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MESOZOIC STRATIGRAPHY IN PENINSULA MALAYSIA

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ABSTRACT The Mesozoic system is exposed in two separate belts in Peninsula Malaysia, one at the northwestern extremity and the other from north to south along the axial region. Chronostratigraphically it is subdivided into two sequences, namely a largely Triassic flysch sequence and an Upper Mesozoic molasse sequence.

At the northwestern belt the Kodiang Limestone is a time equivalent of the Semanggol Formation which is exposed in three separate outcrops that are homotaxial and show good lithostratigraphic correlation.

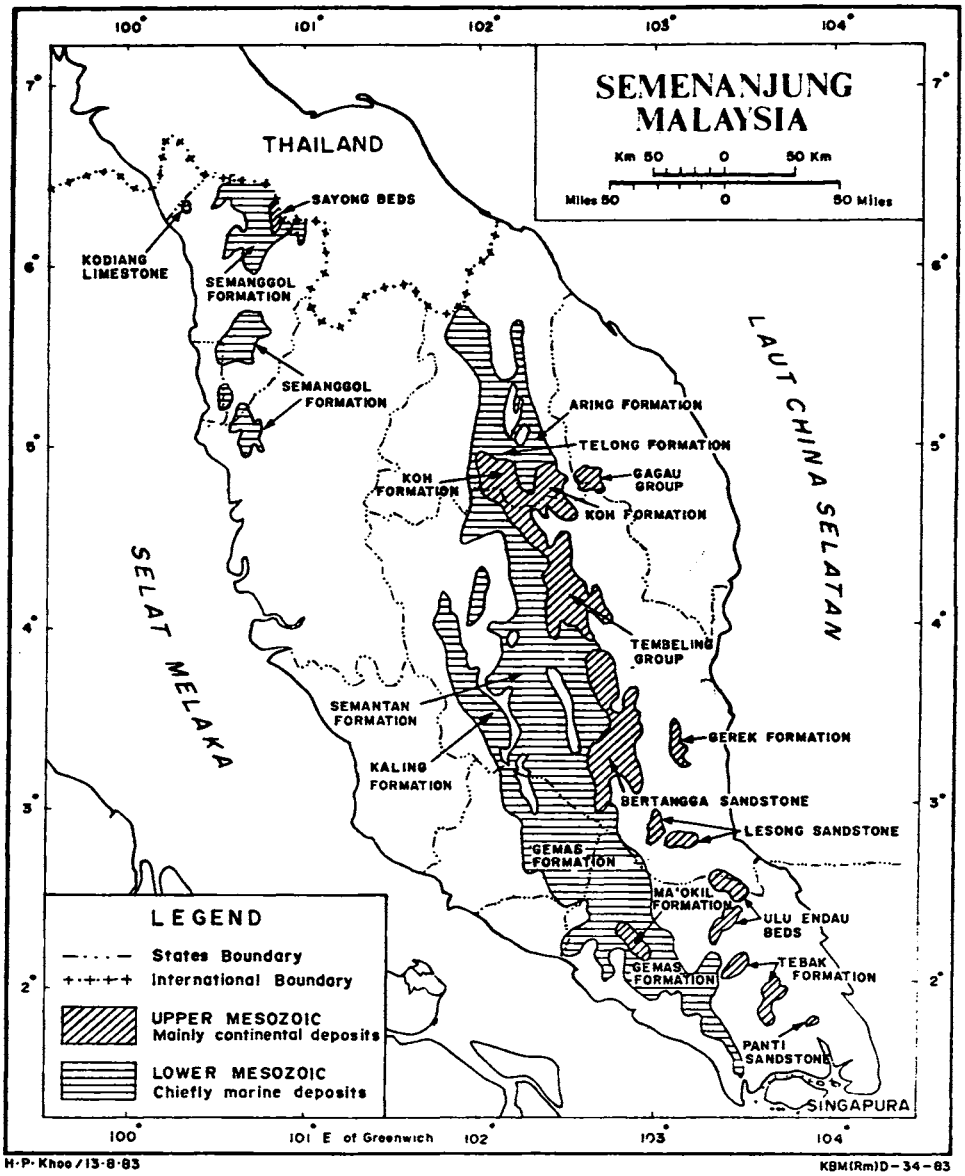
Along the axial belt there are differences in nomenclature even for connected extensions of the same unit as a result of isolated work eventually merging together. At the northern portion for example the Jelai Formation, Kerdau Formation, Gua Musang Formation, Gunong Rabong Formation, Telong Formation and Aring Formation are overlapping and can be reduced essentially to the Aring and Telong Formations. At the central part what has been referred to as the Kerdau Formation, Lipis Group, Semantan Formation, Kaling Formation, Jelai Formation and Gua Musang Formation are now more commonly known as the Semantan and Kaling Formations. In the south where the Gemas Formation, Tenang Beds, Jurong Formation and Jelai Formation has been used for different and overlapping parts of the same continuous unit, the Gemas Formation is now preferred. The Semantan, Gemas and Semanggol are homotaxial with the Telong a time equivalent.

Among the continental sequences the Gagau Group, Tembeling Group, Ulu Endau Beds, Tebak Formation (Kluang) and Panti Sandstone are homotaxial and have good lithostratigraphic correlation with each other as well as with the nonfossiliferous Koh Formation, Bertangga Sandstone, Ma'okil Formation and Saiong Beds.

INTRODUCTION

The Mesozoic System in Peninsula Malaysia is distributed in two separate basins, one on each side of the Main Range (Fig.1). The larger

FIGURE 1. DISTRIBUTION OF MESOZOIC ROCKS



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of these occur in a continuous outcrop along the axial belt of the Peninsula running from the north in the state of Kelantan to the south in the state of Johore. The smaller one is at the extreme northeast, in three separate outcrops aligned north to south, from Kedah to south Perak. This continues into southern Thailand.

Previously the whole system has been divided into three major successions namely a Triassic sequence, an Upper Triassic - Lower Jurassic sequence and an Upper Jurassic - Lower Cretaceous sequence. The first is considered to be marine in origin while the latter two largely continental. Lithostratigraphic units, as they are mapped, are referred to one of these sequences.

While recognition of the marine Triassic sequence is clear the two continental sequences are very similar lithologically and differ only in their style of folding. The Upper Triassic - Lower Jurassic sequence is said to be open folded into major anticlinorium and synclinorium (e.g. the "Tembeling Formation") and the Upper Jurassic - Lower Cretaceous sequence unfolded and tilted with near horizontal dips (e.g. the Gagau Group). This structural criteria was used by fieldworkers to correlate, in the absence of fossils, their units to either of the two sequences. As the practice caught on there developed some discrepancies known as the Upper Mesozoic controversy. Among other things it is found that confirmed Upper Jurassic - Lower Cretaceous units can be gently folded and folded sequences hitherto identified with the Upper Triassic - Lower Jurassic sequence (i.e. the Tembeling Formation) can have extensive areas with near horizontal dips and even belong to Upper Jurassic - Lower Cretaceous.

Based on the above observations and on recent work it may be more comprehensible to view the Mesozoic System as divisible into two major sequences only, a largely Triassic flysch sequence and a largely Upper Jurassic - Lower Cretaceous sequence of molasse. There appears to be a break in the Lower Jurassic as such rocks have not been found. The difference in the style of folding is explained by the position of the outcrops in relation to the major folds. Nearer the crest of an anticline and especially trough of a syncline the bedding appears quite gentle or even horizontal while away from such locations the dip increases. Where the outcrop is extensive the whole fold system is seen and the horizontal element in the dip becomes less significant.

LITHOSTRATIGRAPHY

At the northwestern belt the majority of the rocks belong to the Semanggol Formation. Only a small outcrop at the Malaysia - Thailand border belong to the Saiong Beds and another near Bt. Kodiang to the Kodiang Limestone.

Along the axial belt there is much overlapping of named Triassic units, which is a result of isolated work eventually closing up. With a history dating back to 1907, it is inevitable that the nomenclature have undergone many changes. In recent years the lithostratigraphic units generally

recognised are:

(i) Gua Musang Formation, Gunong Rabong Formation, Aring Formation and Telong Formation in the northern portion (Kelantan & north Pahang).

(ii) Lipis Group, Semantan Formation, Kaling Formation, Kerdau Formation and Jelai Formation in the central portion (Central Pahang).

(iii) Gemas Formation, Tenang Beds and Jurong Formation in the southern portion (Johore).

The Upper Mesozoic units along the axial belt are:

(i) Gagau Group, Tembeling Group and Koh Formation at the northern portion of the belt.

(ii) Bertangga Sandstone and Gerek Formation at the central portion.

(iii) Ulu Endau Beds, Tebak Sandstone, Panti Sandstone and Ma'okil Formation ? along the southern part.

Individual Formations

Kodiang Limestone was introduced by Jones et. al. (1966) for a unit comprising of limestone exposed in hills at the Kodiang area in north Kedah and formalised in 1975 by Coo & Smith. Abundant fossils are present but an age of Middle - Late Triassic is indicated by conodonts. The formation attains a thickness of 125 metres at Bt. Kecil and Bt. Kalong. It overlies Paleozoic rocks but the top is eroded off. Type locality is at the Kodiang area, Kedah and the unit is named after Bt. Kodiang.

Saiong Beds was proposed by Ong S.S. (1968) for a sequence of polymict conglomerate - conglomeratic redbeds in the Bt. Saiong area of Kedah, adjacent to the Malaysia - Thailand border. Red sandstone, shale and mudstone are interbedded and the unit is considered to be continental in origin. No fossils have been found but a Late Triassic - Early Jurassic age (here revised to Late Jurassic - Early Cretaceous) is deduced from its supposed correlation to the Tembeling Group. Although in limited areal extent, it can reach thicknesses of 1,200 metres. It overlies the Semanggol Formation (locally known as Gubir beds) with apparent unconformity while its top is eroded off. The type locality is at Bt. Saiong, a hill after which the unit is named.

Semanggol Formation was introduced by Alexander (1959) for the thinly interbedded arenite - lutite beds with some conglomerate in the Gunong Semanggol area of north Perak and subsequently by others for two homologous sequences, one in south Kedah and the other in central - north Kedah (Fig.1). Abundant fossils significantly Posidonia sp, Halobia sp and Daonella sp indicate a middle to late Triassic age. The best section is in the central - north Kedah region where it is subdivided into three members, namely a chert member at the base overlain by a rhythmite member and then a conglomerate member which is eroded at the top. Near the Bt. Saiong area however it is overlain unconformably by the Saiong Beds. The base has not been seen but the formation appears to overlie granite, especially on its eastern boundary and Paleozoic rocks on its western

boundary. The total thickness is not known but the chert member can reach 600 metres and the rhythmite member 1,000 metres in thickness. A type locality is proposed in the Bt. Merah area (Burton 1973) but no section is available. The unit is named after Gunong Semanggol in north Perak.

Aring Formation was introduced by Aw P.C. (1976 unpublished) for a predominantly pyroclastic sequence in the Sg. Lebir Valley, lower reaches of Sg. Aring and Sg. Relai in south Kelantan. An age ranging from late Carboniferous to Early Triassic is indicated by fossil evidences. The total thickness of the whole formation is 3,000 metres and the top portion of about 1,000 metres, interbedded with slate/tuffaceous limestone/ limestone,is designated as the Paloh member. It is overlain unconformably by the Telong Formation and, where this is absent, by the Koh Formation. The type locality is along Sg. Relai and Sg. Nuar, tributaries of Sg. Lebir. The unit is named after Sg. Aring, another tributary of Sg. Lebir.

Gemas Formation was first introduced informally as Gemas Beds by Foo K.Y. (1970 unpublished) for the mainly argillaceous rocks interbedded with volcanics and arenaceous rocks in the South East Pahang - Negeri Sembilan - North Johore area. A middle Triassic age is indicated by the lamellibranch Daonella cf lommeli, Danonella cf indica and ammonite Arpadites. Later workers (Khoo K.K. unpublished, Loganathan 1977) refer to the extensions of this unit as Gemas Formation. The thickness measured at the Kuala Pilah area is 5,500 metres. It overlies Upper Paleozoic rocks belonging to the Kepis Beds.

Gua Musang Formation was introduced informally by Yin E.H. (1965 unpublished) for a predominantly argillaceous and calcareous sequence interbedded with volcanics and arenaceous rocks in the Gua Musang area of south Kelantan. The unit extends to north Kelantan and southwards to north Pahang. Fossils of ammonoids and pelecypods indicate a middle Permian to middle Triassic age. It is unconformably overlain by the G. Rabong Formation and named after Gua Musang town in south Kelantan.

Gunong Rabong Formation was introduced by Yin E.H. (1965, unpublished) for the predominantly arenaceous - argillaceous sequence with subordinate calcareous, rudaceous and volcanic bands in the Gua Musang area of south Kelantan. Fossil bivales of Daonella sp. and Halobia sp. indicate a middle Triassic (Ladinian) to Late Triassic (Carnian) age. Type locality is in the general Gunong Rabong area of south Kelantan after which the rocks are named.

Jelai Formation, Kerdau Formation, Jurong Formation These are units proposed by Burton in 1973 to cover the whole of the Lower Mesozoic rocks throughout Peninsular Malaysia, in particular the Gemas Formation (Jurong and Jelai Formation) and Semantan Formation (Kerdau Formation). The usage of these terms is limited in recent works.

Kaling Formation was proposed by Ahmad J. (1976) for the predominantly arenaceous sequence in the Karak - Temerloh area of Pahang. It is extended into the Bentong - Raub - Kuala Lipis area by correlation with the Lipis Group. Minor conglomerate, shale and rhyolitic tuff are

associated in the sequence. A Late Triassic age is deduced from its close association with the Semantan Formation on which it overlies. Together with the latter, it constitutes the redefined Raub Group (Ahmad J. 1976). The locality is at Bt. Kaling, in Pahang, after which the unit is named.

Lipis Group This unit was introduced by Alexander (1959) for a predominantly arenaceous unit in the Bentong area, Pahang. It is now included in the Kaling Formation, (Ahmad J. 1976).

Semantan Formation was proposed by Ahmad J. (1976) for a predominantly shale - tuff sequence in the Karak - Temerloh area of Pahang. By correlation to the Raub Group (Alexander 1958) it is extended north to the Raub - Bentong area. Lenses of chert and limestone occur in the sequence. A Middle to Late Trassic age is indicated by fossils of lamellibranchs, cephalopods, gastropods and ammonites. It overlies the Karak Formation and is overlain by the Kaling Formation. The type locality is along Sg. Semantan, a tributary of the Pahang River, after which the unit is named.

Telong Formation was named by Aw P.C. (1972 unpublished) for a sequence predominantly of argillite associated with some tuffs in the Sg. Aring area in south Kelantan. It extends towards the west into the Gua Musang Formation. A probable age of Middle to Late Triassic (Carnian - Ladinian) is proposed from fossils which have not been definitely identified. It is unconformable over the Aring Formation to the east and also probably overlain by the Koh Formation to the south-east and southwest. It is interpreted to be more than 1,000 metres thick. The type locality is along Sg. Telong (a tributary of Sg. Aring) after which the unit is named.

Tenang Beds was introduced by Chong F.S. & Evans G.M. (1968 unpublished) for a tuffaceous - arenaceous suite of rocks near Tenang town in the South Pahang - North Johore area. A Middle to Late Triassic age is indicated by lamellibranch fossils of Daonella sp., Halobia sp. and Posidonia sp. The thickness of the unit is unknown but the arenaceous facies is about 200 metres thick. It is nonconformable on granite but is overlain by the Tebak Formation near Kluang. The type locality is the Segamat - Labis road, Johore. The unit is named after the town Tenang. Extensions of this unit are now referred as the Gemas Formation.

Bertangga Sandstone was introduced by Cook & Suntharalingam T. (1971 unpublished) for a predominantly arenaceous sequence interbedded with argillaceous rocks in the Tasek Bera area in Pahang. Cross bedding and lamination are common in the sandstone beds. No fossils have been found but a post Triassic to pre Cretaceous age is deduced from its younger relationship to the Gemas Formation (Triassic) and its interpreted older relation to the Panti Sandstone (Cretaceous). The thickness is not known, nor is the unit subdivided. The type area is near Bt. Bertangga, the peak of a north south trending strike ridge after which the unit is named.

Gagau Group was formalised by Rishworth (1974) for a succession of gently dipping arenaceous - rudaceous terrigenous rocks forming the G. Gagau plateau at the Kelantan - Trengganu - Pahang borders. This was first discovered and recognised to be of stratigraphic significance by Paton J.R. (1959) and named Gagau Formation by Alexander (1959). Beds of volcanics are also associated. Plant fossils indicate a Late Jurassic to Early Cretaceous age. The sequence is mildly folded and generally flat lying. It overlies, with observed angular unconformity, an eroded undermass of strongly folded Permian and Triassic (?) strata and, at other places, granite. The type area is at G. Gagau after which the Group is named. The Group consists of two formal units, the Badong Conglomerate and the Lotong Sandstone.

The Badong Conglomerate forms the basal unit of the Gagau Group. It consists mainly of reddish polymodal petromict conglomerate with subordinate sandstone, some siltstone and shale. The unit appears irregular in thickness, being more or less wedge shaped and lenticular. The maximum thickness is 400 - 500 metres. Some parts are structureless while others are graded and cross bedded. The type locality is along the headwater stretch of Sg. Badong, a tributary of Sg. Lebir. The unit is named after Sg. Badong.

The Lotong Sandstone overlies the Badong conglomerate but its top is eroded off. Where the Badong conglomerate is absent, the Lotong Sandstone rests unconformably on the undermass. The unit consists mainly of sandstone (white orthoquartzite, protoquartzite and subarkose), some volcanics and rarely coal in thin lenses. The sandstones are poorly sorted and cross bedded. Plant fossils in this unit give a Late Jurassic - Early Cretaceous age. The type locality is along the headwater stretch of Sg. Lotong, after which the unit is named.

Gerek Sandstone is here proposed for the locally distinct arenaceous unit in the Bt. Gerek area of ulu Rompin, Pahang, which was previously referred to as "Panti Type Sandstone" (Cook & Suntharalingam T., unpublished) on its assumed correlation to the Panti Sandstone. It is considered to be homologous to the ulu Endau Beds to its south.

Koh Formation was formalised by Aw P.C. (1972 unpublished) for a rudaceous - arenaceous sequence in the Sg. Aring area of southeast Kelantan. Mudstones are interbedded in the sequence while the base consists of argillaceous limestone. The age is deduced by correlation with the Tembeling Formation (Koopmans 1968) as Late Triassic - Jurassic although fossils at the base suggest a Permian age. The sequence is up to 700 metres thick at the type section but may exceed 1,000 metres at the Tahan range in North Pahang where it is thickest. It is unconformable over the Telong Formation and Nilam marble. The type locality is along a tributary of Sg. Koh after which the unit is named.

Lesong Sandstone was introduced by Foo K.Y. (1970 unpublished), after systematic mapping, for a unit of gently dipping predominantly sandstone sequence in the middle of Sg. Rompin area of Lesong Forest Reserve, South Pahang. This was earlier included in the informally named Lesong

sequence which refers to a more widespread series of homologous outcrops extending southwards to Bt. Selegi in North Johore. No fossils have been found but a Jurassic - Cretaceous age is deduced by correlation with similar rocks of known age to the south. The unit is exposed as mesas and cuestas capping summits of hills. A thickness of about 450 metres is exposed at an escarpment on Sg. Tanglang. It overlies granite, the Sawak Metasediments and Gayong Volcanics. Abundant plant remains, cross bedding and molasse characteristics indicate a continental origin. The unit is named after Gunong Lesong, a prominent peak in the area.

Ma'okil Formation was introduced by Loganathan P. (1977) for a thick sequence of supposedly continental rocks exposed extentively in the Ma'okil Forest Reserve of northwest Johore. The unit is predominantly argillaceous with arenaceous, rudaceous and volcanic rocks being only locally important. The argillaceous and rudaceous facies are often reddish and ferruginous. A Jurassic - Early Cretaceous age has been postulated by lithostratigraphic correlation with the Gagau Group and Tembeling Group. A thickness of 6,700 metres is estimated. The Formation is subdivided into three units with a rudaceous unit at the base overlain by an arenaceous and then an argillaceous unit. A volcanic facies is found in the rudaceous and argillaceous unit. It overlies (paraconformably) the Gemas Formation but its top is eroded off. The type locality is at the Ma'okil Forest Reserve after which the unit is named.

Tebak Formation was introduced by Rajah S.S. (1968 unpublished) for a unit of predominantly arenaceous rocks in the central and southern part of the G. Blumut area in South Johore. Although no fossils have been found, an Early Cretaceous age is deduced on its assumed homology with the Panti Sandstone to its near south. Lithologically it is predominantly arenaceous (quartz arenite, quartz wacke, feldspathic arenite) with minor siltstone and grey - purple mudstone. Thin coal seams are present. It is generally flat to gently dipping. It overlies the Sedili Volcanics with angular unconformity and also granite with nonconformity. The type locality is in the Sg. Tebak area, Johore and the unit is named after this river.
The name has recently been used for another correlatable unit of arenaceous rock thirty to forty kilometres away in the Kahang area of Johore. Here plant fossils indicate a Late Jurassic to Early Cretaceous age.

Tembeling Group First recognised together with the underlying sequence as the Tembeling Series (Scrivenor 1907), this was differentiated and formally named Tembeling Formation (Koopmans 1968) for the thick succession of continental rocks in the Tembleing area of North Pahang. The rank was later upgraded (Khoo H.P. 1977) to Tembeling Group. Plant and bivalve fossils indicate a Late Jurassic - Early Cretaceous age.
The Group consists of four formations namely Termus Shale, Mangking Sandstone, Lanis Conglomerate and Kerum Formation.

Kerum Formation. This is the oldest unit of the Group and is made up of a volcanic - sedimentary suite with intermixed varieties. It appears to be one of the thickest unit, exceeding 2,000 metres, but such

determination is uncertain due to lack of detailed information on folding. It overlies the Paleozoic Bangak metasediments (Khoo H.P. 1977) and is overlain by the Lanis Conglomerate. The type locality is the Sg. Kerum drainage, a tributary of Sg. Tekai, after which the unit is named.

Lanis Conglomerate. It consists of a polymict conglomerate/conglomeratic sandstone/shale/siltstone sequence, most of which are reddish and ferruginous. Volcanic clasts may be significant in some parts. In areal extent and at 1,300 metres thick it is probably the smallest unit of the Group. It overlies the Kerum Formation, probably conformably and is overlain by the Mangking Sandstone with unknown relationship although at one locality this appears to be an unconformable one. Type locality is the G. Lanis ridge after which the unit is named.

Mangking Sandstone. It consists mainly of quartzose sandstone interbedded with grey and reddish argillaceous rocks. Plant fossil Gleichenoides Gagauensis Konno indicates a Late Jurassic to Early Cretaceous age. Thickness of this unit is about 2,000 metres. It overlies the Lanis Conglomerate and is overlain by the Termus Shale. Type locality is along Sg. Mangking, a tributary of Sg. Tekai, after which the unit is named.

Termus Shale. The youngest unit, it consists predominantly of reddish ferruginous shale/mudstone/siltstone interbedded with some quartzose sandstone and lithic sandstone. Bivalve fossils near the base suggest a Late Jurassic - Early Cretaceous age. It overlies the Mangking Sandstone and with its top eroded off reaches up to 1,500 metres. The type locality is along Sg. Tekai, Pahang. The unit is named after Sg. Termus, a tributary of Sg. Tekai, where the rocks are extensively exposed.

Ulu Endau Beds was first proposed as Ulu Endau Arenaceous Formation (Jones 1961), then modified to this by Jones, Gobbett & Kobayashi (1966) and adopted by Cook & Suntharalingam T. (1970) who mapped the unit systematically. It refers to a massively bedded sequence of predominantly arenaceous rocks in the Ulu Endau area of southeast Pahang. The unit is generally horizontal to gently dipping. Some argillaceous rocks are interbedded and coal seams are found. A Cretaceous age is indicated by plant fossils of Gleichenites sp., Otozamites sp. and Equisetite sp. A minimum thickness 300 metres is estimated at Bukit Peta. Current bedding is common and a continental origin is suggested. It overlies with angular unconformity the Mersing Beds, Jasin Volcanics and nonconformably, granite at Bt. Tareoh. It is named after the Ulu Endau area where the unit is well exposed.

Lithostratigraphic Framework

The stratigraphic cross sections of some representative units to show generalised lithology and lithostratigraphic relationship is shown in Fig. 2 and Fig. 3 A correlation chart to show the age relationship is shown in Fig. 4.

FIGURE 2. LOCATION MAP OF STRATIGRAPHIC SECTIONS

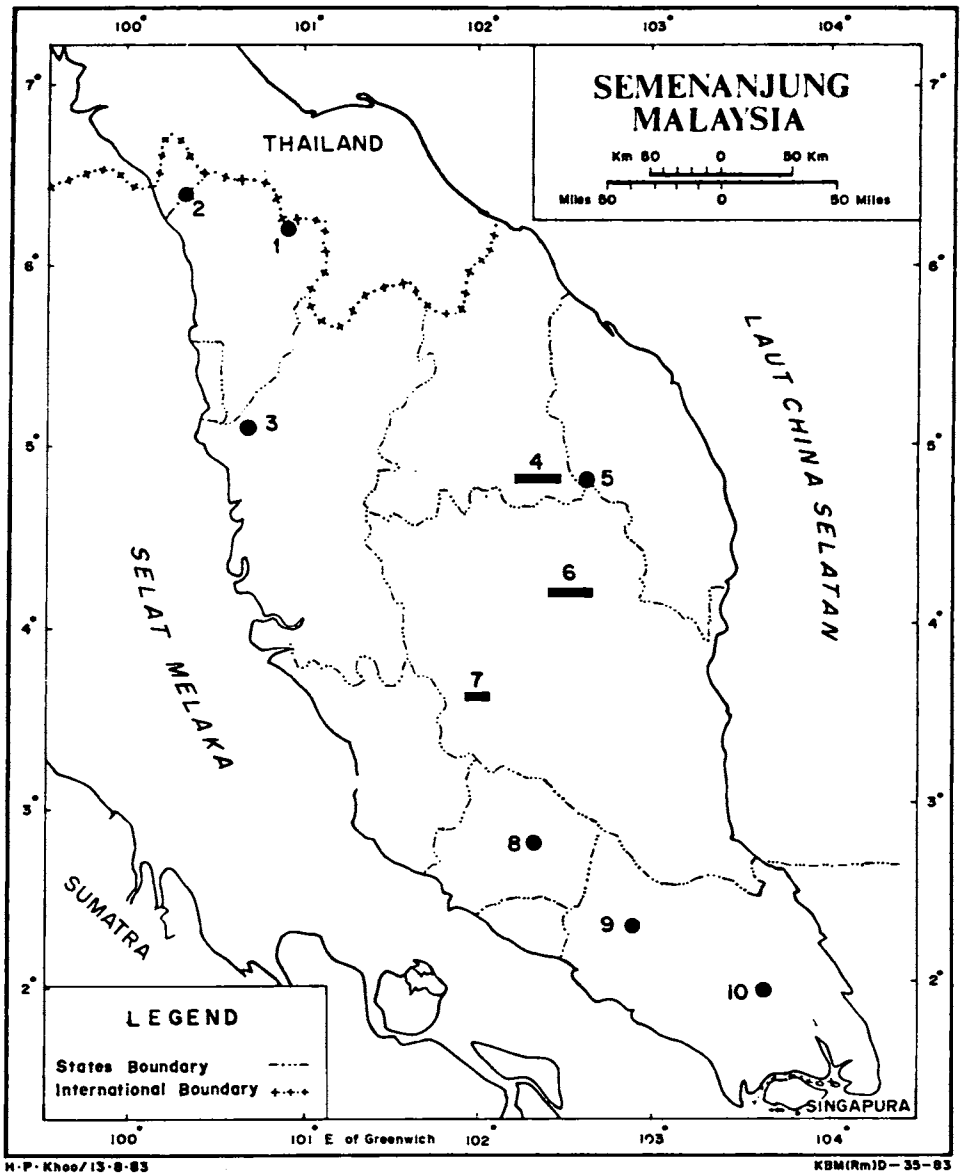


FIGURE 3 STRATIGRAPHIC CROSS SECTION, NORTH-WEST AND CENTRAL AXIAL PENINSULAR MALAYSIA

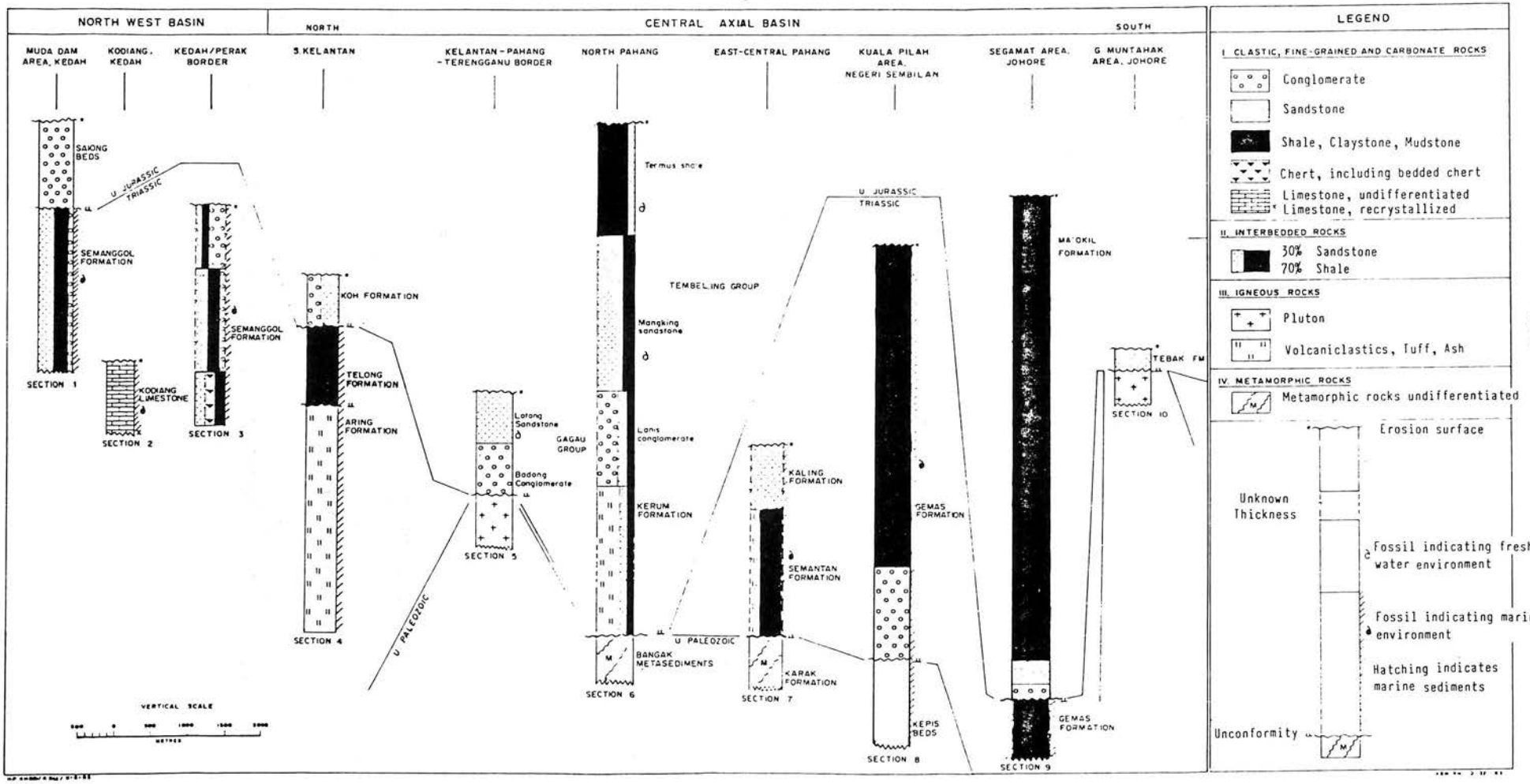
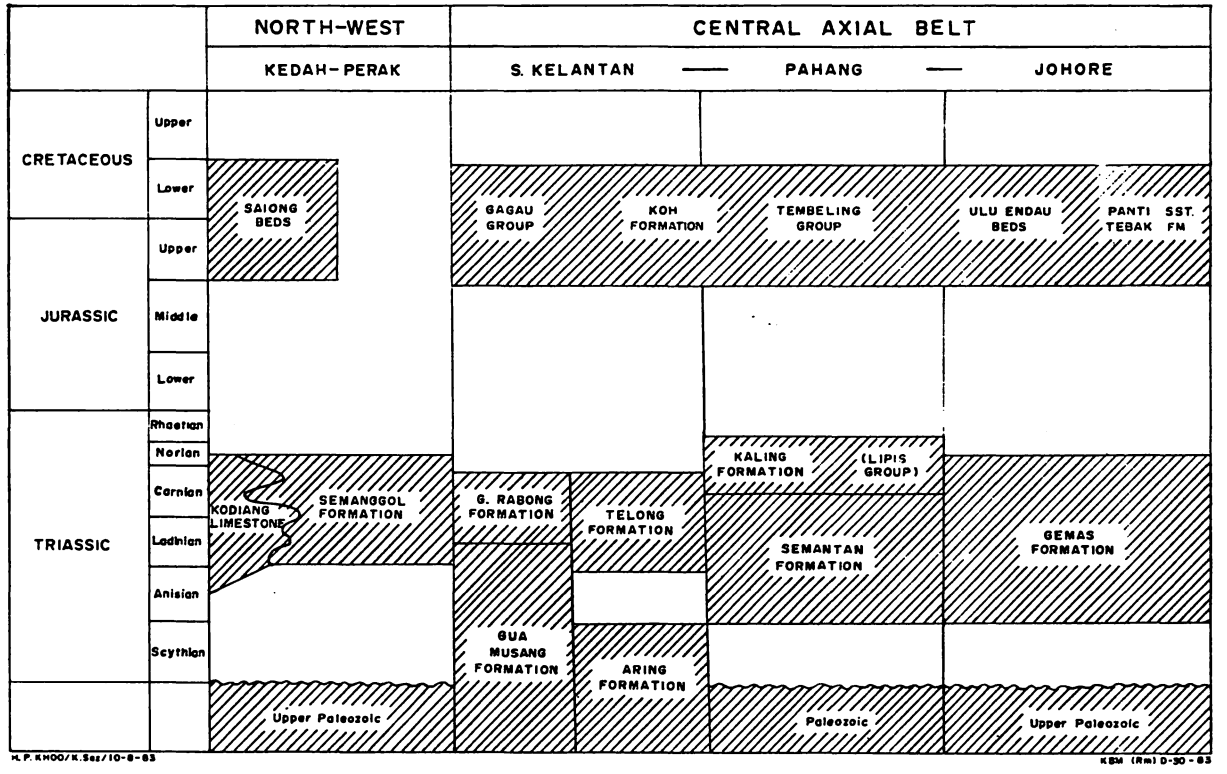


FIGURE 4. CORRELATION CHART



CORRELATION

The Gagau Group, Panti Sandstone, Ulu Endau Beds and Tembeling Group are homotaxial. The Tembeling Group has the thickest section and using this as a basis for comparison it is possible to correlate the Lotong Sandstone of the Gagau Group, the Ulu Endau Beds, the Tebak Formation and the Panti Sandstone to the Mangking Sandstone. In general the Bertangga Sandstone, Koh Formation and Tebak Formation may also be correlated to the Mangking Sandstone. The arenaceous - rudaceous character common to all the above units is not seen in the Ma'okil Formation which is predominantly argillaceous and if correlation is possible (Loganathan 1978) it should be with the Termus Shale. The Saiong Beds is very distantly separated from the above mentioned units (in the axial belt) but has a common lithologic character, colour and stratigraphic position as the Lanis and Badong Conglomerate.

Within the northwestern belt, the three disconnected sequences of the Semanggol Formation have good lithostratigraphic and biostratigraphic correlation to each other.

In the north of the axial belt the Telong Formation is (time) correlated to the Gunong Rabong Formation and the top part of the Gua Musang Formation with the Aring Formation to the rest of the Gua Musang Formation (Aw unpub.). At the central portion of the axial belt, most of the Lipis Group is correlated to the Kaling Formation which should be a better term considering that the former cannot be divided into formations. The Semantan Formation and Gemas Formation are homotaxial and although both have a common predominantly argillaceous character the chert and limestone facies of the Semantan are not seen in the Gemas Formation.
At the southern part, the Tenang Beds which occur within the much larger Gemas Formation, is defined only locally in the Tenang area and fieldworkers prefer to use Gemas Formation for extensions of this unit.

Use of the terms Jelai Formation, Kerdau Formation and Jurong Formation introduced by Burton (1973) to cover all the various units of the Triassic along the axial belt have not caught on with field geologists. The Kerdau Formation is more commonly referred as Semantan Formation in the central portion and as Gemas Formation in the south. The Jelai Formation is referred as Semantan Formation in the central part and Gemas Formation in the south. The Jurong Formation, named after a place of that name in Singapore where a type locality has been proposed (Burton 1973), is usually referred as Gemas Formation.

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