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PERSATUAN GEOLOGI MALAYSIA
(GEOLOGICAL SOCIETY OF MALAYSIA)

Majlis (Council) 1990/91

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CATATAN GEOLOGI
(GEOLOGICAL NOTES)

SLOPE MOVEMENTS IN A GRANITIC SLOPE, PENANG.

Lim Tow Ho,
4, Solok Scott, Penang.

Introduction

Slope movements are earth movements which are due to natural phenomena or man-made causes. There are a variety of slope movements ranging from small simple ones to large complex ones. For this study the classification of Varnes (1978) is used. The speed of slope movements ranges from slow soil creep to sudden landslides. In a tropical terrain, tropical weathering is a major process in altering rock structure and composition. At the surface, decomposed rock and residual soils are common occurrences. The classification of the earth materials here is based on the International Association of Engineering Geology Report (IAEG, 1981). A road cut along the road that leads to the summit of Penang Hill was examined. The location of the examined slope is approximately 600 metres from the base of the hill.

Nature of the slope

The slope is an exposed road cut composed of weathered materials from granite. The weathered materials are residual soils or grade VI. The residual soils are sandy clay with minor amounts of gravel and silt. The colour of the slope is predominantly yellowish brown with small areas of greyish brown. Angular quartz grains can be seen embedded in the residuals soils. Organic material occurs too, largely because the top of the slope is filled with vegetation. Roots are also a common occurrence especially near the top. At the bottom of the slope are soil debris which is silty sand. Coarse sand is common on the surface of the debris. The height of the slope is 4 metres and the width examined is 3.5 metres. The inclination of the slope is near vertical or approximately 90 degrees. A sketch of the examined slope is shown in Fig. 1.

Slope movements

Slope movements in the granitic slope are mainly slides and flows. Two major slides can be seen occurring near the middle of the slope. Both slides are semi-circular at the top and plain below it. The result is an arch-like structure for each slide. The near vertical and exposed slope means stability is low. Failure in the slides are due to gravity overcoming the shear resistance of the clay. The left slide surface has organic material mainly tiny roots which probably weaken the cohesion of the clay. Failure was probably sudden and the soil debris at the bottom of the slope is the result.

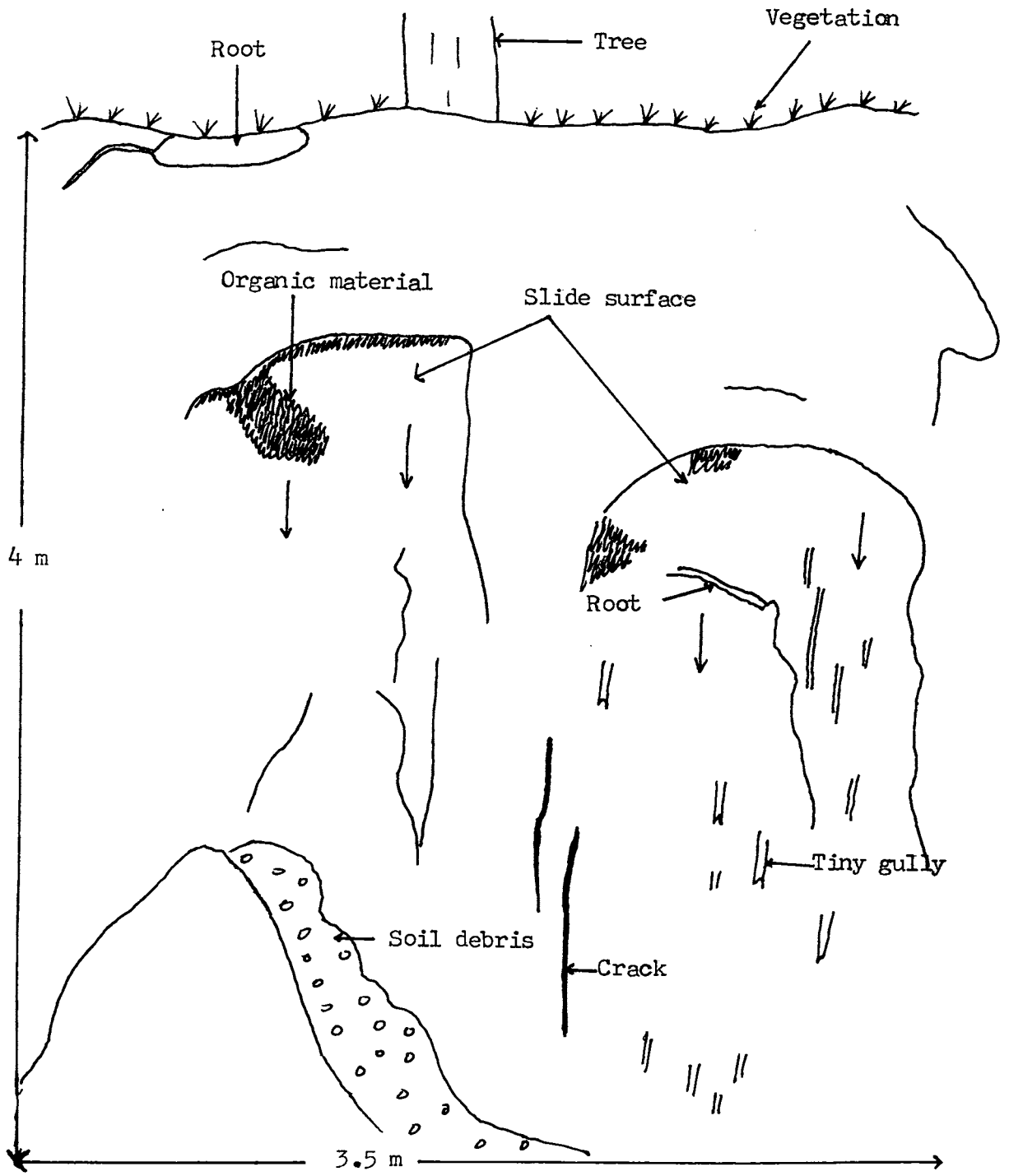

Fig. 1. Exposed granitic slope at Penang Hill Road, a sketch. (Downward arrows indicate direction of slope movement.)

Soil flows have resulted in many tiny gullies especially on the surface of the right slide. The width of the tiny gully is generally 2 cm, depth of 1 cm and height ranges from 10 to 40 cm. The gullies are near vertical in arrangement. The soil flows are due to erosion transport whereby rain water is the medium of transport. Obviously the soil flows are surface phenomena and had occurred only after the slide and during rainfall. The turbulent downward flow of rainwater on the surface of the slope had washed away some residual soils resulting in the formation of the tiny gullies. Coarse sand on the debris is also the result of erosion transport whereby clay and silt had been washed away. Water erosion is an important process in slope movements on exposed granitic slopes in our tropical terrain. Considering the high (2,500 mm) and frequent rainfall, water erosion occurs throughout the year.

Some near vertical cracks are present towards the lower middle of the examined slope. The thickness of the cracks are approximately 0.3 cm. The cracks are due to physical weathering where flowing water had also played a role. In this case the downward movement of groundwater inside the residual soils had resulted in the cracks.

Slope movements on exposed granitic slopes are mainly soil slides and soil flows. Understanding of the nature and causes of slope movements will help towards remedial and preventive measures in preserving earth slopes.

References

International Association of Engineering Geology (IAEG), 1981. Rock and soil description for engineering geological mapping. Report by the IAEG Commission on engineering geological mapping. *Bull. Int. Ass. Engng. Geol., 24: 235-274.*

Varnes, D.J., 1978. Slope movement types and processes. *Landslides Analysis and Control.* Nat. Acad. of Sci., Spec. Report. 176, 11-35. Washington D.C.

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KANDUNGAN (CONTENTS)

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PRELIMINARY SURVEY OF THE GEOTHERMAL POTENTIAL OF THE SUNGAI JEPUN AREA, SEMPORNA PENINSULA.

Sahat Sadikun, Sanudin Hj. Tahir, Jumat Salimon and Dale A. Brunotte, Faculty Science and Natural Resources, Universiti Kebangsaan Malaysia, Sabah Campus.

Abstract

The Sungai Jepun area, situated in the northeastern valley of Mount Pock, Semporna Peninsula, has been chosen for the preliminary survey of the geothermal potential of Sabah. Two hot springs in the area, with temperatures between 65° to 66°C, have been recorded at the surface, seeping out from Middle Miocene volcanic rocks. So far, we have not identified any geothermal reservoir potential at depth since no exploratory drilling or detailed geophysical exploration has been done. However, based on the total heat loss of 15.05 MW, calculated by the geothermometer temperature method, the Sungai Jepun area appears to have potential prospects for future studies for geothermal energy development. A shallow electrical survey has been carried out with limited conclusions made and further surveys should be carried out to delineate the heat source of the area.

Introduction

Reviews of the geology of Sabah and the discovery of several hot springs suggest that the Semporna Peninsula is one of the potential sites in Sabah for geothermal investigation. The Sungai Jepun area, northeast of Gunung Pock, had been chosen as a site for a preliminary survey to assess the existence of geothermal resources in the area. The survey includes geological traverses, a geophysical survey and chemical and geochemical analyses of the hot water.

The hot water is supplied by two hot springs located on the river bank and mixed with cold water of Sungai Jepun. Presently the hot water is piped up into the estate manager's bungalow of the area and the site is a good picnic ground for the plantation's workers.

Geology

The surveyed area, the northern part of Gunung Pock (Figure 1), is made up entirely of Tertiary volcanics. The distribution in the mapped area when viewed in relation to the more limited field geology of the Semporna Peninsula, appears to be eccentrically situated. However, when their regional geological relationships are reconsidered, these localised occurrences gain in significance. They are important links

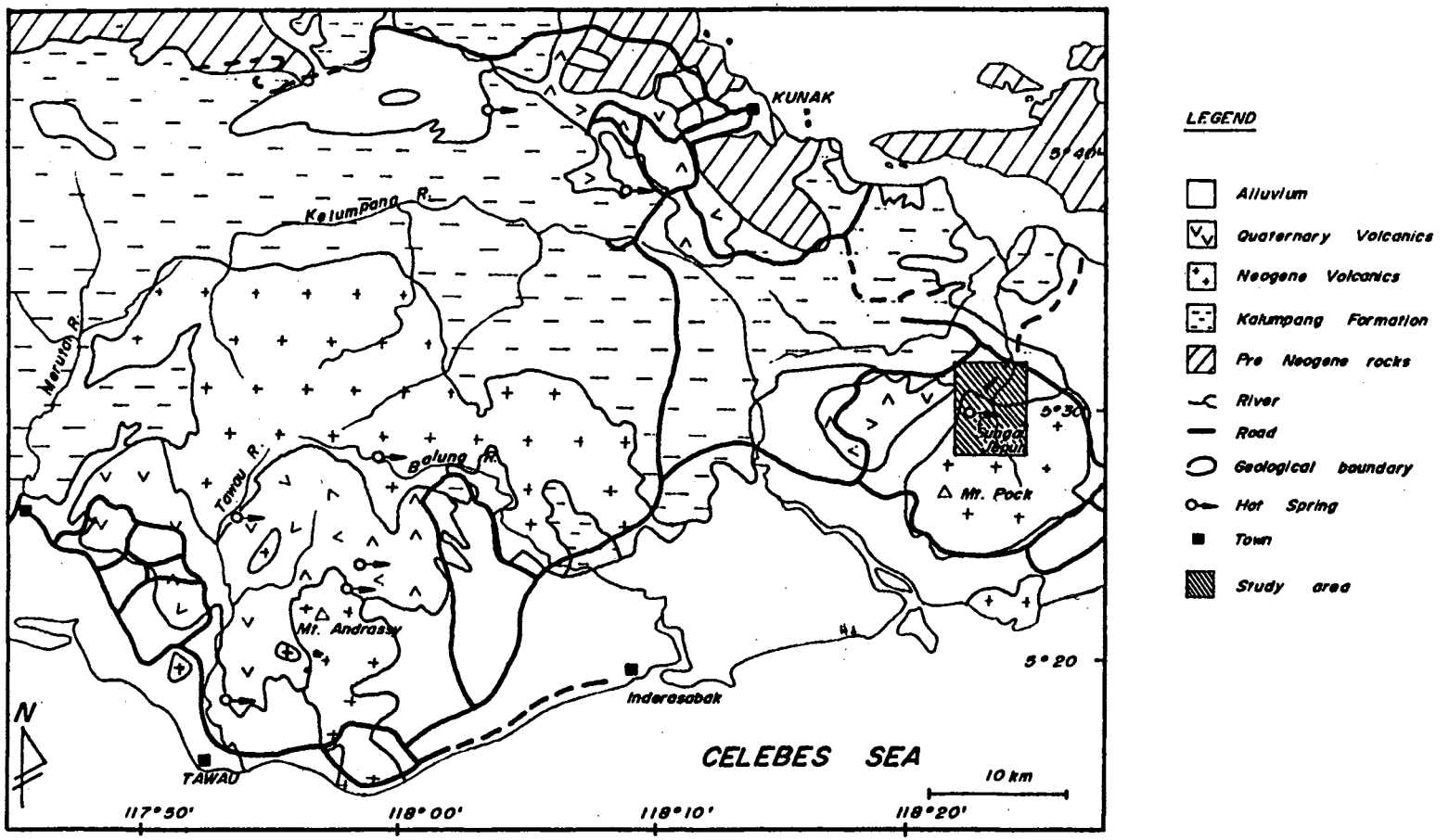

Figure 1. Geological map of the Semporna Peninsula, Sabah.

in the long chain of Tertiary volcanic rocks which extend from the southern part of the Philippines across the Sulu Archipelago to the southeastern part of Sabah, the Semporna Peninsula.

The stratigraphy of the Semporna Peninsula consists of Neogene sequences; the oldest rock association is made up of the chaotic formation, followed by the Kalumpang Formation of Early to Middle Miocene age and finally Plio-Pleistocene volcanics. Gunung Pock and its neighbouring areas can be differentiated into two major rock sequences. The oldest formation is the Kalumpang Formation, which is made up of mainly argillaceous sediment and tuff derived from volcanic eruptions during the Middle Miocene. The main volcanic rocks are andesite, dacite and basalt, together with minor intrusions and extrusions of dacitic and andesitic rocks in the surrounding areas. The sequence of eruption of various rock types is difficult to determine owing to the absence of stratification. However, K/Ar dating of andesitic rocks taken from one of the outcrops at km 38 from Semporna gives an age of 13.5 million years. The andesite is part of the pyroclastic rocks of the Kalumpang Formation and is considered to be of Middle Miocene age.

In the Sungai Jepun areas, two types of andesite have been identified, hornblende andesite and hypersthene andesite. Vesicules found in some thin sections are commonly filled by low temperature minerals such as calcite, chalcedony, chlorite and zeolite, precipitated by circlating ground water.

An igneous intrusion with a composition ranging from dioritic to granitic may have been emplaced in the neighbouring areas during the Late Pliocene to Early Quaternary. Secondary mineralization occurs in the andesites and the important secondary processes are the alteration of the minerals of the country rocks by saussuritization, chloritization, calcitization and silicification. The silicification tends to follow the set of fractures with strikes measuring 340-350^{o}E and dips 65^{o}-80^{o}. These fractures seem to have formed from the same maximum stress that caused the major fault (N36^{o}E) which displaced the Kalumpang Formation and most of the volcanic rocks. There seems to be a relationship between silicification and mineralization in the Semporna Peninsula area and it is suggested that future exploration for geothermal energy prospects as well as economic minerals should be concentrated in the hot spots and the neighbouring areas.

Methods

Geophysical survey:

Several methods of electrical surveys have been successfully carried out in prospecting for geothermal resources (e.g. Singh *et al.*, 1983). Because the resistivity of water saturated rocks decreases with increasing temperature, porosity, salinity and with the presence of clay minerals, ground resistivity is a good target for investigating geothermal areas.

In this study, a standard direct current four-electrode method with Schlumberger configuration was used. The spacings between the

current electrodes were incrementally expanded about a fixed centre to allow the current to penetrate deeper, thus investigating deeper layers of rocks. Five vertical electrical soundings were carried out in the surrounding areas of the hot springs. The objective of this survey was to deduce the variation of resistivity of rocks with depths which might be due to the presence of a hot water system. Due to the ruggedness of the area and the limitations of the instrument used, the surveys were only carried out with a maximum current electrode spacing of 400 meters.

The locations of the electrical soundings in relation to the hot springs are shown in Figure 2. The interpretation of the sounding curves was done using Ebert auxiliary point method (Koefoed, 1979). The sounding curves are drawn in Figure 3 in which stations S-2, S-3, S-4 and S-5 give three layer curves whilst S-1 gives a four layer curve.

Chemical analysis:

All the *in-situ* parameters were measured in the field using the Hach Kit Portable Meter, YS-I51B and Corning 115 pH meter. The content of the chloride ion was analysed by standard argentometric method, phosphate ion by standard ascorbic acid reduction method, sulphate ion by standard formation of barium sulphate method and nitrate ion by standard colour formation of the chromothropic acid as suggested by Greenberg *et al.*, 1985. Most of the cations were analysed by using the Atomic Absorption Spectrometer, Perkin-Elmer model 2380.

Geochemical Survey:

Water samples were collected from upstream and downstream of the Sungai Jepun Hot Springs in September 1989 by members of the Malaysian Geothermal Work Group assisted by James Simandjuntak from the Department of Mining and Energy, PLN, Indonesia for the purpose of assessing the heat lost by the hot spring. The assessment of the natural heat flow can be determined from the geochemical survey. The subsurface temperatures of the hot springs was calculated based on the silica, Na/K and N-K-Ca geothermometers of Truesdell and Fournier (Gupta, 1980).

The minimum total heat loss from the hot spring water was calculated from the Cl concentrations in the upstream and downstream waters, the flow rates of the river into which the hot spring drained and the surface temperature of the hot spring and air temperature, using the formulas below:

$$\text{Mass Flow Rate (MFR)} = \frac{\text{Cl. conc. downstream-upstream}}{\text{Cl. conc. of hot spring}} \times \text{Flow rate of river (l/sec.)}$$

$$\text{Total Heat Loss} = (\text{temp. hot spring-temp. air}) \times \text{MFR} \times \text{Spc. heat water}$$

Results

Results of the geophysical survey of vertical electrical soundings (Figure 2) show the presence of hot water channels at shallow depths, though the heat source is at greater depth. The thickness of the hot water layer is about 4-20 metres and increases towards the north.

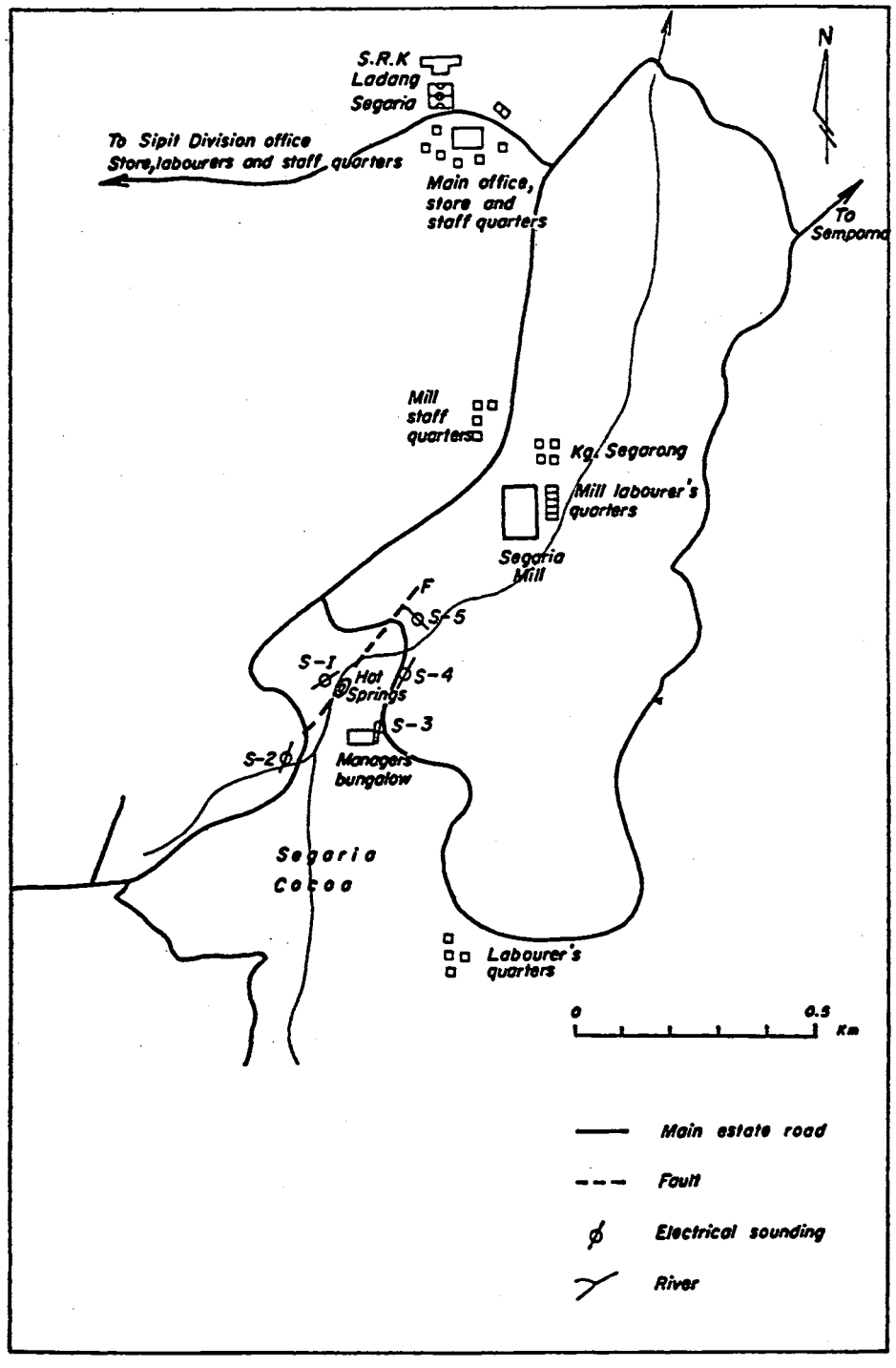

Figure 2. Location of vertical electrical soundings of Sungai Jepun Hot Springs in Segaria Estate, Semporna.

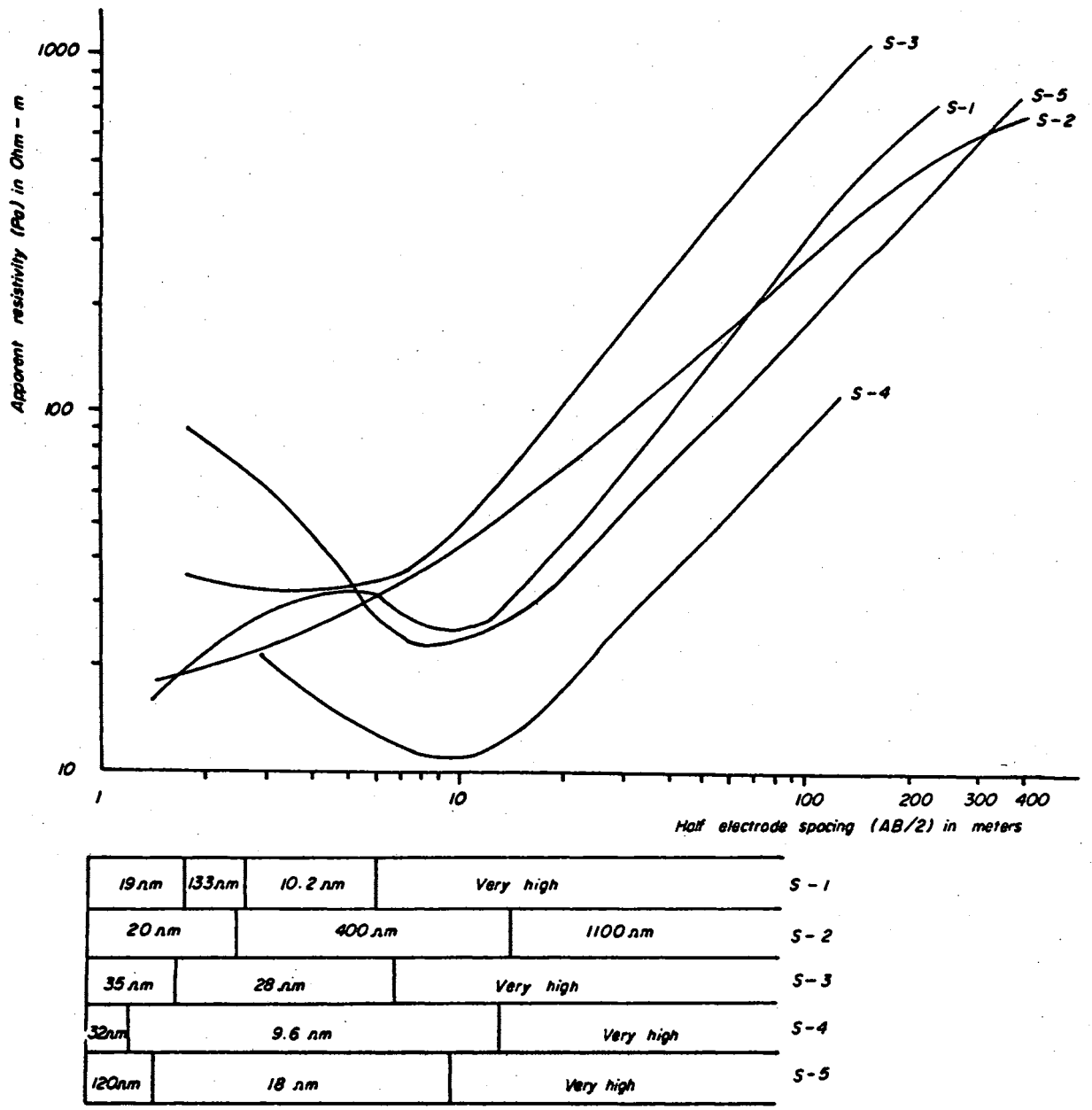

Figure 3. Schlumberger resistivity sounding curves along with their interpretation.

Faults found in the study area provide channels for the hot water passages. The hot water table is about 4.5-12 meters deep (Simanjuntak *et al.*, 1989). The extent of these channels is limited because the sounding station S-2, located about 200 meters south of the hot springs did not detect any hot water zone (low resistivity).

Using the silica geothermometer, the subsurface temperature of the Sungai Jepun hot spring is around 107°C, while the Na/K geothermometer and Na-K-Ca geothermometer gives 99°C and 127°C respectively.

From the data obtained,

Cl conc.	=	6.4 ppm upstream
	=	12 ppm downstream
	=	130 ppm in the hot spring
hot water temperature	=	64.5°C
average air temperature	=	28°C
river flow rate	=	2.0 m^3/sec
total heat loss	=	15.05 x 103 KJ/sec
	=	15.05 MW

The results of the chemical analysis of the hot spring water are listed in Table 1.

Recent geochemical analyses carried out in the areas by Simanjuntak *et al.*, 1989 showed that temperatures of about 127.2°C at depth coule be obtained using the Na-K-Ca geothermometer. This temperature is high enough for binary cycle system (low enthalphy) electricity generation (Radja, 1986) or as a source of heat for agroindustrial use such as in the oil palm and cocoa processing.

Discussions

The interpreted results of all the soundings except S-2 indicates that between the top layer of resistivity 19-120 ohm-m and the resistive bottom layer (very high resistivity) there exists a low resistivity zone of 9.6-28 ohm-m at depths about 1.5-2.7 meters. The resistive bottom layer, with minimum resistivity of 1100 ohm-m (found at S-2) is located at depths of about 6.5-21.5 meters. It is interpreted as dry andesite, characterised by very high resistive layer, and is regarded as impervious rock with poor water storage capacity.

The top layer is made up of weathered tuff (clayey characteristics), with resistivity of 19-120 ohm-m. The weathered tuff is saturated with meteoric water and found at all soundings which give low resistivity except at S-5, where it consists of dry clay with resistivity of 120 ohm-m.

The second layer is made up of low resistivity rocks interpreted as weathered tuff highly saturated with water (hot water). In S-2, which is away from the hot springs no low resistivity zone was detected at shallow depth. The second layer is made up of quite resistive rocks (400 ohm-m) interpreted as andesite saturated with water.

Table 1. The average chemical parameters of the hot water from the Sungai Jepun Hot Spring.

Parameters	Content
pH	7.7
Temperature (^{o}C)	66
Suspended solids (mg/l)	11.0
Dissolved Oxygen (mg/l)	2.7
Salinity (ppt)	2.1
Conductivity (µmHos)	3205
Redox potential (mV)	-27
Cl^- (mg/l)	138
NO_3^- (mg/l)	4.5
HCO_3^- (mg/l)	25.79
SO_4^{3-} (mg/l)	1127
PO_4^{3-} (mg/l)	0.25
H_2S (mg/l)	1.65
NH_3 (mg/l)	3.60
K (mg/l)	12.70
Ca (mg/l)	256.90
Na (mg/l)	63.58
Mg (mg/l)	0.11
Fe (mg/l)	0.117
Mn (mg/l)	0.03
Co (mg/l)	0.28
Cd (mg/l)	0.01
Pb (mg/l)	0.05
Cr (mg/l)	0.01
Cu (mg/l)	0.05

From the chemical analyses, the pH of the water is in a neutral range or slightly alkaline sodium chloride water, as given in the table and remained unchanged throughout the day time. This phenomenon could be the result of the chemical processes involved in the neutralization reactions. The acidity of the water caused by oxidation of hydrogen sulphide gases is neutralized by ammonia, which is quite high in the hot spring water. The chloride, bicarbonate and sulphate contents remain high in the rock-water reaction. The metal content is normal for a neutral water system, due to the low metal dissolution factor.

The high concentration of alkaline metals (K, Ca and Na) could be due to the high alkaline condition of the country rocks. The nutrient contents are in the normal range of natural water systems but the water is slightly high in sulphate content. The oxidation reaction of sulphide gases and sulphide minerals, such as pyrite and chalcopyrite, the decaying process of organic matter and the microbial activities can contribute large amount of sulphate in the hot spring water. These results were later confirmed during the resampling of the hot water by Simanjuntak *et al.* (1989). Based on the total heat loss, 15.05 MW, calculated subsurface geothermometer temperatures and the high chlorine concentration, the area appears to have a possible prospect for geothermal energy development as a small scale, low enthalpy facility.

Conclusions

From the brief survey it is concluded that the study area (the Semporna Peninsula in general) has a good geothermal potential. This energy can be tapped not only for electricity generation but also for agroindustrial use. The authors are of the opinion that further surveys should be carried out. Electrical surveys using larger spacings (deeper penetration) should be carried out to delineate the heat source because the present survey could only detect the passages of the hot water. Detailed and regional gravity surveys and further geochemical investigation as well as exploratory wells should be included in the next programme. Systematic remapping of the entire Semporna Peninsula at a smaller scale (1:10,000) should also be carried out to locate the features and suitable sites for exploratory drilling and further geophysical measurements.

Acknowledgement

The writers wish to thank the Sabah Electricity Board (SEB) Kota Kinabalu for funding the survey, the SEB Tawau Branch for providing field logistics, and the management of the Segaria Estates where the surveys were conducted.

References

Greenberg, A.E., Trussell, R.R. and Clesceri, L.S., 1985. Standard Methods for the examination of water. 16th Edi. American Public Health Association, Washington, D.C.

Gupta, H., 1980. Geothermal Resources; and Energy Alternative. Elsevier Scientific Publ. Co.

Koefoed, O., 1979. *Geosounding Principle 1. Resistivity Sounding Measurements*. Elsevier Scientific Publishing Co., Amsterdam. 103-106 pp.

Radja, V.T., 1986. The Role of ASEAN Geothermal Generation in the World Geothermal Scenario. Sixty Conference on Electrical Power Supply Industry (CEPSI) Nov. 3-7 1986, Jakarta.

Simanjuntak, J., Chan, F.O., Lim, P.S. and Brunotte, D.A., 1989. Geochemical studies for geothermal activity on Andrassy and Sungai Jepun areas. Report for the Malaysian Geothermal Working Group (Unpublished).

Singh, S.B., Drolia, R.K., Sharma, S.R. and Gupta, M.L., 1983. Application of resistivity surveying to geothermal exploration in Puga Valley, India. *Geoexploration 21, 1-11.*

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PERTEMUAN PERSATUAN
(MEETINGS OF THE SOCIETY)

PERSIDANGAN TAHUNAN GEOLOGI '90 (ANNUAL GEOLOGICAL CONFERENCE '90) - LAPORAN (REPORT)

The Society's Annual Geological Conference '90 was held at the Royal Casuarina Hotel, Ipoh, on the 7 & 8th May 1990.

This is only the fifth in the series of such Conferences organized by the Society. However, this year marks a new phase in the stature of the Conference. For the first time a Minister graced the dinner at the Conference and Pre- and Post-Conference fieldtrips were held.

37 papers were presented together with 2 keynote papers and they certainly benefited all the participants present in one way or another.

As usual the Conference served as a forum for members to meet, exchange ideas and notes including advice and assistance in their work, research or similar undertakings.

The Society is indeed grateful to Malaysia Mining Corporation (MMC) for hosting the dinner and other organizations (like Osborne & Chappel Int.) for their financial support.

G.H. Teh

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PERSIDANGAN TAHUNAN GEOLOGI '90
Annual Geological Conference '90

Royal Casuarina Hotel
Ipoh
7th & 8th May 1990

WELCOMING ADDRESS BY PRESIDENT, GEOLOGICAL SOCIETY OF MALAYSIA AT THE 5TH ANNUAL GEOLOGICAL CONFERENCE DINNER - 7 MAY 1990 AT THE ROYAL CASUARINA HOTEL, IPOH.

Yg. Berhormat Dato' Seri Dr. Lim Keng Yaik,
Menteri Perusahaan Utama, Malaysia,
Dr. Teh Guan Hoe,
Pengerusi, Jawatankuasa Pengelola, Persidangan Tahunan Geologi Yang Ke-5,
En. Nor Hisham Hazizi,
Wakil dari Malaysia Mining Corporation,
En. Yin Ee Heng,
Ketua Pengarah, Jabatan Penyiasatan Kajibumi,
Dato-Dato, Datin-Datin,
Para Jemputan Khas,
Tuan Tuan dan Puan-Puan.

On behalf of the Geological Society of Malaysia, I take great pleasure in welcoming YB Dato' Seri Dr. Lim Keng Yaik, Minister of Primary Industries and all our distinguished guests and participants to this dinner tonight, held in conjunction with the Society's 5th Annual Geological Conference.

We are indeed very honoured to have YB Dato' Seri Dr. Lim Keng Yaik present here tonight to grace this occasion, having not only taken time off YB's onerous duties as Minister of Primary Industries but also his many other tasks, especially with all the excitement of a possible general election this year.

YB Menteri's presence is especially significant for us in the geological community as this is the first time a Minister has been invited to address the members at the Society's Annual Geological gathering. This year's conference is the 5th Annual Conference to be organized by the Society and is one of the 2 major events organized every year by the Geological Society, the other being the Annual Petroleum Geology Conference which is now in its 14th year of running.

This Annual Geological Conference has always been very well attended by a good cross-section of geologists from the Geological Survey Department, the local universities and the private sector mining, oil and service companies, and not only provides an avenue of interaction and exchange of ideas on latest developments in geology in the country but also an occasion to renew old comradeships within the geological community.

We are very pleased that this year we have attracted a record total of 40 technical papers, making a very full 2 days programme.

Also, in conjunction with the conference, 2 geological fieldtrips were planned for conference participants, one along the East West Highway on the 5th-6th May, just prior to the conference and another 2-day fieldtrip to the Taiping/Pantai Remis areas to be held after the Conference. We would like to extend our gratitude to the fieldtrip leaders i.e. Prof. Tjia and En. Mustafa Kamal who are leading the trip along the East West Highway and Encik Noor Azim and Dr. Azhar for the Pantai Remis/Taiping trip.

Ladies and Gentlemen,

The Geological Society of Malaysia is indeed very proud to have successfully organized a significant number of conferences, seminars, workshops, fieldtrips and technical talks over the past years. We are indeed happy that tha Society membership is growning now standing at over 400 members.

The Society has always strived very hard to advance geological sciences in this country, as can be seen in its regular publication of technical bulletins and newsletters. To date the Society has produced 25 Technical Bulletins which have gained recognition both regionally and internationally for the high standard of technical papers.

Apart from upgrading the knowledge of geology in this country, the Society is also always striving to upgrade the professionalism of local geologists, to ensure that they play a significant role in the country's development, especially in the important minerals, energy, engineering geology and groundwater sectors.

Ladies and Gentlemen,

On a concluding note, the Society would like to record its appreciation to the Organizing Committee for this Conference led by Dr. Teh Guan Hoe, who also successfully organized last year conference at Cameron Highlands. The Organizing Committee has again done a wonderful job this year.

The Society is also very grateful to Malaysia Mining Corporation who have traditionally hosted this Conference dinner over the past few years, even when the tin price was low.

Finally I would like again to thank all our distinguished guest especially the Honourable Minister and all participants for all their support and kind attendance this evening.

Thank you.

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ADDRESS BY Y.B. DATO' SERI DR. LIM KENG YAIK, MENTERI PERUSAHAAN UTAMA, MALAYSIA AT THE 5TH ANNUAL GEOLOGICAL CONFERENCE DINNER, ROYAL CASUARINA HOTEL, IPOH ON 7 MAY 1990

Tuan Pengerusi Majlis,
Pengerusi Jawatankuasa Pengelola,
Dif-Dif Kehormat,
Tuan-Tuan dan Puan-Puan,

Terlebih dahulu ingin saya mengucapkan terima kasih di atas jemputan untuk saya menyampaikan sepatah dua kata di majlis makan malam ini. Saya juga mengambil kesempatan ini untuk mengucapkan Selamat Hari Raya Aidil Fitri.

I am indeed honoured to be given the opportunity to address this distinguished gathering of geoscientists representing the universities, government, quasi-government bodies and the private sector in the minerals, energy and geotechnical industries. I wish to take this opportunity to share with you some of my views on the needs of the mineral industry in this country.

I have been informed that you have established an institute of geologists which is in the process of drafting a registration of Geologist Act. With such a legislation, I am confident that geologists would be able to play a more significant role in the development of the mineral sector.

Ladies and Gentlemen,

Initial exploration work by the geological survey department has indicated that Malaysia has good mineral potential and there is scope to diversify and expand our mineral industry which has hitherto been dependent on tin for too long. In order to realise our full potential, steps are being taken to give the sector a new direction and emphasis. As many of you are already aware, the government, through the ministry of primary industries, and with the assistance of the united nations, has in early 1989 embarked on a two-year mineral development policy and planning project. The objective of this project is to provide Malaysia with a modern and internationally competitive mineral policy which is attractive to investors in the mineral sector in the effort to expand, diversify and increase the contribution of this sector to the national economy.

To date, significant progress on the formulation of the mineral policy has been achieved and the various outputs are being reviewed by the technical and steering committees comprising representatives from the federal and state governments, the industries, as well as professional bodies, such as the Geological Society of Malaysia and the Institute of Mineral Engineers.

Environment is the major concern of everybody, not only of environmental protection groups, but more so the government. In the formulation of the mineral policy, this particular aspect is given adequate emphasis, whereby the mineral title holder has the obligation to maintain and restore work areas to a safe state and to environment standards set by the

authorities. This is to minimise the negative impact of mining activities on the natural and social environment. The mineral title holder is further charged with the obligation to take all reasonable measures to compensate any damage by rehabilitative and restorative measures. Provision is also made for an environmental impact analysis, where necessary. These compulsory requirements are all aimed at achieving a balance between environmental and development needs.

To further promote the development of industrial minerals, the Ministry of Primary Industries is studying the existing land use policies. This is in consonance with the importance given to this group of mineral commodities under the industrial master plan. The location of deposits of these 'high bulk-low value' commodities are very important to their economic exploitation because of high transportation costs. Minerals are where they are found and if properly exploited are an asset to a nation. When left in the ground they remain valueless. Since we cannot dictate where our mineral deposits should occur, mining has to be given priority over other land use if we are to maximize the value of our national inheritance. There have been many cases where land containing valuable deposits of silica sand, ball clay, kaolin and construction materials have been used for other purposes. To overcome this short-coming and allow state governments to enjoy maximum benefit from their natural resources, a mineral clearance survey should be made mandatory before land is alienated for other development projects.

In line with the study, my ministry will be organizing a training seminar in July this year with the assistance of ESCAP on proper land use and the importance of geological assessment and evaluation in land development. The objective of this seminar is to make planners, decision makers and land valuers more aware of the true value of industrial minerals so that the exploitation of these important commodities would not be hampered by other forms of land development. This training seminar will gather together members of the various disciplines involved in land-use planning and development to discuss problems connected with the exploitation of construction materials especially around growth centers and to recommend the required geological input for reserve zoning for proper development planning.

Research and development (R&D) is another important aspect in the development and exploitation of industrial minerals. To encourage R&D the investor needs security of land tenure. This aspect is also being considered in the formulation of the mineral policy, the aim being to encourage R&D towards optimum usage of the industrial minerals raw materials. What is meant by R&D here is the upgrading of the raw materials for better alternative usages, thus giving them higher value-added and overall increase in revenue. One approach being explored currently is the possibility of the issuance of a longer and more permanent tenure to give the holder more confidence in long term R&D investment.

Whilst the security of land tenure is important to encourage the holder to invest, equally important is the cooperation between the government and the industry when the actual research and development work is conducted. This is because technology has advanced to such a stage where input from the various sectors working in their own specialized fields is necessary. Indeed R&D should not be the work of any one sector but rather

it should be through joint cooperation between all sectors concerned in order to reap maximum benefits from such undertakings. In support of this, the Ministry, through the Geological Survey Department will be organising an ASEAN-EEC training course on 'Assessment procedure for clays and ceramic raw materials' for participants from both the government and the industry. I was informed that this proposed training course has received strong support from the private sector.

Ladies and gentlemen, these are only some of the important issues I would like to tough upon this evening. I am sure in your conference you will be deliberating over a wider spectrum of issues and in the process come up with ideas that could contribute further to the development of the mineral industry in this country in this country. I wish you all every success.

Thank you.

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PERSIDANGAN TAHUNAN GEOLOGI '90 (Annual Geological Conference '90)
- Captions to photos

1. The participants at the Opening Ceremony.
2. Organising Chairman, G.H. Teh, welcoming the participants.
3. Encik Fateh Chand, Deputy Director-General Geological Survey of Malaysia with the Opening Address.
4. K.R. Chakraborty with his Keynote Paper.
5. H.P. Khoo with a question.
6. K.K. Cheang stressing a point.
7. Ab. Rahim Samsudin on gem artifacts.
8. Mohamad Ali Hasan being congratulated by Session Chairman, Fateh Chand.
9. Ong Chu Yin presenting a joint paper.
10. Coffee break. 'Do you know what?'
11. Patrick J.C. Ryall receiving a momento from C.S. Hutchison.
12. Anizan Isahak with her paper.
13. Loganathan putting forward a comment.
14. Abdul Rashid Bachik on groundwater monitoring.
15. Azhar Haji Hussin being congratulated by Session Chairman, Senathi Rajah.
16. Ng Tham Fatt on faults and related features.
17. Coffee break. 'Did you hear that?'
18. Session Chairman, Chong Foo Shin, congratulating Che Aziz Ali.
19. Hamzah Mohammad presenting his paper.
20. Wan Fuad Hassan answering a question.
21. Senathi Rajah making a comment.
22. Coffee break. 'Now listen carefully'.
23. Jasni Yaakub discussing determination techniques.
24. Liau Boon Leong on volcanics and associated mineralisation.
25. Oops! M.K. Choo has finished his question.
26. Basir Jasin on the significance of *Monodiexodina*.
27. Leong Lap Sau happily receiving his momento from Session Chairman, Syed Syed S. Almashoor.

28. Charles S. Hutchison with his keynote paper.
29. Patrick J.C. Ryall seeks some clarification.
30. Ibrahim Komoo with a joint paper.
31. Lim Peng Siong on geothermal prospecting.
32. Session Chairman, D. Santokh Singh, congratulating Cheong Khai Weng.
33. Mazlan Madon with his momento.
34. Yogeswaran presenting his paper.
35. Ng Chak Ngoon on gold mineralisation.
36. H.D. Tjia on young faults.
37. Coffee break. Again?
38. Nor Azim Ibrahim on storm beds in the J. Sandstone.
39. Zaiton Harun receiving her momento from Session Chairman, P.C. Aw.
40. Senathi Rajah poses another question.
41. A jubilant Chow Weng Sum being handed a momento by Session Chairman, T.H. Tan.
42. Coffee break. The tired helpers sure deserve it.
43. Tan Boon Kong with a survey of slope failures.
44. Session Chairman, C.P. Lee congratulating Lam Sia Keng.
45. Closing remarks by the Organising Chairman.

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MAJLIS MAKAN MALAM
PERSIDANGAN TAHUNAN GEOLOGI '90
- Captions to photos

1. Society President, Ahmad Said, with his Welcoming Speech.
2. YB. Datuk Seri Dr. Lim Keng Yaik with his speech.
3. A token of appreciation from the Society to Dr. Lim.
4. En. Nor Hisham Hazizi receiving a token of appreciation from the Society on behalf of Malaysia Mining Corporation from Dr. Lim.
5. Some light moments at the main table as dinner is served.
6. At the table with invited guests.
7. See, no problems with chopsticks.
8. Now everyone look here.
9. The majority are from the Geological Survey.
10. Old friends and new ones.
11. A break before the next course.
12. The younger generation.
13. Take it easy Stanley.
14. The majority here is from UKM.
15. I am sure you recognise all the smiling faces.
16. The Ministry and press people.

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ANNUAL GEOLOGICAL CONFERENCE '90

ANNUAL GEOLOGICAL CONFERENCE '90

PERSIDANGAN TAHUNAN GEOLOGI '90
MAJLIS MAKAN MALAM

PRE-ANNUAL CONFERENCE FIELD MEETING - EAST-WEST HIGHWAY

A two-day field meeting was held to study and discuss on the spot various structural features outcropping along the entire East-West Highway with overnight stay at Sri Banding Resthouse. The outcrops included sheared chaotic deposits near Sri Banding and the northern section across the Bentong Suture zone at the Perak-Kelantan border.

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GEOLOGICAL SOCIETY'S POST ANNUAL CONFERENCE FIELDTRIP

The Society's Stratigraphy/Sedimentology Group organized a Post Geological Society Annual Conference Fieldtrip on the 9th and 10th of May 1990. The fieldtrip was ably headed by Dr. Azhar Hussin and was attended by a total of 13 participants. For a few of the participants, the trip to the northern and central Perak was an unforgettable educational experience, invaluable first-hand knowledge of the 'Semanggol Basin'. During the first day of the trip, the group visited the Semanggol Formation in the area around the Gunung Semanggol, Gunung Putus and the Northern part of the Semanggol.

The Triassic Semanggol Formation consists of three members: a Conglomerate Member of interbedded thin sandstone and conglomerate; Interbedded Sandstone and Shale Member, and a Chert Member. As usual there were some discussions and disagreements on the depositional histories of the Semanggol Formation especially pertaining to the relation of the basal Conglomerate Member to the overlying Members, and its paleogeographic relation to the Kati Formation. However everyone agreed that the sediments were laid in a deepwater setting.

After a night rest at the resthouse in Kuala Kangsar, the group visited a few outcrops of the Kati Formation near Chuping. There were some discussions on the origin of the chert beds seen in the formation as to whether it represents the basinal equivalent of the Semanggol Formation. From Chuping the party headed West to Pantai Remis where two geologists from the Geological Survey's office in Ipoh joined the group. The group visited Pleistocene and Holocene exposures in a tin mine looking at a complete sedimentary sequence that reflects a transition from a fluvial setting at the base to estuarine and shallow marine sediments at the top.

Before calling it a day, the group made one last stop at a 'warung' in Pantai Remis before heading back to Kuala Lumpur. Never mind the sunburn and the fatique. They were a small price to pay for the knowledge gained in the field. But above all it was fun and everyone enjoyed every bit of the camaraderie.

Noor Azim

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ANNUAL GEOLOGICAL CONFERENCE '90

PROGRAMME

MONDAY, 7th May, 1990

7.45 am : Late Registration

8.25 am : Opening Ceremony

SESSION I

8.30 am : KEYNOTE PAPER I
K.R. CHAKRABORTY - Granitic rocks of Penang Island: Minor and trace element variation patterns and implications.

9.00 am : K.K. CHEANG, J.P. VAUGHAN, SHAMSUDDIN ALI & AZIMAH ALI - Electron-microprobe and microscopic studies of gold and associated sulphides and oxides from Malaysia-Implications for process flowchart designs.

9.20 am : AB. RAHIM SAMSUDIN & TAN TEONG HING - Artifaks batuan dan batu permata tabil serta batuan di Pulau Kalumpang, Perak.

9.40 am : MOHAMAD ALI HASAN - Air mineral Malaysia - satu penilaian kritis.

10.00 am : ONG CHU YIN, TAN BOON KONG, IBRAHIM KOMOO & ABDUL GHANI RAFEK - Sifat kejuruteraan tanah granit, Lebuhraya Ipoh-Changkat Jering, Perak.

10.20 am : COFFEE BREAK

SESSION II

10.50 am : PATRICK J.C. RYALL & DWAYNE BEATTIE - A gravity high in Darvel Bay.

11.10 am : ANIZAN ISAHAK - An impact origin for the Late Cenozoic basalt volcanism in Kuantan, Pahang.

11.30 am : ABDUL RASHID BACHIK - Groundwater monitoring system in the Kota Bharu area, Kelantan.

11.50 am AZHAR HAJI HUSSIN - Late Paleozoic and Triassic carbonate platform and basin sedimentation along the western margin of the Central Belt of Peninsular Malaysia.

12.10 am : NG THAM FATT & K.R. CHAKRABORTY - Faults and related features in the eastern part of the Kuala Lumpur area, Peninsular Malaysia.

12.30 am : LUNCH BREAK

SESSION III

2.00 pm : HAMZAH MOHAMMAD - The origin of the Main Range Batholith: supporting evidence from REE content.

2.20 pm : MOHAMAD ALI HASAN, NORLIA YUB GHAZALI & ZAKARIA MARZUKI - Potensi formasi-formasi batu kapur sebagai akuifer penting di Semenanjung Malaysia.

2.40 pm : SIA SAY GEE & G.H. TEH - Geology of the Grik-Lawin area, Perak.

3.00 pm : CHE AZIZ ALI, SYED S. ALMASHOOR & UYOP SAID - Pulau Payar: Kedudukannya dalam turus stratigrafi Semenanjung Malaysia.

3.20 pm : COFFEE BREAK

SESSION IV

4.10 pm : WAN FUAD HASSAN - REE distribution patterns in the Cretaceous granites of Johor and Melaka.

4.30 pm : AZHAR HAJI HUSSIN - Dolomitisation, dedolomitization and calcification in the Triassic Merapoh Limestone.

4.50 pm : JASNI YAAKUB & IBRAHIM KOMOO - Teknik penentuan beberapa sifat kejuruteraan batuan metasedimen klastik terluluhawa.

5.10 pm : LIAU BOON LEONG - Volcanics and its associated mineralization in Peninsular Malaysia.

5.30 pm : BASIR JASIN - Significance of *Monodlexodina* (Fusulininacea) in geology of the Malay Peninsula.

5.50 pm : LEONG LAP SAU, LOW WENG LENG & SAMAT ISHAK Refraction profiling across the shoreline: A modified seismic technique.

7.30 pm : DINNER - Participants take their seats.

7.45 pm : DINNER - INVITED GUESTS take their seats.

8.00 pm : WELCOMING ADDRESS by EN. AHMAD SAID, President, Geological Society of Malaysia.

8.10 pm : ADDRESS by Y.B. DATUK SERI DR. LIM KENG YAIK, Minister of Primary Industries, Malaysia.

8.30 pm : DINNER - Hosted by Malaysia Mining Corporation.

TUESDAY, 8th May, 1990

SESSION V

8.30 am : KEYNOTE PAPER II
CHARLES S. HUTCHISON - The Sulu Sea, a southeast Asian Neogene marginal basin with outcropping extensions in Sabah.

9.00 am : IBRAHIM KOMOO, ABDUL GHANI RAFEK, HAMZAH MOHAMAD, KADDERI MD. DESA & TAN BOON KONG - Pencirian profil luluhawa batuan di Terain Tropika.

9.20 am : LIM PENG SIONG, FRANCIS INTANG & CHAN FOOK ON - Geothermal prospecting in the Semporna Peninsula with emphasis on the Tawau area.

9.40 am : CHEONG KHAI WENG & YEAP EE BENG - Characteristics of the primary tin mineralization of the Menglembu area, Perak Darul Ridzuan.

10.00 am : MAZLAN MADON - Chamositic and phosphatic oolds in the Terengganu shale (Lower Miocene), offshore Peninsular Malaysia.

10.20 am : COFFEE BREAK

SESSION VI

10.50 am : K.R. CHAKRABORTY - Early Mesozoic tectonism in Peninsular Malaysia: A combined strike-slip-plume model.

11.10 am : YOGESWARAN, M - Some aspects of the hydrogeology of peat in Pulau Bruit, Sarawak.

11.30 am : NG CHAK NGOON - The role of metamorphism and faulting in gold mineralisation in Peninsular Malaysia.

11.50 am : CHE AZIZ ALI, IBRAHIM KOMOO, SANUDIN HJ TAHIR & H.D. TJIA - Young faults across the Quaternary Lucia-Magdalena volcanic complex, Taman Bukit Tawau, Semporna, Sabah.

12.10 am : ABDUL MAJID SAHAT & CHOW WENG SUM - Disintegration of road aggregates along parts of the Gurun-Alor Star and Ipoh-Changkat Jering Highways.

12.30 am : AZHAR HAJI HUSSIN - Facies variation in six carbonate bodies of North Sarawak.

12.50 am : LUNCH BREAK

SESSION VII

2.00 pm : NOR AZIM IBRAHIM & MAZLAN MADON - Storm beds as a marine transgressive shoreface and inner shelf sequence in the J sandstone, Malay Basin, offshore Peninsular Malaysia.

2.20 pm : ZAITON HARUN - Hipotesis pembukaan lembangan tengah Trias: Satu alternatif.

2.40 pm : TENG MEE KEE & G.H. TEH - The Silantik area, Sarawak: its geology and coal.

3.00 pm : K.K. CHEANG - Assessment of the quality and quantity of some limestone resources from the North Perak Region, Malaysia.

3.20 pm : NURAITENG TEE ABDULLAH - Dolomitisation history of the Setul Limestone, Northwest Peninsular Malaysia.

3.40 pm : COFFEE BREAK

SESSION VIII

4.10 pm : LAM SIA KENG - Quaternary geological mapping of Kota Samarahan Sub-regional Centre study area, Sarawak.

4.30 pm : TAN BOON KONG - A survey of slope failures along the Senawang-Air Keroh Highway, Negeri Sembilan/Melaka.

4.50 pm : CLOSING REMARKS.

ABSTRACTS OF PAPERS

Geological Society of Malaysia - Annual Geological Conference 1990

GRANITIC ROCKS OF PENANG ISLAND: MINOR AND TRACE ELEMENT VARIATION PATTERNS AND IMPLICATIONS

K.R. CHAKRABORTY
Jabatan Geologi
Universiti Malaya
59100 Kuala Lumpur

Penang Island is made up of variably textured highly evolved peraluminous S-type granitic rocks. Two petrographic suites, Bt. Bendera and Sg. Ara, have been identified by Liew (1983) which broadly correspond to the Penang and Kg. Batak Plutons of Cobbing *et al.*, (1986) respectively. Using currently available minor and trace element data petrogenetic aspects of the two suites are examined.

Harker variation diagrams and other inter-element variation patterns reveal the following characteristic features:

(1) In Bt. Bendera suite, high field strength elements Ti, Zr and P correlate positively with each other, but negatively with SiO_2 implying that these elements behaved as compatible elements with bulk partition coefficients more than unity. In Sg. Ara suite, while Ti and Zr behaved as compatible elements, P characteristically remained incompatible. Ti-P and Ti-Zr relationships clearly distinguish these two suites.

(2) Both suites display similar variation patterns for Rb, Sr and Ba. Sr and Ba are antipathetic to Rb and SiO_2. Evidently Sr and Ba behaved as compatible elements.

(3) Th, Y and Ce appear as incompatible elements in Sg. Ara suite, but show complicated behaviour in Bt. Bendera suite. Significantly, high-Y Bt. Bendera samples have low P_2O_5 values.

(4) Variation trends of several elements are very close for the two suites, but certain inter-element relationships are significantly different (e.g. Th-Ti, Y-Zr, Y-Ti).

(5) Small but perceptible compositional differences exist between the two suites. Ti, Zr, Sr, Y, Ce are relatively (for a given SiO_2) lower and Rb higher in the Sg. Ara suite.

(6) Variation patterns involving Y, Th, Sn are not uniform in Bt. Bendera, but define clusters with different trends. Some of the clusters are quite close to Sg. Ara trend. Sn seems to be a compatible element, particularly in Bt. Bendera suite and this may have a bearing on the question of lack of tin mineralization.

Consideration and analysis of the above characteristics lead to the following conclusions:

(i) Sg. Ara and Bt Bendera suites cannot be regarded as parts of a single fractionated intrusive sequence sampled at different levels of erosion (or at different points). These two suites have evolved through fractionation of two different parental magmas formed by separate crustal melting events. Trace and minor element data do not point to a significantly different crustal source for the two suites. They are consistent with the idea that Bt. Bendera magma has formed from the same source from which Sg. Ara magma has been withdrawn in an earlier melting event.

(ii) Bt. Bendera suite is composite and could not have formed by differentiation of a single parental magma.

(iii) It is possible to group some of the Bt. Bendera samples with the Sg. Ara suite implying a genetic connection between them - a possibility that warrants further study as it addresses to a fundamental question pertaining to the evolution of the two suites.

(iv) Granites of the Kulim complex may be genetically related to the granites of Penang.

ELECTRON-MICROPROBE AND MICROSCOPIC STUDIES OF GOLD AND ASSOCIATED SULPHIDES AND OXIDES FROM MALAYSIA -IMPLICATIONS FOR PROCESS FLOWCHART DESIGNS

K.K. CHEANG, J.P. VAUGHAN , SHAMSUDDIN ALI and AZIMAH ALI
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In general, precious metals, sulphides and oxides associated with economic mineral deposits in Malaysia may occur together as simple mineral grains or as extremely complex interlocking assemblages. The identity, size, shape, relative amounts and textural relationship of these mineral grains determine the design of the mineral processing flowsheet for extraction of the various metals. Because many of the minerals that occur naturally in Malaysia are extremely fine-grained, a Cambridge Mark V electron-microprobe coupled with a reflected light ore microscope are essential in determining ubiquitously the above parameters. In particular, the textures, optical and chemical identity of various minerals from a number of economic prospects are examined together with designs of flowcharts for their extraction.

ARTIFAKS BATUAN DAN BATU PERMATA TABII SERTA BUATAN DI PULAU KALUMPANG, PERAK

AB. RAHIM SAMSUDIN dan TAN TEONG HING
Jabatan Geologi
Universiti Kebangsaan Malaysia
43600 Bangi

Beberapa artifak batu permata tabii dan buatan yang ditemui di tapak arkeologi Universiti Kebangsaan Malaysia di Pulau Kalumpang telah dikenal pasti sebagai beril, sodalit, moldavit, plasma, aventurin, kuarza mata kucing, analsim, jasper dan paling banyak adalah manik kaca. Batu permata ini merupakan manik-manik yang berbentuk persegi, selinder atau sferoidal yang mempunyai 'axial string hole'. Mutu bentuk rupa potongan, asahan dan gilapan pada artifak batu permata tabii ini jauh lebih rendah berbanding dengan mutu pengukiran moden. Walau bagaimanapun batu permata tabii ini amat penting kerana boleh menjadi bukti kepada kesan peninggalan kebudayaan lama.

Manik kaca yang ditemui adalah bersifat alokromatik dan menunjukkan fitur 'annealing' dan retakan lelokan. Daripada geologi Semenanjung Malaysia dapat disimpulkan bahawa artifak batu permata tabii ini tidak diperolehi secara lokal tetapi kemungkinan telah diimpot dari luar negeri seperti India, Timur Tengah dan kemungkinan China. Manik kaca yang ditemui juga diimpot daripada luar dan mungkin sebahagian daripadanya telah disintesiskan semula secara lokal.

Selain daripada artifak batu permata, beberapa artifak batuan juga telah ditemui. Batuan ini berbentuk pebel dan kobel dengan saiz yang berbagai-bagai dan terdiri daripada batu pasir, batu lumpur, rijang, kuarza, skis dan granitoid. Oleh kerana banyak terdapat batuan yang sama litologi di sekitar kawasan kajian, maka dapat disimpulkan bahawa artifak batuan ini kemungkinan besar juga berasal dari kawasan yang sama.

Natural dan synthetic gem artifacts discovered at the Pulau Kalumpang archaeological site, are identified as beryl, sodalite, moldavite, plasma, aventurine, quartz cat's eye, analcime, jasper and glass beads with the latter predominating in quantity over the others. These gems were fashioned either as facetted, cylindrical or spheroidal beads with each containing an axial string hole. The style of cutting, grinding and polishing seen in the natural gem artifacts is relatively inferior in terms of modern day lapidary practices, but nevertheless authenticates that these gems are relicts of past cultures. The glass beads which are allochromatic, comonly show annealing features as well as concholdal fractures. From the geology of the Malay Peninsula, it can be inferred that the natural gem relicts were not locally mined, but had been imported from elsewhere such as India, Middle East and perhaps China. The glass beads were probably imported from elsewhere, with some being synthesized locally.

Besides the gem artifacts, several rock artifacts had also been unearthed. These rock artifacts which occur mainly as pebbles and cobbles of varying sizes, are identified as sandstone, mudstone, chert, quartz, schist and granitoid. Since rocks of similar lithology occur in abundance in the vicinity of the archaeological site, it can be inferred that these rock artifacts, unlike the gem artifacts, were derived from local sources.

Geological Society of Malaysia - Annual Geological Conference 1990

AIR MINERAL MALAYSIA - SATU PENILAIAN KRITIS

MOHAMAD ALI HASAN
Jabatan Geologi
Universiti Malaya
59100 Kuala Lumpur

Kedapatan air mineral (galian), sama ada yang diimpot atau 'buatan' Malaysia, semakin hari semakin bertambah jumlahnya di pasaran Malaysia sekarang. Komoditi unik ini mendapat perhatian dan sambutan awam dengan sebab-sebab tersendiri. Dari kajian awal adalah dipercayai Malaysia mempunyai potensi yang baik untuk mengusahakan air mineral keluaran negeri ini tersendiri. Ini tentunya antara lain dapat menjimatkan kos mengimpot air mineral luar negeri dan dapat juga memanfaatkan sumber-sumber air mineral di Malaysia.

Tujuan pembentangan kertas ini antara lain adalah, untuk memperkatakan:

i) Apakah sebenarnya takrifan dan ciri-ciri penting air mineral.

ii) Apakah sebab-sebabnya air mineral mendapat perhatian dan sambutan masyarakat Malaysia dewasa ini.

iii) Analisis unsur-unsur galian penting air mineral yang diimpot; air mineral buatan Malaysia dan air dari kawasan punca air mineral Malaysia.

iv) Penilaian kritis terhadap air mineral 'buatan' Malaysia.

v) Syor beberapa lokasi punca air mineral Malaysia.

vi) Proses mengusahakan pengeluaran air mineral secara komersial yang lebih terjamin.

vii) Kesimpulan dan syor.

Adalah juga ditekankan di sini bahawa pihak-pihak yang bertanggungjawab hendaklah mengambil langkah-langkah segera industri air mineral ini akan terus diberi perhatian yang lebih bermakna untuk bukan sahaja nama baik industri itu sendiri tetapi juga pihak kerajaan yang memerintah.

GEOLOGICAL SOCIETY OF MALAYSIA PUBLICATIONS

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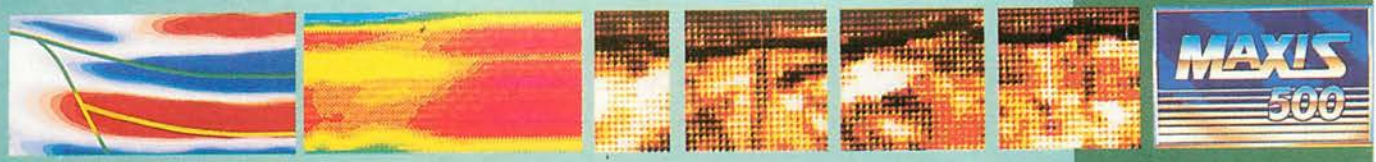

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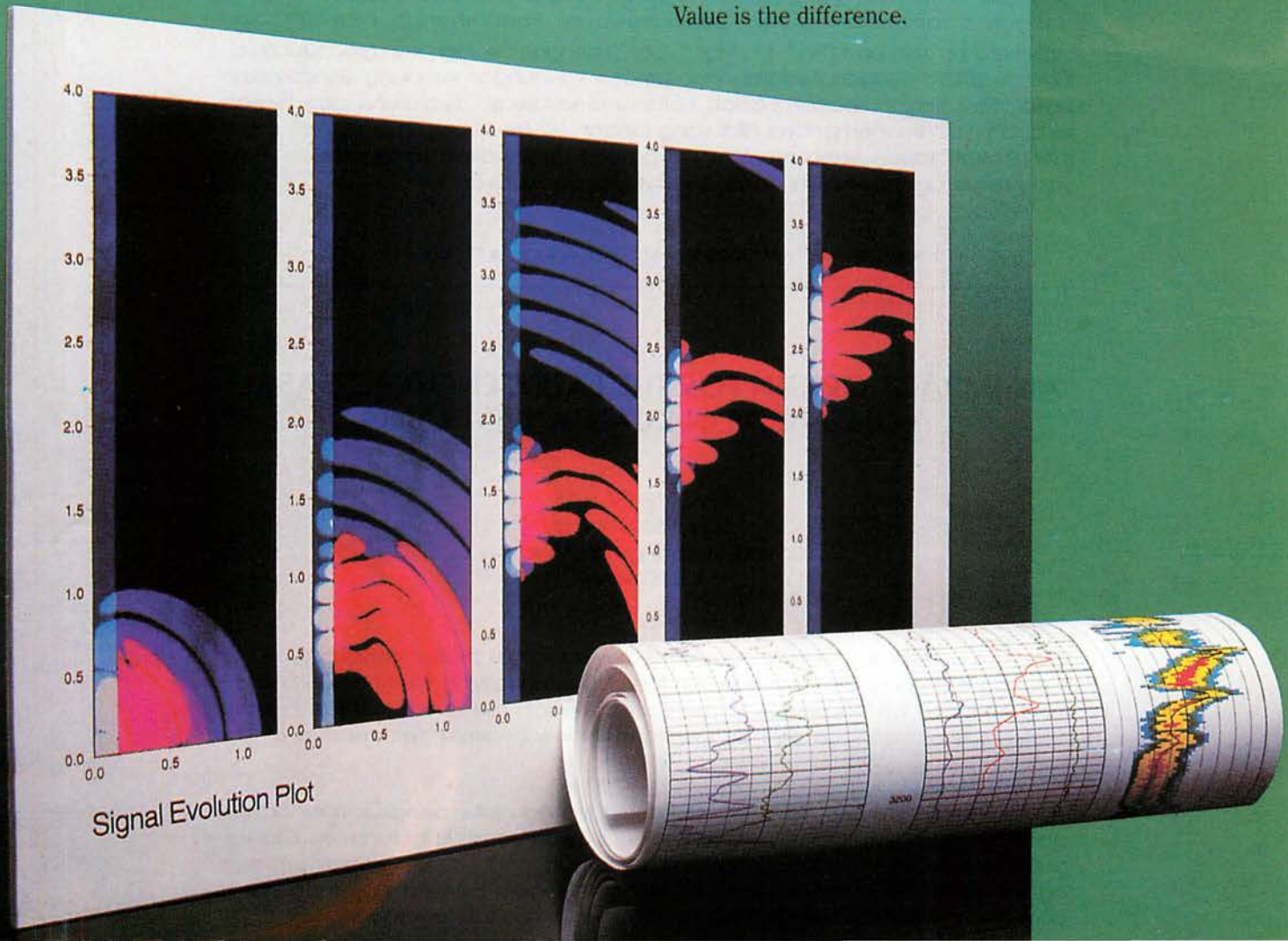
Schlumberger

Value is the difference.



SIFAT KEJURUTERAAN BAHAN TANAH GRANIT, LEBUHRAYA IPOH -CHANGKAT JERING, PERAK DARUL RIDZUAN

(The Engineering Properties of Granitic Soil Materials, Ipoh -Changkat Jering Expressway, Perak Darul Ridzuan)

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Sifat kejuruteraan bahan tanah yang dikaji termasuk spesifik graviti, taburan saiz butiran, had Atterberg, mineralogi lempung dan sifat pemadatan. Selain daripada itu, sifat kimia seperti keupayaan pertukaran kation (KPK) dan kepekatan kation larut air liang juga dikaji. Hasil kajian menunjukkan nilai spesifik graviti dipengaruhi oleh taburan saiz pasir yang merupakan komposisi utama tanah granit. Pertambahan nilai had Atterberg dengan peningkatan gred luluhawa boleh dikaitkan dengan pertambahan peratus kandungan lempung. Mineral lempung yang dominan adalah kaolinit dan illit. Plot carta keplastikan menunjukkan tanah granit bersifat keplastikan sederhana hingga tinggi. Pengurangan ketumpatan kering maksimum dan pertambahan kandungan kelengasan optimum yang diperolehi daripada ujian pemadatan adalah selaras dengan peningkatan darjah perluluhawaan. Pertambahan nilai KPK dan kepekatan kation larut (Na^+, K^+, Mg^{2+}, Ca^{2+}) dengan peningkatan gred luluhawa juga dikaitkan dengan pertambahan peratus kandungan lempung. Berdasarkan parameter kimia didapati nisbah kation monovalensi: dwivalensi dan nisbah serapan natrium mempunyai nilai yang rendah (<2.0). Ini bermakna tanah granit merupakan tanah yang mempunyai potensi penyerakan yang rendah. Hasil yang sama juga diperolehi daripada plot graf penyerakan.

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AN IMPACT ORIGIN FOR THE LATE CENOZOIC BASALT VOLCANISM IN KUANTAN, PAHANG

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The presence of shock induced features such as planar lamellar features, cleavages and kink bands in quartz in the granite underlying the Kuantan basalt is interpreted to be caused by a meteoritic impact. The release of the basaltic material is probably caused by the transient low pressure cell created by the impact.

Kehdiran fitur renjatan, seperti lamela, ira dan jalur bengkuk (kink bands) pada kuarza dalam granit yang terletak di bawah basalt Kuantan menunjukkan bahawa kawasan ini telah mengalami hantaman tahi bintang. Pengaliran basalt adalah disebabkan terbentuknya sel tekanan rendah. Sel tekanan rendah yang bersifat sementara itu adalah hasil daripada hantaman tahi bintang.

A GRAVITY HIGH IN DARVEL BAY

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A gravity survey was carried out along the coastlines of Darvel Bay and many of the islands (e.g. Sakar, Tabauwan, Silumpat) in the Bay. In addition stations were located along the road from Kunak to Lahad Datu. The resulting Bouguer anomaly map shows a broad gravity high of at least 60 mgal which strikes west northwest with its maximum on the southern coast of Pulau Sakar. The anomaly narrows and decreases where it comes ashore and may continue along the Silam-Beeston Complex.

This large positive anomaly suggests that there is an extensive ultramafic body beneath Darvel Bay. The gravity anomaly can best be modelled as a 3 to 5 km thick slab of ultramafic rock under the Bay with amphibolites on its northern and southern edges dipping away from the Bay. This model is consistent with a folded structure which brings upper mantle rocks to the surface. It is unlikely that there is a significant thickness of Chert-Spilite Formation beneath Darvel Bay, although the gravity data would permit a thickness of up to a few hundred metres.

*Now at: Geoterrex Ltd., 2060 Walkley Road, Ottawa, Ontario, Canada K1G 3P5.

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GROUNDWATER MONITORING SYSTEM IN THE KOTA BHARU AREA, KELANTAN

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A pilot groundwater monitoring system was designed and implemented for the Kota Bharu-Tanjung Mas-Pengkalan Chepa area, in which considerable groundwater is being exploited for public water supply. The system consists of nineteen numbers of 75 mm - diameter wells, of which five wells each are located in Kota Bharu and Pengkalan Chepa, and nine wells in the Tanjung Mas area. The depth of the individual wells vary from about 30 metres to 130 metres, and are designed to permit sampling and measurement of hydraulic parameters at horizons corresponding to the major aquiferous zones.

Periodic samplings and analyses of groundwater, and measurements of pressure head are being undertaken as part of a long-term groundwater surveillance programme to monitor and manage the groundwater resources of the area.

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LATE PALEOZOIC AND TRIASSIC CARBONATE PLATFORM AND BASIN SEDIMENTATION ALONG THE WESTERN MARGIN OF THE CENTRAL BELT OF PENINSULAR MALAYSIA

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Late Paleozoic carbonates presently found along the western margin of the Central Belt of Peninsular Malaysia developed as algal boundstones, fusulinid banks, and oolitic and peloidal grainstones sand sheets on marine volcanic highs. These carbonates occur as separate and discrete bodies, and contain several disconformities within their sequences. Laterally, the carbonate microfacies pass into poorly-bedded skeletal packstones and mudstones which in places are interbedded with shales. These shallow marine carbonates grew with time and by Triassic these bodies coalesced to form a major platform now preserved along a stretch of some 80 kilometers from Chegar Perah in Pahang to Sg. Chiku in Kelantan.

The growth of this platform proceeded through several stages and at times were either inundated with thin siliciclastic mud or sub aerially exposed. Extensive dolomitisation, dissolution of meta stable carbonate constituents, coarse calcite cementation, crusts- and caliche- formation, development of neptunian dykes and deposition of intraformational conglomerates of 'black pebbles' resulted during these periods of emergence. The margin of this platform occasionally collapsed and blocks of lithified carbonates and unconsolidated platform material were washed down into the siliciclastic mud-rich basin.

This paleogeographic scenario probably persisted into late Triassic after which these rocks were intruded into by the Main Range Granites and the granitoids of the Central Belt.

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FAULTS AND RELATED FEATURES IN THE EASTERN PART OF KUALA LUMPUR AREA, PENINSULAR MALAYSIA

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The eastern part of Kuala Lumpur area, underlain by granitic and metasedimentary rocks is cut by several major faults. Faults and related features including joints, dikes and veins are conspicuous in the granitic rocks but are less apparent in the metasediments. The dominant strikes of the photolineaments are NW-SE, N-S and NE-SW. The Bt: Tinggi fault zone and Kuala Lumpur fault zone are delineated as NW trending lineament bands.

Field studies show that most of the mesoscopic faults are steeply dipping. The dominant strikes are NW-SE (mode=316^{O}) and N-S (mode=8^{O}). Faults are also striking in the NE-SW, E-W and WNW-ESE directions. The majority of the faults are strike-slip with minor dip-slip components. The NW-SE striking faults are mainly sinistral while both sinistral and dextral displacements are recorded in the N-S and NE-SW trending faults.

Diverse fault-rocks with microstructures indicative of brittle brittle-ductile and ductile deformation are observed. It suggests that there are several episodes of faulting developed under various P-T conditions.

There are 4 sets of steeply dipping regional joints in the granites. The dominant strikes are NW-SE (mode=320^{O}), N-S (mode=10^{O}), E-W (mode=88^{O}) and NE-SW (mode=56^{O}). A cogenetic relationship between the joints and regional faults is deduced.

Microgranite and aplite dikes are common in the granites. They show strong preferred orientation. Dips are high and about 70% of the dikes strike between 310^{O} to 330^{O}. Major quarz reefs are striking between 280^{O} to 320^{O}. In the granites quartz veins are mainly steeply dipping and the dominant strikes are N-S (mode=8^{O}) and NW-SE (mode=314^{O}).

Many of the observed geometric relationships of the faults and related features can be explained by two models of simple shear. An earlier N-S striking sinistral Y-principal shear with corresponding NW-SE striking T-fractures occupied by dikes and quartz reefs. It is followed by a NW-SE striking sinistral Y-principal shear with corresponding dextral NE-SW R-shears and dextral N-S X-shears. Further studies are required to explain faults and related features that do not fit into the above models, in particular the sinistral NE-SW faults.

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THE ORIGIN OF THE MAIN RANGE BATHOLITH: SUPPORTING EVIDENCE FROM THE REE CONTENTS

(Asalmula Batolitos Banjaran Besar: Bukit Tambahan Daripada Kandungan Unsur Nadir Bumi)

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The compositions of major elements and the REEs La, Ce, Nd, Sm, Eu, Tb, Dy, Yb and Lu of 24 coarse to medium grained porphyritic biotite-muscovite granite and 20 medium grained cataclastic biotite granite exposed at km 27 and 36 along the Lebuhraya Kuala Lumpur-Karak were studied. The medium grained biotite granites contain higher amounts of REEs, owing to their higher contents of LREEs. The HREEs and the size of the negative Eu anomaly, however, are smaller than the porphyritic granite. The contrast in the REE contents between the two stocks is thought to be related to the different formation level in the magma chamber. The porphyritic granites, being relatively poorer in plagioclase, is believed to have formed at a higher level, compared to the more granodioritic, lower level medium grained biotite granites. The REEs, (La/Lu)cn, and the Eu/Sm values suggest that the magma fractions have been derived by partial melting of materials such as graywackes, metapelites, quartz metadiorites, tonalites, and silica-rich granulites, which characterise continental crust in general. The similar REE study on the acidic volanics at Lanchang (40 km to the east, on the eastern side of the Bentong Suture) also suggests a continental crust origin. In view of the tectonic setting of the Malay Peninsula, the present study supports the idea of subducting (Sinoburmalaya) beneath the continental crust unit on the east (Eastmal) during the Late Triassic-Early Jurassic Orogeny.

Kandungan unsur major serta unsur nadir bumi (REE) La, Ce, Nd, Sm, Eu, Tb, Dy, Yb dan Lu bagi 24 sampel granit biotit-muskovit porfirit berbutir kasar dan sederhana serta 20 sampel granit biotit kataklas berbutir sederhana di km 27 dan 36 Lebuhraya Kuala Lumpur-Karak telah dikaji. REE lebih tinggi di dalam granit biotit berbutir sederhana, berikutan kandungan LREE yang lebih tinggi. Walau bagaimanapun HREE nya relatif rendah dan anomali Eu negatifnya juga lebih kecil berbanding granit porfirit. Perbezaan kandungan REE ini dikaitkan dengan perbezaan aras pada ruang magma. Granit porfirit, yang secara relatif miskin plagioklas, dipercayai terletak di aras lebih tinggi, berbanding granit biotit berbutir sederhana yang ternyata lebih kegranodioritan dan dipercayai terletak di bahagian lebih bawah ruang magma. Nilai-nilai REE, (La/Lu)cn, dan Eu/Sm mencadangkan magma pembentuk granit-granit ini terlebur separa daripada bahan-bahan seperti metagreiwak, metapelit, metadiorit kuarza, tonalit dan granulit kaya silika, yang umumnya menciri kan kerak kebenuaan. Kajian REE yang hampir sama terhadap batuan volkanc asid di Lanchang (40 km ke timur, di sebelah timur Sutur Bentong) juga mencadangkan batuan volkano ini berasakan kerak kebenuaan. Dari sudut tektonik Semenanjung, kajian ini memperkuatkan gagasan adanya penyusupan kerak benbua (Sinoburmalaya) ke bawah kerak benua di timur (Eastmal) di masa orogeni Trias Lewat - Jura Awal.

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POTENSI FORMASI-FORMASI BATU KAPUR SEBAGAI AKUIFER PENTING DI SEMENANJUNG MALAYSIA

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Di Semenanjung Malaysia terdapat 4 formasi batu kapur yang utama iaitu Formasi Batu Kapur Setul (Ord-Sil) dan Formasi Batu Kapur Chuping (Permian) yang terletak di Barat Laut, sementara Formasi Batu Kapur Kuala Lumpur dan Formasi Batu Kapur Kinta pula di bahagian Zon Barat Semenanjung Malaysia.

Kajian yang terperinci tentang hidrogeologi ke atas formasi-formasi tersebut belum ada lagi. Walau bagaimanapun ada maklumat-maklumat hidrogeologi bagi Formasi-formasi batu kapur Kinta dan Kuala Lumpur hasil daripada projek-projek pembangunan yang telah dijalankan di kedua-dua kawasan tersebut.

Daripada beberapa telaga ujian yang telah dibuat ke atas batu kapur Kuala Lumpur didapati bahawa potensi hasil (yield potential) adalah sangat berbagai iaitu berjulat antara 1,000 gelen sejam hingga 9,000 gelen sejam. Kualiti air tanah di situ boleh dikatakan baik walaupun di beberapa tempat terdapat sadah (hard) sedikit.

Bagi kawasan batu kapur Kinta pula, hasil daripada penyiasatan yang telah dijalankan sebelum ini, kesimpulan yang dapat dibuat adalah bahawa akuifer batu kapur boleh membekalkan air sebanyak kira-kira 7000 gelen sejam manakala dari segi potensi hasil pula akuifer batu kapur merupakan sumber air tanah yang lebih baik daripada aluvium. Dari segi kualiti pula didapati bahawa jumlah pepejal terlarut (TDS) di dalam batu kapur berjulat di antara 100-300 ppm. Ini masih lagi berada didalam keadaan julat air tawar. Walaupun pH air tanah di kawasan batu kapur ini agak tinggi, ianya tidak mengandungi bahan-bahan toksid seperti arsenik dan nitrat didalam jumlah yang membahayakan. Kandungan bahan kimia yang lain juga didapati di dalam julat yang di benarkan oleh Pertubuhan Kesihatan Sedunia (WHO).

Pembentangan kertas kerja ini untuk memaparkan ciri-ciri penting hidrogeologi yang telah ditemui dan tafsirannya setakat ini berdasarkan data-data dan maklumat-maklumat yang ada serta data-data awal penyelidik tentang potensi kedua-dua kawasan batu kapur (Lembah Kinta dan Kuala Lumpur) sebagai akuifer penting di Semenanjung Malaysia. Ciri-ciri hidrogeologi batu kapur di kedua-dua kawasan di zon barat Semenanjung Malaysia juga akan dibandingkan dengan ciri-ciri formasi batu kapur dan formasi batuan lain di Semenanjung Malaysia. Adalah dipercayai bahawa formasi-formasi batu kapur di Semenanjung Malaysia mempunyai potensi sebagai akuifer yang baik untuk dimajukan dan perlu diberi perhatian sewajarnya. Langkah-langkah untuk memajukan akuifer-akuifer batu kapur ke paras optimum juga turut diperkatakan.

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GEOLOGY OF THE GRIK-LAWIN AREA, PERAK

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The Grik-Lawin area is underlain by the Baling group and Lawin basin deposits and are flanked to the east by the Main Range granite and to the west by the Bintang Hill granite.

All of the three formations which make up the Balin group are present in the study area. They are the Papulut quartzite (Late Cambrian), the Grik tuff (Late Cambrian to Early Ordevician) and the Kroh formation (Early Ordovician to Early Devonian). All of these three formations have suffered a certain degree of metamorphism and all the sedimentary structures, except bedding, have been destroyed.

Despite being poorly preserved and some unidentifiable, the fossils and fossil fragments found in the Grik tuff do indicate the shallow marine environment of deposition. A probable volcanic vent was also found in the study area.

The Lawin basin, with deposits of Miocene age, is found to be a fault controlled basin and deposition is by debris flow.

The intrusion of the granitoids is believed to have taken place during Late Devonian into the oldest Papulut quartzite. However, in one instance the granitoids have also intruded the Grik tuff.

Faulting is very intense with one very prominent trend at 340^{O}-350^{O}. At least two phases of movements have been recorded for the faults in the Grik-Lawin area.

The rocks in the Grik-Lawin area have been intensively folded into overturned isoclinal folds which in some cases have given rise to refolded fold patterns.

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PULAU PAYAR: KEDUDUKANNYA DALAM TURUS STRATIGRAFI BARATLAUT SEMENANJUNG MALAYSIA

(The Payar Islands: its position in the stratigraphic column of northeast Peninsular Malaysia)

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Kepulauan Payar, sekumpulan tiga pulau terletak lebih kurang 26 km dari Kuala Kedah, telah dilaporkan terdiri daripada batuan yang berkaitan dengan Formasi Machinchang, Formasi Mahang dan Formasi Semanggol. Pola struktur kepulauan ini bersesuaian dengan struktur yang terdapat di mendala timur Formasi Machinchang, di Pulau Langkawi. Batuan Kepulauan Payar terdiri daripada batu pasir yang sederhana bersih dengan kandungan feldspar lebih kurang 5% isipadu. Struktur sedimen seperti perlapisan silang berskala mega, struktur piring dan lapisan konvolut bersesuaian dengan yang dilihat di beberapa bahagian Formasi Machinchang. Arah arus kuno bergerak dari barat laut ke tenggara. Tiada sebarang fosil dijumpai di sini. Struktur primer dan sekunder yang terdapat di sini mencadangkan Kepulauan Payar sebagai satu ahli di dalam Formasi Machinchang. Kami percaya batuan ini mewakili satu rantaian yang hilang di antara Formasi Machinchang Kepulauan Langkawi dan ahli kuarzit Formasi Jerai di Kedah tengah.

Payar Islands, a group of three islands that are situated about 26 km from Kuala Kedah, have been differently reported as making up of rocks that are affiliated to the Machinchang Formation, to the Mahang Formation and to the Semanggol Formation. The structural grain of the islands is consistent with that of the eastern domain of the Machinchang Formation in Pulau Langkawi. The rocks of Payar Islands are composed of fairly clean sandstone with about 5 volume percent of feldspar. Primary structures such as megascale cross-bedding, dish structure and convolute bedding are similar to that seen in certain sections of the Machinchang Formation. The paleocurrent direction is from the northwest towards the southeast. No fossil is found. The available primary and secondary structures suggest the rocks of the Payar Islands are, most likely, a member of the Machinchang Formation. We believe the rocks represent a missing link between the Machinchang Formation of Langkawi Islands and the quartzite member of the Jerai Formation in central Kedah.

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DOLOMITISATION, DEDOLOMITISATION AND CALCIFICATION IN THE TRIASSIC (?) MERAPOH LIMESTONE

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The Triassic(?) Merapoh Limestone exposed at the abandoned Modal Quarry in the Gua Panjang Hills is composed of a lower sequence of interbedded silicified shale and crinoidal wackestone, gradually being replaced upwards by peloidal packstone and skeletal packstone-grainstone. The top of this bed is scallopped, strongly burrowed and bioturbated and, in places, pass laterally into crinoidal grainstone. Capping this sequence is an extensive but discontinuous laminated crust and caliche surface. Resting on this surface are pockets of intraformational breccia consisting of clasts of strongly dolomitised wackestone rare algal boundstone and skeletal fragments set in a matrix of crinoidal wackestone. An algal boundstone bed of variable thickness (0.5-3.0 m) overlie this breccia or the laminated surface directly, which is in turn overlain by a thick sequence of oolitic-peloidal packstone-grainstone grading upsequence into well-sorted oolitic grainstone. Above this is a very thick (>20 m) massive algal boundstone which is generally inaccessible.

This sequence is interpreted as a series of cyclic sementation beginning with a marine drowning phase of an emergent surface. This is followed by the deposition of a shoaling-upwards sequence, culminating in another emergent phase.

Early diagenetic changes in these rocks are reflected by the change in the ensuing diagenetic realm. Rim Mg-calcites cements (now neomorphosed) predominate in the grainstone facies.

Large-scale dissolution and microfracturing due to collapse indicate suggest an early change of the marine sediment to a freshwater environment. Penecontemporaneous dolomitisation predominantly affected the burrow-fillings and also resulted in the encrustation of particle and fracture surfaces by minute, inclusion-rich stubby dolospars. Subsequent sparry calcite forms the next generation of cement, followed by large coarse, euhedral, often zoned dolomites.

The remaining pore space were filled through the competitive growth of coarse radiaxial fibrous calcite and coarse ferroan dolomite (saddle dolomite). This competitive growth also resulted in the corrosion of the margins and replacement of both the dolomite and the calcite, imparting dedolomitised fabrics in the rocks. This late diagenetic process is envisaged to have occurred under a higher temperature condition, from waters of variable chemistry.

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TEKNIK PENENTUAN BEBERAPA SIFAT KEJURUTERAAN BATUAN METASEDIMEN KLASTIK TERLULUHAWA
(Techniques to determine some engineering properties of weathered clastic metasediment)

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Memilih kaedah persampelan dan teknik ujian yang sesuai masih lagi menjadi persoalan dalam usaha menentukan sifat kejuruteraan batuan lemah, termasuk batuan terluluhawa. Satu siri ujian makmal dilakukan pada batuan metasedimen klastik terluluhawa bertujuan untuk mengenalpasti teknik ujian yang boleh digunakan bagi menentukan sifat kejuruteraan bahan berkenaan. Teknik yang baik berupaya mencirikan perbezaan gred luluhawa bahan batuan.

Ujian kebolehtahanan pemerolan dua kitaran dan ujian pemerolan lima kitaran memperlihatkan perbezaan kesan perubahan kelembapan oleh bahan gred yang berlainan. Ujian kebolehtahanan pemerolan dilakukan menggunakan sampel yang dikeringkan di dalam ketuhar dan diputar pada kadar 20 putaran per minit selama 10 minit. Ujian pemerolan pula melibatkan ulangan proses pengeringan, perendaman dan ayakan sampel basah setiap kali selepas perendaman. Perubahan dimensi sampel apabila terdedah kepada kelembapan dikaji menerusi ujian pengampulan bebas. Pengampulan pada arah paksi sampel diukur menggunakan dial mikrometer berskala kecil.

Penentuan tekanan atau beban di dalam ujian-ujian ke atas batuan lemah memerlukan sistem pengukuran yang lebih peka. Ujian kekuatan mampatan sepaksi dan ujian indeks kekuatan beban titik dijalankan menggunakan transduser beban yang berupaya mengesan beban sekecil 3.0 Newton. Sistem pengukuran beban yang sama digunakan di dalam ujian indeks kekerasan Brineli. Ujian ini memperlihatkan kerintangan bahan batuan terhadap pelekukan oleh suatu bebola keluli.

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VOLCANICS AND ITS ASSOCIATED MINERALIZATION IN PENINSULAR MALAYSIA

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Calc-alkaline volcanics varying from andesitic to dacitic to rhyolitic pyroclastics and flows are widely distributed throughout the peninsula. Basalt flows are locally important but restricted in occurrence.

More recent field investigations have shown that contemporaneous volcanic and pyroclastic rocks are much more extensive geographically with its main bulk in Central Belt (Scrivenor, 1928). In some districts of the Central Belt the volcanics appear to be not metamorphosed compared to the surrounding sediments, thus the volcanicity had continued to a much later age than previously thought. It is expected to young from the west towards the east. Various types of volcanicity have also been recognized such as:

(a) explosive andesite-dacite-rhyolite (subaqueous to subaerial)

(b) quiescent rhyolite dome-flow complexes (subvolcanic)

(c) stratovolcano rhyolite-dacite (subaerial)

(d) postorogenic basalt flows.

The associated mineralization in the volcanic terrain are:

(a) feeder zone stockwork bonanza veins related to Au-Ag deposits

(b) volcanogenic stratiform massive sulphides, sulphates and oxides (Pb, Zn, Fe, Cu + Ag, Au)

(c) explosive calc-alkaline volcanism with proximal Zn-Pb-Cu-Au sulphides and minor sulphides in the distal facies.

Besides the genetically related deposits as mentioned above, there are also some structurally related deposits in the volcanics, whereby the source of mineralizing fluids may not be volcanic in origin. This can be seen in the metamorphism of auriferous rocks, causing remobilization of the precious metals and subsequently filled dilatant zones from the accompanying structural deformation producing mineralized Au-quartz veins in the volcanics.

SIGNIFICANCE OF *MONODIEXODINA* (FUSULININACEA) IN THE GEOLOGY OF THE MALAY PENINSULA

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Monodiexodina sensu stricto is a very rare genus of the Fusulinaceae found in Permian deposits. Its distribution is restricted to a narrow sliver extending from the central Afghanistan in the west to Japan and Malaysia in the east. Only three species of the genus have a wide distribution in the south Asia and Southeast Asia. They are *Monodiexodina sutschanica, Monodiexodina shiptoni* and *Monodiexodina kattaensis.* Their restricted geographic distribution may reveal their paleobiogeographic province which is very important for establishing paleogeography. *Monodiexodina shiptoni* is a good index fossil which is used as a zonal marker for the Artinskian, late Early Permian. The geographic distribution of the species suggests that they were warm-water species which occupied the tropical or subtropical shallow seas. In the SIBUMASU block, only *Monodiexodina sutschanica* and *Monodiexodina shiptoni* were found in either limestone or calcite cemented sandstone which overlies the pebbly mudstone of glacio-marine origin. In the East Malaya block, two species of *Monodiexodina* were found in the Sumalayang limestone. They are *Monodiexodina kattaensis* and *Monodiexodina shiptonii.* They are associated with many species of Fusulinaceae. Their occurrence may give some clues to the evolution of the paleoclimate and tectonic history of the two blocks during the Late Carboniferous and Permian.

RARE-EARTH ELEMENT DISTRIBUTION PATTERNS IN THE CRETACEOUS GRANITES OF JOHOR AND MELAKA

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Granites of Peninsular Malaysia and elsewhere normally have a characteristic rare-earth element pattern, usually with a negative Eu anomaly. In the present study, the Cretaceous granites of Pulai, Gunung Ledang and Batang Melaka have no Eu anomaly. Such a pattern indicates that the Cretaceous granites originate from a source entirely different from the dominant granites of the peninsula.

Geological Society of Malaysia - Annual Geological Conference 1990

THE SULU SEA, A SOUTHEAST ASIAN NEOGENE MARGINAL BASIN WITH OUTCROPPING EXTENSIONS IN SABAH

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Although marginal seas are an outstanding feature of Southeast Asia, their stratigraphy and tectonic evolution has to be interpreted exclusively from oceanographic geophysical surveys and a few well selected DSDP sites. The S.E. Sulu Sea was no exception until it was drilled in 1989. The published details allow a correlation with eastern Sabah geology, where the Miocene and younger geology may be successfully correlated with the DSDP sites. The early stages of the opening of the Sulu Sea were characterized by explosive volcanic activity, and the rifting resulted in large scale melange formation. These events are seen in the onland geology as the Ayer and Tungku formations, and the Kuamut and Garinono formations respectively. Uplift of the Crocker Formation to the west could have provided the only possible source for major quartz sands deposited in Sabah as the Tanjong Formation, and major delta flowing northeasterly near Sandakan would have been the source of the continentialy-derived turbidites that were drilled in the deep Sulu Sea.

Since the ophiolitic complex of Sabah pre-dates the late-Early Miocene opening of the Sulu Sea marginal basin, it must therefore represent the ocean floor upon which was built the volcanic arc, rifting of which gave rise to the Sulu Sea. Remnants of this Palaeogene and older ophiolitic basement therefore underlie and outcrop within the NW margin of the S.E. Sulu Sea (Labuk Valley through the Cagayan Ridge), as well as along the Sulu Archipelago, extending into Darvel Day and Ulu Segama.

Offshore exploration and drilling by several petroleum companies in the Sulu Sea, both in Malaysian and Philippine waters, was unsuccessful. The thick Miocene successions were misinterpreted by them as having been deposited in fore-arc basins. The trend of these basins is northeasterly and therefore unrelated to the inferred trench, which trends northwest parallel to the east coast of Sabah. This trench is a figment of the imagination. The lack of understanding of the tectonic setting undoubtedly contributed significantly to the lack of success by the petroleum companies.

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PENCIRIAN PROFIL LULUHAWA BATUAN GRANIT DI TERAIN TROPIKA

(Characterizations of granite weathering profile in tropical terrains)

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Kadar proses luluhawa kimia yang sangat tinggi di terain tropika menghasilkan lapisan tanah baki dan regolitos yang sangat tebal. Pada batuan granit, ketebalan profil luluhawa ini lazimnya puluhan meter dan membentuk zon tanah, tanah + batuan dan batuan terluluhawa. Dari sudut geoteknik, zon profil luluhawa mempunyai cirian yang kompleks dan tak-homogen. Pembinaan di atas dan/atau pada zon ini telah menimbulkan pelbagai masalah, khususnya masalah ketakstabilan cerun. Penyelidikan ini berhasrat mengkaji proses dan bahan pada zon profil luluhawa secara bersepadu. Kajian pada satu profil pilot melibatkan aspek berikut: survei geometri dan ujuran muka profil, pencirian lapangan profil luluhawa; survei ketakselanjaran jasad batuan, dan kajian petrografi, geokimia, mineralogi, sifat fiziko-kimia dan sifat kejuruteraan bahan terluluhawa yang mewakili keseluruhan zon profil luluhawa. Kajian ini bermatlamat menghasilkan satu prosedur pencirian dan pengelasan profil luluhawa untuk terain tropika.

The high rate of chemical weathering in tropical trains results in deep residual soils and regoliths. In granitic terrain the profile thickness may reach several tens of meters, and can be divided into top proper soil zone, a soil + rock zone and a weathered rock zone. From the geotechnical point of view, the weathering profile is complex in nature, as well as inhomogeneous. The construction at or within the weathering zone always encounter problems, particularly slope instability. This research is an integrated study of the processes involved, and the nature of materials develop at the wathering profile. Detail investigation at the pilot profile involves the following aspects: geometric survey and profile projection, field characterization of weathering profile, discontinuity survey of rock mass, and laboratory studies on petrographic, geochemical, mineralogical, physico-chemical properties, and engineering properties of weathered materials. This integrated studies attempts to formulate characterization and classification procedures of weathering profile for tropical terrains

Geological Society of Malaysia - Annual Geological Conference 1990

GEOTHERMAL PROSPECTING IN THE SEMPORNA PENINSULA WITH EMPHASIS ON THE TAWAU AREA

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Thermal manifestations in the Semporna Peninsula include hot springs, seepages, mud pools and old steaming ground. Mapping of these thermal features showed that they are structurally controlled.

The chemistry of the thermal waters indicate the presence of two types of waters - near neutral sodium chloride and sulphate waters. Thermal waters from the Apas Kiri area are near-neutral sodium chloride waters and the Cl/B and Cl/F ratios suggest they have a common source of geothermal fluid. The thermal water from upper Tawau is acid sulphate type and its chemistry suggest it is steam-heated water or ground water mixed with gas (H_2S). The chemistry of thermal waters from Balung and Sungai Jepun areas suggests they are acid sulphate waters which may have come from a far away source and come into contact with and neutralised by cold ground water. The upper Tawau and Balung springs may indicate the perimeter of a field centered on the Maria Volcanic Complex.

The Apas Kiri area is underlain mainly by Quaternary dacitic lava, tuff and agglomerate. The surface thermal manifestations cover an area of 3 km^2. The volcanic rocks are calcitised, chloritised, argillised and pyritised. Around the thermal features, the rocks are strongly argillised and calcitised.

Several characteristics of the Apas Kiri thermal waters e.g. chloride, Cl/B ratio and geothermometer suggest high subsurface themperature. The Cl/B ratio also suggests the reservoir rocks are andesitic. Total heat loss from the Apas Kiri 2 area has been tentatively stimated at 28.65 MW-Thermal.

The best geothermal prospect so far identified is the Apas Kiri area and it should be further prospected by geophysical methods, in particular geoelectric sounding with large electrode spacing. Measuring of flow rates, additional sampling and analysis of thermal discharges in the upper Tawau area should be carried out. Other known thermal manifestations in the upper Balung area should also be sampled and analysed.

Geological Society of Malaysia Annual Geological Conference 1990

CHARACTERISTICS OF THE PRIMARY TIN MINERALIZATION OF THE MENGLEMBU AREA, PERAK DARUL RIDZUAN

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Primary tin mineralization in the eastern flank of the Kledang Range Granite located about 1 km SW of Menglembu comprises of NE-SW trending veins and vein swarms. The granitic hose consists of biolite rich coarse-grained porphyritic adamellite which shows alignment of the feldspar phenocrysts in the flow direction. The vein type mineralization recognized includes the "streaky bacon" ore, cassiterite-quartz, cassiterite-tourmaline, fluorite veins and others. The richer parts of these veins and vein swarms have formerly been mined by the Menglembu Lode Mining Company.

Field observation and microscopic studies indicate that the mineralization is structurally controlled along shear zones and multiple closely spaced shear planes. Two stages of mineralization can be recognized. The first stage of mineralization brought about the deposition of several generations of cassiterite, fluorite, quartz and other minerals in several well-defined shear fracture planes which is followed by the deposition of the "streaky bacon" ore in very closely spaced shear fractures. The streaky bacon ore substage is characterized by the deposition of quartz, cassiterite, pyrite, chlorite and minor amounts of chalcopyrite, sphalerite and tourmaline. The second stage of mineralization cross-cuts the first stage veins and consists essentially of quartz, chlorite and fluorite.

Fluid inclusions study on the quartz and fluorite indicates that the mineralizing fluids are of low salinity type and the minimum temperature of formation range from 230^{o}C to 160^{o}C.

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CHAMOSITIC AND PHOSPHATIC OOIDS IN THE TERENGGANU SHALE (LOWER MIOCENE), OFFSHORE PENINSULAR MALAYSIA

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The Terengganu Shale (lower Miocene) in the Tenggol Arch area, offshore West Malaysia, consists of generally non-bioturbated and massive, dark green mudstone deposited on a broad and relatively shallow, low-energy shelf. Thin oolitic and granule-sand layers occur in the mudstone, and are composed of mainly chamosite oolds and pisoliths, with some very coarse quartz-feldspar sand and granules, and locally abundant phosphate oolds. Phosphate concretions also occur in the mudstone.

The chamositic oolds and pisoliths are interpreted to have formed by early diagenetic alteration of reworked lateritic ooliths derived from the adjacent landmass which was undergoing tropical weathering. The ooliths were transported by rivers onto the shelf during floods, and were then reworked by storms and incorporated in the shelf muds. Phosphate oolds developed near the contemporary shelf edge, along the then active Tenggol Fault. This area was probably a site for upwelling basinal currents, analogous to present-day continental margins. Phosphate concretions formed during shallow burial diagenesis of anoxic, phosphate-rich shelf muds.

The Terengganu Shale on the Tenggol Arch records a period of maximum flooding of the Sunda Shelf at the end of a major transgression in the early Miocene. Lithological characteristics of the Terengganu Shale, supported by palynological data, indicates that this also was a period of low detrital influx possibly as a result of a relatively dry climate.

REFRACTION PROFILING ACROSS THE SHORELINE: A MODIFIED SEISMIC TECHNIQUE

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A modified shallow refraction seismic technique that permits profiling across the shoreline using a hybrid seismic equipment combination is introduced. Shallow refraction seismics on land often avoids shooting too close to the shoreline. High resolution marine profiling on the otherhand is limited in its ability to operate close to the shore because of shallow water depths. The judicious combination of both land and marine seismic equipment allows direct mapping across this neglected yet economically important land-sea boundary. Geophones and recording equipment from a regular 12-channel signal enhancement seismograph are laid out on shore perpendicular to the shoreline with the usual spacings for a shallow refraction survey. The seismic energy source is replaced instead by an electrically triggered multi-electrode sparker in the sea water moored a pre-selected distance from the first geophone planted on land. Initial tests in the Batu Ferringhi Beach, Penang indicate strong low frequency refraction arrivals from shallow sub-bottom penetration. The hybrid seismic technique is being developed for shoreline Quaternary mapping and littoral horizon identification.

EARLY MESOZOIC TECTONISM IN PENINSULAR MALAYSIA: A COMBINED STRIKE-SLIP-PLUME MODEL

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Late Palaeozoic-Mesozoic tectonism in Peninsular Malaysia is a subject of active study and debate. All published tectonic models have deficiencies of varying degrees. A satisfactory model has yet to emerge.

Models devoted to ideas of subduction and collison, though appealing, are untenable in as much as they either fail to explain, or wrongly interpret, many geological data. Results from structural and petrological studies are brought to bear upon this point.

A model based on strike-ship tectonics in conjunction with mantle plume is discussed that can accommodate most of the relevant geological features of the time.

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SOME ASPECTS OF THE HYDROGEOLOGY OF PEAT IN PENIBONG, PULAU BRUIT, SARAWAK

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A study is in progress to determine the viability of exploiting peat *per se* as a water resource. This is being investigated at Penibong, Pulau Bruit, Sarawak.

The peat, which is in varying stages of humification, is a varied mixture of wood, roots, leaves, fibres and amorphous materials; its thickness averages 3.25 m. It is almost fully saturated with moderate to good quality water. Test production-wells of various designs have been constructed in the peat with the following aims: to determine the most optimum design for exploiting the water from peat, to study its behaviour due to this exploitation and also to determine its hydraulic characteristics. In thi paper, only the determination of the hydraulic conductivity of peat is elaborated, together with a discussion on the interpretation of the pumping tests data.

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THE ROLE OF METAMORPHISM AND FAULTING IN GOLD MINERALIZATION IN PENINSULAR MALAYSIA

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The present review shows that primary gold deposits in Peninsular Malaysia are mostly hosted by metamorphic rocks of greenschist facies and tend to be concentrated along major fault zones. This distribution pattern conforms closely to that required by the metamorphic secretion theory which postulated that during metamorphism gold is mobilised from higher temperatures along fractures, redistributed and concentrated in suitable temperature zones mostly within metamorphic rocks of the greenschist facies.

During an igneous intrusion the gold is remobilised and further concentrated according to the new isotherms. This can explain why the more important gold deposits occur in the proximity of igneous intrusions but not directly traceable into them.

Damar West in West Pahang has been interpreted as a possible extinct volcanic cone thus raising the possibility that primary gold occurrences around it could be epithermal. Therefore, a different genetic model may apply. However, further work will be required to verify this.

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YOUNG FAULTS ACROSS THE QUATERNARY LUCIA-MAGDALENA VOLCANIC COMPLEX, TAMAN BUKIT TAWAU, SEMPORNA, SABAH

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The volcanic mountains crowned by the peaks Lucia (1210 m), Magdalena (1320 m), and Maria (1090 m) consist of Quaternary pyroclastics and lava flows of dacitic, andesitic and basaltic character. Some of these products have become silicified, probably through hydrothermal action. Evidence of the most recent volcanicity consists of a 24 ka old carbonised tree trunk embedded in a lava flow. In spite of its geologic youth, the complex, including the extensive lava surfaces, is transected by numerous long lineaments that occur either as single strands or as zones several kilometres wide. Common lineament directions are 340 degrees, approximately north, 10-15 degrees, 75 degrees, and east. Several of the volcanic peaks are also aligned along three of the mentioned directions, spanning distances between 4 km and 22 km. Along a few northerly trending lineaments normal faulting downthrowing to the west is suggested by triangular facets (more than a hundred metres high) and scarps facing west. A major fault zone, 3 km across and traceable over almost 30 km, is indicated by strongly developed lineaments trending approx. 10 degrees across Mount Magdalena. This interpreted fault zone is transected by many east-striking lineaments that reach lengths of 5 km.

The lineament map of the Lucia-maria-Magdalena complex should be useful for delineating mineralisation targets (along certain lineament directions or in certain rock types; at lineament crossings; in densely "fractured" terrain or otherwise) and geothermal centres (related to radial and/or polygonal lineament patterns in addition to the earlier mentioned indicators).

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DISINTEGRATION OF ROAD AGGREGATES ALONG PARTS OF THE GURUN-ALOR SETAR AND IPOH-CHANGKAT JERING HIGHWAYS

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The Gurun-Alor Setar and Ipoh-Changkat Jering Highways form part of the proposed North-South Highway stretching from Bukit Kayu Hitam in the north to Johor Baru in the south. Soon after the completion of these two stretches of the Highway, brownish streaks were seen on the road surfaces.

X-ray diffraction studies showed that these brownish streaks contained pyrites with some softer secondary minerals such as geothite, hematite, melanterite, jarosite, sulphur, mica, kaolinite and illite.

Petrographic studies carried out on quartzite and hornfels from the Gurun Quarry and on granite from an abandoned quarry near Padang Rengas which supplied aggregates for the construction of the Gurun-Alor Setar and the northwestern portion of the Ipoh-Changkat Jering Highways respectively showed that pyrites are present within the interstices of the rocks.

Oxidation of the pyrites produces iron sulphates and sulphuric acid which react with other minerals in the rock aggregates to form soft secondary minerals with a brownish stain and a large volume increase. When vehicles run over these stained pounched-up spots, the soft secondary minerals break up, causing the aggregates to disintegrate, leaving behind small cavities.

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FACIES VARIATION IN SIX CARBONATE BODIES OF NORTH SARAWAK

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Comparative sedimentological study on six carbonate bodies of Eocene to Middle Miocene age in north Sarawak were undertaken to unravel their depositional environments from their facies. These carbonate bodies are in younging order (their names are all informal):

(f) the Subis Limestone

(e) the Suai Limestone,

(d) the Batu Bertongkat Limestone,

(c) the Batu Parau Limestone,

(b) the Sungai Payang Limestone,

(a) the Batu Gading Limestone.

A small part of the Miocene of Batu Gading and a substantial part of the Subis Limestone exhibit sedimentological characters and faunal and floral content indicate the building-up of the carbonates were through processes of ecologic reef sedimentation. The other limestones were deposited essentially as piling-up of larger foraminifera either as shoal sands, storm deposits or bioclastic banks. Encrusting algae present in some horizons further bound some of these bioclasts into small patch reef boundstones. The main bodies of these carbonates were deposited in shallow marine environment. However, parts of the Subis Limestone were deposited on the reef flanks and deeper basin. The younger Miocene of the Batu Gading Limestone were probably deposited in deeper open marine setting as these are thin well-bedded biomicrite with abundant planktonic forms as well as derived shallow water bioclasts.

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STORM BEDS AS A MARINE TRANSGRESSIVE SHOREFACE AND INNER SHELF SEQUENCE IN THE J SANDSTONE, MALAY BASIN, OFFSHORE PENINSULAR MALAYSIA

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The early Miocene basal J Sandstone in the Malong Field consists of a stacked channel sequence succeeded by a transgressive shoreface and inner-shelf sequence. Progressively increasing depth of deposition in the transgressive sequence is interpreted based on micropaleontological information supported by mineralogical, physical and biogenic sedimentary structures.

Four types of storm fining-upward units are described namely: i) amalgamated planar laminated unit, ii) graded unit, iii) massive sandstone unit and iv) amalgamated bioturbated sandstone unit. Each unit is characterized by a sharp basal contact and exhibits upward increase in bioturbation rate. Features suggestive of hummocky cross-stratification are shown, by the presence of antiformal domal structures, gently undulating and laminated units, lack of grain size grading within the laminae and its restriction to coarse siltstone and very fine-grained sandstone.

The variability of these storm units are interpreted to be controlled primarily by water depth. Apart from being good time-stratigraphic markers for field scale studies, they can also be used for paleogeographic reconstruction.

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HIPOTESIS PEMBUKAAN LEMBANGAN TENGAH TRIAS: SATU ALTERNATIF

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Garis Bentong-Bengkalis merupakan suatu sutura tua yang memainkan peranan penting dalam pergerakan bahagian barat Semenanjung Malaysia bertemu bahagian timur Semenanjung semasa Paleozoik Atas. Taburan litologi Garis Bentong yang sebegitu nipis tanpa jujukan ofiolit yang jelas berjulat umur dari Silur hingga Perm, struktur di dalam olistostrom yang lazimnya menunjukkan pergerakan ke kanan, sesar mengufuk yang berjurus mengutara membuktikan adanya pergerkaan lateral ke kanan menyokong kemungkinan berlakunya pembukaan lembangan Trias melalui proses "pull-apart basin".

Pergerakan gelincir ke kanan semasa Paleozoik di sepanjang garis Bentong-Bengkalis membawa barat semenanjung bertemu timur Semenanjung semasa Perm. Semasa Perm-Trias, setelah kedua-dua bahagian bertemu, pergerakan ke kanan yang berterusan akhirnya menerbitkan satu lengkok yang mengalami transtensi dan mengakibatkan pembentukan lembangan Trias yang terisi oleh (bahan-bahan di sekitarnya) juga bahan yang berpunca daripada dalam lembangan itu sendiri yang terdiri daripada bahan letusan volkano dalam lembangan. Pembukaan lembangan terhenti apabila pergerakan ke kanan terhenti dan diganti oleh pergerakan mengufuk ke kiri yang diikuti pula dengan rejahan granit.

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THE SILANTEK AREA, SARAWAK: ITS GEOLOGY AND COAL

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The Silantek area is made up of sedimentary and igneous rocks.

The oldest sedimentary rock encountered in the study area is the Silantek Formation (Upper Eocene - Miocene ?). The formation comprises of shales, mudstones, siltstones, sandstones and coal seams. The authors have divided the formation into four facies based on lithology, sedimentary structures and environment of deposition which generally varies from deltaic to fluvial. The formation is non-conformable with the Bt. Tabong microgranite, G. Buri microgranodiorite and the Serian Volcanic formation besides being overlain conformably by the Plateau Sandstone.

The rank of the coal in the Silantek Formation varies from medium volatile bituminous to anthracite rank. The coal has low sulphur and low ash content. Geochemical analysis and the petrography of the coal indicates that the paleoenvironment of the swamp is paralic.

The Plateau Sandstone comprises of polymict massive sandstone, conglomerate and subordinate argillites. Most part of the formation is deposited in a fluvial environment.

Igneous rocks in the study area include the Bt. Tabong microgranite (Late Cretaceous ?), G. Buri microgranodiorite (Late Cretaceous ?), Serian Volcanic Formation (Upper Triassic), Bt. Tunggal dacite (Miocene ?) and numerous acidic to basic Miocene sills and dykes. The rock types of the Serian Volcanic Formation include dacite and basaltic andesite. All these igneous rocks (except the sills and dykes which are not geochemically analysed) are calcalkaline. Geochemical analysis failed to show any genetical relationship between Bt. Tabong microgranite and G. Buri microgranodiorite.

The study area formed the northern limb of the Keteongau syncline with gentle southwards dipping strata. Four predominant sets of joints and lineaments are encountered. They are probably related to the Keteongau syncline. Faults observed have strikes similar to the joint directions.

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DOLOMITISATION HISTORY OF THE SETUL LIMESTONE, NORTHWEST PENINSULAR MALAYSIA

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The Setul Limestone in Northwest Peninsular Malaysia is composed essentially of micritic carbonates rich in pellets, peloids and subordinate fossil remains. Early micritization of the allochemical constituents is fairly extensive and affected mainly crinoid plates, algal fragments and oolites. These carbonates have undergone 3 phases of dolomitization. Dolomite crystals formed from the respective phases have characteristic features. The earliest dolomites are very fined-grained with orangish-red cathodoluminesence. In contrast, the second generation dolomites are several times larger, euhedral, and exhibit zoning, with brownish to opaque-rich cores and clear outer zones. CL of these dolomites pick out at least 3 major zones. The third generation dolomites are composed of large euhedral saddle dolomites, the smaller variety is generally unzoned while the coarser one is zoned. The occurrence of the earliest dolomites in the limestone is pervasive, affecting both allochems and orthochems. The formation of these dolomites is very early and is interpreted to have occurred before the formation of marine calcite cement that lithified the rocks. The formation of the second generation dolomites took place before the limestones have suffered subaerial diagenesis and before the formation of stylolites in the rocks. The occurrence of these dolomites in allochems and orthochems favour the interpretation that they were recrystallized from the earliest fine-grained dolomites. The distribution of saddle dolomites is restricted mainly to late fractures, secondary vugs and stylolites, and must have formed in deep burial conditions. The 3 types of dolomites in the Setul Limestone have also undergone various degrees of dedolomitization. Phases of dedolomitization is related to subaerial diagenesis and to the migration of silica-saturated fluids through the limestones.

ASSESSMENT OF THE QUALITY AND QUANTITY OF SOME LIMESTONE RESOURCES FROM THE NORTHERN PERAK REGION, MALAYSIA

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An assessment of the quality and quantity of some limestone resources was carried out in the Northern Perak region in order to better plan quarrying operations as well as to control more effectively, the quality of materials fed to the cement plants. The project involved several phases of work including surface mapping and sampling, diamond drilling, topographic projection using aerial photographic surveys and chemical analyses of all major oxides (SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO) using X-ray fluorescence technique. The Northern Perak region under study comprises a series of karst-dominated, irregular hills. This has given rise to various zones enriched in silica, magnesium or calcium and depletion in other elements. The different grades of limestones delineated, may be used for different purposes.

QUATERNARY GEOLOGICAL MAPPING OF THE KOTA SAMARAHAN SUB-REGIONAL CENTRE STUDY AREA, SARAWAK

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Quaternary geological mapping was carried out in the Kota Samarahan area to obtain geologic data for land-use planning in the Kota Samarahan Sub-regional Centre study area.

The whole study area is covered by Quaternary soft sediments. Two sedimentary facies: floodplain deposits and paludal deposits are exposed in the area. Both deposits are deposited on the deltaic/estuarine deposits and residual soil/bedrock.

The paludal deposits are not suitable for engineering works and severe problems are expected if they are to be used as foundation level for construction. The floodplain deposits is suitable for engineering works if sufficient ground improvement has been done.

Other geologic constrains in the study area include bank erosion, lack of construction materials and deep foundation level.

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A SURVEY OF SLOPE FAILURES ALONG THE SENAWANG-AIR KEROH HIGHWAY, NEGERI SEMBILAN/MELAKA

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The Senawang-Air Keroh Highway is about 60 km in length and traverses four different lithological units, namely: quartz-mica schist, quartzite/phyllite, graphitic schist and granite. Some 112 cut slopes and 106 enbankment slopes along this highway have been surveyed and categorised in terms of slope stability using the following common scheme: category 'A' for major failures, category 'B' for minor failures/erosion/gullying problems, and category 'C' for stable slopes.

The results of the surveys indicate that for the cut slopes, the graphitic schist is the most problematical material followed by the quartz-mica schist, quartzite/phyllite, and then granite. The breakdown for category 'A' cut slopes being: graphitic schist (8), quartz-mica schist (3), and phyllite (1), making a total of 12 category 'A' cut slopes. The breakdown for cateogry 'B' cut slopes is as follows: graphitic schist (11), quartz-mica schist (8), and quartzite/phyllite (6), i.e. totalling 25 for category 'B' cut slopes. In addition to lithologies, other geological factors affecting the stability of the cut slopes include the grade of weathering and the nature and orientation of the fracture planes (foliations, etc.). The stability of the graphitic schist cut slopes is further exercebated by its highly fractured nature, with fractures infilled by soft clay, the formation of secondary minerals from the oxidation of pyrite in the graphitic schist, and the resulting low pH conditions.

The embankment slopes also showed several major and minor failures. The breakdown for category 'A' embankment slopes being: graphitic schist (1), quartz-mica schist (7), and quartzite/phyllite (2), making a total of 10 category 'A' embankment slopes some of which are currently under repair. The category 'B' enbankment slopes consist of graphitic schist (1), quartz-mica schist (1), quartzite/phyllite (7), and unknown materials (3), i.e. totalling 12. The correlation between enbankment slope failures with lithologies or material types is, however, not well established.

CERAMAH TEKNIK (TECHNICAL TALKS)

Azhar Hj. Hussin: Messages in Ancient Carbonates: Decoding Signals in Tertiary Limestones of North Sarawak.

Dr. Azhar of the Geology Dept., University of Malaya gave the above talk at the Conference Room, Geological Survey Malaysia, Kuching, Sarawak on 31st May 1990 (Thursday) at 2.30 p.m.

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SEMINAR ON STRATIGRAPHIC FRAMEWORK OF OFFSHORE BASINS IN MALAYSIA: BASIS, APPLICATIONS AND PROBLEMS

30 June 1990
Ming Court Hotel, Kuala Lumpur.

Laporan (Report)

This one-day seminar organized by Nik Ramli of FORAD on behalf of the society and sponsored by CORE Lab received overwhelming response and the 35 places available were quickly taken up.

Nik Ramli began with an introduction of the various attempts made in the past to correlate the Tertiary sedimentary basins in the Gulf of Thailand and the South China Sea by both ASCOPE, CCOP and the various petroleum companies each with their own scheme.

T. Suntharalingam of the Geological Survey of Malaysia followed with his talk on the stratigraphic practice of the Geosurvey concentrating mainly on lithostratigraphy based on mappability of units on-land.

Wong Chung Lee of Sarawak Shell Bhd. talked on the sedimentary cycle concept applied by SHELL in the stratigraphy of Northwest Sarawak where fossils are found and could be used to delineate the cycles.

In his talk on the chronostratigraphy in Blocks PM-5 and PM-8, Lye Yew Hong of ESSO Production Malaysia Inc. showed the importance of applying seismic stratigraphy for correlation in the Malay Basin where diagnostic fossils are rare to totally absent due to unfavourable paleoenvironmental conditions.

Jaizan Hardi of Petronas Research Institute gave a talk on the critical aspects of biostratigraphic schemes with special reference to palynostratigraphy in offshore Malaysia Basins. Palynostratigraphy was especially important in the earlier cycles where marine fossils were absent.

Finally, Tom Romein of CORE Laboratories presented his paper on the calibration of stratigraphic events in the Sarawak and Malay Basins in which he reviewed the various schemes used and also suggested that perhaps genetic sequence stratigraphy where condensed sequences between unconformities should be used for correlation rather than unconformities as are currently used.

Discussion was lively after each speaker has said his piece and the final proposal by Tom Romein was that one must state which zonation one is using when publishing so that your reader can be certain which scheme is adopted by you.

C.P. Lee

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SEMINAR ON STRATIGRAPHIC FRAMEWORK OF OFFSHORE BASINS IN MALAYSIA
- Captions to photos (Taken by C.P. Lee)

1. Organising Chairman, Nik Ramli, welcoming the participants.
2. Ahmad Said, GSM President, with his Opening Address.
3. Nik Ramli with introductory remarks on correlating Tertiary Sedimentary basins.
4. The good turnout at the Seminar.
5. T. Suntharalingam of Geological Survey Malaysia.
6. A question from the floor.
7. A view of the participants at the front.
8. Wong Chung Lee of Sarawak Shell Bhd.
9. The participants at the back.
10. Lye Yue Hong of Esso Production Malaysia Inc.
11. Session Chairman, Herman Soediono of Sarawak Shell Bhd.
12. Coffee break.
13. Jaizan Hardi of Petronas Research Institute.
14. Another view of participants at the front.
15. Tom Romein of Core Laboratories.

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SEMINAR ON STRATIGRAPHIC FRAMEWORK OF OFFSHORE BASINS IN MALAYSIA

BERITA-BERITA PERSATUAN
(NEWS OF THE SOCIETY)

KEAHLIAN (MEMBERSHIP)

The following applications for membership were approved:

Full Members

1. Goh Cheok Weng, BHP Minerals, Lot 2.16/2.2, 2nd Fl., Block C, No. 76, Kuwasa Complex, 88000 Kota Kinabalu, Sabah.
2. Robert E. Hulsbos, Core Lab., Lot 10-B, Jalan 51A/223, 46100 Petaling Jaya.
3. Lee Swee Kwong, Yazman Hume Quarries, Jalan 219, Off Federal Highway, 46700 Petaling Jaya.
4. Azman Samsudin, Geoservices East Inc., 54 Loyang Way, Singapore 1750.
5. Rudolf J. Poort, Core Lab., Lot 10-B, Jalan 51A/223, 46100 Petaling Jaya.
6. Ian M. Cross, IEDS Rep. Office, 12-01 Hong Leong Bldg., 16 Raffles Quay, Singapore 0104.
7. Trevor J. Magee, WMC Petroleum, 12th Floor, Bgn. Getah Asli, 148, Jalan Ampang, 50450 Kuala Lumpur.
8. Lionel Tan Tuang, Global Minerals (S) Sdn. Bhd., 114 Green Road, 93712 Kuching, Sarawak.
9. Chew Poh Leng, Asia Mining Sdn. Bhd., No. 1, Pesiaran Lidcol, Off Jalan Yap Kwan Seng, 50450 Kuala Lumpur.

Associate Member

1. Elton Frost, Jr., Atlas Wireline Services, Bldg. 103, Cilandak Commercial Estate, Cilandak K K O, Jakarta Selatan, Indonesia.

Student Members

1. Ng Chiang Seng, Jabatan Geologi, UKM, Bangi.
2. Ho Chen Teck, Jabatan Geologi, UKM, Bangi.
3. Dominic Yap Kam Fai, Jabatan Geologi, UKM, Bangi.
4. Lim Sze Chiang, Jabatan Geologi, UKM, Bangi.
5. Sanatulsalwa bt. Hasan, Jabatan Geologi, UKM, Bangi.
6. Baba b. Musta, Jabatan Geologi, UKM, Bangi.
7. Rohayu bte. Che Omar, Jabatan Geologi, UKM, Bangi.
8. Nasaruddin Ahmad, Jabatan Geologi, Universiti Malaya, 59100 K. Lumpur.
9. Hong Boo Eng, Jabatan Geologi, Universiti Malaya, 59100 Kuala Lumpur.
10. Radha Raman Maury, Jabatan Geologi, Universiti Malaya, 59100 K. Lumpur.
11. Rogayah Hj. Tayib, Jabatan Geologi, Universiti Malaya, 59100 K. Lumpur.
12. M.R. Subramaniam, Jabatan Geologi, Universiti Malaya, 59100 K. Lumpur.
13. S. Srimuralitharan, Jabatan Geologi, Universiti Malaya, 59100 K. Lumpur.
14. Aminuddin Yahya, Jabatan Geologi, Universiti Malaya, 59100 K. Lumpur.
15. Siti Faridah Yusup, Jabatan Geologi, Universiti Malaya, 59100 K. Lumpur.
16. Azman Abdullah, Jabatan Geologi, Universiti Malaya, 59100 K. Lumpur.
17. Azman Salleh, Jabatan Geologi, Universiti Malaya, 59100 K. Lumpur.

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PERTUKARAN ALAMAT (CHANGE OF ADDRESS)

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

1. R.P.B. Pitt, 14 Owston St., Mosman Park, Western Australia 6012, Australia.
2. Cheah Tik Wah, c/o Mainline Resources (o.s.) Ltd., Suite 602A, Setiabudi 2 Bldg., Jl H.R. Rasuna Said, Kuningan, Jakarta 12920, Indonesia.
3. Azhar Yusof, AGIP, P.O. Box 11496, 50748 K. Lumpur.
4. B.S. Hodges, 588, Jalan 17/17, 46400 Petaling Jaya.
5. E.F. Durkee, Sogutozu Caddesi 55, 06520 Ankara, Turkey.
6. Chung Kwong Yian, Fugro (Hong Kong) Ltd., 11/F, Park Commercial Center, 2-12, Shelter Street, Causeway Bay, Hong Kong.
7. Daud A.F. Batchelor, Earth Sciences Department, Sultan Qaboos University, P.O. Box 32486, Al-Khod, Sultanate of Oman.
8. Koay Leong Thye, 642/12, Taman Sema, Off Jalan Melang, 72000 Kuala Pilah, Negeri Sembilan.
9. Cheang Kok Keong, 38, Leboh Perajurit 1, Taman Perak, 31400 Ipoh.
10. Lee Fook Weng, B.K. Lim & Co., 38, Tuas Crescent, Singapore 2263.
11. Aw Peck Chin, 3 Jalan Lengkok Gopeng, Taman Golf, 31350 Ipoh, Perak.
12. Sven Laufeld, Täljstensvägen 1, S-752 40 Uppsala, Sweden.
13. Tong Pow Mun, Racal Survey Limited, South Denes, Great Yarmouth, Norfolk NR30 3NU, England.
14. Ciceron A. Angeles Jr., 146 Jalan Bidayuh, 93200 Kuching, Sarawak.
15. Elmer C. Antioquia, 146 Jalan Bidayuh, 93200 Kuching, Sarawak.
16. Ramon Antonio L. Flores, 146 Jalan Bidayuh, 93200 Kuching, Sarawak.
17. Chen Shyong Chang, 146 Jalan Bidayuh, 93200 Kuching, Sarawak.
18. Tim Morison, 15 Bowling Place, Melville W.A. 6156
19. Kazuo Asama, Mogusa 923-7, Hino-shi, Japan 191.
20. Ienori Fujuyama, Shirako 3-19-6-502, Wako-shi, Saitama, Japan 351-01.
21. Chan Kiang Chee, TB 1785, Taman Gek Poh, Mile 1, Jalan Kuhara, 91000 Tawau, Sabah.

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PERTAMBAHAN BARU PERPUSTAKAAN (NEW LIBRARY ADDITIONS)

The Society has received the following publications:

1. The application of version 3.0A software in tin slag analysis by Kartiwa Sumadi. 1989.
2. How to set up an XRF laboratory by Kartiwa Sumadi. 1989.
3. Bedrock profiling using mining geostatistics of Redang Sawa District (Malaysia) by Eric Goh, *et al.* 1989.
4. Living & fossil macrocyprididae (Ostracoda) by Rosalie F. Moddocks. 1990.
5. Earthquakes & volcanoes, vol. 21, no. 1, 3 & 4, 1989.
6. Costam Newsletter, no. 1, 1990.
7. Application of geophysics in the tin mining industry edited by M.M. Purbo Hadiwidjoyo. 1989.
8. AAPG Explorer, June 1990.
9. Berliner Geowissenschaftliche Abhandlungen, Band 108, 109 110, 112, 113, 116, 117, 120.1 & 120.2, 1989.

10. An introduction to the geology of Taiwan Explanatory text of the geologic map of Taiwan by C.S. Ho. 2nd ed. 1988.
11. IMM Bulletin 993, 1990.
12. Science Reports of the Institute of Geoscience, University of Tsukuba, vol. 11, 1990.
13. Palaeontologia Sinica, no. 178, 1989.
14. Memoirs of Nanjing Institute of Geology & Palaeontology, no. 26, 1989.
15. Bulletin of Nanjing Institute of Geology & Palaeontology, no. 12, 1987.
16. Chronique de la recherche miniere. no. 497, 1989.
17. Seatrad Centre, Report of investigation nos. 77 & 78, 1989.
18. AGID News, no. 60, 1989.
19. Guidebook of Excursions in the German Democratic Republic, May/June 1989.
20. Silicic magmatism & metallogenesis of the Erzgebirge. 1989.
21. Petro- und palaomagnetische untersuchungen an jungquartaren, sedimenten der Ostsee. 1989.
22. Principles, policies and procedures: domestic geographic names. 1989.
23. Estimates of undiscovered conventional oil and gas resources in the U.S. - a part of the Nation's energy endowment. 1989.
24. U.S.G.S. Bulletin (1989): 1903, 1747-C, 1872, 1702-J, 1808-E, F, 1787-L, 1899, 1871, 1865, 1808-B-D, 1705-E, 1880, 1741-C, 1884, 1755-A, 1912, 1741-D, 1702-D, 1857-B, 1737-A, 1902.

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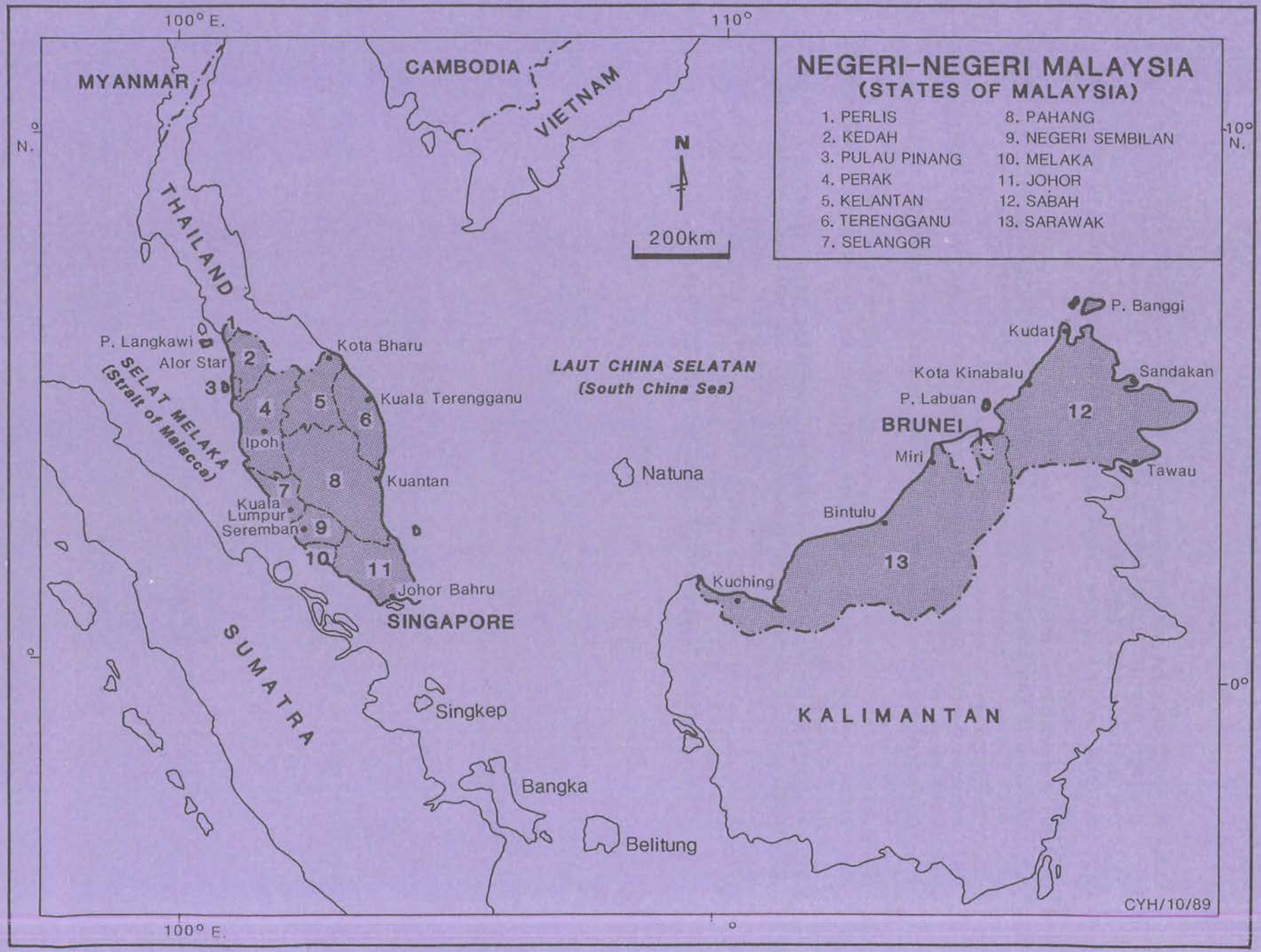
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NEGERI-NEGERI MALAYSIA
(STATES OF MALAYSIA)
1. PERLIS
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3. PULAU PINANG
4. PERAK
5. KELANTAN
6. TERENGGANU
7. SELANGOR
8. PAHANG
9. NEGERI SEMBILAN
10. MELAKA
11. JOHOR
12. SABAH
13. SARAWAK
10° N.
THAILAND
P. Langkawi
Alor Star
Kota Bharu
Kuala Terengganu
Ipoh
Kuantan
Kuala Lumpur
Seremban
Johor Bahru
SINGAPORE
SELAT MELAKA
(Strait of Malacca)
LAUT CHINA SELATAN
(South China Sea)
Natuna
P. Banggi
Kudat
Kota Kinabalu
Sandakan
P. Labuan
BRUNEI
Miri
Tawau
Bintulu
Kuching
KALIMANTAN
SUMATRA
Singkep
Bangka
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