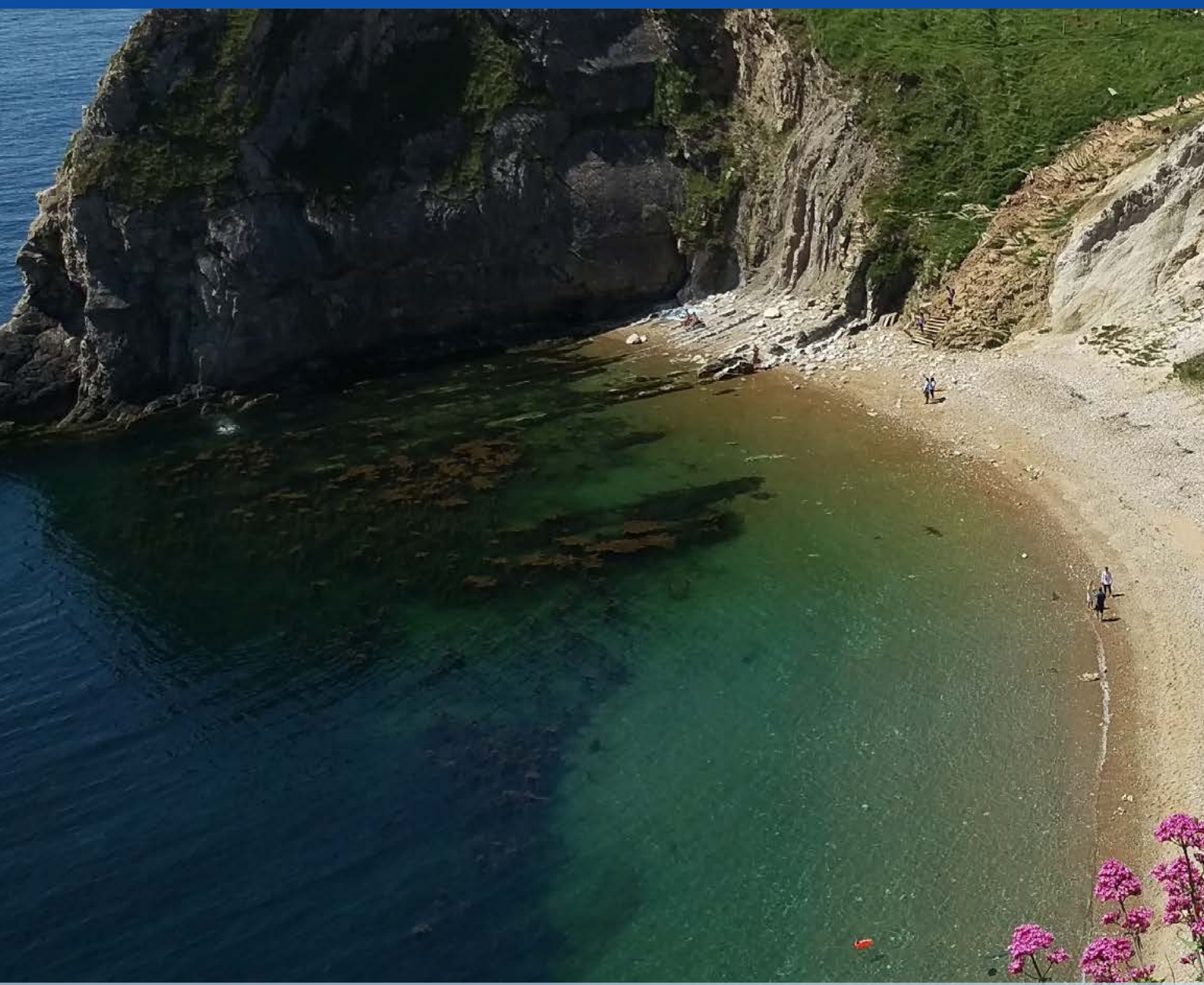
PERSATUAN GEOLOGI MALAYSIA

WARTA GEOLOGI

NEWSLETTER of the GEOLOGICAL SOCIETY OF MALAYSIA



Jilid 44
No. 4

OCTOBER – DECEMBER
2018

Volume 44
No. 4

ISSN 0126 - 5539

PP2509/07/2013(032786)

Warta Geologi

Newsletter of the Geological Society of Malaysia

The Geological Society of Malaysia was founded in 1967 with the aim of promoting the advancement of geoscience, particularly in Malaysia and Southeast Asia. The Society has a membership of about 600 local and international geoscientists.

Warta Geologi (Newsletter of the Geological Society of Malaysia) is published quarterly by the Society. Warta Geologi covers short geological communications and original research, as well as reports on activities and news about the Society. It is distributed free-of-charge to members of the Society. Further information can be obtained from:

The Editor
Geological Society of Malaysia
c/o Department of Geology,
University of Malaya,
50603 Kuala Lumpur, Malaysia
Tel: 603-79577036 Fax: 603-79563900
Email: geologicalsociety@gmail.com

Cover photo: Upper Jurassic and Cretaceous strata at Durdle Door, southern UK. Photo courtesy of Owain Lavis, Geoscientist at Merlin Energy Resources

A "50 m-high tsunami" in Sabah? – a geological "reality check" on a mathematical prediction

Mazlan Madon

Malaysian Continental Shelf Project, Level 11, Wisma JUPEM, Jalan Semarak,
50578 Kuala Lumpur, Malaysia
Email address: mazlan.madon@gmail.com

Abstract: In 2016, there were news reports that a 50 m high tsunami wave could hit the western coast of Sabah if a massive submarine landslide were to occur at the southwestern end of the Sabah Trough. Results of a mathematical simulation, according to the reports, indicate that the tsunami could be triggered by a massive submarine landslide similar to that reported from the shallow subsurface in offshore Brunei. The so-called "Brunei Slide" was used as the basis for a mathematical model of the hypothetical submarine landslide. This paper takes a closer look at some of the assumptions used in the mathematical model and compares them with the geological evidence from offshore Brunei and the adjacent Sabah continental margin. Geological knowledge of the margin suggests that certain basic assumptions that were used in the simulations, such as slide dimension, submergence depth, and seafloor gradient, may not have been the most appropriate or geologically reasonable and, therefore, should be reevaluated.

Keywords: Sabah Trough, Brunei Slide, tsunami wave generation, mathematical simulation, geological assumptions

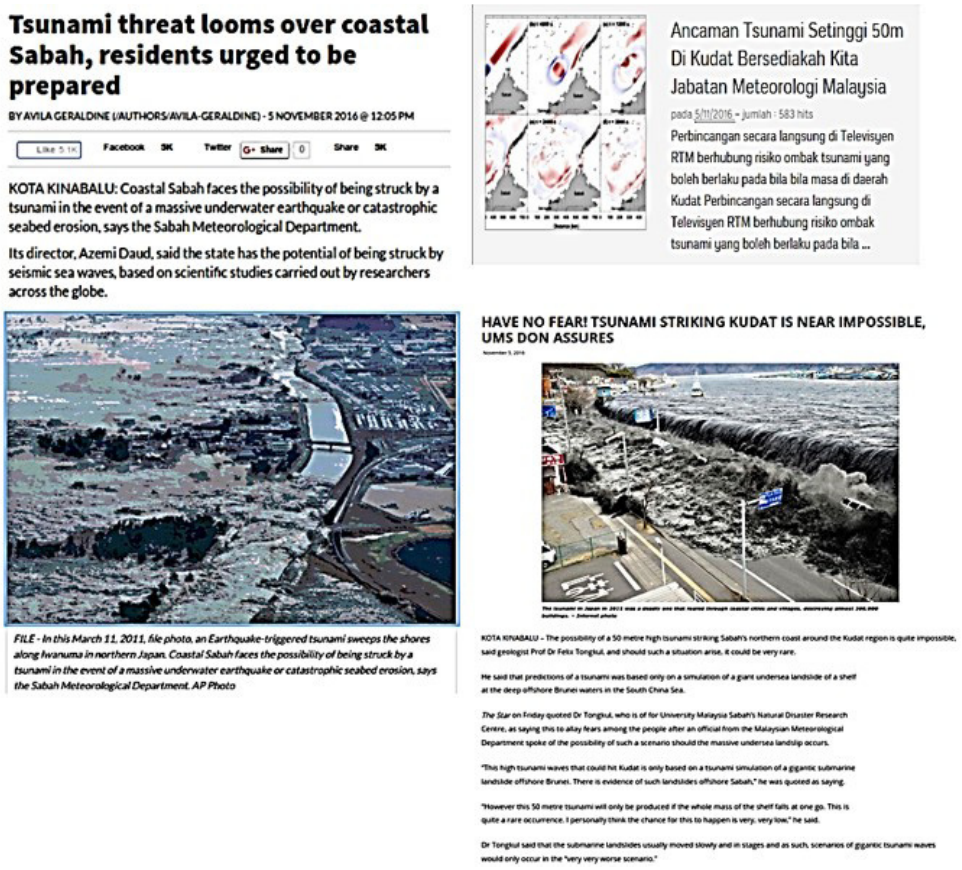
INTRODUCTION

In November 2016, news circulated in the mainstream and social media about the possibility of Kudat (a town in northern Sabah) being inundated by a 50 m-high tsunami had caused unnecessary concern among local residents along the west coast of Sabah (Figure 1). The news had reported a statement by Sabah Meteorological Department director quoting "research findings" which indicate that the catastrophic event could be triggered by an "underwater landslide of massive proportion", and based on numerical simulations, such a landslide in southwest offshore Sabah would generate a tsunami that may attain a height of up to 50 m by the time it hits land in Kudat, near the tip of Borneo[1,2]. The confusion caused by the news had prompted a minister[3] to play down the possibility of such a catastrophe happening by stating that the tsunami threat was merely "hypothetical", although the minister stressed that the public should still be made aware and prepared for any eventuality.

To clarify on this issue, experts, such as Prof. Dr. Felix Tongkul from the University Malaysia Sabah's Natural Disaster Research Centre, were also called upon by the press to comment on these scientific predictions. Professor Tongkul was quoted as saying[4] that a 50 m-high tsunami is a "quite a rare occurrence", and the chance of it happening is "very, very low". According to him, the research findings quoted in the press were based solely on a mathematical simulation of a giant undersea landslide occurring in offshore Brunei and that a 50 m-high tsunami wave would only occur if a whole big piece of continental shelf seabed falls off in one instance. He cautioned, however, as most geologists would understand, that such an event would be a "worst case scenario" because submarine landslides usually "move slowly and in stages".

More than a decade ago, a study of the tsunami threat to the coastal areas of Sabah (Raj, 2007) had found that there was "no threat of local tsunami" on the west coast of Sabah that may arise from earthquakes in the South China Sea. According to that study, the relatively wide continental shelf of Sabah would result in negligible run-ups even if a distant tsunami reaches its coastal areas. The threat of a major tsunami caused by submarine landslide is, however, relatively new, and is a matter of public as well as scientific interest. This short note takes a closer look at the "research findings" upon which the 2016 news headlines were apparently based. It examines the "hypothetical" underwater landslide in offshore Sabah and its implications on tsunami risk, in particular, if a 50-m high tsunami happening as a result. Since the prediction was based on mathematical simulations, there may have been some misconceptions among specialists and the public at large with regard to the application of mathematical simulations in general, and in particular, when applied to natural phenomena such as a tsunami.

1 SabahUp2date, 5 November 2016: "Ancaman tsunami setinggi 50 m di Kudat! Bersediakah kita? – Jabatan Meteorologi Malaysia".
2 Sarawak Voice, 7 November 2016: "Tsunami setinggi 50 meter diramal tenggelamkan Kudat – Meteorologi".
3 Daily Express, 6 November 2016: "Tsunami treat only assumption: Madius".
4 The Star, 4 November 2016: "Expert: Highly unlikely 50 m-high tsunami will hit Sabah".



Tsunami threat looms over coastal Sabah, residents urged to be prepared

BY AVILA GERALDINE (/AUTHORS/AVILA-GERALDINE) - 5 NOVEMBER 2016 @ 12:05 PM

KOTA KINABALU: Coastal Sabah faces the possibility of being struck by a tsunami in the event of a massive underwater earthquake or catastrophic seabed erosion, says the Sabah Meteorological Department.

Its director, Azemi Daud, said the state has the potential of being struck by seismic sea waves, based on scientific studies carried out by researchers across the globe.

FILE - In this March 11, 2011, file photo, an Earthquake-triggered tsunami sweeps the shores along Iwanuma in northern Japan. Coastal Sabah faces the possibility of being struck by a tsunami in the event of a massive underwater earthquake or catastrophic seabed erosion, says the Sabah Meteorological Department. AP Photo

Ancaman Tsunami Setinggi 50m Di Kudat Bersediakah Kita Jabatan Meteorologi Malaysia

pada 5/11/2016 - jumlah : 583 hits

Perbincangan secara langsung di Televisyen RTM berhubung risiko ombak tsunami yang boleh berlaku pada bila bila masa di daerah Kudat Perbincangan secara langsung di Televisyen RTM berhubung risiko ombak tsunami yang boleh berlaku pada bila ...

HAVE NO FEAR! TSUNAMI STRIKING KUDAT IS NEAR IMPOSSIBLE, UMS DON ASSURES

KOTA KINABALU – The possibility of a 50 metre high tsunami striking Sabah's northern coast around the Kudat region is quite impossible, said geologist Prof Dr Felix Tongkul, and should such a situation arise, it could be very rare.

He said that predictions of a tsunami was based only on a simulation of a giant undersea landslide of a shelf at the deep offshore Brunei waters in the South China Sea.

The Star on Friday quoted Dr Tongkul, who is of for University Malaysia Sabah's Natural Disaster Research Centre, as saying this to allay fears among the people after an official from the Malaysian Meteorological Department spoke of the possibility of such a scenario should the massive undersea landslip occurs.

"This high tsunami waves that could hit Kudat is only based on a tsunami simulation of a gigantic submarine landslide offshore Brunei. There is evidence of such landslides offshore Sabah," he was quoted as saying.

"However this 50 metre tsunami will only be produced if the whole mass of the shelf falls at one go. This is quite a rare occurrence. I personally think the chance for this to happen is very, very low," he said.

Dr Tongkul said that the submarine landslides usually moved slowly and in stages and as such, scenarios of gigantic tsunami waves would only occur in the "very very worse scenario."

Figure 1: Newspaper headlines in November 2016 reporting the threat of a 50 m-high tsunami in Sabah.

THE "RESEARCH FINDINGS"

The underwater landslide that occurred in south-west Sabah mentioned in the news referred to an ancient underwater landslide offshore Brunei that was described by oil company geologists in a scientific paper published in 2007. The authors of that paper (Gee *et al*., 2007) called it the "Brunei Slide" (Figure 2). It is hard to determine when the landslide happened, but in the paper the authors estimated that it may have occurred around 2000 to 7000 years ago. According to the news, research findings have shown that if such a large-scale landslide were to occur in south-west Sabah, it would generate a tsunami that can reach a height of 50 m by the time it reaches the coastal town of Kudat in northern Sabah. These research findings referred to by the meteorological department official, were actually based on mathematical simulations published in several papers (e.g., Chai *et al*., 2014). The simulations predict the consequences of such a massive submarine landslide occurring at the southwestern end of the Sabah Trough (Figure 2). It is noted that the same studies were also published in various non-geoscience journals (e.g. Koh *et al*., 2016; Tan *et al*., 2017). In order to understand these research findings, a closer look at the assumptions used in the mathematical model is required.

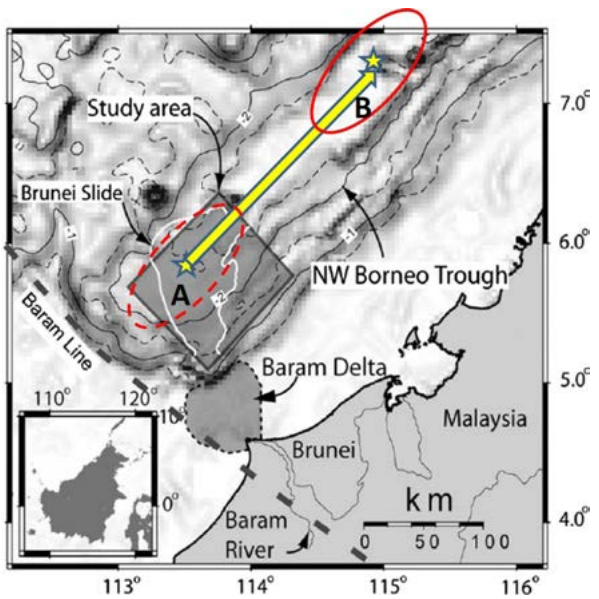


Figure 2: Map of offshore Brunei/Sabah (from Gee *et al.*, 2007) showing the submarine landslide simulated by authors mentioned in this paper. According to Chai *et al*. (2014) the slide block was initially located at latitude of 5.85° and longitude of 113.61°. It then slides downwards to the seafloor in the direction of northeast for a distance of about 211 km, along the axial depths of the Sabah Trough.

THE MATHEMATICAL MODEL

A numerical simulation is a computer calculation of a physical process, e.g. the generation of a tsunami by a landslide, or the flow of turbidity current down a continental slope. In a numerical simulation, the complexity of natural physical systems is approximated by a set of mathematical equations as representing the

system, along with some physical assumptions based on geological "reality", i.e. our understanding of geology and physical processes. These may include the size (volume), velocity, and transport distance of the landslide. Whether or not a submarine landslide will generate a tsunami, and consequently the size of the tsunami wave, is a function of the depth of the landslide, the amount of material that moves downslope (the landslide volume), the initial acceleration of the landslide mass, the speed at which the landslide moves downslope, and the properties of the material (its strength, composition). In order to understand the research results, a closer look at the assumptions is required and discussed below.

The tsunami modeling described in the papers generally involves basically two main steps (Watts *et al*., 2003; Watts *et al*., 2005): (i) generation of initial tsunami wave by the submarine landslide and (ii) propagation of the tsunami wave from the point of origin. Usually, modeling the inundation of the tsunami wave at the shoreline is a third step to complete an analysis, but predicting the initial wave generated by the landslide is the key starting point. The initial tsunami wave is predicted to be generated by the instantaneous movement of a submarine slab causing a perturbation of the sea surface above it (Figure 3). In the papers of Chai *et al*. (2014) and Koh *et al*. (2016), the geometry of the landslide was approximated as a mound with elliptical cross-section sliding down a planar inclined surface at an angle (modelled in two cases, 2° and 4°), to the horizontal (Figure 3). The slide mound has a maximum thickness *T* (240 m) in the middle, a total length *b* (120 km) along the down-slope axis, a total width *w* (two cases 44 m and 64 m) along the cross-slope axis, and an initial vertical submergence *D* (2450 m) at the centre of mass of the landslide. The slide then moved down the slope (of the Sabah Trough) in a northeasterly direction for a distance of about 211 km.

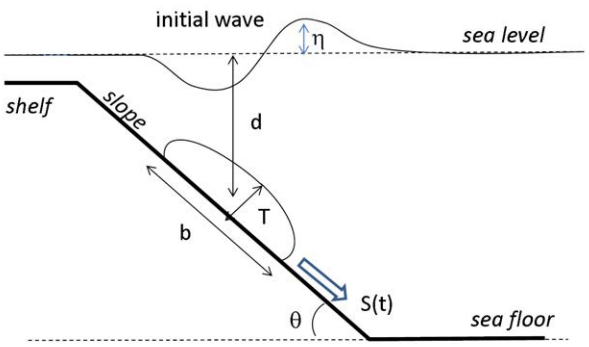


Figure 3: The usual scheme for simulating submarine slide is a rigid body moving along a planar slope with centre of mass motion *s*(*t*) parallel to the planar slope and subject to external forces (hydrodynamic drag, friction, etc.), based on the work of Watts *et al.* (2003, 2005). The slide block is idealized as a mound with elliptical cross-section translating along the planar slope with angle θ from the horizontal, with a maximum thickness *T* in the center, a total length *b* along the planar slope axis, a total width *w* along the cross-section axis, and an initial submergence *D* at the center. A specific density γ @ 1.85, a negligible Coulomb friction coefficient *Cn* @ 0, an added mass coefficient *Cm* @ 1, and a drag coefficient *Cd* @ 1. The formulation may be found in Watts *et al*. (2003, 2005), Chai *et al.* (2014) and Koh *et al*. (2016).

The amplitude of the wave generated by the slide depends on the dimensions of the underwater slide, its velocity and the initial conditions, including water depth, seafloor gradient and topography (Ward, 2001; Harbitz *et al*., 2006). Once the initial wave is generated (for example, in Figure 4), its propagation away from the source could be simulated as a shallow water wave, using one of the many schemes available in the literature, including those by the authors themselves (Tan *et al.*, 2017). The propagation of tsunami wave will not be dealt with here.

SLIDE DIMENSIONS

In the paper on the Brunei Slide, Gee *et al*. (2007) showed an interpretation of seismic reflection data of a "giant" submarine landslide that occurred in offshore Brunei. The size of the landslide was so huge that it had laid down on the adjacent floor of the Sabah Trough a sedimentary mass-transport deposit (MTD) with a thickness of 240 m, covering an area of seafloor approximately 120 km by 60 km (Figure 2). It appears that these reported dimensions of the landslide in offshore Brunei have been used by the authors of the mathematical models (Chai *et al*., 2014; Koh *et al*., 2017) as the basis for their input parameters in the numerical simulations (Figure 3). Hence, in the models the authors parameterised

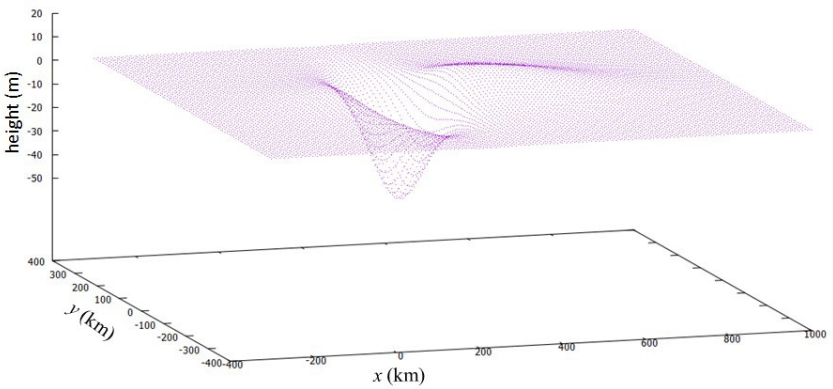


Figure 4: An example of initial wave generated by slide block specified in the text, according to the model in Figure 3, with initial submergence depth, *D*, of 2000 m on a 2° slope.

the submarine landslide as a "rigid body" with dimensions are: length b = 120 km, thickness T = 240 m, and width w = 63 (in Chai *et al*., 2014) and 44 (in Koh *et al*., 2016). Using these dimensions, it is implied that the rigid body or the original slide block had a surface area of 5280 km^2, which almost equal in size to the entire land area of Brunei (~5765 km^2). It is hard to conceive, first of all, such a huge area of continental shelf the size of Brunei had slid down in one piece, and secondly how such a block of sedimentary material would remain almost intact after coming off the submarine cliff.

The numerical scheme used by the authors makes an important assumption, that the landslide moves as a single coherent block, which remains intact throughout the sliding process. In reality, this is not the case, as shown by the large area of seafloor covered by the debris brought about by the mass-transport process (Gee *et al*., 2007). The model therefore failed to take into account the fact that a submarine landslide is not "rigid" but disintegrate as it moves down-slope and deposit its debris over a large area of the sea floor. Gee *et al.* (2007) described large-scale blocks that have rotated from their original positions while being transported, suggesting the initial slide block did not remain intact as a unit of sliding mass. The spectacular occurrences of basal striations of the MTD indicate deep scouring and erosion of the substrate seafloor by the landslide.

It is important to point out that the 120 x 60 km reported by Gee *et al*. (2007) represents the total area of the debris (MTD) left as a result of the slide, and not the original size of the slab of seafloor (the slide block) that came off the submarine cliff and slid down the slope. Assuming that a single sliding event had produced the MTD measuring 120 x 60 x 0.24 km, the volume of MTD is 1728 km^3. Gee *et al*. (2007) estimated a landslide volume of 1200 km^3 and pointed out that this far exceeds the volume of the Baram Canyon source area. They also estimated that as much as 80% of the mass of material in the MTD may have been derived from erosion of the sea floor beyond the Baram Canyon (Figure 2). The MTD could have also come from multiple slide events due to several catastrophic failures of the submarine slope, as the seismic data seem to suggest (Gee *et al*., 2007). The geological evidence therefore indicates that the surface area of the MTD could be many times larger than the size of the generating landslide.

A more realistic input for the dimensions of the slide may be obtained by balancing the volume of the MTD with the originating slide block, and taking into account the physical configuration of the margin as well as the possible contribution from eroded seafloor material to the debris flow. There is no information in Gee *et al*. (2007) on the size of the scar left by the landslide at the Baram Canyon, but their Figure 3 suggests that the width of the canyon could not be more than 20 km. If we assume the estimated total MTD volume of 1200 km^3, and only a fifth of this could have come from the source landslide (i.e. 240 km^3), then a more geologically realistic estimate for the input parameters for a single slide block would be 20 km x10 km x 120 m.

SUBMERGENCE DEPTH

Bearing in mind the problems with the input parameters to the model, let us look at other aspects of the model in more detail. Figure 5 illustrates the mathematical model on a map, showing the translation of the rigid body (red ellipse in Figure 2) from point A to point B, as envisaged by the model. If we compare the model with reality, it becomes apparent that the mathematical model does not take into consideration the actual conditions of the sea floor in the Sabah continental margin. According to the paper by Koh *et al*. (2016),

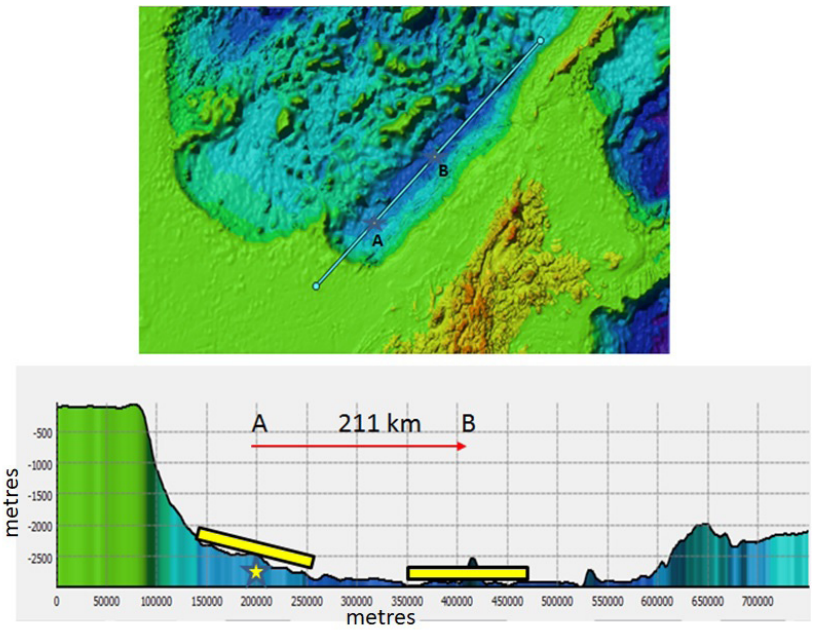


Figure 5: Bathymetric profile along the supposed trajectory of the rigid body (yellow slab), as described in Koh *et al.* (2016), moving from point A to point B in the northeast direction along the Sabah Trough, descending from a water depth of 2450 m to 2900 m, which is the average depth of the trough.

the initial location of the slide is centred at latitude of 5.85° and longitude of 113.61° (point A indicated on the map in Figure 2 and Figure 5). A bathymetric profile is shown in Figure 5 along the supposed trajectory of the rigid body (yellow slab) moving northeastwards from point A to point B. The model requires that the rigid body has an initial "submergence depth" of 2450 m and slides northeastwards from A to B, which is at the average depth of Sabah Trough ~2900 m. This initial condition is problematic. An initial submergence depth of 2450 m for the slide suggests that it had originated within the depths of the Sabah Trough, not on the shelf or even upper slope, as documented by Gee *et al.* (2007). The floor of the Sabah Trough is not flat but has several large seamounts (Hutchison, 2010), which may act as obstacles (e.g. at point B) to the movement of the submarine slides. Furthermore, with 450 m of difference in elevation, from 2450 to 2900 m water depth, the landslide may not have enough potential energy to slide for a distance of 211 km.

SEAFLOOR GRADIENT

Another key aspect of the mathematical model is the gradient or slope angle of the seabed where the landslide is initiated. Both studies by Chai *et al.* (2014) and Koh *et al.* (2016) simulated the landslides using two different values of seafloor gradient, 2° and 4°, in their models. In reality, however, the seafloor gradient at the supposed initial submergence depth location of the landslide is less than 0.1°, i.e. virtually flat (Figure 6). It should be noted that an initial surface wave can still be generated a movement of slide block on a horizontal (flat) sea floor (e.g., as demonstrated by Nokes *et al.*, 2010) but the size of the wave will depend on the water depth. It is, however, impossible for a slide block with the prescribed dimensions to actually move along the Sabah Trough in a manner described by the models. If the slide block were to move for a distance of 211 km horizontally, by trigonometry, the water depth at the final location of the slide block (point B in Figure 5) would be 7,370 m for a seafloor gradient of 2° or 14,750 m for a 4° gradient. Both these values are, of course, absurd since the Sabah Trough is less than 3000 m deep (Figure 6). This again suggests that the mathematical model does not reflect geological reality.

Figure 7a shows the initial elevation of the water surface calculated using the same parameters as those of the authors (water depth = 2450 m) but at various seafloor gradients, which show strong control of seafloor gradient on the wave amplitude; the steeper the slope the larger the amplitude of the initial tsunami wave. Conversely, given the gradient of the seafloor where a landslide occurs, say 2°, the resulting wave amplitude is strongly dependent on the water ("submergence") depth of the slide mass, as shown by the calculated curves in Figure 7b. Hence, it is important

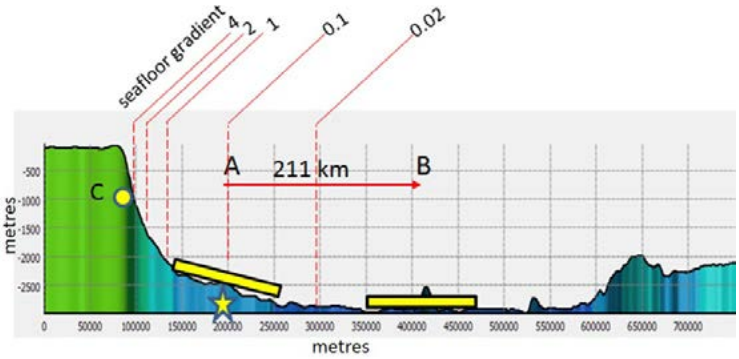


Figure 6: Same profile as in Figure 5, but the seafloor gradients along the Sabah Trough where the slide is supposed to occur is less than 0.1°, i.e. essentially a flat sea floor. The simulation by Chai *et al.* (2014) and Koh *et al.* (2016) assumed slope angles of 2° or 4°. Hence, the yellow circle (C) denotes a more plausible location of a slide block in this study. The resulting wave amplitude generated from this hypothetical slide location (C) is shown in Figure 8.

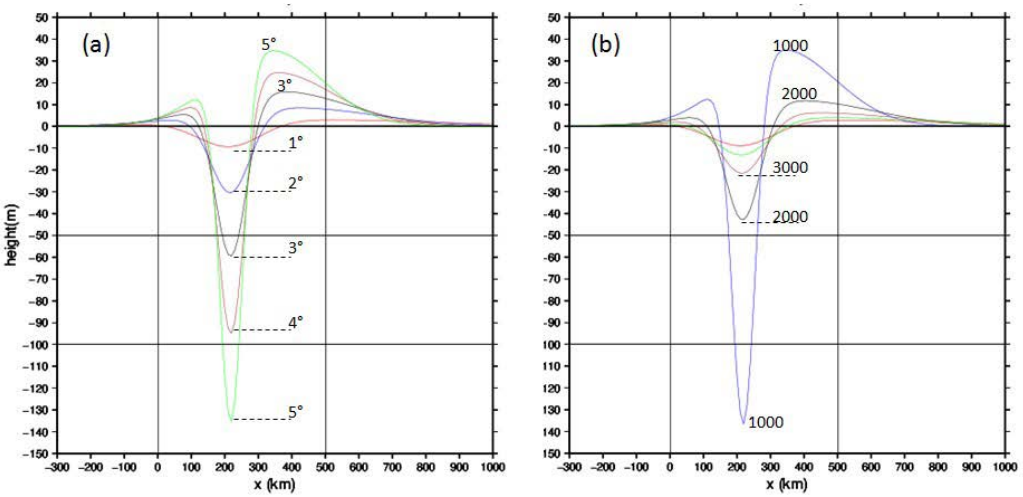


Figure 7: Calculated initial wave amplitudes generated for (a) different seafloor gradients (1, 2, 3, 4, 5°), at same water depth *D*=2450 m. (b) different water depths (1000, 2000, 3000, 4000, 5000 m), at same seafloor gradient of 2°.

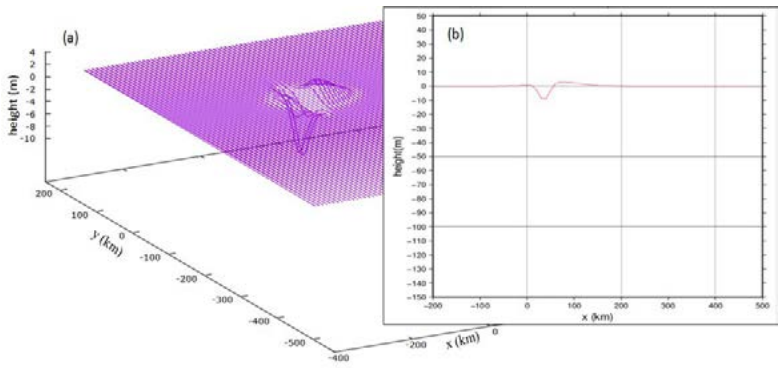


Figure 8: Initial wave generated by slide block based on more geologically realistic parameters, as discussed in the text: Length, b = 20 km, width w = 10 km, thickness T = 120 m, initial water depth, D = 1000 m, slope gradient 4°. (a) 3D view of wave. (b) 2D profile of wave along x-axis at y = 0 in (a). Note the wave amplitude is significantly smaller when compared to the curve for 4° in Figure 7b, plotted at the same scale.

to use the most appropriate and geologically realistic parameters as input to mathematical simulations. Figure 8 shows the initial surface wave amplitude calculated using these parameters: Length, b = 20 km, width, w = 10 km, thickness, T = 120 m, initial water depth, D = 1000 m, slope gradient 4°, which as expected shows a significantly lower initial wave amplitude (<10 m) than predicted by previous authors (>200 m, Chai *et al*., 2014).

CONCLUSION

For a long time, geologists and oceanographers have known about submarine landslides as a common natural geological phenomenon, but its effect of surface waves and tsunamis is not easy to predict. The results of the mathematical simulation of a submarine landslide in offshore Sabah as reported in several studies appear to have been based on a number of geologically unrealistic assumptions. As has been disputed by geological experts, the 50 m-high tsunami predicted to occur in the west coast of Sabah is therefore highly unlikely.

This brief note is intended to demonstrate that input parameters for mathematical simulation need to be chosen carefully based on reliable geological information. Mathematical models are meant to replicate natural phenomena but the physical assumptions must be based on geological reality. Modelling parameters and assumptions that are not checked against geological reality (e.g., slide dimension, submergence depth, seafloor gradient) may result in misleading results and predictions, and in the case of a tsunami, may create unnecessary public anxiety and confusion. Finally, to achieve the best outcome, it would be highly desirable for research on natural hazards, such as earthquakes and tsunami predictions, be carried out as collaborative efforts between engineers, mathematicians and geoscientists in the various government agencies and academic institutions.

ACKNOWLEDGEMENTS

The author would like to thank Prof. John Kuna Raj and Prof. Felix Tongkul for reviewing this note for publication.

REFERENCES

Chai, M.F., Lau, T.L. & Majid, T.A., 2014. Potential impacts of the Brunei Slide tsunami over East Malaysia and Brunei Darussalam. Ocean Engineering, 81, 69–76. DOI:10.1016/j.oceaneng.2014.02.028.

Gee, M.J.R., Uy, H.S., Warren, J., Morley, C.K. & Lambiase, J.J., 2007. The Brunei slide: A giant submarine landslide on the North West Borneo Margin revealed by 3D seismic data. Marine Geology, 246, 9-23.

Harbitz, C.B., Lovholt, F., Pedersen, G. & Masson, D.G., 2006. Mechanisms of tsunami generation by submarine landslides: a short review. Norwegian Journal of Geology, 86, 255-264. Trondheim 2006. ISSN 029-196X.

Hutchison, C.S., 2010. The North-West Borneo Trough. Marine Geology, 271, 32–43.

Koh, H.L., Tan, W.K., The, S.Y. & Chai, M.F., 2016. Simulation of potentially catastrophic landslide tsunami in North West Borneo Trough. International Jour. Environmental Science and Development, 7(12), 889-895. doi: 10.18178/ijesd.2016.7.12.900.

Nokes, R.I., Sue, L.P. & Davidson, M.J., 2010. Modelling tsunami generated by submarine landslide. 17th Australasian Fluid Mechanics Conference, Auckland, New Zealand, 5-9 Dec. 2010.

Raj, J.K., 2007. Tsunami threat to coastal areas of Sabah, East Malaysia. Bulletin of the Geological Society of Malaysia, 53, 51 – 57.

Tan, W.K., Teh, S.Y. & Koh, H.L., 2017. Tsunami run-up and inundation along the coast of Sabah and Sarawak, Malaysia due to a potential Brunei submarine mass failure. Environ. Sci. Pollut. Res., 24, 15976-15994. DOI 10.1007/s11356-017-8698-x.

Ward, S.N., 2001. Landslide tsunami. Journal of Geophysical Research, 106, 11201-11215.

Watts, P, Grilli, S.T., Tappin, D. & Fryer, G.J., 2005. Tsunami generation by submarine mass failure. II: predictive equations and case studies, Jour. Waterway Port Coast. Ocean Eng., 131(6), 298–310.

Watts, P., Grilli, S.T., Kirby, J.T., Fryer, G.J. & Tappin, D.R., 2003. Landslide tsunami case studies using a Boussinesq model and a fully nonlinear tsunami generation model. Natural Hazards and Earth System Sciences, 3, 391–402.

Manuscript received 6 August 2018
Revised manuscript received 11 October 2018
Manuscript accepted 12 October 2018

Penilaian cerun batuan di tapak bekas kuari untuk tebusguna pembangunan - Kajian kes di Kuari Granit Kajang, Kajang, Selangor

(Rock slope assessment at former quarry site for development reclamation - A case study at Kajang Granit Quarry, Kajang, Selangor)

Hamzah Hussin[1,2,*], Tajul Anuar Jamaluddin[2],
Nurshazren Fauzi[1] & Mohd Hariri Arifin[2]

[1]Jabatan Geosains, Fakulti Sains Bumi, Universiti Malaysia Kelantan, 17600, Jeli, Kelantan
[2]Pusat Pengajian Sains Sekitaran & Sumber Alam, Fakulti Sains & Teknologi,
Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor
*Corresponding author email address: hamzah.h@umk.edu.my

Abstrak: Penggunaan kawasan bekas kuari yang ditebusguna bagi pembangunan komersil semakin meningkat terutamanya di kawasan bandar. Bekas tapak kuari seperti Taman Bukit Permai, Cheras telah dibangunkan dengan unit-unit perumahan. Keadaan yang sama turut berlaku pada Kuari Granit Kajang yang terletak di Kajang, Selangor. Kawasan bekas kuari ini telah dicadang untuk dibangunkan dengan unit perumahan dan komersil. Kawasan bekas kuari yang dikelaskan sebagai Kawasan Sensitif Alam Sekitar (KSAS) perlu dilakukan pemetaan kejuruteraan terperinci bagi memastikan kestabilan terutamanya pada cerun batuan. Penilaian cerun dilakukan menggunakan dua peringkat iaitu tafsiran imej satelit dan pemetaan lapangan. Tafsiran imej satelit menunjukkan kehadiran 4 set lineamen yang berorientasi barat laut-tenggara, hampir utara-selatan, timur laut-barat daya dan timur timur laut-barat barat daya. Hasil pemetaan menunjukkan cerun berpotensi untuk mengalami kegagalan baji, satah, terbalikan dan/ atau gabungan antara kegagalan tersebut. Kesan daripada penggunaan kaedah letupan untuk mendapatkan aggregat telah menghasilkan jasad batuan yang hancur, blok–blok batuan yang longgar dan tergantung serta tidak stabil. Blok batuan pelbagai saiz ini berpotensi untuk gagal dalam bentuk jatuhan batuan. Penilaian kekuatan jasad batuan menggunakan perkadaran jasad batuan (RMR) menunjukkan cerun di kawasan ini berkualiti sederhana.

Kata kunci: bekas kuari, cerun batuan, kawasan sensitif alam sekitar, perkadaran jasad batuan

Abstract: The use of reclaimed quarry area for commercial development is increasing especially in urban areas. Former quarry sites e.g. Taman Bukit Permai, Cheras have been developed with housing units. The same situation happened at the former Kajang Granite Quarry located in Kajang, Selangor. Residential and commercial units are proposed to be developed there. The former quarry is classified as Environmentally Sensitive Areas (KSAS) that requires detailed engineering mapping to ensure its stability, especially on rock slopes before any further development is carried out. For this purpose, slope assessment was carried out using two approaches/methods, focusing on satellite imagery and field mapping. Satellite imagery images indicated the presence of 4 set of lineaments oriented northwest-southeast, almost north-south, northeast-southwest and northeast east-west southwest directions respectively. Result from field mapping shows that the slopes are highly potential for wedge, plane, toppling and / or combination of these failures types. Explosive methods used to produce aggregate has resulted in crushed, loose, suspended and unstable rock blocks. The rock blocks varies in sizes and have the possibility to fail rock fall. Assessment on rock mass strength using rock mass rating (RMR) shows the slopes are classified as moderate quality.

Keywords: Former quarry, rock slope, environmentally sensitive area, rock mass rating

PENGENALAN

Pembangunan di kawasan berbukit kini semakin rancak dan berleluasa kerana permintaan yang tinggi untuk pemilikan hartanah di kalangan masyarakat (Ahmad *et al*., 2010; Mustaffa Kamal Shuib & Tajul Anuar Jamaluddin, 2004). Di sebalik kemegahan projek perumahan mewah di kawasan berbukit, ramai yang tidak menyedari bahawa mereka sebenarnya juga terdedah kepada risiko geobencana seperti yang pernah dilaporkan oleh pengkaji seperti Ashaari *et al.* (2008); Mukhlisin *et al.* (2010); Raj (2000); Thanapackiam *et al*. (2012). Kejadian geobencana ini

telah mengakibatkan kemalangan jiwa dan kerosakan pada harta benda.

Kawasan bekas tapak kuari merupakan salah satu kawasan yang sering menjadi pilihan untuk dibangunkan kerana didasari oleh batuan yang kuat seperti granit. Beberapa buah bekas kuari telah dibangunkan dengan projek komersil terutamanya di kawasan bandar besar seperti Kajang, Ipoh, Kuala Lumpur dan Seremban (Jamaluddin, 2011). Secara umumya, kajian pada sesebuah tapak bekas kuari yang ditebusguna tidak dilakukan dengan terperinci yang mengakibatkan berlakunya geobencana jatuhan batuan (Mohammed Ali Mohammed Al-Bared *et al.*, 2015; Mustaffa Kamal Shuib & Tajul Anuar Jamaluddin, 2004).

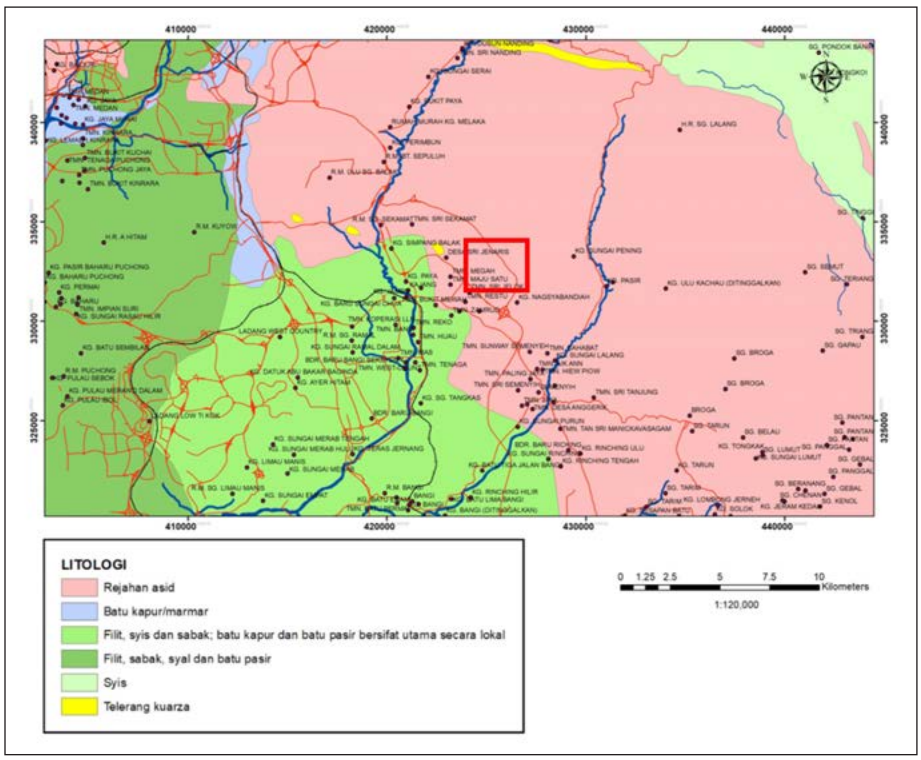
Unit-unit infrastruktur yang dibina biasanya hampir dengan muka cerun bekas kuari. Muka cerun batuan yang tinggi, tidak rata, mempunyai blok-blok batuan yang tidak stabil dan tiada sistem sokongan telah mewujudkan elemen geobahaya kepada manusia atau hartanya (Tajul Anuar Jamaluddin, 2010). Maka, adalah penting untuk melakukan penilaian kestabilan cerun sebelum binaan dilaksanakan. Kertas kerja ini akan membincangkan keperluan untuk melakukan penilaian cerun batuan daripada segi potensi kegagalan cerun yang boleh berlaku dan mengenalpasti kewujudan elemen-elemen geobahaya. Pengenalpastian ini penting bagi membolehkan perancangan pembinaan dapat dilakukan dengan lebih baik sekaligus boleh meminimumkan risiko geobencana pada masa mendatang.

KAEDAH KAJIAN

Kajian melibatkan dua peringkat iaitu kajian awalan dan kajian lapangan. Kajian awalan melibatkan pengenalpastian kedudukan kawasan, keadaan geologi dan geomorfologinya dengan menggunakan imej satelit yang dimuat turun daripada Google Earth. Ini bertujuan untuk mengenalpasti keadaan topografi, saliran semulajadi, bentuk mukabumi dan struktur geologi major (lineamen negatif). Penggunaan imej satelit daripada Google Earth terbukti membantu untuk mendapatkan maklumat kritikal geologi (Lageson *et al.*, 2012; Rana *et al*., 2016) di samping mendapatkan gambaran awal keadaan tapak kajian.

Kajian lapangan pula melibatkan cerapan dan pengukuran data seperti geologi kawasan, geologi kejuruteraan cerun (jenis bahan pembentuk jasad batuan, ketakselanjaran, luluhawa, hidrogeologi, sistem pengukuhan cerun) dan kewujudan elemen geobahaya serta bukti-bukti kejadian geobencana. Imej gambar lapangan digunakan sebagai asas semasa pemetaan bagi membolehkan data dapat diurus dan dicatatkan dengan sistematik. Sebanyak lima buah cerun muka bekas kuari telah dinilai dalam kajian ini.

Analisis kinematik menggunakan kaedah Markland digunakan untuk menilai potensi kegagalan cerun batuan seperti yang dicadangkan oleh Hoek & Bray (1981). Analisis ini boleh membantu mengenalpasti potensi kegagalan satah, baji dan terbalikan yang disebabkan oleh pengaruh orientasi ketakselanjaran yang tidak sesuai dengan binaan. Data jurus dan kemiringan satah ketakselanjaran diplotkan menggunakan perisian DIPS (2015) dalam bentuk plot kutub dan kontur bagi menentukan jumlah set ketakselanjaran yang wujud di lapangan. Potensi kegagalan cerun ditentukan dengan memplot data orientasi cerun dan kon sudut geseran dalaman ke dalam unjuran stereografik.



Rajah 1: Peta geologi kawasan kajian (ditandai oleh kotak) yang di dasari oleh jasad batuan granit.

GEOLOGI DAN KEADAAN KAWASAN KAJIAN

Kawasan kajian didasari oleh batuan granit daripada kumpulan Granit Kajang yang juga merupakan sebahagian daripada Granit Kuala Lumpur (Rajah 1). Batuan granit ini mempunyai saiz butiran sederhana sehingga kasar, bertekstur porfiritik dan berwarna kelabu cerah. Secara umum, kawasan kajian merupakan satu tapak bekas kuari yang baharu dtamatkan operasi. Satu projek pembangunan infrastruktur telah dicadang untuk dibangunkan di kawasan ini. Topografi yang rata dan didasari oleh jasad batuan yang kukuh merupakan faktor utama kawasan bekas kuari menjadi pilihan untuk dibangunkan (Rajah 2).

Pemetaan lineamen menggunakan imej satelit menunjukkan terdapat empat set lineamen wujud di kawasan kajian iaitu berorientasi hampir utara-selatan, timur laut-barat daya, barat laut-tenggara dan timur timur laut-barat barat daya (Rajah 3). Lineamen ini ditafsirkan sebagai kekar utama dan tidak menunjukkan kaitan dengan sesar berskala rantau.

Satah ketakselanjaran yang wujud pada jasad batuan terdiri daripada kekar dan sesar. Satah ketakselanjaran biasanya telah sedikit terbuka kesan daripada proses letupan untuk mendapatkan aggregat. Keadaan ini telah mewujudkan blok-blok batuan yang longgar dalam pelbagai saiz pada semua cerun batuan. Analisis data menunjukkan kehadiran lima ke enam set satah ketakselanjaran pada setiap cerun. Persilangan antara satah ketakselanjaran dan retakan perletupan telah menghasilkan elemen berbahaya dan tidak stabil pada cerun batuan. Blok-blok batuan yang longgar bersaiz antara beberapa sentimeter hingga 2.0 m (Rajah 4). Sisa daripada jatuhan blok batuan boleh dilihat di bahagian kaki semua cerun batuan.

Rajah 2: Pandangan keadaan kawasan kajian yang menunjukkan keadaan kawasan kajian.

Rajah 3: Tafsiran lineamen di kawasan kajian menggunakan imej satelit.

PENILAIAN KESTABILAN CERUN POTONGAN JASAD BATUAN

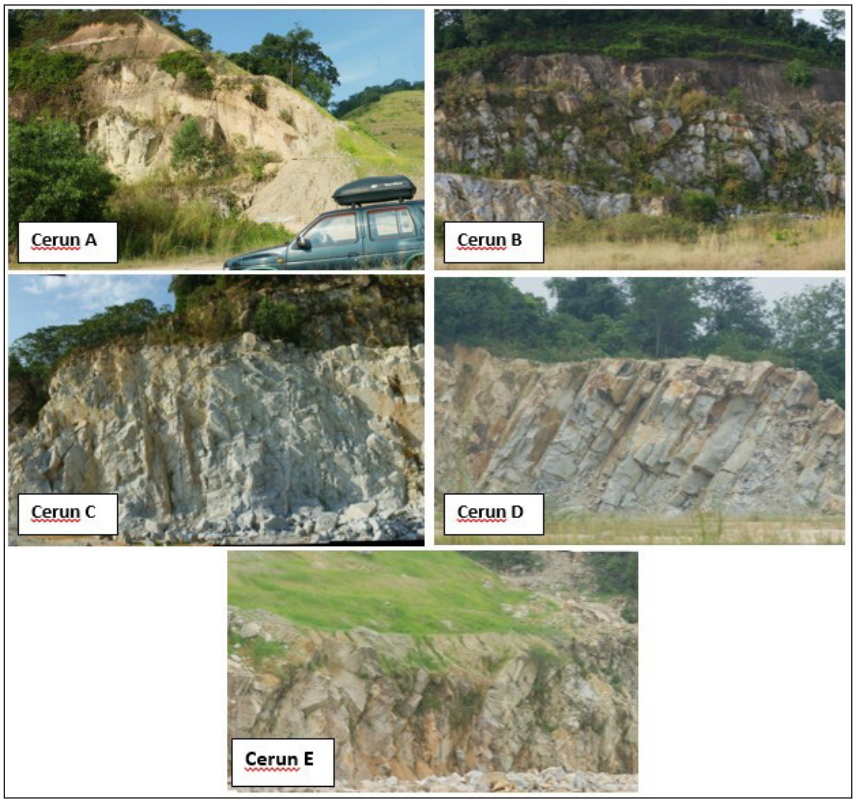
Analisis kinematik kestabilan cerun dilakukan pada lima cerun batuan yang merangkumi cerun A, B, C D dan E (Rajah 5). Cerun batuan yang terbentuk daripada proses pengkuarian mempunyai ketinggian berjulat antara 15-30 m dan berkelebaran antara 35-100 m. Sudut kecondongan setiap cerun ialah 80°, mempunyai permukaan yang tidak rata dan banyak blok-blok batuan yang longgar dan tergantung. Jasad batuan yang terdedah bergred luluhawa daripada gred I (batuan segar) hingga gred IV (terluluhawa sepenuhnya). Secara keseluruhannya, luluhawa gred II dan III merupakan yang paling dominan di sekitar kawasan kajian.

Maklumat asas cerun dan orientasi set ketakselanjaran yang wujud pada jasad batuan ditunjukkan dalam Jadual 1. Cerun yang dikaji merupakan muka bekas kuari yang terhasil daripada aktiviti pengkuarian. Cerun batuan ini berada di sekitar perimeter kawasan cadangan untuk pembinaan unit-unit kediaman dan lot perniagaan. Penilaian kestabilan dilakukan untuk melihat sebarang potensi kegagalan yang boleh mendatangkan ancaman kepada binaan infrastruktur.

Analisis kestabilan kinematik menggunakan sudut geseran dalaman bernilai 32° kerana keadaan permukaan satah ketakselanjaran yang beralun, kering dan bukaan yang sempit. Hasil analisis menunjukkan setiap cerun potongan berpotensi untuk mengalami kegagalan baji, satah, terbalikan atau gabungan antara potensi kegagalan tersebut. Ringkasan potensi kegagalan setiap cerun ditunjukkan dalam Jadual 2. Kegagalan baji merupakan jenis yang paling banyak potensi untuk berlaku pada setiap cerun, diikuti oleh kegagalan satah dan terbalikan. Cerun B dan E paling berpotensi mengalami tiga kegagalan baji, diikuti oleh cerun A, C dan D yang masing-masing dengan dua potensi kegagalan.

Analisis juga menunjukkan potensi kegagalan satah boleh berlaku pada semua cerun kecuali cerun B manakala kegagalan terbalikan berpotensi berlaku pada cerun A, C dan D. Potensi kegagalan dikawal oleh kewujudan dan orientasi satah ketakselanjaran pada setiap cerun batuan. Kegagalan baji disebabkan oleh persilangan antara dua satah ketakselanjaran yang miring ke arah muka cerun. Kegagalan baji kompleks juga boleh berlaku apabila

Rajah 4: Blok batuan bersaiz besar yang jatuh daripada muka cerun akibat persilangan antara satah kekar. Blok batuan yang longgar serta tergantung merupakan elemen geobahaya yang perlu diberi perhatian untuk distabilkan.

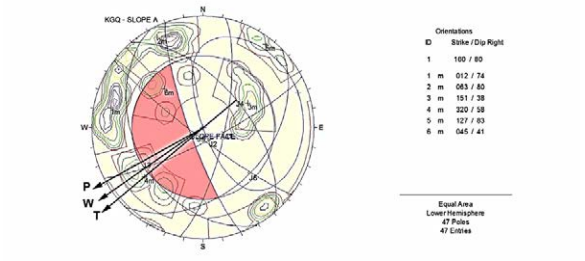
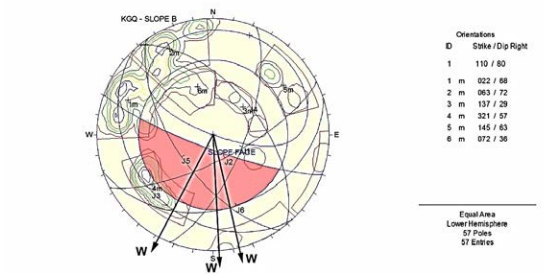
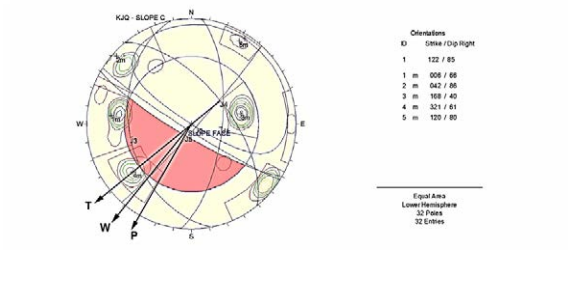
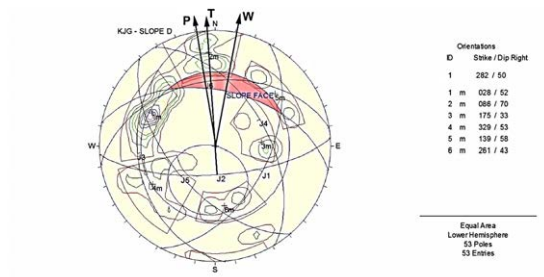


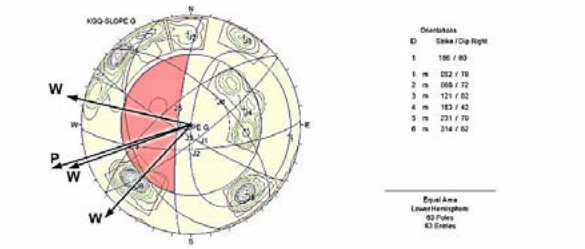
Rajah 5: Keadaan lima buah cerun batuan yang terdapat di kawasan kajian.

Jadual 1: Data maklumat asas cerun dan orientasi set ketakselanjaran.

Cerun A	Ciri cerun					
	Orientasi	Kecondongan (°)	Tinggi (m)	Lebar (m)		
	160°	80	28	70		
Set ketakselanjaran	J1	J2	J3	J4	J5	J6
Jurus /Kemiringan	012°/74°	063°/80°	151°/38°	320°/58°	127°/83°	045°/41°
Cerun B	Ciri cerun					
	Orientasi	Kecondongan	Tinggi	Lebar		
	110	80	25	102		
Set ketakselanjaran	J1	J2	J3	J4	J5	J6
Jurus /Kemiringan	022°/68°	063°/72°	137°/29°	321°/57°	145°/63°	072°/36°
Cerun C	Ciri cerun					
	Orientasi	Kecondongan	Tinggi	Lebar		
	122°	85	25	160		
Set ketakselanjaran	J1	J2	J3	J4	J5	
Jurus /Kemiringan	006°/66°	042°/86°	168°/40°	321°/61°	120°/80°	
Cerun D	Ciri cerun					
	Orientasi	Kecondongan	Tinggi	Lebar		
	282°	50	16	35		
Set ketakselanjaran	J1	J2	J3	J4	J5	J6
Jurus /Kemiringan	028°/52°	086°/70°	175°/33°	329°/53°	139°/58°	261°/43°
Cerun E	Ciri cerun					
	Orientasi	Kecondongan	Tinggi	Lebar		
	186°	80	12	100		
Set ketakselanjaran	J1	J2	J3	J4	J5	J6
Jurus /Kemiringan	052°/79°	088°/72°	121°/82°	163°/42°	231°/70°	314°/62°

Jadual 2: Analisis kinematik kestabilan pada lima cerun di kawasan kajian.

Cerun A		Cerun B	
			
Potensi kegagalan	Satah = J3	Potensi kegagalan	Satah = Tiada
	Baji = J2xJ3		Baji = J2xJ5, J1xJ5, J5xJ6
	Terbalikan = J4		Terbalikan = Tiada
Cerun C		**Cerun D**	
			
Potensi kegagalan	Satah = J5	Potensi kegagalan	Satah = J6
	Baji = J3xJ5		Baji = J4xJ6
	Terbalikan = J4		Terbalikan = J2

Cerun E	
	
Potensi kegagalan	Satah = J4
	Baji = J3xJ5, J4xJ5, J1xJ4
	Terbalikan = Tiada

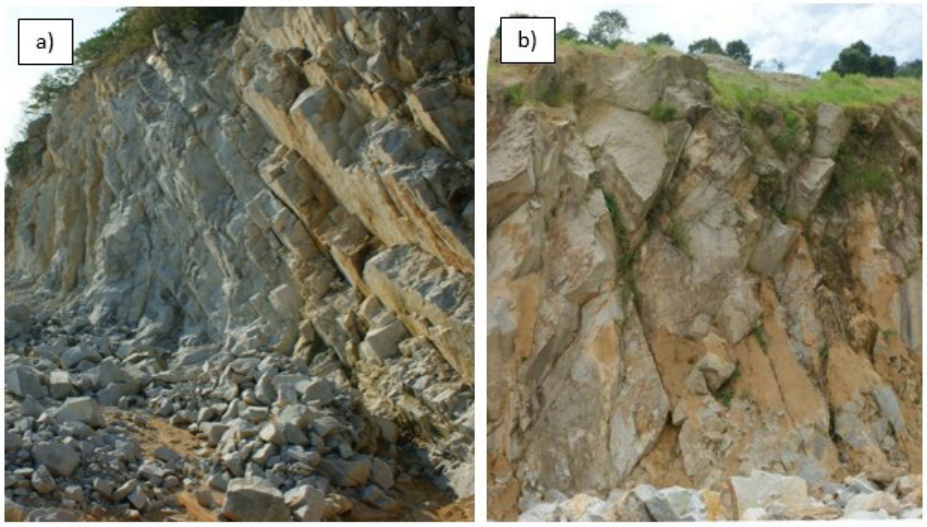
berlaku persilangan antara tiga satah ketakselanjaran, yang mana satah ketiga biasanya merupakan satah yang mengawal kegagalan satah dan/atau kegagalan terbalikan.

Hasil analisis dipadankan dengan cerapan lapangan yang menunjukkan kesamaan ragam kegagalan yang berlaku. Kegagalan terbalikan dan baji masing-masing wujud pada cerun C dan E seperti yang ditunjukkan dalam Rajah 6. Kegagalan terbalikan pada cerun C dikawal oleh orientasi satah ketakselanjaran yang condong setentang dengan muka cerun.

Pengelasan kualiti jasad batuan menggunakan sistem pengelasan perkadaran jasad batuan (Rock Mass Rating) oleh Bieniawski (1989) telah dilakukan pada cerun C dan cerun E. Kaedah garis survei oleh Ibrahim Komoo & Ibrahim Abdullah (1983) telah digunakan bagi mendapatkan data bagi membuat pengelasan RMR. Parameter yang diukur ditunjukkan dalam Jadual 3. Ujian beban titik menunjukkan kekuatan batuan granit di kawasan ini sangat kuat dengan nilai melebihi 5 MPa. Nilai penanda mutu batuan yang melebihi 75% dikategorikan sebagai baik mengikut pengelasan oleh Deere *et al*. (1966). Secara umum, ketakselanjaran mempunyai ciri seperti keterusan sederhana hingga tinggi, bukaan yang ketat, terluluhawa gred II dan III, bukaan yang bersih dan pemukaan ketakselanjaran yang beralun. Setiap ciri ini diberikan perkadaran yang telah ditetapkan. Jumlah akhir daripada nilai perkadaran setiap parameter menunjukkan cerun C dan E berkualiti sederhana.

PERBINCANGAN

Pemetaan geologi mendedahkan cerun batuan hasil daripada aktiviti pengkuarian merupakan cerun yang tidak stabil dan berpotensi untuk mengalami kegagalan cerun. Analisis kinematik kestabilan menunjukkan semua cerun berpotensi mengalami kegagalan baji, satah, terbalikan



Rajah 6: Dua jenis kegagalan yang berlaku pada cerun batuan disebabkan oleh pengaruh ketakselanjaran. a) Kegagalan terbalikan yang direkodkan berlaku pada cerun C; b) Kegagalan baji yang terhasil daripada persilangan antara dua set kekar major pada cerun E.

Jadual 3: Pengelasan kualiti jasad batuan menggunakan sistem perkadaran jasad batuan (RMR).

Pengelasan Jasad Batuan				
Parameter Bahan Batuan	**Cerun C**		**Cerun E**	
Ujian Beban Titik	5.34 MPa		8.02 MPa	
Perkadaran	12		12	
Nilai Penanda Mutu Batuan	82.39 %		78.57 %	
Perkadaran	17		17	
Jarak antara ketakselanjaran	0.50 m		0.73 m	
Perkadaran	13		13	
Keadaan ketakselanjaran				
• Bilangan set	5 set	(1)	6 set	(1)
• Keterusan	Sederhana-tinggi	(2)	Sederhana-tinggi	(2)
• Bukaan	Ketat	(4)	Ketat	(4)
• Keadaan luluhawa	II – III	(2)	II – III	(2)
• Bahan pengisi	Bersih, lain-lain	(4)	Bersih, lain-lain	(4)
• Kekasaran	Beralun	(2)	Beralun	(2)
• Kekuatan dinding	Keras	(3)	Keras	(3)
Perkadaran	18		18	
Air bawah tanah	Kering		Kering	
Perkadaran	10		10	
Jumlah perkadaran	70		70	
Penyesuaian perkadaran dengan orientasi binaan	1 kegagalan baji, 1 kegagalan terbalikan, 1 kegagalan satah		3 kegagalan baji, 1 kegagalan satah	
Perkadaran	-20		-20	
Jumlah perkadaran	50		50	
Kelas Jasad Batuan	Kualiti sederhana		Kualiti sederhana	

dan/atau gabungan antara kegagalan tersebut. Cerun A, C dan D berpotensi mengalami ketiga-tiga ragam kegagalan tersebut, manakala cerun E berpotensi mengalami kegagalan baji dan satah. Cerun B pula hanya berpotensi mengalami ragam kegagalan tunggal iaitu kegagalan baji. Pengaruh orientasi satah ketakselanjaran memainkan peranan penting dalam mengawal potensi kegagalan ini untuk berlaku.

Penentuan kekuatan jasad batuan pada dua cerun iaitu cerun C dan E menunjukkan kedua cerun ini berkualiti sederhana. Nilai yang rendah ini disumbangkan oleh jumlah potensi kegagalan yang boleh berlaku pada setiap cerun. Cerun C berpotensi mengalami tiga kegagalan manakala cerun E pula iailah empat kegagalan. Keadaan ketakselanjaran untuk kedua cerun menunjukkan sifat yang sama. Perbezaan boleh dilihat pada tiga parameter

lain iaitu kekuatan bahan batuan, nilai penanda mutu batuan dan jarak antara ketakselanjaran. Walaupun mempunyai nilai yang sama, tetapi nilai pemberatnya adalah sama kerana julat pemberat untuk setiap kelas adalah besar.

Penentuan kekuatan jasad batuan ini memberi maklumat jelas bahawa cerun batuan di tapak bekas kuari adalah tidak kuat. Maka, sebarang pembangunan yang yang dirancang perlu mengambil kira semua faktor ini bagi memastikan pembagunan secara lestari dapat dilakukan. Satu perkara yang perlu diberi perhatian berkaitan cerun batuan ini ialah untuk mengukuhkannya dengan menggunakan keadah-kaedah yang sesuai seperti pemasangan *rock bolt* dan sistem jaring. Pelan susun atur bangunan perlu mengambil kira faktor ini. Penyediaan zon penampan yang mencukupi perlu seperti mana yang digariskan oleh Kemeterian Perumahan dan Kerajaan Tempatan (KPKT) iaitu sekali ganda daripada ketinggian cerun.

KESIMPULAN

Kawasan bekas tapak kuari yang dikelaskan sebagai kawasan sensitif alam sekitar (KSAS) kerana potensi geobencana yang tinggi. Sebarang pembangunan di kawasan ini memerlukan satu penilaian geologi yang lengkap dan komprehensif merangkumi potensi geobahaya dan geobencana yang wujud di kawasan ini. Cerun batuan yang terhasil daripada aktiviti pengkuarian adalah tidak stabil dan boleh berlaku kegagalan cerun. Potensi kegagalan boleh berlaku dalam pelbagai ragam samada kegagalan baji, satah dan/atau terbalikan. Gabungan antara potensi kegagalan juga boleh berlaku menghasilkan kegagalan yang kompleks. Kekuatan jasad batuan yang rendah meningkatkan potensi geobencana untuk berlaku. Penggunan teknik tebatan yang sesuai perlu untuk mengukuhkan cerun tersebut samada menggunakan sistem pasif atau aktif. Menjadi satu tanggungjawab kepada semua pihak samada pemaju atau pihak berkuasa tempatan untuk memastikan elemen geologi terutamanya aspek kestabilan cerun diambil kira dan diberi penekanan dalam perancangan pembangunan terutama di kawasan yang berisiko tinggi seperti tapak bekas kuari.

PENGHARGAAN

Terima kasih diucapkan kepada Sin Heap Lee Development Sdn. Bhd. selaku pemilik kawasan kajian kerana membenarkan penyelidikan ini dilaksanakan dengan jayanya. Penyelidikan ini dibiayai menggunakan geran oleh Kementerian Pendidikan Malaysia dan Universiti Malaysia Kelantan berkod R/RAGS/A08.00 /01037A/001/2015/000206.

RUJUKAN / REFERENCES

Ahmad, F., Yahaya, A. S., Ali, M. M. & Hussain, W., 2010. Environmental risk assessment on hill site development in Penang, Malaysia: recommendations on management system. European Journal of Scientific Research, 40(3), 318–340.

Ashaari, M., Shabri, S., Mahadzer M, Nik Ramalan, N. H., Fadlee, M. B., Mariappan, S., Low, T. H., Chong, S., Zaini, M. M., & Wan Mohd, R. W. I., 2008. Slope field mapping and findings at Ulu Klang Area, Malaysia. In: Proceedings of the international conference on slopes (pp. 4–6). Kuala Lumpur.

Bieniawski, Z. T., 1989. Engineering Rock Mass Classifications. Wiley, New York. 251 p.

Deere, D. U., Hendron, A. J., Patton, F. D. & Cording, E. J., 1966. Design of surface and near-surface construction in rock. In: C. Fairhurst (Ed.), The 8th US Symposium on Rock Mechanics (USRMS). American Rock Mechanics Association, Minneapolis, MN, 237-302.

DIPS, 2015. Version 6.017. Toronto: Rocscience Inc.

Hoek, E. & Bray, J. W., 1981. Rock slope engineering. Inst. Min. Metall, London. 358 p.

Ibrahim Komoo & Ibrahim Abdullah, 1983. Ketakselanjaran dan kaedah pengukuran di lapangan. Sains Malaysiana, 12(2), 119–140.

Jamaluddin, T. A., 2011. Engineering Geology and Rock Slope Stability for Development in Former Granite Quarry Sites. Buletin SEADPRI Newsletter, 3.

Lageson, D. R., Larsen, M.C., Lynn, H. B. and Treadway, W. A., 2012. Applications of Google Earth Pro to fracture and fault studies of Laramide anticlines in the Rocky Mountain foreland. Geological Society of America Special Papers, 492, 209–220.

Mohammed Ali Mohammed Al-Bared, Rini Asnida Abdullah, Nor Zurairahetty Mohd Yunus, Mohd For Mohd Amina & Haryati Awang, 2015. Rock Slope Assessment Using Kinematic and Numerical Analyses. Jurnal Teknologi, 77(11), 59–66.

Mukhlisin, M., Idris, I., Salazar, A. S., Nizam, K. & Taha, M. R., 2010. GIS based landslide hazard mapping prediction in Ulu Klang, Malaysia. Journal of Mathematical and Fundamental Sciences, 42(2), 163–178.

Mustaffa Kamal Shuib & Tajul Anuar Jamaluddin, 2004. A hazard assessment of a granite cut-slope in a hillside developement off Jalan Kuari Cheras, Selangor. Bulletin of the Geological Society of Malaysia, 49, 1–4.

Raj, J. K., 2000. Rainfall and slope failures in the granitic bedrock areas of Peninsular Malaysia. In: G.H. Teh, Joy, J. Parreira & T. F. Ng (Eds.), Proceedings Geological Society of Malaysia Annual Geological Conference (pp. 275–282). Persatuan Geologi Malaysia.

Rana, N., Chakravarthy, C. P., Nair, R. & Kannan, L. G., 2016. Identification of lineaments using Google tools. In: Recent Advances in Rock Engineering (RARE 2016) (pp. 124–132). Atlantis Press.

Tajul Anuar Jamaluddin, 2010. Urban Geohazards in Developing Quarried Land. Buletin SEADPRI Newsletter, 3.

Thanapackiam, P., Khairulmaini, O. S. & Fauza, A. G., 2012. Vulnerability and adaptive capacities to slope failure threat: a study of the Klang Valley Region. Natural Hazards, 62(3), 805–826. https://doi.org/10.1007/s11069-012-0108-6.

Manuscript received 16 September 2017
Revised manuscript received 30 May 2018
Manuscript accepted 2 June 2018

An assessment of the hydrogeological conditions beneath an unlined municipal and an engineered landfill sites in Malaysia using Numerical Groundwater Flow Models - Case study

Mustapha Atta[1,*], Abd Rasid Jaapar[1], Dharam Singh[1] & Wan Zuhairi Wan Yaacob[2]

[1]Geomapping Technology Sdn. Bhd., 907C Diamond Complex, Bangi Business Park, Jalan Medan Bangi, 43650 Bandar Baru Bangi, Selangor Darul Ehsan
[2]Geology Programme, School of Environmental Sciences & Natural Resources, Faculty of Science & Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor Darul Ehsan
*Corresponding author email address: mustaphaatta211@gmail.com

Abstract: An unlined ex-landfill site in Kuala Lumpur (Site A) and an operating engineered landfill site located in Kuantan, Pahang Malaysia (Site B) were investigated. Visual MODFLOW (VMOD) flex was used to model groundwater flow system beneath the two-landfill sites. MODFLOW 2005 engine code was used to construct the groundwater flow models while the flow path of particles was modeled using MODPATH. The steady-state VMOD flex model revealed that the hydraulic gradient at Site A is mainly from the northwest around the capped landfill area and groundwater is discharging in the northeast and southeast in the river and ponds located within the landfill site. The transient-state model for Site B shows that groundwater flow is from north to south and northeast to south directions towards the ponds and South China Sea. The pathways that contaminants will follow are largely dependent on the direction of groundwater flow at the sites. The impact on groundwater contamination will be direct on the aquifer at Layer 2 (Site A) and is expected to be minor at the aquifer at Layer 3 (Site B) due to engineered landfill and confining sandy clay layers. It is recommended that the aquifers, ponds and river at the sites should be protected from spreading of leachate (as the case in Site A) and surface contaminations (as the case in Site B) with respect to the different conditions of landfilling practices at the sites.

Keywords: Groundwater flow models, landfills, contaminants migrations, leachates, MODFLOW

INTRODUCTION

Groundwater model is a simplified representation of a specific subsurface system. This is carried out by applying computer softwares that uses a set of governing equations, initial and boundary conditions to simulate the various physical, chemical and biological aspects of the system. Computer modelling tools and advances in software programming has enabled a better representation of the actual hydrogeological conditions of a study area. Two sites in Malaysia have been chosen as case studies: Site A (located in Kuala Lumpur) and Site B (located in Kuantan, Pahang Malaysia). Site A was one of the largest national sites for waste management in Malaysia and landfilling of municipal solid waste was carried out without adequate environment safe guard measure. The landfill operated between 1991-2006. Consequentially, eleven (11) years after the closure and restoration of the landfill, there is still the problem of leachate polluting surface and groundwater.

Site B is located within Kuantan, Pahang Malaysia. The company has embarked on industrial metal processing for the repository of waste generated at the site. Both the existing and future landfills are to be located on existing ground with embankments rising up to 14 m above the existing ground level. It is an engineered landfill with adequate protective measures (geotextile liner) that acts as a barrier to the spread of leachate to the soils and groundwater. Landfills without proper lining material are at higher risk of leakage of contaminants compared with the engineered ones. The engineered type offers protection only for limited time and only delays the inevitable pollutants. The protection of groundwater resource in the study area is one of the major considerations for the authorities. The study describes the development of the groundwater flow model at the two sites. The Visual MODFLOW flex modelling software is used for evaluation and thus the hydrological conditions and flow patterns at Sites A and B can be adequately simulated.

MATERIALS AND METHODS

Site description

The site description for the study areas (Site A and B) is summarized in Table 1.

MODEL DESIGN

Conceptual model for Site A

There are three main stratigraphic layers in Site A comprising: one main aquifer unit, one unconfined layer and two confining layers (Table 2). Layer 1 is Sandy SILT with average thickness about 6 m, Layer 2- Silty

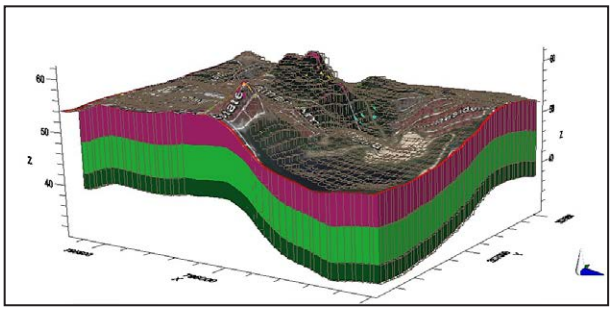


Figure 1: Three layers of hydrostratigraphic unit used in the model at Site A.

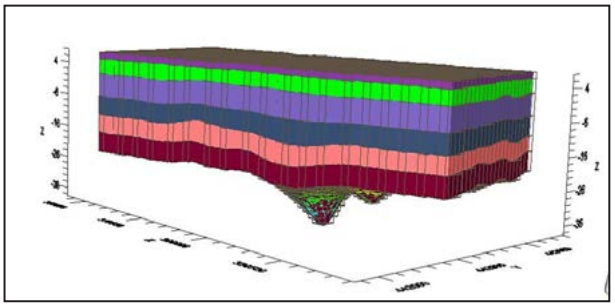


Figure 2: Six layers of hydrostratigraphic unit used in the model at Site B.

Table 1: Summary description for Site A and B.

Study Area	Site A (within Kuala Lumpur area)	Site B (Kuantan area, Pahang state, Malaysia)
Site Location	North Jinjang, Mukim Batu, Lot 28250, 10 km north west of Kuala Lumpur	Gebeng Industrial Estate (GIE) Kuantan, 3 km from the South China Sea, 10 km from Kuantan Port
Coordinate	Latitude: 3. 225º N, Longitude: 101.665º E	Latitude: 4.003842° N, Longitude: 103.377° E
Area	30 hectare	~100 hectares
Topography	Hilly terrain Elevation: 60 m (amsl)	Low-lying, flat land Elevations: ~ 8.004 m (amsl)
Climate /Meteo-rology	Tropical climate: Average yearly rainfall: 2820 mm/yr. Average temperature: 28 – 32 °C	Tropical climate: Average yearly rainfall: 2958 mm/yr. Average temperature: 21 – 32 °C
Drainage	Jinjang River on the south-eastern and con-nected to Nanyang Pond in the south	Balok River in the west and Tunggak River in the south
Bedrock	Kuala Lumpur Limestone	Granite
Monitoring wells	BH1, BH6, BH7, W2, W3 and W5	GWBH1, GWBH2, GWBH3. GWBH4, GWBH5, GWBH6, GWBH7, GWBH8

SAND confined aquifer (12 m). Layer 3 is another Sandy SILT (15 m) at the bottom. The base of Layer 3 is the top of the limestone (bedrock). The limestone bedrock is not considered in the model but simulate as no-flow boundary (relatively impermeable).

Conceptual model for Site B

Site B is considered as six hydrostratigraphic units comprising two aquifers systems (upper and lower) with four unconfined layers and two confining layers. Layer 1 is Sandy SILT. Average thickness is 1.88 m. Layer 2 is sandy CLAY/SILT (4.22 m). It is assumed as a unit providing some leakages to Layer 3 which is the Silty SAND upper aquifer (6.80 m). Layer 4 is another relatively porous sandy CLAY /SILT (5.74 m). Layer 5 is the deeper Silty SAND aquifer (5.20 m). The bottom of Layer 5 is an impervious sandy SILT/CLAY (Layer 6) and is 5.94 m thick. The bottom of this Layer 6 is the base of the model domain and is modeled as no flow boundary. The input data applied for the steady state and transient -state model calibration is shown in Table 2 and 3.

MODEL CALIBRATION

The groundwater flow for Site A was calibrated as steady-state model and Site B was calibrated as transient groundwater flow model. Calibrations were done in manual trial and error method. The fit between the observed and computed heads were accepted for the steady-state model (Site A) with normalized RMS of 0.72 % and mean error of estimate of 1.37 (m). The transient state model calibration (Site B) was accepted with correlation coefficient of 0.79 and mean error of estimate of 1.15 (m). The positive values obtained for NRMS and correlation coefficient in this study generally showed that the calibrated model only slightly overestimate the observed head. Therefore, the model calibrations values are adequate enough to interpret the hydrological conditions at both sites. However, more data are still required to improve the calibrations and reliability of the model.

RESULTS AND DISCUSSION

The groundwater flow outputs (Figures 3, 4, 5 and 6) are displayed as groundwater head contour (equipotential lines). The model also shows the head distributions in colour variations in each model. Red colour in the model layers represents zones with higher groundwater head and blue represent areas with lowest groundwater head.

Model output: Groundwater flow characteristics at Site A

Figure 3 shows groundwater flow beneath the Site A in layer 1 of the model. Groundwater flow is generally in the

Table 2: Input parameters for Steady–state Groundwater Flow model (Site A).

Layer	1	2	3	Remarks
Material description	Sandy SILT	Silty SAND	Sandy SILT	
Layer type	Unconfined	Confined	Confined	
Thickness (m)	6	12	15	Soil investigation - Charita Sdn. Bhd. (2011)
Kx (m/sec)	$1x10^{-7}$	$1x10^{-5}$	$1x10^{-7}$	Pumping test
Ky (m/sec)	$1x10^{-7}$	$1x10^{-5}$	$1x10^{-7}$	Determined, Kx = Ky
Kz (m/sec)	$1x10^{-8}$	$1x10^{-6}$	$1x10^{-8}$	Determined, Kz = 0.1Kx
Total Porosity (θT)	0.45	0.43	0.45	Estimated
Effective Porosity (θe)	0.2	0.33	0.2	Estimated
Specific Yield (Sy)	0.2	0.33	0.2	Estimated, Sy= θe
Specific Storage (Ss)	$2.6x10^{-3}$	$4.9x10^{-4}$	$2.6x10^{-3}$	Estimated
Recharge to aquifer, RCH (mm/yr)	260 (10 % of 2608 mm/year, average annual rainfall in Kuala Lumpur)			

Table 3: Input parameters for Transient–state Groundwater Flow model (Site B).

Layer	1	2	3	4	5	6	Remarks
Material description	Sandy SILT	Sandy CLAY/SILT	Silty SAND	Sandy CLAY/SILT	Silty SAND	Sandy SILT/CLAY	
Layer type	Unconfined	Unconfined	Confined	Unconfined	Confined	Unconfined	
Thickness (m)	1.88	4.22	6.80	5.74	5.20	5.94	SI
Kx (m/sec)	$5.587 x10^{-6}$	$9.20 x10^{-8}$	$1.82 x10^{-6}$	$9.20 x10^{-8}$	$3.72 x10^{-6}$	$9.50 x10^{-8}$	*In-situ* falling head test
Ky (m/sec)	$5.587 x10^{-6}$	$9.20 x10^{-8}$	$1.82 x10^{-6}$	$9.20 x10^{-8}$	$3.72 x10^{-6}$	$9.50 x10^{-8}$	Kx = Ky
Kz (m/sec)	$5.587 x10^{-7}$	$9.20 x10^{-9}$	$1.82 x10^{-7}$	$9.20 x10^{-9}$	$3.72 x10^{-7}$	$9.50 x10^{-9}$	Kz = 0.1Kx
Total Porosity (θT)	0.34	0.67	0.45	0.43	0.45	0.34	Morris & Johnson (1967)
Effective porosity (Sy)	0.2	0.06	0.33	0.06	0.33	0.02	Morris & Johnson (1967)
Effective porosity (θe)	0.2	0.06	0.33	0.06	0.33	0.22	Sy= θe
Specific Yield (Ss)	$4.9 x10^{-5}$	0.5	$4.0 x10^{-4}$	0.5	$4.0 x10^{-4}$	$3.9 x10^{-4}$	Domenico & Mifflin (1965)
Recharge to aquifer, RCH (mm/yr)	296 (10 % of 2956 mm/yr, average annual rainfall in Kuantan)						

Note: K is Horizontal Hydraulic Conductivity, Kx, Ky and Ky

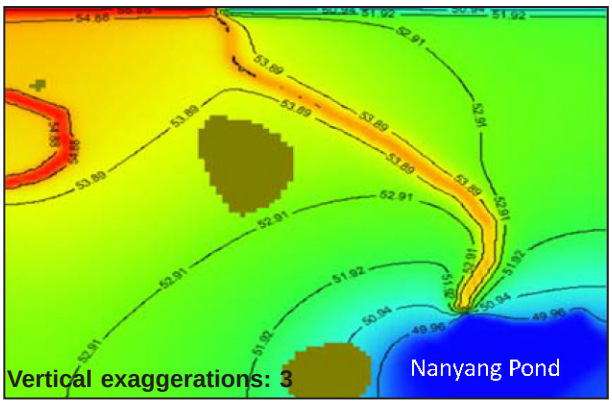


Figure 3: Groundwater head contours in the Site A sandy silt formation (layer 1) - Layer view.

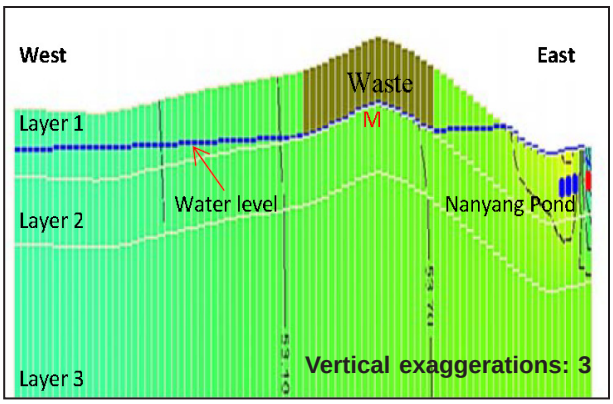


Figure 4: Cross section (west -east) of Site A model along column 34, row 54.

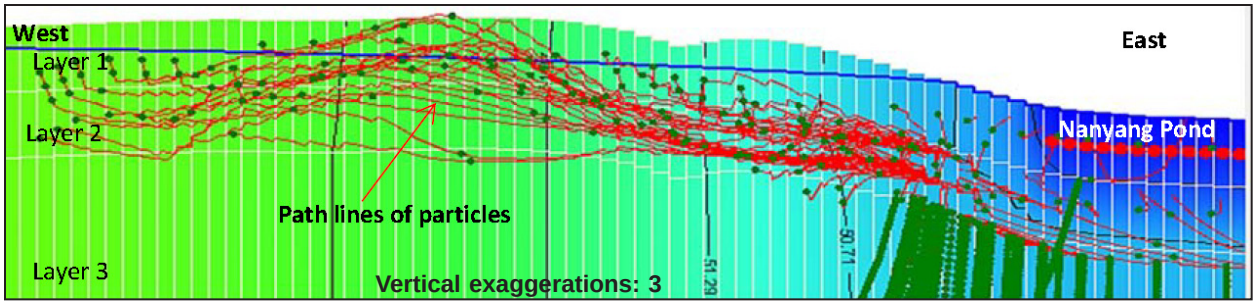


Figure 5: Cross section (west -East) of site A model along column 28, row 64.

North-east and South-east directions towards the Nanyang Pond. The cross section (west -east) of the model (Figure 4) illustrates that leachate is discharging to groundwater, Jinjang River and Nanyang Pond. The area marked "M" is leachate mound which is from the mass of waste outward from the landfill and mixing with groundwater. Hence, groundwater is vulnerable to contamination. The MODPATH output (Figure 5) demonstrate that the impact of contamination is severe in the Layer 2 aquifer (Silty SAND formation) as indicated with Red, densely populated path lines or high velocity particles in the Layer 2.

Model output: Groundwater flow characteristics at Site B

The transient groundwater flow model for Site B (Figure 6 and 7) generally indicate that the trend of groundwater flow is in the North-south and Northeast-south direction towards the retention pond and finally discharging to the South China Sea. Hydraulic head is reaching the level of the retention pond (high groundwater level, Figure 7). The retention pond is an area where water or contaminated water could enter the aquifer at the site and the indication of the risk that may be involved in terms of accidental contaminant discharge from surface activities.

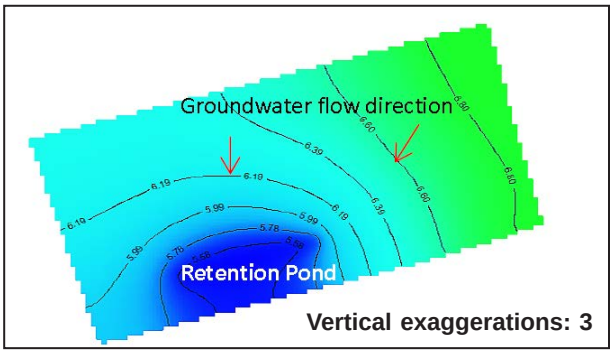


Figure 6: Groundwater head contours in the Site B sandy silt formation (layer 1) at 618 days.

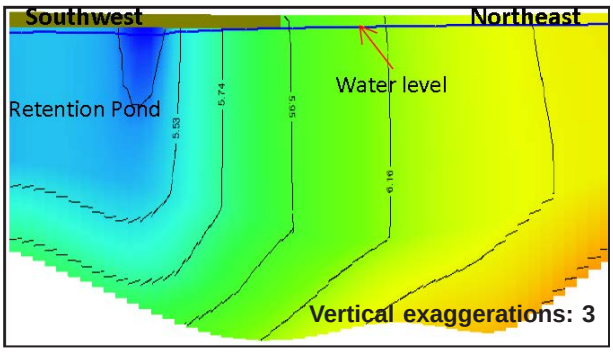


Figure 7: Cross section (southwest -northeast) of Site B model along column 55, row 54.

CONCLUSION

The steady-state groundwater flow model at Site A is generally from NW to SE, towards the Nanyang Pond. Site B is generally in the North-south and Northeast-south direction. The model indicate high negative impact for Site A due to unlined landfill and minimum negative impact for site B because the landfill is an engineered type and confining sandy clay layers could act as barriers to contaminant movement. Numerical groundwater flow modelling for analyzing and solving groundwater problems is a useful tool for evaluating the hydrological conditions in the groundwater regime at the two-landfill sites.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the valuable supports of the landfill operators at Pahang and Kuala Lumpur for access to the sites. Our thanks also goes to Geomapping Technology Sdn. Bhd. for their contributions in making the project a success.

REFERENCES

Charita Sdn. Bhd., 2011. Laporan Kerja Penyiasatan Tapak untuk Kerja Kawalan Kuantiti and Kualiti Air sungai bagi Projek River of Life (ROL).

Domenico, P.O and Mifflin. D., 1965. Water from Low-Permeability Sediments and Land Subsidence. Water Resources Research,1 (4): 563-576

Morris, D.A. and Johnson, A.I., 1967. Summary of Hydrologic and Physical Properties of Rock and Soil Materials, as Analyzed by the Hydrologic Laboratory of the U.S. Geological Survey, 1948-1960. USGS Water Supply Paper: 1839-D.

Manuscript received 6 August 2018
Revised manuscript received 11 October 2018
Manuscript accepted 12 October 2018

A new limestone and shale outcrop profile on the coastal road from Miri to Bekenu

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

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

DESCRIPTION OF THE S-BEND OUTCROP

In March 2018 we discovered, on the occasion of an industry petroleum training class, a new carbonate outcrop on the Coastal Road (Figure 1). It is located, counting from Miri, *ca.* 1km after the Tusan Cliff junction, on the right side roughly between the Internment Camp and the Tusan junction (coordinates: 4.099770^0 N, 113.815445^0 E; Figure 2). It is about one acre of cleared underbrush, but vegetation is well on the way back:

- The profile (Figure 3), shows a clay and carbonate sequence of some 25 m within the Upper (gray) Setap Shale sequence and is located, in stratigraphic terms, some 100 m beneath the Lambir/Belait unconformity (first occurrence of massive sand, Figure 4). The entire sequence is outcropping in the core of an anticline with an observed dip of 50^0 NW.
- The lower section of the profile is formed by some 4 m of muddy and irregularly bedded limestone beds (Figure 5), upwards followed by 1.5 m of transitional beds of limestone and marlstone.
- A thin-bedded unit, 1.5 m thick (Figure 6), and of marly limestone as well as brittle marlstone, forms a transition from massive limestone to the claystone above (Figure 7).
- On top, a sequence of some 19 m of brittle gray to black claystone strata were logged (Figure 8). These contain a number of concretion pebble horizons and marly banks. Another marly carbonate unit is exposed on top of the hill and concludes the profile.

Figure 1: An excursion was held to revisit the outcrop on 10th August 2018 with staff from JX Nippon and Curtin University Malaysia.

Figure 2: Satellite overview map. The S-Bend outcrop (profile marked by light blue line) is located some 40 km south of Miri, and *ca.* 1 km from the Tusan Cliff junction.

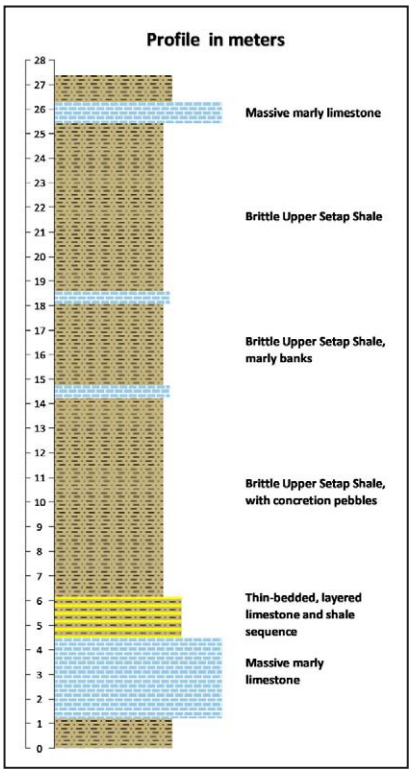


Figure 3: Simplified log profile of the S-Bend carbonate outcrop.

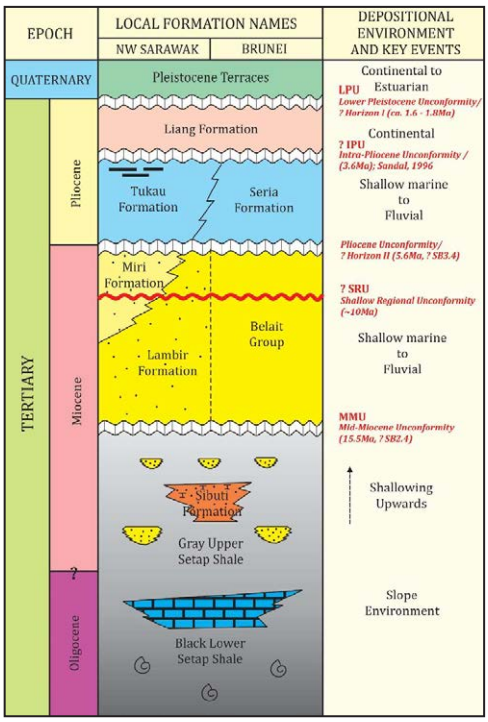


Figure 4: Simplified litho-stratigraphy scheme of the study area. From Kessler & Jong (2017a) and modified from Kessler & Jong (2015).

Figure 5: The lower carbonate unit is irregularly bedded and contains many trace fossils, shell debris and some (so far undetermined) microfossils.

Figure 6: Thin-bedded transition sequence leading from massive limestone to the claystone above.

Figure 7: The central sequence made up by brittle claystone, and a few calcareous concretion pebble layers.

Figure 8: The top sequence is dominated by some 19 m of brittle gray to black claystone strata.

STRATIGRAPHIC IMPLICATIONS OF THE OUTCROP

The profile section is located with the upper section of the Early-Mid Miocene Upper Setap Shale (Figure 4). It has been argued by Kessler (2005, 2006), and Kessler & Jong (2016a, b) that the Setap Shale south of the (West) Baram Line, located in the Tinjar/Luconia Block maybe different in terms of facies from the Baram Delta Block (Figure 9), given it contains multiple distal turbidite sequences, and slumped coastal sandstone olistoliths. This points to a neritic depositional environment. Unfortunately, only the uppermost section of the Setap Shale in the Baram Delta Block is outcropping; where this profile is clearly restricted shallow marine, likewise on the nearby Opak quarry (in 8 km distance; Khor *et al*., 2014) and the Sibuti area outcrops (estimated 7 to 10 km distance; Nagarajan *et al*., 2017). This said, given there are only some 100-150 m of Setap Shale outcropping in the Baram Delta Block anticlines, any good correlation with the same formation from the Tinjar/Luconia areas is thus difficult to achieve.

Another challenging aspect concerns the distribution of carbonates. Within the Baram Delta Block's Setap Shale, a number of spotty carbonate occurrences are noted. These include:

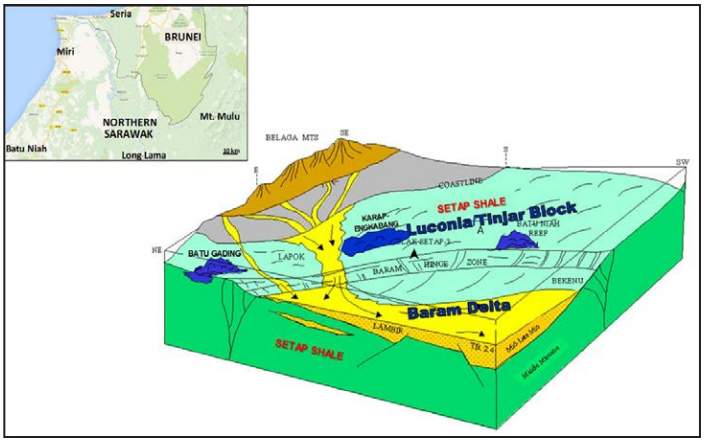


Figure 9: Schematic block diagram with a regional reconstruction of Late Miocene/Pliocene times of northern Sarawak. The Luconia/Tinjar Block constitutes the foot-wall, the Baram Delta the hanging-wall north of the Baram Hinge Zone (West Baram Line). The latter constitutes an important facies boundary with carbonates dominate in Luconia/Tinjar, and clastics in the Baram Delta. It is noted that the Setap Shale south of the West Baram Line, located in the Tinjar/Luconia Block maybe different in terms of facies from the Baram Delta Block, given it contains multiple distal turbidite sequences pointing to a neritic depositional environment. However, the Setap Shale in the Baram Delta Block as investigated in the S-Bend profile is clearly restricted shallow marine. Modified after Kessler (2009) and Jong *et al*. (2016).

Figure 10: Fossiliferous limestone with shell fragments and undetermined microfossils.

- The Opak quarry, a > 40 m thick unit of marly limestones (Khor *et al*., 2014),
- Several small outcrops of marly rock in the Sibuti area (Nagarajan *et al*., 2017),
- Isolated blocks of oyster reefs NE of Pantai Bungai, and
- Possibly, a carbonate buildup offshore drilled with mixed success by Shell and called A1/A2 (no published data).

The above described S-Bend outcrop suggests that marly limestone intercalations within the Upper (gray) Setap Shale might be more common than previously thought. In the outcrop we logged an intriguing transition leading from massive, yet marly limestone to thin-bedded carbonate and claystone beds to massive, brittle shale. This transition points to a gradual change of sedimentary environment, possibly a change of sea level and/or water chemistry, which eventually stopped carbonate production. It is also noted that the rocks are fossiliferous (Figure 10), and detailed investigation of the marine species might reveal further interesting paleo-environmental indications during this time of carbonate growth in northern Sarawak (e.g., Kessler & Jong, 2017b).

REFERENCES

Jong, J., Kessler, F.L., Noon, S. & Tan, T.T.Q., 2016. Structural Development, Deposition Model and Petroleum System of Paleogene Carbonate of the Engkabang-Karap Anticline, Onshore Sarawak. Berita Sedimentologi, 34, 5-25.

Kessler, F.L., 2005. Comments on the Evolution of the Bukit Lambir Area, Sarawak, Malaysia. Paper presented at the GSM conference, Kuala Lumpur, December 2005.

Kessler, F.L., 2006. Observations on Subtle Deformation in the Folded Foreland, Sarawak, Borneo. Paper presented at the Geo Asia Conference, Kuala Lumpur, June 2006.

Kessler, F.L., 2009. The Baram Line in Sarawak: Comments on Its Anatomy, History and Implications for Potential Non-Conventional Gas Deposits. Warta Geologi, 35(3), 105-110.

Kessler, F.L. & Jong, J., 2015. Northwest Sarawak: A Complete Geologic Profile from the Lower Miocene to the Pliocene Covering the Upper Setap Shale, Lambir and Tukau Formations. Warta Geologi, 41(3-4), 45-51.

Kessler, F.L. & Jong, J., 2016a. Paleogeography and Carbonate Facies Evolution in NW Sarawak from the Late Eocene to the Middle Miocene. Warta Geologi, 42(1-2), 1-9.

Kessler, F.L & Jong, J., 2016b. The West Baram Line in the Southern South China Sea: A Discussion with Late Prof. H.D. Tjia on Its Possible Onshore Continuation and Nomenclature. Warta Geologi, 42(3-4), 84-87.

Kessler, F.L. & Jong, J., 2017a. The Roles and Implications of Several Prominent Unconformities in Neogene Sediments of the Greater Miri area, NW Sarawak. Warta Geologi, 43(4), 1-8.

Kessler, F.L. & Jong, J., 2017b. Carbonate Banks and Ramps on the Northern Shore of Paleogene and Early Neogene Borneo: Observations and Implications on Stratigraphy and Tectonic Evolution. Bulletin of the Geological Society of Malaysia, 63, 1-26.

Khor, S., Meor Hakif bin Amir Hassan & Barbeito, M.P.J., 2014. Sedimentology and Stratigraphy of the Miocene Kampung Opak Limestone (Sibuti Formation), Bekenu, Sarawak. Bulletin of the Geological Society of Malaysia, 60, 45-53.

Nagarajan, R., Armstrong-Altrin, J.S., Kessler F.L. & Jong, J., 2017. Petrological and Geochemical Constraints on Provenance, Paleoweathering, and Tectonic Setting of Clastic Sediments from the Neogene Lambir and Sibuti Formations, Northwest Borneo. In: Mazumder, R. (Ed.), Sediment Provenance – Influences on Compositional change from source to sink Chapter 7, Elsevier, p. 123-153. DOI:10.1016/B978-0-12-803386-9.00007-1.

NATIONAL GEOSCIENCE CONFERENCE 2018 (NGC 2018)

Year of 2018 was another great achievement for Geological Society of Malaysia (GSM), where the National Geological Conference (NGC 2018), a prominent annual event that provides an avenue that brought all earth scientists and experts together has been successfully organised in Penang, Malaysia.

"*Georesources Development for a Sustainable Future*" is the theme of NGC2018. Acquaintance of the earth's systems and processes, together with the application of technology has improved our quality of life through the utilization and management of the earth's natural resources such as rocks, minerals, petroleum, natural gas, groundwater and geoheritage are priority nowadays. The use of technologies and innovation in sustainable resource exploration, mining, processing, exploitation and preservation are essential elements of today's industries and practices.

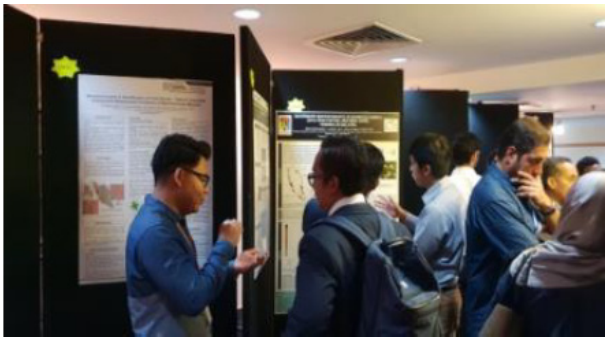
The opening ceremony of NGC 2018 was officiated by Ybg. Ir. Addnan Mohd Razali, Secretary of *Majlis Bandaraya Pulau Pinang,* representing YB Tuan Chow Kon Yeow, Chief Minister of Penang.

In total, the technical program of NGC2018 had received 14 keynote papers, 55 oral papers and 44 poster presentations that encompass areas of interests in Petroleum Geology, Engineering Geology/Geomechanics, Geoheritage, Archaeology, Mining/Quarrying, Blasting Technology, Mineral Processing, Hydrogeology, Remote Sensing, Mineralogy/ Petrology and other aspects of geoscience discipline. All accepted technical papers will be published in a special edition/volume of bulletin of the Geological Society of Malaysia. This meeting would not be a successful event without the support of all institution particularly Geological Society of Malaysia (GSM), Universiti Sains Malaysia (USM), Mineral and Geoscience Department (JMG) Kedah, Institute of Mineral Engineering Malaysia (IEM) and last but not least, in particular to our corporate donors and sponsors - School of Materials and Mineral Resources Engineering, School of Physics and Global Archaeology Centre, SEADPRI-UKM, Information and Computer Technology and Adikarma Art Group of USM and etc.

The one-day short course on the Advanced Blasting Technology organised with the corporation of Institute Mineral Engineering Malaysia (IME) and a post-conference fieldtrip to Gunung Jerai Geoparks, Fort Conwallis, Guar Kepah, Sg. Batu (Geoheritage sites) were amongst the attractions of NGC 2018.

The NGC 2018 finally came to an end with a closing speech by the Chairman, followed by a brief welcome remarks by the next NGC organiser, Universiti Malaysia Sabah (UMS), tentatively to be held in September 2019.

Kamar Shah Ariffin
GSM, Northern Representative






Organising Committee team members (*top left and middle*), a cultural show and part of the Archaeological fieldtrip activities (*top right*). *Bottom right* - Gimmick handover of a geological hammer replica by Geological Society of Malaysia to a representative from Universiti Malaysia Sabah (UMS), Dr. Rodeano Roslee, Deputy Director of Natural Disaster Research Centre (NDRC) UMS. UMS is the organiser of the next National Geoscience Conference (NGC 2019).

15th Regional Congress on Geology, Mineral and Energy Resources of Southeast Asia (GEOSEA XV)

Report on the post- and pre-conference field excursions

The 15th Regional Congress on Geology, Mineral and Energy Resources of Southeast Asia (2018) was held in Hanoi, the capital of Vietnam, from 13th – 21st October 2018. The congress was between 16th and 17th October 2018 in Hanoi. Apart from the main convention, pre- and post-conference field excursions were organized; the pre-conference field excursions were on 13th until 15th October 2018 while the post-conference field excursions were on 18th until 21st October 2018, to a few classic geological areas in Vietnam. The combination of scientific presentations and field studies provided a better geological understanding and interpretation on geological modelling and its uses in supporting sustainable development.

With the theme of 'ASEAN Geosciences and Earth Resources for Sustainable Development', GEOSEA XV is the best platform to emphasize new achievements in geosciences and their applications to improve geological investigation of Earth resources, including prospecting, exploration, exploitation and processing. The conference also emphasized on the importance of prediction, control, and mitigation of and adaptation to geological hazards as contributions to the socio-economic development of nations facing impacts of global warming and sea-level rise. The conference also introduced scientific basis, and recommendations for effective policy-making and governance needed to ensure a sustainable development of earth resources. GEOSEA VX was an excellent opportunity for hundreds of scientists, researchers, managers and administrators from various countries to share their research experiences and recent achievements in geological, mineral and energy studies, within the context of sustainable development. Regionally, the Geological Society of Malaysia (GSM) serves as the Permanent Secretariat for Geological Congress of Southeast Asia (GEOSEA) up to year 2020. The upcoming GEOSEA will be hosted by the Philippines in 2020 and Malaysia in 2022.

One of the pre-conference field excursions was along the Red River Shear Zone and Fansipan Metamorphic Complex. This field trip was participated by 15 international delegates, including one delegate from Malaysia; Ms. Nur Nadwa Syahirah Ai Zamruddin. The main purpose of this excursion was to visit the Tertiary sedimentary basins and high to low grade metamorphic rocks along the Day Nui Con Voi massive that occurred along the Red River Fault zone in northwest of Vietnam. This trip also emphasized on orthogenesis of Archean-Paleoproterozoic ages of Hoang Lien Son metamorphic belt together with the metamorphic phosphorite and copper mines in Lao Cai province of the Hoang Lien Son belt.

The Sin Quyen copper deposit is the largest copper producer in Vietnam, recognised as Iron Oxide Copper Gold (IOCG) deposit with Fe-Cu-Au-REE that mineralised along the Hoang Lien Son metamorphic complex with the ore bodies hosted in gneiss, mica schist, amphibolite and marble of the Upper Sin Quyen Formation. The Sin Quyen and the ore deposits are defined as Neoproterozoic subduction-related ore-forming belt. The Lao Cai Metamorphic Phosphorite mine is composed of metamorphic phosphorite ores from sedimentary-metamorphic origin, including terrigeno-carbonate sediments that extended 100 km with an average width of 1 km to 3 km. The last outcrop for this trip is Fan Si Pan, the highest mountain range composing of granitoid complex and the dolomitic marble of Ham Rong Mountain within the Hoang Lien Son range.

One of the post-conference field excursions arranged for the GEOSEA XV was a trip to the Ha Giang and Dong Van Karst Plateau (DVKP) UNESCO Global Geopark. This trip was well attended by 23 international delegates, including three delegates from Malaysia; Mr. Abd. Rasid Jaapar, Prof. Madya Askury Abd Kadir and Ms. Nur Nadwa Syahirah Ai Zamruddin.

Dong Van Karst Plateau occupies four districts of Ha Giang Province, namely Dong Van, Meo Vac, Yen Minh and Quan Ba that is a mountainous province in the northern most part of Vietnam. The delegates were brought to visit those four districts and witnessed the breath-taking scenery, outstanding geodiversity and diversified ethnic cultures belonging to the Dong Van Karst Plateau. The main highlight of the trip was a visit to the Paleozoic to Mesozoic limestone and karst topography of Dong Van Karst Plateau that covers an area of 2356 km^2, with evidence of Permo-Triassic biostratigraphy boundaries. Apart from that, the delegates also managed to visit the Temple of Hung King and Vuong's Family Palace that are national historical and cultural sites of Ha Giang Province. This was an interesting trip as the delegates were able to learn about the geology of the northern part of Vietnam, as well as its history and cultures.

Nur Nadwa Syahirah Ai Zamruddin
PhD. Postgraduate Student, Department of Geology
University of Malaya Kuala Lumpur

The pre-conference excursion along Hoang Lien Son Metamorphic Terrane-Red River Shear Zone.

The post-conference excursion to Dong Van Global Geopark, North Vietnam. Observed in the last photo is the sharp boundary of Triassic and Permian. Various methods had been adopted to confirm the boundary.

CERAMAH TEKNIK TECHNICAL TALK

Quantification of the impact of weathering on geomechanical strengths: Granites and schists

Goh Thian Lai (UKM)
Date: 5 September 2018
Venue: Department of Geology, University of Malaya

This talk was presented by Dr. Goh Thian Lai (UKM) on 5th September, 2018 at the Department of Geology, University of Malaya. An abstract of the talk is attached below.

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

We thank Dr. Goh for his contribution to the Society's activities.

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

Abstract: Geomechanical strength of rock materials plays a significant role in influencing the stability of both cut rock slopes and underground openings. The characteristics of mechanical strength are subjected to both material strength and condition of weathering. This paper presents the results of a systematic research to quantify the mechanical characteristics of fresh as well as slightly weathered granites and schists of Peninsular Malaysia. A total of 459 geomechanical strength tests were conducted for both lithologies for fresh as well as slightly weathered rock material employing the uniaxial compressive strength test and Brazilan tensile strength test. Statistical analysis of the results at 95 percent confidence level exhibited that the means of compressive strength for fresh and slightly weathered granites were 113.6±7.0 MPa and 68.9±3.6 MPa and the respective values for fresh and slightly weathered schists were 137.3±9.2 MPa and 84.8±5.1 MPa. The respective mean values of tensile strength for fresh and slightly weathered granites were 8.8±0.4 MPa and 5.3±0.1 MPa and the values of mean of fresh and slightly weathered schists were 17.1±0.9 MPa and 10.5±0.4 MPa respectively. The results revealed that the geomechanical strengths of fresh rock material deteriorated by approximately 1/3 upon weathering of rock material reduce to slightly weathered rock materials. The results also exhibited that the Brazilan tensile strength for fresh and slightly weathered granites and schists are approximately 1/13 and 1/8 of uniaxial compressive strength.

Keywords: Uniaxial compressive strength test, Brazilan tensile strength test, granite, schist

ACKNOWLEDGEMENTS

The authors wish to thank the lab staff of the Geology Programme and the Government of Malaysia for the financial assistance through grant FRGS/1/2017/WAB08/UKM/02/1.

CERAMAH TEKNIK TECHNICAL TALK

Basin physiographic controls on shoreline–shelf sedimentary processes and preservation: Integrating numerical tidal modelling and sedimentary facies analysis in the Oligo–Miocene, NW Borneo, South China Sea

Daniel S. Collins

Date: 12 September 2018

Venue: Department of Geology, University of Malaya

Abstract: Shoreline–shelf stratigraphy is an inherently fragmentary record of competing fluvial, tidal, wave and storm processes, and longer-term controls on accommodation space creation, burial and erosion. These controls are influenced by a multitude of regional- to local-scale factors fundamentally related to plate tectonics, principally climate and basin physiography (depth and geometry), which are encapsulated in time-averaged palaeogeographic reconstructions.

This talk investigates the following:

- Utility of numerical palaeotidal modelling for assessing the impact of palaeogeographic changes and uncertainty on tidal processes in the Oligo–Miocene of Southeast Asia.
- Comparison of tidal model results to sedimentary facies and biostratigraphic data from Oligo–Miocene successions in and around the South China Sea
- Sedimentological and stratigraphic characteristics and preservation in mixed-process deltaic successions in the Middle Miocene Baram Delta Province, Northwest Borneo
- Potential impact of evolving tidal systems on mangrove-related carbon burial in the Oligo–Miocene of Southeast Asia.

CERAMAH TEKNIK TECHNICAL TALK

Geohazard survey and its importance to the oil and gas industry

Abdul Azim Farid (Fugro Marine Malaysia Sdn. Bhd.)

Date: 31 October 2018

Venue: Geology Program Meeting Room, Universiti Kebangsaan Malaysia

Pada 31 Oktober 2018, satu ceramah teknik yang lebih kepada perkongsian tentang kerjaya dalam bidang geofizik untuk penjelajahan petroleum telah diadakan di Bilik Mesyuarat Program Geologi, Universiti Kebangsaan Malaysia (UKM).

Penceramah yang dijemput iaitu En. Abdul Azim Farid (Fugro Marine Sdn. Bhd.) merupakan seorang alumni geologi UKM. Penglibatan beliau sebagai ahli geofizik dalam eksplorasi sumber petroleum dikongsi kepada hadirin yang hadir pada hari tersebut.

On 31 October 2018, a technical talk related to career in geophysics for petroleum exploration was held at the Bilik Mesyuarat Program Geologi, Universiti Kebangsaan Malaysia (UKM).

The invited speaker was Mr. Abdul Azim Farid (Fugro Marine Malaysia Sdn. Bhd.) who is a UKM alumni geologist. His involvement as a geophysicist in exploration of petroleum resources was shared with attendees who attended the event.

Summary of talk: The presentation covered the introductory of geohazard survey and its importance to the oil and gas industry. Geohazard survey is one of the most important stages in the development phase of the oil and gas field worldwide. The results and findings of the geohazard survey will aid the oil company in the planning of their field development. The geohazard survey will be the first control measure of any possible geohazard that the oil company might encounter during any drilling or installation activities. Geohazard survey is not only confined to the oil and gas industry but also in the energy industry such as windfarms in the European regions. This presentation also includes the overview of the types of equipment, data examples, basic geological/geophysical interpretations and geophysicist roles in the geohazard survey.

CERAMAH TEKNIK TECHNICAL TALK

Seismic Geomorphology; mitigating lithology prediction risk and providing context for further investigation - Applications and workflows

Henry W. Posamentier (Independent Consultant)

Date: 1 November 2018

Venue: Department of Geology, University of Malaya, Kuala Lumpur

Abstract: As high-quality 3D seismic data has become widely available, our ability to predict the subsurface distribution of lithologies has significantly improved. Stratigraphic interpretation of seismic data involves the integration of stratigraphy and geomorphology, with integrated section and plan view images yielding robust interpretations of stratigraphic architecture and associated lithology.

Geologically-meaningful seismic patterns can be recognized in multiple domains, including section views, plan views, 3D perspective views, and animated (i.e., movie) views. Once such patterns have been identified, interpreters can then populate these patterns with appropriate lithologies. Seismically-derived geologic interpretations can have significant impact on exploration and production in the following ways:

Geology: 1) prediction of lithology, 2) prediction of compartmentalization , 3) development of depositional analogs, 4) Enhanced understanding of geologic processes.

Geophysics: 1) provides depositional context for geophysical analyses (e.g., DHI analysis, reservoir properties from seismic). Understanding geologic context can provide a "reality check" when evaluating geophysical data for rock and fluid properties. 2) Quality control for geophysical processing. Evaluating the quality of seismic images, especially in the plan view domain, of known geologic features can help determine the value of a given processing step. Ensuring that meaningful geologic features are not processed out of the data is critical to maximizing the value of seismic data.

Examples will be shown from deep-marine as well as shallow-marine and non-marine environments, illustrating how patterns observed from multiple seismic domains can lead to robust geologic interpretations and predictions of lithology. Critical workflows designed to efficiently "mine" 3D seismic data also will be illustrated.

CERAMAH TEKNIK TECHNICAL TALK

Impak gempabumi dan geobencana susulan di Palu, Sulawesi - Cerapan lapangan, pengajaran dan peringatan

Norsyafiqah Salimun & Tajul Anuar Jamaluddin
Date: 14 November 2018
Venue: Geology Program Meeting Room, Universiti Kebangsaan Malaysia

Ceramah teknik bertajuk 'Impak Gempabumi dan Geobencana Susulan Di Palu, Sulawesi - Cerapan Lapangan, Pengajaran dan Peringatan' telah diadakan di Bilik Mesyuarat, Program Geologi, Universiti Kebangsaan Malaysia (UKM) pada 14 November 2018. Ceramah ini disampaikan oleh saudari Norsyafiqah Salimun dari Yayasan Dana Kebajikan Muslim dan Prof. Madya Dr. Tajul Anuar Jamaluddin dari Program Geologi UKM.

Penglibatan saudari Norsyafiqah dalam misi bantuan kemanusian di Palu dengan latar belakang geosaintis telah dikongsi dengan baik dibantu oleh Dr. Tajul dengan perkongsian ilmu dari aspek tektonik kawasan Sulawesi. Kupasan pencairan tanah dan geobencana yang telah berlaku mendapat perhatian ramai hadirin pada hari tersebut.

Ringkasan: Pada 28 September 2018, berlaku gempabumi cetek bermagnitud 7.5 dengan epicentre kira-kira 10 km dari Palu, ibukota Sulawesi. Gegaran gempabumi ini boleh dirasai hingga ke Samarinda, Timur Kalimantan dan juga di Tawau, Sabah. Gempabumi ini telah didahului oleh beberapa siri gempa awalan. Gempa awalan paling besar berukuran 6.1 berlaku lebih awal pada hari yang sama. Gempabumi ini juga diikuti dengan puluhan gempabumi susulan. Geobencana gempabumi disertai dengan geobencana pencecairan (liquefaction) dan tsunami yang telah meragut sekurang-kurangnya 2100 nyawa dan ramai lagi yang masih hilang. Gempabumi dikesan berlaku pada garis sesar Palu-Koro yang diketahui merupakan sebuah sesar gelincir jurus sinistral yang aktif dengan kadar pergerakan sekitar 7 cm setahun. Badan Meteorologi, Klimatologi dan Geofizika (BMKG) Indonesia mengesahkan tsunami yang dicetus oleh gempabumi tersebut mencapai ketinggian maksimum 4-7 meter dan melanda Palu, Donggala dan Mamuju.

Cerapan ringkas mengenai impak geobencana gempabumi dan geobencana susulan telah dilakukan sewaktu misi bantuan kemanusiaan di bawah Yayasan Dana Kebajikan Muslim Malaysia (YDKMM) pada 8 hingga 12 Oktober 2018. Lebih 70,000 rumah rosak. Ini termasuklah bangunan-bangunan penting seperti Hospital, pusat beli belah, hotel, sekolah dan masjid.

Keadaan sebuah hotel di Pantai Talise, Palu setelah dilanda tsunami.

Keadaan sebuah masjid di Pantai Talise, Palu setelah gempa.

Pencarian mayat korban yang tertimbus akibat likuifaksi tanah di Petobo.

Tanah runtuh di sepanjang jalan menuju Donggala Barat.

Impak liquifaksi tanah di Petobo.

CERAMAH TEKNIK TECHNICAL TALK

Microgravity in geotechnical / site investigations

Jamaluddin Othman

Date: 28 November 2018

Venue: Geology Program Meeting Room, Universiti Kebangsaan Malaysia

A technical talk by Mr. Jamaluddin Othman from SubMAP Geophysical Services Sdn. Bhd. was held at Bilik Mesyuarat Program Geologi, UKM on 28 November 2018. The talk was attended by more than 30 participants with topic of Microgravity in geotechnical/site investigations. The geophysics working group of GSM will manage more talk related to geophysics survey and career development in geology too.

Summary of talk: The talk primarily focused on the use of microgravity as a useful geophysical tool in site / geotechnical investigations. The theory, field techniques, data processing and interpretation were discussed. The strength and weaknesses of the technique also touched. Several case studies were addressed to show the usefulness of this technique.

Promotion of Geoscience & Young Geologist

Report on Asia Geoscience Student Conference & Exhibition (AGSCE) 2018

Date : 29 & 30 October 2018
Venue : University Technology of Petronas (UTP)
Working Group : Promotion of Geoscience & Young Geologist
Council member involved:
Norazianti Asmari (Chairperson)
Ahmad Tariq b Ahmad Ziyad (Councillor)
Mohd Hariri (Councillor)

The Geological Society of Malaysia (GSM) was one of the sponsors for the AGSCE 2018 held at UTP on 29 and 30 October 2018. The AGSCE unites attendees from all over the Asia-Pacific region, notable industry experts and seasoned academicians from the field of Geoscience.

Activities held include industry exhibition, oral and poster presentation competition, outcrop exhibition competition, networking dinner, keynote sessions and research and abstract submission. The Promotion of Geoscience and Young Geologist working group took part in the industry exhibition to continuously support the students' activities. The Group also sold GSM merchandise and old issues of the GSM Bulletin to the attendees, and shared information about GSM proposed activities for 2019. Several council members were also invited to be the judge for some of the competitions.

In conclusion, the program was a good platform to introduce the GSM as a group that can benefit the society. In the future, any program sponsorship by GSM will also involve the working group in the program to enable council members to connect with new members of the Society.

Report on GSM Young Geologist Network: Skills & challenges to excel in petroleum geology

Date : 24 November 2018
Venue : Geology Department, University of Malaya
Working Group : Promotion of Geoscience & Young Geologist
Council member involved:
Norazianti Asmari (Council & Chairperson)
Ahmad Tariq b Ahmad Ziyad (Councillor)
Farah Fazulah Abdullah (Councillor)

On 24 November 2018, the working group for the Promotion of Geoscience and Young Geologist had successfully organized a talk related to the oil and gas industry. The working group had invited two experienced speakers from the industry to share their knowledge with the young geologists. The speakers were Muhd Syaiful Azman Mustapha from Schlumberger, and Farah Fazulah Abdullah from Cari Gali Hess, who is also a council member of GSM for the 2018/2019 session.

The talk had gathered a total of 33 participants from various universities and fresh graduates who are eager to learn what are the skills needed to start and excel in the petroleum industry. The speakers shared their experience on how they analyse data in their work, and the need for critical analysis in this tough industry.

The participants also learned of the importance of good communication skills in order to embark on a career in the oil and gas industry.

Reports by:
Norazianti Bt Asmari
GSM Council member 2018/2019
Chairperson
Working Group, Promotion of Geoscience & Young Geologist

GSM-Petronas Upstream Courtesy Meeting

Venue: Level 74, Tower 1, PETRONAS Twin Towers,
Kuala Lumpur City Centre

On 20th December 2018, GSM Council members paid a courtesy visit to Petronas Upstream. The main aspiration of this visit was to reconnect and strengthen the bond between the oil industry, via Petronas as a key organization, and GSM.

The GSM was represented by Abdul Rasid Jaapar - GSM President, Farah Fazulah - GSM Council, Ahmad Tariq Ahmad Ziyad - GSM Council, and Anna Lee - GSM Secretariat. We were given the opportunity to meet Madam Emeliana Rice-Oxley, Vice President of Exploration, Petronas Upstream, to convey our interest in strengthening cooperation for mutual benefit and also her support for Petronas participation in the National Geoscience Conference 2019.

Among other topics discussed were:

1) Potential GSM participation in APGCE (Asia Petroleum and Geoscience Conference & Exhibition) or any other future activities for mutual benefit of both parties as well as the geosciences community.
2) Women Empowerment, Gender Equality, and the STEM Movement towards yielding more female geologist for the future.
3) Digitalization movement, both on library and future literature publishing for wider digital accessibility.
4) Concerns on the quality of geoscience Graduates in meeting industry requirement:
   - Emphasizing on soft skills development to meet market and industry requirements.
   - GSM to seek Petronas support for future outreach program – ideal exposure of industry for students.

We believe the session was fruitful in seeking better relationships for mutual benefit thus furthering positive collaboration in 2019 and beyond. As a token of our appreciation to Petronas, the GSM presented Madam Emeliana with complimentary copies of GSM publications, namely:

i. Geology of Peninsular Malaysia, edited by C.S. Hutchison and D.N.K. Tan
ii. Geological Evolution of Southeast Asia by C.S. Hutchison
iii. Warta Geologi, vol 44, no 3, 2018.

Prepared by:
Farah Fazulah (GSM Council Member & GSM Outreach committee)

Discussion between GSM President En. Rasid Jaapar and Vice President for Petronas Exploration.

GSM delegation presenting Madam Emeliana Rice-Oxley with a token of appreciation.

Programme by Universiti Malaysia Kelantan with representatives from American Association of Petroleum Geologist (AAPG) & Geological Society of Malaysia (GSM)

Venue: Universiti Malaysia Kelantan (UMK), Jeli Campus
Date: 18 November 2018

A group of more than 200 Geoscience students of Universiti Malaysia Kelantan (UMK) had attended the event titled "Programme with Representative from American Association of Petroleum Geologist (AAPG) and Geological Society Malaysia (GSM)" that was held at its Jeli Campus, Kelantan. The AAPG representatives were involved in the morning session, while three representatives from GSM, led by the President, Mr. Abd. Rasid Jaapar and two Council Members were invited to be the guests of the second slot during the afternoon session. It was a good opportunity for all of the UMK Geoscience students to understand the role and importance of the geological society in Malaysia, and especially to know more about GSM.

The second slot started with a speech by the Head of Geoscience Programme, Dr. Norshahida Shafie, who introduced UMK four-year Geoscience programme, with 50 per cent fieldwork and 50 per cent theory, student activities and the demographics of the UMK Geoscience students in 2018. The key trends of the demographics showed that the percentage of female students is more significant than the male students. UMK also limits the number of student intake for the Geoscience programme to ensure more effective learning especially during the fieldworks. The second speech was delivered by the Assistant of UMK Exploration Club or better known as SEG, who sang passionately when their club song was played before the speech. The key highlights of the activities organised by SEG are the International Geomapping Competition and Non-Credit Student Mobility Programme.

The final speech and the knowledge sharing session was done by GSM President, Mr. Abd. Rasid Jaapar, who shared two topics - "The Profile of Professional Geologist" and "Geologist in Civil Works", with participation from the students throughout the session and delivery of special gifts from GSM for quiz winners. A key input addressed by Mr. President is the commitment from GSM to support UMK Geoscience students through SEG, as GSM Adopted Club or "Kelab Angkat GSM" that would allow SEG to request up to a yearly amount of RM2,000 for their club activities. The fund will be allocated mainly for the International Geomapping Competition that will be co-organized with GSM soon.

The whole event ended with a photography session with UMK Geoscience students, and a tea time sharing session involving GSM members and UMK lecturers and students.

By:
Ahmad Tariq Ahmad Ziyad
GSM Council Member 2018/2019

HUTCHISON BEST STUDENT AWARD

Hadiah Persatuan Geologi Malaysia untuk pelajar terbaik ijazah pertama dalam bidang Geologi

Pada hari Khamis, 20 Disember 2018 yang lalu, Presiden Persatuan Geologi Malaysia, En. Abd. Rasid Jaapar telah meluangkan masa menyampaikan hadiah cek bernilai satu ribu ringgit (RM1,000) kepada saudari Syazreen Syafiqa binti Azmi, pelajar terbaik Sarjana Muda Geologi dari Universiti Kebangsaan Malaysia dalam satu majlis yang ringkas di pejabat beliau. Tahniah diucapkan kepada saudari Syazreen Syafiqa yang telah menerima tawaran dari Universiti Malaya untuk menyambung pelajaran ke peringkat yang lebih tinggi.

"InsyaAllah saya akan memastikan majlis penyampaian hadiah berprestij sebegini akan diadakan sebaik mungkin dalam majlis yang lebih meriah. Persatuan mungkin perlu mengadakan satu majlis khas seperti *Geoscience Award Night* untuk penyampaian anugerah dan *award* kepada graduan dan ahli geologi yang berjaya seperti ini', kata En. Abd. Rasid Jaapar yang agak terkilan dengan cara pengiktirafan sekarang ini.

Untuk makluman, Hadiah Persatuan Geologi Malaysia untuk Pelajar Terbaik ini telah ditukar nama kepada *Hutchison Best Student Award* sejak 2016 sempena memperingati mendiang Professor Dr. Charles S. Hutchison yang telah banyak berjasa dalam pendidikan geosains di Malaysia.

Presiden Persatuan Geologi Malaysia, En. Abd. Rasid Jaapar sedang menyerahkan cek bernilai RM1,000 kepada saudari Syazreen Syafiqa dari UKM.

IN MEMORIAM

Mohd. Hazreek Zainal Abidin

14 June 1980 - 1 October 2018

Dr. Mohd Hazreek Zainal Abidin passed away at the age of 38 due to a road accident on Monday, October 1, 2018, at Parit Raja in Batu Pahat, Johor. He was born on June 14, 1980, in Batu Pahat, Johor. He is survived by his wife, Dr. Nur Syalinda binti Mohd Zin and daughter, Aisya. His wife also worked together with him in the same faculty at Universiti Tun Hussein Onn Malaysia (UTHM), Batu Pahat, Johor.

He graduated from Civil Engineering School at Universiti Teknologi Mara (UiTM) and did his master's studies by course in civil engineering at Universiti Teknologi Malaysia (UTM). Just recently, in 2018, he obtained his Doctor of Philosophy in geophysics from University Sains Malaysia (USM). Although he graduated from civil engineering school, but his passion, interest and love towards geology is undeniable. His dedication and love towards this subject brought him to register as a Life Member of the Geology Society of Malaysia and was appointed as a representative for southern region.

During his service in the university, he was described by many friends and colleagues in the faculty as a dedicated person, who worked with high integrity level and would complete tasks given to him with full commitment especially in teaching, research, publication and consultancy works. His main interest in teaching was the engineering geology subject. He was also the author of a book on engineering geology for undergraduates and his contributions is very significant, providing views from the civil engineering perspective.

He had published over 100 articles, but was perhaps best known for his two journal contributions to geology and engineering geology: Assessment of seawater intrusion to the agricultural sustainability at the coastal area of Carey Island, Selangor, Malaysia (2012) and Integral analysis of geoelectrical (resistivity) and geotechnical (SPT) data in slope stability assessment (2012). Both were published in high impact journals, and subsequently obtained high citations in journal reference. At a young age, he was quite active in journal writing and scored 10 in H-index Scopus index and 12 in H-index Google Scholar index. He was also involved in various consultancy projects related mainly to geophysics, groundwater exploration, slope stability and environmental geology.

He loved listening to music, playing the guitar, being with his family, having fun with friends and geology fieldwork activities. He touched the lives of many people with his smile, generosity and friendship. He will definitely be missed by his family, friends, colleague and the geology fraternity. Al-Fatihah.

By:
Dr. Mohamad Faizal Tajul Baharuddin (P.Geol)

NEW MEMBERSHIP

Full Membership

1. Ahmad Farid Abu Bakar
2. Azhar Ahmad Nazri
3. Hamka Istamar
4. Hazrul Hisham Badrul Hisham
5. Jenetius Miun
6. Jhstolistikha Percy Dos
7. Larry N Stout
8. May Raksmey
9. Mohd Mokhtar Saidin
10. Mohd Rizal Lai
11. Teoh Ying Jia
12. Yasir Bashir

Student Membership

1. 'Afifah Ishak
2. Abd Alasalam Abduh Saeed Ali Almasgari
3. Abdullah Harith Razak
4. Ahmad Dedi Putra
5. Ahmad Lutfi Zayyani Shahrul Azhar
6. Asiwaju Lanre Oluwaseun
7. Choe Jia Yi
8. Dwiky Pobri Cesarian
9. Gerald Eko Ejiga
10. Ibrahim Danial Maarof
11. Imaad Zahin Mohd Rosdi
12. Ismailalwali Alobaid Magzoub Babikir
13. Izzat Syakir Na'imullah Ismail
14. Lee Shyen Yee
15. Mohamad Faris Hassan
16. Mohd Adli Zikry Mohd Norzaidi
17. Mohd Hasfarisham Abd Halim
18. Mohd Shahrul Akmal Jamaluddin
19. Muhammad Hafizi Hayazi
20. Muhammad Kasyful Qaedi Maad Tazri
21. Muhammad Rafiq Rodzil
22. Nabila Natasha Othman
23. Nabilah Mohamed Zainuddin
24. Nadhirah Mursidi
25. Naimah Lukman
26. Najiatun Najla Mohamad
27. Nik Nur Anis Amalina Nik Mohd Hassan
28. Norhidayahti Mohd Muztaza
29. Noridayu Bakry
30. Nur Aisyah No'man
31. Nur Aqilah Nabila Yahaya
32. Nur Asirah Rahmat
33. Nur Fatin Irdina Zulhamidi
34. Nur Izzati Monir
35. Nur Su'aidah Rezali
36. Nurain Jannati Mohd Shafie
37. Nurazlin Abdullah
38. Nurin Afrina Mohd Zaid
39. Nursyafiqa Shabri
40. Nurul Afiqah Mohammad Zahir
41. Nurul Emilia Ezra Sham Sol
42. Nurul Hanna Mohd Noor Azam
43. Nurul Nadhirah Mohamed
44. Nurul Suhada Mhd Sukri
45. Nusaibah Syahidah Abu Bakar
46. Ratnah Wati Mohd Rapi
47. S Wani Maler
48. Siti Aina Zainon
49. Siti Aisyah Ramli
50. Siti Khairiani Abd Jalil
51. Siti Nurul Siha Mohamad
52. Usman Abdullahi Usman

CHANGE OF ADDRESS

Azimah Ali
PETROLIAM NASIONAL BERHAD (PETRONAS)
Group Technical Data,
Level 28, Tower 3, PETRONAS Twin Towers,
Kuala Lumpur City Centre,
50088 Kuala Lumpur, Malaysia

Lee Seng Keong
No. 75-2, Block G,
Zenith Corporate Park,
Jalan SS7/26, Kelana Jaya,
47301 Petaling Jaya,
Selangor Darul Ehsan

M. Azad B. Noor Azman
No. 8/B, Enclave B,
Persada Aman, Jalan Milenia,
71760 Bandar Enstek,
Negeri Sembilan

Muhammad Syazwan Adzhar
3N Persada Ikhlas,
Alam Milenia,
71760 Bandar Enstek,
Negeri Sembilan

Razmin Ramli
GEOSOIL ENGINEERING SERVICES SDN. BHD.
Lot 9507, Wisma Geosoil,
Jalan Marang - Kuala Terengganu,
21080 Kuala Terengganu,
Terengganu Darul Iman

Siti Aishah Abdullah
B-8-3, Renai Jelutong Residences,
No. 1, Jalan Bazar U8/100, Bukit Jelutong,
Seksyen U8,
40150 Shah Alam,
Selangor Darul Ehsan

Dr. V. R. Vijayan
C5-1, Taragon YKS Puteri,
Jalan Yap Kwan Seng,
50450 Kuala Lumpur

Xi Peng
No. 8, Jin Ming Road,
Qianchuan Street,
Huangpi District,
Wuhan City,
China

Dear Members

Please update your contact details by sending your email address, telephone no. and fax no. to : geologicalsociety@gmail.com

Simposium mineral anjuran Program Geologi UKM dan Malaysian Chamber of Mine (MCOM)

Program Geologi UKM dan Malaysian Chamber of Mine (MCOM) telah mengadakan satu simposium mineral pada 22 Oktober 2018 di Danau Golf Resort, UKM. Program ini telah dihadiri oleh lebih 150 orang peserta dari pelbagai latar belakang. Simposium kali ke-4 ini diadakan dengan sokongan dari pelbagai pihak termasuklah sumbangan tajaan dari Persatuan Geologi Malaysia sendiri. Berikut adalah antara rakaman foto semasa program tersebut berlangsung.

Sesi dialog yang dipengerusikan oleh Dr. Norshahidah Mohd Nazer dengan ahli panel yang di barisi oleh Dato' Sia Hok Kiang (Malaco Mining Sdn. Bhd.); Prof. Dr. Zulkefli Yaacob (Universiti Malaysia Pahang); Dr. Jasmi Hafiz Abdul Aziz (Universiti Malaya) dan Dr. Mohd. Arif Anuar Mohd. Salleh (Tin Solder Technology Researchers Group) dengan tema "Complementing Academia – Industry needs".

En. Nizam Hassan memberikan ucapan mewakili presiden Persatuan Geologi Malaysia.

Antara tetamu utama yang hadir pada simposium tersebut adalah En. Nizam Hassan iaitu wakil presiden Persatuan Geologi Malaysia dan Prof. Dr. Ishak Yusof dari pejabat Strategik UKM dan Pro Canselor UKM selaku perasmi majlis pada hari tersebut.

Pihak persatuan turut membuka meja pameran bagi aktiviti jualan buku terbitan persatuan dan peluang mengisi borang keahlian baru.

University of Malaya American Association of Petroleum Geologists Student Chapter (UM AAPG Student Chapter)

2018/2019 SESSION

Event Report:

1 - AAPG X Kedai Jalanan Universiti Malaya

Kedai Jalanan (or Street Shop) was initiated by the UM Gender Studies Programme Faculty where students or volunteers provide clothes and toiletries to their street customers in a "shop" setup; where donated clothes are hung up on racks while other items are placed in boxes to enable their targeted communities (homeless, low-income families, etc) to browse and pick what they need.

On 6th December 2018 (Thursday), Kedai Jalanan teamed up with UM AAPG Student Chapter members and lead by our director, Syeleeza Aina Madiyah, went to Medan Tuanku for the monthly volunteering work. The participants were all AAPG members and a few volunteers from Kedai Jalanan itself. There was also a team from Dapur Jalanan doing the same charity work at the same time and place.

Our 'shop' was supposedly to open at 8.00 p.m. However, all the AAPG members were required to come early to Medan Tuanku for preparation of all the clothes and other items. Clothes were hung on racks while other items such as bags, shoes, etc were placed in suitable containers. We arrived at Medan Tuanku around 7.15 p.m. and prepared ourselves firstly (dinner and prayers for the Muslims). Our activity started with a short briefing by the representative from Kedai Jalanan. The AAPG members were then divided into groups with different roles for the night, such as a group to manage the crowd, a stock team to ensure there were always clothes on the racks, and attendants. At 8.30 p.m., the 'shop' was officially opened and throughout the event, the AAPG members were really committed in their tasks.

The shop closed at 10.30 p.m. when most of the clothes and items had been taken. Approximately 400 people had come to the Kedai Jalanan to browse and pick items they require.

At the end of the event, the members helped to clean up the place and pack all the remaining clothes. We then gathered with the Kedai Jalanan volunteers and had a reflection session. Our director, Syeleeza and another committee member, Aida, expressed their thoughts on the event. We ended the event with a photography session before heading home.

Prepared by:
Ariff Loqman bin Ismail
Secretary, AAPG x Kedai Jalanan UM

One of AAPG committee members, Ibrahim Hakimi was kept busy with customers and ensuring the clothes were always ready for browsing.

Photography session between AAPG members and Kedai Jalanan volunteers after the reflection session. It was a wrap for the night.

2 - Career Talk

A career talk titled "What It Is Like to be in Oil and Gas Industry" was held at Dewan Kuliah Geologi, Jabatan Geologi, Universiti Malaya on 12th December 2018. The event officially started at 3.00 p.m. and ended at 5.00 p.m. The speaker for the talk was Mr. Avalon Chin Soon Mun, a senior geologist at PETRONAS Cari Gali Sdn. Bhd. The director for the talk was Fakhrulrazi bin Mohd Razif.

The aim of the talk was to expose students not only from the Department of Geology but also from other faculties and departments to the work nature in the oil and gas industry. The exposure will help the students to have a better understanding of the industry and know what are the expected challenges ahead of them. This will certainly help the students in the future.

The talk was divided into two sessions. During the first part of the talk, Mr. Avalon shared his journey in the industry. He graduated from Universiti Teknologi PETRONAS (UTP) in 2014 and had worked for PETRONAS since then. His interest is in stratigraphy and sedimentology. The next part of the talk is a Q&A session where the audience could either ask questions directly or through a website called slido.com. Slido allows people to ask questions anonymously. Therefore, shy audience will benefit from this as they can forward their questions too. Many questions asked were about the life of a geologist in the industry and what one can expect when working in the industry.

Before the event ended, Mr. Avalon was given a certificate from the AAPG as a token of appreciation, followed by a photography session. Tea and snacks were served after the talk ended. During this time, the students had the chance to interact with the speaker informally.

3 - Technical Talk

A technical talk titled "An Explorer's Trail Career Experiencce Insight Into Oil & Gas" was held at Dewan Kuliah Geologi, Jabatan Geologi, Universiti Malaya on 19th December 2018. The event officially started at 9.45 a.m. and ended at 12.00 p.m. The invited speaker was Miss Low Wan Ching, a senior geoscientist at PETRONAS Cari Gali Sdn. Bhd. The director for the talk was Muhammad Fitri bin Mohamed Fathil.

The aim of the talk was to expose students from the Department of Geology and from other faculties and departments to the speaker's journey in the oil and gas industry.

The talk was divided into two sessions. In the first part of the talk, Miss Low shared her life journey. She received her MSc degree in Petroleum Geoscience from Royal Holloway University of London. She was a PETRONAS scholar during her undergraduate years, and a Chevening scholar during her Masters studies. She has done basin evaluation projects covering the offshores in Brazil, Canada, New Zealand, and Senegal. She also shared about the current issues in the oil and gas industry as well as the advantages of Malaysian's oil compared to produce from other country. The second part of the talk was a Q&A session. The audience could either ask their questions directly or through a website called slido.com.

At the end of her talk, Miss Low was given a certificate from the AAPG UM Student Chapter as a token of appreciation, followed by a photography session with the audience. Tea and snacks were served finally and during this time, the students had the chance to interact with the speaker informally.

Prepared by:
Nor Shahirah Binti Khairul Za'im
Secretary, AAPG Career and Technical Talk

Mr. Avalon Chin Soon Mun with the audience after the career talk.

Miss Low Wan Ching with the audience after the technical talk.

Report on XIII IAEG Congress and AEG Annual Meeting 2018 in San Francisco, USA

Representatives from Malaysia were Dato' Zakaria Mohamad, Chairman, IAEG Malaysia National Group and the president for Society for Engineering Geology and Rock Mechanics Malaysia (SEGRM) and the president of Geological Society of Malaysia, Abd. Rasid Jaapar who is also the secretary of IAEG Malaysia National Group and treasurer for SEGRM.

The 2018 IAEG Executive Committee and Council Meeting was held on September 14 – 16, 2018 in Hyatt Regency, San Francisco, USA. The president, Scott Burns, chaired the meeting.

The quadrennial 13th World IAEG Congress was held together with the 61st AEG Annual Meeting between 17th and 23rd September 2018 in San Francisco, USA. The theme of the conference was 'Engineering Geology for a Sustainable World'. There were 42 hot topics in the conference including IAEG Hans Cloos Lecture, AEG Richard Jahns Distinguished Lecture, 10 international invited lectures and over 400 oral presentations. In addition, there were more than 300 posters exchanges and various pre-conference and post-conference exploration routes. At the same time, the IAEG and AEG international competition and awards presentation ceremony, as well as the International Young Engineering Geologists Forum were held during the conference. Over 900 participants from 51 countries attended the conference.

Among the 42 topics, General Dam Symposium was very highlighting, which included 7 half-day sessions. The theme of this year's symposium was 'Infrastructure Improvements to Dams and Levees'. There were two keynote lectures. The first was given by Professor J. David Rogers, who focused on California's experience on dams and disasters. The second keynote lecture delivered by Dr. Donald A. Bruce concentrated on the Application of Deep Mixing Method for Dam and Levee Remediation.

Important awards and honorary titles were conferred for the scholars who achieved distinguished achievement or made great contribution to IAEG. Professor Runqiu Huang from Chengdu University of Technology in China won the IAEG Lifetime Achievement Award – Hans Cloos Medal (HCM), who gave a keynote speech as well as the HCM Lecture shortly after the Awarding Ceremony; past IAEG Secretary-General Dr. Louis Primel from France won the IAEG Contribution Award - Marcel Arnould Medal; while Dr. Wei-An Chao from Chinese Taipei was the winner of Richard Wolters Prize and Dr. Sarah Bastin from New Zealand was the runner-up of Richard Wolters Prize.

Dato' Zakaria Mohamad and En. Abd. Rasid Jaapar with Prof. Dr. Marinos from Greece, the prominent engineering geologist and the past president of IAEG.

Fault activity map of California presented by geologists of California Geological Survey.

The Golden Gate at night. Geological input was used extensively in the construction of this iconic bridge that was completed in 1937.

The IAEG Board of Directors elected the new term (2019-2022) of IAEG Executive Committee. The Executive Committee consists of 12 members including the president, the immediate past president, the secretary general, the treasurer and the vice presidents who are responsible for their own continents. The editor in chief of Bulletin and the web-editor in chief will also be invited to attend the executive meeting in the future.

The Council approved the proposal and decided that the 14th IAEG Congress would be held in Chengdu, China from September 15th – 20th, 2022, with the theme of Engineering Geology for the Future. The Council also decided that the 2019 Executive Committee and Council Meeting would be held during the 12th Asian Regional Conference on September 23rd – 27th, 2019 in Jeju Island, South Korea.

REPORT ON IAEG NATIONAL GROUP FOR MALAYSIA (2017/18)

1.0 INTRODUCTION

The Society for Engineering Geology and Rock Mechanics Malaysia (SEGRM) was incorporated on 16th August 2016 after the IAEG Malaysia National Group and ISRM Malaysia National Group decided to have one common platform for both organisations. SEGRM is a non-profit scientific learned association supported by membership fees and grants/sponsors/donations that do not impair with its academic and professional activities. The society is in affiliation with the International Association for Engineering Geology and the Environments (IAEG) and International Society for Rock Mechanics and Rock Engineering (ISRM).

The main aim of the society is to make contributions in academic and technological advancement through research and international cooperation among the scholars and practitioners in the field of engineering geology, environmental geology, rock mechanics and rock engineering.

2.0 MEMBERSHIP

The members of SEGRM will automatically be members of IAEG and ISRM. The membership stands as follow:

Years	SEGRM	ISRM	IAEG with Bulletin	IAEG without Bulletin
2016	27	27	5	22
2017	46	46	5	41
2018	37	37	5	32

Note: Membership fees for IAEG is still outstanding for 2017 and 2018. All efforts shall be made to clear the fees prior to IAEG Congress 2018.

3.0 ACTIVTITIES

3.1 11th Asian Regional Conference of IAEG

Representatives and participants from Malaysia attended the 11th Asian Regional Conference of IAEG in Kathmandu, Nepal from 28th to 30th November 2017. The event was organised by Nepal Geological Society.

3.2 Annual General Meeting

The 2nd Annual General Meeting (AGM) of SEGRM was organised on 20th April 2018 at the University of Technology Malaysia. A half-day seminar was also conducted together with the AGM with 3 presentations as follow:

- The Effect of Basin Inversion on the Rock Physics Properties and AVO Feasibility of the Malay Basin by Uzir Alimat, Petronas
- Selection and Modelling Issue in Rock Slope by Dr. Rini Asnida Abdullah, UTM
- Integrated Landslide Risk Management in Malaysia: From Policy into Practice by Dr. Khamarrul Azahari Razak, UTM

3.3 Quarterly Forum on Engineering Geology and Rock Engineering #1

The Quarterly Forum on Engineering Geology and Rock Engineering was established to provide platform for engineering geologists and rock engineers to get-together and discuss issues professionally. The forum aim to cover as many issues possible for the betterment of the practice and the profession. Every forum will have specific theme. This first forum was organised on Thursday, 15th March 2018 with a theme 'Back to Basic'. Report from this forum shall be published for further reference and discussion. The topics discussed were:

- Engineering Geological Mapping: Back to Basic by Associate Professor Dr. Tajul Anuar Jamaludin, National University of Malaysia (UKM)
- The Basis of Professional Engineering Geological Practice by Abd. Rasid Jaapar, Rockscience Engineering Sdn. Bhd.
- The Expectation from the Products of an Engineering Geologist: Malaysian Perspective by Dr. Ferdaus Ahmad, Department of Mineral and Geoscience Malaysia

3.4 Symposium on Geo-engineering in Tropical Region (SEGRM-GEO)

SEGRM has successfully organised the Inaugural Symposium on Geo-engineering in Tropical Region (SEGRM-GEO) which was concluded recently on 3rd and 4th July 2018 at the University of Technology Malaysia (UTM), Kuala Lumpur. The symposium managed to gather 73 numbers of like-minded engineers, geologists and other geo-professional from academia as well as the public and private sectors to share their researches, case studies, and experiences. The symposium was organised jointly with Geological Society of Malaysia and Malaysia-Japan International Institute of Technology, UTM.

Four keynotes were delivered as follow:

- Standardisation of Rock Testing, Characterisation and Monitoring, Implementation Problems and Contractual Issues by Professor Dr. Resat Ulusay, President-Elect, ISRM
- Challenges in Urban Tunnelling by Prof. Dr. Seokwon Jeon, ISRM VP for Asia
- Innovation Underground Technology and Engineering for Sustainable Development by Ir. Syed Rajah Hussain Mohd Haniff, Chairman, Tunnelling & Underground Space Technical Division, Institution of Engineers, Malaysia
- CREaTE Future Research Related to Construction Industry in Malaysia by Ir. Dr. Che Hassandi Abdullah, Director, Centre of Excellence for Engineering and Technology (CREaTE)

Representatives from IAEG National Group for Singapore and ISRM National Group for Indonesia also attended the symposium. International participants include from Japan, Korea, Indonesia, Singapore and students from Iran, Nigeria, etc.

3.5 International Short Course on Principles and Practical of Engineering Geology and Rock Engineering

The two-days short course was organised on 5th and 6th July 2018, back-to-back with the symposium and was delivered by Professor Dr. Resat Ulusay, the ISRM President-elect. The short course was well attended by 62 local and international participants.

4.0 FUTURE PLANNING

SEGRM is committed to organise more events in the future including but not limited to the following:

- Symposium on Geo-engineering in Tropical Region to be organised biannually (the 2nd will be in 2020) and it is hoped that the symposium can be organised with collaboration from IAEG and ISRM National Group for Indonesia.
- International Short Courses on Engineering Geology and Rock Engineering to be conducted regularly by eminent lecturers from all over the world.
- Bid to host the 13th Asian Regional Conference of IAEG in 2021.
- Bid to host the ISRM 13th Asian Rock Mechanics Symposium in 2024.

Prepared by:
Abd. Rasid Jaapar
Secretary, IAEG National Group for Malaysia
Treasurer, Society for Engineering Geology and Rock Mechanics Malaysia (SEGRM)

UPCOMING EVENTS

February 26-27, 2019: Workshop on Exploration and Development of Siliciclastic and Carbonate Reservoirs in the Eastern Mediterranean, Tel Aviv, Israel. More details at https://www.aapg.org/

February 27-28, 2019: LNG & Natural Gas for Power and Industries Thailand Forum 2019, Bangkok, Thailand. More information is available on http://www.lng-world.com/lng_thai2019/

March 6-7, 2019: GTW- Unlocking Mexico's Offshore Potential, Mexico City, Mexico. Further information can be obtained at https://www.aapg.org/global/latinamerica/events/workshop

March 16-19, 2019: 14th Middle East Geosciences Conference and Exhibition, Bahrain. Details at https://geo-expo.com

March 26-27, 2019: Europe Regional Conference, Vienna Austria. Details at https://erc.aapg.org/2019/

April 1-3, 2019: Pacific Section AAPG 2019 Annual Convention, Long Beach, California, USA. More details at http://www.psaapg2019.org/

April 2-5, 2019: SEAPEX Exploration Conference, Singapore. Check: https://www.seapexconf.org/event-2019

April 6-9, 2019: AAPG Southwest Section Annual Convention, Dallas, Texas. Visit https://www.2019aapgswsconvention.org/

April, 7-12, 2019: European Geosciences Union - General Assembly 2019, Vienna, Austria. More details can be found at the conference website: https://egu2019.eu/

April 9-10, 2019: Hydrocarbon – Geothermal Cross Over Technology Workshop, Geneva, Switzerland. Check https://www.aapg.org/global/europe/events/

April 23-26, 2019: EAGE-GSM 2nd Asia Pacific Meeting on Near Surface Geoscience and Engineering, Kuala Lumpur, Malaysia. Contact Tel.: +60 3 2722 0140; Email: asiapacific@eage.org for more details.

April 23-26, 2019: Moscow International Oil & Gas Exhibition (MIOGE), Crocus Expo, Moscow. Contact for details - T: +44 (0) 203 545 9741, Website: global-oilgas.com

May 19-22, 2019: AAPG Annual Convention & Exhibition, San Antonio, Texas, USA. For details, contact AAPG Customer Experience Center, T: +1 918 584 2555

May 23-24, 2019: Offshore Conference Latin America 2019 (OCLA 2019), Buenos Aires, Argentina. Contact: Mike Ma, email: mike.ma@inforvalue.com

May 27-31, 2019: International Course on Geotechnical and Structural Monitoring, Rome. Visit https://www.geotechnicalmonitoring.eu/participants-registration

June 23-25, 2019: 20th Asia Oil & Gas Conference, Kuala Lumpur, Malaysia. Discover more at aogc.com.my

July 22-24, 2019: Unconventional Resources Technology Conference (URTec 2019), Denver, Colorado. Visit webpage https://urtec.org/2019 for further information

August 7-8, 2019: The Art of Hydrocarbon Prediction: Managing Uncertainties (Technical Symposium), Bogor, Indonesia. Find out more at https://www.aapg.org/global/asiapacific/events/workshop

August 27-30, 2019: International Conference & Exhbition (ICE 2019), Buenos Aires, Argentina. Visit website for details: https://buenosaires2019.iceevent.org/

September 11-13, 2019 (conference) and September 9-10 & 14, 2019 (workshops): European Conference on Mineralogy and Spectroscopy (ECMS 2019), Prague (Břevnov Monastery), Czech Republic. For details: http://ecms2019.eu; email: info@ecms2019.eu

November 4-8, 2019: Africa Oil Week, Cape Town, South Africa. Contact AfricaOilWeek@news-itegroup.com

Geological Society of Malaysia Publications

General Policy

Papers should be as concise as possible. They may include original results of basic, applied and policy research of national or international significance, current reviews, or discussions on techniques, research programs, organisations, information, or national and international policies in geoscience.

Submission of Papers

Only papers that have not been published elsewhere will be considered for publication. Authors must agree not to publish elsewhere a paper submitted and accepted. All papers will be subjected to review by two or more reviewers. Authors wishing to include published and unmodified figures or text passages are required to obtain permission from the copyright owner(s). Authors of English papers are strongly urged to have their manuscript edited for language before submission by a person whose first language is English.

The Editor reserves the right to reject all or any part of the paper submitted. The Geological Society of Malaysia assumes no responsibility for statements made by authors.

Manuscript should be submitted to:

The Editor,
Geological Society of Malaysia
c/o Department of Geology
University of Malaya
50603 Kuala Lumpur,
Malaysia
Tel: (603) 7957 7036
Fax: (603) 7956 3900
Email: geologicalsociety@gmail.com

Manuscript

The paper can be written in Bahasa Malaysia (Malay) or English. For English papers, use either British or American spelling but not a combination of both. The paper should be checked thoroughly for spelling and grammar. The manuscript must be printed at 1.5 spacing in a single column on one side of A4 paper. All pages should be numbered. Length of paper should be between 3,000 and 6,000 words for the *Bulletin* and between 2,000 and 3000 words for *Warta Geologi*, excluding tables and illustrations. Metric units should be used and all non-standard symbols, abbreviations and acronyms must be defined.

Title

Title must be informative and reflects the content of the paper. Title in Malay should include an English translation. It should be concise (less than 20 words). Avoid using abbreviation in the title.

Author's Address

Addresses of all authors must be provided. The addresses should be sufficient for correspondence. Please include email address, telephone and fax of the corresponding author.

Abstract

Abstract in both Malay and English, each in one paragraph and should not exceed 300 words. It should clearly identify the subject matter, results obtained, interpretations discussed and conclusions reached.

Keywords

Please include 3 to 8 keywords that best describe the content of the paper.

References

In the text, references should be cited by author and year and listed chronologically (e.g. Smith, 1964; Jones *et al*., 1998; Smith & Tan, 2000). For both Malay and English paper, all references must be listed in English. Title of non-English articles should be translated to English.

The list of references should only include articles cited in the text. The list should be arranged in alphabetical order. Please ensure that the reference list is complete and the bibliographical details are accurate. The references should be in the following manner:

Journal article:

Suntharalingam, T., 1968. Upper Palaeozoic stratigraphy of the area west of Kampar, Perak. Geol. Soc. Malaysia Bull., 1, 1-15.

Book:

Hutchison, C.S., 1989. Geological Evolution of South-east Asia. Clarendon Press, Oxford. 368 p.

Chapter of book and Symposium volume:

Hosking, K.F.G., 1973. Primary mineral deposits. In: Gobbett, D.J. and Hutchison, C.S. (Eds.), Geology of the Malay Peninsular (West Malaysia and Singapore). Wiley-Interscience, New York, 335-390.

Article in Malay:

Lim, C.H. & Mohd. Shafeea Leman, 1994. The occurrence of Lambir Formation in Ulu Bok Syncline, North Sarawak. Geol. Soc. Malaysia Bull., 35, 1-5. (in Malay with English abstract).

Tables

All tables should be cited in the text and numbered consecutively. Tables should have a title and a legend explaining any abbreviation or symbol used. Each table must be printed on a separate piece of paper. Do not insert the tables within the text. Data in tables should be aligned using tab stops rather than spaces. Avoid excessive tabulation of data.

Illustrations

Please make sure that all illustrations are useful, necessary and of good quality. A maximum of ten (10) illustrations (photographs, graphs and diagrams) are allowed and these should be cited in the text and numbered consecutively as Figures. The papers are usually published in black-and-white but it may sometimes be possible to include colour figures at the author's expense. The scales for maps and photomicrographs should be drawn on the figure and not given as a magnification. Originals should not be greater than A4 size and annotations should be capable of being reduced down to 50 percent. The caption should be listed on a separate piece of paper. Do not insert the illustration within the text.

Submission of Electronic Files

Submission should be made through email as attachment files or using CD-ROM. The submission should be accompanied with a listing of all files and the software (name and version) used. The file names should reflect the content of the files (e.g. Ali_Fig1.tif).

Preferred Software

Text: Microsoft Word. Do not insert tables and illustration within the text.

Tables: Microsoft Word or Microsoft Excel. Please submit as separate files.

Illustrations – Vector Graphics: Adobe Illustrator (preferred), CorelDraw and Freehand. Final line thickness should be at least 0.5 point or 0.17 mm. For other software, please submit one copy in the native file format and export one copy as a PDF file with all fonts embedded and one copy as a high resolution TIFF or JPEG image.

Photographs or bitmap (raster) images: Adobe Photoshop. Please save as TIFF or PSD files. Save/scan line art at 600 to 1200 dpi and greyscale figures at 300 to 600 dpi. High resolution JPEG, TIFF or GIF files from other sources are also acceptable. The resolution must be high enough for printing at 300 dpi.

Reprints

Twenty five copies of each article published are supplied free of charge. Additional reprints are available at cost price provided that orders are placed prior to publication. Authors will also received a softcopy of the article published in .pdf format.

PP2509/07/2013(032786) ISSN 0126-5539

WARTA GEOLOGI PERSATUAN GEOLOGI MALAYSIA

Newsletter of the Geological Society of Malaysia
Jilid 44, No. 4 • Volume 44, No. 4 • October–December 2018

KANDUNGAN (CONTENTS)

Published by the GEOLOGICAL SOCIETY OF MALAYSIA
Department of Geology, University of Malaya, 50603 Kuala Lumpur, MALAYSIA
Tel: 603-7957 7036 Fax: 603-7956 3900 E-mail: geologicalsociety@gmail.com

Printed by Art Printing Works Sdn. Bhd.
29, Jalan Riong, 59100 Kuala Lumpur, MALAYSIA