PP 169/12/87 ISSN 0126-5539

PERSATUAN GEOLOGI MALAYSIA

WARTA GEOLOGI

NEWSLETTER OF THE GEOLOGICAL SOCIETY OF MALAYSIA

Jil. 14, No. 6 (Vol. 14, No. 6) Nov-Dis 1988

KANDUNGAN (Contents)

DIKELUARKAN DWIBULANAN
ISSUED BIMONTHLY

PERSATUAN GEOLOGI MALAYSIA
(GEOLOGICAL SOCIETY OF MALAYSIA)

Majlis (Council) 1988/89

Pegawai-pegawai (Officers)

Presiden (President)	:	Hamzah Mohamad, Jabatan Geologi, Universiti Kebangsaan Malaysia, 43600 UKM, Bangi.
Naib Presiden (Vice-President)	:	Ahmad Said, Petronas, P.O. Box 12444, 50778 Kuala Lumpur.
Setiausaha Kehormat (Honorary Secretary)	:	Ibrahim Komoo, Jabatan Geologi, Universiti Kebangsaan Malaysia, 43600 UKM, Bangi.
Penolong Setiausaha Kehormat (Honorary Assistant Secretary)	:	Khoo Kay Khean, Geological Survey Malaysia, P.O. Box 11110, 50736 Kuala Lumpur.
Bendahari Kehormat (Honorary Treasurer)	:	Ahmad Tajuddin Ibrahim, Jabatan Geologi, Universiti Malaya, 59100 Kuala Lumpur.
Pengarang Kehormat (Honorary Editor)	:	Teh Guan Hoe, Jabatan Geologi, Universiti Malaya, 59100 Kuala Lumpur.
Presiden Yang Dahulu (Immediate Past President)	:	John Kuna Raj, Jabatan Geologi, Universiti Malaya, 59100 Kuala Lumpur.
Ahli-ahli Majlis 1988-90 (Councillors 1988-90)	:	Khee Kok Kean, Esso Production Malaysia Inc., P.O. Box 10857, 50728 Kuala Lumpur.
		Tan Boon Kong, Jabatan Geologi, Universiti Kebangsaan Malaysia, 43600 UKM, Bangi.
		Idris Mohamad, Jabatan Geologi, Universiti Malaya, 59100 Kuala Lumpur.
		Fateh Chand, Geological Survey Malaysia, P.O. Box 11110, 50736 Kuala Lumpur.
Ahli-ahli Majlis, 1988-89 (Councillors, 1988-89)	:	Hila Ludin Abu Hazim, Petronas, P.O. Box 12444, 50778 Kuala Lumpur.
		Albert Loh, Malaysia Mining Corporation, P.O. Box 10300, 50710 Kuala Lumpur.
		Chin Lik Suan, Ahli Kajibumi (Persendirian), 13 Lorong SS1/11A, 47300 Petaling Jaya.
		Tay Say Ann, Petronas-Carigali, P.O. Box 12407, Kuala Lumpur.
Juruodit Kehormat (Honorary Auditor)	:	Peter Chew

****

Published by the Geological Society of Malaysia, Department of Geology, University of Malaya, 59100 Kuala Lumpur (Tel. 03-7577036).

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

CATATAN GEOLOGI
(GEOLOGICAL NOTES)

ALUVIUM LEBIH TUA DI KAWASAN JOHOR BAHARU, JOHOR

Roslan Mahali dan Tan Boon Kong,
Jabatan Geologi, Universiti Kebangsaan Malaysia, 43600 Bangi.

Abstrak

Aluvium Lebih Tua yang terdapat di kawasan Johor Baharu menunjukkan beberapa ciri tertentu yang dapat dibezakan dari tanah baki batuan di sekitarnya. Enapan ini memperlihatkan ciri-ciri enapan sungai dengan beberapa struktur sedimen. Kebanyakan daripada struktur ini merupakan struktur primer.

Pengenalan

Semasa kerja pemetaan di kawasan Johor Baharu baru-baru ini (Roslan Mahali, 1988), beberapa singkapan Aluvium Lebih Tua yang agak manarik telah ditemui, kebanyakannya di kawasan perumahan yang baru. Catatan ini bertujuan merakamkan beberapa ciri Aluvium Lebih Tua yang menarik ini. Aluvium Lebih Tua di kawasan Johor Baharu merupakan enapan permukaan yang separa padu. Enapan ini ditafsirkan berusia Pleistosen (Burton, 1964). Di lapangan, enapan ini wujud sehingga mencapai ketinggian kira-kira 77 m. Hampir separuh daripada keluasan kawasan Johor Baharu diwakili oleh enapan ini.

Ciri-ciri Aluvium Lebih Tua

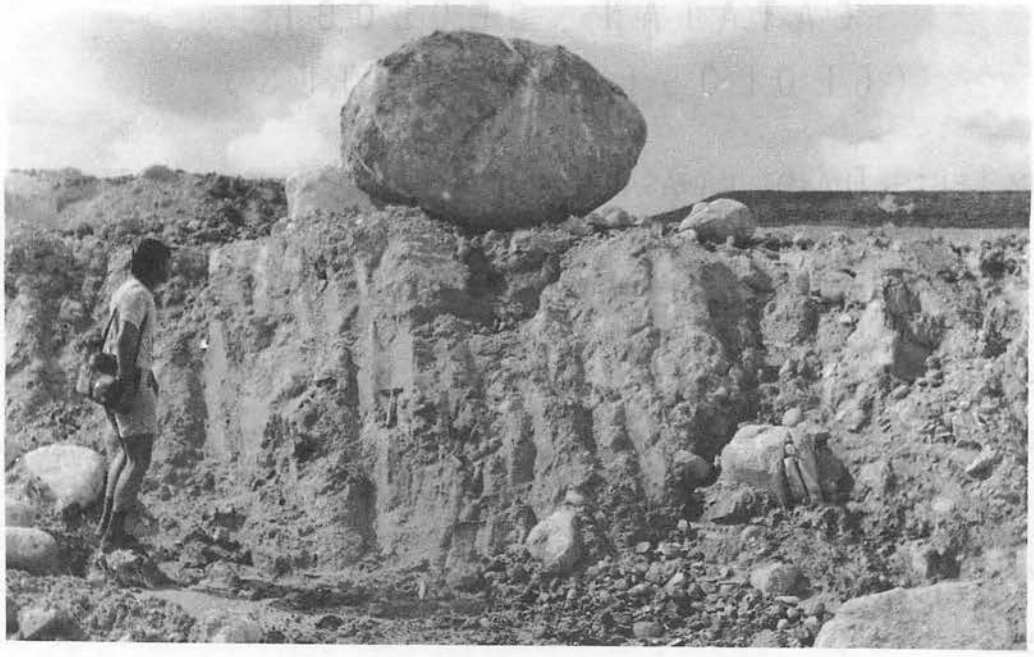
Aluvium Lebih Tua membentuk perlapisan-perlapisan batu tongkol, kelikir berpasir, lempung berkelikir, lempung berlodak, pasir berlodak dan lempung. Umumnya perlapisan yang dibentuk adalah hampir mendatar dengan arah jurus yang berubah-ubah.

Di Taman Universiti, Kangar Pulai, terdapat batu tongkol yang mencapai diameter sehingga 1.3 m (Gambar 1). Ia menunjukkan kebulatan yang bulat dengan kesferaan yang tinggi.

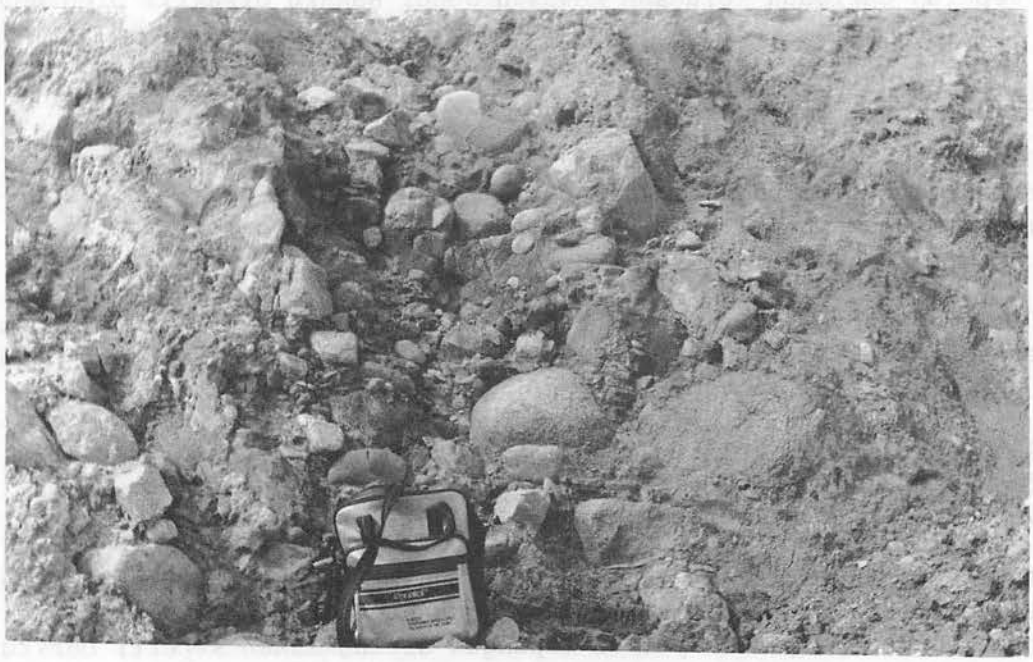
Batu tongkol dan kelikir di dalam Aluvium Lebih Tua ini terdiri daripada berbagai jenis batuan (Gambar 2). Di antaranya kuarza, kuarzit, batu pasir, batu lodak, serpih, granit, granit porfir dan tuf.

Terdapat beberapa ciri yang dapat digunakan untuk membezakan Aluvium Lebih Tua daripada tanah baki granit dan tanah baki gabro. Ciri-ciri Aluvium Lebih Tua yang terdapat di lapangan diringkaskan seperti berikut:

(i) Kehadiran kelikir-kelikir, biasanya kuarza atau kuarzit serta mineral dan batuan lain.



Gambar 1. Menunjukkan batu tongkol yang mencapai saiz 1.3 m di dalam Aluvium Lebih Tua. Taman Universiti, Kangar Pulai.



Gambar 2. Batu tongkol dan kelikir yang terdiri daripada berbagai jenis batuan. Taman Universiti Kangar Pulai.

(ii) Terdapat penstratuman serta struktur sedimen yang lain.

(iii) Kehadiran serpihan lignit, perlapisan gambut dan laterit yang selaras dengan perlapisan (Gambar 3).

(iv) Terdapat warna kuning cerah atau putih cerah pada horizon terbawah, sementara dalam tanah granit/gabro terdapat warna merah tua.

(v) Kehadiran bintik-bintik kemerahan yang biasanya menjajar dalam bentuk menegak pada horizon terbawah.

(vi) Dalam Aluvium Lebih Tua tidak terdapat kesan bentuk-bentuk teras batuan yang biasanya terdapat dalam tanah baki granit/ gabro.

Struktur Aluvium Lebih Tua

Terdapat beberapa struktur yang ditunjukkan oleh Aluvium Lebih Tua. Kebanyakannya merupakan struktur primer seperti perlapisan, perlapisan silang, perlapisan berperingkat, perlapisan kekanta dan struktur palung.

Kebanyakan perlapisan yang ditunjukkan mempunyai sudut kemiringan kurang daripada 15^{o}. Bagaimanapun, di Taman Munsyi Ibrahim, Sekudai, terdapat perlapisan yang berkemiringan sehingga 35^{o} (Gambar 4).

Struktur perlapisan silang diperlihatkan di Batu 8 Jalanraya Johor Baharu-Masai dan di Taman Perling. Struktur ini hanya ditemui pada perlapisan pasir berlodak (Gambar 5).

Struktur perlapisan kekanta memperlihatkan perlapisan lempung membentuk kekanta di dalam perlapisan pasir berlempung.

Struktur palung yang dijumpai di lapangan mempunyai panjang kira-kira 12 m (Gambar 6). Penentuan arus kuno daripada struktur ini memberikan bacaan $U44^{o}T$.

Struktur korok lempung yang ditemui bersaiz 2-3 cm. Ia adalah terhasil oleh pemampatan perlapisan pasir berlempung di bahagian atas terhadap perlapisan lempung di bahagian bawah iaitu akibat tindakan graviti semasa proses pengenapan.

Sekitaran pengenapan

Hasil analisis saiz butiran ke atas lima sampel Aluvium Lebih Tua digunakan untuk pengiraan beberapa parameter statistik saiz butiran. Parameter-parameter yang tertentu kemudian diplotkan antara satu sama lain.

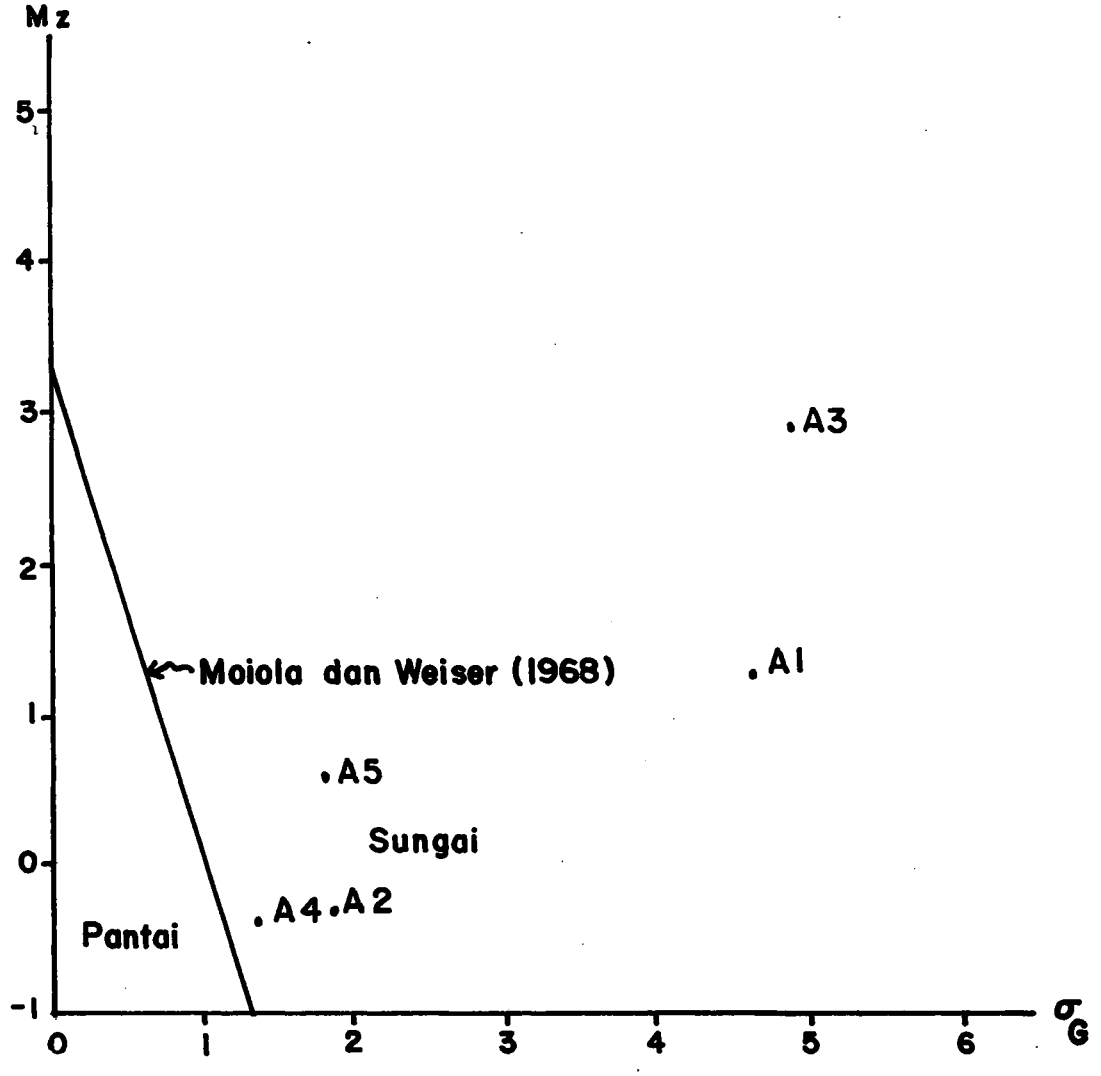
Pada Rajah 1 diplotkan nilai min grafik (Mz), lawan nilai lencongan piawai grafik (σ_G) bagi setiap sampel (Folk & Ward, 1957). Pada rajah ini juga diplotkan garis yang dicadangkan oleh Moiola dan Weiser (1968), yang memisahkan pasir sungai daripada pasir pantai. Plot ini menunjukkan Aluvium Lebih Tua tergolong dalam kategori enapan sungai.

Gambar 3. Perlapisan gambut yang selaras dengan perlapisan Aluvium Lebih Tua. Pasir Gudang. (G = gambut).

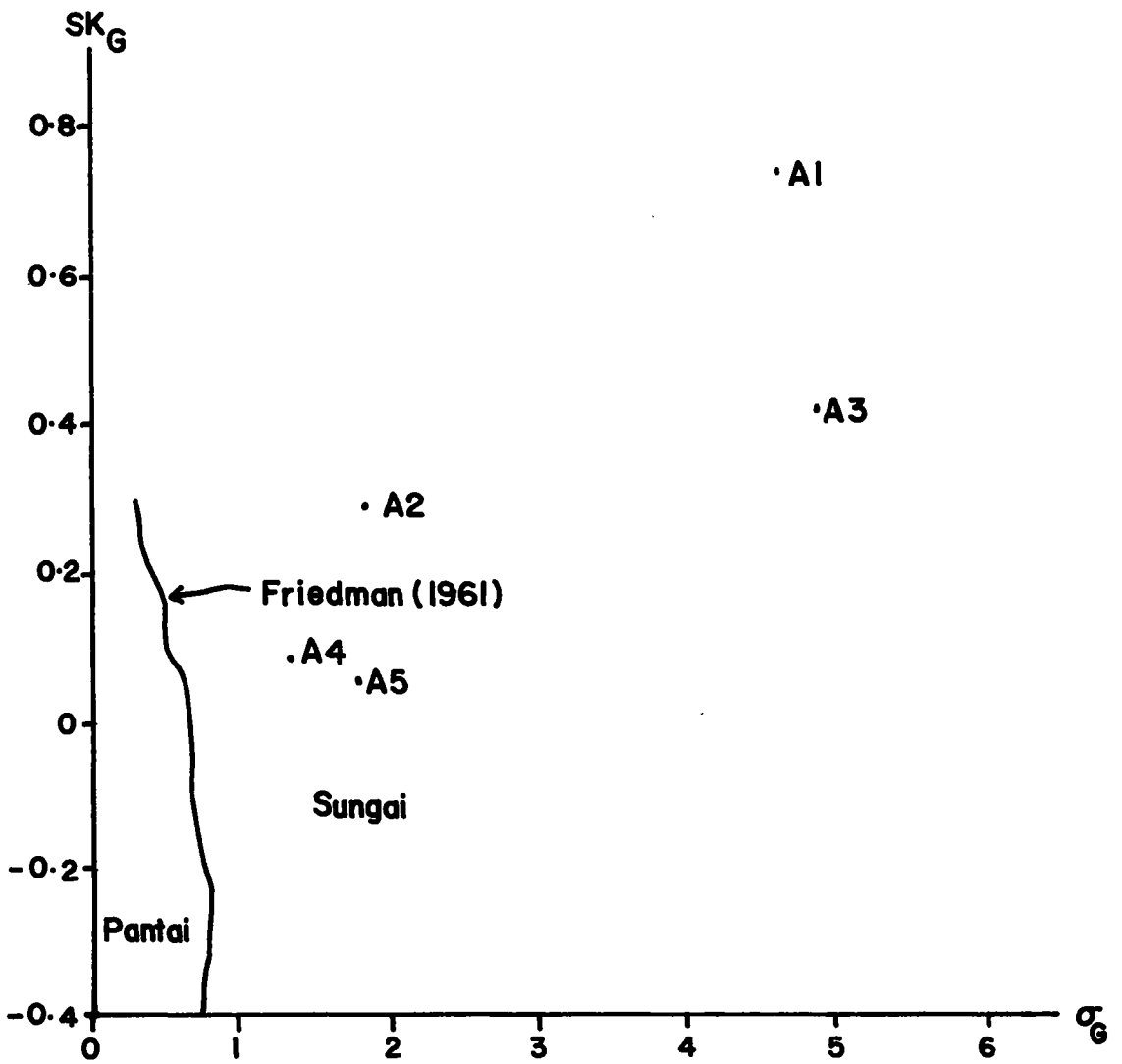
Gambar 4. Selanglapis antara lapisan kelikir (K), lempung berkelikir (L) dan pasir berlodak (P) dengan kemiringan perlapisan 35°. Taman Munsyi Ibrahim, Sekudai.

Gambar 5. Menunjukkan struktur perlapisan silang pada lapisan pasir berlodak. Batu 8 Jalanraya Johor Baharu-Masai.

Gambar 6. Struktur palung pada Aluvium Lebih Tua. Batu 8 Jalanraya Johor Baharu-Masai.



Rajah 1 : Plot min grafik (Mz) lawan lencongan piawai grafik (σ_G) bagi sampel - sampel Aluvium Lebih Tua.



Rajah 2 : Kepencongan grafik (SK_G) lawan lencongan piawai grafik (σ_G) bagi sampel-sampel Aluvium Lebih Tua.

Plot kepencongan grafik (SK_G) lawan lencongan piawai grafik ditunjukkan pada Rajah 2. Di sini juga diplotkan garis yang dicadangkan oleh Freidman (1961) yang memisahkan enapan pantai daripada enapan sungai. Hasil menunjukkan Aluvium Lebih Tua tergolong dalam enapan sungai.

Hasil yang terdapat di sini adalah serupa dengan hasil yang didapati oleh Tai (1972) yang telah menganalisis sampel Aluvium Lebih Tua di kawasan Singapura timur.

Kesimpulan

Aluvium Lebih Tua di kawasan Johor Baharu merupakan satu enapan sungai dan mempunyai ciri-ciri tertentu yang membezakannya daripada tanah baki batuan di sekitarnya. Ini disokong oleh kewujudan struktur-struktur sedimen primer, keadaannya yang separa padu serta kepelbagaian batuan yang membentuk batu tongkol dan kelikir di dalamnya.

Rujukan

Burton, C.K., 1964. The Older Aluvium of Johore and Singapore. *J. Trop. Geogr., Jil. 18*, hlm. 30-42.

Folk, R.L., & Ward, W.C., 1957. Brazos River bar: a study in the significance of grain size parameters. *J. Sediment. Petrol., 27*, 3-26.

Friedman, G.M., 1961. Distinction between dune, beach and river sands from their textural characteristics. *J. Sediment. Petrol. 31*, 514-529.

Moiola, R.J. & Weiser, D., 1968. Textural parameters: an evaluation. *J. Sediment. Petrol. 38*, 45-53.

Roslan Mahali, 1988. *Geologi Kawasan Johor Baharu, Johor Darul Takzim.* Tesis Sm. Sn., UKM, 60 hlm.

Tai, S.A., 1972. *Geology of eastern Singapore Island with special emphasis on the Old Aluvium.* B.Sc. (Hons.) Thesis. Universiti Malaya.

******

Manuscript received 29 November 1988.

ON THE SIGNIFICANCE OF A TIGHT FOLD IN BUKIT PANCHING, PAHANG

M.B. Idris,
Department of Geology, University of Malaya, 59100 Kuala Lumpur.

M.S. Azlan,
Personnel Section, University Pertanian Malaysia, 43400 Serdang.

Abstract

A tight fold exists in the thickly bedded sequence of limestones at Bukit Panching. Its fold trend is similar to that found in the Upper Palaeozoic rocks of the east coast. This fold also suggests that the previously thought thickness of 600 m and massively bedded nature of the Panching Limestone is doubtful.

Abstrak

Satu lipatan ketat didapati dalam turutan lapisan tebal batukapur di Bukit Panching. Ciri-ciri terperinci lipatan ini serupa dengan lipatan-lipatan yang ditemui dalam batuan Palaeozoik Atas di pantai timur. Perlipatan ini juga mencadangkan yang ketebalan 600 m dan ketebalan massif bagi Formasi Panching disangsikan.

Introduction

Bukit Panching is part of the Upper Carboniferous Panching Limestone which is previously estimated to be about 600 m thick, consisting mainly of massively bedded limestone. Recent quarrying activities in the area, revealed that the hill consists of a tightly folded sequence of limestone beds, ranging in thickness between 1-4 m. The significance of this fold is discussed below.

Location and geological setting

Bukit Panching is situated close to Panching town, along the Sungei Lembing - Kuantan road (Fig. 1). It is a relatively small hill that rises to a height of about 148 m.

Geologically, Bukit Panching represents the southernmost exposure of the Panching Limestone that includes three other hills. Northwardly, they are Bukit Charas, Bukit Sagu and Bukit Tinggik, respectively. The Panching Limestone was formally described by Metcalfe *et al.* (1980), to be about 600 m thick of massively bedded limestone. Its age was designated to be Upper Carboniferous, based on conodonts, foraminifera and coral recovered from the limestones. It is underlain by the Charu Formation (Lower - Upper Carboniferous) which is prevalent to the east of the area and the limestone is succeeded by the Sagor Formation (Upper Carboniferous) which is widely exposed on the western part of the area. All these formations are part of the Upper Palaeozoic (Carboniferous) Kuantan Group sediments.

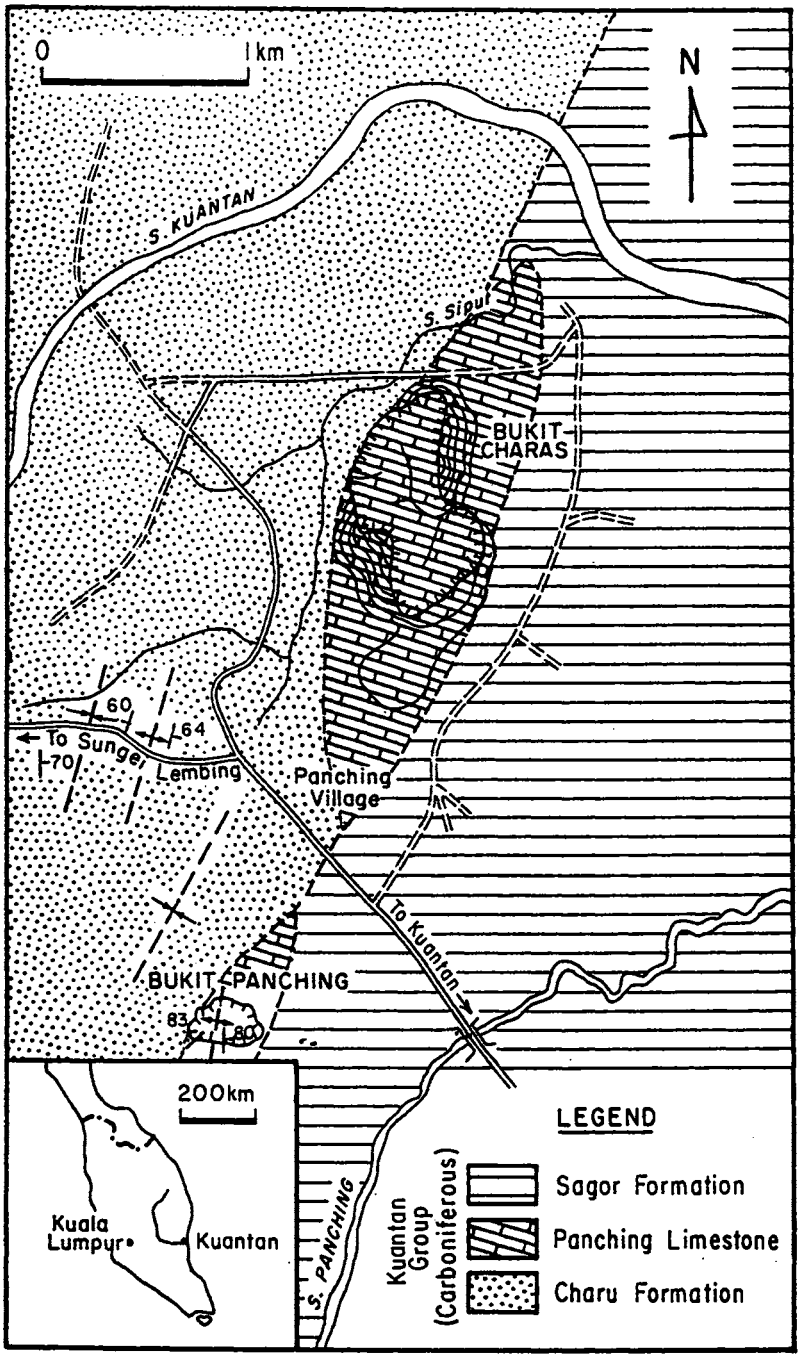


Fig. 1. Geological map of the Panching area (Modified after Tan, 1972).

The current exposure in Bukit Panching (Pl. 1, Fig. 2), clearly shows that the limestones are not massively bedded as previously thought, but consist of a sequence of steeply dipping beds ranging from 1-4 m thick. Most interestingly, these beds are tightly folded, giving an impression that the entire hill represents the crest of a fold. The right limb of this tight fold appears to be gently flexed.

Folding

The tight fold observed in Bukit Panching occupies the southeastern face of the hill. Its fold axis trends in the N-S direction whilst the beds on the western limbs strike 208^{o} and dip 83^{o} west. Those on the upper part of the eastern limb strike 180^{o} and dip 80^{o} east.

The right limb of this tight fold appears to be gently flexed. The upper part of this limb has an attitude of $186^{o}/63^{o}$ east, while those on the lower part, $198^{o}/81^{o}$ west.

The tight fold is probably due to extensive compressive forces in the east-west direction. The stereogram of this fold (inset, Fig. 2), indicates that its axial plane trends 016^{o} vertically. The fold plunges 55^{o} northerly and its dihedral angel is 30^{o}, conforming to a tight fold limit, following Fleuty's (1964) classification of fold types.

A stereoplot of the flexure yielded similar results to that of the tight fold suggesting that it was formed during the same episode of folding.

Discussion

The discovery of this tight fold and the thickly bedded nature of the limestone in Bukit Panching contradicts previous observations. As such, the general thickness of the Panching Limestone as about 600 m is doubtful as all the hills lie on the same strike. It is probably much less.

The presence of the tight fold in Bukit Panching is in general in agreement with the folding trend in the nearby area as exhibited by the beds of the Charu Formation (Fig. 1).

The structural trends of the Upper Palaeozoic sequences in the east coast, commonly known as the Mersing beds have been described by Tjia (1978, 1983), Yap & Tan (1980) and Chakraborthy & Metcalfe (1984). Generally, they agreed that at least more than one phase of folding and local soft sediment deformation have occurred.

The trend of the tight fold at Bukit Panching is consistent with the observations for the northern part of Tanjung Gelang (closest to Panching) area of Yap and Tan (1980) and of Tjia (1983).

Acknowledgements

This research was tenable under University of Malaya Vote-F 103/83 and Petronas Scholarship Award. Mr. Zulraini Mohd. Dhalim assisted in the fieldwork. Drafting aspects were done by Mr. Y.H. Ching.

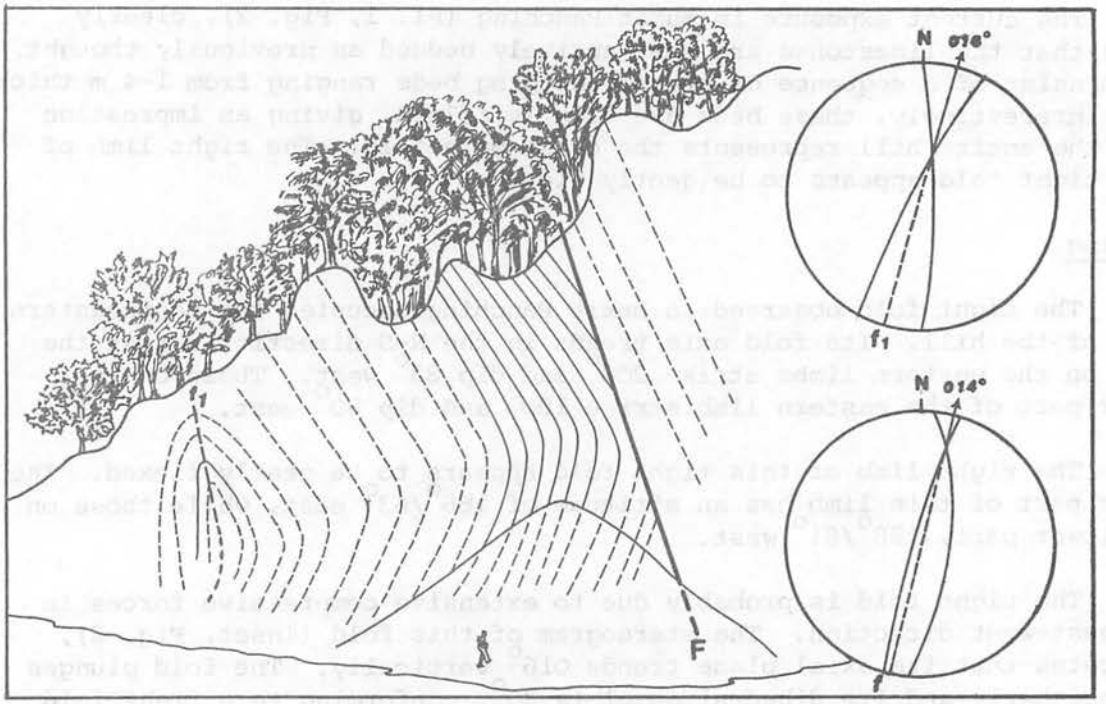


Fig. 2. Sketch of the southern face of Bukit Panching with inset of stereoplots for the tight fold (f_1) and the flexure (f). F - fault.

Plate 1. Tight folding (f_1) of the thickly bedded limestone sequence at Bukit Panching. A man standing at the foot of the hill is encircled.

References

Fleuty, M.J., 1964. Descriptions of folds. *Proc. Geol. Ass. 75*: 461-492.

Chakraborthy, K.R. & Metcalfe, I., 1984. An analysis of microscopic structure at Mersing and Tanjung Kempit, Johore, Peninsula Malaysia. *Geol. Soc. M'sia Bull 17*: 357-371.

Metcalfe, I., Idris, M. & Tan, J.T., 1980. Stratigraphy and palaeontology of the Carboniferous sediments in the Panching area, Pahang, West Malaysia. *Geol. Soc. M'sia Bull 13*: 1-26.

Tan, J.T., 1972. *General geology, stratigraphy and palaeontology of the Panching area, Pahang.* Unpublished University of Malaya B.Sc. thesis.

Tjia, H.D., 1978. Multiple deformations at Bukit Cenering, Trengganu. *Geol. Soc. M'sia Bull. 10*: 15-24.

Tjia, H.D., 1984. Canggaan bertindan di Tanjung Gelang, Pahang. *Sains Malaysiana 12*: 101-117.

Yap, L.S. & Tan, B.K., 1980. Deformation of the Upper Palaeozoic rocks at Tanjung Gelang, Pahang. *Geol. Soc. Bull. 12*: 45-54.

******

Manuscript received 12 October 1988.

THE GEOLOGICAL SOCIETY OF MALAYSIA

NOW AVAILABLE!

PP 170/12/87 ISSN 0126-6187

BULETIN PERSATUAN GEOLOGI MALAYSIA

BULLETIN OF THE GEOLOGICAL SOCIETY OF MALAYSIA

SPECIAL ISSUE ON PETROLEUM GEOLOGY VOL III

KANDUNGAN (CONTENTS)

Editor
G.H. Teh

DECEMBER 1988 **No. 22**

Price: M$40.00 (US$16.50)

Cheques, Money Orders or Bank Drafts must accompany all orders. Please add US$1.30 for bank charges.

Orders should be addressed to: The Hon. Assistant Secretary
GEOLOGICAL SOCIETY OF MALAYSIA
c/o Dept. of Geology
University of Malaya
59100 Kuala Lumpur
MALAYSIA

PERTEMUAN PERSATUAN
(MEETINGS OF THE SOCIETY)

GEOLOGICAL SOCIETY OF MALAYSIA
PETROLEUM GEOLOGY SEMINAR 1988

PROGRAMME

MONDAY, 5th DECEMBER 1988

8.00 am: **REGISTRATION**

8.40 am: Arrival of invited guests

8.50 am: Arrival of Y. Bhg. Dr. Abdul Aziz Hj. Mahmud, Vice-President, Exploration & Production Division, PETRONAS

9.00 am: Welcoming Address by Dr. Hamzah Mohamad, President, Geological Society of Malaysia

9.10 am: Opening Address by Y. Bhg. Dr. Abdul Aziz Hj. Mahmud, Vice-President, Exploration & Production Division, PETRONAS

9.30 am: **COFFEE BREAK**

10.00 am: Palynostratigraphy in Offshore Sarawak: Climate and Eustatic Applications – C. Poumot & Jaizan Hardi Mohamed Jais (Elf Aquitaine Malaysia & PETRONAS Petroleum Research Institute)

10.30 am: Stratigraphic Processing of 3D Seismic by Concurrent Analysis of Surface and Borehole Data – R. Gir, *et al.* (Schlumberger Overseas S.A.)

11.00 am: DMO and NMO as Applied in Seismic Data Processing Jiunnyih Chen (Chinese Petroleum Corporation)

11.30 am: Estimating Reserves in Thinly-laminated Sands with the Help of Petrographic Image Analysis (PIA) – T. Kennaird, D. Bowen & J.W. Bruinsma (Core Laboratories Malaysia Sdn. Bhd.)

12.00 noon: **LUNCH BREAK**

1.45 pm: First Experience in Horizontal Drilling in SSPC (Erb West Field): A Review of Operational Geology – Raja Azhar and Thomas Kuud (Sabah Shell Petroleum Co. Ltd.)

2.15 pm: Seismic Processing Application on a Personal Computer – Geophysical Services (Malaysia) Sdn. Bhd.

2.45 pm: The Hydrocarbon Potential and Tectonics of Indochina – Masao Hayashi (Idemitsu Oil Development Co., Singapore)

3.15 pm: **COFFEE BREAK**

3.45 pm: Application of Vertical Receiver Arrays in 3D Seismic Exploration –R. Bekker (Geco Asia Pacific)

GEOLOGICAL SOCIETY OF MALAYSIA
PETROLEUM GEOLOGY SEMINAR 1988

PROGRAMME

4.15 pm: Effect of Basement on the Location of Petroleum Accumulations in West Malaysia
– Nik Ramli Nik Hassan (PETRONAS Petroleum Research Institute)

4.45 pm: Biostratigraphy of Selected Wells from the Malay Basin
Rashidah Karim, *et al.* (PETRONAS Petroleum Research Institute)

5.15 pm: Aspects of the Geological Evolution of Peninsular Malaysia
– S.P. Sivam (Universiti Malaya)

TUESDAY, 6th DECEMBER 1988

8.30 am: Structural History of the Malay Basin - A Classical Tertiary Wrench Basin
– Kuang Koo Sing (Innovative Technological Geo-exploration, Australia)

9.00 am: Integrating Geology and Geophysics to the Planning of the Guntong Field Development
– Kwok Kwee Pin & Zainuddin Yusoff (Esso Production Malaysia Inc.)

9.30 am: Advancements in Positioning for Marine Seismic 3D
– P. Canter (Geco A.S.)

10.00 am: **COFFEE BREAK**

10.30 am: Application of Nuclear Spectrometry to Formation Geochemical Evaluation
– G. Mathieu, *et al.* (Schlumberger)

11.00 am: Subduction-Collision Models for the Malay Peninsula: An Appraisal
– K.R. Chakraborty (Universiti Malaya)

11.30 am: Geochemical Analyses and Interpretations of Surface Sediment Samples from the Deepwater Areas Offshore Sabah
– B. Mahendran (PETRONAS Exploration Department and Federal Institute for GeoSciences & National Resources of Federal Republic of Germany (BGR))

12.00 noon: **LUNCH BREAK**

1.30 pm: C-GC-MS and Its Application to Crude Oil Analysis
– P.A. Comet, Ooi Siew Tin & Yap Ai Bee
(Core Laboratories Malaysia Sdn. Bhd.)

2.00 pm: The Murau Formation: Lithostratigraphy, Lithofacies and Sedimentary Environment
– Ahmad Jantan, Ibrahim Abdullah & Uyop Said
(Universiti Kebangsaan Malaysia)

GEOLOGICAL SOCIETY OF MALAYSIA
PETROLEUM GEOLOGY SEMINAR 1988

PROGRAMME

The Murau Formation: Post Murau Structures and their Significance to Regional Geology.
– Ibrahim Abdullah, Ahmad Jantan & Uyop Said
(Universiti Kebangsaan Malaysia)

2.30 pm: Depositional Environments and Reservoir Properties of the J Sandstones, Malong Field, Offshore West Malaysia
– Noor Azim Ibrahim & Mazlan Madon (PETRONAS Petroleum Research Institute)

3.00 pm: **COFFEE BREAK**

3.30 pm: Tectonic History of Bentong-Bengkalis Suture
– H.D. Tjia (Universiti Kebangsaan Malaysia)

4.00 pm: Heat-flow Regimes in Malaysian Sedimentary Basins
– Wan Ismail & Wan Yusof (PETRONAS Petroleum Research Institute)

4.30 pm: **CLOSING REMARKS**

Generous support for the Petroleum Geology Seminar 1988 has been received from the following companies:

. Agip (Malaysia) Ltd.
. Core Laboratories Malaysia Sdn. Bhd.
. Digicon Malaysia Sdn. Bhd.
. ECL Australia Pty. Ltd.
. Elf Aquitaine Malaysia
. Esso Production Malaysia Inc.
. Geophysical Service (Malaysia) Sdn. Bhd.
. Idemitsu Sarawak Oil Exploration Co., Ltd.
. JTO Operating Company
. Laiman Corporation Sdn. Bhd.
. Landmark Graphics International Inc.
. Malaysia Baram Oil Development Co. Ltd.
. Marathon Petroleum Exploration, Ltd.
. Mobil Exploration and Producing Services Inc.
. Occidental Petroleum (Malaysia) Ltd.
. Oilfield Minerals & Chemicals Sdn. Bhd., Atlas Wireline Division
, Overseas Petroleum and Investment Corp.
. Petrofina Far East Pte. Ltd.
. Prakla-Seismos A.G.
. Robertson Research (Singapore) Pte. Ltd.
. Sarawak Shell Berhad
. Schlumberger Overseas S.A.
. Sierra Geophysics, Inc.
. Sun Malaysia Petroleum Company
. Tenneco Oil (Malaysia) S.A.
. Total Compagnie Francaise des Petroles
. Wellog (Malaysia) Sdn. Bhd.
. Western Geophysical Company

Petroleum Geology Seminar 1988

Petroleum Geology Seminar 1988

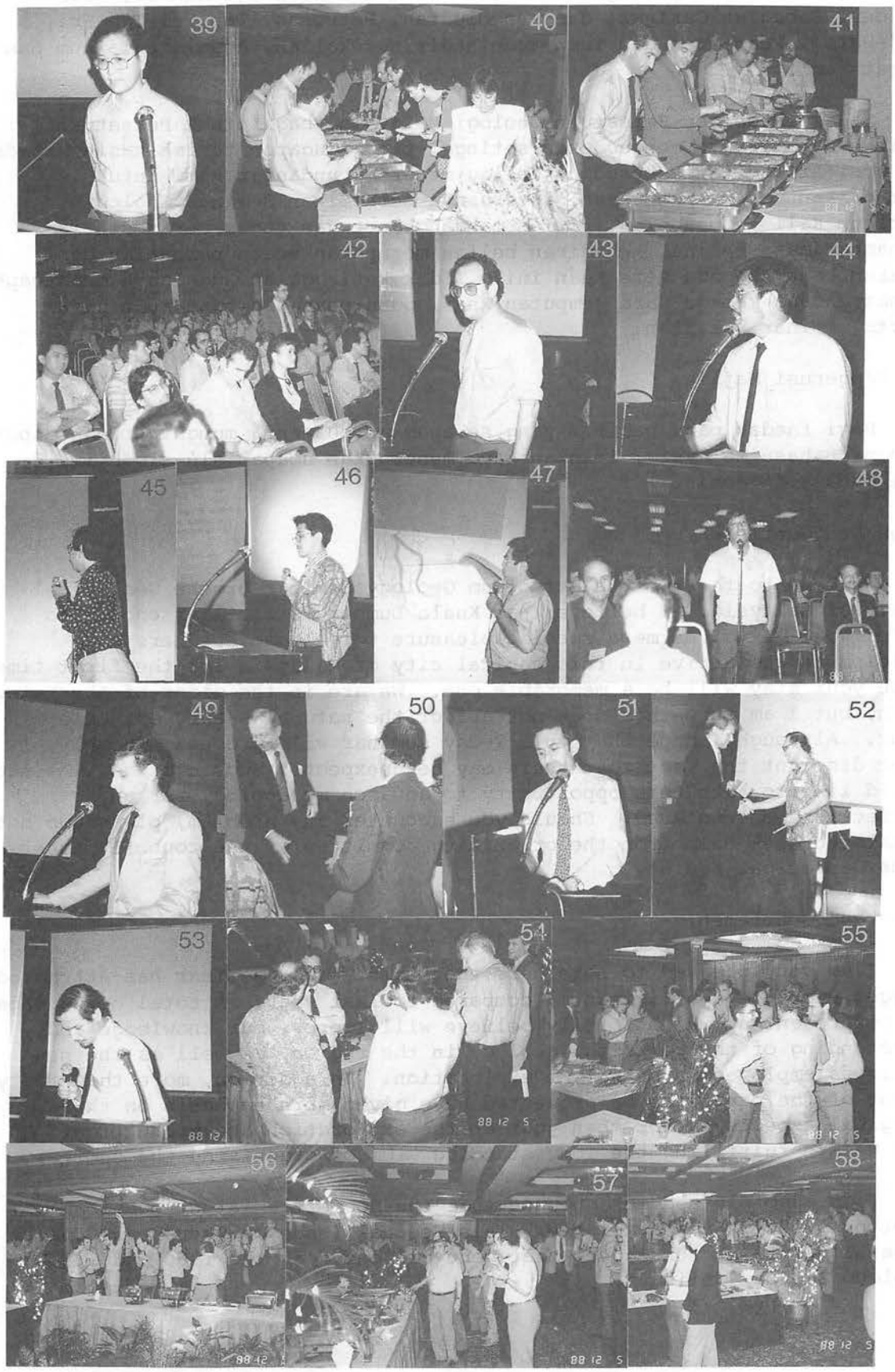
GSM Petroleum Geology Seminar '88

Captions to photos

1-6. Business as usual at the Registration Desk.
7. The arrival of Y.Bhg. Dr. Abdul Aziz Hj. Mahmud.
8. Y.Bhg. Dr. Abdul Aziz Hj. Mahmud meeting GSM Council Members.
9. Y.Bhg. Dr. Abdul Aziz Hj. Mahmud receiving a token of appreciation from GSM President.
10. Organising Chairman, Hila Ludin Abu Hazim, getting the Seminar underway.
11. GSM President, Dr. Hamzah Mohamad, with his Welcoming Address.
12. Y.Bhg. Dr. Abdul Aziz Hj. Mahmud with the Opening Address.
13-21. The large turnout at the Opening Ceremony.
22. C. Poumot with his joint paper.
23. Nik Ramli with a question.
24. R. Gir on processing of 3D Seismic.
25. A question from the floor.
26. Jiunnyih Chen on DMO and NMO.
27. T. Kennaird of Core Lab.
28. Masao Hayashi on the hydrocarbon potential of Indochina.
29. Raja Azhar on Horizontal Drilling.
30. H. Johnson making a comment.
31. A.L. Chuah with her excellent presentation.
32. Nik Ramli Nik Hassan with his paper.
33. R. Bekker on the application of Vertical Receiver Arrays.
34. G. Shanor with a question.
35. Rashidah Karim presenting a joint paper.
36. S.P. Sivam on the Evolution of Peninsular Malaysia.
37. Zainuddin Yusoff on the Guntong Field Development.
38. K.P. Kwok answering queries on her joint paper.
39. K.S. Kuang with his paper.
40-41. Lunch time and 'What do we have here?'.
42. A comment from the floor.
43. P. Canter on Positioning for Marine Seismic 3D.
44. B. Mahendran with his paper.
45. Ahmad Jantan on the Murau Formation.
46. Noor Azim Ibrahim on the J. Sandstones.
47. H.D. Tjia on the Bentong-Bengkalis Suture.
48. S.P. Sivam with a comment.
49. G. Mathieu with his joint paper.
50. Ibrahim Abdullah receiving a token of appreciation from the Session Chairman.
51. P.A. Comet with his paper.
52. K.R. Chakraborty being congratulated by the Session Chairman.
53. Wan Ismail Wan Yusoff on Heat Flow Regimes.
54-58. The relaxed mood at the Cocktail.

******

Petroleum Geology Seminar 1988



WELCOMING ADDRESS BY THE PRESIDENT OF THE GEOLOGICAL SOCIETY OF MALAYSIA AT THE PETROLEUM GEOLOGY SEMINAR 1988

Tuan Pengerusi Majlis, Yang Berbahagia Dr. Abdul Aziz Hj. Mahmud, Naib Presiden, Bahagian Carigali dan Pengeluaran, Petronas, Tan Sri-Tan Sri, Dato'-Dato', Puan-Puan dan Tuan-tuan hadirin sekalian, Assalamualaikum dan selamat pagi.

Selaku Presiden Persatuan Geologi Malaysia, bagi pihak Persatuan terlibih dahulu saya mengucapkan setinggi-tinggi ucapan terima kasih kepada Dr. Abdul Aziz di atas kesudian beliau menerima undangan kami untuk menyampaikan ucapan pembukaan, seterusnya merasmikan Seminar Geologi Petroleum Kali Kedua-belas ini. Memandangkan tugas-tugas berat sentiasa menghambat masa beliau, kehadiran beliau merupakan suatu perhatian dan ganjaran besar kepada Persatuan ini. Tidak ketinggalan juga saya mengucapkan selamat datang kepada para jemputan khas, puan-puan dan tuan-tuan para peserta seminar sekalian.

Tuan Pengerusi Majlis,

Bagi faedah para hadiran yang sebahagian besarnya mungkin tidak dapat memahami Bahasa Malaysia, izinkan saya meneruskan ucapan alu-aluan ini di dalam Bahasa Inggeris.

Ladies and Gentlemen,

Welcome to the twelfth Petroleum Geology Seminar of the Geological Society of Malaysia. I believe that Kuala Lumpur is familiar enough to most of you. It gives me a special pleasure to welcome speakers and participants who arrive in this capital city of Malaysia for the first time. I hope your stay will be a memorable one. We are in the midst of the rainy season, but I am sure this does not affect the natural beauty of Kuala Lumpur. Although I hope that this 2-day seminar will proceed smoothly, I cannot discount the fact that there may be unexpected shortcomings. As such I would like to take this opportunity to advance my apology for any imperfections encountered. Should you encounter any problem, please do not hesitate to seek help from the organizing committee or the council member of the Geological Society.

Ladies and Gentlemen,

I am very pleased to note here that this year's seminar has attracted a bigger number of participants, compared to last year. A total of 22 papers will be presented, which I fully believe will improve our knowledge and understanding of the petroleum geology in the region, as well as the new techniques employed in petroleum exploration. In addition, more than fifty percent of the papers to be presented have given more emphasis on the geological aspects rather than just on the exploration and production. No doubt we are fulfilling the long standing aim of organizing the seminar.

I am also pleased to announce that the Society's latest publication, Bulletin no. 22 is now available. This Special Issue on Petroleum Geology Volume III contains ten papers that were presented at the 1986 and 1987 Petroleum Geology Seminars.

Ladies and Gentlemen,

Financial supports for the Petroleum Geology Seminars from companies and organization related to petroleum industry in this country have been overwhelming. I am very pleased to announce that the Society has dicided to honour a number of the donating companies by awarding them the Society's Institutional Membership for 1989. As you are all aware institutional members shall enjoy all the privileges of corporate members. I hope that this little move will attract more companies to come forward with their support next year.

Ladies and Gentlemen,

On behalf of the society I would like to record our appreciation to those, in one way or another, have contributed towards the successful organization of this seminar. Our thanks are due to the members of the organizing committee, headed for the second consecutive time by our Mr. Hila Ludin. We thank all speakers for their willingness to share their findings with us, and also the organizations they are working with for allowing the findings to be made public. We also thank the chairmen for the four sessions. We thank many individuals and companies for the moral, material and financial supports they gave. Finally, our special thanks are due to Yang Berbahagia Dr. Abdul Aziz for being with us today and to declare the seminar open.

Thank you.

Dengan ini saya dengan hormatnya menjemput Yang Berbahagia Dr. Abdul Aziz Hj. Mahmud, Vice-President Exploration and Production Division Petronas menyampaikan ucapan pembukaan beliau, seterusnya merasmikan Seminar Geologi Petroleum Ke-12 ini. Dipersilakan.

******

PETROLEUM GEOLOGY SEMINAR '88

Merlin Hotel, Kuala Lumpur
5-6th December, 1988

OPENING ADDRESS BY Y. BHG. DR. ABDUL AZIZ HAJI MAHMUD, VICE-PRESIDENT, EXPLORATION & PRODUCTION DIVISION, PETRONAS, ON THE OCCASION OF THE OPENING CEREMONY OF THE PETROLEUM GEOLOGY SEMINAR 1988

Tuan Pengerusi Majlis, Dr. Hamzah Mohamad, Presiden, Persatuan Geologi Malaysia, Encik Hila Ludin Abu Hazim, Pengerusi, Jawatankuasa Pengelola, Seminar Geologi Petroleum Yang Ke 12, Tan Sri-Tan Sri, Dato'-Dato', Puan-Puan dan Tuan-Tuan.

I regard it as a great privilege and honour to be invited by your Society to open the Twelfth Petroleum Geology Seminar here today. Before proceeding any further, allow me to thank the Geological Society for giving this opportunity to address you this morning, and also to especially welcome our international speakers and participants to our country.

I wish to congratulate the Geological Society of Malaysia for continuing to provide this very useful forum for geoscientists within and outside this country to meet and exchange views and information on a regular basis. With oil prices remaining relatively low and the search for oil becoming more difficult, it is imperative that we improve and do more to chalk up a better and better wildcat success ratio in our exploration work. A forum such as this can provide an excellent and useful focal point for petroleum experts from the oil and service companies, government bodies and academia to share relevant experiences and discuss new techniques and issues. I understand that many interesting papers of a high standard have been submitted for discussion this year.

Ladies and Gentlemen,

It is opportune that this particular seminar also coincides with a period of renewed and intensified petroleum exploration work throughout Malaysia. Over the past one and a half years, Petronas has signed 17 new production sharing contracts with some 26 multi-national companies from 8 different countries and we expect to sign quite a few more early next year.

It is significant that for 1989, our PS contractors have budgeted some M$750 million for drilling of about 45 exploration wells, more than triple that drilled this year. Over the next 4 years we expect our current and new PS contractors to drill some 80 wildcat wells together with some 50 appraisal wells resulting in a total of about 30 exploration wells drilled annually till 1992. This is thus the start of another exciting period for the petroleum industry in this country. Vast amounts of new seismic and other geological data are being gathered. The multitude of oil companies now operating here will add new, imaginative and creative dimensions to geological thinking in this country.

With all these developments, one question frequently arises. Why are all these people here? Is it good geology, good PSC terms and tax regime, or is it our good food?

I think the reason is quite clear to all the geoscientists in this room. We firmly believe that there are many good geological prospects still available in this country. This, coupled with a fair fiscal regime, a stable government and good working conditions have resulted in more and more companies coming here. We are confident that many more and larger prospects will be identified soon with this new wave of exploration work.

It is clear to us all, that intensified petroleum activities will stimulate and generate more economic activities here in Malaysia. The present and forecasted high level of exploration investment flowing in from overseas augurs well for the local petroleum ancilliary and support service companies. At the same time, more new job opportunities will be created. Under the present situation of significant unemployment amongst graduate geoscientists this situation is most encouraging. But it is noteworthy that the job creation effect does not stop there. It is said that one expatriate officer can create up to 7 or 8 jobs, albeit low level jobs. He will need a driver, a servant, a gardener and a stenographer/translator amongst others.

Ladies and Gentlemen,

Exploration work in Malaysia will soon mature to a stage where the easy-to-find accumulations will become more scarce and where the search for hydrocarbons will become more elusive. It will involve finding oil in more complex and subtle structures. For instance, the success of petroleum exploration, especially for stratigraphic traps (now largely ignored), depends a good deal on successful interpretation of sedimentary depositional environments of reservoir rocks. Major efforts still need to be made to understand sedimentary depositional environments, especially in Malaysia's tertiary basins where fluvial, deltaic and shallow marine reservoirs predominance. If we are to succeed in finding required future reserves, more modern and sophisticated technology and skills in the field of geology, geophysics and geochemistry must be applied. In this regard the petroleum geologists need to equip themselves not only with expert knowledge in geology but also other relevant disciplines, including petroleum engineering. Likewise the engineer will need to know more geology to be a successful 'oil man'. We in Malaysia are especially proud that a high-tech exploration effort is already well underway here incorporating vast amounts of 3D seismic data, sophisticated data processing packages, and even deep water scientific work.

In today's environment of low oil prices, increasing further the recovery of petroleum from existing fields has also become important. Here expert knowledge of stratigraphy, sedimentology, and structural geology is required to build the right reservoirs models from seismic, core and log data. Regarding efforts to increase field productivity I would like to mention that we are proud that SSPC recently successfully drilled a horizontal well in the ERB west field to increase production. This is the first time the horizontal drilling technique has been used here in Malaysia. You will no doubt here more about SSPC's experiences later this afternoon.

In more mature producing areas E.O.R., the newest and most difficult level of the game is involved and this will constitute a big challenge to our younger geoscientists. Here the identification of thin barriers, thief zones, and fracture systems become essential. Integration of detailed

petrography with petrophysical measurement is required. To-date the predictibility of E.O.R. projects is still poor. Yet mastery of relevant skills in this area of work will become essential in future in our oil industry here in Malaysia because we are not endowed with hugh oil reserves like the Middle East. We need to prepare ourselves now for these emergent problems. Research and development work using a multi disciplinary focus is now a very important aspect in oil industry work. Recognising all these problems Petronas has recently set up the P.R.I. or Petroleum Research Institute. One of P.R.I.'s major efforts should be directed to keeping abreast with the latest developments and advances in the relevant base technology, but also the lead technology and pace technology which can impact significantly or even revolutionise present methods and techniques!

Ladies and Gentlemen,

Exploration of frontier areas that have hydrocarbon potential is Petronas' next key objective. We are now focussing on frontier areas including those in Sarawak and Sabah land blocks, as well as, deep water acreages. The recent signing of a PSC for block SB8 which is in a remote land exploration frontier area in Sabah with Sun Malaysia and Gulf Canada is testimony of Petronas serious intension in this direction. Our joint studies of deepwater areas with B.G.R. of West Germany have also provided positive indications of large structures which could have significant potential for hydrocarbon production in the near future for our country. Next year Petronas intends to initiate work on acquisition of 8,000 kilometers of new seismic data within our deepwater areas.

In conclusion, may I wish you a fruitful deliberation at this Seminar, good fortune in your search for more oil in Malaysia and a happy stay here for our foreign guests. On this note, I have great pleasure in declaring the Twelfth Petroleum Geology Seminar open.

I thank you.

******

ABSTRACTS OF PAPERS

PALYNOSTRATIGRAPHY IN OFFSHORE SARAWAK CLIMATIC AND EUSTATIC APPLICATIONS

CLAUDE POUMOT, ELF AQUITAINE, FRANCE &
JAIZAN HARDI MOHAMED JAIS, PETRONAS PETROLEUM RESEARCH INSTITUTE

The classical qualitative palynostratigraphy of Neogene ages in tropical areas is of limited accuracy owing to the broad age ranges of most vegetals for most pollen taxa and often owing to high sedimentation rates which dilute the fossil pollen record.

In order to fit in with corresponding geological problems, a new palynological zonation was established based on quantitative variations of pollen assemblages. These assemblages are not artificial but correspond to living vegetal ecological assemblages. Neogene pollen grains are so morphologically close to present pollen grains that they are directly identified under plant taxonomy.

Twelve quantitative palynozones occur in the Malaysian offshore from Oligocene to early Pliocene. The study on seven wells shows that the sedimentary significance of quantitative palynozone allows us to assimilate their limits with sequence boundaries defined by seismic stratigraphy.

The pollen assemblages of montaine and inland vegetation evolve in close response with regional climatic changes. The variations in frequencies of littoral flora groups compared with those of spores are correlated with stillstands and changes of sea levels.

STRATIGRAPHIC PROCESSING OF 3D SEISMIC BY CONCURRENT ANALYSIS OF SURFACE AND BOREHOLE DATA

P.S. SCHULTZ, GECO GEOPHYSICAL CO. LTD.,
R. GIR, SCHLUMBERGER OVERSEAS S.A.,
D. PAJOT, SCHLUMBERGER AUSTIN SYSTEMS CENTER, &
STEVE S.C. WU, CHINESE PETROLEUM CORP.

When seismic data is available in production areas, it is often desirable to use it for stratigraphic interpretation to estimate the extent of existing reservoirs. 3D seismic data, which contains the producing wells within its volume, is particularly suitable for such an exercise. We present an interpretive processing procedure, supported by a case study, where surface and borehole data are used in cooperation to achieve maximum reliability of the final surface seismic inversion.

The study addresses a series of producing sand layers from a single well, to be analyzed for reservoir extent. The processing procedure begins with suitably processed 3D seismic and borehole data, from which are extracted: 1) a deviated trace, interpolated along the well trajectory, 2) general time surfaces, a set of mathematical surfaces approximating horizons, and 3) a corrugated section, a generalized 2D section coincident with the deviated well. It

continues with corrections and calibrations to the residual wavelet, computed using the borehole data and applied to the 3D surface seismic data along structure. The procedure concludes with a bandlimited inversion of the seismic data, calibrated by the borehole data, applied to a generalized 2D section, and extrapolated along structure away from the borehole. With the aid of the final calibrated inversion, a refined estimate of the current reservoir volume was possible.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

DMO AND NMO AS APPLIED IN SEISMIC DATA PROCESSING

JIUNNYIH CHEN
CHINESE PETROLEUM CORPORATION

DMO (dip move-out) is recognized as the technique to image the steep dip events which are indiscriminately smeared when the data are processed with the conventional seismic imaging method, which includes NMO, CMP stacking and zero offset migration. From those published papers, we may find many ways to do DMO, such as prestack partial migration, DMO by Fourier transform, offset continuation, single channel DMO ... etc, and the improvements of these techniques are widely recognized. But every technique is available only in two-dimensional case.

To extend DMO to 3D (three dimensional) case, those techniques operating on constant offset section are generally available only when the feathering angle can be constrained in a very small value, but this condition is really hard to achieve when the sea current is rough. In this paper the author is going to extend the "Rocca's smile" operator into 3D cases, so that an easy way of doing DMO will be available to any 3D data.

A further consideration is also given to mixing the NMO with the DMO. The reason for doing this is not only to simplify the process and to save computer time, but also to search for more accurate velocity information for the NMO correction when the dip angle is large. This technique will be very effective comparing to sole DMO when the velocity changes very rapidly with depth.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

ESTIMATING RESERVES IN THINLY-LAMINATED SANDS WITH THE HELP OF PETROGRAPHIC IMAGE ANALYSIS (PIA)

T. KENNAIRD, D. BOWEN & J.W. BRUINSMA
CORE LABORATORIES MALAYSIA SDN. BHD.

Calculating reserves in a reservoir sequence where the productive sands are only millimetres in thickness is very difficult using conventional electric logging and core analysis methods. Petrographic image analysis can be used to determine certain petrophysical parameters within sands of such thickness leading to more realistic estimations of both total and recoverable reserves.

A FIRST EXPERIENCE IN HORIZONTAL DRILLING IN SSPC (ERB WEST FIELD): A REVIEW OF OPERATIONAL GEOLOGY

RAJA AZHAR RAJA M. NOOR & THOMAS KUUD
SABAH SHELL PETROLEUM CO. LTD.

In recent years considerable advances have been made in the technique of drilling horizontal holes. This technique has proven to be particularly applicable in fields with thin oil rims where a horizontal penetration of the reservoir can substantially increase the length of the completion interval. SSPC has investigated the potential for application of horizontal wells in existing offshore Sabah fields that have, to date, been developed by conventional wells. The Erb West field was considered a suitable candidate for a first horizontal well.

This paper outlines the operational geology aspects of this first horizontal well trial, highlighting the geological configuration of the target area, its main uncertainties and the day-to-day geological evaluation of drilling operations.

The Erb West field is a significant hydrocarbon accumulation in offshore Sabah (NW Borneo), consisting of a single 120 to 140 ft thick oil rim overlain by a large gas cap (ca. 550 ft thick). The Erb West field is a relatively simple NE-SW trending anticlinal structure with a collapsed crest and bounded to the NE by a major fault-zone. The hydrocarbons are contained within a ca. 800 ft thick sequence of Upper Miocene shallow marine sandstones in which eight main reservoirs have been defined (M4 and N2-N8 sands).

The main objective of the well was to penetrate the N6 sands in Fault Block 2B over a horizontal section of ca. 800 ft gross (ca. 450 ft net) to provide a drainage point in the southern part of the field.

The target area in the N6 sands was located in a ca. 3300 ft wide East-West trending block bounded to both the north and south by normal faults and some 1000 ft - 1500 ft away from the nearest existing wells. Structurally the main uncertainties were the location and throw of the northern bounding fault, which had to be crossed by the well before entering the target interval, and the structural elevation (true vertical depth) of the top of the sands. In addition, the alternating sand/shale sequences characterising the N5, N6 and N7 reservoir units are very similar in character and increased the uncertainty in correctly identifying the target sands (N6) directly from drilling data.

The MWD Gamma Ray log was not available for correlation for most of the drilling phase due to its interference with deviation control, leaving only the mud logs (penetration rate/cuttings descriptions) for daily monitoring of geology. Interpretation was further hampered, firstly, by the presence of numerous hard stringers (carbonate cemented layers), which slowed down the drilling speed considerably, and secondly, by contamination from cuttings remaining on the low-side of the borehole.

Identification of the target was also difficult because the horizontal section of the well followed an azimuth of approximately N200° through beds which have a structural dip of 6°/N150°, resulting in penetration of the formation from older to younger (instead of younger to older as in conventional wells). Consequently, borehole logs had to be manipulated in such a way that correlation with nearby wells could still be carried out.

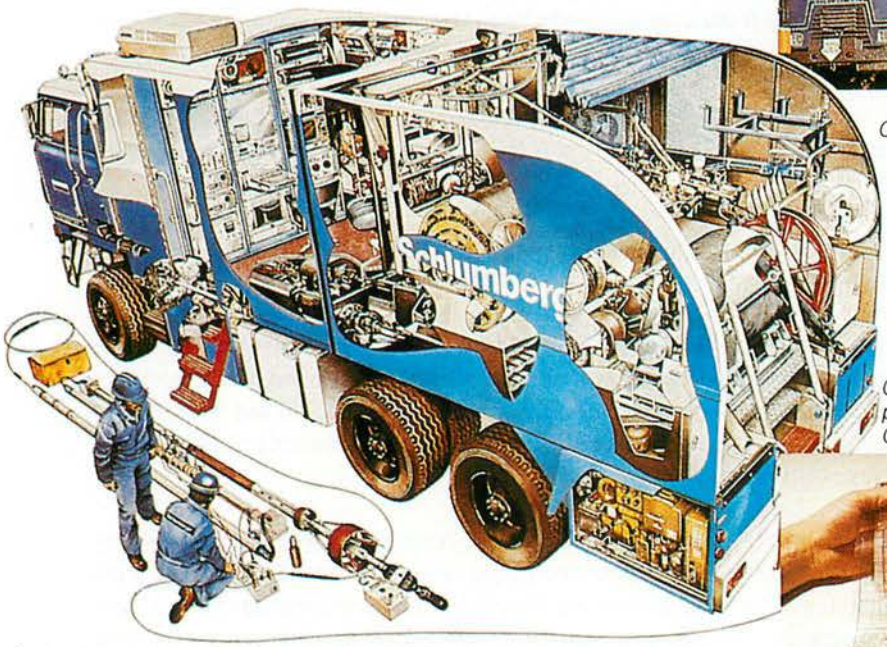
The well was successfully drilled and fully met its main objectives: (1) it provided a 400 ft long completion interval on the N6 reservoir sands and (2) it penetrated the formations horizontally over a length of almost 1500 ft.

Schlumberger: services throughout Malaysia.

Schlumberger, the eyes of the oil industry, has provided services since the discovery of oil in Miri, Sarawak, several decades ago. Its commitment to high technology continues to provide the most cost effective results.

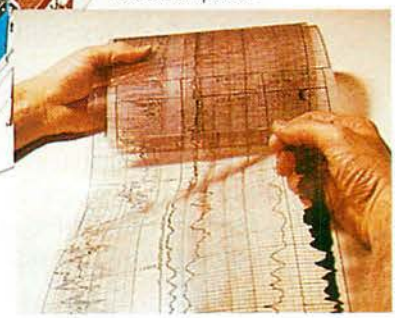
Schlumberger engineer at work with the Cyber Service Unit system inside a wireline logging Unit

Cyber Service Unit on location.



Schlumberger crew checking a logging tool.

Cyberlook, an interpreted log prepared at the wellsite by the CSU computer.



Schlumberger

3rd Floor, Wisma Bunga Raya, 152 Jalan Ampang, 50450 Kuala Lumpur.
Tel: 2485533/2485621/2485947. Telex: SCHLUM MA 31335. Cable: SCHLUMEAD.

Wellog (Malaysia): making full use of data.

Wellog (Malaysia), located in Kuala Lumpur, staffed with specialists, develops the answers with your experts.

It provides a full range of data processing services:

- *Open Hole Log Evaluation*
- *Key Well Study*
- *Reservoir Description Services*
- *Cased Hole Reservoir Analysis*
- *Production Flow Analysis*
- *Well Seismic Processing*
- *Facies Analysis*
- *Dipmeter Processing*
- *Permeability Evaluation*

Our specialists evaluating a set of logging data.

Wellog (Malaysia) Sdn. Bhd.

3rd Floor, Wisma Bunga Raya,
152 Jalan Ampang, 50450 Kuala Lumpur.
Tel: 2434622/2434776/2434890.
Telex: SCHLUM MA 31335.
Cable: SCHLUMEAD.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

SEISMIC PROCESSING APPLICATIONS ON A PERSONAL COMPUTER

GEOPHYSICAL SERVICE (MALAYSIA) SDN. BHD.

This paper demonstrates the "state-of-the-art" processing that has been moved from a mainframe environment to the small office/desk-top machine. Although the data examples are combined to demonstrate a vertical seismic processing example it will be stressed that this application is just an example of a particular grouping of seismic programs from the software library.

As mainframe computers increase in capacity and speed, the personal computers are reducing in size, but not in power. The personal computer will be increasingly used in decision making based on small subsets of data whilst interacting with the mainframe as a workstation.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

THE HYDROCARBON POTENTIAL AND TECTONICS OF INDOCHINA

MASAO HAYASHI
IDEMITSU OIL DEVELOPMENT CO., LTD., SINGAPORE

Indochina covers a wide area between the South China Sea and the Bay of Bengal. The eastern half of the region is selected for the study of the tectonic analysis and the investigation of the hydrocarbon potential. The Kontum Massif, composed of a metamorphosed basement complex, seems to be the core of the Indochina region, and crops out from eastern Vietnam to Laos and Kampuchea. The concept of concentric growth of the orogenic belts along the periphery of this massif seems to have been accepted as being within the scope of the classic theory of orogeny. The application of the modern plate tectonic hypothesis with the aid of LANDSAT image analysis has however enabled a new interpretation of the tectonic development of the area to be made.

The hydrocarbon potential of Indochina is here investigated, based on this interpretation of the region's tectonic development, and taking account of the morphological and textural characteristics detected from the LANDSAT imagery integrated with fundamental geological factors. Three areas, (1) the Mekong Delta, (2) the Khorat Plateau, and (3) the Hanoi Basin, are selected for detailed discussion on their hydrocarbon potential.

APPLICATION OF VERTICAL RECEIVER ARRAYS IN 3D SEISMIC EXPLORATION

R. BEKKER
GECO ASIA PACIFIC

Substantial experience has been gained with a new acquisition technique which comprises two streamers towed at different depths forming a vertical receiver array. This method enables wave field separation into upgoing and downgoing parts.

The process is applied in two steps. Application of the first step gives results which can replace recordings with one streamers at a streamer depth equal to the vertical streamer separation. This permits continued acquisition in bad weather by lowering the streamers below the sea-state induced noise zone. In the second step a deterministic deghosting operator is applied yielding a wider frequency bandwidth and an improved potential resolution.

In addition to a large amount of 2D data, some 3D surveys have been acquired during 1987 using the technique. On one occasion the application was limited to infill lines, and on another it was confined to a local area of the total prospect. In this paper we will present data where part of a survey was shot twice, once conventionally and once with the over/ under technique, thus allowing for a unique 3D comparison. The ability of the over/under technique to match conventional data has been studied by merging these different 3D data volumes. Although the motivation was mainly economic related to the increased production weather window, the potential to obtain enhanced frequency bandwidth by application of the second step of the process was also analysed. Data examples will be shown. Time slices proved to be a suitable tool in this comparison.

EFFECT OF BASEMENT ON THE LOCATION OF PETROLEUM ACCUMULATIONS IN WEST MALAYSIA

NIK RAMLI NIK HASSAN
PETRONAS PETROLEUM RESEARCH INSTITUTE

The location of common hydrocarbon traps in West Malaysia are largely influenced by basement morphology. Types of hydrocarbon traps affected by the basement are (a) drape structures and (b) growth anticlinal structures. Basement drapes are early formed structures located near the edge of the basin whilst growth anticlinal structures are formed much later in deeper basinal areas.

Drape structures are formed over pre-Tertiary basement horsts consisting of either metasediments, limestones or igneous rocks. These structures show progressive increase in closure with increasing depth. Growth anticlinal structures are generally formed by compressional forces acting on sediments overlying basement half grabens. The orientation and shape of the underlying half grabens determines the orientation and shape of growth anticlinal structures. In the southeastern part of the Malay Basin, basement half grabens are oriented east-west, overlain by east-west trending anticlines. Each anticline has its own growth history which may be dependent upon such factors as size of underlying half graben, amount

of graben fill and distance from the edge of the basin. The Sotong Field is an example of drape structure. Primary oil-bearing reservoirs in the Sotong Field are located in fluvio-deltaic sandstones of the Pulai Formation. The main hydrocarbon bearing sandstone unit in this field consists of stacked channel fill sandstones deposited over basement high. Structural closure was formed due to sediment compaction over basement high. Sedimentologic response to Sotong basement resulted in the formation of stratigraphic traps.

The Duyong field is an example of simple growth anticlinal structure. Gas-bearing sandstone units in the Duyong Field consists of fluvio-deltaic K sandstones and offshore bar to storm sheet J sandstones. Based on a study of sedimentologic response to structural growth, it can be shown that growth of the Duyong anticline occurred most probably after early Miocene time.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

BIOSTRATIGRAPHY OF SELECTED WELLS FROM MALAY BASIN, OFFSHORE PENINSULAR MALAYSIA

RASHIDAH HJ ABD KARIM, AHMAD MUNIF KORAINI,
AZMI MOHD YAKZAN, BASIRON JALIL, HO CHEE KWONG,
MOHD RAZALI CHE KOB, RODZIAH DAUD & SHAMSUDIN JIRIN
PETRONAS PETROLEUM RESEARCH INSTITUTE

Biostratigraphy of wells Angsi-1, Seligi-3 and Banggol-1 were investigated by means of nannofossils, foraminifera and palynomorphs. The Early Miocene to Pleistocene strata are best defined by the nannofossil zonations while the Oligocene, is interpreted from palynological data. The diachronous nature of the different rock units are demonstrated. Broad environmental zones are demarcated based on both faunal and floral assemblages. There appears to be an overall transgressive sedimentation pattern from the Late Oligocene to Pleistocene. The depositional setting changed from an earlier brackish lacustrinal to marginal marine and progressively became open marine during the Pliocene onwards. Climatic changes inferred from palynological assemblages in the three wells generally reflect the regional paleoclimatic changes.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

ASPECTS OF THE GEOLOGICAL EVOLUTION OF PENINSULAR MALAYSIA

S.P. SIVAM
UNIVERSITI MALAYA

The complexity of the geology of Peninsular Malaysia is due to the possibility of existence of different tectonic blocks in a narrow peninsula in which outcrops are of average quality. There has been some disagreement over whether the east and west blocks of the peninsula have been separated widely or not and if separated, when did they unite. From evidence ranging from the differences in magmatism, stratigraphy, geologic history, etc., it will be shown that they probably have been separated by a large distance, at least till the later part of the Triassic and that their earliest post union sediments are Rhaetic.

The differences in granites include those in their ages, elemental and mineralogical compositions, enclaves, associated magmatism and levels of emplacement. The mineralization history in both the belts have also been noted to differ. Even the nature of tin mineralization is not similar.

The stratigraphy of both these belts differs markedly and they have undergone different climatic, depositional, geomorphic and basin evolutionary histories. In the Lower Paleozoic, comparison in the peninsula is not possible as they are not proven in the eastern block, so the histories in their northern counterparts in Indochina and Thailand are compared. In the Upper Paleozoic and Triassic, their dissimilarities are striking.

The absence of oceanic crust in both the belts but the presence of sometimes very thick geosynclinal sequences suggest that subsidence by some process probably in addition to crustal attenuation is needed to accommodate these thick sediments. Probably phase changes in the lower crust may account for some of this subsidence.

Attempts have been made to correlate both the eastern and western blocks with Gondwana and more specifically with Australia but from the evidence available only the correlation of the Western Belt with Gondwana is probable at the moment.

In addition, a model for development of basins both onshore and offshore is provided which explains the presence of tensional, compressional and transcurrent features in this area at about the same time. This model is named "Longkang Tectonics".

Geological Society of Malaysia — Petroleum Geology Seminar 1988

STRUCTURAL HISTORY OF THE MALAY BASIN, A CLASSICAL TERTIARY WRENCH BASIN

K.S. KUANG
INNOVATIVE TECHNOLOGICAL GEO-EXPLORATION, AUSTRALIA

This paper describes the major tectonic events of the Malay Basin. Its Eocene inception is postulated to be caused by the collision between the Indian and Asian plates which created a major NW-SE 'scissor' divergent wrench fault along its axis. Today this fault has a right lateral displacement of some 80 km.

The next major tectonic event was the Eo-Oligocene opening up of the South China Sea. It resulted in its E-W en echelon half grabens which together with divergent wrenchings of the NW-SE faults facilitated the rapid development of the Malay Basin during early Miocene.

By middle Miocene, the compressional regime exerted by the impinging Pacific plate was felt in the Malay Basin. This stress was initially taken up predominantly by convergent right lateral wrenchings of the basin inception faults which also caused structural inversion over the E-W half grabens.

By late Miocene, this stress could no longer be taken up by wrench movements resulting in the stress becoming more E-W compressional. This stress caused crustal shortening through tilting of different fault blocks and culminated in a regional truncation unconformity and the prominent set of N-S faults. After that an extensional regime existed probably due to the spreading axis of the South China Sea extending into it.

In summary the structural history of the Malay Basin has been reconstructed with its structural style and timing defined. In so doing, the foundation for precise play type definition has been laid.

INTEGRATING GEOLOGY AND GEOPHYSICS TO THE PLANNING OF THE GUNTONG FIELD DEVELOPMENT

KWOK KWEE PIN AND ZAINUDDIN YUSOFF
ESSO PRODUCTION MALAYSIA INC.

The development of the Guntong Field has been significantly aided by the integration of seismic, well logs, cores and stratigraphic interpretations. Two disciplines have been of particular importance :-

i) the use of 3D seismic data, and
ii) sequence stratigraphic concepts.

Our detailed mapping of amplitudes, using time-slices and datumed lines, clearly defines channel morphology, and also the distribution of hydrocarbon as indicated by strong oil DHIs. The 3D seismic has opened a new dimension, not only to the field structural definitions, but also to the mapping of reservoir facies. The presence of sand-filled incised valleys as the major reservoir units in the Group I has been recognised only recently. Chronostratigraphic correlation of well logs using the latest sequence stratigraphic concepts, integrated with interpretations based on seismic and core data, has allowed accurate structural, facies and net thickness predictions ahead of the bit. As our experience in the development of the Guntong field expands, the advantages of an integrated approach become more apparent.

ADVANCEMENTS IN POSITIONING FOR MARINE SEISMIC 3D

P. CANTER
GECO A.S.

Market demands for highly accurate means of positioning seismic cables and sources in marine seismic 3D surveys have led to many new developments. The process of formulating and implementing concepts utilizing radio navigation and acoustic ranging techniques for in sea positioning has involved several generations of equipment and software. 1988 has been an important year in this process as advanced in sea positioning has become a standard in marine 3D surveying.

In sea positioning in the past has been based on range and bearing computations utilizing nominal offsets from a vessel antenna and bearings from streamer mounted magnetic compasses. Methods now in place include utilization of acoustic responders and hydrophones, attached to seismic sources and streamers, coupled with radio navigation on vessels and towed buoys. The deployed systems must be capable of handling the harsh marine environment and the demand for 24 hour operation with minimum downtime.

The acoustics and radio-navigation must be integrated into a single solution for determination of seismic source and receiver locations. The integrated systems must have flexible hardware and software to handle constantly varying data quality and configuration in sea equipment. In many cases there must be telemetry, interface capabilities and software options for utilizing data from more than one vessel at a time. There must be quality control in the form of inter and intra system statistics as well as graphic display for optimum steering for subsurface coverage. In addition there must be recording capacity for large amounts of nav sensor data recorded for post mission analysis.

This paper shall give an overview of the hardware and software systems presently available for in sea positioning on marine seismic 3D surveys.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

APPLICATION OF NUCLEAR SPECTROMETRY TO FORMATION GEOCHEMICAL EVALUATION

P. COLOMBANI, SCHLUMBERGER-DOLL RESEARCH,
D. ELLIS, SCHLUMBERGER-DOLL RESEARCH,
J. GRAN, SCHLUMBERGER-DOLL RESEARCH,
M. HERRON, SCHLUMBERGER-DOLL RESEARCH,
J. SCHWEITZER, SCHLUMBERGER-DOLL RESEARCH,
O. SERRA, SERVICES TECHNIQUES SCHLUMBERGER,
G. MATHIEU, SCHLUMBERGER OVERSEAS,
AND R. ROESTENBURG, SCHLUMBERGER OVERSEAS

Geological interpretation starts from a description of a rock in terms of mineralogy and texture. The compositional description of the rocks derived from conventional wireline logs is restricted by the complexity of the mineralogical model, and the limited sensitivity of conventional logs (except for the photoelectric factor) to mineralogical changes.

Recent advances in geochemical logging and interpretation give a direct, in situ access to the chemical composition of the rock, thus opening the way to quantitative and complex mineralogical analysis.

Furthermore, a large number of key formation characteristics can be better evaluated through the detailed knowledge of the mineralogical assembly; for example, porosity, permeability, grain size and cation exchange capacity. Conventional log analyses can be improved by the additional information brought by the geochemical log.

Finally, a better characterization of the rock facies, in terms of sand classification and clay typing, is obtained.

It is hoped that these results will ultimately contribute to better prospect definition, reservoir evaluations, and completion strategies.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

SUBDUCTION-COLLISION MODELS FOR THE MALAY PENINSULA: AN APPRAISAL

K.R. CHAKRABORTY
UNIVERSITI MALAYA

Three geologically distinct belts constitute the Malay Peninsula. The evolution and juxtaposition of these belts have been discussed in recent years in terms of subduction-collision models by a number of workers. Although extensional models have also been suggested, the basic theme of subduction-collision seems to have gained general acceptance.

The proposed subduction-collision models, which vary in details even with respect to subduction polarity and collision timing, implicitly or explicitly suggest that (i) the Bentong - Raub Line is an ophiolitic suture that marks the site of a consumed ocean basin, (ii) the Central Belt (including the eastern foothills of the Main Range) represents an accretionary complex, and (iii) subduction related arc-type calcalkaline magmatism dominates the Eastern and Central Belts. Geological evidence, however, is at variance with such assertions and casts serious doubt on the validity of such models.

Much reliance has been attached to the occurrence of serpentinite bodies in interpreting the Bentong-Raub Line as an ophiolitic suture. While serpentinites may bear testimony to the possible existence of an oceanic crust, the virtual absence of spilitic or altered basaltic lavas negates it. Serpentinite bodies,moreover, occur only within the confine of the lower Palaeozoic schists, the implication of which seems to have been overlooked. The dominance of silicic magmatism throughout the Palaeozoic and Mesozoic further testifies to the relative absence (or noninvolvement) of oceanic crust. Evidently, the different belts were not separated by a wide ocean. Proximity, however, is not supported by palaeontological mismatch which suggests wide separation. Isotopic data also indicate that the Western and Eastern Belts are underlain by different Precambrian crust. This paradox, however, disappears if transcurrent motion with large displacement is invoked.

Structural features in the Central Belt are, by and large, characteristic of an extensional terrane and not what one would expect from an accretionary complex that supposedly was squashed between the two colliding blocks. Also, the results of gravity studies suggest crustal thinning below the Central Belt contrary to the expected collisional thickening. Thus geological evidence speaks against collision, particularly during Triassic time.

Magmatism (mainly Triassic) in the Central and Eastern Belts is quite distinctive in being bimodal and predominantly subalkaline (monzonitic) type. Presence of potassic suites and lack of tonalites are also important discriminating features. This magmatic pattern contrasts with the typical arc-type calcalkaline magmas, but resembles those found usually in extensional environments such as continental rift, hot spot, back arc basin, and broadly post-orogenic setting. Back arc setting, if invoked, would require a westerly subduction along a trench located to the east of the Eastern Belt, not along the Bentong-Raub Line. Post-orogenic setting would, on the other hand, necessitate the presence of earlier calcalkaline magmatism for which presently there is no clear evidence. Spreading-ridge subduction is an interesting alternative but it is possible only if ridges are higher order tectonic features.

The geological records briefly outlined above do not support a passage from an oceanic subduction to a continental collision, instead warrant a tectonic scheme on the basis of an overall extensional framework. Currently available data are somewhat equivocal and hence no unique model can be constructed. A combination of transcurrent motion with mantle diapirism seems to provide a viable scheme. This envisages an earlier dominance of strike-slip tectonics (leaky transcurrent fault) which brought two geographically separated blocks into juxtaposition without oceanic subduction, followed by mantle diapirism which created an extensional rift-type environment with attendant crustal thinning, high heat flux and magmatism. The transition from transcurrent phase to diapiric phase probably occurred during Permian effecting significant changes in structural style.

Viewed in a broader perspective, the geotectonic evolutionary pattern of the Malay Peninsula seems to support the idea of a narrow Tethys and Tethyan shear.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

GEOCHEMICAL ANALYSES AND INTERPRETATIONS OF SURFACE SEDIMENT SAMPLES FROM THE DEEPWATER AREAS OFFSHORE SABAH

B. Mahendran & U. Berner

PETRONAS EXPLORATION DEPARTMENT &
FEDERAL INSTITUTE FOR GEOSCIENCES AND NATIONAL RESOURCES
OF FEDERAL REPUBLIC OF GERMANY (BGR)

During the SONNE-49 survey in the deepwater areas offshore Sabah in July 1987, a total of 23 piston and gravity cores were collected along profiles BGR 86-08, 86-22 and 86-24. Degassing and gas chromatographic analyses on the total gases from all cores were carried out onboard the SONNE except at location KL 139 where the poor recovery (about 70 cm) precluded any analyses.

In the Isotope Laboratory at BGR, the total gases were subjected to carbon isotope analyses. 15 samples from 13 coring stations were also degassed for sorbed gas studies which include gas chromatographic and isotope analyses. The ediment samples were also subjected to fluorescence and TOC analyses.

Total gas analyses indicate biogenic derivation. Sorbed gas analyses were not genetically indicative as only low background gas yields in the sorbed position were obtained. The study however conclusively proves that biogenic methane does not or only insignificantly gets into the sorbed position. Fluorescence analyses indicate that migration of thermally-generated long-chained hydrocarbons to the surface sediments has not taken place.

The indeterminability of thermogenically-derived gases in the surface sediments does not however refute the possibility of thermogenically-derived hydrocarbons occuring in the deepwater acreages offshore Sabah. The gas hydrates observed in the area act as effective impermeable seals and have thus probably prevented the upward migration to the surface of any or most of the thermogenic gases.

C-GC-MS AND ITS APPLICATION TO CRUDE OIL ANALYSIS

PAUL A. COMET, OOI SIEW TIN & YAP AI BEE
CORE LABORATORIES MALAYSIA SDN. BHD.

The gas chromatograph linked to a mass spectrometer with computerised data acquisition capability (C-GC-MS) makes for a very versatile and powerful analytical tool. The important function of the GC-MS in petroleum exploration and production studies is its ability to detect biomarkers.

What are biomarkers? They are organic compounds whose carbon skeletons give an unambiguous link with a known natural or biological product. Examples are isoprenoids, triterpanes, steranes, sterols, etc. In other words, they may be described as 'chemical fossils'. Their thermal stability in oils and sediments (source rocks) make them very useful in oil to source rock correlation studies or determination of the number of oil pools present in an area. A study using GC-MS data on nine 'oil stained' rock samples from S.E. Asia and the Bahamas will be highlighted as an example to illustrate the usefulness of C-GC-MS in the recognition of petroleum and determination of its source and maturity.

THE MURAU FORMATION: LITHOSTRATIGRAPHY, LITHOFACIES AND SEDIMENTARY ENVIRONMENT

AHMAD JANTAN, IBRAHIM ABDULLAH & UYOP SAID
UNIVERSITI KEBANGSAAN MALAYSIA

The rocks exposed along the coastal stretch of Murau, east-central Johor, which Koopmans (1968) considered to be the basal member of the Tembeling Formation equivalent to the conglomerate exposed west of Maran town, Pahang, and named as the Murau Conglomerate Member [which Burton (1972) suggested to be taken out of the Tembeling Formation, and which Khoo (1977 and 1983) when he upgraded the Tembeling Formation to Tembeling Group] is best considered as a separate unit and be designated its own formal lithostratigraphic unit or formation, i.e. the 'Murau Formation', based on their geographic position, their probable paleobasin location, their relationship with the underlying rocks, and their lithology.

These Murau rocks consist of variously interbedded lithofacies, predominantly conglomerate with subordinate mudstones and minor sandstone. Bedding is crude. Lateral variability in is very marked. They may grade, be in sharp contact, or in erosive contact. Beds may be tabular, wedging or lenticular/ channel forms.

The conglomerates are very poorly to poorly sorted and consist of granules, pebbles and cobbles with maximum clast size of up to 50 cm. Clasts range from very angular (rock chips), angular to subangular. They may be ungraded, normally graded, reversely graded or variably graded. Sandstones lenses are not uncommon within the conglomerates.

The sandstones are also poorly sorted. They are muddy as well as granular. Bedding is crude. There is marked lack of traction-transport sedimentary structures except for granule streaks. Pebble pockets and shallow channels are not uncommon in the sandstone.

The mudstones are red and grey structureless, except for exotic sand and granule clasts and stringers of sands and granules. Small granule to pebble conglomerate shallow channel occasionally cut the mudstones.

No fossil was found, except for burrows at one locality in the mudstones eg. Tg. Sekakap.

Lithofacies, lithofacies relationship, clast textures, sedimentary structures and absence of fossils together suggest alluvial fan setting where active processes were debris/mass flows dominating the proximal areas, and sediment-laden ephemeral, braided stream dominating the middle and distal areas, and not a fluviatile- deltaic-lacustrine setting as interpreted by Koopmans (1968).

The Murau rocks are interpreted to have been deposited at the foot and near-slope areas of a 'newly formed' down-faulted, normal-fault half-graben basin, most probably during Jurassic- Cretaceous times.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

THE MURAU FORMATION: MURAU STRUCTURES AND THEIR SIGNIFICANCE TO REGIONAL GEOLOGY

IBRAHIM ABDULLAH, AHMAD JANTAN & UYOP SAID
UNIVERSITI KEBANGSAAN MALAYSIA

The Murau rocks are exposed in a very narrow zone along the coastal area south of Mersing. Based on their limited distributions and some field evidence, the boundary between these rocks and the older rocks to the west is interpreted to be a fault contact. The faulting had possibly taken place during the Cretaceous times before the deposition of these rocks. The supposed normal fault formed a steep slope and had set a suitable condition for the deposition of these rocks. The northern part of this formation is truncated by a right lateral fault possibly passing along Sungai Mersing.

The Murau rocks have been folded into open and slightly asymmetrical folds. Based on the fold style and the pebbles stretching near the base, it is interpreted that the folds have developed by flexural slip along the unconformity between this formation and the older rocks. Microgranitoid sills and dykes were introduced into these formation along the foldings, filling some of the tension cracks that have developed near the crest of the anticlines. Strike-ridges displacement as well as field evidence show that both right lateral and left lateral strike-slip fault have taken place. At several localities, the lateral faults cut the microgranitoid sills and dykes. The occurrence of microgranitoid sills and dykes suggests that the igneous activity in these area still continued even after the 'Murau' time. Later deformation produced the lateral faults, possibly as the same system as the Kuala Lumpur-Mersing Fault.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

DEPOSITIONAL ENVIRONMENTS AND RESERVOIR PROPERTIES OF THE J SANDSTONE, MALONG FIELD, OFFSHORE WEST MALAYSIA

NOOR AZIM IBRAHIM AND MAZLAN MADON
PETRONAS PETROLEUM RESEARCH INSTITUTE

Potential reservoirs in the basal part of the J sandstone in the Malong field, Tenggol Arch, offshore West Malaysia, consist mainly of three types of sand bodies representing a) prograding shoreface sequences, b) inner-shelf storm-generated sequences, and c) stacked fluvial channel sequence. The prograding shoreface sequence consists of upward coarsening units whereby very fine-grained argillaceous sandstones are overlain by fine to medium grained, well-sorted sandstone. The inner-shelf storm-generated sequence consists of a) a proximal zone, characterized by amalgamated high-energy indicators and frequent erosional surfaces, b) an intermediate zone of coarsening upward sand units with mixed high and low-energy indicators, and c) a distal zone, comprising low-energy indicators. The stacked fluvial channel sequence is characterized predominantly by trough cross-bedded sandstone.

Porosity and permeability in the J sandstone is primarily controlled by sedimentary facies (lithology, grain size,dispersed matrix content and depositional environments). Poroperm values are highest (Ø = 22-36%, K = 100-8000 mD) in channel sandstones and storm-generated shallow marine sandstones. Shoreface deposits have slightly lower poroperm values (Ø = 24-35%, K = 10-1000 mD). Permeability barriers (Ø = 10-22%, K < 10mD) may occur in lower shoreface to offshore deposits.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

TECTONIC HISTORY OF THE BENTONG-BENGKALIS SUTURE

H.D. TJIA
UNIVERSITI KEBANGSAAN MALAYSIA

The Bentong segment of the suture in Peninsular Malaysia is a southerly trending 13-km wide zone that extends from Tomo, Thailand via Bentong to the coastline east of Malacca. The suture consists of partially sheared packets of olistostrome among non-olistostromal rocks showing subvertical attitudes. The visible olistoliths may reach sizes scores of metres across and consist of pre-Silurian schists, Ordovician to Lower Triassic clastics, volcaniclastics, chert and minor limestone. Within the suture are also isolated bodies of serpentinised mafic-ultramafic rocks representing ophiolite. Its lithology, fabric and deformation style indicate that the suture is a highly compressed accretionary prism that developed first through subduction westward (early tectonic vergence was east), then subduction eastward (tectonic vergence towards west) before the rocks finally experienced tectonic transport eastward along reverse faults. The subduction process probably terminated by Early Triassic time. In the central part of the Peninsula, faults striking parallel to the suture posses dextral slip components that probably developed in pre-Cenozoic time.

Across the Straits of Malacca the suture continues in southerly direction as the approximately 20 km wide Bengkalis Depression and is traceable for more than 200 km until it abuts against the Tigapuluh Mountains, a pre-Tertiary basement high N-S faults with distinct right-lateral slip components occur within and outside the depression. These strike-slips faults created drag folds that trapped the hydrocarbons in the Lalang, Mengkapan, Kerumutan, Kayuara and other fields in Central Sumatra. In addition, the gouge along these wrench faults became lateral seals to the pools. The geothermic gradient is exceptionally high and played a major role in the maturation process. In late Cretaceous-Early Tertiary time the Bengkalis segment of the suture experienced normal faulting that created the depression, while lateral faulting occurred in the Oligocene (?) and the Miocene, before finally NW-striking reverse faults during the Pleistocene became superimposed upon the earlier trend. The Oligocene (?) and younger fault motions have been consistent with the oblique convergence of the Indian-Australian Plate and the Southeast Asian region of the Eurasian Plate.

Geological Society of Malaysia — Petroleum Geology Seminar 1988

HEAT FLOW REGIMES IN SEDIMENTARY BASINS OF MALAYSIA

WAN ISMAIL WAN YUSOFF
PETRONAS PETROLEUM RESEARCH INSTITUTE

Thermal conductivity and geothermal gradient are determined from the measurements made on cores and logging records respectively. The average thermal conductivity estimation of well columns are made using the lithostratigraphic method. In the determination of the geothermal gradient, the corrected logs' Bottom Hole Temperatures are used to estimate the true formation temperatures.

The highest heat flow region lies over the Malay Basin and the western portion of the Sarawak Basin, i.e. the Western Luconia, South West Luconia and the Balingian provinces (60 mWatt/m^2 - 110 mWatt/m^2). The trend varies from high heat flow in western Balingian province and normal heat flow in the eastern Balingian and Baram Delta. The Central Luconia has a high heat flow in the north eastern part and over the Sabah basin of which the average is about 55 mWatt/m^2.

High anomalies of heat flow density are related to the basement involved tectonics, young structurings and hydrocarbon accumulations over all areas. In Central Luconia, prominent high heat flow anomalies are more associated to gas fields than the structurings or lithology. It is suggested that the upward fluid movement may form the major cause for the anomaly in the Central Luconia Province.

BERITA-BERITA PERSATUAN
(NEWS OF THE SOCIETY)

KEAHLIAN (MEMBERSHIP)

The following applications for membership were approved:

Full Members

1. Jan Willem Bruinsma, Core Laboratories Malaysia Sdn. Bhd., Lot 10-B Jalan 51A/223, 46100 Petaling Jaya, Selangor.
2. Barrier Robert, Total Singapore, 435 Orchard Road, Wisma Atria, 1701 Singapore.
3. Marie Jacques, Total C.F.P. Singapore, 17-01 Wisma Atria, Singapore 0923.
4. S. Camille Yarbbough, Atlantic Richfield Indonesia Inc., P.O. Box 63/JKT Jakarta, Indonesia.
5. Charles Rah Cofer, P.O. Box 3293, Jakarta, Indonesia.

Institutional Members

1. Santos Ltd., 101 Grenfell St., Adelaide, S.A. Australia 5000.
2. Home Oil Malaysia, Menara Bank Pembangunan, Level 12, Jalan Sultan Ismail, 50300 Kuala Lumpur.
3. Bishimetal Exploration Co. Ltd., 2-11-6 Kanda-Nishikicho, Chiyoda-Ku, Tokyo 101, Japan.
4. Occidental Petroleum (M) Ltd., Letter Box No. 87, 20th Floor, UBN Tower, 10 Jalan P. Ramlee, 50250 Kuala Lumpur.

******

PERTAMBAHAN BARU PERPUSTAKAAN (NEW LIBRARY ADDITIONS)

The Society has received the following publications:

1. Bulletin of Statistics relating to the mining industry of Malaysia 1985.
2. United States Geological Survey Yearbook Fiscal Year 1986 (1987).
3. Geographic names information system. Data users guide (1985).
4. U.S.G.S. Circular 1007 (1988), 975 (n.d.)
5. Earthquakes and volcanoes, vol. 19, no. 4, 1987.
6. U.S.G.S. Bulletin 1725-C (1987), 1792 (1987), 1710-C (1988), 1731-F (1987), 1383-D (1988), 1793 (1988), 1788 (1988), 1877 (1988), 1837 (1988), 1825 (1988), 1735-C (1988), 1713-B (1988), 1757-C (1988).
7. U.S.G.S. Professional Paper 1456 (1988), 1445 (1987), 1314: A-L (1987), 1433 (1987), 1389 (1987), 1371 (1987).
8. SOPAC News, vol. 6, no. 1, 1988.
9. IMM Bulletin nos. 980 & 981, 1988.
10. AAPG Explorer, Aug. 1988.
11 Problems of the Baltic Sea History edited by J. Donner & A. Rankas, 1988.
12. Geophysical Research Bulletin vol. 26, no. 2, 1988.

******

BERITA-BERITA LAIN
(OTHER NEWS)

PROPOSAL FOR ESTABLISHMENT OF AN INTERNATIONAL GEOLOGICAL CORRELATION PROGRAM (IGCP) PROJECT ON THE GEOLOGY OF RARE-METALS

Project title: Geotectonic, magmatic and postmagmatic evolution of rare-metal mineralization

Proposers: Dr. Peter J. Pollard, Department of Geology, James Cook University of North Queensland, Townsville, 4811, Australia.

Professor Zhu Jinchu, Department of Geology, Nanjing University, Nanjing, People's Republic of China.

Introduction

This proposal for the establishment of a new IGCP project to bring together the presently fragmented work on the geology of rare-metals and provide a framework which will encourage expansion of activities and increased cooperation among countries, institutions and individuals.

Rare-metal deposits from a range of geological environments have many features in common and reflect a variable mix of source regions, magmatic and postmagmatic concentration mechanisms and lighological, structural and chemical controls on ore deposition. In focussing on the processes involved in their evolution, this project will foster an understanding of the interrelationships between geotectonic, magmatic and postmagmatic processes in the formation of rare-metal deposits.

This project proposes to have a significant involvement of developing countries, particularly from the southeast Asian region. As many of these countries seek to diversify their resources industries following the decline in tin and tungsten prices, this project will provide an opportunity to capitalize on existing expertise and expand into new commodities through reorientation of geological perspectives.

Scope of project

The proposed project will bring together workers from all countries with interests in rare-metal deposits and integrate experience from a range of geotectonic environments to gain a comprehensive understanding of ore formation processes. Within the context of this project the term rare-metals encompasses a variety of elements which are enriched in felsic granitic (peralkaline to peraluminous granites, syenites and pegmatites) and carbonatitic magmas including tantalum, niobium, tin, tungsten, rare-earth elements, lithium, beryllium, gallium, caesium, zirconium and hafnium.

The project will cover all aspects of the generation of rare-metal deposits from their tectonic setting; generation, evolution emplacement and crystallization of magmas; hydrothermal fluid evolution, wall-rock alteration and weathering processes. Other, specific aspects to be covered include study of the mechanisms of enrichment and the timing of formation of rare-metal minerals; the development of models for the range of deposit types; and a refinement of exploration strategies.

Objectives

The proposed project has a unique set of objectives, and does not represent a "follow on" from previous projects. The major objectives of the proposed project are to foster international cooperation and collaboration on the geology of rare-metals. Specific objectives of the project include:

1. recognition of regional and local controls on generation and emplacement of magmas.
2. characterization of rare-metal plutons - geochemistry, petrology, mineralogy, isotopes.
3. characterization of rare-metal deposits -
   controls on ore formation
   distribution and timing of rare-metal minerals
   alteration styles and their distribution
   temperature, pressure and fluid chemistry
   geochemical expression
   weathering processes in metal concentration
4. mineralogy of rare-metals -
   crystal chemistry
   physical properties
   phase assemblages
   mineral processing
5. use of the geological, geochemical and geophysical characteristics of rare-metal deposits in guiding mineral exploration.
6. publication of results through journals and conference proceedings.

The project will build upon the results of three previous IGCP projects: IGCP 26 "Metallization associated with acid magmatism", IGCP 30 "Circum-Pacific plutonism", and IGCP 220 "Correlation and resource evaluation of Sn-W granites of southeast Asia and the western Pacific", and aims to develop a body of expertise within participating countries through involvement in meetings and research projects. It is proposed that one major meeting be held during each year of the project to review progress. Since the project will consist of a number of working groups, these will be encouraged to hold specialist meetings as the opportunity arises.

Structure

The proposed project will consist of a number of working groups whose function is to investigate specific aspects of the geology of rare-metals consistent with the aims of the project. It is envisaged that five main working groups will be established:

1. Rare-metal deposits in relation to tectonic processes.
2. Petrology and geochemistry of intrusive and extrusive rocks enriched in rare-metals.
3. Mineralogy of rare-metals
4. Petrology, mineralogy and geochemistry of rare-metal deposits.
5. Exploration for rare-metal deposits.

Programme

A preliminary meeting will be held in Matsue, Japan during the final meeting of IGCP 220 in October, 1988. This meeting will discuss in detail the work programme to be undertaken during the project and appoint working group leaders to organize aspects of the programme.

YEAR 1: If the project is approved by the IGCP board in February 1989, the already high level of awareness of the project will be supplemented by advertising the first official meeting. Negotiations are currently under way to hold the first meeting in Thailand in mid-late 1989. This meeting will provide the opportunity to review rare-metal deposits in southeast Asia. Field work will concentrate on the Sn-Ta-Li pegmatites and the disseminated Sn-Ta deposits hosted by Cretaceous granites.

YEAR 2: The 1990 meeting is planned for Ottawa, Canada and will be held in association with the quadrennial IAGOD meeting. The IAGOD working group on tin and tungsten is holding a meeting in Ottawa and has agreed to cooperate with this project (see letters of support - Dr. M. Stemprok). This will allow the participants maximum opportunity to attend a range of specialist symposia relavent to this project, as well as the project meeting. The possibilities for field work include Nb-bearing carbonatites, Ta-Li-Be-Cs pegmatite, and possibly Be-REE-Y-Zr-Ta deposits in peralkaline syenites.

YEAR 3-5: Planning for years 3 to 5 is still at an early stage is expected to be discussed extensively at the preliminary meeting in Japan. The major possibilities here include meetings in China, the Soviet Union and possibly Africa or Europe. These arrangements will be subject to negotiation with national IGCP committees and national committees set up for this project.

Project proposal form

Brief outline and main objectives of the project:

This project will bring together workers from a number of diciplines to focus on the nature and evolution of rare-metal mineralization in space and time. The principal metals to be considered include tantalum, niobium, tin, tungsten, beryllium, lithium, rare-earth elements and zirconium. The principal deposit types to be investigated include those related to carbonatites and peralkaline to peraluminous granites, syenites and pegmatites. The main objectives of the project are to encourage international cooperation and exchange concerning the geotectonic environments and the magmatic and postmagmatic evolution of rare-metal mineralizing systems.

Estimated duration of project: 5 years (1989-1993).

Tentative work schedule:

1988	Preliminary meeting in Matsue, Japan (October)
1989	Meeting and fieldwork - Thailand.
1990	Meeting and fieldwork - Canada
1991-1993	Subject to discussion and negotiation, possibilities include China, USSR, Africa and Europe

Concrete results expected of the project:

(a) in theoretical sciences

Understanding of the nature of rare-metal mineralizing systems and the interrelationships between tectonic environments, magmatic processes and ore deposit formation. Documentation of the processes which concentrate rare-metals in magmatic and hydrothermal environments, and controls on the deposition of rare-metal minerals.

(b) in applied science and technology

Development of exploration concepts which take account of (a) above and utilize the important characteristics of the different types of deposits to guide exploration. Understanding of the mineralogical features of rare-metal ores with respect to the nature and distribution of rare-metal mineral phases.

The following short term results are expected:

Definition of the range of intrusive and extrusive rock types associated with rare-metal mineralization in terms of their petrology and geochemistry to facilitate resource evaluation programs. Improved understanding of the mineralogy of rare-metals will promote the development of more effective exploration and mineral processing techniques.

Present state of activities in this field:

At present there are no broadly based, international projects which cover activities in this field. Examples of current or recent projects which cover part of the proposed area include:

(a) International projects

IGCP Project 220 which terminates in 1988 has been devoted to tin and tungsten in southeast Asia and the western Pacific. Participants in this project have indicated strong support for the formulation of a new project on rare-metals.

(b) Bilateral projects

British Geological Survey granite mapping project in cooperation with agencies in Indonesia, Malaysia and Thailand (Dr. J. Cobbing, British Geological Survey).

German Geological Survey project on granites and related mineralization in cooperation with Indonesia and Malaysia (Dr. M. Schwartz, German Geological Survey).

United States Geological Survey and Saudi Arabia Directorate of Mineral Resources project on metallogenesis of the Arabian Shield.

Numerous projects between European agencies (United Kingdom, Germany, France) and African and South American countries (Brazil, Nigeria, Zaire, Zimbabwe, Ruanda, Ethiopia, Mozambique).

The establishment of the proposed project will provide the stimulus required to ensure wider cooperation and dissemination of information within and between existing bilateral projects.

Suggested locations for major field activities:

1989 Southwestern Thailand
- granite hosted Sn-Ta deposits and Sn-Ta-Li pegmatites.

1990 Canada
- Nb deposits associated with carbonatites, Ta-Nb-Li-Be pegmatitites, Be-REE-Y-Zr deposits associated with peralkaline granites and syenites.

1991-1993 Under discussion

******

IMA 1990
15TH GENERAL MEETING OF THE INTERNATIONAL MINERALOGICAL ASSOCIATION

28 June - 3 July 1990
Beijing, China
Sponsored by: Geological Society of China
Chinese Society of Mineralogy, Petrology and Geochemistry
Chinese Academy of Geological Sciences

Scientific program

The program will include symposia and plenary lectures organized by Commissions, Working Groups and the Program Committee. A joint symposium on selected interdisciplinary topics will be held jointly with the International Association of Geochemistry and Cosmochemistry. There will be oral and poster sessions organized according to the subjects of contributed papers. Complete details will be given in the Second Circular and in some mineralogical journals.

Exhibition

An exhibition of equipment, books and minerals will be arranged. Potential exhibitors should send all correspondence concerning the exhibition to the following address:

Dr. Huang Zhengzhi,
IMA 1990 Exhibition,
c/o Geological Museum of China,
Xi Si,
Beijing, China.

Publications

All contributions will be published as "extended abstracts" that will be available at the meeting and that will be considered as published articles. There will be no proceedings volume published after the meeting.

Language

The official language of the meeting will be English.

Registration fees

	Preregistration	Late Registration
Participating member	US$250	US$300
Accompanying member	180	230
Student in 1990	160	200

The fees include the rights to attend scientific events associated with the meeting, to receive meeting publications, and to take part in social events especially organized for the meeting.

In the event of a participant having to cancel registration for some reason, the fee paid will be returned 50% when the statement of cancellation is made before 30 April 1990. No reimbursement will be made after this date.

Social program

Several tours will be organized during the meeting for accompanying members such as visiting the Ming Tombs, Summer Palace, Palace Museum and Tian An Men Square. In addition, social events for all members will include a reception, a banquet and a sightseeing of the Great Wall. The other activities will be announced temporarily during the meeting.

Accommodation

Hotel room rates cannot be quoted firmly until the Second Circular but will range between $30 and $100 per night, not including meals.

Important dates

Second Circular:	February, 1989
Abstract deadline:	31 December, 1989
Preregistration deadline:	28 February, 1990
Third Circular:	April, 1990

Address for correspondence

IMA 1990,
Dr. Wang Zejiu,
Chinese Academy of Geological Sciences,
Baiwanzhuang Road 26, Fu Wai,
Beijing 100037, China.

Field trips

Ten field trips are offered to view some typical minerals, rocks and mineral deposits in China, which are all planned to be arranged as both pre-meeting and post-meeting:

1. Archaean metamorphic rocks, gold deposit and granite in Shandong Province.
2. Rare earth elements and iron deposits, skarn minerals and gold deposit in Bayan Obo, Inner Mongolia.
3. Metamorphic rocks of Anshan Group, boron deposit, magnesite deposit and kimberlite in Liaoning Province.
4. Molybdenum and gold deposits in Shanxi Province.
5. Tin - polymetallic mine in Dachang and karst geology in Guilin, Guangxi Zhuang autonomous region.
6. Tungsten, tin, lead, zinc and rare metals deposits in Hunan Province and karst geology in Guilin.
7. Volcanic vent, alkaline volcanic complex, alkaline granite and clay mine in Jiangsu Province.
8. Rare metals pegmatite in Xinjiang Uighur autonomous region.
9. Volcanic rocks, ultrabasic rocks, copper and Cu-Ni mines in Gansu Province.
10. Miarolitic granite, pyrophyllite mine, kinetic metamorphic zone and mylonite zone in Fujian Province.

Notes: (1) The costs for field trips are estimated at the present time approximately to be US$65-85 per day. The Second Circular will contain more accurate information on costs.

(2) The field trip for accompanying person is extra, price US$20 per day.

(3) The deadline for paying field trip fees is 28 February 1990. In the event of a participant having to cancel excursion for some reason, the excursion fee paid will be returned 80% when the statement of cancellation is made before 30 April 1990. No reimbursement will be made after this date.

******

THE FOURTEENTH CONGRESS OF THE COUNCIL OF MINING AND METALLURGICAL INSTITUTIONS (CMMI)
MINERALS, MATERIALS AND INDUSTRY

Edinburgh, Scotland
2-6 July, 1990

Congress theme and call for papers

'Minerals, materials and industry' is the theme of the Congress. Mineral resources, including oil and fossil fuels, are fundamental to the needs of society and, at the technical sessions, attention will be focused on the expanding range of materials that are required by contemporary industry. Four particular areas

(1) Identification of industry's needs
(2) Exploration and assessment of resources
(3) Production and recovery of minerals
(4) Preparation and marketing of mineral products

will be examined in a technological context and, within those broad areas, such traditional associated factors as safety, legislation and fiscal philosophy, operations management and energy employment will be reviewed.

The Organizing Committee invites the submission of abstracts (200-400 words) of papers for its consideration; selected authors will then be required to submit the manuscripts of their papers. Those papers which are accepted for presentation at the technical sessions will be published in volume form for distribution to Congress registrants.

Timetable

July, 1988	Distribution of First Circular
May, 1989	Submission of abstracts of intended papers
July, 1989	Distribution of Second Circular
October, 1989	Submission of completed manuscripts
January, 1990	Distribution of Final Circular/Registration Form
May-June, 1990	Distribution of Congress publications
July, 1990	Fourteenth Congress and its associated events

Associated events

In addition to social functions and sightseeing visits in Edinburgh, technical visits to United Kingdom and European mining and metallurgical operations will be arranged. Full details of these Congress-associated events will be given in future circulars.

General

Enquiries in connection with the Congress should be addressed to:

The Secretary, The Institution of Mining and Metallurgy,
44 Portland Place, London W1N 4BR, England.

******

KURSUS-KURSUS LATIHAN & BENGKEL-BENGKEL (TRAINING COURSES & WORKSHOPS)

1989

September 1989 - November 1989
DRILLING OF GEOTHERMAL WELLS (Mexicali, Mexico). Annual 12-week seminar organized for Latin Americans by the Latin American Organization for Energy with financial assistance from Unesco. Language: Spanish. For Information: Organizacion Latino-americana de Energia (OLADE), P.O. Box 119, Quito, Ecuador.

September 1989 - November 1989
GEOTHERMAL RESERVOIR ENGINEERING (Mexicali, Mexico). Annual 9-week course organized for Latin Americans by the Latin American Organization for Energy with financial assistance from Unesco. Language: Spanish. For Information: Organizacion Latino-americana de Energia (OLADE), P.O. Box 119, Quito, Ecuador.

September 1989 - November 1989
GEOTHERMAL ENERGY (Kyushu, Japan). Annual short course organized by the Government of Japan and sponsored by Unesco. Language: English. For Information: Japan International Cooperation Agency (2nd Training Division, Training Affairs Department), P.O. Box 216, Shinjuku Mitsui Building, 2 - 1, Nishi-shinjuku, Shinkuku-ku, Tokyo 160, Japan.

September 1989 - July 1990
PETROLEUM EXPLORATION GEOLOGY (Headington, Oxford, U.K.). An annual diploma course designed by Oxford Polytechnic to prepare post-graduate geologists for the duties of geologists in oil exploration teams. For Information: M. Hoggins, Department of Geology and Physical Sciences, Oxford Polytechnic, Headington, Oxford OX3 OBP, U.K.

September 1989 - August/November 1990
AEROSPACE SURVEYS FOR: 1) GEOCHEMICAL SURVEY; 2) WATER RESOURCES SURVEY; 3) APPLIED GEOMORPHOLOGY AND ENGINEERING GEOLOGY (Enschede, The Netherlands). Annual post-graduate courses, organized by the International Institute for Aerospace Survey and Earth Sciences (ITC), with Unesco. Language: English. For Information: ITC Student Registration Office, P.O. Box 6, 7500 AA Enschede, The Netherlands.

September 1989 - August 1990
MINERAL EXPLORATION AND EXPLORATION GEOPHYSICS (Delft, The Netherlands). Annual diploma courses organized by the International Institute for Aerospace Survey and Earth Sciences with Unesco. Language: English. For Information: ITC Student Registration Office (ME), P.O. Box 6, 7500 AA Enschede, The Netherlands.

October 1989 - August 1989
HYDROLOGY AND HYDROGEOLOGY (Belgium). Language: French. For Information: Professeur Dr. ir. A. Monjoie, Directeur des Laboratoires de Géologie de l'Ingénieur, d'Hydrogéologie et de Prospection géophysique - Batiment B19, Faculté des Sciences Appliquées, Université de Liége - SART TILMAN, B-4000 Liege, Belgium.

October 1989 - November 1989
TECTONICS, SEISMOLOGY AND SEISMIC RISK ASSESSMENTS (Potsdam, D.D.R.). One-month training course organized annually by East German Academy of Sciences in collaboration with Unesco. Language: English. For Information: Prof. Dr. H. Kautzleben, Director, Central Earth's Physics Institute, Academy of Sciences of the German Democratic Republic, Telegraphenberg, DDR-500 Postdam, German Democratic Republic.

October 1989 - July 1990
ENGINEERING HYDROLOGY (Galway, Ireland). Annual diploma and post-graduate courses organized by the Dept. of Engineering Hydrology, University College, Galway, Ireland. Sponsored by Unesco-IHP and the World Meteorological Organization. For Information: Prof. J-E. Nash, Department of Engineering Hydrology, University College Galway, Galway, Ireland.

October 1989 - September 1990
WATER AND WASTE ENGINEERING FOR DEVELOPING COUNTRIES (Loughborough, England, U.K.). Twelve-month MSc. programme organized annually for engineers and scientists from developing countries by WEDC. For Information: John Pickford, WEDC, University of Technology, Loughborough, Leics, LE11 3TU, U.K.

October 1989 - September 1990
HYDRAULIC ENGINEERING AND HYDROLOGY (Delft, The Netherlands). Diploma courses organized annually by the International Institute for Hydraulic and Environmental Engineering and sponsored by Unesco for professionals from developing countries. Language: English. For Information: International Institute for Hydraulic and Environmental Engineering (IHE), Oude Delft 95, P.O. Box 3015, 2601 DA Delft, The Netherlands.

October 1989 - September 1991
FUNDAMENTAL AND APPLIED QUATERNARY GEOLOGY (Brussels, Belgium). Annually organized training course leading to a Master's degree in Quaternary Geology by the Vrije Universiteit Brussel (IFAQ) and sponsored by Unesco. Language: English. For Information: Prof. Dr. R. Paepe, Director of IFAQ, Kwartairgeologie, Vrije Universiteit Brussel, Pleinlaan 2, B-1050, Brussels, Belgium.

November 1989 - December 1989
REMOTE SENSING APPLICATIONS FOR EARTH SCIENCES (Enschede, The Netherlands). Annual short course organized by International Institute for Aerospace Survey and Earth Sciences (ITC), with Unesco. Language: English. For Information: ITC Student Registration Office, P.O. Box 6, 7500 AA Enschede, The Netherlands.

November 1989 - June 1990
GEOTHERMICS (Pisa, Italy). Certificate course organized annually by the Istituto Internazionale per le Ricerche Geotermiche and sponsored by Unesco, UNDP and Italy. Language: English. For Information: Istituto Internazionale per le Ricerche Geotermiche, I Via Buongusto, 56100 Pisa, Italy.

November 1989 - October 1990
ENGINEERING GEOLOGY (Delft, The Netherlands). Annual post-graduate course organized by the International Institute for Aerospace Survey and Earth Sciences (ITC). Language: English. For Information: ITC Student Registration Office, P.O. Box 6, 7500 AA Enschede, The Netherlands.

1990

January 1990 - July 1990
GENERAL AND APPLIED HYDROLOGY (Madrid, Spain). An annual, 6-month course sponsored by Unesco. Language: Spanish. For Information: Centro de Estudios y Experimentacion de Obras Publicas y Urbanismo, Alfonso XII, Num. 3, Madrid 7, Spain.

January 1990 - July 1990
GROUNDWATER HYDROLOGY (Barcelona, Spain). An annual 6-month, post-graduate course sponsored by Unesco. Language: Spanish. For Information: Curso Internacional de Hidrologia Subterranea, Calle Beethoven, 15, 3°, 08021 Barcelona, Spain.

February 1990
METALLOGENY (Quito, Ecuador). Annual 3-week training course for Latin Americans organized by Central University of Quito, the Autonomous University of Madrid (Spain), and Unesco. Language: Spanish. For Information: Director, Curso Internacional de Metalogenia, Escuela de Geologia, Minas y Petroleos, Division de Post-grado, Universidad Central, Apartado Postal 8779, Quito, Ecuador.

February 1990 - March 1990
GEOCHEMICAL PROSPECTING TECHNIQUES (Tervuren, Belgium). Annual course sponsored by the Royal Museum of Central Africa and UNDP. Language: French. For Information: Musée royal de l'Afrique centrale, Steenveg op Leuven, 13, B-1980 Tervuren, Belgium.

February 1990 - April 1990
INTRODUCTION TO DIGITAL IMAGE PROCESSING (Enschede, The Netherlands). Annual course organized by the International Institute for Aerial Survey and Earth Sciences, Enschede, The Netherlands, with Unesco. Language: English. For Information: Student Registration Office, ITC, P.O. Box 6, 7500 AA Enschede, The Netherlands.

February 1990 - June 1990
MINERAL EXPLORATION (Leoben, Austria). Diploma course organized annually by the University of Mining and Metallurgy in Leoben and sponsored by Unesco. Language: English. For Information: University for Mining and Metallurgy, Post-graduate course on mineral exploration, Montanuniversität, Leoben, A-8700, Austria.

February 1990 - July 1990
HYDROLOGY (Budapest, Hungary). An annual six-month, post-graduate course organized by the Research Centre for Water Resources Development (Budapest) and sponsored by Unesco. Language: English. For Information: VITUKI International Post-Graduate Course on Hydrology, H-1453 Budapest, Pf. 227 Hungary.

February 1990 - August 1990
HYDROLOGY (Padova, Italy). An annual, 6-month, postgraduate course sponsored by Unesco. Language: English. For Information: Professor A. Ghetti, Centro Internazionale di Idrologia "Dino Tonini," via sette Chiese, 35043 Monselice, Italy.

October 1990 - September 1992
GEOLOGICAL EXPLORATION METHODS (Nottingham, U.K.). Two-year MSc course starting every other year with emphasis on applied methodology, data acquisition and interpretations). For Information: Dr. M.A. Lovell, Department of Geology, University of Nottingham NG7 2RD, U.K.

December 1990 - January 1991
METHODS AND TECHNIQUES IN EXPLORATION GEOPHYSICS (Hyderabad, India). Diploma course organized every second year by the National Geophysical Research Institute of the Council of Scientific and Industrial Research, Hyderabad, India, and sponsored by Unesco. Language: English. For Information: The Director, International Training Course on Methods and Techniques in Geophysical Exploration, National Geophysical Research Institute, Hyderabad, 500 007 (A.P.) India.

KALENDAR (CALENDAR)

1989

November 6-9, 1989
GEOLOGICAL SOCIETY OF AMERICA (Annual Meeting), St. Louis, Missouri, U.S.A. (Meetings Department, GSA, P.O. Box 9140, Boulder, CO 80301, U.S.A.).

November 13-15, 1989
MINERAL EXPLORATION PROGRAMME '89 (Symposium), Madrid, Spain. (MEP '89, 4 Brandon Road, London N7 9TR, England, U.K.).

November 14-16, 1989
WORLD WATER (Conference), Wembley, London, U.K. (World Water '89, Conference, Office, Institution of Civil Engineers, 1 - 7 Great George Street, Westminster, London SW1P 3AA, U.K.).

November - December 1989
PETROLEUM GEOLOGY SEMINAR '89, Kuala Lumpur, Malaysia. (c/o Organizing Chairman, Geological Society of Malaysia, Geology Department, University of Malaya, 59100 Kuala Lumpur, Malaysia).

December 4-8, 1989
AMERICAN GEOPHYSICAL UNION (Fall Meeting), San Francisco, Calif., U.S.A. (AGU Meetings, 2000 Florida Avenue NW, Washington, DC 20009, U.S.A.).

1990

January, 1990
ANNUAL CONFERENCE '90, GEOLOGICAL SOCIETY MALAYSIA (Organising Chairman, Geological Society of Malaysia, c/o Geology Dept., University of Malaya, 59100 Kuala Lumpur, Malaysia).

January 15-27, 1990
OMAN OPHIOLITE, STRUCTURE, PETROLOGY, STRATIGRAPHY (International Symposium), Muscat, Sultanate of Oman. (Secretary, Hilal Azry, Ministry of Petroleum and Minerals, P.O. Box 551, Muscat, Oman).

February 5-9, 1990
BRACHIOPODS (2nd International Congress), Dunedin, New Zealand. (J.D. Campbell, Geology Department, University of Otago, P.O. Box 56, Dunedin, New Zealand).

April 18-20, 1990
OROGENESIS IN ACTION: Tectonics and Processes in the West Equatorial Pacific Margin (Meeting), London, U.K. (R. Hall, Department of Geological Sciences, University College London, Gower Street, London WC1E 6BT, U.K.).

May 6-12, 1990
PACIFIC RIM 90 (International Congress), Gold Coast, Queensland, Australia. (The AusIMM-Pacrim 90, P.O. Box 731, Toowong Qld 4066, Australia).

May 14-18, 1990
WORLD MINING (14th Congress), Beijing, P.R. China. (China Organizing Committee, 14th World Mining Congress, 54 Sanlihe Road, Beijing, People's Republic of China).

May 29 - June, 1990
EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS (52nd Annual Meeting), Copenhagen, Denmark. (J. Tychsen, Miljøministeriet, Amaliegade 13, DK-1265, Copenhagen K, Denmark).

June 1990
GEOCHEMISTRY OF WEATHERING (2nd International Symposium), Aix-en-Provence, France. Sponsored by IAGC. (B. Hitchon, Alberta Research Council, Box 8330, Station F. Edmonton, Alberta, Canada T6H 5X2).

June 3-6, 1990
AAPG/SEPM (Annual Meeting), San Francisco, California, U.S.A. (Convention Department, AAPG, Box 979, Tulsa, OK 74101, U.S.A.).

June 25-30, 1990
GEOSCIENCE INFORMATION (4th International Conference), Ottawa, Canada. (A. Bourgeouis, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8).

June 28 - July 3, 1990
INTERNATIONAL MINERALOGICAL ASSOCIATION (15th General Assembly), Beijing, P.R. China. (Prof. Huang Yunhui, c/o Institute of Mineral Deposits, Chinese Academy of Geological Sciences, Baiwan-zhuang Road 26, Fuchengmenwai, Beijing, P.R. China).

July, 1990
CAMBRIAN SYSTEM (3rd International Symposium), Novosibirsk, U.S.S.R. (Dr. J.W. Cowie, Department of Geology, University of Bristol, Queen's Building, University Walk, Bristol BS8 1RJ, England).

July 19-28, 1990
INTERNATIONAL UNION OF CRYSTALLOGRAPHY (15th Congress), Bordeaux, France. (Stefan S. Hafner, University of Marburg, 3550 Marburg, F.R. Germany).

July 29 - August 3, 1990
CIRCUM-PACIFIC ENERGY AND MINERALS RESOURCES (Conference), Honolulu, Hawaii. (Mary Stewart, Circum-Pacific Council on Energy and Mineral Resources, 5100 Westheimer Road, Houston, TX 77056, U.S.A.).

August, 1990
IGES (13th International Geochemical Exploration Symposium), Rio de Janeiro, Brazil. Sponsored by AEG. (Sherman Marsh, USGS, Federal Center MS 973, Denver, CO 80309-0250, U.S.A.).

August 6-10, 1990
IAEG (6th International Congress), Amsterdam, The Netherlands. Language: English and French. (Dr. L. Primel, L.C.P.C., 58 Boulevard Lefebvre, 75732 Paris Cedex 15, France).

August 12-18, 1990
INTERNATIONAL ASSOCIATION ON THE GENESIS OF ORE DEPOSITS (8th Symposium), Ottawa, Canada. (Dr. R.W. Boyle, 601 Booth Street, Ottawa, Canada K1A 0E8).

August 15-17, 1990
ARCTIC GEOLOGY AND PETROLEUM POTENTIAL (Meeting), Troms, Norway. (Norwegian Petroleum Society, Box 1897-Vika, 0124 Oslo 1, Norway).

August 26 - September 1, 1990
SEDIMENTOLOGY (13th International IAS Congress), Nottingham, U.K. (I.N. McCave, Department of Earth Sciences, University of Cambridge, Dowing Street, Cambridge CB2 3EQ, U.K.).

August 26 - September 8, 1990
LATIN AMERICAN CONODONT SYMPOSIUM, La Paz, Bolivia and San Juan, Argentina. (Mario Hunicken, Academia Nacional de Ciencias, Casilla Correo 36, 5000 Cordoba, Argentina).

August 27 - September 1, 1990
WATER RESOURCES IN MOUNTAINOUS REGIONS (International Symposium and IAH 22nd Congress), Lausanne, Switzerland. (Dr. A. Parriaux, Laboratory of Geology EPFL (GEOLEP), CH-1015 Lausanne, Switzerland).

September 1990
GEOCHEMICAL EXPLORATION (13th International Symposium), Prague, Czechoslovakia. Joint IAGC and AEG meeting. (B. Hitchon, Alberta Research Council, P.O. 8330, Station F. Edmonton, Alberta, Canada T6H 5X2).

September - October 1990
IPA GRAPTOLITE WORKING GROUP (4th International Conference), Nanjing, P.R. China. (Chen Xu, Nanjing Institute of Geology and Palaeontology, Academia Sinica, Chi-Ming-Sau, Nanjing, P.R. China).

September 3-8, 1990
VOLCANOLOGY (International Congress), Mainz, F.R.G. (G. Brey, Max Planck Institut für Chemie, Abtl. Kosmochemie, Saarstrasse 23, 6500 Mainz, Federal Republic of Germany).

September 4-7, 1990
DEEP SEISMIC REFLECTION PROFILING OF THE CONTINENTAL LITHOSPHERE (4th International Symposium), Bayreuth, F.R.G. (C. Reichert, DEKORP, NLfB, Postfach 510153, D-3000 Hannover 51, F.R. Germany).

September 17-21, 1990
ARCHAEN (Symposium), Perth, Australia. (D.I. Groves, Department of Geology, University of Western Australia, Nedlands, Western Australia 6009).

September 23-27, 1990
SOCIETY OF EXPLORATION GEOPHYSICISTS (Annual Meeting), San Francisco, U.S.A. (Convention Assistant, SEG, P.O. Box 3098, Tulsa, OK 74101, U.S.A).

September 24-29, 1990
GEOCHRONOLOGY, COSMOCHRONOLOGY AND ISOTOPE GEOLOGY (7th International Conference), Canberra, Australia. (Organizing Committee, ICOG 7, Research School of Earth Sciences, Australian National University, GPO Box 4, Canberra, ACT 2601, Australia).

September 28 - October 2, 1990
BENTHIC FORAMINIFERA (4th International Symposium), Sendai, Japan. (Dr. Yokichi Takayanagi, Institute of Geology and Paleontology, Tohoku University, Sendai, 980 Japan).

October 29 - November 1, 1990
GEOLOGICAL SOCIETY OF AMERICA (Annual Meeting), Dallas, Texas, U.S.A. (GSA, P.O. 9140 Boulder, CO 80301, U.S.A.).

November 1990
MEDITERRANEAN NEOGENE (9th International Congress), Barcelona, Spain. Cosponsored by IUGS. (Prof. Jordi Martinell, Fac. de Geologia, Univ. de Barcelona, Zona Universitaria de Pedralbes, 08028 Barcelona, Spain).

1991

March, 1991
ECONOMIC EVALUATION OF MINERAL RESOURCES (International Conference), Kosice, Czechoslovakia. Languages: Russian and English. (Intergeoekonomika 1991 CSSR, GEOFOND Bratislava-branch Kosice, Eng. St. Richter, Garbanova 1, 040 11 Kosice, Czechoslovakia).

April 7-10, 1991
AAPG/SEPM (Annual Meeting), Dallas, Texas, U.S.A. (Convention Department, AAPG, Box 979, Tulsa, OK 74101, U.S.A.).

April 26 - May 1, 1991
ASSOCIATION OF EXPLORATION GEOCHEMISTS (15th International Geochemical Exploration Symposium), Reno, U.S.A. (Richard B. Jones, Nevada Bureau of Mines and Geology, University of Nevada, Reno, Nevada 89557-0088, U.S.A.

May 27-29, 1991
GAC/MAC (Joint Annual Meeting), Toronto, Canada. (J. Fawcett, Department of Geology, University of Toronto, Toronto, Ontario, Canada M5S 1A1).

August 2-9, 1991
QUATERNARY RESEARCH (13th International Congress), Beijing, P.R. China. (Secretariat, 13th INQUA Congress, Chinese Academy of Sciences, 52 Sanlihe, Beijing 100864, P.R. China).

GEOLOGICAL SOCIETY OF MALAYSIA PUBLICATIONS

Back Issues Available

Bulletin 1 (1968). 79p. 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: M$3.00 (US$1.50).

Bulletin 2 (1968). 152 p. Bibliography and Index of the Geology of West Malaysia and Singapore by D.J. Gobbett. Price: M$10.00 (US$5.00) — Softcover; M$15.00 (US$7.50).

Bulletin 3 (1970). 146 p. Papers in Geomorphology and Stratigraphy (with Bibliography supplement). Edited by P.H. Stauffer. Price: M$10.00 (US$5.00).

Bulletin 4 (1971). 100 p. Papers in Petrology, Structure and Economic Geology. Edited by P.H. Stauffer. Price: M$10.00 (US$5.00).

Bulletin 5 (1973). 70 p. The Search for Tungsten Deposits by K.F.G. Hosking. Price: M$10.00 (US$5.00).

Bulletin 6 (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: M$22.00 (US$11.00) — hardcover only.

Bulletin 7 (1974). 138 p. A collection of papers on geology. Edited by B.K. Tan. Price: M$12.00 (US$6.00).

Bulletin 8 (1977). 158 p. A collection of papers on geology. Edited by T.T. Khoo. Price: M$12.00 (US$6.00).

Bulletin 9 (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. Proce: M$25.00 (US$12.00).

Bulletin 10 (1978). 95 p. A collection of papers on the geology of Southeast Asia. Edited by C.H. Yeap. Price: M$10.00 (US$5.00).

Bulletin 11 (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: M$50.00 (US$22.00).

Bulletin 12 (1980). 86 p. A collection of papers on geology. Edited by G.H. Teh. Price: M$20.00 (US$9.50).

Bulletin 13 (1980). 111 p. A collection of papers on geology of Malaysia and Thailand. Edited by G.H. Teh. Price: M$20.00 (US$9.50).

Bulletin 14 (1981). 151 p. A collection of papers on geology of Southeast Asia. Edited by G.H. Teh. Price: M$30.00 (US$14.00).

Bulletin 15 (1982). 151 p. A collection of papers on geology. Edited by G.H. Teh. Price: M$30.00 (US$14.00).

Bulletin 16 (1983). 239 p. A collection of papers on the geology. Edited by G.H. Teh. Price: M$30.00 (US$14.00).

Bulletin 17 (1984). 371 p. A collection of papers on the geology. Edited by G.H. Teh. Price: M$35.00 (US$15.00).

Bulletin 18 (1985). 209 p. Special Issue on Petroleum Geology. Edited by G.H. Teh & S. Paramananthan. Price: M$30.00 (US$14.00).

Bulletins 19 & 20 (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 — M$50.00 (US$21.90), Non-members — M$125.00 (US$53.20).

Bulletin 21 (1987). 271 p. Special Issue on Petroleum Geology Vol. II. Edited by G.H. Teh. Price: M$40.00 (US$17.00).

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: M$5.00 (US$2.50).

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: M$6.00 (US$3.00).

Proceedings of the Workshop on Stratigraphic Correlation of Thailand and Malaysia Vol. 1. (1983). Technical Papers. 383 p. Price: M$25.00 (US$12.40) (Members: M$12.00/US$6.50).

WARTA GEOLOGI (Newsletter of the Geological Society of Malaysia). Price: M$5.00 (US$3.20) per bimonthly issue from July 1966.

PACKAGE DEAL 1: Bulletin nos. 1–8 + Field Guide 1

Student Members	: M$10.00 (US$5.60)
Members	: M$20.00 (US$10.00)
Non-Members	: M$40.00 (US$19.00)

PACKAGE DEAL 2: Bulletin nos. 9–12

Student Members	: M$30.00 (US$14.50)
Members	: M$40.00 (US$19.00)
Non-Members	: M$60.00 (US$28.00)

PACKAGE DEAL 3: Bulletin nos. 13–17

Student Members	: M$60.00 (US$28.00)
Members	: M$80.00 (US$37.00)
Non-Members	: M$100.00 (US$45.90)

PACKAGE DEAL 4: Bulletin nos. 1–17 + Field Guide 1

Student Members	: M$100.00 (US$45.90)
Members	: M$140.00 (US$64.00)
Non-Members	: M$200.00 (US$90.60)

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 (especially prices in US dollars).

Individual copies of Bulletin nos. 1–10 and Warta Geologi are available to members at half price.

All prices quoted are inclusive of postage and packing by surface mail; for airmail, please write in for enquiry. Allow 8–10 weeks for delivery.

Cheques, money orders or bank drafts must accompany all orders.

Orders should be address to: The Hon. Assistant Secretary
Geological Society of Malaysia
c/o Dept of Geology
University of Malaya
59100 Kuala Lumpur
MALAYSIA

WARTA GEOLOGI – NEWSLETTER OF THE GEOLOGICAL SOCIETY OF MALAYSIA

ADVERTISING SPACE ORDER FORM

Format of Warta Geologi: 20 cm x 28 cm

Rates:	Black & White	Colour
Inside full page per issue	M$300	M$600
Inside half page per issue	M$200	M$500
Inside full page per 6 issues	M$1600	M$3400
Inside half page for 6 issues	M$1000	M$2800

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

Editor,
Geological Society of Malaysia,
c/o Dept. of Geology,
University of Malaya,
59100 Kuala Lumpur, Malaysia.

For further information, please ring 03-7577036

The Editor,
Geological Society of Malaysia,
c/o Dept. of Geology,
University of Malaya,
59100 Kuala Lumpur.

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

	Black & White		Colour	
Inside full page	one issue	❑	one issue	❑
	six issues	❑	six issues	❑
Inside half page	one issue	❑	one issue	❑
	six issues	❑	six issues	❑

Artwork/Positive film or slide* is/is not enclosed.

Company .....

Address .....

.....

Enclosed cheque/money order/bank draft ..... for M$ .....

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

Designation ..... Signature .....

* Please delete as appropriate

GEOLOGICAL SOCIETY OF MALAYSIA PUBLICATIONS

General Information

The Society publishes the *Buletin Persatuan Geologi Malaysia* (Bulletin Geological Society of Malaysia) and the *Warta Geologi* (Newsletter of the Geological Society of Malaysia) which is issued bimonthly.

Papers of general interest or on the geology of the Southeast Asian region (South China, Burma, Thailand, Indochina, Malaysia, Singapore, Indonesia, Brunei and the Philippines) and also marine areas within the region are welcome for publication in the *Bulletin*. Short notes, progress reports and general items of information are best submitted to the *Warta Geologi*.

Papers should be as concise as possible. However, there is no fixed limit as to the length and number of illustrations. Therefore, papers of monograph length are also welcome. Normally, the whole paper should not exceed 30 printed pages and it is advisable that authors of papers longer than 30 printed pages should obtain the consent of the Editor before submission of the papers.

The final decision of any paper submitted for publication rests with the Editor who is aided by an Editorial Advisory Board. The Editor may send any paper submitted for review by one or more reviewers. 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 the Editor for re-consideration if they do not agree with the reasons for rejection. The Editor will consider the appeal together with the 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 to and accepted by the Society.

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

Twenty-five reprints of each paper are free-of-charge. Contributors should notify the Editor of extra reprints (which are of non-profit costs) required.

All papers should be submitted to the Editor, Geological Society of Malaysia, c/o Department of Geology, University of Malaya, 59100 Kuala Lumpur, MALAYSIA

Script Requirements

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

Two copies of the text and illustrations must be submitted. The scripts must be typewritten double-spaced on papers not exceeding 21 × 33 cm. 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.

Original maps and illustrations or as glossy prints should ideally be submitted with sufficiently bold and large lettering to permit reduction to 15 × 22 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 × 12 cm and preferably larger. Use of metric system of measurements (ISU) is strongly urged wherever possible.

Reference cited in the text should be listed at the end of the paper and arranged in alphabetical order and typed double-spaced. The references should be quoted in the following manner:

Suntharalingam, T., 1968. Upper Palaeozoic stratigraphy of the area west of Kampar, Perak. *Geol. Soc. Malaysia Bull.*, 1, 1–15.

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.

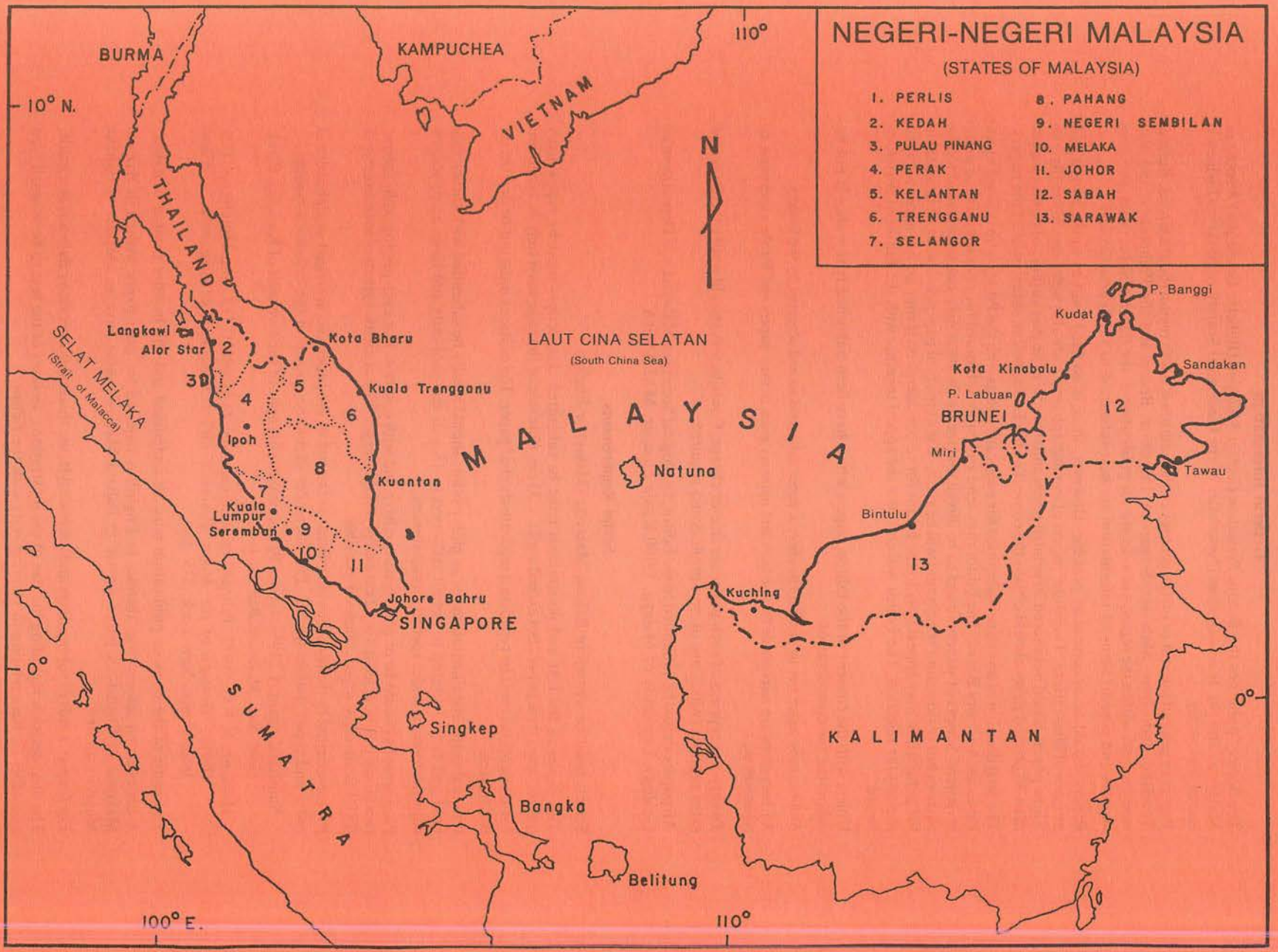
The name of the book or publication must be underlined and will be later printed in italics.

A concise and informative abstract in English is required for each paper written in Bahasa Malaysia or English. A paper written in Bahasa Malaysia must have an abstract in Bahasa Malaysia as well.

For format, kinds of subheadings and general style, use this and the previous *Bulletins* as a guide.

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.

If authors have trouble over the script requirements, please write in to the Editor.


NEGERI-NEGERI MALAYSIA
(STATES OF MALAYSIA)
1. PERLIS
2. KEDAH
3. PULAU PINANG
4. PERAK
5. KELANTAN
6. TRENGGANU
7. SELANGOR
8. PAHANG
9. NEGERI SEMBILAN
10. MELAKA
11. JOHOR
12. SABAH
13. SARAWAK
BURMA
KAMPUCHEA
VIETNAM
THAILAND
10° N.
110°
N
LAUT CINA SELATAN
(South China Sea)
MALAYSIA
SELAT MELAKA
(Strait of Malacca)
Langkawi
Alor Star
Kota Bharu
Kuala Trengganu
Ipoh
Kuantan
Kuala Lumpur
Seremban
Johore Bahru
SINGAPORE
Natuna
P. Banggi
Kudat
Kota Kinabalu
Sandakan
P. Labuan
BRUNEI
Miri
Tawau
Bintulu
Kuching
KALIMANTAN
SUMATRA
Singkep
Bangka
Belitung
0°
100° E.
110°