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The Society has a membership of about 600 earth scientists interested in Malaysia and other Southeast Asian regions. The membership is worldwide in distribution.

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CATATAN GEOLOGI
Geological Notes

Layered microgranite-pegmatite complexes of the Kuala Lumpur Granite, Peninsular Malaysia

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Abstract: The Kuala Lumpur Granite is cut by late magmatic microgranite-pegmatite complexes that occur as gently to moderately dipping and weakly curved composite sill-like bodies. They display prominent grain size layering defined by alternating layers of pegmatite and microgranite. Mineral zoning is conspicuous in the pegmatites. The microgranites exhibit a fine scale, 5 to 100 mm thick, internal rhythmic compositional layering. The microgranite-pegmatite complexes are probably formed by multiple injection of volatile-rich granitic magma, each injection was initially homogeneous and subsequently segregated into pegmatite and microgranite. The rhythmic layering originated from *in-situ* local fractionation of granitic magma and the variation of volatile pressures during crystallization has probably played an important role.

INTRODUCTION

Microgranite dikes and pegmatite bodies are common in the granitic rocks of Peninsular Malaysia. These late stage differentiates often form discrete bodies, however, they are observed to form composite microgranite-pegmatite complexes displaying grain size and rhythmic compositional layering in several places, including Kuala Lumpur, Bukit Mor in Johor, Sungai Siput Selatan in Perak, and near Gunung Jerai in Kedah. Among these places, the microgranite-pegmatite complexes is best exposed in the quarries and road cuts in eastern Kuala Lumpur. This paper describes the interesting and unique layered structures in the microgranite-pegmatite complexes in the Kuala Lumpur Granite, and discusses their possible origins.

THE KUALA LUMPUR GRANITE

The Kuala Lumpur Granite is a large granitic body which is predominantly megacrystic consisting of alkali-feldspar megacrysts set in an allotriomorphic to hypiodiomorphic groundmass. The major minerals are alkali feldspar, quartz and plagioclase, while biotite, muscovite and tourmaline usually occur in minor amounts. The Kuala Lumpur Granite consists of several textural and mineralogical varieties or units, and the main units are megacrystic biotite granite; megacrystic muscovite-biotite granite; and equigranular tourmaline-muscovite granite (Fig. 1). These granitic rocks are cut by late phase differentiates including the microgranite-pegmatite complexes.

The Kuala Lumpur Granite was emplaced during the Late Triassic (199–215 Ma) (Bignell and Snelling, 1977; Liew, 1983; Darbyshire, 1988). The Kuala Lumpur Granite like the other granites of the Main Range batholith, exhibits typical S-type features such as being tin-bearing, and having peraluminous composition, high K_2O/Na_2O ratios, low Fe^{3+}/Total Fe ratios, a restricted compositional range dominated by high SiO_2 granites and high initial $^{87}Sr/^{86}Sr$ ratios (Liew, 1983). On the basis of S-type features and other evidence like absence of associated mafic magmatism, negative e_{Nd}

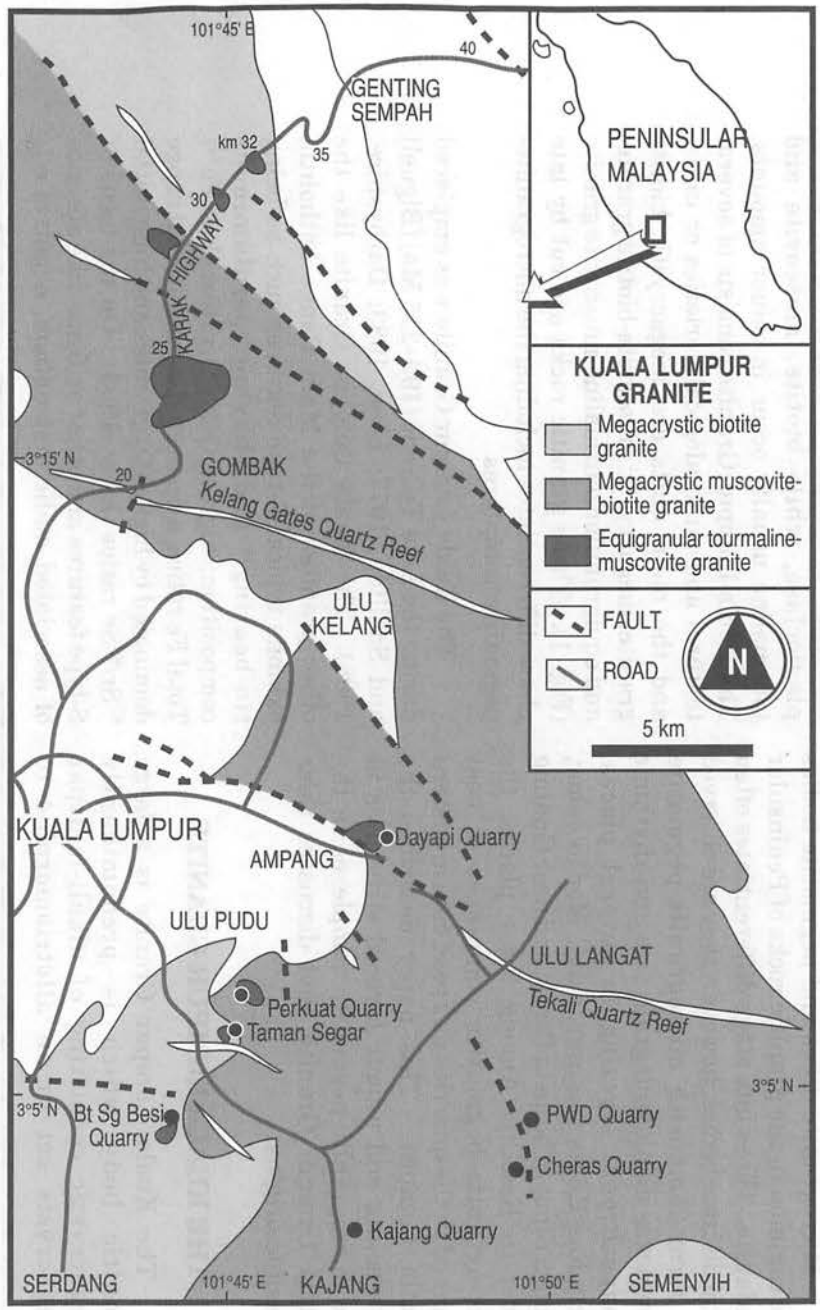

Figure 1. Map showing the distribution of the three main units of the Kuala Lumpur Granite and the location of the quarries where microgranite-pegmatite complexes were observed and studied.

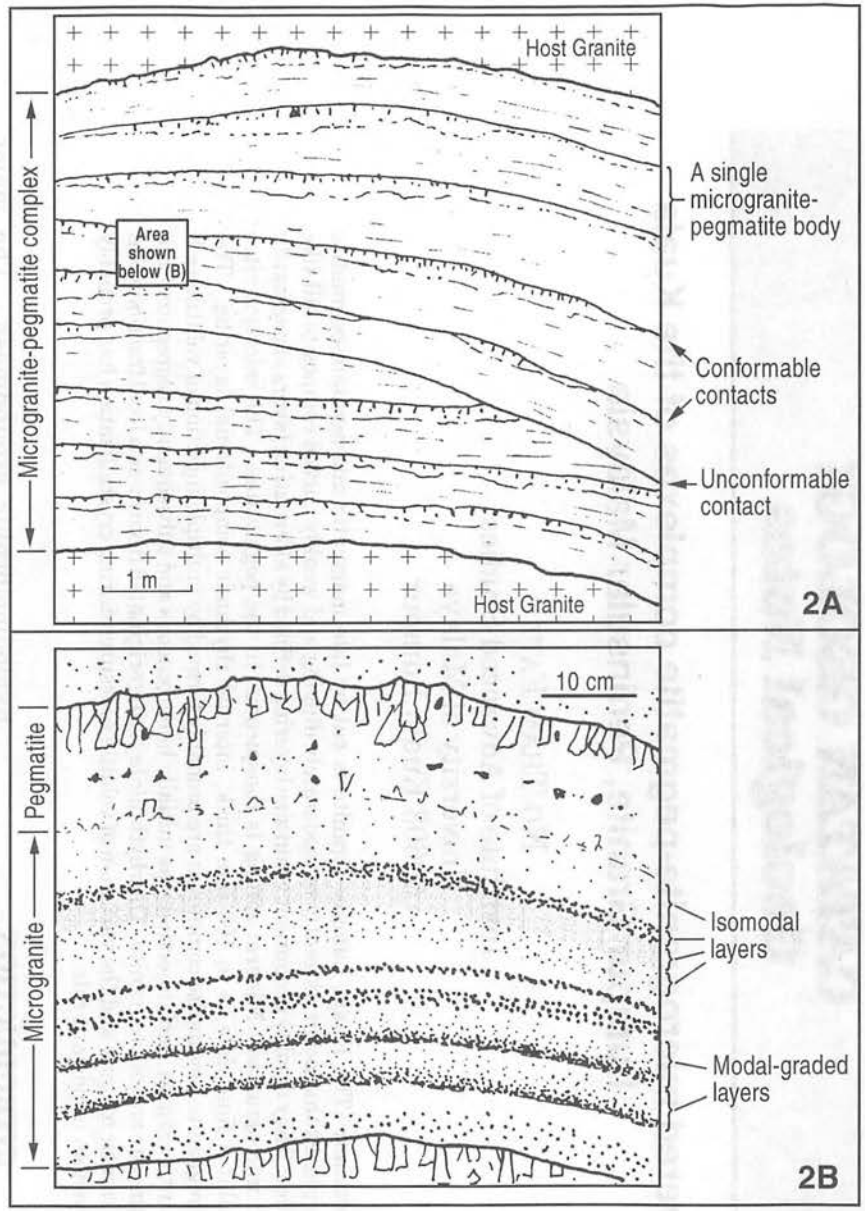

Figure 2. A) Simplified field sketch of a microgranite-pegmatite complex cutting megacrystic muscovite-biotite granite in Dayapi Quarry. The microgranite-pegmatite complex is made up of subparallel microgranite-pegmatite bodies. The contacts of the microgranite-pegmatite bodies are often conformable, but may also be unconformable. B) Sketch of part of the microgranite-pegmatite complex shown in (A) illustrating a microgranite-pegmatite body. Grain size layering is formed by the pegmatite and microgranite with contrasting grain size. The microgranite layer also has internal rhythmic modal layering.

values and the presence of U-Pb zircon inheritance features, Liew (1983) concluded that the Main Range batholiths are derived from partial melting of underlying old continental crust.

GENERAL FEATURES OF THE MICROGRANITE-PEGMATITE COMPLEXES

The microgranite-pegmatite complexes are observed in the Perkuat Quarry, Dayapi Quarry, Bt. Sg. Besi Quarry and km 23 of Karak Highway. They form composite sub-horizontal sill-like bodies cutting the main Kuala Lumpur Granite. They are often confined to the contacts between equigranular granites and megacrystic granites (Fig. 1).

The microgranite-pegmatite complexes commonly form gently to moderately dipping and weakly curved composite tabular bodies. Each composite complex may contain 5 to tens of microgranite-pegmatite bodies, each ranging from 5 cm to 1 m thick, and this gives them a layered appearance (Figs. 2 and 3). Generally the microgranite-pegmatite complexes are 0.5 m to more than 5 m thick and up to tens of meters long.

Each microgranite-pegmatite body is made up of an upper pegmatite layer and a lower microgranite layer. These two subparallel layers may be regarded as well developed grain-size layering (i.e. the pegmatite forms a coarse grained layer, and the microgranite a fine grained one, Fig. 2B). Within the microgranite layers, rhythmic layering is frequently observed (Fig. 2). Individual microgranite-pegmatite bodies within a microgranite-pegmatite complex are usually parallel with conformable contacts. However, unconformable contacts (truncation structures) with apparent angle of discordance ranging from a few degrees to 30° are not uncommon (Figs. 2A and 4). Truncation structures mostly occur towards the outer margin of a microgranite-pegmatite complex, which according to Duke *et al.* (1988), is suggestive of a general upward addition of new magma pulses.

In summary, there are three types of layering of different scales in the microgranite-

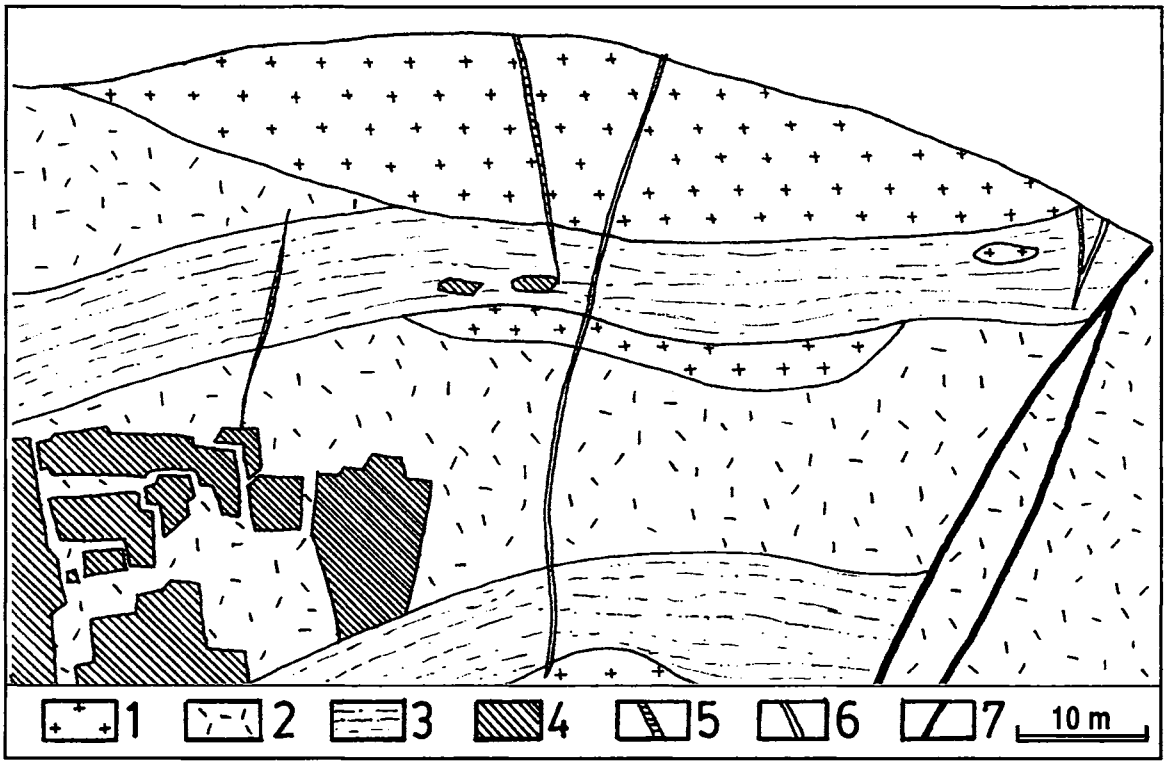

Figure 3. Sketch showing the distribution of microgranite-pegmatite complexes in Perkuat Quarry. 1: megacrystic muscovite-biotite granite; 2: equigranular tourmaline-muscovite granite; 3: microgranite-pegmatite complex; 4: quartz-mica schist enclave; 5: microgranite dike; 6: quartz vein; and 7: fault.

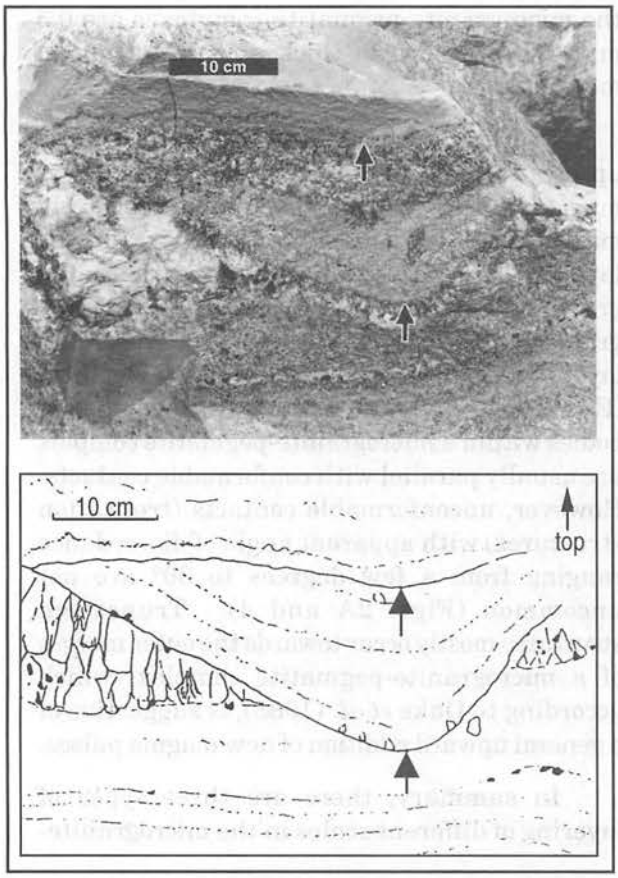

Figure 4. Photograph and sketch showing two truncation structures (unconformable contacts, arrows point to younger layer) in a microgranite-pegmatite complex in Dayapi Quarry.

pegmatite complexes. First is the outcrop-scale layering of the composite microgranite-pegmatite complexes where each microgranite-pegmatite is considered as a single layer. The second is the mesoscopic grain size layering defined by pegmatite and microgranite with contrasting grain size. Lastly, small-scale rhythmic layering are developed in the microgranite layers.

PEGMATITE LAYERS

The pegmatites are commonly planar to irregular tabular and rarely bulbous or podiform in shape. Their thicknesses are seldom uniform laterally, and vary from a few centimetres to 1 m. The pegmatites are composed of perthitic microcline, quartz and acid plagioclase in granitic proportions, and tourmaline and muscovite are common accessory minerals. Grain size may vary from a few centimetres to 30 cm and the coarsest crystals are microcline followed by quartz and plagioclase. Most of the pegmatites consist of three zones: a very coarse-grained upper zone rich in microcline; a central quartz-rich core; and a lower plagioclase-rich zone (Fig. 5).

The upper zone is made up of microcline graphically intergrown with quartz, radiating aggregates of muscovite and subordinate

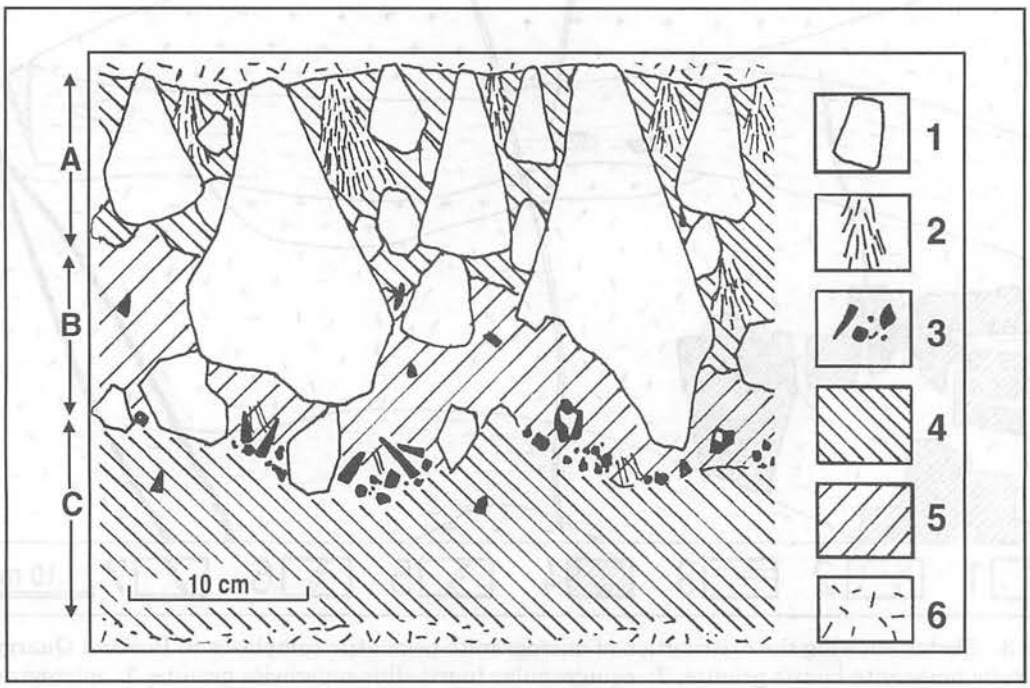

Figure 5. Sketch from a photograph showing typical mineral zoning in the pegmatite of the microgranite-pegmatite complexes. A: upper microcline-rich zone; B: central quartz-rich core; C: lower plagioclase-rich zone; 1: perthitic microcline; 2: muscovite aggregate; 3: tourmaline; 4: plagioclase; 5: quartz; and 6: microgranite.

plagioclase which may also be graphically intergrown with quartz. The wedge-shaped elongated perthitic microcline and cone-shaped muscovite aggregates grow downwards, broadening inward into the core of the pegmatite. The microcline and muscovite crystals are dimensionally orientated approximately perpendicular to the pegmatite layers. The graphic intergrowth of the microcline and quartz is well developed at the margin of the pegmatite and diminishes towards the core. The core of the pegmatite consists of quartz with some microcline and tourmaline. Muscovite and plagioclase may also be present. The quartz-core is commonly absent in thinner pegmatites (less than 0.3 m thick). Plagioclase is mainly concentrated at the lower zone of the pegmatites.

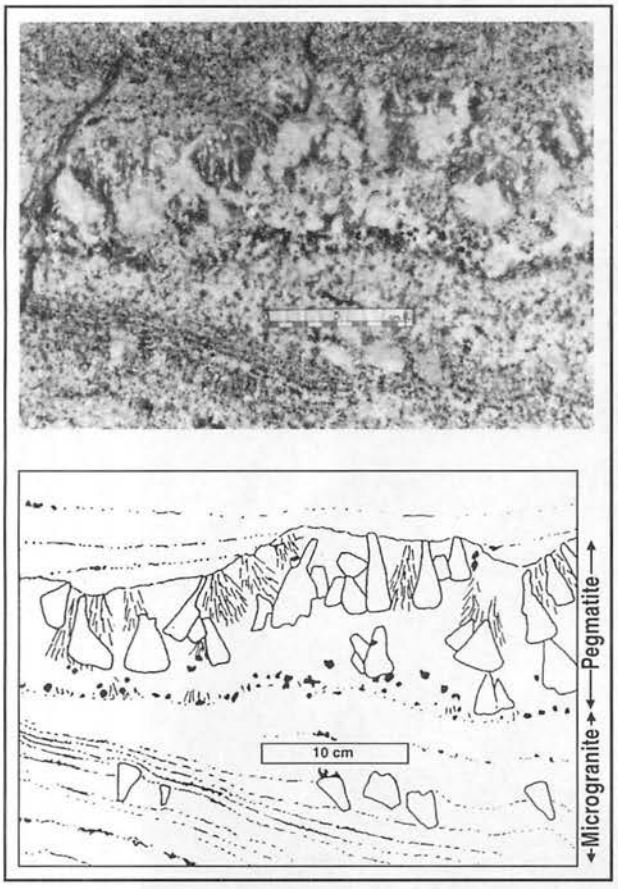

Figure 6. Photograph and sketch of a microgranite-pegmatite body showing grain size layering formed by very coarse grained pegmatite and fine grained microgranite. The microcline grains in the pegmatite broaden downwards into the core and the microcline megacrysts in the layered microgranite broadens in the opposite direction. Note the deflection of fine layering (dark bands) over the microcline megacrysts.

MICROGRANITE LAYERS

Generally, microgranite occupy 60% to 90% of the total volume of the microgranite-pegmatite bodies. Fine grained allotriomorphic granular texture or aplitic texture predominates in the microgranite, but hypidiomorphic texture is not uncommon. They range from leucocratic to mesocratic. They are fine to medium grained with grain size less than 3 mm in the maximum dimension. Occasionally, megacrysts of perthitic microcline up to 5 cm are present. Some of the elongated microcline megacrysts broaden upward from the lower contact of the microgranite (Fig. 6) suggesting that crystallization of the microgranite-pegmatite bodies proceeded upward from the lower contact towards the upper contact (Duke *et al.*, 1988).

The microgranites are internally layered and the layering is commonly rhythmic. The rhythmic layering is defined by modal differences in light and dark minerals (modal layering). This is commonly accompanied by variation in grain size between different layers though the grain size in a single is fairly uniform. Individual rhythmic layers range from 5 mm to 30 cm in thickness, but generally they are less than 10 cm thick. The contacts between the rhythmic layers vary from being fairly sharp to diffused. The layers are subparallel, and planar to gently undulating (Fig. 7) with rare colloform structures. Microgranite layers may also be homogeneous in terms of modal composition and grain size.

Two types of modal layering are observed: (i) isomodal layering defined by alternating dark and light coloured bands with similar composition (Figs. 8 and 9) and (ii) modal-graded layering that is characterized by a gradual stratigraphic variation in modal composition and colour (Fig. 10).

Modal compositions of dark, light and intermediate-coloured bands of microgranite samples with isomodal layering are shown in the form of stacked bar diagrams and are also plotted in a Q-A-P triangle (Fig. 11). The colour of the microgranite is mainly determined by the abundance of tourmaline and to a lesser extent, muscovite. However, the relationship between the colour of the microgranite and the proportion of major minerals is less obvious.

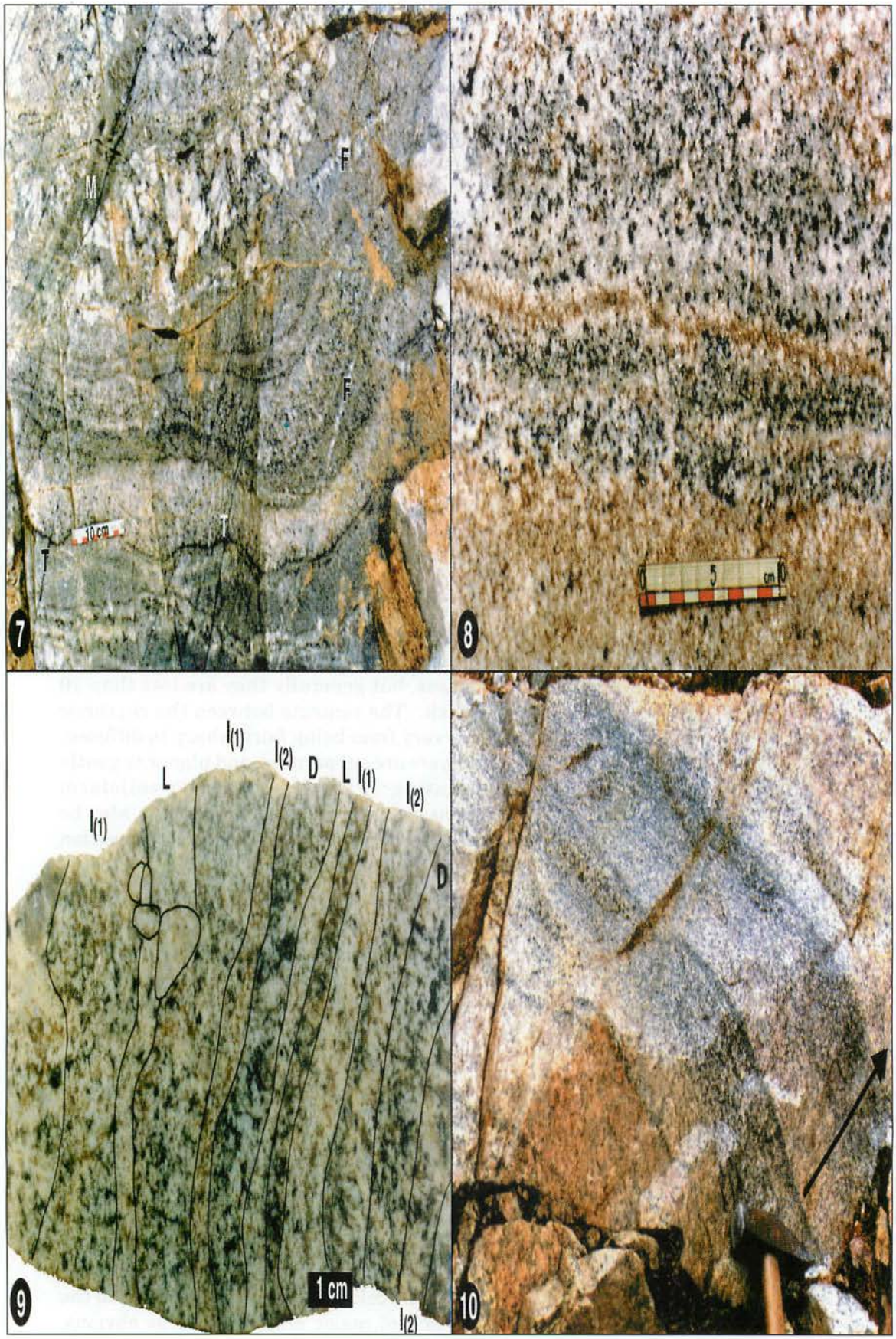

Figure 7. Photograph of the microgranite-pegmatite complex showing curved pegmatite and microgranite layers in Perkuat Quarry. Rhythmic modal layering is developed in the microgranite. The microgranite-pegmatite complex is cut by a younger microgranite dike (M), tourmaline (T) and feldspar (F) veins.

Figure 8. Fine scale isomodal rhythmic layering in the microgranite is formed by bands with similar composition and colour.

Figure 9. Photograph of a microgranite sample with fine scale rhythmic isomodal layering defined by dark (D), light (L) and intermediate ($I_{(1)}$ and $I_{(2)}$) coloured bands. Modal composition of these bands is shown in Figure 11 (Sample K147).

Figure 10. Modal-graded rhythmic layering in the microgranite is made up of microgranite bands with stratigraphic variation of modal composition and colour. Arrow points towards direction of younging.

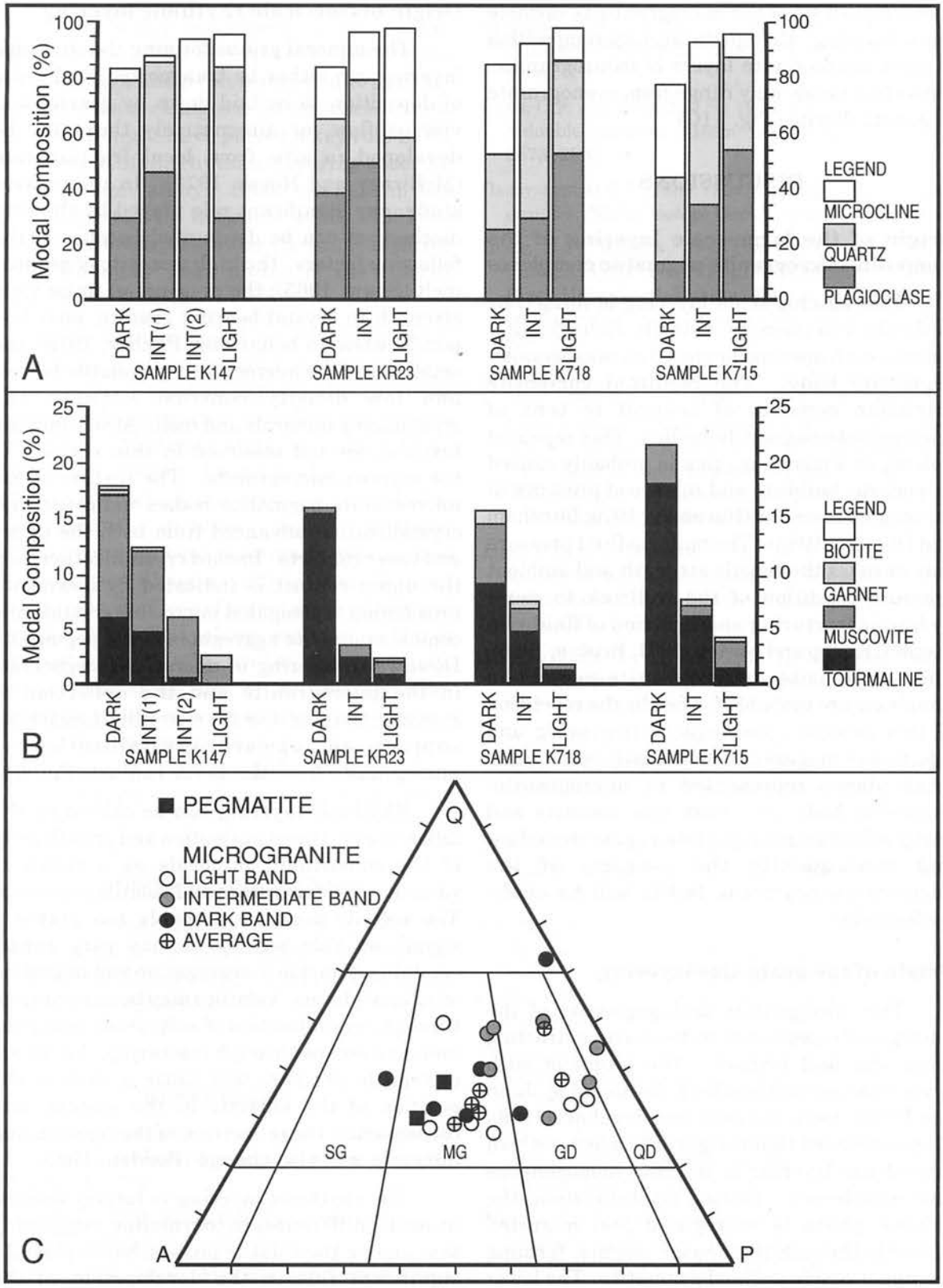

Figure 11. A) and B) are stacked-bar diagrams of modal composition of dark, light and intermediate (INT) coloured bands in rhythmically layered microgranite. Sample K147 is shown in Figure 9. C) Plots of the modal composition of pegmatites and microgranites of the microgranite-pegmatite bodies in the Streckeisen (1976) Q-A-P nomenclature triangle. SG: syenogranite; MG: monzogranite; GD: granodiorite; and QD: quartz diorite.

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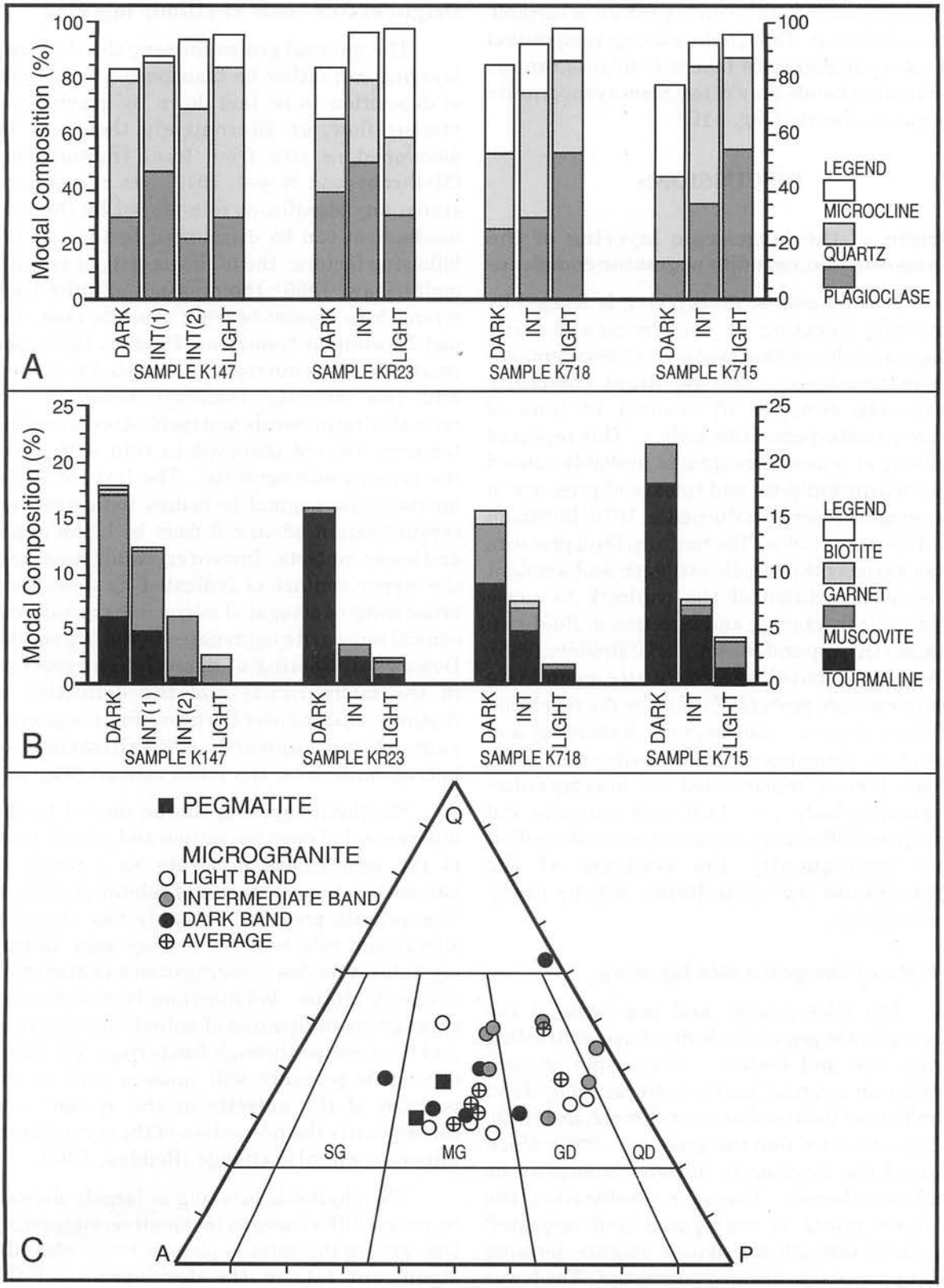

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The composition of the microgranite is variable due to layering. Though the average composition of most microgranite layers is monzogranitic, individual bands may range from syenogranite to quartz diorite (Fig. 11C).

DISCUSSIONS

Origin of the large-scale layering of the composite microgranite-pegmatite complexes

This outcrop-scale layering is formed by multiple injection of volatile-rich granitic magma, each injection produced an microgranite-pegmatite body. The resultant composite intrusion consists of several to tens of microgranite-pegmatite-bodies. This repeated pulsing of aqueous magma is probably caused by periodic build-up and release of pressure in the magma reservoir (Burnham, 1976; Burnham and Ohmoto, 1980). The built-up fluid pressure may surpass the tensile strength and ambient pressure condition of the wallrock to cause hydraulic fracturing and injection of fluid-rich magma (Knapp and Norton, 1981; Brisbin, 1986). The composite microgranite-pegmatite complexes are probably formed by the repetition of this process. Subsequent fracturing and injection of magma can most easily occur along weak planes represented by microgranite-pegmatite body — host rock contacts and partly solidified microgranite-pegmatite bodies, and consequently the contacts of the microgranite-pegmatite bodies will be quasi-conformable.

Origin of the grain size layering

The microgranite and pegmatite of the microgranite-pegmatite bodies have contrasting grain size and texture. The origin of such grain size layering has been discussed by Jahn and Tuttle (1963) and Jahn and Burnham (1969). They concluded that the granitic magma which formed the layering is initially homogeneous and volatile-rich. During crystallization, the volatile phase is segregated and migrated upwards through the denser magma, forming the upper coarse grained pegmatite. The lower portion is impoverished in volatile phase and crystallized into microgranite.

Origin of fine-scale rhythmic layering

The mineral grains forming the rhythmic layering can either be transported to the site of deposition to be laid down by gravity and viscous flow, or alternatively they may be developed *in situ* from local fractionation (McBirney and Noyes, 1979). In the present study, any significant role played by the first mechanism can be discounted because of the following factors: the high viscosity of granitic melt (Shaw, 1965); the presence of finite yield strength in crystal-bearing granitic melt (i.e. non-Newtonian behaviour, Pitcher, 1979); the small size of the microgranite-pegmatite bodies; and low density contrast between the crystallizing minerals and melt. Also, cumulate textures are not observed in thin sections of the layered microgranite. The texture of the microgranite-pegmatite bodies indicates that crystallization advanced from both the upper and lower contacts. Inward crystallization from the upper contact is indicated by downward broadening of elongated microcline crystals and conical muscovite aggregates in the pegmatite. Downward tapering of microcline megacrysts in the microgranite and the deflection of rhythmic layering over the microcline megacrysts support an upward crystallization of microgranite from the lower contact (Fig. 6).

Rhythmic layering can be caused by the differences between nucleation and growth rates of the constituent minerals as a result of variation in temperature and volatile pressures. The volatile pressure probably has played a significant role because it may vary during crystallization due to segregation and migration of volatile phases. Volatiles may be concentrated through crystallization of anhydrous minerals, and may escape through fracturing. Variation of volatile pressure will cause a shift in the position of the eutectic in the system, and consequently the proportion of the crystallizing minerals will also change (Redden, 1963).

The rhythmic layering is largely defined by modal differences in tourmaline, suggesting that among the volatile phases, boron played a significant role in the development of the rhythmic layering. Manning and Pichavant (1983) have shown that boron has a greater

effect than water in depressing the solidus temperature. The interplay of tourmaline crystallization and a consequent shift in phase equilibria due to changes in boron concentration in the melt might have played a key role in the development of the rhythmic layering observed in the present study. Such mechanism has been suggested by Rockhold *et al.* (1987) to explain the origin of similar rhythmic layering in the Calamity Peak pluton of the Harney Peak, South Dakota.

A mechanism based on double-diffusive convection in an essentially static boundary layer has been used to explain the rhythmic layering in basic igneous complexes by several workers (e.g. McBirney and Noyes, 1979; Chen and Turner, 1980). Layering due to double-diffusive convection was also demonstrated in experimental studies using initially homogeneous aqueous solution by cooling and crystallization along a vertical wall (Turner, 1980), along the floor of a container (Chen and Turner, 1980) and along inclined surfaces (Huppert *et al.*, 1987). In the present study, however, the small size of the microgranite-pegmatite bodies as well as the high viscosity of granitic melts probably preclude any significant role of double-diffusive convection in the formation of the observed rhythmic layering.

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This paper forms part of a M.Phil. dissertation at the Institute of Advanced Studies, University of Malaya and I would like to thank Dr. K.R. Chakraborty and Dr. J.K. Raj for their supervision.

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PERTEMUAN PERSATUAN
Meetings of the Society

Ceramah Teknik (Technical Talk)

From limestone to sandstone: The sedimentology of the Gomantong Limestone and Tanjong Formation in Northeast Borneo

JON NOAD

Laporan (Report)

Jon Noad, from University College London, who is back in Malaysia to do further field investigations in Sabah for his Ph.D. thesis, gave the above talk on 26 May 1997 at 5.30 pm at the Department of Geology, University of Malaya.

Abstrak (Abstract)

In eastern Sabah, southeast of the Crocker Range, clastic and subordinate carbonate sedimentary rocks, of Eocene to Miocene age, were deposited in a large east-west trending foreland basin. The basin probably formed as a result of flexural downwarping, in response to sediment loading by material eroded from the accretionary wedge to the north. These deposits include the siliciclastic Kulapis and Labang Formations and the Gomantong Limestone.

The Gomantong Limestone outcrops in the eastern third of the basin, and is interpreted as having been deposited in shallower shoaling portions of the basin. Exposure is limited to isolated outcrops of deformed, often overturned or steeply dipping, carbonates; active quarrying providing scattered but locally excellent outcrop for detailed sedimentological analysis. The studied localities form a linear trend extending some 50 km in a SSW-NNE orientation, although individual outcrops seldom extend for more than 500 m laterally. Limited burial of these carbonates has resulted in excellent preservation of these sediments with very little recrystallization.

The carbonates are made up of lithofacies ranging from open marine shelfal marls to reefal deposits, and a range of depositional environments have been identified as a result of field logging and subsequent petrological analysis. A very rich fauna is present throughout the formation, though intervals are often dominated by large benthic foraminifera, particularly Lepidocyclina. The marls have been dated as latest Oligocene to Lower Miocene in age. The Gomantong Limestone overlies, and may locally be syndepositional with, the Labang Formation and clasts derived from the underlying formation are found at various levels within the limestone sequence. The bulk of the limestone consists of coral-dominated framestone and bindstones and associated forereef facies. Coral morphology (largely Porites), foraminiferal/ algal content and detailed sedimentological observations allow interpretation of relative palaeobathymetry of these carbonates, and the sequences interpreted in terms of relative sea level. The limestones are unconformably overlain by the Tanjong Formation to the west.

The isolated nature of individual outcrops, and the range of dominantly shallow to very shallow marine deposits, suggests that the Gomantong Limestone was deposited along an east-west trending shoreline, developed on a palaeohigh within the foreland basin.

Following deposition of the Gomantong Limestone, extension of the Southeast Sulu Sea in the very early Miocene, by rifting of the pre-existing ophiolitic terrain, led to limited oceanic

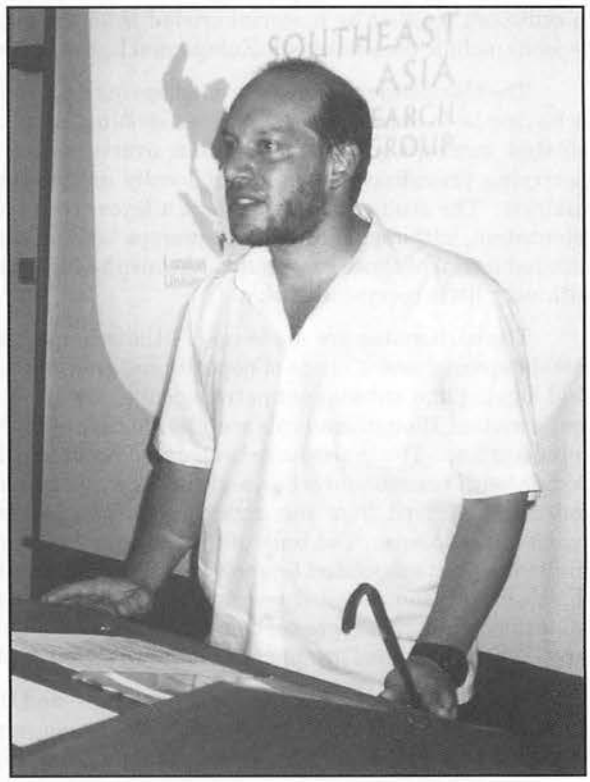
spreading. Eastern Sabah was at the hinge of this spreading zone, and a combination of these extensional forces, together with compression caused by the collision, was accommodated by wrench faulting, opening a series of Tertiary sedimentary basins which overlie a widespread mélange, or distal turbidites derived from the Crocker accretionary prism.

The Bukit Garam and Sandakan Basins form part of a series of distinctive circular Miocene basins, each with basin fills exceeding 2 km in thickness, across northeastern Borneo. Age determination of sedimentary fill is hindered by the absence of microfauna in many intervals. The Sandakan Basin is the most northeasterly of the onshore basins, and my studies show it to be dominated by shallow marine, deltaic and mangrove deposits. The Bukit Garam Basin lies to the southwest of Sandakan in Sabah. Lower-Middle Miocene clastics (Tanjong Formation) are underlain by accretionary wedge turbidites to the west and south. To the north these clastics overlie the Garinono Mélange, and in the study area described above it rests on steeply-dipping late Oligocene shallow marine carbonates of the Gomantong Limestone.

The basin fill comprises Lower to Middle Miocene clastics of the Tanjong Formation, which were deposited in distal deltaic/shelfal to nearshore wave-dominated shallow marine environments. A new section has been exposed in the Sentosa Oilpalm Plantation, and provides over 800 m of almost continuous exposure. It is situated on the eastern margin of the basin, where dips are relatively steep, and outcrops are characterised by ridges of more resistant sandy sediments. Within this sequence several 100–200 m cycles are identified, each beginning with open marine mudstones and thin turbiditic sands and passing up into thick shallow marine sands with abundant carbonaceous material and large amber clasts. A tropical insect fauna is well preserved in the amber.

These shelfal deposits are then incised into by a well defined channel feature. Associated with, and following deposition of the basal channel fill, there is a dramatic change in the character of sedimentation. Extraformational conglomeratic lags, abraded shallow marine fossils and large channelised features are observed. These feature reflect the tectonic uplift of older sediments to the east of the basin, and may result from the latter stages of the Dangerous Grounds block collision event. Towards the top of the section winged channels with fossiliferous basal lags cut into mudstone, and are interpreted as dominantly estuarine and proximal deltaic deposits. Differentiation of palaeoenvironments is supported by sedimentary structures and by the macro- and trace fossils.

The absence of deep marine clastic sediments in the Sandakan basin suggests that the age of the circular basin fill youngs, and sedimentation within the basins becomes progressively shallower marine in character, towards the NE. The absence of sedimentological evidence of the Dangerous Grounds collision event in the Sandakan Basin suggests that it is younger than the Bukit Garam Basin.



JON NOAD

Site Visit — LRT2 Tunnel Site (Sultan Ismail Station) — Report

The half-day site visit to the LRT2 Tunnel Site (Sultan Ismail Station) was held on Saturday 21st June 1997. Organised by the Chairman of the Working Group on Engineering Geology and Hydrogeology, Muhinder Singh, the quota of 30 (due to safety restrictions) was easily filled and many had to be turned away.

Going through the usual Saturday morning jam in the heart of Kuala Lumpur, it was a relief to get from the Geology Department, Universiti Malaya to the tunnel site at Sultan Ismail Station in a good 30 minutes.

En. Zulkifli Mohd Yusoff, General Manager, Project Division LRT, started off the project briefing. The PUTRA-LRT network or LRT System 2 will cover a distance of about 30 km with 24 stations and have an underground system of approximately 5.4 km through the city centre. The skytrains have an average speed of 40 km/hr, with initial capacity of 10,000–16,500 passengers per hr/per direction reaching a maximum capacity of 30,000 by 2005. The estimated frequency of service is 1–3 minutes at peak hours and will operate from 6 am to 12 midnight. There will be 70 trains (10% on standby) and added features include, full automation, driverless, toilets, and handicap facilities.

Of special interest to those present is the underground system which comprises 5 underground stations, namely Benteng, Sultan Ismail, Kampong Baru, KLCC and Ampang Park. The depth of the tunnel will be approximately between 15–20 m. The route comprises two parallel tunnels constructed by means of Tunnel Boring Machines (TBM) that are designed to excavate and construct the tunnel lining simultaneously. At this juncture Mr. Gary Ng of Hyundai and Mr. C.S. Ooi of Hazama took over to handle the technical briefing. The machines arrived in transportable parts and had to be assembled in the work shafts before they are fully operational. There are 2 types of machines, based on the operational functions. One is an Open-Faced Rotary Backhoe Tunnel Boring Machine (by Hyundai-Pati Consortium from Korea), which is used for the construction of the tunnel from Ampang Park to Kg. Baru and the other the Closed-Faced Earth Pressure Shield Tunnelling Machine (by Hazama Corporation of Japan), which is for the construction of the tunnel from Sultan Ismail Station to Kg. Baru Station.

After some refreshments, the participants were shown the Control Room where accurate alignment of the tunnels are made and monitored and where TV monitors keep a constant eye on the tunnelling operations. Next the participants were briefed on the strict safety regulations before climbing down the underground station under construction to visit the tunnel. In the tunnel the group was shown the excavating work in progress by a Shield Tunnelling machine which is presently just below the Klang River and the simultaneous construction of the tunnel lining.

The group 'surfaced' at about 11.30 am and after a group photograph and a round of 'thank yous', had to crawl their way back to PJ through a much thicker Saturday lunch-hour jam.

G.H. Teh

Site Visit — LRT2 Tunnel Site (Sultan Ismail Station)

Captions to photos

1–2 Ready for the briefing.
3. En. Zulkifli on the PUTRA-LRT network.
4. At the Control Room.
5. Safety briefing before descending underground.
6. Head count before entering the tunnel.
7. A closer look at the tunnel lining.
8. Boring site briefing by Mr. C.S. Ooi.
9. A group photo.

Annual Geological Conference 1997

Laporan (Report)

Awana Kijal Beach & Golf Resort
Terengganu

1997 happens to be 'Visit Terengganu Year'. And what better a time to return to Terengganu for the 12th Annual Geological Conference which was held on 30 May – 1 June 1997 at Awana Kijal Beach & Golf Resort Terengganu. The last Annual Geological Conference held there was in 1994 at Kuala Terengganu. Once again the Conference was ably handled by Dr. Ahmad Tajuddin Ibrahim and his organizing committee. It was heartening to note that the Conference this year attracted 167 participants.

There were 30 papers presented and keen interest was shown in the 9 posters as well. The Conference also had a special session on *non-marine environments and deposits*. Two Keynote Papers were presented, one by Prof. Ibrahim Komoo on *geology in the total context of national development for the next millennium* and the other on *non-marine extensional basins* by Prof. J.J. Lambiase.

It was encouraging to note that besides the usual strong participation from the local universities, namely Universiti Malaya and Universiti Kebangsaan Malaysia, there was participation from University of Brunei, Petronas Research & Scientific Services Sdn. Bhd. (PRSS), the Geological Survey of Malaysia besides the welcomed return of Tuan Besar and his group from Universiti Sains Malaysia, Tronoh.

The Conference was again opened by the Menteri Besar Terengganu, Y.A.B. Dato' Seri Amar Di Raja Tan Sri Wan Mokhtar bin Ahmad, who had to come all the way by road from Kuala Terengganu to lend his strong support to the Conference. We are indeed grateful to Y.A.B. for again hosting the Conference Dinner and allowing us the use of the speedboats on the Gunung Gagau fieldtrip, where he has shown interest in its geological as well as tourist potential. At the Opening Ceremony there was also the presentation of the Society's "Common Rocks of Malaysia" posters to all secondary schools and teachers training colleges in Terengganu through the Pengarah Pendidikan Negeri.

Among the novelties at this Conference was the well-participated beach volleyball competition. Life members of the Society were presented their certificates at the Conference Dinner. The Society is also grateful to MMC for hosting the ice-breaker barbecue on the first evening.

The Conference fieldtrips were ably led by Dr. Azhar Hj. Hussin. The Pre-Conference Stratigraphy & Sedimentological Fieldtrip included visits to outcrops in the Kijal and Kemaman areas while the Post Conference Fieldtrip was to Gunung Gagau from Sungai Gawi Jetty on Kenyir Dam after an overnight stay at the Kuala Berang Rest House. It was indeed an exhaustive hike on the first day and when the group decided to make camp at 5 pm, it was still some distance from the foot of mighty Gunung Gagau! Due to time constraints, the Society group had to hike back early the next day to be in time to be picked up by the speedboats to get back to Sg. Gawi Jetty and then Kuala Lumpur. The aim to conquer Gunung Gagau and the hunt for the elusive dinosaur fossils were entrusted on Dr. Lee Chai Peng who carried on with the group from Universiti Kebangsaan Malaysia led by Prof. Ibrahim Komoo.

G.H. Teh

Annual Geological Conference 1997

Ucapan Aluan Pengerusi Penganjur Persidangan, Dr. Ahmad Tajuddin Ibrahim

Yang Berusaha, Tuan pengerusi majlis,
Yang saya hurmati Y.A.B. Dato' Seri Amar Diraja Tan Sri Haji Wan Mokhtar Ahmad, Menteri Besar Terengganu,
Yang Berusaha Dato' Saad Muda, Pegawai Daerah Kemaman,
Yang Berusaha Dr. Khalid Ngah, Presiden Persatuan Geologi Malaysia,
Para jemputan dan tuan-tuan dan puan-puan sekelian.

Assalamualaikum dan salam sejahtera kepada semua. Terlebih dahulu saya mengucapkan selamat datang ke Persidangan Tahunan Geologi 1997. Saya juga mengucapkan selamat datang dan jutaan terima kasih kepada Y.A.B. Tan Sri Menteri Besar Terengganu kerana sudi ke-Majlis kami pada pagi ini dan seterusnya akan merasmikan persidangan kita kali ini.

Ramai di antara kita di sini masih teringat 4 tahun lepas di mana kita dijamu dengan hidangan lazat tradisional Terengganu di kediaman Y.A.B. Tan Sri bersempena persidangan tahunan kita di Kuala Terengganu. Jangan risau, malam ini kita akan dijamu Y.A.B. Tan Sri sekali lagi di Jamuan Rasmi persidangan kita. Terima kasih sekali lagi kita ucapkan kepada Y.A.B. Tan Sri.

Dikesempatan ini izinkan saya menyampaikan terima kasih yang tidak terhingga kepada PETRONAS dan Permint Minerals Sdn Bhd di atas sumbangan kewangan mereka, kepada Y.A.B. Tan Sri sekali lagi kerana sumbangan kemudahan bot laju untuk kerjalapangan ke Gunung Gagau, kepada Ketengah kerana penajaan mereka untuk ke Gunung Gagau, kepada Pegawai Daerah Hulu Terengganu di atas segala bantuan yang diberikan, kepada Perhilitan di atas kerjasama yang diberikan untuk ke Gunung Gagau. Terima kasih juga kepada Jabatan Penyiasatan Kajibumi Malaysia, Jabatan Geologi Universiti Kebangsaan Malaysia dan Universiti Malaya dan Petronas Research & Scientific Services kerana sudi berkerjasama mengusahakan persidangan ini dan juga tridak lupa kepada semua penyumbang kertas kerja. Akhir sekali terima saya juga kepada semua AJK Penganjur, walaupun sibuk dengan tugas masing-masing masih sudi meluangkan masa untuk menjamin kejayaan persidangan ini.

Sekian, terima kasih.

Annual Geological Conference 1997

Ucapan Perasmian oleh Y.A.B. Dato' Seri Amar DiRaja Haji Wan Mokhtar bin Ahmad, Menteri Besar Terengganu

Assalamualaikum warahmatullahi wabarakatuh. Bismillahir-rahmanirrahim.

Yang Mulia Pengerusi Majlis,
Yang Berbahagia Dr Khalid Ngah, Presiden Persatuan Geologi Malaysia.
Yang Berbahagia Dr Ahmad Tajuddin Ibrahim, Pengerusi Jawatankuasa Pengelola Persidangan.
Ahli-Ahli Yang Berhurmat,
Tuan-tuan dan puan-puan serta hadirin yang dihurmati sekelian.

Saya bersyukur kepada Allah dan saya merasa amat gembira diberi kesempatan untuk berucap kepada para peserta persidangan ini yang terdiri dari geosaintis dari semua universiti di Malaysia dan juga mereka yang berkhidmat dengan Kerajaan, Badan-Badan Berkanun dan dari Sektor Swasta.

Saya percaya suasana alam sekitar yang indah, nyaman dan tenteram di sini akan membantu tuan-tuan dan puan-puan melahirkan idea-idea lebih bernas bukan sahaja untuk meningkatkan mutu profession geosaintis tetapi juga dapat memberi sumbangan bermakna di dalam bidang masing-masing ke arah pembangunan negara.

Penyertaan tuan-tuan dan puan-puan jelas menunjukkan betapa pentingnya persidangan ini bukan saja kepada Persatuan malah kepada Negara. Kerajaan mengakui bahawa tuan-tuan dan puan-puan merupakan tenaga penting yang terlibat secara langsung didalam eksplorasi dan pembangunan sumber-sumber asli kekayaan negara seperti petroleum, gas, air bawah tanah, galian metalik dan bukan metalik dan sebagainya.

Tuan-tuan dan puan-puan juga memainkan peranan penting didalam kerja-kerja binaan kejuruteraan dari pembinaan empangan, terowong, rangkaian lebuhraya dan jalanraya sehingga pembangunan kawasan perindustrian dan perumahan.

Malaysia di bawah pimpinan Y.A.B. Perdana Menteri yang kita kasihi Datuk Seri Dr. Mahathir, sedang pesat membangun menuju wawasan negara maju menjelang 2020. Pembangunan seimbang fizikal dan rohani menjadi matlamat kita. Pembangunan seimbang tidak berlaku secara sengaja atau dengan automatik. Ianya memerlukan perancangan yang cukup teliti. Aspek geologi dan sekitaran adalah antara aspek penting yang perlu diambil kira demi memastikan pembangunan seimbang yang berterusan. Adalah menjadi tanggungjawab bersama kita demi generasi akan datang untuk memastikan gangguan negatif yang minima terhadap alam sekitar hasil dari pembangunan yang dilaksanakan.

Tuan-tuan dan puan-puan perlu menjadi agen pembangunan yang proaktif menyuarakan pendapat dan memberi nasihat bila difikirkan perlu. Di samping itu tuan-tuan dan puan-puan juga perlu menjaga mutu professionalisme kerja supaya tidak diragui hasilnya. Saya percaya tuan-tuan dan puan-puan tertunggu-tunggu kelulusan 'akta professional geologis' yang telah lama tuan-tuan dan puan-puan kemukakan kepada Kementerian berkenaan. Saya percaya akta ini akan dapat mengawal profession geologis di samping menjaga kepentingan masyarakat dari akibat kerja-kerja geologi oleh mereka yang tidak berkelayakan melakukannya. Saya

berharap tuan-tuan dan puan-puan akan terus berusaha menjadikan akta ini satu realiti didalam masa terdekat ini.

Negeri Terengganu telah mendapat banyak faedah dari kekayaan geologinya. Daripada zaman kegemilangan Bukit Besi, keperlombongan berbagai jenis bijih iaitu besi, timah dan tungsten di Kemaman dan Dungun hingga kezaman petroleum yang telah merubah Kemaman kepada kawasan industri yang begitu hebat sekali sekarang ini.

Perlombongan bukan hanya terhad kepada mineral metalik sahaja. Ianya juga melibatkan bahan bukan metalik seperti agregat batuan (pengkuarian), lempung, pasir dan kerikil dan pasir silika. Negeri Terengganu mempunyai simpanan pasir silika melebihi 33 juta tan metrik iaitu merupakan simpanan pasir silika semulajadi tertinggi di Malaysia. Terengganu juga mempunyai simpanan lempung yang banyak serta batuan igneus yang banyak dan berbagai jenis. Kerajaan Terengganu akan memberi pertimbangan serius untuk memajukan industri berasaskan mineral-mineral industri tersebut. Kerajaan bercadang mewujudkan kawasan perindustrian berasaskan silika di Dungun. Industri menghasilkan batuan dimensi, cobblestone dan barangan ceramik adalah digalakkan.

Pemilihan Terengganu sekali lagi sebagai tempat persidangan kali ini adalah tepat sekali memandangkan potensi besar untuk memajukan sumber geologinya. Terengganu juga mempunyai banyak tempat-tempat yang menarik yang mempunyai kaitan dengan geologinya. Di antaranya ialah Tasik Kenyir, Gunung Biwah dan Gunung Taat, Gunung Gagau, Air Terjun Chemerong (Ulu Dungun), Lata Tembakah, Taman Rekreasi Bukit Besi dan lain-lain. Kerajaan Terengganu bersedia memberi pertimbangan untuk mengekalkan ciri-ciri geologi yang penting daripada dimusnahkan terutamanya yang boleh menjadi tarikan pelancong.

Tahun 1997 juga adalah Tahun Melawat Terengganu. Saya percaya tuan-tuan dan puan-puan akan mengambil kesempatan ini untuk melawat tempat-tempat yang menarik disini di samping merasa masakan tempatan yang menyelerakan. Sekumpulan dari tuan-tuan dan puan-puan akan membuat kajian ke Gunung Gagau. Saya difahamkan diantara aspek yang akan dilihat ialah samada berkemungkinan terdapat fossil dinosour di sana. Saya mendoakan kajian ini akan mencapai matlamatnya dan mudah-mudahan Terengganu akan mendapat faedah darinya.

Buat mengakhirinya saya sekali lagi mengucapkan ribuan terima kasih kepada pihak penganjur kerana sudi menjemput saya menyempurnakan majlis ini.

Dengan lafaz bismillahir-rahmanir-rahim, saya sukacita merasmikan Persidangan Tahunan Persatuan Geologi Malaysia 1997. Sekian, Selamat Bersidang.

Annual Geological Conference 1997

Programme

FRIDAY 30 May 1997

08.00 : **Pre-Conference Field Trip**
17.00 : **Beach Volleyball Competition**
20.00 : **Ice-Breaker BBQ**

SATURDAY 31 May 1997

08.00 : Late Registration

Opening Ceremony

09.30 : Welcoming Address by Dr. Ahmad Tajuddin Ibrahim, Organising Chairman
09.35 : Welcoming Address by Dr Khalid Ngah, President, Geological Society of Malaysia
09.40 : Official Opening Address by Menteri Besar Terengganu, Y.A.B. Dato' Seri Amar DiRaja Tan Sri Haji Wan Mokhtar bin Ahmad
10.00 : Presentation of 'Common Rocks of Malaysia' Posters to Pengarah Pendidikan Negeri for distribution to all secondary schools and teachers training colleges in Terengganu.
10.05 : **Tea Break**

Session I

● **Keynote Paper 1**

10.25 : **Ibrahim Komoo** (LESTARI, Universiti Kebangsaan Malaysia)
Geologi dalam konteks pembangunan negara menyeluruh untuk milenium akan datang

● **Oral Papers**

11.05 : **Mazlan Madon** (PETRONAS Research & Scientific Services)
Analysis of tectonic subsidence and heat flow in the Malay Basin (offshore Peninsular Malaysia)
11.25 : **Abd. Rahim Samsudin** (Universiti Kebangsaan Malaysia)
Salinity study of coastal groundwater aquifers in North Kelantan, Malaysia
11.45 : **Baba Musta, Mohd Harun Abdullah** (Universiti Malaysia Sabah) **& Mohamad Md. Tan** (Universiti Kebangsaan Malaysia)
Proses permukaan dan taburan unsur-unsur surih dalam tanah di Pulau Manukan, Sabah
12.05 : **Lee Chai Peng** (University of Malaya)
Neolithic Hominid site at Gua Siam, Langkawi
12.25 : **Tuan Besar Tuan Sarif, Radzali Othman, Abd Khalil Abd Rahim & Ab. Halim Hamzah** (Universiti Sains Malaysia & Geological Survey Malaysia)
Pencirian lempung dari Kuala Kangsar, Perak Darul Ridzuan
12.45 : **Lunch**

Session II

14.00 : **Ibrahim Bin Amnan** (Geological Survey Malaysia & Geological Society Malaysia)
The Malaysian stratigraphic guide
14.20 : **Majeed M. Faisal, Sanudin Hj. Tahir & Sahat Sadikun** (Universiti Malaysia Sabah)
Preliminary evaluation of Sabah seismicity in correlation to the Philippines tectonic setting

14.40 : **Hamzah Mohamad** (Universiti Kebangsaan Malaysia)
The geochemical discrimination parameters for limestone: a case study of Bukit Sagu Limestone, Kuantan, Pahang
15.00 : **Mohd Shafeea Leman** (Universiti Kebangsaan Malaysia)
Sedimentology, stratigraphy and paleoecology of Pulau Jemuruk, Langkawi
15.20 : **G.H. Teh & Fahrudean Md. Yunos** (University of Malaya)
Significance of the petrography and geochemistry of the igneous rocks at Kulai-Skudai, Johor
15.40 : **Basir Jasin & Che Aziz Ali** (Universiti Kebangsaan Malaysia)
Significance of Lower Carboniferous Radiolarian chert from Langkap, Negeri Sembilan
16.00 : **Tan Boon Kong & Anizan Isahak** (Universiti Kebangsaan Malaysia)
Physico-chemical and mineralogical properties of basalt soils from Segamat, Johor
16.20 : **Tea Break**

17.00 : **Beach Volleyball Final**
20.00 : **Conference Dinner. Host: Menteri Besar Terengganu, Y.A.B. Dato' Seri Amar DiRaja Tan Sri Haji Wan Mokhtar bin Ahmad**

SUNDAY 1 June 1997

Session III

● Keynote Paper 2

08.30 : **J.J. Lambiase** (University of Brunei Darussalam)
Facies distribution, stratigraphic succession and hydrocarbon habitat in non-marine extensional basins

● Oral Papers

09.10 : **Wan Hasiah Abdullah** (University of Malaya)
Depositional palaeoenvironment determination based on organic facies characterisation — a case study of the Batu Arang coal-bearing sequence
09.30 : **Uyop Said & Che Aziz Ali** (Universiti Kebangsaan Malaysia)
Nenering continental deposits: its age based on the palynological evidence
09.50 : **Azmi Mohd Yakzan** (PETRONAS Research & Scientific Services)
Palynomorphs from non-marine deposits in the Malay Basin
10.10 : **Yeap Ee Beng** (University of Malaya)
The types and the origin of carbonate karsts in Malaysia and their significance
10.30 : **Tea Break**
10.50 : **Abdul Hadi Abd. Rahman & Lee Chai Peng** (University of Malaya)
Stratigraphy and sedimentology of a Jura-Cretaceous 'Park' near Bandar Muadzam Shah, Pahang
11.10 : **Wan Fuad Wan Hassan, Mohd Suhaimi Hamzah & Khalik Hj Wood** (Universiti Kebangsaan Malaysia)
Gold abundances in some metasedimentary rocks of Peninsular Malaysia
11.30 : **Abd. Ghani Rafek** (Universiti Kebangsaan Malaysia), **N. Graf** (Geo-System, Bochum) **and R.M. Spang** (Geo-plan, Witten)
Computer-aided processing of discontinuity data: a case study from km 26.5, Kuala Lumpur-Karak Highway, Malaysia

● Poster Papers

11.50 : **S.H. Goh & E.B. Yeap** (University of Malaya)
The analysis on the cause of the slope failure and debris fluid flows in Penang Island which happened on the 18th September 1995
11.55 : **Marilah Saman & Ibrahim Komoo** (Universiti Kebangsaan Malaysia)
Geologi pemuliharaan: Kajian kes di taman-taman tabii Malaysia — suatu pengenalan

12.00 : **Shamsul Nizam Ariffin** (University of Malaya)
Enapan aliran debris di sekitar kawasan Ladang Boh Cameron Highlands, Pahang Darul Makmur
12.05 : **V. James Danial, Juhari Mat Akhir & Zaiton Harun** (Universiti Kebangsaan Malaysia)
Pemetaan geomorfologi Pulau Timun, Langkawi dengan bantuan fotograf udara
12.10 : **Ros Fatihah Hj Muhammad & E.B. Yeap** (University of Malaya)
The preliminary evaluation and origin of the Sungai Keneras kaolin deposit, Gua Musang, Kelantan
12.15 : **Ab. Halim Hamzah** (Geological Survey Malaysia) **& Tuan Besar Tuan Sarif** (Universiti Sains Malaysia)
Carigali geokimia emas di kawasan Kuala Pilah, Negeri Sembilan
12.20 : **Dana AK Badang, Ibrahim Komoo & Kadderi Md. Desa** (Universiti Kebangsaan Malaysia)
Geologi pelancongan: kajian kes di Taman Kinabalu, Sabah
12.25 : **Umar Hamzah, Abd. Rahim Samsudin, Ab. Ghani Rafek dan Mohd Abu Syariah** (Universiti Kebangsaan Malaysia)
Survei geofizik permukaan dalam pengesanan lohong batu kapur: Kajian kes di Batu Caves (Surface geophysical measurement in subsurface cavity detection: A case study at Batu Caves)
12.30 : **B. Allagu** (Geological Survey Department Malaysia Sabah)
Sedimentation and structural development of the Malibau Basin, Sabah
12.35 : **Lunch**

Session IV

● Oral Papers

14.00 : **Samsudin Hj Taib** (Universiti of Malaya)
Seismic refraction study on sedimentary and granitic terrain
14.20 : **Khairul Anuar Mohd Nayan** (Universiti Kebangsaan Malaysia), **R.J. Whiteley & Paul Famili** (Coffey Partners International Pty. Ltd.)
Seismic tomographic imaging in engineering characterisation of a site in Kuala Kangsar, Perak
14.40 : **Adnan A.M. Aqrawi** (PETRONAS Research & Scientific Services)
Some applications of Multivariate Statistical Packages (MVSP) in sedimentary geology
15.00 : **Muhamad Barzani Gasim** (Universiti Kebangsaan Malaysia) **& Wan Nor Azmin Sulaiman** (Universiti Pertanian Malaysia)
Hydrological characteristic before and after Langat Dam construction, Hulu Langat, Selangor
15.20 : **Che Noorliza Lat** (University of Malaya)
Seismicity of Kenyir, Terengganu
15.40 : **Ibrahim Abdullah, Kamal Roslan Mohamed & Che Aziz Ali** (Universiti Kebangsaan Malaysia)
Struktur Formasi Machinchang: beberapa penemuan baru dan implikasinya
16.00 : **Zaiton Harun** (Universiti Kebangsaan Malaysia)
Kepentingan struktur minor dalam sebilangan zon sesar utama di Semenanjung Malaysia (Significance of minor structures within several major fault zones in Peninsular Malaysia)
16.10 : **G.H. Teh & Kamarudzaman Lokeman** (University of Malaya)
Significance of the geology and geochemistry at Teluk Ewa, Langkawi
16.30 : Closing Address
17.00 : Participants for Post-Conference Fieldtrip depart for Kuala Berang

MONDAY 2 June 1997 to TUESDAY 3 June 1997 (Post-Conference Fieldtrip)

2 June 1997	07.00	:	Depart from Kuala Berang Rest House to Sungai Gawi Jetty
	08.00	:	Breakfast at the Floating Restaurant, Sungai Gawi
	08.30	:	Depart for Gunung Gagau
3 June 1997	15.00	:	Arrive back at Sungai Gawi Jetty from Gunung Gagau and depart for Kuala Lumpur

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Captions to Photos

Annual Geological Conference

1. Arrival of guest-of-honour.
2. Organising Chairman with Welcoming Address.
3. GSM President with his speech.
4. Y.A.B. with the Opening Address.
5–11. The audience at Opening Ceremony.
12–13. Y.A.B. viewing the posters.
14. Ibrahim Komoo with Keynote Paper.
15. Mazlan Madon on the Malay Basin.
16. Abd. Rahim Samsudin on coastal aquifers.
17. Baba Musta receiving momento from G.H. Teh.
18. Lee Chai Peng on Gua Siam.
19. Tuan Besar with his display.
20. Lunch.
21. Ibrahim Amnan on Malaysian stratigraphic guide.
22. Majeed Faisal on Sabah seismicity.
23. Hamzah Mohamad on Bukit Sagu.
24. Shafeea Leman on Pulau Jemuruk.
25. Robert Tate with a question.
26. Basin Jasin on Langkawi radiolarian chert.
27. Anizan receiving momento from P.S. Khor.
28. Joseph Lambiase on extensional basins.
29. Wan Hasiah on Batu Arang coal.
30. Che Aziz Ali on Nenering deposits.
31. Azmi Mohd Yakzan on palynomorphs.
32. E.B. Yeap on carbonate karsts.
33. Abd. Hadi receiving momento from Azhar Hj. Hussin.
34. Wan Fuad on gold abundances.
35. Abdul Ghani Rafek on KL-Karak Highway.
36. Lunch served on a sampan.
37. Samsudin Hj. Taib on shallow seismic refraction.
38. C.P. Lee with a query.
39. Khairul Anuar on seismic tomographic imaging.
40. Adnan Aqrawi on MVSP.
41. Che Noorliza Lat on seismicity of Kenyir.
42. Ibrahim Abdullah on Machinchang Formation.
43. Zaiton Haron on abnormal sense of movement.
44. Muhamad Barzani Gasim on Langat Dam.
45–46. Tea is served.
47. Marilah Saman dengan geologi pemuliharaan.
48. Ab. Halim Hamzah on gold prospecting.
49. Allagu on the Malibau Basin.
50. Dana Ak Badang dengan geologi pelancongan.

Pre-Conference Fieldtrip

51. Briefing at kaolin site.
52. Tuan Besar adds weight to the auger.
53. At the ballclay site.
54. Azhar on outcrops at Tj. Mat Amin.
55. Looking for fossils.
56. A convenient map at the market place.
57. Briefing on the beach at Kemaman.
58. The outcrop at Cherating.

Ice-Breaker BBQ

59. Dinner served on a sampan.
60. Help yourself to the food.
61. The main table.
62. A view of the BBQ.

Beach Volleyball

63–64. Beach volleyball.

The Conference Dinner

65–68. The various tables.

Post Conference Fieldtrip — Gagau

69. Arrival at Kuala Berang Resthouse.
70. Breakfast and briefing.
71. Distribution of rations.
72. A happy group photo.
73. At the jetty.
74. Off we go!
75. Arrival at base camp & lunch.
76. Look only 2 km!
77. Another rest stop.
78. Up go the tents.
79. Waiting for dinner.
80. Dinner almost ready.
81. Dinner time.
82. Group photo — the next morning.
83. Nothing better than a cool dip.
84. On the way back.
85. Back into the boats.
86. Off we go home!

Annual Geological Conference 1997
Abstracts of Papers

Geologi dalam konteks pembangunan negara menyeluruh untuk milenium akan datang

(Geology in the context of national development for the next millennium)

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Keagungan bidang geologi pada awal abad ke-20 telah didorong oleh permintaan mendesak sumber logam untuk menjayakan revolusi industri. Pemetaan geologi, khususnya untuk menilai potensi mineral bijih merupakan agenda utama kebanyakan negara dunia. Kewujudan 'Jabatan Penyiasatan Kajibumi' di kebanyakan negara didesak oleh tuntutan ini. Dalam perkembangan bidang geologi sebagai ilmu sains gunaan, ia sentiasa dikaitkan dengan keperluan eksplorasi bijih untuk industri perlombongan. Tuntutan sumber tenaga untuk mendokong revolusi industri, khususnya sumber arang batu dan petroleum telah meningkatkan lagi martabat Geologi ke suatu tahap yang tinggi, dan menjadikannya ilmu sains gunaan yang penting. Cabang-cabang geologi seperti mineralogi, petrologi, geologi struktur, geokimia, sedimentologi, stratigrafi dan geofizik berkembang pesat untuk menyokong keperluan penerokaan sumber bijih, arang batu dan petroleum ini.

Satu kitaran baru mengenai keperluan sains Geologi terjelma mulai pertengahan abad ke-20. Pembangunan pesat infrastruktur, umpamanya pembinaan jalanraya dan landasan keretapi, empangan, terowong dan jambatan telah meransang input geologi diambilkira dalam industri pembinaan ini. Cabang geologi kejuruteraan pula mulai diperkenalkan. Keperluan sumber air bawahtanah mendorong perkembangan cabang hidrogeologi, dan di kawasan yang sering mengalami geobencana, keperluan pengurusan dan mitigasi menyebabkan cabang-cabang baru geologi, seperti seismologi, volkanologi dan glasiologi pula diperkenalkan. Perkembangan bermakna pada dekad terakhir ini menampakkan muncul cabang geologi sekitaran yang menyokong keperluan kawalan pencemaran dan pemuliharaan kualiti alam sekitar.

Walaupun sejumlah ahli geologi sentiasa diperlukan di kebanyakan negara, trend peminggiran sektor perlombongan dan tanda-tanda kelembapan sektor petroleum memberi implikasi negatif tentang pembangunan bidang Geologi. Mengambil contoh senario di Malaysia, Jabatan Penyiasatan Kajibumi menghadapi tekanan daripada pihak kerajaan untuk berubah dari mod tradisional kepada tuntutan prioriti negara semasa.

Sementara di peringkat pendidikan universiti, pembangunan pesat telah mendorong pewujudan universiti, fakulti dan jabatan baru, namun kehadiran dua jabatan geologi, masing-masing di UM dan UKM nampaknya tidak mengalami pertumbuhan nyata, sama ada daripada aspek tenaga akademik, program pengajian, mahupun jumlah pengambilan pelajar. Hal ini merupakan dilema semasa dan suatu dikotomi kerelevanan bidang Geologi menyahut cabaran milenium akan datang.

Kebuntuan fikiran dalam menangani isu dikotomi kerelevanan berpunca daripada sejarah perkembangan ilmu geologi itu sendiri dan sifat reaktifnya dalam menyahut tuntutan semasa. Walaupun kejayaan cemerlang boleh dicapai pada masa lampau, persaingan semasa dan keterusannya memerlukan pemikiran strategi dan tindakan proaktif. Geologi dengan sifat asasnya sebagai 'sains mengenai Bumi' mempunyai kekuatan untuk menyahut cabaran baru, dan sumbangannya tidak boleh dilihat daripada sudut kerelevanan bidang dan cabang-cabangnya sahaja. Sebaliknya, ahli geologi perlu peka terhadap keperluan pembangunan menyeluruh negara,

dan melihat bagaimana ilmu 'sains mengenai Bumi' boleh memenuhi atau melengkapi keperluan baru ini. Atau dengan kata lain, ahli geologi perlu keluar daripada ruang-lingkup ilmunya, dan sebaliknya melihat semula tuntutan pembangunan menyeluruh negara terhadap ilmu yang berkaitan dengan 'sains mengenai Bumi'.

Jika ditinjau daripada sudut pembangunan negara menyeluruh, dapat diperhatikan wujud empat peringkat asas suatu pembangunan itu terlaksana:

- pembinaan polisi negara
- perancangan bandar dan rantau
- implementasi polisi
- pertumbuhan industri

Perancangan dan implementasi polisi dan garispanduan melibatkan pelbagai kementerian dan jabatan kerajaan, unit perancangan ekonomi di peringkat negara dan negeri, dan kerajaan tempatan. Jika dilihat daripada sudut 'sains mengenai Bumi', sebarang pembinaan polisi dan garispanduan mengenai penggunaan sumber Bumi (fizikal) dan pembangunan infrastruktur pada permukaan bumi dan bawah tanah, mempunyai hubungan yang erat dengan ilmu Geologi. Aktiviti perancangan bandar dan rantau pula merupakan usaha menterjemah polisi dan garispanduaan ini kepada bentuk Plan Struktur dan Plan Tempatan. Penterjemahan ini memerlukan pelbagai input pengetahuan dan pengalaman, dan tentunya pelbagai aspek sains mengenai Bumi merupakan asas dalam proses ini. Apakah bentuk cabang ilmu geologi yang diperlukan dalam menyahut tuntutan ini.

Jelasnya, di peringkat ini pengetahuan yang berkaitan dengan, umpamanya, kesesuaian tapak/kawasan, pengurusan sumber, proses-proses geologi, kadar perubahan fizikal, ramalan bencana tabii (geobencana) dan kelestarian alam fizikal merupakan aspek yang harus disumbangkan. Tuntutan begini mendesak cabang geologi baru diwujudkan, kita boleh menamakan, umpamanya, Geologi Pembangunan!

Ahli geologi cukup biasa dengan tuntutan input ilmu dan pengalaman geologi dalam membangun industri perlombongan dan pengkuarian. Keperluan untuk menentukan potensi kehadiran mineral bijih/bahan binaan, penentuan lokasi, penilaian kualiti dan anggaran kuantiti telah mendorong beberapa cabang geologi diwujudkan, umpamanya, Geologi Ekonomi, Geologi Perlombongan, Geokimia Gunaan dan Geofizik Penerokaan. Tuntutan industri tenaga pula memperlihatkan kemunculan cabang ilmu seperti Geologi Arang Batu dan Geologi Petroleum.

Tuntutan dalam industri pembinaan, khususnya mengenai pembinaan infrastruktur utama memerlukan input tentang kesesuaian tapak, bekalan bahan binaan, kestabilan dasar dan potongan, dan aspek pengoptimuman kos. Tuntutan ini mendorong kepada kewujudan cabang Geologi Kejuruteraan. Akhir-akhir ini, dengan peningkatan kesederaan masyarakat mengenai alam sekitar mampan, wujud pula cabang geologi yang dikenal Geologi Sekitaran.

Kesemua industri yang dinyatakan di atas, iaitu perlombongan, bahan binaan, tenaga dan pembinaan, merupakan industri yang menuntut input ilmu dan pengalaman geologi secara terus. Oleh itu, perkembangan cabang geologi yang berkaitan merupakan desakan industri, atau secara umumnya bersifat reaktif. Bagaimana dengan industri lain dalam kesatuan pembangunan negara menyeluruh? Industri pembuatan, pertanian, pertahanan, pelancongan, pendidikan dan servis lain — apakah input 'sains mengenai Bumi' tidak diperlukan? Jelasnya, mereka memerlukan input ilmu dan pengetahuan geologi secara sampingan dan lazimnya secara tidak terus. Di sinilah letaknya usaha proaktif ahli geologi menerokai domain kerelevanan bidangnya, jika perlu menjadi 'trend setter' dalam kontek pembangunan negara menyeluruh untuk milenium akan datang.

Analysis of tectonic subsidence and heat flow in the Malay Basin (offshore Peninsular Malaysia)

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The Malay Basin has a very high present-day surface heat flow, with an estimated heat flow anomaly of about 33–42 mW m^{-2}. The heat flow anomaly is interpreted as the result of thinning of the lithosphere during basin formation. Its relatively young age (about 35 Ma) implies that the thermal anomaly due to lithospheric thinning has not dissipated completely and that the Basin is still undergoing thermal subsidence. Data from over 60 wells were used in the analysis of subsidence and thermal histories to gain a better understanding of its tectonic evolution. A model of lithospheric stretching was used, whereby rifting occurred over a 10 Ma year period starting at 35 Ma ago. The subsidence histories from well data gave stretching factor (β) estimates ranging from about 1.2 on the basin flanks to about 4 in the centre. The basin flanks were uplifted during the initial rifting, causing subsidence to be delayed for about 10 Ma. Flank uplift was probably the result of non-uniform stretching of the lithosphere and horizontal heat loss through the sides of the basin as the lithosphere was being stretched. Heat flows calculated based on the β estimates agree with those derived from well test data, and thus supports the stretching model. These results are also comparable with those derived from maturity modelling using available vitrinite maturity data.

Salinity study of coastal groundwater aquifers in north Kelantan, Malaysia

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The salinity of the ground water along the coastal aquifers of north Kelantan was investigated using both geophysical and hydrogeochemical methods. In the geophysical method, a geoelectrical sounding technique was employed using ABEM SAS 300C terrameter. A total of 53 sounding stations had been established and resistivity values of the ground water in different aquifers were determined. Salinity of the ground water was interpreted using a classification made by Flathe (1974). Based on this classification, ground water with resistivity values of less than 45 Ohm-m is considered as saline or brackish water and those of greater than 45 Ohm-m is fresh water. The results show that the ground water of the first top aquifer is fresh with resistivities ranging from 47 Ohm-m to 164 Ohm-m except in an area along the coast where the water is brackish. The ground water of the second aquifer generally has resistivity lower than 45 Ohm-m and has been classified as brackish water. Resistivity map of the second aquifer indicates that the brackish water covers an area of up to about 6 kilometres from the coastal line. Only few resistivity data were obtained for the third aquifer and values are generally low (i.e. ranging from 56 to 72 Ohm-m) indicating that the ground water is relatively fresh.

Salinity of the groundwater in all of the aquifers was also studied by analysing their chloride content. Ground water with chloride concentration of less than 250 mg/l is classified as fresh water and those having higher concentration of chloride is considered brackish or saline. Results of the water analysis show that the chloride concentration of the first aquifer is low and averages to only 15.8 mg/l. The fresh water/saline water interface in this aquifer is generally located directly in the coastal area, or very close to it. The concentration

of chloride in the second aquifer is high with values ranging from 500 to 3,600 mg/l and covers an area of up to about 6 kilometres from the coast. Beyond this area, the concentration of chloride appears to be low, with values ranging from 2 to 110 mg/l. Continuous monitoring of its chloride content (Haryono, 1997) indicates little changes with time inferring that the high salinity is not due to seasonal sea water intrusion. The analysis also reveals low concentration of sulphate which suggest that the groundwater of the second aquifer may represents fossilised sea water. The chloride content in the third aquifer is generally low with value ranging from 2 to 210 mg/l and thus the ground water in this aquifer is considered fresh and good for domestic use.

Proses permukaan dan taburan unsur-unsur surih dalam tanih di Pulau Manukan Sabah

Baba Musta[1], Mohd Harun Abdullah[1] and Mohamad Md. Tan[2]

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Pulau Manukan yang terletak di latitud 5°58.2'U–5°58.8'U dan longitud 115°59.5'T–116°00.5'T memungkinkan berlakunya proses-proses perubahan permukaan akibat luluhawa kimia yang aktif. Pulau seluas 2.1 km^2 ini juga terdedah kepada tindakan fizikal seperti proses hakisan ombak, pengangkutan dan pemendapan sedimen. Pada masa kini hakisan pantai amat ketara di kawasan barat-laut pulau ini Fenomena ini ditunjukkan oleh tebing yang curam dan singkapan batuan segar pada kedudukan tersebut. Aktiviti tektonik masa Oligosen akhir-Miosen (Tongkul, 1990), taburan struktur sekunder batuan dan kemiringannya ke arah Tenggara (Mohd. Harun Abdullah *et al.*, 1996) dipercayai mengawal proses permukaan di pulau ini. Ini sesuai dengan cadangan Viles dan Spencer (1995) yang mengatakan bahawa jenis batuan, topografi, tektonik dan hakisan mempengaruhi bentuk tebing. Bahagian tenggara pulau ini berlaku proses pengendapan, berdasarkan pantainya yang luas dan pengendapan sedimen yang tebal.

Selang-lapis batu pasir tebal-syal nipis Formasi Crocker yang dominan di kawasan ini mudah membentuk profil tanih yang tebal disebabkan sifat keporosan batuan induknya. Berdasarkan kajian topografi, pulau ini boleh dibahagikan kepada dua kawasan iaitu kawasan berbukit di bahagian barat-laut (Lokaliti B) dan tanih rendah di bahagian tenggara (Lokaliti PM). Kajian terhadap luluhawa kimia permukaan menunjukkan kedua-dua kawasan bukit dan rendah mengalami perubahan menghasilkan lapisan tanih yang tebal. Walau bagaimanapun didapati bahagian berbukit lapisan tanihnya lebih tebal hingga mencapai 3.0 m ketebalan manakala bahagian rendah pula cuma mencapai 0.5 m. Kajian kepekatan unsur-unsur surih Zr, Sr, Ba, Zn, Cu, Co, Ni, Cr dan Sn dalam tanih telah dijalankan dengan kaedah pendaflour sinar-X. Terdapat perbezaan taburan kepekatan purata Zr, Pb dan Ba yang jelas di Lokaliti B dan Lokaliti PM. Purata kepekatan sampel Lokaliti B bagi Zr, Pb dan Ba masing-masing ialah 247 ppm, 3 ppm dan 58 ppm, manakala Lokaliti PM masing-masing ialah 32 ppm, 19 ppm dan bdl. Perbezaan ini mungkin disebabkan oleh kawalan mineral sekunder seperti mineral lempung. Dipercayai terdapat kuantiti kecil mineral lempung seperti kaolinit di kawasan bukit berdasarkan data geokimia yang menunjukkan korelasi yang baik ($r > 0.94$) antara Al dengan Si. Zr, Pb dan Ba pula boleh dijerap dalam kikisi mineral lempung, kerana didapati korelasi Al dengan Zr, Pb dan Ba baik iaitu $r = 0.80$. Data tersebut sesuai dengan Goldschmidt (1970) yang melaporkan bahawa unsur Zr, Pb dan Ba boleh dikawal kepekatannya oleh mineral lempung seperti kaolinit. Walau bagaimanapun mineral kuarza yang melimpah di kedua-dua lokaliti pula tidak bertindak sebagai mineral yang menjerap unsur tersebut. Sr biasanya mempunyai korelasi positif yang kuat dengan Ca (Goldschmidt, 1970; Smit dan Rocchia, 1996), yang membuktikan taburannya dikawal oleh mineral karbonat. Kehadiran aragonit yang dikesan dengan pembelauan sinar-X dan korelasi CaO ~ Sr yang kuat iaitu $r = 0.98$ membuktikan Sr terjerap dalam aragonit dalam tanih terutama di kawasan yang rendah. Kepekatan Sr rendah dalam tanih di kawasan Lokaliti PM disebabkan mineral kuarza yang

dominan dan tiada kawalan mineral aragonit. Secara umumnya kepekatan unsur-unsur Zn, Cu, Co, Ni, Cr dan Sn di Lokaliti PM kurang daripada 20 ppm. Secara terperinci purata kepekatan Zn, Cu dan Co ialah di bawah had pengesanan (bdl), kecuali sampel PM4 (50 cm) yang nilai Co ialah 24 ppm. Kepekatan Co ini mungkin tertumpu di dalam mineral karbonat sesuai dengan laporan Goldschmidt (1970) yang menyatakan Co boleh wujud jika pH tinggi. Secara terperinci kepekatan purata Cr, Ni dan Sn masing-masing ialah 19 ppm, 1 ppm dan 10 ppm. Kawasan berbukit (Lokaliti B) pula kepekatan Zn, Cu dan Co umumnya di bawah had pengesanan (bdl). Kepekatan purata bagi Cr, Ni dan Sn pula masing-masing 24 ppm, 15 ppm dan 21 ppm. Perbezaan nilai Sn, iaitu lebih tinggi di Lokaliti B kerana Sn di kawal oleh Fe-oksida dan mineral lempung berdasarkan korelasi baik antara Fe dan Al iaitu $r > 0.80$. Nikel yang agak tinggi di Lokaliti B juga boleh di kawal oleh mineral lempung dan Fe-oksida. Manakala Cr yang hampir sama di Lokaliti B dan PM disebabkan unsur ini boleh dijerap kedalam mineral karbonat dan Fe-oksida serta mineral lempung. Taburan unsur-unsur dalam tanih yang rendah pula kerana sifat unsur itu yang mengalami mobiliti dan juga kandungannya sememangnya rendah dalam batuan induk.

Neolithic hominid site at Gua Siam, Langkawi

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Amongst the twenty four caves located, described and illustrated in the tourist book *Mysterious Caves of Langkawi* jointly published by the Department of Irrigation and Drainage, Ministry of Agriculture, Malaysia and Design Dimension Sdn. Bhd. (1994) is Gua Siam located at the Sungai Batu Gajah in the heart of a wide expanse of mangroves in Setul Limestone country south of Tanjong Rhu, northwest Langkawi. Although it is not a very large or spectacular cave compared to the others it was included because skeletal remains of humans and animals and primitive stone tools have been discovered in it. Some broken bones and a monkey skull were illustrated in the photographs in the book.

Two brief visits were made in June and September last year to conduct some preliminary investigations of the cave followed by a third visit in May this year to map out the cave. Accessibility to the cave is difficult as one has to bash through some thick mangrove swamp after arriving by boat before reaching the limestone hill. The cave entrance is not easily seen as it is located about 5 metres above the ground. It is accessible only by climbing up a near vertical cliff using the roots and vines clinging to the rock face.

The cave is located on the west side of the limestone hill with its entrance oriented roughly north-south and it narrows towards the east. The chamber of the cave is not very big being only about 8 metres in diameter at the entrance where it is widest and 14 metres deep with a series of narrow tunnels on the southeast wall. There is sufficient natural lighting to illuminate the chamber during the day.

As is common to most prehistoric cave sites in this country the guano digger has preceded the archaeologist (Peacock, 1965), the cave shows obvious signs of having been dug up and until quite recently too as evidenced by a piece of nylon fish-netting and tin dustpan left in the rubble. Pieces of broken bones (to access the bone marrow for food), tooth of a large herbivore, jaw of a small carnivore and lots of shells of freshwater, brackish and marine molluscs including the common freshwater food-snail, *Brotia costula,* with chopped-off apices were found amidst the rubble and brown earth on the cave floor. The skeletal relics illustrated in the book were gathered together in a small recess on the north side of the entrance. Apparently no one else has visited the cave after DID team's visit. Some samples from the relics including a large crude hand axe were collected during the first visit.

The second visit took place in September 1996. While searching for the entrance to Gua Siam, a few smaller shallow caves including a rather large circular one (which I shall call Gua Bulat), were found slightly

to the north of Gua Siam. There were also indications that they had been inhabited in the past as evidenced by "eaten" shells. While sifting through the rubble a polished stone adze which is a much more refined artifact than the crude hand axe from Gua Siam was found. Another two such stone adzes were recovered by others from Gua Siam itself. Cord-impressed pottery sherds were also recovered from the rubble in Gua Siam indicating that the prehistoric remains in the caves were most likely to be post-"Hoabinhian" that is early Neolithic age as comparable polished centre-edge ground adzes and cord-impressed pottery sherds had been recovered from other prehistoric sites in Malaya, for example at Dengkil by Batchelor (1978).

Another large crude hand-axe was recovered from the smaller cave north of Gua Siam during the third visit. Examination of non-carbonate stones found in the caves showed that many of them had been worked and perhaps abandoned when the flaking did not produce the desired results by the stone-tool makers. An interesting find in Gua Siam during the third visit was two large flat stones, one of which has a distinct worked depression in the middle remniscent of a grind-stone. Also found near it were lumps of greyish clay foreign to the nodular brown soil on the cave floor which could be the parent material to be grounded for pottery manufacture. On the other hand it could also be used for grounding fibrous food or for both purposes. The second flat stone of flaky fine sandstone material also shows an abraded side and could have been used for grinding as well.

These discoveries would add Gua Siam to the numerous known Malaysian Neolithic sites in caves around the region including Pulau Tuba and several others in Kedah and Perlis (Peacock, 1965). A more precise dating of the age could be obtained by radiocarbon dating the shells used as food by the prehistoric inhabitants of Gua Siam. There is a strong possibility that other hard to access caves in Langkawi could also hold prehistoric relics of archeological interest and a find comparable to Perak Man (Zuraina Majid, 1994) is just waiting for the lucky palaeoanthropologist in one of them.

Pencirian lempung dari Kuala Kangsar, Perak Darul Ridzuan

Characterization of clays from Kuala Kangsar, Perak Darul Ridzuan

[1]Tuan Besar Tuan Sarif, Radzali Othman, [2]Abd Khalil Abd Rahim dan Ab. Halim Hamzah

[1]Universiti Sains Malaysia

[2]Geological Survey Malaysia

Lempung dari beberapa tempat di daerah Kuala Kangsar (Kampung Temin, Kampung Sungai Plus, Kampung Ma'amur, Kampung Pulau Kemiri, Kampung Bendang, Kampung Kota dan Kampung Jawang) telah dikaji untuk meninjau kesesuaiannya basi tujuan penggunaan komersial. Ujian pencirian yang dilakukan adalah penentuan mineralogi, komposisi kimia, taburan saiz zarah, keplastikan, graviti tentu, kehilangan bahan meruap (LOI), kecut-bakar, kekuatan keliangan, ketumpatan pukal dan perubahan warna jasad bakar di antara suhu 800–1,200°C.

Pada umumnya, kesemua sampel mengandungi mineral kaolinit, hongquite (TiO) dan kuarza (kecuali sampel Kg. Sg. Plus pada kedalaman 3–5 kaki tidak mengandungi kuarza. Yang anih sampel Sungai Plus ini mengandungi kaolinit dan muskovit sahaja). Mineral muskovit ditemui hanya dalam sampel Kampung Temin, Kampung Sungai Kota dan kampung Sungai Plus. Mineral mikroklin ($KAlSi_3O_8$) ditemui hanya di dalam sampel Kampung Ma'amur dan Kampung Sungai Kota.

Kehilangan bahan meruap didapati tinggi (11%) dalam sampel Kampung Ma'amur dan Kampung Sungai Kota. Nilai ini penting terutama untuk pembuatan ubin. Kecerahan warna pembakaran di dalam kedua-dua sampel tersebut menyarankan banyaknya bahan organik dan ini amat dikehendaki dan sesuai untuk lempung bagi kegunaan pembuatan ubin.

Sifat keplastikan didapati sangat tinggi di dalam Kampung Bendang, diikuti oleh sampel dari Kampung

Temin dan Kampung Pulau Kemiri. Sifat keplastikan paling rendah didapati pada sampel dari Kampung Ma'amur. Nilai graviti tentu terletak di antara 2.20 (Kampung Sungai Kota) hingga 2.43 (Kampung Jawang). Nilai graviti tentu masih lagi kurang daripada nilai graviti tentu mineral kuarza (2.54). Jelasnya, sampel lempung dari Kampung Jawang adalah lebih tumpat sedikit dan ini mungkin ada kaitan dengan kejadiannya dari habuk gunung berapi. Kampung Temin didapati mengandungi zarah < 2 μ paling banyak iaitu 29%. Kampung Sungai Kota dan Kampung Sungai Plus mengandungi 21% zarah < 2 μ. Kadar kecut didapati tinggi bagi sampel Kampung Sungai Plus dan paling kurang pada sampel Kampung Temin. Ujian kekuatan menunjukkan bahawa sampel dari Kampung Pulau Kemiri dan Kampung Sungai Kota agak tinggi iaitu 43 MPa. Kekuatan paling rendah ialah bagi sampel dari Kampung Bendang. Ujian keliangan dan peratusan serapan air didapati mengurang dengan peningkatan suhu.

Kepelbagai ciri yang dikaji bagi sampel-sampel kampung dari Kuala Kangsar jelas menunjukkan bahawa kesemua sampel boleh dikomersialkan tetapi khusus untuk industri tertentu termasuk pembuatan bata, ubin, pasu, labu terracotta dan lain-lain lagi. Kajian lanjutan adalah diperlukan bagi mengekalkan potensi penggunaan yang berterusan lempung-lempung tersebut.

The Malaysian stratigraphic guide

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INTRODUCTION

General

The Malaysian Code of Stratigraphic Nomenclature was first drawn up by a working group of the Geological Society of Malaysia during November 1966–January 1967 and was provisionally accepted by the Council. However, the "guide" was never adopted and in April 1994 a new Committee (Malaysian Stratigraphic Nomenclature Committee) was set up to formulate a more comprehensive Malaysian Stratigraphic Guide that will suite current Malaysian requirements. This Guide is based largely on the Australian Code of Stratigraphic Nomenclature (1985) and the North American Stratigraphic Code (1983).

Objective and philosophy

Stratigraphy is a systematic study of composition, geographical distribution, sequence, history and genesis of rock successions and unconsolidated earth material which can lead to the understanding of the spatial and temporal relationships among rock bodies. This will provide a basis for interpretation of these successions and material for building up a history of events in the geological record.

The basic practice in stratigraphic study is to observe, describe, correlate and interpret rock successions. This embodies two aspects, namely;

i. procedure in defining the rock bodies and earth material which should be based on objective and neutral criteria, and

ii. procedure for expressing opinion about them.

The purpose of this Guide is to describe and recommend systematic procedures in classifying and naming all formally defined stratigraphic units. It seeks to avoid ambiguity in communication which can hamper scientific progress. Classification itself is not an end in stratigraphic study but serves as a basis for scientific investigation, discussion and deliberation

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The Guide recognises the three principal approaches, namely lithostratigraphy (including lithodemic unit), biostratigraphy and chronostratigraphy. Other stratigraphic approaches are also used in more specialised fields. As stratigraphy is a dynamic subject, new approaches and methods of analysis will continue to be formulated.

Problems

Geologists working in Malaysia face numerous problems when dealing with its stratigraphic nomenclatures. The main underlying cause for these problems is the absence of a widely accepted Malaysian stratigraphic guide. An earlier attempt at formulating such a guide in 1966 ended without the guide being published or adopted. In addition, many works involving the naming of stratigraphic units do not follow any scientifically-based international guides. Many stratigraphic names are used without a proper and comprehensive definition or statement of intent at formalising the names.

The problems can be categorised and illustrated as shown below:

i. Many stratigraphic names have not been published for distribution and scrutiny of the scientific community in Malaysia.

ii. Different names are being used by different geologists for the same rock unit in adjacent areas e.g. Dinding schist in the Kuala Lumpur area (Gobbett, 1964) and Jelebu schist in the Kuala Kelawang area (Shu, 1989), or Semantan Formation in the Temerloh area (Jaafar, 1976) and Gemas Formation in the Segamat area (Loganathan, 1977).

iii. Different ranks for the same unit being used by different geologists, e.g. Baling group (Burton, 1988) and Baling Formation (Jones, 1970); Tembeling Formation (Koopmans, 1968) and Tembeling Group (Khoo, 1977).

iv. The internationally recommended binomial name (the formal name of unit should consist of a geographic name and the rank or lithology) for stratigraphic units is not strictly followed, e.g. Chert-Spilite Formation, Upper Detrital member and Older Alluvium.

v. Problems related to the usage of geographic names such as (a) the use of non Malaysian geographic localities, e.g. Setul Formation (after Setul boundary range in south Thailand), Pasir Panjang Formation (after Pasir Panjang in Singapura), Temburung Formation in Sabah but the actual geographic location in Brunei and (b) the continuing use of geographic names that have fallen into disuse e.g. Hawthornden Schist (after Hawthornden Estate) and Kenny Hill Formation (which has subsequently been renamed as Bukit Tunku).

vi. Most stratigraphic names were introduced without type sections, type areas or composite sections being designated, described nor boundaries defined. Hence, difficulties arise as there are no reference sections for comparison and correlation.

vii. Many stratigraphic units are not satisfactorily correlated (e.g. Bukit Keluang formation and Murau conglomerate).

viii. Highly metamorphosed rocks (e.g. Hawthornden Schist) and highly tectonised rocks (e.g. Lubok Antu Mélange) have been classified as lithostratigraphic units instead of lithodemic units.

ix. Unconsolidated onshore deposits (e.g. Simpang Formation in Taiping area) and offshore sediments (e.g. Pilong formation in the Malay Basin) have not been properly defined.

The Committee is of the view that these problems can be overcome with the formulation, publication, distribution and adoption of the Malaysian Stratigraphic Guide and the establishment of a Malaysian Stratigraphic Lexicon.

Preliminary evaluation of Sabah seismicity in correlation to the Philippines tectonic setting

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It is hard to imagine that anything good could come from phenomena so destructive to human life and property as seismic activities. Most of seismic zones are localized in well defined seismic belt. Recent studies indicated that there are several seismic activities present in the region and Sabah is likely located within the seismic zones. It is true that Sabah relatively safe from major earthquakes unlike other countries in the region, but nature has not granted complete immunity from natural calamities. A seismic monitoring program should be implemented immediately in Sabah to record any seismic activities in the area.

The geochemical discrimination parameters for limestone: A case study of Bukit Sagu limestone, Kuantan, Pahang

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Apart from calcite, a limestone may contain dolomite, quartz, and clay minerals in various proportions. Taking into consideration the possible mixture of the four components above, four types of limestone are anticipated to occur: 1) Pure limestone, (2) Siliceous (quartzose) limestone, 3) Aluminous (clayey) limestone, and 4) Magnesium rich (dolomitic) limestone. The hypothesis has been tested using 112 chemical analyses (by XRF techniques and other wet chemical methods) of Bukit Sagu limestone, Kuantan, Pahang. Based on the minerals that occur in the samples (by microscopic study and XRD technique), the four types of limestone have been recognised, with the following geochemical characters:

Petrographic Name	CaO	SiO_2	Al_2O_3	MgO	K_2O
Pure limestone	> 54%	< 1%	< 1%	< 1%	< 1%
Siliceous (quartzose) limestone	40–53%	> 1%	< 1%	< 1%	< 1%
Aluminous (clayey) limestone	52–54%	> 1%	> 1%	< 1%	> 0.2%
Magnesium rich (dolomitic) limestone	38–53%	< 1%	< 1%	> 1%	< 1%

It is also suggested that the compositional discrimination can be easily performed using a diagram SiO_2-(Al_2O_3 + K_2O)-(CaO + MgO), in order to supplement the more conventional diagram SiO_2-CaO-MgO.

Sedimentology, stratigraphy and paleontology of Pulau Jemuruk, Langkawi

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The oldest known rock formation in Malaysia is the Machinchang Formation, the top of which is exposed at Pulau Jemuruk and the surrounding Teluk Kubang Badak in Langkawi. The geology of Pulau Jemuruk and Teluk Kubang Badak is mainly made of medium- to fine-grained sandstone, interbedded with siltstone and shale. The strata is dipping from 10° to 15° towards the E-SE direction, forming several fining upward sequences. The fine-grained sandstone, siltstone and shale within 2 m intervals below each flooding surfaces often yield various kind of fossils, mostly ichnofossils. Fossils were also discovered from the sandstone at the lower interval of the fining upward sequence.

Although the main fossil constituents are trace fossils, the discovery of several species of trilobites and brachiopods is very important for interpretation of the age and depositional environment of the upper part of Machinchang Formation. Among fossils found are trilobite *Saukia* sp., *?Saukioides* sp., *?Acontheus* sp. and *Eosaukia* sp., brachiopod *?Eoorthis* sp. and ichnofossil *Phycodes pedum* SEILACHER, *Teichichnus stellatum* BALDWIN, *Palaeophycus* sp., *Dictyodora* sp., *Chondrites* sp., *Palaeodictyon* sp., *Arenicolites* sp., *Planolites* sp., *Thallasinoides* sp. and *Skolithos* sp.

Saukiid trilobites and orthid brachiopods were previously recorded in the Upper Cambrian of Thailand, China and several other Asian countries, thus confirming an Upper Cambrian age for the upperpart of Machinchang Formation. Some of the ichnogenera and species are also commonly known in Lower Paleozoic rocks. The ichnogenera consists of both dwelling and grazing forms suggesting various environmental regimes.

Table 1. Stratigraphic and spatial distribution of species found at Pulau Jemuruk.

SPECIES	AGE RANGE	DISTRIBUTION
TRILOBITE		
Saukia sp.	Upper Cambrian	Asia, North America
?Saukioides sp.	Upper Cambrian	East Asia
?Acontheus sp.	?Middle Cambrian	Europe
Eosaukia sp.	Upper Cambrian	Asia
BRACHIOPOD		
?Eoorthis sp.	Upper Cambrian	Asia, North America
ICHNOFOSSIL		
Phycodes pedum SEILACHER	Cambrian	Asia
Teichichnus stellatum BALDWIN	?Paleozoic	?Europe
Palaeophycus sp.	wide range	cosmopolitan
Dictyodora sp.	Cambrian to Carboniferous	Asia, Europe
Chondrites sp.	wide range	cosmopolitan
Palaeodictyon sp.	wide range	cosmopolitan
Arenicolites sp.	wide range	cosmopolitan
Planolites sp.	wide range	cosmopolitan
Thallasinoides sp.	wide range	cosmopolitan
Skolithos sp.	wide range	cosmopolitan

Based on the fauna and lithological succession, it can be interpreted that the Upper Cambrian of Pulau Jemuruk and Teluk Kubang Badak was deposited in a shallow marine environment, from an open shelf to a rather confined basin influenced by the shifting of barrier bars. The shelf was also influenced by cyclical transgression as exhibited by the fining upward sequences. The whole succession was formed during a major transgression period, where the shallow marine Jemuruk sequence succeeded a continental deposits of the middle member of Machinchang Formation. This Upper Cambrian shallow marine clastic is then overlain by the Ordovician limestone of Setul Formation. A transitional boundary between the clastic sequence to limestone sequence can be observed at Tanjung Sabung, east of Pulau Jemuruk.

Significance of the petrography and geochemistry of the igneous rocks at Kulai-Skudai, Johor

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The Kulai-Skudai area is mainly underlain by igneous (80%) and sedimentary (20%) rocks where the igneous rocks are mainly plutonic and volcanic in nature and vary from basic to acidic in composition.

Gabbro, the basic intrusive body at Linden estate is believed to be the oldest rock in the area, which is Permian to Carboniferous in age (van Bemmelen in Burton, 1973). This fact is strongly supported by results from geochemical analysis where the D.I. value of the gabbro is 4.31, which is the lowest value compared to the other granitoids of the area. This shows that the gabbro have the earliest history of crystallization and is indeed the oldest rock in the area. Results from geochemical analysis also show that the gabbro is tholeiitic in nature. From petrographic studies, the gabbro comprises mainly clinopyroxene, orthopyroxene, plagioclase and minor olivine and hornblende. Cumulate texture is shown by the orthopyroxene (hypersthene), the cumulus mineral surrounding olivine and plagioclase crystals.

The granitoids of the area are fine grained granite, porphyritic adamellite, medium grained adamellite, elongated quartz adamellite, pink adamellite, granodiorite and coarse to fine grained tonalite. Previous studies show that the age of these granitoids is early Triassic and early Cretaceous. From geochemical and petrography studies, the granitoids are classified as I-type, metaluminous and mineralogically comprises of plagioclase, alkali feldspar, quartz, biotite and hornblende. Apatite, opaque minerals (pyrite) and epidote are common in most of the granitoids in the area. Geochemical and petrographic studies also show that the emplacement of the granitoids was epizonal. The calc-alkaline value for the granitoid in the area is 64.70 which is almost the same as Saim's (1980). AFM and CNK diagrams also show a simple trend of magma evolution, which is the same as Liew's (1983).

The volcanic rock in the area is the Gunung Pulai volcanic member of the Jurong Formation. It is composed of plagioclase, quartz, alkali feldspar and minor biotite and epidote, set in a microcrystalline matrixs. Petrographic studies show that some of the quartz have embayment texture which is a typical characteristic for volcanic rocks. From geochemical studies, the dacite also falls within the calc-alkaline series.

Xenoliths occur in most of the igneous rocks. They are dark, round to ellipsoid in shape and vary in size and sometimes show phenocrysts of plagioclase in them. Petrographically, they are dioritic in composition and made up mainly of plagioclase, biotite and hornblende. There is also a xenolith which is enriched only with quartz, plagioclase and biotite with some rutile. Petrographic studies also show that the xenoliths are of igneous origin.

Epidote, aplite and quartz veins also intrude most of the rocks in the study area. They are post-granitoid in age, being the last phase of magma differentiation and usually intrude following the dominant trend of joints in the igneous rocks.

Results from geochemical analysis using Harker's and D.I. variation diagrams show that all the igneous rocks come from one single magma which is basaltic in composition and through differentiation processes, has evolved to produce other rocks such as tonalite, granodiorite, adamellite and fine grained granite in the area.

The sedimentary rocks located in the southern part of the study area belong to the Bukit Resam Clastic Member of the Jurong Formation. It comprises mainly sandstone interlayered with shale and some siltstone. The general trends of bedding for this formation are northeast-east and northwest-west. Fossils have not been found but from previous studies, fossils of lamellabranch have been found which gives the age of this formation as late Triassic to middle Jurassic (Newton in Burton, 1973).

Significance of Lower Carboniferous Radiolarian chert from Langkap, Negeri Sembilan

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The study area comprises metamorphic rocks which belong to the Bentong Group (Khoo, 1975). The oldest rock unit is the Pilah Schist which is older than Early Silurian, probably Ordovician (Foo, 1983). The Pilah Schist consists mainly of quartz mica schist, graphitic schist, metaquarzite and phyllite with minor serpentinite and chert bodies. The serpentinite, which has been considered an ophiolite (Hutchison, 1989; Tjia, 1987, 1989) represents an extension of the Bentong-Raub suture zone. The schist is unconformably overlain by the Permian Kepis Formation. The chert sequence near Langkap does not belong to either the Pilah Schist or Kepis Formation. Discovery of Late Devonian to Early Carboniferous radiolarian faunas by Spiller and Metcalfe (1995b) proved that the chert is a different formation. In this study, the chert is informally called the Langkap chert.

The Langkap chert consists of thinly bedded chert interbeds with mudstone. The chert forms a narrow ridge and the total thickness is estimated to be about 150 m. It is underlain by the Pilah Schist. The contact between the two formations is not exposed. The chert is overlain by the Kepis Formation. The presence of mudstone in the chert sequence indicates that the depositional environment was very close to a continental margin. The chert-mudstone association is considered as a continental margin chert association by Jones and Murchey (1986).

The Langkap chert is well-exposed at a road cut near Kampung Langkap (02°38'N, 102°21'E). A thick chert sequence totalling 105 m was measured. The chert strikes 60° and dips 50°. The chert is faulted and sheared. There are five shear-zones observed at the outcrop. The colour of the chert varies from black to dark grey. The bottom part of the section comprises chert interbeds with thinly bedded siltstone which has thickness ranging from 4–10 cm. The beds are folded due to slumping. The upper part exhibits 1–2 cm thick parallel bedding with a slight variation in grain size from silt to clay.

The radiolarian chert at Langkap has been studied by Spiller and Metcalfe (1995a, 1995b). They have identified several radiolarian faunas indicating an age of Famennian, Late Devonian and Tournaisian, Early Carboniferous. Recently, a detailed study of the outcrop of the chert sequence was made and 25 samples were collected. Only one sample yielded very high specific diversity of well-preserved radiolarian faunas. The other samples were crystallised and yielded very poorly-preserved radiolarian specimens.

Most of the chert that have crystallised yielded radiolaria that are damaged. At the top of the sequence, an approximately 2 cm thick thinly laminated black mudstone yielded some quite well-preserved specimens of radiolarian fauna. A total of 34 radiolarian taxa were identified. This assemblage is slightly different in composition from those described by Spiller and Metcalfe (1995a, 1995b). The aim of the paper is to discuss the presence of a younger radiolarian assemblage which represents the *Albaillella deflandrei* Zone, and to determine the stratigraphy, depositional environment of the chert and the palaeogeography

Physico-chemical and mineralogical properties of basalt soils from Segamat, Johor

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Some twenty basalt soil samples from the Segamat area were analysed for their physico-chemical and mineralogical properties. The physical properties of the soils analysed are: relative density, water content, Atterberg Limits, grain size distribution, and compaction properties. The chemical properties analysed involved pore fluid chemistry, whereby the pore fluid of the soils were first extracted using the "Saturation Extract" method, and then subsequently analysed for pH, electrical conductivity, cation (Na^+, K^+, Ca^{++}, Mg^{++}) concentrations and anions (SO_4^{2-}, Cl^-) concentrations.

The result for the physico-chemical properties of the Segamat Basalt soils are summarised in Table 1. For simplicity, only the range of values of the various physico-chemical parameters are shown. The results show the following characteristics for the Segamat Basalt soils: relative density is high, i.e. up to 2.98, with many values exceeding 2.70; water contents are generally high with $w_o > 30\%$, up to about 40% indicating high absorption of water; liquid limits are all > 50% (high), with many values in the 70–80% range; grain sizes are predominantly fine-grained, namely M/C, though there are significant amounts of S as well. While most fine-grained soil samples do not contain any gravels (G), the gravel layer in the Segamat Basalt soil profile contains high gravel (G) contents (G = 30–67%); the fine fractions of the soils are classified as MH soils, i.e. silts with high plasticities (LL > 50%); the compacted maximum dry densities are mostly low, i.e. < 1.50 g/cm^3, although several samples show high γ_{dmax} of ~1.70–1.80 g/cm^3; the optimum moisture contents (ω_{opt}) are also generally high (> 30%) and these high ω_{opt} values could account for the generally low γ_{dmax} values obtained.

Results for the pore fluids chemistry indicate the following: pH is < 7 (except for 3 samples only), i.e. slightly acidic; conductivity is low, reflecting the low cation contents of the pore fluids; cations Na^+, K^+, Ca^{++}, Mg^{++} are generally low in concentrations, with K^+, Ca^{++}, Mg^{++} all having values of < 5 ppm; Na predominates over the other cations, with values of 7–20 ppm, thus the ratios of monovalent ($Na^+ + K^+$) versus divalent ($Ca^{++} + Mg^{++}$) cations show high values of >> 2. Both SO_4^{2-} and Cl^- anions show significant concentrations. Some variations in the plasticity of the different portions of the Segamat Basalt soil profiles appear to exist, as evidenced from the plot on the plasticity chart.

Mineralogical studies of selected samples using XRD and TGA methods show that the main minerals in the clay fraction of the soils are kaolinite and goethite.

Table 1. Summary of physico-chemical properties of Segamat Basalt soils.

Physical Property	Range of Values	Chemical Properties	Range of Values
Relative Density (Gs)	2.54–2.98	pH	6.09–7.13
Water Content (%)	11.65–40.64	Electrical conductivity ($mS.cm^{-1}$)	0.083–0.552
		Ion content:	
Atterberg Limits:		Na^{+} (ppm)	7.3–21.5
LL (%)	50–84	K^{+} (ppm)	1.23–7.39
PL (%)	29–44	Ca^{++} (ppm)	0.40–7.23
PI (%)	21–40	Mg^{++} (ppm)	0.08–6.77
		SO_4^{2-}(mg/l)	20–50
Grain size distribution		Cl^{-} (mg/l)	3.8–45.8
G (%)	0–67		
S (%)	4–56		
M (%)	4–61		
C (%)	5–64		
Compaction:			
γ_{dmax} (g/cm^3)	1.26–1.80		
ω_{opt} (%)	20.0–44.0		
Classification (fine fraction)	MH		
Sodium Adsorption Ratio (SAR)	1.03–3.71		

Facies distribution, stratigraphic succession and hydrocarbon habitat in non-marine extensional basins

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Facies distributions in non-marine extensional basins are primarily the sedimentary response to evolving, tectonically-generated basin topography. Six principal structural features strongly influence sedimentation patterns. These are: 1) topographically high accommodation zones which segment the basins into discrete structural half-graben, 2) reactivation of pre-existing structural elements, 3) footwall uplift at main border faults, 4) gentle roll-over of topography on flexural margins, 5) breakup of the basin floor into elongate, basin-parallel fault blocks, and 6) development of fault relay zones and transfer faults. Each of the six structural elements has its own specific affect on sedimentation, and consequently its own contribution to the basin's final stratigraphy.

Different structural elements are prominent at different times during a basin's history. There is a progression through four well-defined structural/stratigraphic stages, each with a specific structural morphology and associated facies distribution. Initially, rift-parallel fault blocks and transfer faults are the most important structures and topographic relief is limited. Sedimentation is dominated by fluvial processes; shallow lacustrine and paludal sediments also can accumulate.

During the second stage, the rate of structurally-induced basin-floor subsidence and basin shoulder uplift exceeds the regional sedimentation rate. Accommodation zones, footwalls, and flexural margins become positive topographic features, resulting in a half-graben morphology. The depositional patterns occur at the basin-wide scale, resulting in sediment starved half-graben. Large, deep lakes will develop in humid climatic settings and small lakes, rivers and deserts will dominate drier basins. On the basin floor, depositional patterns continue to be controlled by basin-parallel fault-blocks and transfer faults.

Sedimentation rate eventually overtakes the rate of basin-floor subsidence and basin shoulder uplift. Basin-floor topographic features such as individual fault blocks and transfer faults are buried. Accommodation zones and basin shoulder topography continue to define the basin margins and to influence sedimentation. Maximum water depth in lakes is limited by the height of the lowest basin-bounding topography, which forces a decrease in maximum depth with time as the basin fills. Generally, accommodation zones are the topographically lowest basin-bounding features and are the next to be buried, converting the basin floor to a fluvially-dominated, linear plain without along-axis topographic barriers.

After accommodation zones are buried, uplifted footwalls and flexural margin rollovers continue to influence sedimentation until they are ultimately eroded. In some basins, this erosion is a result of isostatic uplift and is the final stage in the basin's evolution. Other systems become thermal sag basins that continue to subside as broad, regional depocenters and still others ultimately undergo structural inversion.

The four structural/stratigraphic stages lead to a general stratigraphic succession that correlates well with the stratigraphy observed in numerous Phanerozoic non-marine extensional basins. It begins with a basal unit that is dominated by fluvial and alluvial sands. These are overlain by lacustrine deposits with an abrupt transition from the fluvial to lacustrine environments. Progressively shallower water deposits occur upward through the lacustrine interval, culminating in a gradual transition to fluvio-deltaic sedimentation. Eventually, the transition to subaerial environments is completed, and subsequent deposits are primarily of fluvial and alluvial origin.

This stratigraphic succession has two important implications for their hydrocarbon habitat of non-marine extensional basins. These are that: 1) lacustrine shales and fluviodeltaic sandstones are deposited preferentially in different stratigraphic units, and 2) whilst superficially similar, the stratigraphy of each half-graben develops quasi-independently. The first point indicates potential reservoirs, source rocks and seals develop in specific stratigraphic units, while the second indicates that the quantity and quality of source rocks and reservoirs can vary greatly in adjacent half-graben.

The primary hydrocarbon source rocks are the lacustrine shales deposited during the second tectono-stratigraphic stage. These shales are well-positioned to charge the overlying fluvio-deltaic sandstones and a number of large hydrocarbon accumulations are reservoired in third and fourth stage sands. However, the stratigraphic succession generally coarsens upward from the lacustrine shales so that top seal is absent in many basins and hydrocarbons are either lost or trapped in younger strata, as is the case for nearly all of the hydrocarbon accumulations associated with non-marine extensional basins in the ASEAN region.

High resolution sequence stratigraphic studies indicate that climatically-driven lake level changes cause a variety of progradational sandstone facies to be deposited within the thick lacustrine shale successions of the second stratigraphic stage. These sandstones have not been explored to any significant degree and in the future may prove to be good hydrocarbon reservoirs.

Depositional palaeoenvironment determination based on organic facies characterization — A case study of the Batu Arang coal-bearing sequence

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The Tertiary sequence at Batu Arang, Selangor, is the only reasonably well exposed (albeit transiently!) non-marine coal-bearing sedimentary succession in Peninsular Malaysia and thus has been the subject of a number of studies by various group of workers such as mining engineers, geophysicists, geotechnical engineers

as well as sedimentologists. In this study, an organic petrological and organic geochemical approach has been undertaken with the aim of refining the palaeoenvironmental interpretation within the broad fluvio-lacustrine depositional setting of the coal-bearing sequence.

Based on the organic-richness of the sediments studied, three main rock types were identified i.e. shale with TOC of < 20%, carbargilite with TOC in the range of 20 to 49% and coal with TOC ≥ 50%. The coals are hypautochthonous in origin as evident from the finely detrital organic constituents, higher mineral matter content than truly autochthonous coal, and the presence of the subaquatically formed microlithotype durite, as well as the occurrence of alginite-bearing carbonaceous shale and carbargilite associated with the coal. The coal seams are not believed to have been deposited within lake or open water swamps as suggested by earlier workers. This is based on the absence of alginite in the coal whereas alginite is dominant in the shale and carbargilite samples, thus suggesting a dryer environment of deposition for the coals. Coals in the palaeo-river valley at Batu Arang, being abundant in vitrinite with common occurrence of inertinite, particularly sclerotinite, are interpreted here as peat-swamp deposits of an alluvial flood plain depositional setting.

Two different algal assemblages are present in the shales and carbargilites i.e. the *Botryococcus*-derived telalginite and the *Pediastrum*-derived lamalginite. These are fresh water green algae and their occurrence in high abundances suggests, with little doubt that the shales were deposited in a freshwater lacustrine depositional setting. The carbargilites were probably deposited within smaller ponds or flood basins situated within a swampy alluvial plain on which peats, that formed coals, accumulated.

Based on the organic geochemical data, it is possible to envisage the depositional condition of these different sub-environments. The reducing condition of deposition of the shale is, to some extent, indicated by the low pristane/phytane ratios of 0.8 to 1.5. This is supported by the high TOC and HI values. Slightly higher pristane/phytane values of 1.4 to 2.5 possessed by the coal and carbargilite samples reflect a relatively less reducing/more oxidising conditions of deposition indicative of an alluvial plain setting.

Nenering continental deposits: its age based on palynological evidence

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Considerable attention on aspects of sedimentology, structures and age has been given to the Nenering bed which is exposed in the north of Grik, Perak (Malaysia-Thailand border). Unlike a detailed study on structural and sedimentological aspects which have already been carried out by previous workers, the age determination is still in doubt because the previous age interpretation was not based on palaeontological data. This age determination was based on its similarities in lithology, sedimentary structures and structural style with other equivalent rock sequences. The Nenering bed shows a close resemblance with Tertiary sediments from other areas in Peninsular Malaysia and was then interpreted to be of Tertiary age having derived from the adjacent older sedimentary rocks which were deposited in a limited intermontane basin.

The main objective of this study is to reassess the age assignment to the Nenering bed utilising palynological data. A detailed sedimentological study is also carried out to interpret the environment of deposition and the palaeoclimate, supported by the acquired palynological information.

A total of sixty-two samples from eleven localities along Kampung Lalang-Kampung Air Panas and along the boundary road were collected for palynological analyses. The samples are mainly of dark grey carbonaceous sandstone and shale. The oxidising agents used in the present study to oxidise the light-coloured and the dark-coloured samples are either nitric acid or a stronger Schulze solution respectively. Only three

samples yield a considerable number of indentifiable palynomorphs. Plant remains, however, are dominant in some samples. The plant remains are not identifiable because of poor preservation. The identified palynomorph assemblage has a great number of palynomorphs but shows a limited number of varieties. They are *Psiloschizosporis pseudomonoleta* Trivedi, Ambawni and Kar, *Coronatispora telata* (Balme) Dettmann, *Spheripollenites scabratus* Couper, *Psilodiporites* sp., *Inaperturopollenites limbatus* Balme and *Inaperturopollenites* sp. The most abundant but less significant fungal spores are *Monoporisporites* sp. and *Atrophonites* sp. Most of fungal spores have a long stratigraphic range and therefore are seldom used in age interpretation.

The palynomorph assemblage from Nenering is compared with various palynomorph assemblages recorded from other areas. It is not comparable with the Tertiary's palynomorph assemblage as the latter is characterised by its rich and varied palynomorphs and is furthermore normally characterised by the dominance of pollen indicating the various types of flowering plants. The present palynomorph assemblage is also not comparable to the Early Cretaceous's palynomorph assemblage because the absence of commonly recorded genera such as *Cicatricosisporites* sp. and several species of *Classopollis*. The presence of *Coronatispora telata* and *Spheripollenites scabratus* which characterise the Aptian-Albian age, however, enables the Nenering bed to be assigned as Late Cretaceous. This proposed age is different from that of previously suggested Tertiary age based on lithology, sedimentary structures and structural styles. The dominance of fungal spores is also a supporting evidence of a warm climate during sedimentation.

Palynomorphs from non-marine deposits in the Malay basin

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Malay Basin is a northwest-southeast trending, elongate, pull-apart basin, which began to subside during the latest Eocene or early Oligocene, following the collision of the Indian Plate with Asia, and the subsequent eastward extrusion of a major part of southeast Asian plate toward the Pacific (Tapponnier *et al.*, 1986). The basin contains sediments in excess of 10,000 m, and is bounded to the southwest by the Tenggol Arch, and to the northeast by the Khorat Swell. To the northwest, the Malay basin is connected to the Pattani Trough, and at its southern end, it is connected to the Penyu and West Natuna Basins. The initial phase of sediment accumulation involved the deposition of lacustrine and fluvial sediments during the Oligocene rift phase of basin development. Subsequently in the Early Miocene, the non-marine condition phased out during which evidence of a first marine incursion has been detected in the southern part of the Malay Basin (Azmi *et al.*, 1994).

The non-marine deposits so far penetrated in the Malay basin are mostly equivalent to the Seligi and Ledang formations which comprised of an upper shaly and a lower sandy units. The shale is believed to have been deposited in a lacustrine environment. The lithology and palynomorphs assemblage within these units are correlatable to the West Natuna Basin which is thought to be Oligocene (Morley, personal communication).

This paper discusses the morphotypes, stratigraphy, distribution and source rock potential of palynomorphs from the lacustrine sediments, with emphasis on the freshwater algal palynomorphs. The materials used in this study were ditch-cuttings from wells Ledang-1, Kaca-1 and Angsi-1. These wells are located in the south part of the Malay Basin. The lacustrine sediments in Ledang-1 and Kaca-1 are preserved at relatively shallow depths. Consequently, the morphology of the palynomorphs are easily understood and the knowledge was used to identify poorly preserved specimens from the deeply buried section of the Angsi-1 Well. The results from this study were tested against data from previous study in order to determine their stratigraphic significance.

Freshwater algae dominate the palynomorph assemblage and sometimes constitute up to 80 percent of

the total palynomorph observed in the sediments. They can mostly be referred to the genera *Bosedinia, Granodiscus, Pediastrum* and *Botryococcus*. The former two were well preserved and occur in abundance, whereas the latter two were otherwise. Ten morphotypes of *Bosedinia* and *Granodiscus* were recognised and they can be classified as 'thin' and 'thick'-walled forms. The thin-walled forms comprised the *B. infragranulata* and *B. granulata* and, the thick-walled consisted of the *G. staplinii, B. kuantanensis* and *B. whelkaris*. A new morphotype was identified and named as *Bosedinia gemmata* Azmi (1994). This type is characterised by gemmate ornamentation, sphaerical to subsphaerical cysts with single layered wall typically 1 m in thickness and possessed a distinct omphalos, thickened relative to the cyst wall.

In the Malay Basin, four palynological zones had been recognised within the Ledang and Seligi formations using abundance changes within the thin and thick-walled algal assemblages. The top of PR1 is marked by a decrease in the abundance of algal cysts and is associated with fluvial deposition. The overlying PR2 zone is characterised by high abundance of the algal cysts and is believed to represent a widespread lacustrine unit. PR3 is characterised by reduced abundance of the algal cysts and is thought to be associated with fluvial plain. The low abundance of freshwater algal cysts persisted in PR4 during which the basin was already under marine influence. Further reduction of algal cysts marked the top of PR4 zone. The thick-walled algal cysts are restricted to the wells from the southeast corner of the Malay Basin where the Ledang and Seligi formations had been penetrated, whereas the thin-walled cysts are more widely distributed.

The lacustrine sediments in the south Malay basin, in particular the Ledang and Seligi shale are organically rich and form the major petroleum source rock. The lake that developed, in particular during the Ledang shale time, must be sufficiently deep that permanent water stratification could have formed. This could have caused the organic matter to be preserved. The main source of organic matter in the lacustrine shale is believed to have been the algal palynomorphs and inwashed detritus from terrestrial vegetation. The algal cysts are easily recognised under the microscope by their high fluorescence characteristics.

This study has demonstrated that the occurrence of freshwater algal palynomorphs in the Oligocene sediments of the Malay Basin are important not only as the major source of organic matter in the shale but also as stratigraphic indicator. Therefore, understanding of their morphology and distribution are essential.

The types and the origin of carbonate karsts in Malaysia and their significance

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Karst (named after a region of the same name in the former Republic of Yugoslavia) refers to a characteristic topographic feature or landscape which can be developed by rocks undergoing dissolution by downward percolating meteoric water (Jakucs, 1977). Many features of karst are also developed by flowing water which had flowed laterally on reaching the water-table which becomes the base-level of erosion for the development of the many karstic features observed in the tropics and elsewhere (Zotl, 1989). Several rock types under such natural "weathering/solution" environment can develop karstic topography. They include limestone, dolomite, gypsum, salt deposits and silica rocks (Jennings, 1971).

However, the most common and the best known are those developed by carbonates [calcite, $CaCO_3$ and dolomite, $(Mg, Ca)CO_3$]. Under tropical humid conditions, calcitic and dolomitic limestones or their metamorphosed equivalents develop tropical karstic features which show spectacular tall steep-sided hills (tower karst or mogote) (Jennings, 1982) and solution features such as karren, dolines, uvalas, poljes and cockpits (locally referred to as wangs).

Table 1. Karstic features and karst types and their potential geotechnical problems and hazards.

1. KARST TYPE A: ABOVE SURFACE TOWER KARST (MOGOTE) (IPOH AND LANGKAWI)

KARSTIC FEATURES	*POTENTIAL GEOTECHNICAL PROBLEMS AND HAZARDS*
1. MOGOTE HILLS	A. STEEP VERTICAL FACE
2. CAVES	B. COLLAPSE OF WALL/FACE
3. WANGS (OR COCKPITS)	C. INSTABILITY OF OVERLYING GROUND (SINKHOLE FORMATION)
4. NOTCHES	
5. OVERHANGING CAVES	D. VERY DIFFICULT OR IMPOSSIBLE TO CONSTRUCT UNLESS CUT DOWN TO PLATFORM LEVEL
6. SPLEOTHEMS	
7. KARREN (VARIOUS TYPES)	

2. KARSTIC TYPE B: BURIED RELICT/EXHUMED KARST (KINTA AND KLANG VALLEYS)

KARSTIC FEATURES	*POTENTIAL GEOTECHNICAL PROBLEMS AND HAZARDS*
1. PINNACLES	A. PILE DEFLECTION (DRIVEN PILE)
2. DOLINES AND UVALAS	B. PILE DAMAGE (DRIVEN PILE)
3. CAVITIES	C. UNSTABLE ANCHORAGE (END-BEARING)
4. OVERHANGS	D. MOVEMENTS OF PILE OVER SLABS AND OVERHANGS
5. SLABS	
6. CHANNELS	E. WEATHERED ROCKS AND SOLUTIONS GIVING RISE TO PROBLEMS OF ANCHORING
7. WEATHERED LIMESTONE	F. COLLAPSE OF ROOF OF CAVITIES
	H. WITHDRAWAL OF SEDIMENTS (SURFACE INSTABILITY)

3. KARSTIC TYPE C: STRATIGRAPHIC KARST (K.L. PAN PACIFIC OR K.L.C.C. TYPE)

KARSTIC FEATURES	*POTENTIAL GEOTECHNICAL PROBLEMS AND HAZARDS*
1. UNEVEN BEDROCK	A. MAJOR PROBLEM TO SITE TALL HIGH-RISE DUE TO MAJOR OVERHANGS RELATED TO DEEP AND UNEVEN BEDROCK (E.g. K.L.C.C.)
2. LARGE MASS ROCK HEAD	B. OVERLYING WEATHERED SOFT SEDIMENTS
3. MINOR SOLUTION SURFACE.	C. MINOR IRREGULAR SURFACE AT SHALLOW DEPTHS
4. SOLUTION ZONES	D. VERTICAL CLIFFS AND OVERHANGS
5. DEEP CAVITIES AND CAVERNS	E. SOLUTION OF BEDROCK IN PROGRESS
	F. ARCHING OF OVERLYING SOFT SEDIMENTS
	G. SEDIMENT WITHDRAWAL (SINKHOLES)

4. KARSTIC TYPE D: SUBMARINE KARST (OFF THE COAST OF SOUTHEAST ASIA)

KARSTIC FEATURES	*POTENTIAL GEOTECHNICAL PROBLEMS AND HAZARDS*
	— **BURIED PLATFORM TYPE**
1. PLATFORM AND PINNACLED	A. UNSTABLE ANCHORAGE AT SHARP BEDROCK SURFACE
2. PLATFORM WITH SOLUTION CAVITIES	B. WEAK ZONES TRAVERSED BY FAULTS
	C. AREAS WITH CAVITIES WHICH ARE INTERCONNECTING (AT SHALLOW TO DEEP LEVELS)
	D. SOME SIMILAR PROBLEMS AS FOR SUBSURFACE KARST

3. MINOR SHARP BEDROCK SURFACE

— **BURIED RELICT**

1. MAJOR SHARP SURFACES
   A. UNSTABLE ANCHORAGE OVER SHARP BEDROCK SURFACE
2. WEATHERED ZONES
   B. WEATHERED AND WEAK ZONES (FAULT-CONTROLLED)
3. CAVITIES AND POTENTIAL
   C. POTENTIAL COLLAPSE OF CAVITIES AND CAVERNS CAVERN ROOFS
   D. SOME SIMILAR PROBLEMS AS FOR SUBSURFACE KARST

Stratigraphy and sedimentology of a Jura-Cretaceous 'Park' near Bandar Muadzam Shah, Pahang

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About 50 m of well-preserved Jura-Cretaceous rocks are exposed at about 23 km from Bandar Muadzam Shah, along the road from Pahang River to Bandar Muadzam Shah. Stratigraphic logging of these rocks reveal at least seven upward-fining cycles of sandstone-siltstone-mudstone successions with minor conglomerates.

Cycle I (lowest cycle) is about 9.0 m thick. At the base, a ~2.0 m thick medium-to-coarse grained sandstone occur with a well developed basal conglomerate. Internally, this sand unit displays subhorizontal lignitic laminae with lignitised plant debris. This unit is overlain by a thin silty mudstone layer, which in turn is overlain by another ~2.0 m thick sandstone unit characterised by well developed epsilon cross-bedding. This sand unit is capped by *'en echelon'* inclined sand lenses in a matrix of sandy siltstone. A ~5.0 m thick sandy mudstone represent the uppermost part of this cycle.

Cycle II which overlies Cycle I is also made-up of a lower ~2.0 m cross-bedded sand unit with basal conglomerate. This is succeeded by a ~3.0 m thick siltstone characterised by well developed *'en echelon'* inclined sand lenses. The vertical facies arrangement of Cycle I and II suggests that these cycles represent deposits of a fluvial channel that has undergone chute cut-off type gradual abandonment.

A localised 'channel-fill' conglomerate with chert pebbles and large coal fragments occur at the base of Cycle III. This is sharply overlain by a ~3.5 m thick of poorly sorted 'pebbly' sandstone, dominated by large quartz clasts and well rounded chert granules. Cycle III is capped by ~1.0 m thick dark mudstone. This cycle is probably the product of a neck cut-off of a meander loop.

A relatively thin Cycle IV comprise a thin basal conglomerate at the base of ~1.0 m thick cross bedded sandstone. This is capped by a ~1.5 m thick clayey silt with interbedded sand lenses.

Cycle V (~7.5 m) is distinctly characterised by decimeter thick 'sheets' of fine-grained green sandstone. In the field, the distinctive feature of these green sand layers is the presence of large, rounded concretions (suggesting rapid burial and early cementation). Thin section study of these sandstone samples shows the widespread presence of chlorite cement. This unit is capped by a ~1.0 m thick silty mudstone. This cycle could probably represent products of proximal floodplain processes.

A ~2.0 m thick Cycle VI is made up of a lower 'massive' sandstone with thin basal conglomerate capped by clayey siltstone.

Cycle VII is a composite upward-fining cycle. The base comprises a ~4.0 m thick channelised complex

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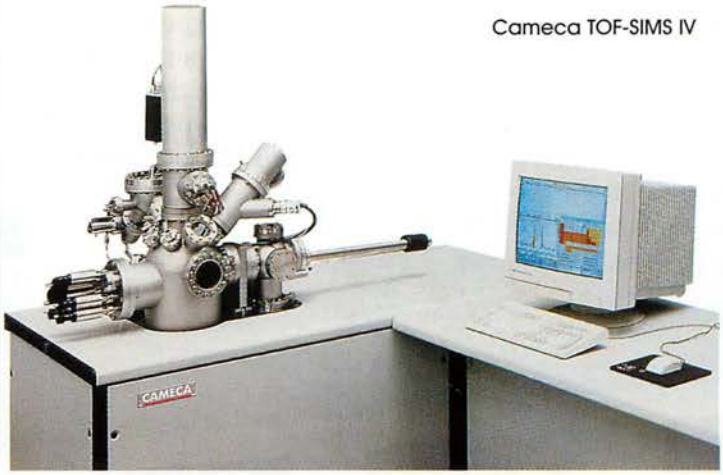

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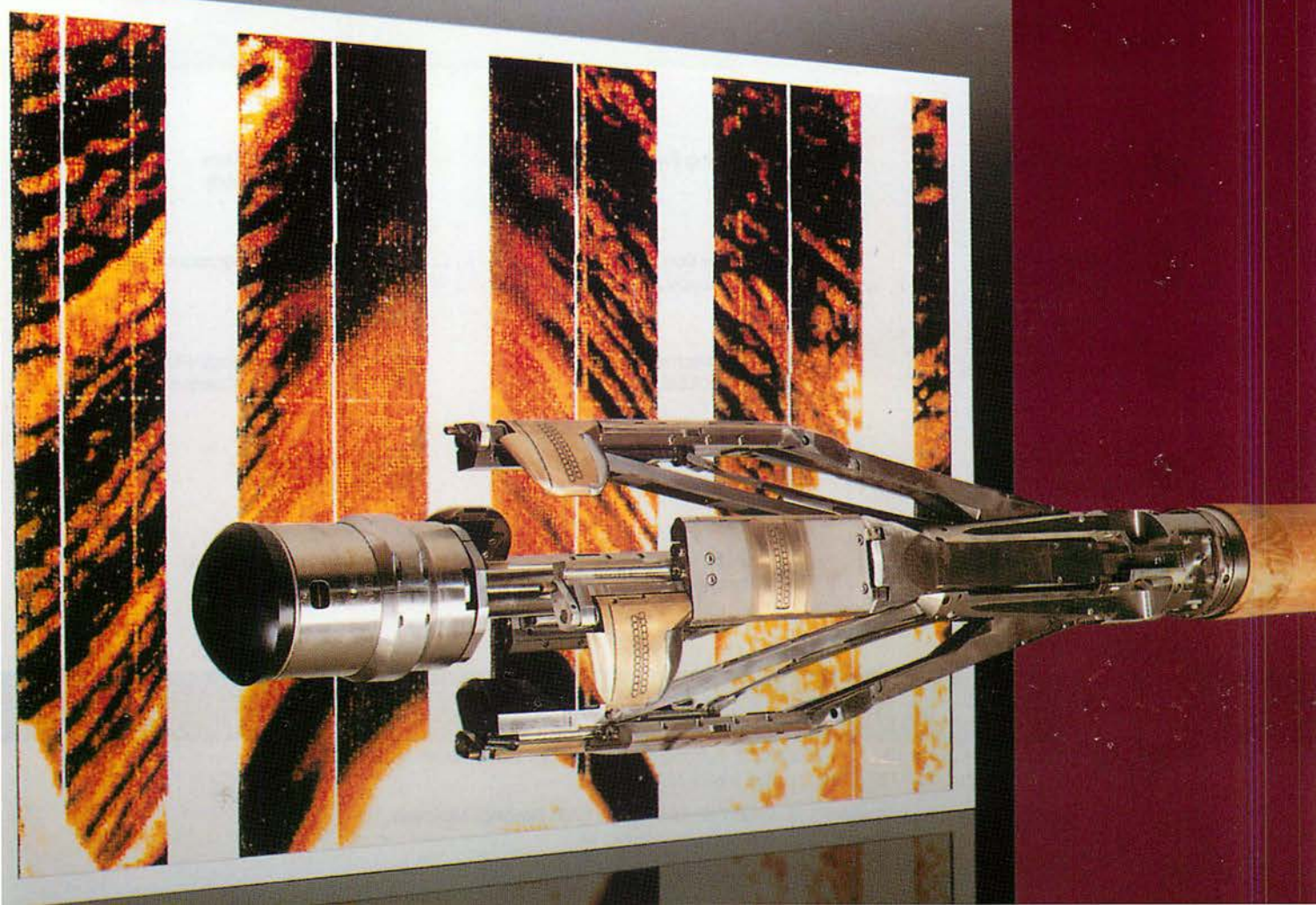

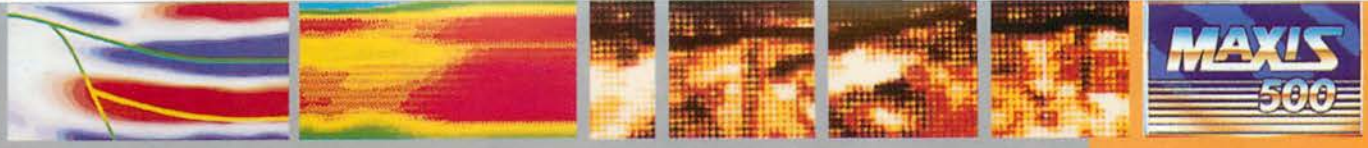

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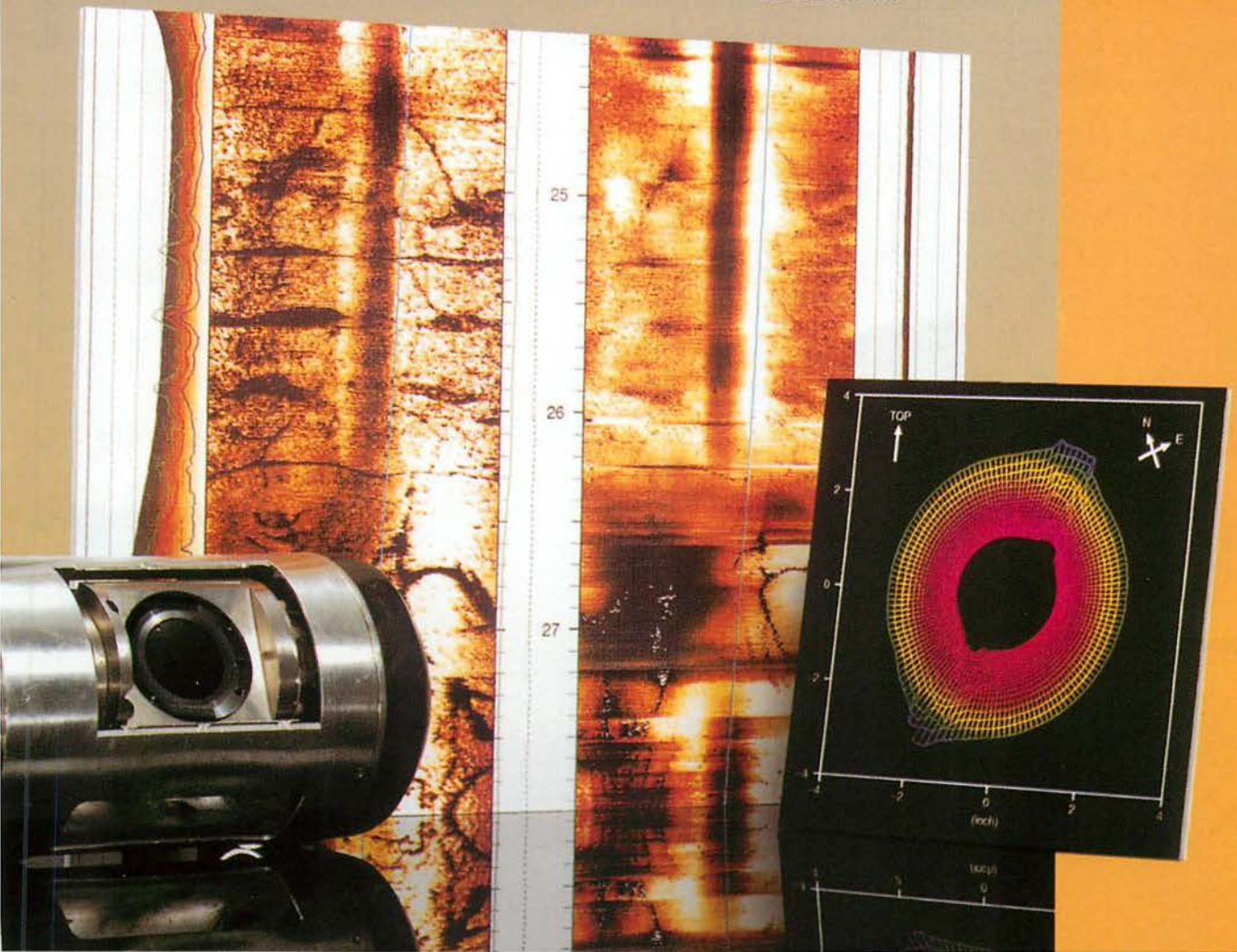

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of clean cross-bedded sandstone bearing rounded mudclasts. The beds are separated in places by mudstone lenses. The upper, finer-grained part of this cycle is ~15.0 m thick. This thick upper unit shows at least nine small-scale coarsening upward units which pass from muds into siltstone or even fine sandstone, which represent records of deposition of fine grained material from suspension in interchannel areas during periodic flooding.

The sedimentary characteristics of the Jura-Cretaceous successions at Muadzam Shah suggests that they are deposits of an alluvial complex of relatively sinuous rivers.

Gold abundances in some metasedimentary rocks of Peninsular Malaysia

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A preliminary study was carried out on the gold abundances of some metasedimentary rock formations of Peninsular Malaysia. Samples from selected rock formations from Gua Musang, through Raub to Kuala Pilah representing the Central Belt, and from Marang and Mersing representing the Eastern Belt were collected. The samples were analysed using Neutron Activation Analysis (NAA) by MINT, Bangi. The analytical results obtained were analysed graphically using log-probability graph paper.

Result of the study shows that most of the samples were multipopulation. The main population representing the background population is usually higher than the average crustal Au abundance of 4.0 ppb. An anomalous population usually forming a smaller fraction of the sample population may have Au abundances a few times higher than the background values. This finding is significant as it indicates that the earth's crust in this part of the peninsular has higher gold abundances. The sedimentary rock formation may be the source-rock for gold mineralization in the Central Belt. If so, than it explains why the gold occurrences in the Peninsular are always away, by a kilometer or so, from the main granite bodies.

Computer-aided processing of discontinuity data: A case study from km 26.5, Kuala Lumpur-Karak Highway, Malaysia

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"Discontinuity" is a term used in geology and engineering geology to describe any break within a rock mass characterised by very low or zero strength (ISRM, 1978). It includes joints fractures cracks, fissures, bedding planes, faults and other similar planes which divide the rock mass into rock blocks. The influence of discontinuities and their characteristics on stability and engineering behaviour of a rock mass has been recognised for some time, e.g. Mueller (1963) stressed on the importance of the degree of fracturing and the use of a fracture index in sub-dividing a rock mass into homogeneous zones.

The processing of discontinuity data is one of the tasks faced by geologists, whether in classical or

applied geological work, before such data can be used for further interpretation. For a long time, this data processing has been carried out manually, based on procedures developed e.g. by Schmidt (1925) and others. In recent years a number of computer programs for such data processing have become available. This paper discusses the use of one such program, WINGESAP, whose initial development started at the Chair of Geotechnics (Prof. Dr. Ing. K.W. John), Institute of Geology, Ruhr University, Bochum and was subsequently refined by N. Graf, Geo-System, Bochum. Data collected from km 26.5, Kuala Lumpur-Karak Highway, (Abdul Ghani Rafek, 1994) was processed at Geoplan, Witten, using different plotting procedures. The results are presented in Table 1 the density isoline plots. The orientation of major discontinuity planes is in the form of dip direction and amount of dip (α/β).

The results of the density isoline plots shown in Table 1 were determined as follows:

(a) Manual processing using the counting nets of Braun (1969);

(b) 1% fixed area cone using the program WINGESAP;

(c) Variable area cone using the program WINGESAP whereby
$F = 100/n$ %
F = counting cone area in %
n = number of readings

(d) Mixed evaluation method, with WINGESAP. In this case the following formula is used:
$\eta = \eta_1 XF_1/(F_1 + F_2) + \eta_2 XF_2/(F_1+F_2)$
F_1 = percentage area of first counting cone
η_1 = number of readings within first counting cone
η_2 = number of readings within second counting cone
η = the results, i.e. the number for that counting area

(e) Determination using the cosine method. This method was developed by Adam (1989) and uses the direction cosines between the centre of the counting point and the discontinuity reading.

Comparison of the different plots and the results in Table 1 leads to a number of conclusions. Amongst them are:

- all the different plotting techniques show that there are four major discontinuity sets.
- with computer-aided processing, the different techniques yield the same results for the orientation (within a range of five degrees). By comparison, differences of the greater than 10 degrees are obtained by manual plotting.
- the values of the percentage density maximums are determined to a greater accuracy using the program WINGESAP.
- using the manual method, eight different discontinuity sets were determined. However some of them have low density and may not be of significance.
- using the different computer-aided processing techniques, it was found that five discontinuity sets were determined by two techniques and four by the remaining two techniques This is being investigated further.

Table 1. Results of processing of discontinuity data using different plotting techniques: Kuala Lumpur-Karak Highway, km 26.

TECHNIQUE	Orientation of major discontinuity planes (α/β) and stereographic density (%)
Manual	055/85; > 6.0; 096/85; 6.0; 110/50; > 6.0 345/86; > 6.0; 000/82; 5.0–6.0; 130/78; 5.0–6.0; 030/55 & 030/55; 3.7–5.0
1% area	0070/85; 19.0; 348/86; 15.0; 093/88; 13.0; 027/49; 11.0; 116/58; 10.0
$F = 100/\eta$	076/87; 18.0; 346/87; 15.0; 115/58; 12.0; 027/49; 7.0
Mixed evaluation	348/86; 18.0; 065/85; 17.0; 093/88; 13.0; 116/57; 10.0; 027/49; 7.0
Cosine method	065/85; 17.0; 353/84; 17.0; 114/62; 13.0; 033/47;110

Seismic refraction study on sedimentary and granitic terrain

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Introduction

There are two ways in which the seismic waves behave when encountering boundaries. It can either passes through the boundary (refracted) or it may bounce back (reflected). These different behaviors give rise to two different types of seismic survey method: the seismic refraction method and the seismic reflection method. The present work is targeted for applications in shallow subsurface material variation. Knowledge of the shallow subsurface characteristic variation is important in site investigation. The examples are: (a) in the construction of structures such as houses in a hilly or undulating region where such information are required to assist in determining the optimum structural platform level (e.g. building and roads), (b) to determine the rippability or excavatibility of the subsurface materials and (c) in quarry industry such seismic information can help determine rock reserve and overburden thickness and volume.

Many of the present construction and rock quarrying activities are conducted in either granitic or sedimentary/metasedimentary terrain. The granite which appears to be relatively homogenous should be excellent for seismic method while the sedimentary/metasedimentary rocks which can change its lithological component drastically and having is bedding dipping in various directions seems more difficult to apply. In addition the weathering of the different rock types at different rates may add to the complexity of the application of seismic method for shallow subsurface variation. It is hoped that the seismic arrivals together with borehole information and outcrop observation will give a clearer picture on these problems.

In working on shallow subsurface problems the seismic refraction method appears to give a reasonably good information. Therefore the study concentrates on the application of the seismic refraction method for the shallow subsurface variation.

Theory of Seismic Method

Seismic exploration method is one of the geophysical method known used to determine the subsurface structure or characteristic. The basis of the seismic method is extremely simple. It involves the initiation of a sudden disturbance or displacement at a small region in or on the subsurface materials. The displacement propagates outward from its starting point as a spherical wave front. It eventually arrives at a distance point and can be detected by the movement it induced in the subsurface material. The time taken for the wave to travel from its starting point to the detection point can be easily determined. For seismic wave travelling directly from its starting point to the detection point in a homogeneous material the speed of travel is easily calculated. Complexity arises when the seismic waves travels through materials having different properties and passing through the boundaries of these different materials. In many cases simplification subsurface models is necessary.

Equipment and field procedure

The present work uses a twenty-four channel seismograph. This seismograph is a 486-DX based system. Thus it acts both as a seismograph and a PC. The data acquisition system is software driven. The software is very basic. It allows selection and stacking of input data during data acquisition. It also allows simple filtering of data during and after acquisition. Identification of the first arrivals and velocity determination can be done during data acquisition period. The data can be displayed on a screen. The field data is stored directly in the hard disk and backup files in the floppy disk.

In this study, the seismic spread is placed where there are logged boreholes or where there are outcrops sufficient to give a depth control on the seismic refraction result. In many shallow refraction work a typical

spread basically consists of twenty-four geophones placed at 5 meters apart giving a 115 meter line spread. Five impact points are normally used to give a relatively accurate result. These are placed at six geophones apart. Where offset shots are carried out another two impact points are added.

Interpretation

An initial and easiest depth estimation is to use the intercept times or critical distance method. These methods provide depth only at the shot points. With the shot point arrangement used it is possible to determine the subsurface profile using the delay time method. This gives greater detail and mapping of undulation is possible. Correlation with the geology can be carried out using the borehole and outcrop data.

Possible Problems

Some of the possible problems observed during the study are described below.

In working in the granite terrain one of the factors which could give rise to problems is the presence of core boulders in the granite weathering zone. In hilly terrain the boulders are often found in abundance at the surface. The distribution within the weathering zone is difficult to estimate. Furthermore the size of the boulders varies markedly. These boulders can be less than one meter in diameter and others are a few meters in diameter. Seismic wave encountering these boulders may be diffracted and some refracted into and then out of the boulders. The arrival times will be shorter than in homogenously weathered material. Normally where core boulders are found, scattering of the arrivals time are noticeable. This will affect the depth estimation. In areas where boulders are found in the weathering profile, borehole data quite often do not give accurate depth to the granite bed rock because many boreholes were made without considering the potential maximum size of the boulders.

It is quite normal to assume that generally the granite weathering profile follows the surface shape. However, observation in outcrop section and seismic refraction survey indicates that this is not always true. In areas where there are alot of fracturing the top of the fresh or relatively fresh granitoid is relatively undulating even over a few meters distance. In some cases this interface forms limestone karst-like features but smoothed.

In sedimentary terrain, among the difficulties encountered is the variability of the sedimentary rock lithological composition. This affects the mean velocity calculated and thus the interpretation on the nature of the sedimentary materials. In dipping layers with interbeds of shale and sandstone or in the metamorphic equivalents, the limestone karst-like feature will invariably be present. However a knowledge of the lithology of the area allows more precise interpretation. Comparison of the seismic result to borehole log data only without understanding the geology, often lead to imprecise interpretation.

In summary the interpretation of seismic refraction data in granitic and sedimentary terrain should take into account the potential associated problems. The seismic data should complement the borehole data in shallow seismic refraction work.

Seismic tomographic imaging in engineering characterisation of a site in Kuala Kangsar, Perak

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Seismic tomographic imaging (STI) have been traditionally applied in rock mass assessment for the evaluation of their fracture intensity, and the existence of shear and fault zones by various researchers (Saito and Ohtomo, 1989; Gustavsson *et al.*, 1986). However a site for a proposed road realignment project at Kg.

Jenalik, Kuala Kangsar was chosen to investigate the effectiveness and the accuracy of the STI method in which both granitic residual soil and its rock mass were encountered.

The objectives of this study aim to assist in the assessment of vertical and lateral variability of the colluvium, the weathered granite and the existence of any ground water regime at the site.

Shallow seismic refraction survey with 5 spread lines were initially carried out to obtained a general subsurface profile of the study area. A total of seven boreholes were drilled using water, foam and a combination of foam and bentonite in order to ensure the accuracy of carrying out subsequent tests encompassing the SPT, pressuremeter and the downhole seismic logging. All the seismic data were acquired digitally on both the Bison 5012 and the Geometrics ES 1225 seismograph, while the geophones employed are the vertical P-wave geophone and the hydrophone which are employed inside the boreholes.

The STI field techniques used were combinations of P-wave seismic methods encompassing the surface refraction (SRM), surface-to-borehole (STB) and the crosshole (CH) seismic which were conducted between borehole BH2 to BH6 and extending along the line of these boreholes. Tomographic images from the STB data were first processed followed by the combination of STB and CH data and finally the combination of STB, CH and the SRM data. All the data were processed using curved ray tomography. Comparisons were made to the seismic refraction survey, geological logging, standard penetration test (SPT), piezometer, pressuremeter and the downhole seismic at the same location. The accuracies of all the final STI images processed were compared in relation to the depths encountered from in situ testing and their results tabulated and outlined.

The images from the three STI processing methods show variations in P-wave velocity contours with depth. Of all the results of the three STI images processed, the processing that intergrates all the STB, CH and SRM data was found to be the most accurate in relation to the downhole seismic and the geological logging at the site. However, the presence of a boulder (about 1–2 metres diameter) near BH6 that had been encountered during drilling was unable to be detected in all the STI images which may be attributed to the lack of velocity contrast at the site.

Some applications of multivariate statistical package (MVSP) in sedimentary geology

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MVSP has been applied to various branches of geology, particularly in sedimentary facies analysis. The results of few sedimentological studies, including two Recent lacustrine case studies, are reviewed in order to demonstrate the application of MVSP in the classification of such sedimentary and/or geochemical facies.

The reliability of most quantitative facies analyses depends upon the accuracy of the counting variables such as petrographic components and/or geochemical measurements. Normalizing the abundance of these variables to 100% is the most practical and applicable method used by many geologists before subjecting them to MVSP statistical analysis. However, the nomenclature of petrographic facies, for example, depends on the classification performed. The latter is mainly based on the distribution of components (i.e. textures) which are the result of the physico-chemical and biological processes of their environments of deposition.

A lot of effort is required to objectively classify a sedimentary sequence into distinctive sedimentary, palaeontological or geochemical facies. However, application of computerised equipments and other related software has minimized the errors in the quantification of the variables (such as petrographic components, fossils or elements). In addition, the statistical analysis of these results reduces the error inherent in such classifications. These statistical packages may be also used in the mapping of results, particularly when data about a wide study area are limited.

MVSP, particularly cluster analysis, could be used in any subject dealing with the distribution of variables to estimate similarities between samples, boreholes or stations studied (i.e. Q-mode analysis). However, a similarity relation between the variables, depending upon their distribution in each sample, might be also adopted (i.e. R-mode analysis).

Hydrological characteristic before and after Langat Dam construction, Hulu Langat, Selangor

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Langat Basin is one of the basin systems, situated at Latitude 3°11'45" and Longitude 101°51'31" in the southeast of Kuala Lumpur. The trend of this basin is more or less north east to south west. Toward the north west there are three rivers, parallel with Langat Basin, viz. Klang, Gombak, and Selangor Rivers. These rivers which flow to the southwest later on merge with Semenyih in the southeast to form Langat River. The boundaries between Klang, Langat and Semenyih Rivers, are characterized by rugged ridges with some culminating points surrounding Langat Basin, such as, Bt. Enggang (338 m), Bt. Arang (556 m), Bt. Chondong (455 m), G. Nuang (1,487 m), Bt. Chenuang (815 m), Bt. Puteh (405 m), Bt. Serdang (177 m), and Bt. Bisa (142 m). These culminating points are high points surrounding the water catchment area for the Langat Basin. The overall size of the Langat Basin cover about 1,990 km^2. The water catchment of this basin is believed to be topographically controlled, due to differences in rock hardness. The Langat River started from the southern part of G. Nuang flowed to the southwest as long as 50 km until it met with Semenyih river at mile 25. Upland elevation of Langat River is more than 200 metres above sea level, but decrease to 91 metres at mile 20, 39.6 metres at mile 10, fall to 24 metres at Kajang Town and finally drop to 14 metres at the junction with Semenyih River. The purpose of this study is to identify the changes in the physical characters of the Langat River such as rainfall, stream flow regime, depth of river and suspended sediment, before and after Langat Dam construction.

Seismicity of Kenyir, Terengganu

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Among the more documented cases of man-made or induced earthquakes are those associated with fluid, including the ones induced by dams or reservoirs. Prior to building, background seismicity data can be used to site a dam. The seismicity records obtained before and after construction can be used to monitor a dam for safety reasons. Monitoring is done throughout the life of the reservoir to assess its seismic risks. Other possible applications of the seismicity data is to study the regional geology and the crust structure between the source and the recording stations.

Reservoir-induced seismicity or RIS, are expected from dams constructed in seismically active areas. However, dams that exceed 100 meters high, with high capacity volume and large surface area are much more likely to experience significantly large tremors (larger than magnitude 4), even when the sites were previously

aseismic. Among the factors contributing to the shocks are existence of nearby failure planes and the rate of change of water levels in the reservoirs. The Kenyir Dam was no exception; tremors were reported (and recorded) near the Kenyir area since 1984. There was no reported earthquakes before from this area. This may be due to lack of local seismic (recording) stations or the fact that no one felt any shocks because the place was remote and the shocks were not big enough. The Kenyir earthquakes of 1984 till 1987 were recorded by stations in Ipoh, Kluang and Petaling Jaya. These stations are a part of a nationwide network managed by the Seismological Division of the Malaysian Meteorological Service (MMS). The data used in this study is from paper seismograms dated back to 1979 and from the published annual reports (1979–1995) from MMS, which also include all of the regional earthquakes.

A total of 27 shocks were recorded by the MMS, with the magnitude ranging from 2.5 to 4.6 on the Richter scale. There were other signals on the seismograms: teleseisms, regional earthquakes from East Malaysia and other neighbouring countries, and localised tremors (probably from explosions). The signals are classified according to the S-P times, their frequency contents and their relative sizes (amplitude and duration). For instance, the S-P time for the Kenyir earthquakes recorded in Kluang is about 35 seconds. The times vary accordingly with distance between source and stations.

Although the probability of any dam suffering significantly damaging shocks is small, the risk is substantial for those who live near and who are directly affected by the dams. The increase in population demands a higher, continuous supply of electricity. Hydro-electricity is usually preferred as it is cheaper and cleaner than fossil fuel, with an added bonus of the reservoir being a tourist attraction. The results of this study is beneficial for future dam projects in Malaysia (especially the larger ones) and manage the risks involved.

Struktur Formasi Machinchang: beberapa penemuan baru dan implikasinya

(Structure of the Machinchang Formation: Some new findings and its implications)

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Pembangunan pesat di Kepulauan Langkawi terutama di bahagian baratlaut Pulau Langkawi menyebabkan banyak singkapan batuan Formasi Machincang didapati di sepanjang jalan. Bersama-sama dengan maklumat yang dikumpulkan di sepanjang pantai, beberapa penemuan dan tafsiran baru tentang struktur formasi ini telah didapati.

Sehingga sekarang, struktur batuan formasi Machinchang telah banyak dikaji oleh pengkaji-pengkaji terdahulu dan disimpulkan bahawa umumnya batuan formasi ini mempamerkan struktur yang mudah dengan peralapisan berada dalam keadan normal, kecuali di kawasan timur Teluk Datai hingga ke Teluk Anak Datai yang ditafsirkan sebagai satu jalur sesar sungkup dan kehadiran batuan Pra-Machinchang. Formasi ini telah ditafsirkan membentuk satu antiklin besar dikenali sebagai antiklin Datai yang menunjam ke arah utara. Satu lagi antiklin yang dikenali sebagai antiklin Buta menunjam ke arah timur laut dengan paksinya di sekitar Tanjung Buta. Selain daripada itu ditafsirkan lineamen utama yang mewakili sesar, memotong batuan formasi ini.

Kajian ini mendapati bahawa dari bahagian barat Teluk Datai hingga ke Tanjung Chinchin jujukan batuan sedimen formasi Machinchang wujud secara berulangang, dengan kemiringan yang berubah-ubah daripada landai hingga menegak miring ke arah barat. Lapisan yang landai berkeadaan normal manakala lapisan yang curam lazimnya berkedudukan terbalik. Perubahan ini terjadi apabila lapisan dipisah-pisahkan oleh sesar atau zon sesar songsang. Berdasarkan kepada cerapan tersebut ditafsirkan keseluruhan kawasan ini

membentuk struktur dupleks dengan sesar sungkup utama terletak di sekitar Teluk Datai dan mempunyai arah hampir utara-selatan.

Kerencaman struktur di kawasan Timur Teluk Datai hingga Teluk Anak Datai telah dikaitkan dengan kehadiran sesar sungkup dan kehadiran lapisan yang ditafsirkan sebagai lapisan Pra-Machinchang oleh pengkaji terdahulu. Ke arah timur kawasan ini hingga ke Padang Golf, batuan di sini membentuk satu sinklin terbuka yang menunjam ke arah utara. Kehadiran sinklin ini boleh dikaitkan dengan seretan yang dihasilkan oleh sesar sungkup. Kearah timur lagi hingga ke Air Terjun Temurun, lapisan berkedudukan sekata miring landai ke arah selatan. Berhampiran dengan Teluk Tok Manap hingga Pasir Tengkorak, lapisan batuan membentuk siri sinklin dan antiklin berskala sederhana yang keseluruhannya merupakan satu antiklin yang menunjam ke timur laut seperti yang telah dilaporkan sebelum ini. Dari Pasir tengkorak ke Tanjung Buta, lapisan umumnya agak landai dan terlipat membentuk lipatan terbuka dan landai menunjam ke arah hampir utara hingga timur laut.

Berhampiran dengan Tangki Air, berhampiran dengan Teluk Kubang Badak, lapisan agak curam mempunyai jurus ke arah timurlaut dan memiring samada ke tenggara atau ke baratlaut. Lapisan yang memiring ke tenggara berkeadaan normal manakala yang miring ke baratlaut berkeadaan terbalik, keseluruhannya membentuk lipatan terbalik. Berdasarkan kepada kehadiran sesar songsang disini, keadaan terbalik ini ditafsirkan berasosiasi dengan sesar songsang atau sungkup yang lebih besar dengan vergen ke tenggara.

Di bahagian timur Teluk Kubang Badak, terdapat lipatan rebah dengan vergen ke barat seperti yang telah ditafsirkan sebelum ini. Selain daripada itu terdapat juga sesar normal yang memisahkan batu kapur Formasi Setul dan batuan Formasi Machinchang di Tanjng Sabong. Lipatan rebah di sini mungkin juga berasosiasi dengan sesar sungkup ke barat.

Secara keseluruhan, struktur batuan formasi Machinchang banyak dipengaruhi oleh kehadiran sistem sesar sungkup. Di bahagian barat Teluk Datai, sesar sungkup umumnya bergerak ke timur, manakala di bahagian timur Teluk Datai pula sungkup ke barat hingga baratdaya. Keadaan ini mungkin menyebabkan zon di sekitar Teluk Datai menjadi pusat tumpuan menyebabkan batuannya lebih tercangga dan keadaan ini memberi gambaran seolah-olah mewakili batuan yang lebih tua daripada Formasi Machinchang. Tafsiran tentang batuan pra-Machinchang perlu disokong oleh bukti-bukti lain selain daripada perbezaan kerencaman struktur dibandingkan dengan batuan formasi Machinchang di tempat lain. Kehadiran Sesar sungkup juga, memberi implikasi yang ketebalan jujukan batuan formasi ini mungkin jauh lebih nipis daripada yang telah ditafsirkan sebelum ini.

Kepentingan struktur minor dalam sebilangan zon sesar utama di Semenanjung Malaysia

(Significance of minor structures within several major fault zones in Peninsular Malaysia)

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Di Semenanjung Malaysia sesar-sesar yang berjurus barat dan baratlaut ditafsirkan sebagai sesar-sesar mendatar ke kiri, dan pergerakan mendatar ke kanan lazimnya di sepanjang sesar-sesar yang berjurus timurlaut. Namun demikian, struktur yang menunjukkan pergerakan mendatar ke kanan dalam zon sesar yang berjurus barat dan baratlaut, dan gelinciran mendatar ke kiri di sepanjang sesar yang berjurus timurlaut, sudah pernah ditemui di beberapa lokasi dan sudah juga dilaporkan. Di Teluk Sudu Pulau Dayang Bunting, pergerakan mendatar ke kanan di sepanjang foliasi milonit sesar Kisap yang berjurus baratlaut ditunjukkan oleh anjakan telerang kuarza (Zaiton Harun, 1996). Jalur *en echelon* telerang kuarza yang berjurus barat-baratlaut tersingkap

dalam olistostrom di Genting Sempah. Susunan jalur *en echelon* tersebut menunjukkan berlakunya pergerakan mendatar ke kanan. Sesar-sesar yang berjurus ke utara dalam olistostrom Genting juga menunjukkan adanya pergerakan mendatar ke kanan dan juga ke kiri (Zaiton Harun, 1993). Sesar-sesar yang berjurus barat dan baratlaut dalam zon sesar Bukit Berapit menunjukkan sebilangan bukti berlakunya pergerakan mendatar ke kanan. Kekanta asimetri feldspar dalam sesar tegak yang berjurus barat-baratlaut ditafsirkan akibat daripada pergerakan mendatar ke kanan (Zaiton Harun, 1994). Kesan hala pergerakan ini juga disokong oleh sesar-sesar dan jalur *en echelon* telerang kuarza yang memotong milonit granit yang mempunyai trend foliasi yang sama di lokasi yang sama. Tjia (1975) pernah menyebut tentang kehadiran sesar berjurus barat dan baratlaut yang mengandungi kesan hala pergerakan mendatar ke kanan dalam zon ricih di Pulau Jemur, Selangor. Dua jalur *en echelon* telerang kuarza yang memotong metasedimen Paleozoik Atas tersingkap di MINT, Bangi, menjurus ke 35° dan 310°, masing-masing ditafsirkan sebagai gelinciran ke kiri dan ke kanan (Zaiton Harun, 1980; Tjia, 1986). Semua pergerakan tersebut dapat diterangkan oleh tegasan mampatan dari utara-baratlaut. Tegasan yang sama juga mungkin menyebabkan pembentukan graben dalam Selat Melaka yang mempunyai trend ke utara (Liew, 1994).

West and west-northwest striking faults have been interpreted as left lateral, and right slip movement has always been along northeast striking faults in Peninsular Malaysia. However, structures having right lateral movement along the west and northwest fault zone, and left lateral slip along the northeast striking faults have been discovered and reported at several localities. At Teluk Sudu, Pulau Dayang Bunting, right lateral movement along the northwest striking mylonite foliation of Kisap fault was indicated by displacement of quartz vein (Zaiton Harun, 1996). West-northwest striking *en echelon* quartz veins indicating the right lateral movement occurred within the Genting olistostrome at Genting Sempah. Northerly trend faults in the Genting olistostrome also showed the right lateral as well as left slip (Zaiton Harun, 1993). West and west-northwest faults within the Bukit Berapit fault zone showed several evidence of the right lateral movement. Asymmetrical feldspar lensoid within vertically west-northwest striking fault can be deduced because of the right lateral movement (Zaiton Harun, 1994). This is also supported by the *en echelon* quartz veins and faults within the mylonite granite of the same trend. Tjia (1975) mentioned the presence of faults striking west and west-northwest, having right slip movement within sheared zone in Pulau Jemur, Selangor. Two zones of *en echelon* quartz veins in Upper Paleozoic metasediments at the MINT at Bangi, striking 35° and 310°, indicating left and right slip respectively (Zaiton Harun, 1981; Tjia, 1986). These movements can be explained by the compressional stress from north-northwest. This may be related to the occurrence of the northerly trend grabens in the Straits of Malacca (Liew, 1994).

Significance of the geology and geochemistry at Teluk Ewa, Langkawi

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The Teluk Ewa area is located in the northern part of Langkawi Island. The area is underlain by the late Cambrian Machinchang Formation, Ordovician to early Devonian Setul Formation and the late Triassic igneous intrusion of the Bukit Sawar Granite. The rocks in the area have undergone regional and contact metamorphism and these have significantly changed the texture and mineralogy of the rocks.

The Machinchang Formation is the oldest rock in the area and consists of two different units, namely:

a) Arenaceous Unit — quartzite and metasiltstone
b) Argillaceous Unit — filit, metamudstone and metatuff

These units occur in the field as interbedded layers with thicknesses varying from a few centimetres to two metres. The beddings strike nearly north-east, ranging from 008° to 080°, with the dip angle between 07° to 56° to the east and west. From the petrography study, the source of the sediments for this formation might be igneous, sedimentary and metamorphic. The depositional environment for the Machinchang Formation is believed to be deltaic, as shown by the occurrence of sedimentary structures such as cross bedding, cross lamination and parallel lamination.

The Setul Formation, conformably overlying the Machinchang Formation, experienced regional as well as low grade contact metamorphism. The formation is found as interbedded layers with thicknesses ranging from 1 m to 5 m, striking from 014° to 041° with dip angles ranging from 018° to 043° to the east and west. The Setul Formation consists of three main facies, namely:

a) Argillaceous Facies — calcareous slate, calc-silicate hornfels and skarn.
b) Carbonaceous Facies — tremolite-scapolite marble and phlogopite-scapolite marble.
c) Calcareous Facies — calcareous sandstone.

Petrography study shows the occurrence of the minerals like tremolite, phlogopite and diopside which formed due to the alteration of rocks rich in Mg and Ca composition during the metamorphic process. Fluorine metasomatism in the skarn rock gave rise to minerals like vesuvianite and fluorite minerals. Log stratigraphy studies on the detrital unit area shows that the deposition of calcareous, argillaceous and carbonaceous facies were probably controlled by the sea level changes or by the vertical tectonic activities such as subsidence and uplift with low depositional energy.

The Bukit Sawar Granite in the area can be divided into two units based on grain size and textures:

Unit 1 — medium-grained porphyritic biotite adamellite.
Unit 2 — fine-grained tourmaline adamellite.

Based on the geochemical study, the granitoid can be classified as S-type, peraluminous and the occurrence of biotite and muscovite minerals from the petrography study supports this conclusion. Petrographic and geochemical studies also show that the emplacement of granitoid was mesozonal. In terms of age, Unit 2 is younger than Unit 1.

Structural study shows that bedding in the Machinchang and Setul Formations have experienced tectonic deformation phases. Both are subjected to the NW to SE forces that resulted in the two folding phases of the Machinchang Formation and the more open folding of the Setul Formation. The negative lineament study shows a connection between the lineaments and the set of joints in the study area, indicating three sets of joints oriented dominantly in the 040° to 050°, 060° to 070° and 310° to 320° directions. The formation of veins in the study area was influenced by these sets of joints.

Geochemical study of the Setul Formation limestones shows almost all the area contain an average MgO percentage of less than 3% and this is suitable for use as raw materials in the Portland cement industry. However, at some localities which contain beds of calc-silicate hornfels, tremolite-scapolite marble and phlogopite-scapolite marble with minerals like tremolite, diopside, phlogopite and dolomite, higher MgO values were recorded. The high average SiO_2 chemical composition occurrences at certain localities are believed to be due to the occurrence of calc-silicate hornfels, marble with chert nodules and quartz veins and the host rock with quartz and muscovite minerals associated with barite veins.

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The analysis on the cause of the slope failures and debris fluid flows in Penang Island which happened on 18th September, 1995

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Widespread slope failures reported in the newspapers (*The Star*, 19 and 20-9-95 and *The Star*, 23-9-1995) were found to have occurred along cut slopes of a number of major roads, the Penang Hill railway route and the Penang Hill jeep track in Penang Island. The slope stability parameters for the scars which include slope angles before and after failure, slope material, slope orientation, size of scars and type of failure were determined. The sizes of the scars are classified arbitrarily into small, medium and large which has the surface area of $< 36m^2$, 36–80 m^2 and > 80 m^2 respectively and only scars of bigger than 1 m x 1 m (width x height) were investigated. The locations of the failure scars were mapped. Representative soil samples were collected to determine the properties of the soil material which were related to the failures.

Geologi pemuliharaan: Kajian kes taman-taman tabii di Malaysia — suatu pengenalan

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Pengenalan

Kajian ini merupakan suatu usaha untuk menggali maklumat, mengenalpasti dan memperkenalkan khazanah atau warisan tabii geologi unik yang boleh didapati di taman-taman tabii Malaysia. Taman tabii sememangnya sangat terkenal sebagai kawasan pemuliharaan tradisional semenjak Taman Negara Yellowstone iaitu taman negara yang pertama di dunia ditubuhkan pada tahun 1872. Di Malaysia taman-taman tabiinya lebih banyak menonjolkan kepelbagaian biologi dan hanya sedikit unsur-unsur fizikal yang telah diketengahkan sebagai daya tarikan pelancong.

Konsep Geologi Pemuliharaan

Geologi pemuliharaan merupakan satu cadangan disiplin baru dalam bidang sains geologi yang agak menyimpang daripada disiplin geologi yang lain seperti geologi petroleum atau geologi perlombongan iaitu ia berkonsepkan penggunaan sumber secara tanpa musnah. Sumber geologi sebagai sumber bumi yang tidak boleh diperbaharui menyebabkan bahan batuan dan lanskap menjadi perakam atau 'memori' kepada sejarah pembentukan bumi yang tersimpan di dalam 'hard-disk'nya sendiri sejak sekian lama. Sebagaimana perisian komputer yang sentiasa diancam oleh pelbagai virus, batuan serta lanskap ini juga tidak terkecuali daripada ancaman pemusnahan yang muncul daripada setiap penjuru seperti projek pembangunan dan juga proses tabii.

Kesedaran mengenai pemuliharaan sumber geologi di Malaysia secara umumnya boleh dikatakan masih di peringkat awal di mana ia mula diperkatakan pada akhir dekad 80-an walaupun ada usaha untuk mengetengahkannya pada masa yang lebih awal lagi (Aw, 1977; Ibrahim dan Kadderi, 1989; Yong, 1989; Kadderi, 1990; Tjia, 1991; Ibrahim dan Hamzah, 1993; dan Kadderi dan Ibrahim, 1996). Pemuliharaan sumber geologi pada mulanya adalah terhad kepada sumber tenaga dan mineral sahaja kerana kewujudan bahan tersebut untuk diekstrak daripada bumi amat terbatas. Berdasarkan kepada kajian literatur setakat ini, definisi geologi pemuliharaan secara spesifik telah cuba ditakrifkan oleh Ibrahim dan Kadderi (1996) sebagai suatu pendekatan baru dalam penilaian sumber geologi bagi kegunaan jangka panjang dan ia membentuk falsafah yang sumber ini perlu digunakan secara tanpa musnah dalam lingkungan pertumbuhan industri pelancongan yang pesat. Walau bagaimanapun istilah daripada konteks pemuliharaan sumber geologi telah didefinisikan oleh beberapa orang pengkaji contohnya Yong (1989) dan Stevens (1994).

Yong menakrifkan pemuliharaan sumber geologi sebagai suatu bidang yang melindungi bentuk fizikal dan fenomena geologi yang mempunyai nilai saintifik tinggi, mewakili peringkat-peringkat berbeza dalam sejarah geologi bumi dan perubahan yang dialami di sepanjang proses geologi daripada mengalami kemusnahan. Menurut Stevens pula, pemuliharaan sumber geologi boleh diistilahkan sebagai memulihara sebahagian daripada sumber fizikal bumi yang mewakili khazanah kebudayaan, termasuk pemahaman mengenai geologi, dan reaksi kepada inspirasi manusia sejagat untuk memulihara sumber.

Kewujudan taman tabii bukan sekadar untuk memulihara kepelbagaian fauna dan flora sahaja malah dalam kebanyakan hal ia juga memenuhi fungsi sebagai sebuah kawasan yang bernilai estetik, rekreasi dan spiritual. Secara umumnya taman tabii diwujudkan untuk mencapai tiga objektifnya iaitu bagi tujuan penyelidikan dan pendidikan, rekreasi dan juga pemuliharaan (Talbot, 1980; Yong, 1989; Tjia, 1991). Carta alir dalam Rajah 1 memberikan gambaran menyeluruh elemen yang berpotensi untuk ditonjolkan dalam pemuliharaan geologi. Sumber intrinsik bahan geologi adalah sumber yang berkait dengan pembentukan dan juga proses yang terlibat dalam membentuk batuan termasuk fosil, manakala sumber muka bumi pula mencakupi bentuk muka bumi unik yang terbentuk serta proses geomorfologi yang membentuknya. Sumber tinggalan unik pula adalah berkenaan dengan tinggalan kawasan atau lokaliti lombong dan aktiviti berkaitan dengan eksplorasi mineral. Sumber intrinsik ringkasnya ialah kemampuan memahami dan penghayatan ilmu mengenai suatu sumber fizikal itu. Sumber sebegini tidak sahaja memiliki daya tarikan pertama, tetapi mempunyai daya tarikan susulan yang berterusan (Ibrahim dan Shafeea, 1996). Namun begitu, tidak semua sumber ini boleh didapati di dalam sesebuah taman tabii terutamanya kawasan kajian ini iaitu Taman Kinabalu, Taman Negara dan Kepulauan Langkawi.

Taman Kinabalu

Kemegahan sebagai puncak tertinggi di Asia Tenggara menjadi aset utama Taman Kinabalu ini begitu dikenali. Hubungan ini dengan geologi sebenarnya sangat berkaitan kerana batuan yang membentuknya terdiri daripada rejahan batuan igneus pluton yang berlaku kira-kira 1.5 hingga 9 juta tahun yang lampau. Ketinggiannya mencecah 4,101 m (13,455 kaki) dengan keluasan kira-kira 60 km persegi. Batolith Kinabalu adalah diantara batolith batuan igneus terbesar di Sabah serta merupakan gunung bukan volkano yang termuda di dunia. Bukti-bukti geologi menunjukkan pengglasieran pernah berlaku di kemuncak Gunung Kinabalu. Di antara kesan hakisan glasier ini ialah lurah antara puncak berbentuk-U, lurah bentuk-V, kesan gurisan, kesan cungkilan, rochee moutonee dan endapan morain (til).

Taman Negara

Taman Negara adalah kawasan hutan simpan tropika tertua yang begitu gah namanya di Malaysia kerana kepelbagaian fauna dan floranya yang sering menjadi tumpuan. Walaupun gaung, sungai, gunung dan air terjun yang terdapat di situ tidak kurang tarikannya kepada pelancong, tetapi maklumat geologi serta pembentukannya jarang mendapat perhatian dan kebanyakan lokaliti yang terpulihara hanya secara kebetulan sahaja. Batuan di Taman Negara mempunyai daya tarikannya sendiri contohnya sesetengah batuan sedimennya mengandungi fosil yang merupakan penunjuk kepada sekitaran kuno Taman Negara pada suatu ketika dahulu. Berdasarkan kepada rekod fosil yang ditemui oleh pengkaji-pengkaji, sekitar 200–270 juta tahun lalu, kawasan

Taman Negara ini berada di dasar lautan dan ia berubah menjadi daratan pada usia sekitar 200 juta tahun lalu. Fosil Dinosaur mungkin boleh ditemui di sini.

Kepulauan Langkawi

Sumber geologi dan fizikal yang ada di Kepulauan Langkawi ini sangat bernilai daripada segi saintifik dan juga rekreasi. Kepulauan Langkawi juga sangat unik kerana disinilah pengembaraan ke zaman Paleozoik Bawah iaitu sela masa atau era tertua mengikut skala masa geologi boleh dilakukan di Malaysia. Batuan yang tertua di kepulauan ini iaitu Formasi Machinchang yang berusia Kambria Akhir membentuk pergunungan Machinchang yang boleh dijadikan sebagai monumen tabii atau mercu tanda bermulanya bumi Malaysia. Pantai yang indah dan menyamankan akan lebih menakjubkan sekiranya maklumat tentang asal mula dan pembentukan pantai seperti Pantai Pasir Hitam, Teluk Datai dan beberapa pantai lagi dimanfaatkan bagi tujuan pemuliharaan. Segala-galanya akan dirasa tidak lengkap tanpa kehadiran fosil yang merupakan hidupan kuno yang hidup di sekitaran tersebut dan lokaliti yang berfosil inilah yang patut diberikan perhatian daripada aspek pengawetan kerana sifatnya yang rapuh terutama daripada tindakan peluluhawaan.

Catatan Penutup

Pembangunan dan pemuliharaan adalah dua aktiviti yang konsepnya saling bertentangan bagi melengkapi tuntutan kehidupan manusia pada alaf ini. Namun dengan prinsip pembangunan mampan yang diwar-warkan semenjak kebelakangan ini, konflik sedemikian mampu untuk ditangani dengan kedua-dua belah pihak saling bertolak ansur atau menyelesaikannya dengan penyelesaian 'menang-menang' (win-win resolution). Geologi pemuliharaan ini hanyalah sebagai satu mekanisma bagi memastikan khazanah tabii geologi yang begitu berharga sebagai bahan tatapan dan sumber pengetahuan kepada generasi masa kini dan juga akan datang terus dipulihara.

Enapan aliran debris di sekitar kawasan Ladang Boh Cameron Highlands, Pahang Darul Makmur

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Ladang Boh terletak di kawasan timur Cameron Highlands didasari oleh batuan granit banjaran utama. Ladang Boh terbahagi kepada beberapa bahagian iaitu Bahagian Ulong, Bahagian Tengah, Bahagian Fairlie 1 dan Fairlie 2 menganjur dari barat ke timur.

Secara amnya kawasan enapan aliran debris di kawasan tersebut dapat dibahagikan kepada 4 bahagian yang berlain berdasarkan kepada ketinggian relatif di antara satu sama lain. Kawasan Ladang Boh dibahagikan oleh suatu sempadan lembangan saliran yang memisahkan Bahagian ulong di sebelah barat dan selebihnya di bahagian timur Ladang Boh.

Saiz bagi bolder-bolder yang didapati di sekitar kawasan kajian berbeza di antara satu sama lain berdasarkan kepada kawasan kewujudannya. Secara amnya 3 kawasan yang menunjukkan saiz bolder yang berbeza-beza.

1. Kawasan berbukit

Saiz bolder di kawasan berbukit di sekitar kawasan pengenapan mempunyai kelebaran dan panjang melebihi 5 m. Berbanding dengan kawasan lain ianya merupakan kawasan di mana bolder bersaiz paling maksimum.

2. Kawasan lurah

Saiz bolder di kawasan lurah menunjukkan saiz besar puratanya 5 m panjang dan 2 m lebar. Saiz agak seragam terutama di kawasan sekitar lurah.

3. Kawasan landai

Kawasan landai adalah kawasan yang mempunyai sudut cerun purata 0–12 darjah. Saiz pebel dan bolder adalah tidak seragam dan lebih merupakan campuran di antara keduanya.

Bentuk bolder yang dijumpai kebanyakkan adalah terbundar bagi bolder-bolder yang bersaiz besar tetapi di kawasan lurah terdapat juga yang sub-bundar. Di kawasan yang lebih tinggi terdapat bolder yang leper dan memanjang. Secara amnya campuran bentuk yang berbeza terbahagi kepada 3 kawasan iaitu:

1. Kawasan berbukit

Ianya mempunyai bentuk yang tidak bundar. Di bahagian yang tertentu di kawasan berbukit terdapat lembah kecil yang diisi oleh bolder pelbagai bentuk dipercayai disebabkan runtuhan kecil.

2. Kawasan lurah

Sebahagian kawasan bentuknya terbundar. Di kawasan tertentu kawasan mempunyai campuran bundar, sub bundar dan leper. Kawasan lurah yang curam dan sempit didapati bolder-bolder leper dan memanjang dan tersusun bersebelahan di antara satu sama lain. Keadaan boleh dilihat di kawasan jalan menuju Ladang Boh Bahagian Tengah dan di kawasan berbukit di bahagian utara.

3. Kawasan landai

Bentuk bolder adalah berbundar di dalam campuran pelbagai saiz. Ianya dapat dilihat di kawasan menuju Ladang Fairlie. Ianya berada di kawasan yang hampir rata.

Bolder-bolder yang dijumpai terdiri daripada batuan granit. Di kawasan yang tinggi dipercayai bolder-bolder ini menunjukkan kehadiran batuan dasar. Analisa kandungan air bagi sampel-sampel dari kawasan yang berbeza menunjukkan kandungan air adalah berkurangan di kawasan yang lebih tinggi. Analisa mineral lempung dilakukan menunjukkan kehadiran klorit, kaolinit, ilit dan mika. Kehadiran kepelbagai lebih didapati bagi sampel di kawasan landai di mana ianya menunjukkan corak yang lebih seragam.

Aliran debris menunjukkan corak aliran tertentu di mana ianya mengakibatkan pengenapan di dalam ketinggian lembangan berbeza-beza. Di kawasan Ladang Boh terdapat 4 bahagian berdasarkan kepada ketinggian relatif di antara satu sama lain. Di dalam bahagian lembangan tersebut ianya terbahagi kepada beberapa zon yang berbeza berdasarkan kepada ketinggian dari aras sungai. Kawasan di bahagian timur ladang merupakan bahagian yang paling luas di mana enapan ini didapati.

Bahagian pertama adalah kawasan lembangan berhampiran dengan kilang pemprosessan di mana ianya merupakan bahagian yang tertinggi. Bahagian lembangan kedua adalah kawasan paling luas meliputi keseluruhan Ladang Boh Bahagian Tengah hingga kawasan Ladang Fairlie. Punca aliran debris di kawasan ini terbahagi kepada 2 sumber utama iaitu dari kawasan berbukit di utara dan dari bahagian lembangan pertama. Ianya terbahagi kepada 4 zon berbeza berdasarkan kepada ketinggian dari aras sungai serta campuran klas-klas butiran. Bahagian pengenapan ketiga adalah berhampiran simpang menuju Ladang Boh Fairlie di mana klas-klas adalah lebih kecil. Bahagian keempat adalah terletak di bahagian paling timur Ladang Boh. Didapati kehadiran bolder-bolder tertumpu di kawasan sungai. Berbanding dengan kawasan lembangan yang lain ianya mempunyai purata saiz klas-klas yang lebih kecil. Dipercayai bolder-bolder yang hadir berpunca dari kawasan berbukit di sekitar kawasan pengenapan.

Sejarah pengenapan bagi lembangan berbeza ini dipercayai disempadani sesar. Sesar gerak alih terutama di bahagian keempat menyebabkan aliran terhenti. Selain itu kehadiran lurah-lurah sempit tidak dapat menampung isipadu aliran juga menyebabkan ianya terhenti. Enapan ini terdiri dari bolder-bolder yang bertindak sebagai suatu empangan menahan beban di bahagian belakang. Hakisan berlaku di antara bolder-bolder menyebabkan hanya bolder yang tertinggal. Ini dapat dilihat di kawasan sempadan yang memisahkan kawasan lembangan enapan yang berbeza. Di kawasan lembangan kedua 4 zon yang berbeza didapati. Selepas

aliran debris pertama berlaku mengenapkan kawasan paling tua kemudian diikuti dengan runtuhan cerun di dalam beberapa fasa yang berbeza menghasilkan kawasan pengenapan yang berbeza ketinggian. Semakin menurun lembangan berbeza aliran semakin perlahan disebabkan kemirinagan cerun yang rendah dan juga akibat tindakan mekanisme halangan. Akhir aliran ini terhenti di kawasan lembangan keempat di mana dipercayai ianya disempadani oleh suatu sesar. Umur bagi lembangan adalah secara relatifnya tua di bahagian bawah dan semakin muda ke bahagian atas.

Pemetaan geomorfologi Pulau Timun, Langkawi dengan bantuan fotograf udara

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Peta topografi (rupa bumi) lazimnya tidak cukup maklumatnya kepada ahli geomorfologi ataupun untuk kegunaan tertentu. Oleh itu, pemetaan geomorfologi merupakan salah satu kaedah yang lebih saintifik untuk memetakan morfologi bertujuan untuk menggambarkan bentuk bumi suatu kawasan dengan lebih terperinci. Sehubungan itu, sebuah peta geomorfologi Pulau Timun, Kepulauan Langkawi telah dibuat berdasarkan pentafsiran fotograf udara dan juga peta topografi. Pengelasan unit-unit geomorfologi dibuat berpandukan petunjuk yang dikemukakan oleh Van Zuidam (1985). Hasil kajian ini menunjukan Pulau Timun terdiri daripada tiga unit geomorfologi (berdasarkan morpho-genesis) iaitu asalan kars, asalan denudasi dan asalan samudera. Selain memberi gambaran terperinci tentang bentuk bumi, peta geomorfologi sedemikian boleh membantu dan berguna bagi tujuan pembinaan, pembangunan serta guna tanah suatu kawasan.

Terain batu kapur yang meliputi sekitar 70% kawasan Pulau Timun dikelaskan kepada unit geomorfologi asalan kars yang terdiri daripada unit penara kars, cerun dan bukit kars, zon kars bintang (labirin), dataran aluvium kars, dataran sempadan kars, kars mogot, kars menara, dolina, uvala dan lubang benam. Penara kars terdiri daripada topografi yang beralun dan lembah lekukan. Cerun dan bukit kars pula terdiri daripada cerun dan bukit yang mempunyai kecerunan sederhana hingga curam. Labirin atau zon kars bintang terdiri daripada perbukitan berkumuncak tajam serta membentuk permatang dengan kecerunan curam hingga amat curam. Topografi mendatar atau hampir mendatar yang terletak di tepi bukit batu kapur merupakan ciri bagi unit dataran aluvium kars. Kawasan kars yang didapati antara batuan gersik dan batu kapur dengan cerun topografinya landai hingga hampir rata dikenali sebagai dataran kars sempadan. Zon kars kon merupakan unit morfologi yang terdiri daripada bukit-bukit yang berbentuk kon dengan cerunnya sederhana hingga curam. Unit kars menara dan mogot terdiri daripada bukit dengan kecerunan sangat curam dan bahagian atasnya membulat. Dolina, uvala dan lubang benam dicirikan oleh topografi dengan lekukan-lekukan dan lurah-lurah hasil pelarutan, runtuhan atau lenturan batu kapur.

Batuan sedimen gersik yang mengalami proses denudasi (pelokosan) dikelaskan sebagai unit geomorfologi asalan denudasi. Ia terdiri daripada unit cerun dan bukit denudasi, bukit denudasi dan lurah denudasi. Unit cerun dan bukit denudasi bertopografi beralun dengan cerun landai hingga sederhana sementara bagi bukit-bukit dengan kecerunan yang tinggi dikelaskan sebagai bukit denudasi. Topografi mendatar dan berbentuk lurah antara cerun dan bukit denudasi dikelaskan sebagai lurah denudasi.

Morfologi asalan samudera meliputi kawasan yang kecil daripada pulau ini dan dibahagikan kepada unit pamah pasang surut, pantai dan endapan aluvium. Kawasan pamah pasang surut bertopografi landai, ditenggelami air ketika air pasang dan lazimnya ditumbuhi oleh tumbuhan-tumbuhan (bakau dan semak). Pantai berpasir, hampir mendatar dengan cerun landai serta mudah dibanjiri oleh air pasang dikelaskan sebagai unit pantai. Unit endapan aluvium dipetakan bagi kawasan tepi pantai bertopografi mendatar serta menjadi temopat endapan lumpur pantai.

The preliminary evaluation and origin of the Sungei Keneras kaolin deposit, Gua Musang, Kelantan

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The Sungei Keneras clay deposit is located on a 2 km long hill trending NNW-SSE at about the 279 km point of the Gua Musang-Kuala Lumpur highway. Geologically, the area which surrounds the kaolin deposit exposed metasediments of the Gua Musang Formation which is believed to be deposited mainly from Middle Lower Permian to Lower Middle Triassic. The folded sediments were then intruded by granite and related rocks in Upper Triassic.

The original rock from which the clay deposit was derived is identified as a muscovite-bearing aplite which had been hydrothermally altered (mainly kaolinization and some sericitization) to form the residual kaolin deposit. Twenty-six samples of the clay deposits from 17 pits were sampled and 13 samples from 10 locations were analyzed for its particle size and total mineralogical content. Some of the raw clay samples were "processed" in the laboratory and the particle size and total mineralogical content were also determined for the processed kaolin clay. The evaluation of the kaolin deposit was made by comparing the properties of the raw and processed clay from the Sg. Keneras area with those from Associated Kaolin Industries Berhad, Bidor, Perak. The Sg. Keneras clay shows a relatively good distribution of the particle size and is comparable to the Bidor raw clay. In terms of mineralogy, the clay deposit from Sg. Keneras shows lower contents of kaolinite and a higher content of amorphous clay and feldspars.

The processed clay using a number of selected samples from the Sg. Keneras area shows whiteness (81.2%) and brightness (80.3%) which exceeds the requirements for kaolin clay which are used as paper and rubber grade fillers, general filler and in the paint industry. However, the processed clay from Keneras shows less kaolin content then the commercial grades produced by the Associated Kaolin Industries Berhad. Overall, the distribution of both grain size and mineral contents in the Sg. Keneras deposit are uneven throughout the kaolinized area sampled though a selected area of substantial size (100 m x 400 m) appears to be suitable for commercial exploitation. Further detailed testing involving taking samples from deeper levels using Bangka drilling is suggested. Processing using settling tank or special bucket to obtain a large enough sample for testing the market is suggested.

Various evidences including topographic location, mineralogical composition, confinement of the kaolinized area to the muscovite aplite, lack of Fe-oxide staining and transition from soft kaolinized to harder sericitized aplite indicate that the Sg. Keneras kaolin deposit originated from hypogene process.

Carigali geokimia emas di kawasan Kuala Pilah, Negeri Sembilan

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Persampelan geokimia secara bersistematik di kawasan Kuala Pilah dijalankan selaras dengan ledakan carigali emas di seluruh dunia. Kawasan kajian yang merangkumi 800 km^2 diliputi oleh batuan sedimen termetamorf yang bersempadan dengan rejahan granit di bahagian barat serta mempunyai rekod aktiviti emas yang baik.

Kajian ini bertujuan menyempadankan zon-zon berpotensi bagi pemineralan emas primer dan emas lanar

menerusi kaedah geokimia dan pengiraan rizab bijih. Dengan adanya kajian seperti ini diharapkan akan merangsangkan kajian susulan bagi potensi ekonomi emas lanar, mendapan emas yang lebih mudah dijelajah dan diusahakan oleh pelombong-pelombong kecil.

Sejumlah 512 sampel sedimen, 245 sampel konsentrat mineral berat dan 38 sampel batuan telah dipungut dan dianalisis bagi emas dan 17 unsur lain (Pb, Ni, Ag, Co, Mo, Cu, Zn, Fe, Mn, As, Sn, W, U, Hg, Sb, Bi dan ba). Hasil penilaian terhadap data geokimia yang diperolehi dapat menggariskan tiga zon berpotensi bagi pemineralan emas. Zon-zon ini dicirikan oleh kelompok sampel yang bernilai anomali emas dalam sedimen dan konsentrat di samping peningkatan nilai unsur-unsur penunjuk seperti Pb, Sb, As, Hg dan Bi. Kaitan dengan struktur dan kehadiran rejahan juga agak ketara. Pemineralan emas primer dipercayai daripada jenis emas lod mesotermal yang terjadi dalam telerang kuarza dan jasad rejahan kecil. Anomali-anomali yang dapat dikesan di dalam kajian ini memerlukan kajian susulan yang lebih terperinci.

Kajian susulan hanya dibuat bagi menentukan potenti emas lanar dalam zon anomali yang disempadankan. Kajian menggunakan kaedah penggerudian banka di dua kawasan pilihan. Sebanyak 121 lubang gerudi telah dibenamkan di Prospek Londah dan Prospek Gemencheh dengan kedalaman purata masing-masing 8.40 m dan 3.99 m. Hanya Prospek Gemencheh sahaja yang menghasilkan keputusan yang sederhana baik. Butiran emas di Prospek ini bersaiz antara 150 mikron hingga 800 mikron ditemui dalam sebahagian daripada lubang gerudi sekitar bahagian hulu Sungai Langkap dan Sungai Rokan. Amnya pengayaan emas lebih bertumpu dalam lapisan berkerikil kuarza di bahagian dasar.

Pengiraan rizab emas paling kritikal dalam setiap aktiviti carigali kerana kesannya yang besar terhadap ekonomi pengusaha. Beberapa kaedah (tradisi, geometri dan statistik) dicuba bagi melihat perbezaannya dan ternyata hasilnya berbeza. Kaedah statistik difikirkan lebih sesuai digunakan bagi kawasan ini kerana taburan analisis emas menunjukkan sifat log-normal serta kaedah ini memberikan ralat pengiraan tertentu. Nilai had bawah selalunya diambil kira sebagai rizab dalam perancangan seterusnya kerana nilai ini dikira lebih "selamat". Hasil kajian menunjukkan kawasan seluas kira-kira 8,000,000 m^2 berpotensi untuk dilombong. Rizab emas sebanyak 850 kg didapati tersimpan dalam 33,000,000 m^3 aluvium pada gred emas 25 mg/m^3.

Geologi pelancongan: Kajian kes di Taman Kinabalu, Sabah

Dana Badang[1], Ibrahim Komoo[2] dan Kadderi Md Desa[3]

[1]Institut Alam Sekitar dan Pembangunan (LESTARI)
Taman Kinabalu, Sabah

[2]Institut Alam Sekitar dan Pembangunan (LESTARI),
Universiti Kebangsaan Malaysia

[3]Jabatan Geologi
Universiti Kebangsaan Malaysia

Pengenalan

Geologi pelancongan diperkenalkan sebagai satu cabang khusus dalam sains geologi mengenai pemakaian pengetahuan geologi, terutama nilai-nilai intrisik yang ada padanya, bagi membangun kegiatan pelancongan melalui pencarian berancang tempat-tempat pelancongan baru dan penaikan daya tarikan bagi tempat-tempat yang sedia ada (Ibrahim dan Hamzah, 1993).

Geopelancongan boleh ditakrifkan sebagai satu langkah penyeliaan kemudahan interpretasi dan servis bagi membolehkan pelancong memperolehi pengetahuan dan kefahaman tentang geologi dan geomorfologi sesuatu tapak (termasuk sumbangannya terhadap pembangunan sains bumi) melangkaui tahap penghargaan estetik biasa (Hose, 1996). Di Malaysia konsep geopelancongan mula diperkenalkan pada akhir tahun 80an, kira-kira sembilan tahun yang lalu di atas kesedaran terhadap pemuliharaan sumber geologi yang terdapat di negara ini. Walau bagaimanapun usaha mengetengahkan konsep geopelancongan secara praktikal hanya

bermula pada tahun 1996 dengan meletakkannya di bawah payung geologi pemuliharaan yang telah lebih awal mula diperkenalkan oleh beberapa ahli geologi Malaysia.

Geologi Pelancongan Taman Kinabalu

Dengan termeterainya memorandum persefahaman di antara UKM dengan Lembaga Pemegang Amanah Taman-Taman Sabah, konsep geologi pelancongan ini telah diselidiki; khususnya aspek geologi dan geomorfologi yang terdapat di Taman Kinabalu. Berikut ialah potensi sumber geopelancongan yang sedang diterokai.

Penara Kinabalu: Penara Kinabalu terdiri daripada permukaan licin berkecerunan landai hingga sederhana yang memaparkan morfologi puncak-puncak baki di sekitar Gunung Kinabalu. Penara ini dibentuk sama ada oleh jasad igneus masif atau susunan bongkah batuan igneus (contoh, Puncak Low), dan menunjukkan kesan hakisan glasier seperti *cirque*, lurah bentuk-U dan lurah gantung.

Panar Laban: Panar Laban terletak pada ketinggian sekitar 3,500 hingga 3,700 meter (10,500 hingga 11,000 kaki) dari paras laut dan merupakan tempat penginapan tertinggi di Taman Kinabalu. Geologi di Panar Laban terdiri daripada batuan adamelit honblend, adamelit porfirit, telerang aplit dan morain hujung (endapan tilloid). Bekas laluan hanyutan glasier ini banyak mengandungi kesan hakisan glasier, di antaranya struktur seakan *rochee moutonnees*, peparit glasier (groove), kesan cungkilan (plucking), kesan bentuk bulan sabit dan kesan seretan.

Rentasan Puncak Low: Litologi batuan di sepanjang rentasan Puncak Low terdiri daripada batuan formasi Trusmadi, stok mikrogranit, ultrabasik, adamelit honblend dan porfirit, dan endapan tilloid. Beberapa fitur geologi penting seperti perlapisan, foliasi dan lineasi mineral dapat dilihat disepanjang rentasan Puncak Low.

Mata Air Panas Poring: Poring terletak di bahagian tenggara Taman Kinabalu dan terletak di Daerah Ranau, kira-kira 30 km dari Taman Kinabalu. Mata air panas ini terletak pada ketinggian 490 meter di atas paras laut. Poring yang merupakan salah satu daripada tiga sub-station Taman Kinabalu menjadi satu destinasi pelancongan terkenal di Sabah kerana kewujudan punca mata air panas. Suhu air panas utama mencapai 60 (C, digunakan untuk mengisi kolam-kolam mandi yang disediakan kepada para pengunjung. Beberapa mata air panas lain juga pernah dilaporkan di sepanjang Sungai Mamut, kira-kira 300 meter ke selatan mata air panas utama yang sedia ada (Sadikun *et al.*, 1992).

Penara Pinosuk: Kawasan Penara Pinosuk terletak di bahagian tenggara Gunung Kinabalu, iaitu di sekitar pekan Kundasang. Kawasan ini berketinggian antara 1,000 hingga 1,800 meter (3,000 hingga 5,500 kaki) dari paras laut dan merupakan kawasan perbukitan berkecerunan rata dan landai di sekeliling Gunung Kinabalu dengan keluasan kira-kira 60 km persegi. Kelikir Pinosuk merupakan endapan berusia Kuaterner yang terdiri daripada bongkah pelbagai jenis batuan berbagai saiz dan belum mengalami pemadatan. Kelikir yang mengandungi bongkah batu pasir, ultrabasik, granodiorit dan adamelit porfirit ini dibahagikan kepada unit Bawah dan unit Atas (Jacobson, 1970).

Penyelidikan Geologi Pelancongan

Berikut adalah beberapa usaha yang sedang dilakukan bagi menjayakan konsep geologi pelancongan di Taman Kinabalu.

Pemetaan geologi. Pemetaan geologi di seluruh Taman Kinabalu dilakukan secara berperingkat bagi melengkapkan data geologi yang telah ada. Pemetaan ini juga bertujuan mengumpul specimen batuan untuk pameran.

Mini Muzium Geologi. Mini Muzium Geologi Taman Kinabalu ialah salah satu daripada produk utama yang dicadangkan dalam kajian ini. Pembinaan perabot mini muzium ini telah dirancang manakala pengumpulan dan pengriwayatan spesimen batuan sedang dilakukan.

Pameran Geologi. Belum ada pameran yang bermotifkan geologi di Taman Kinabalu. Pameran geologi Taman Kinabalu akan melibatkan model Gunung Kinabalu, poster dan fotograf geologi, spesimen batuan dan mineral. Pameran geologi ini terbahagi kepada pameran tetap dan pameran sementara.

Penerangan Awam. Beberapa sesi taklimat awam turut diadakan, yang melibatkan kumpulan pelawat dan penuntut sekolah. Kursus pendedahan geologi juga diberikan kepada pekerja-pekerja taman terutamanya

"*guide*" yang lebih banyak memberi input kepada para pelancong. Pengumpulan data untuk penyediaan "booklet" geologi sedang dijalankan.

Rockarium. Rockarium merupakan satu konsep merekod, meriwayat dan mengkatalogkan spesimen batuan dan mineral dari seluruh Taman Kinabalu dengan cara sistematik, untuk pelbagai kegunaan seperti penyelidikan, rujukan dan sebagai artifak khazanah geologi Taman Kinabalu.

Penyelidikan geologi pelancongan di Taman Kinabalu bermatlamat mengumpul maklumat-maklumat geologi secara terperinci dan menyampaikan maklumat geologi tersebut dengan cara yang ringkas dan mudah difahami bagi memperkenalkan sumber geologi kepada pelancong yang berkunjung ke Taman Kinabalu.

Survei geofizik permukaan dalam pengesanan lohong batu kapur: Kajian kes di Batu Caves

(Surface geophysical measurement in subsurface cavity detection: A case study at Batu Caves)

Umar Hamzah, Abd. Rahim Samsudin, Ab. Ghani Rafek dan Mohd Abu Syariah

Jabatan Geologi
Universiti Kebangsaan Malaysia
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Pengesanan punca bencana geologi kejuruteraan di kawasan batu kapur seperti lohong batu kapur, kewujudan lubang benam dan gua-gua batu kapur telah menjadi amat penting dalam penyiasatan tapak sebelum sesuatu pembinaan seperti jalan raya, jambatan dan bangunan dilakukan. Bagitu juga dalam kerja-kerja penerowongan dan perlombongan, pengetahuan asas sifat kejuruteraan jasad batuan amat perlu diketahui untuk menilai kesesuaian dan keselamatan bangunan yang bakal dibina. Teknik geofizik telah digunakan secara meluas dalam kajian geologi kejuruteraan untuk menangani masalah yang terdapat di tapak-tapak binaan yang mempunyai batu kapur sebagai batuan dasar. Dalam kajian ini teknik seismos pantulan cetek dan kaedah geoelektrik dwikutub-dwikutub telah digunakan untuk mengesan rongga batu kapur yang terdapat di kawasan Batu Caves, Kuala Lumpur. Kedudukan dan kedalaman rongga baru kapur di kawasan kajian telah ditentukan melalui data lubang gerudi dan laporan yang diperolehi daripada Jabatan Kajibumi Malaysia. Berdasarkan data lubang gerudi tersebut terdapat beberapa rongga yang terisi air dan pasir halus berlodak di kedalaman 15.7 m hingga 17.8 m, 20.2 m hingga 21.1 m dan 21.4 m hingga 25.7 m. Tiga profil seismos pantulan cetek telah dibuat di kawasan berongga tersebut dan hasil survei menunjukkan rongga dalam batu kapur tersebut membentuk palung sepanjang hampir 20–30 m pada kedalaman antara 15 m hingga 30 m. Rentisan survei geoelektrik dwikutub-dwikutub yang dilakukan pada profil seismos satu dan tiga juga memperlihatkan kehadiran lohong dan palung dalam batu kapur tersebut.

Identification of a possible source of engineering geological hazard in the limestone area such as cavities, sinkholes and an underground cavern have become necessity for site investigation before any construction of roads, bridges and buildings are carried out. The study is also necessary for tunneling and underground mining works where knowledge of the engineering properties of the rock mass is very important in order to assess the suitability and safety of a proposed building. Geophysical techniques have been widely used in engineering geological study to deal with such problems that normally arise at construction sites with limestone bedrock. In this study, shallow seismic reflection technique and dipole-dipole geoelectrical methods were used to detect the presence of cavity in limestone area of Batu Cave, Kuala Lumpur. The exact location and depth of cavities in the area were determined from the existing bore hole data and report provided by the Geological Survey Department of Malaysia. Based on the bore hole data, several cavities that were filled-up with water and fine silt are encounter at depths of 15.7 m to 17.8 m, 20.2 m to 21.1 m and 21.4 m to 25.7 m.

Three shallow seismic reflection profiles were established on the cavity area and the results show that the cavities in the limestone occur in the form of 20 to 30 m long subterranean channel of 15 to 30 m depth. Dipole-dipole resistivity survey conducted on seismic lines one and three also indicates the presence of the channel and cavities in the limestone.

Sedimentation and structural development of the Malibau Basin, Sabah, Malaysia

B. ALLAGU

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88999 Kota Kinabalu

This research has revised the stratigraphy and distribution of rock formations in the Malibau Basin. Areas that were previously mapped as the Tanjong Formation is mapped as the Kapilit Formation, and vice versa. The Tanjong Formation and Kapilit Formation are found to be of Early to Middle Miocene and middle Middle Miocene to early Late Miocene respectively. The Tanjong Formation which is more deformed covers the southern and eastern parts of the area and is overlain unconformably by the Kapilit Formation which has an open fold structure and covers the central and western parts of the area.

The Tanjong Formation in this area is estimated to be 6,200 metres in thickness and comprises three stratigraphic units. Unit I, Unit II and Unit III represents the lower, middle and upper units respectively. Unit I is dominated by partly sheared argillaceous lithofacies and characterized by a thick sequence of mudstone interbedded with thin fine sandstone. The thickness of this unit is estimated to be 2,500 metres and was deposited in a neritic to bathyl environments. Unit II is dominated by an arenaceous to rudaceous lithofacies and characterized by a sequence of interbedded thick mudstone and sandstone, and contains coal and carbonaceous mudstone facies. This unit shows the presence of a coarsening upward megasequence, where it comprises interbedded mudstone and sandstone gradually become more dominated by thick to massively bedded sandstones towards the top, and further upwards comprises more arenaceous and conglomeratic beds. The thickness of this unit is estimated to be 2,200 metres and was deposited in a fluvial to deltaic environments. Unit III is dominated by an argillaceous lithofacies and characterized by a thick sequence of mudstone interbedded with thin fine sandstone. The thickness of this unit is estimated to be 1,500 m and was deposited in a neritic to bathyl environments. Facies and sequence associations in the Tanjong Formation show the presence of a coarsening upward megasequence between Unit I and II, and a fining upward megasequence into Unit III. This indicates a change in the depositional process from being regressive to transgressive with the sediment deposition moving towards the east.

The Kapilit Formation in this area is estimated to be 4,500 metres in thickness and comprises two stratigraphic units. Unit I and Unit II represents the lower and upper units respectively. Unit I is characterized by interbedded carbonaceous mudstone and thick sandstone with the occurrence of coal. The lower part of this unit is more arenaceous and towards the top is dominated by an argillaceous sequence. Facies association indicate that the lower part of Unit I was deposited in a deltaic environment which prograded towards the east and southeast whereas the upper part of Unit I was deposited in a transitional environment between the inner neritic to coastal plain. The thickness of this unit is estimated to be 3,300 metres. Unit II is characterized by a dominantly argillaceous lithofacies with rare interbeds of thick sandstone and minor limestone. The thickness of this unit is estimated to be 1,200 metres and was deposited in a middle neritic to bathyl environments. Sequence association between Unit I and Unit II shows the presence of a fining upward megasequence which indicates a transgressive process.

The structural morphology of the study area was the result of four main episodes of tectonic deformation trending northwest-southeast and northeast-southwest. Two earlier episodes (D1 and D2) occurred around

Middle Miocene whereas the following two episodes (D3 and D4) occurred around Late Miocene. These deformations have produced tight to close, superimposed and plunging fold structures trending northwest-southeast in the Tanjong Formation, and superimposed open fold structures in the Kapilit Formation. The combination of these four tectonic phases have produced a superimposed megastructure and is mainly responsible for the development of subcircular and elliptical structures in the Miocene sediments. The development of these structural morphology was aided by lateral and growth faults trending northwest-southeast and northeast-southwest.

Based on the morphology and structural geometry, it is interpreted that the Tanjong and Kapilit Formations were deposited in a large proto-basin trending northeast-southwest related to the opening of the Sulu Sea and presently occur as separate basins due to deformation, upliftment and erosional process.

Common Rocks of Malaysia

A full colour poster illustrating 28 common rocks of Malaysia. With concise description of the features and characteristics of each rock type including common textures of igneous, sedimentary and metamorphic rocks.

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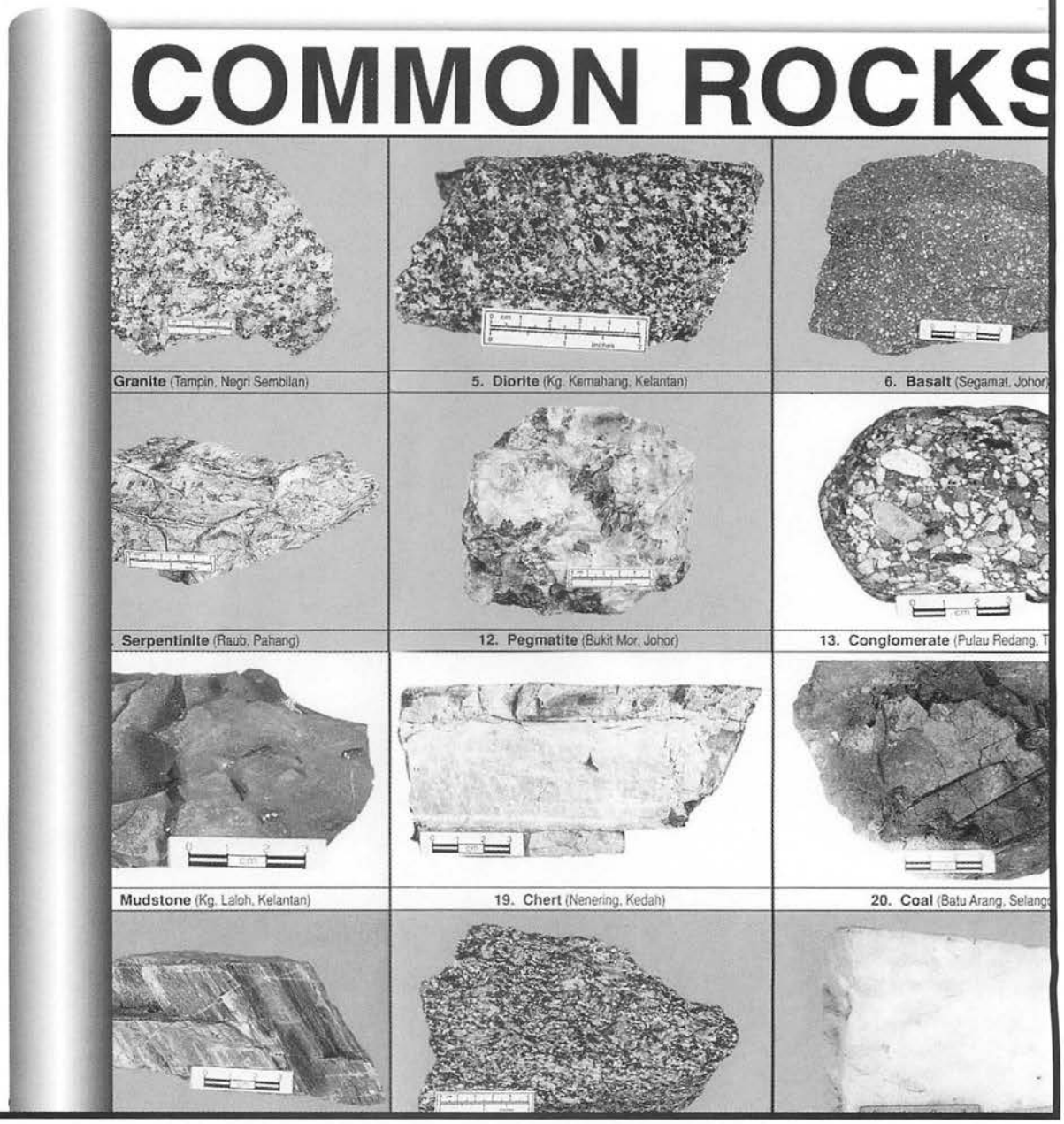

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GEOLOGICAL SOCIETY OF MALAYSIA
c/o Dept. of Geology, University of Malaya
50603 Kuala Lumpur, MALAYSIA

BERITA-BERITA PERSATUAN
News of the Society

KEAHLIAN (Membership)

The following applications for membership were approved:

Full Members

1. Abd Rashid bin Ahmad
   Faculty of Arts and Social Sciences, University of Malaya, 50603 Kuala Lumpur.
2. Gijsbert Karel Nieuwenhugs
   EGS (M) Sdn. Bhd., Kuala Lumpur.
3. Suhaimizi bin Yusoff
   GSD, Kuching, Sarawak.
4. Zainol bin Hj. Husin
   GSD, Ipoh, Perak.
5. Noraini bt Surip
   MACRES, Kuala Lumpur.
6. Zulfahmi Ali Rahman
   Universiti Kebangsaan Malaysia.
7. Rushdi Mohd Yusoff
   Coffey (M) Sdn. Bhd., 50A, Jalan USJ10/1B, Taipan Triangle, 47600 UEP Subang Jaya.
8. Low Teng Huat
   Asiagro Resources Sdn. Bhd., 91 Jalan Batu Tiga, 41050 Klang.

Student Members

1. Azlinda bt Aziz
   Jabatan Geologi, Universiti Malaya, 50603 Kuala Lumpur.
2. Wong Siew Fung
   Jabatan Geologi, Universiti Kebangsaan Malaysia.
3. Tan Chu Ai
   Jabatan Geologi, Universiti Kebangsaan Malaysia.
4. Jau Ipui
   Jabatan Geologi, Universiti Kebangsaan Malaysia.
5. Ouzani Bachir
   No. 13, Jalan DM3, 47100 Sungai Buloh.
6. Siong Chee Sing
   Jabatan Geologi, Universiti Malaya.
7. Mahat Hj. Sibon
   Jabatan Geologi, Universiti Malaya.
8. Saidi Ideris
   Jabatan Geologi, Universiti Malaya.
9. Suhaileen Shahar
   Jabatan Geologi, Universiti Malaya.
10. Hisam Hj Ahmad
    Jabatan Geologi, Universiti Malaya.
11. Wan Mohd Zaizuri Wan Embong
    Jabatan Geologi, Universiti Malaya.

PETUKARAN ALAMAT (Change of Address)

The following members have informed the Society of their new addresses:

1. Adi Suprapto
   Jl. Melati X-L/21, Komp. Pura Melati Indah
   (Jl. Raya Hankam), Pondok Gede-Kodya
   Bekasi 17414, Indonesia.

2. H.W. Ziemand
   P.O. Box 665, Hanna, Wyoming 82327,
   USA.

PERTAMBAHAN BAHARU PERPUSTAKAAN (New Library Additions)

The Society has received the following publications:

1. AAPG Explorer, April, May & June, 1997.
2. Acta Palaeontologica Sinica vol. 35, nos. 5 & 6, 1996 and vol 36, no. 1, 1997.
3. Acta Micropalaeontologica Sinica, vol. 13, no. 4, 1996 & vol. 14, no. 1, 1997.
4. Palaeontological Abstracts, vol. 11, no. 4, 1996 and vol. 12, no. 1, 1997.
5. Episodes, vol. 19, no. 4, 1996.
6. Science Reports of the Institute, Univ. of Tsukuba, vol. 18, 1997.
7. Annual Report, Institute of Geoscience, The University of Tsukuba, no. 22, 1996.
8. AAPG Bulletin vol. 81, no. 2, 4, 5 & 6, 1997.
9. Geoscience, vol. 9, nos. 2, 3, 4 (1995); vol. 10, no. 4 (1996).
10. Earth Science Frontiers, 1995: vol. 2: nos. 2–4; 1996: vol. 3: nos. 1–2.
11. Berliner Geowissenschaftliche Abhandlungen, Band 177, 178, 179, 180, 181, 182, 183, 185.
12. Narromine 1:250,000 map S1/55-3 (2nd ed.).
13. Ana Branch Geological Map, 1997.
14. Quarterly notes, nos. 102–104, 1997.
15. Statistics on mining industry 1992.
16. Tin International, vol. 69, nos. 11/12, 1996 and no. 70, nos. 1/2, 1997.
17. Oklahoma Geology notes, vol. 56, nos. 4–6, 1996.
18. Bulletin Sukutahun, Okt-Dis. 1996.
19. U.S. Geological Survey Professional Paper: 1997: nos. 1412-C, 1412-A.
20. U.S. Geological Survey Water Supply Paper: 1996: Nos. 2381-D.
21. U.S. Geological Survey Bulletin: 1996: Nos. 2141.

BERITA-BERITA LAIN
Other News

Local News

Bau to get RM50 mil lime factory

A US$20 million (RM50 million) Malaysian-Belgian joint-venture chemical lime factory will be built in Bau, Sarawak's gold mining town about 38 km from Kuching.

Bukit Yong Goldmine Group (BYG Group) and Carmeuse Group will undertake this first-of-its-kind project in Sarawak.

Carmeuse Group will hold a 51 per cent stake in the joint-venture firm — Borneo Lime Sdn. Bhd. — which is being set up.

BYG Group general manager Roger L.K. Ling said yesterday the Carmeuse Group is a world leader in chemical lime production, with more than 50 operations in several countries.

The BYG Group's core businesses are gold mining, quarry operations and mineral exploration in various parts of Sarawak.

Ling said the state-of-the-art factory would have an initial production capacity of 200,000 tonnes of lime productions per annum, and was scheduled to begin operations late next year.

"We will produce high-end quick chemical lime and slaked lime mainly for water treatment and other environmental uses."

"We will produce the best quality products in Malaysia which would be good for the steel, paper, construction and environmental industries," he said.

Ling said about 80 per cent of the products would be exported to Asean countries while the balance would cater for the Sarawak, Sabah and the Peninsular Malaysia markets.

"The plant's production will be sufficient to meet the new emerging markets and it will contribute to the development of the region," Ling said.

There are at present several chemical lime plants in the peninsula, mainly in Perak.

Ling said Borneo Lime would use the most advanced technology to process high-purity limestone reserves.

"A chemical lime plant needs at least 20 million tonnes of limestone to operate. We have no problem sourcing the limestone," he added.

Star, 1.5.1997

RM750m cement plant for Pahang

A RM750 million cement plant in Merapoh in Lipis district is expected to start production in June 2000, the Pahang State Assembly was told today.

The plant, a joint venture between the state government and A.P. Land Berhad, will be built in two phases on a 606.9 ha site, Deputy Mentri Besar Datuk Hasan Arifin said.

The annual capacity of the first phase is between 600,000 tonnes and 1.2 million tonnes and the second phase, 600,000 tonnes.

Replying to Abdul Fatah Abdul (BN-Padang Tengku) during question time, Hasan said the first phase was expected to cost RM500 million and the second, RM250 million. The plant is expected to create 238 jobs.

Sun, 1.5.1997

RM4b from oil and gas last year

The federal government earned over RM4 billion in oil and natural gas revenues last year.

Terengganu gained RM500 million, Sarawak RM363 million and Sabah RM83.8 million in the same period.

Deputy Finance Minister Datuk Dr. Affifuddin Omar, replying to Kamarudin Ahmad (BN-Arau), said royalty on oil and natural gas sources obtained by the federal government is in the form of income tax, export duty and royalty payments.

"However, the revenue received by a state government is only in the form of royalty," he said.

While royalty is paid to state which have oil or gas within its borders, he said, the federal government's revenue is distributed to states which do not have these reserves.

However, he said, the government does not have any plan to distribute its concession revenue to other states.

He added that in Kedah, no reserve of commercial value has been discovered.

Sun, 1.5.1997

Detailed EIA for Kedah project: Survey to provide data on changing shoreline

A macro detailed Environmental Impact Assessment (EIA) is being conducted by the National Hydraulic Research Institute of Malaysia (Nahrim) for Kedah's RM30 billion land reclamation project.

Kedah is the second state to conduct such an EIA. The first was Malacca recently for its own coastal reclamation project.

"The assessment will incorporate a hydrographic survey, a hydrolic study and a detailed EIA," Nahrim director-general Prof. Abd Aziz Ibrahim said in an interview.

He said the hydrographic survey, the first of its kind to be conducted in Kedah, would provide crucial data on the coast's changing shoreline and seabed characteristics.

"We hope to submit the detailed EIA report to the Department of Environment for approval by November," he added.

A macro study would allow the state to ascertain the total impact of all reclamation projects along the coast instead of the localised impact of individual projects.

This would ensure the drawing up of complementary mitigating measures.

Prof. Aziz said developers still had to conduct individual EIAs for the projects they wanted to implement on the reclaimed areas because Nahrim's assessment would only cover the coastal reclamation activities.

"We may make it a condition for all developers to replant mangroves between the coastline and the reclaimed land to ensure the mangrove forests in the area are protected," he added.

Commenting on a statement by one of the developers involved in the project — Samudera Baru Darul Aman Sdn. Bhd. — that it would complete its parcel of the project by January next year, Aziz said:

"It is impossible for any developer to complete work by January. Work can only start by January because the approval from local authorities and government agencies for the project is still pending."

The state-proposed project will involve land reclamation along Kedah's 100 km coastline from the northernmost tip of the peninsula to the border with Perak.

A total of 12,800 ha of land is expected to be reclaimed.

The area will be used for an airport, industries, fishing, modern agriculture, housing, recreational activities, golf courses and the development of small towns.

Star, 6.5.1997

New plant to produce geotextile materials

A new joint-venture, Polyfelt-L&M Manufacturing Asia Sdn. Bhd., will set up a plant, probably in Rawang, Selangor, to manufacture geotextile materials and geosynthetic-related products in early July.

Their production, the first in this region, will begin by the third quarter of next year.

Polyfelt-L&M is a joint venture between L&M Agencies, a wholly-owned subsidiary of L&M Corporation (M) Bhd. and L&M Geotechnic Pte. Ltd. and PCD Polymere Gesellschaft m.b.H and Polyfelt Gesellschaft m.b.H. of Germany.

Geotextile materials are commonly used to strengthen and filter soft saturated soils and to prevent coastal and riverbank erosion for earthworks construction and large infrastructure projects.

The Polyfelt technology, which involves the extrusion of continuous fibres in an integrated process of manufacturing the geotextile sheets, allows production of a wide range of products suitable for a variety of common civil engineering applications.

The Polyfelt geotextile, made of high-quality polymers, is not easily damaged or punctured.

L&M Corporation (M) Bhd. deputy chief executive officer Pattis Naidu said the plant was expected to gain a profit of between RM3 million and RM5 million after three years of operation.

"The company is negotiating to acquire a two-hectare piece of land in Rawang for the plant," he told reporters after the company's extraordinary meeting on the joint venture in Petaling Jaya yesterday.

The plant, to cover 9,000 square metres, will have an initial production capacity of 4,000 tonnes per year.

Its maximum production capacity is 8,000 tonnes, or 14 million square metres, per year.

"The plant is being dismantled in the United States and the entire plant is expected to be shipped to Malaysia by the end of next month," he said.

Naidu said the capital investment on the joint-venture was estimated to be about RM87 million.

Under the joint venture, L&M Agencies and L&M Geotechnic will hold 20 per cent and 29 per cent equity respectively, while PCD will hold the remaining 51 per cent.

Naidu said the market for the products was strong and Polyfelt-L&M aimed to export 80 per cent of the products to Australia, New Zealand and East Pakistan.

He disclosed that the company planned to set up another joint venture with a German construction-based company.

"It is still at a preliminary stage," he said.

NST, 6.5.1997

Cabinet opts for 30 m-wide corridor for Highland Road project

The RM2.5 billion Highland Road project will be built on a 30 m-wide corridor instead of the 500 m like in past highway construction.

Works Minister Datuk Seri S. Samy Vellu said the directive was given by the Cabinet to prevent indiscriminate cutting of trees during the construction of the 221 km road to link Genting Highlands, Fraser's Hill and Cameron Highlands.

"The Cabinet wants to ensure there will be minimal effect on the environment."

"When we constructed highways in the past, we used to clear a 500 m-wide corridor but now it will only be 30 m," Samy Vellu told reporters after opening a textile shop here on Saturday.

Samy Vellu also said trees derooted during the construction of the Highland Road would be replanted to preserve the environment.

"We will also re-route the road if we come across any old or large trees," he said.

The minister said a consultant would be appointed by the Government soon to conduct an environmental impact assessment study of the road project.

"The cost of the EIA study has gone up to RM3.5 million from the original RM1.5 million. This is because the scope of the study has be enlarged to please the NGOs," he said.

He also said the EIA study was expected to be completed in a year.

Star, 12.5.1997

Limestone cave at risk of being mined

One of the last two limestone outcrop caves in the state, a popular attraction for cave explorers, is in danger of being mined and levelled to nothing.

Unlike the limestone caves in the Charah outcrop which are protected, the Bukit Tenggek caves could end up destroyed as those in Bukit Sagu, which is five kilometres away, after the outcrop there was mined.

The 25 ha limestone outcrop in Bukit Tenggek has five cave chambers with a natural well in one of them.

It is learnt that a Terengganu-based company applied to the state last August to operate a limestone quarry at Bukit Tenggek in the Sungai Lembing district which is famous for its mountains, rivers and limestone outcrops.

It is understood that Rangkaian Delima Sdn. Bhd. and Gagasan Bukit Bandi Sdn. Bhd. have submitted an official letter to Mentri Besar Tan Sri Haji Mohamad Khalil Yaakob proposing a joint venture to extract 10 million tonnes of limestone reserves.

The managing director of the Rangkaian Delima, Abdul Raof Awang, in the said latter also stated the company was willing to mine in the area for at least 20 years to extract all the 10 million tonnes of mineral.

He also suggested that the application be approved quickly to enable the company to begin extracting the mineral by early this year.

A check by the *The Star* showed evidence of lime samples being taken from several sections of the cave in Bukit Tenggek.

Apart from its natural attraction, there are also Felda settlers staying less than 1 km radius of Bukit Tenggek.

Some of the villagers who were unaware of the quarrying plans questioned how a company could mine the area without blasting and take into consideration the people living nearby.

It was not known if the company had conducted any Environmental Impact Assessment study.

Star, 23.5.1997

New gas field discovered off Kelantan

The Malaysian-Thailand Joint Authority said yesterday that its contractors in the Joint Development Area have discovered a new gas field codenamed the Amarit-1 Wildcat Well.

The gas-field is located 268 km east of Songkhla, Thailand, and 171 km north-east of Kota Baru, Kelantan, MTJA said.

The well, which was spudded on March 30, was drilled to a total depth of 3,150 metres to test for hydrocarbon potential. It encountered several gas-bearing sands.

Three drill stem tests were conducted and it yielded a stable gas flow rate of eight million standard cubic feet per day plus 326 barrels per day of condensate measured through choke size of 64/64 inches.

NST, 27.5.1997

Rock Chemical Industries buys reserve limestone land

Rock Chemical Industries (Malaysia) Berhad has acquired three parcels of land with a total area of 22.01 ha to provide the company with a permanent and constant supply of limestone for its manufacturing operations.

RCI managing director Datuk Lim Keng Kay said the land, which had an estimated limestone reserve of 4.8 million cubic metres, would supply the company's raw material and secure its standing in the lime and cement production industry.

He also said the move was necessary to meet the increasing demand for lime products and white cement as well as to improve the quality of the products.

Speaking to newsmen after the company's annual general meeting yesterday, Lim said the move also took into account the robust growth of the building and construction industry in the country which was expected to continue over the

New plant to produce geotextile materials

A new joint-venture, Polyfelt-L&M Manufacturing Asia Sdn. Bhd., will set up a plant, probably in Rawang, Selangor, to manufacture geotextile materials and geosynthetic-related products in early July.

Their production, the first in this region, will begin by the third quarter of next year.

Polyfelt-L&M is a joint venture between L&M Agencies, a wholly-owned subsidiary of L&M Corporation (M) Bhd. and L&M Geotechnic Pte. Ltd. and PCD Polymere Gesellschaft m.b.H and Polyfelt Gesellschaft m.b.H. of Germany.

Geotextile materials are commonly used to strengthen and filter soft saturated soils and to prevent coastal and riverbank erosion for earthworks construction and large infrastructure projects.

The Polyfelt technology, which involves the extrusion of continuous fibres in an integrated process of manufacturing the geotextile sheets, allows production of a wide range of products suitable for a variety of common civil engineering applications.

The Polyfelt geotextile, made of high-quality polymers, is not easily damaged or punctured.

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Star, 12.5.1997

32 dormant gold mining companies blacklisted

The state government has blacklisted 32 dormant gold mining companies which have been given between one and two years to buck up or face action.

Assistant Minister in the Chief Minister's Office Awang Tengah Ali Hasan said showcause letters had been sent to the firms, some of which had been inactive for 10 to 20 years. The firms had been issued mining leases or mining certificates.

"If the companies fail to reply within the grace period and give concrete proposals to resume operations, the government will suspend their permits," he told reporters after opening a new block of the state Geological Survey Department yesterday.

Meanwhile, department director-general Fateh Chand said that the country's biggest coal deposit of 387 million tonnes has been found at Merti-Pila in Sarawak.

Star, 18.5.1997

Bakun: 'River diversion tunnels ready by October'

Ekran Bhd. executive chairman Tan Sri Ting Pek Khiing has expressed confidence that the river diversion tunnels for the Bakun hydro-electric dam project will be completed by October.

Ting said 80 per cent of the three diversion tunnels had been completed and that there was "no delay as yet" in their final construction. The original target of May could not be met due to unpredictable weather and initial mobilisation problems as well as soil conditions.

"These factors have now been overcome and we know the date when the tunnels will be completed ..... we expect water to go through by October," Ting told a group of journalists after leading them on a media tour of the Bakun dam site in Sarawak.

The said the remaining 20 per cent work to be completed on the river diversion tunnels includes concrete-lining of the tunnels, some infrastructure and excavation.

Denying any delay in the tunnels' construction, Ting reminded journalists that work began on the tunnels 1½ years earlier than originally planned.

He also said the Asea Brown Boveri-Companhia Brasileira de Projectos e Obras consortium, the project's main contractor, is already "present on site" constructing roads, building camps and was starting on some excavation works.

"The tunnel diversion and other works are going on together."

Ting said there would only be a delay if the tunnels were not completed by the time ABB-CBPO set up their construction base.

The three 1.5-kilometre tunnels are to divert the flow of the Balui river to another outlet area so as to allow work to begin on the project's next phase — the construction of the 205-metre high concrete dam spanning 740 metres across the river.

Ting expected ABB-CBPO to start construction of the concrete dam in December, two months after the tunnel are expected to be completed.

Construction of the tunnels, estimated to cost RM250 million, is being undertaken by South Korea-based Dong-Ah Construction Industrial Co. Ltd., which pays wages totalling about RM1 million a month to locals.

The reservoir of the Bakun dam covers an area of 69,000 ha and will take about a year to be flooded.

The developer of the dam is Bakun Hydro-Electric Corporation Bhd. Its shareholders include Ekran Bhd. (32 per cent), Sarawak State Government (19 per cent), Sarawak Electricity Supply Corp. (nine per cent), Employees Provident Fund (5 per cent), Tenaga Nasional Bhd. (5 per cent), Khazanah Nasional Bhd. (5 per cent), and Malaysian public and foreigners (25 per cent) upon completion of its initial public offering of 225 million shares.

With the IPO, the project would be locally funded, and not relying on foreign borrowings, Ting said.

The decision was against foreign borrowings which would have subjected the project to many "conditions and complications", he said.

The dam, to be completed by January 2003, will supply electricity to Tenaga Nasional Bhd. and the Sarawak Electricity Supply Corporation for a period of 30 years.

NST, 19.5.1997

Hilmi: Dam will flood forest reserve

Several river tributaries and part of the forest reserve in Teluk Bahang will be submerged with the building of the island's biggest dam.

The Teluk Bahang Dam, with a capacity of 21 billion litres, is seven times bigger than the Air Itam Dam and will serve the north coast and Batu Ferringhi tourism belt.

State Infrastructure and Public Utilities Committee chairman Datuk Dr. Hilmi Yahaya yesterday confirmed this and added that the stream beside the aboretum, a popular picnic spot here, would be cordoned off once work began in the area.

"About 35 per cent of the project has been completed since it began two years ago," he said, adding the dam was scheduled to be completed in 1999.

The stream, along with other tributaries of Sungai Ubi and Sungai Teluk Bahang and their banks, will be affected as they are located within the area.

The RM160 million dam is a joint venture between the Penang Water Authority (PWA) and China International Water & Electricity Corp. (M) Sdn. Bhd.

A check by *The Star* yesterday found that the once clear waters of Sungai Ubi had turned murky as a result of earthworks for the project.

Although a section of the forest reserve would be taken up by the dam, it is learnt that a major part of the PWA-owned land in the reserve would be retained as a recreation park.

Work at the dam site now includes tunnelling, diversion of a culvert, and a temporary road diversion.

Last year, a 1.7 km stretch of the Teluk Bahang Road was sealed off to facilitate construction of the dam.

A new hill road has been constructed after the forest reserve to link up with the road to temporarily accommodate traffic until work on a new 3.7 km diversion route, linking Teluk Bahang to Balik Pulau, is completed.

Star, 21.5.1997

Highlands highway: Work on EIA to start soon

A consultant engaged by the Works Ministry will start work on the Environmental Impact Assessment of the proposed highway linking three highland resorts in the Main Range in a week's time.

Works Minister Datuk Seri S. Samy Vellu said today the report was expected to be ready within 10 or 11 months.

"A helicopter and sophisticated equipment will be used in the course of the work," he told reporters after opening a Wanita MIC leadership seminar here. *"The consultant will also determine the route of the proposed highway."*

"The report will be submitted to the Science, Technology and Environment Ministry for consideration," he said. The proposed highway will link Genting Highlands, Fraser's Hill and Cameron Highlands.

The project covering 258 kilometres is estimated to cost RM1 billion while the technical study will cost RM10 million.

"Initial work has started to enable work on the EIA to start within a week," Samy Vellu said.

The highway will enable more locals to enjoy the scenic surroundings and cool weather, without having to go overseas.

Prime Minister Datuk Seri Mahathir Mohamad announced in February that the Government would proceed with the project.

He said any further delay could result in an increase to its cost and this could make the project uneconomical.

NST, 22.5.1997

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Star, 23.5.1997

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He also said the move was necessary to meet the increasing demand for lime products and white cement as well as to improve the quality of the products.

Speaking to newsmen after the company's annual general meeting yesterday, Lim said the move also took into account the robust growth of the building and construction industry in the country which was expected to continue over the

next few years.

He said the company's existing limestone land would continue to be used to produce limestone blocks while the newly acquired land would produce white cement and lime products.

He added that the continued robust growth of the construction industry last year was the cause of a 19 per cent increase in the group's turnover to RM33 million from RM27.8 million in 1995.

Lim attributed the increase to better prices for white cement during the year and to improved sales of lime products.

As a result, he said, the group pre-tax profit increased 132 per cent to RM5.6 million in 1996 over that of the previous year's RM2.4 million.

Group profit after taxation was RM4.1 million, an increase of 89 per cent over that of the previous year of RM2.2 million.

Lim also said the future looked bright for the company especially in the manufacturing of white cement and lime products.

He said white cement sales value increased by six per cent in 1996 although total sales volume was two per cent lower as compared to 1995. The product achieved an 11 per cent higher average net selling price.

The higher selling price was due to increased local sales and a reduction in shipments to traditionally lower priced export market.

Lim said even though production costs increased by four per cent, the improved average net selling price brought about a 24 per cent increase in gross profit for white cement.

On the sales of lime products, he said they increased by 111 per cent in terms of value in 1996 compared to 1995.

Lim said due to the encouraging demand for lime products, the company constructed a third lime kiln.

This has increased the production of lime by 30 per cent to 210 tonnes per day from the three kilns.

NST, 6.6.1997

Nature's finest in magical cave

An abundance of limestone and plentiful rainfall combine to produce a great number of spectacular caves in Ipoh but none can compare with Gua Tempurung — an ethereal underground museum showcasing some of nature's finest handiwork.

For its wealth of tourism potential, Gua Tempurung's sempiternal majesty is now being "developed" for all to enjoy.

Heritage Acres Sdn. Bhd., the company entrusted with the task, is determined to make it a popular adventure destination.

The company has attempted not only to light Gua Tempurung's many caverns but also to build a concrete walkway through the cave labyrinth as well.

Heritage Acres is a joint-venture between Yayasan Perak and MKDV Sdn. Bhd. MKDV is a joint-venture between Malaysian Kuwaiti Investment Co. Sdn. Bhd. and the Adorna Group.

Heritage Acres managing director Mohd Noorani Kamarun says: *"We have lit the cave up so that one can enjoy it to the fullest."*

When one walks through the man-made pathway and the lit repositories of the cave system, its majestic effulgence cannot help but overwhelm, invoking raw appreciation.

Located some 25 km south of Ipoh and about 300 metres east of the North-South Highway, Gua Tempurung is located in the imposing Gunung Tempurung and Gunung Gajah limestone massif.

Gunung Tempurung is an elliptical-shaped hill, elongated in a north/northwest direction. It is about 4 km long and about 1.5 km at its widest.

Gunung Gajah is also an elongated hill treading in a north-easterly direction lying south of and connected to Gunung Tempurung. Together they form an upside down letter "T".

The plains surrounding the hills are worked-out mining land. Open and almost barren, they show massive scars of alluvial mining such as scattered ponds and dispersed residual material deposits.

Gua Tempurung itself is about 1.9 km long, traversing the breadth of Gunung Tempurung in an east-west direction with a gurgling river flowing through it. The river, which flows along the lines of a fracture in the limestone, is simply called Sungai Tempurung.

Besides the eastern and western portals, there are three large caverns — beginning with

Lee Ming Chamber, Gergasi Chamber and finally Alam Cavern — all connected to one another by small chambers, some of which are only 0.7 metres high and 0.5 metres wide.

Discovered at the end of the last century, Gua Tempurung was a favourite communist terrorist hide-out during the Emergency, signs and traces of which are still evident.

NST, 7.6.1997

Green light for Bukit Tenggek mining project

The Pahang Government has approved in principle to allow a company to mine the Bukit Tenggek, limestone outcrop in Sungai Lembing, one of the last limestone caves in the state.

Senior government officials said the Pahang-based company would first have to liaise with the state Department of Environment and the Land and Mines Department to make available necessary reports before commencing mining.

The officials also said that the company would be given a long-term lease after producing the environmental impact assessment and other technical reports.

The Star had reported that several companies were eyeing the limestone area, about 58 km from here.

Bukit Tenggek has at least 10 million tonnes of limestone reserves which can be mined for the next 20 years.

The limestone outcrop with five chambers is a haven for local and outstation cavers.

It has a natural hot spring well in one of its chambers.

Local caver, Albert Thang, 29, said there would not be anymore caves to explore or visit within a 100 km radius of the area if the mining project was allowed.

"I am planning to go to the cave this weekend with other cavers to take as many pictures as possible."

"I am sure the caves will soon be history but at least we will have pictures to remember them by," he added.

With Bukit Tenggek gone, the Charah and Kota Gelanggi caves, gazetted as a tourist attraction by the government, would be the only limestone caves left in the state.

Star, 15.6.1997

Low's Peak not the highest point

Malaysia's highest point is not Low's peak on Mount Kinabalu, as has been believed for the past 87 years.

The peak has instead been dwarfed by about 14 m by the nearby Victoria Peak.

Chief Minister Datuk Yong Teck Lee announced the height of Low's Peak to be at 4,093.372 m at the summit of the peak at about 9.30 am yesterday.

The new height was 7 m lower than the previously estimated height of 4,101 m.

Yong said surveyors using the Global Positioning System (GPS) had, however, discovered that the summit plateau of Victoria Peak, just north of Low's Peak, was 4,097 m.

Yong said there was, however, a horn on Victoria Peak which surveyors have estimated to be about 10 m high.

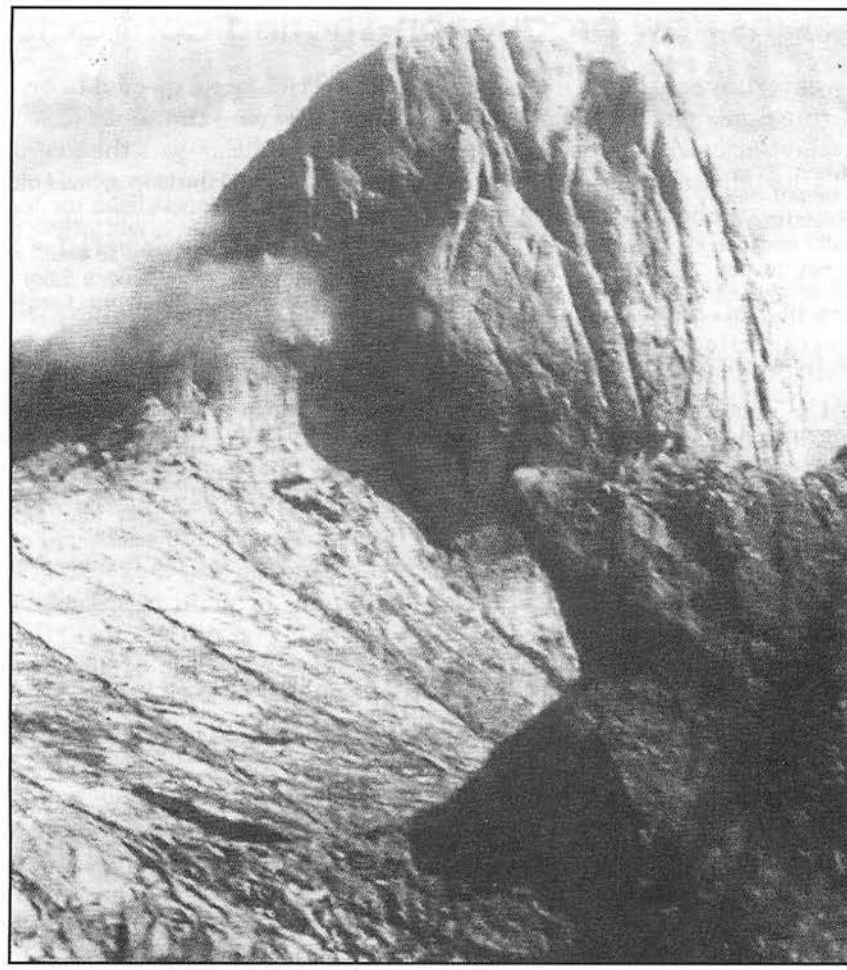
"I have asked the Land and Survey Department to determine the exact height of the Victoria Peak within a year. But even without taking into account the height of the horn, we know that this particular peak is higher than Low's Peak," he said.

Yong announcement was the culmination of a five-day survey expedition jointly organised by the Sabah branch of the Institution of Survey Malaysia and state Land and Survey Department.

Yong was quick to remind people against attempting to conquer Victoria Peak.

"This peak will remain closed to the public. Low's Peak will still be the only highest accessible point," he said.

Yong said the move to make Victoria Peak out of bounds was necessary as the slopes leading to the peak was extremely steep and the journey there from the Laban Rata base camp would



Highest point ..... the Victoria Peak is now the highest summit on Mount Kinabalu. The exact height of the peak is not known yet.

take 12 hours.

"I was also informed that the route leading to the peak could become a fast flowing river after a torrential downpour," he said.

Organising committee chairman Ho Kin Wong said the expedition was aimed at determining the precise height of the mountain by way of satellite technology through the use GPS.

Ho said the date June 25 was chosen to commemorate the exact date in 1910 when the Learmonth expedition mounted by the British North Borneo Company first established the height of the mountain.

Prime Minister Datuk Seri Dr. Mahathir Mohamad is scheduled to proclaim the height of Mount Kinabalu during his visit to Sabah in early August.

Star, 26.6.1997

Petronas signs new production-sharing contracts

Petronas yesterday signed three new Production Sharing Contracts with exploration subsidiary Petronas Carigali Sdn. Bhd. and three Shell companies for oil and gas exploration, development and production in Sarawak and Sabah.

The contractors will commit a minimum total investment of RM115 million under the contracts covering Block SK307 offshore Sarawak and Block SB301 and Deepwater Block J in Sabah.

For Block SK307, the contract was awarded to Petronas Carigali and Sarawak Shell Bhd. in a 50:50 joint-venture with Petronas Carigali as the operator.

This will involve a minimum financial commitment of RM45 million.

The other two blocks were awarded to a Shell-led consortium comprising Petronas Carigali (20 per cent), Sabah Shell Petroleum Co. Ltd. (40 per cent) and Shell Sabah Selatan Sdn. Bhd. (40 per cent).

Sabah Shell Petroleum Co. is the operator for both Block SB301 and Deepwater Block J. This will involve a minimum investment of RM45 million for SB301 and RM25 million for Deepwater Block J.

The signatories to the PSCs were Petronas president and chief executive officer Tan Sri Mohd Hassan Marican, Petronas Carigali director Datuk Hamzah Bakar and Shell Malaysia Ltd. chairman and chief executive officer Megat Zaharuddin Megat Mohd Nor.

Mohd Hassan told a Press conference after the signing ceremony in Kuala Lumpur that the three PSCs are expected to bring in revenue in about 10 years time.

He said this was the average waiting time for profit contribution from such activities, and that drilling would begin next year.

Asked on the potential of these areas for the discovery of hydrocarbon reserves, Mohd Hassan said data from previous studies "looks encouraging".

The three blocks are old areas which had seen exploration and production activities before.

"The block areas have been explored before, but we are bringing in new technology and expertise to help realise the areas' full potential," Megat Zaharuddin said.

He added that the contracting parties will be pumping in more investments into the PSCs depending on the results of the explorations.

The SK307 and SB301 Blocks are awarded under the Revenue-over-Cost terms recently introduced by Petronas for third generation PSCs, following the year 1976 and 1985 PSCs.

Mohd Hassan also mentioned Petronas' interest in promoting greater utilisation of gas in Sabah.

He said Petronas has begun a study of gas utilisation in Sabah and will look into ways of developing the gas reserves for use in power generation or other projects.

"We will need a large investment in Sabah due to our lack of offshore facilities there, but just how much will depend on the findings of our study and what we decide to do," Mohd Hassan said.

NST, 23.6.1997

International Workshop: Tectonics, stratigraphy and petroleum systems of Borneo

This workshop was held at the Universiti Brunei Darussalam from the 23 to the 25 June 1997. It was the first geology conference organized by the department of petroleum geoscience and held in the new sprawling rural campus of the university, which was opened only in December 1994. The 170 participants came from far and wide, Europe and North America, and of course from neighbouring Southeast Asian countries.

The conference was held in the central lecture theatre and opened by the Minister of Law at 8.40 am on Monday 23 June. There was a welcoming reception at the concourse of the central lecture theatre at 7.00 pm the previous evening, which terminated rather abruptly at 9.00 pm with the departure of the organized buses bringing participants back to their downtown hotels. The strongest drinks served were tea and coffee. A few participants, like myself stayed on campus at the comfortable visiting lecturers' quarters and some stayed in students' hostels, within walking distance of the conference venue. Morning and afternoon coffee, tea and snacks were provided on the concourse adjacent to the registration desk. The new edition of the *Geology of Brunei Darussalam*, jointly published by Brunei Shell and the Brunei Museum, was on sale at B$60. Lunch was available daily at the staff cafeteria. On Monday the participants enjoyed an evening at the Jerudong Park, the world's only free "Disneyland" styled theme park. The park is built near the coast upon the Jerudong Line, a tectonic zone of great geological significance, though geology was not on the minds of the participants that evening. On Tuesday evening the Vice Chancellor hosted a formal dinner in the downtown Riverview Hotel.

Two large rooms adjacent to the central lecture theatre concourse were set out with posters, the presenters of which were given approximately 5 minutes each at the conference lecture hall to present the highlights. There were posters on such diverse topics as the Makassar Straits, Tertiary palaeogeography of Borneo, the Balingian Province, algal source rocks of northern Thailand, Tertiary magmatism in Borneo, Baram Delta, carbonates of southern Thailand, the Song Hong Basin, and the eastern continental margin of Vietnam. Dick Murphy bravely went into uncharted territory and presented a set of geological cross sections across Borneo — all drawn to the Moho!

The regular programme was interspersed by invited papers on aspects of sedimentology of delta and turbidite systems, including the results of laboratory experimentation. Bob Morley presented a review of palynological biostratigraphy of S.E. Asia and showed a slide in which he re-classified the base of the Kayan Sandstone as Eocene, making it comparable with the Plateau Sandstone and removing one of the stratigraphic problems of Borneo and the Ketungau Basin.

There were papers on the Baram and Mahakam deltas and on details of the Kutai and Barito basins and their petroleum systems. Mike Fuller, now of the University of Hawaii, reviewed the results and problems of palaeomagnetic research into Borneo. There were also interesting presentations on onland geological research into the extension of the Rajang Group into Kalimantan, the Malibau basin and Gomantang Limestone of Sabah, and the Plateau Sandstone of Sarawak.

The greatest disappointment was a paper by Mobil/Carigali on the results of their aborted deepwater block investigation outboard of the Luconia carbonate province. It was clear that the company little understood the area and could not explain why the shallow marine stratigraphy is now

in a deepwater setting. Their limited geological input added little to help understand this enigmatic region.

One very satisfactory aspect of the conference was the number of papers on Brunei geology both by the oil industry and the university. In the past the Geological Society of Malaysia petroleum conferences had not been able to entice geologists from Brunei to participate. One must hope that they will now play an active role in future society meetings.

There was a well balanced programme of papers and posters and the three days of the conference passed smoothly. The M.Sc. students of the Petroleum Geoscience department must be congratulated on the handling of the audio-visual equipment. The proceedings of the conference are planned for publication by the Universiti Brunei Darussalam next year. The conference was very well organized, so we must expect that this publication will add significantly to the sparse literature on Borneo, an island of complicated and little understood geology and tectonics.

The conference was preceded by a well attended field trip, 20–22 June, across the Baram Delta from the Lambir Hills of Sarawak to the Belait Syncline of Brunei Darussalam. It was organized and led by J. Lambiase, P. Crevello, Azhar Hussin, Boniface Bait, Abdul Hadi Rahman and C. Morley.

Following the conference, there was a well attended field trip across Sabah from Kota Kinabalu (West Crocker Formation) to Mount Kinabalu, Sandakan, the Bukit Garam circular basin and the Kinabatangan River. Participants were favoured by a freshly made outcrop of Garinono Formation mélange near the junction of the Labuk and Lahad Datu roads, clearly demonstrating its relationship to the older redbed Kulapis Formation. The field trip was organized and led by C. Hutchison and F. Tongkul.

C.S. Hutchison

Department of Petroleum Geoscience at Universiti Brunei Darussalam

The department was founded in 1993 as a joint initiative of Universiti Brunei Darussalam (UBD) and Brunei Shell Petroleum (BSP) with assistance from the Department of Geology and Petroleum Geology of the University of Aberdeen, Scotland. Programmes of study include an M.Sc. in Petroleum Geoscience, the first offered in the ASEAN region, plus a Ph.D. to be introduced in 1998. The department began teaching the M.Sc. in 1994. The numbers of enrolled students have steadily grown from 11 in 1994 to 17 in 1996 and 19 in 1997. Students come from Brunei, Malaysia, Thailand, Indonesia, Philippines and Vietnam and are supported by UBD scholarships and by several regional petroleum companies.

The department is housed in a spacious wing of the Faculty of Science building in the new campus, which opened in December 1994. The M.Sc. students live in residence on the sprawling rural UBD campus, which lies immediately south of the Tutong-Muara coastal highway, east of its junction with Jalan Tungku Link, which affords rapid access by car to Jalan Gadong in Bandar Seri Begawan and to Brunei Darussalam international airport.

The department has initiated a research programme that focusses on Reservoir Sedimentology and Sequence Stratigraphy, Reservoir Geophysics and Tectonics and Structural Geology. Research projects span a wide range of geological systems and geographic areas and include studies based on outcrop and subsurface data. The department also offers a place for conducting research towards a Ph.D. for students enrolled at the University of Aberdeen.

The present staff are as follows: Professor J.J. Lambiase (Head of department); Dr. P.D. Crevello (Senior lecturer); Dr. C.K. Morley (Senior lecturer); Dr. S.S. Ronghe (Lecturer) and Dr. P. Van Renbergen (Research Fellow). There are also 5 adjunct lecturers: Mr. D. Baxendale, Dr. M. Holmes, Dr. M.D. Simmons, Mr. J. Swan and Dr. D.W. Waples. There are three visiting lecturers: Professor C.S. Hutchison, Mr. R.W. Murphy and Dr. J. Yarus. The external examiner is Professor A. Hurst of the University of Aberdeen. The technical staff comprise Mrs. Novianti Hesketh (Secretary) and Mrs. Lim Yong Khium (Chief Technician).

Generous support from BSP has allowed the department to be well equipped for core and rock specimen petrographic analysis and with a computer network of 4 workstations complete with Landmark 2D and 3D seismic capabilities. There is a 4 wheel-drive vehicle and a variety of field equipment.

The department came of age this year by being able to successfully organize and host a well attended international workshop on the *Tectonics, Stratigraphy and Petroleum Systems of Borneo* at the UBD campus from 22–25 June. There was a pre-conference field trip to the Baram Delta Province of Sarawak and Brunei from the 20 to 22 June and a post-conference field trip to Sabah from the 26 to 29 June. The proceedings of the conference will be published by the university next year.

C.S. Hutchison and J.J. Lambiase

Delta '98
Modern & Ancient

Mansoura University

First International Symposium on
The Deltas

March 21–27, 1998

Cairo, Egypt

Endorsed and Sponsored by
The Egyptian General Petroleum Corporation

Continuing Call for Papers on "Deltas: modern and ancient" with emphasis on

- Petroleum Exploration and Development.
- Mineral Resources.
- Ground waters.
- Physical Geology and Coastal Management.
- Environmental Geology and Environmental Geophysics.
- Tectonics.
- Sedimentation and Sedimentology.
- Stratigraphy and Paleontology.
- Other related topics.

Abstracts (500 words or less) on the above subjects are to be received by December 31, 1997.

Selected papers will be published in a manual titled "DELTAS".

Authors are advised to adopt the format of the Bulletin of American Association of Petroleum Geologists in preparing their articles.

Program:

- Scientific Sessions March 21–24, 1998, where presentation of technical and scientific original articles will take place in format of talks or posters.
- Field trips March 25–27, 1998 through the modern Nile Delta and the ancient Tertiary Deltas in the Western Desert of Egypt.

Field Trips:

- Modern Nile Delta of March 25, 1998; fee $20.00.
- Mid Tertiary Ancient Delta in the Fayium Province with its fabulous fossils (vertebrates and invertebrates) on March 26–27, 1998; fee $70.00 covering accommodation and transportation.
- An additional trip will be organized to Sinai for those having interests in the Geology of Sinai, its historical sites, and the coral reefs of Gulf of Aqaba.

For Further Information:

Dr. Moharem Elgamal
Geology Department
Faculty of Science at Damietta
Mansoura University
New Damietta, 34517 Egypt

E-Mail: DSCIFAC @ eic.mans-eun.eg
Telephone: 2057 - 334205
Fax: 2057 - 325803

Muscat, Sultanate of Oman
Mar 9–12, 1998

Oil & Gas West Asia

Oil, LNG, Subsea Engineering and Petrochemical Exhibition and Conference for West Asia
GATEWAY TO THE $25 BN WEST ASIAN ENERGY MARKET
Officially Supported by:
Ministry of Petroleum & Minerals, Oman

A major new international oil and gas exhibition, OIL & GAS WEST ASIA, takes place in Oman from March 9–12, 1998.

This event will be staged at the heart of the rapidly emerging 'petro-economic' zone of West Asia, in the centrally-located oil producing nation of Oman.

This West Asian energy-zone is swiftly growing in importance both for the consuming nations in East Asia and the West, and for Middle East and Asian producers.

Within the five years 1997–2001, at least $25 billion will be invested in specified oil and gas project in Western Asia, outside the traditional core Middle East markets of Saudi Arabia, Kuwait, Iran and Egypt.

Yet until now, there has been no specific energy event designed to serve the requirements of this vital region.

Technical Seminar Programme and Investment Conference

Two important conference events will take place at OIL & GAS WEST ASIA 98 — each designed for high level regional management and technical audiences.

Both will be staged in collaboration with IBC Gulf Conference, organisers of the established "Middle East Gas Summit" and "Middle East Oil Congress" events.

Three Days of Technical Seminars

Call for Papers
"The Petroleum Engineering Challenge in Western Asia"

Three full days of technical seminars will be held at the Seeb Novotel Hotel, next to the Oman International Exhibition Centre.

The OGWA 98 Technical Seminar Programme will focus on specific issues within the following key sectors:

- Geology
- Refining and Petrochemicals
- Pipelines
- Drilling
- Production Operations
- Health, Safety and the Environment
- Business, Commerce and Trading aspects of Refining & Production
- Information Systems and Technology

All submissions for papers should be a maximum of 250 words, covering any of these topics, and relating to the Western Asian region.

Oil & Gas Investment Conference

In parallel with the exhibition and the technical seminars a two-day conference will be held on:
"Investment Opportunities in the Oil & Gas Industry in West Asia"

This international conference will be addressed by industry leaders from more than 12 countries across the region — including Bangladesh (where enormous new gas discoveries offer attractive options), Pakistan (as power demand continues to soar) and India (extensive overseas investment in refinery expansion is needed).

Central to the event are over twenty presentations, which will focus on:

- Reserves and resources
- Investment opportunities in West Asia (country studies)
- Financing and securing projects in the region
- Current and future status of Oil and Gas transportation routes
- Principal political risks involved
- Alliance and joint venture opportunities

For Further Information:

Intrenasionale Incorporated USA
2517 North Parkwood Court
Wichita, KS 67220-4035, USA
Tel: 316-683-2426; Fax: 316-683-2517
or
Intrenasionale Incorporated Malaysia
Suite 5-17, AXIS Complex
35 Cantonment Road
10350 Penang, Malaysia
Tel: 04-229-4817; Fax: 04-227-9817
e-mail: intrenasionale@post1.com

KALENDAR (CALENDAR)

1997

July 7–10

REMOTE SENSING TECHNOLOGY, MEASUREMENTS AND ANALYSIS (3rd International Conference), Copenhagen, Denmark. (Robert Rogers, ERIM Conferences, Box 134001, Ann Arbor, MI 48113-4001, USA. Phone: 313 994 1200; telefax: 313 994 5123; e-mail: raeder@erim.org; WWW: http://www.erim.org/CONF/)

July 9–12

MINING PHILIPPINES: PHILIPPINES MINERALS EXPLORATION, MINING EQUIPMENT, AND TECHNOLOGY (Exhibition and Conference), Manila, Philippines. (Stephen Luff. Telefax: 44 171 413 8222)

July 12–14

LANDSLIDE HAZARD ASSESSMENT (International Symposium), Xian, China by Japan Ministry of Education, Science, Culture and Sports and others. (K. Sassa, Disaster Prevention Research Institute, Kyoto University, Uji, Kyoto 611, Japan. Phone: 81/774 0789; telefax: 81/77 432 5597)

July 12–17

VERTEBRATE MORPHOLOGY (5th International Congress), Bristol, UK. (J.M.V. Raynor, School of Biological Sciences, University of Bristol, BS8 1UG, UK. Phone: 44 117 928 111; telefax: 44 117 025 7374; e-mail: icvm97@bristol.ac.uk)

July 14–17

GEOMECHANICS AND GROUND CONTROL IN MINING AND UNDERGROUND CONSTRUCTION (International Conference), Wollongong, NSW, Australia. (Naj Aziz, Dept. of Civil and Mining Engineering, University of Wollongong, Wollongong, NSW, Australia 2522. Telefax: 61 42 213 238; e-mail: n.aziz@uow.edu.au)

July 18–20

WATER POLLUTION MODELING, MEASURING AND PREDICTION (4th International Conference). (Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK. Phone: 44 1703 292853; e-mail: WIT@!wessex.witcmi.ac.uk; WWW: http://www.witcmi.ac.uk)

July 20–27

DEVONIAN CYCLICITY AND SEQUENCE STRATIGRAPHY (Subcommission on Devonian Stratigraphy Symposium and field trips), Rochester, New York, USA. (William Kirchgasser, Department of Geology, SUNY Potsdam, Potsdam, NY 13676-2294, USA. Phone: 315 267 2295; telefax: 315 267 3170; e-mail: kirchgwt@potsdam.edu)

July 27–31

OSTROCODA (13th International Symposium), Greenwich, UK. (ISO '97), School of Earth Sciences, University of Greenwich, Medwat Towns Campus, Chatham Maritime, Kent ME4 4AW, UK. E-mail: iso97@greenwich.ac.uk)

July 28 – August 1

LEARNING ABOUT THE EARTH AS A SYSTEM (Second International Conference on Geoscience Education), University of Hawai'i, Hilo. (Dr. M. Frank Watt Ireton, GeoSciEd II Local Arrangements Coordinator, American Geophysical Union, 2000 Florida Avenue, NW, Washington, DC 20009. E-mail: fireton@kosmos.agu.org)

July 30 – August 9

CELEBRATION OF THE BICENTENARY OF CHARLES LYELL AND JAMES HUTTON, London and Edinburgh, UK. (P. Jackson, BGS, Keyworth, Nottingham NG12 5GG. Phone: 0115 936 3100; telefax: 0115 936 3200)

August

GRANITES AND ASSOCIATED MINERALIZATIONS (2nd International Symposium), Salvador, Brazil. (SGM-2nd ISGAM, General Secretariat, Av. 3, 390, Plataforma IV, CAB 41746-900, Salvador, Bahia, Brazil. Telefax: 5571 231 5655)

August 4–8

SEG/EAGE ISTANBUL '97 INTERNATIONAL GEOPHYSICAL CONFERENCE AND EXPOSITION, Istanbul, Turkey. (SEG, PO Box 702740, Tulsa, Oklahoma 74170, USA)

August 11–13
RESEARCH AND EXPLORATION — WHERE DO THEY MEET? (4th Biennial Meeting of the Society Applied to Mineral Deposits). (Congress Office/SGA Meeting 1997, University of Turku, Lemminkaisenkatu 18-18B, FIN-20520 Turku, Finland. Phone: + 358-21-333 6342; telefax; +358-21-333 6410; e-mail: cescon@utu.fi)

August 17–21
PALEOFORAMS '97, Bellingham, Washington, USA. (Charles A. Ross, Department of Geology, Western Washington University, Belingham, WA 98225-9080, USA. Phone: 360 650 3634; telefax: 360 650 3148; e-mail: rossjrp@henson.cc.wwu.edu)

August 18–29
INTERNATIONAL ASSOCIATION OF SEISMOLOGY AND PHYSICS OF THE EARTH'S INTERIOR (29th General Assembly), Thessaloniki, Greece. (29th IASPEI general assembly geophysical laboratory. University, GR-54006. Thessaloniki, Greece. Phone: 30/31 998 528; e-mail: iaspei@olymp.ccf.auth.gr)

August 19–20
MINERAL EQUILIBRIA AND DATA BASES (International Meeting), Helsinki, Finland. (Pentti Hölttä, Geological Survey of Finland, SF-02150Espoo, Finland. Phone: 358 0 469 32312; telefax: 358 0 462205)

August 28 – September 3
GEOMORPHOLOGY (4th International Conference of International Association of Geomorphologists), Bologna, Italy. (Planning Congressi, s r l Via Crociali 2, I-40138 Bologna, Italy)

September 1–5
GEOLOGY AND ENVIRONMENT (50th Geological Congress of Turkey), Istanbul, Turkey. (Secretary GEOENV '97, PK 464, Kizilay, 06424 Ankara, Turkey. Phone: 90 312 4343691; telefax: 90 312 4342388; e-mail: jdogan@et.cc.hun.edu.tr)

September 1–5
IEC '97: FIFTH INTERNATIONAL ECLOGITE CONFERENCE, Ascona, Switzerland. (Professor V. Trommsdorff and Dr. R. Schmid, Mineralogy IEC 97, ETH centre, 8092 Zurich, Switzerland. Phone: XX41 1 632 3791; telefax: XX41 1 6321088; e-mail: rolf@erdw.ethz.ch; information and preliminary registration up to 31 October 1996 via http://www/erdw.ethz.ch/~rolf/)

September 2–4
PALAEONTOLOGY AND STRATIGRAPHY OF SOUTH AMERICA (2nd European Meeting), in conjunction with the 18th IAS Regional Meeting on Sedimentology), Heidelberg, Germany. (Peter Bengtson, Geologisch-Palaontologisches Institut, Im Neuenheimer Feld 234, D-69120 Heidelberg, Germany. Phone: 49 6221 548293; telefax: 49 6221 548640; e-mail: Peter.Bengtson@urz.uni-heidelberg.de; WWW: http://ix.urz.uni-heidelberg.de/~dc8/geo/lst-sam.html)

September 2–4
SOUTH ATLANTIC MESOZOIC CORRELATIONS (Regional Meeting of IGCP Project 381), Heidelberg, Germany. (Peter Bengtson, Geologisch-Palaontologisches Institut, Im Neuenheimer Feld 234, D-69120 Heidelberg, Germany. Phone: 49 6221 548293; telefax: 49 6221 548640; e-mail: Peter.Bengtson@urz.uni-heidelberg.de; WWW: http://ix.urz.uni-heidelberg.de/~dc8/geo/lst-381.html)

September 1–5
GEOLOGY AND ENVIRONMENT (Int'l. Symposium), Istanbul, Turkey, by the Chamber of Geological Engineers. (I. Yilmazer, GEOENV '97, P.K. 464 Kizilay, 06424 Ankara, Turkey. Phone: 9-0-312-4343601; telefax: 9-0-312-4342388; e-mail: jdogan@et.cc.hun.edu.tr)

September 7–10
AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS (International Conference and Exhibition), Vienna, Austria. (AAPG Convention Department, Box 979, Tulsa, OK 74101, USA. Phone: 1/918 560 26 79; telefax: 1/918 560 26 84)

September 9–12
OFFSHORE EUROPE '97 (Oil and Gas Exhibition and Conference), Aberdeen, Scotland, UK. (Offshore Europe Partnership, Ocean House, 50 Kingston Road, New Malden, Surrey KT3 3LZ, UK)

September 10–15
FAULTS AND SUBSURFACE FLUID FLOW: FUNDAMENTALS AND APPLICATIONS TO HYDROGEOLOGY AND PETROLEUM

GEOLOGY (Geological Society of America Penrose Conference), Albuquerque and Taos, New Mexico. (William C. Haneberg, New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, 2808 Central Avenue SE Albuquerque, NM 87106. E-mail: haneberg@nmt.edu)

September 11–14
ALEWECA — ALPINE EVOLUTION OF THE WESTERN CARPATHIANS AND RELATED AREAS (International Conference held on the occasion of the 100th anniversary of the birth of Professor D. Andrusov), Bratislava, Slovakia. (Dr. Jósef Hok, Slovak Geological Society, Mlynská Dol, 1, SK-81704, Bratislava, Slovak Republic. Phone: +42-7-3705445; telefax: +42-7-371940; e-mail: hoc@guds.sanet.sk)

September 14–18
EXPLORATION '97 (4th Decennial International Conference), Toronto, Canada. (I. Mac Leod, Geosoft Inc., Suite 500, 204 Richmond Street W, Toronto, Ontario ON M5H 2G4, Canada)

September 15–25
SOUTHERN NEW ENGLAND OROGEN, AUSTRALIA (SCCS Field and General Meeting 1997), Armidale, Australia. (Dr. Ian Metcalf, Department of Geology and Geophysics, University of New England, Armidale, NSW 2351, Australia. Phone: 61 67 73 2860; telefax: 61 67 73 3300; e-mail: imetcalf@metz.une.edu.au)

September 16–19
PLACERS AND WEATHERED-ROCK MINERAL DEPOSITS (11th International Symposium), Moscow-Dubna, Russia. (N. Patyk Kara, Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry of RAS, Staromonetny per., 35, Moscow, 109017, Russia. Phone: 007 095 2308427; telefax: 007 095 230 2179; e-mail: pkara@igem.msk.su)

September 21–27
GROUNDWATER IN THE URBAN ENVIRONMENT (27th IAH Congress) (Professor J.D. Mather, Geology Dept., Royal Holloway and Bedford New College, Egham, Surrey TW20 0EX, UK. Telefax: 784 471780)

September 23–28
TECTONICS OF CONTINENTAL INTERIORS (Geological Society of America Penrose Conference), Brian Head Resort near Cedar City, Utah. (Michael Hamburger, Dept. of Geological Sciences, Indiana University, Bloomington, IN 47405, USA. E-mail: hamburg@ucs.indiana.edu)

September 30 – October 3
CONCEPTS AND MODELS FOR SUSTAINABLE WATER RESOURCES MANAGEMENT (FRIEND '97 Conference on Regional Hydrology), Postojna, Slovenia. (Dr. M. Brilly, FGG Hydraulics Division, Hajdrihova 28, 6100 Ljubljana, Slovenia. Phone: (386) 61 1254 333; telefax: (385) 61 219 987; e-mail: mitja.brilly@uni-lj.si)

September 30–October 5
MAIN CHANGES IN THE MARINE AND TERRESTRIAL ATLANTIC REALM DURING THE NEOGENE (2nd Regional Congress), Salamanca, Spain. (Departmento de Geologia (Palaeontologia, Facultad de Ciencias, Universidad de Salamanca, 37008 Salamanca, Spain. Phone: 34 23 294497; telefax: 34 23 394514; e-mail: Civis@gugu.usal.es/ Angel@gugu.usal.es)

October 5–10
ENVIRONMENTAL GEOCHEMISTRY (4th International Symposium), Vail, Colorado, USA. (R.C. Severson or L.P. Gough, US Geological Survey, DFC, Box 25046, MS 973, Denver Colorado 80225, USA. Telefax: (1) 303 236 3200)

October 6–10
MATHEMATICAL METHODS IN GEOLOGY (Part of the Mining Príbram Symposium), Prague, Czech Republic. (V. Nemec, Krybnícum 17, 100 00 Praha 10-Strasnice, Czech Republic. Phone: 422 7811801; telefax: 42306 23169)

October 12–16
TECHNOLOGY AND GLOBALISATION: LEADING THE PETROLEUM INDUSTRY INTO THE 21ST CENTURY (15th World Petroleum Congress), Beijing, China. (Organising Committee, c/o China National

Petroleum Corporation, P.O. Box 766, Liu Pu Kang, Beijing 100724, China)

October 20–22

IMPROVED OIL RECOVERY (9th European Symposium), The Hague, The Netherlands. (IOR '97, EAGE, P.O. BOX 298, 3700 AG Zeist, The Netherlands)

October 20–23

GEOLOGICAL SOCIETY OF AMERICA ANNUAL MEETING, Denver, Colorado, USA. (GSA Meetings Department, P.O. Box 9140, Boulder, CO 80301, USA. Phone: 800 472 1988)

October 26–29

PETROLEUM GEOLOGY OF NORTH-WEST EUROPE (5th Conference and Exhibition), London, UK. (CASIL, 4 Cavendish Square, London, W1M 0BX, UK. Phone: 44/171 499 0900; telefax: 44/171 629 3233)

November 3–5

TECTONICS OF EAST ASIA (International Conference & Sino-American Symposium), Chungli, Taiwan. (Dr. Ching-Hua Lo, Department of Geology, National Taiwan University, 245 Choushan Road, Taipei 106, Taiwan, ROC. Telefax: 886-2-3636095; e-mail: lo@sun03.gl.ntu.edu.tw; www: http://sun03.gl.ntu.edu.tw/tea.html or Dr. Jean Crespi, Department of Geology and Geophysics, University of Connecticut, Storrs, CT 06269-2045, U.S.A. Phone: 860-486-0601; telefax: 860-486-1838; e-mail: crespi@geol.uconn.edu)

November 12–14

THE 19TH NEW ZEALAND GEOTHERMAL WORKSHOP (Workshop), New Zealand. (c/o Geothermal Institute, The University of Auckland, Private Bag 92019, Auckland, New Zealand. Telefax: 64-9-373 7436; e-mail: geo.wshop@auckland.ac.nz)

November 17–19

APPLIED GEOLOGIC REMOTE SENSING (12th International Conference and Workshop), Denver, Colorado, USA. (Robert Rogers, ERIM, Box 134001, Ann Arbor, MI 48113 4001 USA. Phone: (1) 313 994 1200; telefax: (1) 313 994 5123; e-mail: raeder@erim.org)

November 17–21

DEEP FOUNDATIONS, EXCAVATIONS, GROUND IMPROVEMENT & TUNNELLING, (Symposium), Bangkok, Thailand. (Prof. A.S. Balasubramaniam, The Hon. Secretary General Southeast Asian Geotechnical Society, c/o Asian Institute of Technology, P.O. Box 4, Klong Luang, Pathumthani 12120, THAILAND. Phone: (66-2) 524 5519, (66-2) 524 5537; telefax: (66-2) 516 2126, (66-2) 524 5523)

November 30 – December 3

PERMIAN OF EASTERN TETHYS: BIOSTRATIGRAPHY, PALAEOGEOGRAPHY & RESOURCES (International Conference), Melbourne, Australia. (The Secretariat, Permian of Eastern Tethys Conference, School of Aquatic Science & Natural Resources Management, Deakin University, Rusden Campus, 662 Blackburn Road, Clayton, Victoria 3168, Australia. Phone: 61-3-9244 7429; telefax: 62-3-9244 7480; e-mail: asnrm@deakin.edu.au)

1998

CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM (100th annual general meeting), Quebec, Canada. (John Gaydos, Meetings Manager, Canadian Institute of Mining and Metallurgy, 1 Place Alexis Nihon, 1210-3400 de Maisonneuve Boulevard West, Montreal, Quebec H3Z 3B8, Canada. Phone: (514) 939-2710; telefax: (514) 939-2714)

10TH IAGOD SYMPOSIUM, Australia. (Professor I.R. Plimer University of Melbourne, Parkville, VIC 3052, Australia. Phone: 613 3446520; telefax: 613 3447761)

January 28–30

EXPLORATION METHODS '98: PATHWAYS TO DISCOVERY (International Meeting following annual Cordilleran Roundup), Vancouver, Canada. (BC and Yukon Chamber of Mines, Attn. Technical Chair, 840 West Hastings St., Vancouver, British Colombia, Canada V6C 1C8. Telefax: 604 681 2363)

March 23–24

ASIA PACIFIC CONFERENCE ON INTEGRATED MODELLING FOR ASSET MANAGEMENT (Conference), Kuala Lumpur, Malaysia. (SPE Kuala Lumpur Office, Lot F1/01, First Floor, Citypoint, Kompleks Dayabumi, Jalan Sultan Hishamuddin, 50050 Kuala Lumpur, Malaysia. Phone: 6-03-294-7211;

telefax: 6-03-294-5158)

April 13–17

15TH INTERNATIONAL SEDIMENTOLOGICAL CONGRESS, Alicante, Spain. (15th International Sedimentological Congress, Departamento de Cienias de la Tierra y Medio Ambiente, Facultad de Ciencias, Campus de San Vicente de Raspeig, Universidad de Alicante, Apardo 99, 03080 Alicante, Spain. Phone: 34 65903552; telefax: 34 65903552; e-mail: ctierra@vm.cpd.ua.es)

April 13–17

KIMBERLITES (5th International Conference), Cape Town, South Africa. (J.J. Gurney, 71KC, Department of Geological Sciences, University of Cape Town, Private Bag, Rondebosch 7700, South Africa. Phone: 27 21 531 3162; telefax: 27 21 650 3783; e-mail: 71KC@GEOLOGY.UCT.AC.ZA; URL: http://www.uct.ac.za/depts/geolsci/71KC/)

April 19–23

COMPUTER APPLICATIONS IN THE MINERALS INDUSTRY — APCOM '98 (27th International Symposium), London, UK. (Conference Office, Institution of Ming and Metallurgy, 44 Portland Place, London W1N 4BR, UK. Phone: +44 (0)171 580 3802; telefax: +44 (0)171 436 5388; e-mail: 106115.233@compuserve.com)

April 20–22

GEO '98 (Middle East Geosciences Exhibition and Conference), Bahrain. (Stephen Key, Arabian Exhibition Management WLL, P.O. Box 20200, Manama, Bahrain. Phone: 973 550033; telefax: 973 553288)

April 20–23

HYDROLOGY, WATER RESOURCES AND ECOLOGY IN HEADWATERS (International Interdisciplinary Conference — Head-Water '98), Merano, Italy. (HeadWater '98, c/o European Academy, Weggensteinstrasse 12/A, 1-39100 Bozen/Bolzano, Italy. Phone: 39 471 30 61 11; telefax; 39 471 30 60 99; e-mail: HeadWater98@ms.sinfo.interbusiness.it)

June 8–12

EUROPEAN ASSOCIATION OF GEOSCIENTISTS AND ENGINEERS (EAGE) (60th Conference), Leipsig, Germany. (EAGE, E.H. Bornkamp, P.O. Box 298, NI 3700, AG Zeist, The Netherlands. Phone: 31/3069 62 655; telefax: 31/3069 62 640)29)

June 23–25

THE ROLE OF A NATIONAL GEOLOGICAL SURVEY IN SUSTAINABLE DEVELOPMENT (International Conference), Gaborone, Botswana. (The Secretariat (Attention: Mr. B.K. Paya), 50th Anniversary Conference, Department of Geological Survey, Private Bag 14, Lobatse, Botswana. Phone: (267) 331721; telefax: (267) 332013; e-mail: 100076.1001@compuserve.com)

June 28 – July 5

GONDWANA 10, Cape Town, South Africa. (Organising Committee Gondwana 10, Department of Geological Sciences, University of Cape Town, Rondebosch, South Africa. Phone: 27 21650 3171; telefax: 27 21650 3167)

June 29 – July 2

15TH CARIBBEAN GEOLOGICAL CONFERENCE, Kingston, Jamaica. (Dr. Trevor Jackson, c/o Department of Geography and Geology, University of the West Indies, Kingston 7, Jamaica. Telefax; 809 927 1640)

June 29 – July 18

8TH INTERNATIONAL PLATINUM SYMPOSIUM (IAGOD/CODMUR), Johannesburg, South Africa. (Dr. C.A. Lee, P.O. Box 68108, Bryanston, South Africa. Phone: 1127 373 2580; telefax: 1127 836 0371; e-mail: clee@amplats.co.za)

August

10TH IAGOD SYMPOSIUM, Broken Hill, Australia. (Professor I.R. Plimer, University of Melbourne, Parkville, VIC 3052, Australia. Phone: 613 3446520; telefax; 613 3447761)

August 9-15

INTERNATIONAL MINERALOGICAL ASSOCIATION: IMA '98 (17th General Meeting), Toronto, Canada. (Professor A.J. Naldrett, Department of Geology, University of Toronto, Canada M5S 3BI. Phone: (461) 978 3030; telefax: (416) 978 3938; e-mail: ima98@quartz.geology.utoronto.ca)

August 17-19

GEOSEA '98 (Ninth Regional Congress on Geology, Mineral and Energy Resources of Southeast Asia), Kuala Lumpur, Malaysia. (The Organising Secretary, GEOSEA '98, Geological

Society of Malaysia, c/o Department of Geology, University of Malaya, 50603 Kuala Lumpur, Malaysia. Phone: +(603) 757 7036; telefax: +(603) 759 3900; e-mail: geologi@po.jaring.my)

August 17–20

THE JURASSIC SYSTEM (5th International Symposium), Vancouver, Canada. (P.L. Smith, Earth and Ocean Science, University of British Columbia, 6339 Stores Rd., Vancouver, BC, V6T 1Z4 Canada. Phone: (604) 822-6456; telefax: (604) 822 6088; e-mail: psmith@cos.ubc.ca; WWW: http://www.eos.ubc.ca/jurassic/announce.html)

September 8–10

COASTAL ENVIRONMENT 98 — ENVIRONMENTAL PROBLEMS IN COASTAL REGIONS (Conference), Cancun, Mexico. (Liz Kerr, Conference Secretariat, COASTAL ENVIRONMENT 98, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK. Phone: 44 (0) 1703 293223; telefax: 44 (0) 1703 292853; e-mail: liz@wessex.ac.uk; http://www.wesses.ac.uk)

September 14–17

MODERN EXPLORATION AND IMPROVED OIL AND GAS RECOVERY METHODS (2nd International Conference), Kraków, Poland. (DEXTER Congress and Symposium Bureau, Wroclawska 37A, 30-011 Kraków, Poland. Phone: 48 12 340 808; telefax: 48 12 336313; e-mail: kongresy@dexter.kraków.pl)

October 26–29

GEOLOGICAL SOCIETY OF AMERICA ANNUAL MEETING, Toronto, Ontario, Canada. (GSA Meetings Department, P.O. Box 9140, Boulder CO, 80301 USA. Phone: 800 472 1988)

October/November

PHYSICAL, CHEMICAL AND BIOLOGICAL ASPECTS OF AQUIFER-STREAM SEDIMENT INTERRELATIONS (28th IAH Congress) (Dr. J. Rosenschein, USGS MS 414, National Center, Reston Va 22092, USA; Telefax: 703 648 5722)

November 16–20

THIRTEEN SOUTHEAST ASIAN GEOTECHNICAL CONFERENCE (Conference), Taipei, Republic of China. (Dr. John Chien-Chung Li, Secretary General/ SEAGC 13, c/o Public Construction Commission, Executive Yuan, Fl. 9, No. 4, Chung Hsiao West Road, Sec. 1, Taipei, Taiwan, Republic of China. Phone: 886-2-388-4962; telefax: 886-2-388-4959; e-mail: seagc13@mail.pcc.gov.tw)

1999

August 4–12

AFRICA, CRADLE OF HUMANKIND DURING THE QUATERNARY (XV INQUA Congress), Durban, South Africa. (Professor T.C. Partridge, Climatology Research Center, University of Witwatersrand, 13 Cluny Rd, Forest Town, Johannesburg 2193, South Africa. Phone: +27 11 646 3324; telefax: +27 11 486 1689; e-mail: 141tcp@cosmos.wits.ac.za)

August 14–25

CARBONIFEROUS-PERMIAN (XIV International Congress), Calgary, Alberta, Canada. (Dr. Charles Henderson, Associate Professor, Department of Geology and Geophysics, The University of Calgary, N.W. Calgary, Alberta, Canada T2N 1N4. Phone: 403 220 6170; telefax: 403 285 0074; e-mail: henderson@geo.ucalgary.ca)

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HUTCHISON, C.S., 1989. *Geological Evolution of South-east Asia*. Clarendon Press, Oxford. 368p.

SUNTHARALINGAM, T., 1968. Upper Paleozoic stratigraphy of the area west of Kampar, Perak. *Geol. Soc. Malaysia Bull. 1*, 1-15.

TAYLOR, B., AND HAYES, D.E., 1980. The tectonic evolution of the South China Sea basin. *In:* D.E. Hayes (Ed.), The Tectonic and Geologic Evolution of Southeast Asian Sea and Islands, Part 2. *Am. Geophy. Union Monograph 23*, 89-104.

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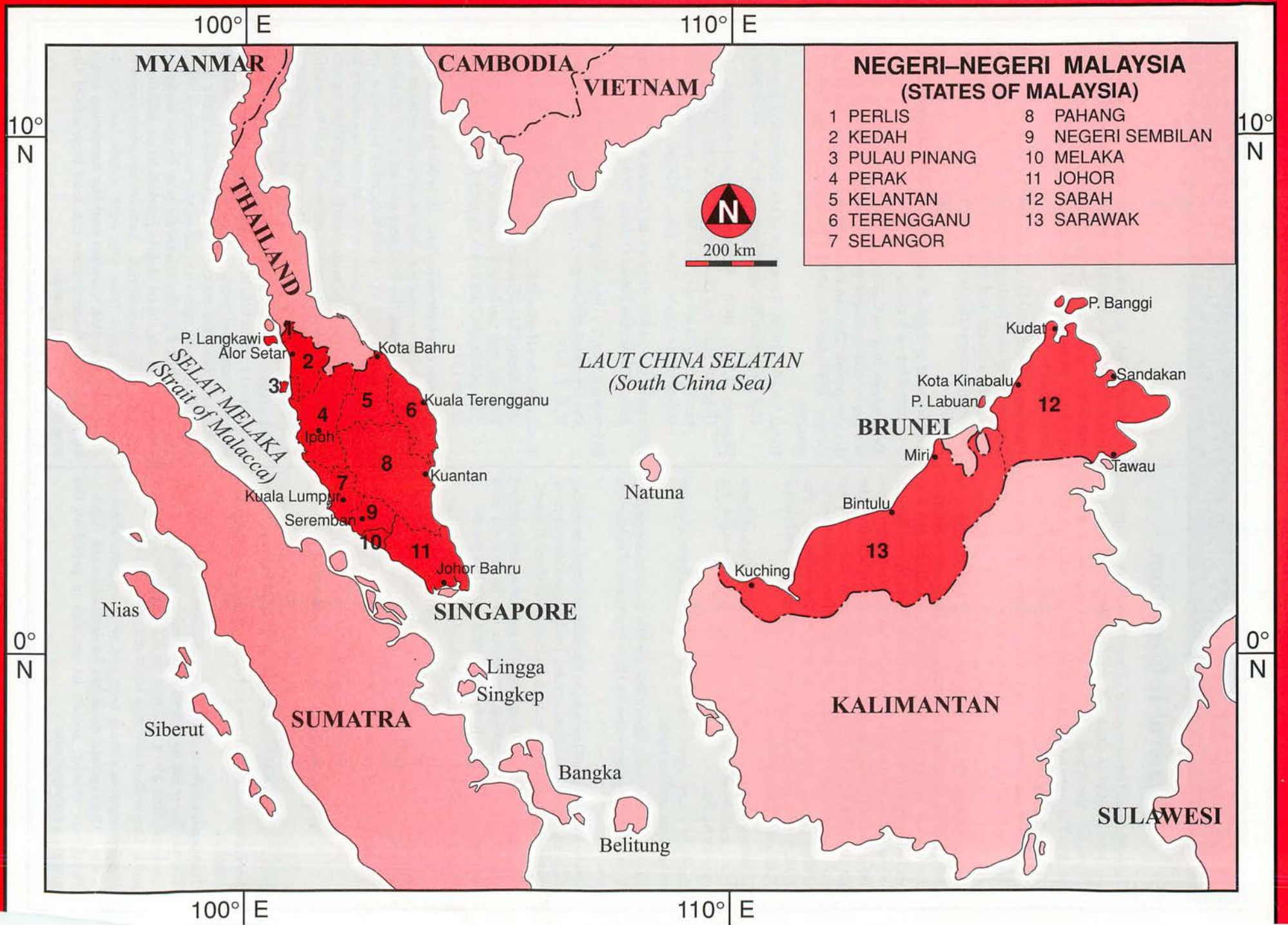
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