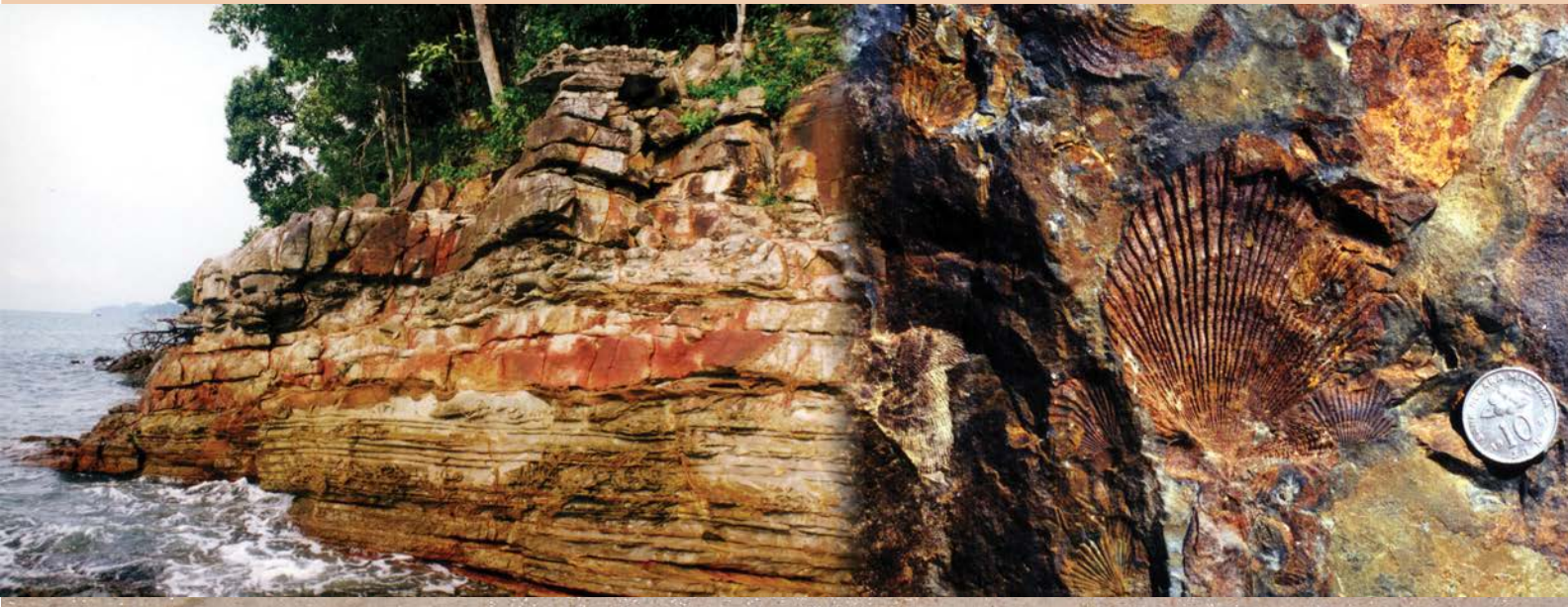
Stratigraphic Lexicon of Malaysia

Lee Chai Peng
Mohd. Shafeea Leman
Kamaludin Hassan
Bahari Md. Nasib
Rashidah Karim



Malaysian Stratigraphic Central
Registry Database Subcommittee
Geological Society of Malaysia
September 2004

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Published by the Geological Society of Malaysia
Department of Geology, University of Malaya, 50603 Kuala Lumpur
Tel: 603 - 7957 7036 Fax: 603 - 7956 3900 E-mail: geologi@po.jaring.my

Printed by Art Printing Works Sdn. Bhd., 29 Jalan Riong, 59100 Kuala Lumpur

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Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Stratigraphic lexicon of Malaysia / Lee Chai Peng ... [et al.].
Bibliography: p 160
ISBN 983-99102-3-X
1. Geology, Stratigaphic. I. Lee, Chai Peng, 1955-. II. Title.
551.700595

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FOREWORD

This much-awaited Stratigraphic Lexicon of Malaysia is a welcome resource to geologists, especially stratigraphers working in Malaysia. Although, this is not the first attempt to compile the rock units of Malaysia, this Lexicon is the first comprehensive review and compilation of both formal and informal Malaysian stratigraphic units. It contains 160 systematic description of formations. It also contains extensive bibliographic and chronologic information as well as fossil records, which are useful starting points for researchers that require further data for their work. It is hoped that through this Lexicon, with its easily accessible comprehensive information, problems related to stratigraphic work in Malaysia can be addressed and improvement on the relationship and correlation between the stratigraphic units be achieved, leading to a better understanding of the geology of Malaysia.

This Lexicon is the result of the hard work put in by the Malaysian Stratigraphic Central Registry Database Subcommittee (MSCRDS) that was set up in 1995. The MSCRDS comprises of dedicated stratigraphers from the Minerals and Geoscience Department Malaysia, the Geology Departments of University of Malaya and Universiti Kebangsaan Malaysia, and PETRONAS. I would like to extend my appreciation and thanks to the Geological Society of Malaysia and the key individuals involved for their fine effort.

Dr. Chu Ling Hing
Ketua Pengarah Jabatan Mineral dan Geosains Malaysia

PREFACE

Although a lot of work has been done in describing and mapping of stratigraphic units in Malaysia especially by pioneer geologists from the Geological Survey since its inception, almost all the stratigraphic names used are informal and published as mapping progressed in the various reports of the Geological Survey. These were supplemented by more informal stratigraphic formations erected by other geologists, notably those from the universities and others from the mining and petroleum industries over the years. Attempts to bring together these formations in a single compilation has resulted in the publication of Gobbett and Hutchison's (1973) "*Geology of Peninsular Malaysia*" and Leichti, Roe and Haile's (1960) "*The Geology of Sarawak, Brunei and the Western Part of North Borneo*".

While the Malaysian Stratigraphic Nomenclature Committee of the Geological Society of Malaysia was producing the Malaysian Stratigraphic Guide (Ahmad bin Jantan *et al.*,1997), the committee realised that there was a need to gather together all published stratigraphic data in the form of a lexicon so that later attempts to formalise informal units or erect new units would be made easier. A separate committee known as the Malaysian Stratigraphic Central Registry Database Subcommittee (MSCRDS) was set up at the beginning of 1995 to undertake the task. The subcommittee consisted of representatives from the Department of Geology in University of Malaya, Faculty of Science & Technology Geology Programme of Universiti Kebangsaan Malaysia, Minerals and Geoscience Department of Malaysia and Petronas. Published data up to 1997 on stratigraphic units in the Palaeozic, Mesozoic, Cenozoic Onshore and Cenozoic Offshore of Malaysia was gathered by members of the subcommittee following an agreed format of 14 categories of information for each stratigraphic unit.

The categories are:- Name, Origin of name, Age, References, Type area, Type section, Boundaries, Correlation, Thickness, Lithology, Subdivisions, Fossils, Environment of deposition and Remarks. Data of varying detail from abundant to scanty has been compiled on 44 Palaeozoic, 37 Mesozoic and 78 Cenozoic Onshore formations. Stratigraphic formations that staddle era boundaries would be included with the section where the bulk of the sediments within the unit are found, for example, the Permo-Triassic Semanggol formation is placed under Mesozoic. The formations in each section are divided into those from Peninsular Malaysia, Sarawak and Sabah and arranged according to their ages from the oldest to the youngest in each section. The numerous Cenozoic Offshore formations had very different based for nomenclature depending on the various schemes used by the different petroleum companies and it was decided not to include them in the present publication.

Since most of the Malaysian stratigraphic units have not been erected formally following the recommendations of the International or Malaysian Stratigraphic Guide, we envisage that much work would be needed to formalise the units and the information contained in this lexicon will provide the necessary background information for the stratigrapher doing it to build on. This lexicon contains published stratigraphic information up to 1997. More work on Malaysian stratigraphy has been done and published since then. It is envisaged that periodic revisions with new information on the existing formations and new formations erected after that would need to be added either as supplements to the existing lexicon or as revised editions of it in the future as stratigaphic work in Malaysia progresses.

Lastly, I would like to thank all the members of the Malaysian Stratigraphic Central Registry Database Subcommittee and their respective organisations for their hard work and support in producing this lexicon. The editorial help of Dr. Ng Tham Fatt is gratefully acknowledged.

Dr. Lee Chai Peng
Chairman
Malaysian Stratigraphic Central
Registry Database Subcommittee

CONTENTS

INTRODUCTION

BACKGROUND

The Malaysian Stratigraphic Central Registry Database Subcommittee (MSCRDS) was formed in 1995 to collate existing published stratigraphic data to produce a lexicon of Malaysian stratigraphy up to that time as a ready reference for those who want to erect new formations or revise existing ones. This was to complement the work of the National Stratigraphic Nomenclature Subcommittee that had set out to publish the Malaysian Stratigraphic Guide to produce a code or guide for stratigraphers working in Malaysia to follow when setting up new formations or revising extant ones. The members of the MSCRDS consist of stratigraphers from the Department of Geology in the University of Malaya, Faculty of Science and Technology (Geology Programme), Universiti Kebangsaan Malaysia (National University of Malaysia), Department of Minerals and Geoscience (formerly Geological Survey Department) of Malaysia and PETRONAS.

A copy of the essential information needed for each stratigraphic unit was drafted and the work of tracking down the published information for the various sedimentary units was assigned to different members of the subcommittee. It was originally decided that the lexicon would have four sections:– (i) Palaeozoic (P), (ii) Mesozoic (M), (iii) Cenozoic Onshore (C) and (iv) Cenozoic Offshore (OC). The Cenozoic Offshore part was later left out because the criteria used for naming the formations and information available from oil companies were too different from that used by stratigraphers working on land.

Stratigraphic formations that straddle era boundaries would be included in the section where the bulk of the sediments within the unit are found, e.g. the Permo-Triassic Semanggol formation is placed under Mesozoic. The formations in each section are divided up into those from Peninsular Malaysia, Sabah and Sarawak and arranged according to their ages from the oldest to the youngest.

The formations are arranged from oldest to youngest in each section and numbered accordingly, eg. P1 is the oldest Paleozoic formation and any subdivisions within the formation would be identified by a number after a full-stop, eg. P6.1 for the Basal limestone (of Setul formation).

Notes on the different categories of information

The 14 categories of information adopted for each stratigraphic unit are explained below.

Category 1: Name

It is the name of the stratigraphic unit at formation or equivalent level following the recommendations of accepted stratigraphic nomenclature guidelines, e.g. capital 'F' for formal formations where a type section has been proposed and lower case 'f' for informal formations. The group the sedimentary formation belongs to, if any, is given in parenthesis, e.g. Grik siltstone (of Baling group). Subdivisions such as members are included where appropriate and identified by their numbering, e.g. P6.1, as well as having the formation it belongs to given in parenthesis, e.g. Basal limestone (of Setul formation).

Category 2: Origin of name

The origin of the name as proposed by its author is given where known. Most formations were named after geographic locations.

Category 3: Age

The age is given at the system level with Lower, Middle and Upper if available for Palaeozoic and Mesozoic units and series level for the Cenozoic units. More specific ages are given in parentheses where available, e.g. Lower to Middle Carboniferous (Viséan to Namurian A). Uncertain ages are indicated by a question mark before the uncertain part, e.g.? Lower Devonian (Lower is uncertain while Devonian is certain), or after the part if the whole age is in question, e.g. Permian to Triassic?(Permian to Triassic is uncertain).These uncertainties are usually due to lack of diagnostic fossils within the unit.

Category 4: References

The first reference given in this category is that of the original proposal or publication of the name. Subsequent references in this category refer to other publications where additional data on the stratigraphic unit has been obtained.

Category 5: Type area

The actual type area if designated is given but the general geographic locality where the stratigraphic unit is exposed if no type area has been designated. This is necessary because many formations have no designated type section and type area proposed but the general area where the unit has been mapped is disclosed.

Category 6: Type section

The location of the type section of the stratigraphic unit if it has been proposed. Most of the formations in Malaysia lack a type section and hence are informal. Some may have type sections mentioned but are not provided with lithological logs or detailed descriptions. Some publications give a reference section instead of a type section.

Category 7: Boundaries

The nature of the basal and upper boundaries, whether they are conformable, unconformable or unexposed in relation to the stratigraphic units above and below it are described where available. In some cases the contacts are faulted boundaries.

Category 8: Correlation

Obvious correlation with other units in adjacent areas in the country and more rarely in neighbouring countries is stated if given in the publications.

Category 9: Thickness

The thickness in meters with feet in parenthesis as is published is given. The symbol ± denotes approximately or estimated, < denotes less than and > denotes greater than. Most of the thicknesses are not measured directly but calculated from mapped sections.

Category 10: Lithology

A brief description of the lithology of the stratigraphic unit as summarized from published sources is given.

Category 11: Subdivisions

A list of any subdivisions, eg. members, found in the stratigraphic unit is given. Details of the subunit would be found in their individual records which follow after the main unit if such subdivisions are substantially described in publications. Minor subdivisions lacking such details such as informal units or facies are just mentioned in this section together with the relevant reference.

Category 12: Fossils

A list of the fossils found in the unit, arranged according to their general groups eg. brachiopod, cephalopod, conodont, coral, trilobite, etc. based on published data is included. Unpublished fossils would be relegated to the category under "Remarks". The fossil data is rather variable in both quantity and quality for most units.

Category 13: Environment of deposition

The environment of deposition as originally interpreted in publications by the proposer or later workers is provided. Many units do not have such an interpretation. Some interpretations are unclear and some have changed with time based on new discoveries.

Category 14: Remarks

Relevant comments on the stratigraphic unit under discussion not included under the other categories, eg. history of nomenclature, useful unpublished information, personal communications etc. are placed here.

Part 1
PALAEOZOIC

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INTRODUCTION

The bulk of the Palaeozoic sedimentary rocks of Malaysia are found in the peninsula where they occupy about 25% of the land area. Only two formations, the Pre-Upper Carboniferous Tuang formation and the Upper Carboniferous to Lower Permian Terbat formation are found in Sarawak. No Palaeozoic rocks have been reported from Sabah.

The 42 Palaeozoic formations of Peninsular Malaysia are distributed in four northwesterly to northerly trending zones parallel to the general elongation trend of the peninsula (Foo, 1983). They are the (i) Northwestern Zone, (ii) Western Zone, (iii) Central Zone and (iv) Eastern Zone (Figure 1). The first two zones are sometimes combined into one (e.g. Aw, 1977) to give a three-fold division instead. The sedimentary formations and their correlations in time across these zones are given in Figure 2.

Lower Palaeozoic rocks are confined to the western part of the peninsula in the Northwestern and Western Zones while the occurrence of Upper Palaeozoic rocks extends into and cover large tracts of land in the Central and Eastern Zones. The grouping of Lower Palaeozoic rocks in the Northwestern and Western Zones had been largely influenced by geosynclinal theory with a shallow miogeosyncline with shelf facies rocks to the west in Langkawi, Perlis and Kedah grading eastwards into a mixed facies of geanticlinal rocks in Kedah, Perak and Selangor followed by eugeosynclinal basinal facies rocks in Pahang and Negeri Sembilan to Malacca for central and south Malaya (Figure 3).

The Northwestern Zone is the area encompassing Kedah, Perlis and the Langkawi Islands. It has the most complete Palaeozoic sequence in the peninsula ranging in age from the Upper Cambrian to Upper Permian. The Palaeozoic formations found in this zone are the Machinchang, Jerai, Setul, Mahang, Sungei Petani, Singa, Kubang Pasu and Chuping limestone. These were mainly shallow marine shelf to basin facies miogeosynclinal rocks.

The Western Zone is the area that stretches from the Perak – Thai border southwards to the state of Malacca adjacent to the flanks of the Main Range granite batholith. Two main stratigraphic groups in the zone are the Baling group of Cambrian to Permian age consisting of the Papulut quartzite, Grik siltstone, Lawin tuff and Bendang Riang formation in north Perak and the Bentong group consisting of the Pilah schist and its correlatives and the Karak formation which is distributed as an unbroken belt along the eastern foothills of the Main Range. Other important Palaeozoic units in this zone are the Silurian to Permian Kinta limestone, Terolak formation and Kati formation in Perak and the Lower Palaeozoic Dinding schist, Hawthornden schist, Kuala Lumpur limestone and Permian Kenny Hill formation in Selangor. These formations have a mixture of shallow and deep facies and were assigned to the geanticlinal part of the geosyncline.

The Central Zone is that belt that stretches from Kelantan in the north to Johore in the south between the eastern foothills of the Main Range to its eastern boundary formed by the Lebir fault in the north down to the western boundary of the Dohol formation in the south. The oldest sediments found are sporadic outcrops of Carboniferous limestone while Permian sediments form the bulk of the Upper Palaeozoic sediments which occur as linear belts flanking the Mesozoic sediments on both edges of the zone. Adjacent to the Lower Palaeozoic rocks in the eastern foothills of the Main Range are rocks of the Raub group in West Pahang and Kepis formation in Negeri Sembilan while the Gua Musang and Aring formations are found to the north in South Kelantan and the Taku schist in eastern Kelantan. The Upper Palaeozoic rocks of the Central Zone belong to the argillaceous, volcanic, calcareous and arenaceous facies with the first two being dominant. The depositional environment was typically shallow marine with intermittent active submarine volcanism starting in the Late Carboniferous and reaching its peak in the Permian and Triassic. In south Pahang and Johore ignimbrite of probable Lower Triassic age overlie unconformably Permian phyllites marking a change from submarine to subaerial volcanism (Foo, 1983).

The Eastern Zone stretches from east Kelantan in the north, down through Trengganu and east Pahang into east Johore in the south. Most of the Palaeozoic sediments in this zone are of Carbo-Permian age. Large areas of Carboniferous sediments belonging to the Kuantan group consisting of the Charu formation, Panching limestone and Sagor formation are found in east Pahang. Southwards extensions are the Seri Jaya and Kambing beds while northwards extensions include the Sungei Perlis beds in

Trengganu. These are mostly shallow marine argillo-arenaceous deposits with some isolated reefal limestone lenses and volcanics. Plant fossils present indicate terrestrial input. Sedimentation was probably continuous throughout the Carboniferous till the Early Permian in the northern part of the basin, while in the southern part Middle to Upper Permian sediments of the Dohol and Linggiu formation respectively are present in east Johore overlain by Lower Triassic ignimbrite. Localized conglomeratic deposits such as the Redang beds of probable Permian age are found along the east coast of the peninsula. Foo (1983) noted a marked reduction of volcanic facies in the northern part of the Eastern Zone compared with the Central Zone and attributed it to probable increased distance from the source of volcanism. No marine sediments younger than the Permian have been found in the Eastern Zone suggesting that it was uplifted probably towards the end of the Permian and coinciding with explosive deposition of the Johore ignimbrite. This set the stage for the continental sedimentation within the mobile Central Zone and subsequent tripartite evolution of the peninsula (Foo, 1983).

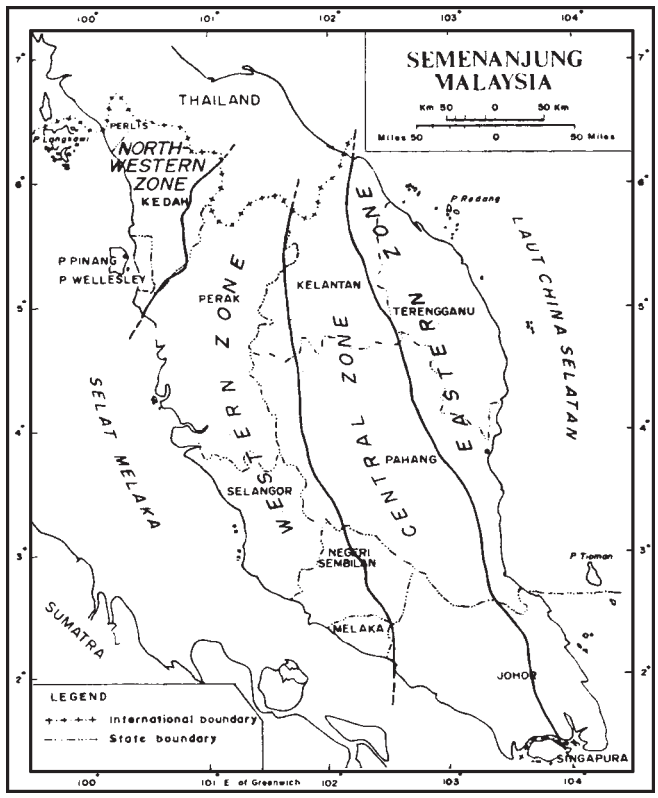

Figure 1. Stratigraphic zones of Peninsular Malaysia (after Foo, 1983).

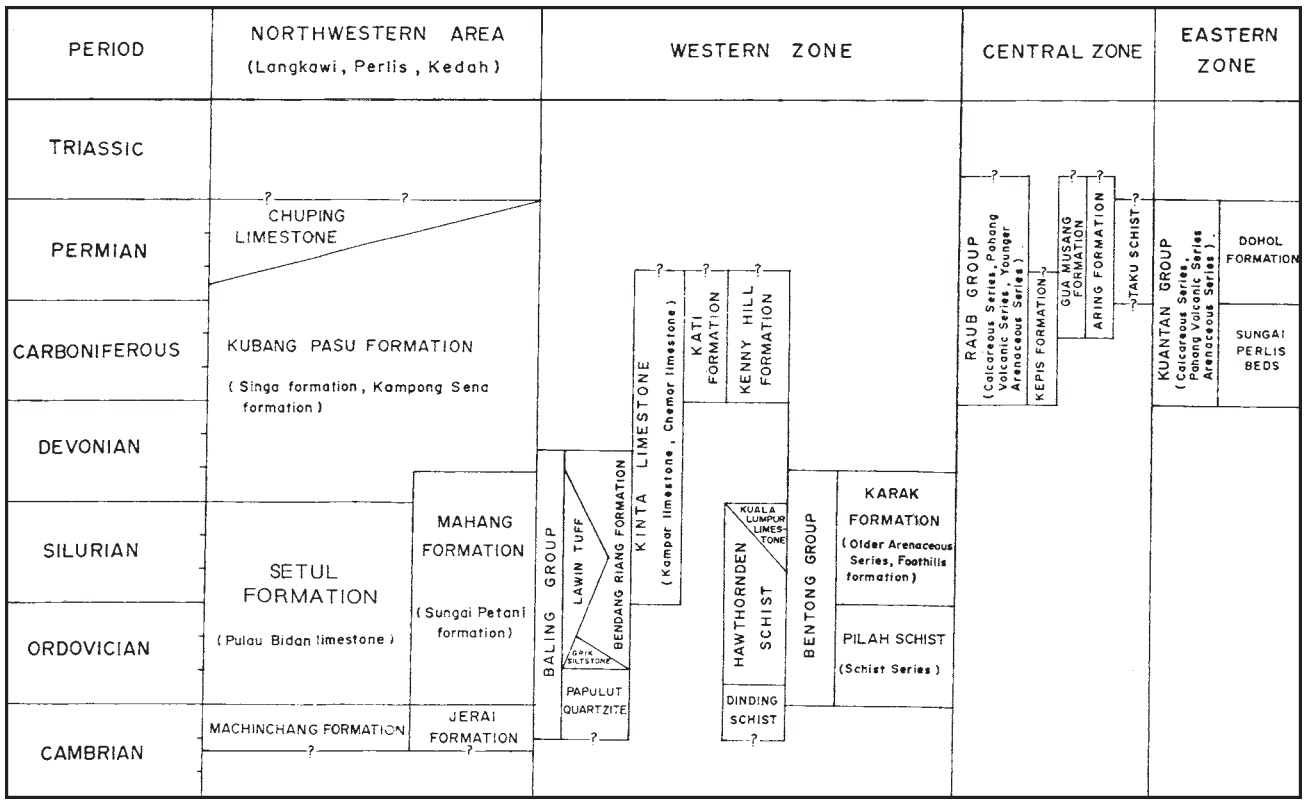

Figure 2. Schematic classification and correlation of Palaeozoic formations of Peninsular Malaysia (after Foo, 1983).

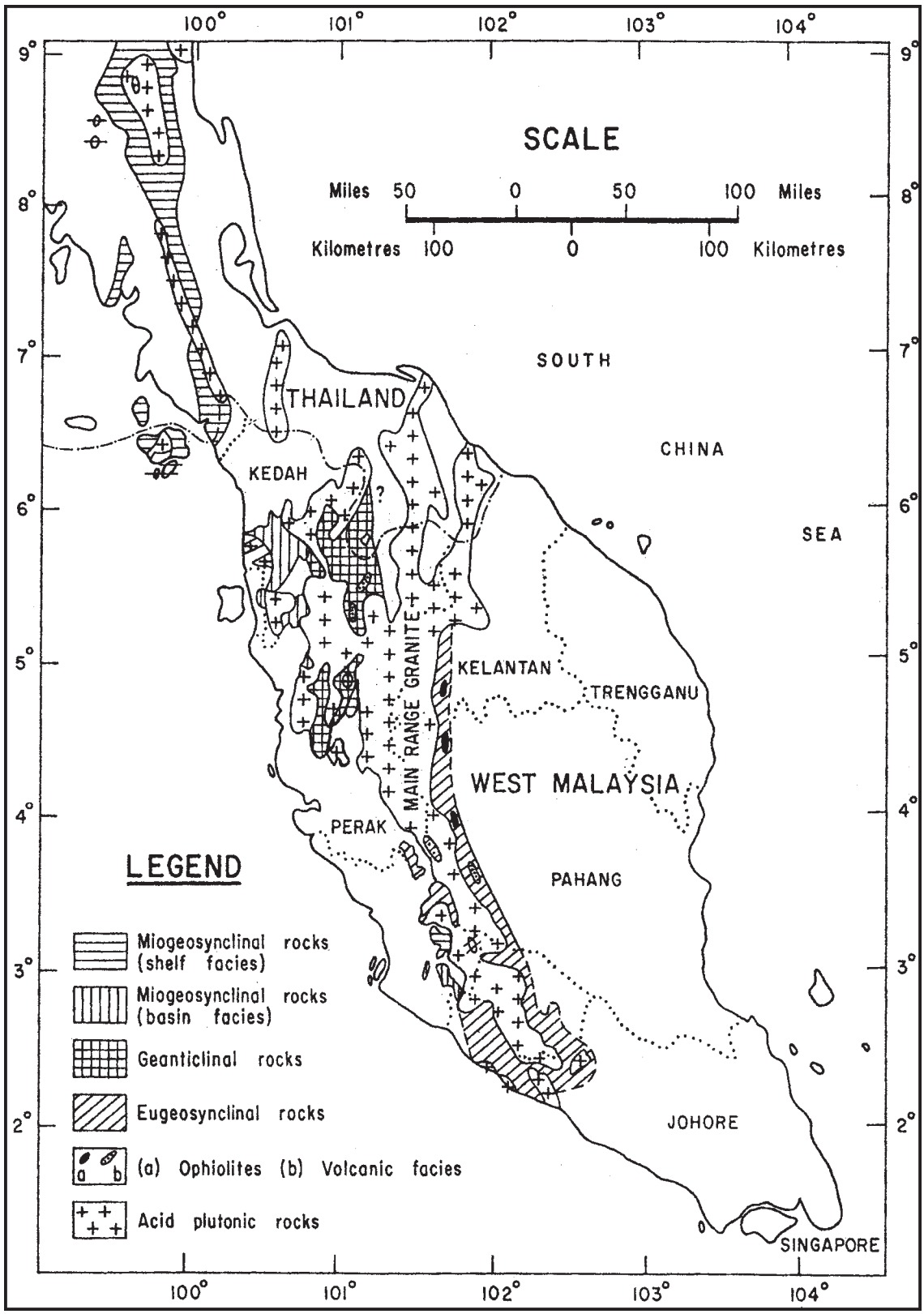

Figure 3. Lithofacies map of the Lower Paleozoic rocks of the Malay Peninsula (after Jones, 1973).

Table 1. List of Palaeozoic rock formations of Malaysia.

No.	Name	Age
	PENINSULA MALAYSIA	
P1	Jerai formation	Cambrian
P2	Machinchang formation	Cambrian to Lower Ordovician
P3	Dinding schist	Cambrian to Ordovician
P4	Papulut quartzite	Upper Cambrian to Upper Ordovician
P5	Pilah schists	?Ordovician
P6	Setul formation	Lower Ordovician to Lower Devonian
P6.1	Basal limestone (of Setul formation)	Lower Ordovician
P6.2	Lower Setul limestone (of Setul formation)	Middle to Upper Ordovician
P6.3	Lower Detrital member (of Setul formation)	Lower Silurian
P6.4	Upper Setul limestone (of Setul formation)	Upper Silurian
P6.5	Upper Detrital member (of Setul formation)	Lower Devonian
P7	Hawthornden schist	Ordovician to Lower Silurian
P8	Terolak formation	Ordovician to Silurian
P9	Jelebu schists	Pre-Silurian
P10	Mahang Formation	Ordovician to Middle Devonian
P11	Grik siltstone (of Baling group)	Upper Ordovician to Upper Silurian
P12	Lawin tuff	Upper Ordovician to Lower Silurian
P13	Kroh formation (of Baling group)	Upper Ordovician to Lower Devonian
P14	Sungai Patani formation	Silurian
P15	Bendang Riang formation (of Baling group)	Lower Silurian to Lower Devonian
P16	Pelong beds (of Bentong group)	Silurian to Lower Devonian
P17	Kuala Lumpur limestone	Middle to Upper Silurian
P18	Kajang schists	Upper Silurian to Devonian?
P19	Karak formation	Lower Devonian
P20	Kinta limestone	Lower Devonian to Middle Permian
P20.1	Kim Loong No. 1 beds (of Kinta limestone)	Silurian to Lower Devonian
P20.2	Thye On beds (of Kinta limestone)	Lower to Upper Devonian
P20.3	Kuan On beds (of Kinta limestone)	Lower to Upper Carboniferus
P20.4	Kim Loong No. 3 beds (of Kinta limestone)	Upper Carboniferous
P20.5	Nam Loong beds (of Kinta limestone)	Lower Permian
P20.6	H.S. Lee beds (of Kinta limestone)	Lower to Middle Permian
P21	Salak Baharu beds	Devonian to Permian
P22	Singa formation	Middle Devonian to Lower Permian
P23	Kubang Pasu formation	Upper Devonian to Lower Permian
P24	Kambing beds	Lower Carboniferous
P24.1	Keliu slates (of Kambing beds)	Lower Carboniferous
P24.2	Terapai metasiltstones (of Kambing beds)	Lower Carboniferous
P25	Sungai Perlis beds	Lower Carboniferous
P26	Charu formation (of Kuantan group)	Lower to Middle Carboniferous
P27	Pinang beds	Carboniferous?
P28	Kelintau conglomerates (of Bentong group)	Upper Carboniferous or Mesozoic?
P29	Belata formation	Carboniferous to Permian
P30	Kenny Hill formation	Carboniferous to Permian
P31	Kati beds	Carboniferous to Permian?
P32	Panching limestone (of Kuantan group)	Middle Carboniferous
P33	Sagor formation (of Kuantan group)	Upper Carboniferous
P34	Aring Formation	Upper Carboniferous to Lower Triassic
P35	Kepis beds	Lower Permian
P36	Taku schists	Permian to Triassic? (or older)
P37	Chuping limestone	Lower Permian to Middle or Upper Triassic
P38	Redang beds	Permian
P39	Dohol formation	Middle Permian
P39.1	Sumalayang limestone member (of Dohol formation)	Middle Permian
P40	Seri Jaya beds	Upper Middle to Lower Upper Permian
P40.1	Jempul slates (of Seri Jaya beds)	Permian
P40.1.1	Luit tuffs (of Jempul slates)	Permian
P40.2	Mengapur limestones (of Seri Jaya beds)	Middle to Upper Permian
P41	Sedili Volcanic formation	Upper Middle Permian to Middle Triassic
P42	Linggiu formation	Upper Permian
	SARAWAK	
P43	Tuang formation	?Pre-Upper Carboniferous
P44	Terbat formation	Upper Carboniferous to Lower Permian

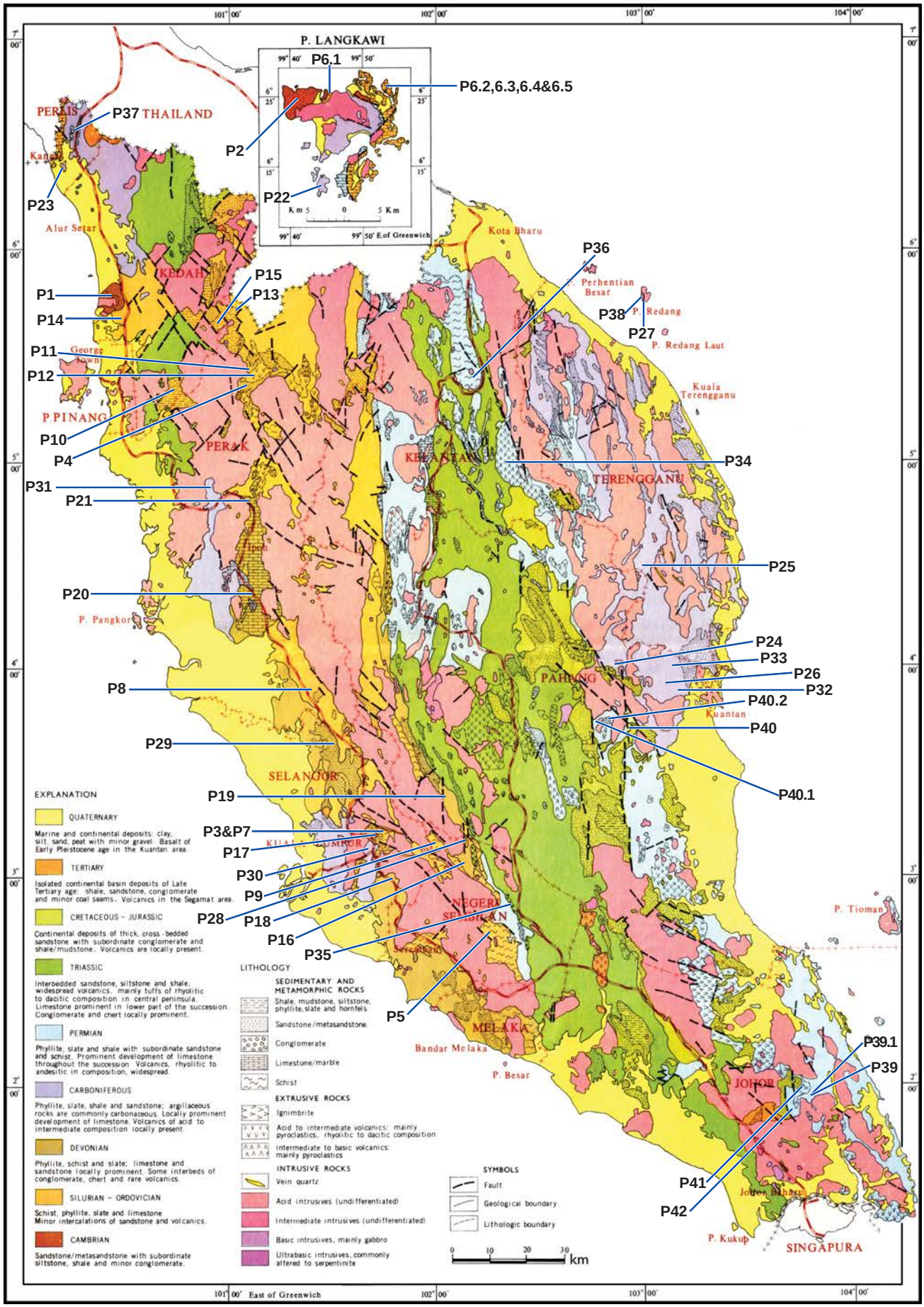

Figure 4. Location of type area of onland Palaeozoic rock formations of Peninsular Malaysia. Map reproduced with the permission of the Director-General of Minerals and Geoscience Department Malaysia.

3.1. PENINSULAR MALAYSIA

P1.

1. Name : Jerai formation
2. Origin of name : After Gunung Jerai, central Kedah
3. Age : Cambrian
4. References : Bradford (1972), Jones (1973)
5. Type area : Gunung Jerai, central Kedah
6. Type section :
7. Boundaries : Base unexposed. Conformable contact with Setul formation and Lower Silurian graptolitic argillite from boreholes in Sungei Patani
8. Correlation : Machinchang formation, Langkawi
9. Thickness : 1425 m
10. Lithology : Quartz arenite with occassional feldspar grit, quartz-mica schist and phyllite with occassional amphibole and garnet-bearing schist.
11. Subdivisions : Two members in Jones (1973)
12. Fossils :
13. Env. of deposition : Shelf
14. Remarks : The trace fossil, *Diplichnites* sp. is found in Gunung Jerai

P2.

1. Name : Machinchang formation
2. Origin of name : After Gunung Machinchang in northwest Langkawi, Kedah.
3. Age : Cambrian to Lower Ordovician
4. References : Jones, (1961, 1981); Lee (1983); Mohd. Shafeea Leman (l997)
5. Type area : Machinchang District, northwest Langkawi
6. Type section :
7. Boundaries : Base unexposed. Gradational upper contact with Setul formation
8. Correlation : Jerai formation, Kedah; Tarutao formation, Thailand
9. Thickness : ± 2830 m
10. Lithology : Sandstone, quartzite and subsidiary beds of conglomerate, grit, siltstone, flaggy shale and mudstone and acid tuffs.
11. Subdivisions : Lower, Middle and Upper member in Lee (l983)
12. Fossils :
    brachiopod
    Eoorthis sp.
    Lingulids
    trace fossil
    Arenicolites sp.
    Chondrites sp.
    Dictyodora sp.
    Palaeophycus sp.
    Phycodes pedum Seilacher
    Planolites sp.
    Skolithos sp.
    Teichichnus stellatum Baldwin
    Thallasinoides sp.
    trilobite
    ? *Acontheus* sp.
    Eosaukia sp.
    ? *Saukioides* sp.
13. Env. of deposition : High destructive, wave dominated delta over offshore shelf deposit (Lee, 1983)
14. Remarks : More fossils have been reported in the equivalent Tarutao formation to the north in Thailand (Lee, 1983).

P3.

1. Name : Dinding schist
2. Origin of name : After Bukit Dinding, Kuala Lumpur
3. Age : Cambrian to Ordovician
4. References : Gobbett (1965)
5. Type area : Bukit Dinding (Wangsa Maju), Kuala Lumpur.
6. Type section :
7. Boundaries : Grades upwards into Hawthornden schist
8. Correlation : Lower part with Machinchang formation
9. Thickness : 3400 m
10. Lithology : Quartz-mica schist, quartzite and subsidiary actinolite, diopside and epidote schist and schistose conglomerate
11. Subdivisions : Quartzite member in the middle of quartz mica schist
12. Fossils :
13. Env. of deposition : Eugeosyncline
14. Remarks :

P4.

1. Name : Papulut quartzite (of Baling group)
2. Origin of name : After Papulut Forest, north Perak
3. Age : Upper Cambrian to Upper Ordovician
4. References : Jones (1973)
5. Type area : Papulut Forest, south of Grik, north Perak
6. Type section :
7. Boundaries : Lower boundary unknown Transitional upper boundary to Grik siltstone
8. Correlation : Probably with Machinchang and Jerai formations
9. Thickness : ± 1500 m
10. Lithology : Predominantly of light brown protoquartzite and subgreywacke and subsidiary lithic greywacke and conglomerate with chert and quartzite pebbles and minor lenses of shale, limestone and schistose greywacke.
11. Subdivisions :
12. Fossils :
13. Env. of deposition : Shallow water
14. Remarks :

P5.

1. Name : Pilah schists
2. Origin of name : After Kuala Pilah, Negeri Sembilan
3. Age : Pre-Permian, (? Ordovician)
4. References : Khoo (l973)
5. Type area : Kuala Pilah, Negeri Sembilan
6. Type section :
7. Boundaries : Unconformable upper contact with Kepis beds
8. Correlation : Dinding schist of Selangor
10. Lithology : Predominantly grey coloured carbonaceous shale, siltstone, slate, phyllite and schists with minor beds of arenite, limestone and volcanics.
11. Subdivisions :
12. Fossils :
13. Env. of deposition :
14. Remarks :

P6.

1. Name : Setul formation
2. Origin of name : After Setul (Satun) Province, Thailand
3. Age : Lower Ordovician to Lower Devonian
4. References : Jones (1961, 1968, 1973, 1981)
5. Type area : North and northeast Langkawi, Kedah. Outcrops extensively in Setul Boundary Range, Perlis
6. Type section :
7. Boundaries : Lower gradational contact with Machinchang formation. Unexposed upper contact with Singa and Kubang Pasu formations.
8. Correlation : Mahang formation in south Kedah Chemor formation in Kinta Valley and Hawthornden schist in Kuala Lumpur.
9. Thickness : 1550 m
10. Lithology : Well-bedded, dark grey, crystalline shelly limestone with at least two detrital members of grey quartzite and subgreywacke black, brown and grey siltstone and black carbonaceous and red shale and cherty beds.
11. Subddivisions : Divided into Basal limestone, Lower Setul limestone, Lower Detrital member, Upper Setul limestone and Upper Detrital member.
12. Fossils :

<u>cephalopod</u> (nautiloid)
Ormoceras langkawiensis, Kobayashi,
Endoceras sp.,
Stereoplasmoceras sp.,
Discoceras (?Hardmenoceras) chrysanthimum, Kobayashi
Discoceras (?Hardmenoceras) laeviventrum Kobayashi,
Armenoceras chediforme Kobayashi,
Chaohuceras sp.,
Wutinoceras robustum (Kobayashi & Matsumoto),
Tongfangoceras nanpiaoense,
Manchuroceras sp.,
Mesaktoceras sp.,
Actinoceras sp.,
<u>gastropod</u>
Hormotoma sp.,
Helicotoma jonesi Kobayashi,
?Helicotoma costata Kobayashi,
Palaeomphalus giganteus Kobayashi,

Leseurilla zonata Kobayashi,
Malayspira rugosa Kobayashi,
Lytospira rectangularis Kobayashi,
Teiichispira Kobayashi, Yochelson & Jones,
Megalomphala sp.,
Lophospira sp.,
trilobite
Dalmanitina malayensis Kobayashi & Hamada,
Langgonbole vulgaris Kobayashi & Hamada,
Stenopareia sp.,
Geragnostella sp.,
Trinodus sp.,
Geratrinodus purconvexus Kobayashi & Hamada,
Geratrinodus levigatus Kobayashi & Hamada,
Eccoptochile sp.,
Nileus malayensis Kobayashi Hamada,
Rempleurides cf. *Emerginatus* Tornquist,
Microparia sp.,
Raphiophorus sp.,
Lonchodomas rhombeus Kobayashi & Hamada,
Decoroproetus sp.
Ligonodina sp.,
Neoprioniodus sp,
Oistodus lanceolatus Pander,
Panderodus acostatus (Branson & Branson),
Panderodus unicostatus (Branson & Mehl),
Scandodus bassleri (Furnish),
Scolopodus giganteus Sweet & Bergstrom,,
Scolopodus aff. *oneotensis* (Furnish),
Plectospathodus sp.,
Trichonodella sp.,
Kockerella sp.,
Ozarkodina sp.,
Ulrichodina wisconsinensis Furnish,
Amorphognathus sp.,
Bryantodus sp.,
Distamodus sp.
graptolite
Monograptus langgunensis Jones,
Monograptus cf. *Uniformis* Pribyl,
Monograptus sedgwickii (Portlock),
Monograptus convolutus (Hisinger),
Monograptus gregarius Lapworth,
Monograptus cyphus (Lapworth),
Dimorphograptus malayensis Jones,
Orthograptus vesiculosus (Nicholson),
Glyptograptus tamariscus (Nicholson),
Climacograptus medius Tornquist,
Climacograptus scalaris (Hisinger),
Climacograptus rectangularis (MaCoy),
Diplograptus modestus Lapworth,
conodont
Acodus similaris Rhodes,
Acodus inornatus Ethington,
Acontiodus insculptus Branson & Mehl,
Cordyolus sp.,
Drepanodus subarcuatus Furnish,
Drepanodus altipes Henningsnoen,
Falcodus sp.,
Keislognatus sp.,
brachiopod
Emanuella malayensis Hamada,
strophomenids,
plectambonids,
tentaculitid
Nowakia sp.,
Styliolina sp.,
scaphopod
Dentalium sp.,
polyplacophoran
Chelodes sp.,
ostracod
stromotoporoid
crinoid
stromatolite

13. Env. of deposition : Shelf
14. Remarks : Burton (1970) has pointed out the impropriety of using a geographic name not from a Malayan locality for a Malaysian formation. The name "Kaki Bukit limestone" was proposed as a replacement.

P6.1.

1. Name : Basal limestone (of Setul formation)
2. Origin of name :
3. Age : Lower Ordovician
4. References : Jones (1973, 1981)
5. Type area : Kuala Kubang Badak, north Langkawi, Kedah
6. Type section :
7. Boundaries : Conformable passage beds with underlying Machinchang formation.
8. Correlation : Lowermost Thung Song Limestone of Ko Tarutao, Thailand
10. Lithology : Grey, heavily banded limestone with abundant siliceous partings
11. Subdivisions :
12. Fossils :

cephalopod
Robsonoceras sp.
nautiloids
polyplacophoran
Chelodes sp.
sponge

13. Env. of deposition :
14. Remarks : It was metamorphosed by the Raya Granite and its relationship with the other parts of the Setul limestone is unclear.

P6.2

1. Name : Lower Setul limestone (of Setul formation)
2. Origin of name :
3. Age : Middle to Upper Ordovician
4. References : Jones (1973, 1981); Igo & Koike (1966)
5. Type area : Pulau Langgun, northeast Langkawi, Kedah
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : 1020 m
10. Lithology : Thickly bedded, dark-grey, finely crystalline limestone with sporadic rich shelly horizons. The rock is variably dolomitic and of a characteristic banded appearance with strongly developed stylolites and irregular laminae. Top of this unit is conspicuous discrete pink limestone.
11. Subdivisions : Jones (1973, p.34) has informally divided it into three units
12. Fossils :

brachiopod
strophomenids
orthids
cephalopod (nautiloid)
Antinoceras perlisense Kobayashi
Armenoceras chediforme Kobayashi
Discoceras (Hardmenoceras?) *chrysanthemm* Kobayashi
Discoceras (*Hardmenoceras?) laeviventrum* Kobayashi
Endoceras sp.
Ormoceras langkawiense Kobayashi
Stereoplasmoceras sp.
coelenterate
cystid
conodont
Acodus oneotensis Furnish
Acodus similaris Rhodes
Acodus mutatus (Branson & Mehl)
Acontiodus hamari Igo & Koike
Acontiodus malayensis Igo & Koike
Cordylodus cf. excavatus
Distamodus?
Drepanodus altipes Hennigs meon
Faltodus sp.
Gnathodus sp.
Ligonodina sp.
*Neopionodu*s sp.
Oisdotudus laceolatus Pander
Oisdotudus orientalis Igo & Koike
Panderodus unicostatus (Branson & Mehl)
Scolopodus cf. *bassler*i (Furnish)
Scolopodus giganteus Sweet & Bergstrom
Scolopodus insculptus (Branson & Mehl)
Scolopodus psendoquadratus Branson & Mehl
Scolopodus staufferi (Furnish)
Scolopodus vulgaris (Branson & Mehl)
Trichonodella cf. *inconstans* Walliser
Ulrichodina misconsinensis Furnish
gastropod
Helicotoma costata Kobayashi
Hormotoma sp.
Leusueurilla zonata Kobayashi
Lytospira rugosa Kobayashi
Palaeonphalus giganteus Kobayashi
Teiichispira Kobayashi Yochelson & Jones

13. Env. of deposition :
14. Remarks : This unit forms the bulk of the Setul formation.

P6.3.

1. Name : Lower Detrital member (of Setul formation)
2. Origin of name :
3. Age : Lower Silurian, (Lower to Lower Upper Llandovery)
4. References : Jones (1973, 1981)
5. Type area : Pulau Langgun, northeast Langkawi, Kedah
6. Type section : West coast of Pulau Langgun (Jones, 1981 p. 64)
7. Boundaries :
8. Correlation :
9. Thickness : 27 m
10. Lithology : Black carbonaceous siltstone, fissile and flaggy shale and chert layers.
11. Subdivisions : Jones (1973 p. 43) has 6 informal units.
12. Fossils :

gastropod
Megalomphada sp.
Lophospira sp.
graptolite
Climacograptus medius Tornquist
Climacograptus rectangularis (McCoy)
Climacograptus scalaris (Hisinger)

Climacograptus yangtzeensis Hsu
Demirastrites convolutus (Hisinger)
Dimorphograptus malayensis Jones
Diplograptus modestus Lapworth
Glyptograptus persculptus (Salter)
Glyptograptus tamariscus (Nicholson)
Monograptus convolutus (Hisinger)
Monograptus distans (Portlock)
Monograptus gregarius Lapworth
Monograptus sedgwickii (Portlock)
Orthograptus vesiculosus (Nicholson)
Pernograptus revolutus (Kurch)
Petalograptus tenuis (Barvande)
Pristograptus concinnus (Lapworth)
Pristograptus cyphus (Lapworth)
Pristograptus regularis (Tornquist)
Pristograptus sandersoni (Lapworth)
Retiolites (Pseudoretiolites) perlatus (Nicholson)
Rhaphidograptus tornquisti (Elles & Wood)
trilobite
Dalmanitina malayensis Kobayashi & Hamada
Stenopareia sp.

13. Env. of deposition :
14. Remark : Renamed "Mempelam Argillaceous member" by Burton (1974).

P6.4.

1. Name : Upper Setul limestone (of Setul formation)
2. Origin of name :
3. Age : Upper Silurian
4. References : Jones (1973, 1981); Igo & Koike (1966)
5. Type area : Pulau Langgun, northwest Langkawi, Kedah
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : ± 120 m
10. Lithology : Banded, light grey, stylolitic limestone less fossiliferous than Lower Setul limestone
11. Subdivisions :
12. Fossils :

cephalopod (nautiloid)
Endoceras sp.
Ormoceras sp.
conodont
Acodus jonesi Igo & Koike
Acodus hamari Igo & Koike
Acodus langkawiensis Igo & Koike
Acodus mutatus (Branson & Mehl)
Amorphognathus sp.
Bryantodus sp.
Cordylodus sp.
Cyrtyoniodus sp.
Distamodus sp.
Drepanodus langoonensis Igo & Koike
Drepanodus malayensis Igo & Koike
Drepanodus suberectus (Branson & Mehl)
Kockerella sp.
Ligonodina cf. s*alopia* Rhodes
Multioistodus sp.
Ozarkodina media Walliser
Panderodus unicostatus (Brenson & Mehl)
Plectospathodus elegans
Plectospathodus extensus Rhodes
Prioniodina bicurvata Ethington
Roundya sp.
Sapthognathodus sp.
Trichonodella excavata Ethington
Trichonodella cf. *inconstan*s Walliser
scaphopod
Dentalium sp.
trilobite

13. Env. of deposition :
14. Remarks :

P.6.5.

1. Name : Upper Detrital member (of Setul formation)
2. Origin of name :
3. Age : Lower Devonian,
4. References : Jones (1973, 1981)
5. Type area : Pulau Langgun, northeast Langkawi, Kedah
6. Type section : West coast of Pulau Langgun (Jones 1981, p. 66)
7. Boundaries : Unconformable upper contact with red conglomeratic mudstones of Upper Devonian age
8. Correlation :
9. Thickness : ± 140 m
10. Lithology : Grey quarzite and subgreywacke, brown and grey siltstone, and black carbonaceous and red shale.
11. Subdivisions :
12. Fossils :

bivalve
graptolite
Monograptus langgunensis, Jones
Monograptus cf. uniformis Pribyl
tentaculitid
Nowakia sp.
Styliolina sp.

13. Env. of deposition : Final phase of infilling off miogeosyncline
14. Remarks : Renamed "Langgon shale" by Burton (1974)

P7.

1. Name : Hawthornden schist
2. Origin of name : After Hawthornden Estate, Kuala Lumpur.
3. Age : Ordovician to Lower Silurian,
4. References : Gobett (1965), Yin (in prep.)
5. Type area : Former Hawthornden Estate, Kuala Lumpur
6. Type section :
7. Boundaries : Lower boundary gradational with Dinding schist. Upper boundary conformable with Kuala Lumpur limestone.
8. Correlation : Mahang Formation and Baling Group. Terolak formation. Upper part equivalent to Kuala Lumpur Limestone
9. Thickness : 910 m
10. Lithology : Carbonaceous schist and phyllite
11. Subdivisions : Yin separated it into 'Kajang Schist' above and Hawthornden schist below
12. Fossils :
13. Env. of deposition : Eugeosyncline
14. Remarks :

P8.

1. Name : Terolak formation
2. Origin of name : After Terolak town (101° 22'E, 3° 53'N), south Perak.
3. Age : Ordovician - Silurian
4. References : Gan (l992)
5. Type area : Terolak (Trolak), south Perak
6. Type section :
7. Boundaries :
8. Correlation : Calcareous member equivalent to Kuala Lumpur limestone (Gobbett, 1965), schist equivalent to Hawthornden schist (Gobbett, 1965) of Kuala Lumpur area.
10. Lithology : Major argillaceous facies of quartz-mica scist, graphitic schist and phyllite, minor arenaceous facies of metaquartzite and quartz schist, minor limestone facies of marble with minor presence of dolomite.

Subdivision : Argillaceous, arenaceous and limestone facies.

12. Fossils :
cephalopod
?Cochlioceras sp.
Endoceras s.l. sp.
?Stereoplasmaceras sp.
Orthoceras s.l. sp.
Ormoceras (? Pararmoceras) sp.
13. Env. of deposition : Marine
14. Remarks : Part of 'Calcareous Series' of Roe (1951). The fossils are in limestone from Kalumpang near Tanjung Malim, south Perak.

P9.

1. Name : Jelebu schists
2. Origin of name : After Jelebu District, Negeri Sembilan
3. Age : Pre-Silurian
4. References : Shu (1989), Loganathan (1993)
5. Type area : Along the Sungei Jerang, Sungei Sertang and from Kampung Cenah (VK 550420) along Sungei Kenaboi
6. Type section :
7. Boundaries : Unconformable upper contact with Pelong beds
8. Correlation : Kuala Lumpur schists
9. Thickness : ± 3000 m
10. Lithology : Mixed sequence of argillaceous, arenaceous and carbonaceous sediments, metamorphosed to quartz-mica schist, quartz schist, quartz-sericite-chlorite schist, quartz-graphite and graphitics phyllite with minor lenses of calcareous sediments and basic igneus rocks converted to amphibolite schist.
11. Subdivisions :
12. Fossils
13. Env. of deposition : Eugeosyncline
14. Remarks : Referred to as "Arenaceous Formation" (Richardson, 1946), "Arenaceous Series" (Alexander, 1959), "Lower Arenaceous Series" and "Bentung Group" (Alexander, 1959). Loganathan (1993) proposed that the Karak Formation be upgraded to Karak group with the Pelong beds overlying the Jelebu schists unconformably.

P10.

1. Name : Mahang Formation
2. Origin of name : After the town Mahang in Kulim, south Kedah.
3. Age : Ordovician to Middle Devonian
4. References : Burton (1967, 1988)
5. Type area : Central and south Kedah
6. Type section : Sungei Ayer Hitam, Dublin Estate, Machang , Kedah (Lat 50°22' 09"N, long. 108^0 43'04"E)
7. Boundaries : Lower boundary with Jerai formation unexposed. Comformable Upper boundary with Kubang Pasu formation.
8. Correlation : Setul formation in Langkawi and Perlis-Baling Group in east Kedah and north Perak Upper part with Kampong Sena formation. Sungei Patani formation.
9. Thickness : Keroh formation. Pilah schist. Karak formation.
10. Lithology : Black carbonaceous and siliceous graptolitic argillite, siltstone, cherty rocks and occasional lighter coloured arenite of euxinic aspect.
11. Subdivisions : Burton (1967) divided it into four facies - argillaceous, arenaceous, siliceous and calcareous but not stratigraphically.
12. Fossils :

graptolite
Monograptus gregarius Lapworth,
Monograptus cf. *inopinus* Tornquist,
Monograptus aff. *concinnus* Lapworth,
Monograptus decipiens Tornquist,
Monograptus convolutus Hisinger,
Monograptus aff. *galaensis* Lapworth,
Cephalograptus tubularifornis Nicholson,
Climacograptus hughesi Nicholson,
Climacograptus rectangularis M'coy,
Diplograptus modestus Lapworth,
Glyptograptus sinnuatus Nicholson,
Orthograptus sp.,
tentaculitid
Nowakia cf. *acuaria*,
Styliolina ex.gr. fissurella Hall
trilobite
cyclopygids
crinoid
hystrichosphere
Dictyotidium sp.,
bivalve
brachiopod
radiolarian
foraminifera
cnidarian

13. Env. of deposition : Restricted euxinic basin with intermittent connections to the open ocean.
14. Remarks : The "Sungei Patani Formation" of Bradford (1972) and Courtier (1974) is homologous with the Mahang Formation (Burton, 1988).

P11.

1. Name : Grik siltstone (of Baling Group)
2. Origin of name : After Grik town, Upper (north) Perak.
3. Age : Upper Ordovician to Upper Silurian, (Llandovery)
4. References : Jones (l973)
5. Type area : Northwest of Grik town
6. Type section :
7. Boundaries : Transitional lower boundary to Papulut quartzite and transitional upper boundary to Bendang Riang formation.
8. Correlation :
9. Thickness :
10. Lithology : Carbonaceous siltstone
11. Subdivisions :
12. Fossils :
13. Env. of deposition :
14. Remarks : Foo (l983) proposed to include it as a member within the Bendang Riang formation as it is lenticular and extremely localized.

P12.

1. Name : Lawin tuff
2. Origin of name : After Lawin town
3. Age : Upper Ordovician to Lower Silurian,
4. References : Jones (1970, 1973
5. Type area : Around Grik and Lawin, north Perak
6. Type section :
7. Boundaries : Interfingers with clastic rocks of Baling group
8. Correlation : Papulut quartzite and Grik siltstone
9. Thickness :
10. Lithology : Bedded and speckled grey to green coloured crystal tuffs of rhyolitic to rhyodacitic composition.

11. Subdivisions :
12. Fossils :
13. Env. of deposition :
14. Remarks : Referred to as Grik pyroclastic member of the Baling formation in Jones (1970) and Grik tuff in Burton (1970, 1986)

P13.

1. Name : Kroh formation (of Baling group)
2. Origin of name : After Kroh (Keroh now renamed Pengkalan Hulu) in north Perak
3. Age : Upper Ordovician to Lower Devonian
4. References : Burton (1986)
5. Type area : Around Kroh (Pengkalan Hulu), north Perak
6. Type section : Suggested between 2-5 and 4-5 km from Kroh on road to Baling
7. Boundaries : Conformable lower contact with Papulut quartzite via the Grik tuff
8. Correlation : Mahang Formation to the west and Karak formation to the east and southeast
9. Thickness :
10. Lithology : Black carbonaceous shale and mudstone, often siliceous and chert with subordinate lenses of arenite and calcareous rocks commonly recrystallized to hornfels, metaquartzite, calc-silicate hornfels and pseudosparite.
11. Subdivisions:
12. Fossils :
    bivalve
    brachiopod
    crinoid
    graptolite
    tentaculitid
    Stylolina sp.
    Nowakia cf. *acuaria*
13. Env. of deposition :
14. Remarks :

P14.

1. Name : Sungai Patani formation
2. Original of name : After Sungai Patani town, south Kedah.
3. Age : Silurian
4. References : Bradford (1972)
5. Type area : Around Kedah Peak.
6. Type section :
7. Boundaries : Overlie Jerai formation conformably
8. Correlation : Mahang Formation (Courtier, 1979), Setul formation, (Jones, 1981) and Baling formation (Burton, 1965)
9. Thickness : > 5000 ft. (1524 m)
10. Lithology : Argillaceous sequence of shale and mudstone, commonly ferruginous and subject to lateritization and in places phyllitic or pyritiferous with a less extensive arenaceous facies of sandstones or orthoquartzite and a single exposure of limestone on Bidan Island.
11. Subdivision : Argillaceous, arenaceous and calcareous facies by Bradford (1972)
12. Fossils :
    bivalve
    Posidonia aff. *siamensis?* Red
    graptolite
    Monograptus cf. *dingani*
    Diplograptus cf. *modestus*
    coniconchid
    tentaculitid
    Homoctenus sp.
    Styliolina sp.
    crinoid
    cephalopod
    nautiloid (straight)
13. Env. of deposition : Deep gulf or geosynclinal basin
14. Remarks : See Mahang Formation.

P15.

1. Name : Bendang Riang formation (of Baling Group)
2. Origin of name : After Bendang Riang Valley, 10 km northeast of Grik, north Perak.
3. Age : Lower Silurian to Lower Devonian.
4. References : Jones (l973)
5. Type area : Near Grik and Kroh in north Perak and east Kedah
6. Type section :
7. Boundaries :
8. Correlation : Mahang Formation in Kedah
9. Thickness : ± 1200 m
10. Lithology : Mainly carbonaceous shale and phyllite with small lenses of limestone and some beds of quartzite and schist.

11. Subdivisions :
12. Fossils :
graptolite
Climacograptus scalaris (Hisinger),
Stomatograptus cf. *Grandis* (Suess),
Monograptus praecedens Boucek,
Streptograptus nodifer (Tornquist),
Spirograptus grobsdorfiensis (Hemmann),
Spirograptus minor (Boucek).
tentaculitid
Nowakia cf. *acuaria (Richter),*
Styliolina sp.
brachiopod
Plectodonta sp.,
Echinocoelia sp.,
trilobite
Trinodus sp.,
Selenoharpes sp.*?*
Isotelus sp.,?
Ogygiocaris sp.,
Microparia sp.
13. Env. of deposition : Deeper water geanticlinal
14. Remarks :

P16.

1. Name : Pelong beds (of Bentong Group)
2. Origin of name : After Bukit Hulu Pelong and Durian Tipus, Negeri Sembilan
3. Age : Silurian to Lower Devonian
4. References : Shu (l989), Loganathan (1993)
5. Type area : Between the Lower Kenaboi and Pikul rivers around Bukit Hulu Pelong, Negeri Sembilan.
6. Type section :
7. Boundaries : Unconformable lower boundary with Jelebu schists. Unconformable upper boundary with Kelintau conglomerates.
8. Correlation : Karak formation (Jaafar, 1976) to the north
9. Thickness : < 3000 m
10. Lithology : Cherts, slates, phyllites micaceous sandstones and subgreywackes and tuff.
11. Subdivisions : Divided into four facies by Shu (l989) as
    1. Chert, non-clastic facies
    2. Shale and siltstone, fine-grained clastic facies
    3. Sandstone and quartzite, medium grained clastic (sandy) facies
    4. Subgreywacke, medium- to fine-grained clastic (sandy) facies.
12. Fossils :
hexatinellid
Hydrodictya cyclix Hall and Clarke
Lyrodictya sp.
brachiopod (Inarticulata)
Orbiculoidea sinensis Mansuy
archaeostraca
Ceratiocaris sp.
graptolite
Monograptus hercynicns Perner
Linograptus aff. posthumns Richter
'*Abiesgraptus*' sp.
cephalopod
?Orthoceras sp.
13. Env. of deposition : Started with deeper waters along continental margins and slopes and ended with shallow water marine and fluvialtile deposits.
14. Remarks : Part of the 'Bentong Group'of Alexander (1968)

P17.

1. Name : Kuala Lumpur limestone
2. Origin of name : After Kuala Lumpur.
3. Age : Middle to Upper Silurian
4. References : Gobbett (1965)
5. Type area : Kuala Lumpur Valley, central Selangor
6. Type section :
7. Boundaries : Overlies the Hawthornden schist without any sharp break. Probably unconformable upper contact with Kenny Hill formation.
8. Correlation : Upper part of Setul formation and lower part of Kinta limestone
9. Thickness : ± 1820 m
10. Lithology : Finely crystalline, grey to cream, thickly bedded, banded marble, saccharoidal dolomite and pure calcitic limestone with minor interbeds of schist and phyllite.

Subdivision :
12. Fossils :
coral
Ketophyllum aff. *Turbinatum* (Linnaeus),
Heliolites aff, *barrandei* var. *spongodes* Lindstrom,
Favosites sp.,
Thecia swinderniana (Goldfuss)
Halysites sp.,
brachiopod
Dalmanella sp.,
Capellinella sp.,
Cymbidium sp.,

"*Conchidium*" sp.,
Atrypella sp.,
Delthyris sp.,
gastropod
Poleumita cf. *discors* (Sowerby),
Poleumita scamnata Clark & Ruedemann,
Euomphalus (Philoxene) sp.,
Loxonoma sp.

13. Env. of deposition : Shallow marine shelf
14. Remarks : Surface outcrops only at Batu Caves and Bukit Takun while most of it is below the Quaternary alluvium.

P18.

1. Name : Kajang schist
2. Origin of name : After Kajang town, Selangor
3. Age : Upper Silurian to Devonian?
4. References : Yin (l976), Raj (1995)
5. Type area : Kajang, Selangor
6. Type section :
7. Boundaries : Overlies the Kuala Lumpur limestone and underlies the Kenny Hill formation.
8. Correlation :
9. Thickness :
10. Lithology : Dark grey to black graphitic-quartz-muscovite schists interlayered with thin bands and lenses of orange to buff-coloured, quartz-muscovite schists with minor intercalations of limestone (marble) and phyllite.
11. Subdivisions :
12. Fossils :
13. Env. of deposition :
14. Remarks : "Kajang Formation" in Yin (1976)

P19.

1. Name : Karak formation
2. Origin of name : After Karak town, west Pahang
3. Age : Lower Devonian
4. References : Jafaar (l976)
5. Type area : Eastern flank of Main Range near Karak, west Pahang.
6. Type section :
7. Boundaries : Base unknown. Unconformable upper contact with Semantan formation of Raub group, Kepis formation (Khoo, 1998), Pelong beds (Shu, 1989)
8. Correlation : Hawthornden schist of Kuala Lumpur.
9. Thickness : > 4800 m
10. Lithology : Predominant argillite with interbeds of conglomerate, chert, quartzite and subgreywacke.
11. Subdivisions : Five rock facies - rudaceous, arenaceous, argillaceous, chert, limestone and pyroclastic.
12. Fossils :
sponge
Hydrodictya cylix Hall & Clarks,
Lyrodictya sp.,
brachiopod
Orbiculoidea sinensis Mansuy
archaeostraca
Ceratiocaris sp.,
graptolite
Monograptus cf. *praehercynicus* Jaeger,
Linograptus aff. *posthumus* Richter
13. Env. of deposition : From shallow water shelf at base to deep water and then to littoral in an infilling geosynclinal basin.
14. Remarks : Previously mapped as "Arenaceous Formation" (Richardson, 1939), "Foothills Formation" (Richardson, 1950), "Lower Arenaceous Series" (Alexander, 1950). For history of nomenclature of Main Range Foothills area see Khoo (l990).

P20.

1. Name : Kinta limestone
2. Origin of name : After Kinta Valley, Perak
3. Age : Lower Devonian to Middle Permian
4. References : Suntharalingam (l968)
5. Type area : Kampar, Kinta Valley, Perak
6. Type section :
7. Boundaries : Base and top not exposed
8. Correlation : Chemor limestone
9. Thickness : ± 1550 m (in Kampar)
10. Lithology :
11. Subdivisions : Divided into the H.S. Lee beds, Nam Loong beds, Kim Loong No. 3 beds, Kuan On beds, Thye On beds and Kim Loong No. 1 beds from youngest of oldest.
12. Fossil :
algae
Permopora sp.,
Epimastopora sp.,
foraminifera
Misellina claudiae (Depart),

Endothyrid.
coral
Amplexus sp.,
Thamnopora sp.,
Chaetetes sp.,
Iranophyllum sp.,
Pavastehphyllum (Sakamotosawanella) permicum Chi.
polyplacophora
Lepidopleurus sp.,
scaphopod
Prodentalium sp.,
gastropod
Palaeozygopleura sp.,
Microptychia sp.,
Orthonema spp.,
Meekospira sp.,
Cylindritopsis cf ? *ovalis* Gemmellaro,
Cylindritopsis cf?. *Vaningeni* Knight,
Oncochilus cf?. *Globulosus* (Klipstein)
Murchisonia spp.,
Straparollus (Euomphalus) sp.,
?*Hypergonia* sp.,
Callistadia sp.,
Bellerophon cf. *timorensis Wanner,*
Knightites (Retispira) quadratus Wanner
Warthia sp.,
Glabrocingulum sp.,
Glabrocingulum (Amanias) sp.,
Eirlysia sp.,
Neoplayteichum dickinsi Mourlonia,
Mourlonia (Pseudobaylea) sp.,
Lacunospira sp.,
Euconospira sp.,
Borestus sp.,
Trachydomia spp.,
Trachyspira sp.,
Naticopsis spp.,
Planospirina spp.,
Halicespira sp.,
Platyzona sp.,
Sallya sp.,
Anomphalus sp.
bivalve
Parallelodon spp.,
Schizodus sp.,
Pterid.
cephalopod
Cyrtoceras sp.,
Metacoceras sp.,
Agathiceras sp.,
Stacheocheras sp.,
Crimites sp.,
Andrianites sp.,
Oncoceratid nautiloids.
brachiopod
Stringocephalus perakensis Gobett,
Derbyia sp.,
Chonetes sp.,
Linoproductus cf. *lineatus* (Waagen),
Cancrinella sp.,
Waagenoconcha sp.,
Spirifer sp.,
Costispirifera sp.,
Camerophoria sp.,
Camerotoechia sp.,
Martinia sp.,
Composita sp.,
Cleothyridina sp.,
ostracod
Bairdia sp.,
Bairdiopillata sp.,
Bairdiocypris sp.,
Healdea sp.,
Bythocypris sp.,
Cytherella sp.,
stromatoporoid
Actinostroma sp.,
Amphipora sp.,
crinoid

13. Env. of deposition : Shallow marine shelfal carbonate build-up with shaly flanks
14. Remarks : The fossiliferous limestones are areally restricted and most of the rest are metamorphosed to marble. The Kinta Limestone forms part of the 'Calcareous Series' of Ingham and Bradford (l960)

P20.1.

1. Name : Kim Loong No. l beds (of Kinta limestone)
2. Origin of name : After Kim Loong No. l Mine
3. Age : Silurian to Lower Devonian
4. References :
5. Type area :
6. Type section :
7. Boundaries : Base not seen. Overlain by Thye On beds
8. Correlation :
9. Thickness : 600 m?
10. Lithology : Mainly pure cream-coloured dolomite
11. Subdivision :
12. Fossils :

bivalve
brachiopod
Spiriferidae?

Ambocoeliidae
coral
Amplexus? sp.
Thamopora sp.
gastropod
Murchisonia sp.
Straparollus sp.
13. Env. of deposition :
14. Remarks :

P20.2.

1. Name : Thye On beds (of Kinta limestone)
2. Origin of name : After Thye On Mine
3. Age : Lower to Upper Devonian
4. References :
5. Type area :
6. Type section :
7. Boundaries : Conformable on Kim Loong No. 1 beds and underlies Kuan On beds
8. Correlation :
9. Thickness : 150 m
10. Lithology : Massive grey recrystallized calcite limestone
11. Subdivisions :
12. Fossils :
bivalve
brachiopod
Stringocephalus perakensis Gobbett
cephalopod
Cytoceras sp.
Oncoceratid nautiloid
coral
gastropod
Murchisonia spp.
stromatoporoid
Actinostroma sp.
Amphipora sp.
13. Env. of deposition :
14. Remarks : At Thye On Mine, the limestone containing *Stringocephalus perakensis* is dated Givetian, Middle Devonian.

P20.3.

1. Name : Kuan On beds (of Kinta limestone)
2. Origin of name : After Kuan On Mine
3. Age : Lower to Upper Carboniferous
4. References :
5. Type area :
6. Type section :
7. Boundaries : Overlies Thye On beds and underlies Kim Loong No. 3 beds
8. Correlation :
9. Thickness : 500 m?
10. Lithology : Thin-bedded grey recrystallized calcite limestone with dolomitic beds, interbedded with thin calcareous and carbonaceous shales.
11. Subdivisions :
12. Fossils :
algae
Dasycladacean
bivalve
Schizodus sp.
cephalopod
Cyrtoceras sp.
gastropod
Hypergonia?
Callistadia? sp.
Eotomarridae?
Holopeidae
Neritopsidae?
13. Env. of deposition :
14. Remarks :

P20.4.

1. Name : Kim Loong No. 3 beds (of Kinta limestone)
2. Origin of name : After Kim Loong No. 3 Mine
3. Age : Upper Carboniferous
4. References :
5. Type area :
6. Type section :
7. Boundaries : Overlies Kuan On beds and underlies Nam Long beds
8. Correlations :
9. Thickness : 100 m
10. Lithology : Pyritiferous black shales and argillaceous sandstone
11. Subdivisions :
12. Fossils :
13. Env. of deposition :
14. Remarks :

P20.5.

1. Name : Nam Loong beds (of Kinta limestone)
2. Origin of name : After Nam Loong No.1 Mine
3. Age : Lower Permian
4. References :
5. Type area :
6. Type section :
7. Boundaries : Overlies Kim Loong No. 3 beds

and underlies H.S. Lee beds

8. Correlation :
9. Thickness : 160 m
10. Lithology : Grey-black crinoidal limestone (100 m) overlain by impure carbonaceous brachiopod-polyzoan limestone (60 m)
11. Subdivisons :
12. Fossils :

brachiopod
Camerophoria sp.
Camerotoechia sp.
Cancrinella sp.
*Composit*a sp.
Costispinifera? sp.
Chonetes sp.
Cleiothyridina sp.
Derbyia sp.
Linoproductus cf. *lineatus* (Waagen)
Martinia sp.
*Spirife*r sp.
Waagenoconcha sp.
bryozoa
Fenestella sp.
crinoid

13. Env. of deposition :
14. Remarks :

P20.6.

1. Name : H.S. Lee beds (of Kinta limestone)
2. Origin of name : After H.S. Lee No. 8 Mine
3. Age : Lower to Middle Permian
4. References :
5. Type area :
6. Type section :
7. Boundaries : Overlies Nam Loong beds. Top not seen
8. Correlation :
9. Thickness : 40 m
10. Lithology : Grey-white bioclastic and fusuline limestone (20 m) overlain by biohermal limestone (20 m)
11. Subdivisions :
12. Fossils :

algae
Epimastopora sp.
Permopora sp.
bivalve
Parallelodon spp.
Schizodus sp.
Pteriacea
brachiopod
Derbyia sp.
Dielasmid
Rhynchonellid
cephalopod
Agathiceras sp.
Andrianites sp.
Crimites sp.
Metacoceras sp.
Stacheoceras sp.
coral
Chaetetes sp.
Iranophyllum sp.
Pavastehphyllum (Sakamotosawanella) *permicum* Chi
echinoderm
cidaroid spines and plates
foraminifera
Misellina claudiae (Deprat)
Pseudofusulina kraffti
ostracod
Bairdia sp.
Bairdiocypris sp.
Bairdiopillata sp.
Bythocypris sp.
Cytherella sp.
gastropod
Anomphalus sp.
Bellerophon cf. *timorensis*
Borestus sp.
Cylindritopsis cf. *ovalis*?
Cylindritopsis cf. *vaningen*i?
Eirlysia sp.
Euconospira sp.
Glabrocingulum sp.
Halicespira sp.
Knightites (Retispira) *quadratus Wanner*
Lacunospira sp.
Meekospira sp.
Micopytchia sp.
Mourlonia sp.
Naticopsis sp.
Neoplatyeichum dickinsi
Oncochilus cf. globulosus?
Othonema sp.
Palaeozygoplewa sp.
Plaurospirina sp.
Platyzona sp.
Sallya sp.
Strapaollus (*Euomphalus*) sp.
Trachyspira sp.
Warthia sp.
polyplacopora
Lepidopheurus sp.
scaphopod
Prodentalium sp.

13. Env. of deposition : Reef complex
14. Remarks :

P21.

1. Name : Salak Baharu beds
2. Origin of name : After Salak Baharu town,Perak
3. Age : Devonian to Permian
4. References : Foo (1990)
5. Type area : Kampong Perak Dalam, Salak Baharu, Salak Estate, Kampong Setia and Enggor.
6. Type section :
7. Boundaries :
8. Correlation :
10. Lithology : Mainly quartz-mica schist, graphytic schist and quartzite, hornfels and chiastolite schists adjacent to granite.
11. Subdivisions :
12. Fossil :
13. Env. of deposition :
14. Remarks

P22.

1. Name : Singa formation
2. Origin of name : After Pulau Singa Besar, Langkawi
3. Age : Middle Devonian to Lower Permian
4. References : Jones (l973, 1981); Ahmad Jantan (1973); Stauffer & Lee (l986); Shi *et al*. (1997)
5. Type area : Southwest Pulau Singa and neighbouring islands, Langkawi, Kedah.
6. Type section :
7. Boundaries : Lower boundary with Setul formation unexposed. Conformable gradational upper boundary with Chuping limestone
8. Correlation : Kubang Pasu formation in central and south Perlis and Kampong Sena formation in Kedah.
9. Thickness : ± 7000 ft.
10. Lithology : Basal part of reddish pebbly mudstone and light coloured sandstone. Other part of dark-grey or black. Well-bedded carbonaceous flagstones and siltstones with subordinate grey and brown immature quartzites and subgreywackes with scattered pebbly mudstone horizons.
11. Subdivisions : Divided into the Rebak, Kentut, Ular and Selang members by Ahmad Jantan (1973)
12. Fossils :
    brachiopod
    Kasetia cf. kaseti Waterhouse
    Stenoscisma quasimutabili Waterhouse
    Rhynchopora culta Waterhouse
    Spirelytha netaliformis (Pavlova)
    Spinomartinia prolifica Waterhouse
    Arionthia sapa Waterhouse
    ?Marginirugus sp.
    Dielasma sp.
    Arctitreta sp.
    Streptorhynchus sp.
    Bandoproductus sp.
    Sulciplica sp.
    ?Martiniopsis sp.
    ?Elasmata sp.
    Terebratulid
    Productid
    Spiriferid
    Chonetid
13. Env. of deposition : Shallow water glacial marine continental margin (Stauffer & Lee, 1986)
14. Remarks : Gobbett (1972) proposed the basal red mudstone of the Singa formation from the Rebak islands and Pulau Langgun as a separate unit called the "Rebanggun beds".

P23.

1. Name : Kubang Pasu formation
2. Origin of name : After Kubang Pasu, Perlis
3. Age : Upper Devonian to Lower Permian
4. References : Jones (l98l), Gobbett (l973)
5. Type area : Central and east Perlis and north Kedah
6. Type section : Reference section at Hutan Haji (2E/9 817 908)
7. Boundaries : Unconformable on Setul formation and conformable upper contact with Chuping limestone and unconformable upper contact with Semanggol formation.
8. Correlation : Singa formation in Langkawi (Burton, 1965) in Kedah
9. Thickness : ± 4500 ft. (± 1500 m)
10. Lithology : Red and grey-coloured shale, mudstone and a variety of poorly sorted argillo-arenaceous deposits varying from muddy siltstone through wacke subgreywacke and arkose to felspathic quarzite.

11. Subdivisions :
12. Fossils :
cephalopod
Agathiceras? sp.
Paralegoceras? sp.
gastropod
Bellerophontid
bivalve
Holobia sp.
Posidonia malayensis Kobayashi
Posidonia aff. becheri Bronn
Posidonia aff. siamensis (Reed)
Posidonia sp.
brachiopod
"Rhynchonella" malayensis Kobayashi
Chonetid
trilobite
Cytosymbole (Waribole) perlisense Kobayashi & Hamada
13. Env. of deposition :
14. Remarks : Differentiated from Singa formation by its lighter coloured rocks. With Chuping formation is placed differently within passage beds in Jones (1973, 1981)

P24.

1. Name : Kambing beds
2. Origin of name : After Bukit Kambing (GR498356), central Pahang.
3. Age : Lower Carboniferous
4. References : Lee (l990)
5. Type area : Valleys of Sungei Terapai, Sungei Keliu, Sungei Kuantan and headwaters of Sungei Song and Sungei Berapit, Hulu Lepar, Pahang.
6. Type section :
7. Boundaries : Base unknown. Unconformably overlain by Mesozoic Tekam tuffs and Berapit sandstones.
8. Correlation : Charu formation of Kuantan Group, Pahang
9. Thickness : > 5500 m
10. Lithology : An older argillaceous sequence known as the Keliu slates and a younger arenaceous sequence known as the Terapai metasiltstones.
11. Subdivisions : Keliu slates and Terapai metasiltstones
12. Fossils :
plant
Calamites cf. *jubatus* Lindley & Hutton,
Pecopteris cf. *hemitelioides* Brongniart,
Cordaites sp.,
Taeniopteris sp,.
13. Env. of deposition : Eugeosynclinal moderately shallow marine to shelf
14. Remarks :

P24.1.

1. Name : Keliu slates (of Kambing beds)
2. Origin of name : After Sungei Keliu, Hulu Lepar, Pahang
3. Age : Lower Carboniferous
4. References : Lee (l990)
5. Type area : Tributaries of the Sungai Keliu and Kuantan
6. Type section : Reference sections between GR473398 to GR468384 of tributary of Sungai Dagut and between GR 491341 to GR494330 along tributary of Sungai Kuantan.
7. Boundaries : Conformable upper contact with the Terapai metasiltstones. Base unknown
8. Correlation : Charu formation of Kuantan Group
9. Thickness : > 2000 m
10. Lithology : Predominantly hornfels, slate and phyllite interbedded occasionally with bands of schist, micaceous metasiltstone, quartzite and rare metaconglomerate.
11. Subidivisions :
12. Fossils :
coral
Zaphrentis sp.
13. Env. of deposition : Eugeosynclinal, moderately shallow marine.
14. Remarks :

P24.2.

1. Name : Terapai metasiltstones (of Kambing beds)
2. Origin of name : After Sungei Terapai, Hulu Lepar, Pahang
3. Age : Lower Carboniferous
4. References : Lee (l990)
5. Type area :
6. Type section : Representative section between GR551406 to GR560406 along Sungei Terapai.
7. Boundaries : Unconformable upper boundary

with Permian Seri Jaya beds and Mesozoic Tekam tuffs and Berapit sandstones. Conformable lower boundary with Keliau slates.

8. Correlation : Charu formation of Kuantan group
9. Thickness : > 2500 m
10. Lithology : Fine grained quartzite and metasiltstone with minor intercalations of argillite, slate and phyllite and their unmetamorphosed equivalents.
11. Subdivisions :
12. Fossils :
    foraminifera
    Endothyra sp.
    bryozoa
    Stenoporid
    crinoid
    ? plant
    bivalve
13. Env. of deposition : Shelf or distal portions of a delta
14. Remarks :

P25.

1. Name : Sungai Perlis beds
2. Origin of name : After Sungai Perlis, Ulu Paka, Trengganu
3. Age : Lower Carboniferous
4. References : Chand (1978)
5. Type area : Catchment areas of Sungai Perlis, Sungai Jengai, Sungai Angka and Sungai Paka.
6. Type section :
7. Boundaries : Base and top not exposed
8. Correlation : Charu formation, Pahang
9. Thickness : ± 1500 m
10. Lithology : Mainly of carbonaceous slate, argillite, phyllite and schist, together with minor lenses of quartzite, meta-conglomerate, and calc-silicate hornfels.
11. Subdivisions : Divided into argillaceous facies, arenaceous facies and calcareous facies by Chand (1978)
12. Fossils :
    bryozoa
    Fenestella sp.,
    brachiopod
    crinoid
    bivalve
    plant
    Lepidodendron sp.
13. Env. of deposition : Shallow marine
14. Remarks :

P26.

1. Name : Charu formation (of Kuantan Group)
2. Origin : After Sungai Charu, east Pahang
3. Age : Lower to Middle Carboniferous (Visean to Namurian A)
4. References : Metcalfe, Idris & Tan (1980)
5. Type area : Between 17th and 19th milestones on the Kuantan - Sungei Lembing road (between GR 250720 and GR 215727)
6. Type section :
7. Boundaries : Base not seen - conformably overlain by Paching Limestone.
8. Correlation : Kambing beds, Hulu Lepar, Pahang
9. Thickness : ± 1600 m
10. Lithology :
11. Subdivisions :
12. Fossils :
    brachiopod
    Antiquatonia sp.,
    Avonia sp.,
    Balanochoncha sp.,
    Buxtonia sp.,
    Camarotoechia sp.,
    Chonetes sp.,
    Crurithyris sp.,
    Dictyoclostus cf. patus (Meek & Worthen),
    Echinoconchus elegans (M'coy),
    Eomarganifera sp.,
    Hustedia cf. *Cabonaria*, (Philips),
    Hustedia cf. *Radialis* (Philips),
    Krotavia aculaeta (Martin),
    Leptaena cf. *analoga* (Phillips),
    Linoproductus sp.,
    Orthothes sp.,
    Plicochonetes cf. *buchiana* (de Konick),
    Productina cf. *Margaritacea* (Philips),
    Productus (s.s) sp.,
    Pugnax cf. *asiaticus* Muir-Wood,
    Punctospirifer pahangensis Muir-Wood.,
    Pustula sp.,
    Schellwienella sp.,
    Schizophoria sp.,
    Sedenticellula sp.,
    Setigerites sp.,
    Streptorhynchus sp., cf. *ruginosum* (Hall & Clark)
    bivalve
    Anthraconeilo aff. *taffiana* Girty,
    Aviculopecten sp.,
    Bakevellia sp.,
    Edmondia cf. *sulcata* Philips,

Myalina sp.,
Parallelodon cf. *bistrialus* (Portlock),
Posidonia sp.,
Scaldia sp.,
Streblochondria sp.,
gastropod
Euomphalus sp.,
trilobite
Linguaphillipsia terapaiensis Stubblefield,
Phillipsia sp.,
crinoid
Poteriocrinus sp.,
echinoid
cf. *Melonechinus* sp.,
bryozoan
Cystodictya sp.,
Fistulipora sp.,
Fenestella cf. *angustata*,(Fischer & Waldheim),
Fenestella cf. *tenax* Ulrich,
Fenestella cf. *polyporata* (Philips),
Fenestella aff. *plebeia* M'Coy,
Yunnanisp sp.,
algae
Koninkopora sp.,
foraminifera
Archaedicus karreri Brady,
Cribrostronium sp.,
Endothyra aff. *bowmani* Brady,
Hemigordius aff. *harltoni* Cushman & Waters,
Millerella sp.,
plant
Lepidodendron sp.,
Stigmaria sp.,

13. Env. of deposition : Shallow marine near shore environment
14. Remarks :

P27.

1. Name : Pinang beds
2. Origin : After Pulau Pinang south of Pulau Redang, Trengganu
3. Age : Carboniferous?
4. References : Khoo, Yaw, Kimura & Kim (1988)
5. Type area : Pulau Pinang, south of Pulau Redang, Trengganu
6. Type section :
7. Boundaries : Unconformable below Redang beds.
8. Correlation :
9. Thickness :
10. Lithology : Quartz, calc-silicate hornfels, pelitic hornfels and slate showing soft sediment deformation structure.
11. Subdivisions :
12. Fossils :
13. Env. of deposition : Deeper water than near shore
14. Remarks :

P28.

1. Name : Kelintau conglomerates (of Bentong group)
2. Origin of name : After Sungai Kelintau, west Pahang
3. Age : Palaeozoic (Upper Carboniferous) or Mesozoic?
4. References : Shu (l989)
5. Type area : Along the Sungai Kelintau in map sheet 96, Pahang
6. Type section :
7. Boundaries : Rests unconformably on both the Pelong beds and Jelebu schists.
8. Correlation :
9. Thickness :
10. Lithology : Boulder, cobble and pebble, polymict conglomerate with subordinate conglomeratic sandstone.
11. Subdivisions :
12. Fossil :
13. Env. of deposition : Terrestrial to fluviatile
14. Remarks : ? Part of 'Upper Arenaceous Series' of Alexander (l968)

P29.

1. Name : Belata formation
2. Origin of name : After Bukit Belata, near Tanjung Malim, south Perak (101° 28'30" E and 3°39' 30"N)
3. Age : Carboniferous to Permian
4. References : Gan (1992)
5. Type area : Belata Forest Reserve, south Perak.
6. Type section :
7. Boundaries :
8. Correlation : Kenny Hill formation (Gobbett, 1965) of Kuala Lumpur.
9. Thickness :
10. Lithology : Argillaceous facies of shale and phyllite in lower portion and a predominant arenaceous facies of metasandstone and metaquartzite in upper portion with thin bedded chert facies in the argillaceous facies.

11. Subdivison : Arenaceous, argillaceous and chert facies.
12. Fossils : ? radiolaria
13. Env. of deposition : Near-shore waters not far from an eroding landmass of low to moderate relief.
14. Remarks : Part of the 'Arenaceous series' of Roe (1953).

P30.

1. Name : Kenny Hill formation
2. Origin of name : After Kenny Hill residential area of Kuala Lumpur (renamed Bukit Tunku)
3. Age : Carboniferous to Permian
4. References : Stauffer (l973), Abdullah Sani H.. Hashim (1985)
5. Type area : Bukit Tunku, Kuala Lumpur.
6. Type section :
7. Boundaries : Overlies Kuala Lumpur limestone unconformably, contact not exposed. Underlies alluvium.
8. Correlation : Singa and Kubang Pasu formations in northwest Malaya.
9. Thickness :
10. Lithology : Monotonous sequence of interbedded phyllitic shale, mudstone and thick bedded fine to medium grained sandstone.
11. Subdivisions :
12. Fossils :

cephalopod
Agathiceras sp.,
Crinoid
Grapherostigma grammodes
Cyclomiscus tenesseensis
radiolaria
bivalve
brachiopod
trace fossil
palynomorph
Leiotriletes sp.,
Punctatisporites sp.,
Dictyotriletes sp.,
Verrucosisporites microtuber-culatus (Loose) Smith & Butterworth,
? *Lycospora* spp.,
Acanthotriletes sp.

13. Env. of deposition : Outer portions of a delta or shelf or upper portion of a submarine slope in restricted basin.
14. Remarks :

P31.

1. Name : Kati beds
2. Origin of name : After Kati Village
3. Age : Carboniferous to ?Permian
4. References : Foo (l990)
5. Type area : South of Kuala Kangsar, Perak.
6. Type section :
7. Boundaries :
8. Correlation :
10. Lithology : Reddish brown to purplish carbonaceous shales, siltstone, mudstone and rare red sandstones with minor conglomerates and lenses of carbonaceous limestone.
11. Subdivision :
12. Fossils :
13. Env. of deposition : Quiet deep environment
14. Remarks : Similar to "Arenaceous series" of Bradford (1960) Foo (1983) refers to it as Kati formation.

P32.

1. Name : Panching limestone (of Kuantan Group)
2. Origin : After Bukit Panching (GR 253706) near Panching Village, east Pahang.
3. Age : Middle Carboniferous (Namurian A)
4. References : Metcalfe, Idris & Tan (1980)
5. Type area : Bukit Charas (most complete section) exposed at Bukit Panching, Bukit Sagu and Bukit Tenggek, east Pahang.
6. Type section :
7. Boundaries : Conformable lower boudary with Charu formation. Conformable upper boundary with Sagor formation
8. Correlation :
9. Thickness : ± 600 m
10. Lithology : Massive, partly recrystallised, fossiliferous limestone of biomicrite, biosparite, biosparudite, oomicite and recrystallised micrite.
11. Subdivision :
12. Fossil :

coral
Amygdalophyllum sp.,
Caninia cf. *gigantea* Michelin,
Hexaphyllia concavia Metcalfe, Idris & Tan,
Hexaphyllia prismatica Struckenberg,

Koninckophyllum sp.,
Lithostrontion (Diphyphyllum sp.),
Palaeosmilia cf. *murchisoni* Milne-Edwards & Haime
crinoid
Poteriocrinus sp.
brachiopod
?*Brachythyris buckmani* Yanishevsky,
Alexandri George,
Athyris sp.,
Avonia cf. *davidsoni* (Jones),
Avonia weberi (Yanishesky),
Brachythyrina cf. *strangwaysi* deVer,
Brachythyris cf. *ovalis* Phillips,
Brachythyris chouteaunsis Weller,
Brachythyris koksuensis Dikareva,
Brachythyris willbourni Muir-Wood,
Buxtonia sp.,
Stenoscisma saquensis Muir-Wood,
Camarotoechia sp.,
cf.? *Chorisites humerosus* (Philips),
Cleiothyridina sp.,
Composita subquadrata Hall,
Composita sulcata Hall,
Crurithyris cf. *planoconvexa* Shumard,
Daviesiella cf. *llangollensis* Davidson,
Dictyoclostus cf. *deruptus* (Romanoswsky),
Dictyoclostus ex.gr. muricatus,
Dielasma cf. *attenuatum* (Martin),
Eomarginifera sp.,
Georgethyris sp.,
Gigantella cf. *latissima* (Sowerby),
Hemiplethorhynchus fallax Tournais,
Krotavia cf. *keyserlingiana* (de Koninck),
Krotavia multituberculata (Yanishevsky),
Linoproductus kokdscharenensis (Grober),
Linoproductus tenuistriatus (deVerneuil),
Linoproductus yunnanensis (Loczy),
Marginicinctus cf. *planus* (Yanishevsky),
Neospirifer derjawini (Yanishevsky),
Phricodothyris sp.,
Proboscidella nana Muir-Wood,
Pugnax asiaticus Muir-Wood,
Pugnax cf. *pugnus* (Martin),
Reticularia cf.
Reticularia imbricata (Sowerby),
Rhipidomella cf. *michelini* Leveille,
Rhynchotetra sp.,
Schelluvienella sp.,
Schizophoria mesoloba (Yanishevsky),
Setigerites sp.,
Sinuatella orientalis Muir-Wood,
Spinifer scrivenori Muir-Wood,
S*pirifer* cf. *condor* d'Orbingy,
mollusc
?*Dentalium* sp.,
Edmondia sp,
Hesperoceras cf. *laudoni,* Miller & Youngquist
Meekospira sp.,
Orthonychia sp.,
Pterinopectinella cf. *granosa* (Sowerby),
Solemnya sp.,
Streblochondria sp.,
Streblopteria sp,
trilobites
Paladin sp.,
Paraphillipsia sp.,
bryozoan
Dyscritella sp.,
Fenestella aff. *polyporata* Phillips,
Fenestella cf. *cellulosa (*Crockford),
Fenestella cf. *compressa* Ulrich,
Fenestella cf. *kawadae* Sakagami,
Fenestella pahangensis Sakagami,
Fistulipora sp.,
Nikiforovella pahangensis Sakagami,
Penniretepora iiwaii Sakagami.
Polypora aff. *elliptica* Elias,
Polypora cf. *subtilis* Nekhoroshev,
Rhabdomeson spp.,
Rhombopora charasensis Sakagami,
Rhombopora tersiensis Nekhoroshev,
Streblascopora superminor Sakagami,
Sulcoretepora malayensis Sakagami,
conodont
Apatognathus cuspidatus Varker,
Apatognathus scalenus Varker,
Apotognathus libratus Varker,
Geniculatus claviger (Roundy),
Gnathodus bilineatus (Roundy),
Gnathodus commutatus (Branson & Mehl),
Gnathodus girtyi rhodesi Higgins,
Gnathodus girtyi simplex Dunn,
Gnathodus nodosus (Bischoff),
Hibbardella geniculata Higgins,
Hibbardella pennata Higgins,
Hindeodella ibergensis Bischoff,
Hindeodella mehli Elias ,
Hindeodella uncata Hass,
Hindeodella undata Branson & Mehl,
Hubbardella acuta Murray & Chronic,
Idiognathoides noduliferus inaequalis Higgins,
Idiognathoides noduliferus japonicus (Igo & Koike),
Idiognathoides noduliferus noduliferus (Ellison & Graves),
Kladognathus sp., *Ligonodina roundyi* Hass,
Lonchodina bischoffi Higgins & Boukaert,
Lonchodina ponderosa Ellison,
Neoprioniodus scitulis (Branson & Mehl),

Neoprioniodus singularis Hass,
Ozarkodina delicatula (Stauffer & Plummer),
Rhachistognathus muricatus (Dunn),
Rhachistognathus primus Dunn,
Spathognathodus campbelli Rexroad,
Spathognathodus scitulus (Hinde),
Streptognathodus lateralis Higgins & Bouskaert,
Subryantodus subaequalis Higgins,
Synprioniodinia microdenta Ellison.
foraminifera
Archaediscus cf. *maximus* Grozdilova & Lebedeva,
Archaediscus ex.gr. *chenoussovensis* Mamet,
Archaediscus exgr. *moelleri* Rauzer-Chernoussova,
Archaediscus krestovnikovi Rauzer-Chernoussova,
Archaediscus ulmeri Mikhaylov,
Asteroarchaediscus ex.gr. *baschkiricus* (Krestovnikov & Teodorovitch),
Biseriella sp.,
Bradyina cf. *rotura* (Eichwald),
Bradyina rotula D' Eichwold,
Brunsia cf. *Pulchara* Mikhaylov,
Calcisphaera laevis (Williamson),
Calcisphaera pachyspaherica (Pronina),
Cribrospira cf. *panderi* Moller,
Deckerella sp.,
Dekerellina sp.,
Endothyranella cf. *armstrongi* Cushman & Waters.
Endothyranopsis cf. p*seudoglobulus* Reytlinger,
Forschia sp.,
Glomospira sp.,
Glomospiroides sp.,
Millerella rossica Rozovskanya,
Monotaxinoides transitorius Brazhinikova & Varteseva,
Permodiscus vetustus Dutkevich,
Pseudoendothyra sp.,
Quasiendothyra cf. *aljutovica* Reytlinger,
Radiosphaerina sp.,
Sacamminopsis sp.,
Seminovella elegantula Rauzer-Chernousova,
Stacheia sp.,
Stacheoides sp.,
Tetratexis cf. *conica* Ehrenberg,
Tetraxis ex.gr. *angusta* Ehrenberg,
Tetraxis minima Lee & Chen,
Tournayella cf. *cepeki* Vasicek & Ruzicka,
Trepeilopsis sp.,
Tuberitina cf. *collosa* Reytlinges
Turrispiroides sp.,
Valvunlinella sp.,
Vicinesphaera sp.,
Yanischewskina cf. *typica* Mikhaylov,

13. Env. of deposition : Shallow marine reef
14. Remarks :

P33.

1. Name : Sagor formation (of Kuantan Group)
2. Origin : After Bukit Pak Sagor, east Pahang
3. Age : Upper Carboniferous
4. References : Metcalfe, Idris & Tan (1980)
5. Type area : Stream section 5 km north of Bukit Pak Sagor between GR. 268804 and GR 295808
6. Type section :
7. Boundaries : Conformable lower boundary with Panching limestone.
8. Correlation : Probable unconformable upper contact with Triassic sediments.
9. Thickness : ± 1500 m
10. Lithology : Conglomerates, sandstone, shale, mudstone, radiolarian mudstone and rare limestone lenses.
11. Subdivisions :
12. Fossils :
    radiolaria
    plant
13. Env. of deposition : Nearshore to slightly deeper marine shelf
14. Remarks :

P34.

1. Name : Aring Formation
2. Origin of name : After Sungai Aring, south Kelantan
3. Age : Upper Carboniferous to Lower Triassic
4. References : Aw (1990)
5. Type area : Sungai Aring, south Kelantan
6. Type section : Sungai Nuar and Sungai Relai (upper section) (QZ916447 to QZ2887443) (QZ 828533 to QZ790456)
7. Boundaries : Lower boundary unexposed. Tectonized upper contact with overlying Telong formation of Upper Triassic age and probable unconformable contact with Koh formation to the south.
8. Correlation : Gua Musang formation in Kelantan and Pahang Volcanic series in northwest and west Pahang and metasediments in southeast Pahang.
9. Thickness : ± 3000 m

10. Lithology : Basal section of dolomite marble overlain by tuff and calcareous argillite followed by fine to coarse pyritiferous tuffs with subordinate amounts of interbedded lavas of rhyolite to andesite composition, agrillite and limestone and topped by an argillo-tuffaceous limestone unit (Paloh member).
11. Subdivisions : Basal section (270 m) of dolomitic marble overlain by tuff and calcareous argillite. Paluh beds (1000 m) at top of argillo - tuffaceous limestone.
12. Fossils :

brachiopod
Choristites sp.,
Derbyia sp.,
Haydonella sp.,
Krotovia sp.,
Marginifera sp.,
Meekella sp.,
Neochonetes sp.,
Neophricadothyris sp.,
Neospirifer sp.,
Phricodothyris sp.,
Productus cf. *gratiosus* Waagen,
Purdonella sp.,
Reticulatia cf. *uralica* (Techernyschew),
Rhipidonella sp.,
Schizophoria sp.,
spiriferids.
foraminifera
Colaniella aff. *parva* (Colani).
Fusulina sp.,
Fusulinella cf. *schwagerinoides* (Deprat),
Globivulina sp.,
Glomospira sp.,
Glomospirella sp.,
Ozawainella sp.,
Pachyphyloia sp.,
Palaeotextularia sp.,
Parafusulina sp.,
Parathurammina sp.,
Pseudostaffella ex.gr. *sphaeroidea* (Ehrenberg),
Schwagerina sp.,
Triticites sp.,
Verbeekina sp.,
bivalve (Triassic)
Claria griesbachi concentrica Yabe

13. Env. of deposition : Neritic with volcanic input
14. Remarks :

P35.

1. Name : Kepis beds
2. Origin of name : After Sungei Kepis, south of Bahau, Negeri Sembilan
3. Age : Lower Permian
4. References : Khoo (l973), Loganathan (l993)
5. Type area : Sungei Kepis, south of Bahau, Negeri Sembilan
6. Type section :
7. Boundaries : Unconformable on Pilah schist. Gradational upper contact with Bahau arenites of probably Triassic age.
8. Correlation :
9. Thickness :
10. Lithology : Reddish brown to purplish carbonaceous shales, siltstone, mudstones and rare red sandstones with minor conglomerates and lenses of carbonaceous limestone
11. Subdivisons : Four facies a) rudaceous facies, (b) arenaceous facies, (c) calcareous facies (Jerai limestone)
12. Fossils :

sponge
Hydrodictya cylix Hall & Clarks,
Lyrodictya sp.,
brachiopod
Orbiculoidea sinensis Mansuy
archaeostraca
Ceratiocaris sp.,
graptolite
Linograptus aff. *posthumus* Richter
Monograptus cf. *praehercynicus* Jaeger,

13. Env. of deposition : Shallow marine
14. Remarks : Referred to as Kepis formation in Foo (1983)

P36.

1. Name : Taku schists
2. Origin of name : After Sungai Taku, central east Kelantan
3. Age : Permian to ?Triassic ? (or older)
4. References : MacDonald (l967), Hutchison (1973) Khoo & Lim (1983)
5. Type area : Sungai Taku and its tributaries, near Manik Urai, central east Kelantan
6. Type section :
7. Boundaries :
8. Correlation : Schists along the eastern foothills of the Main Range

9. Thickness :
10. Lithology : Mica garnet schists and quartz-mica-garnet schists with narrower bands of quartz schists and serpentinite with rare talc-carbonate schsits.
11. Subdivisions : Garnet and biotite metamorphic zones in Khoo & Lim (1983)
12. Fossils :
13. Env. of deposition :
14. Remarks : Referred to as Kelantan schists by Savage (1925). Although Khoo & Lim (1983) put the age as Permo-Triassic, Khoo (pers comm., 1997) thinks that the core of the Taku Schists is probably Pre-Permian while the Permo-Triassic rocks at the edge are equivalent to the Gua Musang formation due to the presence of limestone bodies.

P37.

1. Name : Chuping limestone
2. Origin of name : After Bukit Chuping, a prominent limestone hill in central Perlis
3. Age : Lower Permian to Middle or Upper Triassic
4. References : Jones (1973, 1981)
5. Type area : Bukit Chuping, central Perlis. Outcrops in Perlis, north Kedah and Pulau Dayang Bunting, Langkawi
6. Type section :
7. Boundaries : Conformable transitional lower boundary with Kubang Pasu and Singa formation. Top boundary unexposed.
8. Correlation :
9. Thickness : ± 1000 m in Langkawi and ± 600 m in Perlis
10. Lithology : Massive, generally pale-coloured finely crystalline, pure calcite limestone, fossiliferous and dark grey with chert nodules in its basal part.
11. Subdivisions : Jones (1981) divides it into three broad units - passagebeds, basal part and main part.
12. Fossils :

conodont
"Apatognathus" ziegleri Diebel,
Diplododella latissima (Huckriede),
Diplododella meissneri (Tatge),
Gladigondolella cf. *Abneptis* (Huckriede),
Gladigondolella tethydis (Huckriede),
Gondolella navicula Huckriede,
"Hindeodella triassica Muller,
"Hindeodella" multihamata Huckriede,
"Hindeodella" petrae-viridis Huckriede,
Lonchodina mulleri Tatge,
Neoprioniodus cf. *kochi* (Huckriede),
Ozarkodina saginata Huckriede
gastropod
Bellerophon sp.,
Euomphalus sp.,
bivalve
Cypricardella sp.,
Aviculopecten sp.,
Edmondia sp.,
cf. *Pteronites* sp.,
Schizodus sp.,
Pleurophorus sp.,
scaphopod
Dentalium sp.,
brachiopod
Cancrinella cf. *cancrini* deVern,
Derbyia sp.,
Hamletella cf. *alta* (Hamlet),
Marginifera,
Reticulatia sp.,
Squamularia sp.,
Spiriferids
crinoid
Cyathocrinus sp.,
corals
Chaetetes sp.,
Michelinia sp.,
Lophophyllum pendulum (Grabau),
Myriopora sp.,
Sinopora dendroidea (Yoh),
Stenopora sp.,
bryozoan
Cyclotrypa alexanderi Sakagami,
Fenestella cf. *retiformis* (Schlotheim),
Fistulipora hupensis (Yang),
Polypora aff *timorensis* Bassler,
Polypora gigantae Waagen & Pichel,
foraminifera
Chusunella sp.,
Diliolina cf. *lepida* Schwager,
Nankinella sp.
Schwagerina cf. *granum-avenae* (Roemer),
algae
Anthracoporella sp.,
Epimostopora sp.,
Gymnocardium sp.,
Mizzia sp.,

Ortonella sp.,
Permocalculus sp.,
V*ermiporella* sp., cf. S*uccodium* sp.,
13. Env. of deposition : Shallow marine
14. Remarks : The top of the Kubang Pasu formation is marked by the brown sandstone in Jones (1981) whereas it is placed above the green-grey calcareous flaggy siltstone in Jones (1973)

P38.

1. Name : Redang beds
2. Origin : After Pulau Redang, Trengganu
3. Age : Permian
4. References : Khoo, Yaw, Kimura & Kim (1988)
5. Type area : Southwest Pulau Redang, Trengganu
6. Type section :
7. Boundaries : Uncorformable on Pinang beds
8. Correlation :
9. Thickness :
10. Lithology : Metaconglomerates with subordinate interbeds of black slate, quartzite and pelitic hornfels.
11. Subdivisions :
12. Fossils :

plant
Calamites cf. *jubatus* Lindley & Hutton
Pecopteris cf. *hemitelioides* Brongniart
Cordaites sp.,
Taeniopteris sp.

13. Env. of deposition : Continental fluviatile or near shore deposits
14. Remarks :

P39.

1. Name : Dohol formation
2. Origin of name : After Sungai Dohol, Johore
3. Age : Middle Permian
4. References : Rajah (1986)
5. Type area : Upper reaches of Sungai Sedili and Sungai Dohol, Johore
6. Type section :
7. Boundaries : Base not exposed. Probable unconformable upper contact with Late Permian Linggiu formation.
8. Correlation : > 520 m
10. Lithology : Predominantly grey coloured carbonaceous shale, siltstone, slate, phyllite and schists with minor beds of arenite, limestone and volcanics.
11. Subdivisions : Sumlayang Limestone member
12. Fossils :

foraminifera
Cuniculinella aff. *tumida* (Leven),
Cuniculinella globosa (Deprat),
Cuniculinella zulumartensis (Leven),
Monodiexodina kattaensis (Schwager),
Monodiexodina shiptoni (Dunbar),
Nagatoella sp.,
Nankinella sp.
Parafusulina aff. *vinogradovi* Leven.
Parafusulina dronovi Leven,
Parafusulina dutkevitchi Leven,
Parafusulina granum - avenae (Roemer),
Parafusulina murotbekovi Leven,
Pseudofusulina aff. *dongvanensis* (Colani),
Pseudofusulina quasifusuliniformis Leven,
Schbertella pseudogiraudi Sheng,
Schubertella kingi Dunbar & Skinner,
Schwagerina cf. *otukai* (Fujumoto),
Staffela sp.,

13. Env. of deposition : Shallow marine island arc environment associated with reefal limestone
14. Remarks :

P39.1

1. Name : Sumalayang Limestone member (of Dohol formation)
2. Origin of name : After Gunung Sumalayang, Johore
3. Age : Middle Permian
4. References : Rajah (1986)
5. Type area : Gunung Sumalayang
6. Type section : -
7. Boundaries : Within Dohol formation
8. Correlation : > 150 m?
10. Lithology : Massive, fine-grained, fossiliferous pale grey to black limestone with rare carbonaceous or shaly bands.
11. Subdivisions :
12. Fossils :

foraminifera
Cuniculinella aff. *tumida* (Leven),
Cuniculinella globosa (Deprat),
Cuniculinella zulumartensis (Leven),
Monodiexodina kattaensis (Schwager),
Monodiexodina shiptoni (Dunbar),
Nagatoella sp.,
Nankinella sp.
Parafusulina aff. *vinogradovi* Leven.

Parafusulina dronovi Leven,
Parafusulina dutkevitchi Leven,
Parafusulina granum - avenae (Roemer),
Parafusulina murotbekovi Leven,
Pseudofusulina aff. *dongvanensis* (Colani),
Pseudofusulina quasifusuliniformis Leven,
Schbertella pseudogiraudi Sheng,
Schubertella kingi Dunbar & Skinner,
Schwagerina cf. *otukai* (Fujumoto),
Staffela sp.,

13. Ev. of deposition : Inner neritic shelf
14. Remarks :

P40.

1. Name : Seri Jaya beds
2. Origin of name : After Kampong Seri Jaya (GR 423060) central Pahang
3. Age : Upper Middle to Lower Upper Permian
4. References : Lee (l990)
5. Type area : Hulu Lepar, Pahang
6. Type section : See reference sections for subdivisions
7. Boundaries : Unconformable lower boundary Lower Carboniferous Keliu slates
8. Correlation : Charu formation, Pahang
9. Thickness : ± 2,700 m
10. Lithology : See subdivisions
11. Subdivisions : Jempul slates in lower part and Mengapur limestones above
13. Env. of deposition : Marine with contemporaneous volcanicity
14. Remarks :
12. Fossils :

foraminifera
Schwragerina sp.
Psendofusulina sp.
Sumatrina sp.
Pseudolina sp.
Yabeina sp.
? Costispirifera sp.
Plant
fragments
brachiopod
crinoid
stems
bryozoa

13. Env. of deposition :
14. Remarks :

P40.1.

1. Name : Jempul slates (of Seri Jaya beds)
2. Origin of name : After Sungei Jempul, central Pahang
3. Age : Permian
4. References : Lee (1990)
5. Type area : Headwaters of Sungei Jempul and southern part of Hulu Lepar, Pahang.
6. Type section : Representative sections at GR427059 east of Kampong Seri Jaya along the Kuantan - Kuala Lumpur trunk road and 3 km stretch of headwaters of Sungei Jempul from GR288140 upstream to GR 323153
7. Boundaries : Conformable upper contact with Mengapur limestones. Unconformable lower contact with Kelintau slates.
8. Correlation :
9. Thickness : ± 1500 m
10. Lithology : Primarily of pelitic hornfels, graphitic slate and quartz-sericite phyllite with interbeds of subordinate quartzite, schist, non-carbonaceous slate and argillite and minor interbeds of metatuff, metasiltstone, calc- silicates, metaconglomerate, and slightly metamorphosed sandstone.

Subdivision : Luit tuffs

12. Fossils :

bivalve
Pernopecten sp.
? Dunbarella sp.
brachiopod
Dictyoclostus sp.
Chonetes sp.
foraminifera
Schwagerina sp.
Nankinella sp.
plant
Taeniopteris sp.
Lobatannularia sp.
Sphenophyllum sp.
crinoid

13. Env. of deposition : Reducing sea-bed, possibly a submarine slope
14. Remarks :

P40.1.1.

1. Name : Luit tuffs (of Jempul slates)
2. Origin of name : After Sungei Luit, central Pahang
3. Age : Permian
4. References : Lee (l990)
5. Type area : Sungei Luit - Mengapur area, central Pahang. Reference outcrops at GR357167, GR345054 and GR327055
6. Type section :
7. Boundaries : Interbedded within Seri Jaya beds

Corrrelation :

10. Lithology : Metavolcanics mainly crystal - vitric rhyolitic metatuff with subordinate lithic - crystal and crystal dacitic and andesitic metatuff.
11. Subdivisions :
12. Fossils :
13. Env. of deposition : Shallow marine
14. Remarks :

P40.2.

1. Name : Mengapur limestones (of Seri Jaya beds)
2. Origin of name : After Bukit Mengapur, central Pahang
3. Age : Middle to Upper Permian (S*chwagerina* and *Neoschwagerina* zones)
4. References : Lee (1990)
5. Type area : Bukit Mengapur (GR380137) and Bukit Batu (GR380143), central Pahang.
6. Type section :
7. Boudaries : Conformable lower boundary with Jempul slates.
8. Correlation :
9. Thickness : ± 1200 m
10. Lithology : Principally of grey, massively bedded and strongly jointed marble with lesser calcareous graphitic slate, graphitic and non-graphitic phyllite and schist and quartzite.
11. Subdivisions :
12. Fossils :

foraminifera
Parachwagerina sp.
Neoschwagerina sp.
Verbeekina sp.
gastropod
echinoderm
spines, ossicles and plates.

13. Env. of deposition : Shallow marine reef with mud input
14. Remarks :

P41.

1. Name : Sedili volcanic
2. Origin of name : Sungai Ulu Sedili, Johor
3. Age : Upper Middle Permian to Middle Triassic
4. References : Rajah (1986)
5. Type area : Gunung Chemendong - Bukit Simbang, Sungai Ulu Sedili and Sungai Payong area, Johor.
6. Type section :
7. Boundaries : Interfingers with Linggiu formation
8. Correlation : Linggiu formation
9. Thickness : < 760 m
10. Lithology : Ignimbrite, tuff, agglomerate, lava and volcanic ash varying in composition from rhyolite to rhyodacite and andesite.
11. Subdivisions :
12. Fossils :
13. Env. of deposition : Shallow neritic
14. Remarks : Peak volcanic activity was in the upper Upper Permian.

P42.

1. Name : Linggiu formation
2. Origin : After Sungai Linggiu, Johore
3. Age : Upper Permian
4. References : Rajah (1986)
5. Type area : Sungai Linggiu, Bukit Pachat, Sungai Tempenis, Sungai Payong and Sungai Madek
6. Type section :
7. Boundaries : Probable unconformable lower contact with Dohol formation. Conformable upper contact and interfingering with Sedili Volcanic formation
8. Correlation : Sedili Volcanic formation
9. Thickness : ± 600 m
10. Lithology : Rhythmically bedded grey coloured carbonaceous shale and sandstone with locally prominent conglomeratic beds.
11. Subdivisions :

12. Fossils :
plant
(Gigantopteris longifolia Kodaira*),*
(Gigantopteris nicotianaefolia Halle),
Alphlebia sp.,
Annularia shirakii Kawasaki,
Bicoemplectopteridium hallei Asama
Bicoemplectopteridium longifolium (Kodaira) Asama
Calamites cf. *suckowii* Brongn,
Carpolithus sp.,
Cladophlebis ozakii,Yabe & Oishi,
Cordaicarpus cordai elongata Jongmans & Gothan,
Gigantonoclea (Gigantopteris) largrelli, (Halle*)* Koidzumi,
Gigantopteris nicotiamaefolia Schnek,
Gigantospermum posthumi Jongmans & Gothan,
Lepidodendron cf. *Chosenense* Kawasaki,
Lobatannularia fujiyamae Kon'no & Asama,
Lobatannularia johorensis Kon'no & Asama,
Lobatannularia johorensis-minor Kon'no & Asama,
Lobatannularia suntharalingamii Kon'no & Asama,
Neuropteridium yokoyamae Kon'no & Asama,
Neuropteris sp.,
Pecopteris yinii Kon'no & Asama,
Paratrizygia (Sphenophyllum*) koboensis* (Kobatake*)* Asama,
Paratrizygia (Zamiopteris) *glossopteroides minor* (Kawasaki*)* Asama
Pecopteris arcuata Halle,
Psaronius johorensia Ogura.
Ptychocarpus malaianus Kon'no,
Rajahia (Pecopteris) bifurcata Kon'no,
Rajahia linggiuensis Kon'no,
Rajahia pseudohemitelioides Kon'no,
Rajahia rajahii Kon'no,
Rajahia sengensis Kon'no.
Rhiphidopsis baieroides Kawasaki & Kon'no,
Sphenozomites sp.,
Taeniopteris cf. *Crassicaulis* Jongmans & Gothan,,
Taeniopteris hallei Kawasaki,
Taeniopteris multinervis Weiss,
Taeniopteris nystroemii Halle,
Tingia subcarbonica Kon'no & Asama,
Tricoemplectopteris taiyuanensis Asama,
Trizygia (Sphenophyllum) sinocoreana (Yabe) Asama,
Trizygia speciosa Royle *(Sphenophyllum speciosum),*
Validopteris sinensis Stockmans & Mathieu,,
13. Env. of deposition : Near shore marine to fluvial and paralic swamp environment.
14. Remarks :

3.2. SARAWAK

P43.

1. Name : Tuang formation
2. Origin : After Muara Sungai Tuang, West Sarawak
3. Age : ? Pre – Upper Carboniferous
4. References : Tan, Kho & Hon (1979)
5. Type area : Muara Sungai Tuang, West Sarawak
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness :
10. Lithology : Quartz-mica schist and phyllite
11. Subdivisions :
12. Fossils : tentaculitid
13. Env. of deposition : Marine turbidites?
14. Remarks : Previously referred to as Kerait Schist by Wilson (1965) and shown as "Kerait Schist - Tuang Formation" in Tan, Kho & Hon (l979). For oldest rocks in Sarawak, Fig. 11 of Haile (l954) has a Sebangan hornstone formation of ? Carboniferous to Permian age as the oldest formation in Sarawak.

P44.

1. Name : Terbat Formation (Sarawak)
2. Origin : After Terbat town, west Sarawak
3. Age : Upper Carboniferous, (mostly Muscovian) to Lower Permian, Lower (mostly Wolfcampian)
4. References : Haile (1954), Liechti, Roe & Haile (1960), Tan, Khoo & Hon (l979).
5. Type area : Terbat (0^{o}56'N, 110^{o}32'E), Sadon Valley, west Sarawak
6. Type section :
7. Boundaries : Lower boundary unexposed. Unconformable upper contact with Sadong formation.
9. Thickness : >610 m
8. Correlation :
10. Lithology : Light to dark grey limestone which are mainly calcilutite, calcimicrite and calcirudite, light to dark grey chert beds and nodules, and black shales.
11. Subdivisions : Gunung Selabor limestone

12. Fossils :
foraminifera and algae
Bradyina sp.,
Calcisphaera sp.,
Climacammina sp.,
Cornuspira sp.,
Cribrogenerina sp.,
Cribrostomum sp.,
Endothyra sp.,
Globovalvulina sp.,
Paraschqagerina sp.,
Plectogyra sp.,
*Pseudoschwagerin*a sp.,
Tetrataxis sp.,
Tubertina sp.,
Zellia sp.
13. Env. of deposition : Neritic
14. Remarks :

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Part 2
MESOZOIC

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INTRODUCTION

Mesozoic rock formations are found widespread in the Northwest and Central Belt of Peninsular Malaysia as well as in West Sarawak. Very few Mesozoic rock formations are known in the Eastern Belt of Peninsular Malaysia and in Sabah. Thirty eight Mesozoic rock formations are known in Malaysia (Table 2), including 28 formations from onshore Peninsular Malaysia (Figure 6), 8 formations from West Sarawak (Figure 7) and 1 formation each from Sabah (the Madai-Baturong limestone) and the offshore Malay Basin (the Sotong limestone). Some of the Mesozoic rock formations, i.e. the Chuping limestone (refer Paleozoic section), Kodiang limestone and Semanggol formation in northwest Peninsular Malaysia, and the Gua Musang, Telong and Aring (refer to Paleozoic section) formations in the Central Belt are parts of inseparable Late Paleozoic (Permian) - Early Mesozoic (Triassic) lithostratigraphic units. In Sarawak, the Late Mesozoic Lubuk Antu complex, Kayan sandstone, Belaga formation and in Sabah, the Sabah complex are hardly distinguishable from the Early Tertiary rocks (refer all formations in Tertiary section).

Malaysian Mesozoic rock formations were traditionally grouped together in different geographical and paleoenvironmental settings (Figure 5), thus correlation between different settings are hard to establish. Correlations between different regions were usually based on fossil occurrences, while lithological correlations which were sometimes used have often proven to be in error. These formations are usually very well correlated within the same geographical and paleoenvironmental settings. In some areas several formations were naturally occurring together as a Group, such as the Tembeling, Raub and Gagau Groups in the Central Belt of Peninsular Malaysia.

Mesozoic sedimentary rocks of Peninsular Malaysia are made up of Triassic flysch-type marine sediments and Jurassic-Cretaceous continental sediments (Khoo, 1983, see Figure 7), occurring in three separate belts, namely the Western, Central and Eastern Belts (Khoo & Tan, 1983).

The Mesozoic of the Western Belt is only restricted to its northern part which is considered as the northwestern zone of Peninsular Malaysia by Foo (1983). In Kedah and northwest Perak, the Permo-Triassic marine flysch-type detrital sediment (the Semanggol Formation) are widespread, while the Permo-Triassic of northwest Kedah and Perlis is represented by the north-south trending Chuping and Kodiang Limestones. The uppermost Triassic and Lower Jurassic sediments are missing from this belt. In the late Mesozoic, only two rock units are known from two small isolated basins, the Saiong Bed in northeast Kedah and the Nenering Bed from north Perak.

In the Central Belt of Peninsular Malaysia, where the Mesozoic rocks are dominant, they form a continuous north-south trending belt, extended beyond the international boundaries with Thailand (the Gua Musang Formation) in the north and Singapore (the Jurong Formation) in the south. The Mesozoic of the Central Belt was divided into three groups by Khoo (1983), *viz*. the marine flysch Triassic sediments, the gently folded late Triassic-Jurassic Tekai Group (referred to Tembeling Group in this paper) and the very gentle or flat-bedded Jurassic-Cretaceous continental sediments. Khoo (1983) apparently also included all the Mesozoic rock formations from the Eastern Belt into his so-called the axial belt of Peninsular Malaysia. The marine environment in this belt only prevailed up to Middle Triassic or early Late Triassic in most places (from Kelantan to Johor) but marine conditions persisted up to Early Jurassic in Singapore (the upper part of the Jurong Formation).

In general, the marine Triassic sediments in the Central Belt are more tuffaceous compared with the rocks of the same age in the Western Belt. The Permo-Triassic of the Gua Musang, Aring and Gunung Rabong Formations in Kelantan and northern Pahang is dominated by shallow marine clastics and carbonates with volcanic interbeds. Towards the south, deeper marine turbiditic sediments are more dominant in the Telong, Semantan (Kerdau Formation of Burton, 1973a), and Gemas Formation (including Tenang Bed). These turbidites are also commonly tuffaceous in nature and in places volcanic interbeds occurred. The shallow marine Kaling Formation (Lipis Group of Procter, 1973 or Jelai Formation of Burton, 1973a) forms an elongated belt from northern Pahang to Negeri Sembilan on the western side of these flysch type sediments. On the eastern side of the Central Belt, the Late Triassic - Jurassic Koh Formation and Tembeling

Paloh Formation also unconformably overlying the Triassic sediments in the east, while the Ma'Okil Formation overlie them in the west. Progressive shallowing of the Triassic basin is shown in the Jurong Formation in the south, whereas in the north shallow marine succession of the Kaling (part of) and Kerum Formation often succeeding the generally deeper marine succession of the Semantan Formation.

Except for the newly discovered Triassic limestone in offshore Terengganu, no other marine sediments is known in the onshore Eastern Belt. In the onshore Eastern Belt, flat-bedded Jurassic-Cretaceous sediments occurr in several isolated basins from Kelantan-Terengganu-Pahang states boundary (The Gagau Group) in the north to the Panti Sandstone in southeast Johor. Other formations include the Gerek Formation and Lesong Sandstone in Pahang and the Ulu Endau Bed, Murau Conglomerate and Tebak Formation in Johor.

All Mesozoic sedimentary rocks from East Malaysia were of marine origin, mostly shallow marine shelf deposits except for the chert dominant Sejingkat formation and part of Serabang formation and the Sebangan Hornstone which might have been deposited in a deeper marine condition. The Late Triassic volcanic activities in West Sarawak is shown by the presence of Serian volcanics (interfingering) at the top part of the shallow marine Sadong Formation. Progressive shallowing of the West Sarawak Basin is shown during Jurassic to Cretaceous time. Shallow marine condition with strong continental influence are seen in the Jurassic-Cretaceous Pedawan and Kedadom Formations while shelf carbonate is best displayed by the widespread Upper Jurassic - Lower Cretaceous Bau Limestone in West Sarawak. In Sabah, the basement complexes of Sabah might be of Mesozoic age, but the only certain Mesozoic is represented by the carbonate deposits of the Madai-Baturong Limestone. Towards the end of Mesozoic, the Cretaceous radiolarian chert found within both the Lubuk Antu and Sabah complexes, indicate the presence of deep marine subduction related trenches in both states of East Malaysia.

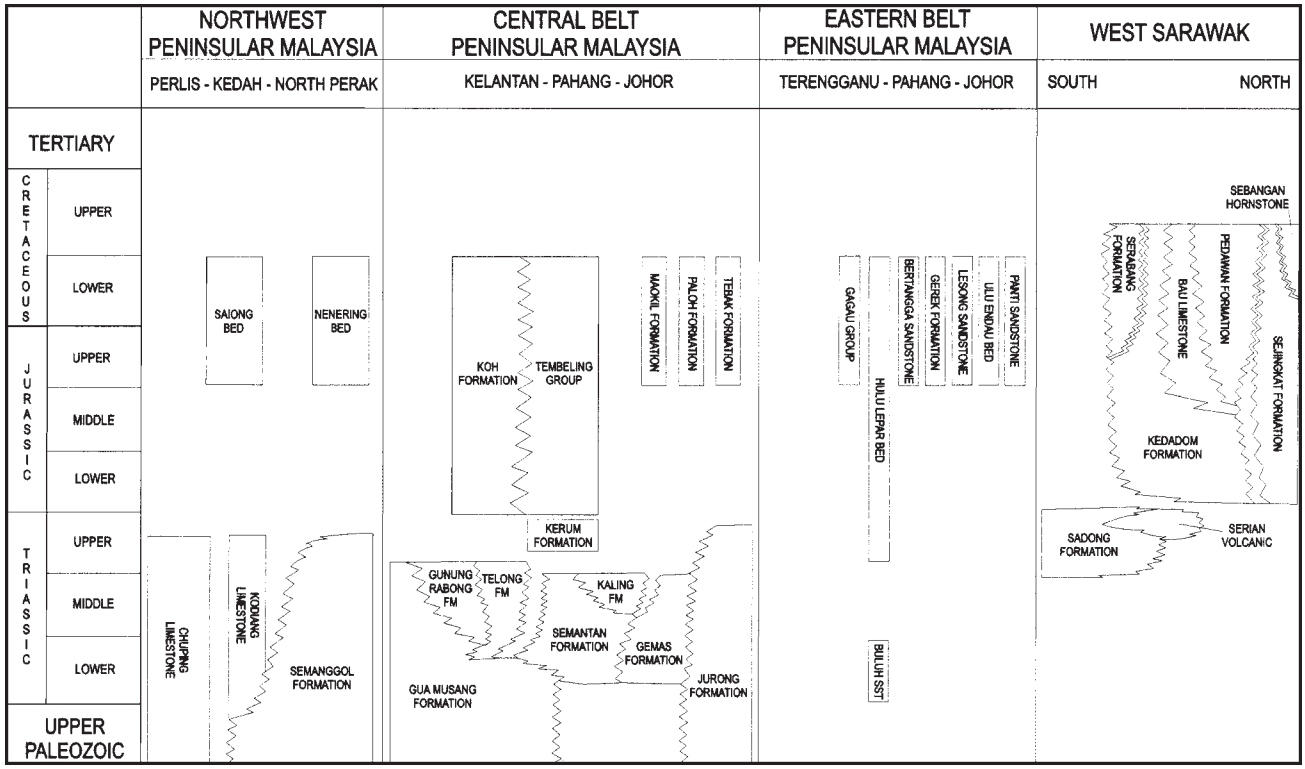

Figure 5. Correlation chart for Mesozoic rock formations in Malaysia.

Table 2. List of Mesozoic rock formations in Malaysia.

No.	Formation	Age
	1. PENINSULAR MALAYSIA	
M1	Semanggol formation	Lower Permian to Upper Triassic
M1.1	Chert member	Lower Permian to Lower Triassic
M1.2	Rhythmite member	Middle Triassic to Upper Triassic
M1.3	Conglomerate member	Middle Triassic to Upper Triassic
M2	Gua Musang formation	Middle Permian to Upper Triassic
M3	Kodiang Limestone	Upper Permian to Upper Triassic
M4	Jurong formation	?Permian to Lower Jurassic
M4.1	Gunung Pulai volcanic member	?Permian to ?Lower Triassic
M4.2	Bukit Resam member	?Middle Triassic to Upper Triassic
M4.3	Pasir Panjang member	Upper Triassic to Lower Jurassic
M5	Telong formation	?Permian to Upper Triassic
M6	Buluh sandstone	?Lower Triassic
M7	Gunung Rabong formation	Middle Triassic to Upper Triassic
M8	Semantan Formation	Middle Triassic to Upper Triassic
M9	Gemas formation	Middle Triassic to Upper Triassic
M10	Kaling Formation	Middle Triassic to Upper Triassic
M11	Hulu Lepar beds	?Middle Triassic to ?Lower Cretaceous
M11.1	Tekam tuff	
M11.2	Serentang tuff	
M11.3	Berkelah conglomerate	
M11.4	Berapit sandstone	
M12	Koh Formation	?Upper Triassic to ?Jurassic
M13	Kerum formation ?(of Tembeling group)	?Upper Triassic
M14	Lanis Conglomerate (of Tembeling group)	?Jurassic
M15	Mangking Sandstone (of Tembeling group)	?Jurassic
M16	Termus Shale (of Tembeling Group)	?Upper Jurassic to Cretaceous
M17	Murau Conglomerate	?Jurassic
M18	Badong Conglomerate (of Gagau group)	?Jurassic
M19	Lotong Sandstone (of Gagau group)	Upper Jurassic to Lower Cretaceous
M20	Tebak Formation	Upper Jurassic to Lower Cretaceous
M21	Ulu Endau Bed	Upper Jurassic to Lower Cretaceous
M22	Bertangga Sandstone	?Jurassic to ?Cretaceous
M23	Paloh Formation	?Jurassic to ?Cretaceous
M24	Gerek Sandstone	?Jurassic to ?Cretaceous
M25	Ma'Okil Formation	?Jurassic to ?Cretaceous
M26	Saiong Bed	?Jurassic to ?Cretaceous
M27	Lesong sandstone	?Jurassic to ?Cretaceous
M28	Nenering Bed	?Cretaceous
	2. SARAWAK	
M29	Sadong Formation	Upper Triassic
M30	Serian Volcanic Formation	Upper Triassic
M31	Kedadom Formation	Lower Jurassic to Cretaceous
M32	Sejingkat Formation	Jurassic to Cretaceous
M33	Pedawan Formation	Jurassic to Cretaceous
M34	Serabang Formation	Upper Jurassic to Lower Cretaceous
M35	Bau Limestone	Upper Jurassic to Lower Cretaceous
M36	Sebangan Hornstone	Cretaceous
	2. SABAH	
M37	Madai-Baturong Formation	Upper Cretaceous

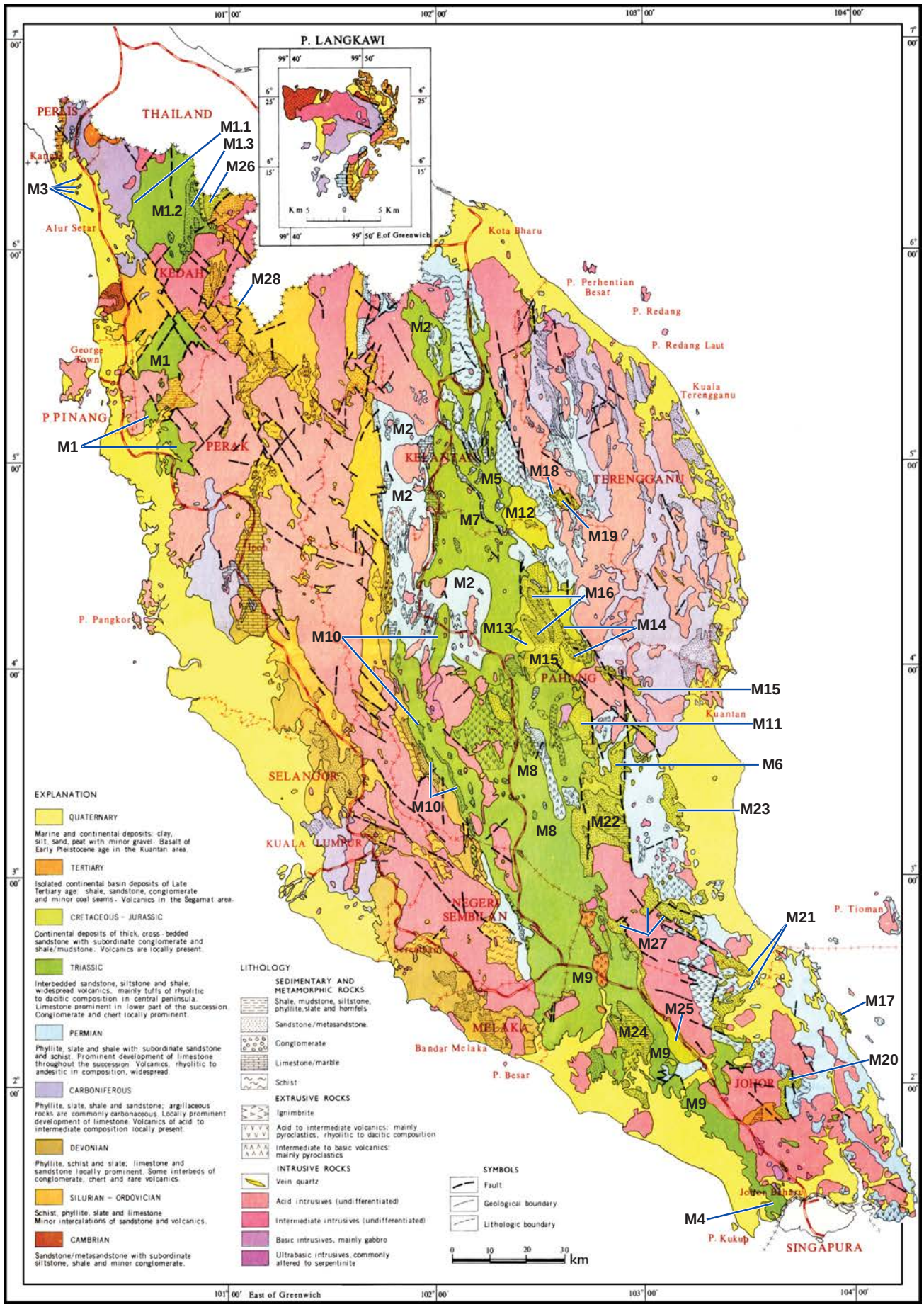

Figure 6. Location of Mesozoic rock formations of Peninsular Malaysia. Map reproduced with the permission of the Director-General of Minerals and Geoscience Department Malaysia.

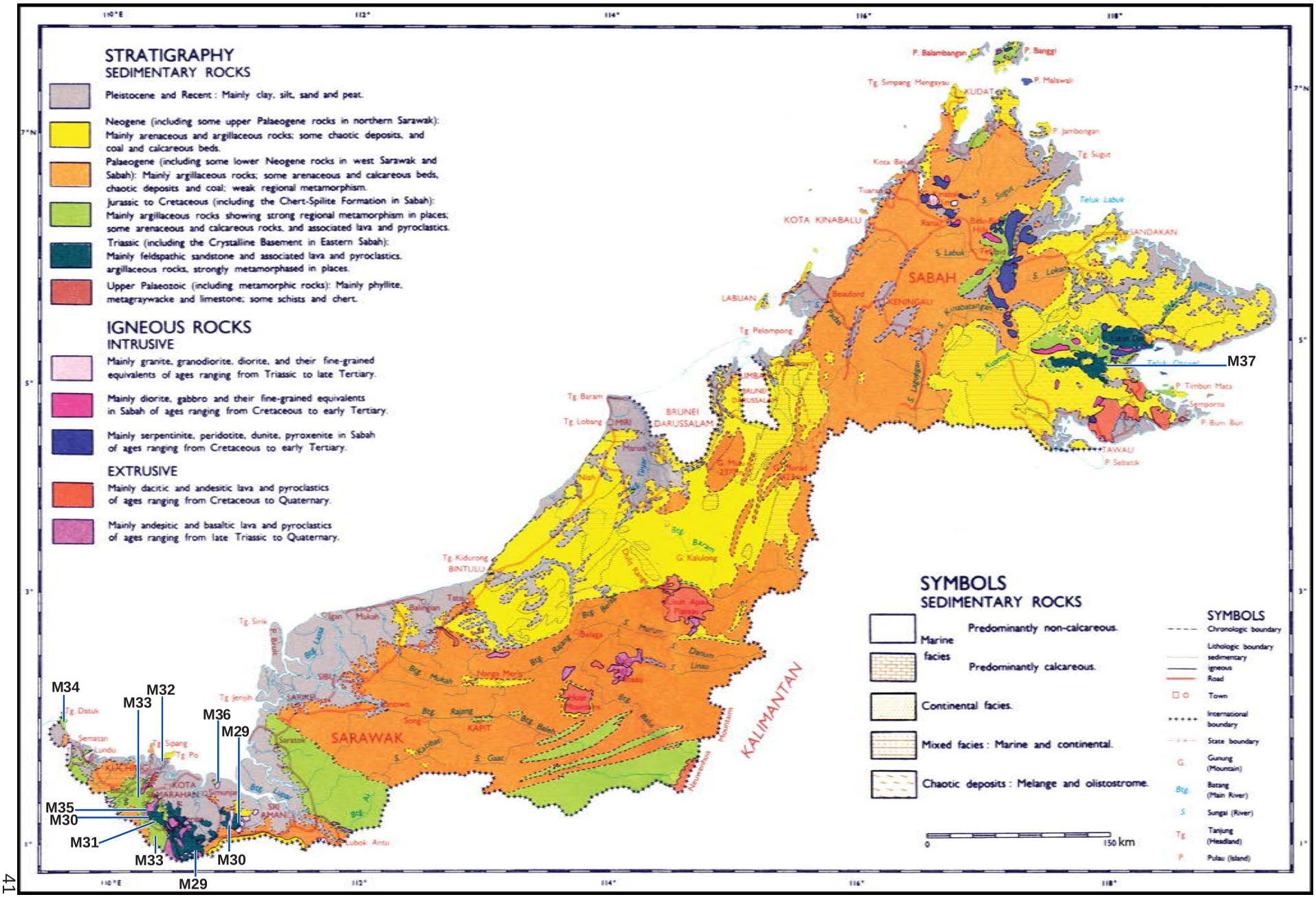

Figure 7. Location of Mesozoic rock formations of East Malaysia. Map reproduced with the permission of the Director-General of Minerals and Geoscience Department Malaysia.

2.1. PENINSULAR MALAYSIA

M1.

1. Name : Semanggol formation
2. Origin of name : After Gunung Semanggol, north Perak
3. Age : Lower Permian to Upper Triassic
4. References : Alexander *et al*. (1959), Burton (1973a), Khoo (1983), Shashida *et al.* (1995), Basir Jasin (1996)
5. Type area : Gunung Semanggol, Perak; also extensively found in Kedah
6. Type section : Bukit Merah, Semanggol, Perak
7. Boundaries : Unconformably overlying Lower Paleozoic rocks in the west; intruded by Upper Triassic granites in the east; unconformably overlain by the Saiong Bed
8. Correlation : The lower part is equivalent to Gua Musang Formation, the upper part is equivalent to Semantan Formation.
9. Thickness :
10. Lithology : (See Chert member , Rhythmite member and Conglomerate member)
11. Subdivision s : Divided into three members i.e. Chert member , Rhythmite member and Conglomerate member
12. Fossils : See members
13. Env. of deposition : Deep marine turbidite
14. Remarks : The formation was introduced by Alexander *et al*. (1959) as a Triassic formation. The subdivision of the formation was introduced by Burton (1973a). The finding of Permian radiolarian in this formation were reported by Shashida *et al.* (1995) and Basir Jasin (1996)

M1.1.

1. Name : Chert member (of Semanggol formation)
2. Origin of name : After dominant lithology.
3. Age : Lower Permian to Middle Triassic
4. References : Alexander (1959), Burton (1973a), Shashida *et al.* (1995), Basir Jasin (1996), Metcalfe (1990)
5. Type area : Central - North Kedah
6. Type section :
7. Boundaries : Unconformably overlying Lower Paleozoic rocks; conformably overlain by the rhythmite member
8. Correlation :
9. Thickness : 600 m
10. Lithology : Thinly bedded light to dark grey chert interbedded with mudstone, sandstone and limestone
11. Subdivision :
12. Fossils :

conodont (Triassic)
Ellisonia sp.
Metapolygnathus polygnathiformis (Budurov & Stefanov)
Neospathodus sp.
?*Xaniognathus* sp.
radiolaria (Permian)
Albaillella excelsa Ishiga, Kito & Imoto
Albaillella levis Ishiga, Kito & Imoto
Albaillella triangularis Ishiga, Kito & Imoto
Entactinosphaera pseudocimelia Shashida & Tonishi
Entactinosphaera sp.
Follicucullus monacanthus Ishiga & Imoto
Follicucullus porrectus Rudenko
Follicucullus scholasticus Ormiston & Babcock
Follicucullus ventricosus Ormiston & Babcock
?Ishigaum sp.
Naxarovella inflata Shashida & Tonishi
Nazarovella gracilis De Wever & Caridroit
Neoalbaillella cf. *pseudoprypus* Shashida & Tonishi
Neoalbaillella ornithoformis Takemura & Nakaseko
Octatormentum sp.
Praedeflandrella sp.
Pseudoalbaillella cf. *asymmetrica* Ishiga & Imoto
Pseudoalbaillella elongata Ishiga & Imoto
Pseudoalbaillella scalprata Ishiga
Pseudotormentus sp.
Ruzhencevispongus sp.
Triplanospongos musashiensis Shashida & Tonishi
radiolaria (Triassic)
Acanthosphaera awaensis (Nakaseko & Nishimura)
Cryptostephanidium sp.
Eptigium mandfredi Dumitrica
Hozmadia rotunda (Nakaseko & Nishimura)
Parasepsagon cf. *asymmetricus* (Kozur & Mostler)
Parasepsagon variabilis (Nakaseko & Nishimura)
Pseudostylosphaera coccostyla (Rust)
Pseudostylosphaera compacta (Nakaseko & Nishimura)
Pseudostylosphaera japonica (Nakaseko & Nishimura)
Pseudostylosphaera magnispinosa (Nakaseko & Nishimura)

Triassocampe deweveri (Nakaseko & Nishimura)
Triassocampe sp.
Yeharia japonica (Nakaseko & Nishimura)
13. Env. of deposition : Deep marine
14. Remarks :

M1.2.

1. Name : Rhythmite member (of Semanggol formation)
2. Origin of name : After dominant lithology.
3. Age : Middle to Upper Triassic
4. References : Burton (1973a), Kobayashi (1963b)
5. Type area : Gunung Semanggol area in North Perak; South Kedah and North - Central Kedah
6. Type section :
7. Boundaries : Conformably overlying the chert member, conformably overlain by conglomerate member.
8. Correlation : Equivalent to Semantan Formation
9. Thickness : 1000 m
10. Lithology : Interbedded sandstone and shale (or mudstone): sandstone - lithic greywacke, litharenite in composition, grading to pebbly sandstone and conglomerate and with cross bedding: shale (light grey to dark grey) with parallel and convolute lamination and slump structure
11. Subdivision :
12. Fossils :

bivalve
Chlamys courtieri Kobayashi
Daonella burtoni Kobayashi & Tokuyama
Daonella cf. *kotoi* Mojsisovics
Daonella cf. *pectinoides* Kobayashi & Tokuyama
Daonella indica Bittner
Daonella multilineata (Jones)
Daonella posidoniformis Kobayashi & Tokuyama
Daonella procteri Kobayashi & Tokuyama
Daonella sp.
Daonella sumatrensis Volz
Gervillia sp.
Halobia ?malayensis Newton
Halobia aotii Kobayashi & Ichikawa
Halobia cf. *austriaca* Mojsisovics
Halobia cf. *mollukana* Wanner
Halobia cf. *styriaca* Mojsisovics
Halobia charlyana Mojsisovics
Halobia comata Bittner
Halobia paralella Kobayashi
Halobia subquadrata Kobayashi
Halobia talauna Wanner
Posidonia cf. *cycloidalis* Kittl
Posidonia cf. *idriana* (Mojsisovics)
Posidonia cf. *japonica* Kobayashi & Hukusawa
Posidonia kedahensis Kobayashi
Posidonia sp.
Posidonia tawarensis Kobayashi & Tokuyama
cephalopod
?Hannoceras nasturtium (Mojsisovics)
Juvavites sp.
foraminifera
Arenovidalina indosinica
Aulotortus sp.
Dentalina sp.
Endothyra sp.
Glomospira sp.
Trochammina sp.
13. Env. of deposition : Distal submarine fan
14. Remarks :

M1.3.

1. Name : Conglomerate member (of Semanggol formation)
2. Origin of name : After dominant lithology.
3. Age : Middle to Upper Triassic
4. References : Burton (1973a)
5. Type area : North - Central Kedah, Gunung Semanggol area in Perak
6. Type section :
7. Boundaries : Conformably overlying the rhythmite member, unconformably overlain by the Saiong bed.
8. Correlation :
9. Thickness :
10. Lithology : Light grey conglomerate (poorly sorted grain supported conglomerate) interbedded with sandstone and shale with gradded bedding and load structure
11. Subdivision :
12. Fossils :
13. Env. of deposition : Prograding submarine fan
14. Remarks :

M2.

1. Name : Gua Musang formation
2. Origin of name : After Gua Musang town in south Kelantan
3. Age : Middle Permian to Upper Triassic
4. References : Yin (1965), Burton (1973a), Khoo

(1983), Fontaine *et al*. (1986), Fontaine *et al.* (1994), Metcalfe (1992), Igo *et al*. (1965), Mohd Shafeea Leman (1993) , Kobayashi & Tamura (1968a)

5. Type area : Gua Musang area, south Kelantan (extended to north Kelantan and north Pahang)
6. Type section :
7. Boundaries : Lower boundary is not known; Upper boundary is overlain by the Koh Formation (nature of boundary is not known)
8. Correlation : The upper part of Gua Musang Formation is interfingering with the Semantan Formation, ?Telong Formation and Gunung Rabong Formation
9. Thickness :
10. Lithology : Argillaceous and calcareous rocks interbedded with volcanic and arenaceous rocks
11. Subdivision :
12. Fossils :

algae

Hikorocodium sp.
Solenopora sp.
Tubiphytes sp.

bivalve

?Antiquilima sp.
Cassianella malayensis Tamura
Cassianella sp.
Chlamys chegarperahensis Tamura
Claraia greisbachi concentrica Yabe
Claraia intermedia multistriata Ichikawa
?Corbula sp.
Costatoria chegarperahensis Kobayashi & Tamura
Costatoria malayensis (Newton)
Costatoria quinquicostata Kobayashi & Tamura
Costatoria sp.
Daonella lindstroemi Mojsisovics
Daonella lomelli (Wiesmann)
Daonella sakawana Mojsisovics
Entolium cf. *discites* Schlotheim
Entolium liscaviense shanglanense Guo
Entolium sp.
Entolium subdemissum Munster
Eopecten sp.
Eumorphotis cf. *multiformis (Bittner)*
Grammotodon cf. *impressa* (Munster)
Hoernessia cf. *chobaiensis* Patte
?Homomya sp.
Lima cf. *lineata* Schlotheim
Lopha montiscaprilis Klipstein
?Myoconcha sp.
Mysidioptera sp.
Mytilus sp.
Neoschizodus cf. *laevigatus elargatus* Philippi
Neoschizodus cf. *ovatus elongatus* Gievel
Neoschizodus laevigatus elongatus Philippi
Neoschizodus sp.
Nuculana cf. *sulcellata* (Wissmann)
Pachymya ?malayensis Tamura
?Paleolima sp.
Palaeonucula subequiUpperra tswaensis (Reed)
Pinna sp.
Plagiostoma sp.
Plicatula (psedoplacunopsis) cf. *carinata* Healey
?Pleuromya sp.
Posidonia sp.
Promyalina sp.
Pteria jaaferi Tamura
Pteria pahangensis Newton
Pteria sp.
Schafhaeutella aff. *astartiformis* (Wissmann)
Terquimia ?malayensis Tamura
Trigonodus cf. *problematicus* (Klipstein)
Unionites sp.

brachiopod

Antiquatonia sp.
Choanosteges sp.
Costispinifera sp.
Crenispirifer sp.
Crurithyris sp.
Derbyia sp.
Derbyoides sp.
Dictyoclostus sp.
Dielasma sp.
Echinauris sp.
Echinoconchus sp.
Enteletes sp.
Haydenella minuta Sarytcheva
Hustedia sp.
Isogramma sp.
Leptodus cf. *catenata* (Waagen)
Leptodus cf. *tenuis* (Waagen)
Leptodus nobilis (Waagen)
Leptodus sp.
Linoproductus lineatus (Waagen)
Linoproductus sp.
Marginifera sp.
Meekella sp.
Micraphelia sp.
Neochonetes sp.
Neophricadothyris sp.
Neospirifer sp.
Oldhamina dicipens (deKoninck)
Oldhamina sp.

Oldhamina squamossa Huang
Orthotichia sp.
Parallytonia sp.
Paraspiriferina sp.
Parenteletes sp.
Plicatifera sp.
Pseudoleptodus sp.
Reticularina sp.
Reticulatia sp.
Retimarginifera sp.
Rhipidomella sp.
Rhynchopora sp.
Schizophoria sp.
Spinifrons sp.
Spiriferella sp
Spiriferellina sp.
Stenoscisma sp.
Transennatia gratiosus (Waagen)
Uncinunellina timorensis (Beyrich)
Waagenites sp.
Waagenoconcha sp.
cephalopod
Arctoceras cf. *blomstrandi* (Lindstrom)
Balatonites sp.
Ceratites sp.
Frechites sp.
?Frecherites sp.
Meekoceras gracilitatis
Owenites carpenteri Smith
Owenites koeneni Hyatt & Smith
?Paraceltites sp.
Paraceratites cf. *trinodosus (*Mojsisovics)
Paraceratites sp.
Paranannites aspenensis Hyatt & Smith
Prosphingingites austini Hyatt & Smith
*Pseudosageceras multilobatum*Noetling
conodont
Cypridodella magnidentata (Tatge)
Cypridodella muelleri (Tatge)
Cypridodella sp
Ellisonia bogschi (Kozur & Mostler)
Ellisonia nevadensis (Muller)
Ellisonia sp.
Ellisonia triassica (Muller)
Ellisonia triconigera Igo & Koike
Ellisonia yini Igo & Koike
?Ellisonia malayensis Igo & Koike
Hibbardella deflexa Igo & Koike
Hibbardella sp.
Hindeodella clarkei Igo & Koike
Hindeodella kobayashii Igo & Koike
Hindeodella serrata Igo & Koike
Hindeodella sp.
Hindeodella tatgei Igo & Koike
Lonchodina nevadensis Muller
Malayagnathus tetraserratus Igo & Koike
Neoprioniodus bicuspidatus Muller
Neoprioniodus cf. *unicornis* Muller
Neoprioniodus hamosus Igo & Koike
Neospathodus dieneri Sweet
Neospathodus sp.
Platyvillosus costatus (Staesch)
Platyvillosus hamadai Koike
Prioniodina procteri Igo & Koike
?Prioniodina kelantanensis Igo & Koike
Roundya sp.
Spathognathus conservatica Muller
Xaniognathus saginatus (Huckriede)
Xaniognathus sp.
coral
Lopophyllidium sp.
foraminifera
?Ammobaculites sp.
?Codonofisiella sp.
Baisalina cf. *pulchra* Reitlinger
Climacammina ex gr *valvulinoides* Lange
Colaniella cf. *media* (Miklukho-Maklay)
colaniella sp.
Dagmarita sp.
Diplopora sp.
Duotaxis sp.
Endothyra sp.
Endothyranella sp.
Frondicularia sp.
Globivalvulina sp.
Glomospira densa (Pantic)
Glomospira sp.
Goniolinopsis hexagona Milanovich
Ichtyolaria cf. *latilimbata* deCivreux & Dessauvagie
Meandrospira dinarica Kochansky-Devide & Pantic
Mizzia sp.
Nankinella sp.
Neodiscus sp.
Pachyploia ovata Lange
Palaeofusulina cf. *bella* (Sheng)
Palaeofusulina sp.
Para globivalvulinoides sp.
Permocalculus sp.
Pilaminella sp.
Reichelina cf. *changshingensis* (sheng & Chang)
Reichelina sp.
Staffella sp.

13. Env. of deposition : Shallow marine shelf deposit. with active volcanic activity
14. Remarks :

M3.

1. Name : Kodiang Limestone
2. Origin of name : After Kodiang Town in north Kedah
3. Age : Upper Permian to Upper Triassic
4. References : Jones *et al*. (1966), deCoo & Smith (1975), Metcalfe (1981), Khoo (1983), Kamal Roslan Mohamed *et al.* 1993)
5. Type area : North Kedah (especially Kodiang area)
6. Type section : Bukit Kechil and Bukit Kalong, Kodiang, Kedah
7. Boundaries : Overlying calcareous mudstone and sandstone unit of unknown unit, upper boundary eroded away.
8. Correlation : Lateral equivalent of part of Semanggol Formation and upper part of Chuping Limestone.
9. Thickness : 125 m
10. Lithology : Thinly bedded dark grey limestone (or dolomite) with finely laminated black shale and chert lenses and nodules; limestone (biopelsparite, calcilutite, calcarenite in composition).
11. Subdivision :
12. Fossils :

algae
Girvanella sp.
Solenopora sp.
Tubiphytes obscurus
bivalve
Eumorphotis sp.
conodont
Apatognathus ziegleri Diebel
Diplodolella lautissima (Huckriede)
Diplodolella meissneri (Tatge)
Gladigondolella cf. *abneptis* (Huckriede)
Gladigondolella tethydis (Huckriede)
Gondolella navicula Huckriede
Hindeodella multithama Huckriede
Hindeodella petrae-viridis Huckriede
Hindeodella triassica Muller
Lonchodina Mulleri Tatge
Neoprionodus cf. *kochi* (Huckriede)
Ozarkodina saginata Huckriede
radiolaria
Capnuchosphaera triassica De Wever
Canoptum cf. *farawayensis* Blome
Canoptum laxum Blome
Canoptum sp.
Capnuchosphaera sp.
Hagiastrum cf. *augustum* Pessagno
Kahlerosphaera sp.
Latium sp.
Paronaella sp.
Perispongidium sp.
Pseudostylosphaera cf. *spinulosa* Nakaseko & Nishimura
Sarla sp.
Sontonaella sp.
Spongostylus sp.
Tetraporobrachia asymmetrica Kozur & Mostler
Triassocampe sulovensis Kozur & Mock
Xenorum flexum Blome
foraminifera
Agathammina ?iranica Zanenetti, Bronnimann, Bozorgnia & Huber
Agathammina australpina Kristan-Tollmann & Tollmann
Agathammina sp.
Ammobaculites sp.
Austrocolomia sp.
Dentalina sp.
Diplotremina astrofimbriata Kristan-Tollman
Diplotremina sp.
Earlandia amplimuralis (Pantic)
Earlandia gracilis (Pantic)
Earlandinita soussii Salaj
Earlandinita sp.
Endothyra kuepperi Oberhausser
Endothyra malayensis Gazdzicki
Endothyra salaji Gazdzicki
Endothyra sp.
Endothyranella lombardi Zaninetti & Bronnimann
Endothyranella sp.
Endothyranella wirzi (Koehn-Zaninetti)
Glomospira densa (Pantic)
Glomospira gemerica (Salaj)
Glomospira grandis Salaj
Glomospira sp.
Glomospirella sp.
Glomospirella spirillinoides (Grozdilova & Glebovskaya)
Involutina cf. *pragsoides* (Oberhausser)
Involutina communis (Kristan)
Involutina gaschei Zaninetti & Bronnimann
Involutina sinuosa (Weynschenk)
Involutina sp.
Meandrospira deformata Salaj
Meandrospira dinarica Kochansky-Devide & Pantic
Meandrospira fusilla (Ho)
?Meandrospiranella sp.
Nodosaria sp.
Ophthalmidium sp.

Planiinvoluta carinata Leischner
?Planiinvoluta sp.
?Pseudonodosaria sp.
Tetrataxis sp.
Textularia sp.
Tolypammina gregaria Wendt
?Triasina sp.
Trochammina almtalensis Koehn-Zaninetti
Trochammmina sp.
Turritella cf. *mesotriasica* Koehn-Zaninetti
Variostoma sp.

13. Env. of deposition : Shallow marine to continental slope
14. Remarks : First introduced by Jones *et al*. (1966) as Kodiang limestone and formalized by deCoo & Smith (1975) as Kodiang Formation.

M4.

1. Name : Jurong formation
2. Origin of name : After Jurong Town in Singapore
3. Age : ?Permian to Lower Jurassic
4. References : Burton (1973a,b)
5. Type area : South Johor and Singapore
6. Type section : Refer to members
7. Boundaries : Intruded by granite, upper boundary - eroded.
8. Correlation : The lower part is equivalent to the Semantan Formation while the upper part is equivalent to the Kaling Formation
9. Thickness :
10. Lithology : (See Gunung Pulai Volcanic member, Bukit Resam member and Pasir Panjang member)
11. Subdivision : Subdivided into Gunung Pulai Volcanic member, Bukit Resam member and Pasir Panjang member.
12. Fossils : See members
13. Env. of deposition : See members
14. Remarks :

M4.1.

1. Name : Gunung Pulai volcanic member (of Jurong formation)
2. Origin of name : After Gunung Pulai in south Johor.
3. Age : ? Permian or ?Lower Triassic
4. References : Burton (1973a,b)
5. Type area : Gunung Pulai area in south Johor
6. Type section :
7. Boundaries : Intruded by granite and ?unconformably overlain by the Bukit Resam member.
8. Correlation :
9. Thickness :
10. Lithology : Mainly dark green to greenish grey rhyodacitic tuff, agglomerate with dacitic to andesitic tuff and lava and minor clastic sediment
11. Subdivision :
12. Fossils :
13. Env. of deposition :
14. Remarks :

M4.2.

1. Name : Bukit Resam member (of Jurong formation)
2. Origin of name : After Bukit Resam in South Johor
3. Age : ?Middle Triassic to Upper Triassic
4. References : Burton (1973a,b)
5. Type area : Bukit Resam area in south Johor , in Singapore Island
6. Type section :
7. Boundaries : ?Unconformably overlying the Gunung Pulai Volcanic member and conformably overlain by the Pasir Panjang member.
8. Correlation : Partly equivalent to the Gemas and Semantan Formation.
9. Thickness :
10. Lithology : Frequent alternation of shale and sandstone with minor siltstone and conglomerate and few volcanic tuff.
11. Subdivision :
12. Fossils :

<u>bivalve</u>
Arca sp.
Cassianella sp.
Costatoria malayensis (Newton)
Costatoria cf. *goldfussi* (Zieten)
Cuspidaria sp.
Gervillia sp.
Gonodon sp.
Lima sp.
Lucina sp.
Modiolus cf. *nachamensis* Mansuy
Myoconcha sp.
Myophoriopsis cf. *carinata* Bittner
?Pachycardia sp.
Pecten sp.
Pleuromya sp.
Posidonia sp.
Prolaria sp.
Pteria sp.

Trigonia cf. *zlambachensis* Haas
Trigonodus sp.

13. Env. of deposition : Shallow marine paralic environment.
14. Remarks :

M4.3.

1. Name : Pasir Panjang member (of Jurong formation)
2. Origin of name : After Pasir Panjang on the south coast of Singapore Island
3. Age : Upper Triassic (Carnian) to Lower Jurassic
4. References : Burton (1973a), Kobayashi & Tamura (1968b)
5. Type area : Pasir Panjang area in Singapore
6. Type section :
7. Boundaries : Conformably overlying the Bukit Resam Member, with interfingering base
8. Correlation : ?Equivalent to part of Kerum Formation
9. Thickness :
10. Lithology : Repeatedly intercalating conglomerate, sandstone and lutite.
11. Subdivision :
12. Fossils :

bivalve
Anodontophora sp.
Arca sp.
Astarte guthriensis Newton
Astarte scrivenori Newton
Cardium scrivenori Kobayashi & Tamura
Cassianella cf. *tenuistriata* (Munster)
Cassianella cf. *verbeeki* Krumbeck
Chlamys cf. *valoniensis* (Defrance-Leymerie)
Costatoria singapurensis Kobayashi & Tamura
Costatoria aff. *goldfussi* (Zieten)
Costatoria cf. *myophoria* (Boettiger)
Cucullea scrivenori Newton
?Cucullaea sp.
?Entolium sp.
Gervillia hantschi Newton
Gervillia scrivenori Newton
Goniomya scrivenori Newton
Goniomya singapurensis Newton
Halobia sp.
Lopha cf. *montiscaprilis* (Klipstein)
?Lucina sp.
Maoritrigonia ?bittneri (Newton)
Modiolopsis gonoides Healey
Myophoria sp.
?Nuculana sp.
Opis cf. *hoeninghausi* (Klipstein)
Palaeocardita cf. *crenata* (Goldfuss)
Palaeoneilo sp.
?Plagiostoma sp.
Posidonia sp.
Promathilda colon (Wissmann)
Prospondylus comtus (Goldfuss)
Schafhaeutella astartiformis (Wissmann)
Spondylus dubiosus (Bittner)
Synclonema sp.
?Thracia sp.
Volsella cf. *compressa* Goldfuss

brachiopod
Spiriferina cf. *fragilis* (Schlotheim)

plant
Carpolithus sp.
Podozamites lanceolatus Lindley & Hutton

13. Env. of deposition : Shallow marine paralic environment
14. Remarks : This member was not discussed by Burton (1973b) when he described the formation from Johor Bahru.

M5.

1. Name : Telong formation
2. Origin of name : After Sungai Telong (a tributary of Sungai Aring) in south Kelantan
3. Age : ?Permian to Upper Triassic (Carnian)
4. References : Aw (1990), Khoo (1983)
5. Type area : Sungai Telong, the upper reaches of Sungai Aring in south Kelantan
6. Type section : Along Sungai Telong from a point at GR QZ793358 upstream to GR QZ765344
7. Boundaries : Lower boundary : Unconformably overlying the Gua Musang Formation and unconformably overlain by the Koh Formation
8. Correlation : ?Lateral equivalent to Gunung Rabung Formation and Semantan Formation
9. Thickness : >1000 m
10. Lithology : Sequence of predominantly argillite associated with some tuff
11. Subdivision :
12. Fossils :

bivalve
Amonotis sp.
Costatoria pahangensis Kobayashi & Tamura

Costatoria quinquicostata Kobayashi & Tamura
Costatoria sp.
Entolium sp.
?Hoernessia sp.
Langsonella sp.
Lima sp.
Neoschizodus sp.
cephalopod
Anatomites sp.
Hoplotropites sp.

13. Env. of deposition : Stable shallow marine environment with occasional supply of fine pyroclastic material
14. Remarks : Khoo (1983) mentioned that the age of Telong formation is probably of Middle to Upper Triassic, while Aw (1990) suggested a ?Permian to Upper Triassic age for this formation.

M6.

1. Name : Buluh sandstone
2. Origin of name : After Sungai Buluh, a tributary of Sungai Lepar in Maran area, Pahang
3. Age : Lower Triassic
4. References : Lee (1990)
5. Type area : Ridges east of Kg. Seri Jaya, extended to Maran area.
6. Type section : Reference Section is from headwater of Sungai Buluh (GR492050) to 2km downstream (GR 513052), Map Sheet 81
7. Boundaries : Unconformably overlying the Permian Seri Jaya beds and intruded by the Upper Triassic granites, upper boundary not known.
8. Correlation :
9. Thickness : ± 650 m
10. Lithology : Prominantly of homogeneous and well bedded sandstone with minor intercalation of siltstone, mudstone and shale. Sandstone is fine to medium grained, well sorted with randomly distributed polycrystalline quartz, often with sutured boundaries, with no calcareous materials.
11. Subdivision :
12. Fossils :
13. Env. of deposition : Shallow, near-shore marine deposition, probably neritic environment.
14. Remarks : Proximal to Berkelah granite, the sandstone has undergone contact metamorphism and changed to phyllite and slate.

M7.

1. Name : Gunung Rabong formation
2. Origin of name : After Gunung Rabong in south Kelantan
3. Age : Middle Triassic (Ladinian) to Upper Triassic (Carnian)
4. References : Yin (1965), Khoo (1983)
5. Type area : Gunung Rabong area in south Kelantan
6. Type section :
7. Boundaries : Unconformably overlying the Gua Musang Formation
8. Correlation : Lateral equivalent to Telong Formation and Semantan Formation
9. Thickness :
10. Lithology : Predominantly arenaceous-argillaceous rocks sequence with subordinate calcareous, rudaceous and volcanic bands
11. Subdivision :
12. Fossils :

bivalve
Daonella sp.
Halobia sp.

13. Env. of deposition :
14. Remarks :

M8.

1. Name : Semantan Formation (of Raub Group)
2. Origin of name : After Sungai Semantan in Temerloh, Pahang
3. Age : Middle Triassic to Upper Triassic
4. References : Jaafar Ahmad (1976); Scrivenor (1911), Richardson (1939), Richardson (1950), Alexander (1959), Burton (1973a), Loganathan (1977), Jaafar Ahmad (1980), Khoo (1983), Kamal Roslan Mohamed (1990,1996), Metcalfe *et al*. (1982), Kobayashi (1963a)
5. Type area : Temerloh area, extended to the north to Jerantut-Kuala Lipis-Raub area and to the south to Air Hitam, Johor

6. Type section : Roadcut between Karak and Temerloh which runs almost parallel to the Sungai Semantan
7. Boundaries : Unconformably overlying the Karak Formation, the top is overlain by the Kaling Formation
8. Correlation : Lateral equivalent to Gunung Rabung, Telong and Gemas Formations.
9. Thickness :
10. Lithology : Rapidly alternating carbonaceous shale, siltstone and rhyolitic tuff with a few lenses of chert and limestone. Shale and tuff
11. Subdivision : Divided into argillaceous, pyroclastic, limestone and chert facies with no time-stratigraphic significance
12. Fossils :

bivalve
Daonella indica Bittner
Daonella lomelli (Wiesmann)
Daonella pahangensis Kobayashi
Daonella pichleri Mojsisovics
Daonella sakawana Mojsisovics
Daonella sp.
Halobia sp.
Mysidioptera sp.
Palaeoneilo sp.
Pecten sp.
Posidonia sp.
cephalopod
Acrochordiceras sp.
Analcites sp.
Arpadites cf. *cinensis* Mojsisovics
Arpadites sp.
Discoceratites sp.
Nevadites sp.
Orestites sp.
Paraceratites trinodosus (Mojsisovics)
Paratrachyceras regoledanum Mojsisovics
Ptychites sp.
Sturia sansovini Mojsisovics

13. Env. of deposition : Distal turbidite with contemporaneous volcanic activity
14. Remarks : These rocks of central Pahang was introduced by Scrivenor (1911) as Raub Series which was subsequently changed into Calcareous formation by Richardson (1939), Calcareous Series by Richardson (1950), Raub Group by Alexander (1959), Kerdau formation by Burton (1973) and finally named as Semantan Formation by Jaafar Ahmad (1976).

M9.

1. Name : Gemas formation
2. Origin of name : After Gemas Town, Negeri Sembilan
3. Age : Middle Triassic to Upper Triassic
4. References : Foo (1970), Loganathan (1977), Khoo (1983)
5. Type area : Gemas area, extended to Air Hitam, Johor
6. Type section :
7. Boundaries : Unconformably overlying the Kepis formation, the top is overlain ?conformably by the ?Kaling Formation
8. Correlation : Lateral equivalent of Semantan Formation.
9. Thickness :
10. Lithology : Rapidly alternating carbonaceous shale, siltstone and rhyolitic tuff with a few lenses of chert and limestone. Shale and tuff
11. Subdivision :
12. Fossils :
13. Env. of deposition : Distal turbidite with contemporaneous volcanic activity.
14. Remarks : The Gemas Formation was considered by Kamal Roslan Mohamed (1990, 1996) as part of Semantan Formation due to their very similar characters.

M10.

1. Name : Kaling Formation (of Raub Group)
2. Origin of name : After Bukit Kaling in Bentong, Pahang
3. Age : Middle Triassic to Upper Triassic
4. References : Jaafar Ahmad (1976); Alexander (1956), Alexander (1959), Burton (1973a), Jaafar Ahmad (1980), Khoo (1983)
5. Type area : Eastern foothill of the main range granite from Kuala Lipis (Pahang) to Bahau (Negeri Sembilan)
6. Type section : Bukit Kaling in Bentong, Pahang
7. Boundaries : Overlying the Semantan Formation with unconformable boundary at Bukit Kaling,

conformable with transitional boundary in other places. The top is not known.

8. Correlation :
9. Thickness : ± 600 m
10. Lithology : Predominantly sandstone and subgreywacke with minor lenses of siltstone, conglomerate, shale and rhyolitic tuff
11. Subdivision :
12. Fossils :

bivalve

Actinodesma bellammyi Newton
Cassianella malayensis Tamura
Cassianella sp.
Costatoria chegarperahensis Kobayashi & Tamura
Costatoria malayensis (Newton)
Costatoria pahangensis Kobayashi & Tamura
Costatoria quinquicostata Kobayashi & Tamura
Costatoria cf. *myophoria* (Boettiger)
Costatoria sp.
Elegantinia inflata (Emmrich)
Entolium subdemissum Munster
Entolium sp.
?Lima sp.
Gervillia inflata Schafhaeutel
Gervillia sp.
Grammatodon malayensis Cox
Hoernessia chobaensis Patte
Hoernessia wilbourni Cox
Hoernessia cf. *bipartita* (Merian)
Langsonella elongata Mansuy
Modiolus sp.
Myophoria sp.
Myophoricardium cf. *lineata* Wohrmann
Mytilus aff. *minutus* Goldfuss
Neoschizodus cf. *laevigatus* Alberti
Neoschizodus cf. *ovatus* (Goldfuss)
Neoschizodus sp.
Nuculana sp.
Paleoneilo sp.
Pinna sp.
Plagiostoma sp.
Pleurophorus elongatus Moore
Pseudoplacunopsis cf. *carinata* Healey
Pteria jaafari Tamura
Pteria pahangensis Newton
Pteroperna malayensis Newton

gastropod

Coelostylina sp.
Euomphalus sp.
Naticopsis signata Koken

13. Env. of deposition : Shallow marine
14. Remarks : This formation was first introduced as the Younger Arenaceous Series by Alexander (1956) and subsequently renamed as the Lipis Group by Alexander (1959), Jelai Formation by Burton (1973a) and then the Kaling Formation by Jaafar Ahmad (1976). Bahau arenite is considered to be a southern extension of the Kaling Formation.

M11.

1. Name : Hulu Lepar bed
2. Origin of name : After the name of Map Sheet 81
3. Age : ?Upper Triassic, ?Upper Jurassic to ?Lower Cretaceous.
4. References : Lee (1990)
5. Type area : Hulu Lepar, Map Sheet 81, the extenion into the adjacent map area is not known.
6. Type section :
7. Boundaries : Unconformably overlying the Permian Seri Jaya bed, the top of the formation is eroded.
8. Correlation : ?Lateral equivalent of the Tembeling Group
9. Thickness :
10. Lithology : (see subdivision)
11. Subdivision : Informally subdivided by Lee (1990) into Berkelah conglomerate, Mangking Sandstone (?of Tembeling Group) and Berapit sandstone, the categories of which are uncertain. The Berkelah conglomerate is overlain by the Mangking sandstone, and the Berapit sandstone is equivalent to the Mangking sandstone. Two tuffaceous units the Tekam tuff and Serentang tuff were also reported by Lee (1990), where the Berkelah conglomerate is ?overlying the Serentang tuff while the Berapit sandstone is ?overlying the Tekam tuff.
12. Fossils :
13. Env. of deposition : Continental environment, largely under fluviatile condition.
14. Remarks :

M11.1. Tekam tuff : Predominantly rhyodacitic to rhyolitic or crystal lithic tuffs with minor dacitic tuff, mostly fine-grained to aphanitic, rarely lapilli tuff or reworked. The lower sequence is thickly bedded to massive while the upper part is thin to thickly bedded. Total thickness of up to 300 m.

M11.2. Serentang tuff : Predominantly of thinly bedded fine-grained tuff with subordinate sandstone, shale, siltstone and rarely conglomerate. Total thickness of approximately 300 m.

M11.3. Berkelah conglomerate : Consist of 100 m of predominant alternating conglomerate and pebbly sandstone, overlain by 200 m sequence of interbedded sandstone and mudstone.

M11.4. Berapit sandstone : Consists of 10 m basal conglomerate followed by 550 m sandstone with mudstone interbeds and 700 m thick sandstone.

M12.

1. Name	: Koh Formation
2. Origin of name	: After Sungai Koh, a tributary of Sungai Lebir in Kelantan
3. Age	: Upper Triassic to ?Jurassic
4. References	: Aw (1990), Khoo (1983)
5. Type area	: Sungai Koh drainage basin, extended to Gunung Tahan area.
6. Type section	: From tributary of Sungai Koh (MR QZ881321) to Sg. Koh (MR QZ901329); map Sheet 46
7. Boundaries	: Unconformably overlying the Telong Formation, the top of the formation is eroded
8. Correlation	: ?Lateral equivalent of the Tembeling Group
9. Thickness	: 700 m, may be more than1000 m
10. Lithology	: Rudaceous-arenaceous sequence interbedded with mudstone; argillaceous limestone at the base
11. Subdivision	:
12. Fossils	:
13. Env. of deposition	: Continental deposit
14. Remarks	:

M13.

1. Name	: Kerum Formation (?of Tembeling group)
2. Origin of name	: After Sungai Kerum, a tributary of Sungai Tekai
3. Age	: ?Upper Triassic
4. References	: Khoo (1977), Khoo (1983)
5. Type area	: Sungai Tekai area in Pahang
6. Type section	: Along Sungai Kerum
7. Boundaries	: Overlain by Lanis conglomerate
8. Correlation	:
9. Thickness	: $\pm$ 2000 m
10. Lithology	: Volcanic-sedimentary suite with intermixed varieties
11. Subdivision	:
12. Fossils	:
13. Env. of deposition	: ?Shallow marine paralic environment.
14. Remarks	: Koopmans (1968) described and formalized the name Tembeling Formation, based on the type section at Sungai Tekai. This name was Upperr upgraded by Khoo (1977) to Tembeling Group which included the Kerum formation, Lanis conglomerate, Mangking sandstone and Termus shale, all based on sections along Sungai Tekai. Khoo (1975) provisionally introduced the four subdivision of Tembeling Group as Kerum Formation, Lanis Conglomerate, Tekai or Mangking Quartzite and the Tekai Redbed. The Kerum Formation was Upperr excluded by Harbury *et al.* (1990) from the Tembeling Group.

M14.

1. Name	: Lanis Conglomerate (of Tembeling group)
2. Origin of name	: After Gunung Lanis ridge in Tekai valley
3. Age	: ?Upper Jurassic to ?Lower Cretaceous
4. References	: Khoo (1975, 1977), Khoo (1983)
5. Type area	: Sungai Tekai area in Pahang,
6. Type section	: Along Gunung Lanis ridge
7. Boundaries	: Overlying the Kerum formation (probably conformably) and conformably overlain by the Mangking sandstone

8. Correlation :
9. Thickness : 1300 m
10. Lithology : Sequence of polymict conglomerate / conglomeratic sandstone / shale / siltstone with significance volcanic clast in some part
11. Subdivision :
12. Fossils :

gastropod
Viviparus sp.
plant
Gleichenoides gagauensis Kon'no

13. Env. of deposition : Continental deposit
14. Remarks :

M15.

1. Name : Mangking Sandstone (of Tembeling group)
2. Origin of name : After Sungai Mangking, a tributary of Sungai Tekai
3. Age : ?Jurassic
4. References : Khoo (1975, 1977), Mohd Shafeea Leman *et al.* (1987), Lee (1990)
5. Type area : Sungai Tekai area in Pahang, extended to the Gunung tahan area in the north and Maran area in the east.
6. Type section : Along Sungai Mangking.
7. Boundaries : Conformable with both the underlying Lanis conglomerate and the overlying Termus Shale
8. Correlation :
9. Thickness : ± 2000 m
10. Lithology : Cross bedded and cross laminated quatzose sandstone interbedded with grey and reddish argillaceous rock.
11. Subdivision :
12. Fossils :

plant
?Carpolithes maranensis Smiley
Conites spinulosus Kon'no
Equisetites sp.
Frenelopsis malaiana Kon'no
Gleichenoides ?serratus Kon'no
Gleichenoides cf. *stenopinnula* Kon'no
Gleichenoides gagauensis Kon'no
Gleichenoides maranensis Smiley
Gleichenoides pantiensis Kon'no
?Nageiopsis cf. *longifolia* Fontaine
Otozamites gagauensis Kon'no
Otozamites malayana Smiley
?Pelourdea cf. *megaphylla* (Phillip)
Ptilophyllum ayobanum Smiley
Zamites cf. *buchianus* (Ettinghaussen)
?Zamites microphylla Smiley

13. Env. of deposition : Continental (fluvial) deposit
14. Remarks :

M16.

1. Name : Termus Shale (of Tembeling group)
2. Origin of name : After Sungai Termus, a tributary of Sungai Tekai in Pahang
3. Age : ?Upper Jurassic to Cretaceous
4. References : Khoo (1975, 1977)
5. Type area : Sungai Tekai area in Pahang
6. Type section : Along Sungai Termus
7. Boundaries : Conformably overlying the Mangking Sandstone
8. Correlation :
9. Thickness : Up to 1500 m
10. Lithology : predominantly of reddish shale/ mudstone/siltstoneinterbedded with sandstone
11. Subdivision :
12. Fossils :

Classopollis sp.
Clavatipollenites sp.
Cycadopites sp.
Ephedripites sp.
Exesipollenites sp.
palynomorph
Cicatricosisporites sp.

13. Env. of deposition : Continental deposit
14. Remarks : First named as Tekai Redbed by Khoo(1975), but Khoo (1975) renamed it as Termus Shale.

M17.

1. Name : Murau Conglomerate (?of Tembeling group)
2. Origin of name : After Tanjung Murau in Mersing, Johor
3. Age : ?Upper Triassic
4. References : Koopmans (1968), Burton (1973)
5. Type area : Coastlines and islands south-southeast of Mersing from Pulau Batu Chawang to Tanjung Tenggaroh
6. Type section : Tanjung Murau headland MR 250793, Map Sheet 119, New series.
7. Boundaries : Uncomformably overlying Upper Paleozoic Mersing Group

8. Correlation : ?Basal part of Tembeling Group
9. Thickness : +200 m
10. Lithology : Thickly bedded to massive conglomerate with alternating layers of more or less matrix or layers of clast of varying size. Shales and sandy shales occur locally as thin interbeds. Conglomerate with scour and fill structures.
11. Subdivision :
12. Fossils :
13. Env. of deposition : Fluvial deposit
14. Remarks : Koopmans (1968) considered the Murau conglomerate as tha basal part of the Tembeling formation.

M18.

1. Name : Badong Conglomerate (of Gagau group)
2. Origin of name : After Sungai Badong, a tributary of Sungai Lebir in southeast Kelantan
3. Age : ?Jurassic
4. References : Rishworth (1974), Khoo (1983)
5. Type area : Gunung Gagau
6. Type section : Along headwater stretch of the east branch of Sungai Badong from MR WF712921 to the east-northeast as far as MR WF722927 then to the east-southeast as far as MR WF 733922 (Old Series topographical sheet 2O/3 and 2O/7).
7. Boundaries : ?Unconformably overlying Upper Paleozoic rocks and conformably overlain by the Lotong Sandstone
8. Correlation :
9. Thickness : 400 to 500 m
10. Lithology : Reddish polymodal conglomerate with subordinate sandstone, some siltstone and shale
11. Subdivision :
12. Fossils :
13. Env. of deposition : Continental deposit
14. Remarks :

M19.

1. Name : Lotong Sandstone (of Gagau group)
2. Origin of name : After Sungai Lotong
3. Age : Upper Jurassic to Lower Cretaceous
4. References : Rishworth (1974), Khoo (1983)
5. Type area : Gunung Gagau
6. Type section : Along headwater stretch of Sungai Lotong commencing from a large junction at MR WF749917 runs northwest to a the junction at MR WF744927 then upstream to the peak, 350 yards south of Gunung Badong (MR WF 742946) (Old Series topographical sheet 2O/3 and 2O/7).
7. Boundaries : Overlying the Badong Conglomerate (conformably) and the Upper Paleozoic rocks (unconformably)
8. Correlation :
9. Thickness :
10. Lithology : Sandstone (orthoquartzite, protoquartzite and subarcose) with subordinate volcanics and rare thin lenses of coal
11. Subdivision :
12. Fossils :

bivalve
Trigonoides konairai Kobayashi & Suzuki
Trigonoides konairai paucisulcatus Suzuki
plant
Carpolithes sp.
Conites spinulosus Kon'no
Equisetites burchardi (Dunker)
Frenelopsis malaiana Kon'no
Gleichenoides gagauensis (Kon'no)
Gleichenoides serratus (Kon'no)
Gleichenoides stenopinnula (Kon'no)
?Nageiopsis cf. *longifolia* Fontaine
?Pelourdea cf. *megaphylla* (Phillip)
Sphenolepidium cf. *kurrianum* (Dunker)
Zamites cf. *buchianus* (Ettinghaussen)

13. Env. of deposition : Continental deposit
14. Remarks :

M20.

1. Name : Tebak Formation (Panti sandstone)
2. Origin of name : After Sungai Tebak in south Johor
3. Age : Upper Jurassic to Lower Cretaceous
4. References : Rajah (1968), Khoo (1983)
5. Type area : Gunung Blumut area in south Johor
6. Type section : Sungai Tebak
7. Boundaries : Unconformably overlying the Sedili volcanic

8. Correlation :
9. Thickness :
10. Lithology : Predominantly of arenaceous rocks with with minor siltstone and mudstone
11. Subdivision :
12. Fossils :

plants

Carpolithes sp.
Conites spinulosus Kon'no
Frenelopsis malaiana Kon'no
Gleichenoides gagauensis Kon'no
Gleichenoides pantiensis Kon'no
Otozamites gagauensis Kon'no
Otozamites malayana Smiley
Podozamites pahangensis Asama
Ptilophyllum ayobanum Smiley
Zamites cf. *buchianus* (Ettinghaussen)

13. Env. of deposition : Continental deposit
14. Remarks :

M21.

1. Name : Ulu Endau Bed
2. Origin of name : After Ulu Endau area in south Pahang.
3. Age : Upper Jurassic to Lower Cretaceous
4. References : Jones *et al*. (1966), Cook & Suntharalingam (1970), Khoo (1983)
5. Type area : Ulu Endau area in south Pahang
6. Type section :
7. Boundaries : Overlying the Mersing group and jasin volcanics with angular unconformity
8. Correlation :
9. Thickness : + 300 m at Bukit Peta
10. Lithology : Horizontal, massively bedded sequence of predominantly arenaceous rocks with argillaceous rocks and coal seam interbeds
11. Subdivision :
12. Fossils :

plants

Gleichenites sp.
Otozamites sp.
Equisetites sp.

13. Env. of deposition : Continental deposit
14. Remarks :

M22

1. Name : Paloh Formation
2. Origin of name : After Bukit Paloh in Johor
3. Age : ?Jurassic to Cretaceous
4. References : Mat Isa Jamaludin (1981), Zakaria Hussain (1986)
5. Type area : Area in between Segamat and Keluang in Johor
6. Type section : Bukit Paloh, near Paloh town in Johor
7. Boundaries : Unconformably overlying the Semantan Formation in the west and granite in the east.
8. Correlation : Partly equivalent of the Ma'Okil Formation.
9. Thickness :
10. Lithology : Interbedded sandstone, shale and mudstone.
11. Subdivision :
12. Fossils :

palynomorph

Apiculatisporites ferox
Araucariacites australis
Biretisporites spectabilis
Biretisporites sp.
Calamospora sp.
Ceratosporites equalis
Cicatricosisporites australiensis
Cyathidites australis
Cybelosporites striatus
Cybelosporites stylosus
Ginkgocycadophytus nitidus
Leptolepidites major
Matonisporites equiexinus
Triletes cf. *tuberculiformis*
?Vernucatosporites sp.

13. Env. of deposition : Shallow marine to continental
14. Remarks : First introduced as Paloh bed by Mat Isa Jamaludin (1981) and then upgraded to Paloh Formation by Zakaria Hussain (1986).

M23.

1. Name : Bertangga Sandstone
2. Origin of name : After Bukit Bertangga in Pahang
3. Age : ?Jurassic to ?Cretaceous
4. References : Cook & Suntharalingam (1971), Khoo (1983)
5. Type area : Bera area in Pahang
6. Type section : Bukit Bertangga
7. Boundaries : Unconformably overlying the Upper Paleozoic rock

8. Correlation :
9. Thickness :
10. Lithology : Predominantly arenaceous sequence with interbedded argillaceous rocks
11. Subdivision :
12. Fossils :
13. Env. of deposition : Continental deposit
14. Remarks :

M24.

1. Name : Gerek Sandstone
2. Origin of name : After Bukit Gerek in Rompin area, Pahang
3. Age : ?Jurassic to ?Cretaceous
4. References : Cook & Suntharalingam (1971), Khoo (1983)
5. Type area : Ulu Rompin, Pahang
6. Type section : Bukit Gerek
7. Boundaries :
8. Correlation : Equivalent to Gagau and Tembeling Groups.
9. Thickness :
10. Lithology : Arenaceous rocks
11. Subdivision :
12. Fossils :
13. Env. of deposition : Continental deposit.
14. Remarks : Previously referred to as Panti type sandstone.

M25.

1. Name : Ma'Okil Formation
2. Origin of name : After Ma'Okil Forrest Reserve in northwest Johor
3. Age : ?Jurassic to ?Cretaceous
4. References : Loganathan (1978), Khoo (1983)
5. Type area : Ma'Okil Forrest Reserve and surrounding area
6. Type section : Ma"Okil Forrest Reserve
7. Boundaries : Unconformably overlying the Semantan Formation
8. Correlation : Equivalent to Gagau and Tembeling Groups - partly Lateral equivalent of the Paloh formation
9. Thickness : $\pm$ 6700 m
10. Lithology : Predominantly argillaceous with arenaceous, rudaceous and volcanic rocks
11. Subdivision : Subdivided into argillaceous, arenaceous and volcanic units
12. Fossils :
13. Env. of deposition : Continental deposit
14. Remarks :

M26.

1. Name : Saiong Bed
2. Origin of name : Named after Bukit Saiong, near Thai - Kedah border
3. Age : ?Jurassic to ?Cretaceous
4. References : Ong (1968), Khoo (1983)
5. Type area : Bukit Saiong area
6. Type section : Bukit Saiong
7. Boundaries : Unconformably overlying the Semanggol Formation
8. Correlation : Equivalent to Tembeling Group
9. Thickness : Up to 1200 m
10. Lithology : Red polymict conglomerate interbedded with red sandstone, shale and mudstone
11. Subdivision :
12. Fossils :
13. Env. of deposition : Continental deposit
14. Remarks :

M27.

1. Name : Lesong sandstone
2. Origin of name : After Gunung Lesong in south Pahang
3. Age : ?Jurassic to ?Cretaceous
4. References : Foo (1970), Khoo (1983)
5. Type area : Lesong forrest reserve in south Pahang to Bukit Seligi in north Johor
6. Type section :
7. Boundaries : Unconformably overlying the Sawak metasediments and Gayong volcanics.
8. Correlation :
9. Thickness : + 450 m at escarpment on Sungai Tanglang
10. Lithology : Gently dipping sequence of predominantly sandstone with cross-bedding and abundant plant remains.
11. Subdivision :
12. Fossils :
13. Env. of deposition : Continental deposit
14. Remarks :

M28.

1. Name : Nenering Bed
2. Origin of name : After Felda Nenering, north Perak
3. Age : ?Upper Cretaceous
4. References : Teh & Sia (1991), Ibrahim Abdullah *et al*. (1991), Uyop Said & Che Aziz Ali (1996)

5. Type area : East of Pengkalan Hulu (Kroh) extended to Thailand.
6. Type section : Kampung Air panas - Kampung Lalang highway (3.5 to 7 km east-southeast of Kampung Air panas), Pengkalan Hulu, Perak
7. Boundaries : Overlying the baling Group (Kroh formation) unconformably
8. Correlation :
9. Thickness :
10. Lithology : Mudstone, sandstone and conglomerate with sand-conglomerate filled channel.
11. Subdivision :
12. Fossils :

palynomorph
Coronatispora telata (Balme) Dettmann
Inaperturopollenites limbatus Balme
Inaperturopollenites sp.
Psilodiporites sp.
Psiloschizosporis pseudomonoleta Trivedi, Ambawni & Kar
Spheripollenites scabratus Couper
spores
Atrophonites sp.
Monopporisporites sp.

13. Env. of deposition : Continental deposit
14. Remarks : First introduced by Teh & Sia (1991) as Nenering Tertiary deposit, but Upperr Uyop said & Che Aziz Ali (1996) quoted the deposit as Nenering bed and dated them as ?Upper Cretaceous

2.2. SARAWAK

M29.

1. Name : Sadong Formation
2. Origin of name : After Batang Sadong in West Sarawak
3. Age : Upper Triassic
4. References : Liechti *et al*. (1960), Pimm (1965), Wilford (1965)
5. Type area : Upper Sadong valley
6. Type section : Batang Sadong; From Serian to Muara Mongkos
7. Boundaries : Rest unconformably on Terbat Formation and Kerait Schist , overlain conformably by the Serian Volcanic formation
8. Correlation : The upper part is interbedded with the Serian Volcanic formation.
9. Thickness :
10. Lithology : Shale, sandstone, arkose, conglomerate, tuff and tuffaceous sandstone with thin beds of coal, chert and limestone
11. Subdivision : Subdivided into arenaceous and argillaceous facies and Serian Arkose member
12. Fossils :

bivalve
Asoella aff. *confertoradiata* (Tokuyama)
Entolium sp.
Entomonotis sp.
Gryphaea aff. *keilhari* Bohm
Halobia ?talauana Wanner
Halobia cf. *molukkana* Wanner
Monotis salinaria Bronn
Monotis subcircularis Gabb
"*Nucula*" sp.
Oxytoma sp.
?*Pleuromya* sp.
?*Tosapecten* sp.
Unionites sp.
cephalopod
Sturia aff. *sansovinii* (Mojsisovics)
foraminifera
Ammodiscus sp.
Glomospira sp.
Trochammina sp.
radiolaria
Cenosphaera sp.
Dictyomitra sp.

13. Env. of deposition : Shallow marine
14. Remarks : Moderately folded

M30.

1. Name : Serian Volcanic Formation
2. Origin of name : After Serian town in West Sarawak
3. Age : Upper Triassic
4. References : Pimm (1965), Wilford (1965)
5. Type area : Serian area and northeast of Krokong
6. Type section : Gunung Semuja in Serian area
7. Boundaries : Conformably overlying the Sadong Formation, unconformably overlain by the Bau Limestone Formation and the Silantek Formation.
8. Correlation : Lower part is interbedded with the upper part of Sadong Formation
9. Thickness : +3000 m
10. Lithology : Thick sequence of lava, breccia and tuff with acidic volcanic rocks

towards the top

11. Subdivision : The Semabang trachyte member is recognised on the top part of the formation.
12. Fossils :
13. Env. of deposition : Marine or estuarine environment; tuff and breccias are in places interbedded with silicified peat.
14. Remarks :

M31.

1. Name : Kedadom Formation
2. Origin of name : After Kedadom village in Penrissen, West Sarawak.
3. Age : Lower Jurassic to Cretaceous
4. References : Wilford (1965), Basir Jasin *et al.* (1996)
5. Type area : Penrissen area in West sarawak.
6. Type section : Binong Pass, 3 km west of Piching.
7. Boundaries : Unconformably overlying the Sadong and Serian volcanic Formations, overlain by the Bau Limestone Formation.
8. Correlation : The upper pert is also interfinguring with the lower part of the Bau Limestone Formation.
9. Thickness : 780 m
10. Lithology : Massive sandstone and conglomerate with thin beds of shale, limestone and tuff
11. Subdivision :
12. Fossils :
    bivalve
    Neoburmesia iwakiensis Yabe & Sato
    cephalopod
    Lithacoceras or *Subplanites* sp.
13. Env. of deposition : Shallow marine.
14. Remarks :

M32.

1. Name : Sejingkat Formation
2. Origin of name : After Gunung Sejingkat in West Sarawak
3. Age : Jurassic to Cretaceous
4. References : Liechti *et al* (1960), Tan (1982)
5. Type area : Kuching and west of Lundu area
6. Type section : Gunung Sejingkat ; along the coast line between Teluk Labuan Gadong and Tanjung Sungai Limo; Melano valley
7. Boundaries : Unconformably overlying Sadong Formation and overlain conformably by Kedadom Formation and Sadong Formation
8. Correlation : Interfingering with Serabang Formation and lower part of Kedadom Formation, Bau Limestone and Sadong Formation
9. Thickness :
10. Lithology : Mainly chert with subordinate phyllite, phyllitic shale, sUpper, greywacke and tuffite
11. Subdivision :
12. Fossils :
    radiolaria
    Meyenella sp
13. Env. of deposition :
14. Remarks :

M33.

1. Name : Pedawan Formation
2. Origin of name : After Pedawan village in Penrissen, West Sarawak.
3. Age : Jurassic to Cretaceous
4. References : Wilford (1965), Wolfenden (1965), Pimm (1967).
5. Type area : Penrissen and Bau area in West Sarawak.
6. Type section : Pedawan road between Tiang Bekap and Pedawan, and at Semadang Valley.
7. Boundaries :
8. Correlation : In places interbedded with the Bau Limestone Formation (its Lateral equivalent).
9. Thickness :
10. Lithology : Thick sequence of shale, mudstone and sandstone with beds of conglomerate, chert and limestone and acidic to intermediatelava and tuff
11. Subdivision : Divided by Wilford (1965) into argillite, arenite, dolomitic limestone and tuffaceous facies.
12. Fossils :
    cephalopod
    Neocomites neocomiensis d'Orbigny
    foraminifera
    Globotruncana cf. *coronata* Bolli
    Globotruncana cf. *lapparenti* Bolli
    Globotruncana concavata (Brotzen)
    Globotruncana tricarinata (Quereau)
    Orbitolina birmanica Sahni
    Orbitolina discoidea Gras
    Orbitolina kurdica (Henson)

Orbitolina lenticularis (Blumenbach)
radiolaria
Archaeocenosphaera sp.
Bagotum sp.
Canoptum anulatum Pessagno & Poisson
Canoptum rugosum Pessagno & Poisson
Canoptum sp.
Canutus indomitus Pessagno & Whalen
Canutus izeensis Pessagno & Whalen
Canutus sp.
Doltus sp.
Katroma sp.
Pantanellium sanrafaelense Pessagno & Blome
Parahsuum simplum Yao
Parahsuum takarazawaensis Shashida
Perispyridium sp.
Praeconocaryomma decora Yeh
Praeconocaryomma media Pessagno & Poisson
Praeconocaryomma sp.
pollen
Acanthotriletes levidensis Balme
Alisporites similis (Balme)
Anacolosidites sp.
Apiculatisporis ferox Muller
Appendicisporites tricornitatus (Weyland & Greifeld)
Aquilapollenites wilfordi Muller
Araucariacites australi Cookson
Caytonipollenites pallidus (Reissinger)
Cicatricosisporites cf. *dorogensis* (Potonie & Gelletich)
Classopollis cf. *classoides* Pflug
Dactylopollis magnificus Muller
Dicolpopollis elegans Muller
Dicolpopollis malesianus Muller
Discoidites borneensis Muller
Distaverrusporites margaritatus Muller
Distaverrusporites simplex Muller
Echistephanoporites obscurus Muller
Echitriporites irregularis Muller
Echitriporites trianguliformis van Hoeken-Klinkenberg
Ephedripites jansonii (Pocock)
Ephedripites multicostatus Brenner
Ephedripites ovalis Muller
Ephedripites sp.
Exesipollenites tumulus Balme
Gemmatricolpites pergemmatus Muller
Ginkgocycadophytus nitidus (Balme)
Inaperturopollenites scabratus Muller
Matonisporites equiexinus Couper
Myrtaceidites sp.
Pediastrum paleogeneites Wilson & Hoffmeister
Pinuspollenites cf. *spherisaccus* Brenner
Polypodiaceoisporites retirugatus Muller
Proxapertites cursus van Hoeken-Klinkenberg
Psilatricolpites kayanensis Muller
Psilatricolporites acuticostatus Muller
Psilatricolporites prolatus Pierce
Psilodiporites wolfendeni Muller
Retitricolpites peroblatus Muller
Retitricolpites sarawakensis Muller
Retitricolpites vulgaris Muller
Retitricolporites crucipori Muller
Retitricolporites semistriatus Muller
Retitriporites aspidopori Muller
Retitriporites variabilis Muller
Rugubivesiculites reductus Pierce
Rugulitriporites vestibulipori Muller
Sapotaceoidaepollenites robustus Muller
Spinizonocolpites baculatus Muller
Spinizonocolpites echinatus Muller*Proxapertites operculatus* van der Hammen
Striatricolporites conspicuus Muller
Striatricolporites minor Muller
Triorites festatus (Takakashi)
Triorites minutipori Muller
Triorites tenuiexinus Muller
Verrutriporites lunduensis Muller
Zonalapollenites sp.

13. Env. of deposition : Steadily subsiding shallow marine basin.
14. Remarks : This formation was included in the Bau Series (Wilford, 1951) and Bau Formation (Liechti *et al*., 1960). The Pedawan Formation was introduced by Wilford (1965).

M34.

1. Name : Serabang Formation
2. Origin of name : After Serabang village in West Sarawak
3. Age : Upper Jurassic to Lower Cretaceous
4. References : Wilford (1955), Basir Jasin & Aziman Madun (1996)
5. Type area : Sematan and Lundu area in Sarawak
6. Type section : Along the coastline between Tanjung Antu Laut and Kuala Samunsan
7. Boundaries : Unconformably overlain by Kayan sandstone
8. Correlation : Lateral equivalent of Sejingkat Formation.
9. Thickness : $\pm$ 3000 m
10. Lithology : Predominantly argillaceous rocks with susidiary arenaceous rocks, chert, conglomerate and minor tuffite and lava (basic) with some

calc-silicate hornfels and marble

11. Subdivision :
12. Fossils :

radiolaria
Archaeodictyomitra lacrimula (Foreman)
Archaeodictyomitra vulgaris Pessagno
Archaeodictyomitra sp.
Hemicryptocaspa cf. *Prepolyhedra* Dumitrica
Hemicryptocaspa sp.
Parvicingula sp.
Pseudodictyomitra puga (Schaaf)
Thanarla conica (Aliev)
Thanarla pulcra (Squinabol)
Xitus sp.

13. Env. of deposition :
14. Remarks : The Serabang Formation was originally described by Wilford (1955), Liechti *et al*. (1960) included it into Sejingkat Formation. Basir Jasin & Aziman Madun (1996) considered that part of the formation is a melange and renamed the formation as Serabang Complex.

M35.

1. Name : Bau Limestone
2. Origin of name : After Bau town in West Sarawak
3. Age : Upper Jurassic to Lower Cretaceous
4. References : Wilford (1951), Liechti *et al*. (1960), Wolfenden (1965), Pimm (1967)
5. Type area : Bau and Krokong area
6. Type section : Western gorges of Gunung Totang and in Penrissen area.
7. Boundaries : Unconformably overlying the Serian Volcanic Formation.
8. Correlation : In places interbedded with the Pedawan Formation.
9. Thickness : ± 850 m
10. Lithology : Massive dark grey bioclastic limestone with subordinate argillaceous limestone; with calcareous sandstone and conglomerate near the base
11. Subdivision :
12. Fossils :

algae
Clypeina arabeca Elliot
Clypeina hanabatanensis Yabe & Toyama
Clypeina martelli Emberger
Clypeina sp.
Lithocodium aggregatum (Elliot)
Lithocodium japonicum Endo
Lithocodium morikawi Endo
Nipponophycus ramosus Yabe & Toyama
Permocalculus inopinatus Elliot
Petrascula sp.
Pseudoepimastopora jurassica Endo
Salpingoporella annulata Carozzi
Triploporella cf. *ramesi* Steinmann

bivalve
Heterodiceras aff. *luci* (Defrance)

coral
Actinaraea sp.
Adelocoenia bacciformis (Michelin)
Amphiastraea gracilis Koby
Astraraea huzimotoi (Eguchi)
Burgundia semiclathrata (Hayasaka)
Calamophyllia cf. *flabellum* Blainville
Cladocoropsis mirabilis Felix
Cladophyllia ramea Koby
Coralostraea sp.
Cuneiphyllia somaensis (Eguchi)
Donacosmilia cara (Eliasova)
Ellipsactinia cf. *ellipsoidea* Steinmann
Epistreptophyllum cylindratum Milaschewitch
Latiphyllia cartieri (Koby)
Latomeandra ramosa (Koby)
Litharaeopsis fontainei Beauvais
Microphyllia cf. *undans* (Etallon)
Microsolena sp.
Milleporidium cf. *styliferum* Yabe & Sugiyama
Milleporidium fasciculatum Yabe & Sugiyama
Milleporidium steinmanni Yabe & Sugiyama
Parastromopora japonica (Yabe)
?Plesiophyllia cf. *recta* Koby
Stylosmillia sp.
Thamnoseris frotei Etallon

foraminifera
Ammomarginulina sp.
Haplophragmoides sp.
Nautiloculina oolithica Mohler
?Protopeneroplis sp.
Pseudocyclammina cf. *cylindrica* Redmond
Pseudocyclammina lituus (Yokoyama)
Trinosuella peneropliformis Yabe & Hanzawa
Trocholina sp.

13. Env. of deposition : Slowly subsiding shallow marine environment.
14. Remarks : This formation was first introduced as the Bau Series by Wilford (1951) and then formalized by Liechti *et al*. (1960) as Bau Formation. Pimm (1965) changed the name into Bau

Limestone Formation and subsequently Tan (1979) corrected the nomenclature as Bau Limestone.

M36.

1. Name : Sebangan Hornstone
2. Origin of name : After Sebangan town in West Sarawak
3. Age : Cretaceous
4. References : Liechti *et al* (1960), Fitch (1960)
5. Type area :
6. Type section : Southeast of Sebangan town and hills in lower Sadong and Sebuyau valley
7. Boundaries :
8. Correlation : Lateral equivalent of the sejingkat and Serabang Formations.
9. Thickness :
10. Lithology : Chert-like hornstone some of which are silicified volcanic rocks, and amphibolite
11. Subdivision :
12. Fossils :
13. Env. of deposition :
14. Remarks :

2.3. SABAH

M37.

1. Name : Madai-Baturong Formation
2. Origin of name : After Bukit Madai and Bukit Baturong in Darvel Bay area, east Sabah.
3. Age : Upper Cretaceous (Campanian)
4. References : Fitch (1955), Kirk (1962), Leong (1974)
5. Type area : Limestone hills south of Tingkayu valley in Darvel Bay area.
6. Type section : Bukit Madai in Darvel Bay area, east Sabah.
7. Boundaries : Lower boundary is unconformably overlying the crystalline basement, upper boundary is unconformably overlain by the Sabah Complex.
8. Correlation :
9. Thickness : +900 m
10. Lithology : Predominantly massive algal limestone with some pisolitic and oolitic layers.
11. Subdivision :
12. Fossils :

algae
Arabicodium sp.
Baccinella sp.
Cayeuxia cf. *jurassica* var. *lanquinei* Pfender
Cayeuxia cf. *kurdistanensis* Elliot
Cayeuxia piai Frollo
Cayeuxia sp.
Clyperina sp.
Cylindroporella sp.
Girvanella sp.
Lithocodium aggregatum Elliot
Lithophyllum torinosuensis Endo
Maeinella lugeoni Pfender
?Microcalamoides sp.
Munieria sp.
Neomeris sp.
Nipponophycus ramosus Yabe & Toyama
Parachaetetes sp.
Pseudoepimostopora jurasica Endo
Pycnoporidium lobatum Yabe & Toyama
Pycnoporidium cf. *sinuosum* Johns & Kan
Pycnoporidium sp.
Solenopora sp.
Stenoporidium cf. *chaetetiformis* Yabe & Toyama
Stenoporidium sp.
Thaumatoporella parvovesiculifera (Rainei)
Triporella sp.
bivalve
echinoid
foraminifera
Coskinolina sp.
Cuneolina sp.
Dictyoconus sp.
Dicyclina sp.
Hedbergella sp.
Heterohelix cf. *costulata* (Cushman)
Orbitolina lenticularis (Blumenbach) *sensu* Hofker
Orbitolina sp.
Quinquiloculina sp.
Textularia sp.
gastropod
Acteonella borneensis Nutall & Leong
Plesioptypmatis sp.
Nerineidae
scaphopod
Hensonella cf. *cylindrica* Elliot
sponge
Thalamida sp.
undifferentiated
Acicularia sp.
Favreina ochtoochetarisu Palik
Favreina sp.
?Marsonella sp.

13. Env. of deposition : Shallow marine
14. Remarks : Fitch (1955) included these limestones at Bukit Madai and Bukit Baturong into the Eocene Kulapis Formation. Kirk (1962) assigned this limestone as Madai-Baturong Limestone member (Creatceous) of the Chert-Spillite Formation. Leong (1974) upgraded these limestone to the formation status, termed the Madai-Baturong Formation.

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Part 3
CENOZOIC

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INTRODUCTION

The Cenozoic onshore formations reported in Malaysia are compiled into three parts:

1. In Peninsular Malaysia, the Cenozoic is mainly represented by the Quaternary sedimentary deposits. Tertiary rock formations are rather localised and limited. Only six Tertiary formations, occurring as small isolated basins are known. These deposits are distributed from north to south of the peninsula in Bukit Arang-Betong in Perlis, Enggor in Perak, Batu Arang in Selangor, and three in Johor viz., Kepong, Kluang-Niyor and Layang Layang. Quaternary sediments cover about 20% of the peninsular land area, mainly occupying the coastal lowlands of both the east and west coasts with minor occurences in the inland river valleys.

   Two approaches are recognised in the naming of Quaternary sediments of the peninsular. Differentiation into Boulder beds, Old alluvium and Young Alluvium are based on the investigations of the outcrops and exposures of the Kinta Valley in Perak, whereas categorisation of the Simpang Formation, Gula Formation and Beruas Formation are made from the subsurface studies carried out in the lowland areas of Taiping and Beruas in Perak, and Kempadang formation from Kuantan area in Pahang.
2. Cenozoic deposits made up the major rock formations of Sarawak. Most of the formation occupies nearly all of the Central-North area of the state, stretching from Bahagian Kapit to Bahagian Limbang in the northeast. The Central-North region has been referred as the 'Northwest Borneo Geosyncline'. In West Sarawak, the Cenozoic rock units are represented by the Layar Member of Belaga Formation, Kayan sandstone, Lubok Antu Melange, Silantik Formation and its subdivisions, and Plateau Sandstone. A total of 22 rock formations have their type area in Sarawak, while 4 formations, the Temburong, Lambir, Belait and Liang are described from the state of Brunei. Quaternary sediments are widespread, basically occupying the deltaic areas of Batang Tinjar, Batang Rajang and Batang Lupar. Raised beaches are common along the coasts, and in the Bintulu and Sematan areas.
3. In Sabah, Cenozoic deposits basically cover most of the state, exception being the Early Triassic metamorphic rocks of the Crystalline Basement in eastern Sabah and other small outcrops in the Labuk valley, Gunung Kinabalu area, Taritipan and the northern islands, and the Madai–Baturong Limestone in the Semporna Peninsula. Thirty eight Cenozoic rock formations are known, out of which two formational names had been derived from the neighbouring states. The Temburong Formation had its origin of name and type area located in Brunei while the Simengaris Formation had its origin of name from Kalimantan, Indonesia. Sediments of Quaternary age are quite limited, ocurring commonly as narrow rims surrounding the coastal areas of the state.

The Cenozoic formations are listed in Table 3. Figures 8, 9 and 10 show the respective generalised Cenozoic stratigraphies of the more common rock formations of Peninsular Malaysia, Sarawak and Sabah. The locations of type area of the onland Cenozoic formations of Peninsular Malaysia, Sarawak and Sabah are shown in Figures 11, 12 and 13, respectively. It is worth noting that in the fossil lists, the naming follows strictly as that described in the cited references, and no attempt was made to segregate the fossils according to their various ages.

Acknowledgements

The author would like to acknowledge various colleagues in the Geological Survey Department, Hj. Mohd Pauzi Abdullah, Nor Asmah Abdul Aziz of the Sabah Office, Richard Mani Banda and Ab Rashid Ahmad from the Sarawak Office, and other colleagues and friends who are directly or indirectly involve with the preparation of this report. To the MSCRD subcommittee members, the patience, friendship and cordial relations shown throughout the many meetings that we were together, are very much appreciated.

Table 3. List of Cenozoic rock formations in Malaysia

No.	Name	Age
	1. PENINSULAR MALAYSIA	
C1	Coal measures	Upper Oligocene to Lower Miocene
C2	Enggor coal beds	Tertiary
C3	Bukit Arang coal beds	Tertiary (?Miocene)
C4	Niyor formation	Upper Tertiary
C5	Kepong formation	Upper Tertiary (?Upper Miocene)
C6	Layang Layang formation	?Pliocene to Pleistocene
C6.1	Badak Shale member	?Pliocene to Pleistocene
C6.2	Pengeli Sand member	?Pleistocene
C7	Lawin Basin deposits	?Pleistocene
C8	Boulder beds	?Lower to ?Middle Pleistocene
C9	Old alluvium	?Lower to ?Middle Pleistocene
C10	Simpang formation	Pleistocene
C11	Kempadang formation	Pleistocene
C12	Young alluvium	Holocene
C13	Gula formation	Holocene
C13.1	Matang Gelugur member	Holocene
C13.2	Port Weld member	Holocene
C13.3	Parit Buntar member	Holocene
C14	Beruas formation	Holocene
C14.1	Pengkalan member	Holocene
	2. SARAWAK	
C15	Belaga Formation	Upper Cretaceous (Turonian to Maastrichtian) to Upper Eocene
C15.1	Layar Member	Upper Cretaceous
C15.2	Kapit Member	Paleocene to Lower Eocene
C15.3	Metah Member	Middle to Upper Eocene
C15.4	Pelagus Member	Upper Eocene (Liechti *et al.*, 1960), Eocene to Oligocene (Banda & Aji, 1986)
C15.5	Bawang member	Eocene
C16	Kayan sandstone	Upper Cretaceous to Lower Eocene
C17	Julan Formation	Upper Paleocene to Eocene
C18	Mulu Formation	Paleocene to ?Lower Eocene
C19	Kelalan Formation	Paleocene to early Upper Eocene
C19.1	Temala member	Middle to Upper Eocene
C20	Lubok Antu Melange	Matrix indicate Lower Tertiary age, most probably Lower Eocene
C21	Tatau formation	Upper Eocene to Oligocene
C21.1	Sap Marl member	Eocene to Oligocene
C22	Kelabit formation	Lower Oligocene to Lower Miocene
C23	Buan formation	Oligocene
C24	Nyalau Formation	Oligocene to Miocene (Liechti *et al.*, 1960), Miocene (Haile, 1962), Upper Oligocene to Upper Miocene (Kho, 1968)
C24.1	Biban Sandstone Member	Oligocene to Lower Miocene
C24.2	Kakus member	Oligocene? to Miocene
C25	Meligan Formation	Miocene
C26	Melinau Limestone Formation	Upper Eocene to Lower Miocene
C26.1	Melinau limestone	Eocene to Miocene
C26.2	Keramit limestone and marls	Eocene to Miocene
C26.3	Selidong limestone	Eocene to Miocene
C26.4	Batu Gading limestone	Eocene to Miocene
C26.5	Tujoh-Siman limestone	Eocene to Miocene

Table 3. Continued

No.	Name	Age
C27	Temburong formation	Oligocene to Upper Miocene (Wilson & Wong, 1964), Upper Oligocene to Lower Miocene (Brondijk, 1963; Tate, 1994)
C28	Setap Shale Formation	Mainly Miocene (Liechti *et al.*, 1960; Kho, 1968), Oligocene (Banda & Aji, 1986), Upper Miocene (Wilson & Wong, 1964)
C28.1	Batu Blah member	Miocene
C29	Tubau formation	Miocene
C30	Tangap Formation	Lower to Middle Miocene
C30.1	Subis Limestone member	Miocene
C31	Sibuti Formation	Miocene
C32	Silantek Formation	Upper Eocene to ?Miocene
C32.1	Basal Sandstone member	Upper Eocene to ?Miocene
C32.2	Temudok member	Upper Eocene to ?Miocene
C32.3	Upper Silantek Redbed member	Upper Eocene to ?Miocene
C33	Plateau sandstone	?Upper Eocene to ?Upper Miocene
C34	Lambir Formation	Upper Miocene
C35	Belait formation	Miocene to ?Lower Pliocene
C36	Miri formation	Miocene to Pliocene
C37	Tukau Formation	Upper Miocene to Pliocene
C38	Balingian formation	Miocene (Liechti, *et al.*, 1960); ?Upper Miocene (Wolfenden, 1960)
C39	Begrih formation	Upper Miocene to Pliocene (Liechti, *et al.*, 1960), Lower Pliocene (Wolfenden, 1960)
C39.1	Begrih Conglomerate member	Upper Miocene to Lower Pliocene
C39.2	Tunggal-Ransi Conglomerate member	Upper Miocene to Lower Pliocene
C40	Liang formation	Pliocene to Middle Pleistocene
C40.1	Lumut member	
C40.2	Berakas member	
C40.3	Patan member	
		3. SABAH
C41	Chert-Spilite formation	Upper Cretaceous to Eocene (Collenette, 1965a; Fitch, 1955; Kirk, 1962; Leong, 1974; Newton-Smith, 1967), Valanginian to Barremian, Lower Cretaceous to Eocene (Leong, 1977)
C42	Sapulut Formation	Upper Cretaceous to Upper Eocene
C43	Trusmadi formation	Paleocene to Middle Eocene
C44	Crocker formation	?Paleocene-?Lower Oligocene (Newton-Smith, 1967), Paleocene to Lower Miocene (Jacobson, 1970), Paleocene to Miocene
C44.1	Banggi Limestone member	Eocene
C45	East Crocker Formation	Paleocene to Lower Eocene
C46	West Crocker formation	Eocene to Miocene
C46.1	Pa Plandok Marl Member	Upper Eocene to ?Lower Miocene
C47	Kulapis formation	Eocene (Fitch; 1955, 1958), Upper Eocene or Oligocene (Collenette, 1965a), Uncertain, probably Paleogene (Haile and Wong, 1965), ?Oligocene, ?Tcd-?Te1-4 (Newton-Smith, 1967)
C48	Kalumpang Formation	Upper Oligocene to Upper Miocene (Kirk, 1962); Upper Oligocene to Upper Miocene (Lee, 1988); Lower to Middle Miocene (Lim, 1981)
C48.1	Sebatik Sandstone-Shale member	Not differentiated
C48.2	Sipit Limestone member	Not differentiated
C48.3	Sandstone Chert facies	
C48.4	Volcanic facies	

Table 3. Continued

No.	Name	Age
C49	Napu sandstones	?Eocene (Ta-b) - reworked?
C50	Temburong formation	Oligocene to Upper Miocene
C51	Labang formation	Oligocene to Lower Miocene (Collenette, 1965a); Lower Miocene (Haile and Wong, 1965)
C52	Tambang beds	Oligocene to Lower Miocene
C53	Kamansi beds	?Oligocene
C54	Langusan beds	?Oligocene to Lower Miocene or later (Leong, 1974)
C55	Kudat Formation	Miocene
C55.1	Tajau Sandstone Member	Miocene
C55.2	Sekuati Member	Miocene
C55.3	Garau Red Shale Member	Miocene
C55.4	Gomantong Member	Miocene
C55.5	Sirar Member	Miocene
C55.6	Dudar Member	Miocene
C56	Wariu formation	Miocene
C57	Balung formation	Middle to Upper Miocene
C58	Gomantong Limestone formation	Upper Miocene
C59	Meligan Formation	Upper Miocene
C60	South Banggi formation	Upper Miocene
C61	Kuamut formation	Upper Miocene (Collenette, 1965a); Upper Lower Miocene to mainly Upper Miocene (Leong, 1974)
C62	Ayer formation	Upper Miocene
C62.1	Tempadong Limestone member	Miocene (most probable Te5)
C63	Libong Tuffite formation	Upper Miocene
C64	Tanjong formation	Lower to Middle Miocene
C65	Kalabakan formation	Upper Miocene
C66	Bongaya formation	Upper Miocene to younger age
C66.1	Balambangan Limestone member	Upper Miocene
C67	Kapilit formation	Upper Miocene
C68	Simengaris formation	Upper Miocene
C69	Garinono formation	Neogene or younger (Collenette, 1966), Upper Miocene (Lee, 1970), Upper Upper Miocene (Newton-Smith, 1967)
C70	Sandakan formation	Upper Miocene
C71	Tungku formation	Upper Miocene to Lower Pliocene
C71.1	Bagahak Pyroclastic member	
C72	Tabanak Conglomerate	Upper Miocene to ?Pliocene
C73	Sebahat Formation	Upper Miocene to Lower Pliocene
C74	Umas Umas Formation	Upper Miocene to ?Pliocene
C75	Ganduman formation	Pliocene
C76	Timohing formation	Pliocene
C76.1	West Timohing member	?Upper Miocene to Pliocene
C76.2	East Timohing member	Pliocene
C77	Togopi Formation	Pliocene to Pleistocene
C78	Pinosuk gravels	Upper Pleistocene to Holocene

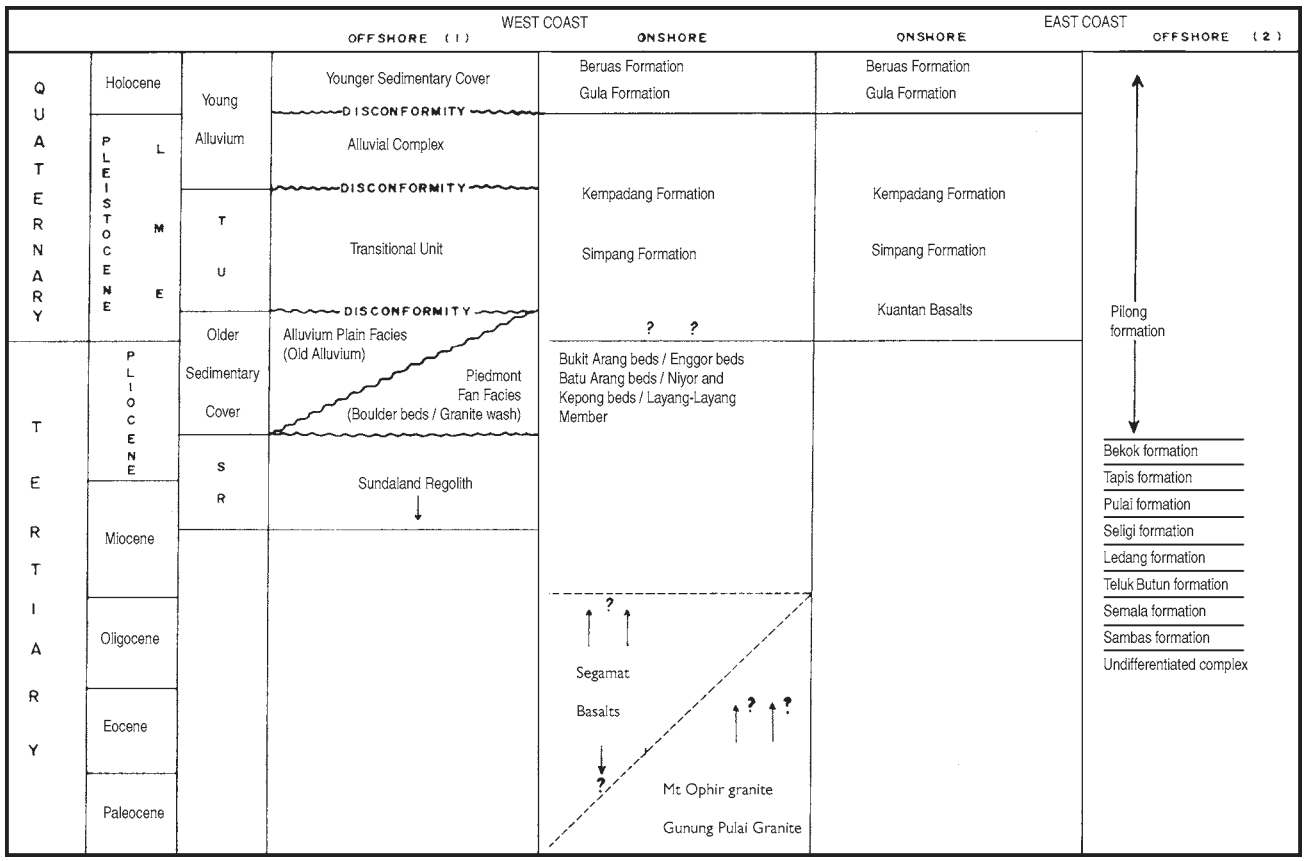

Figure 8. Cenozoic correlation chart for Peninsular Malaysia (after Suntharalingam, 1983).

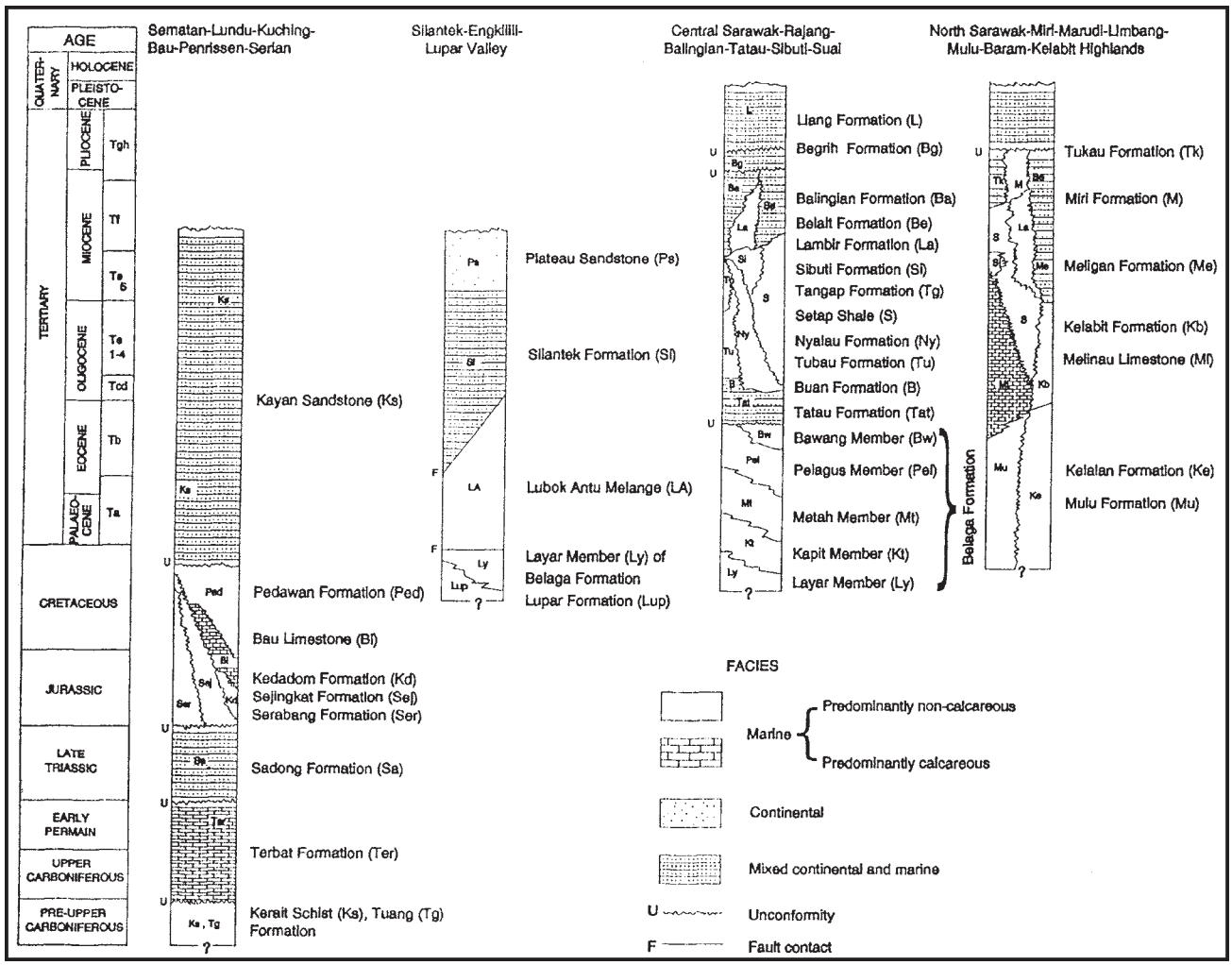

Figure 9. Generalized onland stratigraphy of Sarawak (Chand, 1997).

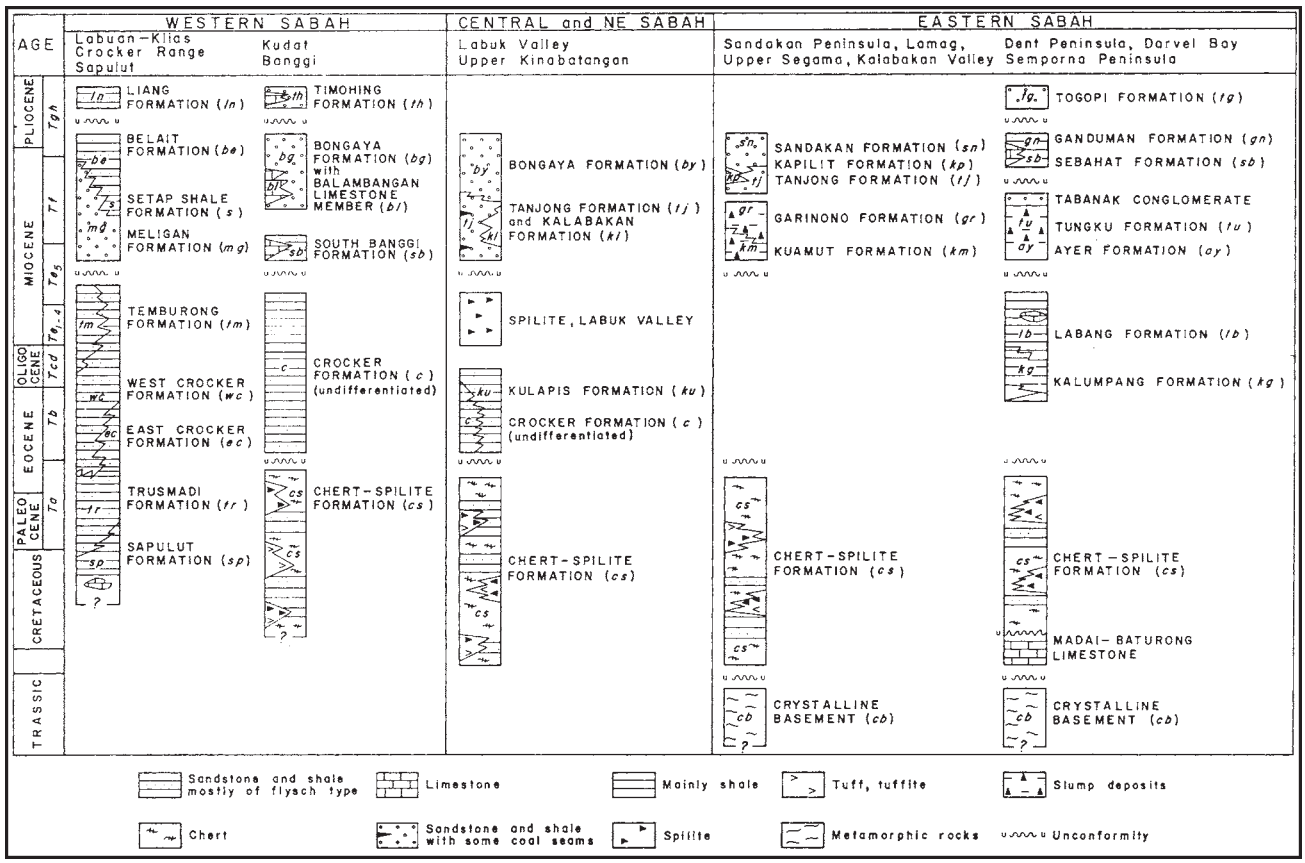

Figure 10. Generalized onland stratigraphy of Sabah (Chand, 1995).

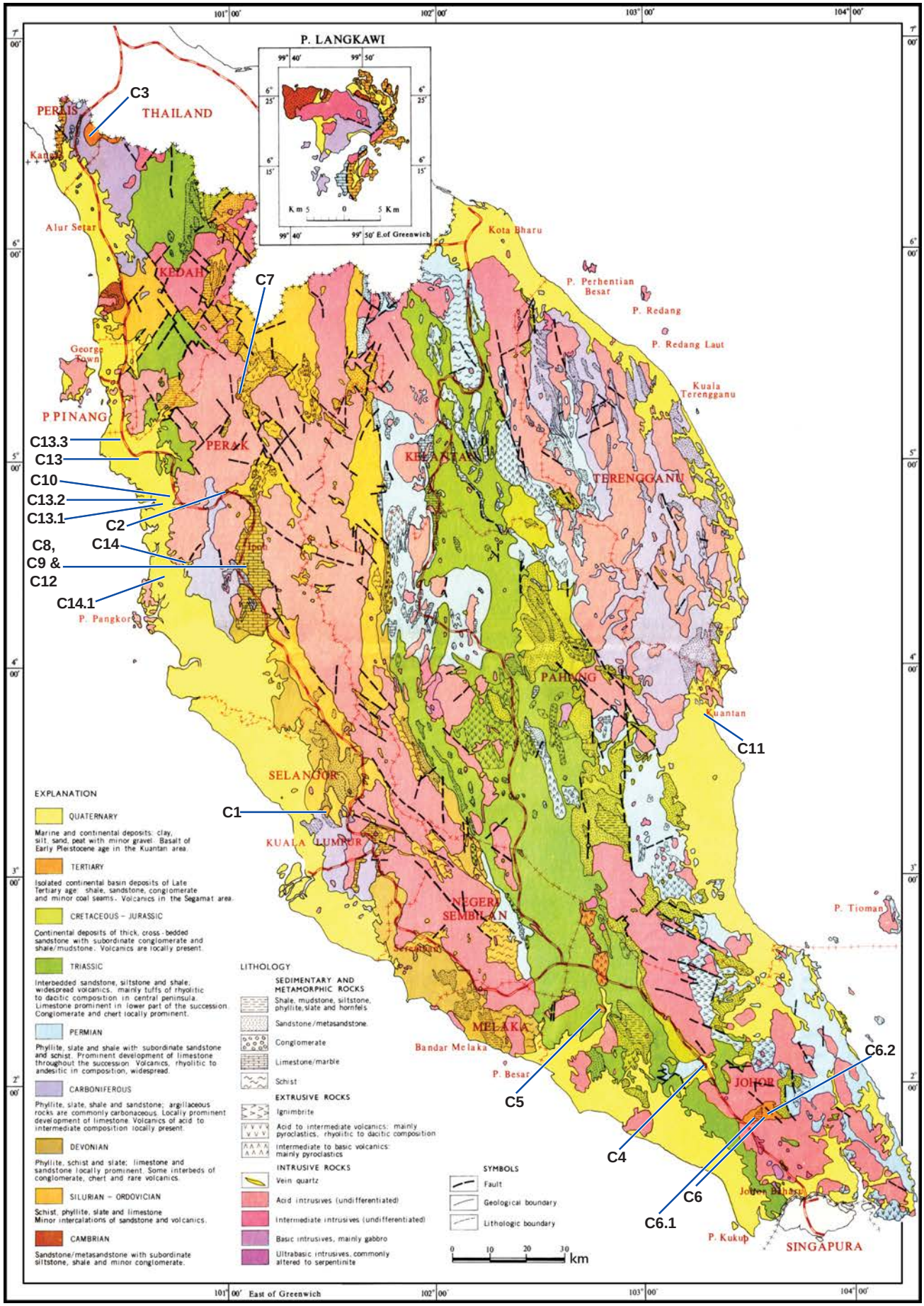

Figure 11. Location of type area of onland Cenozoic rock formations of Peninsular Malaysia. Map reproduced with the permission of the Director-General of Minerals and Geoscience Department Malaysia.

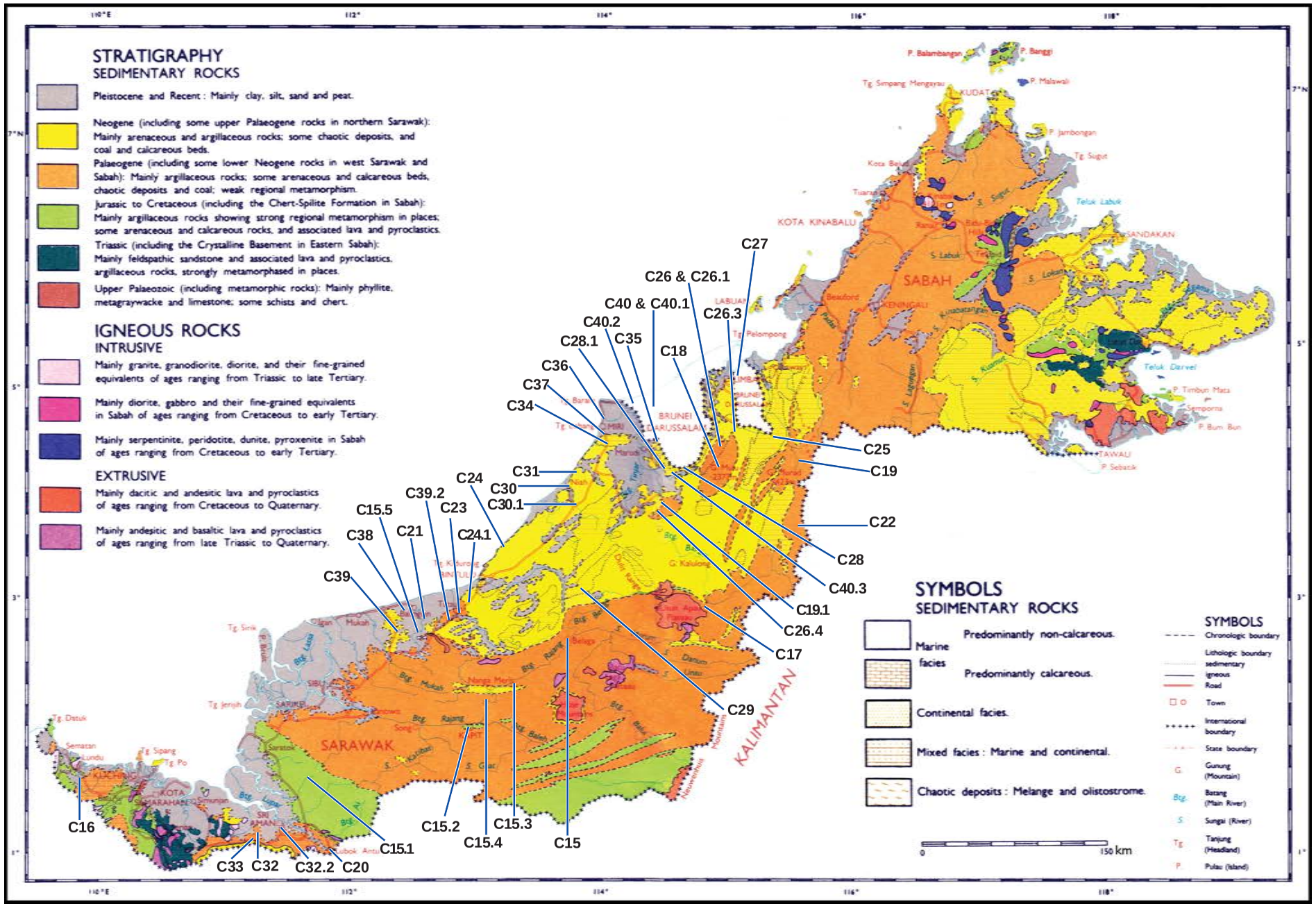

Figure 12. Location of type area of onland Cenozoic rock formations of Sarawak. Map reproduced with the permission of the Director-General of Minerals and Geoscience Department Malaysia.

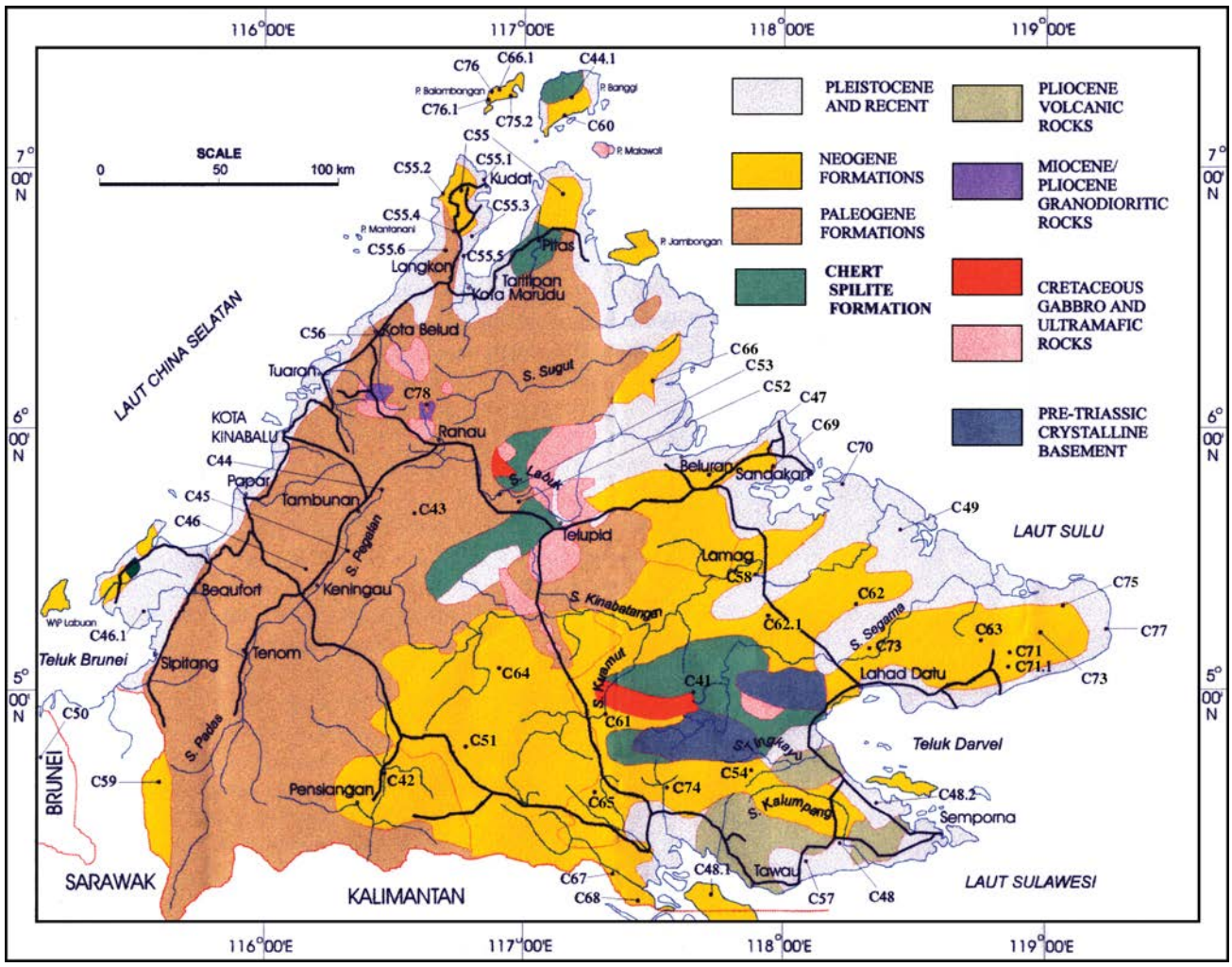

Figure 13. Location of type area of the onland Cenozoic rock formations of Sabah.

3.1. PENINSULAR MALAYSIA

C1.

1. Name : Coal measures
2. Origin of name :
3. Age : Upper Oligocene to Lower Miocene
4. References : Ahmad Munif Koraini (1993), Law (1961, manuscript). Mahendran *et al*. (1991), Roe (1953), Stauffer (1973)
5. Type area : Not specified but refers to the Batu Arang Tertiary beds near Rawang, Selangor.
6. Type section :
7. Boundaries : Unconformably overlying the coal measures are the presumed Pleistocene Boulder Beds while the basal parts made an angular unconformity with the folded Permian? basement rocks.
8. Correlation :
9. Thickness : ± 265 m
10. Lithology : Consists of boulder beds made up of boulders and pebbles of quartzite with fragments of vein-quartz, graphitic schist and chert with gravel, sand or clayey sand as matrix; and coal measures made up of sandstone, shale, coal and sandstone with intercalations of shale, clay and conglomerate.
11. Subdivisions :
12. Fossils :

    algae
    Botryococcus sp.
    Pediastrum sp.
    gastropod
    Viviparus sp.
    palynomorph
    Lagerstroemia sp.
    Nyssapollenites sp.
    Pinuspollenites sp.
    plant (leaves etc.)
    Angiopteris erecta
    Eugenia sp.
    Laurinea sp.
    Macaranga sp.
    Monocarpia marginalis
    Polyalthia sp.
    Tetradenia (Neolitsea) or *Lindera* sp.
    Vaccinium scortechinii?

13. Env. of deposition : Fluvio-lacustrine
14. Remarks : Has been described as coal measures, Batu Arang coal measures, Tertiary coal measures.

C2.

1. Name : Enggor coal beds
2. Origin of name : After Sg. Enggor. Perak
3. Age : Tertiary
4. References : Foo (1990), Ingham (1928), Scrivenor (1917a)
5. Type area :
6. Type section :
7. Boundaries : Lower boundary unconformable over Upper Paleozoic rocks.
8. Correlation : Correlated to coal measures of Batu Arang and Rantau Panjang in Selangor, Durian Condong and Bukit Serampang in Johor, Keluang and Nyiur (also in Johor) and Bukit Arang in Perlis.
9. Thickness : ± 40 m
10. Lithology : Consist of thick uppermost layer of of sandy shale and sandstone followed by thinner zone of grey shale, the first coal seam, thin zone of shale, the second coal seam, black shale and calcareous shale.
11. Subdivisions :
12. Fossils :

    plant
    leaves of monocot and dicot plants

13. Env. of deposition :
14. Remarks : The name was proposed by Foo (1990). It has been earlier referred as Enggor coal field, Enggor coal deposits, Enggor coal beds.

C3.

1. Name : Bukit Arang coal beds
2. Origin of name : After the place Bukit Arang, Perlis
3. Age : Tertiary (?Miocene)
4. References : Alexander *et al*., (1959), Jones (1978), Scrivenor (1913)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation : Correlated to Batu Arang coal measures of Selangor.
9. Thickness : ?> 180 m
10. Lithology : Loose and semi-consolidated deposits of fluvio-deltaic and lacustrine character varying from

variegated plastic clay and shale through sandy clay to running sand, feldspathic grit, gravel and boulder beds. Small seams of soft brown coal occur sparingly. The boulders are waterworn, well rounded and of variable size.

11. Subdivisions :
12. Fossils :
    plant
    leaves of *Tetradenia* sp. or *Lindera* sp.,
    Polyalthia sp. (Anonaceae),
    Eugenia sp. (Myrtaceae)
13. Env. of deposition : Fluviatile or deltaic conditions
14. Remarks : The name was first recorded by Scrivenor (1913). It has been grouped under Arau formation by Alexander *et al*. (1959).

C4.

1. Name : Niyor formation
2. Origin of name : After Niyor town, Johor
3. Age : Upper Tertiary
4. References : Loh (in manuscript), Renwick & Rishworth (1966)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness :
10. Lithology : Poorly consolidated to partly consolidated sand, clay, shale and lignite. The shale is compact pale grey to black and commonly carbonaceous containing abundant decayed plant remains.
11. Subdivisions :
12. Fossils :
    plant (undifferentiated)
13. Env. of deposition :
14. Remarks : Proposed by Loh (in manuscript).

C5.

1. Name : Kepong formation
2. Origin of name : After the village of Kepong, near Pagoh, Johor.
3. Age : Upper Tertiary (?Upper Miocene)
4. References : Alexander (1956), Loganathan (in manuscript)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation : Some beds show resemblance to the rock found at Batu Arang (Selangor) and Enggor (Perak).
9. Thickness : ?± 30 m.
10. Lithology : Interbedded and poorly consolidated volcanic ash, clay, sand layers inercalated with lenses of lignite. Reported occurrences of limestone, shales, coaly shale, oil shale associated with peaty layers.
11. Subdivisions :
12. Fossils :
    gastropod
    Thiara sp.
    Viviparus sp.
    Viviparus ?willbourni
    fish
    teeth
    plant
    remains
13. Env. of deposition : Non-marine, probably lacustrine.
14. Remarks :

C6.

1. Name : Layang Layang formation
2. Origin of name : After the place Layang Layang, Central Johor.
3. Age : ?Pliocene to Pleistocene
4. References : Rajah (1986)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : ± 90 to 150 m.
10. Lithology : See Badak shale member and Pengeli sand member.
11. Subdivisions : Badak shale member and Pengeli sand member
12. Fossils :
    plant
    remains
13. Env. of deposition : Terrestrial.
14. Remarks : Proposed by Rajah (1986). Vijayan (1990) carried out a gravity survey of the Layang-Layang area.

C6.1.

1. Name : Badak Shale member
2. Origin of name : After the former Bukit Badak Estate, Johor
3. Age : ?Pliocene to Pleistocene
4. References : Rajah (1986)
5. Type area :

6. Type section :
7. Boundaries : Basal boundary not exposed. Separated by a thin layer of iron cemented hardpan from the overlying Pengeli sand member.
8. Correlation :
9. Thickness :
10. Lithology : Semi-consolidated to consolidated grey to yellowish-brown sandy clay and layers of clay loam with layers of grey clay and minor orange-yellow clay. Also dove grey, light grey and greyish-brown clay-shale. Pinkish-red to red mottlings are present in places. Subrounded quartz grains and fine laterite or ferricrete pebbles occur quite often in the loam.
11. Subdivisions :
12. Fossils :
    palynomorph
    ?*Pinus* sp.
    plant
    Illipse sp.
    Shorea sp.
    Bruguiera sp.
    Rhizophora sp.
13. Env. of deposition : Intermontane basin/lacustrine
14. Remarks :

C6.2.

1. Name : Pengeli Sand member
2. Origin of name : After Sungai Pengeli, Johor
3. Age : ?Pleistocene
4. References : Rajah (1986)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness :
10. Lithology : Consists mainly of quartzo-feldspathic sand, sandy clay, clayey sand and clay. Colour when fresh ranges from white, creamy white, cream, pale grey and pinkish grey.
11. Subdivisions :
12. Fossils :
13. Env. of deposition :
14. Remarks : Resembles (homologous) the 'Older Alluvium' of Burton (1964).

C7.

1. Name : Lawin basin deposits
2. Origin of name : After Sungai Lawin, Perak
3. Age : ?Pleistocene
4. References : Jones (1970)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : ?> 300 m
10. Lithology : Comprise sequence of poorly graded sediments ranging through sand, grit, gravel and boulder beds. Also include pebbles and boulders of red protoquartzite.
11. Subdivisions :
12. Fossils :
13. Env. of deposition : Delta-like environment
14. Remarks : Proposed by Jones (1970). Comparable in lithology and structure to the late Tertiary basin deposits known at a number of places in the peninsula. However, lignite seams have not been found in the Lawin Basin.

C8.

1. Name : Boulder beds
2. Origin of name :
3. Age : ?Lower to ?Middle Pleistocene
4. References : Stauffer (1973), Walker (1955)
5. Type area :
6. Type section :
7. Boundaries : The 'Boulder Beds' form the basal part of the unconsolidated sediments overlying the (weathered) bedrock, and commonly overlain by the 'Old Alluvium'.
8. Correlation :
9. Thickness : ± 300 m
10. Lithology : Conglomerates of subangular boulders, deeply but variously weathered, some granite boulders are distinguishable. The boulders are largely embedded in tough sandy clay. Beds of sorted sand, clay and pebbles and highly compressed seams of organic mud are also present.
11. Subdivisions :
12. Fossils :

13. Env. of deposition : Colluvial, eluvial, water-washed boulder gravels
14. Remarks : The term 'Boulder Beds' is classified from the study of the alluvial deposits in the Kinta Valley by Walker (1956), Ingham and Bradford (1960). Other related deposits have been decribed by Scrivenor (1912, 1949) as 'Gopeng Beds', Rastall (1927) as 'Tekka Clays', Willbourn (1936) as 'Western Boulder Clays'.

C9.

1. Name : Old alluvium
2. Origin of name :
3. Age : ?Lower to ?Middle Pleistocene
4. References : Kamaludin *et al.* (1993), Stauffer (1973), Walker (1955), Ingham and Bradford (1960), Sivam (1969).
5. Type area :
6. Type section :
7. Boundaries : In the Kinta Valley weathered limestone or 'Boulder 'Beds' underlie the 'Old Alluvium', at some localities the 'Young Alluvium' forms the overlying sediments and the contact is an unconformity.
8. Correlation :
9. Thickness : > 50 m
10. Lithology : Gravel, sand, silt and clay in all possible mixtures, together with peaty sediments, peat, and accumulations of partly lignitized wood and logs.
11. Subdivisions :
12. Fossils :

mammal
Palaeoloxodon namadicus (elephant tooth)
palynomorphs (pollen, spores & others)
pollen
Acanthus sp.
Aglia sp.
Aidia/Randia type
Alangium sp.
Alstonia sp.
Altingia sp.
Aphanamixis sp.
Arytera littoralis
Austrobuxus sp.
Avicennia sp.
Baccaurea sp.
Blumeodendron sp.
Bouea sp.
Brownlowia sp.
Bruguiera sp.
Calamus sp.
Calophyllum sp.
Campnosperma auriculatum
Campnosperma sp.
Capparis sp.
Casearia sp.
Castanopsis/Lithocarpus type
Casuarina equisetifolia
Casuarina sp.
Celtis sp.
Chionanthus elaeocarpus
Chisocheton sp.
Clerodendrum sp.
Combretocarpus rotundatus
Combretocarpus sp.
Cyperaceae
Daemunorops verticillaris
Dendrophthoe pentandra
Dillenia sp.
Diospyros sp.
Durio sp.
Dysoxylum sp.
Elaeocarpus sp.
Ericaceae undiff.
Eugenia sp.
Euodia sp.
Ficus sp.
Flacourtia sp.
Flagellaria sp.
Freycinetia sp.
Garcinia sp.
Glochidion sp.
Gramineae
Homalanthus sp.
Hopea sp.
Hymenodicton sp.
Iguanura sp.
Ilex sp.
Klienhovia hospita
Korthalsia sp.
Leguminosae undiff.
Lepisanthes sp.
Lithocarpus sp.
Lophopetalum multinervium
Lumnitzera sp.
Macaranga sp.
Macaranga/Mallotus
Mallotus sp.
Malvaceae

Melastoma sp.
Melastomataceae undiff.
Meliaceae
Menispermaceae undiff.
Mesua sp.
Moraceae/Urticaceae type
Myrica sp.
Myristica sp.
Myrtaceae
Nepenthes sp.
Nephelium sp.
Nephrolepis sp.
Nypa fruticans
Oncosperma sp.
Oncosprma tigillarium
Palmae
Pandanus sp.
Phoenix paludosa
Phyllanthus sp.
Pinanga sp.
Podocarpus imbricatus
Podocarpus polystachyus
Quercus sp.
Randia sp.
Rhizophora sp.
Rhizophoraceae
Rhopaloblaste sp.
Salacca sp.
Santiria laevigata
Sapindus sp.
Sapium sp.
Sapotaceae
Sapotaceae/Meliaceae
Schefflera sp.
Schuurmansia sp.
Scolopia sp.
Shorea sp.
Sonneratia caseolaris
Sonneratia ovata
Sonneratia sp.
Spondias sp.
Stemonurus sp.
Sterculia sp.
Symplocos adenophylla
Terminalia sp.
Tetracera sp.
Xylocarpus sp.
spore
Acrostichum sp.
Acrostichum aureum
Acrostichum speciosum
Blechnum indicum
Cyathea sp.
Davallia sp.
Lindsaea sp.
Lycopedium cernuum
Lycopodium phlegmaria
Microtropis sp.
Selaginella sp.
Selaginella planata
Selaginella roxburghii
Stenochlaena palustris
Taenitis sp.
other palynomorphs
Chomotriletes circulus
Chomotriletes sp.
plant
remains (incl. logs)

13. Env. of deposition : Coastal/estuarine, fluvial
14. Remarks : The term 'Old Alluvium' was classified from the study of the alluvial deposits in the Kinta Valley by Walker (1956), Ingham and Bradford (1960), Sivam (1969). Other related deposits have been referred as 'High Level Alluvium' by Rastall (1927), Jones (1978), and 'Older Alluvium' by Burton (1964), 'Simpang Formation' by Suntharalingam and Teoh (1985).

C10.

1. Name : Simpang formation
2. Origin of name : From boreholes at Simpang in Taiping, Perak
3. Age : Pleistocene
4. References : Suntharalingam & Teoh (1985), Suntharalingam (1987), Loh (1992)
5. Type area :
6. Type section :
7. Boundaries : Unconformable basal boundary with bedrock. Conformable upper boundary with Gula formation.
8. Correlation :
9. Thickness : > 30 m.
10. Lithology : Made up predominantly of clay, silt and sand with subordinate amounts of gravel towards the lower part of the succession. The sediments are usually mixtures of gravel, sand, silt and clay; the sand and clay are also found intercalated with one another. Peat and peaty clay are also present.

11. Subdivisions :
12. Fossils :
plant
remains
13. Env. of deposition : Fluvial
14. Remarks : Suntharalingam & Teoh (1985) stated the formation as equivalent to the 'Old Alluvium' of Walker (1956).

C11.

1. Name : Kempadang formation
2. Origin of name : From borehole at Kampong Kempadang, near Kuantan in Pahang
3. Age : Pleistocene
4. References : Bosch (1986), Che Ghani Ambak (1983), Loh (1987) and Suntharalingam (1983)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : < 7 m
10. Lithology : Grey to olive brown clay, silt and sand deposited in marine environment.
11. Subdivisions :
12. Fossils : mollusc, brachiopod, echinoderm, foraminifera, ostracod, palynomorph
13. Env. of deposition : Marine
14. Remarks : Referred by Che Ghani Ambak (1983) as the 'Older Marine Unit'. Referred as 'Kempadang Formation by Bosch (1986).

C12.

1. Name : Young alluvium
2. Origin of name :
3. Age : Holocene
4. References : Stauffer (1973), Walker (1955)
5. Type area :
6. Type section :
7. Boundaries : Overlies the 'Old alluvium', 'Boulder beds' or bedrock unconformably
8. Correlation :
9. Thickness : < 35 m
10. Lithology : Unconsolidated deposits of sand and gravel with some peat and clay.
11. Subdivisions :
12. Fossils :
plant
remains
13. Env. of deposition : Fluvial
14. Remarks : The term 'Young Alluvium' is from a study of the alluvial deposits in the Kinta Valley by Walker (1956). Other related deposits have been referred as 'Low Level Alluvium' by Jones (1978), 'Beruas Formation' by Suntharalingam & Teoh (1985).

C13.

1. Name : Gula formation
2. Origin of name : From borehole at Gula near Taiping, Perak
3. Age : Holocene
4. References : Suntharalingam & Teoh (1985), Suntharalingam (1987), Loh (1992)
5. Type area :
6. Type section :
7. Boundaries : Often underlain by Simpang formation or the bedrock. The overlying sediments is the Beruas formation.
8. Correlation :
9. Thickness : < 40 m
10. Lithology : Mainly made up of clay and silt while sand and gravel in small amount. Organic matter and shells are present.
11. Subdivisions : Matang Gelugur member, Port Weld member and Parit Buntar member.
12. Fossils :
foraminifera
Ammonia beccarii (Linne)
Asterorotalia pulchella (d'Orbigny)
Cellanthus craticulatus (Fitches & Moll)
Elphidium cf. *mecallum*
Pseudorotalia schroeteriana
Quinqueloculina sp.
Spiroloculina sp.
Triloculina sp.
gastropod
Coralliophila sp.
Cryptospira sp.
Cylichna sp.
Gemmula sp.
Natica sp.
Pyramidellacea sp.

Sinum sp.
?Stenothyra sp.
Terebra sp.
Trochus s.l.
Turritella cingulifera GB Sowerby
Zeuxis cf. *dorsatus* (Roding)
ostracod
Alocopocythere reticulata indoaustralica Hartmann
Bicornucythere papuensis (Brady)
Carinocythereis hamata Muller
Cyprideis sp.
Cytherella semitalis (Brady)
Cytherelloidae cf. *semireticulata* Keij
Hemicytheridea aff. *paiki* Jain
Neocyprideis (Miocyprideis) sp.
Neomonoceratina cf. *delicata* Ishizaki & Kato
pelecypod
Anadara sp.
Arcopagia s.l.
Calyptraea sp.
Corbula sp.
Laevicardium sp.
Lucinacea
Nucula sp.
Nuculana sp.
Ostrea sp.
Pitar s.l.
Semelangulus sp.
Sinodia sinuata (Gmelin)
Timoclea sp.
Trisidos cf. *tortuosa* (Lamarck)
others
Balanus sp.
Dentalium s.l.
echiniod spine

13. Env. of deposition : Shallow marine to estuarine
14. Remarks : The upper part is differentiated by Suntharalingam & Teoh (1985) into Matang Gelugor member and Port Weld member, and Parit Buntar member by Kamaludin (1989).

C13.1.

1. Name : Matang Gelugur member
2. Origin of name : From borehole at Kampong Matang Gelugur in Taiping, Perak.
3. Age : Holocene
4. References : Suntharalingam & Teoh (1985), Suntharalingam (1987), Loh (1992)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : ± 4 m
10. Lithology : The composition of the sediments varies from clayey sand to sand with rare layers or lenses of clay. Sand is mainly in the upper part while clayey sand is common in the lower part of the succession.
11. Subdivisions :
12. Fossils :

gastropod
Sinum sp.
Turbinella angulatus
pelecypod
Anadara sp.
Arcopagia sp.
Malleus anatinus
plant
remains

13. Env. of deposition : Beach ridge, chenier, shallow marine (coastal)
14. Remarks :

C13.2.

1. Name : Port Weld member
2. Origin of name : From borehole at Port Weld (Kuala Sepetang), Perak
3. Age : Holocene
4. References : Suntharalingam & Teoh (1985), Suntharalingam (1987)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : ± 2 m
10. Lithology : Predominantly clay with occasional lenses or layers of fine to medium sand and silt. The clay varies from brown-black or brownish grey to greenish grey. The clay generally consists of moderate to abundant humic material layered or arranged in haphazard manner.
11. Subdivisions :
12. Fossils :

palynomorph
Acrostichum sp.
Avicennia sp.
Brownlowia sp.
Nypa sp.
Rhizophora sp.

Sonneratia caseolaris
13. Env. of deposition : Marine origin
14. Remarks : The Port Weld member is distinguished from the undifferentiated clays of the Gula formation by the black grey or brown grey colour, abundant plant remains, typical mangrove pollen types and general absence of marine shells.

C13.3.

1. Name : Parit Buntar member
2. Origin of name : From borehole at Parit Buntar, Perak
3. Age : Holocene
4. References : Kamaludin (1989)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : ± 3 m
10. Lithology : Grey to brownish black clay, silt, in places thin layers of sand and gravel, and peat.
11. Subdivisions :
12. Fossils :
palynomorph
Palmae
Pandanaceae
Rhizophora spp.
13. Env. of deposition : Back mangrove
14. Remarks : Differentiated from Port Weld member by the environment of deposition.

C14.

1. Name : Beruas formation
2. Origin of name : From borehole at Beruas, Perak
3. Age : Holocene
4. References : Suntharalingam & Teoh (1985), Suntharalingam (1987), Loh (1992)
5. Type area :
6. Type section :
7. Boundaries : Overlies Simpang formation and Gula formation conformably.
8. Correlation :
9. Thickness : ± 5 m
10. Lithology : Made up of clay, peat, sandy clay and to a lesser extent sand and gravels.
11. Subdivisions : Pengkalan member
12. Fossils :
plant
remains
13. Env. of deposition : Fluvial
14. Remarks : Presumed equivalent to 'Young Alluvium' of Walker (1955).

C14.1.

1. Name : Pengkalan member
2. Origin of name : From borehole at Pengkalan Baharu in Beruas, Perak
3. Age : Holocene
4. References : Suntharalingam & Teoh (1985), Suntharalingam (1987), Loh (1992)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : ± 6 m
10. Lithology : Generally made up of brown, brown-black to black peat with minor amounts of silt and clay. The clay is brown to brown-grey with slight to abundant amounts of humic and plant materials.
11. Subdivisions :
12. Fossils :
palynomorph
Callophyllum sp.
Casuarina sp.
Flagellaria indica
Nepenthes sp.
Pandanus sp.
Sonneratia caseolaris
Gleichenia sp.
Lygodium scandens
Lygodium sp.
Selaginella cf. vaginata type
Stenochlaena palustris
plant
remains
13. Env. of deposition : Freshwater swamp
14. Remarks :

3.2. SARAWAK

C15.

1. Name : Belaga Formation
2. Origin of name : The Belaga Area, Bahagian Sri Aman
3. Age : Upper Cretaceous (Turonian to Maastrichtian) to Upper Eocene
4. References : Liechti *et al*. (1960), Wolfenden (1960).
5. Type area : Entire Rajang River area
6. Type section : See the various Members
7. Boundaries : The basal boundary is exposed in the Lupar area only, where it is a gradual transition into the Lupar Formation.
8. Correlation : Tate (1991) correlated the Embaluh Group in Kalimantan as equivalent of the Layar and Kapit Members of the Belaga Formation.
9. Thickness : ? 10,350-16,900 m.
10. Lithology : Submetamorphic or semi-metamorphic shale succession of huge thickness with intercalations of greywacke and subgreywacke sandstones. From the lower Rajang area, Wolfenden (1968), defined the lithology to consist predominantly of dark shale that has been dynamically metamorphosed to argillite, slate, and some phyllite; unmetamorphosed shale and mudstone are rare. In addition, subordinate graywacke sandstone, rare subgraywacke sandstone, and rare graywacke conglomerate, also occur.
11. Subdivisions : Pelagus Member, Metah Member, Kapit Member, Layar Member. Wolfenden (1960), based on paleontological evidence, differentiated four stages (Stage I to Stage IV) of the Belaga Formation in the lower Rajang area.
12. Fossils : Refer Member
13. Env. of deposition : Fully marine conditions of outer neritic to bathyal
14. Remarks : The term Belaga Formation (Belaga Series of De Boer & Milroy, *1952*) unites the now obsolete Rajang Series and part of Shale-Quartzite Series.

C15.1.

1. Name : Layar Member
2. Origin of name : Batang Layar in Bahagian Sri Aman.
3. Age : Upper Cretaceous
4. References : Kirk (1957), Liechti *et al.* (1960), Tan (1979)
5. Type area :
6. Type section : The section along the Batang Layar, a right hand tributary of the Saribas about 44 km northeast of Sungai Engkari, a tributary of Batang Ai.
7. Boundaries : The basal boundary is a gradual transition into the Lupar Formation (Liechti *et al*., 1960). However Tan (1979) indicate that the contact between Layar Member and the Lupar Formation is a fault. The top of the Layar Member grades upwards into the Kapit Member.
8. Correlation :
9. Thickness : ± 2,000-4,100 m
10. Lithology : Quartzitic sandstones alternate with black shales (Liechti *et al*., 1960). Tan (1979), defined as composed mainly of slate and phyllite with rhythmically interbedded metagraywacke.
11. Subdivisions :
12. Fossils :

    foraminifera

    Bathysiphon spp.
    Globotruncana spp.
    Glomospira 8
    Haplophragmoides sp.
    Nonion 16
    Orbitolina sp.
    Psammosiphonella sp.
    Textularia spp.
    Trochamminoides spp.

    molluscs
13. Env. of deposition : Marine environment, distal turbidite.
14. Remarks : Proposed by Jordi, H.A. and Bowen J.M. in 1956. Layar Member is equivalent to Belaga Formation, Stage I of Wolfenden (1960).

C15.2.

1. Name : Kapit Member
2. Origin of name : After Kapit town, Bahagian Kapit
3. Age : Paleocene to Lower Eocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : The Rajang River section from the Lower Baleh to Sg. Katibas and its southern affluents in the vicinity of Kapit town
7. Boundaries :
8. Correlation :
9. Thickness : ± 3,000 to 6,700 m
10. Lithology : Consists predominantly of shales, the purple and red colors are a striking characteristic of parts of the member. Dark grey and grey-green types of shale are also common. Sandstones are probably less than 10 % of the total. Wolfenden (1960) noted that in the lower Rajang area, the Stage II rocks are closely similar to those in Stage I, in that predominantly steeply dipping, low-grade dynamically metamorphosed, argillaceous rocks (argillite, slate, and some phyllite) with graywacke and rare beds of graywacke conglomerate.
11. Subdivisions :
12. Fossils : Fossils from Wolfenden (1960) Stage II are also included in the list below.

foraminifera

Alveolina (Flosculina) globosa Leymerie
Alveolina oblonga d'Orbigny
Alveolina sp.
Ammodiscus sp.
Anomalina sp.
Assilina sp.
Asterigerina sp.
Bathysiphon spp.
Bulimina sp.
Cibicides spp.
Cristellaria spp.
Cyclammina spp.
Discocyclina sp.
Gaudryina spp.
Globigerina sp.
Globobulimina spp.
Globorotalia aragonensis Nuttall
Globorotalia cf. *aragonensis* Nuttall var. *caucasica* Glaessner
Globorotalia cf. *angulata* White
Globorotalia cf. *crassa* (d'Orbigny) var. *pentacamerata* Subbotina
Globorotalia wilcoxensis Cushman & Ponton
Globorotalia spp.
Glomospira spp.
Haplophragmoides spp.
Lockhartia sp.
Miscellanea miscella d'Archiac & Haime
Nonion spp.
Nummulites atacicus Leymerie type
Nummulites globulus Leymerie type
Nummulites javana Verbeek type
Nummulites cf. *javanus* Verbeek, A form
Nummulites nuttalli Davies
Nummulites sp.
Pellatispira sp.?
Quinqueloculina sp.
Reusella sp.
Sigmoilina spp.
Somalina cf. *stefanini* Silvestri
Trochammina spp.
Trochamminoides spp.

13. Env. of deposition :
14. Remarks : Proposed by Jordi & Bowen (1956). Kapit Member is equivalent to Belaga Formation, Stage II of Wolfenden (1960).

C15.3.

1. Name : Metah Member
2. Origin of name : Sungai Metah, Bahagian Kapit
3. Age : Middle to Upper Eocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : Sungai Metah, a right hand tributary of the Rajang River, originating south of Bt. Mersing
7. Boundaries :
8. Correlation :
9. Thickness : ± 1,300 to 3,900 m
10. Lithology : Made up of interbedded sandstones and shales. The sandstones rarely exceed 1 m thick while the shales are dark grey or grey and often carbonaceous. Wolfenden (1960) noted that in the lower Rajang area, the Stage III rocks are superficially similar to those in Stages I and II, in particular to those in the lower part of Stage II. Stage III is probably

more arenaceous than any other stage of the Belaga Formation but even so argillaceous rocks still predominate, and are made up of argillite, slate, occasional phyllite, graywacke, and rare beds of graywacke conglomerate.

11. Subdivisions :
12. Fossils : Fossils from Wolfenden (1960) Stage III are also included in the list below.

bivalve
Astarte sp.
foraminifera
Ammodiscus sp.
Anomalina sp.
Assilina sp.
Bathysiphon spp.
Cassidulina sp.
Cibicides spp.
Cristellaria spp.
Cyclammina spp.
Dentalina spp.
Discocyclina sp.
Gaudryina spp.
Globigerina dissimilis Cushman & Bermudez
Globigerina sp.
Globigerinoides orbiformis-mexicana group
Globigerinoides sp.
Globobulimina spp.
Globorotalia centralis Cushman & Bermudez
Globorotalia cf. *centralis* Cushman & Bermudez
?*Globorotalia cerro-azulensis* Cole
Globorotalia crassata Cushman
Globorotalia spp.
Glomospira spp.
Gyroidina sp.
Haplophragmoides spp.
Marginulina sp.
*Nodo*saria spp.
Nonion spp.
Nummulites sp.
Operculina sp.
Pellatispira cf. *glabra* Umbgrove
Pellatispira inflata (Umbgrove)
Pellatispira cf. *madaraszi* Hantken
Pellatispira orbitoidae (Umbgrove)
Rotalia sp.
Sigmoilina spp.
Textularia 44
Trochammina spp.
Trochamminoides spp.
Uvigerina sp.
Verneuilina spp.

13. Env. of deposition :
14. Remarks : Proposed by Jordi & Bowen *(1956)*. Metah Member is equivalent to Belaga Formation, Stage III of Wolfenden (1960).

C15.4.

1. Name : Pelagus Member
2. Origin of name : Pelagus rapid, Bahagian Kapit
3. Age : Upper Eocene (Liechti *et al.*, 1960), Eocene to Oligocene (Banda & Aji, 1986)
4. References : Banda & Aji (1986), Liechti *et al.* (1960)
5. Type area :
6. Type section : The Rajang River section in the area of the Pelagus Rapids
7. Boundaries :
8. Correlation :
9. Thickness : ± 3,200 to 6,000 m
10. Lithology : Massive sandstones beds several metres thick interbedded with grey shales and thin sandstones and siltstones. Wolfenden (1960) noted that in the lower Rajang area, the Stage IV rock types are shale, mudstone, argillite, slate, rare phyllite, sandstone, and conglomerate.
11. Subdivisions :
12. Fossils : Fossils from Wolfenden (1960) Stage IV are also included in the list below.

bivalve
?Divaricella sp.
foraminifera
Aktinocyclina sp.
Bathysiphon spp.
Cyclammina sp.
Discocyclina sp.
Fasciolites sp.
Gaudryina spp.
Globigerina sp.
Globobulimina spp.
Globorotalia centralis Cushman & Bermudez
Globorotalia cerroazulensis Cole
Hantkenina alabamensis Cushman
Haplioghragmoides walteri (Greybowski)
Haplioghragmoides spp.
Nummulites sp.
Operculina sp.
Pellatispira cf. *madaraszi* Hantken
Pellatispira sp.

Rotalia sp.
Textularia sp.
Trochammina spp.
Trochamminoides spp.
Verneuilina spp.
Vulvulina sp.

13. Env. of deposition : Shallow to deep marine environment
14. Remarks : Proposed by Jordi & Bowen *(1956)*. Pelagus Member is equivalent to Belaga Formation, Stage IV of Wolfenden (1960).

C15.5.

1. Name : Bawang member
2. Origin of name : Sungai Bawang, Bahagian Bintulu
3. Age : Eocene
4. References : Liechti *et al*. (1960), Wolfenden (1960)
5. Type area : Restricted to the Tatau Horst and the core of the large Arip-Pelagau Anticline
6. Type section :
7. Boundaries : The member is overlain unconformably by the Tatau Formation, or locally, by the Tunggal-Ransi conglomerate.
8. Correlation :
9. Thickness : Unknown
10. Lithology : Blue-grey to grey-black shales, sometimes slaty but usually soft. Thin beds of fine grained sandstones are present.
11. Subdivisions :
12. Fossils : Only poor fauna of crushed foraminifera found.
13. Env. of deposition : Speculated to represent the highly argillaceous probably bathyal equivalent of the Metah Member
14. Remarks : Proposed by de Boer and Milroy in *1952* as Bawang Shale Formation. Wolfenden (1960) introduced the term Bawang Member.

C16.

1. Name : Kayan sandstone
2. Origin of name : Presumably the Kayan River (Batang Kayan), Bahagian Kuching
3. Age : Upper Cretaceous to Lower Eocene
4. References : Kho (1965), Muller (1968), Tan (1993), Wolfenden and Haile (1963)
5. Type area : Considered type section along the Bau-Lundu Road cutting through the Kayan Basin as most appropriate 'type area'.
6. Type section : The Bau-Lundu Road cutting, Bahagian Kuching (Tan, 1993).
7. Boundaries : Overlies with slight angular unconformity, the Pedawan Formation in the Santubong peninsula. The upper part of the Kayan sandstone is an erosional surface, in places unconformably overlain by Recent alluvium.
8. Correlation :
9. Thickness : ± 760 to 4,000 m
10. Lithology : Consists of thick-bedded, current-bedded to massive pebbly to medium-grained sandstone, with lenses of polymict and mudflake conglomerate, intercalated with sequences of thin-bedded, fine-grained sandstone which is regularly interbedded with siltstone, shale, and mudstone.
11. Subdivisions :
12. Fossils : Fossil palynomorphs of the 'Plateau Sandstone' (Muller, 1968; Wolfenden and Haile, 1963), which has been redefined as the 'Kayan sandstone' (Tan, 1993), is listed below;

fish
Odontaspis macrota Aggasiz
gastropod
?Genotia (Pseudotoma) pseudomelongena Martin
?Nassarius sp. indet.
Turritella (?Haustator) boettgeri Martin
Volutocorbis cf. *ptychochilus* (Boettger)
?Buccinid gen. et sp. indet.
?Naticid or Turbinid gen. et sp. indet.
palynomorph (dinoflagellate)
Odontochitina sp.
Gymnodinium sp.
Hystrichosphaera/Hystrichosphaeridium type palynomorph
Acanthotriletes levidensis Balme
Apiculatisporis ferox Muller
Appendicisporites tricornitatus (Weyland and Greifeld) Couper
Cicatricosisporites sp. cf. *C. dorogensis* (Potonie & Gelletich) Couper
Distaverrusporites margaritatus Muller

Distaverrusporites simplex Muller
Matonisporites equiexinus Couper
Polypodiaceoisporites retirugatus Muller
Alisporites similis (Balme) Dettman
Araucariacites australis Cookson
Caytonipollenites pallidus (Reissinger) Couper
Classopollis sp. cf. *C. classoides* Pflug emend. Pocock & Jansonius
Ephedripites jansonii (Pocock) Muller
Ephedripites multicostatus Brenner
Ephedripites ovalis Muller
Ephedripites sp. cf. *E. jansonii* (Pocock) Muller
Ephedripites type D
Ginkgocycadophytus nitidus (Balme) de Jersey
Inaperturopollenites scabratus Muller
Pinuspollenites sp. cf. *P. spherisaccus* Brenner
Rugubivesiculites reductus Pierce
Zonalapollenites sp.
Anacolosidites sp.
Aquilapollenites wilfordi Muller
Dactylopollis magnificus Muller
Dicolpopollis elegans Muller
Dicolpopollis malesianus Muller
Discoidites borneensis Muller
Echistephanoporites obscurus Muller
Echitriporites irregularis Muller
Echitriporites trianguliformis van Hoeken-Klinkenberg
Gemmatricolpites pergemmatus Muller
Myrtaceidites sp.
Proxapertites cursus van Hoeken-Klinkenberg
Proxapertites operculatus van der Hammen
Psilatricolpites kayanensis Muller
Psilatricolporites acuticostatus Muller
Psilatricolporites prolatus Pierce
Psilodiporites wolfendeni Muller
Retitricolpites peroblatus Muller
Retitricolpites sarawakensis Muller
Retitricolpites vulgaris Pierce
Retitricolporites crucipori Muller
Retitricolporites semistriatus Muller
Retitriporites aspidopori Muller
Retitriporites variabilis Muller
Rugulitriporites vestibulipori Muller
Sapotaceoidaepollenites robustus Muller
Spinizonocolpites baculatus Muller
Spinizonocolpites echinatus Muller
Striatricolporites conspicuus Muller
Striatricolporites minor Muller
Triorites festatus (Takahashi) Muller
Triorites minutipori Muller
Triorites tenuiexinis Muller
Verrutriporites lunduensis Muller
other palynomorph
Exesipollenites tumulus Balme
Pediastrum paleogeneites Wilson & Hoffmeister
pelecypod
Cardium cf. *eduliform*e Boettger
Cardium cf. *subfragil*e Boettger
?Cytherea suessonensis Deshayes
Nucula cf. *studeri* d'Archiac
Ostrea sp. indet.
plant
silicified fossil wood
radiolaria
Adelocyrtis? sp.
Cenosphaera sp.
Cerasosphaera sp.
Dicolocapsa sp.
Dictyocephalus? sp.
*Dictyomitr*a sp.
*Dorysphaer*a sp.
Heterosestrum? sp.
Lophoconus sp.
Melitosphaera sp.
Stylostaurus sp.

13. Env. of deposition : Fluviatile-deltaic-estuarine environment
14. Remarks : Had been earlier referred as part of Plateau Sandstone. Had also been named Kayan sandstone and Penrissen sandstone. Tan (1993) redefined the Kayan sandstone and considered the previously described 'Plateau Sandstone' in the Santubong peninsula, Kayan basin, Samunsan Valley and the Bungo Range, all in west Sarawak, to belong to the 'Kayan sandstone'.

C17.

1. Name : Julan Formation
2. Origin of name : Sungai Julan, Usun Apau area, interior Central Sarawak
3. Age : Upper to Eocene Paleocene
4. References : Banda (1989), Banda & Aji (1986)
5. Type area :
6. Type section : Along Sungai Julan, Usun Apau area, interior Central Sarawak
7. Boundaries :
8. Correlation :
9. Thickness : ± 500 to 2,000 m
10. Lithology : Chaotic assemblage of predominantly broken and tightly folded beds of shale and sandstone, and minor limestone, basalt and gabbro occurring

mainly as blocks embedded in a dark-brown mudstone matrix.

11. Subdivisions :
12. Fossils :

algae
foraminifera
Aktinocyclina sp.
Alveolina (Glomalveolina) cf. *primaeva* Reichel
Alveolina (Alveolina.) spp.
Ammobaculites sp.
Ammobaculites sp.
Anomalina sp.
Asterocyclina sp.
Bathysiphon sp.
Bolivina sp.
Cibicides sp.
Cyclammina caminatum (Cushman & Renz)
Daviesina sp.
Discocyclina spp.
Distichoplax biserialis
Distichoplax sp.
Epistominella pulchella (Husezima & Marukasi)
Fabularia sp.
Florilus asanoi (Whittaker & Hodgkinson)
Globotruncana sp.
Globrotalia volascoensis Cushman
Glomospira charoids (Jones & Parker)
Glumbelina sp.
Haplophragmoides sp.
Haplophragmoides sp.
Haplophragmoides walteri (Graybowski)
Hasteriginella sp.
Linderina sp.
Miliolids sp.
Miscellanea sp.
Nummulites sp.
Operculina sp.
Opertorbitolites cf. *dovillei* Nuttal
Pallatispira sp.
Psammosiphonella carapitana (Hedberg)
Rotalia sp.
Spirochyprus sp.
Textularia aggutinans (d'Orbigny)
Trifarion bradyl (Cushman)
Trochammina pacifica (Cushman)
Trochammina sp.
Trochammina umiatensis Tappan

13. Env. of deposition : Deep marine. The original environment of deposition of the broken beds and blocks varies from shallow to deep marine.
14. Remarks : Initially named Chaotic Assemblage by Banda & Aji (1986).

C18.

1. Name : Mulu Formation
2. Origin of name : After Gunung Mulu, north Sarawak
3. Age : Paleocene to ?Lower Eocene
4. References : Haile (1962), Liechti *et al*. (1960)
5. Type area :
6. Type section : The Tutoh Gorge and the Medalam River sections in north Sarawak.
7. Boundaries : The Mulu Massif is completely surrounded by the younger Setap Shale and Melinau Limestone Formations. The top boundary with the Setap Shale Formation is vague and transitional. With the base of the main Melinau Limestone Formation, locally the boundary is clean-cut, i.e. perfect conformity, while there is clear unconformity with the transgressive basal conglomerate of the Selidong Limestone.
8. Correlation : The formation is the rock-stratigraphic and largely also the time-stratigraphic equivalent of the Belaga and Kelalan Formations.
9. Thickness : ± 3,900 to 5,400 m (Leichti *et al*., 1960) and 4,500 to 5,400 m (*Shepherd,1954* in Haile, 1962).
10. Lithology : Succession of thick monotonous submetarmorphic shales and slates with subordinate or, towards the south, predominant, hard sandstones and occasional conglomeratic sandstones.
11. Subdivisions :
12. Fossils :

foraminifera
?Haplophragmoides 19
Discocyclina sp.
Globorotalia 11
Globorotalia wilcoxensis Cushman & Ponton
Nummulites sp.
Trochamminoides 3

13. Env. of deposition : Most likely deposited under bathyal conditions.
14. Remarks : Was earlier described under Mulu Slates and Quartzites and later on as Mulu Series.

C19.

1. Name : Kelalan Formation
2. Origin of name : Sungai Kelalan, north Sarawak
3. Age : Paleocene to early Upper Eocene
4. References : Haile (1962), Liechti *et al*. (1960)
5. Type area :
6. Type section : Along Sungai Kelalan, the main tributary of the Sungai Trusan, north Sarawak.
7. Boundaries : The formation is the northern strike continuation of the Belaga Formation (Pelagus and Kapit Members). To the north the formation continues into the West Crocker Formation of the Crocker Range of North Borneo. The base of the formation is nowhere exposed in northern Sarawak. The top boundary with the Setap Shale Formation is somewhat problematic.
8. Correlation : Rock stratigraphic, and largely also time-stratigraphic to Belaga Formation (excluding the Layar Member) and the Mulu Formation of Sarawak, and the West Crocker Formation of Sabah.
9. Thickness : ± 3,500 m (Liechti *et al*., 1960) and ? 3,000- 6,000 m (Haile, 1962)
10. Lithology : Comprises mainly sandstone and shale, with subordinate limestone, tuffite and tuffaceous limestone, the shale-sandstone showing slight degree of metamorphism. The sandstones range from massive, thick to thinly bedded.
11. Subdivisions : Temala member
12. Fossils :

    algal
    debris
    foraminifera
    Alveolina (Flosculina) globosa Leymerie
    Alveolina sp.
    Assilina sp.
    Chiloguembelina spp.
    Cyclammina 15
    Discocyclina sp.
    Eorupertia sp.
    Globigerina dissimilis Cushman & Bermudez
    Globigerina spp.
    Globorotalia centralis Cushman & Bermudez
    Globorotalia spp.
    Gypsina globulus (Reuss)
    Halkyardia bikiniensis Cole
    Hantkenina dumblei Weinzierl & Applin
    Miscellanea ?stampi Davies
    Miscellanea miscella d'Archiac & Haime
    Nummulites nuttalli Davies
    Nummulites sp.
    *Operculin*a sp.
    Pseudophragmina sp.
    Textularia 44
13. Env. of deposition : Conditions varying from outer neritic to bathyal.
14. Remarks : Earlier termed the Kelalan Series (Jordi & Wijkhuizen, 1955 in Liechti *et al*., 1960).

C19.1.

1. Name : Temala member
2. Origin of name : Sungai Temala, Bahagian Miri
3. Age : Middle to Upper Eocene
4. References : Haile (1962), Liechti *et al*. (1960)
5. Type area : Sg. Temala section south-southeast of Batu Gading (Baram Valley)
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : The exposed thickness estimated approx. 900 m.
10. Lithology : Succession of clay-shales with intercalations of massive or thick bedded slightly calcareous sandstones and some limestones.
11. Subdivisions :
12. Fossils :

    algae
    foraminifera
    Discocyclina sp.
    Nummulites sp.
13. Env. of deposition :
14. Remarks : Differs from the main Kelalan Formation in its higher calcareous content and slighter folding.

C20.

1. Name : Lubok Antu Mélange
2. Origin of name : Lubok Antu town, Lupar Valley, Bahagian Sri Aman
3. Age : Matrix indicate Lower Tertiary age, most probably Lower Eocene
4. References : Liechti *et al*. (1960), Tan (1979), Tan (1982)
5. Type area : Lupar Valley. Well exposed along

the Lubok Antu Road from Km 21.7 south to Lubok Antu town.

6. Type section :
7. Boundaries : The base of the mélange is not exposed, the contact between the two units is probably faulted or sheared. The top of the mélange is in sheared, faulted contact with the Silantek Formation.
8. Correlation : Tate (1991) correlate the Kapuas Complex in Kalimantan as equivalent of the Lubok Antu Mélange Belt.
9. Thickness :
10. Lithology : Composed of fragments and blocks, ranging from a few cm to a few km in maximum dimension, of mudstone, shale, sandstone, chert, hornfels, basalt and gabbro and their metamorphosed equivalents, limestone, and serpentinite in a highly cleaved, pervasively sheared, chloritised, grey to dark grey pelitic matrix.
11. Subdivisions :
12. Fossils : Those identified in the matrix is described first, followed by fossils found in the mélange blocks.

In mélange matrix (Lower Eocene):

foraminifera

Ammobaculites spp.
Ammodiscus spp.
Amphistigina spp.
Angulogerina sp.
Anomalina sp.
Bathysiphon sp.
Bolivina sp.
Bolivinita sp.
Bulimina sp.
Cibicides sp.
Clavulina sp.
Cribrostomoides sp.
Dentalina sp.
Eggerella sp.
Gaudryina sp.
Globigerina bulloides d'Orbigny
Globigerina gravelli Bronnimann
Globigerina linaperta Finlay
Globigerina ?soldadoensis Bronnimann
Globorotalia aragonensis Nuttall
Globorotalia cf. *broedermanni* Cushman & Bermudez
Globorotalia cf. formosa Bolli
Globorotalia gracilis Bolli
Globorotalia palmarae Cushman & Bermudez
Globorotalia rex Martin
Gumbelina sp.
Haplophragmoides sp.
Hastigerina micra (Cole)
Hormosina sp.
Lagena sp.
Lagenammina sp.
Lenticulina sp.
Nonion japonicum Asano
Nonion sp.
Operculina spp.
Praeglobolulimina pupoides (d'Orbigny)
Praeglobolulimina sp.
Psammosiphonella cylindrica (Glaessner)
Psammosiphonella sp.
Quinqueloculina spp.
Rectoglandulina laevigata (d'Orbigny)
Semivulvulina sp.
Sigmoilina sp.
Sigmoilopsis schlumbergeri (Silvestri)
Silicosigmoilina miocenica Brouwer
*Textulari*a sp.
Trifarina sp.
Trochammina cf. pacifica (Cushman)
Trochammina renzi Brouwer
Trochammina sp.
Usbekistania sp.
Verneila sp.
Vulvulina sp.

nannofossil

Birkelundia staurion
Braarudosphaera bigelowi
Chiasmolithus cf. *C. formosa*
Chiasmolithus gammation
Chiasmolithus sp.
Cribrosphaerella ehrenbergi
Discoaster binodosus
Discoaster distinctus
Discoaster kuepperi
Discoaster lodoensis
Discoaster sp.
Ericsonia ovalis
Marthasterites contortus
Micrantholithus sp.
Neochiastozygus sp.
Prediscosphaera cretacea
Prinsiaceae sp.
Sphenolithus radians
Sphenolithus sp.
Thoracosphaera sp.
Zygrhablithus bijugatus

In mélange block (sandy siltstone - Upper Cretaceous):

foraminifera

Orbitolina cf. *discoidea* Gras

Orbitolina lenticularis (Blumenbach)
Orbitolina spp.
In mélange block (chert - Upper Jurassic to Lower Cretaceous):
radiolaria
Acanthocircus dicranocanthos (Squinabol)
Acanthocircus sp. aff. *A. fossilis* (Parona)
Alievium sp. *A.* of Pessagno
Archaeodictyomitra apiarium (Rust)
Archaeodictyomitra vulgaris Pessagno
Archaeodictyomitra sp.
Crucella sp.
Pantanellium corriganensis Pessagno
Pantanellium n. sp.
Pantanellium sp. cf. *P. riedeli*
Paronaella sp.
Parvacingula boesii Parona
Parvacingula citae Pessagno
Parvacingula sp.
Parvacingula sp. cf. *P. citae* Pessagno
Podobursa triacantha
Pseudodictyomitra sp.
Spongocapsula n. sp.
Thanarla conica (Aliev)
Xitus n. sp.
Xitus sp.
Zifondium sp.
In mélange block (limestone - Upper Paleocene to Middle Eocene):
algae
bryozoa
coral
Actinacis sp.
echinoid
foraminifera
Actinacis sp.
?Archaeolithothamnium sp.
Caulastrea sp. cf. *Calamophyllia indica* Duncan
Discocyclina cf. *ramaraoi* Samanta
Distichoplax biserialis (Dietrich) Pia
?Globigerina sp.
Globorotalia sp. indet.
Globotruncana sp.
Halimeda sp.
Miliola sp.
?Nummulites sp.
?Pseudocyclammina sp.
Rotalia sp.
?Stylina sp.
gastropod
?radiolaria
In mélange block (calcareous shale, siltstone and sandstone - Lower Eocene)
foraminifera
*Ammobaculite*s sp.
Ammodiscus glabratus Cushman & Jarvis
Ammodiscus sp.
Bolivina sp.
Cibicides sp.
Clavulina sp.
Discorbis spp.
Eggerella bradyi (Cushman)
Eggerella sp.
Gaudryina sp.
Globigerina ?collactea (Finlay)
Globigerina ?senni (Beckmann)
Globigerina ?soldadoensis Bronnimann
Globigerina linaperta Finlay
Globorotalia ?broedermanni Cushman & Bermudez
Globorotalia aragonensis Nuttall
Globorotalia cf. *broedermanni* Cushman & Bermudez
Globorotalia gracilis Bolli
Globorotalia palmerae Cushman & Bermudez
Haplophragmoides sp.
Hastigerina micra (Cole)
Hastigerina micra (Cole)
Heterolepa sp.
Lagena sp.
Lenticulina sp.
Loxostoma sp.
Marginulina sp.
Nonion japonicum Asano
Osangularia culter (Parker & Jones)
Praeglobolulimina pupoides (d'Orbigny)
Praeglobolulimina pupoides (d'Orbigny)
Psammosiphonella carapitana (Hedberg)
Psammosiphonella spp.
Sigmoilina spp.
Spirosigmoilinella sp.
*Textulari*a sp.
Trochammina renzi (Cushman)
Trochammina sp.
Uvigerina proboscidea Schwager
Uvigerina sp.
nannofossil
Chiasmolithus cf. *neogammation*
Discoaster kuepperi
Discoaster lodoensis
Ericsonia cava
Ericsonia formosa
Ericsonia ovalis
Micrantholithus sp.
?Pontosphaera segmenta
Prinsiaceae sp.
Sphenolithus sp.
In mélange block [agglomerate (volcanic conglomerate?) - Upper Jurassic or Lower Cretaceous]:
foraminifera

Pseudocyclammina sp.

13. Env. of deposition : The matrix indicate that the original sediments were deposited in a marine inner neritic environment.
14. Remarks : Earlier named 'Engkilili Beds', later as 'Engkilili Formation' by Leichti *et al*. (1960). Tan (1979) introduced the term Lubok Antu Mélange, and interpreted to be derived by tectonic processes which mark the site of an old subduction zone, probably fossil Benioff zone.

C21.

1. Name : Tatau formation
2. Origin of name : After Tatau area, central Sarawak
3. Age : Upper Eocene to Oligocene
4. References : Liechti *et al*. (1960), Wolfenden (1960)
5. Type area : The Sap-Saparai locality,Tatau, central Sarawak
6. Type section :
7. Boundaries : The top boundary of the Tatau formation is a gradual transition into the overlying Buan formation.
8. Correlation :
9. Thickness : ± 2,500 to 3,000 m
10. Lithology : Succession of sandstones, argillaceous sandstones, siltstones and shales with intercalations of marls, limestones and locally developed conglomerate. Acid volcanics occurred at cetain localities. Wolfenden (1960) indicate that the volcanic rocks are rhyolite and andesite lavas.
11. Subdivisions : The Sap Marl member. There is no subdivision of the Tatau formation in Wolfenden (1960).
12. Fossils : Fossils from the Tatau formation of Wolfenden (1960) are also included in the list below.

algae (red & green)
Archaeolithothamnion sp.
Corallina spp.
Halimeda sp.
Lithothamnion sp.
Lithophyllum sp.
Lithoporella melobesioides Foslie
Mesophyllum sp?
coral
echinoid
foraminifera
?Alveolina sp.
Aktinocyclina alticostata Nuttall
Aktinocyclina sp.
Alveolina sp?
Ammobaculites sp.
Ammodiscus sp.
Amphistegina sp.
Angulogerina sp.
Anomalina spp.
Assilina sp.
Asterigerina sp
Bathysiphon spp.
Biplanispira sp.
Bolivina spp.
Bolivinita sp.
Bulimina spp.
Buliminella sp.
Cassidulina spp.
Cerratobulimina spp.
Chilostomelloides sp.
Cibicides spp.
Clavulina spp.
Cristellaria spp.
Cyclammina sp.
Discocyclina sp.
Discorbis sp.
Eorupertia sp.
Eponides spp.
Fabiania cf. *saipanensis* Cole
Fabiania sp.
Gaudryina spp.
Globigerina cf. *dissimilis* Cushman & Bermudez
Globigerina cf. *increbescens* Bandy
Globigerina micra Cole
Globorotalia centralis Cushman & Bermudez
Globorotalia cf. *centralis* Cushman & Bermudez
Globorotalia cerroazulensis Cole
Globorotalia cf. *cerroazulensis* Cole
Glomospira sp.
Gumbelina sp.
Gypsina globulus (Reuss)
Gypsina sp.
Gyroidina spp.
Halkyardia cf. *minima* (Liebus)
Hantkenina cf. *alabamensis* Cushman
Hantkenina sp.
Haplophragmoides sp.
Heterostegina sp.
Lagena spp.
Marginulina sp.
Neoalveolina sp.
Nodosaria spp.

Nummulites absurda (Doornink)
Nummulites cf. *javanus* Verbeek, A & B forms
Nummulites kelatensis (Carter?) Douville
Nummulites subglobula Doornink
Nummulites spp.
Nummuloculina sp?
Operculina sp.
Pellatispira crassicolumnata Umbgrove
Pellatispira inflata Umbgrove
Pellatispira cf. *glabra* Umbgrove
Pellatispira madaraszi von Hantken var. *provalei* Yabe
Pellatispira spp.
Planulina spp.
Pleurostomella spp.
Pullenia sp.
Quinqueloculina spp.
Reussella sp.
Rotalia sp.
Sigmoilina spp.
Siphogenerina sp.
Siphonina sp.
Spiroclypeus cf. *vermicularis* Tan Sin Hock
Spiroclypeus sp.
Spiroplectammina sp.
Textularia spp.
Tubulogenerina sp.
Uvigerina spp.
gastropod

13. Env. of deposition : In the Arip-Pelagau area a fully marine, probably inner-neritic environment at the base gradually gave way to littoral, and temporarily even continental. After this regressive phase the area probably subsided to give neritic conditions.
14. Remarks : The greater part of the formation was formerly included in the Rajang Group and partly in the Bintulu Group.

C21.1.

1. Name : Sap Marl member
2. Origin of name : Sap-Saparai locality, Tatau, central Sarawak
3. Age : Eocene to Oligocene
4. References : Liechti *et al*. (1960)
5. Type area : Tatau (Sap-Saparai) area
6. Type section :
7. Boundaries : In the Tatau (Sap-Saparai) area the member forms the base of the Tatau formation
8. Correlation :
9. Thickness : In the Tatau area is about 180 m
10. Lithology : Very hard calcareous, dark-grey to black marls
11. Subdivisions :
12. Fossils :

foraminifera
Globigerina cf. *dissimilis* Cushman & Bermudez
Globigerina cf. *increbescens* Bandy
Globorotalia cf. *centralis* Cushman & Bermudez
Globorotalia cf. *cerroazulensis* Cole
Hantkenina sp.

13. Env. of deposition : Neritic
14. Remarks :

C22.

1. Name : Kelabit formation
2. Origin of name : Kelabit Highlands, Bahagian Miri
3. Age : Lower Oligocene to Lower Miocene
4. References : Haile (1962), Liechti *et al.* (1960)
5. Type area : Type locality for the massive basal sandstones is the Tamabo (Tama Abu) Range, north Sarawak.
6. Type section :
7. Boundaries :
8. Correlation : In part a time equivalent of the Setap Shale Formation.
9. Thickness :At least several hundreds meters
10. Lithology : Comprises mudstone, sandstone, and thin lenses of impure limestone, some lignite and rare conglomerate.
11. Subdivisions : None
12. Fossils :

foraminifera
Ammobaculites? sp.
Ammodiscus sp.
Anomalina sp.
Arenobulimina sp.
Asterigerina? sp.
Bolivina sp. aff. *B. beyrichi* Reuss
Bulimina ovata d'Orbigny
Cassidulina? sp.
Chilostomella sp.
Cibicides spp.
Clavulina sp.
Cristellaria sp.
Cyclammina sp.
Dentalina? sp.
Dorothia? sp.
Ellipsoglandulina sp.
Eponides umbonatus (Reuss)
Eponides sp.

Gaudryina sp.
Globigerina ampliapertura Bolli
Globigerinoides trilobus (Reuss)?
Globoquadrina venezuelana (Hedberg)
Globorotalia centralis Cushman & Bermudez
Glomospira sp.
Gyroidina sp.
Haplophragmoides sp.
Hormosina sp.
Lagenammina sp.
Nodosaria sp.
Nonion? sp. aff. *N. advena* (Cushman)
Nonionella? sp.
Nummulites sp.
Operculina sp.
Plectina sp.
Pleurostomella sp.
Pullenio sp.
Reophax sp.
Robulus spp.
Rotalia sp.
Stilostomella? sp.
Textularia sp.
*Trochammin*a sp.
Trochamminoides sp.
Uvigerina sp.
Vaginulina spp. aff. *V. mexicana* Nuttall
Verneuilina sp.
Verneuilina? (or *Gaudryina?*) sp. juv.
Vulvulina sp.
radiolaria
Cenosphaera sp.
Dicolocapsa sp.
Dictyomitra sp.
Dorysphaera sp.
Melitosphaera sp.
?Stichopera sp.
Stylosphaera sp.

13. Env. of deposition : Shallow open marine
14. Remarks : The formation name was proposed by Haile (in Liechti *et al*., 1960). It was previously included in the Kelalan Formation (Liechti *et al*., 1960).

C23.

1. Name : Buan formation
2. Origin of name : Sungai Buan, Tatau area, central Sarawak
3. Age : Oligocene
4. References : Liechti *et al*. (1960), Wolfenden (1960)
5. Type area : The Bukit Buan area with Sungai Buan, a right tributary of the Sungai Tatau, central Sarawak.
6. Type section :
7. Boundaries : Conformably overlies the Tatau Formation in the Tatau and Arip-Pelagau Areas. Unconformably overlies the Metah Member of the Belaga Formation in the upper Kakus River. Conformable top boundary with the Biban Sandstone Member of the Nyalau Formation.
8. Correlation :
9. Thickness : ± 600 to 900 m
10. Lithology : A clastic succession of shales and clay-shales alternating with argillaceous siltstones and thin sandstones.
11. Subdivisions :
12. Fossils :

foraminifera
Ammobaculites spp.
Bathysiphon sp.
Cristellaria sp.
Cyclammina spp.
Gaudryina spp.
Haplophragmoides spp.
Hormosina spp.
Textularia sp.
Trochammina spp.
Trochamminoides sp.

13. Env. of deposition : Probably inner neritic.
14. Remarks : The earlier term 'Buan Group' (created by Boer & Milroy in 1952) comprised the Muput and Biban Formations. The 'Muput Formation' is renamed as the Buan Formation, the 'Biban' is renamed as the 'Biban sandstone member' of the Nyalau Formation (Liechti *et al*., 1960).

C24.

1. Name : Nyalau Formation
2. Origin of name : Sungai Nyalau, Bahagian Bintulu.
3. Age : Oligocene to Miocene (Liechti *et al*., 1960), Miocene (Haile, 1962), Upper Oligocene to Upper Miocene (Kho, 1968)
4. References : Haile (1962), Kho (1968), Liechti *et al*. (1960), Wolfenden (1960)
5. Type area : The Sabulong-Selungun area (Liechti *et al*., 1960), and hills

behind the coast from Tanjong Kidurong to Kuala Nyalau (Haile, 1962)

6. Type section : Sungai Sabulong, northeast of Tanjong Kidurong, Bahagian Bintulu.

7. Boundaries : Conformable basal boundary with the underlying Buan formation. Locally unconformable on Tatau formation. In the Tatau-Anap-Arip area the basal boundary between the Buan and Nyalau formations is a rapid transition from a largely argillaceous to a more arenaceous lithology. In the Tubau Valley and Sungai Jeladong area, the Nyalau Formation rests on the argillaceous Tubau formation. In the Jelalong Valley (upper Kemena) the formation rests conformably on Setap Shale Formation. The top boundary (including the Kakus Member) is generally an erosional surface, but in the Suai and Koyan headwaters, the formation is overlain conformably by Belait Formation.

8. Correlation : Essentially rock-stratigraphic equivalents of the Setap Shale, the Tangap formation, part of the Buan formation, the entire Tubau formation and Sibuti Formation.

9. Thickness : ± 3,000 to 5,500 m (Liechti *et al*., 1960), exposed thickness of ± 800 to 1,200 m (Haile, 1962)

10. Lithology : Succession of hard, fine-grained, argillaceous, often calcareous, sandstones, in alternation with all possible gradations to shale and clay, and commonly lignitic. Sandy foraminiferal limestone lentils, and also limestone breccias consisting of gastropods, lamellibranchs, and larger foraminifera occur frequently.

11. Subdivisions : The Biban Sandstone Member and the Kakus member

12. Fossils :

algae
echinoderm
foraminifera
Ammobaculites sp.
Ammodiscus sp.
Amphistegina sp.
Asterigina sp.
Austrotrillina howchini (Schlumberger)
Bathysiphon sp.
Cibicides 3A
Cibicides spp.
Cyclammina sp.
Cycloclypeus sp.
Elphidium sp.
Eulepidina sp.
Eponides sp.
Globigerina sp.
Glomospira sp.
Guttulina sp.
Gypsina sp.
Haplophragmoides sp.
Heterostegina borneensis (van der Vlerk)
Heterostegina sp.
Hormosina sp.
Lepidocyclina angulosa Provale
Lepidocyclina atuberculata (van der Vlerk)
Lepidocyclina borneensis Provale
Lepidocyclina formosa Schlumberger
Lepidocyclina isolepidinoides van der Vlerk
Lepidocyclina sp.
Lepidocyclina (Nephrolepidina) spp.
Marginulina sp.
Miliammina sp.
Miogypsina sp.
Miogypsinoides de haartii van der Vlerk
Miogypsinoides ubaghsi (Tan Sin Hock)
Miogypsinoides cf. *bantamensis* Tan
Neoalveolina pygmaea Hanzawa
Nonion sp.
Nonionella sp.
Nummulites cf. *absurda* Doornink
Nummulites divina Doornink
Nummulites cf. *intermedia* (d'Archiac)
Nummulites sp.
Operculina pyramidum (Ehrenberg)
Operculina cf. *pyramidum* (Ehrenberg)
Operculina sp.
Quinqueloculina spp.
Rotalia sp.
Sigmoilina sp.
Spiroclypeus sp.
Spiroclypeus tidunganensis van der Vlerk
Textularia spp.
Trochammina sp.
Valvulina sp.
gastropod
bivalve
plant
remains

13. Env. of deposition : Shallow marine (littoral to inner

neritic) conditions which developed upwards into paralic conditions.

14. Remarks : The name Nyalau is retained although the formation is no longer referred to Sungai Nyalau as type section. Previously the Nyalau Formation was included, together with the Tubau formation, in the Setap Group.

C24.1

1. Name : Biban Sandstone Member
2. Origin of name :
3. Age : Oligocene to Lower Miocene
4. References : Haile (1962), Kho (1968), Liechti *et al*. (1960)
5. Type area : Pandan-Kakus Area (Tatau-Bintulu)
6. Type section : Sungai Sabulong, northeast of Tanjong Kidurong
7. Boundaries : Conformable on the Buan formation. The upper boundary with the overlying Kakus member is transitional.
8. Correlation :
9. Thickness : ± 3,600-4,000 m (Liechti *et al*., 1960), > 1,500 m (Kho, 1968)
10. Lithology : Consists of hard, well bedded, fine to medium grained sandstones with subordinate argillaceous or silty intercalations; a few layers are slightly calcareous. Kho (1968) indicate the presence of 3.5 m limestone bed in the Bintulu area, in the headwaters of the Rerik tributary of Sungai Binai.
11. Subdivisions :
12. Fossils :

algae
bryozoa
foraminifera
Ammobaculites sp.
Austrotrillina howchini (Schlumberger)
Bathysiphon sp.
Cyclammina sp.
Cycloclypeus sp.
Haplophragmoides sp.
Heterostegina cf. *borneensis* van der Vlerk
Heterostegina sp.
Lepidocyclina (Eullepidina) spp.
Lepidocyclina (Nephrolepidina) spp.
Lepidocyclina sp.
Miogypsina sp.
Nummulites cf. *absurda* Doornink
Nummulites divina Doornink
Nummulites sp.
Operculina sp.
Spiroclypeus sp.

13. Env. of deposition : Littoral to inner neritic
14. Remarks : Haile (1962) does not differentiate the Biban Sandstone Member but mapped as undifferentiated Nyalau Formation. Kho (1968) described the Biban Sandstone Member to include the abandoned 'Muput Formation' of the 'Buan Group'.

C24.2

1. Name : Kakus member
2. Origin of name : Kakus area, Bahagian Bintulu
3. Age : Oligocene? to Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : ± 1,500 m.
10. Lithology : Successions of sandstone and laminated clay with lignite seams.
11. Subdivisions :
12. Fossils :

foraminifera
Ammobaculites sp.
Glomospira sp.
Trochammina sp.

13. Env. of deposition : Shallower than the Biban Sandstone Member.
14. Remarks :

C25.

1. Name : Meligan Formation
2. Origin of name : Meligan Range, north Sarawak
3. Age : Miocene
4. References : Haile (1962), Liechti *et al*. (1960)
5. Type area : The formation is restricted to the large synclinal basins (eg. Pasia Syncline, Kanayah Syncline, Ulu Meligan-Pulun Syncline and others) of the Ulu Limbang-Ulu Trusan-Ulu Padas area extending from northern Sarawak into Sabah.
6. Type section : The Limbang Gorge, north

Sarawak, between Long Layat and Long Kaya and a section across the Meligan Syncline and the Pasia syncline from Long Slobang to the Ulu Sepatar.

7. Boundaries : The base of the formation is generally conformable with the underlying Setap Shale Formation
8. Correlation :
9. Thickness : ± 3,000 m
10. Lithology : A predominantly arenaceous formation composed mainly of massive sandstone, with subordinate intercalations of shale and thin layers of quarzitic sandstone.
11. Subdivisions :
12. Fossils :

foraminifera

Ammobaculites sp.
Austrotrillina howchini (Schlumberger)
Bathysiphon sp.
Cyclammina sp.
Globigerinoides sp.
Globoquadrina altispira (Cushman & Jarvis)
Globorotalia cf. *mayeri* Cushman & Ellisor
Heterostegina sp.
Hormosina sp.
Lepidocyclina (Eulepidina) cf. *bridgei* Schlumberger
Lepidocyclina (Eulepidina) cf. *formosa* Schlumberger
Lepidocyclina (Eulepidina) sp.
Lepidocyclina cf. *inflata* Provale
Lepidocyclina cf. *richthofeni* Smith
Miogypsina sp.
Miogypsinoides de haarti van der Vlerk
Nephrolepidina sp.
Trochammina spp.

13. Env. of deposition : Very shallow marine to paralic towards the top.
14. Remarks :

C26.

1. Name : Melinau Limestone Formation
2. Origin of name : Gunong Melinau, north Sarawak
3. Age : Upper Eocene to Lower Miocene
4. References : Haile (1962), Liechti *et al*. (1960)
5. Type area : Type locality is Gunong Melinau, on the northwest-flank of Gunong Mulu, north Sarawak (Liechti *et al*., 1960), while Haile's (1962) type locality is in the Melinau tributary of the Tutoh immediately to the north of the Suai-Baram area
6. Type section : Along Sungai Madalam, north of Gunung Melinau, north Sarawak.
7. Boundaries : The rock and time stratigraphic position is between the top of the Kelalan or Mulu Formations and the base of the Setap Shale Formation. The contact with the overlying Setap Shale Formation is generally conformable. The boundary is usually a rapid but well defined transition, limestone passing up through sandy limestone and marl into non-calcareous shale.
8. Correlation :
9. Thickness : See various subdivisions
10. Lithology : Comprises biohermal limestones with little or no clastic admixture, massive or thick bedded and mainly light grey in colour. Calcarenites predominate, but calcilutites also occur and marls are rarely intercalated.
11. Subdivisions : The following limestones are included in the formation; Melinau limestone, Keramit limestone and marls, Selidong limestone, Batu Gading limestone and Tujoh-Siman limestone.
12. Fossils :

algae
bryozoa
coral
foraminifera

Aktinocyclina sp.
Alveolina sp.
Amphistegina sp.
Austrotrillina howchini (Schlumberger)
Borelis pygmaeus Hanzawa
Chapmania sp.
Cycloclypeus sp.
Discocyclina spp.
Eorupertia plecte (Chapman)
Eulinderina sp.
Globigerina dissimilis Cushman & Bermudez
Globigerinoides index Finlay
Globigerinoides orbiformis Cole
Gypsina spp.
Halkyardia bikiniensis Cole
Halkyardia sp.
Hantkenina dumblei Weinzierl & Applin
Heterostegina cf. *helvetica*
Heterostegina sp.

Lepidocyclina (Eulepidina) spp.
Lepidocyclina (Nephrolepidina) spp.
Lepidocyclina butonensis van der Vlerk
Lepidocyclina isolepidinoides van der Vlerk
Lepidocyclina papuaensis Chapman
Lepidocyclina sp.
Linderina burgesi (Schlumberger)
Linderina sp
Miogypsinoides sp.
Miogypsinoides ubaghsi Tan Sin Hok
Neoalveolina pygmaea Hanzawa
Neoalveolina spp.
Nummulites cf. *globulus* Leymerie
Nummulites cf. *saipanensis* Cole
Nummulites javanus Verbeek
Nummulites sp.
Operculina sp.
Pellatispira crassicolumnata Umbgrove
Pellatispira madaraszi Hantken
Pellatispira sp.
Rupertia sp.
Spiroclypeus spp.
Spiroclypeus vermicularis Tan Sin Hok

13. Env. of deposition : Shallow marine.
14. Remarks :

C26.1.

1. Name : Melinau limestone
2. Origin of name : Gunong Melinau, north Sarawak
3. Age : Eocene to Miocene
4. References : Liechti *et al*. (1960)
5. Type area : Type locality occupies about 200 sq. km (77 sq. mi.) in the northwest-flank of the Mulu Mountains.
6. Type section :
7. Boundaries : Overlies the Mulu Formation in perfect conformity. Reworking of limestone fragments into the basal Setap Shale Formation at the top of the Melinau limestone.
8. Correlation :
9. Thickness : North end ± 480-850 m, south end ± 1,700-2,200 m
10. Lithology : Limestone with algae, bryozoa, large and small foraminifera, with a few corals. The lithology is rather uniform, the only variations occur at the base and the top. The base is formed of a distinctive, red weathering, black shaly limestone with larger foraminifera, grading down into calcareous sandstone of the Mulu Formation. At the top, fairly well bedded brownish-grey sandy limestones occur, often with nodules of very calcareous sandstone.
11. Subdivisions :
12. Fossils :

algae
bryozoa
coral
foraminifera
Austrotrillina howchini (Schlumberger)
Discocyclina spp.
Heterostegina sp.
Lepidocyclina (Eulepidina) spp.
Lepidocyclina (Nephrolepidina) spp.
Lepidocyclina papuaensis Chapman
Miogypsinoides ubaghsi Tan Sin Hok
Neoalveolina pygmaea Hanzawa
Neoalveolina spp.
Nummulites spp.
Pellatispira sp.
Rupertia sp.
Spiroclypeus spp.
Spiroclypeus vermicularis Tan Sin Hok

13. Env. of deposition :
14. Remarks :

C26.2.

1. Name : Keramit limestone and marls
2. Origin of name :
3. Age : Eocene to Miocene
4. References : Liechti *et al*. (1960)
5. Type area : Small anticlinal core in the middle Limbang Valley. Extent is about 0.25 sq. km (25 hectares).
6. Type section :
7. Boundaries : The base of the Keramit limestone and marls is not exposed.
8. Correlation :
9. Thickness : ± 50 m.
10. Lithology : A hard, greyish-yellow, massive biohermal limestone (calcarenite), occasionally built up by zoogene detritus, alternating with cream coloured *Globigerina* limestone (calcilutite). Larger foraminifera, Globigerinidae, Miliolidae, algae and occassionally corals, make up the rock.
The Keramit marls are red, yellowish or greenish shale, badly jointed and locally crushed. Some

dark clay with interbedded sandstone has been observed.

11. Subdivisions :
12. Fossils :

algae
coral
foraminifera
Aktinocyclina sp.
Alveolina sp.
Austrotrillina howchini (Schlumberger)
Chapmania sp.
Cycloclypeus sp.
Discocyclina spp.
Eulinderina sp.
Globigerina dissimilis Cushman & Bermudez
Globigerinoides index Finlay
Globigerinoides orbiformis Cole
Halkyardia sp.
Hantkenina dumblei Weinzierl & Applin
Heterostegina cf. *helvetica*
Heterostegina sp.
Lepidocyclina isolepidinoides van der Vlerk
Lepidocyclina sp.
Linderina burgesi (Schlumberger)
Linderina sp
Miogypsinoides ubaghsi Tan Sin Hok
Neoalveolina sp.
Nummulites sp.
Pellatispira sp.
Spiroclypeus sp.

13. Env. of deposition :
14. Remarks : One of the most fossiliferous rock units in East Malaysia.

C26.3.

1. Name : Selidong limestone
2. Origin of name : Sungai Selidong, Bahagian Limbang
3. Age : Eocene to Miocene
4. References : Liechti *et al*. (1960)
5. Type area : Lens in the east-flank of the Mulu Massif with length of approx. 7 km.
6. Type section :
7. Boundaries : Overlies the Mulu Formation with indication of a local disconformity or even unconformity.
8. Correlation :
9. Thickness : ± 250-270 m
10. Lithology : The base is made up of yellowish-grey, shaly and sandy marls with reworked shales of the Mulu Formation and grading into cobble and boulder conglomerate of shale and sandstone in a marly calcareous matrix. The top consists of grey, massive limestone, poorly bedded, with intercalations of sand streaks and stringers of chert fragments.
11. Subdivisions :
12. Fossils :

foraminifera
Amphistegina sp.
Austrotrillina howchini (Schlumberger)
Cycloclypeus sp.
Discocyclina spp.
Globigerina spp.
Globorotalia spp.
Heterostegina sp.
Heterostegina sp.
Lepidocyclina isolepidinoides van der Vlerk
Lepidocyclina sp.
Miogypsinoides ubaghsi Tan Sin Hok
Neoalveolina sp.
Nummulites sp.
Pellatispira sp.
Spiroclypeus sp.

13. Env. of deposition :
14. Remarks :

C26.4.

1. Name : Batu Gading limestone
2. Origin of name : Batu Gading, Bahagian Miri
3. Age : Eocene to Miocene
4. References : Adams (1958), Haile (1962), Liechti *et al*. (1960)
5. Type area : Lens about 5 km long in the Baram Valley below Long Lama.
6. Type section :
7. Boundaries : Underlain by Kelalan Formation (Temala Member).
8. Correlation :
9. Thickness : ± 45 m (Liechti *et al*., 1960), ± 21-60 m (Haile, 1962)
10. Lithology : The basal Eocene part is made up of dark grey to black sandy limestone, composed mainly of *Nummulites*, algae, echinoid and mollusc fragments, some specimens contain pyrite. These is succeeded by massive compact limestone, typically pale grey, which is also composed of foraminifera (smaller than the large *Nummulites* in the basal

part), algae, and corals. The Miocene part at Batu Gading is composed of limestone breccia overlain by bedded limestone.

11. Subdivisions :
12. Fossils : The fossils are identified from Batu Gading, Bukit Besungai and Bukit Betok (Adams, 1958; Adams and Haak ,1962; Johnson, 1962; and Leichti *et al*., 1960).

algae
Archaeolithothamnium nummuliticum (Gumbel) Rothpletz
Archaeolithothamnium cf. *A. lugeoni* Pfender
Archaeolithothamnium cf. *A. myriosporum* Johnson
Archaeolithothamnium sp.
Corallina spp.
Cymopolia saipania Johnson
Cymopolia sp.
Dermatolithon sp.
Halimeda sp.
Jania vetus Johnson
Jania spp.
Lithophyllum besalotos Johnson
Lithophyllum borneoense Johnson
Lithophyllum prelichenoides Lemoine
Lithophyllum sarawakense Johnson
Lithophyllum traceyi Johnson
Lithoporella melobesioides (Foslie) Foslie
Lithothamnium crispithallus Johnson
Lithothamnium marianae Johnson
Lithothamnium sp.
Melobesia cuboides Johnson
Melobesia cf. *M. cuboides* Johnson
Mesophyllum vaughanii (Howe) Lemoine
Mesophyllum spp.
bryozoa
coral
echinoid
foraminifera
Aktinocyclina sp.
Amphistegina sp.
?Assilina sp.
Austrotrillina howchini (Schlumberger)
Borelis pygmaeus Hanzawa
Borelis cf. *pygmaeus* Hanzawa
Discocyclina cf. *omphala* (Fritsch)
Discocyclina spp.
Eorupertia plecte (Chapman)
Eorupertia sp.
Eulepidina sp.
Fabiania sp.
?Fabiania sp.
Globigerina binaiensis Koch
Globigerina cf. *ciperoensis* Bolli
Globigerina dissimilis Cushman & Bermudez
Globigerina spp.
Globigerinoides spp.
Globoquadrina venezuelana (Hedberg) var.
Globorotalia mayeri Cushman & Ellisor
Gypsina globulus (Reuss)
Gypsina vesicularis (Parker & Jones) var *discus* Goes
Gypsina cf. *globulus* (Reuss)
Gypsina spp.
Halkyardia bikiniensis Cole
Heterostegina borneensis van der Vlerk
Heterostegina spp.
Lepidocyclina (Eulepidina) spp.
Lepidocyclina (Nephrolepidina) spp.
Lepidocyclina spp.
Miogypsinoides ? *ubaghsi* Tan Sin Hok
Miogypsinoides sp.
Neoalveolina pygmaea (Hanzawa)
Nummulites javanus Verbeek
Nummulites saipanensis Cole
Nummulites cf. *globulus* Leymerie
Nummulites cf. *javanus* Verbeek
Nummulites cf. *saipanensis* Cole
Nummulites cf. *semiglobulus* (Doornink)
Nummulites javanus Verbeek
Nummulites sp.
Operculina spp.
Pellatispira crassicolumnata Umbgrove
Pellatispira madaraszi Hantken
Pellatispira orbitoidea (Provale)
Pellatispira cf. *provaleae* Yabe
Pellatispira spp.
Planorbulinella sp.
Spiroclypeus spp.
Textularia sp.
mollusc

13. Env. of deposition : Shallow sea not deeper than 22-30 m with short periods of shallower water conditions.
14. Remarks :

C26.5.

1. Name : Tujoh-Siman limestone
2. Origin of name : Batu Tujoh and Bukit Siman, Bahagian Miri
3. Age : Eocene to Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : ± 300 m

10. Lithology : Consists of massive biohermal limestone similar to Melinau limestone.
11. Subdivisions :
12. Fossils :
foraminifera
Amphistegina sp.
Lepidocyclina sp.
Miogypsinoides sp.
Operculina sp.
Spiroclypeus spp.
13. Env. of deposition :
14. Remarks :

C27.

1. Name : Temburong formation
2. Origin of name : Temburong River, Brunei
3. Age : Oligocene to Upper Miocene (Wilson & Wong, 1964), Upper Oligocene to Lower Miocene (Brondijk, 1963; Tate, 1994)
4. References : Brondijk (1963), Tate (1994), Wilson & Wong (1964)
5. Type area : Type locality is the headwaters area of the Temburong River, Brunei.
6. Type section :
7. Boundaries : Conformably overlies the Mulu and Kelalan Formations. The Meligan Formation and the Setap Shale overlie the Temburong formation unconformably
8. Correlation : Laterally, the formation passes gradually to the NNE into the West Crocker Formation, and to the southwest, it seems to pass gradually into the softer marly Tubau formation.
9. Thickness :
10. Lithology : Comprises a predominantly shaly sequence with locally intercalated sandstone layers. Wilson (1964) stated that the formation is remarkably uniform in lithology, being mainly a flysch-type argillaceous deposit, with fairly common intercalations of slightly calcareous pelagic shale (termed 'Pa Plandok Marl' by Bowen & Wright, *1957*, in Liechti *et al*., 1960).
11. Subdivisions :
12. Fossils :
foraminifera
Ammobaculites spp.
Ammodiscus sp.
Amphistegina sp.
Bathysiphon sp.
Bulimina sp.
Cristellaria sp.
Cyclammina sp.
Gaudryina sp.
Globigerina binaiensis Koch var.
Globigerina cf. *ciperoensis* Bolli
Globigerina dissimilis Cushman & Bermudez var.
Globigerina cf. *increbescens* Bandy
Globigerina spp.
Globigerinoides index Finley
Globigerinoides 'rubra group'
Globigerinoides semi-involuta Keijzer
Globigerinoides 'triloba group'
Globigerinoides spp.
Globoquadrina venezuelana (Hedberg)
Globoquadrina sp.
Globorotalia centralis Cushman & Bermudez
Globorotalia meyeri Cushman & Ellisor
Glomospira sp.
Gypsina sp.
Hantkenina alabamensis Cushman
Haplophragmoides walkeri (Grzybowski)
Haplophragmoides sp.
Hastigerina micra (Cole)
Heterostegina borneensis van der Vlerk
Heterostegina sp.
Kalamopsis spp.
Lepidocyclina (Eulepidina) cf. *ephippioides* (Jones & Chapman)
Lepidocyclina (Eulepidina) sp.
Lepidocyclina (Nephrolepidina) sp.
Lepidocyclina sp.
Miogypsinoides sp.
Operculina spp.
Psammosiphonella spp.
Quinqueloculina sp.
Trochammina sp.
Trochamminoides spp.
Uvigerina sp.
Valvulina spp.
Verneuilina sp.
Virgulina sp.
13. Env. of deposition : Deep water , marine environment, in basin slopes/ basin flanks (Brondijk, 1963). Tate (1994), however, interpreted it as shallow water, in sub-saline quiet-water, lagoon or marine embayment, or estuarine and lower alluvial

floodplain.

14. Remarks : Previously included in the Setap Shale Formation (Liechti *et al*. 1960). Brondijk (1963) explained the presence of unconformity in the Setap Shale Formation, and introduced the term Temburong Formation to represent the part below the unconformity.

C28.

1. Name : Setap Shale Formation
2. Origin of name : Coined from shale succession at Bulak Setap, Bahagian Miri.
3. Age : Mainly Miocene (Liechti *et al*., 1960; Kho, 1968), Oligocene (Banda & Aji, 1986), Upper Miocene (Wilson & Wong, 1964)
4. References : Banda & Aji (1986), Brondijk (1962), Haile (1962), Kho (1968), Liechti *et al*. (1960), Wilson and Wong (1964)
5. Type area :
6. Type section : Extends between the southern end of the Melinau Limestone and the southern rim of the Belait Syncline, North Sarawak. For the younger, highest part of the formation, the section from Bukit Malau to Bukit Ladan in the Limbang Valley.
7. Boundaries : The Setap Shale Formation is defined as the argillaceous succession which underlies the Belait, Miri or Lambir Formations and overlies generally Belaga, Mulu or Kelalan Formation, Melinau Limestone Formation or West Crocker Formation. In the Suai area the formation is overlain conformably, and along a strongly diachronous boundary, partly by Nyalau Formation, and partly, by Belait and Lambir Formations.
8. Correlation : Interfingers with the Belait or Lambir Formation, and the Tubau, Nyalau, Melinau Limestone, Tangap and Sibuti Formations, into which the succession merges laterally.
9. Thickness : > 730 to 5,600 m (Liechti *et al*., 1960). Kho (1968), estimated only about 335 m in the Sibiu Valley in Bintulu Area.
10. Lithology : A thick monotonous succession of dark clay-shales generally with minor intercalations of thin bedded sandstone or siltstone. The shales are occasionally calcareous and a few mostly thin lenses of biohermal or biostromal limestone occur.
11. Subdivisions : Batu Blah Member
12. Fossils :

algae

foraminifera

Ammobaculites sp.
Amphistegina sp.
Anomalina sp.
Asterigeria sp.
Austrotrillina howchini (Schlumberger)
Bathysiphon sp.
Bigenerina sp.
Bolivina sp.
Borelis philippinensis Hanzawa
Borelis aff. *parvulus* Hanzawa
Cibicides sp.
Cyclammina carinata (Cushman and Renz)
Cyclammina cuminatum (Cushman and Renz)
Cyclammina sp.
Cycloclypeus sp.
Eulepidina sp.
?Eurupertia sp.
Flosculinella botangensis Rutten
Flosculinella sp.
Globigerinoides sp.
Globigerinatella sp.
Gypsina globulus Reuss
Gypsina cf. *globulus* Reuss
Haplograraмoides malteri (Grybowski)
Heterostegina cf. *borneensis* v.d. Vlerk
Heterostegina sp.
Hormosina sp.
Kalamopsis grzybowski (Dylazanka)
Lepidocyclina (Eulepidina) cf. *formosa* Schlumberger
Lepidocyclina (Eulepidina) sp.
Lepidocyclina (Isolepidina) sp.
Lepidocyclina (Nephrolepidina) cf. *borneensis* Provale
Lepidocyclina (Nephrolepidina) cf. *isolepidinoides* v.d. Vlerk
Lepidocyclina (Nephrolepidina) sp.
Lepidocyclina cf. *borneensis* Provale
Lepidocyclina spp.
Lepidocyclina. (Eulepidina) cf. *bridgei* Cole
Miogypsina spp.
Miogypsinoides (Conomiogypsinoides) abunensis

Tobler
Miogypsinoides dehaarti van der Vlerk
Miogypsinoides sp.
Neoalveolina pygmaea Hanzawa
Nonion sp.
Operculina sp.
Operculina. cf. *pyramidum* Ehrenberg
Operculinella sp.
Orbulina universa d'Orbigny
Quinquelocullina sp.
Rotalia spp.
Sigmoidella sp.
Sigmoilina sp.
Siphogenerinoides sp.
Spiroclypeus sp.
Textularia sp.
Tritaxilina sp.
Trochammina sp. cf. *T. pacifica* (Cuchman)
reworked foraminifera (Paleocene to Lower Eocene) in the Pangi area
Globorotalia cf. *crassata* (Cushman)
Globorotalia velascoensis Cushman
Globorotalia wilcoxensis Cushman & Ponton
palynomorph
Alangium sp.
Arenga sp.
Casuarina sp.
Durio sp.
Eugeissonia minor
Florschuetzia trilobata
Gramineae
Lycopodium phlegmaria
Picea sp.
Pinus sp.
Podocarpus polystachyus

13. Env. of deposition : The greater part of the formation is fully marine, ranges from outer-neritic environment offshore to littoral environment inland.
14. Remarks : The term 'Setap Shales' was coined by C.M.Pollock (1929, in Leichti *et al*., 1960) for a shale succession at Bulak Setap that, however, now forms part of the Sibuti Formation. Brondijk (1962) has reclassifed part of the Setap Shale Formation in northwest Borneo as the Temburong formation. On Klias Peninsula, Sabah, to the east of Batu Linting and at Tanjong Klias, the Setap Shale Formation of Liechti *et al*. (1960), is now referred to the Crocker Formation on account of its mainly arenaceous nature (Wilson & Wong, 1964).

C28.1

1. Name : Batu Blah member
2. Origin of name : Bukit Batu Blah, middle Baram Valley, Bahagian Miri.
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area : Type locality is the Batu Blah escarpment, situated nearly 3.2 km west of Bukit Batu Blah, middle Baram Valley
6. Type section :
7. Boundaries : The basal boundary is hidden under alluvial plains or under the transgressively onlapping Patan Member of the Liang Formation. The upper boundary is placed at the top of the last major sandstone occurrence. The top boundary lies approx. 760 m underneath the top of the Setap Shale Formation in the Batu Blah Area.
8. Correlation :
9. Thickness : ± 975 m
10. Lithology : Consists of a succession of at least seven major sandstone bodies separated by clay-shales. The sandstones, rarely thicker than 30 m in one bed, are mostly hard and fine-grained, grey to grey-blue and often highly carbonaceous. The shales are silty or sandy, frequently lignitic and often indurated.
11. Subdivisions :
12. Fossils :
    foraminifera
    Trochammina spp.
13. Env. of deposition : Littoral to inner-neritic.
14. Remarks : The member was earlier described as the 'Batu Blah Sandstone'.

C29.

1. Name : Tubau formation
2. Origin of name : Tubau River, a tributary of the Kemena River, central Sarawak
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area : Type locality is the Tubau Valley,

particularly the Tubau River section

6. Type section :
7. Boundaries : The basal boundary, exposed in the upper Tubau Valley, is reportedly an unconformity, a basal conglomerate resting directly on Belaga Formation. The top boundary between Tubau and Nyalau Formation is a rapid transition which is morphologically clearly expressed by the contrast of a shale with a sandstone formation. The dark colours of the Tubau strata disappear and a conspicuous increase in sand takes place in the overlying Nyalau Formation.
8. Correlation :
9. Thickness : Few hundred metres. In the Bukit Lumut Area approx. 760 m is exposed.
10. Lithology : Consists of rather hard dark shales with stringers of sandy or silty shales or siltstones, many calcareous shales, and hard marls with occassional limestones. Sandstones are subordinate.
11. Subdivisions : None
12. Fossils :
    foraminifera
    Lepidocyclina sp.
    Miogypsina sp.
    Miogypsinoides sp.
    Operculina sp.
13. Env. of deposition : The marls and the few biohermal limestones indicate inner-neritic conditions, but the lignitic matter and the conglomerate at the base point rather to a littoral environment.
14. Remarks : N.P. de Boer & W.V. Milroy *(1952)* created the term Tubau Formation.

C30.

1. Name : Tangap Formation
2. Origin of name : Sungai Tangap, tributary of Sungai Niah, central Sarawak
3. Age : Lower to Middle Miocene
4. References : Haile (1962), Liechti *et al*. (1960)
5. Type area :
6. Type section : In Sungai Tangap, a right hand tributary of Sungai Niah, north of Bukit Subis, central Sarawak
7. Boundaries : Extreme interfingering especially with the Nyalau Formation, and also by somewhat transitional boundaries with the Sibuti and Setap Shale Formations. In the subsurface northeast of Subis, the base of the formation rest either on top of the Setap Shale Formation or possibly the Tubau formation. The top boundary is, except to the southwest, a gradual transition into the overlying Sibuti formation.
8. Correlation :
9. Thickness : Ranges from 1,700 m to less than 600 m. In the subsurface the formation extends over an interval of 2,700 m, from which two major tongues of Nyalau Formation of 425 m and 520 m thickness must be deducted.
10. Lithology : Comprises calcareous shale, marl and greenish claystone and occasional beds of purer limestone. Non-calcareous and sandy beds also occur.
11. Subdivisions : Subis Limestone Member
12. Fossils :
    algae
    Archaeolithothamnium sp.
    Corallina sp.
    Halimeda sp.
    Jania sp.
    Lithoporella sp.
    ?Lithothamnium sp.
    Lythophyllum sp.
    Mesophyllum sp.
    bryozoa
    coral
    echinoid
    spine
    foraminifera
    Lepidocyclina sumatrensis Brady
    Miogypsinoides dehaarti van der Vlerk
    Miogypsinoides lateralis Hanzawa
    Spiroclypeus higginsi Cole
    Spiroclypeus orbitoideus Douville
    Spiroclypeus tidunganensis van der Vlerk
    gastropod
13. Env. of deposition : The marls of the Tangap Formation probably indicate deposition in deeper water, at

outer neritic, but bathyal conditions are not positively excluded. It appears quite possible that the sea depth remains within 180 m limit of most mixed carbonate shelf associations.

14. Remarks : C.M. Pollock *(1929)* coined the term 'Tangap Marls'. The formation has repeatedly been redefined, eg. by I.L. Burr & W.E. Crews *(1950)*.

C30.1.

1. Name : Subis Limestone member
2. Origin of name : Gunong Subis
3. Age : Miocene
4. References : Haile (1962), Liechti *et al*. (1960)
5. Type area : Limestone hill forming Bukit Subis
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : The surface occurrence is approx. 365 m thick, the subcrop of limestone extends over an interval of 945 m, half of which is developed as limestone, the other half as clastics.
10. Lithology : Consists of an isolated biohermal growth of the shoal reef type. It is composed of of two genetically different, but closely associated, types of carbonate deposition; the coral-algal reefoid growth probably of bank reef type, and the foraminiferal open-shoal limestone, consisting of larger foraminifera, and echinoidal and algal debris.
11. Subdivisions :
12. Fossils :

foraminifera

Amphistegina sp.
Austrotrillina howchini (Schlumberger)
Cycloclypeus sp.
Heterostegina borneensis van der Vlerk
Lepidocyclina (Eulepidina) dilatata (Michelotti)
Lepidocyclina (Eulepidina) dilatata var. *tidunganensis* van der Vlerk
Lepidocyclina (Eulepidina) ephippoides Jones and Chapman
Lepidocyclina (Nephrolepidina) angulosa Provale
Lepidocyclina (Nephrolepidina) flexuosa (Rutten)
Lepidocyclina (Nephrolepidina) inflata Provale
Lepidocyclina (Nephrolepidina) sumatrensis (Brady)
Lepidocyclina (Nephrolepidina) verrucosa Scheffen
Miogypsina irregularis Michelotti
Miogypsina primitiva Tan Sin Hok
Miogypsina sp.
Miogypsinoides (Conomiogypsinoides) abunensis Tobler
Miogypsinoides (Conomiogypsinoides) sp.
Miogypsinoides dehaarti van der Vlerk
Miogypsinoides ubaghsi Tan Sin Hok
Neoalveolina pygmaea Hanzawa
Operculina cf. *pyramidum* Ehrenberg
Operculina sp.
Spiroclypeus sp.

The limestone moreover carries corals, algae, echinoids, bryozoa, molluscs and rare sponge spicules.

13. Env. of deposition : Middle to inner neritic environment with depth of water oscillating between a few metres and 60 m.
14. Remarks :

C31.

1. Name : Sibuti Formation
2. Origin of name : Sungai Sibuti
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : Sibuti River Section
7. Boundaries : The basal boundary with the Tangap Formation is somewhat vague as the lithology is transitional. Haile (1962) mentioned the formation overlies Tangap Formation conformably. The top boundary with the Lambir Formation is better in evidence though also transitional. The Sibuti Formation merges laterally into both the Tangap and the Setap Shale Formations, likely in the subsurface.
8. Correlation :
9. Thickness : ± 2,400 m to 3,400 m
10. Lithology : Succession of clay-shales with some marl and thin lenses of limestone, and subordinate siltstone and sandstone.
11. Subdivisions : None
12. Fossils :

foraminifera

Gypsina sp.
Lepidocyclina sp.
Miogypsina sp.
Nephrolepidina sp.

13. Env. of deposition : Inner neritic conditions, temporarily there was even a littoral environment
14. Remarks : The formation has been considered as a member of the Setap Shale Formation. However the formation status is adhered to because of the generally accepted usage.

C32.

1. Name : Silantek Formation
2. Origin of name : From a stream and village in the headwaters of Sungai Strap, Klingkang Range, west Sarawak
3. Age : Upper Eocene to ?Miocene
4. References : Haile (1954), Haile (1957), Liechti *et al*. (1960), Pimm (1965), Tan (1979)
5. Type area :
6. Type section : In the Undup River from the Batang Lupar to the base of the Plateau Sandstone Formation. Haile (1957) described the present type section under the heading 'Kantu Beds'.
7. Boundaries : The base transgressively overlaps the Sadong Formation (Upper Triassic), the Lupar Formation (Upper Cretaceous) and pre-Tertiary igneous rocks. The top is a rapid conformable transition into the 'Plateau Sandstone Formation'.
8. Correlation : The Silantek Formation and Plateau sSandstone in Sarawak form the northern and northeastern rim of the major Ketungau basin in West Borneo. The Silantek Formation is similar lithologically to the Melawi Group and Kantu Beds in Kalimantan and is probably synchronous with them. The Upper Silantek Redbed Member is similar lithologically to the Lebang Mudstone in Kalimantan and is probably synchronous with it.
9. Thickness : Estimated approx. 4,200 - 4,500 m by Leichti *et al*. (1960), 5,100 m by Tan (1979) and approx. 6,400 m by Haile (1957). In the Serian area only about 600m of the formation is exposed (Pimm, 1965).
10. Lithology : A succession of mainly silty and/or carbonaceous clays and clay shales, alternating with shales, sandstones, mudstones, siltstones and coal seams. Conglomerate lenses occur near the base and at the top is a sequence of red mudstone, shale, siltstone and sandstone.
11. Subdivisions : Basal Sandstone member, Temudok member and the Upper Silantek Redbed member.
12. Fossils :

bivalve
?Cardium sp.
Batissa subtrigonalis (Krause)
Cardium sp.
Corbula s.l.
echinoid
spine
foraminifera
Aktinocyclina sp.
Ammobaculites sp.
Ammodiscus sp.
Amphistigina spp.
Anomalina sp.
Assilina sp. aff. *A. praespira* Douville
Asterigina spp.
Cyclammina cf. *8*
Cyclammina sp.
Discocyclina spp.
Haplophragmoides sp.
Heterostegina sp.
Miliammina fusca (Brady)
Miliammina sp.
Nonion sp.
Nummulites spp.
Operculina spp.
Operculinella sp.
Quinqueloculina spp.
Rotalia sp.
Sigmoilina sp.
Trochammina sp.
mollusc
Cyrena subtrigonalis Krause
Corbula dajacensis Krause
Geloina hashimotoi Kanno n. sp.
Hindsiella sp.

Melania sp.
Naticaceae
Paludomus gracilis Krause
Tellina sp.
Thiara (Melania) sp.
Turritellidae
Vivaparus sp. / *Paludomus* sp.
nannofossil
Coccolithus sp.
Pemma sp.
Prinsiaceae sp.
plant
Dipterocarp leaves

13. Env. of deposition : From the base upwards; Near-shore to shallow marine environment, gradually becoming estuarine and fluviatile and probably, in parts, lacustrine, and finally terrestrial
14. Remarks : Was first mapped as the Kantu Beds, later included in the Plateau sandstone Series. It was subsequently introduced as the Silantek Formation by Liechti *et al*. (1960).

C32.1.

1. Name : Basal Sandstone member
2. Origin of name :
3. Age : Refer Formation
4. References : Haile (1957), Tan (1979)
5. Type area : Well exposed in the Marup Quarry, along the Jakar-Saratok Road west of the Marup Quarry, in Sungai Melaban and in the headwaters of Sungai Kepayang, a tributary of Sungai Semuyong
6. Type section :
7. Boundaries :
8. Correlation : Forms the base of the Silantek Formation
9. Thickness : ± 1,600 m
10. Lithology : Composed of mainly steeply dipping to vertical, yellow to white, porous to friable polymict to quartzose sandstone beds up to 15 m thick, interbedded with thin beds of silty shale and mudstone and occasionally dark-grey calcareous shale and mudstone.
11. Subdivisions :
12. Fossils :

foraminifera
Actinocyclina sp.
Amphistigina spp.
Assilina sp.
Assilina sp. aff. *Assilina praespira* Douville
Asterigina spp.
Discocyclina spp.
Elphidium spp.
Heterostygina sp.
Nummulites sp.
Operculina spp.
Quinqueloculina spp.
Rotalia sp.
mollusc
nannofossil
Coccolithus sp.
Pemma sp.
Prinsiaceae sp.

13. Env. of deposition : Refer Formation
14. Remarks : Informally named the Basal Sandstone by Haile (1957)

C32.2.

1. Name : Temudok member
2. Origin of name : Bukit Temudok
3. Age : Refer Formation
4. References : Haile (1957), Tan (1979)
5. Type area : The Temudok Ridge and the hills of Tinteng Kemuyang, Tiang Laju and Perapau
6. Type section :
7. Boundaries :
8. Correlation : Lithologically similar to Basal Sandstone member but lack of conglomerate and pebbly sandstones and being more thinly bedded.
9. Thickness : ± 200 m
10. Lithology : Lenticular, sandstone body composed of thin to thick beds (3-150 cm), of yellowish-white to grey, fine to coarse grained sandstone. Alternating with the sandstone are thin beds of sandy to silty mudstone and shale.
11. Subdivisions :
12. Fossils : Nil
13. Env. of deposition : Refer Formation
14. Remarks : Informally named the 'Temudok Sandstone' by Haile (1957)

C32.3.

1. Name : Upper Silantek Redbed member
2. Origin of name :
3. Age : Refer Formation
4. References : Haile (1954), Haile (1957), Tan (1979)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation : Forms the upper part of the Silantek Formation and is overlain conformably by the Plateau sandstone.
9. Thickness : ± 300 m
10. Lithology : Consists predominantly of red micaceous shale and mudstone, occasionally with grey mottles, red siltstone and red sandstone.
11. Subdivisions :
12. Fossils : Nil
13. Env. of deposition : Terrestrial deposition as fans or aprons extending into basins
14. Remarks : Previously referred as the Upper Silantek Beds (Haile, 1954) and the Upper Kantu Beds (Haile, 1957).

C33.

1. Name : Plateau sandstone
2. Origin of name : The term 'Plateau Sandstone' was first used by Dutch geologists working in Kalimantan, It was later referred as 'Plateau Sandstone Series', 'Plateau Sandstone', 'Plateau Sandstone Formation' and again 'Plateau Sandstone'.
3. Age : ?Upper Eocene to ?Upper Miocene
4. References : Liechti, *et al*. (1960), Molengraaf (1902), Tan (1979), Tan (1993), Zeylmans van Emmichoven (1939)
5. Type area : The Klingkang Range, Sarawak. Only the narrow basal part lies in Sarawak.
6. Type section :
7. Boundaries : The base overlies conformably the Silantek Formation. In the Bako Peninsula, the Plateau sandstone unconformably overlies the Sejingkat Formation. The top is an erosion surface.
8. Correlation : In Kalimantan, the formation is reported overlain concordantly by the Ketungau Beds, and in places, by shales of the Silat Group.
9. Thickness : In the Klingkang Range, only about 150 m is exposed in the Sarawak area, but in Kalimantan some 1,800 m is reported (Zeylmans van Emmichoven, 1939).
10. Lithology : A succession of thick, thick-bedded to massive, cross-bedded, polymict to quartzose sandstone, with minor intercalations of grey and red shale and mudstone, and lenses of conglomerate.
11. Subdivisions : None
12. Fossils :
    mollusc
    Clementia papyracea Grey
    Cyrena subrotundata Krause
    Veneridae
    plant
    Palmoxylon spp.
    silicified wood
13. Env. of deposition : Estuarine to terrestrial environment. Tan (1993) concluded, in the Bako peninsula was probably deposited in a mainly fluviatile environment, possibly in braided rivers, and in part, in a deltaic environment.
14. Remarks : Tan (1993) considered the previously described Plateau Sandstone of the Santubong Peninsula, Kayan Basin, Samunsan Valley and the Bungo Range to belong to the 'Kayan Sandstone'. The palynology of the 'Plateau Sandstone Formation' as described by Muller (1968), is now included in the Kayan sandstone.

C34.

1. Name : Lambir Formation
2. Origin of name : Lambir Hill in Brunei
3. Age : Upper Miocene
4. References : Haile (1962), Liechti, *et al*. (1960)
5. Type area : Lambir Hills in Brunei and Bakong Valley in North Sarawak.
6. Type section : Succession in the block between the headwaters of Sungai Muchok

(Sungai Sintulang), Sungai Tanasau and the coast.

7. Boundaries : The basal boundary is a gradual, slightly diachronous transition from the predominantly argillaceous Sibuti Formation. The top boundary, observable only in the Lambir Hills, is a rapid transition to the softer more argillaceous overlying Miri Formation, or further east with the less consolidated Tukau Formation. Haile (1962) states that the top boundary is a conformable transition into the Belait Formation.
8. Correlation :
9. Thickness : ± 1,000-2,100 m
10. Lithology : An alternation of sandstone and shale (of a similar type to the Belait Formation) with a distinctive calcareous admixture (limestone, calcareous shale), which, may be locally absent.
11. Subdivisions : None
12. Fossils :

foraminifera

Ammobaculites sp.
Anomalina sp.
Asterigerina sp.
Austrotrillina sp.
Bigenerina sp.
Bolivina sp.
Cibicides sp.
Cyclammina sp.
Elphidium spp.
Flosculinella botangensis Rutten
Flosculinella (Alveolinella) botangensis Rutten
Flosculinella sp.
Gypsina sp.
Hormosina sp.
Lepidocyclina cf. *sumatrensis* (Brady)
Loxostoma sp.
Miogypsina sp.
Miogypsinoides sp.
Nephrolepidina sp.
Nodosaria sp.
Nonion sp.
Operculina spp.
Rectobolivina spp.
Rotalia spp.
Siphogenerina sp.
Spiroclypeus sp.
*Spirolin*a sp.
Textularia sp.
Triloculina sp.

13. Env. of deposition : Inner neritic to littoral conditions, becoming entirely littoral towards the top.
14. Remarks : S.T. Waite *(1940)* created the term 'Lambir Formation'. Lim & Mohd Shafeea Leman (1994) noted that the Ulu Bok Syncline, in north Sarawak, revealed characteristics of Lambir Formation rather than Belait Formation, as had earlier been mapped.

C35.

1. Name : Belait formation
2. Origin of name : Presumably Sungai Belait, in Brunei
3. Age : Miocene to ?Lower Pliocene
4. References : Haile (1962), Liechti *et al*. (1960), Wilson & Wong (1964)
5. Type area : The entire Belait Syncline in Brunei, including part of the Belait Anticline.
6. Type section :
7. Boundaries : Everywhere overlies Setap Shale Formation or its sandy equivalent, the Nyalau Formation. The basal boundary to the north, is strongly diachronous, the Setap Shale and Belait Formations wedging laterally into one another over a vertical thickness of many hundreds of metres. In the Belait Syncline and in Klias the formation is conformably overlain by the Seria Formation. Wilson & Wong (1964) noted that on Labuan Island, grey mudstone of the Setap Shale Formation occurs fairly consistently but in poor exposures below the Belait formation.
8. Correlation : In the Belait Syncline, the Belait formation comprises the time-stratigraphic equivalents of the Lambir and Miri formations only. Wilson & Wong (1964) mentioned that at least in part the formation is probably a time equivalent of the Meligan Formation.
9. Thickness : Approx. photogeological estimation based on Leichti *et al*.

(1960 :The Belait Anticline 4,500-5,700 m; the Belait Syncline, for the East-flank 11,200 m, the Central part of the syncline 6,300 m, and the West-flank 6,000 m. In Klias Peninsula and Labuan, in Sabah, Heybroek and Crews (in Wilson & Wong, 1964) estimated 1,800 m and 2,100 m of the formation.

10. Lithology : Composed of thick-bedded sandstones which form prominent scarps and mountain ranges, with subordinate grey shale and clay, and some seams of lignite. Wilson & Wong (1964) mentioned the presence of conglomerate and reef limestone in the formation in the Labuan and Padas Valley areas.

11. Subdivisions : Not conceived as proper members but in only descriptive terms by Leichti *et al*. (1960), as the 'marginal sandstones' for the lower part and 'Belait clay' for the upper part of the formation. In addition, Leichti *et al*. (1960) mentioned the 'Intermediate Claystone-Siltstone Member' in the Limbang Syncline but did not clearly elaborate the terminology used.

12. Fossils :

algae
bryozoa
coral
foraminifera
Ammobaculites sp.
Ammobaculites spp.
Bathysiphon sp.
Bolivina sp.
Cyclammina sp.
Elphidium sp.
Flosculinella borneensis (Tan Sin Hok)
Flosculinella globulosa (Rutten)
Gaudryina sp.
Globigerinoids sp.
Gypsina spp.
Haplophragmoides sp.
Hormosina sp.
Lepidocyclina spp.
Miogypsina sp.
Nonion sp.
Perculina sp.
Rotalia sp.
Textularia sp.
Textularia sp.
plant
remains
mollusc
Cardium sp.
*Tridacn*a sp.
Arca sp.
Pecten sp.
Ostrea sp.
Murex sp.
Serpula sp.

13. Env. of deposition : Indicate a paralic environment temporarily and locally developing into shallow marine, i.e. littoral, conditions.

14. Remarks : The term 'Belait Formation' is a synonym of the former 'Belait Group'. Lim & Mohd Shafeea Leman (1994) noted that the Belait formation of Ulu Bok Syncline, in north Sarawak revealed characteristics of Lambir Formation.

C36.

1. Name : Miri formation
2. Origin of name : Presumably the place Miri
3. Age : Miocene to Pliocene
4. References : Liechti, *et al.* (1960)
5. Type area : Original type locality is the Miri Anticline, at Miri Oilfield, north Sarawak. It later includes the Seria subsurface.
6. Type section :
7. Boundaries : In the Seria and Miri subsurface, as also in Tudan and Rasau, the basal boundary with the underlying Setap Shale Formation is a gradual transition from an arenaceous into a predominantly argillaceous succession. In the Bakam-Lambir Area the basal boundary of the Miri formation with the Lambir Formation is fairly well defined, the top sandstone of the Lambir Formation (Lembong Sandstone) contrasting sufficiently with the more argillaceous Miri formation. In the Miri-Seria subsurface the top boundary of the Miri

formation with the overlying Seria Formation is a gradual transition.

8. Correlation : The formation is a marine time-stratigraphic equivalent of the upper part of the Belait formation and restricted to the coastal area.
9. Thickness : ± 1,800 m, in the Seria Field
10. Lithology : A predominantly arenaceous succession, the lower part consists of a succession of sandstones and shales, the latter slightly prevailing; the upper part is more arenaceous, the alternation of sandstone and shales takes place more rapidly and is less regular, the sandstone bodies merge more gradually into argillaceous sandstone and sandy or silty shale. Lignites and dispersed lignitic matter are less frequent and that a marine microfauna is developed.
11. Subdivisions : None
12. Fossils :
    foraminifera
    Bolivinita 1
    Loxostoma 1
    Nonion 3
13. Env. of deposition : Littoral to inner neritic shallow marine environment
14. Remarks :

C37.

1. Name : Tukau Formation
2. Origin of name : Sungai Tukau, north Sarawak
3. Age : Upper Miocene to Pliocene
4. References : Liechti, *et al.* (1960)
5. Type area : Lambir-Bakong Hills
6. Type section : Sungai Tukau in the Liku-Badas Syncline, south of Miri town the Lambir Taniku Corehole Section, Section III of Sheldon's auger survey in the Bakong Hills, and part of the Bakam Corehole section including Wells Bakam 1 and 2.
7. Boundaries : In part the formation develops laterally out of the uppermost Lambir Formation and the Lower Miri formation of the Lambir Hill area, whilst in part it overlies them. The top boundary is a conformable contact with the overlying Liang formation
8. Correlation Time equivalent of the Seria, the Miri and the uppermost Lambir Formations.
9. Thickness : ± 2,700 m
10. Lithology : A succession of poorly poorly consolidated sandstones and sands, alternating with soft clays. Finely dispersed lignitic material or thin lignite layers are frequent.
11. Subdivisions : None
12. Fossils :
    foraminifera
    *Ammobaculite*s sp.
    Bolivina 1
    Glomospira sp.
    Haplophragmoides sp.
    Rotalia spp.
    Trochammina sp.
13. Env. of deposition : Deltaic-paralic deposition with brackish-water conditions prevailing most of the time.
14. Remarks : Previously named the 'Barren Series'.

C38.

1. Name : Balingian formation
2. Origin of name : The place Balingian
3. Age : Miocene (Liechti, *et al*., 1960); ?Upper Miocene (Wolfenden, 1960)
4. References : Liechti, *et al*. (1960), Wolfenden (1960)
5. Type area : The entire outcrop of the Teres-Bakau Anticline, situated between the Mukah and Balingian rivers, central Sarawak.
6. Type section :
7. Boundaries : The top boundary with the Begrih formation in the Teres area is a distinct, though minor, unconformity, marked by the Begrih conglomerate at the base of the Begrih formation. The basal boundary is not exposed.
8. Correlation : For the greater part of the formation probably a time-equivalent of the Belait formation, but the lower part may be older.
9. Thickness : Composite thickness appears to exceed 3,000-3,600 m Liechti, *et al*. (1960), in the Teres and Penipah Valleys the exposed part is about 1,800 m from the

estimated cumulative thickness of 3,000 m (Wolfenden, 1960).

10. Lithology :A very thick paralic succession of sandstones and clay-shales with abundant lignites.
11. Subdivisions : None
12. Fossils :
    foraminifera
    Ammobaculites sp.
    Ammodiscus sp.
    Discorbis sp.
    *Glomospir*a sp.
    Haplophragmoides sp.
    Trochammina sp.
    ostracod
13. Env. of deposition : Estuarine to lagoonal, with strong affinities to deltaic conditions. The foraminiferal fauna proves a brackish-water environment.
14. Remarks : The formation has been the object of much exploratory effort since 1928 when O. Wilhelm created the term Balingian Lignite Series and described the lower part as 'shale/ Quartzite Series'. S.T. Waite *(1940)* separated an 'Upper Balingian Lignite Series' when he recognised that a marine succession termed 'Begrih Marine Series' separated them. The Upper Balingian Lignite Series was later on termed Sikat Formation and forms now part of the Liang Formation. The 'Begrih Marine Series' was eventually retained as Begrih formation and the 'Lower Balingian Lignite Series' was subdivided into a Matading Formation at the base and an overlying Balingian Formation. These two formations have been later united into the present Balingian Formation, as they are lithologically indistinguishable. Later a 'Lignite series' was added on the top, and a 'Shale Quartzite Series' at the bottom, but both were subsequently abandoned since the subdivisions is not recognisable anywhere except in wells Mukah 1 and 2 only.

C39.

1. Name : Begrih formation
2. Origin of name : Sungai Begrih, central Sarawak
3. Age : Upper Miocene to Pliocene (Liechti, *et al*., 1960), Lower Pliocene (Wolfenden, 1960)
4. References : Liechti, *et al.* (1960), Wolfenden (1960)
5. Type area : Exposed over an area 25 km long and 4 to 7 km wide in the south flank of the Teres-Bakau trend, between the Balingian and Mukah Rivers, central Sarawak (Liechti, *et al*., 1960). Type locality is in the Begrih Valley (Wolfenden, 1960).
6. Type section :
7. Boundaries : The basal boundary, the Begrih Conglomerate rests with a distinct, though slight, local unconformity on the Balingian Formation. Where the Begrih Conglomerate is not developed, the Begrih Formation appears to rest conformably on the Balingian Formation. The top boundary with the overlying Liang Formation is an unconformity.
8. Correlation : A probable time-equivalent of the Lower Miri Formation.
9. Thickness : Varies in the surface outcrop from 600-760 m
10. Lithology : A marine succession of clays, sands and grits with pebble beds and, locally, a boulder conglomerate at the base.
11. Subdivisions : The Begrih Conglomerate and the Tunggal-Ransi Conglomerate members.
12. Fossils :
    foraminifera
    Ammobaculites sp.
    Anomalina sp.
    Bolivina spp.
    Cibicides sp.
    Cyclammina sp.
    Elphidium spp.
    Frondicularia sp.
    Glandulina sp.
    Quinqueloculina sp.
    Rotalia spp.
    Siphogenerinoides sp.

Textularia spp.
Triloculina sp.

13. Env. of deposition : Probably predominantly littoral
14. Remarks : Until 1930 the formation formed part of the Balingian formation

C39.1.

1. Name : Begrih Conglomerate Member
2. Origin of name :
3. Age : Upper Miocene to Lower Pliocene
4. References : Liechti, *et al.* (1960)
5. Type area : South Flank of the Teres-Bakau Anticline
6. Type section :
7. Boundaries : The basal boundary, the Begrih conglomerate rests with a distinct, though slight, local unconformity on the Balingian formation.
8. Correlation : A probable rock and time-stratigraphic equivalent of the Tunggal-Ransi conglomerate.
9. Thickness : ± 60 m
10. Lithology : Consists of lenses of sand and conglomerate with a few lignites. Towards the Mukah river the conglomerate is composed of boulders or cobbles up to 38 cm across, but decrease in size to the north and east. The matrix is a soft, clayey sand.
11. Subdivisions : Liechti, *et al*. (1960) suppose that the Tunggal-Ransi conglomerate is probably a member of the Begrih conglomerate.
12. Fossils :
13. Env. of deposition :
14. Remarks : Formally named a member of the Begrih formation by Liechti, *et al*. (1960)

C39.2.

1. Name : Tunggal-Ransi Conglomerate member
2. Origin of name : Bukit Tunggal, Bukit Ransi, Tatau Horst, central Sarawak
3. Age : Upper Miocene to Lower Pliocene
4. References : Liechti, *et al.* (1960)
5. Type area : Type localities are Bukit Ransi and Bukit Tunggal, west and east of the Tatau River respectively. The conglomerate occurrences extend over a distance of about 25 km.
6. Type section :
7. Boundaries : The Tunggal-Ransi conglomerate onlaps transgressively onto the Bawang member of the Belaga Formation, the Tatau formation and the Nyalau Formation. The angle of unconformity is high and varies considerably. The conglomerate also truncates at a high angle the strike of the Bawang member and Tatau formation. The top boundary is hidden or erosional.
8. Correlation : A probable rock and time-stratigraphic equivalent of the Begrih conglomerate.
9. Thickness : 198-213 m
10. Lithology : Alternation of massive grits and conglomerates with a few interbedded shales of grey or pink colour, sometimes strongly lignitic and black.
11. Subdivisions :
12. Fossils :
13. Env. of deposition : Lagoonal or continental deposition very near to the source of detritus.
14. Remarks : Initially termed the 'Tatau Conglomerate Series' and later the 'Tunggal Conglomerate'.

C40.

1. Name : Liang formation
2. Origin of name : Sungai Liang, Brunei
3. Age : Pliocene to Middle Pleistocene
4. References : Haile (1962), Liechti, *et al*. (1960), Wilson & Wong (1964), Wolfenden (1960)
5. Type area : The Lumut Hills east of Seria Oilfield, Brunei, in particular the Sungai Liang Section, serve as type area.
6. Type section :
7. Boundaries : In the coastal area, the formation rests unconformably on calcareous Setap Shale Formation with an angle of unconformity ranging from 12º to more than 40º. In the Klias subsurface the formation rests partly conformably on Seria Formation. In the Balingian-Mukah Area it transgresses successively onto the

Belaga Formation (Metah Member and probably also Bawang member), and the Tatau and Nyalau formations, but only the contact with the Metah Member is exposed. In the Suai Coast the basal boundary is an unconformable onlap on Lambir Formation. Locally a small unconformity or disconformity between the formation and the Lumut Member is in evidence, eg. in the Tudan Area. The top boundary of the Liang formation and its members is either purely erosional, or an unconformity with the overlying Quaternary terraces or Alluvial deposits.

8. Correlation :
9. Thickness : ± 60 to 1,500 m. Estimation from seismic data 1,900 to ± 3,000 m.
10. Lithology : Succession of sands, clays, gravel beds, with some lignites, of very young appearance and poor consolidation.
11. Subdivisions : Not properly classified and explained, but mentioned the Lumut, Berakas and Patan Members (Liechti *et al.*, 1960).
12. Fossils :
    bryozoa
    echinoid
    spine
    foraminifera
    Ammobaculites sp.
    Ammodiscus sp.
    Anomalina spp.
    Bigenerina sp.
    Biloculina sp.
    Bolivinia spp.
    Cancris sp.
    Cibicides spp.
    Cristellaria spp.
    Elphidium spp.
    Eponides spp.
    Glandulina sp.
    Globigerina spp.
    Glomospira sp.
    Gyroidina sp.
    Haplophragmoides sp.
    Lagena spp.
    Nonion spp.
    Operculina sp.
    Orbulina sp.
    Quinqueloculina spp.
    Rotalia spp.
    Sigmoidella sp.
    Sigmoilina spp.
    Siphonina sp.
    Spiroloculina sp.
    Textularia spp.
    Trochammina sp.
    Uvigerina sp.
    Vulvulina spp.
    gastropod
    ostracod
    plant
    remains
13. Env. of deposition : Very shallow, near-shore type of marine deposition which, however, changes inland into paralic or even continental conditions.
14. Remarks : The 'Sikat Formation' and the 'Penian Formation' are now included in the Liang formation.

C40.1

1. Name : Lumut member
2. Origin of name : Lumut Hills, Brunei
3. Age :
4. References :
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness :
10. Lithology : Consists of clays with abundant lignites and lignitic clays with coarse conglomeratic sand lenses. Upwards is composed mainly of sand and sandy clay-shale with pure clay and tuffaceous beds and lignites.
11. Subdivisions :
12. Fossils : Moulds and casts of fossils.
13. Env. of deposition : Wholly paralic, in part deltaic
14. Remarks :

C40.2

1. Name : Berakas member
2. Origin of name : Berakas syncline, Brunei
3. Age :
4. References :
5. Type area :
6. Type section :
7. Boundaries :

8. Correlation : Probably represents a stratigraphic equivalent of the whole Liang formation. On lithology alone it appears the member is a stratigraphic equivalent of the Lumut member.
9. Thickness :
10. Lithology : Consists of lignitic and black sandy clays with well preserved plant remains, alternating with sands, soft sandstones, and one or two beds of gravel which grade into coarse sands. The gravel pebbles consist of quartzite, limestone, coarse conglomerate and black chert.
11. Subdivisions :
12. Fossils :
13. Env. of deposition : Estuarine-lagoonal
14. Remarks : The member could be mistaken for Alluvium, were it not that it is gently folded and unconformably overlain by Jerudong terrace sands.

C40.3

1. Name : Patan member
2. Origin of name : Sungai Patan
3. Age :
4. References :
5. Type area :
6. Type section :
7. Boundaries : Rests unconformably on Setap Shale Formation with a high angle of unconformity. Overlain by Quaternary cobble terrace.
8. Correlation :
9. Thickness :
10. Lithology : Horizontal succession with lignites up to 1.5 m thick. Shepherd and van de Flirt *(1956)* described the succession as an alternation of grey or brown clays or silty clays, lignitic or coaly, with beds or lenses of sand, coal seams, and quartz pebbles at the base.
11. Subdivisions :
12. Fossils :
13. Env. of deposition : Wholly paralic, probably estuarine.
14. Remarks :

3.3. SABAH

C41.

1. Name : Chert-Spilite formation
2. Origin of name : Understandably most likely, from the lithology.
3. Age : Upper Cretaceous to Eocene (Collenette, 1965a; Fitch, 1955; Kirk, 1962; Leong, 1974; Newton-Smith, 1967), Valanginian to Barremian, Lower Cretaceous to Eocene (Leong, 1977)
4. References : Collenette (1965a), Fitch (1955), Kirk (1962), Leong (1974), Newton-Smith (1967), Wilson (1961)
5. Type area : Not specified, but Fitch (1955) defined the formation from the Upper Segama and Darvel Bay area.
6. Type section :
7. Boundaries : In the Upper Segama and Darvel Bay area, the formation unconformably overlies the Crystalline Basement; at Agob-Dabalan, Kawag and Pulau Batik (Leong, 1974). The limestone breccia of the Langusan Beds appears to overlie unconformably on spilitic and associated doleritic rocks of the Chert-Spilite formation in Sungai Langusan. Also, slump breccia deposits of the Kuamut Formation overlies unconformably on the volcanic and other rock types of the Chert-Spilite formation. In the Bidu-Bidu Hills area, the Chert-Spilite formation appears to rest unconformably on metamorphic rocks of the Crystalline Basement, and probably overlain by the Crocker formation (Newton-Smith, 1967). Leong (1974) observed several unconformities between the Chert-Spilite formation and the older Crystalline Basement at various localities in the Upper Segam Valley and Darvel Bay area, and inferred angular unconformity between the formation and the Madai-Baturong Limestone.

8. Correlation :
9. Thickness : Probably several thousands metre
10. Lithology : Comprise a group of sedimentary and volcanic rocks which include sandstone, shale, chert, siltstone, conglomerate, limestone, marl and porcellanite, spilite, pillow lava, basalt, tuff, and agglomerate, and some rare shistose rocks. Wilson (1961) commented that the rocks comprising the formation in most areas have undergone intense faulting and shearing, and rocks of low metamorphic grade, such as quartzite, greenstone, and mylonite are common.
11. Subdivisions :
12. Fossils :

In Kirk (1962):
radiolaria (in chert)
Botrypyle sp.
?Botrypyle sp.
Cenosphaera sp.
?Cenosphaera sp.
Cryptocapsa sp.
Dicolocapsa sp.
Dictyocephalus sp.
?Dictyoceras sp.
Dictyomitra sp.
?Distylocapsa sp.
Hexadoras sp.
Hexastylus sp.
?Kassina sp.
Lithapium sp.
Lithatractis sp.
Lithatroctis sp.
Lithomitra sp.
Lophocorys sp.
Lophophaena sp.
Melitosphaera sp.
Meyenella hensoni Davis
Meyenella meyeni Davis
Meyenella meyeni
Palaeacanthus spinosus Davis
Palaeacanthus sp.
Plectopyramis sp.
Podocyrtis sp.
?Pterocanium sp.
Sciadocapsa sp.
Sethocorys sp.
Staurosphaera sp.
Stichocorys sp.
Stichopera sp.
Stichopera sp.
Theocapsa sp.
Tricolocapsa spp.
Trisyringium sp.
In Newton-Smith (1967):
foraminifera
Ammodiscus sp.
Bathysiphon sp.
Cyclammina sp.
Glomospira sp.
Haplophragmoides walteri (Grzybowski, 1898)
Haplophragmoides sp.
Sigmoilina sp.
Trochammina sp.
Trochamminoides subcoronata (Rzehak, Grzybowski, 1896)
Trochamminoides sp.
radiolaria (in mudstone and shale)
Archicapsa sp.
Cenosphaera sp.
Cryptocapsa sp.
Dicolocapsa sp.
Dictyomitra sp.
Hemicryptocapsa sp.
Meynella ?hensoni
Meyenella meyeni
Meyenella ?rotula
Rhopalastrum sp.
Staurolonche sp.
Stichopera sp.
Stichophormis sp.
?Tricolocapsa sp.
Xiphostylus sp.
In the calcareous and argillaceous sequence (Leong, 1974):
algae
Parachaetes sp.
(?) Pterophyton sp.
Thaumetoporella parvovesiculifera (Reineri) Pia
Trinocladus exoticus sp. nov.
Trinocladus spp.
foraminifera
Aktinocyclina sp.
Alveolina sp.
Assilina sp.
?Assilina sp.
Asterocyclina sp.
Discocyclina sp.
?Eorupertia sp.
?Fabiabia sp.
Fasciolites sp.
Fasciolites sp. indet.
Globigerina cf. *cretacea* d'Orbigny
Globigerina spp.

Globorotalia cf.*abundocamerata* Bolli
Globorotalia cf. *pseudobulloides* (Plummer)
Globorotalia cf. *pusilla* Bolli
Globorotalia cf. *velascoensis* (Cushman)
Globotruncana calcarata Cushman
Globotruncana concavata (Brotzen)
Globotruncana elevata Brotzen
Globotruncana elevata cf. *strautiformis* Dalbiez
Globotruncana tricarinata (Quereau)
Globotruncana aff. *fornicata* Plummer
Globotruncana cf. *arca* Cushman
Globotruncana cf. *bulloides* (Vogler)
Globotruncana cf. *concavata* (Brotzen)
Globotruncana cf. *linneiana* (d'Orbigny)
Globotruncana cf. *renzi* Gandolfi
Globotruncana cf. *schneegansi* Sigal
Globigerina sp. or spp. indet.
Gumbelina sp.
Hedbergella cf. *delrioensis* (Carsey)
Hedbergella cf. *planispira* (Tappan)
Hedbergella sp.
Heterohelix globulosa (Ehrenberg)
Heterohelix cf. *costulata* Cushman
Heterohelix sp. or spp. indet.
Heterohelicidae indet.
Lithamnium sp.
Lithothamnium sp.
Miliola sp.
Nummulites (*N. baguelensis* Verbeek)
Nummulites javanus
Nummulites cf. *javanus* Verbeek
Nummulites pengaronensis
Nummulites cf. *pengaronensi*s Verbeek
Operculina sp.
?Operculina sp.
Pellatispira sp.
Praeglobotruncana (Hedbergella) spp.
Rotaliidae indet.
Textularidae indet.
radiolaria
Adelocyrtis sp.
Amphisphaera sp.
Anthacorys sp.
Botrypyle sp.
Calocyclas sp.
Cenosphaera sp.
Conosphaera sp.
Cryptocapsa sp.
Cryptocephalus sp.
Cyrtophormis sp.
Dicolocapsa sp.
Dictyomitra sp.
Diplactura sp.
Distylocapsa sp.
Dorysphaera sp.
Eusyringium sp.
Flustrella sp.
Glycobotrys sp.
Hagiastrum sp.
Halicapsa sp.
Hemicryptocapsa sp.
Heterosestrum sp.
Hexadoras sp.
*Hexastylu*s sp.
Holocryptocapsa sp.
Lithatractus sp.
Lithatroctis sp.
Lithomitra sp.
Lithornium sp.
Lithostrobus sp.
*Lophoconu*s sp.
Lophocorys sp.
Lophophaena sp.
Melitosphaera sp.
Meyenella hensoni
Meyenella meyeni Davis
Meyenella meyeni
Meyenella sp.
Micromelissa sp.
Palaeacanthus spinosus Davis
Palaeacanthus sp.
Podocyrtis sp.
Pterocanium sp.
Rhodosphaera sp.
Rhopalastrum sp.
Sciadocapsa sp.
Sethocorys sp.
Sethocyrtis sp.
Spongodiscus sp.
Spongolonchis sp.
Staurolonche sp.
Stichocapsa sp.
Stichocorys sp.
Stichopera sp.
Stylosphaera sp.
Stylostaurus sp.
Theocampe sp.
Theocapsa sp.
Theocyrtis sp.
Tricolocapsa sp.
Trisyringium sp.
Xiphatractus sp.
Xiphostylus sp.
In blocks of mainly limestone (Leong, 1974):
algae
Archaeolithothamnium cf. *aschersoni* (Schwag)
Clypeina sp.
Halimeda sp.

Jania sp.
Lithothamnium sp.
Parachaetetes cf. *asrapati* Pia
foraminifera
Asterocyclina sp.
Floborotalis cf. *velascoensis* (Cushman)
Gaudryina spp.
Globigerina(?) dissimilis
Globigerina spp.
Globorotalia centralis Cushman & Bermudez
Globorotalia spp.
Globotruncana laparenti Brotzen
Globotruncana spp.
Glomospira sp.
Heterohelix sp.
?Heterostegina sp.
Nodosaria sp.
Porticulasphaera orbiformis-mexicana group
Trochamminoides sp.
mollusc
Acteonella borneensis nov. sp.
In Leong (1977), from selected chert samples:
radiolaria (whole)
Acaeniotyle umbilicata
Artostrobium urna
Dictyomitra boesii
Dictyomitra duodecimcostata
Saturnalis spp.
Sphaerostylus lanceola
Staurosphaera septemporata

13. Env. of deposition : Both shallow and deep water environments are represented (Leong, 1974). Collenette (1965a) remarks deposition under marine conditions along the eastern side of the Northwest Borneo Geosyncline, with volcanic islands and coral reefs in places.

14. Remarks : The 'Chert-Spilite Formation' was first defined by Fitch (1955) to describe a group of sedimentary and volcanic rocks in the Upper Segama and Darvel Bay area. The term was later applied to similar rocks in the Kudat area (Stephens, 1956), Sandakan area (Fitch, 1958), Banggi Island and Sugut River area (Wilson, 1961), Semporna Peninsula (Kirk, 1962), Dent Peninsula (Haile and Wong, 1965), the Pensiangan and upper Kinabatangan area (Collenette, 1965a), and the Bidu-Bidu Hills area (Newton-Smith, 1967). Leong (1974) revised the work done in the Upper Segama and Darvel Bay area and retained the 'Chert-Spilite Formation' as referred by Fitch (1955). Earlier, Reinhard and Wenk (1951) referred the rocks in the Upper Segama, mapped by Fitch (1955) as the 'Chert-Spilite Formation', is similar to the 'Danau Formation' of the Upper Kapuas area, Kalimantan Indonesia. Kirk (1962) subdivided the Chert-Spilite Formation into the Madai-Baturong Limestone Member, but the latter was classified as a formation by Leong (1974). Collenette (1965a) classified the formation into the Rajang Group. Basir Jasin (1992) grouped the 'Chert-Spilite Formation' and the ultramafic rocks (previously separated) in the Telupid area, as the Telupid complex that represents a part of a dismembered ophiolite sequence.

C42.

1. Name : Sapulut Formation
2. Origin of name : Either Sungai Sapulut, Sapulut Town or Sapulut Valley, Sabah
3. Age : Upper Cretaceous to Upper Eocene
4. References : Collenette (1965a)
5. Type area : Sapulut Valley, Sabah
6. Type section : In the Sapulut River between Paya Rapids and Kuala Sablangan
7. Boundaries : The formation is overlain by the Labang and Tanjong formations with marked unconformity. The lower part of the formation probably passes laterally into the Chert-Spilite formation in the Kuamut area.
8. Correlation : The upper part of the formation may be stratigraphically equivalent to the Trusmadi Formation and the lower part of the Crocker formation.
9. Thickness : Estimated thickness of the strata present in the type section is 9,100 m.
10. Lithology : Consists of rather soft, poorly

bedded blue-black and blue grey mudstone, sandstone, shale, chert conglomerate, argillaceous limestone, limestone, conglomeratic sandstone, greywacke, siltstone, quartzitic greywacke.

11. Subdivisions :
12. Fossils :

foraminifera
Aktinocyclina sp.
Assilina sp.
Cibrohantkenina bermudezi Thalman
Discocyclina sp.
Distichoplax biserialis (Dietrich)
Distichoplax sp.
Globigerina dissimilis Cushman & Bermudez
Globigerina cf. *increbescens* Bandy
*Globigerin*a spp.
Globigerinoides orbitormis mexicana group
Globorotalia aragonensis Nuttall
Globorotalia centralis Cushman & Bermudez
Globorotalia cf. *cerro-azulensis* (Cole)
Globorotalia crassata (Cushman)
Globorotalia aff. *globigeriniformis* van Bellen
Globorotalia lehneri Cushman & Jarvis
Globorotalia spinulosa Cushman
Globorotalia wilcoxensis Cushman & Ponton
Globorotalia spp.
Globotruncana spp.
Gypsina sp.
Hantkenina cf. *alabamensis* Cushman
Hastigerina micra (Cole)
Nummulites sp.
Operculina sp.
algae
bryozoa
coral
echinoid
mollusc
ostracod

13. Env. of deposition : Marine, conditions probably varied from shallow to deep water
14. Remarks : Collenette (1965a) classified the formation in the Rajang Group.

C43.

1. Name : Trusmadi formation
2. Origin of name : Trusmadi Mountains
3. Age : Paleocene to Middle Eocene
4. References : Collenette (1957, 1958, 1965a), Jacobson (1970), Liechti *et al*. (1960)
5. Type area : Trusmadi Mountains, Central Sabah
6. Type section :
7. Boundaries : The stratigraphical relationship between the formation and the surrounding strata is not clear. The boundary with the East Crocker (or the Crocker Formation to the east of the Trusmadi Mountains, where Collenette (1958) has not distinguished between East and West Crocker formations) has not been fully understood. Liechti (1960) states that the mechanism of geosynclinal slope tectonics and its role as facies barrier furnishes the most convincing explanation of the peculiar (East) Crocker-Trusmadi contact. In the Kinabalu area, Jacobson (1970) presumed the relationship between Trusmadi and Crocker formations is probably a faulted contact. Also, in the area, the Trusmadi formation is intruded by the Upper Miocene granitic rocks of the Kinabalu batholith, and is unconformably overlain by the Quaternary Pinosuk Gravels.
8. Correlation : Liechti *et al*. (1960) pointed out the similarity of the Trusmadi formation lithology to that of the Mulu and Belaga Formations in Sarawak. The age for the Trusmadi formation suggests a correlation in time also with the Mulu and Belaga Formations. Haile (1969) has included these three formations in the Rajang Group which forms the eugeosynclinal facies of the Northwest Borneo Geosyncline, and depicted in Jacobson (1970).
9. Thickness : Minimum estimate about 2,000 m. Jacobson (1970) assumed hundreds to few thousands of metres.
10. Lithology : Consists mainly of dark blue-grey mudstone, shale, and quartzite, mildly metamorphosed in places, with subordinate beds of quartzite, sandstone, siltstone, and limestone breccia. Jacobson (1970) indicate the occurrence of cataclasites

(sheared argillite beds containing angular to subrounded sandstone blocks) and volcanic rocks (mainly spilite) in the Kinabalu area.

11. Subdivisions : The 'Trusmadi Slates' and 'Phyllites' are formally named, but not given member status as their relationship is still somewhat obscure.

12. Fossils :

foraminifera

Aktinocyclina sp.
Alveolina (Flosculina) sp.
Alveolina sp.
Assilina sp.
Bathysiphon spp.
Cyclammina spp.
Discocyclina sp.
Distichoplax biserialis (Dietrich)
Eulinderina sp.
Gaudryina sp.
Globigerina spp.
Haplophragmoides spp.
Heterostegina sp.
Miscellanea (Ranikothalia) sp.
Nummulites sp.
Operculina sp.
Operculinella sp.
Opertorbitolites sp.
Pellatispira sp.
Rotalia sp.
Somalina sp.
Trochammina renzi
Trochammina spp.

13. Env. of deposition : The general lack of coarse sediments suggest eugeosynclinal conditions, and the marginal limestone breccias indicate that the area of deposition was bounded by a submarine scarp on the southwest. Marine environment with at least moderate depths of water is indicated by Jacobson (1970).

14. Remarks : Formerly known as Old Slate Formation by G. Niethammer and W. Hotz, who investigated the area from 1913 to 1915. It was later substituted to Slate Formation by Reinhard and Wenk (1951). Later, Collenette (1958) introduced the term Trusmadi Formation. Bowen and Wright (Liechti *et al*., 1960) divided the 'Trusmadi Formation' into the 'Trusmadi Slates' and 'Trusmadi Phyllites'. The 'Trusmadi Phyllites' apparently overlie and flank the 'Trusmadi Slates', and are more tectonically disturbed. However, these units have not been differentiated on a published map and it is not certain whether they are valid (Collenette, 1965a). In the Kinabalu area, Jacobson (1970) stated that the rocks assigned to the 'Trusmadi Formation' include some that were previously mapped as 'Wariu Formation' by Bowen and Wright (Liechti *et al*., 1960), and as 'Undivided Eocene to Miocene' by Collenette (1958).

C44.

1. Name : Crocker formation
2. Origin of name : Crocker Range, Sabah
3. Age :?Paleocene to ?Lower Oligocene (Newton-Smith, 1967), Paleocene to Lower Miocene (Jacobson, 1970), Paleocene to Miocene
4. References : Collenette (1957, 1958, 1965a), Jacobson (1970), Newton-Smith (1967), Wilson (1961), Wilson and Wong (1964)
5. Type area : Crocker Range, western Sabah
6. Type section :
7. Boundaries : In northeast Sabah, in the Sugut River area, the Upper Miocene Bongaya Formation rests unconformably on the Crocker formation. In Bidu-Bidu Hills area, the Crocker formation probably overlies the 'Chert-Spilite Formation', but the contact has nowhere been observed (Newton-Smith, 1967). In western Sabah, in the Padas Gorge, the formation interfingers with the Temburong formation (Wilson and Wong, 1964). Jacobson (1970) stated that in the Kinabalu area, at Tenompok and in Sungai Kuamanan, the formation is faulted against the Trusmadi formation. Also, the Crocker

formation is intruded by the Upper Miocene Kinabalu batholith and is overlain by the Quaternary Pinosuk Gravels with angular unconformity.

8. Correlation : Considered partly as the stratigraphic equivalent of the Trusmadi formation.

9. Thickness : Not ascertained but estimated not less than 6,000 m. In Bidu-Bidu Hills area estimated probably at least 900 m.

10. Lithology : Comprise massive and thinly bedded grey sandstone and siltstone, and grey, red, green, and black mudstone and shale, and rare beds of conglomerate and limestone. In the Sugut River area, Wilson (1961) stated that the formation is essentially a highly folded series of sandstone and shale beds. Wilson and Wong (1964) mentioned that it is impossible to lithologically separate the Crocker formation and the Temburong formation, but they nevertheless remark that the former is dominantly arenaceous while the latter is dominantly argillaceous.

11. Subdivisions : Bowen and Wright *(1957)* divided the formation into East and West Crocker formations (Liechti *et al*., 1960). Wilson (1961) introduced the Banggi Limestone Member and concluded from fossil evidence that it is a facies of the Crocker formation.

12. Fossils :

foraminifera
Aktinocyclina sp.
Alveolina (Flosculina) sp.
Alveolina sp.
Ammodiscus sp.
Assilina sp.
Bathysiphon spp.
Biloculina sp.
Cyclammina spp.
Discocyclina sp.
Distichoplax biserialis (Dietrich)
Gaudryina sp.
Globorotalia velascoensis var.
Globorotalia sp.
Glomospira sp.
Haplophragmoides walteri (Grzybowski, 1898)
Haplophragmoides spp.
Heterostegina sp.
Miscellanea (Ranikothalia) sp.
Nummulites sp.
Operculina sp.
Operculinella sp.
Opertorbitolites cf. *douvillei* Nuttall
Opertorbitolites sp.
Reophax sp.
Somalina sp.
Trochammina spp.
Trochamminoides subcoronata (Rzehak, Grzybowski, 1896)
Trochamminoides sp.
Uvigerina sp.
ichnofossil
Cosmoraphe fusci
Helminthoida labyrinthica
?Scoyenia sp.
Skolithos sp.
Taphrelminthopsis auricularis
?Thallassinoides sp.
plant
remains

13. Env. of deposition : Deposited in the foredeep of the Northwest Borneo Geosyncline, partly in shallow neritic conditions and partly in deeper water. Newton-Smith (1967) explained deposition under eugeosynclinal conditions, and the deposits typical of deep waters of a geosynclinal trough. Jacobson (1970) interpreted marine environment in moderate depth of water, deposition of clastic material at the base of slope involving tubidity currents, mass-flow and slumping, possibly eugeosynclinal. Tajul Anuar (1989) noted that even though the typical flysch sediments indicate deep water environment, shallow marine to continental origin is also present.

14. Remarks : Formerly described as 'Eocene Formation', 'Undivided Tertiary', and 'Crocker Range type sediments'. Collenette (1957) proposed the term 'Crocker Formation' for the sedimentary rocks on which the Crocker Range is built. Bowen and Wright

(Liechti *et al*., 1960) divided the formation into the West and East Crocker Formations. Collenette (1965a) considered that the division was inapplicable outside the type locality of the East Crocker Formation near Keningau. Wilford (1967) adhered to the division but reverted to the name 'Crocker Formation' for the West Crocker Formation. The rocks flanking Gunong Kinabalu were assigned by Wilford to the Crocker Formation, but are in fact a faulted complex referable to the Crocker, Trusmadi and Chert-Spilite formations and to the Crystalline Basement (Jacobson (1970). On Klias Peninsula, Sabah, to the east of Batu Linting and at Tanjong Klias, the Setap Shale Formation of Liechti *et al*. (1960), is referred to the Crocker Formation on account of its mainly arenaceous nature (Wilson and Wong, 1964). Wilson (1961) referred the rocks of the Sugut River area (formerly termed 'Sugut Group') and the rocks of the Kaindangan Formation to the Crocker Formation, since similar lithology and age, and also in structural continuity. Tajul Anuar (1989) focussed on the Crocker Formation primary sedimentary structures and the environmental significance, found in the Tamparuli area.

C44.1.

1. Name : Banggi Limestone member
2. Origin of name : Pulau Banggi, Sabah
3. Age : Eocene
4. References : Wilson (1961)
5. Type area : The type area is not indicated but limestone is only exposed over an area of about 2.6 sq. km on the southern tip of Banggi Island, where it builds two rocky promontories projecting southwestwards towards Marudu Bay.
6. Type section :
7. Boundaries : The base is not exposed. Along its northern margin, the limestone is faulted against the South Banggi Formation.
8. Correlation :
9. Thickness : Indeterminate
10. Lithology : Hard, heavily fractured, grey to buff, granular limestone to chalky limestone to massive, sandy limestone to compact calcareous grit.
11. Subdivisions :
12. Fossils :

    foraminifera
    Actinocyclina sp.
    Asterocyclina sp.
    Discocyclina sp.
    ?Nummulites sp.
    Operculina sp.
    Rupertiidae
    algae
    echinoid
    ostracod
13. Env. of deposition : Shallow water
14. Remarks : Wilson (1961) noted that the rocks of the Banggi Limestone member is distinguished from the adjacent Upper Miocene rocks by their contrasting lithology and structure, and based on the presence of the Eocene foraminifera is correlated with the Crocker formation.

C45.

1. Name : East Crocker Formation
2. Origin of name : The northern Crocker Range, Sabah
3. Age : Paleocene to Lower Eocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : The Pegalan River with its tributaries above Keningau, Sabah
7. Boundaries : The basal or rather lateral boundary with the Trusmadi formation is a facies limit of the first order, formed by a geosynclinal slope which represents an area of strong depositional faulting separating an outer unstable shelf on which the East Crocker Formation was deposited, from an adjacent eugeosyncline, where the Trusmadi formation was

deposited. The top boundary with the West Crocker formation is a gradual transition and rests on very minor lithological distinctions.

8. Correlation :
9. Thickness : Difficult to estimate due to the broken and contorted nature.
10. Lithology : A predominantly arenaceous submetamorphic alternation of sandstones and occasional conglomerates with mudstones, marls and shales. The argillaceous components make up less than half the formation.
11. Subdivisions : None
12. Fossils :
foraminifera
Globigerina spp.
Globorotalia aragonensis Nuttal
Globorotalia cf. *crassa* d'Orbigny var. *pentacamerata* Subbotina
Globorotalia velascoensis Cushman
Globorotalia wilcoxensis Cushman & Ponton
Globotruncana sp.
Haplophragmoides 19A
Trochammina 10
13. Env. of deposition : Shallow neritic waters. There is evidence indicating local or temporary brackish-water conditions.
14. Remarks : Collenette (1957) created the term 'Crocker Formation'. He, however, did not differentiate it into East and West Crocker formations (Collenette; 1958, 1965a).

C46.

1. Name : West Crocker formation
2. Origin of name : Crocker Range Area
3. Age : Eocene to Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation : Interfingers and largely overlies the East Crocker Formation in perfect conformity. The top boundary is in the south either with Setap Shale Formation or Meligan Formation, in the north with Wariu formation.
9. Thickness : Perhaps in the order of 6,000-9,000 m
10. Lithology : A predominantly arenaceous succession of sandstones, shales and mudstones, characterised by monotonous lithology and rather rich, though exclusively arenaceous, foraminiferal faunas.
11. Subdivisions : The Pa Plandok Marl Member
12. Fossils :
foraminifera
Ammodiscus sp.
Bathysiphon spp.
Cyclammina 1
Cyclammina spp.
Haplophragmoides spp.
Trochammina 10
Trochammina spp.
Trochamminoides 1
13. Env. of deposition : Shallow to outer neritic conditions, which locally/ temporarily changed into brackish conditions.
14. Remarks : Liechti *et al*. (1960) remarks that the lithological characteristics of the formation are largely the same as those of the East Crocker Formation, except that the West Crocker formation is inferred richer in arenaceous foraminifera and the presence of the Pa Plandok Marls which are rich in pelagic foraminifera, as compared with the East Crocker Formation..

C46.1.

1. Name : Pa Plandok Marl Member
2. Origin of name : Pa Plandok River
3. Age : Upper Eocene to ?Lower Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : The Pa Plandok River in the Pa Plandok Syncline, in the Ulu Padas Area, across the boundary between Kalimantan and Sabah.
7. Boundaries : The member is contained in the West Crocker formation, of which it forms part. Its position is close to the top in the upper half of the formation.
8. Correlation :
9. Thickness : At the type locality a thickness of 300-450 m is developed but

appears to occur sporadically over a total interval of 900-1,050 m.

10. Lithology : Various beds of calcareous shale and marl alternating with shale and mudstone in the uppermost part of the West Crocker formation.
11. Subdivisions :
12. Fossils :
    foraminifera
13. Env. of deposition : Open marine, i.e. neritic, probably outer neritic with infered depths of water down to 180 m.
14. Remarks :

C47.

1. Name : Kulapis formation
2. Origin of name : Sungai Kulapis
3. Age : Eocene (Fitch; 1955, 1958), Upper Eocene or Oligocene (Collenette, 1965a), Uncertain, probably Paleogene (Haile and Wong, 1965), ?Oligocene, ?Tcd to ?Te_{1-4} (Newton-Smith, 1967)
4. References : Collenette (1965a), Fitch (1955, 1958), Haile and Wong (1965), Newton-Smith (1967)
5. Type area : Sungai Kulapis
6. Type section :
7. Boundaries : The formation underlies the Tanjung Formation along the northern edge of the Bangan Basin with marked unconformity. In the Bidu-Bidu Hills area on the eastern part of Rumidi Estate the formation appears to rest unconformably on the Chert-Spilite formation (Newton-Smith, 1967).
8. Correlation : Presumed the equivalent of either the upper part of the Crocker formation or the lower part of the Labang formation.
9. Thickness : Presumed several hundreds of metres. In Bidu-Bidu area the exposed part is at least 365-450 m (Newton-Smith, 1967).
10. Lithology : Consist of red, purple, and grey sandstone interbedded with red, buff, green, and grey mudstone/ shale and less commonly with red chert and rare limestone and conglomerate. Haile and Wong (1965) mentioned in the Dent Peninsula area, the outcrops of the Kulapis formation are associated with dolerite, altered basalt, and chert, but the field relations are not clear.
11. Subdivisions :
12. Fossils :
    foraminifera
    Bathysiphon spp.
    Cyclammina sp.
    Globorotalia mayeri Cushman & Ellisor
    Glomospira sp.
    Haplophragmoides narivaensis (Bronnimann)
    Haplophragmoides walteri (Grzybowski, 1898)
    Haplophragmoides sp.
    Lagenammina sp.
    Trochammina sp.
    Trochamminoides sp.
    Verneuilina sp. (?)
    radiolaria (from loose blocks in or associated with Kulapis Formation)
    Adelocyrtis sp.
    Cenosphaera sp.
    Cyrtocapsa sp.
    Cyrtophornis sp.
    Hagiastrum sp.
    Lithopium sp.
    Meyenella sp.
    Pterocanium sp.
    Rhopalastrum sp.
    Stichopera sp.
    Theocapsa sp.
    Triacartus sp.
    Tricolocapsa sp.
    Xiphosphaera sp.
13. Env. of deposition : Presumably marine (from evidence of the few foraminifers found in it, and the gross lithology) and the sandstones of greywacke type may be turbidites (refer Fitch, 1958; Collenette, 1965a; Haile and Wong, 1965).
14. Remarks : The term 'Kulapis Formation' was introduced by W.F. Schneeberger *(1937)*. Fitch (1958) modified Schneeberger's description to exclude dark grey quartzitic, jointed, and pillow-structured sandstone which he believed was part of the Crocker formation, but he included chert. In the Bidu-Bidu Hills area Newton-Smith (1967), excluded grey quartzitic

sandstone and chert from the Kulapis formation, the former is included in the Crocker or Chert-Spilite formations, and the latter in the Chert-Spilite formation.

C48.

1. Name : Kalumpang Formation
2. Origin of name : Uncertain, presumably Sungai Kalumpang or Kalumpang Valley, Semporna Peninsula, Sabah
3. Age : Upper Oligocene to Upper Miocene (Kirk, 1962); Upper Oligocene to Upper Miocene (Lee, 1988); Lower to Middle Miocene (Lim, 1981)
4. References : Kirk (1962), Lee (1988), Lim (1981)
5. Type area : Upper Sungai Kalumpang and Binuang Valleys, Semporna Peninsula, Sabah.
6. Type section : Northern tributary of the River Kalumpang, 6.5 km west of the mouth of the River Malati, and in the adjacent headwaters of the River Binuang.
7. Boundaries : The formation is thrust-faulted against the Chert-Spilite formation, and so the basal boundary is not exposed. The formation is overlain by, probably unconformably, by the Umas Umas formation in the lower Umas Umas Valley, by Tertiary volcanic rocks in the Mount Magdalena and Mount Wullersdorf areas, and by Quaternary sediments in the Balung Valley.
8. Correlation :
9. Thickness : Estimated probably in the order of thousands of metres
10. Lithology : Consists predominantly of mudstone and shale with interbedded sandstone (in part greywacke), conglomerate, limestone, marl and rare chert. Volcanic detritus occurs in varying proportions in the sediments and beds of coarse tuffite are common.
11. Subdivisions : Sebatik Sandstone-Shale member, Sipit Limestone member, 'Sandstone Chert Facies', 'Volcanic Facies'.
12. Fossils :

foraminifera

Acervulina sp.
Alveolinella globulosa Rutten
Ammodiscus grzybowskii (Emiliani)
Ammodiscus spp.
Amphistegina sp.
Asterigerina spp.
Austrotrillina howchini Schlumberger
Bathysiphon cylindrica (Glaessner)
Bolivina spp.
Borelis sp.
Bulimina sp.
Carpenteria sp.
Cibicides sp.
Cristellaria spp.
Cyclammina amplectens (Grzybowski)
Cyclammina spp.
Cycloclypeus (Katacycloclypeus) annulatus Martin
Cycloclypeus (Katacycloclypeus) cf. *annulatus* Martin
Cycloclypeus sp.
Cyroidina soldanii (d'Orbigny)
Dentalina spp.
Discorbis sp.
Eggerella bradyi (Cushman)
Ehrenbergina spp.
Flosculinella sp.
Frondicularia spp.
Gaudryina spp.
Globigerina binaiensis Koch
Globigerina binaiensis Koch var.
Globigerina cf. *ciperoensis* Bolli
Globigerina cf. *increbescens* Bandy
Globigerina dissimilis Cushman & Bermudez var.
Globigerina subcretacea Chapman
Globigerina trilobus (Reuss)
Globigerina sp.
Globigerinatella insueta Cushman & Stainforth
Globigerinoides cf. *trilobus* (Reuss)
Globigerinoides glomerosa Blow
Globigerinoides rubra d'Orbigny var.
Globigerinoides sacculiferus Brady
Globigerinoides subquadratus Bronniman
Globigerinoides trilobus (Reuss)
Globigerinoides sp. (*G. rubra* group)
Globigerinoides sp. (*G. triloba* group)
Globigerinoides spp.
Globoquadrina altispira Cushman & Jarvis
Globoquadrina dehiscens Chapman, Parr & Collins
Globoquadrina venezuelana Hedberg
Globoquadrina venezuelana Hedberg var.
Globoquadrina spp.

Globorotalia centralis Cushman & Bermudez
Globorotalia cerroazulensis Cole
Globorotalia cf. *fohsi barrisanensis* Leroy
Globorotalia crassata Cushman
Globorotalia mayeri Cushman & Ellisor
Globorotalia nana (Bolli)
Globorotalia seitula Brady var.
Globorotalia siakensis (Leroy)
Globorotalia spinulosa Cushman
Globorotalia wilcoxensis Cushman & Ponton
Globorotalia spp.
Glomospira spp.
Gypsina globulus Reuss
Gypsina sp.
Gyroidina sp.
Halkyardia sp.
Haplophragmoides narivaensis (Bronnimann)
Haplophragmoides walteri (Grzybowski)
Haplophragmoides sp.
Heterostegina spp.
Lepidocyclina ferreroi Provale
Lepidocyclina (Eulepidina) sp.
Lepidocyclina (*isolepidine* type)
Lepidocyclina (Nephrolepidina) cf. *angulosa* Provale
Lepidocyclina (Nephrolepidina) cf. *sumatrensis* Brady
Lepidocyclina (Nephrolepidina) spp.
Lepidocyclina spp.
Marginospora sp.
Miogypsina spp.
Miogypsinoides sp.
Neoalveolina sp.
Nodosaria spp.
Nonion spp.
Nummulites sp.
Opercuinella sp.
Operculina sp.
Operculinoides sp.
Orbulina bilobata d'Orbigny
Orbulina suturalis Bronniman
Orbulina universa d'Orbigny
Orbulina spp.
Planorbulina sp.
Planorbulinella sp.
Psammosiphonella carapitana (Hedberg)
Psammosiphonella irregularis (Leroy)
Psammosphaera placenta (Grzybowski)
Psammosiphonella spp.
Pullenia spp.
Quinqueloculina sp.
Rotalia spp.
Sorites sp.
Sphaeroidinella multiloba Leroy
?Spiroclypeus sp.
Textularia spp.
Trochammina renzi Nom. Nov.
Trochammina sp.
Trochamminoides spp.
Uvigerina spp.
radiolaria
?Cephalopyramis sp.
?Circospiris sp.
?Eusyringium sp.
?Glycobotrys sp.
Adelocyrtis sp.
Botropyle sp.
Cenellipsis sp.
Cenosphaera sp.
Cornutella sp.
Cryptocapsa sp.
Dicolocapsa sp.
Dictyomitra sp.
Druppula sp.
Eucyrtidium sp.
Flustrella (Centrospira) sp.
Flustrella sl. sp.
Flustrella sp.
Glycobotrys sp.
Halicapsa sp.
Lithapium sp.
Lithapium sp.
Melitosphaera sp.
Meyenella meyeni
Sethocyrtis sp.
Spongasteriscus sp.
Spongolena sp.
Spongotrochus cf. *Stylospongia* sp.
Stichopera sp.
Stylostaurus sp.
Syringium sp.
Theocapsa sp.
Triacartus sp.
Tricolocapsa sp.
algae
bryozoa
coral
echinoid
spine
gastropod

13. Env. of deposition : Deposited in a geosynclinal environment bounded on the south and east by a region of shelf deposition in which the carbonaceous sediments of the Sebatik Sandstone-Shale member and the limestone of the Sipit Limestone member were deposited. Lim (1981) states deposition in a variety of

holomarine neritic environments. Lee (1988) explained deposition was initially in a deep marine environment but later in a much shallower condition.

14. Remarks : The term 'Kalumpang Formation' was first introduced by Kirk (1962). However, Leong (1974) reassigned some of the sedimentary sequences in the Tingkayu area and the type area at Binuang, as well as the massive dacitic tuff in the Mostyn area to the Kuamut formation.

C48.1.

1. Name : Sebatik Sandstone-Shale member
2. Origin of name :
3. Age : Not differentiated
4. References : Kirk (1962)
5. Type area : The type locality is the Sebatik Island.
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : Estimated approx. about 2,700 m
10. Lithology : Consists of a thick succession of strongly folded shale and mudstone, some of which is carbonaceous, and beds of sandstone.
11. Subdivisions :
12. Fossils :

foraminifera
Globigerina binaiensis Koch
Globigerina dissimilis Cushman & Bermudez
Globigerinoides sp. (*G. rubra* group)
Globigerinoides sp. (*G. triloba* group)
Globoquadrina venezuelana Hedberg
Haplophragmoides sp.
Trochammina sp.
bivalve
plant
remains

13. Env. of deposition : Shallow water, with brackish deltaic conditions prevailing at times.
14. Remarks :

C48.2.

1. Name : Sipit Limestone member
2. Origin of name :
3. Age : Not differentiated
4. References : Kirk (1962)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness : Excess of 85 m.
10. Lithology : Massive limestone (essentially of biohermal type) forming four small separate hills on the northern coast of Semporna Peninsula near the mouth of the Sipit River.
11. Subdivisions :
12. Fossils :

foraminifera (mainly of)
Lepidocyclina sp.
Miogypsina sp.
Heterostegina sp.
Operculina sp.
algae

13. Env. of deposition : Refer formation
14. Remarks :

C48.3.

1. Name : Sandstone Chert facies
2. Origin of name : The lithology of the area
3. Age : Refer formation
4. References : Kirk (1962)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness :
10. Lithology : Consists of thick beds of sandstone, mainly greywacke, with layers of chert, with sparse conglomerate and shale.
11. Subdivisions :
12. Fossils :

radiolaria (from the chert, refer formation)

13. Env. of deposition : Refer formation
14. Remarks :

C48.4.

1. Name : Volcanic facies
2. Origin of name :
3. Age : Refer formation
4. References :
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation :
9. Thickness :

10. Lithology : Consists of thick folded beds of volcanic rocks (dacite tuff, tuffitic breccia, feldspathic tuff, tuffaceous mudstone, tuff, keratophyre lava and tuff) with blocks of feldspathic sandstone and limestone.
11. Subdivisions :
12. Fossils :
    foraminifera (from the limestone blocks, refer formation)
13. Env. of deposition : Refer formation
14. Remarks :

C.49.

1. Name : Napu sandstones
2. Origin of name : Bulud Napu Ridge, Sabah
3. Age : ?Eocene (Ta-b) - reworked?
4. References : Haile and Wong (1965)
5. Type area :
6. Type section :
7. Boundaries :
8. Correlation : Considered to be probably part of the Labang formation.
9. Thickness : Estimated approx. 1,100 m
10. Lithology : Consists of conglomeratic mudstone, granule conglomerate, sandstone, and thick massive sandstone. The conglomeratic mudstone contains algal limestone, calcareous sandstone, sandy calcarenite, and calcareous chert-pebble conglomerate, in a matrix of pebbly mudstone. The granule conglomerate is composed of granules of radiolarian chert, siltstone, limestone, sandstone, ?tuff in a calcareous matrix.
11. Subdivisions :
12. Fossils :
    foraminifera
    Alveolina sp.
    Asterocyclina sp.
    Biplanispira sp
    Discocyclina spp.
    Nummulites spp.
    ?Operculinoides sp.
    Pellatispira sp.
    algae
    Distichoplax sp.
    shell
    remain
13. Env. of deposition : Marine
14. Remarks : Haile and Wong (1965) argue that the Napu sandstones may be a faulted inlier of Eocene age, and considered more likely that the Tab (Eocene) fauna is reworked. They described the formation as an informal rock unit and considered the Napu sandstones to be probably part of the Labang formation.

C50.

1. Name : Temburong formation
2. Origin of name : Temburong River, Brunei
3. Age : Oligocene to Upper Miocene
4. References : Brondijk (1962), Wilson and Wong (1964)
5. Type area :Type locality is at the headwaters of the Temburong River in Brunei.
6. Type section :
7. Boundaries : The base of the formation has not been observed, but overlies, apparently conformably, the Mulu and Kelalan Formations. Laterally the formation passes gradually to the north-northeast into the West Crocker formation and also into the softer marly Tubau formation. Overlain by the Meligan Formation in the Padas Valley area and by the Setap Shale Formation on Labuan Island and Klias Peninsula. In Ulu Padas, the youngest part of the Temburong formation contains few interdigitations of arenaceous Crocker formation.
8. Correlation :
9. Thickness :
10. Lithology : Comprises a predominantly shaly sequence with locally intercalated sandstone layers. Wilson and Wong (1964) defined as argillaceous sequence characterised by rhythmic repetitions of siltstone and shale, and lenticles of limestone occur locally.
11. Subdivisions :
12. Fossils :
    foraminifera
    Ammobaculites spp.

Ammodiscus sp.
Amphistegina sp.
Bathysiphon sp.
Bulimina sp.
Bulimina sp.
Cristellarea sp.
Cristellaria sp.
Cyclammina sp.
Gaudryina sp.
Gaudryina sp.
Globigerina binaiensis Koch var.
Globigerina cf. *ciperoensis* Bolli
Globigerina cf. *increbescens* Bandy
Globigerina dissimilis Cushman and Bermudez var.
Globigerina sp.
Globigerinoides '*rubra* group'
Globigerinoides '*triloba* group'
Globigerinoides index Finley
Globigerinoides semi-involuta Keijzer
Globigerinoides spp.
Globoquadrina sp.
Globoquadrina venezuelana (Hedberg)
Globorotalia centralis Cushman & Bermudez
Globorotalia meyeri Cushman & Ellisor
Glomospira sp.
Gypsina sp.
Hantkenina alabamensis Cushman
Haplophragmoides walkeri (Grzybowski)
Haplophragmoides sp.
Hastigerina micra (Cole)
Heterostegina borneensis van der Vlerk
Heterostegina sp.
Kalamopsis spp.
Lepidocyclina (Eulepidina) cf. *ephippioides* Jones & Chapman
Lepidocyclina sp.
Miogypsinoides sp.
Operculina spp.
Psammosiphonella spp.
Quinqueloculina sp.
Reophax sp.
Trochammina sp.
Trochamminoides spp.
Uvigerina sp.
Valvulina spp.
Verneuilina sp.
Virgulina sp.
plant
remain

13. Env. of deposition : Deposited on a basin slope adjacent to a basin trough, and partly in submarine canyons. The faunas mostly indicate an open marine environment, with occasional benthic associations.

14. Remarks : The formation was formerly described as Shale-Quartzite Series, and later part of the formation was named as Eocene or Kelalan Formation. Brondijk (1962) retained the Setap Shale Formation for the softer slates and clays and reintroduced the Temburong Formation for the hard shales. Wilson and Wong (1964) mentioned that it is impossible to lithologically separate the Crocker Formation and the Temburong Formation, but they nevertheless remarked that the former is dominantly arenaceous while the latter is dominantly argillaceous.

C51.

1. Name : Labang formation
2. Origin of name : Village of Labang, on the east bank of the Sapulut River, Sabah.
3. Age : Oligocene to Lower Miocene (Collenette, 1965a); Lower Miocene (Haile and Wong, 1965)
4. References : Collenette (1965a), Haile and Wong (1965), Leong (1974)
5. Type area : Small synclinal basin which lies in the Sapulut Valley, its centre about 10 km east of Sapulut, Sabah.
6. Type section :
7. Boundaries : In the type area, the formation rests unconformably on the Sapulut Formation. Between Bukit Tambunan and the Saburan River, the formation is overlain by the Tanjong formation. An unconformity is suggested. In the east of the Sibuda Valley an unconformity between the Labang and Kapilit formations is also suggested. Haile and Wong (1965) states that the Labang formation probably overlies Kulapis formation, to the north, and in the Kinabatangan Valley is overlain, probably unconformably, by the Gomantong Limestone and Tanjong formations. In the Segama-Darvel Bay area, the formation is tentatively mapped in

the Sungai Malubuk area (Leong, 1974), where it overlies unconformably the volcanic rocks of the Chert-Spilite formation.

8. Correlation :
9. Thickness : In the type area estimated about 3,000 m. The formation is probably considerably thicker, exceeding 4,000 m. Haile and Wong (1965) estimated thickness probably exceeds 1,500 m. Leong (1974) estimated at least 1,200 m of the sandstone-mudstone sequence between the Malua and Malubuk Valleys.
10. Lithology : Comprises sandstone, siltstone, mudstone, and limestone. Haile and Wong (1965) indicate the presence of foraminiferal limestone, and rare conglomerate and tuffaceous beds in the Dent Peninsula.
11. Subdivisions :
12. Fossils :

<u>foraminifera</u>
Alveolina sp.
Amphistegina cf. *radiata* (Fichtel & Moll)
Amphistegina spp.
Austrotrillina howchini (Schlumberger)
?Austrotrillina sp.
Bathysiphon sp.
Borelis sp.
Carpentaria sp.
Cyclammina sp.
Cycloclypeus sp.
Cycloloculina sp. nov.
Eulepidina sp.
Globigerina binaiensis Koch
Globigerina binaiensis Koch var.
Globigerina cf. *increbescens* Bandy
Globigerina ciperoensis Bolli
Globigerina cf. *ciperoensis* Bolli
Globigerina dissimilis Cushman & Bermudez var.
Globigerina spp.
Globigerinoides spp.
Globoquadrina sp.
Globoquadrina venezuelana (Hedburg) var.
Globorotalia mayeri Cushman & Ellisor
Globorotalia sp.
Gypsina discus Goes
Gypsina globula (Reuss)
Gypsina pygmea (Hanzawa)
Gypsina spp.
Gyroidina sp.
Heterostegina borneensis van der Vlerk
Heterostegina cf. *borneensis* van der Vlerk
Heterostegina sp.
Lepidocyclina (Eulepidina) formosa Schlumberger
Lepidocyclina (Eulepidina) cf. *ephippioides*
Lepidocyclina (Nephrolepidina) cf. *sumatrensis* Brady
Lepidocyclina (Eulepidina) spp.
Lepidocyclina (Nephrolepidina) spp.
Lepidocyclina (Nephro- or *Tryblio- lepidina* sp.
Lepidocyclina spp.
?Miogypsinoides sp.
Nephrolepidina sp.
Neoalveolina pygmaea (Hanzawa)
Neoalveolina sp.
?Nummulites sp. (reworked)
Operculina sp.
Operculinoides sp.
Planorbulinell sp. nov.
Rotalia tectoria (Todd & Post)
Rupertids
Sphaerogypsina globulus (Reuss)
Spiroclypeus spp.
Uvigerina sp.

<u>algae</u>

<u>trace fossil</u>
Palaeodictyon

<u>coral</u>
Cyphastraea gemmulifera Gerth
Favia sp. cf. *speciosa* (Dana)

<u>echinoid</u>

<u>mollusc</u>

13. Env. of deposition : Marine environment probably under varying depths. Deep water conditions are suggested by possible turbidites, while shallow water by the larger limestone masses, some containing corals. Haile and Wong (1965) suggests outer shelf or deeper water conditions, and resemble associations found in the Setap Shale Formation of Sarawak and Brunei.
14. Remarks : Collenette (1963) classified the formation in the Kinabatangan Group. Leong (1974), based on lithological and structural grounds tentatively mapped as Labang formation the rock unit outcropping in certain parts of the Sungai Malubuk area.

C52.

1. Name : Tambang beds
2. Origin of name : Sungai Tambang, northeast Sabah
3. Age : Oligocene to Lower Miocene
4. References : Newton-Smith (1967)
5. Type area : In Sungai Tambang, a north bank tributary of Sungai Kiabau
6. Type section :
7. Boundaries : Unknown as outcrop bounded by faults.
8. Correlation :
9. Thickness : Unknown, but estimated possibly as much as 900 m.
10. Lithology : Comprise fine to coarse-grained, commonly laminated sandstone, calcareous sandstone, calcarenite, and shale.
11. Subdivisions :
12. Fossils :

    foraminifera (Miocene)
    Austrotrillina cf. *striata*
    Borelis sp.
    Lepidocyclina (Eulepidina) cf. *ephippioides* (Jones & Parker)
    Lepidocyclina (?Eulepidina) sp.
    Lepidocyclina (Nephrolepidina) cf. *parva* (Oppenoorth)
    Lepidocyclina (Nephrolepidina) sp.
    Neoalveolina sp.
    Spiroclypeus sp.
    foraminifera (Eocene reworked)
    Aktinocyclina sp.
    Discocyclina sp.
    Fabiana sp.
    Nummulites sp.
    Pellatispira sp.
13. Env. of deposition : Marine environment under varying depth conditions, from brackish to shallow to deep water
14. Remarks : Newton-Smith (1967) introduced the term Tambang beds, and noted that the beds have a similar age, lithology, and depositional environment to the Labang formation described by Collenette (1965a), but the stratigraphic relationship between the Tambang beds and the Labang formation is unknown.

C53.

1. Name : Kamansi beds
2. Origin of name : Pamol (Kamansi) Estate or Sungai Kamansi (tributary of S. Labuk), northeast Sabah
3. Age : ?Oligocene
4. References : Newton-Smith (1967)
5. Type area : Road cuts on Pamol (Kamansi) Estate
6. Type section :
7. Boundaries : In the area adjacent of Kuala Sapi, the Kamansi beds are probably overlain unconformably by the Garinono formation.
8. Correlation :
9. Thickness : Unknown, however estimated at least about 550 m (about 150 m is exposed)
10. Lithology : Comprise gently to strongly folded grey sandstone, and grey clayey sandstone, shale, and mudstone with carbonaceous material, and subordinate red mudstone.
11. Subdivisions :
12. Fossils :

    foraminifera
    Bathysiphon spp.
    Glomospira sp.
    Haplophragmoides sp.
    Trochammina sp.
    Trochamminoides sp.
13. Env. of deposition : Under conditions of a fluctuating water depth, partly neritic to paralic, and partly deeper water since the presence of a typical flysch-type fauna.
14. Remarks : Newton-Smith (1967) introduced the term Kamansi Beds, and noted the beds have faunal and depositional features akin to the Kudat Formation, but the sandstones are petrologically unlike those of the Kudat Formation as described by Liechti *et al*. (1960).

C54.

1. Name : Langusan beds
2. Origin of name : Sungai Langusan, a tributary of Sungai Tingkayu, Darvel Bay area, Sabah
3. Age : ?Oligocene to Lower Miocene or later (Leong, 1974)
4. References : Leong (1974)
5. Type area : In Sungai Langusan, a tributary of Sungai Tingkayu.
6. Type section :
7. Boundaries : Appear to overlie unconformably on or are in fault contact with spilitic rocks and chert of the Chert-Spilite formation. The Langusan beds are most probably overlain by slump breccia deposits of the Kuamut formation.
8. Correlation :
9. Thickness :
10. Lithology : Steeply dipping interbedded tuff, tuffaceous shale and limestone breccia.
11. Subdivisions :
12. Fossils :

algae
Corallina sp.
Jania sp.
Lithophyllum quadrangulum Lemoine
Lithoporella melobesiodes Foslie
Lithothamnium sp.
Mesophyllum cf. *pfenderae*
Mesophyllum sp.
Subterraniphyllum cf. *thomasi* Elliot
foraminifera
Aktinocyclina sp.
Amphistegina sp.
Asterocyclina sp.
Austrotrillina striata Todd & Post
Borelis cf. *inflata* Adams
Borelis sp.
Carpentaria sp.
Cycloclypeus sp.
Discocyclina spp.
Fabiania sp.
Fasciolites sp. indet.
?Fasciolites sp. indet.
Globigerinids
Globorotalia centralis Cushman & Bermudez
?Gypsina discus Goes
Gypsina vesicularis sensu Bursch 1947
Gypsina cf. *vesicularis* (Parker & Jones) sensu Bursch 1947
Gypsina sp.
*Halkyardi*a sp.
Hantkenina sp.
Heterostegina cf. *borneensis* van der Vlerk
Heterostegina sp.
Lepidocyclina sp.
?Lepidocyclina sp.
Lepidocyclina (Eulepidina) sp.
Lepidocyclina (?Eulepidina) sp.
Lepidocyclina (Nephrolepidina) sp.
Linderina sp.
Neoalveolina sp.
Nummulites cf. *ficheli* Michelotti
Nummulites cf. *javanus* Verbeek
Nummulites sp.
?Nummulites sp.
Operculina sp.
Pellatispira cf. *madaraszi* (Hantken)
Pellatispira sp. indet.
Pellatispira sp.
Planorbulinella sp.
Praerhapydionina sp.
Sorites sp.
Spiroclypeus sp.
?Spiroclypeus sp.
coral
echinoid

13. Env. of deposition : Marine environment probably at moderate depths
14. Remarks : The term 'Langusan Beds' was introduced by Leong (1974).

C55.

1. Name : Kudat Formation
2. Origin of name : Kudat Peninsula, Sabah
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : See Members
7. Boundaries : To the south the formation is delimited from Wariu Formation by the North Tabilong fault (a 'depositional' fault). The North Tabilong fault is interpreted as a geosynclinal hinge or slope zone, separating the shallow shelf sediments (Kudat Formation) from the synchronous eugeosynclinal sediments of the Wariu formation.
8. Correlation :
9. Thickness : See Members
10. Lithology : Characterised by a predominance

of medium to thick-bedded, quartzose to feldspathic, locally calcareous sandstone, an overall abundance of lignitic and carbonaceous layers, and the presence of red shales throughout the succession. Detrital calcarenites ocur in several places.

11. Subdivisions :
12. Fossils : See Members
13. Env. of deposition : Shallow neritic to paralic
14. Remarks : W.F. Schneeberger's (1937) 'Tajau Sandstone' is a synonym of part of the present Tajau Sandstone Member. He described the present Kudat Formation under the heading 'Sugut'.

C55.1.

1. Name : Tajau Sandstone Member
2. Origin of name :
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : Across the Kelamboh Anticline between Pulau Kelamboh on the west coast and Tanjong Agong Agong on the east coast.
7. Boundaries : The Tajau Sandstone Member in the north is in direct contact with Wariu formation and appear to form the base of the Kudat Formation.
8. Correlation :
9. Thickness : Estimated 6,000 m or more
10. Lithology : The dominant rock is a thick bedded, coarse grained to gritty, micaceous and calcareous feldspathic sandstone, which is conglomeratic and bears hard calcareous concretions up to 0.9 m in diameter. Subordinate rocks alternating with the sandstone include; limestone, dark grey marls, with reworked green shales, red and green marly mudstones, and lignite.
11. Subdivisions :
12. Fossils :

<u>foraminifera</u>

Biplanispira sp. (reworked)
Cycloclypeus eidae Tan Sin Hok
Discocyclina sp. (reworked)
Eulepidina sp.
Heterostegina borneensis van der Vlerk
Lepidocyclina spp.
Miogypsinoides ubaghsi Tan Sin Hok
Neoalveolina pygmaea Hanzawa
Neoalveolina sp.
Nephrolepidina sp.
Nummulites sp. (reworked)
Operculina cf. *pyramidum* Ehrenberg
Pellatispira sp. (reworked)
Spiroclypeus sp.

13. Env. of deposition : Epineritic to littoral
14. Remarks :

C55.2.

1. Name :Sekuati Member
2. Origin of name :
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : Between Miles 10 and 16 on the Kudat-Sekuati road and along the north coast of Kudat Harbour.
7. Boundaries : Overlies the Tajau Sandstone Member, but appears to be bonded by a fault along its southern border, and the relationship to the other members is not clear.
8. Correlation :
9. Thickness : Estimated 4,800 m
10. Lithology : Consists of white to ferruginous-yellow, fine to medium grained, essentially quartzose, well bedded sandstones, alternating with a similar amount of soft homogenous shales, some coal layers and a few foraminiferal calcarenites.
11. Subdivisions :
12. Fossils : <u>foraminifera</u>
13. Env. of deposition : Inner neritic to paralic conditions
14. Remarks :

C55.3.

1. Name : Garau Red Shale Member
2. Origin of name :
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : South flank of the Gomantong Anticline between Bukit Gomantong and the Langkon-Kudat bridle path.

7. Boundaries : The lenticular Garau Red Shale Member is overlain by and interfingers with the Gomantong Member.
8. Correlation :
9. Thickness : Estimated 2,400-3,000 m
10. Lithology : A predominantly argillaceous sequence of red shales with subordinate, thin bedded, argillaceous or calcareous sandstone, thin bedded, grey silty shale and rare, massive, lenticular sandstones at the top.
11. Subdivisions :
12. Fossils :
    foraminifera
    Bathysiphon spp.
    Cyclammina spp.
    Trochammina spp.
13. Env. of deposition : Marine
14. Remarks :

C55.4.

1. Name : Gomantong Member
2. Origin of name :
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : South flank of the Gomantong Anticline and southwards to Pulau Sirar, Sungai Mukong and Sungai Kerangawan, from Pulau Sirar and Sungai kerangawan to Sungai Taburan and Sungai Bintasan, from Sungai Taburan and Sungai Bintasan to the North Tabilong Fault respectively.
7. Boundaries : The Gomantong, Sirar and Dudar Members appear to overlie each other, with the Dudar at the top, but this does not disprove lateral intergrading.
8. Correlation :
9. Thickness : Estimated composite thickness 9,000 m
10. Lithology : Consists of arenaceous and argillaceous sediments in equal proportion; mainly medium bedded to massive, hard, ferruginous, medium to fine grained quartzose sandstones, with current bedding, lignite with sand laminae and grey, variegated red or green shales with silty claystone or argillaceous siltstone.
11. Subdivisions :
12. Fossils : foraminifera
13. Env. of deposition : Littoral or paralic condition
14. Remarks :

C55.5.

1. Name : Sirar Member
2. Origin of name :
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : South flank of the Gomantong Anticline and southwards to Pulau Sirar, Sungai Mukong and Sungai Kerangawan, from Pulau Sirar and Sungai Kerangawan to Sungai Taburan and Sungai Bintasan, from Sungai Taburan and Sungai Bintasan to the North Tabilong Fault respectively.
7. Boundaries : The Gomantong, Sirar and Dudar Members appear to overlie each other, with the Dudar at the top, but this does not disprove lateral intergrading.
8. Correlation :
9. Thickness : Estimated about 2,000 m
10. Lithology : Consists of arenaceous and argillaceous sediments in equal proportion; mainly medium bedded to massive, hard, ferruginous, medium to fine grained quartzose sandstones, with current bedding, lignite with sand laminae and grey, variegated red or green shales with silty claystone or argillaceous siltstone.
11. Subdivisions :
12. Fossils :
13. Env. of deposition : Littoral or paralic condition
14. Remarks :

C55.6.

1. Name :Dudar Member
2. Origin of name :
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area :
6. Type section : South flank of the Gomantong Anticline and southwards to Pulau Sirar, Sungai Mukong and Sungai

Kerangawan, from Pulau Sirar and Sungai kerangawan to Sungai Taburan and Sungai Bintasan, from Sungai Taburan and Sungai Bintasan to the North Tabilong Fault respectively.

7. Boundaries : The Dudar Member in the south is in direct contact with Wariu formation and appear to form the base of the Kudat Formation. The Gomantong, Sirar and Dudar Members appear to overlie each other, with the Dudar at the top, but this does not disprove lateral intergrading.
8. Correlation :
9. Thickness : Estimated about 2,400 m
10. Lithology : Consists of arenaceous and argillaceous sediments in equal proportion; mainly medium bedded to massive, hard, ferruginous, medium to fine grained quartzose sandstones, with current bedding, lignite with sand laminae and grey, variegated red or green shales with silty claystone or argillaceous siltstone.
11. Subdivisions :
12. Fossils :

foraminifera
Discocyclina sp.
Heterostegina
Miogypsinoides ubaghsi Tan Sin Hok
Nephrolepidina sp.
Nummulites spp.
Spiroclypeus sp.

13. Env. of deposition : Inner neritic environment
14. Remarks :

C56.

1. Name :Wariu formation
2. Origin of name : Wariu River, Sabah
3. Age : Miocene
4. References : Liechti *et al*. (1960)
5. Type area : Type locality is the Wariu River section, north of Kinabalu, Sabah.
6. Type section :
7. Boundaries : The base of the Wariu Formation is nowhere exposed. The top boundary is with few exceptions an erosional surface. Locally the Kudat Formation appears to overlie The Wariu Formation, but in part the relationship is probably one of synchronous juxtaposition.
8. Correlation :
9. Thickness : Considerable
10. Lithology : Conceived as a depositionally contorted, squeezed and cataclastic eugeosynclinal scree consisting of clastic sedimentary rocks and radiolarian cherts in association with so-called ophiolitic or spilitic extrusive rocks, either *in situ* or as polymict boulder beds or breccias. The chert and spilitic extrusive rocks are characteristic.
11. Subdivisions : None
12. Fossils :

foraminifera
(Te forms)
Alveolina sp.
Lepidocyclina angulosa Provale
Lepidocyclina (Eulepidina) sp.
Miogypsinoides sp.
Spiroclypeus sp.
and others
(Tab forms)
Assilina sp.
Discocyclina sp.
Numulites sp.
and others

13. Env. of deposition : The spilitic pillow lavas and similar rocks indicate truly eugeosynclinal nature of the environment; of the sedimentary rocks, the shales and the matrix of the conglomerates are autochthonous, but a large proportion of the components have been flushed in as exotic blocks or olistoliths from the adjacent miogeosynclinal shelf. McManus & Tate (1986) suggest the chaotic deposits of the formation are products of mud volcanism.
14. Remarks : The term 'Wariu Formation' is largely synonymous with Niethammer's 'Verquetschte Tertiare Schiefer', the 'Chert-Spilite Association' of North Borneo geologists (Fitch, 1953) and Reinhard and Wenk's (1951) former 'Danau Formation'. It has been introduced by J.M. Bowen

and in a modified way adopted by J.F. Clement to describe the cataclastic sediments with minor chert-splilite occurrences of the Kinabalu, Kota Belud, and Kudat Area.

C57.

1. Name : Balung formation
2. Origin of name : Sungai Balung Kecil, Sabah
3. Age : Middle to Upper Miocene
4. References : Lim (1981)
5. Type area : In Sungai Balung Kecil, Sabah.
6. Type section :
7. Boundaries : The Balung formation probably overlies the Kalumpang Formation with an angular unconformity. The formation probably underlies andesite and dacite along Sg. Balung Kecil. Boulder beds of the high-level alluvium overlie the Balung formation at Sg. Balung Kecil Kanan.
8. Correlation :
9. Thickness : Estimated near maximum thickness 400 m
10. Lithology : Consists predominantly of medium-bedded (6-60 cm), gently dipping, grey volcanic ash, dark grey mudstone, greenish-grey to grey fine to coarse grained lithic, crystal-lithic and crystal tuff, green-grey shale, and rare thin coaly beds. Abundant organic matter, particularly plant remains, is present.
11. Subdivisions :
12. Fossils :

<u>foraminifera</u>

Ammobaculites spp.
Ammodiscoides
Ammodiscus spp.
Ammodiscua grzybowski (Emiliani)
Ammonia sp.
Angulogerina angulosa
Bathysiphon sp.
Bolivina spp.
Cibicides sp.
Cribostomoides sp.
Cyclammina spp.
Cyclammina cancellata (Brady, 1876)
Cyclammina amplectens (Grzybowski)
Discorbis spp.
Eggerella sp.
Eggerella braddyl (Cushman, 1933)
Elphidium spp.
Elphidium koeboeense LeRoy
Gaudryina spp.
Glandulina spp.
Globigerina sp.
Glomospira sp.
Haplophragmoides spp.
Haplophragmoides walteri (Grzybowski, 1898)
Hormosina sp.
Kalamopsis grzybowski (Dylanzanka, 1923)
Karrerielva spp.
Lagena sp.
Lenticulina sp.
Loxostomum karrerianum var. *carinatum* (Millet)
Nonion japonicum (Asano, 1938)
Psammosphaera placenta (Grzybowski, 1898)
Psammosiphonella spp.
Psammosiphonella carapitana (Hedberg, 1937)
Psammosiphonella cylindrica (Glaessner, 1937)
Psammosiphonella irregularis (LeRoy, 1944)
Quinqueloculina sp.
Recurvoides deformis (Andreae)
Reophax sp.
Reusella sp.
Rotalia sp.
Sigmoilopsis schlumbergeri (Silvestri)
Spiroculina spp.
Spirosigmollinella sp.
Streblus ketienzsis (Ishizaki, 1943)
Textularia sp.
Trochammina spp.
Trochammina renzi (Renz, 1948)
Trochammina renzi Brouwer
Trochamminoides spp.
Trochamminoides subcoronata (Rzehak, Grzybowski, 1896)
Usbekistania spp.
Valvulina sp.

<u>pollen and spore</u>

Alangium sp.
Alnus sp.
Amylotheca sp.
Anacolosa sp.
Arenga sp.
Avicennia sp.
Barringtonia sp.
Blumeodendron sp.
Brownlowia spp.
Calamus sp.
Camptostemon sp.
Canthium sp.

Casuarina spp.
Cephalomappa spp.
Ceratopteris sp.
Crudia sp.
Cyclophorus sp.
Dacrydium sp.
Dactylocladus sp.
Dipterocarpus spp.
Durio sp.
Ephedra sp.
Eugeissona insights
Eugeissona minor
Eugeissona sp.
Ficus sp.
Gonystylus sp.
Gramineae sp.
Hibiscus sp.
Longetia sp.
Lycopodium spp.
Lycopodium cernuum
Lycopodium phlegmaria
*Myrtacea*e sp.
Nenga sp.
Palmae
Picea sp.
Pinus sp.
Podocarpus sp.
Podocarpus polystachyus
Pometia sp.
Rhizophora spp.
Sonneratia spp.
Stenochlaena spp.
Stenochlaena areolaris
Stemonurus sp.
Tsuga sp.

13. Env. of deposition : Paralic marine environment with fluctuations from nearshore shallow water to swamp conditions.
14. Remarks : The name Balung Formation was first introduced in 1973 by geologists of the Sabah Teiseki Oil Company Berhad (GSJ CONF. 706/36).

C58.

1. Name : Gomantong Limestone formation
2. Origin of name : Gomantong Hill, Dent Peninsula, Sabah
3. Age : Upper Miocene
4. References : Haile and Wong (1965)
5. Type area : Type locality is the Gomantong Hill, Sabah.
6. Type section :
7. Boundaries : Basal boundary has not been observed. At Gomantong, the westerly dipping limestone is bounded to the east by steeply dipping grey mudstone and ferruginous sandstone of the Labang formation. The limestone apparently overlies the Labang formation unconformably.
8. Correlation :
9. Thickness : Approx. 300 m.
10. Lithology : A compact detrital greyish-orange limestone, much of it crystallised, composed of foraminifers, algae, and corals.
11. Subdivisions :
12. Fossils :

foraminifera
Cycloclypeus eidae Tan
Eulepidina spp.
Flosculinella globulosa (Rutten)
Lepidocyclina perornata Douville
Miogypsina spp.
Miogypsinoides dehaarti van der Vlerk
Nephrolepidina borneensis
Nephrolepidina inflata
Nephrolepidina sumatrensis
Orbitolites cf. *vandervlerki* (de Neve)
algae
coral
echinoid

13. Env. of deposition : Marine.
14. Remarks : Haile and Wong (1965) classified the formation in the Kinabatangan Group.

C59.

1. Name : Meligan Formation
2. Origin of name : Meligan River
3. Age : Upper Miocene
4. References : Wilson and Wong (1964)
5. Type area : In the mountainous country drained by the Meligan and Pulun Rivers.
6. Type section : In the Meligan River
7. Boundaries : Overlies the Temburong and the Crocker formations. In the Sipitang area, the formation is overlain unconformably in places by the Liang formation, but generally its upper surfaces are erosional.

8. Correlation :
9. Thickness : Estimated approx. about 5,000 m
10. Lithology : Composed mainly of buff sandstone, shale white quartzose sandstone and limestone.
11. Subdivisions :
12. Fossils :

foraminifera
Ammobaculites sp.
Ammobaculoides sp.
Ammodiscus sp.
Anomalina spp.
Austrotrillina howchini (Schlumberger)
Bathysiphon spp.
Bigenerina sp.
Bolivina sp.
Cibicides spp.
Cristellaria spp.
Cyclammina sp.
Elphidium sp.
Glandulina sp.
Globigerina sp.
Globigerina subcretacea Lomnicki
Globigerinoides spp.
Gypsina sp.
Gyroidina sp.
Heterostegina sp.
Hormosina sp.
Lepidocyclina (Eulepidina) cf. *bridgei* Schlumberger
Lepidocyclina (Eulepidina) cf. *formose* Schlumberger
Lepidocyclina cf. *inflata* Provale
Lepidocyclina cf. *richthofeni* Smith
Lepidocyclina spp.
Miogypsina (Miogypsinoides) dehaarti van der Vlerk
Miogypsina sp.
Miogypsinoides dehaarti van der Vlerk
Miogypsinoides sp.
Nodosaria sp.
Nonion sp.
Operculina spp.
Quinqueloculina spp.
Textularia sp.
plant
remain
trace fossil

13. Env. of deposition : The pure white, current-bedded sandstone was probably deposited in a shallow water littoral to inner neritic environment
14. Remarks :

C60.

1. Name : South Banggi formation
2. Origin of name : Banggi Island (occurrence in the southern part), Sabah
3. Age : Upper Miocene
4. References : Wilson (1961)
5. Type area : Wilson (1961) dicussed the lithology of the type area but did not specifically delineate the type area.
6. Type section :
7. Boundaries : On both Banggi Island and the mainland (Bengkoka Peninsula) the formation is highly folded and generally has faulted contacts with the adjacent formations, the Chert-Spilite or the Bongaya Formations.
8. Correlation : The upper beds of the South Banggi formation may be a facies of the lower part of the Bongaya Formation.
9. Thickness : Estimated approx. 90 m to 300 m
10. Lithology : Consists of hard flags of grit, in which, constituents that make up the rock include limestone grains, foraminifera, and cement, chloritised fragments of basic igneous rock, chert, and angular quartz grains. Limestones in the west coast of south Banggi are also included in the formation. Other rock types include sandstone and siltstone.
11. Subdivisions :
12. Fossils :

foraminifera
?Cycloclypeus sp.
?Pellatispira
Austrotrillina howchini (Schlumberger)
Biplanispira
Cycloclypeus sp.
Discocyclina
Gypsina spp.
Heterostegina sp.
Lepidocyclina (Eulepidina) spp.
Lepidocyclina (Nephrolepidina) spp.
Lepidocyclina sp.
Miogypsina primitiva Tan Sin Hok
Miogypsina sp.
Miogypsinoides abuensis Tobler
Miogypsinoides dehaarti van der Vlerk

Miogypsinoides sp.
Neoalveolina sp.
Nummulites sp.
Operculina sp.
Operculinella sp.
Orbulina sp.
Pellatispira
Rupertiidae
Spiroclypeus sp.
algae
echinoid

13. Env. of deposition : Shallow marine
14. Remarks : The South Banggi formation was formerly part of the 'Banggi-Balambangan Formation', and also includes rocks on the Bengkoka Peninsula, which was formerly referred to the 'Kaindangan Formation' (Wilson, 1961).

C61.

1. Name : Kuamut formation
2. Origin of name : Sungai Kuamut, Upper Kinabatangan, Sabah
3. Age : Upper Miocene (Collenette, 1965a); late Lower Miocene to mainly Upper Miocene (Leong, 1974)
4. References : Collenette (1965a), Leong (1974)
5. Type area : Outcrop about 32 km long in the lower part of the Kuamut Valley, roughly between Gopag Island in the north and Duri Island in the south
6. Type section :
7. Boundaries : The formation appears to be unconformable on the Chert-Spilite formation and conformable beneath the Tanjong formation. The Kuamut formation probably overlies unconformably on the tentatively mapped Labang formation in the Malubuk area. The formation also overlies unconformably on the Crystalline Basement in the Upper Segama Valley, fault contact between the mudstone of the formation and Basement rocks have been observed near Kuala Rahsia.
8. Correlation : Leong (1974) mentioned that the formation in the Upper Segama Valley and Darvel Bay areas partly resembles the Ayer formation, and the Garinono formation in the Sandakan area. The Kuamut formation mapped in the Upper Tinkayu, Binuang, and Bang areas, which consist of a thick sequence of sandstone and mudstone with some slump breccia and interbedded tuff and tuffite, resembles the lithology of the Kalabakan formation in the Kalabakan and Lower Brantian areas. However the rock sequences in these areas are provisionally mapped as Kuamut formation owing to the presence of the tuffaceous beds in the sandstone-mudstone sequences (Leong, 1974).
9. Thickness : Estimated maximum thickness about 1,500 m. Leong (1974) estimated over 3,000 m thick.
10. Lithology : Comprises sandstone, mudstone, and conglomerate, with rare occurrences of limestone, chert, tuff, spilite, basalt, dolerite, and ultrabasic rocks. Leong (1974) revealed thick sequences of steeply dipping tuff, tuffite, and tuffaceous sediments interlayered with slump breccia deposits in the Upper Segama Valley and Darvel Bay areas. The type area designated by Collenette (1965a), upon reinvestigation, was found to consist entirely of slump breccia deposits.
11. Subdivisions :
12. Fossils :

foraminifera from mudstone matrix of slump breccia deposits of (Leong (1974)
Ammobaculites sp.
Ammodiscus sp.
Amphistegina sp.
Angulogerina sp.
Anomalina sp.
Bathysiphon spp.
Bigenerina spp.
(?)Bigenerina sp.
Bigerina sp.
Bolivina sp.
Bulimina sp.
Cassidulina sp.

Chlostomelloides sp.
Clavulina sp.
Cibicides praecinatus (Karrer)
*Cibicide*s spp.
Cristellaria sp.
Cyclammina amplectens (?) (Grzybowski)
Cyclammina cancellata Brady
Cyclammina minima/amplectens group
Cyclammina spp.
Elphidium koeboense LeRoy
Epistominella pulchella Husezima & Maruhasi
Eponides umbonatus (Reuss)
Eponides sp.
(?)Eponides sp.
Euuvigerina notohispida (Finlay)
Gaudryina spp.
Glandulina sp.
Globigerina binaiensis Koch
Globigerina binaiensis(?) Koch
Globigerina boweri
Globigerina cf. *ciperoensis* Bolli
Globigerina dissimilis Cushman & Bermudez
Globigerina obesa Bolli
Globigerina opima nana Bolli
Globigerina pera(?) Todd
Globigerina sellii (Borsetti)
Globigerina sellii (?) (Borsetti)
Globigerina cf. *tripartita* Koch
Globigerina unicava primitiva/pera(?)
Globigerina spp.
Globigerinoides bispheria Todd
Globigerinoides diminuta Bolli
Globigerinoides (?) ruber
Globigerinoides rubra (?) group
Globigerinoides sacculifera (?) Brady
Globigerinoides sacculiferous
Globigerinoides subquadrata Bronniman
Globigerinoides triloba (Reuss)
Globigerinoides triloba group
Globigerinoides trilobus
Globigerinoides trilobus (?) group
Globigerinoides spp.
Globoquadrina altispira (Cushman & Jarvis)
Globoquadrina (?) altispira
Globoquadrina venezuelana
Globoquadrina sp.
Globoquadrina sp.=*Globigerina tripartitat* Koch var.
Globorotalia crassa
Globorotalia kugleri Bolli
Globorotalia mayeri Cushman & Ellisor
Globorotalia (?) mayeri
Globorotalia scitula (Brady)
Globorotalia velascoensis var.
Globorotalia spp.
Glomospira sp.
Gyroidina soldanii (d'Orbigny)
Gyroidina sp.
Haplophragmoides carinatum Cushman & Renz
Haplophragmoides deformis (Andreas)
Haplophragmoides narivaensis Bronnimann
Haplophragmoides walteri (Grzybowsky)
Haplophragmoides sp.
Hormosina sp.
Itanzawaia sumitomoi Asano & Murata
Lagena sp.
Lagenammina sp.
Laticarinata sp.
Nodosaria sp.
Nonionella micra
Nonion pompilioides (Fichtel & Moll)
Nonion sp.
Pleurostomella sp.
Psammosphaera placenta (Grzybowsky)
Psammosphaera fusca (Schulze)
Pullenia bulloides (d'Orbigny)
Quinqueloculina sp.
Rectoglandulina laevigata (d'Orbigny)
Reophax sp.
Rhizammina sp.
Rotalia spp.
Rotalia? sp.
Sigmoilina sp.
Sphaeroidina bulloides d'Orbigny
Siphogenerinoides sp.
Spiroloculina sp.
Spiroplectammina sp.
Textularia sp.
Triloculina sp.
Trochammina renzi nom. nov.
Trochammina spp.
Trochamminoides subcoronata (Rzehak, Grzybowsky)
Trochamminoides spp.
Tubulogerina sp.
Uvigerina hantkeni Cushman & Edwards
Uvigerina sp.
Vaginulin sp.
Valvulina sp.
Verneuilina sp.
Virgulina sp.
foraminifera from bedded sequence of Leong (1974)
Ammobaculites sp.
Ammodiscus grzybowskii Emiliani
Ammodiscus sp.
Ammoidiscus sp.
Amphistegina spp.
Bathysiphon spp.
Bolivina sp.
Cassidulina sp.

Catapsydrax dissimilis (Cushman & Bermudez)
*Cibicide*s spp.
Clavulina sp.
Cyclammina amplectens (Grzybowski)
Cyclammina cancellata Brady
Cyclammina minima LeRoy
Discocyclina sp.
Eggerella bradyi (Cushman)
Eponides sp.
Frondicularia sp.
Gaudryina spp.
Globigerina cf. *angulisuturalis* Bolli
Globigerina binaiensis Koch
Globigerina ciperoensis Bolli
Globigerina cf. *ciperoensis* Bolli
Globigerina diminuta Bolli
Globigerina dissimilis (Cushman & Bermudez)
Globigerina dissimilis Cushman & Bermudez var.
Globigerina parva Bolli
Globigerina subscretacea Chapman
Globigerina venezuela Hedberg
Globigerina venezuelana
Globigerina spp.
Globigerinatella insueta Cushman & Stainforth
Globigerinoides bispherica Toddy
Globigerinoides glomerosa Blow
Globigerinoides rubra d'Orbigny var.
Globigerinoides subquadratus Bronniman
Globigerinoides triloba (Reuss)
Globigerinoides spp.
Globigerinoides spp. (*G. rubra* group)
Globigerinoides spp. (*G. triloba* group)
Globoquadrina altispira Cushman & Jarvis
(?) Globoquadrina altispira (Cushman & Jarvis)
Globoquadrina dehiscena Chapman, Parra & Collins
Globoquadrina venezuelana Hedberg var.
Globorotalia centralis Cushman & Bermudez
Globorotalia cerroazulensis Cole
Globorotalia cf. *fohsi barisanensis* LeRoy
Globorotalia mayeri Cushman & Ellisor
Globorotalia (?) mayeri Cushman & Ellisor
Globorotalia (?) nana Bolli
Globorotalia cf. *opima nana* Bolli
Globorotalia seitula Brady var.
Globorotalia spinulosa Cushman
Globorotalia wilcoxensis Cushman & Ponton
Globorotalia sp.
Globorotaloides suteri Bolli
Glomospira spp.
Gyroidina soldanii (d'Orbigny)
Haplophragmoides walteri (Grzybowsky)
Haplophragmoides sp.
Heterostegina spp.
?Heterostegina sp.
Kalamopsis grzybowskii (Dylazanka)
Lagena spp.
Lepidocyclina spp.
Lepidocyclina (Eulepidina) spp.
Miogypsinoides sp.
(?)Miogypsinoides sp.
Nodosaria sp.
Operculinids
Porticulasphaera transitora (Blow)
Pullenia bulloides d'Orbigny
(?) Psammosiphonella latissima (Grzybowsky)
Psammosphaera placenta (Grzybowsky)
Recurvoides deformis (Andreae)
Rhizammina sp.
Sphaeroidinella multiloba LeRoy
Trifarina sp.
Trochammina renzi nom. nov.
Trochammina sp.
Trochamminoides spp.
Uvigerina spp.
Valvulina sp.
Vulvulina sp.
algae
foraminifera from blocks in slump breccia deposits of Leong (1974)
Acteonella borneensis nov. sp.
Ammodiscus sp.
Amphistegina sp.
Anomalina sp.
Asterocyclina sp.
Austrotrillina cf. *striata* Todd & Post
Bathysiphon sp.
Borelis cf. *inflata* Adams
Borelis sp.
Cyclammina amplectens (?) (Grzybowski)
?Cycloclypeus sp.
Dentalina sp.
Discocyclina sp.
?Discocyclina sp.
Fasciolites sp. indet.
Floborotalis cf. *velascoensis* (Cushman)
Gaudryina sp.
Glandulina sp.
Globigerina boweri
Globigerina dissimilis Cushman & Bermudez
Globigerina incribescens (?) Bandy
Globigerina unicava primitive/pera
Globigerina cf. *veguaensis* Weinzierland & Applin
Globigerina spp.
Globorotalia araganensis
Globorotalia crassa
Globorotalia velascoensis var.
Globorotalia spp.
Globotruncana laparenti Brotzen

Globotruncana spp.
Glomospira spp.
Glomospora spp.
Guttulina sp.
Gypsina vesicularis sensu Bursch 1947
Halkyardia sp.
Haplophragmoides walteri (Grzybowsky)
Haplophragmoides sp.
Hastigerina micra (Cole)
Hedbergella sp.
Heterohelix navarroensis
Heterohelix sp.
?Heterostegina sp.
Lepidocyclina (Nephrolepidina) sp.
?Lingulina sp.
?Marsonella sp.
Nodosaria sp.
Nonionella micra
Nummulites cf. *ficheli* Michelotti
Nummulites cf. *fishteli*
Nummulites cf. *javanus* Verbeek
Nummulites sp.
Operculina sp.
Orbitolina lenticularis (Blumenbach) *sensus* Hofker
Orbitolina sp.
Praerhapydionina sp.
Textularia sp.
Trochammina renzi nom. nov.
Trochammina sp.
Trochamminoides subcoronata (Rzehak, Grzybowsky)
radiolaria
Cenosphaera sp.
Dictyomitra sp.
?Hemicryptocapsa sp.
?Melitosphaera sp.
?Phormocyrtis sp.
?Theococorys sp.
algae
Archaeolithothamnium cf. *aschersoni* (Schwag)
?Cayeuxia piai
Clypeina sp.
Corallina sp.
Halimeda sp.
Jania sp.
Lithoporela melobesiodies Foslie
Lithothamnium sp.
Mesophyllum cf. *pfenderae*
Mesophyllum sp.
Parachaetetes cf. *asrapati* Pia
Solenopora sp.
coral
echinoid
gastropod
mollusc

radiolaria from chert samples of the Kuamut Formation of Leong (1974)
Adelocyritis sp.
Botropyle sp.
Cenellippis sp.
Cenosphaera sp.
?Cephalopyramis sp.
?Circospiris sp.
Cornutella sp.
Cryptocapsa sp.
Dicolocapsa sp.
Dictyomitra sp.
Flustrella sp.
Lithapium sp.
Meyenella meyeni
Sethocyrtis sp.
Spongolena sp.
Spongotrochus cf. *Stylospongia* sp.
Spongotronchus sp.
Stichopera sp.
Stylostaurus sp.
Syringium sp.
Theocapsa sp.
Triacartus s.l.
Triacartus sp.
foraminifera non age-determining foraminifera from argillaceous samples of the Kuamut formation of Leong (1974)
Ammobaculites sp.
Ammodiscoides sp.
Ammodiscus spp.
Amphistegina sp.
Angulogerina sp.
Anomalina sp.
Bathysiphon spp.
Bigenerina sp.
Cassidulina sp.
Chilostomella sp.
*Cibicide*s spp.
Clavulinoides tricarinatus LeRoy
Cristellaria sp.
Cyclammina amplectens (Grzybowski)
Cyclammina cancellata Brady
Cyclammina spp.
Eponides sp.
Gaudryina spp.
Globigerina spp.
Globigerinoides spp.
Globorotalia sp.
Glomospira spp.
Hanzawaia sumitomoi Asano & Murata
Haplophragmoides narivaensis Bronnimann
Haplophragmoides walteri (Grzybowsky)
Haplophragmoides spp.

Kalamopsis grzybowskii (Dylazanka)
Kalamopsis subnodosiformis (Grzybowsky)
Lagena sp.
Lagenammina sp.
Lituotuba spp.
Nodosaria sp.
Operculina spp.
Psammosiphonella cylindrica (Glaessner)
Psammosiphonella irregularis/cylinderica group
Psammosiphonella latissima (Grzybowsky)
Psammosphaera placenta (Grzybowsky)
Quinqueloculina sp.
Reophaz sp.
Rhizammina sp.
Rotalia sp.
Sphaerodina bulloides d'Orbigny
Textularia sp.
Tritaxilina sp.
Trochammina renzi nom. nov.
Trochammina spp.
Trochamminoides spp.
Trochamminoides subcoronata (Rzehak, Grzybowsky)
Uvigerina spp.
Valvulina sp.
Verneuilina sp.
Vulvulina sp.
List of fossils cited in Collenette (1965a):
algae
bryozoa
echinoid
gastropod
Turritella sp.
Turris (Turris) cf. *carinata* (Gray) subsp.
Terebra (Hastula) sp. indet.
bivalve

13. Env. of deposition : Neritic condition. Suggested as a slump or scree deposit. Leong (1974) explained deposition in fault-bounded deep water submarine basin or basins. Submarine sliding of a pelitic mass incorporated blocks from fault-zones, depositional slopes and on the submarine floor to form the chaotic or slump breccia deposits. The gravity-induced sliding alternated with flysch-type sedimentation and volcanic activity. McManus & Tate (1986) suggest the chaotic deposits of the formation are the product of mud volcanism.
14. Remarks : Collenette (1963) classified the formation in the Kinabatangan Group. Leong (1974) classified the sandstone-mudstone sequence in the Upper Umas-Umas, Binuang, and Tingkayu areas and the thick beds of massive dacitic tuff in the Mostyn area, which was earlier assigned to the Kalumpang Formation (Kirk, 1962), in the Kuamut formation.

C62.

1. Name : Ayer formation
2. Origin of name : Sungai Ayer, Dent Peninsula, Sabah
3. Age : Upper Miocene
4. References : Haile and Wong (1965), Leong (1974)
5. Type area : Type locality in the headwaters of the Sungai Ayer, Dent Peninsula, Sabah.
6. Type section :
7. Boundaries : The base is not known. In the type area the formation is overlain by the well bedded sandy and conglomeratic Libong Tuffite. In places the Ayer formation is overlain by Tungku formation, presumably unconformably. Leong (1974) mentioned that the formation is probably overlain by or is in fault-contact with the Tabanak Conglomerate, and also in gradational contact with the Kuamut formation. He also indicated that within the formation there appears to be a facies change from predominantly calcareous on the west and tuffaceous towards the east.
8. Correlation :
9. Thickness : Approx. estimation 2,500 m.
10. Lithology : Comprises highly disturbed tuffs, slump-breccias, boulder beds, chert, and pebbly mudstone. Leong (1974) mentioned the presence of calcareous facies in the formation.
11. Subdivisions : Tempadong Limestone member
12. Fossils :

foraminifera
Amphistegina sp.
?Amphistegina sp.
Asterocyclina sp.

Austrotrillina howchini (Schlumberger)
Borelis sp.
Cycloclypeus sp.
Globigerina binaiensis Koch
Globigerina bulloides d'Orbigny
Globigerina dissimilis Cushman & Bermudez var.
Globigerina spp.
Globigerina subcretacea Lomnicki
Globigerina tripartita (Koch)
Globigerinatella insueta Cushman & Stainforth
Globigerinoides ?altispira (Cushman & Jarvis)
Globigerinoides altispira (Cushman & Jarvis)
Globigerinoides bispherica-glomerosa
Globigerinoides diminuta Bolli
Globigerinoides glomerosa Blow
Globigerinoides glomerosa glomerosa Blow
Globigerinoides rubra (?) group
Gigerinolobides sacculifera (Brady)
Globigerinoides spp.
Globigerinoides subquadrata Bronnimann
Globigerinoides triloba group
Globoquadrina altispira (Cushman & Jarvis)
Globoquadrina tripartita Koch
Globorotalia fohsi barisanensis LeRoy
Globorotalia fohsi fohsi Cushman & Ellisor
Globorotalia mayeri Cushman and Ellisor
Globorotalia opima nana Bolli
Globorotalia praemenardi Cushman & Stainforth
Globorotaloides suteri Bolli
Heterostegina sp.
Lepidocyclina (Eulepidina) sp.
Lepidocyclina (Nephrolepidina) sp.
Lepidocyclina spp.
Miogypsina sp.
Nummulites sp.
Operculina spp.
Orbulina bilobata (d'Orbigny)
Orbulina suturalis Bronnimann
Rotalia sp.
Rotalids
Sphaeroidinella multiloba LeRoy
Sphaeroidinella sp.
Spirocyclypeus sp.
?Spiroclypeus sp.
algae

13. Env. of deposition : Outer neritic to bathyal conditions. Leong (1974) interpreted as shallow, inner neritic marine environment to deeper water. McManus & Tate (1986) suggest the chaotic deposits of the formation are the product of mud volcanism.

14. Remarks : J.F. Clement and W.K. Bisig *(1959)* introduced the term 'Ayer Formation'. Haile and Wong (1965) classified the formation in the Segama Group, and stated that the tuffs and interbedded sedimentary rocks are mostly steeply bedded, in the northern part, such as in the Tabin and Tagas-Tagas Rivers, the tuffs are mostly fine to medium grained and well-bedded, while tuffs in the Boulder-Bed Facies of the Ayer formation, as in the Tabin Tridus and Lung Tatik Tributaries of the Ayer River, are more disturbed, more massive, and in places are conglomeratic and coarsely breccious, containing blocks of tuff several feet across.

C62.1.

1. Name : Tempadong Limestone member
2. Origin of name : Bukit Tempadong, Segama Valley, Sabah
3. Age : Miocene (most probably Te_5)
4. References : Leong (1974)
5. Type area : Limestone hill of Bukit Tempadong, Segama Valley, Sabah
6. Type section :
7. Boundaries : Limestone of the Tempadong Limestone member overlies bedded greenish grey tuff and coarser tuffite which dip at 20º to the northeast. Near Sungai Mensuli, the limestone appears to be in contact with slump breccia deposits. The limestone at Sungai Segama and Teck Guan Estate occurs as massive lenses within the tuffaceous rocks of the Ayer formation.
8. Correlation :
9. Thickness : Estimated about 90 m.
10. Lithology : Mostly white with varieties of grey or pink, compact, and appears to be a pure calcium carbonate rock, in parts richly fossiliferous.
11. Subdivisions :
12. Fossils :

foraminifera
Amphistegina sp.
Austrotrillina howchini (Schlumberger)
Austrotrillina cf. *howchini* (Schlumberger)
Austrotrillina cf. *striata* Todd & Post
Austrotrillina sp.
*Borel*is sp.
Carpenteria sp.
Cycloclypeus sp.
Flosculinella globulosa (Rutten)
Flosculinella cf. *globulosa* (Rutten)
Globigerina spp.
Heterostegina sp.
Lepidocyclina sp.
Lepidocyclina (Nephrolepidina) sp.
Lepidocyclina (Nephrolepidina) cf. *angulosa* Provale
Lepidocyclina(Nephrolepidina) cf. *ferreroi* Provale
Lepidocyclina(Nephrolepidina) cf. *sumatrensis* (Brady)
Lepidocyclina(Nephrolepidina) cf. *verbeeki* Newton & Holland
Miogypsina sp.
Operculina sp.
Sorites sp.
Sorites cf. *martini*
coral
mollusc

13. Env. of deposition : Shallow, inner neritic marine environment
14. Remarks : Reinhard and Wenk (1951) assigned the limestone at Tempadong to the 'Tempadong Formation' and described as a coral limestone containing *Nephrolepidina ferreroi* and *Alveolinella bontangensis*, transgressive over the pre-Tertiary at Batu Tempadong on Sungai Segama. Leicester (1936) regarded the limestone as the basal member of the 'Segama Formation'. The 'Segama Formation' mapped by Clement *(1959)* in the Dent Peninsula has been redefined and replaced by the Libong Tuffite formation and the original 'Segama Formation' of Leicester in the Lahad Datu area by the Tabanak Conglomerate (Haile and Wong, 1965).

C63.

1. Name : Libong Tuffite formation
2. Origin of name : Libong tributary of the Tungku River, Dent Peninsula, Sabah
3. Age : Upper Miocene
4. References : Haile and Wong (1965)
5. Type area :
6. Type section :
7. Boundaries : The base of the formation is not observed. The Libong Tuffite is overlain unconformably by the Tungku formation. The Bagahak Pyroclastic member of the Tungku formation is transgressive on the Libong Tuffite on the northern flank of Bagahak Syncline.
8. Correlation :
9. Thickness : Estimated approx 650 to 1,000 m
10. Lithology : Consists essentially of tuffaceous conglomerate and sandstone, and shale and limestone
11. Subdivisions :
12. Fossils :

coral
Acanthastraea polygonalis Martin
Alveopora sp.
Cyphastraea monticulifera Felix
Fungia (Cycloseris) martini Felix
Fungia (Cycloseris) stammi Felix
Fungia (Cycloseris) subcyclolites Felix
Fungia (Cycloseris) wanneri Felix
Goniaraea anomala Reuss
Maeandrina sp.
Porites sp.
Stylophora pistillata E.H.
foraminifera
Globorotalia fohsi fohsi Cushman & Ellisor
Globorotalia mayeri Cushman and Ellisor
Globorotalia praemenardi
Orbulina universa (d'Orbigny)
gastropod
Delphinula cf. *fossilis* Martin
Trochus cf. *sondeianu*s Martin
Trochus sp.
Cerithium sp.
Cypraea sp.
bivalve
Thracia sp.
Tellina sp.

13. Env. of deposition : Varying from sub-littoral to neritic and bathyal, with water depths ranging from few metre to 450 m.

14. Remarks : Was formerly called Segama Formation by Clement *(Sabah Shell Petroleum Company, 1959).* Clement further noted that the formation differs from the Ayer formation in its well-bedded character, the improved sorting of its sedimentary rocks, and in the scarcity of true tuff, brecciated zones, and boulder beds. Haile and Wong (1965) classified the formation in the Segama Group.

C64.

1. Name : Tanjong formation
2. Origin of name : Unknown
3. Age : Lower to Upper Miocene
4. References : Collenette (1965a), Haile and Wong (1965), Leong (1974)
5. Type area : Collenette (1965a) proposed the section of the Pinangah River between Lilyan Rapids and Notilo Village, Pinangah Valley, Upper Kinabatangan, Sabah as the type area.
6. Type section :
7. Boundaries : The formation rests on highly folded Cretaceous and Lower Tertiary strata, and is unconformable on the Labang formation. The formation appears to pass laterally into the Kapilit and Kalabakan formations. In the Kuamut area, the formation appears to overlie conformably on the Kuamut formation.
8. Correlation :
9. Thickness : Estimated in the Bangan Basin about 3,600-5,400 m, in Meliau Basin may exceed 12,000 m. The Malua-Latangan Basin is estimated at least about 3,000 m.
10. Lithology : Consists of mudstone, siltstone, and sandstone with rare beds of limestone, marl, coal, and conglomerate.
11. Subdivisions :
12. Fossils :

foraminifera

Ammobacilites sp.
Ammobaculites sp.
Ammobaculoides sp.
Ammodiscus sp.
Amphistegina lessonii d'Orb
Amphistegina sp.
Angulogerina sp.
Anomalina glabrata Cushman
Anomalina sp.
(?) Anomalina sp.
Austrotrillina howchini (Schlumberger)
Bathysiphon sp.
Bigenerina spp.
Bolivina sp.
Carpentaria sp.
Cibicides praecinctus (Karrer)
Cibicides spp.
(?) Cibicides sp.
Clavulina sp.
Cycloclypeus sp.
Eggerella cf. *scabra* (Williamson)
Elphidium koeboeense LeRoy
Elphidium sp.
(?) Elphidium sp.
Epistominella pulchella Husezima & Maruhasi
*Gaudryina s*p.
Globigerina subcretacea Chapman
Globigerinita sp.
Globigerinoides bisphericus
Globigerinoides ruber
Globigerinoides ruber var.
Globigerinoides (?) ruber
Globigerinoides cf. *subquadratus* Bronnimann
Globigerinoides (?) sacculiferus
Globigerinoides trilobus
Globigerinoides spp. of the *Globigerinoides rubrus* group
Globigerinoides spp. of the *Globigerinoides trilobus* (Reuss) group
Globigerinoides subquadratus Bronnimann
Globigerinoides sp.
Globoquadrina altispira cf. Cushman & Jarvis
Globoquadrina altispira Cushman & Jarvis
Globorotalia mayeri Cushman and Ellisor
Gypsina globulus (Ruess)
Gyroidina sp.
Hanzawaia sumitomoi Asano & Murata
Haplophragmoides carinatum Bronnimann
Haplophragmoides carinatum Cushman & Renz
Haplophragmoides narivaensis Bronnimann
Haplophragmoides walteri (Grzybowski)
Haplophragmoides sp.
Heterostegina borneensis van der Vlerk
Heterostegina sp.
Hormosina sp.
Lepidocyclina (Eulepidina) sp.
Lepidocyclina (Nephrolepidina) douvillei Yabe
Lepidocyclina (Nephrolepidina) spp.

Lepidocyclina (Nephrolepidina) sumatrensis Brady
Lepidocyclina flexuosa (Rutten)
Lepidocyclina spp.
Loxostomum sp.
Martinottiella cyclostomata (Galloway & Morrey)
Massilina sp.
Miliolidae
Miliolina sp.
Miogypsina primitiva Tan Sin Hok
Miogypsina sp.
Miogypsinoides (Conomiogypsinoides) abuensis Tobler
Miogypsinoides cf. *dehaarti* van der Vlerk
Miogypsinoides sp.
Nonion japonicum Asano
Nonion sp.
(?) Nonion sp.
Operculina venosa
Operculina sp.
Peneroplidae sp.
Quinqueloculina sp.
Rectoglandulina laevigate (d'Orbigny)
Rotalia spp.
(?) Rotalia sp.
Rupertiidae
Sigmoilina sp.
Textularia sp.
Trochammina sp.
molluscs
Cardium sp.
Globularia carlei (Finlay) [nom. nov. for *Natica callosa* J. de C. Sowerby]
Globularia cf. *fluctuata* (G.B. Sowerby
?Murex sp.
Strombus (Doloena) cf. *sedanensis* Martin
Strombus spp.
?Terebellum sp.
Turritella sp.
'*Venus*' sp.
Vexillum (*?Pusia*) sp.
algae
bryozoa
coral
echinoid
plant
remain
angiosperm leaf
pollen and spore (Tjia *et al*., 1990)
Alangium sp.
Barringtonia sp.
Brownlowia sp.
Casuarina sp.
Cephalomappa sp.
Dacrydium sp.
Durio sp.
Florschuetzia trilobata
Gonystylus sp.
Lycopodium phlegmaria
Lycopodium cernuum
Picea type
Pinus type
Rhizophora sp.
Stenochlaena areolaris
trace fossil (Tjia *et al*., 1990)
Chondrites sp.
Granularia sp.
Ophiomorpha sp.

13. Env. of deposition : Varying environments of deposition, in part beach and shallow marine, partly lagoonal and deltaic, in brackish and estuarine conditions, and in part neritic conditions. Tjia *et al*. (1990) remarked that the formation developed in low-energy environment, probably in wide tidal flats.
14. Remarks : The term 'Tanjong Formation' was introduced during 1937 in an unpublished report by Roothaan and Wenk. Haile and Wong (1965) classified the formation in the Kinabatangan Group. Tjia *et al*. (1990) discusses the Tanjong formation in the Maliau Basin, Sabah.

C65.

1. Name : Kalabakan formation
2. Origin of name : Uncertain, either Sungai Kalabakan or Kalabakan Valley
3. Age : Upper Miocene
4. References : Collenette (1965a), Fitch (1955),
5. Type area : Kalabakan Valley, Sabah
6. Type section : Although no type section has been defined, Collenette (1965a) indicate the strata exposed in the Kalabakan River downstream of Kuala Anjeranjermut are typical of the formation.
7. Boundaries : The formation rests unconformably on the Chert-Spilite formation. It is succeeded, apparently conformably, by the Kapilit formation.
8. Correlation :
9. Thickness : Estimated as 'several thousands of metres' by Reinhard and Wenk

(1951), and in the order of 1,500 m or possibly more (Collenette, 1965a)

10. Lithology : Consists generally of poorly bedded argillaceous rocks with rare beds of siltstone, sandstone, and conglomerate.
11. Subdivisions :
12. Fossils :

foraminifera

Ammodiscus sp.
Bathysiphon sp.
Cibicides spp.
Cyclammina sp.
Discocyclina sp.
Gaudryina sp.
Globigerina binaiensis Koch
Globigerina dissimilis Cushman & Bermudez var.
Globigerina subcretacea Chapman
Globigerina sp.
Globoquadrina altispira Cushman & Jarvis
Globorotalia cocoaensis Cushman
Globorotalia mayeri Cushman and Ellisor
Globorotalia sp.
Glomospira sp.
Gyroidina sp.
Halkyardia minima libeus
Haplophragmoides sp.
Hormosina sp.
Nodosaria spp.
Rhenophax sp.
Rheophax sp.
Sigmoilina sp.
Spiroplectoides cf. *attenuata* Cushman
Trochammina sp.
Trochamminoides sp.
Vulvulina cf. *eocaena* Montagne

13. Env. of deposition : Marine
14. Remarks : In the Segama and Darvel Bay area Fitch (1955) classified the 'Kalabakan Shales', examined by P. Collenette, as the Upper Eocene rocks. Collenette (1965a) indicate that the term 'Kalabakang Shales' mentioned in Reinhard and Wenk (1951) as misleading, and stated that although shaly lamination does occur, it is not typical of the formation.

C66.

1. Name : Bongaya Formation
2. Origin of name : Sungai Bongaya, northeast Sabah
3. Age : Upper Miocene to younger age
4. References : Newton-Smith (1967), Tongkul (1991), Wilson (1961)
5. Type area : Between the Sugut and the Tungud Rivers, on the Bongaya River, Sabah
6. Type section : About 24 km north-northeast of Klagan on Sungai Bongaya
7. Boundaries : In its type area, the formation is bounded to the northwest by the Crocker formation and to the south by alluvial deposits. On the Bengkoka Peninsula, the formation is bounded in the north by the South Banggi formation and in the south by the Crocker formation. On Banggi, the formation covers most of the southern portion of the island and is bounded to the south by the Banggi Limestone member of the Crocker formation and by the South Banggi formation, and towards the north is in contact with the Chert-Spilite formation. Tongkul (1991) indicate the Bongaya Formation in Northern Sabah occurs in several isolated basins lying unconformably on older deformed sediments, which includes the Crocker, Kudat and Chert-Spilite formations.
8. Correlation :
9. Thickness : Estimated exceed 750 m (Wilson, 1961), the exposed section measures about 600 m (Newton-Smith, 1967)
10. Lithology : Principally sandstone and shale series and limestone facies (Wilson, 1961). Newton-Smith (1967) categorised sandstone, siltstone, mudstone and shale in the Bidu-Bidu area.
11. Subdivisions : Balambangan Limestone member
12. Fossils :

foraminifera

Ammobaculites exiguus (Cushman & Bronnimann)
Ammobaculites sp.

Cycloclypeus (Katacycloclypeus) annulatus Martin
Cycloclypeus sp.
Globigerina subcretacea Chapman
Globigerinoides rubrus d'Orbigny var.
Globigerinoides subquadratus Bronnimann
Globoquadrina altispira Cushman & Jarvis
Globoquadrina dehiscens Chapman, Parr & Collins
Globorotalia mayeri Cushman and Ellisor
Globorotalia praemenardii Cushman & Stainforth
Heterostegina sp.
Lepidocyclina sp.
Miogypsina sp.
Nonion sp.
*Operculin*a sp.
Orbulina bilobata (d'Orbigny)
Orbulina suturalis Bronnimann
Orbulina universa d'Orbigny
Pellatispira sp. (reworked)
Sphaeroidinella multiloba LeRoy
Sphaeroidinella seminulina (Schwager)
Trochammina sp.
pollen
Sonneratia sp.

13. Env. of deposition : Shallow water, deltaic
14. Remarks : The formation was first described by Schneeberger in an unpublished manuscript in 1937. Wilson (1961) included the 'Tajau Sandstone' and the 'Jambongan Formation' in the Bongaya Formation due to the lithological and age similarities.

C66.1.

1. Name : Balambangan Limestone member
2. Origin of name : Pulau Balambangan, north Sabah
3. Age : Upper Miocene
4. References : Wilson (1961)
5. Type area : The limestone hill, southern Pulau Balambangan, Sabah
6. Type section :
7. Boundaries : Bounded to the north by ultrabasic rock and by the Chert-Spilite formation. In the south, it is in contact with sandstone, presumably of the Bongaya Formation, which occupies a small area round Sina Village.
8. Correlation : Idris and Kok (1990) suggest correlation of the sedimentary rocks of Mantanani Islands, Sabah, to the Balambangan Limestone member based on the similar litological characteristics, mode of occurrence, and age.
9. Thickness :
10. Lithology : Minor variations occur within the limestone, from pure shelly and algal limestone, to sandy limestone, to foraminiferal and algal limestone containing widely dispersed angular fragments of basic igneous rock, serpentine and shale.
11. Subdivisions :
12. Fossils :

foraminifera
Cycloclypeus sp.
Gypsina sp.
Heterostegina sp.
Lepidocyclina spp.
Miogypsina sp.
Miogypsina tuberosa Tobler
Miogypsina tuberosa Tobler cf. *musperi* Tan Sin Hok
Miogypsinoides sp.
Operculina sp.
Orbulina sp.
Pellatispira sp. (reworked)
Rupertidae
algae
coral
bryozoa
gastropod
echinoid

13. Env. of deposition : Shallow marine
14. Remarks : The limestone formation was formerly considered part of the 'Banggi-Balambangan Formation' by Schneeberger.

C67.

1. Name : Kapilit formation
2. Origin of name : Unknown
3. Age : Upper Miocene
4. References : Collenette (1965a)
5. Type area : No type area is mentioned but Collenette (1965a) states that the formation is exposed in the Serudong, Silimpopon, and upper Kalabakan Valleys, in Sabah, and extends over the international boundary into Kalimantan, in the Simengaris, Simaja, and Siglayan Valleys.
6. Type section :
7. Boundaries : The formation rests on the

Kalabakan formation, probably conformably, and is overlain by the Simengaris formation possibly with slight unconformity.

8. Correlation : The strata in the Silimpopon and lower Serudong Valleys probably correspond to the upper part of the Tanjong formation.
9. Thickness : About 2,100 m to probably more than 4,500 m
10. Lithology : Consists of sandstone and mudstone, with rare beds of coal, conglomerate and limestone.
11. Subdivisions :
12. Fossils :

foraminifera
Ammobaculites sp.
Bolivina ligularia sp.
Cibicides sp.
Cyclammina sp.
Elphidium spp.
Gaudryina sp.
Glandulina laevigata (d'Orbigny)
Globigerina binaiensis Koch
Globigerinoides glomerosa sp. Blow
Globigerinoides subquadratus Bronnimann
Globigerinoides spp. *rubus* group
Globigerinoides spp. *trilobus* group
Glomospira sp.
Hanzawaia tapanoeliensis (LeRoy)
Haplophragmium sp.
Haplophragmoides sp.
Nonion japonicum Asano
Nonion sp.
Operculina sp.
Quinqueloculina sp.
Reusella simplex (Cushman)
Robulus sp.
Rotalia spp.
Spiroloculina sp.
Textularia sp.
Trochammina sp.

13. Env. of deposition : Brackish estuarine conditions to shallow neritic marine environment
14. Remarks : The term 'Kapilit Formation' was introduced in an unpublished report by Wenk in 1938 for strata consisting of a series of thick beds of sandstone (formerly termed 'Kapilit Sandstones' by Reinhard, *1924*) in the Serudong and Silimpopon Valleys, similar beds (formerly the 'Susui Sandstones') in the Susui Valley, mudstone (the 'Tambalunan Shales') in the Tambalunan Valley, and two sets of 'Transitions Beds'.

C68.

1. Name : Simengaris formation
2. Origin of name : Simengaris Valley, Kalimantan, Indonesia (a few km south of the international border)
3. Age : Upper Miocene
4. References : Collenette (1965a)
5. Type area : No type area is mentioned but Collenette (1965a) states that the formation is exposed over a small part of the Pensiangan and upper Kinabatangan area.
6. Type section :
7. Boundaries : The formation rests on the Kapilit formation with slight unconformity.
8. Correlation :
9. Thickness : Estimated not less than 600 m
10. Lithology : Consists principally of soft mudstone with well-preserved molluscs and foraminifers, and subordinate sandstone, silicified tuff, conglomerate, quartzite, and coal.
11. Subdivisions :
12. Fossils :

foraminifera
Ammobaculites sp.
Bigenerina spp.
Cyclammina sp.
Anomalina sp.
Angulogerina sp.
Bolivina sp.
Cibicides spp.
Cristellaria sp.
Elphidium spp.
Globorotalia sp.
Nonion sp.
Operculina spp.
Reusella sp.
Rotalia spp.
Siphogenerina sp.

mollusc
Arca sp.
Cardium spp.
Cerithium sp.
Clementia sp.
Lucina sp.

Macrocallista sp.
Martinocarcinus sp.
Natica sp.
Nucia sp.
Nucia sp. (probably *Nucia fennemai* Bohm)
Nuculana sp.
Rimella sp.
Tellina sp.
Turritella sp.

13. Env. of deposition : Shallow marine conditions alternated with deltaic and estuarine conditions.
14. Remarks : The term 'Simengaris Formation' was introduced by Wenk in 1938 for arenaceous, argillaceous, and carbonaceous beds exposed in the Simengaris Valley, a locality in Kalimantan, a few km south of the international border. These beds extend a short distance into Sabah in the lower parts of the Serudong and Silimpopon Valleys, where Wenk's boundaries have now been modified to include his underlying 'Silimpopon Horizon'.

C69.

1. Name : Garinono formation
2. Origin of name :
3. Age : Neogene or younger (Collenette, 1966), Upper Miocene (Lee, 1970), late Upper Miocene (Newton-Smith, 1967)
4. References : Collenette (1965b, 1966), Lee (1970), Newton-Smith (1967)
5. Type area : On part of the Lokan Peneplains from km 26 and km 80 on the Sandakan-Telupid Road (also referred as the Labuk Road).
6. Type section :
7. Boundaries : The formation rests unconformably on the Rajang and Kinabatangan Groups (Crocker, Kulapis, Labang, and Tanjong formations). In the Bidu-Bidu Hills area the formation is thought to rest unconformably on the Kamansi beds and it contains exotic blocks derived from the Kamansi and Tambang beds. Lee (1970) indicate that in Sandakan Peninsula, the formation is in part unconformable, while in Sungai Manila area, probably conformable with the overlying Sandakan formation.
8. Correlation :
9. Thickness : Unknown but estimated unlikely less than several hundreds to few thousands of metres. In Sungai Manila area, Sandakan Peninsula, a minimum thickness of 1,800 m is estimated.
10. Lithology : Consists of mudstone (also clay matrix), generally containing blocks (from few cm to several metres) of sandstone, limestone, chert, and igneous rocks which include spilite, tuffite, serpentinite, basic agglomerate and ultrabasic rock. In Sandakan Peninsula, Lee (1970) indicate the occurrence of thick sequences of relatively undisturbed mudstone, tuff and tuffite interlayered with slump breccia in the Sungai Manila area.
11. Subdivisions :
12. Fossils :

foraminifera (as listed in Newton-Smith, 1977)
?Aktinocyclina sp.
Ammodiscus sp.
Bathysiphon sp.
Bathysiphon sp.
Fabiana sp.
Globigerinoides cf. *triloba* (Reuss)
Globoquadrina altispira Cushman & Jarvis
Glomospira (?) sp.
Hormosina sp.
Lepidocyclina (Eulepidina) sp.
Lepidocyclina (Nephrolepidina) sp.
Pellatispira sp.
Praeorbulina glomerosa (Blow)
Reophax sp.
Spiroclypeus sp.
Trochammina sp.
Trochamminoides sp.
foraminifera (from bedded sequence suggesting Upper Miocene age in Lee, 1970)
Achrchaias sp.
Ammodiscus incertes
Amphistegina sp.
Austrotrillina cf. *howchini* (Schlumberger)
Bathysiphon sp.
Borelis sp.
?Cycloclypeus sp.
Cycloclypeus cf. *eidae* Tan

Flosculinella cf. *globulosa* (Rutten)
Flosculinella sp. (reicheli or globulosa)
Globigerina bulloides d'Orbigny
Globigerina cip. angustium
Globigerina spp.
Globigerinoides triloba group
Globigerinoides trilobus group
Globigerinoides sacculifera (Brady)
Globigerinoides ruber group
Globigerinoides rubra (d'Orbigny)
Globigerinoides tril. tril.
Globoquadrina altispira (Cushman & Jarvis)
Globoquadrina cf. *altispira*
Globorotalia cf. *fohsi barinsanensis* LeRoy
Globorotalia fohsi fohsi (Cushman & Ellison)
Globorotalia mayeri (Cushman & Ellison)
Globorotalia cf. *scitula* (Brady)
Globorotalia sp. cf. *fohsi fohsi*
Glomospira charoides
Glomospira cf. *charoides*
*Gypsin*a sp.
Haplophragmoides sp.
Lepidocyclina (?Eulepidina) sp.
Lepidocyclina (Nephrolepidina) sumatrensis (Brady)
Lepidocyclina (Nephrolepidina) spp.
Miogypsina sp.
Miogypsinoides cf. *deharrti* van der Vlerk
Orbulina suturalis Bronnimann
Orbulina bilobata (d'Orbigny)
Planorbulina sp.
Planorbulinella sp.
Pullenia bulloides
Rhizammina sp.
Schaerammina sp.
Sphaeroidinella spp.
?Taberina sp.
Trochammina cf. *variola*
Trochamminoides sp.
algae
echinoid
foraminifera (from matrix in slump breccia of slumped mudstone of older formation suggesting Cretaceous to Upper Miocene age of Lee, 1970)
Bathysiphon spp.
Cyclammina spp.
Globigerina spp.
Globigerinoides sacculifera (Brady)
Globigerinoides spp.
Globoquadrina sellii
Globorotalia fohsi barinsanensis LeRoy
Globotruncana spp.
Haplophragmoides aff. *carinatum*
Haplophragmoides cf. *carinatum*
Haplophragmoides cf. *cellyra*
Haplophragmoides sp.
Reophax sp.
Trochammina cf. *varil*a
Trochammina cf. *variole*
Trochammina spp.
foraminifera (from blocks in slump breccia, suggesting Upper Cretaceous to Lower Miocene age of Lee, 1970)
Bathysiphon spp.
Cyclammina spp.
?Cayeuxia sp.
Globotruncana spp.
Gumbelina spp.
Haplophragmoides cf. *carinatum*
Haplophragmoides cf. *collyra*
Lithocadium sp.
*Petrophyto*n sp.
Trochammina cf. *variola*
Trochammina spp.
Trochamminoides sp.

13. Env. of deposition : Collenette (1965b) stated an origin probably by submarine slumping. Nevertheless Collenette (1966), indicate that the origin is probably due to extensive gravity sliding, but since lacking in evidence to indicate whether the slumping was above or below sea level, he argued that the deposition was probably little influenced by either in aerial or marine environments. Lee (1970) explained the slump breccia in the formation was probably formed in a submarine basin, in which submarine slumping alternates with epiclastic and pyroclastic deposition. McManus & Tate (1986) suggested that the chaotic deposits of the formation are the product of mud volcanism.

14. Remarks : Collenette (1965b) introduced the term 'Garinono Formation' for a tilloid deposit exposed between km 35 and km 56 on the Sandakan-Telupid Road, and at places north and south of the road. He originally placed the formation tentatively in the Segama Group, but later discarded the idea (Collenette, 1966).

C70.

1. Name : Sandakan formation
2. Origin of name : Sandakan town or Sandakan Peninsula
3. Age : Upper Miocene
4. References : Lee (1970)
5. Type area : The Sebuga area lying between Batu Sapi Road on the south and Labuk Road on the north in Sabah.
6. Type section :
7. Boundaries : Unconformably overlies the Garinono formation. The formation is overlain unconformably by Quaternary deposits of quartz gravel, sand and clay.
8. Correlation : Correlates closely with the Bongaya Formation of Upper Miocene age in the Bongaya River.
9. Thickness : Estimated at least 2,250 m
10. Lithology : Consists of mudstone, sandstone, siltstone and minor coal seams and conglomerate.
11. Subdivisions :
12. Fossils :

foraminifera

Adercotruma sp.
Ammobaculites sp.
Ammonia spp.
Amphistegina sp.
Augulogerina sp.
Anomalina ammonoides
Anomalina glabrata
Arenobulimina sp.
Bathysiphon arenacea
Bathysiphon sp.
Bolivina cf. canullata
Bolivina plicata
Bolivina cf. schwagerrana
Bolivina sp.
Bolivina subaenariensis mexicana
Bolivina robusta
Cassidulina crassa
Cycloclypeus sp.
?Eliphidium ?craticulatum
Epistomina sp.
Sponides berthelotiana
Eponides praecintus
Eponides cf. praecintus
Flosculinella bontangensis
Globigerina sp.
Globigerinoides ballii
Globigerinoides conglobata
Globigerinoides conglobatus
Globigerinoides rubra
Globigerinoides triloba immatura
Globigerinoides triloba immaturus
Globigerinoides spp.
Globoquadrina altispira altispira
Globoquadrina altispira globosa
Globorotalia fohsi fohsi
Globorotalia cf. fohsi barisanensis
Globorotalia mayeri
Globorotalia sp.
Gyroidina soldanii
Haplophragmoides cf. carinatum
Haplophragmoides sp.
Hormosina sp.
Lagenonodosaria scalaris
Lenticulina gemmeta
Lepidocyclina (Nephrolepidina) sp.
Loxostomum amygdalaeformae
Loxostomum karrerianum
Loxostomum aff. limbatum
Loxostomum sp.
Martinotiella sp.
Miogypsina spp.
Nodosaria insecta
Nodosaria vetebralis
Operculina complanata
Operculina sp.
Orbulina suturalis
Orbulina universa
Orbulina sp.
Ostrachoda
Rectobolivina bilfrons
Reussella striatula
Rhizammina sp.
Robulus calcar
Robulus inornatus
Robulus orbicularis
Robulus sp.
Rotalia ceocarii
Rotalia cf. nipponica
Rotalia cf. papillosa
Rectobolivina viform var.
Sponides praecintus
Trochammina globigeri
Trochammina nafaromis
Trochammina ch. *variola*
Trochammina sp.
Uvigerina laevis
Uvigerina proboscidae
Uvigerina cf. schwagerrana
Uvigerina soendaensis

mollusc

Anadara sp.
Batissa sp.
Brotia (Tinnyea) ? sp.
Cardinium sp.
Cerithidea (?Cerithidea) babylonica (Martin)
Cerithidea (Cerithideopsilla) djadjariensis (Martin)
Cerithidea (Cerithideopsilla) sucabumiana (Martin)
Cerithidea aff. cigulata (Gmelin)
Cerithium sp.
?Corbicula sp.
Corbula sp.
Dentalium sp.
Faunus (Pseudobellardia) sp.
Gari sp.
?Libycerithium sp.
Menkrawia callosolubiata Beets
Nucia cf. fennemai (J. Bohm)
Nuculana sp.
Oliva sp.
Paphia cf. neglecta (Martin)
Pectinid indet.
Pollia sp.
Propeomunium sp.
Protomella sp.
?Pyrazus sp.
Tellinides sp.
Terebralia (Terebralia) cf. miosculcata Vredenburg
Turbinella mekranica Vredenburg
Turritella angulata Sowerby
Turritella sp.
Vicarya callosa Jenkins

13. Env. of deposition : Complex deltaic environment with fluvial or non-marine conditions in some parts of the Sandakan Peninsula and deeper marine conditions in others.
14. Remarks :

C71.

1. Name : Tungku formation
2. Origin of name : Sungai Tungku, Dent Peninsula, Sabah
3. Age : Upper Miocene to Lower Pliocene
4. References : Haile and Wong (1965)
5. Type area : In the headwaters of the Tungku and Sebahat Rivers, Dent Peninsula, Sabah.
6. Type section :
7. Boundaries : The base of the formation rests unconformably on the Libong Tuffite. In other parts the formation rests on steeply dipping Ayer formation. An unconformable contact between the Bagahak Pyroclastic member and the formation is suggested. The top boundary of the formation is an unconformity with the Sebahat formation.
8. Correlation :
9. Thickness :
10. Lithology : Consists of well-bedded tuffaceous and carbonaceous sandstone, with conglomerate, and clay with plant remains.
11. Subdivisions : Bagahak Pyroclastic member
12. Fossils :

foraminifera
Alveolinella batangensis Rutten
Alveolinella sp.
Ammodiscus sp.
Amphisorus hemprichii Ehr.
Bathysiphon sp.
Bolivina spp.
Bolivinita quadrilatera (Schwager)
Bulimina spp.
Cassidulina spp.
Cibicides spp.
Cycloclypeus sp.
Elphidium sp.
Eponides sp.
Globigerina bulloides d'Orbigny
Globigerina nepenthes Todd
Globigerina sp.
Globigerina subcretacea Lomnicki
Globigerinoides rubra (?) group
Globigerinoides sacculifera (Brady)
Globigerinoides spp.
Globigerinoides subquadrata Bronnimann
Globigerinoides triloba group
Globoquadrina altispira (Cushman & Jarvis)
Globorotalia fohsi lobata Bermudez
Globorotalia mayeri Cushman and Ellisor
Globorotalia sp.
Gyroidina sp.
Hastigerina aequilateralis (Brady)
Katacycloclypeus sp.
Miogypsina (Miogypsina) Cushmani Vaughan var. *indonesiensis* Tan
Miogypsina sp.
Nodosaria spp.
Nonion sp.
Operculina sp.
Orbulina bilobata (d'Orbigny)
Orbulina suturalis Bronnimann
Orbulina universa (d'Orbigny)
Pullenia spp.

Robulus spp.
Rotalia spp. (=*Streblus*)
Sphaeroidina sp.
Sphaeroidinella multiloba LeRoy
Trochammina sp.
Uvigerina spp.

13. Env. of deposition : Sub-littoral to neritic, water depth not exceeding 300 m.
14. Remarks : The formation was redefined by J.F. Clement and W.K. Bisig *(1959)*, after Reinhard and Wenk (1951). Haile and Wong (1965) classified the formation in the Segama Group, and mentioned that the formation contains the thickest and coarsest volcanic rocks in the Dent Peninsula, mostly concentrated in the Bagahak Pyroclastic member, in particular the Silabukan Volcanic Breccia.

C71.1.

1. Name : Bagahak Pyroclastic member
2. Origin of name : Bagahak Range, Sabah
3. Age : Refer formation
4. References : Haile and Wong (1965)
5. Type area : Bagahak Range
6. Type section :
7. Boundaries : An unconformable contact between the Bagahak Pyroclastic member and the Tungku Formation is suggested. In the Pungulupi and Lung Sangai Valleys an unconformity separates the Bagahak Pyroclastic member and the Sebahat formation.
8. Correlation :
9. Thickness :
10. Lithology : Massive to bedded, poorly sorted volcanic boulder conglomerate, consisting mainly of andesitic rocks, amphibolite and other crystalline rocks, limestone and coral debris, red claystone, chert, sandstone, and vein quartz, in places with a black tuffaceous sandy matrix, elsewhere in a clayey matrix with plant remains.
11. Subdivisions :
12. Fossils :

coral
foraminifera
mollusc
plant
remains

13. Env. of deposition : Marine
14. Remarks :

C72.

1. Name : Tabanak Conglomerate
2. Origin of name : Tabanak River, Sabah
3. Age : Upper Miocene to Pliocene?
4. References : Haile and Wong (1965), Leong (1974)
5. Type area : The Tabanak River, west of Dent Peninsular area (Haile and Wong, 1965). Leong (1974) states the type area as between north of Lahad Datu and south of Sungai Segama.
6. Type section : Has been described from Sungai Tabanak (Sungai Edam) about 5 km northwest of Lahad Datu town.
7. Boundaries : The formation probably overlies unconformably on the Crystalline Basement and partly on the Ayer formation.
8. Correlation : In the Dent Peninsula area, the formation is in part a time equivalent of the Tungku formation, but may also include equivalents of the Libong Tuffite and Ayer formations.
9. Thickness : The upper conglomeratic part has been estimated at least 760 m. Other estimate as over 1,800 m.
10. Lithology :Comprises conglomerate, boulder conglomerate, tuffaceous sandstone and shale. The conglomerate consists of pebbles of diorite, gabbroic rocks, vein quartz, quartzite, red chert, and tuffaceous sandstone in a clayey and in places tuffaceous matrix.
11. Subdivisions :
12. Fossils :

foraminifera
Dentalina sp.
Globigerina subcretacea Lomnicki
Globigerina sp.
Globigerinoides spp.
Globoquadrina altispira (Cushman & Jarvis)
Globoquadrina dehiscens (Cushman, Parr & Collins)
Globorotalia fohsi fohsi Cushman and Ellisor
Globorotalia mayeri Cushman and Ellisor

?Nonionella sp.
Orbulina bilobata (d'Orbigny)
Orbulina suturalis Bronnimann
Orbulina universa (d'Orbigny)
Robulus sp.
Sphaeroidinella cf. *dehiscens* (Parker & Jones)
Sphaeroidinella multiloba LeRoy
mollusc
Dentalium sp.
Lucina sp.
plant
remains

13. Env. of deposition : Terrestrial and marine
14. Remarks : The Tabanak Conglomerate was introduced and redefined by Haile and Wong (1965) after Wanner and Stamm (Wanner, *1921*). It replaces the previous terminology, 'Tabanak Beds' of Wanner and Stamm and (South) 'Segama Formation' of Leicester *(1936)*. Haile and Wong (1965) classified the formation in the Segama Group. The formation resembles the Tungku formation but differ mainly by the smaller proportion of pyroclastic rocks, absence of volcanic breccia, and the greater proportion in the conglomerate and sandstone of rocks derived from the Crystalline Basement.

C73.

1. Name : Sebahat formation
2. Origin of name : Either Sebahat Anticline, Sungai Sebahat, or Sebahat (renamed Sahabat) Town, Dent Peninsula, Sabah
3. Age : Upper Miocene to Lower Pliocene
4. References : Haile and Wong (1965)
5. Type area : The main outcrop extending from the crest of the Sebahat Anticlinal Uplift, southwest to near Tanjong Membatu, and northwest to the Maruap Valley, Dent Peninsula, Sabah.
6. Type section : No type section has been designated but Clement's description (*1959*) of a section across the thickest part of the formation, approx. along the crest of the Sebahat Anticlinal Uplift, is the most complete (Haile and Wong, 1965).
7. Boundaries : The formation appears conformable on the Tungku formation in some areas. In the Tabin Syncline, the formation is apparently faulted against the Ayer formation, and in parts against Tungku formation. The top boundary is an apparently conformable transition into the Ganduman formation.
8. Correlation :
9. Thickness : Estimated about 2,300 m on the crest of the Sebahat Anticline, in the Tabin Syncline, in the Tabin Valley, estimated about 1,340 m
10. Lithology : Comprises predominant dark-grey mudstone, with subordinate marl, limestone, sandstone and conglomerate.
11. Subdivisions :
12. Fossils :

foraminifera
Amphistegina sp.
Bolivinita quadrilatera (Schwager)
Cycloclypeus sp.
Globigerina subcretacea Lomnicki
Globigerinoides cf. subquadratus Bronnimann
Globigerinoides obligua Bolli
Globigerinoides of *triloba* group
Globigerinoides sacculifera (Brady)
Globigerinoides subquadrata Bronnimann
Globigerinoides cf. *subquadratus* Bronnimann
Globigerinoides spp.
Globoquadrina altispira (Cushman & Jarvis)
Globoquadrina dehiscens (Cushman, Parr & Collins)
Globorotalia fohsi robusta Bolli
Globorotalia mayeri Cushman and Ellisor
Globorotalia praemenardii Cushman & Stainforth
Globorotalia scitula (Brady)
Heterostegina sp.
Katacycloclypeus sp.
Lepidocyclina spp.
Miogypsina sp.
Operculina sp.
Orbulina suturalis Bronnimann
Orbulina universa d'Orbigny
Rotalia cf. hamiltonensis Parr.
Rotalia cf. tuvuthaensis Kleinpell
Sphaeroidinella cf. dehiscens (Parker & Jones)
Sphaeroidinella multiloba LeRoy
Sphaeroidinella sp.
Spiroclypeus sp.

coral
mollusc
shark
tooth

13. Env. of deposition : 'Sublittoral' and neritic conditions
14. Remarks : Wenk (*SSPC, 1938*) introduced the term 'Sebahat Layers' (of the Lower Dent Peninsula Formation) to designate an argillaceous sandy and tuffaceous succession in the Sebahat and Tungku Valleys. Visser (*SSPC, 1949*) introduced the term Sebahat Formation as the equivalent of Wenk's Sebahat Layers, and mapped the formation in the Tabin Syncline, where he divided it into three members. Clement (*SSPC, 1959*) further proposed certain modifications in which he retained parts of the Sebahat formation and assigned other parts to the Tungku formation (Haile and Wong, 1965).

C74.

1. Name : Umas Umas Formation
2. Origin of name : Sungai Umas Umas, Semporna Peninsula, Sabah.
3. Age : Upper Miocene to ?Pliocene
4. References : Kirk (1962)
5. Type area :
6. Type section : In a small eastern tributary of the Umas Umas, about 10 km north of the mouth of the river.
7. Boundaries : The formation overlies, presumably unconformably, the Sebatik Sandstone-Shale member of the Kalumpang Formation. It is apparently faulted against Kalumpang Formation in the lower Merutai Besar Valley.
8. Correlation : In tectonic aspect the formation resembles, on a small scale, the lithologically similar Tanjong formation occupying the large sub-circular Bangan, Meliau, and Melibau basins in central Sabah, and the Tertiary basin formations of Sarawak and Brunei.
9. Thickness : Exposed thickness of about 450 m.
10. Lithology : Comprise grey and black shale, laminated mudstone with some layers rich in carbonaceous material, and thin layers of sandstones.
11. Subdivisions :
12. Fossils :

foraminifera
Globigerinoides triloba group
Globigerinoides sp.

13. Env. of deposition : Shallow marine
14. Remarks :

C75.

1. Name : Ganduman formation
2. Origin of name : Sungai Ganduman, Dent Peninsula, Sabah
3. Age : Pliocene
4. References : Haile and Wong (1965)
5. Type area : Type locality is the area of the Ganduman River, southwest of Tambisan Island, Sabah.
6. Type section :
7. Boundaries : The basal boundary is an apparently conformable transition from fossiliferous marls of the Sebahat formation, into the more sandy, lignitic and mainly unfossiliferous beds of the lower Ganduman. The formation is overlain by the Togopi Formation, possibly with slight unconformity.
8. Correlation :
9. Thickness : Estimated between 1,250-1,500 m
10. Lithology : Characterised by greenish-grey sandstones, interbedded with purplish-grey carbonaceous clays and some seams of lignite.
11. Subdivisions :
12. Fossils :

foraminifera
Globigerinoides obliqua
gastropod
lamellibranch
mollusc
plant
remains

13. Env. of deposition : Paralic (coastal swamp) environment
14. Remarks : The formation was originally defined by Wenk (*SSPC, 1938 and 1939*) and was later redefined by Clement (*SSPC, 1959*), as reported in Haile and Wong (1965). The latter also discussed

the division of the formation into Lower Ganduman formation or Maruap member, and the Upper Ganduman formation, by previous workers, and mentioned that the Lower Ganduman (or Maruap member) differs from the Upper Ganduman only in the larger amount of grey limonitic quartzose sandstone, occassionally calcareous, with undulating clay laminae, plant remains, lignite, and hard slab-like concretions of calcareous sandstone.

C76.

1. Name : Timohing formation
2. Origin of name : Tanjong Timohing, Pulau Balambangan, Sabah.
3. Age : Pliocene
4. References : Wilson (1961)
5. Type area : Type locality in Balambangan Island, Sabah
6. Type section :
7. Boundaries :
8. Correlation : Reinhard and Wenk (1951) correlate the formation with the Pliocene Togopi Formation of Dent Peninsula.
9. Thickness :
10. Lithology : Consists of coral limestone, marl, and sandstone.
11. Subdivisions : West Timohing member and East Timohing member.
12. Fossils :
13. Env. of deposition : Marine
14. Remarks : The formation was first referred to in unpublished oil company reports and later by Reinhard and Wenk (1951). Wilson (1961) divided the formation into West Timohing Member and East Timohing Member, separated by a horst of ultrabasic and Chert-Spilite formation rocks which form low hills across the centre of the Balambangan Island, with northeasterly elongation.

C76.1.

1. Name : West Timohing member
2. Origin of name : Tanjong Timohing, Pulau Balambangan, Sabah.
3. Age : ?Upper Miocene to Pliocene
4. References : Wilson (1961)
5. Type area :
6. Type section :
7. Boundaries : The base of the formation cannot be seen, and its upper surface is covered by a layer of quartz sand and sandy soil. In the southeast the member has a faulted contact against the Chert-Spilite formation.
8. Correlation :
9. Thickness :
10. Lithology : Composed principally of coral limestone and calcareous marl.
11. Subdivisions :
12. Fossils :

    foraminifera

    Orbulina suturalis Bronnimann

    coral

    shell

    remain
13. Env. of deposition : Marine
14. Remarks : Wilson (1961) indicate a typical cross section of the West Timohing member exposed at Tanjong Panbatu, the lower section consists of grey marl with numerous coral and shell fragments, towards the top sandy layers with occassional lenses of coral, and succeeded by coral limestone.

C76.2.

1. Name : East Timohing member
2. Origin of name : Tanjong Timohing, Pulau Balambangan, Sabah.
3. Age : Pliocene
4. References : Wilson (1961)
5. Type area :
6. Type section :
7. Boundaries : The base of the formation is not exposed, its upper surface is capped by a thin layer of quartz sand and sandy soil. Towards the west, it ends abruptly against a

faulted contact with ultrabasic rocks building the centre of the island.

8. Correlation :
9. Thickness :
10. Lithology : Composed of limonitic sandstone with some shale beds.
11. Subdivisions :
12. Fossils : Nil
13. Env. of deposition : Marine
14. Remarks : Wilson (1961) mentioned that the member is well exposed along the coast at the mouth of Sungai Duang-Duang, and at the Priok and Padang headlands.

C77.

1. Name : Togopi Formation
2. Origin of name : Sungai Togopi, Dent Peninsula, Sabah.
3. Age : Pliocene to Pleistocene
4. References : Haile and Wong (1965)
5. Type area : In the Sungai Togopi.
6. Type section : In the Sungai Togopi.
7. Boundaries : It appears that the basal boundary of the Togopi represents a marine transgression, and is probably slightly unconformable. The upper boundary of the Togopi has not been observed, but the formation appears to be overlain with slight unconformity by Sub-Recent alluvium.
8. Correlation :
9. Thickness : Across the section northwest of Kuala Gaya as 416 m.
10. Lithology : Consists of loosely cemented rubbly reef-limestone, calcareous sandstone, clay and marl.
11. Subdivisions :
12. Fossils :

foraminifera
Amphistegina spp.
Calcarina spengleri (Gmelin)
Cibicides sp.
Elphidium craticulatum (Fitchtell & Moll)
Elphidium cf. koeboeense LeRoy
Elphidium of *decipiens-hispidulum* group
Nonion japonicum Asano
Operculina complanata (Defrance)
Peneroplis sp.
Quinqueloculina spp.
Streblus annectens (Parker & Jones)
Streblus ketienziensis Ishizaki
Streblus spp.
Textularia sp.
coral
echinoderm
Echinocyamus cf. planissimus Clark
Prionocidaris cf. bispinosa (Lamark)
crab
lobster
mollusc
otolith (ear bone) from Teleostean fish
Apogon sictatus Stinton
Coilia planata Stinton
Coryphaenoides bipartitus Stinton
Lutianus geminans Stinton
Myctophym circularis (Frost)
Setippinna retusa Stinton

13. Env. of deposition : Littoral to inner neritic, at times shallow water (10-30 m) prevailed.
14. Remarks : The Togopi Formation was defined by E. Wenk (*SSPC, 1938*). Later, Clement investigated along two survey lines cut west from the coast north of Kuala Gaya, and from Hog Point, sited south and north of the Togopi River, respectively (Haile and Wong, 1965).

C78.

1. Name : Pinosuk gravels
2. Origin of name : Kampong Pinosuk, south of Gunong Kinabalu
3. Age : Upper Pleistocene to Holocene
4. References : Jacobson (1970)
5. Type area : Not specified, but Jacobson (1970) states that the Pinosuk Gravels are preserved south and west of Gunong Kinabalu, in three main areas; the Pinosuk Plateau, the Tohubang Valley, and near Tenompok
6. Type section : Not specified, but Jacobson (1970) proposed type exposures along Sungai Mantaki, which flows through the Pinosuk Plateau.
7. Boundaries : The Pinosuk Gravels unconformably overlie ultrabasic, granitic and Tertiary sedimentary rocks. The top boundary is erosional, or an unconformity with overlying Holocene alluvial

terrace deposits.

8. Correlation :
9. Thickness : Estimated 137 m.
10. Lithology : Poorly consolidated Quaternary tilloid deposits preserved on the flanks of Gunong Kinabalu.
11. Subdivisions : Jacobson (1970) informally designated the lower and upper units.
12. Fossils : Wood remains
13. Env. of deposition : The lower unit which consists of partly stratified angular material of local origin is probably a periglacial solifluction deposit. The overlying upper unit with a wide range of particle sizes and containing adamellite boulders is probably a mudflow deposit.
14. Remarks : Collenette (1958) introduced the term Pinosuk Plateau for the plateau composed chiefly of rock debris lying south of Gunong Kinabalu and to the north of Sungai Liwagu and considered as recent piedmont fans deposits. The name was taken from the the village of Pinosuk, which is situated nearby but not actually on the plateau.

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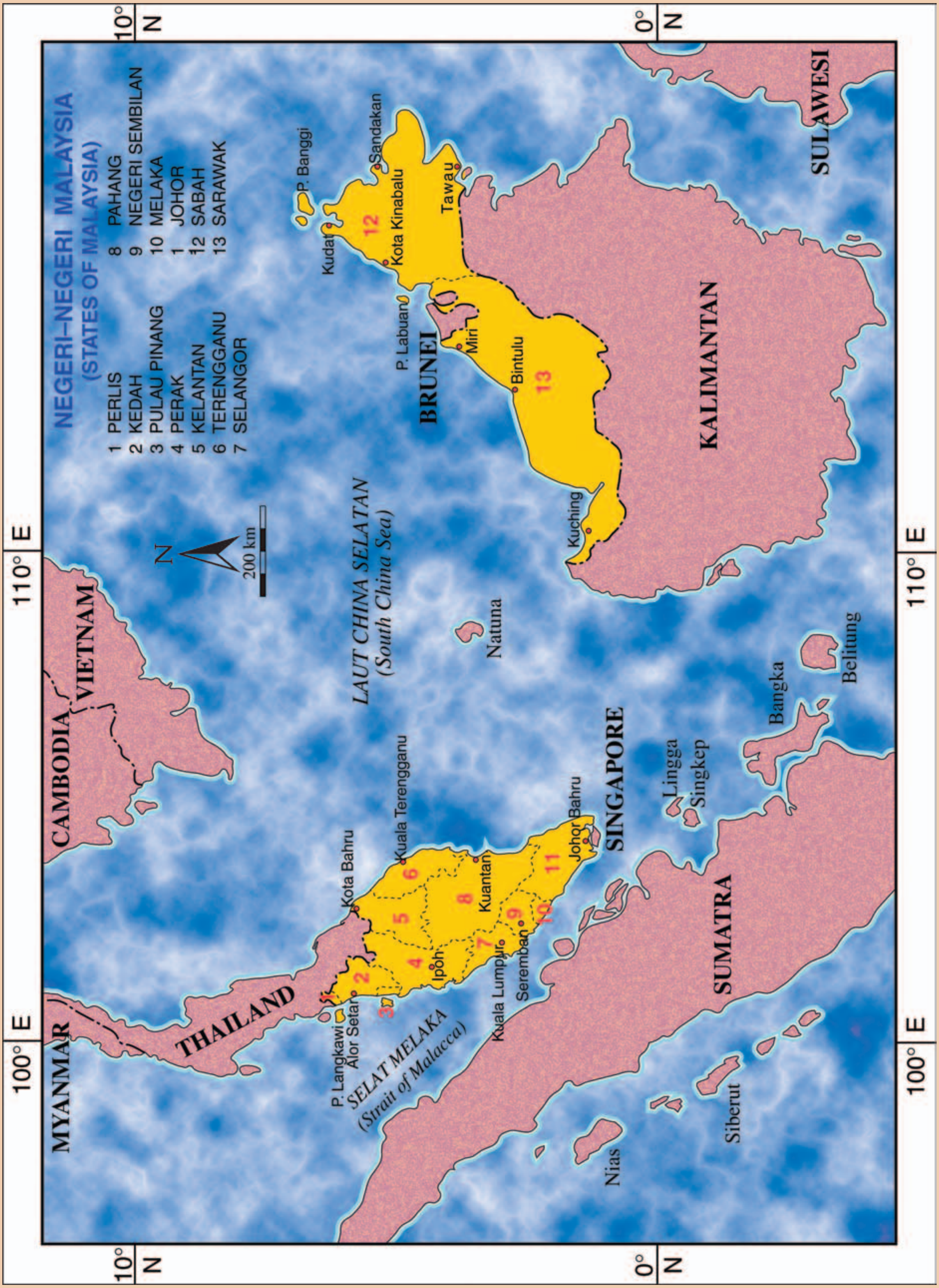

ISBN 983-99102-3-X

Stratigraphic Lexicon of Malaysia

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