to strong 2-10mm subangular blocky or polyhedral; occasionally have 2-10% 2-6mm ferromanganiferous nodules; some soils are gravel free to depths in excess of 20m

Principal profile forms encountered include Gn3.11 and Uf6.31. The Uf forms occur only in cultivation and are a result of mixing during cultivation and in some areas as a result of the loss of A horizons by erosion.

ANALYTICAL DATA

Profile T490 Map Reference Cooper Point 954706
PIN GIN SERIES Sampled from an area cultivated for sugar cane

Depth m	0-.15	.15-.30	.30-.60	.60-.90	.90-1.20	1.20-1.65
Horizon	Ap1	Ap2	B1	B21	B22	B22
pH	5.3	4.9	5.2	5.1	4.9	4.9
E.C.dS/m^{-1}	.080	.040	.018	.018	.021	.024
Org.C%	2.76	1.94	.70	.57		
N%	.10	.08	.02	.02		
AvP ppm	14	6	6	9		
Tot.P%	.210		.200	.220		
Tot.K%	.08		.03	.02		
Tot.S%	.090		.140	.130		
Free Fe%	10.2	10.4	10.3	10.9	12.7	13.7
Exchange properties m.e./100g soil						
Ca	.32		.07	.07		.07
Mg	.38		.07	<.02		.02
K	.27		.02	.02		.02
Na	.04		.02	<.02		<.02
H+Al	.03		.12	.15		.02
ECEC*	1.0		.3	.3		.2
ECEC/100g Clay	2.0		.5	.5		.4
CEC**	3.9		1.1	.9		.7
CEC/100g C.**	7.6		1.8	1.6		1.4
Base Sat***	26		10	11		17
CEC****	1.4		.5	.3		.2
Particle Size %						
Gr	0	2	0	0	2	2
CS	8	6	6	4	2	1
FS	5	5	4	5	6	8
SI	36	35	30	33	42	40
C	51	54	60	55	50	50

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** NH_4 OAc **** Comp. Exch

MENA SERIES

CONCEPT: Grey or grey brown uniform clay soils formed on basalt.

REPRESENTATIVE PROFILE

		G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION		Affinities with Prairie Soil	Uf6.32	Haplic, Selfmulching, Black, Vertosol
LANDFORM	Hilly	RAINFALL 2500mm		
REFERENCE SITE	Bartle Frere	1:100 000 652013		

Horizon	Depth m	
A1	0 to 0.15	Very dark brown (10YR2/2); light medium clay; strong 2-5mm subangular blocky; moist moderately firm; 10-20% 60-200mm, rounded basalt gravel; common 2-5mm roots; diffuse change to-
B1	0.15 to 0.32	Very dark greyish brown (10YR3/2); medium heavy clay; strong 2-5mm subangular blocky; moist moderately firm; few 1-2mm roots; diffuse change to-
B21	0.32 to 0.50	Very dark grey (10YR3/1); heavy clay; moderate 5-10mm angular blocky; moderately moist moderately strong; diffuse change to-
B22	0.50 to 0.95	Very dark grey (10YR3/1); heavy clay; moderate 5-10mm angular blocky; moderately moist moderately strong; gradual change to-
C	0.95 to 1.05+	Weathered grey vesicular basalt.

This soil was found to occur in only one small area of strongly dissected basalt country along the Goldsborough Road. Only one profile was described in detail so no range can be given for the major properties. The profile above was described on an 18% slope. On steeper slopes the solum is much thinner with weathered parent material occurring from as shallow as 30cm. Rock outcrop and boulders to 40cm size are common on the steeper slopes.

ANALYTICAL DATA

Profile T483 Map Reference Bartle Frere 1:100 000 652013
MENA SERIES Cleared, pasture, probably never cultivated

Depth m	0-.15	.15-.32	.32-.50	.50-.95	.95-1.05
Horizon	A1	B1	B2	B2	C
pH	7.0	7.0	7.0	6.5	6.2
E.C.dS/m^{-1}	.077	.058	.026	.014	.014
Org.C%	3.49	0.86	0.46	0.32	
N%	.17	.05	.03	.02	
AvP ppm	308	64	78	150	
Tot.P%	.290		.130		
Tot.K%	1.44		0.19		
Tot.S%	.050		.010		
Free Fe%	4.3	4.1	3.5	3.1	
Exchange properties m.e./100g soil					
Ca	31.4	24.1	21.2	18.3	
Mg	7.92	16.2	22.1	18.3	
K	1.10	0.44	0.33	0.30	
Na	.02	.02	.03	<.02	
H+Al	.10	.10	.02	.81	
ECEC*	40.5	40.9	43.7	44.8	
ECEC/100g Clay	96.4	75.7	91.0	112	
CEC**	46.8	45.0	50.5	50.6	
CEC/100g C.**	111.4	62.6	105.2	126.5	
Base Sat***	86	93	86	87	
CEC****	26.3	40.9	34.6	39.5	
Particle Size %					
Gr	13	1	0	0	0
CS	9	7	10	12	21
FS	12	13	17	21	21
SI	37	27	25	28	30
C	42	54	48	40	28

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$ ** NH_4 OAc **** Comp. Exch

EUBENANGEE SERIES

CONCEPT: Red gradational textured soils formed on basalt, often weakly lateritised.

REPRESENTATIVE PROFILE

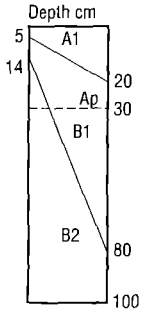
	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Krasnozem	Gn3.11	Haplic, Dystrophic, Red, Ferrosol

LANDFORM Low hills RAINFALL 3990mm
REFERENCE SITE Bartle Frere 1:100 000 920690

Horizon	Depth m	
A1	0 to 0.14	Dark red (2.5YR3/6); clay loam (heavy); strong 2-5mm cast; moist moderately firm; 2-10% 2-6mm ferruginous concretions; abundant 2-5mm roots; diffuse change to-

B1	0.14 to 0.40	Red (2.5YR4/6); light clay; moderate 2-5mm granular; moist moderately weak; <2% 2-6mm, rounded basalt gravel; 2-10% 2-6mm ferromanganiferous concretions; common 2-5mm roots;
B1	0.40 to 0.80	Red (2.5YR4/6); light clay; massive; moist moderately firm; .2% 2-6mm, rounded basalt gravel; 2-10% 2-6mm ferromanganiferous concretions; common 1-2mm roots; diffuse change to-
B21	0.80 to 1.10	Red (2.5YR4/6); light medium clay; weak 5-10mm angular blocky; moist moderately firm; 10-20% 6-20mm, subrounded basalt gravel; 2-10% 2-6mm ferromanganiferous concretions; few 1-2mm roots; diffuse change to-
B22	1.10 to 1.40	Red (2.5YR4/6); medium clay; moderate 5-10mm angular blocky; moist very firm; 10-20% 6-20mm, subrounded basalt gravel; 2-10% 2-6mm ferromanganiferous concretions; diffuse change to-
B23	1.40 to 1.66	Yellowish red (5YR4/6); medium clay; strong 5-10mm angular blocky; moist moderately strong; 2-10% 6-20mm, subrounded basalt gravel; 2-10% 2-6mm ferromanganiferous concretions

RANGE OF CHARACTERISTICS



Ap Dark red (2.5YR3/6);light clay; massive; moderately firm moist; 2-10% 2-6mm ferruginous concretions.
B1 Dark reddish brown to red (2.5YR3-4/4-6);light clay to light medium clay.
B2 Dark reddish brown to red (2.5YR3-4/4-6);light medium to medium clay; often moderately subplastic.

Principal profile forms encountered include Gn3.11, Uf6.5p and Uf6p.

ANALYTICAL DATA

Profile T 489 Map Reference Bartle Frere 1:100 000 920690
EUBENANGEE SERIES Sampled from rainforest

Depth m	0-.14	.14-.40	.40-.80	.80-1.10	1.10-1.40	1.40-1.66
Horizon	A1	B1	B1	B21	B22	B23
pH	4.7	4.7	5.0	5.1	5.2	5.1
E.C.dS/m^{-1}	.208	.070	.027	.021	.014	.014
Org.C%	5.92	2.91	.83	.61		
N%	.08	.13	.03	<.02		
AvP ppm	33	14	13	21	25	
P Retn.%	58					
Tot.P%	.460		.460		.590	
Tot.K%	.13		.05		.05	
Tot.S%	.090		.130		.160	
Free Fe%	12.0	14.6	13.9	19.4	19.8	
Exchange properties m.e./100g soil						
Ca	1.93		0.16		0.12	
Mg	.98		.13		.16	
K	.44		.04		.02	
Na	.09		.04		.05	
H+Al	.56		.02		.13	
ECEC*	4.0		0.4		0.5	
ECEC/100g Clay	7.5		.6		.8	
CEC**	14.3		2.8		2.5	
CEC/100g C.**	27.0		4.9		4.0	
Base Sat***	24		13		14	
CEC****	3.1		.5		.2	
Particle Size %						
Gr	4	3	5	26	7	9
CS	15	12	12	34	25	15
FS	8	9	10	9	5	5
SI	24	18	10	7	7	6
C	53	61	68	50	63	74

* sum of basic and acidic cations *** $\frac{\text{Bases}}{\text{NH}_4\text{ OAc CEC}} \times 100$ ** NH_4 OAc **** Comp. Exch

BINGIL SERIES

CONCEPT: Strongly structured dark red gradational or uniform textured soils formed on interbedded basic volcanics.

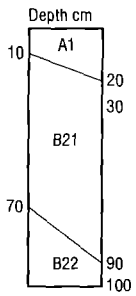
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Krasnozem	Uf6.31	Haplic, Dystrophic Red, Ferrosol

LANDFORM Low hills RAINFALL 3200mm
REFERENCE SITE Bartle Frere 1:100 000 901832

Horizon	Depth m	
A	0 to 0.20	Brown (7.5YR4/4); light clay; moderate 2-5mm cast; moderately moist moderately firm; 20-50% 60-200mm, subrounded amphibolite gravel; diffuse change to-
B21	0.20 to 0.90	Red (2.5YR4/8); medium clay; moderate 5-10mm polyhedral; moist moderately firm; 10-20% 60-200mm, subrounded amphibolite gravel; diffuse change to-
B22	0.90 to 2.50	Dark red (2.5YR3/6); medium clay; strong 2-5mm polyhedral; moist moderately firm; 10-20% 60-200mm, subrounded amphibolite gravel.

RANGE OF CHARACTERISTICS



A1 Brown (7.5YR4/4) to reddish brown (5YR4/4); clay loam to light clay (up to medium clay in some Ap horizons).

B2 *Red (2.5YR4/8) to dark red (2.5YR3/8); light medium clay to heavy clay; moderate to* strong fine blocky or polyhedral; may be gravel free.

BC Solum thickness is commonly 2-3m but shallow gravelly soils are common on very steep slopes.

Morphologically these soils are very similar to the Pin Gin series formed on basalt. Chemically they are also probably very similar. The one Bingil profile analysed has a significantly higher cation status than the Pin Gin soils that have been analysed but that can possibly be attributed to the fact that it was a much shallower profile on an erosional surface and has not been as strongly leached.

Principal profile forms encountered include Uf6.31 and Gn3.11.

ANALYTICAL DATA

This series was not sampled in this survey area. The following data are from the Tully Innisfail area (Murtha 1986).
Profile T289 Map Reference Innisfail 1:100 000 963452
Bilgil series Sampled from undisturbed Eucalypt open forest.

Depth m	0-.10	.10-.20	.20-.30	.30-.60	.60-.90	.90-1.20	1.20-1.50	1.50-1.80
Horizon	A1	B1	B1	B2	B2	B3	BC	C
pH	5.4	5.3	5.3	5.3	5.3	5.2	4.8	5.2
E.C.dS/m^{-1}	.050	.035	.029	.020	.017	.017	.014	.017
Org.C%	2.98	1.97	1.16	.64				
N%	.29	.19		.08				
AvP ppm	10	4		6				
Tot.P%	.027			.024				
Tot.K%	.17			.23				
Tot.S%	.048			.033				
Exchange properties m.e./100g soil								
Ca	.49	.28	.35	.35	.35			
Mg	.91	.64	.58	.35	.35			
K	.15	.08	<.01	<.01	<.01			
Na	.08	.06	.03	.01	.01			
H+Al	1.8	1.2	0.88	1.0	1.44			
ECEC*	3.43	2.26	1.85	1.72	2.16			
ECEC/100g Clay	6.4	4.5	4.0	3.5				
CEC**	10.6	7.4		4.6				
CEC/100g C.**	19.6	14.8		9.6				
Base Sat***	15	14		16				
CEC****	3.5	3.0	2.6	2.9	2.9			
Particle Size %								
Gr	0	0	0	0	0	tr	0	0
CS	5	10	13	5		5		8
FS	11	10	12	13		17		18
SI	30	31	29	34		40		41
C	54	50	46	48		37		33

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$ ** NH4 OAc **** Comp. Exch

GARRADUNGA SERIES

CONCEPT: Red gradational or uniform textured soils formed on basaltic alluvium.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Krasnozem	Gn3.11	Haplic, Dystrophic, Red, Ferrosol

LANDFORM Alluvial plain RAINFALL 3990mm
REFERENCE SITE Bartle Frere 1:100 000 934710

Horizon	Depth m	
Ap	0 to 0.30	Reddish brown (5YR4/3); light clay; moderate 5-10mm subangular blocky; moist moderately firm; gradual change to-
B2	0.30 to 0.90	Reddish brown (5YR4/4); medium clay; moderate 5-10mm subangular blocky; moist moderately firm; diffuse change to-
B2	0.90 to 1.20	Reddish brown (5YR4/3); 10-20% <5mm faint reddish brown (5YR5/3) mottles; medium clay; moderate 5-10mm subangular blocky; moist moderately firm.

RANGE OF CHARACTERISTICS

Garradunga series occurs only as small areas of valley infill on the minor streams draining the basalt uplands. No virgin sites were examined. All sites were cultivated to sugar cane and in many places the soil had been modified by levelling or landfill operations or by accelerated deposition since cultivation of the adjacent uplands. Insufficient data were obtained to provide an accurate range of properties.

ANALYTICAL DATA

Garradunga series was not sampled in this survey area. The following data are from the Tully-Innisfail area (Murtha 1986).
Profile T279 Map Reference Tully 1:100 000 825578
GARRADUNGA SERIES The site is cleared, under grass and may have been cultivated at some stage.

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.60	.60-.90	.90-1.20	1.50-1.80
Horizon	A1	A1	B1	B1	B2	B2	B2	B3
pH	5.8	5.5	5.3	5.4	5.4	5.3	5.3	5.2
E.C.mdS/m^{-1}	.071	.047	.032	.023	.020	.014	.017	.014
Org.C%	3.42	2.22	1.15					
N%	.29	.30	.11					
AvP ppm	23	14		16				
Tot.P%	.260		.210				.160	
Tot.K%	.10		.08				.08	
Tot.S%	.08		.08				.07	
Exchange properties m.e./100g soil								
Ca	3.19	1.45	.84		.95		.06	
Mg	2.41	1.04	.62		.40		.71	
K	.17	.14	.09		.06		.07	
Na	.16	.11	.10		.10		.06	
H+Al	1.20	.76	1.0		4.0		2.1	
ECEC*	7.13	3.50	3.65		5.51		3.0	
ECEC/100g Clay	11.7	5.6	5.9		9.2			
CEC**	11.0		10.7		11.3		8.9	
CEC/100g C.**	18.0		17.3		18.8			
Base Sat***	54		15		13		12	
CEC****	7.9	5.0	2.3		2.8		3.3	
Particle Size %								
Gr	2	tr	tr	6	6	6	4	4
CS	13	10	10	10	12	8		11
FS	10	10	11	10	11	11		14
SI	17	18	18	18	17	16		13
C	61	63	62	61	60	65		62

Mineralogy of the clay fraction	Depth m	Ka%	ChV%	G%	Go/Ha%
	0.45-0.60	50-65	5-10	5-10	10-20

* sum of basic and acidic cations *** $\frac{\text{Bases}}{\text{NH}_4\text{ OAc CEC}} \times 100$ ** NH_4 OAc **** Comp. Exch

KIMBERLEY SERIES

CONCEPT: Red gradational or uniform textured soils formed on alluvial fans derived from basalt or basic metamorphic rocks.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Krasnozem	Uf6.31	Haplic, Dystrophic, Red, Ferrosol

LANDFORM Alluvial fan RAINFALL 2500mm
REFERENCE SITE Bartle Frere 1:100 000 830741

Horizon	Depth m	
A1	0 to 0.20	Yellowish red (5YR4/6); medium clay; moderate cast; moist moderately firm; 2-10% 6-20mm, angular metamorphic rock gravel; diffuse change to-
B2	0.20 to 0.50	Red (2.5YR4/6); medium clay; strong subangular blocky; moist moderately firm; 2-10% 20-60mm, angular metamorphic rock gravel; diffuse change to-
B2	0.50 to 0.90	Dark red (2.5YR3/6); medium clay; strong subangular blocky; moist moderately firm; 2-10% 20-60mm, angular metamorphic rock gravel; diffuse change to.
BC	0.90 to 1.0+	Angular metamorphic rock gravel with pockets of dark red (2.5YR3/6) medium clay.

NOTE: This profile was described on old cane land which has been severely eroded.

All sites described were on cultivated lands where the profile has been modified by cultivation and/or erosion and too few were described to provide a meaningful range of properties.

NOTE: This soil has been classified as a Ferrosol although the Free Fe levels for the one analysed profile may be marginal. Data are not available for the main B horizon but based on data for the horizons above it has been assumed that it would make the 5% required. As tenuous as it might seem morphological evidence such as colour suggests that the soil is a Ferrosol. If the Free Fe is < 5% it would classify as a Haplic, Dystrophic, Red, Dermosol.

ANALYTICAL DATA

This series was not sampled in this survey area, the following data are from the Mossman Cape Tribulation area (Murtha 1989).

Profile T308 Map Reference Mossman 1:100 000 354012
KIMBERLEY SERIES Sampled from undisturbed rainforest

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.60	.60-.80
Horizon	A1	B11	B12	B21	B22	B23
pH	5.6	5.6	5.8	5.9	5.6	5.8
E.C.dS/m^{-1}	.086	.059	.023	.017	.068	.014
Org.C%	2.65	.92	.42			
N%	.48	.16	.08			
AvP ppm	22	8	9	14	14	30
Tot.P%	.095			.047		
Tot.K%	1.12			1.32		
Tot.S%	.055			.017		
Tot. Fe%	4.5		6.0			
Free Fe%	3.8		4.6			
Exchange properties m.e./100g soil						
Ca	6.70		1.08		.66	
Mg	2.14		.64		.57	
K	.35		.15		.14	
Na	.19		.07		.05	
H+Al	.30		.20		.30	
ECEC*	9.7		2.1		1.7	
ECEC/100g Clay	28		6		5	
CEC**	11		3		2	
CEC/100g C.**	31		8		6	
Base Sat***	85		65		71	
CEC****	9.0		2.7		2.1	
Particle Size %						
Gr	32		13		8	
CS	13		12		15	
FS	17		18		21	
SI	35		34		28	
C	35		36		35	

*sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** NH_4OAc **** Comp. Exch

MAPPING UNITS – SOILS OF BASALTIC ORIGIN

PIN GIN ASSOCIATION Pg 31 UMAs 6792ha

Pin Gin association occupies the major part of the basalt flows that originated on the Atherton Tablelands and the limited flows associated with the younger vents. The largest areas of the remnants of the Tableland flows occur adjacent to the North Johnstone River but small areas occur in the upper reaches of the Russell and Mulgrave Rivers and Babinda Creek. Although only remnants remain, the basalt flows once filled the Mulgrave River Valley and extended at least as far as Gordonvale. Soils formed from basalt but now burried by alluvium can be seen in the cutting along the highway on the northern side of the Mulgrave River and in deep drains in Gordonvale.

Green Hill is the best known of the recent vents but the largest in area is the vent in the Seymour Range to the east of Garradunga. The small occurrence at Meringa is probably from a separate vent as it is too elevated to have formed part of the flows from Green Hill. The map of Willmott et al. (1988) shows a vent to the east of the Goldsborough Road. They do not comment on the age of this vent but pedological evidence suggests that it may be an even younger basalt due to the less weathered nature of the Mena series soils which occur in that area.

The Pin Gin series soils occupy more than 90% of the unit and even in areas of strong relief the soils are generally very deep. There may be some variation in colour of the deep subsoil from yellowish red to reddish brown but no pattern of occurrence was apparent in the survey area. Mena series may occur on some of the steeper slopes and occupies most of the southern portion of the UMA north of The Fisheries on the Goldsborough Road. Garradunga series will occupy the minor areas of local alluvium that may be included. The UMAs along the North Johnstone River have rainforest vegetation which makes the airphoto interpretation difficult so areas of soils formed on the metasediments may be included.

EUBENANGEE ASSOCIATION Eu 12 UMAs 1564ha

Eubenangee association has been mapped only in the area between Garradunga and the North Johnstone River. It occupies a number of low rises that have a general surface level significantly lower than that of the flows on which Pin Gin series occur. The soils are characterised chiefly by the presence of ironstone gravels on the surface (but only small amounts) and they may also have lateritised weathered basalt at depth. This laterite is often exposed on the steeper dissection slopes but as it is not always present it may only occur intermittantly. In the natural condition these soils had a snuffy surface characterised by a low bulk density and very friable consistance. As most areas have been subjected to moderate to severe erosion this feature will probably not be observed.

The lower basalt surface on which these soils occur is interpreted as a northern extension of the Mena Creek surface. These basalts have been dated as having a minimum age of 3.3 m.y. which is considerably older than the Pin Gin flows hence the stronger weathering expressed by the lateritisation.

Apart from small areas of Garradunga series which occur on local alluvium no other soils have been observed in this association. In the Garradunga area there has been extensive levelling carried out and Eubenangee soil material has been used to fill swamps where it may now overlie peat or Coom and Timara series soils.

GARRADUNGA ASSOCIATION Gu 5 UMAs 110ha

This unit is restricted to the alluvium of minor streams which has been derived almost wholly from basalt. A number of small areas have been delineated but many more smaller areas occur in the Pin Gin and Eubenangee associations. The two UMAs to the north of Garradunga are not typical of this unit in that they have received accelerated deposition since clearing of the local catchments. Parts of these units overlie soils of the adjacent swamps.

BINGIL ASSOCIATION Bl 4 UMAs 210ha

Small areas of this unit have been mapped along the Graham and Seymour Ranges but the association is almost certain to occur elsewhere, particularly in the Freshwater and Wright Creek

catchments. It occurs on amphibolite which is a metamorphosed basic volcanic interbedded in the metasediments and as most of the uplands are still covered by dense rainforest and there is little access delineation on air photo pattern alone is very difficult.

The dark red strongly structured soils of Bingil series are the only soils observed in this unit although some Galmara and Bicton series formed on the metasediments may be included.

KIMBERLEY ASSOCIATION Ki 4 UMAs 172ha

This association occurs on the coalescing fans derived from amphibolite . The dominant soil is Kimberley series and although only four small units have been mapped (two on the eastern slopes of the Graham Range and two on the lower slopes of Mount Bartle Frere) very small areas occur throughout the metasediment landscape. The most commonly associated soil is Mission series but any of the soils that occur on the metasediment fans may occur as minor associates.

SOILS OF METAMORPHIC ROCK ORIGIN

Eight soil series have been recognised as having formed from metamorphic parent materials. Three of these, Seymour, Galmara, and Bicton series have been described as having formed insitu although it is obvious that there has been downslope movement of surface material and it is often difficult to distinguish sedentary from alluvial or colluvial materials. Mission, Buchan, Dagmar, Edmonton and Clifton series occur on the alluvial fans which may extend up to four kilometers. from the uplands. Many of these fans have slopes of less than 0.5% on their distal ends where they merge with or overlie buried soils of the alluvial environment.

Thompson and Cannon (1988) identified two additional series on the alluvial fans. These are Taylor and Trinity series which occupy small areas around Trinity Beach. Apart from the presence of a black A1 horizon, Taylor series is similar to Clifton series and would probably behave similarly. Trinity series, which has not been identified in this mapping is morphologically and chemically unlike any other soil described on the wet coast lowlands; however it covers a very small area and is of little consequence.

Bingil and Kimberley, series which occur in the metamorphic rock landscapes, and are an associated soil in many of the mapping units are described in the soils of basic rock origin group.

The major morphological features of each of the soil series is summarised in Table 4.

Table 4. Soils of metamorphic rock origin

SERIES	LANDFORM	MAJOR DISTINGUISHING FEATURES
SEYMOUR	Rolling hills to mountains	shallow, gravelly soils on ridge crests and steep slopes
GALMARA	Rolling low hills to steep hills	Red, structured, uniform or gradational textured soils formed insitu.
BICTON	Rolling low hills to steep hills	Yellow, structured, uniform or gradational textured soils formed insitu.
MISSION	Alluvial fans	Red, massive, gradational textured soil.
BUCHAN	Alluvial fans	Yellow, massive, gradational textured soil.
DAGMAR	Alluvial fans	Uniform or gradational textured, bright, red or yellow mottled B horizons.
EDMONTON	Alluvial fans	Gradational textured, structured, mottled brown or yellow brown B horizons.
CLIFTON	Alluvial fan	Gradational textured, strongly bleached A2, pale yellow lower slope and grey mottled B horizon, may have ironstone nodules in A2 and upper B.

GALMARA SERIES

CONCEPT: Red structured uniform or gradational textured soils formed on metasediments.

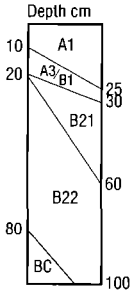
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Affinities with Red Podzolic Soil	Uf4.22	Acidic, Dystrophic, Red, Dermosol

LANDFORM Low hills RAINFALL 4000mm
REFERENCE SITE Bartle Frere 1:100 000 892704

Horizon	Depth m	
A1	0 to 0.10	Brown (7.5YR4/4); clay loam; strong, 2-5mm, subangular blocky; moist very weak; <2%, 2-6mm, quartz gravel; many; <1mm roots; clear change to-
A3	0.10 to 0.20	Strong brown (7.5YR5/6); clay loam; strong, 2-5mm, subangular blocky; moist moderately weak; <2% 2-6mm quartz gravel; many <1mm roots; gradual change to-
B1	0.20 to 0.30	Yellowish red (5YR5/6); clay loam (heavy); moderate 5-10mm angular blocky; moist moderately weak; <2% 2-6mm quartz gravel; few 2-5mm roots; diffuse change to-
B21	0.30 to .40	Yellowish red (5YR5/6); clay loam; moderate 5-10mm angular blocky; moist moderately weak; <2% quartz gravel; diffuse change to-
B22	0.40 to 0.75	Yellowish red (5YR5/6); light medium clay; moderate 5-10mm angular blocky; moist moderately weak; <2% quartz gravel; diffuse change to-
BC	0.75 to 1.20	Yellowish red (5YR5/6); 2-10% faint reddish yellow (5YR6/6) mottles; light clay; strong 2-5mm angular blocky; moist moderately weak; diffuse change to-
BC	1.20 to 1.50	Red (2.5YR5/6); clay loam; weak angular blocky; moist moderately weak; <2% weathered substrate gravel.

RANGE OF CHARACTERISTICS



Ap Very dark greyish brown (10YR4/2) to reddish brown (5YR4/3); cast or subangular blocky structure; variable amounts of quartz or metamorphic rock gravels;. The Ap is often a mixture of the A and B horizon material.

A3/B1 All soils have transitional horizons which have been variously labelled A3 or B1. Strong brown (7.5YR5/6);to red (2.5R4/6); clay loam or silty clay loam; weak to strong cast or angular blocky

B2 Yellowish red (5YR5/8) to red (2.5YR4/6); clay loam (heavy) to light medium clay; weak to moderate fine subangular blocky

BC/C Yellowish red (5YR5/6) to red (10R4/8): light clay to light medium clay; interspersed with strongly weathered substrate.

The solum thickness ranges from .8 to about 2.0m and this may overlie up to 5m of deeply weathered saprolite.

Principal profile forms encountered include Uf4.22, Um4.41, Gn3.14, and Gn3.71.

ANALYTICAL DATA

Profile T66 Map Reference Bartle Frere 1:100 000 892704
GALMARA SERIES Sampled from partially disturbed rainforest

Depth m	0-.10	.10-.20	.20-.30	.30-.40	.40-.60	.60-.75	.75-.90	.9-1.20	1.20-1.50
Horizon	A1	A3	B1	B21	B22	B22	BC	BC	BC
pH	4.8	4.5	4.8	5.1	5.0	5.0	5.0	5.0	5.1
E.C.dS/m^{-1}	.062	.059	.067	.017	.014	.014	.014	.014	.014
Org.C%	4.3	2.6	0.1		0.4		0.2		
N%	.376	.229	0.14		038		.016		
AvP ppm	10	4	3		1		1	1	1
P Retn%	34				27				
Tot.P%	.043	.034	.037		.034		.047	.050	.054
Tot.K%	1.14	1.19	1.42		1.69		2.03	1.92	1.83
Tot.S%	.043	.032	.034		.019		.018	.021	.023
Exchange properties m.e./100g soil									
Ca	0.4	0.3			0.1		0.1		
Mg	0.7	0.3	0.3		0.3		0.2		
K	0.18	0.11	0.08		0.08		0.11		
Na	0.25	0.22	0.23		0.21		0.22		
H+Al	2.88		2.90		2.76		4.04		
ECEC*	4.4				3.5		4.7		
ECEC/100g Clay	9.4				9.0		14.2		
Particle Size %									
Gr	0	0	0		0		0	0	0
CS	3	6	4		3		5	3	0
FS	30	31	34		30		24	29	40
SI	11	12	14		28		40	36	36
C	47	47	45		39		33	29	24

* sum of basic and acidic cations

CLIFTON SERIES

CONCEPT: Strongly bleached gradational textured soils on alluvial fans from metamorphic rocks, usually contain ironstone nodules or gravels in B horizon.

REPRESENTATIVE PROFILE

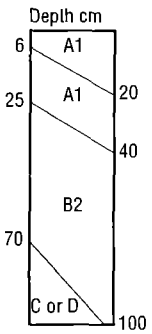
	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Affinities with Yellow podzolic soil	Gn2.74	Bleached-Mottled, Magnesic, Yellow, Kandosol

LANDFORM Alluvial fan RAINFALL 1950mm

REFERENCE SITE Bartle Frere 1:100 000 702108

Horizon	Depth m	
A1	0 to 0.16	Greyish brown (10YR5/2); sandy clay loam, fine sandy; moderate 5-10mm cast; moist moderately weak; common 2-5mm roots; diffuse change to-7
A1/A2	0.16 to 0.26	Greyish brown (10YR5/2); 10-20% 5-15mm distinct light grey (10YR7/2) mottles; sandy clay loam, fine sandy; massive; moist moderately weak; common 1-2mm roots; diffuse change to-
A2	0.26 to 0.40	Light grey (10YR7/2); 2-10% 5-15mm faint yellow (10YR7/6) mottles; sandy clay loam, fine sandy (heavy); massive; moist moderately weak; few 1-2mm roots; gradual change to-
B21	0.40 to 0.57	Brownish yellow (10YR6/6); 20-50% 5-15mm distinct light grey (10YR7/1) primary and reddish yellow (5YR6/8) secondary mottles; sandy light clay (heavy); weak 5-10mm subangular blocky; moist moderately firm; 2-10% 20-60mm, subrounded quartz gravel; 2-10% 6-20mm ferromanganiferous concretions; diffuse change to-
B22	0.57 to .76 m	Brownish yellow (10YR6/6); 20-50% 5-15mm prominent light grey (10YR7/1) primary and reddish yellow (5YR6/8) secondary mottles; light clay (heavy); weak 5-10mm subangular blocky; moist moderately firm; 2-10% 6-20mm ferromanganiferous concretions; diffuse change to-
B23	76 to 1.08 m	Light grey (10YR7/1); 20-50% 5-15mm prominent brownish yellow (10YR6/6) primary and yellowish red (5YR4/6) secondary mottles; medium clay; weak 10-20mm subangular blocky; moist moderately firm; 10-20% 6-20mm ferromanganiferous concretions; diffuse change to-
C	1.08 to 1.35 m	Yellowish red (5YR4/6); 20-50% 15-30mm prominent light grey (10YR7/2) mottles; sandy clay loam; massive; moist moderately firm; 2-10% 6-20mm ferromanganiferous soft segregations;
C	1.35 to 1.65 m	Yellowish red (5YR4/6); 20-50% 15-30mm prominent light grey (10YR7/2) mottles; sandy clay loam; massive; moist moderately firm.

RANGE OF CHARACTERISTICS



Ap Dark grey (10YR4/1) to greyish brown (10YR5/2) or brown (10YR5/3) may occasionally have a sporadic bleach (10YR7-8/2); clay loam fine sandy to silty medium clay; strong 5-10mm cast; moist very weak.

A1 Greyish brown (10YR5/2) to yellowish brown (10YR5/4); sandy clay loam, fine sandy to clay loam, gradual to diffuse change to

A2 Light brownish grey (10YR6/2-4) to light grey (10YR7/2); sandy clay loam, fine sandy to clay loam; clear to gradual change to

B21 Pale olive (5Y6/3) to brownish yellow (10YR6/6) with light grey (10YR7/1) reddish yellow (5YR6/8) or olive yellow (2.5Y6/6) mottles; silty or sandy light to medium clay.

B22 Light brownish grey (10YR6/2) to brownish yellow (10YR6/6) with brown (7.5YR5/6) and yellowish red (2.5YR-5YR4/6-8); clay loam fine sandy to silty medium clay; moderate to very heavy concentrations of ironstone nodules and gravels.

C/D Very gravelly C horizons or buried soils may occur as shallow as 55cm.

Few undisturbed sites were examined. It appears to be reasonably conclusive that these soils, in their original condition, have very strongly bleached A2 horizons but at most sites the profile has been highly modified by cultivation. When dry these soils are very pale coloured and in general of very firm to hard consistence but when wet the A horizons are dark the B horizons are brightly coloured and the soils are very friable. The marked change in general appearance between the wet and dry soil may lead to some confusion in the correct identification of these soils. The A2 horizons may be strongly dilatent.

ANALYTICAL DATA

Profile T482 Map Reference Bartle Frere 1:100 000 702108
CLIFTON SERIES Sampled from undisturbed Melaleuca closed forest

Depth m	0-.16	.16-.26	.26-.40	.40-.57	.57-.76	.76-1.08	1.08-1.35	1.35-1.65
Horizon	A1	A1/A2	A2	B21	B22	B23	C	C
pH	5.2	5.5	6.0	6.1	6.0	5.8	5.5	5.6
E.C.dS/m^{-1}	.052	.025	.017	.016	.014	.016	.031	.039
Org.C%	1.08		0.20	0.14	0.14			
N%	0.04		0.02	<.02	0.02			
AvP ppm	7	7	<2	<2	<2	<2		
Tot.P%	.010			.010		.010		
Tot.K%	0.77			1.25		1.61		
Tot.S%	.010			.010		.010		
Free Fe%	0.6		0.5	1.3	2.6			
Exchange properties m.e./100g soil								
Ca	0.09		0.01	0.05	0.02	<.02		<.02
Mg	0.67		0.32	0.48	0.67	1.21		1.67
K	0.12		0.05	0.02	<.02	0.02		0.03
Na	.08		.08	.09	.10	.14		.03
H+Al	.75		.68	.67	.56	.69		.61
ECEC*	1.7		1.1	1.3	1.4	2.1		2.4
ECEC/100g Clay	15.4		7.8	7.2	7.0	12.4		13.3
CEC**	2.8		1.3	2.1	2.1			
CEC/100g C.**	25.4		9.3	11.7	10.5			
Base Sat***	34		32	25	40			
CEC****	1.6		1.0	1.2	1.6	1.4		2.2
Particle Size %								
Gr	0	3	6	20	16	26	8	0
CS	7	11	12	12	10	13	19	7
FS	64	61	58	53	49	48	51	48
SI	18	17	16	18	21	22	16	27
C	11	12	14	18	20	17	14	18

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** NH_4 OAc **** Comp. Exch

SEYMOUR SERIES

CONCEPT: Shallow gravelly soils formed on metamorphic rock uplands.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Lithosol	Gn3.11	Orthic, Tenosol

LANDFORM Hills - Mountains

REFERENCE SITE Cooper Point 1:100 000 005683

Horizon	Depth m	
A1	0 to 0.26	Dark brown (7.5YR3/2); loam; strong 2-5mm cast; moderately moist moderately weak; 10-20% 20-60mm, subangular metamorphic rock gravel, dispersed; diffuse change to-
B1	0.26 to 0.50	Reddish brown (5YR4/3); clay loam; weak 5-10mm subangular blocky; moderately moist moderately weak; 20-50% 60-200mm, subangular metamorphic rock gravel, dispersed; diffuse change to-
BC	0.50 to 1.40	Yellowish red (5YR4/6); light clay; weak 5-10mm subangular blocky; moderately moist moderately weak; 50-90% 600mm-2m, subangular metamorphic rock gravel, dispersed; diffuse change to-
R	1.40	Metamorphic rock.

These soils occur on narrow ridge crests and very steep slopes on the hilly to mountainous metamorphic uplands. Most of this country is very inaccessible and few sites have been examined. Most sites are much more gravelly and have a thinner solum than the profile described above.

This soil has not been sampled so data are not available

BICTON SERIES

CONCEPT: Yellow gradational textured soil formed on metamorphic rocks.

REPRESENTATIVE PROFILE

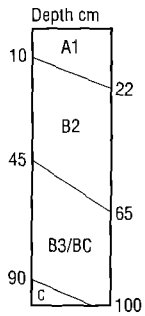
	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Xanthozem	Gn3.71	Acid, Dystrophic Yellow, Dermosol

LANDFORM Hilly to mountainous RAINFALL 3500mm

REFERENCE SITE Cooper Point 1:100 000 974666

Horizon	Depth m	
A1	0 to 0.15	Greyish brown (10YR5/2); fine sandy loam; moderate 5-10mm cast; moderately moist moderately weak; gradual change to-
B21	0.15 to 0.45	Brownish yellow (10YR6/6); 2-10% <5mm distinct reddish yellow (5YR6/8) mottles; sandy clay loam, fine sandy (light); moderate 5-10mm subangular blocky; moderately moist moderately weak; diffuse change to-
B22	0.45 to 0.65	Reddish yellow (5YR6/8); sandy clay loam, fine sandy; moderate 5-10mm subangular blocky; moderately moist moderately weak; diffuse change to-
BC	0.65 to 0.90	Reddish yellow (5YR6/6); fine sandy loam (light); massive; moderately moist moderately weak; 20-50% angular metamorphic rock gravel.
C	0.90 to 1.0	Strongly weathered metamorphic rock parent material.

RANGE OF CHARACTERISTICS



A1 Greyish brown to light yellowish brown (10YR5-6/2-4); fine sandy loam to silty light clay; massive to moderate 5-10mm cast; clear or gradual Change

B2 Brownish or reddish yellow (10YR-7.5YR6/6) with 2-20% <5mm distinct yellowish red (5YR5-6/6-8) mottles; fine sandy clay loam to silty medium clay; 0-20% 5-20mm quartz or metamorphic rock gravels;

BC Reddish yellow (5YR6/6-8); may be whole coloured or have 2-10% <5mm yellow (10YR7/6) mottles; 20-50% 5-60mm quartz and metamorphic rock

The A horizons of these soils are very pale (10YR8/2-4) when dry. In very occasional profiles the red mottle may be dominant in the B2 horizon.

Principal profile forms encountered include Gn3.71, Gn2.34, Uf6.4, and Gn3p.

ANALYTICAL DATA

This soil was not sampled in this survey area. The following data is from the Tully-Innisfail area (Murtha 1986).

Profile T268 Map Reference Innisfail 1:100 000 965458

BICTON SERIES Sampled from undisturbed rainforest

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.60	.60-.70	.70-.90	.90-1.05
Horizon	A11	A12	B1	B2	B2	B2	BC	C
pH	4.4	4.4	4.6	4.7	4.6	4.7	4.6	4.9
E.C.dS/m^{-1}	.110	.140	.036	.024	.039	.027	.039	.021
Org.C%	3.41	2.67	1.57	.49	.27	.16	.14	.11
N%	.26	.16						
AvP ppm	12	7	6		6			
Tot.P%	.024		.018				.013	
Tot.K%	1.06		.97				.89	
Tot.S%	.042		.027				.007	
Free Fe%	1.24	1.46	1.60	1.67	1.97	1.89	1.75	1.82
Exchange properties m.e./100g soil								
Ca	.22		.04		.04	.04		
Mg	.55		.07		.05	.02		
K	.13		.09		.05	.05		
Na	.05		.02		.02	.01		
H+Al	6.5		4.0		2.2	1.9		
ECEC*	7.45		4.22		2.36	2.02		
ECEC/100g Clay	39.2		21.1		13.1	12.6		
CEC**	13.0		6.7		2.9	2.1		
CEC/100g C.**	8.4		33.5		16.1	13.1		
Base Sat***	7		3		6	9		
CEC****	4.6		2.9		2.0	1.7		

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.60	.60-.70	.70-.90	.90-1.05
Horizon	A11	A12	B1	B2	B2	B2	BC	C
Particle Size %								
Gr	0	2	4	4	10	2	0	
CS	2	3	3	4	4	6	10	
FS	66	64	62	62	60	60	65	
SI	14	13	15	15	17	18	16	
C	19	20	20	19	18	16	10	
Mineralogy of the clay fraction	Depth cm 15-30 60-90		I% 40-50 20-30		Ka% 20-30 40-50	Go/Ha% 20-30 20-30		

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\text{ OAc CEC}} \times 100$ ** NH_4 OAc **** Comp. Exch

BUCHAN SERIES

CONCEPT: Yellow, massive, gradational textured soils formed on alluvial fans.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F. .	A.S.C.
CLASSIFICATION	Yellow earth	Um5.52	Haplic, Dystrophic, Brown, Kandosol

LANDFORM Alluvial fan RAINFALL 2100mm

REFERENCE SITE Cooper Point 1:100 000 959785

Horizon	Depth m	
A1	0 to 0.12	Brown (7.5YR4/4); silty clay loam (light); weak 2-5mm cast; moderately moist moderately weak;
B21	0.12 to 0.40	Strong brown (7.5YR5/6); silty clay loam; massive; moist moderately weak;
B22	0.40 to 0.75	Reddish yellow (7.5YR6/8); silty clay loam (heavy); massive; moist moderately weak; 10-20% 6-20mm, subangular metamorphic rock gravel.

NOTE: Max on metasediment gravels at 75cm.

Only one profile was described in detail so ranges cannot be given.

ANALYTICAL DATA

This soil was not sampled as part of this survey. The following data are from Thompson and Cannon (1988).

Site no C10 Map Reference Cairns 1: 100 000 576474

BUCHAN SERIES Cleared and cultivated in the past

Depth m	0-.10	.20-.30	.50-.60	.80-.90	1.10-1.20	1.40-1.50
Horizon	A1	A2	B22	B22	B22	B23
pH	6.1	5.9	6.1	5.4	5.4	5.4
E.C.dS/m^{-1}	0.04	0.02	0.01	0.02	0.01	0.01
Org.C%	1.3	0.97				
N%	0.12	0.09				
AvP ppm	8	5				
Tot.P%	.017	.011	.011	.014	.013	.013
Tot.K%	1.47	1.59	1.80	2.25	2.00	2.15
Tot.S%	.016	.007	.004	.008	.007	.007
Exchange properties m.e./100g soil						
Ca	2.2	1.2	0.88	0.27	0.22	0.30
Mg	1.1	0.47	0.60	0.93	0.71	0.60
K	0.43	0.24	0.13	0.13	0.10	0.11
Na	0.10	<0.1	<0.1	<0.1	<0.1	<0.1
CEC	6	3	1	2	2	2
CEC/100g Clay	33	15.8	4.8	7.7	9.1	10
Particle Size %						
CS	8	7	7	13	10	16
FS	52	52	50	40	45	43
SI	24	24	23	20	22	22
C	18	19	21	26	22	20

For methods see Bruce and Rayment (1982)

EDMONTON SERIES

CONCEPT: Gradational textured, structured, brown or yellow brown soils on alluvial fans from metamorphic rocks.

REPRESENTATIVE PROFILE

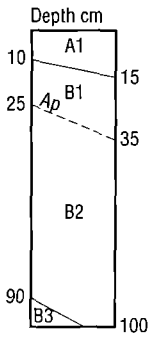
	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Affinities with Yellow podzolic soil	Gn3.71	Mottled, Magnesic, Yellow, Dermosol

LANDFORM Alluvial fan RAINFALL 1950mm

REFERENCE SITE Bartle Frere 1:100 000 689133

Horizon	Depth m	
A1	0 to 0.11	Dark greyish brown (10YR4/2); clay loam; moderate 5-10mm subangular blocky; moderately moist very firm; common 1-2mm roots; gradual change to-
B1	0.11 to 0.28	Yellowish brown (10YR5/4); light medium clay; moderate 5-10mm subangular blocky; moderately moist very firm; common 1-2mm roots; diffuse change to-
B21	0.28 to 0.46	Brownish yellow (10YR6/6); <2% <5mm faint reddish yellow (5YR6/8) mottles; medium heavy clay; strong 5-10mm subangular blocky; moderately moist very firm; few 1-2mm roots; diffuse change to-
B22	0.46 to 0.66	Reddish yellow (7.5YR6/6); 2-10% <5mm faint reddish yellow (5YR6/8) mottles; medium heavy clay; strong 5-10mm subangular blocky; moderately moist very firm; 10-20% 6-20mm ferromanganiferous nodules; few 1-2mm roots; diffuse change to-
B23	0.66 to 1.15	Light yellowish brown (10YR6/4); 10-20% <5mm distinct yellowish red (5YR5/8) mottles; heavy clay; strong 10-20mm subangular blocky; moderately moist moderately strong; 2-10%, 6-20mm ferromanganiferous nodules; few 1-2mm roots; diffuse change to-
B3	1.15 to 1.44	White (10YR8/1); 20-50% 5-15mm distinct yellowish brown (10YR5/8) mottles; medium heavy clay; moderate 20-50mm subangular blocky; moderately moist moderately firm; diffuse change to-
BC	1.44 to 2.00	Yellowish brown (10YR5/6); 20-50% 5-15mm distinct white (10YR8/2) mottles; sandy light clay; massive; moderately moist moderately firm;

RANGE IN CHARACTERISTICS



Ap Dark brown (7.5YR3-4/3) to reddish brown (5YR4/3); clay loam to light clay; massive to moderate cast; may have to 30% 10-15mm quartz or metamorphic gravels clear change to

B21 Dark brown (7.5YR4/4) to brownish yellow (10YR6/6); light clay to medium heavy clay; moderate to strong 5-10mm subangular blocky; 2-10%, 2-6mm ferromanganiferous concretions; gradual or diffuse to

B22 Brown (7.5YR5/6) reddish yellow (7.5YR6/6) or yellowish brown (10YR5/5) may have some fine red mottles; light medium to medium heavy clay; 2-20%, 2-20mm ferromanganiferous nodules; may have up to 20% weathered rounded metamorphic rock gravel

Only one undisturbed site was described. In ploughed sites some soils have a uniform texture profile but that is almost certainly a result of mixing of surface horizons during cultivation. Edmonton series differs from Buchan series chiefly by the slightly heavier texture and structure in the B horizon. They otherwise have much in common.

Principal profile forms encountered include Gn3.71, Gn3.2p, and Uf6.34p.

ANALYTICAL DATA

Profile T484 Map Reference Bartle Frere 1:100 000 686146

EDMONTON SERIES Sampled from cleared site, may have been cultivated.

Depth m	0-.11	.11-.28	.28-.46	.46-.66	.66-.84	.84-1.15	1.15-1.44	1.44-1.80	1.80-2.00
Horizon	A1	B1	B21	B22	B23	B23	B3	BC	BC
pH	5.9	5.6	5.4	5.4	6.0	6.1	6.0	6.1	5.9
E.C.dS/m^{-1}	.025	.014	.015	.016	.011	.020	.008	.009	.011
Org.C%	2.18	.0.72	0.41	0.22					
N%	.08	.04	.03	.02					
AvP ppm	10	2	<2	2	2				
Tot.P%	.040		.020			.020			
Tot.K%	2.11		2.23			2.40			
Tot.S%	.030		.010			.010			
Free Fe%	2.0	2.3	2.4	2.9	2.3	2.7			
Exchange properties m.e./100g soil									
Ca	2.18		0.10	0.05		0.05		<.02	
Mg	1.30		0.65	0.82		1.54		1.67	
K	.14		.06	.06		.04		.03	

Depth m	0-.10	.10-.20	.20-.30	.30-.45		.45-.60	.60-.70	.70-.90	.90-1.05
Horizon	A1	B1	B21	B22	B23	B23	B3	BC	BC
Na	.06		.02	.02		.05		.03	
H+Al	0.58		1.53	1.25		1.63		0.76	
ECEC*	4.3		2.4	2.2		3.3		2.5	
ECEC/100g C.	13.4		6.3	6.3		10.3		12.5	
CEC**	8.9		4.3	3.5		4.1			
CEC/100g C**	27.8		11.3	10.0		12.8			
Base Sat***	42		17	27		41			
CEC****	4.8		2.3	2.3		3.2		3.3	
Particle Size %									
Gr	0	0	0	0	0	0	0	0	0
CS	2	3	2	3	3	4	7	19	5
FS	21	18	12	21	27	13	29	35	22
SI	44	45	47	42	39	51	38	26	49
C	32	34	38	35	32	32	26	20	24

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** NH_4 OAc **** Comp. Exch

MISSION SERIES

CONCEPT: Red massive gradational textured soils formed on alluvial fans from metamorphic rocks.

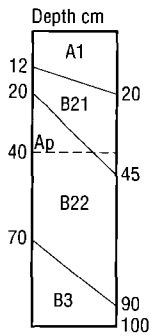
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Red earth	Um5.52	Haplic, Mesotrophic, Red, Kandosol

LANDFORM Alluvial fan RAINFALL 2100mm
REFERENCE SITE Bartle Frere 1:100 000 697114

Horizon	Depth m	
A1	0 to 0.12	Dark reddish brown (5YR3/4); sandy clay loam; weak 10-20mm platy; moderately moist moderately firm; 2-10% 6-20mm, subangular metamorphic rock gravel; 2-10% 2-6mm manganiferous concretions; common 1-2mm roots; gradual change to-
B21	0.12 to 0.30	Reddish brown (5YR4/4); sandy clay loam; massive; moist moderately weak; 2-10% 6-20mm, subangular metamorphic rock gravel; 2-10% 6-20mm manganiferous concretions; common 1-2mm roots; diffuse change to-
B22	0.30 to 0.56	Dark red (2.5YR3/5); sandy clay loam ; massive; moist moderately weak; 20-50% 20-60mm, subangular metamorphic rock gravel; few 1-2mm roots; diffuse change to-
B3	0.56 to 0.80	Reddish brown (5YR5/4); sandy loam ; single grain; moist very weak; 50-90% 20-60mm, subangular metamorphic rock gravel; diffuse change to-
C	1.00 to 1.30	Reddish brown (5YR4/4); loamy sand ; single grain; moderately moist loose; 50-90% 20-60mm, subangular metamorphic rock gravel; diffuse change to-
C	1.30 to 1.60	Reddish brown (5YR5/3); sand; single grain; moderately moist loose; 50-90% 20-60mm, subangular metamorphic rock gravel.

RANGE IN CHARACTERISTICS



A1 Dark reddish brown (5YR3/4) to dark brown (7.5YR4/4); sandy loam, clay loam to silty clay loam; weak to moderate, 5-10mm cast or granular occasionally platy;

B1 Yellowish red (5YR5/6);silty light clay (light);weak 5-10mm subangular blocky; moderate firm moist;

B21 Dark red (2.5YR3/6) to yellowish red (5YR4/4-6);sandy clay loam to silty light clay; massive to weak 5-10mm subangular blocky

B22 Dark red (2.5YR3-4/5-6) to yellowish red (5YR4/6); sandy clay loam, fine sandy to silty light clay; massive to weak 5-10mm subangular blocky; may have 10-20%, 20-60mm subangular metamorphic rock gravel.

The B1 horizon qualifies as a colour A2 horizon in the factual key but occurs only very occasionally. The depth to and amount of gravel in the B/C or C horizon varies considerably and over a very short distance.

Principal profile forms encountered include Um5.52, Gn2.11, Gn2.14 and some ploughed soils will be on the lighter textured end of Uf6.5.

ANALYTICAL DATA

Profile T485 Map Reference Bartle Frere 1:100 000 694120
MISSION SERIES Sampled from cleared site, may have been cultivated.

Depth m	0-.12	.12-.30	.30-.56	.56-.80	1.00-1.30	1.30-1.60
Horizon	A1	B21	B22	B3	C	C
pH	5.8	5.8	5.5	5.6	5.9	5.9
E.C.dS/m^{-1}	.029	.018	.013	.012	.008	.007
Org.C%	1.42	0.73	0.30	0.07		
N%	.06	.02	<.02	<.02		
AvP ppm	8	7	9	21	21	
P Retn %	25					
Tot.P%	.070		.010		.050	
Tot.K%	0.91		1.03		1.03	
Tot.S%	.030		.010		.010	
Free Fe%	2.9	2.9	2.5	2.5	2.3	
Exchange properties m.e./100g soil						
Ca	2.44	1.17	0.65	0.61	0.60	
Mg	1.48	0.89	0.48	0.31	0.25	
K	.12	.08	.07	.05	.03	
Na	.10	.05	.06	.02	.02	
H+Al	.04	.15	.26	.18	.01	
ECEC*	4.2	2.3	1.5	1.2	0.9	
ECEC/100g Clay	21.0	10.5	8.3	8.0	9.0	
CEC**	5.2	3.5	2.1	1.3	1.0	
CEC/100g C.**	26.0	15.9	11.7	8.7	10	
Base Sat***	80	61	59	78	89	
CEC****	2.3	2.2	1.2	1.1	1.2	
Particle Size %						
Gr	6	15	30	43	65	19
CS	16	17	22	28	55	46
FS	52	50	51	45	26	33
SI	12	11	10	12	9	12
C	20	22	18	15	10	9

* sum of basic and acidic cations *** $\frac{\text{Bases}}{\text{NH}_4\text{OAc CEC}} \times 100$ ** NH_4 OAc **** Comp. Exch

DAGMAR SERIES

CONCEPT: Bright yellow with red or grey mottles; uniform or gradational textures; formed on alluvial fans.

REPRESENTATIVE PROFILE

		G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION		? Yellow Podzolic	Uf6.34p	Yellow, Dermosol
LANDFORM		Alluvial fan		
REFERENCE SITE		Bartle Frere 1:100 000 921821		
Horizon	**Depth m**			
A1	0 to 0.08	Very dark greyish brown (10YR3/2); light medium clay; moderate 5-10mm subangular blocky; moist moderately firm; diffuse change to-		
B1	0.08 to 0.30	Brownish yellow (10YR6/7); light clay; weak 5-10mm subangular blocky; moist moderately firm; diffuse change to-		
B21	0.30 to 0.65	Brownish yellow (10YR6/7); light clay; moderate 5-10mm subangular blocky; moist moderately firm; 2-10% 6-20mm, angular quartz gravel; diffuse change to-		
B22	0.65 to 1.20	Yellowish brown (10YR5/8); 20-50% 5-15mm faint greyish brown (10YR5/2) mottles; medium clay; moist very firm.		

NOTE: The above profile was described in a degraded pasture and the site has been severely eroded. This is a minor soil occurring on the upper slopes of alluvial fans derived from metamorphic rocks. Few soils were examined. All have been highly modified by cultivation and erosion so the nature of the original surface horizons and the texture profile is unknown.

This series has not been sampled for analysis.

MAPPING UNITS: SOILS OF METAMORPHIC ROCK ORIGIN

GALMARA ASSOCIATION Ga 59 UMAs 4781ha.

This unit occupies the greater part of the low hilly to hilly terrain of the Barron River Metamorphics. The boundary between Galmara Association and the metamorphic mountainous unit M1 is somewhat arbitrary. An attempt has been made to restrict this unit to terrain with slopes of less than about 30% but it is obvious that some of the short slopes will exceed that value. Likewise the boundary between Galmara Association and the fan units is somewhat arbitrary. For the most part the boundary has been run along a break in slope which occurs at about 10-12% which also coincides roughly with the upper level for regular cultivation. This also coincides to some extent with the upper limit of the alluvial fans which is convenient as morphologically it is difficult to distinguish between materials formed insitu and those that have been transported a short distance.

The red soils of Galmara series are by far the most common soils and can occur from the ridge crest to lower slope in the landscape. The strongly structured dark red soils of Bingil may occur throughout the unit and may be co-dominant in some areas. Bingil series is particularly common in the units mapped along the Graham and Seymour Ranges. The yellow Bicton series soil is a common associated soil but it is impossible to predict where it may occur. Evidence suggests that it has formed on harder less weatherable metasediments so the distribution control is lithologic rather than topographic.

Seymour series may occur on some of the steeper upper slopes and ridge crests while Mission series will be dominant on any small areas of alluvial fan that may be included and Ramleh series may occur on the narrow valley flats.

BICTON ASSOCIATION Bi 16 UMAs 1985ha.

This unit is mapped only along the western edges of the Graham and Seymour Ranges and in the Woopen Creek catchment. Although the yellow Bicton series have been mapped as dominant the red Galmara series are closely associated and may be co-dominant over much of the area. The strongly structured dark red soils of Bingil series are common and may be more extensive than the mapping suggests. The shallow gravelly soils of Seymour series may occur on some ridge crests. The lack of access and the rainforest vegetation cover makes airphoto interpretation difficult.

Mission series will be dominant on any small areas of alluvial fan that may be included and Ramleh series may occur on the narrow valley flats.

MISSION ASSOCIATION Ms 58 UMAs 6882ha.

This unit surrounds most of the metamorphic uplands. For the most part it occupies the upper 5-10% slopes of the alluvial fans but in some areas; most notably around Edmonton it can occur on a much lesser slope, in some cases less than 1%.

The red massive soil of Mission series is the dominant soil. Small areas of the sedentary soils of Galmara series will be included where the fans abut the uplands. The yellow massive soils of Buchan series may occupy some downslope positions but is only a minor component. The most common associated soil is Edmonton series which may be co-dominant on the lower slope fans around Meringa and Edmonton where they occur in minor depressions on the fan surface. Kimberley series may be co-dominant in the units on the western slopes of the Freshwater Creek catchment, and to a lesser extent to the south of Cairns. To the north of the Barron River delta Mission series abuts and in part overlies the beach ridges on which the red Brosnan series occur.

BUCHAN ASSOCIATION Bc 8 UMAs 1015ha.

This association is restricted chiefly to a number of small units on the fan slopes to the north of the Barron River. One small area has been mapped near Bartle Frere. The yellow massive soil of Buchan series is the only soil recorded as having been observed in these units but small areas of Mission series are probably included on the upper slopes and some Clifton series will occur on the lower slopes. Most of these areas have been highly disturbed by recent urban development.

EDMONTON ASSOCIATION Et 7 UMAs 1399ha.

This association is common on the lower angle fans around Meringa and Edmonton. Most occurrences are a complex of soils with Edmonton series occurring in lower sites and Mission series on the higher sites. The lower sites are part of an incipient drainage network but there is no suggestion of any channel flow. In fact the differences in elevation are very subtle and are not always evident on casual observation. Because of this topographic relationship it is uncommon to find large uniform areas of Edmonton series and some UMAs will have Mission series as a co-dominant. Some Buchan series are almost certain to occur and areas of Clifton series will be included where this unit abuts Clifton association or the alluvial units.

CLIFTON ASSOCIATION Ct 21 UMAs 3113ha.

This association occupies the lower end of the fan slopes. It is most extensive on the low angle fans around Meringa, Edmonton, and to the north of the Barron River but small areas may occur throughout the extent of the metamorphic uplands.

Although Clifton series is the dominant soil, areas of almost any of the soils occurring on the fans of metamorphic origin may occur. In particular narrow and slightly elevated tongues of Mission series may occur throughout the unit. Where this association abuts the poorly drained alluvium and particularly where soils of Coom or Timara series are dominant it can be very difficult to pick the change and some misinterpretations may occur at this point. The error is not serious as the land use constraints of these soils are similar.

A nodular variant which has low to moderate concentrations of ironstone nodules in the A2 and upper B horizon or soils where the red mottles irreversibly harden on drying can occur. No distribution pattern was apparent for these soils. The units to the north of the Barron River and one unit in Wright Creek head-waters occur on the steeper fan slopes and extend much higher in the landscape. These are probably associated with local seepages and may contain small areas of Miallo series (see the Mossman-Cape Tribulation report (Murtha 1989)).

MOUNTAINOUS UNIT M1 19 UMAs 47211ha.

This unit includes all of the high hilly to mountainous lands of the Barron River metamorphics. The differentiation between this unit and Galmara association is somewhat arbitrary but the intention has been to include in this unit all of those lands that are too steep for any form of cultivation including pasture development. Obviously there will be considerable overlap.

Little access has been gained to most of the unit. The dominant soil will be the red structured soils of Galmara series but the yellow structured soil of Bicton series are closely associated and may be co-dominant in some areas. Bingil series also occurs and may be co-dominant along that section of the Graham Range mapped on the geology map as Babalangee amphibolite. The shallow gravelly soils of Seymour series will occur on the ridge crests and upper slopes. Any of the fan soils may occur on the lower slopes and Ramleh series may occur on some of the larger valley flats.

Because of the difficulty in airphoto interpretation the boundaries between this unit and the hilly granite and basalt units are at the best approximate and some adjustment will be necessary if or when better access is available.

SOILS OF GRANITIC ORIGIN

The Mareeba granite is the sole parent material for these soils and it makes up the greater part of the Bellenden Ker and the Malbon-Thompson Ranges and forms the northern part of the Graham Range. For the most part these are very steep rainforest clad mountains and there is very little access. Soil inspections were limited to the occasional foothill and to the extensive alluvial fans which surround the uplands.

A total of nine soil series have been identified. Only one of these, Utchee series, has formed insitu. The remainder have formed on the alluvial fans. Although the normal red-yellow-grey sequence (Tyson-Thorpe-Lugger) of soils does occur, the red Tyson soils are very limited in occurrence and the yellow or mottled yellow soils of Thorpe and Prior series are by far the most extensive.

The major distinguishing features of each soil are summarised in table 5.

Table 5. Soils of granitic origin

SERIES	LANDFORM	MAJOR DISTINGUISHING FEATURES
UTCHEE	Hilly-mountainous	Uniform or gradational textured, red structured soils formed in situ.
TYSON	Upper slopes of alluvial fans	Gradational textured red massive soils.
THORPE	Mid slopes of alluvial fans	Uniform or gradational textured yellow massive soils.
PRIOR	Lower slopes of alluvial fans	Uniform or gradational textured mottled yellow and grey massive soils coarse sandy textures.
LUGGER	Lower slopes of alluvial fans	Uniform or gradational textured pale grey massive soils coarse sandy textures
MALBON	Lower slopes of alluvial fans	Uniform or gradational textured grey (may be mottled) massive or weak structure sandy clay textures.
ALMA	low hills and upper slopes of alluvial fans	Deep > 20 cm dark A horizon; bright red massive B horizon uniform or gradational textured
KIRRAMA	Mid slope of alluvial fans	Deep > 20 cm dark A horizon, bright yellow sandy clay loam to medium clay B horizon.

TYSON SERIES

CONCEPT: Red massive gradational textured soils formed on alluvial fans from granite.

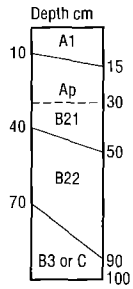
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Red earth	Uf6.52	Acidic, Dystrophic, Red, Kandosol

LANDFORM Alluvial fan RAINFALL 4250mm
REFERENCE SITE Bartle Frere 1:100 000 819775

Horizon	Depth m	
A1	0 to 0.10	Reddish brown (5YR5/4); light medium clay; moderate 2-5mm cast; moderately moist moderately weak; 10-20% 2-6mm, angular quartz gravel; gradual change to-
B21	0.10 to 0.40	Yellowish red (5YR5/6); medium clay; massive; moderately moist moderately weak; 10-20% 2-6mm, angular quartz gravel; diffuse change to-
B22	0.40 to 0.80	Red (2.5YR5/8); medium clay; massive; moderately moist moderately weak; 10-20% 2-6mm, angular quartz gravel; diffuse change to-
B3	0.80 to 1.20	Dark red (10R3/6); light clay; weak 2-5mm subangular blocky; moderately moist moderately weak; 10-20% 2-6mm, angular quartz gravel.

RANGE IN CHARACTERISTICS



Ap Dark reddish brown to reddish brown (5YR3-4/3-4); sandy clay loam to light medium clay; massive or moderate 2-5mm cast; clear or gradual change

B21 Yellowish red (5YR4-5/6-8); sandy clay loam to sandy medium clay

B22 Yellowish red (5YR4/6) to red (2.5YR3-5/6-8); sandy clay loam to sandy medium clay; massive to weak 5-10mm subangular blocky; gradual or diffuse change

B3/BC Dark red (10R3/6) to yellowish red (5YR5/8); fine sandy clay loam to light clay

These soils are often very deep and may overlie stratified sediments or a sequence of buried soils. Soils on the upper part of the alluvial fan may have coarse granitic gravels on the surface and throughout the profile. Many of these fans are very deeply dissected with the modern drainage system entrenched up to 40m below the fan surface.

Principal profile forms encountered include Gn2.1p, Uf6.52 and Um5p.

ANALYTICAL DATA

This soil was not sampled in the survey area. The following data are from the Tully- Innisfail survey (Murtha 1986).
Profile T241 Map Reference Tully 1:100 000 852153
TYSON SERIES Sampled from undisturbed rainforest

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.60	.60-.90	.90-1.20	1.20-1.50	1.50-1.80
Horizon	A11	A12	B1	B1	B21	B22	B22	B22	B3
pH	4.5	4.7	5.0	4.8	4.8	4.9	4.8	4.9	5.0
E.C.dS/m^{-1}	.146	.091	.065	.042	.041	.048	.032	.026	.029
Org.C%	2.78	1.53	0.75	0.44	.025	.018			
N%	.18	.13	.08	.05	.02				
AvP ppm	14	9	2		1				
Tot.P%	.020		.015		.014		.014		
Tot.K%	.21		.28		.31		.23		
Tot.S%	.036		1.35		1.97	2.44	2.25		
Free Fe%	.96		1.35		1.97	2.44	2.25		
Exchange properties m.e./100g soil									
Ca	.56		.16		.08	.08	.08		
Mg	.49		.13		.09	.13	.09		
K	.13		.08		.05	.07	.07		
Na	.05		.02		.02	.02	.05		
H+Al	2.0		1.6		1.3	1.2	1.3		
ECEC*	3.23		1.99		1.54	1.5	1.59		
ECEC/100g Clay	14.7		8.0		3.5	3.1	3.1		
CEC**	7.3		3.6		2.5	2.6	2.3		
CEC/100g C.**	33.2		14.4		5.7	5.3	4.5		
Base Sat***	17		11		10	12	13		
CEC****	2.3	2.4			1.8	2.0	2.0		
Particle Size %									
Gr	24	30	32	16	18	20	22	16	10
CS	53	42	50	37	34	33	32	37	50
FS	18	20	17	18	15	11	10	13	14
SI	7	9	7	6	8	7	7	8	9
C	22	28	25	39	44	49	51	41	26

Mineralogy of the clay fraction	Depth cm	ChV%	Ka%	G%	Go/Ha%
	20-30	1-5	>80	10-20	1-5
	45-60	1-5	65-80	20-30	1-5

* sum of basic and acidic cations *** $\frac{\text{Bases}}{\text{NH}_4\text{OAc CEC}} \times 100$ ** NH_4 OAc **** Comp. Exch

UTCHEE SERIES

CONCEPT: Red gradational or uniform textured soil formed in situ on granite.

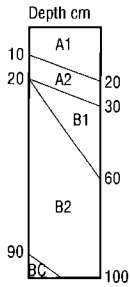
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	No suitable group	Gn2.14	Acidic, Dystrophic, Red, Kandosol

LANDFORM Low hills RAINFALL 4100mm
REFERENCE SITE Bartle Frere 1:100 000 823794

Horizon	Depth m	
A11	0 to 0.10	Brown (7.5YR4/3); sandy clay loam (light): moderate 2-5mm granular; moist moderately weak; <2% 2-6mm quartz gravel; gradual change to-
A11	0.10 to 0.20	Strong brown (7.5YR4/5); sandy clay loam (light); moderate 2-5mm granular; moist moderately weak; many roots; clear change to-
A2	0.20 to 0.30	Yellowish red (5YR5/6); sandy clay loam; weak 2-5mm granular; moist moderately weak; common roots; gradual change to-
A2/B1	0.30 to 0.45	Yellowish red (5YR5/6); sandy clay loam; weak 5-10mm angular blocky; moist moderately weak; <2% 2-6mm quartz gravel; few roots; diffuse change to-
B1	0.45 to 0.60	Yellowish red (5YR4/8); sandy light clay; massive; moist moderately weak; few roots; diffuse change to-
B1	0.60 to 0.90	Yellowish red (5YR4/8); sandy medium clay; massive; moist moderately firm; diffuse change to-
B21	0.90 to 1.20	Red (2.5YR4/7); sandy medium clay; weak 10-20mm angular blocky; moist very firm; <2% 2-6mm quartz gravel; diffuse change to-
B22	1.20 to 1.80	Red (2.5YR4/7); medium clay; weak 10-20mm angular blocky; moist very firm; diffuse change to-
B3	1.80 to 2.40	Red (2.5YR4/7); sandy light clay weak 10-20mm angular blocky; moist moderately firm; diffuse change to-
BC	2.40 to 3.00	Red (2.5YR4/7); sandy light clay; massive moist moderately weak

RANGE IN CHARACTERISTICS



A1 Reddish brown (5YR4/3-4); clay loam to sandy light clay; moderate to strong 2-5mm cast; 0-20% 2-6mm angular quartz gravel; gradual or diffuse change

B1 Dark red (2.5YR3/6) to red (2.5YR4/8); massive to weak 5-10mm subangular blocky; 0-10% 2-6mm angular quartz gravel

B2 Dusky red (2.5YR3/2) to red (2.5YR4/6); massive to weak 5-10 subangular blocky

Few profiles have been examined due to lack of access to most of the granite uplands. The ranges given here may not cover the range that might be encountered.

The profiles described in this survey tend to be less well structured than those in the Tully-Innisfail and Cardwell-Tully survey areas but they are otherwise very similar.

Principal profile forms encountered include Gn2.14, Gn3.14, Uf6.53 and Gn2.11.

ANALYTICAL DATA

Profile T242 Map Reference Bartle Frere 1:100 000 823794
UTCHEE SERIES Sampled from undisturbed closed forest

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.60	.60-.90	.90-1.20	1.20-1.50	1.50-1.80
Horizon	A11	A11	A2	A2/B1	B1	B1	B21	B22	B22
pH	5.0	4.9	4.8	4.8	4.8	4.9	4.9	4.9	4.9
Org.C%	1.47	1.11	0.97	0.62	0.45	0.31			
N%	.128	.105	.090	.060	.038				
AvP ppm	11	8	4		1				
Tot.P%	.020		.012		.009		.007		.008
Tot.K%	0.24		0.24		0.91		1.10		1.36
Tot.S%	.04		.04		.022		.023		.024
Free Fe%	0.66		0.96	1.76		1.29	1.59	1.69	.173
Exchange properties m.e./100g soil									
Ca	0.48		0.08		0.08	0.08	0.08		0.08
Mg	0.45		0.13		0.09	0.05	0.09		0.13
K	.09		.09		.02	.01	.005		.005
Na	.10		.06		.03	.03	.02		.03
H+Al	1.41		1.82		1.57	1.68	2.23		3.05
ECEC*	2.5		2.2		1.8	1.9	2.4		3.3
ECEC/100g Clay	10.0		7.3		5.1	5.8	7.7		13.2
Particle Size %									
Gr	14		16		14	14	10		12
CS	57		51		42	37	32		32
FS	8		8		10	11	12		15
SI	10		11		13	16	25		28
C	25		30		35	33	31		25

* sum of basic and acidic cations

ALMA SERIES

Few sites with the Alma series were described in this survey area and all had been highly disturbed. The following is from the Cardwell-Tully report (Cannon et al. 1992)

CONCEPT: A uniform to gradational soil, dark A horizon > 20cm and a red massive B horizon.

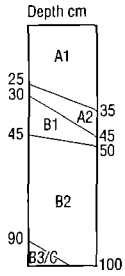
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Red Earth	Gn2.14	Melacic, Magnesic Red, Kandosol

LANDFORM Hillslope RAINFALL 2250mm
REFERENCE SITE Bartle Frere 1:100 000 758059

Horizon	Depth m	
A1	0 to 0.30	Black (10YR2/1); sandy clay loam(light); massive; moderately weak; many 2-5mm roots; diffuse broken change to-
A2	0.30 to 0.45	Very dark grey (5YR3/1); sandy clay loam; massive; moist moderately weak; common 1-2mm roots; clear change to-
B1	0.45 to 0.50	Reddish brown (5YR4/3); light clay; massive; moist moderately firm; few 1-2mm roots; clear change to-
B2	0.50 to 2.00	Red (2.5YR4/8); medium clay; massive; moist moderately firm; 20-50%, 2-6mm, subangular, dispersed quartz gravel.

RANGE OF CHARACTERISTICS



Ap Black (10YR2/1); sapric loam to clay loam; massive to weak subangular blocky or cast

A1 Black (7.5YR-10YR2/0-1) to dark brown (7.5YR3/2-3); sapricloam to clay loam; common angular quartz gravels; massive to moderate cast and subangular blocky; gradual or diffuse change

A2 Very dark grey (5YR3/1) to brown (7.5YR4/4); light sandy clay loam to sandy clay loam; clear or gradual change

B1 Dark brown (7.5YR3/4) to strong brown (7.5Yr5/8); clay loam to light clay; massive to weak subangular blocky

B2 Yellowish red (5YR3/6) to red (2.5YR4-5/8), distinct reddish yellow (7.5YR6/8) mottles may occur in lower B; clay loam to medium clay; common angular gravels; massive to moderate subangular blocky; some ironstone nodules have been recorded

Principal profile forms encountered include Gn2.14, Gn2.11, Gn3.11, Um7.11, and Dr2.11

ANALYTICAL DATA

This soil was not sampled in the survey area the following is from the Cardwell-Tully report (Cannon et al. 1992)
Profile T 361 Map Reference Kirrama 1:100 000 844944
ALMA SERIES Sampled from undisturbed eucalypt open forest

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.50	.50-.60	.60-.90	.90-1.20	1.20-1.50
Horizon	A1	A1	A1	A2	B1	B2	B2	B2	B2
pH	5.4	5.1	5.0	4.9	5.1	5.3	5.4	5.5	5.5
E.C.dS/m^{-1}	0.07	0.06	0.04	0.04	0.03	0.02	0.01	0.01	0.01
T.C.%	9.01		5.19	4.0		0.65			
N%	0.34		0.21	0.14		0.04			
AvP ppm	9	9	5	3	3	2			
P retn.%	82		83		78		41		
Free Fe%	2.0		1.9			2.4			
Tot.P%	0.03		0.021			0.011	0.008		
Tot.K%	0.19		0.16			0.13	0.06		
Tot.S%	0.05		0.032			0.016	0.024		
Tot.Fe%	1.5		2.1			2.4			
Tot.Cu%	.0005		<.0005			<.0005			
Tot.Zn%	.0016		.0027			.0033			
Tot.Mn%	0.016		0.01			0.007			
Exchange properties m.e./100 g soil									
Ca	2.5		0.11			<0.02	<0.02		<0.02
Mg	1.0		0.23			0.66	0.83		1.13
K	0.18		<0.02			<0.02	<0.02		<0.02
Na	0.03		0.03			<0.02	<0.02		<0.02
H+Al	0.76		2.46			0.71			0.12
ECEC*	4.5		2.9			3.5			1.3
ECEC/100g Clay	13.6		6.0			7.0			2.0
CEC**	24.2		17.1			1.4			3.2
CEC/100g C.**	73.3		35.6			2.8			4.8
Base Sat***	15		2			53			37
CEC****	4.2		2.5			1.9			2.4
Particle size %									
Gr	13	7	9	18	19	22	20	22	22
CS	35	33	32	29	34	36	35	36	26
FS	13	12	13	13	12	10	9	7	6
Si	13	11	7	7	5	4	2	1	1
C	39	44	48	51	50	50	54	56	66

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Qz%	Ha/Go%	G%
	60-90	1-5	>80	1-5	1-5	6-10

* sum of basic and acidic cations *** $\frac{\text{Bases}}{\text{NH}_4\text{OAc CE}} \times 100$ ** NH_4 OAc **** Comp. Exch

LUGGER SERIES

CONCEPT: Grey, massive, uniform or gradational textured soils formed on alluvial fans from granite.

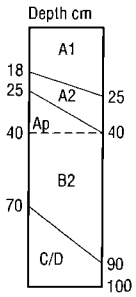
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Grey earth	Uc5.23	Acidic, Kandosolic, Oxyaquic, Hydrosol

LANDFORM Alluvial fan RAINFALL 4000mm
REFERENCE SITE Bartle Frere 1:100 000 848772

Horizon	Depth m	
A1	0 to 0.18	Very dark grey (10YR3/1); coarse sandy loam; weak 5-10mm cast; moist moderately weak; 10-20% 2-6mm, angular quartz gravel; gradual change to-
B21	0.18 to 0.33	Light grey (10YR7/2); coarse sandy loam; massive; moist very weak; 10-20% 2-6mm, angular quartz gravel; diffuse change to-
B22	0.33 to 0.67	Pale brown (10YR6/3); coarse sand; single grain; moist loose; 20-50% 2-6mm, angular quartz gravel; clear change to-
D1	0.67 to 0.80	Greyish brown (10YR5/2); sandy medium clay; moderate 5-10mm angular blocky; moist moderately weak; gradual change to-
D2	0.80 to 1.20	Very pale brown (10YR7/4); coarse sand; single grain; moist loose; 20-50% 2-6mm, angular quartz gravel.

RANGE OF CHARACTERISTICS



A1/Ap Black (10YR2/1) to dark grey (10YR4/1); coarse sandy loam to coarse sandy clay loam

A2 The majority of sites examined had been cultivated so any evidence of A2 horizons had been destroyed. In addition the A2 designation is often very subjective as there is little colour difference between the A2 and the B and there may or may not be a textural change

B2 Brownish grey (2.5Y5/2) to pale brown (10YR6/3) or white (10YR8/1); coarse sand to sandy medium clay, commonly sandy clay loam.

Lugger series can overlie stratified sediments or D horizons ranging from coarse sands to highly pedal clays. It often occurs in close association with Malbon series. The main feature which differentiates the two soils is the surface texture – Lugger series is coarse sandy, Malbon is much finer and may be as heavy as sandy medium clay.

Principal profile forms encountered include Uc5.23, Gn2.91p, Gn2.94, and Uc3.

ANALYTICAL DATA

This soil was not sampled in this survey area. The following data are from the Tully-Innisfail area (Murtha 1986).
Profile T292 Map Reference Tully 1:100 000 918123
LUGGER SERIES Site is cleared and has been cultivated for many years.

Depth m	0-.10	.10-.20	.20-.30	.30-.40	.40-.60	.60-.90	.90-1.20	1.20-1.50
Horizon	Ap	Ap	Ap	A3	B1	B2	B2	B3
pH	6.4	5.5	5.3	5.5	5.3	5.3	5.4	5.5
E.C.dS/m-1	.059	.044	.041	.035	.023	.020	.008	.017
Org.C%	1.28		1.16		0.64			
N%	.09		.09		.06			
AvP ppm	76		17		11			
Tot.P%	.027				.012			
Tot.K%	1.78				2.54			
Tot.S%	.018				.017			
Exchange properties m.e./100g soil								
Ca	.54		.12		.29		.20	
Mg	.77		.11		.11		.12	
K	.15		.15		.06		<.01	
Na	.04		.03		.04		<.01	
H+Al	.40		1.9		2.3		1.1	
ECEC*	1.90		2.31		2.80		1.42	
ECEC/100g Clay	14.6		10.0		14.0			
CEC**	3.9		5.2		4.0			
CEC/100g C.**	30.0		22.6		20.0			
Base Sat***	38		8		12			
CEC****	2.3		2.2		2.1		1.5	
Particle Size %								
Gr	6	8	5	tr	tr	4	5	tr
CS	58	51	43	39	36	39		49
FS	21	24	24	28	33	35		24
SI	9	10	11	10	11	9		9
C	13	16	23	23	20	17		18

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4oAc\ CEC} \times 100$ ** NH_4oAc **** Comp. Exch

THORPE SERIES

CONCEPT: Yellow massive gradational or uniform textured soils formed on alluvial fans from granite.

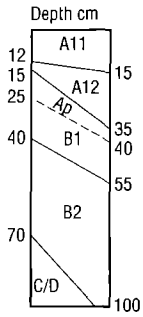
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Yellow Earth	Gn2.21	Haplic, Dystrophic, Brown, Kandosol

LANDFORM Alluvial fan RAINFALL 4000mm
REFERENCE: SITE Bartle Frere 1:100 000 843756

Horizon	Depth m	
A11	0 to 0.13	Brown (10YR4/3); sandy loam ; massive; moist very weak; 20-50% 2-6mm,subrounded granite gravel; common 1-2mm roots; diffuse change to-
A12	0.13 to 0.36	Brown (10YR4/3); sandy loam ; massive; moist very weak; 10-20% 2-6mm,subrounded granite gravel; few 1-2mm roots; diffuse change to-
B1	0.36 to 0.55	Yellowish brown (10YR5/4); sandy clay loam, coarse sandy; massive; moist very weak; 2-10% 6-20mm, subrounded quartz gravel; few 1-2mm roots; diffuse change to-
B2	0.55 to 0.75	Light olive brown (2.5Y5/4); sandy clay loam, coarse sandy (heavy); massive; moist moderately weak; 10-20% 6-20mm, subrounded granite gravel; diffuse change to-
B3	0.75 to 1.00	Light olive brown (2.5Y5/4); sandy clay loam ; massive; moist moderately weak; 20-50% 2-6mm, subrounded granite gravel; diffuse change to-
C	1.00 to 1.60	Greyish brown (2.5Y5/2); loamy sand ; single grain; moist very weak; 50-90% 6-20mm, subrounded granite gravel; diffuse change to-
D	1.60 to 1.78	Light brownish grey (2.5Y6/2); fine sandy loam; massive; moist moderately weak.

RANGE OF CHARACTERISTICS



Ap Very dark greyish brown to brown (10YR4-5/2-3);sandy loam (heavy) to sandy light clay; massive or weak 5-10mm cast; moderately weak moist; 2-20% 2-6mm sub rounded granite gravel.

A1 Dark grey to dark brown (10YR3-4/1-3);sandy loam to sandy clay loam; massive to moderate subangular blocky or cast;

B1 Dark yellowish brown to pale brown (10YR3-6/3-4); sandy loam (heavy) to sandy clay loam; massive to weak 5-10mm subangular blocky; 2-20% 2-20mm subrounded granite gravel; gradual or diffuse change to;

B2 Dark yellowish brown to brownish yellow (10YR3-6/4-6), may occasionally have a few faint mottles; sandy clay loam to sandy light clay.

Thorpe series may overlie C horizons of coarse unsorted granitic detritus, or buried soils formed on fan materials, or along the toe of the fans it may overlie buried soils formed on riverine alluvium. The majority of the soils described were in cultivated cane lands where the texture profile has been modified by deep cultivation and to a lesser extent by soil erosion.

Principal profile forms encountered include Gn2.21. Gn2.2p (most common), Um5.5p, Gn2.8p, Uc4.21 and Uf6.6p.

ANALYTICAL DATA

Profile T487 Map Reference Bartle Frere 1:100 000 842755
THORPE SERIES Cleared site, may have been cultivated in the past.

Depth m	0-.13	.13-.36	.36-.55	.55-.75	.75-1.00	1.00-1.30	1.30-1.60	1.60-1.78
Horizon	A11	A12	B1	B2	B3	C	C	D
pH	5.5	5.4	5.2	5.5	5.7	5.7	5.8	5.7
E.C.dS/m^{-1}	.032	.018	.020	.014	.008	.008	.009	.009
Org.C%	2.15	1.67	1.16	0.70				
N%	.09	.05	.03	.03				
AvP ppm	25	13	9	13				
Tot.P%	.080		.070	.070				.040
Tot.K%	3.20		3.34	3.68				4.31
Tot.S%	.030		.020	.020				.010
Free Fe%	0.8		0.7	0.7				
Exchange properties m.e./100g soil								
Ca	.70		.20	.16		<.02		.64
Mg	.56		.16	.16		.88		.18
K	.22		.04	.04		.03		.12
Na	.06		.04	.04		.05		.08
H+Al	1.10		1.15	0.82		0.20		1.21
ECEC*	2.6		1.6	1.2		1.2		2.2
ECEC/100g Clay	15.3		7.6	5.5		12.0		18.3
CEC**	5.1		3.1	3.0				
CEC/100g C.**	30.0		14.8	13.6				
Base Sat***	29		24	13				
CEC****	2.2		1.4	1.1		0.9		1.2
Particle Size %								
Gr	46	28	38	28	49	53	52	1
CS	61	56	56	63	57	67	65	22
FS	11	13	13	14	16	16	18	51
SI	11	11	10	10	9	8	8	16
C	17	20	21	22	18	10	9	12

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** NH_4 OAc **** Comp. Exch

PRIOR SERIES

CONCEPT: Mottled yellow and grey massive uniform or gradational textured soils formed on alluvial fans from granite.

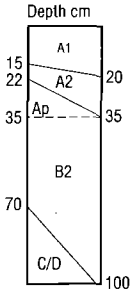
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	?Gleyed Podzolic soil	Gn2.8p	Yellow, Kandosol

LANDFORM Alluvial fan
REFERENCE SITE Cairns 1:100 000 734219

Horizon	Depth m	
Ap	0 to 0.35	Dark greyish brown (10YR4/2); sandy clay loam; massive; moderately moist weak; 10-20% 2-6mm, angular quartz gravel; clear change to-
B21	0.35 to 0.70	Light yellowish brown (10YR6/4) with 10-20% 15-30mm distinct very pale brown (10YR7/3) and strong brown (7.5YR5/8) mottles; coarse sandy clay; massive; moderately moist firm; 10-20% 2-6mm, angular quartz gravel; diffuse change to-
B22	0.70 to 1.25	Light brownish grey (10YR6/2) 10-20% 5-15mm distinct yellowish brown (10YR5/6) mottles; coarse sandy light clay; massive; moderately moist firm; 20-50% 2-6mm, angular quartz gravel; diffuse change to-
D	1.25 to 1.50	Grey (10YR6/1) 10-20% 5-15mm prominent reddish yellow (5YR6/8) mottles; coarse sandy loam; weak 2-5mm subangular blocky; moderately wet very weak; 20-50% 2-6mm, angular quartz gravel.

RANGE OF CHARACTERISTICS



Ap Very dark grey (10YR3/1) to very dark greyish brown (10YR3/2); sandy clay loam to sandy light clay; massive to weak subangular blocky.
A1 Very dark greyish brown (10YR3/1) to dark greyish brown (10YR4/2); clay loam to light clay; massive to moderate cast and subangular blocky.
A2 Grey (10YR5/1) to light yellowish brown (10YR6/4), may be bleached; coarse sandy loam to coarse sandy clay loam; 10-20% 2-6mm angular quartz gravel.
B21 Yellowish brown (10YR5/8) to brownish yellow (10YR6/6-8) with light grey (10YR7/1) mottles; sandy clay loam to sandy medium clay; massive to weak subangular blocky
B22 Grey (10YR6/1) to light brownish grey (10YR6/2) with red (10R4/8) to brownish yellow (10YR6/6-8) mottles; sandy clay loam to sandy medium heavy clay; massive to moderate sub angular blocky.
D There may be a number of D horizons which are usually dominantly light grey in colour but have a wide texture range from coarse sand to medium clay.
Principal profile forms encountered include Gn2.84, Gn2.91, Gn3.71 and Gn2.7p
This soil was not sampled in this survey area, the following is from the Cardwell-Tully report (Cannon et al. 1992)

ANALYTICAL DATA

Profile T367 Map Reference Kirrama 1:100 000 843989
PRIOR SERIES Sampled from undisturbed Melaleuca low woodland.

Depth m	0-.05	.05-.10	.10-.15	.20-.30	.30-.60	.60-.90	.90-1.20	1.20-1.50	1.50-1.80
Horizon	A11	A12	A12	A2	B21	B22	B22	D	D
pH	5.9	5.6	5.7	5.8	5.5	5.7	6.1	6.0	5.7
E.C.dS/m^{-1}	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	2.89	1.62		0.31	0.13			0.05	
N %	0.15	0.08							
AvP ppm	2				2				
P retn. %	28								
Free Fe %	1.0				1.1			0.4	
Tot. P %	0.009				0.003			0.001	
Tot. K %	3.06				3.44			1.0	
Tot. S %	0.031				0.012			0.003	
Tot. Cu %	0.0006			0.0005	0.0008				
Tot. Zn %	0.0024			0.0026	0.0026				
Tot. Mn %	0.012			0.009	0.007				
Exchange properties m.e./100g soil									
Ca	0.16	0.05		0.02	0.02			<.02	<.02
Mg	0.29	0.17		0.25	0.49			0.34	0.75
K	0.08	0.11		0.09	0.06			0.04	0.08
Na	0.03	0.04		0.05	0.02			<.02	0.02
H+Al	1.54	1.02		0.73	1.12			0.67	1.01
ECEC*	2.1	1.4		1.1	1.7			1.1	1.9
ECEC/100g Clay	11.7	8.7		6.5	8.1			7.9	6.6
CEC **	6.5	3.8		1.0	3.8			1.6	2.0
CEC/100g C.**	36.1	23.7		5.9	18.1			11.4	
*Base Sat.****	*9*	*10*		*41*	*15*			*26*	*44*
CEC****	2.3	1.3		1.3	2.1			1.7	1.7
Particle size %									
Gr	1	6	18	15	18	37	23	12	13
CS	56	60	59	54	50	48	47	53	47
FS	13	17	16	18	17	16	19	21	14
Si	13	10	10	10	12	12	13	12	10
C	18	16	14	17	21	25	21	14	29

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Qz%
	30-60	6-10	>80	1-5
	150-180	1-5	>80	1-5

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4OAc\ CEC} \times 100$ ** NH_4OAc **** Comp. Exch

KIRRAMA SERIES

Few sites were described in this survey area and all had been highly disturbed. The following is from the Cardwell-Tully report (Cannon et al. 1992)

CONCEPT: A uniform to gradational soil, dark A horizon > 20cm and a yellow massive B horizon.

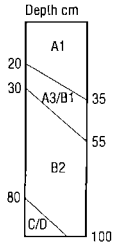
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Yellow Earth	Gn2.21	Melacic, Magnesic Yellow, Kandosol

LANDFORM Alluvial fan RAINFALL 2250mm
REFERENCE SITE Bartle Frere 1:100 000 781040

Horizon	Depth m	
A11	0 to 0.10	Black (10YR2/1), (10YR2/1d); sapric sandy clay loam; massive; moist very weak; diffuse change to-
A12	0.10 to 0.30	Very dark grey (10YR3/1), (10YR3/2d); sandy clay loam; massive; moist very weak; diffuse change to-
A3/B1	0.30 to 0.55	Dark yellowish brown (10YR4/4); 10-20% 5-15 mm faint, brownish yellow (10YR6/8) mottles; sandy clay loam; massive; moist moderately weak; 2-10% 2-6mm, angular quartz gravel; gradual change to-
B21	0.55 to 1.0	Yellow (10YR7/8); sandy light clay; massive; moist moderately weak; 20-50% 2-6mm, angular quartz gravel; diffuse change to B22 1.0 to 1.4 Yellow (10YR7/8) 10-20%, 5-15mm, prominent, red 2.5YR 4/8) mottles; sandy light clay; massive; moist moderately firm; 20-50%, 2-6mm, subangular quartz gravel; diffuse change to-
B/C	1.4 to 2.0	Red (2.5YR4/8); 10-20% 5-15mm distinct, yellow (10YR7/8) mottles; sandy light clay; massive; moist moderately firm; 20-50% 2-6mm, subangular quartz gravel

RANGE OF CHARACTERISTICS



A1 Black (10YR2/1) to very dark grey (10YR3/1); light sandy clay loam to sandy clay loam (often sapric); massive to moderate cast
A2 Brown (10YR5/3) to yellowish brown (10YR5/4); coarse sandy loam; massive; earthy; clear or gradual change
A3-B1 Brown (10YR5/3) to yellowish brown (10YR5/4); sandy clay loam to clay loam; gradual or diffuse change
B2 Olive yellow (2.5Y6/6) to yellow (10YR-2.5Y 7/6-8) with prominent red (7.5R-10R 5/8) mottles at depth; sandy clay loam to medium clay; clear or diffuse change
B3-BC Yellow (2.5Y7/6) to red (2.5YR4/8) mottled either colour may be dominant; sandy light clay to medium clay; massive to weak subangular blocky
The colour of the lower B horizon may change sharply from whole coloured yellow to whole coloured red. Principal profile forms encountered include Gn2.21, Gn2.24 and Um4.23.

ANALYTICAL DATA

This soil was not sampled in this survey area the following is from the Cardwell-Tully report (Cannon et al. 1992)
Profile T362 Map Reference Kirrama 1:100 000 853933
KIRRAMA SERIES Sampled from undisturbed eucalypt forest.

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.55	.60-.90	1.00-1.20	1.40-1.50	1.50-1.80
Horizon	A11	A12	A12	A3	B1	B21	B22	BC	BC
pH	5.4	4.8	5.1	5.2	5.3	5.5	5.6	5.4	5.3
E.C.dS/m^{-1}	0.01	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
T.C. %	5.45		2.88			0.24	0.11		
N %	0.28		0.12						
AvP ppm	7	4	3	2	2	2			4
P retn. %	64		66		43	32			
Free Fe %	1.3		1.4			1.5			
Tot. P %	0.02		0.012			0.01			0.015
Tot. K %	0.15		0.06			0.06			0.05
Tot. S %	0.039		0.029			0.02			0.018
Tot. Cu %	<.0005		<.0005			<.0005			
Tot. Zn %	0.002		0.003			0.004			
Tot. Mn %	0.013		0.012			0.01			
Exchange properties m.e./100g soil									
Ca	0.16		<.02			<.02			<.02
Mg	0.24		0.06			0.45			0.85
K	<.02		<.02			<.02			<.02
Na	0.02		<.02			0.04			0.03
H+Al	2.9		1.9			0.26			0.1
ECEC*	3.3		2.0			0.8			1.0
ECEC/100g Clay	12.7		6.1			2.2			1.8
CEC **	17.1		9.5			2.3			2.6
CEC/100g C.**	65.8		28.8			6.2			4.7
Base Sat.***	3		1			23			35
CEC****	3.0		1.8			1.7			2.2
Particle size %									
Gr	3	6	8	11	15	15	24	21	19
CS	56	47	46	48	46	47	40	40	36
FS	12	17	16	15	16	14	12	8	8
Si	6	6	5	5	4	2	3	2	2
C	26	30	33	32	34	37	45	50	55

Mineralogy of the clay fraction	Depth cm	I%	Ka%	ChV %	Qz%	G%
	60-90	<1	>80	1-5	1-5	1-5

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** NH_4 OAc **** Comp. Exch

MALBON SERIES

CONCEPT: Grey, occasionally yellow, may be mottled, uniform or gradational textured soils formed on alluvial fans from granite.

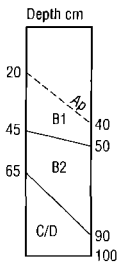
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Affinities with Yellow Earth	Gn2.21	Acidic, Dystrophic, Brown, Kandosol

LANDFORM Alluvial Fan RAINFALL 4000mm
REFERENCE SITE Bartle Frere 1:100 000 851751

Horizon	Depth m	
Ap	0 to 0.21	Dark greyish brown (10YR4/2); sandy clay loam; moderate 10-20mm subangular blocky; moist very firm; 2-10% 2-6mm, subrounded quartz gravel; few 1-2mm roots; clear change to
B2	0.21 to 0.57	Greyish brown (2.5Y5/3); sandy light clay; weak 10-20mm subangular blocky; moist moderately firm; 10-20% 6-20mm, subrounded quartz gravel; few 1-2mm roots; diffuse change to
B3	0.57 to 0.82	Greyish brown (2.5Y5/2); 2-10% 5-15mm yellowish brown (10YR5/6) mottles; sandy clay loam, coarse sandy ; massive; moist moderately weak; 20-50% 2-20mm, subrounded granite gravel; clear change to
BD	0.82 to 1.04	Brown (10YR5/3); 20-50% 15-30mm yellowish brown (10YR5/8) mottles; sandy light clay; massive; moist very firm; <2% 2-6mm, subrounded quartz gravel; diffuse change to
D	1.04 to 1.23	Strong brown (7.5YR5/8); 20-50% 15-30mm light grey (10YR7/1) mottles; heavy clay; moderate 5-10mm angular blocky; moist very firm; diffuse change to
D	1.23 to 1.55	Grey (10YR6/1); 20-50% >30mm strong brown (7.5YR5/6) primary and red (2.5YR5/8) secondary mottles; heavy clay; moderate 5-10mm angular blocky; moist moderately strong;
D	1.55 to 1.92	Grey (10YR6/1); 20-50% >30mm strong brown (7.5YR5/6) primary and red (2.5YR5/8) secondary mottles; heavy clay; moderate 5-10mm angular blocky; moist moderately strong.

RANGE OF CHARACTERISTICS



Ap Dark greyish brown (10YR4/2) to light brownish grey (10YR6/2); sandy loam to sandy medium clay; massive to moderate 10-20mm subangular blocky;
B1 Greyish brown (10YR5/2); sandy medium clay; massive; moderately moist.
B2 Brown to pale olive (10YR-5Y 5-6/2-4); 10-50% prominent yellowish brown (10YR5-6/8) mottles; sandy light clay to sandy medium heavy clay; massive to weak 10-20mm subangular blocky.
Buried soils formed on fine textured riverine alluvium occur from depths as shallow as 0.95m. No virgin soils were examined. Evidence suggests that these soils were gradational textured in their undisturbed state but the textured profile has been modified by cultivation such that most soils are now uniform fine textured.
Principal profile forms encountered include Gn2.21p, Uf6.4p, Uf6.6p and Gn2.6p.

ANALYTICAL DATA

Profile T488 Map Reference Bartle Frere 1:100 000 851751
MALBON SERIES Sampled from cultivated cane

Depth m	0-.21	.21-.40	.40-.57	.57-.82	.82-1.04	1.04-1.23	1.23-1.55	1.55-1.92
Horizon	Ap	B2	B2	B3	BD	D	D	D
pH	5.8	5.8	5.3	5.1	5.1	5.1	5.1	5.3
E.C.dS/m^{-1}	.036	.017	.015	.015	.014	.016	.017	.016
Org.C%	1.74	0.92	0.61	0.45				
N%	.04	.04	.03	.02				
AvP ppm	42	23	17	62				
Tot.P%	.070		.040			.040		
Tot.K%	2.86		3.09			2.59		
Tot.S%	.030		.030			.020		
Free Fe%	0.5		0.4			2.1		
Tot Fe %	1.69		1.62			4.61		
Tot Cu %	.0011		.0013			.0024		
Tot Zn %	.0046		.0042			.0068		
Tot Mn %	.030		.030			.050		
Exchange properties m.e./100g soil								
Ca	3.0		0.66			0.44		0.62
Mg	.30		.10			.17		.26
K	.10		.05			.09		.12
Na	.08		.08			.06		.06
H+Al	0.16		1.53			2.65		2.36
ECEC*	3.6		2.4			3.4		3.4
ECEC/100g Clay	13.8		9.2			9.7		7.9
CEC**	5.9		3.7			5.2		
CEC/100g C.**	22.7		14.2			14.9		
Base Sat***	58		24			14		
CEC****	3.4		1.6			1.8		1.3
Particle Size %								
Gr	8	12	16	51	5	1	0	0
CS	34	40	40	53	50	4	3	4
FS	20	17	18	14	21	23	13	16
SI	20	17	16	8	11	37	35	37
C	26	26	26	24	17	35	49	43

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** NH_4OAc **** Comp. Exch

MAPPING UNITS : SOILS OF GRANITIC ORIGIN

UTCHEE ASSOCIATION Ut 10 UMAs 687ha.

This association includes all of the undulating to low hilly units on granite bed-rock. It is very limited in area and takes in some of the foothills of Mounts Bartle Frere and Bellenden Ker and a few small units along the Malbon Thompson Range.

The dominant soils are the red structured soils of Utchee series. Similar yellow soils (Severin series of Laffan 1988) may also occur. The red massive soils of Tyson series will be the dominant soil on any of the alluvial fans which may be included. Due to the difficulty of differentiation on the basis of airphoto pattern, small areas of the soils of Galmara association may be included where this unit abuts the metamorphic uplands and around the lower slopes of Mounts Bartle Frere and Bellenden Ker.

TYSON ASSOCIATION Ty 40 UMAs 3613ha.

This association is dominated by the red massive soils of Tyson series which occupy the upper slopes of the alluvial fans. It is not as extensive as might be expected in this survey area considering the extent of the granitic fans. The yellow Thorpe series continues much further up the slope and this must be a result of wetter conditions due to the sheer volume of water shed from the uplands as subsurface flow. The catchment of many of these fans receive in excess of 6 000mm rainfall per annum and significant falls can occur throughout the year.

Although a number of units have been mapped in this association, many of these were inaccessible and were not inspected during the course of the survey. The authors have relied wholly on air photo interpretation so there may be some doubt as to the dominant and associated soils. This comment applies particularly to the units on the eastern side of the Malbon Thompson Range and to those in the head-waters of the Mulgrave and Russell Rivers and Babinda Creek

Although Tyson series is the dominant soil, Thorpe series is closely associated and may be co-dominant in some areas. Alma series which is similar to Tyson series but has a thick black A horizon, may occur at random throughout the unit but usually only as small patches. Although it may not be significant in area it may have very different nutritional requirements particularly in relation to phosphorus retention. Small areas of Utchee series will be included on the upper slopes or on any hard rock outliers which may be mapped with the fans

Some of the upper fan slopes are very gravelly with boulders up to two metres in diameter and some are very deeply dissected. As an example the modern drainage is entrenched some 25-30m into the fans behind Mirriwinni.

THORPE ASSOCIATION Th 36 UMAs 5453ha.

This is the most extensive of the units mapped on the granitic fans. It usually occupies the mid slope position but as discussed in Tyson association it can extend much higher up the slope in this part of the wet coast. In addition, some of these fan slopes are very complex with evidence of successive additions by mass flow and then periods of relative stability when soil formation took place. Some of the fans in the vicinity of Mirriwinni have up to five buried soils where the full profile including the A horizon has been preserved and where the morphology of the buried soils are remarkably similar to the modern soil.

Although the whole coloured yellow soils of Thorpe series are dominant, few areas can be mapped even as reasonably pure units. Many have been mapped as co-dominants and the co-dominant soil varies somewhat. In the Mirriwinni area it is most likely to be Malbon series while along the Malbon Thompson Range it is most likely to be Prior or Lugger series. On the lower end of the fans and particularly where this association abuts the Malbon association small areas

of a heavy textured variant of Thorpe series, as described by Cannon et al (1992), may occur. The complexity of the fans , the scale of mapping and the masking of the airphoto pattern due to disturbance and cultivation has rendered any further subdivision impracticable. Lugger series will be a commonly associated soil on the lower ends of the units. Small areas of Kirrama series occur particularly in the Fishery Falls area.

LUGGER ASSOCIATION Lu 4 UMAs 318ha.

This association which is dominated by Lugger series occurs on the lower end of the granitic fans and is the wettest of the units formed on the fans. Although parts of this survey area receive the highest rainfalls on the wet coast, there are surprisingly few mappable areas of Lugger series. The largest area occurs to the south east of Green Hill where it is mapped as a co-dominant with Thorpe series. Smaller units occur in the Babinda-Mirriwinni area. Associated soils include Thorpe and Prior series on upper slopes and Malbon series on lower slopes. A heavy texured variant of Lugger series occurs in the fans around Mirriwinni. The B horizon texture may be as heavy as coarse sandy medium clay. It differs from Malbon series in that B horizon colours are paler and it is not structured.

PRIOR ASSOCIATION Pr 3 UMAs 773ha.

Prior association is limited to the western slopes of the Malbon Thompson Range in the vicinity of Green Hill. The soil pattern on these fans is very complex and it was difficult to determine any real pattern in the soil distribution. To a large extent this is due to the drainage works that have been carried out. These works include excavation of a system of straight drains along the block layout and the filling and levelling of the natural channels. Large amounts of soil are moved and the natural landform significantly modified.

While the mottled soils of prior series are dominant a number of other soils are closely associated and may be co-dominant in some areas. Thorpe series is commonly associated in the better drained sites while Malbon and Lugger series occur in the poorer drained sites. Small areas of the dark surfaced soils of Kirrama series may also occur.

MALBON ASSOCIATION Mb 12 UMAs 2000ha.

This association occurs on the lower end of the alluvial fans. To some extent it is restricted to the longer fans where there may have been some downward fining resulting in the heavier textured soils. It is common along the Bellenden Ker Range and on the northern end of the Malbon Thompson Range.

The dominant soils are Malbon series which are yellow and grey mottled soils similar to Prior series but with much heavier textures in the A and B horizons. Thorpe and Prior series are the most commonly associated soils and in a number of areas are mapped as co-dominants. Lugger series and a heavy textured variant are minor associates. Low elongate rises of channel infill are common particularly on the slopes to the east and north east of Mirriwinni. Goolboo and Thorpe series occur on these rises

The UMA straddling Pine Creek Road immediately to the north of Green Hill has been mapped as Malbon series dominant but the interpretation of landform and airphoto pattern is by no means unequivocal. This area seems to be flat yet the soils have high amounts of granitic grit throughout and for that reason alone it has been included with the granitic soils. It is possible that in this area there has been some reworking of the fans by wave action when sea level was a little higher than present.

KIRRAMA ASSOCIATION Km 2 UMAs 149ha.

This is a minor unit and has been mapped in only two areas. One occurs on the upper fan slopes of Walshs Pyramid and the other on the fan slopes to the east of Green Hill. The dark surfaced yellow soils of Kirrama series are dominant but similar red soils of Alma series are closely associated on the upper slopes and some Prior series may occur on the lower slopes.

MOUNTAINOUS UNIT M2 5 UMAs 64256ha.

This unit includes all of the hilly to mountainous granite lands. Small areas of metasediments may be included particularly on the lower eastern slopes of Mounts Bartle Frere and Bellenden Ker where disturbance has made accurate photo interpretation difficult. There is little access to these areas so examinations are limited to the few roads and lower slopes that abut the cane-lands. On these lower slopes it is difficult to distinguish between soils that have formed insitu from those that are a result of downslope movement. Mass movement and surface wash are major features of this environment so there are probably few soils that could be described as having wholly formed insitu.

The red structured soils of Utchee series are probably dominant but there may be areas of similar yellow soils (Severin series of Laffan 1988) and the red massive soils of Tyson series will occur on the lower slopes. The slopes are steep to very steep, the surface of much of the unit will be littered with boulders and there are significant areas of bare rock as evidenced by the slopes of Walshs Pyramid.

WELL DRAINED SOILS FORMED ON ALLUVIUM

Ten soil series have been included in this grouping. Their major distinguishing features are summarised in Table 6. To some extent the distinction between well and poorly drained is somewhat arbitrary as in most places the soils form a continuum slowly changing from one to another. Many of the soils formed on alluvium can be identified with a particular landform element and the boundary between the soils is as sharp as the landform change. Where the change is very gradual a large part of the area will have soils which exhibit properties of two soils. In such cases discretion is needed to place the soils in the series considered most appropriate.

To a large extent the alluvial soils have formed on mixed deposits from all three parent materials. There are small areas of soils along some of the minor streams formed from a single parent material particularly from the granite and metamorphic rocks. The contribution from basalt varies considerably between catchments and in some catchments there appears to be greater or lesser contribution over time but it hasn't made a significant difference to the distribution of soils. The major exception is the lack of the finer textured soils in particular Innisfail series along the Barron River. The Barron has a large catchment and drains a large area of basalt on the Atherton Tablelands but has a relatively insignificant alluvial plain and the vast majority of that is of recent origin. This indicates that the Barron as a significant stream is a relatively recent addition to the coastal drainage waters.

Table 6. Well drained soils formed on alluvium

SERIES	LANDFORM	MAJOR DISTINGUISHING FEATURES
TULLY	Stream levees flood plain and terraces	Uniform to gradational texture profile, yellow, strongly structured, silty clay loam to silty clay textures.
INNISFAIL	Stream levees flood plain and terraces	Uniform to gradational texture profile, brown, strongly structured, silty clay loam to medium clay textures.
MOSSMAN	Flood plain	Similar to Tully series but with a dark A1 or Ap horizon.
LIVERPOOL	Low terraces, channel benches and levees	Brown, massive, uniform textured, fine sandy loam to clay loam over stratified sands.
JAPOON	Channel bench	Stratified coarse sands with cobble and boulders.
VIRGIL	Stagnant alluvial plain	Massive, red uniform to gradational textured.
JARRA	Stagnant alluvial plain	Structured, mottled yellow brown and grey gradational textured soil.
CANOE	Stream levees and prior streams	Massive, yellow, uniform to gradational textured, fine sandy texture.
SILKWOOD	Prior stream levees	Gradational textured soils with red massive B horizons.
GOOLBOO	Prior streams	Coarse uniform sands.

TULLY SERIES

CONCEPT: Bright yellowish , uniform or gradational silty clay loam to silty medium clay texture profile.

REPRESENTATIVE PROFILE

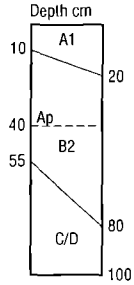
	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	No provision	Gn3.71	Acidic, Dystrophic, Brown, Dermosol

LANDFORM Alluvial plain RAINFALL 4250mm
REFERENCE SITE Bartle Frere 1:100 000 844794

Horizon	Depth m	
A1	0 to 0.20	Dark brown (10YR3/3); silty clay loam (heavy); moderate 2-5mm cast; moderately moist moderately firm;
B21	0.20 to 0.45	Yellowish brown (10YR5/6); silty light clay; moderate 2-5mm subangular blocky; moist moderately firm;
B22	0.45 to 0.65	Strong brown (7.5YR5/8); sandy medium clay (heavy); moderate 2-5mm subangular blocky; moist moderately firm;
B23	0.65 to 1.00	Yellow (10YR7/8); 2-10% 5-15mm distinct red (2.5YR4/8) mottles; sandy medium clay (heavy); moderate 2-5mm subangular blocky; moist moderately firm;
B24	1.00 to 1.20	Brownish yellow (10YR6/6); 10-20% 5-15mm distinct light yellowish brown (2.5Y6/4) primary and red (2.5YR4/8) secondary mottles; heavy clay; strong 2-5mm subangular blocky; moist very firm.

NOTE: Red mottles are slightly hardened

RANGE OF CHARACTERISTICS



Ap Dark greyish brown (10YR4/2) to yellowish brown (10YR5/4) (10YR7/3-4) dry; light clay to medium clay, often silty, occasionally fine sandy; moderate to strong 2-5mm subangular blocky or cast.

B2 Yellowish brown (10YR5/6) to brownish yellow (10YR6/6) very occasionally with 2-10% faint 5-10mm yellowish red (5YR5/6) mottle; moderate to strong 5-10mm subangular blocky.

BC/C BC and C horizons are extremely variable. In most soils there is a gradual increase in sandyness to stratified well sorted sands from about 80cm although it may occur from as shallow as 55cm.

In some soils there is evidence of a sequence of buried B horizons but only rarely is the whole buried soil profile preserved. Very occasionally they overlie buried peats.

Principal profile forms encountered include Gn3.71, Uf6.34, and Uf6.4.

ANALYTICAL DATA

This soil was not sampled in this survey area. The following data are from the Tully- Innisfail area (Murtha 1986).
Profile T257 Map Reference Tully 1:100 000 860118
TULLY SERIES Sampled in undisturbed rainforest

Depth m	0-.10	.10-..20	.20-.30	.30-.45	.45-.60	.60-.90	.90-1.20	1.60-1.80
Horizon	A1	A3	B1	B21	B22	B3	BC	C
pH	5.3	4.7	5.2	5 0	4.9	4.9	4.8	4.8
E.C.dS/m^{-1}	.063	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Org.C%	2.79	1.44	0.65	0.39		0.17		
N%	.22	.15	.65	.09				
AvP ppm	21	8		3				
Tot.P%	.058				.019			
Tot.K%	2.36				2.20			
Tot.S%	.056				.028			
Free Fe%	1.75	1.82		1.82		1.29		
Exchange properties m.e./100g soil								
Ca	3.02	.88	.32	.16	.16	.08	.08	.08
Mg	2.31	1.09	.54	.30	.22	.19	.11	.15
K	.52	.23	.11	.06	.06	.02	.06	.06
Na	.09	.05	.06	.07	.06	.05	.04	.03
H+Al	.85	2.8	3.2	3.6	3.4	2.9	2.7	1.7
ECEC*	6.79	5 05	4.23	4.19	3.9	3.24	3.99	2.02
ECEC/100g Clay	15.8	11.5	9.8	9.7	10.0	11.6	15.0	13.5
CEC**	15.3		7.7		6.3	4.6	3.9	
CEC/100g C.**	35.6		17.9		16.2	16.4	19.5	
Base Sat***	39		13		8	7	7	
CEC****	7.0			4.3				
Particle Size %								
GR	0	0	0	0	0	0	0	5
CS	2	2	2	2	2	2	4	37
FS	23	24	23	27	32	49	58	34
SI	32	30	32	28	28	20	19	13
C	43	44	43	43	39	28	20	15

Mineralogy of the clay fraction	Depth cm	ChV%	I%	Ka%
	10-20	1-5	10-20	65-80
	60-90	5-10	10-20	65-80

* sum of basic and acidic cations *** $\frac{\text{Bases}}{\text{NH}_4\text{OAc CEC}} \times 100$ ** NH_4 OAc **** Comp. Exch

INNISFAIL SERIES

CONCEPT: Structured brown or reddish brown uniform or gradational textured soil formed on well drained alluvium.

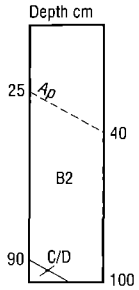
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	No Provision	Uf6.33	Haplic, Dystrophic Brown, Dermosol

LANDFORM Alluvial plain RAINFALL 3200mm
REFERENCE SITE Bartle Frere 1:100 000 789055

Horizon	Depth m	
Ap	0 to 0.25	Brown (10YR4/3), (10YR5/4d); silty medium clay; moderate 2-5mm subangular blocky; moist moderately firm;
B21	0.25 to 0.45	Brown (7.5YR4/4); silty medium clay; moderate 2-5mm subangular blocky; moist very firm; diffuse change to-
B22	0.45 to 0.80	Strong brown (7.5YR5/6); silty medium clay; moderate 2-5mm subangular blocky; moist very firm; diffuse change to-
B23	0.80 to 1.15	Yellowish brown (10YR5/6); 10-20% <5mm faint strong brown (7.5YR5/8) mottles; silty medium clay; moderate 2-5mm subangular blocky; moist very firm; diffuse change to-
B24	1.15 to 1.20	Yellowish brown (10YR5/6); 20-50% 5-15mm distinct yellowish brown (10YR5/8) mottles; medium clay (light); moderate 2-5mm subangular blocky; moist very firm.

RANGE OF CHARACTERISTICS



Ap Dark brown to dark yellowish brown (10YR3-4/3-4); light to medium clay, may be silty; moderate to strong 2-10mm subangular blocky or cast.

B21 Brown (7.5YR4/4) to dark yellowish brown (10YR4/4); light medium clay to silty medium clay; moderate to strong 2-10mm subangular blocky.

B22 Strong brown (7.5YR5/6) to yellowish brown (10YR5/6); may have to 20% faint 2-10mm brownish yellow (10YR6/6) and yellowish red (5YR5/6) mottles; medium clay or silty medium clay; moderate to strong 2-10mm subangular blocky.

C/D The solum may overlie stratified sands or buried soil horizons from depths of about 90cm.

No virgin sites were examined and all soils have been modified by cultivation and land levelling.

Principal profile forms encountered include Uf6.31p and Uf6.33p.

ANALYTICAL DATA

This soil was not sampled in this survey area. The following data are from the Tully- Innisfail area (Murtha 1986).
Profile T281 Map Reference Innisfail 1:100 000 969594
INNISFAIL SERIES Sample site cultivated to sugar cane.

Depth m	0-.10	.10-.20	.20-.30	.30-.37	.37-.60	.60-.90	.90-1.20	1.20-1.50	1.80-2.10
Horizon	Ap	Ap	Ap	Ap	B2	B2	B3	B3	C
pH	5.3	5.2	5.0	5.2	5.5	5.6	5.4	5.4	5.5
E.C.dS/m^{-1}	.056	.047	.038	.041	.026	.026	.026	.023	.023
Org.C%	1.48	1.06		0.63		0.19			
N%	.15	.16		.12		.04			
AvP ppm	142	200		28		9			
Tot.P%	.200			.180		.065			
Tot.K%	1.42			1.42		1.66			
Tot.S%	.043			.048		.021			
Exchange properties m.e./100g soil									
Ca	1.46	1.30		1.09	1.54	2.38			
Mg	1.40	0.67		0.72	0.75	0.90			
K	.35	.18		.14	.12	.07			
Na	.08	.09		.09	.10	.12			
H+Al	3.0	3.6		3.0	0.53	1.6			
ECEC*	6.29	5.84		5.04	3.04	4.07			
ECEC/100g Clay	15.7	14.6		11.0	7.4	4.8			
CEC**	5.7	5.5		5.6	5.9	4.8			
Particle Size %									
Gr	0	0	0	0	0	0	0	0	0
CS	3	1	1	1	0	1		4	6
FS	32	33	33	24	26	49		48	62
SI	25	26	23	29	33	24		22	16
C	40	40	43	47	41	26		26	17

Mineralogy of the clay fraction	Depth cm	ChV%	I%	Ka%
	15-30	10-20	10-20	65-80
	60-90	10-20	20-30	65-80

* sum of basic and acidic cations ** Comp. Exch

MOSSMAN SERIES

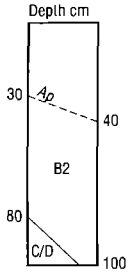
CONCEPT: Uniform or gradational textured soils with dark A horizons and bright yellow structured upper B horizons.
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	No suitable group	Gn3.7p	Haplic, Dystrophic Yellow, Dermosol

LANDFORM Stagnant alluvial plain RAINFALL 2400mm
REFERENCE SITE Bartle Frere 1:100 000 857916

Horizon	Depth m	
Ap1	0 to 0.15	Black (10YR2/1); clay loam; moderate 5-10mm subangular blocky; moist moderately weak; clear change to-
Ap2	0.15 to 0.30	Dark grey (10YR4/1); silty light clay; moderate 5-10mm subangular blocky ; moist moderately firm; clear change to-
B21	0.30 to 0.70	Brownish yellow (10YR6/6); silty medium clay; strong 2-5mm subangular blocky; moist very firm; diffuse change to-
B22	0.70 to 1.2	Yellow (10YR7/6) 10-20%, 5-15mm distinct red (2.5YR4/8) mottles; silty medium clay; strong 5-10mm subangular blocky; moist very firm; some red mottles are slightly hardened; gradual change to-
D	1.2 to 1.65	very pale brown (10YR7/4), 20-50% 5-15mm distinct brownish yellow (10YR6/6) mottles; sandy loam; massive; moist very weak

RANGE OF CHARACTERISTICS



Ap Black (10YR2/1) to dark grey (10YR4/2); loam to light medium clay; weak to moderate cast or subangular blocky.

A3/B1 Very dark greyish brown (10YR3/2) to brownish yellow (10YR6/6); fine sandy clay loam to medium clay; moderate subangular blocky; moist very firm; occasionally some soft 2-6mm manganese nodules; diffuse change

B2 Brown (7.5YR-10YR4/3) to brownish yellow (10YR6/6-8) or red (2.5YR4/8); silty light to medium clay; moderate to strong subangular or angular blocky; occasionally some soft 2-6mm manganese nodules; gradual or diffuse change

D Vary considerably from stratified sands to clays

ANALYTICAL DATA

This soil was not sampled in this survey area. The following data are from the Mossman-Cape Tribulation area (Murtha 1989).
Profile T324 Map Reference Mossman 1:100 000 257787
MOSSMAN SERIES Sample site cultivated to sugar cane.

Depth m	0-.10	.10-.30	.30-.60	.60-.90	.90-1.20	1.20-1.50	1.50-1.80	1.80-2.10
Horizon	Ap	Ap	B21	B21	B22	D1	D1	D2
pH	5.8	5.8	5.5	5.6	5.4	5.2	5.4	5.3
E.C. dS/m^{-1}	.035	.026	.041	.032	.029	.026	.014	.011
Org. C %	1.05		.44					
N %	.09		.05					
Av.P ppm	68	72	12	4				
Tot. P %	.050		.019					
Tot. K %	1.52		2.86					
Tot. S %	.017		.011					
Free Fe %	2.0		2.2					
Exchange properties m.e./100 g soil								
Ca	3.09		1.39		1.44			
Mg	.20		.03		.09			
K	.34		.11		.09			
Na	.07		.06		.05			
H + Al	.3		1.1		.6			
ECEC *	4.3		2.7		2.3			
ECEC/100g Clay	15		8		7			
CEC **	6				4			
CEC/100g C.**	22				12			
Base Sat.***	67				42			
CEC ****	4.8		2.4		2.4			
Particle size								
Gr	0		0	0	1		3	
CS	11		7	10	14		20	
FS	28		26	27	28		32	
Si	34		34	31	26		19	
C	27		33	32	32		30	

Mineralogy of the clay fraction	Depth cm	ChV %	I %	Ka %	G %	Go/Ha %
	30-60	5-10	20-30	50-65	1-5	5-10

*sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ **NH_4 OAc ****Comp. Exch

LIVERPOOL SERIES

CONCEPT: Uniform fine sandy loam or loam soils on low alluvial flood plains and levees.

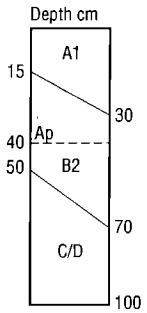
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	No provision	Um5.52	Acidic, regolithic, Orthic, Tenosol

LANDFORM Alluvial plain RAINFALL 3500mm
REFERENCE SITE Bartle Frere 1:100 000 717092

Horizon	Depth m	
A1	0 to 0.30	Dark yellowish brown (10YR4/4); silty clay loam; strong 2-5mm cast; moist very firm; diffuse change to-
B2	0.30 to 0.70	Yellowish brown (10YR5/8); silty clay loam (heavy); massive; moist moderately firm; diffuse change to-
B3	0.70 to 0.80	Yellowish brown (10YR5/6); sandy clay loam, fine sandy (light); massive; moist moderately weak; diffuse change to-
C	0.80 to 0.95	Brown (10YR5/3); sand; single grain; moist loose.

RANGE OF CHARACTERISTICS



Ap Dark brown to yellowish brown (10YR3-5/3-4); sandy loam to silty clay, most commonly fine sandy or silty clay loam; massive or weak to moderate subangular blocky or cast.

B2 Dark yellowish brown (10YR3/4) to yellowish brown (10YR5/8); sandy loam to silty clay loam, most commonly fine sandy or silty clay loam; usually massive very occasionally weak 2-5mm subangular blocky.

BC-C or D These soils usually grade to stratified well sorted sands from about 50cm depth but in some places overlie buried soils.

Undisturbed soils always have a strongly developed 2-5mm cast structure in the A horizon. Ploughed soils are massive immediately after cultivation but quickly redevelop a cast structure after cessation of cultivation.

Principal profile forms encountered include Um5.52 and Uc5.22. Many soils have a reverse texture profile i.e. heaviest on the surface and decreasing in clay with depth and hence there is no adequate provision in the Factual Key.

ANALYTICAL DATA

This soil was not sampled in this survey area. The following data are from the Tully-Innisfail area (Murtha 1986).
Profile T287 Map Reference Tully 1:100 000 939408
LIVERPOOL SERIES Sampled from undisturbed rainforest

Depth m	0-.10	.10-.20	.20-.30	.30-.60	.60-.90	.90-1.20	1.20-1.50
Horizon	A1	A1	B1	B2	B3	B3	D
pH	5.3	5.2	5.3	5.2	5.2	5.2	5.2
E.C.dS/m^{-1}	.071	.050	.026	.020	.023	.017	.017
Org.C%	2.93	1.39		0.34			
N%	.25	.15		.05			
AvP ppm	25	15	4				
Tot.P%	.003			.019			
Tot.K%	0.38			1.70			
Tot.S%	.020			.014			
Exchange properties m.e./100g soil							
Ca	2.11	0.43	0.16	0.02	0.07		
Mg	1.00	0.35	0.08	<.01	0.12		
K	.27	.15	.04	.06	<.01		
Na	.14	.10	.02	.06	.03		
H+Al	1.2	2.0	1.6	2.2	1.6		
ECEC*	4.72	3.03	1.9	2.35	1.83		
ECEC/100g Clay	23.6	13.2	8.6	12.4	10.8		
CEC**	4.4	2.4	2.0	1.7	1.9		
Particle Size %							
Gr	0	0	0	0	0	0	0
CS	8	6	7	10	11	5	19
FS	58	58	58	62	59	64	57
SI	14	14	13	10	13	15	11
C	20	23	22	19	17	16	13

Mineralogy of the clay fraction	Depth cm	ChV %	I %	Ka %	G %	Go/Ha %
	15-30	10-20	30-40	50-65	1-5	1-5
	60-90	5-10	20-30	50-65	1-5	1-5

* sum of basic and acidic cations ** Comp. Exch

VIRGIL SERIES

CONCEPT: Uniform or gradational textured red massive soils on high terraces.

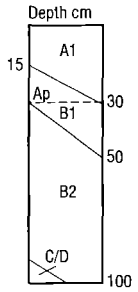
REPRESENTATIVE PROFILE

		G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION		Red earth	Gn2.11	Haplic, Dystrophic, Red, Kandosol

LANDFORM Stagnant alluvial plain RAINFALL 1950mm
REFERENCE SITE Bartle Frere 1:100 000 760070

Horizon	Depth m	
A11	0 to 0.15	Brown (7.5YR4/2); loam, fine sandy; moderate 5-10mm subangular blocky; moist moderately firm; diffuse change to-
A12	0.15 to 0.30	Brown (7.5YR4/4); loam, fine sandy; weak 5-10mm subangular blocky; moist moderately weak; diffuse change to-
B1	0.30 to 052	Reddish brown (5YR4/4); sandy clay loam, fine sandy; massive; moist moderately firm; diffuse change to-
B21	0.52 to 0.85	Yellowish red (5YR4/6); sandy clay loam, fine sandy; massive; moist moderately firm; diffuse change to-
B22	0.82 to 1.3	Yellowish red (5YR5/6); sandy clay loam, fine sandy (light); massive; moist moderately firm; 2-10% 6-20mm, subrounded granite gravel; diffuse change to-
BC	1.37 to 2.80	Yellowish red (5YR5/6); 10-20% <5mm faint light grey (10YR7/2) mottles; silty clay loam; weak 5-10mm angular blocky; moist moderately firm;

RANGE OF CHARACTERISTICS



Ap Reddish brown (5YR3-4/2-4) to dark brown (7.5YR3/2); sandy loam to coarse sandy clay loam; massive to moderate 5-10mm cast; moist moderately weak
A1 Yellowish red (5YR5/5) to brown (7.5YR4/2); loam to sandy clay loam; moderate 5-10mm subangular blocky or cast
B1 Reddish brown (5YR4/4) to yellowish red (5YR5/8)
B2 Dark reddish brown (5YR3/4) to yellowish red (5YR4-6/6-8); sandy clay loam to sandy clay loam, fine sandy; occasional profiles may have 2-10% 20-60mm subangular quartz gravel
BC Red (2.5YR4/6) or yellowish red (5YR5.6) occasionally with 10-20% <5mm faint light grey (10YR7/2) mottles; silty to coarse sandy clay loam
The solum usually overlies stratified sands or gravels. In many areas there are obvious buried soils (D horizons) from as shallow as 90cm. In the immediate vicinity of Gordonvale, Virgil series overlies a structured red clay soil very similar to those formed on basalt. No virgin and few non-cultivated sites were examined. Cultivation and levelling have modified the texture profile and destroyed the surface and subsurface horizonation at many sites.
Principal profile forms encountered include Gn2.11, Gn2.1p, Gn2.14, and Um5.52p.

ANALYTICAL DATA

Profile T478 Map Reference Bartle Frere 1:100 000 760069
VIRGIL SERIES Sampled from cleared site which may have been cultivated in the past

Depth m	0-.15	.15-.30	.30-.52	.52-.82	.82-1.14	1.14-1.37	1.37-1.80	1.80-2.20
Horizon	A11	A12	B1	B21	B22	B3	BC	BC
pH	5.4	5.4	5.3	5.4	5.6	5.6	5.5	5.7
E.C.dS/m^{-1}	.028	.023	.013	.013	.011	.010	.011	.010
Org.C%	1.47	1.06	0.46					
N%	0.06	0.03	0.06					
AvP ppm	5	11	<2	<2				
Tot.P%	.040		.040		.030			
Tot.K%	1.31		1.36		1.54			
Tot.S%	.030		.020		.010			
Free Fe%	2.3		2.1		2.2			
Tot.Cu %	.002		.0018		.0019			
Tot.Zn %	.0047		.0046		.0039			
Tot.Mn %	.110		.130		.030			
Tot.Fe %	3.37		3.24		3.57			
Exchange properties m.e./100g soil								
Ca	0.91		0.28	0.21	0.26		0.11	
Mg	0.55		0.19	0.39	0.33		0.78	
K	0.22		0.03	0.03	0.03		0.04	
Na	0.05		<.02	<.02	0.02		0.02	
H+Al	0.93		0.71	0.50	0.45		1.18	
ECEC*	2.7		1.2	1.2	1.1		2.1	
ECEC/100g Clay	12.3		4.4	4.4	5.2		10.5	
CEC**	4.3		3.1	3.6	2.5		3.9	
CEC/100g C.**	19.5		11.5	13.3	11.9		19.5	
Base Sat***	41		16	19	26		24	
CEC****	1.9		1.5	1.6	1.7		2.6	
Particle Size %								
Gr	2	0	0	0	3	6	0	0
CS	6	7	6	8	13	18	2	2
FS	57	52	53	51	52	47	52	56
SI	14	16	14	15	13	19	26	26
C	22	25	27	27	21	16	20	16

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** $NH_4\,OAc$ **** Comp. Exch

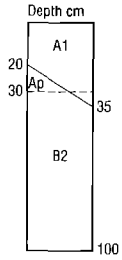
JARRA SERIES

CONCEPT: Gradational textured mottled yellow brown structured soils on high terraces.
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Affinities with Yellow podzolic soil	Gn3.91	Melanic, Dystrophic, Brown, Dermosol
LANDFORM	Stagnant alluvial plain	RAINFALL 1950mm	
REFERENCE SITE	Bartle Frere 1:100 000 754078		

Horizon	Depth m	
A11	0 to 0.15	Very dark greyish brown (10YR3/2); loam; strong 5-10mm angular blocky; moist moderately weak; common 1-2mm roots; diffuse change to-
A12	0.15 to 0.36	Very dark greyish brown (10YR3/2); clay loam; moderate 5-10mm angular blocky; moist moderately firm; common 1-2mm roots; diffuse change to-
AB	0.36 to 0.52	Dark greyish brown (10YR4/2); 20-50% 15-30mm faint brown (10YR4/3) mottles; light clay; moderate 5-10mm angular blocky; moist moderately firm; few 1-2mm roots; this horizon is a mixture (by biological mixing) of A and B horizon materials; diffuse change to-
B21	0.52 to 0.74	Yellowish brown (10YR5/4); light medium clay; moderate 5-10 mm angular blocky; moist moderately firm; diffuse change to-
B22	0.74 to 1.10	Yellowish brown (10YR5/5); <2% <5mm faint yellowish red (5YR5/8) mottles; medium clay; strong 2-5mm angular blocky; moist very firm; 2-10% 6-20mm manganiferous nodules; diffuse change to-
B23	1.10 to 1.40	Strong brown (7.5YR5/6); 10-20% <5mm faint yellowish red (5YR5/8) mottles; light medium clay; moderate 2-5mm angular blocky; moist moderately firm; 2-10% 2-6mm manganiferous soft segregations; diffuse change to-
BC	1.40 to 1.65	Strong brown (7.5YR5/6); 10-20% 5-15mm faint yellowish brown (10YR5/4) mottles; fine sandy clay; massive; moist moderately firm; 10-20% 6-20mm manganiferous soft segregations.

RANGE OF CHARACTERISTICS



Ap Dark greyish brown (10YR4/2); moderate to strong 5-10mm angular blocky or cast; silty light clay to medium clay; moist moderately firm.

B21 Yellowish brown (10YR5/4) to brownish yellow (10YR6/6) occasionally with 2-10% 5-15mm yellow red (5YR5/8) mottles; silty light clay to medium clay.

B22 Light yellowish brown (2.5YR6/3) to yellowish brown (10YR5-6/3-5) with brown (7.5YR5/8) and yellowish red (5YR5/8) mottles; silty medium clay to heavy clay.

C/D This series may overlie buried soils or stratified sandy sediments from as shallow as 120cm.

These soils occur in minor depressions in the landscape in units in which Virgil series is the dominant soil.
Principal profile forms encountered include Gn3.91 and Uf6.4p. The Uf profile form is the most common but it is strongly suspected that this is a texture profile modified by cultivation.

ANALYTICAL DATA

Profile T479 — Map Reference Bartle Frere 1:100 000 754078
JARRA SERIES — Sampled from cleared site which may have been cultivated in the past

Depth m	0-.15	.15-.36	.36-.52	.52-.74	.74-1.10	1.10-1.40	1.40-1.65
Horizon	A11	A12	AB	B21	B22	B23	BC
pH	5.6	5.5	5.8	5.7	5.7	5.7	5.6
E.C.dS/m^{-1}	.049	.050	.014	.011	.012	.011	.013
Org.C%	2.17	1.41	0.85				
N%	0.09	0.06	0.03				
AvP ppm	16	5	4	<2	7		
Tot.P%	.080		.090				
Tot.K%	1.97		2.18				
Tot.S%	.030		.200				
Free Fe%	1.5		3.1		2.6		
Tot.Cu %	.003		.0026				
Tot.Zn %	.0065		.0072				
Tot.Mn %	.060		.110				
Tot.Fe %	2.89		4.89				
Exchange properties m.e./100g soil							
Ca	1.80		0.51	0.62	0.55		0.55
Mg	1.29		0.75	0.63	0.63		0.74
K	0.30		0.05	0.04	0.04		0.03
Na	0.03		<.02	<.02	<.02		0.02
H+Al	0.41		0.80	0.65	0.52		0.44
ECEC*	3.8		2.1	2.0	1.8		1.8
ECEC/100g Clay	14.6		7.0	6.1	5.6		7.2
CEC**	7.4		6.3	4.6	5.0		3.2
CEC/100g C.**	28.5		21.0	13.9	15.6		12.8
Base Sat***	46		21	29	26		42
CEC****	7.4		6.3	4.6	5.0		3.2
Particle Size %							
Gr	4	0	0	0	0	0	0
CS	15	7	9	7	9	6	5
FS	40	43	38	38	37	44	54
SI	18	23	22	22	22	21	15
C	26	27	30	33	32	30	25

* sum of basic and acidic cations

*** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** $NH_4\,OAc$ **** Comp. Exch

CANOE SERIES

CONCEPT: Massive yellow gradational or uniform textured soil; may become mottled at depth.

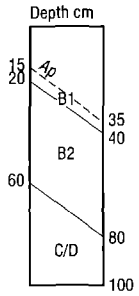
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Yellow earth	Gn2.24	Haplic, Magnesic, Brown, Kandosol

LANDFORM Low terrace
REFERENCE SITE Bartle Frere 1:100 000 857917

Horizon	Depth m	
Ap	0 to 0.15	Dark greyish brown (10YR4/2); sandy loam; moderate 5-10mm cast; moist moderately weak; gradual change to-
B1	0.15 to 0.35	Light yellowish brown (10YR6/4); loamy sand; massive; moist very weak; gradual change to-
B21	0.35 to 0.60	Yellowish brown (10YR5/5); sandy clay loam; massive; moist moderately weak; diffuse change to-
B22	0.60 to 0.95	Yellowish brown (10YR5/5); sandy clay loam (heavy); massive; moist moderately weak; diffuse change to-
B3	0.95 to 1.20	Brownish yellow (10YR6/5); sandy clay loam (light); massive; moist very weak.

RANGE OF CHARACTERISTICS



Ap Dark brown (10YR3-4/3); sandy clay loam or fine sandy clay loam

B2 Yellowish brown (10YR5/4-5) to brownish yellow (10YR6/6); sandy clay loam or fine sandy clay loam;

C Brownish yellow (10YR6/6) stratified fine to coarse sand;

The stratified sands are often underlain by finer textured material similar to the B2 horizon or occasionally by buried soils similar to the present profile.

Principal profile forms encountered include Um5.52p and Gn2.21p.

ANALYTICAL DATA

This soil was not sampled in this survey area. The following data are from the Cardwell-Tully report (Cannon, et al. 1992)
Profile T445 Map Reference Kirrama 1:100 000 796994
CANOE SERIES Sampled from undisturbed sclerophyll woodland

Depth m	0-.12	.12-.27	.27-.46	.46-.78	.78-.95	.95-1.22	1.22-1.45
Horizon	A1	AB	B21	B22	B23	B24	C
pH	5.0	5.3	5.7	5.6	5.9	6.0	6.1
E.C.dS/m^{-1}	.112	.034	.016	.013	.014	.015	.015
Org.C%	1.98		0.36		0.17		0.12
N%	0.11		0.02		<.01		
AvP ppm	13		7		5		5
Tot.P%	.019		.009		.006		.006
Tot.K%	3.30		3.23		3.47		3.45
Tot.S%	.026		.010		.007		.005
Free Fe%	1.0		1.0		1.0		
Tot. Fe %	1.8		2.0		2.0		1.9
Tot.Cu %	.0005		.0002		.0002		.0003
Tot.Zn %	.0036		.0036		.0036		.0028
Tot.Mn %	.074		.029		.027		.022
Exchange properties m.e./100g soil							
Ca	1.21		<.02		0.17		0.29
Mg	0.92		0.52		0.67		0.87
K	0.15		0.03		0.04		0.02
Na	0.08		0.07		0.17		0.14
H+Al	1.1		1.58		0.77		0.46
ECEC*	3.5		2.2		1.8		1.8
ECEC/100g Clay	18.4		11.0		12.9		16.4
CEC**	6.0		3.0		3.0		2.0
CEC/100g C.**	31.6		15.0		21.4		18.2
Base Sat***	39		21		35		66
CEC****	2.9		2.4		2.5		2.3
Particle Size %							
Gr	0	0	0	0	0	0	0
CS	26	26	28	32	22	31	31
FS	39	40	41	41	53	47	50
SI	16	13	11	9	11	9	8
C	19	21	20	17	14	12	11
BD	1.2	1.3	1.3	1.3	1.2	1.1	1.2
1 Bar % water	28	22	22	23	25	20	20
15 Bar % water	15	15	14	15	12	11	9

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4OAc\ CEC} \times 100$ ** NH_4OAc **** Comp. Exch

JAPOON SERIES

CONCEPT: Gravelly or stratified sands on recent alluvium.

REPRESENTATIVE PROFILE

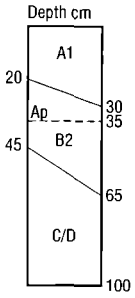
	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Alluvial soil	Uc1.21	Basic, Stratic, Rudosol

LANDFORM Channel bench RAINFALL 2100mm

REFERENCE SITE Bartle Frere 1:100 000 857916

Horizon	Depth m	
A1	0 to 0.12	Very dark greyish brown (10YR3/2); coarse sandy loam; massive; moist very weak; 10-20% 60-200mm, rounded granite gravel; clear change to-
B2	0.12 to 0.46	Yellowish brown (10YR5/4); coarse sandy loam; massive; moist very weak; 20-50% 200-600mm, rounded granite gravel; diffuse change to-
C	0.46 to 1.10	Yellow (10YR7/5); coarse sand; massive; moist loose; 20-50% 200-600mm, rounded granite gravel.

RANGE OF CHARACTERISTICS



A/Ap Dark brown (7.5YR4/2) to very dark greyish brown (10YR3/2); loamy sand to coarse sandy loam; gravel free to 50-90% 20-200mm rounded mixed gravels

B Coarse sand to coarse sandy loam; 20-90% 20-200mm rounded mixed gravels

C/D Stratified sands and gravels

These are very juvenile soils with little profile development beyond the accumulation of organic matter in the A1 horizon. There may be moderate aggregation , largely of biological origin, in the finer textured A horizons under pasture or rainforest vegetation.

Principal profile forms encountered include Uc1.21 and Ucp

ANALYTICAL DATA

The following data are from Thompson and Cannon (1988).

Site No. C11 Map Reference Cairns 1:100 000 576476

JAPOON SERIES Sampled from undisturbed open forest

Depth m	0-.10	.20-.30	.50-.60
Horizon	A11	A12	B
pH	5.7	5.5	5.9
E.C.dS/m^{-1}	0.18	0.04	0.01
Org.C%	2.6	1.2	
N%	0.24	0.12	
AvP ppm	4	3	
Tot.P%	.032	.022	.016
Tot.K%	1.65	1.97	1.92
Tot.S%	.037	.011	.007
Exchange properties m.e./100g soil			
Ca	6.7	1.6	1.6
Mg	1.9	0.50	0.35
K	0.34	0.08	0.07
Na	<.01	<.01	<.01
CEC	11	3	3
CEC/100g Clay	84.6	30.0	23.1
Particle Size %			
CS	20	21	13
FS	50	51	57
SI	19	19	19
C	13	10	13
.33 Bar % water	22	16	19
15 Bar % water	7	4	5

For methods see Bruce and Rayment (1982)

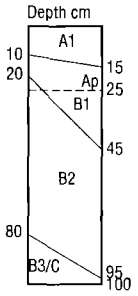
SILKWOOD SERIES

CONCEPT: A uniform to gradational soil, massive red B horizon formed on relict levees.

REPRESENTATIVE PROFILE

		G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION		Red Earth	Gn2.11	Red, Kandosol
LANDFORM		Relict levee		
REFERENCE SITE		Bartle Frere 1:100 000 715412		
Horizon	**Depth m**			
Ap	0 to 0.25	Dark greyish brown (10YR4/2); sandy clay loam; weak 5-10mm subangular blocky moist moderately weak; diffuse change to-		
B1	0.25 to 0.45	Brown (7.5YR4/4); sandy clay loam (heavy); massive; moist moderately firm; diffuse change to-		
B2	0.45 to 0.95	Yellowish red (5YR 4/6); sandy light clay; massive; moist moderately firm; diffuse change to-		
B3	0.95 to 1.2	Red (2.5YR4/6); sandy clay loam; massive; moist moderately firm; 2-10% 2-6mm angular quartz gravel		

RANGE OF CHARACTERISTICS



A1 Black (10YR2/1) to dark greyish brown (10YR4/2); sandy loam to sandy clay loam; massive to moderate cast; clear to diffuse change

A3/B1 Dark brown (7.5YR 3/4) to yellowish red (5YR4/8);sandy loam to sandy clay loam; massive or weak cast;

B2 Yellowish red (5YR5/6) to red (2.5YR4/8); coarse sandy clay loam to sandy light clay

B3/BC Yellowish red (5YR5/6) to red (2.5YR4/8); sandy clay loam to coarse loamy sand; gravel free to 20% 2-20mm quartz and mixed gravels

Principal profile forms encountered include Gn2.11, Gn2.2p Um4.2p

This is a minor soil and has not been sampled in any of the wet coast surveys. Apart from forming on a different landform element it is similar in most respects to Virgil series and the data for Virgil series could be used as a reasonable guide.

GOOLBOO SERIES

CONCEPT: Coarse uniform sands formed on prior streams.

REPRESENTATIVE PROFILE

		G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION		Siliceous sand	Uc5.1p	Acidic, Regolithic, Orthic, Tenosol
LANDFORM		Prior stream		
REFERENCE SITE		Bartle Frere 1:100 000 872820		
Horizon	**Depth m**			
Ap	0 to 0.25	Yellowish brown (10YR5/6); coarse loamy sand; single grain; moist loose; 2-10% 2-6mm angular quartz gravel; diffuse change to-		
B	0.35 to 0.90	Yellowish brown (10YR5/6); coarse sand; single grain; moist loose; 10-20% 2-6mm angular quartz gravel; diffuse change to-		
B3/C	0.90 to 1.20	Brownish yellow (10YR6/6) 10-20% 5-15mm pale brown (10YR6/3) mottles; coarse sand single grain ; moist loose		

No virgin sites and few cultivated sites were examined in this survey area so no meaningful range in properties can be given. At the above site the soil has been modified by cultivation, in particular most of the original A horizon has been lost. As these soils occur on narrow slightly elevated ridges highly modified profiles could be expected for most cultivated sites.

This soil has not been sampled so no analytical data are available

MAPPING UNITS : WELL DRAINED SOILS FORMED ON ALLUVIUM

JAPOON ASSOCIATION Jp 10 UMAs 849ha.

This association occurs along the upper reaches of most streams. On the larger streams it occurs on benches just above the normal flow levels of the stream. On the minor streams it may occupy all of the flood plain. This is particularly common along the minor streams that are deeply incised into the granite fans. Many areas are too small to delineate at the mapping scale and are included in other units.

The dominant soils are the very gravelly Japoon series but small areas of Liverpool and Canoe series are also included. These alluvial benches are a source of sand and gravel for the construction industry and many areas are highly disturbed and this is particularly true for the units along the Barron River and Wright Creek

Frequent flooding often by very high velocity flows is one of the major constraints to land use in this unit.

LIVERPOOL ASSOCIATION Li 35 UMAs 6958ha.

This unit occurs along virtually all streams but in some places is too narrow to delineate at the mapping scale. The position it occupies is dependent upon the morphostratigraphy of the riverine sediments. In hilly or mountainous land where the valley is confined there may be up to four terrace levels. In this situation the Liverpool association is usually confined to the lower level or to those levels which flood on a regular basis. As the streams emerge from the coastal ranges the terraces disappear and the sediment pattern is one of prominent stream levees with gentle slopes to the back swamps. In this pattern Liverpool association occurs on the levee and for a short distance down the backslope.

These patterns can be clearly seen along the Mulgrave River. The Mulgrave Valley is too narrow for the terrace levels to be well preserved but three distinct levels can be found about two km upstream of Gordonvale where the river emerges from the confining hills. About four kilometres downstream from Gordonvale the last terraces terminate and the levee becomes more prominent downstream. In contrast, the Barron River is deeply incised into the coastal range and emerges only about four kilometres from the ocean outfall. On this stream there are no terraces, nor has the levee flood plain pattern developed. The riverine alluvium is a complex braided delta system. The dominant soils in the delta are Liverpool series but many have a coarser sand fraction than is normal reflecting the higher energy depositional environment one would expect over such a short discharge distance.

Associated soils include Japoon series which occur on small channel benches and Tully or occasionally Innisfail series which may be co-dominant in some areas. These invariably occur on slightly elevated areas which are probably remnants of a higher terrace level. Some reworked or bevelled beach ridges may be included in the area of the Barron River delta.

In the northern part of the area many of the Liverpool Series soils may have features indicative of slightly wetter conditions. They have prominent rusty brown root linings or linings to pores and on first appearance seem to be mottled. The mottle is almost impossible to quantify and seems to be a lighter grey sheen rather than a matrix colour. These features are not apparent when the soils are dry. It is not perfectly clear but these are probably the soils described and mapped as Mulgrave series by Holz (1985).

TULLY ASSOCIATION Tu 24 UMAs 5432ha.

This is the most widespread unit on the higher level, better drained alluvium of mixed origin. It occurs along most streams the major exceptions being those with a high percentage of basalt in their catchments (e.g. the North Johnstone River) or those rising wholly in the metamorphic rock

uplands. The unit is dominated by the yellow to yellow-brown strongly structured soils of Tully series but the associated soils can vary from area to area.

Liverpool series will occur along some of the narrow stream levees that are included and minor areas of Japoon series may occur on channel benches. Where the unit slopes off to the back swamps Coom, Timara, and occasionally Hewitt series may be included. Coom series may be co-dominant in parts of some U.M.A's.. Where this has been observed the multiple symbol Tu-Co is used on the map. Goolboo series occurs on low rises marking the position of old infilled channels and Silkwood series occur along what is interpreted as relic stream levees.

A sandy variant occurs along parts of the Russell River alluvium particularly in the area between Pawngilly and Bartle Frere. In this area the sand has been inherited from granite fans that have been reworked by streams draining the adjacent uplands. Canoe series, which is similar to Tully series but is sandier and not structured, may occur on the low terraces and levees of small streams draining the granite uplands.

Small areas of Bulgun and Mossman series may be included particularly in the areas along Babinda Creek and to the south of Aloomba. The boundary between the lower end of the fans and the alluvium is very difficult to place in some areas. It is further complicated by land levelling and general cultural practices leading to considerable mixing of soil in these areas.

INNISFAIL ASSOCIATION In 18 UMAs 4260ha.

This unit occurs on the better drained alluvium along streams which have a higher percentage of basalt in their catchments. It occupies most of the North Johnstone River alluvium and occurs along the upper reaches of the Russell River. Some very small areas occur along Freshwater Creek where there is sediment contribution from amphibolite or basic members of the Hodgkinson Formation.

The unit is dominated by Innisfail series which is similar to Tully series apart from the browner B horizon colours. There tends to be a downstream gradation in colours. They grade from red-brown in the upper reaches to brown and then in the lower reaches grade to the yellow brown or yellow Tully series. As an example; along the Russell River the transition from Innisfail to Tully series occurs as a diffuse change at about the point where the highway crosses the river.

Liverpool series will occur on stream levees and lower terraces. The only other major associate is Daradgee series which is a brown and grey mottled soil occupying lower sites. Innisfail-Daradgee occupy the same relationship as Tully-Coom series. Very sandy Goolboo series occur on low elongate rises marking the presence of old infilled channels.

VIRGIL ASSOCIATION Vi 13 UMAs 2455ha.

This association was first identified on the Daintree River where it occupies the highest and oldest terrace level. It was subsequently mapped in the Tully and Jarra Valleys again occupying the older alluvium. In this area it occupies extensive old high terraces along the Mulgrave River. Small areas have been mapped along the North Johnstone River upstream of Coccolah Island. Paired terraces occur on the southern side of the river in this area but they were not recognised in the mapping of the Tully- Innisfail area (Murtha 1986).

The dominant soil is the fine sandy red massive earth of Virgil series. The sandy nature of these soils is the main property distinguishing them from other alluvial soils. The only associated soil is Jarra series which is a brown or yellow structured soil and occupies any minor depression on the terrace surface. No reason can be put forward as to why the deposits in this phase of deposition are so different to subsequent deposits.

JARRA ASSOCIATION Jr 3 UMAs 589ha.

This association has been mapped around the margins of the Virgil association to the north-east of Gordonvale. Jarra series usually occurs as a minor associate in depressions within the Virgil landscape. Jarra series becomes the dominant soil where the Virgil landscape slopes off to more recent alluvium which is poorly drained or where it abuts the very low angle metamorphic fans. Small areas of Virgil series are included in the unit.

Some difficulty may be experienced in differentiating Jarra series from Coom series which will occur on the alluvium and from Clifton and Edmonton series which occur on the fans. All soils have features in common, the landform on which they are developed is the major differentia.

MOSSMAN ASSOCIATION Mm 2 UMAs 269ha.

Only very small areas of this unit have been mapped and these occur along the Mulgrave River alluvium at a level below that of the Virgil Association and slightly above that of the Tully Association. All areas are under cultivation and have been considerably modified so it is difficult to delineate these units with much confidence. They will contain some soils of all surrounding associations.

SILKWOOD ASSOCIATION Si 2 UMAs 290ha.

This association is restricted to two units adjacent to Simmonds and Mackey Creeks. Silkwood series has formed on the levees of recently abandoned channels of these streams. Small areas of soils of adjacent associations may be included and gravel free Japoon series may occur on the narrow channel benches

CANOE ASSOCIATION Cn 4 UMAs 205ha.

This is a minor association and is restricted to the alluvium of small streams which originate in the granitic uplands. It occurs most commonly lower in the drainage system where the alluvium of the minor streams merge with that of the major streams. If Tully series occurs on the alluvium of the major stream, the soils may be difficult to differentiate as Canoe and Tully series are very similar in many respects. The chief differences are; Canoe may be marginally lighter in texture and is not structured. Canoe may also be confused with Liverpool series which is usually closely associated on the upstream margin of the units. Liverpool series is usually slightly lighter in texture and is browner in colour.

POORLY DRAINED SOILS FORMED ON ALLUVIUM

Eight soil series have been included in this group and all except Ramleh series occur on alluvium of mixed origin. Ramleh series occurs only on alluvium of minor streams rising in the metamorphic uplands. All of the major streams have contribution from the three major parent materials and although the percentage of contribution varies somewhat it hasn't made much difference to the distribution of the soils.

Given the high rainfall for much of this survey area there are much smaller areas of the poorly drained soils than might have been expected. Apart from possibly the North Johnstone River, all of the major streams appear to be at a much younger stage of development than other major streams on the wet coast and have not yet fully formed the classical back-plain where these soils occur. The present Mulgrave-Russell system is relatively recent. The Russell probably joined with the North Johnstone with a course through Eubenangee swamp but that was interrupted by the basalt flows from the unnamed hill to the east of Garradunga. That caused the river to flow north and join the Babinda Creek outlet to the sea. The Mulgrave obviously once had its outlet through Trinity Inlet and that course certainly post dated the Green Hill basalt flows. Just what caused it to flow south and join with the Russell is not clear but it may be a simple case of stream capture by the head waters of Behana Creek.

Coom, Timara and Hewitt series form a continuum becoming progressively more poorly drained. Coom series is flooded only for short periods but has high subsoil water-tables for much of the year. Timara and Hewitt series are flooded for considerable periods each year and in the latter the water-table may not recede more than about 10cm into the B horizon in most years. Hewitt series also occurs as a fringe to most of the peat swamps.

The major distinguishing features of each series are summarised in Table 7.

Table 7. Poorly drained soils formed on alluvium

SERIES	LANDFORM	MAJOR DISTINGUISHING FEATURES
COOM	Alluvial plain	Uniform or gradational textured soil, mottled light grey and brownish yellow B horizons, strongly structured, seasonally saturated.
TIMARA	Backplain	Uniform or gradational textured soil, light grey upper B horizon, strongly structured, saturated for long periods each year.
HEWITT	Backplain	Duplex texture profile, sapric loam A horizon over light grey whole coloured or mottled silty clay B horizons.
DARADGEE	Alluvial plain	Uniform or gradational textured, mottled brown and light grey strongly structured B horizons. Occurs in association with Innisfail series.
HOLLOWAY	Alluvial plain or Swale	Mottled grey and yellow duplex soils with bleached A2 horizons.
RAMLEH	Alluvial plain	Uniform or gradational textured, mottled yellow grey and reddish medium to heavy clay B horizons.
INLET	Alluvial plain	Uniform or gradational textured, mottled yellow and grey strongly structured medium to heavy clay B horizons.
BULGUN	Alluvial plain	Dark A horizon (moist and dry) over mottled yellow and grey (occasionally red) clay B horizons.

COOM SERIES

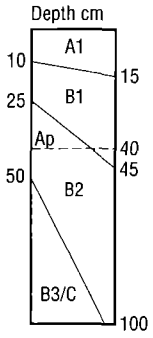
CONCEPT: Uniform or gradational textured soil, yellow and grey mottled B horizons.
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	No provision	Uf6.4p	Mesotrophic, Dermosolic, Redoxic, Hydrosol

LANDFORM Alluvial plain RAINFALL 1950mm
REFERENCE SITE Bartle Frere 1:100 000 707141

Horizon	Depth m	
Ap1	0 to 0.15	Light brownish grey (10YR6/2); 10-20% <5mm distinct dark yellowish brown (10YR4/6) mottles; medium clay; moderate 10-20mm angular blocky; moist very firm; diffuse change to-
Ap2	0.15 to 0.40	Light yellowish brown (10YR6/4); 10-20% <5mm distinct dark yellowish brown (10YR4/6) mottles; medium clay; moderate 10-20mm angular blocky; moist very firm; diffuse change to-
B21	0.40 to 0.80	Olive yellow (2.5Y6/5); 2-10% 5-15mm faint brownish yellow (10YR6/6) primary and red (2.5YR4/6) secondary mottles; medium clay; moderate 5-10mm subangular blocky; moist moderately firm; 2-10% 6-20mm ferruginous nodules; diffuse change to-
B22	0.80 to 1.20	Light grey (10YR7/2); 20-50% 5-15mm distinct brownish yellow (10YR6/6) primary and yellowish red (5YR5/8) secondary mottles; medium heavy clay; moderate 5-10mm subangular blocky; moist moderately firm.

RANGE OF CHARACTERISTICS



Coom series forms part of a continuum from the freely drained Tully series to the poorly drained Timara series soils. As a result there is considerable variation in the amount of mottling and the dominant colour. Brownish yellow or olive yellow colours are dominant on the better drained end while the light grey colours are dominant on the less well drained end of the continuum.

Most soils examined in this survey area were in cultivated and drained sites and hence the profiles have been highly modified. It is therefore virtually impossible to provide a meaningful range of properties. What evidence is available suggests that these soils in their virgin state had a gradational texture profile but have been modified under cultivation to a uniform fine texture profile.
Principal profile forms encountered include Uf6.4p, Uf6.41, and Gn3.91.

ANALYTICAL DATA

Profile T65 Map Reference Bartle Frere 1:100 000 715120
COOM SERIES Sampled in undisturbed Acacia tall open forest

Depth m	0-.10	.10-.20	.25-.30	.30-.45	.45-.60	.60-.90	.90-1.20	1.20-1.50	1.50-1.80
Horizon	A1	A3	B21	B21	B22	B22	B3	B3	B3
pH	5.7	5.7	5.7	5.8	5.9	5.8	5.7	5.7	5.6
E.C.dS/m^{-1}	.029	.017	.017	.023	.023	.029	.035	.032	.041
Org.C%	1.9	0.5	0.4		0.1		0.2		
N%	.148	.077	.042		.021		.027		
AvP ppm	9	6	3		2		9		10
Tot.P%	.036	.030	.026		.023		.050		.064
Tot.K%	1.47	1.47	1.44		1.53		1.81		1.87
Tot.S%	.017	.011	.008		.006		.007		.008
Exchange properties m.e./100g soil									
Ca	0.8	0.3	0.2		0.2		0.1		0.1
Mg	1.4	0.7	0.7		1.4		1.6		2.5
K	0.21	0.15	0.21		0.25		0.32		0.25
Na	0.27	0.21	0.20		0.33		0.26		0.18
Particle Size %									
Gr	4	2	14	12	6	0	0	0	0
CS	8	7	8	8	9		4	1	2
FS	39	41	45	44	42		34	38	46
SI	21	23	23	22	20		32	37	46
C	32	24	23	26	29		29	22	37

TIMARA SERIES

CONCEPT: Uniform or gradational textured light grey soils formed in very poorly drained sites.

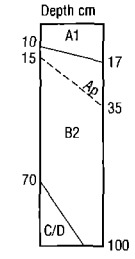
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Affinities with Gleyed podzolic soil	Uf6.33	Mesotrophic, Dermosolic, Redoxic, Hydrosol

LANDFORM Alluvial plain (swamp) RAINFALL 4000mm
REFERENCE SITE Bartle Frere 1:100 000 862976

Horizon	Depth m	
A1	0 to 0.17	Dark greyish brown (10YR4/2); silty medium clay; moderate 5-10mm cast; moist moderately weak; common 1-2mm roots; clear change to-
B21	0.17 to 0.32	Greyish brown (2.5Y5/2); 2-10% <5mm distinct yellowish red (5YR4/6) mottles; silty medium clay; moderate 10-20mm subangular blocky; moist moderately weak; common <1mm roots; diffuse change to-
B22	0.32 to 0.68	Greyish brown (2.5Y5/2); 2-10% <5mm distinct strong brown (7.5YR5/6) mottles; silty medium clay; moderate 10-20mm subangular blocky; moist moderately firm; few <1mm roots; clear change to-
2A1	0.68 to 0.76	Dark grey (10YR4/1); 10-20% 5-15mm distinct greyish brown (2.5Y5/2) primary and dark yellowish brown (10YR4/4) secondary mottles; silty light clay; weak 20-50mm subangular blocky; wet moderately firm; few <1mm roots; clear change to-
2B2	0.76 to 1.01	Grey (5Y5/1); 2-10% <5mm distinct dark yellowish brown (10YR4/6) mottles; silty medium clay; weak 20-50mm subangular blocky; wet moderately firm; few <1mm roots; gradual change to-
D	1.01 to 1.12	Brown (10YR5/3); 10-20% 5-15mm distinct very dark brown (10YR2/2) mottles; clayey peat; massive; wet very weak; gradual change to-
D	1.12 to 1.60	Very dark brown (10YR2/2); fibrous peat; massive; wet very weak; diffuse change to-
D	1.60 to 1.88	Black (10YR2/1); fibrous peat; massive; wet very weak.

RANGE OF CHARACTERISTICS



Ap Greyish brown (10YR4-5/2); light medium clay to heavy clay, similar silty clays; strong 5-10mm cast or subangular blocky; firm moist

B21 Light grey to grey (2.5YR5-7/2) <2%,5-15mm yellowish brown (10YR6/6) or yellow (2.5Y7/6); medium heavy to heavy clay; moderate to strong 5-20mm subangular blocky

B22 Grey (2.5Y5-6/2) or light brownish grey (10YR6-7/2) with 2–20% 5-15mm distinct brown (7.5YR5/8) or yellowish brown mottles; fine sandy or silty medium clay to heavy clay; moderate to strong 5–20mm subangular blocky.

Timara series may overlie materials ranging from fine stratified sand to peat or well preserved buried soils at depths as shallow as 75cm. The A and B horizons of these soils are very pale (10YR8/1-2) when dry although in their natural state they would probably never become dry. Excessively drained and cultivated soils will dry out hence the Uf2 principal profile forms.

Principal profile forms encountered include Uf6.33, Uf6.4p and Uf2p.

ANALYTICAL DATA

Profile T486 Map Reference Bartle Frere 1:100 000 862976
TIMARA SERIES Sampled from undisturbed rain forest.

Depth m	0-.17	.17-.32	.32-.45	.45-.68	.68-.76	.76-1.01	1.01-1.12	1.12-1.38
Horizon	A1	B21	B22	B22	2A1	2B2	D	D
pH	4.5	4.8	5.1	5.0	4.9	5.0	4.7	2.9
E.C.dS/m^{-1}	.185	.080	.056	.118	.162	.124	.190	3.13
Org.C%	4.44	1.90	1.60		2.09	2.02		
N%	.15	.10	.08		.07	.06		
AvP ppm	46	54	102	168				
Tot.P%	.120	.090		.110				.030
Tot.K%	2.60	2.75		2.73				1.87
Tot.S%	.090	.050		.050				
Free Fe%	1.2	1.2		1.1				
Tot.Cu %	.0039	.0036		.0043				.0024
Tot.Zn %	.0098	.0108		.0098				.0032
Tot.Mn %	.040	.030		.030				.0232
Tot Fe %	3.73	3.83		3.52				1.90
Exchange properties m.e./100g soil								
Ca	1.49	1.07	0.87	0.16	0.54	0.48	0.51	0.67
Mg	1.23	0.75	0.78	0.16	0.75	0.91	0.60	0.61
K	.18	.07	.04	.05	.02	.04	.02	<.02
Na	.05	.18	.22	.03	.16	.13	.04	.04
H+Al	2.82	3.20	2.66	2.76	2.52	2.95	2.26	36.6
ECEC*	5.8	5.3	4.6	3.2	4.0	4.5	3.4	37.9
ECEC/100g Clay	19.3	15.6	14.4	8.2	11.1	9.4	10.0	223.0
CEC**	15.1	9.6		10.4				
CEC/100g C.**	50.3	28.2		26.7				
Base Sat***	14	22		4				
CEC****	5.2	3.9	3.4	1.8	2.0	2.3	3.7	5.9
Particle Size %								
Gr	0	0	0	0	0	0	0	0
CS	3	1	1	1	1	0	2	19
FS	5	4	5	6	5	4	17	15
SI	61	62	62	54	57	48	48	49
C	30	34	32	39	36	48	34	17

* sum of basic and acidic cations *** $\frac{\text{Bases}}{\text{NH}_4\text{OAc CEC}} \times 100$ ** NH_4OAc **** Comp. Exch

HEWITT SERIES

CONCEPT: Gleyed texture contrast soils with a very dark organic surface.

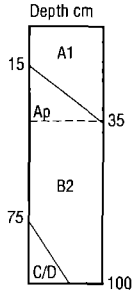
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Humic gley	Dy4.51	Melacic, Kurosolic, Oxyaquic, Hydrosol

LANDFORM Alluvial plain (swamp) RAINFALL 4000mm
REFERENCE SITE Bartle Frere 1:100 000 879737

Horizon	Depth m	
O	+.06	Leaf, grass and sedge litter.
A1	0 to 0.20	Black (10YR2/1); loam (sapric); massive; moist moderately weak; <2% 2-6mm, subangular granite gravel, dispersed; abundant 1-2mm roots; clear smooth change to-
B21	0.20 to 0.32	Greyish brown (10YR5/2), (10YR8/1d) ; light clay; massive; moist moderately weak; <2% 2-6mm, subangular granite gravel, dispersed; many 1-2mm roots; clear smooth change to-
B22	0.32 to 0.41	Greyish brown (2.5Y5/3); light clay; massive; moist moderately weak; <2% 2-6mm, subangular granite gravel, dispersed; many 1-2mm roots; clear change to-
B23	0.41 to 0.75	Olive (5Y5/3); medium clay; massive; moist moderately weak; <2% 2-6mm, subangular granite gravel, dispersed; few 1-2mm roots; diffuse change to-
B24	0.75 to 1.25	Yellowish brown (10YR5/4); 20-50% 15-30mm faint yellowish brown (10YR5/8) mottles; light medium clay; moderate 2-5mm subangular blocky; wet moderately firm;
1.25 to 1.60		Dark yellowish brown (10YR4/6); 20-50% >30mm distinct grey (5Y5/1) mottles; light medium clay;
1.60 to 1.90 +		Grey clayey grit not retrievable with auger

RANGE OF CHARACTERISTICS



Ap Black or very grey (10YR2-3/1); loam to silty loam or clay loam (sapric); massive; moist moderately weak.

A1 Black (10YR2/1) to very dark greyish brown (10YR3/2); loam (sapric) to clay loam (sapric); usually gravel free.

B21 Dark grey (2.5Y4/1) to light brownish grey (2.5Y6/2); may occasionally have a fine brownish or reddish yellow (7.5YR - 10YR6/8) mottle; light to medium clay often silty; massive to weak 5–10mm subangular blocky.

The upper part of the B horizon is usually whole coloured but the lower B is always mottled, light grey dominant with bright yellow.

In some soils there appears to be a mixing of A and B horizons over a zone of about 20cm thick and it tends to be more common on those soils with the thicker A horizons. It is not readily apparent how this mixing might occur as there is little evidence of biological activity in most of these soils.

ANALYTICAL DATA

Profile T475 Map Reference Bartle Frere 1:100 000 879737
HEWITT SERIES Sampled in undisturbed Melaleuca tall open forest.

Depth m	0-.20	.20-.32	.32-.41	.41-.75	.75-1.25	1.25-1.60
Horizon	A1	B21	B22	B23	B24	
pH	3.6	3.9	4.1	4.1	4.0	4.1
E.C.dS/m^{-1}	0.35	0.07	0.05	0.04	0.04	0.04
Tot.C%	16.6	3.2	2.2	0.94		
N%	1.22	0.22	0.17			
AvP ppm	84	18	26	12		
Exchange properties m.e./100g soil						
Ca	1.50	0.24	0.24	0.04	0.09	0.05
Mg	1.16	0.43	0.35	0.33	0.34	0.29
K	0.25	0.08	0.03	0.02	0.03	0.06
Na	0.24	0.13	0.06	0.04	0.04	0.05
H+Al	5.79	2.74	2.29	1.95	2.10	1.58
ECEC*	8.9	3.6	3.0	2.4	2.6	2.0
ECEC/100g Clay	18.9	10.0	8.6	7.7	6.3	
CEC**	2.0	2.0	2.0	1.8	1.7	1.3
Particle Size %						
Gr	0	0	0	0	0	0
CS	5	13	15	21	15	
FS	4	16	14	18	16	
SI	45	35	36	30	28	
C	47	36	35	31	41	

* sum of basic and acidic cations ** Comp. Exch

INLET SERIES

CONCEPT: Mottled, uniform or gradational textured soils formed on alluvium of possible marine origin

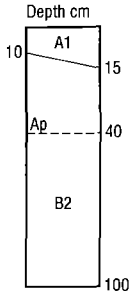
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	No suitable group	Uf6.41	Magnesic, Dermosolic Redoxic, Hydrosol

LANDFORM Alluvial plain (? stagnant alluvial plain) RAINFALL 2200mm
REFERENCE SITE Bartle Frere 1:100 000 693190

Horizon	Depth m	
A1	0 to 0.09	Dark greyish brown (10YR4/2); light clay; weak 10-20mm subangular blocky; moist very firm; abundant 2-5mm roots; clear change to-
AB	0.09 to 0.22	Light brownish grey (10YR6/2); 10-20% 5-15mm faint light grey (10YR7/2) primary and yellowish brown (10YR5/8) secondary mottles; medium heavy clay; moderate 10-20mm subangular blocky; moist very firm; 2-10% 2-6mm manganiferous soft segregations; common 1-2mm roots; diffuse change to-
B21	0.22 to 0.45	Light brownish grey (10YR6/2); 20-50% 5-15mm distinct brownish yellow (10YR6/6) mottles; heavy clay; moderate 10-20mm subangular blocky; moist moderately firm; few 1-2mm roots; diffuse change to-
B22	0.45 to 0.85	Light grey (10YR7/1); 20-50% 5-15mm prominent red (2.5YR4/8) primary and brownish yellow (10YR6/6) secondary mottles; heavy clay; weak 10-20mm subangular blocky; moist moderately firm; diffuse change to-
B23	0.85 to 1.64	Grey (10YR6/1); 20-50% 15-30mm prominent red (10R4/6) mottles; heavy clay; strong 10-20mm subangular blocky; moist very firm; diffuse change to-
D1	1.64 to 2.46	Grey (N5/0); 20-50% >30mm prominent dark yellowish brown (10YR4/4) mottles; heavy clay; strong 50-100mm lenticular; moist moderately strong; 2-10% 6-20mm manganiferous nodules; diffuse change to-
D2	2.46 to 2.79	Grey (N5/0); 20-50% >30mm prominent dark yellowish brown (10YR4/4) mottles; heavy clay; strong 50-100mm lenticular; moist very strong; 2-10% 2-6mm manganiferous nodules.

RANGE OF CHARACTERISTICS



Ap Greyish brown (10YR5/2) to yellowish brown (10YR5/4); light medium or silty light clay to silty medium clay; moderate to strong 5–10mm cast; moist firm.

A1 Dark greyish brown (10YR4/2) to pale brown (10YR6/3); clay loam to clay; weak to moderate 10-20mm subangular blocky or 5–10mm cast.

B21 Light brownish grey (2.5Y-10YR6/2) or yellowish brown (10YR5/4) to brownish yellow (10YR6/8); 20-50% 5-15mm distinct brownish yellow (10YR6/6) or yellowish red (7.5YR-5YR5/8); silty medium clay to light medium or heavy clay; moderate to strong 10–20mm subangular blocky;

B22 Dark grey (7.5YR4/0) to light grey or light brownish grey (10YR6-7/1-2); 20-50%, 5-15mm prominent red or yellowish red (2.5YR-5YR4-5/4-8) and lesser brownish yellow (10YR6/8); silty medium clay or medium to heavy clay; weak to strong 10-20mm subangular blocky.

D Highly pedal light grey D horizon may occur as shallow as 160cm.

The A horizon at undisturbed sites is generally lighter textured than cultivated soils probably due to some mixing of A and B horizon material during cultivation.

Principal profile forms encountered include Uf6.41, Uf6.34 (most common), and Gn3.73. It is suspected that most of the Uf soils would be Ug when artificially drained.

ANALYTICAL DATA

Profile T481 Map Reference Bartle Frere 1:100 000 693190
INLET SERIES Sampled from undisturbed Eucalyptus tall woodland

Depth m	0-.09	.09-.22	.22-.45	.45-.66	.66-.85	1.19-1.64	2.11-2.46	2.46-2.79
Horizon	A1	AB	B21	B22	B22	B23	D1	D2
pH	5.4	5.2	5.3	5.3	5.5	5.4	5.9	6.6
E.C.dS/m^{-1}	.059	.044	.033	.036	.034	.066	.326	.561
Org.C%	1.89	0.51	0.27	0.16				
N%	0.05	0.02	0.02					
AvP ppm	6	2	<2	<2	<2			
Tot.P%	.030		.020		.010		.020	
Tot.K%	1.82		1.76		1.76		1.36	
Tot.S%	.030		.030		.020		.010	
Free Fe%	1.2		1.7		2.3			
Exchange properties m.e./100g soil								
Ca	1.50		0.09	0.07	0.09	0.66	4.53	2.74
Mg	1.44		1.05	0.94	1.08	3.18	4.77	2.33
K	0.26		0.10	0.04	0.04	0.02	0.03	<.02
Na	0.25		0.14	0.20	0.23	0.71	1.44	0.86
H+Al	0.93		3.49	4.45	4.43	4.71	0.18	0.04
ECEC*	4.4		4.9	5.7	5.9	9.3	11.0	6.0
ECEC/100g Clay	11.6		12.2	13.6	14	26.5	22.4	11.8
CEC**	7.7		6.3	7.0	7.3	11.7	14.3	14.7
CEC/100g C.**	20.2		15.8	16.7	17.4	33.4	29.2	28.8
Base Sat***	45		22	18	20	41	75	40
CEC****	4.7		3.7	4.1	4.1	4.1	9.2	12.7
Particle Size %								
Gr	0	0	0	0	0	0	0	0
CS	9	9	8	9	9	9	6	5
FS	31	36	34	32	33	21	12	4
SI	22	20	18	17	16	35	33	30
C	38	35	40	42	42	35	49	51

* sum of basic and acidic cations *** $\frac{\text{Bases}}{\text{NH}_4\text{OAc CEC}} \times 100$ ** NH_4 OAc **** Comp. Exch

HOLLOWAY SERIES

CONCEPT: Mottled grey and yellow duplex or uniform textured soils with conspicuously bleached A2 formed on poorly drained alluvium and usually abutting the littoral zone.

REPRESENTATIVE PROFILE

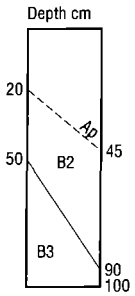
	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Soloth	Dy2p	Magnesic, Kurosolic, Oxyaquic, Hydrosol

LANDFORM Alluvial plain RAINFALL 2200mm
REFERENCE SITE Cairns 1:100 000 644403

Horizon	Depth m	
Ap	0 to 0.20	Dark greyish brown (10YR4/2), (10YR6/2d); sandy clay loam; weak 10-20mm subangular blocky; moist moderately firm; clear change to-
B2	0.20 to 0.50	Very dark greyish brown (10YR3/2); sandy medium clay; weak 10-20mm subangular blocky; moist moderately firm; diffuse change to-
B31	0.50 to 0.90	Greyish brown (2.5Y5/2); <2% 5-15mm faint brown (10YR5/3) mottles; sandy clay loam (heavy); massive; moist moderately weak; diffuse change to-
B32	0.90 to 1.20	Light brownish grey (10YR6/2); sandy clay loam; massive; wet moderately weak.

NOTE: Very strong hydrogen sulphide smell from 90cm but no gley colours.

RANGE IN CHARACTERISTICS



Ap Very dark grey (10YR3/1) to dark greyish brown (10YR4/2); sandy clay loam to heavy clay;

B2 Maybe whole coloured or mottled, very dark greyish brown (10YR3/2) to dark grey (10YR4/1) or grey (5Y5/1),2-10% 5-30mm distinct brown (7.5YR-10YR4-5/3-4) mottles; sandy medium clay to heavy clay.

These soils occur at the margins of the tidal zone, in swales associated with beach ridges and on alluvium adjacent to the beach ridges. In some areas there has been some reworking of the beach ridge sands which can give rise to much sandier textures. Also in some areas these soils may be strongly sulphidic from as shallow as 50cm. Insufficient inspections have been made to determine how widespread the sulphidic conditions are or if they are seasonal or permanent. In the Mossman area these soils had a strongly bleached A2 horizon. All soils examined in this area have been highly disturbed but evidence suggests that they had a bleached A2 horizon.

Principal profiles forms encountered include Dy2p and Uf6.41p.

ANALYTICAL DATA

The following data are from Thompson and Cannon (1988)
Site No C3 Map Reference Cairns 1:100 000 642402
HOLLOWAY SERIES Sampled from undisturbed Melaleuca forest.

Depth m	0-.10	.20-.30	.50-.60	.80-.90	1.10-1.20
Horizon	A1	A2	B1	B22	D
pH	5.4	5.7	5.0	5.2	5.6
E.C.dS/m^{-1}	0.05	0.02	0.08	0.04	0.03
Org.C%	1.90	0.46			
N%	0.12	0.04			
AvP ppm	5	2			
Tot.P%	.013	.005	.008	.007	.005
Tot.K%	1.74	1.67	1.77	1.97	1.90
Tot.S%	.034	.009	.014	.017	.009
Exchange properties m.e./100g soil					
Ca	2.20	0.31	0.01	0.01	0.01
Mg	2.00	0.38	1.80	2.80	0.95
K	0.17	0.05	0.15	0.19	0.08
Na	0.46	0.20	0.90	1.40	0.30
CEC	11	1	7	10	3
CEC/100g Clay	68	17	30	30	33
Particle Size %					
CS	53	63	53	43	69
FS	16	19	16	14	17
SI	14	10	8	10	7
C	16	6	23	33	9

For methods see Bruce and Rayment (1982)

RAMLEH SERIES

CONCEPT: Mottled uniform or gradational textured soils formed on local alluvium from metasediments.

REPRESENTATIVE PROFILE

CLASSIFICATION	G.S.G. Affinities with Yellow Podzolic soil	P.P.F. Uf6.34	A.S.C. Acidic, Dystrophic Brown, Dermosol
LANDFORM	Alluvial plain (valley flat)	RAINFALL 3200mm	
REFERENCE SITE	Tully 1:100 000 905639		

Horizon	Depth m	
A1	0 to 0.20	Brown (7.5YR4/4); light clay; strong 2-5mm cast; moist moderately firm; 2-10% 20-60mm subrounded metamorphic rock gravel; gradual change to-
B1	0.20 to 0.50	Strong brown (7.5YR5/6), 2-10% 5-15mm faint reddish yellow (7.5YR6/8) mottles; light medium clay; moderate 5-10mm subangular blocky; moist very firm; 2-10% 20-60mm subrounded metamorphic rock gravel; 2-10% 2-6mm manganiferous nodules; diffuse change to-
B21	0.50 to 0.75	Strong brown (7.5YR5/8); 10-20% 15-30mm distinct grey (10YR5/1) mottles; heavy clay; moderate 5-10mm subangular blocky; moist very firm; 2-10 % 20-60mm subrounded metamorphic rock gravel; 2-10 % 2-6mm manganiferous nodules; diffuse change to-
B22	00.75 to .90	Dark yellowish brown (10YR4/6) 20-50 % 15-30mm distinct grey (10YR5/1) mottles; heavy clay; strong 20-50mm angular blocky; moist very firm; <2% 2-6mm manganiferous soft segregations; diffuse change to-
B3	0.90 to 1.50	Brownish yellow (10YR6/8) 20-50 % 15-30mm prominent grey (2.5Y5/0) mottles; fine sandy medium clay; moderate 20-50mm angular blocky wet very firm; water table at 1.15m

RANGE IN CHARACTERISTICS

Too few profiles were described to provide a meaningful range. This is not a very diverse group of soils and most differ little from that described above. The characteristic features of these soils are the heavier textures and the very greasy or soapy feel when textured. They are much tougher to work and break to a fine tilth than any of the other alluvial soils apart possibly from Inlet series and give the impression that although not excessively wet, they would be very slow to drain where drainage might need to be improved.

ANALYTICAL DATA

This soil was not sampled in the survey area. The following data are from the Tully-Innisfail report (Murtha 1988). The profile below is lighter in texture than those found in this survey area.

Profile T290 Map Reference Innisfail 1:100 000 952441
RAMLEH SERIES Sample site under pasture but has never been cultivated.

Depth m	0-.10	.10-.20	.20-.30	.30-.50	.50.60	.60-.90	.90-1.10	1.20-1.50
Horizon	A1	A3	B1	B1	B21	B22	B23	B23
pH	5.1	5.0	4.9	4.9	4.9	4.8	4.8	5.0
E.C. dS/m^{-1}	.050	.023	.017	.017	.020	.026	.020	.023
Org. C %	1.18	.63		.53	.87	.23		
N %	.11	.09			.08			
Av. P ppm	21	11		11				
Tot. P %	.026				.032			
Tot. K %	1.20				2.44			
Tot. S %	.018				.026			
Exchange properties m.e./100 g. soil								
Ca	.31	.03		.06	<.02	.06		
Mg	.33	<.01		<.01	<.01	.02		
K	.15	.05		<.01	.05	<.01		
Na	.07	.04		<.01	.04	<.01		
H+Al	1.5	2.1		2.1	2.0	2.4		
ECEC*	2.36	2.23		2.19	2.12	2.5		
ECEC/100g Clay	13.1	10.6		9.1	6.2	6.6		
CEC **	3.9	3.9			3.4			
CEC/100 g C.**	21.7	18.6			10.0			
Base Sat.***	22	3			4			
CEC ****	2.1	1.9		1.6	2.0	2.2		
Particle size %								
Gr	tr	tr	tr	tr	6	tr	tr	tr
CS	4	3	4	5	7	4		8
FS	51	46	45	47	27	20		21
Si	28	30	28	24	33	38		36
C	18	21	23	24	34	38		35

Mineralogy of the clay fraction	Depth cm	ChV %	I %	Ka %	Go/Ha %
	60-90	1-5	50-60	10-20	30-40

* sum of basic and acidic cations

*** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$

** NH_4 OAc

****Comp. Exch

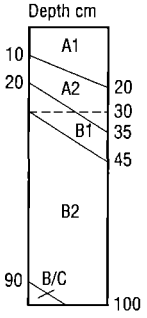
BULGUN SERIES

CONCEPT: Dark A horizon (moist and dry) over mottled clay B horizon.

REPRESENTATIVE PROFILE

		G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION		Affinity with Gleyed Podzolic soil	Uf6.41	Acidic, Dystrophic Grey, Dermosol
LANDFORM		Alluvial plain	RAINFALL 3200mm	
REFERENCE SITE		Bartle Frere 1:100 000		
Horizon	**Depth m**			
Ap	0 to 0.30	Dark greyish brown (10YR4/2); silty light clay; moderate 2-5mm cast; moist moderately firm; 2-10% 2-6mm ferromanganiferous nodules; clear change to-		
B21	0.30 to 0.40	Light brownish grey (10YR6/2) with 2-10% <5mm distinct yellowish red (5YR5/8) mottles; light medium clay; moderate 5-10mm subangular blocky; moist moderately firm; <2% 2-6mm ferromanganiferous nodules; diffuse change to-		
B22	0.40 to 0.90	Light brownish grey (10YR6/2) with 10-20% 5-15mm prominent red (2.5YR5/8) mottles; medium clay; moderate 5-15mm angular blocky; moist very firm; diffuse change to-		
BC	0.90 to 1.25	Light grey (10YR7/1) with 10-20% 5-15mm prominent red (2.5YR4/8) mottles; fine sandy light clay; weak 5-15mm subangular blocky; wet moderately firm		

RANGE IN CHARACTERISTICS



Ap Black (10YR2/1) to dark greyish brown (10YR4/2) loam to light medium clay; weak to strong cast or subangular blocky

A1 Black (10YR2/1) to greyish brown (2.5Y5/2) silty clay loam to light medium clay; weak to strong cast or subangular blocky

A2 Dark grey (10YR4/1) to pinkish grey (10YR6/2), rarely bleached; clay loam to light clay; weak to moderate 5-15mm subangular blocky; gradual or clear change to

B1 Dark grey (10YR4/1) to very pale brown (10YR7/4) faint to distinct yellow (10YR7/6) mottles; light clay to silty medium clay; massive to moderate subangular blocky; gradule or diffuse change

B2 Dark greyish brown (10YR4/2) to light grey (10YR7/2) with prominent brownish yellow (10YR6/8) or red (2.5YR5/8) mottles; light clay to medium heavy clay; moderate to strong prismatic or strong subangular or angular blocky

There is considerable variation with depth. Some profiles grade slowly to sandy sediments while in others there is a sharp change to strongly stratified sandy sediments or buried soils.

Principal profile forms encountered include Uf6.41, Gn3.71, and Gn3.74.

ANALYTICAL DATA

This soil was not sampled in the survey area. The following data are from the Tully-Innisfail report (Murtha 1988).

Profile T271 Map Reference Innisfail 1:100 000 970350
BULGUN SERIES Sample site undisturbed eucalypt and Melaleuca open forest.

Depth m	0-.10	.10-.20	.20-.30	.30-.45	.45-.60	.60-.90	.90-1.20	1.20-1.50
Horizon	A1	A21	A22	B1	B1	B2	B3	BC
pH	4.9	5.0	5.0	4.9	5.0	5.0	5.1	4.9
E.C. dS/m^{-1}	.064	.029	.024	.051	.020	.024	.019	.018
Org. C %	4.25	2.39	1.58		.44			
N %	.19	.09	.07		.04			
Av. P ppm	14	9	3	2	6			
Tot. P %	.043					.011		
Tot. K %	.90					.91		
Tot. S %	.130					.038		
Exchange properties m.e./100 g soil								
Ca	.13	.08		.04		.04		
Mg	.24	.05		.16		.23		
K	.05	<.01		<.01		<.01		
Na	.08	.05		.16		.03		
H + Al	2.9	2.5	2.6	2.5		2.5		
ECEC *	3.4	2.69		2.87		2.81		
ECEC/100 g Clay 7.2	5.8		6.8		5.6			
CEC **	18.7	11.6	8.3	5.3		5.3		
CEC/100 g C.**	39.8	25.2	18.4	12.6		10.6		
Base Sat. ***	3	2		7		6		
CEC ****	2.5	2.1		2.3		2.2		
Particle size %								
Gr	0	0	0	0	0	0	0	
CS	13	11	10	11		8	11	
FS	19	21	22	24		17	16	
Si	22	22	23	23		26	26	
C	47	46	45	42		50	47	

Mineralogy of the clay fraction	Depth cm	ChV %	I %	Ka %	G %
	60-90	5-10	10-20	65-80	10-20

* sum of basic and acidic cations *** $\frac{\text{Bases}}{\text{NH}_4\text{OAc CEC}} \times 100$ ** NH_4 OAc **** Comp. Exch

DARADGEE SERIES

CONCEPT: Brown mottled uniform textured soils formed on mixed alluvium

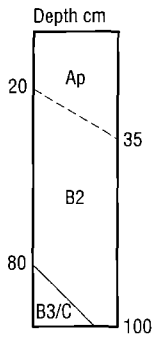
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	No provision	Uf6.41	Dermosolic, Redoxic, Hydrosol

LANDFORM Alluvial plain
REFERENCE SITE Cooper Point 1:100 000 950672

Horizon	Depth m	
Ap	0 to 0.30	Dark yellowish brown (10YR4/4); 10-20% <5mm faint brown (7.5YR4/4) mottles; silty light clay (light); weak 20-50mm subangular blocky; moist moderately firm; diffuse change to-
B21	0.30 to 0.50	Dark brown (10YR3/3); 10-20% <5mm distinct dark reddish brown (2.5YR3/4) mottles; silty light clay; moderate 10-20mm subangular blocky; moist moderately firm; diffuse change to-
B22	0.50 to 0.80	Dark yellowish brown (10YR4/4); 10-20% <5mm distinct grey (10YR5/1) primary and dark reddish brown (2.5YR3/4) secondary mottles; heavy clay; moderate 10-20mm angular blocky; moist moderately weak; diffuse change to-
B23	0.80 to 1.20	Grey (10YR6/1); 20-50% 5-15mm distinct brownish yellow (10YR6/6) primary and dark red (2.5YR3/6) secondary mottles; heavy clay; moderate 10-20mm angular blocky; wet moderately weak, very plastic, normal plastic.

RANGE IN CHARACTERISTICS



Ap Brown (10YR5/3) to dark yellowish brown (10YR4/4); light clay to medium clay, occasionally silty; weak 5-10mm cast or 20-50mm subangular blocky

B21 Dark brown (10YR3/3) to brown (2.5Y - 10YR5/3);10-20% 2-15mm dark reddish brown (2.5YR3/4) to yellowish red (5YR5/8) or yellowish brown (7.5YR5/6) mottles; silty light clay to medium heavy clay; moderate to strong 10-20mm subangular blocky

B22 As above with some grey (10YR5/1) mottles.

B23 Grey (10YR6/1) to greenish grey (5G6/1);10-50% 5-15mm distinct brownish yellow (10YR6/6) and dark red (2.5YR3/6) mottles; medium to heavy clay.

No virgin soils were examined. Daradgee series occupies wetter sites in association with Innisfail series. It is the equivalent of Coom series where that occurs in association with Tully series.

Principal profile forms encountered include Uf6.41, Uf6.4p and very occasionally Um6.3.

This is a minor soil and has not been sampled for analysis.

MAPPING UNITS – POORLY DRAINED SOILS FORMED ON ALLUVIUM

COOM ASSOCIATION Co 32 UMAs 2086ha.

This association occurs along most of the larger streams where it occupies the higher parts of the backplain. It commonly abuts the low angle alluvial fans and in many of these situations the soils on the fans and Coom series have features in common and it may be difficult to make the distinction. There are only a few small areas of this association left uncleared. In most cases extensive drainage works have been carried out so the soils are highly disturbed.

The dominant soil is Coom series which is in effect the yellow Tully series soil in a less well drained site and as a result has developed some grey mottling. As the drainage becomes poorer the amount of grey mottling increases and becomes the dominant colour. With a further increase in wetness the yellow mottle disappears, the soil then becomes whole coloured light grey this is the Timara series. This is a very common continuum on the mixed alluvium and all areas of Coom association have Tully and Timara series as associated soils. Coom series always occurs where Tully association abuts poorly drained areas but it may not always occur in large enough areas to map as the dominant soil. Small areas of Hewitt series occur where this association lies adjacent to peat swamps.

TIMARA ASSOCIATION Ti 25 UMAs 2593ha.

This association occupies sites that are in most cases marginal to and more poorly drained than the Coom association. Unless artificially drained, these areas pond water for considerable periods each year and have near permanent shallow ground-water. Small areas of this unit occur in the back-swamps of all the major streams or occur marginal to the larger swamps. Although large areas have been cleared and drained, most of the national park to the west of the Russell River has been included in this unit. The original vegetation ranged from tall Melaleuca quinquenervia forests to closed forests dominated by palms. Prominent swamp hummock surface microrelief is common to most areas. It can take a number of forms and the vertical interval ranges from about .10m to 0.90m. Tree fall is the only obvious cause for the formation of this microrelief but in many areas it is not a very convincing explanation.

Timara series is the dominant soil but Coom series is very closely associated and may be co-dominant in many areas. Minor associated soils include Tully and Liverpool series along small streams traversing the unit and Hewitt series where this association abuts the peat swamps. In the cleared areas, few soils are in anything like their original condition as a result of the extensive drainage works and the spreading of spoil from the drains

HEWITT ASSOCIATION He 17 UMAs 1028ha.

The mapped occurrences of this association are restricted almost entirely to the margins of Eubenangee and Wyvuri Swamps. It could possibly occur on the western margins of Ella Bay Swamp but that area was inaccessible at the time of the survey. Some smaller areas have been mapped marginal to the mangrove communities. Unless artificially drained these areas pond water for considerable periods each year and have near permanent shallow ground-water although the surface would dry out each year. The vegetation is almost always a low Melaleuca quinquenervia forest. Prominent swamp hummock or debil debil microrelief is common throughout the unit.

Hewitt series is the dominant soil but Coom and Timara series will be closely associated on the drier margins of the unit and some peat soils will be included where it abuts the swamps. Sumalee series which is often sulphidic will be the most commonly associated soil in the areas adjacent to tidal lands or in swamps immediately behind the coastal beach ridge systems. Although Hewitt series is not regarded as a sulphidic soil weak acid sulphate conditions have been encountered soon after the onset of the wet season. The surface of these soils is relatively high in organic matter and the sulphidic conditions may be associated with reducing conditions brought about by the first flush of oxidation of the organic fraction.

INLET ASSOCIATION Il 3 UMAs 1317ha.

This unit is restricted to lands marginal to the mangroves on the southern and south western sides of Trinity Inlet. The unit overlies marine sediments (see D horizon data for Inlet series) and it is thought that the sediments may have been deposited in a marine or brackish water environment. The soils have a much heavier and tougher clay than the other alluvial soils although the cause is not evident in the chemical or particle size data. The clay also has the very greasy or soapy feel of highly sodic or magnesic clays.

Inlet series is the only soil that has been recorded in this unit although in wetter parts of the unit the morphology will be very similar to Coom series.

HOLLOWAY ASSOCIATION Ho 7 UMAs 508ha.

This is a minor unit of heavier textured soils that occur either immediately behind some of the beach ridges or just above the tidal influence of some of the smaller inlets. It occurs chiefly north of the Barron River delta. It has almost certainly had some marine influence but that is not

very evident in the data for the one profile sampled. The area that has been mapped as Made Land on the eastern side of Trinity Inlet would have been dominantly Holloway series apart from the portion originally occupied by mangroves. Holloway series is the only soil that has been recorded but some Timara series, Hewitt series or very similar soils may occur.

RAMLEH ASSOCIATION Ra 13 UMAs 574ha.

This association is restricted to alluvium derived wholly from the Barron River metasediments. It has been mapped only along some of the minor streams in the metamorphic rock landscape but very narrow areas will occur throughout the Galmara association and the mountainous unit M1. Ramleh series is the dominant soil and although the landscape is not poorly drained, these soils exhibit many of the characteristics of poor drainage and they are regarded as difficult soils to manage. Soils similar to Tully or Canoe series occur on the levees of minor streams traversing the unit.

DARADGEE ASSOCIATION Dd 2 UMAs 130ha.

This is a minor unit occupying small areas of back-swamp on the alluvium of the North Johnstone River. Daradgee series is the dominant soil. It is a mottled grey and brown soil. Innisfail-Daradgee series have the same relationship as Tully-Coom series. This is the only soil that has been recorded in the mapped areas but most have been highly disturbed by draining and spreading of spoil to the extent that in some cases they would more properly be mapped as Made Land.

BULGUN ASSOCIATION Bg 3 UMAs 579ha.

Bulgun series seems to occur almost at random across the alluvial plains although it is usually at a slightly lower level than the well drained alluvium on which Tully or Mossman series occur. Only one area has been delineated and that occurs on the Mulgrave River alluvium to the south of Allomba. Small areas of Kirrama, Malbon or Thorpe series may be included where this unit abuts the granitic fans.

SOILS OF THE SWAMPS AND TIDAL ZONE

This survey area contains six large and numerous smaller swamps. These are highly significant wetland areas but many are being significantly modified by draining and to a lesser extent by accelerated deposition. Probably only the Ella Bay Swamp is in it's original condition. This area is inaccessible apart from on foot and there has been virtually no disturbance of the catchment. It is interesting to note that there is active retreat of the shore line in this area as swamp peats are exposed to seaward at low water. The swamp at Yarrabah has been little disturbed but there is increasing disturbance around the margins. There has been limited drainage to the northern and western margins to Wyvuri Swamp and there are plans by the present owners for a major drainage of the southern end. The East Derral Swamp is part of a drainage scheme and about 50% of the area has been cleared and cultivated to cane. The Babinda Swamp has been drained and cleared and the largest part of the area is cultivated to cane or used for improved pastures. Eubenangee is the largest swampland in the area and while a significant part is in national park much of the margin has been cleared, drained and cultivated. There is also clear evidence of accelerated deposition as a result of increased erosion of much of the catchment area. Apart from East Derral all of these swamplands contain fresh water peats on the surface. There may be some surface peat in East Derral but for the most part it has about one metre of the poorly drained Timara series overlying peat.

While these swamplands can be highly productive if properly managed there are potential problems which are not receiving sufficient attention. In some areas of Babinda swamp the surface has lowered at least one metre since the initial draining. No information is available on other areas but it is almost certain that shrinkage has occurred. The lowering of the surface is largely a result of shrinkage of the peat after removal of water and the burning of the surface layers. There are uncorroborated reports of large holes being burnt in the peat but it is common to find 15-25cm of the surface burnt after a deliberate or wild fire if conditions are very dry. The initial depth of drains and the regular cleaning required needs to be strictly controlled to prevent excessive removal of water. Excessive shrinkage will quickly result in the land surface dropping to the point where there is insufficient fall to provide drainage. To a lesser extent the enzyme activity of the peat needs to be investigated. Enzyme activity is a major form of decomposition and hence shrinkage of peat but remedial measures can easily be undertaken.

The major concern with these swamplands is the presence of acid sulphate or potential sulphidic materials. While some weakly sulphidic conditions have been recorded during the course of this survey, the extent and the degree of development of potential acid sulphate materials is unknown. It is a major concern that drainage schemes are being planned and carried out without a thorough investigation of the potential risk. While the water-tables remain high, the materials cause no real problem and the potential risk is low. The difficulty occurs on drainage when oxidation leads to the development of very acidic conditions with disastrous long term effects both onsite and downstream.

Three soils that occur in the swamps have been identified. They are all peats and are differentiated chiefly on the degree of decomposition of the peat. The terms used for the identification of peat materials are those adopted by McDonald et al (1990). Briefly they are:-

- Fibric - Fibrous plant remains where the plant species can be clearly identified
- Hemic - Clearly plant remains but it is not possible to identify the species
- Sapric - Organic materials that are completely decomposed

Babinda and Sumalee series occurs where the water recedes below the surface in most years permitting decomposition of the peat. The depth of the sapric material probably equates with the depth to water in the dry season. Nind series occurs in those swamps that have either permanent surface water or where the water receds below the surface only very rarely.

MANGROVE SOIL

CONCEPT: Soils subject to tidal inundation.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Solonchak	Uf6	Intertidal, Hydrosol
LANDFORM	Chenier plain		
REFERENCE SITE	Innisfail 1:100 000 990632		

Horizon	Depth m	
A	0 to 0.25	Dark brown (7.5YR3/2); clay loam (organic); weak 5-10mm subangular blocky; wet sticky; abundant 1-2mm roots;
B	0.25 to 0.90	Brown (7.5YR4/2); light medium clay; weak 2-5mm subangular blocky; wet sticky; common 1-2mm roots;
D	0.90 to 1.20	Dark grey (10YR4/1); peat; massive; wet.

NOTE: Prominent orange and black banding 2cm thick through A horizon

The profile described above may not be representative. Few observations were made of the mangrove soils

The following data are from Thompson and Cannon (1988). They identified the Mangrove soils as Machan series

Site No C2 Map Reference Cairns 1:100 000 671352
MACHAN SERIES Sampled from undisturbed Mangrove forest.

Depth m	0-.10	.20-.30	.50-.60
Horizon	A1	B	D
pH	6.4	6.4	7.5
E.C.dS/m-1	5.1	6.7	9.6
Cl %	1.001	1.34	2.04
Org.C%	2.5		
N%	0.13		
AvP ppm	21	20	
Tot.P%	.031	.035	.047
Tot.K%	1.99	2.00	2.07
Tot.S%	.125	.151	.165
Exchange properties m.e./100g soil			
Ca	4.6	4.4	7.1
Mg	12.0	13.0	15.0
K	1.7	1.8	2.1
Na	<0.1	<0.1	<0.1
CEC*	19	17	17
Particle Size %			
CS	26	23	20
FS	25	22	19
SI	25	28	28
C	25	37	37

* For methods see Bruce and Rayment (1982)

BABINDA SERIES

CONCEPT: Sapric over fibric peat.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Acid Peat	0	Regolithic, Acidic, Fibric, Organosol*
LANDFORM	Swamp RAINFALL 4000mm		
REFERENCE SITE	Bartle Frere 1:100 000 891798		

* This is a Sulphidic, Fibric, Organosol but the appropriate pH after incubation has not been determined.

Horizon	Depth m	
P1	0 to 0.15	Black (10YR2/1); sapric peat; moderate 5-10mm subangular blocky; moist moderately weak; abundant >5mm roots;
P1	0.15 to 0.30	Black (10YR2/1); sapric peat; moderate 5-10mm subangular blocky; moist moderately weak; common 1-2mm roots; gradual smooth change to-
P2	0.30 to 0.55	Dark brown (7.5YR3/2); sapric peat; moderate 5-10mm subangular blocky; wet moderately weak; common 1-2mm roots; clear change to-
P3	0.55 to 0.90	Dark brown (7.5YR3/2); fibric peat; massive; wet moderately weak; few <1mm roots; diffuse change to-
P3	0.90 to 1.20	Dark brown (7.5YR3/2);fibric peat; wet moderately weak; diffuse change to-
P4	1.20 to 1.50	Dark brown (7.5YR3/2); 2-10% >30mm distinct brown (10YR5/3) mottles; fibric peat; wet moderately weak; diffuse change to-
P4	1.50 to 1.80	Dark brown (7.5YR3/2); 2-10% >30mm distinct brown (10YR5/3) mottles; fibric peat; wet; moderately weak; diffuse change to-
P5	1.80 to 2.10	Dark brown (7.5YR3/2); fibric peat; wet moderately weak; diffuse change to-
P5	2.10 to 2.20	Dark brown (7.5YR3/2); fibric peat; wet very weak.

NOTE: .03m of O horizon; light grey band from .50-.52m; weak hydrogen sulphide smell from 1.30-1.50m; strong prismatic structure to 1.00m in nearby drain.

RANGE OF CHARACTERISTICS

These are highly organic materials formed from the remains of sedges, pandanas and trees. They have 0.40 to 0.60m of sapric (very decomposed with no recognisable plant remains) material over a fibric (very fibrous with unidentifiable plant remains) peat. Although most areas have been artificially drained they have water tables high in the profile for much of the year and only rarely does water fall below a depth of one metre from the surface.

The surface material is always black (10YR2/1) in colour and becomes granular and difficult to rewet if allowed to dry completely. The fibrous peat ranges in colour from dark brown (7.5YR3/2) to yellowish brown (10YR5/8) and the colours maybe weakly banded.

The fibrous peats are underlain by light grey (10YR8/1) sandy clay or heavy clay riverine deposits. These have only been observed where they have been excavated during drainage works as nothing can be recovered by hand augering equipment below the water table or because of logs in the profile.

Weak sulphidic odours are often encountered but they appear to be restricted to layers 30-50cm thick. Much detailed examination with suitable coring equipment would be required to properly characterise these peats.

ANALYTICAL DATA

Profile T474 Map Reference Bartle Frere 1:100 000 891798
BABINDA SERIES Sampled from undisturbed Melaleuca open forest.
Samples were not air dried before analysis. They were stored under refrigeration at field moisture.

Depth m	0-.10	.15-.30	.30-.55	.55-.90	.90-1.20	1.20-1.50	1.50-1.80	1.80-2.10	2.10-2.20
Horizon	P1	P1	P2	P3	P3	P4	P4	P5	P5
pH	4.5	4.7	4.3	4.1	4.1	4.2	4.3	4.2	4.3
E.C.dS/m^{-1}	.135	.087	.066	.076	.066	.073	.056	.058	.061
Org.C%	17.4		33.0		37.1	25.2	25.8	33.1	31.4
N%	.82	.91	.77	.66	.76	.52	.59	.65	.60
AvP ppm	57	11		11					70
Tot.Cu%	.0058	.0044	.0084	.0051	.0059	.0027	.0065	.0082	.0081
Tot.Zn %	.0052	.0024	.0017	.0014	.0020	.0018	.0018	.0024	.0030
Tot.Mn %	.0107	.0030	.0022	.0014	.0014	.0018	.0015	.0022	.0036
Tot. Fe%	2.14	0.75	0.50	0.31	0.35	0.42	3.92	0.53	0.71
Exchange properties m.e./100g soil									
Ca	0.66	0.40	0.14	0.20	0.15	0.08	0.09	0.12	0.12
Mg	0.35	0.27	0.21	0.32	0.63	0.94	0.62	0.71	0.69
K	0.14	0.14	0.08	0.10	0.03	0.05	0.05	0.06	0.11
Na	0.17	0.28	0.14	0.13	0.18	0.23	0.26	0.26	0.27
H+Al	4.61	3.53	3.78	3.03	2.45	2.30	2.47	2.16	2.41
ECEC*	5.9	4.6	4.4	3.8	3.4	3.6	3.5	3.3	3.6
CEC**	45	55	55		65	50	55	60	
Base Sat***	3	2	1		1	3	2	2	
CEC****	5.6	4.0	4.2	4.6	3.7	3.9	3.4	2.8	3.6

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4OAc\ CE} \times 100$ ** NH_4OAc **** Comp. Exch

SUMALEE SERIES

CONCEPT: Sapric over hemic peat.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	A.S.C.
CLASSIFICATION	Acid peat	0	Regolithic, Sulphidic, Hemic, Organosol

LANDFORM Swamp RAINFALL 4000mm
REFERENCE SITE Bartle Frere 1:100 000 922748

Horizon	Depth m	
P1	0 to 0.12	Brown (10YR4/3); clay loam; moderate 2-5mm subangular blocky; wet very weak; abundant <1mm roots; clear smooth change to-
P2	0.12 to 0 .27	Very dark grey (10YR3/1); 10-20% 15-30mm distinct light olive brown (2.5Y5/4) mottles; sapric peat; moderate 100-200mm prismatic parting to weak 20-50mm subangular blocky; wet very weak; abundant <1mm roots; diffuse change to-
P2	0.27 to 0.42	Very dark grey (10YR3/1); 10-20% 15-30mm distinct light olive brown (2.5Y5/4) mottles; sapric peat; moderate 100-200mm prismatic; wet very weak; abundant <1mm roots; diffuse change to-
P3	0.42 to 1 70	Very dark grey (10YR3/1); hemic peat; saturated; diffuse change to-
P4	1.70 to 2.05	Dark greyish brown (2.5Y4/2); light clay (sapric);saturated; diffuse change to-
P5	2.05 to 2.10	Very dark greyish brown (10YR3/2); light clay (sapric); saturated; diffuse change to-
P6	2.10 to 2.20	Dark greyish brown (2.5Y4/2); light clay (sapric); saturated.

RANGE OF CHARACTERISTICS

These are highly organic materials formed primarily from the remains of sedges but including pandanas and trees. They have .30 to .45m of sapric peat (highly decomposed) over a hemic peat (moderately decomposed). At the time of examination these soils had high water tables and often had free water at the surface. Under natural conditions the water table probably only rarely falls below .30m. Most sites were mildly to moderately sulphidic in the upper 1m of the peat profile.

The peats have been found to overlie riverine sediments from depths of from .85 to 1.90m. These are commonly light grey (10YR7/2) light clay to silty light or medium clays but they may occasionally be organic stained dark greyish brown colours (10YR-2.5Y3-4/2).

In some areas these soils have been subjected to recent deposition. The upper .05 to .25m may be brown (10YR4/3) or reddish brown (5YR5/3) in colour and very organic silty clay loam to clay loam in texture.

ANALYTICAL DATA

Profile T476 Map Reference Bartle Frere 1:100 000 921748
SUMALEE SERIES Sample site had been cleared but never cultivated.
Samples were not air dried before analysis. They were stored under refrigeration at their field moisture.

Depth m	0-.12	.12-.27	.27-.42	.60-.90	.90-1.20	1.20-1.70	1.70-2.05	2.10-2.20
Horizon	P1	P2	P2	P3	P3	P3	P4	P6
pH	4.5	4.7	4.9	5.1	5.3	5.5	5.0	4.9
E.C.dS/m-1	.267	.183	.142	.048	.028	.025	.063	.082
Org.C%	11.7	15.9	17.5	13.4	8.7	9.4	14.4	10.6
N%	0.67	0.85	1.02	0.64	0.48	0.42	0.29	0.25
AvP ppm	20	28		42			28	18
Tot.Cu %	.0071	.0001	.0008	.0004	.0004	.0004	.0005	.0005
Tot.Zn %	.0065	.0076	.0072	.0094	.0092	.0082	.0052	.0069
Tot.Mn %	.0112	.010	.0089	.0092	.0091	.0086	.0058	.0072
Tot Fe%	1.92	2.22	1.68	2.46	1.91	1.88	1.18	1.52
Exchange properties m.e./100g soil								
Ca	1.47	1.83	2.14	3.08	0.56	0.66	2.52	1.93
Mg	1.39	1.21	1.31	0.45	0.25	0.46	2.12	3.01
K	.28	.26	.24	.11	.12	.18	.13	.22
Na	.22	.24	.26	.22	.18	.17	.21	.23
H+Al	3.97	3.64	4.00	2.92	1.99	2.21	3.65	4.05
ECEC*	7.3	7.2	8.0	6.8	3.1	3.7	8.7	9.4
CEC**	29		45	27	25	30	25	23
Base Sat***	15		9	14	4	5	20	24
CEC****	2.6	2.6	4.8	2.9	2.3	2.7	6.1	6.8

* sum of basic and acidic cations *** $\frac{\text{Bases}}{NH_4\,OAc\ CEC} \times 100$ ** NH_4 OAc **** Comp. Exch

BABINDA ASSOCIATION Bb 7 UMAs 1800ha.

The largest area of this unit occurs in the Babinda swamp but a number of smaller swamps have been mapped as this series. Many of the smaller occurrences are not readily accessible and even if access can be gained it is difficult to go much beyond the margin of the unit. As a result, the confidence of this interpretation is low and many of these units could be Sumalee or Nind series.

Hewitt series is the most commonly associated soil and usually occurs as a margin to the peats. In the Babinda swamp it can be between 100 and 150 metres wide and as such is a mappable unit but it is impossible to place a boundary with any precision without a lot of traversing.

SUMALEE ASSOCIATION Sl 20 UMAs 1502ha.

Sumalee association is dominated by Sumalee series which are sapric over hemic peats. These soils are frequently sulphidic but the extent and severity of the acid sulphate condition is unknown. This association most commonly occurs where the peat swamps abut the mangroves but has also been found to commonly occur on the margins of the peat swamps where there is a sharp transition to another landform, for example where the swamps lie adjacent to an alluvial fan.

Many of the areas mapped as Sumalee association have not been visited. They have been delineated on the basis of air photo interpretation alone so the confidence level of the mapping is low. No other soils have been recorded occurring with Sumalee series but, for the reason stated above, any of the swamp soils or poorly drained soils formed on alluvium may occur.

NIND ASSOCIATION Nd 13 UMAs 3128ha.

Nind series is a fibric peat and occurs in swamps which, unless artificially drained, have permanent water or dry only in exceptionally dry periods. It has been mapped as occupying the greater part of Eubenangee Ella Bay and Wyvuri swamps.

No adequate descriptions have been made of these materials due to the difficult access and lack of suitable drilling equipment so no series description has been given. The depth of the peat will vary considerably probably from as little as one metre to in excess of four metres. At one point of inspection on the edge of Eubenangee swamp, logs were encountered at all depths but the auger could be pushed to four metres without encountering any significant resistance apart from the logs. It is expected that these peats have a very low density and would shrink considerably if drained. The vegetation of these swamps ranges from open reeds to Melaleuca quinquenervia open forests with a Pandanas and Bulguru understory.

BULGURU ASSOCIATION Bu 7 UMAs 457ha.

Bulguru series was originally defined (Murtha 1986) as a soil with a fibric peat (generally 20-30cm thick) overlying sandy to clayey gleyed sediments. Such soils occurred in oxbow type swamps on the alluvial backplain. In this area a number of small areas have been identified in the Yarrabah area. Here they are thin fibric peats overlying gleyed clays. A somewhat similar soil in the same area Needep series is a thin fibric peat overlying sand. In this area Bulguru series has developed on the lower end of the alluvial fans where they merge with swamp. As the area was very wet with surface water 12cm deep at the time of inspection no soils were described so no series description has been given. No other soils were recorded in the areas mapped as Bulguru association.

MANGROVES Mg 36 UMAs 6156ha.

The largest area of mangroves occur on Trinity Inlet. This area was entered at one point only where the soil consisted of dominantly a mangrove root peat with about .04m of fine textured deposit on the surface which appeared to be of fairly recent origin. In this area there

was no evidence of biological activity. High biological activity (mainly crabs) is a feature of most of the mangroves and this activity is sufficient to mask any pedological activity. It is expected that the larger part of this unit would consist of fine textured deposits. There is a series of low beach ridges through the unit and it appears that the estuary on which these mangroves occurs has truncated the beach ridge system on which Cairns city is built so some of the unit may be formed on reworked beach ridge sands. This unit along with those in Mission Bay are actively extending seawards. The remainder of the unit consists of minor occurrences near the mouths of streams.

ANALYTICAL METHODS AND ABBREVIATIONS

pH ..... Determined on a 1:5 soil/water suspension using glass and calomel electrodes and a direct reading meter after shaking for 1 hour.

Electrical conductivity ..... Measured on the above 1:5 suspension.

Total nitrogen ..... Determined by the Honda (1962) modification of the Kjeldahl method.

Organic carbon ..... Readily oxidizable organic matter was determined by the method of Walkley and Black (1934). No factor has been applied.

Phosphorus retention ..... Single point index by the method described in Blakemore et al. (1981).

Total carbon ..... Dry combustion using a LECO CR-12 carbon system (Nelson and Sommers 1982).

Available phosphorous ..... Determined by the method of Kerr and Von Stieglitz (1938) by extracting with 0.005 M sulphuric acid for 16 hours.

Total P, K and S ..... Determined by X-ray spectrography as described by Stace et al. (1968)

Exchangeable cations and exchange capacity ..... Calcium, magnesium, potassium, and sodium were extracted by shaking two grams of soil with 20 ml of a mixture of 0.1 M $BaCl_2$ and 0.1 M NH_4Cl for two hours. The cations in the extract were determined by atomic absorption spectroscopy. For CEC determination, the amount of Mg absorbed by the soil at the approximate soil field pH and at an ionic strength of 0.006 was measured using a compulsive exchange technique (Gillman 1979). Acidic cations (H + Al) were extracted with 1 M KCl (Soil Survey Staff 1972).

Ammonium acetate CEC ..... Air dry soil extracted with 1 M NH_4 OAc at pH 7.0 (Soil Survey Staff 1972).

Ammonium chloride CEC ..... Air dry soil extracted with 1 M NH_4Cl at pH 7.0 (Bruce and Rayment 1982).

Base saturation ..... Calculated as a percentage, sum of basic cations divided by the ammonium acetate CEC.

Total Cu, Zn and Mn ..... Determined by X-ray spectrography as described by Stace et al. 1968

Free Fe ..... Extracted with citrate-dithionite at room temperature (Holmgren 1967).

Particle size ..... Determined using the pipette and sieve method of Coventry and Fett (1979).

E.C. dS/m-1 ..... Electrical conductivity decisiemens per metre

Org. C ..... Organic carbon

T.C. ..... Total carbon

N .....Total nitrogen
Ca .....Calcium
Mg .....Magnesium
K .....Potassium
Na .....Sodium
H+Al.....Hydrogen + Aluminium
CEC .....Cation exchange capacity
ECEC.....'Effective' cation exchange capacity
Base Sat .....Base saturation
AvP.....Available phosphorus
P.Retn. .....Phosphorus retained
Tot. P .....Total phosphorus
Tot. K .....Total potassium
Tot. S .....Total sulphur
Tot. Fe .....Total iron
Tot. Cu.....Total copper
Tot. Zn.....Total zinc
Tot. Mn.....Total manganese
Gr.....Gravel
CS .....Coarse sand
FS .....Fine sand
Si.....Silt
C .....Clay
BD .....Bulk density
0.1 Bar .....Volumetric water % at 0.1 bar suction
15 Bar .....Volumetric water % at 15 bar suction
Ch/V .....Chloritised vermiculite
I.....Illite
Ka .....Kaolin
G.....Gibbsite
Ha/Go .....Haematite/Goethite
Qz .....Quartz

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance and advice given by numerous people during the course of the survey field operations. Chemical analyses were carried out under the direction of Mr. W. Hicks, CSIRO Division of Soils Townsville. Maps and figures were prepared by R.M. Schuster under the direction of Mr. D. A. Wright CSIRO Division of Soils Adelaide. Ms. Grace Mazza and Ms.Eva Ford were responsible for the digitising of the maps while Mrs. Catherine Williams assisted with preparation of the manuscript. Finally thanks are due to Dr. Neil McKenzie for the task of final editing of the manuscript.

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