PP 2509/8/97

ISSN 0126-5539

PERSATUAN GEOLOGI MALAYSIA

WARTA GEOLOGI

NEWSLETTER OF THE GEOLOGICAL SOCIETY OF MALAYSIA

GEOLOGICAL SOCIETY OF MALAYSIA

Jilid 24
No. 5

Volume 24
No. 5

Sept– Oct
1998

KANDUNGAN (Contents)

DIKELUARKAN DWIBULANAN
ISSUED BIMONTHLY

PERSATUAN GEOLOGI MALAYSIA
Geological Society of Malaysia

Majlis (Council) 1998/99

Presiden (President)	:	Ibrahim Komoo
Naib Presiden (Vice-President)	:	S. Paramananthan
Setiausaha (Secretary)	:	Ahmad Tajuddin Ibrahim
Penolong Setiausaha (Asst. Secretary)	:	Mazlan Madon
Bendahari (Treasurer)	:	Lee Chai Peng
Pengarang (Editor)	:	Teh Guan Hoe
Presiden Yang Dahulu (Immediate Past President)	:	Khalid Ngah

Ahli-Ahli Majlis (Councillors)

1998–2000

M. Selvarajah
Abd. Ghani Mohd Rafek
Tajul Anuar Jamaluddin
Muhinder Singh

1998–1999

Azhar Hj. Hussin
K.K. Liew
Kadderi Md. Desa
Tan Boon Kong

Jawatankuasa Kecil Pengarang (Editorial Subcommittee)

Teh Guan Hoe (Pengerusi/Chairman)

Fan Ah Kwai Ng Tham Fatt J.J. Pereira

Lembaga Penasihat Pengarang (Editorial Advisory Board)

Aw Peck Chin	Foo Wah Yang	Mazlan Madon	Tan Boon Kong
Azhar Hj. Hussin	C.A. Foss	Ian Metcalfe	Tan Teong Hing
K.R. Chakraborty	N.S. Haile	S. Paramananthan	Teoh Lay Hock
Choo Mun Keong	C.S. Hutchison	Senathi Rajah	H.D. Tjia
Chu Leng Heng	Lee Chai Peng	Shu Yeoh Khoon	Wan Hasiah Abd.
Denis N.K. Tan	Leong Lap Sau	P.H. Stauffer	Yeap Cheng Hock

About the Society

The Society was founded in 1967 with the aim of promoting the advancement of earth sciences particularly in Malaysia and the Southeast Asian region.

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

Published by the Geological Society of Malaysia,
Department of Geology, University of Malaya, 50603 Kuala Lumpur.
Tel: 603-757 7036 Fax: 603-756 3900 E-mail: geologi@po.jaring.my

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

CATATAN GEOLOGI
Geological Notes

Chemistry of biotite from the Noring pluton, Stong complex, north Peninsular Malaysia

AZMAN ABDUL GHANI
Department of Geology
University of Malaya
50603 Kuala Lumpur

Abstract: The Stong complex is located in the northern part of Peninsular Malaysia and consists of three components, namely, Berengkat tonalite, Kenerong microgranite and Noring pluton. The Noring pluton which is the largest body of the complex consists of plagioclase, K-feldspar, quartz, biotite, hornblende, sphene, apatite, magnetite, allanite and zircon. The biotite is slightly magnesium rich with 11.5 to 12.5% MgO and a Mg/(Fe + Mg) value of 0.48 to 0.55. Contents of other elements are typically: 17.15–19.1% FeO, 8.9–10.1% K_2O, 0.1–2.2% BaO and 2.1 to 3.3% TiO_2. Variation within crystal also occurs, thus from core to rim, Ti, Al^{vi} and CaO increase whereas Ba, Al^{iv} and Fe decrease. On the XMg vs Si plot, biotite from the Noring granite plot in the phlogopite field. The biotite composition appears to be defined by oxygen fugacities near to those of the Fe_2SiO_4-SiO_2-Fe_3O_4 buffer. It has been estimated that the biotite crystallised at temperatures of 740 to 780°C and log fO_2 of about -13.

INTRODUCTION

The Stong complex is located north of Peninsular Malaysia and consists of three components, namely, the Berengkat tonalite, Kenerong microgranite and Noring pluton (Fig. 1). The complex lies to the southwest of the Kemahang granite and immediately east of the Main Range batholith. It was dated as Cretaceous age (Bignell and Snelling, 1977; Cobbing *et al.*, 1992) and was emplaced into metasedimentary rocks that comprise of sillimanite gneisses and calc silicate gneisses.

The largest granite body in this complex, the Noring pluton is an oval shaped body (Fig. 1) aligned in a northerly direction with dimensions of approximately 30 x 20 km (Cobbing and Mallick, 1987). The pluton has been divided into 2 main facies that is, (1) Terang facies which occurs along the eastern side of the pluton and consists of K-feldspar megacrysts granite with biotite as the only mafic phase and (2) Belimbing facies of biotite hornblende granite which occurs in the central parts of the pluton (Cobbing and Mallick, 1987). The aim of this paper is to provide the chemistry of biotite from the Noring granite and to compare the biotite chemistry of the granite to other granites from Peninsular Malaysia.

PETROLOGY

Singh *et al.* (1984) grouped the Stong complex as part of the Eastern granitic Belt of Peninsula Malaysia. They showed that on grounds of textural and mineralogical composition the Berengkat tonalite and Noring granite are similar to those from the Eastern Belt. The Noring granite is undeformed and consists of distinctive pink K-feldspar megacryst of biotite to biotite hornblende granite (Cobbing *et al.*, 1992). The principal mineral phases are plagioclase, K-feldspar, quartz, biotite, hornblende, sphene, apatite, magnetite, allanite and zircon. Plagioclase is euhedral to subhedral with average composition of An_{30-40}. Zoning of both normal and oscillatory types can be seen in most plagioclase crystals. Inclusions of small

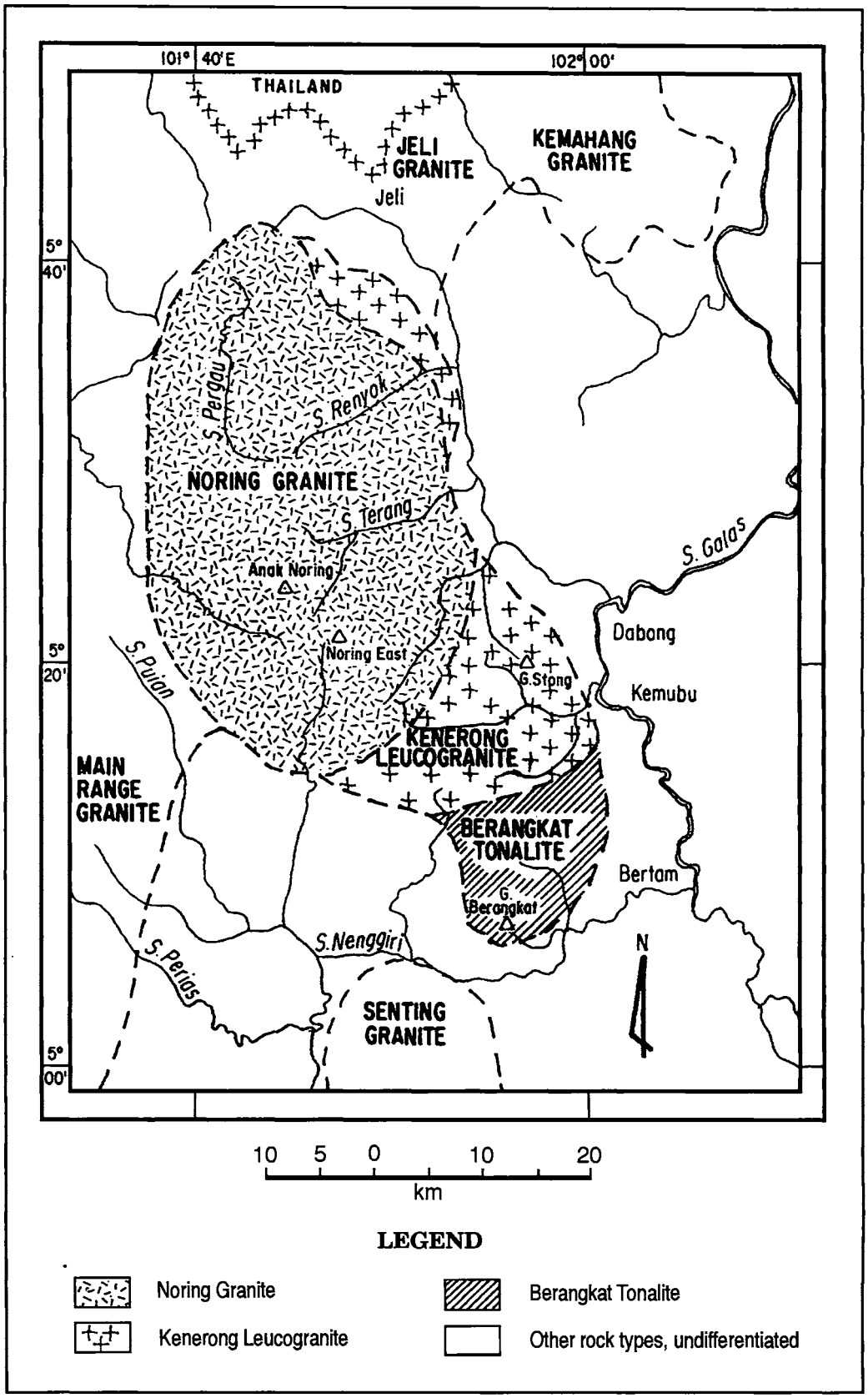


Figure 1. Map showing the location of Noring granite and Stong complex.

biotite, hornblende and magnetite sometimes occur at the core of the crystal (Fig. 2). Large, pink K-feldspars, up to 3 cm across often give the rock a distinctly porphyritic appearance in hand specimen. The main type is perthitic K-feldspar, which often shows an euhedral outline in hand specimen but sometimes appears to be very irregular in thin section. The crystals are sometimes rimmed by smaller, euhedral to subhedral plagioclases which give distinctive mantle feldspar texture (Azman, 1998). Quartz occurs either as anhedral crystals clustered together with serrate grain boundaries or as interstitial pockets (Fig. 3). The latter usually occurs within clusters of K-feldspar and plagioclase. This texture suggests that quartz crystallised after the feldspars had formed an interlocking framework (Bryon *et al.*, 1994; 1995).

Hornblende is euhedral to anhedral with size up to 5 mm across. The pleochroic scheme is X = Y = brown green and Z = green. It usually occurs in mafic aggregates associated with apatite, magnetite and biotite. Biotite occurs as subhedral to anhedral grains up to 4 mm across. It is found as isolated grains or inclusions in other minerals (e.g. feldspars). More typically the biotite forms aggregates comprised of several biotite grains as well as other minerals (e.g. hornblende). These aggregates commonly occur along the margins of larger grains of feldspar or quartz. Biotite exhibit light to dark brown pleochroism and slight bending and kinking of the plates sometimes occur. Zircon and apatite are common inclusions in biotite.

GEOCHEMISTRY

Before discussing the chemistry of biotite from the Noring pluton, it is necessary to briefly discuss the whole rock geochemistry of the granites. The major and trace elements data for the Noring granites used in this section are taken from Cobbing *et al.* (1992). Representative analyses are given in Table 1. Geochemistry of this pluton shows that it is metaluminous (ACNK between 0.88 to 0.97) (Shand, 1943) with SiO_2 ranging from 62.51 to 70.46% (Cobbing *et al.*, 1992). The rocks have high alkali content, with $Na_2O + K_2O$ ranging between 7.82–8.71%. On a K_2O vs SiO_2 diagram (Peccerillo and Taylor, 1976), all samples plot in the high-K calc alkaline field. None of the five analysed samples have normative corundum (C = 0). On a Na_2O vs K_2O plot, all samples plot in the 'I' type field of White and Chappell (1983). The 'I' type nature of the granite is further support by the occurrence of sphene and hornblende.

Table 1. Representative major element analyses of the Noring granite (data taken from Cobbing *et al.*, 1992).

Sample No.	166	164
SiO_2	62.51	70.46
Al_2O_3	16.30	14.36
TiO_2	0.83	0.39
Fe_2O_3	1.03	0.62
FeO	3.50	1.83
MgO	2.43	0.99
CaO	3.91	2.21
Na_2O	4.24	3.84
K_2O	3.90	4.50
MnO	0.06	0.03
P_2O_5	0.41	0.19
Total	99.61	99.79

BIOTITE CHEMISTRY

Representative biotite compositions from the Noring granite is given in Table 2. Structural formulae have been calculated on a basis of 22 oxygen. For classification purposes all the biotite from the Noring pluton are plotted in the XMg vs Si and Mg^{2+} vs $Al^{iv} + Fe^{3+} + Ti$ vs $Fe^{2+} + Mn$ (Foster, 1960) diagrams. On a XMg vs Si plot (Fig. 4), biotite from the Noring granite plot in the phlogopite field. On a Mg^{2+} vs $Al^{iv} + Fe^{3+} + Ti$ vs $Fe^{2+} + Mn$ diagram (Fig. 5) the biotites plot towards the field of Mg^{2+} biotite.

Abdel Rahman (1994) demonstrated that the chemistry of biotite in granitic rocks depends largely upon the nature of the magma. He showed that using several discriminant diagrams e.g. FeO* vs MgO-Al_2O_3, FeO* vs MgO, Al_2O_3 vs MgO where FeO* = [FeO + (Fe_2O_3 x 0.89981)], biotite from different environments (calc-alkaline, alkaline and peraluminous suite) can be distinguished. Biotites from Noring granite plot in the calc-alkaline field on a Al_2O_3-MgO

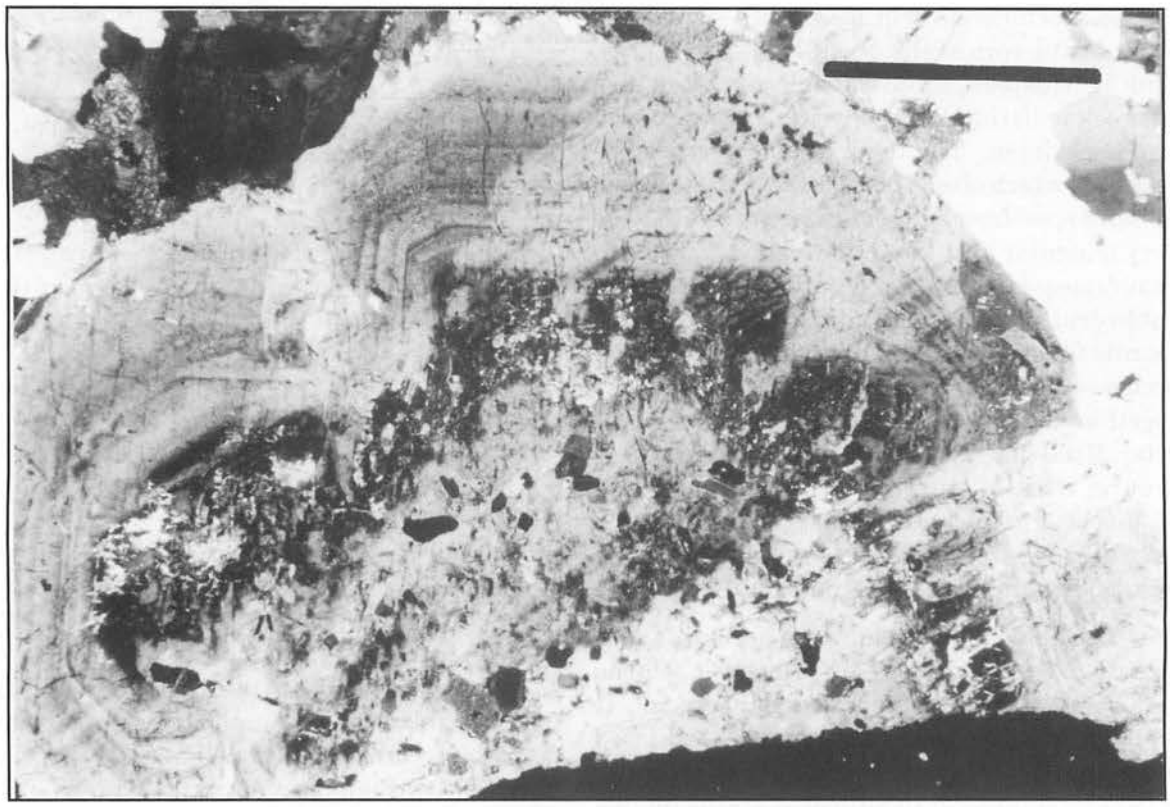


Figure 2. Photomicrograph showing plagioclase with corroded core. Note the inclusions of small biotite, hornblende and magnetite crystals (Scale bar: 2 mm).

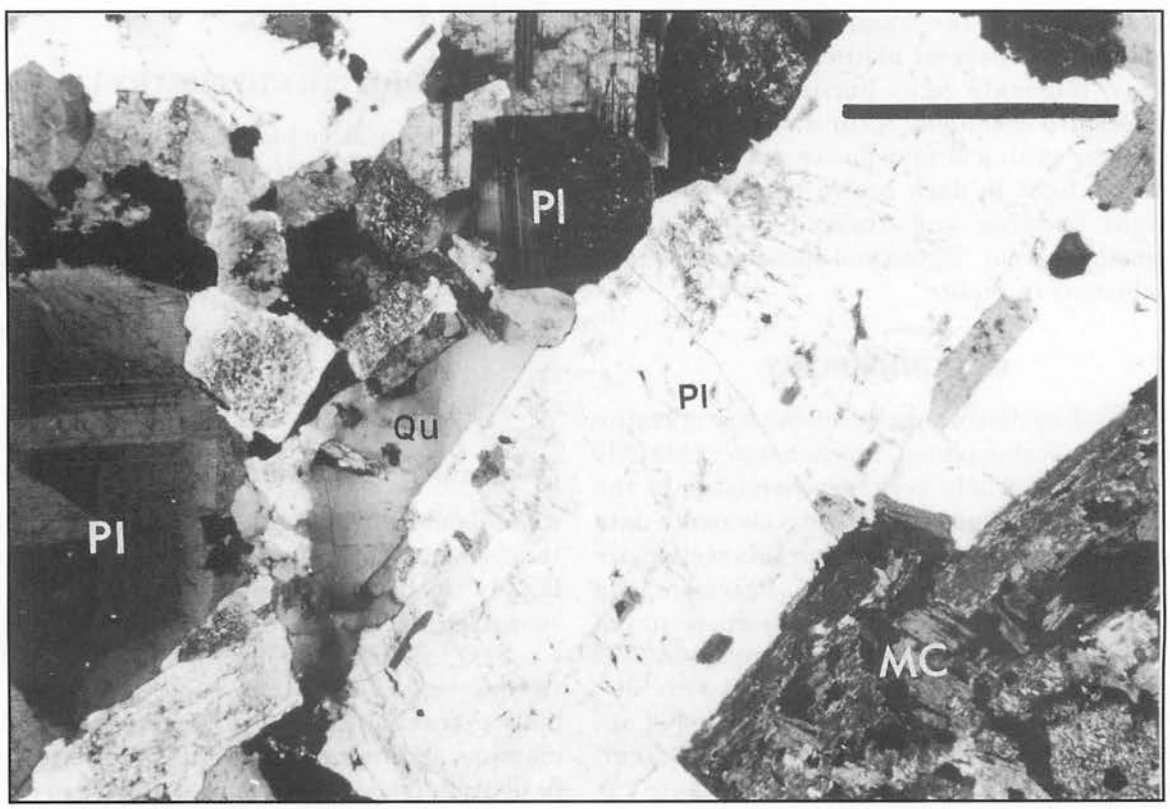


Figure 3. Photomicrograph showing interstitial quartz surrounded by plagioclase crystals. Qu: Quartz, Pl: Plagioclase, MC: Mafic clot (Scale bar: 2 mm).

Table 2. Representative biotite analyses and structural formulae (calculated on a basis of 22 oxygen) of the Noring granite.

Sample No. Loc	21(7) core	21(8) rim	21(9) core	21(10) core	21(8') core	PR11(7) core	PR11(8) rim
SiO2	37.29	37.44	37.67	36.88	36.79	37.63	37.36
TiO2	2.69	2.77	3.27	2.98	2.98	2.77	2.66
Al2O3	13.32	13.18	13.40	12.76	13.03	13.04	13.15
Cr2O3	0.09	0.04	0.08	0.00	0.00	0.15	0.08
FeO	18.76	18.99	18.34	18.06	18.86	18.65	18.50
MgO	12.81	12.52	12.82	12.36	12.18	12.73	12.74
CaO	0.03	0.01	0.00	0.00	0.00	0.04	0.07
Na2O	0.32	0.44	0.34	0.33	0.43	0.49	0.32
K2O	9.21	9.36	9.35	9.26	9.18	9.35	8.94
BaO	0.48	0.19	0.34	0.75	0.29	0.69	0.11
Total	95.13	95.06	95.68	93.58	94.08	95.63	94.02
Structural formulae on basis of 22 oxygen							
Si	5.71	5.73	5.71	5.75	5.71	5.74	5.76
Al^{iv}	2.29	2.27	2.29	2.25	2.29	2.26	2.24
Z site	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Al^{vi}	0.11	0.11	0.10	0.09	0.09	0.09	0.15
Cr	0.01	0.01	0.01	0.00	0.00	0.02	0.01
Fe^{3+}	0.26	0.27	0.26	0.26	0.27	0.26	0.26
Fe^{2+}	2.14	2.16	2.07	2.10	2.18	2.12	2.12
Mg	2.92	2.86	2.90	2.87	2.82	2.90	2.93
Ti	0.31	0.39	0.37	0.35	0.35	0.32	0.31
Y site	5.75	5.80	5.71	5.67	5.70	5.71	5.77
Ca	0.01	0.00	0.00	0.00	0.00	0.01	0.01
Na	0.09	0.13	0.10	0.10	0.13	0.14	0.10
K	1.80	1.83	1.81	1.84	1.82	1.82	1.76
Ba	0.03	0.01	0.02	0.05	0.02	0.04	0.01
X site	1.93	1.97	1.93	1.99	1.96	2.01	1.87

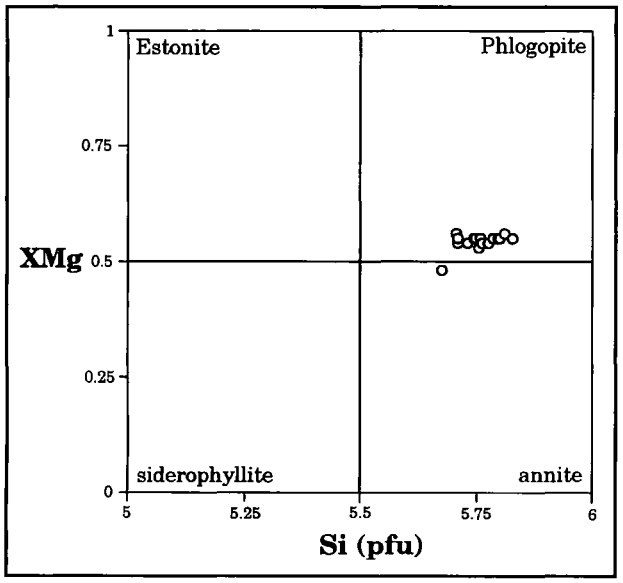


Figure 4. XMg vs Si plot for biotite from the Noring granite.

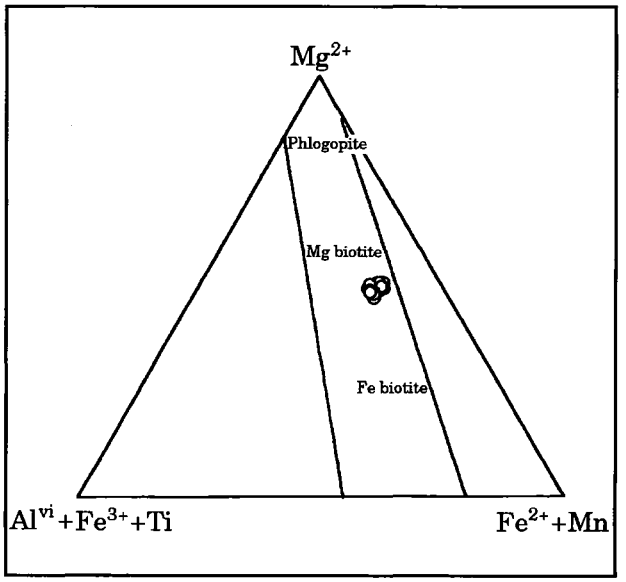


Figure 5. Mg^{2+} vs Al^{iv} + Fe^{3+} + Ti vs Fe^{2+} + Mn plot (Foster, 1960) for biotite from the Noring granite.

diagram (Fig. 6). The calc alkaline nature of the biotite from the Noring granite is comparable to the whole rock analyses which also have calc alkaline affinities.

The biotite compositions have a slight deficiency in the Y sites (5.46 to 5.79 based on the 22 p.f.u) compared to the ideal value (6) in the end members of trioctahedral micas. It is slightly magnesium rich with 11.5 to 12.5% MgO and a Mg/(Fe + Mg) value of 0.48 to 0.55 (mean 0.54; n = 17). It also has higher Ba content with 0.1–2.2% BaO (mean 0.72%; n = 17). Ti content range from 2.1 to 3.3% (mean: 2.8%). Considering the different combinations of possible substitution mechanisms, the best fit for Ba is by plotting $Si^{iv} + Al^{vi}$ vs $Al^{iv} + Ti^{iv}$ (Fig. 7). Contents of other elements are typically: 17.15–19.1% FeO and 8.9–10.1% K_2O. Variation within crystal also occurs, thus from core to rim, Ti, Al^{vi} and CaO increase whereas Ba, Al^{iv} and Fe decrease.

Chemistry of the biotite from the Noring granite has been compared to biotite from the Eastern and Western Belt granites of Peninsular Malaysia [data taken from Liew (1983) and Kumar (1985)] and I/S type granite from the Lachlan Fold Belt Australia. On a Al^{vi} vs Fe/Fe + Mg plot (Fig. 8), biotites from the Noring granite have a very narrow Fe/Fe + Mg ratio compared to the biotites from the Eastern Belt granite. K_2O content of the Noring biotite is comparable to biotite from Eastern Belt granites ($K_2O > 9\%$; Liew, 1983). However, TiO_2 content is slightly lower compared to the latter.

On a Al^{iv} vs Fe/Fe + Mg diagram (Fig. 9) the biotite analyses plot in the same field with the biotite from the I-type (e.g. Jindabyne granite) of the Lachlan Fold Belt, Australia. The biotite has low Al^{iv} compared to the biotite from the S-type rocks (Strathbogie granite) (Bukhard, 1993).

ESTIMATED OXYGEN FUGACITY ON BIOTITE COMPOSITION

Wones and Eugster (1965) carried out the main investigations on the stability of biotite. They discussed the variations in composition of biotite along the phlogopite-annite join with changing temperature, oxygen fugacity (fO_2) and pressure. The oxygen fugacities were defined by a number of oxygen buffers which included the Fe_2O_3-Fe_3O_4 (HM), Ni-NiO (NNO) and SiO_2-Fe_2SiO_4-Fe_3O_4 (QFM) buffers. The estimated position of the biotite solid solutions for each of these buffers is shown in Figure 8 together with the composition of the biotite from the Noring pluton. As the Fe^{3+} contents were not determined separately, the Fe^{3+} in the biotites were recalculated so that $Fe^{3+}/(Fe^{2+} + Fe^{3+}) = 0.11$ (Mason, 1982). The general trend shown by the biotite from the Noring granite is parallel to the estimated composition of biotite solid solution for individual buffers. This trend suggests that consanguineous granitoid was buffered during crystallisation, fO_2 increasing with decreasing temperature. The plot shows

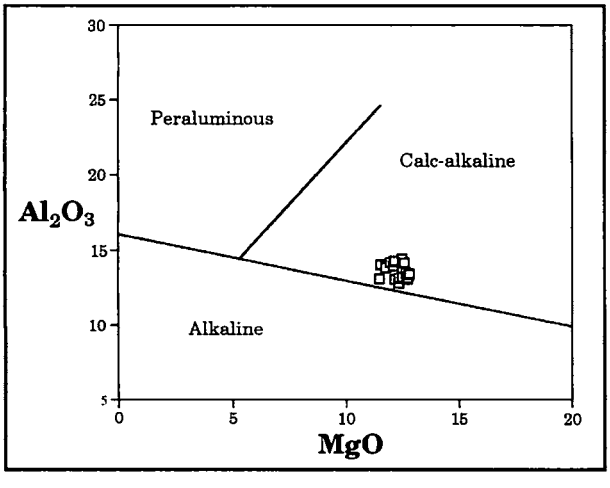


Figure 6. Al_2O_3 vs MgO plot (after Abdel Rahman, 1994) for biotite from the Noring granite.

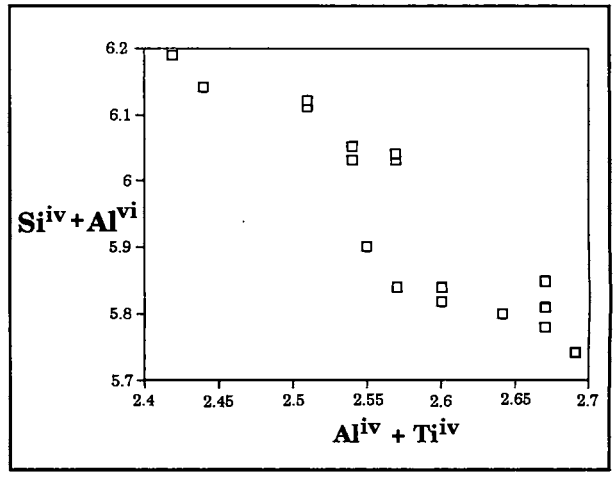


Figure 7. $Al^{iv} + Ba^{xii}$ vs $Si^{iv} + K^{xii}$ plot for barium in biotite from the Noring granite.

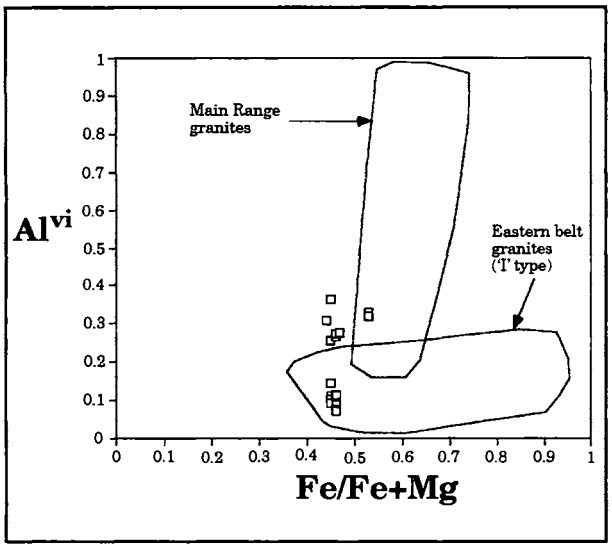


Figure 8. Al^{vi} vs Fe/Fe + Mg plot for biotite from the Noring granite. Field of biotite from the Western and Eastern belt granites of the Peninsula Malaysia is after Liew (1983).

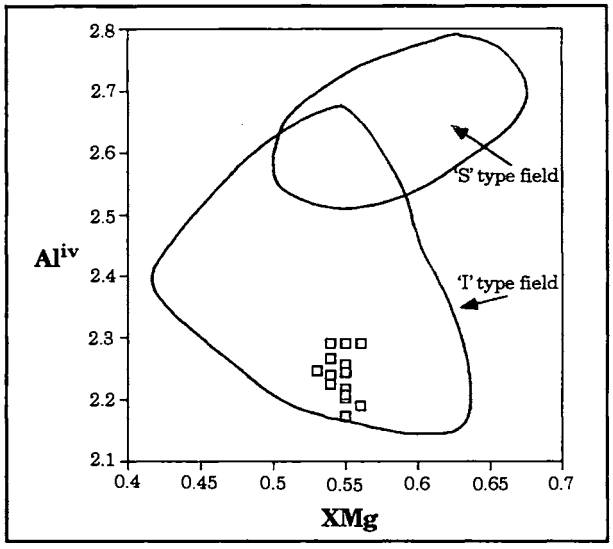


Figure 9. Al^{iv} vs XMg plot for the biotite from the Noring granite. Field of biotite from the 'I' and 'S' types granites, Lachlan Fold Belt, Australia.

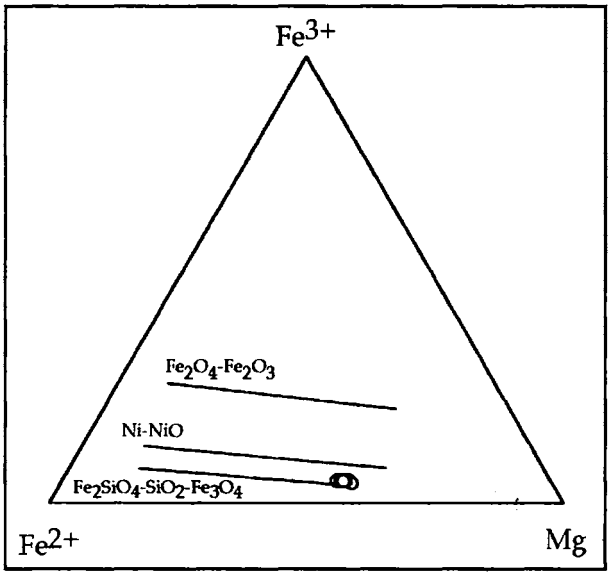


Figure 10. The relationship between the Fe^{3+}-Fe^{2+}-Mg contents of biotites from the Noring granite (Fe^{3+} calculated values). The estimated position of biotite composition defining the HM, NNO, and QFM oxygen buffers are shown as dashed lines (Wones and Eugster, 1965).

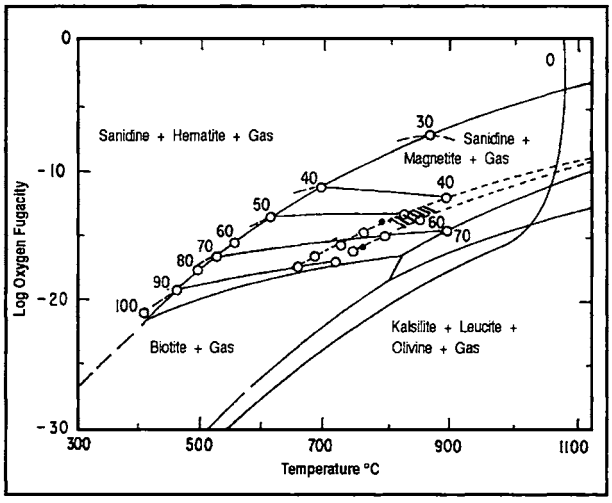


Figure 11. Stability of biotite as a function of oxygen fugacity and temperature at 2,070 bars total pressure. The position of biotite-sanidine-magnetite equilibria are shown as heavy contours of constant 100 x Fe/(Fe + Mg) values of biotites. Lightweight and dotted lines represent 'buffer' curves. The biotite compositions determined in this study are shown (shaded) (after Wones and Eugster, 1965, Fig. 4).

that the compositions of the biotites under study were defined by fO_2 near to that of the Fe_2SiO_4-SiO_2-Fe_3O_4 buffer (Fig 10).

A qualitative estimate of the oxygen fugacity and temperature from the biotite composition can be obtained using the fO_2-T plane diagram at 2,070 kbar (Wones and Eugster, 1965). The granitoids biotite normally co-exist with K-feldspar and magnetite and are thought to have formed at or near to the present level of emplacement at a total pressure of about 2 kbar (Atherton and Brenchley, 1972). This is also the case of the Noring granite that has pressure below 2 kbar from hornblende geobarometer data (Azman, unpublished data). The data of Wones and Eugster (1965) have therefore been used to get an idea of the conditions under which the biotites crystallised. A range of $Fe/(Fe + Mg)_{biotite}$ values have been plotted on Figure 11. The general trend of the Noring biotite is also parallel to the solid oxygen-buffer curves which suggests that they crystallised under buffered conditions with fO_2 generally decreasing with temperature (Speer, 1984). The plot shows that the biotite crystallised at temperatures of 740 to 780°C and values of log fO_2 of about -13. The range of temperatures deduced from this diagram is much narrower compared to biotites from elsewhere, for example Mason (1981) found that biotite from the Coastal Batholith, Peru crystallised at temperatures of 750 to 900°C.

CONCLUSIONS

1. Based on the limited geochemical data of Cobbing *et al.* (1992), the Noring granitic rocks belong to the high-K calc alkali series and are metaluminous (ACNK: 0.88 to 0.97). They are generally 'I' type.
2. The mineralogy of the granite is plagioclase, alkali feldspar, quartz, biotite, hornblende, sphene, apatite, magnetite, allanite and zircon which is similar to the mineralogy of 'I' type granites elsewhere (e.g. Chappell and White, 1974; Bateman *et al.*, 1963).
3. Biotites from the Noring granite plot in the calc-alkaline field on a Al_2O_3-MgO diagram and in the phlogopite field on XMg vs Si diagram. On a triangular Mg^{2+} vs $Al^{iv} + Fe^{3+} + Ti$ vs $Fe^{2+} + Mn$ diagram the biotite plot towards the Mg^{2+} biotite field. The composition of the biotite is similar to biotite from the granitic rocks from the Eastern Belt of Peninsular Malaysia and 'I' type granite of the Lachlan Fold Belt, Australia.
4. The biotite compositions appear to be defined by oxygen fugacities near to those of the Fe_2SiO_4-SiO_2-Fe_3O_4 buffer (results obtained from calculated Fe^{3+} value). It has been estimated that the biotite crystallised at temperatures of 740 to 780°C and log fO_2 of about -13.

ACKNOWLEDGEMENT

En. Roshdy is thanked for drafting the figures.

REFERENCES

ABDEL RAHMAN, A.M., 1994. Nature of biotites from Alkaline, Calc-alkaline and peraluminous magmas. *Jour. Petrol., 35(2)*, 525–541.

ATHERTON, M.P. AND BRENCHLEY, P.J., 1972. A preliminary study of the structure, stratigraphy and metamorphism of some contact rocks of the western Andes: near the Quebrada Venado Muerto, Peru. *Geol. Jour., 8*, 161–178.

AZMAN A GHANI, 1998. Microscopic observation of the mantle feldspar from Noring granite, Stong Complex. *Warta Geology, 24(1)*, 1–4.

BATEMAN, P.C., CLARKE, L.D., HUBER, N.D., MOORE, J.G. AND RINEHART, C.D., 1963. The Sierra Nevada batholith, a synthesis of recent work across the central part. *Geol. Surv. Prof. Paper 414D*, 46p.

BIGNELL, J.D. AND SNELLING, N.J., 1977. The geochronology of Malayan granites. *Overseas Geology and Min. Resources, 47*, 1–72.

BRYON, D.N., ATHERTON, M.P. AND HUNTER, R.H., 1994. The description of the primary textures of 'Cordilleran' granitic rocks. *Contrib. Mineral. Petrol., 117*, 66–75.

BRYON, D.N., ATHERTON, M.P. AND HUNTER, R.H., 1995. The interpretation of granitic textures from serial thin sectioning, image analysis and three dimensional reconstruction. *Mineral. Mag., 59*, 203–211.

BUKHARD, D.J.M., 1993. Biotite crystallisation temperatures and redox states in granitic rocks as indicator of tectonic setting. *Geologie en Mijnbouw*

71, 337–349.

CHAPPELL, B.W. AND WHITE, A.J.R., 1974. Two contrasting granite types. *Pacific Geol., 8*, 173–174.

COBBING, E.J. AND MALLICK, D.I.J., 1987. *South East Asia granite project: Field report for Peninsula Malaysia*. BGS, 129p.

COBBING, E.J., PITFIELD, P.E.J., DARBYSHIRE, D.P.F., AND MALLICK, D.I.J., 1992. The granites of the South-East Asian tin belt. *Overseas Memoir 10*, B.G.S.

FOSTER, M.D., 1960. Interpretation of the composition of trioctahedral micas. *Prof. Pap. U.U. Geol. Surv., 354B*, 11–49

KUMAR, S.C., 1985. *Enclaves of Peninsular Malaysia granitoid*. Unpubl. Ph.D. thesis, Univ. Malaya Kuala Lumpur.

LIEW, T.C., 1983. *Petrogenesis of Peninsular Malaysian granitoid batholiths*. Unpubl. Ph.D. thesis, Aust. Nat. Univ. Canberra.

MASON, G.H., 1982. *The mineralogy and textural history of the Coastal Batholith, Peru*. Unpubl. Ph.D. thesis, Univ. of Liverpool.

PECCERILLO, A. AND TAYLOR, S.R., 1976. Geochemistry of Eocene calc-alkaline volcanic rocks from the Kastamona area, northern Turkey. *Contrib. Mineral. Petrol., 58*, 63–81.

SHAND, S.J., 1943. *Eruptive rocks*. T Murby and Co., London, 2nd edn., 444p.

SINGH, D.S., CHU, L.H., TEOH, L.H., LOGANATHAN, P., COBBING, E.J. AND MALLICK, D.I.J., 1984. The Stong Complex: a reassessment. *Geol. Soc. Malaysia Bull., 17*, 61–77.

SPEER, J.A., 1984. Mica in Igneous rocks. *In:* S.W. Bailey (Ed.), Mica: Review in Mineralogy V, 13. *Min. Soc. America*, 299–356.

WHITE, A.J.R. AND CHAPPELL, B.W., 1983. Granitoid types and their distributions in the Lachlan Fold Belts; southeastern Australia. *In:* J.A. Roddick (Ed.), Circum Pacific plutonic Terranes. *Geol. Soc. Am, Mem., 159*, 21–34.

WONES, D.R. AND EUGSTER, H.P., 1965. Stability of biotite: experiment, theory and application. *Am. Mineral., 50*, 1228–1272.

Manuscript received 31 March 1998

NEW

MALAYSIAN STRATIGRAPHIC GUIDE

Prepared by

Malaysian Stratigraphic Nomenclature Committee

Geological Society of Malaysia

December 1997

CATATAN GEOLOGI
Geological Notes

Piezocone as a tool for stratigraphic logging of Malaysian Quaternary deposits: a review

ABD. RASID JAAPAR
Soil Centralab Sdn. Bhd.
No. 3 & 5, Jalan P/8
Kawasan Perindustrian MIEL
43650 Bandar Baru Bangi
Selangor Darul Ehsan

Abstract: The use of Cone Penetration Testing (CPT) and in particular the Cone Penetration Testing with pore water pressure measurement (CPTU) or commonly referred to as the "Piezocone Test" in site investigations has gained popularity only in the last eight to ten years in Malaysia. The test is primarily used for sounding purposes to detect the subsoil stratigraphy and to evaluate the depth variation of soil properties such as shear strength, overconsolidation ratio, coefficient of consolidation and to provide a basis for field control of ground improvement and reclamation projects. This paper reviews the uses of Piezocones with emphasis on the geological aspects in the determination of subsoil stratigraphy in Malaysian Quaternary Deposits.

INTRODUCTION

As part of the investigations of soft ground particularly the Quaternary deposits, Piezocone have been widely used in addition to boreholes and sampling. It should be stressed that these tests are not being advocated as replacements for boreholes and sampling. They should be used in conjunction with each other and by careful planning and supervision, the results should be better and more accurate.

QUATERNARY GEOLOGY

Unconsolidated sediments of Quaternary age are found throughout Peninsular Malaysia (Fig. 1), particularly in its coastal areas where they give rise to broad stretches of flat to gently undulating terrain (Bosch, 1988). These coastal plains are, furthermore, backed inland by hilly areas where similar unconsolidated sediments are to be found in the valleys and upper flood-plains of the several rivers that meander across the coastal plains. These coastal plains are particularly well developed in the northwestern and southwestern sectors of the Peninsula, where they are up to 20 km wide and more than 70 km long.

The Quaternary age which is usually considered to have begun when there was a global sea-level some 50 m or so below present-day sea-level (Guilcher, 1969). Based on Quaternary Geological Map published by Geological Survey Department (1989), the deposits can be divided to Gula Formation and Beruas and Simpang Formation. The Gula Formation comprises of Holocene marine deposits which is partly the Port Weld Member consisting of clay and silt, locally very clayey or silty sand and Holocene marine coastal sand of the Matang Gelugor Member which consists of sand locally gravelly. Beruas and Simpang Formation comprise of Holocene paludal deposits of Pengkalan Member which consists of peat, humic clay and silt and Pleistocene and Holocene

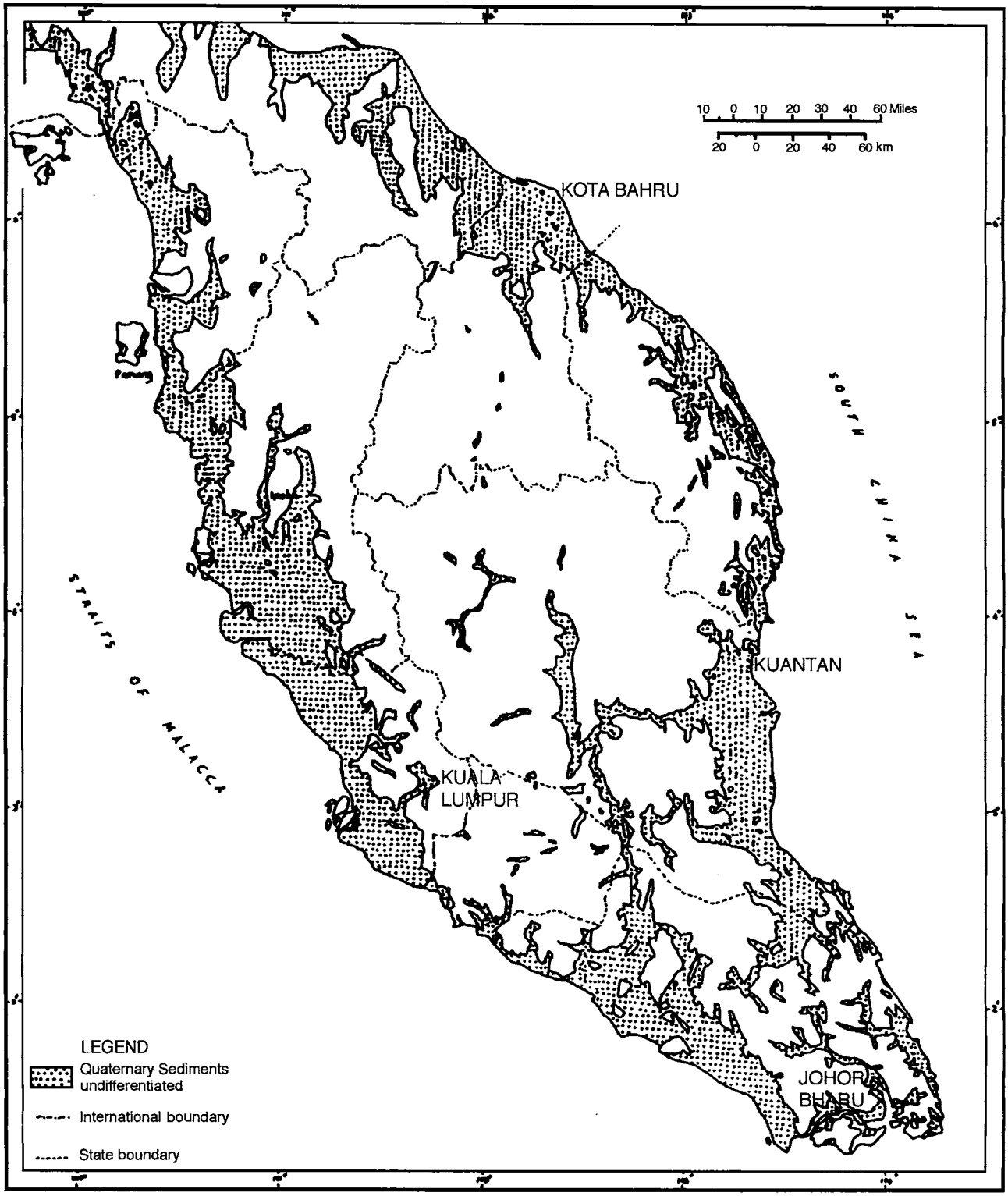


Figure 1. Undifferentiated Quaternary sediments in Peninsular Malaysia (after Stauffer, 1973).

terrestrial deposits consisting of clay, silt, sand and gravel.

The present-day coastal plains were thus non-existent at this time for there would have been here undulating to hilly areas that provided tributaries to the main northwestward trending rivers. In view of the fact that Peninsular Malaysia was tectonically stable throughout the Quaternary (Stauffer, 1973; Gobbett and Tjia, 1973), the rise of sea-level during Holocene would thus have led to inundation of the undulating to hilly areas and tributary valleys (that underlie the present-day coastal plains).

THE EQUIPMENT

The piezocone test is a form of deep sounding or static cone penetration test in which an instrumented probe is pushed into the ground while various measured parameters are recorded.

The general arrangement of the equipment is shown on Figure 2a. The probe or piezocone is a nominal 50 kN cone and Figure 2b illustrates its features. The parameters measured by the piezocone are:

cone resistance, qc	:	force on cone divided by cone area
local friction, fs	:	shear force on friction sleeve divided by friction sleeve area
water pressure, u	:	water pressure within soil adjacent to filter
inclination, I	:	uniaxial deviation of cone from vertical
temperature, t	:	temperature measured inside cone

The jacking unit has twin cylinders with a total push-down force of 100 kN. The unit is mounted on a crawler chassis, and the combined dead-weight of all the equipment gives a push-down force of about 25 kN. By using six screw anchors this can be increased to 50 or 60 kN. This is adequate for soft ground testing, and gives sufficient push-down force to penetrate stiffer clays and sands.

The data acquisition equipment consists of a computer which monitors the output from the piezocone. An event marker determines the depth when each set of measured parameters is recorded (every 25 mm) and a proximity switch ensures that recording is only activated as the rams are going downwards. The computer has a magnetic cartridge (bubble) memory for data storage and is connected to a printer for production of hard copy listings and plots on site. For use in soft clays, sensitivity must be high so that resolution of the measuring system is:

qc	:	0.01 MPa
fs	:	0.1 kPa
u	:	1 kPa
I	:	0.1°
t	:	0.1°C

TEST EXECUTION

The probe is pushed into the ground at a rate of 20 mm/s measuring the five parameters as described earlier. The technician has a live display of all these parameters on the computer screen allowing him to monitor the progress of the test. Inclination of the cone is an important indicator, and if it becomes excessive or changes suddenly, the test is stopped. Excessive inclination is a situation where damage can happen quite easily, and depth values become erroneous. The test is normally terminated on reaching maximum push-down capacity.

During a test, penetration of the piezocone can be halted and the subsequent reduction of measured water pressure recorded against time. This is referred to as the "dissipation test" and can be used to assess the horizontal coefficient of consolidation, C_h.

PRESENTATION OF RESULTS

Piezocone final results are presented as plotted profiles of qc, fs and u. The friction ratio, defined as fs/qc is also calculated and plotted. An example of a typical result sheet is shown on Figure 3. This sheet is computer generated directly from the file of results recorded by the field computer. Tabulated results

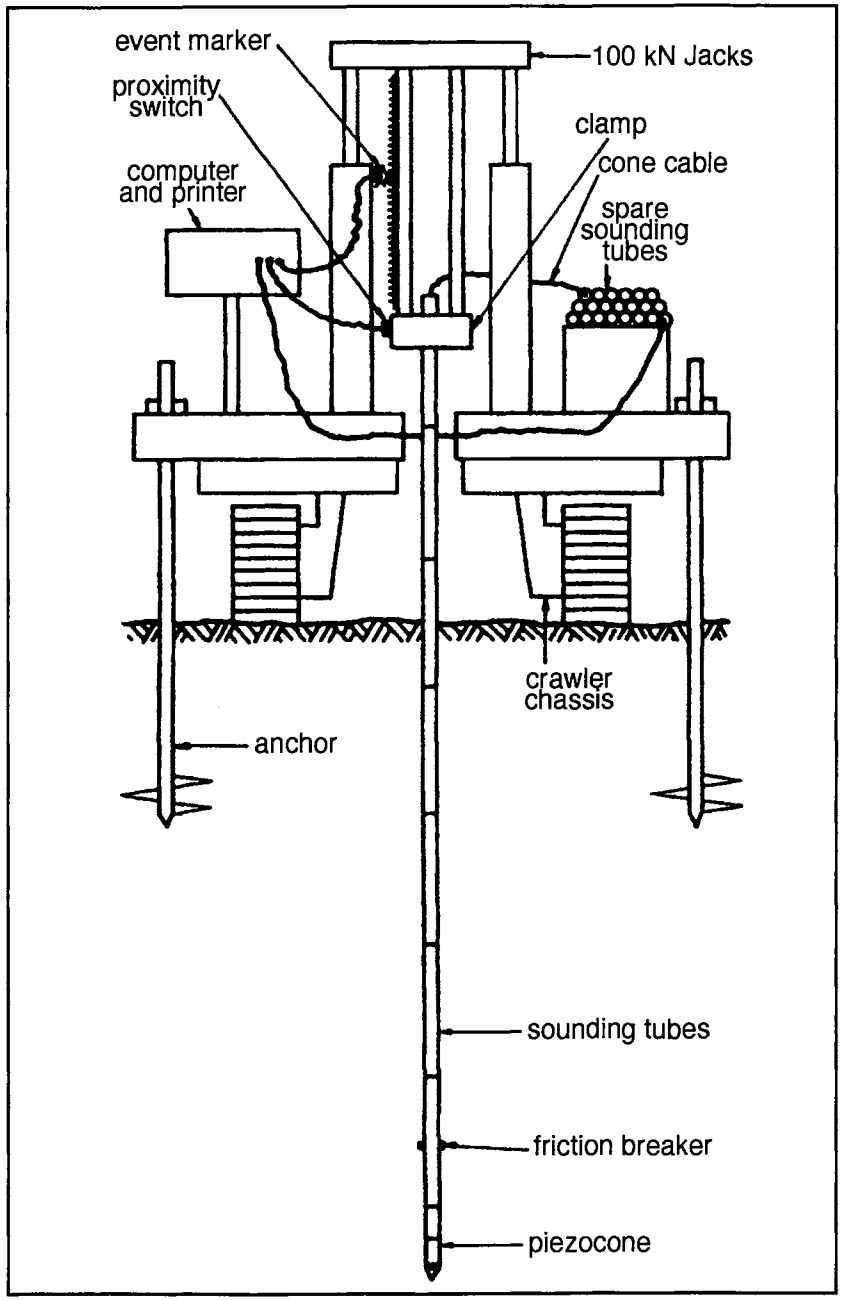


Figure 2a. Arrangement of equipment for piezocone testing (after Dobie, 1990).

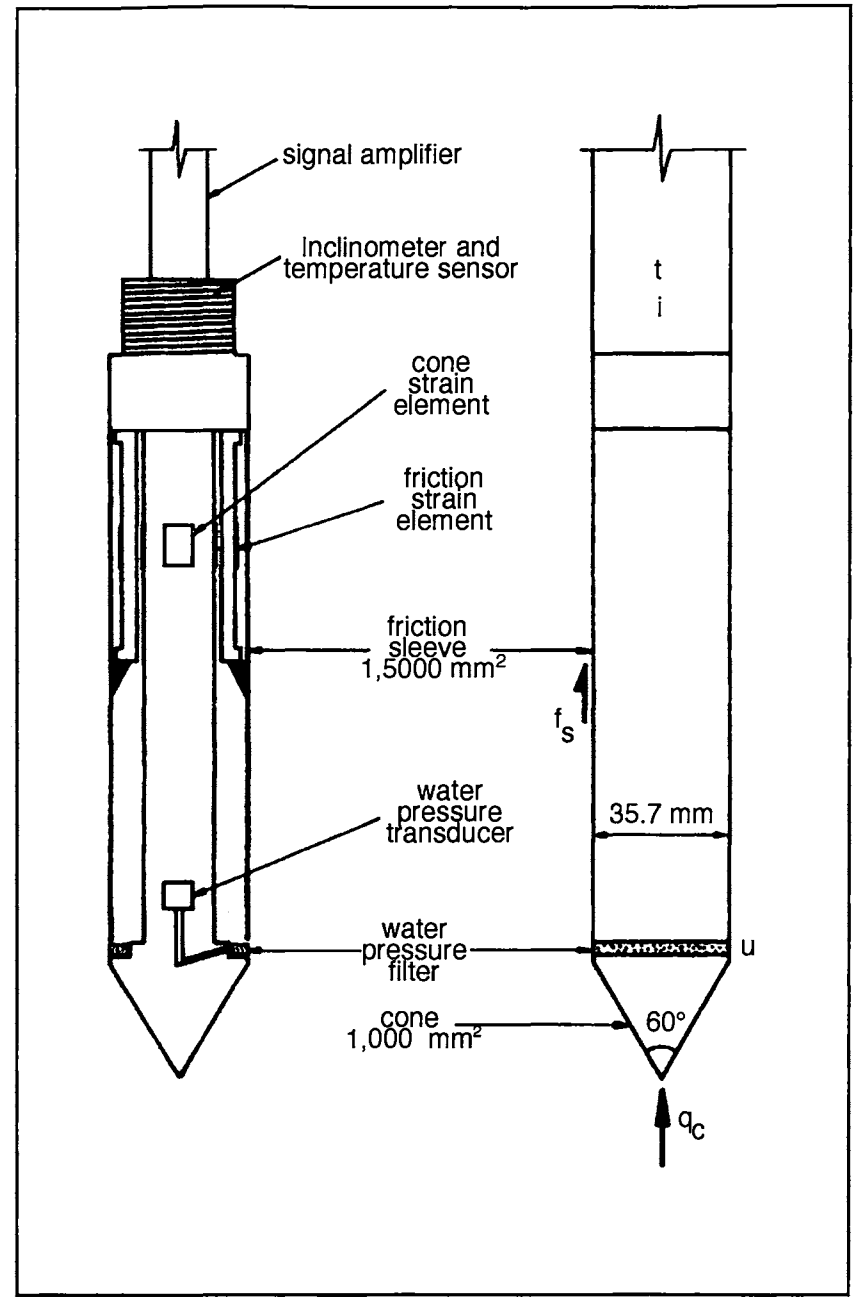


Figure 2b. Details of piezocone (after Dobie, 1990).

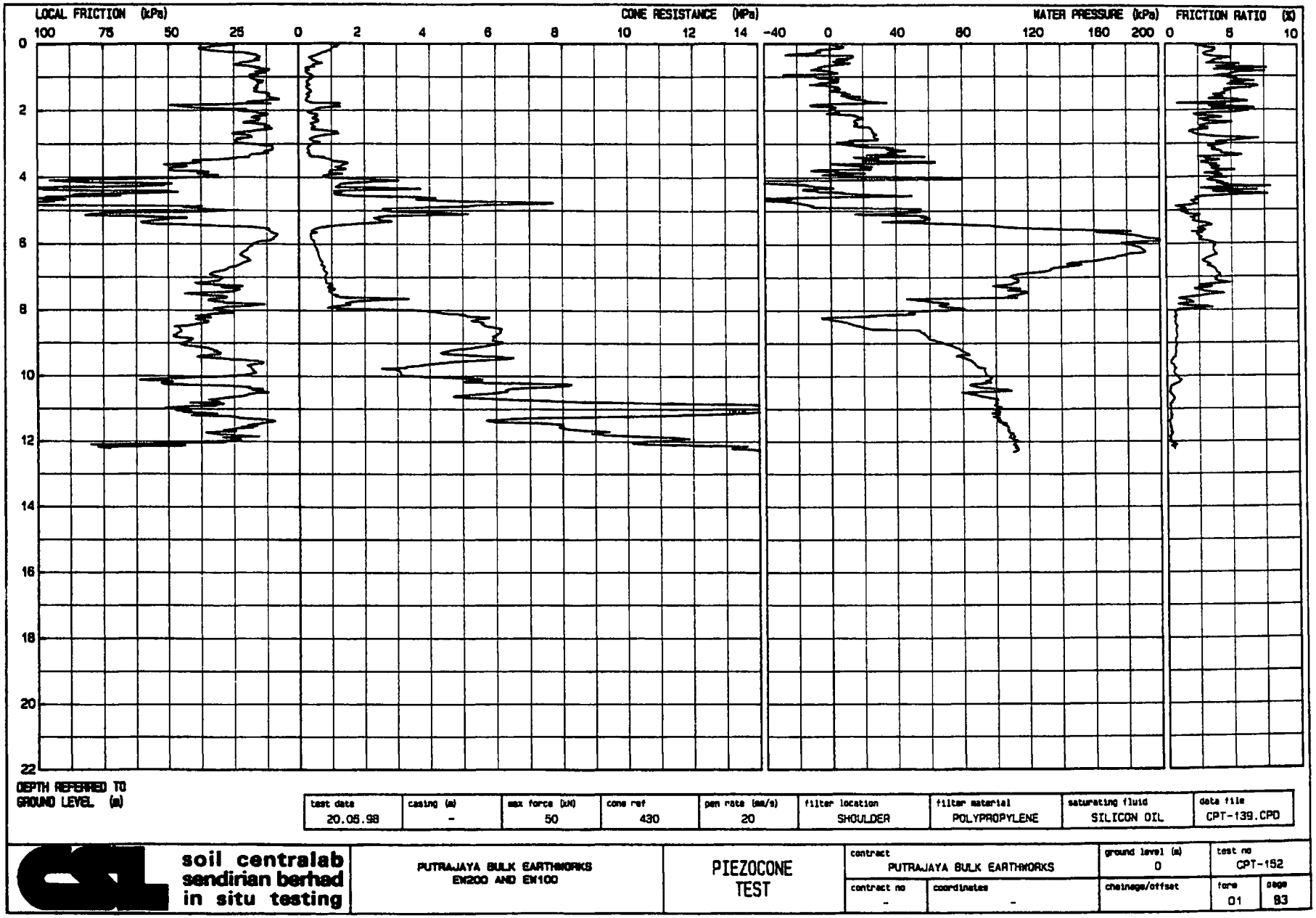


Figure 3. Typical piezocone result (sample from Putrajaya development area).

of all parameters are printed during the test.

INTERPRETATION

The interpretation for this paper is restricted principally to the sediments of Quaternary deposits, and examines the interpretation of soil type only although the interpretation for undrained shear strength and degree of overconsolidation can be derived from this test. The interpretation in this paper is basically based on Dobie and Wong (1990).

Interpretation of soil type is divided into two methods, based on friction ratio and cone resistance or pore water pressure.

Using Friction Ratio and Cone Resistance

This is a well established method which a simple chart is presented on Figure 4a (Robertson and Campanella, 1983) and Figure 4b presented the cone resistance profiles with soil consistency. However the accurate measurement of local friction and, therefore, friction ratio in soft clays is difficult, so that this parameter must be regarded as approximate.

Using water pressure

Charts have been published which define soil type in terms of water pressure and cone resistance, for example Jones and Rust (1982) and Senneset and Janbu (1985). Water pressure is usually expressed as either:

excess pressure, $\delta u = u - u_0$

or, water pressure ratio, $Bq = (u - u_0)/(q_T - \sigma_v)$

Where u_0 is hydrostatic water pressure, q_T is corrected cone resistance and σ_v is total overburden pressure. The water pressure plot from piezocone principally indicates changes in permeability. This is illustrated on Figure 5 which presents a profile consisting of several soil types. Interpreted soil names are given on the figure and it is interesting to note that the sand layers indicate a non-hydrostatic ground water profile.

CASE HISTORY

This case history was originally described by Rose Mina (1990) where a site investigation has taken place before the construction of North South Expressway. The investigation was carried out near Sungai Dua in Seberang Prai, Penang. Geologically, the area is underlain by unconsolidated Holocene deposits consisting of grey soft to stiff silty clay. Sand layers and lenses are also present in between the clay layers.

Figure 6 shows how the interpretation of ground profile changed from that based on the single borehole of the preliminary investigation to that based mainly on the piezocone test of the detailed investigation. The locations of the additional investigation such as boreholes and field vane tests were selected on the basis of the profile produced from the piezocone test results, see Figure 7.

CONCLUSIONS

The piezocone can be used to define soil layers with great precision and determine soil types adequately.

A major advantage of the piezocone tests is that results are available instantaneously and it is not necessary to wait for laboratory testing.

Profiling by piezocone at the initial stage of the site investigation and selecting the location of boreholes and other test methods at critical areas where change of strata is obvious proves that it is a better method of execution of soft ground investigation.

REFERENCES

BOSCH, J.H.A, 1988. The Quaternary deposits in the coastal plains of Peninsular Malaysia, *Quaternary Geological Section Report QG/1*, GSD Malaysia, 87.

DOBIE, M.J.D. AND WONG, J.T.F., 1990. Piezocone testing: interpretation in Malaysia alluvial clays. *Proceeding Seminar on Geotechnical Aspects of the North-South Expressway*, Kuala Lumpur, 75–85.

DOBIE, M.J.D., 1990. *In situ* testing methods for soft ground. *Proceeding Seminar on Geotechnical Aspects of the North South Expressway*, Kuala Lumpur, 9–23.

GOBBETT, D.J. AND TJIA, H.D., 1973. Tectonic history. *In:* Gobbett, D.J. and Hutchison, C.S. (Eds.), *Geology of the Malay Peninsular West Malaysia and*

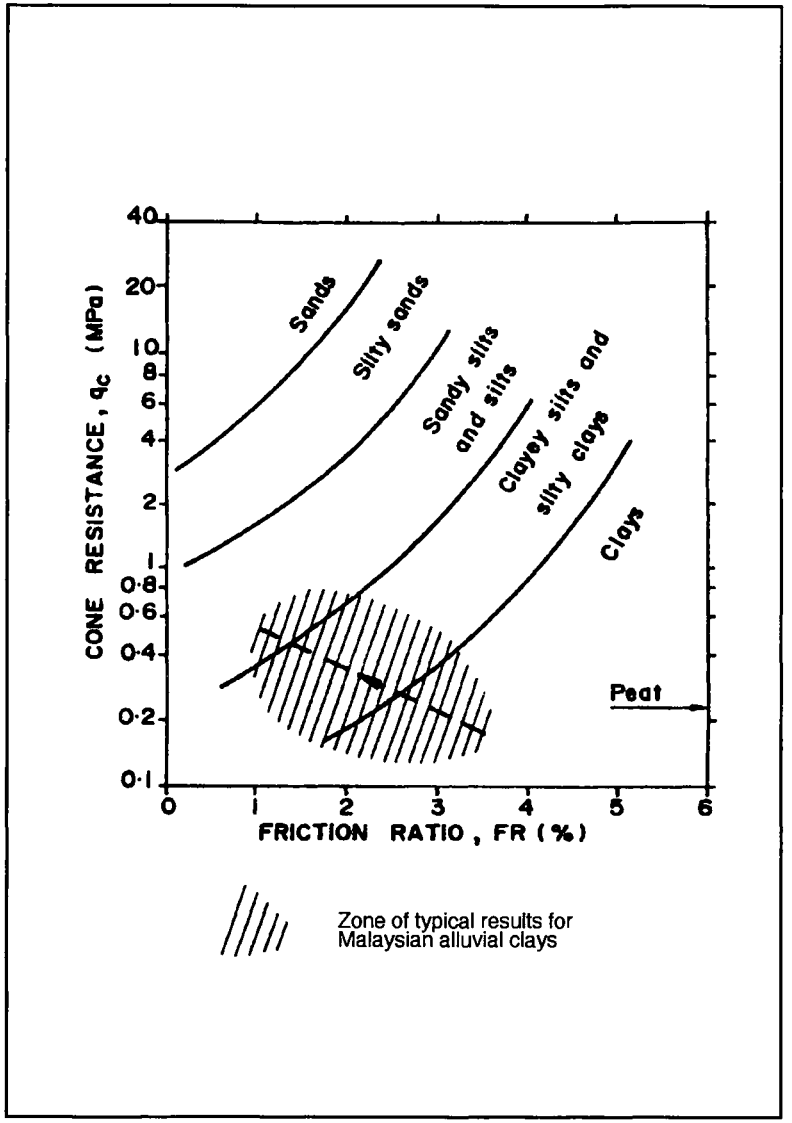


Figure 4a. Chart for identifying soil type using electric cones (after Robertson and Campanella, 1983).

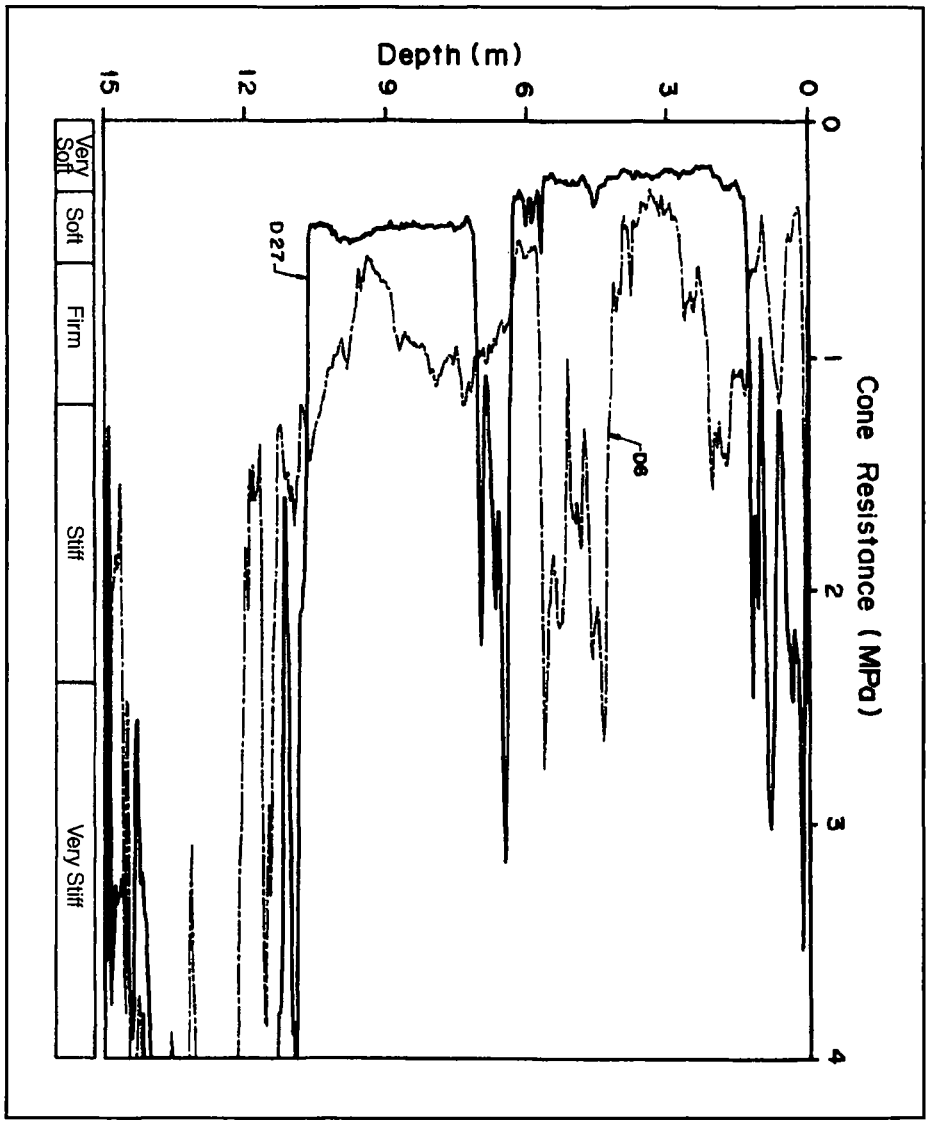


Figure 4b. Cone resistance profiles with soil consistency (after Dobie, 1990).

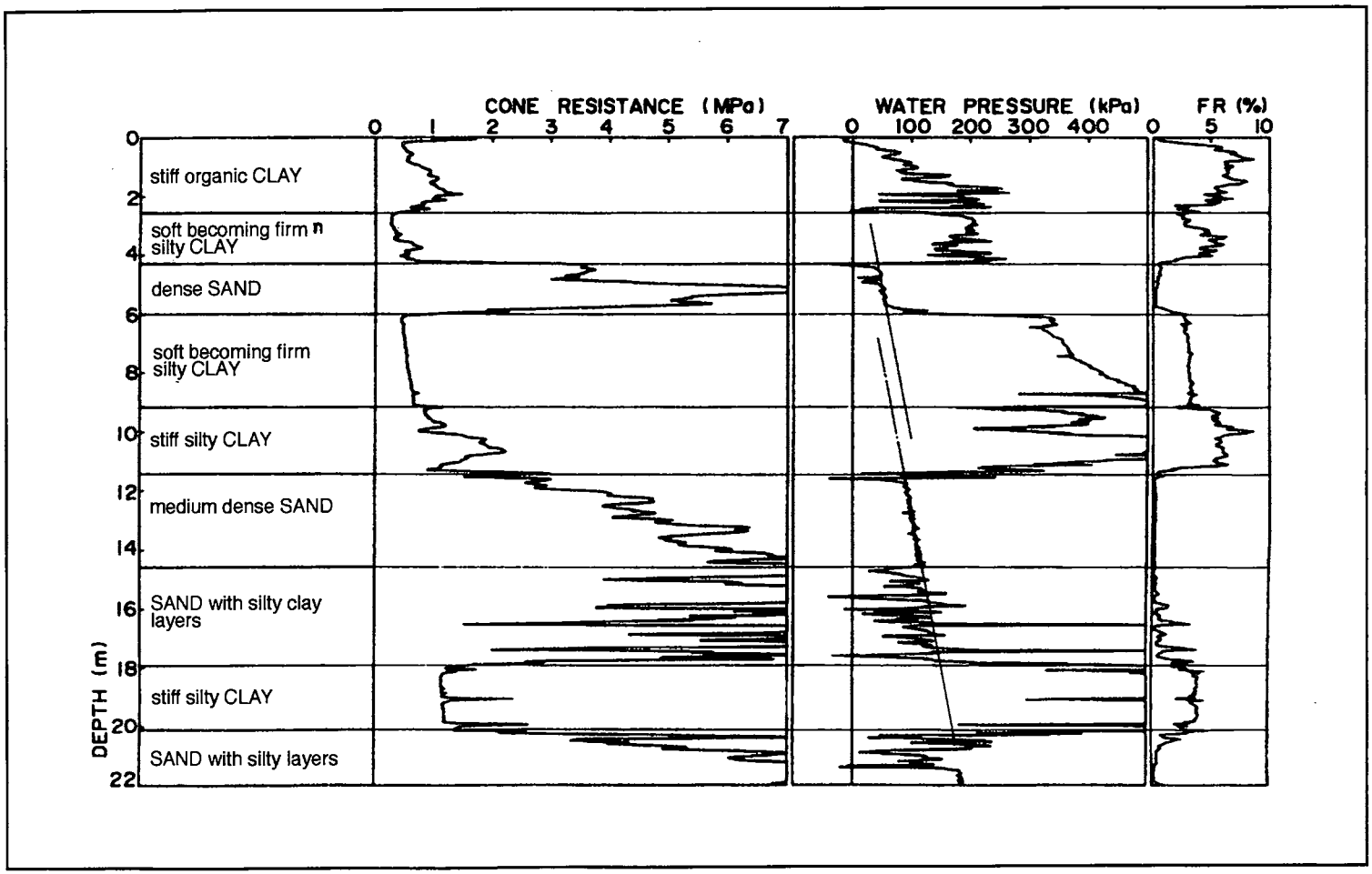


Figure 5. Example of defining soil layers and interpreting soil names (after Dobie and Wong, 1990).

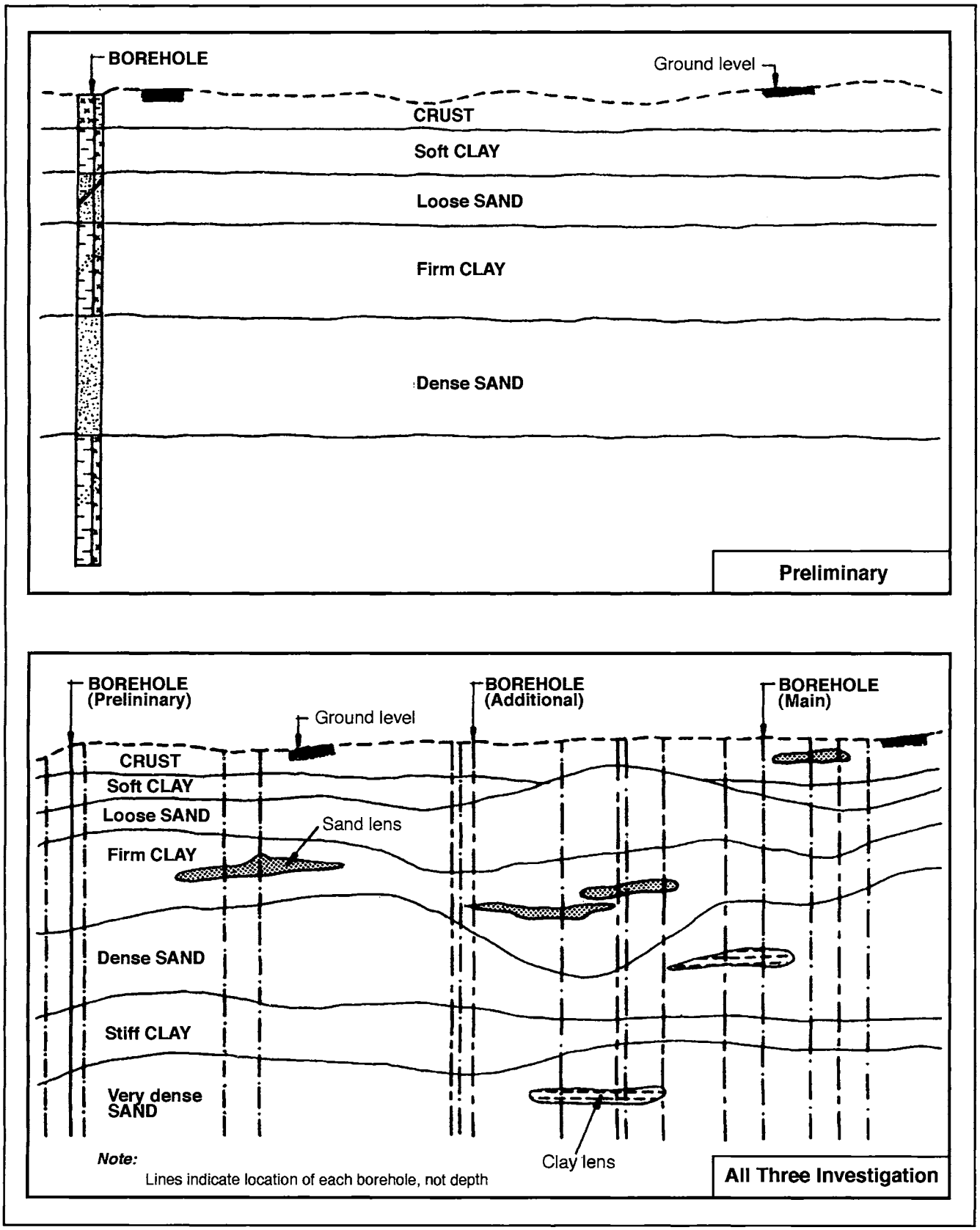


Figure 6. Comparison of soil profiles derived from boreholes in the preliminary and additional investigation using piezocone (after Rose Mina, 1990).

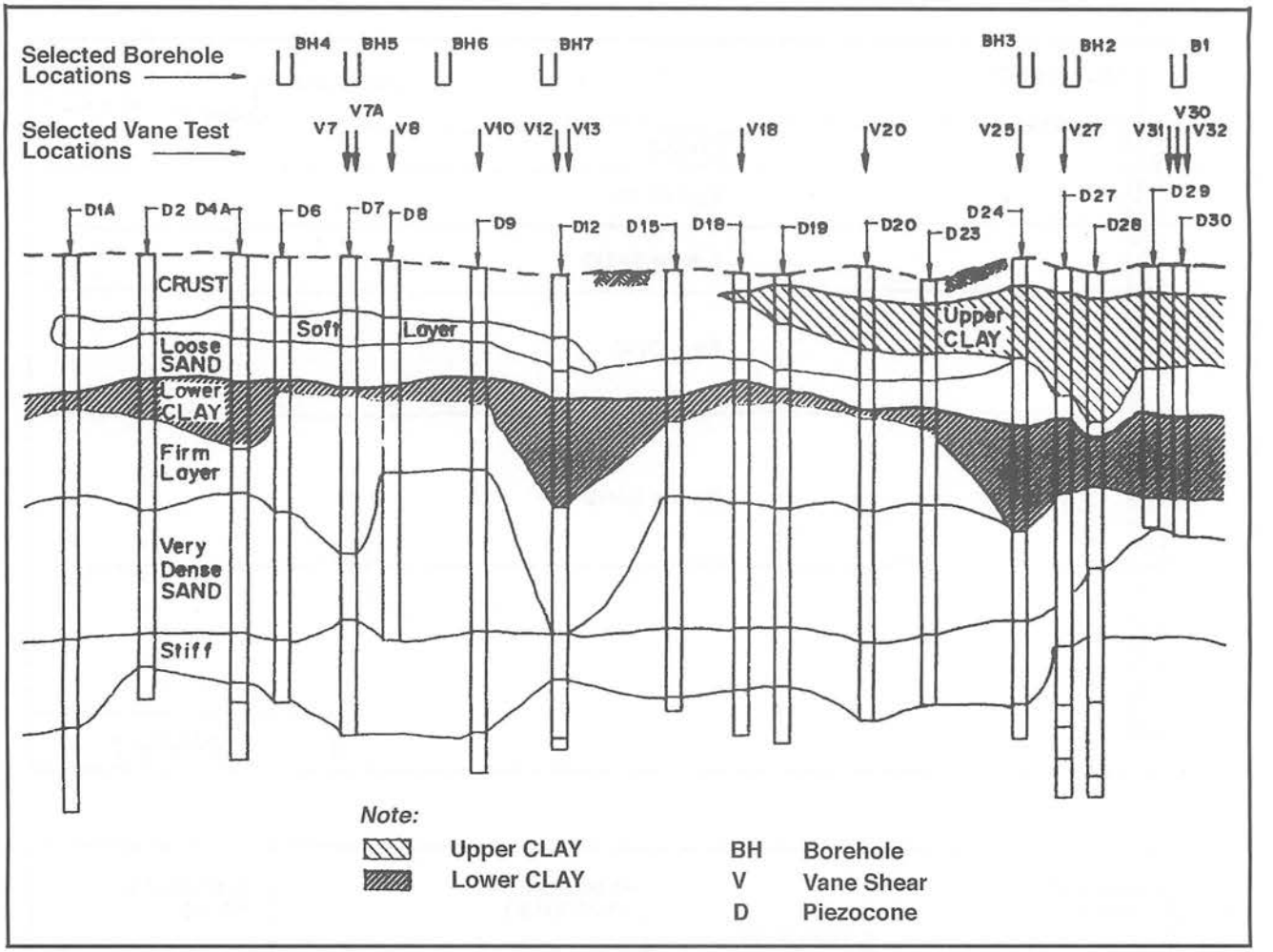


Figure 7. Other *in-situ* test methods such as borehole and penetration vane test locations selected after profiling with piezocone (after Rose Mina, 1990).

Singapore. John Wiley Interscience, New York, 205–334.

GUILCHER, A., 1969. Pleistocene and Holocene sea-level changes. *Earth Science Report, 5*, 69–97.

JONES, G.A. AND RUST, E., 1982. Piezometer penetration testing CUPT. *Proceeding 2nd European Symposium on Penetration Testing* (ESOPT-@), Amsterdam, 607–614.

ROBERTSON, P.K. AND CAMPANELLA, R.G., 1983. Interpretation of cone penetration tests: Parts 1 and 2, *Canadian Geotechnical Journal, 20*, 718–745.

ROSE MINA, 1990. Execution of soft ground investigation: a case history. *Proceeding Seminar on Geotechnical Aspects of the North-South Expressway,* Kuala Lumpur, 65–74.

SENNESET, K. AND JANBU, N., 1985. Shear strength parameters attained from static cone penetration tests. *Paper a-84-1, Institute of Geotechnical and Foundation Engineering*, NIT, Trondheim.

STAUFFER, P.H., 1973. Cenozoic. *In:* Gobbett, D.J. and Hutchison, C.S. (Eds), *Geology of the Malay Peninsular West Malaysia and Singapore.* John Wiley Interscience, New York, 143–176.

Manuscript received 2 July 1998

PERTEMUAN PERSATUAN
Meetings of the Society

Ceramah Teknik (Technical Talk)

Piezocone and dilatometer tests

ABD. RASID JAAPAR

Laporan (Report)

The talk was presented by Sdr. Abd. Rashid Jaapar from the Central Soil Laboratory (CSL) on 30th September 1998 at the Geology Department, University of Malaya. Unfortunately, the second speaker for the evening did not show up as he had a meeting in K.L.

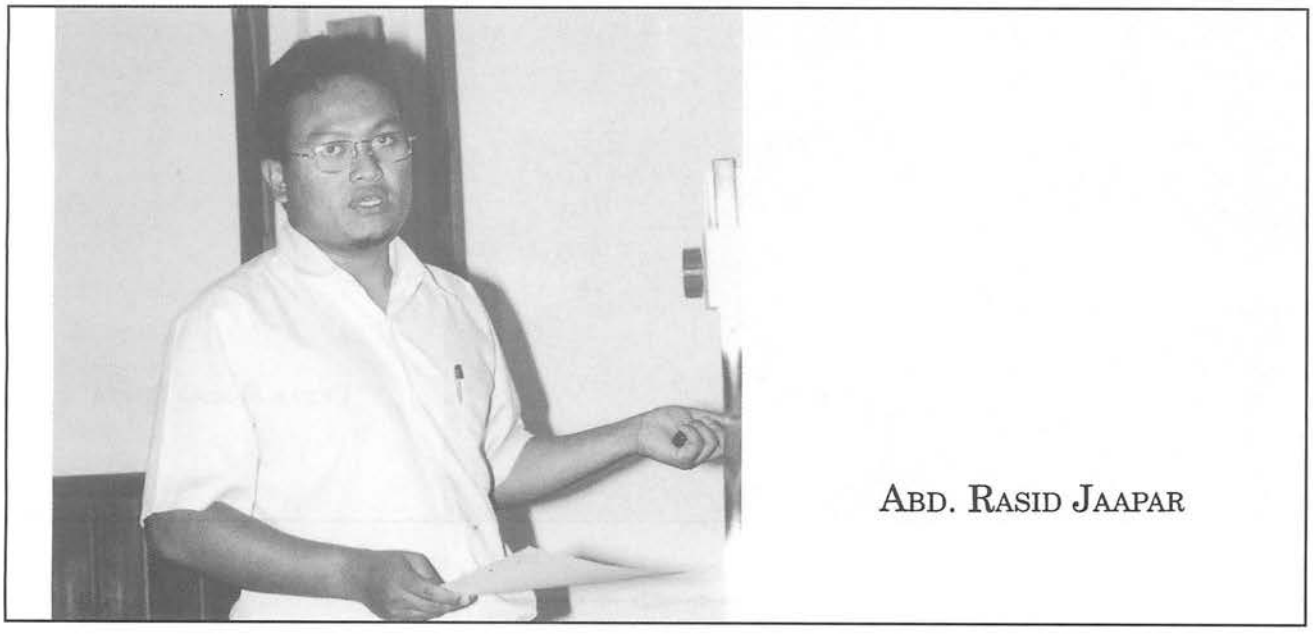
Sdr. Rasid talked on the piezocone, dilatometer and the vane shear tests. These field tests are very useful in obtaining various soil parameters of soft soils (e.g. soft clays) such as the undrained shear strength overconsolidation ratio, pore pressure distribution, differentiation of soil types, etc.. Instrumentations, test set-ups interpretations of results and applications were all well illustrated, together with some local case studies.

The speaker ended the talk with an overview (slide show) of activities by CSL, including slope repairs or stabilizations along parts of the North-South Expressway.

A discussion centred on these field tests versus borehole sampling and laboratory tests followed the talk.

The talk was attended by about 20 members.

Tan Boon Kong



ABD. RASID JAAPAR

Mars Exploration Programme

CHEICK MODIBO DIARRA

Report

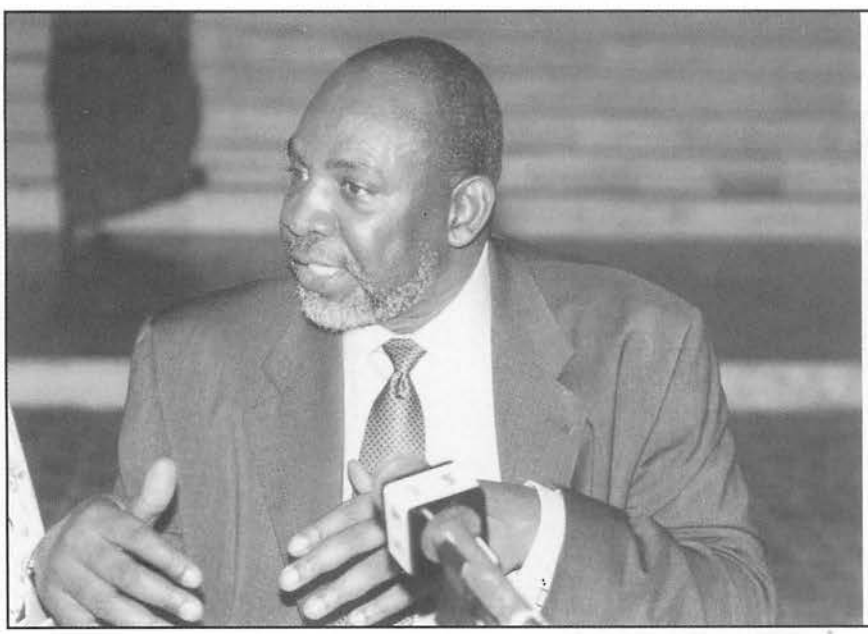
Malaysia was privileged to play host to Dr. Cheick Modibo Diarra from the Jet Propulsion Laboratory, NASA from 5th to 10th October 1998. His first public lecture on 5th October 1998 was co-organised by GSM with the Eisenhower Fellowship Association Malaysia and the Ministry of Science, Technology and the Environment.

During the public lecture, which was staged at the Space Theatre in the National Planetarium, Dr. Diarra talked about the Mars Pathfinder Project of which he was the manager. He navigated the spacecraft which successfully deployed the robot Sojouner on to the surface of Mars.

The Mars Pathfinder Project was an extremely robotic mission to explore the surface of the Red Planet. The major scientific objectives included the surface morphology and geology of Mars at meterscale, surface mineralogy, elemental composition of rocks, soil, and surface minerals and the magnetic properties and soil mechanics of the surface. The mainly geological mission was hugely successful and Dr. Diarra highlighted the main results. Amazing high-resolution pictures of the rocks of Mars thrilled the audience which consisted of top level corporate members, scientists and students. Unfortunately very few GSM members turned up for the lecture despite its highly geological nature.

It is time members think about the necessity of expanding our horizons to embrace the importance of geology in various fields, in this case, space science. Geologists have a lot to contribute to other disciplines and many of us had certainly missed the chance to see an impressive display of the relevance of geology to the society at large.

Ibrahim Komoo
President, GSM



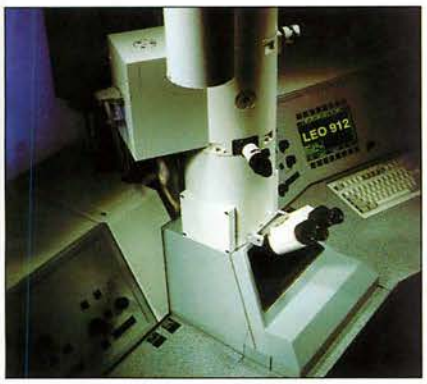
CHEICK MODIBO DIARRA

Your Partner In Microscopy & Microanalysis

LEO VP SEM

LEO FE SEM

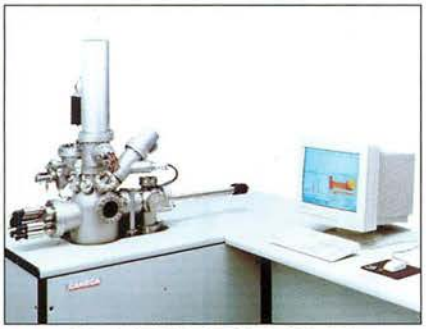
KSI SAM



LEO EF TEM

MICRION FIB

MICRION IN-LINE FIB



CAMECA TOF SIMS

CAMECA EPMA

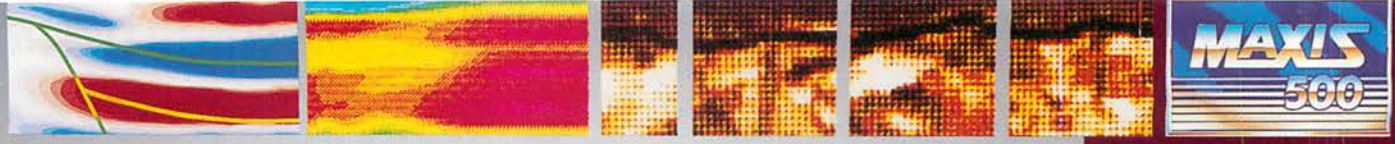
CAMECA IMS SIMS

- Research Optical Microscopy
- High Frequency Scanning Acoustic Microscopy (SAM)
- Infrared Microscopy
- XYZ Measuring Microscopy
- Confocal Laser Scanning Microscopy (CLSM)
- Scanning Electron Microscopy (SEM, VP SEM, FE SEM)
- Energy Filtered Transmission Electron Microscopy (EF TEM)
- X-Ray Microanalysis System (EDX, WDX)
- Focused Ion Beam System (FIB)
- Secondary Ion Mass Spectrometry (SIMS)
- Electron Probe Microanalysis (EPMA)
- Vacuum Technology (Pumps, Leak Detectors, Components)
- Thin Film and CD Measurement
- Imaging Processing and Analysis (IA)

HI-TECH INSTRUMENTS SDN BHD

Head Office: 9A Jalan USJ 11/3, 47620 UEP Subang Jaya, Selangor Darul Ehsan, Malaysia.
Tel : 603-737 0980 Fax : 603-737 0950

Penang Branch: 29, Lorong Helang Dua, Desa Permai Indah, 11900 Pulau Pinang.
Tel : 604-659 9152/153 Fax : 604-659 9154
E-mail: Sales@htimail.com.my
Service@htimail.com.my



Schlumberger's New Fullbore Formation MicroImager Doubles Your Coverage With Core-Like Clarity

The FMI* fullbore electrical imaging tool makes evaluation of complex reservoirs simpler and quicker than ever before. Its 192 microelectrical sensors give you twice the coverage of previous tools and improved spatial resolution, to 0.2 inches.

The fullbore images enable direct structural analysis and characterization of sedimentary bodies even in extremely complex sequences. The fine detail provided by FMI images allows determination of paleocurrents and rock anisotropy, including the recognition of permeability barriers and paths. And determination of net-to-gross ratio in thin bed sand/shale sequences is automatic.

Understanding the internal structure of the rock can confirm hypotheses regarding its geological evolution and can provide valuable clues to geologists and engineers regarding local porosity and permeability changes. This is possible with the enhanced textural analysis from the new high-resolution sensors, as well as detailed evaluation of fracture networks and other secondary porosity.

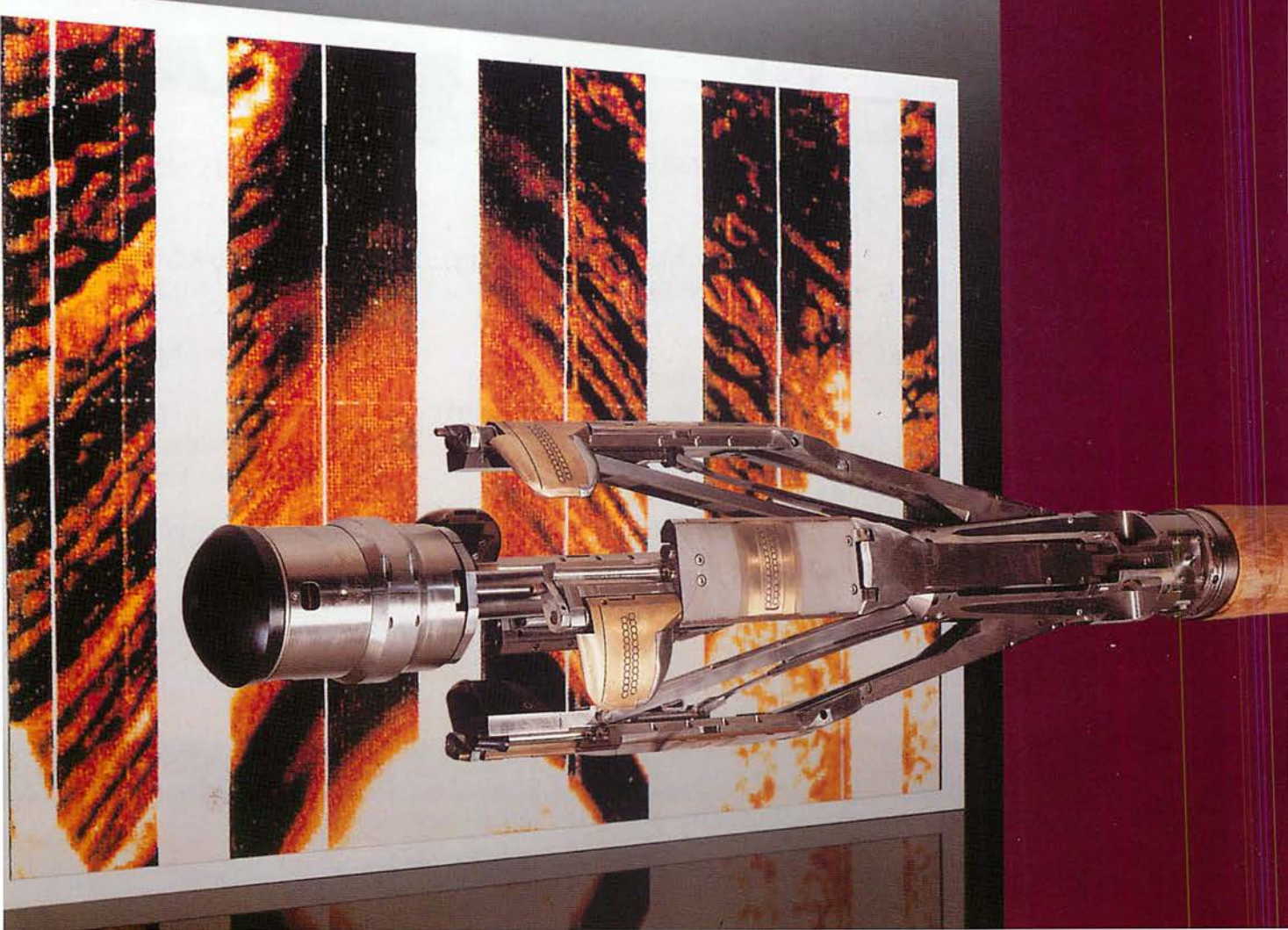
Ask to see an example of the new FMI log. You'll be looking at the clearest, most complete picture of the rock available today.

Schlumberger (Malaysia) Sdn Bhd., 7th & 8th Floor, Rohas Perkasa
No. 8, Jalan Perak, 50450 Kuala Lumpur.
Tel: (03) 2667788. Fax: (03) 2667800.

Schlumberger

Value is the difference.

Mark of Schlumberger– the FMI tool is a MAXIS 500 tool



The Schlumberger Ultrasonic Borehole Imager Detects Openhole Problems and Fractures, Even in Oil-Base Muds.

Accurate, high-resolution, acoustic measurements by the UBI* Ultrasonic Borehole Imager let you examine an openhole for stability problems, deformation and fractures when nonconductive, oil-base muds prevent resistivity measurements. On the same trip, the UBI rotating transducer can check for corrosion and mechanical wear of the internal surface of the casing as the tool is pulled out of the hole.

No other borehole measurement gives you the thin-bed resolution you get with the UBI tool. The images, cross-section plots and pseudo-3D "spiral" plots generated from UBI measurements also reveal keyseats, breakouts, shear sliding and shale alteration to help you avoid the added drilling costs that result from stuck pipe and lost time or equipment. In addition, you get horizontal stress information for mechanical properties evaluations to predict breakouts and perforation stability in unconsolidated sands.

Talk to your Schlumberger representative about detecting openhole problems and fractures acoustically, even in oil-base muds. What UBI images show you could save you time, expense or possibly your well.

Schlumberger

Value is the difference.

Mark of Schlumberger–the UBI tool is a MAXIS 500 tool

Schlumberger (Malaysia) Sdn Bhd., 7th & 8th Floor, Rohas Perkasa
No. 8, Jalan Perak, 50450 Kuala Lumpur.
Tel: (03) 2667788. Fax: (03) 2667800.

Common Rocks of Malaysia

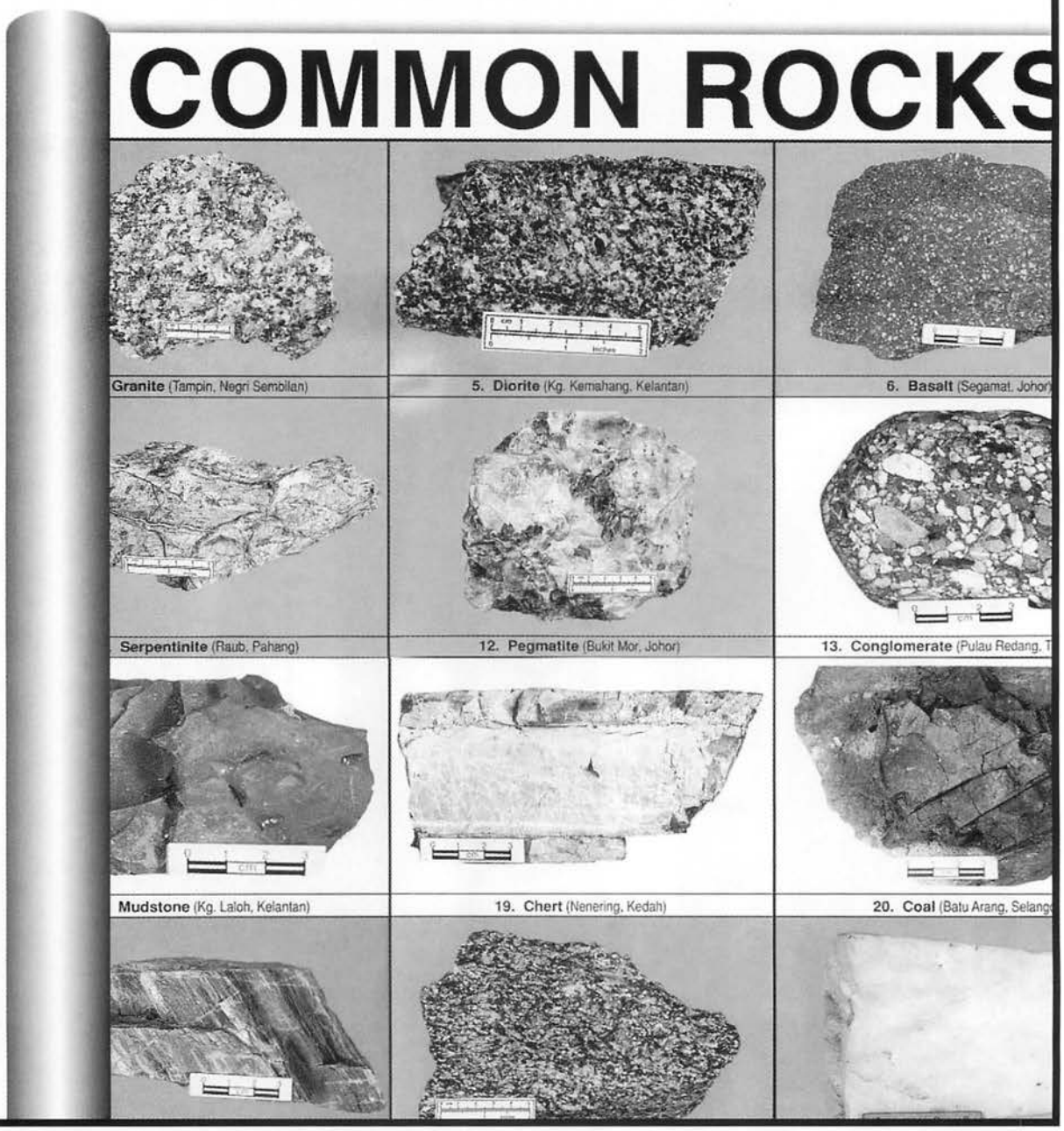
A full colour poster illustrating 28 common rocks of Malaysia. With concise description of the features and characteristics of each rock type including common textures of igneous, sedimentary and metamorphic rocks.

Laminated

Size: 94 cm x 66 cm (42" x 26")

Price:

Student members	RM7.00 (one copy per member, subsequent copies RM10.00 each)
Members	RM8.00 (one copy per member, subsequent copies RM10.00 each)
Non-members	RM10.00 per copy



Cheques, Money Orders or Bank Drafts must accompany all orders. Orders will be invoiced for postage and bank charges. Orders should be addressed to:

ORDERS

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

Geological input for mechanised tunnelling — case study of Kelinci Transfer Tunnel, Negeri Sembilan

MOGANA SUNDRAM

Report

Dr. Mogana Sundram gave the above talk on the 8th October 1998 at the Geology Department, University of Malaya. The talk centred on the geological investigations carried out for the Kelinci Transfer Tunnel, such as satellite imagery on aerial photographs interpretations for lineaments, detailed field mapping of joints and faults prior to construction, boreholes and again detailed logging and mapping of the tunnel excavation. The main purpose of the geological investigations is to predict the probable ground conditions that would be encountered during tunnel boring excavation. A close correlation between predicted and actual/encountered ground conditions was obtained.

The performance of the tunnel boring machine in relation to varying ground conditions was also discussed.

A short slide presentation showing some details of the tunnel boring machine, problems of ground collapses and stabilization, and water seepage problems, etc. concluded the talk, which was then followed by some discussions.

About 20 people attended the talk, 2 arrived at the "conclusion" stage, and 1 at the end of discussions!! (Guess who??)

Tan Boon Kong
Chairman
Working Group on Engineering Geology
& Hydrogeology

MOGANA SUNDRAM

NEW

Geological Evolution of South-East Asia

CHARLES S. HUTCHISON

GEOLOGICAL SOCIETY OF MALAYSIA

SPECIAL LOW-PRICED SOFT-COVER EDITION
LIMITED STOCK! GET YOUR COPY NOW!

PRICE:	**Member**	:	**RM50.00**
	Non-Member	:	**RM100.00**
	Student Member	:	**RM30.00**

Cheques, Money Orders or Bank Drafts must accompany all orders. Orders will be invoiced for postage and bank charges. Orders should be addressed to:

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

BERITA-BERITA PERSATUAN
News of the Society

KEAHLIAN (Membership)

The following applications for membership were approved:

Full Members

1. Thomus Kuud Nyanat
   Lot 792, S/L 1, Lutong-Kuala Baram Road, Miri 98100.
2. Emmy Suparka
   Jalan Kurnia 9, Bandung 40161, Indonesia.
3. Mark Morgan Harris
   c/o 46A, Tras Street, Singapore 078985.
4. Roques Delphine
   Dept. of Geology, Birckbeck College, London WUE.
5. Paul Crevello
   P.O. Box 2905, Bandar S.B., Brunei BS8675.
6. Michael Scherer
   Sarawak Shell, Locked Bag No. 1, 98009 Miri.

Student Members

1. Hong Chin Weng
   Sekolah Sains & Teknologi, Universiti Malaysia Sabah, 88999 Kota Kinabalu.

PETUKARAN ALAMAT (Change of Address)

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

1. Askury Abd. Kadir
   Jabatan Penyiasatan Kajibumi, Tingkat 9, Wisma Persekutuan, 20200 Kuala Terengganu, Terengganu.
2. Zainuddin Md Yusoff
   Jabatan Kejuruteraan Awam, Fakulti Kejuruteraan, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan.

CURRENT ADDRESS WANTED

The GSM is seeking the address of the following member. Anyone knowing the new address please inform the Society.

1. Zakaria Marzuki
   Petronas Carigali, Petronas Twin Tower 1
   (19 Floor), P.O. Box 11785, 50756 Kuala
   Lumpur.

PERTAMBAHAN BAHARU PERPUSTAKAAN (New Library Additions)

The Society has received the following publications:

1. U.S. Geological Survey: 1998: Professional Paper 1551-B, 1552-B, 1574, 1592, 1557, 1573, 1576, 1552-C, 1409-G, 1418, 1596-A-B, 1595, 1602. 1997: Professional Paper 1577
2. U.S. Geological Survey: 1997: Bulletin 2127, 2000-P, 2044. 1998: Bulletin 2158, 1995-T, U, V
3. U.S. Geological Survey: 1997: Circular nos. 1120-K, 1141. 1998: Circular no. 1172
4. AAPG Explorer, June–October 1998
5. Elf ep editions Memoire 19, 1997
6. Geoscience Journal, vol. 1, nos. 1–4, 1997
7. Humans & Nature, no. 8, 1997
8. Nature & Human Activities, no. 2, 1997
9. Monthly statistics on mining industry in Malaysia, Feb-Jun 1998.
10. University of Kansas, Paleontology Contribution, no. 9, 1998
11. AAPG Bulletin, vol. 82/7, 82/8, 82/9, 1998
12. Tin International, vol. 71, no. 6, 8 & 9, 1998
13. Geoscience Journal, vol. 2, no. 1, 1998
14. Annales Academiae Scientiarum Fennicae, no. 159, 1998
15. American Museum Noritates, nos. 3230, 3231, 3233, 1998
16. Episodes, vol. 21, no. 3, 1998
17. Oklahoma Geology Notes, vol. 58, no. 1–3, 1998

BERITA-BERITA LAIN
Other News

Local News

Enough water from next May with new dam

The RM135 mil Teluk Bahang Dam project, due for completion in May next year, will provide a strategic water reserve when it is fully operational by the year 2000.

A spokesman for the project consultant said the dam would provide the necessary reserves for drought and emergency use in addition to meeting water supply demands of neighbouring areas.

The dam is being constructed by China International Water & Electric (M) Sdn. Bhd. which jointly prepared the design with local counterpart SMHB Sdn. Bhd.

"It is crucial for Penang that the dam be ready as soon as possible to ensure that the state has enough water supply storage during the dry season next year," the spokesman said.

"How soon the dam can be filled depends on the frequency and volume of rainfall over the dam — the process will probably take up to a year,"

The dam and reservoir across the valley of Teluk Bahang river, with a catchment area covering 844.4 hectares, has a total capacity of about 21 million cubic metres.

Comparatively, the Mengkuang Dam in Seberang Prai can take up to 23.6 million cubic metres of water.

A 3.4 km water-transfer tunnel linking the dam and the Batu Ferringhi Treatment Plant is almost completed. Water will be transferred from one of the reservoirs within the dam, en route to a treatment plant situated at one end of the tunnel.

The project's supporting facilities are the Batu Ferringhi Treatment Plant and the upgraded Guillemard Treatment Plant with a total daily capacity of 155,000 cubic metres.

It has been proposed that the dam and reservoir, which are located near the Batu Ferringhi tourist belt, be developed into a recreation site to enhance tourism development.

Star, 9.9.1998

Warning of sinkholes, landslides

The National Disaster Management and Relief Committee today warned of possible sinkholes and landslides occurring in hilly areas during La Nina and directed local authorities to take immediate precautionary measures.

These include preventing soil erosion, ensuring waterways are not clogged, upgrading the drainage system and taking all precautionary measures to protect the people.

Committee chairman Datuk Seri Mohamed Rahmat said in the long run, however, local authorities should limit development activities in high-risk areas especially on hilly terrain.

"What we are concerned about now is heavy rain which can cause landslides and even buildings to collapse ..... these can endanger lives."

"This is a new aspect of disaster that we have to look into," he told reporters after chairing a meeting to prepare for La Nina, which is expected to hit Malaysia from next month.

The meeting, held at the National Security Division of the Prime Minister's Department, was attended by some 40 officials from the relevant federal and state agencies including the police, and the departments of the Fire and

Rescue, Geological, Works, and Welfare Services.

At the meeting, the Geological Department presented a map of landslide and sinkhole risk areas in the Klang Valley.

The committee had earlier directed the department to carry out a study of the risk areas so that precautionary measures could be taken by the relevant authorities. The department was today directed to expand the study nationwide.

Mohamed said the committee had informed the local authorities about the high-risk areas and recommended several short-term measures including preventing soil erosion and cleaning and upgrading the drainage systems.

Local authorities are to organise campaigns to inform those living on hilly terrain and other high-risk areas to take precautionary measures.

"We hope they would also take this into consideration when deciding on building plans."

"We are afraid that rapid development allowed by local authorities in these areas may increase the chances of landslides and collapse of buildings," said Mohamed.

Geological Department deputy director-general Chu Ling Heng said most of the high-risk areas were densely populated.

"Development of hillslopes are mainly concentrated in Damansara, Bangsar and Hulu Kelang areas."

"There is much hill-cutting and the risk is quite high in these areas," he said.

Mohamed said local authorities should be careful when considering and approving development projects, whether small or major, at such areas to prevent mishaps.

"We may even recommend to the authorities to limit development activities in high-risk areas once the department has completed its nationwide study," he said.

He added that these measures were being recommended based on the 1993 Highland Towers tragedy.

Mohamed also urged all State Government to immediately relocate all those staying on river reserves. This is to prevent any mishap during the rainy season.

NST, 16.9.1998

Hillslope ruling — reports a must for projects on 20 degree gradient

Developers carrying out projects on hillslopes exceeding a 20° gradient must submit geo-technical reports from independent consultants to City Hall.

Datuk Bandar Tan Sri Kamaruzzaman Shariff said City Hall wanted to ensure that all safety measures were taken before developers were allowed to start work.

"Developers will have to follow the original terrain of the hilly area while carrying out their projects," he said after chairing a City Hall Town Planning Committee meeting yesterday.

He said measures had to be taken in view of the *La Nina* weather phenomenon which was expected to bring heavy rains next month.

He added that City Hall would be strict in ensuring that developers adhered to the safety requirements.

Kamaruzzaman said developers should also build drains and turf the project sites to avoid soil erosion.

"We have begun inspecting buildings which are under construction on hillslopes to ensure they are safe," he said.

He added hat City Hall had a special team from the Planning and Building Control Department to carry out the job.

Kamaruzzaman said the team would also monitor existing buildings on hilly areas.

"The team will submit reports if buildings or areas need extra safety measures."

"Owners should take care of their own premises while the authority will help by monitoring the situation," he said.

Kamaruzzaman said property owners and developers should play their role and not depend solely on City Hall to look after the safety of their premises.

Star, 25.9.1998

M'sians hold 90% of Shell's top posts

Malaysians now hold 90% of the 906 senior staff positions in Sabah Shell Petroleum Company Ltd. and Sarawak Shell Bhd. (SSPC/SSB).

According to SSPC/SSB managing director Lim Haw Kuang, the figure reflects the success of the company's Malaysianisation effort.

He said 75% of the 65 top management positions and 80% of the 410 positions in the middle management level were held by Malaysians while the lower management level was 100% local.

"We have successfully created a Malaysian-based organisation and this is attributed to the careful planning in the company over the last 12 years," he said.

Lim was speaking at the annual Kinabalu Shell Press Award officiated by Sabah Chief Minister Tan Sri Bernard Dompok here on Saturday night.

One way the company developed local talents and expertise was by sending senior staff for attachment with Shell central offices in London and The Hague as well operating units in the Netherlands, Britain, Oman, Nigeria, the United States and Australia, Lim said.

With such assignments, they would gain exposure in various capacities, he said.

"In addition to running our multi-billion ringgit businesses here using Malaysian expertise, we are also deploying local talents as experts to work in various units within the Royal Dutch / Shell Group of Companies worldwide,"

Star, 5.10.1998

Damansara to Puchong highway opens in December

The RM1.4 billion Damansara-Puchong Highway (LDP) is expected to be opened two months ahead of schedule in December, Works Minister Datuk Seri S. Samy Vellu said today.

He said work on the 40 km six-lane highway stretching from Sri Damansara in the north to Putra Jaya in the south was originally scheduled for completion in late February next year.

Construction work on the project commenced on Sept 1, 1996.

Samy Vellu was speaking to reporters after performing the topping up ceremony of the 680-metre LDP Cable Stayed Bridge near the Federal Highway-Kelana Jaya interchange today.

It is the first cable stayed land Bridge in the country.

He was also briefed by Gamuda Berhad managing director Datuk Lin Yun Ling during the tour of the LDP project. Also present was Lingkaran Trans Kota Sdn. Bhd. (Litrak) chairman Tan Sri Wan Abdul Rahman Wan Ya'acob.

The concession for the privatisation of the LDP on a build-operate-transfer basis was awarded to Litrak in April 1996.

Litrak will have a concession agreement to

collect toll for a period of 33 years.

Litrak is wholly-owned by Lingkaran Trans Kota Holdings Berhad. Its major shareholders are Irama Duta Sdn.Bhd. and Gamuda Berhad.

The LDP is the final link to the western section of the Middle Ring Road II project that completes the Government's greater Kuala Lumpur Masterplan.

The project will help improve traffic movement by providing a ring road that would allow traffic to by-pass busy city centre roads. The LDP is divided into two packages.

Package 1 which stretches from Sri Damansara to Puchong Jaya covers a distance of 23 km and has 10 interchanges. Package 2 runs from Puchong Jaya to Sime UEP-Hicom and Putra Jaya, covering a distance of 17 km with four interchanges.

Upon completion, it will have 14 interchanges and four toll plazas at the Penchala, Petaling Jaya, Puchong Barat and Puchong Selatan interchanges.

The LDP will also be equipped with an advanced traffic control and surveillance system to inform motorists of the traffic situation and road conditions.

The LDP will be a free-flow highway which will link the economic centres of Kepong, Damansara, Petaling Jaya and Puchong as well as be a catalyst for greater development.

On the proposed toll rates for the LDP, Samy Vellu said he would make an announcement at a later date.

NST, 6.10.98

Charcoal proves to be Perak's 'black' gold

Perak, once the richest State in the country, still has its share of wealth in various forms.

One of these is its claim of having Peninsula Malaysia's largest mangrove forests — the 52 km stretch of the Larut Matang forest reserve — teeming with life and economic viability.

Besides its undeniable role as a vital buffer between land and water, the mangrove swamps offer man one of his important sources of fuel — charcoal.

For it is from the mangrove logs that the best charcoal is produced, making Perak the country's largest producer of charcoal.

Manufacturing charcoal is a wholly natural process. No chemicals are used and more importantly, it is a process in which every step in the manufacturing process utilises natural resources, from fire to brick and clay to manual labour.

A highly labour-intensive effort, the turning of mangrove logs into charcoal starts, of course, with the feeling of the trees.

In Perak, the Larut-Matang mangrove reserve is felled in 30-year rotations to ensure the sustainability of the forest. This is also a way in which the rich forest and swamp life is continuously preserved while offering man sustainable use of the timber.

The two species of mangrove logs most suitable for making charcoal are the *Rhizophora Mucronata* or "bakau kurap" and *Rhizophora Apiculata* or "bakau minyak" — both available aplenty in the Larut-Matang area.

After the logs are cut with the help of basic tools, they are floated down the rivers to the processing site.

Having reached the kiln and drying area, the logs are once again manually transferred to land.

Here they are stripped of their bark in preparation for drying in the huge igloo-like structures known as baking kilns.

The brick-and-clay kilns are constructed to withstand the extreme heat the logs are exposed to during the month-long drying process.

The logs measuring 1.6 m and between 7.5 cm and 10 cm in diameter are stacked close together on stones in the igloo to ensure they are dried properly.

The first stage of drying takes between 10 and 12 days when a large fire is kept burning round the clock with temperature ranging between 82 and 85 degrees Celsius.

Four holes around the kiln allow for the expulsion of steam which gets progressively hotter as the days go by.

After the first 10 and 12 days, the fire is banked down and maintained for another 10 to 12 days, after which the door to the kiln is sealed and the fire put out to allow for a cooling period.

One kiln accommodates about 40,000 tonnes of raw mangrove wood, which after drying, yields

between 10,000 and 12,000 tonnes of charcoal.

The charcoal pieces are then packed in bags manually and are now ready for the market.

As a fuel, it is widely used by hawkers to fire their stove while filling up barbecue pits at homes.

Charcoal pieces make excellent "soil" for orchid plants which require controlled and minimum amount of water.

In the garden, charcoal is used as a soil conditioner and as part of potting mixtures.

Many of us also use charcoal as filters — they form one of the main composition in the purification system of water filters which many households use.

Charcoal also comes in handy to absorb the smell of durians in enclosed spaces like cars.

Put some in the refrigerator for a few days and you will also find the stale smell disappearing.

NST, 9.10.1998

Four houses in Perak affected by sinkholes

Four sinkholes appeared in the compounds of four houses in Bukit Merah, about 8 km from here, over the past few days.

MP for Batu Gajah, Yeong Chee Wah, who visited the four houses affected by the sinkholes with Datuk Bandar Datuk Talaat Husain, said the Geological Survey Department would conduct a study on sinkhole-prone areas in Bukit Merah.

He said the department was expected to complete the study in a week and would submit it to the city council.

"Four days ago, one of the houseowners was shocked to find a sinkhole in front of his house compound while his neighbour felt something wrong with his house flooring."

"He took an hammer and tried to knock on his floor and the floor collapsed."

"The department will conduct the study to look for the cause of the sinkholes." Yeong told reporters at the sites.

He said about 5,000 villagers here were told to look out for sinkholes in the area.

A resident, Khoo Sin, 60, whose house was affected by a 3.3 m deep sinkhole, said he had earlier seen his neighour's car plunge into a sinkhole.

No one was injured in the incident.

"The state government wanted to relocate us to a new housing scheme in 1980 but the project was shelved."

"We hope the Government will do something soon as this place is dangerous."

"We have been staying here for the past 30 years and nothing like this has happened," he said.

Star, 9.10.1998

Petronas expects 120,000 bpd from two oil fields in Iran

National petroleum company Petronas expects production from its two oil fields in Iran to tough 120,000 barrels a day next year.

Petronas president Tan Sri Mohd Hassan Marican said its Sirri A oil field started production of 7,000 barrels from Friday while its Sirri E oil field was expected to start production of 100,000 barrels early next year.

"Sirri A will be able to increase its production to 20,000 barrels soon," he said in Kuala Lumpur on Saturday. The oil field, located offshore in the Persian Gulf, has estimated reserves of 560 million barrels.

Petronas has 30 per cent equity in the venture, with the rest being held by France's SA Total and Russia's Gazprom.

Apart from interest in the oil field, Petronas also has a 30 per cent stake in the tripartite consortium undertaking a US$2 billion (RM7.6 billion) gas field project to develop the South Pars Gas Field.

In May, Malaysia welcomed the US's agreement with the European Union to waive the sanctions on Malaysian, European and Russian firms involved in the gas deal with Iran.

The US had voiced strong opposition to the

Iran gas project, involving Petronas, signed last September, which it said violated the Iran and Libya Sanctions Act of 1996.

(The Iran-Libya Sanctions Act contains provisions for sanctions to be imposed by the US against foreign companies making investments of more than US$20 million a year in the oil and gas sector of the targeted countries.)

Malaysia had also made its point in April during a visit from a representative of the US State Department that Petronas had not contravened any law or World Trade Organisation regulation by participating in the consortium to develop the South Pars Gas Field in Iron.

As for Petronas's new activities elsewhere, Mohd Hassan said the company's exploration activities in Vietnam would soon bear fruit when its oil field, Ruby Crude, located near Ho Chi Minh City, began production in November.

"We expect production to be 20,000 barrels a day," he said.

Vietnam is considered the company's first overseas oil exploration venture on its own.

The Ruby field is estimated to have a reserve of 200 million barrels.

Currently, Petronas is involved in upstream and downstream exploration and production activities in 20 countries.

NST, 12.10.1998

Expressway soil erosion peril

A study by Institut Teknologi Mara (ITM) has found that several areas along the North-South Expressway are prone to soil erosion which can cause landslides.

Civil Engineering Faculty Associate Prof. Dr. Ruslan Zainal Abidin said the "most dangerous" period for this tendency to occur was during this month.

"Our analysis of rainfall data from 60 weather stations along the highway showed that October had the highest intensity of rainfall in the past five years."

"With the probability of the La Nina weather phenomenon developing by the end of the year, this makes the likelihood of soil erosion even stronger," he said in an interview yesterday.

Dr. Ruslan, who conducted the one-year stud, was commenting on the findings of the report, which was displayed at the International Invention, Innovation, Industrial Design and Technology Exhibition from last Saturday to yesterday.

In the first phase of the study, he used a universal soil loss calculation to detect the different soil erosion features along the 448 km stretch from Kuala Lumpur to Bukit Kaya Hitam in the north.

Dr. Ruslan said the study observed that there were three different soil erosion features along the expressway — sheet erosion, rill erosion and gully erosion.

"Of this three, the gully erosion feature is the most dangerous as it can lead to cave-ins and holes forming in the soil."

"And most of these areas are located along the expressway in Perak and Selangor, where the original soil has finer particles with a high amount of silt and sand," he said.

Areas along the expressway in Penang and Kedah, Dr. Ruslan said, were only prone to sheet erosion which occurred on surfaces as these were mainly flat land and most of the hills were not cut through.

Rill erosion is shallow, narrow openings running in parallel lines which, if left untreated and exposed to high intensity of rain, can develop into gully erosion.

"Some of the most dangerous areas are in Gua Tempurung and the stretch between Kuala Kangsar and Changkat Jering, which in the event of heavy rain may collapse," said Dr. Ruslan.

To prevent this, he proposed that areas of exposed soil along the expressway be adequately covered with either concrete lining or grass.

Star, 14.10.1998

New Gopeng-Tapah stretch to open before Deepavali

The new Gopeng-Tapah stretch of the North-South Expressway near Gua Tempurung is nearing completion and is scheduled to open before Deepavali.

A visit to the site today showed that work on the new alignment was almost completed and workers were seen doing the final touches such as putting up road signages, chevron markers and road surfacing.

Work on the alignment which began early last year, is being undertaken by Projek Lebuhraya Utara-Selatan, the concessionaire of the expressway.

PLUS officials, however, could not be reached for comment.

Meanwhile, Perak Infrastructure and Public Utilities Committee chairman Datuk Ong Ka Chuan confirmed today that the new 1.3 km stretch was nearing completion and would be opened soon.

He said the Malaysian Highway Authority was expected to inspect the road either tomorrow or the day after.

It is learnt that the opening will be in time for the Deepavali celebrations to enable motorists to enjoy a smoother drive along the stretch of the expressway, compared with the bumpy ride at the temporary 704-metre slip road.

The slip road was built after the Gopeng-Tapah stretch was damaged when the concrete embankment of one of the slopes collapsed on Jan 6, 1996. A lorry attendant, Abdul Hamid Kodin, 33, was killed in the incident triggered by a landslip.

The collapsed embankment was part of three built along the highway near the Gua Tempurung rest area.

Ong said with the opening of the new RM26 million alignment, the slip road would be closed permanently. It would be used as a maintenance camp by PLUS.

He said the new alignment, at 308.8 km of the NSE, was built 120 metres away from the collapsed embankment which had been rehabilitated through rock buttressing and slope strengthening measures.

The re-alignment is permanent and conforms to the required expressway standards, allowing motorists to travel at 110 km per hour.

However, Ong said the speed limit along the stretch might be reduced to 80 km per hour as the road sloped downhill.

Currently, motorists are advised to reduce speed to 80 km per hour when approaching the slip road and at 60 km per hour while on the slip road.

Ong also said measures were being taken by PLUS to ensure the safety of the new stretch.

One of the measures, he said, was using a new premix on the stretch. The premix, he explained, was of a more coarse material and more porous to increase friction and to absorb water more easily.

Ong said PLUS had also taken the initiative to remove the top surface of the other existing stretches along the NSE so that the new pre-mix could be applied.

Previously, the pre-mix was of a non-porous substance and when it rained, the road became extremely slippery.

NST, 15.10.1998

Petronas starts oil production in Vietnam's Ruby field

Petroliam Nasional Bhd. (Petronas) has successfully commenced crude oil production from the Ruby field offshore Vietnam on Oct 22, 10 days ahead of schedule.

It said in a statement yesterday that commercial production from the field represented a significant milestone as it was the first overseas exploration and production project undertaken by the company as an operator.

The initial production, averaging 8,000 barrels per day (bpd), comes from slim twin wells, which are two wells drilled and completed from a single conductor. This is a drilling technology developed by Petronas and applied for the first time in Vietnam.

Petronas said production from the Ruby Field was planned at 20,000 bpd for next year.

The Ruby Field, located in Block 01 and 02, is operated by Petronas under a production sharing contract signed in 1991 with

PetroVietnam, the state oil company of Vietnam. Petronas holds 85% stake in both blocks. The remaining 15% is owned by PetroVietnam subsidiary PetroVietnam exploration and Production Co.

Star, 27.10.1998

Analysts: Consolidation of cement industry timely

Malayan Cement Bhd.'s proposed acquisition of a 65% stake in Kedah Cement Holdings Bhd. marks another major step in the consolidation of the country's cement industry.

Analysts said the ongoing consolidation was timely given the oversupply situation in the industry that had been aggravated by the economic slowdown.

"While consolidation has been occurring over the last couple of years, Malayan Cement's move signals the start of real changes with Britain's Blue Circle plc taking a controlling position in the local industry," said a research head of a local stockbroking firm.

Blue Circle has a 57.8% interest in Malayan Cement and the latter is expected to end up with 100% stakes in both Associated Pan Malaysia Cement Sdn. Bhd. (APMC) and Kedah Cement, via a general offer, by the year-end.

APMC has a cement production capacity of about 6.2 million tonnes a year and Kedah Cement, just under six million tonnes.

Together, they account for 50% of the country's total annual cement production capacity of 24 million tonnes.

"In this industry, size does matter and Malayan Cement's economies of scale would bring huge benefits to Blue Circle in the long run," the research head said, adding that although cement demand would be affected at least until 2,000 when the construction sector was expected to emerge from the doldrums, the Blue Circle investment was sound.

Another analyst who tracks the cement industry said the latest news was not a surprise given the oversupply situation in the industry.

"It is good news as the oversupply situation this year is still expected to be 45% compared with the higher earlier estimate of 53%," she said.

She added that it was a logical step for Blue Circle to expand its operations in Malaysia but questioned the premium being paid for each Kedah Cement share.

Malayan Cement is paying RM2.60 for each Kedah Cement share. The shares were trading at RM2.27 on the KLSE yesterday when they were suspended.

"The premium could be due to Kedah Cement's location or other assets apart from the plant that is to be bought over. Or it could be because Malayan Cement would end up with a dominant stake in the industry," the analyst said.

She added that the next target of a buy-out could be Cement Industries of Malaysia Bhd., a unit of the Renong group but said pricing and ongoing issues at Renong could be a barrier to negotiations.

Star, 28.10.1998

OBITUARY

J.H. LEOW
28.6.1931 – 5.4.1998

J.H. Leow commonly known as Tony or Mr. Leow to his many friends and former students died of cancer at the Singapore General Hospital on 5 April 1998. Although he had been suffering from a number of ailments over the past ten years, his demise was quite unexpected, as he had maintained his usual jovial disposition and optimism even during his last days in the hospital.

Tony Leow was born in Singapore, the last of 4 children, having 2 sisters and a brother. He was an orphan (father died before his birth and mother after) and was brought up by his uncle. He excelled academically but World War II interrupted his primary schooling. After the war, he returned to school and was rapidly promoted. He did his schooling at St. Andrew's School in Singapore. In his final year at he was the school captain and head prefect.

After his secondary schooling, he studied at the University of Western Australia and resided at St. George College. He originally studied Engineering but became interested in Geology and switched to Geology after his first year. Amongst his contemporaries at St. George College was his good friend, the late Chung Sooi Keong, a former Director General of the Geological Survey of Malaysia. Tony excelled in sports and was the Western Australia Badminton Champion. He also swam and water-skied. Later, he took up golf and quickly attained a low handicap.

Tony joined the teaching staff at the Geology Department of the University of Malaya in the late fifties when the Department was established in Singapore. He was the first local academic staff and moved to Kuala Lumpur when the department was transferred to the Kuala Lumpur campus. His enthusiasm for teaching and research and his friendly and helpful nature made him a popular lecturer. His former students will always remember his numerous interesting anecdotes, which were a part and parcel of his lectures. Many Malaysian geologists were encouraged and supported to pursue their careers in Geology by Tony. His contributions to the

local geological scene extended way beyond his departure from the University in the early seventies. For the next fifteen years, he undertook a number of mining and engineering geology ventures in this region. Tony always kept in close touch with his colleagues, friends and the general geological community in this country. His last attendance at a geological function in Malaysia was the Society's 1996 Annual General Meeting.

While at the University of Malaya, his contribution to the setting up of the Department was outstanding. Since the department had a teaching staff of less than 5 for most of the first 10 years, Tony had to shoulder much of the teaching, fieldwork and administrative duties as well as establish teaching and research facilities. Amongst his valuable contributions was the setting up of the ore microscopy laboratory and his pioneering work on Malaysian tin ore and other economic deposits. He was a former President of the influential University of Malaya Academic Staff Association and worked hard to promote the welfare of the academic staff and their families. He was also a founder member of the Geological Society of Malaysia.

Tony was also active in community services. He was the Chairman of the Singapore Museum Board where he worked tirelessly to restore Singapore Museum and preserve buildings of historical significance. He was also President of the "Zipper's" Association (Coronary Bypass Operation patients) and worked to support people who had to undergo cardiac surgery. This was in the early days when this type of operation was in its infancy. Later he also worked to help people with kidney disease. Owning to ill health, he retired in 1988 and moved to Adelaide to spend more time with his grandchildren.

In Adelaide, he continued to support and be involved in the local Renal Association. He enjoyed fine wines. He always had an interest in leading edge technology and was communicating by e-mail and surfing the internet, until just before his death.

He will always be remembered as a gentleman and a true friend who always went out of his way to help others. He was the life of the party. He made friends easily and was well liked wherever he went. Even in hospital he always had a smile on his face and was more concerned over the comfort of his visitors then himself.

He leaves behind his wife, son, two daughters, a grandson and a grand daughter.

BKT

KALENDAR (CALENDAR)

1998

October/November

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

November 8–11

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS (International Conference and Exhibition), Rio de Janeiro, Brazil. (Contact: AAPG Conventions Department, P.O. Box 979, 1444 S Boulder Ave., Tulsa, OK 74101-0979, USA. Tel: +1 918 560 2679; Fax: +1 918 560 2684)

November 16–20

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

December 1–3

ORIGIN OF THE EARTH AND MOON (International Conference of the Geochemical Society), Monterey, California, USA. (Contact: LeBecca Simmons, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston TX 77058-1113, USA. Tel: 1 281 486 2158; Fax: 1 281 486 2160; E-mail: simmons@lpi.jsc.nasa.gov)

December 2–3

SEAPEX SILVER JUBILEE EXPLORATION CONFERENCE, Suntec City Exhibition Center, Singapore. (Contact: Mr. T.C. Chew, Southeast Asia Petroleum Exploration Society, P.O. Box 423 Tanglin Post Office, Singapore 812. Tel: (65) 338-9108; http://web.singnet.com.sg./~seapex)

December 6–10

AMERICAN GEOPHYSICAL UNION (Annual Fall Meeting), San Francisco, California, USA. (Contact: AGU Meetings Department, 1998 Fall Meeting 2000 Florida Avenue NW, Washington, DC 20009, USA. Tel: +1 202 462 6900 (in Washington, D.C. area and outside North America), *or* +1 800 966 2481 (toll-free in North America); Fax: +1 202 328 0566; E-mail: meetinginfo@kosmos.agu.org; WWW: http://www.agu.org)

1999

February 1–5

SHALLOW TETHYS (International Symposium), Chiang Mai, Thailand. (Contact: Shallow Tethys 5 Symposium Secretary, Dept. of Geological Sciences, Chiang Mai University, Chiang Mai 50200, Thailand. Fax: 66 53 89 2261)

March 1–3

THIRTEENTH INTERNATIONAL CONFERENCE AND WORKSHOPS ON APPLIED GEOLOGIC REMOTE SENSING: Practical Solutions for Real-World Problems. Hotel Vancouver, Vancouver, British Columbia, Canada. Organized by ERIM with sponsors that include NASA, U.S. DOE Nevada Operations Office and Remote Sensing Lab, and USGS. (Contact: ERIM Geologic Conferences, Box 134001, Ann Arbor, MI 48113-4001 USA. Tel: +1 313 994 1200, ext. 3234; Fax: +1 313 994 5123; E-mail: wallman@erim.org)

March 1–4

SOCIETY FOR MINING, METALLURGY, AND EXPLORATION (Annual Meeting), Denver, Colorado, USA. (Contact: SME, 8307 Shaffer Parkway, P.O. Box 625002, Littleton, CO 80162-5002, USA. Tel: 1 303 973 9550; E-mail: smenet@aol.com)

March 9–11

INTERNATIONAL CONFERENCE ON PANGEA AND THE PALEOZOIC-MESOZOIC TRANSITION, Wuhan, Hubei, China. (Contact:

Dr. Tong Jinan, Faculty of Earth Science, China University of Geosciences, Wuhan, Hubei 430074, China. Tel: +86-27-7482031; Fax: +86-27-7801763; E-mail: jntong@dns.cug.edu.cn)

April 11–14

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS (Annual Meeting), San Antonio, Texas, USA. (Contact: AAPG Conventions Department, P.O. Box 979, 1444 S. Boulder Ave., Tulsa, OK 74101-0979, USA. Tel: +1 918 560 2679; Fax: +1 918 560 2684; E-mail: dkeim@aapg.org)

May 26–28

GEOLOGICAL ASSOCIATION OF CANADA-MINERALOGICAL ASSOCIATION OF CANADA, JOINT ANNUAL MEETING, Sudbury, Ontario. (Contact: Dr. P. Copper, Dept. of Earth Sciences, Laurentian University, Sudbury, Ontario P3E 2C6, Canada. Tel: (705) 657-1151 ext. 2267; Fax: (705) 675-4898; E-mail: gacmac99@nickel.laurentian.ca)

June

FOURTH INTERNATIONAL AIRBORNE REMOTE SENSING CONFERENCE AND EXHIBITION, Ottawa, Ontario, Canada. Organized by ERIM. (Contact: ERIM Airborne Conferences, Box 134001, Ann Arbor, MI 48113-4001 USA. Tel: +1 313 994 1200, ext. 3234; Fax: +1 313 994 5123; E-mail: wallman@erim.org)

June 7–11

EUROPEAN ASSOCIATION OF GEOSCIENTISTS AND ENGINEERS (EAGE, 61st Conference), Helsinki, Finland.

July 19–30

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS, Birmingham, UK. (Contact: IUGG99, School of Earth Sciences, University of Birmingham, Edghaston, Birmingham B15 2TT, UK. Fax: 44 121 414 4942; E-mail: IUGG99@bham.ac.uk)

August 3–12

INTERNATIONAL UNION FOR QUATERNARY RESEARCH (INQUA) (15th Congress), "The Environmental Background to Hominid Evolution in Africa", Durban, South Africa. (Contact: Dr. D. Margaret Avery, INQUA XV CONGRESS, P.O. Box 61, South Africa Museum, Capetown 8000, South Africa. Tel: +27 21 243 330; Fax: +27 21 246 716; E-mail: mavery@samuseum.ac.za; WWW: http://inqua.geoscience.org.za)

August 4–12

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

August 14–25

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

August 22–25

SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS (SGA) (5th Biennial Meeting), "Mineral Deposits: Processes to Processing," London, UK. Imperial College Natural History Museum. (Contact: Dr. Chris Stanley, Department of Mineralogy, Natural History Museum, Cromwell Road, London, SW7 5BD, UK. Tel: +44 171 938 9361; Fax: +44 171 938 9268; E-mail: cjs@nhm.ac.uk)

September

THE CONTINENTAL PERMIAN OF THE SOUTHERN ALPS AND SARDINIA (ITALY): Regional reports and general correlations (International Field Conference), Brescia, Italy. (Contact: Prof. G. Cassinis, Dipartimento di Scienze della Terra, Universita di Pavia, Via Ferrata, 1, I-27100 Pavia, Italy. Tel: 39 382 505834; Fax: 39 382 505890; E-mail: cassinis@ipv36.unipv.it)

September

INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS (29th Congress), Bratislava, Slovakia. (Contact: Prof. L. Melioris, Comenius University, Mylinska Dolina, 84215 Bratislava, Slovakia. Tel/Fax: +42 7 725 446; E-mail: podzvody@fns.uniba.sk)

September

INTERNATIONAL SOCIETY OF ROCK MECHANICS (9th International Congress), Paris, France. (Contact: Dr. S. Gentier, Secrétaire Général du CFMR, BRGM/DR/GGP, Avenue Claude Guillemin, B.P. 6009, F-45060 Orléans Cedex 2, France. Tel: +33 2 38 64 38 77; Fax: +33 2 38 64 30 62)

September 12–15

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS (International Meeting), Birmingham, UK. (Contact: AAPG Conventions Dept., P.O. Box 979, Tulsa, OK 74101-0979, USA. Tel: 1 918 560 2679; Fax: 1 918 560 2684)

October 25–28

GEOLOGICAL SOCIETY OF AMERICA (Annual Meeting), Denver, Colorado, USA. (Contact: GSA Meetings Dept., P.O. Box 9140, Boulder, CO 80301-9140, USA. Tel: +1 303 447 2020; Fax: +1 303 447 1133; E-mail: meetings@geosociety.org; WWW: http://www.geosociety.org/meetings/index.htm)

October 30 – November 4

SOIL SCIENCE SOCIETY OF AMERICA (Annual Meeting), Salt Lake City, Utah, USA. (Contact: SSSA, 677 So, Segoe Rd., Madison, WI 53711, USA. Tel: 1 608 273 8090; Fax: 1 608 273 2021; E-mail: rbarnes@agronomy.org)

2000

March 6–9

SOCIETY FOR MINING, METALLURGY, AND EXPLORATION (Annual Meeting), Salt Lake City, Utah, USA. (Contact: SME, 8307 Shaffer Parkway, P.O. Box 625002, Littleton, CO 80162-5002, USA. Tel: 1 303 973 9550; E-mail: smenet@aol.com)

August 6–17

31ST INTERNATIONAL GEOLOGICAL CONGRESS, Rio de Janeiro, Brazil. Theme of the Congress: Geology and Sustainable Development: Challenges for the Third Millenium. (Contact: Prof. Hernani Chaves, President of the Preparatory Commission for the 31st IGC, Ave. Pasteur, 404, Urca: Cep 22290-204, Rio de Janeiro, Brazil. Tel: +55 21 295 5337; Fax: +55 21 542 3647; E-mail: Hernani@uerj.br)

October

INTERNATIONAL MILLENIUM CONGRESS ON GEOENGINEERING, Melbourne, Australia. (More information soon)

November 13–16

GEOLOGICAL SOCIETY OF AMERICA (Annual Meeting), Reno, Nevada, USA. (Contact: GSA Meetings Dept., P.O. Box 9140, Boulder, CO 80301-9140, USA. Tel: +1 303 447 2020; Fax: +1 303 447 1133; E-mail: meetings@geosociety.org; WWW: http://www.geosociety.org/meetings/index.htm)

2001

June 3–6

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS (Annual Meeting), Denver, Colorado, USA. (Contact: AAPG Conventions Department, P.O. Box 979, 1444 S. Boulder Ave., Tulsa, OK 74101-0979, USA. Tel: +1 918 560 2679; Fax; +1 918 560 2684; E-mail: dkeim@aapg.org)

November 5–8

GEOLOGICAL SOCIETY OF AMERICA (Annual Meeting), Boston, Massachusetts, USA. (Contact: GSA Meetings Dept., P.O. Box 9140, Boulder, CO 80301-9140, USA; Tel: +1 303 447 2020; Fax: +1 303 447 1133; E-mail: meetings@geosociety.org; WWW: http://www.geosociety.org/meetings/index.htm)

2002

March 10–13

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS (Annual Meeting), Houston, Texas, USA. (Contact: AAPG Conventions Department, P.O. Box 979, 1444 S. Boulder Ave., Tulsa, OK 74101-0979, USA. Tel: +1 918 560 2679; Fax: +1 918 560 2684; E-mail: dkeim@aapg.org)

October 28–31

GEOLOGICAL SOCIETY OF AMERICA (Annual Meeting), Denver, Colorado, USA. (Contact: GSA Meetings Dept., P.O. Box 9140, Boulder, CO 80301-9140, USA; Tel: +1 303 447 2020; Fax: +1 303 447 1133; E-mail: meetings@geosociety.org; WWW: http://www.geosociety.org/meetings/index.htm)

PP 3279/11/93 ISSN 0126–6187

BULETIN PERSATUAN GEOLOGI MALAYSIA

GEOLOGICAL SOCIETY OF MALAYSIA

KANDUNGAN (CONTENTS)

Editor: G.H. Teh

Bulletin of the GEOLOGICAL SOCIETY OF MALAYSIA

JULY 1994 **No. 35**

PP 3279/11/93 ISSN 0126–6187

BULETIN PERSATUAN GEOLOGI MALAYSIA

GEOLOGICAL SOCIETY OF MALAYSIA

SPECIAL ISSUE ON PETROLEUM GEOLOGY VOL. VIII

KANDUNGAN (CONTENTS)

Editor: G.H. Teh

Bulletin of the GEOLOGICAL SOCIETY OF MALAYSIA

DECEMBER 1994 **No. 36**

GEOLOGICAL SOCIETY OF MALAYSIA PUBLICATIONS

BULLETIN OF THE GEOLOGICAL SOCIETY OF MALAYSIA

WARTA GEOLOGI — NEWSLETTER OF THE GEOLOGICAL SOCIETY OF MALAYSIA

ADVERTISING SPACE ORDER FORM

	WARTA GEOLOGI Format: 20 cm x 28 cm		BULLETIN Format: 20 cm x 28 cm	
RATES:	Black & White	Colour	Black & White	Colour
Inside full page per issue	RM300	RM600	RM1,000	RM1,500
Inside half page per issue	RM200	RM500	RM500	RM800
Inside full page for 6 issues	RM1,500	RM3,000	—	—
Inside half page for 6 issues	RM1,000	RM2,500	—	—

Artwork and positive films or slides (for colour or black & white) should be supplied by the advertiser.

Please send the completed form below together with remittance payable to "Geological Society of Malaysia" to

The Editor,
Geological Society of Malaysia
c/o Dept. of Geology,
University of Malaya,
50603 Kuala Lumpur, Malaysia.

For further information, please ring 603-7577036 or fax 603-7563900.

The Editor,
Geological Society of Malaysia
c/o Dept. of Geology,
University of Malaya,
50603 Kuala Lumpur.

We would like to take up advertising space in WARTA GEOLOGI/BULLETIN in the form (please tick as appropriate):

	WARTA GEOLOGI		BULLETIN	
	Black & White	Colour	Black & White	Colour
Inside full page	one issue ☐ six issues ☐	one issue ☐ six issue ☐	one issue ☐ issues ☐	one issue ☐ issues ☐
Inside half page	one issue ☐ six issues ☐	one issue ☐ six issue ☐	one issue ☐ issues ☐	one issue ☐ issues ☐

Artwork/Positive film/slide* enclosed ☐ not enclosed ☐

Company .....

Address .....

.....

Enclosed cheque/money order/bank draft* ..... for RM .....

Person to be contacted ..... Tel: .....

Designation ..... Fax: .....

* Please delete as appropriate.

Signature .....

ORDER FORM

GEOLOGICAL SOCIETY OF MALAYSIA PUBLICATION

Date: .....

The Assistant Secretary,
Geological Society of Malaysia,
c/o Department of Geology,
University of Malaya,
50603 Kuala Lumpur,
MALAYSIA

Dear Sir,

Please send me the following publications. I enclose US$/RM*..... in cheque/money order/bank draft.*

Item	No. of Copies	Price

Sub–Total _____

Total _____

Signature: _____

*Delete where applicable

Please mail to : _____

(Please print) _____

_____

_____

_____

GEOLOGICAL SOCIETY OF MALAYSIA PUBLICATIONS

Back Issues Available

Bulletin 1 (Feb 1968). 79 p. Studies in Malaysian Geology. Edited by P.H. Stauffer. A collection of papers presented at a meeting of the Geological Society on 31st January 1967. Price: RM3.00. **Out of Stock.**

Bulletin 2 (Dec 1968). 152 p. Bibliography and Index of the Geology of West Malaysia and Singapore by D.J. Gobbett. Price: RM10.00 - Softcover, M$15.00.

Bulletin 3 (Mar 1970). 146 p. Papers in Geomorphology and Stratigraphy (with Bibliography supplement). Edited by P.H. Stauffer. Price: RM10.00.

Bulletin 4 (Jun 1971). 100 p. Papers in Petrology, Structure and Economic Geology. Edited by P.H. Stauffer. Price: RM10.00.

Bulletin 5 (Feb 1973). 70 p. The Search for Tungsten Deposits by K.F.G. Hosking. Price: RM10.00.

Bulletin 6 (Jul 1973). 334 p. Proceedings, Regional Conference on the Geology of Southeast Asia. A collection of papers, Kuala Lumpur, March, 1972. Edited by B.K. Tan. Price: RM22.00 – hardcover only.

Bulletin 7 (Jun 1974). 138 p. A collection of papers on geology. Edited by B.K. Tan. Price: RM12.00.

Bulletin 8 (Dec 1977). 158 p. A collection of papers on geology. Edited by T.T. Khoo. Price: RM12.00.

Bulletin 9 (Nov 1977). 277 p. The relations between granitoids and associated ore deposits of the Circum-Pacific region. A collection of papers presented at the IGCP Circum-Pacific Plutonism Project Fifth Meeting. 12-13 November 1975, Kuala Lumpur, Edited by J.A. Roddick & T.T. Khoo. Price: RM25.00. **Out of stock.**

Bulletin 10 (Dec 1978). 95 p. A collection of papers on the geology of Southeast Asia. Edited by C.H. Yeap. Price: RM10.00. **Out of stock.**

Bulletin 11 (Dec 1979). 393 p. Geology of Tin Deposits. A collection of papers presented at the International Symposium of 'Geology of Tin Deposits', 23-25 March 1978, Kuala Lumpur. Edited by C.H. Yeap. Price: RM50.00.

Bulletin 12 (Aug 1980). 86 p. A collection of papers on geology. Edited by G.H. Teh. Price: RM20.00.

Bulletin 13 (Dec 1980). 111 p. A collection of papers on geology of Malaysia and Thailand. Edited by G.H. Teh. Price: RM20.00.

Bulletin 14 (Dec 1981). 151 p. A collection of papers on geology of Southeast Asia. Edited by G.H. Teh. Price: RM30.00.

Bulletin 15 (Dec 1982). 151 p. A collection of papers on geology. Edited by G.H. Teh. Price: RM30.00.

Bulletin 16 (Dec 1983). 239 p. A collection of papers on geology. Edited by G.H. Teh. Price: RM30.00.

Bulletin 17 (Dec 1984). 371 p. A collection of papers on geology. Edited by G.H. Teh. Price: RM35.00.

Bulletin 18 (Nov 1985). 209 p. Special Issue on Petroleum Geology. Edited by G.H. Teh & S. Paramananthan. Price: RM30.00.

Bulletin 19 (Apr 1986) **& 20** (Aug 1986). GEOSEA V Proceedings Vols. I & II, Fifth Regional Congress on Geology, Mineral and Energy Resources of Southeast Asia, Kuala Lumpur, 9-13 April 1984. Edited by G.H. Teh & S. Paramananthan. Price for both Bulletins 19 & 20: Members – RM50.00, Non-Members – RM125.00.

Bulletin 21 (Dec 1987). 271 p. Special Issue on Petroleum Geology Vol. II. Edited by G.H. Teh. Price: RM40.00.

Bulletin 22 (Dec 1988). 272 p. Special Issue on Petroleum Geology Vol. III. Edited by G.H. Teh. Price: RM40.00.

Bulletin 23 (Aug 1989). 215 p. A collection of papers on the geology of Malaysia, Thailand and Burma. Edited by G.H. Teh. Price: RM35.00.

Bulletin 24 (Oct 1989). 199 p. A collection of papers presented at GSM Annual Geological Conference 1987 and 1988. Edited by G.H. Teh. Price: RM35.00.

Bulletin 25 (Dec 1989). 161 p. Special Issue on Petroleum Geology Vol. IV. Edited by G.H. Teh. Price: RM40.00.

Bulletin 26 (Apr 1990). 223 p. A collection of papers presented at GSM Annual Geological Conference 1989 and others. Edited by G.H. Teh. Price: RM40.00.

Bulletin 27 (Nov 1990). 292 p. Special Issue on Petroleum Geology Vol. V. Edited by G.H. Teh. Price: RM40.00.

Bulletin 28 (Nov 1991). 292 p. Special Issue on Petroleum Geology Vol. VI. Edited by G.H. Teh. Price: RM40.00.

Bulletin 29 (Jul 1991). 255 p. A collection of papers presented at GSM Annual Geological Conference 1990 and others. Edited by G.H. Teh. Price: RM40.00.

Bulletin 30 (Apr 1992). 90 p. Annotated bibliography of the geology of the South China Sea and adjacent parts of Borneo by N.S. Haile. Edited by G.H. Teh. Price RM20.00

Bulletin 31 (Jul 1992). 176 p. A collection of papers presented at GSM Annual Geological Conference 1991 and others. Edited by G.H. Teh. Price: RM35.00.

Bulletin 32 (Nov 1992). 283 p. Special Issue on Petroleum Geology Vol. VII. Edited by G.H. Teh. Price RM50.00

Bulletin 33 (Nov 1993). 419 p. Proceedings Symposium on Tectonic Framework and Energy Resources of the Western Margin of the Pacific Basin. Edited by G.H. Teh. Price: RM60.00.

Bulletin 34 (Dec 1993). 181 p. Bibliography and Index — Publications of the Geological Society of Malaysia 1967-1993. Compiled by T.F. Ng. Edited by G.H. Teh. Price: RM30.00.

Bulletin 35 (Jul 1994). 174 p. A collection of papers presented at GSM Annual Geological Conference 1992 & 1993 and others. Edited by G.H. Teh. Price: RM35.00.

Field Guide 1 (1973). A 7-day one thousand mile, geological excursion in Central and South Malaya (West Malaysia and Singapore). 40 p. by C.S. Hutchison. Price: RM5.00. **Out of stock.**

Abstracts of papers (1972). Regional Conference on the Geology of Southeast Asia, Kuala Lumpur, 1972. 64 p. 8 figs, 3 tables, many extended abstracts. Edited by N.S. Haile. Price: RM6.00.

Proceedings of the Workshop on Stratigraphic Correlation of Thailand and Malaysia Vol. 1. (1983). Technical Papers. 383 p. Price: RM25.00 (Members: RM12.00).

WARTA GEOLOGI (Newsletter of the Geological Society of Malaysia). Price: RM5.00 per bimonthly issue from July 1966.

PACKAGE DEAL 1: Bulletin nos. 2-8, 11
Student Members: RM10.00; Members: RM20.00;
Non-Members: RM40.00

PACKAGE DEAL 2: Bulletin nos. 12-16
Student Members: RM30.00; Members: RM40.00;
Non-Members: RM60.00

PACKAGE DEAL 3: Bulletin nos. 17-18 and 21-23
Student Members: RM60.00; Members: RM80.00;
Non-Members: RM100.00

PACKAGE DEAL 4: Combination of Package Deals 1-3
Student Members: RM100.00; Members: RM140.00;
Non-Members: RM200.00

PACKAGE DEAL 5: Bulletin nos. 19 & 20 + Proceedings of Workshop on Stratigraphic Correlation of Thailand & Malaysia Vol. 1.
Student Members: RM30.00; Members: RM50.00;
Non-Members: RM125.00

Please note that the Package Deal offers is limited to ONE order per member only. There is no limit on the number of orders for non-members. Prices may be changed without notice.

Individual copies of Bulletin nos. 2-8 and Warta Geologi are available to members at half price. All prices quoted are not inclusive of postage. Please write in for details on postage. Allow 8-10 weeks for delivery.
Cheques, money orders or bank drafts must accompany all orders.

Orders should be addressed to:

The Hon. Assistant Secretary, Geological Society of Malaysia
c/o Dept. of Geology,
University of Malaya,
50603 Kuala Lumpur,
MALAYSIA.
TEL: 603-7577036, FAX: 603-7563900

For orders, please write to the Society and you will be invoiced.

GEOLOGICAL SOCIETY OF MALAYSIA PUBLICATIONS

General Information

Papers should be as concise as possible. However, there is no fixed limit as to the length and number of illustrations. Normally, the whole paper should not exceed 30 printed pages. The page size will be 204 x 280 mm (8 x 11 inches).

The final decision regarding the size of the illustrations, sections of the text to be in small type and other matters relating to printing rests with the Editor.

The final decision of any paper submitted for publication rests with the Editor who is aided by a Special Editorial Advisory Board. The Editor may send any paper submitted for review by one or more reviewers. Authors can also include other reviewers' comments of their papers. Scripts of papers found to be unsuitable for publication may not be returned to the authors but reasons for the rejection will be given. The authors of papers found to be unsuitable for publication may appeal only to be Editor for reconsideration if they do not agree with the reasons for rejection. The Editor will consider the appeal together with the Special Editorial Advisory Board.

Unless with the consent of the Editor, papers which have been published before should not be submitted for consideration.

Authors must agree not to publish elsewhere a paper submitted and accepted.

Authors alone are responsible for the facts and opinions given in their papers and for the correctness of references etc.

One set of proofs will be sent to the author (if time permits), to be checked for printer's errors. In the case of two or more authors, please indicate to whom the proofs should be sent.

Twenty-five reprints of each article published are supplied free-of-charge. Additional reprints can be ordered on a reprint order form, which is included with the proofs.

Correspondence: All papers should be submitted to

The Editor (Dr. Teh Guan Hoe)
Geological Society of Malaysia
c/o Geology Department
University of Malaya
50603 Kuala Lumpur, MALAYSIA
Tel: (603) 7577036 Fax: (603) 7563900
E-mail: geologi@po.jaring.my

Script Requirements

Scripts must be written in English or Bahasa Malaysia (Malay).

Two copies of the text and illustrations must be submitted. The scripts must be typewritten double-spaced on paper not exceeding 210 x 297 mm (or 8.27 x 11.69 inches, A4 size). One side of the page must only be typed on.

Figure captions must be typed on a separate sheet of paper. The captions must not be drafted on the figures. The figure number should be marked in pencil on the margin or reverse side.

Original maps and illustrations or as glossy prints should ideally be submitted with sufficiently bold and large lettering to permit reduction to 18 x 25 cm: fold-outs and large maps will be considered only under special circumstances.

Photographs should be of good quality, sharp and with contrast. For each photograph, submit two glossy prints, at least 8 x 12.5 cm and preferably larger. Use of metric system of measurements (SI) is strongly urged wherever possible.

An abstract in English which is concise and informative is required for each paper.

References cited in the text should be listed at the end of the paper and arranged in alphabetical order and typed double-spaced. The name of the book or journal must be in *italics*. The references should be quoted in the following manner:

HAMILTON, W., 1979. Tectonics of the Indonesian region. *U.S. Geological Survey Professional Paper* 1078, 345p.

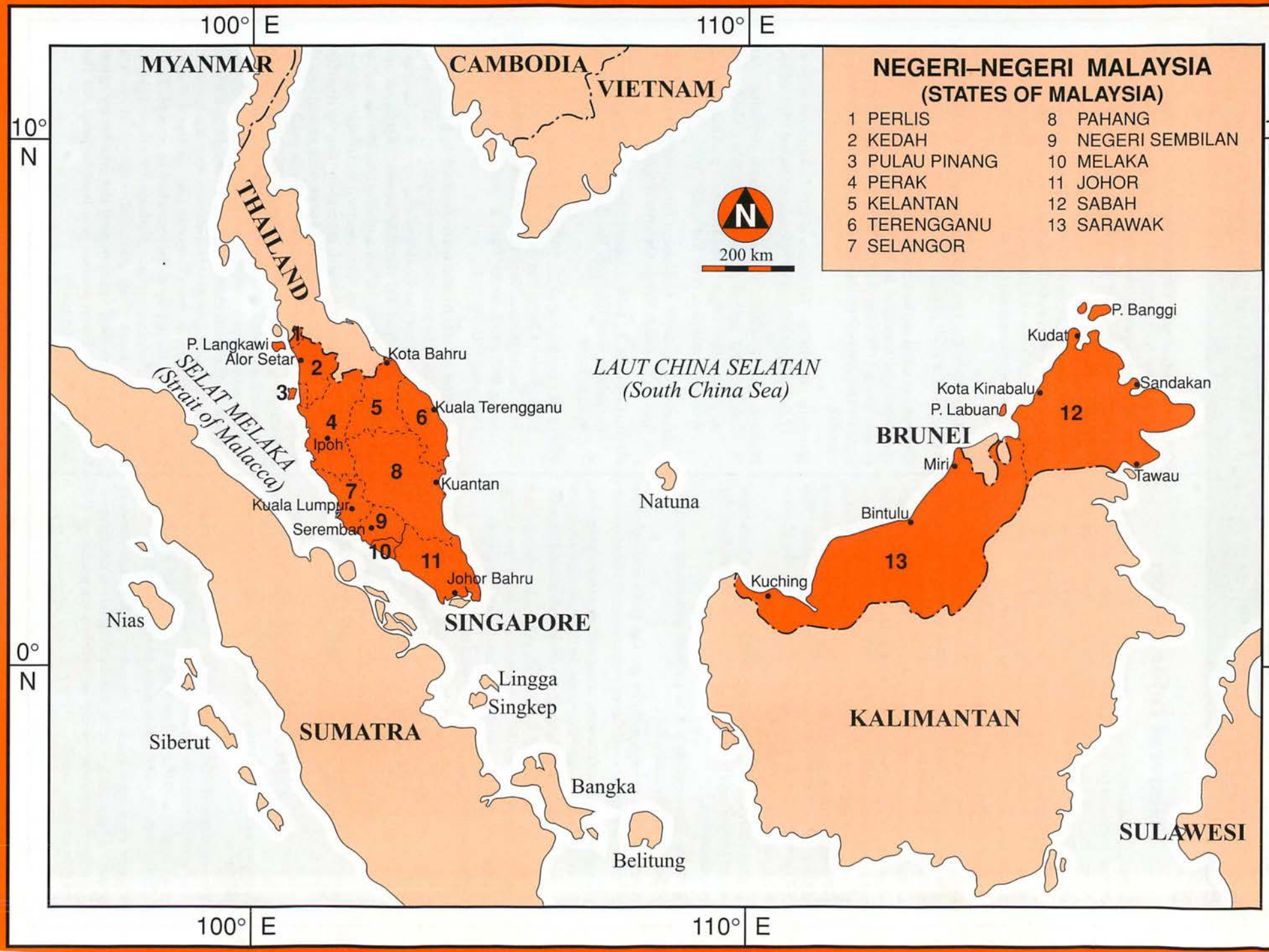
HOSKING, K.F.G., 1973. Primary mineral deposits. *In:* Gobbett, D.J. and Hutchison, C.S. (Eds.), *Geology of the Malay Peninsula (West Malaysia and Singapore).* Wiley-Interscience, New York, 335-390.

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

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

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

Submission of electronic text. In order to publish the paper as quickly as possible after acceptance, authors are requested to submit the final text also on a 3.5" diskette. Both Macintosh and PC (DOS/Windows) platforms are supported. Main text, tables and illustrations should be stored in separate files with clearly identifiable names. Text made with most word processors can be readily processed but authors are advised to provide an additional copy of the text file in ASCII format. Preferred format for illustration is Encapsulated PostScript (EPS) but authors may submit graphic files in their native form. It is essential that the name and version of softwares used is clearly indicated. The final manuscript may contain parts (e.g. formulae, complex tables) or last-minute corrections which are not included in the electronic text on the diskette; however, this should be clearly marked in an additional hardcopy of the manuscript. Authors are encouraged to ensure that apart from any such small last-minute corrections, **the disk version and the hardcopy must be identical**. Discrepancies can lead to proofs of the wrong version being made.


100° E
110° E
10° N
0° N
MYANMAR
CAMBODIA
VIETNAM
THAILAND
NEGERI–NEGERI MALAYSIA
(STATES OF MALAYSIA)
1 PERLIS
2 KEDAH
3 PULAU PINANG
4 PERAK
5 KELANTAN
6 TERENGGANU
7 SELANGOR
8 PAHANG
9 NEGERI SEMBILAN
10 MELAKA
11 JOHOR
12 SABAH
13 SARAWAK
N
200 km
P. Langkawi
Alor Setar
Kota Bahru
Kuala Terengganu
Ipoh
Kuantan
Kuala Lumpur
Seremban
Johor Bahru
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
SINGAPORE
Nias
Lingga
Singkep
SUMATRA
Siberut
Bangka
Belitung
KALIMANTAN
SULAWESI