

PERSATUAN GEOLOGI MALAYSIA
GEOLOGICAL SOCIETY OF MALAYSIA



PROCEEDINGS
NATIONAL GEOSCIENCE
CONFERENCE 2012

Pullman Hotel Kuching, Sarawak
23 – 24 June 2012

*Geoscience
In Everyday Life*

Co-organisers

Minerals & Geoscience
Department Malaysia



Academy of Sciences
Malaysia



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Message by

ORGANISING CHAIRMAN NATIONAL GEOSCIENCE CONFERENCE 2012

The National Geoscience Conference is the only conference with a wide spectrum of geology held annually in Malaysia. It gathers geologists from various disciplines. This conference also serves as the venue for presenting new discoveries, research findings and new ideas. It also incorporates geologists from various quarters such as government bodies, private sectors and institutions of higher learning. The NGC2012 was selected to be held in Kuching, Sarawak. It is a great honour to the State of Sarawak, the Land of the Hornbills. I sincerely hope that this will be followed by subsequent geological studies to be conducted more in Sarawak as Sarawak is too broad with many areas still needed to be explored and documented in detail. I am also very touched by the desire of few individuals from other countries to attend the conference. I think we should also officially invite some international participation in the years to come especially from neighbouring countries that we have some form of collaboration.

The theme of this NGC2012 is ***Geoscience in Everyday Life***. This theme was chosen to instil awareness of the importance of geosciences that inhabit our daily lives. Almost everything that we touch has to do with geology. In Sarawak alone, geoscience services have directly improve the living standard of rural population through a system of water supplies, either using underground water resources through Sistem Penapisan Air Tanah Ringkas (SPATR) and simple gravity feed. The discovery of coal resources has also helped spur the development of government program in the SCORE area.

The programme we arranged for NGC2012 consist of four keynote papers, 50 oral presentations and 41 posters covering various fields. I am very confident participants will gain much benefit by mutual sharing of experience and knowledge through presentations and discussions.

On behalf of the NGC2012 Organising Committee, I welcome your arrival and your presence in this conference. I also want to express my appreciation for all authors for their contributions, the continued support by various parties, especially JMG, Akademi Sains Negara and Institutions of higher learning. I also am very grateful to our generous sponsors who help in various forms.

DR. RICHARD MANI BANDA
Organising Chairman NGC2012

PROGRAMME**DAY 1 – SATURDAY 23 JUNE 2012**

08:00 – 09:00	REGISTRATION	
09:00 – 10:00	OPENING CEREMONY Welcoming Speech by Y.Bhg. Dato' Yunus bin Abdul Razak, Ketua Pengarah Jabatan Mineral Dan Geosains Malaysia Welcoming Speech by Prof. Dr. Joy Jacqueline Pereira, President Geological Society of Malaysia Opening Speech by YB Datuk Amar Haji Awang Tengah bin Ali Hassan Minister of Resource Planning and Environment (II), Minister of Public Utilities & Minister of Industrial Development	
10:00 – 11:00	POSTER SESSION 1 AND TEA BREAK	
11:00 – 11:30	KEYNOTE 1 AZIMUDDIN BAHARI Towards a national policy on geoscience	
	TECHNICAL SESSION A1	TECHNICAL SESSION B1
11:30 – 11:50	PAPER A1 AYE KO AUNG, NG THAM FATT & KYAW KYAW NYEIN The first record of the Late Permian waagenophyllid rugose corals from Pahang, Central Peninsular Malaysia	PAPER B1 A.H.A. TEH SAUFIA, ROSLI SAAD, M.M. NORDIANA, NUR AZWIN ISMAIL, NOER EL HIDAYAH ISMAIL, ANDY ANDERSON BERY, NISA' ALI The role of self potential prospecting in delineating underground streams for engineering problems
11:50 – 12:10	PAPER A2 Junaidi Asis & Basir Jasin Some Cretaceous radiolaria from Kuamut Melange, Kunak, Sabah	PAPER B2 AFIKAH RAHIM, HAREYANI ZABIDI & ABDUL GHANI MOHD RAFEK Mechanised construction of tunnel boring machine (TBM-1) in granitic body in Karak, Pahang
12:10 – 12:30	PAPER A3 BASIR JASIN, ATILIA BASHARDIN & ZAITON HARUN Middle Permian Radiolarians from the siliceous mudstone block near Pos Blau, Ulu Kelantan and their significance	PAPER B3 I.N. AZWIN, ROSLI SAAD & M.M. NORDIANA Classification of saturated zones from signal amplitude of ground penetrating radar
12:30 – 12:50	PAPER A4 YONG ADILAH MUSTAFA & AYE KO AUNG Discovery of the Permian Foraminifera: A significant evidence for the age of limestone pinnacles at Gua Seh area, Pahang, Central Peninsular Malaysia	PAPER B4 WAN NORMIMIAIDA W.MOHAMED, HAREYANI ZABIDI & ABDUL GHANI MOHD RAFEK Joint pattern study of meta-sedimentary rocks at Karak Site for the Interstate Raw Water Transfer Tunnel Project
12:50 – 14:00	LUNCH BREAK	

14:00 – 14:30	KEYNOTE 2 IBRAHIM KOMOO Geopark: Inovasi untuk pembangunan lestari wilayah	
	TECHNICAL SESSION A2	TECHNICAL SESSION B2
14:30 – 14:50	PAPER A5 CHE AZIZ ALI & TANOT UNJAH Intergrated research for conservation, land use planning and geotourism in Langkawi Geopark, Malaysia	PAPER B5 ISMAIL ABD RAHIM, SANUDIN HJ. TAHIR, BABA MUSTA AND SHARIFF A. K. OMANG Adjustment factor of Slope Mass Rating (SMR) system: Revisited
14:50 – 15:10	PAPER A6 JOANES MUDA Geological heritage resources and potential geotourism development at the tip of Borneo, Northern Sabah, Malaysia	PAPER B6 MUHAMMAD FADZLI DERAMAN, HAMLEE ISMAIL &TAJUL ANUAR JAMALUDDIN Geobencana kegagalan cerun di laluan jalanraya merentasi kawasan perbukitan Hulu Terengganu
15:10 – 15:30	PAPER A7 MOHD. FAUZI RAJIMIN @ JEMAN, KAMAL ROSLAN MOHAMAD & CHE AZIZ ALI Pemuliharaan warisan geologi kepulauan Mersing, Johor	PAPER B7 RODEANO ROSLEE, TAJUL ANUAR JAMALUDDIN & MUSTAPA ABD. TALIP Intergration of GIS in deterministic model (infinite slope) for landslide susceptibility analysis (LSA) at Kota Kinabalu area, Sabah, Malaysia
15:30 – 15:50	PAPER A8 DONY ADRIANSYAH NAZARUDDIN, HASIMAH HASSAN & AHMAD FADLI AHMAD SANUSI Mount Chamah: Explore the hidden geological treasure in remote Kelantan	PAPER B8 TAN BOON KONG Slope failures associated with water tank and reservoir sites – Some case studies in the Kuching Area, Sarawak
15:50 – 16:20	TEA BREAK	
16:20 – 16:40	PAPER A9 ARHAM MUCHTAR ACHMAD BAHAR Geomorphological mapping of Chamah, Kelantan using GIS technique	PAPER B9 AMIRRUDDIN ROSNI, M. AZIZUL, M. HASSAN, SELAMAT, M. ZULFIKRI & M. NASIR, RASININ KALING Influence of geological features in blasting and quarry face design: A case study of the IJM MRP granite quarry, Kulim, Kedah
16:40 – 17:10	PAPER A10 MUHAMMAD MUSTADZA MAZNI Sumber geowarisan dan geopelancongan di sekitar pembangunan wilayah ekonomi koridor utara Perlis	PAPER B10 S.V. ALAVI NEZHAD KHALIL ABAD, EDYTONNIZAM MOHAMAD, IBRAHIM KOMOO, R. KALATEHJARI & M. HAJIHASSANI A review on the limitations and applications of geological strength index
17:10 – 17:30	PAPER A11 RAMLI MOHD OSMAN Guide to greening of quarries in Malaysia	PAPER B11 TAJUL ANUAR JAMALUDDIN Survei ketakselajaran dan permodelan struktur geologi cerun potongan batuan
19:00 – 22:00	CONFERENCE DINNER	

DAY 2 – SUNDAY 24 JUNE 2012

08:30 – 09:00	KEYNOTE 3 CHEN S. P. & ALEXANDER UNYA AMBUN A half century of geological surveying in Sarawak	
9:00 – 10:00	POSTER SESSION 2 AND TEA BREAK	
	TECHNICAL SESSION A3	TECHNICAL SESSION B3
10:00 – 10:20	PAPER A12 AZMAN A GHANI, MOHD ROZI UMOR & KHIN ZAW High Ba alkalic series rocks from the Benom Complex, Peninsular Malaysia: evidence of mantle infiltration to lower crust	PAPER B12 IFTIKHAR AHMED SATTI, MONA LISA & MUHAMMAD SAJID Integration of seismic and seismological data interpretation for better subsurface structure identification
10:20 – 10:40	PAPER A13 KYAW KYAW NYEIN, AZMAN A. GHANI, WAN FUAD WAN HASSAN & AYE KO AUNG Preliminary study of petrology and geochemistry of the Langkawi granites	PAPER B13 M. M. NORDIANAA, ROSLI SAADB, I. N. AZWINC, EDY TONIZAM MOHAMAD Iron ore detection using electrical methods with enhancing horizontal resolution (EHR) technique
10:40 – 11:10	PAPER A14 KHAIRIL IZAM SELAMAT DIN & MOHD ROZI UMOR Kajian petrografi dan geokimia untuk menentukan asalan Pluton Palong, Jempol, Negeri Sembilan	PAPER B14 MUHAMMAD AHMED RAZA, WAN ISMAIL BIN WAN YUSOFF & MUHAMMAD IRFAN SULEMAN Fluvial channels delineation and geomorphologic characterization using well and seismic data
11:10 – 11:30	PAPER A15 NUR ISKANDAR TAIB Plio-pleistocene volcanism in the Upper Rajang Valley – a window into the crust under the Rajang Group	PAPER B15 MOHD HARIRI AREFIN Kajian kesesuaian pembangunan di tanah bekas lombong sekitar Kampar, Perak menggunakan kaedah keberintangan geoelektrik
11:30 – 11:50	PAPER A16 YUNIARTI ULFA, TAN HONG KIEW & HAM WEN YI The transformation of amphibolite facies gneiss to greenschist facies: an Interesting phenomenon in East-West Highway Route A173, Baling-Gerik, Malaysia	PAPER B16 SAHIBIN ABD RAHIM, WAN MOHD RAZI IDRIS, ZULFAHMI ALI RAHMAN, TUKIMAT LIHAN & NURUL NAQIRAH ABDUL SHUKOR Physico-chemical properties of ultrabasic soil from Petaseh, Negeri Sembilan
11:50 – 12:10	PAPER A17 ZAKARIA ENDUT, TEH GUAN HOE, NG THAM FATT & SHARAFUDDIN MOHAMED Some aspect of vein texture, microstructure and implication to gold mineralization episode in Penjom Gold Mine	PAPER B17 RAMLI MOHD OSMAN & MOHD ANUAR ISHAK Geospatial analysis of ex-mining land of Perak

12:10 – 12:30	PAPER A18 MAHAT BIN HJ SIBUN, HABIBAH JAMIL, MOHD ROZI UMUR & WAN FUAD WAN HASSAN The source of gold and tin mineralization in the Western Belt of Peninsular Malaysia: Evidence from heavy mineral studies	PAPER B18 MOHAMAD ABD MANAP, MOHAMMED HATTA KARIM, NORAINI SURIP, HISAM AHMAD, NORHAZIDI MASROM & NURUL NADIA ABD MALEK Lithology and lineament density for delineation of groundwater potential areas at the Muar Basin
12:30 – 12:50	PAPER A19 MOHD SUHAILI ISMAIL The interdependence relationship of the minerals sector within the Malaysian economy	PAPER B19 EDY TONNIZAM MOHAMMAD, FARAH SHAFIQAH MOHD MAZNY & ROSLI SAAD Excavation of hard material for construction work in Labis, Johor
12:50 – 14:00	LUNCH BREAK	
14:00 – 14:30	KEYNOTE 4 WAN ZAWAWIE WAN AKIL Coal mining in Sarawak-Issues and challenges	
	TECHNICAL SESSION A4	TECHNICAL SESSION B4
14:30 – 14:50	PAPER A20 RICHARD MANI BANDA, AMIRUDDIN, WAHYU GUNAWAN, ALEXANDER YAN, YUSOP RAMLI, DANA BADANG, THOMPSON GALIN & REDZUAN BANJAR Progress report – Malaysian-Indonesian geological correlation program in the border area Sintang-Silantek area	PAPER B20 EDY TONNIZAM MOHAMAD & NORAZUIN ABU Assessment of potential alkali silica reaction on aggregates with ‘fool’s gold’ from Kampung Melayu Majidee, Johor Bahru
14:50 – 15:10	PAPER A21 WONG YIEN LIM & LEE CHAI PENG Stratigraphy of the Ransi Member, Tatau Formation (Middle Eocene-Oligocene) in the Tatau-Bintulu area, Sarawak	PAPER B21 NORAZNIDA KAMARUSZAMAN, W.ZUHAIRI W.YAACOB & ABDUL RAHIM SAMSUDIN Sintesis dan pencirian nano zero valent iron (NZVI) untuk rawatan air tercemar
15:10 – 15:30	PAPER A22 MUSTAFA KAMAL SHUIB The occurrences of probable Tertiary boulder beds along Chenur-Paloh Hinai Road, near Maran, Pahang and their implications	PAPER B22 M. A. ASHRAF, M. J. MAAH & I. YUSOFF Chemical speciation and potential mobility of heavy metals in the soil of former tin mining catchment
15:30 – 15:50	PAPER A23 IBRAHIM BIN AMNAN & ASSANEE MEESOOK The Singa and Kubang Pasu Formation: A review	PAPER B23 NUR ATIQA ANUAR & W. ZUHAIRI W. YAACOB Keupayaan beberapa jenis tanah dalam menjerap logam berat
15:50 – 16:10	PAPER A24 KHOR SIMON, MEOR HAKIF BIN AMIR HASSAN & MUHAMAD PEDRO J. BARBEITO Sedimentology and stratigraphy of Kampung Opak Limestone, Bekenu, Sarawak	PAPER B24 PRIVEETHA MANOGARAN, DAHLILA KAMAT & RAJA RAJESWARY SUPPIAH Study on characteristics of Malaysian sand as proppant

16:10 – 16:30	PAPER A25 MOHD DANIAL HARIZ MOHD AZIR, CHE AZIZ ALI & KAMAL ROSLAN MOHAMED Pendolomitan dan simen silika dalam batu kapur Formasi Setul di Tanjung Rhu, Langkawi, Kedah	PAPER B25 ABDUL RAHMAN ZAKARIA & ASKURY ABD KADIR Fractured metasediment outcrops at Pulau Redang, offshore Terengganu: An Analogue for natural fractured reservoir (NFR) basement in Malay Basin
16:30 – 17:00	CLOSING CEREMONY	
17:00 – 17:30	TEA BREAK	

POSTER SESSION 1: 10:00 – 11:00, Saturday 23 June 2012

- P1-1 LING HWEI CHIH, NG THAM FATT, AHMAD FARID BIN ABU BAKAR & JOY J. PEREIRA
Microstructure of deformed quartz in the mylonite of the Selinsing Gold Mine: Implications for the mechanism and condition of deformation
- P1-2 AYE KO AUNG, MEOR HAKIF BIN AMIR HASSAN, KYAW KYAW NYEIN, KYAW ZAY MYINT, AUNG AYE LIN, KYAW ZAY YA, MYO THU SOE, THAN HTOO AUNG & AUNG MIN OO
Stratigraphic correlation of the Carboniferous-Permian sequence of Malaysia and Myanmar
- P1-3 MOHAMMED HAIL HAKIMI, WAN HASIAH ABDULLAH & MOHAMED RAGAB SHALABY
Palynofacies characterization of the Upper Jurassic Madbi Formation in the Kharir oilfield and their relation to oil generation potential
- P1-4 JOANES MUDA
Geoart: An innovative tool to promote geology and geotourism
- P1-5 JULAIHA AZMI & AYE KO AUNG
Some new findings of the coral and fusulinid faunas from the Jengka Pass Limestone, Pahang, Central Peninsular Malaysia
- P1-6 MOHAMAD TARMIZI MOHAMAD ZULKIFLEY, S. PARAMANANTHAN, NG THAM FATT, ROSLAN HASYIM & JOHN KUNA RAJ
Classification of tropical lowland peats
- P1-7 NOORHASHIMA ADENAN, CHE AZIZ ALI & KAMAL ROSLAN MOHAMED
Sedimentologi lapisan perantaraan Formasi Kubang Pasu dan Formasi Chuping, Beseri Perlis
- P1-8 NIZARULIKRAM B. ABDUL RAHIM, NOORAZHAR B. NGATIMIN & ABDULLAH SANI B. H. HASHIM
Fosil Kayu Terpetri Di Dalam Alluvium Kuaternari Di Ulu Tiram, Johor
- P1-9 ZARIFAH ZAMAN & AYE KO AUNG
Depositional Environment of the Sediments of the Calcareous Unit of the Gua Musang Formation from the Padang Tengku Area, Pahang – Analogs to the Western Great Bahama Bank
- P1-10 WONG YIEN LIM, LEE CHAI PENG & NURAITENG TEE ABDULLAH
Sediment and fauna of the Arip Limestone of the Tatau Formation, Sarawak, Malaysia
- P1-11 AHMAD. A.R. & ROSLI SAAD
The effectiveness of seismic refraction tomography for groundwater study
- P1-12 HAZWANI ANUAR & HAREYANI ZABIDI
Influence of rock properties on NATM drilling rate in Interstate Raw Water Transfer Tunnel
- P1-13 NISA' ALI, ROSLI SAAD, M. M. NORDIANA, NUR AZWIN ISMAIL, NOER EL HIDAYAH ISMAIL, A. B. ANDY & A. H. A. TEH SAUFIA
Imaging subsurface geological contact zone using 2D resistivity method at Batang Merbau, Tanah Merah, Kelantan
- P1-14 ROSLI SAAD, I.N. AZWIN & AHMAD. A.R
The use of P wave in pile length measurement for engineering application

- P1-15 SITI NORLIYANA HARUN, ZULFAHMI ALI RAHMAN, SAHIBIN ABDUL RAHIM, TUKIMAT LIHAN & WAN MOHD RAZI IDRIS
Kesan simen portland terhadap sifat geoteknik tanah gambut
- P1-16 ANDY A. BERY, ROSLI SAAD, MOHD MOKHTAR SAIDIN, NORDIANA MOHD MUZTAZA, NOER EL HIDAYAH ISMAIL & NUR AZWIN ISMAIL
Application of electrical resistivity and magnetic surveys in archaeology at Sungai Batu, Kedah, Malaysia
- P1-17 DEWANDRA BAGUS EKA PUTRA
Kajian survei geofizik dengan menggunakan kaedah graviti di kawasan Bukit Bunuh, Lenggong, Perak
- P1-18 M.M. NORDIANA, ROSLI SAAD, M.N.M. NAWAWI & I.N. AZWIN
Horizontal resolution of 2D pole-dipole resistivity imaging as assessed by EHR technique
- P1-19 MUSTAFFA KAMAL SHUIB, AHMAD NIZAM HASAN, MOHD ROZI UMOR, ABDUL GHANI RAFEK, AHMAD ZULHILMI AHMAD YUSRI & MOHD HARIRI ARIFIN
The influence of natural slope geomorphology on active cut slope failures near Gunung Pass, Simpang Pulai-Lojing Highway
- P1-20 MAHMOUD KHAKI, MOHAMMED ABU SHARIAH & ISMAIL YUSOFF
Comparison between Gauss Newton and Quasi Newton methods for an experimental 2D electrical resistivity tomography for dyke model
- P1-21 AZMAN A. GHANI, MOHD FARID ABU BAKAR, WAN NUR ATIQA HAN ISMAIL, FATIN IZZANI HAZAD, MUHAMMAD HATTA ROSELEE & KYAW KYAW NYEIN
Ultrafelsic granitic rocks from Besar, Tengah and Hujung Islands, Johor: Implication to the high felsic granite from Peninsular Malaysia
- P1-22 AZRIN AZMI, AHMAD HUZAIFAH & ZAITON HARUN
Struktur Formasi Kubang Pasu di Guar Sanai dan Bukit Chondong, Perlis
- P1-23 DAYANG NOR ASYILLA BINTI ABANG ABDULLAH & SANUDIN TAHIR
Lithostratigraphy of the Belait Formation in Klias Peninsula, Sabah

POSTER SESSION 2: 9:00 – 10:00, Saturday 24 June 2012

- P2-1 FATEN TAHEERA & BASIR JASIN
Lower Carboniferous Liobole (trilobite) from the Kubang Pasu Formation Northwest Peninsular Malaysia
- P2-2 MOHAMAD TARMIZI MOHAMAD ZULKIFLEY, WAN HASIAH ABDULLAH, NG THAM FATT, S. PARAMANANTHAN, ROSLAN HASYIM & JOHN KUNA RAJ
Evaluation of hydrocarbon source potential of tropical lowland peats and organic soils based on the source rock analyzer (SRA) technique
- P2-3 MOHAMAD HANIF KAMAL ROSLAN, NOR YUSNIZA MD YUNUS, MUHAMAD FAIQ YAHAYA & ZAITON HARUN
Struktur dalam Formasi Kubang Pasu di Bukit Meng, Pokok Sena Kedah
- P2-4 NORSAAFAWATI BT. SAAID, NG THAM FATT & AZMAN A. GHANI
Deformation microstructures of mylonites along the Bukit Tinggi Fault Zone, Peninsular Malaysia
- P2-5 NUR SUSILA MD. SAAID & BASIR JASIN
Facies study of the Kubang Pasu Formation, Northwest of Peninsular Malaysia
- P2-6 REZAL RAHMAT & SHARIFF A.K. OMANG
Petrologi batuan basalt Sungai Baliojong, Kota Marudu, Sabah
- P2-7 A. A. GHANI, NUR CHITRA DEWI MOHAMAD NOOR, N A MAJID & M H A HASSAN
Rare earth elements content and weathering style of granite and basalt soils from Kuantan, Peninsular Malaysia
- P2-8 NOOR HAZWANI BINTI ABDUL RAHIM & MOHD SHAFEEA LEMAN
Struktur biogeni di dalam batuan Formasi Singa, Pulau Singa Besar dan Pulau Singa Kecil, Langkawi

- P2-9 ANDY A. BERY & ROSLI SAAD
Mathematical analysis of geoelectromagnetic waveguiding system in isotropic and gyrotropic media for environmental subsurface study
- P2-10 HARDIANSHAH SALEH & ABDUL RAHIM SAMSUDIN
Pencirian keberintangan geoelektrik batuan sedimen di Semenanjung Dent, Lahad Datu, Sabah
- P2-11 MOHD AMIR ASYRAF, UMAR HAMZAH, MOHAMAD FARIE & HONG TZY YANG
Aplikasi teknik geofizik dalam kajian lubang benam kajian kes di Perak
- P2-12 HANIZA ZAKRI & AZIMAH HUSSIN
The silica rock resources in Negeri Sembilan
- P2-13 NISA' ALI, ROSLI SAAD & M. M. NORDIANA
Delineating geologic contacts using seismic refraction method
- P2-14 NURUL JANNAH ABD RASHID, TAJUL ANUAR JAMALUDDIN & ABD GHANI RAFEK
Pemetaan geologi kejuteraan dan taburan tanah runtuh di kawasan Hulu Klang/Ampang, Selangor
- P2-15 ROSLI SAAD, M. MOKHTAR SAIDIN, M.M. NORDIANA, NUR AZWIN ISMAIL, NOER EL HIDAYAH ISMAIL, ANDY ANDERSON BERY & EDY TONNIZAM MOHAMAD
The study of Bukit Bunuh subsurface for impact crater using seismic refraction method: Preliminary study
- P2-16 DONY ADRIANSYAH NAZARUDDIN
The importance of tsunami-related sites: Notes from Aceh, Indonesia
- P2-17 SITI NORLIYANA HARUN, ZULFAHMI ALI RAHMAN, SAHIBIN ABDUL RAHIM, TUKIMAT LIHAN & WAN MOHD RAZI IDRIS
Kesan pencemaran cecair larut resap terhadap had Atterberg dan sifat pemadatan tanah baki granit
- P2-18 ZULHERRY ISNAIN & JUHARI MAT AKHIR
Integrasi penderiaan jauh dan sistem maklumat geografi (GIS) Dalam pemetaan kawasan berpotensi air tanah sekitar Kota Kinabalu, Sabah
- P2-19 MUHAMMAD HAZIQ BIN HAZIZAN & ARHAM MUCHTAR ACHMAD BAHAR
Utilizing geo-information technologies in managing volcanic hazard and disaster
- P2-20 NOR ARINA MUHAMMAD ARIS
Identification and assessment of geotourism potentials in Jeli District, Kelantan
- P2-21 YEO CHIEH TSING, JACKY CHEN ZON JIE, GLAIZA MARIE GAGNO, TAI CHEW YEE & KONG PEI LU
Logging of a sedimentary sequence in the Sungai Rait Valley of Miri
- P2-22 KHALID, KHAIRUL ASYRAF, AZEEZA B. , FATIN HAMIMI A., MOHD SYAFIQ S., MUHAMMAD HAFIZ Z. & MPIOLO, S.
Mapping of the Lubang Lelong Cave System (Niah National Park)
- P2-23 MOHAMED ALI YUSOF BIN MOHD HUSIN
Toxicity level of selected heavy metals in volcanic soils from Tawau, Sabah
- P2-24 NUR FATINIDIANA RAMLEE
Mineralogical and microstructural study of lime stabilized clayey soil from Trusmadi Formation

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The following papers submitted by students are sponsored by the Academy of Sciences Malaysia (ASM). The papers were selected by a committee comprising representatives from the Geological Society of Malaysia and the Academy of Sciences Malaysia.



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Mohd. Fauzi Rajimin @ Jeman, Kamal Roslan Mohamad & Che Aziz Ali: Pemuliharaan warisan geologi kepulauan Mersing, Johor

Zulherry Isnain & Juhari Mat Akhir: Integrasi penderiaan jauh dan sistem maklumat geografi (GIS) Dalam pemetaan kawasan berpotensi air tanah sekitar Kota Kinabalu, Sabah

UNIVERSITY OF MALAYA

Khor Simon, Meor Hakif bin Amir Hassan & Muhamad Pedro J. Barbeito: Sedimentology and stratigraphy of Kampung Opak Limestone, Bekenu, Sarawak

Norsafawati bt. Saaid, Ng Tham Fatt & Azman A. Ghani: Deformation microstructures of mylonites along the Bukit Tinggi Fault Zone, Peninsular Malaysia

UNIVERSITI MALAYSIA KELANTAN

Muhammad Haziq bin Hazizan & Arham Muchtar Achmad Bahar: Utilizing geo-information technologies in managing volcanic hazard and disaster

Nor Arina Muhammad Aris: Identification and assessment of geotourism potentials in Jeli District, Kelantan

UNIVERSITI MALAYSIA SABAH

Mohamed Ali Yusof bin Mohd Husin: Toxicity level of selected heavy metals in volcanic soils from Tawau, Sabah

Nur Fatinidiana Ramlee: Mineralogical and microstructural study of lime stabilized clayey soil from Trusmi Formation

UNIVERSITI SAINS MALAYSIA

A.H.A. Teh Saufia, Rosli Saad, M.M. Nordiana, Nur Azwin Ismail, Noer El Hidayah Ismail, Andy Anderson Bery, Nisa' Ali: The role of self potential prospecting in delineating underground streams for engineering problems

Nisa' Ali, Rosli Saad, M. M. Nordiana, Nur Azwin Ismail, Noer El Hidayah Ismail, A. B. Andy & A. H. A. Teh Saufia: Imaging subsurface geological contact zone using 2D resistivity method at Batang Merbau, Tanah Merah, Kelantan

CURTIN UNIVERSITY SARAWAK CAMPUS

Yeo Chieh Tsing, Jacky Chen Zoon Jie, Glaiza Marie Gagno, Tai Chew Yee & Kong Pei Lu: Logging of a sedimentary sequence in the Sungai Rait Valley of Miri

Khalid, Khairul Asyraf, Azeeza B., Fatin Hamimi A., Mohd Syafiq S., Muhammad Hafiz Z. & Mpilo, S.: Mapping of the Lubang Lelong Cave System (Niah National Park)

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NOTES

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NOTES

Towards a national policy on geoscience

AZIMUDDIN BAHARI

Minerals and Geoscience Division, Ministry of Natural Resources and Environment

The Minerals and Geoscience Division is responsible for establishing policy directions for sustainable development and advancement of the mining and quarrying sector whilst promoting environmental protection through the integration of geoscience information. The Division also aims to increase contribution to the national income by promoting the added value of minerals and rock materials, implementing an effective export permit system for these products and safeguarding national interests in deliberations on international trade and environment. The Division has several functions pertaining to the minerals and geoscience sectors. These include formulating policies, laws, regulations and programmes; setting long-term and immediate goals and strategic plans; collation and dissemination of information; monitoring, coordinating, evaluating and continuous improvement of the implementation of policies, programmes, laws, regulations and services related to the management of mineral resources and geoscience; promotion of national interests in multi and bilateral relations as well as in the international platform; and processing of export permits for minerals and rock materials. The Minerals and Geoscience Division has formulated and reviewed policies, laws, regulations for the minerals sector as part of its mandate since its establishment. The geoscience sector is a recent focus in view of its increasing importance to the nation.

The field of geoscience is broad and encompass engineering geology, geophysics, hydrogeology, environmental geology, geological conservation and heritage, marine geology, petroleum geology, geochemistry and geomorphology, among others. The contribution of geoscience in reducing the underlying risks associated with socio-economic development and wealth creation needs to be strengthened (Azimuddin, 2012). In addition, the potential of geoscience in contributing directly and indirectly to solutions for issues such as climate change and its implications on water, food and energy security needs to be effectively harnessed (Pereira et al., 2012). Clearly, there is need for a policy framework to provide guidance for improved coordination as well as clear goals and directions. This will in part address the calls for mainstreaming geoscience and targeting geoscience inputs to appropriate levels to ensure societal well-being in the quest for development, which have been made since the late 1990s (Komoo, 1997; Pereira & Komoo, 2003; Pereira & Chen, 2008).

The Minerals and Geoscience Division initiated the project on formulating the National Geoscience Policy in 2011. The project aims to evaluate the role of geoscience in fulfilling national socio-economic needs and assess the contribution of geoscience in addressing issues related to the environment, climate change, risk of geohazards and inputs to green technology (Azimuddin 2012). The ultimate goal is the National Policy on Geoscience that would serve to harmonise the roles of various agencies that manage geoscience activities to ensure implementation that is systematic, focused and effective. Geoscience fields that meets the socio-economic and environmental needs of the country in the immediate, medium and long-terms need to be highlighted and prioritised.

Stakeholder consultation is an integral part of the policy formulation process. A series of consultation workshops were held involving participants from government and non-government organisations as well as the private sector. These include workshops held in Shah Alam (11 – 12 August 2011), Bukit Tinggi (14 – 16 October 2011), Ipoh (2 – 4 December 2011) and Kampar (March - 1 April 2012). The meetings have resulted in draft National Policy on Geoscience encompassing a policy statement, objectives, strategic plans and action plans that meets the socio-economic and environmental needs of the country.

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Geopark: Inovasi untuk pembangunan lestari wilayah (Geopark: Innovation for regional sustainable development)

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Geopark merupakan satu instrumen pembangunan yang diperkenalkan berasaskan keperluan untuk memulihara dan menggunakan sumber warisan geologi secara lestari. Pada peringkat awal, tumpuan diberikan kepada pendekatan untuk memastikan warisan geologi bernilai tinggi (geotapak dan landskap geologi) dipulihara untuk kepentingan sains, untuk pendidikan awam dan untuk aktiviti geopelancongan. Dalam konteks ini, definisi geopark yang diperkenalkan oleh UNESCO (2006) menyatakan geopark ialah *'nationally protected area containing a number of geological heritage sites of particular importance, rarity or esthetic appeal which can be developed as part of an integrated concept of conservation, education and local socioeconomic development'*. Walau bagaimanapun, pelaksanaan konsep geopark telah memperluaskan pengertiannya menjurus kepada idea pembangunan lestari wilayah. Pengertian terkini seperti yang terkandung dalam garis panduan pembangunan geopark oleh UNESCO (2010) diuraikan seperti berikut:

"A geopark is a geographical area where geological heritage sites are part of a holistic concept of protection, education and sustainable development. The geopark should take into account the whole geographical setting of the region, and shall not solely sites of geological significance. The synergy between geodiversity, biodiversity and culture, in addition to both tangible and non-tangible heritage are such that non-geological theme must be highlighted as an integral part of geopark, especially when their importance in relation to landscape and geology can be demonstrated to the visitors. For this reason, it is necessary to also include and highlight sites of ecological, archaeological, historical and cultural value within each geopark. In many societies, natural, cultural and social history is inextricably linked and cannot be separated."

Konsep pembangunan wilayah menggunakan model geopark (Ibrahim Komoo & Sharina Abdul Halim, 2012) telah mendapat perhatian banyak negara kerana konsep ini memberikan tumpuan kepada pembangunan berasaskan pemuliharaan dan utilisasi sumber geowarisan tanpa mengabaikan keperluan pemuliharaan warisan biologi dan budaya, sambil memajukan suatu wilayah melalui aktiviti pelancongan (Ibrahim Komoo, 2009). Berasaskan pendekatan ini, pertempatan penduduk, kawasan pertanian dan industri, dan tapak pemuliharaan warisan tabii dan budaya, berada dalam sebuah geopark. Dalam konteks ini, pembangunan geopark perlu memberikan perhatian kepada tiga komponen utama (Ibrahim Komoo 2010), iaitu: a) pemuliharaan warisan; b) pembangunan komuniti; dan c) pembangunan ekonomi.

Kertas ini akan menghuraikan komponen utama pembangunan geopark, menunjukkan bagaimana setiap komponen dibangunkan dengan mengambilkira hubungkait dengan komponen lain secara terintegrasi, sambil memberikan contoh pembangunan beberapa geopark yang telah dibangunkan dengan jayanya. Berasaskan pengalaman menilai dan menilai semula kemajuan geopark global di rantau Asia Pasifik, model pembangunan geopark boleh menjadi contoh nyata dalam 'inovasi untuk pembangunan lestari wilayah'.

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Rajah 1: Kerangka Pembangunan Geopark: Tumpuan kepada mengimbangi keperluan Pemuliharaan Warisan, Pembangunan Ekonomi dan Kesejahteraan Komuniti.

A half century of geological surveying in Sarawak

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The geological survey department, Sarawak was established in 1949. Prior to that, geological work was carried out on an ad-hoc basis by geologist and explorers; notable pioneers include Shell geologists, C. Hose, van Bemmelen and others. With the establishment of the geological survey department, systematic geological work commenced. In the span of more than 60 years' existence of the geological survey department, notable changes of its purpose and focus of work are clear. For the first 2 decades, under the colonial administration, the department was pre-occupied with the reconnaissance mapping with the aim of achieving complete geological coverage of the State. The geological mapping focus was maintained in the initial years after Sarawak, Sabah and Peninsular Malaysia formed Malaysia in 1963, but shifting to more detailed coverage of priority areas. The next 2 decades were outstanding years in the sense that many geoscience, particularly resource related projects were carried out with foreign technical assistance. Through these joint projects, expertise in new areas of geoscience was acquired and valuable outputs produced. The thirst for more geological information and geoscience inputs to meet development needs of the State after independence necessitates the department to shift its resources and priority to more investigative type of geological work. This role underpins the main focus of work of the department until today. In the transformation of the civil service that started in the mid 1990's, resources for the department were allocated according to the answer to the questions "who are the clients for the output and outcome of the work and how the work can benefit the public?" Therefore it was becoming increasingly difficult to secure resources to support work for the sole purpose of just gaining geoscience knowledge.

The paper will illustrate the changes through time of how work was done, the achievements, the impact of technologies, the role of the geological survey and its geologists in the present-day society and the challenges faced in ensuring its continued relevance and purpose in the future.

Coal mining in Sarawak : Issues and challenges

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Sarawak Coal Resources Sdn Bhd, a subsidiary of the State Government of Sarawak, was established in the year 2005 with the aim of consolidating coal resources in the State of Sarawak. Through this Sarawak State Government's Coal Consolidation Policy, Sarawak Coal Resources have been entrusted to ensure availability, reliability and hence price stability of coal supply for domestic market obligation, and hence sustainable coal mining in Sarawak. Since its inception, the Mukah-Balingian Coalfields have been the focus of development with 60 – 70% of the coal supply for Mukah Power Generation (275 MW Coal-Fired Plant) in Metadeng and the remaining for Sejingkat Power Corporation (220 MW Coal-Fired Plant) in Kuching.

The intent of this paper is to provide a snapshot of the issues and challenges of coal minings from both Mukah Coalfield and Balingian Coalfield in Mukah Division, Sarawak. The issues and challenges, but not limited to the followings, are land matters, infrastructures, quality of the coal, vast areas of deep peat swamps and excessive rainfall.

The first record of the Late Permian waagenophyllid rugose corals from Pahang, Central Peninsular Malaysia

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Late Permian waagenophyllid rugose corals are recovered (Ng, 1986; Aye Ko Aung & Ng, 2012) from the limestone unit of the Gua Musang Formation (Yin, 1965) of Middle Permian to Upper Triassic (Mohd Shafeea Leman, 1993, 2004) age in the Selbourne Estate-Padang Tengku area, Pahang, central Peninsular Malaysia. The Permian limestone lens bearing corals is locally developed as small isolated outcrops in the Selbourne Estate area. It is 162 m long and 79 m in maximum width. These limestones are generally massive, consist of dark coloured bioclastic wackestone. At Selbourne Estate locality, the limestone beds display well preserved faunal assemblage (e.g. rugose corals, gastropods, brachiopods and crinoids) and burrows on the weathered surface and showing very fine and micritic texture when they are fresh. Black chert concretions of variable sizes and shapes are frequent in the upper part. The coral fauna includes one new genus and five new species. The new genus is distinguished from other genera of the family Waagenophyllidae by having phaceloid corallum with third or higher order septa suggesting it to be included in the subfamily Wentzelellinae. Five species of waagenophyllid rugose corals are preliminarily identified: new genus and species, *Waagenophyllum* sp. nov., *Iranophyllum* sp. nov. A, *I.* sp. nov. B, and *I.* sp. nov. C. The genus *Iranophyllum* is reported for the first time from Malaysia. In this study, we identified 20 foraminiferal genera from a single limestone outcrop at Selbourne Estate locality. They comprise the species *Tetrataxis* spp., *Reichelina* spp., *Palaeofusulina* sp., *Colaniella* spp., *Nankinella* sp., *Climacamina* spp., *Lunucamina* sp., *Geinitzina* sp., *Dagmarita* spp., *Pachyphloia* spp., *Globivalvulina* sp., *Paleotextularia* sp., *Pseudokahlerina* sp., *Multidiscus* sp., *Tuberitina* sp., *Nodosinelloides* sp., *Deckerella* sp., *Frondina* sp., *Langella* sp., and *Maichelina* sp. (Aye Ko Aung et al., 2011). The above foraminifera (*Paleofusulina-Colaniella-Reichelina*) fauna associated with the coral assemblage indicates a Changhsingian (Late Permian) age for this part of the formation.

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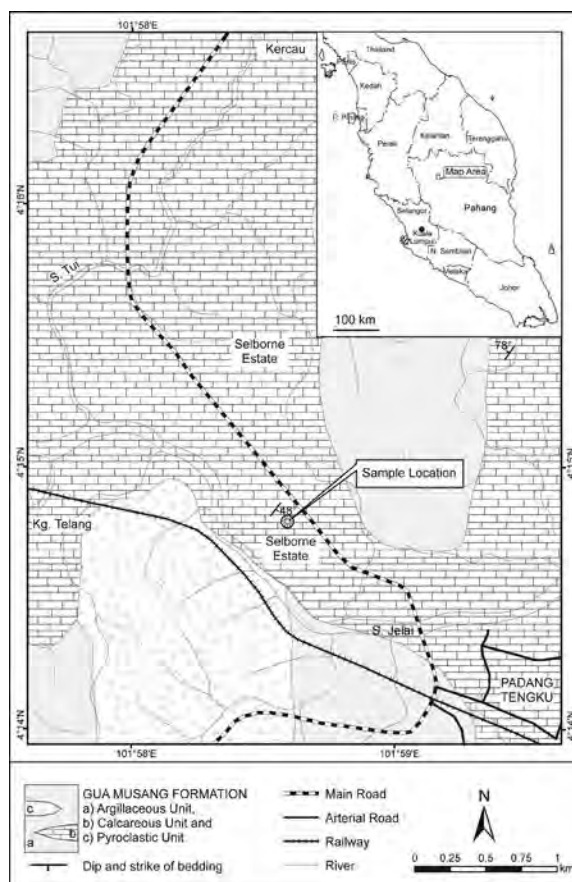


Figure 1: Geological map of the Padang Tengku area showing the Late Permian rugose coral sample locality in Selbourne Estate.

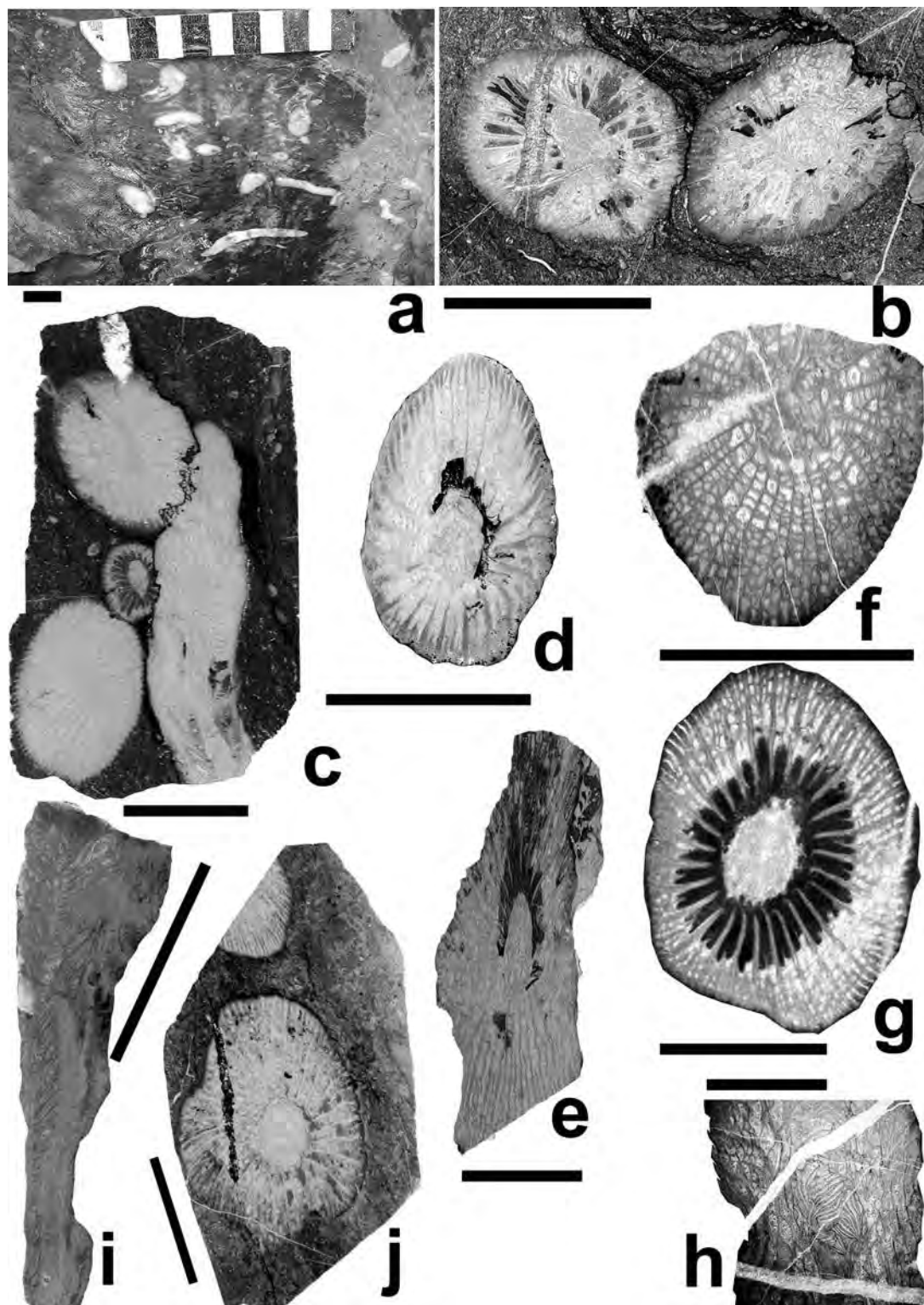


Figure 2: Late Permian rugose corals from Selborne Estate, north Padang Tengku, Pahang. a. Phaceloid *Waagenophyllum* in life position; b. *Waagenophyllum* sp. nov., transverse section. c. transverse and longitudinal sections. d-e. *Iranophyllum* sp. nov. A. d. transverse section, e. longitudinal section. f. *Iranophyllum* sp. nov. B. transverse section. g-h. *Iranophyllum* sp. nov. C. g. transverse section, h. longitudinal section. i-j. new phaceloid rugose coral genus, i. longitudinal section, j. transverse section. Scale bar = 1 cm.

Some Cretaceous radiolaria from Kuamut Melange, Kunak, Sabah

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Introduction

The Kuamut Mélange was formerly known as the Kuamut Formation which was first introduced by Collenette (1965). The Kuamut Mélange is a chaotic mixture of clasts and blocks of broken Paleogene rock formations, and dismembered Ophiolite blocks embedded in shale matrix (Clennell 1991; Sanudin & Baba 2007). The blocks are of various sizes and highly fractured and faulted. This rock unit was exposed at Kunak-Lahad Datu Road, Tingkayu and Sabahan river area. The blocks of Kuamut Mélange comprise of basalt, pillow basalt, serpentinite, chert, sandstone, mudstone, tuffaceous sandstone and shale. The chert in Kuamut Mélange commonly exists as blocks or clasts. The chert is reddish-brown in colour and interbedded with thin siliceous shale. The thickness of the chert ranges from 1 to 10 cm and strongly folded and faulted. The Kuamut Mélange overlies the Darvel Bay Ophiolite Complex at the Upper Segama area and is overlain by the Kalumpang Formation. Collenette (1965) stated that the age of the Kuamut Mélange is from Oligocene to Miocene, and then Leong (1974) revised and assigned it to Miocene. The aim of the research is to establish the age and the origin of chert blocks in the Kuamut Mélange. The study area is located at two outcrops near Tingkayu River, Kunak District, of southeast Sabah (Figure 1).

Materials and methods

Fourteen samples of cherts were collected from two outcrops S1 and S2 at 24 kilometers from Kunak Town. Three and eleven chert samples were collected from two outcrops S1 and S2 respectively. All samples were crushed into small fragments (1cm to 2cm) and then all the fragments soaked into diluted hydrofluoric acid (5% or ratio of water and acid is 9:1) for about 24 hours (Pessagno and Newport 1972). After that all samples were rinsed and dried. The residues were examined under binocular microscope. Well-preserved specimens have been photographed by scanning electron microscope (SEM) for further examination.

Result and discussion

A total of 44 species belong to 30 genera have been identified. Only 36 selected species are used to determine the age of the radiolarian chert (Figure 2). The radiolarians can be grouped into three assemblage's zones (*Crucella gavalai* Zone, *Xitus mclaughlini* Zone and *Crucella cachensis* Zone). The *Crucella gavalai* Zone is characterized by the zonal marker *Crucella gavalai*. This assemblage zone consists of *Dictyomitra excellence*, *Crucella bossoensi*, *Hiscocapsa asseni*, *Hexapyramis precedes*, *Thanarla brouweri*, *Acanthocircus levis*, *Obeliscoites vinassai*, *Stichomitra communis*, *Staurosphaeretta longispina*, *Xitus spicularius*, *Triactoma cellulosa*, and *Dactyliosphaera maxima*. This assemblage zone is from Aptian to Albion in age (122 to 107 million years). The *Xitus mclaughlini* Zone is represented by the zonal marker of *Xitus mclaughlini* which indicated an Albion to Cenomanian in age. This assemblage zone comprises *Xitus spinosus*, *Stichomitra tosaensis*, *Dictyomitra gracilis*, *Dictyomitra montisserei*, *Pseudodictyomitra pseudomacrocephala*, *Pessagnobrachia fabianii*, *Crucella messinae*, *Tuguriella pagoda*, *Dictyomitra obesa*, *Triactoma paronai*, *Rhopalosyringium euganeum*, *Acanthocircus venetus*, *Acaeniotyle rebellis*, *Dictyomitra formosa* and *Pseudodictyomitra tiara*. The *Crucella cachensis* Zone consists of *Patulella helios*, *Hemicryptocapsa polyhedra*, *Eostichomitra bonum*, *Alievium superbum*, *Ultranapora cretacea* and *Pseudotheocampe tina*. This assemblage zone is recognized by the zonal marker *Crucella cachensis* that indicates the Turonian age (93 to 88 million years). In conclusion, the age of chert blocks in the Kuamut Mélange ranges from Aptian to Turonian, Cretaceous (122 to 88 million years). The chert blocks are often associated with ultramafic rocks of the ophiolite sequence. But there are also neogen sedimentary rocks that associated with ophiolite rock association. These rocks association can be interpreted as Mélange Association (Jones & Murhcey, 1986). The age of neogen sedimentary rocks was estimated to be Early Miocene in age (Basir 2002; Sanudin and

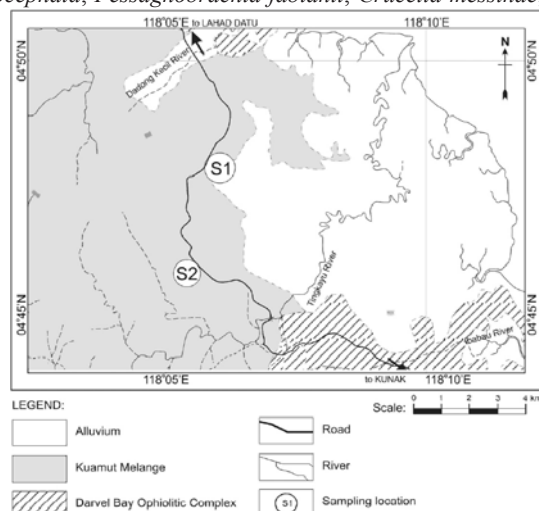


Figure 1: Geological map of study area. (modified after Leong 1974).

Baba 2007). The chert blocks of the Kuamut Mélange were originally deposited in deep marine environment at the spreading center during Aptian to Turonian, Cretaceous, and later was subjected to tectonic compression or shortening and formed chaotic mélangé during Miocene. The formation of mélangé was related to the opening of Sulu Sea (Rangin et al 1990; Clennel 1991; Hutchison 1992).

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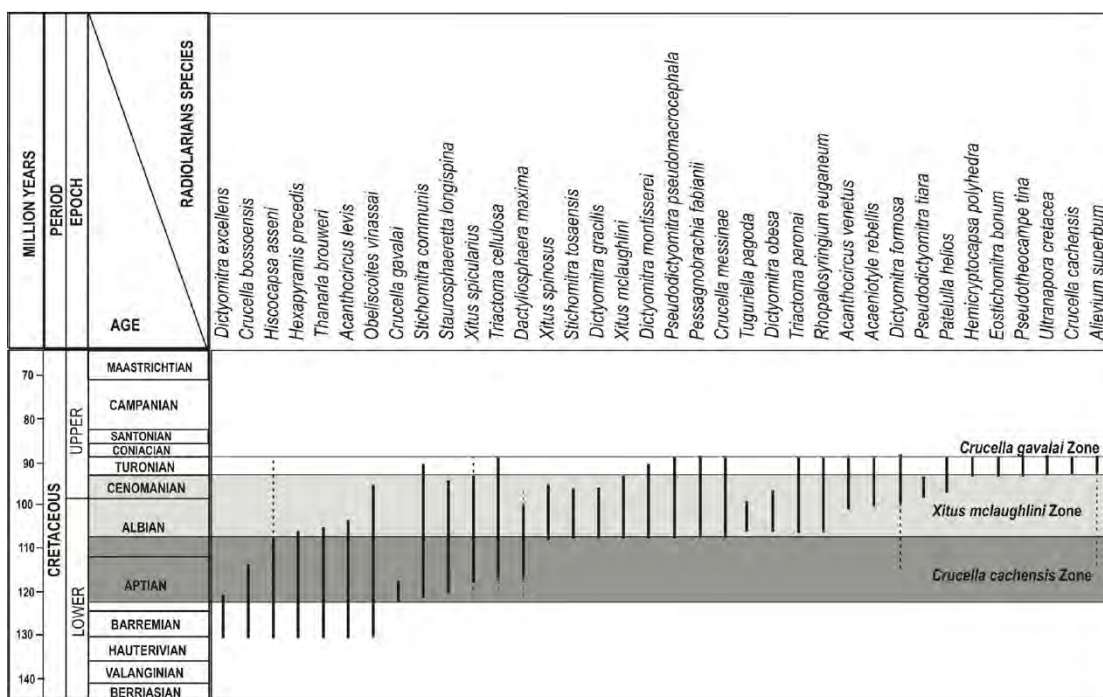


Figure 2: Stratigraphic distribution of selected species from the Kuamut Melange.

Middle Permian Radiolarians from the siliceous mudstone block near Pos Blau, Ulu Kelantan and their significance

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Siliceous mudstone in Pos Blau area is associated with chert. It is located on the top of the chert sequence. Several chert blocks are exposed along the Gua Musang-Cameron Highland road. The cherts and siliceous mudstone occur as blocks in the mélange of Bentong-Raub Suture Zone. The chert blocks in Pos Blau area yielded Early Permian radiolarian assemblages belonging to *Pseudoalbaillella lomentaria* and *Pseudoalbaillella scalprata* m. *rhombothoracata* Zones (Spiller and Metcalfe, 1995, Basir and Che Aziz, 1997; Spiller, 2002). Spiller and Metcalfe (1995) and Spiller (2002) have reported an early Middle Permian radiolarian assemblage indicating the uppermost part *Pseudoalbaillella longtanensis* – lowermost part of *Pseudoalbaillella globosa* Zones from the tuffaceous argillite and chert near Pos Blau.

Recently, twenty two samples of siliceous tuffaceous mudstone were collected from an outcrop of abandoned timber track (Figure 1). The rocks comprise thinly bedded siliceous mudstone interbeds with tuffaceous mudstone and steeply dipping towards southeast. Five samples yielded very low number of individuals but fairly well preserved specimens. Fourteen radiolarians taxa were identified i.e. *Albaillella* cf. *asymetrica* Ishiga and Imoto, *Pseudoalbaillella globosa* Ishiga and Imoto, *Pseudoalbaillella fusiformis* (Holdsworth and Jones), *Pseudoalbaillella* cf. *longtanensis* Sheng and Wang, *Pseudoalbaillella aidensis* Nishimura and Ishiga, *Pseudoalbaillella convexa* Rudenko and Panasencko, *Pseudoalbaillella* cf. *longicornis* Ishiga and Imoto, *Latentifistula texana* Nazarov and Ormiston, *Latentifistula asperspongiosa* Sashida and Tonishi, *Follicucullus monacanthus* Ishiga and Imoto, *Gustefana obliqueannulata* Kozur and *Ruzhencevispongus girtyi* Nazarov and Ormiston. Two radiolarians biozone are recognized:

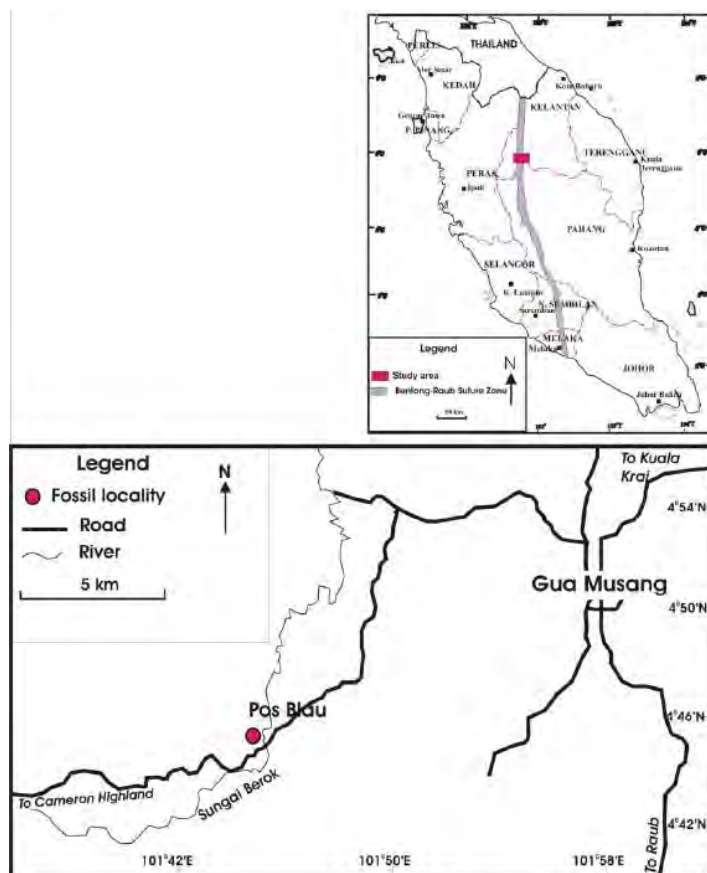


Figure 1: Map showing the fossil locality.

***Pseudoalbaillella fusiformis* Zone**

The zone contains *Pseudoalbaillella fusiformis*, *Pseudoalbaillella globosa*, *Pseudoalbaillella aidensis*, *Pseudoalbaillella* cf. *longicornis*, *Pseudoalbaillella convexa*, *Hagleria mammilla*, *Pseudoalbaillella* cf. *longtanensis*, *Pseudoalbaillella aidensis* and *Latentifistula texana*. The assemblage zone is found from samples BC18 to BC20. The common occurrence of *Pseudoalbaillella fusiformis* and rare occurrence of *Pseudoalbaillella globosa* suggest this zone represents the upper part of *Pseudoalbaillella globosa* Zone of Ishiga (1990). Zhang Ning et al. (2010) have modified the upper part of the *Pseudoalbaillella globosa* Zone. They proposed a new biozone *Pseudoalbaillella fusiformis* Zone. The lower boundary of the zone is marked by the first appearance of *Pseudoalbaillella fusiformis*. The assemblage represents an age of Roardian, early Middle Permian.

***Follicucullus monacanthus* Zone**

The zone is characterized by the occurrence of zonal marker *Follicucullus monacanthus* which has very short stratigraphic range and restricted to the zone. Other species found in the zone are *Pseudoalbaillella fusiformis*, *Pseudoalbaillella convexa*, *Pseudoalbaillella* cf. *longicornis*, *Hagleria mammilla*, *Latentifistula* sp., *Gustefana obliqueannulata* and *Ruzhencevispongia girtyi*. The assemblage is obtained from samples BC21 and BC22. This assemblage suggests Wordian age, middle Middle Permian.

The siliceous tuffaceous mudstone block near Pos Blau is considered as a remnant of oceanic sediment developed in the Bentong-Raub Suture Zone. The occurrence of Middle Permian radiolarians suggests that the Palaeo-Tethys was an ocean from Devonian to Middle Permian. The closing of Palaeo-Tethys started during the Late Permian and the ocean became a shallow sea during Late Permian followed by the deposition of Triassic limestone. The interbedded tuffaceous mudstone and siliceous mudstone indicates the supply of tuffaceous material from the volcanic activities in the area during the Middle Permian.

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Discovery of the Permian Foraminifera: A significant evidence for the age of limestone pinnacles at Gua Seh area, Pahang, Central Peninsular Malaysia

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The first reported occurrence of Permian foraminifera in the limestone pinnacles widely distributed in the areas of Kampong Gua, Kuala Lipis Pahang marks a significant discovery in updating information on the calcareous facies of the Gua Musang Formation. The study area is located in the Padang Tengku area, Kuala Lipis, Pahang. The area is geologically underlain by the Gua Musang Formation, the Jelai Formation and the unnamed granitoids. The Gua Musang Formation consists of three facies: argillaceous facies, calcareous facies and volcanic facies. The calcareous facies of this formation is described as oolitic, intraclastic and fossiliferous limestone (Ng, 1986). The limestone pinnacles can be found in several localities at Kampong Gua, about 1.5 km south of Padang Tengku. The Kampong Gua had a prominent massive limestone hill of Gua Seh that is included in the carbonate succession of the Gua Musang Formation. The pinnacles are occurred at 7 localities showing varying degrees of recrystallization with color ranging from light to dark grey. In addition, dolomitization is also partially developed in several pinnacles. The Gua Musang Formation is regarded as the age of Middle Permian to Upper Triassic (Mohd Shafeea Leman, 1993, 2004). The Middle Carboniferous (Visean) fossils have previously been reported from the Gua Seh area and correlated to one that is found in Gua Bama area (Lee Chai Peng, 2009). Gobbet (1973) stated that the age of the Gua Bama and Gua Seh is predicted to be Visean to Anisian based merely on macrofossils discovered. Among fossils found includes *Ortoceras*, *Cryptoceras*, *Solenacheilus* sp. Nuraiteng Tee Abdullah & Abdul Hadi Rahman (1993) described the occurrences of upper foraminifera in Northwest Pahang from the middle to upper part of the lower limestone succession in Gua Panjang (northwest Pahang). The foraminiferal assemblages are composed of *Paleofusulina*, *Reichelina* and *Colaniella*. It bears similarities with upper Permian assemblages reported from South Kelantan and South East Asia. The Gua Seh limestone pinnacles contain fairly rich in macrofossils (various genera of sponges) and microfossils (foraminifera). To date, some Permian foraminifera species such as *Reichelina* sp., *Tetrataxis* sp., *Pachyphloia* sp., *Multidiscus* sp. and ?*Colaniella* sp. are identified from several limestone collections. The assemblage indicates Permian age for the limestone pinnacles. Making more thin sections of the Gua Seh limestone is in progress and we hope to find more foraminifera of precise dating

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Intergrated research for conservation, land use planning and geotourism in Langkawi Geopark, Malaysia

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Being and oldest landmass with the most complete Paleozoic rock sequence Langkawi Geopark hosts the richest geological diversity and heritage resources in Malaysia. This geological diversity has in turn created a wide range of biological and socio-culture diversities that attract tourists to Langkawi. Independent scientific research in Langkawi geopark has been going on since the middle of the past century covering all aspects of science including geology and biology. During that period there was no effort had been made to connect all the research aspects that can produce a meaningful use of the research outcomes let alone to envisage the natural resources in Langkawi as heritage. More intensified research programmes that were trying to bring out the heritage value and heritage conservation was only started in 1996 after the Geological Heritage Group of Malaysia was established. Since then more effort has been focused on identifying, characterizing and ranking all the geological features in Langkawi. In 2002 the Langkawi Research Center (LRC) was established after realizing that integration all research programmes can enhance the significance and value of the heritage resources in Langkawi. Under LRC all short terms and long terms research are being plan to ensure that the Langkawi Geopark will sustain over a long period of time. At the same time LRC also provides logistics to facilitate all research in Langkawi. To date there are more than 90 interesting geological features located at more than 10 geosites have been identified, characterized and proposed for conservation. At the same time more than 10 potential biosites that are associated with geosites have also been identified and in the process of further characterization. The importance of these two interdependent natural resources have been combined and conserved within 3 geoareas known as geoforest parks. The geosites and biosites that are located outside the integrated conservation areas are always under stress due to the needs of space for the development. In this case Langkawi Geopark has come up with a Langkawi Geopark Management Plan that suggests all the important sites be included in future land use planning.

Geological heritage resources and potential geotourism development at the tip of Borneo, Northern Sabah, Malaysia

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Introduction

The Kudat District in Northern Sabah is becoming a popular tourist destination for local and foreign visitors. However, the attractions are limited to the native longhouses, gong making, beadwork, bee farming and the beautiful beaches (Hutton, 2003). In order to sustain the tourism industry in the district and Sabah in general, more tourism products should be produced.

One of the sites in Kudat which are popular among the local and foreign visitors is the Tanjung Simpang Mengayau, also popularly known as the Tip of Borneo. Tourists visit this rocky promontory because of its picturesque coastal landscape. Visitors are willing to drive for three hours from the State's capital to visit the Tip of Borneo simply to enjoy its scenic coastal landscape. From this site, visitors have command view of the South China Sea and the Sulu Sea. Sunrise and sunset could also be observed from this site. To the non-geoscientist tourists, the attractions end here. However, unknown to the tourists and public, the Tanjung Simpang Mengayau is rich in geological wonders that are hidden to the untrained eyes (Tongkul, 2008). The geological wonders are in fact the geological heritage asset of the site. Therefore, a detailed study was carried out to identify the geological heritage resources at Tanjung Simpang Mengayau for geotourism development purpose in order to supplement and enhance tourism in the district and the State in general (Figure 1 and 2).

Objective

The objective of the study is to identify and characterize the potential geological heritage resources in the study area and to recommend a sustainable development proposal for geotourism purpose.

Methodology

The R&D on geological heritage resources for geotourism purpose is a multi-disciplinary approach involving earth science, planning, law and management (Ibrahim Komoo, 2000). The research component of the study involves inventory, characterization (geological mapping), classification, evaluation and ranking of geosites while the development component involves geoconservation and geotourism development.

Results

The study has identified geological heritage resources such as 3D faults, striking joints, ancient sea notches, sandstone concretions, ancient shore platforms, tafoni, beautiful cliffs, Liesegang bands, garnet beach sands, geoarts and various weathering and erosional features. Other resources include sea caves that have been formed more than 2,000 years ago and unique remnant sandstone concretions (Figure 3). These resources are significant as they will contribute to better scientific understanding of the geomorphological, tectonic and geological history of the study area and the region in general. Besides, they have high aesthetic, recreational, cultural and ecological values which are related to the geology of the area. These resources are under threats of destruction due to absence of legal protection and lack of awareness of their importance for scientific, research, educational, cultural, historical, recreational and ecological values. The proposed geoconservation measures include erecting warning signs and creating awareness through education. The geological heritage resources at the site have high geotourism potential and therefore proposed for geotourism development. The geotourism development proposal plan includes the setting up of visitor centre and other infrastructure such as geotrail, kiosk, observation huts, information panels, directional signs and associated interpretative materials.

Conclusions

Study on the geological heritage resources at the Tanjung Simpang Mengayau area has revealed several geological heritage resources with high scientific, aesthetic, recreational and cultural values. The geological heritage resources have high geotourism potential for research, educational and recreational activities. This new tourism product will directly benefit the local community as well as the tourism industry in the State in general. Some of the benefits of geotourism development include the sale of local products and new employment and business opportunities. In order for the geotourism development to be sustained, the local community needs to be highly involved. The local community would protect the site if they could gain economic benefits from the tourism development and

have a sense of pride of the heritage in the area. It will also instil awareness on the local community and the public in general on the needs to conserve and protect the environment. In order for the geotourism development to be realised, a committee needs to be formed that includes both the government and private sectors.

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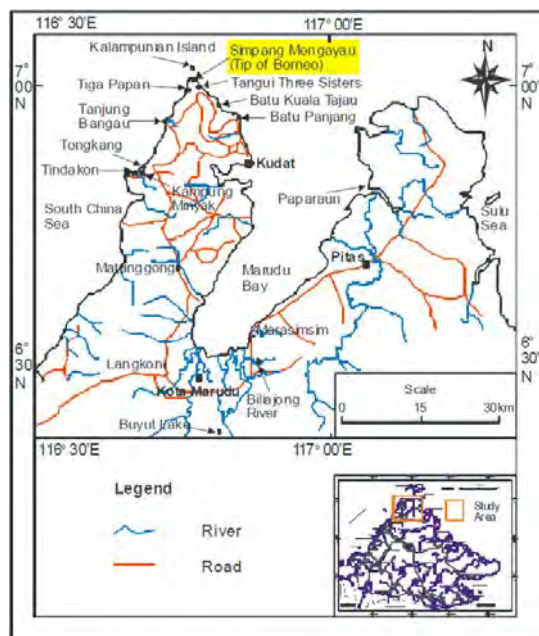


Figure 1: Location of study area at Northern Sabah (Muda, 2009).



Figure 2: Aerial view of the Tip of Borneo at Tanjung Simpang Mengayau, Kudat, Sabah.

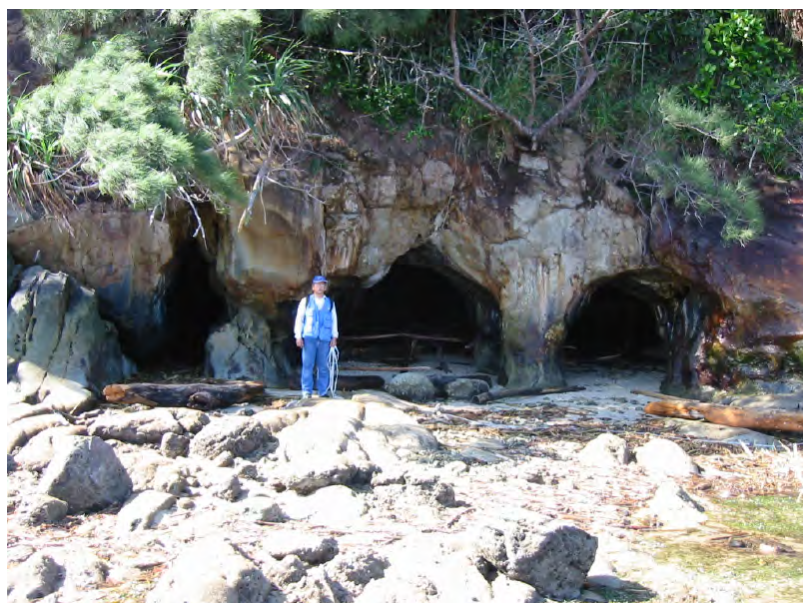


Figure 3: Sea caves at Tanjung Simpang Mengayau.

Pemuliharaan warisan geologi kepulauan Mersing, Johor

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Pengenalan

Warisan geologi merupakan konsep di mana sumber geologi dan landskap yang menyimpan rekod sejarah bumi penting, unik, mempunyai bentuk sangat menarik, mempunyai perkaitan rapat dengan ketamadun manusia atau mempunyai keindahan tabii luarbiasa (sumber warisan geologi) adalah sesuatu yang bernilai warisan. Nilai warisan sumber geologi dan landskap ini pula terdiri daripada nilai saintifik, nilai estetik, nilai rekreasi dan nilai budaya (Ibrahim Komoo et al., 2001).

Sumber warisan geologi yang terdiri daripada batuan, mineral, fosil dan rupabumi merupakan aset kekayaan negara. Pembentukannya yang mengambil masa jutaan tahun akan musnah dalam masa yang singkat sekiranya tiada langkah-langkah pemuliharaan diambil. Pembangunan pada beberapa dekad yang lalu lebih memfokus kearah pembangunan prasarana dan eksplorasi sumber secara meluas hingga melampaui tampungan alam sekitar. Kepentingan pemuliharaan di dalam sesuatu perancangan pembangunan perlu diberi perhatian serius di dalam usaha untuk mengekalkan aset penting yang berusia jutaan tahun ini

Pulau-pulau di Daerah Mersing, Johor mempunyai pelbagai khazanah dan sumber warisan geologi yang jarang ditemui di tempat lain, termasuklah kepelbagaian jenis batuan, morfologi, landskap dan pantai (Mohd Fauzi Rajimin 2009). Kepulauan ini terdiri daripada 13 buah pulau yang merupakan sebahagian dari Taman Laut Johor. Pulau-pulau utama seperti Pulau Besar, Pulau Tinggi, Pulau Sibul, Pulau Aur dan Pulau Pemanggil menjadi tumpuan pelancong dan penyelam skuba kerana pantai dan terumbu karangnya yang cantik. Setiap pulau mempunyai keistimewaan geologinya yang tersendiri.

Inventori dan pencirian

Daripada kajian inventori, sebanyak 14 geotapak yang telah dikenalpasti terdapat di kelima-lima pulau utama iaitu empat di Pulau Sibul, dua di Pulau Besar, tiga di Pulau Tinggi, dua di Pulau Pemanggil dan tiga di Pulau Aur.

Pulau Sibul merupakan tinggalan batuan gunung berapi kuno yang berusia 290 juta tahun. Keseluruhan pulau ini terdiri daripada batuan igneus vulkanik iaitu jenis lava dan piroklas. Keunikan pulau ini terletak pada kepelbagaian fasies vulkanik yang terdiri daripada lapisan nipis sedimen piroklas yang terendap di sekitaran air hinggalah lapisan tebal piroklas yang mempunyai klasta yang bersaiz bungkah (bom). Penemuan fosil kayu di dua lokasi pulau ini menunjukkan sekitaran kebenuaan. Morfologi pantai pula boleh di cerap di sepanjang pantai timur pulau ini termasuklah morfologi tombolo yang menyambungkan bahagian utara dan selatan pulau.

Pulau Besar pula mempunyai batuan granit yang mengandungi SiO_2 sangat tinggi dan ini jarang ditemui dalam jumlah isipadu yang besar. Data geokimia menunjukkan kandungan SiO_2 melebihi 76% (Azman 2004). Jumlah ini adalah lebih tinggi berbanding kebanyakan pluton granit yang terdapat di Jalur Timur seperti granit Maras Jong dan granit Kuantan yang mempunyai kandungan SiO_2 sekitar 72% hingga 74%. Keadaan ini adalah luarbiasa kerana kebiasaannya batuan berkomposisi granit di Semenanjung Malaysia yang mengandungi lebih dari 76% SiO_2 wujud sebagai aplopegmatite atau telerang fasa lewat yang memotong batuan granit lain.

Pulau Tinggi merupakan pulau tertinggi di kepulauan Mersing. Batuan vulkanik adalah dominan di pulau ini dan telah mengalami metamorf sentuh akibat rejahan granit. Pantai berbatu sepanjang lima kilometer di bahagian utaranya membentuk lebih dari sepuluh buah gua kawalan struktur. Arah bukaan gua adalah sama dengan arah jurus kekar dan sesar yang memotong batuan iaitu sekitar 175° hingga 200° .

Pulau Aur dan Pulau Pemanggil pula dibentuk oleh batuan igneus plutonik yang paling ke timur dalam Jalur Timur Semenanjung Malaysia. Kedua-dua pulau ini terdiri daripada kepelbagaian batuan plutonik pertengahan hingga mafik seperti diorit, trakit dan gabro. Selain daripada pelbagai rupabumi pantai yang menarik terdapat beberapa morfologi yang jarang ditemui iaitu morfologi kubah (dome) batuan pluton Bukit Buau di Kampung Teluk Buau, Pulau Pemanggil dan morfologi tebing tinggi sepanjang satu kilometer yang di Tanjung Neratan, Pulau Dayang.

Pengelasan, penilaian dan pentarafan

Kepelbagaian fasies vulkanik yang tersingkap di keseluruhan Pulau Sibul adalah bernilai luarbiasa kerana setakat ini tidak lagi dijumpai singkapan sepertinya di Malaysia. G Kepelbagaian fasies yang ada jelas menunjukkan sama ada punca letusan gunung berapi terletak tidak jauh dari Pulau Sibul ataupun pulau ini sendiri adalah merupakan tinggalan gunung berapi kuno. Geotapak pulau ini boleh ditarafkan sebagai taraf kebangsaan. Pulau Besar, Pulau Aur dan Pulau Pemanggil mempunyai kepelbagaian batuan igneus pluton dan kepelbagaian landskap. Kesemuanya

bernilai tinggi dan bertaraf negeri atau rantau. Manakala Pulau Tinggi pula mempunyai kepelbagaian morfologi pantai yang bernilai sederhana namun bertaraf negeri.

Kesimpulan

Hasil kajian ini mencadangkan kesemua pulau-pulau di Kepulauan Mersing ini dipulihara sebagai Taman Geologi bertaraf kebangsaan dengan Pulau Sibul diangkat sebagai salah satu geotop di Malaysia. Diharap dengan adanya kajian warisan geologi ini akan menambahkan sumber tarikan pelancong selain dari aktiviti skuba dan rekreasi yang lain. Namun demikian kesedaran untuk memelihara sumber warisan ini juga perlu ditingkatkan. Konsep geologi pemuliharaan dan geopelancongan perlu diterapkan bagi memastikan kedua-dua pemuliharaan dan pembangunan selari.

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Mount Chamah: Explore the hidden geological treasure in remote Kelantan

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Mount Chamah (its peak: 2171 m = 7123 ft) is the highest point in the state of Kelantan and is one of the mountain peaks of the Main Range (also called the Titiwangsa Range). It is situated in the western corner of Kelantan, near the state border with Perak and within the area of Gua Musang district (Figure 1). From the GPS reading, it lies on the coordinates of N 5°13.632', E 101°34.438'. It is the tenth highest mountain in Malaysia and is the fifth in Peninsular Malaysia. It is also one of the Group 7 (G7), a mountain category with more than 7,000 feet altitude in Peninsular Malaysia.

This paper consists of preliminary identification and mapping of the hidden geological treasures and attractions in Mount Chamah area. There are several beautiful landforms/landscapes and important geological treasures in the area. Those landforms/landscapes and treasures have many stories to tell: the materials, the processes, the products, and the history of the Earth. All those things are within the scope of geology. According to Neunendorf et al. (2005), geology is the study of planet Earth, the materials of which it is made, the processes that act on these materials, the products formed, and the history of the planet and its life forms since its origin. Understanding how beautiful landforms/landscapes and treasures originated would become a subject of interest.

Identification and mapping of geological treasures in Mount Chamah area is still in the early stage. It has been done during the Explore Chamah 2011 programme, organized by Kelantan State Forestry Department in collaboration with Universiti Malaysia Kelantan on 24 – 29 July 2011. The objectives of this study are to identify and to map the main geological treasures of Mount Chamah area, the hidden treasures of Kelantan; to make general observations of the geological treasures in the area; and to propose an initiative to conserve and develop Mount Chamah area to become an alternative geotourism site in Kelantan. Field observation and GIS analysis methods were used in this study.

Mount Chamah is assumed as the most challenging mountain in Malaysia because of its accessibility from the town to the area and from the start of the trek to the peak. It is a remote and secluded mountain, as well as a dense forest, but contains some beautiful landscapes within its area. It is also rather untouched and still unknown by general public and even by researchers. This mountain is famous only among few hikers and conservationists. This area has a wide range of natural resources, both biodiversity and geodiversity.

In geodiversity, even the area is monotonously dominated by granitic rocks, it possesses some geological features and beautiful landforms, such as hilly to mountainous terrain, rivers, waterfalls, and rock outcrops. Mount Chamah area is a part of the Main Range, which consists mostly of granite with some several enclaves of sedimentary and metamorphic rocks. The Main Range is the “backbone” of Peninsular Malaysia, the most prominent mountain range which extends from southern Thailand in the north to Negeri Sembilan in the south with the elevations rarely less than 910 m and peaks of over 2,100 m (Raj, 2009). The morphology of Mount Chamah is marked by the undulating hills with steep valley walls and sharp-crested ridges with the summit at elevation of 2171 m (7123 ft). Some granites here are megacrystic granites with coarse to very coarse grained/ large phenocrysts (up to 7 cm). This area is overlain by thick granitic soils, the weathering product of granitic rocks.

Eder & Patzak (2004) stated that many countries have started to develop schemes for recognizing important geological and geomorphological sites or landscapes within their national boundaries. Such sites are important for educating the general public in geological and environmental matters. They also serve as tools for demonstrating sustainable development and for illustrating methods of site conservation whereby recalling that rocks, minerals, fossils, soils, landforms and landscapes are both the products and records of the evolution of our planet Earth. Tjia (2000) writes that Earth scientists/geologists can contribute to the sustained development of the area by identifying geological aspects and bringing this information to the knowledge of general public and the relevant authorities.

Like other mountains, Mount Chamah are also important for various aspects of life. According to Scherrer and Pickering (2010), mountain areas have economic, cultural, and ecological values. Many indigenous people still live in the area and rely their life on the mountain resources such as water from mountain for drinking and sanitation.

Several interesting geological treasures have been identified and mapped, such as Lata Pichong waterfall, Pichong river, “Boat Rock” outcrop, and the panorama of the Main Range from the summit area. The geological map and distribution map of geological treasures in Mount Chamah area are shown in Figure 2.

Lata Pichong waterfall (Figure 3 (a)) is a part of Pichong river which has more than 15 meter height and around 15 meter width. Its water is so clean and cool. The underlying rock here is monotonous granitic rocks (coarse-grained porphyritic quartz granite), a part of the Main Range Granite. This waterfall is very attractive and suitable for the recreation. Visitors can swim and take a bath here. It seems to be the main geological treasure and attraction of Mount Chamah area.

Pichong river (Figure 3 (b)) flows through the Pichong village. It is a pleasing and relaxing water flow. Not like most rivers in Kelantan, it has the cold and crystal-clear water that are not easily found today. So, this river is very important to secure freshwater resources in Kelantan.

“Boat Rock” outcrop (or “Batu Perahu” in Malay, **Figure 3 (c)**) is actually a name given by staff of Kelantan State Forestry Department to an outcrop of granitic rock in Mount Chamah area. This granite outcrop is unique because its shape is like a boat. It provides an example of the importance of geological interpretation at this unique phenomenon. Boat Rock is a 2.5-metre overhanging natural wall of granite which extends for a length of about 10 m. The granite is interpreted to undergo fracturing before some parts of it weathered. The weathered part of granite is then eroded by rain waters running off the exposed part. When



Figure 1: Location map of Mount Chamah.



Figure 3: Some hidden geological treasures of Mount Chamah area: (a) Lata Pichong waterfall; (b) Pichong river; (c) “Boat Rock” outcrop; and (d) the panorama of the Main Range.

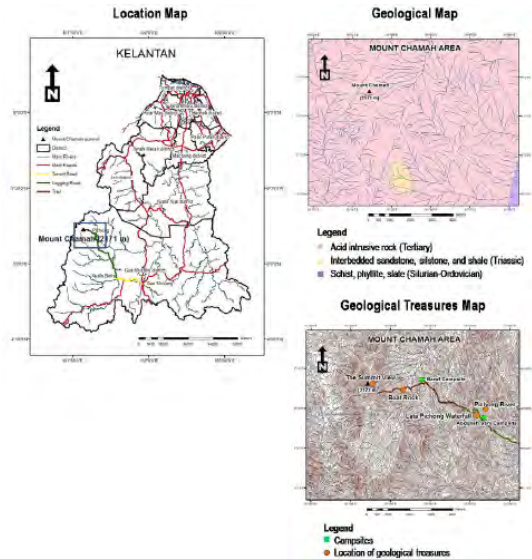


Figure 2. The location map, geological map, and geological treasures map of Mount Chamah area.

the weathered part of granite was removed due to erosion, a tilted and smooth slope was revealed. The outcrop looks like a boat in this time. The process occurred over a long period of time.

The panorama of the Main Range (Figure 3 (d)) can be seen from the summit of Mount Chamah. It will be fun and enjoyable when a hiker arrived in the peak of the mount. They can see and enjoy beautiful panorama from the top such as the wonderful scenery of the Main Range and some of its peaks. However, it has always been a challenge to climb to the summit area of Mount Chamah. A hiker might be able to see wild animal and other fauna and flora, whereas there are a lot of mosses to the summit area. This range is the result of some geological processes such as tectonic uplift that produced that mountainous range.

Earth scientists or geologists should play an important role to identify, to map, and also to promote geological treasures of the area. Detail geological mapping of Mount Chamah area are needed to be conducted. The authorities, both local and central governments, should build the supporting elements in the area, such as the proper roads (accessibility) and facilities for researchers, hikers, tourists and general public. The academics and researchers have to take a part in proposing attempts for conservation and development planning of the area, such as for the purpose of a new, alternative (geo)tourism destination in Kelantan.

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Geomorphological mapping of chamah, kelantan using GIS technique

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Keywords: geomorphic process, morphometry, batholith landform, granite intrusion, GIS technology

Comprehensive information about geomorphology is needed as a basis for understanding biodiversity of Chamah. This research focused to the presentation of data, especially geomorphic process and morphometry data on Chamah as a primary component of Land-systems Inventory map units, as a primary component of integrated ecological map units and to help characterize or define the physical parameters of Chamah. Primary data were obtained through mapping activity and interviewing some residents around Chamah. Mapping was done in one main traverse from Base Camp Abdullah Sani to the peak of Chamah. Other areas was mapped by other researchers through short distance trajectories. The main instrument used in this mapping is a GPS which has been installed with digital data of Chamah. Secondary data is obtained in a topographic maps scale 1: 50,000, satellite imagery, and digital data covering the entire area of chamah. All data were analyzed using GIS technology. Geomorphology of Chamah composed by tectonic and fluvial geomorphic process. Geomorphic processes shows two geomorphic subprocesses, Faulting with Fault Scarp landform unit and compound fault scarps landform unit and Structural subprocess with batholith landform unit which is occur as a result of Granite intrusion.

Fluvial Geomorphic process includes fluvial slope processes with specific landform unit such as surface eroding processes dan stream processes. Through analysis of the topography known that the drainage pattern in Chamah is dendritic. Generally the rivers are still on the young stadia.

In addition to the mathematical relationships found in Chamah stream ordering, various aspects of drainage network forms were also found to be quantifiable. One such relationship was drainage density. Drainage density is a measure of the length of stream channel per unit area of drainage basin. Mathematically it is expressed as:

Drainage density (Dd) = Stream Length / Basin Area

Drainage density of Chamah = $506.670/133 = 3.81\text{km/km}^2$

The measurement of drainage density provides a hydrologist or geomorphologist with a useful numerical measure of landscape dissection and runoff potential. On a highly permeable landscape, with small potential for runoff, drainage densities are sometimes less than 1 kilometer per square kilometer. On highly dissected surfaces densities of over 500 kilometers per square kilometer are often reported. Closer investigations of the processes

Table 1: Stream ordering and calculation of Chamah.

Order	No. of Segments	Bifurcation Ratio
1	652	
2	149	4.38
3	43	3.47
4	6	7.17
		6
5	1	

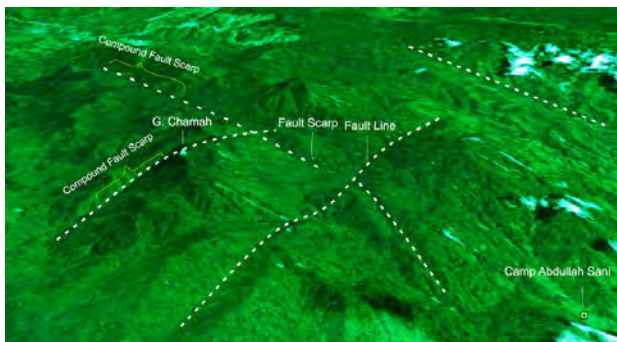


Figure 1: Faults structures of Chamah in 3-D view

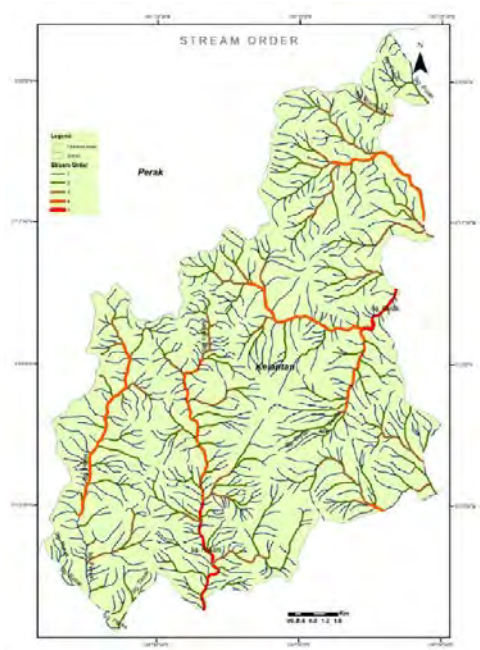


Figure 2: Chamah stream order

responsible for drainage density variation have discovered that a number of factors collectively influence stream density. These factors include climate, topography, soil infiltration capacity, vegetation, and geology.

By morphometry analysis the slope is generally classified as steep with angle between 30°-65°, It is also classified as an area with High-density stream. Weathering that occurred in the area is not too strong. It can be concluded that geomorphology chamah generally controlled by landform batholith which is formed by Granite intrusion.

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Sumber geowarisan dan geopelancongan di sekitar pembangunan wilayah ekonomi koridor utara Perlis

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Geowarisan dan geopelancongan adalah pendekatan yang inovatif untuk memelihara warisan dan menggalakkan penyelidikan, pendidikan awam serta pembangunan ekonomi tempatan. Kepelbagaian khazanah geologi di Perlis menjadikan negeri ini antara negeri yang unik di Malaysia. Jujukan batuan di Perlis terdiri daripada jujukan batuan samudera berusia dari kambrian hingga ke Trias yang terdiri daripada empat (4) formasi utama batuan iaitu Formasi Machinchang, Formasi Setul, Formasi Kubang Pasu dan Formasi Chuping. Selain itu, terdapat juga endapan kebenuaan yang terdiri daripada Lapisan Arang berusia Tertier. Sempadan antara Formasi Setul dan Formasi Kubang Pasu dapat dicerap di Guar Sanai, Utan Aji. Didalam Rancangan Struktur Negeri Perlis (2009-2020), salah satu tema pelancongan iaitu geologi dan arkeologi telah dijadikan asas pembangunan pelancongan Negeri Perlis dimasa depan. Melalui panduan Rancangan Struktur (RT) ini, cadangan pembangunan geotapak dapat dirancang dan seiring dengan dengan keperluan semasa. Terdapat beberapa kawasan mempunyai potensi berdasarkan ciri-cirinya yang sesuai sebagai sumber geowarisan dan geopelancongan negeri Perlis. Kawasan-kawasan tersebut adalah seperti Gua Kelam, Gua Cenderawasih, Gunung Perlis, Gua Wang Burma, Hutan Lipur Bukit Kubu, Utan Aji, Guar Geteri, Bukit Lagi dan lain-lain lagi.

Geoheritage and geotourism is an innovative approach for protection of the heritage, encourage scientific research, public education and local economic development. The variety of geological resources in Perlis makes it to be one of the unique states in Malaysia. Rock sequences in Perlis are made of the sequence from Cambrian to Triassic that consists of four main rock formations that is Machinchang, Setul, Kubang Pasu and Chuping Formations. Other than that, a tertiary continental deposit was also found at Bukit Arang Beds of tertiary age. The boundary between Setul and Kubang Pasu Formations can be observed at Guar Sanai, Utan Aji. In Perlis State of Structure Plan (2009-2020), one of the tourism theme it is geology and archeology have been used as the basis of tourism development of the future State of Perlis. Through the Structure Plan guidelines (RT), the proposed development of geoheritage site can be planned with the current requirements. There are several places that had a great potential based on its feature as a resource of geoheritage and geotourism of Perlis. The area includes Gua Kelam, Gua Cenderawasih, Gunung Perlis, Gua Wang Burma, Hutan Lipur Bukit Kubu, Utan Aji, Guar Geteri, Bukit Lagi and others.

Guide to greening of quarries in Malaysia

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Surveys on quarries done showed that many Malaysian quarries are not adequately greened. As quarrying activities to some extent cause negative impacts on the environment in the form of visual intrusion, dust, noise and fly rocks, these quarries should be adequately landscaped and restored with suitable trees, whereas ex-quarries that impart visual intrusion should be adequately restored and rehabilitated. A landscaped and restored quarry provides pleasant settings for the surrounding neighbourhoods and encourages wildlife interest in enhancing biodiversity and aiding natural propagation of plants. This paper focuses on guide to green quarries in Malaysia in term of the selection of suitable plant species and planting techniques to be used, highlighting on the four elements of effective greening of quarries i.e. screening, shading, green and aesthetic. In addition, the selection of plants shall preferably be those that are disease and drought resistance, able to thrive on nutrient poor soil and of wildlife interest.

Survei ke kuari-kuari menunjukkan bahawa banyak kuari di Malaysia tidak dihijaukan dengan secukupnya. Oleh sebab aktiviti kuari sedikit sebanyak memberi kesan negatif terhadap alam sekitar dalam bentuk gangguan pandangan, habuk, bunyi bising dan batu terpelanting, kuari-kuari ini perlu dilandskap dan dipulihkan secukupnya dengan penanaman pokok-pokok yang sesuai, manakala bekas kuari yang memberi kesan gangguan pandangan perlu dipulihkan dan dibaikpulihkan. Kuari yang dilandskap dan dibaikpulih menyediakan suasana yang menyenangkan kepada kejiranan sekitar dan menggalakkan kepentingan hidupan liar dalam meningkatkan biodiversiti dan membantu pembiakan semula jadi tumbuhan. Kertas kerja ini memberi tumpuan kepada panduan menghijaukan kuari-kuari di Malaysia dalam segi pemilihan spesies tumbuhan yang sesuai dan teknik penanaman yang digunakan dengan mengenengahkan empat elemen penghijauan iaitu perlindungan, peneduhan, hijau dan estetik. Di samping itu, pemilihan tumbuhan sebaik-baiknya hendaklah yang tahan terhadap penyakit dan kemarau, dapat tumbuh di atas tanah tandus nutrien dan mempunyai kepentingan hidupan liar.

High Ba alkalic series rocks from the Benom Complex, Peninsular Malaysia: evidence of mantle infiltration to lower crust

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High Ba alkalic series rock from the Benom Complex, Central Belt Peninsular Malaysia can be divided into 2 main rock units (1) mafic unit consists of gabbro and diorite and (2) felsic unit consists of gabbro and syenite. All rocks contain very high Ba content ranging from 1810 to 10744 ppm (mean: 4245ppm). The Ba content reported in this paper is far higher compared to the recorded value in literature (Ye et al. 2008; Fowler et al. 2008; Choi et al. 2009; Seo et al. 2010). Average Ba content of the Northern Highland syenite from British Highland (Fowler et al. 2008) and mangerite/syenite from Gwangcheon Korea (Seo et al. 2010) is 3467 ppm and 3328 ppm respectively. It also higher compared to the Ocean island basalt and north Atlantic high grade craton rocks. Field evidence showed that there is magma mixing between mafic and felsic units. Stages of mixing and mingling between these two magmas clearly identified which suggested that both are synplutonic. The gabbroic rock is usually surrounded by syenite and monzonite rocks for a net veined complex giving rise to a pillow-like structure. Though the contacts between the phases are sharp on the broad outcrop scale, they are commonly lobate to crenulate in detail. Pillowing of the more mafic phase in the more felsic phase adjacent to their contact is common. Shape of the gabbroic enclaves are extremely variable ranging from rounded to ellipsoidal. In other parts, the contacts between the gabbroic rock and the monzonite are diffuse and the whole rock is more homogeneous. Medium to large K-feldspar crystals from the monzonitic rocks can be seen dispersed in the gabbroic rock in varying degrees. The crystals form a train of K-feldspar or schlieren-like texture in gabbroic material.

Underplating and mixing between mafic and felsic magmas have been proposed to explained the occurrence of high Ba igneous rocks. This paper provides a direct evidence of interaction between mantle and crustal magmas. Various degree of mixing and mingling between felsic and basic end members suggested that the mantle and crustal interaction occur in the alkalic series. The structure suggested that both felsic (monzonitic) and mafic (gabbroic) magmas may be injected more or less simultaneously into the same set or sets of fracture or magma chamber. The synplutonic textures which support the simultaneous emplacement of both basic and felsic magma in the study area are: (1) dispersion of K-feldspar from monzonitic rock in the gabbroic magma, (2) formation of monzonitic net-vein surrounding the rounded gabbroic enclaves and (3) reduction of monzonitic K-feldspar megacryst. The strong enrichment of Ba is related to transfer of enriched fluids from the mantle into the lower crust. Thus the high Ba characteristics of all Benom rocks (monzogabbro, monzodiorite, syenite and monzonite) may represent a significant mantle components addition to the crust.

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Preliminary study of petrology and geochemistry of the Langkawi granite

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This paper reports an ongoing petrological and geochemical research of the Langkawi granite. The Langkawi granite consists of four main bodies, Gunung Raya, Kuah, Pulau Tuba and Pulau Dayang Bunting granites. Jones (1981) believed that these granites are connected to each other along the sea floor. Wan Fuad et al. (2001) has divided the Langkawi granite into two sub-groups, Gunung Raya-Dayang Bunting granite and Kuah-Tuba granite based on the rare earth element (REE). Texturally Gunung Raya-Dayang Bunting granite shows very coarse- to medium-grained biotite granite and some show strongly porphyritic texture with K-feldspar phenocrysts reaching 6 cm in length. On the other hand Kuah-Tuba granite consists of highly evolved fine- to medium-grained tourmaline granite. Based on K-Ar dating by Bignell and Snelling (1977) the age of the granite from Langkawi is 217 ± 8 which is during Late Triassic time.

SiO_2 for both Gunung Raya – Dayang Bunting and Kuah-Tuba granite overlap. The highly evolved magma of the Kuah-Tuba granites supported by high Rb/Sr ratio (4.6-56.7), compared to the Gunung Raya-Dayang Bunting granite which is less differentiated (3.1-6.8). Other than that both granites have no significant differences. All granites have $\text{ASI} > 1$ which is peraluminous.

Wan Fuad et al. (2001) pointed out that the REE modeling of both Gunung Raya-Dayang Bunting and the Kuah-Tuba granite shows that they may be derived from the Cambro-Ordovician Machinchang clastic formation by simple batch melting and fractional crystallization. The Gunung Raya-Dayang Bunting granite differs slightly from the Kuah-Tuba granite in having higher LREE contents and a steeper LREE gradient. A comparative studies of the Langkawi granite REE pattern with that of the Main Range granite show that the Langkawi granite constitutes familiar birds-wing REE pattern and strong negative Eu anomaly which is similar to the dominant S-Type granites of Main Range (Liew, 1983; Wan Fuad & Suhaimi, 1998).

Geochemical comparison between the Langkawi granites and northern Main Range granites show the former represent a different magmatic pulse. This is evident from Sr vs Ba plot (Figures 1 & 2). The plot shows that the evolution of both magmas are controlled by the different minerals such as K-feldspar and biotite (Langkawi granite) and K-feldspar and plagioclase (northern Main Range granite).

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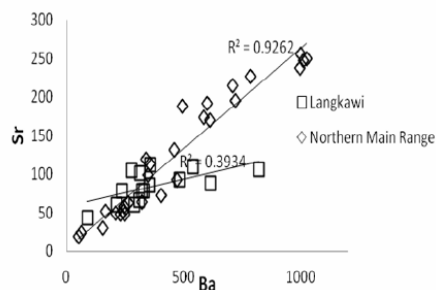


Figure 1: Ba vs Sr diagram of the Langkawi and northern Main Range granite.

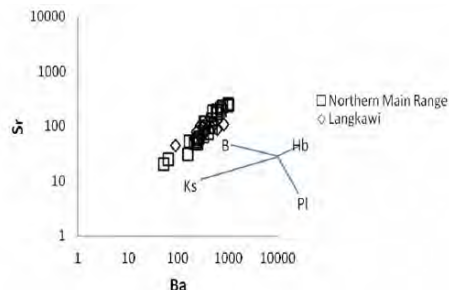


Figure 2: Ba vs Sr log plot for the Langkawi and northern Main Range granite.

Kajian petrografi dan geokimia untuk menentukan asalan Pluton Palong, Jempol, Negeri Sembilan

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Pluton Palong terletak di antara sempadan Negeri Sembilan dan Pahang meliputi daerah Jempol dan daerah Bera. Bandar Bahau berada di bahagian selatan Pluton Palong, sementara pekan Kemayan berada di bahagian utara. Ia dibatasi oleh garis longitude 102°15' T hingga 102°23' T dan garis latitude 2°55' U hingga 3°15' U. Pluton Palong merupakan salah satu offset satah lipatan di mana Pluton Manchis yang berada di bahagian barat dikatakan sebagai bahagian paksi sinklin lipatan tersebut. Ia membentuk sebuah jasad granit yang memanjang selari dengan jurus rantau kawasan iaitu hampir utara-selatan. Keluasan Pluton Palong dianggarkan seluas 250km persegi.

Pluton Palong ini menerobos ke dalam Formasi Semantan yang berusia Trias Awal. Penerobosan ini berlaku pada masa Trias Akhir menurut Loganathan (1993). Penerobosan ini menyebabkan berlakunya proses metamorf sentuh yang membentuk hornfels di beberapa zon sentuhan. Tegasan yang dialami telah menghasilkan sesar di beberapa kawasan. Jurus foliasi hornfels adalah selari dengan sempadan sentuhan granit iaitu hampir utara-selatan.

Pluton Palong terdiri daripada 3 variasi granit, iaitu Granit Kemayan, Granit Lui dan Granit Serting mengikut Askury (1993). Granit Kemayan merupakan granit biotit berbutir sederhana hingga kasar, megakristal dan sesetengah lokaliti menunjukkan pengaturan mineral (pengaturan biotit dan megakris feldspar membentuk foliasi yang nyata). Megakristal feldspar didapati kebanyakannya bersaiz 1-5cm panjang dan 0.2-0.5cm lebar dan berwarna merah jambu pucat. Granit Kemayan meliputi kawasan timur dan utara Pluton Palong yang merangkumi 125km² keluasan pluton ini. Komposisi utama Granit Kemayan terdiri daripada megakris k-feldspar (25%), feldspar sebagai matriks (40%), kuarza (15%) dan biotit (20%). Granit Kemayan lebih tinggi kandungan mineral legap jika dibandingkan dengan Granit Lui dan Granit Serting yang lebih bersifat leukokrat (kurang daripada 7% mineral gelap).

Granit Lui dicirikan oleh granit biotit berbutir sederhana dan bertekstur sama butiran dengan saiz butiran berjulat dari 2mm hingga 5mm. Ia meliputi hampir 85km² bahagian tengah hingga ke selatan Pluton Palong. Batuan ini berwarna kelabu dan di sesetengah kawasan menunjukkan warna kuning yang setara. Kandungan mineral berdasarkan anggaran terdiri dari kuarza (25-30%), feldspar (50-60%) dan mineral mafik (5-10%).

Granit Serting pula merupakan leukogranit yang berbutir sederhana dan bertekstur sama butiran. Ia berbeza dengan Granit Lui berdasarkan sifatnya berwarna kelabu keputihan dan kehadiran mineral mafik yang rendah, iaitu kurang daripada 3%. Ia ditemui di bahagian selatan Pluton Palong yang merangkumi hampir 40km² kawasan. Granit Serting terdiri daripada feldspar (60%), kuarza (30%), sulfida (8%) dan biotit yang telah berubah kepada klorit (2%). Granit Serting ini juga boleh dijumpai sebagai inklusi (rejahan kecil) di dalam Granit Lui dan Granit Kemayan.

Hubungan ketiga-tiga jenis granit amat jelas dengan mempamerkan jujukan pembedaan magma atau penghabluran berperingkat yang selari atau berterusan tanpa sebarang gangguan aktiviti hidroterma lain. Granit Kemayan yang kurang terevolusi telah berubah kepada Granit Lui dan seterusnya membentuk Granit Serting yang terbeza tinggi. Pluton Palong boleh dikelaskan kepada granit jenis-I berdasarkan kandungan kimianya bertepatan dengan Coobbing dan lain-lain (1986).

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Plio-pleistocene volcanism in the Upper Rajang Valley – a window into the crust under the Rajang Group

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The sediments of the Rajang Group extend in an arc from coastal plain of Sarawak (where it is exposed at the Tatau Horst) into the interior, as is thought to be contiguous with the Crocker Formation in Sabah. In western and central Sarawak, the sediments were deposited in a deep marine environment, and were folded and uplifted later during the late Eocene and Miocene. The nature of the crust underlying these sediments is unclear – the model presented in Hutchison (1988) has oceanic crust being subducted to the south, with the Rajang Group representing the deep marine portion of the accretionary wedge, the sediments being eroded from the Schwaner Mountains in the south.

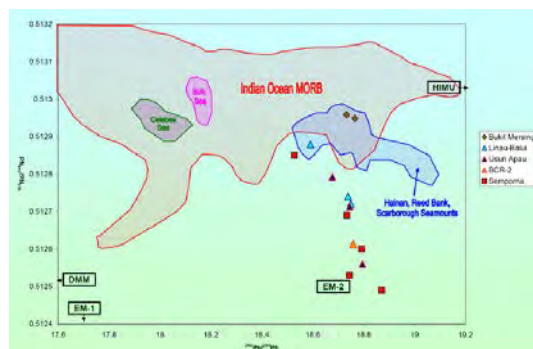
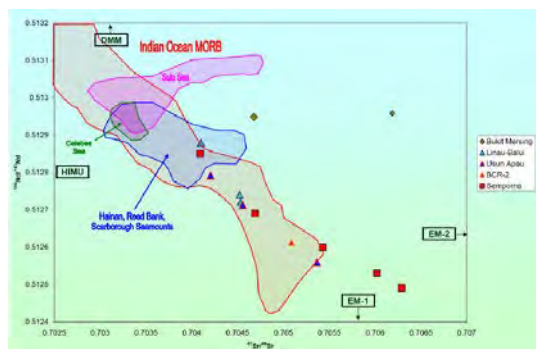
Several bimodal volcanic edifices of Plio-Pleistocene age occur in the upper Rajang valley, namely, the Niewenhuis Mountains, Usun Apau, the Hose Mountains, the Linau-Balui volcanics and several others across the border in northern Kalimantan. Early dacite tuffs and lava flows are followed by a later, minor phase consisting of basalt and basaltic andesite flows. The youngest are the the Linau-Balui basalts, which were erupted on what appear to be modern river terraces (Kirk, 1957). These volcanics may or may not be related to intraplate volcanics of similar age which occur throughout the “eastern seaboard” of the Eurasian plate, from the Kuantan basalt on the Malay Peninsula (Ghani & Taib, 2007), through eastern Thailand, Laos and Vietnam, all the way north to Hainan and Korea (e.g. Barr and MacDonald, 1981; Choi et al., 2006; Ho et al., 2003; Nguyen et al. 1996; Zhou & Fan, 2010), of which the last known eruption took place in 1923, at the Ile de Cendres off the Vietnam coast.

Recent efforts at dating these rocks yield $^{40}\text{Ar}/^{39}\text{Ar}$ dates of 4 ma. for Usun Apau dacites (Cullen, pers. comm.) and 2-2.5 ma. for Usun Apau and Linau-Balui basalts. The Usun Apau and Linau Balui basalts have steep REE and incompatible element profiles reminiscent of Oceanic Island Basalts (OIB), which are associated with mantle plumes and rifting/extension. Bimodal volcanism is also associated with rifting and extension. Radiogenic isotope measurements for Linau-Balui and Usun Apau basalts yield $^{206}\text{Pb}/^{204}\text{Pb}$ ratios of 18.590 to 18.795, $^{87}\text{Sr}/^{86}\text{Sr}$ of 0.7041 to 0.7053, and $^{143}\text{Nd}/^{144}\text{Nd}$ of 0.5126 to 0.5128. Usun Apau dacites yield similar values (Cullen, pers. comm.), as do basalts from the Southern Sulu Arc on the Semporna peninsula (MacPherson et al. 2010).

These values are too radiogenic for melts which originate in the mantle. The model suggested by MacPherson (2010) for the Southern Sulu Arc volcanics calls for the contamination of mantle melts with a radiogenic component from the lower crust, this being continental crust domains of Paleozoic age. Given the similarity in isotopic signatures, the Upper Rajang Valley should also similarly be underlain by continental crust, some of which is Paleozoic in age. Since the Rajang Group in this area is deep marine, the continental crust has been thinned by rifting and extension.

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The transformation of amphibolite facies gneiss to greenschist facies: an interesting phenomenon in East-West Highway Route A173, Baling-Gerik, Malaysia

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Introduction

The East-West highway route A173 of Baling to Gerik area is located at the South Kedah and North Perak of Peninsular Malaysia. It exposes undulating to high land of some low grade metamorphic rocks and granite intrusions in the western belt orogen, and has long been considered as part of Mesozoic regional metamorphism (Jones, 1970; Burton, 1972; Courtier, 1974). Highway route A173 is a relatively new road which was built after year 2000. Previously this area was part of the reserved forest. Due to the development of this new road, fresh and new outcrops were exposed here. Although there is general agreement about the geology of this area (Jones, 1970; Burton, 1972; Courtier, 1974), the fresh and new outcrops remain new geological information particularly the metamorphic rock type which indicating the different characteristic, type and degree of metamorphism.

Geological setting

According to Jones (1970) and Burton (1972), this area consisting of a complex sequence of sedimentary-pyroclastic strata of Lower Paleozoic age which is mainly Baling Formation specifically comprises of the argillaceous facies of Bendang Riang shale member with small lenses interbedded with arenaceous rocks at the lower part of the succession. The rock types are mainly shale, mudstone and phyllite subfacies. These rocks were probably affected by an Upper Paleozoic phase of deformation. It is then further deformed and intrusion of granite might occur during the Mesozoic orogeny that probably after the east-west compressional forces had caused the development a series of regional north-south trending folds (Jones, 1970). Bintang granite trends almost north-south and a mountain chain with southward stretching is formed (Courtier, 1974).

Methodology

Field work was conducted to investigate the geology of the area. Eight samples were collected from six outcrops along the highway. The determined rock types are consisting of two meta-granite, pegmatite and five metamorphic rocks. In this study, petrography analysis was focused on the 7 samples of meta-granite and metamorphic rocks.

Petrography Analysis

The samples selected for detailed analysis included meta-granite, gneiss, chlorite-mica-slate, phyllite and mylonite. Table 1 list the modal contents of the samples studied.

Based on the petrography analysis, two facies metamorphism were identified in this area. They are (i) amphibolites facies gneiss and (ii) greenschist facies. Here, amphibolites facies metamorphic grade gives way southeastward to the greenschist facies grade in the southern Gerik, as the highway extent. Petrographic investigations along the transformation zone have established the following points:

1. Sample BG-1, BG-2 and BG-6 were included in amphibolites facies. According to Bucher and Grapes (2011), amphibolite facies is influenced by temperature of 500° to 700°C and pressures in excess of 1.2 GPa.
2. Sample BG-4, BG-5, BG-7 and BG-8 were included in greenschist facies. According to Bucher and Grapes (2011), greenschist facies is influenced by temperature of 400° to 550°C and pressure of 0.18 to 1.0 GPa.
3. The correlation between mineral assemblages of metamorphic rocks in Gerik area and the range of pressure (0.18 Gpa – 1.2 Gpa) and temperature (400°C – 700°C) during the metamorphism process can be interpreted that the area was affected by regional metamorphism where most of the rocks identified in this area is foliated in texture. In orogenic metamorphism along a Ky-type prograde path, the greenschist-amphibolite facies transition occurs at

Table 1: Modal contents of the samples studied.

	Bt	Chl	Ep	Hbl	Kfs	Mc	Ms	Op	Or	Pl	Py	Qtz	Ser	Tur
BG-1	18.75	-	-	5	25	-	4.5	-	-	3.25	-	33.5	-	13.75
BG-2	3.75	-	-	13.75	-	10	20	-	-	23.75	-	28.75	-	-
BG-4	-	32.5	17.5	-	-	-	20	12	-	-	-	15.5	-	-
BG-5	-	50	-	-	-	-	30	19.5	-	-	-	0.5	-	-
BG-6	17.5	-	-	-	43.75	-	-	-	-	-	-	27.5	-	11.25
BG-7	-	11.25	17.5	-	-	-	10	-	-	-	-	27.5	3.75	-
BG-8	-	32.5	5.25	-	-	-	28.75	-	-	-	-	33.5	-	-

temperatures at $500^{\circ}\text{C} \pm 50^{\circ}\text{C}$ (400–500 MPa) (Bucher & Grapes, 2011). Pegmatite dyke in the area indicates that during the regional metamorphism, intrusion bodies may happen resulted as local contact metamorphism. While the existing of mylonite in the area indicates that during the regional metamorphism processes which involve the action of plate tectonics supported by the intensive joints and minor faults found in all outcrops of the area create a local dynamic metamorphism.

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Some aspect of vein texture, microstructure and implication to gold mineralization episode in Penjom Gold Mine

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Introduction

Vein is the main component of hydrothermal system as hot fluid with silica and minor carbonate minerals associated with metal and variable sulphide minerals deposited along shears, fracture or fault. The aim of the study is to determine the mesoscopic and microscopic vein textures in the Penjom Gold Mine and to establish the relationship between vein textures with deformation, vein paragenesis and gold-sulphide mineralization. Term of vein textures is based mainly on terminology by Dowling & Morrison (1989) from their study in North Queensland, while terminology of Passchier & Trouw (2005) is used for deformation microtextures or microstructures. Characteristics of vein textures and microstructure are indicative of physico-chemical environment under confining pressures where fluid filled the space through crack seal mechanism. Local low mean stress allowed veins to grow and exhibit extensional vein structure.

Geological setting of study area

The Penjom Gold Mine is located about 8 km southwest of Kuala Lipis, Pahang. It lies about 30 km east of the Bentong-Raub Suture within the Central Belt of Peninsular Malaysia. Penjom Gold Mine is hosted within Late Permian sedimentary rock of Gua Musang Formation (Shaffeea Leman, 2005) and felsites intrusive, similar to Padang Tengku area, north of Penjom. Regional structures as seen on shaded-relief map generated from Shuttle Radar Topographic Mission (SRTM) dataset (Ng, 2007) show that Penjom area is situated along a NNE trending geological structure that splays from the Bentong-Raub Suture, that coincide with the Penjom thrust mapped in the Penjom Gold mine. Strike ridge is also dominant which may represent the east dipping sequence resulted by earlier geological event related to D1 deformation. Penjom thrust is responsible for refolded and development of local antiform-synform (D2). Faulting (D3) continues to dominate after the fold has been locked-up. Cross-cutting by northerly direction fault (D4) can also be observed as displace and deformed the vein system.

Detail of vein description

Structurally veins are categorized into two main types, namely shear vein or fault-filled vein and extension vein (Hodgson, 1989). Shear veins are ribbon to laminated veins developed mainly in carbonaceous units either thick or very thin units, parallel to bedding or shearing. This vein type is interpreted as being formed during folding and thrusting events involving repeated opening of bedding and shearing planes. Associated with shear veins are several types of extensional veins including sub-vertical extension vein arrays, breccias and stockwork commonly at lithology contrast units. Reverse and dextral NNE fault has further controlled extension vein of the same morphology. Southwest of the pit, NNW trending fault subparallel to stratigraphy, reactivated along the existing shear vein and responsible for more vein systems.

At hand specimen scale, veins show a variety of texture either primary or secondary structure. Primary textures represent early vein introduction while overprinted structure or modification resulted to development of secondary textures. Primary textures are minor comb in extension vein, anhedral buck quartz for thicker vein and laminae or vein septa which represent early vein introduction without additional overprinted vein or modification. Secondary textures are ribbon, stylolitic vein, breccia texture and late spider veinlet. These textures are common in mesothermal gold deposit. Primary and secondary or superimposed textures are not applied to the timing of structural event but rather as relative deformation to veining process. Both secondary and primary textures can occur in earlier structural episode, especially when the vein structures undergone repeated opening or shearing of the structure. Secondary textures were resulted by parallel reactivation by bedding slip or fault and upon interception of vein with later fault involving vein modification. Ongoing deformation also indicated by microstructures such as deformation lamellae, polygonal subgrain, neocrysts and sutured grain boundaries.

Discussion and conclusion

Detail study of geological structures and classification of vein is important to the understanding of the deformation history and its relationship to gold mineralisation in the Penjom Gold Mine. Characterization of veins in mesoscopic scale or hand specimen can reveal process of vein formation and paragenesis of different types of vein. Primary textures can be superimposed by the ongoing deformation that produces secondary texture. Fracturing and healing may occur throughout the deformation process and can be seen in veins formed during D2 or D3 events. Significant

vein deformation or textural destruction is observed as a result of later faulting event during D4 deformation, which is post mineralization. Common association of vein textures with different types of gold deposits provides a simple way of understanding the geology and mineralization control.

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The source of gold and tin mineralization in the Western Belt of Peninsular Malaysia: Evidence from heavy mineral studies

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Peninsular Malaysia has been traditionally divided into three mineral belts, viz the Western Belt for tin, the Central Belt for Gold and the Eastern Belt for both tin and gold. Although the Western Belt is accepted as the tin belt, close examination of geological maps and reports revealed that gold do occur in various places in this tin belt. In Johor and Negeri Sembilan gold is being mined and in Tapah-Bidor, Perak and Batu Cave, Selangor gold has been recovered as a by product in placer tin mining (New Straits Times 1990). Tin deposits are widespread in the Western belt, some in the Eastern Belt and absent in the Central Belt. A study of heavy mineral concentrates in the stream sediments in two areas, viz., Tapah area in Perak and Kuala Pilah area in Negeri Sembilan was carried out to observe their mineral distribution patterns. The heavy mineral concentrates were panned from the streams and studied under a binocular microscope. Bedrock geology in both areas are somewhat similar, being underlain by granite and metasediments. The the metasediments were variably metamorphosed ranging from phyllite to schist.

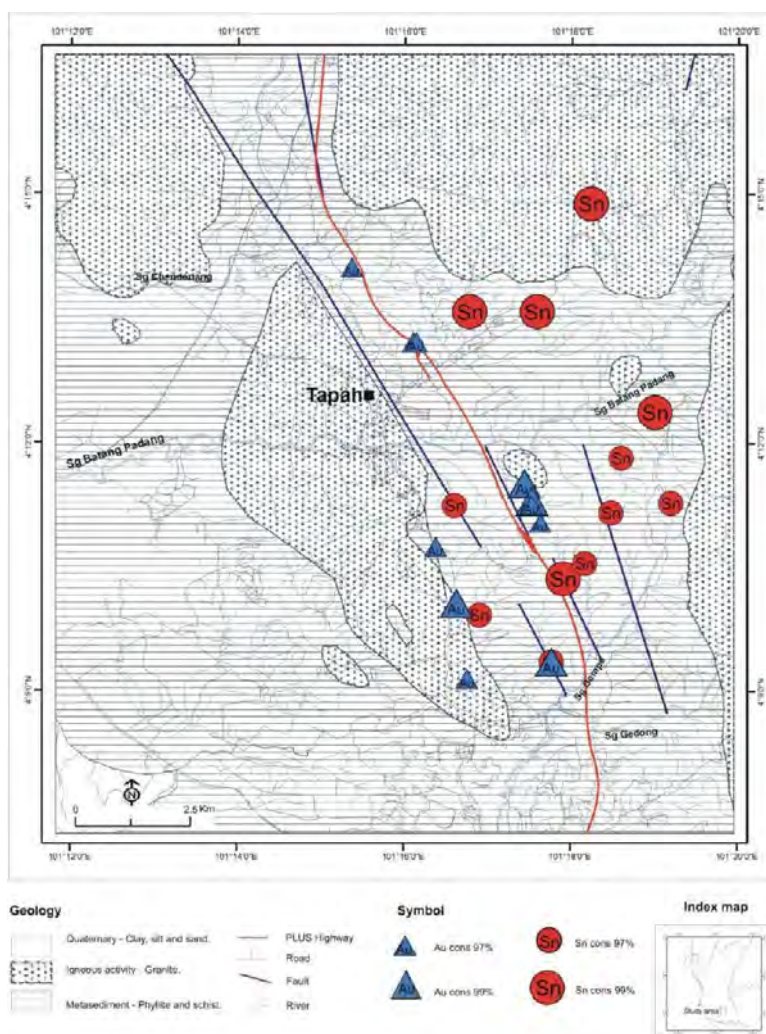


Figure 1: Distribution patterns of gold and tin in heavy mineral concentrates in stream sediments in Tapah area, Perak.

In Tapah area, fine gold flakes and cassiterite grains are common and variably observed in almost all heavy mineral concentrates collected. When their respective concentrates were plotted on a map, gold and tin have dissimilar distribution patterns. Concentrates with gold flakes are confined to the metasedimentary areas whereas cassiterite bearing concentrates are found in the metasedimentary areas as well in the granite areas. In Kuala Pilah area, similar trend for gold and cassiterite grains were observed. It was once thought that primary gold originates from the veins in granite (Emmons, 1933). If all gold originates from the granite, we would expect some gold flakes to be found in the heavy mineral concentrates overlying the granite bedrock. The fact that gold bearing concentrates are confined to the metasedimentary areas show that gold originates in the metasediment and not from the granite. The odd occurrence of gold flakes in concentrates overlying granite is because it has been carried across granite from metasedimentary bedrock by the streams.

Cassiterite distribution on the other hand is found in both the granite and the metasedimentary areas. This is readily explainable because cassiterite veins, originating from the granite bodies, can cut across both the granite and the metasediment country rock. Cassiterite originates from late magmatic fluids. It is being carried by hydrothermal solution from the magma and deposited in veins regardless of the bedrock type. Gold on the other hand originates from the sedimentary rocks. It is being squeezed out from the metasedimentary rocks, dissolved by circulating hydrothermal waters that circulates driven by heat during some igneous intrusion and deposited in the veins. Since it originates not from granitic fluid, it is found away from the granite. The distant relationship between gold mineralization and igneous intrusion is observed not only in these two areas, but has also been observed in the gold bearing Central Belt (Lee et al., 1980). In most cases gold mineralization occur in metasedimentary rocks at distances more than a km away from the nearest granite body.

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The interdependence relationship of the minerals sector within the Malaysian economy

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This paper looks at the interrelationship of the Malaysian minerals sector with the other sectors of the economy based on the information from the Malaysian input-output table. The input-output table is an accounting table that shows the flow of inputs and outputs among sectors within an economy. The purchase of inputs by a sector is referred as backward linkage while the selling of its outputs is referred as forward linkage. The analysis of backward and forward linkages is perhaps the best method to analyse the interdependence relationships among sectors within an economy. The method can also give an indication of how significant a sector is to an economy in particular for a minerals sector in a highly industrialised economy like Malaysia where contribution to the country's Gross Domestic Product (GDP) may not be significant. The minerals sector referred to in this paper include both the upstream activities comprising mining and quarrying as well as the downstream activities comprising the mineral-based industries. Analysis showed that there is close interdependence relationship between mining and quarrying with the construction industry and also, as expected, with the downstream mineral-based industries. The findings also showed that among the industries that have close relationship with the construction industry, five were mineral industries. Other industries identified to have close relationship with the minerals industries include transport, petroleum and coal, and electricity and gas industries.

Kertas teknikal ini melihat kepada hubungan sektor mineral Malaysia dengan sektor-sektor lain dalam ekonomi Malaysia berdasarkan maklumat-maklumat daripada jadual input-output Malaysia. Jadual input-output ialah jadual perakaunan yang menunjukkan pergerakan input dan output di antara sektor-sektor dalam sebuah ekonomi. Pembelian input oleh sektor dirujuk sebagai 'backward linkage' manakala penjualan output dirujuk sebagai 'forward linkage'. Analisis 'backward' dan 'forward linkage' dilihat sebagai satu kaedah yang terbaik untuk menganalisa hubungkait sektor-sektor dalam sesuatu ekonomi terutamanya untuk sektor mineral dalam ekonomi berasaskan perindustrian seperti Malaysia di mana sumbangan sektor mineral kepada Keluaran Dalam Negara Kasar (KDNK) dilihat sebagai tidak signifikan. Sektor mineral dalam kertas teknikal ini merujuk kepada aktiviti hulu terdiri daripada perlombongan dan pengkuarian serta aktiviti hiliran terdiri daripada industri-industri berasaskan mineral. Analisis menunjukkan terdapat hubungkait rapat di antara aktiviti perlombongan dan pengkuarian dengan industri binaan serta, seperti yang dijangkakan, dengan industri-industri berasaskan mineral. Juga didapati daripada laporan industri yang mempunyai hubungkait rapat dengan industri binaan, lima adalah industri berasaskan mineral. Antara industri-industri lain yang dikenalpasti mempunyai hubungkait rapat dengan industri mineral adalah pengangkutan, petroleum dan arang batu, elektrik dan gas.

Progress report – Malaysian-Indonesian geological correlation program in the border area Sintang-Silantek area

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Introduction

A joint Geological Correlation project along Sarawak-Kalimantan border area was carried since early 2011. The main objective is to solve the confusion on the nomenclature of the rock formation in the border area. The Sintang-Silantek area is chosen as the pilot project area. Based on the preliminary result of recent ground survey, the project area is underlain by 3 main types of rock formations namely i) the turbidite in the northeastern part, ii) the melange in the central region iii) the sandy formation towards southwestern part. These sedimentary formations were intruded by the dacitic and granitic bodies. However, these rock formations were named differently over the border. Both Indonesian and Malaysia Technical Working Group Committee (TWG) proposed the names as follows: i) Lubok Antu Melange for the melange and chaotic deposit; ii) Silantek Formation for the sandy formation, iii) Tutoop Formation for upper clean sandy formation; iv) the Sintang Intrusives for the bodies or stocks of Miocene igneous rocks. At the moment no compromised name or nomenclature proposed for the turbidite formation.

Objective

The naming or the nomenclature of the rock formations in the border area of Kalimantan/Sarawak is now becoming more confusing which needs a collaborative effort and commitment from both government of Indonesia and Malaysia to address this issues by means of the geological correlation across the border. Sarawak, Sabah the east Malaysian states in Borneo have a long stretch of border area with Kalimantan, Indonesia, stretching about 140,000km from the Tanjung Datu in West Sarawak to Sibatek, Eastern Sabah. There are in places, the border areas are being underlain by an interesting geology which could be rich in mineral deposits. The new data or information obtained from this recent survey could contribute better understanding on the geology of the border area and Borneo Island as a whole.

Preliminary geology

The Sintang-Silantek area, a small window of the border area is located in West Sarawak; is a chosen area for the pilot project (Figure 1). The fieldwork in the Sintang-Silantek was commenced in early 2011, soon after that both parties: the Department Minerals & Geoscience Malaysia (JMG) and Geological Agency signed the MOU in January 2011. The preliminary survey indicated the same geological formations are stretching across the political border but their names and stratigraphic nomenclatures are different over the border.

Generally, there are 3 main types of rock formations underlying the border area; namely i) the turbidite in the northeastern part, ii) the melange in the central region and iii) the sandy formation towards southwestern part. These sedimentary formations are intruded by the dacitic and granitic bodies (Figure 2).

i) The turbidite is the most common lithology found in the area, located in the NE part of the Lupar and Badau Valley. The turbidites are rhythmic sequences of sandstone interbedded with shale and sometime mudstone. There are two types of turbidites, namely the proximal and distal turbidites. The proximal turbidites contains more sandstone as compared to distal turbidites. Mudclast conglomerate and slumping features are commonly observed in the proximal turbidites. The distal variety is made up sequences of thinly bedded shale and thin beds of sandstone. Tightly folded and broken beds or block turbidites is named the Kapuas Complex in Nanga Badau area in Kalimantan. The equivalent unit in Sarawak is named Lupar Formation. The Pakong mafic Complex and Danau Mafic complex made a fault contact with the proximal turbidites. However, at the moment no compromised name or nomenclature for this formation.

ii) The melange which is made up of broken formation or crushed lithologies as the result of the tectonic force while subducting into the SW Borneo Basement. The most common rocks are the broken parts of oceanic crust, the ophiolitic rocks and the deep sediment like chert, set up in the sheared matrix of shale, mudstone. This unit was mapped as Kapuas Complex in Kalimantan or Lubok Antu Melange in Sarawak. The broken formation is consisting mainly the oceanic rock components is named the Danau Mafic Complex in Nanga Badau, Kalimantan; where as in Sarawak is named Pakong Mafic Complex. The exotic blocks of chert are dated as old as Jurassic but mostly Cretaceous. However, the pelitic matrix is dated as old as Palaeocene (Tan, 1979).

iii) The sandy formations that formed the sandstone basins in the Silantek, Sintang and Ulu Kapuas areas are namely the Kantu, Tutoop and Ketungau Formations of the Merakai Group. The Kantu Formation is extended into Sarawak as the Silantek Formation. Overlying the Silantek Formation is the clean sandstone formation named the Plateau Sandstone. The Silantek Formation comprises thick-bedded sandstone, pebbly sandstone, conglomerate lenses, red mudstone, interbedded with thick sequences of regularly interbedded thin beds of sandstone, shale and mudstone exhibiting well-developed cross beddings and ripple marks. This formation had provided the ambience for coal formation. The Plateau sandstone which is termed Tutoop Formation in upper Sintang District is overlying the Silantek Formation in Lupar Valley and the Kantu Formation in the Sintang District. The Plateau sandstone is generally composed of thick bed of clean, cross bedded sandstone. However, there are beds of shale and mudstone in minor amount.

iii) The intrusive rocks mainly granitic to dacitic in composition are intruded into the sandy formation in the Sintang and Silantek area. The intrusives are named as the Bukit Nimong, Bukit Selanjan, Bukit Kelambi intrusives in Sarawak but in Kalimantan it is only named as the Sintang Intrusives.

Nomenclature

The procedures stipulated in the International Subcommission of Stratigraphic Classification (ISSC, 1994) and the Malaysian Stratigraphic Guide (1995) is the main guide in correlation project. The Indonesian Stratigraphic Guide is not available to the TWG yet. However based on the preliminary data, the geology of the project area; the Sintang-Silantek area is made up 3 main types of sediments namely: a) Melange, b) Tightly folded turbidite and c) Sandstone basin. However, at this point, the group only managed to undertake the geological correlation across the border for the melange and the sandstone basin formations, which is now respectively named as the Lubok Antu Melange and the Silantek Formation as described by Tan, 1979; based on the detailed geological mapping scale 1:50,000 in Silantek and Lupar Valley. This stratigraphic nomenclature is both agreed by both parties of Indonesia and Malaysia. Therefore, the previous names of melange, the Keriau Melange (Pieters et al, 1993) and the Kapuas Complex (Pieters et al., 1993) is now abandoned. This also applies to the sandstone basin formation; the Kantu Formation (Williams et al., 1986; Pieter et al., 1987; Heryanto et al., 1993) which is being abandoned. The main reason to the adopt the term Lubok Antu Melange and Silantek Formation, is because the type section, type area, type locality, type area, reference section, boundary section are clearly described in Silantek area and Lupar Valley by Tan, 1979; which is according to the rules stipulated in the ISSC (1994).

The TWG is now working on the establishment of formal lithostratigraphic unit of Tutoop Formation and the Sintang Intrusives. The Tutoop Formation is made up mainly clean sandstone, sometimes cross bedded and coal barren overlying the Silantek Formation. The equivalent unit of this in Sarawak is the Plateau sandstone.

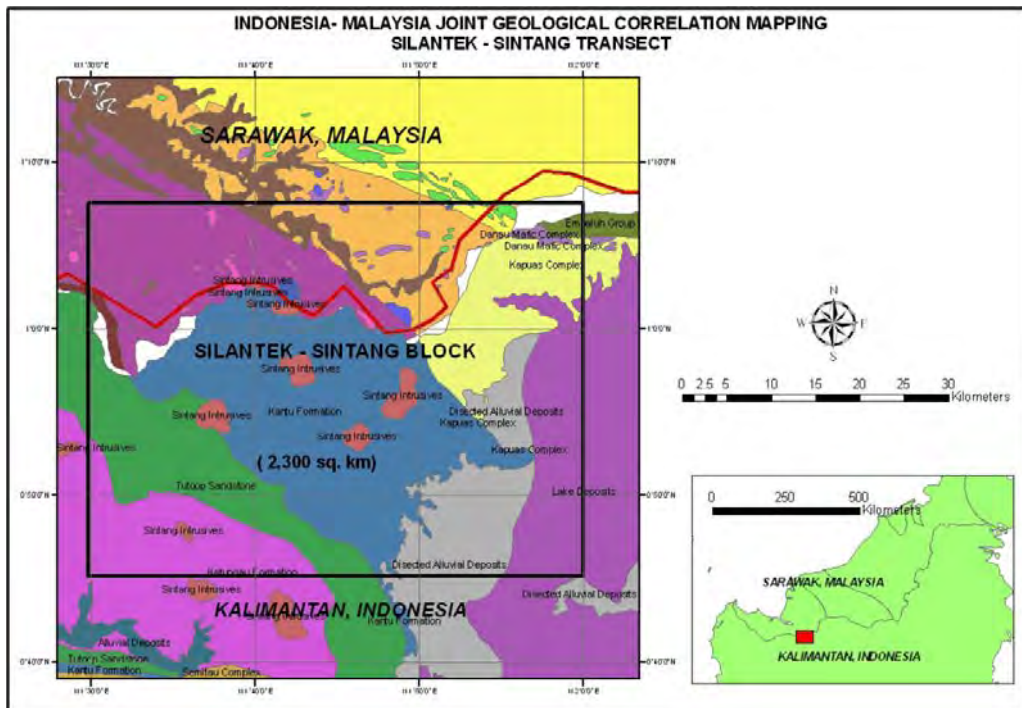


Figure 1: Silantek-Sintang block in Borneo.

The intrusive rocks which mainly Miocene in age in Sintang and Silantek area are widespread in this project area. In Kalimantan these intrusives are named as Sintang Intrusives (Williams et al., 1986). The term Sintang Intrusive is preferred by the TWG, with the type locality in Sintang Valley in Kalimantan. In Silantek (or Lupar Valley), the bodies or the stock of igneous bodies have many different names. There are namely: Bukit Klambi, Bukit Nimong, Bukit Menuku and Bukit Buri intrusives.

Conclusion

The preliminary result of the border geological correlation project is that, the area is made up of 3 main types of the rock formations, namely the turbidites, melange, sandy formation and the igneous intrusives. However, these rock formations are named differently across the border. The TWG proposed the term Lubok Antu Melange to be retained to describe melange or chaotic rock assemblages unit. The Silantek Formation is also retained describing sandy formation that in places contained coal deposit. Tutoop Formation is to describe the cross bedded sandy formation overlying the Silantek Formation. This stratigraphic nomenclature is both agreed by both TWG of Indonesia and Malaysia. Therefore, the previous names of melange, the Keriau Melange (Pieters et al., 1993) and the Kapuas Complex (Pieters et al., 1993) is now abandoned. This also applies to the sandstone basin formation; the Kantu Formation (Williams et al., 1986; Pieter et al., 1987; Heryanto et al., 1993) which is being abandoned. The main reason to the adopt the term Lubok Antu Melange and Silantek Formation, is because the type section, type area, type locality, type area, reference section, boundary section are clearly described in Silantek area and Lupar Valley by Tan (1979); which is according to the rules stipulated in the ISSC (1994).

At this point, the nomenclature for igneous rock like the Pakong Mafic Complex and its equivalent the Danau Mafic Complex in Kalimantan is still under study by the geological correlation group. The decision on the nomenclature will be attempted when a comprehensive data are available to substantiate for correlation purpose.

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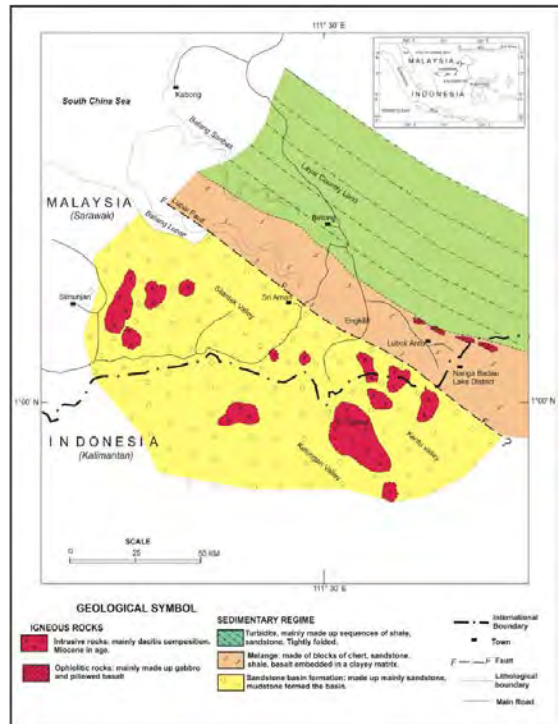


Figure 2: Geological map of Central Borneo.

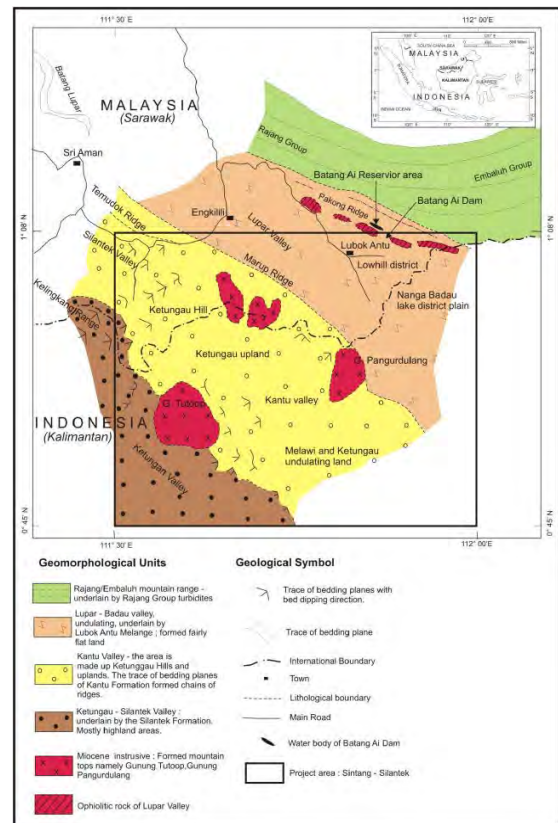


Figure 3: Radar Image Interpretation of Sintang-Silantek area.

Stratigraphy of the Ransi Member, Tatau Formation (Middle Eocene-Oligocene) in the Tatau-Bintulu area, Sarawak

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A recent study in the Tatau-Bintulu area indicates that the Ransi Member which was originally dated as Upper Miocene to Pliocene (Kamaludin Hassan, 2004) is part of the Upper Eocene to Upper Oligocene Tatau Formation. This finding is inconsistent with that of Liechti et al. (1960) who proposed that it was equivalent to the Middle to Upper Miocene Begrih Formation while Ismail (2000) proposed that it was equivalent to the Upper Miocene to Pliocene Balingian Formation.

The Ransi Member is made up of three different facies, that is: Facies 1 is of light grey graded conglomerate to pebbly coarse sandstone. Facies 2 is of light brownish to dark grey arenaceous cross and parallel strata, coarse to medium grained sandstone with bioturbation. Facies 3 is of bioturbated argillaceous greyish shale and fine sandstone interbeds. Sediment of Ransi Member beds are mainly composed angular to sub-angular clasts of chert, quartz, igneous and metamorphic fragments. From overall distribution of the facies, Ransi beds shows a decrease in thickness for both F1 and F2 but increase in thickness and frequency for F3 upsection showing a fining upwards sequences. In general, Ransi beds are deposited in a channel system with numerous channels that subjected to marine influence with the presence of *Orphiomorpha* burrows. The igneous clasts are composed of rhyolite similar to Middle Eocene Piring igneous intrusion. A very thick black carbonaceous horizon was found at the northeastern part of Tatau Hill.

The discovery of significant burrowing in many sandstone beds within the upper part of the Ransi Member together with marine microfossils in the shale beds suggest that the fluvial channels in a lower coastal plain environment was gradually replaced by a shallower marine environment indicative of a marine transgression. The source of the Ransi beds was largely from the radiolarian rich chert and metamorphic rocks of the older Rajang Group located to the south as indicated by paleocurrent determinations. The presence of volcanic clasts in the conglomerate from Tatau Hill suggests a volcanic source in the hinterland during the deposition of the Ransi beds.

The correlation of the Ransi Member was base on the underlying angular unconformity with the bathyal turbidite Belaga Formation changing suddenly into terrestrial with marine influence depositional beds. The correlation was supported by the Vitrinite Reflectance (Vr) of the coal found in Ransi member which is different from that of adjacent formations. The Vr reconstruction suggests that the burial history in the Ransi Member (with average 0.85-1.00) is older than Nyalau Formation (with average 0.6 – 0.4, Pebrina, 2008) but younger than the metamorphosed Belaga Formation (Vr more than 1.2). The Ransi Member is probably the basal part of the Tatau Formation above the major unconformity caused by the Eocene Sarawak Orogeny (Hutchison, 2005) (Figure 1).

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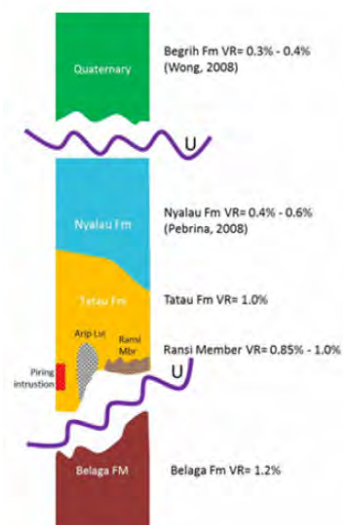


Figure 1: Propose stratigraphy base on the vitrinite reflectance (Vr%) and petrology study.

The occurrences of probable Tertiary boulder beds along Chenur-Paloh Hinai Road, near Maran, Pahang and their implications

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Abstract: A reconnaissance field traverses along Chenur to Paloh Hinai road, near Maran, Pahang, revealed the presence of a thick sequence of horizontally layered boulder beds across 6 km stretch of the road in Kemajuan Tanah Sungai Putat-Serenggam. This area is previously mapped as the Tembeling Group. The Boulder Beds deposits comprise mainly stacked sheets of thick-bedded, unsorted–very poorly sorted, clast- to matrix-supported conglomerates with maximum clast sizes ranging from cobbles to large boulders with outsized clasts. The debris is subangular–sub-rounded, comprising fragments of local bedrock, mainly sandstones, conglomerates, shales and minor quartz belonging to the underlying JK Tembeling Group rocks. The common presence of JK Tembeling Formation conglomerates within the boulder beds together with the association with flat bedded interbedded coaly/ carbonaceous mudstone and sandstone with palynomorphs described as of Tertiary age suggest that the Boulder Beds are younger than the JK Tembeling Group. A tectonic event is thus implied, which disrupted the deposition of the older conglomerate sequence, preceding the deposition of the Boulder Beds. A Tertiary age for the Boulder beds is thus invoked. The Tertiary deposit is hereby called the Sungai Putat Boulder Beds and the basin as the Sungai Putat Tertiary Basin. The association of the Sungai Putat Boulder Beds with Tertiary flat-bedded coaly/ carbonaceous mudstone and sandstone believed to be deposited in an ephemeral stream further attest to an alluvial fan setting of deposition of the Sungai Putat Tertiary basin. The presence of a Tertiary basin on Central belt may be formed by the released of stresses consistent with the interpretation that onshore Peninsula Malaysia probably acted as buffer zone between the Sumatran basins (in the west) and the Malay and Penyu basins to the east.

Keywords: Boulder Beds, Tertiary basin, coal, conglomerate, alluvial fan

Introduction

A reconnaissance field traverses along Chenur to Paloh Hinai road (Figure 1), along the southern bank of Pahang River, near Maran, Pahang, revealed the presence of a thick sequence of horizontally layered boulder beds across 6 km stretch of the road in Kemajuan Tanah Sungai Putat- Serenggam. This area is previously mapped as the Tembeling Group, (Koopmans, 1968) which consists of four formations namely Kerum Formation, Lanis Conglomerate Formation, Mangkin sandstone formation and Termus Shale Formation. The boulder beds outcropped just 8 km to the east of the well exposed outcrop of flat bedded interbedded coaly/ carbonaceous mudstone and sandstone recently described as of Tertiary age due to the presence of Late Miocene and/or younger palynomorphs (Ahmad Munif Koraini et al., 2011). They are found along an elongated stretch bounded by NW and NE striking lineaments and cut by NS lineaments (Figure 1). It is the purpose of this presentation to briefly describe the occurrences of this newly discovered boulder beds hereby named the Sungai Putat Boulder Beds and to discuss its implications.

Boulder Beds characterization

The Boulder Beds deposits comprise mainly stacked sheets of thick-bedded, unsorted–very poorly sorted, matrix- to clast-supported conglomerates with maximum clast sizes ranging from cobbles to large boulders with outsized clasts (Figure 2). The debris is subangular–sub-rounded, comprising fragments of local bedrock, mainly sandstones, conglomerates, shales and minor quartz belonging to the underlying JK Tembeling Group rocks.

The matrix is an unsorted mixture of angular finer grained gravel and sand. The clay content of the matrix is below 5%. Pebbles with modal diameters of 10–30 cm are dispersed within this matrix. Outsized clasts are common and reach diameters of more than 1.5 m. They are predominantly conglomerate boulders. These outsized boulders are concentrated in a several distinct beds. Between the conglomerate beds thin lenticular sand–granule layers are present. the boulder beds generally form in settings where a hinterland with a steep relief lies adjacent to a lower gradient basin where the Tertiary ephemeral peat swamp were situated, separated by a strong change in the slope gradient, for example by a syndimentary active fault.

Conglomerate bed boundaries are often indistinct and amalgamation is a common feature. Thicknesses of individual conglomerate beds range from 40 cm to more than 3 m. Where outcrop conditions permit, observations of individual beds over a few metres reveal a sheet-like–broadly lenticular geometry. Most beds are internally massive and appear structureless. Crude horizontal stratification defined by subhorizontally oriented clasts is not uncommon. The bases of thick boulder beds are planar and show no obvious erosion. Some of the thinner beds with lenticular geometry display erosional, convex- downward bases and locally show low-relief scouring of a few tens of centimetres. Inversely graded have been observed on several beds, and most outsized clasts are concentrated in the upper half of the beds. The fabric is mainly disorganized with no preferred clast orientation, and large boulders

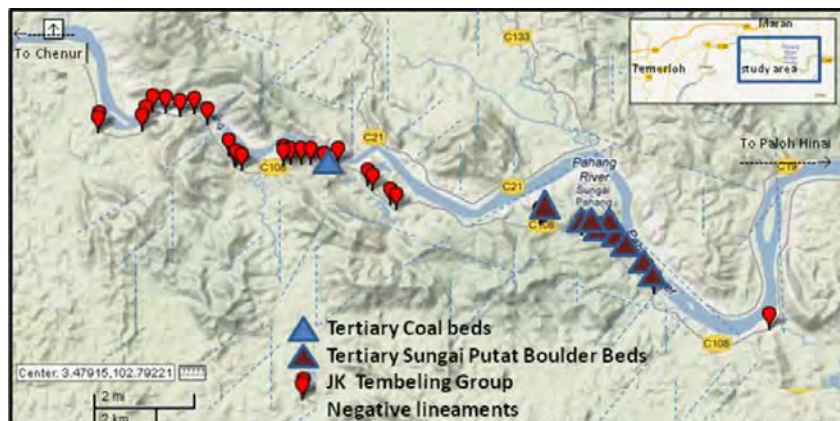


Figure 1: Location map of the study area.

in nearly vertical positions are present. The tops of beds are often crudely normal graded and show transitions to interbedded sandstones. Large cobbles and boulders project above the surfaces of many beds.

The boulder conglomerate beds are sometimes separated by roughly horizontally stratified thinner conglomerate beds up to 80 cm thick, with organized fabric and rare lenses of fine-coarse sandstone (Figure 2). Sandstones display planar lamination locally marked by pebble stringers. In places the beds show step like syndimentary normal faults.

These boulder beds are bounded by gently to moderately dipping and gently folded JK Tembeling Group conglomerate, red sandstone and shale sequences. However their contact is not exposed. But the presence of outsized megablocks of JK Tembeling Group conglomerates within the deposits (Figure 3) suggest an unconformity separated the two units.

Discussion

The common presence of JK Tembeling Formation conglomerates within the boulder beds together with the association with flat bedded interbedded coaly/ carbonaceous mudstone and sandstone described as of Tertiary age suggest that the Boulder Beds are younger than the JK Tembeling group. A tectonic event is thus implied, which disrupted the deposition of the older conglomerate sequence, preceding the deposition of the Boulder Beds. A Tertiary age for the Boulder beds is thus invoked. The Tertiary deposit is hereby called the Sungai Putat Boulder Beds.

The association of the Boulder Beds with Tertiary flat-bedded coaly/ carbonaceous mudstone and sandstone believed to be deposited in an ephemeral stream further attest to an alluvial fan setting of deposition for the Sungai Putat Tertiary basin. The dominant boulder-bearing conglomerate facies is interpreted to represent deposits of a wide variety of debris-flow types from mudflows to largely cohesionless debris flows and transitions to sheetfloods. The disorganized fabric, the presence of large outsized clasts, predominantly clast with matrix- supported bed intervals and clasts in vertical position indicate deposition on a debris-flow-dominated proximal part of an alluvial fan. Sedimentologic data on alluvial fan sediments support previous interpretations on western belt Tertiary basins of semiarid to sub-tropical paleoclimate during the Miocene.

The disorganized fabric, the presence of large outsized clasts, predominantly clast with matrix- supported bed intervals suggests that the boulder beds generally form in settings where a hinterland with a steep relief lies adjacent to a lower gradient basin where the Tertiary ephemeral peat swamp were situated, separated by a strong change in the slope gradient, for example by a syndimentary active fault.

Syn-sedimentary tectonic movements, are shown by the presence of small NNW striking normal faults within the beds and demonstrated by the occurrence of outsized clasts of a few meters in diameter throughout the whole succession of the boulder beds which calls for a high-gradient, constantly exposed hinter land providing a mountainous source area. Higher-gradient mountainous streams in the uplifted hinterland can transport coarse detritus to the faulted basin margin of a low-relief plain, where alluvial-fan deposition occurs.

Implications

The presence of a Tertiary basin near Chenur suggests that onshore Tertiary basins are not restricted to the western belt only. They are also found in the Central Belt. They may be found within the regions designated to be underlain by the JK Tembeling Group rocks. The inaccessibility of the region and their similar lithologic characteristics may hinder the Tertiary strata recognition.

It is interpreted that subsidence along NW and NE trending strike-slip faults resulted in an asymmetric basin,



Figure 2: The boulder conglomerate beds are sometimes separated by roughly horizontally stratified thinner conglomerate beds.



Figure 3: Outsized clasts within the boulder beds. Note the Tembeling Group conglomerate as outsized boulder within the boulder beds.

which was filled by the wedge-shaped clastic fans of the Boulder Beds, a typical situation for a small continental basin. A similar situation has been illustrated for the Tertiary Batu Arang Basin.

The presence of a Tertiary basin on Central belt may be formed by the released of stresses consistent with the interpretation (Liew, 1995) that onshore Peninsula Malaysia probably acted as buffer zone between the Sumatran basins (in the west) and the Malay and Penyu basins to the east.

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The Singa and Kubang Pasu Formation: A review

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The Singa Formation, made up essentially interbeds of dark coloured shale and mudstone mudstone interbedded with minor thin beds of sandstone is well exposed in the Langkawi Islands. Minor limestone lenses were also reported to occur within the fossiliferous shale and sandstone sequence at the top most part of the Singa formation. It was believed that the Singa Formation was deposited in a laterally shallower environment as compared to the Kubang Pasu Formation which consists of mainly sandstone and lesser shale with the occurrence of radiolarian chert/siliceous mudstone at the bottom and top of the rock sequence that is well exposed in east Perlis-north Kedah to north Perak. Both the Singa and Kubang Pasu rock units were considered by most of the earlier workers as Upper Devonian to Permian in age and are conformably underlain by the thin bed of the upper Devonian to Early Carboniferous reddish shale/mudstone. Since the introduction of Singa and Kubang Pasu Formation, several authors have discussed on their lithostratigraphy and palaeontology but not much were mentioned on the lower and upper limits of both stratigraphic sequences. Recent studies on the correlation of Carboniferous rocks in the Malaysia-Thailand border areas carried out by the Malaysia-Thailand Working Group of the Malaysia-Thailand Joint Geological Survey Project has revealed that there is a need to revise both the Singa and Kubang Formations according to the Malaysian Stratigraphic Guide. This paper will discuss, with emphasis on the lithostratigraphic and palaeontological evidences to be considered for in revising the two rock formations.

Formasi Singa, terdiri terutamanya dari lapisan syal dan batu lumpur berwarna gelap berselang lapis dengan sedikit lapisan batu pasir ditemui tersingkap dengan baik di Pulau Langkawi. Kekanta batu kapur minor juga dilaporkan wujud dalam jujukan syal dan batu pasir berfosil di bahagian atas Formasi Singa. Adalah dipercayai bahawa Formasi Singa telah terendap secara lateral dalam lingkungan lebih cetek dibandingkan dengan Formasi Kubang Pasu yang terdiri terutamanya dari batu pasir dan kurang sedikit syal dengan kewujudan rijang/ batu lumpur bersilika pada bahagian bawah dan atas jujukan batuan tersebut dan formasi ini ditemui tersingkap dengan baik di bahagian timur Perlis- utara Kedah ke utara Perak. Kedua-dua unit batuan Formasi Singa dan Kubang Pasu telah dianggap berusia Devon Atas ke Perm oleh kebanyakan pengkaji terdahulu dan didasari secara selaras oleh lapisan nipis syal/ batu lumpur berwarna kemerahan berusia Karbon Bawah ke Devon Atas. Sejak kedua Formasi Singa dan Kubang Pasu diperkenalkan, beberapa penulis telah membincangkan mengenai litosrtatigafi dan peleontologi kedua-dua jujukan batuan tersebut. Hasil kajian terkini mengenai korelasi batuan berusia Karbon di kawasan sempadan Malaysia-Thailand oleh Pasukan Petugas Malaysia-Thailand Projek Pemetaan Geologi Bersama Malaysia-Thailand menunjukkan bahawa terdapat keperluan bagi menyemak semula kedua-dua Formasi Singa dan Kubang Pasu selaras dengan Pedoman Stratigrafi Malaysia. Kertas ini akan menjurus untuk membincangkan bukti-bukti litostratigrafi dan palaeontologi yang perlu dipertimbangkan dalam penyemakan semula kedua-dua formasi batuan tersebut.

Sedimentology and stratigraphy of Kampung Opak Limestone, Bekenu, Sarawak

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Introduction

This paper presents the results of a sedimentological and stratigraphic study of a limestone unit exposed near Kampung Opak, Bekenu, Sarawak. The limestone is located stratigraphically within the Sibuti Formation which is a succession of clay-shales with subordinate siltstone and limestone. It can be considered as a member of the Setap Shale Formation, which it resembles closely, differing only in more frequent marls and thin limestones. A few larger Foraminifera from limestones intercalated in the Sibuti Formation of the Bakong area indicate a Te5-Tf age (Lower Miocene to early Middle Miocene), based on the presence of *Lepidocyclina* sp., *Nephrolepidina* sp., *Miogypsina* sp., and *Gypsina* sp. (Liechti, 1960). The objectives of the present study is to describe the sedimentology and further determine the depositional environment of the Kampung Opak limestone, to provide a stratigraphical scheme for the Kampung Opak limestone and to study the relationship between the Kampung Opak Limestone and the other Tertiary carbonates in Sarawak.

Data and methodology

The sedimentology study was carried out by sketching and logging the limestone cross section. Limestone blocks were collected and polished to study their ichnological aspect. Petrographic study under microscope was used to classify the limestone into different facies. 100 thin sections were prepared and analysed. Microfossils were identified from the thin sections and used to date the limestone. The biostratigraphy was determined using the Planktonic Foraminifera zonation established for subtropical to tropical environments (Postuma, 1971).

Sedimentology and interpretation

The Kampung Opak limestone is composed of mud-supported mudstone and wackestone interbedded with thin marls. Three facies have been identified based on the percentage of quartz grains in the limestone. A retrogradational pattern is noticed throughout the sequence.

The depositional environment is interpreted as inner platform, associated with a more or less flat, shallow marine shelf. Clastic-influenced limestone suggests a proximal position on the shelf, not very far from the land/source. A bioturbation index of BI3 - 5 (moderate - strong) for the limestone indicates either a slow depositional rate or high faunal biomass. The presence of Skolithos and Cruziana ichnofacies in the limestone indicates a sublittoral environment on the shelf. The abundance of pelagic foraminifera indicates an open sea with high productivity. D/T ratio of *Amphistegina* sp. indicates a water depth less than 40 m below sea-level.

Biostratigraphy

Twelve species of planktonic foraminifera were identified from the Kampung Opak limestone: *Cassigenella chipolensis*, *Globigerina venezuelana*, *Globigerinoides altiapertura*, *Globigerinoides immaturus*, *Globigerinoides obliquus*, *Globigerinoides subquadratus*, *Globigerinoides trilobus*, *Globoquadrina dehiscens*, *Globorotalia mayeri*, *Hastigerina aequilateralis*, *Orbulina bilobata* and *Orbulina suturalis*. The microfossil assemblage gives a Middle Miocene (*Globorotalia peripheroronda* zone – *Globigerinoides subquadrata* zone) age. This further extends the age range of the Sibuti Formation from Early Miocene to late Middle Miocene age. The Kampung Opak limestone probably represents the upper part of the Sibuti Formation.

Conclusions

The Kampung Opak limestone is composed of wackestone and mudstone which is deposited in an inner platform of a shallow marine shelf. The biostratigraphic study suggests a Middle Miocene age (*Globorotalia peripheroronda* zone – *Globigerinoides subquadrata* zone) based on planktonic foraminifera zonation. The Kampung Opak limestone could be related to the widespread development of carbonate buildups in the Central Luconia Province further offshore and therefore could be a good outcrop analogue to study the depositional environment of Luconia carbonates.

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Pendolomitan dan simen silika dalam batu kapur Formasi Setul di Tanjung Rhu, Langkawi, Kedah

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Pengenalan

Formasi Setul merupakan formasi batuan karbonat yang tertua di Semenanjung Malaysia berjulat usia Ordovisi hingga Devon Awal. Menurut Jones (1981), Formasi Setul merupakan satu unit litostatigrafi yang tersingkap di sempadan antara negeri Perlis dengan Thailand dan dicirikan oleh lapisan batu kapur dan batuan gersik. Formasi batuan yang berusia Ordovisi ini terdiri daripada batu kapur tidak tulen yang bercampur dengan lumpur dalam amaun yang agak tinggi, batu kapur dolomit dan dua ahli gersik yang terdiri daripada peralapisan syal, batu lumpur kaya silika, batu lodak, batu pasir dan sedikit rijang. Menurut Basir Jasin dan Zaiton Harun (2002), Batu Kapur Setul telah terendap dalam samudera cetek yang berjulat daripada sekitaran pasang-surut hingga ke penghujung lagun. Kamal Roslan Mohamed dan Che Aziz Ali (2001) berpendapat bahawa batu kapur yang membentuk Formasi Setul ini adalah terenap di kawasan sekitaran laut cetek. Sekitaran karbonat ini adalah terdiri daripada lumpur karbonat yang tidak membentuk jasad terumbu.

Kawasan persampelan dan kaedah kajian

dalam kertas kerja ini, batu kapur Formasi Setul yang tersingkap di kawasan Tanjung Rhu akan dijelaskan proses diagenesis yang telah berlaku dengan keutamaan kepada proses pendolomitan dan pensilikaan. Cerapan telah dilakukan di beberapa singkapan batuan Formasi Setul di bahagian utara Langkawi iaitu di kawasan Tanjung Rhu. Rintisan mengelilingi pulau ini telah dilakukan bagi mendapatkan sampel. Sebanyak 66 sampel batuan telah di ambil untuk di analisis di makmal. Kesemua sampel tersebut kemudiannya dijadikan sampel hirisan nipis.

Pendolomitan dan pensilikaan

Dolomit interlocked

Jenis dolomit dengan tekstur saling mengunci merupakan jenis dolomit yang paling dominan di kawasan ini. Hablur dolomit ini kebanyakannya adalah kasar dengan tekstur idiotopik hingga hipidiotopik. Dalam beberapa sampel, terdapat jenis dolomit ini wujud dalam variasi saiz kasar, sederhana hingga halus. Umumnya dolomit jenis ini bentuk hablur euhedral hingga subhedral.

Dolomit pengganti

Dolomit jenis kedua merupakan dolomit pengganti yang mengganti komponen sedimen terutamanya matrik dan fitur diagenesis awal terutamanya simen kalsit pre-cursor. Hablur dolomit ini terbentuk secara hablur terasing mengganti mikrit dalam batu kapur ataupun simen kalsit awal membentuk tekstur gegula (Che Aziz Ali, 1993). Morfologi hablur dolomit ini lazimnya berbentuk euhedral dengan tekstuk idiotopik.

Simen dolomit

Dolomit jenis ketiga wujud sebagai simen dolomit yang terbentuk sebagai pengisi system rekahan dan ruang kosong akhir. Hablur simen dolomit ini wujud sebagai kerak circumvoid yang isopak dan mengisi rongga kosong. Ia memperlihatkan saiz hablur yang kasar dan menunjukkan bentuk rhombik subhedral limpid dengan tekstuk hipidiotopik. Hablur dolomit ini juga kadang kala terbentuk bersama simen kalsit poikilotop.

Dolomikrit

Dolomikrit merupakan jenis dolomit bersaiz halus dengan hablur rhombik berbentuk euhedral. Ia memperlihatkan tekstur idiotopik hingga hipidiotopik. Kehadirannya mengisi jalur stilolit dan lipid pelarutan yang memotong fabrik. Jenis dolomit yang terakhir merupakan dolomit sadle yang mempunyai satah hablur melengkung dan sempadan hablur yang tidak sekata. Lazimnya hablur dolomit sadle ini kelihatan berawan dan mempunyai padaman bergelombang.

Simen kuarza dan kalsidoni

Kewujudan simen kuarza membentuk fabrik simen mikrokuarza yang dibentuk oleh hablur kuarza sama saiz yang halus dan fabrik simen kalsidoni yang dicirikan oleh hablur-hablur limpid dengan jalur pertumbuhan berpusat yang jelas (Che Aziz Ali & Kamal Roslan Mohamed, 1996). Simen mikrokuarza wujud sebagai agregat sederhana halus dengan bentuk ekuian subhedral hingga anhedral. Simen kalsidoni pula wujud sebagai hablur radial-berserat

yang kelihatan jernih hingga berawan membentuk struktur isopakus ke arah pusat rongga. Kalsidoni merupakan mendakkan primari dan bukannya hasil pertukaran daripada silika pelopor lama (Che Aziz Ali, 1995).

Kesimpulan

Berdasarkan bukti-bukti petrografi pembentukan dolomit dan simen kuarza autigen ini berjulat dari ketika sedimen dimendapkan sehinggalah tertimbus dalam, dalam sekitaran percampuran dengan pengaruh air meteorik dan air masin. Bendalir pendolomitan boleh ditafsirkan terhasil daripada pengepaman masuk air laut normal ke dalam sedimen dan juga berkemungkinan hasil daripada pemampatan mekanikal secara progresif apabila sedimen semakin tertimbus dalam (Qing & Mountjoy, 1989), manakala pembentukan kuarza autigen pula berlaku dalam sekitaran penimbunan cetek zon percampuran meteorik-marin (Noble & Stempvoort 1989).

Penghargaan

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The role of self potential prospecting in delineating underground streams for engineering problems

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Keywords: self potential; streams; water seepage; engineering problems;

Geophysical method is well known as the tool assisting various fields. Self potential (SP) prospecting is associated with ground water flow and it is useful in solving engineering problems such as dams and reservoir floors seepage, delineation of groundwater flow and cavity detection (Parasnis, 1997). It is also proven to be a fast and cheapest geophysical method among others. The objective of the study is to delineate seepage paths of water caused by underground streams which ended up forming subsurface saturated zone by using tides as its variable parameter. Study area was takes place in PPSB power plant, Seberang Perai, Pulau Pinang where it shows several signs of damaged such as small sinkholes, soil settlement along the building sides, sinking of the concrete structure, primary armor rock moved and severe cracks on the building's wall. The location of the site which is near to the shore could be one of the major factors for this case. Therefore, the survey was fixed which is based on the variation of tides to show the effect of water level. Two study sites were acquired; first site is located along the shore line near to the water outlet with two survey lines of the total length 88m and the spacing between every pot is 4m. The second site with a grid of 24mx28m with pots spacing of 4m was carried out between two big water tanks and building. These sites will be repeated during the high tide. SP signals obtained from variations of electrical potential between base porous pot and a moving porous pot without the injection of electrical current. It allows the naturally occurring currents via electrokinetic coupling to be generated and flows throughout the system. SP is very unique where it is the only geophysical method that responds directly to flowing fluids on earth materials (Fagerlund & Heinson, 2003). The results indicate that there were existences of several main saturated zones in the study area due to the water intrusion (Figure 1). In the Figure 1a), shows that the water is slowly charging and discharging with the value between -16 to 20 volt contrary to Figure 9b) whereby it presents actively charging and discharging of water flow. Positive value is commonly associated with subsurface water flow which the areas of water discharge while negative value represents areas of water infiltration. During low tide, the rate of water which flows in and out is almost the same, thus, does not show a very wide accumulative saturated zone. It differs during the high tide where most of the area was intruded by water. In conclusion, SP method is really utilizable in detecting the subsurface streams flow. At the same time, this study can be used as reference for case study related to engineering field.

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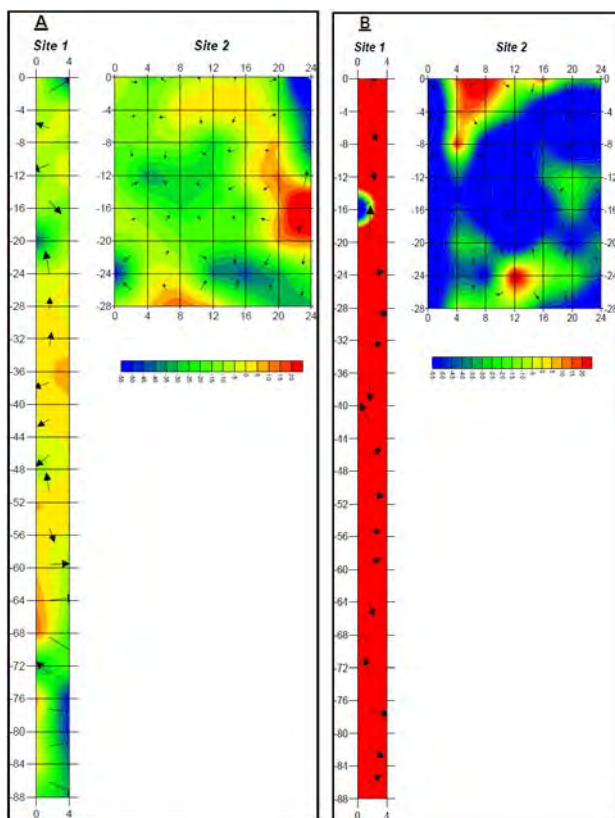


Figure 1: The cumulative results for SP a) during the low tide b) during the high tide.

Mechanised construction of tunnel boring machine (TBM-1) in granitic body in Karak, Pahang

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Keywords : Tunnel Boring Machine (TBM), geological conditions, discontinuities, TBM performance, Main Range granite

This research is to discuss Tunnel Boring Machine (TBM-1) tunnel which located at Karak, Pahang corresponding to Interstate Raw Water Transfer (ISRTW) project in difficult ground conditions. In order to avert a major water crisis for the millions of residents including Selangor, Kuala Lumpur and Putrajaya with raw water daily from Sungai Semantan in Pahang to the Hulu Langat through a transfer tunnel via outlet connecting basin and pipelines to the water treatment facility in Selangor. The transfer tunnel is planned to be 44.6 km in length, including the inlet connecting basin, inlet conduit and outlet conduit to cross the igneous rocks Titiwangsa Main Range granite batholith with some part of the Semantan Formation and Jelebu Schist Formation and the metasedimentary rocks of the Karak Formation where the contact zone between the Karak Formation and Titiwangsa Main Range granite which located west of Bentong-Raub suture lies somewhere near chainage 3.50 kilometer of the inlet.

The tunnel excavation is designed to be constructed in two different methods of construction with Tunnel Boring Machine (TBM) for 35 km while the upper and lower ends will be excavated with the conventional New Austria Tunneling Method (NATM) about 10 km.

The study area in this research is located at the TBM-1 (Karak, Pahang) part of the ISRTW project, which mainly involves the coarse grained granitic body of Titiwangsa Main Range Granite. The Main Range granite forms the backbone watershed mountain range of the Peninsula Malaysia. It extends to the north into Peninsular Thailand, and southward to the Indonesian 'tin' islands. The main pluton of Titiwangsa Main Range Province of the Peninsula Malaysia were implaced into phyllite and limestone, predominantly of Ordovician to Devonian age. Titiwangsa Main Range granite made up of several large batholiths located west of Bentong-Raub Suture. The Bentong Raub Suture Zone, along the eastern foothills of the Main Range, forms the western boundary of the Central Belt. East of this lies a marine Permo- Triassic zone, a narrow trending N-S trending line of plutons and to the east are Jurassic-Cretaceous continental sediments. (Cobing et al., 1986; Pitfield et al., 1990; Cobing et al., 1992).

Tjia & Syed Sheikh (1996) showed that the rocks within the suture along the East–West Highway, Karak where the study area located can be divided into at least 7 tectonic units that form an imbricate structure. Detailed structural studies of deformation within the Bentong Raub Suture Zone show that the suture zone had undergone progressive transpressive deformation and affected with continuous and numerous faults at area nearby. The deformation started with dextral and followed by sinistral transpression. The latest deformation involved dextral N-S strike slip faulting. Generally, the rock formation and the granitic batholiths in this area are well deformed and resulting an intense structures of joints and faulting is a common structure. (Mustaffa 1994; Jatmika & Ibrahim Abdullah, 2003).

Hereby, problems pose serious questions on the use of mechanized TBM tunnelling that reduce dramatically with the average progress rates and practical consequences may be such as to rock behavior at the TBM-1. The inauspicious conditions can be produced by a rock mass of very poor quality strong and determining very low penetration rates. However, it is to be observed that when using the full face mechanized excavation method such in TBM-1, the influence of the rock mass quality on the machine performance has not an absolute value: the influence is in fact to be referred to both the TBM type used and the tunnel diameter. A few remarks on TBM tunnelling in relation to the selection and dimensioning of mineralogical analyses and mechanical tests are posed on the limiting geological conditions. It may be envisaged with respect to the performance rates of TBM tunnelling and on the importance of geological investigations, in order to derive an appropriate understanding of the rock mass conditions along the line of the tunnel. In general, through the geological features with the TBM performance, a reliable geological which completely explains the tunnel environment and two is to find the significance parameters that show TBM performance that may decrease due to those two factors which are rock behavior.

In purpose for the rock characterization, mineralogical properties will be tested with thin sections, where the mineralogical characteristics such as minerals composition, and rock texture are to be determined. While for mechanical properties, Uniaxial Compressive Strength (UCS), Brazilian Tensile Strength, and Point Load Strength tests will be carried out. These results are commonly supported with numerical parameters in TBM data to find the correlation between the tunnel behavior, hydraulic behavior, the rock mass behavior and the potential of failure mechanism.

The discussion is centered upon the relatively more important or difficult ground conditions including borability limits of TBM machine, instability of excavation walls, instability of excavation face, fault zones and squeezing. While geo mapping and TBM performance data available and based on ISRWT project progress, the point of view is illustrated by *in-situ* data, which give the opportunity to underline specific difficulties encountered and a better understanding of the tunnel in TBM-1 granitic bodies in Karak, Pahang.

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Classification of saturated zones from signal amplitude of ground penetrating radar

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Keywords: GPR, saturated zones, amplitude, conductivity, signal

Ground penetrating radar (GPR) is one of geophysical method that is efficiently used in broad area focusing generally in hydrogeology study. It involve the transmission of high frequency radar pulses from a surface antenna into the ground which dependent on the target, geologic environment, subsurface features and other factors that affect the contrast of the target to the surrounding medium. Various parametric anomalies such as frequency, amplitude and phase anomalies are associated with presence of stratigraphic and hydrogeologic changes within the subsurface (Jordan *et al.*, 2004). As in sediment, water saturation primarily cause changes in dielectric properties and therefore, this method is apply at best in classification of water saturated zones. The presence of small amount of water will dominated the behavior of the dielectric permittivity of porous media in a multi-fluid system. The dielectric permittivity generally increases along the moisture content from the ground surface to the saturated zone (Mundher & Nashait, 2011). Velocity information is extracted from radar profile obtained. In this study, saturated zone is identified using the relationship between amplitude of reflected signal and the electrical conductivity of the reflector obtained from resistivity survey. The behavior of radar signal that attenuate in conductive area resulting in variation of amplitudes was used in identify the saturated zones as high water content will enhance the electrical conductivity. Generally, features with higher electrical conductivity attenuate the signal resulting in decaying of reflection amplitude and vice versa (Bello & Kamaruddin, 2011). Attenuation of GPR signatures is based on reflected electromagnetic wave characteristics. Based on the analysis of the relationship between radar amplitude and water content of heterogeneous sandy soil, the distribution of maximum amplitude could serve as an indicator for expected water content in the soil (Schmalz *et al.*, 2002). The amplitude map was produce to locate and identify the saturated zones. Area of Tronoh, Perak, Malaysia was selected as study area which mostly made up of sand and underlain by sandstone. Manmade lake due to tin mining industry is found located almost 500m toward Eastern of study area. Four GPR survey lines were conducted with one of the line lies on the same location as 2-d resistivity survey lines. Results from geophysical methods, ground penetrating radar and 2-d resistivity method show good correlation in classification of saturated zones. Figure 1 and 2 shows the results of ground penetrating radar and 2-d resistivity methods respectively. Based on results obtained, high moisture content zone was identified at depth > 10-15m which may indicate as wet sand.

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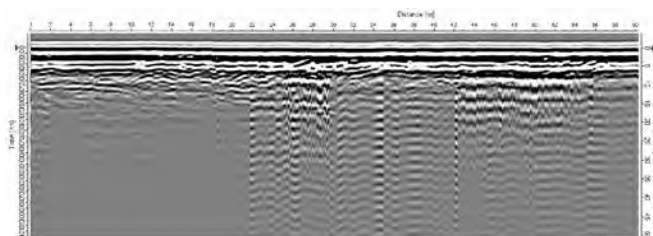


Figure 1: Ground penetrating radar profile for line 4.

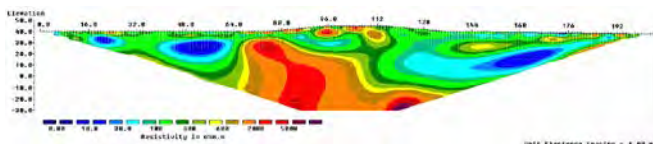


Figure 2: Resistivity section of line 1 from 2-d resistivity survey.

Joint pattern study of meta-sedimentary rocks at Karak Site for the Interstate Raw Water Transfer Tunnel Project

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Keywords: joint pattern, fault, Karak formation, metasedimentary rock

The Pahang – Selangor Raw Water Transfer Project is located in a central area of Peninsula Malaysia. The Project is to convey raw water from the Semantan River through a transfer tunnel to the Selangor / Kuala Lumpur region for domestic and industrial uses to mitigate future water shortages. The transfer tunnel is approximately 44.6 kilometer long, 5.2 meter in diameter for Tunnel Boring Machine (TBM) section and will transfer raw water on a slope 1:1,900 from Pahang to Selangor. The inlet portal of the transfer tunnel is on the left reservoir rim of the Telemong dam and the outlet portal is situated 3.5 kilometer North-northeast of the existing Langat Treatment Plant. The Interstate Raw Water Transfer tunnel is designed to cross solid rock along the alignment with the overburden ranges from just several meters at each portal to more than one thousands meters at the centre of the tunnel. Geology of the alignment comprises of metasedimentary rock at the northern end and granitic rock to the rest of the tunnel. This paper presents the finding of joint pattern analysis of metasedimentary rocks from Karak Formation. The Karak Formation is a series of tightly folded, metamorphosed predominantly argillaceous sediments of Bentong Group in south Pahang. The strata consist supposedly of at least 4800 m of schist and hornfels interbedded with chert, quartzite, shale, phyllite, conglomerate, intraformational breccias and rhyolite tuff. It is believed to be of Early Silurian to Early Devonian age. The study area is located at NATM-1, Karak site. The north-south direction is the occurrence of the Karak Fault and Karau Fault with a distinct topography features. These two main fault lines are believed to be accompanied by high permeability fracture zones, which are likely to go to deep weathering profiles. Fracture zones and joint is a discontinuity plane of natural origin along where it has been no visible displacement. Often, the joints have certain common characteristics within the type of rock they are developed. The joint pattern for this type of rock was studied using the geological mapping data and analyzed using Rocscience software. The main data collection is obtained from the geological mapping carried out at different blasted tunnel distances. In this tunnel project, rock is blasted at commonly range of 2 to 3 meters depends on the quality of rock mass. It is common to have two or three sets of joints at every tunnel face. The data of joint planes were analyzed to indicate the orientation densities. Results of the densities distribution show that NATM-1 has several predominant joint planes with different strike and dip orientations. NW-SE and NE-SE striking joints are the most common with some joints also having other intermediate trends. Figure 1 is a rose diagram of the entire data set that was prepared for a statistical analysis. It is clear from figure 1 that NW-SE joints have the maximum frequency and hence are the dominant set to have developed in the area. The different in the orientations is believed due to parts of the deformation history of the area.

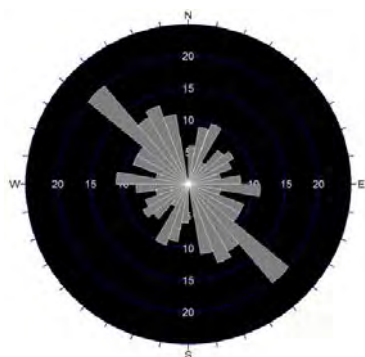


Figure 1: Rose diagram of joint recorded at the tunnel face of the study area. NW-SE trending joints are the most dominant set.

Adjustment factor of slope mass rating (SMR) system: Revisited

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Keywords: discontinuity orientation, Crocker Formation, slope mass rating (SMR), new approach of adjustment factor (NAAF)

The SMR (Romana, 1985) is obtained from RMR_b (basic RMR) by adding an adjustment factor (F). The adjustment factor of SMR is the product of four factors from Romana (1985) and Anbalagan *et al.* (1992).

$$F = (F_1 \times F_2 \times F_3) + F_4 \quad (1)$$

F_1 depends on parallelism between direction of discontinuity intersection line or discontinuities and slope dip direction. F_2 refers to discontinuity dip and plunge angles of intersection line in the planar and wedge mode of failures, respectively. F_3 reflects the relationship between slope and discontinuity dips. F_4 is an adjustment factor for method of excavation which considers natural slope and methods of blasting and excavation (presplitting, smooth blasting, blasting and mechanical and normal blasting).

This SMR system was applied to four slopes in rock quarry at Tamparuli (Figure 1) and found a problem in calculating adjustment factor parameters. The result is quite reasonable and consistence for sub-parameters F_2 , F_3 and F_4 but not for F_1 . Some of the results do not fulfill the parallelism concept ($0^\circ < \text{parallelism}, \theta < 90^\circ$) and ranges of rating values (0 to 1) especially for toppling mode of failure.

This study also found that, there is a strange in the calculation of F_1 rating value for toppling failure by Romana (1985) and Anbalagan *et al.* (1992). They are using B in calculating parallelism value but A in Equation 2 for F_1 rating value. This is quite different with the calculation of parallelism and F_1 rating value for planar and wedge failures. Both failures are calculated by using A in Equation 2 (Table 1).

$$F_1 = (1 - \sin A)^2 \quad (2)$$

Due to that situation, this study was trying an alternative to calculate the rating value for toppling failure by using B in the original F_1 of Romana (1985) and Anbalagan *et al.* (1992). The result is better but some F_1 rating values are still over estimated.

In order to fulfill the parallelism concept and ranges of rating values in F_1 sub-parameter, the new approach of adjustment factor (NAAF) for SMR was introduced (Table 2 and Equation 3).

$$F_1 = (1 - \sin Z)^2 \quad (3)$$

The parallelism and rating values of F_1 by NAAF for the study area are shown in Table 3. The result shows that the NAAF are more accurate, consistence, without assumption and user friendly to calculate parallelism sub-parameter (F_1) of adjustment factor for slope mass rating (SMR) system.



Figure 1: Location of the study area and slope B1, B2, B3 and B4 in CPSB rock quarry, Tamparuli.

Table 1 Mode of failure and parallelism.

Mode of failure	Parallelism	
	A	B
Planar, P	$ \alpha_j - \alpha_s $	
Wedge, W	$ \alpha_i - \alpha_s $	
Toppling, T	$ \alpha_j - \alpha_s $	$ (\alpha_j - \alpha_s) - 180^\circ $

Note: α_j - discontinuity dip direction; α_s - slope dip direction; α_i - intersection line plunge direction

Table 3: Value of parallelism and F_1 rating value by new approach of adjustment factor (NAAF).

Case	α_s	α_j or α_i	Mode of failure	Parallelism, Z (°)	F_1 (rating) (1 - sin Z) ²
1	260	164	T	84	0.00003
2	260	36	T	44	0.09
3	260	329	W	69	0.004
4	317	126	T	11	0.65
5	317	13	P	34	0.19
6	80	175	T	85	0.00001
7	131	136	W	5	0.83
8	131	56	P	75	0.001

Note: α_j - discontinuity dip direction; α_s - slope dip direction; α_i - intersection line plunge direction

Table 2: New approach of adjustment factor (NAAF) (modified from Romana, 1985; Anbalagan *et al.*, 1992).

Case	Z	VF	F	Fr	UF	VUF
P	360° – K or L; (K or L = 270°-360°) 270° – K or L; (K or L = 180°-270°) 180° – K or L; (K or L = 90°-180°) K or L; (K or L = 0°-90°)	> 30°	30-20°	20-10°	10-5°	5°
W	360° – M or N; (M or N = 270°-360°) 270° – M or N; (M or N = 180°-270°) 180° – M or N; (M or N = 90°-180°) M or N; (M or N = 0°-90°)					
T	180° – L; (90°<L<180°) L – 180°; (180°>L> 270°) 180° – K; (90°<K<180°) K – 180°; (180°>K> 270°)					
F₁		0.15	0.40	0.70	0.85	1.00
Relationship		$F_i = (1 - \sin Z)^2$				
P	β_j	< 20°	20°-30°	30°-35°	35°-45°	45°
W	β_j					
F₂	P/W	0.15	0.40	0.70	0.85	1.00
	T	1	1	1	1	1
P	$\beta_j - \beta_s$	> 10°	10°-0°	0°	0-(-10°)	< -10°
W	$\beta_j - \beta_s$					
T	$\beta_j - \beta_s$	< 110°	110°-120°	120°-140°	140°-170°	170°-180°
F₃		0	-6	-25	-50	-60
F₄		Natural slope	Presplitting	Smooth blasting	Blasting & mechanical	Deficient blasting
		+15	+10	+8	0	-8

Note: P- planar; T- toppling; W-wedge; α_j - discontinuity dip direction; α_s - slope dip direction; α_i – intersection line plunge direction; β_j - discontinuity dip angle; β_s - slope dip angle; β_i –intersection line plunge angle; VF-Very Favourable; F-Favourable; Fr-Fair; UF-Unfavourable; VUF-Very Unfavourable; K = ($\alpha_j - \alpha_s$) if ($\alpha_j > \alpha_s$); L = ($\alpha_s - \alpha_j$) if ($\alpha_s > \alpha_j$); M = ($\alpha_i - \alpha_s$) if ($\alpha_i > \alpha_s$); N = ($\alpha_s - \alpha_i$) if ($\alpha_s > \alpha_i$); Z-parallelism in degrees and depends on mode of failure

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Geobencana kegagalan cerun di laluan jalanraya merentasi kawasan perbukitan Hulu Terengganu

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Pembangunan jaringan jalanraya merupakan aspek penting bagi menjana pertumbuhan ekonomi di Malaysia. Ini termasuklah pembinaan jalanraya di kawasan tanah tinggi dan perbukitan yang melibatkan banyak pemotongan bukit dan pembinaan cerun. Bagaimanapun cerun-cerun potongan di kawasan perbukitan tanah tinggi seringkali mengalami kegagalan yang memerlukan kos pembaik pulihan yang tinggi. Kertas ini membincangkan masalah geobencana kegagalan cerun potongan batuan metasedimen dan vulkanik terluluhawa di jalanraya baru di antara Pasir Pulau di Hulu Terengganu dan Kg. Aring, GuaMusang, Kelantan.

Kawasan kajian merupakan sebahagian daripada lapan pakej utama projek jalanraya yang menghubungkan Simpang Pulai-Lojing-Gua Musang-Kuala Berang dan meliputi bahagian barat Hulu Terengganu. Geologi kawasan kajian didasari oleh batuan metasedimen berusia Karbon Lewat hingga Perm Awal yang terdiri daripada jujukan selang lapis batuan syal, batu pasir, batu lumpur, batu lodak, konglomerat dan batu kapur. Jujukan batuan metasedimen ini dibahagikan kepada lima fasies iaitu; 1) fasies batuan vulkanik, 2) fasies batuan berudit, 3) fasies batuan berarenit, 4) fasies batuan berargilit dan 5) fasies batuan berkapur. Batuan metasedimen ini ditindih pula oleh jujukan batuan vulkanik andesit berporfiritik dan piroklastik. Jujukan batuan yang lebih tua ini terancang hebat akibat direjah oleh jasad granit (Granit Lawit) berusia Trias Atas.

Hasil kajian ini menunjukkan cerun potongan batuan metasedimen terluluhawa, terutamanya yang melibatkan batuan meta-argilit, mudah mengalami kegagalan berskala besar. Sebahagian besar kegagalan yang berlaku adalah jenis lingkaran, dan terdapat juga kegagalan jenis baji. Daripada keseluruhan 10 buah kegagalan cerun major di kawasan kajian, lima daripadanya melibatkan cerun batuan meta-argilit terluluhawa. Faktor utama penyebab kegagalan adalah kekuatan bahan yang rendah akibat luluhawa, kehadiran air dan ketakselajaran yang padatkerana batuan terancang hebat. Sifat fizikal bahan meta-argilit terluluhawa yang boleh menyimpan air dengan banyak mewujudkan fenomena 'bengkakan' dan akhirnya menyumbang kepada kegagalan apabila berat cerun mengatasi kekuatan ricih bahan. Keadaan seperti ini sering ditemui berlaku pada morfologi lembah tergantung. Daripada enam buah cerun potongan batuan vulkanik pula, dua daripadanya mengalami kegagalan major. Kedua-dua cerun yang gagal terdiri daripada batuan vulkanik terluluhawa dan mengalami kegagalan jenis lingkaran. Cerapan lapangan mendapati batuan vokalnik di kawasan kajian mempunyai kepadatan ketakselajaran yang tinggi, dan satah-satah ketakselajaran memotong jasad batuan dalam pelbagai orientasi. Keadaan ini membolehkan air larian permukaan menyusup ke dalam jasad bahan melalui satah-satah ketakselajaran, menyebabkan penepuan bahan dan peningkatan tekanan air disepanjang satah-satah ketakselajaran serta meningkatkan tegasan ricih cerun lalu mencetuskan kegagalan.

Pembinaan jalanraya di kawasan perbukitan tinggi beriklim tropika lembab dengan batuan yang terancang dan terluluhawa hebat sering berhadapan dengan masalah kegagalan cerun. Kajian geologi terperinci seperti ini penting untuk memahami proses dan faktor geologi semulajadi dan pengaruhnya terhadap kestabilan cerun untuk membantu mengurangi risiko geobencana walaupun jalanraya telah siap dibina.

Intergration of GIS in deterministic model (infinite slope) for landslide susceptibility analysis (LSA) at Kota Kinabalu area, Sabah, Malaysia

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Keywords: deterministic slope stability (DSS), infinite slope model (ISM), landslide susceptibility analysis (LSA), failure probability

A practical application for landslide susceptibility analysis (LSA) based on two dimensional deterministic slope stability (infinite slope model) (DSS-ISM) was used to calculate factor of safety (FOS) and failure probabilities for the area of Kota Kinabalu, Sabah. LSA is defined as quantitative or qualitative assessment of the classification, volume (or area) and spatial distribution of landslides which exist or potentially may occur in an area. In this paper, LSA value can be expressed by a FOS, which is the ratio between the forces that make the slope fail and those that prevent the slope from failing. An geotechnical engineering properties data base has been developed on the basis of a series of parameter maps such as effective cohesion (C'), unit weight of soil (g), depth of failure surface (Z), height of ground water table (Z_w), Z_w/Z dimensionless (m), unit weight of water (gw), slope surface inclination (β) and effective angle of shearing resistance (f). Taking into consideration the cause of the landslide, identified as groundwater change, two scenarios of landslide activity have been studied. Scenario 1 considers the minimum groundwater level recorded corresponding to the actual situation of the most recent landslide while the scenario 2 is vice-versa. A simple method for error propagation was used to calculate the variance of the FOS and the probability that will be less than 1 for each pixel. The highest probability value of the various scenarios was selected for each pixel and final LSA 1 (scenario 1) and LSA 2 (scenario 2) maps were constructed (Figures 1 and 2). It has been found from this study that β and Z_w parameters have the higher influence on landslide instability. The result validation between the examined LSA 1 and LSA 2 maps and result of landslide distribution map (LDM) were evaluated. This DSS-ISM had higher prediction accuracy. The prediction accuracy is 81 % (LSA 1) and 84 % (LSA 2), respectively (Figure 3). Overall the case of both factors, LSA 2 model used showed a higher accuracy than cases of LSA 1 model used. The resulting LSA maps can be used by local administration or developers to locate areas prone to landslide area, determine the land use suitability area and to organize more detailed analysis in the identified "hot spot" areas.

Intergrasi GIS dalam model deterministik (cerun tak terhingga) untuk kemudahrentanan gelinciran tanah (landslide susceptibility analysis, LSA) di kawasan Kota Kinabalu, Sabah, Malaysia

Aplikasi yang praktikal untuk analisis kemudahrentanan gelinciran tanah (*landslide susceptibility analysis*, LSA) berdasarkan kepada dua dimensi deterministik kestabilan cerun (model cerun tak terhingga) (DSS-ISM) telah digunakan untuk mengira faktor keselamatan (*factor of safety*, FOS) dan kebarangkalian kegagalannya di kawasan Kota Kinabalu, Sabah. LSA ditakrifkan sebagai penaksiran secara kuantitatif atau kualitatif bagi pengelasan, isipadu (atau keluasan) dan taburan spatial gelinciran tanah yang hadir atau berpotensi berlaku di sesuatu kawasan. Dalam kertas kerja ini, nilai LSA diungkapkan sebagai FOS, iaitu nisbah di antara tekanan yang menyebabkan cerun gagal dan yang menghalang cerun daripada gagal. Pangkalan data untuk sifat kejuruteraan geoteknikal telah dibangunkan berdasarkan kepada beberapa siri parameter peta-peta seperti kejelikitan berkesan (C'), berat unit tanah (g), kedalaman permukaan kegagalan (Z), ketinggian paras air bawah tanah (Z_w), Z_w/Z berdimensi (m), berat unit air (gw), kecondongan permukaan cerun (β) dan sudut geseran ricihan berkesan (f). Dengan mengambil kira punca kejadian gelinciran tanah, melalui pengenalpastian perubahan air bawah tanah, dua senario aktiviti gelinciran tanah telah dikaji. Senario 1 mempertimbangkan paras air bawah tanah yang minimum dicatatkan sepadan dengan keadaan sebenar gelinciran tanah semasa manakala senario 2 adalah sebaliknya. Satu kaedah yang mudah untuk mempropagasikan ralat telah digunakan untuk mengira varians FOS dan kebarangkalian ianya menjadi kurang daripada 1 bagi setiap piksel. Nilai kebarangkalian tertinggi daripada pelbagai senario telah dipilih untuk setiap piksel dan akhirnya peta-peta LSA 1 (senario 1) dan LSA 2 (senario 2) telah dihasilkan (Rajah 1 dan 2). Hasil kajian mendapati bahawa parameter-parameter β dan Z_w mempunyai pengaruh yang sangat tinggi kepada ketidakstabilan gelinciran tanah. Validasi keputusan dilakukan melalui penyemakan hasil daripada peta-peta LSA 1 dan LSA 2

dengan peta taburan gelinciran tanah (*landslide distribution map, LDM*). DSS-ISM mempunyai ketepatan peramalan yang sangat tinggi. Ketepatan ramalan adalah sebanyak 81% (LSA 1) dan 84% (LSA 2) masing-masing (Rajah 3). Hasil kajian mendapati bahawa model LSA 2 menunjukkan ketepatan yang lebih tinggi berbanding dengan model LSA 1 yang digunakan. Keputusan peta-peta LSA boleh digunakan oleh pihak berkuasa tempatan atau pemaju dalam mengesan kawasan-kawasan yang terdedah kepada gelinciran tanah, menentukan kesesuaian kawasan jenis guna tanah (Table 1) dan menjalankan analisis yang lebih terperinci di kawasan “titik panas” yang dikenal pasti.

Table 1: Land use suitability classes from FOS value.

Landslide Susceptibility Level	Procedural requirements for development
Very low	- Development highly recommended. - Environmental Impact Assessment (EIA) must be conducted followed by available suitable procedure guidelines or acts (Handbook of EIA Guidelines, 2001 (DOE), Pindaan Akta Perancangan Bandar dan Desa, Akta A933 (1995), Garis Panduan DBKK, etc). - Detailed engineering geological and geotechnical reports. - Conduct landslide hazard assessment (LHA) – hazard identification & hazard analysis.
Low to moderate	- Development slightly recommended. - Environmental Impact Assessment (EIA) must be conducted followed by available suitable procedure guidelines or acts (Handbook of EIA Guidelines, 2001 (DOE), Pindaan Akta Perancangan Bandar dan Desa, Akta A933 (1995), Garis Panduan DBKK, etc). - Detailed engineering geological and geotechnical reports. - Suitable structural control works planning (stabilization and mitigation). - Conduct landslide risk analysis (LRAn) – LHA, consequence analysis & risk estimation.
High	- Development to be allowed. - Environmental Impact Assessment (EIA) must be conducted followed by available suitable procedure guidelines or acts (Handbook of EIA Guidelines, 2001 (DOE), Pindaan Akta Perancangan Bandar dan Desa, Akta A933 (1995), Garis Panduan DBKK, etc). - Detailed engineering geological and geotechnical reports. - Suitable structural control works planning (stabilization and mitigation). - Conduct landslide risk assessment (LHAs) – LHA, LRAn & risk evaluation.
Very high	- Basically development is not recommended. However, if there is no choice or the developer or the local authorities really want to develop this area, some procedures to be observed as follows: - Environmental Impact Assessment (EIA) must be conducted followed by available suitable procedure guidelines or acts (Handbook of EIA Guidelines, 2001 (DOE), Pindaan Akta Perancangan Bandar dan Desa, Akta A933 (1995), Garis Panduan DBKK, etc). - Detailed engineering geological and geotechnical reports. - Suitable structural control works planning (stabilization and mitigation). - Conduct landslide risk management (LRM) – LHA, LRAn, LRAs & risk treatment.
Extremely high	- Development is not recommended. - Suitable non structural control works planning: Regulatory measures, public awareness, disaster preparedness, behavioral modification and early warning system)

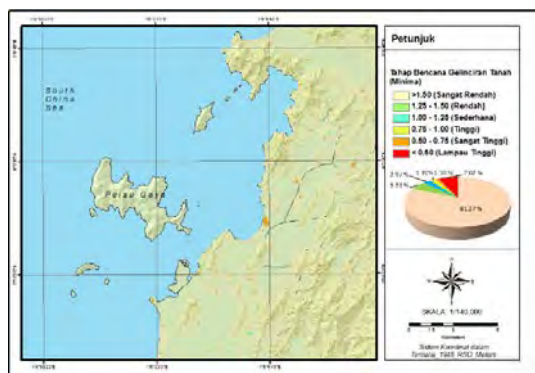


Figure 1: Landslide Susceptibility Analysis (LSA) map 1 (Scenario 1 – Z_w is minimum).

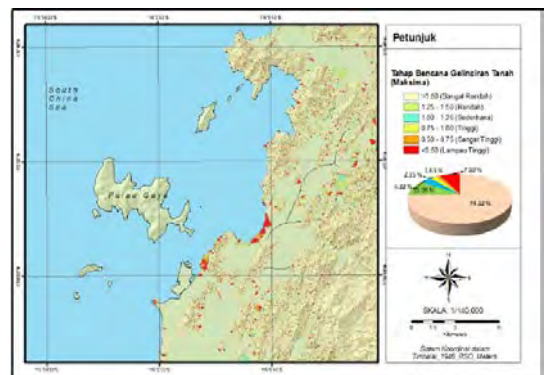


Figure 2: Landslide Susceptibility Analysis (LSA) map 2 (Scenario 2 – Z_w is maximum).

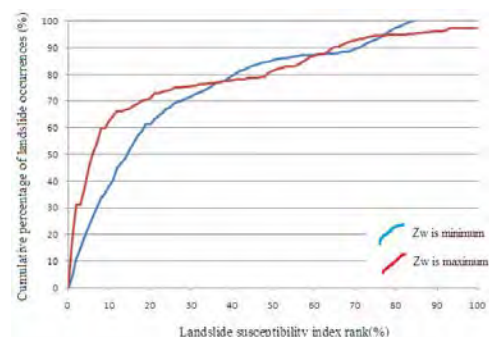


Figure 3: Illustration of cumulative frequency diagram showing landslide susceptibility index rank (y-axis) occurring in cumulative percentage of landslide occurrence (x-axis).

Slope failures associated with water tank and reservoir sites – Some case studies in the Kuching Area, Sarawak

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Water tanks and reservoirs are sited on top of hills and in hilly terrains. As such, slope failures can and are often encountered associated with these sites. This paper presents case studies on slope failures associated with five water tank and reservoir sites in the Kuching and vicinity areas. The engineering geologic studies cover: site geology, soil profile, soil/rock materials involved in the slope failures, causes of failures, and risk classification. The results of the studies are summarised in Table 1 below. Slope failures involved the weaker surficial soils such as fill materials and Old Alluvium, and in two cases, the residual soils as well. Rainfall/water infiltration into the slope is a common causative or triggering factor. Steeper slopes have higher slope failure risk as compared to gentler slopes. The plotting of isopach maps showing the thickness of the fill materials and Old Alluvium at the various water tank and reservoir sites is particularly useful in depicting and assessing potential slope failures.

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Table 1: Slope Failures Associated with 5 Water Tank and Reservoir Sites.

Location	Fill/Alluvium	Residual Soil	Bedrock	Slope Failure
Pending	Old Alluvium, 2-9m sand, pebbles, cobbles	clayey silt 6-24m	Tuang Fm dark grey-black phyllite	Flow slide involving Old Alluvium
Datu Muda	Fill (clayey silt & silty sand), 2-8m	silty sand, gravels 1-12m	Tuang Fm Light grey metagraywacke	Slide remedied fill/residual soils
9 ¾ Mile	Fill (clayey silt) 2-8m	clayey silt 1-5m	Microtonalite	Failure involved fill and residual soils
Matang	Fill (cobbles, boulders, sand) 1-9m	clayey silt 5-20m	Pedawan Fm sandstone/shale	Failure involved fill materials dumped into a natural valley
Muara Tuang	Tipped fill 2.7-7.1m	clayey silt - silty clay 2-8m	Tuang Fm dark grey phyllite	Failure involved fill materials dumped into a natural valley

Influence of geological features in blasting and quarry face design: A case study of the IJM MRP granite quarry Kulim, Kedah

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Introduction

In a quarry that produce aggregate like granite quarry in Junjung, Kulim, Kedah own by MRP Sdn. Bhd., the process was started with production blasting at quarry face, load and haul to the primary jaw crusher, transporting 6"x 9" block to the cone crusher, and lastly transporting crushed aggregate to the screens for different kind of products. The efficiency of whole process that was measured in Tonne Per Hour (TPH) must be reach by the company in order to get the profit or minimizing the lost. So, as the primary jaw crusher in this quarry only required rock of less than 30" of maximum dimension, the percentage of oversize rocks must be less than 10% from each production blasting. Other than having oversize rocks less than 10%, the research were also done to minimize the over break of bench, to minimize "*stomach curve of bench*" and lastly to educate the shot firer to handle blasting according to the geological features.

Materials and method

In this research, the method was started by doing desk study about any structure or past movement which occurs in this area. Then, it was continued by doing field survey together with the driller to understand the variation of rock of the quarry face. For each area that will be blast, the discontinuity survey to collect 40 to 50 data of discontinuities was done in order to identify major discontinuity orientation together with the bench orientation. As the survey result shows more than one of major discontinuities set of dipping $\geq 60^\circ$, then the modified excavability classification system by Franklin et al. (1971) like Figure 1 were used to choose which discontinuity orientation to be blast exactly or almost perpendicular to its strike direction because in order to get better fragmentation or less oversize rock, the blasting direction must be perpendicular to weak plane which fault plane, bedding, and others, (U.S. Army, 1972). Lastly, the amount of detonator that was needed to blast ≈ 60 feet height bench was qualitatively determines using the Geological Strength Index (GSI) like in Figure 2 and analyzing the dry drilling dust of the bench.

Results and discussion

Based on the desk study and discontinuity survey, J1 ($0^\circ/88^\circ$), as the major discontinuity set was believed the result of the north – south wrench fault (Courtier, 1974). In the same orientation, a fault zone of 139 feet thick was found inside the quarry face. Two other discontinuity orientations were J2 ($262^\circ/54^\circ$) and J3 ($57^\circ/42^\circ$). By using the modified excavability classification system by Franklin et. al (1971), two major steep discontinuity sets which is J1 ($0^\circ/88^\circ$) and J2 ($262^\circ/54^\circ$) together with the bench face of ($160^\circ/89^\circ$) were compared, and the result of fragmentation by choosing the bearing of blasting direction towards $N270^\circ E \pm 20^\circ$ is very good where qualitatively the oversize amount is less than 10%. As the best blasting direction was determined, the benches were redesign to be exactly or almost parallel to J1 ($0^\circ/88^\circ$) orientation. Besides that, the bench which the GSI value was under 50 ± 5 or / and the dry drilling dust is greenish grey such as the fault zone, the amount of detonator that was needed to blast the bench is 2 rather than 1 for normal condition of bench (bench with fresh granite colour and few discolouration along crack line), so that the distribution of energy to fracturing the rock is better because for the weaker rock, the energy tend to propagate through the weaker plane which is the shattered line of rock.

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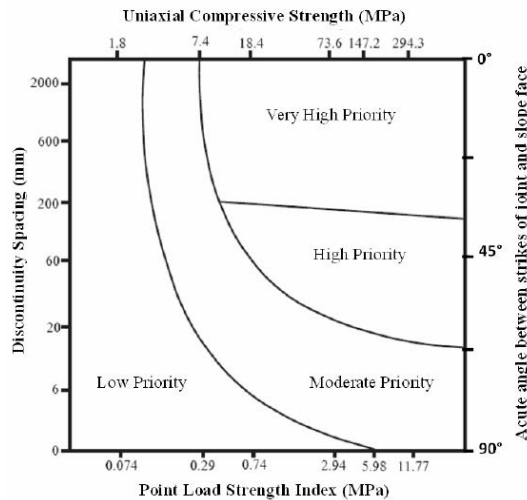


Figure 1: Modified excavability classification system by Franklin et al. (1971).

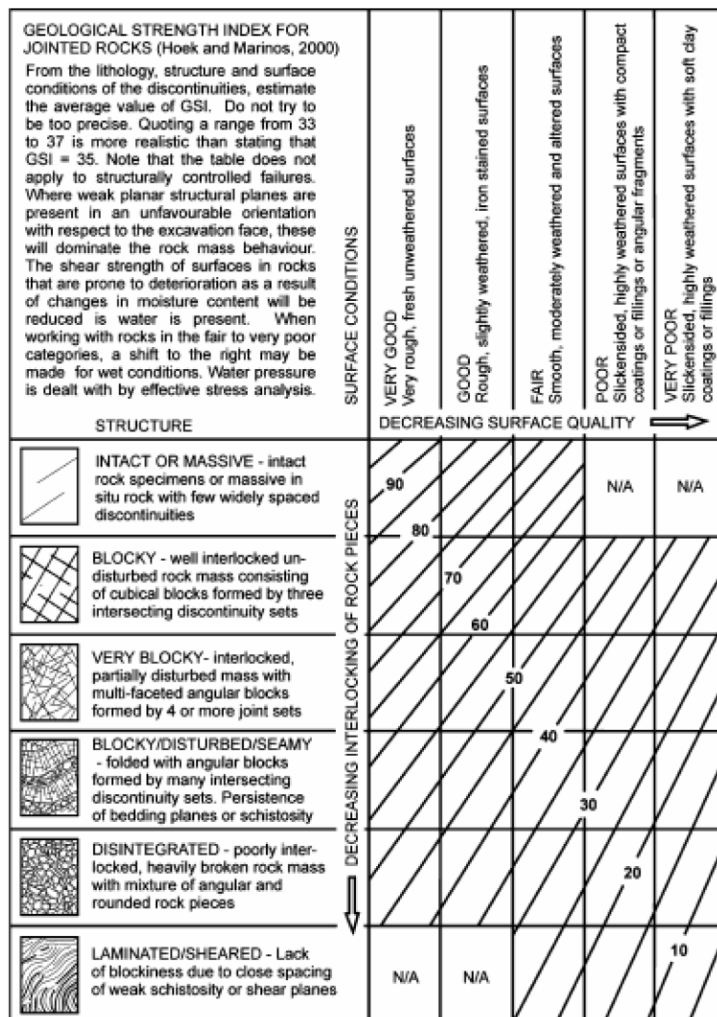


Figure 2: GSI chart for determining the amount of detonator in each hole of blasting where the bench quality under 50 ± 5 must use double detonator for blasting (Marinos et al., 2005).

Review on the limitations and applications of geological strength index

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Keywords: strength, deformation, discontinuities, geological strength index, anisotropy, weathered rock

Reliable estimates of the strength and deformation characteristics of rock masses are required for almost any form of analysis used for engineering design. A method for obtaining estimates of the strength of jointed rock masses, based upon an assessment of the interlocking of rock blocks and the condition of the surfaces between these blocks were proposed and over the years, it was being modified in order to fulfill engineering requirements that were not considered when the original criterion was developed. In addition, as it is basically impossible to determine the strength and deformation characteristics of the rock mass through direct in situ testing except for back-analysis of already constructed tunnels, a need for some method to estimate the rock-mass properties from the intact rock properties and the characteristics of the discontinuities in the rock mass was required (Hoek et al., 1998). Therefore, the new classification called Geological Strength Index (GSI) was developed; extended from the original criterion. The GSI classification system greatly respects the geological constraints that occur in nature and are reflected in the geological information. Currently, in order to meet the need for dependable input data, especially when rock-mass properties are required as the input for numerical analysis or closed form solutions, the GSI system has been proposed (Marinos & Hoek, 2000). As a direct input to the selection of parameters related for the prediction of rock deformability as well as rock-mass strength, the geological character of rock material and assessment through observation of the mass it forms, have been applied. This approach has the ability to be considered a rock mass as the mechanical continuum without losing the geological influence on its engineering properties. In order to characterize rock masses which are complicated to describe, a field method has been provided by GSI. This paper tries to review some critical questions that exist about the correct selection of the index for a range of rock masses under different conditions after years of GSI application and its quantitative characterization of rock mass variations. Given cases where the GSI is not appropriate to be used, additional recommendations on the GSI usage are provided. Specifically, a suggestion and discussion which are related to issues such as the presence of ground water, the influence of great depth, size of the rock mass, its anisotropy, the properties of weathered rock masses and soft rocks and the aperture and the infilling of discontinuities are presented. The GSI has considerable potential for use in rock engineering because it permits the manifold aspects of rock to be quantified thereby enhancing geological logic and reducing engineering uncertainty. Its use allows the influence of variables, which make up a rock mass, to be assessed and hence the behaviour of rock masses to be explained more clearly. One of the advantages of the index is that the geological reasoning it embodies allows adjustments of its ratings to cover a wide range of rock masses and conditions but it also allows us to understand the limits of its application. Finally, there were some suggestions for using GSI.

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Survei ketakselajaran dan permodelan struktur geologi cerun potongan batuan (Discontinuity survey and structural geological modelling of cut slopes)

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Katakunci: survei ketakselajaran, ketakselajaran relikta, model geologi struktur cerun

Pengaruh ketakselajaran ke atas kelakuan geomekanik jasad batuan dan kestabilan cerun batuan telah banyak diperbincangkan oleh pengkaji terdahulu. Pemetaan atau survei ketakselajaran pada cerun yang belum dibina ataupun yang telah siap dibina tetapi terluluhawa teruk dan ditutupi tumbuh-tumbuhan, memang sangat menyukarkan. Struktur ketakselajaran lazimnya tidak lagi jelas kelihatan pada cerun yang telah terluluhawa teruk (gred IV-V). Untuk itu, pemetaan cerun terluluhawa perlu dilakukan dengan penuh berhati-hati dengan mengukur bacaan orientasi ketakselajaran relikta setepat dan sebanyak mungkin. Data orientasi ketakselajaran/ketakselajaran relikta yang diperolehi akan diplotkan ke dalam unjuran stereografi dan dianalisis untuk menentukan bilangan set ketakselajaran yang hadir di dalam jasad batuan pembentuk cerun. Data-data ketakselajaran tersebut seterusnya digunakan untuk menilai kestabilan dan potensi ragam kegagalan cerun sebagaimana kaedah yang dipelopori oleh Hoek & Bray (1981). Maklumat ketakselajaran yang diperolehi daripada analisis kinematik boleh dimanfaatkan seterusnya untuk menghasilkan model struktur geologi cerun dengan cara mengunjurkan set-set ketakselajaran di dalam keratan rentas cerun. Dengan model ini, ragam kegagalan cerun dan kehadiran satah-satah ketakselajaran yang kritikal dapat dinilai untuk pertimbangan rekabentuk penstabilan cerun yang paling optimum. Model geologi cerun yang dihasilkan sangat penting untuk pemilihan orientasi dan panjang struktur penstabilan (e.g. “soil nails”, “rock bolts”, “ground anchor”, dan sebagainya) yang diperlukan untuk cerun. Model ini juga sangat membantu dalam menentukan kedalaman optimum untuk cerucuk yang diperlukan untuk pendasaran struktur bangunan di atas cerun. Sebanyak 3 kajian kes disajikan di dalam kertas ini untuk memberikan contoh aplikasi pemodelan cerun batuan yang dijana daripada survei dan analisis data ketakselajaran.

Keywords: discontinuity Survey; relict discontinuities, structural geological model of slope

The influences of discontinuities on geomechanical behaviour of rock mass and stability of rock slopes have been long discussed in the literature. The mapping or survey of discontinuities on badly weathered and densely vegetated slopes, either before or after constructions, are proven tedious. Discontinuities in badly weathered (grade IV-V) cut slopes are often obscured and difficult to be identified. In such situation, the slope mapping has to be done with extra cautious and relies on the presence of relict discontinuities. Their orientations (strike and dip) should be measured as many and as accurate as possible. The obtained readings are then plotted into stereographic projection and analysed to identify the discontinuity sets present in the slope-forming rock mass. The discontinuity data from the slope mapping can also be used to assess slope stability and to identify the potential modes of failure following the methods proposed by Hoek & Bray (1981). Results from the kinematics stability analysis can be further manipulated to produce a structural model for the slope by projecting the discontinuity planes in the slope's cross section. By virtue of the structural model, the anticipated modes of failure and the critical plane of weakness in the slope can be visualised for due consideration in designing the suitable slope's stabilisation measures. The structural geological model of slope is very helpful to facilitate the required design (orientation and length) of the reinforcement/stabilisation structures (e.g.: soil nails, rock bolts, ground anchors, and etc.). The slope model is also very helpful to facilitate the engineering design of structural foundations for proposed buildings on rock/cut slopes, notably in deciding the optimum length or depth of piles to be driven on the slopes. In this paper 3 case studies are presented to provide examples on the application of structural geological modelling of rock slopes which are generated from the discontinuity survey and analyses.

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Abstract: The structural interpretation of a part of eastern Potwar (Missa Keswal) has been carried out with available seismological, seismic and well data. Seismological data contains both the source parameters and fault plane solution (FPS) parameters and seismic data contains ten seismic lines that were re-interpreted by using well data. Structural interpretation depicts two broad types of fault sets namely, thrust and back thrust faults. These faults together give rise to pop up structures in the study area, and are also considered responsible for many structural traps and seismicity in the area. Seismic interpretation includes time and depth contour maps of Chorgali Formation while seismological interpretation includes focal mechanism solution (FMS), depth, frequency, magnitude bar graphs and renewal of Seismotectonic map. The Focal Mechanism Solutions (FMS) that surrounds the study area are correlated with the different geological and structural maps of the area for the determination of the nature of subsurface faults. Results of structural interpretation from both seismic and seismological data show good correlation. It is hoped that the present work will help in better understanding of the variations in the subsurface structure and can be a useful tool for earthquake prediction, planning of oil field and reservoir monitoring.

Keywords: focal mechanism solution (FMS), fault plane solution (FPS)

Introduction

Pakistan is considered as a seismically very active region. The north Potwar deformed zone (NPDZ) and other parts of Potwar appear to be relatively less active as compared to adjacent areas (Mona Lisa et al., 2004). The Missa Keswal oil field (study area) is located in the eastern part of Potwar Plateau Figure 1. Eastern Potwar Plateau is characterized by north-east, south-west trending tight, faulted anticlines separated by broad synclines (Moghal et al., 2003). Anticline represents folding phenomenon while synclines are not true folds and represents un-deformed area between anticlines. The tectonic framework of the eastern Potwar region is largely controlled by the Salt Range and Domeli forward thrust systems along with DilJabba and Domeli backthrusts. Chorgali Formation of Eocene age is the main reservoir rock in the study area. The shale and clays of Murree Formation act as cap rocks (Aamir & Siddiqui, 2006).

Methodology

The seismicity and focal mechanism solution (FMS) are two important tools for the identification/correlation of the major structure and subsurface structures. These techniques have been used in various parts of the world for the structural interpretation as well as for the hazard mitigation. In the present study both techniques are employed along with seismic reflection and well data.

Seismological data interpretation gives information about the nature of earthquake, nature of stresses and also helps in understanding the kinematic behavior of the seismic zones. Seismicity map of the Potwar area is generated for the period 1973-2007 as shown in Figure 2. Bar graphs and 3D models are prepared to find the magnitude, depth

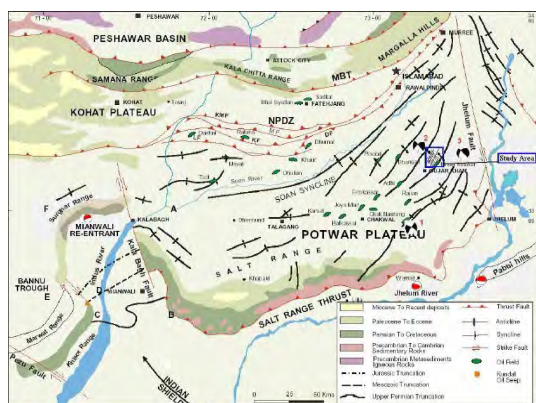


Figure 1: Structure map of the Kohat Potwar with location of study area and FMS updated from Wandrey et al. (1999).

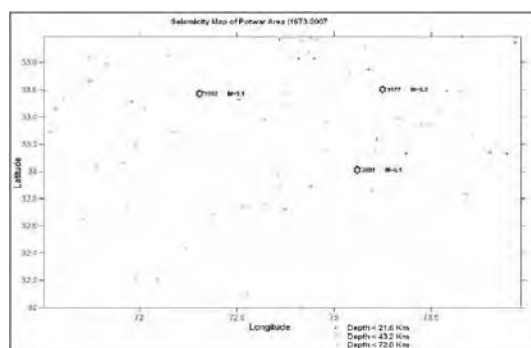


Figure 2: Seismicity map of Potwar area (1973-2008) shows that Potwar is tectonically active area and maximum magnitude earthquake has originated in the eastern Potwar.

and frequency of earthquakes in the Potwar area. FMS map of Potwar area shows the dominance of strike slip faults, followed by some thrust/reverse mechanism.

Seismotectonic map of the NW Himalayan fold and thrust belt (Mona Lisa et al., 2004) is modified by using international data from USGS. All the earthquakes that have occurred in NW Himalayan fold and thrust belt from 2006-2008 having magnitude > 4 mb are added in the map as the events till 2005 has already been added. From the map it is clear that tectonic activity has increased in the NW side.

Results obtained from the structural interpretation of seismological data are correlated with structural map of Kohat-Potwar area. The position of FMS also marked on the two way time map of the Potwar area Figure 3. Depth of these three FMS is from 5-33 km and their dip is towards NW. The orientation of the surface structure present in the area is also from NE-SW and is dipping towards NW.

Rheological model of the study area is prepared by using stereonet, shows the thrust dominant strike slip stresses which correlates with the seismological models (FMS) surrounding the study area and it also shows that faults are changing their nature from thrust to strike slip Figure 4.

Conclusions

Potwar area was highly tectonically active during 1992-93 and 2005-07, maximum magnitude earthquake was originated in the eastern Potwar. Strike slip faults are dominant in the Potwar area followed by some thrust/reverse mechanism. FMS1, FMS2 and FMS3 are prepared through seismological data interpretation, shows the correlation with the surface structure and the structure interpreted from seismic data. With the depth faults are changing their nature from thrust to strike slip. More seismic and earthquake data is required for correlation of results obtained from seismic and seismological data interpretation and this will be very useful for earthquake prediction.

Future work

This study mainly focused on the integration of seismic and seismological data interpretation to identify the nature and direction of subsurface structures. In future, more work is required to apply this integrated technique not only for structure identification but also for reservoir engineering.

Focal mechanism solution technique can be applied to determine the direction and spatial extent of fracture induced by fluid injection/extraction for oil production. Seismological studies define the rate and direction of stress in the area which can be helpful in planning of oil field and reservoir monitoring.

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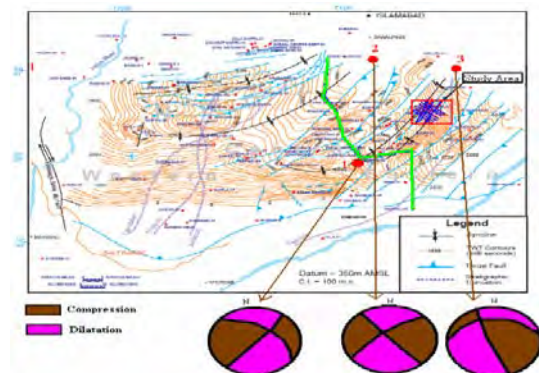


Figure 3: Two way time map at base Miocene updated from (Moghal et al., 2003). Green line shows the locations of the points where eastern Potwar cross section is taken. Mark 1- 3 shows location of FMS.

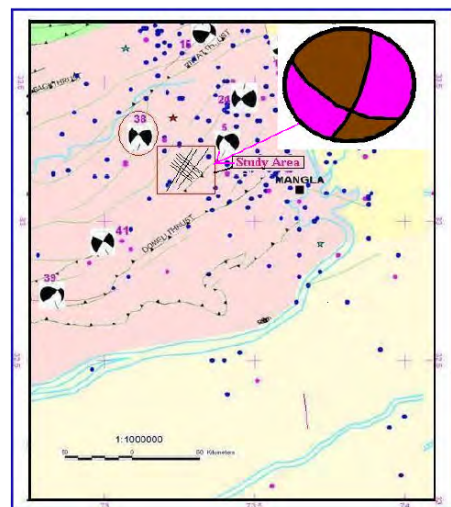


Figure 4: Seismotectonic map of NW Himalayan Fold and Thrust Belt updated from Mona Lisa et al. (2004) shows the shows the seismological models (FMS) while the map at the top right corner shows the rheological model of study area

Iron ore detection using electrical methods with enhancing horizontal resolution (EHR) technique

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Keywords: electrical method, electrical resistivity, induced polarization (IP), iron ore, EHR

Electrical methods have broad application to solve mineral and geo environmental problems. They may be used to identify sulfide minerals, structures and lithologies. All geophysical techniques are based on the detection of contrasts in different physical properties of materials. Electrical methods depend on the contrasts distribution of electrical resistivity (Telford & Sheriff, 1990). Two electrical methods in this study are electrical resistivity and Induced Polarization (IP) to map the iron ore distribution. Electrical resistivity surveys are used to provide information on the depth to bedrock and information on the electrical properties of bedrock and overlying units. The IP method makes use of the capacitive action of the subsurface to locate zones where clay and conductive minerals are disseminated within their host rock. The electrical methods were employed to study and detect the subsurface variation of resistivity and chargeability of iron ore in the area. There are two types of iron ore which are categorized into high-grade ore and low-grade ore. High-grade ore comes from large deposits of massive hematite rock formed by the in situ enrichment of iron, most commonly a banded iron formation. Low-grade ore is a term applied to iron-rich rocks cut-off grades in the range of 25-30% Fe (Table 1). The dominant economic iron mineral in low-grade ore is magnetite. The ore may be easily beneficiated by a process known as wet-magnetic separation. Enrichment is always separated from primary deposition by a period of erosion and oxidation (Bastin, 1931). Three survey lines were conducted using electrical methods and based from the result obtained, L3 was selected to run EHR technique at selected area in Johor, Malaysia. For each electrical measurement, a total spread of 400 m and 690 m were obtained with a vertical depth of penetration of about 140 to 150 m. Pole dipole arrays was conducted with minimum 5 m electrode spacing. Result (Figure 1) of the electrical resistivity as well as the Induced Polarization (IP) show that the area is underlain by a thick alluvium with resistivity value of 10-800 ohm-m iron which has chargeability rate of 0.1-3 msec. From the results of EHR technique show detail distribution of iron at L3. From the results show that the electrical method can determine the subsurface layer and the subsurface layer are characterized by a different chargeability from the surrounding layers, and its presence is indicated clearly by IP method. Table 2 shows the chargeability and resistivity for some common rocks and minerals.

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Table 1: Major iron minerals (Lindgren & Waldemar, 1933).

Name	Formula	%Fe
Hematite	Fe ₂ O ₃	69.9
Magnetite	Fe ₃ O ₄	74.2
Goethite/Limonite	HFeO ₂	~63
Siderite	FeCO ₃	48.2
Chamosite	(Mg,Fe,Al) ₆ (Si,Al) ₄ (OH) ₈	29.61
Pyrite	FeS	46.6
Ilmenite	FeTiO ₃	36.81

Table 2: Chargeability and resistivity of some common rocks and minerals (modified from Sumner, 1976; Telford & Sheriff, 1984).

Material	Chargeability (msec)	Resistivity (Ohm-m)
<i>Igneous / Metamorphic</i>		
Granite	10-50	5 x 10 ³ - 10 ⁸
Quartz	5-12	10 ³ - 2 x 10 ⁶
Schist	5-20	20 - 10 ⁴
<i>Sediments</i>		
Sandstone	3-12	8 - 4 x 10 ³
Conglomerate		2 x 10 ³ - 10 ⁴
Shale	50-100	20 - 2 x 10 ³
Limestone	10-20	50 - 4 x 10 ²
<i>Unconsolidated sediment</i>		
Gravels	3-9	800-10 ³
Clay		1 - 100
Alluvium	1-4	10 - 800
Marl		1 - 70
<i>Groundwater</i>		
Fresh water		10 - 100
Salt water		0.2
<i>Minerals</i>		
Galena	3.7	10 ⁻² -300
Magnetite	2.2	10 ⁻² -10 ¹
Hematite	0.2	10 ⁻¹ -10 ²

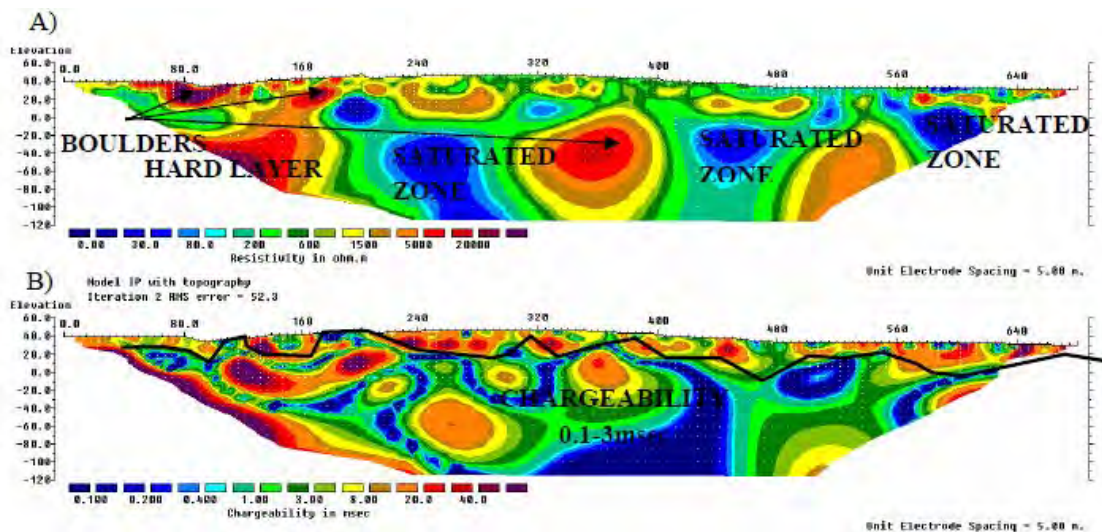


Figure 1: A) Inversion model resistivity of L1 from electrical resistivity and B) chargeability section from IP survey.

Fluvial channels delineation and geomorphologic characterization using well and seismic data

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Introduction

The seismic attribute analysis to understand distribution and geomorphology of channels within I group in XYZ field, Malay Basin. Seven main channels were identified and studied using different seismic attributes (horizon slicing on full stack volume and structure volume, SpecDeomp, RMS amplitude and sweetness. In the final step well log correlation was done based on sequence stratigraphy 3rd /4th order theory. Seismic attributes help us to delineate seven fluvial channels in I group. Furthermore seven different sequences were also identified which were also validated by well logs.

Fluvial environments are complex systems of erosion, sediment transport and deposition which give rise to a great variety of landforms. They refer to river and stream activity and to their deposits. Meandering stream deposits, with their abundant impermeable floodplain shales and lateral y restricted sand bodies, are most likely to form stratigraphic traps of limited size. Because fluvial sediments are commonly associated with plant material and coal, they are commonly considered more likely to contain gas than oil. Braided-river deposits offer excellent reservoirs in many cases, but have little potential for stratigraphic traps because of their paucity of thick, continuous fine-grained sediment (Epic, 1994).

Objective

The main goal of the study is to accurately identify the channels which offer excellent reservoirs and to perform their characterization in terms of geomorphology.

Methodology

The display of synthetic seismogram in well correlation was used to know the top of each sequence either by peak or trough (Brow, 1991). If there is no facie change over at any level there will be no polarity change and the result will be either peak or trough, but if there is change in facies on one level there will be difference in polarity and the result will be peak in some areas and trough in others.

Time slices along with the vertical sections pulled out of the volume can be used for the structural interpretation (Posamentier et al., 1996). Tying of wells with seismic depth of interest can be observed in time domain. Time slices helps to identify structure. Time slices shows structural dip closure and the trend of structure in an area, faults and lateral discontinuities, and visible channel features gives good impression about the presence of channels. Meandering channels exhibits narrow width but high bending deflection, so it appears on seismic sections short events with high amplitudes.

Seismic attribute (Landmark, 2004) were used to detect channels within different groups to estimate channels geomorphology by carrying out following steps: Estimation of width using horizon slicing technique; thickness estimation using spectral decomposition; and estimation of sinuosity and wavelength of a channel using thread and ruler.

Results and conclusion

Integrated studies of seismic attributes, coherency, RMS amplitude and Sweetness act as an aid for the delineation and characterization of seismic attributes. Seven main channels were identified within I group of AX field. Type of channels found here was meandering and straight. Channels flow direction was mostly East or South East direction. Average width of channels found here was 300-700 m. Sweetness marks good results regarding sand quality of channels. Spec decomposition also act as a good tool for channel thickness estimation with uncertainty of +/-5m only. Channel thickness estimated with a range of 20-30 m.

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Kajian kesesuaian pembangunan di tanah bekas lombong sekitar Kampar,
Perak menggunakan kaedah keberintangan geoelektrik
(Development suitability of ex-mining land At Kampar, Perak base on geoelectrical
resistivity assessment)

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Kepesatan pembangunan di daerah Kampar, Perak memerlukan tebus guna tanah yang baru terutamanya di tanah bekas lombong. Keadaan geologi bekas lombong bijih timah sekitar Kampar yang dihampari oleh batu kapur dan ketebalan lapisan selut lombong yang tebal serta kemungkinan wujudnya lubang benam memerlukan kajian lanjut dalam menentukan kesesuaian pembinaan di atas tanah tersebut. Sepanjang tahun 2011 hingga 2012, sebanyak 24 garis survei geoelektrik telah dilakukan menggunakan susunatur Wenner. Keadaan tanah yang berporositi tinggi menyebabkan masalah timbul semasa pengambilan data di lapangan. Kaedah '*use extended model*' telah digunakan untuk mengatasi masalah tersebut dan membolehkan pentafsiran di kawasan yang lebih besar. Secara umumnya, hasil kajian geoelektrik di tanah bekas lombong menunjukkan lapisan pasir yang poros diikuti oleh selut lombong (*slime*) dan batu kapur sebagai batuan dasar. Kesesuaian pembinaan di atas tanah bekas lombong boleh ditentukan menggunakan kaedah geoelektrik dengan sokongan lubang gerudi untuk pengesahan litologi bahan yang ditafsir. Umumnya, penyediaan tapak dan tebus guna tanah kawasan bekas lombong memerlukan penusukan tiang asas hingga ke batuan dasar dan melepasi selut lombong bagi mengelak berlakunya masalah dikemudian hari.

Physico-chemical properties of ultrabasic soil from Petaseh, Negeri Sembilan

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Abstract: This study was conducted to determine physico-chemical and specific properties of ultrabasic soil from selected areas in Peninsular. *In-situ* parameters such as coordinate, elevation from sea level, slope steepness and landuse were recorded from studied areas. Soil physical determined were particle size distributions, true and bulk density, organic matter content and porosity percentage, whereas chemical properties analysed were soil pH, electrical conductivity, available nutrient and total Ni, Cr, Fe and Mn content. Data on soil physical analysis showed that soil texture for studied areas were clay. Values of true density ranged from 2.41 to 2.66 g/cm³, with bulk density ranged from 0.78 to 1.07 g/cm³. Calculated porosity were between 59.5 to 67.7%. Data on chemical analysis showed that soil in the study area were slightly acidic with pH between 5.23 to 6.32. Soil organic matter contents were moderate at 5.91 to 8.782%. The electrical conductivity values ranged from 1.85–2.29 mS/cm. For available nutrient content (K, Mg, P) low values were recorded for P (6.08-13.54 mg/kg), Mg (13.47-19.38 mg/kg) and K (21.8-111.02 mg/kg). Highest value for Ni was 597 mg/kg were recorded in P5 and the lowest value was 176 mg/kg recorded from P4. Highest value of Cr was from P5 area with value 9270 mg/kg and the lowest value was from P4 with values of 748 mg/kg. The Fe concentration was high in all areas under study with values ranged from 74950 mg/kg for P1 areas to 395512 mg/kg for P5 areas. Mn concentration also ranged from low to high concentration with the lowest being in P4 at 562 mg/kg with the highest from P5 area with values at 943 mg/kg.

Keywords: physico-chemical, ultrabasic soil, heavy metals, nutrient

Introduction

Ultrabasic soil has low silica (SiO₂) contents of less than 45%. Serpentine mineral including talc, olivine, pyroxene and amphibole exist in fine size fraction (< 2 mm). Ultrabasic soil is less fertile land with near neutral pH (5 – 6.5) and contains low organic. The presence of this type of soils has created numbers of abnormality in the growth of surrounding plants because this soil developed from ophilitic rocks which are typically high in heavy metals content. The most important characteristic of this soil is its infertility, low important nutrient and organic matter contents and high in magnesium contents which creates imbalance in nutrient contents. Ultrabasic soils in the tropical areas are more weathered than ultrabasic soil in other areas in the world. Sahibin et al. (2008) shows the total Ni, Co, Mn and Fe bioavailability in ultrabasic soil is higher than schist-mica soil at Kuala Pilah, Negeri Sembilan. Ultrabasic soil is unsuitable growing media for most of the plant due to various deficiencies like low N, P, K content, low organic matter content, low cation capacity exchange, low water holding capacity and low Ca:Mg ratio, besides high in heavy metal such as Ni, Cr, and Co. Low N, P, K content is due to slow nutrient cycle (Burt et al., 2001). Low Ca:Mg ratio and high heavy metal content are inherited from serpentinite from materials that are rich in Mg and heavy metals (Robert & Proctor, 1992; Burt et al., 2001). Ultrabasic soil areas in Peninsular Malaysia are sparsely distributed in the states of Negeri Sembilan, Pahang and Kelantan. This study is focused to acquire physico-chemical characteristics of ultrabasic soil in Malaysia.

Materials and methods

Ultrabasic soil from Petaseh, Negeri Sembilan was studied. Eighteen soil samples from 18 sampling stations (P1, P2, P3, P4, P5 & P6) within the ultrabasic area were collected using stainless steel auger. Each sampling stations contain three soil replicates. About 1 kg of top soil (0-20cm) samples were collected and transported to the laboratory for soil physico-chemical analysis. Soils were air dried and crushed to pass 63 µm sieves. These soil samples are ready for analysis. Soil physical properties determined are particle size distribution, true density, bulk density and organic matter content. Chemical properties determined are soil pH, electrical conductivities, available nutrient, cation capacity exchange and total heavy metal content. Soil particle sizes were determined by pipette method with dry sieve (Abdullah 1966). Organic matter content was determined by loss on ignition technique (Avery & Bascomb 1982). True and bulk densities were determined using picnometer and waxing method, respectively. Soil pH was determined in soil:water ration of 1:2.5 (Metson, 1956). Soil electrical conductivity was determined from saturated CaSO₄·2H₂O extract (Massey & Windsor, 1967). Cation exchange capacity was determined using summation method (McLean, 1965). Available phosphorus, K and Mg was extracted using double acid (Ammonium acetate-acetic acid mixture). Phosphate contents was determined using UV-Visible Spectrophotometer v 4.55,

Table 1: Physico-chemical parameters of ultrabasic soil from Petaseh, Negeri Sembilan.

Parameter	Unit	Station					
		P1	P2	P3	P4	P5	P6
Organic Matter	%	8.21	8.17	8.14	8.78	5.91	7.17
Available Nutrient							
K	mg/kg	56.15	30.17	41.78	111.02	21.8	47.32
P	mg/kg	6.08	6.58	7.78	8.11	13.45	13.54
Mg	mg/kg	18.52	15.05	14.47	19.38	13.47	18.58
Total Heavy Metal Content							
Ni	mg/kg	202	281	307	176	597	226
Cr	mg/kg	964	1479	1175	748	9270	1032
Fe	mg/kg	74950	101665	95443	67922	395512	101456
Mn	mg/kg	662	796	902	526	943	854
Cation Capacity Exchange	meq/100g	1.36	2.00	1.57	2.47	1.13	1.95
pH		5.54	6.32	5.26	6.08	5.23	5.32
Electric Conductivity	mS/cm	1.92	2.35	2.06	2.04	1.85	2.29
True Density	g/cm ³	2.41	2.66	2.54	2.52	2.60	2.56
Bulk Density	g/cm ³	0.78	1.07	0.91	0.89	0.99	0.95
Porosity	%	67.7	59.5	63.9	64.5	61.8	63.1
Sand	%	20	13	16	29	30	23
Silt	%	4	4	6	8	13	3
Clay	%	76	84	78	64	57	70
Texture		Clay	Clay	Clay	Clay	Clay	Clay

whereas K and Mg were determined directly from the solution using ICP-MS. Total heavy metal contents were extracted using wet digestion method (AOAC, 1995) and determined by ICP-MS.

Results and discussion

Soil chemical analysis results of the study areas found that the soils are acidic to slightly acidic, with pH ranging from 5.23 to 6.32. Soil organic matter contents are ranged from 5.91 to 8.78%. Soil electric conductivities are low with values between 1.85 to 2.35 mS/cm. Electrical conductivity values of studied area are at index under 3. According to Massey and Windsor (1967), conductivity values at index 3 and below do not damage plants.

Soil particle size distribution of study areas analysis found that dominant sizes are tends to fine fraction which is clay with range from 57-84%. Soil textures are clay. In Paramanathan (2000) the topsoil of Sg. Mas Series soil which is an ultrabasic soil, contained 30% silt, 27% clay and 43% sand. The clay content is considered low by him. The reason being the clay dispersion is insufficient during determination. According to him, the actual clay content is estimated to be more than 65%. In this study the clay content in five of the sampling location recorded clay contents of more than 64%. The true density range from 2.41 to 2.66 g/cm³, whereas bulk density ranged from 0.78 to 1.07 g/cm³. Calculated porosity ranged from 59.5 to 67.7%.

For available nutrient content (K, Mg and P), values of available P, K and Mg are low. Cation capacity exchange values for study area are very low with values between 1.13 to 2.47 meq/100g. Exchangeable cation concentration sequence is $Mg^{2+} > Na^{+} > K^{+} > Ca^{+}$. Total heavy metal concentration is high with range from 176 to 597 mg/kg for Ni, 964 to 9270 mg/kg for Cr, 74950 to 395512 mg/kg for Fe and 526 to 943 mg/kg for Mn. High Ni and Cr content in ultrabasic soils was also recorded in previous study by Sahibin et al. (2009).

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Geospatial analysis of ex-mining land of Perak

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Abstract: Ex-mining land plays important role in socio-economic development, such as, agriculture, aquaculture, livestock, mining and quarrying, housing, industry, flood prevention, component of wetlands, sport fishing, and providing space for recreation and relaxation. The knowledge about ex-mining land distribution in Malaysia has become increasingly important to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime ex-mining ponds, destruction of important wetlands, and loss of wildlife habitats. Therefore, there is a need for proper monitoring and planning to ensure that the provisions of these ex-mining lands are adequately developed and conserved for current and future generations. For these reasons, in the Tenth Malaysian Plan (RMKe-10) of the first Rolling Plan (RP-1), 2011-2012, Mineral Research Centre, Minerals and Geoscience Department Malaysia is undertaking a project to develop a digital database on the distribution ex-mining land in Malaysia. As of 2011 various efforts have been carried out to meet this objective. Developing a digital database for the land-use in ex-mining land of Perak is one of them. This paper describes the method used to develop this database and the geospatial analysis of the existing ex-mining land in term of land-use. The ex-mining land of Perak covers 3.85% of the total acreage of the state. From the study, much of the land in the ex-mining land is idle (49.7%). The remaining land-use in the ex-mining are: agriculture (18.3%), water bodies (12.3%), residential (5.4%), industry (3.3%), forest (3.2%), others (2.6%), open space and recreation (2.2%), institution and public facilities (2.1%), infrastructure and utilities (0.8%), and business and services (0.2%). These statistics, however, are not current as it is not possible to acquire an up-to-date land-use data, the paper discusses various efforts made to come up with the most recent statistics. It is hoped that this work provides a starting point to establish a dynamic digital database of ex-mining land of Perak and the rest of the country.

Keywords: geospatial analysis, ex-mining land, land-use, ideal land, ex-mining ponds

Introduction

Ex-mining land plays important role in socio-economic development, such as, agriculture, aquaculture, livestock, mining and quarrying, housing, industry, flood prevention, component of wetlands, sport fishing, and providing space for recreation and relaxation. The knowledge about ex-mining land distribution in Malaysia has become increasingly important to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime ex-mining ponds, destruction of important wetlands, and loss of wildlife habitats. Therefore, there is a need for proper monitoring and planning to ensure that the provisions of these ex-mining lands are adequately developed and conserved for current and future generations.

For these reasons, Mineral Research Centre, Minerals and Geoscience Department Malaysia is undertaking a project to develop a digital database on the distribution of ex-mining land in Malaysia. The project is carried out in the Tenth Malaysian Plan (RMKe-10) of the first Rolling Plan (RP-1), 2011-2012. To meet this objective, a number of efforts have been made to develop the digital database (Abdullah et al., 2011; Ramli et al., 2011a; 2011b; 2011c). Developing a digital database for land-use in ex-mining land of Perak 2008 is another step towards achieving this goal.

This paper describes the method used to carry out geospatial analysis in term of land-use in the ex-mining land of Perak and discusses results obtained from various workers. It also provides example to develop digital databases of land-use in ex-mining lands for the rest of the country.

Materials

Digital ex-mining land distribution map of Perak was obtained from Lim, 1995, who compiled mining land statistics of Perak during the 6th Malaysian Plan, 1990-1994. Mining scheme plans obtained from Perak State Mining Offices were digitised in ArcGIS format to determine the distribution of mining land in Perak. Ramli et al. (2011c) used this information to come up with an ex-mining land base map for Perak. The distribution of ex-mining land of Perak according to district is shown in Figure 1.

The most current (as of 2008) digital land-use map of Perak was obtained from Department of Town and Rural Planning (JPBD) of Perak (Figure 2). The land-use depicted in the map is as follows:

- | | | |
|--------------------------------|--------------------------------------|-----------------------------|
| • Water Bodies | • Forest | • Industry |
| • Infrastructure and Utilities | • Institutions and Public Facilities | • Residential |
| • Business and Services | • Agriculture | • Open Space and Recreation |
| • Idle Land | • Local Center | • Trade |
| • Tourism | • Pedestrian | • Parking |

The most current (as of 2008) digital land-use map of Ipoh City was obtained from Ipoh City Council (MBI) as shown in Figure 3. The land-use depicted in the map is as follows:

- Water Bodies
- Infrastructure and Utilities
- Business and Services
- Idle Land
- Forest
- Institutions and Public Facilities
- Agriculture
- Transportation
- Industry
- Residential
- Open Space and Recreation

Geospatial Analysis

Geospatial analysis by Ramli et al. (2011c) shows that the ex-mining land of Perak covers 81,750 ha or 3.9% of the state. The district of Kinta has the highest acreage of ex-mining land, 47,614 ha (58.2%) followed by Batang Padang, 21,064 ha (25.8%); Perak Tengah, 5,095 ha (6.2%); Larut Matang, 4,610 ha (5.6%); Kuala Kangsar, 1,581 ha (1.9%); Hulu Perak, 982 ha (1.2%); Manjung, 661 ha (0.8%); and Hilir Perak, 143 ha (0.2%) as shown in Table 1. However, a number of other works that have been done in estimating the acreage of ex-mining land in Perak yielded the followings: 85,000 hectares (Salim, 1997); 53,216 hectares (UPEN Perak, 1998); and 65,500 hectares (Baharuddin, 2003).

The land-use digital maps from Department of Town and Rural Planning (JPBD) of Perak and Ipoh City Council (MBI) were merged to form the JPBD of Perak and MBI Digital Land-Use Map (shown in Figure 4). To synchronise the land-use for both JPBD of Perak and MBI, the following classification of land-use is adopted where “Others” includes Local Centre, Trade, Tourism, Pedestrian, Parking and Transportation:

- Water Bodies
- Infrastructure and Utilities
- Business and Services
- Idle Land
- Forest
- Institutions and Public Facilities
- Agriculture
- Others
- Industry
- Residential
- Open Space and Recreation

The JPBD of Perak and MBI Digital Land-Use Map was then intersected with the ex-mining land base map of Perak to form the Digital Map of Land-Use in Ex-Mining Land Map of Perak (Figure 5).

Figure 5 and Table 2 show statistics of land-use in the ex-mining land of Perak. Much of the land in the ex-mining land is idle, 40,597 ha (49.7%). The remaining land-use in the ex-mining are agriculture, 14,951 ha (18.3%); water bodies, 10,074 ha (12.3%); residential, 4,429 ha (5.4%); industry, 2,672 ha (3.3%); forest, 2,605 ha (3.2%); others, 2,117 ha (2.6%); open space and recreation, 1,767 ha (2.2%); institutions and public facilities, 1,681 ha (2.1%); infrastructure and utilities, 658 ha (0.8%); and business and services, 199 ha (0.2%).

Regarding the distribution of ex-mining ponds in Perak, Ramli et al. (2011a), did a geospatial analysis on them as shown in Figure 6.

Discussion

According to the latest land-use map (as of 2008) obtained from Department of Town and Rural Planning of Perak, there were some 40,597 ha of idle ex-mining land in Perak while Ramli et al., 2011c indicated that as of 2011, there were 29,948 ha. The latter study was done by taking into consideration the committed development lots as of

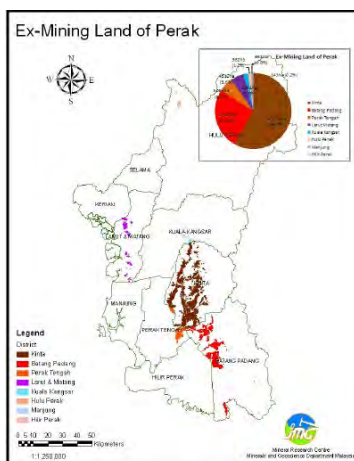


Figure 1: Ex-mining land of Perak (modified after Ramli et al., 2011c).

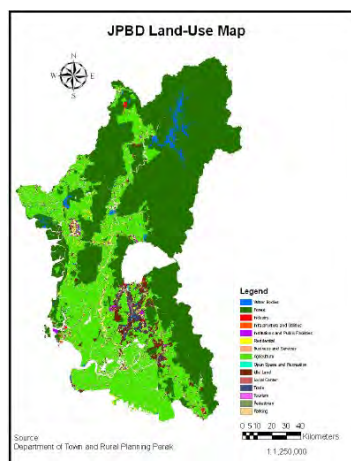


Figure 2: JPBD land-use map.

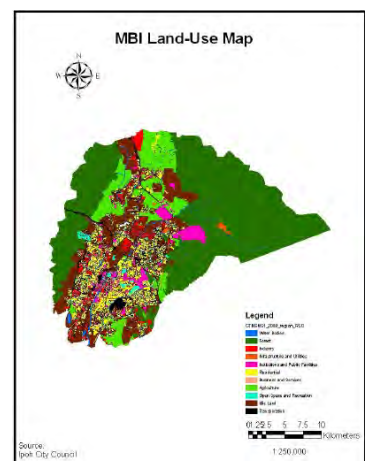


Figure 3: MBI land-use map.

Table 1: Distribution of ex-mining land of Perak according to district.

No.	District	Area	
		(ha)	(%)
1	Kinta	47,614	58.2
2	Batang Padang	21,064	25.8
3	Perak Tengah	5,095	6.2
4	Larut Matang	4,610	5.6
5	Kuala Kangsar	1,581	1.9
6	Hulu Perak	982	1.2
7	Manjung	661	0.8
8	Hilir Perak	143	0.2
Total		81,750	100.0

Table 2: Statistics of land-use in ex-mining land of Perak.

No.	Land-Use	Area	
		(ha)	(%)
1	Idle Land	40,597	49.7
2	Agriculture	14,951	18.3
3	Water Bodies	10,074	12.3
4	Residential	4,429	5.4
5	Industry	2,672	3.3
6	Forest	2,605	3.2
7	Others	2,117	2.6
8	Open Space and Recreation	1,767	2.2
9	Institutions and Public Facilities	1,681	2.1
10	Infrastructure and Utilities	658	0.8
11	Business and Services	199	0.2
Total		81,750	100.0

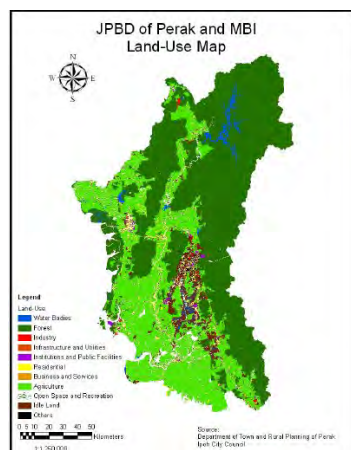


Figure 4: JPBD of Perak and MBI digital land-use map.

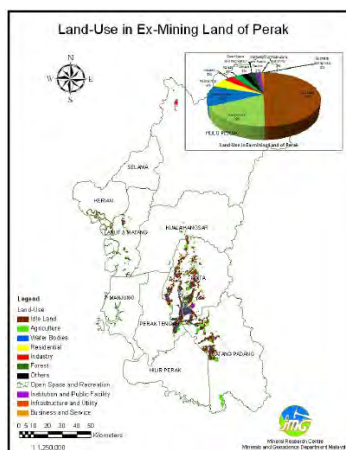


Figure 5: Digital map of land-use in ex-mining land of Perak.

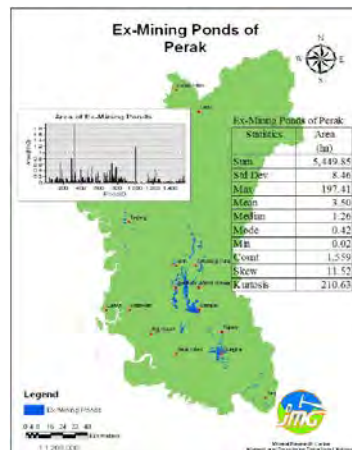


Figure 6: Ex-mining ponds of Perak (modified after Ramli et al., 2011a).

2011 obtained from Department of Town and Rural Planning of Perak. It shows that over a period of 3 years, 10,649 ha or 26% of idle ex-mining land has been converted into other land-uses.

The current study indicated that water bodies, which are entirely ex-mining ponds, covers 10,074 ha of the ex-mining land (Table 2). However, Ramli et al., 2011a shows that there were 1,559 ex-mining ponds in Perak with a total area of 5,450 ha. The latter study was done by digitizing and mapping of the ex-mining ponds from SPOT-5 Fusion Supermode PNC ortho rectified satellite images with a spatial resolution of 2.5 m processed at level 3 and map projected to Rectified Skew Orthomorphic (RSO) Kertau. These satellite images were obtained from Malaysian Centre for Remote Sensing (MACRES) in 2007.

As the latest data on land-use obtained from Department of Town and Rural Planning of Perak is of 2008, the statistics of land-use in the ex-mining land is not up to date. Figure 5 on Digital Map of Land-Use in Ex-Mining Land of Perak provides a mere guide of the land-use in the ex-mining land. The most up to date land-use can interpreted from satellite images as illustrated by Ramli et al. (2011b).

Conclusion

The current study is based on the latest digital land-use maps of JPBD and MBI. Being as of 2008, they are however out-of-date. The land-use map of ex-mining land in Perak produced here is just a guide. An up-to-date map of land-use could be done by analysing SPOT-5 2.5 m resolution satellite images. Site visits should be followed up to confirm all satellite images interpretations. Monitoring the availability of ex-mining land left should be done from time to time to keep abreast with the development of the land.

As of 2011, there were some 29,948 ha of idle land in the ex-mining land (Ramli et al., 2011c). An idle land is defined as land that shows no observable human activities. It is essentially a wasteland or a bush land and has potential to be developed. Study should be done to determine the best use of this idle land. It could be converted into agriculture, livestock, mining and quarrying, housing, industry, agroforestry, open space and recreation, and other developmental uses.

Likewise, up- to-date study on the distribution of ex-mining ponds should be made to determine its status. Undeveloped ex-mining ponds could be converted into aquaculture, duck farming, storm water facilities for flood prevention, component of wetlands, sport fishing, wetland and wildlife sanctuary, and providing space for recreation and relaxation, recreational ponds, and theme parks.

It is hoped that this paper provides a starting point to establish a dynamic digital database of ex-mining land that could be used for strategic development of the remaining ex-mining land in the state of Perak to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime ex-mining ponds, destruction of important wetlands, and loss of wildlife habitats. The contribution of this database in some way may lead toward land-use sustainability as to satisfy the ever changing society.

Also, the method described will provide example to develop digital databases of ex-mining land and land-uses in ex-mining lands for the rest of the country.

Acknowledgments

We thank Y. Bhg. Dato' Hj. Zulkifly Abu Bakar, Director of Mineral Research Centre, Ipoh for his unwavering support and encouragement in carrying out the project and to Y. Bhg. Dato' Hj. Yunus Abdul Razak, Director General of Minerals and Geoscience Department Malaysia for granting permission to publish this paper. Thank is also due to the Department of Town and Rural Planning of Perak and the Ipoh City Council for providing land-use digital maps.

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Lithology and lineament density for delineation of groundwater potential areas at the Muar Basin

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The aim of this study is to delineate groundwater potential areas at the Muar Basin using Geographical Information Systems (GIS) and remote sensing data. Aerial photographs along with Landsat imagery have been utilized to extract information on the groundwater controlling features of lineament and lithology of the study area. In addition published geological and topographical map were used as supplement. The study area have different type of hard rock lithologies such as acid intrusive, phyllite with slate and shale, sandstone metastone and limestone, hornfels and quartz vein. Meanwhile lineament was analysed using length density. Results were then used to delineate area into four classes i.e. very high, high, moderate and low groundwater potential. Study results indicate that correlations exist between lineament and tubewell yield.

Tujuan kajian ini adalah untuk menentukan kawasan berpotensi air bawah tanah di Lembangan Muar menggunakan Sistem Maklumat Geografi (GIS) dan data penderiaan jauh. Foto udara bersama dengan imej Landsat digunapakai untuk mendapatkan maklumat berkaitan fitur mengawal air bawah tanah iaitu lineamen dan litologi bagi kawasan kajian. Sebagai tambahan peta geologi dan topografi yang telah diterbitkan turut digunapakai. Kawasan kajian mempunyai beberapa jenis litologi batuan keras seperti asid intrusif, filit dengan syal dan batu lodak, batu pasir and batu kapur, honfel and telerang kuarza. Manakala lineamen dianalisa menggunakan panjang kepadatan. Hasil kajian kemudiannya digunakan dalam menentukan kawasan kepada empat pengelasan iaitu sangat tinggi, tinggi, sederhana dan rendah potensi air bawah tanah. Hasil kajian menunjukkan terdapatnya korelasi diantara lineamen dan kadar luahan telaga tiub air bawah tanah.

Excavation of hard material for construction work in Labis, Johor

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Keywords: hard material, excavation, completely weathered granite, moisture content, Labis

Introduction

The meaning of 'excavation' is to dislocate the rock massif from its original place (in-situ). Digging the ground and its disposal is two main operations that involves. Before excavation execute, assessment need to be done in order to determine the exact excavation method. The assessment can be done in two different ways which is direct method and indirect method. However, problem encounter when the material cannot be classified either in term of rock or soil. It is called hard material due to its behaviour. It is stiff when in dry condition and hard for ripping but relatively soft and brittle when in moist condition. Besides that, there is an issue arise where the construction located too near with the existing building which is about only 15 meter apart. Regarding the issues arise; therefore the main problem is to determine the most suitable excavation method that can be carried out in order to not harm the existing building besides giving the highest productivity of material excavated.

This paper will discuss about the affecting parameter influencing the excavation progress and its productivity also assessment of the productivity of excavation with the chosen method. A case study being done at a construction site located at Labis, Johor. The properties for this hard material are studied in order to determine the affecting parameter influencing the excavation progress and its productivity. This research focus on the strength and moisture content of the hard material. One of the main scopes in this research is focused on field study. Field study concentrates on field recognition on other environmental assessment for the type of excavation adopt and problems related on the adoption.

Methodology

Field assessment is executed on the construction site in order to measure the volume of the material to be excavated, properties and behaviour of material and . Apart from that, the assessment also being done by observing the productivity of the excavated material. Productivity being assess in different weather condition which is during the rainy day and sunny time. Ripper or excavator being used to assist this assessment. The samples of hard material were collected at the location which representing the weathering granite and the samples are taken to the laboratory for the further significant assessment in accordance to the field study. In order to analyse the parameter affecting, laboratory test preparation have been performed throughout the research project. Moisture content test and point load test was performed to see the connection between moisture in material the strength.

Result and discussion

From the field assessment, this hard material is classified as weathered granite grade V. A few physical properties of the material can be seen. The material is radish in coloured (Ibrahim Komoo, 1995), rock is substantially discoloured and has broken down to a soil but with original fabric (mineral arrangement & relict joints) still intact (after Attewell, 1993). It is also disintegrate in water and crushable by hand. The presence of discontinuities with about 1 meter to 2 meter long and 50 cm width (Figure 1) and iron concentration also can be seen (Figure 2, Figure 3). The material contain about less than 5% of moisture content during the dry climate and contain about 10%



Figure 1: Discontinuity plane.



Figure 2: Concentration of iron.



Figure 3: Concentration of iron.

of moisture content after raining day. As for the adoption of suitable excavation method, it can be seen from the excavation scheme from Pettifer and Forkes (1994) based on the result of point load test (Figure 4).

Conclusion

Based on the result obtain, we found out that this material is completely weathered granite and the strength of it is influenced by the presence of moisture. The increment of moisture content in the rock material has inversely proportional with the strength measured (Edy Tonnizam et al., 2011). Hence, the rate of excavation also the method of excavation is highly dependable with the Point Load Index, I_{s50} in order to get the highest productivity.

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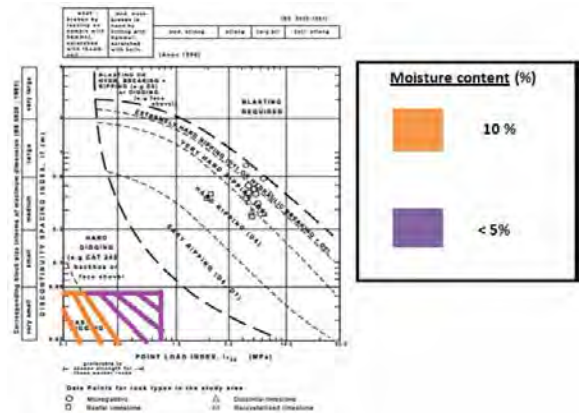


Figure 4: Method of excavation adopted based on excavation scheme from Pettifer & Forkes

Assessment of potential alkali silica reaction on aggregates with ‘fool’s gold’ from Kampung Melayu Majidee, Johor Bahru

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Keywords: alkali silica reaction (ASR), aggregates, pyrite

‘Gold rush’ at Kampung Melayu Majidee, Johor Bahru was a national top news during January 2012. Publics thought the glitters found on the aggregates used for the road upgrading project are real gold. However, it was confirmed that the glitters are actually iron pyrite which is characterised by its brassy yellow hue, which gives off a lustre similar to gold. The aggregates were sourced from a small part of the quarry face in BJ Kuari Sdn. Bhd., Inas, Kulai, Johor. An alkali silica reaction test by using accelerated mortar bar test (ASTM 1260) was carried out on this aggregates to evaluate suitability of the affected rock material to be used as major components in concreting. This paper also comparing the results on the aggregates without any pyrite, sourced from the same quarry.

Sintesis dan pencirian *nano zero valent iron* (NZVI) untuk rawatan air tercemar

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Pengenalan

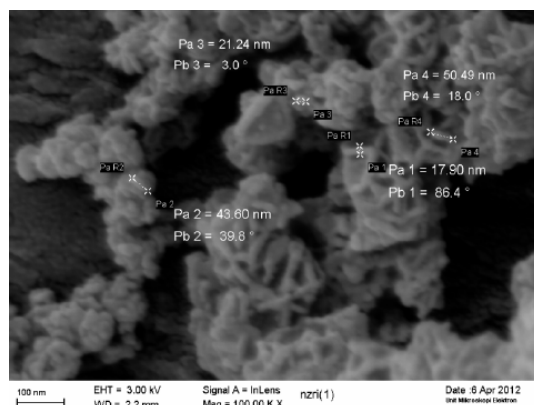
Penggunaan *nano zero valent iron* merupakan satu teknologi dalam merawat pencemaran tanah, air permukaan, dan air bawah tanah. Partikelnya yang bersaiz sangat kecil menjadikan ia lebih bersifat efektif dalam penyingkiran bahan pencemar. Saiz partikel bersaiz nano meningkatkan kadar tindakbalas, menurunkan jumlah penggunaan bahan penurun, mengawal risiko pembebasan bahan bertoksik secara terus dan menghasilkan hasil akhir tindakbalas yang tidak bertoksik (Hwang et al., 2011). Pelbagai kaedah digunakan dalam mensintesis zero valent iron bersaiz nano ini antaranya penurunan kimia, menghancurkan partikel logam besi bersaiz mikrometer kepada nanometer, menurunkan besi oksida menggunakan gas hidrogen pada suhu yang tinggi dan beberapa kaedah lain (Panturu et al., 2010). Penurunan kimia mempunyai beberapa kaedah yang berbeza seperti *gas-phase reduction*, *reverse micelle: microemulsion*, *controlled chemical coprecipitation*, *chemical vapour condensation*, *pulse electrodeposition* dan *liquid flame spray* (Klimkova et al.)

Bahan dan kaedah

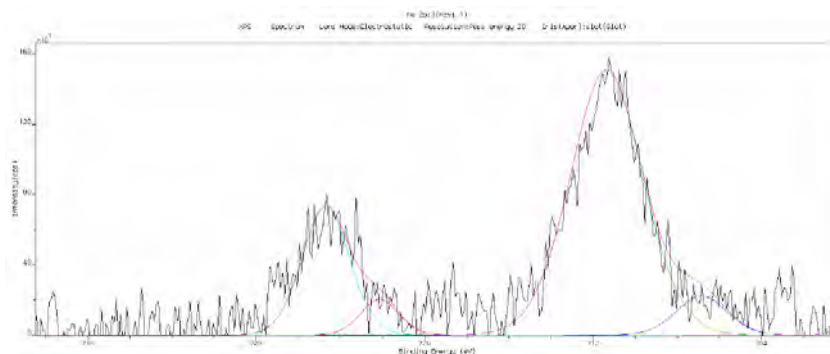
Kaedah sintesis yang digunakan adalah penurunan kimia atau *liquid-phase reduction* mengikut Uzum et al. (2007) dengan sedikit modifikasi. Kaedah ini menggunakan Ferum Klorida (FeCl_2) sebagai larutan Ferum dan Natrium Borohidrat (NaBH_4) sebagai agen penurunan. Kuprum nitrat, Plumbum nitrat, Zink klorida dan Nikel nitrat masing-masing digunakan dalam menyediakan larutan stok logam. Tindakbalas antara kedua-dua bahan ini akan menghasilkan satu persamaan; $\text{Fe}^{2+} + 2\text{BH}_4^- + 6\text{H}_2\text{O} \rightarrow \text{Fe}^0 + 2\text{B}(\text{OH})_3 + 7\text{H}_2$ (Uzum et al., 2007). Pepejal ini dilabel FeR-1b. Ujian penjerapan berkelompok dilakukan mengikut kaedah yang dilaporkan oleh USEPA (1992) untuk menentukan keupayaan penjerapan FeR-1b terhadap 4 logam berat iaitu Kuprum (Cu), Plumbum (Pb), Nikel (Ni) dan Zink (Zn).

Hasil dan perbincangan

Pencirian FeR-1b dilakukan dari kandungan kimia, struktur, morfologi, saiz, nilai valensi, keupayaan pertukaran kation (CEC), luas permukaan spesifik (SSA), graviti spesifik dan keupayaan penjerapan FeR-1b terhadap logam berat iaitu logam Cu, Pb, Ni dan Zn. Berdasarkan analisis pembelauan sinar-X (XRD), spektrum terhasil menunjukkan kehadiran unsur Ferum, secara dominan dalam keadaan Fe^0 , dicirikan oleh pantulan pada sudut 2-teta 44.9° dan pantulan lemah pada sudut 2-teta 36° yang mencirikan Ferum Oksida iaitu hematite (Fe_2O_3). Imej dari *scanning electron microscope* (SEM) direkodkan terhadap FeR-1b memberikan imej berantai seperti yang direkodkan oleh Hwang et al. (2011), pengelompokan partikel oleh Wang dan Zhang (1997) dan struktur jejaram oleh Dong et al. (2004) seperti ditunjukkan dalam rajah 1. Imej berantai tersebut diperincikan melalui analisis yang dijalankan melalui *transmission electron microscopy* (TEM). Analisis TEM memberi imej teras dan petala terhadap satu partikel FeR-1b dengan petala memberikan panjang 3 hingga 7 nanometer. Berdasarkan analisis TEM, saiz partikel FeR-1b secara purata bersaiz 10 hingga 50 nanometer. Nilai valensi diperolehi dari analisis *X-ray photoelectron spectroscopy* (XPS) seperti dalam rajah 2. Berdasarkan analisis XPS, tenaga ikatan petala Fe 2p menunjukkan secara dominan diwakili Ferum oksida dan Fe^0 adalah minor. Puncak Fe $2p_{3/2}$ yang mewakili ferum oksida adalah pada kedudukan 711.212 Ev. Puncak Fe 2p yang mewakili Fe^0 adalah pada kedudukan 706.846 Ev. Analisis keupayaan pertukaran kation memberi nilai 1.13, 1.05 dan 1.32 (meq/100g). Hasil dari analisis luas permukaan spesifik memberikan nilai 279.8, 220.1, 248.5 (m^2/g). Ujian graviti spesifik memberi nilai 2.23, 2.25 dan 2.25. Empat logam berat diuji dalam menentukan kapasiti penjerapan FeR-1b iaitu Kuprum, Plumbum, Nikel dan Zink. Secara relatif, lengkung penjerapan yang mendekati paksi-y pada graf penjerapan menunjukkan ia mempunyai kapasiti penjerapan yang lebih tinggi daripada lengkung



Rajah 1: Imej FeR-1b daripada SEM memberikan imej berantai, pengelompokan dan jejaram.



Rajah 2: Tenaga ikatan petala Fe 2p menunjukkan secara dominan diwakili Ferum oksida dan Fe^0 adalah minor. Puncak Fe $2p_{3/2}$ yang mewakili ferum oksida adalah pada kedudukan 711.212 Ev. Puncak Fe 2p yang mewakili Fe^0 adalah pada kedudukan 706.846 Ev.

penjerapan yang mendekati paksi-x (Wan Zuhairi et al., 2008). Oleh itu, kapasiti penjerapan yang lebih tinggi terhadap logam Plumbum dengan mengikut turutan Plumbum>Nikel>Kuprum>Zink.

Penghargaan

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Chemical speciation and potential mobility of heavy metals in the soil of former tin mining catchment

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Within the terrestrial ecosystem, soils play a major role in element cycling and accumulate heavy metals in concentration orders of magnitude higher than in water and air. Meanwhile, soils are the reservoir for many harmful constituents, elemental and biological, including heavy metals and trace metals, henceforth referred to as just metals (Cottenie & Verloo, 1984). Total metal content of soils is useful for many geochemical applications but often the speciation (bioavailability) of these metals is more of an interest agriculturally in terms of what is biologically extractable (Cottenie et al., 1980). Speciation is defined as the identification and quantification of the different, defined species, forms or phases in which an element occurs (Tack & Verloo, 1995) and is essentially a function of the mineralogy and chemistry of the soil sample examined (Tessier et al., 1979). Quantification is typically done using chemical solutions of varying, but specific, strengths and reactivities to release metals from the different fractions of the examined soil (Ryan et al. 1980). In terms of bioavailability, various species of metals are more biologically available in the ecosystem (Nelson & Donkin, 1985). Bioavailability and the mobility of metals are also related to each other, then the higher the concentration of mobile toxic metals (Cu, Pb, Cd, and Al) in the soil column which increases the potential for plant uptake, and animal/human consumption (Tack & Verloo, 1995; Lund, 2009; Ratusny et al., 2009). Heavy metals take part in biogeochemical cycles and are not permanently fixed in soils; therefore, assessment of their distribution in soils is a key issue in many environmental studies (Salim et al., 1993). Heavy metals are included in soil minerals as well as bound to different phases of soil particles by a variety of mechanisms, mainly absorption, ion exchange, coprecipitation and complexation. Moreover, soil properties such as contents of organic matter, carbonates, oxides as well as soil structure and profile development influence the heavy metal mobility (Kabata-Pendias & Pendias, 2001). The knowledge of the binding of metals with the different soil phases and components is of major interest to assess the connections with other biotic and abiotic elements of the environment (Hirmer, 1992). Nevertheless, as Cabral and Lefebvre indicate, the metal speciation is a more complex task than determination of total metal contents (Cabral & Lefebvre, 1998).

It is generally recognized that information about the physico-chemical forms of the elements is required for understanding their mobility, pathways and bioavailability (Rauret, 1988). Therefore, identification and quantification of the different species or forms of phases in which the heavy metals occur is very important to determine their bioavailability in the environment. Bestari Jaya catchment is located at 3° 24' 40.41" N and 101° 24' 56.23" E. It is a part of Kuala Selangor district, located in Selangor, biggest state of the country. District Kuala Selangor has three main towns namely, Mukim Batang Berjuntai, Mukim Ulu Tinggi, Mukim

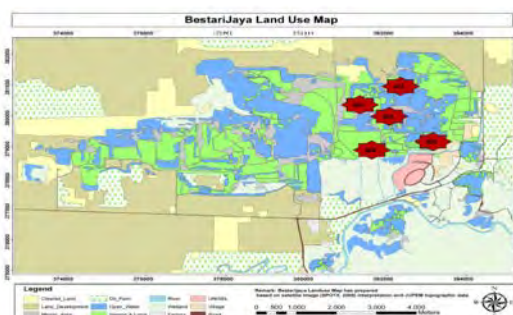


Figure 1: Map of Bestari Jaya catchment.

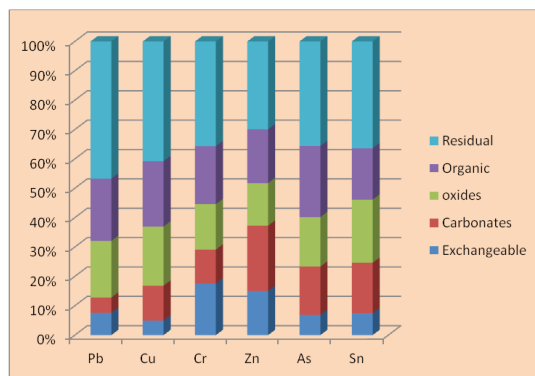


Figure 2: Percentages of metals in different fractions.

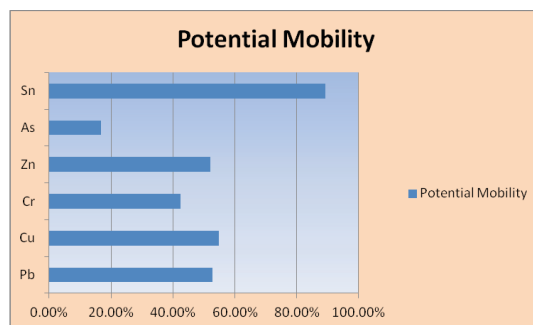


Figure 3: Potential mobility of soil.

Tg.karang. Bestari Jaya is located in Mukim Batang Berjuntai. Tin mining activities has ceased from last ten years, now sand mining. The catchment has total of 442 small and big mining lakes and ponds. Bestari Jaya has a tropical, humid climate, with very little variations in temperature throughout the year. The average temperature of the area is 32 °C during day and 23 °C at night (Ashraf, 2011). A total of five selected sites have been sampled and five subsamples were taken in each site to create a composite sample (Usero, 1998). The six elements have been analysed by the sequential extraction procedure using optical emission spectrometry (ICP OES). Small amounts of Cu, Cr and As were retrieved from the exchangeable phase, the ready available for biogeochemistry cycles in the ecosystems (Campanella, 1995). Therefore, low quantities of Cu and As can be taken up by plants in these acidic soils. Zn was not detected in the bioavailable forms as well as Pb that was only present in negligible amounts in very few samples. The absence of mobile forms of Pb in all soils eliminates the toxic risk both in the trophic chain and from its migration downwards the soil profile (Quevauvillier et al., 1996). The largest contents of Sn, Pb, Zn and As were retrieved from the residual phase where metals are strongly bound to minerals, whereas Zn from the carbonate and oxide phases amounts (50.14%) of its total content. Cr (39.24%) was mostly abundant in exchangeable fraction, Pb (42.27%) was mostly abundant in the fraction bound to oxides, Cu (51.33%) was mostly abundant in the fraction bound to organic matter and the remaining metals were mostly abundant in residual fraction. Results indicate that most of the metals had high abundance in residual fraction indicating lithogenic origin and low bioavailability of the metals considered (Wilcke, 1998). The average potential mobility was calculated for the metals giving the following order: Sn>Cu>Zn>Pb>Cr>As.

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Keupayaan beberapa jenis tanah dalam menjerap logam berat

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Pengenalan

Kumpulan logam berat merujuk kepada semua logam yang 'berat' iaitu logam yang mempunyai ketumpatan relatif melebihi 5 (Harmsen, 1977). Logam berat bersifat toksik walaupun pada kepekatan yang rendah. Logam berat yang digunakan dalam kajian ini adalah plumbum (Pb), zink, (Zn), kuprum (Cu) dan juga nikel (Ni). Keempat-empat logam berat ini jika berlebihan boleh mendatangkan masalah kesihatan kepada manusia dan juga alam sekitarnya.

Oleh itu, satu kajian penjerapan logam berat dengan menggunakan tiga jenis medium geologi yang berbeza telah dijalankan. Media geologi yang digunakan ialah lempung laut (MC), lateri (LS) dan juga gambut (OP). Objektif kajian ini adalah untuk mengira pekali penjerapan logam berat di dalam kepelbagaian medium geologi. Di samping itu, hasil daripada kajian ini, dapatlah diketahui media geologi yang manakah yang akan menjerap logam berat dengan paling efektif dan seterusnya boleh digunakan sebagai penghalang kepada pergerakan logam berat.

Ujian penjerapan berkelompok (BET) digunakan untuk melihat kadar penjerapan media-media geologi tersebut terhadap logam berat. Ujian ini adalah ujian yang ringkas tetapi memberikan hasil yang paling efektif.

Bahan dan kaedah

Terdapat 2 ujian utama yang dijalankan; (1) ujian fiziko-kimia dan (2) ujian penjerapan berkelompok (BET). Sampel tanah lempung laut diambil di Sg. Besar, Kuala Selangor, tanah laterit dari Hulu Selangor dan gambut dari Tg. Sepat, Banting. Ketiga-tiga sampel dikeringkan pada suhu bilik terlebih dahulu. Ujian fizikal dilakukan mengikut panduan British Standard, BS 1377 (BSI, 1975). Ujian yang dilakukan ialah taburan saiz butiran, ujian had-had atterberg, ujian ketumpatan relatif dan juga ujian pemadatan. Manakala ujian kimia adalah seperti pH, kandungan organik, kapasiti pertukaran kation (CEC) dan juga luas permukaan spesifik (SSA).

Bagi ujian BET, sampel diayak dengan menggunakan ayakan bersaiz 63 μ m. Hanya sampel yang melepasi ayakan tersebut akan digunakan dalam ujian BET nanti. Sebanyak 4 gram sampel ditimbang dan dimasukkan ke dalam tiub pengempar dan 40ml bahan pencemar (garam nitrat) dimasukkan ke dalam bekas yang sama. Sampel kemudiannya digoncangkan selama 24 jam dan kemudiannya diasingkan larutan serta bahan geologinya dengan menggunakan mesin pengempar (USEPA, 1992). Kesemua sampel diempar pada kadar 1100 rpm juga selama 1 jam. Selepas diempar, larutan yang terasing kemudiannya dituras dengan menggunakan vakum penuras bagi mendapatkan cecair yang benar-benar jernih sebelum cecair tersebut dihantar analisis dengan menggunakan mesin Fotometer Nyala dan Spektrometer Serapan Atom (AAS). Sebagai permulaan, satu larutan yang berkepekatan 500 ppm dihasilkan, kemudian, sebanyak 8 jenis kepekatan larutan dihasilkan melalui kaedah pencairan, iaitu 25 ppm, 50 ppm, 75 ppm, 100 ppm, 125 ppm, 150 ppm, 175 ppm dan 200 ppm. Kesemua bahan pencemar dan larutan yang berkepekatan berbeza-beza ini ditetapkan pHnya kepada pH 4 dengan menitisikan HCl atau NaOH kepadanya. Ujian ini diulangi sebanyak 3 kali.

Hasil analisis yang diperolehi boleh dikira dan diplotkan di atas graf antara jumlah unsur pencemar yang dipindahkan daripada larutan, q_c dalam unit mg/g melawan kepekatan dalam keseimbangan yang tertinggal dalam larutan selepas ujian, C_f dalam unit mg/L. Nilai-nilai tersebut boleh dikira dengan menggunakan rumus berikut (Griffin and Shimp, 1978) :

$$q_c = \frac{(C_o - C_f) \cdot V}{(M \times 1000)}$$

Di mana,

q_c = jumlah unsur pencemar yang dipindahkan daripada larutan (mg/g),

C_o = kepekatan unsur pencemar dalam larutan sebelum dicampurkan dengan sampel tanah (mg/L),

C_f = kepekatan dalam keseimbangan yang tertinggal dalam larutan selepas ujian (mg/L)

V = isipadu yang digunakan (L),

M = Jisim sampel yang digunakan (g)

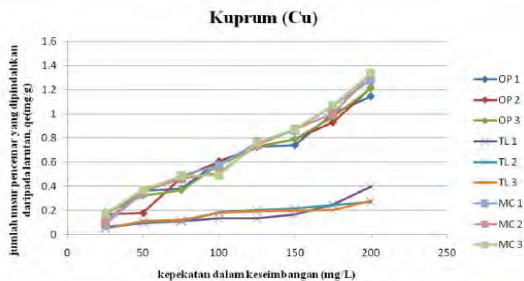
Hasil dan perbincangan

Julat ketumpatan relatif bagi MC adalah dari 2.24-2.36, LS berjulat 2.63-2.67 dan OP 0.55-0.62. Tanah LS mempunyai nilai yang lebih tinggi kerana kandungan tanahnya yang mempunyai banyak silika, besi dan juga aluminium. Secara purata, hasil daripada ujian taburan saiz butiran, MC mempunyai peratusan kandungan pasir yang rendah, peratus kandungan lodak dan lempung yang tinggi berbanding dengan LS. Keadaan ini adalah disebabkan

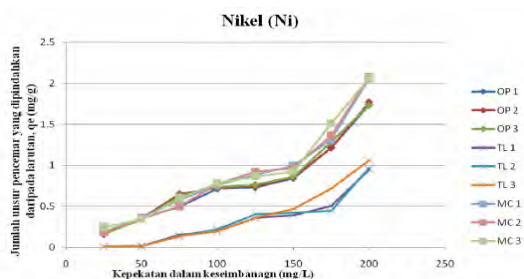
oleh kehadiran mineral kuarza dalam tanah LS sebagai mineral sekunder yang tahan terhadap luluhawa. MC dapat dikelaskan sebagai tanah liat berkeplastikan tinggi manakala LS dikelaskan sebagai tanah lodak berkeplastikan tinggi berdasarkan graf yang diplot hasil daripada ujian had-had atterberg. Ujian pemadatan pula mendapati kandungan air optimum bagi MC adalah berjulat dari 23.22-31.95 % dan LS dari 15.71-18.36 %.

Hasil daripada ujian kimia tanah pula mendapati nilai pH tanah bagi MC adalah berjulat dari 8.00-8.62, LS dari 4.91-5.13 dan OP dari 3.58-3.74. Menurut Mason & Moore (1982), logam berat sangat sensitif terhadap perubahan pH. Apabila pH semakin tinggi, iaitu semakin berasid, logam berat lebih cenderung untuk termendak dengan hidroksida/oksida dan bahan karbonat. Maka tanah MC berkeupayaan untuk menjrap lebih banyak logam berat berbanding OP dan TL. OP mempunyai % kandungan organik yang paling tinggi berbanding MC dan LS, iaitu 38.25-86.83 %, diikuti MC 13.00-23.17 % dan LS berjulat dari 3.25-11.00 %. Ini adalah kerana tanah OP itu sendiri terbentuk daripada hasil enapan organik yang berasal daripada sisa-sisa tumbuhan yang telah mati dan telah mengalami proses separuh reput. MC mempunyai nilai yang tinggi berbanding OP dan LS bagi ujian kapasiti pertukaran kation (CEC) dan juga luas permukaan spesifik (SSA). Mengikut Wan Zuhairi, 2003a, 2003b & Yong, 2001, keupayaan penjerapan sesuatu tanah itu meningkat dengan meningkatnya nilai CEC dan SSA. Ini jelas menunjukkan bahawa tanah MC mempunyai keupayaan menjerap logam berat lebih tinggi berbanding yang lain. Tanah OP dianggap unik kerana mempunyai nilai pH yang rendah, tetapi nilai CEC dan SSAny adalah lebih tinggi daripada LS. Nilai pH yang rendah adalah disebabkan terdapat banyak pereputan bahan organik yang membantu merendahkan nilai pH tanah. Namun, disebabkan nilai CEC dan SSAny yang tinggi, maka tanah OP ini mempunyai keupayaan menjerap logam berat lebih tinggi daripada tanah LS.

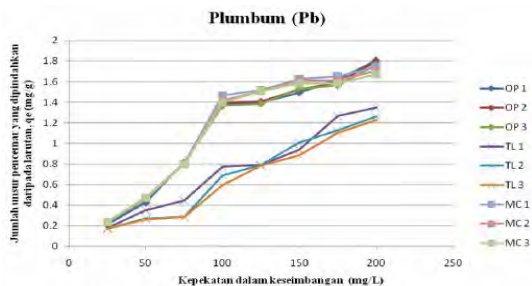
Ujian fiziko-kimia sebenarnya banyak mempengaruhi keputusan terhadap ujian BET. Dalam jadual 1 dan 2 jelas menunjukkan bahawa tanah MC mempunyai kadar penjerapan yang lebih tinggi berbanding tanah OP dan LS. Hal ini dapat dibuktikan selepas ujian BET dijalankan. Hasil daripada ujian BET menunjukkan MC menjerap kesemua logam berat Pb, Cu, Ni dan Zn lebih banyak diikuti oleh OP dan LS. Hal ini disebabkan oleh MC mempunyai nilai pH, CEC, dan SSA yang tinggi yang mendorong untuk menyebabkan MC menjerap lebih banyak logam berat. pH larutan yang asalnya pH 4 juga menunjukkan peningkatan sehingga mencapai kepada pH 7 kecuali tanah OP yang kekal dengan julat pH 3. OP menjerap lebih banyak bahan pencemar disebabkan kandungan unsur surihnya yang kurang mengandungi unsur bahan pencemar berbanding tanah LS yang sudah sedia ada bahan pencemar di dalamnya yang menjadikan tanah LS ini kurang menjerap berdasarkan kepada ujian pendafloor



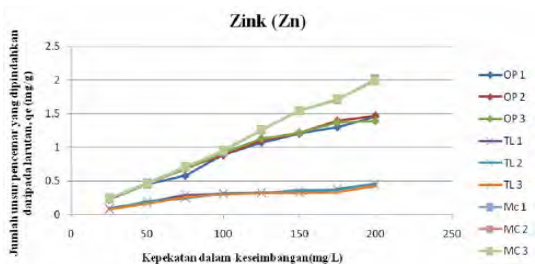
Rajah 1: Jumlah Cu yang dijerap oleh semua tanah.



Rajah 2: Jumlah Ni yang dijerap oleh semua tanah.



Rajah 3: Jumlah Pb yang dijerap oleh semua tanah.



Rajah 4: Jumlah Ni yang dijerap oleh semua tanah.

Jadual 1: Hasil analisis pencirian kimia bagi semua jenis tanah.

Sampel	pH	Kandungan Organik (%)	Kapasiti Pertukaran Kation, CEC (meq/100g)	Luas Permukaan Spesifik, SSA (m ²)
MC 1	8.62	13.00	113.44	102.90
MC 2	8.00	21.83	116.03	123.00
MC 3	8.56	23.17	112.39	95.47
LS 1	5.13	3.25	0.608	46.62
LS 2	5.09	9.17	0.597	62.54
LS 3	4.91	11.00	1.466	26.11
OP 1	3.61	38.25	4.32	90.56
OP 2	3.58	59.83	2.202	91.96
OP 3	3.74	86.83	2.000	87.42

Jadual 2: Hasil analisis pencirian fizikal semua jenis tanah.

No. Sampel	Ketumpatan Relatif	% Pasir (S)	% Lodak (M)	% Lempung (C)	Had Cecair	Had Plastik	Indeks Keplastikan	Pengelasan Tanah	pd_{max} (MG/m ³)	W_{opt} (%)
MC 1	2.24	1	71	28	93	55	38	tanah lempung	1.45	31.95
MC 2	2.30	2	55	43	81	46	35	berkeplastikan	1.52	25.85
MC 3	2.36	1	68	31	82	39	43	tinggi	1.55	23.22
LS 1	2.66	47	30	23	59	22	37	Tanah lodak	1.30	15.71
LS 2	2.67	37	19	44	60	22	38	berkeplastikan	1.29	16.67
LS 3	2.63	38	13	49	65	24	41	tinggi	1.28	18.36
OP 1	0.62	NA	NA	NA	NA	NA	NA	NA	NA	NA
OP 2	0.57	NA	NA	NA	NA	NA	NA	NA	NA	NA
OP 3	0.55	NA	NA	NA	NA	NA	NA	NA	NA	NA

sinar-X (XRF). Logam berat Pb adalah yang paling banyak dijerap oleh ketiga-tiga jenis tanah berbanding logam berat yang lain.

Kesimpulan

Ujian fiziko-kimia penting bagi menunjukkan sifat-sifat sesuatu tanah itu berkeupayaan menyerap logam berat dengan lebih banyak. Didapati, semakin tinggi nilai pH, CEC dan SSA serta kandungan mineral lempung yang banyak, maka semakin cenderung sesuatu tanah itu menyerap logam berat. Dalam ujian BET, tanah MC menyerap lebih banyak logam berat berbanding OP dan LS.

Penghargaan

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Study on characteristics of Malaysian sand as proppant

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This project presents literature review and experimental work on local sands for possible use as proppant especially sand samples from the Terengganu coastal area. Currently, there is no local proppant manufacturer in Malaysia and Malaysia has to import proppants from overseas especially from United States and Canada. This leads to the high well stimulation costs in Malaysia. If the local sand in Malaysia qualifies to be used as proppant, Malaysia can produce its local proppant manufacturer which may reduce the well stimulation costs in Malaysia. Thus, in this project, the characteristics of the Terengganu local sand will be examined and then are compared to the characteristics of the existing proppant used in current market. In this project, the Terengganu sand samples will be tested upon the sphericity, roundness, bulk density and shear strength.

Roundness and sphericity are important properties of proppant because they impact the porosity and packing of the proppant pack. Grain roundness is a measure of the relative sharpness of grain corners, and particle sphericity is a measure of how closely the grain approaches the shape of a sphere (Sedimentation and Stratigraphy Laboratory: Roundness and Sphericity, 2011). The proppant strength is a very essential property because the proppant must have the ability to withstand the pressure and temperature within the reservoir. Strength can be measured by shear stress (shear strength) and compressive normal stress known as crushing strength (Dusseault).

On the study of the sphericity and roundness, they are measured using the polarizing microscope with 40x magnification. The images of the sample particles are taken and the shapes are compared to the Krumbein chart. According to the API RP 56, sand should have roundness and sphericity of 0.6 or greater. Ceramic has the highest value for both sphericity and roundness. The Terengganu sand samples did not meet the roundness specification. However, they meet the sphericity value. Comparing to the sample 7 which is the silica sand from India, the local sand gives almost the same value for both sphericity and roundness.

The shear test method is performed to determine the shear strength of a sand material in direct shear. The shear strength test is performed using the shear box 100 × 100. The test is executed by deforming the sand material across the horizontal plate between two halves of the shear box while applying normal load. In this test, each sand sample was tested few times with varying normal load which are 98.1kPa, 196.2kPa and 294.3kPa. The strength of the sand was calculated using the Coulomb's shear strength equation given below:

$$\tau_f = C + \sigma_f \tan \theta$$

τ_f = shearing resistance of soil at failure, kPa

c = apparent cohesion of soil

σ_f = total normal stress on failure plane, kPa

θ = angle of shearing resistance of soil (angle of internal friction), degree

The angle of shear resistance was calculated after the measurement of shear stress was gained. Then, the shear strength was calculated using the Coulomb's equation whereby the cohesion is zero since the samples are loose sand and there is no cementation between the particles of the sample. From figure 2, Sample 1 gives the highest shear strength for all the mesh size distributions due to the highest friction angle. The Terengganu sand samples have lower shear strength than the India sample for all the mesh size distributions. However, the shear strength of these samples is higher than the ceramic proppant from China. Sample 7 gives a very significant difference between the shear strength off mesh size 20/40, 30/50 and 30/80 meanwhile the other samples have almost the same shear strength for the same mesh size distributions. Comparing between the Terengganu sand samples, sample 6 has the highest shear strength followed by sample 3. Sample 4 and 5 behaves similarly in terms of shear strength.

The Terengganu sand samples do possess some of the required proppant characteristics. Based on the results, it is possible for Malaysia to produce our own local proppant with some essential adjustments through coating with suitable resin materials. Further research on the crush resistance test should also be executed on these samples.

Table 1: Sphericity and roundness.

Sample	Image	Roundness	Sphericity
Sample 1		0.50	0.67
Sample 2		0.54	0.67
Sample 3		0.47	0.61
Sample 4		0.56	0.74
Sample 5		0.50	0.62
Sample 6		0.58	0.72
Sample 7		0.54	0.66
Sample 8		0.86	0.90

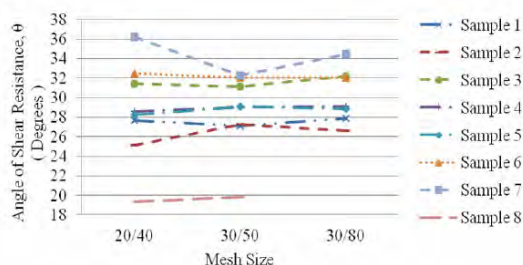


Figure 1: Angle of shear resistance of all the samples with different mesh size distribution.

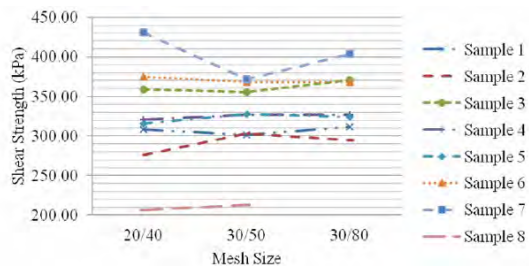


Figure 2: Shear strength of all the samples with different mesh size distribution.

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Fractured metasediment outcrops at Pulau Redang, offshore Terengganu: An analogue for natural fractured reservoir (NFR) basement in Malay Basin

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Introduction

Pulau Redang is located 45km off the coast of Kuala Terengganu, is the largest of a group of nine protected islands dotting the South Chinese Sea off the Terengganu coast. The Pulau Redang archipelago comprises Pulau Redang, Pulau Lima, Pulau Paku Besar, Pulau Paku Kecil, Pulau Kerengga Besar, Pulau Ekor Tebu, Pulau Ling and Pulau Pinang. Pulau Redang is the biggest of all the islands in the Marine Park, measuring about 7 km long and 6km wide. Geology in Pulau Redang comprises granitic and meta-sediment rocks. More than 75 percent of the north eastern part of the island are granite and others in the south-west are meta-sediment rock. These rock can be subdivided into three main units such as Pinang Formation, Redang Formation and Tumbu Kili Conglomerate (Kamal Roslan et al., 1999) (Figure 1). Any proposed fractured basement requires good accessible field examples illustrating different fracture types, geomechanical concepts and evaluation method relevant to fractured basement plays.

Pinang Formation (carboniferous) outcrop in southern of Redang island formerly identified as Pinang Bed (Khoo et al., 1988; Yaw, 1977; Zaidi Daud, 1992). Pinang Formation consist of meta- sediment and highly deformed quartzite, hornfels and slate showing soft sediments deformation structure. This sequence has undergone a great deformation resulting in the formation of tight folds and faults. Structural geological studies show that this formation has undergone three phases of deformation. These formations have been cut by pegmatite or aplite and become a metamorphic rocks due to the intrusion of igneous. They also believe that this Pinang Formation is formed much earlier or much older than the granite intrusion (Kamal Roslan et al., 1999).

Redang Formation (Permian) outcrop are situated in the southwest of Redang island (Khoo et al., 1988) This formation consist of metaconglomerates, interbeds of black slate, quartzite, hornfels and the bedding is generally striking north-south dip to the west. Based on the tectonic deformation, it is believed the Redang Formation is younger than the Pinang Formation. This is due to Redang Formation just experienced two phases of deformation that form open folds with axes trending nearly north-south (Kamal Roslan et al., 1999). They also believed that Redang Formation has deposited on top of the Pinang Formation (unconformity). Redang Formation is older than the granite intrusion due to the sequence of Redang Formation has metamorphism at the boundary of this formation to the granite.

A number of plant fossils were found consists of species such as Pecopteris sp, Calamites sp, Taeniopteris sp and Cordaites known as Redang Flora, represent Carboniferous-Permian age (Khoo et al., 1988). Environment deposition of this formation is continental fluvial or near shore deposits.

Based on general structure of Pulau Redang (Mohamad Kadir, 2010) found that a consistent shear fractures trends demonstrated by FMI data from Anding wells was observed on the surface outcrops at Redang island. The existing of surface fractured basement at Redang Island is a good analogue for indepth studies of fracture distribution and its connectivity within basement reservoir. He also observed that the presence of fracture distribution and connectivity on the metasediment and granite rocks in Redang Island and surrounding area. He added that most open fractures trending NNE-SSW and ENE-WSW which same trend with Principle Stress in Malay Basin (general trend is NE-SW). Fractured density observed 1-2 fractures/m. NW-SE fractures trend most likely closed.

Materials and methods

This section discusses and explains the methods that will be used to conduct the study. The first part of the section which is, fieldwork will clarify how the data will be collected from the field especially in structural geology in field and how the samples are collected for lab analysis. The following section which is Lab analysis will elaborate more on the experimental works. The final part is data analysis using a stereographic projection using a geological software.

Fracture Orientation

In terms of structures study in this area, collecting valid fracture parameter data in subsurface using scan line method. Four mechanical strata, characterized by homogeneous lithology and texture have been analyzed using scan lines and were analyzed using stereonet software for graphical and statistical analysis of orientation. In Figure 2, that shows strike diagram and major fractures for Redang Fm and Pinang Fm.

For Redang Fm, out of six scan line (R1,R2,R3,R4,R5,R6) and for Pinang Fm have seven scan line (P1,P2,P3,P4,P5,P6,P7). From the strike diagram, maximum stress (σ_1) for all scan line in Redang Formation

(R1-R6) and mostly in Pinang Formation (P1,P2,P4,P6) were interpreted as a open fractures with two major fractures orientation NE-SW and ENE-WSW which same trend with principle stress (σ_1) in Malay Basin (general trend is NE-SW). However, from scan line P3,P5 and P7 were interpreted as a conjugate shear oriented NW-SE and NNW-ESE and trend most likely closed.

Conclusion

From the fractures analysis of the strike diagram, maximum stress (σ_1) for all scan line in Redang Formation (R1-R6) and mostly in Pinang Formation (P1,P2,P4,P6) were interpreted as a open fractures with two major fractures orientation NE-SW and ENE-WSW which same trend with principle stress (σ_1) in Malay Basin (general trend is NE-SW). From scan line P3, P5 and P7 were interpreted as a conjugate shear oriented NW-SE and NNW-ESE and trend most likely closed. It can be concluded that the meta-sediments in Redang Fm and Pinang Fm is followed with principle stress in Malay Basin. Fractured basement at Redang Island is a good analogue for indepth studies of fracture distribution and its connectivity within basement reservoir.

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GEOLOGY OF PULAU REDANG

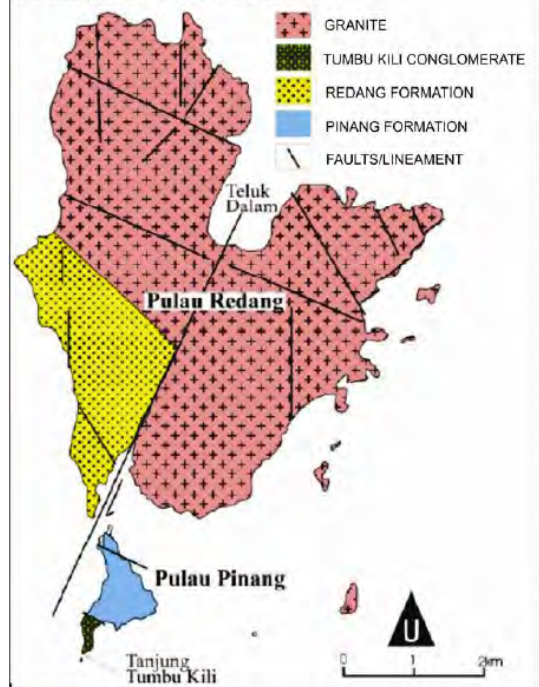


Figure 1: Map showing geology of the Pulau Redang and its surrounding area (Yaw, 1977).

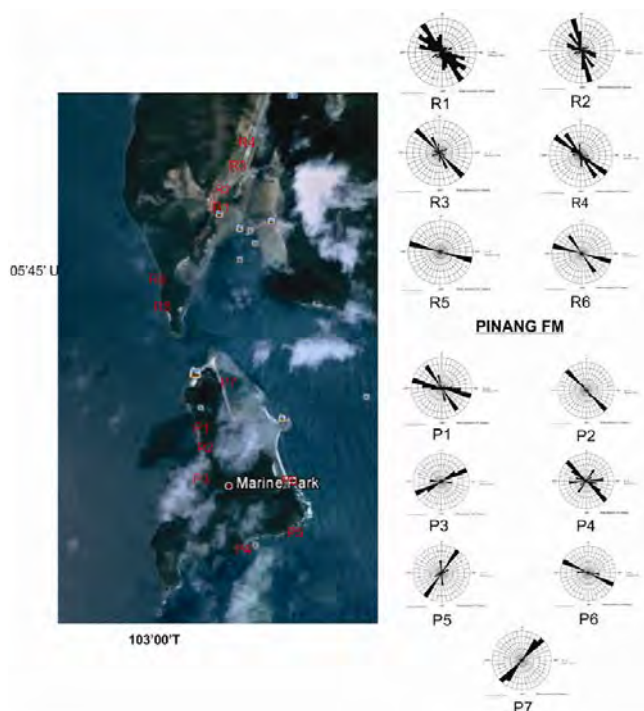


Figure 2 : Figure shows strike diagram for each locations of scan line.

Microstructure of deformed quartz in the mylonite of Selinsing Gold Mine: Implications for the mechanism and condition of deformation

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Introduction

Selinsing gold mine is located about 50 km north of Raub, northwest Pahang. Gold has been mined since the 1880s, first using the underground method (Richardson, 1950). During the early 1990s, small scale open pit mining was carried out and gold was extracted using gravity methods (Pereira, 1993). The current mining operation by Selinsing Gold Mine Manager Sdn Bhd involved large-scale open pit mining and gold is extracted by cyanidation. The rocks in Selinsing experienced fault-related deformation. Mylonites and to a lesser extent, cataclasites are common. Fragments of vein quartz are widespread within the mylonite. The objective of this paper is to determine the microstructures of quartz in the mylonite, so that the mechanism and condition of quartz deformation can be constrained.

Geological setting

Gold mineralisation in the Selinsing area is related to quartz veins hosted in the argillaceous unit of the Permo-Triassic Gua Musang Formation. The rocks experienced low grade metamorphism and comprises phyllite, argillite, tuffaceous slate, calcareous slate and minor meta-tuffs, quartzite and marble. Lower Devonian carbonaceous slate, quartzite and meta-conglomerate of the Karak formation occur at the west of the mine, while fine-grained marble (calcareous unit of the Gua Musang Formation) occur at the east.

The rocks in the mine, together with quartz veins were deformed along a N-S normal fault zone, generating porphyroclastic mylonite and cataclasite (Pereira, 1996). Subsequent reactivation along this fault zone produced a series of N-S discrete faults, which were later displaced by younger NW-SE, NE-SW and E-W faults. The NW-SE faults are mainly left-lateral while the NE-SW faults are mainly right-lateral (Mohd Basril et al., 2009). Composite foliations (S-C surfaces) and porphyroclastic texture are distinctive in the mylonites. Foliations are often better developed when quartz porphyroclasts are present. Cataclasites have random fabric and comprises of angular metasediments clasts. The mylonites are cut by foliation-parallel quartz veins, as well as E-W trending quartz veins that are nearly perpendicular to the foliations. Quartz stockworks are also observed.

Methodology

Geological mapping was carried out at the Selinsing mine pit to determine the lithology and geological structures. Base map was prepared from survey plan provided by the mine. Samples were collected and made into thin sections for petrographic studies. Kinematic analysis of the mylonite was carried out in the field and on several oriented mylonite samples. About 30 thin sections comprises deformed rocks, veins and protoliths were examined.

Protolith

Clasts of vein quartz, phyllite, tuffaceous argillite and quartzite are observed in the mylonites. The matrix is composed of fine-grained white mica, quartz, carbonaceous matter, calcite and occasionally, chlorite and pyrite. The matrix mainly was formed by the comminution of the metasedimentary protoliths, but pyrite and some of the calcite and chlorite that show no evidence of deformation are likely to be autometamorphic. Most of the quartz clasts, especially the quartz porphyroclasts were derived from vein quartz.

Quartz microstructures

Quartz form porphyroclasts in the mylonite because it is more rigid compared to the metasediments. Quartz porphyroclasts in the mylonite are ranging from 1 mm to 50 mm in diameter and most are about 20 mm. They are mostly slightly elongated with long axis aligned sub-parallel to the S-surfaces. Grain shapes are variable from subrounded to angular to irregular and embayed. The grain shape is influenced by the deformation related processes. The quartz clasts were derived from the fragmentation of quartz veins, and the initial clasts were angular. With progressive shearing, rounding of quartz clasts occur through abrasive wear and adhesive wear. During abrasive wear, sharp edges were broken-off on contact with other clasts by microfracturing in the brittle domain. Adhesive wear was took place probably in the presence of fluid, where very fine-grained quartz neocrysts formed at clast margins were entrained into the matrix during shearing. Irregular and embayed clasts were resulted from pressure

solution, which preferentially occurred along the top and bottom clast margins that are parallel to the foliation. Deposition of dissolved silica form fine elongated quartz neocrysts or quartz fibers parallel to the foliation. Deposition preferentially occurs at pressure shadow areas, such as margins of quartz clasts and pyrite grains facing the foliation. The quartz neocrysts often form asymmetrical wings of the sigma porphyroclasts.

The internal microstructures of quartz clasts are undulatory extinction, deformation bands, deformation lamellae, polygonisation and recrystallisation. Most of the deformation bands and lamellae are not parallel to the foliation, probably due to rotation of the clasts during progressive shearing. Recrystallisation along crystal boundaries and deformation bands, and pressure solution are widespread.

Discussion and conclusion

The quartz clasts in the mylonite experienced both brittle and plastic deformation. Early brittle behaviour is indicated by fragmentation of veins into angular clasts and microfracturing. On progressive deformation, quartz shows plastic microstructures. The transformation from brittle to plastic behaviour could be due to an increase in differential stress, decrease in strain rate or weakening of the quartz and heating of the deformed rocks by hydrothermal fluid. The presence of fluid is indicated by widespread pressure solution and local silicification. Fluid played an important role in foliation development in the mylonite by modifying the shape (flattening) of the clasts by preferential solution and mobilising quartz (both dissolved silica and quartz neocrysts) to form elongated grains parallel to the foliations.

Most of the quartz neocrysts were formed by grain boundary bulging (BLG) and subgrain rotation (SGR) is less common. The BLG neocrysts are confined along grain boundaries and are about 10 μm in size. In the SGR process, there is a progression from subgrains to neocrysts towards grain boundary, and the neocrysts are coarser (20–40 μm).

Studies of deformed quartz veins by Stipp et al. (2002) show that plastic deformation begin at approximately 250°C and recrystallisation by the process of BLG begin at 280°C, which at 400°C replaced by SGR mechanism. The dominance of BLG dynamic recrystallisation of quartz in the mylonite indicates that the temperature of deformation was between 280°C and 400°C.

Acknowledgements

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Stratigraphic correlation of the Carboniferous-Permian sequence of Malaysia and Myanmar

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A well represented sequence of Carboniferous to Permian is found in both Peninsular Malaysia and Myanmar. These units are closely correlatable in aspects of stratigraphy and palaeontology (Aye Ko Aung, 2010; 2012). The Carboniferous sequence of Malaysia is represented by the Singa and Kubang Pasu Formations. The Singa Formation (Langkawi Island) comprises thin-poorly bedded rapidly alternating black mudstone, slaty shale and lithic to quartzitic sandstone with pebbly horizons in parts of the black mudstone. The Singa Formation can be correlated to the more sandier and lighter coloured Kubang Pasu Formation that outcrops in central and east Perlis and northwest Kedah. It is largely composed of thick-bedded quartzite and feldspathic grey or red or purple sandstone interbedded with subordinate varicoloured mudstone. The Lower Carboniferous age is confirmed by the occurrences of some foraminifera (Scrivenor, 1926) and radiolaria (Basir et al., 2003) (Lee, C. P, 2009).

The above unit can be correlated to the Taungnyo Group of southern Myanmar which consists of massive, reddish to yellowish brown fossiliferous siltstone includes mainly of brachiopods and bryozoans. Most of the previous workers referred the Taungnyo Group to Carboniferous in age on account of macrofossils (brachiopods, bivalves and gastropods) (Brunnschweiler, 1970) and later, the age of the group was extended in to Lower Permian by the evidence of some brachiopods (Zaw Win & Kyaw Htin Khaing, 2006). It is therefore, the microfossil evidences are urgently required to confirm the age of the Taungnyo Group. The contact between the Taungnyo Group and the overlying Moulmene Limestone (Permian) is said to be transitional. The later comprises bedded, fossiliferous, fusuline, cherty limestone.

Similarly, a very well-exposed transitional sequence from clastics to carbonates can be found in the Bukit Chundong area, northern Perlis where the passage beds characterized by the predominance of arenaceous sediments with rich Lower Permian fusuline (*Monodioxodina*) and vertical burrows indicates deposition in a shallow marine moderate to high energy. The overlying Chuping Formation is massive and unfossiliferous except for the basal part, composed of well-bedded dark grey shelly limestone with chert nodules in layers parallel to the bedding. Fossils include brachiopods and bryozoans identified by Sakagami (1963). The age of the Chuping Formation ranges from Late Early Permian to Late Triassic (Metcalfe, 1990; Basir et al., 1995).

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Palynofacies characterization of the Upper Jurassic Madbi Formation in the Kharir oilfield and their relation to oil generation potential

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The Upper Jurassic Madbi Formation, a principal petroleum source rock, consists of organic-rich shales in the Masila Basin, Eastern Yemen (Hakimi et al., 2010). Organic-rich shales from one oilfield in the East Shabowah, Masila Basin (Kharir oilfield; Figure 1) were studied in order to evaluate source rock and oil generation potential. Oil generation potential of these sediments is evaluated based on petrographic analysis (palynofacies and thermal alteration index (TAI) of spores/pollen colouration) and geochemical analysis (Rock Eval pyrolysis).

Palynofacies can be used to help not only for establishing the depositional environment but also to evaluate the hydrocarbon generation potential. The palynofacies analysis of the Madbi Formation in the area reveals rich-organic matter and the main palynofacies identified are structured organic matter (SOM) and structureless (amorphous) organic matter (AOM). The structured organic matter contains phytoclasts and palynomorphs (spores, pollen and marine microfossils). The Madbi shale samples reveal a more marine organic matter according to palynofacies observations. This composition is characterised by a higher proportion of amorphous organic matter (AOM) and presence of marine microfossils. Amorphous organic matter is predominating in the total kerogen residues. The amorphous organic matter appears well aggregated (flaky), yellow-brown, and granular textured under normal white light (Figure 2). Ultraviolet light excitation, distinct fluorescence intensities were observed corresponding to amorphous organic matter assemblages (AOM) (Figure 2). Terrestrial organic matter (spores, pollen and woody fragments; Figures 3d and e) were found in lesser amounts. Marine microfossils are rare (dinoflagellates and microforaminifers linings; Figures 3a-c).

The TAI value for the organic matter in these sediments has been ascertained as 2.6-3.00, corresponding to a palaeotemperature range of 60–120°C. These are the optimum oil-generating strata.

Rock-Eval pyrolysis results support the petrographic composition of organic matter in the Madbi shale sediments. The Madbi shales contain algal Type II with minor Type I. This is suggested by high hydrogen index values in the range of 302-834 mg HC/ g TOC.

Based on this study, the Madbi shale sediments have very good source rock generative potential for significant oil prone as supported by high amounts of organic matter predominantly Type II kerogen and Type I kerogen with rich fluorescent amorphous organic matter of marine origin.

Our results also revealed that the Upper Jurassic Madbi shales have high amounts of organic matter mainly due to good preservation of marine organic matter in suboxic-anoxic conditions.

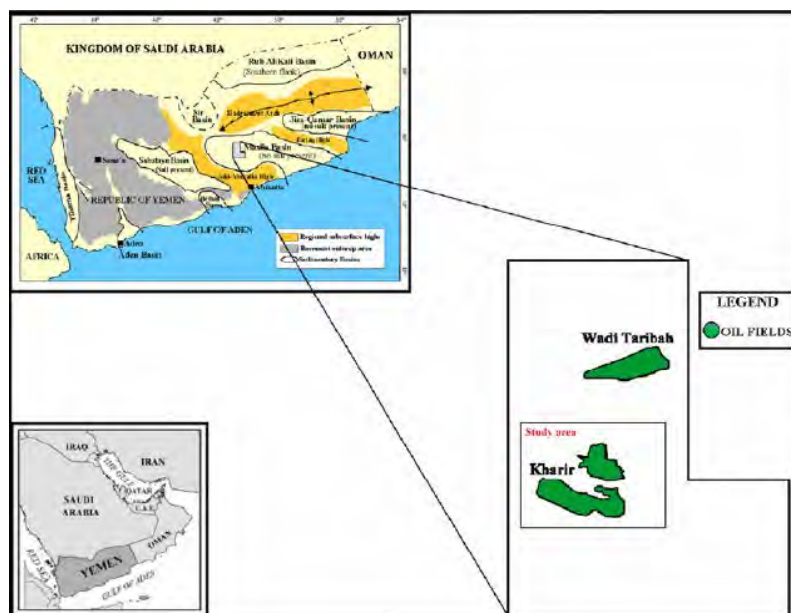


Figure 1: Main sedimentary basins map in Yemen showing location of the Masila Basin and the study area.

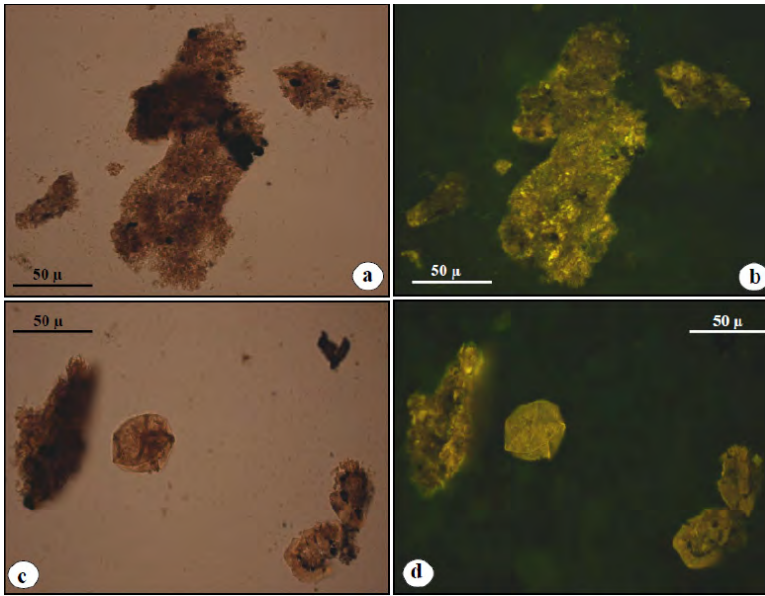


Figure 2: Photomicrographs of amorphous organic matter in the marine shales of the Madbi Formation under white and UV transmitted light and SEM; (a) amorphous organic matter appears well aggregated (flaky); (b) as (a) under ultraviolet light excitation, distinct fluorescence intensities corresponding to amorphous organic matter assemblages; (c) Yellow brown amorphous organic matter associated with spores; (d) as (c) under ultraviolet light.

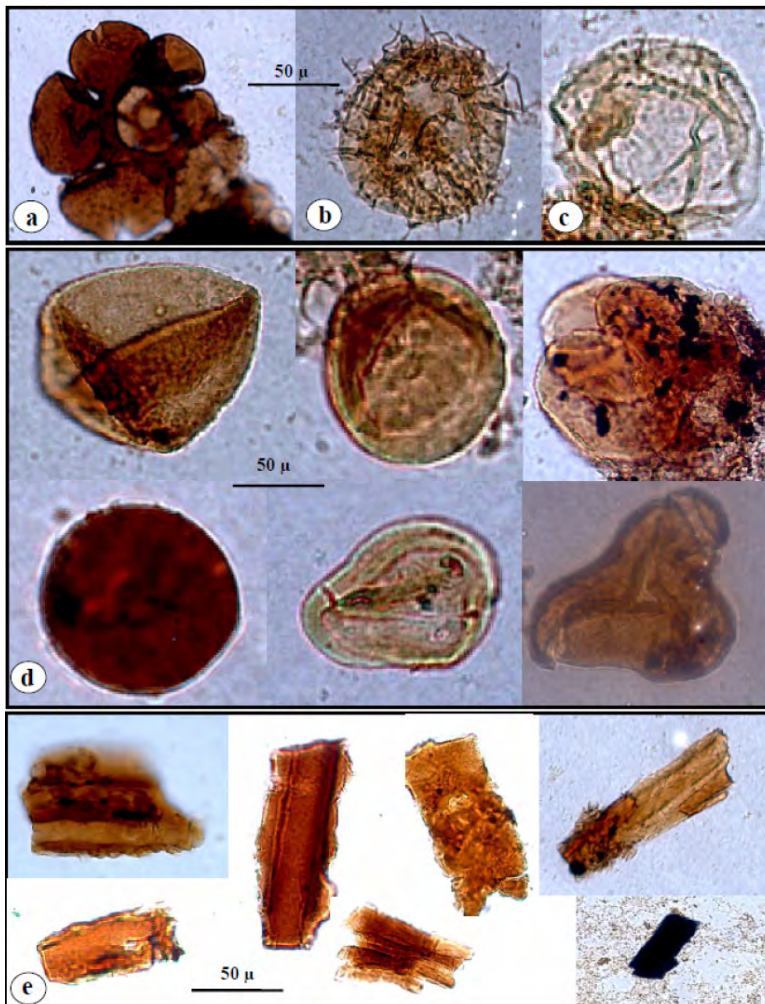


Figure 3: Photomicrographs of palynofacies organic matter in the marine shales of the Madbi Formation, Masila Basin under white transmitted light; (a-c) Marine microfossils (a. microforaminifera linings ; b and c. dinoflagellates); (d) Spore and pollen species; (e) Structured phytoclasts (woody tissue).

Geoart: An innovative tool to promote geology and geotourism

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Geology has gained public attention and interest in recent years due to catastrophic events such as tsunamis, earthquakes, volcanic eruptions and landslides. The public interest in geology should be sustained in order to build a scientific community as outlined in the country's 2020 vision. One of the tools to sustain the interest is through the introduction of geological arts (or geoarts) to the public. A proper study on geoarts has never been carried out before and this study attempt to identify, characterize and introduce the geological masterpieces to the public. This study is an innovative method to stimulate interest and to popularize the subject of geology among the non-geoscientist public. Geoart is defined by the author as an artistic piece or three dimensional object which is related to geologic and geomorphologic interest and crafted by natural processes. Geoart could be in scale of atoms, landscapes or the whole universe. Geoart is based on the principle that by looking with both artistic and scientific eyes, people could appreciate geologic knowledge that could benefit either art or geological enthusiasts. It could arouse interest in geology and its related processes and be used as tool to observe, describe and understand the physical world and to convey concepts and knowledge to the non-geoscientists. Geoarts which have scientific, aesthetic, recreational and cultural values are important geoheritage assets that should be protected. For the same reasons, geoarts could be promoted for geotourism development.

Some new findings of the coral and foraminifera faunas from the Jengka Pass Limestone, Pahang, Central Peninsular Malaysia

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The “Jengka Pass Limestone” (Jengka Pass Formation by Ichikawa et al., 1966) is one of the best known outcrops in Malaysia represent folded marine Permian strata covered unconformably by continental Mesozoic red-beds (Tembeling Group equivalent to Khorat Group) that located along the Temerloh-Maran Road from Kuala Lumpur, about 24 km east of Temerloh which is exposed in a road cutting with Latitude and Longitude N 03° 32.537', E 102° 37.393' was famous for their fossiliferous rocks and evidence of the Indosinian Orogeny in Malaysia. There are several studies that had been carried out in aspects of palaeontology and stratigraphy of the Jengka Pass area, (Cummings, 1965; Gowda, 1965; Ichikawa et al., 1966; Ishii, 1966; Igo, 1967; Enzo Kon'no and Kazuo Asama, 1967; Sakagami, 1973; Nakazawa, 1973; Fontaine, 1986; Fontaine et al., 1988). In present day, the Jengka Pass outcrop was hardly weathered and covered by thick vegetation which is totally different from the past where the outcrop was freshly cut and exposed. The present study is concerned primarily with some new findings of the rugose coral and foraminifera species collected from the Jengka Pass limestone. The lithostratigraphic section of the Jengka Pass limestone is logged along with the biostratigraphic collection of the fusulinids. The 30 meters thick Jengka Pass section mainly comprises biomicrite and biopalmicrite that rich in fusulinids and only one colonial rugose coral specimen was found together with the foraminifers.

This paper stresses an outline of the new fossil record of the Jengka Pass Limestone. One phaceloid rugose coral species is identified as *Yatsengia* sp. nov. which is reported for the first time from the Jengka Pass Limestone and is different from any of the previously described species having a comparatively large corallite diameter. There are a number of microfossils collected from the Jengka Pass Limestone, such as *Climacammina* sp., *Deckerella* sp., *Neoschwagerina* sp., *Pseudofusulina* sp., *Tetrataxis* sp., *Verbeekina* sp. nov., *Yabeina* sp. nov., and *Sumatrina* sp. The age of the Jengka Pass Limestone corresponds to the boundary of the *Neoschwagerina-Yabeina* Zones i.e. the Murgabian-Midian boundary; it ranges from the Upper Murgabian to the Lower Midian.

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Classification of tropical lowland peats

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Peat is considered as an undesirable material in engineering work and usually it is removed or stabilised during development. Peat and related organic soils need to be properly classified, so that material with similar physical, mechanical and/or chemical properties can be grouped together, and each group shows similar characteristics relevant to their use or performance. The objective of this paper is to review the classification of tropical peats, particularly peats in Sarawak, based on both soil science and engineering approaches. The main aspects used in the classification, such as organic content and degree of humification, will be discussed.

Peats are formed when there is a net accumulation of organic soil materials, ie. accumulation greater than decomposition. The organic materials can consist of undecomposed, partially decomposed and highly decomposed plant remains. Tropical lowland peats usually have undecomposed and partly decomposed branches, logs or twigs. Tropical lowland peat deposits form a fragile ecosystem because of their domed shape and almost pure organic content (Paramanathan, 2010). Organic materials accumulate to form peat under certain conditions, whereby it is essential that the production of biomass (organic materials) is greater than its chemical breakdown to form peat (Andriess, 1988). Anaerobic, swampy conditions, which prevent the micro-biological activity needed for the chemical breakdown of organic materials are generally assumed to be largely responsible for the accumulation of partly decomposed biomass/organic matter in the form of peat.

Depending on the purpose of classification, the cut-off value of the percentage of organic matter for the classification of a superficial deposit or soil as peat, and to differentiate peats from soils with lesser amounts of organic content, varies throughout the world (Huat, 2004). Generally, soils with organic contents greater than 20% are termed as organic soil. The definition of peat varies between the fields of soil science and engineering. In soil science, peat is defined as soils with organic content greater than 35%. In geotechnical engineering, soils with organic contents greater than 20% are termed as organic soils, while those with organic contents greater than 75% are known as 'peats' (Table 1). The rationale in the geotechnical engineering classification is that when the organic content of the soil is greater than 20%, the mechanical properties of the soil will change significantly. According to the Malaysian Soil Classification System for Engineering Purposes and Field Identification (Engineering Geology Working Group, 2007), soils having organic content ranging from 3 to 20% are termed as slightly organic soils, from 20 to 75% as organic soils and greater than 75% as peat.

The main criteria used in the soil science classification for tropical lowland peats involves the use of key methods to classify and identify soils and tropical lowland peats using parent materials. The procedure involves the distinction between tropical highland and lowland soils, the division between organic and mineral soil materials, followed by the definition of an organic soil profile. Lowland organic soil profiles are soils in which the thickness of organic soil layers make up more than half the soil profile to 100 cm or shallower if rocks or parent materials are present at less than 100 cm. Lowland organic soils are sub-divided based on the thickness of the organic soil layer. Lowland organic soils (or peat) or histosols soils are subdivided into ombrogambists or deep organic soils (>150 cm thick) and topogambists or moderately deep and shallow organic soils (50 to 150 cm thick). The criteria used in the classification of tropical lowland peats into different categoric levels are the minimum cumulative thickness, drainage class (poor or well drained), thickness of organic layer (ombro or topo), dominant component in the sub-surface (50-100 cm) tier (Terric, Sapric, Hemic or Typic /Fibric), nature of substratum (whether marine or riverine/terrestrial clay/sand), soil temperature regime (isohyperthermic or isomesic), presence and nature of wood (woody decomposed or undecomposed or non-woody) and mode of origin (whether autochthonous or allochthonous) (Table 2).

Parameters used in the classification of tropical lowland peat for engineering purposes include organic content and degree of humification. The ASTM standard method of classifying peat (ASTM D 4427) includes the use of field test method for degree of humification (ASTM D 5715). The Von Post humification test (Von Post Classification system) involves squeezing of peat and the examination of material extruded between the fingers. The peat is classified as one of ten (H1 to H10) humification or decomposition categories. Peat is then further subdivided into fibric or fibrous peats (Ptf) (humification range of H1 to H3), hemic or moderately decomposed peats (Pth) (H4 to

Table 1: Organic soil classification based on organic content ranges (Jarret, 1995; Huat, 2004).

Basic soil type	Description	Symbol	Organic Content (%)
Clay or silt or sand	Slightly organic	O	2-20
Organic soil		O	25-75
Peat		Pt	>75

Table 2: Summary of criteria used for the classification of tropical lowland organic soil or peat of Malaysia (Paramanathan, 2010).

CATEGORIC LEVEL	CRITERIA USED	EXAMPLE
ORDER	Minimum cumulative thickness of 50 cm within 100 cm or more than half to lithic/paralithic or terric layer	HISTOSOLS
SUB-ORDER	Drainage Class – poor, well	GAMBIST – poorly drained FOLIST – well drained
GREAT GROUP	- Thickness of organic layer - Ombro: >150 – Ombro - Topo: 50-150 – Topo	Ombrogambist Topogambist
SUB-GROUPS	- Dominant in sub-surface (50-100 cm) tier - Terric, Sapric, Hemic, Typic (Fibric)	Hemic Topogambist Sapric Ombrogambist
FAMILY	- Nature of substratum - marine clay/sand - riverine clay/sand - Soil temperature regime - isohyperthermic/isomesic	BARAM FAMILY ADONG FAMILY
SOIL SERIES	- Presence and nature of wood - no wood - wood decomposed - wood undecomposed - Mode of origin autochthonous/allochthonous*	Baram Series: Sapric Topogambist, marine-sandy, isohyperthermic, non-woody, autochthonous. Adong Series: Hemic Ombrogambist, marine-sandy, isohyperthermic, decomposed wood, autochthonous.
PHASE	- Depth - shallow: 50-100 cm - moderately deep: 100-150 cm - deep: 150-300 cm - very deep: 300+ cm	Baram/shallow Baram/moderately deep Adong/deep Adong/very deep

* allochthonous: organic deposits which have been transported and redeposited

Table 3: The Von Post Classification system (adapted from Andriess, 1988).

Symbol	Description
H1	Completely undecomposed peat which, when squeezed, releases almost clear water. Plant remains easily identifiable. No amorphous material observed present.
H2	Almost entirely undecomposed peat which, when squeezed, releases clear or yellowish water. Plant remains still easily identifiable. No amorphous material present.
H3	Very slightly decomposed peat which, when squeezed, releases muddy brown water, but from which no peat passes between the fingers. Plant remains still identifiable, and no amorphous material present.
H4	Slightly decomposed peat which, when squeezed, releases very muddy dark water. No peat is passed between the fingers but the plant remains are slightly pasty and have lost some of their identifiable features.
H5	Moderately decomposed peat which, when squeezed, releases very “muddy” water with a very small amount of amorphous granular peat escaping between the fingers. The structure of the plant remains is quite indistinct although it is still possible to recognize certain features. The residue is very pasty.
H6	Moderately highly decomposed peat with a very indistinct plant structure. When squeezed, about one-third of the peat escapes between the fingers. The residue is very pasty but shows the plant structure more distinctly than before squeezing.
H7	Highly decomposed peat. Contains a lot of amorphous material with very faintly recognizable plant structure. When squeezed, about one-half of the peat escapes between the fingers. The water, if any is released, is very dark and almost pasty.
H8	Very highly decomposed peat with a large quantity of amorphous material and very indistinct plant structure. When squeezed, about two-thirds of the peat escapes between the fingers. A small quantity of pasty water may be released. The plant material remaining in the hand consists of residues such as roots and fibres that resist decomposition.
H9	Practically fully decomposed peat in which there is hardly any recognizable plant structure. When squeezed it is a fairly uniform paste.
H10	Completely decomposed peat with no discernible plant structure. When squeezed, all the wet peat escapes between the fingers.

H6) and sapric or amorphous peats (H7 to H10) (Table 3). The organic content is determined using the ignition test (ASTM D 2974) to obtain the percentage of organic content lost during ignition (LOI).

Acknowledgement

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Sedimentologi lapisan perantaraan Formasi Kubang Pasu dan Formasi Chuping, Beseeri Perlis

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Pengenalan

Lapisan perantaraan Formasi Kubang Pasu adalah merupakan lapisan peralihan daripada jujukan batuan klastik Formasi Kubang pasu berubah kepada jujukan batu kapur Formasi Chuping. Kajian ini dilakukan untuk mengenalpasti unit-unit batuan dan fasies pengendapan yang terdapat pada jujukan peralihan ini. Analisis dilakukan terhadap jujukan batuan yang dicerap semasa di lapangan dengan mengambil kira ciri-ciri saiz dan jenis butiran, struktur sedimen dan fosil.

Bagi tujuan kajian ini, terdapat sebanyak 6 lokaliti, meliputi kawasan Pekan Beseeri, Perlis telah digunakan iaitu dua di kuari A, tiga di kuari B dan satu di Bukit Merah (Rajah 1). Menurut Jones (1981), kawasan ini terdiri daripada dua formasi yang menindih secara selaras antara satu sama lain, iaitu Formasi Kubang Pasu ditindih oleh Formasi Chuping.

Fasies Sedimen

Satu kajian terperinci telah dibuat di Kuari B untuk melihat fasies dan perubahan fasies di dalam lapisan perantaraan Formasi Kubang Pasu (Rajah 2). Kajian ini telah mengenalpasti empat fasies iaitu selang lapis batu pasir dan batu lumpur nipis, batu lumpur tebal, batu pasir berpelapisan tebal dengan sedikit lumpur dan batu pasir yang terbioturbasi.

Fasies selang lapis batu pasir dan lumpur nipis.

Fasies ini terdiri daripada batu pasir yang berselang lapis dengan batu lumpur nipis. Lapisan batu pasir di dalam jujukan ini adalah dominan berbutir halus dan mempunyai ketebalan 1 ke 10 cm manakala batu lumpur pula adalah 0.5 ke 5 cm tebal. Antara struktur sedimen yang dijumpai dalam fasies ini adalah laminasi silang, laminasi bergelombang, palung dan klasta lumpur tercabut. Fasies ini juga mempunyai fosil yang terdiri daripada fosil surih dan brakiopod. Jujukan selang-lapis seperti ini menunjukkan keadaan kawasan yang mempunyai tenaga arus yang berubah-ubah dan terendap secara gabungan mendapan dan seretan (Felix, 2000).

Fasies batu lumpur tebal

Fasies ini adalah merupakan jujukan batu lumpur tebal, lebih daripada 0.5 meter tebal dan berwarna kelabu gelap. Fosil surih dan struktur palung boleh dijumpai di dalam beberapa lapisan. Fasies ini ditafsirkan sebagai endapan secara ampaian di kawasan yang tenang dan mempunyai tenaga arus yang perlahan. Kehadiran fosil surih mencadangkan kawasan ini dihuni oleh organisma kawasan air cetek.

Fasies batu pasir berpelapisan tebal dengan sedikit lumpur

Fasies ini terdiri daripada jujukan lapisan batu pasir tebal, 0.2 ke 3 meter tebal dengan sedikit lumpur dalam bentuk lapisan nipis (<2 cm) dan klasta kecil. Batu pasir ini terdiri daripada batu pasir berbutir halus ke sederhana dan mempunyai struktur sedimen kesan riak dan palung. Bentuk kesan riak adalah merupakan riak simetri dan ditafsir sebagai riak ombak yang terbentuk di kawasan lautan sangat cetek. Struktur palung pula menandakan pengendapan arus bertenaga tinggi.

Fasies batu pasir yang terbioturbasi

Fasies ini adalah merupakan jujukan batu pasir yang telah mengalami perubahan dari segi struktur disebabkan oleh proses biologi, juga dikenali sebagai gangguan biologi. Ini ditunjukkan dengan adanya fosil surih dan litologi yang bercampur aduk, iaitu batu pasir dan batu lumpur (Hatt et.al, 2011). Keadaan litologi yang terdiri daripada batu pasir dan batu lumpur ini menunjukkan bahawa batuan ini telah termendap di kawasan yang tenaga arusnya berubah-ubah. Namun aktiviti biologi ini menandakan kawasan yang mempunyai tenaga arus sederhana (Alonso et.al, 2011).

Hubungan antara fasies dan tafsiran model pengendapan

Analisis fasies menunjukkan terdapat dua jenis jujukan batuan iaitu jujukan mengkasar ke atas (JKA) dan jujukan menghalus ke atas (JHA). Jujukan mengkasar ke atas adalah dimulai dengan fasies I dan diikuti oleh fasies III. Jujukan ini kebanyakannya mempunyai kesan riak simetri ataupun gelombang laut cetek dan ditafsirkan sebagai maraan garis pantai. Jujukan menghalus ke atas pula dimulai oleh fasies III dan diikuti oleh fasies I dan II. Terdapat banyak struktur palung di dalam jujukan ini. Fasies ini ditafsirkan sebagai alur.

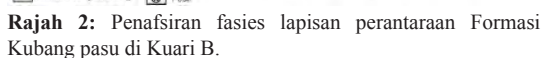
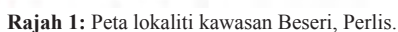
Perubahan jujukan-jujukan fasies di dalam lapisan perantara Kubang Pasu ini menunjukkan bahawa berkemungkinan proses pengendapan lapisan ini berlaku secara berulang beberapa kali, disebabkan oleh fasa regresi (Sukhantar, 2004 dan Felix, 2000). Secara keseluruhan, pengendapan adalah merupakan endapan kawasan transisi antara benua dan laut marin, iaitu sekitaran pasang surut dan pelantar benua.

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Fosil kayu terpetri di dalam alluvium Kuaternari di Ulu Tiram, Johor

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Kertas ini mendokumenkan penemuan fosil kayu terpetri di dalam enapan alluvium berusia Kuaternari di kawasan Ulu Tiram, Johor. Fosil tersebut ditemui di sebuah kuari pasir yang sedang beroperasi. Singkapan di mana fosil tersebut ditemui adalah enapan tidak konsolidat yang terdiri daripada lapisan pasir halus hingga kasar secara berlapis dan bersilang. Terdapat juga lapisan pasir berlodak dan berlempung wujud secara kekanta selain lapisan nipis klast bersaiz kelikir dan pebel terdiri daripada kuarza dan batu pasir. Keadaan ini menunjukkan persekitaran pengendapan delta sungai berhampiran kawasan pasang surut di mana arus datang dari pelbagai arah. Fosil kayu yang ditemui adalah tidak sempurna sepenuhnya, terdiri daripada pelbagai saiz, bentuk dan warna. Sifat-sifat pada permukaan kayu dan gelang tumbesaran adalah jelas kelihatan. Penyiasatan lanjut terhadap fosil ini adalah diperlukan untuk mengkaji karakter dalaman, spesies kayu dan umurnya. Akhirnya, sifat-sifat biodiversiti, persekitaran pengendapan dan penyesuaian pokok tersebut kepada perubahan cuaca pada masa lampau akan dapat ditentukan.

This paper documents the discovery of silicified fossil wood in Quaternary alluvium from one sand quarry in Ulu Tiram, Johor. The outcrop is composed of fine-coarse grained sand layer with lenses of silty and clayey sand. Thin layer of quartz and sandstone gravel and pebble are widely found in the outcrop. Cross stratification and lamination with additional existence of sand lenses are indicative of deltaic and tidal environment in which the currents coming from different directions. The fossil wood found are variable sized, form and colour but not in complete form. The excellent preservation of this mature wood specimen shows the good outer surface characteristics and growth rings. Further studies are crucial to determine the wood inner characteristics, its spesies and age. Its palaeoecological studies in terms of biodiversity and adaptational response to climate change could also be determined.

Depositional Environment of the Sediments of the Calcareous Unit of the Gua Musang Formation from the Padang Tengku Area, Pahang – Analogs to the Western Great Bahama Bank

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The scattered distribution of the limestone unit of the Gua Musang Formation was found in the Selbourne Estate region, four kilometers northwest of Padang Tengku, Pahang. On basis of the discoveries of rugose corals and foraminifers in these limestone outcrops, Aye Ko Aung et al. (2011) and Aye Ko Aung & Ng (2012) suggested that the age of the limestone unit is of Late Permian. At least three lithofacies can be identified in this limestone sequence; (1) oolite–grapestone grainstone, (2) oolitic grainstone and (3) lime mud and pellet mud wackestone. Both of the oolites–grapestone and oolitic grainstones are co-existed in SE2 (Selbourne Estate locality) whereas the lime-mudstone–wackestone is found in SE1, located further southwest to the former. The variations between these lithofacies are primarily due to different carbonate components present in each of them – a factor controlled by depositional setting as well as different energy levels acted during deposition though all were formed under warm and shallow marine condition. On the other hand, Bathurst (1975) and Freile & Milliman (1999) proposed four major shallow subtidal sedimentary facies present in the Western Great Bahama Bank, three of which are similar to the previously mentioned lithofacies of the Selbourne Estate area in exception that a coralgall lithofacies of the former is weakly developed in the calcareous unit of the present area. Thus, by referring to James Hutton's renowned phrase '*The Present is the Key to the Past*', lithofacies similarity found in the Selbourne Estate area of Pahang, Central Peninsular Malaysia to that of the sedimentary facies of the Western GBB implies that both areas share a similar depositional environment – an open carbonate platform setting. For that reason, a paleo-depositional environment for the calcareous unit of the Gua Musang Formation from the Selbourne Estate has been constructed in this study, showing variations in the depositional settings occurred in the areas between interior of the platform and the platform margin.

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Sediment and fauna of the Arip Limestone of the Tatau Formation, Sarawak, Malaysia

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The new biostratigraphic data obtained confirm the presence of fossiliferous Lutetian to Priabonian (Middle Eocene to Upper Eocene) carbonate rocks (Arip Limestone) in the Tatau area. In this study, the name “Arip Limestone” is tentatively used as a Member of the Tatau Formation.

The Arip Limestone of the Tatau Formation is well exposed in the southwestern part of Tatau area. The type section of the Arip Limestone is defined along the Arip River and Arip Road. It consists of shallow marine deposits rich in planktonic and benthonic foraminifers. The age of the limestone is regarded as Middle Eocene to Upper Eocene which is probably similar age with Piring Intrusion (Hutchison, 2005) and Ransi Member (Wong, 2011).

The lower part of the Arip Limestone is composed of the interbedded sequence of dark grey calcareous shale and dark grey limestone which is characterized by the parallel laminations and partly cemented by calcite. This wackestone suggest a low-energy depositional setting towards the base of the photic zone. It contains in abundance of fragments of planktonic foraminifera and some larger benthonic foraminifera. These predominant microfossil fragments are able to identify as of *Globigerinatheca* (Figure 1) and some nummulitid and discocyclinid. The foraminifera assemblage such as *Globigerinatheca* and some benthic foraminifera fragments that presence in lower part of Arip Limestone representing the middle slope of the carbonate platform (Beavington-Penny & Racey, 2004).

In the upper, the Arip Limestone forms caves near by the Arip River area where the number of benthonic foraminifera and fragments of the coralline algae are gradually increased. The fossils include coralline algae and large benthonic foraminifera such as *Nummulites* (Figure 2), *Discocyclina*, and *Pellatispira* (Figure 3) together with echinoderm fragments. The foraminifera of this packstone from the cave suggests a relatively higher intermediate energy depositional setting within the photic zone where red coralline algae and benthic foraminifera dominate. This nummulitic-rich limestone probably represents a shallow marginal carbonate ramp deposited on a structural high in front of the uppermost parts of the foreslope of continental margin.

The calcareous sandstone that found at Lesong area is composed of benthonic foraminifera and coralline algae fragments. This calcareous sandstone suggests high clastic sediment input. It is deposited in a high energy very shallow marine with the absence of mud. Reworked Nummulites suggests that the unit is a younger sequence which could be related to a relative drop in sea level that washed the foraminifera together with clastic sediments into the basin.

The previous study by Leitchi et al. (1960) stated that the microfossil of the Arip Limestone (base of the Tatau Formation) the age is Early Eocene previously. However the present study suggests, on basis of microfossils extends the age to Late Eocene. The depositional environment model of the Tatau Formation during Sarawak Orogeny within this time frame is also provided.

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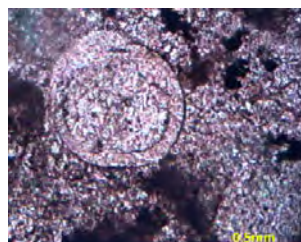


Figure 1: Equatorial section (Centre) and axial section (left) of *Nummulites pengaronensis*. Chambers arranged spirally, height of the chambers gradually increasing as added. 3 whorls present for the equatorial section.

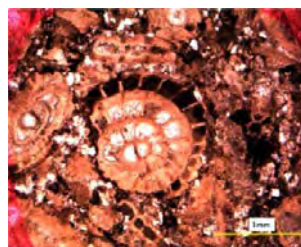


Figure 2: Axial section of *Pellatispira*. Biplanar with slightly lenticular specimen and presence of two spiral chamber lumen.

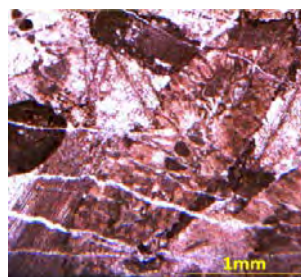


Figure 3: Thick walled subglobular *Globigerinatheca mexicana mexicana* with enclosing an earlier chamber within it.

The effectiveness of seismic refraction tomography for groundwater study

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Keywords: tomography, seismic refraction, 2-D resistivity, groundwater

Seismic refraction is of essence in shallow subsurface study. The application of seismic refraction uses sound wave (hammer, seisgun, dynamite) that is imposed to earth surface. The wave will propagate inside earth in all directions and comply medium elasticity features to produce reflection and refraction waves (Figure 1). This method also mirrors rock intrinsic characteristics such as porosity, density, particle size and shape, anisotropy, mineralogy, degree of cementation and moisture effect (Bradybrooke, 1988). Electrical imaging system is now mainly carried out with a multi-electrode resistivity meter system (Figure 2). Such surveys use a number (usually 25 to 100) of electrodes laid out in a straight line with a constant spacing. A computer-controlled system is then used to automatically select the active electrodes for each measure (Griffith and Barker, 1993). The resistivity method basically measures the resistivity distribution of the subsurface materials. The resistivity of rocks is mainly dependent on the degree of fracturing. Since the water table in Malaysia is generally shallow, the fractures are commonly filled with ground water. The greater the fracturing, the lower is the resistivity value of the rock. Soils above the water table is drier and has a higher resistivity value, while soils below the water table generally have resistivity values of less than 100 ohm-m. Also clay has a significantly lower resistivity than sand. The study implemented seismic refraction techniques on a resistivity survey line where the first geophone was at 10m of resistivity line. 2-D resistivity imaging shows the section consist of two zones. The first zone was alluvium and sandy clay with resistivity value of <200 Wm and the second zone was bedrock with resistivity value of > 250 Wm. The fractures zone was detected at 140-170m (Figure 3). Seismic refraction shows the section consist of two main zones. The first zone was alluvium and sandy clay with velocity of 300-1800 m/s and the second zone was bedrock with velocity of >300m/s. The fractured zone was detected at the same place as 2-D resistivity result which was at distance 130-180m (Figure 4). The study shows that seismic refraction tomography can be use for groundwater study.

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Table 1: Resistivity values of common rocks, soil and water.

Material	Resistivity (ohm-m)
Alluvium	10 to 800
Sand	60 to 1000
Clay	1 to 100
Groundwater (fresh)	10 to 100
Sandstone	8 - 4 x 10 ³
Shale	20 - 2 x 10 ³
Limestone	50 - 4 x 10 ³
Granite	5000-1,000,000
Precipitation	30 - 1000
Surface water, in areas of igneous rock	30 - 500
Surface water, in areas of sedimentary rock	10 - 100
Groundwater, in areas of igneous rock	30 - 150
Groundwater, in areas of sedimentary rock	> 1
Sea water	>> 0.2
Drinking water (max. salt content 0.25%)	> 1.8
Water for irrigation and stock watering (max. salt content 0.25%)	> 0.65

Table 2: Resistivity and seismic velocity of some common rocks and minerals (Telford & Sheriff, 1984; Jakosky, 1950).

Material	Seismic (m/s)	Resistivity (Ohm-m)
<i>Igneous / Metamorphic</i>		
Granite	4580 - 5800	5 x 10 ³ - 10 ⁸
Weathered granite rocks	305 - 610	1 - 10 ²
Basalt	5400 - 6400	10 ³ - 10 ⁶
Quartz		10 ³ - 2 x 10 ⁶
Marble		10 ² - 2.5 x 10 ⁸
Schist		20 - 104
<i>Sedimentary rocks</i>		
Sandstone	1830 - 3970	8 - 4 x 10 ³
Conglomerate		2 x 10 ³ - 10 ⁴
Shale	2750 - 4270	20 - 2 x 10 ³
Limestone	2140 - 6100	50 - 4 x 10 ²
<i>Unconsolidated sediment</i>		
Clay	915 - 2750	1 - 100
Alluvium	500 - 2000	10 - 800
Marl		1 - 70
Clay (wet)		20
<i>Groundwater</i>		
Fresh water	1430 - 1680	10 - 100
Salt water	1460 - 1530	0.2

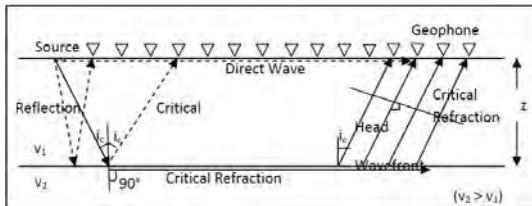


Figure 1: Direct wave, reflection and refraction ray (Telford, 1984).

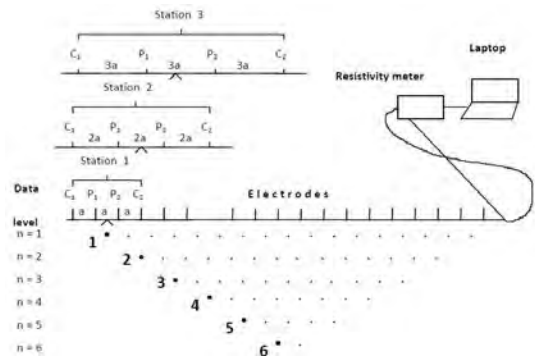


Figure 2: The arrangement of electrodes for a 2-D electrical survey and the sequence of measurement used to build up a pseudosection (Griffith & Barker, 1993).

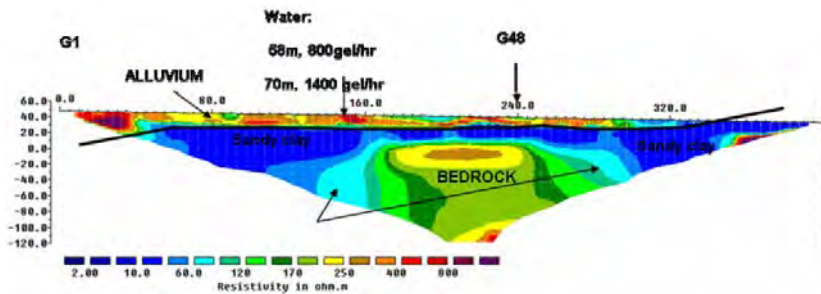


Figure 3: Resistivity section of study line.

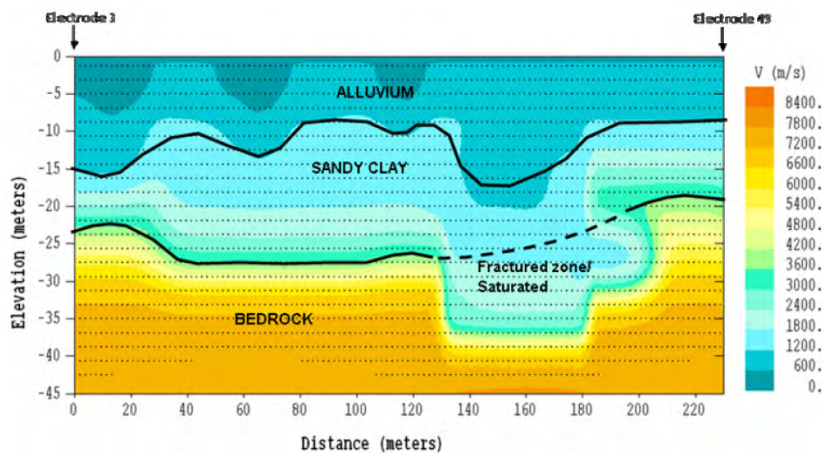


Figure 4: Seismic refraction tomography of study line.

Influence of rock properties on NATM drilling rate in Interstate Raw Water Transfer Tunnel

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Keywords: NATM, Main Range granite, drilling rate, rock mass properties, geological mapping

Kuala Lumpur, Putrajaya and Selangor have experienced water shortage and this is not a new issue in Malaysia. The rapid growth of economy influenced the high water demand at this region centre of the country and this situation has initiated the idea of channelling water from Pahang to Kuala Lumpur via a tunnel. The 44.6 km long Interstate Raw Water Transfer (ISRWT) tunnel will channel raw water from Semantan River to the Hulu Langat, Selangor where the water will be treated before piped to the consumers (Figure 1). The ISRWT tunnel is designed to cross solid rock of the Titiwangsa Main Range granite along the alignment with overburden ranges from just several meters at each portal to more than thousand meters at the centre of the tunnel (KeTTHA, 2000). Geology along this tunnel comprises of metasedimentary rock at northern end and granitic rock to rest of the tunnel. The tunnel is designed to be constructed in two different methods which is TBM and NATM method. The NATM method is chosen in this study because it provides a fresh blasted outcrop to study the rock mass properties. In tunnelling, drillability assessment is important because it will influence the tunnelling performance also determining the total construction cost. Drillability is a term used in construction to describe the influence of a number of parameters on the drilling rate (drilling velocity) and the tool wear of the drilling tool (Thuro and Spaun, 1996). Drilling rates is affected by various parameters of the rock mass properties. This paper presents a study on the influence of spacing of discontinuities (weakness planes), orientation of discontinuities with respect to tunnel axis, joint aperture and filling material, Uniaxial Compressive Strength (UCS) and weathering of rock mass on the drilling rate. The drilling rate was recorded while drilling holes for blasting at NATM 1 and NATM 4 which comprise of meta-sedimentary and granite rock respectively of the Interstate Raw Water Transfer tunnel project. To address this issue, tunnel mapping from the tunnel face (Figure 2) was carried out and the rock samples were collected from the drilling locations and mechanical properties of the rocks were determined by testing in the laboratory. During mapping activities, all joints, fractures and rock fabric orientations were mapped in considerable details along the entire tunnel length. Raw data obtained from the geological mapping, laboratory testing, and added with the previous other research study was used to investigate the relationship between penetration rate and some geological parameters. The correlation of mechanical testing (UCS), spacing of discontinuities and angle of drilling orientation with respect to tunnel axis with drilling rate performance were plotted directly into diagrams. The degree of weathering, joint aperture and filling material parameters were recorded by mapping and were correlated it directly with drilling rate. It can be seen that the average of drilling rate for each Tunnel Drill (TD) are different between the two formation, metasedimentary and granite rock and each of the parameters of rock mass properties has individually affected the drilling rate of blasting holes.

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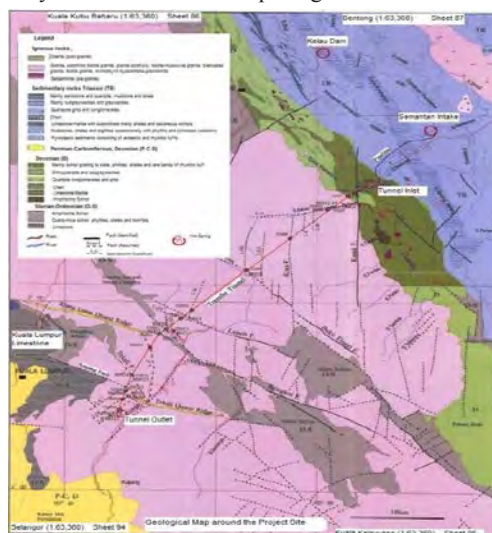


Figure 1: Map of Pahang – Selangor Raw Water Transfer Project.

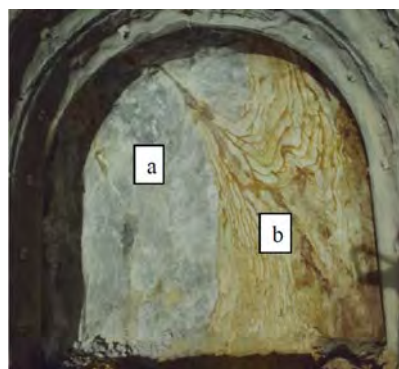


Figure 2: Tunnel face at NATM 4 (TD 1921.5); a) fresh rock, b) weathered rock.

Imaging subsurface geological contact zone using 2D resistivity method at Batang Merbau, Tanah Merah, Kelantan

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Keywords: contact zone; 2D resistivity method; fractures; Batang Merbau

The place where two geologic units located next to each other is called a contact. Contact zone could indicate further geological structure nearby its area such as fracture, aquifer, faults, etc. In geologic map, contact lines are drawn to show where two geologic units meet or contact (Polard, 2011). In nature, rocks may be brought into contact through deposition, intrusion, faulting and shearing. The ways in which rock bodies fit together is deduced from geologic mapping, supplemented wherever possible by drilling and geophysical data (Davis, 1984). Geophysical techniques and concepts are widely used to resolve individual geologic structures and to explore the crustal or larger scale structure of the earth. They help to resolve near surface structure and to extract information about the nature of the deeper crust and mantle. One of the techniques useful in delineating geologic structure includes electrical methods (Hatcher, 1995). A geophysical study is conducted at Batang Merbau, Tanah Merah, Kelantan with the coordinate of $5^{\circ} 50' 45.0''$ N and $102^{\circ} 01' 49.6''$ E to locate the contact zone at this area using 2D resistivity method. The survey applied 2D resistivity method to give significant depth information and the geological contact extension. The study area was located in agriculture farm with gently undulating and some bushes. The geology of the area was Permian with sediments of argillaceous and arenaceous interbeds. Prominent geological feature is volcanic strata with flows, tuffs and agglomerates of andesitic to rhyolitic composition, predominantly andesitic crystal tuffs. There are some igneous intrusive with acid and undifferentiated granitic rocks (Geological Map Of Peninsular Malaysia, 1985). The Upper Paleozoic and Triassic of south Kelantan strike northward toward the metamorphic complex of Gunung Stong and from the map, it shows that the metamorphic complex is extended to the study area (Gobbett & Hutchison, 1973). Quartzite with quartz boulders found scattering at L2 shows metamorphism process had occurred to the sandstone near the contact zone (Figure 1). Four survey lines of 400m each has been made in this area utilizing Pole-dipole array with 5m electrode spacing (Figure 2). Based on the 2D resistivity method, there are three significant zones in this area with the first zone consist of alluvium giving resistivity value of 10-800 ohm-m, the second zone consist of sandstone with resistivity value of 1000-3000 ohm-m and the third zone is granite bedrock with resistivity value >3000 ohm-m. Resistivity pseudosection map (Figure 3 & 4) reflects the vertical resistivity distribution within depth of 150m. From the pseudosection map, the contact zone is determined by the trend of the resistivity contour. Thus, the contact zone found is between granite and sandstone, which also produce fracture zone. Correlating with the discovery of quartzite and quartz near the contact zone suggesting metamorphism process has occurred in this area altering sandstone into quartzite. The quartzite presence in small boulder size scattering within an outcrop has proposed the existence of fractures nearby.



Figure 1: Quartzite found at Line 2 about 85 m from the first electrode.

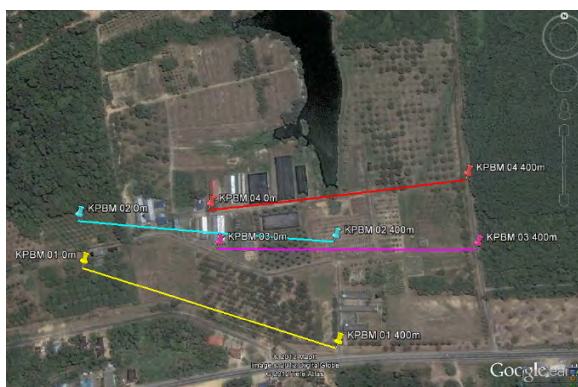


Figure 2: Survey Lines on study area.

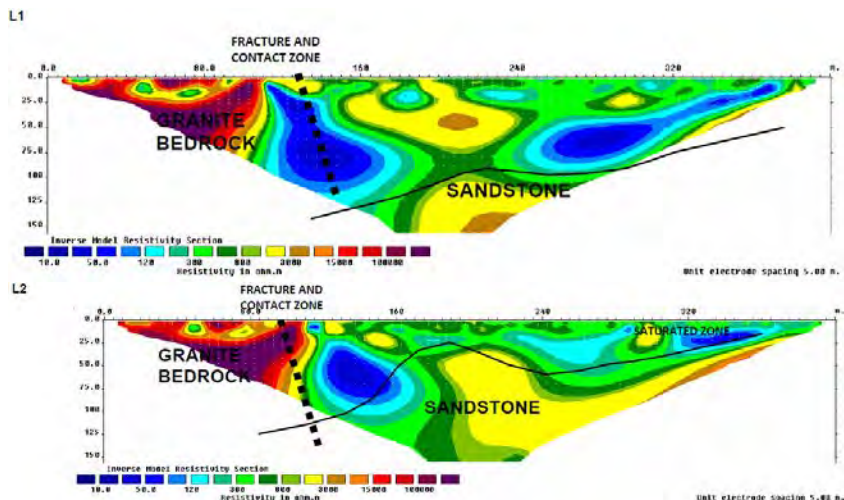


Figure 3: Resistivity pseudosection of survey line L1 and L2 at Batang Merbau, Tanah Merah, Kelantan.

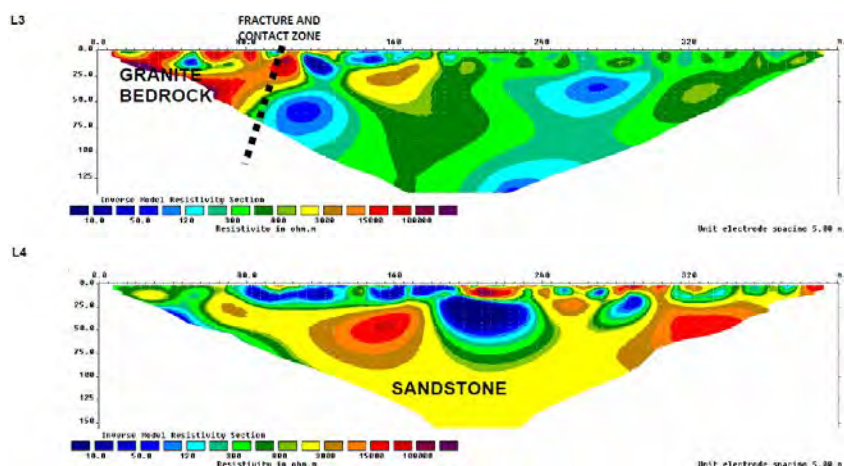


Figure 4: Resistivity pseudo section of survey line L3 and L4 at Batang Merbau, Tanah Merah, Kelantan.

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The use of P wave in pile length measurement for engineering application

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Keywords: Direct wave, reflection wave, intersection, ultraseismic, pile length

Few methods introduced for determining the length of pile. Each method has their unique advantage and disadvantage depending on the environment. Knowledge of pile length is a vital component for calculating weight of the structure on it. Piles are typically driven until they reach a predetermined resistance, and then trimmed at the end to provide a solid level surface for substructure construction. Limited research has been conducted to evaluate the length of embedded piles. Davis (1994) described use of sonic echo and parallel seismic methods for estimating pile length. The sonic echo method is based on impacting the head of the pile and measuring the time for the reflected stress wave to reach an accelerometer, also mounted on the head of the pile (Figure 1). Davis reported several difficulties using this method when a structure is resting on the pile: (a) damping of the stress wave and multiple reflected waves made determination of the echo from the pile tip difficult; (b) attaching the accelerometer to the side of the pile was difficult and (c) delivering a direct impact to the side of the pile was difficult. The parallel seismic method used by Davis (1994) avoids the difficulty of not having access to the head of the pile. Cost is a primary limitation to conducting the parallel seismic test on piles. The parallel seismic method has achieved acceptance for concrete structures and a modified sonic echo technique (termed ultraseismic) also shows promise for higher-value structures (Jalinoos and Olson, 1996). Douglas and Holt (1993) used analysis of bending waves in timber piles to estimate length. A kernel method was developed to allow for processing of dispersive bending waves having frequency components which travel at different velocities and therefore, render signal processing more difficult particularly when dealing with unknown geometries. Research on timber poles and piles (Anthony et al, 1989; 1992) resulted in nondestructive evaluation (NDE) techniques based on longitudinal stress wave propagation that provided the means to evaluate the length of timber piles (Engineering Data Management 1992). To adapt the technology for pile length determination modifications to existing impact methods and sensor attachments were necessary, coupled with further testing on log and concrete of known lengths. Field testing of the technique was conducted to identify the accuracy, limitations and the means of applying the pile length determination technology.

The study proves the length of known pile length can be measures using compressional wave (P waves). Using first arrival and reflection events, the length of wood log (Figure 2) and concrete pier (Figure 3) were measured correctly. The accuracy is depends on the variability of material's velocity and frequency of the seismic source. Intersection between direct wave (linear positive moveout) and reflected wave (linear negative moveout) will result in the evaluation of pile length (Figure 4 and 5).

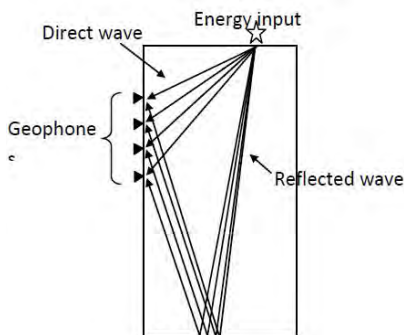


Figure 1: The test array and wave travel for ultraseismic test.

(a)



(b)

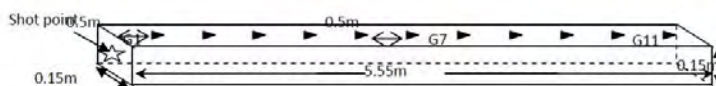


Figure 2: The Ultraseismic test for wood log. (a) photo of the test (b) schematic diagram.

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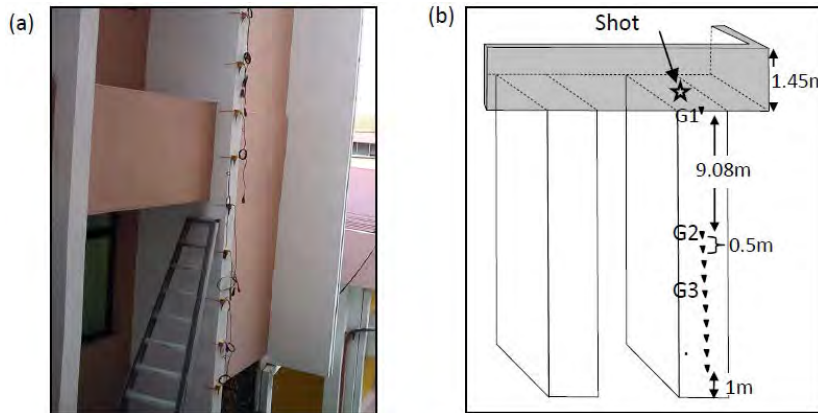


Figure 3: The Ultraseismic test for concrete pier. (a) photo of the test (b) schematic diagram.

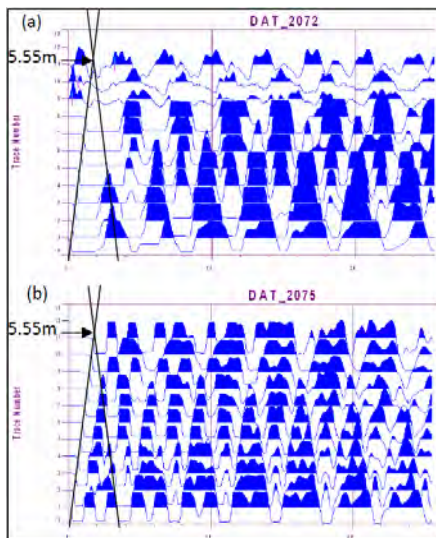


Figure 4: Seismic signals obtained from wood log using two types of source hammer. a) rubber hammer and b) steel hammer.

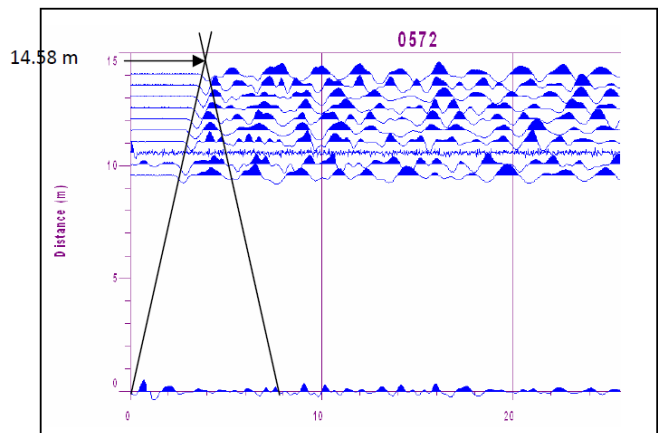


Figure 5: Seismic signals obtained from concrete pier using 12lb sledgehammer.

Kesan simen portland terhadap sifat geoteknik tanah gambut (Effects of portland cement on geotechnical properties of peat soil)

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Abstrak: Tanah gambut memberi banyak manfaat terutamanya di dalam sektor pertanian seperti nenas dan kelapa sawit. Namun, tanah gambut membawa masalah dari segi kejuruteraan kerana ia merupakan tanah yang tidak begitu sesuai untuk pendasaran disebabkan oleh kekuatan yang rendah dan kompresibiliti yang tinggi. Kajian ini dijalankan untuk mengkaji ciri-ciri asas tanah gambut dan kesan penambahan simen Portland terhadap sifat geoteknik tanah gambut. Persampelan dilakukan di Kampung Bagan Lalang, Tanjung Sepat, Sepang, Selangor (2° 36' 14.97" U 101° 41' 53.79" T). Pencirian asas tanah gambut yang dikaji adalah penentuan graviti tentu (Gs), pH, mikroskop elektron imbasan (SEM) dan pembelauan sinar-X (XRD). Manakala pencirian geoteknik bagi tanah terawat simen pula merangkumi ujian tiga paksi tidak terkukuh tidak tersalir (UU), had-had Atterberg, kekonduksian hidraulik dan ujian kekuatan mampatan sepaksi (UCS). Simen Portland digunakan di dalam kajian ini. Nisbah kandungan simen yang digunakan adalah 0%, 10%, 20% dan 40% daripada berat kering sampel tanah gambut yang digunakan. Berdasarkan hasil analisis pencirian asas tanah gambut, didapati nilai graviti tentu adalah 2.03, nilai pH adalah 3.68, kandungan bahan organik adalah di antara 50%-65% dan analisis XRD menunjukkan kehadiran mineral kuarza dan muskovit. Kekuatan ricih tanah gambut, Cu pula adalah 170.33kN/m². Kehadiran simen didapati memberi kesan kepada nilai had-had Atterberg. Had-had atterberg didapati sedikit menurun apabila semakin banyak kandungan simen ditambah. Kekonduksian hidraulik juga semakin menurun apabila jumlah pertambahan simen semakin meningkat. Manakala kekuatan mampatan sepaksi (UCS) tanah gambut semakin meningkat apabila kandungan simen semakin bertambah. Kajian ini menunjukkan penambahan simen telah memberi kesan kepada sifat kejuruteraan tanah gambut dari segi nilai had Atterberg, kekonduksian hidraulik dan kekuatannya.

Kata kunci: tanah gambut, simen Portland, kekuatan mampatan sepaksi

Abstract: Peat soil provides many benefits, especially in the agricultural sector, such as pineapple and palm oil. However, peat soil presents problems in terms of engineering as it is not suitable for the foundation due to low strength and high compressibility. This study was conducted to investigate the basic properties of peat and the effect of Portland cement admixture to the geotechnical properties of peat soil. Sampling was performed at Kampung Bagan Lalang, Tanjung Sepat, Sepang, Selangor (2° 36' 14.97" N 101° 41' 53.79" E). The basic characterisation parameters studied were specific gravity (Gs), pH, scanning electron microscope (SEM) and X-ray diffraction (XRD) and unconsolidated undrained tests. As for the geotechnical characterisation for effects of cement admixture covered Atterberg limit, hydraulic conductivity and unconfined compressive strength (UCS). Portland cement was used in this study. Ratio amounts of cement added to peat soil were 0%, 10%, 20% and 40% of the dry weight of peat soil samples used. Based on the analysis showed the specific gravity of peat samples was 2.03, pH value was 3.68, organics content ranged from 50% - 65% and XRD analysis showed the presence of mineral quartz and muscovite. The shear strength of undisturbed samples was 170.33kN/m². The presence of cement has affected the Atterberg limit value of liquid and plastic limits. It was found that the liquid and plastic limit values slightly dropped with the increase in cement content. The hydraulic conductivity also decreased with the increase of cement content. Meanwhile, the unconfined compressive strength (UCS) of peat soil increased with the increase in cement contents. This study showed that cement admixture has influenced the engineering behavior of peat soil in terms of Atterberg limit, hydraulic conductivity and strength.

Keywords: peat soil, Portland cement, unconfined compressive strength

Pengenalan

Malaysia merupakan sebuah negara yang sedang membangun dan bergantung kepada perkembangan ekonomi yang pesat dan kukuh untuk kemajuan negara. Projek pembangunan terutamanya dalam bidang perumahan dan industri yang semakin meningkat seiring dengan kemajuan negara telah menyebabkan keperluan tanah semakin meningkat. Keperluan tanah yang semakin meningkat menyebabkan kawasan-kawasan yang mempunyai tanah yang tidak kukuh untuk pendasaran seperti tanah gambut diperlukan dalam industri pembinaan. Tanah gambut telah dikenalpasti sebagai salah satu kumpulan tanah utama di Malaysia, di mana sebanyak 3.0 milion hektar atau 8% daripada kawasan dilitupi dengan tanah gambut (Huat et al., 2004). Tanah yang mengandungi lebih daripada 70% bahan organik dikelaskan sebagai tanah gambut (Huat et al., 2007). Tanah gambut ini harus dilakukan pembaikan sebelum ia digunakan untuk menjadi teras bangunan. Beberapa kajian terdahulu telah merekodkan bahawa penstabilan menggunakan bahan kimia boleh meningkatkan kekuatan tanah (Bergado, 1996; Hashim & Islam, 2008; Huat et al., 2005). Kaedah penstabilan tanah gambut menggunakan simen Portland telah digunakan dalam kajian ini. Kajian ini bertujuan untuk mengkaji sifat fiziko-kimia tanah gambut dan melihat kesan simen Portland terhadap

sifat kejuruteraan tanah gambut. Parameter geoteknik yang dikaji terdiri had Atterberg, ketelapan dan kekuatan mampatan sepaksi.

Bahan dan kaedah

Persampelan tanah

Sampel tanah gambut telah diambil dari Kampung Bagan Lalang, Sepang, Selangor ($2^{\circ}36' 14.97''\text{U}$ $101^{\circ}41' 53.79''\text{T}$) yang terdiri daripada sampel tidak terganggu dan terganggu. Sebanyak tiga set sampel tanah tidak terganggu dengan setiap set terdiri daripada tiga sampel tanah yang diambil menggunakan tiub logam. Sampel-sampel ini dipateri dengan lilin dan disalut dengan filem plastik bagi mengekalkan kelembapan air lapangan. Sebanyak 40kg sampel pukal tanah gambut terganggu diambil dan disimpan di dalam bekas bertutup makmal untuk tujuan pengeringan dan pencirian di makmal.

Penyediaan sampel

Sampel-sampel tanah tidak terganggu yang diambil digunakan untuk menentukan kekuatan ricih tanah di lapangan. Manakala, sampel tanah gambut terganggu dikeringkan pada suhu bilik selama 24 jam. Sampel tanah terganggu boleh digunakan bagi tujuan pencirian asas tanah gambut. Pencirian asas tanah yang dilakukan terdiri daripada penentuan graviti tentu, pH, pembelauan sinar-X (XRD), kandungan bahan organik, mikroskop imbasan electron (SEM) dan penentuan kekuatan ricih tidak tersalir, C_u .

Penyediaan sampel bagi pencirian geoteknik tanah gambut terawat simen adalah dilakukan dengan mencampurkan sebanyak 0%, 10%, 20% dan 40% simen kepada berat kering tanah bagi setiap ujikaji yang dijalankan. Parameter-parameter yang digunakan dalam penentuan ciri geoteknik tanah gambut terawat simen Portland adalah had-had Atterberg, Ujian kekonduksian hidraulik dan ujian kekuatan mampatan sepaksi (UCS).

Pencirian asas

Penentuan nilai graviti tentu, G_s dilakukan dengan memasukkan sampel tanah dan air suling ke dalam botol piknometer dan dibiarkan selama 24jam. Berat campuran sampel ini direkodkan selepas 24jam. Kemudian, botol piknometer dibersihkan dan air suling dimasukkan sehingga penuh dan bacaan berat air suling dan botol piknometer dicatat.

Analisis pH bertujuan untuk mengetahui keasidan atau kealkalian tanah. Sebanyak 10g sampel tanah digunakan. Sampel tanah ditimbang di dalam bikar 50ml. Kemudian, sebanyak 25ml air suling ditambah ke dalam bikar dan dikacau bersama sampel tanah. Sampel tanah bersama air suling dibiarkan berendam selama 30minit. Kemudian, ampai dikacau dan bacaan diambil serta-merta dengan menggunakan pH meter. Penimbal pH 4.0 dengan pH 7.0 digunakan.

Pembelauan sinar-X (XRD) menggunakan 1g sampel yang diserbukkan. Tujuan analisis ini adalah untuk mengenalpasti kandungan mineral yang terkandung dengan menggunakan kaedah Hukum Bragg.

Sebanyak 5-10g sampel pula digunakan untuk penentuan kandungan bahan organik tanah. Sampel dimasukkan ke dalam mangkuk porselin dan dimasukkan ke dalam oven semalaman. Kemudian sampel ditimbang dan kemudian sampel dimasukkan pula ke dalam relau bersuhu 400°C semalaman untuk pembakaran. Berat sampel direkodkan dan kandungan bahan organik ditentukan.

Mikroskop Imbasan Elektron (SEM) merupakan sebuah mikroskop yang mampu mencerap imej permukaan dan keratan sesuatu sampel pada pembesaran yang sangat tinggi ($100000\times$) dan mempunyai resolusi sehingga 2.5nm pada voltan pecutan 30 kV. Sebanyak 0.5 g sampel tanah gambut yang telah diserbukkan digunakan. Bagi sampel tanah gambut terawat simen, sebanyak 20% berat simen kepada berat kering sampel tanah gambut digunakan. Sampel tanah gambut yang telah dicampurkan simen digaul dengan air untuk kehomogenan. Kemudian sampel tanah dikeringkan dan diserbukkan.

Penentuan kekuatan ricih tanah ditentukan dengan menggunakan kaedah ujian tiga paksi tidak terkukuh tidak tersalir (UU). Tiga set sampel tanah tidak terganggu digunakan dan setiap sampel dalam setiap set akan dikenakan tegasan mengurung, σ_3 140, 280 dan 420kPa sebelum pembebanan dikenakan ke atas sampel tanah. Nilai kekuatan ricih, C_u ditentukan menggunakan kaedah bulatan Mohr.

Pencirian geoteknik

Had-had Atterberg merangkumi had cecair dan had plastik. Sebanyak 100 g sampel terawat simen tanah disediakan bagi setiap jumlah peratusan kandungan simen untuk penentuan had cecair. Sampel tanah yang telah dicampurkan dengan air suling digaulkan di dalam satu gelas. Sebahagian sampel tanah dimasukkan ke dalam cawan logam dan diratakan secara mengufuk serta dibahagikan dengan membuat alur melalui pangsi mangkuk logam. Bilangan ketukan direkodkan. Ujian ini diulang sebanyak 3 kali dengan kandungan air yang semakin bertambah. 10-15g sampel tanah dikeluarkan daripada sampel penentuan had cecair untuk menjalankan penentuan had plastik. Sampel tersebut diuli membentuk rod bebanang. Seterusnya sampel dikering oven dan berat direkodkan.

Penentuan konduktiviti hidraulik pula ditentukan adalah untuk mengetahui kadar penyusupan air dalam tanah. Tiub yang mempunyai panjang satu meter digunakan. Sampel tanah 0%, 10%, 20% dan 40% dimasukkan ke dalam tiub sehingga mencapai ketinggian 10cm. Sampel kemudiannya direndam ke dalam air untuk membolehkan pembasahan berlaku tanpa mengganggu susunan tanah. Setelah pembasahan berlaku, air dimasukkan ke dalam tiub perlahan-lahan daripada bahagian atas sehingga mencapai ketinggian tertentu. Kemudian, kadar penyusupan air dikira.

Ujian kekuatan mampatan sepaksi dilakukan untuk mereka bentuk struktur dan menentukan kekuatan struktur sampel tanah. Ujian ini bertujuan untuk mengukur kekuatan mampatan sepaksi sampel menggunakan spesimen berbentuk sekata. Sebanyak 4 set sampel iaitu 0%, 10%, 20% dan 40% disediakan. Kuantiti sampel yang digunakan di dalam kajian ini adalah 2.5kg sampel tanah gambut. Sampel tanah gambut dipadatkan dengan menggunakan alat pemadatan Proctor. Tiub Proctor ditekan ke dalam sampel tanah yang telah dipadatkan untuk menyediakan sampel berukuran 63.5mm panjang x 38mm garis pusat. Kemudian, sampel dikering udara selama seminggu. Ujian kekuatan mampatan sepaksi dijalankan selepas seminggu sampel dirawat dengan simen Portland. Sampel tanah ini diberi tekanan mampatan sepaksi sehingga sampel menunjukkan kegagalan. Nilai tekanan mampatan sepaksi direkodkan. Ujian dilakukan sebanyak 3 kali bagi setiap nisbah peratusan simen dengan sampel tanah.

Hasil dan perbincangan

Hasil pencirian asas tanah gambut ditunjukkan dalam Jadual 1. Kandungan bahan organik di dalam sampel tanah gambut adalah ber julat antara 65% dan 70%. Ini selaras dengan pengelasan yang dicadangkan oleh *United States Department of Agriculture* (USDA), di mana tanah dengan kandungan organik melebihi 60% boleh dikelaskan sebagai tanah gambut. Purata nilai pH bagi tanah gambut dalam kajian ini adalah 3.68. Kandungan organik yang tinggi di dalam tanah gambut menyebabkan tanah ini berasid. Purata graviti tentu bagi tanah gambut ini adalah 2.03. Kehadiran unsur-unsur seperti quarza dan muskovit yang menambah berat sampel. Unsur-unsur ini dikesan menerusi analisis pembelauan sinar-X (XRD). Jumlah purata bagi kekuatan ricih, C_u bagi sampel tanah gambut di kawasan ini ialah 170.33kN/m².

Pemerhatian SEM menunjukkan tanah gambut menjadi lebih padat setelah penstabilan dilakukan serta struktur ikatan antara simen dan tanah gambut dapat diperhatikan dalam Rajah 1. Struk sampel tanah gambut yang tidak dicampur simen kelihatan kurang padat (Rajah 1 (a)) jika dibandingkan dengan struktur tanah gambut yang telah ditambah simen (Rajah 1 (b)). Struktur penggumpalan hasil tindak balas simen dan tanah gambut dapat diperhatikan pada Rajah 1 (b). Tindak balas tersebut dinamakan tindak balas pozzolanik. Simen bertindak balas mengikat butiran tanah gambut dan mengisi liang-liang di antara butiran tanah gambut supaya struktur tanah gambut akan lebih padat dan kukuh.

Hasil penentuan had-had Atterberg tanah gambut ditunjukkan dalam Rajah 2. Nilai had cecair bagi sampel tanah gambut adalah ber julat di antara 23.7% hingga 25.6%, manakala nilai had cecair pula ialah ber julat di antara 19.3% hingga 23.7%. Didapati had cecair dan had plastik semakin berkurang dengan penambahan simen. Manakala indeks plastik pula semakin meningkat.

Hasil penciriam kekonduksian hidraulik ditunjukkan dalam Rajah 3. Ketelapan air semakin berkurang apabila kandungan simen semakin meningkat.

Ujian kekuatan mampatan sepaksi (UCS) telah dilakukan ke atas sampel tanah gambut terawat simen. Hasil ujian mendapati kekuatan mampatan tanah gambut meningkat dengan peningkatan kandungan simen (Rajah 4). Simen adalah bahan pengikat yang menguatkan lagi struktur tanah gambut. Tindak balas pengikatan yang berlaku di antara simen dan tanah gambut iaitu tindak balas *pozzolanic* telah meningkatkan lagi kekuatan ricih tanah gambut.

Kesimpulan

Kesimpulannya, sifat geoteknik tanah gambut semakin meningkat dengan kehadiran simen. Oleh sebab itu, simen merupakan bahan kimia yang baik untuk penstabilan tanah gambut. Selain itu, penstabilan tanah gambut harus dilakukan terlebih dahulu sebelum sebarang aktiviti pembinaan dijalankan.

Cadangan lanjutan untuk kajian akan datang ialah perlu dilakukan perbezaan tempoh masa penstabilan tanah gambut dengan campuran simen. Selain itu, penggantian simen dengan bahan lain seperti kapur atau debu kaca boleh dijalankan.

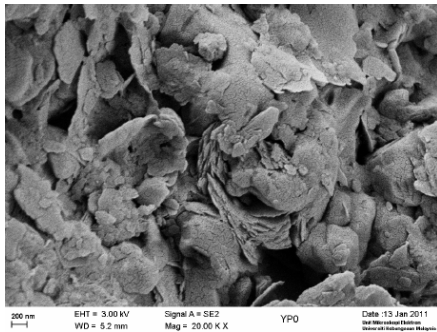
Penghargaan

Penulis ingin memanjatkan setinggi-tinggi kesyukuran dan terima kasih yang tidak terhingga kepada semua pihak yang terlibat dalam menjayakan tesis ini. Selain itu, jutaan terima kasih kepada Universiti Kebangsaan Malaysia yang telah menyediakan segala prasarana dan kemudahan sepanjang menjalankan kajian ini.

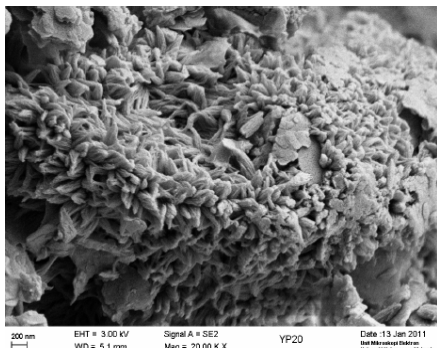
Jadual 1: Hasil analisis pencirian asas tanah gambut.

Parameter pencirian asas	Hasil
Kandungan bahan organik (%)	65-70
pH tanah gambut	3.68
Kandungan mineral	
	Kuarza
	Muskovit
Kekuatan ricih, C_u (kNm ²)	170.33

a

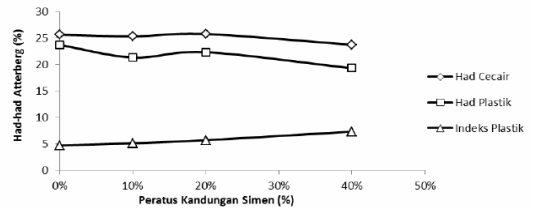
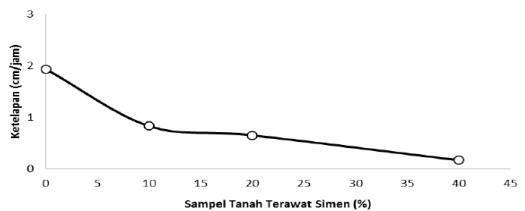
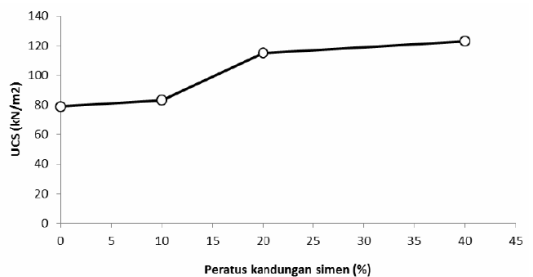


b

**Rajah 1:** Imej SEM sampel tanah gambut (a) sebelum dan (b) selepas penambahan simen.

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**Rajah 2:** Kesan kandungan simen terhadap had cecair dan had plastik bagi tanah gambut.**Rajah 3:** Kesan kandungan simen terhadap ketelapan sampel tanah terawat simen.**Rajah 4:** Perubahan kekuatan mampatan sepaksi (UCS) tanah gambut terhadap kandungan simen.

Application of electrical resistivity and magnetic surveys in archaeology at Sungai Batu, Kedah, Malaysia

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Introduction

The present of this paper is the result of a cooperative work between geophysicists and archaeologists in which was carried out an integrated geophysical prospecting in an archaeological site near Sungai Batu, Kedah. The used of geophysics method that is resistivity method and magnetic method successfully help to indentified the ancient river bed and also width of the ancient river at Sungai Batu archaeology area which play a very significant role in the evolution and development of the settlements in the Sungai Batu area. There are two geophysical methods were used at Sungai Batu archaeology site to determining the ancient river. The two geophysical are resistivity method and magnetic method. The Sungai Batu area can be divided into two difference sites that is Site 1 and Site 2. For Site 1, there are 9 lines of survey. Meanwhile, for Site 2, there are 11 lines of survey.

The purpose of electrical surveys is to determine the subsurface resistivity distribution by making measurements on the ground surface (Loke, 2000). The magnetic survey lines were located on the same line with the resistivity lines survey at Sungai Batu archaeology area. Magnetic survey lines for Site was on the same line with the resistivity survey lines.

Resistivity theory

The fundamental physical law used in resistivity survey is Ohm's Law. That governs the flow of current in the ground. The equation for Ohm's law in vector form for current flow in a continuous medium is given by

$$\vec{J} = \sigma \cdot \vec{E} \quad (1)$$

where σ is the conductivity of the medium, J is the current density and E is the electric field intensity. In practice, what is measure is the electric field potential. We note that in geophysical surveys, the medium resistivity ρ , which is equal to the reciprocal of the conductivity ($\rho = (1/\sigma)$). The relationship between the electrical potential and field intensity is given by

$$\vec{E} = -\nabla \Phi \quad (2)$$

By combining both equations (1) and (2), we will get

$$\vec{J} = -\sigma \nabla \Phi \quad (3)$$

In almost all surveys, the current sources are in the form of point sources. In this case, over an element volume ΔV surrounding the a current source I , located at (X_s, Y_s, Z_s) the relationship between the current density and the current (Dey & Morrison, 1979) is given by

$$\nabla \cdot \vec{J} = \left(\frac{I}{\Delta V} \right) \delta(X - X_s) \delta(Y - Y_s) \delta(Z - Z_s) \quad (4)$$

where is the Dirac delta function. Equation (3) can then be rewritten as

$$-\nabla \cdot [\sigma(X, Y, Z) \nabla \phi(X, Y, Z)] = \left(\frac{I}{\Delta V} \right) \delta(X - X_s) \delta(Y - Y_s) \delta(Z - Z_s) \quad (5)$$

Magnetic potential and field

By anomaly with the gravitational potential, the scalar magnetic potential, W , at a point P , due to a pole of strength, p separated from P by distance r , is given by

$$W = \frac{\mu_0}{4\pi} \left(\frac{p}{r} \right) \quad (6)$$

where μ_0 (regarded as a universal constant) is a permeability of vacuum and has a numerical value of $4\pi \times 10^{-7}$ in SI units. The magnetic field in the direction of r is given by $-\text{grad } W$. In the SI system, the magnetic field is fundamentally expressed as the flux density (B-field). It follows from Equation (6) that the B-field at P is

$$\vec{B} = -\text{grad } (W) = \frac{\mu_0}{4\pi} \left(\frac{p}{r^2} \right) \vec{r}_1 \quad (7)$$

where r_1 is a unit vector directed from the magnetic pole, p towards P.

The sign convention and units for the quantities used in the above equation are as follows: the ‘north-seeking’ pole corresponding to that at the end of a compass needle is the positive pole, pole strength in ampere meter (Am), r in meters (m), μ_0 in Henry per meter (Hm^{-1}) and B in Weber per meter², which in SI units has the name Tesla (T).

The ancient river bed is 4-10m, while the width is 60-100 m. There are anomalies found at both archaeological sites. The anomaly found at Site 1 is at depth 9 m while at site 2 is at depth 6 m. The anomaly is very low resistivity value (less 10 Ωm , sandy clay) overlay high resistivity value (less 50 Ωm , compact alluvium) as shown in Figure 1 below. This potential area could cover huge archaeological aspects such as the religion of the settlers, ancient utensils in their daily life and the development of the settlements at Sungai Batu area. On the contrary, magnetic survey result did show clear magnetic anomalies referable to the buried features. However the anomalies found at these archaeological sites could be artefacts unearthed as shown in Figure 2. Results coming from resistivity showed an unexpected with good overlapping. This prospective was supported by monument found at the Sungai Batu area dated 110 A.D. These results confirmed, once more, that integration between geophysical techniques and archaeology is a really powerful tool.

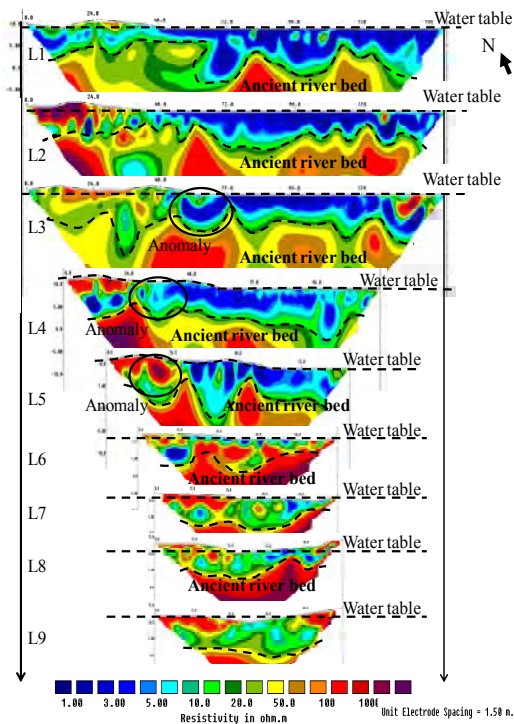


Figure 1: Resistivity survey at archaeological site 1.

These could be the good evident for the people to travel from Sungai Merbok through Sungai Batu Ancient River to reach the Buddhist temples around Gunung Jerai area. In addition to this find, there is a discovery of a votive tablet with a relief of a Buddhist image. This find is now displayed at the Museum of Archaeology at Lembah Bujang in Merbok. Several early settlement sites situated in an area between the south bank of Sungai Merbok and northern bank of the Sungai Muda were found.

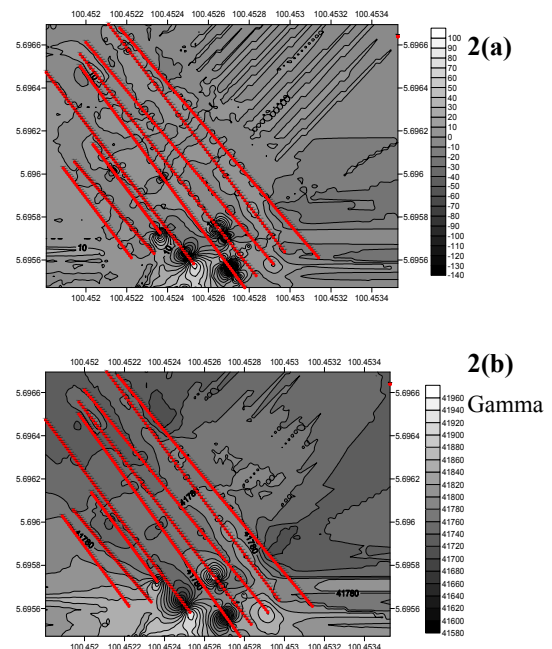


Figure 2: Magnetic residual (a) and anomaly (b) values for archaeological site 1 (Red lines represented by resistivity lines).

The used of geophysics method that is resistivity method and magnetic method successfully help to indentified the ancient river bed and also width of the ancient river at Sungai Batu archaeology area which play a very significant role in the evolution and development of the settlements in the Sungai Batu area. This potential area could cover huge archaeological aspects such as the religion of the settlers, ancient utensils in their daily life and the development of the settlements at Sungai Batu area.

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Kajian survei geofizik dengan menggunakan kaedah graviti di kawasan Bukit Bunuh, Lenggong, Perak (Geophysical survey using gravity method at Bukit Bunuh area, Lenggong, Perak)

DEWANDRA BAGUS EKA PUTRA

Program Geologi, Pusat Pengajian Sains Sekitaran & Sumber Alam,
Fakulti Sains & Teknologi, University Kebangsaan Malaysia.

Pengenalan

Kawasan Bukit Bunuh terletak sekitar 1 kilometer dari Kampung Kota Tampan, Lenggong, Perak. Kajian survei geofizik telah dilakukan di kawasan ini dengan menggunakan kaedah graviti yang bertujuan untuk membuktikan adanya kewujudan kawah akibat hentaman meteorit yang dijangkakan terjadi sekitar 1.83 juta tahun yang lalu. Kewujudan kawah impak meteorit di kawasan ini diketahui setelah ditemukannya beberapa bukti lapangan termasuk salah satunya batuan suevit yang merupakan batuan bekas impak meteorit. Survei graviti dijalankan di kawasan yang memiliki keluasan 25km² yang meliputi area-area sekitar Bukit Bunuh dan secara lebih fokus di bahagian Bukit Bunuh tersebut dengan jumlah stesen pengukuran sebanyak 554 stesen. Purata jarak setiap stesen ialah 500 meter untuk kawasan sekitar Bukit Bunuh dan 50 meter untuk di Bukit Bunuh.

Bahan dan kaedah

Kaedah graviti telah dijalankan di kawasan kajian. Sebanyak 554 stesen telah dibina untuk melakukan pengukuran nilai graviti kawasan kajian dengan stesen induk berada di Pusat Arkeologi Lapangan Universiti Sains Malaysia, Kampung Kota Tampan. Pengukuran nilai graviti dilakukan dengan menggunakan alat *Scintrex CG-5 micro-gravity meter* yang merupakan alat pengukuran graviti jenis semi-automatik. Sepasang *altimeter* jenis Wallace & Tiernan digunakan untuk mengukur ketinggian setiap stesen sementara itu untuk pengukuran suhu disetiap stesen dilakukan dengan menggunakan termometer. Kedudukan setiap stesen ditentukan dengan menggunakan GPS dan data ini nantinya akan digunakan pada pembetulan latitud nilai graviti. Beberapa sampel telah diambil di lapangan untuk mendapatkan nilai ketumpatan batuan kawasan kajian yang digunakan pada pembetulan nilai graviti Bouguer.

Nilai graviti yang telah diukur di setiap stesen akan mengalami beberapa pembetulan (*gravity data reduction*). Beberapa pembetulan yang dilakukan ialah pembetulan rayapan (*drift correction*), pembetulan udara bebas (*free-air correction*), pembetulan Bouguer (*Bouguer correction*) pembetulan latitud (*latitude correction*) dan pembetulan terrain (*terrain correction*). Setelah semua pembetulan dilakukan maka akan didapat nilai graviti anomali Bouguer yang akan digunakan dalam analisis. Analisis data graviti dilakukan dengan menggunakan perisian komputer *Oasis Montaj (Geosoft)* yang akan menghasilkan peta anomali graviti Bouguer (*Bouguer gravity anomaly maps*), peta anomali graviti baki (*Residual gravity anomaly map*), peta *Total Horizontal Derivative (THD)* anomali graviti baki, peta anomali graviti rantau (*Regional gravity anomaly map*) dan peta *Total Horizontal Derivative (THD)* anomali graviti rantau. Peta yang dihasilkan akan digunakan untuk melakukan tafsiran secara kualitatif dan kuantitatif.

Hasil dan perbincangan

Hasil kajian dan tafsiran secara kualitatif dari peta anomali Bouguer mendapati nilai graviti anomali di kawasan Bukit Bunuh ialah bernilai negatif dan bernilai lebih rendah dibandingkan dengan kawasan sekitarnya (Rajah 1). Kawasan yang mempunyai nilai anomali graviti rendah ini berbentuk bulat dengan diameter sekitar 2.5 kilometer (C1). Bentuk anomali ini di tafsirkan dan dipercayai merupakan kawah bekas impak meteorit yang terbentuk di bawah permukaan kawasan Bukit Bunuh.

Selain adanya nilai anomali graviti Bouguer yang menunjukkan kemungkinan kewujudan kawah bekas hentaman meteorit di Bukit Bunuh, dalam peta anomali graviti Bouguer di atas juga dapat ditafsirkan adanya kemungkinan kewujudan kawah lain yang berada tidak jauh dari Bukit Bunuh, pada posisi utara dan selatan (C2 & C3), dan kawah-kawah ini memiliki diameter yang sedikit lebih kecil dibandingkan kawah di Bukit Bunuh iaitu sekitar 2 kilometer. Nilai anomali graviti di kawasan kajian mempunyai korelasi yang baik dengan ketumpatan batuan kawasan, dimana nilai graviti yang bernilai tinggi merupakan kawasan batuan granit yang juga merupakan batuan dasar kawasan kajian dan nilai graviti yang lebih rendah menunjukkan kawasan sedimen.

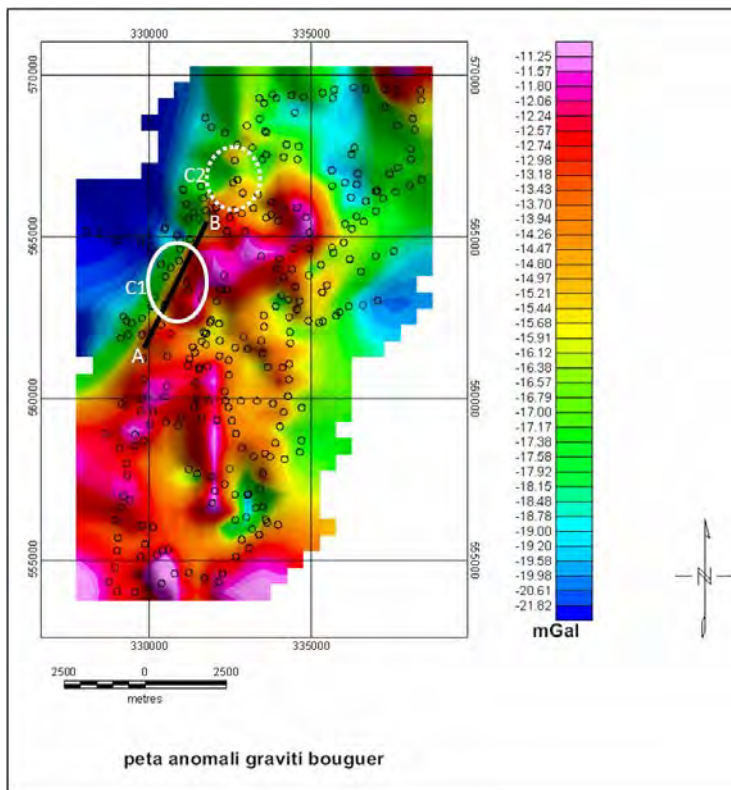
Tafsiran awal secara kuantitatif juga telah dilakukan dan didapati model 2 matra (2-D) dari bentuk kawah impak meteorit di Bukit Bunuh yang dipotong oleh garis A-B (Rajah 2). Model graviti 2-D yang dihasilkan menunjukkan jenis kawah impak meteorit yang terbentuk di kawasan ini ialah jenis kawah kompleks (*complex meteorite crater*) disebabkan oleh adanya kenaikan di bahagian tengah kawah. Titik terdalam kawah diperkirakan 300 m dari permukaan.

Penghargaan

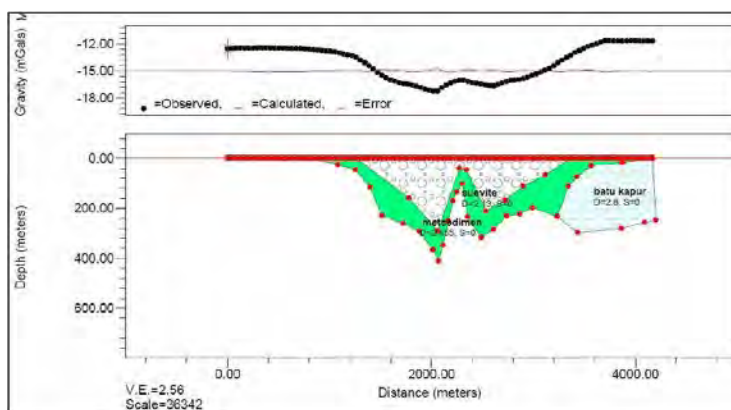
Terima kasih kepada Prof. Dr. Abdul Rahim Samsudin yang telah membanttu dan menyelia kajian ini dan kepada Program Geologi, Pusat Pengajian Sains Sekitaran dan Sumber Alam, Fakulti Sains dan Teknologi yang telah memberikan kemudahan peralatan dan kemudahan makmal.

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Rajah 1: Peta anomali graviti Bouguer, C1 menunjukkan kemungkinan kewujudan kawah bekas hentaman meteorit di Bukit Bunuh.



Rajah 2: Model graviti 2-D garis A-B yang menunjukkan jenis kawah impak meteorit yang kompleks.

Horizontal Resolution of 2D Pole-dipole resistivity imaging as assessed by EHR technique

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Keywords: 2D resistivity imaging, Enhancing Horizontal Resolution (EHR), Pole-dipole, resolution

Inversion model of 2D resistivity imaging was done in order to enhance the horizontal resolution by using Enhancing Horizontal Resolution (EHR) technique. By increasing the electrode spacing, more of the injected current will flow to greater depths, as indicated in Figure 1. If the electrode spacing is much closer, current flows mostly near the earth surface and apparent resistivity will be dominated by resistivity structure of the near surface (Burger, 1992). By using the Enhancing Horizontal Resolution (EHR) technique, the current will flow close to each other at a greater depth (Figure 2). 2D resistivity survey is to determine the subsurface resistivity distribution by taking measurements on the ground surface. The true resistivity of the subsurface can be estimated (Loke, 1994). Figure 3a shows the datum points for common array while Figure 3b represents the datum points for modified array with EHR technique adopted for this study. The Pole-dipole array was used throughout. Two survey lines with 200 m and minimum electrode spacing, 5m were conducted at Tronoh, Perak, Malaysia. Electrode spacing of 5 m was adopted in each of survey line. After the data acquisition on the first survey line was complete, the electrodes were shifted to the right by 1 m on the same line and the process of data acquisition was repeated. The process continued for maximum of fourth shifting on the same line. The set of data obtained for each line was combined during processing using Res2Dinv software. The results of each profile were compared to see the effectiveness of persistent with EHR technique in the survey line regarding the horizontal resolution. The results show that the better horizontal resolution obtained due to the frequent electrode shifting (Figures 4 and 5).

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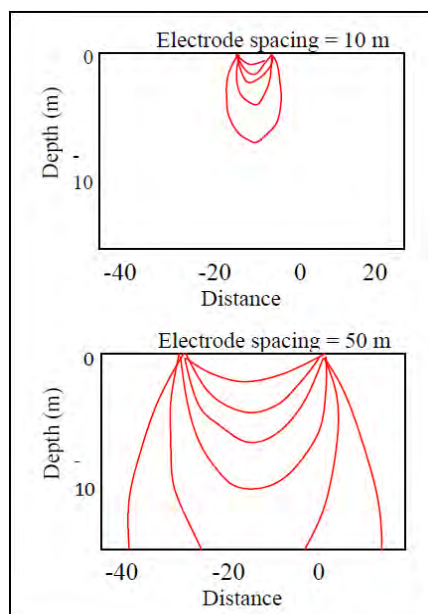


Figure 1: Current flow through the earth with different electrode spacing (after Burger, 1992).

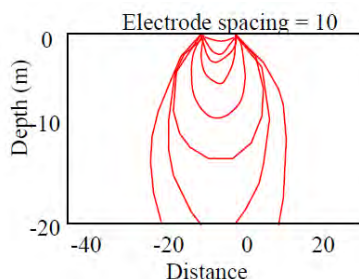


Figure 2: Current flow through the earth after using EHR technique.

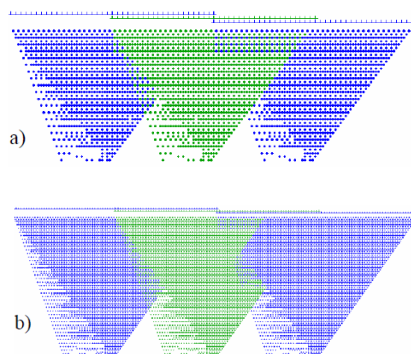


Figure 3: The arrangement of electrodes for a resistivity survey and the sequence of measurements a) datum points for Pole-dipole common array b) datum points after used EHR technique to build up a detail pseudo section.

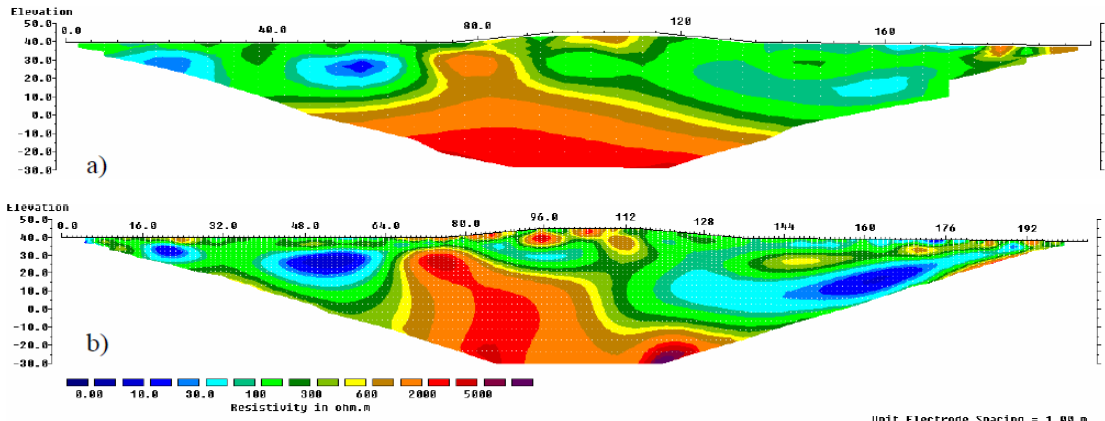


Figure 4: Inversion model resistivity of L1 with Pole-dipole array a) common array without EHR technique b) with EHR technique.

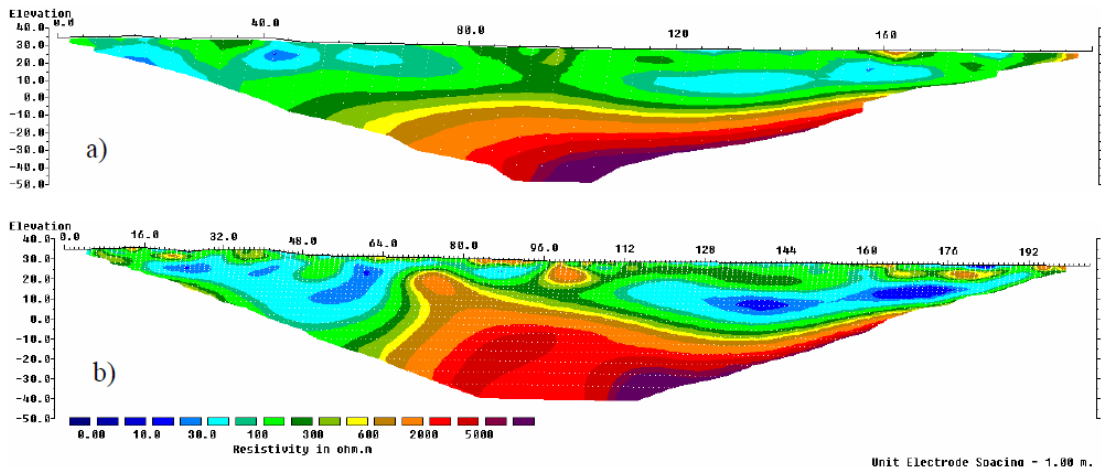


Figure 5: Inversion model resistivity of L2 with Pole-dipole array a) common array without EHR technique b) with EHR technique.

The influence of natural slope geomorphology on active cut slope failures near Gunung Pass, Simpang Pulai-Lojing Highway

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Abstract: Geomorphological and geophysical studies were undertaken on the natural slope overlying the cut slopes near Gunung Pass, Cameron Highlands. The natural slope is littered with relict landslide scars. It is found that there is a close correlation between the presence of relict landslide scars on the natural slope and the presence of cut slope instabilities. The scars are connected at depth with circular slip surfaces inferred from resistivity and seismic refraction studies. It may be inferred from both surface and subsurface observations that the natural slope is creeping. The failure involves sliding at the head and in the upper main body of the landslide on joints roughly orthogonal to the foliation, which dips at a shallow to steep angles into the slope. In the central and toe zone, the landslide is sliding down and out on the foliation. The whole body of natural slope crept downslope. These induce shallow planar and circular failures at the cut slope. It is concluded that inherent natural slope geomorphological features such as the cuesta topography, relict landslide scars and lineaments are some of the most important factors that influence underlying cut slope instabilities.

Keywords: Gunung Pass, natural hill-slope movement, relict landslide scars, geomorphology, resistivity survey

Introduction

The Simpang Pulai-Lojing Highway (Figure 1), the 3rd East-West highway in Malaysia, constructed in 1997 is plagued with cut slope failures. Field investigations confirmed that they are mostly minor landslides except the ones that occurred along km 23 to 26 from 2003 till the present near Gunung Pass. These landslide sites are considered as active landslide sites due to the ongoing failures which affected the natural slope above the cut slope. Many studies (Omar et al., 2004, Tajul A. Jamaluddin, (2003)) and monitoring programmes (Habebah Lateha et al., 2010 & 2011) have been done to understand and mitigate these active landslides. All previous studies focus on the **cut slope** features. This paper describes the result of a geomorphological and geophysical studies of the **natural slope** above the cut slopes along km 23 to 26 section of the highway near Gunung Pass.

Geomorphology

It is noted that the natural slope near Gunung Pass is underlain by schists forming a cuesta which is littered with relict landslide scars (Figure 1) associated with several lineaments. Based on satellite imagery studies, it is found that these relict landslides tend to be distributed above small debris flows on natural slopes and actively failing cut slopes below the relict landslide scars. The relict landslide scars are semi-circular or linear in plan view, characterized by steep scarps with step-like landform filled with colluvial deposits. They tend to coincide with fault traces and major discontinuities. These scars provide the pathways for ephemeral streams leading to intense gulleying along the slope.



Figure 1: Relict landslide scars and lineaments along the natural slope.

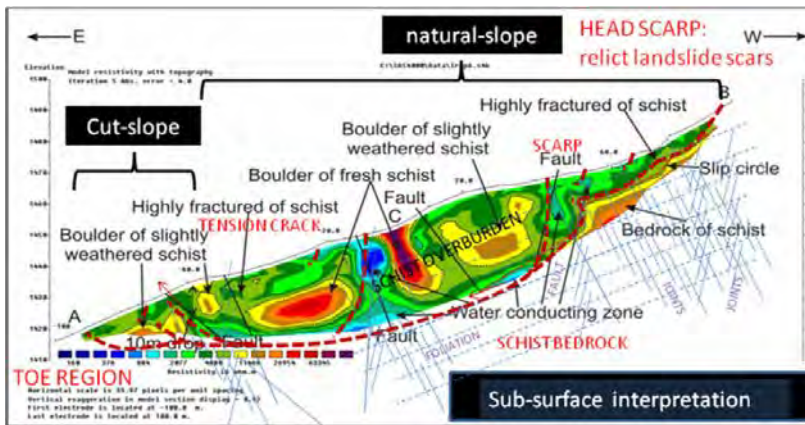


Figure 2: Resistivity subsurface profile across the cut and natural slope.

Fresh tension cracks are also found on the natural slopes suggesting that the cut slope below are actively failing. In most cases, the relict landslide scars are found above cut slopes which show evidences of slope instabilities.

Sub-surface studies

Resistivity and seismic refraction surveys (figure 2) across the relict landslide scars shows that the steep relict scarps are connected at the subsurface by a circular slip surface. The scarps and terraces, at depth are represented by steep weak zones interpreted as slip surfaces. There are several slip surfaces that merged at depth into a single detachment plane interpreted as a basal slip plane or gliding surface. The head scarp region is represented by the topmost slip surfaces (relict landslide scars) with tension cracks suggestive of extensional strains. The main mass of about 30 meter thick is divided by several slip surfaces. The toe region is characterize by reversed slip surfaces suggestive of compressional strain.

It may be inferred from both surface and subsurface observations that the natural slope is creeping. The failure involves sliding at the head and in the upper main body of the landslide on joints roughly orthogonal to the foliation, which dips at a shallow to steep angles into the slope. in the central and toe zone, the landslide is sliding down and out on the foliation. The whole body of natural slope crept downslope, as shown by the reverse cracks at the toe (top of cut slope). These induce shallow planar and circular failures at the cut slope.

Conclusion

It is conclude that inherent natural slope geomorphological features such as the questa topography, relict landslide scars and lineaments are some of the most important factor that influence underlying cut slope instabilities.

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Comparison between Gauss Newton and Quasi Newton methods for an experimental 2D electrical resistivity tomography for dyke model

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Keywords: Quasi-Newton, Gauss–Newton, resistivity, 2D imaging

The inversion of Geoelectrical resistivity data is an important task due to its non linear nature. Several methods have been suggested for the solution of the resistivity inverse problem. A mathematical model for the solution of the inverse problem is made up of set of differential equations affecting electrical current. For the sake of simplicity, some assumptions are made in mathematical modeling of the apparent resistivity. The least squares inversion method can be applied to improve the model. Experimental measurements in the laboratory tank models of resistant with Wenner and Schlumberger arrays are presented. In the comparison of the Gauss Newton and Quasi Newton methods, the results obtained for the Gauss Newton in the interpretation of resistivity data is more accurate than Quasi Newton method.

A 2D Geoelectrical resistivity technique was used. A resistivity measurement was carried out using an ABEM SAS 4000 Terrameter. Wenner and Schlumberger electrode configuration were employed.

The inversion problem is to find the resistivity of the cells that will minimize the difference between the calculated and measured apparent resistivity values. In the smoothness-constrained least-squares method (deGroot-Hedlin & Constable, 1990; Rodi & Mackie, 2001), the following objective function is minimized" (Loke & Dahlin 2002):

$$\Psi(r_i) = g_i^T g_i + \lambda_i r_i^T C^T C r_i \quad (1)$$

where g_i is the iteration number, λ_i is the discrepancy vector which contains the differences between the logarithms of the measured and calculated apparent resistivity values, C is the damping factor, r_i is a roughness filter matrix and is the model parameters (the logarithm of the model resistivity values) vector.

The Gauss Newton method involves the solution of the following system of equations (Sasaki, 1989; Oldenburg and Li, 1994):

$$(J_i^T J_i + \lambda_i C^T C) P_i = J_i^T g_i - \lambda_i C^T C r_{i-1} \quad (2)$$

Where P_i is the perturbation vector to the model parameters. In the inversion algorithm used in this research, the damping factor parameter is initially set at a large value (λ_0), and it is progressively reduced after each iteration until it reaches the minimum limit (λ_m) selected (Loke and Barker, 1996a).

Quasi-Newton methods are probably the most popular general-purpose algorithms for unconstrained optimization. The basic idea behind quasi-Newton methods is quite simple. The quasi-Newton methods that build up an approximation of the inverse Hessian are often regarded as the most sophisticated for solving unconstrained problems. A typical iteration of the method is $x_{i+1} = x_i + \alpha P_i$

The study is concluded that pseudosection drawing is significant tools for estimating of resistivity data quality. Comparison of diagrams has illustrated that resistivity profile is strongly depended on electrode arrangement and materials which have used.

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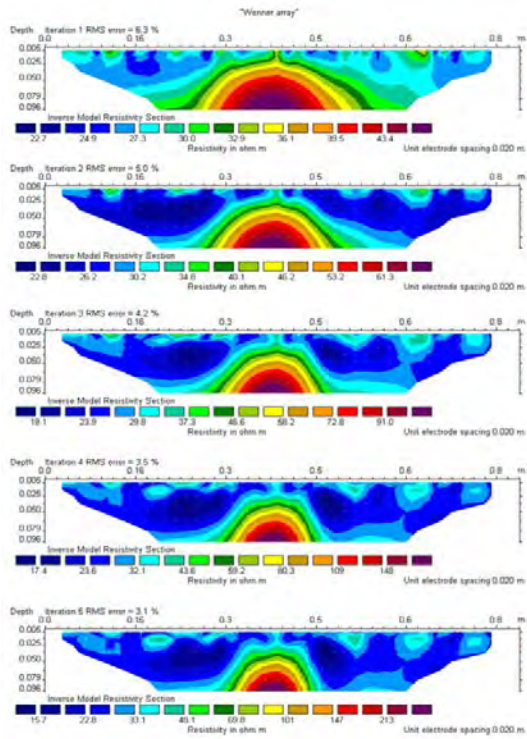


Figure 1: Inversion models obtained by the Gauss Newton method and recalculation of the Jacobian matrix for one, two, three, four and five iteration.

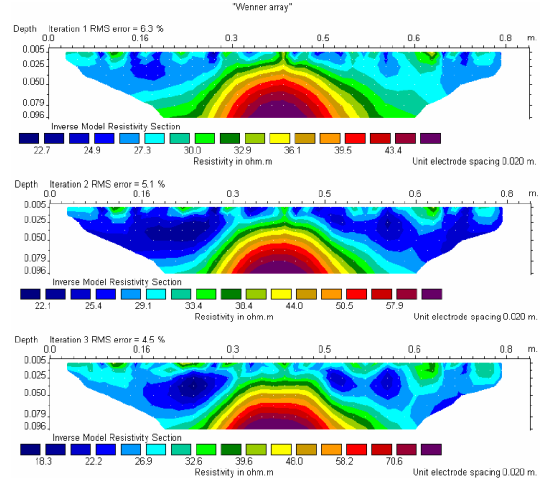
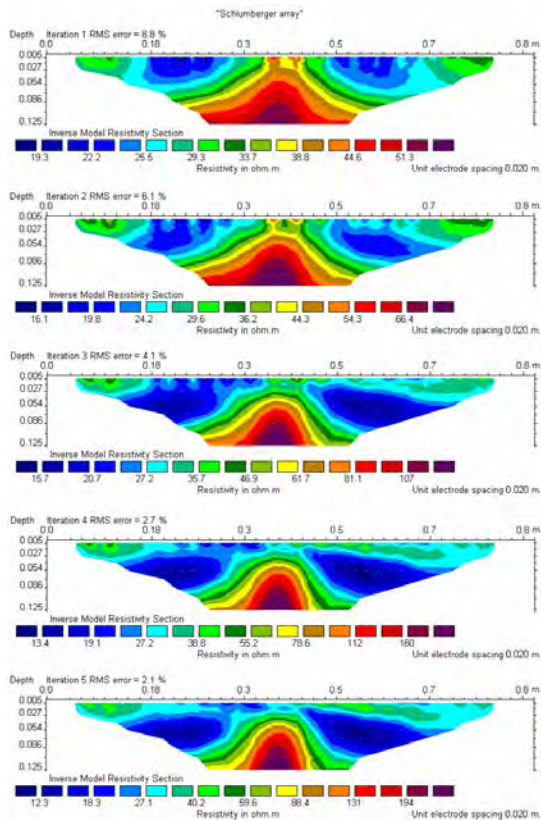


Figure 2: Inversion models obtained by the Quasi Newton method and recalculation of the Jacobian matrix for one, two and three iteration.

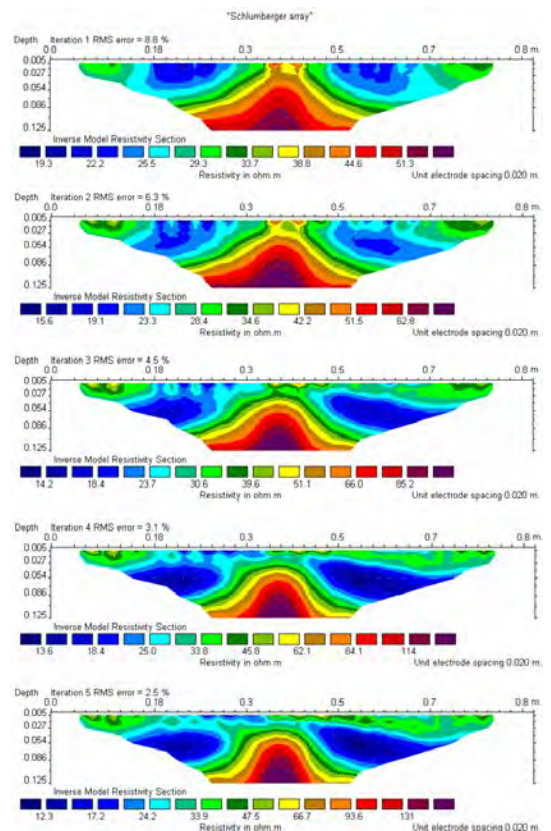


Figure 3: Inversion models obtained by the Quasi Newton method and recalculation of the Jacobian matrix for one, two, three, four and five iteration.

Figure 4: Inversion models obtained by the Gauss Newton method and recalculation of the Jacobian matrix for one, two, three, four and five iteration.

Ultrafelsic granitic rocks from Besar, Tengah and Hujung Islands, Johor: Implication to the high felsic granite from Peninsular Malaysia

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The Besar, Tengah and Hujung islands located at the southeastern of Peninsular Malaysia composed of highly felsic granitic rocks with SiO₂ content ranging from 76.24% to 77.90%. The granitic rock is characterized by high SiO₂ content >76%, homogeneous, medium to coarse grained and mostly equigranular and generally is devoid of xenoliths and other enclaves. The granites occur in a large volume (~ 4 km²) and this by far larger compared to felsic high level granite elsewhere in the Peninsular Malaysia. All granite samples can be classify as syenogranite and consists of K-feldspar, plagioclase, quartz, biotite, apatite, zircon, sericite and chlorite. The granite is weakly peraluminous; with ACNK value ranging from 1 to 1.16 (Average 1.05). Interestingly all samples have normative hypersthene, ranging between 0.09 to 0.44. Differentiation index for all granite samples ranging from 94.2 to 97.84. All granite samples generally have high alkali content (Na₂O + K₂O) ranging between 7.88 to 8.59 wt%. REE profile for granite samples are shown in Figure 6. Majority of the rocks analysed display a striking uniformity in their REE pattern shapes and Eu anomalies. The profile decreases with increasing SiO₂. Interestingly the total REE for the granite samples are quite high, ranging from 268 to 615 ppm and the value decrease with increasing SiO₂. Another interesting feature of the REE profile is that although all the analysed samples constantly have very high SiO₂, the profile do not show a tetrad effect profile as shown by many other high SiO₂ granites elsewhere

Granophyric intergrowths involve quartz and alkali feldspar, intergrown on scales from submicroscopic to 1 or 2 mm. Approximately equal amounts of SiO₂, NaAlSi₃O₈ and KAlSi₃O₈ participate in most of these intergrowths, which have a truly granitic composition. Granophyric intergrowths occur as mesostasis, groundmass, and megacrysts, and result from relatively rapid simultaneous growth of quartz and alkali feldspar from a melt, vapor, or devitrifying glass. The most striking features of the granitic rock from the study area is all the samples analysed are constantly have very high SiO₂ content. The composition of major and most trace elements of the Besar islands granite as well as of its constituting minerals appear to be very constant. This large amount of high SiO₂ granite may imply that the source rock relatively homogeneous and not highly variable composition; otherwise the anatexis would have produced large heterogeneities. Besar granite samples plot in the granitoid triangle as proposed by Tuttle and Bowen (1958) and found that all samples plot in the granitoid composition limit. The granite samples also have minimum pressure of 0.5-1kb, which is an indication of high-level emplacement and plot closer to the 0.5 kb point (average Ab/An=2.33) suggesting a minimum temperature of 695° (Winkler, 1979).

Reference

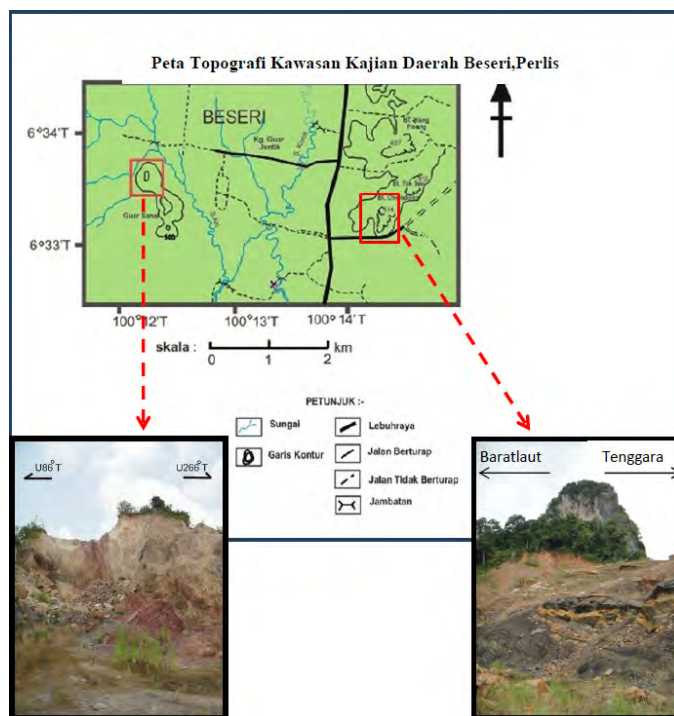
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Struktur Formasi Kubang Pasu di Guar Sanai dan Bukit Chondong, Perlis

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Kawasan kajian terletak di daerah Beseri, Perlis dan merupakan singkapan potongan bukit. Jujukan bawah Formasi Kubang Pasu tersingkap di Bukit C, Guar Sanai, manakala jujukan atas formasi tersebut tersingkap di Bukit Chondong. Formasi Kubang Pasu yang tersingkap di Perlis menindih Formasi Setul dan ditindih oleh Formasi Chuping secara selaras. Usia Formasi Setul ialah Ordovisi sehingga Devon Awal, Formasi Kubang Pasu pula berusia Karbon Awal sehingga Perm Awal manakala Formasi Chuping berusia Perm Awal hingga Trias. Jujukan bawah Formasi Kubang Pasu terdiri daripada selang lapis rijang dan batu lumpur, batu lumpur masif, selang lapis batu lumpur dan batu pasir sama tebal. Jujukan tersebut menunjukkan pengendapan sekitaran laut dalam. Jujukan atas Formasi Kubang Pasu yang tersingkap di Bukit Chondong terdiri daripada batu pasir tebal selang lapis dengan batu lumpur sangat nipis, batu pasir berkapur yang kaya dengan fosil *Monodioxodina* dan lapisan kokuina boleh ditafsirkan sekitaran pengendapannya ialah laut cetek. Batu pasir berkapur ini dipanggil sebagai lapisan perantaraan. Secara keseluruhannya, jujukan Formasi Kubang Pasu ialah mengkasar ke atas. Jurus pelapisan adalah berjulat antara $U350^{\circ}T$ hingga $U20^{\circ}T$, tetapi terdapat juga beberapa lapisan yang berjurus keselatan. Kemiringan lapisan adalah sederhana sehingga curam iaitu sekitar 40° sehingga 80° . Struktur sedimen yang dijumpai dalam formasi ini adalah laminasi selari, laminasi silang, kesan kerukan, kesan beban dan kesan riak. Berdasarkan kepada kedudukan struktur sedimen, keseluruhan jujukan adalah memuda ke arah timur. Sesar ditentukan dengan adanya gores upam, jinjang cabutan, pemineralan, kekar di atas permukaan satah sesar dan juga jalur sesar di isi milonit dan breksia sesar. Sesar utama di kedua-dua kawasan kajian ialah sesar songsang yang berjurus hamper utara dan selatan yang mempunyai kemiringan yang pelbagai dari 40° sehingga 80° sama ada ke timur dan ke barat. Sesar songsang ini telah mengubah arah kemiringan beberapa pelapisan iaitu ke arah barat. Zon milonit di Bukit C mengandungi lapisan rijang yang berselang-lapis dengan batu lumpur. Zon milonit yang dicerap di Bukit Chondong dianggarkan selebar 34 m terdiri daripada selang lapis batu pasir dan batu lumpur. Kedua-dua zon milonit tersebut adalah akibat sesar songsang yang berjurus $U20^{\circ}T$ sehingga $U40^{\circ}T$ dengan kemiringan sekitar 40° manakala di Bukit Chondong



Rajah 1: Singkapan batu lumpur merah yang mempunyai arah miring ketimur (i) dan barat (ii) di Bukit C, Guar Sanai.

Rajah 2: Singkapan Formasi Kubang Pasu di Bukit Chondong.

zon sesar songsang tersebut mempunyai kemiringan 82° ke timur. Terdapat juga sesar sinistral yang berjurus ke arah baratlaut. Sesar dekstral yang dicerap di Bukit C, Guar Sanai mempunyai jurus yang sama dengan sesar dekstral di Bukit Chondong iaitu mengarah ke timur laut. Kebanyakan sesar sinistral dan sesar songsang dipotong oleh sesar dekstral. Sesar normal yang terdapat di kawasan kajian mempunyai pelbagai arah kemiringan. Sesar-sesar ini telah mengubah kedudukan asal per lapisan formasi di kedua-dua kawasan kajian. Antaranya ialah sesar sinistral yang telah menganjakkkan lapisan batu pasir selang lapis batu lumpur di Bukit C sehingga beberapa puluh meter. Sesar songsang pula menyebabkan perulangan Formasi Setul. Perulangan Formasi Setul ini tersingkap di baratlaut dan tenggara Formasi Kubang Pasu di Bukit C, Guar Sanai. Sesar songsang di Bukit C yang mempunyai dua arah kemiringan yang berbeza juga telah mengangkat Formasi Kubang Pasu ke kedudukan yang lebih tinggi daripada Formasi Setul. Arah kemiringan sesar songsang yang berbeza iaitu ke arah timur dan barat menunjukkan kehadiran struktur bunga positif. Sesar songsang di Bukit Chondong pula telah mengangkat Formasi Chuping ke kedudukan yang lebih tinggi.

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Lithostratigraphy of the Belait Formation in Klias Peninsula, Sabah

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Keywords: lithostratigraphy, Belait Formation, Klias Peninsula, shoreface, crossbedded sandstone

Klias Peninsula is located in the southwestern part of Sabah. This area lies between the latitudes of $05^{\circ}17.1'N$ to $05^{\circ}38.6'N$ and longitudes from $115^{\circ}24.6'E$ to $115^{\circ}37.9'E$ with an area about 1332 km². The Temburong Formation, the Setap Shale Formation, the Belait Formation and the Liang Formation are the four rock units in ascending order in age recognised in the study area. The Belait Formation, the second youngest unit, can be found in the western to north-western parts of Klias Peninsula. The age of the Belait Formation is Late Miocene. New roads exposed excellent outcrops in the area. The outcrops were measured and their lithology and sedimentary structures are presented for facies analysis. Seven stations within an area of 6.7 km² were chosen representing the Belait Formation (Figure 1). The data then analysed as lithologs and interpreted to determine their depositional environment.

Several samples of sandstone were taken from the selected sampling stations for petrographic analysis, giving sublitharenite type. There are four rock units belong to the Belait Formation, namely; the conglomerate – hummocky crossbedded sandstone, the swaley – hummocky crossbedded sandstone, the trough crossbedded sandstone interbedded with thick shale and the trough crossbedded sandstone (Figure 2).

The oldest rock unit of the sequence is the conglomerate – hummocky crossbedded sandstone which consists of thick conglomerates, hummocky crossbedded sandstone, swaley crossbedded sandstone and shale. This rock unit is underlain by the late Middle Miocene rock unit, the Setap Shale Formation unconformably. The thick conglomerate can be classified as orthoconglomerate, with no grading structure can be seen. The hummocky crossbedded sandstone and swaley crossbedded sandstone varies from fine to medium grained. There are trace fossils visible in the shale, the *Ophiomorpha* sp. The thick conglomerate and the hummocky crossbedded sandstone suggested that the rock unit was deposited at a lower shoreface with a very strong current, possibly influenced by series of storm events. The second rock unit is the swaley – hummocky crossbedded sandstone which consists of swaley crossbedded sandstone, hummocky crossbedded sandstone and shale. Both the swaley crossbedded sandstone and hummocky crossbedded sandstone vary from fine to medium grained. Some of the hummocky crossbedded sandstone appears as lenses with trough cross-bedded in thick shale. The existence of both swaley and hummocky crossbedded structures suggested that it has been deposited at the middle shoreface (Figure 3). The third rock unit is the trough crossbedded sandstone interbedded with thick shale. It consists of swaley crossbedded sandstone interbedded with thick shale and hummocky crossbedded sandstone. Similar to the older rock unit, some hummocky crossbedded sandstone appears as lenses in shale. The swaley crossbedded sandstones are mostly from medium to coarse grained. It can be suggested that the swaley crossbedded sandstone could be deposited as a sand pit which occurred somewhere in the middle of middle shoreface and upper shoreface. The upper most rock unit of the sequence is the trough crossbedded sandstone which consists mainly of swaley crossbedded sandstone, planar crossbedded sandstone and minor shale. The swaley crossbedded sandstone varies from fine to coarse grained with some of it has lamination while the planar crossbedded sandstone is fine grained, deposited in an upper shoreface environment. Thus, the whole sequence of the Belait Formation in the study area is interpreted as deposited in a shoreface environment.

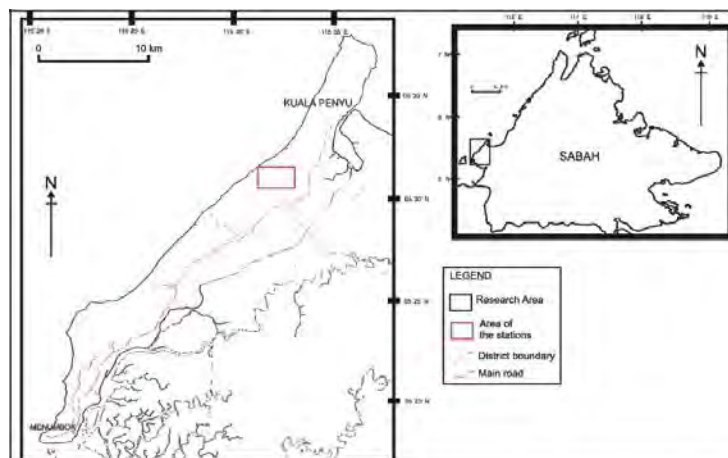


Figure 1: Map of the Klias Peninsula showing the area of the seven stations.

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Figure 2: Lithostratigraphy for Belait Formation (a) conglomerate – hummocky crossbedded sandstone (b) swaley – hummocky crossbedded sandstone (c) trough crossbedded sandstone interbedded with thick shale; and (d) trough crossbedded sandstone.

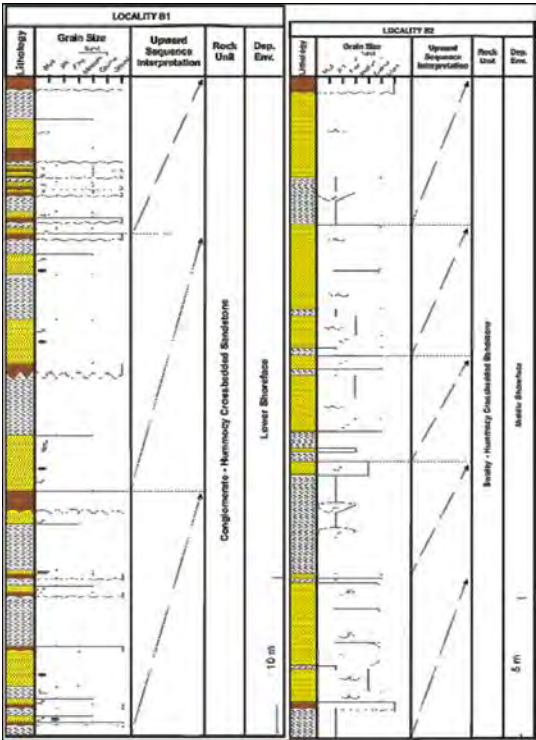


Figure 3: Litholog showing two measured sections of Locality B1 (Pantai Tempurong) and Locality B2 (Kampung Kiambor)

Lower Carboniferous *Liobole* (trilobite) from the Kubang Pasu Formation Northwest Peninsular Malaysia

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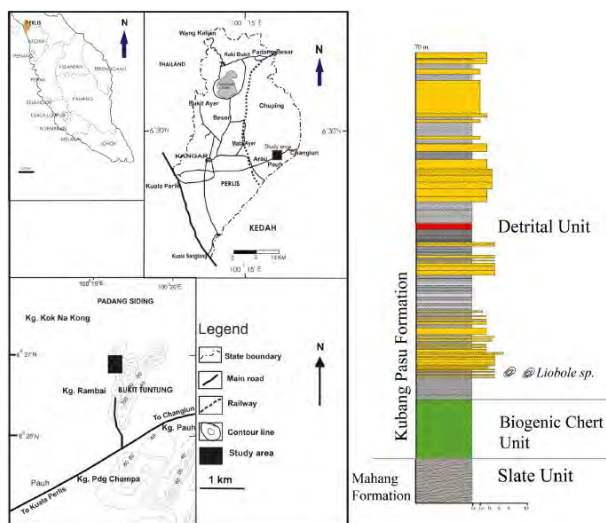
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Trilobites are very important fossils for stratigraphical application of the Paleozoic rocks. They were abundant, rapidly evolved, and have short stratigraphic range. Trilobite in general is mainly characterized by its exoskeleton, which is divisible into three segments, cephalon, thorax and pygidium. Trilobites have been discovered from the Kubang Pasu Formation. These trilobites belong to the order Proetida (Kobayashi & Hamada, 1966). Kobayashi & Hamada (1966) stated that the lower boundary of Kubang Pasu Formation was Late Devonian or Early Carboniferous based on the trilobite fossil, *Cyrtosymbole (Waribole) perlisensis* which was found at an outcrop in Utan Aji, Perlis. Recently a study on the Kubang Pasu Formation was carried at a new exposure of an earth quarry north of Bukit Tuntung, Ulu Pauh Perlis. Bukit Tuntung is a strike ridge with NNE-SSW orientation and the study area is approximately 13,500 square metres which exposed three main rock units namely slate, biogenic chert and clastic rocks. The slate belongs to the upper part of Mahang Formation and it is overlain by biogenic chert which forms the lower part of the Kubang Pasu Formation. The chert contains radiolarians *Stigmospheerostylus variospina* (Won) and *Callela hexactina* Won, indicating Tournaisian age, Early Carboniferous (Basir et al., 2010). The chert is considered as a marker bed to mark the lower boundary of the Kubang Pasu Formation. The clastic rocks are composed of mudstones interbedded with sandstones. The mudstones contain fossils such as bivalves, gastropods, cephalopods, crinoid stems, rugose corals and trilobites. Trilobite found at the study area also belongs to the order Proetida but does not share the same traits as *Cyrtosymbole (Waribole) Perlisensis*. The trilobite belongs to genus *Liobole* and this is the first discovery of the genus in Peninsular Malaysia. The trilobite shares the same traits with those from the Kulm facies of the central Europe and recently reported from South China. Sixteen specimens of trilobites belong to the genus *Liobole* are recovered. The specimens obtained are mostly quite good preservation and some are slightly deformed. All of specimens were retrieved from mudstone bed of few metres thick and stratigraphically younger than the chert. Sixteen cranidia and twelve pygidia were recovered. The size of cranidium ranging from 3mm to 7mm, while pygidium sizes range from 2mm to 8mm. The specimens have no librigenae (free cheeks) only cranidia are preserved. They are apparently devoid of eyes and giving away to the straightening facial sutures. The cranidium contains sub-cylindrical glabella and distinct lateral posterior glabella furrow (S1). Some cranidium have occipital ring preserved where distinct occipital furrow and lobe can be seen. Palpebral lobes are undeveloped or rudimentary and preglabellar region is subdivided into preglabella field of medium width and raised anterior border. Posterior border of fixigena is marked well where the line is projecting laterally and cranidium surface is smooth. Pygidium is broad with semi-circular outline or fan shaped. Axis is long and slender with blunt terminal axial piece and subdivision into rings can be seen in some specimens. These specimens share similar features to *Liobole (sulcubole) xiangzhouensis* Hahn & Hahn (2005) from South China. *Liobole* is a very important trilobite which is used to define the Tournaisian-Visean boundary of Early Carboniferous.

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An evaluation of hydrocarbon source potential of tropical lowland peats and organic soils based on the Source Rock Analyzer (SRA) technique

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Keywords: tropical lowland peat, organic soil, source rock analysis

Augered peat samples from a tropical lowland peat basin and several organic soil and soil samples from the Kota Samarahan-Asajaya area, West Sarawak were tested using the Source Rock Analyzer (SRA) method to determine some of their geochemical characteristics. Their potential as coal-precursors possessing probable hydrocarbon source material was also evaluated. The samples were oven dried at 55°C for three days before they were crushed into fine powder and analyzed using the Source Rock Analyzer (SRA Weatherford) which is equivalent to the conventional TOC/TPC Rock-Eval instrument used for evaluating source rock quality in petroleum exploration. The SRA is a non-isothermal open-system source rock analyzer (compatible with Rock-Eval) used to measure parameters as described by Espitalie et al., (1977) and Peters (1986).

The parameters measured for peat samples by the SRA in TPH/TOC mode are the S1, S2, S3, TOC and Tmax values. The S1 value (measured in mg/g of rock) represents the thermally extractable hydrocarbons or volatiles in the peat samples. These are the free, thermally extractable hydrocarbons present in the whole rock sample which vaporize at approximately 330°C. The S2 value represents the amount of hydrocarbons released from kerogen cracking and high molecular weight-free hydrocarbons (mg HC per gram of rock). These are the hydrocarbons which result from the cracking of kerogen and high molecular weight free hydrocarbons which do not vaporize in the S1 peak. The S3 parameter (mg CO₂ per gram of rock) is the quantity of CO₂ evolved during low temperature (<400°C) pyrolysis (mg CO₂ per gram of rock). The S4 is the residual organic carbon and its value is obtained by: $S4 = 10 * TOC - k * (S1 + S2)$; where $k = 0.83$ (an average carbon content of hydrocarbons by atomic weight). The TOC (Total Organic Carbon) value is measured in weight percentage. The TOC value is composed of two fractions: a convertible fraction which represents the hydrocarbons already generated (S1) and the potential to generate hydrocarbons (S2). $TOC = (S4 + k[S1 + S2]) / 10$. The Tmax parameter (Table 1) represents the temperature (°C) at which the maximum release of hydrocarbons occur from cracking of kerogen during pyrolysis (top of S2 peak). The Hydrogen Index ($HI = S2 * 100 / TOC$; in mg HC per gram TOC) is the normalized hydrogen content of a rock sample. Kerogen typing is derived from this value because Type I kerogens are hydrogen rich, Type III kerogens are hydrogen poor, whereas Type II kerogens are intermediate between Type I and III (Table 2) (Espitalie et al., 1977).

Based on the S2 versus TOC graph (Figure 1), it is observed that the organic matter quality of the peats and organic soils samples analyzed are categorized as Type III to IV gas prone, mixed Type II to III oil-gas prone and Type II oil prone source material. The HI versus OI graph (Figure 2) indicates that the organic matter type of the peat and organic soil samples from the study area are mostly plotted within the Type II region. The HI versus Tmax plot (Figure 3) shows that the peat and organic soils are plotted within the Type II-III oil to gas-prone, Type III gas-prone and Type IV inert source rock/ material area.

From the interpreted SRA data, it is concluded that the peat and organic soils from the Kota Samarahan-Asajaya area in West Sarawak, possess rich organic matter that could contribute to hydrocarbon potential upon reaching sufficient depth of burial and thermal maturity.

Acknowledgement

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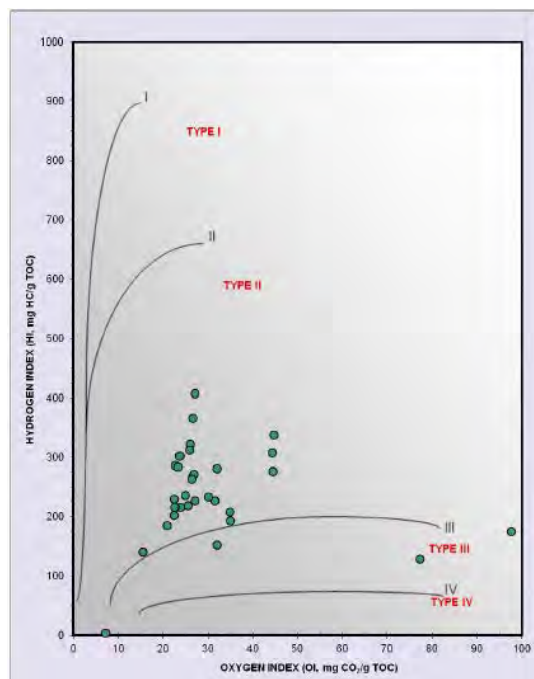
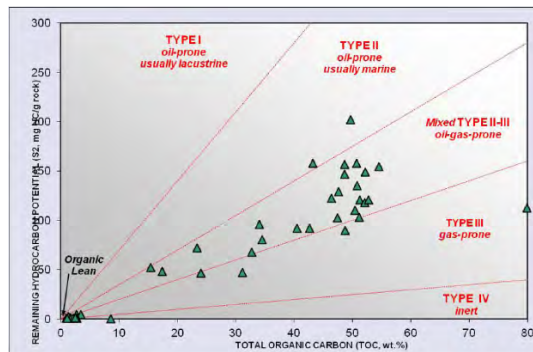
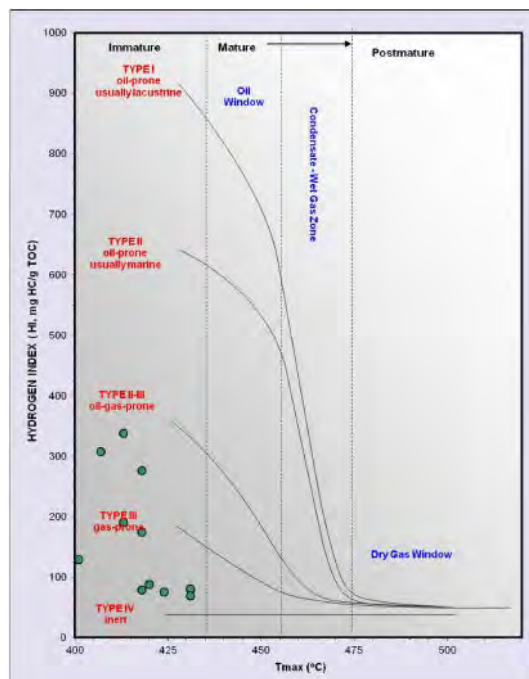
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Table 1: Range of Tmax values and related hydrocarbon type and maturity (from Espitalie et al., 1985)

Type I	Type II	Type III	Maturity
	<430°C	<430°C	Immature
440-445°C	430-450°C	430-465°C	Oil window
	>450°C	>465°C	Gas window

Table 2: Relationship between HI values and kerogen type (Espitalie et al., 1977).

HI	Kerogen Type
<150	Type IV (gas prone)
150-300	Type III (gas/ oil prone)
300-600	Type II (oil prone)
>600	Type I (oil prone)

**Figure 2:** Hydrogen Index versus Oxygen Index plot from SRA data of peat and organic soil samples from the Kota Samarahan-Asajaya area.**Figure 1:** S2 versus Total Organic Carbon plot from SRA data of peat, organic soil and silt/clay soil (less than 4 % TOC) samples from the Kota Samarahan-Asajaya area.**Figure 3:** Hydrogen Index versus Tmax plot from SRA data of peat and organic soil samples from the Kota Samarahan-Asajaya area.

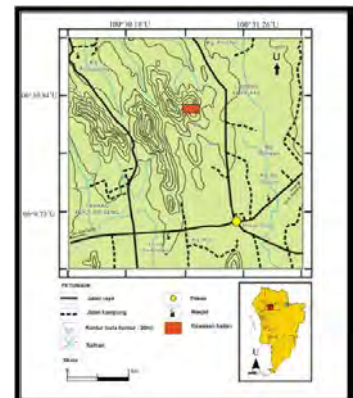
Struktur dalam Formasi Kubang Pasu di Bukit Meng, Pokok Sena Kedah

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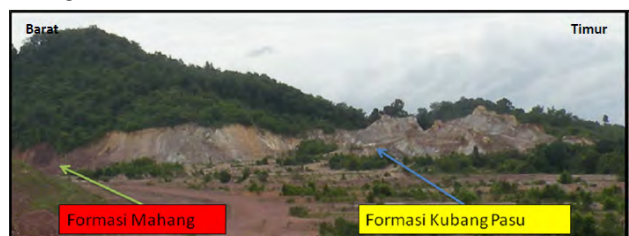
Kawasan kajian terletak dua kilometer ke utara pekan Pokok Sena dan terdiri daripada singkapan potongan bukit untuk pembangunan kawasan perumahan. Batuan di kawasan kajian terdiri daripada jujukan bawah Formasi Kubang Pasu di sebelah timur dan Formasi Mahang di sebelah barat. Batuan Paleozoik Formasi Mahang berusia Ordovisi - Devon Awal manakala batuan Formasi Kubang Pasu yang tersingkap berusia Karbon – Perm Awal. Jujukan Formasi Kubang Pasu yang tersingkap di Bukit Meng terdiri daripada selang lapis rijang dengan batu lumpur, batu lumpur tebal, selang lapis batu lumpur dengan batu pasir dan batu pasir masif. Batuan Formasi Mahang yang tersingkap pula terdiri daripada sabak berwarna merah yang terluluhawa. Secara umumnya, batuan Formasi Kubang Pasu terdiri daripada jujukan yang mengkasar ke atas. Fosil yang boleh dijumpai di kawasan kajian terdiri daripada *Posidonomya sp.*, batang krinoid dan trilobit. Cerapan struktur sedimen yang dijumpai seperti kas beban, kas flut dan laminasi silang mendapati Formasi Kubang Pasu yang tersingkap mempunyai jujukan memuda ke arah timur. Jurus peralapisan batuan Formasi Kubang Pasu di kawasan kajian berjulat antara $U340^{\circ}T$ hingga $U30^{\circ}T$ dengan kemiringan yang sangat curam ke arah timur. Sempadan di antara Formasi Mahang dan Formasi Kubang Pasu merupakan sesar songsang yang berjurus $U200^{\circ}T$ dengan kemiringan 65° ke barat. Sesar songsang tersebut juga membentuk zon milonit selebar 10 meter. Selain itu terdapat juga beberapa sesar songsang lain yang mempunyai arah jurus yang pelbagai iaitu ke arah utara, barat laut dan tenggara dengan kemiringan yang pelbagai. Sebahagian sesar-sesar songsang ini telah mengubah arah jurus peralapisan batuan di kawasan kajian. Jujukan batuan Formasi Kubang Pasu di Bukit Meng dipotong juga oleh sesar mendatar ke kiri atau sesar sinistral yang berjurus barat laut-tenggara. Di lapangan sesar sinistral ini ditunjukkan dengan keadaan batuan yang teranjak selain orientasi jurus peralapisan di kawasan kajian yang menunjukkan ia telah berubah mengikut arah pergerakan sesar tersebut. Sesar sinistral ini juga telah menganjakkan ke kiri sesar songsang yang menjadi sempadan Formasi Kubang Pasu dan Formasi Mahang. Sesar normal juga banyak terdapat di kawasan kajian. Kebanyakan sesar normal ini mempunyai jurus ke arah timur-barat. Perbentukan sesar-sesar normal ini terjadi bagi menstabilkan batuan di kawasan kajian selepas terbentuknya sesar songsang dan sesar mendatar ke kiri. Kira-kira 700 meter di selatan Bukit Meng, terdapat satu singkapan kecil sepanjang 40 meter. Di singkapan tersebut, Formasi Kubang Pasu tersingkap di sebelah barat manakala Formasi Mahang tersingkap di sebelah timur. Formasi Kubang Pasu terdiri daripada lapisan rijang selebar 10 meter. Formasi Mahang pula terdiri daripada sabak berwarna merah yang terluluhawa. Kedua-dua formasi ini disempadani oleh satu sesar songsang berjurus $U14^{\circ}T$ dengan kemiringan 80° ke arah timur. Sesar tersebut juga telah membentuk satu zon milonit selebar kurang daripada satu meter. Secara keseluruhannya sesar songsang menjadi sempadan Formasi Kubang Pasu dan Formasi Mahang menyebabkan Formasi Mahang seolah-olah menindih Formasi Kubang Pasu. Sungkupan Formasi Mahang ke atas Formasi Kubang Pasu pada dua arah yang berbeza di Bukit Meng menyebabkan Formasi Kubang Pasu kelihatan berada di tengah-tengah Formasi Mahang.

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Rajah 1: Peta Lokasi Kawasan Kajian.



Rajah 2: Singkapan potongan bukit di Bukit Meng.

Deformation microstructures of mylonites along the Bukit Tinggi Fault Zone, Peninsular Malaysia

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Keywords : Bukit Tinggi Fault Zone, mylonite, microstructures, brittle-ductile transition

Introduction

Bukit Tinggi Fault Zone (BTFZ) is one of the major fault zones in Peninsular Malaysia. This NW-SE trending fault zone cuts the Main Range granite and strongly expressed by prominent lineaments and a broad zone of mylonite, which can be traced from Kuala Kubu Bharu through Bukit Tinggi and down to north of Bahau (Shu, 1969). Granitic rocks along the BTFZ have undergone several episodes of faulting and as a result, various types of deformed granite were generated. Mylonites were produced by brittle-ductile deformation, which were superimposed by later brittle deformation produced fault breccias and cataclasites (Ng, 1994). Mylonite is a cohesive fault rock occurring in a tabular zone characterised by a well developed foliation resulting from tectonic reduction of grain size, and commonly porphyroclastic (Snook *et al.*, 1996; IUGS, 2007). The objectives of the study are to determine the deformation and recovery microstructures of mylonites and to interpret the deformation condition.

Methodology

Mylonites exposed along the Karak Highway, a waterfall at Sungai Tanglir east of Bukit Tinggi town and road cuts near the Sungai Selangor dam were studied and oriented samples were collected for the preparation of thin sections for microscopic studies.

Microstructures

The protolith in the mylonite is generally a coarse grained megacrystic biotite granite comprises quartz, K-feldspar and plagioclase as major minerals and minor biotite. Deformation microstructures observed in quartz are undulatory extinction, deformation lamellae, ribbon structure, subgrains and neocrysts. With increasing strain, quartz in the mylonites tends to form ribbons enclosed by fine grained matrix. The elongation of the ribbon structure is parallel to the shear direction or C-surface. Recovery process of quartz is indicated by widespread polygonisation and recrystallisation. The polygonal and elongated subgrains show grain shape preferred orientation, usually with long axis parallel to the S-surfaces, forming oblique foliations. Quartz neocrysts are formed by subgrain rotation.

Common microstructures of K-feldspar in the mylonites are microcracks, flame perthite, book-shelf microfracturing, porphyroclasts and minor recrystallisation. Microcracks and microfaults produced angular clasts in K-feldspar, which sometimes display book shelf texture. Flame perthite usually appear at highly stressed areas, such as at the contact where one K-feldspar clasts impinges on another. Neocrysts are uncommon in K-feldspar. They mainly occur at the margin of K-feldspar clasts and as lenticular aggregates in the wings of K-feldspar porphyroclasts.

Plagioclase shows deformation twinning, microcracks and recrystallisation, however, the last two features are less noticeable when compared to K-feldspar. Similar to the flame perthite, mechanical twinning also often occurs near the clasts contacts, where the stress is high. Most biotite has undergone recrystallization to form fine aggregates in discontinuous bands parallel to the foliation. Some biotite also form mica-fish.

Deformation condition

According to Nikishawa and Takeshita (1999), at low grade conditions (below 300°C) undulatory extinction are common in quartz while deformation lamellae are typical at the temperature between 300–400°C (Stipp *et al.*, 2002). Abundant recovery, recrystallization structures and oblique foliation usually occurred within 400–500°C (Passchier *et al.*, 2005).

Feldspar shows numerous features of mineral deformation from low temperature to moderate temperature regimes. Feldspar clasts display brittle behavior indicated by angular grain fragments and microfaults, which are formed at temperatures below 400°C (Tullis *et al.*, 1987; Passchier & Trouw, 2005). According to Passchier (1982), Jensen and Starkey (1985) and Smith and Brown (1988) deformation twinning occurred below 400°C for plagioclase. The flame-shaped albite lamellae in K-Feldspar with flame perthite occur between 400°C and 500°C (Debat *et al.*, 1978; Passchier, 1982a; Pryer, 1993; Pryer & Robin, 1995). Bookshelf microfracturing (Passchier, 1982a; Pryer, 1993) and antithetic fractures (Pryer, 1993) in feldspar are common between 400°C and 500°C. Development of core and mantle feldspar porphyroclast with recrystallized grains occur at higher temperatures of between 450°C and 600°C (Passchier, 1982; Simpson, 1985; Simpson and Wintsch, 1989).

Conclusion

Based on the microstructures, deformation of mylonite of the Bukit Tinggi Fault Zone occurred at temperatures between 250°C and 500°C, which is within the brittle-ductile transition. K-feldspar and plagioclase are mainly deformed in the brittle domain while quartz and biotite are ductile.

Acknowledgement

Financial assistance provided by University of Malaya research grant RG047/09AFR is greatly appreciated.

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Facies study of the Kubang Pasu Formation, Northwest of Peninsular Malaysia

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Keywords: Kubang Pasu Formation, Tournaisian, turbidite, Bouma sequence, deep sea fan

The Kubang Pasu Formation is an Upper Paleozoic rock sequence exposed in Kedah and Perlis. The formation was previously studied by Jones (1981) based on very limited outcrops exposed at Utan Aji, Perlis and Bukit Tunjang Quarry, Kedah. Progressive development in Kedah and Perlis resulted in more earth quarries were excavated. Now more geological information can be obtained. The purpose of the study is to observe the detailed sedimentary features of the Kubang Pasu Formation and to look at the possibilities of the formation can be divided into two different formations. The study focuses on the sedimentary facies of the Kubang Pasu Formation and to solve the stratigraphic problem of the Malaysia-Thailand Border Joint Geological Survey Committee (MT-JGSC) in correlating The Kubang Pasu Formation either with the Khuan Klang Formation or with the Yaha Formation in Thailand. According to previous studies on the Kubang Pasu Formation was deposited in shallow sea area near the continent and deepening towards the east. The collection of the data started from the quarries at Bukit Guar Sanai, Bukit Semadong and Bukit Tuntung in Perlis towards the Bukit Pala, Bukit Inas and Bukit Meng or Bukit Saudagar Din in Kedah. This study involves detailed logging to set-up a lithologic log, rock samplings for thin section, XRD, XRF, SEM and microfossils as well as microfossils study by using HF leaching technique (Pessagno and Newport, 1972). For this preliminary stage, this paper will focus on the evidences found at Bukit Pala, Bukit Inas and Bukit Meng in Kedah which represent the deep-water environment. The Kubang Pasu Formation in the area forms NW-SE strike ridges. The base succession of Kubang Pasu Formation can be identified by ribbon chert which contains Tournaisian radiolarians, Early Carboniferous (Basir Jasin, 2001). The succession of the radiolarian cherts facies mostly black or dark grey and some grey in colour followed by the series of terrigenous turbidites (complete classical bouma sequence) composed of sandstone-shale and rhythmic mudstone-sandstone, large scale of load cast structure. The turbidite facies deposited confirmable above the ribbon chert. Bedding of turbidite consists of T_A , T_B , T_C , T_D & T_E representing classical complete Bouma sequences (Lewis 1983). T_A , consists of coarse sandstone deposited along with pebbles and cobbles showing poor sorting in dark grey colour. There are no clear boundaries between the T_A and T_B . T_B is a sequence of medium-coarse grain sandstone parallel laminated light grey to dark grey in colour. T_C showed a clear cross-lamination consists of medium grained, grey to dark grey and black sandstone. T_D is a sequence of fine laminated sandstone followed by bedded shale /mudstone of T_E . The turbidite can easily be seen at a few walls of the outcrop with large flute casts caused by turbidity currents. The turbidite facies was later change to a sequence of repetition mudstone and sandstone. These evidences indicate that the depositional environment of the Kubang Pasu Formation was in a deep sea fan environment. However, this succession was typically disturbed at some places e.g.: Bukit Inas and Bukit Meng due to intrusion of the pyroclastic rock. Further studies are needed to assign a type section for the deep-water facies of the Kubang Pasu Formation.

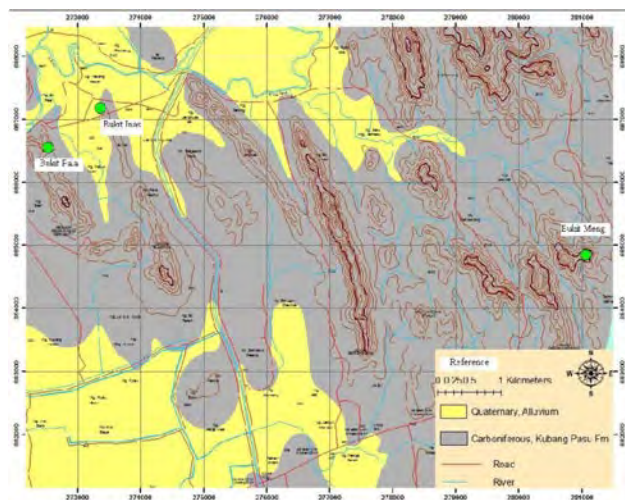


Figure 1: The location of the study area.



Figure 2: The wall outcrop of Bukit Pala (top) and Bukit Meng (bottom) showing mega-scale structures of the loading effects caused by turbidity currents.

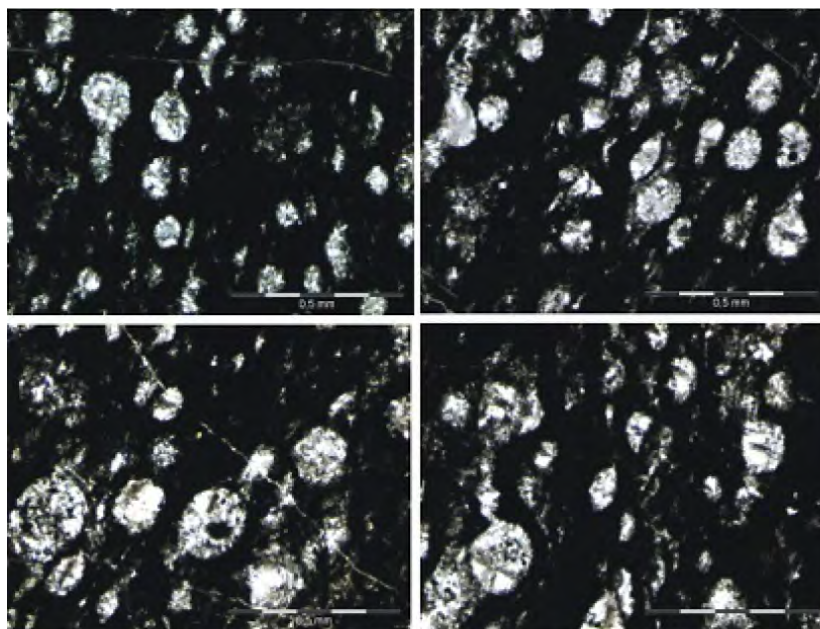


Figure 3: Various species of radiolarians from Bukit Pala, Bukit Pinang, Alor Setar, Kedah.

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Petrologi batuan basalt Sungai Baliojong, Kota Marudu, Sabah

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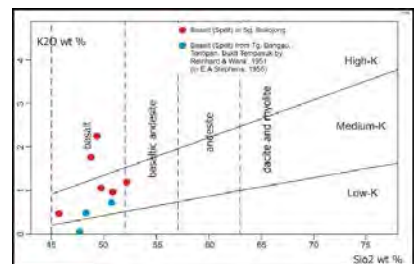
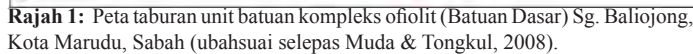
Abstrak: Batuan basalt yang tersingkap di sungai baliojong (Rajah 1) merupakan sebahagian daripada jujukan ofiolit hirisan kerak lautan kuno yang berusia Kapur lewat-Paleosen dan ia merupakan sebahagian daripada kompleks ofiolit (Sanudin & Baba, 2007). Unit batuan di kawasan terdiri daripada batuan Ultrabases (terserpentin) dan basalt (Spilite) yang berasosiasi dengan gabro, dolerit, rijang dan batu lumpur (Stephen, 1956 dan Muda & Tongkul, 2008). Kawasan kajian yang tersingkap akibat daripada episod tektonik yang berkait rapat dengan pembukaan Laut Cina Selatan sejak zaman Kapur, serta zon pelanggaran atau subduksi aktif pada Jurang Palawan – Borneo Utara (Palawan – North Borneo Trench). Ini seterusnya mengakibatkan pemendekan plat aktif semasa Paleogen lewat – Miosen Awal yang diwakili oleh sungkupan dan lipatan di luar persisir Sabah sepanjang zon pelanggaran ini (Rangin *et. al.*, 1990).

Analisis petrografi dilakukan dengan mikroskop pengutuban model Leica DM500 dan analisis geokimia unsur major menggunakan mesin Spektrometri Pendarfluor Sinar-X (XRF) model BRUKER S8 TIGER. Teknik penyediaan sampel bagi analisis telah dibincangkan dalam Anzelmo, 2001 dan Ghani *et. al.*, 2006. Hasil analisis petrografi batuan basalt menunjukkan tekstur afanatik dan mineral yang dapat diperhatikan adalah seperti piroksen, plagioklas dan kaca. Hablur mineral klinopiroksen berbentuk prisma dan plagioklas (andesin–labradorit) berbentuk bilah-bilah yang halus dengan komposisi An_{42-68} . Tekstur Amigdaloidal juga dapat diperhatikan di mana ruang-ruang kosong (*vesicles*) di dalam batuan diisi oleh mineral sekunder seperti kalsit dan klorit (Rajah 2A & B). Ulasan berkaitan petrografi batuan basalt di kawasan kajian juga pernah disebut dalam Stephen E. A., 1956. Hasil analisis geokimia unsur major (oksida major) dan CIPW norm sampel basalt kawasan kajian (Jadual 1) diplotkan pada diagram AFM, K_2O vs SiO_2 dan TAS (Rajah 3A - C) menunjukkan sampel batuan basalt di kawasan kajian berjulat antara basalt-trachy basalt dengan K-sederhana dan berasal daripada magma siri kalk-alkali. Sekitaran pembentukan batuan basalt merujuk Omang, 1993 menggunakan % TiO_2 menunjukkan batuan terbentuk pada sekitaran permatang tengah lautan (*MORB*) dengan kandungan % TiO_2 antara 1-2%.

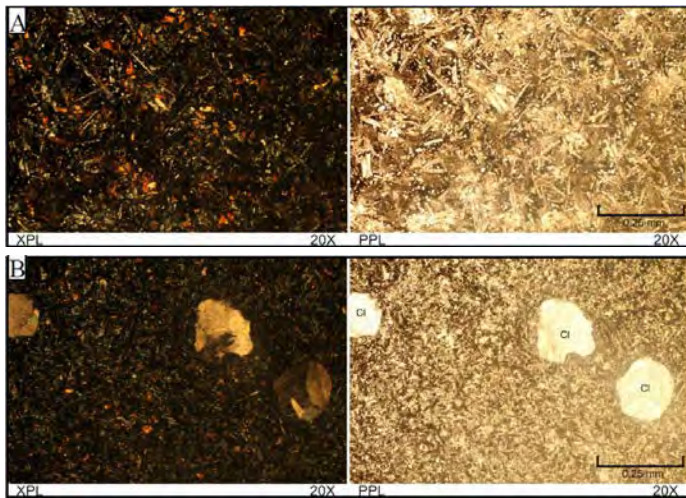
Jadual 1: Data Oksida Major dan CIPW norm bagi beberapa sampel batuan igneus di kawasan kajian.

	Basalt	Basalt	P.basalt	P-Basalt	Basalt	Basalt	Basalt (Spilit)**		
Oksida major	S1	S2	S3	S4	S5	S6	Nh 12	H 78	Nh 199
SiO_2	45.72	49.72	50.81	52.16	48.76	49.30	48.27	47.7	50.72
TiO_2	0.75	1.09	1.55	1.62	1.93	1.84	1.60	1.40	1.29
Al_2O_3	19.05	14.67	16.65	13.68	14.94	15.47	15.73	13.67	15.37
$Fe_2O_3^*$	7.55	9.35	8.70	9.39	9.55	7.76	10.1	11.02	8.3
MnO	0.11	0.14	0.10	0.13	0.14	0.10	0.20	0.18	0.14
MgO	7.36	7.31	7.07	6.62	6.79	7.32	6.93	7.86	7.66
CaO	11.58	10.20	3.93	8.43	6.95	5.61	9.60	10.38	9.04
Na_2O	2.57	3.29	5.40	2.85	3.79	3.55	4.00	3.58	6.04
K_2O	0.46	1.04	0.95	1.19	1.74	2.22	0.47	0.05	0.71
P_2O_5	0.07	0.11	0.23	0.26	0.31	0.24	0.14	0.27	0.08
LOI	4.76	3.06	4.60	3.67	5.10	6.58	3.44	4.17	1.18
SUM	99.99	100.00	99.99	100.00	99.99	100.00	100.48	100.28	100.53
$A=Na_2O+K_2O$	3.04	4.33	6.35	4.04	5.53	5.76	4.47	3.63	6.75
$Fe_2O_3^* = \text{jumlah besi}$									
Q	0.00	0.14	0.00	7.98	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Or	2.74	6.16	5.59	7.04	10.29	13.11	2.78	0.30	4.20
Ab	21.79	27.84	45.71	24.08	32.07	30.00	33.85	30.29	35.19
An	39.06	22.17	18.02	21.04	18.62	19.74	23.58	21.08	12.73
Ne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.63
Di	12.24	19.03	0.00	10.83	6.02	0.38	14.28	19.06	21.52
Hy	3.48	9.39	9.06	11.47	10.40	15.82	2.93	9.65	0.00
Ol	6.44	0.00	5.99	0.00	2.62	1.58	5.40	0.76	6.38
Il	0.24	0.31	0.22	0.27	0.31	0.22	0.43	0.39	0.30
Hm	7.55	9.35	8.70	9.39	9.55	7.76	10.10	11.02	8.30
Tn	1.53	2.29	0.00	3.64	4.33	4.25	3.38	2.94	0.00
Pf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.93
Ru	0.00	0.00	1.44	0.00	0.00	0.00	0.00	0.00	0.00
Ap	0.17	0.27	0.54	0.62	0.73	0.58	0.33	0.64	0.19
Sum	95.24	96.95	95.41	96.35	94.92	93.43	97.05	96.13	99.36

** Reinhard & Wenk, 1951 (dalam E.A Stephens, 1956)



Rajah 3: A). Plot Diagram TAS. B). Plot K₂O vs SiO₂ C). Plot Diagram AFM



Rajah 2: A.) Tekstur batuan basalt afanetik yang terdiri daripada piroksen dengan jisim latar bilah plagioklas+kaca yang bersaiz halus dalam sampel S3. B.) Cl = Kalsit yang menghablur mengisi ruang kosong (*vesicles*) dalam sampel S5; tekstur amigdaloidal.

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Rare earth elements content and weathering style of granite and basalt soils from Kuantan, Peninsular Malaysia

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The Kuantan area located at the central part of the Eastern Belt of Peninsula Malaysia. The area is underlain by two main types of igneous rock that is Permian Kuantan granite and Pleistocene basaltic formations. Contact between these two rocks can be easily traced as the soils of the granite and basalt in this area show a very different colour and physical characteristics. Numerous lateritic weathering profiles have developed over both of the granitic and basaltic rocks in different ways. The weathering process of basaltic rock started with formation of hard rounded spheroidal surrounding the core stone to the rind of softer weathered material whereas the weathering of granitic rock started with discolouration of the granitic main mineral from grey and white to yellowish band.

Three samples each were collected from basalt and granite soil profiles. Total REE for fresh basalt rock sample (79 ppm) is lower than the fresh granite sample (129 ppm). High accessory mineral abundance in granite contributed to the high total REE content. Total REE for granitic soil increase with depth, that is from 40 to 159 to 356 ppm. La, Nd, Sm and Gd show a significant difference between the rock and soil. They decrease by 19%, 13%, 11% and 15% respectively indicates a significant removal of these elements from the fresh granite. All three granitic soil profile (Figure 1) have prominent Ce positive anomaly correspond to the depth of the sample (KPG3>KPG2>KPG1). Compared to the granite REE profile (Figure 1), the basalt profile shows more coherent profile. The total REE for all basaltic soil do not show any trend with increasing depth (231 to 266 ppm). HREE of the basaltic soils is higher and LREE is lower compared to the fresh basalt. In general the basaltic profile suggested that REE content in basaltic soil is less fractionated during the weathering process compared to the granitic soil.

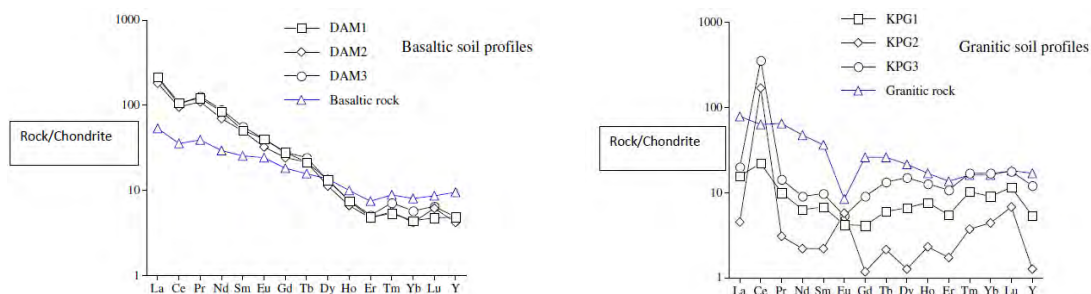


Figure 1: Basalt and granitic rock and soil REE profiles. Granite soil (KPG1 – KPG2 – KPG3) and basaltic soil (DAM1 – DAM2 – DAM3).

Struktur biogeni di dalam batuan Formasi Singa, Pulau Singa Besar dan Pulau Singa Kecil, Langkawi

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Pendahuluan

Struktur biogeni atau fosil surih merupakan struktur sedimen yang terhasil daripada aktiviti organisma hidupan lautan yang terawet di dalam batuan. Ianya terdiri daripada aktiviti rintisan, rayapan, perlubangan, korekan, kesan tapak dan sebagainya. Struktur ini lazimnya berasosiasi dengan fasies sedimen dan keadaan sekitaran sesuatu kawasan. Kajian fosil surih secara teliti sangat sesuai digunakan dalam membantu penafsiran paleosekitaran sesuatu kawasan, berbanding jasad fosil kerana struktur fosil surih terbentuk secara *insitu* di mana ianya jarang sekali dikerjakan semula daripada batuan yang sedia ada (Seilacher, 1964). Kehadiran fosil surih yang berbeza-beza di dalam sesuatu sekitaran adalah bergantung kepada faktor-faktor tertentu seperti jenis butiran strata, kekuatan arus, kadar pengenapan sedimen, tahap oksigen, kemasinan air, kualiti dan kuantiti nutrien di kawasan tersebut (Pemberton et al, 1992). Perbezaan kumpulan iknofasies yang tertentu mempamerkan ciri sekitaran dan batimetri yang tertentu (Seilacher, 1967). Cerapan struktur fosil surih telah dilakukan di dalam perlapisan batuan pada singkapan Formasi Singa di bahagian timurlaut Pulau Singa Besar dan Pulau Singa Kecil, iaitu baratdaya Kepulauan Langkawi.

Hasil dan perbincangan

Beberapa jenis himpunan fosil surih ditemui di dalam batuan klastik di singkapan Pulau Singa Besar dan Pulau Singa Kecil. Struktur fosil surih dicerap kebanyakannya di dalam dan atas lapisan heterolitik berstruktur kekanta dan flaser, selanglapis batu pasir dan batu lumpur, lapisan batu lodak dan batu pasir halus. Struktur ini menunjukkan kelimpahan yang tinggi di dalam lapisan tertentu terutamanya di bahagian bawah jujukan batuan dan berkurang apabila menghampiri bahagian atas jujukan. Kebanyakan surihan ini dibentuk dan diisi oleh batu lodak dan batu pasir halus. Fosil surihan yang dapat dikenalpasti terdiri daripada himpunan *Skolithos*, *Cruziana*, *Zoophycus* dan *Nereites*. Iknofasies *Skolithos* terdiri daripada *Ophiomorpha nadosa*, *Arenicolites* sp., *Skolithos* sp., dan *Rosselia* sp?. Himpunan *Cruziana* terdiri daripada *Planolites* sp., *Chondrites* sp., *Rhizocorallium* sp?., *Teichichnus* sp. *Scolicia* sp. dan *Asteriacites* sp. Himpunan *Zoophycus* pula terdiri daripada *Zoophycus* sp., manakala himpunan *Nereites* terdiri daripada *Dendrotichnium haentzscheli* dan *Helminthopsis* sp.. Sekitaran pengendapan bahagian timurlaut Pulau Singa Besar dan Pulau Singa Kecil ditafsirkan terenalap pada zon pesisir pantai hingga pelantar luar. Tafsiran ini dibuat berdasarkan daripada jenis himpunan fosil surihan di dalam lapisan, di samping jujukan fasies batuan dan struktur sedimen inorganik yang dicerap.

Penghargaan

Kajian ini telah dibiayai daripada peruntukan projek UKM-GUP-PLW-08-11-142 dan UKM-GUP-2011-275. Beberapa pihak turut membantu dalam penyelidikan ini, antaranya ialah pihak LADA yang sudi memberi kebenaran menggunakan bot sepanjang kerjalapangan, penyelia Mohd Shafeea Leman yang banyak membantu, Dr. Tanot Unjah serta pelajar-pelajar geologi Fayyadah, Mosin dan Nur Syafiq. Jutaan terima kasih diucapkan.

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Mathematical analysis of geoelectromagnetic waveguiding system in isotropic and gyrotropic media for environmental subsurface study

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Introduction

Layered guides have been extensively studied in environmental and also science field around the world. They are particularly important for studies of atmospheric wave propagation (Budden, 1961), geophysics (Wait, 1982) and photonic (Synder & Love, 1983). In this study, theorems and techniques were embarking on the analysis of the waves in waveguiding systems filled with inhomogeneous media. The simplest form of inhomogeneously loaded waveguide is a parallel plate guide. This is a planar structure, defined in rectangular coordinates, in which an inhomogeneous medium is placed between two parallel screens. The medium parameters are allowed to vary only in the direction perpendicular to the screens. Under this condition, the analysis of Maxwell's equations is simplified and many useful properties of waves can be derived in an elegant way. A method of analysis is chosen that can develop the isotropic and the gyrotropic media for environmental study.

Isotropic Media

The study begins with the analysis of the structures loaded with an isotropic medium. The most elegant analysis uses scalar potentials. Suppose the guide consists of two perfect electric or magnetic screens situated at $x = x_0$ and $x = x_N$ and the medium is described by the relative permittivity and permeability given by scalar functions $\epsilon(x)$, $\mu(x)$ as shown in Figure 1. Let us assume that $\epsilon(x)$, $\mu(x)$ vary continuously for $x_0 < x < x_N$. An important practical case of a layered structure shown in Figure 1(a) will be treated separately.

Maxwell's equations for such a medium become

$$\nabla \times \vec{E} = -j\omega \mu_0 \mu(x) \vec{H} \quad (1)$$

$$\nabla \times \vec{H} = j\omega \epsilon_0 \epsilon(x) \vec{E} \quad (2)$$

$$\nabla \cdot \epsilon_0 \epsilon(x) \vec{E} = 0 \quad (3)$$

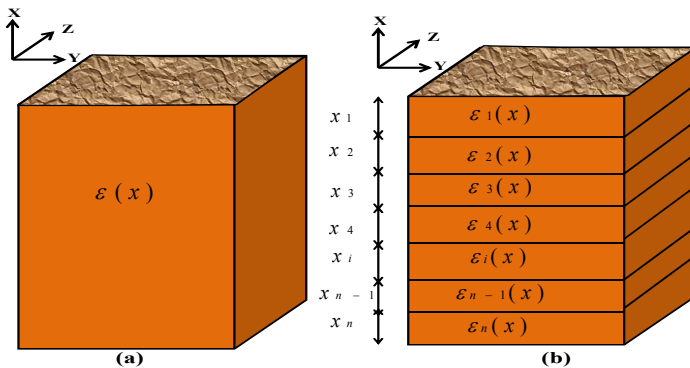


Figure 1: A parallel plate line loaded with an isotropic medium continuously varying medium parameters (a) and layered case (b).

$$\nabla \cdot \mu_0 \mu(x) \vec{H} = 0 \quad (4)$$

Let us denote by the subscript t field vectors with the x component excluded

$$\vec{E}_t = E_y \hat{y} + E_z \hat{z} = \vec{E} - E_x \hat{x} \quad (5)$$

$$\vec{H}_t = H_y \hat{y} + H_z \hat{z} = \vec{H} - H_x \hat{x} \quad (6)$$

Analogously we denote

$$\nabla_{\perp} = \nabla - \hat{x} \frac{\partial}{\partial x} \quad (7)$$

Using vector identities we find that for an arbitrary vector $\vec{A}_{\perp}$

$$\nabla_{\perp} \times \vec{A}_{\perp} = \nabla_{\perp} \times (\hat{x} \times \vec{A}_{\perp} \times \hat{x}) = \hat{x} \nabla_{\perp} \cdot (\vec{A}_{\perp} \times \hat{x}) \quad (8)$$

And consequently Maxwell's equation can be written in the form

$$x \times \frac{\partial}{\partial x} \vec{E}_{\perp} + \nabla_{\perp} E_x \times \hat{x} + \hat{x} \nabla_{\perp} \cdot (\vec{E}_{\perp} \times \hat{x}) = -j\omega \mu_0 \mu(x) \vec{H} \quad (9)$$

$$x \times \frac{\partial}{\partial x} \vec{H}_{\perp} + \nabla_{\perp} H_x \times \hat{x} + \hat{x} \nabla_{\perp} \cdot (\vec{H}_{\perp} \times \hat{x}) = j\omega \epsilon_0 \epsilon(x) \vec{E} \quad (10)$$

Applying $\hat{x} \cdot$ to both sides of Equation 9 and equation 10, we recover the relationship for the x components

$$\nabla_{\perp} \cdot (\vec{E}_{\perp} \times \hat{x}) = -j\omega \mu_0 \mu(x) H_x \quad (11)$$

$$\nabla_{\perp} \cdot (\vec{H}_{\perp} \times \hat{x}) = j\omega \epsilon_0 \epsilon(x) E_x \quad (12)$$

Gyrotropic Media

In order to organize the results obtained in the previous section for the isotropic guides, now let consider a parallel plate waveguide loaded with lossless gyrotropic medium and sandwiched between electric and magnetic screens located at $x = x_0$ and $x = x_n$ as shown in Figure 2 below. The medium is assumed to be homogeneous in the y and z directions and its properties are characterized by the relative permittivity and permeability tensors $\vec{\epsilon}(x)$, $\vec{\mu}(x)$. The x axis is assumed to be the bias axis for the medium, which implies that the constitutive parameters have the following tensor forms:

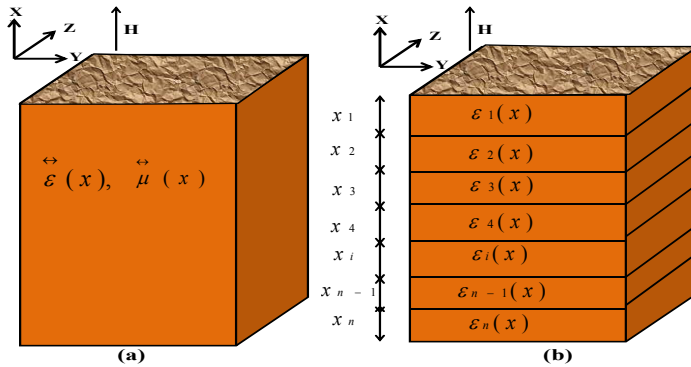


Figure 2: A parallel plate line loaded with a gyrotropic medium for (a) continuously varying medium parameters and (b) a layered case.

$$\vec{\mu}(x) = \begin{bmatrix} \mu_x(x) & 0 & 0 \\ 0 & \mu(x) & -j\mu_a(x) \\ 0 & j\mu_a(x) & \mu_x(x) \end{bmatrix} \quad \vec{\epsilon}(x) = \begin{bmatrix} \epsilon_x(x) & 0 & 0 \\ 0 & \epsilon(x) & -j\epsilon_a(x) \\ 0 & j\epsilon_a(x) & \epsilon(x) \end{bmatrix} \quad (13)$$

Again we start with the case of the continuous variation of the medium parameters as shown in Figure 2(b) above. For this study, let consider Maxwell's equations in an inhomogeneous gyrotropic medium described by tensors in Equation 13.

$$\nabla \times \vec{E} = -j\omega_0 \vec{\mu}(x) \vec{H} \quad (14)$$

$$\nabla \times \vec{H} = j\omega_0 \vec{\epsilon}(x) \vec{E} \quad (15)$$

We shall attempt to eliminate the y and z components of the fields using the technique proposed by Przezdziecki and Hurd (1979). The main steps are identical to those for the isotropic medium. Firstly, split the Maxwell's equations into x and t components

$$\nabla_t \cdot (\vec{E}_t \times \hat{x}) = -j\omega \mu_0 \mu_x(x) H_x \quad (16)$$

$$\nabla_t \cdot (\vec{H}_t \times \hat{x}) = j\omega \epsilon_0 \epsilon_x(x) E_x \quad (17)$$

$$-j\omega \mu_0 \mu_x(x) \frac{\partial}{\partial x} \vec{H}_t = k_0^2 \mu_x(x) \left[\vec{\epsilon}(x) \vec{E}_t \right] \times \hat{x} + \nabla_t \nabla_t \cdot (\vec{E}_t \times \hat{x}) \quad (18)$$

$$j\omega \epsilon_0 \epsilon_x(x) \frac{\partial}{\partial x} \vec{E}_t = k_0^2 \mu_x(x) \left[\vec{\mu}(x) \vec{H}_t \right] \times \hat{x} + \nabla_t \nabla_t \cdot (\vec{H}_t \times \hat{x}) \quad (19)$$

The analysis is simplified if we note that for the assumed form of the constitutive parameters, $\vec{\epsilon}(x) \vec{E}_t$ and $\vec{\mu}(x) \vec{H}_t$ can be decomposed into Equation 20 and Equation 21 below

$$\vec{\epsilon}(x) \vec{E}_t = \epsilon(x) \vec{E}_t + j\epsilon_a(x) (\hat{x} \times \vec{E}_t) \quad (20)$$

$$\vec{\mu}(x) \vec{H}_t = \mu(x) \vec{H}_t + j\mu_a(x) (\hat{x} \times \vec{H}_t) \quad (21)$$

Thus relations in Equation 18 and Equation 19 can be written as follows

$$-j\omega \mu_0 \mu_x(x) \frac{\partial}{\partial x} \vec{H}_t = k_0^2 \mu_x(x) \epsilon(x) \vec{E}_t \times \hat{x} + jk_0^2 \mu_x(x) \epsilon_a(x) \vec{E}_t + \nabla_t \nabla_t \cdot (\vec{E}_t \times \hat{x}) \quad (22)$$

$$j\omega \epsilon_0 \epsilon_x(x) \frac{\partial}{\partial x} \vec{E}_t = k_0^2 \epsilon_x(x) \mu(x) \vec{H}_t \times \hat{x} + jk_0^2 \epsilon_x(x) \mu_a(x) \vec{H}_t + \nabla_t \nabla_t \cdot (\vec{H}_t \times \hat{x}) \quad (23)$$

The decomposition of $\vec{\epsilon}(x) \vec{E}_t$ and $\vec{\mu}(x) \vec{H}_t$ can also be used in the divergence equations, yielding

$$\nabla_t \cdot \vec{\epsilon}(x) \vec{E}_t = \epsilon(x) \nabla_t \cdot \vec{E}_t + j\epsilon_a(x) \nabla_t \cdot (\hat{x} \times \vec{E}_t) \quad (24)$$

$$\nabla_t \cdot \vec{\mu}(x) \vec{H}_t = \mu(x) \nabla_t \cdot \vec{H}_t + j\mu_a(x) \nabla_t \cdot (\hat{x} \times \vec{H}_t) \quad (25)$$

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Pencirian keberintangan geoelektrik batuan sedimen di Semenanjung Dent, Lahad Datu, Sabah

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Pengenalan

Kajian keberintangan geoelektrik (VES) telah dijalankan di Semenanjung Dent, Lahad Datu, Sabah. Kawasan kajian terletak di sebelah pantai timur Sabah yang meliputi keluasan sekitar 104,500 hektar (Abd.Manaf *et al.*, 1990). Secara umumnya, kawasan timur sabah di dominasi oleh morfologi batuan vulkanik neogen yang berasal daripada kompleks terbesar yang membentuk Semenanjung Dent dan Semenanjung Semporna (Sanudin *et al.*, 1995). Secara geologi, Semenanjung Dent (Rajah 1) terbentuk daripada dua kumpulan batuan iaitu Kumpulan Segama (vulkanik) dan Kumpulan Dent (sedimen).

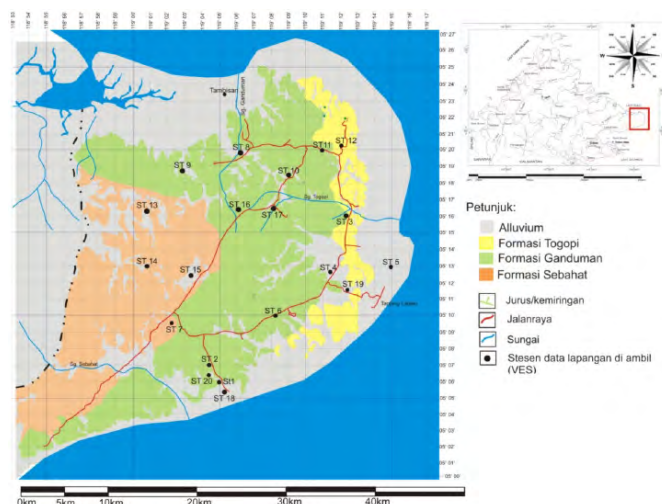
Kajian ini hanya melibatkan kawasan batuan sedimen Kumpulan Dent yang terdiri daripada batuan sedimen iaitu Formasi Sebahat, Ganduman dan Togopi. Formasi Sebahat adalah formasi paling tua dan dicirikan oleh lapisan batu lumpur kelabu yang tebal. Formasi Ganduman pula didefinisikan sebagai selang lapis batu pasir tebal dan lempung nipis yang ditafsirkan terbentuk di kawasan enapan tebing paya. Manakala Formasi Togopi yang paling muda terdiri daripada batu kapur bercampur sedikit batu pasir, lempung dan napal. Batuan sedimen ini menunjukkan lapisan yang hampir mendatar dengan kemiringan sekitar 6°–20° dan ditafsirkan tidak terganggu oleh aktiviti tektonik. Usia batuan ini adalah sekitar Miosen Atas hingga Pliosen.

Metodologi

Kaedah elektrik yang dilakukan adalah teknik duga dalam menegak (VES). Teknik ini dilakukan untuk mengukur perubahan keberintangan dengan kedalaman (Koeffoed, 1979). Empat elektrod di susun secara linear, dua di bahagian luar untuk mengalirkan arus (AB) dan dua lagi di bahagian dalam untuk mengukur keupayaan (MN). Jarak elektrod arus dibesarkan dan jarak elektrod keupayaan dikekalkan pada setiap pembacaan. Jarak maksimum bukaan elektrod arus adalah 500 meter. Ini bermakna kedalaman maklumat kerintangan yang boleh dicapai adalah sekitar 100m (Umar *et al.*, 1993). Data lapangan (VES) diambil dengan menggunakan alat keberintangan ABEM Terrameter SAS 300C di semua 20 stesen kajian (Rajah 1) dan menggunakan susunan elektrod mengikut tatarajah *Schlumberger* yang menggunakan 4 elektrod besi tahan karat. Data keberintangan yang diperolehi diplot dan diproses dengan menggunakan perisian PROGRESS.

Hasil dan perbincangan

Lengkung keberintangan geoelektrik menunjukkan pola yang berbeza mengikut jenis dan keadaan batuan (Jadual 1). Hasil kajian menunjukkan terdapat empat pola lengkung keberintangan tipikal (Rajah 2) yang ditafsirkan berasosiasi dengan jenis formasi batuan di kawasan kajian dan boleh di kelaskan sebagai:



Rajah 1: Peta geologi kawasan kajian dan lokasi stesen keberintangan elektrik (ubahsuai dari Hale & Wong 1965).

Jadual 1: Julat keberintangan bagi pelbagai batuan dan jenis air (Telford *et al.*, 1990).

Jenis bahan	Nilai keberintangan (Ωm)
Batu pasir	1 – 6.4X10 ⁸
Pasir	60 – 1000
Lempung	1 – 100
Pasir aluvium	10 – 800
Air bawah tanah	0.5 – 300
Air bawah tanah (segar)	10 – 100
Air laut	0.2

Lengkung keberintangan Formasi Sebahat

Lengkung keberintangan Formasi Ganduman (Bahagian atas)

Lengkung keberintangan Formasi Ganduman (Bahagian bawah)

Lengkung keberintangan Formasi Togopi

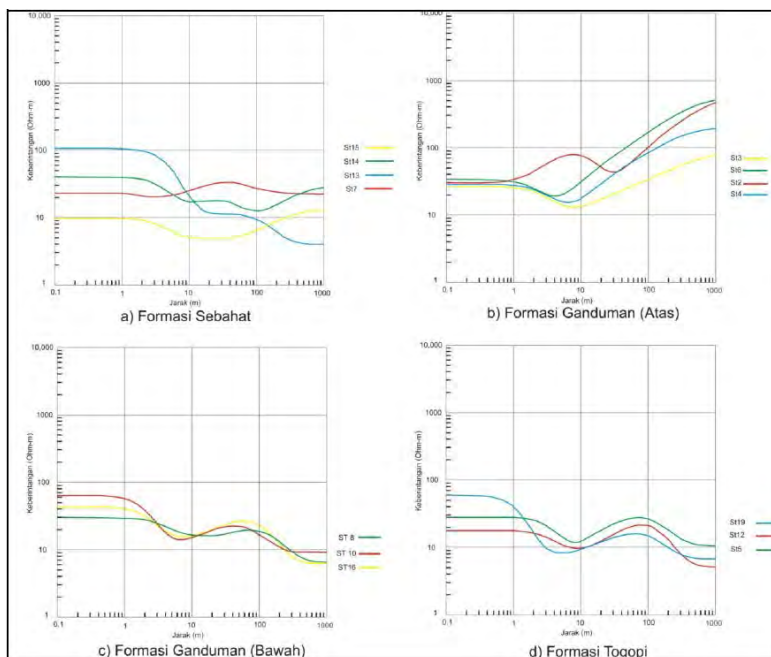
Nilai keberintangan dalam Formasi Sebahat adalah rendah berikutan formasi ini dibentuk oleh batu lumpur yang tebal. Bentuk lengkung graf keberintangan dalam Formasi Sebahat agak berbilang berikutan ketebalan batu lumpur tidak sekata atau masif. Dalam Formasi Ganduman pula, 2 lengkung graf yang tipikal dapat diperolehi. Lengkung keberintangan bahagian atas dan bawah formasi Ganduman agak berbeza. Hal ini kerana bahagian bawah Formasi Ganduman mempunyai kelimpahan rangka foraminifera, koral, algae dan sedikit moluska yang tidak terdapat di bahagian atas Formasi Ganduman (Sanudin & Baba, 2007) dan lengkung keberintangan di tunjukkan dengan jelas oleh 3 stesen VES yang berlainan. Manakala bahagian atas Formasi Ganduman bentuk lengkung yang agak berbeza diperlihatkan oleh 4 stesen VES. Namun bagi pengelasan batuan, Formasi Ganduman atas dan bawah di gabungan sebagai Formasi Ganduman sahaja berikutan usia dan sekitaran pengendapan adalah sama. Lengkung tipikal keberintangan pada Formasi Togopi jelas ditunjukkan oleh 3 stesen VES berbeza. Berdasarkan kajian geologi, formasi ini terbentuk dari batu kapur padat namun berkemungkinan wujud retakan atau kekar terisi air yang menyebabkan nilai keberintangan menjadi rendah.

Penghargaan

Penulis ingin merakamkan jutaan terima kasih kepada Kementerian Pengajian Tinggi dan Universiti Malaysia Sabah dalam menyokong dan memberikan tajaan bagi meneruskan pengajian di peringkat sarjana di Universiti Kebangsaan Malaysia. Tidak lupa juga kepada pensyarah-pensyarah dan pembantu makmal yang memberikan panduan dan sokongan teknikal.

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Rajah 2: Lekur keberintangan tipikal untuk batuan sedimen dalam formasi berbeza a)Formasi sebahat. b)Formasi Ganduman bahagian atas. c)Formasi Ganduman bahagian bawah. d) Formasi Togopi.

Aplikasi teknik geofizik dalam kajian lubang benam kajian kes di Perak (Appliction of geophysical techniques in study of sinkholes at Perak)

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Pengenalan

Kajian lubang benam adalah satu kajian bencana geologi kejuruteraan yang mampu menyeamatkan kehilangan harta benda dan nyawa. Menurut Smith (1999) lubang benam didefinisikan sebagai pembentukan lubang pada saiz tertentu dari atas permukaan tanah sehingga ke dasar dengan bacaan kedalaman dan diameter tertentu. Ianya terbentuk bermula dari pembentukan lohong di bawah tanah di kawasan yang didasari oleh batu kapur. Objektif kajian ini dijalankan ialah untuk mengesan potensi kehadiran lubang benam dengan menggunakan teknik geofizik yang bersesuaian. Tiga kawasan kajian telah dipilih di sekitar negeri Perak. Kajian dilakukan di Kampung Chabang Dua, Kuala Dipang, Lapangan Terbang Sultan Azlan Shah, Ipoh dan Sekolah Menengah Kebangsaan Sultan Idris Shah, Gopeng. Kawasan yang dipilih ini mempunyai rekod kejadian lubang benam yang direkodkan oleh Jabatan Mineralogi dan Geosains Perak.

Bahan dan kaedah

Kajian geofizik umumnya bertujuan untuk mengkaji dan mendapatkan maklumat tentang maklumat bawah bumi melalui pengukuran di bawah bumi. Antara teknik-teknik yang lazim digunakan untuk tujuan eksplorasi ini ialah teknik seismos pantulan dan biasan, teknik keberintangan elektrik, teknik graviti, magnet dan lain-lain. (Abd Rahim, 1990)

Di dalam kajian ini, kaedah pengimejan keberintangan elektrik, kaedah seismos biasan dan kaedah radar penusukan bumi (*Ground Penetrating Radar; GPR*) telah digunakan. Secara umumnya, kaedah keberintangan elektrik digunakan untuk tujuan menentukan keadaan bawah bumi seperti penyiasatan struktur bawah tanah dan akuifer, sempadan air tawar dan air masin, mengesan ruang kosong dalam batu kapur dan sebagainya (Herman, 2001). Kaedah seismos biasan umumnya digunakan untuk kajian menentukan sempadan litologi di bawah permukaan, kajian memetakan luluhawa batuan, menentukan litiologi batuan di bawah permukaan dan lain-lain (Keary et. al., 2002). Manakala kaedah GPR digunakan untuk mengesan kehadiran lohong batu kapur atau lubang benam, struktur-struktur geologi seperti ketakselarasan, mengesan bahan binaan bawah tanah, penjelajahan arkeologi dan lain-lain (Sabbar, 2007). Kaedah keberintangan elektrik menggunakan tatasusunan Wenner 32SX dan sebanyak 41 batang elektrod telah digunakan manakala kaedah georadar menggunakan antena berperisai berfrekuensi 250MHz. Bagi kaedah seismos biasan pula sebanyak 24 geofon digunakan.

Hasil dan perbincangan

Hasil kajian mendapati kesemua garis rentas GPR menunjukkan imej pantulan yang baik terdiri daripada pantulan jenis kacau, beramplitud tinggi dan rendah, pantulan putus-putus dan ada juga zon tiada pantulan. Zon keberintangan tinggi akan menghasilkan pantulan beramplitud tinggi manakala zon keberintangan rendah akan menghasilkan pantulan beramplitud rendah. Zon keberintangan rendah ini menyerap gelombang elektromagnet dan menghasilkan zon pantulan lemah. Ini jelas ditunjukkan di sekitar paras air tanah dimana pada aras ini pantulan sangat lemah berbanding zon di bahagian atas. Zon kacau dan beramplitud tinggi ditafsirkan sebagai zon yang mempunyai potensi kehadiran kaviti berdasarkan perbandingan yang dibuat pada imej keratan rentas 2D profil keberintangan yang sama. Keratan rentas keberintangan geoelektrik pula menunjukkan terdapat banyak zon keberintangan tinggi berdasarkan kepada keratan rentas 2D. Nilai zon keberintangan tinggi ini di sekitar 3000 Ω m-20000 Ω m. Zon ini ditafsirkan sebagai potensi lubang benam. Zon biru yang mempunyai nilai keberintangan rendah ditafsirkan sebagai kaviti yang telah terisi lempung tepu air kerana air telah meresap melalui kapilari ke dalam lapisan pasir. Zon keberintangan rendah ini bernilai sekitar 10 Ω m- 100 Ω m. Garis seismik biasan yang dibuat pada rentasan yang sama juga menunjukkan perubahan halaju dari 150 hingga 3000 m/s mewakili tanah penutup hingga ke batu dasar. Terdapat juga bentuk lapisan berbentuk lembangan (*basin shape*) seolah-olah berlaku depresi atau runtuh tanah yang masuk melalui rekahan dalam batu kapur. Aras air tanah yang ditunjukkan ialah sekitar 4 m kerana halaju air lebih rendah berbanding lapisan batuan. Kesimpulannya, ketiga-tiga kaedah ini berjaya mengesan lubang benam dan anomali rongga, manakala kaedah pengimejan keberintangan geoelektrik dan kaedah seismos biasan berjaya mengesan lapisan yang terdapat di kawasan kajian. berdasarkan imej keratan rentas GPR, kaedah ini berjaya menentukan kedudukan rongga dengan tepat berbanding kaedah yang lain. Kaedah GPR juga berjaya mengesan struktur menegak yang terdapat di kawasan kajian seperti retakan dan sesar. Dengan mengesan kehadiran struktur ini dapat memudahkan lagi kajian dalam mengenalpasti potensi lubang benam.

Penghargaan

Terima kasih kepada Prof. Dr. Umar Hamzah yang telah membantu dalam menyelia kajian ini dan Program Geologi, Pusat Pengajian Sains Sekitaran dan Sumber Alam, Fakulti Sains dan Teknologi yang menyediakan kemudahan peralatan geofizik dan makmal.

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Silica rock resources of Negeri Sembilan

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Introduction

Quartz which is mainly silica or silicon dioxide (SiO_2), is the most common mineral next to feldspar, occurring either as colourless/coloured crystal or in crystalline or cryptocrystalline masses. Silica is usually present in the form of low-quartz, which is stable at atmosphere temperature. Highly pure silica in the form of rock crystal, quartz vein and quartz pegmatite are considered economically important. High purity silica has become one of today's key strategic materials for the high technology industries and it is used in a variety of applications and products. This paper will discuss on the silica rock resources that exist in the state of Negeri Sembilan.

Previous study

Mohd. Ros (1993) found 14 quartz exposures/cliffs throughout the state, namely Bt. Batu Sawah, Kg. Temelang, Bkt. Hammock, Kg. Sendayan, Labu, Seri Menanti, Ladang Chembong, Kg. Padang Biawas, Sikamat, Gaing, Hillside Estate, Bukit Bunga, Kg. Lada and Kg. Batu Putih. Most of the resources were underlain by granitic rock while the others were metamorphic. The results of the chemical analysis showed that certain silica deposits were suitable for industries such as glass flint, glass container and tableware manufacturing, as a source of ferrosilicon and silicon, abrasives and as well as filler in the industry of paint, woods, rubber, stucco plaster and gypsum board. Another investigation on the silica rock in Negeri Sembilan was undertaken by Rosni and Haniza (2010). Four deposits with high silica content namely Bukit Bunga, Bukit Kota, Bukit Sembilan and Sg. Muntoh were recommended for further exploration for its suitability in the polysilicon industry.

Recent study

A few more samples collected recently from various areas in Negeri Sembilan showed quite a promising chemical results and will be discussed in the paper. To-date, there is no activity of silica rock mining in Malaysia. With some information sharing in this paper, hopefully will fruitful some positive perspective on the current scenario of the existing silica rock resources in this country.

Preliminary tests are carried out in order to identify the characteristics of the silica rock deposits in Negeri Sembilan include X-ray Fluorescence (XRF) and X-Ray Diffraction (XRD) analyses. Table 1 shows the XRF result of major elements from samples taken from different localities in Negeri Sembilan.

Results showed that those silica deposits are highly pure silica rock where three of the samples reached 99.0% of SiO_2 content. The value of the other elements which are related to impurities, depends on the standard of the end product requirement. Based on verbal communication with private companies, the minimum level of SiO_2 content that can be accepted for solar application is 97%.

As shown in Figure 2, the XRD analysis of silica rock exhibits a regular pattern which is normal for polymorph. Quartz has the highest peak.

Conclusion

Specifications for numerous applications vary, but generally the three most important factors are chemistry, mineralogy and physical properties. In this paper, the specification demand will be narrowed to the chemical purity of the deposits. Hence, a high content of SiO_2 and minimal amounts of impurities are generally desirable. At this preliminary stage, the result of the XRF analysis is compared with the raw material specifications for silica resources as shown in Tables 2 and 3.

From Table 3, it is clear that generally the specifications of raw silica rock in Negeri Sembilan almost pure and meets to the requirement in ferrosilicon and metallurgy silicon manufacture. However, further physical and chemical beneficiation is needed in the case of Si-metal (chemistry) usage. As a conclusion, these deposits are potentially significant to be exploited in the future as high purity silica resources in this country.

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Table 1: XRF result (major elements) of silica rocks.

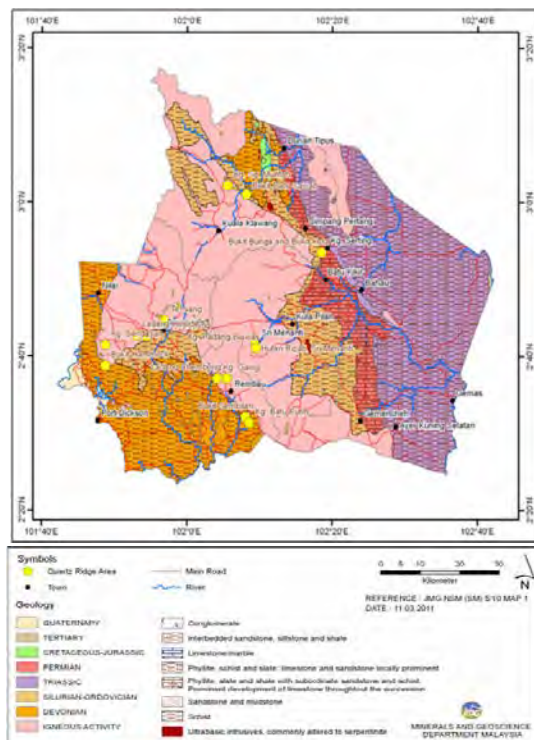
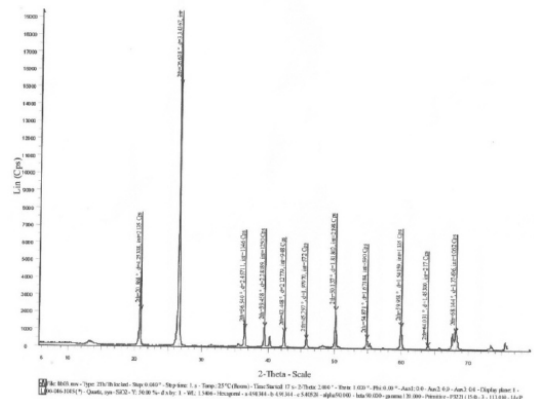
No.	Sample No.	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	Na ₂ O	K ₂ O	CaO	MgO	MnO	P ₂ O ₅	Cr ₂ O ₃	SO ₃	LOI
1	PRN/01	97.5	2.29	0.08	0.02	0.02	0.40	0.04	0.07	0.01	0.03	15.5	<0.01	0.17
2	PRN/02	98.6	0.81	0.05	0.01	0.02	0.13	<0.01	0.05	<0.01	0.01	12.4	<0.01	0.18
3	PRN/03	98.1	0.98	0.07	0.02	0.03	0.13	0.01	0.05	<0.01	0.01	18.2	<0.01	0.14
4	PRN/04	99.0	0.36	0.04	0.01	0.01	0.01	<0.01	0.04	<0.01	0.01	10.5	0.01	0.09
5	PRN/05	97.6	2.03	0.08	0.03	0.03	0.39	0.02	0.08	0.03	0.01	19.1	<0.01	0.18
6	HLD/01	98.7	0.61	0.04	0.01	0.02	0.08	0.01	0.05	<0.01	0.01	10.4	<0.01	0.11
7	HLD/01	98.8	0.66	0.06	<0.01	0.01	0.06	0.01	0.05	<0.01	0.01	14.8	<0.01	0.10
8	HLD/01	98.4	0.59	0.05	<0.01	0.02	0.09	0.03	0.02	<0.01	0.01	14.1	<0.01	0.09
9	BT/01	97.9	0.93	0.14	<0.01	0.01	0.13	0.02	0.01	<0.01	0.01	16.2	<0.01	0.10
10	BT/02	97.2	1.51	0.22	0.03	0.03	0.31	0.14	0.10	<0.01	0.02	15.2	<0.01	0.15
11	BT/03	98.5	0.56	0.11	0.02	0.02	0.04	0.20	0.05	0.01	<0.01	23.1	<0.01	0.13
12	BT/04	98.0	1.38	0.17	0.03	0.04	0.25	0.02	0.08	<0.01	0.01	12.6	<0.01	0.14
13	TMG/01	98.7	0.37	0.04	0.02	0.01	0.11	0.02	0.04	0.01	0.01	15.2	<0.01	0.10
14	TBK/01	98.4	0.60	0.05	0.03	0.02	0.19	0.01	0.05	0.01	0.01	14.5	<0.01	0.10
15	PBS/01	98.6	0.39	0.01	0.01	0.01	0.02	0.04	0.03	<0.01	0.01	13.1	<0.01	0.09
16	PBS/02	98.7	0.24	0.03	0.01	0.01	0.03	0.04	0.03	<0.01	0.01	18.1	<0.01	0.08
17	PBS/03	98.8	0.07	0.02	0.01	0.02	0.02	0.09	0.04	<0.01	0.01	13.2	<0.01	0.08
18	PBS/04	99.0	0.09	0.03	0.02	0.01	0.02	0.04	0.03	<0.01	0.01	16.1	<0.01	0.07
19	PBS/05	99.0	0.08	0.05	0.02	0.01	0.03	0.04	0.03	<0.01	0.01	12.1	<0.01	0.07

Table 2: Specifications for quartz resources (in %) (Lorenz & Gwosdz, 2003).

Application	SiO ₂	Fe ₂ O ₃	Al ₂ O ₃	Na ₂ O+K ₂ O	CaO	MgO	TiO ₂	Impurities
Ferrosilicon	>96	<0.1	<0.4	<0.3	<0.2	<0.2	<0.1	P<0.1
Si-metal (chemistry)	>99.3	<0.05	<0.1		<0.005		<0.002	P, S, As = 0
Si-metal (metallurgy)	>98	<0.1	<0.2		<0.2	<0.1	<0.02	P, As = 0

Table 3: Average value (in %) of silica rock in Negeri Sembilan.

SiO ₂	Fe ₂ O ₃	Al ₂ O ₃	Na ₂ O+K ₂ O	CaO	MgO	TiO ₂	Impurities
98.39	0.07	0.77	0.15	0.04	0.05	0.02	P=0.01, S=0.01

**Figure 1:** Location of silica rock resources in Negeri Sembilan.**Figure 2:** XRD pattern of silica rock.

Delineating geologic contacts using seismic refraction method

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Keywords: contact zone, seismic refraction, faults

The aim of this research is to locate the contact zone for engineering purpose using geophysical method which is seismic refraction survey. A contact is the surface where two different kinds of rocks come together. A unit is a closed volume between two or more contacts (Groshong, 2006). Delineating contact zone in an area of engineering construction will provide essential information as geologic contacts could indicate the presence of fracture or fault nearby. Several geophysical methods have been used in locating contact zone such as gravitational survey (Noh et al., 2008), magnetic survey (Noh et al., 2008; Pilkington, 2007.), and 2D electrical resistivity method (Srinivas, et al., 2008). Seismic refraction surveys are widely used in foundation studies on construction sites to derive estimates of depth to rockhead beneath a cover of superficial material (Kearey and Brooks, 1991). The study area is located at PT 8088, Mukim Batu, Gombak, Selangor, Malaysia with the coordinate of $3^{\circ} 15' 37.2''$ N and $101^{\circ} 38' 48.22''$ E. The area was cut and filled with undulating surface and some bushes (Saad et al., 2011) with fine grained granite comprising granite porphyry and microgranite as the main rock material (Roe, 1953). The seismic refraction method is based on the principle that when a seismic wave impinges upon a boundary across which there is a contrast in velocity, then the direction of travel of that wave changes on entry into the new medium (Reynolds, 1997). Seismic energy is provided by a source located on the surface and radiates out from the shot point, either travelling directly through the upper layer, or travelling to higher velocity layers before returning to the surface and then detected on surface using a linear array of geophones (Catalano, 1999). The travel-times of refracted signal will be derived from the data and are then processed to determine depth profiles of the contact zone. Table 1 provide seismic P-wave velocity in Earth materials (Reynolds, 1997). The method was conducted on four survey lines with 3 lines running from NW to SE which about parallel to each other and 40 m apart while the fourth line was running from SW to NE (Figure 1). The survey used 5m geophone spacing with the length of each spread is 115 m. The offset shot was +30m and -30m. A borehole, BH3 situated 14.5m and 37.5m from SELA2 and SELA4 respectively (Saad et al., 2011). Seismic data obtained by seismograph were transferred to computer using thumb drive for data processing. The software used was FIRSTPIX for picking first arrival time and plotting travel time curve. GREMIX15 software was used for velocity analysis to produce seismic cross section. The seismic results (Figure 2, 3, 4 and 5), shows the area consist of two layers. The first layer (top layer) with velocity of 460 m/s – 900m/s which was alluvium mix with boulders. The second layer with velocity of 2060 m/s – 3140 m/s with depth 71 – 90 MSL. Borehole record, BH3 indicate that the study area is covered by alluvium, mostly sand. Granite in BH3 found as bedrock at depth of 25.5m. This borehole data match with seismic cross sections (SELA2 and SELA4) where the second layer situated nearest to BH3 give the velocity of weathered granite at depth about 25 m from the surface. Figure 6 shows the cross section of the borehole record BH3. The thickness of the overburden is 5 – 15 m. There is a contact zone between granite and alluvium.

Table 1: Seismic P-wave velocities in earth materials.

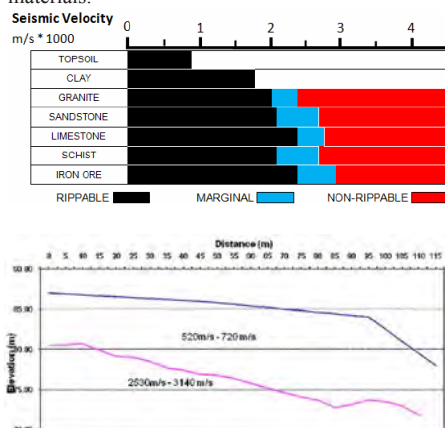


Figure 2: Seismic cross section of SELA1.



Figure 1: Survey lines at survey area.

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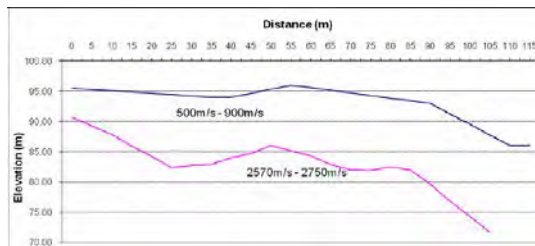


Figure 3: Seismic cross section of SELA2.

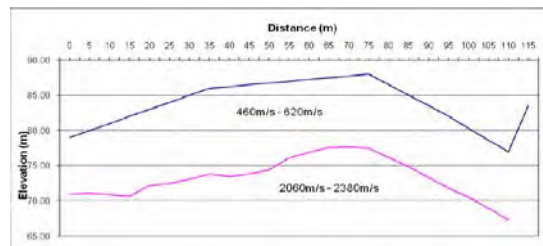


Figure 4: Seismic cross section of SELA3.

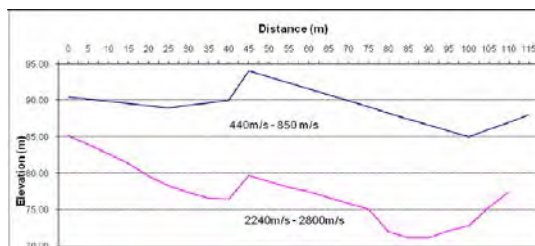


Figure 5: Seismic cross section of SELA4.

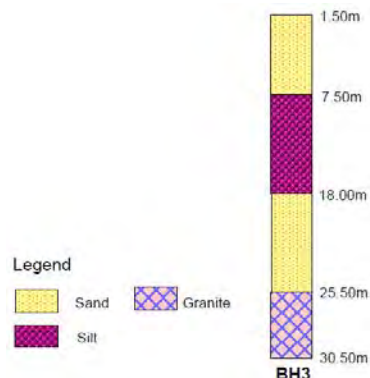


Figure 6: A cross section of borehole record BH3.

Pemetaan geologi kejuteraan dan taburan tanah runtuh di kawasan Hulu Klang/Ampang, Selangor

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Pengenalan

Peta geologi kejuruteraan adalah peta yang menggabungkan input-input geologi kejuteraan dan sekitarannya bagi sesebuah kawasan (Dearman, 1991). Kawasan kajian terletak di dalam Daerah Hulu Klang yang dibatasi oleh grid 354500 U, 417100 T dan 349500 U, 420700 T. Kajian ini meliputi kawasan Ampang, Bukit Antarabangsa, Taman Bukit Mewah, Taman Ukay Perdana, Taman Bukit Mulia, Taman Sering Ukay, Taman Bukit Utama, Taman Hill View, Taman Ukay Heights dan Taman Tun Abdul Razak. Kawasan ini dipilih untuk kajian ini kerana kerap terjadinya bencana tanah runtuh yang membimbangkan penduduk setempat. Objektif kajian ini adalah untuk menghasilkan peta geologi kejuteraan yang terperinci dan boleh dijadikan sebagai bahan rujukan kepada pihak-pihak yang berkepentingan seperti pemaju, penyelidik dan penduduk setempat. Secara umumnya, geologi kawasan terdiri daripada batuan granit dan syis (Gobbett, 1964) daripada batuan syis dikenali sebagai Formasi Syis Hawthornden dan Syis Dinding. Menurut Jabatan Mineral dan Geosains 2009, batuan granit yang terdapat di kawasan kajian adalah Granit Kuala Lumpur yang berusia dari Trias Tengah Akhir-Jura Awal. Granit kawasan ini terdiri daripada biotit-granit berwarna kelabu cerah hingga kelabu gelap dan berbutir sederhana hingga kasar. Manakala, batuan syis kawasan kajian terdiri daripada Formasi Syis Hawthornden dan Formasi Syis Dinding. Syis Hawthornden berusia Silur Awal (Jones, 1973). Secara umumnya Syis Hawthornden ini berwarna hitam dan ia boleh dikelaskan sebagai filit. Mengikut Gobbett (1964), filit hitam ini mempunyai agregat mineral legap seperti pirit dan grafit, dan filit ini telah dikelaskan sebagai filit grafit-kuarza, manakala Syis Dinding pula terdiri daripada batuan syis kuarza-mika dan juga kuarzit. Syis Dinding merupakan batuan tertua yang terdapat di sekitar Kuala Lumpur iaitu lebih tua daripada Formasi Batu Kapur Kuala Lumpur dan Syis Hawthornden. Foo (1983) mencadangkan Syis Dinding dikorelasikan dengan Formasi Machinchang dan usia syis ini dicadangkan Kambrian-Ordovisi.

Kaedah dan bahan

Dalam penghasilan peta geologi kejuteraan di kawasan Hulu Kelang/Ampang, data utama yang diperlukan ialah peta geologi, peta topografi, fotograf udara, data imej satelit dan data cerapan lapangan. Pada peringkat awal, data-data tersebut dikumpulkan iaitu peta geologi didapati daripada Jabatan Mineral dan Geosains (JMG), peta topografi Tahun 2005 daripada Jabatan Ukur dan Pemetaan Malaysia (JUPEM), fotograf udara Tahun 1981, 1989, 1992, 1997, 1999 dan 2003 (JUPEM), data satelit Quickbird 2008, Ikonos 2008 dan Spot5 2007 daripada Pusat Pencerapan Bumi UKM (EOC). Peringkat kedua ialah kerja lapangan. Objektif utama kerja lapangan adalah untuk melihat keadaan sebenar keadaan tanah runtuh lama dan baru di lapangan dengan mengkaji dengan lebih teliti jenis-jenis cerun samaada cerun semulajadi, cerun potongan atau cerun tambahan, geologi kawasan, bahan bumi dan struktur-struktur geologi di kawasan kajian. Peringkat ketiga ialah kerja makmal yang melibatkan analisis data dan penghasilan peta. Tafsiran imej satelit menggunakan kaedah penderiaan jauh untuk melihat struktur lineamen yang terdapat di kawasan tersebut. Sistem saliran dan kontur pula didapati daripada peta topografi. Ujian hidrometer dan had Atterberg dilakukan bagi menentukan saiz butiran dan keplastikan tanah di kawasan kajian, manakala ujian belauan sinar-X (XRD) pula dilakukan untuk penentuan taburan mineral di dalam sampel tanah. Seterusnya, data-data yang telah siap dianalisis akan dikumpulkan dan dimasukkan di dalam perisian ArcGIS 9.3 dan akhirnya sebuah peta geologi kejuruteraan yang lengkap akan dihasilkan.

Hasil dan perbincangan

Daripada hasil analisis tafsiran imej Quickbird 2008, sesar dan lineamen di kawasan Hulu Kelang/Ampang dapat diketahui. Arah sesar utama di kawasan kajian hampir kesemuanya menunjukkan ke arah Timur Laut, manakala lineamen pula kebanyakan berserenjang dengan arah sesar utama iaitu Tenggara. Survei ketakselajaran pula telah dilakukan pada dua singkapan muka cerun iaitu singkapan A (titik grid 352604 U, 419338 T) dan singkapan B (titik grid 352473 U, 419202 T) di cerun potongan Jalan Wangsa 7 menunjukkan ke dua-dua cerun batuan tersebut berpotensi mengalami kegagalan bentuk baji kerana adanya persilangan antara dua set kekar yang berlainan memotong pada muka cerun. Hasil cerapan lapangan pula, mendapati sebanyak 28 parut runtuhan lama dan baru seperti yang ditandakan dalam Rajah 1. Bagi setiap kegagalan cerun yang dicerap, maklumat asas seperti lokasi tanah runtuh, jenis kegagalan, skala kegagalan dan faktor penyebab tanah runtuh direkodkan sebagai inventori kegagalan cerun dan diringkaskan dalam Jadual 1. Ia akan dijadikan inventori taburan tanah runtuh di kawasan kajian. Lokasi mata air juga didapati di beberapa kaki bukit dan di plotkan di dalam peta ini. Jenis-jenis cerun di kawasan kajian ditentukan melalui cerapan di lapangan, terutama bagi membezakan antara cerun-cerun potongan,

cerun semulajadi dan cerun tambahan. Cerun tambahan dapat di tentukan melalui cerapan fotograf udara lama dan bukti-bukti lapangan, manakala cerun potongan terus dapat dikesan di lapangan. Cerun-cerun ini diplotkan di dalam peta geologi kejuteraan. Hasil analisis saiz butiran dan hidrometer didapati bahawa kawasan kajian majoritinya terdiri daripada tanah jenis pasir berlodak yang berkeplastikan sederhana. Terdapat juga sedikit tanah berlodak dan pasir halus di beberapa kawasan. Hasil analisis XRD secara kualitatif didapati kandungan mineral yang terdapat di dalam sampel di kawasan kajian ialah kaolinit, kuarza, muskovit dan mikroklin.

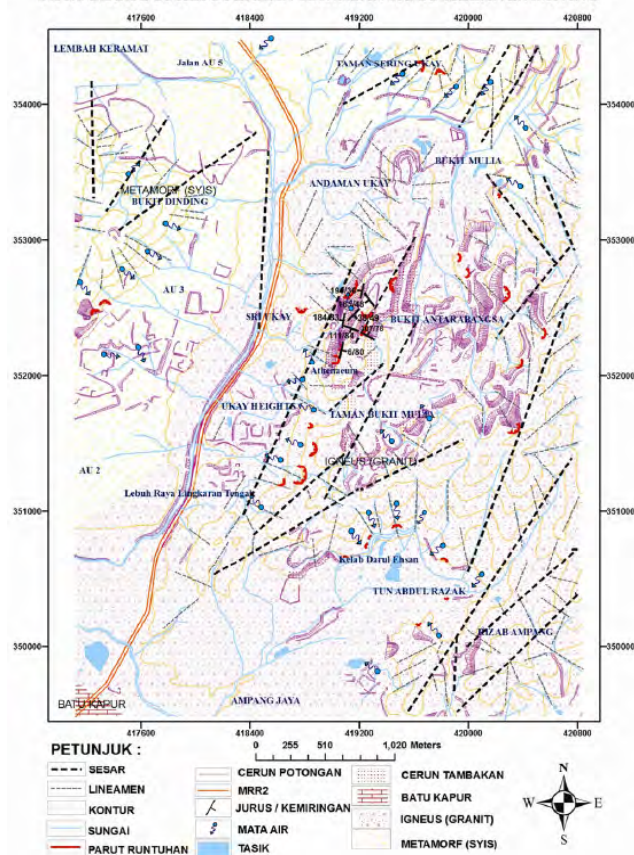
Kesimpulan

Hasil gabungan semua parameter yang telah dikumpulkan dan dianalisis dimuatkan ke dalam sebuah peta. Peta ini dilengkapi dengan parameter seperti berikut; geologi kawasan, saliran dan mata air, topografi, lineamen dan sesar, bacaan set-set kekar, jenis cerun buatan atau semulajadi, parut runtuh lama dan baru, dan jenis tanah. Bagi setiap parameter tersebut dipersembahkan di dalam bentuk peta tematik yang dihasilkan secara berasingan. Peta-peta tematik tersebut digabungkan dan seterusnya terhasilah peta geologi kejuteraan yang lengkap bagi kawasan Hulu Kelang/Ampang, Selangor. D daripada peta geologi kejuteraan yang dihasilkan dapat disimpulkan bahawa kawasan kajian adalah kawasan yang sangat kerap berlaku bencana tanah runtuh. Iaitu dipengaruhi oleh faktor semulajadi dan susulan daripada aktiviti manusia. Pembangunan yang dilakukan di kawasan morfologi yang berbukit tanpa mengikut piawaian yang betul dan infrastruktur yang mantap adalah faktor utama bencana tanah runtuh di kawasan kajian ini.

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PETA GEOLOGI KEJUTERAAN KAWASAN HULU KELANG/AMPANG



Rajah 1 : Peta geologi kejuruteraan kawasan Hulu Kelang/Ampang, Selangor.

Jadual 1: Senarai kejadian tanah runtuh yang dikesan di Hulu Klang dari tahun 1990 hingga 2011.

No	Lokasi		Jenis Kegagalan	Skala		Faktor penyebab
	Latitud	Longitud		kegagalan		
1	352553	417325	Gelongsoran tanah	Sederhana	Hakisan pada cerun	
2	352470	417246	Gelongsoran tanah	Kecil	Hakisan pada cerun	
3	354299	419655	Gelongsoran tanah	Sederhana	Sudut cerun yang curam	
4	354252	419791	Gelongsoran tanah	Kecil	Sudut cerun yang curam	
5	353327	420221	Gelongsoran tanah	Kecil	Hakisan dan cerun curam	
6	352331	419239	Gelinciran tanah dan batuan	Sederhana	Cerun potongan yang curam	
7	352159	419038	Aliran debris	Besar	Tambakan dan hakisan tanah	
8	352452	419266	Jatuhan batuan	Sederhana	Cerun potongan yang curam	
9	352481	418764	Gelongsoran tanah	Sederhana	Cerun potongan yang curam	
10	352615	419153	Gelinciran tanah dan batuan	Besar	Cerun curam dan tiada penyelenggaraan yang baik.	
11	351458	418889	Keterbalikan	Besar	Hakisan tanah	
12	351260	418787	Aliran debris	Besar	'Overloading' bahagian atas	
13	351200	418649	Gelongsoran tanah	Kecil	Hakisan tanah	
14	351620	418843	Gelinciran tanah	Sederhana	Hakisan tanah	
15	350164	419636	Gelongsoran tanah	Sederhana	Cerun potongan yg curam	
16	350353	419843	Gelongsoran tanah	Kecil	Cerun potongan yg curam	
17	350639	419830	Aliran debris	Sederhana	Terletak di lembah bukit	
18	350894	419442	Gelongsoran tanah	Kecil	Hakisan tanah	
19	350805	419278	Gelongsoran tanah	Kecil	Hakisan tanah	
20	350805	419253	Gelongsoran tanah	Kecil	Hakisan tanah	
21	350669	419095	Gelinciran tanah	Kecil	Hakisan tanah	
22	352701	419440	Gelongsoran tanah	Besar	Cerun curam & hakisan & hujan	
23	352881	419928	Gelinciran tanah	Kecil	Cerun potongan curam	
24	352752	420005	Gelinciran tanah	Sederhana	Hakisan tanah	
25	352565	420284	Aliran debris	Sederhana	Hakisan tanah	
26	352313	420559	Gelongsoran tanah	Sederhana	Hakisan tanah	
27	352316	420564	Gelongsoran tanah	Sederhana	Hakisan tanah	
28	352093	420379	Gelongsoran tanah	Sederhana	Hakisan tanah	
29	352360	419315	Jatuhan batuan	Kecil	Cerun potongan curam	
30	351566	419102	Jatuhan batuan	Kecil	Cerun potongan curam	
31	351294	418242	Gelinciran tanah	Sederhana	Cerun potongan curam	
32	353959	417742	Gelongsoran tanah	Sederhana	Hakisan tanah	
33	352874	417609	Gelongsoran tanah	Kecil	Hakisan tanah	
34	352985	417588	Gelongsoran tanah	Kecil	Hakisan tanah	

Skala kegagalan: Kecil < 10 mm³, Sederhana 10 – 50 mm³, Besar > 50 mm³

The study of Bukit Bunuh subsurface for impact crater using seismic refraction method: Preliminary study

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Keywords: Bukit Bunuh, seismic refraction, crater, crater rim.

Impact craters have potential to become significant hydrocarbon reservoirs after erosion, infilling and burial. Traditionally, impact features on Earth's surface are identified by their topographic characters such as circular hills – similar to a large bowl with an upturned rim and sometimes uplifted centre. Geophysical studies such as seismic, resistivity, gravity and magnetic surveys may reveal the existence of hydrocarbon accumulation and buried structures includes raised rims, annular synforms, terraced regions, inferred breccia infills, and meso-scale faults. Impact craters can be classified as simple or complex based on their size and morphology. A 'simple crater' can be recognized from its bowl-shaped cavity partially filled with a breccia lens. In addition, simple impact craters also tend to have well-defined rims and regular shapes. The rim-to-floor depth is ~ one-fifth of the rim-to-rim diameter, and the rim height is ~ 4 % of the total diameter (Melosh, 1989). The maximum diameter of such a crater is strongly influenced by the surface gravity of the impacted body with additional influence of the strength of the impacted surface. In igneous rock, the limit is ~ 4 km, whereas in sedimentary rock, it is ~ 2 km. Beyond this limit, the morphology of an impact crater would change dramatically because of the gravity which flattens the crater. Complex crater is characterized by the formation of a central uplift and slump blocks arranged within an annular synform, which appear like collapsed simple craters and have much smaller diameter. Rocks originated from below the crater floor makes up the central peak. The total amount of stratigraphic uplift is approximately 8 percent of the crater's final diameter (Melosh, 1989). An ejecta blanket is present in both types of craters. Usually overturned stratigraphic features can be observed around the rim of simple craters or on top of the slumped blocks in a complex crater. The central peak would change into a concentric ring of peaks as crater size increases. The peak ring does not surpass half the rim-to-rim diameter. The peak to peak-ring transition diameter scales the same way as the simple to complex transition diameter, that is, inversely with the gravitational acceleration. Both simple and complex craters demonstrate a raised rim structure that is caused by both ejected deposits and structural uplift of the underlying pre-impact surface. The uplift is upmost at the rim crest and vanishes at ~ 1.3 to 1.7 centre radii from the centre (Melosh, 1989). As the crater grows, an enormous radial force tends to push the rock units upwards (Sawatzky, 1972; Isaac and Stewart, 1993). Early searches for terrestrial impact craters were executed by examining topographic features and drainage patterns for signs of circular structures. However, a number of natural processes may produce round features that can be confused with impact craters. Subsurface seismic imaging can help to decipher their genesis. Many basins have been imaged well by seismic surveys and most of the data has been scrupulously interpreted for possible impact structures (Sawatzky, 1972; Isaac and Stewart, 1993; Westbrook, 1997; Mazur, 1999). The seismic method allows identification of the impact features by providing an image of contrasting lithologies. These features may include: down-thrown slump blocks, uplifted rocks at both the rim and central uplift, breccia infill, melt sheets, and zones of structural pinching. Located perpendicular to Sungai Perak and two mountain ranges, Bintang and Titiwangsa Range, a few geophysical methods were applied to study the impact crater at Bukit Bunuh, Lenggong, Perak (Malaysia). Seismic refraction and drilling techniques were used (Figures 1 & 2). A survey line of 8 km was covered using sledgehammer as a source and the ABEM MK8 seismograph. The results show the area consists of two major layers. The first layer with a velocity of 331-1000 ms⁻¹ was alluvium and boulders, while the second layer with a velocity of >2000 ms⁻¹ was suggested as the bedrock with depth of 5-30 m. The top litho-layer is thinner towards west and thicker towards east while there are characteristic crater rim indicated at >1000 m of the whole of survey line (Figure 3).

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Bh 1-BUKIT BUNUH (riverside)

Location : N05° 4'8.10" E100°58'27.18"

Legend	Depth (m)	Lithology
	0.20	Susville
	0.50	Sand and clay
	1.50	Coarse sand and silt
	3.00	Weathered granite
	4.50	Weathered granite
	6.00	Weathered granite
	7.50	Weathered granite
	9.00	Weathered granite
	10.50	Weathered granite
	12.00	Weathered granite
	12.50	Granite
	14.00	Granite
	15.00	Granite

Bh 2 (BUKIT BUNUH) (river side)

Location : N05° 4'8.16" E100°58'27.06"

Legend	Depth (m)	Lithology
	1.50	Laterite
	3.00	Laterite
	4.50	Granite
	5.00	Granite

Bh 3 (BUKIT BUNUH) (river side)

Location : N05° 4'8.10" E100°58'27.00"

Legend	Depth (m)	Lithology
	1.50	Laterite
	3.00	Laterite
	4.00	Weathered granite
	5.00	Granite
	6.00	Granite
	7.10	Granite

D1 (BUKIT BUNUH)

Location : N05° 4'14.94" E100°58'9.78"

Legend	Depth (m)	Lithology
	1.50	Sand
	2.00	Sand
	3.00	Coarse grained sand
	3.50	Muddy sand
	4.50	Weathered granite
	5.00	Weathered granite
	9.50	Granite
	11.00	Granite
	12.50	Granite
	14.00	Granite
	15.50	Granite
	17.00	Granite
	18.50	Granite
	20.00	Granite
	21.50	Granite
	22.50	Granite
	24.00	Granite
	25.50	Granite
	27.00	Granite
	28.50	Granite
	30.00	Granite
	31.50	Granite
	33.00	Granite
	34.50	Granite
	36.00	Granite
	37.50	Granite
	40.00	Granite

D2 (BUKIT BUNUH) (small central peak of crater)

Location : N05° 4'12.54" E100°58'12.42"

Legend	Depth (m)	Lithology
	1.50	Laterite
	3.00	Laterite
	4.50	Laterite
	6.00	Laterite
	7.50	Laterite
	9.00	Laterite
	10.00	Laterite
	12.00	Laterite
	13.50	Laterite
	15.00	Laterite and weathered granite
	16.50	Laterite and weathered granite
	18.00	Laterite and weathered granite
	19.50	Weathered granite
	21.00	Granite
	23.50	Granite
	25.00	Granite
	26.50	Granite

Figure 1: Borehole record Bh1, Bh2 and Bh3 near riverside at Bukit Bunu, Perak (Malaysia).

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Figure 2: Borehole record D1 and D2 (small central peak crater) at Bukit Bunu, Perak (Malaysia).

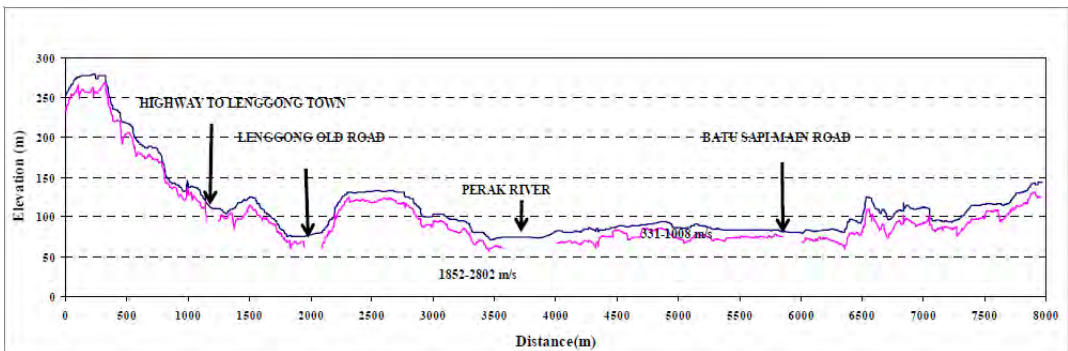


Figure 3: Seismic cross section of west to east (0-8000 m).

The importance of tsunami-related sites: Notes from Aceh, Indonesia

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Keywords: Aceh Province, tsunami, tsunami-related site

Aceh Province (or its full name is Aceh Darussalam) is located on the northern tip of the island of Sumatra, Indonesia. The province is the closest point of land to the epicentre of some giant earthquakes. The 26 December 2004 Indian Ocean earthquake with magnitude of 9.3 on the Richter Scale triggered a big tsunami that killed more than 200,000 people all over the world. At that time, Aceh is the area hardest-hit by the tsunami which caused the loss of around 170,000 local people, destroyed many buildings and infrastructures in Aceh. This natural hazard, however, has inspired Aceh people to build some tsunami-related sites such as Aceh tsunami museum, tsunami educational park, tsunami inundation museum, a floating boat of diesel plant, a fishing boat on the roof, the replica of tsunami, and some others. This paper will expose those tsunami-related sites and their importance as learning and educational sites for the general public and as alternative tourism places as well.

Katakunci: Provinsi Aceh, tsunami, tapak yang berkaitan dengan tsunami

Provinsi Aceh (atau nama penuhnya ialah Aceh Darussalam) terletak di hujung utara pulau Sumatera, Indonesia. Wilayah ini merupakan tempat yang paling dekat dengan pusat gempa beberapa gempa bumi gergasi. Gempa bumi Lautan Hindi pada 26 Disember 2004 dengan magnitud 9.3 pada Skala Richter mencetuskan tsunami besar yang membunuh lebih daripada 200,000 orang di seluruh dunia. Pada masa itu, Aceh merupakan kawasan yang paling teruk dilanda tsunami yang menyebabkan kehilangan sekitar 170,000 orang, memusnahkan banyak bangunan dan infrastruktur di Aceh. Bencana alam ini, bagaimanapun, telah memberi inspirasi kepada rakyat Aceh untuk membina beberapa tapak yang berkaitan dengan tsunami seperti muzium tsunami Aceh, taman pendidikan tsunami, muzium banjir tsunami, bot loji diesel terapung, bot nelayan diatas bumbung, replika tsunami, dan lain-lain. Kertas kerja ini akan mendedahkan tapak-tapak yang berkaitan dengan tsunami dan kepentingan tapak-tapak tersebut sebagai tapak pembelajaran dan pendidikan untuk masyarakat am dan juga sebagai tempat pelancongan alternatif.

Kesan pencemaran cecair larut resap (CLR) terhadap had Atterberg dan sifat pemadatan tanah baki granit (Effects of leachate on Atterberg limit and compaction characteristic of granitic residual soil)

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Abstrak: Cecair larut resap (CLR) merupakan cairan yang dihasilkan dari tapak-tapak pelupusan sampah. Pencemaran CLR jelas mengundang masalah alam sekitar seperti pelarutlesapan nutrien dan logam berat ke dalam tanah dan air bawah permukaan. Namun demikian kesan kehadiran CLR terhadap sifat geoteknik tanah adalah tidak begitu difahami. Kertas ini membentangkan hasil kajian awal terhadap kesan pencemaran CLR terhadap had Atterberg dan sifat pemadatan tanah baki asalan batuan granit. Sampel-sampel tanah tercemar disediakan dengan menambah CLR dalam kuantiti 0, 5, 10 dan 20% terhadap berat kering tanah yang dikaji. Kajian ini menunjukkan had cecair dan had plastik menyusut dengan pertambahan kandungan CLR. Ujian pemadatan menunjukkan nilai ketumpatan kering maksimum dan kandungan air optimum menyusut dengan pertambahan cecair larut resap. Kajian ini menunjukkan bahawa kehadiran CLR dalam tanah telah mengubahsuaai sifat lakukan geoteknik yang dikaji.

Kata kunci: Cecair larut resap, tanah baki, had Atterberg, kekuatan ricih

Pengenalan

Perkembangan ekonomi dan sistem perbandaran yang semakin maju pada masa kini telah mengubah cara hidup masyarakat dan ia telah menyumbang kepada peningkatan sisa buangan harian. Oleh itu, tapak pelupusan sampah memainkan peranan penting untuk menampung sisa-sisa buangan tersebut. Cecair larut resap (CLR) yang terhasil dari tapak-tapak pelupusan sampah ini banyak memberi kesan negatif kepada alam sekitar jika tidak diuruskan dengan baik seperti pencemaran air dan pencemaran tanah. Sunil et al. (2006) dalam kajiannya mendapati pencemaran bahan CLR ini ke persekitaran tanah bukan sahaja mencemari kualiti tanah malah turut menjejaskan sifat mekanik tanah tersebut. Beberapa kajian berkaitan kesan CLR terhadap sifat kejuruteraan tanah pernah dilakukan (Sunil et al. 2006; Soule & Burns 2001; Roque & Didier 2006). Kajian lampau yang dilakukan menunjukkan terdapat interaksi CLR dan tanah yang menyebabkan berlakunya pengubahsuaian sifat sesuatu tanah.

Pembangunan semula tapak-tapak pelupusan ini menyebabkan maklumat berkaitan sifat geoteknik amat perlu dikaji. Ini penting dalam merangka kerja-kerja yang perlu dilakukan bagi menjamin tanah tercemar ini dirawat sebelum digunakan untuk tujuan penambakan atau pendasaran. Kajian awalan ini bertujuan untuk melihat kesan pencemaran larut resap terhadap pencirian geoteknik tanah yang dicemari dengan CLR di makmal. Cirian geoteknik yang diperhatikan adalah kesan penambahan CLR terhadap sifat Atterberg dan sifat pemadatan tanah berbanding tanah yang tidak dicemari CLR.

Bahan dan kaedah

Sampel tanah dan larut resap

Tanah yang digunakan dalam kajian ini telah diambil di Batu 14 Hulu Langat, Selangor mewakili tanah baki asalan batuan granit. Ia dicirikan oleh warna oren kekuningan dengan kehadiran partikel kuarza yang ketara (Rajah 1). Analisis saiz taburan tanah baki granit ditunjukkan oleh Rajah 3. Penciran asas tanah ini ditingkaskan sebagaimana ditunjukkan oleh Jadual 1.

Persampelan cecair larut resap dilakukan di Pusat Pelupusan Sampah Sanitari Jeram, Selangor. Persampelan cecair larut resap dilakukan dengan menggunakan botol sampel yang dilengkapi penutup dan penyokong bagi memudahkan kerja-kerja persampelan di tapak pelupusan. Cirian asas CLR adalah ditunjukkan oleh Jadual 1. Rajah 2 menunjukkan imej SEM bagi sampel tanah tidak tercemar dan tercemar CLR.

Jadual 1: Parameter asas tanah baki granit dan CLR.

Parameter	Tanah	CLR
pH	4.30-4.56	8.93
Kandungan Lembapan	23.40%	
Graviti tentu	2.50 – 2.64	
Bahan organik tanah	3.30%	
Mineral	Kaolinit Muskovit Kuarza	
Kekuatan ricih	156-207kPa	
TSS		0.22
Logam Berat (ppb)	Kromium	277.3
	Mangan	269.0
	Nikel	106.0
	Kuprum	19.8
	Zink	46.3
	Arsenik	287.4
	Kadmium	0.2
	Plumbum	4.6

Penyediaan sampel tercemar

Sampel-sampel tanah yang diambil dikering udarkan terlebih dahulu selama seminggu pada suhu bilik. Sampel tanah dicampurkan dengan 0, 5, 10 dan 20% CLR berdasarkan berat kering tanah. Campuran CLR dan tanah digaul rata di dalam bekas plastik dan disimpan selama dua minggu. Ini bertujuan untuk menghasilkan campuran sampel dan CLR yang homogen. Parameter-parameter kejuruteraan bagi tanah tercemar dan tidak tercemar cecair larut resap adalah had-had Atterberg, kekuatan ricih tanah (UU) dan pemadatan.

Pencirian tanah tercemar

Kesan pencemaran CLR terhadap tanah ditentukan berdasarkan penentuan had Atterberg dan ujian pemadatan makmal. Had Atterberg melibatkan had cecair dan had plastik. Had cecair ditentukan dengan menggunakan kaedah Casagrande. Had plastik pula ditentukan dengan memintal sampel tanah ke bentuk rod antara 3-4mm panjang. Kandungan lembapan air sampel tanah ditentukan bagi setiap ujian yang dilakukan.

Ujian pemadatan tanah menggunakan Proctor 2.5kg dengan acuan selinder berisipadu 993.25cm³. Sampel tanah dipadatkan dengan menggunakan pelantak 2.5kg dengan jatutan bebas pada ketinggian 300mm. Tanah dipadatkan dengan tiga lapisan dengan ketebalan yang sama di mana setiap lapisan mengalami 25 kali hentaman. Kandungan lembapan air dan ketumpatan kering ditentukan. Kaedah penentuan had Atterberg dan ujian pemadatan yang dijalankan adalah berdasarkan piawaian yang dicadangkan oleh BSI 1377 (1990) Part 2:5.3 dan Part 4:3.3.

Hasil dan perbincangan

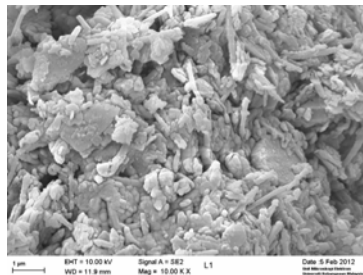
Hasil ujian had-had Atterberg menunjukkan penyusutan nilai-nilai had cecair dengan pertambahan cecair larut resap iaitu 59.7% hingga 40.5%, manakala had plastik pula adalah 41.3% hingga 35.0%. Nilai indeks plastik juga menurun dari 18.4% hingga 5.5% dengan pertambahan cecair larut resap. Kehadiran cecair larut resap di dalam tanah menyebabkan pengurangan nilai had cecair dan had plastik tanah baki granit. Hasil bagi analisis had-had Atterberg ditunjukkan dalam Rajah 4.

Ujian pemadatan dilakukan bagi mengikat suatu tanah dengan menyendatkan zarah-zarah supaya padat dan mengurangkan isipadu udara. Darjah pemadatan sesuatu jenis tanah disukat di dalam ungkapan ketumpatan kering. Ketumpatan kering sesuatu tanah selepas pemadatan bergantung kepada kandungan air dan tenaga yang dibekalkan oleh peralatan pemadatan.

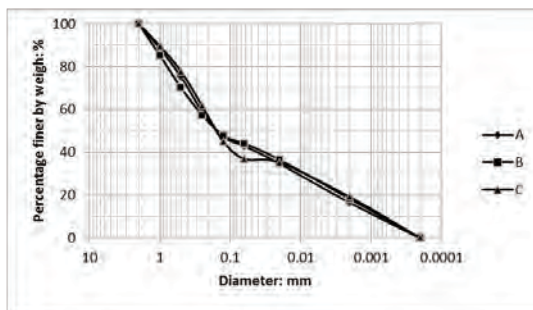
Rajah 5 menunjukkan nilai ketumpatan kering maksimum dan kandungan air optimum menyusut dengan pertambahan cecair larut resap. Menurut Craig (1993) pada nilai kandungan air yang rendah, kebanyakan tanah menjadi kaku dan sukar dipadatkan. Apabila kandungan air ditambah, tanah menjadi senang diuli, boleh menanggung pemadatan dan menghasilkan ketumpatan kering yang lebih tinggi. Walau bagaimanapun, pada kandungan air yang tinggi, ketumpatan kering berkurangan dengan penambahan kandungan air iaitu apabila sebahagian besar isipadu tanah dipenuhi air. Sekiranya semua udara di dalam tanah boleh dinyah keluar melalui pemadatan, tanah akan



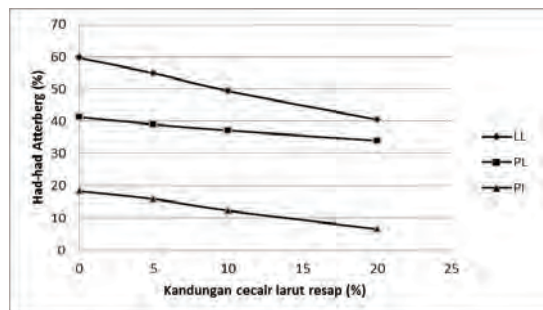
Rajah 1: Tanah baki granit.



Rajah 2: Imej SEM tanah (kiri) tidak tercemar dan (kanan) tercemar cecair larut resap.



Rajah 3: Taburan saiz butiran tanah baki granit.



Rajah 4: Graf had cecair, had plastik dan indeks plastik.

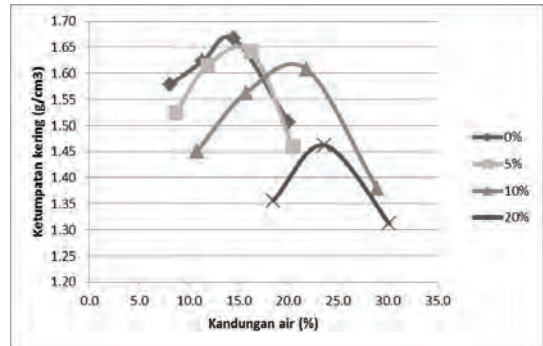
menjadi tepu sepenuhnya dan ketumpatan keringnya merupakan nilai maksimum termungkin bagi kandungan air tertentu. Kehadiran cecair larut resap di dalam tanah menurunkan sifat geoteknik tanah gambut. Oleh itu, cecair larut resap merupakan suatu medium pencemar yang akan memberi kesan negatif kepada sifat geoteknik tanah. Tanah tercemar cecair larut resap perlu dibaikpulih terlebih dahulu sebelum sebarang pembinaan dilakukan. Kajian lanjutan amat penting untuk menentukan kaedah membaik pulih tanah tercemar cecair larut resap dilakukan.

Kesimpulan

Kesimpulannya, berdasarkan kajian ini, kehadiran cecair larut resap di dalam tanah menurunkan sifat geoteknik tanah gambut. Oleh itu, cecair larut resap merupakan suatu medium pencemar yang akan memberi kesan negatif kepada sifat geoteknik tanah. Tanah tercemar cecair larut resap perlu dibaikpulih terlebih dahulu sebelum sebarang pembinaan dilakukan. Kajian lanjutan amat penting untuk menentukan kaedah membaik pulih tanah tercemar cecair larut resap dilakukan.

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Rajah 5: Graf pemadatan tanah baki granit tercemar cecair larut resap.

Integrasi penderiaan jauh dan sistem maklumat geografi (GIS) Dalam pemetaan kawasan berpotensi air tanah sekitar Kota Kinabalu, Sabah

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Abstrak: Kajian yang dijalankan di kawasan sekitar Kota Kinabalu, Sabah ini merangkumi lima peringkat iaitu pengumpulan dan penyediaan data asas, analisa data satelit, pembinaan pengkalan data ruang, analisa ruang dan integrasi. Beberapa parameter telah digunakan seperti imej satelit Landsat TM (thematic mapper), taburan hujan, nisbah lempung dan pasir, saliran, topografi dan lineamen untuk menghasilkan peta-peta tematik dalam bentuk digit menggunakan perisian ERDAS 8.4 dan ILWIS 3.3. Setiap poligon di dalam peta tematik ini diberikan nilai pemberat yang sesuai mengikut pengaruhnya dalam penghasilan air tanah. Kaedah pemberian nilai pemberat adalah mengikut nilai yang diberikan oleh Krishnamurthy et al. (1997) iaitu nilai terendah ialah sepuluh (10) dan nilai tertinggi ialah lima puluh (50). Proses penindihan atau integrasi dilakukan ke atas semua parameter tadi menggunakan kaedah Model Tindihan Indeks bagi mendapatkan hasil akhir kajian. Hasil akhir iaitu peta zon potensi air tanah dibahagikan kepada 5 kelas iaitu zon sangat tinggi, tinggi, sederhana, rendah dan sangat rendah.

Katakunci: pengkalan data ruang, analisa ruang, integrasi

Pengenalan

Umum telah mengetahui air tanah merupakan sumber alternatif terbaik bagi menampung kekurangan bekalan sumber air sedia ada. Air tanah ditakrifkan sebagai air yang mengisi ruang, rongga, pori dan retakan di dalam tanah, batuan atau regolith di bawah permukaan bumi, terbentuk apabila air di permukaan seperti air hujan menyusup masuk ke dalam ruang atau rongga antara butiran sedimen, sesar atau retakan sesuatu jasad batuan. Kaedah penderiaan jauh dan sistem maklumat geografi (GIS) digunakan untuk memproses data yang mempengaruhi pembentukan air tanah, dan seterusnya bagi menghasilkan peta ramalan zon berpotensi air tanah di sekitar Kota Kinabalu, Sabah. Perisian ERDAS 8.4 dan ILWIS 3.3 digunakan bagi memproses parameter-parameter yang dikenalpasti mempengaruhi kedapatan air tanah.

Bahan dan kaedah

Perisian ERDAS IMAGINE 8.4 dan ILWIS 3.3 digunakan semasa peringkat pembinaan pengkalan data ruang, analisa ruang dan integrasi. Kesemua parameter yang digunakan dalam kajian ini diubah ke bentuk digit bagi proses tindihan untuk mendapatkan peta akhir zon potensi air tanah di kawasan kajian. Imej satelit Landsat *Thematic Mapper* (TM) yang diperolehi daripada pihak Agensi Remote Sensing Malaysia (ARSM) digunakan adalah bagi tujuan mendapatkan parameter ketumpatan lineamen. Pada peringkat analisa ruang setiap poligon dalam peta tematik ini akan diberikan nilai pemberat mengikut nilai yang diberikan oleh Krishnamurthy et al. (1997) iaitu nilai terendah ialah sepuluh (10) dan nilai tertinggi ialah lima puluh (50). Penindihan atau integrasi bagi mendapatkan peta zon potensi air tanah dilakukan menggunakan Model Tindihan Indeks, di mana kesemua peta tematik dengan pemberat masing-masing ditetapkan pada satu 'georeference' agar ianya boleh ditindihkan menggunakan perisian ILWIS 3.3 menggunakan Persamaan Linear Hopkins.

Hasil dan perbincangan

Hasil akhir iaitu peta zon potensi air tanah, dibahagikan kepada 5 kelas iaitu zon sangat tinggi, tinggi, sederhana, rendah dan sangat rendah.

Kesimpulan

Daripada hasil yang diperolehi, didapati antara faktor yang mempengaruhi potensi kedapatan air tanah di kawasan kajian ialah nisbah antara lempung dan pasir, ketumpatan saliran serta ketumpatan lineamen. Selain itu, potensi air tanah lebih tinggi ditemui di kawasan yang rendah atau landai dengan taburan hujan yang agak sederhana.

Penghargaan

Terima kasih kepada Agensi Remote Sensing Malaysia (ARSM), Jabatan Mineral dan Geosains Malaysia (JMG), Jabatan Ukur dan Pemetaan Malaysia (JUPEM), Jabatan Pertanian Sabah, Malaysia, Jabatan Pengairan dan Saliran Sabah (JPS), Jabatan Perkhidmatan Kajiucua Malaysia, Jabatan Penyiasatan Kajibumi Malaysia (GSM) dan Pusat Pengajian Sains Sekitaran dan Sumber Alam, Fakulti Sains Dan Teknologi, UKM, Bangi, Selangor atas bantuan yang diberikan.

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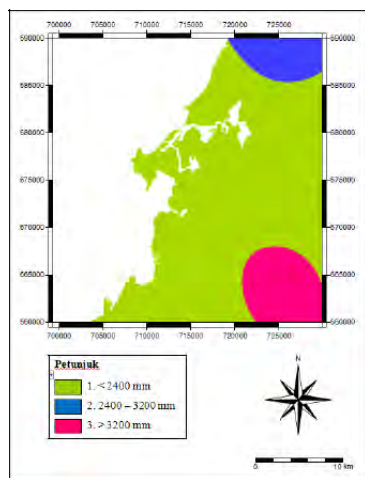
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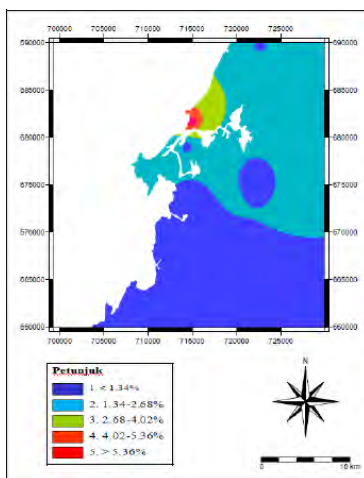
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Jadual 1: Rumusan perkaitan antara parameter yang dikaji dengan zon potensi air tanah.

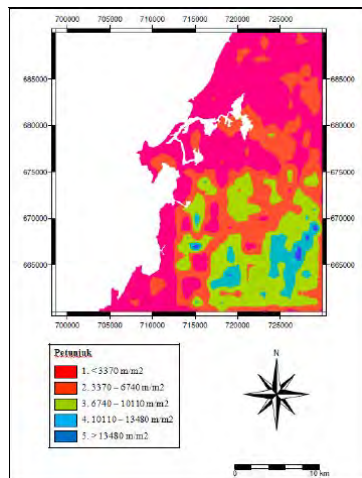
Zon Peta	Sangat Rendah	Rendah	Sederhana	Tinggi	Sangat Tinggi
Taburan Hujan	Sederhana, Sangat tinggi	Sederhana, Sangat tinggi	Sederhana – Sangat tinggi	Sederhana – Tinggi	Sederhana
Nisbah lempung dan pasir	Sangat rendah	Sangat rendah – Rendah	Sangat rendah - Rendah	Sangat rendah - Rendah	Sederhana - Sangat tinggi
Ketumpatan saliran	Sangat tinggi	Sederhana – Tinggi	Sangat rendah – Sederhana	Sangat rendah – Sederhana	Sangat rendah
Ketinggian topografi	Tinggi – Sangat tinggi	Sederhana – Tinggi	Sangat rendah – Tinggi	Sangat rendah	Sangat rendah
Ketumpatan lineamen	Sangat rendah	Sangat rendah – Sederhana	Sangat rendah – Sederhana	Tinggi – Sangat tinggi	Sangat tinggi



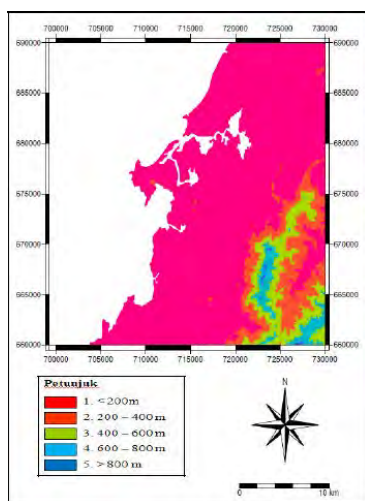
Rajah 1: Peta taburan hujan.



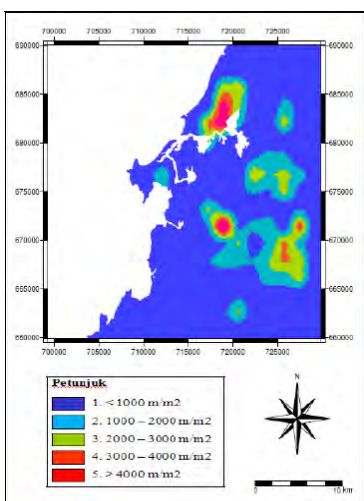
Rajah 2: Peta nisbah lempung dan pasir.



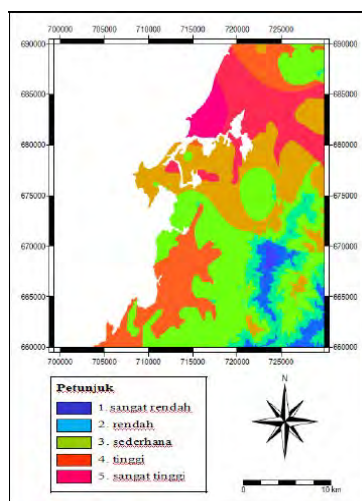
Rajah 3: Peta ketumpatan saliran.



Rajah 4: Peta ketinggian topografi.



Rajah 5: Peta ketumpatan lineamen.



Rajah 6: Peta zon potensi air tanah kawasan kajian.

Utilizing geo-information technologies in managing volcanic hazard and disaster

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Keywords: Geo-information technology, disaster management, volcanic eruption, volcanic hazard

The main objective of this paper is to improve disaster mitigation by using a technologies of Geo-Information Technology. These technologies are discussed in the context of the four major phases of disaster management: preparedness, response, recovery and mitigation. Examples of some technologies discussed in detail include real time hazard warning or monitoring systems; advance loss estimation methodologies and tools; remote sensing for response and recovery; and field data collection and visualization systems, especially those that are GIS and/or GPS-based.

Volcanic eruption is a typical hazard. A volcanic disaster extends over a wide range of areas involving a loss of lives and properties, with unpredictable eruption events. A volcanic hazard is measured in terms of the probability of an eruption event occurring at a given place and time which in the extreme situations can be effusive or explosive.

This paper concludes with a brief discussion of research or implementation issues, focusing specifically on the above technologies related with volcanic hazard and disaster, and including issues related to real time even monitoring: privacy protection ; and information sharing and trust management.

Identification and assessment of geotourism potentials in Jeli district, Kelantan

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Keywords: geotourism, landform/landscape, geological phenomena, Jeli district

This research presents a study for identifying and assessing some amazing landforms/landscapes and geological phenomena in Jeli district, Kelantan, which are potential for geotourism purposes. Its aim is to qualify and quantify their potentials in terms of scenic/aesthetic, scientific, cultural/historical, and social/economic values, and the uses of these potentials. In this paper, the identification of the landforms/landscapes and the phenomena is firstly presented by observing physical characteristics of each location. Then, the assessment of their geotourism potentials was determined by doing field observation, survey/questionnaire, and interview methods. There are several potential geotourism resources in the area, such as Gunung Reng (hill and cave), Pergau river, Jeli hotspring, Lata Janggut cascade, Lata Renyok waterfall, Lata Chenai cascade, and Pergau lake/dam.

Logging of a sedimentary sequence in the Sungai Rait Valley of Miri

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A study of channelized sandstone and tidal clay deposits has been conducted for 3 months in Sg. Rait, Bakam, Miri. This project was focused on one large quarry section of the Tukai Formation dated as Pliocene. This project includes the production of topography map, interpretative diagrams, stratigraphy logs and a master profile of the Sg. Rait area. A topography map was constructed using two softwares -ArcGIS Desktop 9.3 and Golden Software Surfer 8 which helped produce and smooth altimetry contours. Intervals of 10 meters were plotted on the map. The elevation of this area is increasing from Northwest to Southeast towards the Lambir Hills. Two outcrops of approximately 700 m² were studied so far and the channelized sandstone and tidal clay deposits were sampled. Coals, amber, fossils were also found in the main quarry area. Cross-bedding features in the sandstones were identified and measured for paleocurrent. Other than that, a number of geophysical and geochemical tests were carried out. By applying XRF, a significant amount of chromium and cobalt was discovered in the clay samples. The origins of these elements are still being discussed.

Mapping the Lubang Lelong Cave System (Niah National Park)

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Niah National Park is located in Northern Sarawak, approximately 80 km southwest of Miri and 20 km inland from the coast. It is surrounded by low-lying alluvial plain. Within the Park is a limestone region of 16 km² and reaching the height of 400 meters above sea level. These limestones are a part of the Subis Formation. Many studies to understand the cave systems of Northern Gunung Subis have been conducted by scientists and explorers, especially the Great Cave and the Painted Cave in the north east of the Park. However, very little scientific interest has been shown towards the south west region of the Park due to its relative inaccessibility. Our research has focused on a cave called Lubang Lelong, the entrance of which is located about 50 meters above the alluvial plain in the south west of Niah National Park. The limestone cliff in which Lubang Lelong entrance is located faces the Sungai Niah, which flows northward. Several other caves have been explored in this area by the local community for bird nest harvesting.

To date, our studies include cave exploration, cave mapping and preliminary geological observations. These are conducted to determine the main controlling factors of cave development and karstification. To map the caves, two cave surveying methods were developed using a laser measuring device, clinometers, compass and other simple portable tools suitable for underground work. The two methods were developed to suit the particular geometry of the cave: the first is a traversing method used in both tube caves and chambers, and the second is a wall curvature measurement method used only in the chambers. Both methods were applied to mapping Lubang Lelong. The survey data was then plotted using COMPASS software, allowing 3D views of the caves to be constructed as well as various cave maps to be plotted. This will enable the study of the cave morphology to be undertaken and the karst system of this part of Gunung Subis to be better understood.

Toxicity level of selected heavy metal in volcanic soils from Tawau, Sabah

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Keywords: Heavy metals; Tawau; volcanic soils

Heavy metals are one of the serious pollutants in environment because its toxicity. Severe concentration of heavy metals can harm the plants, animals and even human. During the pedogenesis process, heavy metals from the parent rock are mobilized in soils and redistribute in to the environment. The objective of this paper is to study the concentration and toxicity level of selected heavy metals in volcanic soils around Tawau, Sabah. In this study 10 soil samples were collected from different sampling station. The selection of soil samples were based on the different type of volcanic rocks in the study area. The determination of concentration of heavy metals in soil samples were carried out using X-Ray Fluorescence (XRF) analysis. The result of analysis shows that highest concentration was chromium with the average of 141 ppm, and followed by zinc with concentration level was 112 ppm. The concentration of copper was 49 ppm, cobalt was 47 ppm, nickel was 15 ppm, lead was 8 ppm and arsenic was 7 ppm. The soil samples are identified as moderately polluted due to the moderate concentration of heavy metals when compared with the Sediment Quality Guidelines of USEPA. Chromium is regarded as heavily polluted agent while zinc, copper and arsenic indicated that the area is moderately polluted. Nickel and lead average concentration show no indication of pollution in the area. From the study also, it is found out that pH value, organic matter and clay percentage has influenced the heavy metal concentration in volcanic soil of the study area.

Mineralogical and microstructural study of lime stabilized clayey soil from Trusmadi Formation, Sabah

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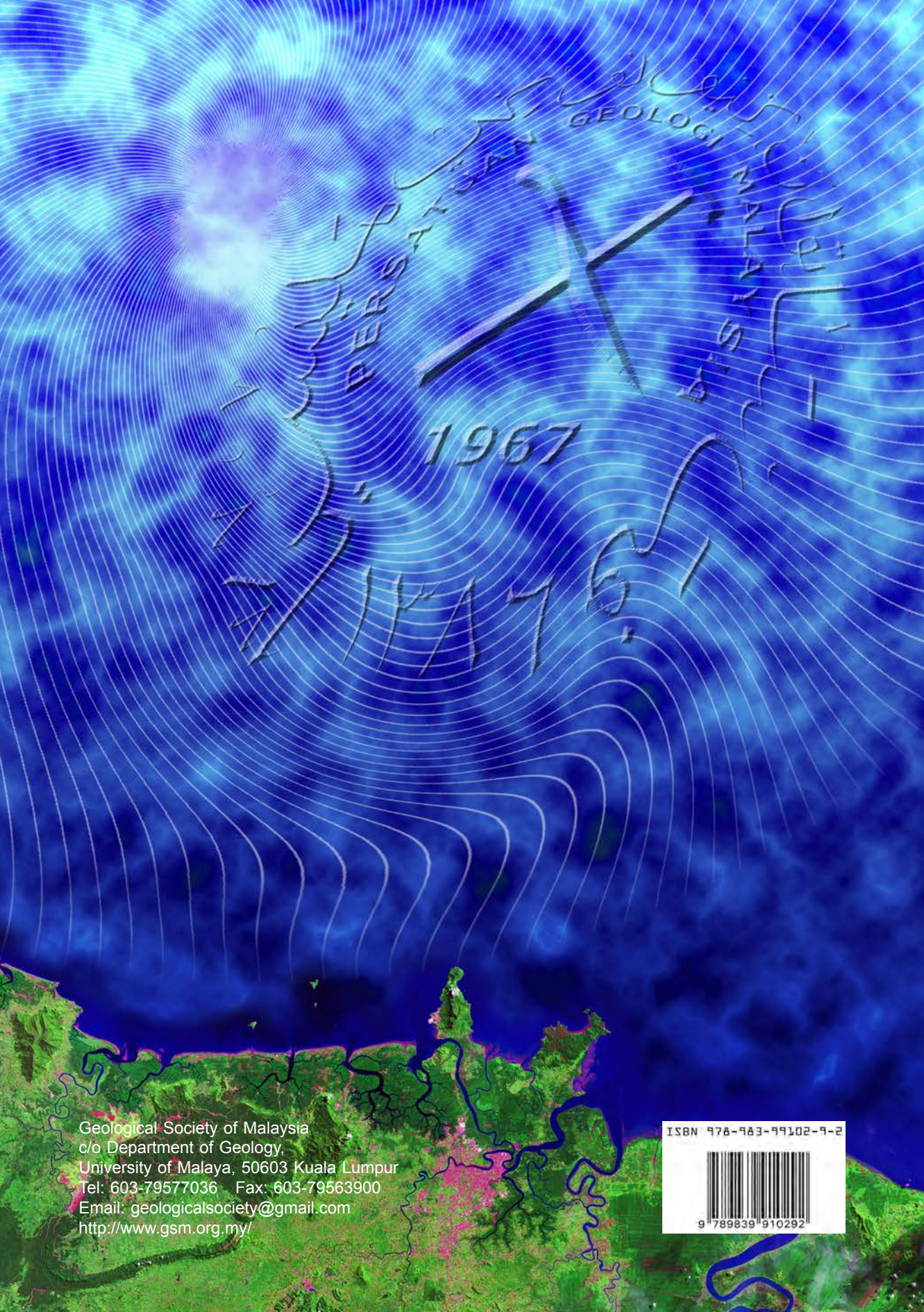
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Keywords: calcium aluminates silicate (CAS), calcium silicate hydrate (CAH); clayey soils, stabilization; Trusmadi Formation

This paper discusses the physical characteristics, mineralogy and microstructure of clayey soil stabilized with lime. The soil samples were collected from weathered rock of Trusmadi Formation. Trusmadi Formation is mainly made up by interbedded sandstone and gray shale with low grade of metamorphism. The soil sample collected is best classified as clayey silt with gray in colour. The result of XRF analysis indicated that the range of SiO_2 was 59.62% - 62.24%, Al_2O_3 was 17.58% - 16.29%, CaO was 0.37% - 6.09% and Na_2O was 1.01% - 1.18%. In this study different percentages of lime i.e (0%, 2%, 4%, 6% and 8%) were mixed into the soil samples; before cured for 0, 7, 14, 21 and 28 days before analyses for the mineralogical, microstructural and compressive strength were conducted. The result of compressive strength analysis shows that the maximum compressive strength value (1383 kPa) was achieved for soil mixed with 8% of lime and cured for 28 days. The reaction of lime and minerals in the soil which produced of calcium silicate hydrate (CSH) and calcium aluminates silicate (CAS) were observed using SEM. Furthermore, the appearance of CSH and CAS minerals were also identified from the X-ray diffractogram peaks.



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