

PERSATUAN GEOLOGI MALAYSIA

WARTA GEOLOGI**NEWSLETTER OF THE GEOLOGICAL SOCIETY OF MALAYSIA**

Jil. 15, No. 6 (Vol. 15, No. 6)

Nov-Dis 1989

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DIKELUARKAN DWIBULANAN
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*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.

AMOUNT OF DISPLACEMENT ALONG THE BOK BAK FAULT: ESTIMATION BY USING THE LITHOFACIES EQUIVALENCE

Ibrahim Abdullah, Ahmad Jantan, Basir Jasin, Abd. Rahim Samsudin and Uyop Said,
Jabatan Geologi, Universiti Kebangsaan Malaysia, Bangi, Selangor.

Abstract

The amount of displacement along the Bok Bak Fault has previously been estimated about 55 km based on the displacement of the western boundaries of the Semanggol formation rocks, north and south of the fault zone. This estimate did not take into account two important factors, namely the Semanggol rocks south of the fault zone have suffered some degree of clockwise rotation prior to the left lateral displacement, and the lithofacies relationship of the rocks of this formation north and south of the fault zone. By taking both factors into account, the more reliable total displacement along the fault is estimated to be only about 25 km left laterally.

Abstrak

Anjakan total di sepanjang Sesar Bok Bak pernah dianggarkan sejauh 55 km berdasarkan kepada sempadan barat batuan formasi Semanggol di bahagian utara dan selatan sesar tersebut. Anggaran ini tidak mengambil kira dua faktor penting, iaitu batuan formasi Semanggol di selatan zon sesar telah mengalami putaran mengikut jam sebelum tersesar ke kiri, dan taburan litofasies batuan formasi ini di utara dan selatan sesar. Dengan mengambil kira kedua-dua faktor di atas, anjakan total ke kiri yang lebih menasabah dianggarkan hanya sekitar 25 km.

Introduction

The Bok Bak Fault, one of the very well-known strike-slip faults in the Malay Peninsula, was first described by Burton (1965). The fault or more appropriately referred to as a fault zone, displaced the Triassic sediments of the Semanggol formation as well as the granite. Since then, the fault has been popularly mentioned and further described by many workers when discussing the fault systems of the Malay Peninsula in general or strike-slip faults of the region in particular (for examples see Tjia, 1972 & 1978). Based on the mapping by using LANDSAT imagery, Raj (1982) proposed that the Bok Bak fault zone could be extended southeastwards to central Perak and southwest Kelantan. Although the trace of the fault zone in central Kedah is rather straight, the southeastwards trace appears on a regional scale to be arcuate. Recently, the extension of this fault was recognised in North Perak (Abd. Majid Sahat, 1987). The sense of displacement on the fault planes is shown by the shift of the western boundary of the Semanggol formation north and south of the fault. Based on that, the amount of left-lateral displacement in Baling area was estimated to be approximately 55 km. However, Raj (1982) has shown that by undoing the fault along the proposed extended fault zone by 20 km right laterally,

the continuity of the main range granite in southwest Kelantan and the Lower Palaeozoic strata in central Perak can be restored. Unfortunately, by doing so, the lithologies across the fault line in central Kedah and northwest Perak are still mismatched. To explain this discontinuity, the idea of block faulting that pre-dated the left lateral movement has been used. In this paper, we will discuss the other and more proper way of estimating the total displacement along the lateral fault in general and along the Bok Bak fault in central Kedah in particular, based on the results of lithofacies and structural studies of the Semanggol formation in northwest Malay Peninsula.

Present estimate

1. Lithofacies consideration

Detailed study of the rocks of the Semanggol formation in Gunung Semanggol, Kulim-Baling and Padang Terap areas separately and together indicate that there is a rock facies change laterally. The lithofacies boundaries of each area are traceable on the map (Ahmad Jantan *et al.*, in prep.). The general lithofacies map is shown in Figure 1. Furthermore, the general lithofacies of the three areas can also be correlated laterally by undoing the fault. However, by pulling back the Padang Terap area right-laterally by 55 km, the lithofacies boundaries of the north and south of the fault do not match. This gives the implication that the previously estimated total displacement need to be reevaluated.

2. Structural consideration

A further study on the structure of the Semanggol formation in three areas (Gunung Semanggol, Kulim-Baling and Padang Terap) clearly shows that the general structural trend in the middle area (Kulim-Baling) is very different from that of the other two areas (Figure 2). The trend in the northern and southern areas is almost in a north-south direction, whereas the trend in the middle area is northeast-southwest. This middle area is bounded by the lateral faults on the northeastern and southwestern sides, as shown in many geological maps of this area. On the northeastern side, it is bounded by the Bok Bak fault. The change of the structural trend in this area is considered to be the result of a clockwise rotation. The rotation is facilitated by the existence of the two fault zones. These fault zones are believed to have been formed before lateral movement took place, as suggested by Burton (1965).

There are two possible ways by which the modification of the structural trend of the middle area involving the Bok Bak fault can be brought about. The first possibility is by invoking the activity of a right-lateral movement, later followed by a more extensive left-lateral movement along the previous fault plane. The second possibility is by considering the operation of a clockwise rotation due to the granite intrusion, and this was followed by a left-lateral movement along the Bok-Bak fault. The merit of both mechanisms are briefly discussed below.

For the first mechanism (Fig. 3B), we do not have any field evidence to support the supposed right-lateral movement. Furthermore, if this earlier movement produced a clockwise rotation as well as the drag (Fig. 3B-1), there is no reason why the more extensive left-lateral movement

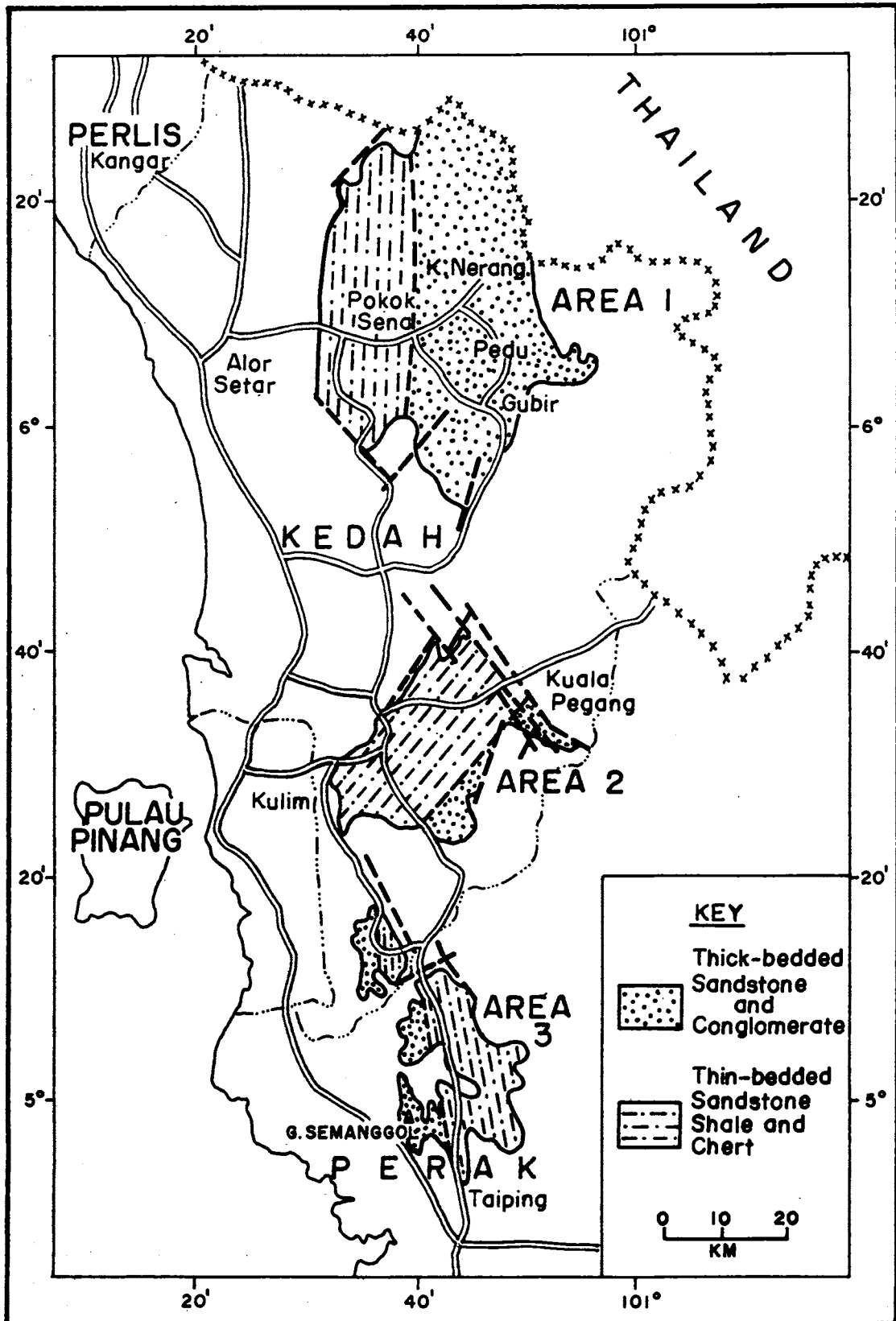


Fig. 1. The generalised lithofacies distribution map of the Semanggol formation.

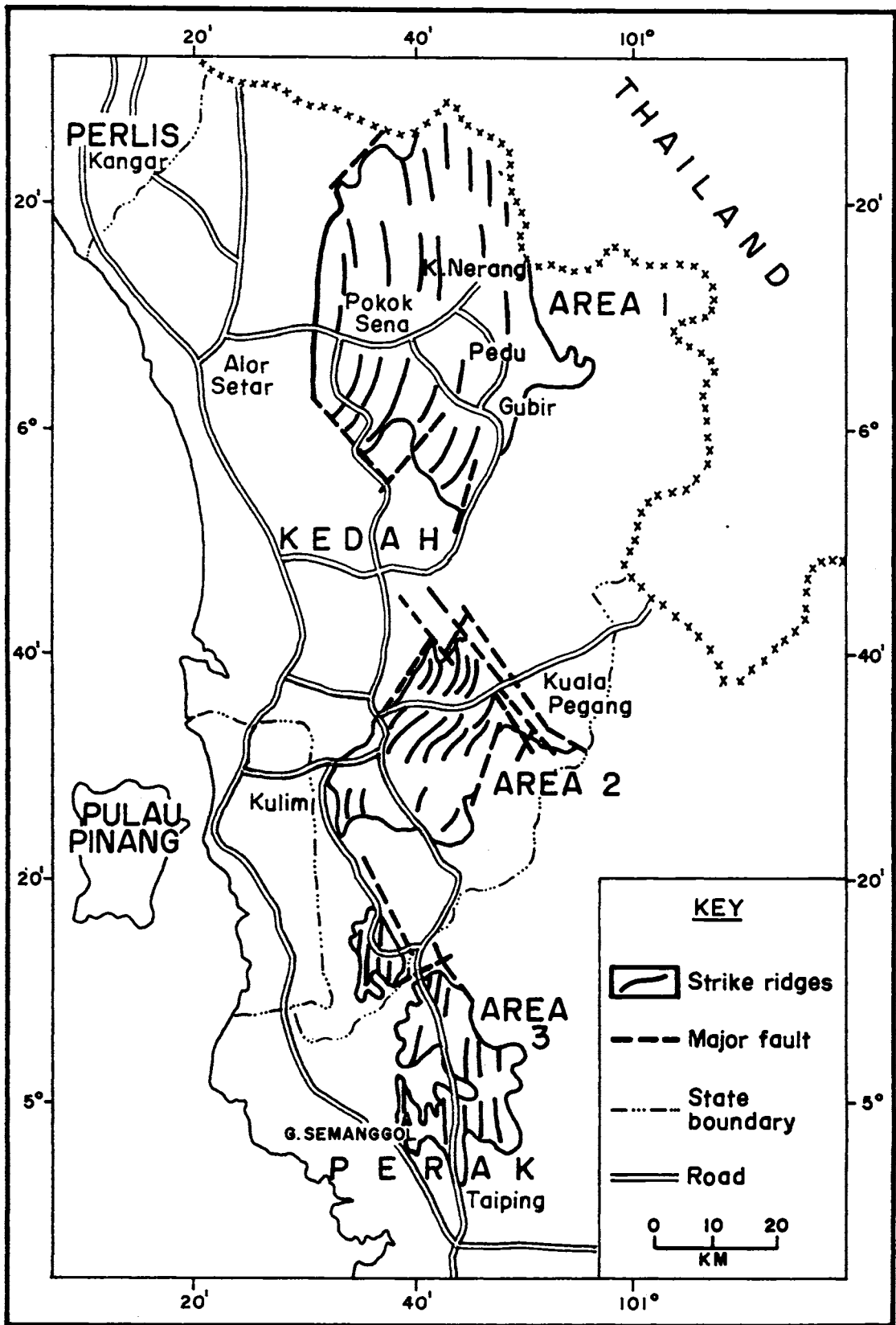


Fig. 2. Distribution of Semanggol formation rocks and the general trend of strike ridges.

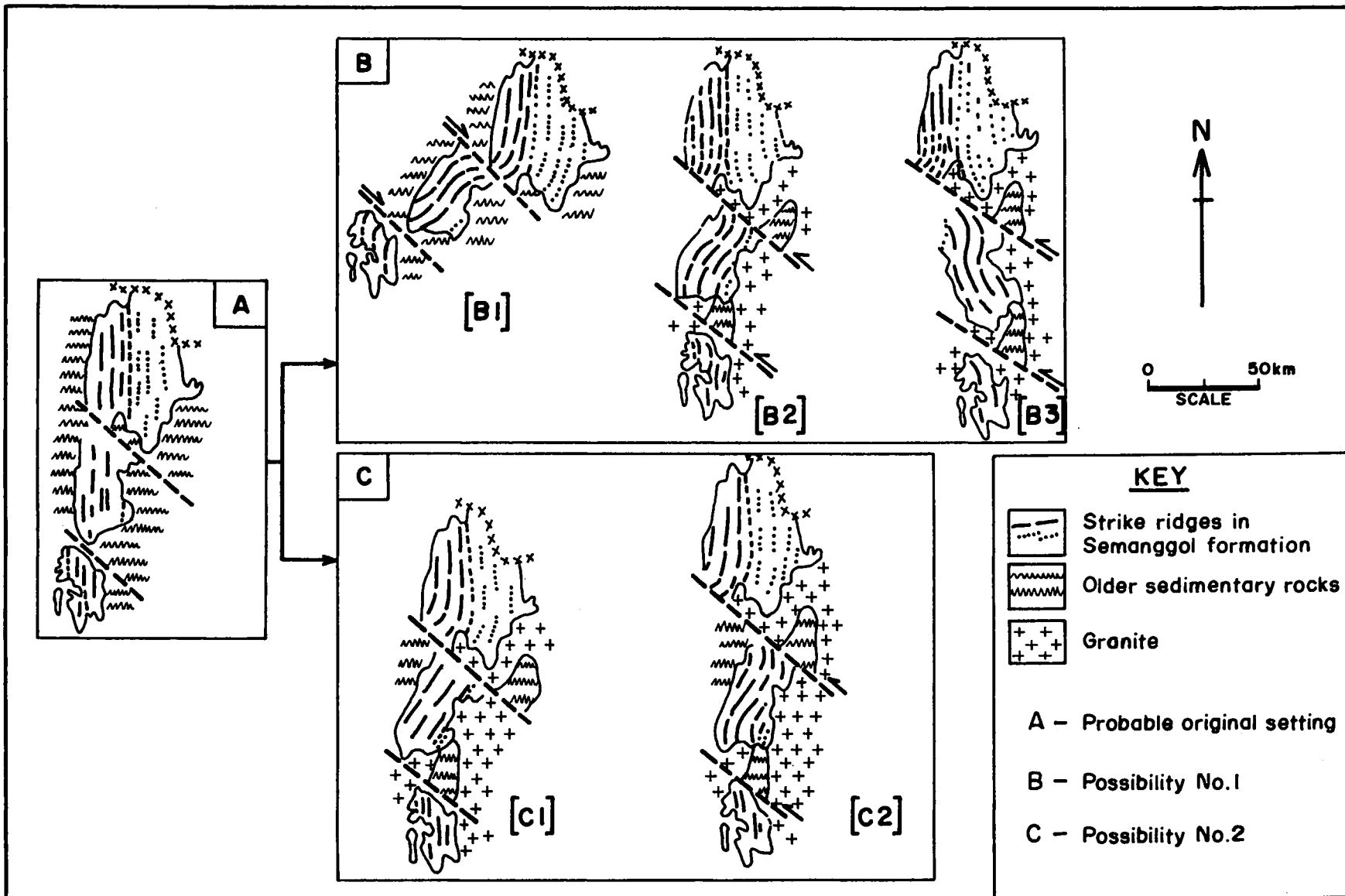


Fig. 3. Two possible mechanisms involving the Bok Bak fault in the modification of structural trend in the central area of Semangol formation.

that occur later could not yield a more extensive anticlockwise rotation to produce the setting as shown by Fig. 3B-3. That is, this mechanism is bound to produce the setting as shown in the Figure 3B-3 rather than the setting that we actually have (Fig. 3B-2). It is therefore difficult to uphold this mechanism.

In the alternative mechanism, it is suggested that the change in the structural trend in the middle area is mainly due to the intrusion of 'Kulim-Bkt. Bintang-G. Perak granite'. It is believed the intrusion did not bring about any major translation, but merely rotation along the preexisting fracture zone. The presence of the Jerai formation (Gunung Jerai) acting as a stable landmass within this zone, possibly played a very important role in preventing the translational movement. Apart from that, the granite intrusion caused a small deflection of the southern end of the northern (Padang Terap) area and also brought up to older sedimentary rocks which, in many places, had been eroded. The emplacement of the 'Kulim-Bukit Bintang-G. Perak granite' seemed to be controlled by the earlier fracture or fault systems (Fig. 3C-1). The left-lateral movement that followed caused only a small drag near the fault zone. North of the fault, the drag is negligible because the effect of the faulting was absorbed by the granite body (Fig. 3C-2).

Discussion

Two very important aspects in estimating the total displacement along the Bok Bak Fault were not considered, that is the rotation of the rocks prior to the left-lateral movement and the lithofacies boundaries north and south of the fault. The lithofacies boundary is the more reliable boundary to be correlated as compared to the formation boundary. The necessity to use lithofacies boundaries becomes more compelling when dealing with a faulted formation such as the Semanggol formation. The western boundaries of the Semanggol formation both in Kulim-Baling as well as Padang Terap areas are fault boundaries. A lateral fault separates the Semanggol rocks of Kulim-Baling area from Silurian Mahang formation, whilst in the Padang Terap area, the Semanggol rocks are separated from the Carboniferous Kubang Pasu formation by a reverse or thrust fault (Ibrahim Abdullah *et al.*, in prep.). It is very clear, in the case of the Semanggol formation, that the formation boundary cannot be used as the pre-faulting equivalent points in estimating the amount of displacement. Therefore, whenever possible, the lithofacies boundaries are still the best to be considered as the equivalent points in estimating total displacement along a transcurrent fault.

By considering the rotation suffered by the formation under consideration, together with the lithofacies boundaries, the total displacement along the Bok Bak Fault is estimated to be approximately 25 km (Figure 4). This figure agrees very well with the figure estimated for the proposed southeastwards extended fault by Raj (1982). Coincidentally, this estimate of 25 km displacement also agrees with the estimation by the gravity method of Burley & Jamaludin Othman (1989).

Acknowledgement

We wish to thank Universiti Kebangsaan Malaysia and Sarawak Shell Berhad for financing the project under the research grant No. 25/86. The figures were drafted by Mohd. Sith Samad.

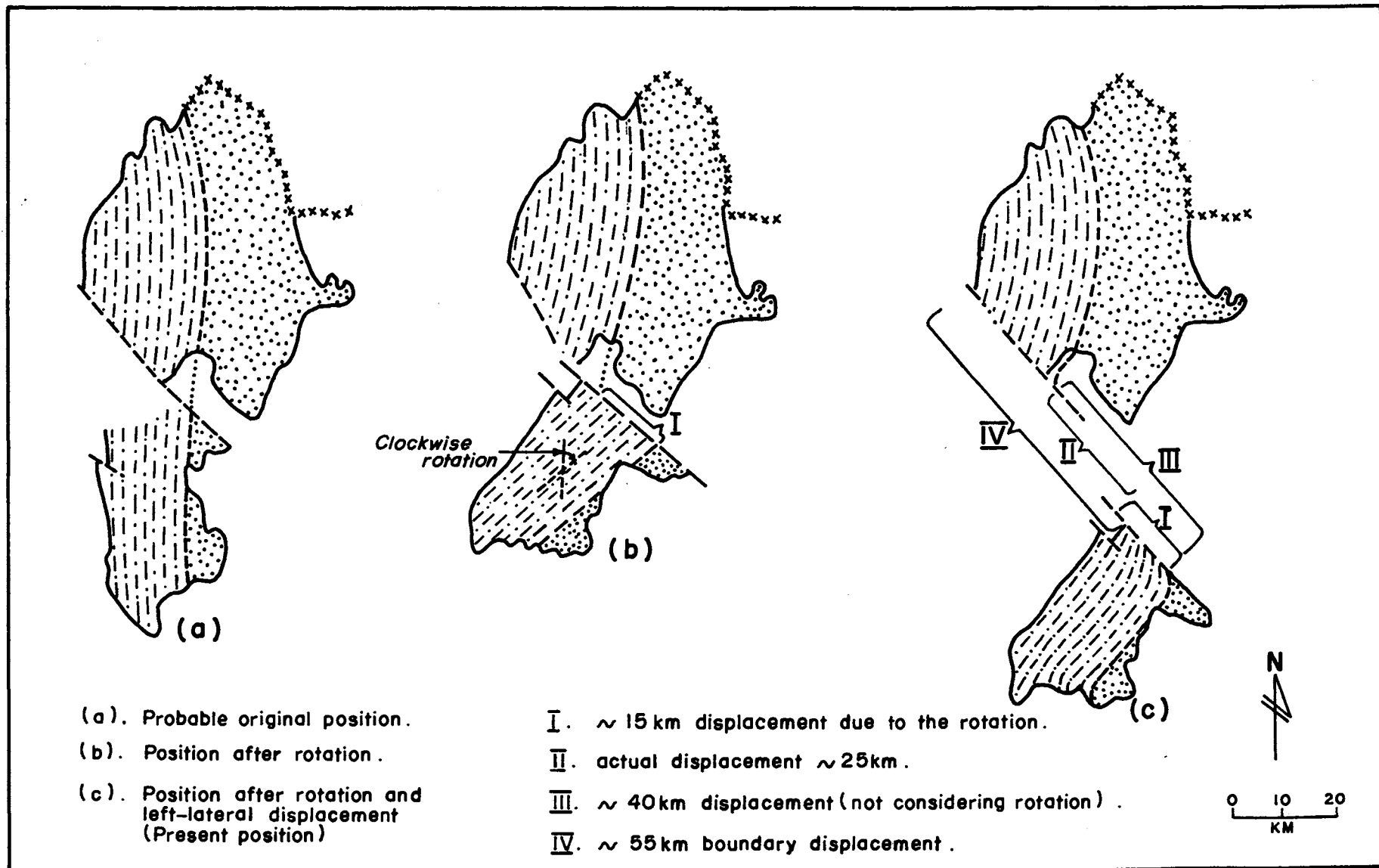


Fig. 4. A reconstruction from probable original position (a) to illustrate the displacement due to rotation (b) and left-lateral faulting (c).

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Manuscript received 1 March 1989.

Revised manuscript received 7 October 1989.



PERSATUAN GEOLOGI MALAYSIA
Geological Society of Malaysia

**PERSIDANGAN TAHUNAN
GEOLOGI '90**
Annual Geological Conference '90

The Royal Casuarina Hotel
Ipoh
7th & 8th May 1990

First Circular
November 1989

REGISTRATION FORM

GEOLOGICAL SOCIETY OF MALAYSIA
ANNUAL GEOLOGICAL CONFERENCE '90
7th & 8th May 1990

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Please tick appropriate boxes:

I intend to participate in the above Conference

I intend to present a paper entitled: _____

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The Royal Casuarina Hotel, Ipoh

Single occupancy

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PERSATUAN GEOLOGI MALAYSIA
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PERSIDANGAN TAHUNAN GEOLOGI '90
Annual Geological Conference '90

	Advance Registration Fees	Late Registration Fees
Full Members	MR10.00	MR20.00
Non-Members	MR20.00	MR40.00
Student Members	Free	Free
Student Non-Members	MR5.00	MR6.00

OBJECTIVES

The Geological Society of Malaysia is planning to hold the 1990 Annual Geological Conference on the 7th & 8th May 1990 at The Royal Casuarina Hotel, Ipoh. The Conference is the fifth in a series of such annual conferences organised by the Society.

Papers presented at the previous conferences have contributed significantly to the better understanding of the geology of Malaysia in particular and the S.E. Asian region in general. In addition, the Conferences have provided the forum for exchange of scientific and technical information among the many conference participants from government organisations, universities, consulting and service companies as well as research organisations in the region and those interested in the region.

PAPERS

In the wake of many outstanding papers that have been presented at the four previous Conferences, the Geological Society of Malaysia would greatly appreciate your contribution of a paper to this Conference.

Papers on any topic relevant to the understanding of geology, energy and mineral resources of Malaysia and the S.E. Asian region would be most welcomed.

Please inform us of your intention to present a paper at this Conference before 28th January 1990. Abstracts should be submitted at the same deadline or latest by 28th February 1990.

Full papers submitted before 15th April 1990 will be made available to all registrants.

Authors are also encouraged to submit their full papers after the conference for consideration for publication in the Society's Bulletin series.

REGISTRATION

All intending participants are advised to register early for the Conference as a large turnout will again be expected this year.

Advance registration for the Conference will be accepted until 15th April 1990. Late registration will be accepted at the Society's Registration Desk at the Conference venue.

Presenters of papers at the Conference will be exempted from payment of registration fees.

Payment by crossed cheques, bank drafts or cashiers orders is acceptable and should be made payable to the "Geological Society of Malaysia." Outstation cheques should include sufficient bank charges.

Please send registration fees together with the attached Registration Form to:

The Treasurer,
Geological Society of Malaysia,
c/o Department of Geology,
University of Malaya,
59100 Kuala Lumpur,
MALAYSIA.

to reach us before 15th April 1990.

ACCOMMODATION

Accommodation will be at the participants' own expenses but reservations can be arranged upon request on a first-come-first-serve basis at the following rates:

The Royal Casuarina Hotel, Ipoh

The room rates are as follows:

Single occupancy	: MR92.00 nett per day
Twin sharing	: MR92.00 nett per day
Triple sharing	: MR117.00 nett per day

Please indicate clearly in the Registration Form if arrangements for accommodation is required.

FURTHER INFORMATION

Fur further information, please write to or call:

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Annual Geological Conference 1990,
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c/o Department of Geology,
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Tel: 03-7577036

PERTEMUAN PERSATUAN (MEETINGS OF THE SOCIETY)

ECONOMIC GEOLOGY STUDY GROUP - REPORT ON FIELDTRIP TO GOLD MINES - PAHANG

About 35 participants went on a 2-day fieldtrip organised by the Society's Economic Geology Study Group on the 11th and 12th November 1989 to study some of the gold mines operating in Pahang. Due to the considerable travelling distance by bus from Kuala Lumpur, an overnight stay was made at Raub. The trip was ably led by the Study Group Chairman, Dr. Tan Teong Hing, who had earlier visited the area to plan a visit to mines recovering gold from hard rocks, eluvium and alluvium.

With gold commanding a high market price, more and more miners in Malaysia and elsewhere, are turning to gold mining. In view of the current trend in the mining industry, the fieldtrip was planned to show participants the geology of the gold deposits, the mining methods employed, and gold dressing procedures of some of the gold mines in Central Pahang.

Kim Chuan Gold Mine, Raub

The main host rock in this mine is sedimentary rock consisting mainly of shale, interbedded with minor sandstone and siltstone. The sedimentary sequence is folded into anticlines and synclines. Silicification appears to be most dominant at the anticlinal fold axes. Gold mineralization is largely localized along these silicified fold axes. Structural mapping and identification of silicified zones would be useful in targeting future gold deposits in this area. The gold which occurs as rarely visible tiny flakes are separated by crushing, milling and jiggling. Besides gold, some scheelite are also present.

In addition to primary gold, the mine also recovers gold from eluvial-colluvial deposits which are derived from weathering of the host rocks.

Topics discussed in the field:

- 1) Is this deposit a Bendigo-style mineralization?
- 2) Where and what is the source of gold and silica?

Syarikat Ajmal Sdn. Bhd., Padang Tungku

This mine recovers gold from hard rocks as well as eluvial-alluvial deposits. The host rock is limestone which is currently being quarried as construction materials. The gold, together with sulphide minerals (mainly galena and minor chalcopyrite) occur in fault-controlled quartz veins and dikes cutting the limestone. Where galena predominates, gold is rare or absent, suggesting that

gold mineralization occurred at low sulphur fugacity. The presence of galena would also suggest that mineralization occurred at a relatively low temperature (possibly from 100 to 300°C). The size of gold is variable, ranging from minute flakes to nuggets!

The eluvium-alluvium blanket is about a few meters thick overlying limestone which expresses karst topography. Recovering gold from this placer differs from that of tin which frequently employs hydraulic monitors. If the latter are being used, gold owing to its high specific gravity (19.3), would sink down and perhaps eventually trapped within pot holes and fractures in the limestone, resulting in poor recovery. Instead the gold-bearing eluvium-alluvium are removed directly by bulldozers and other heavy machineries, and transported into the palong for dressing.

Sejati Jadi Sdn. Bhd., Kechor Tui

The mine has just open a new mine pit, recovering gold from eluvium-alluvium.

Sontari Utama Mining Sdn. Bhd., Kechor Tui

This mine recovers gold from alluvial deposit. The latter, lacking in clay, is generally cleaner than the eluvial deposit. The gold-bearing alluvium is separated from the underlying limestone-shale country rock by a layer of peaty-coal layer. The gold is fine grained and rounded indicating transport from source. Again hydraulic monitors are not used in placer gold mining.

Topics discussed in the field:

- 1) Is the intermediate peaty-coal layer a member of the Tertiary Bed?
- 2) Could this layer imply a lowering of sea level which allowed rejuvenation of the drainage system in which gold was redeposited?

Primary gold, like many other ore metals, is widespread in small amounts (as low as a few parts per billion) in most igneous rocks. It also found in metamorphic as well as in sedimentary rocks. It occurs mostly in the native state, remaining chemically uncombined except with tellurium and possibly selenium and bismuth. Tellurium, selenium and bismuth could probably be used as pathfinder elements in geochemical exploration for primary gold deposits. Unlike sulphide deposits, large masses of gold-bearing rock rich enough to be called ores are unusual. The important deposits containing significant amounts of gold are: hydrothermal veins where it is often associated with quartz; and placer deposits derived from weathering of gold-bearing rocks.

The origin of gold is not fully known, but it is believed that the gold was carried up from great depths with other minerals, perhaps in partial solid solution, and latter precipitated as native mineral. There appears to be a close spatial and temporal relationship between gold and quartz.

Are gold and associated quartz derived directly from a hydrothermal source? (Ajmal Mine)

Have gold and silica present in country rocks been remobilized by igneous and tectonic activities prior to its deposition? (Chuan Kim Mine)

As a final note to those interested in gold mining, gold usually occurs as invisible disseminated grains, more rarely as flakes large enough to be seen, and even more rarely as nuggets, masses or veinlets. Hence to strike gold, it is not absolutely necessary to see gold instead laboratory testing and fire assay may prove its worth.

G.H.Teh & Tan Teong Hing

ECONOMIC GEOLOGY STUDY GROUP FIELDTRIP TO GOLD MINES IN PAHANG



The geologist at Kim Chuan Gold Mine, Raub, briefing the group on the geology of the area.

ECONOMIC GEOLOGY STUDY GROUP FIELDTRIP TO GOLD MINES IN PAHANG



Mr. Wong of Syarikat Ajmal, Padang Tunku, showing the group around his mine.



GSM President thanking the organiser over lunch at Kuala Lipis resthouse.



At the new mine pit at Sejati Jadi, Kechor Tui



Observing mining operations at Sontari Utama Mining, Kechor Tui.

CERAMAH TEKNIK (TECHNICAL TALK)

Robert C. Speck: Rock slope study and stabilization in Pittsburgh, Pennsylvania: a case history

Laporan (Report)

The talk was held on the 27th November 1989 at the Department of Geology, University of Malaya. It was attended by about 30 members of the Society.

The talk was in two parts. The first part dealt with a case history on rock slope stabilization in Pennsylvania. The abstract of this part of the talk is given below.

Abstract

The Duquesne Bluff, located near the center of the city of Pittsburgh, Pennsylvania, is 4240 feet long and 60 to 115 feet high. A 4-lane boulevard runs directly along the crest of the slope and a 6-lane highway parallels its base. In plan, only 50 to 95 feet separate the near curbs of the two roadways. A major rock-fall in April, 1978 ultimately resulted in the inclusion of the slope in the Pennsylvania Department of Transportation's Parkway Safety Update Program.

Failure modes occurring along the length of the slope included plane, wedge, toppling, and rock-fall types. General disintegration of the rock surface was also present. Two sets of tectonically-induced joints, as well as vertically-oriented stress-relief joints, and joints formed by the wet-dry, freeze-thaw weathering cycles were responsible for the various modes of failure.

From a cost effectiveness standpoint, no single type of corrective measure was found to be appropriate for the entire slope. Consequently, the slope was divided into a series of design zones based on a judgement of the potential for particular modes of rock failure, the possible consequences of rock failure, and the most promising methods for correction. Five categories of design zones were thus established. For comparative purposes, several candidate treatment programs were developed in the context of the design zones. The program ultimately adopted included construction of a reinforced concrete band to retard weathering of soft rock strata which historically had led to the development of large overhangs. The program also included rock trimming by mechanical methods (crane-mounted hydraulic hammers and a crane-mounted continuous miner), and the use of rock bolts and wire mesh and other techniques. The entire program is expected to cost 1.5 to 2.5 million US dollars.

In the second part of the talk, the speaker showed a series of slides on engineering problems and touristic views in Alaska. The engineering problems associated with permafrost in Alaska include thermal sinkholes (similar to sinkholes in karst areas), subsidence or soil failures due to melting of ice in the soil subsequent to road or housing construction, special preventive or remedial measures using thermal piles and elevated structures, etc. Beautiful scenes of various parts of Alaska and the University of Alaska-Fairbanks during the summer and winter seasons were also shown.

Some lively discussions on the rock slope stabilization measures followed, after which the meeting adjourned at about 6.45 p.m.



ROBERT C. SPECK

Footnote: The speaker also expressed interest in getting Malaysians to undertake undergraduate or post-graduate studies in the University of Alaska-Fairbanks. The University offers low-cost education with possibility of scholarship awards. Members who are interested can write to: Dr. R.C. Speck, Dept. of Mining & Geological Engineering, Univ. of Alaska-Fairbanks, Fairbanks, Alaska, U.S.A.

Tan Boon Kong

PETROLEUM GEOLOGY SEMINAR '89 - LAPORAN (REPORT)

The annual Petroleum Geology Seminar '89 was held on the 4 & 5th December 1989 at the Shang-La Hotel, Kuala Lumpur. The Seminar this year, 13th in the series, was held at a new venue (Shangri-La Hotel) and attracted a record breaking crowd of 400.

The 2-day Seminar this year was declared open by Y.B. Datuk Dr. Sulaiman Haji Daud, Minister in the Prime Minister's Department and Minister of Justice, Malaysia. In his Opening Address Datuk Dr. Sulaiman noted, among other things, that the new production sharing contract of 1985 has met with good response and PETRONAS, to date, has successfully signed 23 new contracts. This, he foresees would be in line with the nation's aspiration to maintain Malaysia's status as a net exporter of petroleum in the future years.

Next Dr. Sulaiman touched on the future trend of international exploration in prospective frontier areas and noted that Malaysia is lucky to have large frontier areas. PETRONAS is actively pursuing the future exploration of these frontier deepwater areas, where the risk is high but the rewards large.

Datuk Dr. Sulaiman is happy to note that there is also an active level of exploration of onshore blocks awarded by PETRONAS especially in the eastern Sabah and Bintulu areas.

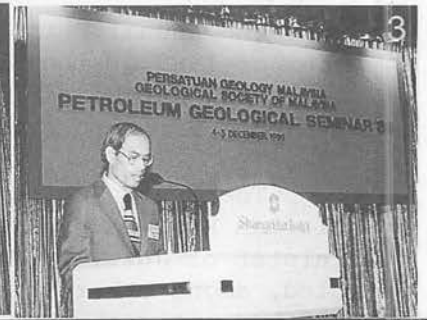
Due to the dramatic revolution in technology in the field of hydrocarbon exploration, Datuk Dr. Sulaiman noted that it is indeed encouraging that oil exploration in Malaysia employs the latest and most modern techniques available, thanks to the oil service companies for bringing in the new technologies to Malaysia.

31 papers were presented and were well received at the 2-day Seminar. The abstracts of papers, including the Minister's Opening Address and President's Welcoming Speech are found in this issue. The Society is indeed grateful to the many donors, presenters of papers, participants and all who helped in making the Seminar another resounding success.

G.H. Teh



PETROLEUM GEOLOGI SEMINAR 1989



PETROLEUM GEOLOGI SEMINAR 1989



PETROLEUM GEOLOGI SEMINAR 1989



GSM PETROLEUM GEOLOGY SEMINAR '89

Captions to photos

1. At the Registration Desk at Shangri-La Hotel.
2. The Organising chairman welcoming the participants.
3. GSM President with his Welcoming Address.
4. Opening Address by YB Datuk Dr. Sulaiman Haji Daud.
- 5-12. The large audience at the Opening Ceremony.
13. Coffee break.
14. E. Antonielli of Agip with his paper.
15. A.J.T. Romein receiving his momento from Session Chairman.
16. Chiu Shao-Kang on the use of SAR Imagery.
17. J. Almond of Shell with her presentation.
18. A question from the floor.
19. Azhar Hj. Hussin on the Subis Limestone.
20. Richard M. Protor from Geological Survey of Canada.
21. R. Chemali on MWD tools in Horizontal Wells.
- 22-26. Participants helping themselves to lunch.
27. Rodziah Daud with her joint paper.
28. Mark Ganue discussing "Sniffer" surveying.
29. Hanif with a question.
30. S.P. Sivam with his paper.
31. R. Tate putting forward a question.
32. Bunstan on Reservoir Monitoring.
33. Ramly Khairuddin on crude oils from Tapis and Pulau Formations.
34. R.F. Mast of U.S.G.S. being congratulated by the Session Chairman.
35. Felix Tongkul on the structure & tectonics of Sabah.
36. I. Metcalfe with a question.
- 37-39. At the Cocktail Party.
40. Roopa Gir of Schlumberger receiving her momento.
41. J.M. Lamy of Shell with his joint paper.
42. D.G. Bowen of Core Lab on Reservoir Description.
43. H.D. Tjia on the Maliau Basin, Sabah.
44. J.K. Faraguna elaborating on the Improved Borehole Televiewer System.
45. K.R. Chakraborty ably presenting his paper.
46. Mohamed Taha of Schlumberger on Borehole Electrical Imagery.
47. Vincent Kong of Shell presenting his joint paper.
48. C.S. Hutchison discussing the Models for SE Asian Cainzoic Faulting and Subsidence.
49. William C. Ade of Occidental on the Badak and Nilam Field, Kalimantan.
50. Nik Ramli on Sequence Stratigraphy.
51. F.G. Bercha with his paper on Remote Sensing Applications.
52. Tony Palicki of Intergraph Systems with his paper.
53. Kuang Koo Sing on the Modified Stress-Strain Ellipsoid.
54. Lee Chai Peng on Circular Basins of Sabah.
55. Emeliana D. Rice-Oxley of Shell being congratulated by the Session Chairman.
56. Noor Azim with a question.
57. Organising Chairman, Hila Ludin, with his closing remarks.

NOW AVAILABLE!

PP 187/12/88

ISSN 0126-6187

**BULETIN PERSATUAN
GEOLOGI MALAYSIA**

BULLETIN OF THE GEOLOGICAL SOCIETY OF MALAYSIA

SPECIAL ISSUE ON PETROLEUM GEOLOGY VOL IV

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Editor
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DECEMBER 1989

No. 25

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59100 Kuala Lumpur
MALAYSIA

WELCOMING ADDRESS BY THE PRESIDENT OF THE GEOLOGICAL SOCIETY OF MALAYSIA AT THE PETROLEUM GEOLOGY SEMINAR 1989

Tuan Pengerusi Majlis, Yang Berhormat Datuk Dr. Sulaiman Haji Daud, Menteri di Jabatan Perdana Menteri dan Menteri Kehakiman Malaysia, Tan Sri-Tan Sri, Dato'-Dato', Para jemputan khas, Puan-puan dan Tuan-tuan hadirin sekalian, Assalmualaikum dan salam sejahtera.

Bagi pihak Persatuan Geologi Malaysia, terlebih dahulu saya ingin menyatakan penghargaan dan ucapan terima kasih tidak terhingga Persatuan ini kepada Yang Berhormat Datuk di atas kesudian beliau meluangkan masa bersama-sama kita pagi ini untuk menyampaikan sepatah dua kata, seterusnya merasmikan Seminar Geologi Petroleum Kali Ke-13 ini. Tidak lupa juga saya mengucapkan selamat datang kepada para jemputan khas, puan-puan dan tuan-tuan pada peserta semianr sekalian.

Tuan Pengerusi Majlis,

Memandangkan sebahagian besar daripada hadirin di dewan ini mungkin tidak dapat memahami Bahasa Malaysia, maka izinkan saya menyampaikan kata-kata aluan ini seterusnya dalam Bahasa Inggeris.

Yang Berhormat Datuk, Ladies and Gentlemen,

The Geological Society of Malaysia welcomes you all to its Thirteenth Petroleum Geology Seminar. Specially for speakers and participants who are here in Kuala Lumpur for the first time, it is my pleasure to wish them a nice and memorable stay. As you might have noticed, this capital city is being dressed-up for the "Visit Malaysia Year 1990", and we are only a month to the official launching. So you are fortunate in a way that you can start to enjoy the extra bonanza Visit Malaysia Year has to offer. Eventhough the organizing committee has done their best to ensure the smooth running of this two-day seminar, I would like to advance my apology on their behalf for any unexpected shortcomings.

Ladies and Gentlemen,

I am very glad to note here that this year's seminar has received overwhelming response. The number of papers scheduled to be presented has reached the new record of 32, which is about the most that can be accommodated in two days. They are prepared by over sixty authors from 20 companies related to petroleum industry, and two leading higher institutions in this country. As far as I can see, almost all important aspects of petroleum exploration and production are covered. No doubt once again it is worthwhile to note that the long standing aim of establishing the Petroleum Geology Seminar is being fulfilled. It is even more joyful to mention that this year's seminar is followed by a four-day short course on "Modern and Ancient Deep Sea Fan Sedimentation", also organized by the Society, which I believe will benefit some of us here.

I am also very pleased to announce that the Society's Bulletin No. 25 is now available. This Special Issue on Petroleum Geology, Volume IV in its series, contains 7 papers, 5 were presented in last year's Seminar, and

one each from the previous years, We would like to invite speakers of this year's seminar to submit their papers for publication at the earliest opportunity, so that their findings can be made known without delay and will benefit more people in the community.

This year, as the years before, we have received very encouraging financial support from companies and organizations related to the petroleum industry. Their generosity is acknowledged here. We have decided to renew the institutional memberships honoured to a number of companies last year, as well as awarding a few more to new donating companies this year.

Ladies and Gentlemen,

On behalf of the Society, I would like to record our appreciation to the following, with regards to their contributions towards the organization of this seminar: Members of the organizing committee, headed for the third consecutive time by Mr. Hila Ludin; speakers and their organizations, the chairmen of the four sessions, Dr. Nik Ramli Nik Hassan, the post-seminar course organiser, and last but not least the many individuals and companies for their moral, material and financial support.

Finally our special thanks are due to Yang Berhormat Datuk Dr. Sulaiman Haji Daud, Minister in the Prime Minister's Department and Minister of Justice, Malaysia, for his willingness to spare his time with us this morning and to declare the seminar open.

Without further delay, I will now call upon Yang Berhormat Datuk Dr. Sulaiman to deliver his opening speech and declare the Thirteenth Petroleum Geology Seminar open.

Thank you.

PETROLEUM GEOLOGY SEMINAR '89



Shangri-La Hotel, Kuala Lumpur
4-5th December, 1989

OPENING ADDRESS BY Y.B. DATUK DR. SULAIMAN HAJI DAUD, MINISTER
IN THE PRIME MINISTER'S DEPARTMENT & MINISTER OF JUSTICE,
MALAYSIA, ON THE OCCASION OF THE OPENING CEREMONY OF THE
PETROLEUM GEOLOGY SEMINAR 1989

Tuan Pengerusi Majlis, Dr. Hamzah Mohamad, Presiden, Persatuan Geologi Malaysia, En. Hila Ludin Abu Hazim, Pengerusi, Jawatankuasa Pengelola, Seminar Geologi Petroleum Yang Ke-13, Tan Sri-Tan Sri, Dato'-Dato', Puan-Puan dan Tuan-Tuan, Ladies and Gentlemen.

I certainly feel very honoured to be invited to address this distinguished gathering of professionals from the upstream sector of the petroleum industry. To those of you who have come from afar to participate in this seminar, I would like to wish you 'selamat datang' or welcome to Malaysia.

I would like to take this opportunity also to congratulate the Geological Society of Malaysia for having had a successful track record in the past 13 years in organizing this annual seminar, which I understand is to bring together local as well as foreign geo-scientists, with a view to promote a two way exchange of knowledge and information drawn from their respective experiences in the petroleum industry. This is a commendable effort particularly as much can be gained from an interdependent stance in any profession.

In Malaysia, petroleum resources were exploited as early as 1910 and today's petroleum production is consequential to the intensive exploration efforts made mainly between the period 1966 to 1981. We are currently in the midst of another wave of exploration activities with the implementation of the new production sharing contract in 1985. The production sharing contract of 1985 has met with a good response and to date, Petronas has successfully signed 23 new contracts. Consequently, with the recent upsurge in exploration activities, we expect to see a steady increase in the hydrocarbon resources of the country in the 1990s. This would be in line with our nation's aspiration to maintain Malaysia's status as a net exporter of petroleum in the future years.

Our recent successful attempts in attracting new production sharing contractors to our exploration acreages are attributable to the fact that Malaysia still holds a substantial amount of remaining undiscovered potential. In this regard, the recent discoveries made by some of our new production-sharing contractors under the new terms, attest to the fact that Malaysia has much to offer foreign investors. In addition, the political stability and the sound economic management in our country also play an important role in creating a conducive investment climate, not only for the oil companies but also for the petroleum ancillary and support services companies.

Over the past few years, we have seen moves by major and independent oil companies to place more emphasis on international exploration to replace their declining reserves and production. Part of this exploration effort will be directed in so-called 'frontier' exploration areas where the risk will be high but where the rewards could be large.

In Malaysia, we have seen exploration being concentrated on the very accessible continental shelf areas. Malaysia is indeed lucky to have vast areas of shallow waters underlain by sedimentary basins with good petroleum potential. However as these accessible areas are identified and exploited by drilling, the trend in future will be to look toward exploration of prospective 'frontier' areas. In Malaysia, we are also lucky to have large 'frontier' areas. We have large tracts of deepwater areas which are as yet undrilled and also large jungle areas which have not yet even been properly surveyed using modern geophysical methods. It is encouraging to note that Petronas is actively pursuing the future exploration of these frontier areas. I understand that seismic surveys of our deepwater areas have already been conducted by Petronas and studies are now underway to evaluate their potential. This is indeed a timely step toward future exploration drilling in the deepwater areas.

The onshore areas in Malaysia are also beginning to show an active level of exploration with the award of onshore blocks by Petronas. We have seen recently the first onshore oil discovery in Malaysia in 70 years, made by Malaysia Baram Oil Development Company in Block SK 14, in an area adjacent to the Miri Oil Field in Sarawak. We are also seeing active frontier exploration in eastern Sabah by Sun Malaysia Petroleum Company and its partners in the onshore Block SB 8 area, which is a truly unexplored area with difficult logistics. We are also seeing Overseas Petroleum and Investment Corporation (OPIC) of Taiwan very active in the onshore Bintulu area known as Block SK 12. We certainly hope that these new companies which are aggressively paving the way in conducting the first modern integrated onshore exploration programmes in the country, will have good success in their efforts.

All the massive exploration efforts in Malaysia will require the latest technology. During the past decade, there has been a dramatic revolution in technology in the field of hydrocarbon exploration. These rapid technological advancements are mainly attributed to the development of new equipment and research techniques coupled with the advancement in computer technology. These technological advances have clearly progressed beyond their earlier role of simply assisting the geo-scientists in the search for hydrocarbon instead, these high-tech tools now at our disposal are telling the explorationists where to drill. However, the effectiveness of these mechanical processes still need a human touch i.e. I believe, the ultimate ingredient and the key to successful search for oil lies in the 'creativity' of the human mind, in this case, the mind of the explorationist. New laboratory techniques and advances in computer technology can foster new ideas but it is up to the creative mind of the geo-scientists to transform these ideas into wildcat successes. However, we have to acknowledge the fact that we are living in an age of increased computer reliance and as computer sophistication grows, so does our dependence on them. We must harness their capabilities to better complement the work of geo-scientists in Malaysia.

It is indeed encouraging to note that oil exploration in Malaysia employs the latest and most modern techniques available in the industry today; particularly in seismic acquisition, where 3-D acquisition is becoming an everyday affair; seismic processing which is also helping to improve old data; wireline logging where new tools are helping the geologists

understand better the subsurface rocks and fluid distribution; and laboratory analyses which are providing quicker and more accurate measurements of rock properties and in geochemistry. Usage of the most advanced interpretation workstations is also helping to digest the vast amounts of data being collected by the oil companies.

It is indeed encouraging that oil service companies in Malaysia are playing an important role in bringing in this new technologies into this country. There are tremendous prospects for the future and it is my hope that these service companies will continue in this fine effort and also in upgrading of the skills of the many Malaysian staff that they have hired.

Since the oil crisis of the seventies, concerted efforts have been carried out continuously in attempting to develop other sources of energy. However, to date, none has proven its capability in displacing hydrocarbons as the world's primary energy source. It was reported recently that research on controlled fusion has come close to achieving this objective. Research in the field of nuclear fusion has attracted much interest in the scientific community, for the development of this form of energy is clean and limitless. Maybe someday in the future, these attempts at substitution may become a reality. Until such a time arrives, we must all accept that hydrocarbon resources will continue to occupy a key position among the various sources of energy. In this regard, the geo-scientific community will continue to remain as an important and indispensable contributor in the future world energy environment. All the geologists present here today would need to continue to play their role in ensuring continued exploration activities. In short, you will never be out of a job!

Ladies and Gentlemen,

I do not wish to take more of your time as most of you are technical people looking forward to the many interesting papers that will be presented today and tomorrow. May I wish you all fruitful discussion at this seminar. For our guests from abroad, I hope that you will find some time to visit the various tourist attractions in Malaysia. The festive air in the city, that you may have noticed, has been the result of recent staging of two major events i.e. the South-East Asia Games in August and the Meeting of Commonwealth Heads of Government in October. Right now it is geared to welcome all of you to Kuala Lumpur!

With this, I have great pleasure in declaring the 13th Petroleum Geology Seminar open.

Thank you.

Programme

Geological Society of Malaysia — Petroleum Geology Seminar 1989

GEOLOGICAL SOCIETY OF MALAYSIA PETROLEUM GEOLOGY SEMINAR 1989

PROGRAMME

MONDAY, 4th DECEMBER 1989

- 8.00 am : **REGISTRATION**
- 8.20 am : Arrival of invited guests
- 8.30 am : Arrival of Y.B. Datuk Dr. Sulaiman Haji Daud, Minister in the Prime Minister's Department and Minister of Justice, Malaysia
- 8.35 am : Welcoming Address by Dr. Hamzah Mohamad, President, Geological Society of Malaysia
- 8.45 am : Opening Address by Y.B. Datuk Dr. Sulaiman Haji Daud, Minister in the Prime Minister's Department and Minister of Justice, Malaysia
- 9.05 am : **COFFEE BREAK**
- 9.35 am : Sequence Chronostratigraphy in the Malay and Sarawak Basin
- A.J.T. Romein (Core Laboratories Malaysia Sdn. Bhd.)
- 10.00 am : Miocene-Pliocene Paleogeographic Evolution of a Tract of Sarawak Offshore between Bintulu and Miri
- E. Agostinelli, Mohamad Raisuddin, E. Antonielli & Mohamad Mohd Aris (Agip (Malaysia) Ltd.)
- 10.25 am : The Use of SAR Imagery for Hydrocarbon Exploration in Sarawak
- Chiu Shao-Kang & Mohd Khair Abd Kadir (Overseas Petroleum & Investment Corp./PETRONAS Carigali Sdn. Bhd.)
- 10.50 am : The Application of Detailed Reservoir Geological Studies in the D18 Field, Balingian Province, Offshore Sarawak
- J. Almond, P. Vincent & L.R. Williams (Sarawak Shell Berhad)
- 11.15 am : Relative Timing of Hydrocarbon Migration in the Miocene Subis Limestone of NW Sarawak
- Azhar Hj. Hussin & Nuraiteng Tee Abdullah (University of Malaya)
- 11.40 am : Geological Survey of Canada's Approach to Petroleum Resource Assessment
- Richard M. Proctor & Gordon C. Taylor (Geological Survey of Canada)
-

**GEOLOGICAL SOCIETY OF MALAYSIA
PETROLEUM GEOLOGY SEMINAR 1989**

PROGRAMME

- 12.05 pm : **LUNCH BREAK**
- 1.30 pm : Induction, Resistivity and MWD Tools in Horizontal Wells
– S. Gianzero, R. Chemali & S.M. Su (Halliburton Logging Services, U.S.A.)
- 1.55 pm : A Triassic 'Reefal' Limestone in the Malay Basin, South China Sea: Regional Implications
– Rodziah Daud, Updesh Singh & Henri Fontaine (PETRONAS Petroleum Research Institute/CCOP Bangkok)
- 2.20 pm : A Discussion of 'Sniffer' Surveying, Offshore Malaysia
– Mansor Ahmad & Mark Ganue (Sun Malaysia Petroleum Company/Inter-Ocean)
- 2.45 pm : Palaeoenvironmental and Stratigraphic Evolution of Western Peninsular Malaysia
– S.P. Sivam & Idris Mohamad (University of Malaya)
- 3.10 pm : **COFFEE BREAK**
- 3.40 pm : An Introduction to Reservoir Monitoring
– Ian McMahon (Geophysical Service (Malaysia) Sdn. Bhd.)
- 4.05 pm : Application of Correlation Index, Trace Elements, Bulk Properties and Gas Chromatography in the Correlation of Crude Oils Produced from Tapis and Pulai Formations, Malay Basin
– Ramly Khairuddin (PETRONAS Petroleum Research Institute/ University of Malaya)
- 4.30 pm : High Resolution Site Surveys using Waterguns with Semi-exploration Objectives
– Tong Pow Mun & John Warr (Racal Survey (Malaysia) Sdn. Bhd./ Sun Malaysia Petroleum Co.)
- 4.55 pm : Estimates of Undiscovered Recoverable Conventional Oil and Gas Resources of the United States
– Richard F. Mast (U. S. Geological Survey)
- 5.20 pm : Structural Style and Tectonics of Western and Northern Sabah
– Felix Tongkul (Universiti Kebangsaan Malaysia, Sabah)
- 7.00 pm : **COCKTAIL PARTY**
-

**GEOLOGICAL SOCIETY OF MALAYSIA
PETROLEUM GEOLOGY SEMINAR 1989**

PROGRAMME

TUESDAY, 5th DECEMBER 1989

- 8.00 am : Sonic Waveform Signature Analysis for Reservoir Evaluation
– Roopa Gir & Gilles Mathieu (Schlumberger Overseas S.A.)
- 8.25 am : Tectonic Evolution of the N.W. Sabah Continental Margin since
Late Eocene
– Denis N.K. Tan & J.M. Lamy (Sabah Shell Petroleum Co. Ltd.)
- 9.15 am : Reservoir Description: A Synergistic Approach to More Accurate
Determination of Oil and Gas Reserves
– D.G. Bowen, T. Kennaird & J. Hill (Core Laboratories Malaysia/
Singapore)
- 9.40 am : The Maliau Basin, Sabah: Geology and Tectonic Setting
– H.D. Tjia, Ibrahim Komoo, P.S. Lim & Tungah Surat
(Universiti Kebangsaan Malaysia/Geological Survey of Malaysia,
Sabah)
- 10.05 am : **COFFEE BREAK**
- 10.30 am : An Improved Borehole Televiwer System: Image Acquisition,
Analysis and Integration
– J.K. Faraguna, D.M. Chace & M.G. Schmidt (Atlas Wireline
Services/Western Atlas International, Inc. U.S.A.)
- 10.55 am : Geodynamics of Cenozoic Basins in Northern Sundaland Area
– K.R. Chakraborty (University of Malaya)
- 11.20 am : Thin Bed Resolution and the Determination of Flushed Zone
Resistivity in Oil Based Mud
– Joseph F. Goetz, Roland Chemali & Douglas Seifert
(Halliburton Logging Services, U.S.A)
- 11.45 am : Exploration and Production Applications of the Borehole
Electrical Imagery
– Mohamed Taha (Schlumberger Overseas S.A.)
-

**GEOLOGICAL SOCIETY OF MALAYSIA
PETROLEUM GEOLOGY SEMINAR 1989**

PROGRAMME

- 12.10 pm : 3D Marine Exploration Seismic Survey in Shallow Water Areas, Offshore Sabah
– Vincent W.T. Kong, J. Smethurst, B. H. Chiem & R. C. Stewart (Sabah Shell Petroleum Co. Ltd.)
- 12.35 pm : **LUNCH BREAK**
- 2.00 pm : None of the Models for SE Asian Cainozoic Faulting and Subsidence is Satisfactory
– Prof. Charles S. Hutchison (University of Malaya)
- 2.25 pm : Seismic Lithology at the Badak and Nilam Field, Kalimantan, Indonesia
– William C. Ade (Occidental Petroleum (M) Ltd.)
- 2.50 pm : Sequence Stratigraphy - Concepts, Applications and Examples from Malaysia and the U.S.A.
– Nik Ramli Nik Hassan (FORAD Group)
- 3.15 pm : Remote Sensing Applications to Geologic Exploration
– F.G. Bercha, P. Fuenning, O. Sawicki (Bercha International Inc.)
- 3.40 pm : **COFFEE BREAK**
- 4.05 pm : Computer - Aided Energy Exploration and Data Integration
– Sunny A.A Singh & Tony Palicki (Intregraph Systems SEA Pte. Ltd.)
- 4.30 pm : Applying the Modified Stress-Strain Ellipsoid to re-define the Structural/Geological Provinces of Sarawak, Brunei and NW Sabah
– Kuang Koo Sing (Innovative Technological Geo-Exploration, Australia)
- 4.55 pm : Circular Basins of Sabah
– Lee Chai Peng & Tham Kum Choong (University of Malaya/The Analytical Laboratories (M) Sdn. Bhd.)
- 5.20 pm : Palaeoenvironments of the Lower Miocene to Pliocene Sediments in the Offshore N.W. Sabah Area
– Emeliana D. Ride-Oxley (Sabah Shell Petroleum Co. Ltd.)
- 5.45 pm : **CLOSING REMARKS**
-

**GEOLOGICAL SOCIETY OF MALAYSIA
PETROLEUM GEOLOGY SEMINAR 1989**

Generous support for the Petroleum Geology Seminar 1989 has been received from the following companies up to 25th November 1989.

1. Overseas Petroleum and Investment Corp. (OPIC)
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 17. Occidental Petroleum (M) Ltd.
 18. Schlumberger Overseas S. A./Wellog (M) Sdn. Bhd.
 19. Halliburton Geophysical Services
 20. Excel Energy Group Sdn. Bhd.
 21. Digicon Singapore
 22. Spectron Sdn. Bhd.
 23. Total Compagnie Francaise Des Petroles
-

Abstracts of Papers

Geological Society of Malaysia — Petroleum Geology Seminar 1989

SEQUENCE CHRONOSTRATIGRAPHY IN THE MALAY AND SARAWAK BASINS

A. J. T. ROMEIN
CORE LABORATORIES MALAYSIA SDN. BHD.

The stratigraphic nomenclature applied at present in the subdivisions and correlations of the Oligocene to Recent sedimentary sequences in the offshore Malay and Sarawak Basins is of a highly informal and confusing nature. Current stratigraphic schemes consist of number - and/or letter coded, local "Cycles", "Units" or "Stages", which are difficult to correlate as they are based on often poorly dated paleoenvironmental events. A unifying stratigraphic scheme based on a combination of high-resolution biostratigraphy and sequence chronostratigraphy is proposed.

Geological Society of Malaysia — Petroleum Geology Seminar 1989

MIOCENE-PLIOCENE PALEOGEOGRAPHIC EVOLUTION OF A TRACT OF SARAWAK OFFSHORE BETWEEN BINTULU AND MIRI

EROS AGOSTINELLI, MOHAMAD RAISUDDIN AHMAD TAJUDDIN,
EUGENIO ANTONIELLI & MOHAMAD MOHD ARIS
AGIP (MALAYSIA) LTD.

A data base consisting of 5200 km of seismic lines and data from six wells has been utilized to reconstruct the evolution of the main environments of sedimentation in a tract of the Sarawak Offshore between Bintulu and Miri.

A sequence of six maps shows the progressive shifting through time of the position of the paleo-coastline in the area as well as that of the major deltaic systems.

The presence of a morphological paleoescarpment along the so-called West Baram line is evident since at least the Middle Miocene. The data suggest its presence also in older ages but could not definitely demonstrated with our data set.

The basin to the northeast of this paleoescarpment has been filled mainly during the Late Miocene-Pliocene by the deposits associated to the progradation of the paleo-Baram delta system.

The spatial distribution of the different environments of sedimentation is at any time controlled by the position of the coastline (input of sediments) and by the presence of the paleoescarpment. This situation is still reflected by the present geography of the area.

THE USE OF SAR IMAGERY FOR HYDROCARBON EXPLORATION IN SARAWAK

CHIU SHAO-KANG
OVERSEAS PETROLEUM & INVESTMENT CORPORATION
&
MOHD KHAIR ABD KADIR
PETRONAS CARIGALI SDN. BHD.

Side Looking Airborne Radar (SLAR) has been widely used in hydrocarbon exploration recently. However the use of Synthetic Aperture Radar (SAR) has greatly improved the problem of aperture restriction caused by the limited antenna length in the use of real aperture SLAR.

A SAR survey of Block SK-12, onshore Sarawak, Malaysia resulted in strip prints of SAR imagery for each flight line at a scale of 1:100,000. Computer processed mosaics in three sheets were produced at the same scale for plotting geological and cultural interpretations of the SAR data.

The geological interpretation and lineament analysis resulted in more detailed information than that available from the published maps of the Geological Survey of Malaysia whilst the cultural interpretation included the identification of forest type and land use.

Areas of structural interest identified from the geological interpretation are now being surveyed from the ground. The cultural interpretation is used as a guide for accessibility for both geological field crews and seismic crews and was used in the planning of the seismic programme.

THE APPLICATION OF DETAILED RESERVOIR GEOLOGICAL STUDIES IN THE D18 FIELD, BALINGIAN PROVINCE, OFFSHORE SARAWAK

J. ALMOND, P. VINCENT & L. R. WILLIAMS
SARAWAK SHELL BERHAD

The D18 Field is located 56 miles north-west of Bintulu in sub-block 4Q-15 of the Balingian Province, offshore Sarawak. The productive reservoirs comprise Lower Miocene age (Cycle II) lower coastal and delta plain deposits. The field is a tectonically complex structure, bounded to the south by a high angle reverse fault and is fault and dip closed to the north, west and east. The internal geometry is complicated by the presence of numerous cross cutting ENE/WSE and N/S trending faults.

The field was discovered in 1981 and following encouraging appraisal of the eastern part, an eight slot mini-production platform was installed. Five development wells were drilled and the field came on stream in 1986. The field produced at a peak rate of 5300 BOPD although a rapid production decline was observed in some of the wells. The poorer than expected results combined with the presence of several different fluid contacts and variable sand distribution raised uncertainties about the lateral extent and degree of interconnectedness of the reservoir sands.

A detailed reservoir geological study (including some 1400 ft of core and ten wells) was therefore undertaken to develop a geological model for the Cycle II sediments which could be used to determine the characteristics (sand quality/heterogeneity) and architecture (geometry/lateral extent/connectedness) of the reservoir sands. This was integrated with the results of a 3D seismic study which was primarily undertaken to determine the extent of reservoir level faulting, but also supported an Intra Cycle II reservoir correlation and assisted in defining sandbody geometry.

The Cycle II deposits have been sub-divided into an Upper, Middle and Lower Interval. The main productive reservoirs occur in the Middle Cycle II. Four genetic sandbody types are identified namely; fluvial/distributary channel, crevasse, mouthbar and shallow marine sands. A geological model was proposed which envisages the north-west to north-easterly progradation and abandonment of small delta lobes in a river dominated lower delta plain setting.

Detailed log correlation in the Middle Cycle II interval indicated the considerable lateral extent of both the shallow marine sands which occur field wide (> 22,000 ft), and the crevasse and mouthbar sands which can be correlated over distances of 3,000 to 10,000 ft. These sands are thin (10 to 30 ft) and exhibit a wide range in reservoir quality depending upon their location relative to either the proximal or distal parts of the abandoned delta lobe margin (shallow marine sands) or the active distributary channel (crevasse and mouthbar sands). The thicker (30 to 50 ft) and better reservoir quality fluvial/distributary channel sands are of more restricted lateral extent (typically 800-2,500 ft) and can only occasionally be correlated between wells on the current well spacing.

The geological model has provided an improved understanding of the distribution of the reservoir sands and recoverable reserves in the D18 Field. The study has indicated that different fluid contacts observed in laterally extensive sands are probably the result of offset by sealig faults. These faults compartmentalise the D18 field into several fault bounded blocks each containing isolated reservoir sands capable of supporting their own fluid columns. Detailed mapping of the reservoir sands within the fault bounded blocks has enabled more accurate determinations of hydrocarbon volumes, predictions of ultimate well recoveries and production potential of the D18 Field.

RELATIVE TIMING OF HYDROCARBON MIGRATION IN THE MIOCENE SUBIS LIMESTONE OF NW SARAWAK

AZHAR HJ. HUSSIN & NURAITENG TEE ABDULLAH
UNIVERSITY OF MALAYA

Quarrying on the southern tip of Subis Hill exposed the uppermost part of the carbonate buildup, revealing the existence of two reefal sequences. At the base of each sequence is algal-foraminiferal packstone which acted as substrate upon which coral thickets and head and algal encrustation grew. The upper part of the reef is composed of rudstone representing the demise and breakdown of the reef. The sequence is finally capped by miliolid-rich wackestone probably deposited in lagoonal setting. The reefal sequences were transgressed by reef flank sediments consisting essentially of thick algal-lepidocyclina packstone beds. Basinwards the sequence is composed of shale with interbeds of graded packstone. These packstones are rich in planktonic foraminifera and derived shallow-water fauna.

These sediments were subjected to a phase of early marine diagenesis. Subsequently they were exposed and were affected by meteoric water in the vadose and phreatic environment. Pore space were later partly or completely occluded by calcite cements, which in places are ferroan and poikilotopic. Minor dolomitisation also occurred but was restricted mainly to the flank sediment. Microrhombic dolomite crystals form patches in the lime mud and in fossils having high magnesium calcite as their skeletal constituent.

With increasing burial, compaction of the limestone led to the formation of fracture and stylolites. Bedding-parallel stylolites preceded the formation of bedding-oblique stylolites. Into these fractures and other vugs, saddle dolomite and coarse calcite grew competitively. Several generations of the saddle dolomite were formed and cannibalised. Timing of the saddle dolomites and coarse calcites formation span from a pre-stylolite phase to well into the phase in which these bedding-oblique stylolites were developed. Hydrocarbon migration took place at around the time of the saddle dolomite formation.

The history of sedimentation and early diagenesis of this limestone can be explained in terms of cycles of relative sea level changes. Later diagenetic events were the results of burial followed by folding and fracturing. Late Pliocene uplift led to the exhumation of the Subis Limestone.

GEOLOGICAL SURVEY OF CANADA'S APPROACH TO PETROLEUM RESOURCE ASSESSMENT

RICHARD M. PROCTER AND GORDON C. TAYLOR
GEOLOGICAL SURVEY OF CANADA

The Geological Survey of Canada uses two methods to evaluate oil and gas resources, both of which operate at the exploration play level, selected because they are capable of estimating the size and reservoir characteristics of individual pools as well as estimating the total play potential. The two approaches are called the discovery process model and the subjective probability methods.

The discovery process model is a statistically based method developed by Lee and Wang. For established plays, with as few as eight discoveries, this method has been found to be the more powerful of the analytic approaches. The underlying theory is that discoveries made in the course of exploration represent a biased sample of a population of pools, the sum of which is equal to the resources in a play. If the discovery process can be understood and modelled, then methods can be developed to estimate the characteristics of the population. The discovery process model of Lee and Wang uses the sizes of discoveries that have already been made and their sequence of discovery to produce estimates of both play potential and individual pool sizes. This method, using two of the most reliable sets of input data, deals equally well with stratigraphic and structural plays, a feature that not all methods have.

The subjective probability method is used mainly for conceptual and very immature plays. For these plays, subjective opinion, combined with such data from exploration as exist, is used to estimate the size and number of prospects by constructing frequency distributions of the variables involved. The method also required the subjective estimation of either the exploration risk of the total number of pools.

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INDUCTION, RESISTIVITY AND MWD TOOLS IN HORIZONTAL WELLS

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HALLIBURTON LOGGING SERVICES, U. S. A.

Conventional induction and focused resistivity tools are designed to measure resistivity from a vertical borehole surrounded by a cylindrically invaded zone while minimizing the signal contribution from adjacent horizontal beds. In recent years our understanding of these devices was extended to include beds exhibiting a large dip relative to the borehole as in the case of a highly deviated well. We shall investigate the applicability of induction and resistivity devices to horizontal wells, where the borehole run parallel to the bed boundaries.

The presence of the borehole may be simply ignored for induction sondes and the tool response is computed via an analytic solution. Because of the relative simplicity of the induction solution, the log response is computed for entire trajectories for the more common radii of curvature used in the drilling process.

On the other hand, for focused resistivity devices such as the dual laterolog or the MWD toroid sonde the borehole is an essential part of the problem. The tool response is evaluated using a numerical solution to stimulate accurately the complex physical situation.

The modeling results for the resistivity devices indicate that the measurement is more sensitive to conductive than to resistive shoulder beds. Typically, for the MWD sonde fifty percent of the resistivity signal comes from the adjacent conductive bed when it is half a foot away from the approaching borehole wall. A similar sensitivity to a resistive adjacent bed is not attained until the borehole has actually penetrated the bed. The reverse physical situation is evidenced with induction devices; resistive adjacent beds are more readily detected than conductive adjacent beds.

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A TRIASSIC 'REEFAL' LIMESTONE IN THE MALAY BASIN, SOUTH CHINA SEA: REGIONAL IMPLICATIONS

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PETRONAS PETROLEUM RESEARCH INSTITUTE
&
HENRI FONTAINE
CCOP BANGKOK

A palaeontological and sedimentological study was carried out on samples from a well, Sotong B-1, drilled in the South Malay Basin. This study was confined to the pre-Tertiary limestone basement rocks. This limestone has been assigned to the Late Triassic and displays characteristics similar to other Late Triassic limestones of the Tethyan realm. The age of the limestone allows to imagine that a pre-Tertiary basement sequence ranging from the Lower Carboniferous to the Upper Triassic probably exists in the offshore areas of the Malay and Thai Basins.

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A DISCUSSION OF SNIFFER SURVEYING, OFFSHORE MALAYSIA

MANSOR AHMAD & MARK GANUE,
SUN MALAYSIA PETROLEUM CO. /INTEROCEAN

This paper describes the SNIFFER geochemical technique and its use off the western coast of Malaysia. SNIFFER analysis techniques, operational considerations and interpretive methodologies are discussed. Data from the SNIFFER are integrated with the seismic showing a high degree of correlation between interpreted structures and SNIFFER anomalies. Examples of three structures, SINGA UTARA, SINGA BESAR and SINGA TIMUR are related to the geochemical SNIFFER data.

PALAEOENVIRONMENTAL AND STRATIGRAPHIC EVOLUTION OF WESTERN PENINSULAR MALAYSIA

S. P. SIVAM & IDRIS MOHAMAD
UNIVERSITY OF MALAYA

Throughout the Palaeozoic, the western belt of Peninsular Malaysia appears to have been representative of a passive rifted margin with the deeper waters to the east. The climate was seasonal to arid and the setting one of oscillatory subsidence.

In Langkawi, the Cambrian is represented by a shallow marine deltaic/continental sequence. Despite the higher surface temperatures the weathering intensity appears to be less probably because of the absence of vegetation. Eolian activity must have been extensive but this has been masked by aqueous reworking suggesting the environment was one of a warm humid desert. The lower Setul limestones bear various evidence for meta or hypersalinity indicating an arid/semiarid climate at times in the Ordovician. The Early Palaeozoic in the mainland on the other hand is represented mainly by volcanoclastics, basinal black shales and limestones and there appears to have been uplift in the central region giving rise to carbonate banks in the Kinta-Kuala Lumpur area.

A major tectonic episode is interpreted to have taken place in the Devonian and the seas retreated almost totally from the Peninsular. However, though this episode resulted in significant topographic inversion did not produce much topographic relief on land.

The Late Palaeozoic exhibits various evidence for a much colder climate, though no evidence for glaciation has been reported. This together with the significant topographic inversion with marine environments altering drastically explains the conflict in the interpretation of the diamictites in the Singa Formation. Evidence also is presented for a more arid environment in parts of the Permo-Triassic limestones of the Chuping and Kodiang Formations.

There was again significant uplift in the Permian which resulted in the closure of the basins to the east whilst sedimentation continued through the Triassic in the Semanggol Sea. A major tectonic episode in the Late Triassic occurred when the union of the eastern and western blocks convened.

The continental sediments of the Mesozoic Tembeling Group indicate environments ranging from an arid to one of a well developed seasonal climate.

During the Cenozoic vertical block and oscillatory movements and lesser volcanic activity dominated. Geomorphic studies indicate probable climatic changes may have taken place.

Preliminary palaeogeographic interpretations place Western Peninsular Malaysia in higher (Northern?) latitudes throughout the Palaeozoic and Mesozoic. Lithofacies studies also indicate that no deep oceanic sediments are present suggesting that sedimentation took place throughout on a continental and/or attenuated crust. Subsidence dominated the Palaeozoic whilst uplift appears to have been dominant in the Mesozoic and Cenozoic.

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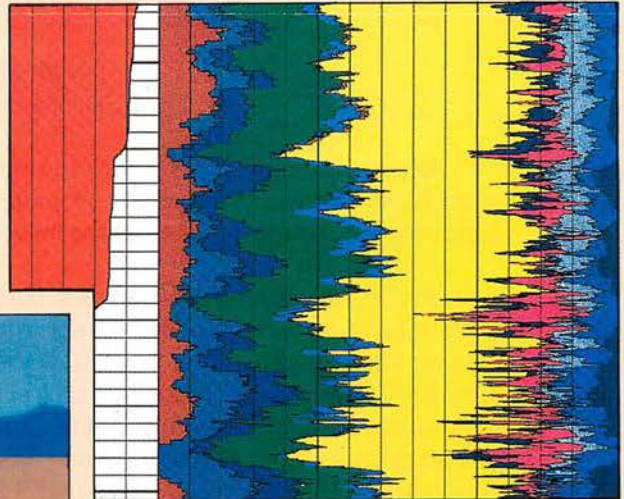
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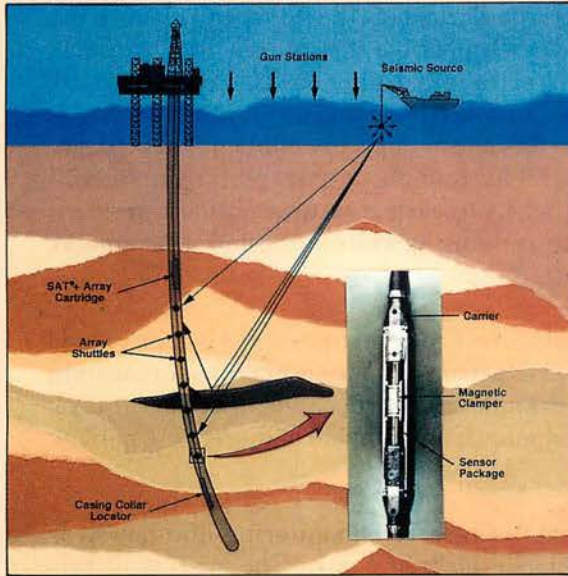
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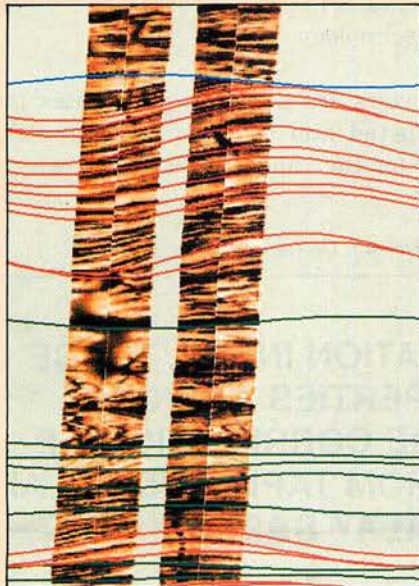
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AN INTRODUCTION TO RESERVOIR MONITORING

IAN MCMAHON
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Reservoir monitoring is a new and emerging technology. It is the application of multiple surveys of reflection seismic integrated with reservoir description and reservoir simulation to track the movement of fluid saturation in a reservoir.

Reservoir monitoring includes both the measurement of the past and current location of the fluids and the prediction of how the fluids will move in the future. This breakthrough in technology is possible through the integration of several disciplines and the focus of each of these disciplines on the reservoir being monitored. Accurate monitoring of the interwell position and movement of fluids in a producing hydrocarbon reservoir can yield major economic benefits through, for example: avoidance of premature breakthrough, optimal placement of infill wells by accurately defining areas of high hydrocarbon saturation, measurement of cone development before coning into a producing well occurs, and other similar improvements in field development.

Seismic response to original fluid contacts has been observed in many fields and reported previously. Recent field experiments, based upon past research, have shown that a differential technique using repeated seismic surveys, reservoir description, and reservoir simulation is capable of discerning moving oil-water fronts in a reservoir.

This paper addresses the concept of reservoir monitoring and how it is performed. Technical issues are introduced that control the success of this technology when applied to the complex reservoirs found in practice as well as the economic justification for applying the technology.

It is concluded that many more reservoirs are potential candidates for reservoir monitoring than previously predicted and there is a substantial economic return. Guidelines are presented for the range of reservoirs which might benefit from reservoir monitoring.

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APPLICATION OF CORRELATION INDEX, TRACE ELEMENTS, BULK PROPERTIES AND GAS CHROMATOGRAPHY IN THE CORRELATION OF CRUDE OILS PRODUCED FROM TAPIS AND PULAI FORMATIONS, MALAY BASIN

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Analysis based on the characteristics of the whole crude and characteristics of the crude distillates and their residues were performed on the crude oils from Tapis and Pulai oilfields. The crudes were tapped from the J-10, 15, 20, 25, 30 sandstone reservoirs of the Tapis Formation and K-10, 20, 30, 38 sandstone reservoirs of the Pulai Formation.

Three types of crude oils were then recognised from the correlation studies.

The correlation index (calculated using the specific gravities @ 15 deg. C and the average boiling points of the crude fraction cuts) plotted against the fraction cuts/numbers of all the crudes displayed characteristics curves according to their basic hydro-carbon structures. Structurally the Tapis crude (Tapis Oil Type 1) are highly paraffinic while the Pulai crudes are mostly naphthenic (Pulai Oil Type 1) with the exception of one crude exhibiting naphtheno-paraffinic trend (Pulai Oil Type 2).

The levels of V, Ni, Co, Mn, Cu, Al, Fe and Zn are mostly low in concentration and are significantly different for the various crudes. Generally the Tapis crudes which are relatively more viscous, with higher pour points and higher asphaltene contents, contained relatively higher concentrations of trace elements when compared to the Pulai crudes. These are strongly linked to some source environmental factors for the crudes. Na, Ca, Ba and Mg concentrations are anomalously high in the Pulai crudes and this is believed to be attributed to the influence of the incorporated oilfield waters. The V/Ni ratios show slight difference between the three crude families.

The capillary gas chromatographic analysis on the crude saturates based on n-alkanes and isoprenoids (pristane and phytane) showed that all the crudes are "normal" and matured. The chromatograms of the C₁₂ saturates of the crudes revealed the gross differences between the Tapis and the Pulai crudes with the latter clearly signify their naphthenic nature by the prominent cyclo-alkanes background peaks. Among the Pulai crudes, the Pulai Oil Type 2 registered very much less cyclo-alkanes compared to the Pulai Oil Type 1. The organic sources are mainly terrigenous and the source environments for the crudes were able to be deduced from the gas chromatographic analysis when coupled with the geological knowledge of the areas.

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HIGH RESOLUTION SITE SURVEYS USING WATERGUNS WITH SEMI-EXPLORATION OBJECTIVES

TONG POW MUM & JOHN WARR
RACAL SURVEY (MALAYSIA) SDN. BHD. /SUN MALAYSIA PETROLEUM CO.

Seismic site surveys have traditionally concentrated almost exclusively on very shallow targets usually down to a few hundred metres. Spreads have been short and sources have been rich in high frequencies and low in energy. It has often been impractical to consider both shallow and deep targets in one survey due to the increasingly great depths of target reflectors.

In Block PM1 offshore Malaysia, we have a target at around 2000 metres which was imaged by the deep seismic survey as a weak but relatively uncomplicated unconformable reflector. An extended site survey was designed to explore potential shallow hazards and rig anchor characteristics, but also to investigate the target reflector with more resolution, both spatial and temporal.

ESTIMATES OF UNDISCOVERED RECOVERABLE CONVENTIONAL OIL AND GAS RESOURCES OF THE UNITED STATES

RICHARD F. MAST
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In 1987, the U. S. Geological Survey and Minerals Management Service completed the assessment of the undiscovered conventional resources of crude oil and natural gas in the United States. The assessed resources were defined as (1) those considered recoverable under current technology, and (2) those that could be recovered economically under specified price-cost relationships. Not included in the study were resources from TAR deposits, heavy oil deposits, oil shales, gas in low-permeability 'tight' reservoirs, coal bed methane, gas in geopressed shales and brines, and gas in natural gas hydrates.

The assessments were based upon the analysis of oil and gas plays and prospects supported by studies and analysis of the petroleum geology, exploration history, finding-rates, and field size distributions. Probability procedures were used in their derivation.

The estimates of undiscovered recoverable conventional oil resources for the United States range from 33 to 70 billion barrels, with a mean estimate of 49 billion barrels and the estimates of undiscovered gas range from 307 to 507 trillion cubic feet, with a mean of 399 trillion cubic feet.

The undiscovered economically recoverable oil and gas resources for the United States are estimated to range from 21 to 54 billion barrels of oil and 208 to 326 trillion cubic feet of gas. The mean value for oil is 35 billion barrels and for gas 263 trillion cubic feet.

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STRUCTURAL STYLE AND TECTONICS OF WESTERN AND NORTHERN SABAH

FELIX TONGKUL
UNIVERSITI KEBANGSAAN MALAYSIA, SABAH

The western and northern part of Sabah consisting of sedimentary and igneous rocks of Early Cretaceous to Pliocene age have undergone several episodes of deformation related to the opening of the South China Sea Basin. The western and northern part of Sabah are characterised by a linear regional pattern of long parallel ridges trending approximately N20E and N110E respectively. These linear ridges are cross-cut by several strike-slip faults trending approximately N-S, NE-SW and NW-SE. In Western Sabah these ridges are represented by sedimentary rocks of the Crocker and Trusmadi Formations, while in Northern Sabah they are represented by the sedimentary rocks of the Crocker, Kudat and Bongaya Formation.

The earliest episode of deformation which was responsible for the deformation and uplift of the basement rock (Chert-Spilite Formation) here, probably occurred during Early Eocene time as indicated by the common appearance of limestones during this time. This deformation is characterized by tightly folded chert beds with randomly orientated fold axes, sheared and brecciated igneous rocks, seen mostly in Northern Sabah. This early deformation is thought to have controlled the development of an elongate basin trending approximately N-S in Western Sabah and E-W in Northern Sabah as indicated by paleocurrent measurements.

The elongate basin in Western and Northern Sabah became the site for the deposition of the Crocker, Kudat and Trusmadi Formations during Middle Eocene to Early Miocene times. These sediments were subsequently deformed during Middle Miocene times to form a series of imbricate thrust slices (1-2 km wide). These thrust slices are commonly represented by large asymmetric folds verging towards the west and north in Western and Northern Sabah respectively. Shaly units (red and grey shales of about 20-30 m thick) within these formations provided the decollement surface for the development of this imbricate thrust structure. These decollement surfaces are generally characterised by a sheared and disrupted beds. In Northern Sabah, blocks of basement rocks, Crocker and Kudat Formations mixed together in a sheared grey shale matrix probably represents major fault zones.

The presence of the two major regional trends indicates at least two major compressional directions, a NW-SE compressional direction in Western Sabah and a N-S compressional direction in Northern Sabah. The timing of both deformations is uncertain due to poor age control of the sediments in Western and Northern Sabah. Structural evidence around the hinge of both trends showing the occurrence of refolded fold however suggests that these compressional directions probably occurred progressively from NW-SE to N-S directions.

The NW-SE and N-S compressional directions controlled the development of NE-SW and E-W trending basins in Western and Northern Sabah respectively for the deposition of younger sediments during Upper Miocene to Pliocene times. The continued N-S deformations in Northern Sabah affected the Bongaya Formation to form gentle folds trending E-W and extensional faults trending N-S. Both compressional forces continue today as shown by the presence of active mud volcanoes in Western and Northern Sabah.

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SONIC WAVEFORM SIGNATURE ANALYSIS FOR RESERVOIR EVALUATION

ROOPA GIR & GILLES MATHIEU
SCHLUMBERGER OVERSEAS S. A.

A number of properties of the sonic waveform such as amplitude, phase, frequency and velocity of the various wave types (compressional, shear and stoneley waves) are grouped together in a waveform display. By means of sonic attribute analysis (SONATA*), it becomes possible to decompose the amplitude information from the phase or frequency information, which adds another dimension to waveform interpretation.

Several properties of the full waveform sonic have been analysed in various lithologies and borehole environment (open hole, cased hole, water base and oil base mud). These are :

- Compressional and shear envelopes (instantaneous amplitude) and their ratio,
- Compressional and shear transit times and their ratio,
- Stoneley energy and frequency behaviour.

The examples highlight the following various applications :

1. Fluid differentiation i.e. gas vs oil and gas vs water.
2. Formation strength for mechanical properties of rocks.
3. Determination of natural fractures.
4. Fracture height determination in case of induced fractures.
5. Lithology differentiation.

* A trade mark of Schlumberger

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TECTONIC EVOLUTION OF THE NW SABAH CONTINENTAL MARGIN SINCE LATE EOCENE

DENNIS N. K. TAN & J. M. LAMY
SABAH SHELL PETROLEUM COMPANY LTD.

The NW Sabah continental margin, located in the northern part of NW Borneo, consists of a Tertiary trench-associated sedimentary basins (with up to 12 km of siliciclastic sediments) and the Southern South China Sea platform, separated by the deep and relatively narrow, NE-trending NW Sabah Trough.

The Tertiary sedimentary sequence was deposited during two main phases of basin development :

- (1) A pre-early Middle Miocene phase of generally deep-marine clastic sedimentation (Stages I, II and III). The sediments were subjected to strong compression to form an imbricate wedge related to the subduction of the South China Sea plate. This was concomitant with the counterclockwise rotation of the Borneo plate, and the relative motion of the two plates may have produced N-S wrench faults, and
- (2) A post-early Middle Miocene phase of clastic shelf/slope deposition (Stage IV) which prograded northwestward over the underlying imbricated wedge and separated from the latter by a major regional unconformity.

Based on different structural styles and sedimentation histories, the NW Sabah continental margin can be sub-divided into 7 tectonostratigraphic units of provinces : (1) Crocker Accretionary Prism, (2) Inboard Belt, (3) Outboard Belt, (4) East Baram Delta, (5) NW Sabah margin, (6) NW Sabah Trough and (7) Southern South China Sea platform. Some 87 exploration and exploratory appraisal wells have been drilled in the NW Sabah offshore and, apart from minor oil and gas shows in the pre-early Middle Miocene deep-marine sediments,

all commercial accumulations discovered to date are in the Middle Miocene or younger clastic reservoirs in the Inboard Belt, Outboard Belt and East Baram Delta. The other tectonostratigraphic units have not been drilled to date.

The tectonic evolution of the NW Sabah continental margin occurred over four stages:

- (1) The Late Eocene to early Middle Miocene subduction of the South China Sea oceanic crust beneath Borneo with deposition and subsequent imbrication of deep-marine sediments into an accretionary prism.
- (2) The collision and subduction of the South China Sea attenuated continental crust with Borneo in Early Middle Miocene which led to regional uplift and erosion of the accretionary prism resulting in the Deep Regional Unconformity. This was followed by NW progradation over the Inboard Belt from coastal plain to deep marine during Middle Miocene to early Late Miocene.
- (3) Cessation of active subduction in middle Late Miocene was accompanied by major tectonic activities. The Inboard Belt was subjected to strong compressional deformation, probably associated with deep-seated major N-S shear zones. The area was strongly folded, uplifted and eroded resulting in the Shallow Regional Unconformity. Transensional tectonics at the western margin of the Belt resulted in the formation of two major depocentres i.e. the Outboard Belt and the East Baram Delta.
- (4) From the Late Miocene to Holocene, the Inboard Belt was a shallow stable area which was continuously eroded till Stage IVF times. In the Outboard Belt and East Baram Delta, a thick prograding wedge built out towards the northwest from Late Miocene to Holocene. A Late Pliocene phase of deformation affected mainly the Outboard Belt and East Baram Delta and gentle anticlinal features with numerous crestal faults were formed.

RESERVOIR DESCRIPTION: A SYNERGISTIC APPROACH TO MORE ACCURATE DETERMINATION OF OIL AND GAS RESERVES

D. G. BOWEN, T. KENNAIRD & J. HILL
CORE LABORATORIES MALAYSIA/SINGAPORE

Many Oil and Gas producing companies in Asia are discovering that their major fields have significantly more recoverable reserves and oil in-place, than originally estimated.

Inadequate Reservoir Description by traditional methods has been identified as a major contribution to this phenomena.

Presented here is a selection of possible causal factors, chosen from case histories in the area, and, a practical, systematic approach to the evaluation of data normally acquired at different scales of measurement. This data includes :- Processed Seismic data, Well Test data, Well Log data and Core Derived data.

Particular emphasis is placed upon the synergy between these parameters in their application to Reservoir Description, and the role of core data is emphasized.

THE MALIAU BASIN, SABAH: GEOLOGY AND TECTONIC SETTING

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UNIVERSITI KEBANGSAAN MALAYSIA

&

P. S. LIM & TUNGAH SURAT
GEOLOGICAL SURVEY OF MALAYSIA

New field data were collected from the Maliau Basin that is entirely composed of the lower to middle Miocene Tanjong Formation. The rocks are mainly grey to black, often carbonaceous mudstone; fine-to medium-grained, grey to brownish grey sandstones; siltstone; coal seams and minor beds of conglomerate. Light-coloured coarse-grained, friable sandstone occurs locally as thick to massive beds. The sandstone beds contain ripple marks, other current features, and organic imprints. Sole markings may also occur and consist of groove, load and flute casts. Some strata display tabular and trough cross beds, bedding-parallel as well as bedding-transgressive burrows and up to metres wide sandy palaeo-channels. Palaeocurrents ran mainly in NE-SW direction. In the south-central part and in the rest of the surveyed area, palaeo-current sense was towards northeast and towards southwest, respectively.

The presence of carbonaceous material and coal seams indicate an estuarine to brackish environment of deposition. The thick coal seams suggest origins in poorly drained swamps. The arenaceous palaeo-channels, trough cross-beds, and one occasion of crescentic flute marks on a sandstone bedding surface are consistent with deltaic/tidal flat surroundings. Pollen and spores from mudstone representing the middle and lower parts of the formation indicate Early Miocene age. Among the trace fossils were determined *Chondrites* sp., *Granularia* sp., and *Ophiomorpha* sp. Foraminifera include *Quinqueloculina* sp. and *Rotalia* sp.

Thirty one coal seams ranging in thickness from a few centimetres to 1.8 m were recorded from 24 localities. The thicker seams are more frequent in the middle and lower parts of the formation. The ISO-tests of two coal seams indicate generally low moisture content; one has also low ash content and corresponding high, gross calorific value. The great thickness of the Tanjong Formation, estimated at 12 km, and the widespread presence of carbonaceous mudstone favour the occurrence of hydrocarbons. Structural traps may be provided by northeast striking fault zones flanking the Maliau Basin on the west and east sides. The basinal structure and the presence of a sufficiently large watershed are favourable for developing hydropower in the Maliau Basin.

The outer rim of the Maliau Basin, represented by the Lutong Ridge, shows a rounded outline 25 km across, but the morphology and bedding attitudes within the basin indicate that the basinal structure is not concentric. The basinal centre is close to the southern outer rim while bedding-strikes intersect obliquely the trends representing Lotung Ridge. These features may have resulted from a depositional area that steadily decreased in size and a southward migrating depocentre during the development of the Tanjong Formation. Bedding dips vary between 10 and 20 degrees; occasional steeper dips are found associated with gravity faults. Long joints spaced a metre or so apart form two to three vertical fracture sets in the sandstone. Some of the prominent lineaments on aerial photographs are parallel to the major joints. Folds are extremely rare and occur near fault zones.

The Maliau Basin is part of the Tarakan Trough, an early-middle Miocene aulacogen belonging to the Makassar rift system. By 13 Ma (Middle Miocene) spreading of this system came to a halt; the Makassar rift arm by the arrival of Sulawesi terranes from the east, and the Tarakan aulacogen by welding of the East Sabah Terrane to Borneo.

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AN IMPROVED BOREHOLE TELEVIEWER SYSTEM: IMAGE ACQUISITION, ANALYSIS AND INTEGRATION

J. K. FARAGUNA, D. M. CHACE AND M. G. SCHMIDT
ATLAS WIRELINE SERVICES/WESTERN ATLAS INTERNATIONAL, INC.

Borehole imaging devices can provide valuable information to aid reservoir descriptions. Applications include fracture identification, stratigraphic interpretation and thin-bed analysis. The imaging devices range from video cameras for use in air-filled or clear-fluid-filled boreholes, to resistivity scanning devices for use in conductive muds, to circumferential acoustic imaging devices for both conductive muds, to circumferential acoustic imaging devices for both conductive and non-conductive mud systems.

A circumferential borehole imaging device utilizes a rotating transducer operating in a pulse-echo mode to scan the entire circumference of the borehole wall. Variations in lithology, physical rock features (such as fractures, vugs, and laminations), and borehole geometry cause changes in the measured amplitudes and traveltimes, collectively providing a map, or image of the borehole wall. Although the instrument provides total borehole coverage, and can be used in fresh and oil-base muds, application has been limited in the past due to poor image quality, slow logging speeds, and mud weight restrictions.

An improved borehole imaging system (Circumferential Borehole Imaging Log - CBIL) has been developed which incorporates an improved transducer design, operating at higher data sampling rates. High quality images are obtained with improved vertical and horizontal resolution in an expanded range of borehole sizes and mud weights.

This paper addresses various applications of the new instrument, with particular emphasis on integrated approach to borehole televiewer interpretation in combination with other geophysical data.

GEODYNAMICS OF CENOZOIC BASINS IN NORTHERN SUNDALAND AREA

K. R. CHAKRABORTY
UNIVERSITY OF MALAYA

Cenozoic basins in northern Sundaland region have developed in continental intraplate setting. Geodynamical aspects of their evolution are poorly understood, and currently available data do not permit any detailed analysis. A qualitative evaluation of the basin-forming mechanisms and relevant forces is attempted through integration of various lines of evidence including the following: (i) predominance of extensional structures, (ii) episodic magmatic events (iii) high heat flow, (iv) triple junction of rift grabens, (v) continental to marine sediment sequence in many basins. These features and other geological evidence are somewhat equivocal and can be accommodated in both time-dependent lithospheric stretching and thermal perturbation models.

The main problem of lithospheric stretching models concerns the source/origin of the required horizontal tensional force. Transtensional force induced by "extrusion tectonics" (consequent upon collision of India) has been invoked in recent years by several workers who regard these basins as wrench basins. Available evidence, in particular the timing of rifting, argues against this interpretation. (Extrusion tectonics itself as hypothesized on the basis of model study is suspect). Although the timing of rifting is not well constrained, a Cretaceous, and possibly earlier, age can be inferred based on geological evidence (dyke injection, basin stratigraphy). Thus, the initiation of rifting predates the India-Asia collisional event, and hence the proposed transtensional forces can be discounted. Lithospheric stretching is perhaps due to membrane stresses generated by the movement of Sundaland (in response to the non-sphericity of the Earth). In expanding Earth, however, lithospheric stretching is an inevitable consequence - a viable alternative.

Pre-rift doming is expected in thermal perturbation models. Although evidence for late Mesozoic doming exists, its temporal relationship with rifting cannot be precisely ascertained. Consequently the validity of thermal perturbation models remains uncertain inasmuch as doming is also possible in lithospheric stretching models. A distinct possibility exists that in this region lithospheric stretching broadly coincided with thermal perturbation.

Multiple episodes of rifting and subsidence occurred in this area with variable effects on basins. The latest rifting episode is possibly marked by the thermal event represented by alkali basaltic volcanism (mainly Late Miocene -

Opposing rotation of Malay Peninsula - Borneo (anticlockwise) and Indochina (clockwise) would impose significant variations in stress patterns in time and space. Localised compression in overall tensional environment is likely. Subsidence and uplifts of basin centres relative to margins, narrowing and widening of basins, onlaps and offlaps, differential deformation of basin fills, etc. may be attributed to such stress variations. The evolutionary patterns of Sundaland basins, thus, can only be understood when viewed in proper time-space perspective.

THIN BED RESOLUTION AND THE DETERMINATION OF FLUSHED ZONE RESISTIVITY IN OIL BASED MUD

JOSEPH F. GOETZ, ROLAND CHEMALI & DOUGLAS SEIFERT
HALLIBURTON LOGGING SERVICES, U. S. A.

In the detailed description of reservoirs, thin bed resolution by wireline techniques is a vital factor. While common microresistivity devices may suffice in water based muds, special techniques must be devised for oil based drilling fluids. Rather than running an exclusively designed tool, a cost saving could be effected if the desired information could be derived from a logging tool routinely run for other purposes. The Six Arm Dipmeter has been extraordinarily successful in producing dips in oil based muds. The raw data can also be used for discrimination of sand-shale laminae down to thicknesses of one inch. A reliable measurement of net sand thickness is thus provided as well as the volume fraction of shale in laminated form, V_{lam} , for input into laminated shaly sand saturation equations.

In addition, the same measurement provides data for the value of the flushed zone resistivity, R_{xo} , in oil based muds, information which can be used to further refine saturation computations. This is possible because the Six Arm Dipmeter generates resistivity curves absolutely calibrated in ohm-m. Furthermore, there is scope to study the depth of invasion of specific oil based muds, and because measurements are made on six sides of the hole, to recognize and bypass pad contact problems.

These applications of the Six Arm Dipmeter are approached from both computer modeling and field examples.

EXPLORATION AND PRODUCTION APPLICATIONS OF THE BOREHOLE ELECTRICAL IMAGERY

MOHAMED TAHA
SCHLUMBERGER OVERSEAS S. A.

Borehole electrical imagery provides valuable structural, stratigraphic, and sedimentological information for explorationists, production geologists, and reservoir engineers.

The use of the imagery in extracting, with a high degree of confidence, structural and stratigraphic dip information has been found of great value in evaluating new exploration plays. Also, it illustrates clearly, for the first time, the various distinctive tectonic elements, that intersected by boreholes, and manifests their morphology.

The high resolution images improve our capacity in exploring for and appraising secondary porosity reservoirs. Vuggy and fractured reservoirs are of great significance in different parts of the world. Fractured basement associated with shear zones have become an important exploration target in the Gulf of Suez.

In highly laminated reservoirs and where standard well log evaluation tend to give a pessimistic results, the borehole imagery, and due to its high resolution, is able to reveal thin reservoir beds and attains its gross thickness. Furthermore, it can help in better estimating the percentage of clays in the formation which in turn leads to more realistic computation for hydrocarbon saturation.

Furthermore, the capabilities for the 3-dimensional analysis of sedimentary structures has give the geologists and reservoir engineers the ability in locating successfully development and injector wells. Indicating such features along a vertical sequence make it feasible to interpret as accurate as possible the depositional environment of this sequence together with the orientation of reservoir bodies. On the other hand, it has been evidenced that each type of crossbedding has its preferable permeability orientation.

The interactive analysis on the Sun workstation have further enhanced the contribution of the borehole electrical imagery to the industry.

The basic limitations, however, of the electrical imagery are related to the nature and/or the mud resistivity as well as to the washed over boreholes.

Geological Society of Malaysia -- Petroleum Geology Seminar 1989

3D MARINE EXPLORATION SEISMIC SURVEY IN SHALLOW WATER AREA OFFSHORE SABAH

VINCENT W. T. KONG, J. SMETHURST, B. H. CHIEM & R. C. STEWART
SABAH SHELL PETROLEUM COMPANY LTD.

The Production Sharing Contract in the SB1 block, offshore Sabah was signed in mid 1987. Exploration seismic surveys commenced immediately, with a large programme of 8600 km 2D and approximately 300 sq km 3D seismic survey planned. The exploration 3D seismic in particular was planned to over some shallow water areas over the Vernon Bank.

Shallow hazards within the 3D survey area were identified and 2-boat undershooting was initially planned to obtain requisite coverage under the shallow water parts of the prospect. A detailed hydrographic survey was conducted by Sabah Shell Petroleum Co. Ltd. to augment the available Admiralty hydrographic data over the prospect. Shortly after commencement of the seismic survey, it was reported by the crew that the vessel was not able to cover about half of the survey area due to extreme shallow water. Ensuing operational planning enabled the survey to be successfully completed to within 10% of the originally planned coverage. This was achieved in a timely manner using a combination of a regular line direction survey, orthogonal survey lines and a 2-boat undershooting programme.

NONE OF THE MODELS FOR SOUTHEAST ASIAN CAINOZOIC FAULTING AND SUBSIDENCE IS SATISFACTORY

PROF. CHARLES S. HUTCHISON
UNIVERSITY OF MALAYA

Regional Compression Hypothesis

Wood (1985) related the Cainozoic fault and basin pattern to E-W compression. However Mohr-Coulomb theory does not apply in a direct way to the faulting of anisotropic and pre-fractured rocks because planar weaknesses, oriented at angles as high as 65° to σ_1 , can be re-activated at relatively low critical stress levels. Therefore "it is unlikely that principal stress orientations responsible for the faulting can be deduced from the geometric facts available" - G.H. Davis (1984).

The flaws in the analysis of Wood (1985) are: a) No recognition was given to regional basement anisotropy, b) No change in stress pattern with time was entertained, c) His map is interpretative, and his fault extrapolations cannot be substantiated, d) There seems to be little case for a major Cainozoic E-W directed σ_1 .

Escape Tectonics Hypothesis

The innovative plasticene experiment of Tapponier *et al.* (1982) gave new direction to analysis of the Eocene and younger tectonics. The primary motivator is no longer regional compression (σ_1), but wrench faults propagated through the region from the Yunnan Syntaxis. The strain ellipsoid can be used to analyse the relationship between the wrench faults, and induced extension and compression patterns localized above and contiguous with the faults.

Pre-existing suture zones and narrow deformed fold belts should be the first to suffer wrench tectonics. The notable examples, which by fortuitous (?) accident lay in the orientation required for extrusion tectonics, are the E-W Quinlin and the NW-SE Red River-Song Ma. Both were active in the Paleozoic and Mesozoic, and presently are earthquake zones.

Wrench motion can be documented on the Bentong-Raub and Nan-Uttaradit-Luang Prabang to Dien Bien Phu sutures. However they are not now seismically active. N-S right-lateral wrench motion in the Central Belt of Peninsular Malaysia is held responsible for *en-echelon* folding of the predominantly Jurassic Tembeling Formation. In the Eastern Block, which is devoid of wrench faults, the Jurassic-Cretaceous formations are not folded, but have been differentially uplifted and tilted along the margins of the Malay Basin.

Early rifting of the Penyu Basin is documented by Albian (110 Ma) basaltic dykes at Kuantan. However, like most pre-existing zones of weakness, it was probably re-activated in the Cainozoic.

The N-S trending morphology of the Gulf of Thailand is controlled by Paleozoic and Mesozoic structures in Malaysia and Thailand. The E-W opening of Cainozoic basins in the Gulf and in North Thailand may have resulted from Cainozoic strike slip motion on the NW-SE Mae Ping and Three Pagodas Pass faults. The N-S striking elements are of older ancestry.

The Sibul Zone (Lupar and Mersing lines) continues towards the Natuna Arch as a Late Cretaceous through late Eocene active plate margin. Its accompanying volcano-plutonic arc should extend from the Schwaner Mountains towards the southern part of the Malay Basin. The Ketungau and Melawi fore-arc basins are related to this plate margin.

Essential towards an understanding of the fault systems and basins of Southeast Asia is a regional basement map, so that a **distinction** can be made between **older structures**, which may or may not have been re-activated, and the **completely new features imposed by Cainozoic escape tectonics**.

Triple Junction Rifting Hypothesis

The fractures and crustal attenuation patterns may have resulted from a high regional heat flux from the mantle, with little help from escape or compression tectonics. The S.E. Asian region seems to have been a very large mantle hot spot since the Late Mesozoic, resulting in triple junction rifting. There is one outstanding triple junction, which was active from the Palaeocene through the Miocene. The three arms are:

1. The Red River-Gulf of Bacbo (Tonkin);
2. The N.E. trend from south Hainan towards Taiwan; and
3. The N-S faulted margin of Vietnam.

One arm of a triple junction will invariably be defined by a pre-existing zone of weakness (arm 1). The other two are new directions. Arm 2 caused the rifting of the Chinese continental shelf, and eventually developed sea-floor spreading as the South China Sea Basin. Arm 3 became a major strike slip fault, responsible for removing part of the Precambrian Kontum Massif to an unknown destination (West Borneo?).

Complications From Plate Rotations

Other possible triple junctions have been so modified by plate rotations as to be difficult to decipher. The plate rotations are real. Schmidtke *et al.* (in press) proved that the whole of West Borneo has progressively rotated anti-clockwise, by 90° since Mid Cretaceous and by 45° since Eocene. There is support for an anti-clockwise rotation of S.E. Peninsular Malaysia. What drives this rotation is uncertain, but we also do not know what drives sea-floor spreading and subduction. The anti-clockwise rotation runs totally counter to the escape tectonics hypothesis.

Pessimistic Conclusion

Is there any possibility of evolving a satisfactory hypothesis for S.E. Asian Cainozoic tectonics?. Probably not, for tectonic processes are non-linear and non-linear processes usually defy analysis. No single process is allowed to continue long in S.E. Asia before being modified by other geological events, and plate rotations will result in continuously changing regional and local stress patterns.

SEQUENCE STRATIGRAPHY – CONCEPTS, APPLICATIONS AND EXAMPLES FROM MALAYSIA AND THE U.S.A

NIK RAMLI NIK HASSAN
FORAD GROUP, MALAYSIA

Seismic and sequence stratigraphic methods have helped to improve our understanding on the processes and events leading to the formation of a stratigraphic sequence. These methods have been applied to the outcrop on land. Some examples of sequence stratigraphic studies on outcrops in the San Juan Basin are given. Similarities between paleodepositional systems in the San Juan Basin and the Malay Basin are highlighted and comparisons made between the outcrop (San Juan Basin) and subsurface (Malay Basin) studies carried out in these basins.

REMOTE SENSING APPLICATIONS TO GEOLOGIC EXPLORATION

P. FUENNING, O. SAWICKI, F. G. BERCA
BERCA INTERNATIONAL INC.

An arsenal of tools deployed in the lower and upper atmosphere exists for use in exploring below the surface of the earth. A range of sensors covering teledetectors for virtually the entire range of the electromagnetic spectrum is available in airborne or spaceborne configurations, giving data applicable to many phases of geologic exploration, from mineral or structural anomaly detection to detailed seismic logistic planning.

In this paper, following a systematic description of active and passive remote sensing systems, a series of descriptions of their applications to exploration geology is given. The examples given include the following:

- (a) SAR and SLAR (radar);
- (b) Thermal infrared scanners and sensors;
- (c) Multispectral scanners;
- (d) Multisensor multiband systems.

Both spaceborne and airborne systems are considered. The examples are based on practical applications, generally from actual exploration projects to illustrate a variety of results useful to explorationists. Data acquisition and its characteristics, digital and analogue data processing, as well as visual and digital image analysis and interpretation are described. A comparative evaluation of remote sensing techniques available for support of exploration activities is presented in conclusion.

COMPUTER-AIDED ENERGY EXPLORATION AND DATA INTEGRATION

SUNNY A. A. SINGH & TONY PALICKI
INTERGRAPH SYSTEMS SEA PTE. LTD.

APPLYING THE MODIFIED STRESS-STRAIN ELLIPSOID TO RE-DEFINE THE STRUCTURAL/ GEOLOGICAL PROVINCES OF SARAWAK, BRUNEI AND NW SABAH

KUANG KOO SING
INNOVATIVE TECHNOLOGICAL GEO-EXPLORATION, AUSTRALIA

By applying the modified stress-strain ellipsoid, three main subplates can be defined in NW Borneo and its offshore. They are named, the Rajang, the Central Sarawak and the Baram-NW Sabah subplates. Their tectonics are dominated by the opening up of the South China Sea which since Cycle III or Stage IV caused a south easterly up tilt. Superimposed onto it are the anticlockwise rotation of Borneo during early tertiary, the cessation of subductions along the Lupar line, the Bukit Mersing line, and part of the Palawan Trough. The vast quantity of tertiary sediments brought down by the paleo river systems also has its impact.

By classifying their structural styles and its associated structuring mechanisms within the different subplates, one could define the various structural provinces. The important structuring mechanisms are (1) Thrustings, (2) Pull-aparts (3) Convergent wrenchings, (4) Divergent wrenchings and Diapirism. Due to the orientations of NW Borneo's paleo coastlines being virtually constant (NE-SW) since Cycle III or Stage IV, and its very gently dip, the structural provinces defined also correspond to its geological provinces.

The pre-Cycle III or pre-Stage IV structural styles are dominated by wrenching which is probably related to the propagation of the spreading axis of the opening up of the South China Sea. The accompanying anticlockwise rotations make it difficult to define its geological provinces.

CIRCULAR BASINS OF SABAH

LEE CHAI PENG
GEOLOGY DEPARTMENT, UNIVERSITY OF MALAYA
&
THAM KUM COONG
THE ANALYTICAL LABORATORIES (M) SDN. BHD.

The circular to oval Miocene basins are a rather widespread and curious feature of Borneo geology. No completely satisfactory explanation has been advanced for their origin. It is proposed that diapirism caused by gravity loading and slab-faulting related to basement tectonics play important roles in the formation of some of these basins. Examples of the former from a study of Labuan Island and the later from a study of the Bukit Garam basin are discussed.

PALAEOENVIRONMENTS OF THE LOWER MIOCENE TO PLIOCENE SEDIMENTS IN OFFSHORE NW SABAH AREA

EMELIANA D. RICE-OXLEY
SABAH SHELL PETROLEUM CO. LTD

A biostratigraphic reinvestigation of 108 SSPC and competitor wells was undertaken in order to review the palaeoenvironments of the Lower Miocene to Pliocene deposits in the offshore NW Sabah area.

The study was integrated with seismostratigraphic data, which defined the positions of the palaeoshelf edge/palaeocoastline, and allowed for more detailed palaeoenvironmental reconstructions. For each stratigraphic interval, palaeoenvironment maps showing the areal distribution of depositional environments, sand percentages and source rock potential were constructed. In addition detailed biostratigraphic/seismostratigraphic correlation enabled the recognition of four "seismic facies" (base of slope, slope, shallow marine-coastal and coastal plain). Integration with geochemical results allows the characterisation of the palaeoenvironments/seismic facies in terms of their source rock potential.

The study has provided a much better understanding of the depositional history of the offshore NW Sabah area and will assist in assessing the reservoir potential of undrilled prospects in Block SB 1.

MODERN AND ANCIENT DEEP-SEA FAN SEDIMENTATION - REPORT ON THE COURSE, WORKSHOP AND FIELDTRIP

The Petroleum Geology Study Group organised a three-day course on the "Modern and Ancient Deep-sea Fan Sedimentation", a one-day Core Workshop and a Fieldtrip from 6th December to 9th December 1989. The course was conducted by Dr. C.H. Nelson of the United States Geological Survey and Dr. T.H. Nilsen who is a Consultant Geologist. A group of about 25 geologists and geophysicists, mainly from petroleum companies and universities participated in this course which was held in the Shangri-La Hotel and about 20 attended the workshop at the Petronas Laboratory in Ulu Klang and the fieldtrip along the Karak Highway.

The course began with a review of the deep-sea fan concepts with emphasis that the present knowledge on deep-sea fans is derived from studies on modern fans from a variety of geologic settings as well as ancient sediments interpreted to have been in deep-sea fans. As such there are different perspectives due to these different studies.

Dr. Nelson reviewed the current observations and experimental studies on turbidity current and proceeded to discuss the morphology and stratigraphy of modern fans. He showed how depositional processes and patterns on modern fans led to the distribution of fan facies and facies associations.

Dr. Nilsen reviewed ancient deep-sea fan deposits and turbidite facies. He discussed how models of ancient turbidite deposits were made through examination and interpretation of turbidite facies and facies associations.

The final part of the course, which was conducted by both the course instructors, dealt with the synthesis of current knowledge of the deep-sea fans and their deposits and the applications to petroleum geology.

On the 9th December 1989, a core workshop was held which featured some examples of recent and ancient turbidites from offshore Sabah. Cores from Tembungo Field and those from the Sabah Trough were made available for study and discussion with the kind permission of Petronas Exploration Department. Discussions were mainly focussed on the type of sedimentary facies and on the probable turbidite models to be used for paleoenvironmental interpretation for these cores. Several seismic sections brought by a participant from Indonesia were also discussed. Before breaking for "teh tarik" at a stall near the laboratory, Dr. Nilsen showed a few examples of producing turbidite sequences from California.

By around noon the bus was on its way to the Karak Highway. The fieldtrip was headed by Dr. Azhar Hussin from University of Malaya. The first few stops were before the tunnel at Genting Sempah. Deformed turbidite sequences and olistostromes and paleozoic cherts were examined. The Group later stopped at some stalls east of the tunnel for a quick lunch before continuing further east. Three more large exposures were examined in the afternoon. The first was the exposure of turbidites, chert and conglomerates near Bukit Cinta Manis. The other two were a few miles east of this exposure along the Karak Highway. Thin laterally continuous medium grained turbidites interbedded with black shale were

well-exposed in the first road cut. This sequence was overlain by thick coarse-grained tuffaceous turbidite with a scoured base. Thick bedded turbidites and associated debris-flow deposit were examined in detail in the second outcrop. Much discussions were generated in the fieldtrip covering a variety of topics from facies interpretations, provenance and tectonic setting of the rocks examined.

The group started returning to Kuala Lumpur at about 4 pm and reached the Shangri-La Hotel at about 6 in the evening.

Azhar Hussin & Nor Azim.

Modern and Ancient Deep-sea Fan Sedimentation Workshop



Dr. C.H.Nelson conducting the workshop

CERAMAH TEKNIK (TECHNICAL TALK)

James Harding: Assessment of geological resources and management of the coastal zone.

Dr. James Harding, Senior Quaternary Geologist with Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas (CCOP), Bangkok, Thailand, gave the above talk on the 6th December 1989 at Institute for Advanced Studies (IPT), University of Malaya. The talk, jointly sponsored by GSM and IPT, attracted an audience of about 40.

Dr. Harding started his talk by defining the coastal zone as the tide limit landward and the 200 fathom limit seaward. The coastal zone is important as 81% of the world's population live an hour's drive from the coast and the principal resources, among others, include fish and hydrocarbon.

Because of such importance, there is need for proper management of the coastal zone. The major problems encountered in the coastal zone can be divided into two groups: 1) natural effects and 2) man-made or related effects. Natural effects include tornadoes, typhoons, surnamis, coastal erosion, land subsidence and sea level rise. The man-made or related effects include extraction of water, land reclamation, subsidence, dredging, wastes disposal, canalisation, irrigation, construction of resort areas parallel to strand line, mining, blasting, barriers, jettys, sea-walls etc.

Dr. Harding then went on to show some examples of these effects worldwide and in particular those at the SE Coast of USA and Thailand. In concluding his talk, Dr. Harding stressed the importance of coastal zone management so as not to repeat the mistakes made and lessons learnt elsewhere.

G.H. Teh



BERITA - BERITA PERSATUAN (NEWS OF THE SOCIETY)

KEAHLIAN (MEMBERSHIP)

The following applications for membership were approved:

Full Members

1. Azhar Yusof, Caleb Brett (M), 6 Jalan 51A/223, 46100 Petaling Jaya.
2. Bernard S. Hodges, Caleb Brett (M), 6 Jalan 51A/223, 46100 Petaling Jaya.
3. Harwant Singh, Asia Mining, No. 1, Pesiaran Lidcol, Off Jalan Yap Kwan Seng, Kuala Lumpur.
4. Zuraida bt. Mat Isa, EPMI, P.O. Box 10857, 50728 Kuala Lumpur.
5. Jariah bt. Kanip, EPMI, P.O. Box 10857, 50728 Kuala Lumpur.
6. Kamarolzaman Yahya, Petronas Carigali, P.O. Box 12407, 50776 Kuala Lumpur.
7. Koay Leong Thye, Wan Mohd. & Khoo, 737 Lorong 97, Taman Ria, 08000 Sungai Petani, Kedah.

Institutional Member

1. Enron Oil & Gas, Attn: David Lincoln, 1400 Smith St., Houston, Tx. 77251-1188, USA.

PERTUKARAN ALAMAT (CHANGE OF ADDRESS)

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

1. Chow Yue Cheong, c/o XGS/2, Sarawak Shell Bhd., Lutong 98100, Sarawak.
2. Technical Librarian, Ashton Mining Limited, P.O. Box 805, West Perth WA 6005, Australia.
3. Michael C. Friederich, BHP-Utah International, 200 Fairbrook Drive, Herndon, VA 22070-5200.
4. R.P.B. Pitt, GPO Box D164, Perth WA 6000, Australia.
5. Wahid Abdul Rahman, Pejabat Penyiasatan Kajibumi, Tingkat 5, Blok A, Wisma Persekutuan, 80000 Johor Bahru.

PERTAMBAHAN BARU PERPUSTAKAAN (NEW LIBRARY ADDITIONS)

The Society has received the following publications:

1. Commonwealth Science Council, July-Aug & Sept & Oct., 1989.
2. Determination of stream reaeration coefficients by use of tracers by F.A. Kilpatrick, *et. al.*, 1989.
3. Geophysical Research Bulletin, vol. 27, no. 2, 1989.
4. South Pacific marine geological notes, vol. 3, no. 4, 1989.
5. Measurement of time of travel in streams by dye tracing by F.A. Kilpatrick & J.F. Wilson, 1989.
6. Isrademt: Proceedings of the International Symposium on Research & development in extractive metallurgy of tin and related metals, 17-21 Oct. 1989, Ipoh, Malaysia, 1989.
7. Proceedings: 6th Regional Conference on the geology, mineral and hydrocarbon resources of southeast Asia, Jakarta, July 6-12 1987. 1989.
8. U.S. Geological Survey, Prof. Paper 1989: 1404-D, 1405-D, 1370-B, 1403-D.
9. U.S. Geological Survey Bulletin, 1989: 1756-D, 1757-E, 1809, 1756-E, 1721-D, 1749-B, 1715-D.
10. U.S. Geological Survey Circular, 1989: 1031.
11. AAPG Explorer, Nov & Dec 1989.
12. Books about Singapore, 1988.
13. Seatrad Bulletin, vol. X, no. 3, 1989.
14. Earthquakes & volcanoes, vol. 20, no. 6, 1988.
15. AGID News, no. 59, 1989.

BERITA - BERITA LAIN (OTHER NEWS)

INSTITUTE OF GEOLOGY, MALAYSIA

This is to inform you that the Institute of Geology Malaysia is now formally registered with the Registrar of Societies and is in the process of recruiting members. In connection with this, please find attached an application form for membership of the Institute. It is to be noted that the application for membership has to be sponsored by two corporate members of the Institute who at the present moment are the following:-

1. Mr. Fateh Chand, Jabatan Penyiasatan Kajibumi, Kuala Lumpur.
2. Dr. John Kuna Raj, Universiti Malaya, Kuala Lumpur.
3. Mr. Chin Lik Suan, Berkat Untungan Sdn. Bhd., Petaling Jaya.
4. Dr. Ahmad Tajuddin, Universiti Malaya, Kuala Lumpur.
5. Dr. Zainal Mohd. Eusof, Inst. Penyelidikan Getah, Kuala Lumpur.
6. Dr. Syed S. Almashoor, Universiti Kebangsaan Malaysia, Bangi.
7. En. Abdul Aziz b. Hussin, Universiti Teknologi Malaysia, Kuala Lumpur.
8. Mr. Chong Foo Shin, Jabatan Penyiasatan Kajibumi, Kuala Lumpur.
9. Dr. Leong Lap Sau, Universiti Sains Penang, Pulau Pinang.
10. Dr. Ibrahim Komoo, Universiti Kebangsaan Malaysia, Bangi.
11. Mr. Koh Tuck Wai, Petronas, Kuala Lumpur.
12. Mr. Zakaria b. Huissain, Jabatan Penyiasatan Kajibumi, K.T.
13. Mr. Ahmad Said, Petronas, Kuala Lumpur.
14. Dr. Azhar Haji Hussin, Universiti Malaya, Kuala Lumpur.
15. Dr. Abdul Ghani Rafek, Universiti Kebangsaan Malaysia, Bangi.
16. Mr. Albert Loh, Malaysian Mining Corp., Kuala Lumpur.
17. Dr. S. Paramanathan, Universiti Pertanian Malaysia, Serdang.
18. Mr. Khee Kok Kean, Esso Prod. Malaysia, Kuala Lumpur.
19. Mr. Yeoh Gaik Chooi, Esso Prod. Malaysia, Kuala Lumpur.
20. Mr. Chen Shick Pei, Jabatan Penyiasatan Kajibumi, Kuching.
21. Mr. Lim Peng Siong, Jabatan Penyiasatan Kajibumi, Kota Kinabalu.
22. Mr. Senathi Rajah, Kota Baru.
23. Mr. Loh Chiok Hoong, Jabatan Penyiasatan Kajibumi, Johore Bharu.

For your further information, the present Pro-Tem Committee of the Institute consists of the following:-

President	- Mr. Fateh Chand
Vice President	- Dr. John Kuna Raj
Secretary	- Mr. Chin Lik Suan
Treasurer	- Dr. Azhar Hj. Hussin
Ordinary Members	- Dr. Ibrahim Komoo
	Dr. Syed S. Almashoor
	Dr. Leong Lap Sau
	Mr. Chong Foo Shin
	Mr. Koh Tuck Wai
	Mr. Abdul Aziz Hussin
	Dr. Zainol Mohd. Eusoff
	Dr. S. Paramanathan
	Mr. Choo Mun Keong
	Dr. Ahmad Tajuddin Ibrahim

It is to be noted that the Institute of Geology Malaysia has been set up with the primary aim of establishing an Act of Parliament that will regulate as well as uphold the dignity, standing and reputation of the profession of geology in the country. The Institute as such is thus not envisaged as taking over the primary role of the Geological Society of Malaysia which is promoting the advancement of the geological sciences in the country and other neighbouring areas.

In view of the primary aim of the Institute, it is to be noted that several details are needed to be furnished together with the application forms. Please return the forms, addressed to: 'Institut Geologi Malaysia', c/o Jabatan Geologi, Universiti Malaya, Lembah Pantai, 59100 Kuala Lumpur. Please note that all the fees due shall be forwarded to the Treasurer of the Institute after approval of the forms for membership.

Please be informed that after receipt and approval of the forms for membership, a general meeting of the Institute will be called at which a new Council will be elected. It is hoped that this general meeting be held in January 1990.

Chin Lik Suan
Hon. Secretary
Pro-Tem Committee



INSTITUT GEOLOGI MALAYSIA
(INSTITUTE OF GEOLOGY MALAYSIA)

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APPLICATION FOR CORPORATE MEMBERSHIP

APPLICATION FOR TRANSFER OF CORPORATE MEMBERSHIP

1. TYPE OF MEMBERSHIP REQUIRED:
(See Footnote for conditions on type of membership and fees due).
2. NAME:
(Write your name and title exactly as you wish it to appear on mailing labels and underline your surname if applicable).
3. IDENTITY CARD NO. SEX: MALE/FEMALE
4. MAILING ADDRESS:
.....
POST CODE TELEPHONE
5. PERMANENT ADDRESS:
.....
POST CODE TELEPHONE
6. PLACE OF BIRTH:
..... DATE OF BIRTH:
7. ACADEMIC QUALIFICATIONS:
UNIVERSITY OR INSTITUTION MAJOR SUBJECT DEGREE & YEAR
.....
.....
.....
8. OTHER PROFESSIONAL QUALIFICATIONS:
.....

9. YOUR MAIN AREA(S) OF EXPERTISE IN GEOLOGY:

CATEGORY	YEARS INVOLVED	REPORTS/PAPERS
A) Regional Geology	Yes/No
B) Mineral Exploration	Yes/No
C) Mining Geology	Yes/No
D) Mineralogy/Petrology/Petrography	Yes/No
E) Stratigraphy/Palaeontology	Yes/No
F) Petroleum Geology	Yes/No
G) Engineering Geology/Hydrogeology	Yes/No
H) Geophysics	Yes/No
I) Others (Please specify)		
.....	Yes/No

(Please attach a list of relevant documents to substantiate the chosen area(s) of expertise. Please note that the Council has the right to decide on your proper area(s) of expertise).

10. ARE YOU A MEMBER OF THE GEOLOGICAL SOCIETY OF MALAYSIA:

YES/NO. (If YES, From To)

11. MEMBERSHIP IN OTHER PROFESSIONAL BODIES:

..... - From To

..... - From To

12. NAME AND ADDRESS OF PRESENT EMPLOYER:

.....

.....

POST CODE TELEPHONE

PRESENT POSITION

13. NAMES AND ADDRESSES OF PREVIOUS EMPLOYERS (IF ANY):

i)

..... POST CODE TELEPHONE

POSITION HELD FROM TO

ii)
..... POST CODE TELEPHONE
POSITION HELD FROM TO

(Attach details in separate sheets if insufficient space).

14. NAMES AND ADDRESSES OF SPONSORING CORPORATE MEMBERS:

1. NAME:
IDENTITY CARD NO. ADDRESS:
.....
POST CODE TELEPHONE

2. NAME:
IDENTITY CARD NO. ADDRESS:
.....
POST CODE TELEPHONE

15. I HEREBY DECLARE THAT ALL OF THE DETAILS CONTAINED IN THIS APPLICATION FORM ARE TRUE.

.....
DATE

.....
SIGNATURE OF APPLICANT

We certify that to the best of our knowledge the details contained in this application form by Mr./Ms. are true.

.....
DATE

.....
SIGNATURE OF FIRST SPONSOR

.....
DATE

.....
SIGNATURE OF SECOND SPONSOR

I furthermore, certify that I have known the said applicant in a personal capacity for a period of some years and consider him/her to be a fit and proper person to be admitted to Corporate Membership of the Institut Geologi Malaysia.

.....
DATE

.....
SIGNATURE OF RELEVANT SPONSOR

FOOTNOTE:

1. There are four classes of membership of the Institute i.e. Fellows, Members, Licenciates and Graduate Members. Fellows, Members and Liceniates are Corporate Members of the Institute.
2. All applications for membership must be proposed by two Corporate Members of the Institute, one of whom must certify his/her personal knowledge of the applicant.
3. A candidate for election into the class of Graduate Members must have a Bachelor's degree with Honours in Geology recognized by the Government of Malaysia or equivalent qualification.
4. A candidate for election into the class of Licenciates must not be less than twenty-one years of age and must possess the following qualifications:
 - a) at least a Diploma in Geology or equivalent qualification,
 - b) experience in a branch of Geology of at least five years duration,
 - c) passed the Membership examinations of the Institute though the Council may exempt a candidate from part of these examinations if he or she has passed other recognized external examinations approved by the Council, and
 - d) be a fit and proper person to become a Licenciante.
5. A candidate for election into the class of Members must not be less than twenty-one years of age and must possess the following qualifications:
 - a) a Bachelor's degree with Honours in Geology from a University or Institution of Higher Learning recognized by the Government of Malaysia or equivalent qualification,
 - b) professional experience in a branch of Geology of at least three years duration which should include at least one year of responsible work in Geology, and
 - c) be practising the profession at the time of application and be a fit and proper person to become a Member.
6. A candidate for transfer or election into the class of Fellows shall possess the following qualifications:
 - a) be a member or have satisfied the conditions for admission to the class of members;
 - b) at least fifteen years of professional experience in the geology profession, of which at least five years should have been spent in responsible charge of important geological operations or should have been spent as a consultant or advisor in the branches of geology provided that the training and technical experience of the candidate engaged as a consultant or advisor justified such professional status,
 - c) be practising at the time of application and satisfy the Council that he or she is a fit and proper person to become a Fellow.
7. The entrance fee shall be M \$ 50 (Fifty), the transfer fee M \$ 50 (Fifty), and the annual subscription due M \$ 20 (Twenty).

Forthcoming Bulletin

BULLETIN 24 (October 1989)

Among the papers appearing:-

1. **Wan Fuad Wan Hassan**
Some characteristics of the heavy detrital minerals from Peninsular Malaysia
2. **E.H. Tan & Mahan Singh**
Groundwater supply studies in Northern Kelantan
3. **Mohammad Sayyadul Arafin & C.Y. Lee**
Diagnostic resistivity sounding curves of karstic aquifers in the Chuping Limestone
4. **Abdul Ghani Rafek**
Contoh penggunaan Kaedah Kerintangan Geoelektrik untuk penjelajahan bawah tanah
5. **Kamaludin bin Hassan**
Significance of palynology in Late Quaternary sediments in Peninsular Malaysia
6. **Fan Choon Meng & P.C. Aw**
Processing of illite powder in Bidor, Perak: A study of the process and the potential uses of illite clay
7. **Kwan Tai Seong**
K/Ar mica dates for granites from the Bujang Melaka area
8. **M.B. Idris & M.S. Azlan**
Biostratigraphy and palaeoecology of fusulininids from Bukit Panching, Pahang
9. **C.S. Hutchison**
Chemical variation of biotite and hornblende in some Malaysian and Sumatran granitoids
10. **Mohd. Suhaimi, Abd. Khalik, Zaini Hamzah & Che Seman**
Beberapa aspek penggunaan teknik analisis pengaktifan neutron dalam kajian Geologi
11. **Tajul Anuar Jamaluddin**
Struktur sedimen dalam Formasi Crocker di kawasan Tamparuli, Sabah
12. **Yusuf bin Bujang**
Penyasatan terperinci hidrogeologi di kawasan Jebungan, Mukah, Sarawak
13. **Henry Litong Among**
Pembinaan perigi-perigi mendatar di Kampung Paloh, Bahagian Sarikei, Sarawak

Forthcoming Bulletin

BULLETIN 26 (April 1990)

Among the papers appearing:-

1. **Tan Teong Hing & Lim Kin Leong**
Environment of placer gold deposits in Northern Pahang
2. **Alan J. Burley & Jamaluddin Othman**
A gravity survey of Perlis, Kedah and Penang
3. **K.F.G. Hosking**
Prospect over and around a strange hill
4. **M.B. Idris & K.H. Kok**
Stratigraphy of the Mantanani Islands, Sabah
5. **Kamaludin bin Hassan**
A summary of the Quaternary geology investigations in Seberang Perai, Pulau Pinang and Kuala Kurau
6. **V.R. Vijayan**
Gravity survey of the Layang-Layang Tertiary Basin in Johore, Peninsular Malaysia – A preliminary report
7. **David T.C. Lee**
Formation of Pulau Batu Hairan and other islands around Pulau Banggi, Northern Sabah
8. **Kwan Tai Seong**
K-Ar Dating of micas from granitoids in the Kuala Lumpur – Seremban area
9. **Chow Weng Sum & Abdul Majid Sahat**
Potential alkali-silica reactivity of tuffaceous rocks in the Pengerang area, Johor
10. **Mohammed Hatta Abd. Karim**
Variations in some groundwater characteristics, Belawai water supply, Sarikei Division, Sarawak
11. **I. Metcalfe**
Triassic conodont biostratigraphy in the Malay Peninsula
12. **Michael O. Schwartz & A.K. Askury**
Granite magmatism and tin-tungsten metallögenesis in the Kuantan-Dun-gun area, Malaysia
13. **Michael O. Schwartz & Surjono**
Sungei Isahan – a new primary tin occurrence in Sumatra
14. **Aw Peck Chin**
Sepiolite from Kramat Pulai, Perak

ULASAN BUKU (BOOK REVIEW)

Geological Evolution of South-East Asia, by C.S. Hutchison,
Clarendon Press, Oxford, 1989, 368 pages, M\$396.00 (Hardback).

This is volume 13 in the series of Oxford Monographs on Geology and Geophysics. The author has lectured for more than thirty years at the University of Malaya (since 1959 located in Kuala Lumpur) and has field knowledge of various parts of the region covered by the book. Coverage includes the larger part of the Indonesian Archipelago (except most of Irian Jaya-Papua Niugini), the Philippine islands, and continental Southeast Asia bordered by India and China. The chapter titles adequately represent the material and include:

- Late Mesozoic and Cainozoic tectonic features
- Cainozoic sedimentary basins
- Phanerozoic tectonic framework
- Terrains of Cathaysian affinity
- Gondwana terrain affinity
- Ophiolites and sutures
- The Great Sunda-Pacific volcanic arcs
- Granite and associated plutonic rocks.

It is supported by more than 30 pages of references, totalling about 750 items. Most references are post-1970, but even so are limited to review or fundamental articles, except those concerning Malaysian territory which also include unpublished reports of undergraduate students' projects. Except for this bias, I feel that the relevant literature has been adequately represented.

The book has many illustrations; valuable are the compilation maps that accompany the various chapter topics. The seventeen photographs are not as representative and I feel that the author could have solicited relevant thematic photos from the various geological surveys and colleagues.

As the author stated in the preface, the book is a personal interpretation of the region. Treatment of geological evolution of so vast a region and its tectonics can hardly be otherwise. In spite of these limitations, I find that the author has generally managed to present a balanced treatment. Conflicting views are stated next to the author's preference or conviction. In the past, Hutchison had initiated thoughts and had improved on several topics in the region, such as aspects of granites in relationship to mineralization, on ophiolites, and on the Raub-Bentong Line. These subjects are of course highlighted and his current views emphasized in the book.

In a compilation, wide-ranging in area and topics, such as this book, inaccuracies are probably unavoidable. Some of the errors in the parts that I read more thoroughly are, for instance:

- Page 13, para 3, line 5: the age of magnetic lineations decreases (not increases) from 130 Ma in the south to 120 Ma in the north of the Banda Sea.



- Fig. 2.1 No active volcano exists in Irian Jaya (a report of an expedition to this mountain was published in the *Bulletin Volcanologique*, volume 43 (3), 1980).

- Figs. 5.13 and 5.14: The "Pulau Bengkalis Fault" is shown as left lateral, but in reality it has right-lateral slip component.

- Geographic errors: Kutei (not Kuteu, p. 80, line 4), Kuamat (not Kuamat, p. 80, line 8), Karimunjava (not Karimodjava, p. 291, para 4), Ciletuh and Jiwo (p. 267, 7.1.16; not Tjiletuh and Djiwo). In 1972 Indonesian and Malaysian orthography was changed and since then Indonesian place names follow the new spelling.

With this volume, Hutchison has accomplished in providing a comprehensive, useful and up-to-date guide to the geology of the region. In addition, many of his ideas and statements challenge colleagues and others to investigate and develop their versions. All libraries should own this book. At a price close to four hundred Malaysian ringgit, however, only those geologists having financial windfalls (or doting spouses or assorted other relatives) would be lucky enough to own personal copies.

H.D. TJIA
Jabatan Geologi FSEG
Universiti Kebangsaan Malaysia
43600 Bangi

<small>OXFORD MONOGRAPHS ON GEOLOGY AND GEOPHYSICS NO. 13</small>	
<h1>Geological Evolution of South-East Asia</h1>	
<hr/> CHARLES S. HUTCHISON	
Price MR396.50	No. of pages 368 pages
	
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GEOLOGI INDONESIA volume 12 (1), July 1989, 635 pages (US\$50.00).
J.A. KATILI COMMEMORATIVE VOLUME (60 YEARS)

Published by Ikatan Ahli Geologi Indonesia, c/o Direktorat Jendral Geologi dan Sumberdaya Mineral, Jalan Jendral Gatot Subroto 49, Jakarta, P.O. Box 633/KBY.

Contents

S. LAUFELD, John Ario Katili, sixty years of eruption - W. HAMILTON
Convergent-plate tectonics viewed from the Indonesian region - H.D. TJIA,
Tectonic history of the Bentong-Bengkalis suture - J.A. KATILI, Evolution
of the Southeast Asian arc complex - YARMANTO & KARSANI AULIA, Seismic
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Halmahera, a typical Cainozoic volcanic island arc in eastern Indonesia -
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- E.M. ARSADI, SUWIJANTO, S. NISHIMURA & J. NISHIDA, Preliminary report on
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- DJUHAENI & M. SOEJONO, Stratigrafi daerah Majalengka dan hubungannya
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Overview of the Indonesian coal development - SOEHANDOJO, Coal exploration
and exploitation in Indonesia - J.F. McDIVITT, Overview of mineral
development in Indonesia - Y. SUNARYA, Overview of gold exploration and
exploitation in Indonesia - S. SOEPARMAN & BOEDIJONO, Cu-skarn deposits at
Ertsberg Mine area, Irian Jaya, Indonesia - A. NIODE-KATILI, Evaluation of
environmental management in mining companies - MUDJUR MUIF, Sistem peresapan
air permukaan dengan sumur resapan sebagai alternatif "recharge" air tanah
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Petrokimia batuan kompleks Anak Ranakah, Flores, Nusa Tenggara Timur -
ADJAT SUDRADJAT, Volcanic eruption monitoring using space platforms -
S. SISWOWIDJOYO, Seismicity and other phenomena with the eruption of
Galunggung volcano in West Java, Indonesia, in 1982-1983 and their volcano-
logical implications - Y. SUYATNO YUWONO, Petrologi dan mineralogi G.
Lompobatang, Sulawesi Selatan - R. CLAPROTH, Magmatic affinities of volcanic
rocks from Ungaran, Central Java - N. MacCLEOD, Sector-failure eruption in
Indonesia volcanoes - T.J. CASADEVALL, L. PARDYANTO, H. ABAS TULUS, The
1988 eruption of Banda Api volcano, Maluku, Indonesia.

This volume was officially launched by IAGI on 17 October 1989 at a
function attended by over a hundred members and invited guests at a leading
hotel in Jakarta.

H.D. TJIA
*Jabatan Geologi ESFG
Universiti Kebangsaan Malaysia
43600 Bangi*

XXIII INTERNATIONAL CONGRESS - AQUIFER OVEREXPLOITATION

International Association of Hydrogeologists
Spanish Chapter
15-19, April 1991
Puerto de la Cruz, Tenerife
(Canary Islands, Spain)

Presentation

Intensive exploitation of aquifers often occurs, particularly in arid and semi-arid areas, where it constitutes one of the main factors in the economic development of these areas. The mismanagement of the water resources has, however, led to important changes in the natural state of aquifers. Some of the most obvious, because they are the most immediately apparent, are ground water table drawdown, the drying up of natural outfalls and changes in water quality. This Congress has been organised in an attempt to define and analyze the positive and negative effects of over-exploitation as well as examine the situation as it exists today.

Given the importance of the problem, at the June 1988 meeting in Orleans, the International Association of Hydrogeologists decided to support the proposal put forward by de Spanish Chapter to organise the XXIII International Congress in Spain.

Sponsors

The Public Works and Water Department of the Canary Islands Government has announced its sponsorship.

Scientific program

The topics to be covered are:

- I. Characterisation of aquifer over-exploitation. Hydrogeological and hydrochemical aspects.
- II. Environmental effects related to over-exploitation.
- III. Protective and corrective measures in cases of over-exploitation.
- IV. Legal and socio economic problems related to aquifer over-exploitation.
- V. Over-exploited aquifers in water resources management.

Language

Official language will be Spanish and English. Simultaneous translation will be provided.

Call for papers

Participants wishing to contribute papers or posters are requested to submit an abstract of 300 words. The abstract must be written in Spanish or English and must include the title and the name(s) and address of the author(s). The Scientific Committee will inform authors of the

accepted abstracts and will provide instructions for the preparation of the extended abstract.

At the opening of the Congress, all participants will receive a copy of the extended abstracts and papers presented by guest speakers.

Schedule

- December 1, 1989: Deadline for preliminary abstracts.
- January, 1990 : Second Circular
- May 1, 1990 : Scientific Committee will notify authors of accepted abstracts.
- November 1, 1990: Deadline for extended abstracts.
- December, 1990 : Third Circular

Registration

The registration fees covers scientific and social events and the proceedings of the Congress (not for accompanying persons).

Registration fees

A.I.H. members	US\$300
A.I.H. non members	US\$400
Students and Accompanying persons	US\$150

Secretary and information

All correspondence should be sent to:

Dr. Fermin Villarroya,
Departamento de Geodinámica,
Facultad de Ciencias Geológicas,
Universidad Complutense,
28040 Madrid (Spain)

Tel.: (34-1) 449-73-91
Telex.: 41798 UCCEO
Telefax: (34-1) 243-91-62

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

1990

February - 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, Steenveeg op Leuven, 13, B-1980 Tervuren, Belgium.

February - 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, 11-1453 Budapest, Pf. 227 Hungary.

February - 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.

February - November, 1990

PHOTOINTERPRETATION APPLIED TO GEOLOGY AND GEOTECHNICS (Bogota, Colombia). Forty-week course organized by the Government of Colombia, the Interamerican Centre of Photointerpretation (CIAF), International Institute for Aerial Survey and Earth Sciences (The Netherlands) and Unesco. Language: Spanish. For Information: Academic Secretariat of the CIAF, Apartado Aereo 53754, Bogota 2, Colombia.

March - April, 1990

MINERAL EXPLORATION (Paris, France). A 4-week annual course organized by the Ecole Nationale Supérieure des Mines and sponsored by Unesco. Language: French. For Information: Prof. K.D. Khan, Ecole des Mines, 35 rue St. Honoré, 77305 Fontainebleau Cedex, France.

March - November, 1990

PHOTOINTERPRETATION APPLIED TO GEOLOGY AND GEOTECHNICS (Bogota, Colombia). Annual post-graduate diploma courses organized by the Government of Colombia, Centro Interamericano de Fotointerpretación, International Institute for Aerial Survey and Earth Sciences and Unesco. Language: Spanish. For Information: Academic Secretariat of the CIAF, Apartado Aereo 53754, Bogota 2, Colombia.

June - August, 1990.

TECHNIQUES OF HYDROLOGIC INVESTIGATIONS (Washington, D.C. and Denver, Colorado, U.S.A.). Annual training course for international participants. For Information: Office of International Hydrology, Water Resources Division, U.S. Geological Survey, 470 National Center, Reston, VA 22092, U.S.A.

July - August, 1990

CRYSTALLOGRAPHY, MINERALOGY, METALLOGENY (Madrid, Spain). Annual course organized by the Department of Geology and Geochemistry of the Universidad Autónoma de Madrid and sponsored by Unesco. Language: Spanish. For Information: Departamento de Geología y Geoquímica, Facultad de Ciencias, Universidad Autónoma de Madrid, Canto Blanco, Madrid 34, Spain.

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.

1991

February - March, 1991

STRUCTURAL GEOLOGY (Dehra Dun, India). A six weeks training course organized every second year by the Wadia Institute of Himalayan Geology, sponsored by the Government of India and Unesco. Language: English. For Information: The Organizer of the Regional Training Course in Structural Geology, Wadia Institute of Himalayan Geology, 33 General Mahadev Singh Road, Dehra Dun 24 8001, India.

May - November 1991

GENERAL HYDROLOGY with emphasis on groundwater (Buenos Aires, Argentina). A six-month post-graduate diploma course organized every other year and sponsored by Unesco. Language: Spanish. For Information: Comité Nacional para el Programa Hidrológico Internacional de la República Argentina, Av. 9 de Julio 1925 - 15^o piso, 1332 Buenos Aires, Argentina.

August - October, 1991

GEOCHEMICAL PROSPECTING METHODS (Prague, Czechoslovakia). Certificate course organized every second year by the Geological Survey of Czechoslovakia and sponsored by Unesco, IAGC and Czechoslovakia. Language: English. For Information: GEOCHIM Unesco CSSR, Geological Survey of Prague, Malostranské nám. 19, 11821 Prague 1, Czechoslovakia.

Kalendar (Calendar)

1990

January 29-30, 1990

ADVANCES IN RESERVOIR GEOLOGY (Meeting), London, U.K. (Dr. Ashton, Badley, Ashton & Associates Ltd., Winceby House, Winceby, Horncastle, Lancs. LN9 6PB, U.K.)

February 4-9, 1990

GONDWANA, TERRANES AND RESOURCES (10th Australian Geological Convention), Hobart, Australia. (10th AGC, c/o P.O. Box 56, Rosny Park, Tasmania TAS 7018, Australia).

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).

February 12-14, 1990

PNG PETROLEUM CONVENTION (Conference), Port Moresby, Papua New Guinea. (Mr. M. McWalter, First PNG Petroleum Convention, c/o PNG Chamber of Mines and Petroleum, P.O. Box 7059, Boroko, Port Moresby, Papua New Guinea).

March/April 1990

ENGINEERING GEOLOGY PROBLEMS IN RESIDUAL SOILS (International Symposium), Abidjan-Yamassoukro, Ivory Coast. Sponsored by IAEG. English and French. (G. Cougny, Laboratoire du Bâtiment et des Travaux Publics, O4BP3 Abidjan O4, Ivory Coast).

March 14-17, 1990

ASIA/PACIFIC MINING (2nd Conference), Jakarta, Indonesia. (Asia/Pacific Mining Conference Secretariat, c/o Cahners Exposition Group (S) Pte. Ltd., 1 Maritime Square, #13-02 World Trade Centre, Singapore 0409).

April 4-6, 1990

THRUST TECTONICS (International Conference), Egham, U.K. (Dr. K. McClay, Department of Geology, Royal Holloway and Bedford New College, Egham, Surrey TW20 OEX, U.K.).

May 7-8, 1990

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

May 6-12, 1990

PACIFIC RIM 90 (International Congress), Gold Coast, Queensland, Australia. (The AusIMM-Pacrim 90, P.O. Box 731, Toowoong, Qld 4066, Australia).

May 14-18, 1990

WORLD MINING (14th Congress), Beijing, P.R. China. (14th World Mining Congress, 54 Sanihe Road, Beijing, P.R.C.).

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 2-6, 1990

GEOANALYSIS 90 (International Symposium), Muskoka area, Canada. (Dr. A. Vander Voet, Ontario Geological Survey, 77 Grenville Street, Toronto, Ontario, Canada M7A 1W4).

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, U.K.).

July 2-6, 1990

GEOLOGY AND MINERAL RESOURCES OF CONTINENTAL MARGINS: ANCIENT AND MODERN (23rd Earth Science Conference, Geological Society of South Africa), Cape Town, South Africa. (Dr. P.G. Gresse, Geological Survey, P.O. Box 1739, Bellville, 7530, South Africa).

July 2-6, 1990

MINERALS, MATERIALS & INDUSTRY (IMM 14th Congress), Edinburgh, Scotland, U.K. (Secretary, Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR, U.K.).

July 2-6, 1990

BASEMENT TECTONICS (9th International Conference), Canberra, Australia. (91BT ACTS, GPO Box 2200, Canberra, ACT 2601, Australia).

July 9-13, 1990

GROUNDWATER IN LARGE SEDIMENTARY BASINS (International Conference), Perth, Western Australia. (Groundwater Conference, University of Western Australia, Nedlands, Western Australia 6009).

July 19-28, 1990

INTERNATIONAL UNION OF CRYSTALLOGRAPHY (15th Congress), Bordeaux, France. (Stefan S. Hafner, University of Marburg, 3550 Marburg, Federal Republic of 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 6-10, 1990

INTERNATIONAL ASSOCIATION OF ENGINEERING GEOLOGY (6th International Congress), Amsterdam, The Netherlands. English and French. (Dr. L. Primel, L.C.P.C., 58 Blvd. Lefebvre, 75732 Paris Cedex 15, France).

August 12-18, 1990

INTERNATIONAL ASSOCIATION ON THE GENESIS OF ORE DEPOSITS (8th Symposium), Ottawa, Canada. (Dr. L.M. Cumming, 601 Booth Street, Ottawa, Canada K1A 0E8).

August 12-18, 1990

MINERAL DEPOSIT MODELING (International Conference), Ottawa, Canada. Held with 8th IAGOD Symposium. Sponsored by IUGS and Unesco. (R.V. Kirkham, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8).

August 25-31, 1990

GEOCHEMICAL EXPLORATION (14th International Symposium), Prague, Czechoslovakia. (Geological Survey/UUG, Symposium on Geochemical Prospecting, Malostranske nam. 19, 118 21 Prague 1, Czechoslovakia).

August 26 - September 1, 1990

SEDIMENTOLOGY (13th International IAS Congress), Nottingham, U.K. (I.N. McCave, Dept. Earth Sciences, Cambridge University, Downing Street, Cambridge CB2 3EQ, U.K.).

August 26 - September 8, 1990

LATIN AMERICAN CONODONT SYMPOSIUM, La Paz, Bolivia and San Juan, Argentina. (M. Hunicken, Academia Nacional de Ciencias, Casilla Correo 36, 5000 Cordoba, Argentina).

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-Ssu, Nanjing, P.R. China).

September 17-18, 1990

GEOCHEMISTRY OF CLAY-PORE FLUID INTERACTIONS (meeting), London, U.K. (D. Savage, Fluid Processes Research Group, British Geological Survey, Keyworth, Notts. NG12 5GG, U.K.).

September 17-21, 1990

ARCHEAN (Symposium), Perth, Australia. (D.I. Groves, Department of Geology, University of Western Australia, Nedlands, Western Australia 6009).

September 18-20, 1990

HYDROGEOLOGY: Parameter Identification and Estimation for Aquifer and Reservoir Characterization (5th Canadian-American Conference), Calgary, Alberta. (S. Bachu, Alberta Research Council, Box 8330, Station F, Edmonton, Alberta, Canada T6H 5K2).

September 24-29, 1990

GEOCHRONOLOGY, COSMOCHRONOLOGY AND ISOTOPE GEOLOGY (7th International Conference), Canberra, Australia. (Organizing Committee, ICOG 7, Research School of Earth Science, 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).

1991

March 1991

ECONOMIC EVALUATION OF MINERAL RESOURCES (International Conference), Kosice, Czechoslovakia. Languages: Russian and English. (Intergeoeconomika 1991 CSSR, GEFOND, Eng. St. Richter, Garbanova 1, 040 11 Kosice, Czechoslovakia).

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 1991

QUANTITATIVE METHODS OF INVESTIGATION OF THE STRUCTURE OF SOILS AND ROCKS (IAEG International Symposium), Moscow. (Dr. M. Primel, LCPC, 58 Bd. Lafayette, 75732 Paris Cedex 15, France).

August 2-9, 1991

QUATERNARY RESEARCH (13th INQUA International Congress), Beijing, P.R. China. (Secretariat, 13th INQUA Congress, Chinese Academy of Sciences, 52 Sanlihe, Beijing 100864, People's Republic of China).

September 16-20, 1991

ROCK MECHANICS (7th International Congress), Aachen, F.R. Germany. (Deutsche Gesellschaft für Erd- und Grundbau, Kronprinzenstrasse 35a, D-4300 Essen 1, F.R.G.).

September 22-27, 1991

CARBONIFEROUS-PERMIAN STRATIGRAPHY AND GEOLOGY (12th International Congress), Buenos Aires, Argentina. Language: English. (Dr. S. Archangelsky, Museo Argentino de Ciencias Naturales, Av. A. Gallardo 470, Buenos Aires 1405, Argentina).

1992

June 1992

WORLD MINING (15th Congress), Seville, Spain. (World Mining Congress, Al Ujazdowskie 1-3, PL-00583, Warsaw, Poland).

June 28 - July 1, 1992

PALEONTOLOGY (5th North American Convention), Chicago, U.S.A. (Dr. Peter R. Crane, Field Museum of Natural History, Roosevelt Road at Lake Shore Drive, Chicago, IL 60605-2496, U.S.A.).

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- 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).
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- 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).
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- Bulletin 16** (1983). 239 p. A collection of papers on geology. Edited by G.H. Teh. Price: M\$30.00 (US\$14.00).
- Bulletin 17** (1984). 371 p. A collection of papers on 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. Paramanathan. 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. Paramanathan. Price for both Bulletins 19 & 20: Members — M\$50.00 (US\$21.90), Non-members — M\$125.00 (US\$53.20).

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