

PERSATUAN GEOLOGI MALAYSIA

WARTA GEOLOGI

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CATATAN GEOLOGI (GEOLOGICAL NOTES)

AN OCCURRENCE OF SHEARED DIAMICTITE NEAR GENTING SEMPAH

I. Metcalfe, Dept. of Geology, Universiti Kebangsaan Malaysia, Bangi

Abstract

Variably sheared diamictite comprising clasts of predominantly tuff, tuffaceous sandstone and mudstone in a mud matrix occurs along the new Kuala Lumpur - Karak highway approximately two kilometres southwest of Genting Sempah. Primary sedimentary structures in many clasts indicate that they were originally turbidite beds. This diamictite represents either a tectonic melange or a sheared olistostrome and may correlate with similar deposits of early Triassic age in the Raub - Bentong area.

Abstrak

Diamiktit tericih berbeza yang mengandungi klast-klast utamanya tuff, batupasir bertuff dan batu lumpur didalam matriks lumpur dijumpai sepanjang lebuh raya Kuala Lumpur - Karak lebih kurang dua kilometer barat daya dari Genting Sempah. Struktur-struktur enapan primer didalam kebanyakan klast-klast menunjukkan bahawa mereka berasal sebagai lapisan-lapisan terbidit. Diamiktit ini merupakan sama ada sesuatu melange tektonik atau olistostrom tericih dan mungkin boleh dikorelasikan dengan mendapan yang sama yang berusia Trias awal dikawasan Raub - Bentong.

Haile *et al.*, (1977) reviewed the Palaeozoic and Mesozoic stratigraphy of the Bentong - Raub and Genting Sempah areas and presented a map of the Genting Sempah area showing the distribution of the Selut Schist, Gombak Chert and Sempah Conglomerate with associated rhyolitic lavas and ignimbrite (Fig. 1). The purpose of this note is to report the occurrence of diamictite in a road cut exposure mapped as Selut Schist along the new Kuala Lumpur - Karak highway and to briefly discuss its significance.

At this locality (Fig. 1), variably sheared metasedimentary and sedimentary rocks occur. In some parts of the road cut the rocks resemble the typical black graphitic type schist well known in this region but in other parts of the cutting the rocks are much less sheared and in places appear hardly deformed at all. These zones of minimal deformation appear to have escaped shearing perhaps due to rigid body rotation and are bounded by intense shear zones or faults (both thrust and normal). Lithologically, the less deformed zones are seen to be diamictite with clasts of predominantly tuff, tuffaceous sandstone and mudstone set in a mud matrix (Fig. 2). Clast sizes vary from a few millimetres to several metres (see Figs. 2 & 3) and some of these clasts preserve primary sedimentary structures such as graded bedding, convoluted bedding, parallel laminations, small scale cross bedding and mud rip-up clasts which indicate that they were originally turbidite beds (Figs. 4 & 5).

Many clasts comprise disrupted single turbidite beds, showing typical bouma sequence structures, which have suffered 'soft' sediment faulting and fracturing (Fig. 5). Other large clasts comprise sequences of interbedded mudstones and distal turbidite beds (Fig. 3). Some of the turbidite beds are clearly inverted and the orientations of clasts which exhibit bedding and way-up criteria appears to be chaotic.

The age of the diamictite is not presently known. The only fossil found so far is a fairly well preserved crinoid stem in a small mudstone clast (Zaiton Harun, pers. comm.). Although not age indicative, the presence of the crinoid stem indicates the possibility of obtaining further, hopefully age indicative, fossils.

Significance of the diamictite

The diamictite occurring at Genting Sempah could represent either a tectonic melange or a sheared olistostrome but it is impossible at present to distinguish between these two possibilities. Current structural work by Zaiton Harun in the Genting Sempah area may help with this problem.

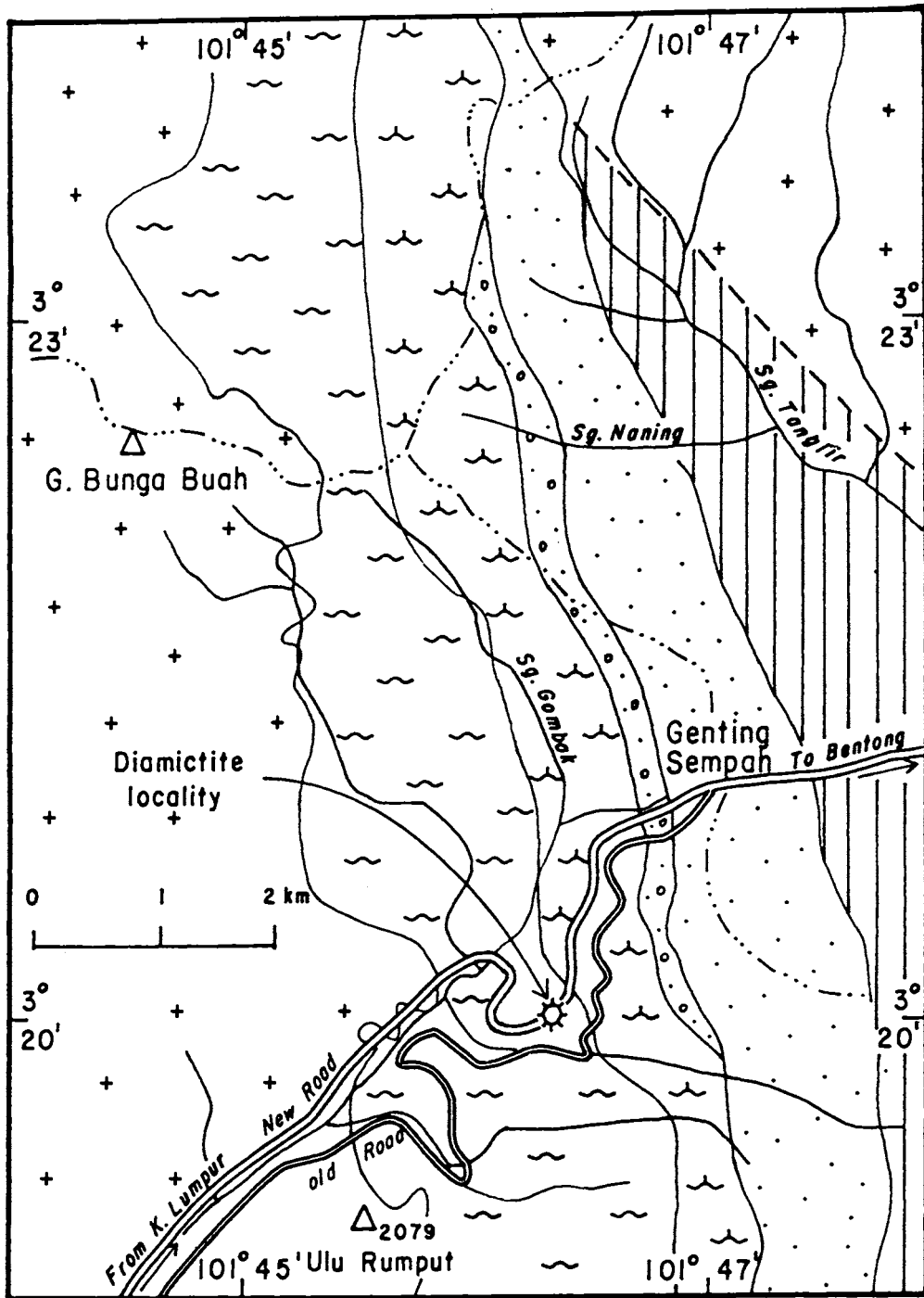
Similar diamictites also occur in the Raub-Bentong-Karak area where they define a relatively narrow zone along the Bentong-Raub line (Chakraborty & Metcalfe, 1987; Tjia, 1987). These diamictites are clearly of regional tectonic significance and it is hoped, with further studies, to identify the tectonic setting and origin of these deposits. The diamictites in the Raub area have been dated as probably late late Lower Triassic (Metcalfe, unpublished). The Genting Sempah diamictite may well form part of this early Triassic melange/olistostrome belt.

Acknowledgements

I wish to thank Drs. K.R. Chakraborty, C.A. Foss, A.M.C. Sengor and Prof. C.S. Hutchison for valuable discussions.

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





SEDIMENTARY ROCKS	IGNEOUS ROCKS
 Rhyolite, rhyodacite dacite equivalent tuffs & tuff breccia	 Porphyritic Microgranodiorite
 Sempah Conglomerate	 Coarse Granite
 Gombak chert	
 Selut schist	

Fig. 1. Geological sketch map of the Genting Sempah area (after Haile *et al.*, 1977 and Tee, 1977) showing the diamictite locality.



Fig. 2. The Genting Sempah diamictite showing chaotically oriented clasts of tuff, tuffaceous sandstone and mudstone in a muddy matrix.



Fig. 3. Part of the road cutting showing large internally undeformed clasts of sequences of interbedded mudstones and distal turbidites.

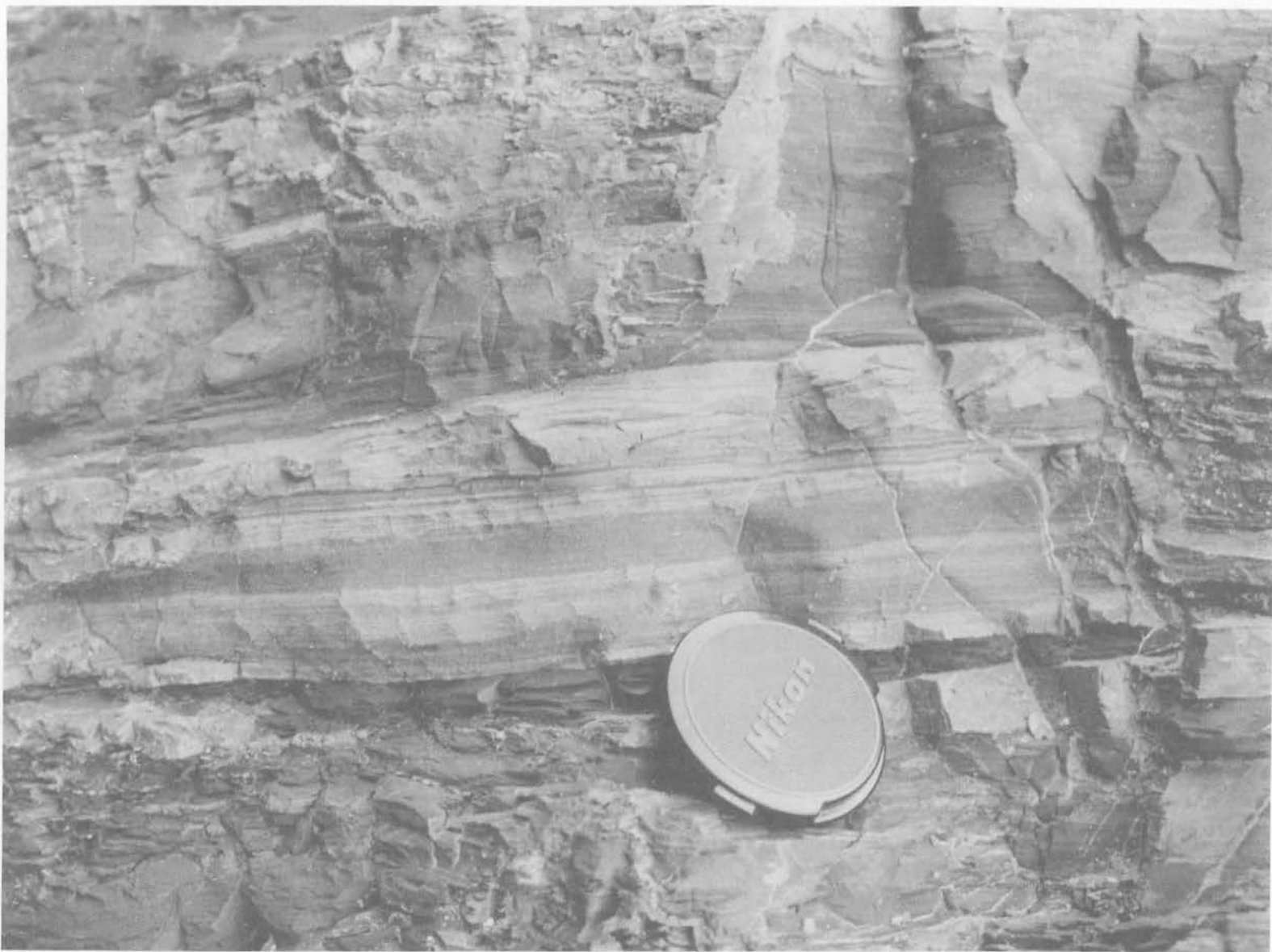


Fig. 4. Detail of part of a turbidite sequence clast showing parallel laminations and small scale cross bedding in a distal turbidite.

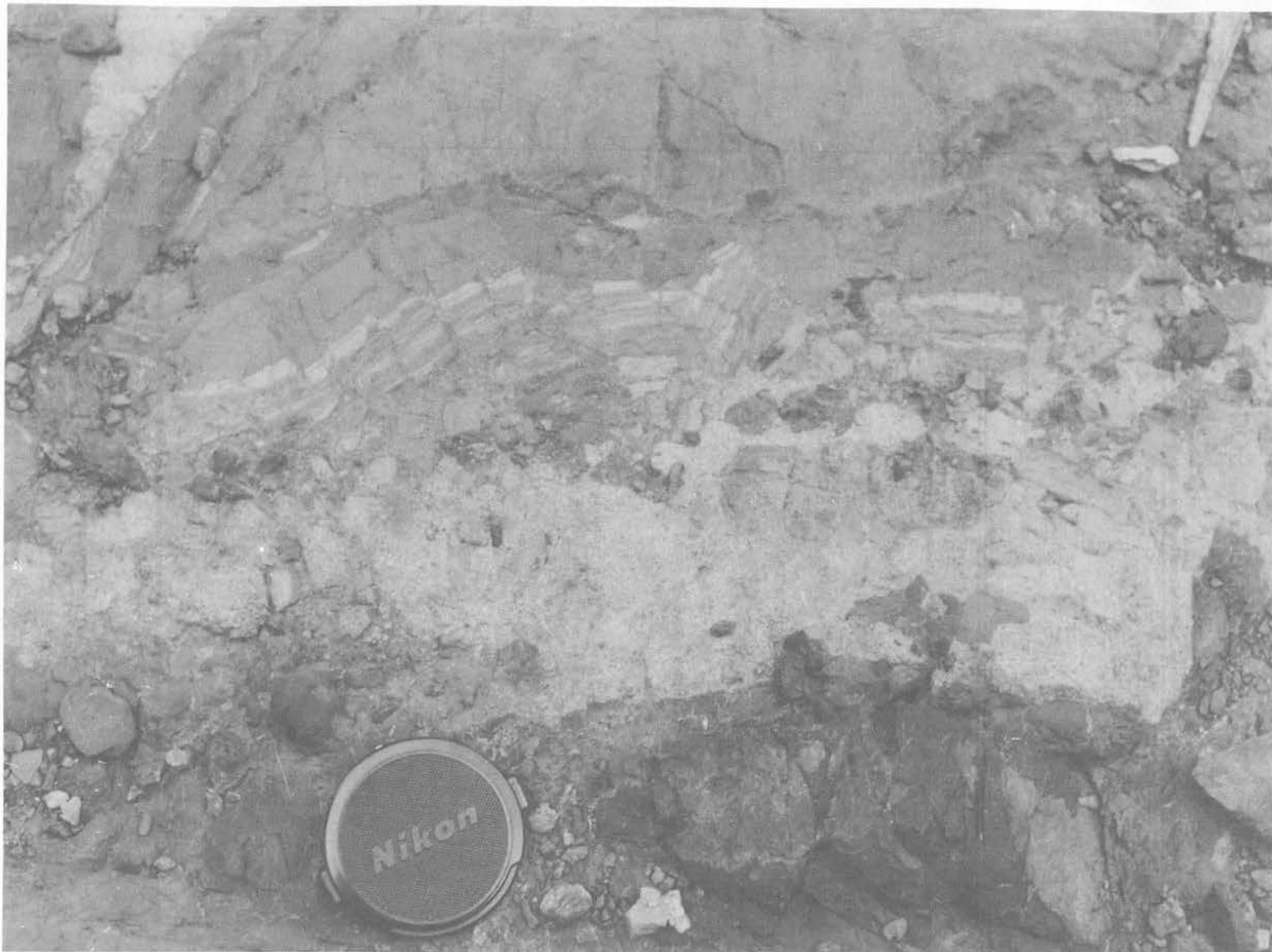


Fig. 5. Clast comprising a disrupted single turbidite bed which is normally graded and shows parallel laminations in its upper part and which also contains mud rip-up clasts.

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OLISTOSTROME IN THE BENTONG AREA, PAHANG

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Abstract

Within the Karak formation (older name Bentong Group) that outcrops between Bentong and Teranum are several up to a few metres-wide zones of slump or debris-flow deposits consisting of phenoclasts reaching maximum size over 5 m long in a matrix of argillaceous material. The phenoclasts are metasandstone, phyllite, tuffite, and red clastics of Lower Devonian and Carbo-Permian ages. Often the matrix is sheared and the containing phenoclasts reshaped into lenticular to sigmoidal bodies. These suggest various directions of tectonic transport. The variety of types of phenoclasts of various ages together with the presence of serpentinite bodies strongly suggest that the formation is a sheared olistostrome that developed near collisional plate boundaries as late as the late Palaeozoic.

Abstrak

Di dalam formasi Karak (nama lama Grup Bentong) yang tersingkap antara Bentong dan Teranum didapati sejumlah zon selebar beberapa meter yang terdiri daripada longgokan nendatan atau aliran gersik. Fenoklas mencapai garispusat melebihi 5 m, terdiri daripada meta-arenit, filit, tufit, rijang dan sedimen klastik lain yang berwarna merah dalam matriks argilit. Seringkali matriks itu telah diricih dan fenoklasnya terancang kepada bentuk kekanta hingga sigmoid. Bentuk itu mencadangkan pelbagai arah pergerakan tektonik, secara mengufuk mahupun menegak. Di antara fenoklas ada yang berusia Devon Bawah dan Karbon-Perm. Kepelbaggian usia batuan, sifat nendatan yang hadir bersama jasad serpentinit mencadangkan formasi itu adalah olistostrom terricih yang wujud pada sempadan keping litosfera yang saling berlanggar selama Paleozoik Atas.

The road between Bentong and Teranum, Pahang (Fig. 1), runs NNW roughly parallel to the strike of quartz schist and other metasediments that were named the Bentong Group by Alexander (1968). Farther towards the SSE Jaafar Ahmad (1976) mapped the continuation of the group as the Karak formation that contains lower Devonian graptolites among its fossils. The Karak formation consists of six lithological groups: rudite-arenite, argillite, chert, limestone, pyroclastics, and minor bodies of usually serpentinitised mafic and ultramafic rock. The rocks in the vicinities of the north and south ends of the road stretch under discussion were partially subdivided into separate formations by Haile *et al.*, (1977). The aligned occurrences of the mafic and ultramafic rocks were interpreted to mark a lower Palaeozoic subduction trench zone dipping east (Hutchison, 1973). Hamilton (1979, p. 76) stated that some of the outcrops between Bentong and Raub displaying weathered sandstone lenses in a matrix of sheared shale are quite suggestive of a melange and Metcalfe (1987) has confirmed this. To Malaysian geologists the eastern foothills region of the Main Range,

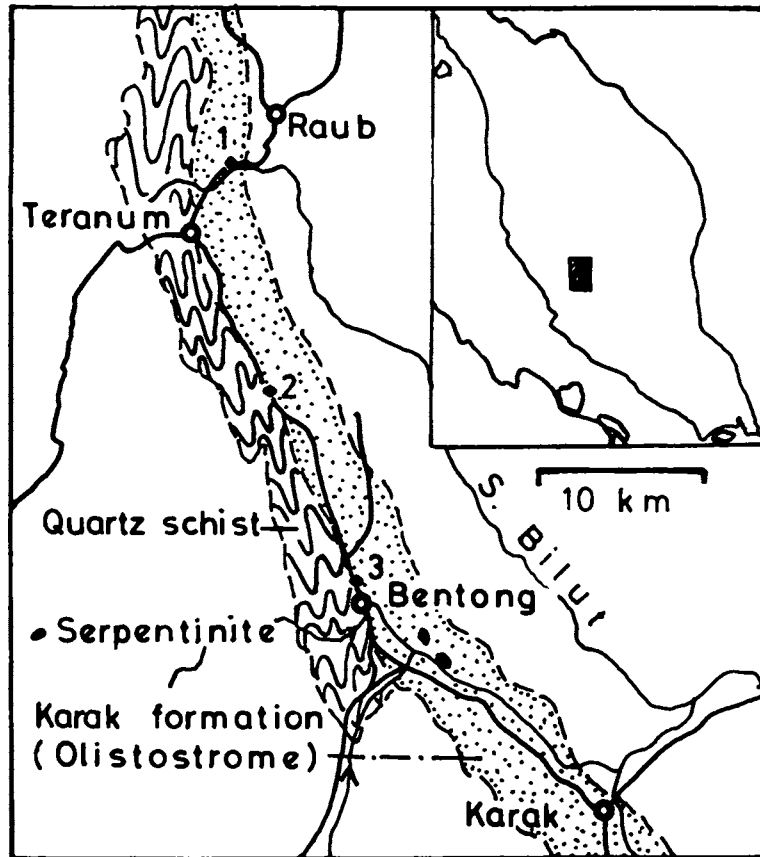


Fig. 1. The Karak formation and quartz schist in the Bentong-Teranum zone. Locality 1 - outcrop of regularly bedded red clastics; 2 - roadcuts N and S; 3 - roadcut near cemetery.

known as the "Bentong Line", is believed to separate two major, a western and an eastern, tectonic regimes. As far as I am aware no published information exists on the fabric and internal structure of the peculiar rudite-arenite associations that outcrop at more than ten localities between Bentong and Teranum. In this note evidence is presented that suggests these associations to represent olistostrome. Fabric and internal structures also indicate several geologic transport directions that were experienced by these rocks.

Lithology

Three outcrops, one at a Chinese cemetery at the northern outskirts of Bentong and two adjacent roadcuts at Ladang Bentong, Sungai Penjuring area, some 13 km northwest of Bentong, are representative of the rudite-arenite association.

In a long and high roadcut near the cemetery (loc. 3 on Fig. 1) deeply weathered metasediments consists of masses of massive sandstone, bands of light-coloured phyllite, and several metres-wide to narrower zones of rudite-arenite associations best described as pebbly siltstone and pebbly mudstone. The groundmass ranges from fine grained sand to silty clay. The phenoclasts are commonly 10 to 30 cm long and exceptionally may exceed a metre in length. The long dimensions are parallel to foliation which is 320 to 345° and the dip is steeply east. The thickness of the phenoclasts normal to the foliation ranges between one-fifth (softer material) to almost two-thirds of the long dimensions. The phenoclasts are argillaceous ironstone, meta-arenite, (vein?) quartz, quartzite, rare dark coloured crystalline schist and a single weathered igneous rock, very probably aplite. The shapes of the clasts are commonly conformable to foliation and are lenticular, sigmoidal, very rarely of odd shapes, such as barbell-like. The harder clasts may be incongruous to foliation. The sigmoids, small drag folds and fault displacements may indicate differential motion of the rudite-arenite bands. The general impression is that the rocks containing phenoclasts experienced tectonic stretching. The rock containing elongated and streamlined phenoclasts is more aptly designated as flaser conglomerate. Within these rocks there may be metres-wide or narrower zones in which the matrix is also sheared. The variety and shapes of the clasts suggest that the rudite-arenite associations may be classified as zonally sheared slump or debris-flow deposit. Asymmetrical shapes of the sigmoids indicate that the east side moved up differentially. In other words, vergence may be westward. Foliation-parallel reverse faults accompanied by drag folds and dm-size offsets also indicate west vergence.

At Sungai Penjuring the roadcuts, respectively naked S and N (locality 2 on Fig. 1), are approximately 300 m and 500 m towards Teranum from the 85-km post (from Kuala Lumpur, or 389 km from Kota Bharu). Roadcut S consists of schist-phyllite interfoliated with meta-sandstone beds, and metres-wide zones of sheared pebbly to bouldery argillite to arenite. The general foliation is 330/65. The elongated phenoclasts of cm-dm lengths consist of metasandstone, red slate, red granulate-mudstone, white tuffite (?). Those of boulder and block size are usually metasandstone and may reach lengths of 5 cm and widths of 2 m (Fig. 3). In plan view, the sigmoidal phenoclasts suggest right-lateral motion along the strike of the foliation (Fig. 2). A reverse fault (attitude 340/60, straight outcrop trace and, therefore, probably representing younger motion) is accompanied by fold drag suggesting WSW vergence.

Roadcut N is dominated by the occurrence of large blocks and boulders of metasandstone, disharmonic folds in well-bedded silicified tuffite (?), and bands of flaser conglomerate of the kind already described from the outcrops mentioned earlier. The sandstone blocks and boulders display a disrupted situation (Fig. 4) and together with the disharmonic folds appear to represent the effect of debris-flow or slumping. The flaser conglomerate is interpreted as tectonically stretched diamictite. Most disharmonic folds strike between N and NNE and pitch gently to moderately (not more than 30 degrees) northerly. Slumping or debris-flow was normal to the strike, either east or westward. As yet no reliable indications of stratigraphic facing have been determined.

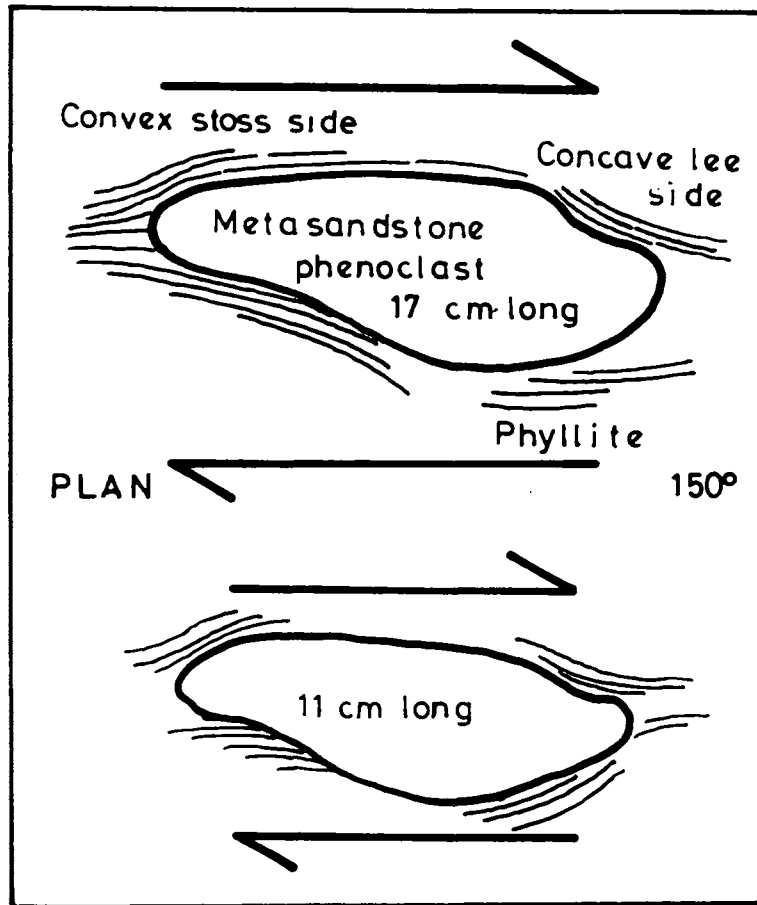


Fig. 2. Plan view of two lenticular, slightly sigmoidal phenoclasts of metasandstone in a matrix of phyllite. Differential motion is indicated by the shapes of foliation adjoining phenoclasts. Roadcut S near Sungai Penjuring; loc. 2 on Fig. 1.

The slump deposits consisting of large disjointed blocks and boulders in roadcuts N and S clearly represent olistostrome that according to Friedman and Sanders (1978, p. 388) is a debris flow deposit containing large blocks. Some of the smaller phenoclasts can be correlated with rocks occurring in normal, non-disjointed outcrops. The silicified tuffite (?) occurs among the so-called bedded chert that forms the Bilut gorge near Raub (Fig. 1). The red clastics of roadcut S are similar to those forming well-bedded and foliated red arenite-argillite (with local conglomerate bands) that outcrops some 300 m towards Raub from the 108 km post (from Kuala Lumpur) on the road between Teranum and Raub (loc. 1 on Fig. 1). The dark coloured crystalline schist may represent fragments of the quartz-schist that occurs on the west side of the Karak formation.

Geologic Transport

These outcrops and other observations along the Bentong-Teranum road stretch indicate that direction of slumping or debris-flow was approximately normal to the present structural trend. One of the objectives of ongoing field research is to establish the sense of slumping; was it westward or eastward? Tectonic vergence in the Bentong olistostrome appears to indicate the results of various motions, of which the sequence has yet to be established. The three outcrops under discussion suggest that one vergence was towards the WSW. The tectonic stress responsible for this vergence could also have caused right-lateral displacement within some foliation-parallel zones of the NNW-striking Karak formation, resulting among other things, in sigmoidal flaser conglomerate. Figure 3 suggests that normal motion down the foliations has also taken place.

Preliminary Conclusion

The occurrence of olistostrome in close association with serpentine bodies, the various ages of the phenoclasts (red clastics may be Carboniferous-Permian; calcareous rock south of Karak contains lower Devonian fossils), and zonally sheared diamictite support the contention that the "Bentong Line" may represent the suture of converging plate boundaries. The suture still existed in late Palaeozoic time as is suggested by the presence of phenoclasts of red clastics.

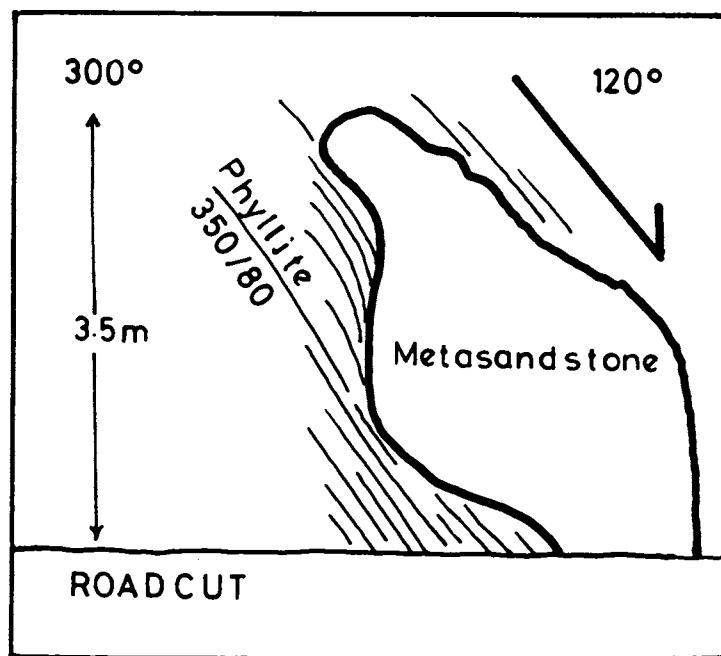


Fig. 3. Roadcut S displaying a mega phenoclast. The shape of phyllite foliation suggests that the east side moved down differentially.

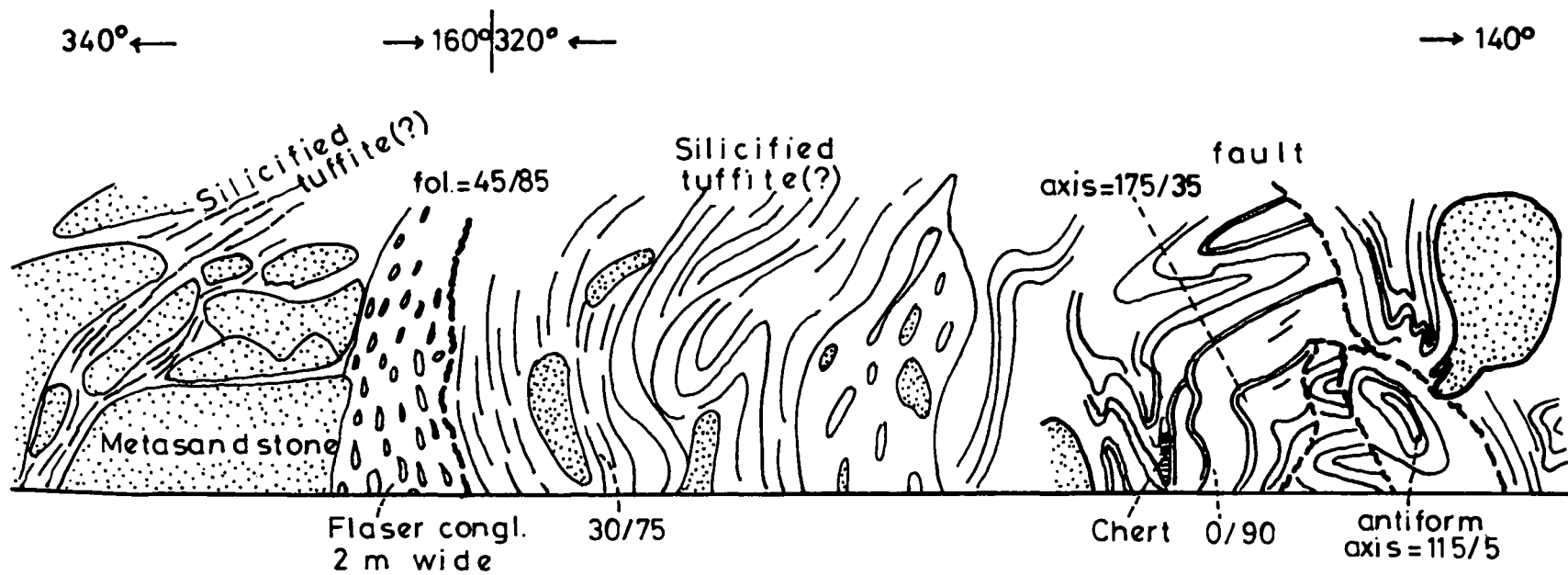


Fig. 4. Part of roadcut N (loc. 2 on Fig. 1) shows complex internal structures and disjointed blocks of metasandstone. These structures were developed through, probably subaqueous, slumping and debris flowage. Length of section is approx. 18 m; height of sketch is 3.5 m.

Acknowledgement

This ongoing study is supported by research grant No. 26/86 of Universiti Kebangsaan Malaysia.

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PROGRESS REPORT ON GEOLOGICAL INVESTIGATION AT THE DANUM VALLEY FIELD RESEARCH CENTRE

Muhammad Barzani Gasim, Sanudin Hj. Tahir, Kadderi Md. Desa, Dale Brunotte and Tan Teong Hing, Jabatan Sains Bumi, Universiti Kebangsaan Malaysia, Sabah.

The Danum Valley Field Research Centre is located 70 km west of Lahad Datu town, in east Sabah, and occupies an area of approximately 171.2 square kilometres, or more accurately, is bounded by the latitudes between $4^{\circ} 44'N$ and $5^{\circ} 00'N$, and longitudes $117^{\circ} 47'E$ and $117^{\circ} 55'E$ respectively (Fig. 1). The study area is jointly managed by Universiti Kebangsaan Malaysia (Sabah Campus), the Sabah Foundation and the Forestry Department. It is a part of the geological research activities jointly undertaken by the lecturers and the final year students of the Jabatan Sains Bumi of Universiti Kebangsaan Malaysia.

The study area is composed of a complexity of rock associations, namely; the Basement Complex, Chert-Spilite Formation, Kuamut Formation, Ayer Formation, and other volcanic and sedimentary rocks, that range in age from Mesozoic till Late Tertiary (Leong, 1974). The relationship among the outcrops from the view point of correlation is difficult to ascertain. The rocks which have undergone metamorphism are of continental or oceanic crust origin and also include bedded and unbedded sedimentary and volcanic rocks. All the rock types mentioned so far are distributed in a haphazard manner making their correlation difficult to accomplish. The diversity of rock types and their origins as well as obscured structural relationships led the present researchers to conclude the geology of the area as a melange.

Part of the study area is composed of amphibolite, banded diorite, and other igneous and metamorphic rocks similar to type classified as 'Crystalline Schists' by Reinhard and Wenk (1951) and 'Crystalline Basement' by Kirk (1963, 1964) and Leong (1974). These rocks are believed to be of Jurassic age or older.

Fitch (1951) defined the Chert-Spilite Formation as an association of sedimentary and volcanic rocks of Upper Cretaceous till Eocene age distributed in the northern and eastern of Sabah.

A recent study of radiolarian fossils of the Chert-Spilite Formation from Kudat area has confirmed a Lower Cretaceous age (Basir, *et al.*, 1985).

The Kuamut Formation, found in the valley of the Kuamut River, consists of a mixture of olistholiths of various lithologies in a shaly matrix, ranging from Lower Miocene to Upper Miocene in age based on pelagic foraminifera (Collenette, 1963, 1965).

This Formation is unconformably underlain by the 'Crystalline Basement', and consists of a variety of olistholiths of different sizes, some up to almost a diameter of one kilometre. The rock types include

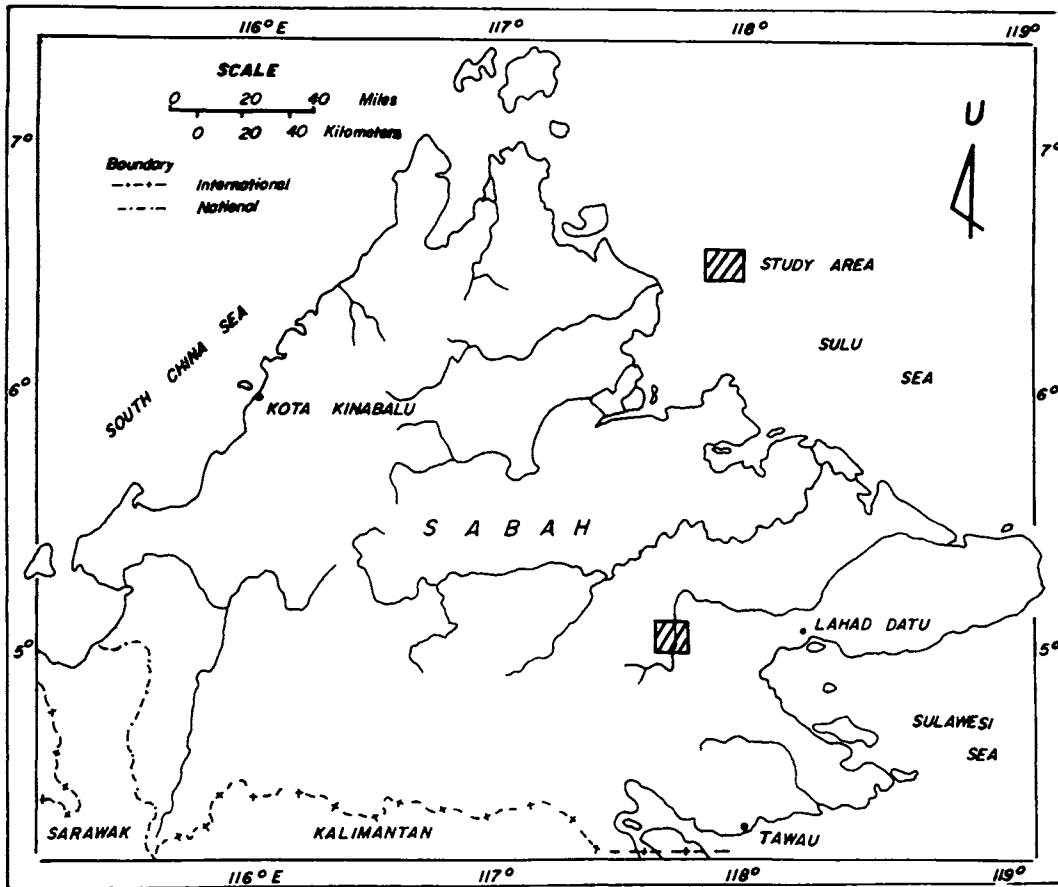


Fig. 1. Map of Sabah showing location of the study area.

tuff, tuffite, basalt, andesite, sandstone, mudstone, tuffaceous sandstone, chert and shale, while the matrix essentially consists of mud and shale that has undergone shearing. The inclusion of these olistoliths within the Chert-Spilite Formation is questionable because no such outcrops have been found in the study area.

The chert-spilite association is believed to be olistoliths that have been tectonically transported in an area said to be a melange (Sanudin & Tan, 1986). Considering that the study area has been exposed for a long time to a high degree of weathering the rock outcrops have their original properties altered especially their hardness and physical features.

Detailed studies of the area and other parts of Sabah should be undertaken to update their geology.

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CATATAN GEOLOGI (GEOLOGICAL NOTES)

Rb/Sr AND Sm/Nd ISOTOPE STUDIES ON GRANITES OF SOUTHEAST ASIA

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Despite having analysed a great many samples during the course of the study very few good isochrons were available and therefore the ages obtained are not as well defined as expected. This was a difficulty noted by Beckinsale and workers in Thailand but it seems to be a general problem throughout S.E. Asia. Of course this in itself tells us something about the rocks of this region.

Part of the problem is that because of the reconnaissance nature of the project, there was the tendency to have too few samples from individual plutons. However in some cases, despite adequate sampling, good isochrons were not obtainable. The rocks are just not homogeneous and there is nothing one can do about it. Irregular cooling in a large intrusion can result in certain diffusional domains within a granite which continue to exchange ^{87}Sr after other domains have become closed systems. This produces a range of initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios rather than a unique value and therefore a scatter of the data points about a straight line. Incomplete mixing during magma genesis can also result in a range of initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios. Hydrothermal fluids may also be the cause of some of the problems even though the rocks analysed were collected well away from areas of known mineralisation.

Starting with Malaysia - results from the Eastern Province I-type granites show a range of ages from 200 Ma to 240 Ma. While Bignell and Snelling's K:Ar data for the region showed a younging from East to West we did not observe this with the Rb:Sr, nor did we obtain ages as old as 260 Ma. That is not to say they are not correct. Certain of Bignell's samples have been re-analysed and the data incorporated mainly to augment the sample numbers. 20 years ago when Bignell's samples were analysed Rb:Sr dating and in particular mass spectrometry was not as sophisticated as it is now. While the data is substantially correct the errors are such that the $^{87}\text{Sr}/^{86}\text{Sr}$ ratios are really only good to 3 decimal places. Similarly with K:Ar of that vintage you need to apply errors of ± 20 Ma. The initial ratios for the Eastern Belt fall in the range 0.708 - 0.712, so while they are considered to be I-type granites they are not solely of mantle origin - typical mantle derived magmas are characterised by initial ratios of 0.703 - 0.705. Lanchoo is unusual in that it is highly differentiated minimum melt composition and this is reflected in the higher initial ratio. The Main Range plutons have even higher initial ratios which commensurate with their S-type characteristics. The age

range of 210 Ma to 230 Ma is both in agreement with Bignell and Snelling's results and with Liew's U-Pb data. The Central belt plutons have initial ratios which place them within the Eastern Belt Province. Though the data is limited a Cretaceous age for the Stong complex is established.

The Tin Islands of Indonesia would appear to have a range of ages from 250 Ma (Belinyu type/Penangas) to circa 200 Ma (Tanyong Layang). The majority of these were obtained from the S-type granites which have a greater spread of Rb/Sr ratios thus to some extent compensating for the paucity of samples. Initial strontium ratios of 0.713 - 0.727 are slightly lower than those obtained for the Main range plutons of Malaysia. The Eastern province I-type granites are, with the exceptions of West Central Singkep and Batam, much less radiogenic than the S-type granite. Initial ratio or model age calculations have such high associated errors that the results are meaningless. Where initial ratios have been obtained from isochron plots they are lower than 0.710 and are therefore consistent with values from the East coast Province I-type granites of Malaysia.

The only published isotope data for the Tin Island Belt is that of Priem *et al.*, who analysed samples from Belitung, Banka, Karimata and Pulau Tudjuh. Mineral K:Ar ages of 210 to 224 Ma for Kelapa, Menumbing and Parangbuloh are in reasonable agreement with the data presented here. However for the Rb:Sr data, Priem adopted a policy of plotting all the data from several plutons on the same isochron diagram. Plotting the data for individual plutons yields linear arrays but with such high MSWD the information is not of much value. The larger errors associated with analyses 10 - 15 years ago often had the effect of masking geological errors and one appears to get successful isochrons.

There are quite a number of good, recently determined, isochrons for the Thai granites, notably the work of Nakapadungrat, Beckinsale *et al.* and Putthapiban and Gray.

The Western Province of Thailand would seem to be almost exclusively Cretaceous since no ages older than 130 Ma have been obtained. The initial strontium ratios are very varied from 0.7086 for Mae Lama to 0.741 for Khao Tosae in Phuket.

Ages from the North Thai province are more varied. The data from Chiang Dao, although from five samples plots with a two point distribution and the high age of 269 may therefore be suspect. In any case the data do not fit the line very well as shown by the MSWD of 12. Similarly the age of 250 Ma for Mae Sariang must also be viewed with care as the data points show a large degree of scatter. The initial ratios are in general the highest in the region. Cretaceous granites are also present for example the Mae Yan pluton in the Chiang Dao batholith. There is certainly a Tertiary magmatic event, samples from Baw Kaew unit of South Samoeng are dated at 54 Ma, thus providing confirmation for the biotite K:Ar age obtained for the marginal facies of the Mae Chae pluton - 49 Ma.

The Thai Main Range Province has yielded very comparable ages and initial ratios to the Malaysian Main Range Province. The high error on the age for Ban Nong Yai merely reflects the limited spread of Rb/Sr

ratios. This pluton comprises very primitive material comparable to the Stong complex in Malaysia and in fact is intruded along an extension of the Raub - Bentong line.

In contrast to the Cretaceous granites of the Western Province the younger granites of the Main range and the North Thai Provinces have much lower initial strontium ratios. The only data from the Eastern Province is that of Teggin for the Tak granites.

It is interesting that while we see episodes of granite magmatism through S.E. Asia at c.260 Ma, 240 Ma and 210 Ma we do not see granites of Cretaceous age in the Tin Islands. On the other hand Taylor and Silver suggested that granites with initial ratios of c. 0.708 might be genetically associated with altered oceanic lithosphere (seafloor alteration has an upper limit $^{87}\text{Sr}/^{86}\text{Sr}$ of c. 0.708) and this is the lower end of the range of values. The elevated initial ratios of the I-types may more likely be the result of minor contamination of a mantle derived magma with crustal strontium.

The study of the isotopic composition of Nd, usually in conjunction with that of Sr, has shed new light on the complex problems of the origins of magmas and the formation of igneous rocks. The isotopic evolution of Nd in the earth is described in terms of a model called CHUR which stands for "Chondritic Uniform Reservoir". This model assumes that terrestrial Nd has evolved in a uniform reservoir whose Sm/Nd ratio is equal to that of chondritic meteorites.

The Sm/Nd ratios for the S- and I-type granites are indistinguishable from each other being characterised by pronounced but uniform light rare earth enrichment. The exceptions are Tan Yong and Songkla from the Thai Main Range, Nal and Kuantan from the Malaysian Eastern Belt and Karimun, Kundur and Dabo from the Riau Archipelago all of which have $^{147}\text{Sm}/^{144}\text{Nd}$ ratios which approach the chondritic value of 0.1967. This indicates a very flat REE pattern which is rather unusual for granite rocks but has been observed elsewhere.

The systematic variation of initial Nd and Sr can result from the mixing of two components in different proportions to produce the granite source rocks. The two cases most important in igneous petrology are:

1. Contamination of mantle derived magma with rocks of granitic composition in the upper continental crust.
2. Contamination of mantle derived magma with granulites at the base of the crust.

For the S.E. Asia samples it would seem that we have two mixing curves. One defined by the Thai samples which suggest mixing of a depleted mantle like component with a crustal component that has very characteristic negative ϵ_{Nd} values. The other less clearly defined by the Malaysian samples indicates a crustal component with less negative ϵ_{Nd} values. In each case the data are consistent with the production of all the granites by mixing a similar depleted mantle-like component with a distinctive crustal component. The I-type granites dominated by the

depleted mantle component and the S-type by the crustal component in their source rocks. The Indonesian samples fall between the two, but a mixing hypothesis would certainly go a long way towards explaining the spatial arrangement of these granites.

Correlation of isotope ratios can also be caused by melting of heterogeneous assemblages of crustal rocks or by blending of magmas derived from different sources. The greater range of ϵ_{Nd} values of the Malaysian Main Range samples may reflect the blending of magmas derived from different sources. Geochemical and mineralogical data besides isotope compositions are also required to unravel the petrogenesis of rocks in a given region.

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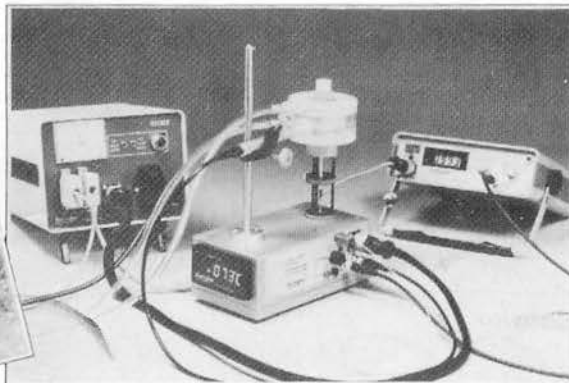
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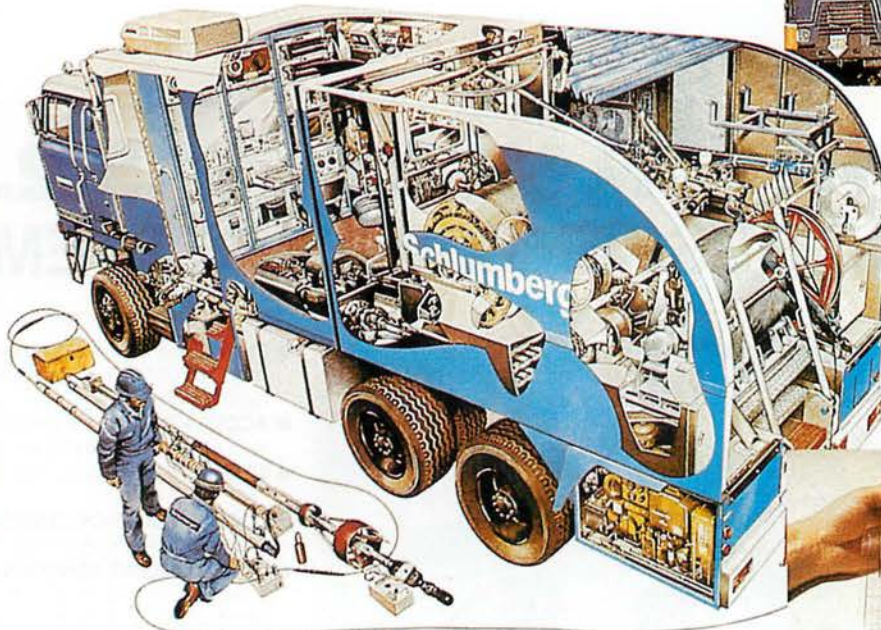
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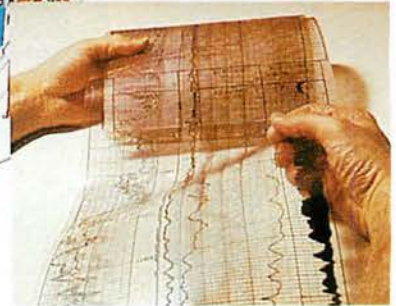


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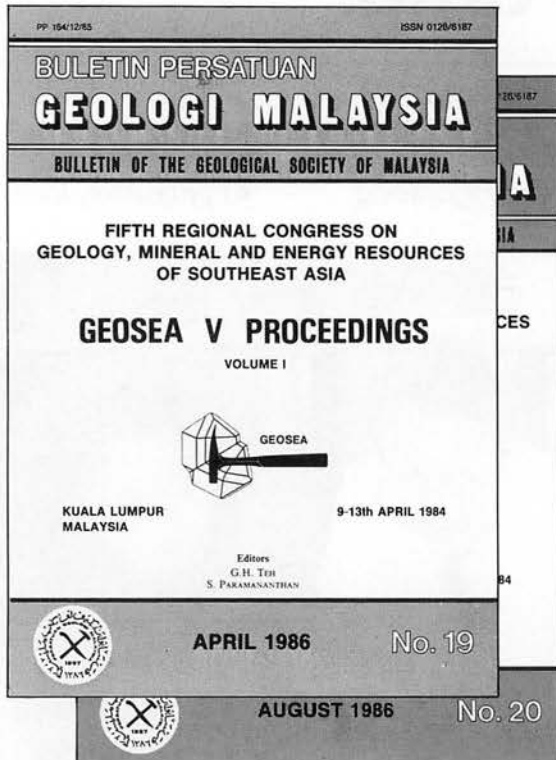
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GEOCHEMISTRY OF THE TIN ISLANDS GRANITES OF INDONESIA IN RELATION TO THOSE OF PENINSULAR MALAYSIA

Peter E.J. Pitfield, British Geological Survey, Keyworth, Nottingham
NG12 5GG, England.

In the Thai-Malay Peninsula the separate identities (typological, petrographic, geochemical and isotope) of the Main Range and Eastern Province (Central and Eastern Belts) granitoids have been well established and reaffirmed by a number of workers including ourselves (E.J. Cobbing, P.E.J. Pitfield & P.F. Darbyshire).

Subdivision of these two granite provinces is sharply defined by the Raub-Bentong line (interpreted by some workers as an interplate suture) and this can be traced northward into Central and Northern Thailand with a fair degree of confidence.

These two granite provinces broadly correspond to two major tectonic terrains of contrasting character.

Main Range (and North Thai) Province comprise Lower Palaeozoic shallow water/shelf sequences for the most part - whilst the

Eastern Province dominantly comprises Permo-Triassic deeper water volcano-sedimentary sequences.

Although with the exception of the isles of Kundur and eastern Singkep, the Tin Islands seem to largely fall in the Permo-Triassic volcano-sedimentary terrain, on the basis of field and petrographic characteristics those granites distinguished as Main Range and Eastern Province types appear to be intermixed with no clear-cut geographical separation such as present in the Thai-Malay Peninsula.

Since the granites do not readily partition on the basis of their respective settings extrapolation of the Raub-Bentong line southward into this segment of the S.E. Asian orogenic arc becomes highly speculative.

It is with this problem in mind that this paper deals with the petrographic subdivision and geochemical characteristics of the Tin Islands granites; comparing and contrasting, where appropriate, with certain features of the Thai-Malay peninsula. From recognisable features common to each suite, an attempt is made to define a magmatic series, identify the different source characteristics and suggest a plausible tectonic setting for their emplacement.

A number of petrographic granite types can be distinguished. They include:

- (i) Tin mineralised S-types analogous to those of the Main Range

Province in Peninsular Malaysia.

e.g. Kundur pluton of the Riau Archipelago,
Menumbing pluton of Bangka Island,
Tanjong Pandang pluton of Belitung Island.

These are typically coarse primary textured K-feldspar megacrystic biotite \pm muscovite granites with a considerable amount of two phase variation and development of secondary derivative phases which are commonly tin mineralised.

- (ii) Tin mineralised S- and IS-types which have no analogues within the Main Range of Malaysia.

e.g. Karimun and Dabo plutons of the Riau Archipelago,
Mangkol pluton of Bangka Island.

They dominantly comprise two phase sparsely megacrystic microgranites and relatively coarse inequigranular to equigranular pseudoprimarily textured mesogranites. They host Sn \pm W deposits.

- (iii) Tin associated (i.e. spatially associated with alluvial tin deposits) S-types as typified by the Belinyu pluton of the Klabat batholith on Bangka Island. These are dominantly coarse primary textured K-feldspar megacrystic biotite granites which may be preceded by foliated or unfoliated precursor anatectites, and commonly give rise to a limited amount of two phase variation which host a certain amount of tin mineralisation.

These granites are typical of the Main Range Province of Malaysia.

- (iv) Tin associated IS-types is typified by the Bebulu batholithic suite of Bangka Island. This granite type is typified by the mafic assemblage biotite \pm hornblende \pm allanite \pm sphene e.g. Pading pluton. Representatives of this type are rather more mafic and may be foliated. They are usually spatially associated with I-type intrusions with which they form composite suites. The parental primary textured granites of this group nevertheless show a variety of textural and petrographic features.

- (v) Locally Cu \pm Mo mineralised I-type multipluton complexes and multipluton intrusions of high magnetic susceptibility are spatially associated with pyroclastic andesites and rhyodacitic volcanics.

e.g. Plutons on the Islands of Bintan and Batam, Riau Archipelago.

Petrographically they can be extremely variable: parental granite types may be equigranular or megacrystic and range to true porphyries. K-feldspar is perthite \pm microcline (often bright pink), normally zoned plagioclase, biotite \pm hornblende \pm allanite \pm sphene. More highly evolved two phase variants and derivative microgranites and mesogranites locally occur.

- (vi) Unmineralised or tin-associated I-type plutons of tonalite, quartz diorite, granodiorite and monzogranite on the Isles of Bangka and Belitung which have no apparent relationship with volcanics.

The mafic mineral assemblage is typified by essential hornblende and biotite and accessories.

e.g. Parangbuloh (Belitung) which is sparsely megacrystic, contains cognate xenoliths and enclaves of quartz diorite, and frequently exhibits partial disequilibrium assemblages/textures i.e. non disruptive two phase development, biotite mantling amphibole, etc.

cf. Kelumpang (Belitung) is abundantly K-feldspar megacrystic, largely due to subsolidus potash metasomatism. Pegmatitic segregates are also common. These plutons are locally associated with small Sn-mineralised S-type plutons e.g. Buntar granite adjacent to Parangbuloh or as in the case of Gunong Mang to stratiform Sn-magnetite lodes of Kelapa Kampit.

With the plutons/suites ordered from the most mineralised S-types to essentially unmineralised I-types, SiO₂ and CaO invariant plots of absolute abundances show a progressive diminution in SiO₂ and increase in CaO in response to increasing proportions of Anorthite vs Alkaline feldspar and Hornblende ± Ca accessories vs Biotite. SiO₂ histograms for the Main Range and Eastern Province types for each geopolitical segment of the S.E. Asian Tin Belt show the Tin Islands to have the highest SiO₂ contents (both in range, mean and mode) irrespective of the degree of two phase variation, relative to the rest of the Thai-Malay peninsula.

ORG normalised multielement plots on a selection of incompatible LIL and HFS elements of petrogenetic significance yield characteristic patterns for each petrographic group. The most distinctive features are that the I-type group, being less abundant in Rb, Th and U and more abundant in Sr, Ba and Zr yield smoother, flatter profiles than the S-type granites, and that the Riau Archipelago I-type suite exhibits a flatter HFS profile than the Bangka-Belitung I-type suite which reflects their more primitive magmatic character.

A dendrogram for all samples constructed by Q-mode cluster analysis using these incompatible trace elements, a selection of ore elements and the major alkalis (a total of 18 elements) illustrates the relative degree of similarity between samples by pair group linkage. Those samples which are most geochemically similar are linked first, followed by the next most similar and so on, so that a hierarchy of association is depicted. The dendrogram or tree diagram is constructed in such a way that all samples are constrained to eventually link up whether or not they are at all similar. However above the 95% probability level the samples cluster into nine statistically significant groupings. By inspection you can see that the predominantly S-type clusters. Furthermore the Riau Archipelago and Bangka-Belitung I-types form discrete clusters each with a high level of similarity.

S- and IS-type granites are less specific in their association, and

because of the compositional convergence of most highly evolved secondary derivatives of all granite types there is a preferential clustering between two phase microgranite and mesogranite samples of different parentage rather than more specific correlation with their respective primary textural ancestral types.

We will first examine the geochemical differences between the I-type suites.

Alkali balance

A plot of K_2O vs Na_2O for the granitoids of Peninsular Malaysia shows all the Eastern Province types to lie in the high Na_2O (i.e. low K_2O/Na_2O) field corresponding to the compositional category derived by Chappell and White (1974, 1983) for I-type granitoids of the Lachlan fold belt in S.E. Australia. The spread of S-types (i.e. Main Range granites) into this compositional field can be ascribed to Na_2O enrichment of two phase variants and derivative secondary magmatic phases which are often tin-mineralised.

By contrast a plot of K_2O vs Na_2O for the Tin Islands shows the two I-type suites to have distinctive K_2O/Na_2O ratios. Riau Archipelago I-types fall in the Na_2O -rich field similar to the Eastern Province granitoids of Malaysia. The Eastern Province types of Bangka and Belitung however, all lie in the K_2O -rich field (of S-types) in contradiction to the Chappell and White criteria.

On the K_2O - Na_2O - CaO ternary plot the sodic Riau Archipelago I-type suite and potassic Bangka-Belitung I-type suite yield different evolutionary fractionation paths. Both however correspond to the calc-alkaline trend and eventually converge in the compositional field of S- and IS-type granites. Similarly on the AFM diagram, both fall on the calc-alkaline trend but the Bangka-Belitung suite is distinctly more (FeO + MgO) rich.

The Riau Archipelago suite, as typified by the granitoids of Batam and Bintang have a wide compositional spectrum ranging from primitive metaluminous to more highly evolved peraluminous minimum melt granites e.g. East Bintang.

The Bangka-Belitung I-type suite also have a wide compositional range, but notably exhibit distinct compositional clustering and a pronounced compositional break between diorites and granodiorites in the SiO_2 range 55-65%. In contrast to the Riau Archipelago there is a greater degree of chemical uniformity and all except Gunong Mang are metaluminous.

The most distinctive trace element characteristics of the Riau Archipelago suite are the very high Ba contents over the whole range of TTDI (suggesting plagioclase-dominated fractionation) and the marked depletion in compatible transition metals (e.g. Cr, V, Ni and Ti).

By contrast the Bangka-Belitung I-type suite have Ba contents consistent with the fractionation trends of the S- and IS-type granitoids whilst Cr and V values are the highest of all the Tin Island granite types.

On the Rb-Ba-Sr ternary plot the Bintan-Batam granite suite exhibit a different fractionation trend to all other granite associations and are some of the only granites which spread into the low Ca granite field outlined by El Bouseilly and El Sokkary. It is also clear from this diagram that Batam is a more highly evolved peraluminous member of the East Bintang magmatic series.

On the Rb/Sr vs Thornton Tuttle DI plot, Main Range granites of the Thai-Malay Peninsula exhibit higher Rb/Sr values than the Eastern Province granitoids of equivalent TTDI. An empirical line subdividing these two provinces can thus be drawn. The few Eastern Province granitoids that stray into the Main Range field have usually been affected by a subsolidus potash metasomatic overprint, whilst the Main Range granites that fall in the field of Eastern Province granitoids are usually as a result of silicification (or late hydrothermal SiO₂ enrichment) which tends to increase the TTDI without any attendant effect on the Rb/Sr ratios.

The distribution of plots for the Main Range and Eastern Province types represented within the Tin Islands segment shows the arbitrary line derived from the Thai-Malay Peninsula to be equally applicable.

Four major differences are however apparent: -

- (i) The Main Range types of the Tin Islands do not range to the low values of TTDI exhibited by the Thai-Malay Peninsula.
- (ii) Whilst the Eastern Province granitoids of the Thai-Malay segment describe a fractionation path which originates at exceedingly low Rb/Sr ratios (i.e. ≤ 0.1) those of the Tin Islands maintain a value close to unity even at the lowest TT differentiation indices. This is interpreted as an expression of the greater crustal input at source for the Bangka-Belitung suite of the Tin Islands.
- (iii) The Batam-Bintan granitoids describe a relatively straight or more gently curved fractionation path similar to those of Peninsular Malaysia (particularly the Cretaceous plutons) and incidentally also the coastal batholith of Peru.
- (iv) The west central Singkep pluton within the Riau Archipelago, which has all the features of an A-type granite i.e. ferropargasitic hornblende, abundant sphene, allanite, apatite and zircon and high Rb, Nb, Th, Y, Zr and REE values, plots in both the Main Range and Eastern Province compositional fields.

Amongst the S-type petrographic subdivisions geochemical characterisation of the different subsets is complicated by the much greater involvement of secondary magmatic derivatives which considerably extend the compositional ranges of these types.

A dendrogram constructed by cluster analysis of averaged primary textured compositions for each pluton/unit using a similar selection of variables as before, removes much of this complication and reveals two distinct S and IS associations with a very high degree of interunit similarity.

These two geochemical groupings correspond more or less to:

- (a) The Klabat S-type batholithic association (North Bangka), and
- (b) The Bebulu IS-type batholithic association (South Bangka and NW Belitung)

The Klabat batholith is characterised by a complex S-type association with the following sequence of intrusion:

Precursor granites:	Tanjong Layang and Tanjong Batu
Mixed precursor and	
Main phase derivatives:	Tanjong Raya Complex (includes Sungei Liat)
Main Phase granites:	Belinyu, Penangas and Menumbing
Secondary derivatives:	Bukit Gais and Tempilan

From the dendrogram it is noted that the precursor granite Tanjong Layang has greater geochemical similarity with the Bebulu IS suite. Also that Kelumpang (a metasomatised Bangka-Belitung I-type) preferentially correlates with the Bebulu association. Tanjong Pandang which exhibits petrographic features typical of a mineralised S-type also has close chemical affinities with the Bebulu suite of predominantly tin associated IS-types, although as will be noted later in this discussion it has a similar pattern of secondary enrichment to typical Main Range S-type (e.g. Klabat suite).

The Bebulu batholithic association is characterised by mixed I-S affinities, consistently high SiO₂ contents and fairly uniform major alkali proportions.

Qz-Or-Ab ternary plots show all plutons of the Bebulu suite (with the exception of Tanjong Pandang) to plot on or close to the minimum melt composition on the 1-2 kb cotectic. Tanjong Pandang exhibits more of a spread in response to a higher anorthite content. The non-minimum melt composition is evident in this section in that all textural types of Tanjong Pandang exhibit cores of andesine in the more sodic plagioclase feldspars.

In contrast to the Bebulu suite (as typified by Toboali, Permisan and Pading plutons) the Klabat parental granites lie well off the isobaric minimum melt composition.

Inspection of the trace element data shows that the main differences between these two suites are that the Klabat association has much higher ore element contents particularly for Sn, W, Pb and Zn (e.g. Klabat 10-25 ppm Sn; Bebulu < 8 ppm Sn).

The Klabat suite shows Na₂O enrichment trends with increased two phase development and generation of secondary magmatic differentiates.

Menumbing pluton, the parental phases of which are geochemically correlated with the Klabat suite on the cluster dendrogram, exhibits an increase in SiO₂ and Na₂O and a depletion in K₂O with increased two phase variation. Normalised multielement profiles of the separate phases of

Menumbing (G₁-G₄) show an increasing degree of specialisation in the later residual phases. This is most evident from the increase in Rb, Th and Y, and the decrease in Sr, Ba. Amongst the ore elements there is a pronounced increase in U, W and to a lesser extent Pb and Ni whilst Cr is depleted, and there is a fall in the Sn content probably in response to preferential partition into mineralised greisen systems. On the Rb/Sr vs TTD_i plot, the least differentiated parental Menumbing (primary textured) sample has the same TT index as the most differentiated sample of Belinyu. Two phase variants and secondary derivatives (like Bukit Bais and Tempilan) from Belinyu follow the usual line of liquid descent i.e. more or less parallel with the trend of the empirical line of division between the Main Range and Eastern Province types. Menumbing however shows a much steeper fractionation path with Rb/Sr ratios higher than all the other granites of equivalent degree of differentiation. It could seem therefore that Menumbing is a separated parental magma extract from the Main phase batch melt (typified by Belinyu type) which has subsequently evolved along a different fractionation path.

The Bebulu suite, by contrast with members of the Klabat association, generally exhibit K₂O enrichment trends whilst Na₂O remains constant or becomes slightly depleted with increasing two phase involvement.

Tanjong Pandang is again the exception in that alkali trends are similar to the Klabat suite. Trace element enrichment trends are also comparable (increase in Rb and depletion in Sr and Ba).

With the Klabat suite there is a more or less continuous compositional transition between the parental and mineralised derivative phases whereas with the Bebulu suite there may be distinct (temporal and/or) compositional breaks.

Increased specialisation within the Klabat suite invariably culminates in tin mineralisation, whereas in the Bebulu suite this is not always the case.

On the Zr/TiO₂ vs K/Rb variation plot it is evident that the Bebulu suite describes a much steeper fractionation path than the Klabat suite.

Tin mineralisation associated with plutons/units of the Klabat batholith largely takes the form of massive (disseminated) greisen or greisen bordered vein swarms. In the Bebulu suite the mineralisation is confined only to peripheral zones or late cross-cutting microgranites. Tanjong Pandang appears to be an exception in that much of the mineralisation is associated with small stocks (and breccia pipes such as Tikus) which penetrate the interior of the pluton. Abundant secondary magmatic mesogranite and megacrystic microgranites may also host tin which has subsequently concentrated by supergene processes.

The last category are the tin (± wolfram) mineralised S- or IS-types of the Riau Archipelago as typified by Karimun and Dabo (or Mangkol on Bangka island). These are highly specialised granites characterised by high Rb, Nb, Pb, Ga, Th, U, Sn ± W ± Mo, Y ± Yb.

On the dendrograms they have no overall geochemical similarity with

the other S/IS-type suites and are themselves quite distinct from each other. With regard to some of the major chemical-mineralogical criteria (they are sodic and metaluminous) and initial isotope ratios they appear to have more affinity with the Eastern Province types. Rb/Sr ratios are generally so high that the plot against TTDI is a little ambiguous. It would seem therefore more appropriate to consider this subset as highly evolved IS-types of the Eastern Province.

In conclusion it would seem that these different granitoid types may be ordered in a sequence of magmatic maturation which would equate with a subduction-related convergent microplate scenario as follows.

- (i) CALC-ALKALINE VOLCANIC ARC (I-type) INTRUSIONS as typified by metaluminous to Cu-Mo mineralised peraluminous granitoids on the islands of Batam and Bintan (Riau Archipelago) which are mostly juvenile melts derived from the mantle (\pm oceanic crust component) with selective enrichments in some LIL elements would concur with a pre-collisional subduction related Andinotype setting. Tonalite, monzodiorite-monzogranite suites in Southern Johore and parts of the Central Belt of Peninsular Malaysia are quite comparable.
- (ii) PERALUMINOUS ALKALI-CALCIC (S-type) INTRUSIONS as typified by Kundur pluton (Riau Archipelago) and the Klabat batholithic association of N. Bangka, are largely derived by partial melting of crustal material. Prograde anatexitic precursor melts are followed by the uprise of batch melts with an extended differentiation series. Selective enrichments in some LIL and HFS elements. Endmembers are invariably tin mineralised. These S-type granites are generally considered to be syn-collisional in origin.
- (iii) COMPOSITE I- to IS-type INTRUSIONS: 2 subtypes
 - (a) META- TO PERALUMINOUS IS-type INTRUSIONS as typified by Karimun and Dabo (Riau Archipelago) and the Bebulu suite (S. Bangka and NW. Belitung) are largely derived by partial melting of the lower crust with some mantle contribution. Extreme enrichments in some incompatible elements (including ore elements) may take place under F- and B-rich volatile conditions. Generally more localised Sn \pm W mineralization. These are considered to be syn- to post-collisional in type. They appear to be part of the same fractionation series as subtype (b) and may in some case post date the calc-alkaline I-types.
 - (b) CALC-ALKALINE I-type INTRUSIONS as typified by the Bangka and Belitung I-type suite are derived from a lower crust-mantle source but with extensive upper crustal contamination. Truncated magmatic series characterised by a number of restricted compositional types sometimes with a potash metasomatic overprint giving some erratically high LIL element values. Generally unmineralised. These accord with post-collisional (Caledonian) I-types which are generally considered to be exposed in uplifted orogenic belts.
- (iv) ALKALINE TO POTASSIC SUBALKALINE (or A-type) INTRUSIONS as typified

by the west central Singkep pluton which are mostly derived from a depleted mantle or lower crustal source under anhydrous F-, B-rich conditions. They characteristically carry high concentrations of both LIL and HFS elements and are typically found in tensioned back-arc situations of orogenic belts.

Finally if one attempts to extrapolate the Raub-Bentong line southward into the Tin Islands there is some justification for passing it between Karimun (Eastern Province type) and Kundur (Main Range type) along the chain of isles comprising the Merak gabbro. Further south it would seem to pass through the central portion of Singkep Island between Dabo (Eastern Province type) and an unnamed Main Range pluton in the southwest. This would mean that the west central Singkep A-type pluton must be situated more or less on the line.

Whilst Belitung seems to comprise largely Eastern Province plutons (comparable to the Terengganu segment of Peninsular Malaysia) there is no easy way in which the plutons can be geographically separated on Bangka Island, and it is necessary to postulate almost simultaneous melting of different source rocks in the same lithospheric segment.

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- White, A.J.R. & Chappell, B.W., 1983. Granitoid types and their distribution in the Lachlan Fold Belt, Southeastern Australia, *Geol. Soc. Am., Mem.*, 159, 21-34.

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P E R T E M U A N P E R S A T U A N
(M E E T I N G S O F T H E S O C I E T Y)

CERAMAH TEKNIK (TECHNICAL TALKS)

D.P. Fiona Darbyshire: Rb/Sr and Sm/Nd isotope studies on granites of Southeast Asia.

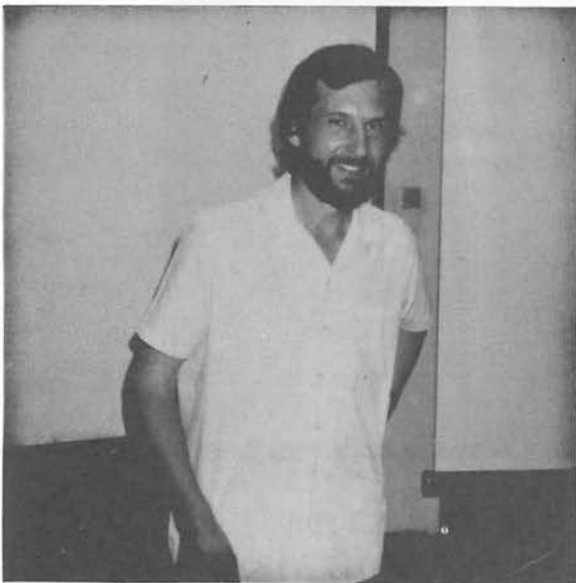
Peter E.J. Pitfield: Geochemistry of the Tin Islands granites of Indonesia in relation to those of Peninsular Malaysia.

Laporan (Report)

Both Dr. Darbyshire and Dr. Pitfield are with the British Geological Survey (BGS) and are co-workers with Dr. E.J. Cobbing on S.E. Asian granites. They presented their respective talks on Friday, 26 June 1987, at the Geology Department, University of Malaya, after successfully helping in conducting the Geology Dept. UM - BGS sponsored 'Granite Workshop'.

Both speakers have kindly submitted transcripts of their talks and realising their usefulness, the Editor has decided to include them under 'Geological Notes' in this issue.

G.H. Teh



PETER E.J. PITFIELD



D.P. FIONA DARBYSHIRE

BERITA - BERITA PERSATUAN (NEWS OF THE SOCIETY)

MEMBERSHIP IN THE COSTAM COMMITTEE

The Council has agreed to the appointment of Albert Loh of MMC as the Society's representative to the COSTAM Committee.

After some discussion, the Council decided to continue payment of the annual contribution of M\$100 with the hope that the committee would come out with some activities of benefit to the various contributing societies.

2ND MALAYSIAN OIL, GAS & PETROCHEMICAL ENGINEERING EXHIBITION

The Society was invited to participate in the above mentioned exhibition at the Putra World Trade Centre from 8-11 June 1987.

The opportunity was taken to highlight the Society's activities and the various Society's publications were displayed and sold.



THE SOCIETY'S STAND AT THE EXHIBITION

KEAHLIAN (MEMBERSHIP)

The following applications for membership were approved:

Full Member

1. Ajit Singh s/o Pola Singh, No. 1, Jln. Batu Geliga Tiga, Taman Melawar, Batu Caves

Associate Member

1. Antonio F. R. de Almeida, SGS (Malaysia) Sdn. Bhd., 80, Jalan SS22/25, Damansara Jaya, 47400 Petaling Jaya

Student Members

1. Mohd. Nasir Abd. Rahman, Jabatan Geologi, Universiti Malaya, Kuala Lumpur
2. Liau Boon Leong, - ditto -
3. Husaini Omar, - ditto -
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5. Cheah Eng Hoe, - ditto -
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2. Mara Institute of Technology, Bahagian Majallah, Perpustakaan Tun Abdul Razak, 40450 Shah Alam, Selangor.

PERTAMBAHAN BARU PERPUSTAKAAN (NEW LIBRARY ADDITIONS)

The Society has received the following publications:

1. Episodes, vol. 10, no. 1, 1987
2. Annual Report: Chinese Academy of geological sciences, 1984
3. Grondboor en Hamer, nos. 5 & 6, 1986
4. Oklahoma Geological Survey, Bulletin 139 & 140, 1986
5. The University of Kansas, Paleontological contributions, paper 118, 1987
6. VGM-IS-a system for filing, editing of borehole data, construction of downhole semi-variograms and average semi-variograms in 1-dimensional (uni) configuration designed in BASIC for microcomputers by Eric K.H. Goh. 1986
7. KRIG-2 - a system for filing, editing of borehole data, and calculating Kriged point estimates in 2-dimensional configuration designed for microcomputers with BASIC language capabilities by Eric K.H. Goh. 1986
8. VGM-2 - a system for filing, editing of borehole data, construction of histograms and experimental semi-variograms in 2-dimensional configuration designed in BASIC for microcomputers by Eric K. H. Goh. 1986
9. Evaluation of tin and tantalum in tin shed products of Chaiyayuth Dredge, Phangnga, Thailand by Kit Watanarorakitkul. 1986

BERITA - BERITA LAIN (OTHER NEWS)

BENGKEL GRANIT (GRANITE WORKSHOP)

The Granite Workshop, jointly organised by the Geology Department, University of Malaya, and the British Geological Survey (BGS) was held from 15 June to 20 June 1988 at the Geology Department, University of Malaya. The Workshop was made up of lectures, practical classes and one-day field visits. The main speakers were Dr. E. John Cobbing and his co-workers at BGS, namely Dr. Peter E.J. Pitfield and Dr. D.P. Fiona Darbyshire.

The Workshop was well attended by 30 people and this included participants from the Geological Survey Malaysia, University of Malaya, Universiti Kebangsaan Malaysia and SEATRAD Centre.

Programme

15 June 1987

- 9.00 - 10.00 a.m. The Andean batholith and the SE Asian granitic province - E.J. Cobbing
- 10.30 - 11.30 a.m. Geochemical behaviour of elements - P.E.J. Pitfield
- 11.30 - 12.30 p.m. Background isotopic work - D.P.F. Darbyshire

16 June 1987

- 9.00 - 10.00 a.m. Rb/Sr Systematics - D.P.F. Darbyshire
- 10.30 - 11.30 a.m. Major element criteria - P.E.J. Pitfield
- 11.30 - 12.30 p.m. Geochemistry of Peninsular Malaysia granites - L.H. Teoh
- 2.00 - 4.00 p.m. Practical on sample collection and description

17 June 1987

- 9.00 - 10.00 a.m. Sm/Nd Systematics - D.P.F. Darbyshire
- 10.30 - 11.30 a.m. Minor element criteria - P.E.J. Pitfield
- 11.30 - 12.30 p.m. Geochemical signatures - L.H. Teoh
- 2.00 - 4.00 p.m. Practical on description of thin section - Indonesian examples

18 June 1987

- 9.00 - 10.00 a.m. Rb/Sr studies in SE Asia - D.P.F. Darbyshire
- 10.30 - 11.30 a.m. Deformation in granites (examples from Stong and Ban Non Yai) - E.J. Cobbing

11.30 - 12.30 p.m. Geochemical characteristics of principal granite types - P.E.J. Pitfield

2.00 - 4.00 p.m. Thin section studies

19 June 1987

9.00 - 10.00 a.m. Geochemical variation due to secondary magmatic processes - P.E.J. Pitfield

10.30 - 11.30 a.m. Sm/Nd studies in SE Asia - D.P.F. Darbyshire

11.30 - 12.15 p.m. Granite genesis - thermal and tectonic consideration - K.R. Chakraborty

2.45 - 4.15 p.m. Practical - Recognition of textural differences between granitic units

20 June 1987

9.00 - 10.00 a.m. Fluid inclusion studies of Bujang Melaka pluton, Kinta Valley - M. Schwartz

10.30 - 11.30 a.m. Geology and geochemistry of the Bujang Melaka pluton - Askury

11.30 - 12.30 p.m. Magma evolution, hydrothermal alteration and tin mineralisation of the Bujang Melaka pluton - M. Schwartz.

G.H. Teh



PARTICIPANTS OF THE GRANITE WORKSHOP

SENARAI DISERTASI SEMESTER II SESI 1986/87, JABATAN GEOLOGI, UKM

- Danis Buik - Geologi Kawasan Kuala Tembeling, Pahang.
- Teh Kok Boon - Geologi Kawasan Bekenu - Sibuti - Tanjung Batu, Sarawak.
- Abdul Halim Mohd. Yusoff - Geologi Kawasan Kampung Batu Melintang, Jeli, Kelantan.
- Azemi Hj. Eki - Geologi Am Kawasan Gua Musang, Kelantan.
- Lim Hock Kuang - Geologi Kawasan Bukit Lambir, Sarawak.
- Teoh Chuen Lye - Geologi Kawasan Baratdaya Tatau, Sarawak, Malaysia Timur.
- Maziran Mustafa Kama - Geologi Am Kawasan Jerantut, Pahang Darul Makmur.
- Mohd. Mokhtar Saidin - Geologi Kawasan Grik, Perak.
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- Wan Mohd. Nizam Wan Isa - Geologi Kawasan Bukit Ibam, Pahang.
- Md. Faduzi Rashid - Geologi Kawasan Triang Ilir, Jelebu, Negeri Sembilan.
- Tajul Anuar Jamaluddin - Geologi Kawasan Tamparuli, Sabah.
- Rohazli Yon - Geologi Kawasan Sungai Tiang, Pendang, Kedah.
- Abu Bakar Awang - Kajian Geologi Kawasan Raub, Pahang.
- Azizan Abdul Aziz - Geologi Kawasan Tebing Tinggi, Jerantut, Pahang Darul Makmur.
- Mohamad Fauzi Ghazali - Geologi Kawasan Changkat Jering-Kuala Kangsar, Perak.
- Yaman Baharom - Geologi Kawasan Layang-Layang, Johor.
- Sharifah Fatimah S. Zin - Geologi Kawasan Sekitar Damak Jerantut, Pahang Darul Makmur.
- Ahmad Fakruddin Abdullah - Geologi Kawasan Pulau Labuan Sabah (Penekanan Pada Formasi Belait).
- Che Di Basirah - Geologi Kawasan Sungai Tiang-Sik, Kedah.
- Zulkifli Mat Zain - Geologi Am Kawasan Mukim Pertang Jelebu, Negeri Sembilan.

INVENTORY OF QUATERNARY SHORELINES

The "Inventory of Quaternary Shorelines, Pacific and Indian Oceans Region" was edited by T. Yoshikawa and published in January 1987. The Inventory was planned and compiled by the editor who is current President of the Subcommission for the Pacific and Indian Oceans Region of the main INQUA Commission on Quaternary Shorelines. For its publication an grant was secured from the Ministry of Education of Japan. The Inventory contains 130 pages and lists extensive data from areas ranging from the USSR (Far East) and China in the north to New Zealand and French Polynesia in the southeast. Index maps locate the localities mentioned in the lists. From the marine areas contiguous to Malaysia are tabled 74 radiocarbon ages of shorelines of which the oldest are close to 36,000 years B.P. from Pulau Bangau-Bangau in Sabah.

Address of the editor is: Professor T. Yoshikawa,
NODAI Research Institute,
Tokyo University of Agriculture,
Setagaya, Tokyo 156,
Japan.

H.D. Tjia

ASEG/SEG INTERNATIONAL GEOPHYSICAL CONFERENCE & EXHIBITION

Feb. 14-21, 1988, Adelaide, Australia

Call for Papers

The will be the first joint ASEG/SEG Conference and will be held in Australia during the bicentenary of European settlement of the continent- an appropriate time for the industry to review exploration history and forecast the future of exploration geophysics.

The Conference will be broad ranging in scope and will appeal to explorers in the fields of:

- * conventional exploration geology and geophysics
- * solid earth
- * leading edge, technology and software
- * commerce and marketing

Field trips, Seminars and Workshops are being organised.

Topics

Papers are invited from a wide range of disciplines and technologies, hard-rock, soft-rock and peripheral activities. In addition papers are welcomed on integration of traditional geophysical tools and techniques with the allied activities of marketing, finance and conservation. It is considered that in these uncertain times it is important to be aware of government and corporate attitudes to the future requirements of the industry.

Papers covering the following areas are particularly welcome:

- * New approaches to solving old problems
- * Geophysics in the South Pacific
- * Recent acquisition and processing advances
- * Education requirements for environmental issues
- * International investment trends
- * Practical case studies, incorporating problem solving - including what went wrong in addition to successes
- * Multiple methods and integration of techniques
- * Tectonics of the South Pacific Basin
- * Commercial/marketing
- * The rise of the workstation
- * Risk analysis/risk management
- * Governmental & regulatory attitudes

Instructions for Authors

Intending authors are invited to submit titles supported by no more than 250 words outlining aims, content and conclusions.

Presentation

Presentations will be of either 15 or 25 minutes with a following 5-10 minutes for questions. Intending authors should specify for which time period their period their paper has been prepared.

Address for all communications

ASEG/SEG Adelaide '88 Conference
 c/- Elliservice Convention Management
 P.O. Box 753
 Norwood 5067
 South Australia, Australia.

Tel: National (08) 332-4068 Telex: AA87129
 Fax: (08) 333-2248
 International (618) 332-4068 Telex: AA87129
 Fax: (618) 333-2248

FIRST ASIA/PACIFIC MINING CONFERENCE & EXHIBITION

24-27 February, 1988, Bangkok, Thailand

Sponsored by the Asean Federation of Mining Associations

Theme: Minerals and the Economic Development of the Asia/Pacific Region

The ASEAN Federation of Mining Associations (AFMA), which links the mining associations of the four ASEAN mineral producing countries - Indonesia, Malaysia, the Philippines and Thailand - is establishing a long-range programme to monitor the changes in the industry and to facilitate harmonious promotion and development of the mineral wealth of the region with a view of optimizing the contribution of minerals to economic development. The 1st Asia/Pacific Mining Conference and Exhibition which will be organized by AFMA in cooperation with the mining associations of other countries in the region is a step in this process that is planned to be held in the capitals of these countries at two or three years interval.

The Conference will cover the full range of issues both technical and non-technical, related to the development of metals, industrial minerals and solid fuels in the Asia/Pacific region. It will be of interest to mining engineers, geologists and others who are directly associated with mineral production, but the programme will also appeal to those involved in mining finance, mineral trading and other activities as well as to government officials in the region whose decisions influence the environment within which mineral development takes place.

AFMA is a nonprofit and nonpolitical body organized by the Indonesian Mining Association, the States of Malaya Chamber of Mines, the Chamber of Mines of the Philippines and the Mining Industry Council of Thailand, representing the mineral producers in these countries. Because of its membership and links with other national mining bodies, AFMA has access to the world's leading professionals in mining, metallurgy, geology and mineral economics in and outside the region who will share their expertise and experience during the conference.

Preliminary Program

Day 1 (Wed. 24 Feb., 1988) Full day of plenary sessions with keynote papers to identify and outline the ASEAN Framework.

- * Welcoming Remarks (Chairman of the Organizing Committee)
- * Welcoming Remarks (President of AFMA)
- * Opening Address (by the Minister of Industry of Thailand, Honorary Patron of the Conference)
- * Review of the Mineral Situation in the Asia/Pacific Region (the Executive Secretary of ESCAP has been requested to have this paper prepared and presented by ESCAP).
- * Review of the Mineral Situation on the World Level (to be presented by P.C.F. Crowson, Economic Advisor, Rio Tinto Zinc Corp., London)
- * Thailand Mineral Industry Review (by Director General of the Department of Mineral Resources of Thailand)
- * Philippines Mineral Industry Review (by a representative of the Philippines)

- * Malaysia Mineral Industry Review (by a representative of Malaysia)
- * Indonesia Mineral Industry Review (by Drs. Soetaryo Sigit, Dir.Gen of Mining, Indonesia)

Day 2 (Thur. 25 Feb., 1988) Sessions on the three main conference topics, including overview papers and three simultaneous symposia.

- * Overview Paper on Economic (Non-Technical) Aspects (invited paper by a high-level mineral economist from a U.S. mining company)
- * Overview Paper on Mineral Exploration (invited paper by an international authority on mineral exploration from Australia)
- * Overview Paper on Mining and Processing (invited paper by an international authority from a university or research institution in Europe)
- * Symposium A - Economic (non-technical) Aspects
- * Symposium B - Mineral Exploration
- * Symposium C - Mining and Processing

Day 3 (Fri. 26 Feb., 1988) Panel discussions on topics of regional interest (each panel will consist of a chairman/discussion leader as noted and three specialists)

- * Panel I Gold (Gold Fields/Newmont + Philippines)
- * Panel II Thai Airborne Geophysics Project (Thailand + Canada)
- * Panel III Coal (chaired by Indonesia)
- * Panel IV Tin (chaired by Malaysia)
- * Panel V Industrial Minerals (EEC-ASEAN)
- * Panel VI Legal Aspects and Implications
- * Informal Working Group (a series of informal working groups will be scheduled to follow up on panel discussions or to deal with topics which have not been covered in the program)

Day 4 (Sat. 27 Feb., 1988) The summing up

- * Final Plenary Session (the Conference Chairman and the three symposia rapporteurs will serve as a panel to review the general conclusions of the meeting with a focus towards "Mineral Development Strategies for the Future in the Asia/Pacific Region").

AUSTRALIAN MINERAL FOUNDATION - INDEX TO 1988 COURSES - JANUARY TO JULY

Chronological Listing

Course No.

562/88	Modern and Ancient Deep-Sea Fan Sedimentation	14-18 March	Adelaide
563/88	Geological Interpretation of Aerial Photographs and Satellite Images	11-22 April	Adelaide
564/88	Advanced Structural Geology for Mineral Exploration	2-7 May	Adelaide
565/88	Structural Geology in Petroleum Exploration	9-13 May	Adelaide
566/88	Gas Conditioning and Processing	16-27 May	Sale
567/88	Economic Guidelines for Gold Exploration	23-27 May	Melbourne
568/88	Economic Guidelines for Gold Exploration	13-17 June	Kalgoorlie
569/88	Economic Guidelines for Gold Exploration	20-24 June	Townsville
570/88	Natural Gas Processing	30 May - 3 June	Adelaide
571/88	Nodal Systems Analysis - Production Optimization for Oil and Gas Wells	6-10 June	Adelaide
572/88	Gas Production Engineering	20-24 June	Adelaide
573/88	Practical Well Testing	27 June - 1 July	Adelaide
574/88	Decision Analysis for Petroleum Exploration	27 June - 8 July	Adelaide
575/88	Petroleum Geology	4-15 July	Adelaide
576/88	Exploration Stratigraphy	4-8 July	Adelaide
577/88	Petroleum Engineering	11-15 July	Adelaide
578/88	Basic Surface Production Operations	18-22 July	Adelaide
579/88	Basin Analysis Essential for Petroleum Exploration	25-29 July	Adelaide

For further information: Australian Mineral Foundation
63 Conyngham Street
Glenside
South Australia 5065
Telephone: (08) 379 0444; Telex: AA87437
Facsimile: (08) 79 4634

ASIAN MINING 88 - SECOND CIRCULAR

Asia's International Conference and Exhibition
8-11 March 1988, Kuala Lumpur, Malaysia

Organized by The Institution of Mining and Metallurgy in association with The States of Malaya Chamber of Mines, The Malaysian Section of the Institution of Mining and Metallurgy, The Institute of Mineral Engineering, Malaysia, The Geological Society of Malaysia and The Australasian Institute of Mining and Metallurgy, The Canadian Institute of Mining and Metallurgy, The Hong Kong Section of the Institution of Mining and Metallurgy, The Mining and Metallurgical Institute of Japan, The Non-Ferrous Metals Society of China, The Society of Mining Engineers of AIME.

The Venue

The conference and exhibition will be held in the Putra World Trade Centre, Kuala Lumpur, Malaysia, from 8 to 11 March 1988.

The Conference

Asian Mining '88 is the third in the successful series of conferences organized by the Institution of Mining and Metallurgy (the first conference was held in Singapore in 1981 and the second in the Philippines in 1985). Devoted to the development of the Asian minerals industry, the conference will provide a forum for the discussion of economics, exploration, evaluation, mining, mineral processing and metallurgy included in the discussion will be presentations on minerals industry research and practice as well as mining projects and the opportunities for investment in mining within the region.

The conference will open on 8 March, 1988, and the inaugural address will be delivered by Dato' Dr. Lim Keng Yaik, Minister of Primary Industries, Government of Malaysia. In addition to the technical presentations, keynote lectures/review papers will consider, among other topics, the United Nations Revolving Fund, mining and mineral policies in Malaysia, the aftermath of the October 1985 tin price collapse, the pace of change in mineral processing and the limits to growth in the minerals industry.

Technical Programme

The following papers are under consideration for presentation at the conference.

- Geomodelling of bauxites profiles from Kutch Gujarat State, India by K.S. Balasubramaniam (India)
- Role of mining in the national economy of Iran by S.H. Bassir (Iran)
- Cassiterite placer deposits in the South Perak and Malacca offshore areas of Peninsular Malaysia by D.A.F. Batchelor (Malaysia)
- Complete extraction of wide precious metal orebodies: proposal for an Indian mine by R. Bhadada and A.S.R. Sai (India)
- Eco-development and mining in the twenty-first century by R. Bhadada and U.K. Verma (India)
- Texture analysis for the characterization of comminution products by G. Bonifazi (Italy)

- Mechanical and chemical modification of alluvial gold by J.F.W. Bowles (United Kingdom)
- New course in mineral technology at Chiangmai, Thailand by M.L. Brooks (United Kingdom)
- Preparation of electrolytic manganese dioxide from manganese ore (Deogiri area, Karnataka State, India) for manufacture of dry batteries by R.R. Dixit, G.P. Kundargi and B. Somasekar (India)
- Outcrop magnetic susceptibility measurements as a means of differentiating rock types and their mineralization - with examples from Southeast Asia by R.B. Evans (United Kingdom)
- Stability problems in the soft soils of Southeast Asia by P.J. Forbes (United Kingdom)
- Gold deposits of the Northern Bicol Peninsula, Luzon, Philippines, and their analogues in older greenstone belts by L.P. James (USA)
- Computer-aided geochemical mapping and mineral exploration in Sumatra, Indonesia by C.C. Johnson, R.C. Jones (United Kingdom), S.A. Ghazali, Hariwidjaja and E. Suganda (Indonesia)
- Beneficiation of complex tin ores and slags by fuming in Southeast Asia by D.S. Karsidi (Malaysia)
- Improvement in drill productivity, Donimalai iron ore project by use of screw compressor by U. Kumar (Sweden)
- Maintenance tool-PC computer by J.W. Kupfner (USA)
- Development of rilling techniques for underground mining in southern China by Liu Gansheng and Jiang Rongchao (China)
- Investigation into the purification of Chinese bauxites for refractory use by Lu Chouci, Shang Weijun, Zhu Xiaozhen and Huang Ketao (China)
- Method of predicting the damaged rock zone around mine drifts by A. Mukherjee and A. Mahtab (USA)
- Effect of some design parameters in floating cells by S.I. Mustafa, M.Y. Saada and S.I. Hawash (Egypt)
- Technical and economic aspects of high-speed tunnelling in hard rock conditions by M. Palmu (Finland)
- Development and application of Yunnan Tin Corporation six-deck slime shaking table by Pan Guozhu and Zhang Muduo (China)
- Gold heap leaching operations, Masbate, Philippines by R.S. Pizarro, V. V. Pato and L.R. Ricafort (Philippines)
- Ventilation of adits and tunnels during excavation and in use by K. Pucher and R. Pinter (Austria)
- Electron microscope and beneficiation studies on some Indian iron ores by S.A. Ravishankar, J.S. Sharman, N. Prasad and A.K. Biswas (India)
- Quality improvement in steelmaking raw materials by B.M. Shields (USA)
- Microbial pretreatment of refractory gold ores by G.N. Shrestha (United Kingdom)
- Continuous mining systems for surface mining of coal by R.K. Singhal (Canada)
- Mount Whaleback - a case history of the importance of geology to pit slope design by C.F. Swindells, D.M. Ransom and A.C. Wilson (Australia)
- Hexagonal cross-section wet revolving screen - new concept for future fine size range classification by R. Vajarapong and M. Narunat (Thailand)
- Total resource planning - a case study at Panguna (Bougainville Copper Ltd) by I.R. Worth (Papua New Guinea)
- Retreatment of tailings from dressing plants treating stanniferous granite by Xiong Zongrong (China)
- Use of combined techniques in the beneficiation and metallurgical treatment of tin-bearing ores in Gejiu, China by Yan Ze-Xiang and

Du Chang-Ya (China)

- Effect of grinding media-mineral interaction on chalcopyrite flotation by M.K. Yelloji Rao and K.A. Natarajan (India)

All papers selected for presentation at the conference will be pre-printed and sent to registrants ahead of the event.

Technical Tours

Details of the post-conference four-day technical tour, which will take place from 12 to 15 March, are given below:

- Day 1 · Visit Timah Dermawan Sdn. Bhd. (bucket dredging and treatment and Sungei Raia Marble Industries Sdn. Bhd. (marble slabs manufacturing plant); overnight Ipoh.
- Day 2 Visit Gopeng Berhad (hydraulic mining of tin), gravel pump mine and mineral retreatment plant or a solder manufacturing plant; overnight Ipoh.
- Day 3 Visit the laboratories of the Geological Survey of Malaysia, Mines Research Institute of Department of Mines and the South-east Asia Tin Research and Development Centre; overnight Penang.
- Day 4 Visit Malsyia Smelting Corporation Sdn. Bhd. (tin smelting plant); return to Kuala Lumpur.

In addition, day visits to Berjuntai Tin Dredging Bhd. and Anti-Abrasion Rubber Products Sdn. are being arranged. Full details of all the tours and their cost will be given in the Final circular/Registration Form.

Exhibition

Following the success of the Asian Mining '85 exhibition in Manila, the organizers are pleased to announce that a full-scale exhibition will be held alongside the Asian Mining '88 conference. Featuring the latest technology and equipment, the exhibition will involve the participation of manufacturers, suppliers and associations from all over the world.

Enquiries relating the exhibition should be addressed to

Infinity Plus, 3rd Floor, Makati Stock Exchange Building,
Ayala Avenue, Makati, Metro Manila, Philippines
(telephone: 851921; Telex: 26436 SEARBY PH).

or Malcolm Taylor, Brintex Ltd.,
178-202 Great Portland Street, London W1N 6NH, England
(tel: 01-637 2400; tlex: 262568 MUNBEX G)

Further Information

Enquiries about the conference and its associated events should be addressed to: The Conference Office, The Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR, England. Tel: 01-580 3802, Telex: 261410 IMMG.



GEOLOGICAL SOCIETY OF MALAYSIA
Persatuan Geologi Malaysia

FORTHCOMING PUBLICATION

SPECIAL BULLETIN ON PETROLEUM GEOLOGY Vol. III
some of the papers appearing

The role of carbonate diagenesis in exploration and production from Devonian pinnacle reefs, Alberta, Canada

N. R. Watts (Texaco)

Significance of stylolite development in hydrocarbon reservoirs with an emphasis on the Lower Cretaceous of the Middle East

R. B. Keopnick (Mobil)

Studies of carbonates of the Tembesi River Basin, Sumatra

L. Beavais (Univ. Paris)

Tectonic evolution and structural styles of Cenozoic basins around Taiwan area

Frank Fu-Wen Huang (CPC)

Advances in Diplog data processing for stratigraphic analysis

C. Carter Waid *et al.* (Dressler)

Habitat of Hydrocarbons on the Norwegian Continental Shelf

Odd R. Heim *et al.* (Statoil)

Stratigraphic tectonic model for Eastern Borneo

C. S. Hutchison (Univ. Malaya)

Stratigraphy and palaeofacies development of Blocks PM 6 and 12 Offshore Peninsular Malaysia

Md. Nazri Ramli (PETRONAS Carigali)

The geological configuration of the Betty Field, Baram Delta Province, offshore Sarawak

H. D. Johnson *et al.* (Sarawak Shell Berhad)

Better accuracy from sidescan records: The Object-Chord Method

Malcolm James and P. M. Tong (Racal)

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