CHAPTER 1
INTRODUCTION

1.1. Preface

The present research work started in September 1996 when my supervisors organised fieldtrip to my proposed research area, around Kuantan, Pahang, Kemaman and Chukai, in the state of Terengganu, West Malaysia, to access the possibility of working on the organic and inorganic geochemistry of the Upper Palaeozoic Kuantan Group and Early Triassic carbonaceous sediments.

The fieldtrips were undertaken for field data observation and sample collection. Laboratory analysis using a very highly sensitive and advanced techniques including chemical and petrographic analysis for both organic and inorganic geochemistry were carried out at University of Malaya, Kuala Lumpur, University Kebangsaan Malaysia, Bangi, and Petronas Research and Scientific Services laboratories.

1.2. Purpose of Study

The objectives of this project are:-

1. To perform organic and inorganic geochemical analyses on selected Upper Palaeozoic Kuantan Group, Permian and Early Triassic carbonaceous sediments from the Central and Eastern belts of the Malay Peninsula.

2. To determine the mineralogy and clay minerals of the carbonaceous sediment.

3. To determine the total organic carbon content (TOC) and thermal maturity from mean vitrinite reflectance (%Ro).

4. To discuss the distribution of biomarkers (or geochemical fossils) in assessing the type of organic matter, thermal maturity and depositional environments.
5. To determine the diagenesis that the sediments had undergone.

6. To determine the interrelationships between organic and inorganic reactions.

7. Finally to compare results between the three studied localities of Pahang and South Terengganu.

1.3. Location and Accessibility

The study areas are located in the central and eastern belts of the Malay Peninsula, along road cuts to Kuantan districts (state of Pahang) and along the coast of the state of Terengganu in the Kuala Kemaman (Cukai) Figure 1.1. The areas in the state of Pahang are situated in two parts (Central and Panching), the central Pahang area covered rock exposures along Mentakab – Temerloh and Jengka Pass road, the Panching area covered rock exposures situated between West of Kuantan town and east of Sungai Lembing. Accessibility of both areas is quite good, most of the field observations were done on road cut sections along Kuantan and in quarries.

The Kemaman area covered rock exposures situated along the coast of the state of Terengganu, Kemaman (Chukai). This area is linked by the East Coast trunk round running north – south and a branch road leading to inland towns west from Kemaman. Outcrops are available along road cutting and quarries.

1.4. Geography

1.4.1. Drainage

The drainage pattern and main rivers draining the area of study can be traced from topographic map.

In the central Pahang, Sungai Semantan which flow eastwards is the main river draining the district in the rugged hilly region. The drainage pattern is radial and streams follow the joints and fractures of the granite hills. Waterfalls are common
Figure 1.1 Location map showing area surveyed.
features in the area. In the lowlying undulating region the drainage is controlled by the topography stream and rivers that meander through the valleys. Flood occur after heavy rain and during the monsoon seasons.

In the Panching area the major river draining the area is Sg. Kuantan and its tributaries. Sg. Kuantan meanders its way through valleys and low landscape forming Ox-bow lakes at certain places. Drainage pattern is apparently controlled by lithological variation in areas having sedimentary rocks. Finer drainage on softer sedimentary rocks and coarser in the more resistance beds. Water percolate from joint planes and cracks gave rise to smaller streams drainage in the limestone hills.

In granitic areas towards the south drainage pattern is probably controlled by topographic slopes giving rise to denderitic pattern with radial pattern developing on higher topography. Sungai Kemaman and Sungai Chukai are the main meandering rivers in Kemaman area. Radial drainage pattern is shown in the northern part of Kemaman where granite hill are dominant.

1.4.2. Vegetation and Land Use

Tropical rain forest dominate the vegetation in the study areas. About 75% of the areas are covered by jungle. The ground strata are occupied by bushes, low shrubs, climbers interspersed with tall dominate trees. In the central Pahang rubber estate strung out along both sides of the main roads and lines. In the Panching area the land use includes logging for timber, rubber estate covers most parts of the area. Granitic soil is more favourable land and has been cleared for oil palm cultivation.

Vegetation in the Kemaman area is also of tropical forest which flourish over most of the isolated hills and ridges. Vegetation over the metasediments is relatively
less dense than those over granite hills due to thinner soil cover on these hills. The sandy beach ridges support the growth of grasses and trees along the Kemaman beach. Coconut plantation are confined to the beach ridges along the coast and rubber plantation are scattered over rolling hills.

1.5. Geomorphology

1.5.1. Topography

The general topography of the study areas can be interpreted from a topographic maps. In the central of Pahang the area is undulating by many hills and ridges of which a few exceed 500 feet in the elevation and this lowlying terrain is underlain mainly by interbedded shale and tuff of the Semantan Formation.

In the Panching – Sg. Lembing area the terrain consist of low hills cut by narrow alluvial plain of Sg. Kuantan extending from west of the study area to the southeast. Variation in topography is related to change in lithology. The strike ridges consist mainly of steeply dipping sandstone and shale. The karst limestone hills of Bt. Panching and Bt. Charas dominate the landscape across the middle of Panching Sg. Lembing area.

In the Bukit Pak Sagor area the topography illustrate undulating land of rolling hills between (Bt. Pak Sagor, Bt. Sagu and Bt. Tenggek) in the southeast and the hilly Sg. Lembing area in the west. This part of the area rise to about 30 m above sea level. The elevation of the Bt. Sagu is (341 m) and Bt. Tenggek (182 m), both are isolated karst limestone hills. According to Yong (1985) Bt. Sagu is of 214,000 m² and Bt. Tenggek is of 80,000 m². The hills are mound like and lenticular in plan view and rise precipitously from the surrounding lowlying land.
1.5.2 Karst Topography

This feature dominate the landscape in the Panching area, it’s developed as consequence of surface and subsurface solution of limestone. Fitch (1951), believed the karst topography in the Panching area is due to under-cutting by rivers and possibly by solution of swamp water had led to collapse of over hanging rock and formation of vertical limestone cliffs.

1.5.3. Sinkholes

Sink holes are common features in the Panching area. Tan (1972) reported that the sinkholes are elongated shape, probably brought about by collapse of roof over an underground solution opening. According to the same author, the large sinkhole in this area is at Bukit Sagu which are of approximately fifty meters in diameter.

1.6. Previous Geological Work

Investigations on the geology of the Pahang and South Terengganu areas of central and Eastern Belts, Peninsular Malaysia have been the subject of repeated geological studies, particularly by numerous researchers from the geological survey department of Malaysia or by both geological student and academic staff members of Universities of Malaysia namely, UM and UKM.

Muir Wood 1948 made the first major publication on the paleontology of macrofossils from Bt. Charas, Bt. Sagu and Bt. Tenggek and dated them as Early Carboniferous Visean. Fitch (1951) a geologist from the Geological Survey Department of Malaysia investigated the geology of the Upper Paleozoic rocks of the Panching area in (1934-1941) and (1946-1949). The accounts of the geology were published in memoir “The geology and mineral resources of the neighbourhood of
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Kuantan, Panching”. Fitch (1951) named the Upper Paleozoic rocks around Kuantan as the arenaceous and calcareous series. However, the relationship between them along the Kuantan – Temerloh trunk road westwards to Sg. Lepar was undefined. Alexander (1959) renamed these rocks as the Kuantan Group. Metcalfe (1980) retained and formalized the use of the term Kuantan Group and further subdivided it into three formations, namely Charu Formation, Panching Limestone, and Sagor Formation. According to the same author, the Kuantan Group was assigned as Visean to Late Carboniferous age in the Panching area. Metcalfe et al. (1980) reported that the Panching Limestone was dated as Late Carboniferous and inferred to be a reef formed in a warm shallow marine environment, the Charu Formation was dated as Visean – basal Namurian age and inferred to be deposited in a shallow marine nearshore environment in a relatively shallow marine environment. Sidibe et. al (1994) investigated geochemistry of the Kuantan Group rocks and reported the Charu Formation is characterised by the predominance of K$_2$O, Al$_2$O$_3$ and Fe$_2$O$_3$ in the shales and by feldspathic and MgO-rich mudstone, Sagor Formation is dominated by potassic shales and subarkose, both of which are poor in Fe$_2$O$_3$ and Al$_2$O$_3$.

In the central Pahang the earlier report on Semantan Formation were very general and extremely brief. Alexander (1959) named the Upper Paleozoic sediments as the Raub Group to replace the name calcareous series. Jaafar (1976) did an extensive work on rock exposed in Karak – Temerloh road. In his discussion he proposed to rename the Raub Group (Alexander, 1959) as Semantan Formation. The presence of bivalves in these sediments lead Jaafar (1976) to suggest a deep marine environment.
In the Kemaman area, Fitch (1951) had commented lightly on metamorphism and the rock types just north of the border where the rhyolitic rocks of Tanjung Cherating lie between the outcrops of arenaceous rocks in Bt. Batu Puteh, and Tanjong Geliga (outside the writer’s area) and are therefore thought to be interbedded with the latter on the assumption that the rocks at Tanjong Geliga are of Triassic age. Fitch (1951) did not comment on the geochemistry of the area. Nossin (1964) had reviewed the formation of the beach ridges analysed the beach sand for heavy minerals and determined the grain-size distribution. Goh Sing (1973) in his unpublished B.Sc. thesis studied the geology of Kemaman area, and he reported a detail study on the metamorphism that the area had undergone. Tan Beng (1979) in his unpublished thesis had studied the geology, mineralogy and geochemistry of the Chye Heng Long– mine in Kemaman.

1.7. Regional Geology

1.7.1. Outlines on the Tectonics of South East Asia

The tectonics of SEA had been studied by many geologists, all providing to us a good literature review about the formation of blocks in the Southeast Asian region. Metcalfe (1988) recognised four composite of Late Paleozoic blocks for Southeast Asian region, i.e the Sibumasu block, the East Malaya block, Indochina, and South West Borneo. The Sibumasu block comprises northwest Sumatra, Western Peninsular Malaysia. Peninsular Thailand and Burma, northwest Thailand and the Shan state of Burma, and possibly extending northwards into western China and Tibet. The East Malaya block includes eastern Peninsular Malaysia, South eastern Sumatra, Natuna, a
Figure 1.2. Setting of the Eastern Peninsular Malaysia in the tectonic of South East Asia. (from Metcalfe, 1988).
pre-Tertiary basement area beneath the Malay Peninsular, West Natuna, Penyu basins and the Sunda shelf northeast of Sumatra. The Indochina block comprises eastern Thailand, Laos, Cambodia and Vietnam (except the portion northeast of the Song Ma-Song Da Zone Figure 1.2). The South West Borneo block comprises West Sarawak and South West Kalimantan and bounded to the North by the Lupar Suture to the Southeast by the Meratus Suture and to South West by the Limits to the east Malaya block.

1.7.2. General Geology

1.7.2.1. Geology Outline of Peninsular Malaysia.

Most of the geologists in the Peninsular Malaysia use the terms “block” and “belt”. Stauffer (1974) and Hamilton (1979) divided Malaysia Peninsular into an Eastern and western block separated by a media suture, the former called these blocks the East and the West Malay blocks and the Later used Western and Eastern Malaya Peninsular blocks.

Bignell and Snelling (1977), Khoo and Tan (1983) divided the Geology of Malaya Peninsular in to three belts, West, Central and Eastern Malaya belt (Figure 1.3). The stratigraphy of the Western and Central belt are well known in Peninsular Malaysia. The Eastern belt is dominated by Carboniferous and Permian clastics and carbonates which constitute the Kuantan Group. The central belt is dominated by Permian and Mesozoic age sediments.

1.7.2.2. General Geology of the Study Areas

1.7.2.2.1. Geology of the Central Pahang

The general geology of the Central Pahang is dominated by the presence of
Figure 1.3. Location of the three geological belts in the West Malaysia. (from Metcalfe, 1988).
Permian and Triassic age sediments. The Permian sediments is composed of interbedded series of black limestones, calcareous shales, sandstones and a band of conglomerate. According to Jaafar (1976) the Semantan Formation is an essentially marine facies made up mainly of carbonaceous shale interbedded with rhyolitic tuff and marine intercalation of limestone, chert and sandstone.

1.7.2.2. Geology of Panching – Sg. Lembing Area

The calcareous series and Arenaceous series of Fitch (1951) was divided into Calcareous Facies and Argillaceous Facies by Tan (1972). The Charu Formation consists of sandstone, siltstone and shale, that are interbedded and often alternate with each other, where the argillaceous sequence dominates. Fitch (1951) reported volcanic tuff along Sg. Reman and Sg. Batu. Sidibe (1993) reported the strata of the Charu Formation are broadly open folded. They are locally tightly folded (near Sg. Charu). The Charu Formation is cut by numerous small normal as well as reverse faults “along the Kuantan – Sg. Lembing road” near Sg. Charu. At this locality small concentration of faults is observed, folds are generally open, and the general trends of fold axis is north – notheast. The events of deformation is said to be related to the emplacement of igneous intrusion into the Carboniferous rocks (Yong, 1985). The Panching Limestone which forms the hills in Panching area, all of which have similar strike (N-NE-S-SE) Sidibe (1993). According to the same author a huge batholith extends from Sg. Lembing to Gambang Area. As a result of shallow igneous intrusion the sedimentary rocks are thermally metamorphosed to hornfels and spotted slate.
structural geology of the area is interpreted to be broad open folds in the sedimentary strata, joints are more prominent in the limestone (Sidibe, 1993).

1.7.2.2.3. Geology of Bt. Pak Sagor

The Sagor Formation consist of lenses of conglomerate. Sandstone interbedded with siltstone, mudstone and shale. The beds are steeply dipping striking in similar direction to the older sequence “the Charu, and Panching Limestone Formations” (Sidibe, 1993).

The rock units conformably laying on the Sagor Formation are described by Sidibe (1993) as Taweh Formation, that outcrops along Sg. Taweh, Sg. Endon and in the Felda Bt. Sagu. Lithologically this formation consist of a sequence of interbedded conglomerate, sandstone and shale.

According to Stauffer (1974) a wrench fault filled by quartz dyke at Bt. Rongin which is about 6 kms west of Kuantan, produced a 4 km left lateral movement that displaced the Bt. Sagu and Bt. Tenggek pair of limestone hills. Tan (1972) said the fault was inferred as Jurassic or younger in age.

1.7.2.2.4 Geology of Kemaman

The sedimentary rocks of the Kemaman area had undergone a regional metamorphism of low-grade type producing metamorphic rock units. The oldest rocks in this area are well exposed at Tanjong Geliga, Tanjong Mat Amin and Tanjong Berhala. The metasediments are composed of metaquartzite, carbonaceous phyllite and slate. Goh (1973) reported about the volcanic rocks and said that the volcanic rocks include acidic pyroclastics (lapille tuff and ashy tuff) and rhyolitic lava
flow. The intermediate and basic igneous rocks are found as marginal facies of the granite.

1.7.3. **Paleozoic Rocks of Peninsular Malaysia**

The Paleozoic rocks of Peninsular Malaysia were represented in a well sequence ranging in age from middle Cambrian to Permian and it is found in two sedimentation regimes. Foo (1983) recognised two sedimentation regimes based on their different periods of initial sedimentation.

1. A Western regime to which Lower Paleozoic Strata are confined and where a conformable Cambrian-Permian succession is evident in Langkawi, Perlis and Kedah area.

2. An eastern regime where Carbo-Permian strata outcrop in the central and eastern parts of the Peninsular. According to the same author, on one basin of their regime stratigraphic record and characteristics, the western regime can be divided into the north western and western zones and the eastern regime into central and eastern zone.

The lithostratigraphy of the north western zone are represented by the Machinching Formation, Setul Formation, Mahang Formation, Kubang Pasu Formation and the Chuping Limestone. Those of the western zone are represented by the Baling Group, Bentong Group, Kinta Limestone, Kati Formation, Kenny Hill Formation, Dinding Schist, Hawthornden Schist and Kuala Lumpur limestone.

Those of the central zone are preresented by the Raub Group, Kepis Formation and Taku Schist and those of the eastern zone by the Kuantan Group (Pahang, Terengganu, Kelantan) and consists of dated Carboniferous rocks found in the Kuantan – Sg. Lembing area. Charu Formation Panching Limestone and Sagor
Formation (Metcalfé, et. al., 1980) made up the Kuantan Group. Shallow marine sandstone and shale of the Charu Formation have yielded visean brachiopod and plants. The fossiliferous and reefal Panching Limestone has yielded abundant of fossils such as foraminifera, conodonts, bryozoa and trilobites which indicate an Early Namurian age (Mamet and Saurin, 1970, Ozawa, 1975, Metcalfé et. al., 1980). The overlying Sagar Formation is of Carboniferous age and does contain Permian fossils in its upper part. Sediments considered as part of Kuantan Group extended northwards over wide areas of Terengganu and Kuantan where they comprise tuffaceous shales and sandstone with rare limestone lenses containing corals, brachiopods, bivalves cephalopods, and plants indicating a Carboniferous age.

The Aring Formation of Kelantan consists of tuffs and flows of andesitic to rhyolitic composition with minor interbedded of argillite and dolomite which have yielded marine fossils of middle Carboniferous to Early Triassic age.

Similar sediments outcrops along the Terengganu and Kelantan coast and are dated at a few localities as Carboniferous by Metcalfé (1984). These coastal outcrops are highly deformed and equivalent inland sediments although tightly folded in places it isn’t appear to show the same degree of deformation (Metcalfé, 1984).

Similar highly deformed rocks occur further south near Mersing, Johore and these are also of Carbo – Permian age. North of Kinta Valley, the Carboniferous is represented by parts of the Kuantan Limestone but most of the Tournaisian is absent. Metcalfé (1984) reported there is a non-sequence between Late Devonian and Late Tournaisian.
In Kedah and Perlis a sequence of marine sandstone and mudstone known as the Kubang Pasu Formation is broadly equivalent to the Singa Formation and mostly Carboniferous in age (Metcalf, 1984).

Rocks belonging to the Permian are widespread in Malaya and have been recorded from all states except Selangor, Negeri Sembilan and Melaka (Gobbett, 1968). The oldest Permian limestones both in the NW (Pulau Langkawi, Perlis, Kedah) and Kampar Perak is of Late Early to Early Middle Permian age (Chand 1993).

1.7.4. Triassic Rock in Peninsular Malaysia

The Triassic rocks form major parts of the surface area in Peninsular Malaysia in NW and along the Central Belt of the country, from the northern border to the South in Johor. In the Central Belt the Triassic is represented by the Raub Group (Semantan and Kaling Formation). Only the Semantan sediments were analysed in this study. The sediments comprise of thinly and thickly bedded tuffaceous sandstone and interbedded mudstone and shale. The tuffaceous sandstone is well bedded greyish orange colour and it occur with sharp plane top and basal contact with the alternating mudstone and shale beds.