

## PERSATUAN GEOLOGI MALAYSIA

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# CATATAN GEOLOGI (GEOLOGICAL NOTES)

## AN INTERESTING EXPOSURE OF UNCONSOLIDATED SEDIMENTS IN THE KUANTAN AREA OF PAHANG, PENINSULAR MALAYSIA

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### Abstract

*Unconsolidated sediments, exposed in a recent slope cut in the Kuantan area, can be subdivided into a lower unit (of approximately 3 to 6 m thick) of alternating, horizontal to gently dipping layers of coarse sand and sandy clay, and an upper unit (of approximately 3 to 5 cm thick) of homogenous clayey sand. The lower unit, which unconformably abuts against weathered granite, and unconformably overlies weathered basalt, is likely to be of a littoral or fluvial origin while the upper unit is likely to be of a fluvial or aeolian origin.*

*It is recommended that these sediments be examined palynologically as the results would raise interesting speculations on the Quaternary of Peninsular Malaysia.*

### Introduction

In the Semambu Industrial Estate of Kuantan, Pahang has been recently exposed a sequence of unconsolidated sediments that abut against weathered granite and overlie weathered basalt. This exposure is seen in a slope cut made into a small ridge that is approximately located at the intersection of latitude  $1^{\circ} 51' 25''$  N and longitude  $103^{\circ} 19' 27''$  E (Figure 1). The base of the cut is located 26.3 m (119 feet) above the present sea-level (determined by a "pocket theodolite" survey), while the cut itself has a maximum height of 10.6 m. The upper surface of the cut forms a gently sloping surface that has a slope of  $4^{\circ}$ .

### Description of exposure

In the scaled sketch of the northern part of the exposed cut (Figure 2) can be seen the outcrop patterns, and characteristic features of the different lithologies present that include weathered granite, weathered basalt and unconsolidated detrital sediments.

The weathered granite shows an approximate domal shaped outcrop and is identifiable by the presence of coarse grained, angular, quartz crystals and angular, kaolinized feldspar grains. The weathered granite shows mottled red/yellow colours and consists of sand sized quartz grains embedded in a matrix of mainly clay sized particles (that have been derived from the alteration of feldspars and other primary minerals) (Figure 3). The weathered basalt, however, shows a very gently sloping (subhorizontal) upper surface and is identifiable by its characteristic variegated, bluish to purplish colour and silty clay texture (Figure 3). Unconformably, resting against the weathered granite, and overlying the weathered basalt (Figure 2) can be seen a sequence (of approximately

3 to 6 cm thick) of alternating, horizontal to gently dipping layers of buff coloured, coarse sand and variegated, bluish to orange coloured, sandy clay. These layers are of variable thicknesses (from 15 to 150 cm), though generally decreasing in thickness down-dip. A thin layer (of about 3 cm thick) of iron cemented quartz grains is furthermore, seen along the contact between a coarse sand layer and the weathered basalt (Figure 2). The coarse sand layers are poorly sorted and consist largely of angular, fine to coarse sand sized, quartz grains with some clay (Figure 4), while the sandy clay layers consist mainly of clay sized particles with some silt and sand-sized angular quartz grains (Figure 4).

Overlying the sequence of alternating coarse sands and sandy clays, and covering the outcrop of the weathered granite (Figure 2), is seen a thick, buff coloured layer of clayey sand (of approximately 3 to 5 m thick). This layer is devoid of sedimentary structures and consists of angular, fine to coarse sand sized, quartz grains and clay (Figure 4).

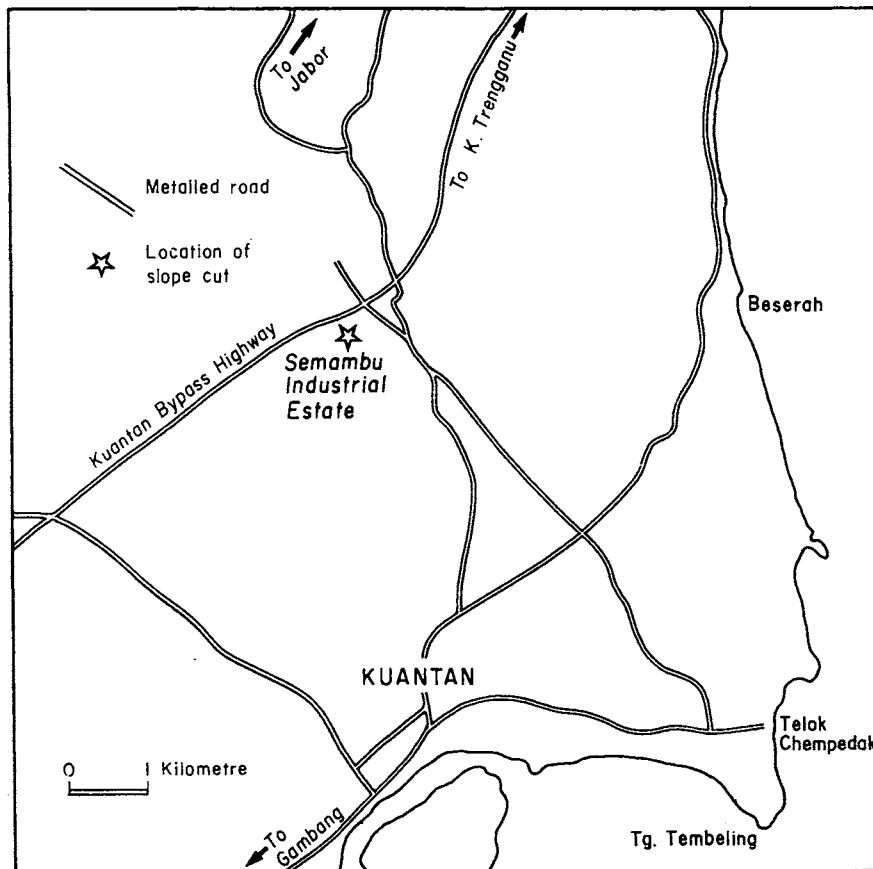


Figure 1. — Location map of the slope cut exposure of unconsolidated sediments in the Semambu Industrial Estate of Kuantan.

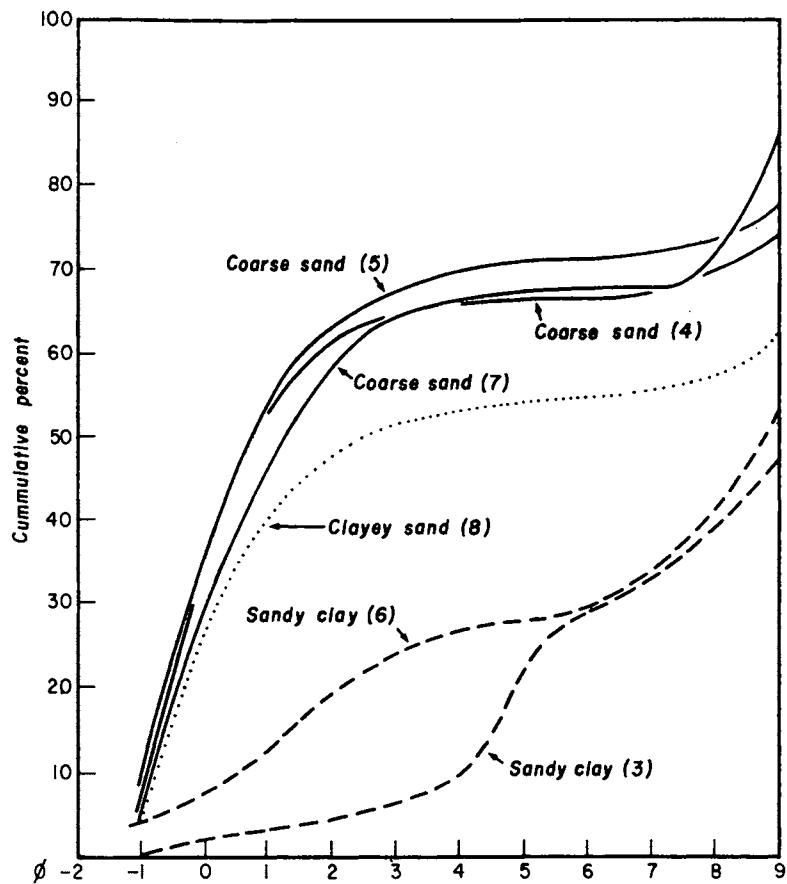


Figure 4—Grain size distributions of the unconsolidated sediments. Cumulative curves on semi-log paper. Note: Numbers in brackets refer to sample numbers.

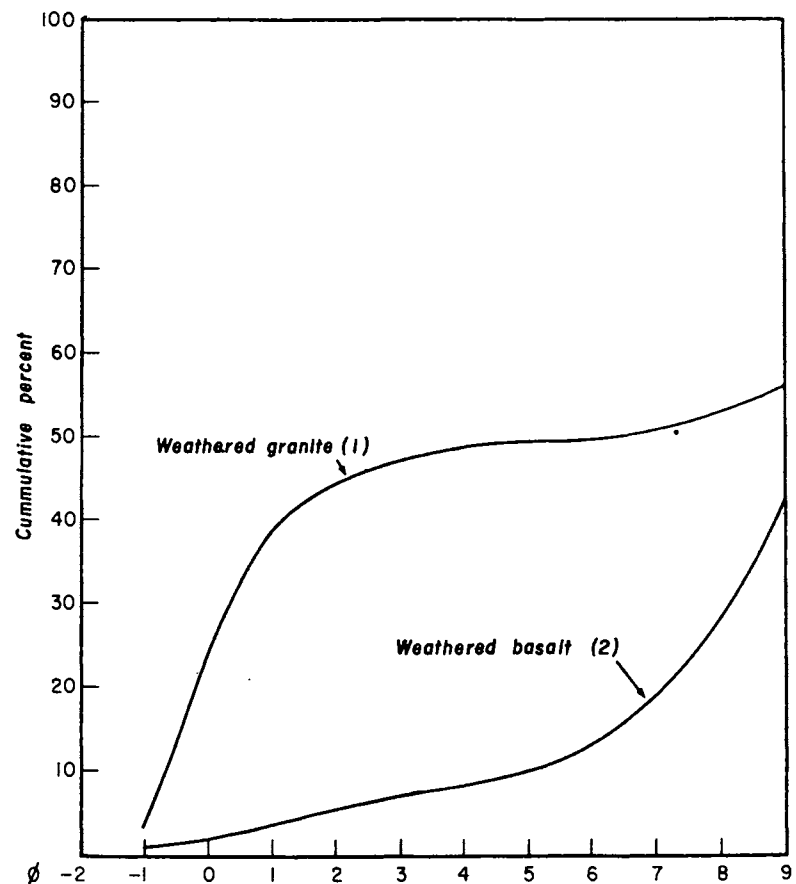
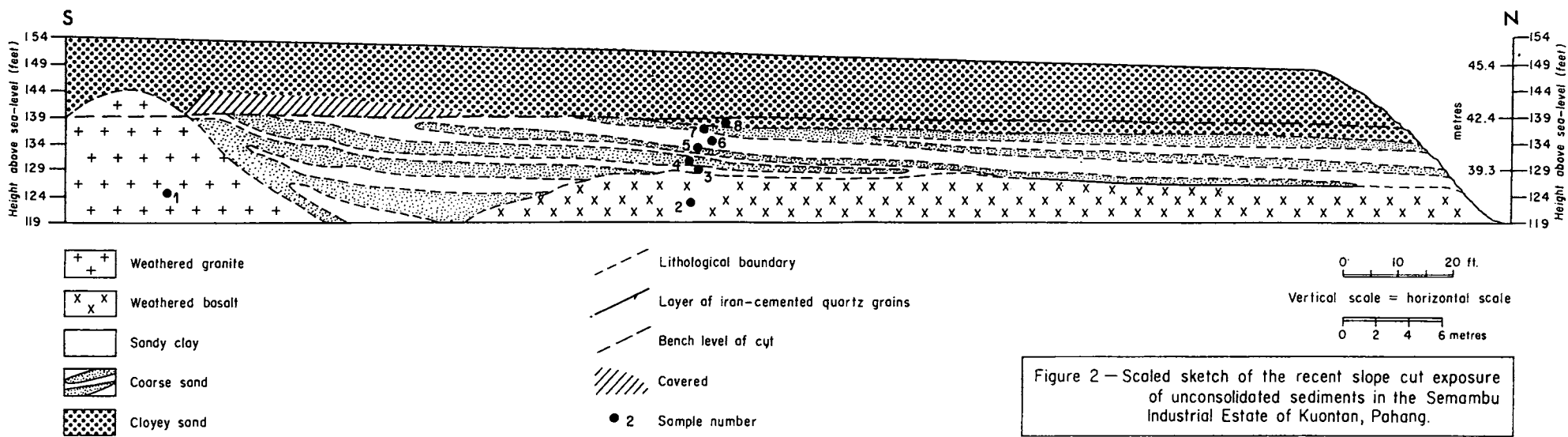


Figure 3—Grain size distributions of weathered granite and weathered basalt. Cumulative curves on semi-log paper. Note: Number in brackets refer to sample numbers.



### Discussion and Interpretations

Although no fossils have been found in the unconsolidated sediments, an interpretation of their origin is possible in view of various features exposed at the cut. These exposed features can, however, be interpreted in different ways and the following discussion considers the different possible interpretations.

The lower unit of inter-layered coarse sands and sandy clays can firstly only have developed through the alternate deposition of more coarser and more finer sediment by fluvial, sheet-wash or littoral processes. The 'lensing-out' of some of the sandy clay layers, however, rules out an origin by sheet-wash processes and the lower unit can thus be considered to have been deposited by either fluvial or littoral processes. If an origin by littoral processes is considered, as is in fact argued for by the horizontal to gently sloping layers, the coarse sand, and sandy clay, layers would have been deposited during conditions of high energy and low energy waves respectively. The poor sorting of the coarse sand layers (Figure 4) is, however, inconsistent with a littoral origin though it is likely that this poor sorting is a post-depositional feature resulting from the weathering of original sand-sized labile constituents. If an origin by fluvial processes is considered for the lower unit, the coarse sand, and sandy clay, layers would have been deposited during the high, and low, velocity discharges of a large river respectively. The poor sorting of the coarse sand layers would then be consistent with such a fluvial origin, though the horizontal to gently sloping layering cannot be accounted for unless post-depositional subsidence is invoked. The sandy clay layers would furthermore indicate that fluvial deposition occurred at, or close to, the base level of erosion of the river. No definite conclusion on a fluvial or littoral origin of the sediments of the lower unit can, however, be postulated at this stage, though the layer of iron-cemented quartz grains (Figure 2) (which may be interpreted as being a beach rock) favours a littoral origin as this layer is a distinctly syndepositional feature for the sloping coarse sand layer (and resultant sloping subsurface water movements) precludes its post-depositional formation by pedogenetic processes. The overlying thick unit of homogenous clayey sand can furthermore, only have developed through deposition by fluvial, sheet-wash or aeolian processes. The 4° slope of the overlying ground surface and the homogenous character of this unit in fact argue for its formation by sheet-wash processes, though its capping of the weathered granite outcrop (Figure 2) rules out such an origin (as the weathered granite outcrop would have to serve as the source of the sediments). The sediments of the upper unit are thus likely to be of a fluvial or aeolian origin, though the absence of sedimentary structures prevents a firmer conclusion on their origin. If these sediments are considered to be of a fluvial origin (as is suggested by the poor sorting), they would have been deposited by a river of variable flow velocity, though if they are considered to be of an aeolian origin (the poor sorting being possibly due to post-depositional weathering) they are likely to have been deposited by coastal wind action in view of the earlier discussed possible littoral origin of the lower unit.

### Recommendation

Although no definite conclusion on either the fluvial or littoral origin of these unconsolidated sediments can be proposed at this stage, it is recommended that these sediments be examined palynologically as the results would raise interesting speculations on the Quaternary of Peninsular Malaysia; these sediments being of a Quaternary age as they overlie the Quaternary Kuantan Basalt (Bignell, 1972).

### Acknowledgements

The writer thanks Professor P.H. Stauffer for commenting on the draft of this article. Encik Srinivass drafted the figures while Cik Fauziah Hanim typed the manuscript.

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# UJIAN PANTULAN TUKUL SCHMIDT UNTUK MENGANGGAR KEKUATAN BATUAN DENGAN CONTOH-CONTOH BATUAN GRANIT DI KAWASAN PULAU PINANG

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## Abstrak

*Penganggaran kekuatan kompresi sepaksi ke atas batuan dengan menggunakan kaedah ujian pantulan tukul Schmidt masih lagi boleh diperkembangkan. Penggunaan satah kekar pada batuan granit dari beberapa lokaliti di kawasan Pulau Pinang untuk mendapatkan nilai tukul Schmidt ternyata memberikan hasil yang seragam dengan sisihan piawai yang relatif rendah.*

## Abstract

*An estimation of the uniaxial compressive strength of rock using the Schmidt rebound-hammer test can still be improved. Application of the test on joint planes in granites from certain localities in the Penang area yielded consistent results with a relatively low standard deviation.*

## Pengenalan

Sehingga sekarang nilai kekuatan kompresi sepaksi batuan utuh masih merupakan parameter utama dalam menilai kesesuaian batuan sebagai bahan kejuruteraan. Kerumitan untuk menyediakan contoh dan menjalankan ujian sering memaksa penggunaan ujian-ujian ganti yang dapat dilakukan dengan mudah dan pantas. Ujian indeks kekuatan beban titik, I (Franklin *et al.*, 1971) telah sangat umum digunakan untuk menganggar nilai kekuatan kompresi sepaksi batuan. Meskipun mudah dan pantas tetapi alat ini sukar untuk dibawa ke lapangan. Jenis ujian lain yang sering digunakan sebagai pengganti ujian kompresi sepaksi adalah ujian pantulan tukul Schmidt. Ujian ini mula diperkenalkan oleh Hucka (1965) dan diperkembangkan pula penggunaannya pada batuan oleh Franklin (1974). Penggunaan ujian tukul Schmidt kurang mendapat perhatian meskipun ia dapat digunakan dengan mudah dan pantas, dan mudah pula dibawa ke lapangan. Hal ini disebabkan banyak yang berpendapat ralat pengukurannya terlalu besar.

## Tukul Schmidt

Gambarajah yang menunjukkan bahagian-bahagian dari tukul Schmidt boleh dilihat pada Rajah 1. Tukul Schmidt asalnya digunakan untuk menganggar kekuatan konkrit di kawasan tapak pembinaan. Penggunaannya telah diperkembangkan untuk menilai kekuatan batuan utuh oleh Rankilor (1974) dan untuk jasad batuan oleh Franklin (1974). Tukul Schmidt sebenarnya adalah sejenis ujian pantulan, iaitu ia mengukur tinggi pantulan dari beban piawai yang dikenakan dengan tenaga tetap pada permukaan batuan yang akan dikaji. Prinsip kaitannya dengan kekuatan kompresi sepaksi adalah dengan mengangap pantulan balik oleh batuan akan bersesuaian dengan ciri-ciri kekenyalan dinamik batuan itu sendiri. Oleh kerana ujian ini menggunakan prinsip pantulan maka permukaan sentuh antara tukul Schmidt dengan permukaan batuan banyak mempengaruhi nilai tukul Schmidt yang diperolehi.

Penyerakan data atau ralat di antaranya disebabkan oleh beberapa faktor berikut:

- a. Orientasi tukul Schmidt sama ada ia berkedudukan menegak, dalam keadaan  $45^{\circ}$  atau mendatar dengan permukaan batuan dapat memberikan sedikit perbezaan pada nilai yang diperolehi.
- b. Untuk batuan yang mempunyai kekuatan kompresi yang hampir sama tetapi berlainan ketumpatan, batuan yang berketumpatan rendah biasanya menunjukkan nilai tukul Schmidt yang lebih tinggi.
- c. Semakin tinggi nilai kekuatan kompresi sepaksi, penyerakan nilai tukul Schmidt ternyata lebih besar.

Semua faktor di atas telah diambil perhatian oleh Franklin (1974) yang kemudiannya menghasilkan graf korelasi antara nilai tukul Schmidt dengan kekuatan kompresi sepaksi (Rajah 2).

### Permukaan Batuan

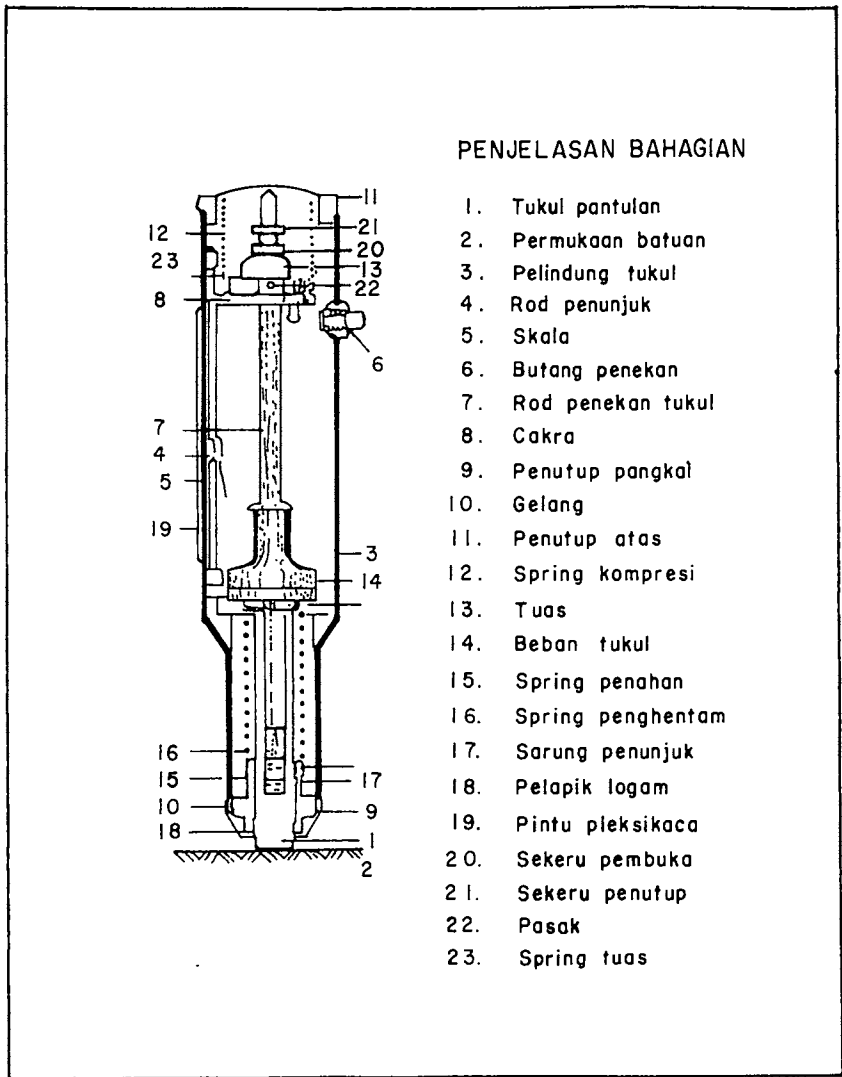
Ketepatan hasil yang diperolehi ternyata banyak bergantung kepada semulajadi sentuhan antara tukul Schmidt dengan permukaan ketepatan data. Saiz batuan yang kecil atau pada jasad batuan yang jarak kekar-nya sangat rapat (Ibrahim Komoo, 1981) nilai tukul Schmidt yang diperolehi bukan sepenuhnya hasil dari kekenyalan dinamik batuan itu sendiri, tetapi boleh juga merupakan nilai gabungan batuan dengan permukaan alas atau batuan dengan satah-satah lemah. Dari pengalaman lapangan, ketebalan atau jarak di antara titik sentuh dengan permukaan bebas lebih dari 10 cm memadai untuk mendapatkan hasil yang memuaskan.

Secara umum permukaan batuan yang tersingkap di lapangan boleh dibagikan kepada tiga jenis; permukaan letupan, permukaan kekar, dan permukaan ricih/sesar. Ketiga-tiga jenis permukaan ini mempunyai ciri-cirinya yang tertentu dan masing-masing boleh mempengaruhi nilai tukul Schmidt.

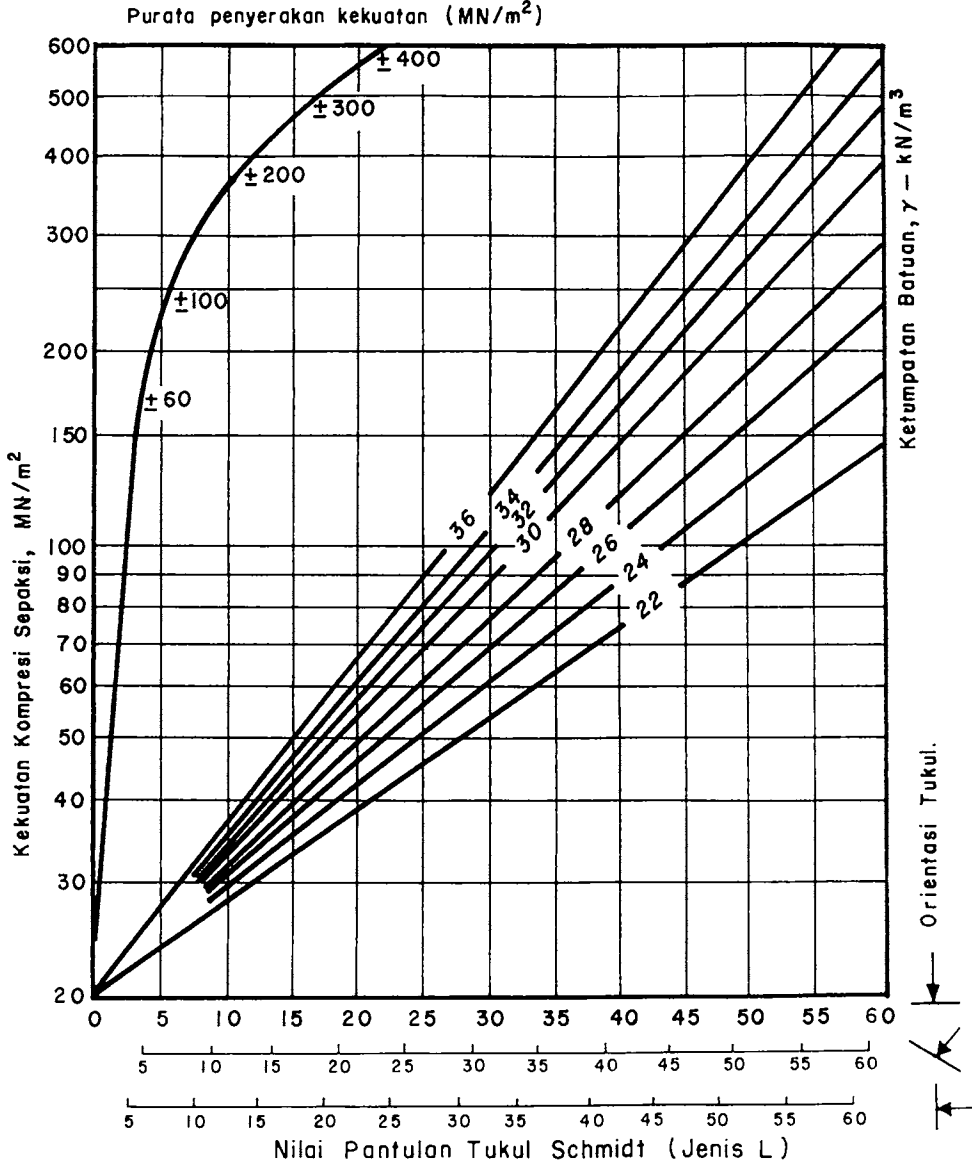
*Permukaan letupan* mudah dijumpai pada kawasan kuari, potongan jalan dan di kawasan pembinaan projek kejuruteraan. Secara umum permukaannya kelihatan rata hingga beralum jika dilihat dari skala makro, dan beralum hingga tidak rata pada skala mikro. Batuannya pula umumnya segar. *Permukaan kekar* boleh didapati pada hampir semua jenis singkapan. Permukaannya rata pada skala makro, tetapi rata hingga beralum pada skala mikro. Darjah perluluhawaan umumnya dari segar hingga terluluhawa sedikit. *Permukaan ricih/sesar* hanya dijumpai pada singkapan yang berhampiran dengan zon ricih. Umumnya satah ricih/sesar sangat rata dan kadang kala bergilap. Pada permukaan yang bergores-garis sesar ada bahagian yang gilap, beralur mikro dan berhonggolan yang tidak rata. Batuannya pula boleh bersela dari segar hingga yang telah mengalami breksiasi.

### Hasil Ujian

Ujian pantulan tukul Schmidt telah dijalankan pada enam lokaliti di kawasan berhampiran dengan Bukit Mertajam dan Pulau Pinang. Kajian awal ini hanya menumpukan pada batuan granit Kulim, iaitu terobosan granit yang berusia Trias Atas di kawasan sekitar Kulim dan Pulau Pinang. Pemilihan lokaliti pula banyak bergantung pada kesegaran singkapan dan kehadiran ke tiga jenis permukaan. Oleh itu permukaan-permukaan kuari adalah tempat yang sangat sesuai. Granit pada lokaliti Air Terjun Sungai Pinang telah mengalami luluhawa sedikit, lokaliti ini masih diper-timbangkan memandangkan tidak terdapat kuari disekitarnya.



Rajah 1. Keratan rentas menunjukkan bahagian-bahagian dari tukul Schmidt.



Rajah 2. Graf hubungan antara nilai pantulan tukul Schmidt dengan kekuatan kompresi sepaksi (Franklin 1974)

Pada satu-satu lokaliti, lebih 100 bacaan telah dikumpulkan dari setiap jenis permukaan batuan. Purata dan sisihan piawai nilai pantulan tukul Schmidt ditunjukkan dalam Jadual 1. Secara keseluruhan nilai purata untuk permukaan letupan lebih kecil berbanding dengan nilai purata pada permukaan kekar. Pada permukaan ricih/sesar pula nilai puratanya agak tinggi. Sisihan piawai pada permukaan kekar ternyata lebih rendah berbanding dengan nilai-nilai sisihan piawai pada permukaan letupan dan permukaan ricih/sesar.

Sela kekuatan kompresi sepaksi daripada berbagai jenis batuan granit umum bersela antara  $100 \text{ MN/m}^2$  hingga  $250 \text{ MN/m}^2$ , sementara ketumpatannya pula bersela antara  $26 \text{ kN/m}^3$  hingga  $29 \text{ kN/m}^3$  (Attewell dan Farmer, 1976). Sekiranya purata data dari setiap jenis permukaan (tidak termasuk data dari Air Terjun Sungai Pinang kerana ia telah mengalami luluhawa sedikit) dikorelasikan dengan kekuatan kompresi sepaksi menggunakan graf hubungan Franklin (1974), hasil yang diperolehi adalah seperti berikut: Kekuatan kompresi sepaksi pada satah letupan bersela antara  $100 \text{ MN/m}^2$  hingga  $130 \text{ MN/m}^2$ , pada permukaan kekar bersela antara  $120 \text{ MN/m}^2$  hingga  $160 \text{ MN/m}^2$ , dan pada satah ricih/sesar bersela antara  $140 \text{ MN/m}^2$  hingga  $190 \text{ MN/m}^2$ . Hasil ini menunjukkan nilai tukul Schmidt untuk permukaan kekar berada pada bahagian tengah dari sela kekuatan kompresi sepaksi granit umum, nilai pada permukaan letupan berada di rantau rendah, sementara untuk permukaan ricih/sesar pada rantau tinggi.

Jadual 1

Purata ( $\bar{x}$ ) dan sisihan piawai ( $\sigma$ ) nilai pantulan tukul Schmidt dari beberapa lokaliti di kawasan<sup>n</sup> berhampiran Bukit Mertajam dan Pulau Pinang

Lokaliti	Nilai Pantulan Tukul Schmidt					
	Satah	Letupan	Satah	Kekar	Satah	Ricih/Sesar
	$\bar{x}$	$\sigma_n$	$\bar{x}$	$\sigma_n$	$\bar{x}$	$\sigma_n$
Kuari JKR Penanti, Bukit Mertajam	32.9	3.8	39.4	2.2	43.8	1.7
Kuari Tanjung Batu, Bukit Mertajam	40.2	2.6	44.8	2.1	45.1	3.8
Kuari Choong Lim Lim, Glugor, Pulau Pinang	40.2	4.8	41.4	3.5	48.1	5.1
Kuari Bukit Bendera, Pulau Pinang	39.7	3.2	43.7	2.5	45.3	3.1
Tapak Mt. Pleasure, Resort Living, P. Pinang	37.9	4.2	40.8	2.9	43.7	3.9
Singkapan di Air Terjun, Sungai Pinang, P. Pinang	34.6	3.1	38.2	2.7	42.4	3.3

## Perbincangan dan Kesimpulan

Hasil kajian ini menunjukkan pengukuran nilai tukul Schmidt pada jenis permukaan batuan tertentu dapat memperkecilkan lagi sela penyerakan data; ini bererti hasilnya boleh lebih dipercayai. Purata nilai tukul Schmidt untuk setiap jenis permukaan ternyata menunjukkan perbezaan yang ketara, hal ini antara lain disebabkan oleh ciri-ciri permukaan batuan itu sendiri. Sekiranya aspek ini tidak diambil kira, data yang diperolehi akan menunjukkan penyerakan yang lebih luas, dan nilainya pula menjadi sukar untuk dipercayai.

Nilai yang diperolehi dari permukaan kekar ternyata lebih seragam dan bersisihan piawai secara relatifnya lebih kecil berbanding dengan nilai yang diperolehi dari permukaan letupan dan permukaan ricih/sesar. Hal ini antara lain disebabkan oleh ciri permukaan kekar ternyata lebih seragam, sederhana rata dan kurang mengalami perubahan sekunder selain dari proses luluhawa. Nilai tukul Schmidt yang agak rendah pada permukaan letupan banyak dipengaruhi oleh ciri permukaannya yang kurang rata. Permukaan yang kurang rata hanya akan menyebabkan kecekapan pemindahan tenaga pada satah sentuhan menjadi rendah, dan hal ini mengakibatkan mekanisme pantulan oleh sifat kekenyalan dinamik batuan menjadi berkurangan. Nilai pada permukaan ricih/sesar pula kelihatan lebih tinggi. Meskipun keratan permukaannya baik tetapi pergerakan sesar atau ricihan sering mengakibatkan pepadatan dan penghabluran semula pada permukaan ricih, dan hal ini sudah tentu akan menyebabkan kekerasan atau kekuatan permukaan tersebut bertambah.

Kajian ini menunjukkan bahawa permukaan kekar pada batuan igneus sesuai digunakan untuk memperolehi nilai pantulan tukul Schmidt. Data yang didapati dari permukaan kekar lebih seragam dengan sisihan piawai yang relatif kecil. Hasil yang seumpama ini akan dapat dikorelasikan dengan kekuatan kompresi sepaksi dengan lebih baik.

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P E R B I N C A N G A N  
( D I S C U S S I O N )

OCCURRENCE OF A NOT UNEXPECTED DOLERITE IN CENTRAL KEDAH -  
A DISCUSSION

C.S. HUTCHISON, Dept. of Geology, University of Malaya, Kuala Lumpur.

*Sir:* Khoo and Tan claim to have solved the mystery of the weathered igneous rock locality at the 10½ milestone Alor Star - Pokok Sena road, Kedah. However, Abdullah Haron (1979), has done a B.Sc. undergraduate thesis on the area and this has not been acknowledged by Khoo and Tan.

Abdullah (1979) described thin sections of the fresh rock, and illustrated his thesis with photomicrographs. He showed the rock to be composed of plagioclase (55%), clinopyroxene (35%), and minor chloritized biotite, quartz, calcite, sericite and apatite. He described the texture as that of diabase. He also gave a chemical analysis: SiO<sub>2</sub> 49.52%, Al<sub>2</sub>O<sub>3</sub> 14.04, FeO (total) 9.48, MgO 9.98, CaO 9.32, K<sub>2</sub>O 1.98, Na<sub>2</sub>O 3.21, MnO 0.23, and TiO<sub>2</sub> 1.20. He concluded that this dolerite represents a sill intruded between bedded chert and shale.

Many students produce undergraduate theses that deserve publication at least in part. However, this is seldom realized, because subsequent employment comes in the way of their plans to write.

23 June 1982

Reference

Abdullah Haron, 1979. The stratigraphy and general geology of Poko Sena area, Kedah. Unpubl. B.Sc. thesis, Department of Geology, University of Malaya, 84 pages + maps.

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*\* This letter has been edited according to the suggestions and recommendations of the Editorial Advisory Board*

## OCCURRENCE OF A NOT UNEXPECTED DOLERITE IN CENTRAL KEDAH - A REPLY

T.T. KHOO & B.K. TAN, Dept. of Geology, University of Malaya,  
Kuala Lumpur

*Sir:* We refer to the letter by Prof. C.S. Hutchison dated 23rd June 1982 commenting on our paper on the 'Occurrence of a not unexpected dolerite in Central Kedah', *Warta Geologi*, 7, 1981, 187-189.

There is only one point in the letter, i.e. in an unpublished report of Abdullah Haron, the dolerite has been discovered and a study made. In truth we are unaware of this study in Abdullah's work and we are happy that our separate studies have arrived at similar conclusions.

The number of unpublished undergraduate student theses or rather project reports as they are now officially called is increasing at a very rapid rate and it is practically impossible for anyone to keep pace with all the findings reported in such unpublished works. As such, it is impossible to acknowledge someone else's work if one is not aware of its existence.

One of the functions of the GSM publications is to make known to everyone the findings of the many geologists who have worked in this country. To this end, the GSM used to publish the Bibliography of Malaysian Geology. I hope the GSM will try to reactivate such publications so that the main findings reported in unpublished works are made known to everyone.

28 June 1982 & 0 Jan 1983

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\* *This letter has been edited according to the suggestions and recommendations of the Editorial Advisory Board*

PERHUBUNGAN LAIN  
(OTHER COMMUNICATIONS)

ALPHABETISING PEOPLE'S NAMES - IT'S DRIVING ME  
CRAZY, DR. SIGMUND!

PETER H. STAUFFER (or Peter H. Stauffer or P.H. Stauffer), Jabatan  
Geologi, Universiti Malaya, Kuala Lumpur

The world today is international, and many aspects of culture, including science, are international. But, fortunately for the richness of the human race, cultures themselves still show great variation in many features. One of these is the way people are named. In European culture, an individual carries one or two (rarely more) individual names plus a surname, which is a continuing family name. However, in some other cultures, there is no continuing family name, but commonly individual name(s) plus the (individual) name of the father. Even in some cultures using family names, the order may be different, as with Chinese names, in which the family name comes first.

When a geologist publishes a paper, that paper may be referred to by others, and will almost certainly be listed by various abstracting and bibliographic services. In all these cases the paper will be listed alphabetically by the author's name - but which name? Unfortunately, the answer to that is not always clear, if you are not familiar with the culture the name derives from. Since most of the listing services are run by people from European cultures, non-European names often are mistakenly interpreted.

To illustrate the problem, perhaps the Malaysian readers of the *Warta* would like to take a short quiz? Listed below are the names of some authors as they were indexed (and alphabetised in the bibliography section) in the *A.G.I.'s Bibliography and Index of Geology*, Vol. 45, No. 7 (July 1981). See how many of these Malaysian geologists you can identify! To give you a hint, I indicate the general topic of the paper the author is indexed for.;

Chin, A.P. (kaolin)  
Choi, L.T. (East Sabah)  
Chye, O.A. (limestone in Kinta)  
Heng, K.C. (Sarawak & Sabah)  
Hock, T.L. (Quaternary)  
Hoong, L.K. (Gemas)  
Hoong, L.C. (Keluang)  
Kee, Y.S. (Straits of Malacca)  
Keong, C.S. and Heng, Y.E. (Peninsular Malaysia)  
Kiat, Denis Tan Ngoh (an easy one!)  
Mailvaganam, Y. (Hose Mountains)  
Peng, K.H. (Sg. Tekai)  
Peng, S.C. (Gunung Tahan)  
Sai, G.A. (Tanjung Malim)  
Siong, L.P. (east Sabah)  
Yeh, W.P. (Northwest Borneo)



Such mix-ups may be amusing, and in personal life they usually do no harm. I am by now used to being referred to as "Dr. Peter", though this tends to confuse me with our dogs' veterinarian. And I am used to looking for my name in lists under "P" (it has never been anywhere else in the books of the University of Malaya Cooperative Bookshop). When Malaysia's then Minister of Finance, Tun Tan Siew Sin, toured Europe some years ago and the press there referred to him as "Mr. Sin", again no real harm was done.

But when scientific works are indexed and alphabetised by different people in different ways, and when the result is that some authors' names are garbled to the point of unrecognizability, real confusion may ensue, leading to duplication and loss of time and effort. Therefore I would like to make a plea: Whenever we publish anything, let us ensure that it is clear which of our names is to be used for alphabetising. While things would be unambiguous if everyone used only one name plus initials, many people (myself included) prefer to use fuller forms of our names. Here editors and publishers could help by using a special style for the author(s) name(s) at the beginning of an article, as I have done on this note. The name to be used in alphabetising could be printed in all capital letters or underlined. If some such style were adopted, much confusion could be avoided, and bibliographers and others referring to papers would grow fewer grey hairs and be less likely to have to seek out the couch of one Dr. Sigmund's disciples!

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*Article received 22 April 1982*

# ORIGIN OF KINTA LIMESTONE HILLS - BY GEORGE!

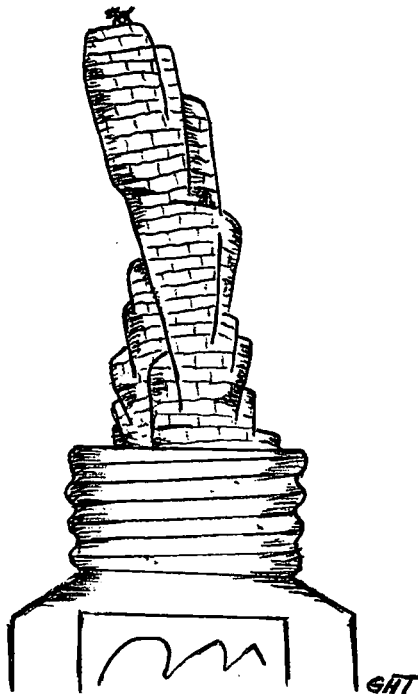
T.T. KHOO, Dept. of Geology, University of Malaya, Kuala Lumpur

The limestone hills that are studded over the alluvial plain of Kinta, in the State of Perak, are the home of a considerable number of these goats (the serow). The sides of these hills are sheer precipices, and one gets a good idea of their general appearance when one learns that, in some period of geological pressure and upheaval, the limestone was forced up in a liquid state through the granite in the same way that oils in a painter's tube are squeezed out: the hills stand up above the plains in exactly the same way that the oil stands up above the mouth of the tube..... The hills vary in size, some being little more than gigantic isolated boulders, whilst others are two thousand feet high and many miles in circumference.

(From 'In Malay Forests' by  
Sir George Maxwell, 1907)

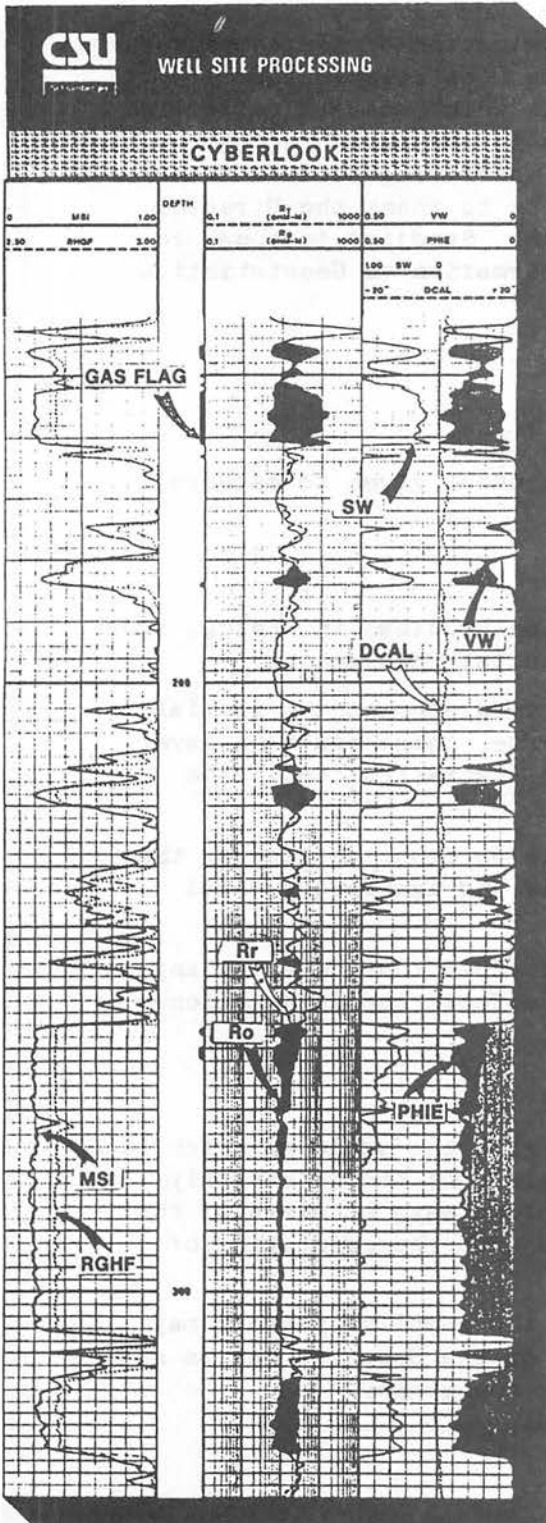
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*Article received 28 September 1982*



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# PERTEMUAN PERSATUAN (MEETINGS OF THE SOCIETY)

## TECHNICAL TALKS

### L. SANDJIVY: Geostatistics and its application for the evaluation of tin deposits

On the 22 September 1982, 30 members were present at the Dept. of Geology, University of Malaya to listen to Mr. Luc Sandjivy talk on "Geostatistics and its application for the evaluation of tin deposits". Mr. Sandjivy, a Geostatistician from Centre de Geostatistique de Fontainebleau (France), had just completed his work and data collection at the SEATRAD Centre, Ipoh. The Society was indeed lucky that Mr. Sandjivy was able to present this talk as he was flying back to France the very next day. The Society would also like to thank the Director of SEATRAD Centre for making it possible for Mr. Sandjivy to speak to its members. Members who would like more information on Geostatistics can write to

Centre de Geostatistique  
Ecole des Mines de Paris  
35 rue Saint Honore  
77305 Fontainebleau, France

What follows is an edited version of a handout given to members present at the talk.

#### Introduction

Mining geostatistics deals with estimation problems in mining, from the global ore reserve estimation to the exploitation planning.

Its principal characteristic is to take into account the spatial structure of the variable to be estimated (grade, thickness of a layer, depth of the bedrock .....), using a simple statistical tool, the variogram.

The spatial continuity of a phenomenon is an important factor that is intuitively stated by geology in its models and ignored by usual statistics.

Geostatistics is based on three major concepts that underly any estimation problem that are called the scale effect, the information effect and the support effect.

#### The scale effect

The variability of a deposit can change with the scale at which it is studied. A good continuity at a small scale does not necessarily mean to be good at a larger scale and we should always be aware of the size of the area to be studied and look for a good representation of the variability at this scale.

For example, in a tin alluvial deposit, the sampling pattern may allow a good estimation of the average grade of the deposit, but is not suitable for a mapping of the karstic bedrock topography.

### The information effect

There is always a difference between the true grade of a block and its estimated value because the information is fragmentary at the time of the estimation. Important properties for an estimator are to be unbiased and precise. It should not lead to any systematic error and be as precise as possible. This is very important when a selection is made on estimated values, between waste and valuable ore.

A biased estimation, however precise it maybe, will lead to an economical loss due to a wrong selection of the payable ore. Let us stress that this is the principal drawback of the polygon of influence method for local estimation, as it underestimates the low grade blocks and overestimates the high grade ones.

### The support effect

In the same deposit, the variability of the grade will depend on the size of the support on which it is measured. The core grades will be more scattered than bigger block grades. Thus, the distribution of the core grades is different from that of block grades.

Blocks are mined but not cores and the recoverable tonnage estimation must be made with the right support distribution.

A classical ore reserve study can be divided into two parts:-

First is the structural analysis of the area under consideration that leads to the modelisation of the experimental variogram. Second is the estimation of block grades using Kriging techniques that give local estimates and a global one for the deposit along with a precision of the estimation.

These names are quite familiar to anybody dealing with ore reserve estimation. Let us just present a short definition and the main characteristics of these geostatistical tools.

### The variogram

In a fixed direction  $\alpha$  using the drilling information and the boreholes location, the following statistic is computed, which is called the experimental variogram:

$$\gamma^*(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} (Z(x+h) - Z(x))^2$$

where  $Z(x)$  is the grade of sample located at point  $x$

$Z(x+h)$  is the grade of sample located at point  $x+h$  in the direction  $\alpha$

$h$  is the distance between two points, a multiple of the sampling grid when it is regular

$N(h)$  is the total number of pairs  $(Z(x+h), Z(x))$  available at the distance  $h$

$\gamma^*(h)$ , the experimental value of the variogram function, is a measurement of the variability of the grade between two points distance of  $h$  in the direction  $\alpha$ .

The experimental variogram is computed in four directions in the

horizontal plane for a two dimensional study and in the vertical plane for a 3-dimensional study.

The different experimental curves  $\gamma^*(h) = f(h)$  show the spatial structure of the grade.

Several characteristics of the deposit such as anisotropy, continuity or small scale variations, zones of influence of a sample can be deduced from the experimental variogram and it can be usefully interpreted by geologists. The diagram (Fig. 1) shows the applications of this structural tool.

These curves are then fitted by appropriate mathematical functions to obtain a unique variogram model to represent the variability of the grade at the scale of the study.

The variogram function is used to compute:

- Precision of an estimation - Definition of sampling grid (Information effect)
- Correction needed by the change of support from cores to blocks (Support effect)
- Kriged estimates for estimation purpose
- Simulated values for simulation purpose

### Kriging

It is an estimation method that use all the information available within and in the neighbourhood of the volumes to be estimated. The kriged value is a weighted sum of the boreholes data.

$$Z^*_k V = \sum^N \lambda_i Z_{vi} \quad \text{Kriging is a linear method}$$

$Z^*_k V$  = Kriged estimate of the unknown grade of ZV of a volume V

$Z_{vi}$  : N sample value of volume  $v_i$

$\lambda_i$  : Kriging weighing factor of sample  $v_i$

The  $\lambda_i$  are such that

$E(ZV - Z^*_{kV}) = 0$  there is no systematic difference between the real value ZV and its estimate  $Z^*_{kV}$ . Kriging is unbiased

$E(ZV - Z^*_{kV})^2$  is minimum. The variance of estimation of ZV by

$Z^*_{kV}$  is minimum, the precision is maximum.

So kriging is the Best Linear Unbiased Estimator.

The  $\lambda_i$  depend on:

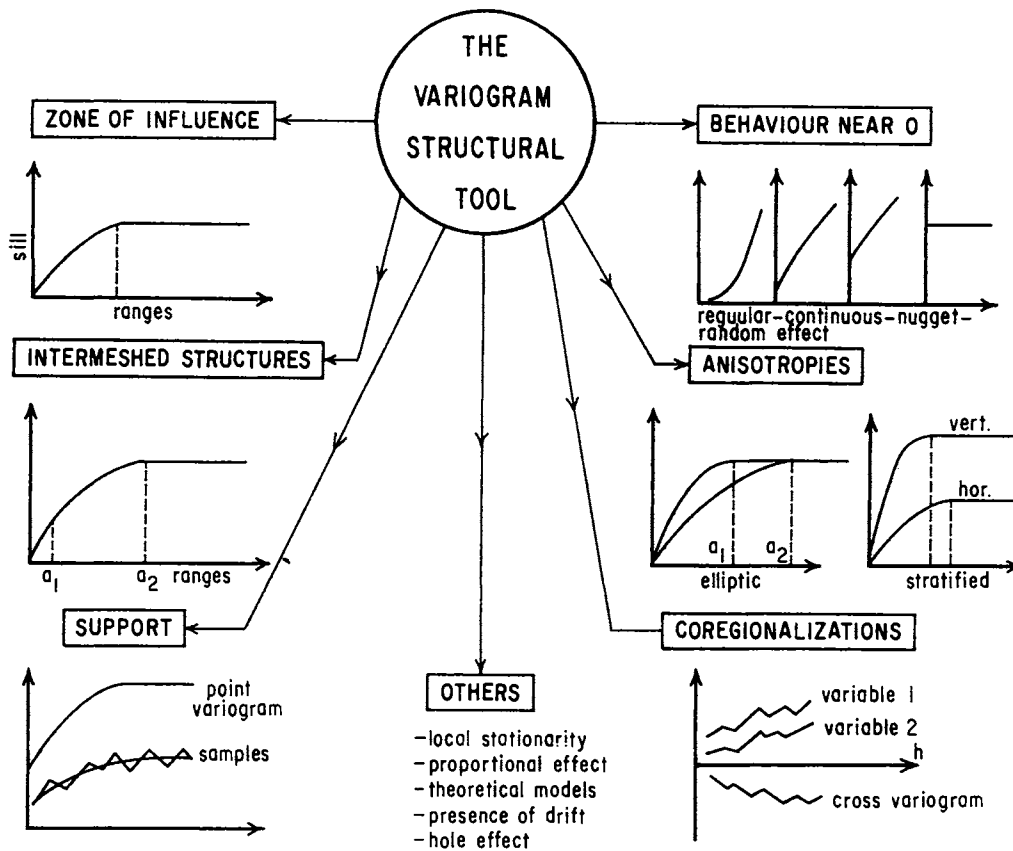
- the geometry of V
- the geometry of  $V_i$
- the spatial continuity of the grade

### Geostatistics and Alluvial Tin Deposits Evaluation

We shall distinguish three main steps in the estimation of a tin deposit and see if and how geostatistics can be applied. These steps are: sampling, global estimation, and local estimation.

## Sampling

The main purpose of sampling is to lead to a good estimation of the deposit. A sampling is good when there is no systematic over or under estimation of grades of drilling samples and when there are enough boreholes to allow a precise estimation.



Bias can be seen by comparing actual recovered grades with estimated ones over a long period. Without consideration on precision, the estimated values should be as many times higher or lower than the true ones. A systematic bias may be due to the sampling grades themselves or to the estimation method.

In tin mining there seem to be a systematic underevaluation of grades which is of a major economical importance because it can lead to a wrong appreciation of the areas to be mined or discarded.

We already know that the polygon of influence method underestimates the low grade blocks and over estimates the high grade ones. But the major cause of underevaluation should be mainly looked for in the sampling itself.

Firstly, the SEATRAD Centre researches tend to show that Banka drilling and the volume measurements, as they are done now, underestimate the true grade of the borehole.

Secondly, the irregular bedrock topography and the presence of rich pockets not systematically sampled is a factor that contributes to underevaluation.

Geostatistics can certainly be helpful for the bedrock topography problems. The 4 chains sampling grid is too large to allow a precise mapping of the bedrock. Anyway, geostatistical simulation of the bedrock topography could be made that could help to see if significant improvements would occur with different definitions of the sampling pattern.

A specific research should be carried on the sampling pattern in alluvial deposit using geostatistics techniques.

### Global estimation

To estimate the average grade of the ore in a fixed volume is called global estimation. If we use only the available borehole information inside the area, all the linear methods including kriging will give the arithmetic mean of data as the average grade. Improvement in global estimation can come from additional information provided by other parameters measured on the boreholes, such as the contents of amang and sand.

Geostatistics can be used too for multivariate estimations with such techniques as co-kriging, which uses the intercorrelation between variables.

It is important too in global estimation to be able to indicate the precision of the estimation, provided of course that the sample data are unbiased, and to define the best sampling pattern which gives the best precision for the lower cost. In this field, geostatistics can provide the precision of a global estimation and select the best sampling pattern. This can be done very easily and just require the knowledge of the variogram of the deposit.

### Local estimation

To estimate the grade of a smaller volume or block is called local estimation. The volumes defined by the polygon of influence method, or mining exploitation units are examples of blocks that are to be estimated before mining.

For all selection problems, when one has to decide the geometry of the area to be mined or the thickness of overburden to be stripped off, local estimation of blocks is required. An unbiased and precise estimation method is very important to minimise the selection errors.

This is the main routine field for geostatistics with the kriging method which provides unbiased and precise estimations. This technique is now widely used in mining industry all over the world, and it has proved to be a major improvement compared to polygon of influence for local estimation of blocks.

### Conclusion

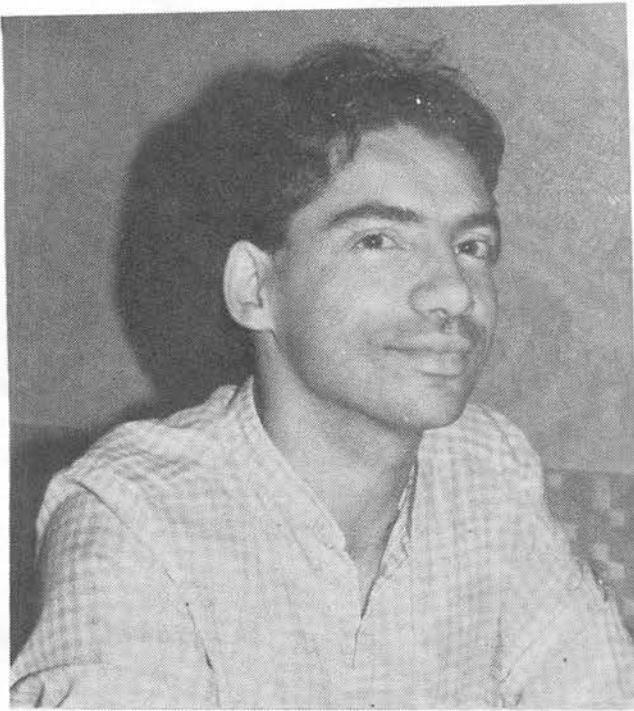
This is a general overview of the possibilities of geostatistics in alluvial tin mining. The specific problems in dredging and open cast mining can surely be expressed in geostatistical terms and further discussion and work will show the improvements that can be expected from the use of this technique. The geostatistical tools already exist for standard evaluation problems such as sampling grid patterns or local estimation and others can be fitted with a little research to sampling and bedrock problems.

G.H. Teh

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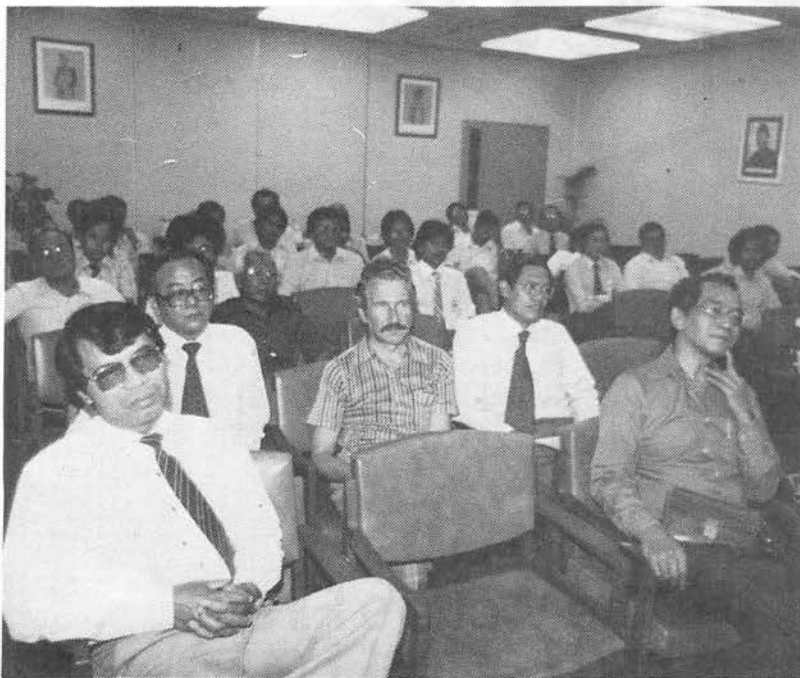
# TECHNICAL TALKS SEPT - OCT 1982



L. SANDJIVY



I. MURATA



J.F. McDIVITT



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## I. MURATA: Some aspects of earthquake prediction in Japan

Dr. Ichiro Murata of the Faculty of Surveying, University of Technology Malaysia, presented his talk entitled "Some aspects of earthquake prediction in Japan" on 1st October 1982 at the Dept. of Geology, University of Malaya to a crowd of about 35. Dr. Murata is a gravimetry specialist seconded from the Earthquake Research Institute, University of Tokyo, Japan.

Japan is an Earthquake Country as it suffers frequently from earthquakes. The need for earthquake prediction had been given top priority. In fact it is one of the country's urgent scientific research projects which is taken as a national project.

The three factors of earthquake prediction are place, time and magnitude. The current target figures are a place of 100 km distance, time of 1 month and a magnitude of  $\pm 1$ .

According to Dr. Murata, nowadays, the cause of earthquake is known to be a breaking up phenomenon of the earth's crust under accumulating stress. The mechanism of great earthquakes is especially well explained by means of the plate tectonics hypothesis.

For earthquake prediction it is necessary to identify the precursors of earthquakes. Judging from the mechanism of earthquake occurrence, the following list presents the phenomena which can be taken to assume the role of precursors:

- Seismological phenomena (like seismicity gap, foreshock, change in mechanism, change in seismic-wave velocity)
- Geophysical phenomena other than seismological ones (like geomagnetism, geoelectricity, gravity, radioactivity)
- Geodetic measurements (like triangulation, contraction, extension, trilateration, levelling, sea level change, crustal movements, strain, tilt)
- others (like underground water, animal behaviour, meteorological phenomena).

There are evidences accumulated to show the relationship between these phenomena and earthquake occurrences.

Although the characters of these phenomena as precursors are not yet fully understood, it is hoped that further studies will reveal them in the near future.

In Japan the administration for the earthquake prediction project has three centres set up to monitor and collect the data on various geophysical phenomena. They include the Crustal Activity Monitoring Centre, the Seismicity Monitoring Centre, and the Earthquake Prediction Observation Centre. Through these channels data are then presented to the Coordinating Committee for Earthquake Prediction.

This committee is responsible for the judgement of anomalous phenomena suspected to be precursors. The area where anomalous phenomena are found is designated, according to the degree of anomaly and their significance, as the Area of Special Observation, the Area of Intensified Observation, and the Area of Concentrated Observation.

These designations are based on such factors as the neighbouring region of great earthquakes, a calm region after a great earthquake of some hundreds years ago, a suspected area from the viewpoint of geo-

science although there is no historical earthquake document, stress accumulating area, and high density population area.

In Japan, the present state of observation network for earthquake prediction are now operating following forms of observation networks as well as scientific research. These include geodetic survey (with precise geodetic network consisting of 6,000 stations and a survey repetition cycle of 5 years; precise levelling network of 20,000 km in length, with a survey repetition cycle of 5 years over a suspected area for 1 - 2 years), tidal observation (100 stations at 100 km separation), crustal movement observation (about 20 observatories - some other proposed observatories), seismic observation (modernized instrumentation for existing meteorological observatory - several tens, micro earthquake observatory - 19 stations, deep bore hole station - 3 stations), seismic wave velocity (one a year), geomagnetic observation (14 stations), and data processing centres.

During the discussion that followed, Dr. Murata was able to confirm that the rate of success of prediction has been good, that the Japanese people are understanding about the vast sum of money spent on earthquake prediction and research, and assured the audience that Peninsular Malaysia is outside the sphere of earthquake activity.

G.H. Teh

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**J.F. McDIVITT: Some aspects of mineral development in the ASEAN Region: needs for the promotion of mechanisms for overcoming non-technical obstacles to international mineral development**

This Technical Talk by Dr. James F. McDivitt was co-hosted by the Society and the Institute of Mineral Engineering Malaysia on 15 October 1982 at the Conference Room, Pemas Charter Management Sdn. Bhd., Wisma Bunga Raya and attended by an audience of about 40.

Dr. McDivitt, a familiar figure in this region, has held the office of Director, UNESCO Regional Office for Science and Technology for Southeast Asia in Jakarta 1967-1979 and the UNESCO Division of Technological Research and Higher Education in Paris 1979-1982. As such, Dr. McDivitt with his vast experience, was particularly very much at home with the subject of his talk.

In commenting on the very great changes which are going to take place in world industry including the mineral industry in the remaining years of this century, Dr. McDivitt referred to two recent books. The first is the latest publication of the Club of Rome titled "For Better or for Worse - the Impact of Micro-electronics on Society", which supports the belief of many that we are on the verge of a new revolution which will see a large part of today's job market taken over by electronic devices such as microprocessors, robotics. This book emphasizes the social implications which will be quite devastating, so much so that employment as it exists today will be wiped out.

The second book titled "Japanese Technology - Getting the Best for the Least" is by Masanori Moritani of the Namura Research Institute of Tokyo, a well-known specialist on R & D management and analysis. He

contends that, based on existing technology, and with heavy emphasis on the as yet only partially realized potential of micro-processors, revolutionary innovations will continue to be developed in a wide variety of fields which will change the structure and character of industry. Taken together, these books present a challenging and somewhat frightening picture of a future which is already on our doorstep.

We already see something of this in the mineral industry with new approaches to exploration including such things as satellite imagery, in the mines themselves with growing computerization, and the obvious jobs for robots, and in mineral processing where, for example, the potential of microbiology is being given increased attention. More and more of today's engineers and technicians must be and are knowledgeable in the various and expanding applications of microprocessors to their work, applications which even a decade ago were unheard of. But with the potential for improvement and innovation, and above all, with the much lower costs of electronic technology, this must only be the beginning.

It is clear that the nature of the mineral industry will change significantly both on the demand and on the supply side, and in many cases we cannot even guess at these changes. Markets will change as the nature of society changes, with relatively more emphasis on light and specialized metals and on some of the rarer elements required by advanced technology. But markets for basic metals - iron, copper, tin, etc., can be expected to hold up well as new supplies are devoted to meeting the enormous accumulated and latent demand for transportation, appliances, building materials and services of the developing countries whose people will increasingly share in the benefits of technology.

Perhaps it is on the supply side that the most apparent changes will take place as we see the increasing use of radio-controlled and computer-programmed trucks and drills and various forms of earth-moving equipment, and of robots in many of the more dangerous and unattractive tasks both underground and in the mills and processing plants. And in all this, studies have shown that low-wage countries have no advantage, and that there is no practical wage level at which human labour can be cost competitive with such technology.

If one agrees that there is some validity to these concepts, it is clear that mining in the future (and the future is already with us) will be a very different ball game - different rules, different players. The experience will certainly be traumatic for most of us and early steps must be taken to make this transition as smooth as possible.

Over recent years a number of people have considered this challenge and ways to meet it. As one step towards this they are proposing the establishment of an international mechanism which would serve as a forum for officials and specialists involved with mineral supply to discuss and exchange views on issues and problems affecting long-term mineral development and supply, and to work out strategies to deal with these issues and problems.

The programme will be based on regular broadly based planning and review meetings supported by working groups and research studies to deal with problem areas in depth. It will prepare and distribute reports and newsletters and will work closely with the various bodies, UN, inter-governmental and non-governmental, working in related areas.

This will be only one step to face a changing world but it does have

potential to help the countries of Southeast Asia to identify and consider those issues which will have the greatest effect on them. Some additional information on this proposal was made available in a brochure for distribution.

## FORUM FOR INTERNATIONAL MINERAL DEVELOPMENT

### Background

Long-range mineral supply is emerging as one of the critical problem areas for the future. Much has been written on the subject, and a number of organizations give attention to it on a limited and sporadic basis, but at present there does not appear to be any group or body giving it continuing attention. To help fill this gap, it is proposed to establish a mechanism to analyse and review the full breadth of the problem area with a view to improving the environment for mineral development throughout the world, with some emphasis on the needs and potential of developing countries.

Basically, the world faces a situation in which meeting the raw materials needs of the developed world and the new industrial countries will call for increasing amounts of minerals which must be recovered from the limited and non-renewable resources of the earth. Significant amounts come from developing countries where they can make a major contribution to the economy and its development. In many cases large multinational companies which have mineral operations in many parts of the world are involved in this production.

The interests of these three main components (the consumers, the producing country, and the producing company) are not always in harmony. Thus the pattern of availability and supply does not always function smoothly and in the most efficient manner and it would appear that the resources of developing countries are not being opened up and used to the extent that seems warranted. Anything which can be done to improve the harmony within this system will improve the pattern today and for the future, both on the levels of assured supply and increased benefits.

The report of the Brandt Commission draws attention to the relatively weak position of most developing countries in the identification and development of their mineral resources, and the urgent need to take steps to remedy this. The report notes "Traditionally mineral exploitation in developing countries has been dominated by international mining companies, which provided capital, technical knowledge and marketing facilities, and bore the exploration risks themselves. There has often been a lack of balance of costs and advantages to developing countries. This pattern of exploration and investment has now broken down". The report goes on to discuss the causes for this and possible steps to improve the situation concluding "Here, therefore, is an area where new initiatives, involving imaginative new arrangements, can clearly be in the interests of North and South alike".

This is a realistic assessment which identifies among other things the need to establish communication and promote exchange and understanding involving the producers, consumers and producing countries, with a view to evolving a harmonious pattern of mineral supply for the future. The following proposal can be considered as one initiative towards this goal, designed to fill a gap in the present institutional structure.

## Proposal

The proposal is to establish an international non-governmental programme which will serve as a forum for officials and specialists involved and concerned with long-term world supply of minerals on the technical, economic and political levels. These include representatives of producing and consuming countries and companies, financing bodies, regulatory bodies, associations and other interested groups. Within this neutral and constructive framework they will be able to discuss and exchange views on areas of mutual interest and concern and to identify and consider issues and problems which affect international mineral development and supply.

The programme will be based on regular planning and review meetings supported by working groups and research studies in special areas, and will include distribution of information and reports. This will involve setting up a small secretariat, possibly related to an existing administrative structure, to prepare and follow up on meetings, to commission and carry out studies, and to assemble and distribute information. It will work closely with UN and other bodies functioning in related areas.

## Development objectives

Through improving the mechanisms and channels for communication and through development of mutual understanding between the various components involved in mineral development the forum aims to:

- promote increase in the level of development of and investment in mineral extraction and processing in developing countries;
- help assure the orderly expansion of mineral markets and the orderly flow of materials to satisfy these markets.

## Programme structure

Programme activities are considered on five levels:

- (a) Periodic international assemblies, bringing together specialists from the several groups involved in the programme to discuss the broad area of long-term mineral supply and, more specifically, to identify and advise on present and potential issues and steps the forum might take to deal with them, and to outline and approve a programme of action. Once the programme is running, the assemblies would review results and progress;
- (b) Working groups would be established to study and prepare "state-of-the-art" reviews on specific issues which have been identified by the assembly. Working group meetings, in most cases on a regional or subregional level, would bring together 10-15 working level specialists with background and interest in the subject under discussion for 2-5 days, 2-3 times before reporting back to the next assembly. Their work might involve exchange visits which would allow staff of participating bodies to share experience and to work on problems of mutual interests;
- (c) Studies and analyses to support the reviews of the working groups can be carried out on a limited basis by the secretariat; are being or can be carried out by other groups and organizations with which cooperative links will be established; are being or have been carried out by organizations participating in the programme which may be willing to make all or part of the results of their work

available to the working groups; and in other cases, can be turned over to universities and other research bodies working in related fields;

- (d) Information services would initially consist of a quarterly newsletter outlining developments in the programme, notes on major developments of interest to participants, and abstracts or titles of recent articles and publications. Over time, it is expected that the programme will lead to technical papers, popular articles and books which will be published through normal professional and commercial channels;
- (e) International or regional seminars on specific subjects of wide interest, in some cases organized in cooperation with other groups working in related areas.

#### Administrative and operational structure

Because of the complexity and sensitivity of the field of mineral supply, special care is being taken to assure that all aspects of the programme are as balanced and unbiased as possible. As a step towards this, it is proposed that programme activities be carried out through a consortium or club consisting of a relatively large number of members (150 - 200) drawn from groups working in fields related to mineral supply, and paying a subscription. Members would be invited to attend the assemblies, and to nominate participants for the working groups. The consortium or club will be serviced by a small secretariat unit, consisting initially of a coordinator, an administration/documentation officer, and a secretary. The secretariat will receive guidance and instructions from an advisory council of specialists representing the various participating groups, which will serve as a board of trustees until a formal structure is approved.

During the first years the programme is expected to operate with limited staff and facilities. Office space and most facilities are expected to be provided by the host institution(s). There are advantages to locating the headquarters of the Forum in a developing country and, initially at least, it might share facilities with an existing organization working in a related area (AGID - the Association of Geoscientists for International Development - which has its headquarters at the Asian Institute of Technology in Bangkok, is a possibility). However, the Forum should maintain its own separate identity, and there are clear advantages to it being formally established as a non-profit, non-governmental organization once it has passed through its first stage of development.

#### Support

Support for the programme falls into two main categories, administration and programme. Much of the programme support will be for travel and per diem of participants to take part in the various programme activities, although it is expected that about half of this cost will be covered directly by employers of participants. By the end of the first five years, expenses are expected to build up to the order of \$500,000 per year, about 40% for administration and 60% for the forum share of programme activities. During the start up period of a budget about half this amount is foreseen.

There is advantage in obtaining support from as large a number of



sources as possible to avoid any question of pressure or bias. Support for core (administrative) activities will be sought in the form of grants from foundations, international organizations and programmes, associations and non-commercial bodies which have interest in the subject of the programme but which would be expected to participate to a limited extent in its activities. Support for programme activities will be sought from the large number of organizations which would be expected to participate actively in the programme, including producing and consuming companies, banks, investment groups, government agencies, mineral development associations and others. These would be members of the consortium and would pay an annual subscription (\$1000-\$5000) to participate in the programme. It is expected that over 2-3 years the list of participating members would build up to 150-200.

In practice it may not always be possible to split the support into core and programme in this way since many funding sources require that the major part of their support be used for programme activities. It seems essential that, even from the beginning, a significant part of the support come from mineral development related sources as an indication of their genuine interest and involvement in the programme. To facilitate the generation of support and the development of an effective structure it is proposed that the first three years of operation be considered as a development stage.

#### Development stage

During the development stage, special attention will be paid to building up contacts and structure, to developing the information services and to establishing and testing the working group procedures on a regional level. Most of the initial support is expected to come from sources outside of the mineral industry, while membership of the consortium or club is being built up.

During this period regional working groups will be established, initially in Southeast Asia where AGID has its headquarters and where there are a number of important mineral producing countries (Burma, Indonesia, Malaysia, Papua New Guinea, Philippines, Thailand) but at the same time there are no mineral dominated economies: and in Africa, where CERNA - Centre d'Etudes des Ressources Naturelles - is already developing related programmes. Operations will be extended to Latin America at the end of the developing stage, by which time decisions will have been made on the best long-term structure.

From the beginning this must be viewed as an international programme which deals with international issues, and to assure this it is proposed that each regional working group include participants from other regions.

G.H. Teh

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## ECONOMIC GEOLOGY SEMINAR 1982

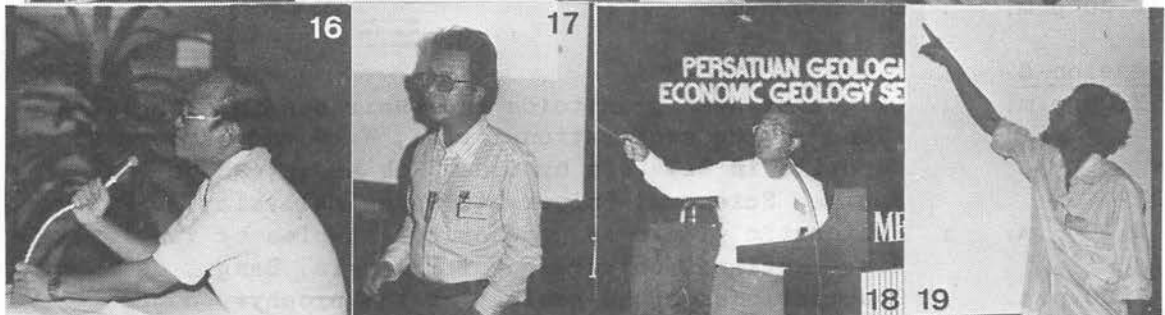
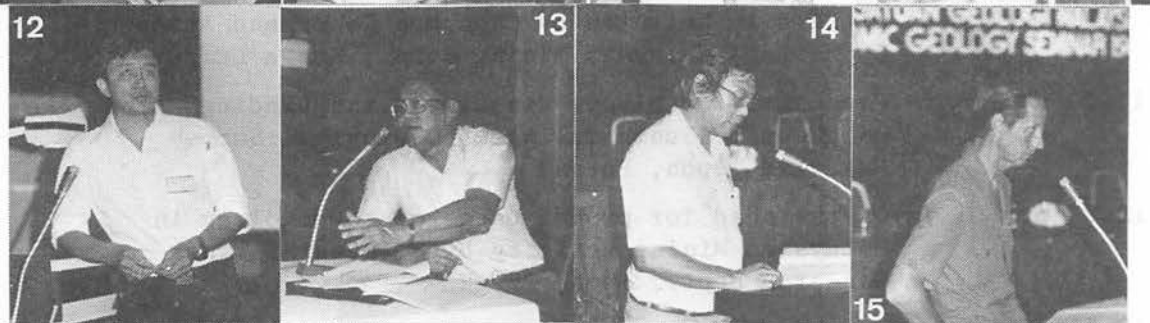
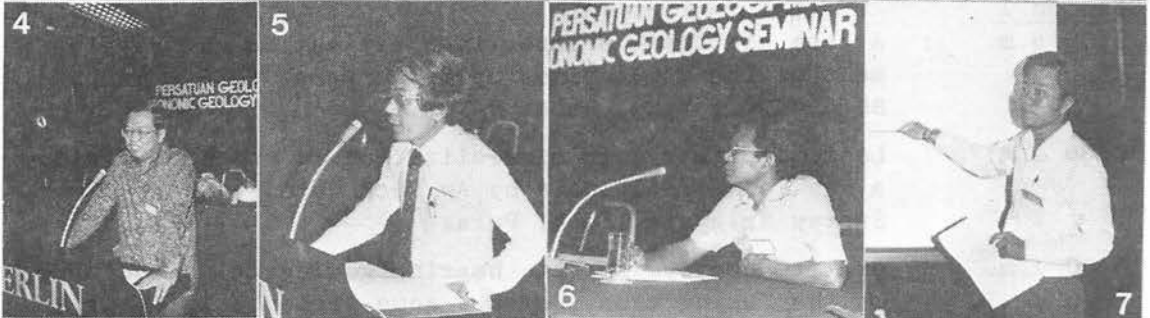
The Society's Economic Geology Seminar 1982 was held at the International Hall, Hotel Merlin on the 25th October 1982. It was attended by a most encouraging crowd of 80.

In his Opening Address, the Society President, Dr. T.T. Khoo, spoke

Economic Geology Seminar 1982 - Caption to photos

- 1 - 3 Sections of the audience at the Seminar
- 4 GSM President with his Opening Address
- 5 P.C. Aw with his paper on tin mineralization in the Kinta Valley
- 6 Session 1 Chairman, Abdullah Hasbi, listening to a question from the floor
- 7 M.H. Loke on gravity surveys in the Pusing area
- 8 C.S. Hutchison with his paper on tungsten deposits of Xihaushan
- 9 A. Spykerman talking on the 6-inch Bangka drill
- 10 H. Hussin on terminology in Malaysian Mining activity
- 11 M.K. Choo with a comment from the floor
- 12 K.K. Cheang answering questions on granitoids
- 13 Chairman S.K. Chung ably handling Session 3
- 14 T.H. Tan on subaquatic plants as geochemical samples
- 15 C.K. Burton with his paper on porphyry copper
- 16 Session 4 Chairman, M.K. Choo, well in command
- 17 E.B. Yeap answering queries on Sn-Fe mineralization at Pelepah Kanan
- 18 Wan Fuad on niobium-tantalum deposits of Peninsular Malaysia
- 19 Abdul Halim indicating the area of his limestone survey.

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on the austere nature of this year's seminar to conform with the world's economic situation. However, this was not reflected in the nature of papers presented as they were certainly of higher quality, involving a wider spectrum of mineralization types and techniques and definitely giving the seminar a more regional flavour (see Programme). This augurs well for the future of the Society's Economic Seminar, for with interest registered, this Seminar may well rival the Society's Petroleum Geology Seminar in stature.

G.H. Teh

Programme

- 8.30 a.m. : Registration  
8.50 a.m. : Official Opening Address by the President

Session 1

- 9.00 a.m. : A case history - prospecting, evaluation and development of the Mamut Mines by Y. Akiyama, OMRD - Sabah Bhd., Mamut Mine, Sabah  
9.30 a.m. : Loci of primary tin mineralization in the Kinta Valley - a new look of old data by Aw Peck Chin, Geological Survey Malaysia, Ipoh, Perak  
10.00 a.m. : Gravity surveys for tin bearing geological structures in the Pusing area, Perak - some preliminary results by Loke Meng Heng, Lee Chong Yan, School of Physics, Universiti Sains Malaysia and Ho Choon Seng, Geological Survey Malaysia, Ipoh, Perak  
10.30 a.m. : Coffee break

Session 2

- 10.50 a.m. : Tungsten deposits of Xihuashan, China by C.S. Hutchison, Dept. of Geology, University of Malaya, Kuala Lumpur  
11.20 a.m. : The 6-inch Banka Drill as a sampling tool for auriferous placers in Kelantan by Choo Mun Keong and Andrew Spykerman, Malaysia Mining Corp., Kuala Lumpur  
11.50 a.m. : Prospects for placer tin around the Dindings area, Perak by T. Suntharalingam, Geological Survey Malaysia, Ipoh, Perak  
12.20 p.m. : On the need for proper usage of terminology in Malaysian Mining activity by H. Hussin, Mines Research Dept., Ipoh, Perak  
12.50 p.m. : Lunch break

Session 3

- 2.00 p.m. : Origin of some granitoids and their possible implications in the exploration for Sn, W, U and base metal deposits in Malaysia by Chean Kok Keong, School of Applied Sciences, Universiti Sains Malaysia, P. Pinang  
2.30 p.m. : Subaquatic plants as geochemical samples by Tan Teong Hing, National University of Malaysia, Bangi, Selangor  
3.00 p.m. : Observations on the geology of the porphyry copper, Sub-Province of Southwest Negros, Philippines by C.K. Burton, Billiton, Philippines  
3.30 p.m. : Coffee break

Session 4

- 3.50 p.m. : Reinterpretation of the Sn-Fe mineralization of the Waterfall Mine, Pelepah Kanan by Yeap Ee Beng, Dept. of Geology, University of Malaya, Kuala Lumpur
- 4.20 p.m. : Niobium - Tantalum minerals from Peninsular Malaysia by Wan Fuad Wan Hassan, Dept. of Geology, National University of Malaysia, Bangi, and Oleg von Knorring, Dept. of Earth Sciences, University of Leeds, Leeds, England
- 4.50 p.m. : Limestone survey by seismic reflection by Abdul Halim Quazi, School of Physics, Universiti Sains Malaysia, Penang.

## ABSTRACTS OF PAPERS

**A case history - prospecting, evaluation and development of the Mamut Mine: Yoshio Akiyama, OMRD- Sabah Bhd., Mamut Mine, Sabah**

*The Mamut porphyry copper deposit is situated in north-western Sabah, about 68 kilometers east of Kota Kinabalu. It has been in operation for approximately seven and a half years and is currently producing 20,000 tonnes of ore averaging 0.57 % Cu and 25,000 tonnes of waste per day.*

*The history of exploration of the Mamut porphyry copper prospect might be traced back to 1958 when copper anomalies were discovered in the basalt and ultrabasic rocks in the Labuk Valley by Fitch (1958). During the period of 1963 to 1965, a systematic stream sediment survey, which led to the discovery of some anomalous areas around the present property, was conducted by the United Nations Labuk Valley project team. In 1966, the Geological Survey of Malaysia implemented the subsequent reconnaissance programme at the present ore deposit, which involved mapping, geochemical soil surveys, shallow diamond drilling and pitting so as to make a preliminary assessment of the Mamut ore deposit. Following an investigation by the Geological Survey the Overseas Mineral Resources Development Company of Japan conducted an exploration programme in the Mamut area during the period of 1968 to 1969. The exploration programme was carried out through the stages of general appraisal by surface geological mapping, geophysical surveys, geochemical soil and stream sediment surveys and aeromagnetic surveys covering the area of prospecting license to a detailed investigation by diamond drilling and underground exploratory tunnelling in the mineralized area. The mine was put into operation in 1975 after the completion of a feasibility study on the basis of the results of exploration.*

*An experience obtained through a series of various exploration programmes, which led to the discovery and subsequent development of the Mamut Mine, has shown the system of reconnaissance geochemical survey by stream sediments followed by detailed grid soil sampling proved to be a successful exploration method in this region. Grid drilling and subsequent development of the mine revealed the ore deposit to coincide with the most intense anomalous area of both geochemical (soil) and geophysical (IP) surveys. The ore deposit lies approximately within the range above 300 ppm of soil copper content and 10% of Frequency Effect.*

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**Loci of primary tin mineralization in the Kinta Valley - A new look at old data: Aw Peck Chin, Geological Survey Malaysia, Ipoh, Perak**

Data from 150 occurrences/deposits of primary tin mineralization are reviewed with respect to their geographical positions, host rocks, associated minerals and structural trends. Most of the primary tin mineralization is found along the flanks of the Main Range and the Kledang Range. Geographically, the most important area stretches from Jelapang, Menglembu to Teronoh, which accounts for about 50 percent of the loci of mineralization.

Primary tin mineralization is found in granitoid, marble, schist, shale interbedded with sandstone/chert and granitoid in contact with marble or schist. Most of the loci of mineralization is found in granitoid and marble or near granitoid in contact with marble or schist.

The common minerals associated with cassiterite in granitoids and schists are quartz, pyrite and tourmaline whilst in marble are arsenopyrite and pyrite. Arsenopyrite, chalcopyrite and fluorite are, in places, common associated minerals in all the three host rocks. Tourmaline has not been recorded with marble host rock and quartz is rarely found associated with it.

Incomplete data on the structural trends of the mineralization show that in granitoid host rocks the veins/stockworks mainly trend NE and subordinately towards NW, ENE and WNW directions. The ore shoots in marble host rocks are mainly in the form of irregularly shaped pipes. Stockwork is the prevalent form of mineralization in the schist or shale and sandstone/chert host rocks.

Most of the primary deposits have been mined out. However there are a few lodes where mining was stopped either due to the prevailing low tin price at that time or to excessive water in the workings. Present review shows that mining of primary tin deposits is, as it was in the past, more important than it has been credited for. As alluvial tin deposits become depleted, mining of primary tin deposits is likely to become more important in the Kinta Valley. Areas where search for primary tin deposits should be focused are Papan - Teronoh, Sabak North - Chemor and the western flank of the Main Range.

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**Gravity surveys for tin bearing geological structures in the Pusing Area, Perak - Some preliminary results: Loke Meng Heng, School of Physics, Universiti Sains Malaysia, Penang; Ho Choon Heng, Geological Survey Malaysia, Perak and Lee Chong Yan, School of Physics, Universiti Sains Malaysia, Penang.**

The gravity surveys were carried out at two different areas near Pusing, Perak. In the first area, there was formerly a tin mine extracting tin bearing alluvium from an extremely large pothole in the limestone bedrock. This area is about 0.5 mile south of Pusing town. The purpose of this gravity survey was to determine whether there were other large potholes in this area. In this survey, two minor gravity anomalies of about -0.2 and -0.3 mgals respectively were obtained which could be due to depressions in the limestone bedrock.

The second area is located about 0.5 mile to the south of the first area. The purpose of this gravity survey is to determine the size and shape of an elongated sandstone body apparently surrounded by

limestone. From an outcrop at a tin mine, it has been found that primary tin mineralization is associated with this sandstone body. Two gravity traverses running approximately perpendicular to the strike of this body were carried out. The first traverse which cuts across the central portion of the sandstone body shows a prominent gravity minimum of about  $-1$  mgal over it. A preliminary gravity model shows that the width and thickness of the body is about 150 and 170 metres respectively. The second traverse which is located near the southern end of the sandstone body shows a less distinct gravity minimum of about  $-0.6$  mgal over it. Both profiles show a larger gravity minimum of about  $-4$  mgals to the west of the sandstone body. It could be due to another larger, subcropping sandstone body located to the west of the present one.

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**The tungsten deposits of Xihuashan, China: Charles S. Hutchison, Dept. of Geology, University of Malaya, Kuala Lumpur**

*The Nanling Range of S.E. China is the richest tungsten province in the world and Xihuashan is the most important mining district, situated in its central part, in southern Jiangxi province, about 9 km NW of the county town of Dayu, which lies about 100 km SW of Ganzhou city.*

*The Xihuashan tungsten vein deposits occurs in Early Yanshanian (Jurassic) medium grained biotite granite. The deposits were discovered in 1908. About 3000 tons of ore are now treated daily. Most of the ore veins taper and die out when the Cambrian country rocks are approached. The 615 commercial ore veins are of sizes variable in length from 300 to 600 m generally. Width is generally 0.4 m to 3.6 m. The commercial mineralization extends down to 200 m generally, but never below 300 m. Three sets of fissure veins strike  $65^{\circ}$  -  $75^{\circ}$ ,  $80^{\circ}$  -  $90^{\circ}$ , and  $275^{\circ}$  -  $285^{\circ}$ , all steeply dipping.*

*The gangue minerals are quartz and alkali feldspar. The major ore mineral is wolframite, and it is associated with economically extractable cassiterite, molybdenite, bismuthinite, beryl, scheelite, and rare earth minerals.*

*The veins show excellent reversed zoning. The high temperature minerals cassiterite, beryl and topaz are common in the upper parts of the veins, while wolframite, molybdenite and bismuthinite are concentrated in the middle levels. They diminish downwards as the low temperature sulphides increase downwards, and the lowest parts of the veins are usually of barren quartz.*

*Wall-rock alteration is important and pronounced. Greisenization (and silicification) is intense in the upper part but rather weak at depth.*

*The average grade for the whole deposit is 1.086%  $WO_3$ . The tungsten mineralization is mainly concentrated within 200 m below the roof of the granite, with the richest mineralization at the top of the cupola roof and at the contact between different granite phases. Local enrichment occurs where two or more veinlets intersect.*

*Mineralization was in the order (early silicates, oxides, sulphides, carbonates late), and was related to a range of sub-solidus magmatic-*

hydrothermal phenomena, beginning with alkali metasomatism, through albitization, to greisenization.

The Dangping tungsten-beryllium deposit lies 4 km north of Xihuashan, with which it shares the same geology. Over 210 veins are commercial. This deposit was located and surveyed in 1958. The quartz veins all occur in E-W fissures (75 - 85%) dipping generally at 85°. Average length of a vein is 251 m, average thickness 0.3 m. The veins extend down to 200 m. Branching and swelling is common. The veins die out into the Cambrian country rock (hornfels) and mineralization is confined to the Early Yanshanian granite.

The main ore minerals are wolframite and beryl, with bismuthinite, scheelite and chalcopyrite being of secondary importance. Quartz is the main gangue, occurring with muscovite, fluorite, and calcite. The commercial wolframite mineralization extends to a depth of 60 to 80 m below the contact with hornfels, but beryl and molybdenite extend as deep as 80 to 100 m. High tungsten correlates with low beryllium, and vice versa. The mineralization stages are (1) W - Mo, (2) W - Be - Mo (3) W- sulphide. Wall rock alteration is mainly greisenization.

The Piaotang tungsten-tin vein deposit is about 18 km NE of Xihuashan. It is a cassiterite-wolframite polymetallic quartz vein deposit, controlled by NE and E-W fissure vein systems. Two igneous rock types intrude the Middle to Upper Cambrian flysch rocks. They are quartz diorite (exposed) and biotite granite (occurring at depth). The diorite is Hercynian (274 Ma) and the granite is Early Yanshanian (Jurassic). It is the granite that was responsible for the mineralization, which occurs within the sediments, strongly hornfelsed to andalusite-biotite-chlorite assemblages. 11 veinlet zones and 5 large veins are commercially mineralized, mostly within the hornfels. The largest main vein (No. 3) is over 1200 m long and extends 600 m down, with a width varying from 10 m to over 40 or more. It is composite, made of several veinlets, E-W trending, containing cassiterite-wolframite. There are 4 metallogenic periods and 7 hydrothermal episodes:

1. garnet-diopside-actinolite skarn stage
2. molybdenite-beryl-quartz veins (minor wolframite)
3. cassiterite-wolframite-quartz veins (minor beryl)
4. sulphide-cassiterite-wolframite quartz veins (main episode)
5. sulphide quartz veins (with minor wolframite)
6. sulphide-chlorite quartz veins
7. fluorite-carbonate veins (with minor pyrite)

There is a complex overlap of the stages near the granite, in the inner zone.

The frequency of veins and the richness of mineralization increases downwards to the granite contact. When any vein system extends into the granite, its complexity is lost and is replaced by a single quartz vein.

Isotope studies indicate that the mineralization results from metal transportation by hydrothermal waters of magmatic origin.

The Dalongshan Tungsten-Molybdenum vein deposit lies about 13 km NE of Xihuashan. This is a large quartz vein deposit in Cambrian country rocks. The 30 commercial veins are generally 500 m long. The longest is 800 m. They extend to a depth of 300 to 500 m, with thicknesses of 1.0 to 0.25 m. Tungsten and molybdenum are the main elements, but tin, bismuth and beryllium are important by-products. The mine



began in 1955. The responsible granite is of Early Yanshanian (Jurassic) age, found at depth in the mine.

There are 3 vein trends: WNW, NW and ENE. The mineralogy is extremely varied and includes: wolframite, molybdenite, cassiterite, native bismuth, bismuthine, scheelite, chalcopyrite, pyrite, pyrrhotite, beryl, bismuthinite, tungstic ochre, covellite, quartz, muscovite, lepidolite, fluorite, calcite, chlorite.

The following stages are recognized: 1) W-Mo, (2) W-Be-sulphides (main), (3) Be-pyrite, (4) calcite-fluorite. Cassiterite in the outer zone is different both in colour and crystallinity from the inner zone.

Wolframite is richest where veins branch, thicken, or change dip. Where there is wall rock alteration, the mineralization is richest. This includes silicification and greisenization, tourmalinization, topaz enrichment, sericitization and chloritization.

### General Comments

The polycyclic igneous events of S.E. China range from Donganian (Middle Proterozoic), through Xuefengian (Upper Proterozoic), Caledonian (Devonian), Hercynian-Indosinian (Triassic), Early Yanshanian (Jurassic) to Late Yanshanian (Cretaceous). From the earliest to the latest, the granites become progressively depleted in siderophile elements such as vanadium, chromium, cobalt and nickel, and also in zinc, copper and lead. By contrast, those elements which have a strong affinity for the continental crust, such as tin, tungsten, molybdenum and beryllium, become progressively richer in the younger granites.

The Chinese view is that these elements became concentrated in granitic magmas that were ultimately derived from the Lower Palaeozoic or Proterozoic sedimentary strata (the source beds). Polyphase granitic activity caused tin and tungsten to become progressively enriched in the younger granites, derived originally from the source beds, but mobilized several times through anatectic granitic magmatism of S-type.

Also, at sub-solidus temperatures, the W and Sn is enriched in the hydrothermal quartz veins and greisen zones as a result of alkali feldspar metasomatism within the deeper parts of granite cupolas. This alkali feldspar formation caused the release of W and Sn, which is then deposited at the greisenization stage at the contact zone with the country rocks.

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**The 6-inch Bangka Drill as a sampling tool for auriferous placers in Kelantan: Choo Mun Keong, & Andrew Spykerman, Malaysia Mining Corp., Kuala Lumpur**

During a major placer gold exploration programme conducted over the main drainage valleys in central and southern Kelantan, detailed analysis of volume recoveries recorded by the conventional 4-inch Bangka drill, the 6-inch drill and the larger diameter 8-inch over auriferous gravelly horizons were carried out to determine whether the samples recovered by the more portable 4 and 6-inch drills were representative from a sampling point of view. The analysis comprised the determination of sample volume recoveries as well as the percentages of clay, sand and gravel recovered in each section.

Gold distribution within the area prospected, as in other placer

gold deposits, is in general confined to the basal gravelling horizons. The auriferous horizons contain gravels which are commonly within the 2-50 mm size range although clasts up to 60 mm in diameter have been encountered. For accurate determination of the grades of the auriferous gravelly sediments within the boreholes, the samples recovered should be representative and the sand:clay:gravel ratios more or less similar to their in-situ compositions. As the gold colours/flakes are associated with the clayey/sandy matrix, an over-recovery of the finer sediments will lead to over-evaluation and vice versa.

The results of the analysis show that there was a tendency for the 4-inch drill to recover a greater proportion of finer sediments in place of the larger clasts which were pushed out of the holes. With regard to 6-inch and 8-inch drilling, the sand and clay: gravel ratios obtained by 12 6-inch and 12 8-inch holes drilled at close intervals along 2 test lines are rather consistent despite fluctuating overall volume recoveries and that the effective cross-sectional area of the 8-inch drill is 1.8 times larger than that for the 6-inch drill. Sampling by the 6-inch and 8-inch drills is therefore considered to be representative and as a consequence the more portable mechanised 6-inch drill is selected as the standard drilling tool instead of the 8-inch drill which is rather heavy and bulky to handle.

During the final evaluation drilling stage, it would also be prudent to compare ore grades indicated by 6-inch drilling over selected small blocks with those obtained by bulk sampling. Pitting/trenching of the river beds/banks would however be expensive as appropriate equipment and support would be required to cope with the large water inflow and induced caving or flushing of gold bearing matrix into the pits/trenches.

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**Prospects for placer tin around the Dindings Area, Perak: T. Suntharalingam, Geological Survey of Malaysia, Ipoh, Perak**

The Quaternary Geology Division of the Geological Survey of Malaysia have been carrying out systematic mapping of the unconsolidated sediments in the coastal areas of Taiping - Beruas - Lumut, since early 1977. Three stratigraphic units namely the continental Simpong Formation (equivalent to the Old Alluvium of Walker), Gula Formation (a Holocene marine unit) and the continental Beruas Formation (equivalent to the Young Alluvium of Walker) have been delineated in the area.

The thickness of the unconsolidated sediments varies from a few metres in the east to more than 90 metres to the west. Cassiterite occurs in economic quantities only in the lower sand member of the Simpong Formation. Trace or small amounts of tin are found in the Gula and Beruas Formations.

The occurrence of angular cassiterite of more than 200 mesh size (BSS) with the poorly sorted, angular gravels of a variety of rock types have been generally found not far from the granitic hills. Most of these deposits (alluvial and eluvial) are concentrated in small pockets in the granitic margins in river valleys. They have been mined by gravel pump methods.

The study revealed the existence of palaeochannels in the area. The likely prospects are located at Sungei Sepetang, Port Weld, Kampong Matang Pasir (Taiping) and Hutan Simpong Sungei Tinggi (Beruas).

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**Origin of some granitoids and their possible implications in the exploration for Sn, W, U and base metal deposits in Malaysia:**  
**Cheang Kok Keong, School of Applied Sciences, Universiti Sains Malaysia, Penang**

*The origin of granites is discussed in terms of their mineralogy, geochemistry, initial strontium and oxygen isotopic compositions, field relations and types of ore mineralization. A specific example from Wyoming (Cheang, 1982, U.S.G.S. Professional Paper, in press), is presented. Discrimination between the various granite types in Malaysia may allow identification of suitable source rocks in the exploration for Sn, W, U and base metal deposits. Post granite emplacement processes (hydrothermal alteration, weathering) may modify the actual location of ore deposits.*

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**Subaquatic plants as geochemical samples: Tan Teong Hing, Dept. of Geology, National University of Malaysia, Bangi**

*Along drainage systems, subaquatic plants invariably occur. These plants with their root systems immersed in the water, behave as accumulator plants particularly towards soluble mobile heavy metals present in the water. The metal concentrations in these plants and in the stream sediments are compared.*

*The geochemical anomalies, determined from stream sediment samples, are always expressed by the subaquatic plants. The higher geochemical contrasts obtained from these plants, as compared to the stream sediments suggest that those plants can be used as samples for mineral prospecting.*

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**Observations on the geology of the porphyry copper sub-province of Southwest Negros, Philippines: C.K. Burton, Billiton Philippines Inc., P.O. Box 441, Manila, Philippines**

*The southwest Negros porphyry copper sub-province is distinguished from other mineralised areas in the Philippines by a number of geological phenomena. Salient amongst these are:*

- 1) *An apparent (K/Ar) Eocene-Oligocene age of the mineralized intrusive rocks*
- 2) *Significant amounts of molybdenum whilst gold seems to be limited in the copper ores, although occurring elsewhere in the area*
- 3) *The Sipalay orebody is the second largest in the country and probably contains over one billion tons of ore. The next biggest deposit in Negros is around one quarter of this size whilst all other known occurrences are considerably smaller*
- 4) *Long and narrow outcrops of intrusive rocks and elongate faults give SW Negros a marked NW structural strike which has strongly influenced the disposition of the mineralization. The larger, northern, part of the island has a NNE trend. The junction between the two portions is rectilinear and may constitute either a major transcurrent fault or a tectonic suture*
- 5) *Offshore SW Negros is bordered by a sedimentary (forearc?) basin beyond which is a short arcuate trench. These may be resurgent*

*and/or aborted features unconnected with the generation of the copper porphyries and of uncertain relationship to Quaternary volcanic activity*

*No satisfactory account of the tectonic evolution of southwest Negros has yet been evolved.*

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**Reinterpretation of the Fe-Sn mineralization at the Waterfall Mine, Pelepah Kanan, Johore: Yeap Ee Beng, Dept. of Geology, University of Malaya, Kuala Lumpur**

*The Fe-Sn mineralization at the Waterfall Mine, Pelepah Kanan, Johore takes the form of a lensoid massive marmitized coarsely crystalline martite body which occupied the trough of a gently plunging syncline formed by a band of highly weathered metasediments overlying a thicker sequence of variegated light to dark green calc-silicate hornfels. The thinner southward plunging portion of the massive martite appeared to be connected vertically downward by a feeder zone consisting of a patch of magnetite + quartz + cassiterite on the west and a larger crescent-shaped magnetite + fluorite + cassiterite (+ loellingite + quartz + scheelite + sulphides) on the east separated by a band of highly weathered metasediments cut by lenses of iron ore. Numerous feldspar + quartz + cassiterite + fluorite (+ scheelite + loellingite + chlorite + sulphides) veins cutting the calc-silicate hornfels parallel to the synclinal bedding traces radiated out from both flanks of the feeder zone while those within the zone strike roughly parallel to the fold axis and dip steeply to vertically.*

*Lower Triassic biotite granite is encountered below the hornfels while a smaller aplite body is exposed immediately NE of the ore body.*

*Early views on the genesis of the ore body include igneous intrusion, secondary enrichment (iron ore) of the amphibole-magnetite rock and injection of a 'mobile mixture of Sn-F-B-Si compounds' which had segregated out from a highly siliceous magma. Later views agreed that the iron deposited was pyrometasomatic (skarn) in origin while the spatially associated cassiterite bearing veins were hydrothermal.*

*The magnetite + fluorite + cassiterite body of the feeder zone exposed recently by open-cut mining operation is observed to consist largely of contorted rhythmic and finely banded magnetite-fluorite (+ cassiterite) which had replaced the calc-silicate rocks or hornfels. Mineralogically and texturally, this portion of the ore body is similar to a special group of banded Sn-bearing magnetite-fluorite skarn from several parts of the world.*

*Mineralization of the Waterfall Mine Fe-Sn skarn took place in three distinct stages. Stage 1 resulted directly from the emplacement of the biotite granite and aplite which caused the conversion of the folded calcareous pelitic rocks into calc-silicate hornfels (hornblende + quartz + feldspar + sphene + diopside) and calc-silicate rocks (garnet + actinolite + grunerite + calcite + biotite). It is envisaged that Stage 2 mineralization started after the granite had formed a carapace and when fluid over-pressure derived from crystallizing magma further down, fractured the carapace and overlying hornfels and calc-silicate rocks at the feeder zone. Fe-rich high salinity fluid and volatile rich vapour phase migrated upwards via the feeder zone and caused the*

replacement of calc-silicate rocks at the trough of the syncline by coarsely crystalline magnetite to form the massive capping ore body (stage 2a). Replacement was probably controlled by the chemistry of the rock (calcite and calc-silicate minerals) and also by cooling of the fluid (increasing distance from magmatic source). When the temperature of the mineralizing fluid fell and its composition changed (+ Si + F + Sn), the spaces between the coarsely crystalline magnetite were filled with finer cassiterite, quartz and cassiterite and replacement became active at the lower part of the lensoid body and at the feeder zone resulting in the formation of the rhythmic magnetite-fluorite (+ cassiterite) ore and then the magnetite-quartz-cassiterite ore. Stage 3 mineralization involved the deposition of quartz + cassiterite + fluorite + chlorite (+ epidote + sulphides) superimposed on the rhythmic banded magnetite fluorite and as vein fillings.

Preliminary fluid inclusion investigation revealed that Stage 2b fluid is quite strongly saline (30 to 50 equiv. wt. % NaCl by visual estimate) locally rich in CO<sub>2</sub> and showed intermittent boiling. Homogenization (largely in fluid) temperatures determined for early cassiterite, fluorite and quartz gave a range of 475°C to 495°C. Stage 3 fluid is much less saline (< 26 equiv. wt. % NaCl) and did not show boiling phenomenon. Homogenization temperatures for quartz and fluorite gave a very narrow range of temperature of 185°C to 206°C.

The veins together with the feeder zone provided the plumbing system of the mineralization. Most of the veins flanking and within the feeder zone were developed at the start of Stage 2. The attitudes of the vein are consistent with fracturing as the result of localized pressure (fluid over-pressure) directed from below at the trough of the syncline. Prior to the Stage 3 mineralization reopening of the earlier vein-filled fractures occurred and new fractures were developed. While the veins within the feeder zone provided channel ways for the mineralizing fluids during replacement of the massive iron ore capping and the feeder zone ore bodies, the flanking veins are interpreted as leakaway veins largely for the Stage 2b mineralization and were also filled by Stage 3 minerals.

Three rhythmic banded magnetite-fluorite Sn-bearing deposits are found in Australia and these have been named as wrigglyite skarn. Evidence of replacement of the wrigglyite skarn by an assemblage of pyrrhotite + fluorite + F-biotite + cassiterite of the Moina Deposit, Western Tasmania to which the Waterfall Mine rhythmic banded magnetite + fluorite + cassiterite body resembles (in terms of texture, mineralogy, fluid inclusions and overall mineralization) has been regarded as a transition to the Sn-sulphide replacement deposits such as at Renison Bell, Tasmania, one of the world's largest primary tin deposits. Recognition of the presence of such wrigglyite skarn mineralizing system in the Eastern Tin Belt of Peninsular Malaysia is significant in this respect.

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**Niobium-Tantalum minerals from Peninsular Malaysia: Wan Fuad bin Wan Hassan, Dept. of Geology, National University of Malaysia, Bangi, and Oleg von Knorring, Dept. of Earth Sciences, University of Leeds, Leeds LS2 9JT, England**

*Niobium-tantalum minerals found in concentrates and heavy-minerals from Peninsular Malaysia have been studied, and their mode of occurrences described. Chemical compositions were determined mainly by electron-*

probe microanalysis, but X-ray fluorescence method has also been applied. From the study, columbite-tantalite, Nb-Ta-rutile, wodginite and fersmite have been recognised. Their geographical distribution and geochemical compositions were delineated.

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**Limestone survey by seismic reflection: Abdul Halim Quazi, School of Physics, Universiti Sains Malaysia, Penang.**

Limestones are rocks composed of calcite ( $\text{CaCO}_3$ ), usually with some dolomite ( $\text{CaCO}_3\text{MgCO}_3$ ), sandy and clay particles. In pure varieties of limestone impurities do not exceed 5%. Limestones may be variously coloured depending on the quantity and nature of impurities. A most important use of limestone is for the production of portland cement for which purpose they are mixed in a definite proportion with certain clays. About 1.23 tons of limestone, 0.31 ton of clay and 0.04 ton of gypsum are required for producing one ton of cement. Depending on the quality of coal, about 20 to 25% coal is needed for burning purpose and in case of gas-fired kiln about 5000 to 6000 cu. ft. of gas are required for a ton of cement.

Special type of limestone is used in the production of glass. Limestones are used as fluxes in metallurgy, in agriculture (for soil liming), to produce lime, as building, road and railway stones etc. so, limestone is a very important material for the economical and industrial development of the country especially for Bangladesh where commercial quantities of limestones are not available in sufficient quantity at mineable depth.

So, the survey was conducted in the month of April 1978 and subsequently the drilling confirmed in 1979 the postulated depth of limestone is 1693 feet from the surface in the north eastern side of the survey area.

The quality of seismograms were very good. A strong reflection band of three to five phases was prominent. The average thickness of low velocity layer was about 10 m and the velocity varied from 800 to 1400 m/sec. A continuous reflection-line-up was recorded around 0.55 sec., which is likely to be sylhet limestone. The depth of the top of sylhet limestone from sea level is about 550 m with an average velocity of 2000 m/sec.

Unconformities could not be identified by this survey. It cannot be confirmed whether minor faults will block or lead ground water flows at the time of limestone mining especially at the time of shaft sinking.

Sylhet limestone does not consist of a homogeneous thick layer. The time lags between the different reflections within limestone beds are smaller than  $1/4$  of a phase of the prevalent wavelength and are below the possible resolution of the method. This prevents the mapping of the bottom of the limestone and consequently the drawing of an isopach-map.

The accurate depth calculation is possible because two deep wells are situated in the western side of the survey area.

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BERITA PERSATUAN  
(NEWS OF THE SOCIETY)

**GSM COUNCIL 1983/84 ELECTION**

The Council's list of nominees for the 1983/84 Council is as follows:

President	:	Khoo Teng Tiong (University of Malaya)
Vice President	:	Leong Khee Meng (Carigali-BP Sdn. Bhd.)
Hon. Secretary	:	Mohd. Ali Hasan (University of Malaya)
Hon. Asst. Secretary	:	Koh Tuck Wai (Petronas-Carigali)
Hon. Treasurer	:	Gan Ah Sai (Geological Survey Malaysia)
Editor	:	Teh Guan Hoe (University of Malaya)
Councillors (2-year)	:	Andrew Spykerman (Malaysia Mining Corp.) Choo Mun Keong (Malaysia Mining Corp.) Syed Sheikh Almashoor (National University of Malaysia) Yeap Ee Beng (University of Malaya)

The following will continue to serve as Councillors (1-year) in the 1983/84 Council :

Abdul Aziz Hussein (Universiti Teknologi Malaysia)
Khoo Kay Khean (Geological Survey Malaysia)
Michael Leong Pheng San (Petronas)
Yeoh Gai Chooi (Esso Production Malaysia)

The Immediate Past-President will be Mohd. Ayob (Petronas)

At the close of nominations, the following was nominated:

Abdul Rahim Samsudin (Universiti Kebangsaan Malaysia) for the post of Councillor. He was proposed by Ibrahim Komoo and seconded by Wan Fuad Wan Hassan.

Therefore there will be an election for four 2-year Councillors from the 5 persons listed below:

Abdul Rahim Samsudin (Universiti Kebangsaan Malaysia)
Andrew Spykerman (Malaysia Mining Corp.)
Choo Mun Keong (Malaysia Mining Corp.)
Syed Sheikh Almashoor (Universiti Kebangsaan Malaysia)
Yeap Ee Beng (University of Malaya)

The last day for receiving the ballot papers is 31 December 1982.

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**WORKSHOP ON STRATIGRAPHIC CORRELATION OF THAILAND AND MALAYSIA: 8 - 10 SEPTEMBER 1983**

organised by : Geological Society of Thailand  
Geological Society of Malaysia

in cooperation with: Department of Mineral Resources of Thailand  
Geological Survey of Malaysia  
Association of Geoscientists for International  
Development  
Prince of Songkhla University  
Chulalongkorn University  
University of Malaya

to be held at: Lee Gardens Hotel, Haad Yai, Thailand

### Objectives

The onshore and offshore areas of the Thai-Malay Peninsula are well known for their mineral wealth. Their full potentials, however, have not been realized due largely to the lack of better understanding of the geology of the areas. This Workshop attempts to bring together geoscientists who either work or are interested in the areas in order that they can for the first time focus their attention on the stratigraphic and related problems of the border areas between the two countries. Specifically the objectives of this Workshop are:

1. To review current knowledge of the stratigraphy of the two countries
2. To establish, as far as possible, the formal stratigraphic units, their regional aspects, and sequences in the border areas
3. To attempt the correlation of stratigraphy of the two countries
4. To acquaint geoscientists of the region with the stratigraphy of Thailand and Malaysia
5. To provide a venue for geoscientists and interested persons to exchange ideas and experiences
6. To define research needs in the regional stratigraphy.

### Call for Papers

Original papers on any topic relevant to aspects of geology and stratigraphy of the border areas between Thailand and Malaysia are most welcome. Two copies of the Abstracts in English of not more than 500 word equivalents should be submitted for review before April 15, 1983, and authors will be notified before May 15, 1983. Final manuscript of not more than 6000 word equivalents should be in before July 31, 1983. All papers accepted will be published in the Workshop proceedings which will be distributed at the beginning of the Workshop.

### Language

The official language of the Workshop will be English.

### Tentative Program

- |              |                                                                                  |
|--------------|----------------------------------------------------------------------------------|
| September 8  | Morning<br>Reviews of Paleozoic stratigraphy                                     |
|              | Afternoon<br>Reviews of Mesozoic and Cenozoic stratigraphy                       |
| September 9  | Morning<br>Reviews of igneous and metamorphic rocks                              |
|              | Afternoon<br>Geologic evolution of Thai-Malay Peninsula                          |
| September 10 | Morning<br>Papers on aspects of geology and mineral resources of the border area |
|              | Afternoon<br>Continuation                                                        |
|              | Closure                                                                          |



Registration Fees

Registration fee for participants attending the Workshop is 600 Baht or 60 Malaysian dollars if registered before June 15. After that date the registration fee will be 700 Baht or 70 Malaysian dollars. Registration fees for members of the Geological Society of Malaysia (GSM) or of the Geological Society of Thailand in good standing in 1982 and 1983 is 300 Baht or 30 Malaysian dollars if registered before June 15. After that date the registration fee for members in good standing will be 350 Baht or 35 Malaysian dollars. The paid participants will receive a set of proceedings at the Workshop.

Accommodation

First class air-conditioned double rooms are available at the Lee Gardens Hotel, Haad Yai, Thailand. The rate for 1 double room is 380 Baht per night. The charge is the same for single or double occupancy.

Field Trips

Three field trips are planned. In each of these the minimum number of persons is 20 and the maximum 35. If the minimum number is not reached the trip will be cancelled. Places will be allotted in order of application.

The registration for a trip is considered to have been made when the fee is received.

1. Geology of Haad Yai and its environs - one day (300 Baht)
  - Tin mining
  - Environmental geology of Songkhla lake
  - Quaternary geology of Songkhla area
2. Geology of the Phuket areas - 3 days (2000/2500 Baht)
  - Tin mining - onshore and offshore
  - The pebbly mudstone
  - The lithium bearing pegmatites
  - Tin-tungsten bearing granites
3. Geology of Pulau Langkawi - 5 days (2000/2500 Baht)
  - Cambro-Ordovician sandstone
  - Ordovician-Lower Devonian limestone
  - Permo-Carboniferous formations
  - Granites

Official Addresses

## Workshop on Stratigraphic Correlation of Thailand and Malaysia

Dr. Prinya Nutalaya  
 Coordinator - Thailand  
 Asian Institute of Technology  
 G.P.O. Box 2754  
 Bangkok 10501, Thailand  
 Tel. 5239300 - 13 Ext. 190  
 Cable AIT BANGKOK  
 Telex: 84276 TH

or  
 Dr. Bock Kang Tan  
 Coordinator - Malaysia  
 Department of Geology  
 University of Malaya  
 Kuala Lumpur, Malaysia  
 Tel. 575466 Ext 230  
 Cable GEOLOGY DEPT. UNIVSEL K.L.

## KEAHLIAN (MEMBERSHIP)

The following have joined the Society:

### Full Members

1. Goh Leng Siang, c/o XSB, Sarawak Shell Bhd., Lutong, Sarawak
2. Thomas Binne van der Veen, PE6/31, Sarawak Shell Bhd., Lutong, Sarawak
3. D.W. Lewis, Standard Oil Co. of California, 575 Market St., San Francisco, Ca. 94105, USA
4. Muhinder Singh s/o Dasondha Singh, Minconsult Sdn. Bhd., No. 14 Jalan 20/16A, Paramount Garden, P.J.
5. Tan Seng Lai, Minconsult Sdn. Bhd., P.O. Box 2263, K.L.
6. John Pitts, School of Civil & Structural Engineering, Nanyang Technological Institute, Upper Jurong Road, Singapore 2263
7. John H. Burney, Jr. 21A Goldhill Plaza (Podium Block), Singapore
8. Sim Chee Hui, EPMI, P.O. Box 857, K.L.
9. Michael R. Smith, Gaffney, Cline & Associates, 21A Goldhill Plaza (Podium Block), Singapore 1130
10. John D. Archer, Gaffney, Cline and Associates, 21A Goldhill Plaza (Podium Block), Singapore 1130
11. Yee Boon Koo, Kenyir Hydro Project, Lembaga Letrik Negara, Kampung Jenagor, Kuala Brang, Terengganu

### Student Members

1. Ajon Winnie, UKM, Kampus Sabah, Locked Bag no. 62, Kota Kinabalu, Sabah
2. Goh Lam Hoo, - ditto -
3. Ling Nan Ley, - ditto -
4. Hii King Kai, 334/040 Desa Bakti, USM, Penang

### Associate Member

1. Abdul Ghani bin Mohamed, MMC, 4129A Jalan Tengku Ismail, Kota Bharu, Kelantan
2. Mohammad Haji Majid, Geol. Dept. UM., K.L.

### Institutional Members

1. Petroconsultants Ltd., Cumberland House, Fenian St., Dublin 2, Ireland. Attn: Mr. G. Cathcart
2. Perpustakaan, UPM Sarawak, P.O. Box 482, Kuching, Sarawak

### Student Members

1. Zulkipli Che Kasim, Geology Dept., UM.
2. Hussin Omar, UKM Sabah, Beg Berkunci 62, Kota Kinabalu, Sabah
3. Wan Abdullah Wan Yusoff, - ditto -
4. Abdul Ghani Yahya, Jab. Geologi, UKM, Bangi
5. Maarof Seman, UKM Sabah, Beg Berkunci 62, Kota Kinabalu, Sabah
6. W. Hasiyah Abdullah, Geology, UM.

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## KEAHLIAN PROFESIONAL (PROFESSIONAL MEMBERSHIP)

The following have been elected as Professional Members of the Society:

1. Mr. Liew Yoke Choy
2. Dr. Ibrahim Komoo
3. Dr. Cheang Kok Keong
4. Mr. Raja Kumar s/o Shiv Ram

Any member who has objection to any of the above being admitted as Professional Member should write in to the Society before 15 November 1982.

Hon. Sec.

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### PERTUKARAN ALAMAT (CHANGE OF ADDRESS)

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

1. Robert McTavish, Apt. 1, 6 Medan Ria, Lorong Yap Kwan Sing, Kuala Lumpur
2. Soundararajan Perumal, Energy Support Sdn. Bhd., Suite A, 14th Floor, Angkasaraya, Jalan Ampang, Kuala Lumpur
3. Racal-Decca Survey (M) Sdn. Bhd., 7th Floor, Wisma Budiman, Pesiaran Raja Chulan, Kuala Lumpur 05-02

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### PERTAMBAHAN BARU PERPUSTAKAAN (NEW LIBRARY ADDITIONS)

The following publications were added to the Library:

1. SEA Oil Directory, 1982-83
2. Pub. of the Geological Research & Dev. Centre, Paleontology series nos. 1 & 2, 1981
3. Bull. Geological Research & Dev. Centre, nos. 1-6, 1979-1982
4. National Library Singapore, adult reference collections, accessions list, Aug - Oct 1982
5. Commonwealth Science Council, Newsletter nos. 4 & 5, 1982
6. South Pacific Marine Geological Notes, v. 2, no. 6, 1982
7. IMM Bc11. nos. 911, 912, 913, 1982
8. AAPG Explorer, Oct. 1982
9. Riset: Geologi dan Pertambangan, vol. 4, no. 1, 1981
10. Research on Geology (1), 1982
11. Scientia Geologica Sinica, no. 4, 1982
12. Inst. of Geoscience, The Univ. of Tsukuba, Annual Report no. 8, 1982
13. Petromin Asia, Nov. & Dec. 1982
14. Seatrad Library, acquisition list (July-Sep 1982)
15. Journal of the Geological Society, vol. 139, pt. 5, 6, 1982
16. Kaolin in New South Wales by C.J. Baker & R.E. Uren, 1982
17. Acta Palaeontologica Sinica, vol. 21, nos. 2-4, 1982
18. Epsiodes, vol. 1982, no. 3, 1982
19. Bulletin of the National Science Museum, vol. 8, no. 3, 1982
20. IMM Transactions, Sect A, vol. 91, Oct 1982
21. Journal of water resources, vol. 1, no. 1, 1982
22. South Pacific marine geological ntes, vol. 2, nos. 7 & 8, 1982
23. National Geophysical Research Inst., Ann. Rep. 1980-81
24. Twenty years Research & Development Activity of the National Geophysical Research Inst., 1982
25. Bulletin du Bureau de Recherches Geologiques et Minières, Sect. II: Geologie des gites minéraux, no. 1, 1982.

24. Non-metallic and tin deposits of the Broken Hill District  
by S.R. Lishmund, 1982.

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BERITA - BERITA LAIN  
( OTHER NEWS )

UNIVERSITI MALAYA PROJECT REPORTS 1981/82

1. Geology of Gunung Perak - Bukit Mat Insun area, Kedah by Muhammad Adib b. Abdullah Hudi
2. General geology, granite studies and some geochemical stream sediments study of the Sungai Kundor area, Gua Musang, Kelantan by Saidin Karim
3. The Palaeontology and stratigraphy of North Central Perlis by Rohaiyah Ismail
4. Stratigraphy and petrography of the Mersing area, Johore by Roslant bin Abu
5. Geology of Southeastern Langkawi Islands, Kedah, Malaysia by Encik Aris Yub
6. The geology with emphasis on structure of the Jabor-Air Putih Highway, Trengganu by Maria Gertrude Ambuvirayan
7. A study of the 'Semanggol Formation' in the Tawar Area, Kedah by Manoharan Govindasamy
8. Geological and magnetometer studies in the region of the Kemuning Gabbro, Kemaman by Lee Hin Leong
9. Geology and geomorphology of the Bukit Tebakang area, South Central Pahang by Mansor Ahmad
10. Stratigraphy, structure and palaeontology of Gua Musang area by Alias Haji Salleh
11. The petrology and radioactivity studies of Gunung Rembau area, Negri Sembilan by Shaharudin Abdul Aziz
12. Geology, mineralization and geochemical studies of the Chenderong area (Eastern part), Kemaman, Trengganu, Peninsular Malaysia by Abdul Jalil bin Muhamad
13. Metamorphic rocks, granite, iron and tin mine of the eastern part of Gunung Jerai, Kedah by Awalludin Harun
14. Kenyir damsite, Trengganu: Structure and petrology of granite and dyke rocks by Wan Zakaria b Wan Ibrahim
15. Geology of Bukit Kemuning area with mineralization and geochemical studies at Chee Heng Mine, Sungai Siput, Perak, Peninsular Malaysia by Hamidon Mohamed
16. The geophysical studies of Kudat Peninsula by Tong Pow Mun
17. Geology of the Sipitang area, Sabah, East Malaysia by Richard Batoi Janton
18. Geology of south-western Banggi Island, Kudat, Sabah, East Malaysia by Yusoff Mohd. Kamari
19. Sedimentology, stratigraphy and structure of the Nyalau Formation in Tanjung Kidurong area, Bintulu, Sarawak by Bahari Md. Nasib
20. Geology of Wong Irup - Wong Pakong, West Sarawak, East Malaysia by Richard Manie Bandak

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# SEMINAR ON PHOSPHATE ROCK POTENTIAL IN SOUTHEAST ASIA

January 19 - 21, 1983

organized by United States Geological Survey  
 Association of Geoscientists for International Development  
 Committee for Co-ordination of Joint Prospecting for  
 Mineral Resources in Asian Offshore Areas (CCOP)  
 East West Center  
 Department of Mineral Resources  
 Asian Institute of Technology

to be held at Asian Institute of Technology, Bangkok, Thailand

## Venue and Time

The Seminar will take place at the Asian Institute of Technology, Bangkok, Thailand. It will be held during January 19 - 21, 1983

## Objectives

The seminar has two specific objectives: (1) to transfer recent developments in the geology of phosphate rock to geologists of Southeast Asia and (2) to describe the techniques of phosphate rock resource assessment and exploration in humid tropical areas.

In the last several years, geologic theory on the paleogeography, paleoceanography, episodicity of deposition and effects of weathering has been rapidly developing, largely through the stimulation of Project 156 (Phosphorites) of the International Geological Correlation Programme of UNESCO. The advances in knowledge have a large import concerning the potential of Southeast Asia for containing phosphate.

## Structure of Seminar

The Seminar will cover the geology of phosphate rock and techniques of phosphate-rock resource assessment and exploration in humid tropical areas. The Seminar will be conducted as a normal scientific meeting in which formal presentations will be given by experts, each followed by discussion periods of sufficient length to insure that any comments, questions or misunderstandings have been aired.

## Participation

Four geologists from the United States will conduct the Seminar. Richard P. Sheldon will discuss the deposition, episodicity and paleogeography of ancient phosphorites. William C. Burnett will discuss the paleoceanography of phosphorite. Z.S. Altschuler will discuss the weathering and geochemistry of phosphorite. Warren B. Hamilton will discuss the paleogeography of Southeast Asia.

On the Southeast Asian side, two geologists from each country working on economic sedimentary mineral deposits or regional geology will be invited to attend. Others who wish to attend are welcome.

## Sponsorship

The Seminar will be co-sponsored by the multinational non-political Association of Geoscientists for International Development (AGID), the United Nation ESCAP Committee for Coordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas (CCOP), East West Center and Department of Mineral Resources.

Correspondence

All correspondence regarding the Seminar and Workshop should be addressed to:

Dr. Prinya Nutalaya  
AGID - AIT  
G.P.O. Box 2754  
Bangkok, 10501  
Thailand

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**SYGENESIS AND EPIGENESIS IN PETROGRAPHY AND ECONOMIC GEOLOGY**  
On the occasion of the 60th Birthday of Prof. Dr. G.C. Amstutz  
19 February 1983  
Earthscience Lecture Hall  
Mineralogical-Petrographical Institute  
University of Heidelberg, West Germany.

Programme

- 8.30 Welcoming  
9.00 A. Patwardhan (Poona)  
Syngensis and epigenesis in stratabound metamorphosed  
Precambrian sulfide deposits  
9.45 K. Hsü (Zurich)  
A non-steady model of diagenesis and ore deposits  
10.30 Break  
11.00 C. Field (Corvallis)  
The origin of sulfur in oceanic rock  
11.45 E. Stumpfl (Leoben)  
Edelmetall-Lagerstätten: Kooperation von Pluton und Neptun?  
12.30 Lunch  
14.00 P. Nicolini (Paris)  
Méthodes en géologie stratiforme  
14.45 J.D. Weisser (Frankfurt)  
Geologie und exploration der Pb-Zn-Lagerstätte Nanisevik im  
Society Cliff Dolomit, Baffin Island, NWT  
15.30 Break  
16.00 H. Gruszczak (Krakau)  
Die erzführung und lithologie in oberschlesischen Pb-Zn-  
Lagerstätten  
16.45 K. Gunnesch (Heidelberg)  
Syngenetische und epigenetische Pb-Zn-Lagerstätten in den  
Pucara-Kalken Zentral-Perus  
17.30 G.C. Amstrutz  
Closing speech

For further information: Prof. Dr. A. Wauschkuhn  
 Postfach 104040  
 D 6900 Heidelberg 1  
 West Germany

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## AUSTRALIAN MINERAL FOUNDATION

The Australian Mineral Foundation (AMF) is a National Organisation which was established in May 1970 by the industries, institutions and departments in Australia concerned with minerals and petroleum to provide specialised continuing education and information services to the mining and petroleum industries.

These industries and the geosciences in general share with other technical disciplines the educational problems associated with rapid changes in technology. This applied particularly in the sphere of exploration where high risk and high level expenditure are involved.

Further there is an inevitable time lag between the development of new ideas and processes and the transmission of these to those who are involved in operational problems or who are planning new projects. In addition the demands of society today require a wider knowledge of matters outside a professional's primary discipline.

The Foundation bridges this communication need in several ways:

- \* by providing short term concentrated training courses for professional and other specialised staff
- \* through the medium of symposia, conferences and distinguished lectures
- \* through information systems and services supported by a specialised geoscience library and resource centre.

The AMF is an independent, not-for-profit institution. Companies, organisations and institutions are invited to become a subscribing members of the Foundation.

Further information on AMF and Training Course can be obtained by writing to:

Dean S. Crowe  
 Director  
 Australian Mineral Foundation Incorp.  
 P.O. Box 97  
 Glenside, South Australia 5065.

### Information Services

These services cover:

- \* Earth Science and Related Information - Selected Annotated Titles (ESRISAT) monthly current awareness annotated bulletin covering subject topics of interest to the Foundation's member organisations, culled from a selective cross-section of world technical literature.
- \* Australian Earth Sciences Information System Quarterly a hard-copy current awareness bulletin produced from the AESIS data base which covers Australian-generated published and unpublished documented material over the full subject range of the earth sciences, as well as material on continental Australia from all sources from 1979 onwards. The Quarterly is available through membership of the Foundation or on subscription. Included in the subscription is AESIS

Cumulation which is a progressive cumulation of all citations in the database. The cumulation is produced annually in December as Computer Output on Microfiche.

- \* A literature search service for all disciplines relevant to the mineral and petroleum industries which includes manual and on-line retrospective searches of AESIS and other international data bases. All searches have subject specialist back-up and analysis.

#### Continuing Education Programme/Training Course

The short term (one or two week) courses arranged and conducted by the Foundation cover the most recent developments in mineral and petroleum technology and related topics, as needed by the resource industries. World experts with an applied emphasis are engaged to conduct the courses. In designing courses a blending of learning methods appropriate to the basic topic is incorporated in the programme. These include:

- \* formal lectures
- \* intensive workshop exercises either for individual or syndicate examination
- \* Case studies presented by course participants or by selected resource personnel from government and industry
- \* Panel discussion
- \* Practical demonstrations (in the laboratory)
- \* Field visits (where practical work can be undertaken by the participants).

In most cases a course leader is chosen to design and present the course in accordance with a basic specification laid down by the Foundation.

In any one calendar year between 18-20 training courses are presented. Details of courses are given in an annual syllabus which is published 3 months prior to the commencement of each calendar year. Individual application forms are distributed for each course.

In the seven years of operation to December 1978, a total of 98 courses has been presented by AMF in Australia with a further seven overseas in Indonesia, Philippines, Papua New Guinea and Singapore. The total number of participants has exceeded 3000 during the seven year period.

Course attendance ranges from 20-35 with an optimum of 25 participants. Aside from attendance by personnel from government and industry, provision is made by AMF for staff and post-graduate students from Universities and Colleges of Advanced Education.



1983 Programme - Training Courses

Project no.	Date	Title	Venue	Course Leaders	Fee Structure (Aust \$)	
					Member	Non-member
220/83	7-11 February	Seismic Exploration Method - Modern Concepts	Melbourne	Dr. S.N. Domenico	1275	1400
221/83	7-11 February	Seismic Interpretation for Geologists	Melbourne	Mr. J. Duncan	1275	1400
222/83	7-11 February	Drill Stem Test Interpretation	Adelaide	Mr. H. Reid	1275	1400
223/83	8-19 February	Geology for Engineers	Adelaide	Prof. D. Stapledon	1200	1475
224/83	10-11 February	Use of High Speed Motion Pictures in Open Pit Blasting	Perth	Dr. W.A. Crosby	550	600
225/83	14-18 February	Drilling and Blasting in Open Pits and Quarries- Hard Rock	Perth	Dr. W.A. Crosby	1000	1125
226/83	21-25 February	Drilling and Blasting in Open Pits and Quarries- Soft Materials	Perth	Dr. W.A. Crosby	1000	1125
227/83	28 Feb- 4 March	Geophysics for Geologists	Adelaide	Prof. D. Boyd Mr. R. Smith	800	925
228/83	7-11 March	Seismic Field Technology and Quality Control	Adelaide	Mr. D.G. Lang	1250	1375
229/83	14-18 March	Hydraulic Fracture Treatment Design	Adelaide	Dr. S. Holditch	1750	1875
230/83	21-25 March	Geology and Exploration for Non-Geologists	Adelaide	Dr. R. Fardon	550	675
231/83	11-22 April	Geological Interpretation of Aerial Photographs and Satellite Images	Adelaide	Mr. C. Maffi	1200	1450
232/83	11-22 April	Geochemical Exploration	Adelaide	Dr. A. Joyce	1300	1550
267/83	18-22 April	Statistical Methods for Exploration and Mining	Sydney	Prof. P. Switzer	600	725
233/83	5-13 May	Commodity Economics	Adelaide	Dr. van Rensburg	1250	1450

Project no.	Date	Title	Venue	Course Leaders	Fee Structure (Aust \$)	
					Member	Non-Member
234/83	9-13 May	Geophysics For Geologists	Adelaide	Prof. D. Boyd Mr. R. Smith	800	925
235/83	9-13 May	Mineral Law	Perth	Dr. M. Crommelin	850	975
236/83	16-19 May	Computers in the Mining Industry - Understanding the Essentials	Perth	Dr. P. Hadingham	800	900
237/83	23-28 May	Coal Geology	Newcastle	Dr. C. Diessel	800	950
238/83	6-10 June	An Introduction to Accounting, Economics and Finance for the Mineral Industry	Adelaide	Dr. B. Hughes	700	825
239/83	20-26 June	Uranium Geology and Exploration	Darwin	Dr. R. DeVoto	950	1075
240/83	20 June - 1 July	Drilling Practices School	Adelaide	Mr. J. Shursea	1900	2150
241/83	27 June - 1 July	Tin/Tungsten Deposits - Geology and Exploration	Adelaide	A/Prof. R. Taylor	800	925
242/83	4-8 July	Numerical Methods for the Design of Excavations in Rock	Brisbane	Dr. J. Meek	1000	1125
243/83	4-7 July	Computers in the Mining Industry-Understanding the Essentials	Melbourne	Mr. G. Maynard	800	900
244/83	11-22 July	Mineral Economics	Adelaide	Prof. B. Mackenzie	1250	1500
245/83	18-20 July	Coal Geostatistics	Brisbane	Dr. M. Armstrong	850	925
246/83	18-22 July	Well Testing	Adelaide	Dr. H.K. van Poolen	1350	1475
247/83	25-29 July	Production Technology- Completions and Workovers	Adelaide	Dr. H.K. van Poolen	1350	1475
248/83	1-12 Aug.	Basic Gas Conditioning and Processing	Adelaide	Prof. J. Erbar	1700	1950
249/83	15-19 Aug.	Mineral Law	Brisbane	Dr. M. Crommelin	850	975
250/83	15-17 Aug.	Pumps and Pumping Systems	Adelaide	Dr. K. Enever	700	775
251/83	18-20 Aug.	Hydraulic Transport of Solids	Adelaide	Dr. K. Enever	700	775
252/83	22-27 Aug.	Coal Mining Geology	Newcastle	Dr. K. Moelle	800	950
253/83	22 Aug. - 2 Sept.	Advanced Gas Conditioning and Processing	Adelaide	Prof. J. Erbar	1875	2125

Project no.	Date	Title	Venue	Course Leaders	Fee Structure (Aust \$)	
					Member	Non-Member
254/83	29-31 August	Coal Technology and Coal Utilization	Brisbane	Prof. D. Rowlands	450	525
256/83	12-16 Sept.	Reservoir Engineering - Basic	Adelaide	Dr. K. van Poolen	1350	1475
257/83	19-23 Sept.	Reservoir Engineering- Applied	Adelaide	Dr. H. van Poolen	1350	1475
255/83	19-28 Sept.	Management Training for Senior Geologists	Adelaide	Prof. W. Lacy	1350	1350
258/83	3- 7 Oct.	Principles of Hydrocarbon Generation and Migration	Adelaide	Mr. F. Meissner	1150	1275
259/83	12-20 Oct.	Structural Mapping of Mine Areas	Adelaide	Dr. T. Hopwood	1250	1475
260/83	17-21 Oct.	Petroleum Law	Adelaide	Dr. M. Crommelin	850	975
261/83	17-28 Oct.	Geological Interpretation of Aerial Photographs and Satellite Images	Adelaide	Mr. C. Maffi	1200	1450
262/83	31 Oct.- 5 Nov.	Geology and Geophysics in Petroleum Exploration of Cratonic Basins	Adelaide	Dr. R. Weimer	1250	1400
263/83	7-11 Nov.	Interpretation of Airborne Magnetic Surveys	Adelaide	Prof. D. Boyd	800	925
264/83	14-18 Nov.	Solvent Extraction Technology	Adelaide	Prof. C. Hanson	1050	1175
265/83	16 Nov. - 1 Dec.	Exploration Management	Adelaide	Dr. R. Davis	2750	2750
266/83	8- 9 Dec.	South Australia - Exploration Potential	Adelaide		50	50

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# PETROLEUM & GEOLOGICAL ENGINEERING - 1983 SCHEDULE OF COURSE OFFERINGS

## Republic of Singapore

Waterflooding for Engineers	June 13-17 1983
Natural Gas Engineering and Operations	June 20 - July 8 1983
Corrosion Technology	June 20 - 24, 1983
Basic Petroleum Geology for Non-Geologists	June 27-July 1, 1983
Basic Oil Field Development and Operations	July 4-8, 1983
Applications of Petroleum Fluid Data	July 11-15, 1983
Gas Process Plant Operation	July 11-15, 1983
Crude Oil Dehydration and Desalting	July 18-22, 1983
Liquefied Gas Safety Technology	July 18-22, 1983

The instructors responsible for the content and presentation of the following courses are:

Dr. Paul J. Root - Natural Gas Engineering and Operations (Weeks I and II)  
Waterflooding for Engineers

Mr. Walter E. Huffman - Natural Gas Engineering and Operations (Weeks III)  
Gas Process Plant Operation  
Crude Oil Dehydration and Desalting

Dr. William E. Martinsen & Dr. Edward Brown - Liquefied Gas Safety Technology

Dr. James B. Garber - Corrosion Technology

Dr. George G. Huffman - Basic Petroleum Geology for Non-geologists

Dr. George G. Huffman & Dr. Paul J. Root - Basic Oil Field Development and Operations

Dr. Fred F. Farshad & Dr. J.L. LeBlanc - Applications of Petroleum Fluid Data

## Conduct of the courses

The courses consist of a balanced series of lectures, discussions, problem-solving sessions and work periods. Formal sessions will be held daily Monday through Friday and will run from 0830 to 1200 and 1300 to 1630. Reading and problem assignments will be given each evening.

The structure of the sessions makes it possible for the participants to exchange information and experience on a variety of oil and gas industry problems. Informal discussions of field operations, encouraged throughout the course, lead to a sharing of knowledge.

A manual prepared especially for the course will be used to introduce most of the topics considered. The basic material in the manual is supplemented with reprints of recent articles, reference lists on key topics, problems with solutions, field examples and case histories.

Participants are encouraged to bring portable, electronic calculators capable of performing the full range of engineering calculations.

## Cost of courses

The participant may enroll for individual weeks of the courses.

The following fees in US dollars

One week - 1025  
 Each additional week\* - 925

\* *Applicable to additional weeks of Natural Gas Engineering and Operations only*

The enrollment fee for an individual is due and payable on or before the first day of the course. All class materials and the manual for the course are included in the above fee. Living costs are not a part of the fee.

The above fees include an administrative fee of 10 percent; the remainder is the instructional fee. In the case of a registration cancellation, the administrative fee is not refundable unless notice of such cancellation is received at least two weeks prior to the start of the course. In the event that an enrollee does not complete his program, the unused portion of the instructional fee will be credited toward future course enrollments. The participating company can change enrollees at any time.

A program may be cancelled if the level of enrollment is insufficient to provide for effective sessions. In this case, enrollment fees will be refunded in full.

#### Registration and Enrollment

Class enrollment will be limited during each week of the courses. In order to insure a place for an individual, registration should be made promptly by letter, telephone, cable or telex or by submitting the registration form on the last page of this brochure. All registrations will be confirmed by return mail and an invoice will be sent to each participating company.

For further information write to:

PETROLEUM AND GEOLOGICAL ENGINEERING, INC.  
 1839 Rolling Hills/Norman, Oklahoma 73069, USA  
 Telephone (405)-364-9626  
 TWX 910-830-6532 PETRO GEO NORM  
 Cable: PETRO GEOL

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## AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS (AAPG) ANNUAL CONVENTION 1983 - DALLAS

### Technical Programme

Monday Morning, April 18

AAPG U.S. Exploration Economics  
 AAPG Clastic Facies in Exploration  
 AAPG World Exploration Frontiers I  
 SEPM Carbonate and Siliciclastic Storm Deposition  
 SEPM Carbonate and Siliciclastic Sedimentology  
 SEPM Carbonates Associated with Evaporites

**Monday Afternoon, April 18**

AAPG World Exploration Frontiers II  
 AAPG Integrated Reservoir Geology  
 AAPG Seismic Expression of Structural Styles  
 AAPG/SEPM Source Rocks: Where, When and Why  
 SEPM Foraminifera as Paleobathymetric Indicators  
 SEPM Non-Marine Siliclastic Deposits  
 SEPM Techniques in Carbonate Research  
 DPA Symposium

**Tuesday Morning, April 19**

AAPG Research Symposium: Role of Clay Minerals in Hydrocarbon  
 Exploration I  
 AAPG Modeling Basin Subsidence and Stratigraphy  
 AAPG U.S. Exploration Frontiers  
 AAPG/SEPM The Terminal Eocene Event in the Oceans I:  
 Biostratigraphy and Regional Studies  
 SEPM Biogenic Structures in Carbonates  
 SEPM Research Symposium: Carbonate Cements Revisited  
 SEPM Deep-Marine Siliclastic Deposits  
 EMD Oil Shale and Tar Sands

**Tuesday Afternoon, April 19**

AAPG Research Symposium: Role of Clay Minerals in Hydrocarbon  
 Exploration II  
 AAPG Hydrocarbon Habitats in Texas  
 AAPG/SEPM The Terminal Eocene Event in the Oceans II:  
 Paleo-ocenaography  
 SEPM General Paleontology  
 SEPM Modern and Ancient Shallow-Marine Siliclastic Deposits  
 SEPM Research Symposium: Carbonate Cements Revisited  
 EMD Geology of Uranium Orebodies

**Wednesday Morning, April 20**

AAPG Exploration in China  
 AAPG Frontiers in Research  
 AAPG Fractured Reservoirs  
 AAPG/SEPM Carbonate to Clastic Facies Change I  
 SEPM Models of Siliclastic Diagenesis  
 SEPM Geochemistry of Oil and Gas: Case Studies  
 The Best of SEG for AAPG  
 EMD Coal and Lignite

**Wednesday Afternoon, April 20**

AAPG Egypt: Geology and Prospects  
 AAPG Exploration Technology  
 AAPG Diagenetic Traps  
 AAPG Structural Geology  
 AAPG/SEPM Carbonate to Clastic Facies Change II  
 SEPM Radiolaria  
 SEPM Tectonic Control of Siliclastic Sedimentation  
 SEPM Thermal Maturity of Source Rocks: Models and Case Studies

**Short Courses**

**Sedimentary Tectonics of the Appalachian Basin**  
*A - Saturday, April 16, 9.00 a.m. - 4.30 p.m.*  
*B - Sunday, April 17, 9.00 a.m. - 4.30 p.m.*  
*Dallas Convention Center*

*Lecturer: John M. Dennison (University of North Carolina,  
Chapel Hill)*

**Oil and Gas Reserve Estimates - Prospect and Producer**

*Sunday, April 17, 9.00 a.m. - 4.30 p.m.*

*Dallas Convention Center*

*Lecturers: Field Roebuch and Daylon Walton*

*(Roebuch-Walton, Inc., Dallas)*

**New ideas and methods for exploration for carbonate reservoirs  
(Depositional fabrics, stratigraphic patterns and diagenesis)**

*A - Saturday, April 16, 9.00 a.m. - 4.30 p.m.*

*B - Sunday, April 17, 9.00 a.m. - 4.30 p.m.*

*Dallas Convention Center*

*Lecturers: Sedimentology Group at the University of Michigan in  
Ann Arbor, Michigan, including James Lee Wilson,  
Bruce H. Wilkinson and K.C. Lohmann*

**Understanding and interpreting 3D seismic data volumes**

*Sunday, April 17, 9.00 a.m. - 4.30 p.m.*

*Dallas Convention Center*

*Lecturer: Marion R. Bone (Sohio Petroleum Co., Dallas)*

**Techniques for presenting papers at meetings**

*Sunday, April 17, 1.00 - 5.00 p.m.*

*Dallas Convention Center*

*Lecturers: R.L. Freed (Trinity University, San Antonio),  
D.L. Harris (Kerr-McGee Corp., Oklahoma City)*

**Fractured reservoir analysis**

*Sunday, April 17, 9.00 a.m. - 4.00 p.m.*

*Dallas Convention Center*

*Lecturer: Ronald A. Nelson (Amoco Production Co., Tulsa)*

**Alaska North Slope Oil-rock correlation study**

*Sunday, April 17, 8.30 a.m. - 4.30 p.m.*

*Dallas Convention Center*

*Organizers: Leslie Magoon (U.S.G.S. Menlo Park);  
George Claypool (U.S.G.S., Denver)*

**Workshop in interview skills**

*A - Sunday, April 17, 8.30 a.m. - 11.30 a.m.*

*B - Sunday, April 17, 1.30 - 4.30 p.m.*

*Dallas Convention Center*

*Lecturer: Mary Sue Hayward (Sun Production Co., Houston)*

**Career opportunities in petroleum geology and energy minerals**

*A - Sunday, April 17, 8.30 a.m. - 11.30 a.m.*

*B - Sunday, April 17, 1.30 - 4.30 p.m.*

*Dallas Convention Center*

*Lecturers: William Ayrton, Thomas Bultman, Kelton Cloud, Roger  
Harris, James Hartman, Gary Huber, Susan Landon,  
Robert Megill, Robert Sneider*

**Carbonate Buildups - core workshop***A - Saturday, April 16, 8.30 a.m. - 5.00 p.m.**B - Sunday, April 17, 8.30 a.m. - 5.00 p.m.**Dallas Convention Center**Organizer: P.M. Harris (Gulf Oil Exploration and Production Co., Houston)***Stable isotopes in sedimentary geology***Saturday, April 16 - Sunday, April 17, 8.30 a.m. - 5.00 p.m.**Dallas Convention Center**Lecturers: Michael A. Arthur (University of South Carolina)**Organizer: Thomas F. Anderson (University of Illinois); Isaac R. Kaplan (University of California - Los Angeles); Lynton E. Land (University of Texas-Austin); Jan Veizer (University of Ottawa)***Geowriting - quickly, concisely, effectively***Saturday, April 16, 8.30 a.m. - 5.00 p.m.**Dallas Convention Center**Lecturer: Wendell Cochran, Geotimes*

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**TRAINING COURSES****January 31 - February 25, 1983**

Remote sensing: digital image processing (Flagstaff, Arizona, USA): Advanced training course for foreign nationals. English. For information: Training Section, Office of International Geology, U.S. Geological Survey, 917 National Center, Reston, Virginia 22092, USA

**February - November 1983**

Geothermal technology (Auckland, New Zealand): Post-graduate course on utilization of geothermal energy for power generation. For nationals of developing countries or N.Z. with B.Sc. or B. Eng. degrees. Leads to Diploma in Energy Technology (Geothermal), UNDP fellowships available. English. For information: Director, Geothermal Institute, University of Auckland, Private Bag, Auckland, New Zealand

**February - November 1983**

Photointerpretation applied to geology and geotechnics (Bogota, Colombia): Short course organized by the Interamerican Centre of Photo-interpretation (CIAF) in cooperation with ITC and Unesco. Spanish. For information: Academic Secretariat of the CIAF, Apartado Aereo 53754, Bogota, Colombia.

**February - June 30 1983**

Mineral exploration (Leoben, Austria): Diploma course sponsored by Unesco. English. For information: University for Mining and Metallurgy, Postgraduate course on Mineral Exploration, Montanuniversitat, Leoben, A 8700 Austria

**February 15 - December 15 1982**

Geothermics (Pisa, Italy): Certificate course on geothermal energy sponsored by Unesco, UNDP and Italy. Spanish. For information: Istituto Internazionale per le Ricerche Geotermiche, 1, Via Buongusto, 56100 Pisa, Italy

**March - April 1983**

Mineral exploration (Paris, France): Short course sponsored by



Unesco. French. For information: Prof. H. Pelissonnier, Ecole des Mines, 60 Bd Saint Michel, 75272 Paris, Cedex 06, France

June - August 1983

Principles and methods of engineering geology (Budapest, Hungary): Certificate course sponsored by Unesco. English. For information: Hungarian Geological Institute, Nepstadion ut 14, P.O. Box 106, H 1142 Budapest, Hungary

July - August 1983

Summer course on Earth Sciences: crystallography, mineralogy, metallogeny (Madrid, Spain): Short course sponsored by Unesco. Spanish. For information: Departamento de Geolgi y Geoquimica, Facultad de Ciencias, Universidad Autonoma de Marid, Canto Blanco, Madrid 34, Spain

August - October 1983

Geochemical prospecting methods (Prague, Czechoslovakia): Certificate course organized by Geological Survey of Czechoslovakia and sponsored by Unesco, IAGC and Czechoslovakia. English. For information: GEOCHIM CSSR UNESCO, Geological Survey, Malostranske nam. 19, 118 21 Prague, Czechoslovakai.

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## KALENDAR (CALENDAR)

A bracketed date (Mar-Apr 1982) denotes entry in that issue carried additional information.

### 1983

- Feb 1 - 11 : XV Pacific Science Congress, Dunedin, New Zealand. (Secretary-General, 15th Pacific Science Congress, P.O. Box 6063, Dunedin, New Zealand). (Jan-Feb 1982).
- Feb 1 - 11 : Pacific Neogene Stratigraphy, (3rd International Meeting), Dunedin, New Zealand. Sponsored by the Royal Society of New Zealand and IUGS. (A.R. Edwards, Secretary, N.Z. Geological Survey, P.O. Box 30-368, Lower Hutt, New Zealand).
- Feb 19 : Symposium on Syngenesi and Epigenesis in Petrography & Ore Deposits to commemorate Prof. Dr. G.C. Amstutz's 60th Birthday, Mineralog-Petrog. Institute, Universitat Heidelberg, W. Germany (Prof. Dr. A. Wauschkuhn, Postfach 104040, D 6900 Heidelberg 1, W. Germany). (Sept-Oct 1982)
- Feb 20 - 25 : Lithospheric dynamics and evolution of continental crust (6th Convention), Canberra, Australia. (M.B. Duggan, Organizing Secretary, 6th Australian Geological Convention, P.O. Box 1923, Canberra City, ACT 2601, Australia)
- Mar 6 - 10 : 3rd International Symposium on Hydrometallurgy, Atlanta, Georgia, USA. K. Osseo-Asare, Dept. of Materials, Science and Engineering, 202A, Steidle Building, The Pennsylvania State University, University Park, Pennsylvania 16802, USA). (Jul-Aug 1982)
- Mar 16 : Metamorphic Studies Research in Progress, (Meeting), London, U.K. (M. Brown, Honorary Secretary, Metamorphic

- Studies Group, Dept. of Geology and Physical Sciences, Oxford Polytechnic, Headington, Oxford OX3 OBP, UK)
- Apr 10 - 15 : Rock Mechanics (5th International Congress), Melbourne, Australia. (Australian Geomechanics Society Institution of Engineers, Australia, 11 National Circuit, Barton, ACT 2600, Australia)
- Apr 11 - 13 : Proterozoic '83 (1st International Conference), Lusaka, Zambia. Field trips. Sponsored by Geological Survey of Zambia and GSA. Languages: English and French. (The Secretariat, Proterozoic '83, P.O. Box 50135, Lusaka, Zambia)
- Apr 11 - 15 : Benthos '83 (2nd International Symposium on Benthonic Foraminifera), Pau, France. Sponsored by French Academy of Sciences and French Paleontological Association. (M. Hamaoui, SNEA(P), Direction Exploration, Centre Micoulau, B.P. 65, 64018 Pau, France)
- Apr 17 - 20 : American Association of Petroleum Geologists (AAPG) Annual Convention, 1983, Dallas. (L.S. Pittman, AAPG, P.O. Box 979, Tulsa, Oklahoma 74101, USA) (Sep-Oct 1982)
- Apr - May : International Association of Sedimentologists, (4th European Meeting), Split, Yugoslavia. Pre- and post-Conference field trips. (V. Jelaska, Geoloski Zavod, Sachsova 2, 41000 Zagreb, Yugoslavia)
- May : Soil Mechanics and Foundation Engineering, (8th European Conference), Helsinki, Finland. (Secretary-General, VIII ECSMFE, c/o VTT/GEO, SF-02150 Espoo 15, Finland)
- May 2 - 6 : Methods and Instruments for the Investigation of Ground-water Systems, (International Symposium), Noordwijkerhout, The Netherlands. Co-sponsored by UNESCO, IHP, IAHS and IAH. Languages: English and French. (Secretary, Organizing Committee, Congress Bureau of the Corporate, Communication Dept. TNO, 148 Juliana van Stolberglaan, 2595 CL The Hague, The Netherlands)
- Aug 7 - 12 : Fossil Corals (Symposium), Washington, D.C. (W.A. Oliver, Jr., U.S. Geological Survey, E-305 Natural History Building, Smithsonian Institution, Washington, D.C. 20560, USA)
- Aug 27 : Krakatau Eruption (Centennial Symposium), Jakarta, Indonesia. (D. Sastrapradja, Indonesia Institute of Sciences, Box 250, Jakarta, Indonesia)
- Aug 29 - Sep 8 : International Association of Geochemistry and Cosmochemistry, (4th International Symposium of Water-Rock Interaction), Misasa, Japan. Technical sessions and post-Symposium field trips. Sponsored by Institute for Thermal Spring Research, Geochemical Society of Japan and Geothermal Research Society of Japan. (H. Sakai, Secretary-General, WRI-4, Institute for Thermal Spring Research, Okayama University, Misasa, Tottori-ken 682-02, Japan)

- Sep : International Symposium on Engineering Geology and Underground Construction, Lisbon, Portugal.  
Sociedade Portuguesa de Geotecnia, c/o L.N.E.C., Av. Brasil, 101, 1799 Lisboa Codex, Portugal)
- Sep : Geomaterials: Rocks, Concretes, Soils, (Meeting)  
Evanston, Illinois, USA. (Secretary-General, IUTAM, Chalmers University of Technology, Fack, S-40220 Gothenburg 5, Sweden)
- Sep 8 - 10 : Workshop on Stratigraphic Correlation of Thailand and Malaysia, Haad Yai, Thailand. (Coordinators: Dr. Prinya Nutalaya, A.I.T., G.P.O. Box 2754, Bangkok 10501, Thailand; or Dr. B.K. Tan, Geology, Universiti Malaya, Kuala Lumpur, Malaysia) (Sep - Oct 1982)
- Sep 12 - 17 : Carboniferous Stratigraphy and Geology, (10th International Congress), Madrid, Spain. (Comite organizador del X Congreso Internacional de Estratigrafia y Geologia del Carbonifero, Instituto Geologico Minero de Espana, Rios Rosas, 23-Madrid-3, Espana),
- Sep 19 - 23 : World Energy, (12th Conference), New Delhi, India. (E. Ruttley, World Energy Conference, 34 St. James Street, London SW1A 1HD, U.K.)
- Sep 19 - 23 : Quaternary (6th Meeting), Galicia, Spain. (Sr. Secretario del Grupo Espanol de Trabajo del Cuaternario, Instituto de Edafologia y Biologia Vegetal, Serrano, 115 duplicado, Madrid-6, Spain)
- Dec : Groundwater 1983 (IAH Symposium), Sydney, Australia. (W. Williamson, Ibis House, 201/211 Miller St., P.O. Box 952, North Sydney, NSW 2060, Australia)
- 1984
- Mar/Apr : Geology, Mineral and Energy Resources of Southeast Asia (GEOSEA V), Kuala Lumpur, Malaysia. (T.T. Khoo, Geological Society of Malaysia, Dept. of Geology, University of Malaya, Kuala Lumpur 22-11, Malaysia)
- Mar 26 - 30 : Computer applications in the mineral industries (18th International Symposium), London, U.K. Organized by the Institution of Mining and Metallurgy. (The Conference Office, Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR, UK)
- Aug 4 - 14 : 27th International Geological Congress, Moscow, USSR. (N.A. Bogdanov, General Secretary, Organizing Committee of the 27th IGC, Staromonetny per. 22, Moscow 109180, USSR).
- Aug 9 - 18 : Crystallography, (13th General Assembly and International Congress), Hamburg, F.R.G. (E.E. Snider, American Crystallographic Association, 335 East 45th Street, New York, NY 10017, USA)
- Aug 24 - 30 : 6th International Palynological Conference, Calgary, Canada. Sponsored by ICP, CAP, CSPG, the University of Calgary, and Arctic Institute of North America. Pre- and post-Conference excursions. (L. Kokoski,

Conference Office, Faculty of Continuing Education,  
Education Tower Room 102, Calgary, Alberta, Canada  
T2N 1N4)

- Sep : Caledonide Orogen, (IGCP Project 27, Working Group Meeting), Edinburgh, Scotland. Pre-Meeting excursions in Ireland, Scotland, England and Wales. (A.L. Harris, The University of Liverpool, Jame Herdman Laboratories of Geology, Brownlow Street, P.O. Box 147, Liverpool L69 3BX, UK)
- Nov 5 - 8 : Geological Society of America, (Annual Meeting), Reno, USA. (S.S. Beggs, Geological Society of America, P.O. Box 9140, 3300 Penrose Place, Boulder, Co. 80301, USA)
- Dec 2 - 6 : Society of Exploration Geophysicists, (54th Annual Meeting), Atlanta, Georgia, USA. (J. Hyden, SEG, Box 3098, Tulsa, Oklahoma 74101, USA)

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