

PERSATUAN GEOLOGI MALAYSIA

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PERSATUAN GEOLOGI MALAYSIA  
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Tujuan Persatuan Geologi Malaysia adalah untuk memajukan sains bumi, terutamanya di Malaysia dan tempat-tempat berhampiran. Sesiapa yang ingin menjadi ahli Persatuan sila dapatkan borang-borang daripada Setiausaha Kehormat.

The aim of the Geological Society of Malaysia is to promote the advancement of geological sciences particularly in Malaysia and nearby areas. Anyone interested in becoming a member of the Society should obtain the necessary forms from the Hon. Secretary.

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Some Bahasa Malaysia (Malay) geographical terms

Bukit (Bt)	- hill	Kuala (K)	- mouth of river
Genting (Gtg)	- pass	Pulau (P)	- island
Gunung (G.)	- mountain	Sungai (S.)	- river
Jalan (Jln.)	- road, street	Tanjung (Tg.)	- cape
Kampung (Kg.)	- village	Teluk (T.)	- bay

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## G E O L O G I C A L   N O T E S

Olivine nephelinite and limburgite from Kuantan, Pahang

K.R. Chakraborty, Jabatan Geologi, Universiti Malaya, Kuala Lumpur

### Introduction

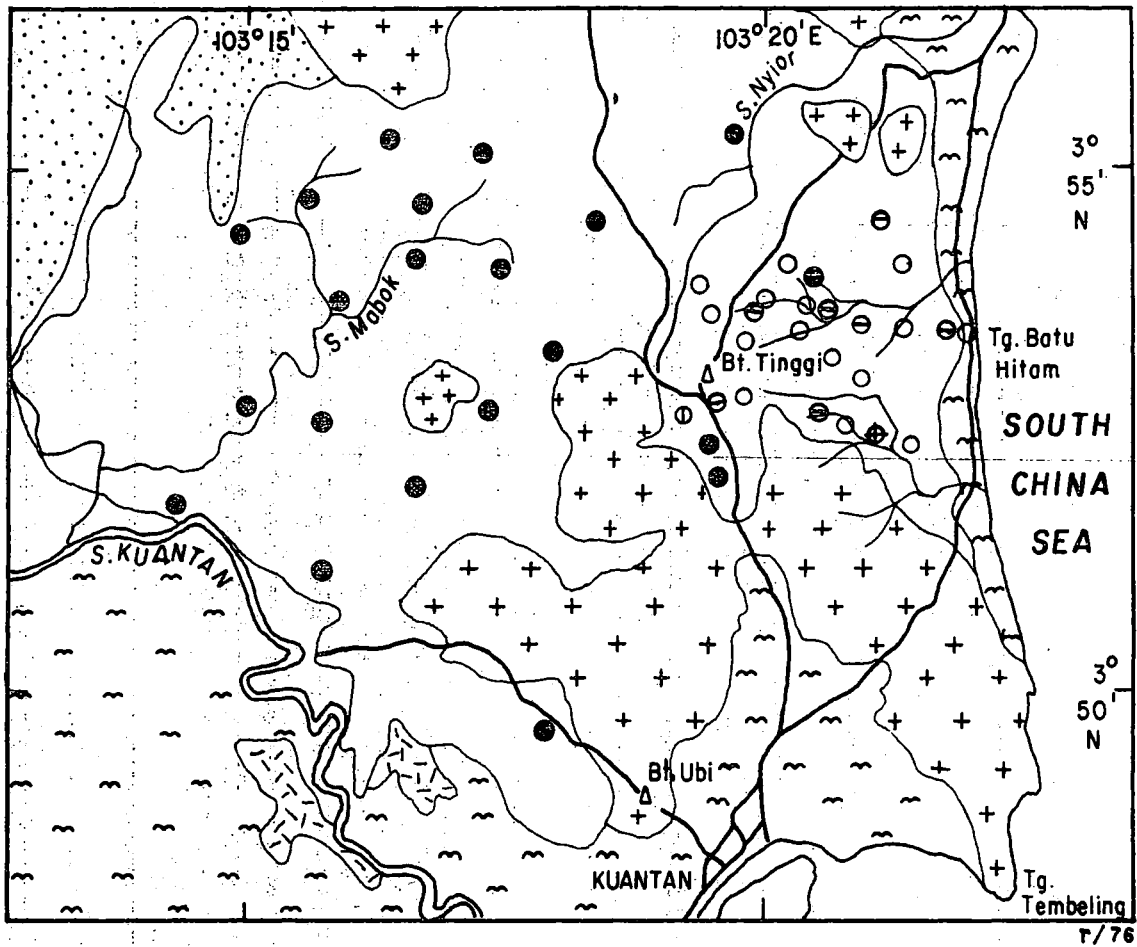
Late Cainozoic basaltic rocks of the Kuantan area were first described by Fitch (1952, p. 38) as olivine basalts with or without nepheline. Recently, Hanif (1975), who made a somewhat detailed petrographic and chemical study of these rocks, distinguished two rock types - alkali olivine basalt and basanite (doleritic dykes in Triassic 'granite' in the area are not considered here). The writer is currently examining these basaltic rocks for petrogenetic considerations. From thin section studies of about 50 specimens, supplemented by a few chemical analyses, several other important rock types have been identified. But what seems to be more significant is that the basaltic rocks of Kuantan belong to two distinct and perhaps independent magma types, alkali olivine basalt magma and olivine nephelinite magma. The former, areally more widespread, is relatively undifferentiated and represented almost exclusively by olivine basalts and rare differentiates like olivine mugearite (?) and possibly basanite. The rock types belonging to the latter, on the other hand, are varied and include olivine nephelinite (dominant), nephelinite, limburgite (only two specimens), basanite, etc. The spatial distribution of these rock types have not yet been fully delineated. However, it appears that olivine basalts by and large occur in the western part whereas olivine nephelinites, etc., are restricted to the eastern side (Fig. 1). The sequence of eruptions of the different types of lavas is not known. But from Hanif's report it appears that olivine nephelinite is, at least in part, later than olivine basalt (incidentally, the basanites described by Hanif are mostly olivine nephelinites).

### Petrography and chemistry

Olivine basalt: The petrography of the olivine basalt has been described by Fitch (1952) and Hanif (1975) and will not be described here. In one of the specimens so far studied, the plagioclase seems to be relatively more sodic (oligoclase) and this is tentatively identified as olivine mugearite.

Olivine nephelinite: Olivine nephelinites (see Table 1 for chemical composition) are fine grained, aphyric to microphyric rocks consisting of microphenocrysts of olivine and clinopyroxene set generally in a

Fig.1. Distribution of Basaltic Rocks in Kuantan Area.



- |                    |  |                     |  |                 |   |                                   |
|--------------------|--|---------------------|--|-----------------|---|-----------------------------------|
| Quat.              |  | Alluvium            |  | Basalt          | ● | Ol. Basalt                        |
| Upper Palaeoz. (?) |  | "Arenaceous series" |  | Rhyolitic rocks | ○ | Ol. Nephelinite                   |
|                    |  |                     |  | "Granite"       | ⊕ | Limburgite                        |
|                    |  |                     |  |                 | ⊙ | Mugearite (?)                     |
|                    |  |                     |  |                 | ⊖ | Basanite / Phonolitic Nephelinite |

Table 1 : Chemical Data

<u>Oxide</u>	<u>01. Basalt*</u>	<u>01. Nephelinite</u>	<u>Limburgite</u>	<u>Clinopyroxene</u>
SiO <sub>2</sub>	48.04	40.29	44.81	48.08
TiO <sub>2</sub>	1.95	2.37	2.76	1.88
Al <sub>2</sub> O <sub>3</sub>	15.77	13.89	12.84	5.36
FeO	10.81	12.98	12.06	7.41
MgO	7.73	9.62	9.83	12.47
MnO	0.17	0.35	0.24	-
CaO	9.14	11.54	10.35	23.71
Na <sub>2</sub> O	3.58	4.08	2.76	n.o.
K <sub>2</sub> O	1.41	2.19	1.69	n.o.
P <sub>2</sub> O <sub>5</sub>	0.52	0.81	0.67	-
H <sub>2</sub> O	0.24	1.06	1.12	-
<u>Total</u>	<u>99.36</u>	<u>99.18</u>	<u>99.13</u>	<u>98.91</u>

CIPW Norm\*\*

or	8.37	0.00	10.15
ab	26.18	0.00	14.54
an	22.91	13.29	17.94
lc	0.00	10.28	0.00
ne	2.31	18.94	4.98
cs	0.00	0.08	0.00
mt	4.90	8.46	5.52
il	3.72	4.56	5.33
ap	1.24	1.94	1.61
ol	14.82	11.29	16.03
di	15.54	31.16	23.90

\* From Hanif (1975), average of six analyses

n.o. = peaks not observed during scanning

\*\* Fe<sub>2</sub>O<sub>3</sub>/FeO from Fitch's (1952) analysis has been used for Norm calculation.

holocrystalline groundmass dominated by tiny prisms of clinopyroxene and euhedral to subhedral grains of nepheline. Granules of titanomagnetite and tiny needles of apatite are always present and occasionally are quite abundant. A small amount of interstitial glass may sometimes be present. With diminishing amount of olivine, olivine nephelinite grades into nephelinite (rare).

Olivine is rather fresh, although marginal alteration to serpentine and brownish iddingsite is not uncommon. Occasionally, few grains of olivine cluster together giving an impression of a microglomeroporphyritic texture. Clinopyroxene crystals are in general faintly brownish, but in some specimens they have a greenish tint. Microprisms of clinopyroxene often show subparallel arrangement. Microprobe analyses of brownish clinopyroxene (Table 1) show high CaO, TiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> but no Na<sub>2</sub>O. The calculated formula of the clinopyroxene is Ca<sub>0.96</sub>(Mg<sub>0.70</sub>Fe<sub>0.23</sub>Ti<sub>0.05</sub>Al<sub>0.06</sub>)<sub>1.04</sub>(Si<sub>1.82</sub>Al<sub>0.18</sub>)<sub>2.06</sub>.

Nepheline always occurs as a groundmass phase. Euhedral crystals are hexagonal or squarish in outline. Characteristically, almost all nepheline grains have inclusions of clinopyroxene. From semiquantitative microprobe analyses these nephelines appear to have high K<sub>2</sub>O ( 11 - 12%) and FeO ( 2%) but no CaO and have silica in excess of stoichiometry. Such a high Fe-bearing nepheline is rather unusual. Apparently Fe has substituted for Al.

In typical olivine nephelinite, feldspar is usually absent or only a minor constituent of the groundmass. With increasing amount of feldspar, olivine nephelinite grades either into basanite or phonolitic olivine nephelinite depending on the type and composition of the feldspars.

Limburgite: Limburgites are dark coloured, aphanitic and aphyric to microphyric rocks made up essentially of microphenocrysts of olivine and clinopyroxene set in a dense hypocrySTALLINE and hyalopilitic groundmass with abundant minute prisms of clinopyroxene, granules of opaques and interstitial brownish glass presumably rich in alkali (see Table 1 for chemical composition). Felsic minerals are conspicuous by their absence. Occasionally megacrysts (1-2 mm) of optically negative orthopyroxene with rare inclusions of deformed carbonate grains are observed.

### Discussion

The olivine basalt-olivine nephelinite association here is interesting from petrogenetic point of view and is also significant in the context of crustal and tectonic evolution of the Malay Peninsula. The petrogenetic aspects will be discussed in a later article.

But it should be pointed out that available petrographic and chemical data of these rocks do not support the idea that olivine nephelinite is a differentiate of olivine basalt magma. Apparently, two different and mutually independent types of magma have erupted from a single centre (Bt. Tinggi as suggested by Fitch) without any significant time difference. Although such a situation is by no means uncommon, it is nevertheless very intriguing as far as the evolution of the magma is concerned.

There is no clear relation between tectonic lines and the occurrence of the alkaline lavas in this area. It is difficult to relate them with any particular tectonic pattern until more centres of alkaline igneous activities become known and more detailed structural informations are available. But it seems reasonable to assume that alkaline volcanism here is not connected with compressional tectonics in view of the time difference between the regional folding phase and the lava eruptions. The close connection between alkaline igneous activities and tensional tectonics is universally well documented and similar conditions are likely to have prevailed in this region during the time of alkaline volcanism. It is quite probable that the Kuantan lavas are associated with tensional faulting or stretching consequent upon crustal arching. Although critical evidence in support of this postulation are as yet lacking, further investigations along these lines in this region, particularly in the adjoining South China Sea, may be revealing.

#### Acknowledgement

Thanks are due to Dr. C.S. Hutchison for his help with the microprobe analyses and to Encik Hanif Hussein for sparing his samples.

#### References

- Fitch, F.H., 1952. The geology and mineral resources of the neighbourhood of Kuantan, Pahang. Mem. Geol. Surv. Dep. Fed. Malaya, 6, 143 p.
- Hanif Hussein, Abdul, 1975. The geology of the Kuantan area, with special reference to the petrology and chemistry of the basalts and dolerites. Unpubl. B.Sc. (Hons) Thesis, Dept. of Geology, University of Malaya.

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Magnetite-bearing tin ore from Pahang Consolidated Mines, Sungai Lembing, Pahang, Peninsular Malaysia

K.F.G. Hosking, Calle Isla de Cuba, 23, 1<sup>o</sup>, 3, Sitges, Spain.  
E.B. Yeap, Jabatan Geologi, Universiti Malaya, Kuala Lumpur.

### Introduction

When we visited P.C.C.L., in mid-1975, we were told by the Manager (Mr. W. Tinker) and the Assistant Manager (Mr. C.T. Tay) that undesirably high concentrations of iron were being reported in the analyses of the cassiterite concentrates they were currently sending to the smelters. Apparently, the appearance of this peculiarity coincided with the collection of magnetic ore by the tramp-iron magnet at the head of the mill. So it was concluded that pieces of magnetic ore that entered the mill circuit might well be responsible for the unusually high iron content of the concentrates. In order to investigate this problem, and at the same time to determine the nature of the magnetic ore, thin and polished sections were prepared from samples of the latter that had been isolated by the tramp-iron magnet. In addition, the cassiterite from some of this ore was recovered by vanning a crushed and ground sample of it. Also, the magnetics in a sample of cassiterite concentrate that was ready to be sent to the smelters were isolated by means of an Eclipse magnet. These two samples of grains were briquetted and thin and polished sections of the briquettes were prepared for examination under the microscope. The results of these examinations appear below.

### The samples of grains

Examination, under the microscope, of the thin and polished sections of the grains revealed that both the samples, consisted essentially of cassiterite but that a high percentage of the sample that had been obtained by means of the Eclipse magnet, and an appreciable proportion of the vanned concentrate, consisted of cassiterite grains that were partly or completely fringed by chlorite (Fig. 1). A rather small percentage of the coarser cassiterite grains was veined by one or more iron-rich species, but notably pyrrhotite and magnetite. In addition, in the magnetic fraction there were a few grains of magnetite and pyrrhotite.

There can be little doubt but that chlorite, (which has an appreciable magnetic susceptibility) was the major contributor of iron to the finished cassiterite concentrate. During the process of crushing and grinding, chlorite, particularly when in the form of comparatively coarse flakes, does not readily become detached from the cassiterite with which it is in contact in the ore. Instead, because it



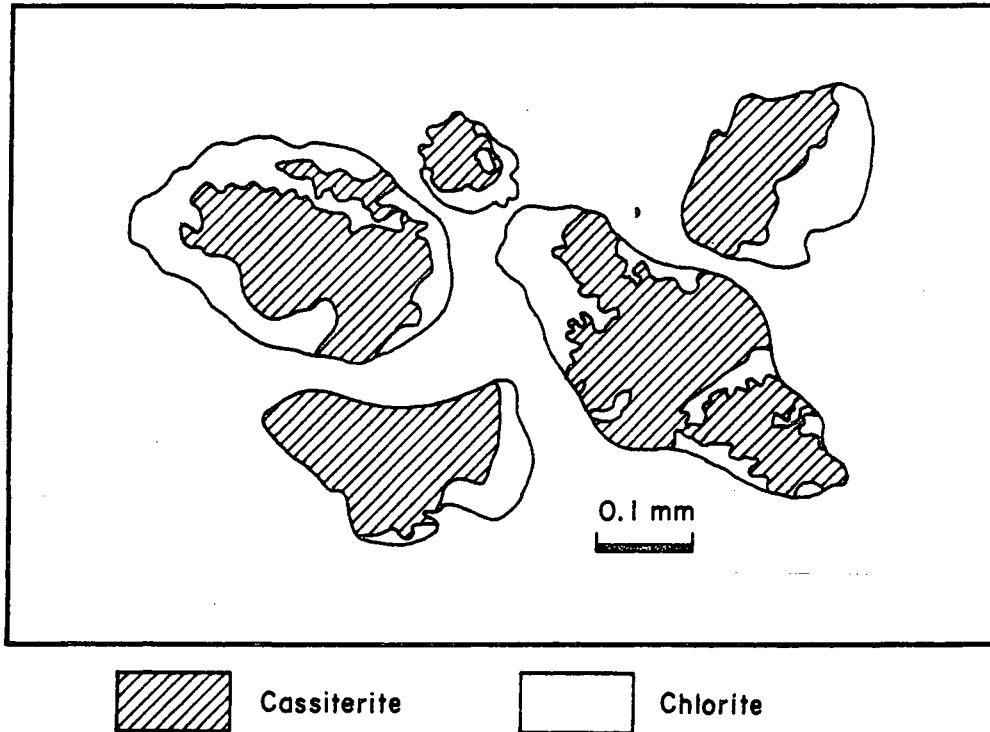


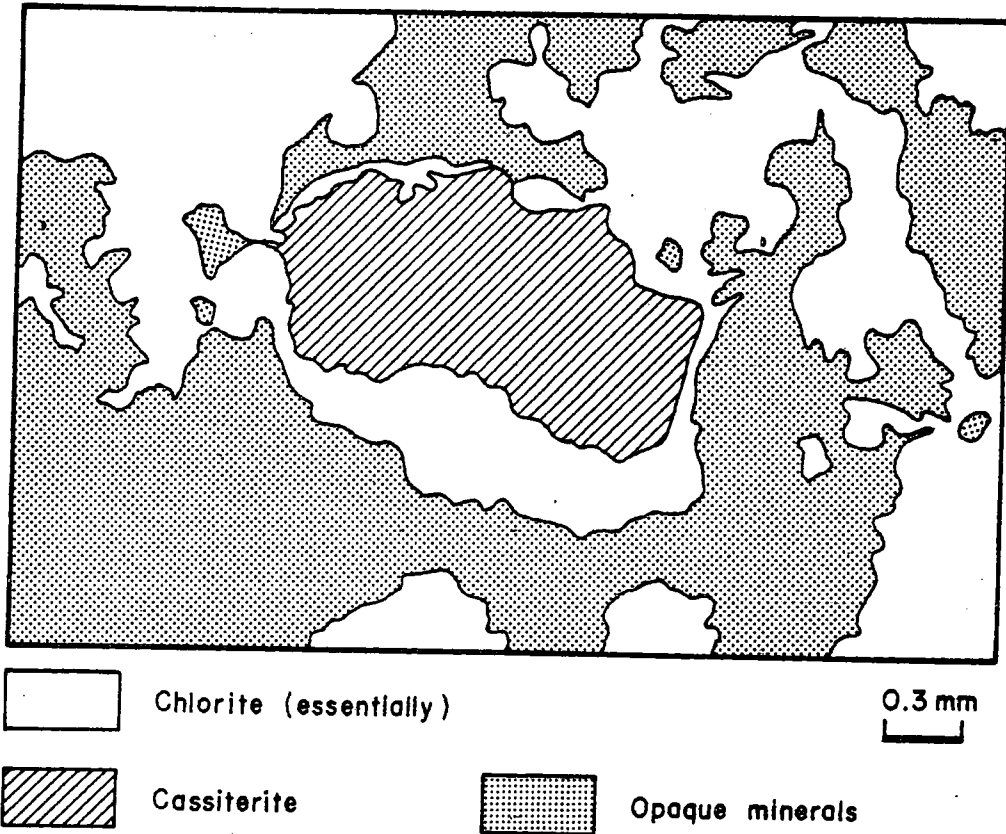
Fig. 1 Composite cassiterite/chlorite grains that were extracted by means of an Eclipse magnet from a P. C. C. L. concentrate ready for despatch to the Smelter. (Tracing from a photomicrograph of a thin section of briquetted grains)

is flexible, but not elastic, it tends to wrap itself around the cassiterite. This, and the fact that chlorite is magnetic, created a problem at South Crofty Tin Mine (Cornwall, United Kingdom) about twelve years ago. There, during magnetic separation, which was employed to make a clean cassiterite concentrate, an appreciable quantity of the cassiterite reported with the magnetics. Roasting a sample of composite chlorite/cassiterite grains will convert the chlorite into a brittle substance that can then be released by a light grind, and a clean cassiterite concentrate can then be obtained by tabling the product. The iron content of such composite grains can be reduced by subjecting them to a warm HCl leach. Whether the one or the other might be usefully applied to the P.C.C.L. concentrates depends, of course, on whether the offending ore can be conveniently isolated and treated separately in the mill, also on the quantity of iron-rich concentrate which will be produced per month, and on the tonnage of this particular ore that the mine is likely to produce. Doubtless the reader will think of other factors that would need to be considered.

#### The magnetic ore

Examination of thin and polished sections of the magnetic ore under the microscope indicate that it consists essentially of magnetite, a number of iron sulphides, several generations of chlorite, economically important concentrations of cassiterite, and minor amounts of sphalerite, chalcopyrite, galena, siderite, calcite and early apatite.

In thin section the cassiterite tends to occur as clusters of more-or-less equidimensional crystals, that whilst being generally very pale-coloured shown, nevertheless, considerable variation in their colour zoning. Furthermore, the colour-zoning of crystals of a given cluster is often appreciably different from the zoning of crystals in another zone. Some crystals have small darkbrown zones but it is much more common for the crystals to possess only a few faint, narrow, and rather diffuse orange zones. The cassiterite is at the most only slightly pleochroic. Some of the cassiterite crystals contain inclusions of strong green chlorite and some of the cassiterite clusters are crossed by veins, that are generally very narrow and that contain various combinations of chlorite, magnetite and iron sulphides. Whilst, on occasion, cassiterite may be in contact with, or surrounded by one of the later iron-bearing species (magnetite, pyrrhotite, etc) it is commonly separated from these by chlorite which is usually of a rather strong green in colour, comparatively coarse-grained and which overlapped the deposition of the cassiterite (Fig. 2). By-and-large, the later generations of chlorite most of which are brownish (iron-rich) in colour, tend to be closely associated with magnetite and sulphides in particular pyrrhotite. The brown variety of chlorite is believed to be one of the minerals resulting from the alteration of pyrrhotite.



**Fig. 2** Tracing of a photomicrograph of a thin section of P. C. C. L. magnetic ore, showing the commonest textural relationship that is encountered between cassiterite and the gangue minerals.

The textural relations between the cassiterite and the green chlorite are such that it is abundantly clear why chlorite/cassiterite composite grains are likely to be generated during the crushing and the grinding processes to which the ore is subject in the mill.

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## MEETING OF THE SOCIETY

D. Pfeiffer: Groundwater exploration in Peninsular Malaysia. Geohydrological case study - Kampung Raja area, Trengganu.

Dr. D. Pfeiffer of the German Hydrogeologic Mission in Malaysia presented two talks to the Society on Jan. 7, 1977. In his first talk Dr. Pfeiffer spoke on some aspects of the ground water present in a number of alluvial plains between Kota Bharu and Kuantan along the east coast of Peninsular Malaysia. He described the types and characteristics of the aquifers present and presented excellent geological sections (prepared from borehole data) of the alluvium in these areas. Three to four aquifers have been recognized and show good potential in being exploited for ground water. Estimated recharges and yields together with the methods of calculation were also presented. A geohydrological map of the Malay Peninsula was also presented.

In his second talk, Dr. Pfeiffer described the potential aspects of ground water exploration and exploitation and illustrated this by a case study of the Kg. Raja area in Trengganu. Yields, methods of monitoring ground water fluctuations, recharge possibilities and types of aquifers present were also described.

JKR

## NEWS OF THE SOCIETY

International Symposium and Tin Training Course

With the support of the Association of Geoscientists for International Development (AGID) and the UNESCO, our Society will be organizing an international symposium on the Geology of Tin Deposits and a Tin Training Course. The symposium will be held tentatively on

24 - 25 March, 1978 in Kuala Lumpur and the training course which will immediately follow the symposium will be concluded on 15 April 1978.

The symposium will focus on the following topics:

- ( i ) Magmatism associated with tin deposits,
- ( ii ) Review papers on specific tin fields,
- ( iii ) Types and genesis of tin deposits,
- ( iv ) Tin mineralogy including experimental aspects,
- ( v ) Geological controls of primary epigenetic tin mineralization,
- ( vi ) Onshore and offshore placer tin deposits,
- ( vii ) Global tectonics and tin mineralization, and
- (viii) New developments in exploration methods for tin deposits.

A number of distinguished geoscientists in the field of tin geology will be invited to present papers in this symposium. Papers from other contributors are also invited. Anyone wishing to contribute papers should write to the Secretary, Organizing Committee, Symposium/Training Course on Tin Deposits, Geological Society of Malaysia, c/o Dept. of Geology, University of Malaya, Kuala Lumpur 22-11, giving the title and brief outline of the contributions as soon as possible.

The Tin Training Course will consist of lectures, practical demonstrations and fieldwork and the course is designed for graduate geoscientists at an early stage of their careers. The fee for this course has yet to be fixed but it will be kept at the minimum possible level to cover mainly the cost of subsistence and local transport. AGID and UNESCO have indicated willingness to support a limited number of participants from Southeast Asian countries for this course. Those wishing to participate in this course should write to the Secretary, Organizing Committee (address given above) giving a brief curriculum vitae as soon as possible. The language of the course will be in English.

Circulars will be sent to all members from time to time to keep them informed about the symposium and training course. Non-members who are interested to participate and wish to receive circulars should write to the Secretary, Organizing Committee (address given above) as soon as possible.

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International Mineralogical Association

The Council has decided to terminate the Society's membership with the IMA as only very few of our members are keen on the activities of the IMA.

Membership

The following have been elected to membership:

Full membership

Aminuddin Yusof  
R.G. Bertagne  
P. Dheeradilok  
Ismail Mohd. Noor  
M. Kouno  
S. Kwaebaidhoon

F. Lucas  
D. Pfeiffer  
C.R. Pietersz  
S. Sampattavanija  
S. Subramaniam  
P.C. Waller.

Student membership

Daud Mohamad  
Lim Peng Lai  
Mohd. Shahid Ayub

Tuan Besar Tuan Ngah  
Umar Hamzah  
Zaiton Harun

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O T H E R   N E W S

EARTH SCIENCE DEPT., PRINCE OF SONGKHLA UNIVERSITY, THAILAND

"It is a great joy for us to inform you that by the grace of Nature and through great kindness of many people, the project to

establish at the Prince of Songkhla University of Thailand an organization for research, survey and training in the field of geology and related sciences and technology finally reached its stage of practical work when standing staff of the organization started their work at Hat Yai, Thailand in August 1976.

The organization would bring up real geologists, even a few in number, who love research, survey and practical training in field and indoor works, starting with quite simple but basic instruments, and who devote themselves to the real happiness of all the people of the nation and also of the world to live in harmony with nature.

The organization is not for undergraduate education and is not intending to give any title such as Ph. D. or Master. We consider such titles are just like foot-prints. When we walk, foot-prints are left, but we do not walk to produce foot-prints.

In the organization, there would be no teacher nor students. All are co-workers. The routine work of the institute would be field work and directly related indoor work to accumulate our experience and basic information on stratigraphy of this part of the world. We may start with using quite simple instruments such as hammer, clinometer and plane table.

A special study team would be formed whenever a suitable leader/expert of good personality is made available. All the research staff would work together as a team and by the time of departure of that leader/expert from the university, a report of that study team would be prepared and presented to the Rector to be published for distribution to all those concerned throughout the world not later than one year.

There will be three kinds of staff in the organization:

- 1) standing staff of the organization itself;
- 2) cooperating staff from other units of the university; and
- 3) visiting staff whose salary and other fundamental support may come from sources other than the university but practical working conditions would be the same as those mentioned above in 1) and 2).

The organization also has Honorary Advisors to Rector on this project. At present the following distinguished persons in the field of geology and related sciences and technology throughout the world are kindly our Honorary Advisors:

Bender, F. Prof. Dr., President of Federal Institute for Geosciences and Natural Resources, Federal Republic of Germany;

Kobayashi, T. Prof. Dr., Academician of Japan, Prof. Emer., University of Tokyo;



Li, C.Y. Dr., Project Manager/Coordinator, United Nations U.N.D. P./C.C.O.P.;

Noakes, L.C. Dr., Director, Bureau of Mineral Resources, Geology and Geophysics, Australia; and

Reinemund, J.A. Dr., Chief, Office of International Geology, U.S. Geological Survey.

It is also expected that in the not too distant future the organization may receive several experts from many countries of the world. It may have a Japanese petrographer initially for four months, quite possibly in 1977, to have preliminary study of granitic rocks and related ore deposits. After this preliminary study by his team, a systematic long-range plan would be established and real work of this plan would be started accordingly with little lapse of time after this planning.

In the later part of 1977 and early 1978, a New Zealand geologist is expected to be a visiting staff for a few months as an expert in stratigraphy and palaeontology, specially of the Triassic. A plan is being made to have a Canadian geologist, field/hard rock oriented, in the near future. He is expected to be a standing staff to assist the project in its early stages. In other fields of work such as palaeontology, study of limestone, Tertiary and Quaternary and training for topographic survey specialized for geological survey and mining works, several experts are expected to join the organization from many countries in the near future.

After several years the organization is expected to have more and more sophisticated facilities and to undertake more studies most suitable to the local conditions. This may mean the maximum utilization of human effort, expenses and facilities compared with the cases to send inexperienced post-graduates to faraway countries without definite academic purpose and in the selection of the most suitable institute for their studies. In such countries, the natural geological settings, geological study level, study facilities and teaching staff's understanding of the conditions in Thailand would be quite different from the conditions found in Thailand at present. At this organization, as the facilities will be made available step by step when they are really necessary for the studies undertaken, it would be impossible for people to see expensive and sophisticated facilities lie idle covered by dust.

The organization needs more guidance, help and cooperation of many people and organizations. It is believed it should have many cooperating/joint studies with people and organizations in Malaysia. Hence, it was quite encouraging that staff of the organization receive proposals and suggestions of such works when they visited Malaysia last December with kind invitation of the President of Geological

Society of Malaysia and the Director-General of Geological Survey of Malaysia to attend the Society's meeting and to observe the Survey's activities and facilities respectively."

17 Jan. 1977.

H. Sawata  
S. Arpornsuwan

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New Journals

Earth Surface Processes (A journal of geomorphology). Published quarterly by John Wiley & Sons Ltd. Price for 1 volume (4 numbers) - US\$41 (not in UK & USA).

International Journal for Numerical and Analytical Methods in Geomechanics. Published quarterly by John Wiley & Sons Ltd. Price for 1 volume (4 numbers) - US\$45 (not in UK & USA).

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SIAMOS

An international symposium on 'Water in Mining and Underground Works' (SIAMOS) organized by various Spanish professional bodies and the National Water Well Association (USA) will be held on 18 - 22 September 1978. The symposium topics are (a) projects and works under the water table, (b) surface water contribution to excavations and underground works, (c) role of water in the behaviour of excavations, (d) special techniques (freezing, injection, cementing, etc) and (d) mathematical models applied to drainage systems.

The organizers said that social activities organized in conjunction with the symposium include visits to the Alhambra, Palace & Gardens which is claimed to be one of the man-made wonders of the world. If you are interested and your Spanish, French and English

are proficient enough (the permitted languages of the symposium) then write to:

Prof. Dr. Eng. Rafael Fernandez-Rubio  
Director of the Work Group of Hydrogeology  
Universidad de Granada  
Apartado de Correos, 556  
Granada, Spain.

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A B S T R A C T   F R O M   A   T H E S I S

The following abstract appeared in the IMM Trans (Sect B)  
Vol. 85, Nov 1976, p. B305 and is reproduced here as it is of interest.

Iron ore deposits of Ulu Rompin, Malaysia

J.B. Bean

Ph. D. thesis, University of Durham, 1976.

The Ulu Rompin iron deposits are located in area of rugged topography in the state of Pahang, Malaysia. There are several high-grade primary orebodies and superficial sheets of lateritic ore. The area is underlain by sheared alkalic rhyolite lavas and tuffs, in which there are small lenses of sedimentary rocks, with carbonates the most important. There are several small stocks of hornblende granodiorite, which probably merge into one, larger, parental mass at depth.

The Bt. Ibam orebody, which is the largest, is a tabular mass of magnetite in a highly magnesian gangue, originally of chlorite and actinolite but now largely altered to talc. Underneath the ore there is a thin intermittent layer of calcic skarn; massive chlorite appears along parts of the hanging-wall. A short distance below the footwall there is granodiorite. The Bt. Batu Puteh deposit is magnetite associated with calcite marble. At Bt. Hitam magnetite is found just above granodiorite. At Bt. Pesagi and Bt. Saniong the primary ore is hematite with very little magnetite. These bodies are located in shear zones in the volcanic rocks, and are not associated with calcic or magnesian minerals.

All the orebodies and country rocks have been pyritized, and other sulphides and sulphosalts have impregnated the Bt. Ibam body. These have produced zones contaminated by copper and zinc and, to a lesser degree, by bismuth and lead. Hypogene and supergene alterations have extensively affected the iron ores and rocks, and caused some redistribution of the impurity elements. The iron ores probably originated in the cooling granodiorite magma, and were transported as chlorides or chloride complexes. The control over the loci of mineralization was partly lithological - magnetite bodies in calcic and magnesian rocks - and partly structural - hematite bodies in shear zones.

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P U B L I C A T I O N S   O F   I N T E R E S T

1. Petroleum Mining Act, 1966 (Revised 1972). Price \$1.00
2. Petroleum Development Act, 1974. Price \$0.50 cents.
3. Geological Survey Act, 1974. Price \$0.50 cents.
4. Geological Map of Asia, 20 maps coloured, each map 20½ x 28½ inches, boxed. Published by Cartographic Publishing House (Peking). Compiled by Academy of Geological Science of China (Peking). Price \$150 (approx.)

(Publications 1-3 can be obtained from major bookshops in Malaysia. Publication 4 can be obtained from Joint Publishing Co., 9, Queen Victoria St., Hong Kong. All prices quoted are in Malaysian ringgit).

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AS I SEE IT

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