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The Editor
Geological Society of Malaysia
c/o Department of Geology,
University of Malaya,
50603 Kuala Lumpur, Malaysia
Tel: 603-79577036 Fax: 603-79563900
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Cover photo: Salt weathering in laminated sandstone, Tanjung Layang-Layangan, Labuan. T.F. Ng

Relationship between joint spacing and bed thickness and distribution of joint spacing in clastic sedimentary rocks in northern Labuan, Malaysia

Ng How Sik* & Ng Tham Fatt

Department of Geology, University of Malaya, 50603 Kuala Lumpur
*email address: howsik93@gmail.com

Abstract: Joints are commonly formed perpendicular to the bedding in competent sedimentary strata such as sandstone. Thicker beds have been reported to have wider joint spacing than thinner beds. This paper study the distribution of the joint spacing and their relationship with bed thickness in clastic sedimentary rock of Belait Formation in northern Labuan Island, Malaysia. Joint spacing was measured directly parallel to bedding in the field. Spacing of individual join set and cumulative joint spacing on bedding surfaces also were determined from digitized photographs using ArcMap. Histograms of the spacing values were plotted to determine their frequency distribution. Spacing-thickness (S/T) ratio was calculated by dividing the mean spacing with bed thickness, whereas thickness-spacing (FSR) ratio was calculated as the mean number of joints per meter bed thickness. Frequency histograms of the cumulative joint spacings shows a negative exponential distribution, whereas the joint set spacing can be fitted to a negative power law. Log-log plots of joint spacing frequency shows that the joint spacings cannot be fitted statistically into fractal distribution. The median cumulative joint spacing measured along the strata increases exponentially with thickness of bed.

1 INTRODUCTION

Joints are common geological structure in rocks. They are present in all rock types. In competent sedimentary strata joints are commonly perpendicular to the bedding and systematically oriented (Bai *et al*., 2000). Previous studies have shown that fracture spacing and density in sedimentary rocks show specific relation with the bed thickness, petrographic properties and physical properties (Rustichelli *et al*., 2013; Odonne *et al*., 2006; Hooker *et al*., 2013).

In competent layer of limestone stratabound by incompetent argillaceous rocks, it was shown that the fracture spacing increases with layer thickness (Odonne *et al*., 2006). This relationship enable the establishment of S/T ratio for a layer of sedimentary rock. S/T ratio is defined as the ratio of mean joint spacing to the thickness of mechanical layer (Wu & Pollard, 1995).

Joint spacings in crystalline rocks have been reported to have negative exponential distribution (Wallis *et al*., 1980; Ng, 1994) and fractal distribution (Nagahama, 1993). The frequency of joints with negative exponential distribution increases exponentially with decreasing spacing. Fractals are infinitely complex patterns that are self-similar across different scales. The idea of fractal has been proposed by some earlier worker since 17th century. The idea is very limited without the aid of computer and graphic presentation in the past until Benoit Mandelbrot consolidated the previous work and make it clearer on the concept of self-similarity (Mandelbrot, 1967; 1982).

Few studies on rock fragmentation have demonstrated a power law distribution, where N(R) is the cumulative number of fragments whose sizes are larger than size r, and is a constant, which is the fractal dimension. The distribution of the fragments obey power-law, governed by D_S. Fractal is applicable to various scale, if the size r increase by an order, the N(R) will decrease by the fractal dimension D_S. The changes will be governed by the fractal dimension for different scales (Takeuchi & Mizutani, 1968; Hartmann, 1969; Mandelbrot, 1982; Matsushita, 1985; Turcotte, 1986a & b; Nagahama, 1993). For joints exhibiting fractal distribution, the fractal dimension can be used to extrapolate the joint frequency in various scales.

The objectives of this study are to establish the relationship between joint spacing and layer thickness and to determine distribution of the joint spacings in clastic sedimentary rocks (sandstone and siltstone). The study is conducted on clastic sedimentary rocks of the Belait Formation in northern Labuan.

2 STUDY AREA

Labuan Island is an extension of onshore west Sabah, Brunei and north Sarawak (Liechti *et al*., 1960; Wilson, 1964). Temburong Formation (?Oligocene to Lower Miocene) is the core of anticline, followed by Setap Shale Formation (Miocene) and Belait Formation (Middle Miocene to ?Pliocene). Only Belait Formation which is situated in northern part is studied in this project. Belait Formation consist of conglomerates, sandstones, shale and some coals, gradually change into thinly bedded shales and sandstones to the north (Madon, 1994).

Three Belait Formation outcrops were selected to carry out the study, Kampung Ganggarak, Bukit Kubong and Pantai Layang-Layangan, representing deposition from shallow marine to fluvial and tidal environments. Although the environment of deposition is not uniform, all strata experience same geological history (same age, burial depth and deformation). Therefore differences in tectonic and geological history on joint formation can be minimized and the measurements can be plotted together. Measurements were made on competent sandstone since joints are not well developed in incompetent rocks such as shale. The joints are predominantly mode I (opening mode) fractures that are perpendicular to the bedding.

3 METHODOLOGY

Two types of joint spacing were determined in this study. Joint spacing measured on strata in the field and joint spacing measured from photographs of bedding surfaces using ArcMap software. Joint spacing and layer thickness were measured in the field using measuring tape at suitable outcrops, together with the strike and dip of joints and beddings. The spacing was measured perpendicular to the fracture, parallel to the bedding strata as shown in Figure 1. The thickness of some strata varies laterally. These strata were divided into a few segments of similar thickness. The S/T (spacing/thickness) ratio and FSR (thickness/spacing) ratio are calculated from the bed thickness. FSR is defined as the bed thickness to achieve 1 m mean joint spacing. The S/T ratio is the mean joint spacing for 1 m thick of bed (S/T = 1/FSR). For example, when the mean joint spacing is 1 m in a 1 m thick bed the S/T ratio is 1, and when the mean joint spacing is 0.1 m in a 1 m thick bed, the S/T ratio of 0.1. For the same bed thickness, lower S/T ratio will have closer joint spacing and a higher joint density.

Another approach is also used to measure the joint spacing. The spacing was measured from photographs of bedding surfaces. Outcrops in Pantai Layang-Layangan and Kampung Ganggarak which have bedding surfaces with well developed joints were photographed using a Nikon D800 digital camera. The method involves digitizing of joints observed in photographs using ArcMap to measure the spacing (Figure 2). In the field, points representing the four corners of a 1 m x 1 m right angle square are marked on the bedding surface and one or more photographs were taken. The four points later were used to remove geometric distortion of the photograph and as scale for spacing measurements. A projected coordinate system in meter was used and the coordinates of the four points were defined as (0,0), (0,1), (1,0) and (1,1) during georeferencing. The joints on each photograph were digitized manually in separate polyline shapefiles. The joint polylines were then converted into raster files and the spacings were extracted using ArcMap's Spatial Analyst from rasterized scanlines (Figure 3). The spacing values were imported into Microsoft Excel for further calculations.

Both cumulative spacing and set spacing of the fractures on the bedding surface were measured. The cumulative or general spacing is the distance between two joints along a scanline, irrespective of the joint or scanline orientation. The set spacing is the spacing between two joints belonging the same set measured perpendicularly to the joints, and correction is made to convert the apparent spacing measured in ArcMap to true set spacing using procedure by Ng (1994).

4 RESULTS AND DISCUSSION

4.1 Relationship between joint spacing and bed thickness

Joint spacings measured along the strata are summarized as Table 1. Individual joint spacings were recorded, and the mean and median spacing values were calculated. The thickness of strata used for joint spacing measurement ranges from 0.03 to 2.3 m and most are less than 0.5 m thick. The median and mean joint spacing range from 0.02 m to 0.4 m, and from 0.23 m to 0.515 m, respectively, while the FSR and S/T ratios are from

Figure 1: Measuring joint spacing along strata using measuring tape.

Figure 2: Digitized joint traces ready to be measured using scanline.

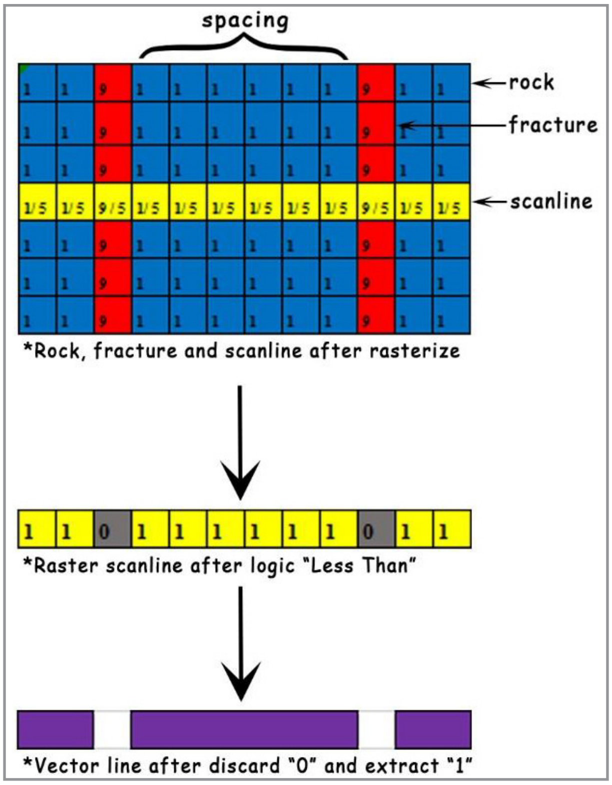

Figure 3: Schematic diagram showing the steps of calculating spacing along a scanline using ArcMap's Spatial Analyst.

0.29 to 4.46 and from 0.22 to 3.46, respectively.

Joint spacing was plotted against the bed thickness. After trying with several types of plots (linear, logarithmic, exponential and power), it was found that exponential law best fit the results with the highest correlation coefficient (Figures 4 and 5). When plotted against mean joint spacing, the coefficient of correlation, R is 0.84. R is 0.88, indicating that median joint spacing correlates with thickness better than with mean spacing. Although the coefficient of correlation values are high, there are some uncertainties in the exponential relationship between bed thickness and joint spacing due to insufficient data from 0.5 m to 2 m thick beds.

Joint spacing increases at a decreasing rate when the thickness of bed increases for spacing with exponential relationship, in contrast with a linear relationship, where the rate of increase is constant. The gradient of the thickness against joint spacing plot is the FSR, whereas the inverse of the gradient is the S/T ratio. The gradient increase when the thickness is increasing, which mean higher FSR and lower S/T ratio.

Relationships between bed thickness and FSR and S/T are shown in Figures 6 and 7. FSR increases with bed thickness (R=0.80) whereas the S/T ratio decreases with thickness (R=0.79), both are best described by a power law. These trends indicate that when bed thickness

Table 1: Summary of joint spacing measurements along strata and the corresponding S/T ratio and FSR ratio.

Sample	**Strata thickness (T/m)**	**Min spacing (m)**	**Max spacing (m)**	**Median spacing (M/m)**	**Mean spacing (S/m)**	**FSR (T/S) ratio**	**S/T ratio**
GBSt1	0.030	0.03	0.36	0.080	0.104	0.29	3.46
GASS3	0.038	0.01	0.10	0.050	0.050	0.76	1.32
GBFS1	0.040	0.03	0.41	0.080	0.108	0.37	2.70
LASS3	0.040	0.07	0.20	0.120	0.120	0.33	3.00
GASS3	0.051	0.04	0.24	0.080	0.088	0.58	1.73
LASS4	0.065	0.03	0.13	0.080	0.071	0.92	1.09
GBSS1	0.070	0.01	0.06	0.020	0.023	3.00	0.33
GASS3	0.076	0.03	0.13	0.060	0.061	1.24	0.80
GASS3	0.127	0.03	0.18	0.085	0.087	1.46	0.69
BKSS1	0.175	0.01	0.21	0.115	0.124	1.41	0.71
BKFUS1	0.200	0.03	0.43	0.070	0.103	1.94	0.52
BKSS1	0.240	0.07	0.24	0.190	0.168	1.43	0.70
GASS1	0.250	0.01	1.05	0.220	0.330	0.76	1.32
BKFUS1	0.300	0.03	0.28	0.155	0.158	1.90	0.53
GASS1	0.320	0.10	0.50	0.200	0.239	1.34	0.75
GASS2	0.350	0.04	0.70	0.200	0.217	1.62	0.62
GASS1	0.350	0.20	0.70	0.200	0.360	0.97	1.03
BKFUS1	0.500	0.04	0.42	0.170	0.185	2.71	0.37
BKSS2	1.130	0.02	0.76	0.340	0.348	3.25	0.31
BKTSS1	2.300	0.20	1.30	0.400	0.515	4.46	0.22
Minimum	0.030	0.01	0.10	0.020	0.023	0.29	0.22
Maximum	2.300	0.20	1.30	0.400	0.515	4.46	3.46

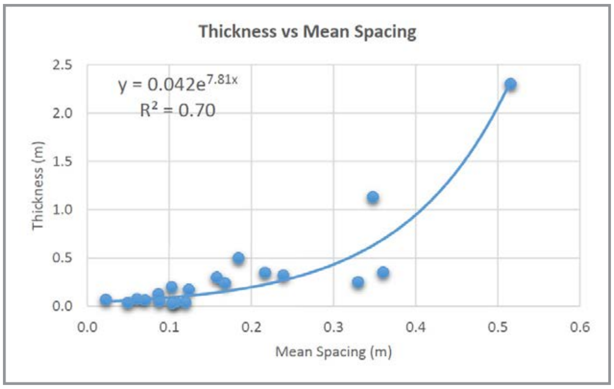

Figure 4: Layer thickness plot against mean joint spacing.

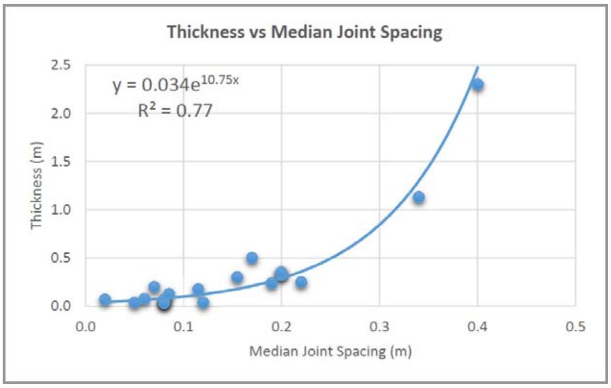

Figure 5: Layer thickness plot against median joint spacing.

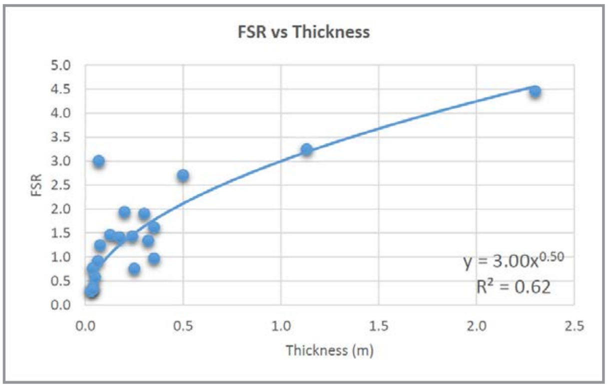

Figure 6: Plot of FSR ratio against bed thickness.

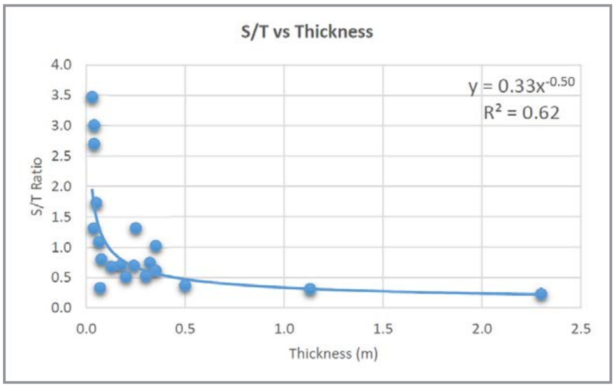

Figure 7: Plot of S/T ratio against bed thickness.

increases, the relative joint density also increases. Even though the joint spacing seems to be wider in thicker beds, the relative joint density of thicker beds is actually higher. This imply that thicker beds is more prone to brittle deformation compare to thinner beds. Thicker beds may have greater strength and higher stress is accumulated before the development of fractures, forming more joints.

4.2 Joint spacing distribution

The aggregated frequency distribution of general spacing from 5 bedding surfaces is shown in Figure 8, and the set spacing frequency distribution in Figure 9. General joint spacing along strata also is plotted in frequency distribution in Figure 10. All the histograms show a decrease in frequency with increasing spacing values.

The general cumulative spacing on bedding surface can be best fitted to a negative exponential distribution ($R = 0.98$) whereas set spacing on bedding surface is fitted with a negative power law ($R = 0.96$). The difference between exponential law and power law is that exponential law will have the frequency decrease at lower rate from one joint spacing class to another, whereas power law will have the frequency decrease at higher rate. Although the R values from the exponential and power equations are high, the equation is not accurate for the extrapolation of joint spacing frequency by substituting the x value in the equation. The equations only fit a few joint spacing classes and beyond that, the frequency (y value) obtained from the equations deviate from the measured frequency data.

The set joint spacing is controlled by the bed thickness, thus the set joint spacing value always clustered around a specific interval. Since the beds where the sets spacing are taken do not cover a wide range of thicknesses, the sets spacing of different beds are almost similar. Thus, beyond the range of value of sets spacing, the frequency of joint spacing drops quickly as defined by negative power law.

The joint spacings measured along strata include all joints, thus it is considered as general cumulative spacing as well. The frequency distribution matches the negative exponential law, as in the general spacing on bedding surfaces. General spacing covers a broader range of spacing classes, thus the frequency decrease is smoother than in sets spacing.

4.3 Fractal distribution of joint spacing

Two methods can be used to identify the fractal distribution of joint spacings; the statistical method and graphical method. Statistical method is performed by plotting the frequency distribution of joint spacing in a logarithmic scale. Graphical method is done by analyzing images of joints using specialized software such as Fractalyse (Frankhauser & Pumain, 2007; Ng & Teh, 2009).

In this study, the statistical method is used. If the joint spacing has fractal relationship, a straight line will be formed when the frequency is plotted in log scale.

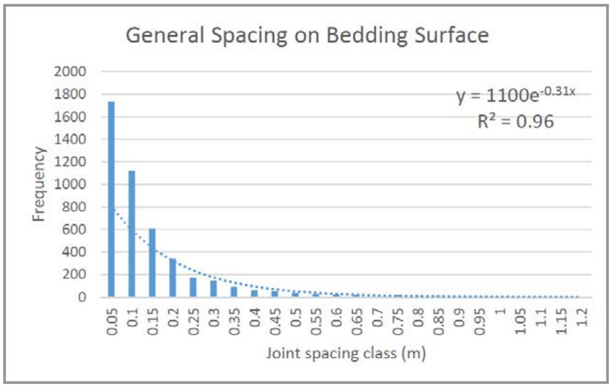

Figure 8: Frequency distribution of general spacing measured on bedding surfaces.

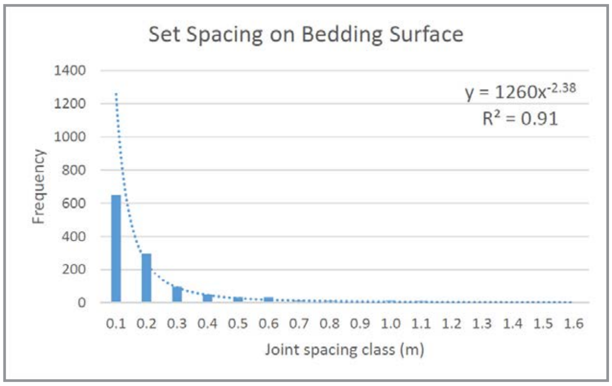

Figure 9: Frequency distribution of set spacing measured on bedding surfaces.

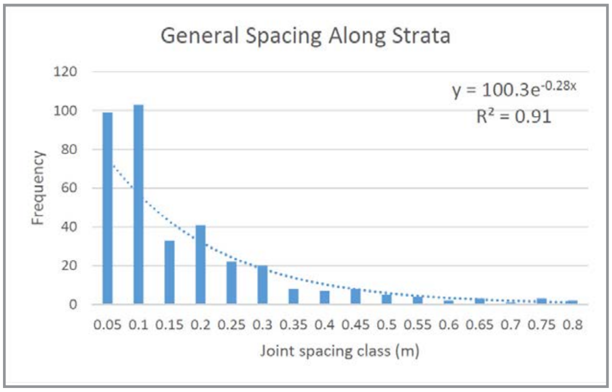

Figure 10: Frequency distribution of general spacing measured along strata.

However, the results show that they do not have fractal relationship, thus only the results from two bedding planes are shown (Figures 11 and 12). The fractal relationship and fractal dimension cannot be used to quantify the relationship between the joint spacing and frequency, and it was shown in earlier section that they are better described using exponential law. The log-log plots show stair-stepping pattern, where for one order of joint spacing the frequency does not vary very much, the frequency increases only when the joint spacing increases an order in magnitude. The reason might be that the joint spacing is controlled by bed thickness thus the joint spacing always clustered around a range of values. The histogram plots of sets spacing in LASS2 and LASS4 (Figure 13) show that set 1 (dominant set) and set 2 spacings are clustered around different values. Also within same set the distribution is not uniform and there tend to be two clusters of different order. The irregular distribution may partly be due to the small spacing population measured.

Cumulative joint aperture plots by Odonne *et al.* (2006) show that the increase in joint aperture is not smooth and has stair-stepping pattern. The joint aperture is controlled by the extent of vertical dimension of a joint. Where the vertical dimension is large, the aperture is larger. The large vertical joint dimension also controls the joint aperture of adjacent small joints by relieving the stress accumulated around it, creating a stress shadow (Odonne *et al.*, 2006). Small joints under the stress shadow will not have sufficient stress to develop, thus has limited joint aperture. Similarly, stresses sufficient to form the next joint are only achieved outside the stress shadow, thus restricting the joint spacing to outside of the stress shadow (van der Pluijm & Marshak, 2004). Referring to Figure 14, the sudden increase in joint aperture in the stair-step pattern is contributed by large vertical dimension joints. Some distance before and after a large joint, we can see the joint aperture is small since they are all within the stress shadow. After some distance away from the stress shadow, larger vertical dimension joints with large aperture

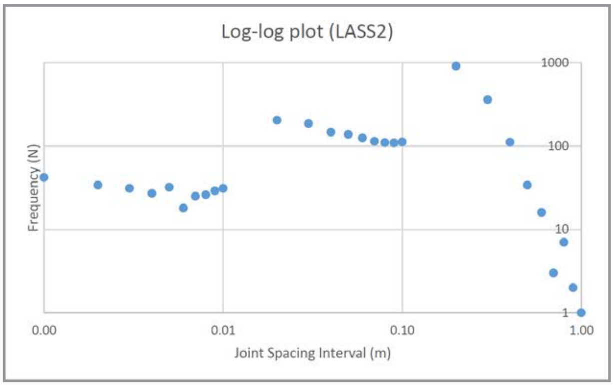

Figure 11: Log-log plot of frequency distribution of joint spacing on bedding plane LASS2.

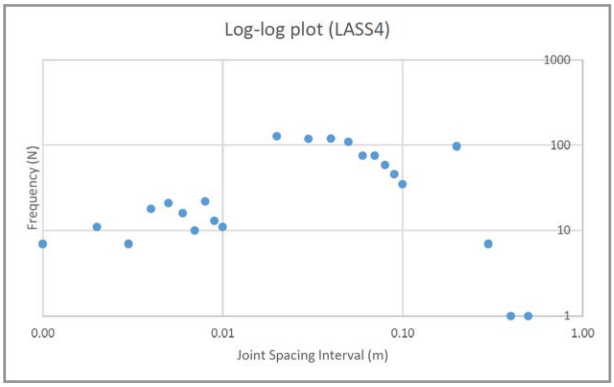

Figure 12: Log-log plot of frequency distribution of joint spacing on bedding plane LASS4.

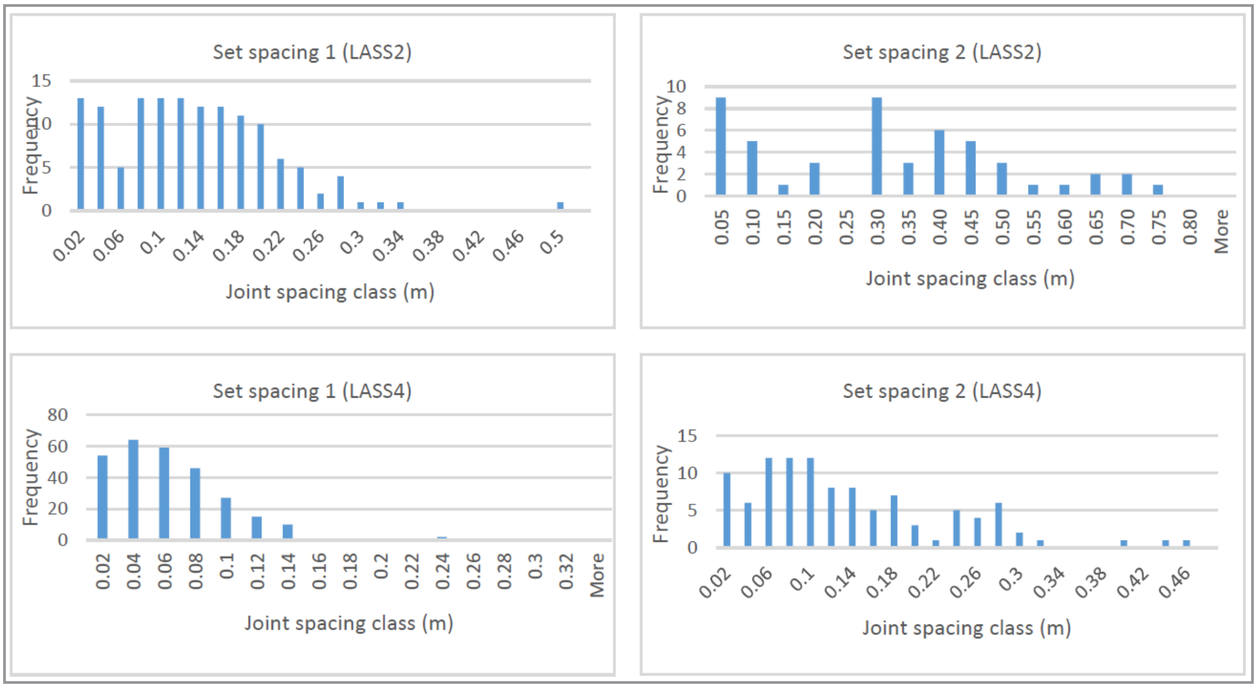

Figure 13: LASS2 set 1 spacing clustered from 0.02-0.04m and 0.08-0.2m, set 2 from 0.05-0.01m and 0.3 to 0.45m. LASS4 set 1 spacing clustered around 0.02-0.08m, set 2 around 0.06 to 0.1m and 0.24 to 0.28m.

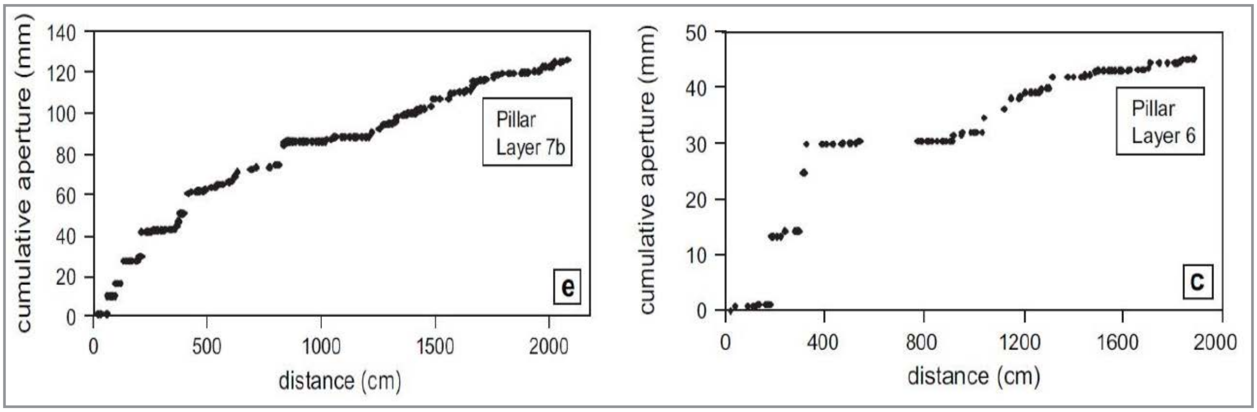

Figure 14: Graph of cumulative joint aperture against distance from starting point (from Odonne *et al*., 2006).

appear again. This is similar to the joint spacing in bedded sedimentary rocks which is controlled by bed thickness. The frequency does not show significant increase for a range of joint spacing, followed by abrupt increase for a range of joint spacing, forming stair-steps. The joint spacing frequency remains unchanged for a set of spacing and only increases in frequency where another range of spacing is of the dominant set. Comparing Figures 11 and 12 with the finding of Odonne *et al*. (2006), one is controlled by bed thickness and whereas the other is controlled by the vertical joint dimension, but both show a similar pattern.

5 CONCLUSION

The relationship between joint spacing and layer thickness and the distribution of the joint spacings of clastic sedimentary rocks of the Belait Formation in northern Labuan were investigated. The focus is on competent sandstone. Joint spacing was measured along the strata in the field. Joints observed in photographs of bedding surfaces with well developed joints were digitized and used to determine the general and set joint spacings using the software, ArcMap.

The general joint spacing measured along the strata increase exponentially with bed thickness. The rate of increase of joint spacing is represented by S/T ratio or FSR ratios. S/T ratio is shown to decrease with increasing thickness while FSR increases with thickness. A low S/T ratio indicates a high relative joint density, so thicker beds have higher relative joint density compared to thinner beds even though the joint spacing increases, and the joints are wider apart.

General joint spacing measured along strata and general spacing on bedding surfaces show negative exponential distribution, while set spacing has power distribution. The reason is that set spacings are clustered around a range of values and controlled by bed thickness. Log-log plots of frequency of joint spacing show non-linear stair-step patterns and do not have fractal distribution.

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Anggaran sokongan berdasarkan sistem pengelasan jasad batuan: kajian kes di terowong keretapi Tenom, Sabah

Ismail Abd Rahim

Unit Kajian Bencana Alam, Universiti Malaysia Sabah, Jalan UMS
88400 Kota Kinabalu, Sabah
Emel: arismail@ums.edu.my; iabdrahim@gmail.com

Abstrak: Objektif kajian ini adalah untuk menentukan kualiti jasad batuan dan seterusnya anggaran sokongan untuk sebuah terowong keretapi satu lorong di daerah Tenom, Sabah menggunakan sistem pengelasan jasad batuan. Kawasan kajian didasari batu pasir tebal teramalgamasi Formasi Crocker yang berusia Eosen Lewat – Miosen Awal. Sistem pengelasan jasad batuan yang dipilih adalah Perkadaran Struktur Batuan (RSR), Perkadaran Jasad Batuan (RMR) dan Sistem Q (Q). Kajian lapangan melibatkan pemetaan geologi dan garis imbasan, sementara kajian makmal adalah analisis petrografi, analisis kinematik, ujian beban titik (point load test) dan analisis data ketakselanjaran. Hasil kajian mendapati kualiti jasad batuan bagi RSR, RMR dan Q, masing - masing adalah 77, sederhana (fair), buruk (poor). Anggaran sokongan bagi sistem RSR adalah 8 kaki jarak kancing batuan (rock bolt) dengan 1 inci semburan konkrit (shotcrete). Sokongan bagi sistem RMR pula adalah 20mm diameter, 4m panjang dan 1.5-2m jarak kancing batuan pada bumbung dan dinding dengan pemasangan jaringan dawai pada bumbung, di samping 50-100mm dan 30mm tebal semburan konkrit, masing-masing pada bumbung dan dinding terowong dan set keluli tidak diperlukan. Bagi sistem Q, 1.4m jarak kancing batuan dengan 40-100mm semburan konkrit yang tidak diperkuat (unreinforced) dianggarkan sebagai sokongan. Sebagai kesimpulan, anggaran sokongan berdasarkan sistem pengelasan jasad batuan di kawasan kajian adalah 20mm diameter, 4m panjang dan 1.5m jarak kancing batuan, 50mm tebal semburan konkrit yang diperkuat serat keluli (reinforce steel fiber shortcrete) dan lubang leleh (weep hole).

Kata kunci: Rock Mass Rating (RMR), Rock Structure Rating (RSR), sistem Q, Formasi Crocker, Tenom

PENGENALAN

Kawasan kajian terletak di sekitar kawasan terowong keretapi Tenom, Sabah yang didasari unit batu pasir tebal teramalgamasi dan selang-lapis batu pasir dan syal Formasi Crocker berusia Eosen Lewat – Miosen Awal (Rajah 1 dan Foto 1). Unit batu pasir tebal terdiri dari wak litik berbutiran sederhana (Fotomikro 1), berketebalan sehingga 3m dan berkeadaan segar hingga terluluhawa sedikit. Unit selang lapis batu pasir dan syal pula berketebalan sekitar 10-50sm. Batu pasir terdiri daripada wak litik berbutiran halus (Fotomikro 2) dan sedikit terluluhawa.

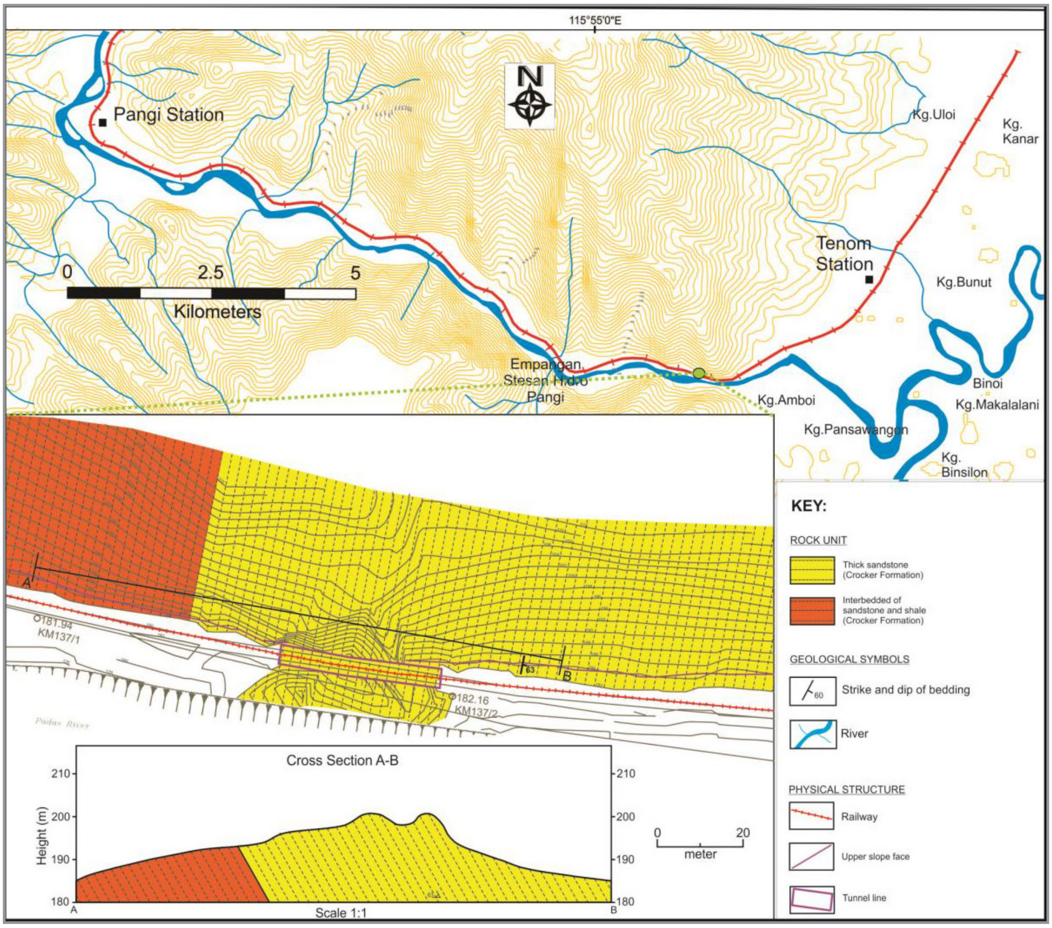
Sejak pembinaan terowong keretapi 42.69m panjang, 4.4m lebar dan 4.6m tinggi di dalam unit batu pasir teramalgamasi pada tahun 1905, belum pernah berlaku sebarang kejadian runtuhan atau jatuhan blok major sepanjang terowong ini. Bagaimanapun, kehadiran satah ketakselanjaran (Foto 2) dan kesan tirisan air pada dinding dan lantai (Foto 3) terowong telah menyebabkan kajian ini dijalankan.

Objektif kajian ini adalah untuk menentukan kualiti jasad batuan dan seterusnya menentukan anggaran sokongan untuk terowong keretapi satu lorong tersebut menggunakan sistem pengelasan jasad batuan iaitu sistem Perkadaran Struktur Batuan, RSR (Wickham *et al.*, 1972), Perkadaran Jasad Batuan, RMR (Bieniawski, 1989) dan Sistem Q (Barton *et al.*, 1974).

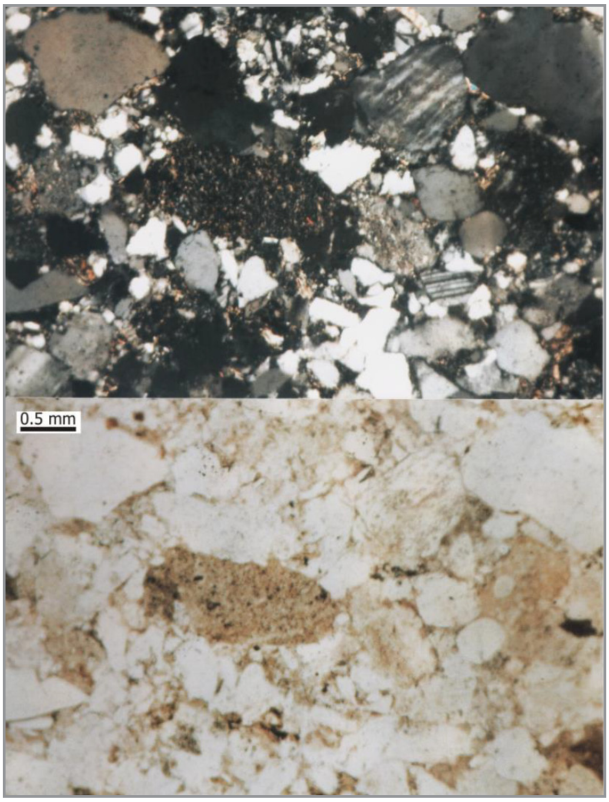
Foto 1: Batu pasir tebal teramalgamasi Formasi Crocker.

METODOLOGI

Metodologi kajian ini melibatkan kajian awal, lapangan dan makmal. Kajian awal melibatkan penyediaan peta dasar, helaian data ketakselanjaran dan kajian fotograf udara. Kajian lapangan pula melibatkan pemetaan geologi dan garis imbasan (scan line) (ISRM, 2007), sementara kajian makmal adalah kajian petrografi, analisis kinematik (Markland, 1972), ujian beban titik (point load test) (ISRM, 2007) dan analisis data ketakselanjaran untuk sistem RSR, RMR dan Q.



Rajah 1: Lokasi dan peta geologi kawasan kajian.



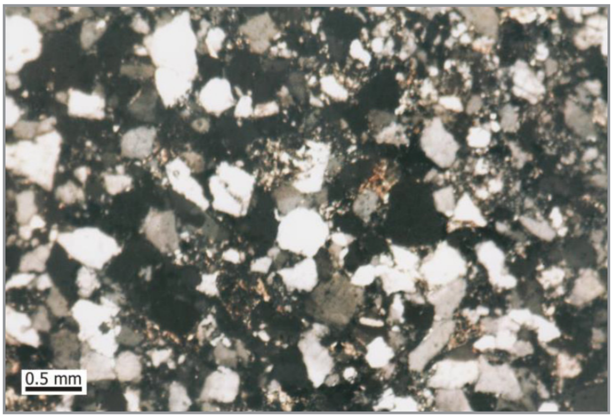
Fotomikro 1: Litik wak berbutiran sederhana Formasi Crocker. Pandangan Nikol silang (atas) dan Nikol selari (bawah).

Terdapat tiga (3) parameter yang ditentukan untuk RSR iaitu geologi am kawasan, geometri (kesan corak ketakselanjaran) dan keadaan air bawah tanah serta kekar. Sebanyak enam (6) parameter yang ditentukan untuk RMR iaitu kekuatan mampatan ekapaksi (UCS), Petanda Mutu Batuan (RQD), jarak ketakselanjaran, keadaan ketakselanjaran dan orientasi ketakselanjaran.

UCS untuk RMR adalah merujuk kepada kekuatan utuh bahan batuan pembentuk cerun yang diperolehi daripada nilai kekuatan utuh bahan batuan melalui ujian beban titik menggunakan pendekatan Unit Ketebalan Litologi (Ismail Abd Rahim *et al.*, 2009). RQD ditentukan melalui data ketakselanjaran menggunakan kaedah Deere *et al.* (1967), sementara jarak ketakselanjaran menggunakan kaedah purata jarak set ketakselanjaran (Ismail Abd Rahim, 2011). Keadaan ketakselanjaran dan aliran air pula menggunakan kaedah purata (Ismail Abd Rahim, 2011). Orientasi ketakselanjaran pula dianalisis menggunakan kaedah Bieniawski (1989).

Parameter yang terkandung dalam sistem Q adalah saiz blok (RQD/J_n), kekuatan ricih antara-blok (J_r/J_a) dan tegasan aktif (J_w/SRF) di mana J_n - bilangan set ketakselanjaran; J_r - bilangan kekasaran ketakselanjaran; J_a - bilangan ubahan ketakselanjaran; J_w - faktor pengurangan air ketakselanjaran dan SRF - faktor pengurangan tegasan.

Kaedah penentuan anggaran sokongan adalah berdasarkan nilai perkadaran yang telah ditetapkan dalam



Fotomikro 2: Litik wak berbutiran halus Formasi Crocker. Pandangan Nikol silang.

Foto 2: Kekar bukan sederhana.

Foto 3: Kesan tirisan air pada dinding (kiri) dan dasar (kanan) terowong.

sistem Perkadaran Struktur Batuan, RSR (Wickham *et al.,* 1972), Perkadaran Jasad Batuan, RMR (Bieniawski, 1989) dan Sistem Q (Barton *et al.,* 1974).

KEPUTUSAN DAN PERBINCANGAN

Terdapat enam (6) set satah ketakselanjaran sepanjang terowong ini (Rajah 2 dan 3). Hasil ujian Markland (Markland, 1972) menunjukan ragam kegagalan yang berpotensi adalah kegagalan baji (persilangan kekar 1 dan 4) dan kegagalan satah (masing-masing kekar 3 dan 5) di kiri dan kanan dinding terowong (Rajah 4).

Ujian beban titik (ISRM, 1981) pula menunjukan kekuatan batuan utuh wak litik berbutiran sederhana kasar adalah kuat (94.88 MPa). Memandangkan 97% daripada kawasan terowong terdiri daripada wak litik sederhana kasar maka nilai UCS (kekuatan batuan utuh bahan batuan pembentuk cerun) menggunakan LUT (Ismail Abd Rahim *et al*., 2009) adalah kuat (95MPa).

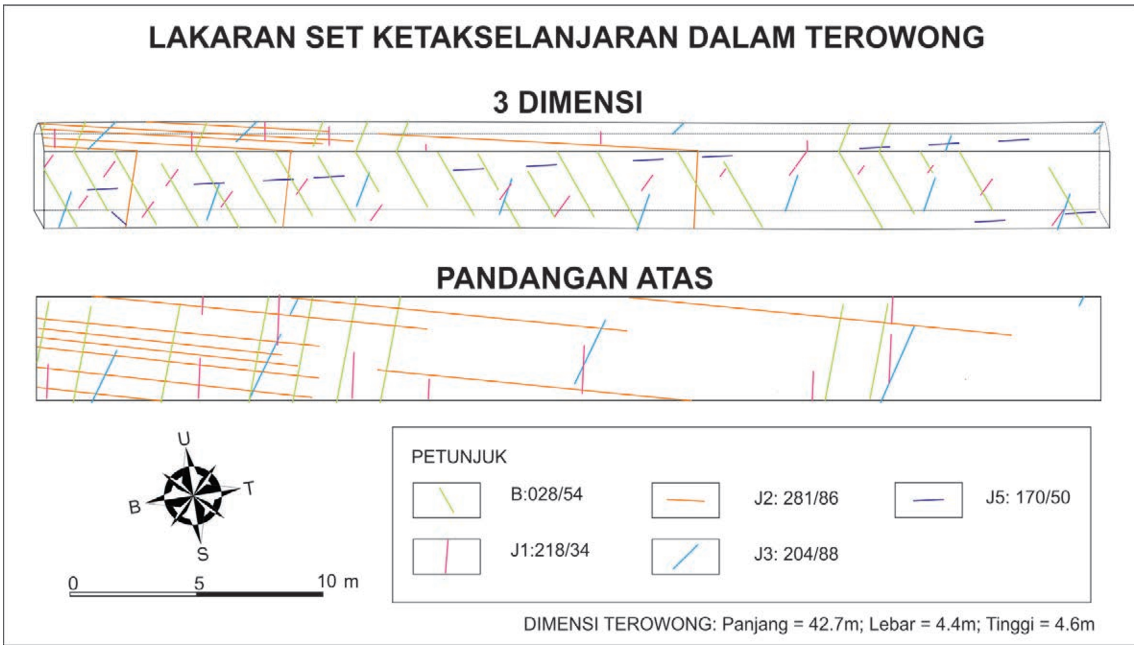
Hasil kajian pengelasan jasad batuan pula mendapati kualiti jasad batuan untuk RSR, RMR dan Q, masing-masing adalah 77 (Jadual 1), sederhana (fair) (Jadual 2) dan buruk (poor) (Jadual 3).

Berdasarkan nilai RSR (77), batuan di kawasan kajian terdiri dari batuan sedimen yang berkekuatan sederhana, terlipat dan tersesar sederhana, berjarak ketakselanjaran melebihi 4 kaki, arah kemiringan satah ketakselanjaran yang paling dominan adalah selari dan bersudut dengan paksi terowong, mengandungi sedikit aliran air dan keadaan ketakselanjaran yang sederhana.

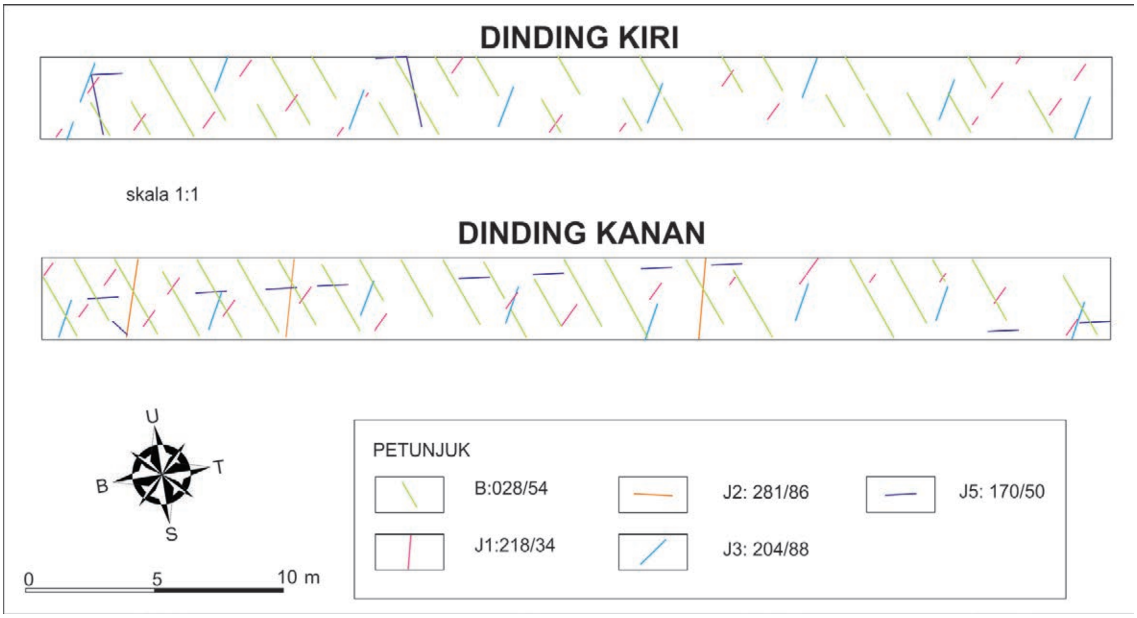
Nilai RMR pula menunjukan kualiti jasad batuan yang sederhana (kelas III) di mana kekuatan mampatan ekapaksi (UCS) adalah kuat, saiz blok yang sederhana serta jarak ketakselanjaran yang sangat jarang. Keadaan ketakselanjaran pula menunjukan permukaan yang kasar, berketerusan tinggi, pisahan sempit dan dinding yang tidak terluluhawa. Tiada aliran air di dalam dan permukaan jasad batuan di samping orientasi ketakselanjaran yang sederhana sesuai.

Parameter dalam sistem Q pula menunjukan kualiti jasad batuan yang buruk (3.48) di mana saiz blok adalah sederhana tetapi bilangan set satah ketakselanjaran adalah melebihi empat (4). Kekuatan ricih antara blok pula adalah tinggi kerana permukaan ketakselanjaran yang kasar dan tidak terluluhawa. Bagaimanapun, tegasan aktif adalah tinggi pada jasad batuan berlaku akibat kehadiran zon ricih yang meningkatkan faktor pengurangan tegasan (SRF).

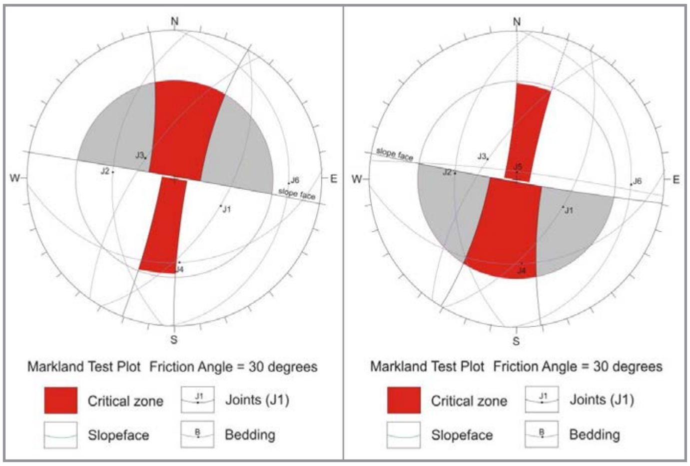
Berdasarkan Wickham *et al*. (1972), anggaran sokongan bagi sistem RSR adalah 8 kaki jarak bagi 1 inci diameter kancing batuan (rock bolt) dengan 1 inci semburan konkrit (Rajah 5). Bagi sistem RMR



Rajah 2: Lakaran dan set kekar dalam tiga (3) dimensi dan pandangan dari bahagian atas terowong.



Rajah 3: Lakaran dan set kekar pada bahagian kiri dan kanan dinding terowong.



Rajah 4: Hasil ujian Markland dan ragam kegagalan. Kiri dan kanan, masing-masing mewakili bahagian kiri dan kanan dinding terowong.

Jadual 1: Nilai perkadaran dan kualiti jasad batuan untuk sistem RSR (Wickham *et al.*, 1972).

Parameter	**Huraian**	**Perkadaran**
A	Batuan sedimen; kekuatan sederhana; terlipat dan tersesar sederhana	15
B	>4 kaki jarak ketakselanjaran; arah kemiringan searah dengan paksi terowong dan bersudut	43
C	58 nilai perkadaran kualiti jasad batuan; sedikit aliran air; keadaan ketakselanjaran sederhana	19
Nilai Perkadaran RSR		**77**

Jadual 2: Nilai perkadaran dan kualiti jasad batuan untuk sistem RMR (Bieniawski, 1989).

Parameter	**Huraian**	**Perkadaran**
UCS	94.88 MPa (Sederhana kuat)	7
RQD	98% (Sangat baik)	20
Jarak DC	4.97m (Sangat jarang)	20
Keadaan DC	Keterusan tinggi; sempit; sedikit kasar; bersih; tidak terluluhawa	20
Aliran air	Kering	15
Orientasi DC	Sederhana sesuai	-25
Nilai Perkadaran RMR		**57 (Sederhana)**

Catatan: DC-ketakselanjaran

Jadual 3: Nilai perkadaran dan kualiti jasad batuan untuk sistem Q (Barton *et al.*, 1974).

Parameter	**Huraian**	**Perkadaran**
RQD	98% (Sangat baik)	98
J_n	4 set DC dengan DC rawak	15
J_r	Kasar dan tidak seragam, beralun	3
J_a	Belum terubah, keras, tidak dilembutkan, isian tidak telap	0.75
J_w	Pengorekan kering atau aliran dalaman minima iaitu < 5 l/m secara tempatan	1
SRF	Multi zon ricih dalam batuan kompeten (bebas lempung), sekitar batuan adalah longgar (sebarang kedalaman)	7.5
ESR	Terowong keretapi	1.2-1.3
Nilai Perkadaran Q		**3.48 (buruk)**

Catatan: DC-ketakselanjaran; l-liter; m-meter

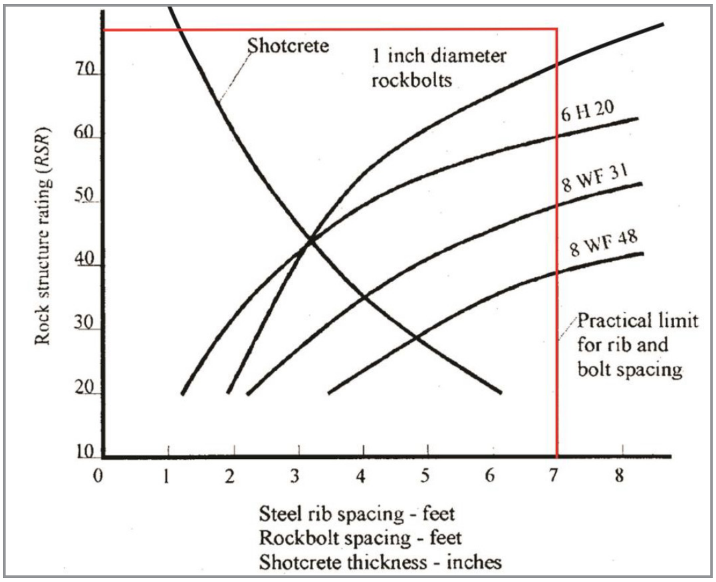
(Bieniawski, 1989), anggaran sokongan adalah 20mm diameter, 4m panjang dan 1.5-2m jarak kancing batuan pada dinding dan bumbung dengan pemasangan jaringan dawai pada bumbung, 50-100mm dan 30mm tebal semburan konkrit, masing-masing di bumbung dan dinding terowong dan tidak memerlukan set keluli. Sementara untuk sistem Q, 1.4m jarak kancing batuan dengan 40-100mm semburan konkrit yang tidak diperkuat (unreinforced) dianggarkan sebagai sokongan (Rajah 6).

Berdasarkan ketiga-tiga sistem pengelasan jasad batuan yang digunakan, anggaran sokongan bagi terowong keretapi yang terdapat di kawasan kajian adalah 20mm diameter, 4m panjang dan 1.5m jarak kancing batuan, 50mm tebal semburan konkrit yang diperkuat serat keluli dan pemasangan lubang leleh pada tempat terpilih (Rajah 7).

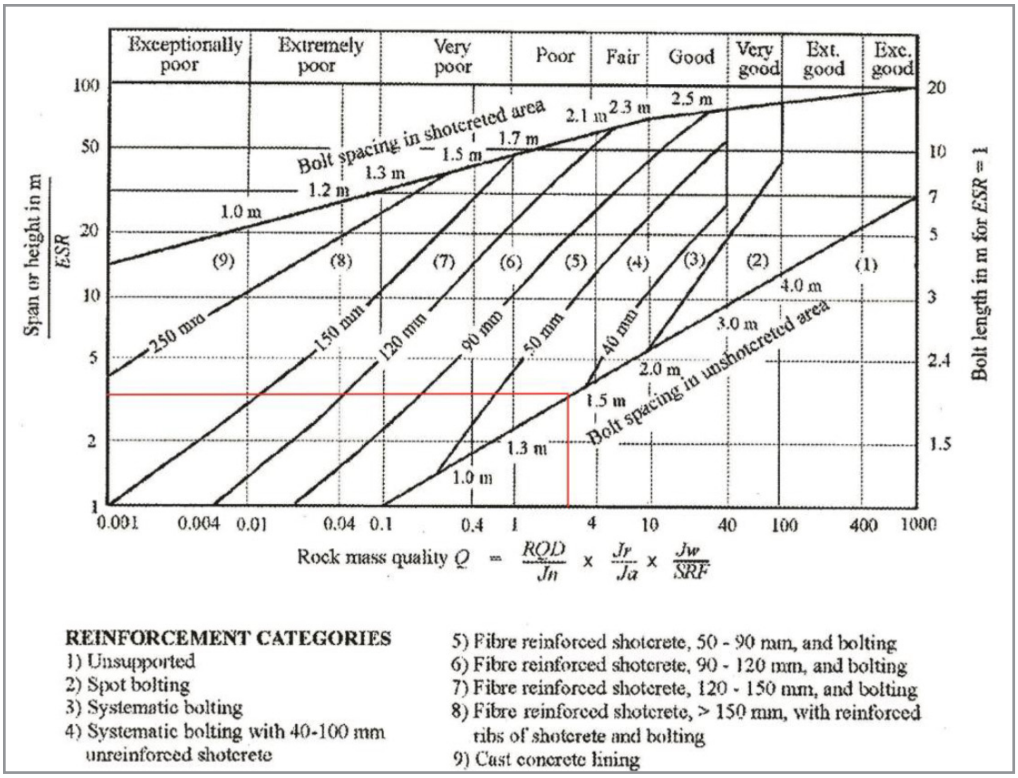
KESIMPULAN

Kesimpulan kajian adalah;

1. Kualiti jasad batuan bagi sistem RSR, RMR dan Q, masing-masing adalah 77, sederhana (kelas II) dan buruk.
2. Anggaran sokongan bagi sistem RSR adalah 7 kaki jarak dan 1 inci diameter kancing batuan (rock bolt) dengan 1 inci semburan konkrit (shotcrete).
3. Anggaran sokongan bagi sistem RMR adalah 20mm diameter, 4m panjang dan 1.5-2m jarak kancing batuan pada bumbung dan dinding dengan pemasangan jaring dawai pada bumbung, di samping 50-100mm dan 30mm tebal semburan konkrit, masing-masing di bumbung dan dinding terowong dan tidak memerlukan set keluli.
4. Sokongan bagi sistem Q adalah 1.4m jarak kancing



Rajah 5: Anggaran sokongan untuk RSR (Wickham *et al.*, 1972). Garis merah merujuk kepada nilai di kawasan kajian.



Rajah 6: Anggaran sokongan untuk sistem Q (Barton *et al.*, 1974). Garis merah merujuk kepada nilai di kawasan kajian.

batuan dengan 40-100mm semburan konkrit yang tidak diperkuat (unreinforced).

5. Cadangan anggaran sokongan berdasarkan sistem pengelasan jasad batuan di kawasan kajian adalah 20mm diameter, 4m panjang dan 1.5m jarak kancing batuan, 50mm tebal semburan konkrit yang diperkuat serat keluli dan lubang leleh.

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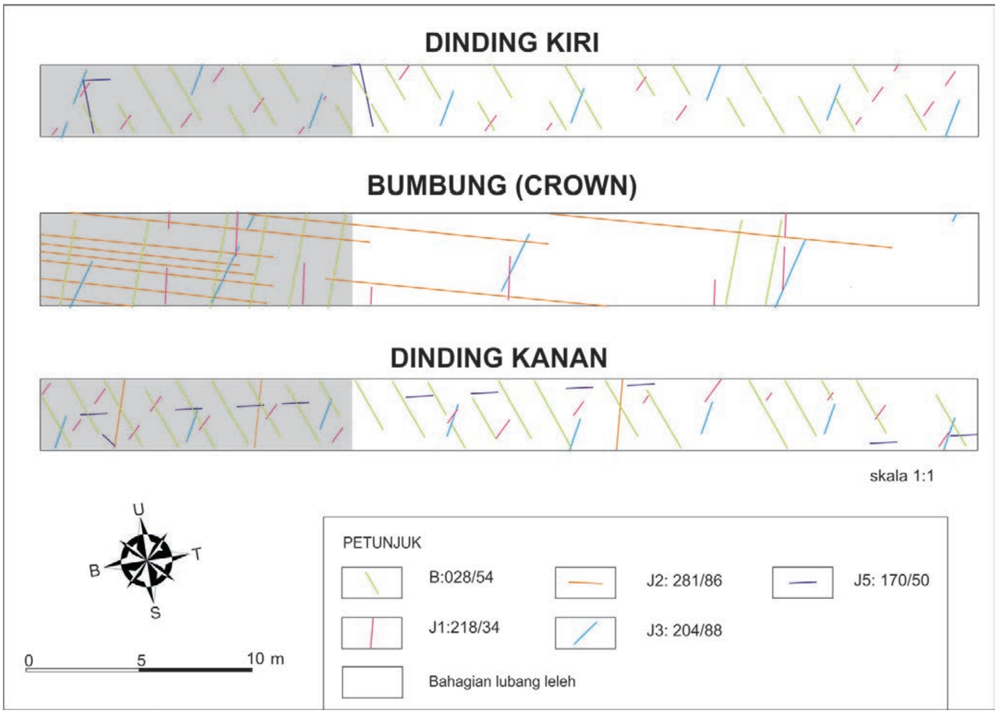

Rajah 7: Bahagian yang dicadangkan untuk pemasangan lubang leleh.

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Examples of fault architecture and clay gouging in Neogene clastics of the Miri area, Sarawak

Franz L. Kessler[1] & John Jong[2]

[1] Goldbach Geoconsultants O&G and Lithium Exploration, Germany
Email address: franzlkessler32@gmail.com
[2]JX Nippon Oil and Gas Exploration (Deepwater Sabah) Limited
Email address: jjong2005@gmail.com

Abstract: The greater Miri area offers particularly well-exposed examples of fault geometry and clay gouging. Such data are important analogues for predicting, or to simulating pressure and retention of hydrocarbon columns in fields in Brunei, Sabah and Sarawak. This short paper focuses on two excellent outcrop areas, where measurements were dominantly carried out on normal faults. Our fieldwork suggests a good correlation between normal fault throw, and gouge thickness. The studied outcrops offer further research potential in the areas of gouge mineralogy, gouge stratification and pressure retention.

Keywords: faults, clay gouging, sealing, Neogene, oil and gas

INTRODUCTION

Figure 1 shows the regional structural elements of NW Sarawak. The Miri area is characterized by moderately folded siliciclastics of Neogene age: The Late Miocene Miri and Lambir Formations, and the Pliocene Tukau Formation as illustrated in Figure 2. A simplified litho-stratigraphy scheme of the study area is shown in Figure 3.

The Tukau Formation unconformably overlies the Lambir Formation and is formed by intertidal clastics, in particular tidal channel deposits that appear strongly amalgamated, and are interbedded with silty laminated beds. Individual channel beds are often characterized by 'side-stepping' and asymptotic foresets, in which laminae can consist of thin, gray claystone or lignite (Kessler & Jong, 2015 & 2016).

The Mid-Late Miocene Lambir and Miri Formations form the crestal area of the Bukit Lambir and Miri Hills (Figure 1). These formations contain about equal amounts of claystone and sandstone, the latter mainly formed by (sometimes nested) tidal channels and beach bars.

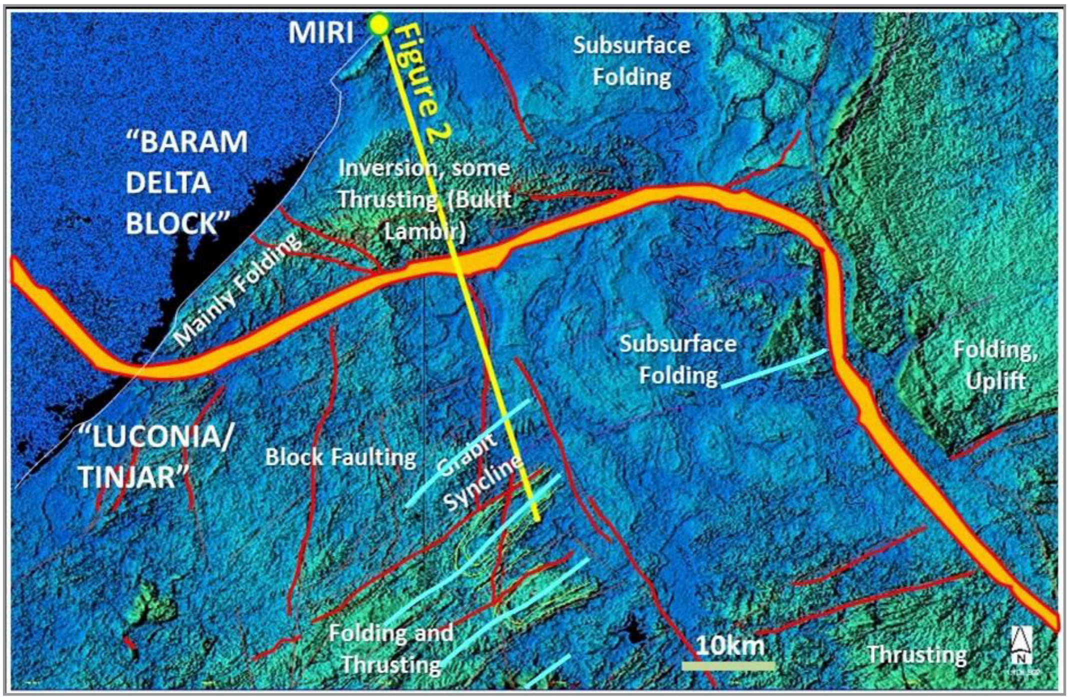

Figure 1: Regional structural elements of NW Sarawak. The orange Baram Line constitutes an important facies boundary, with carbonates dominating in Luconia/Tinjar and clastics in the Baram Delta Block. Inversion features such as Bukit Lambir is seen along the lineament. From Kessler & Jong (2015).

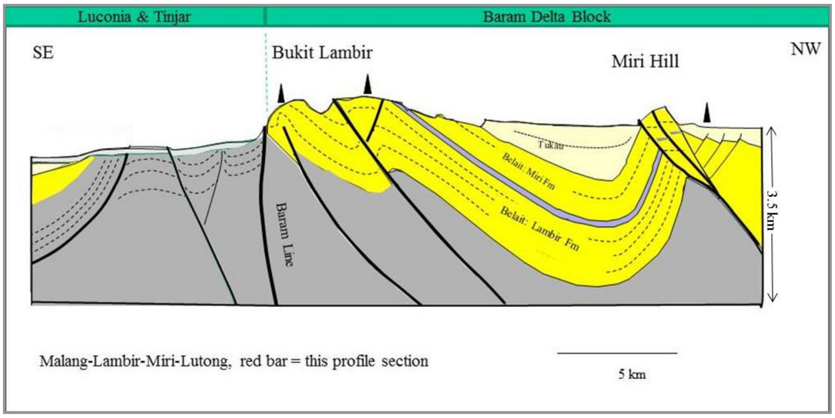

Figure 2: Tectonic/stratigraphic cross-section showing folded Neogene sediments. See Figure 1 for line location. From Kessler & Jong (2016).

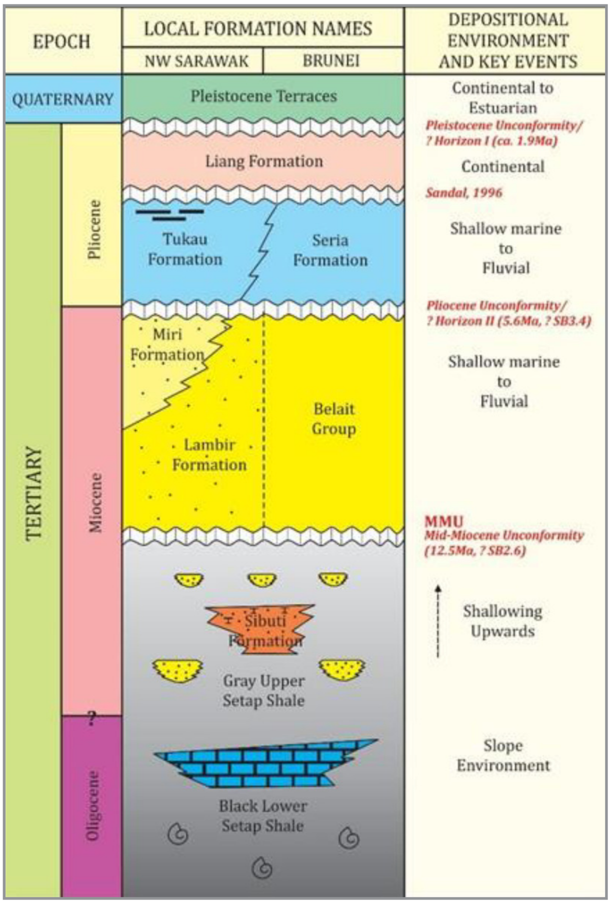

Figure 3: Simplified litho-stratigraphy scheme of the study area. The nomenclature of Miri Formation is generally used in the Greater Miri area and is age-equivalent to the upper section of the Lambir Formation, Sandal (1996) however, placed the formation partially age-equivalent to the lower Tukau Formation. Likewise, the mid Early Miocene Sibuti Formation is more locally confined with the Subis Limestone Member in the lower part of the formation located along the central anticlinorium of the Sibuti Formation (Banda & Honza, 1997). Carbonates are also widespread in the Palaeogene section, and are seen in a number of outcrops and wells (e.g., Batu Niah, Engkabang-1; Jong *et al*., 2016). Note the unconformity between Tukau/Seria and Liang Formations was not observed in this study but in Brunei has been documented by Sandal (1996). From Kessler & Jong (2015).

Most channels are 'reworked' and strongly amalgamated (Kessler & Jong, 2015 & 2016).

This paper focuses on the study of fault geometry and clay gouging from two excellent outcrops areas, the faults are predominantly normal and we couldn't prove a strike–slip component with certainty.

METHODOLOGY

Fieldwork in the mentioned outcrops was carried out as follows:

- Detailed mapping of the areas surrounding the faulted sequences;
- Measurement of fault cut, and thickness of gouging material;
- Calculation of fault cuts and clay gouge ratio;
- Photographic documentation and selective sampling.

Outcrop located near the Coastal Road/Tusan Beach Junction (Figure 4)

The coastal Miri-Bintulu road transects, near the Tusan Junction some 40 km South of Miri, show a series of normal faults, vested in an 80^0 dipping clastic sequence belonging to the Tukau Formation (Figures 5 and 6). The contact with the underlying Miocene Lambir Formation is not exposed, but likely overprinted by faulting. The outcrop shows beautiful examples of clay gouging, fault drag and brecciation. Faults have been measured and correlated, and clay gouging indicates a correlation between gouging thickness and fault throw (Figure 7). Development of fault rock (Figure 8) occurs within competent (hence brittle) sandstone units, regardless of hanging wall or footwall position, whereas clay bodies react in a ductile fashion and show fault drag. It was also found that gouging occurs in any type of fault and at almost any scale, and the gouging material can be coal and/or sand (Figure 9).

Outcrop at Jalan Mukah in Miri (Figures 10 and 11)

This outcrop shows a world-class example of a normal fault, and is expressed in the C-sand section of the Late Miocene Miri Formation. A litho-stratigraphic correlation between the hanging wall and footwall suggests a fault throw of 40-50m. The hanging wall is characterized by a buckling of the strata (Figure 12), which is quite common in deltaic/growth fault settings. We also observe materials from discrete hanging wall layers being drawn into the fault plane (Figures 11 and 12). The gouge material is layered, with the layers occurring parallel to the fault plane, consisting of up to 80% clay.

DISCUSSION AND IMPLICATION FOR FURTHER STUDIES

As mentioned above, the greater Miri area offers many particularly well exposed fault outcrops. But why should one spend resources studying fault seal and retention capability? The answer is simple, the success of secondary oil recovery, or enhanced oil recovery may depend on a proper understanding of fault seal and pressure retention. In a Sabah example (Figure13), several layered reservoirs are shown (in yellow, with average pressure). The claystone intervals (grey) are of variable thickness, and the minimum proven pressure retention potential is highlighted in red. A persistent pressure jump of 500 psi is observed from sand reservoirs in the block of Wells 1and 2, and is compared to the block of Well 3. Although pressure is seen increasing by layer and depth, the pressure build-up is controlled by the fault between Well 2 and Well 3. This is probably a clay-gouged fault (displacement is omitted here), and based on the pressure differential may have a maximum sealing capacity in the order of 500 psi.

Faults, such as the Jalan Mukah example, may not be resolved on seismic and is therefore invisible on a seismic section. However, a lateral seal as shown will be sufficient to affect the distribution of pressure and liquids. Therefore, some so-called 'well-imaged' or 'well-understood' oil and gas fields of Northern Borneo may be far more segmented than seismic may suggest. Pressure boundaries may only appear when pressure is drawn further down after years of production.

Figure 4: Satellite picture indicating the outcrop area (red oval) at the Coastal Road/ Tusan Beach Junction.

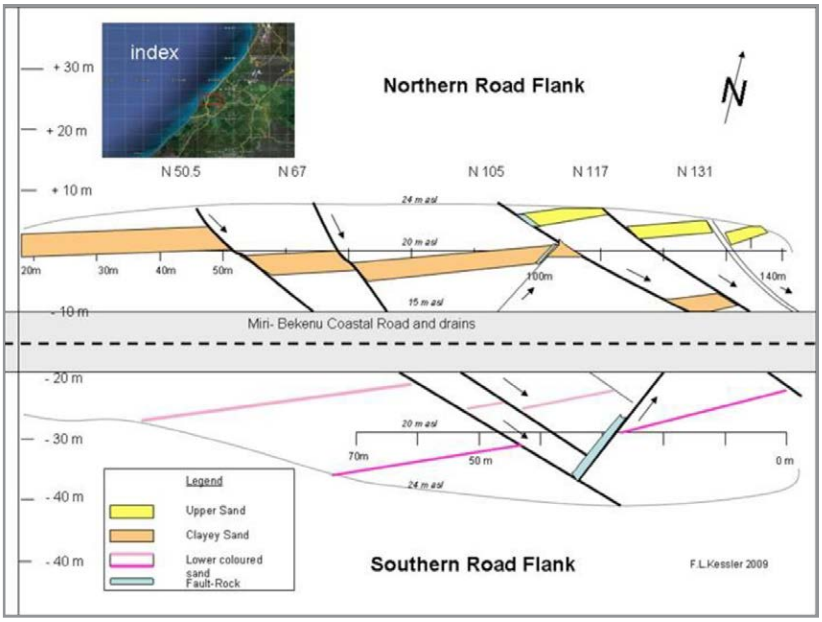

Figure 5: Outcrop section. Note that the rocks are dipping 80^0 to the west and gives the outcrop a 'map-view' flavour. From Kessler & Jong (2010), and Kessler *et al.* (2010).

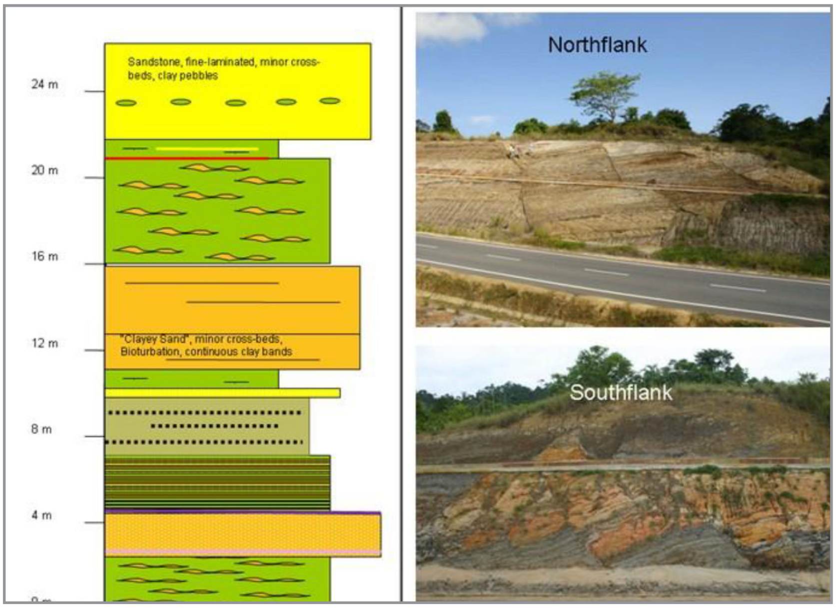

Figure 6: Both flanks of the road outcrops. Take note that the oldest part of the stratigraphic sequence is found on the crest of the south flank, and the youngest on the crest of the north flank. The sedimentary deposits as shown belong to the Pliocene Tukau Formation and are of intertidal origin. From Kessler & Jong (2010), and Kessler *et al*. (2010).

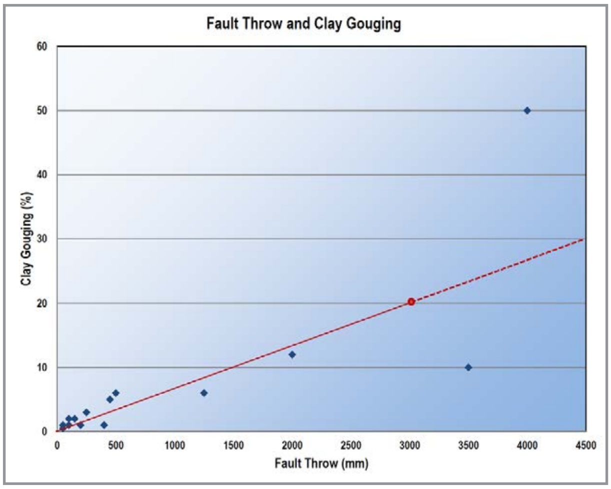

Figure 7: Small fault throws result in thin layers of clay gouging, whereas large fault throws offer thick layers of clay smear. Note the lack of data points for fault throws of more than 2000mm resulted in an unreliable trend line for throw values of more than 3000mm. Nonetheless, this trend may be substantiated further with more data, and may be useful to predict potential hydrocarbon columns in fault-traps. Data from Kessler *et al*. (2010).

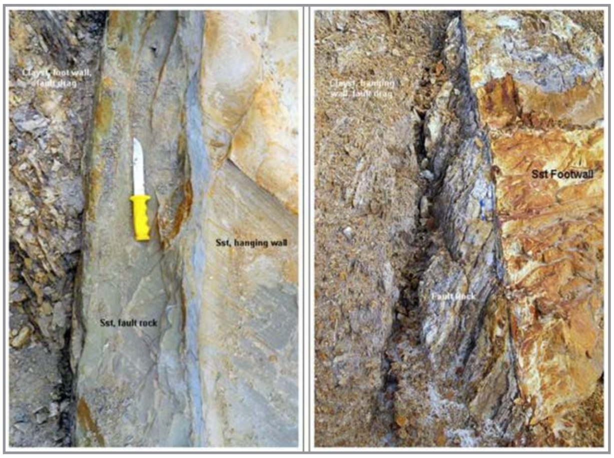

Figure 8: Lateral fault sealing is further complicated by the presence of fault rock common for brittle material. Clay gouging is observed between claystone and fault rock, and between fault rock and the tectonically unaffected part of the sandstone bodies. In the studied outcrop, fault rock is formed in major sandstone bodies, regardless of in hanging wall, or footwall position. From Kessler *et al*. (2010). The authors intend to further investigate clay gouge sealing capacity, and calibrate the outcrop data with modeling tool such as FaultRisk™.

Fault sealing capability is also important in the context of overpressured reservoirs. A relatively weak lateral seal can retain a significant oil or gas column, but only a very short overpressured gas column, as shown in Figure 14. A potential length of a hydrocarbon column is defined by the 'gradient space' left between reservoir pressure and the lithostatic fracture gradient (red vertical stripes). The fracture gradient is mostly inferred from a few leak-off test points in the shallow well section (these pressures are mostly lower than the actual fracture pressure), and (less precisely, though) by mud-weight data. The blue gradient in Figure 14 represents hydrostatic pressure gradient, the green line a moderately elevated pressure gradient. Hard overpressures, when developing over a short depth range are notorious for retaining only short gas columns.

By cross-plotting the values of Shale Gouge Ratio (SGR), a measure of the percentage of shale and clay in the slipped interval of a fault (Yielding *et al*., 1997), and across-fault pressure difference (Bretan *et al*., 2003), we can estimate the fault seal retention pressure, which in turn can be used to estimate the potential hydrocarbon column in a particular fault compartment (Figure 15). In a nutshell, fault seal research in the context of field work, gouge mineralogy and simulation can be an important avenue to better understand hydrocarbon accumulations.

Figure 9: Gouging occurs in any type of fault and at almost any scale. In this section the gouging material is coal and sand. Note a keychain is placed for scale.

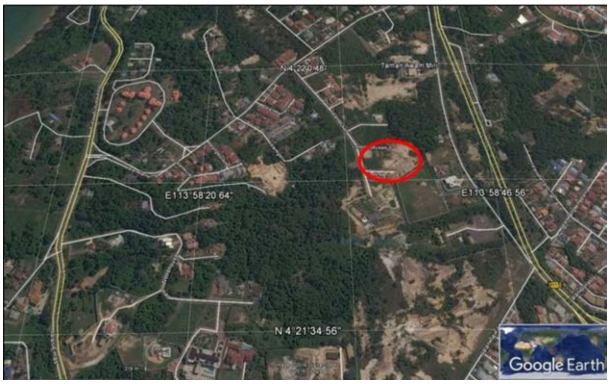

Figure 10: Area of excellent fault exposure, Miri Hills in Miri, in walking distance from Taman Awam.

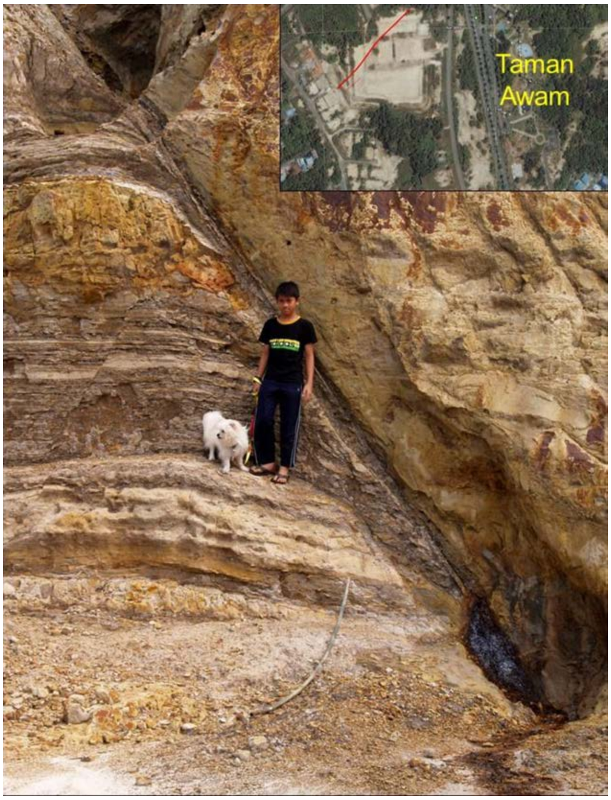

Figure 11: The Jalan Mukah fault, here in section view, is one of the biggest faults on the Miri Hills. The gouging material consists of layered clay and sand. Inset map shows the location of the fault marked in red.

Figure 12: The Jalan Mukah outcrop is particularly useful because one can observe and measure the fault in both section and map view.

ACKNOWLEDGEMENTS

We thank Mr. Hajime Kusaka, GM Exploration at JX Nippon in Miri (2009-2011) for sponsoring and endorsing field studies. This study has benefited from the discussion with Dr. Titus Murray, a fault seal expert whom we had visit the outcrops and conduct a field course. We also thank our reviewers Dr. Mike Scherer and Mr. Steven Barker for their constructive reviews that enhanced the quality of this manuscript.

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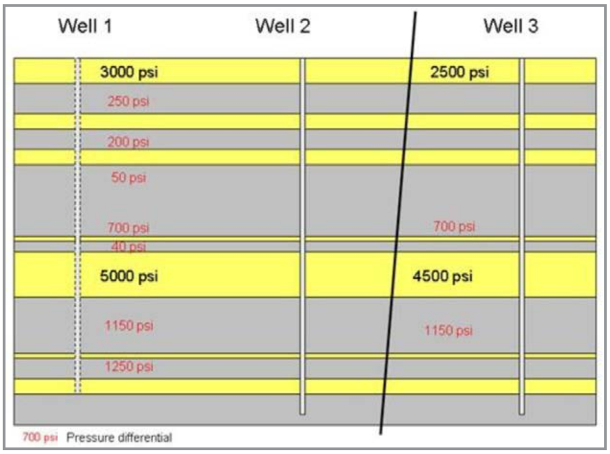

Figure 13: A Sabah example of fault seal and pressure retention. See text for further explanation.

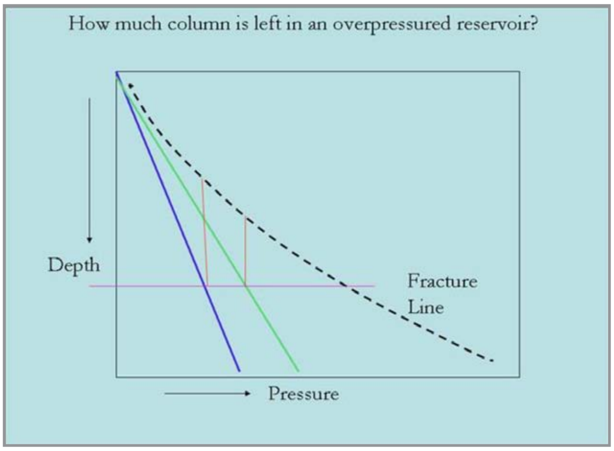

Figure 14: An example of depth versus pressure plot for estimation of hydrocarbon column lengths, where the potential length of a hydrocarbon column is defined by the 'gradient space' left between reservoir pressure and the lithostatic fracture gradient (red vertical stripes). See text for further explanation.

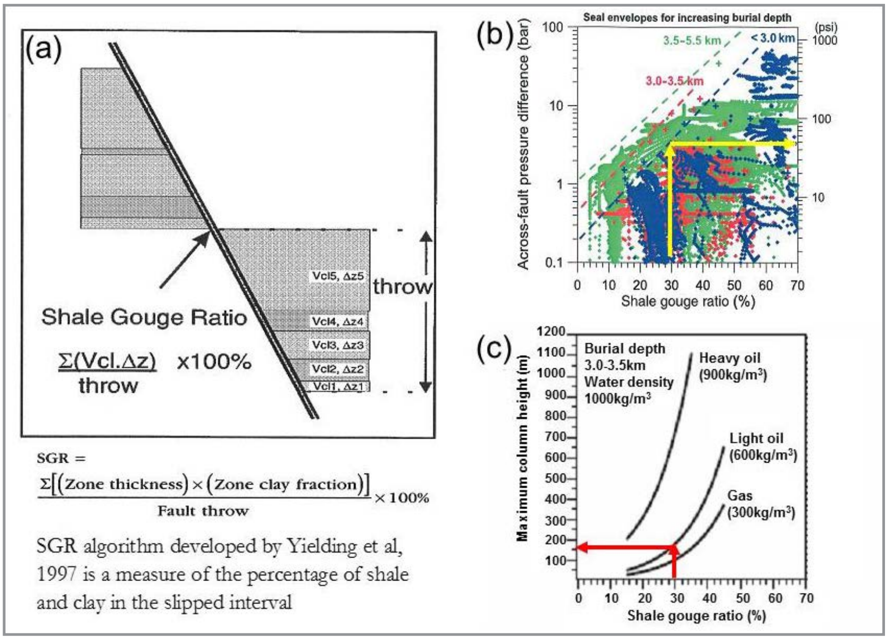

Figure 15: (a) SGR calculation (Yielding *et al*., 1997) and calibration with (b) across-fault pressure difference, and (c) hydrocarbon column height (Bretan *et al*., 2003). For example, an SGR of 30% is capable of holding a pressure of up to 50 psi, which in turn is estimated to hold up to 150m of light oil column.

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Chairman's Lecture No. 22

Geology vis-à-vis tunnelling in the Kuala Lumpur area

Tan Boon Kong
Date : 12th January 2017
Venue : Department of Geology, University of Malaya

Chairman's Lecture No. 22 – "Geology vis-à-vis Tunnelling in the Kuala Lumpur Area" was delivered by Sdr Tan Boon Kong on 12th Jan 2017 at the Dept of Geology, UM. An abstract of the lecture is attached below.

As usual, some lively discussions followed the lecture.

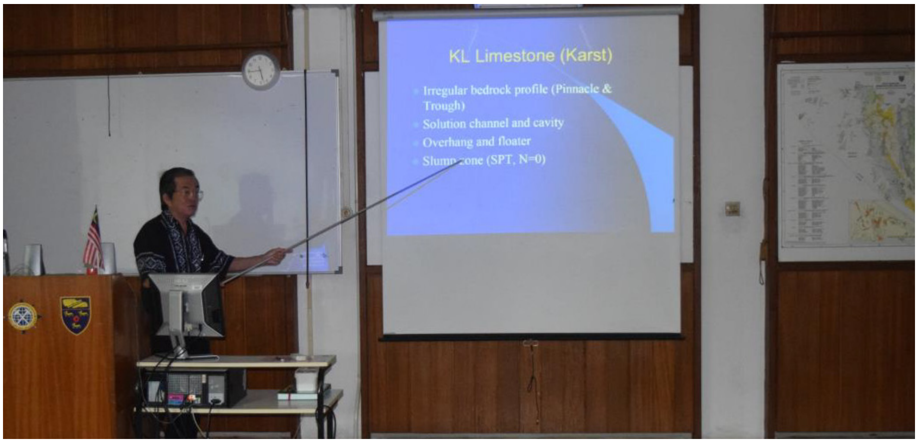
Tan Boon Kong,
Chairman, W/G on Engineering Geology, Hydrogeology & Environmental Geology

Abstract: Geology has a direct impact on tunnelling works. Risk assessment of potential geohazards due to various ground conditions (i.e. geology) is an important component in the planning and execution of tunnelling projects. This lecture discusses the geology of the Kuala Lumpur (KL) area and its impact on recent tunnelling works carried out in the area.

The rock formations encountered in recent tunnelling projects in the area include Granite, the Kenny Hill formation, and the KL Limestone. Since these rock formations have their own unique features and characteristics, they impact tunnelling works differently. For example, granite exhibits distinct weathering profiles with possible boulders in the grade IV zone; hence potential soil-rock mixed face with boulders for the Tunnel Boring Machine (TBM). The Kenny Hill formation comprises interbedded Quartzite and Phyllite, with the former having very high strength (Unconfined Compressive Strength, UCS of up to ~ 300 MPa) which impedes the progress of TBM. Quartzite is also highly abrasive to TBM cutters since its mineralogical composition is basically 100% quartz or silica (SiO_2). The KL Limestone is well known for its karstic features (irregular or pinnacled bedrock profile, cavities and solution channels, slump zone with Standard Penetration Test, SPT N = 0, etc.) which pose serious geohazards to tunnelling works.

In addition, superficial deposits such as Alluvium and Mine Tailings also pose potential problems since they are weak materials/soils. Mining slime deposits are particularly treacherous with SPT N = 0. The occurrence of mine tailings in the Limestone pinnacle zone can potentially trigger a sinkhole when intersected by a TBM.

Finally, geological structures such as major faults, quartz and granitic dykes which are prevalent in the KL area can also impact on tunnelling works. Tunnelling through major faults or fault zones would encounter highly crushed/brecciated rock weathered to soils (i.e. weak zones). Quartz dykes consisting of crystalline quartz would be highly abrasive to TBM cutters and impede TBM progress. Granitic dykes encountered tend to be weathered to weaker materials/soils. In any case, faults and dykes would serve as conduits for groundwater ingress into the tunnels.



CERAMAH TEKNIK TECHNICAL TALK

Geophysical investigation: the good, the bad and the ugly

Devendran Arumugam & Boon Chia Weng (Gamuda)
Date : 17 February 2017
Venue : Department of Geology, University of Malaya

This talk was presented by Sdr. Devendran Arumugam and Dr. Boon Chia Weng (Gamuda) on 17th Feb. 2017 at the Dept. of Geology, UM. Numerous case studies were presented, and they were associated mainly with recent tunnelling works in the KL area. One major conclusion of the talk was that the combination of two different geophysical methods would reduce uncertainties in the interpretation of the ground conditions, hence produce better results. An abstract of the talk is attached below.

As usual, there was a lively discussion session following the presentations.

Tan Boon Kong,
Chairman,
W/G on Engineering Geology, Hydrogeololy & Environmental Geology

Abstract: The use of geophysical methods is irregular in Geotechnical Site Investigation works. There are however limitations to each technique, and the prescriptions of these techniques ought to be related to the geology and setting of the site. Some case examples are presented, highlighting the cases where the geophysical surveys are used successfully and less successfully. The goal of this presentation is to show that the quality of the results is subject to the mercy of the geology, data acquisition, data processing and interpretation.

CERAMAH TEKNIK TECHNICAL TALK

Pembangunan Geopark di Malaysia: cabaran dan masa depan

(Challenges for Geoparks development in Malaysia and way forward)

Dr. Tanot Unjah
Date: 22 March 2017
Venue: Bilik Mesyuarat Program Geologi, Bangunan Geologi, FST, Universiti Kebangsaan Malaysia

Dr. Tanot's presentation was attended by Malaysia geological heritage experts and researcher. To develop a Geopark is a challenge and she shares the idea on how to develop it. Dr. Tanot also teaches Geological Conservation subject in Geology Programme, UKM. The abstract is attached.

Muhammad Ashahadi Dzulkafli,
Universiti Kebangsaan Malaysia

Abstract: Geopark merupakan pendekatan pembangunan yang berasaskan sumber warisan geologi bernilai tinggi dengan gabungan warisan tabii lain dan budaya. Semenjak kewujudan geopark pada awal tahun 2000 sehingga kini gagasan ini telah berjaya mewujudkan 120 buah global geopark di lebih dari 30 buah negara. Perkembangan pesat dalam pewujudan geopark kebelakangan ini secara global dan khusus di Asia selaras dengan pengiktifan sebagai program di bawah UNESCO, geopark menjadi pilihan bagi kawasan yang memerlukan lonjakan ekonomi. Agenda geopark turut menjadi agenda negara bagi sesetengah negara untuk mengembalikan kegemilangan dan juga membangunkan kawasan tinggal atau kawasan luar bandar. Meskipun Malaysia merupakan negara terawal yang terlibat dengan pembangunan geopark namun perkembangannya agak perlahan berbanding negara disekitarnya yang telah menjadikan geopark global iaitu Langkawi sebagai model untuk pembangunan geopark di negara masing-masing. Proses mewujudkan geopark yang berikutnya mengambil masa yang lebih panjang dan ini disebabkan terdapatnya cabaran yang perlu di atasi oleh pelbagai pihak yang berusaha mewujudkan geopark baru. Antara aspek yang akan dikupas adalah aspek governance, penyelidikan, pembinaan keupayaan dan promosi dan jangkauan. Setiap aspek ini akan melihat penglibatan dan peranan ahli geosains dalam mengembang dan membangunkan geopark di Malaysia.

Post presentation photograph together with Prof. Emeritus Dr. Dato Ibrahim Komoo, Head of Geology Programme P. Madya Dr. Habibah Jamil and UKM geology students.

Workshop on Disaster Resilient Cities: Risk Assessment and Forecasting of Geophysical and Atmospheric Hazards

9-10 March 2017, Hotel Istana Kuala Lumpur

NURFASHAREENA MUHAMAD & JOY JACQUELINE PEREIRA

SEADPRI-Universiti Kebangsaan Malaysia

The Workshop on Disaster Resilient Cities: Risk Assessment and Forecasting of Geophysical and Atmospheric Hazards was held on 9 and 10 March 2017 in Hotel Istana Kuala Lumpur. The Workshop was supported by the Newton-Ungku Omar Fund (NUOF) under the administration of Malaysian Industry-Government Group for High Technology (MIGHT) and Innovate-UK. This inaugural Workshop for the NUOF Project was jointly organized by Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM), City Hall of Kuala Lumpur (DBKL), National Disaster Management Disaster Agency (NADMA), Town and Country Planning Department Peninsular Malaysia (JPBD), Geological Society of Malaysia (GSM), Asian Network on Climate Science and Technology (ANCST) and others partners.

The Workshop commenced with an officiating keynote by YBhg. Datuk Hj. Mohd Najib bin Hj. Mohd, Executive Director of Planning on behalf of the Mayor of Kuala Lumpur. In his speech, YBhg. Datuk emphasized the importance of strengthening the role of DBKL in nurturing strong alliances and participation of stakeholders at the local level to enhance disaster risk reduction in the city. More than 100 participants comprising technical representatives including risk assessors, planners, engineers and geologists from various cities in Malaysia attended the Workshop. A total of 22 papers were presented by invited speakers from Malaysia and United Kingdom.

The first session of the Workshop was on Regulator's Perspective on Building Resilient Cities. This session provided an overview on the guidelines for land-use planning, the uniform building bylaws and standards for disaster resilient infrastructure for cities as well as an insight to integrated management for geophysical hazards. The second session was on the Geophysical Hazards-Risk Assessment and Forecasting Approaches in Cities. This session covered aspects of landslides and floods, case studies on hazard susceptibility mapping and slow-onset hazards as well as challenges in modelling landslides hazards and flash floods in cities. The third session on Atmospheric Hazards-Risk Assessment and Forecasting Approaches in Cities focused on forecasting air quality and extreme temperatures in cities, urban micro-climate and building design as well as challenges in modelling atmospheric hazards in cities. The final session on Stakeholders' Perspective on Building Resilience highlighted health impact assessments, communication of risks to the city planners and explored the potential architectural blueprint for multi-hazards forecast. The Workshop concluded with a discussion on pathways for building disaster resilience in cities. The Workshop enabled a review of existing approaches for modelling hazards in cities and indirectly appraised the availability of key information for developing new approaches.

A token of appreciation was presented by Mr. Mohd Zakwan Zabidi (**left**), Vice President of MIGHT to YBhg. Datuk Hj. Mohd Najib Hj. Mohd (**right**), Executive Director of Planning, who delivered the officiating keynote on behalf of the Mayor of Kuala Lumpur.

Participants of the Workshop comprised technical representatives from various cities in Malaysia including risk assessors, planners, engineers and geologists.

Moderators and presenters of the first session discussing the challenges for building disaster resilience in cities.

Dr. Helen J Reeves of British Geological Survey, United Kingdom presented a paper on integrated management of geophysical hazards in cities.

Professor Joy Jacqueline Pereira (**left**) and YBhg. Datin Paduka Dr. Halimaton Saadiah Hashim (**middle)** moderated the discussion on pathways for building disaster resilience in cities. Dr. Mazrura Sahani (**far right**) presented the challenges on health impact assessment in cities.

The Workshop was closed by Ms. Ida Semurni Abdullah Ali, the Programme Director of MIGHT.

CERAMAH TEKNIK TECHNICAL TALK

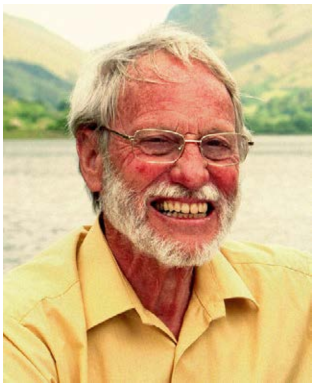
The Towuti Drilling Project and the challenges in reconstructing the climate and environmental history of Central Indonesia

Satria Bijaksana (Institut Teknologi Bandung, Indonesia)
Date : 29 March 2017

Venue : Bilik Mesyuarat Program Geologi, Universiti Kebangsaan Malaysia

Abstract: Located in the Island of Sulawesi, Lake Towuti is the largest tectonic lake in Indonesia, and the longest known terrestrial sediment archive in Southeast Asia. In 2015, 30 scientists from 8 different countries joined forces in the Towuti Drilling Project (TDP) and recovered over 1,000 meters of sediment core from 3 different drill sites in the northern part of Lake Towuti. The main objective of the TDP is to decipher the climate and environmental history of central Indonesia, which is important in the reconstruction of long-term changes in terrestrial climate in the Western Pacific warm pool, heart of the El Niño-Southern Oscillation (ENSO). Preliminary findings show that apart from alteration of lake clays and calcareous sediments in the upper ~ 100 m as well as peats and gravels in the basal units of our records, there are numerous tephra layers in the sediments. This presentation will show the operational aspects of the TDP and the challenges the TDP face in understanding the climate and environmental history of the region.

OBITUARY



Derek John Gobbett, 1934-2016

Derek Gobbett, geologist, naturalist, educator and co-founder of the Geological Society of Malaysia, died on 30th November 2016 in England after a short illness. He was born on 8th August 1934 in Collier Row near Romford, east of London, and throughout his life he joked that he was at heart a Cockney. His primary school education took place through the Second World War years, and that part of outer London saw plenty of German bombing raids; when the air-raid sirens sounded he was instructed by his parents always to stay away from windows and hide under the stairs.

Although so close to London, that part of Essex was a much greener and leafier place than it is now. Open countryside was nearby, and Derek developed a love of the natural world that never left him. Butterflies, birds, bugs and plants fascinated him and he built up a collection of specimens and acquired a deep knowledge and understanding of Nature. In 1945, having sat and passed what was then called the 11+ examination, he entered the Royal Liberty grammar school, and began his secondary education.

Two teachers played a crucial part in Derek's school career. Monty Faithfull taught botany and zoology, and in the Sixth-form John Reekie was the geology teacher. Both were inspirational teachers, and over those post-war years many pupils passed through their hands and went on to become successful professional scientists. Derek's interest in natural history burgeoned through his school years. By bicycle he travelled far and wide over Southern England pursuing his particular passion for bird-watching. Generally those expeditions were with school friends (including David Bridgewater and this writer), often staying at youth hostels, and frequently in the cold winter months when many species of birds visited British coasts on migration. While Derek could not be described as having been particularly burly, he was tough, often cycling more than 100 miles a day in bitterly cold weather – and frequently dressed in short trousers!

In the Sixth Form Derek began his A-level course in geology under teacher John Reekie. A Scotsman educated in Edinburgh and Cambridge, Reekie had been a professional geologist in Africa before having to return to Britain with health problems, and after his recovery he became a schoolteacher. To what extent that career change influenced Derek in the career that he was later to follow is a matter of conjecture. His cycling expeditions to watch birds in places such as the Norfolk coast, the Essex marshes, and the Isle of Wight now included stops to examine any rocks that cropped out along the way. At the end of his Sixth Form years Derek sat for his examinations in Geography, Zoology and Geology, and then, in December after his A-levels, (and after intensive courses in Physics and Inorganic Chemistry) he took the scholarship examination at Magdalene College Cambridge and was awarded an Open Exhibition, to take up his position following his period of National Service. Meanwhile, the head teacher, Reginald Newth, recognizing Derek's interests and adventurous nature, put his name forward to the British Schools Exploring Society to take part in their 1952 expedition to Iceland. Living under canvas on the edge of the ice-cap, existing on pemmican, hard-tack biscuits and porridge, and hiking long distances over rough ground to examine the plant-life, birds, and rocks were much to Derek's liking.

That was the time in Britain when National Service was mandatory, and in early 1953 Derek was called up to spend two years in uniform. He opted to specialize in aircraft maintenance, and after an initial training in Northern England he was posted to Hong Kong. The job of maintaining five Auster light aircraft in Hong Kong was not demanding, and in his spare time Derek explored the hills to the east of the small RAF airfield, often butterfly net or binoculars in hand. Not content with servicing 'planes, he took an Observer course and learned how to fly. In February 1955, and now age 20, he returned to Britain and was demobilised from the Air Force.

With several months before he could take up his place at Cambridge, Derek took a temporary job as ward orderly at Harold Wood Hospital, and later got a better-paid job teaching mathematics and English to youngsters who had not managed to pass the 11-plus examination, his first taste of teaching. In the summer of 1955, and still in touch with several of his old school friends, Derek organized a natural history expedition to Norway. The weather was extremely wet, but it didn't stop this small band of budding scientists from collecting mosses and bryophytes in dripping woodlands, and ringing a colony of Arctic terns.

Derek went up to Cambridge in October 1955 to study Natural Sciences (geology, mineralogy and zoology), and settled into modest, unheated, accommodation close to Magdalene College. He joined the Natural History Society, and therebroadened his circle of friends to include several botanists. Cycling remained his main form of transport, and Derek thought nothing of pedalling from Cambridge to Devon where his parents now ran a small village shop. Later in the summer of 1955 he and a friend did a cycling and camping tour of Scotland, climbing as many mountains as they could. But on his way south from Orkney he fell off his bike, broke his collarbone, and had to return to Cambridge by train. In his final undergraduate year, Derek added the philosophy of science to his geological studies, graduating in 1958.

He had already set his heart on studying for a PhD, and in the summer of his graduation year he and a party of eight other geologists under lecturer Mike Atherton set out by ship from Newcastle to Svalbard. Fieldwork in Svalbard is tough: the weather can be treacherous, the terrain includes extensive ice-caps and glaciers and is rugged, and there is the ever-present danger of a polar-bear attack. Derek spent two summer field seasons studying the stratigraphy and collecting Carboniferous and Permian fossils from Ny Friesland, Bünsow Land and Dickson Land, but the work was not without tragedy. In the first field season on arrival in the capital, Longyearbyen, the group divided and Derek with two colleagues made a three-day trek to set up a camp in their work area. Soon after, while working near a cliff face, one of them suffered severe injuries from a rock-fall. Derek and his colleague got him to their tent, and Derek remained with the injured man while the third man set off back to the group's base camp to get help. Sadly, before help arrived days later the injured man had died and they buried him near their camp. Not until the following year, 1959, when the group returned to continue their fieldwork could the body be recovered and taken south for a proper burial. Derek was awarded his PhD in 1961 for his thesis on the Carboniferous and Permian brachiopods of Svalbard, and so he became Dr Gobbett.

While still at Cambridge, Derek's interest in country dancing led him to meet Margaret, and they married in May 1960 and honeymooned on the Isle of Skye before settling briefly in a small house in Cambridge. Their first child, Jane, was born in August the following year. That year, 1961, also saw publication of Derek's first important geological paper 'The Permian brachiopod genus *Horridonia* Chao' (Palaeontology **4**, 42-53). Two years later his thesis formed the basis for his major monograph 'Carboniferous and Permian brachiopods of Svalbard' published by the Norsk Polarinstitutt (1963, Skrifter Nr. 127, 256 pp), which remains a standard reference on Late Palaeozoic boreal brachiopod faunas.

Funding for his postgraduate research was running out, and in 1961 Derek accepted a lectureship at the fledgling Department of Geology of the University of Malaya (UM). The Gobbetts, including young daughter Jane, were initially housed on the university campus in Petaling Jaya, and soon Derek began establishing an undergraduate course of lectures and laboratory instruction in palaeontology and stratigraphy. At the same time he set about building the Department's palaeontology collection and organizing the Department's museum, but still found time to join the Malayan Nature Society to continue his birdwatching and butterflying. The society, established in 1940, has conservation objectives, and Derek played a part in lobbying for protection of the ecologically and historically important Batu Caves near Kuala Lumpur. Derek's aptitude for organizing was put to good use outside the Department also, and he was made honorary curator of geology at the Muzium Negara (National Museum) in Kuala Lumpur.

Over the six years that Derek was at UM he pursued his principal interest, Upper Palaeozoic palaeontology and stratigraphy. Fieldwork was central to his approach, and he travelled widely to collect material for study. One such trip was to Cambodia, and 35 years later, at the request of another researcher at UM, Derek was able to provide a copy of his field notebook entry from the Sisophon area. He published a number of papers, but perhaps his greatest contribution to our understanding of SE Asian geology was his co-editing (with Charles Hutchison) and contributing chapters to 'Geology of the Malay Peninsula', published by Wiley in 1973. Equally important was the part he played in founding the Geological Society of Malaysia, and in its formative period holding the position of secretary; as Charles Hutchison wrote in the Newsletter (No. 10) at the time of Derek's leaving Malaysia in 1968, "*…..without his unfailing conviction that such a society was needed in Malaysia, it is doubtful if you would be reading this Newsletter today.*"

Derek's physical stamina has been alluded to, and in Kuala Lumpur another outlet for his boundless energy took the form of running. He joined the Hash House Harriers, a loosely structured movement established in Malaysia in 1938 and now worldwide, where members meet weekly to let off steam by cross-country (or suburban) running, and then slake their thirst at a favourite hostelry.

As Charles Hutchison suggested (Newsletter No. 10, January 1968), '*perhaps Derek's greatest single contribution to the geological community in Malaysia has been his fostering of co-operation between Malaysian and Japanese* *palaeontologists and stratigraphers. His efforts in this direction have included field surveys with Japanese geologists in parts of West Malaysia, and a study tour of Japanese universities.'*

Children John, Ann and Charlie were born in Kuala Lumpur before the Gobbett family departed Malaysia in early 1968. Derek returned to the Sedgwick Museum, Cambridge, to take up a position of Senior Assistant in Research. His involvement with the Geological Society of Malaysia continued, however, editing and writing papers for publication in its Newsletter and Bulletin. A major achievement was his 'Bibliography and index of the geology of West Malaysia and Singapore' published as Bulletin No. 2 of the Society in 1968, with a first supplement in 1970 (Bulletin No. 3), and a second (with Peter Stauffer) in 1974 (Bulletin No. 7).

In 1972 Derek's research position at the Sedgwick was coming to an end, and according to his son he had become a little disenchanted with his position in the university. His search for a job was made difficult by the political and industrial unrest in Britain in the 'seventies. But, probably mindful of the influence of teacher John Reekie on his own career, he was appointed in 1974 as geology teacher at the newly-established Solihull Sixth Form College, near Birmingham.

Many young men and women benefited from Derek's experience and enthusiasm, some of them proceeding from college to university to start a career in geology. But he felt that studying geology need not only lead to a career as a geologist, it also provided a valuable broad training, embracing as it does chemistry, physics, biology, physical geography, and the ability to visualize in three dimensions. Justin King exemplified Derek's thinking: having studied geology at Solihull, he proceeded to become Chief Executive of Sainsbury's, the supermarket chain, and later was appointed to the Prime Minister's Business Advisory Group. In an interview with the Times Educational Supplement (29 April 2005), Justin King looked back on his school days, saying: *"…the reason why he (Dr Gobbett) is my most memorable teacher is that he took a class of pupils who had never done the subject before, and enthused them….. He had an ability to inspire and an absolute commitment to his subject…..What Dr Gobbett taught me about most was passion and commitment."*

Derek was active too in the Earth Science Teachers Association (formerly the Association of Teachers of Geology), attending their annual conferences and revising their fieldwork guide which was published in the Association's magazine in September 1980. For many years one of his 'extra-mural' activities was as a tutor of the Open University and as a leader of OU field trips.

In 1999, after 24 years teaching in Solihull, Derek retired, and he and Margaret settled in Driffield, Yorkshire. His passion for geology was undimmed, and soon he became a member of the venerable Hull Geological Society, publishing several papers in 'Humberside Geologist' of which he was a co-editor. Most of Derek's papers were based on his fieldwork in NE England, his greatest interest being the geology and geomorphology of the Wolds, the gently rolling Chalk hills that extend south from Flamborough Head.

Shortly before his death, Derek submitted a short article to the periodical *Down to Earth* (No. 98, p.10). Its title was 'A Note on the Symmetry of Lulworth Cove, Dorset' ascribing the curve of the cove to refraction around the headlands as waves enter from the open sea. The last words of this obiturary go to the editor of that periodical: *"Derek Gobbett was a fine geologist and educator who spent much of his life passing on his knowledge and enthusiasm for geology to others. May this be a lasting memorial to him."*

Michael F Ridd.
with help from John and Charlie Gobbett, Masatoshi Sone, Ian Metcalfe and others.

"Derek Gobbett (right) on a bird-watching and geology cycling trip to the Isle of Wight in January 1953, with school friends Michael Ridd (centre) and David Bridgewater (left)."

Organizing Committee

Advisor: Dr Mazlan Madon
Chairman: Mr Abd Rasid Jaapar
Deputy: Mr Mohd Badzran Mat Taib
Secretary: Dr Lim Choun Sian
Treasurer: Mr Ahmad Nizam Hasan

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Assoc. Prof. Askury Abd Kadir (Petroleum Geology)
Dr. Cheang Kok Keong (Mineral Resources)
Mr. Abd Rasid Jaapar (Professionalism and Ethics)
Prof Dr Joy Jacqueline Pereira (Disaster Risk & Climate Change)
Prof. Dr. Che Aziz Ali (Geotourism & Geoheritage)
Prof. Dr. Azman Bin Abd Ghani (Regional Geology)

For more information and details,
visit our website at:

www.ngc2017.com

Contact us at:

Geological Society of Malaysia
University of Malaya
50603 Kuala Lumpur, Malaysia

Phone: +(603)-7957-7036
Fax: +(603)- 7956 - 3900
Email: geologicalsociety@gmail.com

NGC 2017 NATIONAL GEOSCIENCE CONFERENCE

2nd Circular: Call for Papers

Hotel Istana
Kuala Lumpur
9 – 10 October 2017

In conjunction with the
Geological Society of Malaysia
50th Anniversary

Invitation

The Geological Society of Malaysia (GSM) proudly presents the National Geoscience Conference (NGC) 2017. The Society invites the international geoscientists community to join the event and engage in the knowledge sharing session in Kuala Lumpur on 9th – 10th October 2017.

The main theme for this 30th NGC edition is "Geoscience for a Sustainable Future". As the economy is driving into a continuous uncertainty, geoscientists have to adapt to ensure sustainability in the geological field. In conjunction with the 50th anniversary of GSM, the conference will also look from past experiences to prepare for the future of fellow geoscientists and the direction of geoscience in general.

Themes

Main Theme

Geoscience for a Sustainable Future

Limited natural resources and increasing concerns on the environment has forced geoscientists to venture into multiple fields to cater to the ever changing needs. While several traditional geoscience sectors are currently experiencing a slump, new arising opportunities are waiting to be capitalized and ensuring the sustainability.

Sub Themes

- Engineering Geology and Rock Mechanics
- Petroleum Geology
- Mineral Resources
- Regional Geology
- Professionalism, Ethics and Education in Geosciences
- Disaster Risk Reduction and Climate Change Adaptation
- Geoheritage, Geoparks and Geotourism

GSM 50th Anniversary

The society was founded in 1967 with the aim of promoting the advancement of the earth sciences in Malaysia and the Southeast Asian (S.E.A) region. Currently, it has a membership of more than 600 earth scientists worldwide of various disciplines and expertise.

Sponsorship and Exhibition

Sponsorship Packages

Platinum – RM30,000 Logo on opening screen and goodies, advertisement (colour) on front/back page of event magazine, 5 admission tickets and 5 tickets for student sponsorship & 1 slot of talk	
Diamond - RM20,000 Logo on opening screen and goodies, advertisement (colour), 4 admission tickets and 2 tickets for student sponsorship & 1 slot of talk	**Gold - RM10,000** Logo on opening screen and goodies, advertisement (black and white), 3 admission tickets and 1 tickets for student sponsorship & 1 slot of talk
Silver - RM5,000 Logo on opening screen, advertisement (black and white), 2 admission tickets & 1 slot of talk	**Bronze – RM2,000** Logo on opening screen, 1/2 page of advertisement (black and white) & 1 admission ticket

Exhibition: The price for 3m × 3m booth is RM 3,000.

Registration

Categories	Fees
GSM Members	RM 550
Non – GSM Members	RM 750
Student GSM Members	RM 350
Student Non – GSM Members	RM 550
Student Daily Pass	RM 200
Late Registration	RM 1000

Entitlements
All participants are entitled for tea breaks and lunch meals except for student daily pass

Payment: Please bank the money into our account:
Geological Society of Malaysia
Standard Chartered Bank
794 105402263

Please mail the bank in slip to us for verification.

Venue & Accommodations

Venue
Hotel Istana Kuala Lumpur
Located at the heart of Kuala Lumpur, Hotel Istana offers a strategic place in the middle of the bustling area of Bukit Bintang. The venue offers exquisite bedrooms at affordable price

Nearby Hotels

Parkroyal Kuala Lumpur

Hotel Grand Millennium

Hotel Metro 360

Important Dates

Submission of Extended Abstract: 30th June 2017
Acceptance of Extended Abstract: 1st August 2017
Early registration deadline: 15th September 2017

Registration deadline is on 15th September2017. Registration after that date will be considered as late registration

Kindly submit the full papers once the acceptance notice is issued

Programme Tentative

Date	8th Oct	9th Oct	10th Oct	11th Oct	12th Oct
Morning	Golf/Short Courses	Keynote Speech	Technical Sessions 3&4	Field Trip	Field Trip
Afternoon		Technical Sessions 1&2	Technical Sessions 5&6		

*Golf, Short Courses and Field Trips are charged separately. Tea breaks and lunch are provided to all participants

Publications

Full papers from the presentations at the conference will be published in the Bulletin of the Society. All presenters are required to submit the full papers once the acceptance notice is issued.

Keynote Lectures

Prof. Dr. John Kuna Raj
Tentative Title: Historical Perspective of GSM

After 50 years of its establishment, the Geological Society of Malaysia has experienced numerous ups and downs, from the days of bustling tin mining to recent decline in oil and gas industry. The history of GSM in turn provides a valuable experience to prepare for the future of geological field in Malaysia.

Prof. Emeritus Dato Dr Ibrahim Komoo
Tentative Title: Challenges and Future Prospects for Geoscientists

Modern challenges including depleting mineral resources and increasing concerns about the climate change has forced geoscientists to venture out of the traditional geological job scope to cater the ever changing environment. Geoscientists must adapt to these challenges and open new opportunities to ensure the relevance of geological field in driving the economy.

Short Courses

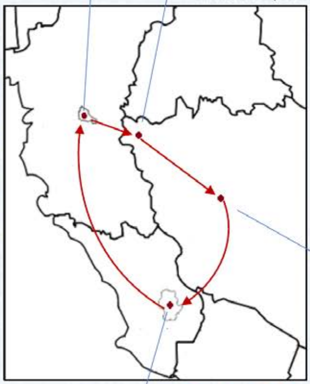
Geohazards and Disaster Risk Reduction	Mineral Resources
Petroleum Geology	Engineering Geology and Professional Practices

* All short courses will be charged separately. The short courses will be held at Hotel Istana, Kuala Lumpur

Field Trip

Tambun, Ipoh, Perak
Geoheritage
The karst area of Kinta offers scenic view but geohazards persists in terms of rock fall

Cameron Highlands, Pahang
Geohazards
Rapid development with lack of planning often results in disaster such as flash floods and landslides (Gunung Pass area)



Kuala Lumpur
Start and Finish Point
The bustling city of Kuala Lumpur where the conference will be held also serve as the starting and finishing point for the field trip.

Penjom Mine, Pahang
Mineral Resources
The Penjom mine is among the biggest gold mine in Malaysia, situated along the gold belt east to the Main Range

*The field trip contains two packages; the first one is to visit every locality shown on the map above. The second package is to stay at Cameron Highland on the second day for a short course on geohazards but will not visit the Penjom Mine.

Mineral Applications to the Manufacturing Industries & Environment.

11th October, 2017

Department of Geology, University of Malaya, 50603 Kuala Lumpur

A 1-Day Short Course (& refresher) for economic and exploration geologists, mining &mineral process engineers, technical, production as well as mine owners, investors involved in quarrying, clay mining, mineral resource development, sales & marketing, researchers & academics to be able to develop innovative, value-added mineral products to stakeholders, new customers, in new territories, especially within the ASEAN region

Programme by

Dr. K.K. Cheang & AP Kamar Shah Ariffin

Organized and Supported by:
1)Geological Society of Malaysia (in Conjunction with 50th Anniversary)
2)Department of Geology, UM
3)Mineral Resource Engineering Program, USM
4)Japan International Cooperation Agency (JICA)
5)Institute of Mineral Engineers Malaysia
Also in Conjunction with the National Geoscience Conference 2017.

Mineral Applications to the Manufacturing Industries & Environment

Short Course

REGISTRATION FORM

PARTICIPANT'S DETAILS

NAME ……………………………………………………………………………..

JOB TITLE ……………………………………………………………………………..

ORGANIZATION ……………………………………………………………………..

ADDRESS ……………………………………………………………………………..

……………………………………………………………………………………………..

POSTCODE …………………….. CITY ……………………………………………..

TEL. NO. ………………….……………EMAIL……………………………………

PAYMENT DETAILS

Course Fees:RM550 (members) & RM600 (non-members) (inclusive of one lunch & two refreshments). Registration for 3 or more participants, is entitled to RM500 for members & RM550 for non-members. First ten registrants get a unique mineral sample from Canada.

☐ I enclose a cheque / bank draft for the sum of RM ………………………………………………..
Cheque / draft No. …………………..Bank ……………………………………
(please make cheque/draft payable to "Geological Society of Malaysia"

☐ I bank in the fee of RM ……………………… directly into the following account: Name: Geological Society of Malaysia
Bank: Standard Chartered Bank
Account No.: 7941 0540 2263
(please mail the payment slip to us as evidence-for payment by internet)

☐ Please invoice the above organization for the sum of RM ………………

Dateline:Note the last day for registration is 1st August, 2017.

Send completed Registration Form to:
Geological Society of Malaysia
c/o Department of Geology
University of Malaya, 50603 Kuala Lumpur
Email: geologicalsociety@gmail.com
Tel.: +60 3 7957 7036 Fax: +60 3 7956 3900

For further information, contact: Ms Anna Lim or Dr. K.K. Cheang
Email: geologicalsociety@gmail.com
Tel.: +60 3 7957 7036;
H/P=0123271888 (K.K. Cheang)

INTRODUCTION:

Quarries and mining operations in Malaysia and in the ASEAN region, produce rock and stone aggregates for construction purposes such as for houses, condominiums, commercial buildings, factories, power and cement plants, dams, tunnels, bridges, LRT, MRT, BRT etc.

Mineral resources are being used at an ever increasing rate to a number of manufacturing industries in Malaysia. These include the glass, ceramics, paint & coatings, rubber, plastics, oil & gas, automotive, agricultural and electronic industries. Understanding of Minerals in providing **Environmental Solutions** is also on the rise.

The demand for granites, limestone, sand, gravel, kaolin, ballclay, feldspar, dolomite, barite, bentonite, silica sand, coal (fuel), iron ore and bauxite will also continue to rise exponentially, in tandem with the dynamic growth of the economy in the ASEAN region (4 - 6%).

These mineral products are engineered to be finer in sizes, can command relatively much higher prices than aggregates, and are required on a regular basis. Some specifications and requirements will be discussed.

Many of the engineered mineral products are also imported from all over the region, at many more times the price of local products. Hence, the need to develop innovative products from Malaysia's own local mineral resources, to complement those imported, would be critical to the competitiveness of the manufacturing industries & **Sustainability of the Environment** in Malaysia.

PERSATUAN GEOLOGI MALAYSIA
GEOLOGICAL SOCIETY OF MALAYSIA

NOTICE

Invitation to Training Program in conjunction with the National Geoscience Conference (NGC) 2017

TOPIC: Applications of Minerals to the Manufacturing Industries and the Environment

Date:	11th October 2017
Time:	8.00 a.m. - 5.00 p.m.
Venue:	Department of Geology, University of Malaya, Kuala Lumpur

A one-day training course that aims to develop young researchers, mineral students, budding geologists, future leaders in government and industries; and also a refresher course for those in senior positions of mines, quarries, government, consultants, industries, who would like to update themselves but lack the time due to heavy work commitment.

Key invited trainers:
Associate Professor Hashim Hussin
Associate Professor Kamar Shah Ariffin
Dr. K.K. Cheang

For queries, please contact:

Dr. K. K. Cheang,
P. Geol, MIGM, Convenor, Mineral Resources,
National Geoscience Conference 2017, Malaysia.
Tel.: 012 3271888, E-mail: kkcheang49@gmail.com

Abdul Rasid Jaapar, P. Geol, MIGM, Chairman, Organizing Committee,
National Geoscience Conference, 2017, Malaysia
Tel.: +6019-355-5915, E-mail: abdrasid@geomappingtechnology.com

NEW MEMBERSHIP

Full Member

1. Aamir Ab' Kamel Thani
2. Aziz Ejan
3. Azmi Omar
4. Binhadi Bakri
5. Chan Jon Kit, Andrew
6. Chaoqing Yang
7. David Alan Stanbrook
8. Edward J Jansen
9. Erfa Izhana Othman
10. Hafzan Eva Mansor
11. Hazerina Pungut

Student Member

1. Abdul Hadi Omar
2. Abdul Nazirul Mubin Abdul Jalil
3. Afiq Aizuddin Zamri
4. Afiq Farhan Abdul Rahim
5. Ahmad Adib Nordin
6. Ahmad Danial Zainal
7. Ahmad Daniel Zainal Abidin
8. Ahmad Hafiz Mohd Khairi
9. Ahmad Syahmi Sulaiman
10. Ain Nazirah Rosli

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Wilayah Persekutuan,
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No. 3, Jalan Indah, Seksyen 14,
40000 Shah Alam, Selangor

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Lot 651, Jalan Duta 3, Pujut 2B,
98000 Miri, Sarawak

Che Ahmad Bin Che Wanik
10-3A-12, Petaling Indah Condominium,
Jalan 1C/149,
57100 Sungai Besi, Kuala Lumpur

David G Bowen
9, Masonic Court,
Keith, Moray_AB55 5 GA UK

Flavia Kandau
Geologist Senior Advisor - D18 Alliance,
Level 52, Menara 3 PETRONAS,
Persiaran KLCC, Kuala Lumpur City Centre,
50088 Kuala Lumpur

Muhammad Abdullah
Jabatan Mineral & Geosains Malaysia, Pahang,
Jalan IM 4/1, Bandar Indera Mahkota,
25604 Kuantan, Pahang

Noran Nabilla Binti Nor Azlan
Jabatan Mineral & Geosains Negeri Sembilan/Melaka,
Jalan Tunku Kurshiah,
70400 Seremban, Negeri Sembilan

Tay Thye Sun
12, Arumugam Road #04-02,
LTC Building B,
Singapore 409958

Dr Mazlan Madon, FASc, President of the Geological Society of Malaysia, among 58 geologists honoured by the American Association of Petroleum Geologists at its 100th Anniversary Annual Convention and Exhibition 2017

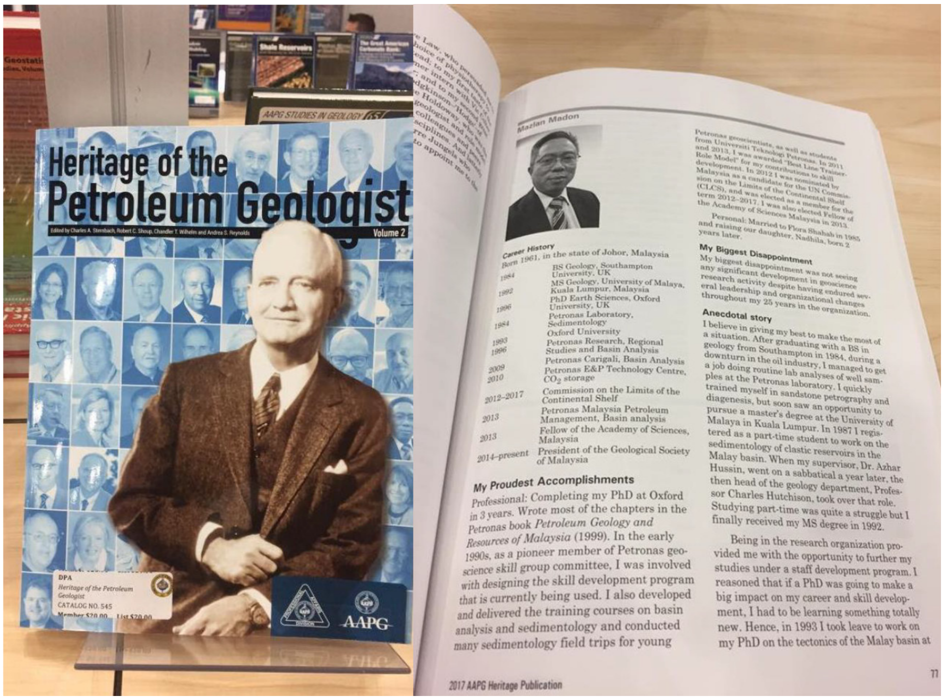
Dr Mazlan attending a session at the UN Headquarters in New York.

The American Association of Petroleum Geologists (AAPG), probably the world's largest association of geoscientists, to which GSM is affiliated, held its 100th anniversary (1917-2017) celebrations in conjunction with its Annual Convention and Exhibition 2017 in Houston, Texas, from 2 to 5 April. One of the highlights of the event was a special luncheon on 4 April hosted by its Division of Professional Affairs, themed "Toward a Philosophy of Oil Finding: Then, Now, Tomorrow!".

According to AAPG, the luncheon was a sequel to the 2002 "Heritage of the Petroleum Geologist" luncheon, which had honoured 43 "pioneering and notable geologists" of those times. This 2017 luncheon was to honour 58 more "accomplished and distinguished geologists", bringing the total of recognized honourees to 101; a symbolic 100 to celebrate AAPG's centennial, plus 1 additional individual *"to symbolize the passing of our deep heritage to the next generation of energy-finders."* More details in this link http://ace.aapg.org/2017/networking-and-events/luncheons#Panel_36643

GSM president, Dr Mazlan Madon, who is also the Custodian of Petroleum Geoscience in PETRONAS where he has worked for the past 32 years, was one of the 58 honourees invited to the luncheon and to receive a special publication entitled "The Heritage of the Petroleum Geologist". The book is a compilation of short write-ups by the individual honourees on their successes, disappointments, anecdotes and advice for the benefit of the next generation of geologists and oil-finders.

Due to his tight schedule attending the 43rd session of the Commission on the Limits of the Continental Shelf at the UN Headquarters in New York, Dr Mazlan could not be present at the luncheon to receive a personal copy of the book. However, with this recognition by AAPG, Dr Mazlan is the only Malaysian geologist to have been honoured by this prestigious international scientific organisation and has made Malaysia, PETRONAS and GSM proud of his achievement, particularly the international recognition for his contributions to petroleum geoscience and exploration.



Front cover of the "Heritage" book, and a page of the write-up on Dr Mazlan.

SEMINAR ON NON-PETROLEUM GEOLOGICALLY-RELATED SOURCES OF ENERGY IN MALAYSIA

27 SEPTEMBER 2016, UNIVERSITY OF MALAYA ALUMNI ASSOCIATION CLUB

Introduction

The Institute of Geology Malaysia (IGM) organised for the first time a seminar on "Non-Petroleum Geologically-related Sources of Energy in Malaysia" on Tuesday, 27th September 2016 at the University of Malaya Alumni Association Club hall, Kuala Lumpur. The Seminar was organised as part of an awareness programme on IGM and its role and functions.

The Seminar was officiated by Tuan Haji Mior Sallehuddin Mior Jadid, President, IGM and Director-General, Jabatan Mineral dan Geosains Malaysia.

A total of 55 partcipants attended the event.

Background to the Seminar

Malaysia has always been dependent on petroleum and coal for its energy sources, whether in the transportation sector or in power sector, but with concerns over green-house gas (GHG) emissions and the Government's commitment to reduce Malaysia's GHG emissions, there is a need to look into the alternative potential energy sources that Malaysia has to offer.

Malaysia has adopted the Five-Fuel Diversification Strategy energy mix which was implemented since the year 1999. In this Strategy, the energy mix is contributed by five main sources, namely natural gas, coal, oil, hydro and renewable energy. Although high prices of fuel at one time was the reason for maintaining the Five-Fuel Diversification Strategy, security of supply through diversification is also an important reason. With a balanced energy mix, the economy, and particularly the power sector, is less vulnerable to shocks in the fuel supply.

Seminar Organising Committee

The Seminar was organised by the following IGM Members:

Mr. P. Loganathan – Chairman
Datuk Fateh Chand
Mr. Teoh Lay Hock
Mr. Seet Chin Peng
Mr. Kamal Daril
Mr. Ling Nan Ley
Ms Haniza Zakri

Objectives

The objectives of the Seminar were as follows:

To highlight the existence of geologically-related alternative sources of energy in Malaysia;

To discuss the potential of developing these sources, and any issues arising from their development, to meet the growing energy needs of the nation;

To prepare recommendations to be forwarded to the relevant authorities for their consideration.

Paper Presentations

A total of 9 papers (abstracts and presentations) in 4 Sessions were presented as follows:

<u>Session I: (Energy Policy and Hydro-Power Development); Chair: Datuk Fateh Chand</u>

"Malaysia's Energy Policy" by Datin Badriyah Ab. Malek, Deputy Sec. Gen., Ministry of Energy, Green Technology and Water

"Geological Constraints in the Development of Hydro-Power" by Asso. Prof. Dr. Chow Weng Sum, Universiti Teknologi Petronas

<u>Session II: (Malaysia's GeoEnergy Resources); Chair: Mr. Seet Chin Peng</u>

"Geothermal and Hot Dry Rock Resources" by Mr. Fredolin Javino, Jabatan Mineral dan Geosains Malaysia, Sabah

"Sabah Coal-Bed Methane Potential: A Preliminary Assessment" by Mr. Jontih Enggihon and Mr. Dee Dee Daulip Lakkui, Jabatan Mineral dan Geosains Malaysia, Sabah, and Mr. Y. P. Tan, Coal/CBM Consultant

"Coal Resources and their Utilisation in Malaysia" by Dr. Joseph Jubin Aro, Jabatan Mineral dan Geosains Malaysia, Sabah

Session III: Non-Conventional Energy Sources; Chair: Mr. Teoh Lay Hock

"Malaysia's Thorium Resources for Energy Generation" by Dr. Dahlan Hj. Mohd, Deputy Director-General, Timb. Ketua Pengarah (Technical Program), Malaysia Nuclear Agency

"Ocean Thermal Energy Conversion (OTEC)" by Datuk Prof. Ir. Dr. Abu Bakar Jaafar, Universiti Teknologi Malaysia

Session IV: Renewable Energy Resources and R&D; Chair: Mr. P. Loganathan

"Renewable Energy Sources (Wind, Wave and Solar)" by Dr. Chen Sau Soon, SIRIM

"Silicon Photovoltaics : Moving Up The Value Chain And A Sustainable Solution To Future Energy Generation" by Dato' Prof. Dr. Kamaruzzaman Sofian, Universiti Kebangsaan Malaysia

Seminar Take-Away Messages

From the presentations made and the discussions that followed them, the following points can be made:

The nation's energy policies are open and friendly to developing conventional and unconventional sources of energy in the country;

Much in-depth geological knowledge is needed for the development of hydropower dams and therefore there is a need for well-trained geologists in this field;

There is potential for the development of new coal deposits as well as for the development of coal-bed methane (CBM), especially in Sarawak. JMGM needs to continue with its coal exploration to determine their quality and amount as well as work on CBM to determine their potential;

There is also potential for the development of geothermal resources and hot-dry rocks nationally as proven by the Tawau geothermal development by the private sector after this resource was proven by JMGM. JMGM therefore needs to continue with identifying other geothermal resources in Sabah as well as the potential of developing hot-dry rocks in Peninsular Malaysia for possible uptake by the private sector either as a power supply source or for tourism needs;

There is much potential from the use of thorium as an energy source for nuclear power supply. JMGM and MNA need to further undertake exploration activities to identify and assess thorium resources in the country, specifically in Peninsular Malaysia with a view to assessing their economic potential for development. MNA needs to continue identifying next-generation nuclear power plants that use thorium as the power source;

The Sabah Trough is a potential site for development of OTEC. The Government should support any proposal to set up a pilot plant as a public-private sector initiative; and

There is potential of using wind energy in selected sites in eastern Peninsular Malaysia and Sabah. Solar energy is already a known source of energy in off-grid areas in the country and the Government should continue to support setting up solar panels in these areas as well as support the establishment of the nation's high-grade silica sand (in Sarawak) to value-add using environmentally friendly techniques to produce solar panels. Wave potential is minimal.

Prepared by:
P. Loganathan FIGM; P.GEOL.
4th January 2017

GEOSCIENCE EXHIBITION AND COMPETITION AT UNIVERSITI TEKNOLOGI PETRONAS

19 July 2016, Universiti Teknologi Petronas

On the 19th July 2016 and 20th July 2016, students from Department of Geology, University of Malaya had participated in the Geoscience Exhibition and Competition (GEnC) at Universiti Teknologi Petronas. Two teams from UM had taken part in the event which are GeoMalaya and Visean UM.

The competition is divided into two parts which were the outcrop description presentation on the first day while the outcrop and poster display was held on the second day. Through this presentation, contestant would be needed to explain their finding based on their respective outcrop by using slideshows in Microsoft Power Point. They would present their findings along with the evidences and summarise all the geological features present in their outcrop. During the presentation, they can also include their methodology, rock samples and etc based on their creativity. Participants were needed to present their chosen outcrop geologically on simple slides, videos or pictures according to their creativity at their respective booths.

This competition was not only joined by local universities such as Universiti Teknologi Petronas and Universiti Malaysia Kelantan, but also received participation from overseas such as Universiti Padjajaran, Universiti Pembangunan Nasional Jogjakarta and also the National University of Singapore.

GeoMalaya managed to place second for the Overall Championship with their presentation entitled Mine Preservation and Geotourism Potential of Penjom Gold Mine, Pahang. The team consisted of Ahmad Hafiz, Muhammad Rasta, Muhammad Ismail, Nur Ain, Nor Amira and Intan Irwani. They brought the idea of preserving an uneconomically viable mine and turning it into a geotourism potential. This would enable the community to understand the history of gold mining in Malaysia and also experience the real life working experience in a gold mine and step – by – step approach on how gold is produced.

Commiseration for Visean UM which consisted of Ridzuan, Muhammad Hazman, Muhammad Hafiz, Nur Adibah, Hafizah Munirah and Nuril Hasni as they did not manage to place in the top three. However they brought a brilliant idea of preserving the karst features of the Gunung Rapat area in Perak to enhance its geotourism potential but had serious challenges from a lot of other universities from the ASEAN region.

UPCOMING EVENTS

July 10-12, 2017: Managing Risk across the Mining and Oil & Gas Lifecycle, Imperial College London. For details, visit: www.geolsoc.org.uk/mogrisk17

July 11-13, 2017: OGA 2017 – The 16th Asian Oil, Gas & Petrochemical Engineering Exhibition, Kuala Lumpur, Malaysia. Contact Shahril Anuar, Project Manager-shahril@mesallworld.com; Husna Dzun Nurin, Project Secretary - husna@mesallworld.com. Details at: www.oilandgas-asia.com

July 13-14, 2017: Sharing an Uncertain World: Lessons in Managing Risk, Burlington House, London. Visit: www.geolsoc.org.uk/uncertainworld17

July 24-26, 2017: Unconditional Resources Technology Conference, Austin, Texas. Details at: urtec.org/2017.

August 20-29, 2017: 12th International Eclogite Conference, Åre, Sweden. For more information, visit: http://www.geology.lu.se/IEC12

September 4-6, 2017: "Geosciences: a tool in a changing world", Pisa, Italy. More details at : http://www.geosciences.it/pisa2017/index.php/abstracts/info-e-norme

September 7-8, 2017: GSL (Geological Society of London) Building Resilience to Geohazards in the face of uncertainty, Burlington House, London. More information at: www.geolsoc.oorg.uk/buildingresilience17

September 13-14, 2017: AAPG Technical Symposium 2017: Hidden Potential in Mature Basins; Play Analogs and Best Practices, Bandung, Indonesia. Email to apereira@aapg.org for more information.

September 13-17, 2017: Conference on Accessory Minerals (CAM – 2017), Vienna. Visit website http: //www.univie.ac.at/Mineralogie/CAM-2017 or contact Lutz Nasdala (lutz.nasdala@univie.ac.at) for enquiries.

September 14-15, 2017: GSL (Geological Society of London) The evolution of flooding and flood risk: past, present and future, Burlington House, London. More information at: www.geolsoc.oorg.uk/flooding17

September 25-27, 2017: Fermor Meeting 2017: Factory Earth, Burlington House, London. More information at: www.geolsoc.org.uk/fermor17

October 3-5, 2017: William Smith Meeting 2017: Plate Tectonics at 50, Burlington House, London. More information at: www.geolsoc.org.uk/wsmith17

October 9-10, 2017: National Geoscience Conference, Hotel Istana, Kuala Lumpur. Contact: Phone: +(603)-7957 -7036, Fax: +(603)-7956 -3900, Email: geologicalsociety@gmail.com

October 15-18, 2017: AAPG/SEG International Conference & Exhibition 2017, London. Contact: Jeremy Richardson, +44 207 836 3201.

October 26-27, 2017: GSL (Geological Society of London) Conference: Ground Related Risks to Transportation Infrastructure, London. More information at: www.geolsoc.oorg.uk/infrastructure17

October 31-November 2, 2017: GSL (Geological Society of London): Fold and Thrust Belts: Structural style, evolution and exploration. London. More information at: http://www.geolsoc.org.uk/PG-Fold-and-Thrust-Belts-Structural-style-evolution-and-exploration

November 6-7, 2017: Janet Watson Meeting 2017, The Future of Contaminated Land Risk Assessment; stakeholder perspectives. Burlington House, London. For more information visit: www.geolsoc.org.uk/jwatson17

November 7-21, 2017: Puzzling out Gondwana, Bangkok, Thailand. For details, contact: SecretaryGondwana.16@gmail.com

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