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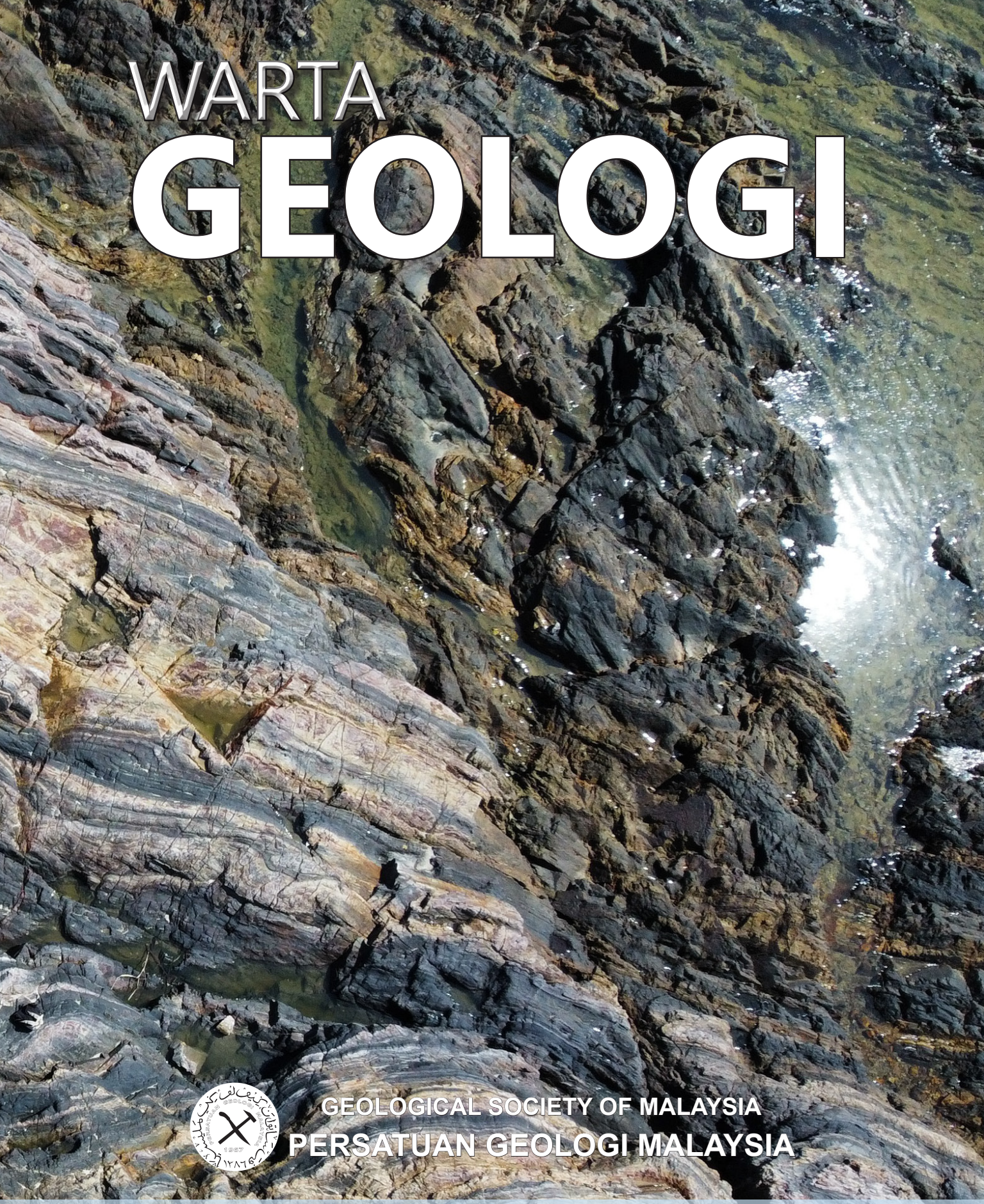

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Cover photo: Aerial view of strongly deformed meta-sedimentary rock, Chendering, Terengganu. Photo by: Meor Hakif Bin Amir Hassan

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Excavability of inter-bedded quartzites and phyllites of the Lower Carboniferous Sungai Perlis Beds at Bukit Teluk Batu, Terengganu Darul Iman

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Abstract: North-south striking quartzites and phyllites of the Carboniferous Sungai Perlis Beds with steep eastward and westward dips give rise to the ridge at Bukit Teluk Batu. The strata with individual bed thicknesses of 0.5 to 2.0 m, are strongly jointed and weathered to variable depths; slope cuts showing three broad weathering zones i.e., an upper pedological soil, an intermediate saprock, and the bottom bedrock. The pedological soil is 2 to 4 m thick and consists of yellow to red, firm to stiff, silty clays with quartz clasts and lateritic concretions. The saprock is some 15 to 20 m thick and consists of alternating bands of yellow to brown and grey, loose to dense, sands (representing completely to highly and moderately weathered quartzites), and soft to hard, clayey silts and silts (representing completely to highly and moderately weathered phyllites). Original bedrock minerals, textures and structures are distinctly preserved in the saprock zone which can be separated into sub-zones IIA, IIB and IIC. Bedrock, at depths exceeding 20 m, consists of steeply dipping, pink to dark grey, slightly weathered quartzites and phyllites. Seismic refraction surveys show the pedological soil to have p-wave velocities <500 m/s, whilst the saprock has velocities between 700 and 1,200 m/s, and the bedrock, velocities >2,100 m/s. Borehole standard penetration tests show the pedological soil to have N values <15 and the saprock N values >20, whilst the bedrock requires coring. The pedological soil and saprock have been excavated by scraping and ripping, though the bedrock zone is non-rippable; its upper surface marked by the teeth marks of scrapers. It is concluded that seismic refraction surveys and borehole standard penetration tests in areas of inter-bedded quartzites and phyllites can allow for differentiation of weathering zones and prediction of their excavability.

Keywords: Sungai Perlis Beds, quartzites and phyllites, weathering zones, pedological soil, saprock, bedrock, rippable, non-rippable

INTRODUCTION

Excavation refers to the process of removing earth materials to form a cavity at, or below, the earth's surface. Excavations at the surface are called open excavations and are carried out during the construction of slope cuts, foundations, borrow pits and quarries, whilst subsurface excavations are involved in the construction of tunnels and underground chambers (Bell *et al.*, 1995). Geological conditions are a most important consideration in the formation of excavations for they affect the method of excavation as well as the stability of the opening, and surrounding, or overlying, ground. The term 'excavatability' is a measure of how easy it is to remove earth materials and as a means of determining appropriate excavation methods (BGS, 2015). 'Excavatability' is considered to be a function of the geotechnical properties of earth materials (strength or density), as well as mass characteristics, in particular, the mechanical discontinuities present (BGS, 2015).

Bell *et al.* (1995) differentiate between excavation in soft ground where the process may proceed without the need to loosen the ground before excavation, and that in hard ground where drilling and blasting or mechanized excavation would probably be chosen. In ground that is too hard for direct immediate excavation, ripping is an inexpensive method of breaking discontinuous ground or soft rock masses, before removal by earth moving machinery. The process is carried out by driving a pick into the rock mass and dragging it across the area to be excavated. Geological factors which influence rippability in rock masses include the rock type and fabric, intact strength and degree of weathering, rock hardness and

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abrasiveness, and the nature, incidence and geometry of discontinuities (Bell *et al.*, 1995).

In Malaysia, the Public Works Department (Jabatan Kerja Raya) distinguishes between 'hard material/rock', and 'common', excavation; hard material/rock excavation being "excavation in any material that cannot be loosened by an excavator with a minimum operating weight of 44 tons (US or short tons) and minimum engine rating of 321 BHP" (JKR, 2005). Broad guidelines on the expected method of excavation in different earth materials in Malaysia have been published by the Public Works Department (JKR, 2005).

Published work on the excavatability of earth materials in Malaysia is limited to the paper discussing a proposed rippability classification of quartzites from the Kenny Hill Formation at Dengkil in Selangor Darul Aman (Mohd For Mohd Amin *et al.,* 2009). The proposed classification involved comparison of field production rates (Q_r) with a laboratory calculated specific energy (SE) parameter. The field production rate (Q_r) in m^3/hour was calculated using a single shank Caterpillar D6 ripper dozer (165 horse power) and measuring the volume of cut per ripping cycle, whilst the specific energy (SE) (in MJ/m^3) was calculated using the mean power (in Joules) required to rip a block sample in the laboratory with a cutting shank divided by the volume of the cut. Several laboratory determined material properties of the quartzites were found to have good correlations with the specific energy (SE) as tensile strength (R^2=0.903), laboratory seismic velocity (R^2=0.861) and rebound value (R^2=0.866) (Mohd For Mohd Amin *et al.*, 2009).

The standard weathering classifications of rock mass by IAEG (1981) and ISRM (1981) furthermore, require considerable modification when applied to meta-sedimentary bedrock in humid tropical areas in view of their continuous weathering to form residual soils (Komoo & Morgana, 1988). The absence of fresh or unaltered meta-sedimentary bedrock at surface outcrops, and in boreholes, in Malaysia furthermore, makes it difficult to define the boundary between rock and soil and thus disallows use of rock/soil ratios for classification of rock mass weathering (Komoo & Mogana, 1988).

The rock mass weathering grades of IAEG (1981) were thus generalized in classifying outcrops of weathered slates, quartzites, phyllites and schists of the Sungai Perlis Beds at Chendering in Terengganu Darul Iman (Hamzah Hussin *et al.*, 2015). Weathering grade VI formed the topmost 1.5 to 2.0 m thick soil cover, whilst grades IV and V varied in colour from yellowish to reddish brown and red. Grade IV was said to be very weak to extremely weak rock, whilst grade V behaved totally as a soft soil. The original rock fabric and structures (as bedding, foliation and joints) were recognizable in both grades IV and V; the relict structures largely controlling their geo-mechanical behaviour. Grade III (moderately weathered) was said to be generally light to pale grey in colour and normally behaved as medium strong to weak rock (Hamzah Hussin *et al.*, 2015).

As part of a study to define the excavatability of earth materials in Malaysia, several excavations in inter-bedded quartzites and phyllites of the Lower Carboniferous Sungai Perlis Beds at Bukit Teluk Batu in south Terengganu Darul Iman were investigated. The excavations had been created by scrapers and rippers attached to earth moving machinery and showed the bedrock to be weathered to variable depths. In this geological short-note, an idealized weathering profile over the inter-bedded quartzites and phyllites is first described before its' constituent zones and sub-zones are correlated with borehole standard penetration tests and p-wave velocities from seismic refraction surveys. The assignment of rock mass classes (ISRM, 2007) and rock mass weathering grades (IAEG, 1981; ISRM, 1981) to the weathering zones and sub-zones is also discussed as is their excavability based on the past field performances of earth moving machinery.

GEOLOGICAL SETTING

The study area covers the western side of the ridge at Bukit Teluk Batu which is located to the south of the small town of Kemasik in south Terengganu Darul Iman (Figure 1). The ridge is developed over approximately north-south striking meta-sedimentary strata that dip

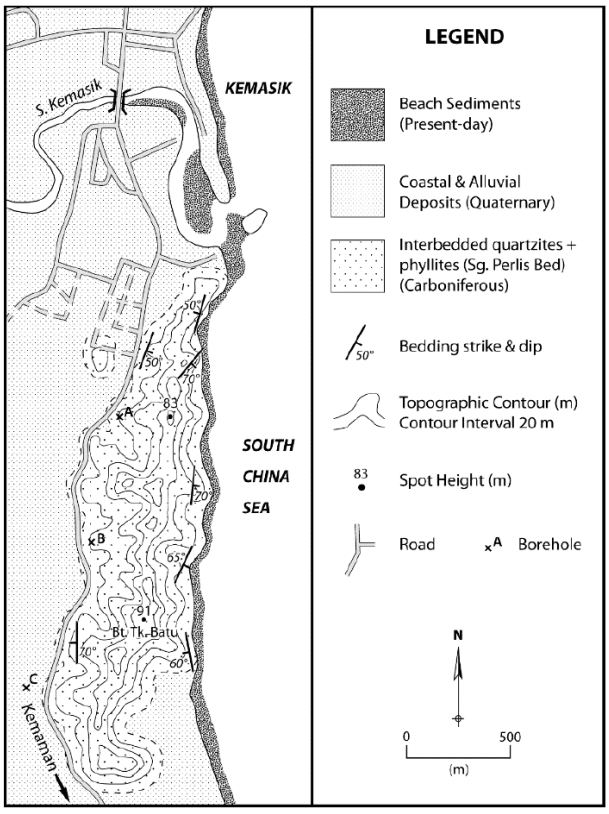

Figure 1: Geology map of Bukit Teluk Batu.

moderately to steeply towards the east and west. The strata, with very variable individual bed thicknesses are strongly jointed and have been separated into two broad lithological sequences by Ahmad Zainuddin (1984). On the western side are found sequences of inter-bedded quartzites and phyllites; the strata having individual bed thicknesses of 0.5 to 2.0 m. On the eastern side, and forming prominent headlands along the coast, are found massive meta-quartzites with thin beds of meta-argillites (phyllites and slates). Quartz veins of different generations are seen in the meta-quartzites which have a blocky appearance due to the presence of several sets of joints.

Fossils have not been found at Bukit Teluk Batu, though plant fossils in similar meta-sediments to the south at Tanjung Sulong in Kemaman (Goh, 1973), and at Tanjung Gelang in Pahang Darul Makmur (Yap, 1976), indicate a Lower Carboniferous age. To the northwest, in the Ulu Paka area, similar Lower Carboniferous meta-sediments have been informally named the "Sungai Perlis Beds" and consist of mainly carbonaceous slate, argillite, phyllite and schist, together with minor bands and lenses of quartzite, meta-conglomerate, and calc-silicate hornfels (Chand, 1978; Lee, 2009).

METHODOLOGY

Excavations in inter-bedded quartzites and phyllites on the west side of Bukit Teluk Batu (Figure 2) were first visited and the exposed weathering profiles described in terms of several pedological and geological features. Pedological features that were described are based on the Soil Survey Manual for Malayan Conditions (Leamy & Patton, 1966) and the Guidelines for Soil Description (FAO, 2006), and include descriptions of the color, consistency, soil structure and texture of the earth materials as well as their content of concretions and organic matter. Geological features that were described primarily involve the extent of preservation of the original bedrock minerals, textures and structures now seen as relict features in the *in situ* weathered strata. From the field descriptions of the pedological and geological features, an idealized weathering profile over the inter-bedded quartzites and phyllites was then formulated. In view of the steep dips, variations in weathering (or alteration) of individual quartzite and phyllite beds could be traced up-dip from slightly to moderately weathered strata at the foots of cuts through highly and completely weathered strata to pedological soil at the tops.

Figure 2: Excavation in Sungai Perlis Beds on west side of Bukit Teluk Batu.

In order to better describe the subsurface earth materials present, boreholes were sunk at three sites in the area; two on the crests of low ridges, and one in a broad plain (Figure 1). The boreholes were advanced by wash boring with split spoon samples at 1.5 m intervals. The SPT (Standard Penetration Test or N) values for advancement of the split spoon sampler of 0.45 m length were recorded with samples described in the field before being sent to the laboratory for standard soil classification tests.

Seismic refraction surveys were also carried out along two lines to determine the thicknesses and seismic velocities of subsurface layers; the survey lines passing through boreholes A and B (Figure 1). P (primary) waves were generated at the ground surface with the use of a hammer and a metal plate, whilst the refracted seismic waves were detected with a series of vertical component geophones and recorded with a 24-channel ABEM Mark VI seismograph.

IDEALIZED WEATHERING PROFILE

The idealized weathering profile comprises the three broad zones of the pedo-weathering profile concept (Tandarich *et al*., 2002), i.e., the top pedological soil (zone I), the intermediate saprock (zone II), and the lower bedrock (zone III) (Table 1 and Figure 3). The pedological soil is some 2 to 4 m thick and consists of IA, IB and IC soil horizons (Table 1). The IA and IB horizons (solum) are relatively thin and comprise yellowish brown, firm clay with some lateritic concretions, whilst the IC horizon (saprolite) consists of mottled red and reddish yellow, stiff, gravelly silty clay with many vein quartz clasts and a few lateritized core-stones.

The saprock (zone II) is some 15 to 20 m thick and consists of steeply dipping, alternating bands of completely to highly and moderately weathered quartzites and phyllites that indistinctly to distinctly preserve the minerals, textures and structures of the original bedrock material and mass. Variations in relative contents of the completely to highly and moderately weathered strata allow the saprock to be separated into an upper IIA sub-zone, an intermediate IIB sub-zone, and a lower IIC sub-zone (Table 1 and Figure 3).

The upper IIA sub-zone is characterized by alternating bands of red to pink, loose to medium dense, sand (representing completely weathered quartzite) and reddish to yellow, soft to stiff, clayey silt and silt (representing

Table 1: Pedological and geological features of idealized weathering profile.

Zone	Sub-zone	Thickness	Pedological and Geological Features
Pedological Soil (I)	IA	≈0.5 m	Yellowish brown, firm clay with some roots.
	IB	≈1.0 m	Brownish yellow, firm clay with reddish yellow & red mottles. Some lateritic concretions. Boundary sharp.
	IC	≈1.5 m	Mottled red & reddish yellow, stiff, gravelly silty clay. Many vein quartz clasts & a few lateritized core-stones. Boundary gradual.
Saprock (II)	IIA	≈3.0 m	Indistinct to distinct, bands of red to pink, loose to medium dense, sand (completely weathered quartzite) and reddish to yellow, soft to stiff, clayey silt & silt (completely weathered phyllite). Indistinct preservation of minerals, textures & structures of original bedrock material & mass. Boundary irregular & gradual.
	IIB	≈6.0 m	Steeply dipping, thin to thick, distinct bands of pink to yellow, medium dense to dense, sand (highly weathered quartzite) and yellow to red, stiff to hard, clayey silt & silt (highly weathered phyllite). Distinct preservation of minerals, textures & structures of original bedrock material & mass. Boundary irregular & gradual.
	IIC	≈8.0 m	Steeply dipping, thin to thick, distinct bands of yellow to grey, dense to very dense, sand (moderately weathered quartzite) and pink to yellow, hard, clayey silt & silt (moderately weathered phyllite). Distinct preservation of minerals, textures & structures of original bedrock material & mass. Boundary very irregular & distinct.
Bedrock (III)	IIIA	>20.0 m	Steeply dipping, thin to thick, alternating strata of dark grey, slightly weathered quartzite and pink to grey, slightly weathered phyllite. Many quartz veins & pods.

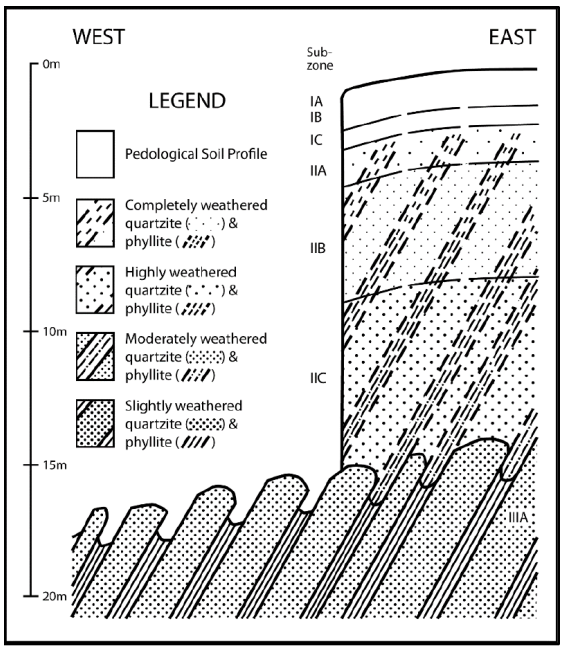

Figure 3: Idealized geological cross-section through the western side of Bukit Teluk Batu.

completely weathered phyllite) with indistinct to distinct preservation of the original bedrock minerals, textures and structures. The bottom IIC sub-zone, however, is characterized by alternating bands of yellow to grey, dense sand (representing moderately weathered quartzite) and pink to yellow, hard, clayey silt and silt (representing moderately weathered phyllite) with distinct preservation of the minerals, textures and structures of the original bedrock material and mass. The intermediate IIB sub-zone, furthermore, is characterized by alternating bands of pink to yellow, medium dense to dense, sand (representing highly weathered quartzite) and yellow to red, stiff to hard, clayey silt and silt (marking highly weathered phyllite) with distinct preservation of the minerals, textures and structures of the original bedrock material and mass.

The bedrock zone (zone III) is characterized by steeply dipping, alternating strata of dark grey, slightly weathered quartzite, and pink to grey, slightly weathered phyllite with total preservation of the minerals, textures and structures of the original bedrock material and mass. The use of a geological hammer for field determination of unconfined compressive strengths (as per BS EN ISO

14689-1:2003) shows the slightly weathered quartzites and phyllites to be classified as extremely weak to very weak rock. Field point load tests on block samples of the slightly weathered quartzites and phyllites support this interpretation for they yield point load strength indices [$Is_{(50)}$] between 0.5 and 3.3 MPa (Table 2).

Outcrops of bedrock are marked by a very irregular ground surface with protruding, narrow to broad, linear stumps of slightly weathered quartzite separated by linear, shallow depressions along slightly weathered (and less resistant) phyllite. These irregular ground surfaces mark the limits of "common excavation" (JKR, 2005) for the surfaces of the protruding quartzite stumps are marked by the teeth marks of scrapers attached to dozers (Figure 4).

Figure 4: Teeth marks (10 cm width) of scrapers on slightly weathered quartzite.

SEISMIC REFRACTION SURVEYS

Seismic refraction line 1 in the north, runs generally downslope and is oriented 190°-010°, i.e., about parallel to the strike of the quartzites and phyllites. Three subsurface layers could be differentiated; the topmost layer with a thickness of 1 to 3 m and p-wave velocity of 420 m/s and the second layer with a thickness of 10 to 22 m and velocity of 727 m/s. The bottom layer has a p-wave velocity of 2330 m/s; its upper surface located some 12 to 24 m below the ground surface (Table 3).

Seismic refraction line 2 in the south runs upslope and is about parallel to the strike of the meta-sedimentary bedrock as it is oriented 160°-340°. Three subsurface layers could also be differentiated; the topmost layer with a thickness of 1 to 3 m and p-wave velocity of 488 m/s and the intermediate layer with a thickness of 7 to 25 m and velocity of 1160 m/s. The bottom layer has a p-wave velocity of 3724 m/s; its upper surface located some 12 to 28 m below the ground surface (Table 4).

P-wave velocities of the bedrock zone of 2330 m/s and 3724 m/s can be correlated with the laboratory determined velocities of 1571 to 3063 m/s of quartzite samples from the Kenny Hill Formation at Dengkil in Selangor Darul Ehsan (Mohd For Mohd Amin *et al.,* 2009). P-wave velocities of the saprock zone of 727 m/s and 1160 m/s in the present study furthermore, can be correlated with the field determined seismic velocities (V_f) of 1000 to 2000 m/s of *in situ* rippable quartzites of the Kenny Hill Formation at Dengkil (Mohd For Mohd Amin *et al.,* 2009).

BOREHOLE INVESTIGATIONS

Field logs of the three boreholes show variations in SPT (or N) values with depth, indicating differences in resistance to penetration by the subsurface earth materials (Tables 5 to 7). Three broad zones, however, can be differentiated; the zones coinciding with the pedological soil, saprock and bedrock zones of the idealized weathering profile.

Table 2: Point load strength indices of quartzite and phyllite from the Sungai Perlis Beds.

Rock Type	Locality	$Is_{(50)}$ MPa	Orientation of samples	Reference
Quartzite	Bukit Teluk Batu	2.303	Perpendicular to bedding	Raj (2010)
Quartzite	Kuala Dungun	3.236	Perpendicular to bedding	Zulnaidi Bin Ismail (2012)
Quartzite	Kuala Dungun	1.195	Parallel to bedding	
Phyllite	Kuala Dungun	0.863	Not specified	

Table 3: Seismic refraction survey along line 1 (through borehole BH A).

Layer	Velocity	Thickness	Interpretation
1st (Top)	420 m/s	1 - 3 m	Pedological soil zone
2nd (Middle)	727 m/s	10 - 22 m	Saprock zone - Moderately to highly & completely weathered quartzites & phyllites
3rd (Bottom)	2330 m/s	12 - 24 m depth	Bedrock zone - Slightly weathered to fresh quartzites & phyllites

In borehole A, the top 2.5 m thick, yellow brown, stiff, sandy silt (N=13) represents the pedological soil and overlies a 4.5 m thick, yellow brown and grey, hard sandy silt (N=50/90 mm) interpreted to be highly weathered phyllite and quartzite (Table 5). Below the highly weathered strata is a 5.5 m thick, reddish brown to grey, hard, sandy silt (N=50/15 mm and N=50/90 mm) that is interpreted to represent moderately weathered phyllite and quartzite (Table 5).

In borehole B, the top 2 m thick, yellow brown to grey, stiff, sandy silt (N=13) represents the pedological soil and overlies a 2 m thick, yellow to dark grey, stiff sandy silt (N=22) interpreted to be completely weathered phyllite and quartzite (Table 6). Below the completely weathered strata is a 4.5 m thick, yellow to grey, hard, sandy silt (N=50/225 mm, and N=50/180 mm) considered to represent highly weathered phyllite and quartzite. Below the highly weathered strata is a 5 m thick, reddish to yellow and grey, hard, sandy silt (N=50/90 mm and N=50/95 mm), interpreted to be moderately weathered phyllite and quartzite. At depths of 13.5 to 15 m, and from 18 to 19.5 m, cores show fractured yellow brown shale (RQD=0) interpreted to represent slightly weathered phyllite. Between 15 and 18 m depth is a yellow brown to grey, hard, sandy silt (N=50/95 mm) considered to represent moderately weathered phyllite and quartzite (Table 6).

In borehole C, which is located in a broad plain, the top 5 m thick, loose to medium dense sand (N=8 and N=11) represents Holocene beach sands that overlie some 5 m of very stiff, sandy silt (N=22) and medium dense, silty sand (N=25) considered to represent completely weathered phyllite and quartzite (Table 7). Below the completely weathered strata is some 3 m of very dense silty sand

Table 4: Seismic refraction survey along line 2 (through borehole BH B).

Layer	Velocity	Thickness	Interpretation
1st (Top)	488 m/s	1 - 3 m	Pedological soil zone
2nd (Middle)	1160 m/s	7 - 25 m	Saprock zone - Moderately to highly & completely weathered quartzites & phyllites
3rd (Bottom)	3724 m/s	12 - 28 m depth	Bedrock zone - Slightly weathered to fresh quartzites & phyllites

Table 5: Field log of borehole A.

Depth (m)	SPT (N)	Description	Interpretation
0.0-1.0	-	Top soil. sandy SILT	Pedological soil
1.0-2.5	13	Stiff, yellow brown to grey, sandy SILT	
2.5-7.0	50/90 mm	Hard, yellow brown & grey, sandy SILT	HW phyllite & quartzite
7.0-10.0	50/15 mm	Hard, reddish brown to grey, sandy SILT	MW phyllite & quartzite
10.0-12.25	50/90 mm		

Note: HW = Highly Weathered; MW = Moderately Weathered

Table 6: Field log of borehole B.

Depth (m)	SPT (N)	Description	Interpretation
0.0-1.0	-	Top soil. Sandy SILT	Pedological Soil
1.0-2.0	13	Stiff, yellow brown to grey sandy SILT	
2.0-4.0	22	Stiff, yellow to dark grey, sandy SILT	CW phyllite & quartzite
4.0-5.5	50/225 mm	Hard, yellow to dark grey, sandy SILT	HW phyllite & quartzite
5.5-8.5	50/180 mm	Hard, yellow brown, sandy SILT	
8.5-11.5	50/90 mm	Hard, reddish to grey, sandy SILT	MW weathered phyllite & quartzite
11.5–13.5	50/95 mm	Hard, reddish to yellow, sandy SILT	
13.5-15.0	Core	Fractured, brown shale. RQD=0%	Slightly weathered phyllite
15.0-18.0	50/95 mm	Hard, brown to grey, sandy SILT	MW phyllite & quartzite
18.0-19.5	Core	Fractured, brown shale. RQD=0%	Slightly weathered phyllite

Note: CW = Completely Weathered; HW = Highly Weathered; MW = Moderately Weathered

(N=50/225 m and N=50/190 mm) representing highly weathered quartzite that is inter-bedded with some 7 m of very dense, silty sand (N=50/90 mm and N=50/95 mm) representing moderately weathered quartzite (Table 7).

DISCUSSION

Idealized weathering profile correlation with p-wave velocities and SPT (N) values

Inherent differences in pedological and geological features allow the zones and sub-zones of the idealized weathering profile to be correlated with the seismic refraction surveys (Tables 3 and 4) and borehole logs (Tables 5, 6 and 7). The seismic refraction surveys in particular demarcate clearly the three broad weathering zones; the pedological soil with low p-wave velocities (<500 m/s), the bedrock with high p-wave velocities (>2300 m/s) and the saprock with intermediate velocities (700-1200 m/s) (Table 8).

The pedological soil furthermore, has low SPT values (N<15) whilst the saprock has larger values (N>20) and the bedrock zone requires coring. The SPT tests also allow indirect evaluation of the extent of weathering of the inter-bedded quartzites and phyllites; completely weathered quartzites and phyllites having moderate SPT values (N=20-30), whilst highly, and moderately, weathered quartzites and phyllites are characterized by very large SPT values of N=50/>100 mm, and N=50/<100 mm, respectively (Table 8).

Idealized weathering profile and assignment of rock mass classes

It has been earlier pointed out that considerable modifications are required when the standard classifications for weathering of rock mass (IAEG, 1981; ISRM, 1981) are applied to meta-sedimentary bedrock in humid tropical areas in view of their continuous weathering to form residual soils (Komoo & Morgana, 1988). Modifications are also needed in view of the heterogeneous and anisotropic character of meta-sedimentary bedrock that results from the inter-bedding of different lithologic units

Table 7: Field log of borehole C.

Depth (m)	SPT (N)	Description	Interpretation
0.0-1.0	-	Top soil. Sandy SILT	Top Soil
1.0-2.0	8	Loose, silty Sand	Holocene beach sands
2.0-5.0	11	Medium dense, silty SAND	Holocene beach sands
5.0-8.0	22	Stiff to very stiff, sandy SILT	CW phyllite
8.0-10.0	25	Medium dense, silty SAND	CW quartzite
10.0-11.5	50/225mm	Very dense, silty SAND	HW quartzite
11.5-14.5	50/90 mm	Very dense, silty SAND	MW quartzite
14.5-16.0	50/190mm	Very dense, silty SAND	HW quartzite
16.0-19.5	50/95 mm	Very dense, silty SAND	MW quartzite
19.5-19.81	50/165mm	Very dense, silty SAND	HW quartzite

Note: CW = Completely Weathered; HW = Highly Weathered; MW = Moderately Weathered

Table 8: Correlation between weathering sub-zones, p-wave velocities, borehole SPT (N) values and rock mass class (ISRM, 2007).

Weathering Zone & Sub-zone		Description	Zone Thickness	P wave Velocity	Borehole SPT	Rock Mass Class
Pedological Soil	IA, IB & IC	Agricultural soil horizons	≈3 m	<500 m/s	N <15	VI
Saprock	IIA	Completely weathered quartzites & phyllites	7 - 25 m	700 - 1200 m/s	N = 20 to 30	V
	IIB	Highly weathered quartzites & phyllites			N = 50/>100 mm	IV
	IIC	Moderately weathered quartzites & phyllites			N = 50/<100 mm	III
Bedrock	IIIA	Slightly weathered quartzites & phyllites	12 - 28 m depth	>2300 m/s	Coring	II

as well as their variability in their orientations. The absence of fresh or unaltered meta-sedimentary bedrock at surface outcrops, and in boreholes also makes it difficult to define the boundary between rock and soil and thus disallows use of rock:soil ratios for classification of weathering (Komoo & Mogana, 1988).

Notwithstanding these limitations, the pedological soil (zone I) of the idealized weathering profile can be directly correlated with class VI of the ISRM (2007) scheme for classification and description of rock mass, or rock mass weathering grade VI of the IAEG (1981) and ISRM (1981) classification schemes. Sub-zone IIIA (bedrock) furthermore, is best correlated with class II, or grade II, of the said classification schemes in view of the slightly weathered quartzites and phyllites present. Saprock sub-zones IIA, IIB and IIC can then be correlated with classes V, IV and III, of the ISRM (2007) classification scheme, or mass weathering grades V, IV and III, respectively, of the IAEG (1981) and ISRM (1981) schemes.

Idealized weathering profile and excavability

Field observations show excavations at Bukit Teluk Batu to have been created by scrapers and rippers attached to earth moving equipment of different manufacturers. These excavations can therefore, be classified as involving "common excavation" in terms of the Guidelines published by the Public Works Department of Malaysia (JKR, 2005). At the feet of most of the excavations furthermore, is found a very irregular ground surface with narrow to broad, protruding, linear stumps of slightly weathered quartzite separated by linear, shallow depressions along slightly weathered phyllite. This irregular ground surface marks the limits of "common excavation" for the surfaces of the protruding quartzite stumps are marked by the teeth marks of scrapers. The bedrock zone can thus be considered to be non-rippable, whilst the overlying pedological soil and saprock zones are rippable.

This difference in excavability can also be correlated with the charts of ripper performance based on seismic velocity developed by different manufacturers of earth moving equipment. In the case of the Caterpillar D8R Ripper for instance, schist, shale, sandstone and conglomerate are considered non-rippable when seismic velocities exceed 2400 m/s, but rippable when seismic velocities are less than 1800 m/s, and marginal when velocities are between 1800 and 2400 m/s (Caterpillar, 2000). In view of extreme variations amongst earth materials, however, the charts need to be recognized as being just one indicator of rippability (Caterpillar, 2000).

CONCLUSION

Excavations in steeply dipping, interbedded quartzites and phyllites of the Lower Carboniferous Sungai Perlis Beds at Bukit Teluk Batu allowed formulation of an idealized weathering profile. The idealized profile consists of three broad zones, i.e., an upper pedological soil, an intermediate saprock, and the lower bedrock. The pedological soil is some 3 m thick and consists of yellow to red, firm to stiff, silty clays with quartz clasts and lateritic concretions. The saprock is some 7 to 25 m thick and consists of alternating bands of yellow to brown and grey, loose to dense, sands (representing completely to highly and moderately weathered quartzite), and soft to hard, clayey silts and silts (representing completely to highly and moderately weathered phyllite). Original bedrock minerals, textures and structures are distinctly preserved in the saprock which can be separated into sub-zones IIA, IIB and IIC. Bedrock is found at depths exceeding 12 m and is marked by an irregular surface of narrow to broad, linear stumps of slightly weathered quartzite separated by shallow depressions in slightly weathered phyllite.

Seismic refraction surveys show the pedological soil to be characterized by p-wave velocities of less than 500 m/s, whilst the bedrock zone has velocities exceeding 2300 m/s and the saprock, velocities of 700 to 1200 m/s. Boreholes show the pedological soil to have SPT (N) values of less than 15, whilst the saprock has (N) values exceeding 20, and the bedrock requires coring. Excavation of the pedological soil and saprock zones involved common excavation whilst the bedrock zone is non-rippable; its upper surface marked by the teeth marks of scrapers. It is concluded that the differentiation of weathering zones and sub-zones in areas of interbedded quartzites and phyllites will allow for prediction of their excavability.

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AUTHORS CONTRIBUTION

JKR - project concept and writing-up (70%); ANH - seismic refraction surveys (15%); AZ - performed borehole investigations (15%).

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Application of residual basalt for the cultivation of jasmine rice from northeastern Thailand; an example of the reduction of methane emissions

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Abstract: The cultivation of rice in mainland Southeast Asia countries is concerned with the emissions of greenhouse gases (GHG) today. Methane is one of the GHG gases originating from long flooding periods of rice growth. This paper aimed to experiment with the environmentally re-soil technique by adding residual basalt in the rice cultivation process with non-fertilizer usage and to shorten the flooding period as a consequence to reduce methane emissions. We apply wet-dry techniques in rice production to measure rice growth and yield. We analyzed the chemical qualities of residual basalt from the Khao Kradong, Buriram province, northeastern Thailand where extinct volcanoes and residual soils are extensively located nearby. A geological survey after processing the GIS data was carried out to specify the suitable residual basaltic sites. Then, residual basaltic soil from 7 profiles was analyzed by XRD and XRF. Then, the selected residual basalt was used for mixing with local soil in the jasmine rice experiment where the rice growth and yield, coupled with aromatic properties were observed. The results showed that the re-soil technique significantly and positively affected the height of rice, germination, number of ears, number of seeds per ear, and the total yield weight.The yield of the experiment is equal to the average yield of planting with chemical or organic fertilizers, but water is saved for 42 days. With a total cultivation period of 126 days, rice production can reduce water usage by 33.3%, with no need for fertilizers.

Keywords: Residual basalt, re-soil, methane, GHG, Khao Dawk Mali 105, Khorat Plateau

INTRODUCTION

Rice is a staple food that is consumed by more than half of the world's population. The grain of rice is not only important for food security, but cultivation is also an important source of livelihood. Rice production from Asia covers 90% of the total global production (Fukagawa & Ziska, 2019). Although rice is useful to humans, using fertilizers for rice farming today affects the environment and causes global warming. Some steps of rice production also release greenhouse gases (GHG) into the environment, and it impacts both, directly and indirectly, the biodiversity (Jeswani *et al*., 2018). For example, the excessive addition of chemical fertilizers may cause nutrient leaching, and storage of water in the paddy fields significantly emit carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (Berkhout *et al*., 2015; Chang *et al*., 2018; He *et al*., 2018; Jeswani *et al*., 2018; Habibi *et al*., 2019; Dastan *et al*., 2019; Fukagawa & Ziska, 2019; Liu *et al*., 2022; Mahmood & Gheewala, 2023).

Over the past few decades, researchers around the world have tried to find a method to improve rice production that gives a high yield, reduces the environmental impact due to rice cultivation, and is sustainable for rice production. Some of the methods, for example, are organic rice farming (Mahmood & Gheewala, 2023), system of rice intensification (SRI) (Berkhout *et al*., 2015), wetting and drying water management and rice straw incorporation, and efficient post-harvest management, such as handling rice straw by turning it into compost (Zakarya *et al*., 2018). Sustainable and environmentally friendly rice cultivation is a challenge that cannot be a successful case with one method, but using multiple processes at each stage of cultivation can help to achieve the objectives (Lin & Fukushima, 2016). Consequently, in this paper, we focus on examining natural nutrients from residual basalt to reduce fertilizer use, and water level control to reduce methane. It is well-known that weathering basalt

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is rich in natural nutrients such as silica, iron, aluminum, potassium, and calcium which plants need and benefits plant growth (Römheld & Marschner, 1986; Marschner, 1995; Nozoye *et al*., 2011; Rout & Sahoo, 2015; Farooq & Dietz, 2015; Guerriero *et al*., 2016; Artyszak, 2018; Sukyankij *et al*., 2020; Ramírez-Olvera *et al*., 2021; Swe *et al*., 2021; Zuverza-Mena *et al*., 2023).

Adding fertilizers can ensure that plants receive the nutrients they need at planting time and during the growing period. However, some substances in fertilizer can impact the environment. Over-fertilizing can be hazardous, such as the toxicity of iron, aluminum, and manganese in rice. Overfertilization can also lead to sudden plant growth with an insufficient root system to supply adequate water and nutrients to the plant. Poor root structure causes inefficiency in nutrient absorption and can also inhibit plant growth (Dobermann *et al*., 2002).

Water management in paddy fields can reduce environmental impacts. Normally, a higher and longer flooding periods of paddy fields will increase methane (CH_4) emissions. Conventional rice production (90 - 120 days of irrigation) also promotes the highest impacts on CH_4 emission (Carrijo *et al*., 2017; Oo *et al*., 2018; Liao *et al*., 2020; Zhang *et al*., 2021; Liao *et al*., 2023). Although the short flooding water into the rice farm reduces methane emissions, some studies have also found that water level in paddy fields has the potential to release N_2O if the source of nitrogen is from both chemical or organic fertilizers (Kiese *et al*., 2008; IPCC, 2013; Xu *et al*., 2013; Yang *et al*., 2015; Zhu *et al*., 2015; Abraham *et al*., 2016; Xia *et al*., 2017; Qaswar *et al*., 2020; Liang *et al*., 2022).

In Southeast Asia, one source of greenhouse gases (GHG) is released from growing rice. Fertilizers and traditional irrigation or conventional rice production emit CO_2, CH_4, and N_2O throughout the cultivation process. We believe that the use of fertilizers in soil is a matter of concern for GHG release in rice fields. Therefore, in this paper, we selected and analyzed the residual soil from basaltic terrain in the southern part of the Khorat Plateau, northeastern Thailand. We focused on the experiment to propose environmentally-friendly ways of cultivation by omitting fertilizer and replacing the residual basalt in the soil instead. We set up the re-soil experiment for growing jasmine rice (Khao Dawk Mali 105 (KDML 105)).

MATERIALS AND METHODS

Data acquisition

Remote sensing and geographic information system (GIS) data

In this study, we made a geological field survey around Khao Kradong and the surrounding areas where an extinct volcano is located (Figure 1). We accessed various types of remote sensing data including Landsat-8OLI satellite images (Path 128 and Row 050) taken on June 22, 2021, Zone 48N with the geodetic reference system WGS 84. The resolution is 30 m for bands OLI-1 to OLI-7, respectively.

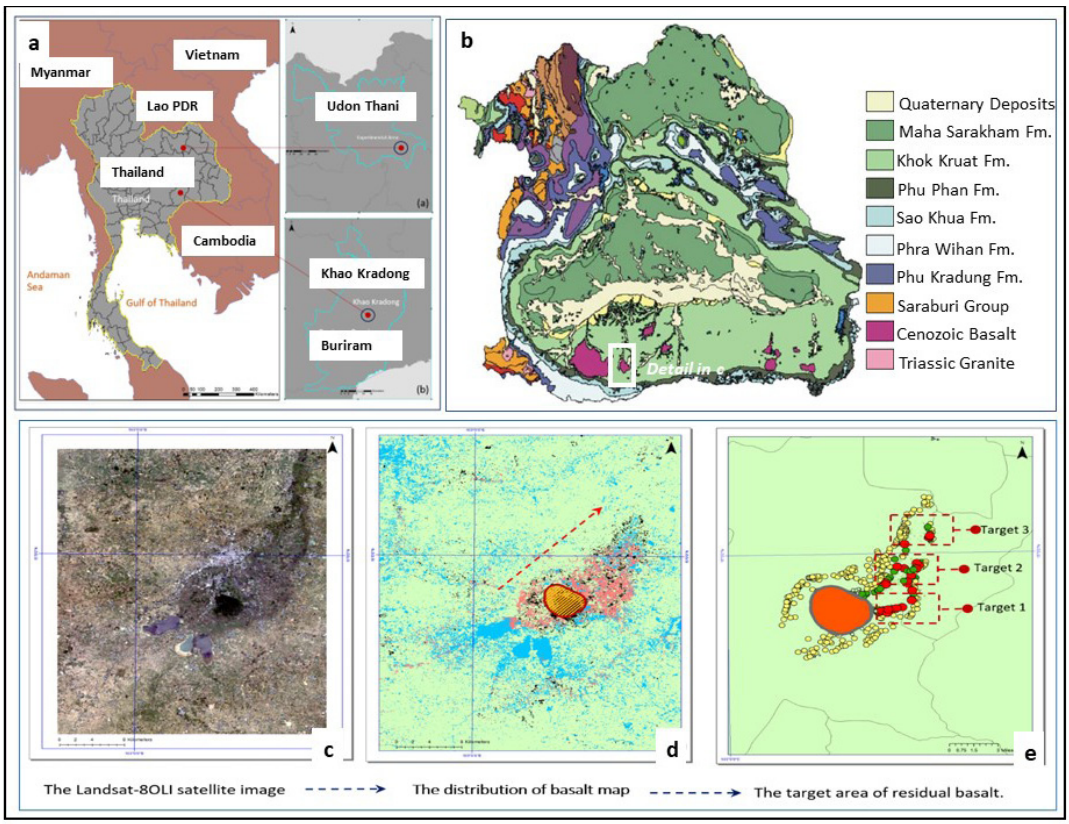

Figure 1:
(a) Index map of Thailand and provincial names mentioned in this paper.
(b) Geological map with basalt exposure in the south.
(c) Landsat 8 satellite image.
(d) Basalt exposure and distribution of residual basalt, Khao Kradong, Buriram Province.
(e) Three target areas of residual basalt for this study.

GIS data used in this work include (i) Buriram provincial boundaries (province, district, sub-district), polygons (reserved forest, water reservoir, wetland, and national park, basin), lines (stream, river, road), points (village, groundwater well) and land use. Geological data include geological boundaries, aquifers, faults, soil groups, and slopes.

Various types of remote sensing data were classified. The aim was to locate the distribution of basaltic exposures and residual basalt. All data were processed using GIS software to define target areas 1, 2, and 3 and to determine the excavated location. The method is shown in Figure 2.

Experimental design

In this study, we explored and targeted the sources of residual basalt around the Khao Kradong, an extinct volcano, in Buriram Province, northeastern Thailand. Remote sensing and GIS analysis were applied to locate the high-potential areas for basaltic soil excavation (more than 50% of SiO_2 , based on XRF and XRD analysis) (Kaew-in & Choowong, 2023). Basaltic soils were transported and used in the experimental rice growing area at Rai Kaew-In, Udon Thani Province (Figure 1a). The experiment was designed as the randomized complete block design (RCBD) consisting of 5 treatments, i.e., t1-t5 (Figure 2). The mixing ratio of each treatment is shown in Figure 3. The experimental unit is 0.5 m high and 1 m in diameter. The distance between the blocks and the units is 1 m (Figures 3a-b). The number of treatments and blocks was randomly selected, as shown in Figure 3(d). The crop processes are demonstrated in Figure 3e. Rice was harvested at 18 weeks (126 days) after planting. Plant parameters and yield were recorded, including plant heights measured from the soil surface to the tip of rice every week until the harvested period, stem size, leaf size, number of stems, number of leaves, number of ears, number of seeds per ear, total weight, and the smell from volatile gas called 2-Acetyl-1-Pyrroline (2AP) analysis by using Headspace Gas Chromatograph Mass Spectrometry (HS-GC/MS). The present study was analyzed for statistical variance using the Analysis of Variance (ANOVA) method.

RESULTS AND DISCUSSIONS

Remote sensing and GIS

The Landsat-8 satellite images were processed and limited to the distribution of residual basalt located about 20 km to the northeast of Khao Kradong, on the way to Huai Rat District from Muang Buri Ram District. The distribution map of basaltic rock and soil is shown in Figure 1(b). Based on the remote sensing and GIS analyses, the most suitable area for collecting basaltic soil is from the Khao Kradong buffer zone, 15 km of distance to the northeast where the criteria of site selection is the highest potential (Kaew-in & Choowong, 2023) (Figures 1b-c). The first target area is situated

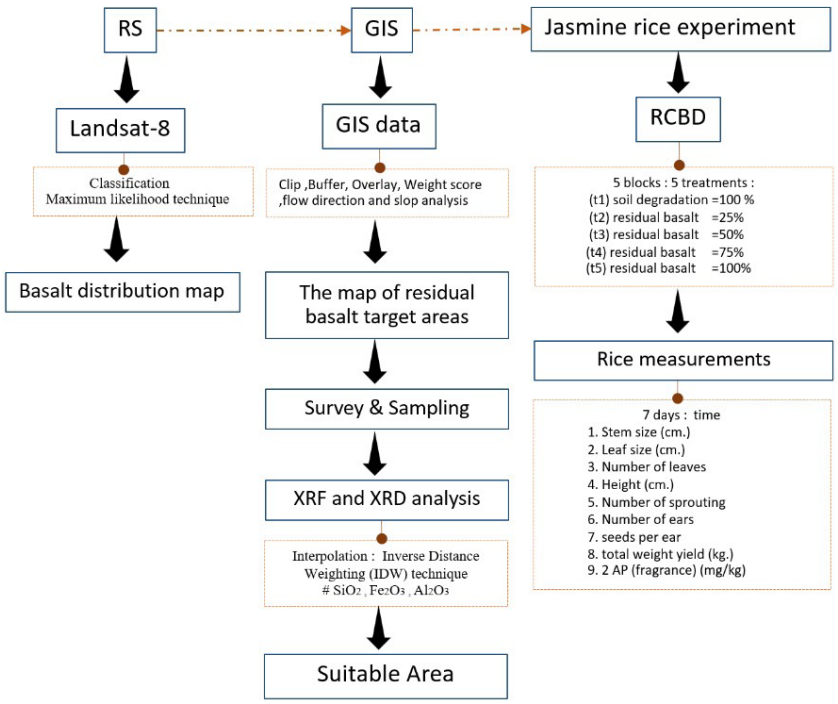

Figure 2: Flowchart shows the methodology for residual basalt site selection, mineral analysis, and parameters for rice measurement in this work.

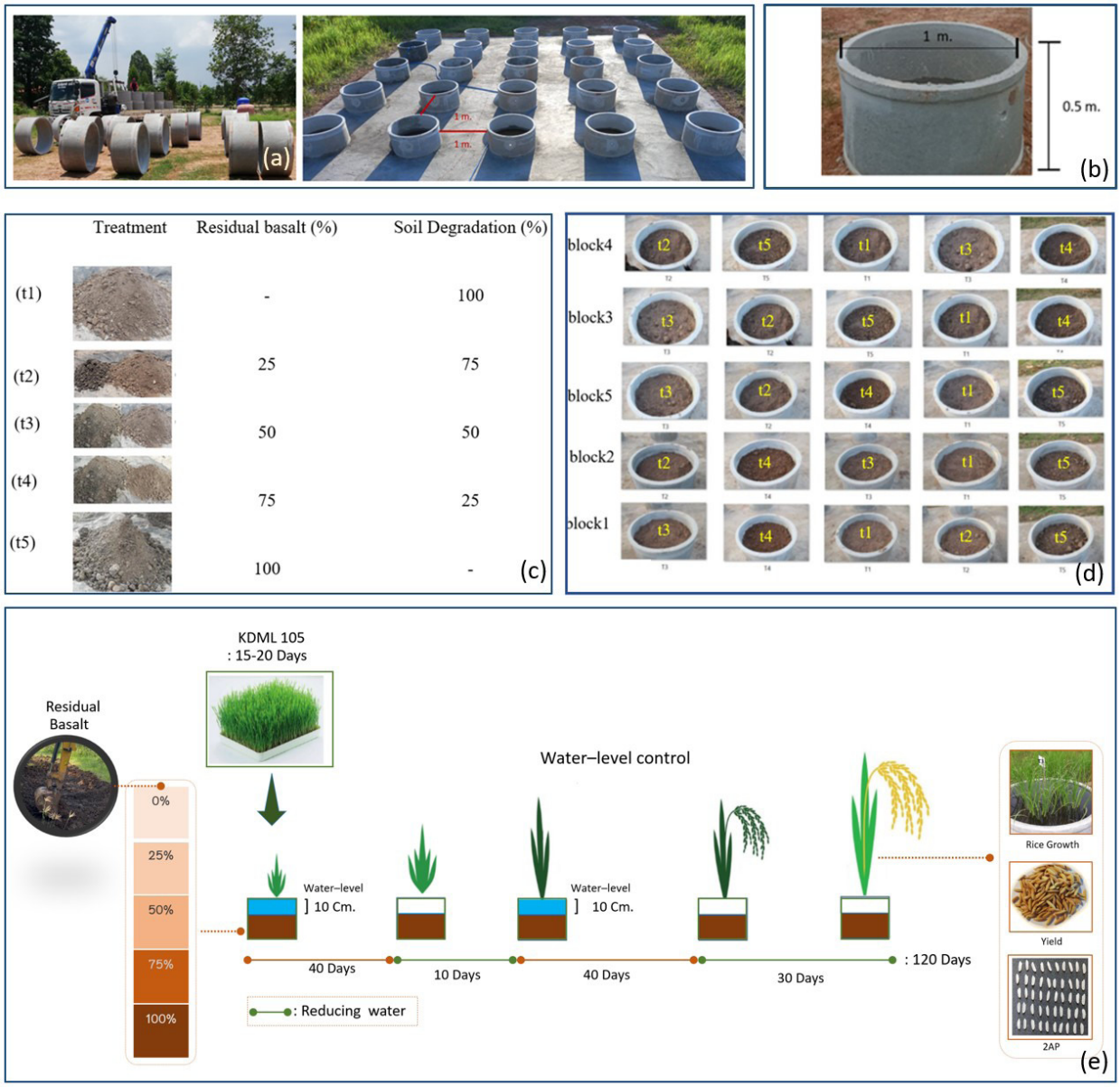

Figure 3: Experimental design, (a) the experimental unit preparation, (b) the height and diameter of the experimental unit, (c) the ratio of treatment designed for this study, (d), the number of treatments and blocks was randomly selected, (e) the cultivation process.

in Sawai Cheek Subdistrict, Mueang Buriram District, about 4 km from the buffer zone. The second target area is located at the Huai Rat and Isan Subdistrict, 7 km from the buffer zone. The third target area is located in Ban Yang Subdistrict, Mueang Buriram District, 12 km from the buffer zone. All three target areas are shown in Figure 1(e).

After the target areas were selected, we created the profile point for the survey and sampling. Target area 1 contains three profiles (profiles 1 to 3 in Table 1). Target area 2 has two profiles (profiles 4 and 5). Target area 3 includes two profiles (profiles 6 and 7). The profile point and coordinate are shown in Table 1.

Growth and yield of KDML 105

The farming system in Thailand comprises two common seasons. The first is called "in-season rice" or "rain-fed rice", representing rice grown during the regular farming season. It starts from May to October and harvest is completed by February. On the other hand, the second is called "off-season rice", referring to rice grown outside the regular farming season. It starts in January and finishes in April. Our experiment began in August to November 2022 (in-season farming). The experiment was divided into 2 phases. Phase I measured the growth of stems and leaves, starting from the first week to the 12th week. Phase II was for fertility and seed formation, from

Table 1: The coordination of the profiles in the three target areas.

Target area	Coordinate			Lithology
Target 1				
Profile 1	0300259E	1652017N	Zone 48 P	Black and blown color of soil, mixed plant roots, mostly soil, and no weathered basalt at depth upper 60 cm.
Profile 2	0300573E	1651987N	Zone 48 P	
Profile 3	0300013E	1651780N	Zone 48 P	
Target 2				
Profile 4	0302967E	1655620N	Zone 48 P	Clay sediment and mixed rock in the ratio of 95:5, dark brown-black color and weathered basalt
Profile 5	0300089E	1655726N	Zone 48 P	
Target 3				
Profile 6	0302967E	1655620N	Zone 48 P	Dark brown with basalt fragments. Clay per grain is 70:30 with grain size 0.1-2 cm of weathered basalt.
Profile 7	0300089E	1655726N	Zone 48 P	

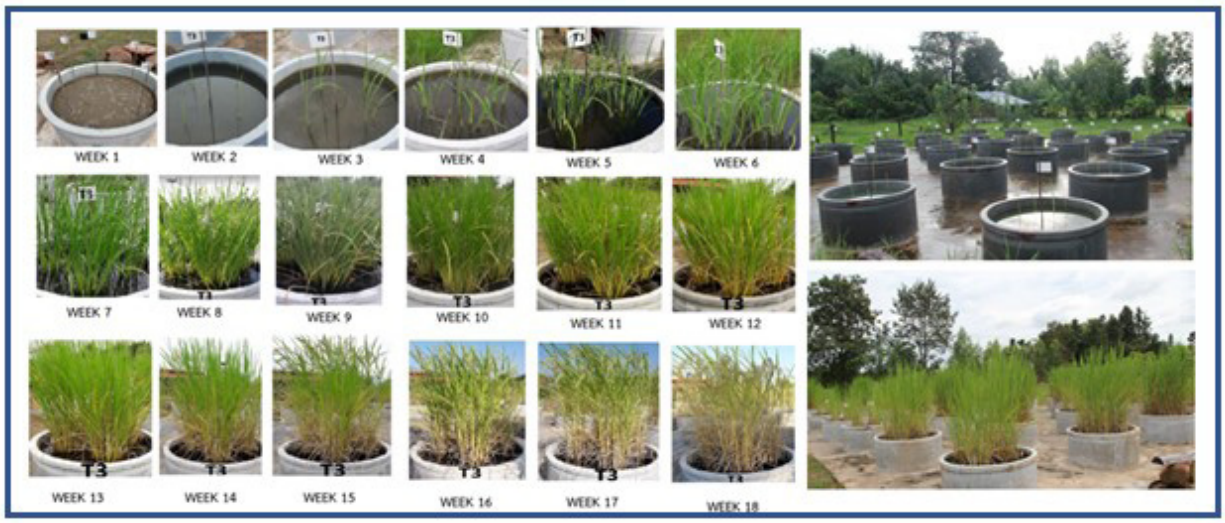

Figure 4: Series of photographs showing rice growth between week 1st – week 18th.

Table 2: Property of soils (0 - 15 cm) before conducting the experiments.

Property	Amount/Unit	Result
Organic matter (OM)	0.57%	Low
Phosphorus (P)	6 mg/kg	Low
Potassium (K)	22 mg/kg	Very low
Calcium (Ca)	561mg/kg	Low
Magnesium (Mg)	57 mg/kg	Low
pH	6.3	Slightly acidic
Electrical Conductivity (EC)	0.03 mS/m	None
Soil texture	-	Sandy loam

the 13th week to the 18th week (Figure 4). The original soil in the study area is classified as paddy soil, owing to poor nutrients. The original soil properties before the experiments are shown in Table 2.

The experiment started with seedlings for 15 days, and then transplanted into an experimental unit. Results were collected weekly by measuring stem and leaf size, height, number of leaves, and sprouting. The results are shown in Figure 5. The measurements of leaf size (b) showed that there was little difference in growth during the 1st and 2nd weeks of each treatment (t1-t5) (also see ratio of each treatment in Figure 3c). From the 3rd to the 12th week, t2 had the highest leaf width, followed by t1 (Control), t3, t4, and t5, respectively. The number of leaves (c) increased steadily and was noticeable in the 7th to 12th week, then decreased with the greatest number of leaves similar between t1 and t2, followed by t3, t4 and t5, respectively. For the size of the stem (d), the result shows in the 1st to 5th week, the growth was evident in all experimental units. From week six onwards, the stem size remained stable, starting with t2, with no change at week 5th, t1, t3, t4, and t5, and no change at week 9th until the harvesting period. The number of sprouting (e) showed that growth and sprouting increased significantly between weeks 4–12, with t2 having the highest budding followed by t1, t3, t4, and t5, respectively. From week 13 onwards, the budding number has slightly changed until the harvest time. The height of rice plants (f) continued to increase from the first week to the last week, with t2 having the highest elevation, followed by t1, t3, t4, and t5, respectively.

In the reproductive stage, from the 13th week onwards, the rice pinnacle initiated, then the seed turned from green to yellow. Finally, the grain color was brown and ready for harvest in the 18th week (Figure 6a). t2 gave the most significant number of ears of KDML 105 rice, followed by t1, t3, t4, and t5, respectively (Figure 6b). The number of seeds per ear showed that t2 had the highest mean number of grains per ear, and the fourth block was significantly higher, followed by t1, t3, t4, and t5, respectively. The number of maximum, minimum, and average seeds per ear in each block is shown in Figure

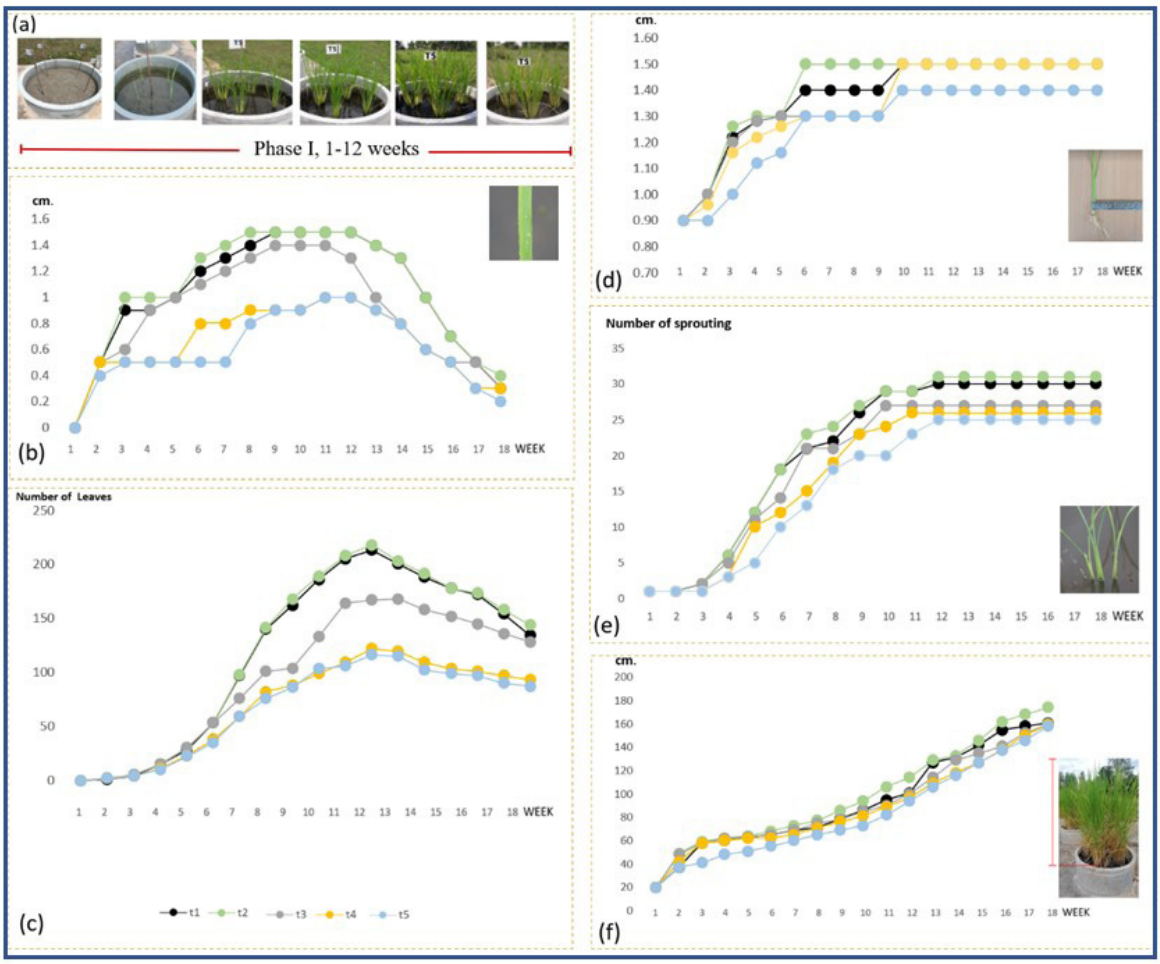

Figure 5: The stem and leaves measurement. (a) The picture of rice growth at 1-12 weeks, (b) the leaf size, (c) the number of leaves, (d) the stem size, (e) the number of sprouting, and (f) the height of rice plants.

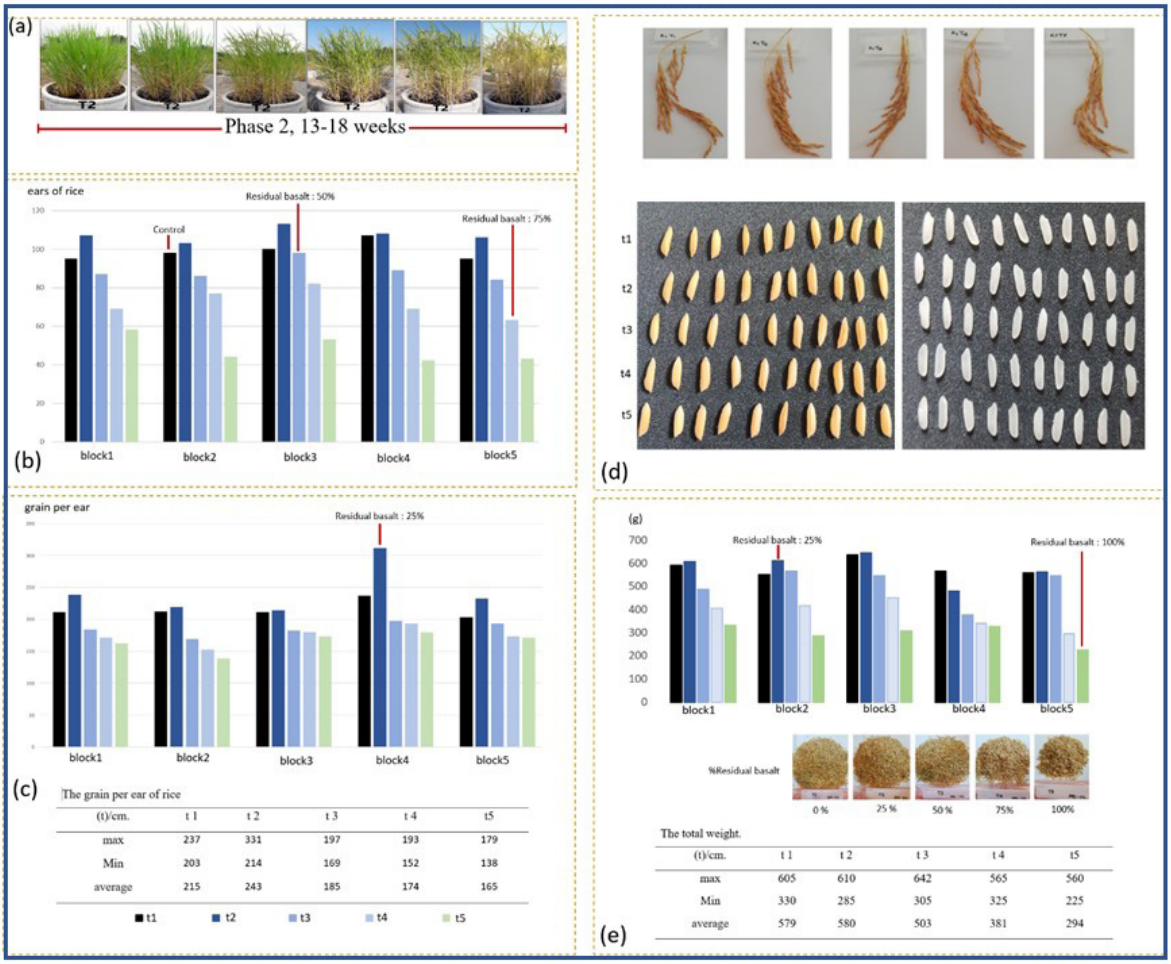

Figure 6: The reproductive stage. (a) The picture of rice growth 13-18 weeks, (b) the number of ears of rice, (c) the number of seeds per ear, (e) the total weight.

6(c). The ears and seeds' visual observations have the same physical characteristics (Figure 6d). However, t2 gives the most extensive total weight, followed by t1, t3, t4, and t5, respectively (Figure 6e).

2AP analysis

Results from analysis of rice aroma (2AP) by HS-GC/MS technique suggest that, in block one, t1 gave the highest aroma, followed by t5, t2, t4, and t3, respectively. In block two, t5 gave the highest aroma, followed by t2, t3, t1, and t4, respectively. In block three, t1 gives the highest aroma, followed by t4, t3, t5, and t2. In block four, t5 gives the highest aroma, followed by t3, t4, t2, and t1, respectively. In block five, t5 give the most aroma, followed by t1, t2, t3, and t4, respectively (Figure 7).

Statistical analysis

The results show that residual basalt significantly affected the height of rice plants, germination, number of ears, number of seeds per ear, and the total yield

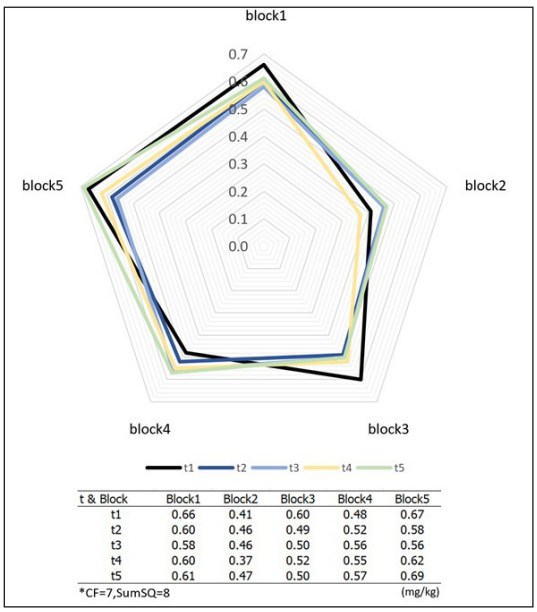

Figure 7: The analysis of aromatic KDML 105 from an experiment.

Table 3: Analysis of variance for growth and yield of KDML105 experiment in the 2022 season.

Parameter/(t)	(t1)	(t2)	(t3)	(t4)	(t5)	Significance
Stem size (cm)	1.5	1.5	1.5	1.5	1.4	-
Leaves size (cm)	1.4	1.4	1.3	1.2	1.0	-
Number of leaves	810	871	719	550	330	* and **
Height (cm)	148	159	145	141	138	* and **
Number of sprouting	30	31	27	26	24	* and **
Number of ears	99	107	89	72	48	* and **
Seeds per ear	215	243	185	174	165	* and **
Total weight yield (g)	579	580	503	381	294	* and **
2AP (mg/kg)	0.56	0.53	0.53	0.53	0.57	-

* and ** - Significant at 0.05 and 0.01 levels, respectively.

weight. The analysis of variance for growth and yield of the KDML 105 experiment in the 2022 season is summarized in Table 3.

CONCLUSIONS AND RECOMMENDATIONS

In this study, based on geological and geochemical analyses, the high potential site of residual basalt in the southern part of the Khorat Plateau is target 2 at the coordination of 302967E, 1655620N. Residual basalt is located behind Huai Rat Sub-district Administrative Organization in the administrative area of Huai Rat Subdistrict, Huai Rat District, Buriram Province. We used residual basalt from this site for a jasmine rice (KDML 105) experiment at a depth of 10-80 cm where soil texture and mineral composition are the most appropriate for agriculture. However, the location of the potential residual basalt, in addition to physical and chemical data, should also be considered together with the other contexts, such as the ease of accessibility of an area, consent, and cooperation from the landowner.

After an experiment of adding basaltic soil to the KDML 105 farm, the growth and yield, coupled with aromatic properties were slightly increased. Adding residual basalt into the original and local soil also shows the increasing number of leaves, height, sprouting, ears, seeds per ear, and total yield weight. However, the leaves' size, the stem's length, and the aromatic of rice are among those of significance. We suggest that mixing residual basalt at 25% in local soil provides the best growth for KDML 105. The yield of the experiment is equal to the average yield for planting with chemical or organic fertilizers, but water is saved by 42 days. With a total cultivation period of 126 days, rice production can reduce water use by 33.33%, and no need for any fertilizers. Our experiment shows that the flooding period of paddy rice fields is shortened, and this leads to reduced methane (CH_4) emission.

We recommend the re-soil technique by adding the residual basalt into local soil which improves the productivity and quality of jasmine rice significantly. Overall, the application of re-soil from this study not only has a positive effect on the growth of KDML 105 but also confirms the easy and environmental friendly ways for rice cultivation to reduce GHG emissions into the environment.

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AUTHORS CONTRIBUTION

WK – conceptualization, experiment design, writing draft manuscript; MC – writing, review and editing.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the effort reported in this paper.

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National Geoscience Conference (NGC) 2023

The National Geoscience Conference (NGC) 2023 was held from 7–8 November 2023 at the Everly Putrajaya, Kuala Lumpur. This is the 36th edition of the annual conference. The post-conference fieldwork was held on 9 November 2023. NGC 2023 was organised by the Geological Society of Malaysia (GSM) and co-organised with the Department of Mineral and Geoscience (JMG) Malaysia and the Institute of Geology Malaysia (IGM). The chairman of the organising committee was P. Geol. Assoc. Prof. Dr. Mohd Hariri Arifin, President of Geological Society of Malaysia (GSM), while the co-chairman was P. Geol. Dr. Abdullah Sulaiman from JMG Malaysia.

The opening ceremony was officiated by Datuk P. Geol. Zamri bin Ramli, Director-General of JMG Malaysia. During the opening, Datuk P. Geol. Zamri bin Ramli launched the MyBahaya Platform, a product of the IDRC Project led by Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM), with GSM as a collaborator. The NGC was attended by 233 participants, including technical committee members, students, academicians, geoscience researchers, and practitioners from various kinds of organisations, including universities, government institutes and departments, the private sector and non–government organisations. A total of 65 participants joined the post-conference fieldwork. In total, there were 4 keynote papers, 48 oral papers, and 19 poster presentations covering various topics such as engineering geology, geophysics, regional geology and tectonics, mining, quarrying, mineral processing, marine geology, geo-environment, hydrogeology as well as energy and basins. Plenary keynotes, oral presentations and posters from the event are presented below.

NGC 2023 - Plenary Keynotes

No.	Speaker	Position	Title
1	P. Geol. Mr. Abd Rahim bin Harun	Timbalan Pengarah, Unit Perancangan Geosains, JMG	*Pelan Pembangunan Geopark Negara 2021-2030 dan Pelan Pelaksanaan Geopark Negara dalam memperkasa ekonomi dan kesejahteraan komuniti setempat*
2	P. Geol. Prof. Dr. Joy Jacqueline Pereira	Professor and Principal Research Fellow of SEADPRI, UKM	Energy transition and climate risks – Catalysing transformation of the geology workforce?
3	P. Geol. Dr. Abdullah bin Sulaiman	Timbalan Ketua Pengarah (Korporat dan Ekonomi Mineral), JMG	*Perlombongan dasar laut dalam di Malaysia: Isu dan cabaran*
4	Dato' Hamzah bin Hussin	Chief Executive Officer, Sustainable Energy Development Authority (SEDA) Malaysia	Geothermal potential under National Energy Transition Roadmap (NETR)

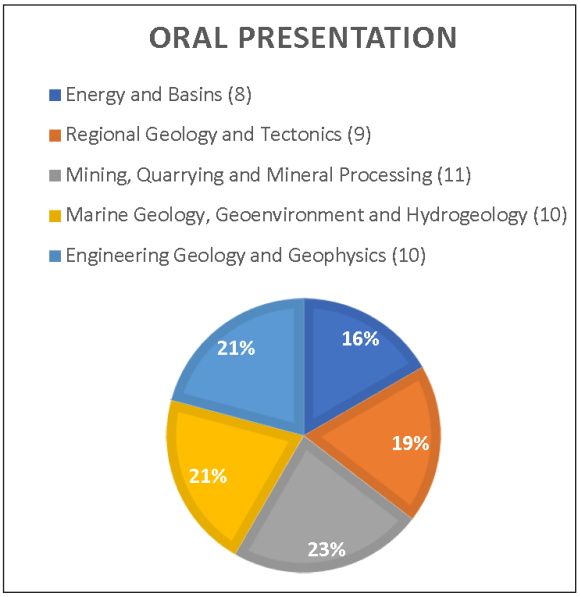
NGC 2023 – IDRC Regional Workshop on Youth Innovation in Disaster Prevention and Climate Science

In conjunction with NGC 2023, SEADPRI-UKM, with support from the Asian Network on Climate Science (ANCST), International Development Research Centre (IDRC) Canada and other partners organised a side session to empower young geoscientists in climate science. The Regional IDRC Workshop: Youth Innovation in Climate Science was held on 7 November 2023. This session focused on engaging geoscientists in the region to not only recognise and investigate hazards but also to facilitate effective liaison and collaboration with various stakeholders. The session started with the introductory remarks by Prof. Dr. Joy Jacqueline Pereira with the title "Promotion of Social Entrepreneurship in Disaster Risk Reduction to Build Community Resilience". This was followed by a keynote address by Prof. Dr. Alfredo Mahar F.A. Lagmay from University of the Philippines – Diliman. After the keynote, five speakers were involved in a panel session. The speakers and their topics are provided below.

No	Name	Organisation	Title
1	Prof. Dr. Alfredo Mahar F.A. Lagmay	National Institute of Geological Sciences, University of the Philippines – Diliman	Keynote Address: Citizen science: The role of the academe in building resilience
2	Mr. Navakanesh M. Batmanathan	SEADPRI UKM	MyBahaya application for building community resilience
3	Ms. Nurul Sri Rahatiningtyas	Universitas Indonesia & U-INSPIRE Indonesia	Leveraging the OpenStreetMap (OSM) project to enhance decision-making processes
4	Prof. Dr. Chhinh Nyda	Royal University of Phnom Penh, Cambodia	Promoting community resilience and social entrepreneurship
5	Ms. Jolly Joyce Sulapas	University of the Philippines- Diliman	Innovative open science for geological hazards
6	Mr. Muhammad Gazali Rachman	University Brunei Darussalam	Land subsidence and it's impacts on coastal flood hazards in Brunei Darussalam

NGC 2023 - Oral Presentations

Oral presentations were given throughout the two-day conference. They cover a wide range of disciplines, including energy and basins, regional geology and tectonics, engineering geology and geophysics, marine geology, geoenvironment and hydrogeology, mining, quarrying, and mineral processing. The oral presentations were evaluated by the chairman of each session, who is an expert in their own discipline. Following is a list of the papers.



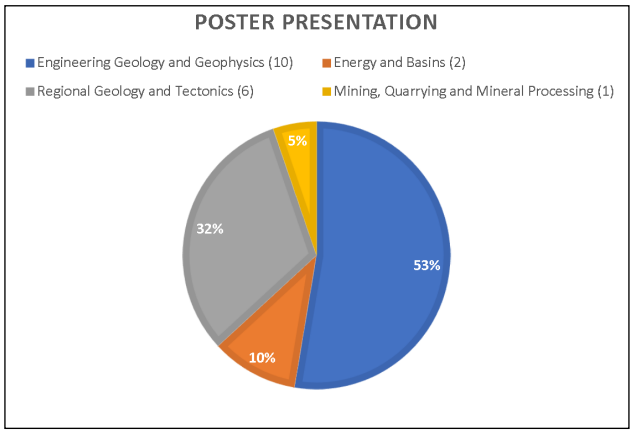
No.	Speaker	Title
1	Shaufi Sokiman	Potentiality of rare earth elements (REE) bearing minerals resource accumulation from river bottom sediments in tropical fluvial systems (Sungai Terengganu)
2	Azman A Ghani	Mineralogical control of REE from weathered granite of I and S type granites in Western Belt Granite, Peninsular Malaysia
3	Siti Zaniza Tohar	REE-ion adsorption clay type deposit characteristics in Kuantan's weathered granite profiles
4	Nadirah Aiyob	Concentration of rare earth elements in granitic soil profile at Hulu Langat
5	Zakaria Endut	Mineralogy and geochemistry of the tin-tungsten deposit in Sintok, Kedah
6	Nur Ainin Sofia Binti Md Yusri	Rare earth elements in weathered granite of Ladang Blue Valley, Cameron Highlands
7	Muhammad Firdaus Abd Halim	Lithofacies and ichnological analysis of the Middle-Late Miocene Sandakan Formation, Northeast Sabah, Malaysia
8	Nor Syazwani Zainal Abidin	Coal facies and depositional environment of the Pliocene - Pleistocene age, Balingian Coal, Sarawak, Malaysia
9	Mohd Hariri Arifin	Cadangan penyediaan garis panduan bagi pembangunan sumber geoterma di Malaysia
10	Sanatul Salwa Hasan	The application of bioevent for refine stratigraphic correlation: An example for X Field, West Baram Delta, Sarawak, Malaysia
11	Nurul Nadiah binti Misman	Coral reef classification using drone screening in Teluk Segadas, Pulau Pangkor
12	Marilah Sarman	Penentuan geotrail berpotensi secara bersistem dengan menggunakan geotapak-geotapak di Gombak untuk aktiviti geopelancongan
13	Kee Soo Chen	Sub-surface mapping at the underwater archaeological site of the national heritage zone of the Bidong shipwreck
14	Khairunnisa Alias	Water balance study in Paya Indah Wetlands and the effect of groundwater abstraction to its hydrological system
15	Habibah Jamil	Kesan gas rumah hijau (karbon dioksida) terhadap pengumpulan kadmium dalam pokok padi di tanah sawah tercemar

16	Vishnuvartini Rasaya	REE study in granitic soil of I-type Semenyih Granite, Kuala Kelawang, Negeri Sembilan
17	Mohamad Haziq Bin Shafee	Sumber batuan silika di Gua Musang, Kelantan
18	Noran Nabilla Nor Azlan	Prospektif sumber bahan binaan agregat di Bukit Batu Hangus, Jelebu, Negeri Sembilan
19	Catrina Ng	Solving the rare earth and other element challenges using a multi-quadrupole ICP-MS
20	Mohamad Yusof bin Kamaruzzaman	Platinum group mineral identification in river sediments along the tributaries of Sungai Kapuakan, Ranau
21	Riyan Subekti	Assessment of infiltration rate on flooded areas in Shah Alam, Selangor
22	Meor Hakif Amir Hassan	What is the Kubang Pasu Formation? A re-examination of its stratigraphy and proposal to upgrade to group status
23	Zaidulkhair Bin Jasmi	Prediction of groundwater pathway and optimization of well placement approaches: Insights from 3D groundwater modeling and management at NR-REE mining sites
24	Mohd Khairul Nizar Shamsuddin	Understanding the impacts of groundwater abstraction at Olak Lempit, Selangor
25	Zahidi bin Hamzah	Saltwater intrusion and the resilience of groundwater coastal aquifers of North Kelantan: Sungai Pengkalan Datu case study
26	Dr. Mark Tingay	Mythbusting: Did Pulau Tiga first appear in 1897?
27	Nurul Fatin Izzatie binti Salman	Karst geomorphology analysis for geohazard assessment via the application of seismic relief and dip attributes in a carbonate platform: JX Field, Central Luconia Province, Malaysia
28	Ong Poh Yee	Fracture and karst delineation using core samples in Central Luconia Province, Sarawak
29	Nurjulia Batrisyia Mohd Jailam Jeganathan	Conventional mapping technique for subsurface karst and its associated risks
30	Muhammad Ashahadi Dzulkafli	Fosil Radiolaria berusia Perm Awal (*Artinskian* dan *Kungurian*) daripada singkapan Jalan Ladang Tenang, Pos Blau, Gua Musang barat daya Kelantan
31	Nasim Javid	Cleavage analysis of deformation events in the Manki Slates of the Attock-Cherat Ranges, Pakistan
32	Nurul Syafiyya Muhamad Sukri	Geologi am dan petrologi batu laterit di Kota Supai, Alor Gajah, Melaka
33	Choong Chee Meng	Batu Arang Basin revisited and its proposed development
34	Muhammad Afiq Md Ali	Control of the lower crustal flow on deformation localization during crustal extension
35	Muhamad Zaidi Bin Zainudin	Geologi am dan petrologi igneus di Tanjung Bidara, Melaka
36	Tan Yan Eng	Structural analysis using 3D digital outcrop model: A case study in Kebun 500 outcrop, Kedah, Peninsular Malaysia
37	Mohd Rozi Umor	The petrography and geochemistry of granitic rocks from Gebeng Quarry and its tectonic implication on the evolution of Peninsular Malaysia
38	Muhammad Fuad Razali	Remote sensing and field analysis of the Bentong-Raub Suture Zone
39	Azlan Shah Nerwan Shah	Pencirian sifat fiziko-kimia dan kebolehakisan tanah terserak tropika berdasarkan mekanisme hakisan dalaman di kawasan tanah runtuh
40	Muhammad Azman Aseri	Evaluation on the stability of slope at Taman Bukit Kuchai, Puchong, Malaysia

41	Nor Shahidah Mohd Nazer	Penentuan satah gelinciran tanah runtuh menggunakan teknik pengukuran lapangan
42	Muhammad Bin Abdullah	Sinkhole susceptibility mapping at Kinta Valley, Perak using frequency ratio (FR) method and analytical hierarchy process (AHP) method
43	Haryati Awang	Rock mass classifications evaluation of granite slopes from Lanchang - Karak, Malaysia
44	Mohd Mustaqim Mohd Nordin	Application of 3D X-ray micro-computed tomography on rock material for internal structure characterizations: A case study on Setiu Conglomerate
45	Nur Anati Azmi	Non-kinematic investigation of rock strength from Gombak to Gambang: Implications for slope stability
46	Joey Lim	Local site effect evaluation of Kenyir Region through horizontal-to-vertical spectral ratio (HVSR) analysis
47	Abd Rasid Jaapar	Geological impact assessment as one of the products by professional geologists in Malaysia – The conceptual framework
48	Abdull Halim Abdul	Prediction of CPT geotechnical properties and surface settlement caused by earth strain using 2D SSPT geo modelling system

NGC 2023 - Posters Presentations

A total of 19 abstracts were selected for the poster presentations. The poster presentations were allocated 10 minutes each, including the Q&A sessions. They were evaluated by representatives from UM, UMK and UKM. Below is the list of the papers.



No.	Speaker	Title
1	Ismail Abdul Rahim	Slope stability assessment by kinematic and kinetic approach on poor outcrops: A case study along Nabalu– Ranau Road, Sabah, Malaysia
2	Mohd Farizwan Mohd Saibi	Survei geofizik kaedah keberintangan 2 dimensi bagi kerja – kerja pengesanan kubur di atas Lot 14801, Wilayah Kuala Punti, Mukim Hulu Kinta, Perak
3	Hamzah Hussin	Landslide inventory: Enhancing hazard mitigation and management
4	Ahmad Faiz Salmanfarsi	Comparison of discontinuity mapping from unmanned aerial vehicle, terrestrial laser scanning, and scanline: Case study from Lanchang-Karak, Malaysia

5	Muhammad Zaharul Asyraf Zaharin	Penentuan zon merah operasi mencari dan menyelamat di bawah Arahan No.20 Majlis Keselamatan Negara berkaitan pengurusan bencana tanah runtuh
6	Arindam Chakraborty	Fossil algal research in Malaysia: Tunnel to past environment
7	Muhammad Afiq Md Ali	Reef facies distribution of Soyak Island and Salang Bay, Tioman Island, Pahang
8	Nurdayana Batrisyia binti Nasrah	Surface investigation of the relationship between magnetic susceptibility and heavy metal contamination of Minna Soil, Niger State, Nigeria
9	Muhammad 'Ammar bin Ahmad Dahisam	Resistivity and seismic refraction cross-gradient joint inversion: Application for near surface characterization and qualitative comparison with rock samples analysis
10	Ain Nabilah binti Zamri	Minerals and subsurface structural mapping using integration of 2D resistivity, induced polarization, petrography and XRD analysis
11	Jivan A/L Gunasegaran	Geophysical characterization of sedimentary rocks for different facies
12	Intan Nur Dania Asrul Amir	A study on the grain size and heavy mineral distributions of fluvial sediments in Sungai Dungun, Terengganu
13	Muhammad Ramzanee Mohd Noh	Pengenalpastian potensi sesar aktif di Daerah Gombak, Selangor
14	Thomson Galin	Active fault studies in the Niah Area, Sarawak, Malaysia
15	Isaac Abraham	General geology of Bongaya Formation, Jambongan Island, Beluran, Sabah
16	Hikmat Salam	Geochemical characterization of ophiolitic basalts and isotropic gabbros in Waziristan Ophiolite, NW Pakistan: Implication for tectonic setting
17	Harry Telajang Linang	Crustal structure and tectonics of Borneo and Sulawesi
18	Ahmad Aqil bin Effendi	Geologi am dan petrologi batuan igneus di Pengkalan Balak, Melaka
19	Nurul Neeta Syafika Muhammad Zaki	Hybrid seismic noise delineation method of distributed acoustic sensing (DAS) data

NGC 2023 - Exhibitors

There were 11 exhibitors from various industries that cover mining, marine exploration, oil and gas etc. Each of the exhibitors promoted their specialities and expertise in their own industry. Below is the list of exhibitors for NGC 2023.

1 Beicip-Franlab Asia
2 KSSB Consult Sdn Bhd
3 Geothermal Resources Sdn Bhd
4 UKMShape
5 Orogenic Resources Sdn Bhd
6 Board of Geologists (BOG) Malaysia
7 Jabatan Mineral dan Geosains (JMG) Malaysia
8 Perkin Elmer Malaysia
9 Hydrokinetik Group Sdn Bhd
10 Syarikat E.J. Motiwalla
11 MCRE Resources Sdn Bhd

On 9 November 2023, we had post-conference fieldwork in four different localities. A total of 65 participants, including the committee members, participated in this fieldwork.

1 Tapak Tanah Runtuh, Taman Bukit Permai, Cheras
2 Komuniti Sedar Bencana Geologi, Bukit Antarabangsa
3 Batu Arang Geosite, Gombak- Hulu Langat Geopark (GHLGp)
4 KSSB Sand Mining, Bestari Jaya, Kuala Selangor

The event ended with an official closing ceremony by the co-chairman of NGC 2023, P. Geol. Dr. Abdullah bin Sulaiman, Timbalan Ketua Pengarah (Korporat dan Ekonomi Mineral), JMG. During the closing ceremony, gimmick handover of the hammer was made by GSM President to the next organiser of NGC 2024, Assoc. Prof. Dr. Meor Hakif Amir Hassan.

As a conclusion, the organising committee would like to thank all conference and fieldwork sponsors, including Beicip-Franlab Asia, KSSB Consult, Rahman Hydraulic Tin (RHT) Sdn. Bhd., GoGeo Engineering (M) Sdn. Bhd., and Progeo Consult. We are also thankful to JMG and IGM for their cooperation and support in making this event successful.

Official opening ceremony by Datuk P. Geol. Zamri bin Ramli, Director-General, Department of Mineral and Geoscience Malaysia (JMG).

Participants at the opening ceremony.

The VIPs during the official opening ceremony.

Launching ceremony of MyBahaya Platform.

Plenary keynote by P. Geol. Mr. Abd Rahim bin Harun, P. Geol. Prof. Dr. Joy Jacqueline Pereira, P. Geol. Dr. Abdullah bin Sulaiman and Dato' Hamzah bin Hussin.

Gimmick handover of hammer by GSM to the next organiser of NGC 2024.

Booth visits by the Director- General of JMG, Datuk P. Geol. Zamri bin Ramli.

Oral presentation by the speakers.

Post-conference fieldwork.

Prepared by,
Nazatul Athirah binti Abdul Khalil
Geological Society of Malaysia
13th December 2023

CERAMAH TEKNIK TECHNICAL TALK

Over-the-horizon shallow geophysical surveying from home - An experience sharing

Sr. Safaruddin Kamaruddin
THS Geoscience Sdn. Bhd.
Date: 10 August 2023
Platform: Zoom and FB Live

In November 2020, during the COVID pandemic, I gave an on-line presentation on the subject of conducting hydrographic surveys from home. This was a time when working from home was a new experience to all of us. Since then, we have been able to expand our activities to include bathymetry, the mapping of natural and manmade debris and shallow geology, all conducted from home. In the following three years, THS Geoscience has been able to participate in over-the-horizon XOCEAN's USV and remote data processing from home.

This presentation is about that experience.

Prepared by,
Dr Abdull Halim bin Abdul
Chairperson, Working Group Offshore Hazard
12th August 2023

CERAMAH TEKNIK TECHNICAL TALK

Crustal structure and tectonics of Borneo and Sulawesi

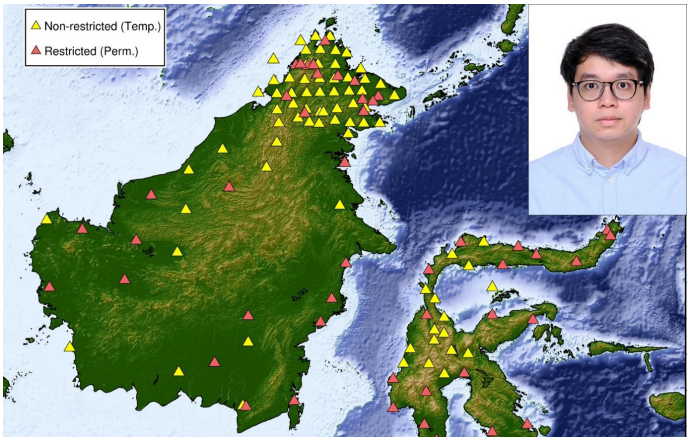
Harry Telajan Anak Linang
Universiti Malaya
Date: 18 August 2023
Platform: Zoom

The above talk was delivered by Dr. Harry Telajan Anak Linang (UM) on 18th August, 2023 via Zoom. Some 71 members participated. An abstract of the talk is given below:

Abstract: Southeast Asia (SEA) is arguably the most tectonically active region on the planet, fuelled to a large extent by nearly 10,000 km of ongoing subduction on its western, southern and eastern flanks that accommodates the northward motion of the Indo-Australian plate and westward motion of the Philippine Sea plate. It has hosted one of the largest earthquakes ever recorded (Mw 9.2 Sumatra-Andaman earthquake in 2004) and perhaps the most famous volcanic eruption in history (Krakatoa eruption of 1883), which profoundly affected the Earth's climate. While the western Pacific margin and Indonesian archipelago along the Sunda and Banda arcs have been well studied, the same is not true of the interior region of Southeast Asia, which includes Borneo and Sulawesi. Borneo is the 3rd largest island in the world and lies on the eastern margin of Sundaland, the continental core of Southeast Asia, but its intraplate setting means that it has no active volcanoes and little in the way of seismicity. By contrast, the adjacent island of Sulawesi features active subduction and a network of continental transform faults that give rise to high levels of earthquake activity. How this central region of southeast Asia was formed, and the tectonic relationship between Borneo and Sulawesi, is still poorly understood.

In this study, the Receiver Function Analysis (RFA) and the Virtual Deep Seismic Sounding (VDSS) were applied to data from 135 seismic stations across Borneo and Sulawesi, with the aim of obtaining reliable crustal thickness estimates; to determine whether a major difference in lithospheric structure between the two islands exists. Results in this study show that the crust in Sulawesi is much more complex than that of Borneo. The crustal thickness gradually changes throughout Borneo with northern Borneo (Sabah) having an overall thicker crust than other parts of the island. In Sulawesi, the crustal thickness is much more varied across small distances, especially along the northern and southern arms of the island.

We thank Sdr Harry for his support and contribution to the Society's activities.



Prepared by,
Meor Hakif Amir Hassan
Chairman, Working Group on Regional Geology and Stratigraphy
13th December 2023

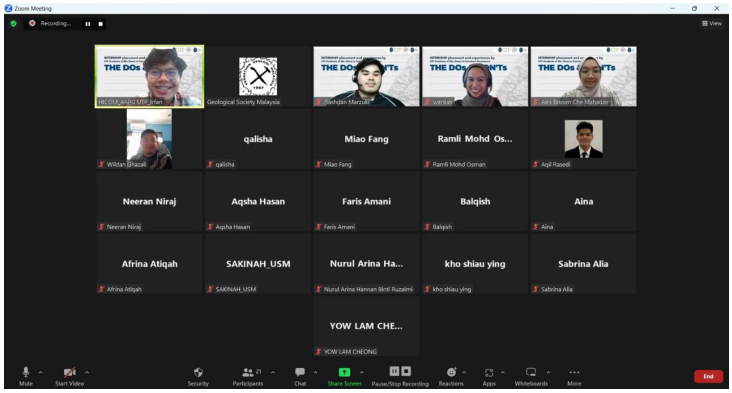
CERAMAH TEKNIK TECHNICAL TALK

Internship, the dos and don'ts

Amirah Wardah Binti Mohd Azmir
Mohamad Rashdan Bin Marzuki
Aini Tasnim Binti Che Mahadzir
Date: 21 August 2023
Platform: Zoom

A technical talk by UTP alumni who had just graduated and were newly employed was conducted on 21st August 2023. This talk was co-organized by the Geophysics Working Group in the Geological Society of Malaysia (GSM) together with the UTP Alumni Office. The objective of this talk was to expose geoscience students from universities in Malaysia on the experience of undergoing internships and the real experience working full time. The three UTP alumni who gave presentations were Amirah Wardah Binti Mohd Azmir, Mohamad Rashdan Bin Marzuki. and Aini Tasnim Binti Che Mahadzir. The session was chaired by Muhammad Irfan Jusmila, from AAPG Student Chapter of UTP. The talk focused on the internship experience and placement, which focused on the dos and don'ts related to the internship. This talk aimed to give perspectives from the alumni who were just entering the industry as permanent employees to geosciences students, especially those about to go for internship.

The talk started at 2:00 p.m. with welcoming remarks and the moderator's introduction to the topic and speakers. The discussion was very interesting as the speakers had different backgrounds and experiences while working and during their Final Year Projects (FYP). Varied answers and points of view were given as each speaker had different perspectives and experiences individually during the internship, final year and working life. Also discussed was whether we should choose the industry that was related to the topic/focus we wanted to pursue for the Final Year Project and working life, or try different and new things. This allowed the graduates to either choose to focus/have a certain niche/expertise or have additional knowledge for them to be more marketable. This talk also discussed the challenges and provided tips to overcome certain difficulties during the internship. Using LinkedIn was also among the topics discussed as it gives an overview of an individual's soft skills and social skills while acting as a second resume and a professional profile for the purposes of promoting oneself. This talk was important for Geoscience students as an overview of internship and working life later. The talk then ended with a Q&A session.



Prepared by,
Dr. Siti Nur Fathiyah Jamaludin
Chairman, Geophysics Working Group
23rd August 2023

CERAMAH TEKNIK TECHNICAL TALK

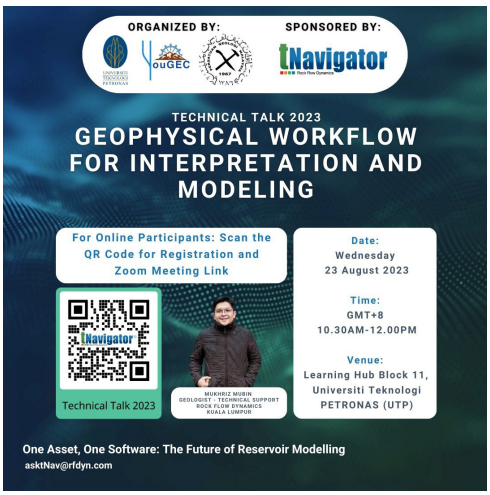
Geophysical workflow for interpretation and modeling

Mukhriz bin Mubin
Rock Flow Dynamics
Date: 23 August 2023
Venue and platform: UTP and Zoom

On 23rd August 2023, the Geological Society of Malaysia, in collaboration with Universiti Teknologi PETRONAS (UTP) and Rock Flow Dynamics (RFD) under their Navigator flagship program, presented a technical talk titled "Geophysical Workflow for Interpretation and Modeling". This talk was organized under the Geophysics Working Group in GSM. The talk was delivered by Mr. Mukhriz bin Mubin, Geologist-Technical Support at Rock Flow Dynamics. The talk was conducted in hybrid mode with the physical event taking place in UTP in conjunction with the UTP Young Geo-Explorer Challenge.

Out of 57 participants, 20 attended the talk physically at UTP and 37 participants attended virtually. The participants who attended the event physically consists of YouGec participants including students and advisors from Universiti Kebangsaan Malaysia (UKM), Universiti Malaysia Kelantan (UMK) and UTP from Malaysia, as well as Universitas Brawijaya and Institut Teknologi Bandung (ITB) from Indonesia. Mr. Mukhriz had engaged very well with the participants both virtually and physically. He started his talk by asking relevant questions related to the need of performing geophysical analysis for geological purposes. This had sparked the interest of many participants to stay focused until the end of the talk.

At the end of the talk, the participants had asked several questions related to correlating geological features through utilization of geophysical software and the assumptions that are needed to do this. Mr Mukhriz, along with the chairperson, Dr. Siti Nur Fathiyah Jamaludin used several analogues to ensure that the participants were able to grasp the concept and importance of using both geological and geophysical aspects in the interpretation of geological data.



Poster for the talk

The participants of YouGec with Mr. Mukhriz Mubin (center) after the talk

Prepared by,
Dr. Siti Nur Fathiyah Jamaludin
Chairman, Geophysics Working Group
23rd August 2023

CERAMAH TEKNIK TECHNICAL TALK

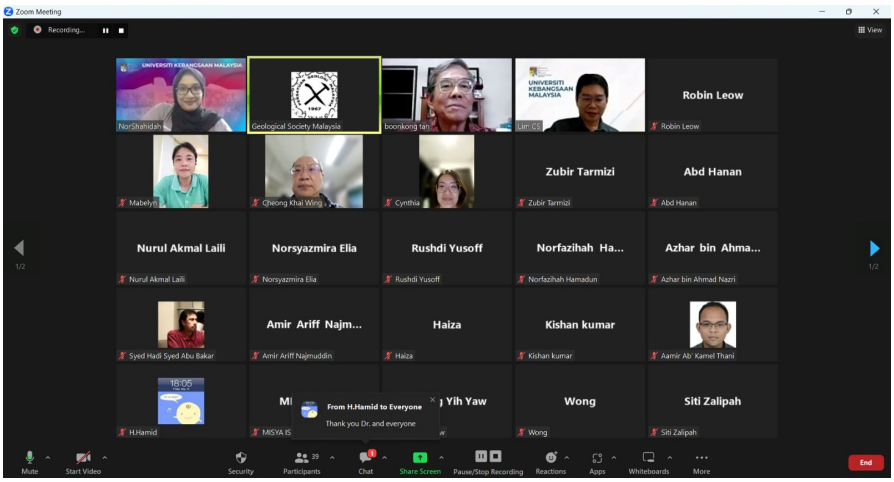
Field identification of clay minerals based on desiccated crack morphological pattern

Nor Shahidah Mohd Nazer
Universiti Kebangsaan Malaysia
Date: 13 September 2023
Platform: Zoom

The above talk was delivered by P.Geol. Dr. Nor Shahidah Mohd Nazer (UKM) on 13th September, 2023 via Zoom. Some 60 members participated. An abstract of the talk is given below:

Abstract: Clay is a common constituent of soils and controls the engineering behaviour of soils with the presence of water. Clay particles are much smaller compared to silt and sand and cannot be identified in situ by conventional optical or physical methods. Therefore, a novel qualitative method based on the concept of the ternary diagram and relying on the morphological crack pattern of dried soil under dry conditions was proposed. Kaolinite-, illite-, vermiculite- and montmorillonite-rich soils were used for the simulation, sieved to 0.075 mm and first mixed with distilled water with double liquid limit to form slurry mixtures. The mixtures were then placed in a petri dish and air dried at controlled room temperature for 1 week. The results showed that all the soils formed quadrangular to pentagonal crack patterns with angular to subangular intersection (60° - 90°). Kaolinite-rich soils and illite-rich soils show a more angular polygonal pattern with smooth, linear sides, while montmorillonite-rich soils show a more subangular pattern with wavy, undulating sides. All 3 clay soils had a high number of crack segments, with illite having the highest number, followed by kaolinite and montmorillonite-rich soil. Vermiculite-rich soils have less significant polygon patterns due to the low number of crack segments. Regular crack patterns are more pronounced in clay minerals with low to medium plasticity (kaolinite and illite) than in clay minerals with high plasticity (montmorillonite and vermiculite). It can be deduced that the soils show different morphological patterns for different clay minerals and can therefore be used to identify the type of clay minerals present in each soil. This allows for practical and rapid identification of clay minerals without the use of robust and advance technology in the laboratory.

We thank Sdri Shahidah for her support and contribution to the Society's activities.



Prepared by,
Tan Boon Kong
Chairman, Working Group on Engineering Geology
14th September 2023

CERAMAH TEKNIK TECHNICAL TALK

Foundation challenges at geological interface zone

Chow Chee Meng
G&P Sdn. Bhd.
Date: 11 October 2023
Platform: Zoom

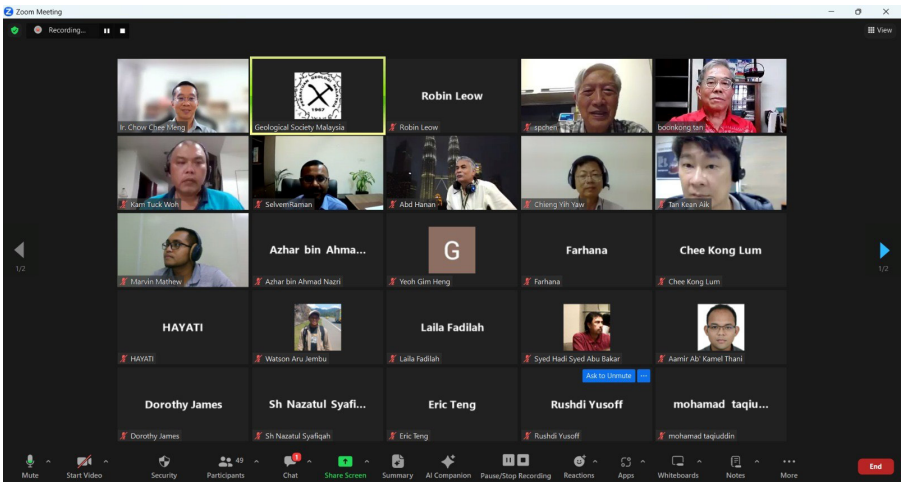
The above talk was delivered by Ir Chow Chee Meng (G&P) on 11th October, 2023 via Zoom. Some 70 members participated. An abstract of the talk is given below:

Abstract: Geological interface zone is known to be highly complex and heterogeneous where proper planning of subsurface investigations (SI) and selection of appropriate foundation system are very important to ensure safety and construction at site can progress smoothly. Challenges associated with foundation works in such interface zone have been reported previously, e.g. Mitchell (1985) in the construction for a 30-storey hotel in Kuala Lumpur on karstic limestone formation at the boundary of the Kenny Hill Formation and a granitic intrusion.

In this talk, two case histories of foundation works at geological interface zone will be shared. In the first case history, foundation challenges for a high-rise development of up to 46-storeys located at Granite-Limestone interface zone will be presented. The foundation system for the building comprises bored piles socketed into Granite bedrock. The geological conditions at the interface zone are very complicated where there are limestone floaters above the Granite bedrock. In addition, other types of rocks such as breccia, pyrite and skarn are also encountered at the interface zone which further complicates the foundation design. Results of instrumented test piles carried out at site and construction challenges will be discussed.

In the second case history, a mixed development on a 9-acres site at Kenny Hill-Granite interface zone will be presented. The foundation system for the building of up to 59-storeys high comprises of bored piles socketed into Granite bedrock and bored piles designed to a pre-determined length at the Kenny Hill side of the site. In both case histories, the importance of SI will be discussed where adequate subsurface information especially at the interface zone is crucial during design such that the design caters for the complex and heterogeneous ground conditions at the interface zone and enables construction works to progress smoothly with minimal interruptions and delays.

We thank Sdr Chow for his support and contribution to the Society's activities.



Prepared by,
Tan Boon Kong
Chairman, Working Group on Engineering Geology
12th October 2023

CERAMAH TEKNIK TECHNICAL TALK

3D multiphysics technology for accurate geothermal resource exploration

Max A. Meju
Geomaxo Ltd.
Date: 25 October 2023
Platform: Zoom and FB Live

1) Virtual presentation

The ZOOM and FB live talk on 25th October 2023 was presented by Dr Max A. Meju (founder and Managing Director of Geomaxo Ltd), on invitation from GSM and UKM. It was well attended with participants from Malaysia, Indonesia, USA and Africa. Assoc. Prof. Ts. P.Geol. Dr. Mohd Hariri Arifin (UKM), President of GSM, introduced the speaker and moderated the 2-hour (4-6 pm) session. The speaker began by explaining the reasons for the rapidly emerging interest in multiphysics investigation of geothermal energy resource. According to him, easy-to-find oil and gas accumulations no longer exist, and the deepening climatic emergency is driving a global transition to low-carbon energy sources, such as native hydrogen and geothermal reservoirs whose exploration pose very significant challenges. The technical challenges are made more difficult by the fact that individual geophysical methods on their own provide non-unique models of subsurface property and fluid-type present. However, integrating them together with geological models maximizes accuracy, minimizes uncertainty in a SHARED EARTH model, and leads to a consistent prognosis for the sought resource system. This is the basis of Multiphysics imaging. Multiphysics imaging technology combines different data types to improve subsurface exploration and monitoring and is emerging as the central tool for unlocking **geothermal resources**. He stressed that the methodological advancements in 3D/4D Multiphysics imaging and novel integrated investigative workflows (e.g. Meju, M.A. & Saleh, A.S., 2023. *Minerals* 2023, 13, 745. https://doi.org/10.3390/min13060745) provide a way for improved resource mapping and monitoring and, hence, a technology that could play a critical role in helping the world reach **net-zero CO_2 emissions by 2050**.

The 2-hour lecture introduced the attendees to the state-of-the art practice of multiphysics integration in geothermal energy industry and equipped them with the basic tools to drive applications in other fields of geoscience. The lecture consisted of two parts. **Part 1: Introduction to Multiphysics subsurface imaging technologies** focusing on the effective combination of seismic, electromagnetic, gravity, magnetic and geological measurements to improve accuracy, reduce interpretational uncertainty and create value (Figure 1). Part 2: **Crossgradient Multiphysics imaging for accurate geothermal (and geologic hydrogen) exploration and development**. He explained how to solve Multiphysics imaging problems using the crossgradient multiphysics data fusion technology that he co-invented (Figure 2) and practical applications in geothermal fields in Indonesia (Figure 3), Kenya, China and Brazil.

It was a highly interactive lecture, and the attendees were excited and continued to discuss with the presenter long after the official 6 pm stop and the recording was stopped at 6.30 pm. It was quite clear from the lively discussions that the attendees benefitted from the talk in terms of understanding what is meant by Multiphysics imaging or integration, the physico-chemical linkages used for resolving imaging challenges faced in subsurface investigations for geothermal resources, how/why geophysical models can be integrated to reduce uncertainty, why/how Multiphysics methods are used for geothermal reservoir exploration and production monitoring, and importantly the energy transition challenges on the road to **Net-Zero emissions by 2050**.

The video of the talk and discussions can be assessed at GSM Facebook page.
Link: https://us02web.zoom.us/j/86972943537?pwd=QXdoTEFmM0lCRk9aUlJZWGFIVWljdz09
Meeting ID: 869 7294 3537
Passcode: 907532

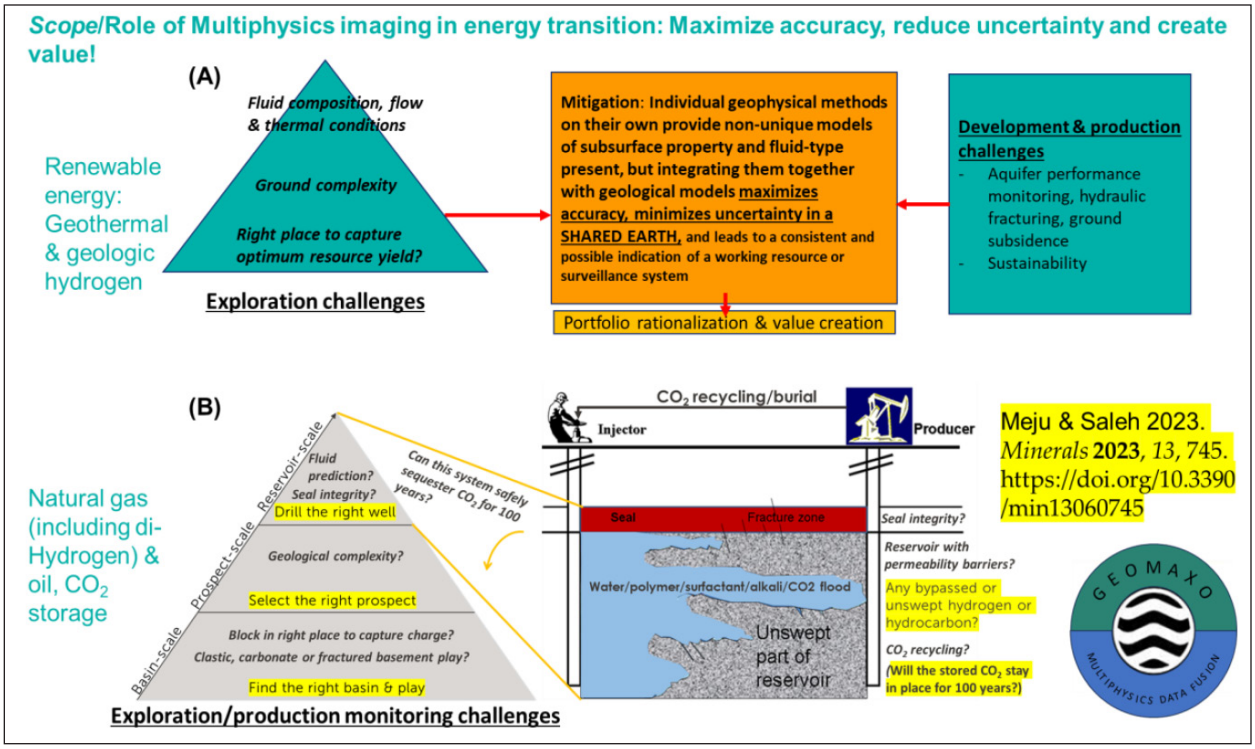


Figure 1: Scope of Multiphysics imaging in energy transition: Maximize accuracy, reduce uncertainty and create value! (A) Challenges in geothermal and geologic hydrogen exploration. (B) Challenges in natural gas (including di-Hydrogen) and oil reservoir surveillance, and CO_2 recycling and storage to reduce carbon footprint (after Meju & Saleh, 2023).

2) Crossgradient Joint Inversion technology for accurate resource evaluation

The deepening climatic emergency is driving a global transition to low-carbon energy sources, such as geologic hydrogen and geothermal reservoirs whose exploration pose very significant challenges. It is now necessary to quantitatively integrate various geophysical, geological and environmental modelling tools to increase accuracy and hence reduce uncertainty in subsurface predictions. In realistic practical operations, such a quantitative integration is best achieved using the crossgradient method invented by Gallardo & Meju (2003) and demonstrated in Figures 2 and 3.

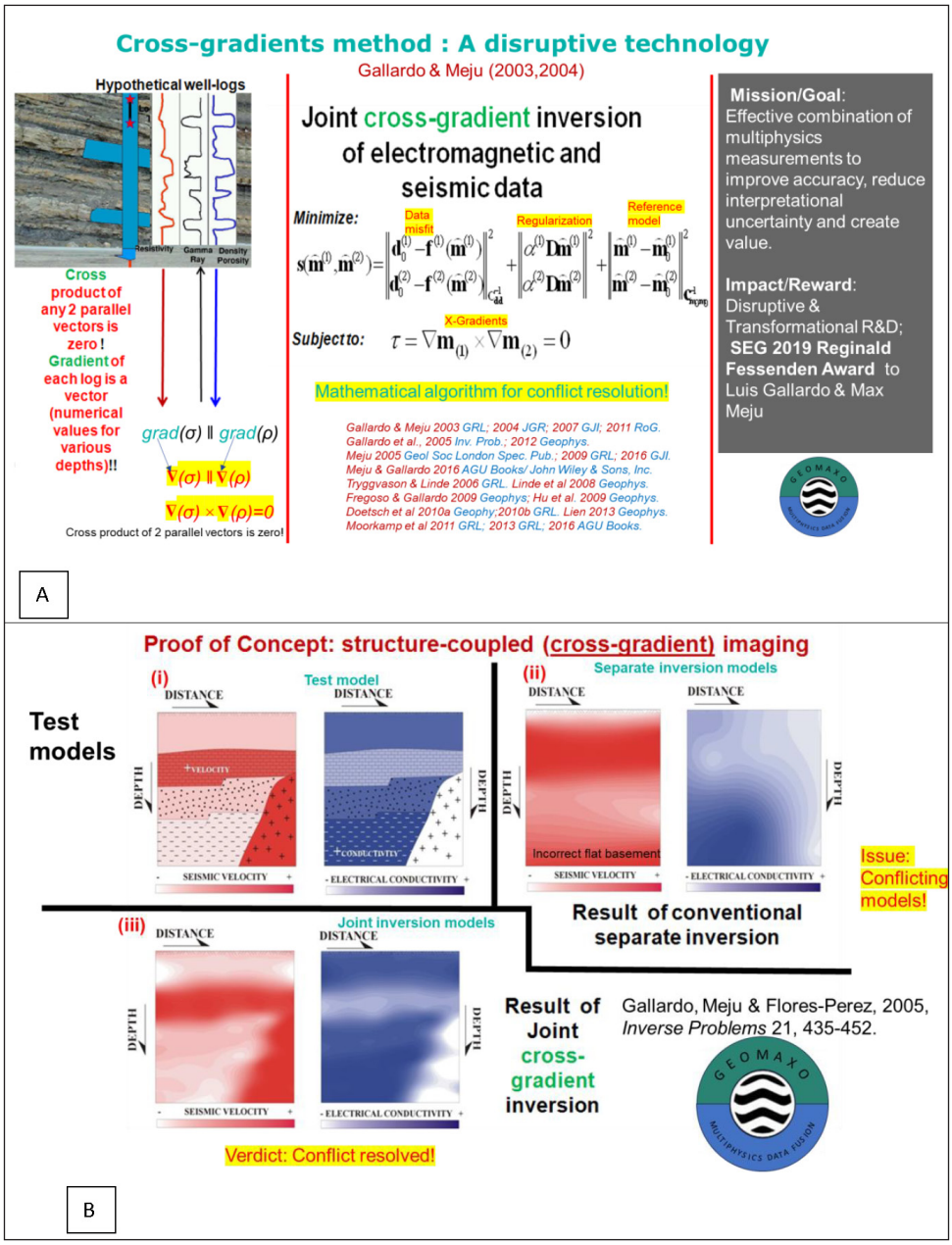


Figure 2: Crossgradient Multiphysics imaging technology to maximize accuracy and reduce uncertainty in decision-making with subsurface models. (A) Concept and mathematical algorithm. (B) Proof-of-concept using synthetic data. (i) Adopted geological test model; (ii) results of separate seismic refraction inversion and dc resistivity inversion; (iii) result of crossgradient joint inversion of seismic refraction and dc resistivity data.

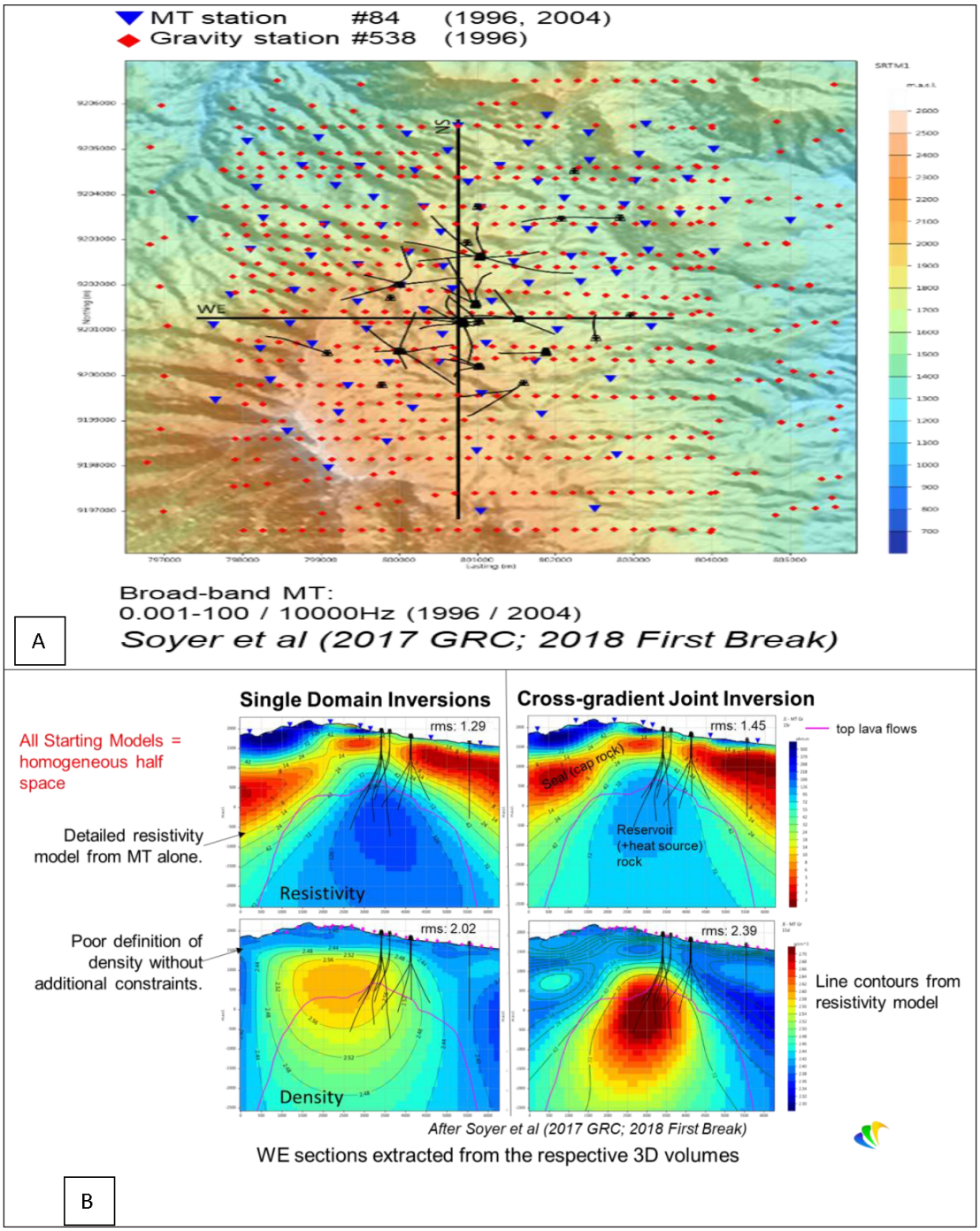


Figure 3: Application of crossgradient Multiphysics imaging technology to maximize accuracy and reduce uncertainty in subsurface models at the **Darajat geothermal field, West Java, Indonesia** (Soyer *et al*., 2018, First Break). (A) Geophysical survey layout. MT and gravity stations are shown. (B) Results from separate (single-domain) 3D inversions of MT and gravity data (left panels) compared to the result of crossgradient joint 3D inversion of MT and gravity data (right panels). The individual (single domain) MT and gravity models show different structure; there is poor definition of density without additional constraints. Crossgradient joint inversion forces them to be geologically consistent and more reliable.

Prepared by,
Dr. Max A. Meju
Founder & Managing Director, Geomaxo Ltd.
28th November 2023

CERAMAH TEKNIK TECHNICAL TALK

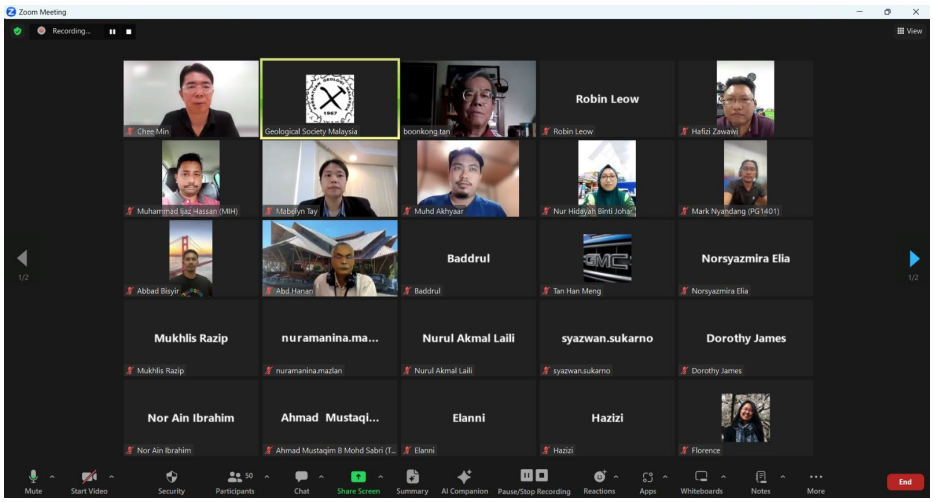
Geotechnical challenges in geologically complex urban underground construction

Khoo Chee Min
MRTC Sdn. Bhd.
Date: 15 November 2023
Platform: Zoom

The above talk was delivered by Ir Khoo Chee Min (MRTC) on 15th November, 2023 via Zoom. Some 90 members participated. An abstract of the talk is given below:

Abstract: Like all other metro underground stations/tunnels designed as part of the urban city, the Klang Valley Mass Rapid Transit (KVMRT) underground constructions face technical (complex geology, engineering design and construction) and social (environmental and land related) challenges. Needless to say, underground construction in Klang Valley is intensified with the inherent geotechnical challenges presented by complex ground conditions ranging from hard granite, heterogenous Kenny Hill formation and extreme karstic limestone with fully developed weathered profiles to soft recent deposits including alluvium and mine tailing that is under-consolidated in places due to past mining activities. The development of this large-scale underground infrastructure project has not only opened up tremendous works and new frontier for tunnelling and geotechnical engineering in Malaysia, but it also provided a wealth of information of unique geotechnical challenges/accomplishments as well as technological breakthrough and design innovation in underground engineering. The presentation will focus on some of the geotechnical challenges and some interesting learning lessons, as well as numbers of innovations embedded into this highly complex urban underground construction project. The use of the advances in engineering geophysics to highlight the areas of potential ground risks will be described with case studies. The knowledge gained, and lessons learned from the KVMRT Line 1 and Line 2 are being effectively transferred to the design and construction of Line 3 which is expected to have even greater technical challenges.

We thank Sdr Khoo for his support and contribution to the Society's activities.



Prepared by,
Tan Boon Kong
Chairman, Working Group on Engineering Geology
16th November 2023

CERAMAH TEKNIK TECHNICAL TALK

How effective are the peer reviews of groundwater models?

Ehsan Kamali Maskooni
Flinders University, Australia
Date: 23 November 2023
Platform: Zoom

Introduction of the speaker:

Mr. Ehsan Kamali Maskooni is a PhD candidate, holding a Master of Science (M.Sc.) degree in Natural Resources Engineering from Shiraz University, Iran. His academic journey led him to an international research experience as a visiting researcher at Lund University, Sweden, for two years. During this period, Ehsan actively contributed to various research projects, honing expertise in the fields of hydrogeology and remote sensing and published his findings in several international journals, which led him to receive a highly competitive scholarship (FIPRS) to continue his education.

Since March 2022, Ehsan is commencing his doctoral research project, titled 'A numerical modelling investigation of mining impacts in the central Galilee Basin (Australia): Conceptual model testing and analysis of threats to an iconic spring complex.' Ehsan's work centres around groundwater modelling, with a specific focus on assessing the environmental implications of coal mining activities on springs, in the Galilee Basin, central Queensland, Australia.

Summary of the webinar:

Around 51 online participants attended the online talk, which is quite encouraging, considering that Malaysia has limited numbers of groundwater practitioner. The talk is aimed to spur the interest of the local groundwater industries, especially the authorities, to look back at previous groundwater reports and maybe re-analyse the reports.

Peer reviews are very important and crucial, in making sure that the earlier reports are accurate and not-biased. Several examples were highlighted by the speaker, and the standout ones probably the case of ADANI Coal Mines, which also caught the attention of international groundwater communities.

In local context, the speaker suggested that maybe LYNAS Pahang case could be a good start for a peer review exercise, as the environmental impact of it will surely be huge.

Throughout the webinar, Prof. Adrian Werner, the Professor of Hydrogeology at Flinders University, also interacts and put out his opinion on several aspect of the talk.

Several specific questions regarding the talk were also answered by both Mr. Ehsan and Prof. Adrian, before the webinar ended at 1.45 pm.

Prepared by,
Adam Hashim
Chairperson, Hydrogeology Working Group
13th December 2023

CERAMAH TEKNIK TECHNICAL TALK

Geotechnical behaviour and interpretation of reconstituted geomaterials for soil-structure applications

Dominic E.L. Ong
Griffith University, Australia
Date: 13 December 2023
Platform: Zoom

The above talk was delivered by Ir Dr Dominic E.L. Ong (Griffith University, Queensland) on 13th December, 2023 via Zoom. Some 50 members participated. An abstract of the talk is given below:

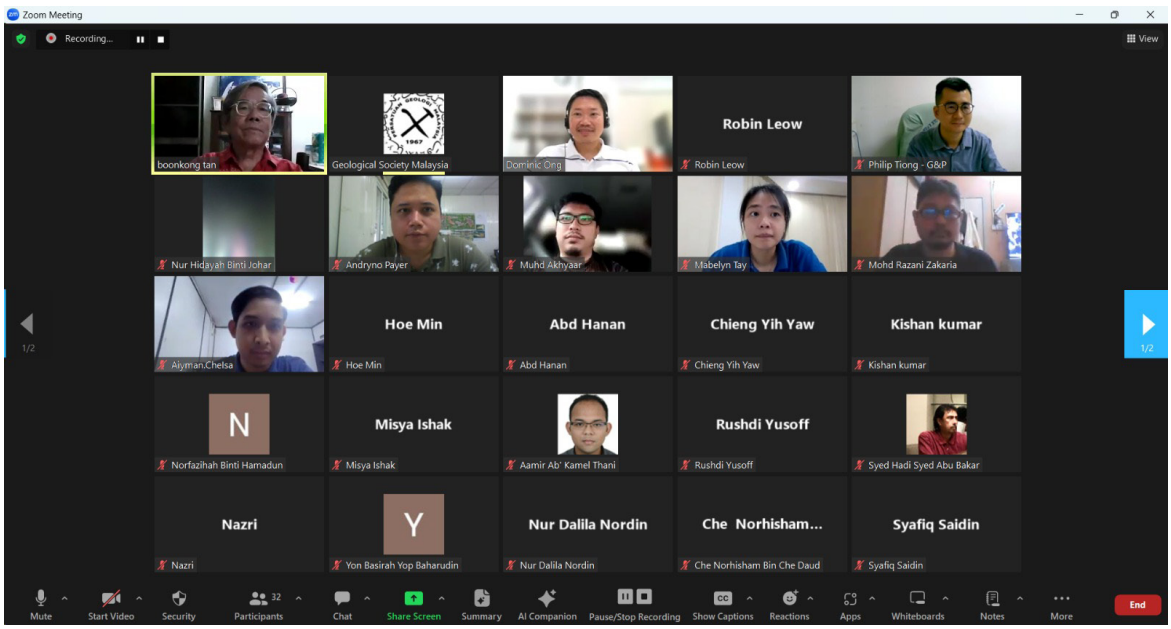
Abstract: This presentation discusses case studies of the performance of micro-tunnelling in weathered geology and floating stone columns in thick, soft clay based on careful characterisation of granular geomaterials interfacing with structural elements during the installation process.

The presentation will detail the methodology proposed, namely (i) direct shear test using reconstituted granular geomaterials followed by interpretation using (ii) Power Law function and (iii) Generalised Tangential Method to derive the equivalent shear strength parameters of the granular materials, capturing the effect of apparent cohesion and dilatancy.

Subsequently, back-analyses are carried out to benchmark the results against field cases studies to demonstrate the reliability of the methods used.

Finally, the fundamental discussion of the geomaterial behaviour is presented with reference to the developed methodology.

We thank Sdr Ong for his support and contribution to the Society's activities.



Prepared by,
Tan Boon Kong
Chairman, Working Group on Engineering Geology
14th December 2023

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Student Membership

1. Aina Syazana Kelana
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3. Akif Darwisy Adam
4. Alya Sofea Ismail
5. Annuar Syamil Abdul Pirus
6. Farisya Syairah Mohd Akashah
7. Farzana Ahmad Faisal
8. Hechley Joel Jaespanis
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11. Jimy Ikmal Mohamad Hisam
12. Mardina Sophia Mokhtar
13. Mei Lisya Malitou
14. Mohamad Fareez Wajdi Yusri Effendi
15. Mohamad Mu'izzuddin Jufri
16. Mohamad Yusof Kamaruzzaman
17. Muhamad Faris Zakwan Mohd Fadhli
18. Muhammad Danish Mohd Aidil
19. Muhammad Faris Abdurrachman
20. Muhammad Firdaus Dhiyauddin Ami-Sharil
21. Muhammad Ikhmal Danial Mohd Tarmizi
22. Muhammad Nabil Halimi
23. Muhammad Umar Aiman Mohd Zamri
24. Najwa Zawani Dhamirah Mohamad Bahtiar
25. Nasiha Athira Shaari
26. Ngai Wan Qi
27. Nik Aiefa Nik Rosdi
28. Noor Fanidah Akadilin
29. Noor Syakinah M Salleh
30. Nur Aina Safia Jelatllah
31. Nur Alia Mohd Daud
32. Nur Ameera Nadia Mohd Ali
33. Nur Anati Azmi
34. Nur Diyanah Suandi
35. Nur Ezzatul Liyana Anuar
36. Nur Irsalina Nadirah Abdul Razak
37. Nur Shafiah Ahmad Nordin
38. Nur Zahida Affrina Zahir
39. Nurfarah Diyana Daud
40. Nurfarah Mat Jaya
41. Nurharisha Alia Abdul Halim
42. Nurul Farhana Muhammad Firdaus Chan
43. Nurul Fatin Izzatie Salman
44. Ong Poh Yee
45. Puteri Erysha Md Zamri
46. Rafiqi Haziq Razali
47. Syed Izzat Hamizan Wan Azman
48. Wakin Wardah Rizal

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2. Jackson Raao Devadas
3. Shukri Zakaria

Full Membership

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2. Ammar Mohammad Anuar
3. Arman Md Yasin
4. Benjamin Mark Bastian
5. Elanni Md Affandi
6. Farhana Mansor
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8. Lau Ai Yun, Jacinta
9. Lim Jen Juen
10. Mark Robert Paul Tingay
11. Mat Arifin Ismail
12. Muhammad Azri Ismail
13. Muhammad Faiz Kasim
14. Mukhriz Mubin
15. Nur Amelya Mohammed Jamal
16. Nur Hamizah Mohd Jafar
17. Nurul Nadia Abd Malek
18. Rasanubari Asmah Rahman Abdul Hamid
19. Razmy Assim
20. Rohil Suryavarma Kunasegar
21. Roziah Che Musa
22. Siti Aizatie Ramli
23. Siti Nor Amira Mohd Khair
24. Voo Lok Zan, Edward
25. Zafinas Azahani Moktar

From Student To Full Membership

1. Nur Aishah Atihrah Shaharuddin
2. Nurul Izati Abd Jalil

From Full To Life Membership

1. Ahmad Zulqurnain Ghazalli
2. Burhanuddin Ab Aziz
3. Mark Robert Paul Tingay

IN MEMORIAM

Dr. Hj. Umar Hamzah dalam kenangan

Umar bin Hamzah. Anak kelahiran Cherating, Pahang, dan merupakan bapa kepada enam orang cahaya mata ini merupakan pemegang Ijazah Sarjana Muda dalam bidang Sains Geologi pada tahun 1978 dari Universiti Kebangsaan Malaysia (UKM). Semangat untuk menimba ilmu tidak terhenti di situ sahaja apabila beliau terus menyambung pengajian Diploma of Imperial College di Imperial College, University of London. Kemudian, beliau meneruskan pengajian di peringkat Ijazah Sarjana di University of London dan juga di Birmigham. Setelah itu, beliau meneruskan pengajian Ijazah Doktor Falsafah (PhD) di Universiti Kebangsaan Malaysia (UKM) dan memperoleh PhD beliau pada tahun 2000.

Memulakan tugasan di Universiti Kebangsaan Malaysia pada tahun 1979 sebagai tutor di bawah Program Geologi dan seterusnya menjadi Pensyarah Kanan di universiti yang sama setelah beliau menamatkan pengajian PhD. Beliau telah dilantik sebagai Profesor setelah berkhidmat di Universiti Kebangsaan Malaysia lebih dari dua dekad. Bidang kepakaran beliau adalah geofizik yang berfokuskan kepada kaedah keberintangan geoelektrik, kaedah seismos, kaedah graviti serta magnet. Beliau telah terlibat dengan pelbagai projek survei geofizik termasuklah projek penyiasatan tapak cadangan projek pembangunan, penerokaan air bawah tanah dan mineral, pencirian jisim batu dan pengesanan rongga, kajian dan ramalan tanah runtuh dan penentuan pencemaran air bawah tanah. Beliau telah menerbitkan lebih dari 200 artikel jurnal dalam bidang geologi serta geofizik.

Sepanjang lebih dari 30 tahun menabur bakti, keringat dan ilmu di Universiti Kebangsaan Malaysia, beliau telah melahirkan ramai graduan di bawah bimbingan beliau samada di peringkat sarjana muda, sarjana mahupun di peringkat ijazah kedoktoran. Betapa bersemangatnya beliau untuk berkongsi ilmu, beliau juga menjadi pensyarah jemputan walaupun telah berpencen sehinggalah beliau menemui Pencipta-Nya.

Lebih dari sedekad mengenali beliau, tiada apa yang tidak akan dirindui setelah beliau tiada. Pertama kali mengenali beliau, beliau seorang yang sangat positif, suka memberi nasihat dalam pelbagai perkara. Beliau seorang yang suka merendah diri walaupun beliau seorang profesor dan tidak lokek dengan ilmunya. Ya, pada saya amat sukar untuk kita temui seorang insan seperti beliau. Seorang yang merendah diri serta seorang bapa dan suami yang penyayang, beliau sememangnya akan dirindui oleh kami di Universiti Kebangsaan Malaysia. Semoga rohnya dicucuri rahmat serta ditempatkan di kalangan orang-orang beriman dan dikasihi-Nya.

Disediakan oleh,
Noorzamzarina Sulaiman & Mohd Hariri Arifin
Universiti Malaysia Kelantan & Universiti Kebangsaan Malaysia
12hb Disember 2023

CERAMAH TEKNIK TECHNICAL TALK

Surface settlement prediction using 2D SSPT geomodelling system

Abdull Halim bin Abdul
Ground Wave SSPT Sdn. Bhd.
Date: 16 August 2023
Platform: Zoom and Facebook Live

The above talk was delivered by Dr. Abdull Halim bin Abdul on 16th August 2023, via Zoom/Facebook Live of Faculty Science and Technology, UKM. The total attendees were 36 persons.

An abstract of the talk is given below:

In order to determine the appropriate method for predicting surface settlement caused by earth strain, 2D SSPT geomodelling method and a general soil settlement calculation were employed, and the results were compared. The non linear relationship between seismic shearing dispersion wave and inversion SPT-N value were analyzed. The surface settlement for each layer and shield operation geotechnical parameters were considered in the SSPT geomodelling system. The data from three CPT were obtained from the PIC Pengerang, Johor site and were used to validate the SSPT models. A modified exponent function of shearing wave and SPT-N value index that defines the geotechnical properties and significance of the input parameters was proposed to quantify the geological parameters, which improves the prediction accuracy of SSPT Geo Modelling system. Through this modelling, the SPT-N and surface settlement were calculated for every layer.

We thank Dr. Abdull Halim for his continuous support and contribution to the Society's activities.

Prepared by,
Dr Norsyafina Roslan
Universiti Kebangsaan Malaysia
17th August 2023

CERAMAH TEKNIK TECHNICAL TALK

Reversal in structural transport direction in the NW Borneo deep water fold and thrust belt

Sudirman Dawing
Exploration Assurance Team, PETRONAS
Date: 18 October 2023
Venue/platform: Bilik Mesyuarat Geologi FST, UKM; Zoom/Facebook (hybrid session)

The above talk was delivered by Dr. Sudirman Dawing on 18th October 2023, at Bilik Mesyuarat Geologi, Faculty Science and Technology, Universiti Kebangsaan Malaysia and also via Zoom/Facebook Live of Faculty Science and Technology, UKM. The total attendees were 70 persons.

An abstract of the talk is given below:

The deep-water fold-and-thrust belt of NW Borneo contains a structurally complex region of active folds. This paper uses three-dimensional (3D) seismic data to define fold-and-thrust belt evolution. We document, for the first time, an apparent reversal in structural transport direction between early and later mature stages of fold development. The opening of the South China Sea during Oligocene to Middle Miocene times led to a Southeastward rifting of the continental crust of the Dangerous Grounds. Subduction of oceanic crust to the Southeast took place under the NW Borneo continental margin, with oceanic subduction ending at ~16 Ma. Collision between the Dangerous Grounds and the NW Borneo margin resulted in uplift and erosion of the Crocker Ranges, and shed large volumes of sediment Northwest into the adjacent sedimentary basins. The resultant fold-and-thrust belt hosts up to 8 km thickness of Mid-Miocene to Recent turbidites and submarine fan sediments, closely associated with fold growth. We provide new balanced interpretations of regional, crustal-scale, three-dimensional (3-D), multichannel seismic-reflection profiles, that allow for the quantitative interpretation of tectonic shortening throughout the deep-water fold-and-thrust belt of NW Borneo. A key result of this study is the recognition of three phases of fold evolution that have been spatially and temporally defined using these new datasets. Phase one was solely influenced by the subduction of the Proto-South China Sea towards Borneo in a Northwest to Southeast direction. This phase is marked by asymmetrical folds that verge towards the Southeast, and tectonic thickening of pre-folding strata. Phase two occurs from the end of the Middle Miocene to the end of the Late Miocene, and is characterized by symmetrical fold geometry, with multiple thrust geometries and detachment surfaces. This phase is identified as the early onset of gravitational sediment loading and sediment supply from the shelfal and coastal plains of NW Borneo. Phase three records continued fold growth from the end of the Late Miocene until Recent, and is characterized by strong, asymmetrical, fold growth with Northwestward vergence and abrupt upward growth. Phase three folds are solely influenced by gravitational sediment loading and strongly influence routing of channelized turbidite flows and submarine fan evolution. This research highlights the importance of creating accurate spatial and temporal frameworks to reconstruct fold growth in complex deep-water fold-and-thrust belts, particularly where there are very large volumes of sediment deposited in the basin from proximal shelfal and prograding deltaic margins.

We thank Dr. Sudirman for his continuous support and contribution to the Society's activities.

Prepared by,
Dr Norsyafina Roslan
Universiti Kebangsaan Malaysia
20th October 2023

Dr Sudirman presenting his talk at Bilik Mesyuarat Geologi, UKM.

The participants that joined the session at Bilik Mesyuarat Program Geologi, UKM.

The participants that joined the session through Zoom.

Photographic session with the delegates from Petronas.

CERAMAH TEKNIK TECHNICAL TALK

Bridging geology and engineering for sustainable solutions: Addressing global challenges

Mohamad Faruq Syahmi Bin Md Aripin
Geomapping Technology Sdn. Bhd.
Date: 22 November 2023
Venue: Bilik Mesyuarat Geologi, Jabatan Sains Bumi dan Alam Sekitar, FST UKM, Bangi

Satu pembentangan bertajuk Bridging Geology and Engineering for Sustainable Solutions: Addressing Global Challenges telah disampaikan oleh En. Mohamad Faruq Syahmi Bin Md Aripin (PGeol.) di Bilik Mesyuarat Geologi, Jabatan Sains Bumi dan Alam Sekitar, FST Universiti Kebangsaan Malaysia, Bangi. Pembentangan telah dijalankan pada 22hb November 2023 dalam Slot Ceramah Teknik Geologi Siri 11/2023.

En. Mohamad Faruq Syahmi Bin Md Aripin (PGeol.) merupakan Chief Operating Officer di syarikat Geomapping Technology Sdn Bhd dan juga bertindak sebagai Chairperson of Young Geoprofessional Group, Society for Engineering Geology and Rock Mechanics dan sebagai National representative, Young Engineering Geologists, International Association of Engineering Geology and the Environment.

Dalam pembentangan tersebut, beliau mendedahkan kepada para pelajar tentang kewujudan SEGRM, peranan dan kepentingan persatuan ini dalam usaha membangun bidang geologi kejuruteraan baik dalam industri dan akademik ke arah penyediaan pelan pembangunan mapan kepada masyarakat. Sebagai penutup, cenderamata penghargaan telah disampaikan oleh Dr. Norshahidah Mohd Nazer yang mewakili Ketua Program Geologi.

Pihak Program geologi UKM dan Jabatan Sains Bumi dan Alam Sekitar, JSBAS merakamkan ucapan jutaan terima kasih kepada En. Mohamad Faruq atas perkongsian ilmu tersebut. Tidak lupa juga kepada Institut Geologi Malaysia (IGM) dan Persatuan Geologi Malaysia atas kerjasama penganjuran sesi ceramah teknik ini. *Geology to the Fore!!*

Abstract: In the face of escalating natural disasters, the collaborative efforts of geologists and engineers play a pivotal role in devising sustainable solutions to mitigate their impact. This presentation delves into the indispensable roles that geologists and engineers assume in addressing global challenges related to natural disasters. By leveraging geological insights and engineering innovations, professionals in these fields can develop resilient infrastructure, implement early warning systems, and design disaster-resistant habitats. This abstract explores real-world case studies, highlighting the importance of interdisciplinary approaches in addressing global challenges for disaster risk reduction. As an international-related association, the Society for Engineering Geology and Rock Mechanics (SEGRM) would like to emphasize the importance of a unified strategy, this presentation underscores the critical synergy between geological expertise and engineering ingenuity, essential for building disaster-resilient communities and ensuring a sustainable future amidst natural adversities.

En. Mohamad Faruq ketika berkongsi maklumat berkenaan SEGRM dengan para hadirin (Gambar kiri) dan sesi penyerahan cenderamata penghargaan yang disampaikan oleh Dr. Norshahidah Mohd Nazer mewakili Ketua Program Geologi (Gambar kanan).

Disediakan oleh,
Muhammad Ashahadi Dzulkafli
Universiti Kebangsaan Malaysia
23hb November 2023

STUDENTS' REPORT

AAPG UM SC Team Building Day

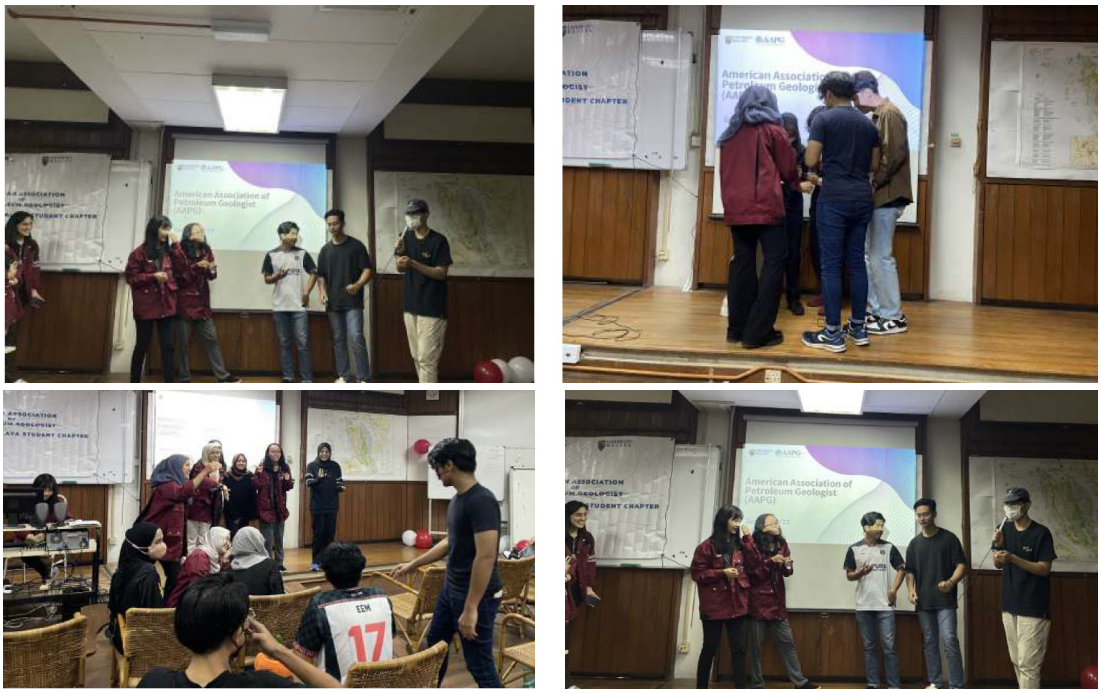
On 5th November 2022, American Association of Petroleum Geologist University Malaya Student Chapter (AAPG UMSC) had organised a Team Building Day among officers in the association planned out by the third year students of the current session. The main objective behind this internal event was to encourage officers from different bureaus in the association to bond and get to know each other before kick-starting the session as a team. This team building is targeted to ensure smoothness and excellent teamwork throughout the two semesters. Also, it is important for new members to increase their productivity as well as enhance their motivation. Consequently, collaboration can be achieved while also fostering trust and respect among the AAPG members. Communication, planning, problem-solving, and conflict resolution together with empathy and compassion are some of the skills that are developed through team building.

The event was held in Dewan Kuliah Geologi (DKG) starting from 9 a.m. and ended approximately around 5 p.m. with a lunch session in between. The Team Building Day was attended by a total of 30 officers from all five bureaus - Public Relations, Academic, Multimedia, Event Management and Social Media.

The event started with an introductory presentation of AAPG's background story followed by the official welcoming speech by AAPG UMSC advisor, Associate Prof. Dr. Meor Hakif bin Amir Hassan. Right before getting into the activities, this term's president, Malavika also delivered her speech. It was more of an easy going and laid-back session where all members managed to complete a couple of activities together. Overall, the event went smoothly and officers really took this opportunity to socialise and had fun. In general, the first physical event of this term was not just successful, but also interesting since internal events like this have never been done in past sessions.

Speech by AAPG UMSC's Advisor, Assoc. Prof. Dr. Meor Hakif.

Second and third years officers.



While activities were conducted and officers took part.

AAPG UMSC's officers in 2022/2023 session.

Prepared by,
Nur Farhana Binti Mohd Sazlee
Secretary
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

STUDENTS' REPORT

AAPG UM SC Rare Earth Element (REE) talk

On the 3rd of December 2022, AAPG UM SC had organised its very first event, a virtual talk on Rare Earth Elements (REE) given by Raja Shazrin Shah bin Raja Ehsan Shah, the managing director of Galaxy Tech Solutions (KL) Sdn. Bhd. He is also an alumnus of University of Malaya where he completed his Bachelor's Degree in Chemical Engineering and Master's Degree in Engineering Science. Recently, he has been posted as a task force member at the Academy of Sciences Malaysia (ASM). Also, he has extensive experience as a professional environmental consultant majoring in waste management, wastewater treatment, cleaner production, carbon footprint, sustainability, and planetary health. He has published articles in more than 12 impactful peer-reviewed journals on waste management, wastewater treatment, and chemical engineering. Moreover, he has strong collaborations with governmental, private, and international agencies as well as academic institutions including University of Malaya.

The virtual event was scheduled between 9:00 a.m and 11:00 a.m and conducted via Microsoft Teams. The talk drew the attention of undergraduates who were curious about the Rare Earth Elements (REE) and their sustainability in Malaysia. Around 35 participants including students from other local universities and colleges joined the online talk. Raja Shazrin Shah explained briefly the fundamentals of REE, which are a set of seventeen metallic elements, an overview of the REE industry in Malaysia and the aspects of sustainability related to REE. He also added the economic importance of REE and its surging marketing values. At the end of the talk, a QnA session was conducted to provide the participants a platform to raise questions and clear their doubts with the guest speaker. Overall, it was a responsive and engaging talk session which laid the foundation of more talks in future since participants can gain exposure and amplify their knowledge on a suggested topic within hours. This also leaves way to more social interaction and network that could be forged between the professionals in the industries and students. Ultimately, the talk was a success.

Figure shows the interaction between the guest speaker and participants.

Prepared by,
Yogahnisha Manohar
Project Director, Rare Earth Element (REE) Talk
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

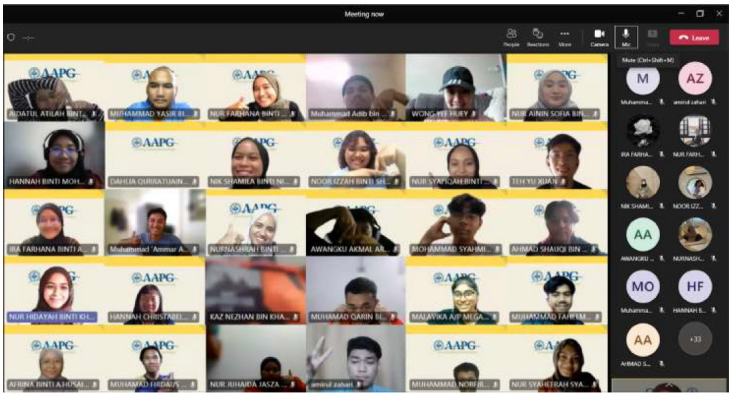
STUDENTS' REPORT

AAPG UM SC AAPG Day

On 17th December 2022, American Association of Petroleum Geologist University Malaya Student Chapter (AAPG UMSC) hosted a special event called AAPG Day. It was a joint effort together with AAPG Student Chapters/geology clubs from other local universities. This is to manifest more alliance opportunities in the near future and of course to expand connections. Apart from that, it is also to enhance the motivation for both existing and new officers to increase their productivity when working as a team. Consequently, collaboration can be achieved while also fostering trust and respect among student chapters.

The event was held virtually mainly on Microsoft Teams as well as several other platforms such as Gather. The event started at 10.30 a.m. and ended approximately around 1.00 p.m. After invitations were sent out, only four out of seven institutions responded and attended. A total of 44 officers from 4 universities which are from UKM, USM, UMS, UMK with inclusion from UM student chapter took part for the day.

There are a number of activities done during the event including a sharing sessions, games sessions, event planners and exhibition tours. The event started with a welcoming speech by The President, Ms. Malavika Meganathan and followed by the introduction of organisational structure of AAPG UMSC executive board. It was so much of an informal and fun session. Soon after that, the day kicked off with the first activity which was an ice breaking session. Attendees were divided into groups randomly and played games in the breakout groups where all members managed to complete a couple of activities together. Consequently, officers got to socialise leisurely and exchange new ideas from one another. Since they all mixed randomly and came from different universities, they shared a lot of interesting stories and the game session became very engaging yet insightful to many. The event was continued with presentations of event planner for 22/23 session from each one AAPG/association representatives and got along with discussion on the probable collaborations that could be handled together. The event ended with a virtual exhibition tour where we prepared a number of infographics within geology scope for attendees to walk around, actually read and share their thoughts. Overall, the event went smoothly and each one of them really took this opportunity to connect and enjoyed themselves. In general, the first physical event of this term was not just successful, but also interesting since internal events like this have never been done in past sessions.



Prepared by,
Nur Farhana Binti Mohd Sazlee
Secretary
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

STUDENTS' REPORT

AAPG UM SC ArcGIS software workshop

On the 14th of January 2023, AAPG University Malaya Student Chapter organised a software workshop (ArcGIS), led by our guest speaker of the morning, Dr. Nobert Simon, who is a geology lecturer at Universiti Kebangsaan Malaysia. As a UKM alumni, he furthered his studies in Victoria University of Wellington, New Zealand and completed his PhD there. His expertise include geological mapping and regional landslide research using remote sensing and GIS.

The event started at 10 a.m. and ended at around 4 p.m. The talk was targeted towards all geology students that are interested in learning the basics and tips and tricks on the usage of ArcGIS. This event was held at the Geology Department of UKM upon the collaboration with Kelab Geologi UKM. The participants consist mostly of UKM geology students and a number of UM geology students.

Dr. Nobert was really helpful in guiding the participants, even the first time users. He guided everyone with step-by-step techniques throughout the session. The workshop had a really laid-back atmosphere. It was fun learning about the shortcuts and hacks of ArcGIS.

The participants were very responsive and even asked a lot of questions during the Q&A session. The UKM students were really great hosts, we felt very welcomed while we were there. Overall, the talk was a success as we were able to achieve our objectives and more.

Prepared by,
Noor Izzah binti Shaharuddin
Project Director, Software Workshop
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

STUDENTS' REPORT

AAPG UM SC Geomarathon 1.0

On the 28th and 29th of January 2023, AAPG University of Malaya Student Chapter had organised a program entitled "Geomarathon 1.0" with our representative mentors from University of Malaya's American Association of Petroleum Geologist (AAPG). There were 18 tutors consisting of second and third year AAPG UM members in the organised event. The first-year session was led by second-year students from AAPG UM, while the second-year session was led by third-year students from AAPG UM.

On 28th January 2023, the first part of the session covered the first-year subjects, and on the second day, second-year subjects were presented. The "Geomarathon 1.0" program started at 8.00 a.m. and ended at 4.00 p.m. on the first day, while on the second day, the program lasted from 8 a.m. till 10.00 p.m. On the first day, the first topic was "Structures and Geological Maps", followed by "Earth Surfaces Processes," and lastly was "Introduction to the Earth", all presented by the tutors. On the second day, four topics were presented, starting with "Igneous and Metamorphic Petrology", followed by "Introduction to Geophysics", then "Sedimentology", and ended with "Structural Geology". The presentations were made by the tutors.

This program was intended for all University of Malaya geology students who are interested in taking part in the sharing session and the past year papers answering technique, shared by senior students who are also members of AAPG UM. About 30 students participated in this program. Overall, the participants were quite attentive and engaged in the discussions; they even posed several questions during the Q&A segment. This kind of program is crucial because it exposes students to the subjects and helps them learn more from the seniors. The program was a success.

Prepared by,
Mohammad Syahmi Bin A Rahim Musly
Project Director, Geomarathon 1.0
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

STUDENTS' REPORT

AAPG UM SC seismic interpretation workshop

On the 1st of April 2023, AAPG University of Malaya Student Chapter had organised an event titled "Seismic Interpretation Workshop" with our guest speaker, Mr. Oskar Pakpahan. He is currently employed as Vice President, Development & Strategic Relations/Head of Geophysics at UMD Petroleum Sdn. Bhd. which is a subsidiary of UMD Group of Companies. Mr. Oskar has 17 years of experience and has held a few notable positions throughout his career such as Geophysical Advisor/BD Manager at UMD Petroleum Sdn. Bhd., Senior Geophysicist at Carigali-PTTEPI Operating Company Sdn. Bhd., Quantitative Interpreter (QI) and Support and Pre-Sales Geoscientist at Ikon Science, Operation Geophysicist/Seismologist at Geokinetics Inc. and a Jr. Geophysicist Interpreter at Halliburton. His key competencies include rock physics, seismic interpretation, seismic modelling, investor relation manager, business development, and Geophysical champion Specialties: seismic interpretation, reservoir geophysics (QI) & business development. He is also a Season Lecturer at University Malaya that conducts classes for M.Sc. of Petroleum Geoscience Program and also was an Adjunct Lecturer at PETRONAS University of Technology. Here are Mr. Oskar's educational background:

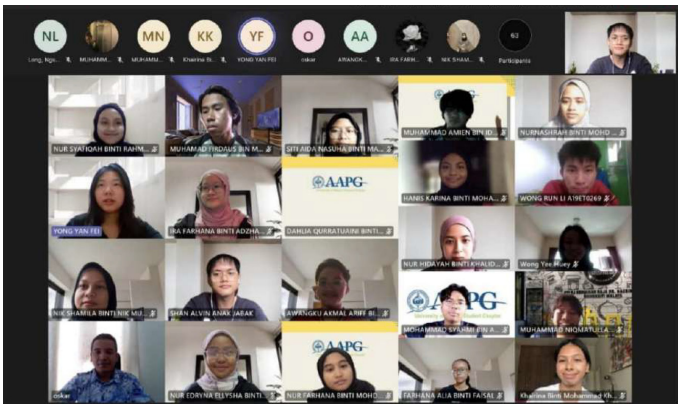
Bandung Institute of Technology (ITB):

- MSc, Petroleum Geophysics, cum laude
- BSc, Geophysics

National University of Malaysia (UKM):

- MSc, Petroleum Geoscience

The event started at 10:00 a.m. and finished at 12:00 p.m. The talk was targeted towards all aspiring geologists and also students who are interested in learning more about seismic interpretation and experiences being a veteran in that field. There were about 70 participants, inclusive of students from other local universities. Mr. Oskar Pakpahan covered the topics such as the basics of exploration geophysics namely the seismic acquisition and processing on field, basic well logging and shot survey, and basic geology such as sedimentation and examples of outcrops. He also carried out some seismic interpretation routine activities as a practice for the students to grasp a glimpse of working in this field. Overall, the participants were very responsive and even asked a lot of questions during the Q&A session. It was a very interactive talk with some discussions and jokes on the side. Talks like this are important as students gain exposure and learn more on a topic from a professional who works in the industry. Overall, the talk was successful.



Mr. Oskar(bottom left) with the participants of the event.

Prepared by,
Awangku Akmal Ariff Bin Awang Ariffin
Project Director, Seismic Interpretation Workshop
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

STUDENTS' REPORT

AAPG UM SC well log analysis workshop

On the 15th of April 2023, American Association of Petroleum Geologist (AAPG) University of Malaya Student Chapter had organised a workshop titled "Well Log Analysis" with our guest speaker, Arie Krisna Lopulisa. He graduated from University of Malaya with a Masters of Science in Petroleum Geology. Mr. Arie Krisna Lopulisa is a Geoscientist with more than 18 years of industrial experience focusing on the development and exploitation phase. He is also exposed extensively to reservoir geology and geophysics, with significant strength in static geological model building. Some of his specialties include, 3D Geological Modelling, Development and Production Geology, Reservoir Characterization and Sequence Stratigraphy. He was also a Consultant Geoscientist and Petroleum Geoscience Master candidate at University of Malaya from May 2017 till August 2018. Currently he is working as a Senior Geologist at Schlumberger (SLB) for a year and 6 months.

The event started at 10.30 a.m. and ended at 12 p.m. The talk was targeted towards geology students from University of Malaya who are interested in well log analysis to identify unswept oil in a waterflood reservoir. Students outside of University of Malaya were welcomed as well. There were about 57 participants, inclusive of participants from other local universities.

Mr Arie Krisna Lopulisa took the effort to cover the basics of well log analysis and progressed deeper into the topic later on. He shared his real life experiences and included some activities for students to try on and share their answers. Mr Arie Krisna Lopulisa also presented a case study from a brown field in Peninsular Malaysia. The exposure to real life application was found knowledgeable and insightful for the participants. Students were actively participating as well as opened up a few questions during the workshop. All in all, the workshop proved to be a success.

Prepared by,
Shakti Kumara Shanmuga Kumaraiah
Event Director, Well Log Analysis Workshop
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

STUDENTS' REPORT

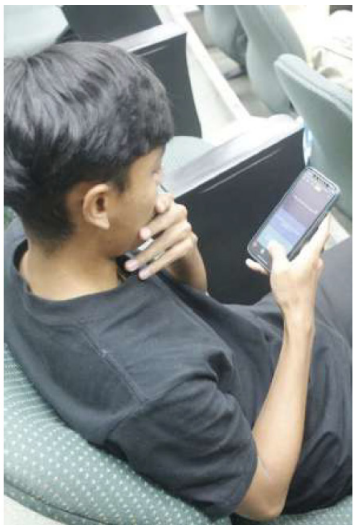
AAPG UM SC GIW Petrobowl competition

On the 13th of May 2023, AAPG University of Malaya Student Chapter had organised a Petrobowl competition during the first day of Geoscience Industrial Week 2023. The event was held in Ixora Lecture Hall, Faculty of Science.

The competition was held from 9.00 a.m. until 3.00 p.m. The competition was a quiz-type game using Quizizz as the main platform. The quiz was conducted for several rounds every hour. The quiz was about technical and non-technical questions about the oil and gas industry. The competition was participated by almost 50 students from University Malaya and MRSM Sungai Besar.

Throughout the competition, the participants had an intense session of answering all the questions in a short period of time. For those who scored 12 marks and above, they received a free tote bag exclusively designed by AAPG UMSC. Nevertheless, the competition gave an opportunity to all participants to get some insight and gain knowledge on the oil and gas industry. Overall, the competition was successful. Attached herewith are some of the photos throughout our successful event:





Prepared by,
Nur Farhana Binti Mohd Sazlee
Secretary
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

STUDENTS' REPORT

AAPG UM SC School Out Kids In (SOKI)

On the 30th and 31st of May 2023, AAPG University Malaya Student Chapter with collaboration of UM GSM organised an event called SOKI, led by Dr Muhammad Hatta Roselee at Pusat Sains Negara. The event was initiated by the Malaysian Government to promote STEM by exposing the importance and brief studies of geology, chemistry, physics, biology and other science courses.

The event started at 11a.m. and ended at around 5p.m. The participants were mostly primary and secondary school students accompanied by their parents or teachers. At our booth, we divided our stations into four parts, and the first was for analysing petrographic thin sections using a petrographic microscope. At this station participants were able to see minerals and were amazed by the unique features of minerals. The second station was for display of rocks and minerals. Three trays of sedimentary rocks, igneous and metamorphic rocks were displayed and two members explained to the participants the minerals' features and how to differentiate them. The third station was where the hardness and acid test were done. Interesting fossils were also displayed, such as brachiopods and lingula. The 4th station was where infographics were displayed about planets, rocks and oil and gas industry and a printed infographic was given to each participant.

A total of 4 members from AAPG and 4 members from GSM guided this event which had about 100 students for two days. The event was fun as we got to interact with the school students and explained about geoscience. Overall, the event was a success as we were able to achieve our objectives and more.

Pictures from the event:

Prepared by,
Malavika a/p Meganathan
Project Director, School out Kids In (SOKI)
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

STUDENTS' REPORT

AAPG UM SC monthly infographics - A long term project

As a part of our continuous initiative throughout the session, we initiated a monthly online infographics bulletin on our website as a reading platform among geology students all around Malaysia. The aim for this project is to cultivate knowledge among geology students on unique geological formations and processes that occur all around the world. We believe that this initiative would foster curiosity among the students and encourage them to pursue reading and researching other topics in the oil and gas field. The information gathered in the infographics are procured from careful study of research journals and articles by our AAPG members.

We have been constantly improving our infographics from our constructive feedback received from our loyal readers and this long-term project has been impactful academic-wise among the geology students in Malaysia.

Access link for all the infographic issues:

https://instagram.com/aapgumsc?igshid=MzRlODBiNWFlZA==

Prepared by,
Nur Farhana Binti Mohd Sazlee
Secretary
American Association of Petroleum Geologist University Malaya Student Chapter
15th September 2023

STUDENTS' REPORT

Summary report on GSM-UMS Geology Club 'Geotalk 12.0: Geohazard'

KOTA KINABALU – A webminar, 'Geotalk 12.0: Geohazard' was held on July 8, 2023 which was participated by geology students from UMS and the public with geological background. The panellist invited was Mr. Lee Kun You, P. Geol, one of the alumni of UMS geology program. The objective of this program was to exposed geology students and the public to geohazards such as landslides and the intervention of geologists in landslide prevention and recovery. The program was carried out smoothly, with positive feedbacks from the participants. We truly want to host more interactive and implement more geological elements in our future activities in conjunction with GSM and GSM-UMS Geology Club. Thank you very much.

Poster of 'Geotalk 12.0: Geohazard' programme. Photo by: Geotalk 12.0 Publicity Team

Group photo of the participants of the programme with panelist. Photo by: Geotalk 12.0 Publicity Team

Prepared by,
Wong Yee Huey
Secretary, GSM-Universiti Malaysia Sabah Geology Club
26th October 2023

UPCOMING EVENTS

January 17-18, 2024: SURINAME 2024 Technical Symposium: Maturing Sustainable Solutions to Explore, Develop and Produce Oil and Gas Across the Guyana Suriname Basin, Paramaribo, Suriname. More details at https://www.aapg.org/global/latinamerica/events/workshop/articleid/64337.

January 30-31, 2024: EAGE/ AAPG Workshop on New Discoveries in Mature Basins, Kuala Lumpur. More details at https://eage.eventsair.com/workshop-on-new-discoveries-in-mature-basins.

February 7-9, 2024: 2024 NAPE Summit. More details at https://napeexpo.com/summit.

February 12-14, 2024: International Petroleum Technology Conference (IPTC); Dhahran Expo, Kingdom of Saudi Arabia. Visit https://www.iptcnet.org/ for more information about the event.

February 20-23, 2024: 18th Regional Geoscience Conference of Southeast Asia : GEOSEA 2024; Khon Kaen, Thailand. Contact information@geosea2024.com for general information.

February 26-29, 2024: 14th Asian Regional Conference (ARC14) of International Association for Engineering Geology and the Environment (IAEG); Kota Kinabalu, Sabah, Malaysia. More details at https://www.arc14.asia/.

March 4-6, 2024: 4th Edition: Stratigraphic Traps of the Middle East, Al-Khobar, Saudi Arabia. More details at https://www.aapg.org/global/middleeast/events/workshop/articleid/64424.

March 11-13, 2024: Carbon Capture, Utilization, and Storage (CCUS): An Emerging Field for Energy Professionals, George R. Brown Convention Center in Houston, Texas. More details at https://ccusevent.org/2024.

March 26-27, 2024: AAPG/GESGB: Business & Exploration Opportunities Show, Islington, London, UK. More details at https://www.beosevent.com/.

April 1-11, 2024: Grand Canyon IUGS Geoheritage Adventure; Arizona. For further details, visit https://iugs-geoheritage.rg/iugs-adventure/ or contact iugs.globalgeosites@igme.es.

April 22-24, 2024: Cross Regional Carbonates and Mixed Carbonate Systems Symposium: Sicily, Italy. More details at https://www.aapg.org/global/europe/events/workshop/articleid/66092.

May 9-10, 2024: CANADA 2024- Geosciences Technology Workshop: Optimizing Exploration Workflows: Bridging Expertise between the Rockies and the Andes. More details at https://www.aapg.org/career/training/in-person/workshops/workshop-details/articleid/66145#program.

May 22-23, 2024: Carbon Capture, Utilization and Storage (CCUS), Rie de Janeiro, Brazil. More details at https://ccusevent.org/latinamerica/2024/save-the-date.

May 28-29, 2024: AAPG Europe Regional Conference 2024, Krakow. More details at https://erc.aapg.org/2024.

May 6-9, 2024: Offshore Technology Conference 2024; Houstan, Texas, USA. See details at https://2024.otcnet.org/.

June 17-19, 2024: Unconventional Resources Technology Conference (URTeC) 2024; Houstan, Texas, US. More details at https://urtec.org/2024/save-the-date.

August 25-31, 2024: 37th International Geological Congress (IGC 2024), Busan, Republic of Korea. Further information about the conference can be found athttps://www.iugs.org/igc.

Jointly organised by:

UNIVERSITI MALAYA

In conjunction with
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65th Sapphire Jubilee

NGC 2024

The 37th National Geoscience Conference

28TH-30TH MAY 2024

First Circular

Call for Papers:

We invite abstracts for oral and poster presentations that will fit the main theme or sub-themes of the conference. Abstracts can be submitted to email (geologicalsociety@gmail.com).

Deadline: 22 April 2024

Topics

- Climate change, renewable energy and carbon sequestration
- Conservation geology, geoarcheology and geotourism
- Disaster risk reduction, climate hazards and engineering geology
- Geophysics, geospatial applications and geotechnology
- Groundwater resources and water security
- Mineral resources development and environment
- Petroleum geology and exploration
- Quaternary, coastal and marine geology
- Stratigraphy, sedimentology and paleontology
- Tectonics and structural geology

Venue

Within the vicinity of Universiti Malaya, Kuala Lumpur
*The conference venue and date will be announced in the second circular.

Attractions

GSM-NGC Student Grants
Post Conference Field Trip
Best Poster Presentation Award
Best Oral Presentation Award
BOG CPD POINTS

Accepted extended abstract/full manuscripts will be published in the Bulletin of the Geological Society of Malaysia or Warta Geologi and indexed in:

Scopus · AAPG Datapages, Inc. · MyJurnal Journal Management System · MyCite malaysian citation index

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Geological Society of Malaysia Publications

Instruction to Authors

General Policy

Manuscripts should be as concise as possible. Original results of basic, applied and policy research in geology that is of national or international significance are welcome. Current reviews and discussion on techniques, research programs, organisations, information, or national and international policies related to geology are also acceptable.

Submission of Manuscripts

Only manuscripts that have not been published elsewhere including electronically, will be considered for publication. Authors must agree not to publish elsewhere the submitted or accepted manuscripts in the same form, in English, Malay or other languages. Similarity detection services will be used to check your manuscript to verify its originality. Only manuscripts that clear a preliminary compliance check will be sent for review.

All manuscripts 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 manuscripts 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 manuscript submitted. The Geological Society of Malaysia assumes no responsibility for statements made by authors. The paper should be submitted to:

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The Manuscript

The manuscript can be written in Bahasa Malaysia (Malay) or English. For English manuscripts, use either British or American spelling but not a combination of both. The paper should be thoroughly checked for grammar and spelling. The manuscript must be printed at 1.5 spacing in a single column on A4 paper. All pages should be numbered. Length of paper should be between 3,000 and 10,000 words for Bulletin of the Geological Society of Malaysia, and between 2,000 and 3,000 words for Warta Geologi, excluding abstract, references, tables, and illustrations. Metric units should be used and all non-standard symbols, abbreviations and acronyms must be defined.

Title

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

Author's Address

Affiliations, address, and email of all authors must be provided. The addresses should be sufficient for correspondence.

Abstract

Abstracts in Malay (optional for manuscripts in English) and English, each in one paragraph and should not exceed 300 words, is mandatory. It should clearly identify the subject matter, results obtained, interpretations discussed, conclusions reached and significance of the study. The abstract should not contain any undefined abbreviations or references.

Keywords

Four to eight keywords (including in the Malay language for manuscripts in Malay) that is relevant to the content of the paper is mandatory.

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Acknowledgement to reviewers and institutions or agencies must be included at the end of the text. All funding sources must be mentioned in this section and acknowledged accordingly.

Authors Contributions

A statement of the roles played by each author, e.g. data analysis, experimental design is required.

Declaration of Competing Interest

A declaration of any conflict of interest must be communicated in a statement in the published 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 manuscripts should be translated to English. Where available, include Digital Object Identifier (DOI) and URLs for the references that have been provided. Self-citations should be limited to less than 10% of the total citations in the paper.

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Suntharalingam, T., 1968. Upper Palaeozoic stratigraphy of the area west of Kampar, Perak. Bulletin of the Geological Society of Malaysia, 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. & 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. Bulletin of the Geological Society of Malaysia, 35, 1-5. (in Malay with English abstract).

Online document:
Smith, J., 2019. Minerals and rocks are valuable natural resources. Minerals Web Society. http://minerals.org/articles/12/32/index. Accessed 20 July 2020.

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Use the table function in Word to insert tables. Tables are limited to a maximum of five (5) and these should be cited in the text and numbered consecutively. Do not submit tables as images. Tables should have a title and a legend explaining any abbreviation or symbol used. Insert the caption at the top of each table. The captions should begin with the term Table followed by the number and a colon, all in bold. The text after the colon should be in regular font. Avoid excessive tabulation of data. Tabulated data may be included as an Appendix or Supplementary Data.

Illustrations

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Preferred Software

- *Text*: Microsoft Word.
- *Tables*: Microsoft Word or Microsoft Excel.
- *Illustrations – Vector Graphics*: Adobe Illustrator (preferred), CorelDraw and Freehand. For other software, please submit one copy in the native file format and export one copy as a PDF file with all fonts embedded as a high resolution TIFF or JPEG image.
- *Photographs or bitmap (raster) images*: Adobe Photoshop, high resolution JPEG, TIFF or GIF or files from other sources. The resolution must be high enough for printing at 300 dpi.

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