Persatuan Geologi Malaysia
Geological Society of Malaysia

PROCEEDINGS
NATIONAL GEOSCIENCE CONFERENCE 2014

Grand Continental Hotel
Kuala Terengganu
13-14 June 2014

Climate and Sea Level Change Through Geologic Time

Co-organizers

Universiti Malaysia Terengganu

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A Message from the Chairman, Malaysia National Geoscience Conference 2014

Welcome to Kuala Terengganu!

We are proud to host the National Geoscience Conference, the annual meeting of the Geological Society of Malaysia, for the first time since its inception in the early 1970's. This honor is undoubtedly due to the increasing emphasis on geoscience research and programs at the Universiti Malaysia Terengganu and Institute of Oceanography and Environment.

The Conference is a premier geoscientific event in Malaysia which is well attended by geoscientists from academia as well as the public and private sectors. NGC 2014 is co-organised with the Minerals & Geoscience Department Malaysia (JMG) Terengganu and Universiti Malaysia Terengganu (UMT).

This year's theme is “Climate and Sea-Level Change through Geologic Time”. The potential effects of ongoing and future climate and sea-level change are of global concern, especially to the many countries throughout Asia with coastal economies. An important way of predicting future coastal patterns is by using analogs from the past. Earth’s history has been characterized by substantial changes in climate and sea level on various time scales and with various driving factors. The most recent period, the Quaternary, has been characterized by orbitally-driven, high-frequency climate and sea-level change.

This conference will focus on understanding the geological record of these changes and using that understanding to predict future coastal trends. This subject has stimulated both national and international participation in NGC 2014 with four keynote addresses on relevant topics. In addition to papers related to the conference theme, we have sessions related to geohazards, engineering geology, petrology, geochemistry, hydrogeology, economic geology, geo-heritage and policy. I am sure that the presentations will elicit lively discussion.

I would like to thank the authors and contributors for their submissions and the time and effort that each represents, the generous sponsors whose contributions helped make this event happen and the conference organizing committee for their energy, dedication and experience.

Cheers! Have a great meeting and experience in Terengganu.

Dr. Peter R. Parham
Chairman
National Geoscience Conference 2014

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DAY ONE : 13 JUN 2014 (FRIDAY) VENUE : PERHENTIAN HALL, GRAND CONTINENTAL HOTEL		
0800-0900	**REGISTRATION**	
0900-1030	**OPENING CEREMONY**	
1030-1100	**POSTER SESSION 1 AND TEA BREAK**	
1100-1140	**KEYNOTE I** Prof. Dr. Fredolin Tangang (UKM) **– IPCC AR5 Key Findings on Past, Present and Future Climate Change**	
1140-1215	**KEYNOTE II** Dr. Daud Batchelor (International Institute of Advanced Islamic Studies) **–** **Clarification on Stratigraphic Correlation and Dating of Upper Cainozoic Alluvium in Western Peninsular Malaysia**	
1215-1445	**LUNCH BREAK AND JUMAAT PRAYER** **Lunch sponsored by JMG**	
Presentation Time	**SESSION A1 :** SEA LEVEL CHANGE/PALAEO ENVIRONMENT PERHENTIAN HALL, GRAND CONTINENTAL HOTEL	**SESSION B1 :** GEOHAZARD/ENGINEERING GEOLOGY KAPAS HALL, GRAND CONTINENTAL HOTEL
	Chairperson : Dr. Vijayan (JMG/UMT)	***Chairperson : Dr. Mazlan Madon (PETRONAS)***
1445-1500	**P003** Ramli Mohd Osman and Siearra Celastra Sarina Ramli : **Cape Peron – A Hike Through The Upper Quaternary**	**P006** Tan Boon Kong : **Engineering Geologic Investigations of Rock Slopes – Two Recent Case Studies**
1500-1515	**P017** Kamal Roslan Mohamad : **Perkembangan Delta Kelantan**	**P071** Nuur Hani Bte Mohammed,Wan Zuhairi Wan Yaakob : **Physico-Chemical Properties Of Schist And Granite As A Liner Material**
1515-1530	**P022** Stephen J. Culver, David J. Mallinson, Eduardo Leorri, D. Reide Corbett, Peter R. Parham, Noor Azhar Mohd Shazili, Rosnan Yaacob : **Holocene coastal response to monsoons and relative sea-level changes in northeast peninsular Malaysia**	**P019** Abdul Ghani Rafek, Goh Thian Lai, Mohd Hariri Arifin, Norbert Simon dan Azimah Hussin : **Pengkuantitatifan kestabilan cerun berdasarkan sistem perkadaran jasad cerun:kajian kes bukit batu kapur di Ipoh, Perak.**

1530-1545	**P031** Babangida M. Sarki Yandoka , Wan Hasiah Abdullah , Abubakar M.B : **Alluvial - Lacustrine Depositional System In Rifted Basin: The Early Cretaceous Non-Marine Sedimentation Of Bima Formation In Yola Sub–Basin, Northern Benue Trough, NE Nigeria**	**P021** Nurul Syazwani Yahaya, Choun-Sian Lim, Joy Jacqueline Pereira : **Assessment Of Landfills Settings In Selangor And The Emerging Hazards Under A Changing Climate**
1545-1600	**P086** Muhd Nur Ismail Abdul Rahman and Sanudin Hj. Tahir : **Analisis Fasies Jujukan Kipas Tengah Laut Dalam Eosen Lewat Kawasan Tenom, Sabah, Malaysia**	**P034** Norbert Simon , Rodeano Roslee , Nightingle Lian Marto , Abdul Ghani Rafek, Goh Thian Lai , Azimah Hussin , Mohd Rozi Umor , Mohd Basril Iswadi , Marilah Sarman, Nur Syafina Roslan : **Landslide Density Analysis Along The Ranau-Tambunan Road**
1600-1615	**P062** Bird, M.I., Teh, T.S. and Yap, H.B : **Radiocarbon Dates Of Shell Beds And Stranded Coral At Kampung Gambut, Southeast Johor**	**P043** Wan Salmi W. H., Norbert, S., Goh T. L. & Ghani Rafek, A : **Pencirian Geomekanik Jasad Batuan Batu Kapur Dan Analisis Kestabilan Cerun Di Gunung Keriang, Alor Setar, Kedah**
1615-1630	**SHORT BREAK**	
Presentation Time	**SESSION A2 :** SEA LEVEL CHANGE/PALAEO ENVIRONMENT PERHENTIAN HALL, GRAND CONTINENTAL HOTEL	**SESSION B2 :** GEOHAZARD/ENGINEERING GEOLOGY KAPAS HALL, GRAND CONTINENTAL HOTEL
	Chairperson : Dr. Peter Parham (UMT)	***Chairperson : Mr. Tan Boon Kong***
1630-1645	**P033** Habibah Jamil, Yongqiang Zong & Khairiah Jusoh : **A Preliminary Study Of Diatom Record In Quaternary Deposits Of Kuala Langat Area, Selangor**	**P051** Norsafiah Sulaiman , Zulfahmi Ali Rahman & Joy Jacqueline Pereira : **Pencirian Tanah Runtuh Di Universiti Kebangsaan Malaysia**

1645-1700	**P039** Abdullah Sulaiman,Jonathan Bull, John Davis, V.R. Vijayan, Mohd. Lokman Husain, Rosnan Yaacob and Peter R. Parham : **Quaternary Sediment Deposition And Submerged Palaeo Sea Level Terraces At Permatang Sedepa (One Fathom Bank) Area, Straits Of Malacca Related To Sea Level Changes Duringthe Late Pleistocene And Holocene**	**P065** Lee Kiun You & Ismail Abd. Rahim : **Application of Geological Strength Index (GSI) For The Tunnel In Crocker Formation: A Case Study In Tenom, Sabah, Malaysia**
1700-1715	**P045** Nur Susila Md. Saaid & Basir Jasin : **Litho and Biostratigraphy of the Tournaisian Chert, the Kubang Pasu Formation of the Kedah and Perlis, Malaysia.**	**P066** Muhammad Safwan Ishak , Ahmad Nizam Hasan , Ahmad Zulhilmy Ahmad Yusri , Abdul Kadir Ahmad Akhri , Dato' Zakaria Mohamed , Muhammad Shukri Ramlan , Rozeta Md Yusuf , and Siti Shaidatul Hanim : **Geological Consideration In Development And Landuse Planning For Soft Ground Area – Study Case Of BPK 7.2 Labu Lanjut, Sepang, Selangor Darul Ehsan**
1715-1730	**P046** Meor H. Amir Hassan , Aye-Ko Aung , R.T. Becker , Noor Atirah Abdul Rahman , Ng Tham Fatt , Azman A. Ghani , Mustaffa Kamal Shuib: **Carboniferous (Mississippian) Dropstones And Diamictite From The Chepor Member, Basal Kubang Pasu Formation: Earliest Record Of Glacial-Derived Deposits In Peninsular Malaysia**	**P070** Ismail Abd Rahim : **Geomechanical Classification Scheme For Heterogeneous Crocker Formation In Kota Kinabalu, Sabah, Malaysia: An Updated**
2000-2200	**CONFERENCE DINNER (Sponsored by Universiti Malaysia Terengganu)**	

DAY TWO : 14 JUN 2014 (SATURDAY) VENUE : PERHENTIAN HALL, GRAND CONTINENTAL HOTEL		
0845-0915	**KEYNOTE III** Dr. Kamaludin Hasan (JMG) **- Climate And Sea Level Change: The Late Quaternary Record In Malaysia**	
0915-0945	**KEYNOTE IV** Prof. Emeritus Dr. H.D. Tjia **- Stepwise sea-level changes since Mid-Holocene in Peninsular Malaysia**	
0945-1000	**TEA BREAK**	
Presentation Time	**SESSION C1 :** PETROLOGY/GEOCHEMISTRY PERHENTIAN HALL, GRAND CONTINENTAL HOTEL	**SESSION D1** : HYDROGEOLOGY KAPAS HALL, GRAND CONTINENTAL HOTEL
	Chairperson : Prof. Dr. Azman Ghani (UM)	***Chairperson : Dr. Edlic Sathiamurthy (UMT)***
1000-1015	**P016** Nur 'AishahZarime and W.Z.W. Yaacob: **Transport Behaviour of Cadmium through Compacted Granite Soil**	**P037** Atea.K.A.Abdalsadiq , Wan Zuhairi Yaacob , Abdul Rahim Samsudin And Jasni Yaacub : **Physical And Chemical Characteristics Of Ground Water In The First Aquifer Of Kota Bharu, North Kelantan, Malaysia**
1015-1030	**P024** Mohamad Shaufi Sokiman,Sharifah Nur Faizah Binti Syed Nooh,Dr. Nor Antonina Abdullah : **Sedimentology And Geochemistry Of Redang Island Sediments, Terengganu**	**P042** Jaineh Lingi & Baba Musta : **Kajian Geokimia Kesan Interaksi Batuan dan Air Bawah Tanah dalam Formasi Belait di Kg. Ganggarak, Utara Pulau Labuan**
1030-1045	**P027** Mohd Rozi Umor, Muhammad Asyraf Yusof, Ikhsan Zikrurramadhan, Azman Abd Ghani, Hamzah Mohamad, Mohd Shafeea Leman, Azimah Hussin, Habibah Jamil, Mohd Basril Iswadi, Goh Thian Lai, Norbert Simon, Marilah Sarman and Nur Syafina Roslan : **Kajian Geokimia Batuan Igneus Pulau Redang, Terengganu**	**P049** Azrul Normi Idris , Ahmad Zaharin Aris , Saim Suratman , and Ismail Tawnie : **Preliminary Hydrogeochemical Assessment of Kg Salang, Tioman Island, Pahang, Malaysia**

1045-1100	**P050** Norsafawati Saaid , Ng Tham Fatt & Azman A.Ghani : **Textural And Geochemical Transformation Of Granite Along Bukit Tinggi Fault Zone, Peninsular Malaysia**	**P056** Umi Amira Jamaluddin , Jasni Yaakub , Saim Suratman & Joy Jacqueline Pereira : **Sea-Level Rise – Threats To Groundwater**
1100-1115	**P053** Azmiah Jamil and Azman Abd. Ghani : **Petrology, Geochemistry & Geochronology Of Jerai Granite, Kedah**	
1115-1130	**SHORT BREAK**	
Presentation Time	**SESSION C2 :** PETROLOGY/GEO-CHEMISTRY PERHENTIAN HALL, GRAND CONTINENTAL HOTEL	**SESSION D2 :** HYDROGEOLOGY KAPAS HALL, GRAND CONTINENTAL HOTEL
	Chairperson : Prof. Dr. John Kuna Raj (UM)	***Chairperson: Tn. Hj. Mohammed Hatta Abd. Karim (JMG)***
1130-1145	**P012** C.H. Woo, Y.C. Chow, K.K. Teng & Mazshurraiezal Nasir : **Magnetic Characteristics Of The Rock Formations On Mount Kinabalu, Sabah.**	**P004** Andy A. Bery, Rosli Saad and M.M. Nordiana : **Time-Lapse Resistivity Tomography Using Optimized Resistivity Array And Engineering Soil Characterization For Slope Monitoring Study**
1145-1200	**P025** Noorhashima Binti Adenan , Che Aziz Ali & Kamal Roslan Mohamed : **Diagenetic History of the Chuping Limestone at Bukit Tengku Lembu, Perlis Malaysia**	**P073** M. F. Ishak , N. Ali , A. Kassim , T.A. Jamaluddin : **The Analysis of Slope Stability Due To Tree Induced Suction on Tropical Residual Soil**
1200-1215	**P029** Kamilia binti Sharir, Che Aziz Ali, Norbert Simon : **Lineament Orientations In Different Geological Formations In The Main Island Of Langkawi**	**P011** S.M. Goh, C.C. Yip, C.H. Woo & Y.C. Chow : **Electrical Resistivity Survey For Slope Stability Study At Taman Desa Ampang, Selangor**

1215-1230	**P030** Muhammad Fahmi bin Abdul Ghani, Norbert Simon, Goh Thian Lai, Abdul Ghani Rafek, Azimah Hussin, Mohd Rozi Umor, Rodeano Roslee, Lee Khai Ern, Mohd Basril Iswadi, Marilah Sarman and Nur Syafina Roslan : **Rock Mass Assessment Of Limestone Hills In The Kinta Region**	**P026** Mohd Khairul Nizar Shamsuddin, Anuar Sefie, Azrul Normi, Ismail Tawnie, Saim Suratman : **Impact of Sea Level Rise to the Coastal Groundwater Resources at Kuala Terengganu, Terengganu.**
1230-1245	**P059** Azman A Ghani , C.-H Lo and S.-L Chung : **Geochronology Of Volcanic And Plutonic Rocks From The Islands Off Pahang And East Johor, Peninsular Malaysia**	
1245-1400	**POSTER SESSION II AND LUNCH**	
Presentation Time	**SESSION E :** SEA LEVEL CHANGE/PALAEO ENVIRONMENT/POLICY PERHENTIAN HALL, GRAND CONTINENTAL HOTEL	**SESSION F :** ECONOMICS GEOLOGY/GEO-HERITAGE KAPAS HALL, GRAND CONTINENTAL HOTEL
	Chairperson : Dr. Kamaluddin Hasan (JMG)	***Chairperson : Prof. Dr. Mohd. Lokman Hussain (UMT)***
1400-1415	**P047** John Kuna Raj : **A Late Pleistocene Terrace And River Capture In The Kampung Air Jernih Area, Terengganu Darul Ehsan, Malaysia**	**P002** Ramli Mohd Osman, Ernest Geyer & Helmut Steiner : **Conservation of Gunung Lanno Cave Systems – Proposal for Geoheritage Site**
1415-1430	**P054** Junaidi Asis , Muhd Nur Ismail Abdul Rahman, Basir Jasin, and Sanudin Tahir : **Late Upper Oligocene to Lower Miocene Planktic Foraminifera from the Temburong Formation, Tenom, Sabah**	**P072** Mohd Sazaly Basarian and Sanudin Tahir : **Hot Water Reservoir Potential Using Geoelectrical Method In Apas Kiri, Tawau, Sabah**

1430-1445	**P055** S. Rokiah,P. R. Parham,H. Mohd Lokman,B. Satyanarayana, S.Noraisyah : **Modern Benthic Foraminifera Of Kelantan Delta Mangroves, Tumpat, Malaysia And Their Environmental Controls For Future Research In Sea-Level Studies**	**P035** Nur Atyrah binti Anua , Norbert Simon , Mohd Hariri Arifin , Goh Thian Lai , Nur Affiffah binti Mohd Nor , Azimah Hussin , Abdul Ghani Rafek , Mohd Rozi Umor , Mohd Basril Iswadi , Marilah Sarman , Nur Syafina Roslan : **Geothermal Exploration In Hulu Langat, Selangor**
1445-1500	**P063** Fatin Izzati Minhat, Peter R. Parham, Mohd Lokman Husain, and Behara Satyanarayana : **Review Of Foraminiferal Studies In Nearshore Areas, Peninsular Malaysia**	**P038** Muhammad Mustadza Mazni : **Sumber Geowarisan Dan Geopelancongan Di Sekitar Pembangunan Wilayah Koridor Galakan Pelancongan Negeri Perlis**
1500-1515	**P068** Joanes Muda : **Geological Indicators Of Sea-Level Changes At Northern Sabah, Malaysia: Tools For Instilling Public Awareness On Global Climate Changes**	**P044** Adebanji Kayode Adegoke , Wan Hasiah Abdullah : **Source Rock Characteristics, Burial History Reconstruction And Thermal Maturity Modelling Of Late Cretaceous Sequences In The Chad (Bornu) Basin, NE Nigeria.**
1515-1530	**P069** Edlic Shathiamurthy ,Md. Mostafizur Rahman ,Zhifei Liu : **LGM to Recent incised channel morphology on Offshore Pahang**	**P048** Azmi bin Abu Bakar , Azimah binti Hussin : **Kepelbagaian Sumber Silika Di Negeri Perak**
1530-1545	**P075** Mazlan Madon : **Geology and the Law of the Sea: The Work of the Commission on the Limits of the Continental Shelf**	**P058** Jagaan Selladuri & Askury bin Abd Kadir : **Optimization of Malaysian Mica in Oil Based Mud**
1545-1400	**P076** Manoj Mathew , David Menier , Abdul Hadi Abdul Rahman , Manuel Pubellier, Yazid Mansor , Numair Siddiqui , Peter Parham : **Tectonic And Eustatic Controls Onmiocene Sedimentation Of Nyalau Formation (Sarawak, Borneo)**	**P013** Md. Farhaduzzaman, Wan Hasiah Abdullah, Md. Aminul Islam and Delwar Hossain : **Hydrocarbon generation potential, source input and depositional condition of the Miocene Bhuban Formation shales, Bengal Basin, Bangladesh.**

1600-1615	**P077** Manoj Mathew , David Menier , Abdul Hadi Abdul Rahman , Manuel Pubellier , Yazid Mansor , Numair Siddiqui , Peter Parham : **Preliminary Analysis Of Palaeochannels And Associated Depositional System Of Bay Of Terengganu (West Malaysia)**	
1615	**COSING CEREMONY**	
1715	**TEA BREAK**	

POSTER PRESENTATIONS

1	**P001** Siearra Celastra, Sarina Ramli and Ramli Mohd Osman : **Meeting The Challenge Of Penjom Gold Mine Geology In The Recovery Of Fine Gold In Carbonaceous Ores**
2	**P007** Ramli Mohd Osman and Nor Azlin Hj Ahmad : **Geospatial Analyses Of Ex-Mining Land In Johor**
3	**P009** Goh Thian Lai , Abdul Ghani Rafek , Ailie Sofyiana. Serasa , Norbert Simon & Lee Khai Ern : **Estimating Uniaxial Compressive Strength from Slowness : Malaysian granites**
4	**P015** Nur Athirah Mohamad Basir &Wan Zuhairi Wan Yaacob : **Ladle Furnace Slag, Bentonite, Zeolite And Active Carbon For Remediation Of Acid Mine Drainage**
5	**P020** Ahmad Faiz Salmanfarsi , Mustaffa Kamal Shuib : **Sheared granite along K173, Baling-Gerik Highway, Kedah**
6	**P023** Mohamad Shaufi Sokiman and Nor Antonina Abdullah : **A Study On The Mineral Contents, Sedimentological Characteristics And Chemistry Of Kemaman Coastal Sediments**
7	**P028** Mohd Rozi Umor , Azman Abd Ghani, Hamzah Mohamad, Mohd Shafeea Leman, Azimah Hussin, Habibah Jamil, Mohd Basril Iswadi, Goh Thian Lai, Norbert Simon, Marilah Sarman and Nur Syafina Roslan : **Kajian Petrografi Dan Geokimia Pluton Bukit Tinggi Di Sepanjang Jalan Empangan Kuala Kubu Bharu Ke Bukit Fraser, Selangor**
8	**P040** Dony Adriansyah Nazaruddin : **Geo-Imagination As A New Approach To Socialize Geology To Public: A Case Study In Malaysia**
9	**P041** Abdul Rahim Samsudin, Nur Suraya Ahmad & Umar Hamzah : **Geophysical Evidences Of A Possible Meteorite Impact Crater At Langkawi Island , Kedah**
10	**P052** Ramli Mohd Osman and Meor Abdul Rahman Meor Taharim : **Estimation Of Sub-Surface Limestone Reserve Under Idle Ex-Mining Land In Perak**

11	**P060** Azman A Ghani, Muzammil Shahjamal : **Ce anomaly in weathering profile of I type fractionated granitic rock from Peninsular Malaysia**
12	**P061** Azman A Ghani : **Tectonic setting of basaltic dykes from the Eastern Belt of Peninsular Malaysia**
13	**P067** Muhammad Shukri Ramlan , Dato' Zakaria Mohamed , Ahmad Nizam Hasan , Ahmad Zulhilmy Ahmad Yusri , Muhammad Safwan Ishak , Abdul Kadir Ahmad Akhri , Rozeta Md Yusuf , and Siti Shaidatul Hanim Saharudin : **Pelan Kekangan Geologi Dalam Penghasilan Pelan Impak Pembangunan Sebagai Kawalan Pembangunan Guna Tanah Majlis Perbandaran Sepang**
14	**P074** Mei Kee Koh , Khawar Sultan , Edlic Sathiamurthy , Zhifei Liu : **Geochemistry Characterization Of Clay Mineralogy In Surface Sediment Of Kelantan River, Terengganu River And Pahang River Of Peninsular Malaysia**
15	**P078** Mat Niza bin Abdul Rahman, Hamid bin Ariffin, Mohamad Hussein bin Jamaluddin and Suvapak Imsamut : **Lithostratigraphic correlation of the Rebak/Khuan Klang Formation along the Malaysia-Thailand border area**
16	**P079** Mohamad Hussein bin Jamaluddin and Mat Niza bin Abdul Rahman : **Lithology and Stratigraphy of the Panau formation**
17	**P080** Kamar Shah Ariffin : **Application of Seismic refraction imaging in Lampas Kaolin deposit genetic modeling, Simpang Pulai-Pos Slim, Ipoh**
18	**P081** Zamzarina, Umar Hamzah and Abdul Rahim Samsudin : **Analisis Morfologi sungai dengan teknik potongan-masa seismic 3D: Satu kajian awal pada blok timur laut Lembangan Melayu**
19	**P082** Hamlee Ismail : **Stratigrafi dan Paleontologi Paya Peda, Jertih, Terengganu**
20	**P083** Muhammad Mustaqim bin Mohd Rosli : **Wind Influence Towards Shoreline Movement At Pantai Sabak, Kelantan Darulnaim**

21	P**084** Nur Hazmira bt Nawi : **Soil Erosion Risk Assessments Using GIS for Chin Tick Farm, Gua Musang, Kelantan**
22	**P085** Noraisyah, S., Parham, P.R., Mohd-Lokman, H., Rosnan, Y. ,Nor-Antonina, A. and Rokiah, S: **Sandy Beach Morphodynamic Classifications Index Based On Wright And Short (1984) At Selected Beaches Along Terengganu, Malaysia**

NOTES

KEYNOTE 1

IPCC AR5 Key Findings on Past, Present and Future Climate Change

Prof. Dr. FredolinTangang

IPCC Working Group I Vice-Chair

The Inter-governmental Panel on Climate Change (IPCC), a panel under the United Nations, in September 2013 released its latest climate change report "*Climate Change 2013: The Physical Basis*" as the Working Group I (WG1) latest contribution to the IPCC Fifth Assessment Report (AR5). This report presents new evidence of past and future climate change based on many independent scientific analyses including from observations of the climate system, paleoclimate archives, theoretical studies of climate processes and simulations using climate models. The report represents thelatest and comprehensive assessment of scientific body of knowledge on the physical basis of climate change, both at global and regional scales. Throughout its preparation it involved 259 lead authors and received 54,667 review comments from 1089 experts. This report concluded that warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.

The report concluded that human influence on the climate system is clear. Concentrations of CO_2, CH_4, and N_2O now substantially exceed the highest concentrations recorded in ice cores during the past 800,000 years. The mean rates of increase in atmospheric concentrations over the past century are, with *very high confidence*, unprecedented in the last 22,000 years. It is *extremely likely* that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. Over a period of more than 100 years (1880-2012), the globally combined land and ocean surface temperature data as calculated by a linear trend, show a warming of 0.85 [0.65 to 1.06]°C.Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 (*high confidence*). On a global scale, the ocean warming is largest near the surface, and the upper 75 m warmed by 0.11 [0.09 to 0.13] °C per decade over the period 1971 to 2010. It is *virtually certain* that the upper ocean (0–700 m) warmed from 1971 to 2010, and it *likely* warmed between the 1870s and 1971. Over the last two decades, the Greenland and Antarctic ice sheets have been losing mass, glaciers have continued to shrink almost worldwide, and Arctic sea ice and Northern Hemisphere spring snow cover have continued to decrease in extent (*high confidence*). The average rate of ice lossfrom glaciers around the world, excluding glaciers on the periphery of the ice sheets, was *very likely* 226 [91 to 361] $Gtyr^{-1}$ over the period 1971 to 2009, and *very likely* 275 [140 to 410] $Gtyr^{-1}$ over the period 1993 to 2009. The average rate of ice loss from the Greenland ice sheet has *very likely* substantially increased from 34 [–6 to 74] $Gtyr^{-1}$ over the period 1992 to 2001 to 215 [157 to 274] $Gtyr^{-1}$ over the period 2002 to 2011. The average rate of ice loss from the Antarctic ice sheet has *likely* increased from 30 [–37 to 97] $Gtyr^{-1}$ over the period 1992–2001 to 147 [72 to 221] $Gtyr^{-1}$ over the period 2002 to 2011. There is *very high confidence* that these losses are mainly from the northern Antarctic Peninsula and the Amundsen Sea sector of West Antarctica. The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia (*high confidence*). Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] m.

The report also stated that, in comparison to the less than 1°C increase in the global mean air temperature during the last century, the projected increment by the end of the 21st century will be much higher unless theconcentration growth of greenhouse gases in the atmosphere can bereduced. Increase of global mean surface temperatures for 2081–2100 relative to 1986–2005 is projected to *likely* be in the ranges derived from the concentration-driven CMIP5 model simulations, that is, 0.3°C to 1.7°C (RCP2.6), 1.1°C to 2.6°C (RCP4.5), 1.4°C to 3.1°C (RCP6.0), 2.6°C to 4.8°C (RCP8.5). For the ocean, the best estimates of ocean warming in the top one hundred meters were about 0.6°C (RCP2.6) to 2.0°C (RCP8.5), and about 0.3°C (RCP2.6) to 0.6°C (RCP8.5) at a depth of about 1000 m by the end of the 21st century. For cryosphere, year-round reductions in Arctic sea ice extent are projected by the end of the 21st century from multi-model averages. These reductions range from 43% for RCP2.6 to 94% for RCP8.5 in September and from 8% for RCP2.6 to 34% for RCP8.5 in February (*medium confidence*). Global mean sea level rise for 2081–2100 relative to 1986–2005 will *likely* be in the ranges of 0.26 to 0.55 m for RCP2.6, 0.32 to 0.63 m for RCP4.5, 0.33 to 0.63 m for RCP6.0, and 0.45 to 0.82 m for RCP8.5 (*medium confidence*). For RCP8.5, the rise by the year 2100 is 0.52 to 0.98 m, with a rate during 2081 to 2100 of 8 to 16 mm yr^{-1}(*medium confidence*).

KEYNOTE 2

Clarification on Stratigraphic Correlation and Dating of Upper Cainozoic Alluvium in western Peninsular Malaysia

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Malaysia was the world's largest tin producer for 100 years until mid-1980s, with more than 95% mined from placers. Numerous mine exposures and drillholes facilitated detailed study of the Upper Cainozoic alluvium, especially in Perak and Selangor, as well as the Indonesian Tin Islands. Batchelor (1979) building upon work of Walker (1956) and Stauffer (1973), proposed a regional Upper Cainozoic stratigraphic scheme (Figure 1) incorporating the traditional division of "Old Alluvium" and "Young Alluvium", and correlated the Indonesian offshore units of Aleva and Others (1973). The important distinction between the Old Alluvium (OA) and the Young Alluvium (YA) in presently emergent and nearshore areas of the Sundaland continent shows that OA comprises less well sorted generally aggrading alluvial fan and plain deposits of broad palaeochannel systems while the YA infills V--shaped valleys incised into the landscape. These units reflect a major palaeogeomorphological change. The Transitional Unit was deposited during transition between the two dominant regimes. The bulk of placer tin deposits lies within the Old Alluvium and Transitional Unit. Evidence was published for dating these units using palaeoenvironmental and sea level changes, palaeomagnetism, palynology, and radiocarbon dating (Batchelor 1988).

From studies in Perak and the East Coast Suntharalingam also erected Upper Cainozoic stratigraphic units (Suntharalingam, 1983) including the continental Simpang Formation and Beruas Formation. He correlated the Simpang Formation with the Older Alluvium of Walker (1956) and believed it to be Pleistocene, and the latter with the Young Alluvium of Walker (1956). A difference in views exists on dating of the Old Alluvium. Batchelor (1988) demonstrated that its age likely extends from Late Pliocene to Middle Pleistocene time, prior to the Brunhes normal magnetic period (>0.75 Ma BP), while the Young Alluvium was determined as Late Pleistocene to Holocene. Kamaludin (1993) suggested however, the Simpang Formation dates in part to Late Pleistocene based on "young" radiocarbon dates (28 ka BP to 67 ka BP). I argue strongly against such ages for the Old Alluvium and believe instead that young dates attributed to the Old Alluvium have either (1) been wrongly attributed and actually derive from younger units (e.g. YA) separated by erosional disconformity from OA, or (2) the original carbon has been contaminated with young carbon, a common situation near the maximum range of the C-14 method.

The former case is apparent where the upper sequence in Teluk Mengkudu, Pantai Remis, Perak attributed to the Old Alluvium by Kamaludin (1993), is from my own studies most likely part of the Young Alluvium in the sequence published in Batchelor (1988; Table 2) and described in detail in my 1983 PhD thesis. A widespread episode of organic peat deposition is assigned by Walker (1956) to a distinct post-Old Alluvium depositional phase. Radiocarbon dates of ±61,080 to ±67,860 yr BP from deeper possibly OA horizons cannot however, be considered authoritative for such age for the Old Alluvium. Organic deposits within the upper OA are quite rare and may have resulted from regional forest devastation due to effects of the well-documented 0.8 Ma BP Southeast Asian tektite meteorite shower.

References

Aleva GJJ, Bon EH, Nossin, JJ and Sluiter WJ 1973. A contribution to the geology of part of the Indonesian Tinbelt– the sea areas between Singkep and Bangka Islands and around the Karimata Islands. Bull. Geol. Soc. Malaysia 6: 61-86.

Batchelor BC 1979. Geological characteristics of certain coastal and offshore placers as essential guides for tin exploration in Sundaland, Southeast Asia. Bull. Geol. Soc. Malaysia 11: 283 – 313.

Batchelor DAB 1988. Dating of Malaysian fluvial tin placers. J. Southeast Asian Earth Sciences 2(1): 3-14.

Kamaludin bH, Nakamura T, Woodroffe, CD and Fuji S 1993. Radiocarbon and thermoluminescence dating of the Old Alluvium from a coastal site in Perak, Malaysia. Sediment. Geol. 83: 199-210.

Stauffer PH 1973. Cenozoic In: Geology of the Malay Peninsula (West Malaysia and Singapore), DJ Gobbett and CS Hutchison (eds))(New York: Wiley): 143-176.

Suntharalingam T 1983. Cenozoic Stratigraphy of Peninsular Malaysia. Proc., Workshop on Stratigraphic Correlation of Thailand and Malaysia, Haad Yai, Thailand, 8-10 September 1983: 149-158.

Walker D 1956. Studies in the Quaternary of the Malay Peninsula. 1. Alluvial deposits of Perak and changes in the relative levels of land and sea. Fed. Mus. J., 1 and 2: 19-34.

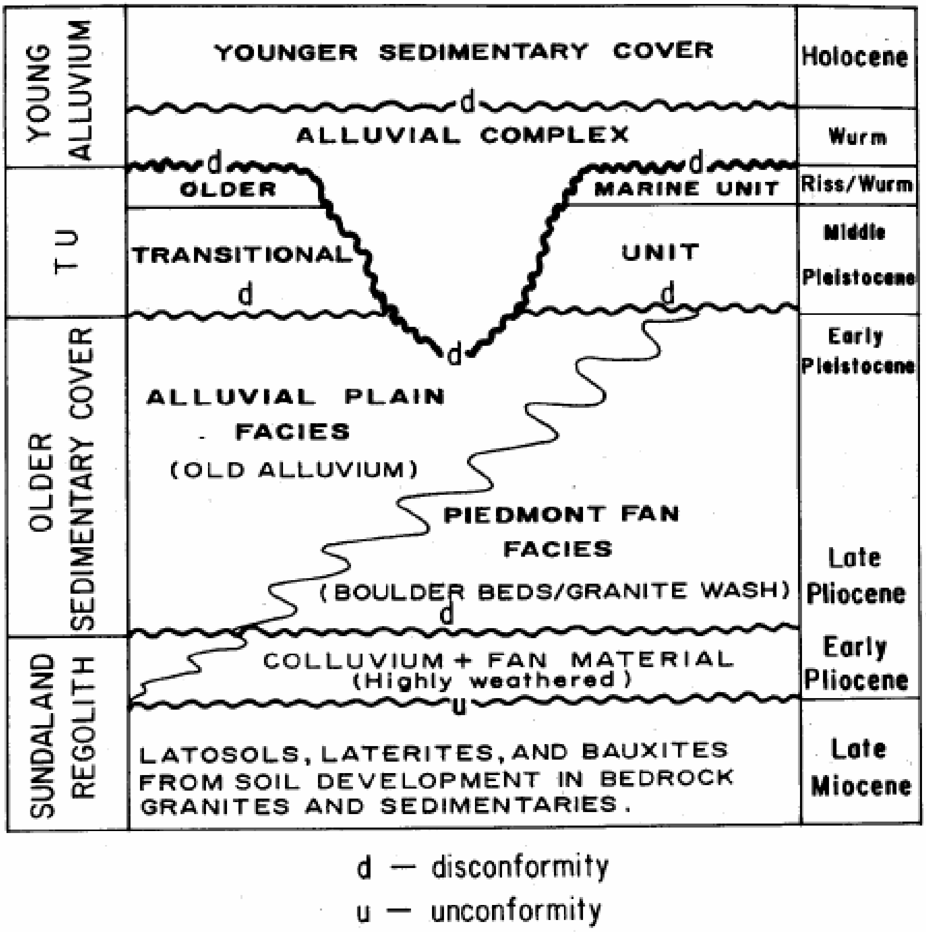

Fig. 7. Regional Late Cainozoic stratigraphic relationships in Sundaland, Southeast Asia.

KEYNOTE 3

Climate and Sea Level Change: The Late Quaternary Record in Malaysia

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The earth's climate has changed throughout the geological history. Periods of warm and cool global climates are known, none more significant than the Quaternary where staggering periods of cold and warm phases being recorded in a comparatively very short geological time scale. Climate variables measurements have been interpreted from climate proxy records such as sediments, fossils and isotopic evidences extracted from diverse sedimentary environments like the deep oceans, mountains, coasts and lakes; and ice cores from polar ice caps and glaciers, and others.

Among the most compelling evidence of climate change is the sea level change. The cycles of glacial and interglacial periods recorded in the northern hemisphere during the Pleistocene had successively influenced the expansion and contraction of the continental ice sheets. In response, global sea levels had fluctuated, as a result of repeated abstraction of water from and its return to the sea and oceans. During the glacial phase large tract of the earth's land masses were covered by ice sheets. Global temperature was estimated lowered by 8-10°C and sea level was low and has been estimated at around 120 m below the present sea level, during the glacial maximum.

In Malaysia the late Quaternary climate change and the consequent sea level change records are known from many parts of the country. The late Pleistocene glacial low sea level stands is revealed from the offshore Malay basin in the South China Sea and investigated in the tin mine exposures in the state of Perak. The interglacial mid-Holocene high sea level is fairly widespread while the Little Ice Age low sea level is still being discovered.

The future climate and sea level change are presently scenarios of much concerned and debated. The Intergovernmental Panel on Climate Change in its Fifth Assessment Report has indicated that global warming is unequivocal while global mean sea level will continue to rise in the 21st Century. Estimate for Malaysia is that sea level rise of at least 2mm/yr is projected till the end of this century. The future impact that the sea level rise will have on our coasts will be significant, to which the government, planners and we as citizens need to be aware, informed and be prepared.

KEYNOTE 4

Stepwise Sea-Level Changes since Mid-Holocene in Peninsular Malaysia

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Peninsular Malaysia is part of the semi-cratonic terrane known as Sundaland. Throughout the Cenozoic, Sundaland has experienced average annual vertical movements only in the sub-millimeter range. Coseismic uplift and subsidence in the Peninsula resulting from the 2004-mega earthquake of the northeastern Indian Ocean bear this out. Tectonic lateral displacements on the known major wrench faults may be of much larger orders (as suggested by seismic data in the subsurface of the Tertiary basins offshore the Peninsula) but effects of crustal deformation have probably been restricted to the immediate surroundings of the faults. For the short time span of the past 5000 years (since the Mid Holocene), amounts of vertical displacement of the crust of the Peninsula can thus be ignored.

Fossil biogenic and morphological paleo-shoreline indicators comprise upper tidal zone rock-clinging oysters and calcareous algal crusts, near sub-low-tide corals and Tridacna sp., elevated calcareous beach rock, buried subsea-bottom mollusks, mangrove-peat layers and lenses, predominantly fish-hook type sea-level notches (in limestone cliffs and occasionally also in non-calcarous sea walls), abrasion platforms, several levels of accordant tops in boulders of hard rock, and beachridge systems. The accuracy of paleo-elevation of former strandlines determined by these indicators remains in the half-meter range.

To date, eighty of these indicators provide radiometric ages that define a rapidly rising sea from at least -70-m low stand in post-Late Glacial Maximum (LGM) time to peak 4 to 4.5 m above present sea level around 4400 y B.P. Since then secular sea level on the Peninsular coast progressively subsided three times before again rising a meter or so four hundred years ago. Initially, the successive post-Mid Holocene sea level drops were interpreted to follow a wave-like progression. The common presence of stacked sea-level notches, of series of abrasion surfaces and of accordant boulder tops on the coasts of the Peninsula as well as elsewhere in Sundaland (such as the in Indonesian tin islands of Bangka, Belitung, Singkep, Kundur; see Tjia et al. 1983/1984) is better explained by stepwise descent of the sea since the Mid Holocene (figures 1 and 2). The mentioned morphological indicators could only be formed if the descending sea remained temporarily stationary to allow abrasion to carve the respective notches and rocky flats.

In the early part of the Holocene, abnormally high shorelines left marks in northwestern Peninsular Malaysia. A westward shift of the geoid was the most likely cause. The shift may be attributed to decrease of the Earth's spin rate belatedly reacting to redistribution of surface loads of ice masses melting into ocean waters, or to one of the Milankovitch cycles.

Unresolved issues of paleo-sea level stands concern the relative elevation of the older and Holocene beachridge series, absence of ridges in a relatively wide zone between these two series, several distinct stream-course deflections in the post-mid Holocene coastal plains bordering the South China Sea as well as those fronting the Malacca Strait, and the several tens of meter high flat upland surfaces all along the east coast, and Johor and Kulim.

REFERENCES

Tjia, H.D., S. Fujii & K. Kigoshi 1983, Holocene shorelines of Tioman Island in the South China Sea. Geologie en Mijnbouw 62: 599-604.

Tjia, H.D., S. Sujitno, Y. Sukliya, R.A. Harsono, A. Rahman, J. Hainim & Djunaedi 1983/1984, Holocene shorelines in the Indonesian tin islands. Modern Quaternary Research in Southeast Asia 8: 103-117.

Tjia, H.D. & Sharifah Mastura S.A. 2013, Sea Level Changes in Peninsular Malaysia: A Geological Record. Universiti Kebangsaan Malaysia Publisher, Bangi: 150 pages.

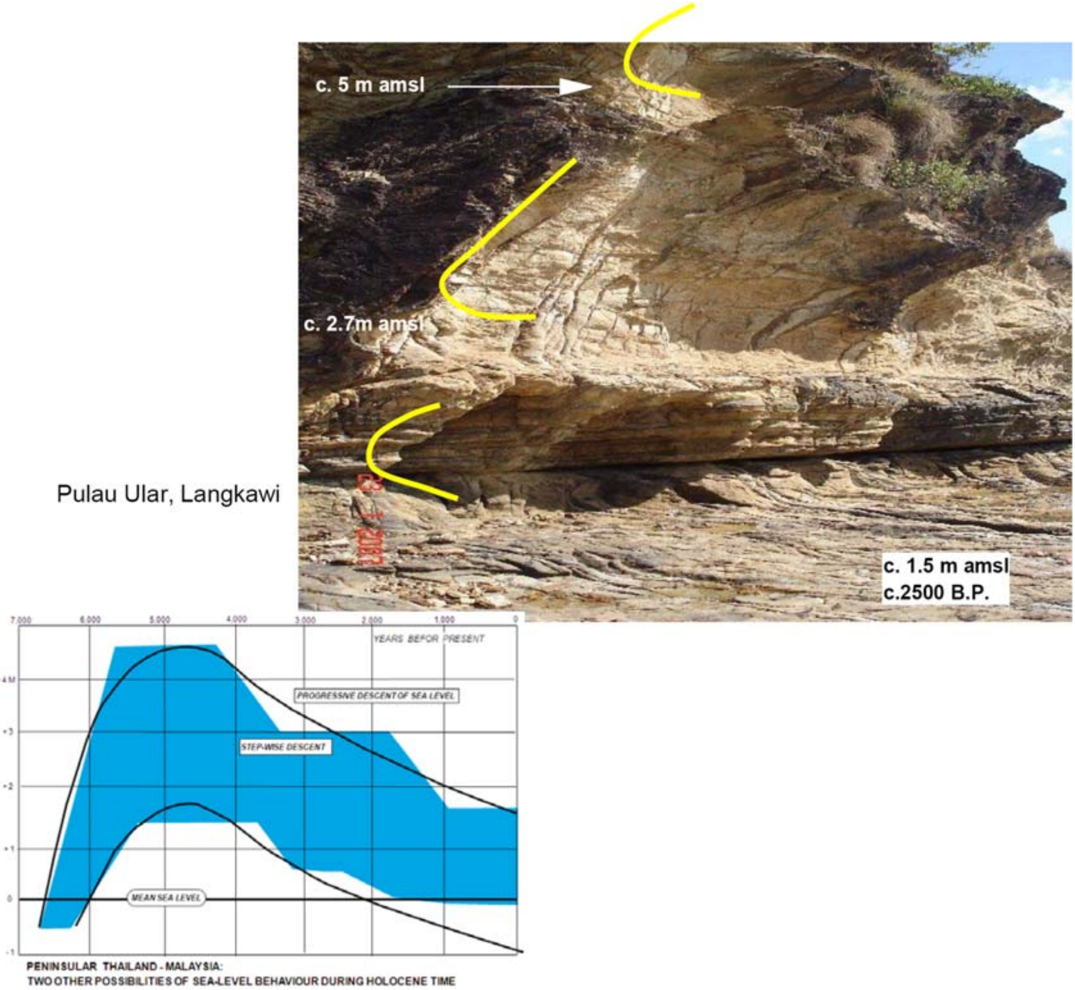

Figure 1. Smaller figure: After reaching the Mid-Holocene high the paleo-sea descended stepwise as indicated by a series of stacked notches at Pulau Ular, Langkawi Islands (upper figure). Between the two sinusoidal curves are most of the eighty radiometrically dated shoreline indicators determined from the Peninsula. The curves also represent the general sea level change reaching a high in Mid-Holocene followed by a general fall to its current position, The blue stepped zone indicates how the descent proceeded. From Tjia & Sharifah Mastura (2013).

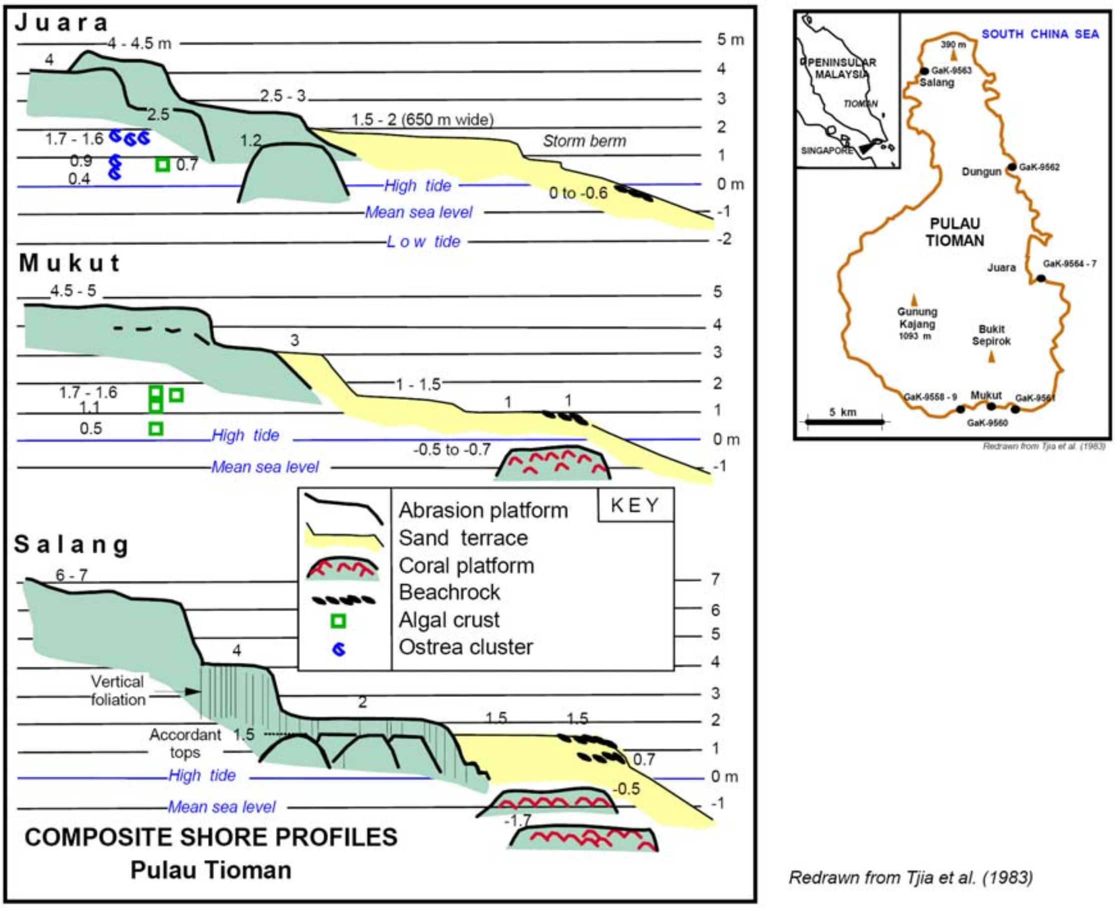

Figure 2. Series of stacked abrasion surfaces on hard rock ,with several of their associated biogenic indicators dated radiometrically, support stepwise descent of sea level since the Mid Holocene. These three localities are at Pulau Tioman located in the interior of Sundaland.

P003

Cape Peron – a Hike Through the Upper Quaternary

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Today's coastline may appear unchanging – a fixed curved line on a map, but of course it is forever changing - building out, eroding back. During the Ice ages of the last few hundred thousand years, this coastline repeatedly migrated back and forth many kilometers over the coastal plain as the sea level rose and fell. To represent this coastal dynamics due to sea-level changes in the Perth region (from Guilderton to Mandurah), the authors had chosen Cape Peron as the study site. Fairbridge (1950) described in detail the geology and geomorphology of Cape Peron, and through his work Cape Peron has become a site of global significance in studying worldwide (eustatic) changes in sea level (Fairbridge, 1961). Later studies include that of Passmore (1967). Cape Peron is composed of Tamala Limestone, overlain by dune sand of the Quindalup Dune System. Here the Tamala Limestone (associated with calcrete and rhizoliths) is all large-scale cross-bedded, indicative of aeolian origin, and no marine foreshore or nearshore deposits have been recognised within the aeolian sequence.Rocks exposed along the coast at Cape Peron show evidence for sea-level changeswith sub-aerial features below sea level, elevated marine and beach deposits (beach rocks) and elevated wave-cut platforms and notches (Gozzard, 2007).

Without doubt, the most obvious of the coastal features around Cape Peron are the elevated shoreline platforms. Three levels of shoreline platforms can be recognised: an upper level at about 3 m; an intermediate level at about 1.5 m; and a lower level at about 0.6 m above the modern shoreline platform. Playford (1988) described three levels of elevated shoreline platforms on Rottnest Island, at 2.4 m, 1.1 m, and 0.5 m above the elevation of the modern platform. Since absolute dating of the elevated shoreline platforms at Cape Peron has been problematic (Gozzard, 2007), and given that both Cape Peron and Rottnest Island have similar geomorphological settings, and similar elevation of these ancient shorelines, it is tempting to immediately correlate the three levels at Cape Peron with the three levels on Rottnest Island, however there are differences. This paper will discuss these differences.

From radiocarbon data and sea-level indicators in the measured sections of the sand ridges (each marking the position of a former shoreline), Searle and Woods (1986) and Searle et al. (1988) were able to construct a sea-level history from Rockingham-Bercherplain. Although this reconstructed sea-level curve is in general agreement with previous studies in this region (Fairbridge, 1961; Playford 1988), there are some significant differences. This paper will also discuss these differences.

Since then significant progress has been made to extend sea-level research in regard to the post-glacial sea-level rise globally and around the Australian coasts. This paper attempts to highlight the evidence of sea-level changes at Cape Peron and the Perth region by interpreting them using Miller et al. (2005) Phanerozoic record of global sea-level change curve and work by Lewis et al.(2012) post-glacial sea-level changes around the Australian margin.

On the national front, the paper will compare these findings with the sea level curve for the Sunda Shelf derived from shoreline facies of cored samples (Hanebuth et al., 2000 and Kamaludin, 2004) and works on Holocene sea level transgression in the Sunda Shelf (Sathiamurthy and Voris, 2006). It is of interest to note that although these regional sea-level data indicate a maximum Holocene highstand up to 5 m above present, whereas in the Perth region and Western Australia the maximum transgression is 3 m, the previously thought timing of these highstands are similar, i.e. between about 6,000 to 4,000 years ago. It is also of interest to note that the work of Parham et al. (2013) for maximum Holocene transgression in Terengganu mainland in Peninsular Malaysia occurred at about 7,000 years ago is similar to that of Lewis et al. (2012) for Western Australia.

However, to the authors' current knowledge, there is no evidence of occurrence of the dipping of sea-level below present level due to the Little Ice Age event in Late Holocene in the Perth region or in Western Australia or in Australia as noted by Kamaludinet al. (2013) at Merang, Terengganu, Peninsular Malaysia.

REFERENCES

Fairbridge, R.W., 1950. The geology and geomorphology of Point Peron, Western Australia, Journal of the Royal Society of Western Australia, v. 34, p. 35-72.

Fairbridge, R.W., 1961. Eustatic changes in sea level, in Physics and chemistry of the earth, v. 4, Pergamon, London, p. 99-185.

Gozzard, J.R. 2007.Geology and landforms of the Perth Region, Western Australia Geological Survey,pp. 126.

Hanbuth, T., Stattegger, K., and Grootes, P.M., 2000. Rapid flooding of the Sunda Shelf: a late glacial sea-level record, Science, 288, 1033-1035.

Kamaludin Hassan, 2004. The postglacial and Holocene periods. In: Nik Hassan Shuhaimi (ed) Early History, The Encyclopedia of Malaysia, Archipelago Press, 16-17.

Kamaludin Hassan, Tuan Rusli Tuan Mohamed, SuzannahAkmal, KadderiMdDesa, HabibahJamil, and Zong, Y., 2013. Paleo sea-level changes at Merang, Terengganu, Proceedings of the National Geoscience Conference 2013, Ipoh, 8-9th June 2013.

Lewis, S.E., Sloss, C.R., Murray-Wallace, C.V., Woodroffe, C.D., and Smithers, S.G., 2012. Post-glacial sea-level changes around the Australian margin: a review, Quaternary Science Reviews (2012), http://dx.doi.org/10.1016/j.quascirev.2012.09.006.

Miller, K.G., Kominz, M.A., Browning, J.V., Wright, J.D., Mountain, G.S., Katz, M.E., Sugarman, P.J., Cramer, B.S., Christie-Blick, N., and Pekar, S.F., 2005. The Phanerozoic record of global sea-level change, Science 25 November 2005, vol. 310, no. 5752, pp. 1293-1298.

Parham, P.R., Saito, Y., NoraisyahSapon, RokiahSuriadi, and Noor AzariyahMohtar, 2013. An early Mid-Holocene coral reef and extensive marine deposits on the Terengganu mainland, Peninsular Malaysia: implications for maximum Holocene transgression, Proceedings of the National Geoscience Conference 2013, Ipoh, 8-9th June 2013.

Passmore, J.R., 1967. The geology, hydrology, and contamination of shallow coastal aquifers in the Rockingham District, Western Australia, University of Western Australia, PhD thesis (unpublished).

Playford, P.E., 1988. Guidebook to the geology of Rottnest Island, Excursion Guidebook no. 2, Geological Society of Australia, Western Australia Division, pp. 67.

Sathiamurthy, E. and Voris, H. K., 2006. Maps of Holocene sea level transgression and submerged lakes on the Sunda Shelf, The Natural History Journal of Chulalongkorn University, Supplement 2:1-43.

Searle, D.J., Semeniuk, V., and Woods, P.J., 1988. Geomorphology, stratigraphy and Holocene history of the Rockingham-Becher Plain, south-western Australia, Journal of the Royal Society of Western Australia, v. 70, p. 89-109.

Searle, D.J., and Woods, P.J., 1986. Detailed documentation of a Holocene sea level record in the Perth region, southern Western Australia,Quaternary Research, v. 26, p. 229-308.

P017

Perkembangan Delta Kelantan

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Sungai Kelantan yang mengalir ke Laut China Selatan merupakan sebuah sungai utama di Semenanjung Malaysia yang membentuk satu kompleks delta yang besar dan sangat padat dengan penduduk. Kawasan tadahan sistem delta ini merangkumi hampir keseluruhan keluasan negeri Kelantan, yang menjadi punca sedimen dan membekalkan pasir dan lumpur ke delta. Delta Kelantan terdedah kepada pengaruh ombak yang kuat terutama semasa musim monsun timurlaut (November-Februari) setiap tahun dan juga aliran arus susur tepi pantai yang mengarah ke barat. Pengaruh sungai, ombak serta arus lautan dan juga pasang surut memainkan peranan penting dalam perkembangan delta ini. Sedimen lumpur dan pasir yang dibawa dan dienapkan oleh sungai di bahagian muara akan diubahsuai atau dikerjakan semula oleh ombak dan arus lautan. Arus susur tepi pantai akan membawa sedimen ini ke arah barat membentuk beting pasir. Beting pasir ini membesar dan memanjang ke arah barat yang akhirnya menyebabkan terbentuk satu pantai yang terlindung atau lagun. Ombak di musim tengkujuh pula menghakis dan menolak beting pasir ini menghampiri pantai menyebabkan lagun makin mengecil. Dengan mengkaji peta topografi, gambar udara dan juga imej satelit pada tarikh yang berbeza, perkembangan Delta Kelantan perhatikan. Proses pembentukan beting pasir yang membesar ke aras barat dan pada masa yang sama beting bergerak juga ke arah daratan boleh diperhatikan berlaku berulang kali dan data-data yang ada ini mungkin boleh dianalisis dan digunakan untuk mengkaji perubahan delta di masa hadapan.

P022

Holocene Coastal Response to Monsoons and Relative Sea-Level Changes in Northeast Peninsular Malaysia

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The mid to late Holocene coastal evolution of the Setiu estuary/lagoon (northeast peninsular Malaysia) has been studied using a multidisciplinary/multiproxy approach including sedimentologic, geomorphologic, and ground penetrating radar (GPR) data combined with optically stimulated luminescence (OSL), radiocarbon and Pb-210 age estimates to provide the chronologic framework. The Setiu coastal region of Terengganu comprises five geological and geomorphic units representing distinct evolutionary phases of this coastline. Estimated marine limiting point elevations indicate deposition of an aggradational strandplain shoreline associated with a sea-level elevation of ca. -0.1 to +1.7 m between ca. 6.8 ka and 5.7 ka, in agreement with previous sea-level studies from the Malay-Thai peninsula (Tjia and Fujii, 1992; Tjia, 1997; Kamaludin, 2002; Horton et al. (2005). A rapid sea-level rise may have occurred between ca. 5.7 ka and 3.0 ka resulting in shoreline erosion and a hiatus between successive coastal units. Relative sea-level fall occurred between ca. 3.0 and 1.9 ka, resulting in a progradational system. A brief period of relative sea-level rise or still-stand occurred between ca. 1.9 and 1.4 ka, creating an aggradational to transgressive barrier and estuary. Relative sea-level fall at ca. 1.4 ka caused further progradation and abandonment of the estuary and barrier island. This was followed by another reversal in mode creating another barrier and estuary, bracketed between 1.4 ka and 0.3 ka. The final phase began at ca. 300 cal y BP and established the modern transgressive barrier and Setiu estuary/lagoon, and associated mangrove swamps. The new GPR, OSL and radiocarbon data add to our understanding of Holocene coastal evolution of this coastal system and the response to sea-level change and monsoons and corroborate previous research (Teh, 1980, 1993). Data suggest that sequential development of clinoforms and ultimate progradation is dictated by monsoonal variations, with erosional/depositional cycles occurring on annual to decadal scales. The data support an oscillating relative sea-level possibly governed by meteorological phenomena such as ENSO variability, but a possible correlation to sea-level records from widely separate areas also suggests a global sea-level signal. Thus, coastal facies can be useful proxy indicators for meteorological and paleoclimatic change across a wide temporal spectrum (decadal to millennial time-scales).

We performed a high-resolution study of the final phase of coastal evolution and sea-level changes in the Setiu wetland (the past ca. 300 years) based on mangrove swamp foraminifera. Foraminferal data from three surface transects across fringing mangrove swamps were used to interpret foraminiferal data from four cores from high to mid mangrove swamp settings. Patterns of foraminiferal distribution were determined by correspondence analysis, canonical correspondence analysis and detrended canonical correspondence analysis of dead assemblage data. We used weighted averaging as the transfer function model and produced a composite reconstruction of sea level for the last ca. 200 years. Sea level rose during the 19th century at1.26 mm yr^{-1}. Around 1900 CE, roughly coincident with rate increases recorded globally, the rate of sea-level rise increased to 3.2 ± 0.6 mm yr^{-1}. This rate is considerably greater than that of global estimates (1.8 to 1.9 ± 0.3 mm yr^{-1}) for the 20th century. These results are in agreement with data from the Gulf of Thailand derived from GPS-corrected tide gauge data and provide additional information to a region with geographically variable rates of sea-level rise. The data from the Setiu wetland provide the first high-resolution, foraminifera-based sea-level reconstruction from the southeastern South China Sea and expand the utility of foraminifera-based sea-level studies to tropical settings.

REFERENCES

Horton, B. P., Gibbard, P.L., Milne, G.M., Morley, R.J., Purintavaragul, C., and Stargardt, J.M., 2005. Holocene sea levels and palaeoenvironments, Malay-Thai peninsula, southeast Asia. The Holocene, 15, 1–15.
Kamaludin, B.H., 2002. Holocene sea-level changes in peninsular Malaysia. Bulletin of the Geological Society of Malaysia, 45, 301–307.
Teh, T.S., 1980. Morphostratigraphy of a double sand barrier system in peninsular Malaysia. Malaysian Journal of Tropical Geography, 2, 45–55.
Teh, T.S., 1993. Potential impacts of sea level rise on the Permatang Coasts of peninsular Malaysia. Malaysian Journal of Tropical Geography, 24, 41–55.
Tjia, H.D., Fujii, S., 1989. Late Quaternary shorelines in peninsular Malaysia, in Tjia H.D. and Sharifah Mastura (eds.), The Coastal Zone of Peninsular Malaysia, IGCP Project 274 Ipoh, Malaysia.
Tjia, H.D., 1997. Sea-level changes in the tectonically stable Malay-Thai Peninsula. Quaternary International, 31, 95–101.

P031

Alluvial - Lacustrine depositional system in rifted basin: the early Cretaceous non-marine sedimentation of Bima Formation in Yola Sub–basin, Northern Benue Trough, NE Nigeria

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The Benue Trough of Nigeria is a major rifted basin formed from the tension generated by the separation of African and South American plates in the Early Cretaceous. It is divided into Southern, Central and Northern Benue portions. The Northern Benue is made up two major sub-basins; the N – S trending Gongola Sub-basin and the E – W trending Yola Sub-basin. The Bima Formation is the oldest lithogenetic unit occupying the base of the Early Cretaceous successions in the Northern Benue Trough. It is differentiated into Lower Bima (B1), Middle Bima (B2) and Upper Bima (B3) Bima Members. Facies analysis of early Cretaceous sediments of Bima Formation was conducted with an objective of interpreting the paleodepositional environments and reconstructing a depositional model. Ten facies were identified on the basis of lithology, grain size, sedimentary structures and paleocurrent analysis. The facies constitute three facies associations; the gravelly dominated, the sandy dominated and the fine grain dominated. The facies and facies associations were interpreted and three facies successions were recognized; the alluvial – proximal braided river, the braided river and the lacustrine – marginal lacustrine. The depositional model indicates a rifted (?pull-apart) origin as the facies distribution shows a progradational succession from a shallow lacustrine/marginal lacustrine (at the axial part of the basin) to alluvial fan (sediment gravity flow) – proximal braided river (gravel bed braided river) and braided river (channel and overbank) depositional systems. The facies stacking patterns depict sedimentation mainly controlled by allogenic factors of climate and tectonism.

Keywords: Northern Benue Trough, Bima Formation, Facies, Alluvial, Braided, Lacustrine.

Introduction

The Benue Trough of Nigeria is a major rifted basin formed from the tension generated by the separation of the African and South American plates. It is sub-divided into Northern, Central and Southern portions (Abubakar, 2006). The Northern Benue is made up of two major sub-basins; the N–S trending Gongola Sub-basin and E–W trending Yola Sub-basin (Fig. 1). Stratigraphic succession in the Yola Sub-basin of Northern Benue Trough comprises the continental early Cretaceous Bima Formation, the Cenomanian transitional marine Yolde Formation and marine late Cenomanian–Santonian Dukul, Jessu, Sekuliye, Numanha Shales and Lamja Formations. This study describes and analyses the facies of Early Cretaceous sediments of Bima Member Formation in the Yola Sub-basin with an objective of identifying palaeodepositional environments and reconstructing a depositional model. Facies model concept was used to study the sediments.

The Bima Formation is the oldest unit occupying the base of the Cretaceous successions in the Northern Benue Trough. It is differentiated into three members; Lower Bima (B_1), Middle Bima (B_2) and Upper Bima (B_3). The Lower Bima (B_1) is described to consist of fault controlled conglomerates, sands and gravels with poorly defined internal structures with well-defined fining upward motif. The Middle Bima (B_2) unconformably overlies the Lower Bima. The Upper Bima (B3) conformably overlies the Middle Bima (B_2). Traverses were made on the exposed outcrops of the Lower Bima Member around Lamurde Anticline in Yola Sub-basin. Measurements and description of outcrops, documenting thicknesses, lithology and beds were carried out. Ten stratigraphic sections were studied for facies analysis and paleoenvironmental reconstruction and ten facies were identified on the basis of texture and sedimentary structures.

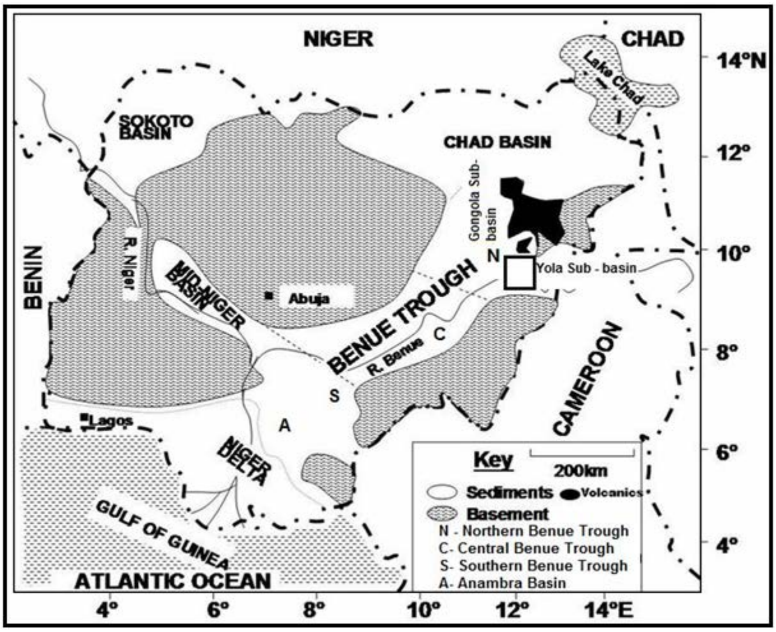

Fig. 1: Generalized geological map of Nigeria showing the study area represented as Open Square (from Abubakar, 2006)

Facies Model

Facies Gcm: This is characterized by massive clast-supported conglomerates. The clasts are angular to rounded, poorly sorted and rarely imbricated. It is interpreted as debris flow deposit.

Facies Gmm: This is characterized by massive matrix-supported conglomerates that are poorly sorted with sub- angular clasts. It is interpreted as plastic debris flow deposits.

Facies Sr: This facies is characterized by fine to medium grained, moderate to moderately well-sorted sandstone with current ripples. It is interpreted as sheetflood deposits.

Facies Sc: This facies is characterized by convoluted medium to fine grained, moderately sorted sandstones. It is interpreted as post depositional structure triggered by seismic shocks.

Facies Sp: This facies is characterized by planar cross bedded coarse to medium grained, moderate to moderately well sorted sandstones. It is interpreted as transverse bars deposits.

Facies St: The trough cross bedded sandstone facies comprises medium to very coarse grained sandstone, moderately sorted with scattered sub-angular to sub-rounded pebbles. It is interpreted as migrating sinuous 3-D dunes that stack up to generate bar forms in a channel.

Facies Sh: This facies is composed of medium to fine grained, moderately sorted to moderately well sorted, predominantly buff colored sandstones, beds have combination of horizontal lamination. It is interpreted as plane bed sand deposited in section of river valley as channel fill.

Facies (Fm): This facies is characterized by laminated mud and silts occurring between gravels and sandstone. It is interpreted as overbank, thus it may represent the most distal floodplain.

Facies (Fl1): This facies is characterized by dark grey shale with thin beds of silts. The facies lack marine shells, body and trace fossils. It is interpreted as shallow lacustrine environment.

Facies (Fl2): This is characterized by rippled laminated fine grained sand and siltstone. It is interpreted as shallow lacustrine (lake delta sandstones).

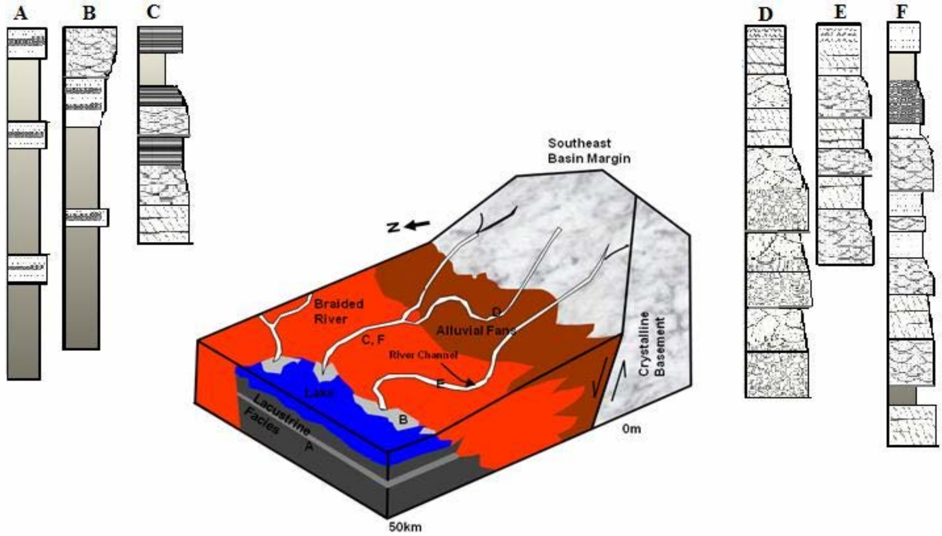

Fig. 2: Alluvial – Lacustrine depositional model

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REFERENCES

Abubakar M.B (2006). Biostratigraphy, paleoenvironment and organic geochemistry of Cretaceous sequences, Gongola Basin, Upper Benue Trough, Nigeria. PhD thesis A.T.B.U, 625p

Babangida M. Sarki Yandoka, W. H. Abdullah, Abubakar M.B., M.H Amir Hassan (2014). Facies analysis of early Cretaceous sediments of Lower Bima Member in Yola Sub-basin, Northern Benue Trough, NE Ngeria. 9th Mathematics and Physical Science Congress, 2014.

Miall, A. D. (1985). Architectural elements analysis: A new method of facies analysis applied to fluvial deposits, Earth Science Reviews 22, 261 –

P086

Analisis Fasies Jujukan Kipas Tengah Laut Dalam Eosen Lewat Kawasan Tenom, Sabah, Malaysia

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PENDAHULUAN

Kawasan kajian mengunjur secara membujur iaitu berlongitud dari 115°47' T hingga 115°57' T dan mengunjur secara melintang iaitu berlatitud dari 5°00' U hingga 5°15' U. Kawasan kajian bermula dari sebelah barat kawasan kajian iaitu 40 KM ke Tenom sehingga ke utara pedalaman Beaufort (termasuk Halogilat) (Rajah 1). Kawasan kajian dilingkungi oleh kawasan perbukitan sehingga ke gunung Lumaku yang berketinggian sehingga 1000 meter dan juga terdapat topografi yang rendah iaitu di bahagian lembah. Seperti yang diketahui umum kawasan Tenom merupakan sebahagian daripada tulang belakang banjaran Crocker di bahagian barat Sabah. Pendedahan Formasi Crocker dan Formasi Temburong yang terbaik adalah di kawasan ini seperti yang dijelaskan oleh Wilson dan Wong (1985). Pendedahan unit-unit batuan yang jelas dan lengkap mudah diperhatikan di kawasan ini kemungkinan berkait rapat dengan aspek topografinya yang bersifat lurah. Setiap banjaran perbukitan yang wujud merupakan hasil daripada sayap-sayap lipatan yang tertunjam oleh proses tektonik yang rencam berarah barat laut-tenggara. Matlamat utama kajian ini adalah untuk menjelaskan sifat-sifat fasies dan model pengendapan jujukan klastik laut dalam yang berusia Eosen Lewat di kawasan Tenom.

BAHAN DAN KAEDAH

Kajian fasies yang dilakukan pada kedua-dua formasi mengambil kira parameter seperti yang ditetapkan oleh Selley (1988), Tucker (2003), Sanudin dan Baba (2007) iaitu geometri, litologi, struktur sedimen, fosil dan paleoarus. Walau bagaimanapun, parameter seperti geometri dan struktur sedimen merupakan parameter yang mudah dan tepat dalam membezakan fasies di lapangan. Kaedah korelasi antara fasies batuan yang sama dengan menggunakan sebaran litolog secara vertikal memudahkan untuk menganggarkan sebaran sedimen dan perubahan fasies antara Formasi Crocker dan Formasi Temburong. Selain itu data paleoarus yang dipersembahkan ke dalam gambar rajah ros untuk analisis arah arus kuno sangat berguna dalam pembentukan model cadangan bagi kedua-dua formasi ini.

ANALISIS FASIES

Unit batuan kawasan kajian yang terdiri daripada jujukan klastik laut dalam telah dikelaskan sebagai Formasi Crocker dan merupakan unit batuan tertua dengan julat usia Eosen hingga Miosen (Wilson, 1964) (Rajah). Manakala Sanudin dan Baba (2007), menjelaskan usia formasi ini sebagai Eosen Atas (Rajah). Formasi Crocker tersebar secara meluas ke Labuan dan Lembah Padas dari utara hingga ke selatan iaitu ke arah Sarawak dan Sempadan Kalimantan. Formasi Crocker yang terletak di *Tenom Gorge* (kawasan kajian) mengikut Wilson (1964) adalah yang paling mudah untuk dicerap dan merupakan keratan rentas terbaik Banjaran Crocker yang terdedah di Sabah. Unit-unit batuan Fromasi Crocker seperti yang dihuraikan oleh pengkaji terdahulu tergolong dalam siri endapan turbidit. Kod-kod seperti fasies A hingga Fasies G yang dicadangkan oleh Mutti dan Ricci-Lucci (1972) serta lapisan-lapisan dalam jujukan Bouma (1962), menjadi parameter untuk kesesuaian jenis-jenis litologinya dalam penetapan fasies turbidit dalam kajian ini. Antara unit-unit batu pasir Formasi Crocker yang dibezakan fasiesnya di kawasan kajian ialah:-

i) Unit Batu Pasir Tebal
ii) Unit Selang Lapis Batu Pasir dan Syal
iii) Unit Selang Lapis Batu Pasir Sederhana Tebal dan Syal

iv) Unit Selang Lapis Batu Pasir Nipis dan Syal

Asosiasi fasies yang dikenal pasti bagi formasi ini seperti yang dicadangkan oleh Normark (1978) terdiri daripada fasies alur-lob, asosiasi fasies lob pasir, asosiasi fasies lob-tepian dan asosiasi fasies cerun lembangan. Namun fasies alur-lob, alur, migrasi lob dan levee memberi kejelasan yang cukup baik dalam analisis lembangan Formasi Crocker di bahagian barat Sabah (Muhd Nur Ismail, 2011). Kajian fasies terdahulu menunjukkan sistem pengendapan bagi Formasi Crocker di bahagian kipas laut dalam (Jackson *et.al*, 2009).

Analisis fasies bagi formasi ini mengambil kira parameter-parameter yang sesuai untuk penentuan sebenar fasies. Untuk parameter fasies, seperti yang disepakati oleh pengkaji terdahulu seperti Selley (1970), Tucker (2003), Sanudin dan Baba (2007), adalah seperti geometri, litologi, struktur endapan, fosil dan paleoarus. Analisis setiap unit batuan di kawasan kajian untuk penentuan fasies dengan lebih jelas. Analisis setiap unit batuan formasi ini adalah merujuk kepada kajian Stauffer (1967) dan juga kajian awal Rodeano (2002). Kajian ini lebih menyeluruh dan agak sesuai untuk dirujuk, walaupun ada perbezaan dari sudut unit batuannya. Walau bagaimanapun setiap apa yang dibincangkan dalam penulisan ini telah disesuaikan dengan pemerhatian di lapangan. Seperti yang dibuat oleh pengkaji fasies di kawasan lain, penerangan dan pembahagian fasies Formasi Crocker adalah menggunakan struktur yang berkaitan dengan proses pengendapan dan bersesuaian dengan jujukan Bouma (1962).

Analisis Fasies

Fasies / Kriteria	Fasies 1 (F1: Lapisan Ta/Tb) (Rajah 2.)	Fasies 2 (F2: Lapisan Ta-Te) (Foto 1. A & B Foto 2.)	Fasies 3 (F3: Lapisan Tb/Tc-Te) (Foto 3.)	Fasies 4 (F4: Lapisan Td-Te) (Foto 4.)
Geometri	Jujukan batu pasir tebal dan tersusun (*stacked*)	Jujukan menipis ke atas. (JHA)	Jujukan menebal ke atas. (JKA)	Jujukan menipis ke atas. (JHA)
Litologi	Batu pasir tebal beramalgamasi	Selang lapis batu pasir dan syal	Selang lapis batu pasir sederhana dan syal	Selang lapis batu lodak dan syal tebal
Struktur Sedimen (Jujukan Bouma)	Ta-Tb (Pasir masif dan laminasi selari	Ta-Te (Pasir bergred, Laminasi selari, laminasi silang @ laminasi gelombang, Laminasi lumpur dan lumpur hemipelagik)	Tb/Tc-Te (Laminasi selari (jarang), laminasi silang atau laminasi konvout, laminasi lumpur dan lumpur dan hemipelagik)	Td-Te (Laminasi lumpur dan lumpur hemipelagik)
Struktur sedimen pra-pemendapan	Alur	Alur, kesan beban, gruf dan flut	Kesan beban, gruf dan flut	Tiada
Fosil Surih	Tidak wujud	Wujud antaranya: *cosmorhaphe sp.* dan *Helminthopsis sp.*	Wujud tapi kurang ektensif	Wujud perlubangan (bioturbasi) tapi tidak terlalu ektensif
Fosil mikro	Tidak dijumpai	Foraminifera planktonik dan bentik	Foraminifera planktonik (dominan)	Tidak dijumpai
Paleoarus	Berdasarkan pengukuran lapisan: bertren barat laut	Pengukuran flut: barat laut	Pengukuran flut: barat daya	-
Tafsiran sekitaran	Alur utama (A1)	Alur pembahagi (A2)	Lob distal	levee

ASOSIASI FASIES FORMASI CROCKER

Melalui analisis fasies yang telah dibuat bagi unit-unit batuan Formasi Crocker di kawasan kajian, terdapat 3 asosiasi fasies yang berjaya dikenal pasti. Asosiasi fasies ini merupakan gabungan tafsiran fasies seperti alur, levee, lob dan lob distal. Antara asosiasi fasies yang dapat dibentuk daripada tafsiran tersebut ialah asosiasi alur-levee dan asosiasi lob beralur dan lob distal.

A) ASOSIASI ALUR-LEVEE

Keterangan

Jujukan-jujukan bersifat fasies alur-levee yang merujuk kepada fasies 1, fasies 2 dan fasies 4 adalah unit-unit batuan yang membentuk asosiasi fasies ini. Sebanyak 15 strata bersifat alur ditemui dalam kawasan kajian. Kajian jujukan lapisan menunjukkan asosiasi fasies ini berjulat daripada jujukan batu pasir beramalgamasi sehingga selang lapis unit batu pasir tebal dan unit batu pasir nipis. Di lapangan kajian sifat alur ini boleh dikumpulkan ke dalam beberapa kumpulan supaya ia menjadi lebih jelas untuk penentuan alur pada sifat batuan yang berbeza. Kumpulan yang pertama adalah lapisan batu pasir tebal beramalgamasi (A1) dan kedua ialah selang lapis batu pasir tidak beramalgamasi (A2) (Rujuk litolog bagi fasies 2). Sebaran fasies 1 dan 2 secara menegak dan mensisi memberikan gambaran yang cukup jelas berkenaan dengan kriteria geometri beralur di kawasan kajian. Di kawasan kajian sifat alur didominasikan oleh lapisan beramalgamasi (A1) dan seterusnya tergred secara lateral kepada lapisan yang tidak beramalgamasi (A2). Jujukan-jujukan A1 dan A2 diselangi dengan Fasies 4 yang ditafsirkan sebagai levee.

Tafsiran

Jujukan yang menghalus ke atas dengan ketebalan melebihi 1 meter merujuk kepada geometri alur laut dalam. Ketebalan jujukan lapisan batu pasir bermula dari bawah merupakan angkutan sedimen berketumpatan tinggi yang melimpah sebelum diendapkan ke kawasan yang menerima pengendapan yang sedikit bermula daripada tenaga pengendapan daripada tinggi ke rendah. Keadaan ini dapat dibuktikan jika alur diisi dengan limpahan sedimen makanya ia akan membentuk jujukan yang menebal ke atas dan tiada jujukan menipis ke atas kecuali jujukan tersebut merupakan lapisan masif atau beramalgamasi. Kewujudan lapisan nipis yang berselang dengan syal yang tebal di antara alur dalam keadaan menebal ke atas (kehadiran levee), menunjukkan limpahan sedimen oleh arus turbdit yang berketumpatan rendah ditafsirkan sebagai asosiasi alur – levee.

B) ASOSIASI LOB-BERALUR

Keterangan

Asosiasi lob-beralur terdiri daripada fasies 2 (ditafsirkan sebagai lob) dalam suatu jujukan singkapan batuan lengkap. Asosiasi ini mengandungi unit yang hampir sama dengan fasies 2 (yang ditafsirkan sebagai alur) tetapi geometri unit batuan antara satu sama lain adalah berbeza. Di kawasan kajian, kedudukan asosiasi fasies ini adalah di bahagian hadapan alur, menunjukkan pengendapan lapisan bersifat alur terendap terlebih dahulu sebelum lob. Jujukan unit batu pasir mengalami julat perlapisan yang semakin menebal ke atas (JTA) sehingga mencapai ketebalan hampir 80 sentimeter. Jujukan ini terus bersambung ke arah alur tanpa adanya F4 (levee). Setiap individu lapisan yang bersifat alur mempunyai persentuhan yang rata di bahagian bawah lapisan dan tergred normal dengan lapisan bergeometri lob. Saiz butiran adalah lebih seragam di bahagian lob ataupun tergred sederhana ke halus, berbanding di bahagian alur yang tergred kasar ke halus.

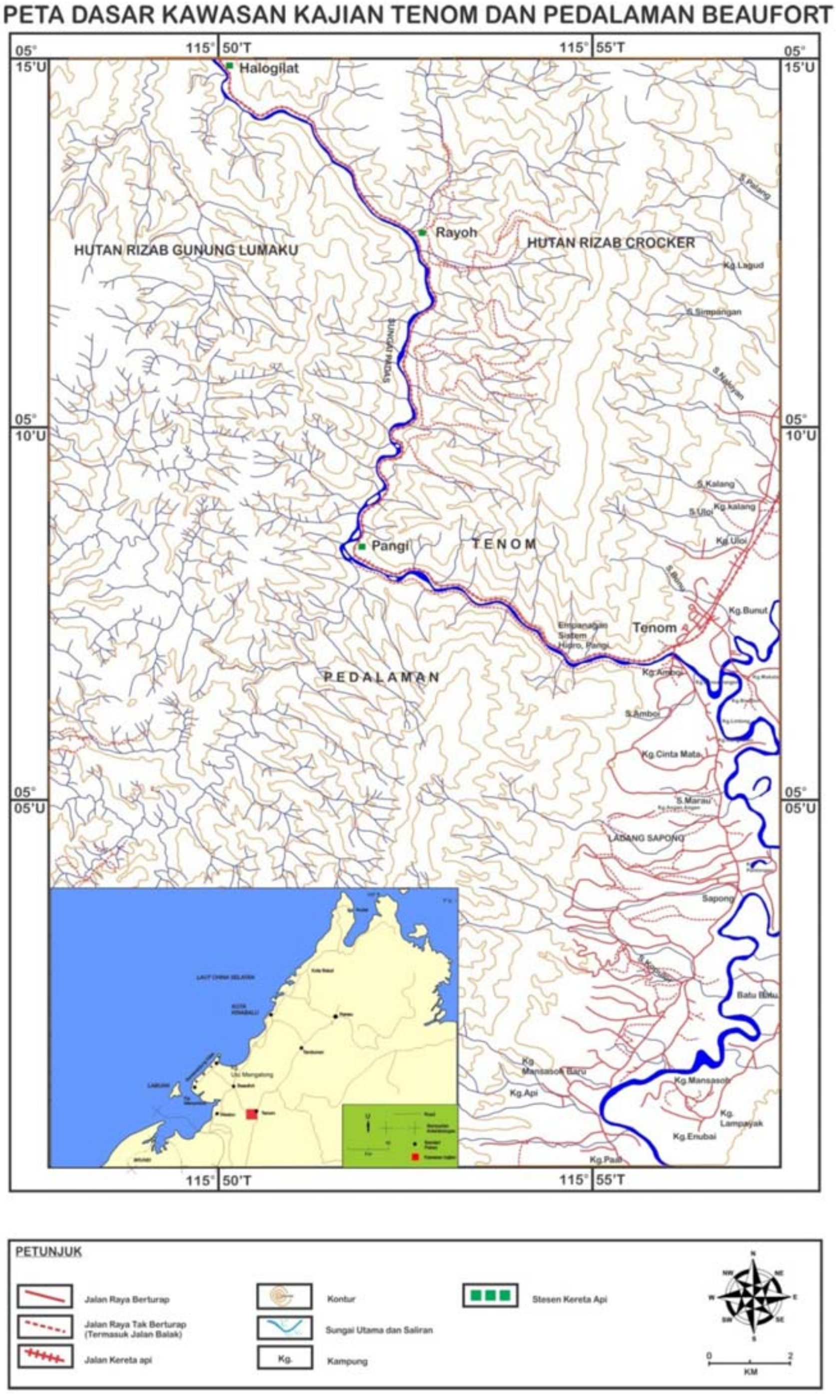
Tafsiran

Jujukan lapisan yang wujud dengan julat ketebalan yang semakin menebal ke atas adalah disebabkan oleh tindakan progradasi ke depan hasil daripada penyebaran sedimen melalui alur yang aktif. Walaupun begitu, sebarannya tidak terlalu jauh dan boleh dikatakan sebagai pengendapan turbidit dalam skala yang kecil. Pengaliran sedimen yang laju di bahagian alur menyebabkan sedimen yang tersisa akan diangkut ke depan membentuk kipas lob. Hal ini akan menyebabkan pembentukan saiz batuan yang maksimum dengan saiz butiran yang hampir serupa dengan sedimen yang diendapkan di bahagian alur. Asosiasi alur-lob telah dibahas oleh Walker (1992), Mutti (1985) dan Normark (1978) dengan membahagikan jenis kipas laut dalam kepada tiga peringkat pembentukan kipas. Antaranya ialah pembentukan kipas peringkat ke dua (jenis II), iaitu alur penghasil lob (*channel feeding lobe*). Beliau menggabungkan kesan saiz butiran dan perubahan aras laut ke atas model kipas laut dalam. Perlapisan yang rata kemudian mengalami pengredan kemungkinan disebabkan oleh arus yang bertindak adalah dalam bentuk perolakkan, perulangan dan berketekanan rendah.

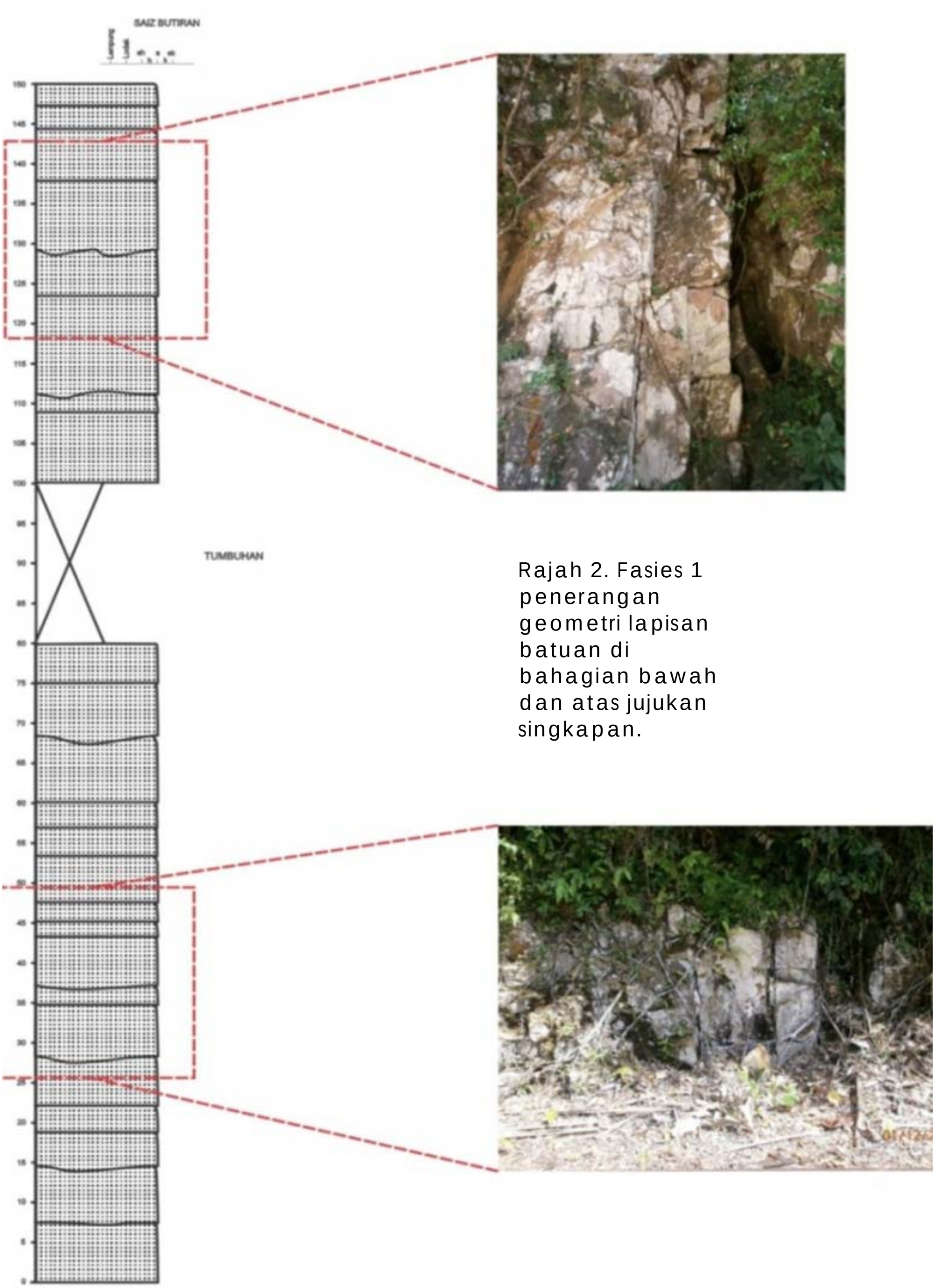
C) ASOSIASI LOB DISTAL

Keterangan

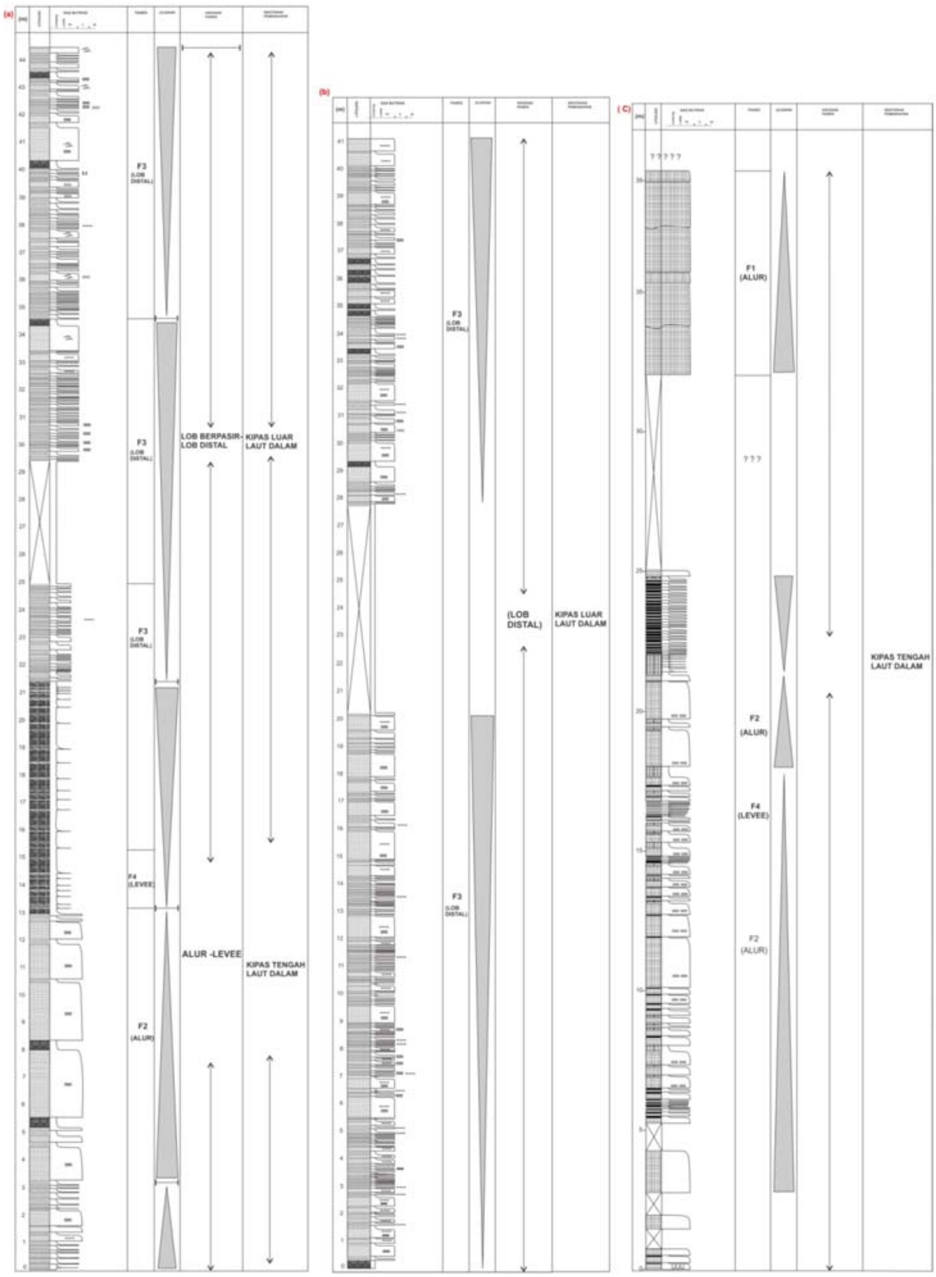
Asosiasi lob distal didominasikan oleh fasies 3 dalam Formasi Crocker. Di kawasan kajian, asosiasi fasies ini wujud di Halogilat, lokaliti 2, lokaliti 4 dan lokaliti 6. Jujukan unit-unit batuan yang wujud



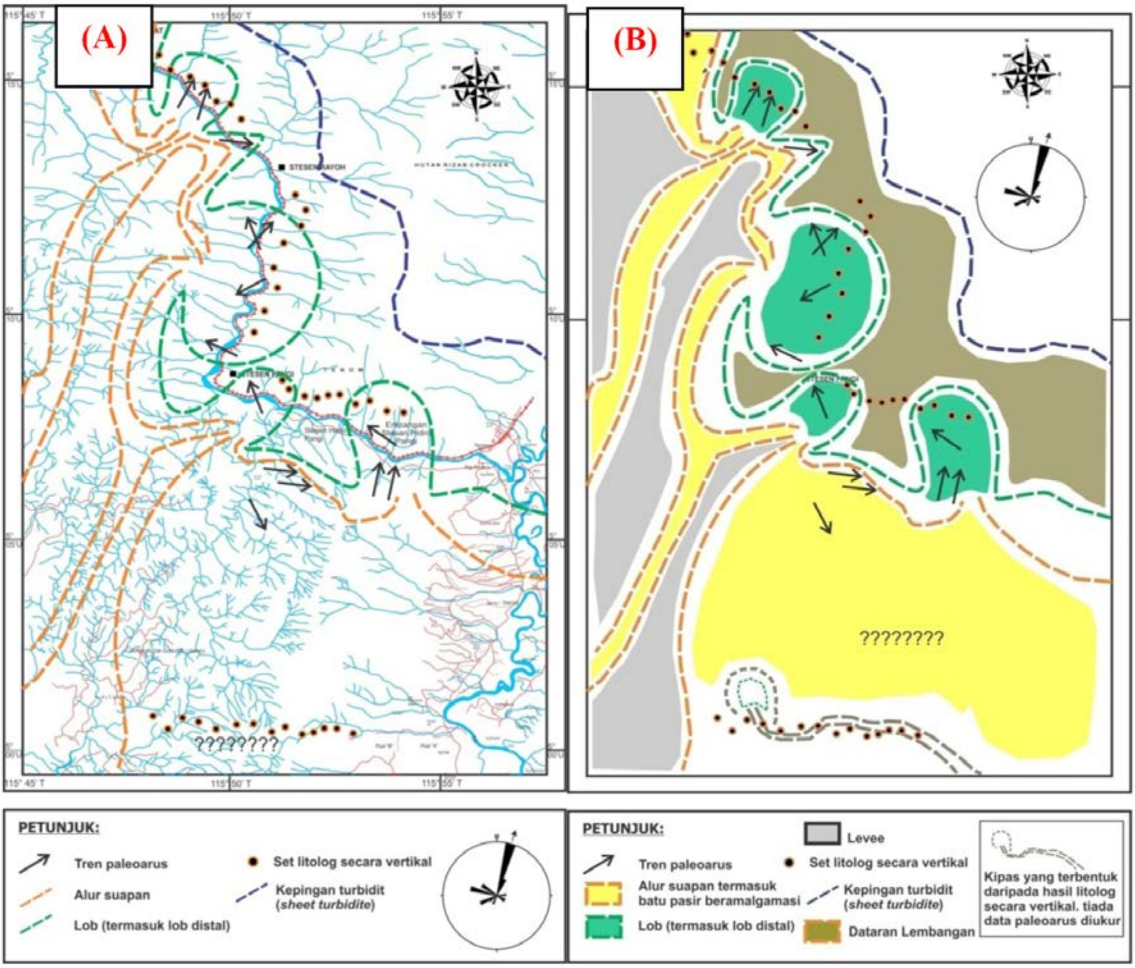
Rajah 1. Kedudukan kawasan kajian iaitu di bahagian Tenom.



Rajah 2. Fasies 1 penerangan geometri lapisan batuan di bahagian bawah dan atas jujukan singkapan.



Rajah 3. Set log lengkap yang menunjukkan gabungan beberapa fasies membentuk asosiasi fasies.



Rajah 4. (A) Gambaran model kawasan kajian, dengan arah arus yang berarah dari barat daya ke timur laut. (B) Cadangan model kawasan kajian, aliran sumber sedimen adalah melalui alur pembahagi yang berasal daripada bahagian barat daya.

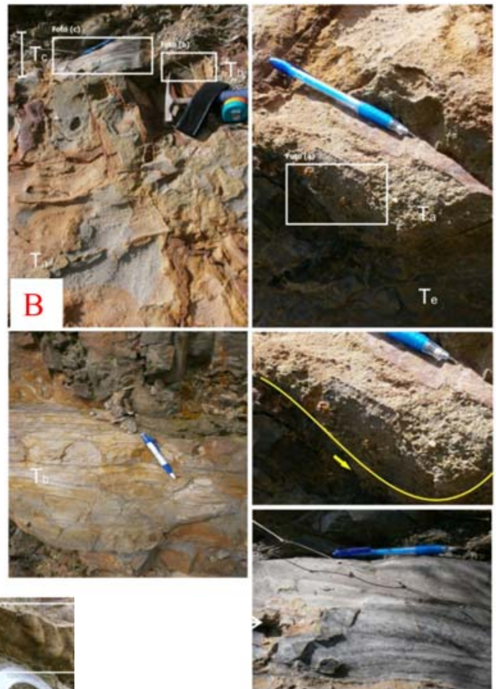


Foto 1: (A) Sebahagian daripada singkapan fasies 2. Anak panah menunjukkan arah memuda. (B) Unit jujukan Bouma yang lengkap pada lapisan batuan fasies 2.

Foto 2: Foto menunjukkan sebahagian daripada struktur sedimen yang wujud di bahagian fasies 2

Foto 3: (A) Foto menunjukkan sebahagian daripada singkapan fasies 3 yang terdedah di kawasan kajian. (B) Sebahagian daripada struktur sedimen yang wujud.

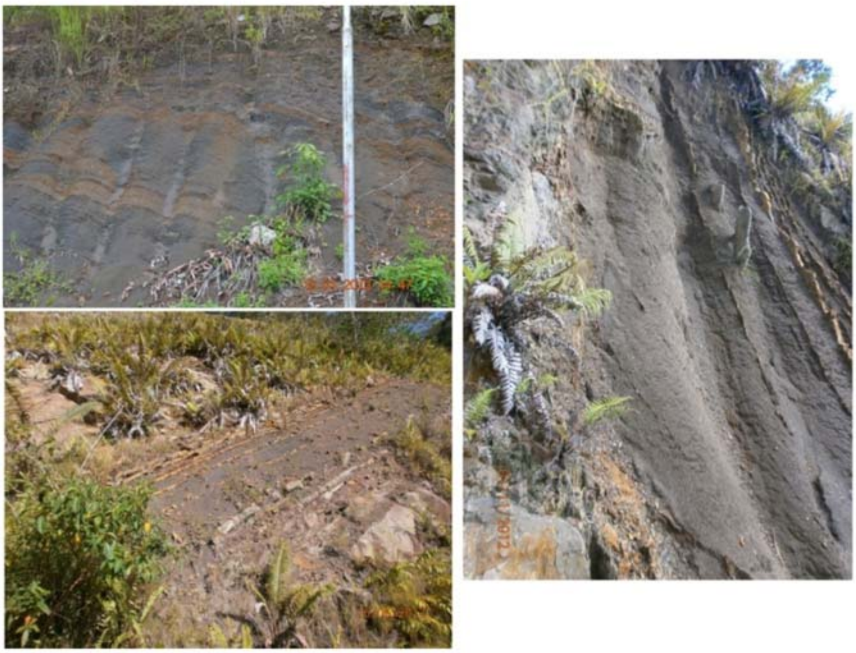


Foto 4: Foto menunjukkan sebahagian daripada fasies 4 yang terdedah di kawasan kajian.

menunjukkan ketebalan yang pelbagai tetapi dalam keadaan menipis. Julat ketebalan yang biasa diperhatikan dari yang tebal kira-kira 20 cm hingga ketebalan yang paling nipis iaitu 1 cm. Dianggarkan nisbah pasir dan syal adalah 1:1 dan 1:2. Individu lapisan menunjukkan persentuhan yang rata di antara selang lapis batu pasir dan syal. Jujukan perlapisan yang wujud menunjukkan dua keadaan. Keadaan yang pertama adalah, jujukan perlapisan yang lengkap bermula daripada lob terus ke bahagian distal, tetapi jujukan distal tidak terlalu jauh. Keadaan yang ke dua menunjukkan jujukan perlapisan yang tidak wujud bersama dengan lob. Saiz butiran yang seragam menunjukkan lapisan batuan tidak tergred. Keadaan jujukan adalah sama dengan lob utama (fasies 2) iaitu menebal dan mengkasar ke atas tetapi dalam keadaan skala yang lebih nipis.

Tafsiran

Asosiasi fasies ini merupakan hasil daripada progradasi dan migrasi lob ke depan. Dalam erti kata lain, ia merupakan lebihan sedimen daripada lob utama (penerangan daripada asosiasi alur-lob). Walau bagaimanapun ia merupakan sebaran yang sangat kecil. Pengenalpastian unit ini di kawasan kajian, adalah melalui angkutan sedimen semasa progradasi lob dan proses pengaliran sedimen adalah singkat. Keadaan ini menunjukkan sebaran sedimen yang terbentuk selepas progradasi adalah sedikit. Oleh sebab itu jika diperhatikan di bahagian Formasi Crocker sebaran bagi asosiasi fasies ini tidak lari jauh daripada lob utama. Kewujudan asosiasi fasies ini yang tidak bersambung dengan lob utama juga wujud di bahagian Formasi Crocker menunjukkan keadaan yang seiras dengan Formasi Temburong. Keadaan ini memungkinkan asosiasi bagi kedua-dua formasi adalah sama. Lapisan yang berjulat daripada ketebalan sederhana ke nipis menerangkan berkenaan dengan halaju arus yang semakin berkurang ketika menghampiri kawasan distal. Persentuhan yang rata antara batuan menunjukkan halaju arus yang berubah daripada tinggi ke rendah. Menurut Pickering dan Hiscott (1992) ia adalah halaju arus yang berulang dan akhirnya membentuk struktur sedimen yang pelbagai.

MODEL PENGENDAPAN

Fasies alur laut dalam wujud di bahagian Formasi Crocker dan kadang-kadang menipis ke fasies distal lob tanpa sempadan yang jelas. Perubahan fasies ini memberi gambaran berkenaan dengan penyusutan aras laut dan luahan sedimen ke arah lembangan yang statik (Spieker, 1949) kemudiannya apabila berlaku pengangkatan aras laut, sedimen yang baru akan menyusut masuk mengambil alih tempat sedimen yang tertolak ke lembangan yang statik. Walau bagaimanapun, jujukan keseluruhan ini ditafsirkan sebagai jujukan kipas tengah endapan laut dalam. Penggunaan set litolog secara vertikal banyak membantu dalam sebaran fasies secara menegak dan mengenalpasti pelbagai unsur tafsiran fasies dalam persekitaran laut dalam. Endapan lob pula terdiri daripada lapisan yang berjujukan menebal dan mengkasar ke atas (jujukan negatif). Kipas tengah dikenalpasti mempunyai jujukan yang menipis dan menghalus ke atas (jujukan positif). Analisis litolog Formasi Crocker menghasilkan 4 fasies iaitu fasies 1 (alur utama), fasies 2 (alur pembahagi dan lob), fasies 3 (levee) dan fasies 4 (lob distal). Secara keseluruhan model yang dibentuk, dapat diperhatikan proses pembekalan sumber sedimen adalah diangkut melalui alur suapan (*feeder channel*) dan kemudiannya disebar kepada alur pembahagi (*distributary cahnnel*) untuk diagihkan ke lob. Arah aliran sedimen adalah bermula dari julat antara barat-barat daya ke timur-timur laut (Rajah 4). Alur yang ditunjukkan adalah termasuk alur yang bersifat amalgamasi dan alur selang lapis batu pasir dan syal. Profail litolog secara menegak diperhatikan adanya perubahan transisi antara sifat alur beramalgamasi dengan sifat alur biasa. Alur bersifat amalgamasi yang wujud menunjukkan kadar hakisan yang tinggi oleh arus turbidit. Di kawasan kajian, alur utama ditafsirkan sebagai fasies 1 dan juga terdapat juga alur-alur pembahagi yang ditafsirkan sebagai fasies 2 yang mengalirkan sedimen ke lembangan pengendapan. Alur-alur pembahagi yang adakalanya wujud hampir dengan kipas bawah akan menjadi pembekal utama sedimen terus ke bahagian lob distal dan dataran lembangan. Menjadi penerangan bahawa tidak wujudnya alur-levee di bahagian ini (Bouma, 2000) dan juga anggapan perubahan fasies bagi Formasi Crocker.

Kajian fasies jujukan turbidit (Formasi Crocker dan Formasi Temburong) di bahagian barat Sabah memberi dua penafsiran pengendapan iaitu di bahagian kipas tengah dan bahagian kipas luar. Dianggarkan fasies Formasi Crocker diendapkan di bahagian kipas tengah manakala fasies Formasi Temburong diendapkan di bahagian kipas luar (Rajah 5).

KESIMPULAN

Kajian fasies bagi Formasi Crocker dan Formasi Temburong (sedimen turbidit) merupakan suatu kajian ilmiah yang agak baru di Sabah. Oleh itu tidak mustahil kajian ini mempunyai pro dan kontranya sendiri. Segala bentuk olahan data dan penggunaan kaedah yang digunakan adalah berdasarkan kaedah yang ditetapkan oleh pengkaji yang berpengalaman dan pernah melalui kajian seperti ini. Diharapkan selepas penelitian berkenaan dengan kajian ini, ia akan membuka lebih banyak ruang untuk perbincangan serta penambahbaikan ke hadapan. Kajian fasies Formasi Crocker memberi maklumat bahawa formasi ini diendapkan di bahagian kipas turbidit laut dalam dan menerima sumber sedimen yang sama. Hal ini dapat dibuktikan melalui parameter-parameter fasies yang telah ditetapkan oleh pengkaji terdahulu seperti, geometri, litologi, struktur sedimen dan paleoarus. Kewujudan beberapa ciri-ciri fasies yang sama pada kedua-dua formasi seperti fasies 3 di bahagian Formasi Crocker dan fasies 1 di bahagian Formasi Temburong menguatkan lagi pengendapannya adalah daripada sistem yang sama.

Melalui analisis paleoarus, sumber sedimen disebarkan melalui arah barat daya. Tetapi persoalan yang timbul sumber sedimen bukan hasil daripada benua tetapi daripada suatu sumber delta yang luas. Hal ini merujuk kepada kajian Davies (1972) dan Devine et al (1973), berdasarkan komposisi sedimen dan saiz butiran yang wujud, sumber sedimen Formasi Crocker dan Formasi Temburong adalah berasal daripada sistem delta.

RUJUKAN

Bouma, A.H. 1962. Sedimentology of some Flysch Deposits: A Graphic Approach to Facies Interpretation. Elsevier, Amsterdam. 168 ms.

Bouma, A. H. 2000. Fine-grained, mud-rich turbidite systems: model and comparison with coarse-grained, sand-rich systems. Dalam: A. H. Bouma and C. G. Stone, eds., Fine-Grained Turbidite Systems, AAPG Memoir 72/ SEPM Special Publication. 68: 9-20.

Davies, D. K., 1972. Deep sea sediments and their sedimentation, Gulf of Mexico. Am. Assoc. Pet. Geol. Bull., 56(ll):2212-2239.

Devine, S. B., Ferrell, R. E., Jr., and Billings, G. K., 1973. Mineral distribution patterns, deep Gulf of Mexico. Am. Assoc. Pet. Geol. Bull., 57(1):28-41.

Muhd Nur Ismail Abdul Rahman. 2011. Geologi Am dan Sedimentologi Kawasan Mesapol-tenggara Weston. Thesis sarjana muda.

Mutti, E. & Ricci Lucchi, F. 1972. Turbidites of the northern Apennines: introduction to facies analysis (English translation by T.H. Nilsen, 1978). Int. Geol. Rev, 20: 125 – 166.

Mutti, E. 1985. Turbidite systems and their relations to depositional sequences. Dalam: Zuffa, G.G. (Ed.), Provenance of Arenites. Reidel Publishing, Dordrecht. 148: 65-93.

Normark, W.R. 1978. Fan valleys, channels, and depositional lobes on submarine fans: characters for recognition of sandy turbidite environments. Am. Assoc. Pet. Geol. Bull. 62: 912-931.

Pickering, K.T and Hiscott, R.N. 1992. Contained (reflected) turbidity currents from the middle Ordovician chloridorme Formation, Quebec, Canada:an alternative to the antidune hypothesis..Int.Assco. of Sedimentologist.3: 89-110

Rodeano Rosli. 2002. Facies analysis of the Crocker Formation along Bundu Tuhan to Ranau highway, Sabah, Malaysia. Preliminary report.

Sanudin Hj. Tahir & Baba Musta. 2007. Pengenalan Kepada Stratigrafi. Universiti Malaysia Sabah. Kota Kinabalu.

Selley, R.C. 1970. Studies of sequence in sediments using a simple mathematical device. Q. J. geol. Soc. Lond. 125: 557-581.

Selley, R.C. 1988. Applied Sedimentology. Academic Press Limited: London, 493.

Spieker, E.M. 1949. Sedimentary facies and associated diastrophism in the Upper Cretaceous of central and eastern Utah. The Geological Society of America. Memoir 39: 55-82.

Stauffer, PH. 1967. Studies in the Crocker Formation, Sabah. Borneo Reg. Malay. Geol Surv. Bull, 8, 1-13.

Tucker, M.E. 2003. Sedimentary Rocks In The Field. John Wiley and Sons Ltd: England, 249.

Walker, R.G. 1992. Turbidite and submarine facies. Dalam: Walker, R.G., James, N.P. (Eds.), Facies Models. Geological Association of Canada. 239-265 ms.

Wilson, R. A. M. & Wong, N. P. Y. 1985. The Geology and Mineral Resources of Labuan and Padas Valley Area, Sabah, Malaysia. Geo. Surv. Dept. Borneo Region. Memoir 17.
Wilson, R.A.M. 1964 The geology and mineral resources of the Labuan and Padas Valley area, Sabah, Malaysia. Geological Survey of the Borneo Region of Malaysia, Memoir 17.

P062

Radiocarbon Dates Of Shell Beds And Stranded Coral At Kampung Gambut, Southeast Johor

Bird, M.I., Teh, T.S. and Yap, H.B.

There is widespread evidence of Holocene high sea levels around Peninsular Malaysia in the form of erosional and depositional features. Some of these emerged features have been dated in an attempt to reconstruct the Holocene sea level history (Tjia et al, 1977, Streif, 1979, Kamaludin Hassan, 2001). This has been a difficult task and although there is general consensus that the Holocene sea rose to above its present level during the height of the marine transgression, the manner of its retreat to the present level is less clear. Part of the reason is the different types of materials used for dating and the method in which a particular sample is related to sea level. Those working around the coast will be familiar with the general absence of bench marks in which accurate levelling could be carried out to determine accurately the elevation in which a sample is derived. Those using subsurface materials have to content further which compaction after deposition. Ideally erosional surfaces which have largely maintained their original elevation should be used but unfortunately dataeble materials are very rarely found on such surfaces.

There are impressive coastal features that are clearly relicts from former high sea levels along the east coast of Peninsular Malaysia. The stranded oyster beds of Bukit Keluang and Tanjung Penunjuk, the high level beach rock of Pantai Buluh in Sedili and that in Tanjung Balau in Desaru and the dead coral heads extending up river Kemasik. Inland are the well-developed *permatang*, some cresting several metres higher than the beach ridges formed under present sea level (Teh 1980). But some are dune capped and extremely difficult to use their ridge heights as sea level indicator.

This paper forms part of our study on early mid-Holocene sea level fluctuation which used mainly subsurface materials in reconstructing the sea level curve (Bird et al, 2007). Three of the dates, however, are from Kampung Gambut in Southeast Johor (Figure 1)

Two of the dates were derived from shell beds and another from a stranded coral head (Figure 2). The elevations from which the samples were taken were determined using an automatic level and the elevations were tied to a bench mark along the main road. GPS were used to accurately pinpoint the location of the samples. Mapping of the coastal features and levelling across the backing permatang terrace and stratigraphic studies were also carried out to understand the deposition history.

The results of the dates and elevation are shown in Table 1. The higher shell bed at elevation 2.30m reduced level was dated at 4120+/-80 years BP, the lower shell bed at 1.94m reduced level was dated at 2160+/-70years BP and the degraded coral head at -0.51 m reduced level dated at 6380+/-90 years BP.

These features are obviously emerged but it is also clear that ascribing a particular elevation to them would be extremely hazardous. Interpretation of their possible former sea levels will be discussed in the full paper.

REFERENCES

Bird, M.I., Fifield, Teh T.S., L.K., Chang, C.H., Shirley, N. and Lambeck, K. 2007. An inflection in the rate of early mid-Holocene sea level rise: a new sea level curve for Singapore. Estuarine, Coastal and Shelf Science. Volume 71 (3-4): 529-536.

Kamaludin Hassan, 2001. Geological evidence: Core samples. In: Ong J.E. and Gong W.K. (eds) Encyclopedia of Malaysia, Vol. 7. Seas, Archipelago Press, Singapore.

Streif, H., 1979. Holocene sea level changes in the Straits of Malacca, in proceedings 1978 International Symposium on Coastal Evolution in the Quaternary, Sao Paulo, Brazil, pp.552-572.

Teh, T.S., 1980. Morphostratigraphy of a double sand barrier system of Peninsular Malaysia. Mal. Journ. Trop. Geog. 2: 46-56.

Tjia, H.D., Fujii, S and Kigoshi, K. 1977. Changes of sea level in the southern South China Sea during Quaternary times. In Quaternary Geology of the Malay-Indonesian Coastal and Offshore Areas, United Nations ESCAP, CCOP Technical Publication 5: 11-36.

Table 1. Results of Kampung Gambut radiocarbon dates and their elevation

ID	Elev. (m)	ANU number	14 C age (yrs BP)	+/-	Calibration curve
GAM-1 shell	2.30	11998	4120	80	Marine98.14c
GAM-2 shell	1.94	11999	2160	70	Marine98.14c
GAM coral 2a	-0.51	12000	6380	90	Marine98.14c

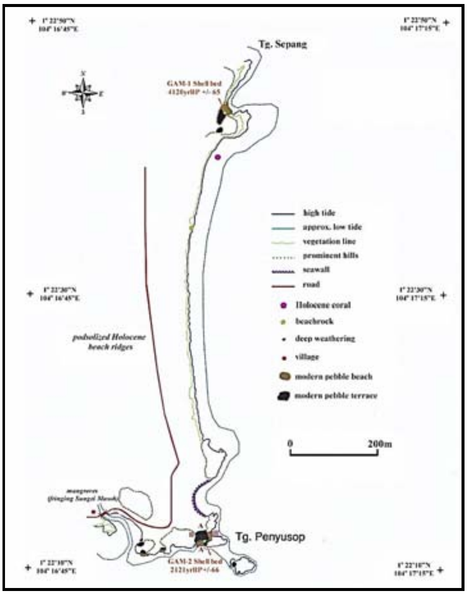
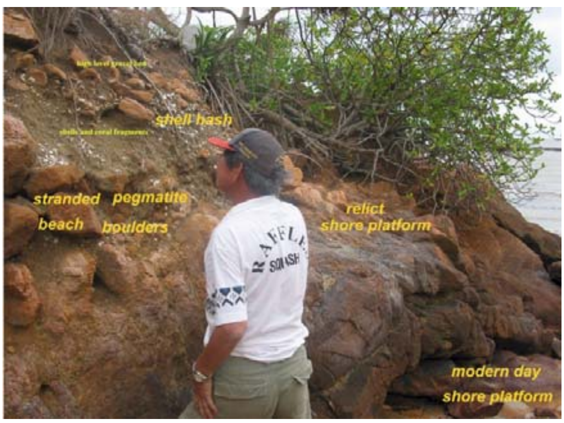


Figure 1. Study area from Tanjung Sepang to Tanjung Penyusup in Southeast Johor



Lower shell bed

Upper shell bed

Figure 2. Stranded shell beds used for dating to reconstruct the Late Holocene sea level in Southeast Johor

P033

A Preliminary Study of Diatom Record in Quaternary Deposits of Kuala Langat Area, Selangor

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Diatom assemblages has been successfully used as paleo sea-level changes and paleoenvironmental indicators. However, such technique has yet to be tested in Quaternary deposits of Kuala Langat area. In this study, diatom assemblages and its paleoenvironmental attributes is examined from four localities across a coastal plain transect. Diatom assemblages in the greenish gray silty clay deposits are dominated by both polyhalobous and mesohalobous species, indicating marine and brackish water deposits at mangrove swamp and tidal flat areas. The rich organic, dark grayish brown silt deposits at the landward area contains fewer diatoms. Few individuals are identified as freshwater diatoms, suggesting an isolated fresh water pond. Diatom is not detected in the very pale brown sandy clay deposits at the end of the transect. Samples from this locality may represent the beach sand deposits at the time of highest paleo sea-level.

P039

Quaternary Sediment Deposition and Submerged Palaeo Sea Level Terraces at Permatang Sedepa (One Fathom Bank) Area, Straits of Malacca Related to Sea Level Changes During the Late Pleistocene and Holocene

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A comprehensive marine geophysical survey comprising 650 line km of side scan sonar, seismic (boomer) and 100 grabs and cores samples was analysed from the Permatang Sedepa (One Fathom Bank) area, Straits of Malacca (Figure 1). Side scan sonar and seismic reflection (boomer) interpretation revealed five types of bedforms composed of sand banks, sand waves, ripples, flat beds and rock pinnacles. The surface seabed is predominantly covered by sand waves, ripples and sand banks, which comprise 45%, 30% and 10% respectively of the study area (Figure 2). The sediment transport interpreted from sand waves asymmetry indicates the net sand transport direction in the study area is to the northwest, and confirms the general trend of current flow through the Straits of Malacca. General seismic stratigraphic analysis demonstrated that two bedrock types (granite and consolidated sediments), are covered by Quaternary sediment. The thickness of the Quaternary sediment ranges from 0 to 45 ms (Figure 3). The thickness of the Holocene sediments varies between 0 - 7 ms while the Pleistocene sediments varies from 2 – 45 ms.

In places there are no deposits of Holocene sediments in the western and eastern centre of study area where the Pleistocene sediments are exposed on the seabed. Towards the southwest (eastern corner) of the study area, Holocene sediments directly overlie the bedrock where there are no deposits of Pleistocene sediments. Quaternary sediment isopach maps demonstrate that thick sediments were deposited during the Pleistocene to Holocene period within old channels and small basins.

Three peat deposits were encountered at -30 m, -37 m and -47 m O.D. which, with reference to sea-level curves, gives an interpolated age of 9,600 -10,200 years B.P. Submerged palaeo sea level terraces have been interpreted from flooding surface contour map to occur at -24 m, -30 m, -37 m and -47 m O.D. which similarly gives an interpolated age of 9,300 -10,200 years B.P. The agreement of the depths of the peats and submerged terraces (at -30 , - 37 and -47 m) support episodic sea level rise between 9,500 and 10,200 years B.P in the Malacca Strait.

Keywords Quaternary sediment, bedforms, sea level, submerged terraces, Straits of Malacca

REFERENCES

Amos, C.L., King, E.L., 1984. Bedforms of the Canadian Eastern seaboard: a comparison with global occurrences. Marine Geology 57, 167-208.

Batchelor, B.C., 1979b. Geological characteristics of certain coastal and offshore placers as essential guides for tin exploration in Sundaland, Southeast Asia. Geological Society Malaysia Bulletin 11, 283-313

Emery, K.O., 1971. Bottom sediment map of Malacca Strait. Economic Commission for Asia and the Far East. Geol.Surv. Jpn. Techn. Bull., 4: 147-152.

Emmel, F.J., Curry, J.R., 1982. A submerge late Pleistocene delta and other features related to sea level changes in the Malacca Strait. Marine Geology 47, 197-216.

Geyh, M.A., Kudrass, H. Streif, H., 1979. Sea level changes during the Late Pleistocene and Holocene in the Strait of Malacca. Nature 278, 441-443.

Hanebuth, T., Stattegger, K., and Grootes, P. M. (2000). Rapid flooding of the Sunda Shelf: A late-glacial sea-level record. Science 288, 1033–1035.

Keller, G.H., Richards, A.F., 1967. Sediments of the Malacca Strait, Southeast Asia. Journal of Sedimentary Research, 37 (1), 102-127.
Kudrass, H.R., Schluter, H.U., 1994. Development of cassiterite-bearing sediments and their relation to Late Pleistocene sea-level changes in the Straits of Malacca. Marine Geology, 120, 175-202.
Siddall,M., Rohling, E.J., Almogi-Labin, A., Hemleben, Ch., Meischne, D., Schmelzer, I., Smeed, D.A., 2003. Sea-level fluctuations during the last glacial cycle. Nature 423, 853-858.
Suntharalingam, T., 1983. Cenozoic stratigraphy of Peninsular Malaysia. In Workshop on Stratigraphy correlation of Thailand and Malaysia Haadyai, Thailand, 149-158.
Tjia, H.D., 1996. Sea-level changes in the tectonically stable Malay-Thai Peninsula. Quaternary International 31, 95-10

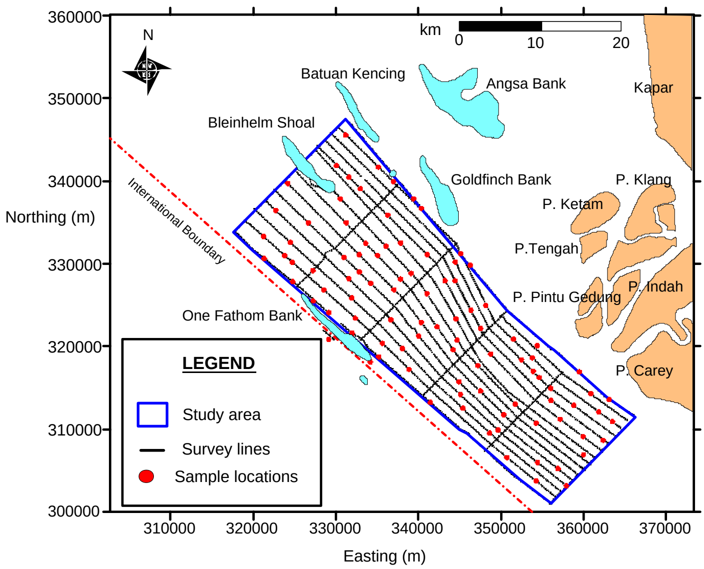
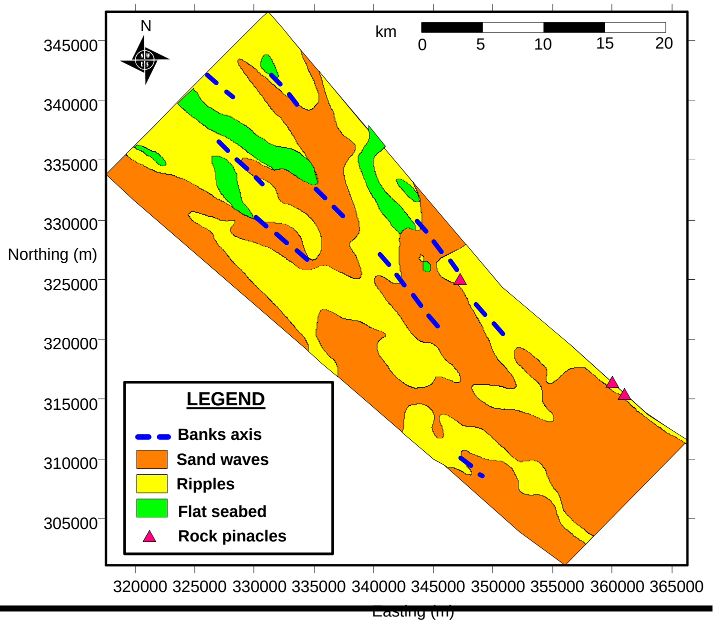


Figure 1: Map showing the survey lines and sample locations.

Figure 2: Map showing the bedforms distribution and classification based on Boomer and side scan sonar interpretation.



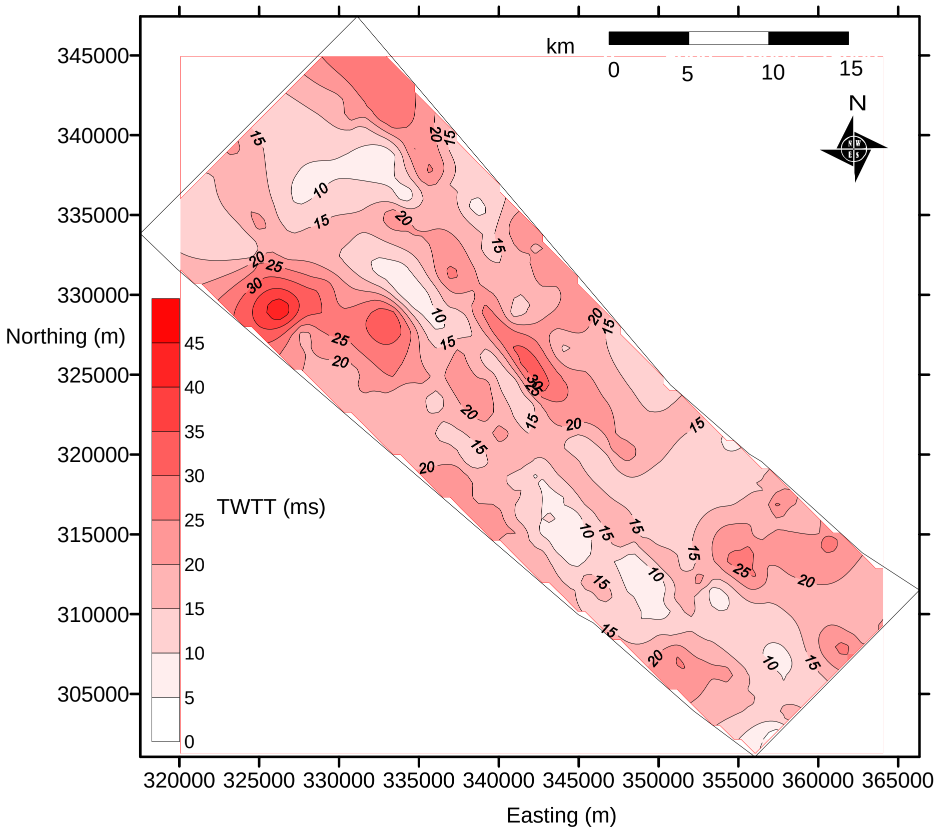


Figure 3: Map showing the distribution and the thickness of the Quaternary sediments in the study area (Two Way Travel Time (TWTT) in milisecond)

P045

Litho and Biostratigraphy of the Tournaisian Chert, the Kubang Pasu Formation of the Kedah and Perlis, Malaysia.

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The Kubang Pasu Formation is an established formation of Upper Paleozoic rocks of the Northwest Peninsular Malaysia. This formation is equivalent to the Singa Formation of the Langkawi Island. The formation was deposited in wide ranging environments from deep marine to shallow marine environments. Previously, the age of the formation was thought to be ranging from Late Devonian to Permian. To date more information was obtained from new outcrops and the age of the formation is now placed from Early Carboniferous to Early Permian. The lower boundary of the formation is based on the occurrence of radiolarian chert layers indicating Tournaisian age underlain by the black fossiliferous shale of Setul Formation at Bukit Guar Sanai, west of Perlis. The Tournaisian chert from Bukit Tuntung, Ulu Pauh, Perlis and Bukit Meng, Pokok Sena, Kedah is underlain by the slate of Mahang Formation. The uppermost part of Kubang Pasu Formation in Perlis consists of the calcareous sandstone of passage beds which pass to the Chuping Limestone Formation. While in Kedah the uppermost succession of Kubang Pasu Formation is overlain by the deep marine succession of the Semanggol Formation. A revision of the Kubang Pasu Formation is being done to find out the differences and the similarities of the rock sequence of the Kubang Pasu Formation in Perlis and Kedah. The research has been carried out in several localities; Guar Sanai, Bukit Tuntung and Bukit Tengku Lembu in Perlis, Bukit Pala, Bukit Inas, Bukit Meng and Bukit Jelutong in Kedah. The results are very important to solve the stratigraphic problem of the Malaysia-Thailand Border Joint Geological Survey Committee (MT-JGSC). In this paper we focus our research on the chert layer of the lower part of the Kubang Pasu Formation. We made a detailed study of the chert sequence exposed at six localities namely Bukit Guar Sanai, Bukit Tuntung, Bukit Pala, Bukit Inas, Bukit Jelutong and Bukit Meng and more than 80 samples of chert were collected. The study of the thin sections and extraction of the microfossil were carried out. The chert yielded Tournaisian radiolarians consist of *Stigmosphaerostylus variospina* (Won), *Stigmosphaerostylus vulgaris* (Won), *Astroentactinia multispinosa* (Won) and *Belowea* sp. The chert layers of Tournaisian are wide-spread in Kedah. The aim of this paper is to propose a new member for the chert unit based on the new outcrop as a stratotype and type locality in accordance with the Malaysia Stratigraphic Guide, 2007. The chert beds are proposed as the Pala Member represents lowermost succession of the Kubang Pasu Formation. The Pala Member was named after the locality of Bukit Pala, Bukit Pinang, Alor Setar, Kedah as the type section. The location can be easily reach about 17 km from Alor Setar, consist of 16-18 m of succession beds of the bedded chert grey to black in colour. The individual thickness of the chert bedding is about 2cm to 15cm and partly parting with grey shale with the thickness of 2mm to 20mm contains the abundance of pyrite and the thin volcanic lenses. The Pala Member is underlain by the slate of Mahang Formation. The contact between the beds can be observed at the Bukit Pala, Bukit Pinang, Alor Setar, Kedah. The Pala member was deposited during the Tournasian age at the continental rise. This is indicated by the low diversity of the radiolarians, the color of grey to dark grey radiolarians and the radiolarian preservation is poor to moderate. The chert is a low grade chert or the hemipelagic chert and contains more than 50% of mud at some places. Among the study area only the Bukit Pala chert is still remain in good condition and still can be observed during this time. The bedded chert of the Pala Member consist of mostly entactinarian with diameter range of 80-145um occur together with some sponge spicules of Pentactine. The Telaga Jatoh Member which was proposed earlier by Meor at al. (2004, 2005) was not properly described and the type section was not designated. The section at Telaga Jatoh is poorly exposed and is not a suitable to be used

as type section. It is therefore the name Telaga Jatoh Member is not valid and not accordance with the Malaysia Stratigraphic Guide (2007).

REFERENCES

Ahmad Jantan et al. 1997. *Malaysian Stratigraphic Guide*. Malaysian Stratigraphic Nomenclature Committee. Geological Society of Malaysia.

Basir Jasin & Zaiton Harun. 2001. *Some Radiolarians from the bedded chert of the Kubang Pasu Formation.* Geological Society of Malaysia annual Geological Conference 2001. P111-114.

Basir Jasin. 2003. *Rijang Beradiolaria Perakam Sejarah Tabii Malaysia.* Universiti Kebangsaan Malaysia.

Basir Jasin, 2008. Some Permian Radiolarians From Bukit Yoi, Pokok Sena, Kedah. Bulletin of the Geological Society of Malaysia 54 (2008) 53-58, doi: 10.7186/ bgsm2008009

Basir Jasin, Atilia Bashardin, Nazariah Jamaluddin & Norhifzan Ishak 2008. Occurrence of slate in Perlis and its significance, Geological Society of Malaysia, Bulletin 56, pp. 75 – 78

Basir Jasin & Zaiton Harun, 2011. Lower Carboniferaous (Tournaisian) radiolarians from Peninsular Malaysia and their significance. Bulletin of the Geological Society of Malaysia 57 (2011) 47-54, doi: 10.7186/ bgsm2011007

Basir Jasin, 2010. *Warisan Geologi Negeri Perlis.* Geological Society of Malaysia, Bulletin 56, December 2010, pp 87 – 93.

Jones, C. R., Gobbett, D.J and Kobayashi, T. 1966. Summary of Fossil Record In Malaya and Singapore 1900-1965. Reprinted From Geology and Paleontology of Southeast Asia. Vol II, pp 309-359, Dec. 1966.

Jones, C. R. 1978. Geology and Mineral Resources of Perlis, North Kedah and Langkawi Islands. Geological Survey Malaysia. District Memoir 17.

Meor Hakif Hassan & Lee C. P. 2004. *The Depositional Environment of The Mid-Palaeozoic Red Beds at Hutan Aji, Perlis and its bearing on Global Eustatic Sea Level Change.* Geological Society of Malaysia, Bulletin 48, Jun 2004, p 65-72.

Meor Hakif Hassan & C.P. Lee. 2005. *The Devonian-Lower Carboniferous succession in Northwest Peninsular Malaysia.* Journal of Asian Earth Sciences 24. Elsevier. Pp719-738.

Nur Susila bt. Md. Saaid. 1999. *Geologi Am Bukit Pinang – Kepala Batu Kedah Darulaman.* Disertasi Ijazah Sarjana Muda Sains Universiti Malaya (unpublished).

Nur Susila Md. Saaid and Basir Jasin, 2012. *Facies study of the Kubang Pasu Formation, Northwest of Peninsular Malaysia.* Proceeding of National Geoscience Conference 2012. 23-24 Jun 2012. Sarawak. Geological Society of Malaysia.

Nur Susila Md. Saaid and Basir Jasin. 2013. *Occurrence of pyroclastic rock in the Kubang Pasu Formation, Northwest Peninsular Malaysia.* Proceeding of National Geoscience Conference 2013. Perak. Geological Society of Malaysia.

Nazariah binti Jamalludin. 2008. *Stratigrafi dan Sedimentologi Kuari Tanah Bukit Tuntung, Ulu Pauh, Perlis.* Desertation Universiti Kebangsaan Malaysia. (unpublish).

Nurul Laila 'Adilah bt. Amran. 2009. *Stratigrafi dan Sedimentologi Bahagian Tengah Kuari Tanah Bukit Tuntong, Ulu Pauh, Perlis.* Desertation Universiti Kebangsaan Malaysia. (unpublish).

The Malaysia – Thai Working Group, MT-JGCS 2009. *Geology of The Bukit Batu Puteh-Satun Transect Are Along The Malaysia-Thailand Border. Geological Papers Volume 8.* A joint project carried out by Minerals and Geoscience Department, Malaysia and Department of Mineral Resources, Thailand.

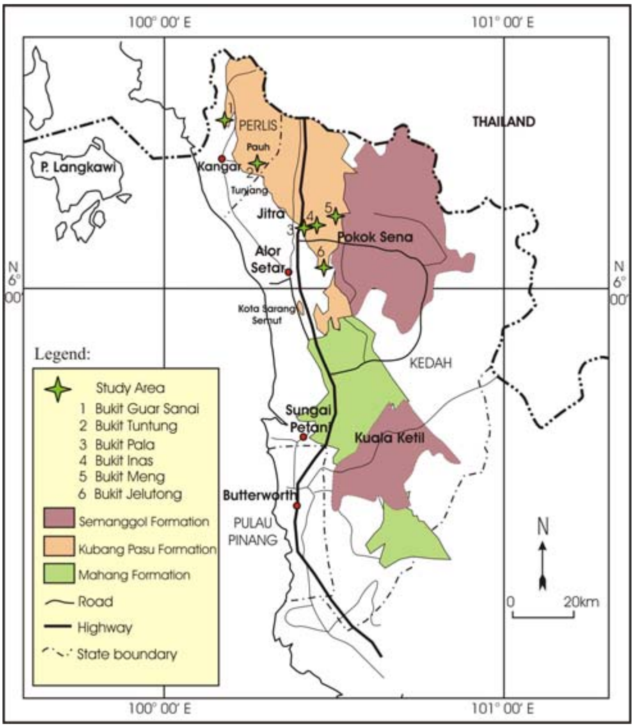

Figure 1: Simplified geologic map and the study area of chert, North Peninsular Malaysia

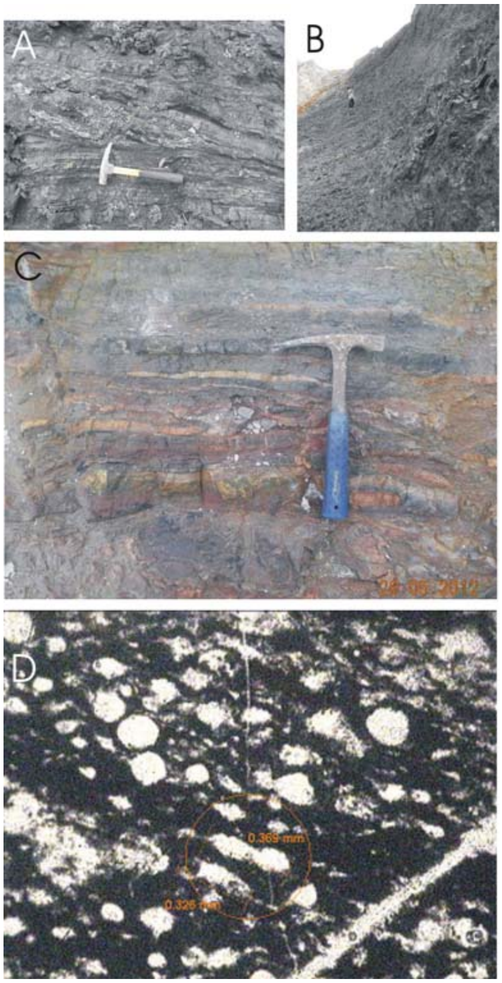

Figure 2: Pala Member - Chert Lithofacies (A&B) – from the outcrop of Bukit Pala, Bukit Pinang - thin bedded chert (2-15cm) with shale parting and some volcanic lenses (C). D - Thin section of photomicrograph of the Bukit Pala chert showing abundance of radiolarians.

P046

Carboniferous (Mississippian) Dropstones and Diamictite from the Chepor Member, Basal Kubang Pasu Formation: Earliest Record of Glacial-Derived Deposits in Peninsular Malaysia

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INTRODUCTION

Ancient glacial marine deposits are known from the Singa Formation in Langkawi, which contains dropstones, diamictites and cold water brachiopods (Stauffer and Lee, 1986; Mohd Shafeea Leman, 1996). These have been associated with widespread Permo-Carboniferous glaciation on Gondwana (Veevers and Powell, 1987). Fossil brachiopods associated with these glacial marine deposits indicate an Early Permian (late Asselian-Early Sakmarian) age.

We here describe pebbly mudstone and diamicite intervals from the Carboniferous Chepor Member, Kubang Pasu Formation, and interpret them as representing the earliest record of glacial marine conditions on Peninsular Malaysia.

GEOLOGIC SETTING AND LOCATION

The basal unit of the Kubang Pasu Formation, known as the Chepor Member, is exposed at several small hills in Perlis state, Malaysia, including Guar Sanai, Hutan Aji and Bukit Tuntung, Pauh (Fig. 1). The unit comprises thick, grey to red fossiliferous mudstone with interbedded quartzitic and occasional feldspathic sandstone (Amir Hassan et al., 2014). The Chepor Member unconformably overlies Devonian black shales and limestone, and Tournaisian chert. A facies analysis of the Chepor Member succession in Guar Sanai and Hutan Aji was conducted. This was then combined with palaeontological data to construct a depositional model for the unit.

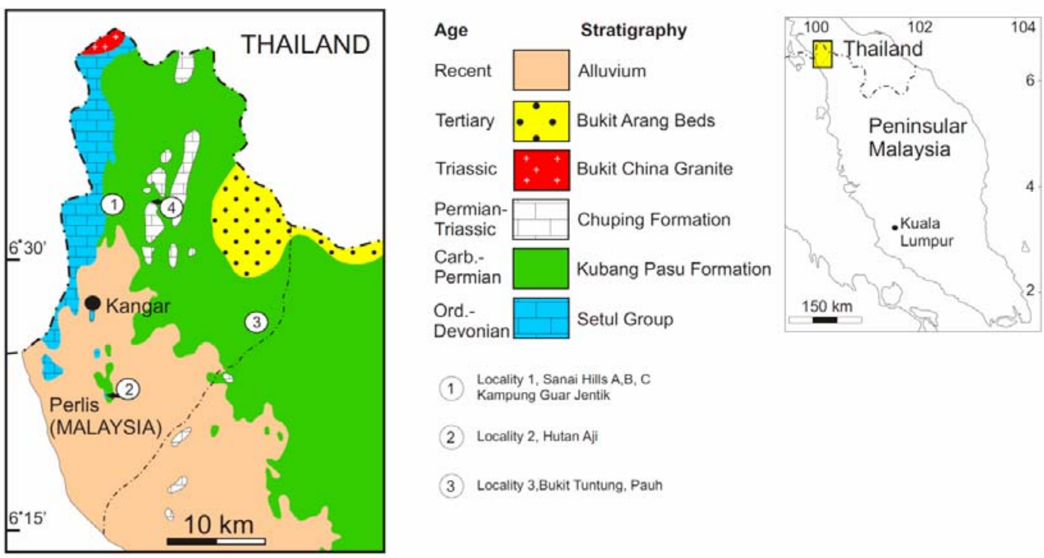

Figure 1: Location and geologic map of study areas in Perlis.

RESULTS AND DISCUSSION

The rocks of the Chepor Member are divided into four main facies: (1) Mudstone Facies characterised by thick fossiliferous mudstone interpreted as shelfal deposits; (2) Graded Sandstone Facies characterised by normal graded beds and incomplete Bouma sequences, interpreted as gravity-driven turbidites; (3) Clean Sandstone Facies characterised by fine grained sandstone displaying abundant wave and current generated sedimentary structures and interpreted as storm- and tide-generated bars, dunes, shoals or ridges, and; (4) Diamictite Facies characterised by poorly sorted sandstone with floating pebbles. Isolated pebbles are commonly found floating in the Mudstone Facies, where they disrupt and deform underlying laminae (Fig. 2A). The pebbles are interpreted as dropstones. Some intervals of the Mudstone Facies are also poorly sorted, with abundant, coarse grained sandstone grains distributed in the rock. These poorly sorted units are interpreted as rain-out diamictites. Both features probably represent debris fall out from melting icebergs. The Diamictite Facies is interpreted as gravity-driven debris flow deposits (Fig. 2B). The combination of shallow marine facies and glacially-derived dropstones and diamictites are consistent with the interpretation of a glacial marine shelf depositional setting.

The presence of the trilobite *Weyeraspis* sp. (previously ?*Diacoryphe* sp.) and the ammonoids ?*Goniatites* sp. and *Praedaraelites tuntungensis* indicate a possible Mississippian (Viséan) age for the glacial marine deposits of the Chepor Member.

CONCLUSIONS

The combination of glacial-derived dropstone and diamictites, shallow marine, shelfal facies and a marine fossil assemblage indicates a glacial marine depositional setting, with the dropstones and diamictites originating as fall out debris from melting icebergs.

The fossils indicate that these glacial marine deposits are significantly younger than the glacial marine deposits of the Singa Formation which are Early Permian in age. Thus, the Chepor Member dropstones and diamictites are the earliest records of glacial marine conditions in Peninsular Malaysia.

REFERENCES

Amir Hassan, M.H., Aung, A-K., Becker, R.T., Rahman, N.A.A., Fatt, N.T., Ghani, A.A., Shuib, M.K. 2014. Stratigraphy and palaeoenvironmental evolution of the mid- to upper Palaeozoic succession in Northwest Peninsular Malaysia, Journal of Asian Earth Sciences 83, 60-79.

Mohd Shafeea Leman, 1996. The occurrence of brachiopods from pebbly mudstone near Kilim, Langkawi: their age, paleobiogeography and paleoclimatic implication (Abstract). Geol. Soc. Malaysia Newslett. 22, 100–102.

Stauffer, P.H., Lee, C.P., 1986. Late Paleozoic glacial marine facies in Southeast Asia and its implications. Bull. Geol. Soc. Malaysia 20, 363–397.

Veevers, J. J., Powell, C. M., 1987. Late Paleozoic glacial episodes in Gondwanaland reflected in transgressive-regressive depositional sequences in Euramerica. *Geological Society of America Bulletin* 98, 475–87.

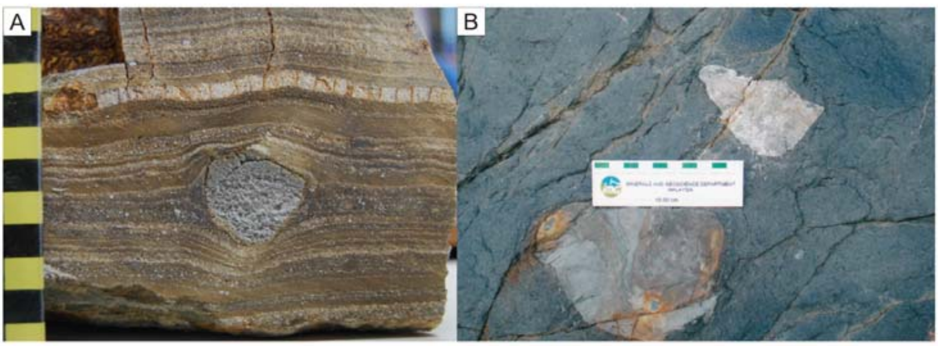

Figure 2: Glacial marine deposits of the Carboniferous Chepor Member, Kubang Pasu Formation. (A) Dropstone penetrating laminae of the Mudstone Facies. (B) Pebbles in the Diamictite Facies.

P006

Engineering Geologic Investigations of Rock Slopes – Two Recent Case Studies

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Rock slopes feature frequently in numerous construction projects, such as in highways/roadways, housing developments, dams, etc. Numerous case studies on rock slope stability associated with housing development projects, highways, etc. have been documented by the author in the past, e.g. Tan (2004a), Tan (2004b), Tan (2004c), etc. This paper presents two recent case studies on the investigations and assessments of the stability of rock slopes associated with a condominium project in the Kuala Lumpur area, and a new road under construction in the Murum area, Sarawak.

The condominium in the Kuala Lumpur area is underlain by rocks of the Kenny Hill formation, namely interbedded quartzite and phyllite, Yin (1976). Survey of the rock slopes at the periphery of the condominium indicates potential toppling and planar failures from the quartzite. For details on various modes of failures in rock slopes, the reader is referred to the book by Hoek & Bray (1974). An interesting feature encountered here is the occurrence of roots of big trees penetrating and wedging into joints of the bedrock, hence dislodging rocks and causing rockfalls. Thus, in addition to the normal remedial or stabilization measures such as guniting and wire nets, chopping down of the big trees/removal of the roots was an additional necessary work. Again, Hoek & Bray (1974) discusses various rock slope stabilization measures commonly adopted. In this particular case study, guniting the entire rock slope was the main stabilization measure adopted. Figure 1 shows root wedging in the quartzite rock slope.

The new road in the Murum area traverses rocks of the Belaga Formation, mainly interbedded sandstone and shale. Cut-slopes into the rocks face potential instability mainly from the bedding planes of the sedimentary rocks. In addition, joints within the massive/thick sandstone beds can also produce minor instabilities or rockfalls. The black/carbonaceous shale also suffers from ravelling of rock materials since it is a relatively weak rock. In one particular cut-slope that was investigated in detail, four major failures had occurred, and removal of the failed materials was the remedial measure adopted. Figure 2 shows major failures in the cut-slope comprising interbedded sandstone and shale.

REFERENCES:

Hoek, E. & Bray, J.W. (1974). Rock Slope Engineering. Institution of Mining and Metallurgy, London.

Tan, B.K. (2004a). Assessment of rock slope stability: Three case studies. Proc. Malaysian Geotechnical Conf. 2004, 16-18 March 2004, IEM, Subang Jaya, 449-456.

Tan, B.K. (2004b). Engineering geology of rock slopes in highway construction. Proc. 6th Malaysian Road Conf., 16-18 Aug. 2004, Subang Jaya, Paper no. 25, 6 pp.

Tan, B.K. (2004c). The practice of engineering geology in Malaysia. Proc. Malaysian Geotechnical Conf. 2004, 16-18 March 2004, IEM, Subang Jaya, Special Lecture, 131-148.

Yin, E.H. (1976). Geologic Map of Selangor, Sheet 94 (Kuala Lumpur).

Figure 1: Root wedging in quartzite rock slope.

Figure 2: Major failures in cut-slope of interbedded sandstone-shale.

P071

Physico-Chemical Properties of Schist and Granite as a Liner Material

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PENGENALAN

Masalah di tapak pelupusan sampah semakin hari semakin bertambah rumit. Ini berikutan berlakunya pertambahan isipadu sampah dalam jangka masa yang singkat. Secara logiknya, pertambahan bilangan penduduk yang begitu pesat pada suatu tempat akan menghasilkan banyak sisa sampah. Pertambahan sisa sampah yang terhasil sekaligus menambahkan beban ke atas pelapik yang bertindak sebagai penghalang bahan pencemar. Jika kekuatan pelapik yang sedia ada tidak mencukupi untuk menampung beban sampah, berkemungkinan akan berlakunya masalah air larut resap yang mana bahan–bahan pencemar dari sampah sarap akan menembusi tanah dan mencemarkan alam sekitar. Oleh sebab itu, reka bentuk yang memenuhi kriteria-kriteria bagi suatu pelapik adalah sangat penting sama ada dari segi kekuatan, kebolehtelapan dan had pengecutan. Pengetahuan tentang sifat tanah itu sendiri penting, terutamanya yang berkaitan dengan kekuatan tanah supaya tanah dapat menampung beban yang berada di atas pelapik tanah. Dengan itu, untuk mengkaji permasalahan ini, ujikaji yang akan dikaji adalah merujuk kepada kekuatan tanah baki termampat. Beberapa kajian dan penyelidikan telah dilakukan untuk melihat tahap kekuatan tanah baki termampat sebagai bahan pelapik tanah (Qian et al. 2002).

Pelapik tanah juga dikenali sebagai pelapik tanah liat termampat, '*Compacted Clay Liner*' (CCL). Pelapik yang berasaskan tanah sering diguna pakai kerana keadaan tanah tersebut yang mempunyai kekuatan tanah yang semulajadi. Selain itu, pelapik jenis ini juga murah, mudah di perolehi dan tidak mudah rosak apabila berada di dalam tanah untuk jangka masa yang lama. Kebiasaannya, pelapik tanah yang baik terdiri daripada lodak atau tanah liat atau bahan yang mempunyai keterlapan rendah (Radzuan 2006).

Tetapi, bahan jenis ini juga mempunyai keburukannya. Hal ini demikian, dari segi geologinya bukan semua bahan tanah sesuai dijadikan sebagai bahan pelapik bagi penimbusan sampah. Ini disebabkan tanah mempunyai variasi tersendiri dari segi komponen pepejal seperti mineral lempung, bahan organik, bahan amorfous, bahan berkapur, pH dan sebagainya. Oleh itu, kajian yang terperinci mengenai geologi dan hidrologi kawasan pembinaan tapak pelupusan hendaklah dikaji secara terperinci. Walau bagaimanapun, pengubahsuaian tanah boleh dilakukan jika tanah di kawasan tersebut tidak mempunyai kandungan bahan liat yang cukup untuk mencapai tahap keterlapan yang sesuai di tapak pelupusan. Oleh sebab itu, penambahan bahan-bahan lain seperti bentonit boleh digunakan sebagai bahan tambahan untuk meningkatkan sifat keterlapan tanah (Hughes et al. 2005c).

Selain bahan mineral pelapik yang lain, bentonit dan campuran pasir-bentonit memainkan peranan yang penting sebagai bahan pelapik dalam sistem penimbusan sisa. Secara umumnya, bahan-bahan ini lebih seragam sifatnya, seperti penggalian tanah liat tanpa memerlukan sebarang perawatan. Terdapat kebanyakkan kes, bentonit dicampur dengan pasir menggunakan teknik-teknik yang berbeza. Percampuran serbuk kering bentonit dengan tanah lebih disyorkan untuk mendapatkan penutup yang memuaskan dengan satu ketebalan yang minimum 0.3m diperlukan untuk mengurangkan risiko gangguan pada lapisan pasir-bentonit. Bentonit merupakan tanah liat semulajadi, yang mempunyai ciri-ciri istimewa yang menyediakan pelbagai kegunaan terutamanya dalam bidang kejuruteraan dan aktiviti industri. Ia mengandungi mineral montmorilonit bagi tanah liat diikuti dengan beidelit. Kedua-dua mineral ini adalah dalam kumpulan smektit.

BAHAN DAN KAEDAH

Kawasan kajian yang dipilih adalah kawasan Ampang, Hulu Langat yang terletak pada garis bujur 101° 44' T sehingga 101°49' T dan pada garis lintang 03° 04' U sehingga 03°08' U dengan keluasan kira-

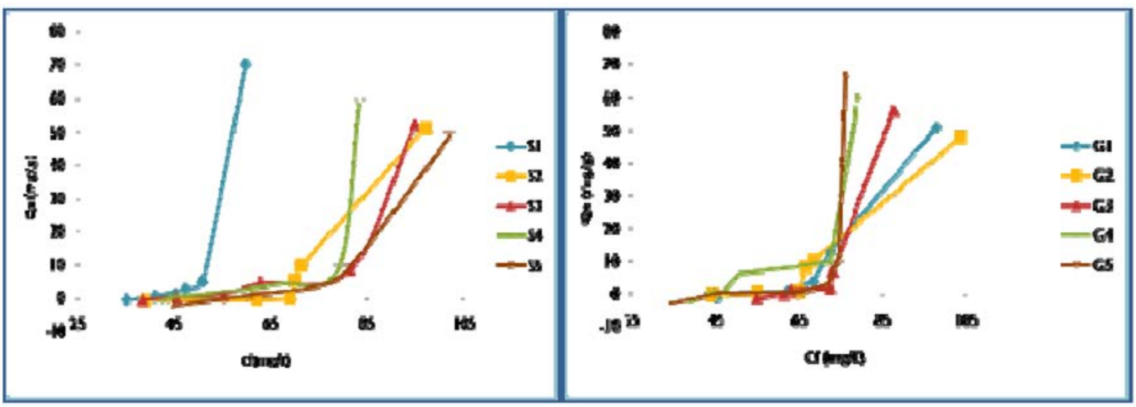
Jadual 1 Analisis pencirian fizikokimia tanah baki syis dan granit Ampang,Selangor

Sampel	% Lempung	LL (%)	PL (%)	Kelas	W_{opt} (%)	γd_{max} (Mg/m^3)	Gs	K (m/s)
S1	1.81	30.00	26.00	ML	9.40	0.81	2.24	4.46×10^{-7}
S2	2.21	31.00	28.00	ML	9.34	0.77	2.26	3.51×10^{-8}
S3	3.72	30.00	28.00	ML	11.65	0.78	2.09	7.75×10^{-7}
S4	1.05	54.00	37.00	CI	12.28	0.76	2.04	1.62×10^{-7}
S5	2.08	48.50	36.00	MI	13.41	0.75	2.10	2.36×10^{-7}
G1	2.00	43.88	23.79	CI	10.76	1.91	2.52	4.97×10^{-7}
G2	1.01	51.82	34.99	MH	14.06	1.89	2.52	4.31×10^{-7}
G3	8.95	60.06	36.85	MH	14.86	1.96	2.59	2.99×10^{-8}
G4	1.99	52.99	30.31	MH	13.29	2.03	2.57	3.11×10^{-7}
G5	3.97	47.39	32.50	MI	13.92	1.80	2.52	1.64×10^{-7}

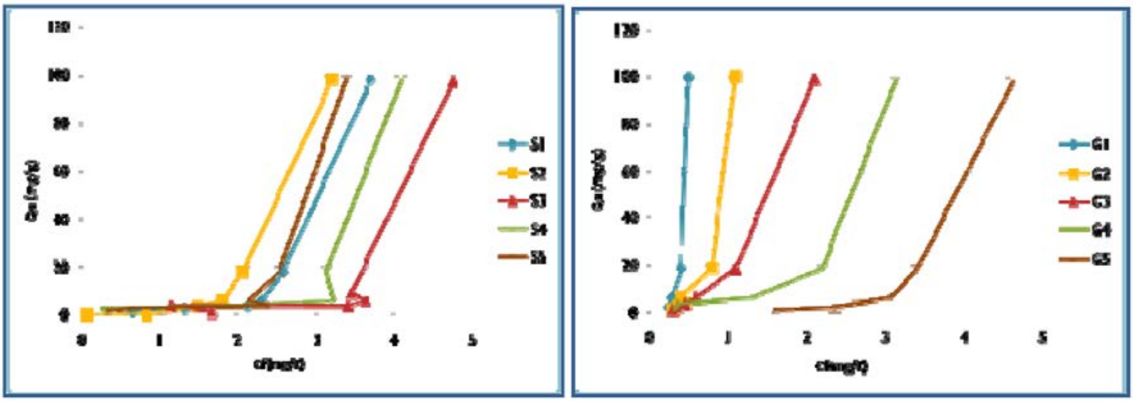
S =Tanah baki syis
G =Tanah baki granit
LL =Had cecair
PL =Had plastik
W_{opt} = Air optimum
γd_{max} = Nilai ketumpatan maksimum
G_s = Spesifik graviti
K = Ketertelapan

Sampel	% organik	SSA(m2/g)	CEC(meq/100g)	Mineralogi
S1	4.5	8.04	0.995	Q>Mc>K
S2	5	11.89	1.4614	Q>Mc>K
S3	10.2	12.94	0.1757	Q>Mc>K
S4	7.85	25.87	1.2586	Q>K
S5	3.15	18.53	0.9559	Q>K
G1	1.1	22.73	1.4539	Q>K>M>F
G2	11.15	38.81	1.6274	K>Mc>Q>M
G3	12.85	34.62	3.7805	Mc>Q>K>M
G4	4.65	30.07	2.9153	K>Q>M
G5	6.3	23.43	2.2926	K>Q>M>Hb

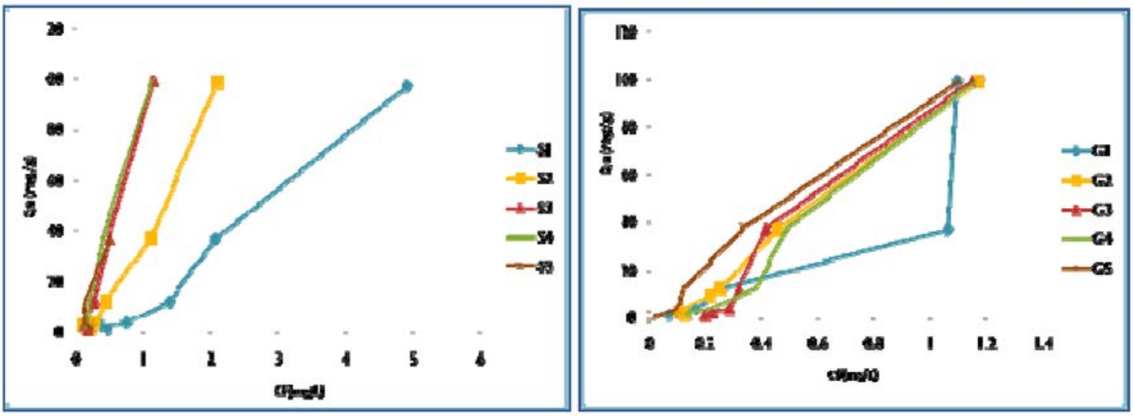
SSA = Luas permukaan spesifik
CEC = Kapasiti pertukaran kation
ML = Kelodak berkeplastikan rendah
MI = Kelodak berkeplastikan sederhana
MH = Kelodak berkeplastikan tinggi
CL = Lempung berkeplastikan rendah
CI = Lempung berkeplastikan sederhana
CH = Lempung berkeplastian tinggi
Q= Kuarza
Mc = Mikroklin
K = Kaolinit
M = Muskovit
F = Florit



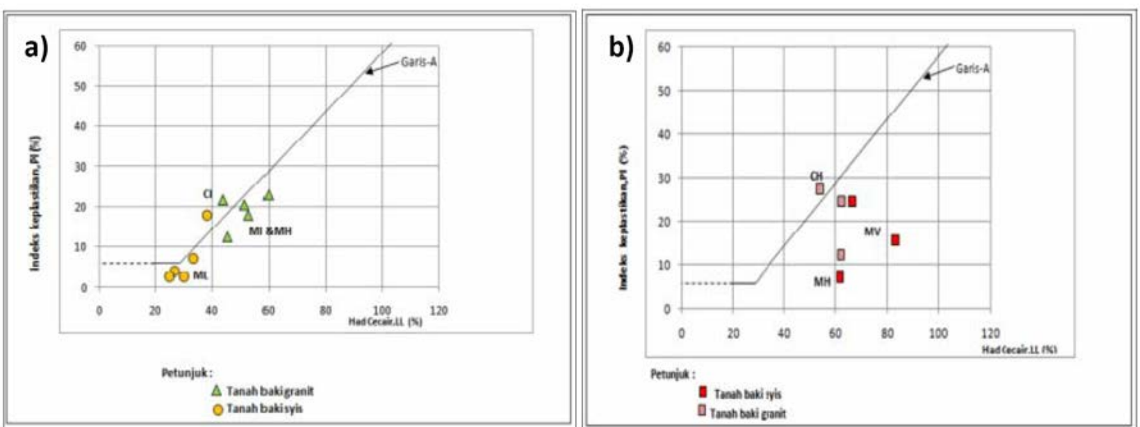
Rajah 1 Graf penjerapan logam berat Pb bagi qe (mg/g) melawan Ce (mg/L) tanah baki syis (S) dan tanah baki granit (G) bagi semua sampel kajian.



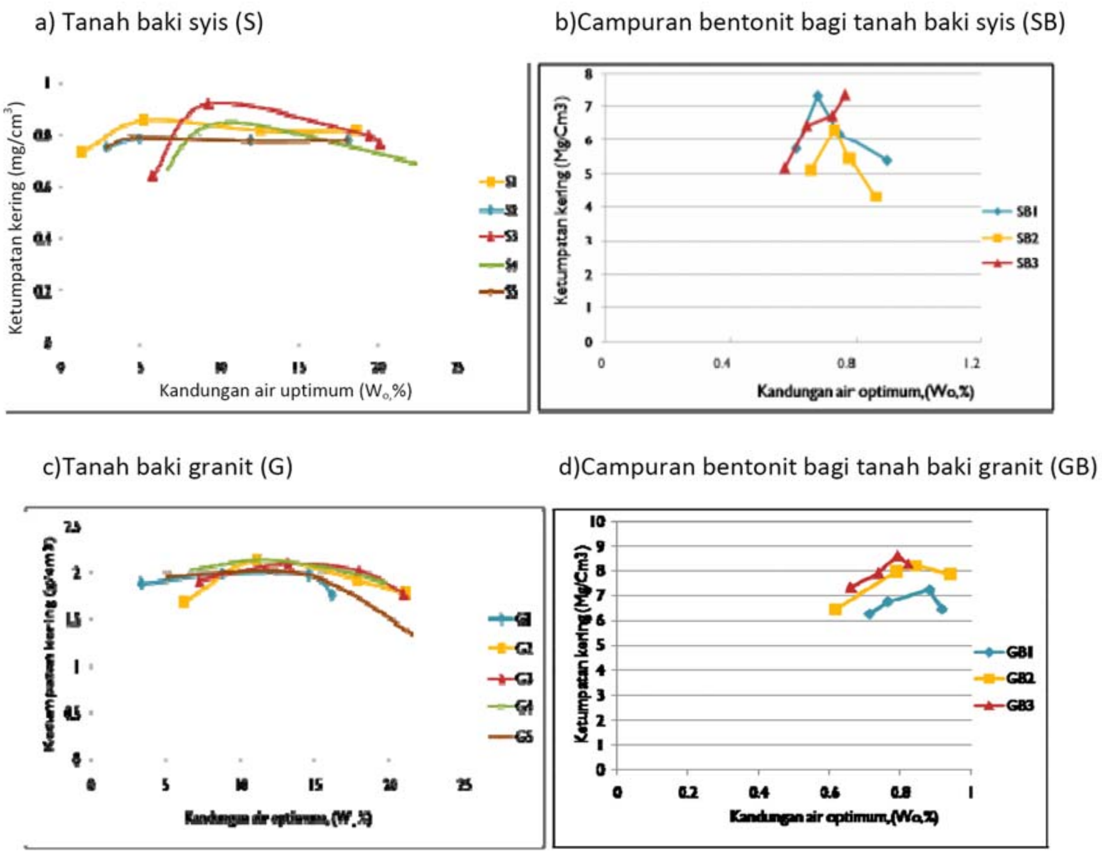
Rajah 2 Graf penjerapan logam berat Cu bagi q_e (mg/g) melawan C_e (mg/L) untuk tanah baki syis (S) dan tanah baki granit (G) bagi semua sampel kajian



Rajah 3 Graf penjerapan logam berat Zn bagi qe (mg/g) melawan Ce (mg/L) untuk tanah baki syis (S) dan tanah baki granit (G) bagi semua kajian



Rajah 4 Carta keplastikan tanah baki syis dan tanah baki granit sebelum (a) dan selepas campuran bentonit (b)



Rajah 5 Graf lengkung pemadatan bagi tanah baki syis (S) dan granit (G) dan graf lengkung pemadatan tanah baki syis (SB) dan granit (GB) dengan campuran bentonit sebanyak 12.5%, 25% dan 50%

kira 90 km². Kawasan kajian ini terletak kira-kira 14 km ke timur Bandaraya Kuala Lumpur. Sebanyak lima sampel tanah baki granit dari Kg. Melayu Sg Sering dan lima sampel tanah baki syis daripada Taman Bistari Ukay, Jalan Ukay Perdana digunakan dalam kajian ini.

Sampel-sampel ini diambil pada berdekatan dengan permukaan atau dalam kedalaman yang cetek. Semua sampel akan diuji secara kimia dan fizikal. Sebelum ujikaji kimia dilakukan, semua sampel terlebih dahulu dilakukan pencirian fizikal untuk mengetahui sifat-sifat bahan kajian. Antara ujian fizikal yang terlibat ialah ujian graviti tentu, taburan saiz butiran, had-had atterberg, pemadatan tanah, ujian keterlapan tanah serta XRD sampel. Uji kaji secara kimia yang terlibat dalam kajian ini antaranya ialah luas permukaan tertentu (*specific surface area-SSA*), kebolehan penukaran kation (CEC), peratus kandungan organik dan ujian penjerapan berkelompok (*batch equilibrium test*). SSA diperolehi menggunakan kaedah serapan *Ethylene Glycol Monoethyl* (EGME), manakala CEC diperolehi menggunakan ujian keseimbangan dengan memasukkan penukaran ammonia asetat. Selain itu, ujian ini turut melibatkan penambahan bentonit pada sampel kajian untuk mengukuhkan data yang diperolehi.

HASIL DAN PERBINCANGAN

Berdasarkan hasil analisis setiap kajian yang dilakukan (Jadual 1), tanah baki granit mempunyai taburan saiz butiran yang lebih seragam berbanding tanah baki syis dengan kandungan fraksi berbutir halus yang lebih tinggi. Sifat fizikal yang terdapat pada tanah baki granit ini seterusnya mempengaruhi nilai dan hasil ujian-ujian lain yang dilakukan dalam kajian ini. Daripada ujian had-had atterberg yang diperolehi, sampel tanah baki yang dikaji dikelaskan kepada empat pengelasan jenis tanah yang utama berdasarkan nilai indeks keplastikan yang diperolehi iaitu kelodak berkeplastikan rendah (ML), kelodak berkeplastikan sederhana (MI), kelodak berkeplastikan tinggi (MH) dan lempung berkeplastikan sederhana (CI). Hasil analisis ujian

Hasil kajian fizik yang diperolehi, bacaan taburan saiz butiran mendapati saiz butiran tanah baki di kawasan kajian didominasi oleh butiran bersaiz pasir bagi tanah baki syis (41 % hingga 87 %) dan tanah baki granit (56% hingga 64%). Nilai Gs bagi tanah granit yang lebih tinggi (2.52 hingga 2.59) berbanding tanah baki syis yang menunjukkan nilai Gs yang lebih rendah (2.00 hingga 2.26) disebabkan oleh kehadiran oksida besi yang tinggi akibat daripada proses dan tindakan luluhawa yang pesat yang berlaku di kawasan kajian. Sifat kebolehan penyerapan air yang tinggi pada tanah baki granit adalah kerana ia mempunyai kandungan air optimum, Wo (10% hingga 15%) dan nilai ketumpatan maksimum,γd (1.8 Mg/m3 hingga 2.1 Mg/m3) yang lebih tinggi berbanding tanah baki syis. Manakala hasil nilai keterlapan yang diperolehi bagi tanah baki granit, nilai yang diperolehi adalah rendah berjulat antara 1.621 x 10-7 m/s hingga 3.512 x 10-8 m/s disebabkan kehadiran fraksi-fraksi berbutir halus yang lebih tinggi dan seragam. Sistem pelapik yang mempunyai keterlapan yang rendah dengan kandungan mineral lempung yang tinggi meningkatkan keupayaan tindakan penjerapan tanah terhadap unsur-unsur kimia (Pierzynski et al., 2000).

Nilai luas permukaan spesifik tanah baki granit tinggi disebabkan kehadiran mineral lempung kaolinit yang lebih tinggi berbanding tanah baki syis hasil analisis graf spektrum XRD. Jika kehadiran mineral lempung seperti kaolinit tinggi, maka kadar keupayaan penjerapan adalah lebih tinggi yang berkadar langsung dengan luas permukaan spesifik (Westlake, 1997). Secara keseluruhannya, didapati nilai kapasiti pertukaran kation (CEC) bagi tanah baki granit juga adalah lebih tinggi berjulat di antara 1.4539 meq/100g hingga 3.7805 meg/100g. Hasil ujian penjerapan berkelompok (BET) juga mendapati bahawa jumlah logam berat yang dijerap oleh bahan kajian, qe adalah berkadar langsung dengan pertambahan kosentrasi daripada kepekatan 25 mg/L, 50 mg/L, 75 mg/L, 100 mg/L, 150 mg/L dan 200 mg/L. Berdasarkan nilai kepekatan keseimbangan dan lengkung penjerapan bagi setiap unsur logam berat yang ditunjukkan, menunjukkan sampel tanah baki granit mempunyai kapasiti penjerapan yang lebih tinggi untuk menjerap Cu (Rajah 2) daripada Pb (Rajah 1), sebaliknya tanah baki syis mempunyai keupayaan yang tinggi untuk menjerap unsur logam berat Zn berbanding unsur lain yang dikaji (Rajah 3). Hasil kajian juga menunjukkan bagi tanah baki syis, unsur logam berat tunggal yang mempunyai kadar penjerapan tertinggi berdasarkan susunan ialah Zn > Cu > Pb, manakala bagi tanah bagi granit pula unsur logam berat yang mempunyai kadar penjerapan yang paling tinggi ialah Cu > Zn > Pb. Lengkok graf yang lebih menghampiri paksi-y mempunyai keupayaan penjerapan logam berat yang lebih tinggi berbanding lengkung graf yang menghampiri paksi-x (Wan Zuhairi et al., 2004).

Kajian khas yang dilakukan melibatkan penambahan bentonit dan sampel-sampel tanah baki yang dikaji mengikut peratus yang telah ditetapkan iaitu 12.5 %, 25 % dan 50 %. Hasil ujian had-had atterberg yang dilakukan, dengan kadar penambahan bentonit yang semakin meningkan akan meningkatkan nilai indeks keplastikan. Tanah baki granit seperti yang telah dibincangkan mempunyai nilai indeks keplastikan yang tinggi berbanding tanah baki syis, setelah dilakukan penambahan bahan bentonit akan meningkatkan nilai indeks keplastikan yang diperolehi dengan setiap peningkatan kadar yang berbeza-beza. Dengan meningkatnya pertambahan fraksi-fraksi berbutir halus pada sampel kajian, kumpulan pengelasan tanah juga secara tidak langsung akan berubah (Rajah 4). Carta Sistem Pengelasan Tanah Bersekutu mendapati bahawa setelah campuran tanah baki syis dan bentonit dilakukan, hasil analisis menghasilkan carta pengelasan tersendiri yang berkadar langsung dengan peningkatan nilai had cecair (LL) dan indeks keplastikan (PI) yang diperolehi. Sebaliknya, hasil ujian pemadatan yang dijalankan mendapati nilai ketumpatan gembur kering, γdmax(Mg/m3) dan peratus kandungan air bagi kedua-dua sampel akan berkurangan dengan setiap kadar pertambahan bentonit yang dilakukan (Rajah 5). Hal ini disebabkan peningkatan tindakan penjerapan tanah lempung yang diperolehi hasil campuran tanah baki-bentonit.

KESIMPULAN

Hasil analisis semua ujian fizikal dan kimia yang telah dilakukan membuktikan bahawa tanah baki granit merupakan bahan geologi semulajadi yang lebih sesuai dan berpotensi untuk dijadikan sebagai bahan pelapik tapak penimbusan sampah sarap berbanding tanah baki syis kerana;

1.keupayaan penjerapan logam berat yang tinggi
2.kehadiran fraksi tanah lempung yang tinggi
3.nilai ketertelapan yang rendah
4.Kadar penyerapan air yang tinggi

Penambahan bahan bentonit juga sebagai bahan tambahan yang paling berkesan untuk meningkatkan ciri-ciri fizikal-kimia bagi bahan pelapik tanah semulajadi. Contohnya pertama, semakin tinggi nilai kapasiti pertukaran kation (CEC) yang diperolehi semakin berkesan sifat tanah bertindak sebagai bahan perangkap bahan pencemar dalam tanah. Selain itu, fraksi berbutir kasar mempunyai luas permukaan yang lebih kecil berbanding fraksi berbutir halus. Jika penambahan bentonit dilakukan, fraksi berbutir halus dalam tanah akan meningkat dan seterusnya akan mempengaruhi kadar penjerapan pada permukaan tanah

Kajian ini membuktikan juga bahawa tanah baki granit dengan campuran bentonit akan menghasilkan bahan yang mempunyai ciri-ciri utama yang paling efektif sebagai pelapik yang berkos rendah, bersifat mesra alam, dan mempunyai kadar keupayaan penjerapan yang tinggi untuk merawat bahan pencemar yang hadir seterusnya dapat menghalang berlakunya pencemaran alam semulajadi yang ketara pada dasar dan juga di permukaan tapak perlupusan sampah.

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Rujukan

Hughes K.L., Christy A.D.dan Heimlich J.E., 2005. *Landfill Types and Liner Systems, OSU Extension Fact Sheet* CDFS – 138 – 05.

Pierzynski, G.M., Sims, J.T. & Vance, G.F., 2000. Soil phosphorus and environmental quality. *Soils and Environmental Quality*, 155-207.

Qian, X., Koerner, R.M dan Gray, D.H., 2002. *Geotechnical Aspects of Landfill Design and Construction*, Prentice Hall, Inc.

Radzuan Junin , 2006. Rancang Pelupusan Sampah Secara Berkesan, Utusan Malaysia.

Wan Zuhairi, W.Y, Abdul Rahim Samsudin, Mohd Ramziemran & Chan Yik Loon., 2004. Natural Sorption capability of heavy metals: Granitic residual soil from Broga and marine clay from Sg. Besar Selangor. *Bulletin Geological Society of Malaysia*, 48: 13-16.

Westlake A.S., 1997. *An evaluation of the attenuation properties of clays used as landfill liners in South Wales*. Division of Civil Engineering, University of Wales

P019

Pengkuantitatifan kestabilan cerun berdasarkan system perkadaran jasad cerun: Kajian kes bukit batukapur di Ipoh, Perak.

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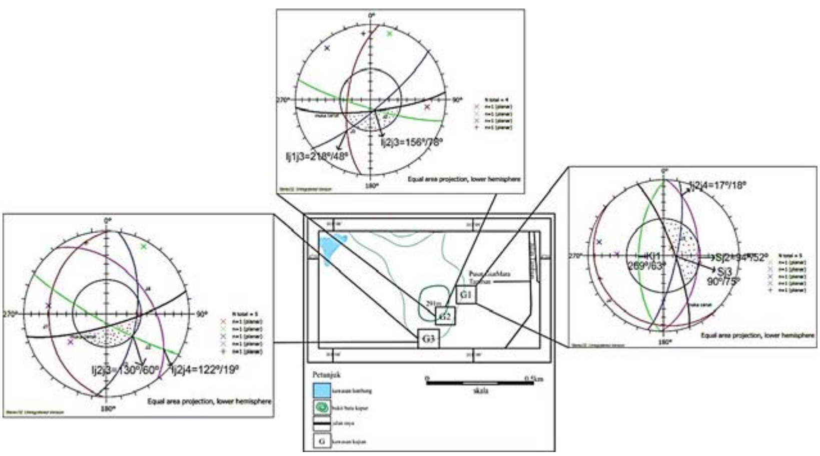
Bukit batukapurdenganpemandanganindahmempunyainilaigeowarisandankerap kali menjaditapaktarikanpelancong. Akan tetapi kawasan perbukitan batukapur juga ada sejarah runtuhan dan jatuhan batuan yang telah menyebabkan kehilangan nyawa dan hartabenda. Pembentangan ini membincang keberkesanan penggunaan system pengelasan jasad batuan, RMR (Bieniawski, 1989) dan system perkadaran jasadcerun, SMR (Romana, 1985) untuk pengkuantitatifan kestabilan cerun batuk apur terpilih dan menentukan keutamaan dari segi ketidakstabilannya. Tiga tapak kajian adalah Gunung Layang-Layang, Gunung Cheroh dan Gunung Bercham di sekitar Ipoh, Perak. Di setiapt apak survey ketak selanjaran terperinci bersama dengan ujian lantunantukul Schmidt dijalankan. Hasilnya membolehkan penentuan RMR berdasarkan Bieniawski (1989). Plot stereo grafunjuransama luas satahketak selanjaranutam adancerun di setiaptapak memboleh kanpenentuanragam kegagalan. Input inidigunakanbersamadengan RMR dansudutgeseranpermukaansatahketakselanjaranuntukpenentuan SMR, pengelasancerun dan seterusnya mendapat keberangkalian kegagalan. Rajah 1 – 3 menunjukkan plot ragamkegagalancerundanjadual 1 beruparumusanpenentuan RMR, SMR, kelascerundankeberangkaliankegagalan.

G. Berchamdikelaskansebagaikelas IV, iaitutidakstabilmanakalasemuacerun lain adalahkelas III, iaituseparastabil. Jikalangkahpenebatandilaksanakanuntukmenstabilkancerun, G. Berchamsepatutnyadiberikeutamaan.

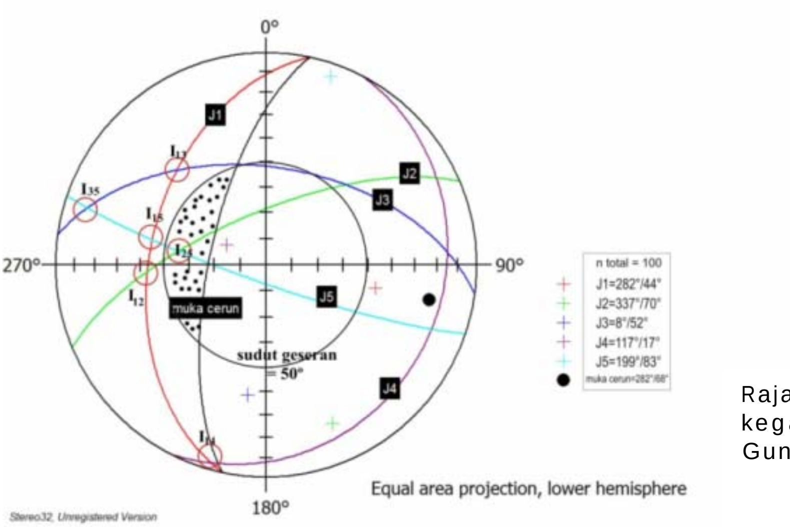
RUJUKAN:

Bieniawski, Z.T. (1989). *Engineering Rock Mass Classifications.* John Wiley, p.251.

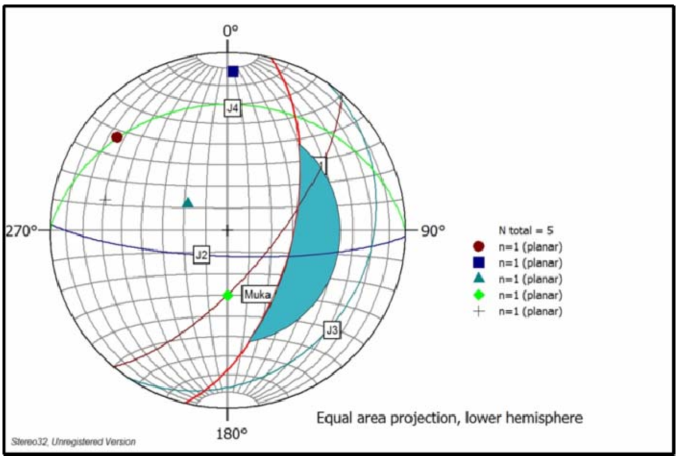
Romana, M. (1985). New adjustment ratings for application of Bieniawski classification to slopes *Proceedings of the International Symposium on the Role of Rock Mechanics in Excavations for Mining and Civil Works, International Society of Rock Mechanics*, Zacatecas, pp. 49–53



Rajah 1: Ragamkegagalancerun, GunungLayang-Layang, Ipoh



Rajah 2: Ragam kegagalan cerun, Gunung Cheroh, Ipoh



Rajah 3: Ragamkegagalancerun, GunungBercham, Ipoh

Lokasi	RMR_{asas}	SMR	KelasCerun	Keberangkaliankegagalan
G. Layang-Layang G1	69	50	III	0.4
G. Layang-Layang G2	65	50	III	0.4
G. Layang-Layang G3	70	50	III	0.4
G. Cheroh	84	54	III	0.4
G. Bercham	60	30	IV	0.6

Jadual 1: RMR, SMR dankeberangkalainkegagalan, G. Layang-Layang, G. Cheroh& G. Bercham, Ipoh.

P021

Assessment of Landfills Settings in Selangor and the Emerging Hazards Under a Changing Climate

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Topographic settings of landfills play an important role in the exposure to climate-induced geo-hazards especially in the forms of flooding and landslides. In the advent of climate change, general rise in flood magnitude and frequency is expected that may increase the exposure of more landfills to the risk of flooding. This paper studies spatial location and settings of landfills and open dumps in Selangor in an attempt to identify the risk of exposure to regular and large floods, the potential for landslide and to address possible implications in the form of cascading hazards. A preliminary assessment by proximity analysis of landfills and open dumps in Selangor was conducted based on the topography of landfill sites and available flood hazard maps. The results reveal that 8 out of 24 identified sites are highly exposed to the risks of regular and large flooding, with possible cascading effects on humans and the environment.

Keywords: Landfill, flooding, landslides, cascading hazards, climate change, Selangor

INTRODUCTION

An increased risk of floods is expected in a number of major river basins due to an increase in river discharge and the greater risk of intense storm-related precipitation events (Meehl et al., 2007). Besides flooding at the low-lying areas, landfills that are located in the highland area or at hillslope are also exposed to the risk of landfill landslides from heavy rainfall events (Blight, 2008). Understanding of the potential exposure, impacts of the disaster and the cascading hazards associated with flooding and landslides at landfills is crucial step towards reducing the landfills vulnerability to the impact of climate change and ensuring the sustainability of landfills and the surrounding environment.

METHODS

A preliminary assessment was carried out using spatial analysis and limited ground checking for landfill sites in Selangor to evaluate the exposure to the risk of flooding and landslide. Using GIS, the flood prone and 100-year flood maps are overlaid on the Digital Elevation Model of Selangor with superimposed landfills distribution (Figure 1). The relief between landfills to the nearest estimated flood boundary were estimated to calculate the potential depth of 100-year flood relative to the elevation of landfills. Flood risk exposure was then tentatively assigned based on the selective criteria as specified in Table 1. The potential exposure to landslide is measured based on the topographic height of the terrain. In this assessment, landfills that are located on hillslope at an elevation above 100 meter is considered as endangered.

RESULTS AND DISCUSSION

The results show that out of the 24 landfill sites in Selangor, eight sites are currently endangered to the risk of flooding (Table 2). All the sites that are endangered to the risk of flooding also have negative elevation difference values and thus may be inundated in the scenario of 100-year flood events. From the analysis for possible slope failure threats, the Hulu Langat and Seri Gombak landfills are found to be potentially exposed.

CONCLUSION

Additional pressures from climate disasters are likely to adversely affect the integrity of landfill security and their lifetime. By recognizing the exposures and the current conditions of the landfills, it is important to plan for appropriate mitigation measures against the risks of the disasters.

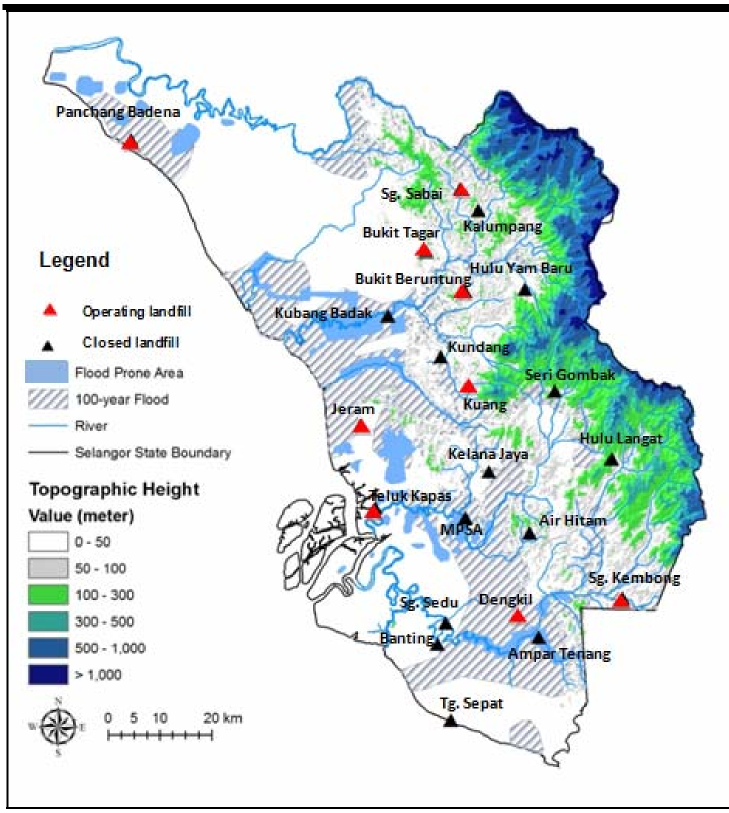

Figure 1. Landfill sites distribution on topographic, flood prone and 100-year flood maps in the state of Selangor, Malaysia.
(Sources:
Flood maps: JPBD, 2009;
Landfill sites: JPSPN, 2013;
Suratman & Sefie, 2010)

REFERENCES

Blight, GE. (2008) Slope failures in municipal solid waste dumps and landfills: a review. Waste Management and Research: 26: 448-463

Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao (2007) Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jabatan Perancangan Bandar dan Desa Semenanjung Malaysia (JPBD) (2010) Kementerian Perumahan dan Kerajaan Tempatan. Rancangan Fizikal Negara Ke-2.

JPSPN (2013) Negeri Selangor. Bilangan Tapak Pelupusan Mengikut Negeri (Operasi dan Tidak Beroperasi) http://www.kpkt.gov.my/jpspn_2013/main.php?Content=articles&ArticleID=55&IID. Accessed 27 February, 2014.

Suratman, S., Sefie. A. (2010) Groundwater contamination at landfill sites in Selangor. IAH, Krakow. 2205-11

Exposure category	Criteria
Endangered	Landfill is situated inside the 100-year flood area OR flood prone area
Probably Endangered	Landfill is situated within 200m from 100-year flood area OR flood prone area
Probably Not Endangered	Landfill is located between 200 – 2000m parameter from the 100-year flood area.
Not Endangered	Landfill is located more than 2000m from the 100-year flood area.

Table 2. List of MSW landfills in Selangor with the deduced category of flood risk exposure to each site based on evaluation

Site Name (Local Authorities)		Status	Level	Location Details	Proximity to river (m)
Endangered					
1	MPSA (MD Shah Alam)	Closed	0	Near industrial area	10
2	Sg. Kembong (MP Kajang)	Closed	0	A residential area 1km from the site	5
3	Kelana Jaya (MB Petaling Jaya)	Closed	0	Near developed and populated area	No river nearby
4	Kundang (MP Selayang)	Closed	0	Near a residential area	100
5	Ampar Tenang (MP Sepang)	Closed	I	Near residential areas, within flood prone area	30
6	Kubang Badak (MD Kuala Selangor)	Closed	II	Near residential areas, 100, from flood prone area	40
7	Panchang Badena (MD Sabak Bernam)	Operating	I	2.5km from coastline, surrounded by plantation and sparse housing area	300
8	Dengkil (MP Sepang)	Operating	0	Surrounded by plantation and residential area	No river nearby
Probably Endangered					
1	Jeram (MD Kuala Selangor)	Operating	IV	Surrounded by dense plantation	No river nearby
Probably Not Endangered					
1	Teluk Kapas (MP Klang)	Closed	I	3.6km from coastline, 4m elevation	100
2	Air Hitam Sanitary Landfill (MP Subang Jaya)	Closed	IV	Nearby residential areas and a creek	30
3	Kuang (MP Selayang)	Operating		Surrounded by vegetation, plantation	No river nearby
4	Bukit Tagar (MD Hulu Selangor)	Operating	I	Remote are with heavy plantation	3000

5	Banting (MD Kuala Langat)	Closed	I	Close to residential and developed areas with plantation	300
6	Tanjung Dua Belas (MD Kuala Langat)	Operating	IV	9 km from coastline, surrounded by plantation and vegetation	No river nearby
7	Seri Gombak (an illegal dump site)	Closed	0	On hillslope, near residential areas	A creek nearby, no river
Not Endangered					
1	Hulu Langat (MP Ampang Jaya)	Closed	0	Hilly terrain, steep slope, a resort down form slope	No river nearby
2	Sg. Sabai (MD Hulu Selangor)	Operating	0	Remote area with dense vegetation	2000
3	Bukit Beruntung (MD Hulu Selangor)	Operating	0	Located beside a freeway and cultivated area	5
4	Hulu Yam Bharu (MD Hulu Selangor)	Closed	0	Near cultivated and residential areas	20
5	Tanjung Sepat (MD Kuala Langat)	Closed	0	200m from coastline, near residential areas	No river nearby
6	Sg. Sedu (MD Kuala Langat)	Closed	I	Near to plantation area	40

10	Bukit Beruntung (Hulu Selangor)	Operating	0	55	25	30	~ 2000	5	Located beside a freeway and cultivated area	Not endangered
11	Hulu Yam Bharu (Hulu Selangor)	Closed	0	53	39	14	~3500 - 4000	20	Close to a river, cultivated and residential areas	Not endangered
12	Jln Besar Tanjung Malim, (Hulu Selangor)	Closed	0						Information cannot be found	
13	Kuang (Kepong)			75	44	31	~1000	none	Surrounded by vegetation and plantation	Probably not endangered
14	Tanjung Sepat (Kuala Langat)	Closed	0	6	8	-2	9000	none	~200m from coastline Near to residential areas	Not endangered
15	Sg. Sedu (Kuala Langat)	Closed	I	8	17	-9	~2800	40	Adjacent to plantation and a main river	Not endangered
16	Kubang Badak/Kg. Hang Tuah (Kuala Selangor)	Closed	II	8	42	-34	Inside	40	~100m from flood prone area. Residential areas nearby	Endangered
17	Jeram (Kuala Selangor)	Operating	IV	13	14	-1	160		Surrounded by heavy plantation	Probably endangered
18	Bukit Tagar (Hulu Selangor)	Operating	I	67	27	40	3800 from the nearest 100-year flood zone		Remote area with heavy plantation	Probably not endangered
19	Banting (Kuala Langat)	Closed	IV	8	11	-3	750 m	1000	Close to plantation, developed and residential areas	Probably not endangered

20	Panchang Badena (Sabak Bernam)	Operating	I	5	9	-4	Inside	300	2.5 km from coastline, surrounded by plantation and small patches of houses.	robably not endangered
21	Tanjung Dua Belas (Kuala Langat)	Operating		8	22	-14	1150	No river nearby	9 km from coastline, surrounded by heavy plantation and vegetation	Probably not endangered
22	Dengkil (Sepang)	Operating		9	25	-16	Inside	No river nearby	Surrounded by plantation and residential areas	Endangered
23	Seri Gombak *An illegal dump site			83	152	-69	~1250	A small creek down the slope	On hillside with steep slope, nearby residential areas	Probably not endangered

P034

Landslide Density Analysis along the Ranau-Tambunan Road

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Landslide density analysis based on a temporal landslide distribution over four different years were conducted along the Ranau-Tambunan road in Sabah. The analysis involved landslides that occurred in 1978, 1994, 2005 and 2008. Landslides for the earlier three years wereidentified based on aerial photographs interpretation while landslides in 2008 were based on field investigations. From the analysis, there were 202 landslides distributed along the Ranau-Tambunan road. The landslides were digitised as points and the point density was calculated based on the kernel density approach. Based on the landslide density analysis, there are 8 spots that were identified as highly susceptible to landslide. This assumption is based on the total landslides that occurred approximately at the same locations over the four assessment years. However, redundant landslides were not digitised. These spots are approximately at km 14, 20,27, 25, 30, 35, 41, and 46 from Ranautownship. Out of these spots, km 27 and 29 were indicated as the most susceptible location for landslides. These two locations are located close to the boundary between the Trusmadi and Crocker Formations. This study suggests that the road where km27 and 29 arelocated cut across a fault that separates the two rock formations. Major shearing and fracturesdue to the presence of the fault leadsto higher landslide occurrencesat km 27 and 29. A detailed investigation on these 8 spots should be conducted due to their higher susceptibility to landslidesas indicated by the landslide density map.

Keywords: Landslide density, landslide, landslide susceptibility, TrusmadiFormation, Crocker Formation

INTRODUCTION

The research effort of this work is directed towards determining the section area of high slope failure susceptibility along the Ranau-Tambunan road through landslide density analysis that uses landslide historical data. Several researchers have shown the importance of using landslide historical data to identify area that are susceptible to landslide (Coe *et al.*, 2004; Tropeano&Turconi, 2004)

METHODOLOGY

Past landslide events were acquired by aerial photograph interpretation. The landslide data were collected from 1978, 1994, and 2005 aerial photographs. Fieldwork was also conducted in 2008 to collect information on recently occurred landslides. All the landslides were digitised in a point format in GIS environment for the density calculation. The density calculation used kernel density method provided in ArcGIS software with 1 km^2 of search radius. The use of this method to analyse landslide density has been demonstrated in Kukemilks& Saks (2013).

RESULT & CONCLUSION

Based on the landslide density analysis, there are 8 spots that were identified as highly susceptible to landslide. This assumption is based on the total landslides that occurred approximately at similar locations over the four assessment years. The landslide density map is shown in Figure 1. These spots are approximately at km 14, 20, 27, 25, 30, 35, 41, and 46 from Ranautownship. Out of these spots, km 27 and 29 were indicated as the most susceptible location for landslides. These two locations are located close to the boundary between the Trusmadi and Crocker Formations. This study suggests that the road where km 27 and 29 are located cut through a fault that separates the two rock formations where major shearing and fractures due to the presence of the fault leads to higher landslide occurrences.

ACKNOWLEDGEMENT

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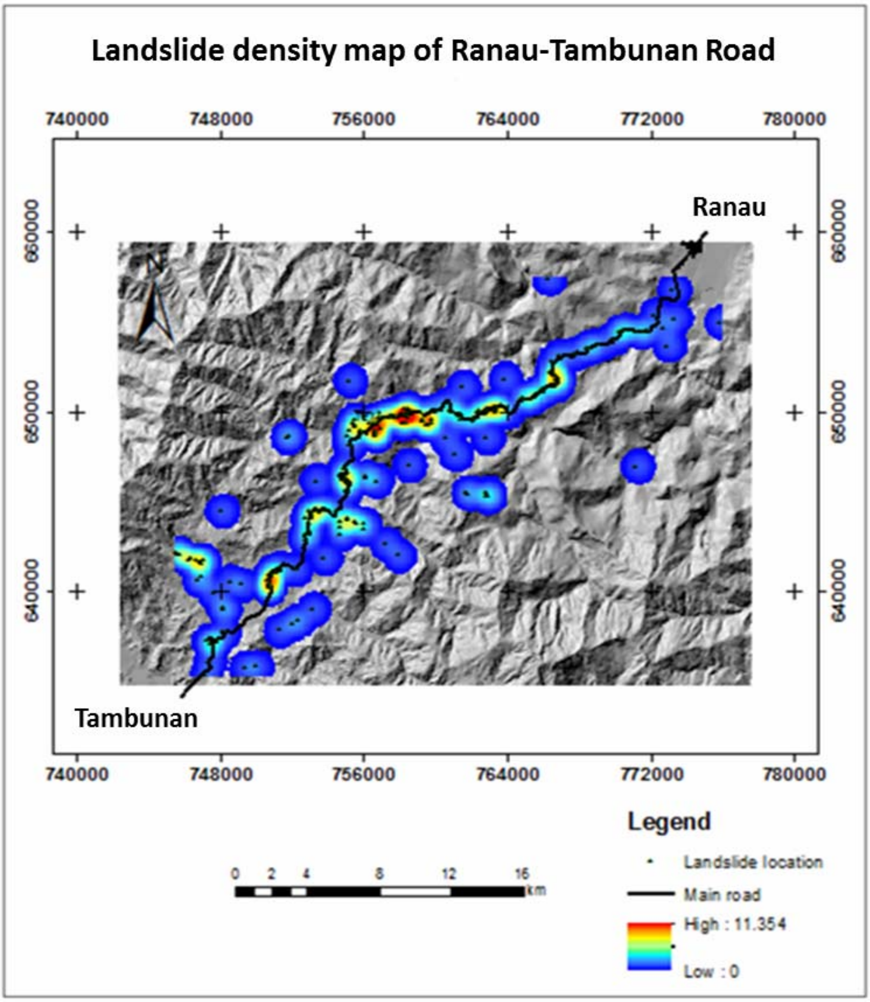
REFERENCES

Coe, J.A., Michael, J.A., Crovelli, R.A., Savage, W.Z., Laprade, W.T., &Nashem, W.D. 2004.Probabilistic Assessment of Precipitation-TriggeredLandslides Using Historical Records of LandslideOccurrence, Seattle, Washington. Environmental & Engineering Geoscience, 10, 103–122.

Kukemilks, K. & Saks, T. 2013.Landslides and gully slope erosion on the banks of the Gauja River between the towns of Sigulda and Ligatne. Estonian Journal of Earth Sciences, 62 (4): 231-243

Tropeano, D. &Turconi, L. 2004. Using Historical Documents for Landslide, DebrisFlow and Stream Flood Prevention. Applications inNorthern Italy. Natural Hazards 31: 663–679



P043

Pencirian Geomekanik Jasad Batuan Batu Kapur dan Analisis Kestabilan Cerun di Gunung Keriang, Alor Setar, Kedah

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Kajian dilakukan di Gunung Keriang, Alor Setar untuk menilai kestabilan cerun dengan melakukan pencirian geomekanik terhadap jasad batuan batu kapur. Bukit batu kapur ini dicirikan oleh bukit bertebing hampir tegak hingga tegak dan mempunyai struktur geologi khusus hasil proses semulajadi bumi seperti gegua, lohong, , kikisan lereng, alur pelarutan, stalagtit dan stalagmit. Kewujudan satah-satah ketakselanjaran seperti struktur kekar, sesar dan perlapisan membentuk blok-blok batuan longgar dan berpotensi untuk mengalami bencana runtuhan batuan. Faktor geologi di mana keadaan satah ketakselanjaran dan parameter geomekanik jasad batuan memainkan peranan yang penting dalam mempengaruhi kestabilan jasad batuan batu kapur.

Pendekatan secara sistematik dalam analisis kestabilan cerun telah dicadangkan untuk menilai kestabilan cerun dengan gabungan plot streograf dan sistem Perkadaran Jasad Cerun, SMR (Slope Mass Rating) yang telah diperkenalkan oleh Romana (1985, 1993, 1995) sebagai tambahan dalam penilaian kestabilan cerun bukit batu kapur. Sistem SMR mengambilkira konsep Perkadaran Jasad Batuan (Rock Mass Rating – RMR)(Bieniawski 1979, 1989) ditambahkan dengan perkadaran yang mengambil kira orientasi ketakselanjaran utama dan cerun.

Hasil kajian ini dapat memberi maklumat mengenai status kestabilan cerun dan membantu pihak berkuasa negeri dalam mengenalpasti cerun-cerun batu kapur yang berisiko tinggi. Langkah-langkah yang perlu diambil untuk meningkatkan kestabilan cerun boleh dilakukan dan secara tidak langsung dapat mengelakkan masalah runtuhan batuan di kawasan kajian. Ia juga dapat membantu dalam merangka satu garis panduan yang lebih sistematik dan berkesan dalam mengkelaskan tahap keselamatan tebing bukit batu kapur bagi menentukan kesesuaian zon guna tanah bagi pembangunan di sekitar bukit batu kapur di Malaysia.

The study was conducted at Gunung Keriang, Alor Setar to assess slope stability by doing geomechanics characterization of limestone rock mass. Limestone is characterized by cliff hills almost vertical to vertical and has a natural geological structure as a result of natural processes such as caverns, cavities, undercut, grooves dissolution, stalactite and stalagmite. The occurrence of discontinuities structures such as joints, faults and bedding planes will form a loose rock blocks and has the potential to suffer catastrophic rock falls. Geological factors discontinuities structures in rock mass and geomechanics parameters bodies play an important role in influencing the stability of the rock mass of limestone.

Systematic approach in the analysis of slope stability has been proposed to evaluate the stability of slopes in the combined streographic plot and Slope Mass Rating system, SMR which was introduced by Romana (1985, 1993, 1995) in addition to the assessment of slope limestone hill . SMR system include the concept of Rock Mass Rating - RMR (Bieniawski, 1979, 1989) were added to the proportion that takes into account the orientation of major discontinuity and slope.

The results of this study could provide information on the status of slope stability and assist the state authorities in identifying the limestone slopes of the high risk. Measures should be taken to improve the

stability of slopes can be done and can indirectly prevent problems ruins rocks in the study area. It can also help in developing a set of guidelines that a more systematic and effective in classifying the level of security limestone cliff to determine the suitability of land use zoning for development in the vicinity of limestone hills in Malaysia.

RUJUKAN

Abdul Kahar Embi. 2000. *Kajian geologi sub-permukaan menggunakan teknik Seismik pembiasan dan pengimejan geoelektrik 2D di cadangan lebuhraya Kuala Kangsar fasa 2*. Seminar Penggunaan Geofizik dalam Kajian Geoteknik.Jabatan Mineral dan Geosains Malaysia.

Bieniawski Z.T. 1974. *Geomechanics Classification of Rock Masses and its Application in Tunneling*. Proceedings of The 3rd International Congress On Rock Mechanics: 27-32

Bieniawski Z.T. 1979. *The Reomechanis Classification in Rock Engineering Applications*. 4th Int. Congress Rock Mech. Montreux. 2:41-48

Bieniawski Z.T. 1989. *Engineering Rock Mass Classifications*. New York : John Wiley & Sons.

Chow, W.S., 2003. Demarcation of safety zones in the vicinity of limestone hills. *Technical papers 2 : 31-35.* Kuala Lumpur : Minerals and Geoscience Department Malaysia.

Deere, D.U. 1964. *Geological considerations, rock mechanics in engineering practice*. New York : Wiley.

Hutchison,C.S., & Tan, D.N.K., 2009. *Geology of Peninsular Malaysia*. University of Malaya and The Geological Society of Malaysia.

Hoek, E. & Bray, J.W., 1981. *Rock Slope Engineering*, 3rd ed., London : The Institution of Mining & Metallurgy.

Jones,C.R., 1976. *Geology and mineral resources of Perlis, North Kedah and the Langkawi Islands*. District Memoir No.17. Geological Survey Malaysia. Kuala Lumpur : Jabatan Penyiasatan Kajibumi Malaysia.

Keller, G.V. and Frischknecht, F.C., 1966. *Electrical Methods in Geophysical Prospecting*. Oxford, UK : Pergamon Press

Romana, M.R., 1985. *New Adjustment for Application of Bieniawski calssification to slopes*. Int. Symp. On the role of rock mechanics, ISRM, Zacatecas, pg. 49-53.

Wan Salmi Wan Harun, 2008. Pemetaan Zon Selamat Bukit Batu Kapur Gunung Keriang, Alor Setar, Kedah. Jabatan Mineral Dan Geosains Malaysia

P051

Pencirian Tanah Runtuh di Universiti Kebangsaan Malaysia

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Kejadian tanah runtuh merupakan suatu fenomena yang seringkali berlaku disebabkan oleh faktor perubahan iklim. Perubahan iklim yang semakin membimbangkan dewasa ini menyebabkan berlakunya peningkatan jumlah curahan hujan yang turun pada musim-musim tertentu seperti ketika Monsun Timur Laut dan Monsun Barat Daya. Sejurus itu, satu kajian pencirian tanah runtuh di Universiti Kebangsaan Malaysia, Bangi, Selangor telah dilakukan bagi tujuan mengelaskan tanah runtuh di Universiti Kebangsaan Malaysia mengikut saiz dan jenis serta mengkaji hubung kait di antara parameter-parameter dalam analisis makmal dengan kejadian tanah runtuh. Melalui tinjauan lapangan dan analisis makmal, tanah runtuh berpotensi untuk berlaku di kawasan yang mempunyai tahap keporosan yang tinggi di mana tanah di kawasan tersebut terdiri daripada sejumlah besar kandungan pasir. Selain itu, tanah runtuh lebih mudah untuk terjadi di kawasan yang berkelembapan tinggi di mana tanah di kawasan tersebut mampu menyimpan banyak air yang seterusnya menjadi tidak stabil apabila menerima jumlah kandungan air yang berlebihan. Oleh itu, pencirian tanah runtuh ini amat perlu dijalankan supaya masalah kegagalan cerun dapat diatasi pada masa akan datang.

Kata kunci: Tanah runtuh; Pencirian; Pengkelasan; Luluhawa; UKM Bangi

PENGENALAN:

Kejadian tanah runtuh yang berlaku memberi impak yang besar terutama kepada mangsa yang terlibat dengan bencana tersebut sama ada dari segi kehilangan nyawa, kerugian harta benda mahupun kedua-duanya. Tanah runtuh ditafsirkan sebagai sebarang pergerakan tanah atau batuan yang menuruni cerun akibat kegagalan ricih pada sempadan jisim yang bergerak (Skempton & Hutchison 1969), di bawah pengaruh graviti (Varnes 1978). Masalah kegagalan cerun yang melibatkan tanah runtuh sudah menjadi lumrah terutama pada musim lembap di mana mengalami jumlah curahan hujan yang tinggi (Zulfahmi et al. 2007). Pembinaan infrastruktur yang pesat melibatkan pembinaan perumahan, jalan raya dan lebuh raya, empangan, aktiviti perindustrian dan pelancongan turut menyumbang kepada fenomena ini.

METODOLOGI:

Sejumlah 13 kawasan yang mengalami kegagalan cerun di sekitar Universiti Kebangsaan Malaysia, Bangi, Selangor telah dipilih sebagai tapak persampelan dalam kajian ini. Kerja lapangan dijalankan di tapak persampelan ini bagi memperoleh data lapangan melibatkan saiz dan skala tanah runtuh serta sudut runtuhan. Selain itu, sampel tanah kawasan cerun terganggu dan cerun tidak terganggu turut diambil bagi tujuan analisis makmal. Beberapa parameter seperti penentuan saiz partikel, kandungan lembapan semula jadi tanah, kandungan bahan organik, kadar ketelapan tanah, ketumpatan kumin dan kandungan mineralogi turut dianalisis. Keseluruhan data kemudiannya dianalisis bagi menentukan hubungan antara parameter analisis makmal dengan kejadian tanah runtuh di UKM Bangi.

HASIL DAN PERBINCANGAN:

Hasil daripada kerja lapangan yang dijalankan mengelaskan tanah runtuh kepada tiga kumpulan yang berbeza yang mana dikelaskan berdasarkan saiz dan skala tanah runtuh iaitu bersaiz besar, sederhana dan kecil. Selain itu, pemerhatian lapangan turut mencirikan keadaan luluhawa setiap kawasan persampelan serta keadaan litupan vegetasi di kawasan berkenaan.

Keputusan yang diperoleh daripada analisis makmal menunjukkan keadaan tanah di kawasan rata-ratanya terdiri daripada tanah bersifat lom iaitu tanah yang mempunyai tekstur sederhana sama ada sederhana kasar, sederhana mahupun sederhana halus. Tanah yang bertekstur sederhana ini lebih terdedah kepada kejadian tanah runtuh berikutan keadaan tanah yang mempunyai kadar ketelapan yang rendah sehingga menyebabkan air permukaan tidak dapat menyerap masuk ke dalam tanah dan mengakibatkan air permukaan bertakung di permukaan tanah. Keadaan ini menyebabkan tanah menjadi tepu dan struktur tanah menjadi longgar dan tidak stabil sehingga menyebabkan berlakunya tanah runtuh.

KESIMPULAN:

Secara keseluruhan, data analisis makmal menunjukkan setiap parameter mempunyai hubung kait antara satu sama lain dengan kejadian tanah runtuh yang berlaku di UKM Bangi. Keadaan cerun yang mempunyai tanah yang bertekstur sederhana dan mempunyai kadar ketelapan yang rendah menyebabkan cerun lebih terdedah kepada kejadian tanah runtuh. Selain itu, kadar luluhawa serta litupan vegetasi turut berperanan dalam fenomena bencana ini. Kadar luluhawa yang tinggi serta litupan vegetasi yang sedikit menyebabkan kebarangkalian untuk terjadinya kejadian tanah runtuh adalah tinggi.

RUJUKAN:

Skempton, A.W & Hutchinson, J. 1969. Stability of natural slopes and embankment foundations. Soil Mech & Fdn Eng Conf Proc. Mexico. 291-340.

Varnes, D.J. 1978. Slope movements: types and processes. In Eckel, E.B. (eds.). Landslides Analysis and Control. Transp. Res. Board, Spec. Rep. 176. 11-33.

Zulfahmi, A.R., Sahibin, A.R., Jasni, Y. & Wan Muhd Razi, I. 2007. Tinjauan awal potensi ketidakstabilan cerun dan cirian fiziko-kimia tanah di Cameron Highlands, Pahang. Sains Malaysiana 36(2). 105-116.

P065

Application of Geological Strength Index (GSI) for the tunnel in Crocker Formation: a case study in Tenom, Sabah, Malaysia

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Keywords: geological strength index (GSI), tunnel, Crocker Formation, limit equilibrium analysis

INTRODUCTION

This study was conducted around 42.69 m tunnel in Tenom, Sabah (Figure 1). The study area is underlain by Crocker Formation of Eocene to Early Miocene ages (Tongkul, 1991) which consists of thick amalgamated sandstone with thin shale layers. The objectives of this study are to determine the value of Geological Strength Index (GSI), rock mass properties, very unfavourable discontinuities combination and tunnel support pressure for rock bolts or shotcrete.

METHODOLOGY

Engineering geological mapping and discontinuity survey were conducted to obtain quantitative description of discontinuities (ISRM, 1978) as well as rock sampling based on grain sizes. GSI values (Marinos, 2007) and the disturbance factor (Hoek *et al.*, 2002) were obtained by field observation on the tunnel face. Laboratory study was done to determine the Uniaxial Compressive Strength (UCS) via point load test (ISRM, 1985) and unit weight by dry density test (ISRM, 1977). The final UCS and dry density values of intact rock were obtained via weighted average method (Marinos, 2011). Intact rock parameter (m_i) was based on the suggested values given by Marinos and Hoek (2000). Rock mass properties of the tunnel were determined using RocLab software (Rocscience, 2013). Unwedge software (Rocscience, 2004) has been used to determine the very unfavourable discontinuities combination which form wedge failure and tunnel support pressure required by rock bolts or shotcrete for design factor of safety of 2.

RESULTS AND DISCUSSION

The GSI value from field observation for the study area is 50 after being reduced from 55 as suggested by Marinos (2014) because the tunnel consists of thick amalgamated sandstone with thin shale layers (Figure 2). Table 1 shows the result of laboratory testing, parameters and derived rock mass properties from related schemes and software. The disturbance factor was obtained based on the excavation method in example blasting and excavating with conventional method during that period of time. Friction angle of the bedding plane was reduced by 5° due to its lower shear strength compare to joints. The result of limit equilibrium analysis by Unwedge (Rocscience, 2004) was presented in Table 2. There are eight possibilities of discontinuities combinations on tunnel crown that have F.O.S lower than 2 where all of it are located at the crown of the tunnel with a maximum wedge volume of 28.37 m^3. The maximum support pressure needed by rock bolts or shotcrete to achieve F.O.S of 2 at the tunnel crown is 0.04 MN.

CONCLUSION

GSI value is 50.
Rock mass properties have been determined.
Very unfavourable discontinuities combination is J2J4J6.
Support pressure required for rock bolts or shotcrete is 0.04 MN.

REFERENCES

Hoek, E., Caranza-Torres, CT. & Corcum, B., 2002. Hoek–Brown failure criterion 2002 edition. In: Bawden HRW, Curran J, Telsenicki M (eds) *Proceedings of the NARMS-TAC 2002*. Mining Innovation and Technology, Toronto, pp 267–273

ISRM, 1977. SM for determining water content, porosity, density, absorption and related properties and swelling and slake-durability index properties. ISRM Suggest. Methods 2, pp 92–94.

ISRM, 1978. Suggested method for quantitative description of discontinuities in rock masses. *Int. Journal of Rock Mech., Mining Sc. and Geomechanics* Abstracts **15**, pp 319-368.

ISRM, 1985. Suggested method for determining point load strength. *International Journal of Rock Mechanics, Mining Sciences and Geomechanics Abstracts* **22**, pp 51–60.

Marinos, P., 2014. Personal communication.

Marinos, P. & Hoek, E., 2000. GSI – A geologically friendly tool for rock mass strength estimation. *Proc. Geo Eng 2000 Conference*. Melbourne.

Marinos, V., 2007. *Geotechnical classification and engineering geological behaviour of weak and complex rock masses in tunnelling*. Doctoral thesis. School of Civil Engineering, Geotechnical Engineering Department, National Technical University of Athens (NTUA). Athens.

Marinos, V., Fortsakis, P. & Prountzopoulos, G., 2011. Estimation of geotechnical properties and classification of geotechnical behaviour in tunnelling for flysch rock masses. *Proc. of the 15th European Conference on Soil Mech. And Geotechnical Eng.*, Part **1**, pp 435-440. Athens.

Rocscience Inc., 2004. *UNWEDGE Ver. 3*. Toronto, Ontario, www.rocscience.com

Rocscience Inc., 2013. *ROCLAB Software for Calculating Hoek–Brown Rock Mass Strength*. Toronto, Ontario, www.rocscience.com

Tongkul, F., 1991. Tectonic Evolution of Sabah, Malaysia. *Journal of Southeast Asian Earth Sciences.* Volume **6**: 395-405.

P066

Geological Consideration in Development and Landuse Planning for Soft Ground Area – Study Case of BPK 7.2 Labu Lanjut, Sepang, Selangor Darul Ehsan

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In the process of planning the land use of an area, town planners would require basic information such as the geology, topography and landform of the area, as well as other relevant geotechnical details such as whether the area is potentially unstable due to presence of settlement, landslides, or severe erosion. Such information will assist engineers in preparing the layout plans, designing the foundation system and deciding on the most appropriate type and method of construction. This paper presents a case study of development and land use planning in BPK 7.2 Labu Lanjut area, Sepang, Selangor Darul Ehsan, where geologist was called upon to conduct a subsurface studies for providing a substantial subsurface information of the study area that faced intense settlement problem in several development area were attributed by geological factor. To verify this issue, a detailed subsurface investigation works was carried out to produce subsurface maps for land use planning purposes. These maps provide information consist of distribution of soil layer, thickness, chemical and physical properties, and geotechnical constraints and geohazard.

Geomechanical Classification Scheme for Heterogeneous Crocker Formation in Kota Kinabalu, Sabah, Malaysia: An Updated

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INTRODUCTION

The study area is underlain by Crocker Formation of Late Eocene – late Early Miocene ages. Crocker Formation is a turbidite deposits, consists of interbedded sandstone and shale and moderate to highly deformed. The design of slope in interbedded rock masses such as Crocker Formation presents a major challenge for engineering geologists and geotechnical engineers. Then, Modified Slope Mass Rating (M-SMR) system which identified as the most suitable geomechanical classification scheme for heterogeneous Crocker Formation in Kota Kinabalu, Sabah (Figure 1) was proposed by Ismail Abd Rahim *et al.* (2009a).

M-SMR was used to characterized and to proposed preliminary rock cut slope design as well as recommendation of the level for design model review by engineering geologist or geotechnical engineers. In this paper, updated M-SMR classes, names and slope designs will be highlited.

METHODOLOGY

The Modified Slope Mass Rating (M-SMR) is a modification of RMR Bieniawski (1989) and SMR (Romana, 1985; Anbalagan *et al*., 1992; Tomas *et al.,* 2012) classification systems in terms of parameters calculation and determination methods. The method was discussed in Ismail Abd Rahim *et at.* (2009a) and Ismail Abd Rahim (2011).

The 'Lithological unit thickness' approach (Ismail Abd Rahim *et al.,* 2009b), RQD method (Deere *et al.,* 1967), weighted average of discontinuity set spacing, weighted average and statistical mode of discontinuity condition, normal condition of water flow (Bieniawski, 1989) and new approach of adjustment factor (NAAF) methods (Ismail Abd Rahim *et. al.,* 2012) were used to evaluate the parameters in M-SMR.

MODIFIED SLOPE MASS RATING (M-SMR) CLASSIFICATION

There are only five (5) classes in previous M-SMR classification scheme for heterogenous Crocker Formation i.e. class II, class III, class IV, class V and class VI. But after the recovery of 'very favourable' discontinuity orientation and higher discontinuity condition rating value in slope BS (Figure 1 and Table 1), then class I for M-SMR was proposed.

Based on recent study, the classes for M-SMR consists of class I (very good), class II (good), class III (moderate), class IV (bad), class V (very bad) and class VI (extremely bad). Selected rock cut slope that represent complete M-SMR classes in the study area are shown in Photograph 1. M-SMR class name is also changed from using 'risk' term to 'good and bad' because the meaning of risk not really sound rock mass classification. The updated M-SMR class names are shown in Table 2.

ROCK SLOPE DESIGN

The form of slope design in M-SMR system are stabilization (rock removal and reinforcement) and protection measures and has been discussed in Ismail Abd Rahim (2011). Updated rock cut slope stabilization and protection measure are shown in Figure 2. Local trimming, slope re-profiling, weep hole, horizontal drainage, concrete detention or buttress, sport bolting or dowel, wire mesh or rope nets, reinforce shotcrete and benching are proposed slope design.

Slope Rating	IRS	RQD	DC sp (m)	DC cond	Water	DOF	RMR_b	M-SMR	Class
BS	130	98	1.4	24	Dry	VF	86	81.5	I
	12	20	15		15	-4.5			Very Good

Note: IRS-intact rock strength; DC sp-discontinuity spacing; DC cond-discontinuity condition; DOF-discontinuity orientation factor; RMRb-basic RMR; VF-very favourable.

Table 1 M-SMR class I (very good) and parameters value for slope BS.

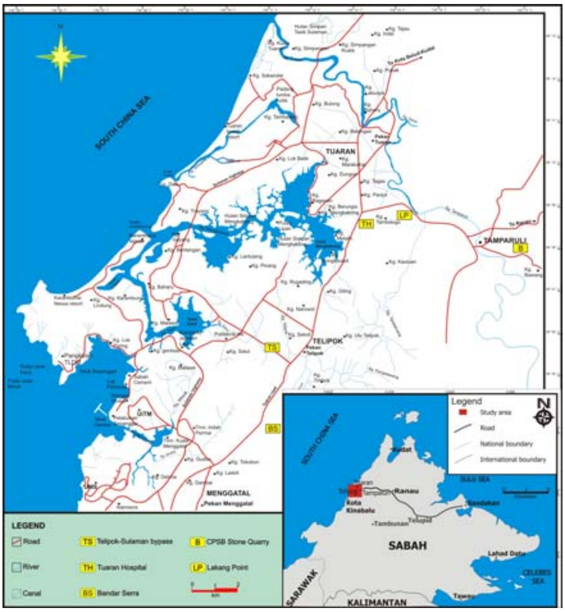
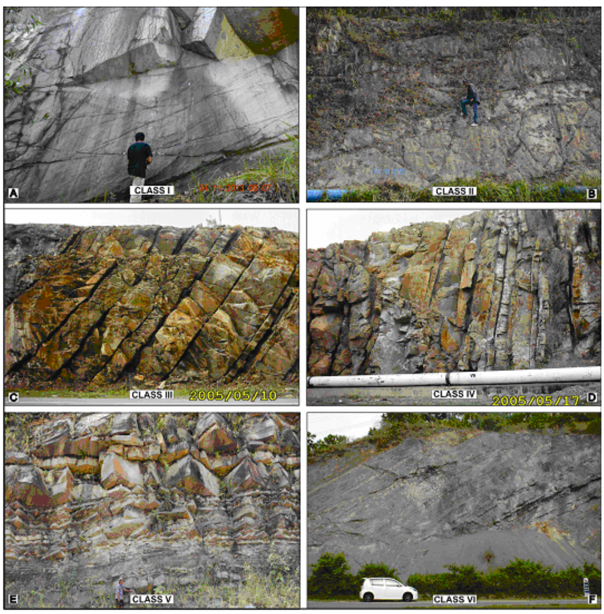


Figure 1: Location of the study area and selected slopes.



Photograph 1 Modified Slope Mass Rating (M-SMR) classes for selected slopes. A – Slope BS; B – Slope LP; C – Slope TS2; D – Slope TS1; E – Slope B; F – Slope TH.

M-SMR CLASS	2009 & 2011	2014
I	Very Low Risk	Very Good
II	Low Risk	Good
III	Moderate Risk	Moderate
IV	High Risk	Bad
V	Very High Risk	Very Bad
VI	Extreamely Risky	Extremely Bad

Table 2 The name of M-SMR class for 2009, 2011 and 2014.

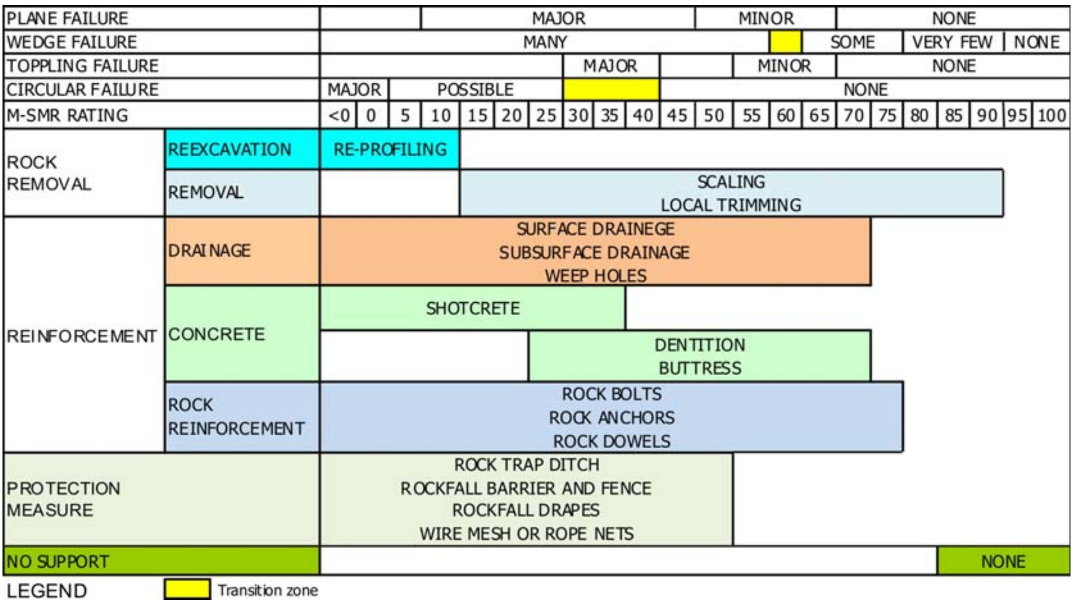


Figure 2 Suggested slope stabilization and protection measure for M-SMR (Adapted from Ismail Abd Rahim, 2011).

DESIGN MODEL REVIEW AND SLOPE REMAPPING

The design model review and slope remapping for the M-SMR classes is recommended in order to ensure the stability and safety of the rock cut slope. Recommendation levels for design model review by suitable engineering geologist was determined by the rock mass classes. Normal to detailed Design Model Review (DMR) and slope remapping are recommended to highly recommend by engineering geologist or geotechnical engineers to expert engineering geologist or geotechnical engineers for class I to class IV, respectively.

REFERENCES

Anbalagan, R., Sharma, S. & Tarun, R. 1992. Rock mass stability evaluation using modified SMR approach. *Proceeding of the Sixth National Symposium on Rock Mechanics, Kolar*, pp. 258-268.

Bieniawski, Z. T. 1989. *Engineering Rock Mass Classifications*. Wiley, New York, 248 p.

Deere, D. U., Hendron Jr, A. J., Patton, F. D. & Cording, E. J. 1967. Design of surface and near surface construction in rock. In: Fairhurst, C. (Ed). *Failure and Breakage of Rock*. Society of Mining Engineers of AIME, New York, pp. 237-302.

Ismail Abd Rahim, Sanudin Hj. Tahir, Baba Musta, & Shariff A. K. Omang. 2012. Adjustment factor for Slope Mass Rating (SMR) system: Revisited. *Proceeding of National Geoscience Conference 2012 (NGC2012)*, 22-23 Jun 2012, Hotel Pullman, Kuching, Sarawak.

Ismail Abd Rahim, Sanudin Tahir & Baba Musta. 2009a. Modified Slope Mass Rating (M-SMR) system: A classification scheme of interbedded Crocker Formation in Kota Kinabalu, Sabah, Malaysia. *Proceeding of the 8th Seminar on Science and Technology 2009 (S&T2009)*, 18-19 December 2009, Shangri-La's Rasa Ria Resort, Pantai Dalit, Tuaran.

Ismail Abd Rahim, Sanudin Tahir, Baba Musta & Shariff A. K. Omang. 2009b. Lithological unit thickness approach for determining Intact Rock Strength of slope forming rock material of Crocker Formation. *Borneo Science,* 25, pp. 23-31. ISSN 1394-4339.

Ismail Abd Rahim. 2011. Rock mass classification of the Crocker Formation in Kota Kinabalu for rock slope engineering purpose, Sabah, Malaysia. *PhD Thesis,* Universiti Malaysia Sabah, Kota Kinabalu, Sabah.

Tomas, R., Cuenca, A., Cano, M. & Garcia-Barba, J. 2012. A graphical approach for slope mass rating (SMR). *Engineering Geology* 124, pp. 67-76.

Romana, M. 1985. New adjustment rating for application of Bieniawski classification for slopes. *Proceeding of International Symposium on the Role of Rock Mechanics,* Zacatecas, pp 49-53.

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P016

Transport Behavior of Cadmium through Compacted Granite Soil

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This research investigates the mobility of Cd through compacted granite soil using mini column centrifuge test. Broga granitic soil (BGR) was collected in Broga, Selangor and was subjected to three main tests; physical test (ie; particle size distribution, Atterberg Limit and specific gravity), chemical test (ie;pH, organic matter, SSA and CEC) and mini column centrifuge test. Column test followed the falling head permeability concepts where different G-force was used ranging from 230G to 1440G. Breakthrough curves show the concentration of Cd in granites becomes higher with the increasing of G-force. The selectivity for sorption in all gravity forces in granite can be ranked in the following order; 230G>520G>920G>1440G. When influent solution added from 1PV up to 60PV, pH values of effluent solution became more acidic, while conductivity curves became higher with the increasing of pore volume. SEM results also demonstrated that granite soils have potential to adsorb Cd. This study concluded that physical-chemical and sorption using mini column centrifuge test have very good linked to study the transport of Cd through compacted granitic soil.

Keywords: Granite, Cadmium, mini column test, breakthrough curve

P024

Sedimentology and Geochemistry of Redang Island Sediments, Terengganu

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The South China Sea (SCS) is the largest marginal sea with an area of 3.3 million km2, which is largely surrounded by land (Morton and Graham, 2001). Khoo et al., 1988 mentioning that the study area were consist of metaconglomerate and interbedded with some slate, quartzite and also politic hornfels. A study on the sediment characteristics and geochemistry of Redang Island sediment was conducted during pre and post-monsoon seasons (Figure 1).

The sediments were collected around the Redang Island using UNIPERTAMA VII. The sediments were analyzed for their sedimentological characteristics using dry sieve method, soil pH, mineralogy; using X-ray diffractometer (XRD) and scanning electron microscope energy dispersive x-ray spectroscopy (SEM-EDS) and the concentrations of metals and rare earth elements (REEs) were determined using an inductively coupled plasma mass spectroscopy(ICP-MS). The organic carbon content was determined using the wet oxidation method. Generally, sediments during both monsoons are coarse sand, poorly sorted, negatively skewed and extremely leptokurtic. No relationship was observed between mean size and sampling sites ($R^2 = 0.05$ pre-monsoon), ($R^2 = 0.0017$ post monsoon) and seasons (Figure 2). The coarseness of the sediment in the study area might be due to the weathering product of granite which is the dominant rock in the East Coast of Peninsular Malaysia. This finding is supported by Hishakawa et al. (1986) which found that bottom sediments of the East Coast of the Peninsular Malaysia off Terengganu are exclusively sandy. Soil pH showed no significant differences ($p=0.147>0.05$) between pre and post monsoons.

Mineral contents in marine sediments of the Redang Island showed that these samples have similar mineral constituent as found by Nor Antonina (2001) where quartz and calcite are the dominant minerals observed in the East Coast of Peninsular Malaysia. Quartz is a stable mineral that dominates the island and are very resistant to weathering. Rothwell (1989) stated that quartz is the most stable mineral in the Earth's crust. Calcite is also dominant due to the shell fragments that are present in the sediment. Besides quartz and calcite that are the dominant minerals observed in the study area,kaolinite, illite and smectite also found in the study area which occurred in trace amounts. For the compounds, the highest percentage detected was SiO_2 (43%), followed by CaO (21%) and Al_2O_3(17%) which indicate that the area is dominated by sand fractions and shell fragments. Other compounds detected in lesser percentage were Na_2O (3%), MgO (3%) and K_2O (2%). The concentrations of Al, As, Ba, Fe, Cd, Cu, Cr, Mn, Ni and Pb in sediments are lower compared to the crustal values with the exception of Zn. The pre monsoon season has higher metal contents compared to the post monsoon period. The REE patterns in sediments reflected the source rock patterns with an overall order of abundance light rare earth element (LREE)>> middle rare earth element (MREE)> heavy rare earth element (HREE) during both monsoons. The chondrite normalized patterns of REEs show enrichment of LREEs over HREEs with La/Yb of 13.6 during the pre monsoon and 14.1 during post monsoon. However chondrite normalized values show no change in HREE ratios (Gd/Yb) between the pre monsoon (2.06) and post monsoon (2.08) periods.The metal enrichment

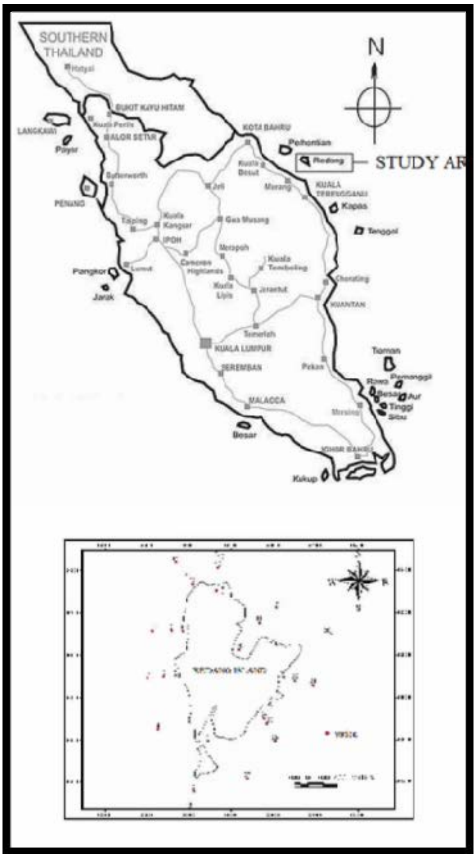

Figure 1: Study area, Pulau Redang

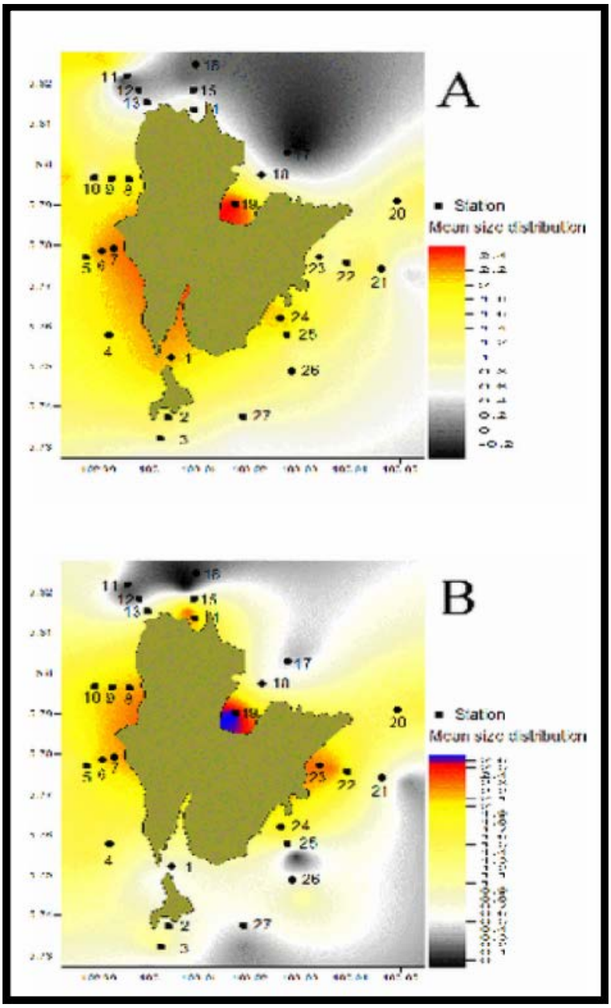

Figure 2: Mean size distribution before (A) and after monsoon (B)

factor (EF) values suggest that the sources of metals and rare earth elements are solely natural, as there was only deficiency to the minimal enrichment of metals and REEs.

KEYWORDS. Redang Island,pre- and post monsoon, rare earth elements

REFERENCES
Hishakawa, S., Uchiyama, M., Hidaka, M. Nishi, T. and Arima, S. 1986. On the bottomsediments of the South-Western portion of the South China Sea-II off Terengganu- Pahang. Ekspedisi Matahari. pp 65-74. Malaysia.
Khoo, T.T., Yaw, B.S., Kimura, T. and Kim, J.H. 1988. Geology and paleontology of the Redang Islands, Terengganu, Peninsular Malaysia. Journal of Southeast Asian Earth Sciences 2 (3-4):123-130.
Morton, B. and Graham, B. 2001. South China Sea. Marine Pollution Bulletin 42:1236 – 1263
Rothwell, R.G. 1989. Minerals and mineraloids in marine sediments: An optical identification guide. pp 279. London: Elsevier Applied Science. Nor Antonina, A. 2001.
Sedimentology and heavy metal studies of the Gulf of Thailand, East Coast of Peninsular Malaysia and Sabah and Sarawak Continental Shelf Sediments. Ph.D Thesis, University Putra Malaysia Terengganu, Malaysia.

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Batuan igneus meliputi hampir 80 % daripada keluasan Pulau Redang dan selebihnya terdiri daripada batuan sedimen dan metamorf. Hampir keseluruhan batuan igneus adalah terdiri daripada batuan plutonik jenis granit, sementara batuan sedimen terdiri daripada Formasi Redang, Formasi Pinang dan Lapisan Konglomerat Tumbu Kili dan batuan metamorf pula jenis metamorf sentuh seperti hornfel dan metasedimen. Kajian secara geokimia secara ekstensif terhadap granit Pulau Redang belum pernah dilakukan. Kebanyakkan kajian hanya melibatkan pengenalan dan pengelasan granit di lapangan sahaja. Kajian ini bertujuan untuk mengaitkan jenis-jenis granit yang dikelaskan di lapangan dengan geokimia batuan. Berdasarkan tren geokimia, hubungan usia relatif antara jenis-jenis granit boleh dicadangkan dengan sokongan daripada hubungan usia relatif yang telah dicerap di lapangan. Unsur-unsur geokimia setiap batuan juga digunakan untuk mengelaskan siri batuan, asalan magma dan sekitaran tektonik. Kajian yang dijalankan adalah terbatas kepada jasad granit di Pulau Redang dan Pulau Pinang yang berada di selatan. Skop kajian melibatkan cerapan dan pengelasan jenis granit di lapangan dan geokimia batuan sahaja. Kajian ini tidak mengkhusus kepada batuan sedimen dan metamorf. Terdapat 50 stesen cerapan telah dikaji dan ditanda lokasinya di seluruh Pulau Redang meliputi singkapan tepi pantai, bukit dan jalan raya serta perkampungan. Batuan granit Pulau Redang terdiri daripada granit biotit-hornblend berwarna merah jambu, berbutir sederhana hingga kasar dan berporfir sebagai unit yang utama, diikuti oleh granodiorit berwarna keputihan berbutir hampir sama saiz sebagai unit kedua, dan rejahan mikrogranit fasa lewat yang memotong kedua-dua unit yang awal sebagai unit ketiga. 25 sampel terpilih mewakili ketiga-tiga unit batuan ini telah dilakukan analisis XRF untuk penentuan unsur-unsur major dan surih. Tren geokimia berdasarkan Gambar Rajah Harker menunjukkan granodiorit merupakan unit terawal dalam jujukan pembentukan batuan, diikuti oleh granit biotit-hornblend berwarna merah jambu dan terakhir adalah telerang mikrogranit. Tren ini hampir sama dengan tren Gambar Rajah Labah-labah terhadap normalan mantel primitif yang ditunjukkan oleh penurunan nilai-nilai P, Zr dan Ti daripada granodiorit, granit biotit-hornblend merah jambu dan mikrogranit. Ketiga-tiga unit ini dikelaskan sebagai siri kalk-alkali kaya K dan asalan magma adalah jenis I. Berdasarkan pengelasan sekitaran tektonik, granit Pulau Redang ditafsirkan terbentuk semasa perlanggaran “syn-collision”. Daripada kajian ini dapat disimpulkan bahawa batuan igneus Pulau Redang adalah eksklusif jenis I yang berasal daripada asalan bahan igneus yang terbentuk semasa perlanggaran. Rejahan granit ini dipercayai berusia Perm Tengah hingga Perm Akhir kerana ia didapati merejah batuan sedimen Formasi Redang yang berusia Karbon hingga Permian. Usia rejahan granit Pulau Redang kemungkinan selaras dengan usia granit Kapal dan granit Maras-Jong yang terletak berdekatan dengan tanah besar Terengganu yang berusia Perm Tengah hingga Perm Akhir mengikut Liew (1983).

P050

Textural and Geochemical Transformation of Granite along Bukit Tinggi Fault Zone, Peninsular Malaysia

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The Bukit Tinggi Fault Zone (BTFZ) is a major NE-SW trending fault zone in Peninsular Malaysia. It cuts the Main Range Granite near Kuala Kubu Bharu through Bukit Tinggi down the Kenaboi Valley (Shu, 1969). A broad zone of mylonitic granite is formed along the Bukit Tinggi Fault Zone. The mylonite is exposed at several places along Kuala Kubu Bharu-Fraser Hill road, road cuts along the Karak highway and at a waterfall on Sungai Tanglir, east of Kampung Baru Bukit Tinggi.

Based on textural, mineralogical and petrographical features, granitic rocks in the Kuala Kubu Bharu and Bukit Tinggi areas belong to the Gap granite unit of the Bukit Tinggi pluton of Cobbing & Mallick (1987). The granites are megacrystic, medium to coarse-grained with allotrimorphic granular texture of tabular K-feldspar megacrysts set in cluster of grey or blue quartz, white plagioclase and commonly have clotty biotite. In the north of Kuala Kubu Bharu, the fault forms a boundary between the granite and the metasedimentary rocks from the Trolak formation. Mylonitic granite occurs along the boundary, but mylonitic metasedimentary rocks were not observed. In the Bukit Tinggi area, BTFZ forms a boundary between Bukit Tinggi pluton in the eastern part and Genting Sempah pluton in the western part. Along the western boundary of the Bukit Tinggi pluton, a broad zone of mylonitic granite (foliated porphyroclastic mylonite) as a result of deformation along the Bukit Tingi Fault Zone.

Most of the mylonites found in the study area comprises protomylonites with lesser mesomylonites and rare ultramylonites. Protomylonites in BTFZ display weak S-C foliation, while mesomylonite and ultramylonites characterized by well-developed S-C foliation together with higher degree of recrystallization. The microstructural evolution of quartz in the mylonite of BTFZ represented by the formation of porphyroclastic ribbons from the anhedral equant grains in the undeformed granite. The ribbons are consisting of quartz subgrains and/or quartz neocrysts produced by subgrain rotation (SGR) mechanism. Feldspars in BTFZ were affected by fracturing and cracking. K-feldspar shows minor neocrysts formed by bulging recrystallization (BLG) mechanism and widespread flame perthite. Only minor recovery features are observed in the plagioclase. Mica shows bending, kinking and recrystallization. Microstructures of the minerals indicates that the mylonites were deformed in the brittle-ductile transition, where quartz and biotite having ductile behavior and feldspar are brittle.

Geochemical analysis was carried out on samples of the protolith and mylonitic granites to determine chemical changes accompanying deformation along the BTFZ. The geochemical gain and losses of major and trace elements will be discussed. Commonly, these changes in major oxide and trace elements abundances are a reflection of the observed modal changes that are a significances of the textural changes attending the process of mylonitisation (Roberts & Nissen, 2006).

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REFERENCES :

Shu, Y.K., 1969. Some north-west trending faults in the Kuala Lumpur and other areas. Newl. Geol. Soc. Malaysia, 17, p. 1-5.

Cobbing, E.J. & Mallick D.I.J., 1987. South-East Asia granite project field report for Peninsular Malaysia. British Geological Survey.

Roberts, D. & Nissen A.L., 2006. Geochemical changes accompanying mylonitisation of granite at the base of the Helgeland Nappe Complex, Nord-Trondelag, central Norway.

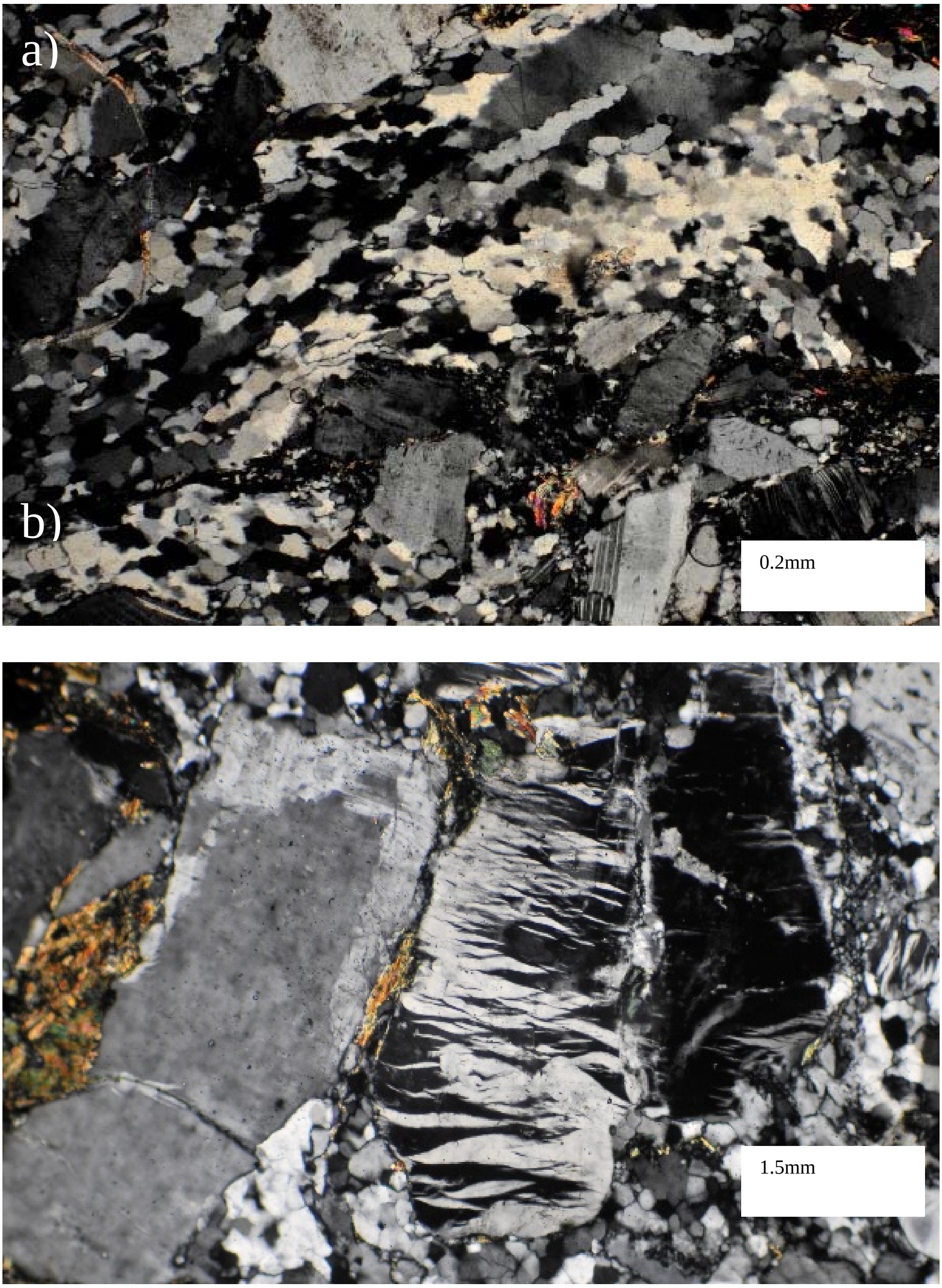

Figure 1. Photomicrographs of the mylonite showing a) quartz subgrains formed parallel to the S-foliation.Fraser Hill-Kuala Kubu Bharu road, x-nicol. b) Well defined flame perthite in K-feldspar. Kuala Lumpur-Karak highway, x-nicol.

P053

Petrology, Geochemistry & Geochronology of Jerai Granite, Kedah.

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OBJECTIVE:

1. To characterize the Jerai granite by determining their petrographic characteristics and geochemical compositions.
2. To determine the age of Jerai granite using U-Pb zircon geochronology.
3. To identify and determine the differences and similarities between the Jerai granite and Main Range granite.
4. To interpreted the petrogenesis of Jerai granite and analyze their magmatic history relation with Main Range granite.

INTRODUCTION:

This work contribution is to use new whole rock major and trace element data for the Jerai granites to place constraints on melting processes that led to the peraluminous S-type Main Range granite character. Previous studies have investigated the age of pegmatite and muscovite of Jerai granite gave an age no more than 135 ± 6 Ma and being the younger granitic rocks in the the Main Range granite. Here new analyses of Jerai granite give different result and represent much older age. It is hoped that this study will help in advancing an understanding for granite and help to better understand in granitoids rocks of Peninsular Malaysia. There is currently in constrained in detailed description and reliable age information which probably represents a marker for the geotectonic evolution of Peninsular Malaysia.

GEOLOGICAL SETTING:

The Main Range granite is dominated in western part of Peninsular Malaysia by the extensive Main Range Batholith that runs from Malacca in the south to the Thai border in the north and to the east by Bentong Raub Suture. Smaller intrusive plutons occur farther to the northwestern, for examples at Pulau Pinang, Pulau Langkawi and Gunung Jerai. The Main Range granite is linked to syn-collisional tectonism during the suturing of Sibumasu and East Malaya (Cobbing et al., 1986; Metcalfe, 2000, 2013; Ghani, 2000, 2013). The tin bearing and continental collision S-type Main Range granite emplaced at Triassic around 200 Ma to 220 Ma (Searle et al., 2012; Ghani et al., 2013; Cottam et al., 2013).

Main Range granite has restricted compositional range from granite to granodiorite, which almost entirely made up of peraluminous biotite granite and has typical ilmenite-series characteristics (Ghani, 2009; Ghani et al., 2013). The petrogenesis of those granite is explained by partial melting of the Sibumasu crust subducted beneath the Paleo-Tethys accretionary complex, which explained the distribution although poorly exposed granite intrude to the east of the Bentong-Raub Suture zone rocks (e.g. mélange at Genting Sempah) (Metcalfe, 2000, 2013; Ghani et al., 2013). Main Range granite has been regarded to be constituted by S-type granites (Liew, 1983; Hutchison, 1996) with many I-type characteristics of the Lachlan Fold Belt, Australia (Chappell & White, 1974, 1992; Ghani, 2000; Ghani et al., 2013). This I- and S- duality feature in Main Range granite is believed to reflect the progressive remobilization of continental crust in granitoid genesis with time as the locus of magmatism migrated landwards (westward as Main Range granite) away from the trench in subduction system (Pitcher, 1983; Ghani, 2000).

Jerai granite is part of Main Range granites having transitional I- S-type characteristic emplaced into Paleozoic sediments (Ghani, 2009; Ghani, et al., 2013). The pluton represents one of numerous granite plutons cropping out in the farther to the west of the Main Range granite and Jerai pluton occurs as pluton smaller than 100 km2. Compared to Main Range granite Jerai granite is more highly evolved peraluminous leucogranites, in the sense of Patino Douce (1999), form by partial melting of aluminum-rich metasedimentary rocks. Their intrusive geometries are almost circular pluton and weakly elliptical steep-sided pluton. Jerai pluton is argue to be the Main Range granite magma ascent paths that became discrete and significantly localized to narrow and isolated, steep-sided cylindrical conduits that pierce through the host rock (Jerai Formation).

Jerai granite is described in three facies, based on the mineralogy and texture; (i) biotite-muscovite granite, (ii) tourmaline granite and (iii) pegmatite and aplopegmatite phases. Biotite-muscovite granite dominated whereas tourmaline granite only a subordinate distribution and also associated the granites are the later stages of plutonism; the large greisens-type pegmatite vein networks, layered pegmatite-aplite dike (aplopegmatite) and metasomatic tourmaline-quartz pods. The occurrences of the biotite-muscovite granite are covering almost the southwestern part of Gunung Jerai except in Tanjung Jaga. Most of the biotite granite is medium-grained and has subhedral-granular texture. The more evolved Jerai granite is recorded by the appearance of tourmaline granite. Jerai pegmatite intrusions are texturally and compositionally heterogeneous, consists three phases that outcrop rather randomly across the current erosional exposure: (i) dominant large pegmatitic K-feldspar; (ii) layered pegmatite-aplite facies; and (iii) lenticular to pod-shaped tourmaline-rich pegmatite.

PETROGRAPHY:

Biotite-muscovite granite is dominantly a medium-grained biotite-muscovite-bearing type, typically comprise of K-feldspar, plagioclase, quartz, biotite, muscovite and zircon. K-feldspars are anhedral to subhedral, as microperthitic orthoclase and microcline. Plagioclase is subhedral with typical albite twinning and some grains show Carlsbad-albite twinning. Quartz is mostly anhedral interstitial grains. Its most characteristic inclusions are fluid cavities. Biotite commonly occurs as euhedral to subhedral flakes and strong pleochroism from light brown to reddish brown is typical. Some of the biotite is partly replaced by chlorite and common inclusion in biotite is zircon. Muscovite is being associated with biotite but occupies less than biotite. Zircon and apatite are ubiquitous accessory phases.

Tourmaline granite is very felsic and contains relatively abundant tourmaline and garnet. They are composed of quartz, K-feldspar, plagioclase, tourmaline and garnet. Muscovite and iron oxide are common accessory minerals. Biotite appears to have had an antithetic relationship with tourmaline, being absent in tourmaline granite with significant amounts of magmatic tourmaline. This maybe evident in the suggested zoned Jerai granite which has a biotite-muscovite granite core and outer zone of tourmaline granite (Ghani et al, 2013). Such an antithetic relationship is consistent with the findings of Pichavant & Manning (1984) who reported muscovite to be the common mica in tourmaline granite. Tourmaline is strongly pleochroic from light brown to brown and tourmaline partially replaces micas. The accumulation of tourmaline in the vicinity of the contact and its widespread occurrence in the aureole of Jerai pluton reflects the flux of a volatile-rich H2O fluid from the granite (Pichavant & Manning, 1984), and its diffusion throughout the aureole by infiltration during crystallization of the magma (Cartwright & Valley, 1991).

The simple pegmatites are usually composed of the minerals characteristic of granitoid rocks, namely, quartz and feldspar, with or without muscovite, biotite and a few other accessory minerals. Complex pegmatite may contain one or more unusual minerals, including tourmaline, garnet and a host of other exotic minerals. Tourmalization – conversion of biotite to brown tourmaline, decomposed feldspar and clear quartz. Final result of change, the rock consist wholly of tourmaline (brown with patches of blue) and clear quartz, largely of new formation. Tourmaline replacing an albite crystal is deep blue, while the rest of the same crystal of tourmaline is brownish green (Harker, 1972). As further modification, the feldspar may be replaced partly or wholly by tourmaline and quartz, the former sometimes occurring in little needles with radiate grouping embedded in clear quartz.

GEOCHEMISTRY:

In contrast to the tourmaline granite, the biotite-muscovite granite has higher contents of TiO_2, FeO, MgO, CaO and K_2O, and lower contents of Al_2O_3, MnO, Na_2O and P_2O_5. In contrast to the both granites, the pegmatite has higher contents of CaO, and lower contents of TiO_2, FeO, MnO, MgO, K_2O and P_2O_5. Both granites and pegmatite however overlap in the MgO, Na_2O and Al_2O_3 contents. For trace elements, the granites and pegmatite overlap in Ni, Cr, Sc, Nb, Ga, Cu and U; with tourmaline granite and pegmatite overlap in Ba, Y, La, Ce, Zn, Pb, Th, Nd; and pegmatite with lower content of Rb, Sr and Zn. Biotite-muscovite granite exclusively have higher contents of Ba, Zr, Y, La, Ce, Zn, Pb, Th and Nd; and Sr which is exclusively higher in tourmaline granite.

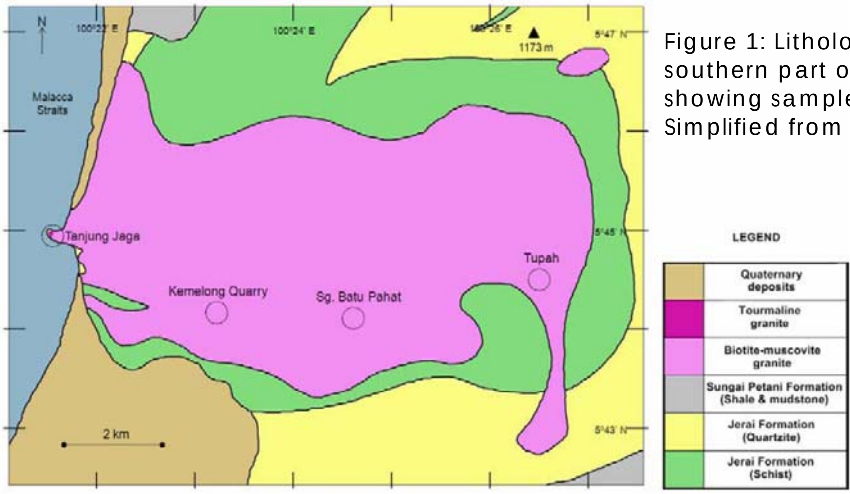

Figure 1: Lithological map of southern part of the Jerai area showing sample locations. Simplified from Bradford (1972).

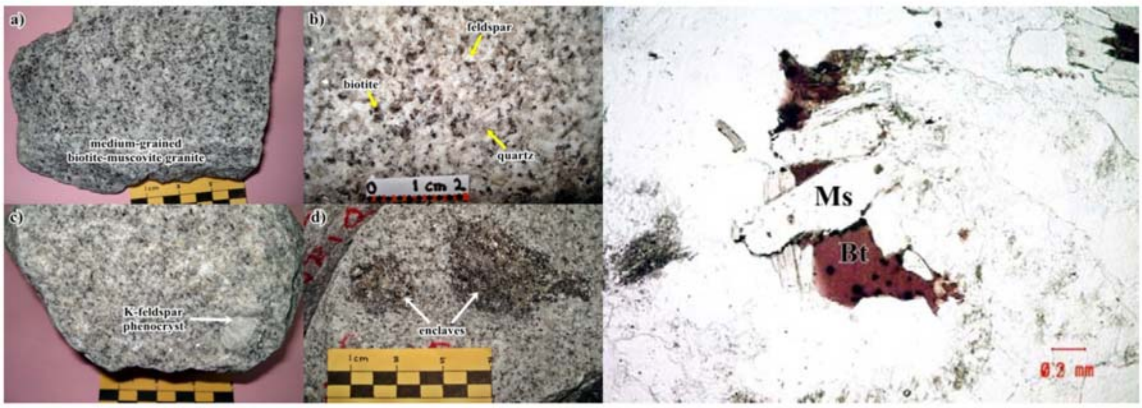

Figure 2: Hand specimens and photomicrograph of biotite-muscovite granite.

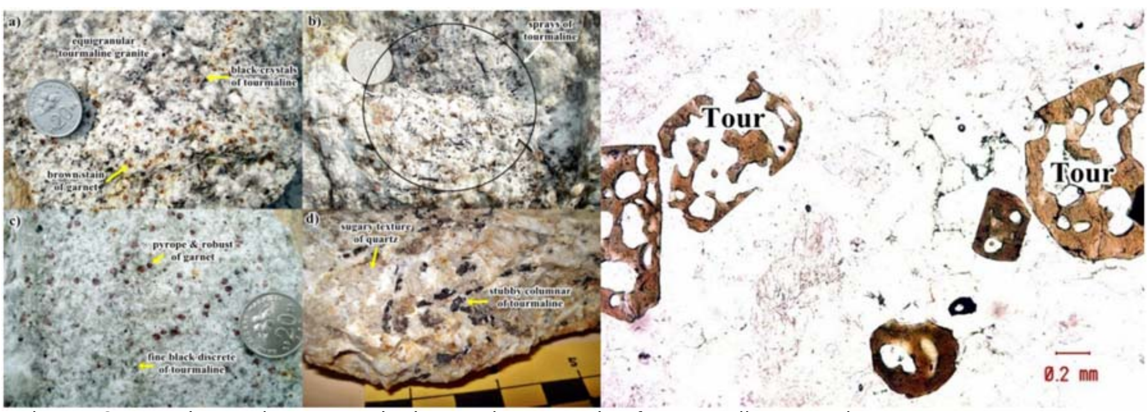

Figure 3: Hand specimens and photomicrograph of tourmaline granite.

Figure 4: Hand specimens and photomicrograps of pegmatite

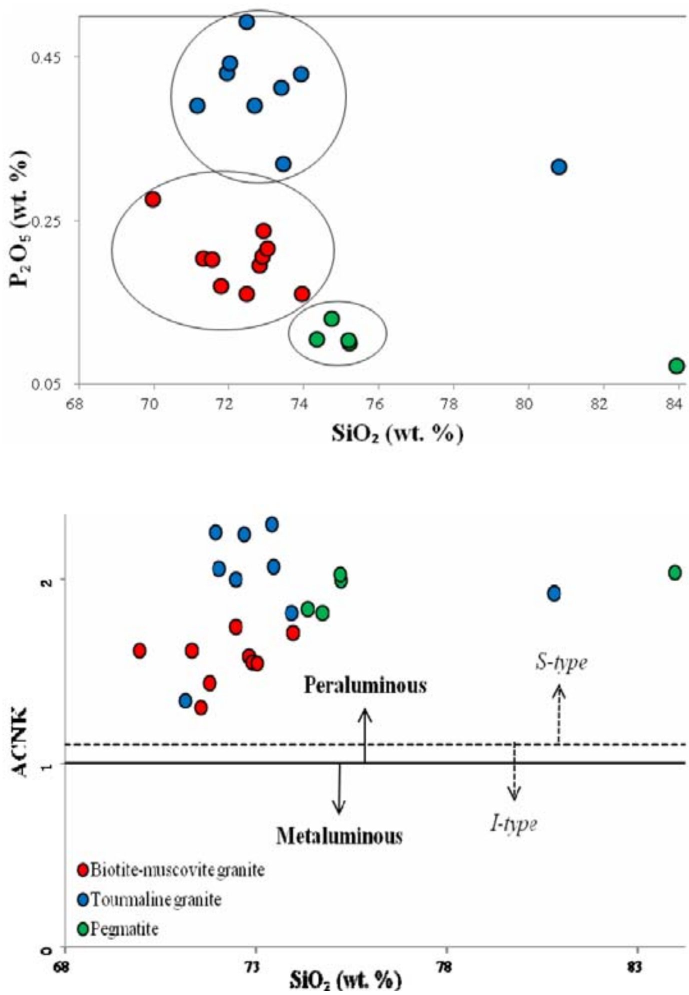

Figure 5: Selected Harker diagrams and ACNK vs SiO_2 plot of the granitic rocks.

Table 1: Result of U-Pb zircon geochronology.

Jerai granite units	U-Pb zircon age
Biotite-muscovite granite	205.5 ± 4.1 Ma
Tourmaline granite	205.5 ± 2.0 Ma
Pegmatite	204.6 ± 4.3 Ma

Table 2: Data set of U-Pb zircon geochronology of Jerai granite

	Concentrations				Isotope ratios				Age (Ma)	
Sample-spot	U ppm	Th ppm	Th/U	206Pb ppm	207Pb/206Pb	± 1 σ	206Pb/238U	± 1 σ	206Pb/238U	± 1 σ %
BG4Q, Biotite-muscovite granite										
107	14391	90	0.0062	363.8	0.0517	0.6%	0.0290	3.5%	184	6
103	12875	56	0.0043	338.3	0.0515	1.6%	0.0312	1.9%	198	4
108	12260	61	0.0049	342.9	0.0514	0.6%	0.0312	1.7%	198	3
99	6582	108	0.0164	195.2	0.0628	0.8%	0.0318	0.9%	199	2
109	7585	65	0.0085	219.1	0.0529	0.8%	0.0322	0.9%	203	2
106	8712	36	0.0041	246.8	0.0546	1.2%	0.0323	1.2%	204	2
101	5352	29	0.0054	148.1	0.0539	1.8%	0.0323	1.4%	204	3
100	7299	57	0.0078	211.9	0.0591	1.4%	0.0332	1.8%	209	4
104	4544	74	0.0164	140.5	0.0554	1.8%	0.0335	1.3%	211	3
102	7893	77	0.0098	242.6	0.0526	2.7%	0.0341	2.2%	216	5
110	7385	24	0.0032	227.3	0.0523	0.9%	0.0348	1.2%	220	3
105	8562	84	0.0098	270.2	0.0535	0.6%	0.0349	2.0%	220	4
BG1T, Biotite-muscovite granite										
129	2460	102	0.0413	90.4	0.0592	2.2%	0.0406	2.0%	254	5
126	1851	65	0.0351	70.6	0.0560	1.1%	0.0422	2.2%	265	6
127	1452	1389	0.9562	67.1	0.0569	2.4%	0.0425	2.4%	267	6
130	2191	124	0.0566	110.0	0.0892	1.0%	0.0509	1.5%	306	5
128	1228	789	0.6422	69.5	0.0615	1.3%	0.0537	1.8%	334	6
131	1059	223	0.2108	93.5	0.0616	1.0%	0.0904	2.6%	556	14
TG3J, Tourmaline granite										
82	9231	27	0.0029	237.3	0.0498	1.1%	0.0297	1.2%	188	2
81	8085	25	0.0031	220.7	0.0504	0.7%	0.0306	0.7%	194	1
84	4694	6	0.0012	132.0	0.0499	2.0%	0.0312	1.3%	198	3
91	8995	7	0.0008	254.9	0.0505	0.6%	0.0317	0.8%	201	2
85	9842	15	0.0015	282.6	0.0513	1.5%	0.0319	1.2%	202	2
92	6109	13	0.0021	174.9	0.0512	0.8%	0.0320	0.8%	203	2
83	7162	9	0.0012	197.0	0.0499	1.2%	0.0321	1.3%	204	3
90	5774	8	0.0013	158.6	0.0499	1.8%	0.0322	1.5%	205	3
86	7081	5	0.0008	195.5	0.0508	1.4%	0.0323	1.3%	205	3
87	6624	8	0.0012	184.3	0.0503	1.3%	0.0325	1.3%	206	3
88	7077	7	0.0010	213.0	0.0554	1.3%	0.0327	0.8%	206	2
89	8209	11	0.0013	235.2	0.0500	0.9%	0.0325	1.5%	206	3
PG2Q, Pegmatite										
125	33336	448	0.0134	746.9	0.0540	0.7%	0.0258	2.0%	163	3
124	4368	15	0.0035	116.0	0.0500	2.2%	0.0310	1.3%	197	2
122	4895	15	0.0032	136.5	0.0510	0.9%	0.0311	0.8%	197	2
121	4208	14	0.0034	120.7	0.0539	1.2%	0.0320	1.0%	202	2
120	4717	20	0.0043	136.4	0.0533	1.0%	0.0320	0.8%	202	2
119	7118	52	0.0074	208.6	0.0510	1.2%	0.0320	1.9%	203	4
123	4997	20	0.0039	148.9	0.0518	1.4%	0.0327	1.0%	207	2
117	4021	44	0.0109	120.2	0.0542	1.9%	0.0335	1.5%	211	3

The geochemical classification of the igneous rock is first made from the TAS (total alkalis versus silica) diagram of Cox et al. (1979) and adapted by Wilson (1989). Based on the TAS diagram, tourmaline granite and pegmatite generally have low alkali content, with $NA_2O + K_2O$ ranging between 4.96 to 7.62 wt% for tourmaline granite, 3.84 to 7.10 wt% for pegmatite. Pegmatite samples are noted to not belong in granite field. However the biotite-muscovite granite has higher alkali contents that are 7.87 to 11.26 wt%. On the basis of the Irvine & Baragar (1971) classification scheme tourmaline granite & pegmatite samples belong to the subalkaline field while alkaline field only occupy by biotite-muscovite granite and single sample of tourmaline granite.

Further classification of alkali and subalkaline rocks is made after Peccerillo & Taylor (1976), Ewart (1982), Middlemost (1985), Le Maitre at al. (1989) and Rickwood (1989) on the basis of K2O versus SiO2 content. The tourmaline granite and pegmatite samples plot at the low to medium K, calcic (tholeeite) to calc-alkaline series boundary and biotite-muscovite granite samples plot at high K, alkalic (shoshonite) series.

In the classification based on the concept of alumina saturation was made using the A/CNK versus A/NK diagram of Shand (1943) and Maniar & Precoli (1989). The A/CNK is defined as molar Al2O3/(Cao + Na2O + K2O) whereas A/NK is molar Al2O3/ (Na2O + K2O). All the Jerai granite samples plot in the composition of peraluminous domain. Nevertheless, the ratio of the molecular A/CNK of biotite-muscovite granite as well as tourmaline granite and pegmatite are > 1.1, hence all the rocks samples are S-type in the sense of Chappell & White (1974).

GEOCHRONOLOGY:

The analysis are using laser ablation – inductively coupled plasma – mass spectrometry (LA-ICP-MS) at ARC Centre of Excellence in Ore Deposits (CODES), University of Tasmania, Hobart, Tasmania, Australia to analyze U-Pb isotopes from zircon from biotite-muscovite granite, tourmaline granite and pegmatite. Although a relatively small sample of the zircons in each of granite was analysed, almost all of the several zircons in each sample are similar and consistent with magmatic growth of Main Range granite. Moreover, the consistency of ages obtained from different spot of randomly selected crystals indicated that most zircons within each sample are the same age. Therefore interpretation of the isotopic ages as dating the crystallization of the pluton has been made. The three results range from 204.6 to 205.5 Ma and agree to within analytical precision, consistent with the Jerai pluton having crystallized during a single magmatic event at about 205 – 206 Ma.

This study shows that the Jerai intrusion constituted a specific event that took place at 205.5 ± 4.1 Ma at Late Triassic. Jerai granite would be equivalent in U-Pb zircon age of Main Range granite range between 198 and 220 Ma (Liew & McCulloch, 1985; Liew & Page, 1985; Searle et al., 2012) and probably in meaning to the latest intrusive ones in the Main Range granite. This Jerai granite ages can be related to the extentional, as the locus of magmatism migrated westward away from the trench in subduction system (Pitcher, 1983; Ghani, 2000; Ghani et al., 2013).

Another interesting consideration is that biotite-muscovite and tourmaline granite are almost coeval, the former being slightly older. Pegmatite intrusion is clearly separated in time from that of tourmaline granite and of the biotite-muscovite granite. The age link between both granite and pegmatite is an expected result of this study and confirms their age.

CONCLUSION:

1. Jerai granite units can be divided into three facies; (i) biotite-muscovite granite, (ii) tourmaline granite and (iii) pegmatite and aplopegmatite phase.
2. U-Pb zircon geochronology of the Jerai granite gave an age ranging from 204 ± 4.3 Ma for pegmatite and 205 ± 4 Ma and 205 ± 2 Ma for biotite-muscovite granite and tourmaline granite respectively.
3. Pegmatite and tourmaline granite are more differentiated than biotite-muscovite granite, as demonstrated also by a lower amount of biotite, a higher SiO2 content (70.95-83.94 wt.% vs. 69.45-73.35 wt.%) and a more pronounced peraluminous character.
4. Jerai granites are similar with S-type Main Range granite but are more fractionated pluton and have signature of late-stage hydrothermal fluids interaction.

REFERENCES

Barber, A.J., 2000. The origin of the Woyla Terranes in Sumatra and the Late Mesozoic evolution of the Sundaland margin. Journal of Asian Earth Sciences 18, 713–738.

Barber, A.J., Crow,M.J., De Smet,M.E.M., 2005. Tectonic evolution. In: Barber, A.J., Crow,M.J., Milsom, J.S. (Eds.), Sumatra: Geology, Resources and Tectonic Evolution. Geological Society of London, Memoir, pp. 234–259.

Benard F, Moutou P, Pichavant M. 1985. Phase-relations of tourmaline leucogranites and the significance of tourmaline in silicic magmas. Journal of Geology 93:271-291.

Best, M. G, (2003). Igneous And Metamorphic Petrology 2nd Edition. Blackwell Publishing, USA.

Bradford E. F. (1972) Geology and mineral resources of the Gunung Jerai area, Kedah. Geological Survey Malaysia, Memoir. 13.

Brown, M. & Solar, G. S. 1998. Granite ascent and emplacement during contractional deformation in convergent orogens. Journal of Structural Geology **20**, 1365–93.

Cameron, E.N., Jahns, R.H., McNair, A.H. & Page, L.R. (1949): Internal structure of granitic pegmatites. Econ. Geol., Mon.2,

Cartwright, I. and Valley, J. W. (1991) Steep oxygen isotope gradients at marble-metagranite contacts in the NW Adirondack Mts., N.Y. Earth. Planet. Sci. Letts. 107, 148-163.

Chappell, B.W., White, A.J.R., 1974. Two contrasting granite types. Pacific Geology 8, 173–174.

Chappell, B.W., White, A.J.R., 1992. I- and S- type granites in the Lachlan fold belt. Transactions of the Royal Society of Edinburgh: Earth Sciences 83, 1–26.

Clemens, J.D., 2003. S-type granitic magmas – petrogenetic issues, models and evidence. Earth Science Reviews 61, 1–18.

Cobbing, E.J., Mallick, D.I.J., Pitfield, P.E.J. and Teoh, L.H. 1986. The granites of the Southeast Asia Tin Belt: Journal of the Geological Society, London, **143**, p. 537-550.

Cobbing, E.J., Pitfield, P.E.J., Darbyshire, D.P.F., Mallick, D.I.J., 1992. The granites of the SE Asian Tin Belt. Overeas Memoirs of the British Geological Survey, 10.

Cottam, M.A., Hall, R., Ghani, A.A., 2013. Late Cretaceous and Cenozoic tectonics of the Malay Peninsula constrained by thermochronology, Journal of Asian Earth Sciences 76, 241-257.

Cox, K.G., Bell, J.D. & Pankhurst, R.J. (1979), The interpretation of igneous rocks.

Duke, E.F., Shearer, C.K., Redden, J.A., and Papike, J.J. (1990) Proterozoic granite-pegmatite magmatism, Black Hills, South Dakota. In J.F. Lewry and M.R. Stauffer, Eds., The Early Proterozoic Trans-Hudson Orogen of North America. Geological Association of Canada Special Paper 37, p. 253.269.

Duke, E. F., Papike, J. J. & Laul, J. C. 1992. Geochemistry of a boron-rich peraluminous granite pluton: the Calamity Peak layered granite-pegmatite complex, Black Hills, South Dakota. Canadian Mineralogist **30**, 811–34.

Ewart, A., 1982, The mineralogy and petrology of Tertiary-Recent orogenic Volcanic rocks, igneous series classification.

Förster, H.-J., Tischendorf, G. and Trumbull, R.B.(1997). An evaluation of the Rb vs. (Y+Nb) discrimination diagram to infer tectonicsetting of silicic igneous rocks. Lithos, V.40, pp. 261–293.

Ghani, A.A., 2000. The Western Belt granite of Peninsular Malaysia: some emergent problems on granite classification and its implication. Geosciences Journal 4 (4), 283–293.

Ghani, A.A., 2009. Plutonism. Ch. 10 In: Hutchison, C.S., Tan, D.N.K. (Eds.), Geology of Peninsula Malaysia. Geological Society of Malaysia, pp. 211–231.

Ghani, A.A., Searle, M., Robb, L. & Chung, S.L. (2013). Transitional IS type characteristics in the Main Range Granite, Peninsular Malaysia. Journal of Asian Earth Sciences.

Guillot, S., Le Fort, P., Peˆcher, A., Roy Barman, M. & Aprahamian, J. (1995a). Contact metamorphism and depth of emplacement of the Manaslu granite (central Nepal): implications for Himalayan orogenesis. Tectonophysics 241, 99–119.

Harker, Alfred; Tilley, C.E,, Nockolds, S.R.; Black, M. (1972). Harker's Petrology for Students - an Introduction to the Study of Rocks Under the Microscope. Cambridge University Press.

Hatch F H, Wells A K, Wells M K. 1972. Petrology of the Igneous Rocks. 13th edn. 551 pp. London: George Allen & Unwin.

Hotson, M.D., Khin, Z., Oliver, G.J.H., Meffre, S. & Manaka, T. 2011. U–Pb zircon geochronology of granitoids from Singapore: implications for tectonic setting. Abstracts for 8th Meeting, Asia Oceania Geological Society, (AOGS) Taipei, Taiwan.

Hutchison, C.S., 1996. Geological Evolution of South East Asia. Geological Society Malaysia, pp. 368.

Hutchison, C.S., & Tan, D.N.K., (eds) 2009. Geology of Peninsular Malaysia. University of Malaya, Geological Society of Malaysia, Kuala lumpur.

Irvine, T.N. & Baragar, W.R.A. 1971. A guide to the chemical classification of common volcanic rocks. Canadian Journal of Earth Sciences 8, 523-548.

Jahns, R.H., Tuttle, O.F., 1963. Layered pegmatite–aplite intrusives. Spec. Pap.-Miner. Soc. Am. 1, 78–92.

Leeman W P, Sisson V B. 2002. Geochemistry of boron and its implications for crustal and mantle processes. In: Grew E S, Anovitz L M, editors. Boron, Mineralogy, Petrology and Geochemistry. Mineralogical Society of America, Reviews in Mineralogy. Vol. 33. p. 645-707.

Le Maitre, R. W., Bateman, P., Dudek, A., Keller, J., Lameyre, J., Le Bas, M. J., Sabine, P. A., Schmid, R., Sorensen, H., Streckeisen, A., Woolley, A. R. & Zanettin, B. 1989. A Classification of Igneous Rocks and Glossary of Terms: Recommendations of the International Union of Geological Sciences Subcommission on the Systematics of Igneous Rocks. Oxford: Blackwell Scientific.

London, D., 2008. Pegmatites. Special Publication 10, Canad Mineral, pp 1–347.

London, D. 2009. The origin of primary textures in granitic pegmatites. Canadian Mineralogist, 47, 697-724.

Liew, T.C., 1983. Petrogenesis of the Peninsular Malaysia granitoid batholith. PhD thesis. Australia National University. Canberra, pp. 291.

Liew, T.C., Mc Culloch, M.T., 1985. Genesis of granitoid batholiths of Peninsular Malaysia and implication for models of crustal evolution: evidence from Nd–Sr isotopic and U–Pb zircon study. Geochimica et Cosmochimica Acta 49, 587–600.

Liew, T.C., Page, R.W., 1985. U–Pb zircon dating of granitoid plutons from the west coast province of Peninsular Malaysia. Journal of the Geological Society London 142, 515–526.

Maniar, P. D. & Piccoli, P. M. 1989. Tectonic discrimination of granitoids. Geological Society of America Bulletin 101, 635–643.

Meffre, S., Large, R.R., Scott, R., Woodhead, J., Chang, Z., Gilbert, S.E., Danyushevsky, L.V., Maslennikov, V., Hergt, J.M., 2008. Age and pyrite Pb-isotopic composition of the giant Sukhoi Log sediment-hosted gold deposit, Russia.Geochimica et Cosmochimica Acta 72,2377-2391

Metcalfe, I., 2000. The Bentong–Raub suture zone. Journal of Asian Earth Sciences 18, 691–712.

Metcalfe, I., 2013. Gondwana dispersion and Asian accretion: tectonic and palaeogeographic evolution of eastern Tethys. Journal of Asian Earth Sciences. http://dx.doi.org/10.1016/j.jseaes.2012.12.020.

Middlemost, E.A.K. 1985. Magmas and magmatic rocks. Longman Group Limited, Essex, U.K.

Nabelek, P.I., Liu, M., 2004. Petrologic and thermal constraints on the origin of leucogranites in collisional orogens. Transactions of the Royal Society of Edinburgh: Earth Sciences, **95**, 73–85.

Nabelek, P.I., Russ-Nabelek, C., and Haeussler, G.T. (1992) Stable isotope evidence for the petrogenesis and fluid evolution in the Proterozoic Harney Peak leukogranite, Black-Hills, South-Dakota. Geochimica et Cosmochimica Acta, 56(1), 403-417.

Oliver, G., Khin Zaw, Hotson, M.D., 2011. Dating rocks in Singapore: plate tectonics between 280 and 200 million years ago. Innovation Magazine 10 (No., 2), 22–25.

P012

Magnetic Characteristics of the Rock Formations on Mount Kinabalu, Sabah.

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A ground magnetic survey from the foot to the summit of Mount Kinabalu revealed the distinguishing magnetic characteristics of the different rock formations.

Generally Mount Kinabalu consists of granites at its core on the higher ground of the mountain, surrounded by sedimentary rocks of Crocker/Trusmadi formations at its foot, with serpentinite found between the granites and sedimentary rock at the west, southwest and south margin. The occurrences of serpetinite are more extensive in the west of granites. Jacobson (1970) has mapped and sub-divided the granites into hornblende granite, biotite granite and porphyritic granite. The occurrences of porphyritic granite are found in a narrow belt between serpentinite in the lower portion and hornblende granite in the upper portion of the mountain.

A land magnetic data acquisition was conducted in May 2013 along the trail from Mesilau to the summit of Mount Kinabalu and from summit down at Timpohon gate. The processed magnetic data show distinguishing magnetic characteristics of three different rock formations of Mount Kinabalu. The Crocker/Trusmadi sedimentary formations are magnetically “quiet and smooth”, with the small variation (40000 to 40300 nT) of total magnetic field across the formations. Large variation of total magnetic fields from 39700 to 41050 nT are observed to associated with profoundly sharp changes within the serpentinite zone. The total magnetic field decrease gradually with relatively smaller variation within the porphyritic granite from the serpentinite at lower contact into the massif hornblende granite at the higher ground of the mountain. The hornblende granite has a consistent total magnetic field of 40100 to 40200 nT from the contact of porphyritic granite to summit.

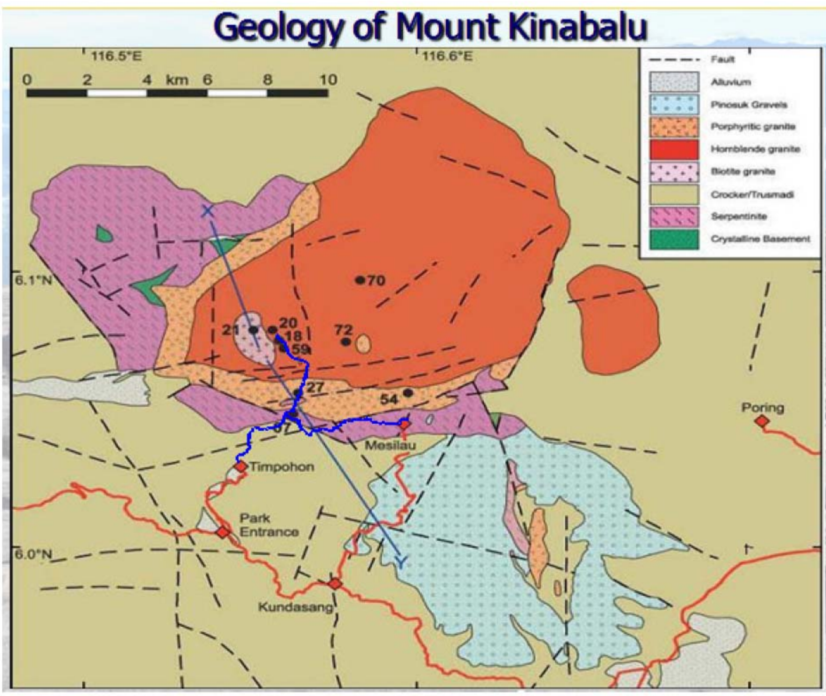


Figure : 1 Geology of Mount Kinabalu with survey track (Blue color)

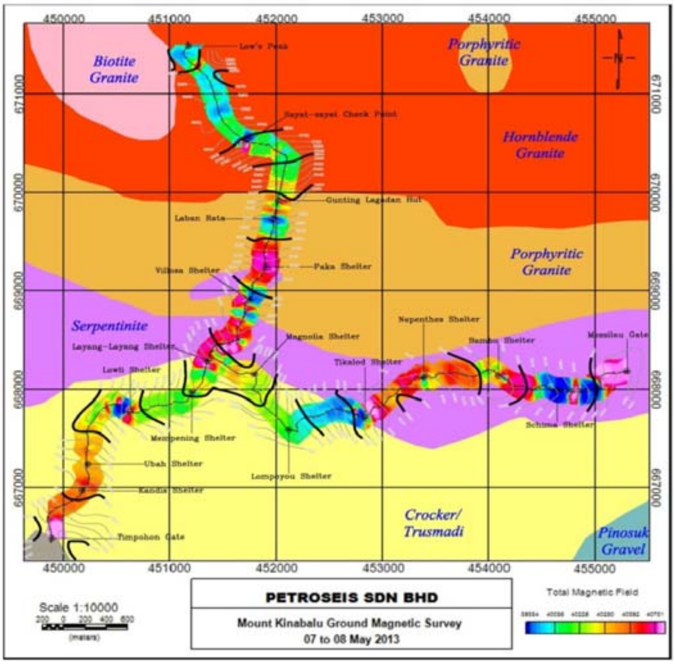
REFERENCES:

Elvaene James, Hamzah Mohamad, Shariff & Mohd Rozi Umor, 2010. Characterisation of enclaves at Mount Kinabalu as a geological heritage. Bulletin of the Geological Society of Malaysia 56 (2010) 121 - 125

M.Cottam, R.Hall, C.Sperber & Armstrong, 2010. Pulsed emplacement of the Mount Kinabalu granite, Northern Borneo. Journal of the Geological Society, London, Vol. 167, 2010, pp 49-60

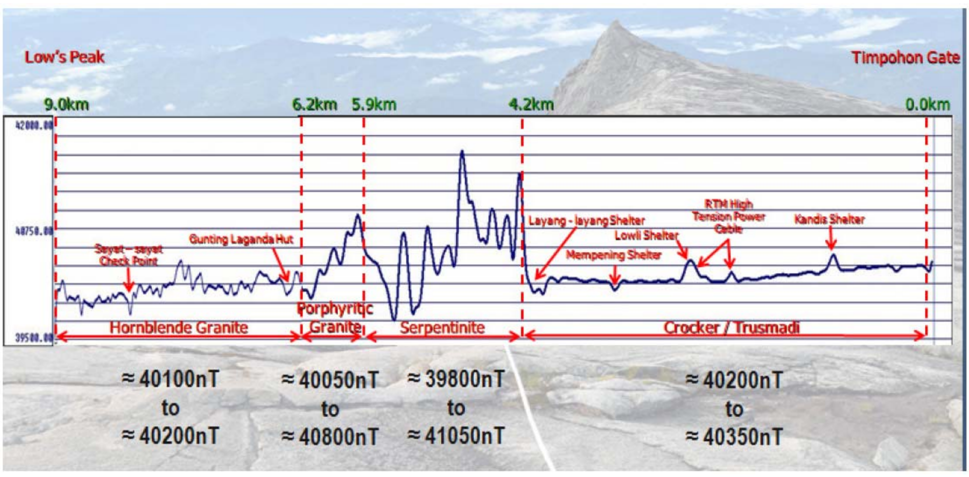
P. Collenette, 1964. A Short Account of the Geology and Geological History of Mt. Kinabalu, Journal of Proceeding The Royal Society London, Vol. 161, 1964, pp 56-63

Jacobson, G. 1970. Gunung Kinabalu area, Sabah, East Malaysia. Malaysia. Geological Survey Report, No 8. Sarawak Government Press, Kuching.



(Left)Figure2: Graphical display of Total Magnetic Field Along Survey Track

(Below) Figure 3: A Graph shows Total Magnetic Field from Summit to Timpohon Gate



P025

Diagenetic History of the Chuping Limestone at Bukit Tengku Lembu, Perlis Malaysia

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Figure 1: Study area in Beseri Perlis.

The Early Permian to Late Triassic limestones of Chuping Formation in Bukit Tungku Lembu exhibits various types of cementation, reflecting history of diagenesis that the rock has gone through. From the 89 samples collected for detailed petrography studies, 6 microfacies have been identified including brecciated limestone, dolomites, mudstones, wackestones, packstones and grainstones. Four major diagenetic processes that took place in different diagenetic environments have also been identified: micritization, cementation, compaction and dolomitization. Micritization was the first diagenetic process that took place soon after the sediments were deposited on the sea floor. This process is shown by the presence of grains with which have been partly turned into micrite. This process took place in facies deposited in quiet environments. Shallow marine calcite cementation is also detected in some of the samples. The second diagenetic process which involve grain compaction that occurred during early burial which is shown by the presence of fractures and grain deformation as well as the destruction of the whole grain's structure. This process was followed by the formation of stylolites.due to pressure solution as the depth of burial become deeper. Deep burial dolomitization is also detected in the sample which marked the final stage of diagenesis in the limestone.

INTRODUCTION

Diagenesis is a process that transforms soft sediments such as carbonates mud and grains into all grains together and become more stable (Wayne, 2008). The process is wide and varied depending on place and time of deposition. For example the diagenetic processes that took place in shallow marine environments are different from the sediment deposited in deeper water environments. Hence diagenetic processes that the sediments have gone through could somewhat indicate their depositional setting as well as the water condition during deposition. Several diagenetic stages associated with the diagenesis of carbonate sediments and rock are already widely accepted such as dissolution of skeletal or any carbonate bodies to cementation and replacement, neomorphism, recrystallization and dolomitization (Sukhantar, 2004 and Flugel, 2004). Diagenesis may also occur mechanically through compaction and pressure solution which could take place in any of the major diagenetic environments which include marine, meteoric and subsurface (Moore, 1989).

This paper documents the different cement types in the Chuping Limestone from Bukit Tungku Lembu area. Their characteristics and diagenetic environment are also identified and discussed.

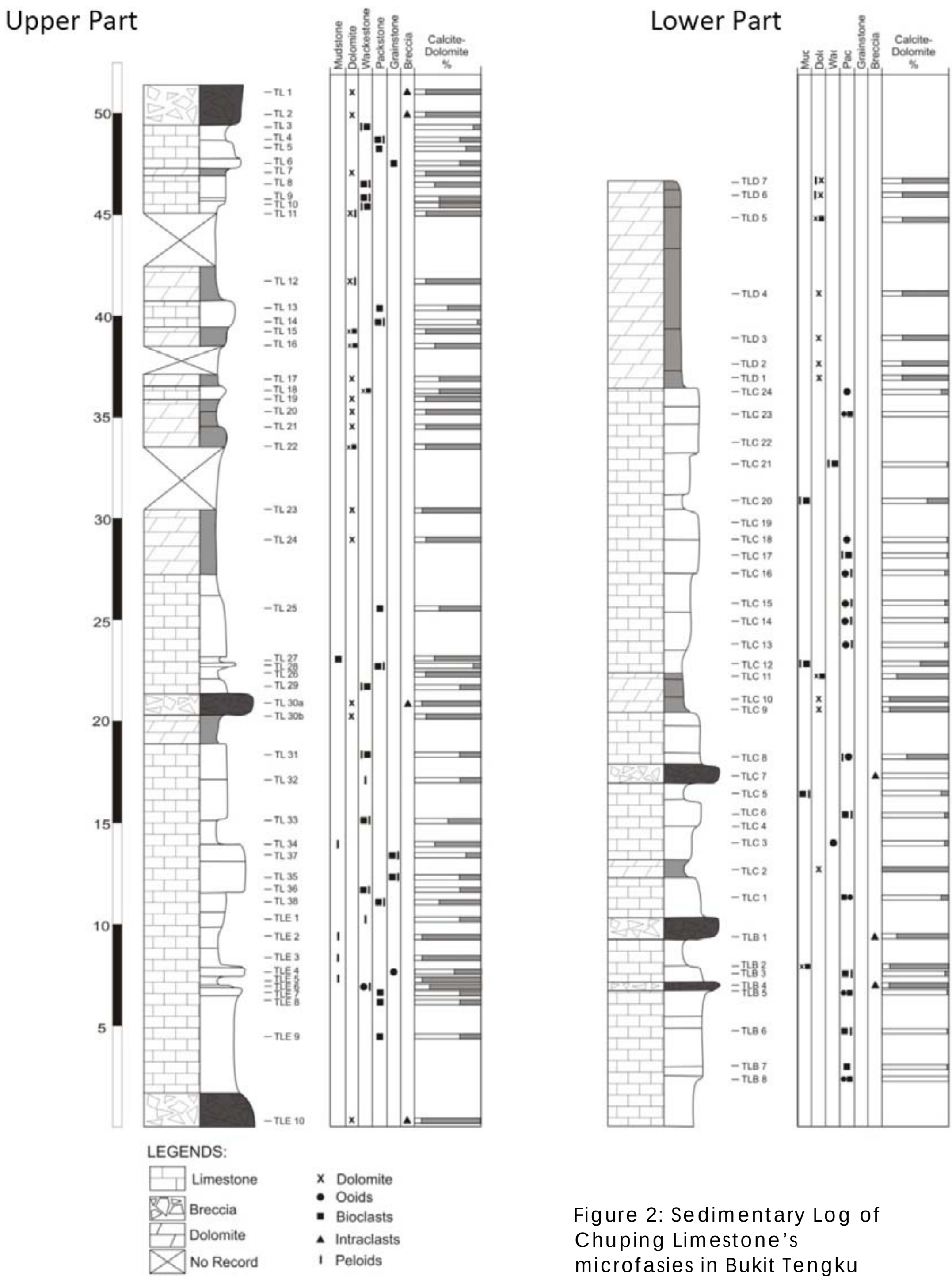


Figure 2: Sedimentary Log of Chuping Limestone's microfasies in Bukit Tengku Lembu

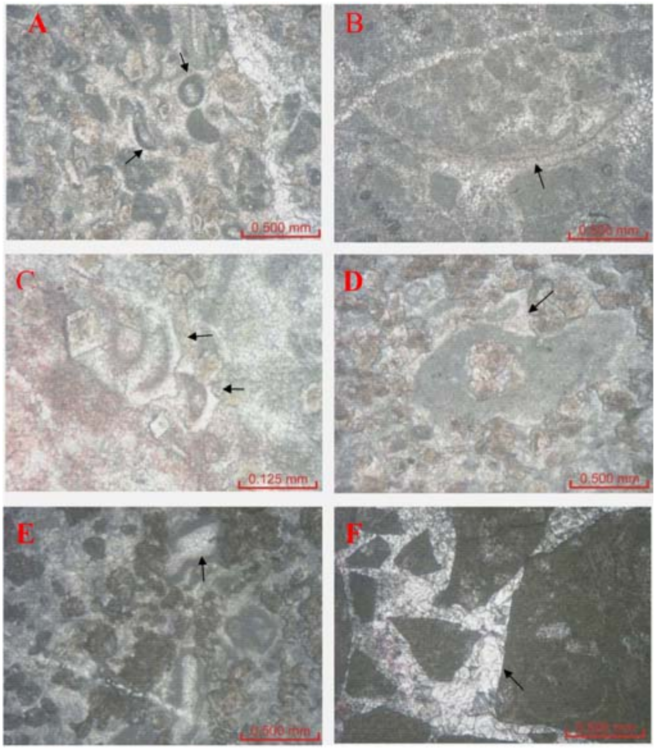
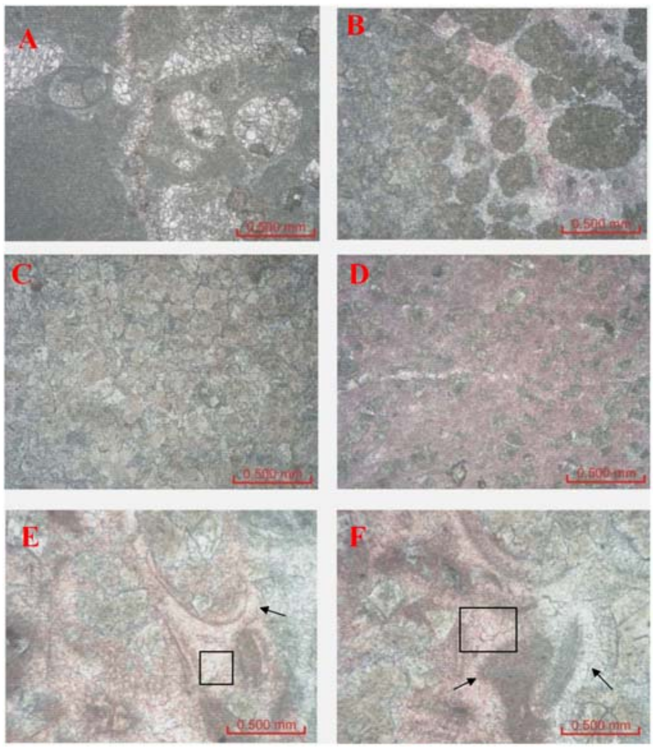


Figure 3: (A) Showing abundances fibrous rim cements, (B)Fibrous rim cement on the surface of a brachiopod clast, (C) Growth of pendant cements indicating a vadose meteoric environment, (D) inter-granular fine equant calcite cement (E) Drusy mosiac calcite cement and (E) Medium to coarse grained blocky calcite cement with micritic pockets.

Figure 4: (A) Moldic voids formed through leaching and dissolution in a meteoric phreatic environment, (B) Dolomitization happened as replacement in ooids grains, (C) Complete dolomitization, (D) Partially dolomitized, the stained in red are calcite while the unstained minerals are dolomites, (E) and (F) showing the occurrence of first (indicated by the arrow) and second generation cement (in the box).



GEOLOGICAL SETTING

This study was carried out in Bukit Tungku Lembu, Beseri Perlis. Jones in 1981 reported that this area consists of two formations namely Chuping Formation, also known as Chuping Limestone and Kubang Pasu Formation. Chuping Limestone of Malaysia is very well-known for its pure calcitic massive limestone with a diverse fossil content. It was named by Jones (1962) after the Chuping Hill in Perlis. After the discovery of Triassic conodonts by Ishii and Nogami in 1966, Jones decided to merge the Chuping Limestone with the Kodiang Formation as the later resembles the basal part of Chuping Formation in Perlis. In 1975, de Coo and Smith had separated these two formations into two different stratigraphic units claiming that they are composed of completely different lithologies. However the relationships between these two formations still remain as a subject of debate until today. The formation is exposed mainly in the north-western part of the Malay Peninsula, which is in Perlis and Langkawi (Gobbett, 1973). In Langkawi, Chuping Limestone is exposed mainly in Pulau Singa Kecil, Pulau Singa Besar, Pulau Jong and Pulau Jerkom. It was found overlying the clastic rocks of Singa Formation. However in Perlis it was found overlying the Kubang Pasu Formation at Bukit Tengku Lembu, Bukit Wang Pisang, Bukit Manek and Bukit Chondong. The same limestone also forms several small hills namely Bukit Mata Ayer, Bukit Chabang, Bukit Tok Sami, Bukit Termiang, Bukit Tau, Bukit Guar Sami, Bukit Jerneh, Bukit Keteri, Bukit Panggos and Bukit Ngolong (Azimah, 1998). These hills are located in Perlis aligned in two parallel belts side by side in a North-South direction stretching from the Southern Thailand to North Kedah forming a prominent karst topography. In Thailand it was named as Ratburi Limestone (Fontaine et al, 1994). Azimah (1998) had recorded that the limestones from the two different belts have different geochemical properties.

METHODOLOGY

Detailed sedimentary logging and samplingwere done to an outcrop at Bukit Tengku Lembu where 89 samples were collected at every 1 meter interval along the rock sequence. In general, the samples consist of pale to dark grey, pure calcitic laminated limestones. These samples were thin-sectioned and studied under the microscope for their petrographic properties. Before that the thin sections were stained using a combined solution of Alizarin Red S and Potassium Ferricyanide, dissolved in Hydrochloric Acid. Using this staining method, one is able to differentiate between different mineral contents. Calcite will stain red, ferroan calcite stains in blue and dolomite will be left unstained.

RESULTS

Using the classification system by Dunham (1962) as well as Leighton and Pendexter (1962), 7 carbonate microfacies have been identified i.e, limestione breccia, dolomites, mudstones, wackestones, packstones, grainstones and oolitic limestone (Figure 2). This paper mainly focuses on their diagenetic processes based on the evident shown in the thinsection.

Diagenetic processes

The main diagenetic processes are micritization, dissolution, cementation, compaction and dolomitization.

Micritization

Figure 3E shows micritic pockets in packstone. This is formed by microbes which bore small holes along the boundaries of the sediments, giving spaces for micrites to move in (Bathurst, 1980). Micritization may take place continuously throughtout the rock history, repeated micritization will eventually destroy the original grain structure (Halimeh et al. 2013). It mainly fills skeletal bodies and matrix where cements are absent.

Micritization is the first diagenetic phase in formation of carbonate rocks (Adabi, 2009, Mohammad et al, 2013). It takes place in the marine environment where the sediments were first deposited. In order for micritisation to happen, the sediments have to remains on the ocean floor for a period of time instead of being quickly buried as soon as it it deposited (Kabanov, 2000).

Cementation and Cement Type

Four cement types namely fibrous calcite cement, fine equant calcite cement, drusy mosaic calcite cement and medium-coarse blocky calcite cement have been identified in this limestone. Cementation happened as early as after the sediments are deposited and as a replacement of dissolved clasts.

Fibrous Calcite Cement

The fibrous cement appears as a rim-like fabric around the surface of the particle and occurs quite frequently in the Chuping Limestone rock sequence. It consists of radial, needle-like or columnar, fine to medium sized calcite crystals growing perpendicular to the particle's surface (figure 3A). The fibrous crystals usually grow radiating outwards from the surface of the particles in a same length forming a parallel isophacus or sub-isophacus crusts of about 20-50 µm thick. In some cases, the cement is only concentrated at one side of the particle and in some it appears to be undulating.

Fibrous cement usually indicates the first generation cement formed on walls of particles as a result of early marine diagenesis precipitation (Kendall, 1985). Figure 3B shows same sized, fibrous cement radiating from the surface of a brachiopod clast. It was formed by reprecipitation from dissolution of marine bodies and an early stage of cementing sediments into hard rocks. It grows from the skeletal surface towards the centre of inter-particles pore (Flugel, 2004). The growth of fibrous rim cement formation may also be interrupted by growth of other organisms such as algae during deposition or by late diagenetic cements as shown in figure 3C.

Fine equant calcite cement

Fine equant calcite cements can be observed in most grainstones of the Chuping Limestone. The cement can be found in inter-particles pores. The size ranges from 5 to 50 µm, filling the pores equally and appears in anhedral and subhedral shape (Figure 3D).

This pores filling cement may be a result of recrystallization of pre-existing cement. The granular mosaic calcite cement may indicate a deep burial setting (Flugel, 2004).

Drusy Mosaic Calcite Cement

This type of cement shows an increasing size towards the centre of inter-particle pores. It is found precipitated inside molds, intergranular pores and molds of pre-existing skeletal bodies (Figure 3E). The calcite crystals are subhedral to anhedral with size ranging from 5 to 50 µm.

Drusy mosaic cements usually indicate a later cementation history in a burial or near-surface meteoric environment (Flugel, 2004). In cases in which it fills both the matrix and molds of skeletal grains, Scholle (2003) interpreted that the grains were completely dissolved, leaving voids and later were filled with sparry calcite cement together with its inter-granular pores. The boundaries between the grains and the matrix were distinguished by the micritic pockets preserved from the original sediment. It suggested that the sediments undergo early marine dissolution and followed by meteoric and burial diagenesis. Wilkinson et al (1985) also discovered that the increasing nature of the equant crystal size towards the centre of pores suggest that instead of aragonite, the cement were precipitated as calcite.

Medium-coarse grained blocky calcite cement

The medium to coarse grained cement are found in sizes more than 50 µm in molds of particles and in intergranular pores between rock fragments in breccias. It does not possess any defined shape, showing distinct boundaries between each crystal grains. They are made of non-ferroan calcite, with well developed cleavage and extinction.

Blocky cements are typical in meteoric phreatic and burial environment as a late pore-filling stage. Medium-sized cement may also be found in moldic pores of ooids remnants. This was caused by leaching of the ooids bodies leaving voids to be filled by calcite cements in the later diagenesis. The cements are different from intergranular cement as it is lighter in colour, granular with no distinct crystal faces and fractured. Coarser blocky calcite cements are typical in brecciated rock as cements between rock fragments (Figure 3F).

Compaction and Pressure Solution

Compactions are quite dominant in Chuping Limestone as shown by fractures, broken, deformed grains, stylolites and pressure solutions in the thin sections. This indicates that the overburden pressure from burial had caused both mechanical and chemical compaction to occur (Knut and Kaare, 1995).

Mechanical compaction happened after few meters of burial (during early burial settings) causing fractures, broken and deformed grains. After a few meters deep, the overburden pressure increased, bringing grains in contact with each other and dissolved forming pressure solution (Halimeh et al. 2013). Dissolution happened and formed new cements.

Dolomitization

Dolomites are very dominant in Chuping Limestone of Bukit Tengku Lembu area. The dolomites range from fine to coarse grains scattered as individual rhombs or as complete pervassive dolomite. The textural fabrics of dolomites in the Chuping Formation are in the forms of planar-e and planar-s. Most of them have well-cleavage, cloudy, inclusion-free and are replacing in nature. It replaces grains and in some limestone, it had replaces the fabrics completely.

Grain-replacing dolomites made about 1 to 30% of the total rock volume, selectivey replacing grains especially in ooids, pellets and skeletal allochems, leaving the matrix undolomitized (figure 4B). Most of them are very cloudy in nature, some also possessed a clear rim in a perfect euhedral rhomb shape. Meanwhile a complete dolomitised rock is made up of 80 to 100% of dolomites (figure 4C). These dolomites usually have a subhedral to anhedral shape with curvy to straight boundaries (figure 4D). They have very well developed cleavages, with distinct extinction under cross polars.

DIAGENETIC HISTORY

From the cement type analysis and petrography results, the diagenetic environments and history of Chuping Limestone at Bukit Tungku Lembu are as follows:

Early Marine Diagenesis

An early process of diagenesis is characterised by its early depositional micrites and precipitation of early fibrous circumvoid rim cements. The early precipitation of calcite cements acts as the first generation cement that binds sediments together. This process is assisted by water movement such as wave forcing, tidal pumping, thermal convection and diffusive transport (Scholle, 2003). They transport and force water from the surface into the interior of the sediments and fill the pores between particles. Micritisation also helps to fills pores in between grains aided by microbial activities as suggested by Pratt in 1982 (Kim & Lee, 1996).

Shallow to Deep Burial Diagenesis

Burial diagenesis takes place in the subsurface, shown by evidence of physical alteration such as compaction, pressure solution (existence of stylolites) and late stage cementation (Flugel, 2004). It may be studied from observation of broken and deformed clasts, boundaries between them as well as from dolomites.

From their petrographic data, it shows that most of the dolomite crystals are of medium to coarse crystal size, light to dark brown in colour. Individual rhombus dolomite crystals that are not affected by any compaction or pressure indicate a replacement by dolomite crystal growth in a shallow burial environment. However, dolomites that are tightly packed, giving an irregular boundaries between the anhedral to subhedral dolomite crystals suggested a late burial environment in which the rock experienced compaction. This is also supported by the presence of saddle dolomite.

Medium to coarse, blocky, sparry calcite are also formed as a result of late burial diagenesis as well as broken fragments of allochems. The formation of brecciated or fractured limestone might also indicate extensive compaction in deeper burial environments.

Meteoric water diagenesis

A meteoric environment may be divided into two zones; the phreatic (saturated) and vadose (unsaturated) zones (Flugel, 2004 and Scholle, 2003).

A phreatic zone is a zone below water table where the pores of sediments are completely fed with freshwater (Flugel, 2004). Dissolution occurs, forming moldic porosity, intergranular porosity and vugs. Figure 4A shows formation of moldic vugs in ooids, destroying the structures of ooids completely and replacing it with medium grained granular calcite cement. It is also shown by the complete formation of equant calcite in pores (Figure 3A).

A vadose zone is located nearest to the surface of the earth, overlies the phreatic zone. Here, the cement fabrics usually reflect the way how water was distributed through the particles. It includes formation of pendant-like cement, meniscus cement in between grains, whisker crystals, microspar and some other features (Scholle, 2003). Figure 3C shows pendant cements in grainstone.

There is also an indication of a possible dedolomitization process happening in the Chuping Limestone. Referring to the petrophysical and geochemical data of TL12, the high Ca/Mg ratio does not reflects the 80% dolomite crystal observed in the thin section. It is believed that the dolomite crystals have been replaced by calcite due to their unstable Ca-dolomite crystal lattice.

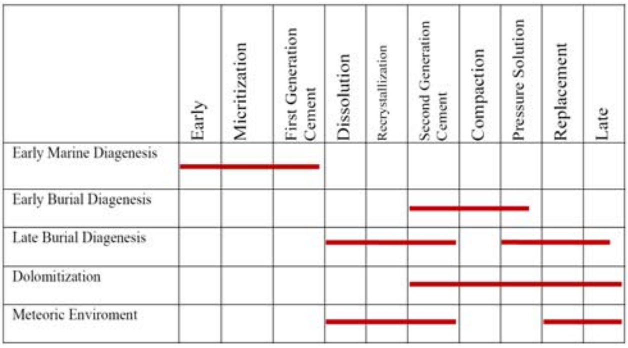


Figure 5: Paradiagenetic Sequence of Chuping Formation

PARADIAGENETIC SEQUENCE

Figure 5 shows a paradiagenetic sequence which consisted of the various diagenetic processes experienced by the Chuping Limestone in their approximate order of occurrence. Through the petrographic evidence, it was shown that the first generation cement appeared in the form of fibrous rimmed cement on the surface of the allochems. Its formation is assisted by water movement and also from secretions of bacteria and other multicellular animals in the earlier marine diagenesis. This binds the sediments together and formed a hard rock. This is followed by dissolution of skeletal assemblages and recrystallisation forming secondary calcite spar cements that fills the pores in between the sediments. This happened in the meteoric environment in which dissolution is most possible. Then a series of physical and chemical compaction takes place as the rocks came to a late burial diagenetic phase. Stylolites, pressure solution and deformation of clasts occur due to the pressure. Dolomitisation serves as the final diagenetic process as it replaces matrix and molds of skeletal clasts with euhedral to subhedral dolomites crystals.

CONCLUSION

These diagenesis processes play a really important role in the formation of Chuping Limestones, It is crucial to acknowledge its formation history to correlate with the global geological events. Overall the Chuping Limestone had undergone 3 diagenesis processes. It started with early marine diagenesis which is indicated by the process of micritization and formation of fibrous rim calcite cements. Marine phreatic environment then took place in shallow marine water involving the stabilizing of metastable minerals into stable calcite cements. This is followed by burial diagenesis. Mechanical compaction took place after few meters of burial forming fractures, deformation and destruction of grain structures. As the overburden pressure increases, dissolution occurs forming pressure solutions, stylolites as well as new cement generations. Replacement by dolomites follows and re-changed the whole limestone fabrics and structures. Then the sediment came into a meteoric phreatic environment in which voids and pores from dissolution are cemented. These cements are post-burial as calcite could not withstand burial temperature (Mohamad et al, 2013).

REFERENCES

Adabi, M. 2009. Multistage Dolomitization of Upper Jurassic Mozduran Formation, Kopet Dagh Basin, N.E. Iran. Carbonates Evaporites 24. 16-32.

Azimah Binti Hussin. 1998. Pengaruh Litologi dan Geokimia ke atas Kualiti Kapur daripada\\Batu Kapur Formasi Chuping, Perlis. Tesis Sarjana Sains. Universiti Kebangsaan Malaysia.

Bathurst, R. G. C. 1971. Carbonate Sediments and Their Diagenesis. Elsevier Publishing Company. Netherlands. 415.

Bathurst, R. G. C. 1980. Stromatactis origin related to sub-marine-cemented crust in Paleozoic mudmounds. Geology 8. 131-134.

Castanier, S. Le Metayer-Levrel, G. and Perthuisot, J. P. 1999. Ca-Carbonates Precipitationand Limestone Genesis- the Microbiogeologist Point of View. Sedimentary Geology. 126. 7-23
Coo, J. M. C. De and Smith, O. E. 1975. The Triassic Kodiang Limestone Formation in Kedah, West Malaysia. Geol. Mijnb. 54(3/4). 169-176.
Dunham, R. J. 1962. Classification of Carbonates Rocks according to Depositional Texture.American Ass. of Petroleum Geo. 43. 1-38.
Flugel, E. 2004. Microfacies of Carbonate Rocks. Springer, Germany. 996 p.
Fontaine, H. Chonglakmani, C. Ibrahim Bin Aman and Piyasin, S. 1994. A well-defined Permian Biegeographic Unit: Peninsular Thailand and Northwest Peninsular Malaysia. Journal of Southeast Asian Earth Sciences. 9 (1/2). 129-151.
Fontaine, H. Khoo, H. P. and Vachard, D. 1988. Discovery of Triassic Fossils at Bukit Chuping in Gunung Sinyum area and at Kota Jin, Peninsular Malaysia. Journal of Southeast Asian Earth Sciences. 2 (3/4). 145-162.
Gobbett D. J. dan Hutchison C. S. 1973. Geology of The Malay Peninsula. John Wiley & Sons, Inc. United States of America.
Halimeh Hashemi Azizi S. Gholamreza Mirab Shabestari And Ahmadreza Khazaei. 2013.Petrography & Geochemistry of Paleocene-Eocene Limestones in the Ching-Dar Syncline, Eastern Iran. Geoscience Frontiers. 1-10.
Ishii, K. S. And Nogami, Y. 1966. Discovery of Triassic Conodonts from the so-called Paleozoic Limestone in Kedah, Malaya. Journal Inst. Polytech. Osaka. Cy. Univ. 9. 93-98
Jones, C. R. 1962. Progress Report on Geological Work in Upper Perak and The Langkawi Islands. Prof. Paper Geol. Survey Dept. Fed. Malaya. E-63. 2-G. 11-12
Jones, C.R. 1981. The Geology and Mineral Resources of Perlis, North Kedah and the Langkawi Islands. Geological Survey of Malaysia Memoir 17, 1-257.
Jones, C. R., Gobbett, D.J. dan Kobayashi, T. 1966. Summary of fossil record in Malaya and Singapore 1900-1965. Geol. Palaeontology Southeast Asia 2, 309-359.
Kendall, A. C. 1985. Radiaxial Fibrous Calcite: a Reappraisal. In: Schneidermann, N. and Harris, P. M. (Editors). Carbonate Cements. Spec. Publ. Soc. Econ. Paleontol. Mineral. 36. 59-77.
Kim, J. C. and Lee, Y. I. 1996. Marine Diagenesis of Lower Ordovician Carbonate Sediments (Dumugol Formation), Korea: Cementation in Calcite Sea. Sedimentary Geology. 105. 241-257.
Kobayashi, T. and Tamura, M. 1968. Myophoria (s.l.) in Malaya in a note on the Triassic Trigoniacea. In Geology of Palaentology of Southeast Asia. Univ. of Tokyo Press. Tokyo.
Leighton, M. W. And Pendexter, C. 1962. Carbonate Rock Types. American Ass. of Petroleum Geo. Memoirs. 33-61.
Mohammad Sahraeyan, Mohammad Bahrami, Mohammad Hooshmand, Shahid Ghazi, And Ali Ismail Al-Juboury. 2013. Sedimentary Facies and Diagenetic Features of the Early Cretaceous Fahligan Formation in the Zagros Fold-Thrust Belt Iran. Journal of African Earth Sciences. 87. 59-70.
Moore, C. H. 1989. Carbonate Diagenesis and Porosity. Elsevier Science Publisher B. V. Netherlands.
Rao, C. P. 1988. Paleoclimate of Some Permo-Triassic Carbonates of Malaysia. Sedimentary Geology. 60. 163-171.
Scholle, P. A. And Ulmer-Scholle, D. S. 2003. A Color Guide to the Petrography of Carbonate Rocks: Grains, textures, porosity, diagenesis. AAPG. Tulsa Oklahama, U.S.A.
Sibley, D. F. and Gregg, J. M. 1987. Classification of Dolomite Rock Textures. Jour. Sediment. Petrol. 57. 967-975.
Sukhtankar R.K. 2004. Applied Sedimentology. CBS Publishers & Distrubutors.
Tucker, M. E. and Wright, V. P. 1990. Carbonate Sedimentology. Blackwell. Oxford
Veizer J. 1983. Chemical diagenesis of carbonates: theory and application of trace element technique. In: Arthur M. A. Anderson T. F. Kaplan I. R. Veizer J. and Land L. S. (Editors) Stable Isotopes in Sedimentary Geology.
Wayne M. A. 2008. Geology of Carbonate Reservoirs: The Identification, Description, and Characterization of Hydrocarbon Reservoirs in Carbonate Rocks. John Wiley & Sons, Inc., Hoboken, New Jersey. 144.
Wilkinson, B. H. Smith, A. L. and Lohman, K. C. 1985. Sparry Calcite Marine Cement in Upper Jurassic Limestone of South Eastern Wyoming. In: Schneidermann, N. and Harris, P. M. (Editors). Carbonate Cements. Spec. Publ. Soc. Econ. Paleontol. Mineral. 36. 169-184.

Zhang J. Wenxuan H. Yixiong Q. Xiaolin W. Jian C. Jingquan Z. Qing L. and Xiaomin X. 2009. Formation of saddle dolomites in Upper Cambrian carbonates, western Tarim Basin (northwest China): Implications of fault-related fluid flow. Marine and Petroleum Geology. 26. 1428-1440.

Lineament Orientations in Different Geological Formations in the Main Island of Langkawi

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Lineament mapping was conducted on the main island of Langkawi to identify the lineament orientations for the Machinchang, Singa, and Setul Formations and the granite bodies. The Machinchang comprises of sedimentary rocks such as sandstone, conglomerate and shale; the Singa formation is mainly consists of mudstone and siltstone and the Setul Formation is composed of mainly limestone. This study utilised RADARSAT-1 image filtered with Robinson 5x5 directional filter for lineaments identification. The results showed that 66 lineaments ranging from 1.07-5.06 km were identified in the Machinchang Formation. The Singa Formation has 217 identified lineaments with the length range of 1.09-8.35 km. Setul Formation has 76 lineaments with 1.07-5.66 km in length. The granite bodies have the highest identified lineaments (223) with the recorded length of 1.08-8.34 km. The major lineament orientation of Machinchang and Singa Formations and the granite bodies are similar trending NE-SW with minor direction of NW-SE. Only the Setul Formation exhibits NE-SW as the major orientation. This might be caused by the occurrence of the Kisap fault, which is also oriented in the NE-SW direction. The lineament orientations of the Machinchang and Singa Formations are controlled mainly by both bedding structure and secondary structures or fractures, while the lineament orientation in the granite bodies is controlled only by fracture.

Keywords: *lineaments, Langkawi, Machincang Formation, Singa Formation, Setul Formation*

INTRODUCTION

Literature has shown the importance of utilising remote sensing to interpret regional structural information on large area (e.g. Olgen, 2004; Rinaldi, 2007; Papadaki et al., 2011). This study fully utilises the advantage of radar image as an active remote sensing system to extract lineaments for the different rock formations in the Langkawi Island. The geological formations are the Machinchang Formation, Singa Formation and Setul Formation. Apart from the rock formations, the granite bodies were also examined.

METHODOLOGY

The lineament of the study area was acquired through satellite image interpretation. This study used the RADARSAT-1 standard mode image for lineament interpretation. To obtain the lineament from this image, a 5x5 Robinson directional filter was used.

RESULT & CONCLUSION

The results showed that 66 lineaments ranging from 1.07-5.06 km were identified in the Machinchang Formation. The Singa Formation has 217 identified lineaments with the length range of 1.09-8.35 km. Setul Formation has 76 lineaments with 1.07-5.66 km in length. The granite bodies have the highest identified lineaments (223) with the recorded length of 1.08-8.34 km. The direction of the lineaments in each formation is shown in Figure 1.

The major lineament orientation of Machinchang and Singa Formations and the granite bodies are similar trending NE-SW with minor direction of NW-SE. Only the Setul Formation exhibits NE-SW as the major orientation. This might be caused by the occurrence of the Kisap fault, which is also oriented in the NE-SW direction. The lineament orientations of the Machinchang and Singa Formations are controlled mainly by both bedding structure and secondary structures or fractures, while the lineament orientation in the granite bodies is controlled only by fracture.

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REFERENCES

Olgen, M.K. 2004. Determining Lineaments and Geomorphic Features Using Landsat 5-TM Data on the Lower Bakirçay Plain, Western Turkey. Aegean Geographical Journal, 13, 47-57.

Papadaki, E.S., Mertikas, S.P., & Sarris, A. 2011. Identification of Lineaments with Possible Structural Origin Using Aster Images And Dem Derived Products In Western Crete, Greece, EARSeL eProceedings, 10, 9-26.

Rinaldi, M. 2007. Remote sensing capability in structural geology analysis of different geodynamic settings: the example of Al Qarqaf Arch (Libya). Scientifica Acta 1, 1, 43 – 46.

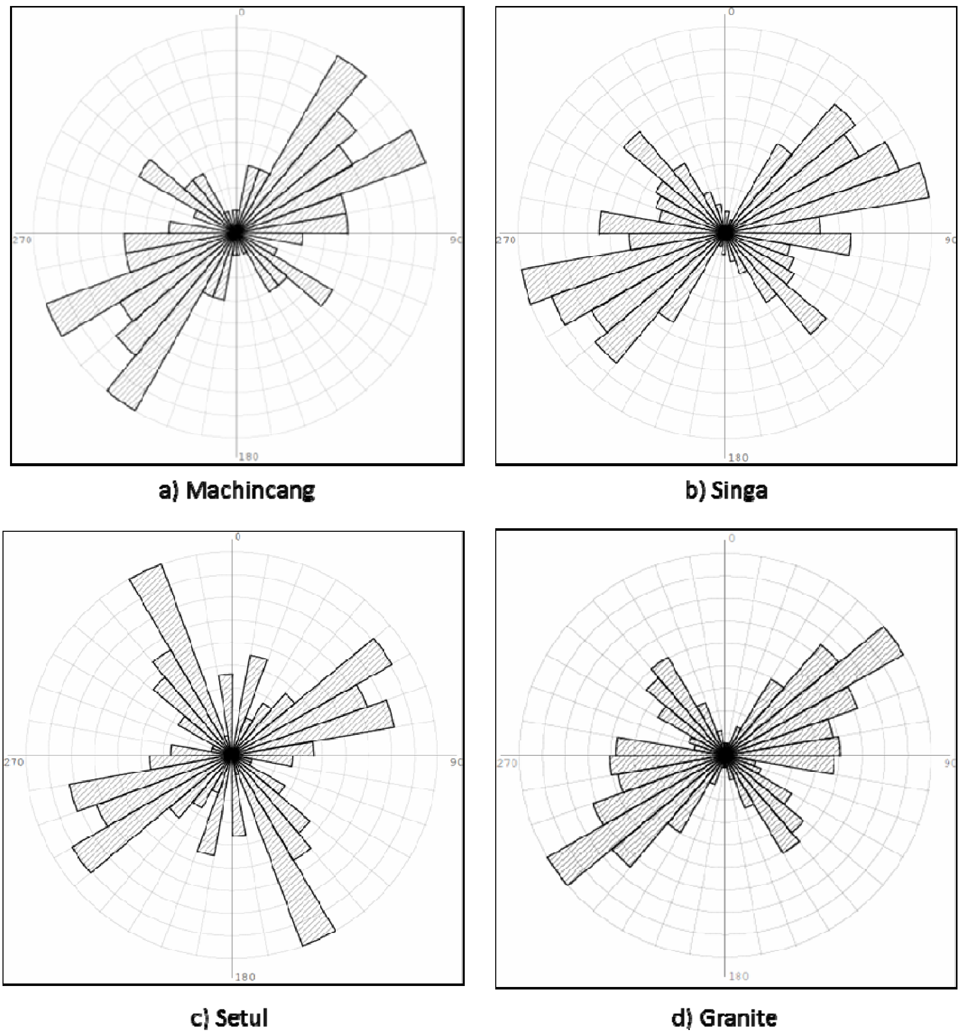

Figure 1 Lineament orientations for each rock formation and the granite bodies in Langkawi

P030

Rock Mass Assessment of Limestone Hills in the Kinta Region

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This study was conducted to assess the condition of seven limestone hills in the Kinta region. These hills are Gunung Rapat, Gunung Datok, Gunung Lang, Gunung Paniang, Gunung Kandu, Gunung Panjang, and Gua Tempurung. The significant of studying these hills are their locations that are close to roads, residential areas and possible develop as tourist attractions. A total of twelve assessment stations with two to three stations for each of the hills were conducted using the rock mass strength system (RMS). Seven components that are used by the RMS are intact rock strength (Schmidt hammer), weathering, spacing of joints, joint orientations, width of joints, continuity of joints, and outflow of groundwater. The hills are then classified into very strong, strong, moderate, weak, or very weak group based on the sum of ratings for all components. The assessment has indicated that Gunung Rapat and Gunung Lang are classified as weak, while Gunung Datok is classified as moderate to weak. The main reasons are these hills are heavily jointed with smaller joints spacing (below 300 mm), joint daylighting steeply out of slopes (85-90°), wider joints opening (larger than 20 mm) and very low Schmidt hammer rebound values (below 35 average). These hills have very low rating for these four factors and due to this, they are classified as weak (< 50 for the RMS), which indicate that they have higher susceptibility to fail. Detailed investigations should be conducted for these three hills that classify as weak to minimise risk on human and property.

Keywords: Limestone, rock mass strength, susceptibility, rock fall, rock mass assessment

INTRODUCTION

The main scope of this research paper is the presentation of the assessment on the stability of limestone hills using the rock mass strength assessment scheme. The study area is located in the Kinta region where massive limestone hills are presence in the midst of highly urbanised area. The assessment was carried out on seven limestone hills, namely, Gunung Rapat, south and northern parts of Gunung Datok, Gunung Lang, Gunung Paniang, Gunung Kandu, Gunung Panjang and Gua Tempurung, with a total of one to three stations for assessment for each of the hills. The significance of these stations is their close proximity to roads and developed area. Several reports on the rockfall occurrences in the study area can be obtained in Chung (1981) and Tuan Rusli Mohamed & Ahmad Khairut Termizi (2012a & b).

METHODOLOGY

The rock mass strength scheme published by Selby (1980) was used to assess the stability of limestone slopes. In this method, six rock mass parameters were established to assess the overall strength of a rock mass. The parameters employed in this system are: Intact rock strength (Ir); weathering (W), joints spacing (Js), joints orientation (Jo), joints width (Jw), joints continuity (Jc) and groundwater outflow (Gw). The sum of these six parameters will indicate the condition of the rockmass.

RESULT & CONCLUSION

A total of 12 assessment stations with one to three stations for each hill were selected. The number of stations and their assessment results based on the RMS are given in Table 1. Out of the seven hills, Gunung Rapat, Gunung Datok, and Gunung Lang were classified as weak by the RMS, while the other four hills were classified as moderate.

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REFERENCES

Chung, S.K. 1981. Geological Survey Malaysia Annual Report, Geological Survey Department Malasia, Ministry of Primary Indutries.
Selby, M.J. (1980). A rock mass strength classification for geomorphic purposes: with tests from Antartica and New Zealand. Zeitschrift fuer Geomorphologie, 24, 31-51.
Tuan Rusli Mohamed & Ahmad Khairut Termizi. 2012a. Report Summary of Geological Hazard at Yee Lee Edible Oils Sdn Bhd. Minerals & Geoscience Department, Malaysia, Perak.
Tuan Rusli Mohamed & Ahmad Khairut Termizi. 2012b. Report Summary of Geological Hazard at Gua Tempurung, Kampar, Perak. Minerals & Geoscience Department, Malaysia, Perak.

Table 1 RMS result for each assessment station

Name of Hill	Station	Final Score	Classification
Gunung Rapat	R1	50	Weak
	R2	46	Weak
	R3	52	Moderate
Gunung Datok	D1	49	Weak
	D2	63	Moderate
Gunung Lang	L1	47	Weak
	L2	49	Weak
Gunung Paniang	Pi1	55	Moderate
Gunung Kandu	K1	51	Moderate
	K2	52	Moderate
Gunung Panjang	Pj1	50	Moderate
Gua Tempurung	T1	52	Moderate

Geochronology of volcanic and plutonic rocks from the islands off Pahang and east Johor, Peninsular Malaysia

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The islands off coast Johor-Pahang southeastern Peninsular Malaysia consist of more than ten main islands. Among the biggest are Tioman, Besar, Tinggi, Sibu, Rawa, Pemanggil and Aur islands. They are underlain by various igneous and metamorphic rocks. The igneous rocks consist of both volcanics (rhyolite, dacite, andesite and pyroclastics of ash and tuff) and plutonic (granite, granodiorite, diorite and gabbro). Based on Ar Ar and U Pb geochronology the age of volcanic and plutonic rocks in the study area ranging from 80 to 300 Ma (Table 1).

ACKNOWLEDGEMENT

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Sample	Location	Age (Ma)	Rock type/SiO_2	Method
U Pb Zircon				
TG4	Pulau Tengah	280.1 ± 2.4	Granite	U Pb Zircon
BES 5	Pulau Besar	281.7 ± 2.1	Granite	U Pb Zircon
MYNG5	Pulau Aur	79.7 ± 0.7	Diorite	U Pb Zircon
TL1	Pulau Pemanggil	80.1 ± 0.4	Diorite	U Pb Zircon
T1	Tioman	80.1 ± 0.8	Granite	U Pb Zircon (Searle et al. 2012)
S1	Sibu island	285 ± 5	Pyroclastic ash	U Pb Zircon (Oliver et al. 2013)
Ar Ar wholerock				
PBXZ	Sibu Island	297.6 ± 11.54	Pyroclastic ash / n.d.	Ar Ar Wholerock
PS11	Sibu Island	299 ± 12.58	Pyroclastic ash / n.d.	Ar Ar Wholerock
BM2	Sibu Island	335.6 ± 9.40	Pyroclastic ash / n.d.	Ar Ar Wholerock
SPB	Sibu Island	296.8 ± 0.69	Pyroclastic ash / 81.24	Ar Ar Wholerock
TT1a	Tinggi Island	88.95 ± 6.61	n.d.	Ar Ar Wholerock
TGRC	Tinggi Island	89.17 ± 6.02	n.d.	Ar Ar Wholerock
BK5	Tinggi Island	120.1 ± 4.8	n.d.	Ar Ar Wholerock
BK4	Tinggi Island	111.6 ± 4.3	n.d.	Ar Ar Wholerock
PC2	Tinggi Island	92.3 ± 4.8	n.d.	Ar Ar Wholerock
TGRC2	Tinggi Island	84.6 ± 4.8	n.d.	Ar Ar Wholerock
TIN1	Tinggi Island	84.28 ± 3.68	Andesite / 58.16	Ar Ar Wholerock
TIN2	Tinggi Island	122.3 ± 11.7	Basaltic / 48.83	Ar Ar Wholerock
	Pemanggil island	80 ± 1	Diorite	Biotite separate

P037

Physical and Chemical Characteristics of Ground Water in the First Aquifer of Kota Bharu, North Kelantan, Malaysia

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Groundwater represents about 95% of total water resources in the region; due to increased human activity in the recent period, the groundwater in some places has suffered from many environmental problems, such as pollution, Stalinization, and consumes. The study area consists of Quaternary sediments ranging in thickness from 25 m inland to value in excess of the 200 m near the coast. The Quaternary sediments consist of four underground alluvial aquifers, separated by salty clay layers. The topmost is between a few meters to maximum 15 m below the ground surface and separated from the second aquifer by a layer composed mainly of clay. The second aquifer's depth is generally between 20m to 35m with a thickness approximately 15 m. Once again a clay-rich layer separates this aquifer from the third aquifer below it. The depth of third aquifer is generally greater than 40 m and it also exhibits considerable thickness exceeding 50 m in some boreholes. Immediately overlying the granite bedrock is the fourth aquifer, which not always detected. The third aquifer represents the main source of drinking water, but about 30- 40 % of people are still using the first aquifer for drinking, and other domestic uses specially people who living in villages. This paper aims to study the chemical and physical properties of water in the first aquifer to see how they conform to the specifications of the World Health Organization. Samples were collected for 28 deep wells in Kota Bharu. The results of physical measurements showed that, the (water level ranged from 0.35- 8.97 m, total depth, from 1.55-13.43 m, average of temperature 28.27℃ moreover, average of electrical conductivity 286.63 µs/cm. Total dissolved solids average 0.174 g/L, salinity 0.127, while dissolved oxygen 14.32% and pH 6.13) were carried out in the field, whereas the chemical parameters (Ca, Na, K, Mg, Mn, Fe, C l, F, HCO_3, SO_4, As, Cu, Ni, Zn Cd, Cr, Pb, NO_2, NO_3) were analyzed in the laboratory. High average of Na, Ca and K, which are29.86, 1036.77, and470.44 mg/L respectively, followed by total hardness 3.48, alkalinity 115.79, and acidity 07.64 mg/L. In general the water in the first layer is fresh, due to very low average of salinity, total dissolved solids, and conductivity. However the ground water can be classified on the basis of two types of waters, sodium bicarbonate Na-HCO_3, and calcium bicarbonate Ca-HCO_3. But the ground water is not suitable for consumption, and domestic use, without treatment; due to high average of sodium, and calcium exceeding WHO guidelines.

P042

Kajian Geokimia Kesan Interaksi Batuan dan Air Bawah Tanah dalam Formasi Belait di Kg. Ganggarak, Utara Pulau Labuan

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Lokasi kajian terletak di Bukit Minyak Gas, Kg. Ganggarak, Utara Pulau Labuan. Geologi kawasan ini terdiri daripada lapisan batu pasir, syal, lapisan nipis konglomerat serta kehadiran dua singkapan lapisan arang batu dalam Formasi Belait. Lapisan batu pasir telah dikenalpasti sebagai akuifer air bawah tanah dan menjadi sumber bekalan air yang penting kepada penduduk Pulau Labuan. Formasi ini tersingkap oleh aktiviti pengambilan batuan untuk pembinaan jalanraya dan sebagainya. Akibatnya, proses luluhawa aktif telah berlaku dan mengubah geokimia batuan dan air di sekitar kawasan ini. Beberapa sampel air telah dikutip dari aliran air permukaan serta air bawah tanah dari telaga pemantauan (kedalaman sehingga 10.5 m). Hasil analisis kimia menunjukkan nilai pH adalah rendah (2.7 - 5.5) serta nilai konduktiviti yang tinggi (melebihi 1000 uS/cm). Kehadiran beberapa unsur surih dan logam berat seperti Cu, Ni, Pb, Zn, Fe, Mn dan Sr merupakan petunjuk bahawa batuan di sekitar kawasan ini telah mengalami proses geokimia yang ekstrem dan berpotensi mempengaruhi kualiti air bawah tanah.

P049

Preliminary Hydrogeochemical Assessment of Kg Salang, Tioman Island, Pahang, Malaysia

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Hydrogeochemistry of major ions of water samples have been used to identify the chemical characteristics and the water type of groundwater in the low lying area in Kampong Salang located at north-west of Tioman Island in Pahang state of Malaysia. In order to evaluate the quality of groundwater in study area, fifteen groundwater wells were collected and analysed for various parameter for three 3 months sampling activities. Physical and chemical parameters of groundwater such as pH, electrical conductivity (EC), total dissolved solids (TDS), Ca, Na, Mg, K, HCO_3, Cl, SO_4, NO_3, were determined. Generally, groundwater in the study area is fresh, based on the analytical results. Hydochemical facies of groundwater in the study area are dominant by Ca-HCO_3 and Ca-Mg-HCO_3 water type. A software known as PHREEQC was used to calculate the saturation indexes for the main mineral phases with respect to carbonate and sulphate mineral. Most of the mineral were saturated to undersaturated with respect to carbonate minerals and undersaturated with respect to sulphate minerals composition. Maximum ionic strength in the study area is 0.009 which was found 90m from the shoreline. Mostly minerals from calcite and dolomite precipitation are from bedrock of pyroxene hornfel.

Keywords: Hydrogeochemistry, PHREEQC, saturation indexes, undersaturated, ionic strength

P056

Implications of Sea-Level Rise to the Coastal Groundwater Resources: A Preliminary Study in Kuala Selangor.

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The IPCC Fifth Assessment Report (AR5) states with high confidence that since the mid-19th century, the rate of sea level rise has been larger than the mean rate during the previous two millennia. Thermal expansion and the melting of glaciers are highly suspected as the dominant contributors to the rise in sea levels. Higher and stronger storm surge is expected to occur, making the coastal areas susceptible to marine inundation. Over time, the extending inundated area may results in further encroachment of tidal water into estuaries and coastal river system, and eventually infiltrates into the aquifer. The rise in sea level also accelerate the movement of saltwater-freshwater interface landward and upward and subsequently increase the rate of saltwater intrusion into fresh groundwater aquifer depending very much on subsurface conditions. In fact, human activities such as groundwater extraction will aggravate the impacts where interface mounding may occur. Water table in coastal aquifer rises simultaneously with sea level which at worst results in groundwater inundation. Apart from wetlands change, disruption of underground systems such as septic tanks and landfills or open dumps by subsurface flooding might cause groundwater contamination. Coastal ecosystems are particularly vulnerable since the rise in sea level will lead to damage of infrastructures, degradations of agricultural areas, contamination to surface and groundwater, and loss of biodiversity; which cover a wide range of negative impacts to various socio-economic sectors. Preliminary findings indicate that Kuala Selangor which hosts several groundwater aquifers and a significant national rice bowl is susceptible to groundwater salinization and other major impacts of the sea level rise. A comprehensive assessment is required to evaluate the potential impacts of sea level rise in this area so that appropriate adaptation measures can be identified and implemented to ensure sustainable socio-economic development and community wellbeing at the local level.

Keywords: groundwater, climate change, sea-level rise, hydrologic cycle, Kuala Selangor

P004

Time-Lapse Resistivity Tomography Using Optimized Resistivity Array and Engineering Soil Characterization for Slope Monitoring Study

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In this paper, we present high resolution time-lapse resistivity tomography study for slope monitoring using two optimized resistivity array of wenner-schlumberger. This optimized resistivity array of wenner-schlumberger give total of 665 datum points for each data set. This slope monitoring study was conducted at Minden, Penang Island, Malaysia. When in-field datum points for this optimized wenner-schlumberger array were analyzed using 2-D inversion, the resistivity tomography results were able to resolve and image well the slope subsurface characterizations. The overall results using optimized array was quite compromising and remarkably significant for good improvement in data acquisition and data quality which helped in interpretation of the Earth's subsurface.

Keywords: Time-lapse resistivity; Optimized resistivity array; Improvement; Data quality

INTRODUCTION

Monitoring in general can be regarded as the regular observation and recording of activities taking place in a certain structure. It is a process of routinely gathering information on all aspects of the object. The term may be narrowed down with respect to deformation monitoring, whereas deformation monitoring is the systematic measurement and tracking of the alteration in the shape of an object as a result of external forces. However, especially in slope monitoring the inclusion of soil parameters like water content, vegetation, erosion and drainage as well as geomorphology and historical information is a major concern. Deformation monitoring and gathering measured values is a major component for further computation of soil and rock stability, deformation analysis, prediction and alarming (Moore, 1992). Since each monitoring project has specific requirements, the used measuring device for a deformation monitoring depends on the application, the chosen method and the required regularity and accuracy. Therefore, monitoring of slopes or landslide areas can only be defined, designed and realized in an interdisciplinary approach (Wunderlich, 2006). A close cooperation with experts from geophysics, geology and hydrology together with other experts from any measurement discipline such as geodesy and remote sensing is an indispensable requirement.

METHODOLOGY

Time-lapse direct-current (DC) resistivity tomography is shown to be a useful method for permafrost monitoring in high mountain areas conducted by Hauck and Vonder Mühll (2003). In their study, a combination of radiation, snow cover and resistivity measurements seem promising for long-term monitoring programmes of the permafrost evolution at low cost. Ng, Springman and Alonso (2008) have used back-analysis in saturated soil engineering which can help to refine and improve understanding, providing guidance for future designs, where the effects of soils suction and hydraulic hysteresis are still being explored. Resistivity method is predominantly used in shallow subsurface investigation and it is non-destructive and non-invasive (Nordiana et al. 2011).

This time-lapse resistivity study was conducted at the same line but at different time. This is due to monitoring study of the slope. The length of study line is 20 m with 0.5 m electrode spacing. In this study, we have chosen an optimized array which is wenner-schlumberger array. RES2DINV software was used for inverting the apparent resistivity data to a resistivity model section.

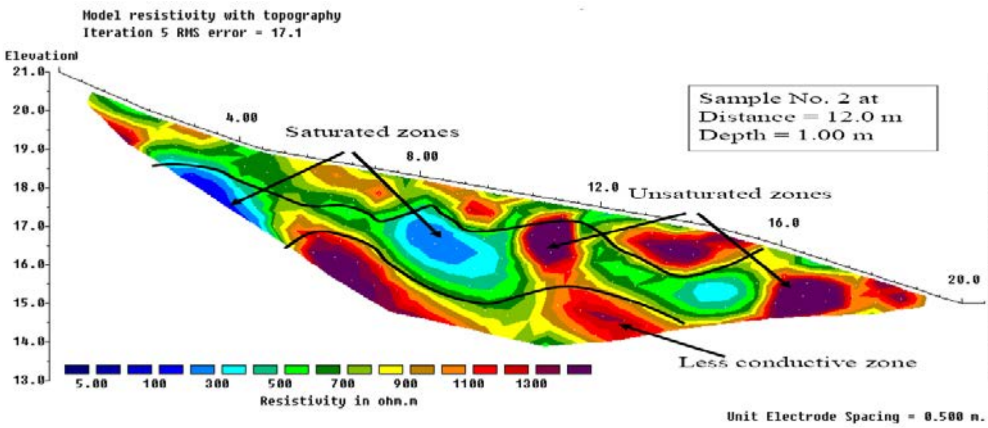

Figure 1: The 2-D electrical resistivity result for January's infield test.

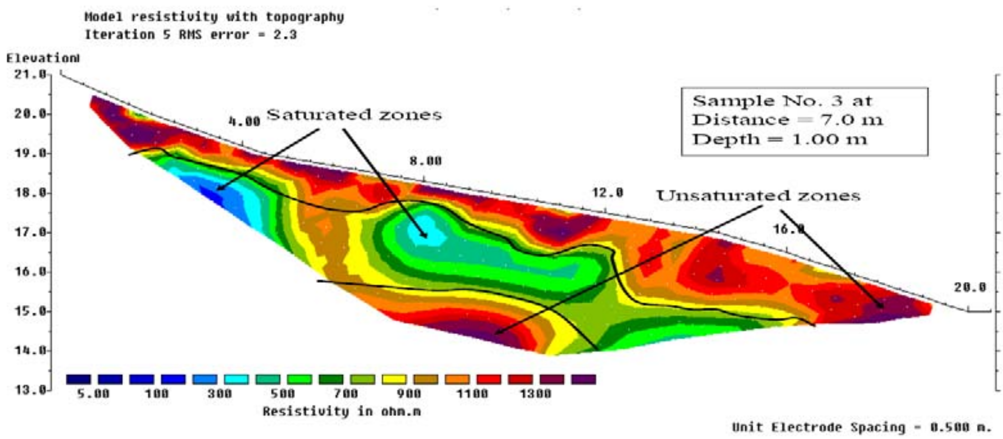

Figure 2: The 2-D electrical resistivity result for February's infield test.

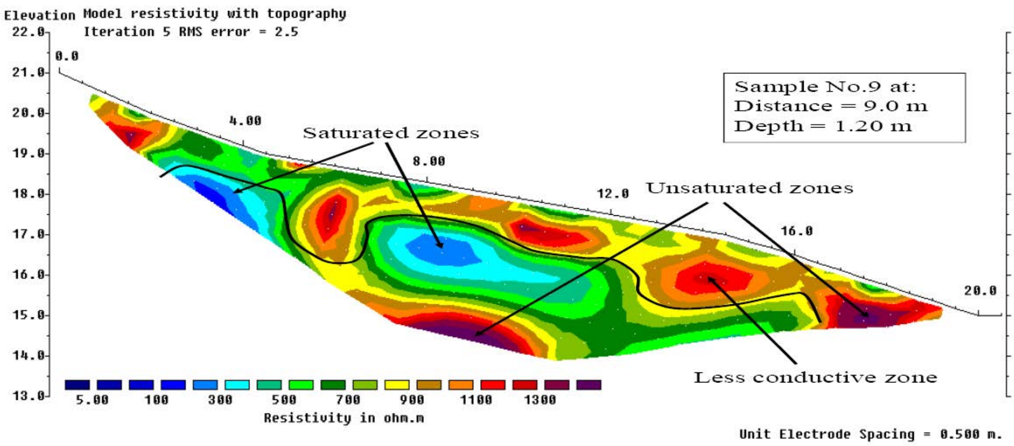

Figure 3: The 2-D electrical resistivity result for May's infield test.

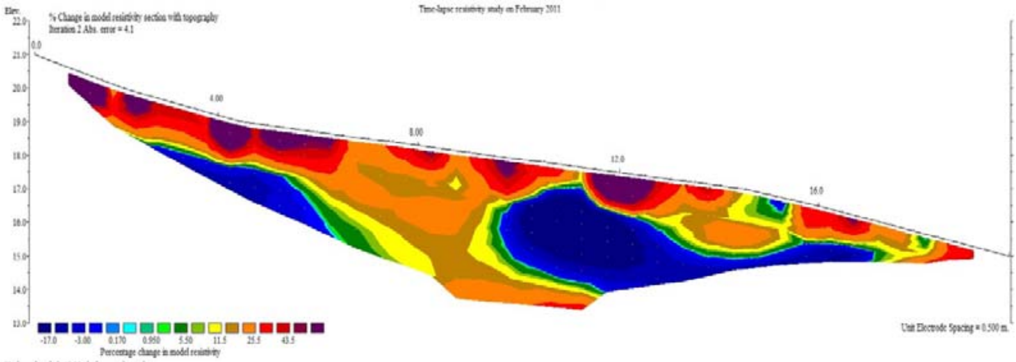

Figure 4: Time-lapse resistivity result for February 2011

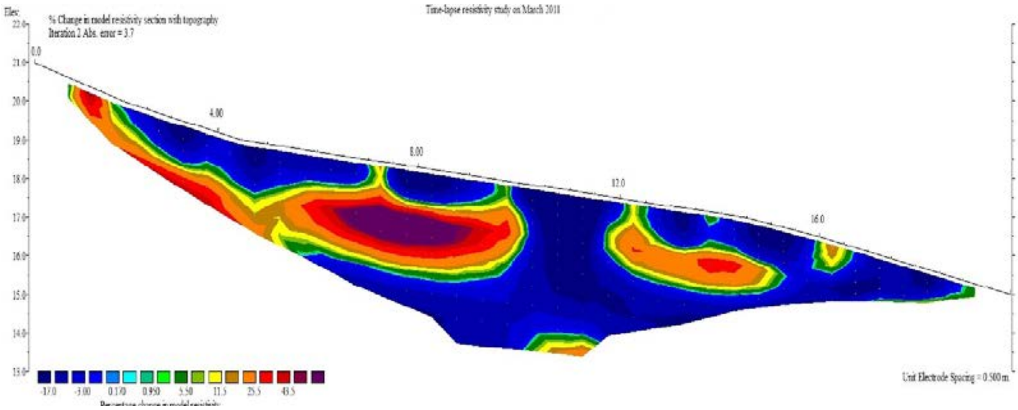

Figure 5: Time-lapse resistivity result for March 2011

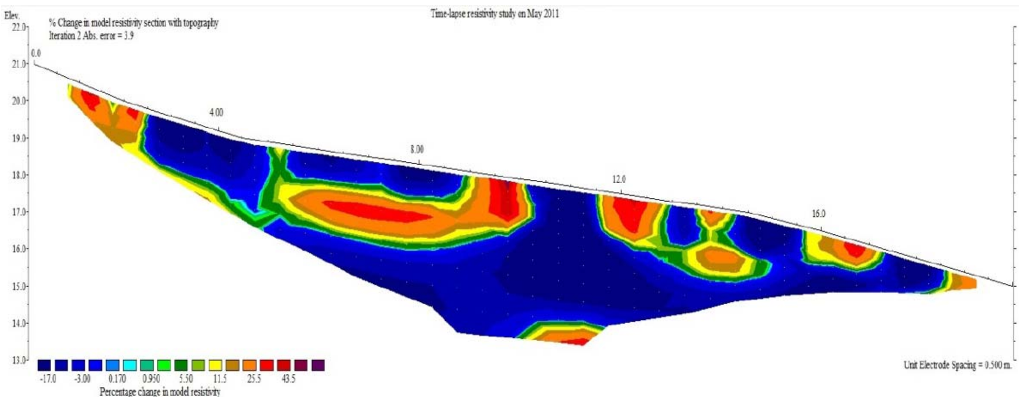

Figure 6: Time-lapse resistivity result for May 2011

RESULTS AND DISCUSSION

This study was conducted from February 2011 until May 2011. From January's infield test results (as reference data set), the resistivity result showed that the subsurface of the study area consisted of two main zones. Readings of less than 900 Ω.m was indicative of residual soils while reading greater than 1100 Ω.m was indicative of a weathered layer or unsaturated zone. Saturated zones (wet clayey sand) may be present with resistivity value of less than 300 Ω.m. The presence of saturated zones and unsaturated zones can be associated with loose zones and compacted soil (Figure 1).

Figure 2 showed the result of the February's infield test of subsurface conditions using the resistivity imaging method. The subsurface consisted of two main zones less where readings of less than 900 Ω.m indicated residual soils and readings greater than 1100 Ω.m indicated a weathered layer or unsaturated zone. Saturated zone represent in areas with resistivity value of less than 300 Ω.m.

Results for May's resistivity infield test below showed two main zones of the subsurface. The first zone with resistivity values of less than 900 Ω.m indicative of residual soils. The second zone which has resistivity values greater than 1100 Ω.m was indicative of weathered layer or unsaturated zones. Saturated zones are areas with resistivity values of less than 300 Ω.m as shown in Figure 3.

Time-lapse resistivity tomography results for February 2011, March 2012 and May 2011 were displayed Figure 4, Figure 5, and Figure 6. From the time-lapse resistivity results, it shows that the water is present in the subsurface especially during rainy season. It shows that the higher percentage change of model resistivity, the weaker the subsurface zone. This is cause by the rapid changes of subsurface due to change in water content. Meanwhile, zones with less or no percentage change in model resistivity indicate that the subsurface is compacted or unsaturated zones.

The empirical correlation between liquid limit (WL) and resistivity (ρ) represent as $W_L = -0.060\rho + 91.84$ with regression coefficient (R^2) at approximately 0.645. The empirical correlation between plastic limit (Wp) and resistivity (ρ) is $Wp = -0.018\rho + 45.89$ with regression coefficient (R^2) at approximately 0.133. Meanwhile, the empirical correlation between plasticity index (PI) and resistivity (ρ) is $PI = -0.041\rho + 45.95$ with regression coefficient (R^2) at approximately 0.473. These show that all these three parameters are inversely proportional to resistivity. The reason these relation found is the presence of water able to influence the resistivity value. A low resistivity indicates that clayey sand soil having high water amount (WL, Wp and PI) in clayey sand soil samples. The lower water presence in clayey sand soils, the slower transition from plastic to liquid state (Figure 7).

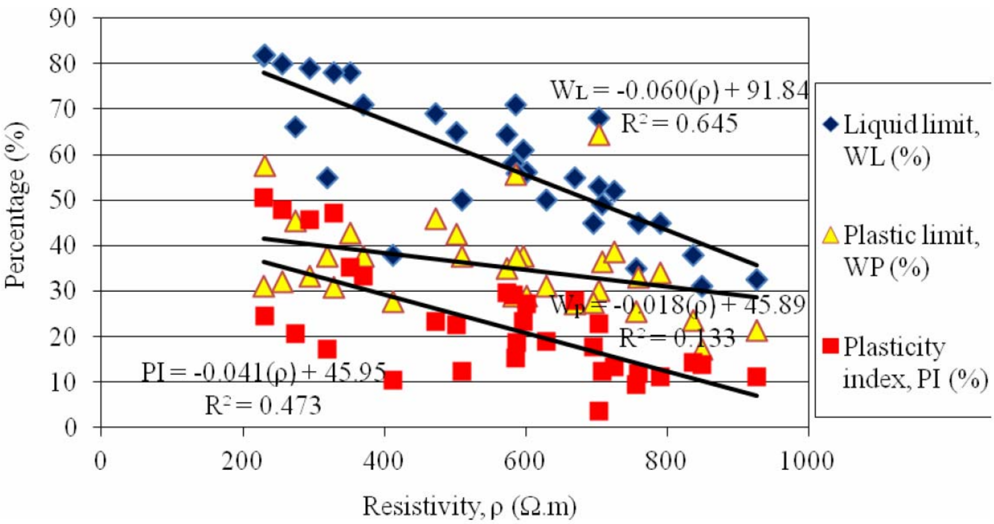

Figure 7: The empirical correlation between liquid limit (WL), plastic limit (Wp) and plasticity index (PI) with resistivity (ρ) of 32 clayey sand soil samples.

CONCLUSION

Although data collected using optimized arrays of wenner-schlumberger and pole-dipole did helped us to characterize the slope subsurface, the overall results using these two different arrays were quite compromising and remarkably significant for improve data acquisition technique. We conclude that despite the location, for most applications, the merging data levels using both wenner-schlumberger and pole-dipole arrays is successful in locate and give the actual changes of the slope subsurface condition at different period of monitoring study. The additional time and expense associated with merging data levels using these two different optimized arrays might be justified under exceptional circumstances where the target of interest is at the limit of the investigation depth or where limited access precludes using only one array. Moreover, this study is successful because this study is conducted at a low cost and provides reliable and acceptable slope subsurface information.

REFERENCES

Hauck, C and Vonder Mühll, D. 2003, Permafrost monitoring using time-lapse resistivity tomography, Permafrost (Philips, Springman and Arenson, eds), Swets and Zeitlinger, Lisse, pp. 361-3666. ISBN: 90 5809 5827

Moore, J.F.A. (1992). Monitoring building structures. Blackie and Son Ltd.

Ng, C.W.W, Springman, S.M. and Alonso, E.E. (2008). "Monitoring the permafrost of unsaturated soil slopes," Journal Geotechnical and Geological Engineering, Vol. 26, No.6, pp. 799-816.

Nordiana, M.M., Saad, R., Nawawi, M.N.M., Adiat, K.A.N., Ismail, N.A., Ismail, N.E.H. and Bery, A.A. (2011). "Assessing the efficacy of Enhancing Horizontal Resolution (HER) technique using 2D Resistivity Method," Electronic Journal of Geotechnical Engineering, Vol.16, Bund. R, pp. 1405-1413.

Wunderlich (2006) Geodatisches monitoring – Ein fruchtbares feld fur interdisziplinare Zusammen-arbeit, Vermessung and Geoinformation, 1+2/2006, pp. 50-62.

The Analysis of Slope Stability Due to Tree Induced Suction on Tropical Residual Soil

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This research was conducted to study the effect of matric suction related to slope stabilization on tropical residual soil slope located at Faculty of Electrical Engineering, University Teknologi Malaysia, Johor Bahru. The regional geology of this area consisting of intrusive igneous rock that occupied by granite batholiths and categorized as hornblende-bearing adamellite (Burton, 1973). This formation of rock, which part of the surface exposure is made up of included gabbros, intermediate igneous rock and various minor granitic bodies occurred since lower Triassic age. Between hornblende-bearing adamellite intrusive rock has occur, as there were some evidence of discontinuity in Jurong Formation as shown in Bukit Resam Clastic member with roof pendants of sedimentary rock origin seemed to be the upper Triassic to Jurassic age. The later formation was the Older Alluvium that laid down into the southern part of Johor which included Skudai and Johor Bahru. It is believed occur on Lower Pleistocene age, rests upon the older rocks with marked unconformity and in general is flat-lying. The Older Alluvium that is composed mainly of coarse feldspathic sand of igneous rock parentage, and is partly consolidated and well developed weathering profile where coarse cross-bedding is of fairly common occurrence. The deposits mainly comprise of semi-consolidated weathered coarse sand, sandy clay and gravel are well represented (Hutchison and Tan, 2009). To assessment on slope stability, hydrologic data (matric suction) were used in computer modelling. In this case, it appropriate to perform slope stability analyses which include the shear strength contributed by the matric suction (negative pore-water pressure). The limit equilibrium method of slices is widely used for its simplicity in assessing slope stability (Fredlund and Rahardjo, 1993). The factor of safety (FOS) is defined as that factor by which the shear strength of the soil must be reduced in order to bring the mass of soil into a state of limiting equilibrium along a selected slip surface. The equation (1) produced by Rees and Ali (2012) were used to calculate stability of a slope by performing divided the soil mass above the circular slip surface into vertical slices.

$$\text{FOS}=\frac{\sum c'\,lR + NR\tan\phi' + SRl\tan\phi^b}{\sum W_x} \qquad (1)$$

The field investigation works (trial pit) was carried out accordance to the British Standard Code of Practice BS 5930: 1999. The disturbed and undisturbed soil samples were collected from near the ground surface up to 1.5 m depth of the study area. The upper portion down to depth 0.5 m of the profile consists of residual soil, RS (Grade VI). Medium red with a little medium yellow mottled, sandy SILT soil of this layer was later classified according to British Soil Classification System (BSCS) as sandy SILT (MVS) with moist smooth-textured soil particles. The tropical residual soil can be categorized in Grade VI of the six-grade rock weathering classifications of International Society for Rock Mechanics, ISRM (1981) and British standard, BS 3950:1999. The study was carried out at slope with the existence of mature tropical tree Acacia mangium situated at latitude (+1°33' 32.03") and longitude (+103° 38' 38.04"). The tree was located at the toe of slope at Faculty of Electrical Engineering Universiti Teknologi Malaysia as shown in Figure 1. To develop soil matric suction profile, Jet-fill tensiometers were use (Figure 2a). The equipment was installed at the depth of 0.5m, 1.0m and 1.5m at slope (Figure 2b). The distance from tree for the insertion of tensiometer were measured according to 0.1h, 0.2h, 0.4h etc (where h is the height of the tree).

Figure 1 Acacia mangium tree located at the toe of slope

Figure 2 Field monitoring equipment (a) Tensiometer (b) Tensiometer installed at slope to measured matric suction

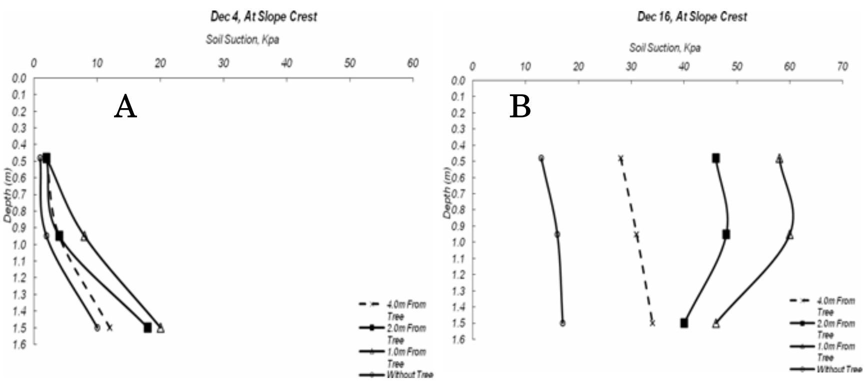

Figure 3 The matric suction profile influence by rainfall (A) Pattern A on 4th December 2011 (B) Pattern B on 16th December 2011

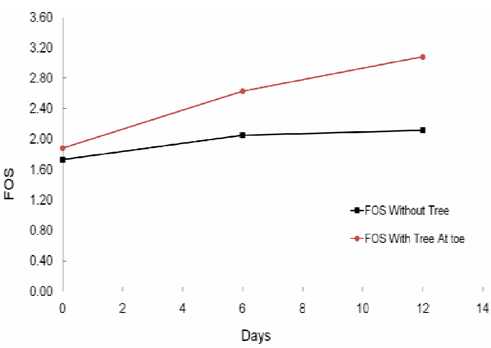

Figure 4 The variation of FOS in time due to tree induced suction

	Unsaturated Slope Without Tree	Unsaturated Slope With Tree at Toe	Percentage Different,(%) Unsaturated Slope With Tree at Toe
FOS on 4th December 2011	**1.73**	**1.88**	**8.84**
FOS on 16th December 2011	**2.12**	**3.08**	**45.54**

Table 1 Comparison of FOS on 4th and 16th December 2011, for slope with and without tree at toe

The matric suction profile distribution responded to several rainfall patterns in month of December 2011 was used to analysis and observation in certain interval of time. The isolation of data toward the monitoring of slope can be denoted as pattern A (Figure 3a), influenced by heavy rainfall and pattern B without rainfall (Figure 3b).

The comparison has been made on 4th and 16th December due to tree induced matric suction is show in Table 1.

It shows that FOS can rise up with various times in 12 days of this analysis, through out from the conditions of high intensity rainfall and without rainfall (Figure 4). This figure present the FOS varies with time and increases with matric suction in soil with and without tree at toe of slope.

Based on the finding on field monitoring result it is expected that the established of root water uptake is likely to happen after condition is high rainfall was occurred. A root tree zone could help to reinforce the soil by increasing matric suction related to enhance FOS. This study indicated that matric suction generated caused by the presence of mature tropical tree (Acacia mangium) at toe of the slope can readily increase the FOS against slope failure up to 45.54%.

REFERENCES

Fredlund, D.G. and Rahardjo, H. (1993). Soil Mechanic for unsaturated Soils. Canada: John Wiley & Sons, Inc, Printed Ltd.

Hutchison, C.S. and Tan, D.N.K., (2009). Geology Of Peninsular Malaysia. University of Malaya and Geological Society of Malaysia, Kuala Lumpur, 405.

Burton, C.K. (1973). Geology and Mineral Resources Johore Bahru-Kulai Area South Johore. Geological Survey of Malaysia, Ministry of Primary Industries Malaysia.

Rees, S.W. and Ali, N. (2012). Tree Induced Soil Suction And Slope Stability. Geomechanics and Geoengineering: An International Journal. Taylor & Francis Group, London, Uk. Vol. 7, No. 2, 103-113.

M. F. Ishak, N. Ali and A. Kassim (2013). The Effect Of Tree Induce Suction On Slope Stabilization Analysis. International Journal of Civil Engineering and Geo-Environment, Universiti Malaysia Pahang, No. 4.

BSI, (1999). Code of Practice for Site Investigations, (BS 5930). London: British Standards Institution.

ISRM (1981). Basic Geotechnical Description for Rock Masses. International Journal of Rock Mechanics, Mining Science and Geomechanics. 18: 85-110.

P011

Electrical Resistivity Survey For Slope Stability Study At Taman Desa Ampang, Selangor.

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An electrical resistivity survey has been carried out at Taman Desa Ampang, Selangor to identify the failure plane for further engineering work to strengthen the slope. Several resistivity survey lines have been carried out on the slope. Resistivity profiles were correlated with the existing borehole data for the interpretation. The soil properties are found to correlate well with the processed resistivity result. Different soil types or rocks display different resistivity values. Hence sub-surface soil may be identified by comparing the processed resistivity value with the standard value of known soil. With these identified soil or rock, the failure plane can be interpreted.

The result after the inversion model shows that the site is covered by alluvium (100 - 1,000 Ωm), shale (800 - 2,000 Ωm), harder sediments (2,000 - 5,000 Ωm) and boulder of granite (> 5,000 Ωm). Generally the top soil is covered by alluvium which consists of sandy SILT with approximately of maximum 5m depth. The top soil material is clarified by previous borehole data. Shale is expect to be underlain the top soil. There are several high resistivity value observed within the alluvium and shale layer. It is believed that this high resistivity value is link with granite boulders.

During prolonged heavy rainfall, water infiltrated through top layer soil into subsurface thus decrease the binding between soil and boulders. Possible water saturated alluvium also decrease the shear strength between the particles. When shear strength and friction of soil or rocks against slope failure exceed, burden such as soil (alluvium) and boulders may slide downhill.

REFERENCES:

Yin.E.H, 1976. Geological Map of Geology and Mineral Resources of Kuala Lumpur, Malaysia. Geological Survey Department. Map

B.K.Tan, 2006. Urban Geology of Kuala Lumpur and Ipoh, Malaysia. Journal of the Geological Society of London, paper number 24, 2006

W.H.Ting, 1985. Foundation in limestone areas of Malaysia. Special Lecture, Proc. 8th S.E.Asian Geotechnical Conf., Kuala Lumpur, vol. II, 124-136

Fahad Irfan Siddiqui & Syed Baharom Azhar, 2012. Integrating Geo-Electrical and Geotechnical Data for Soil Characterization. International Journal of Applied Physics and Mathematics, Vol 2, No. 2, 2012

Andy A.B, Rosli Saad & M.M.Muztaza, 2012. Geophysical and Geotechnical Engineering Assessment of Slope Stability and Clayey Sand Soil Behavior Analysis. Asia Pacific Conference on Environmental Science and Technology Advances in Biomedical Engineering, vol 6, 2012

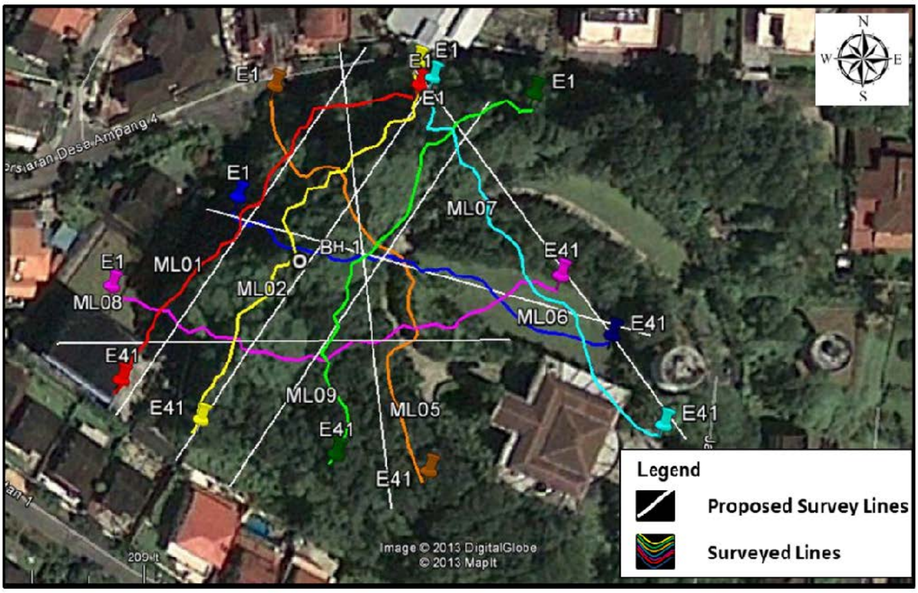

Figure 1: Map shows Resistivity survey track

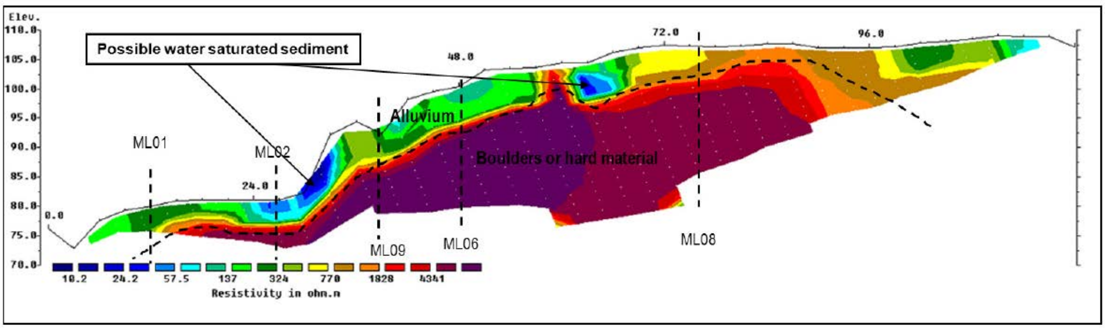

Figure 2: Resistivity survey Result for ML05

P026

Impact of Sea Level Rise to the Coastal Groundwater Resources at Kuala Terengganu, Terengganu.

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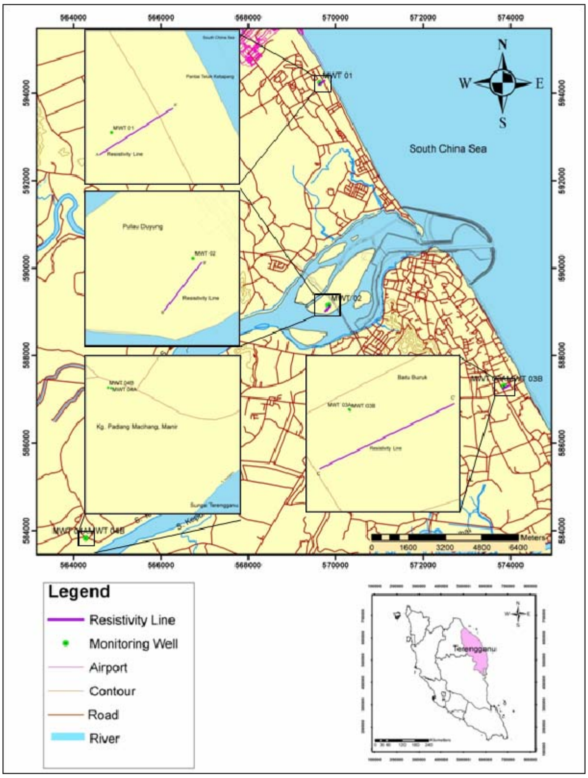

Figure 1: Location of monitoring wells and resistivity lines at Kuala Terengganu

Global warming and climatic changes have been identified as a main factor lead to sea level rise. Sea level rise will have profound effect by increasing flooding frequency and inundating low lying coastal area, and threatens the communities residing along them. Rising sea level also could increase the rate of erosion along the coast, and some beaches could disappear. Continued population growth in low-lying coastal regions will increase vulnerability as the effects of climate change become more pronounced. This study is carried out at the mouth of Terengganu River area in Kuala Terengganu, Terengganu with approximately 6 km radius. The study carried out is aim to assess the potential impact of sea level rise by locating the fresh water-saltwater interface and the current status of groundwater quality. In-situ groundwater quality measurement and geophysical analysis were employed in this study. Results revealed that the fresh water and saltwater interface has been identified. The finding of the study could be used to characterise the occurrence and movement of saline groundwater and to better understand linkages between groundwater and seawater, and therefore to enhance the sustainability of coastal groundwater resources.Generally, groundwater levels in the study area are heavily influenced by recharge from rainfall; at the same time, the aquifers in the coastal area typically exhibit strong influence of tidal fluctuation due to high hydraulic conductivities and direct hydraulic connection with the sea. Due to low hydraulic gradient as the area is flat, the potential of seawater intrusion threat is likely to be higher; particularly during periods of low recharge (drier month). The EC and resistivity survey data indicated that the impact of sea level rise due to climate change could lead to saltwater intrusion as the aquifer is hydraulically connected to the sea. The rising sea level would increase the head of the saline water and hence pushing the fresh/saline water interface further inland. Finding of the study also identified that area of Pulau Ketam (Pulau Duyung) has higher potential for seawater intrusion compared to other places as this area is surrounded by brackish river water with direct hydraulic connection with the aquifer. The dynamic nature of the saltwater interface needs to be investigated in-depth and the potential of seawater intrusion under different approaches should be assessed. To achieve this, a more in-depth study and analysis of seawater intrusion is required, involving the application of numerical modelling involving 3D dispersive image. To improve the confidence in the sustainable management of the groundwater resources with focus on impact of climate change, frequency of the monitoring at the higher-risk area typically at Pulau Ketam

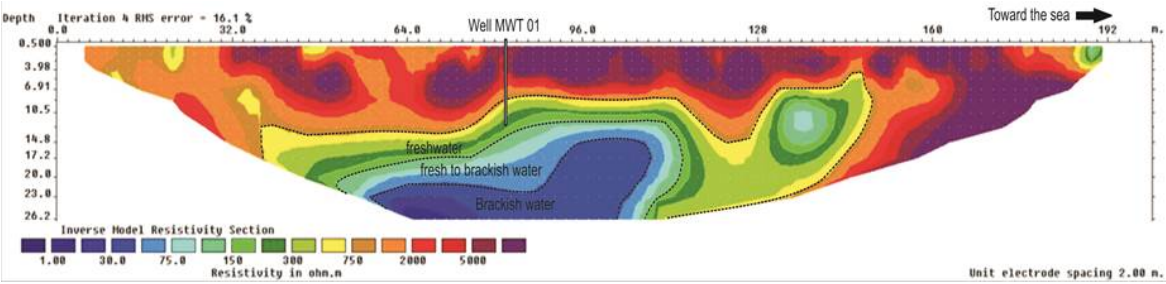

Figure 2: Resistivity profile at Kg. Teluk Ketapang area

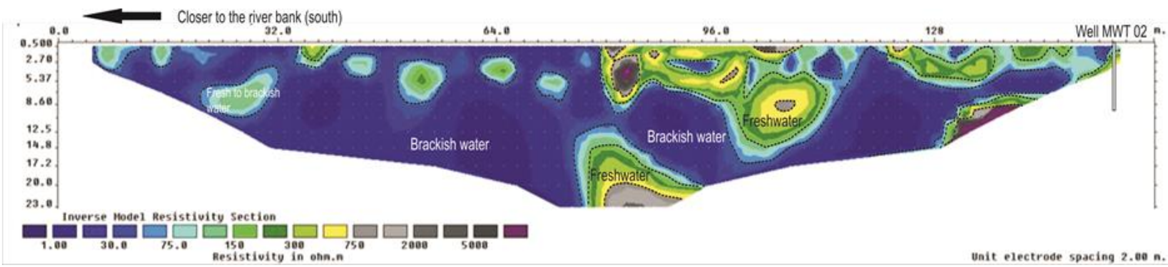

Figure 3: Resistivity profile at Kg. Pulau Ketam (Pulau Duyung) area

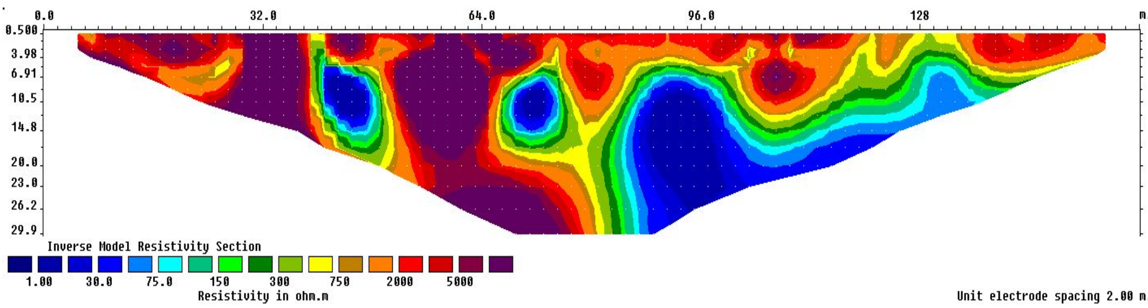

Figure 4: Resistivity profile at Batu Buruk area

(Pulau Duyung) should be increased, and the number and depth of monitoring wells increased. Screen installation should also be improved by lengthening the screen to cover the whole length of the monitoring wells so that the in-situ monitoring of the EC could give better picture of the position of the interface of the fresh/saline water. There is a need for an improved understanding of the movement of the fresh/saline water interface over time and ensure protection of these crucial groundwater resources for their long term sustainability.

REFERENCE

Ang, N. K. and Otto, T., (1997). Hydrogeological Investigations Kuala Terengganu. Geological Survey of Malaysia. Jabatan Penyiasatan Kajibumi Malaysia, 6p.

Barlow, P. M., (2003). Groundwater in Freshwater-Saltwater Environments of the Atlantic Coast. U.S. Geological Survey, Circular 1262, 113p.

Cooper, M. J. P., Beevers, M. D., and Oppenheimer, M., (2008). The potential impacts of sea level rise on the coastal region of New Jersey, USA. Clim Change, 90, p475–492.

Department of Statistics Malaysia, (2010). Population Distribution by Local Authority Areas and Mukims, Department of Statistics Malaysia, 473p.

Gregory, J. M., Church, J. A., Boer, G. J., Dixon, KW, Flato, G. M., Jacket,t D. R., Lowe J. A., O'Farrell, S. P., Roeckner E., Russell, G. L., Stouffer, R. J. and Winton, M., (2001). Comparison of results from several AOGCMs for global and regional sea-level change 1900-2100. Clim Dyn 18, p225–240.

Intergovernmental Panel on Climate Change (IPCC), (2007). Climate change 2007: Synthesis Report. IPCC, Geneva, 52p.

Hem, J. D., (1970). Study and interpretation of the chemical characteristics of natural water, U.S. Geological Survey Water-Supply Paper 1473, 363p.

Jeftic, L., Kecke,. S. and Pernetta, J. C., (1996). Implications of future climatic changes for the Mediterranean coastal region. In Climate change and the Mediterranean, Edward Arnold, London, 2, p1-25.

Lokman, H.M., Rosnan,Y. and Shahbudin, S. (1995). Beach Erosion Variability during a Northeast Monsoon: The Kuala Setiu Coastline, Terengganu, Malaysia. Pertanika J. Sci. & Technol.Vol. 3 No. 2, 1995, p337-348.

MBH Engineering System, 2008. A Practical Guide to Conductivity Measurement. Available from http://www.mbhes.com/conductivity_measurement.htm.

Perera, E. D. P., Jinno, K., Tsutsumi, A. and Hiroshiro, Y., (2008). Simulation of saltwater intrusion caused electric conductivity fluctuations due to groundwater pumping in a coastal aquifer. In Advance in Geoscience, Volume 17, Hydrological Science, p1582-1588.

Rosnan, Y., Hussein, M.L. and Tajuddin, A. (1995). Variation of Beach Sand in relation to Littoral Drift Direction along the Kuala Terengganu Coast. Geol. Soc. Malaysia, Bulletin 58, December 1995, p71-78.

Schölzel, H. and Ricci, G., 1998. Assessment of Water Resources Manono Island, Samoa. SOPAC Technical Report 255, 38p.

Sundaram, B., Feitz, A., Caritat, P. de, Plazinska, A., Brodie, R., Coram, J. and Ransley, T., (2009). Groundwater Sampling and Analysis - A Field Guide. Geoscience Australia, Record 2009/27, 95p.

Ward, J. D., Werner A. D. and Howe, B., (2009). Saltwater Intrusion in Southern Eyre Peninsula, 56p.

P047

A Late Pleistocene Terrace and River Capture in the Kampung Air Jernih Area, Terengganu Darul Ehsan, Malaysia

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Narrow to broad stretches of flat to gently undulating terrain underlain by sandy to pebbly, braided river deposits (some 3 to 5 m thick) mark a late Pleistocene terrace in the Kampung Air Jernih area. The terrace is located some 10 to 12 m above sea-level with the alluvial sediments overlying weathered granitic and meta-sedimentary bedrock. To the west, the study area is bounded by hilly terrain over granite rising to over 200 m above sea-level, whilst to the north and east, it is bordered by hilly terrain over meta-sedimentary bedrock (Sg. Perlis Beds) rising to some 150 m above sea-level.

Three main rivers are found in the study area; Sungai Air Jernih and Sungai Payuh draining the west, central and southeast sectors and flowing south towards Sungai Kemaman, whilst Sungai Tumpat drains the northeast sector and flows eastwards via Sungai Kemasik directly into the South China Sea. The floodplains of these rivers (located some 7 to 8 m above sea-level) are incised into the late Pleistocene terrace and overlie about 2 to 8.5 m of grey, soft, silty to sandy clays, or loose sands, with abundant organic matter; these sediments deposited during the global rise in sea-level after the last glacial maximum (LGM) at ≈22,000 years BP.

Broad terrace remnants and braided river deposits indicate that the late Pleistocene terrace was formed at a time when the main rivers of the study area all flowed in a north south-direction towards Sungai Kemaman. Correlation with published data on late Pleistocene sea-levels and oxygen isotope stratigraphy indicate that headward erosion by Sungai Kemasik from ≈122,000 to ≈22,000 years BP (during the drop in global sea-level associated with establishment of the last major glacial phase in higher latitudes) led to capture of the headwaters of the then north-south flowing Sunai Tumpat. The braided river deposits forming the late Pleistocene terrace are therefore, likely to have been deposited from ≈145,000 to 122,000 years BP during the rise in global sea-level prior to establishment of the last major glacial phase.

The following denudational chronology is therefore, proposed for the development of landforms in the Kampung Air Jernih area (Table 1)

Table 1: Denudational chronology for development of landforms in the Kampung Air Jernih area.

Years BP	Geomorphological Events
≈240,000 - ≈145,000	Drop in global sea-level with establishment of second last major glacial phase in higher latitudes. Study area sub-aerially exposed with north-south flowing braided rivers under a more seasonal climate. Weathering of bedrock & development of weathering profiles in study area..
≈145,000 - ≈122,000	Global rise in sea-level to ≈6 m above present level. Aggradation by north-south flowing braided rivers in the study area. Upper surface of aggradation forms late Pleistocene terrace surface.
≈122,000 - ≈22,000 (Last Glacial Maximum)	Drop in global sea-level to ≈120m below present level with establish-ment of last major glacial phase in higher latitudes. Linear erosion by rivers in the study area leading to isolation of late Pleistocene terrace remnants. Headward erosion by Sg. Kemasik from the east and capture of the headwaters of Sg. Tumpat.
≈22,000 to ≈4,500	Global rise in sea-level to ≈4.5 m above sea-level. Aggradation by rivers in the study area with deposition of the sediments underlying the present-day floodplains.
≈4,500 to present-day	Gradual drop in sea-level to the present level with incision of rivers into their floodplains in the study area.

P054

Late Upper Oligocene to Lower Miocene Planktic Foraminifera from the Temburong Formation, Tenom, Sabah

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INTRODUCTION

The Temburong Formation firsly introduced by Brondijk (1962) and then revised by Wilson and Wong (1964). This formation is dominantly argillaceous, characterized by rhythmic repetition of siltstone and shale, and some rare lenticles of limestone. The formation is remarkably uniform in lithology, being mainly a flysch deposit, with common intercalations of slightly calcareous pelagic shale (Hutchison, 2005). Wilson (1964) has described some turbidite sedimentary structures in the siltstones, such as graded bedding and flute and groove casts which can be seen in the eastern Brunei and south of Beaufort, Sabah. Over two decade several studies have been conducted on the Temburong Formation and can be concluded that this formation has been deposited in deep marine environment by weak turbidity currents as a flysch deposits (Wilson, 1964; Tate, 1994; Mazlan Madon, 1997). The age of the formation ranges from Oligocene to Lower Miocene based on planktic foraminiferal assemblage (Wilson, 1964). Ever since there are no significant paleontological study has been conducted.

Planktic foraminifers recovered from one outcrop of the Temburong Formation exposed at Paal River, Tenom, southwest of Sabah. The outcrop consists of dominantly thick shale and interbeded with thin siltstone. The vertical sequence of the beds is coarsening upwards and having less turbidite structure. This rock sequence is interpreted as a distal lobe of a deep-sea fan environment. The objective of this researcher is to identify the planktic foraminifera and their significance in age determination.

MATERIAL AND METHOD

Two samples of shale (TF0101 and TF0102) have been collected at an outcrop exposed at Paal River, in Tenom area, southwest of Sabah. The thickness of shale bed is 10 metres. The samples are crushed into small size (1-2 cm) and then boiled with distil water and sodium bicarbonate (Na2CO3) for several hours. After that the samples were washed and sieved and then dried. Foraminifera were pick and analysed by binocular microscope (Amrstrong & Brasier, 2005). Well-preserved specimens of planktic foraminifera were photographed by scanning electron microscope (SEM).

RESULT AND DISCUSSION

The shale beds display poorly preserved foraminiferal assemblages. However some of them are still identifiable. A total of eleven planktic foraminiferal species have been identified from two samples (TF0101 and TF0102). The foraminiferal assemblage is composed of Catapsydrax unicavus Bolli, Loeblich, and Tappan, Catapsydrax dissimilis Cushman and Bermudez, Globigerina praebulloides Blow, Globoquadrina venezuelana (Hedberg), Globigerina ciperoensis Bolli, Globigerina eamesi Blow, Globigerina primordius Blow, Globigerinoides triloba (Reuss), Globigerina (Zeaglobigerina) connecta Jenkins, Globorotalia (Jenkinsella) bella Jenkins, Praeorbulina sicana (De Stefani). The classification and stratigraphic distribution of foraminiferal species are based on Stainforth et al. (1975), Kennett and Srinivasan (1983), and Bolli and Saunders (1985). The foraminifera assemblage was comparable with foraminifera zones by Berggren et al. (1995). It shows that the age of the shale unit of Temburong Formation range from Chattian of late Upper Oligocene (P22-Globigerina ciperoensis Zone) to Burdigalian of late Lower Miocene (M4-Catapsydrax dissimilis-Praeorbulina sicana Zone) Figure 1.

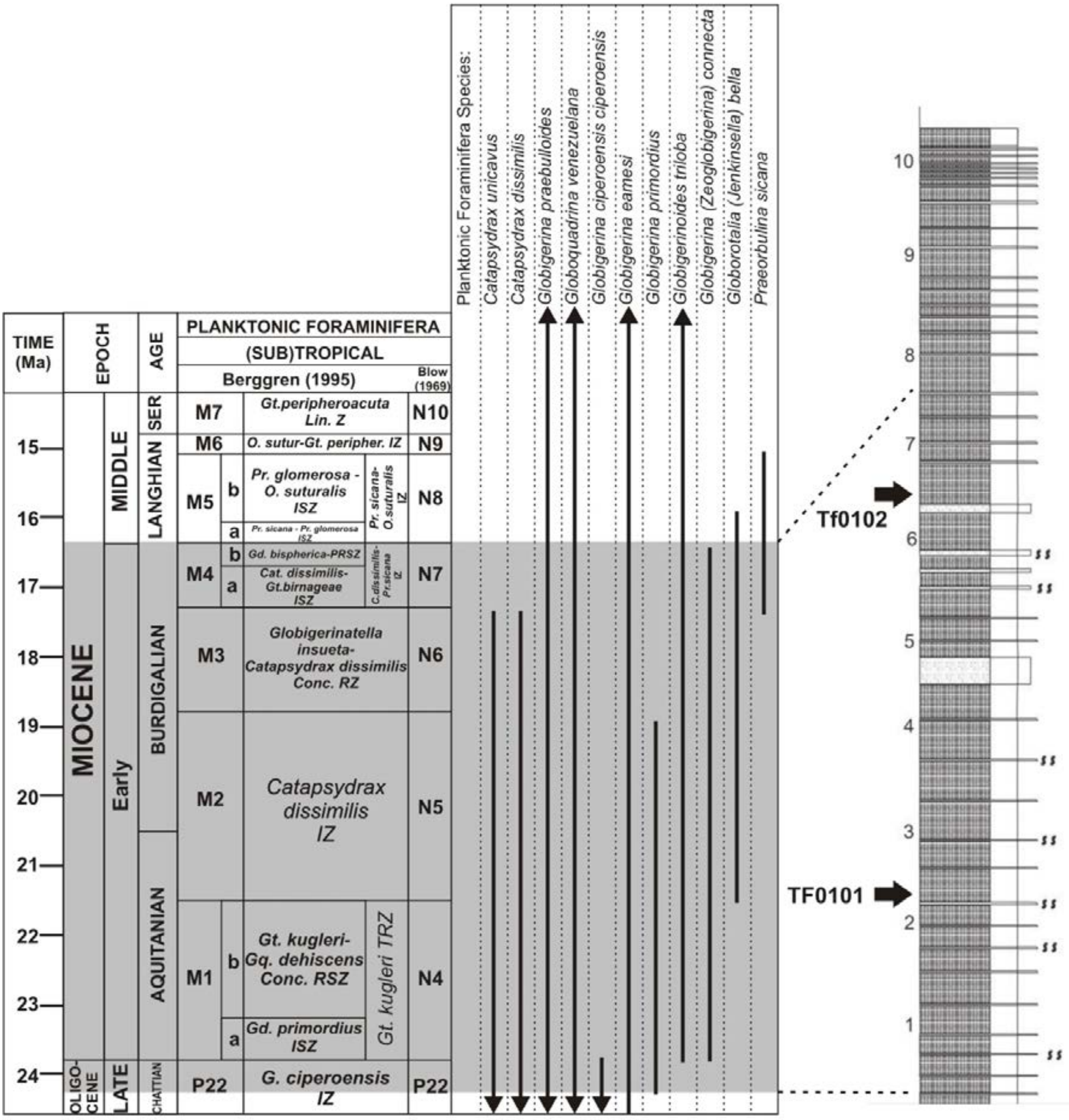

Figure 1 Stratigraphic distribution of planktic foraminifera and foraminifera zones proposed by Berggren et. al. (1995) and Blow (1969).

CONCLUSION

The shale unit of Temburong Formation from Sg. Paal Tenom was interpreted as a distal lobe of a deep-sea fan environment. The shale unit contains planktic foraminifera which an age ranges from Late Upper Oligocene to late Lower Miocene (Chattian to Burdigalian).

REFERENCE

Armstrong H.A. & Brasier M.D., 2005. Microfossils. 2nd edition. United Kingdom. Blackwell Publishing.

Berggren, W.A., Kent, D.V., Swisher III, C.C., Aubry, M.-P., 1995. A revised Cenozoic geochronology and chronostratigraphy In: Berggren, W.A., Kent, D.V., Aubry, M.-P., Hardenbol, J. (Eds.), Geochronology, Time Scales and Global Stratigraphic Correlation: A United Temporal Framework for an Historical Geology: SEPM Spec. Publ. 54. 129-212.

Bolli, H. M. & Saunders, J. B., 1985. Oligocene to Holocene low latitude planktic foraminifera, In: Bolli, H. M., Saunders, J. B., and Perch-Nilsen, K., eds., Plankton Stratigraphy. Cambridge. Cambridge University Press. 155-262.

Brondijk, J.E., 1962. Reclassification of part of the Setap Shale Formation as Temburong Formation. British Borneo Geological Survey Annual Report for 1962. 56-60.

Hutchison, C.S., 2005. Geology of North-West Borneo (Sarawak, Brunei and Sabah). Amsterdam. Elsevier.

Mazlan Madon, 1997. Sedimentological aspects of the Temburong and Belait Formations, Labuan (offshore west Sabah, Malaysia). Geol. Soc. Malay. Bull. 41. 61-84.

Kennett, J. P. & Srinivasan, M., 1983. Neogene Planktonic Foraminifera: A Phylogenetic Atlas. Stroudsburg. Hutchinson Ross Publishing Co. p 265

Stainforth, R. M., Lamb, J. L., Luterbacher, H., Beard, J. H., & Jeffords, R. M., 1975. Cenozoic planktonic foraminifera zonation and characteristics of index forms. Lawrence. University of Kansas Paleontological Contributions. 62. p. 1-425

Tate, R. B. 1994. The sedimentology and tectonics of the Temburong Formation – deformation of early Cenozoic deltaic sequence in NW Borneo. Geol. Soc. Malay. Bull. 35. 97-112.

P055

Modern Benthic Foraminifera of Kelantan Delta Mangroves, Tumpat, Malaysia and their Environmental Controls for Future Research in Sea-Level Studies

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Modern foraminiferal samples and associated environmental information were collected from three sites in Kelantan Delta mangroves, Tumpat, to elucidate the relationship of the foraminiferal assemblages with elevation and environment. Altogether, 33 surface sediment samples were collected from three different transects. As a result, 23 benthic foraminiferal species were recorded and dominated by agglutinated species. These foraminifera belong to two suborders (Textulariina and Rotaliina), seven families (Acupeinidae, Ammodiscidae, Lituolidae, Rzehakinidae, Saccamminidae, Trochamminidae, and Amphisteginidae), and 16 genera (*Acupeina, Ammodiscus, Ammoastuta, Ammobaculites, Ammotium, Haplophragmoides, Miliammina, Pseudothurammina, Arenoparrella, Caronia, Jadammina, Paratrochammina, Siphotrochammina, Tiphotrocha, Trochammina,* and *Amphistegina*). Environmental variables include porewater salinity and pH, total organic carbon (TOC) content, grain size, vegetation, and elevation level above Mean Sea Level (MSL). The foraminiferal assemblages indicated that a vertical zonation of foraminifera does occur. We used Canonical Correspondence Analysis (CCA) and Redundancy Analysis (RDA) to support the hypothesis that the distribution of foraminifera in the intertidal zone is a direct function of elevation, and the duration and frequency of inundation as the most important factors. Monte Carlo permutation test suggest significant relationship between foraminiferal community and their environment (p value = 0.002), with elevation level and porewater salinity and pH being the most significant factors.

KEYWORDS: foraminifera, mangrove, Kelantan Delta, species-environment relationship, vertical zonation, sea-level

REFERENCES

de Rijk, S., and Troelstra, S. R. 1997. Salt marsh foraminifera from the Great Marshes, Massachusetts: environmental controls. *Palaeogeography, Palaeoclimatology, Palaeoecology* 130:81-112.

Horton, B. P., and Culver S. J. 2008. Modern intertidal foraminifera of the Outer Banks, North Carolina, U.S.A., and their applicability for sea-level studies. *Journal of Coastal Research* 24(5):1110-1125.

Horton, B. P., Larcombe, P., Woodroffe, S. A., Whittaker, J. E., Wright, M. R., Wynn, C. 2003. Contemporary foraminiferal distributions of a mangrove environment, Great Barrier Reef coastline, Australia: implications for sea-level reconstructions. *Marine Geology* 198:225-243.

Wilson, B., Miller, K., Thomas, A., Cooke, N., Ramsingh, R. 2008. Foraminifera in the mangal at the Caroni swamp, Trinidad: Diversity, population structure and relation to sea level. *Journal of Foraminiferal Research* 38(2):127-136.

P063

Review of Foraminiferal Studies in Nearshore Areas, Peninsular Malaysia.

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Benthic foraminifera occupy all marine habitats including marginal environment (such as lagoons, estuaries, mangroves and salt marshes), coastal waters and deep sea. Because they have calcareous or agglutinated tests, benthic foraminifera tend to be preserved in the sedimentary record. Due to their widespread distribution, short life and reproductive cycles, high diversity, and specific ecological requirements, foraminifera are sensitive to environmental gradients. Hence, foraminifera are good environmental indicators of various marine and transitional marine settings. Here, we review previous research on benthic foraminifera along the Peninsular Malaysia coast, summarize the status of ongoing research, identify gaps and suggest direction for future studies. This review is important because it thoroughly summarizes the current status of foraminiferal work in Malaysia which may help avoid the repetition of work and guide future researchers. Bibliography of foraminiferal studies is highlighted in this paper. So far, only a limited number of studies have considered recent benthic foraminifera in nearshore areas along the Malaysia peninsula. For the last 50 years (1960's – 2010's) there have been < 10 published foraminiferal studies in Malaysia. Most of these studies focus more on foraminiferal distribution and less on their application. Close analysis of published literature on recent foraminiferal studies along the west coasts and east coasts are summarized in Table 1. The analysis indicates that out of nine published papers, five studies were conducted on the east coast of Peninsular Malaysia. Four were published on the distribution of recent benthic foraminifera along the west coast. Most of these studies have been carried out in mangroves and estuarine environments. Only two studies focused on subtidal foraminifera.

TAXONOMIC AND ECOLOGICAL STUDIES

Studies along the east coast by Mohamed and others (2008) discussed the decrease in distribution of agglutinated foraminifera from upper intertidal towards shallow marine settings. Culver et al. (2012) recognized the association of foraminiferal distribution with salinity gradient in a NE Peninsular Malaysia intertidal mangrove system. Husain and others (2007) observed the vertical distribution of foraminifera in the Matang and Kapar mangroves along the west coast of the peninsula. This study indicated that the upper intertidal mangrove areas were dominated by agglutinated foraminifera *Haplophragmoides wilberti* and *Arenoparrella mexicana*while areas with more marine influence favored calcareous forms (Husain and others, 2007). Study of *Miliammina fusca* from the Pahang, Kelang and Sedili Besar deltas showed that distribution is closely related to salinity (Hassan and others, 2012). Minhat and others (2013) demonstrated that subtidal foraminifera around the coastal waters of Penang Island were composed of a mix of calcareous and agglutinated forms.

STUDIES ON FORAMINIFERAL APPLICATION

Researchers utilize modern foraminiferal assemblages and their habitat associations as analogues for fossil assemblages and interpreting depositional environments in sedimentary sequences. Study of foraminiferal biofacies along the Sedili River in Johor by Hughes (2007) recognized the potential use of foraminifera to determine the paleoenvironment. Hawkes and others (2007) recognized the potential for using foraminifera to estimate sediment source and wave characteristics based on pre and post 2004 Indian Ocean Tsunami samples from NW Peninsular Malaysia. Benthic foraminifera offer accurate zonation that enables us to detect even small sea-level changes. Culver and others (2013) found that the mangrove foraminiferal assemblages are good candidates for sea-level interpretation based on down-core mangrove assemblages. Foraminifera are highly utilised as proxy for anthropogenic pollution. Minhat and others (2014) acknowledged the potential use of subtidal foraminifera to gauge pollution impact.

No.	Authors	Years	Area	Remarks
1.	Mohamed et al.	2005	Sedili River, Johor	Agglutinated foraminifera assemblages and distribution from Sedili River, estuary and offshore area was studied. Zonation of foraminifera according to their ecological preference was observed.
2.	WynApGwilym Hughes	2007	Sedili River, Johor	The study recognized the significant of biofacies application to determine the paleoenvironment. In area where there is a normal marine influence, the distribution of foraminifera supports the mixed calcareous assemblages. The lower estuarine area supports a diverse agglutinated foraminiferal assemblage. Meanwhile the upper estuarine support lower diversity of agglutinated foraminifera.
3.	Hwakes et al.	2007	Sungai Burong, Penang and Kuala Teriang, Langkawi.	The study observed the foraminiferal assemblages to characterize pre-tsunami and tsunami sediment from the Indian Ocean Tsunami along the Malaysia–Thailand Peninsula. The foraminiferal zones identified help provide estimates of sediment source and wave characteristic.
4.	Husain et al.	2007	Kapar and Matang, Perak	This study looks at the distribution vertical distribution of foraminifera near coastal plain in Kapar and mangroves in Matang. The foraminifera distribution in brackish intertidal environment dominated by calcareous assemblages. Meanwhile, *Haplophragmoides wilberti* and *Arenoparrella mexicana* dominated the uppermost intertidal environment in Matang.
5.	Hasan et al.	2012	Kelang Delta, Pahang Delta and SediliBesar Rivers	The authors look at the distribution of *Miliammina fusca*in brackish water. This study indicated that *M. fusca* is highly related to salinity and sedimentary facies.
6.	Culver et al.	2012	Setiu estuary and lagoon, Terengganu.	This manuscript discuss on the distribution of foraminifera in estuary-lagoon setting in comparison to environmental variables. Five biofacies was recognized which pertaining to salinity.
7.	Culver et al.	2013	Setiu wetland, Terengganu	The study observed the downcore distribution of dead foraminifera in mangrove settings of the Setiu wetland. This study is looking at the application of foraminifera in sea-level study.
8.	Minhat et al.	2013	Northwestern Penang Island	The study observed the distribution of shallow coastal water foraminiferal assemblages. The assemblages were mixture of calcareous and agglutinated foraminifera. Salinity and other environmental gradient are almost has little variation along the transect. Hence do not influence the foraminiferal assemblages.
9.	Minhat et al.	2014	Northwestern Penang Island	This study recognized the potential use of subtidal foraminifera as pollution indicator. The spatial distributions of foraminifera indicate the sedimentary characteristic and changes due to anthropogenic activities.

Table 1: Summary on published literature on recent nearshore foraminifera study along Peninsular Malaysia

Despite extensive study of foraminifera elsewhere in the world, the study of recent foraminifera in Malaysia has received relatively little attention. The shortage of baseline data on foraminiferal distribution makes the attempt to compare and apply foraminifera in sea-level, paleoenvironment and pollution study harder. So far no published literature has been found on laboratory study using live foraminifera. Some of the major causes to these problems could be due to the size of the foraminifera which make it hard to study, the lack of regional taxonomist and the high costs to sample further from intertidal area.

REFERENCES

Culver, S. J., Leorri, E., Corbett, D. R., Mallinson, D. J., Shazili, N. A. M., Mohammad, M. N., Parham, P. R. and Yaacob, R. (2013). Infaunal Mangrove Swamp Foraminifera in the Setiu Wetland, Terengganu, Malaysia. Journal of Foraminiferal Research, 43: 262-279.

Culver, S. J., Mallinson, D. J., Corbett, D. R., Leorri, E., Rouf, A. A., Shazili, N. A. M., Yaacob, R., Whittaker, J. E., Buzas, M. A. & Parham, P. R. (2012). Distribution of Foraminifera in the Setiu Estuary and Lagoon, Terengganu, Malaysia. Journal of Foraminiferal Research, 42:109-133.

Hasan, S. S., Mohamed, M., Muhsin, N. and Jirin, S. (2012).The distribution of Miliamminafusca in three different environmental settings of Malay Peninsular, Malaysia. In: Alegret, L., Ortiz, S. and Kaminski, M.A. (eds), 2012. Ninth International Workshop on Agglutinated Foraminifera. Grzybowski Foundation Special Publication, 18: 38.

Hawkes, A. D., Bird, M., Cowie, S. Grundy-Warr, C., Horton, P., Hwai, A. T. S., Law, L., Macgregor, C. Nott, J., Ong, J. E., Rigg, J., Robinson, R., Tan-Mullins, M., Sa, T. T., Yasin, Z. and Aik, L. W. (2007). Sediments deposited by the 2004 Indian Ocean tsunami along the Malaysia-Thailand Peninsula Quaternary land-ocean interactions; sea-level change, sediments and tsunami. Marine Geology, 242: 169-190.

Hughes, G. W. A. G. (2007). Recent brackish Foraminifera and thecamoebae from Sedili River, West Malaysia.In: Kaminski, M.A. and Coccioni,R. (eds.), Proceedings of the seventh international workshop on agglutinated foraminifera. Grzybowski Foundation Special Publication, 13: 41- 45.

Husain, M. L., Satyanarayana, B., and Ibrahim, R. (2007).Down-core variations of foraminiferal distribution in the mangrove sediments of Kapar and Matang, West Coast of peninsular Malaysia.Journal of Sustainability Science and Management.2 (2): 38-54.

Minhat, F. I., Yahya, K., Talib, A. and Ahmad, O. (2013). A survey of benthic foraminiferal assemblages in tropical coastal water of Penang, Malaysia. Tropical Life Sciences Research, 24(1): 35–43.

Minhat, F. I., Yahya, K., Talib, A. and Ahmad, O. (2014). Benthic foraminiferal distributions as bioindicators in coastal waters of Penang National Park, Malaysia. Journal of Foraminiferal Research, 44 (2): 143-150.

Mohamed, M., Hasan, S. S., Yakzan, A. M. and Jirin, S. (2008). Agglutinated foraminiferal trends and assemblages of the SediliBesar River and its offshore area, Southeastern Peninsular Malaysia. In: Filipescu, S. and Kaminski M.A. (eds), 2008. Eighth International Workshop on Agglutinated Foraminifera, Grzybowski Foundation Special Publication, 14: 35.

P068

Geological Indicators of Sea-Level Changes at Northern Sabah, Malaysia: Tools for Instilling Public Awareness on Global Climate Changes

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Since the Last Glacial Maximum (LGM) about 21,000 to 19,000 years BP, the Earth has seen global sea-level rise by approximately 120 meters to reach its current level. In the Peninsular Malaysia, the sea-level rose during the Holocene Marine Transgression to about 5 meters above the present level some 5,000 years BP before falling and stabilizing to its present level (Tjia, 1996). This last sea transgression and regression and the associated erosion and depositional processes have resulted in the coastal geomorphology that is seen today. Study at Northern Sabah shows evidence of geological indicators of sea-level changes preserved on the coastal areas (Muda, 2009). The geological features are found on remnant cliffs, remnant islands, shore platforms and raised beach deposits. They have high scientific value and as such they comprise the geological heritage of the area. They are found at Batu Kuala Tajau, Batu Panjang, Tanjung Simpang Mengayau, Pulau Kalampunian, Tindakon and Sikuati (Figure 1, Photo 1 and 2). The ancient sea-level indicates height of several meters above the present sea-level. However, a proper and detailed study needs to be carried out in order to determine the meaningful historical sea-level changes to take into account the tectonic uplift in the area. Several of the sites are easily accessible, therefore they could be used as field education sites to educate and create awareness among the public on global climate changes due to global warming currently affecting the Earth. Sea-level changes throughout the Earth history provide considerable insight into the past tectonic and climatic history of the Earth. The catastrophic impact of global climate changes is the rise of global sea-level. Among others, the potential environmental and socio-economic effects include flood risk and submergence, salinisation of surface and ground waters, tidal inundation, shoreline erosion, loss of agricultural and fisheries production and damage to coastal infrastructure (Moste, 2000; Nicholls, 2003). Besides the scientific value, some of the sea-level geological indicators in the area have aesthetic, recreational and cultural values and should be protected. Such aspects could be explained to visitors so that they can appreciate the importance of conservation. The geological heritage sites have high geotourism potential and could be developed for geotourism purpose with steps to ensure sustainability and protection of the sites. The promotion of educational geotourism at the sites, especially on sea-level changes, could instill public awareness on global climate changes due to global warming and thus would encourage the public to protect the environment.

Keywords: Global climate changes, sea-level changes, Northern Sabah

REFERENCES

Muda, J., 2009. Potential geoheritage resources and geotourism development in Northern Sabah, Malaysia. Universiti Malaysia Sabah (MSc Thesis, unpublished).

Moste, (2000). Malaysia 'Initial National Communication' submitted to the United Nations Framework Convention on Climate Change. Ministry of Science, Technology & Environment, Malaysia. July, 2000. 120 pp.

Nicholls, R.J., 2003. Case study on sea-level rise impacts: ww.oecd.org/environment/cc/ 2487234.pdf

Tjia, H.D., 1996. Sea-level changes in the tectonically stable Malay-Thai Peninsula. Quaternary International, 31, 95-101.

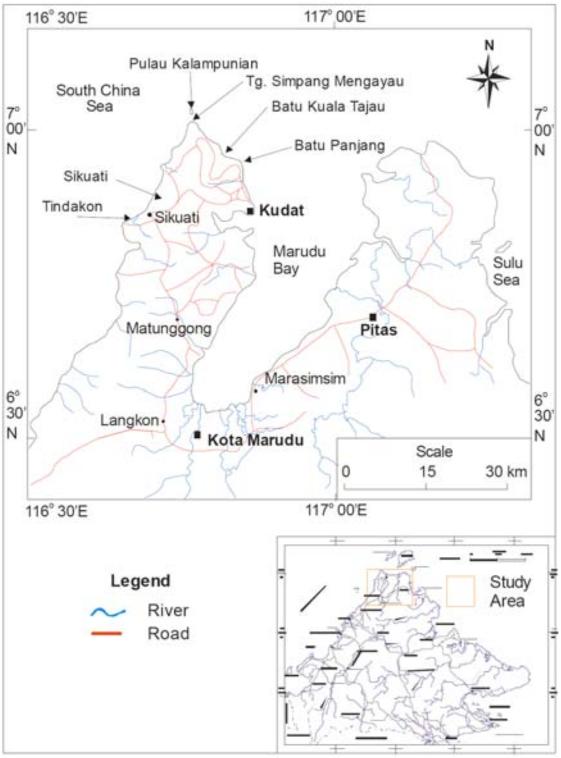

Figure 1: Location of geological indicators of sea-level changes at Northern Sabah

Photo 1: A remnant cliff showing ancient sea-level (red arrow)at Batu Panjang, Kudat, Northern Sabah.

Photo 2: New and ancient shore platforms indicating sea-level changes at Tanjung Simpang Mengayau, Kudat, Northern Sabah (Photo credit: C.L. Chan).

P069

Offshore Pahang Palaeo Channels Morphology: Last Glacial Maximum to the Holocene

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INTRODUCTION:

Palaeo climate change could be studied by examining evidences of fluvial morphologic evolution/response using sequence stratigraphy. Hence,high resolution acoustic profiles of palaeo channels located offshore of Pahang was analyzed. The survey was conducted in 2009. The palaeo channels existed during the Last Glacial Maximum or LGM (around 21 ka BP) when the sea level was 123 +/- 3 m lower than present day mean sea level (MSL) (Hanebuth et al., 2009; Hanebuth et al., 2011). Subsequently, the channels were submerged and in filledthrough the late Pleistocene-Holocene marine transgression.

Late Quaternary sea level and climate change studies have been done using various approaches such aslitho, bio, and chrono-stratigraphy (Kamaludin, 2002);coral reefs dating (Hanebuth, 2000); seismic profiles along with sediment cores (Hanebuth et al., 2009); geo-acoustic survey and radiocarbon dating of core (Puchała et al., 2011); high resolution seismic profiles pointing onlap and off-lap markers (Zhonget al., 2004); sedimentation rate, organic $\delta^{13}C$, and foraminiferal $\delta^{13}C$ proxy records (Bird et al., 2010); and modern satellite bathymetry (Sathiamurthy and Voris, 2006).

The study area, i.e.Penyu Basin (Fig. 1) is located on the eastern section of the Sunda Shelf. The shelf is geologically complex region that has evolved through various phases of continental accretion, mountain building and rifting (Madon, 1999), where three lithospheric plates converged, i.e. the Pacific, the Indo-Australian and Eurasian plates. Penyu Basin is separated from larger Malay Basin by Tenggol Arch and extends towards South China Sea which is structurally contiguous with the West Natuna Basin of Indonesia (Madon and Anuar, 1999). The basin probably formed during Late Eocene to Early Oligocene (~40-35 Ma) around the same period as the West Natuna Basin (Madon, 1995; Madon and Watts, 1998). These basins are mainly bounded by faults on which extensional dip–slip and strike–slip are predominant (Miall, 2006; Hall et al., 2008). The sediments of the basin are typically siliciclastic, consisting inter-bedded shale, siltstone and sandstone (Madon, 1995).

METHODOLOGY:

A wide transect 2D sub-bottom profiling of the sea bed was conducted in October, 2009.A single EdgeTech SB-0512i sub-bottom profiler (CHIRP technology) that could penetrate 20 m (coarse calcareous sand) to 200 m (clay) of sub-seabed with 8-20 cm resolution was employed.Frequency range used was 7-12 kHz. Sound velocity was set at 1600 m/s for both sea water and subsurface sediments for the purpose of TWTT-depth calculation.

Captured sub-bottom images were graphically enhanced in order to make subtle differences more visible for the purpose stratigraphic delineation. Stratigraphic sequence concept is used the basis for acoustic data interpretation where different units are delineated based on their continuity, amplitude, frequency, pattern and sedimentation trend. Sequence systems tract formation is controlled by the interaction of sedimentation rates and base level changes. Base level changes are effected by a combination of factors such as eustasy, tectonics, compaction of sediments and energy level in the environment. Here, base level changes are assumed to be relative sea level changes by disregarding the effect of environmental energy, i.e. wave actions and currents.

Four system tractswere used to understand the sedimentary architecture related to sea level changes i.e., falling stage system tract (FSST) correspond to regression state; low-stand system tract (LST), where sedimentation is higher than sea level rise;transgressive system tract (TST), where sea level rise is higher than the sedimentation; and high-stand system tract (HST), a later stage of sea level transgression and sedimentation rate is higher than sea level rise rate (Catuneanu et al., 1998; Darmadi et al., 2007).

Figure1: Transect locations (yellow lines).

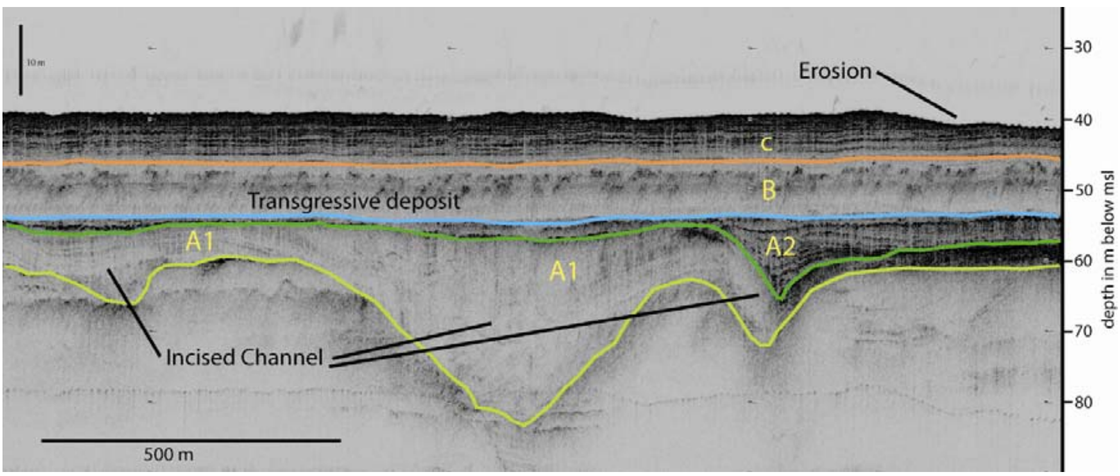

Figure 2: A1 and A2:Incised multiple channels in the LGM followed by, B:delta progradation during the marine transgression; C) marine deposits after submergence of shelf, erosion of sea bed by scouring is also evident.

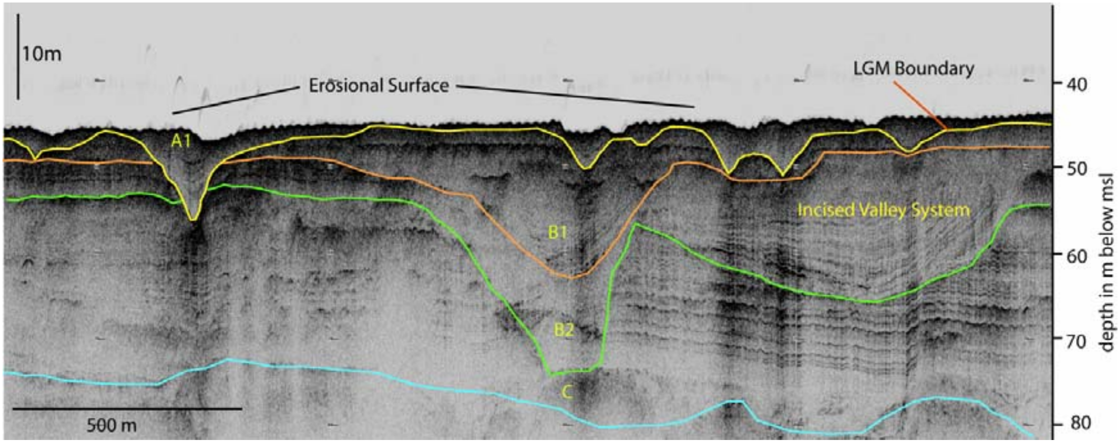

Figure 3: A1: LGM low-stand incised valley system. After deglaciation the channels were filled up with Holocene sediment. However, the top Holocene sediments were almost eroded probably due to sea bed scouring. B1,B2,C: pre LGM layers, evidence of other incised valley systems.

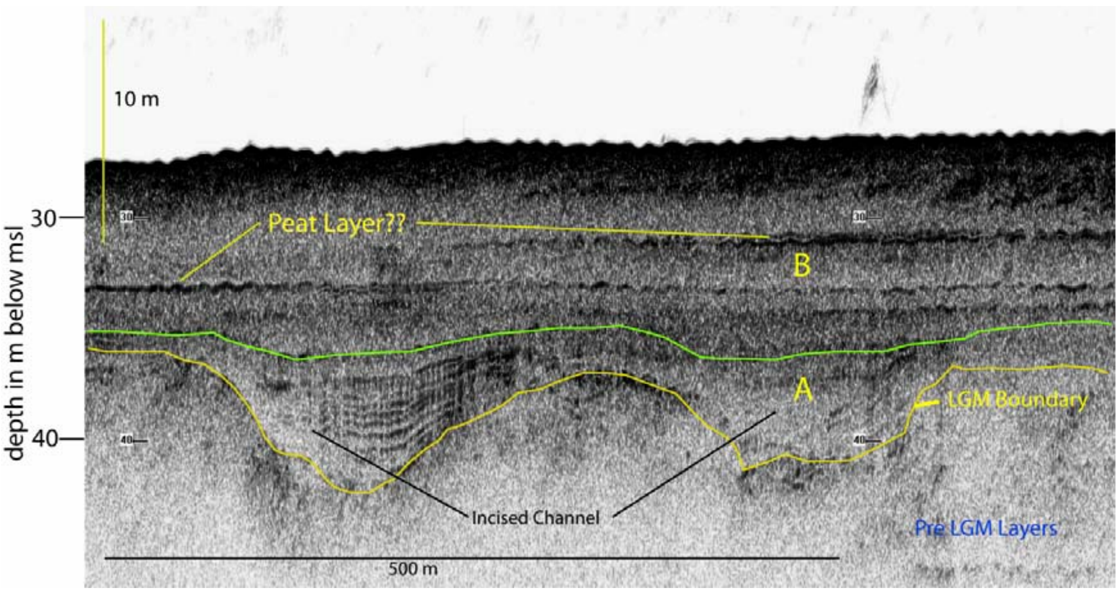

Figure 4: Transect in the near to modern day Pahang River delta.A: incised channel system. B: Holocene deposits probably inter-bedded peat deposits.

RESULTS AND DISCUSSION:

Figure-2: In this transect, the average water depths is about 45 to 50 m correspond to modern MSL. The LGM layers is approximately at the depth of 60 m from MSL possibly near to estuary. Evidence of multiple incised channels width ranging from 30 to 1.5 km was exited during LGM. After, marine transgression during deglaciation, a 8-10 m thick transgressive progradation layers (unit B) found on top incised channel fill sediments (Unit A1,A2). On top of TST layers, a continuous stratified marine deposits of 6-8m a continuous stratified strata found. This Holocene sediments deposited after the completion of submergence due to sea level rise. The sea floor had eroded in few places possibly due to sea bed scouring (Fig. 1,2).

Figure-3: In this section, the minor channels apart from estuary in further upstream, is interpreted that the channel incision occurred during the LGM (unit A1), followed by marine transgression sediments in TST condition. However, the most of the Holocene layers possibly have been eroded due to seabed scouring that exposed the post LGM channel fill layers in the sea floor. In contrast, the pre LGM incised channel also found below the LGM boundary (unit-B1,B2)(fig-3). The average water depth is about 44m below msl, while, the average LGM layer depth is approximately 46m below msl.

Figure-4 In further upstream near to present day shoreline in Pahang River delta (Fig-1), the channel incision took place during LGM. A 10 m (+/- 2m) thick sediments found on top of the deglacial channel fill deposits probably inter-bedded with peat deposits. The water depth is about 25m from MSL and the average LGM boundary is found 35m below msl (Fig 4).

However, the incised channel morphology and sequence boundary of regressive and transgressive sediment sequence helped to depict the climate change induced sea level change during LGM to recent in Late Quaternary. The channel incision in the LST condition during LGM followed by a marine transgression during TST condition produced the channel fill sediment as well as the Holocene to recent sediment layer. The LGM layers extend from 40-60 m below MSL while, the Holocene sediment thickness also varied due difference in sediment input.

REFERENCE

Darmadi, Y.; Willis, B.J. and Dorobek S.L. (2007) Three-Dimentional seismic architecture of Fluvial sequences on low-gradient Sunda Shelf, Offshore Indonesia, *Journal of Sedimentary Research,* 77, 225–238

Hall, R., Hattum, M.W.A and Spakman, W. (2008) Impact of India–Asia collision on SE Asia: The record in Borneo,*Tectonophysics*, 451. 366–389

Hanebuth, T.J.J., and Stattegger K., and Bojanowski, A. (2009) Termination of the Last Glacial Maximum sea-level lowstand: The Sunda-Shelf data revisited, *Global and Planetary Change,*66, 76-84,.

Hanebuth, T.J.J., Statttegger, K and Grootes, P.M (2000) Rapid Flooding of the Sunda Shelf: A Late-Glacial Sea-level Record. *Science,* 288, 1033 – 1035

Hanebuth, T.J.J., Voris, H.K., Yokoyama, Y., Y. Saito, Y. and Okuno, J. (2011) Formation and Fate of Sedimentary depocentres on Southeast Asia's Sunda Shelf over the past sea-level cycle and biogeographic implications, *Earth Science Reviews,*104, 92-110,.

Kamaludin B.H., (2002) Holocene sea level changes in Peninsular Malaysia, Geological Society of Malaysia, *Annual Geological Conference*

Madon, M. (1995) Tectonic Evolution of the Malay and Penyu Basins, Offshore Peninsular Malaysia.PhD.Thesis, *University of Oxford*.

Madon, M. and Anuar, A. (1999), Penyu Basin, In: Petroleum Geology and Resources of Malaysia, *PETRONAS*, Kuala Lumpur, 219-234

Madon, M. and Watts, A.B. (1998) Gravity Anomalies, Subsidence History and the Tectonic Evolution of the Malay and Penyu Basins (Offshore Peninsular Malaysia), *Basin Research*, 10. 375-392

Miall A.D. (2002) Architecture and sequence stratigraphy of Pleistocene fluvial systems in the Malay Basin, based on seismic time-slice analysis, *AAPG Bulletin*, 86(7), 1201–1216

Catuneanu, O, Willis, A.J., Miall, A.D., (1998) Temporal significance of sequence boundaries, *Sedimentary Geology,*121, 157–178

Posamentier H.W. (2001) Lowstand alluvial bypass system: Incised vs. unincised, *AAPG Bulletin,*85(10), 1771-1793

Puchała R.J.; Porębski, S.J.; Śliwiński, W.R.and August, C.J. (2011) Pleistocene to Holocene transition in the central basin of the Gulf of Thailand, based on geoacoustic survey and radiocarbon ages, *Marine Geology*, 288, 103–111

Sathiamurthy E., and Voris, H. K., (2006) Maps of Holocene Sea Level Transgression and Submerged Lakes on the Sunda Shelf, *The Natural History Journal of Chulalongkorn University*, Supplement 2: 1-43

Zhong, G.; Geng, J.; Wong, H.K.; Ma, Z. and Wu, N. (2004) A semi-quantitative method for the reconstruction of eustatic sea level history from seismic profiles and its application to the southern South China Sea, *Earth and Planetary Science Letters*, 223, 443–459

P075

Geology and the Law of the Sea: The Work of the Commission on the Limits of the Continental Shelf

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Under Article 76 of the United Nations Convention on the Law of the Sea (UNCLOS), the **continental shelf** of a coastal State comprises *"the **seabed** and **subsoil** of the **submarine areas** that extend beyond its territorial sea throughout the **natural prolongation of its land territory** to the **outer edge of the continental margin**, or to a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extend up to that distance".* Article 76 provides the entitlement for a coastal state to extend its continental shelf beyond 200 nautical miles (Fig. 1) by making a submission to the Commission on the Limits of the Continental Shelf (CLCS) explaining the technical justifications along with supporting geological, geophysical and bathymetric data. The CLCS is a technical body that comprises 21 members who are experts in geology, geophysics and hydrography, and are elected by States Parties to the UNCLOS, with the mandate to consider the submitted materials and to make recommendations on the limits of the continental shelf in accordance with the provisions of Article 76. Members are elected for a five-year term and, since 1997, four commissions have been elected; the last election having taken place in June 2012. Since receiving the first submission in 2001, the CLCS has received a total of 71 submissions from coastal states, including Malaysia (jointly with Viet Nam) in 2009. As of February 2014, 20 recommendations have been adopted. Although playing an important role in the implementation of Article 76 of UNCLOS, the CLCS is generally unknown to the geological community and to the general public. To bridge this gap, particularly in the Malaysian geological fraternity, this paper gives an overview of the work of the CLCS and introduces some of the key geological concepts regarding the continental shelf and its outer limit as contained in Article 76 (e.g., Fig. 2). *The views expressed in this presentation, however, are solely those of the author in his personal capacity and do not necessarily reflect the views of the Commission on the Limits of the Continental Shelf.*

REFERENCES

United Nations Convention on the Law of the Sea (1982). United Nations Division of Ocean Affairs and the Law of the Sea, New York. UN publication, 1997.

Commission on the Limits of the Continental Shelf. Official website http://www.un.org/depts/los/clcs_new/clcs_home.htm, accessed 15 April 2014.

Training Manual for delineation of the outer limits of the continental shelf beyond 200 nautical miles and for preparation of submissions to the Commission on the Limits of the Continental Shelf. United Nations Division of Ocean Affairs and the Law of the Sea, New York (UN publication, 2006).

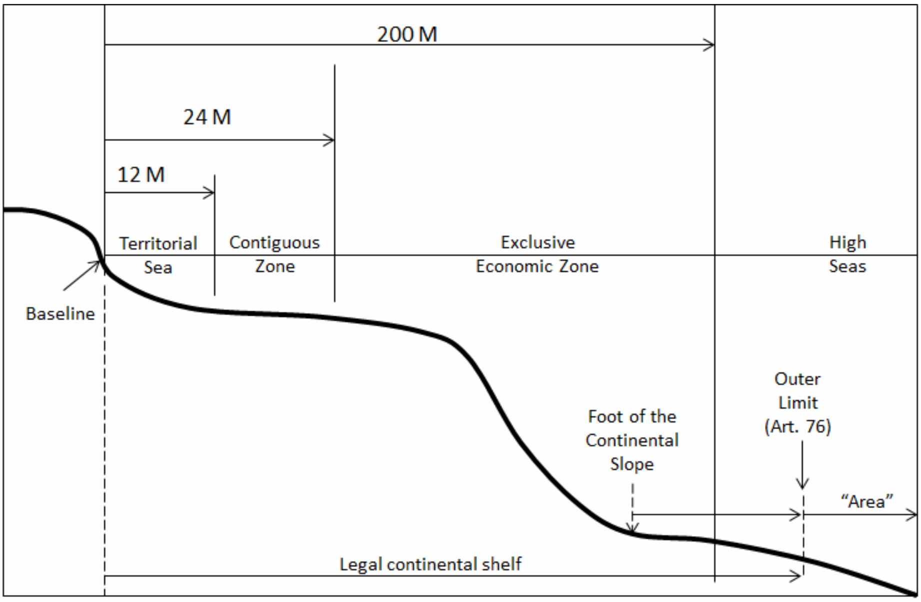

Fig. 1. According to article 76 of UNCLOS, a coastal state may establish the outer limits of its 'legal' continental shelf wherever the continental margin extends beyond 200 nautical miles (M) by establishing the foot of the continental slope and the outer limit of the continental margin, using the provisions of article 76, paragraphs 4 to 7, of the

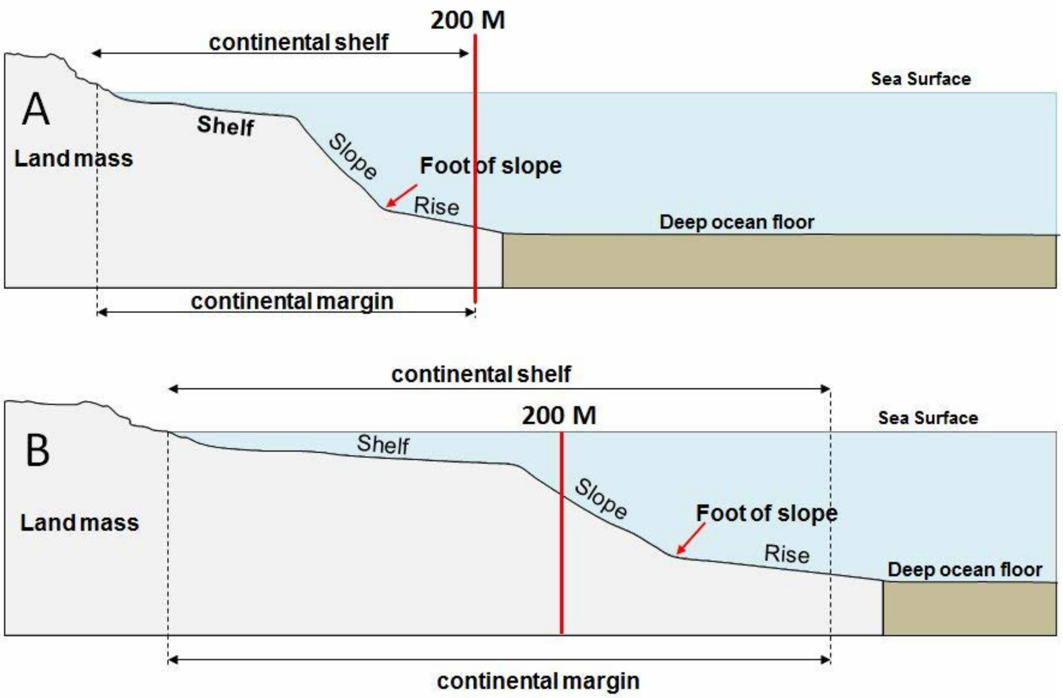

Fig. 2. Simple concept of a continental shelf in relation to the 200 nautical mile (M) limit with respect to (A) a narrow continental margin with its legal continental shelf equals the exclusive economic zone at the 200 M limit, and (B) a wide continental margin with an outer limit beyond 200 M. (Modified figure from "**The Law of the Sea: Training Manual for Delineation of the Outer Limits of ...**" United Nations. Division for Ocean Affairs and the Law of the Sea.

P076

Tectonic and Eustatic Controls On Miocene Sedimentation of Nyalau Formation (Sarawak, Borneo)

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Tectonism constitutes one of the major controls of sediment in-fill within sedimentary basins around the world. Understanding the tectonic activity that shaped the architecture of the basin and aided in facies distribution, plays a vital role in basin analysis and forward modeling. A few outcrops from the Nyalau Formation in Bintulu, Sarawak, East Malaysia are studied to interpret facies characteristics, vertical successions and depositional environments by observing sediment grain size, changing rates of sediment supply, bioturbation intensity and sedimentary structures. Predictions of depositional environments and settings throw light on controls of tectonism, eustatic sea level fluctuations or a combination of both. From the analysis, variations of facies successions were observed ranging from fine- to very fine-grained sandstones with hummocky cross stratification, interbedded very fine-grained sandstone with lenticular bedded mudstone, intensely bioturbated very fine-grained sandstone and carbonaceous mudstone. Depositional settings range from lower shoreface, middle shoreface (transition), upper shoreface, foreshore, backshore and fluvio-tidal deposits and conceptual models, pre/ post tectonism, of depositional settings are conceived. The models emphasize on tectonic activities and eustatic sea level variations responsible for local erosional unconformities, explaining in detail, the shift in environments of deposition. A periodic cycle of lower shoreface and foreshore depositional settings due to sea level rise and drop are observed prior to tectonism. Following a series of tectonic events in Borneo, observations can be made of a significant and substantial shift in depositional setting marked by a local erosional unconformity.

REFERENCES

Cullen, A. B., 2010. "Transverse segmentation of the Baram-Balabac Basin, NW Borneo: refining the model of Borneo's tectonic evolution", Petroleum Geoscience, GeoScience World, February v. 16, no. 1, pp. 3-29.

Dalrymple, B. A. Zaitlin, R. Boyd, "Estuarine facies models: conceptual basis and stratigraphic implications," Journal of Sedimentary Petrology, vol. 62, pp. 1130–1146, 1992.

Hall, R., 1997. "Cenozoic plate reconstructions of SE Asia", In: Hall R., Blundell D. J. (eds) Tectonic Evolution of Southeast Asia, Geological Society London Special Publications, v. 106, pp. 153-184.

M. H. Amir Hassan, Howard D. Johnson, Peter A. Allison, Wan Hasiah Abdulla, "Sedimentology and stratigraphic development of the upper Nyalau formation (Early Miocene), Sarawak, Malaysia: A mixed wave- and tide-influenced coastal system," Journal of Asian Earth Sciences, vol. 76, pp. 301–311, 2013.

Madon M., and Abdul Hadi Abd Rahman, "Penecontemporaneous deformation in the Nyalau Formation (Oligo-Miocene), Central Sarawak," Geological Society of Malaysia Bulletin, vol. 53, pp. 67-73, 2007.

Mat-Zin, I. C., 1996. "Tertiary tectonics and sedimentation history of the Sarawak basin, East Malaysia", PhD theses, Durham University, Available at http://etheses.dur.ac.uk/5198/, 277p.

Mazlan M., C. L. Kim, R. Wong, 2013, The structure and stratigraphy of of Deepwater Sarawak, Malaysia: Implications for tectonic evolution, Journal of Asian Earth Sciences, vol 76, pp. 312-333.

Mitchum, R. M.; P. R. Vail; S. Thompson III, 1977. "Seismic stratigraphy and global changes of sea level, part 2: The depositional sequence as a basic unit for stratigraphic analysis.", American Association of Petroleum Geologists, v. 26, pp. 53-62.

Morley, C. K., 2002. "A tectonic model for the Tertiary evolution of strike slip faults and rift basins in SE Asia", Tectonophysics, v. 347, pp. 189-215.

Schumm, S.A., 1993. River Response to Base level Change: Implications for Sequence Stratigraphy. The Journal of Geology 101, 279-294.

P077

Preliminary Analysis of Palaeochannels and Associated Depositional System of Bay of Terengganu (West Malaysia)

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This study describes the morphology and infilling of palaeochannels related to the Holocene transgression utilizing very high-resolution seismic data. The study area is located about 10 km offshore the present day Terengganu River basin, Peninsular Malaysia (water depth approximately 25-60 m below the present MSL). The presence of large to narrow palaeochannels have cut 20 m deep into the older strata (regression intervals of the past three sea-level cycles, i.e. 300 ka) and are very well illustrated. Most of the channel fill corresponded to the transgressive to early high-stand depositional system tracts. The main deposits were aggrading offshore muddy sands capped and cut by tidal channels belts. Both being overlain by modern sand and mud depending on modern hydrodynamic factors and affected by strong current and storm during the monsoon period. The most prominent boundaries within the channel are the tidal ravinement surface (TRS) at the base of the channel belts and the wave ravinement surface (WRS) at the base of the offshore muddy sands. Finally, from this preliminary analysis conclusion can be drawn the paleo-drainage could be dependent on structural constraints.

Boyd, R. Dalrymple, B. A. Zaitlin, “Classification of clastic coastal environments,”, Sedimentary Geology, vol. 80, pp. 139-150, 1992.

Foyle A.M. & Oertel G.F. (1997). Transgressive systems tract developpement and incised-valley fills within a Quaternary estuary-shelf system: Virginia inner shelf, USA. Marine Geology 137, 227-249.

Menier D., Tessier B., Proust J.N., Baltzer A., Sorrel P., and Traini C. (2010). The Holocene transgression as recorded by incised-valley infilling in a rocky coast context with low sediment supply (southern Brittany, western France) (2010). Bull. Soc. Géol. Fr., t. 181, n°2, pp.115-128.

Mitchum, R. M.; P. R. Vail; S. Thompson III, 1977. “Seismic stratigraphy and global changes of sea level, part 2: The depositional sequence as a basic unit for stratigraphic analysis.”, American Association of Petroleum Geologists, v. 26, pp. 53-62.

Zaitlin B.A., Dalrymple R.W., and Boyd R., (1994). The stratigraphic organization of incised valley systems associated with relative sea-level change. In: R.W. DALRYMPLE, R.J. BOYD & B.A. ZAITLIN, Eds., Incised valley systems : origin and sedimentary sequences. SEPM Spec. Publl., 51, pp.45-60.

P002

Conservation of Gunung Lanno Cave Systems – Proposal for Geoheritage Site

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A team of international speleologists were engaged in a speleological expedition to Gunung Lanno, Keramat Pulai, Perak during the late 1990's and early 2000's. At 407 m high, Gunung Lanno is the fourth highest of the 45 limestone hills in Kinta Valley (Malayan Nature Society, 1991). It consists of crystalline limestone and is part of the Kinta Limestone of Silurian-Lower Permian age (Lee, 2009).

Thirty six caves were discovered and documented. All of these caves were surveyed except for Gua Thai Monk, Gua Batu Pencuri and Gua di tepi Tasik. The bulk of the discoveries were made during the Speleological Expedition Gunung Lanno Malaysia 2001 (Geyer et al., 2005 & Ramli, 2010a). These caves are of geological, speleological, biospeleological, heritage conservation (evidence of tin mining activities), show cave (cave with spectacular speleoterms), and cultural (temple caves) interests. This paper highlights the importance of these cave systems and that they should be conserved and recognized as a geoheritage site.

The presences of collapse breccias at the entrances of Gua Cicak and Gua Tanah Merah and along the cliffs between these caves provide evidence that both Gua Cicak and Gua Tanah Merah were once connected but are now separated due to the collapse of the connecting chambers between these caves (Ramli, 2010b).

Interesting fossilised gastropods are found cemented at the cave entrance of Gua Puncak whereas loose intact riverine gastropods, *Brotia costula* (Malayan Nature Society, 1991 & Zuraina, 1994), provide evidence of the presence of paleorivers, are found on the floors of many of the caves in Gunung Lanno.

No thorough speleological study has yet been done on these caves systems but it is generally believed that the majority of the caves are river caves fitting the corrosion and solution model of cave formation (Geyer et al., 2005). Many of these caves, either at ground or high levels, were filled with river sediments that have yet to be studied and interpreted. The possibilities that these caves were formed by other mechanisms such as chemical solution by stagnant water and rock disintegration are not excluded.

The caves of Gunung Lanno also provide field laboratories in the study of the development of spectacular active speleoterms such as in the Fairytale Chamber of Gua Angin, chambers of Gua Monophyllaea, and at the entrance of Gua Polai Atas.

A total of 1026 individuals from at least 130 taxa were collected in 25 different caves. The identification of these individuals resulted in the discovery of a new species of mite harvestman, *Stylocellus globosus* (Schwendinger et al., 2004) in Gua Gereja Hujan, Gua Angin, Gua Gatsch, Gua Monophyllaea, Gua Puncak, and Gua Kwong Fook Ngan. *Lychas hosei cavernicola* (Lourenço, 2007), a new subspecies of the genus *Lychas* (scorpion) was found in Gua Kala Jengking. Gua Cicak harbours a total of 14 nests of *Liphistius tempurung*, a trap door spider (a living fossil of Carboniferous period), which are only known to exist in Gua Tempurung of Gunung Tempurung-Gajah complex (Platnick et al., 1997; Steiner, 1998 & Geyer et al., 2005)

The presence of water pipes, timber support structures, water retaining concrete structures, and excavating tools provide evidences that tin mining activities were once carried out in Gua Gatsch, Gua Puncak, and Gua Portal.

Gua Puncak holds western Malaysia's second largest chamber, the "Lanno Summit Chamber", 190 m x 80 m x 60 m, located directly below the peak of Gunung Lanno. Other big caves are Gua Selari, Gua Lanno and Gua Kong Fook Ngan. Of these, Gua Lanno is noted for being the most spectacular in term of speleoterm development. Among others, Gua Kupu Kupu contains spectacular display of calcite crystals in its crystal chamber. These caves are recommended to be developed and managed as show caves and/or adventure caves with minimum impact on cave biology and structures.

There are 5 temple caves in the mountain: Buddhist caves in Gua Piyachat, Gua Thai Monk, Gua Kwong Fook Ngan, and Gua Ngia, and a Hindu cave in Gua Sri Siva Subramaniar.

For its scientific, heritage, and cultural interests, the cave systems of Gunung Lanno and the limestone hill itself have to be protected by some legal instruments and machineries (Tunku Mohd Nazim, 1991). It is suggested that they should be recognized as a geoheritage site and their conservation and protection have to be undertaken by government agencies such as Department of Land and Mines, Department of Minerals and Geoscience, and Department of Heritage. It is hope that higher learning institutions such as Universiti Kebangsaan Malaysia, Universiti Malaya, and Universiti Sains Malaysia would be interested in engaging speleological studies of these cave systems and be actively involved in pursuing the geoheritage conservation of these caves. It is also hope that non-government organizations such as Malaysian Nature Society should also play their parts to ensure the conservation of these cave systems and limestone hill (Zakaria et al., 2008).

The urgency of this conservation effort should be emphasised as there are currently 45 limestone quarry operators that quarry the limestone hills in Perak. The most seriously affected is the Gunung Terundum that is situated in the heart of the Kinta Valley. This act of merciless destruction is spilling over to the nearby Gunung Lanno. While the destiny of Gunung Terundum is already predetermined, Gunung Lanno, which harbours the 36 cave systems of great speleological and geoheritage interest, could still be saved (Ramli, 2013).

REFERENCES

Geyer, E., Schmidt, F. & Jeutter, P. (eds.), 2005. *Speleological Expedition Gunung Lanno Malaysia*. Verein für Höhlenkunde in Obersteier (VHO), Bad Mitterndorf, Austria, 240p.

Lee, C.P., 2009. Palaeozoic Stratigraphy. In: Hutchison, C.S. & Tan, D.N.K. (eds.), 2009. *Geology of Peninsular Malaysia*. UM & GSM, Kuala Lumpur, Malaysia, pp 55-86.

Lourenço, W. R., 2007. On Some Scorpions from Malay Peninsula, with the Description of a New Subspecies of Lychas C. L. Koch, 1845 (Scorpiones, Buthidae). *Entomol. Mitt. zool. Mus.* Hamburg, 14 (177), 415-419.

Malayan Nature Society, 1991. A Conservation Assessment of Limestone Hills in the Kinta Valley. *Final Report MNS Project 1/90*, Kuala Lumpur.

Platnick, N.I., P.J. Schwendinger & H. Steiner, 1997. Three New Species of the Spider Genus *Liphistius* (Araneae, Mesothelae) from Malaysia. *American Museum Novitates* No. 3209, 13p.

Ramli Mohd Osman, 2010a. Reliving the Legacy of Gunung Lanno Speleological Expedition 2001. *Malaysian Nature Society (Perak Branch) Newsletter Edition* December 2010 – February 2011, Ipoh.

Ramli Mohd Osman, 2010b. Biospeleological and Speleogenesis Assessment of Gua Cicak and Gua Tanah Merah. *Malaysian Nature Society (Perak Branch) Newsletter Edition* December 2010 – February 2011, Ipoh.

Ramli Mohd Osman, 2013. The Need to Practise Sub-Surface Limestone Quarrying in Perak, Paper presented in Symposium Mineral 2013, 12th – 13th November 2013, Kinta Riverfront Hotel, Ipoh, Perak.

Schwendinger, P.J., Giribet, G. & Steiner, H., 2004. A Remarkable New Cave-Dwelling Stylocellus (Opiliones, Cyphothalmi) from Peninsular Malaysia, with a Discussion on Taxonomic Characters in the Family Stylocellidae. *Journal of Natural History* 38, 1421-1435.

Steiner, H., 1998. Perak's very own trap door spiders. *Malaysian Naturalist* 51 (3&4), 25-27.

Tunku Mohd Nazim Yaacob, 1991. Caves. In Kiew, R. (ed.) *The State of Nature Conservation in Malaysia*. Malayan Nature Society, Kuala Lumpur, 15-18.

Zakaria Hussain, Mohammad Roston Zakaria & Mohd Shafeea Leman, 2008. Geoheritage of Malaysia. In Mohd Shafeea Leman, Reedman, A. & Chen, S.P. (eds.) *Geoheritage of East and Southeast Asia*. Institut Alam Sekitar dan Pembangunan (LESTARI), UKM, Bangi, Selangor, 151-184.

Zuraina Majid (ed.), 1994. *The Excavation of Gua Gunung Runtuh and the Discovery of the Perak Man in Malaysia*. Department of Museums and Antiquity Malaysia, 174p.

P072

Hot Water Reservoir Potential using Geoelectrical Method in Apas Kiri, Tawau, Sabah

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The study of hot water reservoir potential was carried out in Apas Kiri, Tawau, Sabah. It is focused at the foothill of Mount Maria, an area where number of naturally formed hot cones scattered all over at a wide barren steaming area. The area is composed of Quaternary andesitic rock. The current steaming ground is estimated to be the remnant hot temperature of the Late Pleistocene volcanism. Hot water temperature data measured for the last 40 years showed no change in value. Cones expelled hot water from subsurface through fault zones and flows into the river channels nearby. The salinity of the hot water is high due to the high salt concentration. Since the heat source is at shallow depth, geothermal energy source is relatively easy to explore. Abem Terrameter SAS 4000 was used to interpret subsurface resistivity data. This geophysical equipment using resistivity method is to show and differentiate types of earth materials. The results are in pseudo-section with distribution of resistivity in Ωm unit. The survey uses a pole-dipole electrode array where it can penetrate deeper compare to other electrode arrays. The data interpretation is to determine and identify the resistivity of the hot water reservoir. The results of the survey found a low resistivity values between 0.02 to 0.78 Ωm and can be interpreted as a source of hot water. The hot water has potential for alternative energy to be explored.
Keywords – Abem Terrameter SAS 4000, geothermal, resistivity, Pole-Dipole.

Kajian potensi reservoir air panas telah dilakukan di kawasan Apas Kiri, Tawau, Sabah. Ia tertumpu di kaki Gunung Maria di mana terdapat kawasan tandus yang mempunyai kon-kon air panas yang terbentuk secara semulajadi. Batuan yang terdapat di kawasan kajian ini adalah terdiri daripada batuan volkanik Kuaternari jenis andesit. Aktiviti volkanisme semasa Holosen masih menyimpan kepanasan hingga ke hari ini, di mana haba yang terhasil di permukaan masih lagi aktif dan membentuk kon-kon yang membebaskan air panas ke permukaan. Data suhu air panas ini yang telah diukur dalam tempoh 40 tahun menunjukkan nilai yang tidak berubah. Oleh kerana sumber haba ini dekat dengan permukaan, sumber tenaga geotherma agak mudah untuk diterokai. Kon-kon ini mengeluarkan air panas dari bawah tanah yang datangnya dari zon sesar dan seterusnya mengalir masuk ke dalam sungai yang berhampiran. Air panas yang keluar ini mempunyai rasa yang masin disebabkan oleh kandungan garam yang tinggi. Kajian kerintangan geoelektrik telah dilakukan dengan menggunakan Abem Terrameter SAS 4000. Survei ini menggunakan susunatur elektrod pole-dipole di mana susun atur ini dapat mencerap data lebih dalam berbanding susunatur elektrod yang lain. Data yang telah dicerap dapat menentukan dan mengenalpasti nilai rintangan air panas. Hasil dari survei didapati nilai rintangan yang rendah sekitar 0.02 hingga 0.78 Ωm dapat ditafsirkan sebagai sumber air panas. Sumber air panas ini mempunyai potensi tenaga alternatif elektrik untuk diteroka.
Kata kunci – Abem Terrameter SAS 4000, geotherma, kerintangan, Pole-Dipole.

INTRODUCTION

The study area is located in Semporna Peninsula, Sabah, Malaysia(Figure 1). The precise surveyed location is at the foothill of Andrassy Hill (coordinate of the steaming ground - 04°21'40.74"N and 117°59'9.23"E) carved by Apas Kiri River. This area is part of the Tawau Hills Park and was built up by the Miocene to Quaternary andesitic volcanic rocks. The study area was built up by the Quaternary volcanic rocks which are made up of andesitic rock type and is widely exposed in Semporna Peninsula. The oldest volcanic rocks formed part of the Tinagat Hill in the southern foot hill of Magdalena. The Andrassy, Lucia, Maria, Wullersdof, Pock and the Magdalena mountains, equivalent type of rock, form the major topographic feature of Semporna Peninsula. Mount Lucia and Mount Maria are made up of Pleistocene dacites. The youngest volcanic rocks, which are basaltic type, erupted during Late Pleistocene time. Their outcrops occur in random distribution overlying the older volcanic rocks covering an extensive area of the low-lying areas.

Figure 1: Map of Southeast Asian Region showing the location of Sabah, Malaysia.

Table 1: Stratigraphy of the Semporna Peninsula Area.

AGE	Letter Classification	SEDIMENTARY ROCKS	IGNEOUS ROCKS AND TECTONIC ACTIVITY
QUATERNARY		Alluvial deposits	Olivine basalt lava
PLIOCENE	Tgh	Dacitic and andesitic volcanic breccia and tuff with subordinate epiclastic	Dacitic and andesitic volcanic breccia and lavas Dacite and andesite lavas and pyroclastics
LATE MIOCENE	Tf_3	Umas-Umas Fmn.: Interbedded sandstone and mudstone	
MIDDLE MIOCENE	Tf_{1-2}	Kalumpang Fmn.: Tuff, volc. Breccia, tuffite, clastic and limestone	Volcanics (andesite) and tectonic activities associated with the Kalumpang Fmn.
EARLY MIOCENE	Te_5	Kalabakan Fmn.: Interbedded sandstone and shale	
OLIGOCENE	Te_{1-4}		

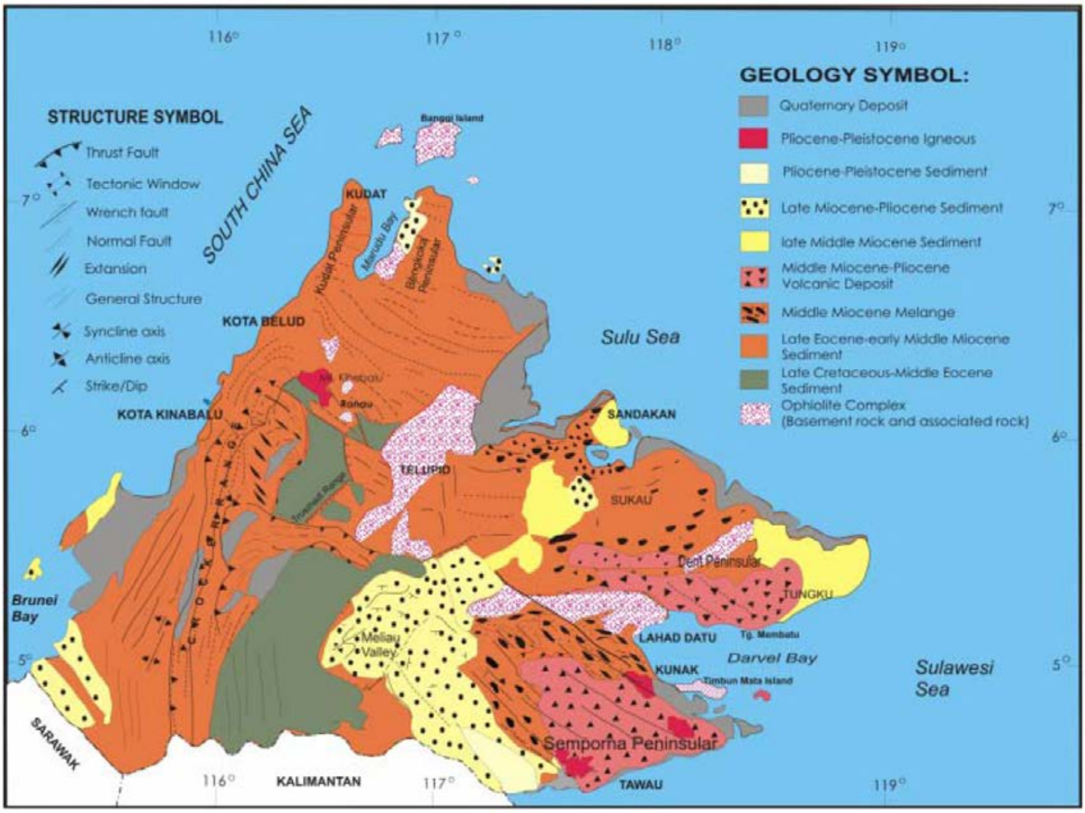

Figure 2: Geological map of Sabah (modified from Yin, 1985)

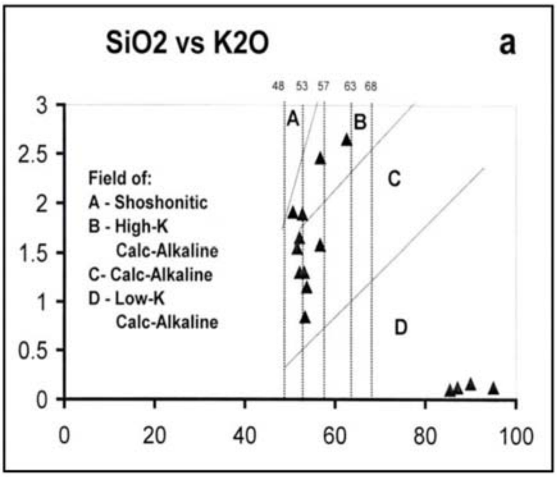

Figure 3: Calc-Alkaline type of volcanic rocks - eleven samples analysed from the study area.

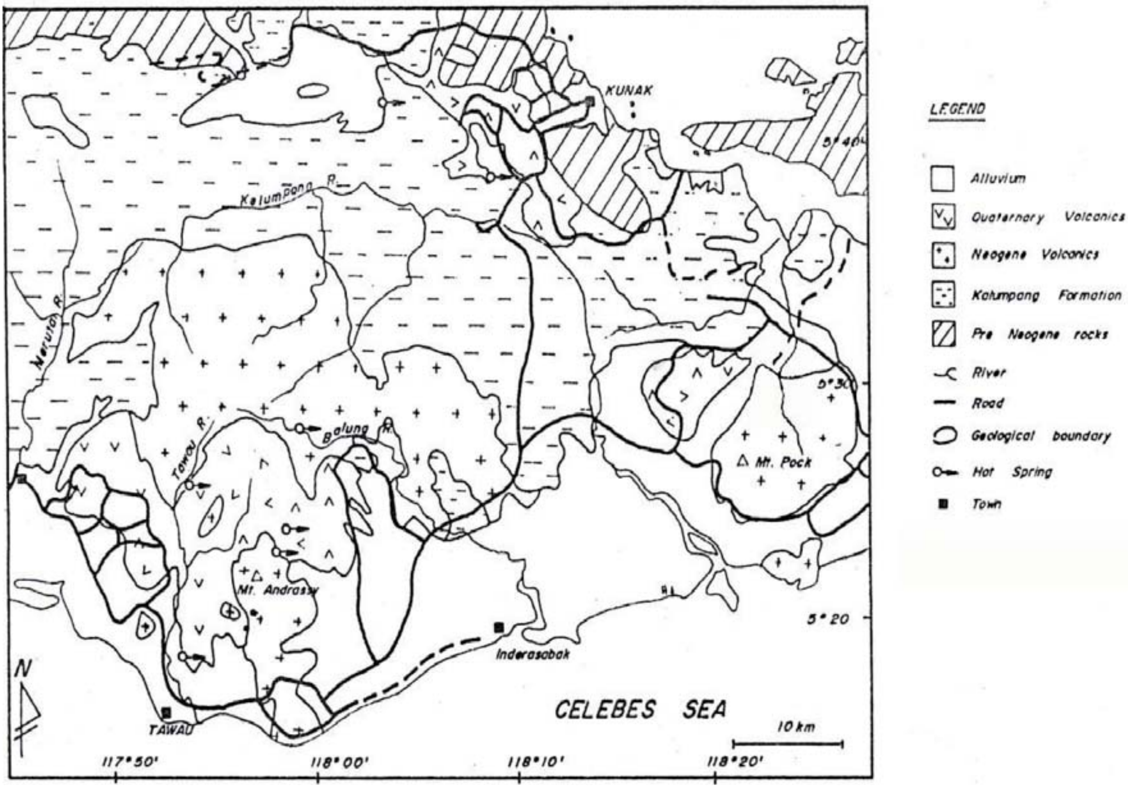

Figure 4: Volcanics and distributions of hot springs in Semporna Peninsula (Sahat et al. 1990).

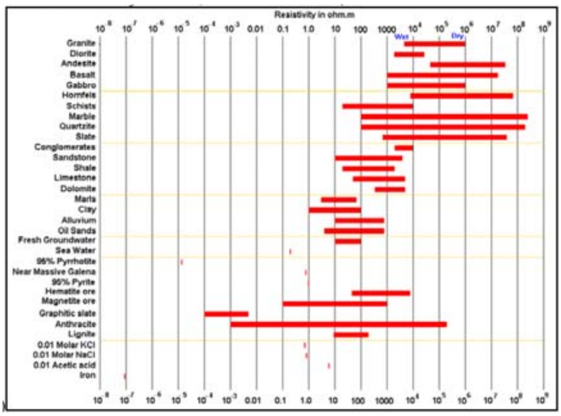

Table 2: The resistivity of rocks, soils and minerals (Terrameter SAS4000 - Course

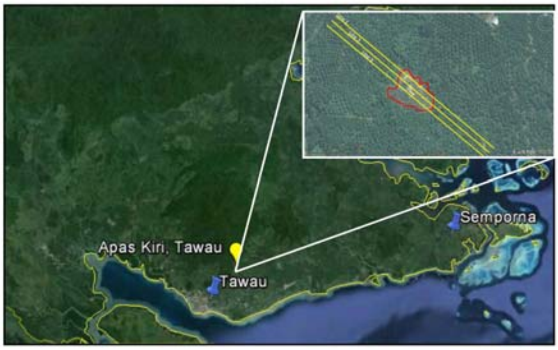

Figure 5: Survey lines layout at Apas Kiri, Tawau. Survey line orientation (inset picture).

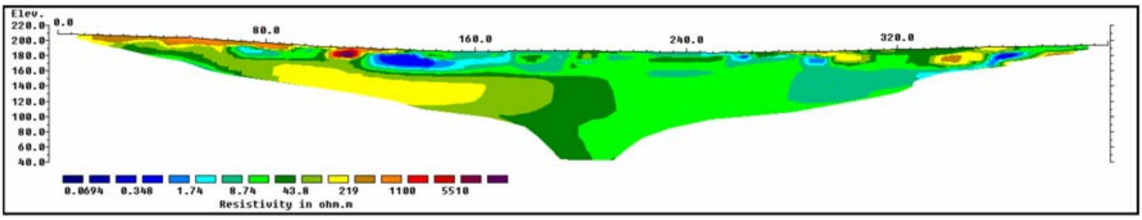

Figure 6: Pseudosection for survey line 1

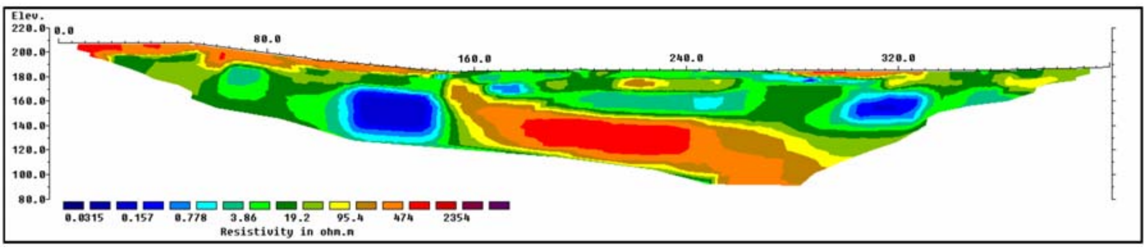

Figure 7: Pseudosection for survey line 2

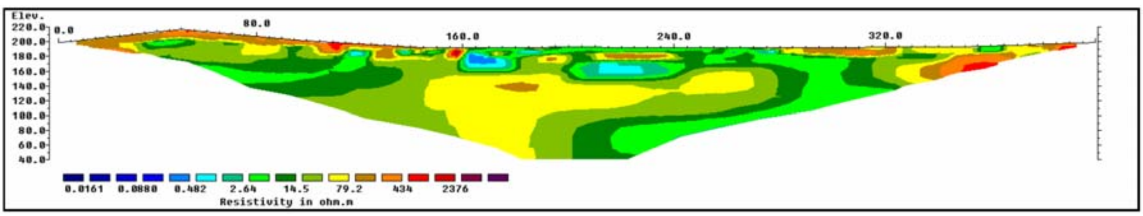

Figure 8: Pseudosection for survey line 3

The major positive lineaments that fringe the mountains could be the reflection of major fractured zones of the area with a NNW-SSE orientation (Figure 2). Several hot springs are located at or near the contacts between different lithologies and close to lineaments indicating that they could be related to the major fractured zones. Active mud volcanoes can be found northeast of Semporna Peninsula. This survey was conducted to look at the possible potential of shallow underground hot water reservoir by using electrical method for the benefit of future geothermal energy exploration.

GEOLOGIC SETTING AND STRATIGRAPHY

Tawau hills in Semporna Peninsula were formed from series of Quaternary volcanisms, those piled up to form stratovolcanic layers. The area is mainly made up of Neogene to Quaternary calc-alkaline type of andesite – dacite association (Figure 3). The andesitic and dacitic rocks around Mount Magdalena and Mount Andrassy are believed to have erupted during Pleistocene time followed by latest eruptions of dacitic rocks from Mount Maria. The oldest volcanic rock association is a sequence of tuff, volcanic breccia and tuffite associated with sandstone, shale, mudstone, agglomerate and subordinate limestone, classified as the Kalumpang Formation. The rock sequence shows that the clastic facies of the Kalumpang Formation was probably formed in a deep shelf environment as suggested by the numerous sedimentary features and could be part of the Middle Miocene basin of the Dent – Semporna Peninsula area. The straigraphy of Semporna Peninsula is as shown in Table 1.

VOLCANIC TERRAINS

Volcanic rocks of the dacite-andesite-basalt association of the Plio-Pleistocene age found in the area form the major mountainous backbone of the Semporna Peninsula. The earliest phases of volcanic activities appeared to coincide with the Middle Miocene tectonic movements during the deposition of the Kalumpang Formation.

Intense volcanic activities were mainly from explosive endesitic-dacitic volcanoes along Semporna Peninsula forming the major volcanic cones of the area. Dacitic rock, probably of Pliocene to Pleistocene age forming stratovolcanic cone, is in Mt. Wullersdorf and in the west of Semporna District. Dacite eruptions also formed the major rock type of Mt. Maria that preserved a dacitic crater on top of the older eroded andesite. The latest eruption of olivine basalt lava flows covered the major low lying areas of the peninsula.

GEOTHERMAL ENERGY POTENTIAL

Geothermal energy resource is available in Semporna Peninsula and after doing filtration, the most promising area is located at the foothills of Andrassy Hill. The potential area among the steaming grounds is the Apas Kiri River area (Figure 4). Its geological conditions and previous data show that the area is suitable for the exploration potential of geothermal energy (Leong 1974 and Sanudin and Dale 1992). The geothermal system of the area is considered to be hot water dominated with the total heat loss of 28.65 MW Thermal (Sanudin and Dale 1992). Recent surface temperature recorded was 78.0^{o}C. Continuing heat loss is estimated from the deep fault system that connects between the hot reservoir rock at depth as the heat source and the surface of the area. There is a risk of not finding any potential heat source after extensive effort on reconnaissance and surface exploration works. Carefully implemented regional reconnaissance surveys may, however, lead to a sound prioritisation of targeted area by filtering out of less promising area. Subsequent assessment of resource size and production capacity is possible to reasonable levels of certainty and forms a critical part of any geothermal development (Dalimin et al. 1998).

From geophysical survey by previous study has shown that there are coherent negative anomalies have been detected that occurred north and west of the known steaming ground of the Apas Kiri area (PLNI 1993). These anomalies are all occurring along faults or fault intersections identified from geologic mapping, and are thought to indicate fluid up flow zones. All anomalies occur in a broad area of low resistivity interpreted from current resistivity surveys. The low electrical resistivity and previous data of spontaneous potential anomalies interpreted as fault zone south and west of the known steaming ground of the area and surface geology support a model for the geothermal system. This evidence supports the occurrence for a primary hot-water reservoir. The thermal fluid is estimated to move north and east along major structures and feed the steam cap located nearby. Stratigraphically, there are two hot-water reservoir layers can be considered which act as the aquifer, namely: the Middle Miocene sandstone facies of the Kalumpang Formation and the thick Quaternary pyroclastic layer. Both layers are intersected by major fault systems connecting between the heat source and the ground surface and thus, giving a promising prospect of the area.

GEOPHYSICS SURVEY

In this study, Abem Terrameter SAS 4000 was used to interpret subsurface resistivity data. This geophysical equipment using resistivity method is to show and differentiate types of earth materials. The results are in pseudo-section with distribution of resistivity in Ωm unit. The relationship between resistivity values and geological condition and types of surrounding rocks can tell the possible subsurface condition in the study area. The aim of this study is to locate hot water reservoir based on its resistivity value. The salt content in the hot water give resistivity values >0.1Ωm and <1Ωm (Table 2).

RESULTS AND DISCUSSION

There are three parallel survey lines stretched and are separated approximately 10 meters each (Figure 5). Each survey line was stretched for 400 meters and penetrated up to 157 meters at the centre of the survey lines.

Survey line 1 (Figure 6) shows small portion of hot water reservoir. It can be detected from 130 meters to 170 meters with 37.4 meters thickness along the survey line. The resistivity values ranging from 0.0694-1.74Ωm interpreted as hot water source. Resistivity value ranging from 8.47-5510Ωm is interpreted as andesite that dominated the surrounding area.

Survey line 2 (Figure 7) was stretched near the surface manifestation that produces hot cone. Two anomaly bodies with resistivity values ranging from 0.0315-0.778Ωm indicate hot water zone. Resistivity values ranging from 3.86-2354Ωm can be interpreted as andesite.

On this Pseudosection of survey line 3 (Figure 8), only small amount of hot water detected with resistivity ranging from 0.0161-0.482Ωm (Figure 8). The andesite rock resistivity can be interpreted having resistivity value ranging from 2.65-2376Ωm.

This study shows that the salty hot water gives resistivity values equivalent to that of the saline water at the coastal area. The hot saline water acts as a highly conductive layer giving low resistivity values due to the characteristic of salt water as a good conductor for electric current. Therefore the electric current from the equipment easily flow through the conductive materials rather than resistive materials. The anomaly bodies with resistivity values ranging from 0.0315-0.778Ωm indicate hot water zone. The hot reservoir in this study area is detected at survey line 2 (Figure 7) where the surface manifestations of build-up hot cones show the major concentration of the hot saline water. Andesitic volcanic rock that dominated the surrounding area gave resistivity values up to 5000Ωm. Lower resistivity zones are estimated to be fractured area soaked with hot water.

REFERENCES

Kirk, H.J.C. Geology and mineral resources of the Semporna Peninsula 1959. Memoir 14: Brit. Borneo Geol. Survey Ann. Rept. For 1958, 191-206.

Leong,K.M. 1994. The geology and mineral resources of the Upper Segama Valley and Darvel Bay area, Sabah. Geol. Survey of Malaysia Memoir 4 (Rev.).

Mohd Noh Dalimin, A. Harris A. Tuah, Sanudin Tahir and Sahat Sadikun 1998. Current and future development of geothermal energy in Malaysia. Proc. of Asean Geothermal Energy, Subic, Philippines.

Perusahaan Lestrik Nasional Indonesia (PLNI) 1993. Geophysical prospecting in the Andrassy Hill, Tawau. Spec. Report on Geothermal System, Semporna Peninsula for Geol. Surv. Malaysia.

Sahat Sadikun, Sanudin Tahir, Jumat Salimon and Brunotte, D.A. 1990. Preliminary survey on geothermal potential of the Sungai Jepun hot spring, Semporna Peninsula. Warta Geologi, 16, 91-100.

Sanudin Tahir, Baba Musta and Ismail Abd Rahim 2010. Geological heritage features of Tawau volcanic sequence, Sabah. Geol. Soc. Of Malaysia (56), pp. 79 – 85.

Sanudin Hj. Tahir and Dale, A.B. 1992. Geothermal resources of Sabah. Proc. Science and Technology Symp., Kota Kinabalu.

P035

Geothermal Exploration in Hulu Langat, Selangor

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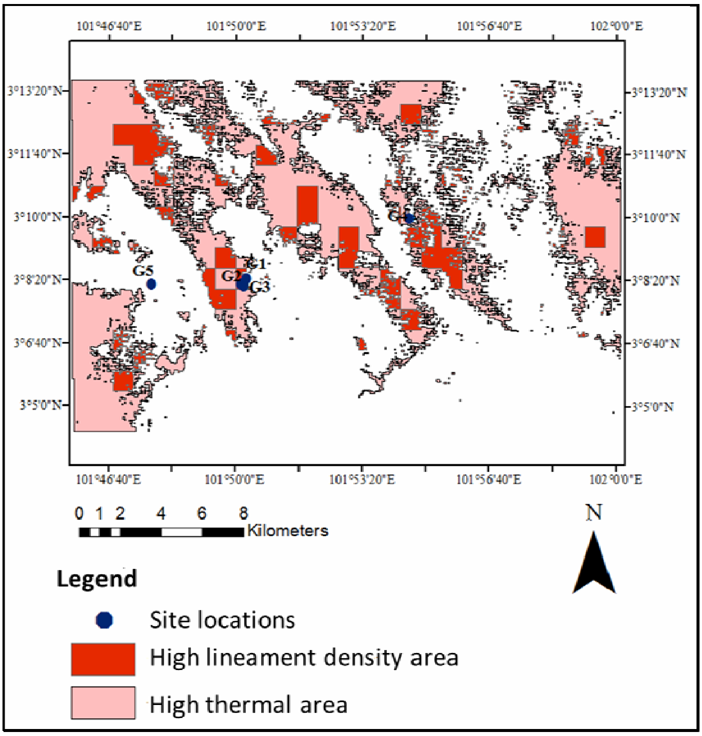

Figure 1 Area with high geothermal potential

The study aims to explore the potential geothermal source by means of remote sensing and GIS techniques. The reconnaissance research concerning parameters such as lineament density and thermal signature maps was conducted covering 457 km² area in Hulu Langat, Selangor. The lineament density was identified accordingly to the viable lineament length in each 1 km² area on a RADARSAT-1 image filtered with 5 x 5 directional filter. Consequently, the lineament density map is distinguished into three classes of low (<335 m), moderate (335-818 m) and high (> 818 m). The thermal signature map was produced from band 6 of the Landsat 7 ETM+ satellite image and it is classified into every 10˚C class with the maximum of > 60˚C (maximum heat up 68˚C). The class above 50˚C is classified as high heat signature. The final geothermal potential map is produced by overlaying both of the maps together. Existing geothermal sources found in the field were later used to validate the potential map. Based on the field investigation, there are five geothermal sites in the study area. Three of the sites are located in the high lineament density class and four out of the five sites were classed into high heat spot in the thermal map. The recorded temperatures for the five geothermal sites are 47⁰ to 60˚C. The final potential map shows that 147 km² of the study area is classified as highly potential to have geothermal sources. Three out of five existing geothermal sites are located in the high potential area. Moreover, this potential area is not populated and still covered with dense vegetation.

Keywords: Geothermal, lineament, thermal, remote sensing, geothermal potential map

INTRODUCTION

Geothermal activities often manifest itself by the existence of fumaroles and hot steams on the earth's surface. However, these phenomena are not often observable in areas that are dense with vegetation. The use of remote sensing in identifying geothermal area has been well established and demonstrated in the literatures (e.g. Yamaguchi *et al.*, 1992; Siahan *et al.*, 2011; Peng *et al.*, 2013).

The study area is located area in Hulu Langat, Selangor with an area of 457 km^2. Five points of geothermal sites (location) were identified in the study area. The points were recorded where steam and hot water pond were observed.

METHODOLOGY

The reconnaissance research concerning parameters such as lineament density and thermal signature maps. The lineament density were identified accordingly to the viable lineament length in each 1 km^2 area on a RADARSAT-1 image filtered with 5 x 5 directional filter. Consequently, the lineament density map is distinguished into three classes of low (<335 m), moderate (335-818 m) and high (> 818 m).

The thermal signature map was produced from band 6 of the Landsat 7 ETM+ satellite image and it is classified into every 10˚C class with the maximum of > 60˚C (maximum heat up 68˚C). The class above 50˚C is classified as high heat signature. The final geothermal potential map is produced by overlaying both of the maps together. Existing geothermal sources found in the field were later used to validate the potential map.

RESULT & CONCLUSION

The landslide density and thermal maps were intersected with the five sites identified from the field. Three of the sites are located in the high lineament density class and four out of the five sites were classed into high heat spot in the thermal map. The recorded temperatures for the five geothermal sites are 47^0 to 60˚C. The final potential map shows that 147 km^2 of the study area is classified as highly potential to have geothermal sources (Figure 1). Three out of five existing geothermal sites are located in the high potential area. Moreover, this potential area is not populated and still covered with dense vegetation.

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REFERENCES

Peng, F., Xiong, Y., Cheng, Y., Fan Q., & Huang, S. 2013. Towards Application of Remote Sensing Technology in Geothermal Prospecting in Xilingol in Eastern Inner Mongolia, NE China. Advanced Materials Research, 610-613, 3628-3631.

Siahan, M.N., Soebandrio, A., & Ketut, W. 2011. Geothermal Potential Exploration Using Remote Sensing Technique (Case Study : Patuha Area, West Java). Asia Geospatial Forum

Yamaguchi, Y.H., Hase, H., & Ogawa, K. Remote Sensing for Geothermal Application, Episodes, 15, 1, 62-67.

P038

Sumber Geowarisan dan Geopelancongan di Sekitar Pembangunan Wilayah Koridor Galakan Pelancongan Negeri Perlis

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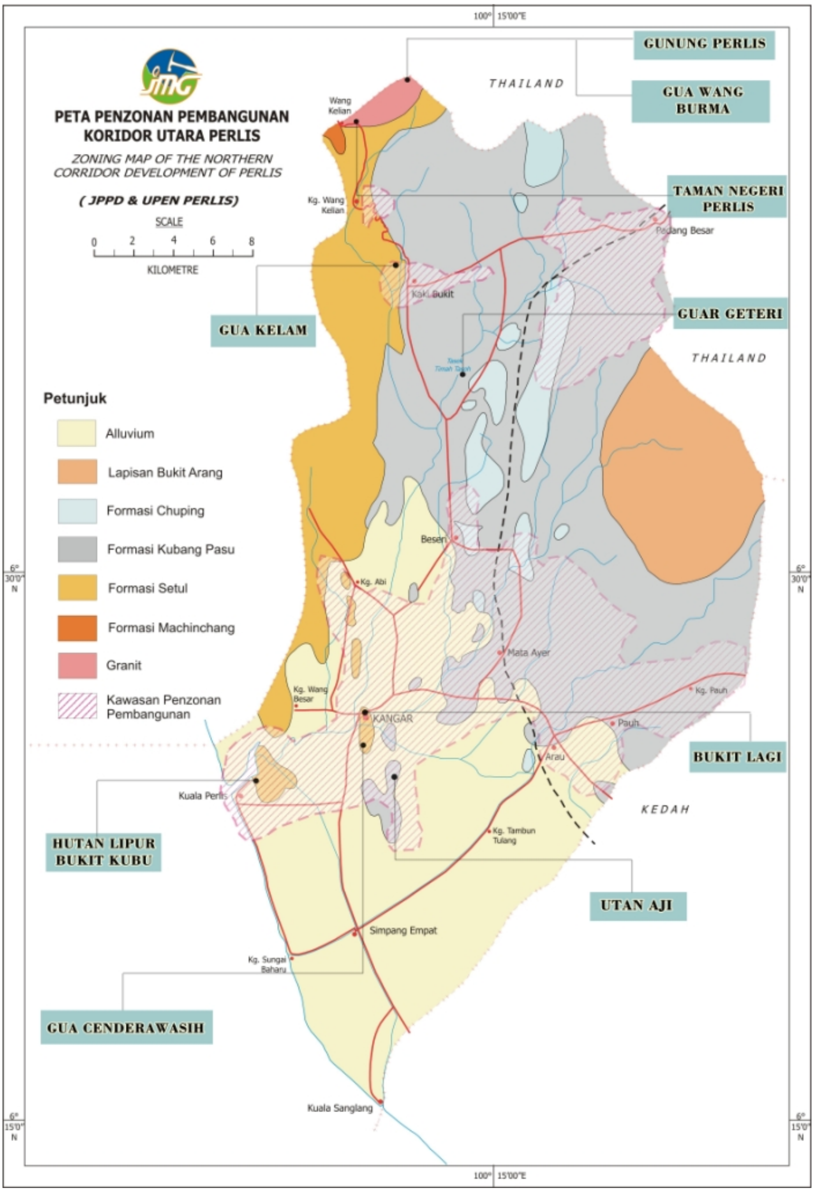
Geowarisan dan geopelancongan adalah pendekatan yang inovatif untuk memelihara warisan dan menggalakkan penyelidikan, pendidikan awam serta pembangunan ekonomi tempatan. Kepelbagaian khazanah geologi di Perlis menjadikan negeri ini antara negeri yang unik di Malaysia. Jujukan batuan di Perlis terdiri 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 seiiring 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.

RANCANGAN STRUKTUR TEMPATAN DAN PEMBANGUNAN WILAYAH EKONOMI KORIDOR UTARA NEGERI PERLIS

Pembangunan koridor utara adalah pembangunan yang berteraskan pembangunan ekonomi di negeri-negeri wilayah utara yang terdiri daripada negeri Perlis, Kedah, Pulau Pinang dan Perak. Tujuan pembangunan ini adalah untuk menarik pelabur-pelabur dari luar untuk melabur di negeri-negeri tersebut dan pada masa yang sama akan meningkatkan taraf ekonomi dan memajukan sektor-sektor yang berkaitan. Industri pelancongan juga menjadi salah satu fokus utama dalam membangunkan koridor raya utara.



Rajah 1 : Peta Lokasi Cadangan Geotapak Negeri Perlis

Selain itu, visi utama pembangunan ini adalah untuk mewujudkan wilayah ekonomi pilihan bertaraf dunia untuk tujuan pelaburan, tempat untuk tinggal, tempat untuk berkerja, tempat untuk menuntut ilmu, tempat untuk dilawati dan tempat untuk membesarkan keluarga dalam keadaan yang selamat, bersih dan persekitaran yang mapan. Berdasarkan sumber geowarisan dan geopelancongan yang terdapat di sekitar Perlis, ianya boleh menjadi salah satu tumpuan baru dalam industri pelancongan untuk dipromosikan dan pada masa yang sama turut mendidik masyarakat tentang kepentingan pengetahuan dalam bidang pemuliharaan warisan geologi.

Berdasarkan maklumat yang di perolehi dalam rancangan struktur tempatan bagi negeri Perlis (2009-2020), industri berteraskan arkeologi dan geologi merupakan kategori pelancongan yang baru dikenalpasti dalam kajian tersebut. Terdapat kira-kira 34 tapak arkeologi yang dipercayai berada di sekitar negeri Perlis yang mempunyai nilai-nilai arkeologi dan sumber geologi berdasarkan maklumat daripada kajian Kawasan Sensitif Alam Sekitar (KSAS). Namun begitu, terdapat beberapa kawasan yang masih belum dapat dikenal pasti dan diketahui oleh pengkaji mahupun masyarakat setempat. Daripada 34 tapak arkeologi tersebut kira-kira 6 tapak di cadangkan berdasarkan sumber geowarisan dan geopelancongan yang bertepatan.

Rancangan struktur tempatan Negeri Perlis bagi tahun 2009-2020 adalah bertujuan untuk merangka cadangan-cadangan pembangunan terperinci di peringkat Laporan Draf Rancangan Tempatan Majlis Perbandaran Kangar. Rancangan tempatan mempunyai teras-teras pembangunan utama yang secara amnya untuk membangunkan Negeri Perlis dari segala aspek dengan lebih licin dan mapan.

Melalui teras-teras yang terdapat dalam rancangan tempatan ini, pembangunan sumber geowarisan dan geopelancongan dapat dibangun secara seiring dan pada masa yang sama mewujudkan pertalian dalam membangunkan geotapak secara mapan.

Selain itu, berdasarkan laporan perangkaan sosioekonomi Negeri Perlis 2010, terdapat beberapa cadagan geotapak untuk sumber geowarisan dan geopenlancongan yang berada dalam kawasan cadangan pelan pembangunan sehigga tahun 2020 iaitu termasuklah Hutan Lipur Bukit Kubu, Gua Cenderawasih, Gua Kelam, dan Wang Kelian. Pembangunan di sekitar kawasan geotapak ini dapat meningkatkan lagi kecekapan dalam membangunkan sumber geowarisan dan geopelancongan di Negeri Perlis.

KESIMPULAN

Kawasan Pembangunan Koridor Wilayah Ekonomi Utara Negeri Perlis berpotensi besar dengan disertakan cadangan sumber geowarisan dan geopelancongan di Negeri Perlis yang terdiri daripada kawasan-kawasan yang memiliki sumber geologi yang bernilai tinggi dan saintifik. Sumber geowarisan ini juga boleh dipromosikan dan dijadikan salah satu ikon produk pelancongan Negeri Perlis. Selain itu, kawasan geotapak yang terletak dalam kawasan pembangunan yang dirancang akan menjadi lebih mudah untuk dipromosikan dan dipantau untuk kunjungan para pelancong ke Negeri Perlis. Ini kerana melalui pembangunan di sekitar kawasan tesebut secara tidak langsung usaha untuk menaik taraf dapat dilaksanakan disamping dapat memberi kesedaran kepada orang awam kepentingan warisan geologi melalui sejarah evolusi pembentukan bumi Perlis.

PENGHARGAAN

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RUJUKAN

Basir Jasin, 2010. Warisan Geologi Negeri Perlis, Geological Society of Malaysia Bull 56, 87-93

C. S. Hutchinson & D.N.K. Tan. 2009. Geology of Peninsular Malaysia. The University of Malaya and The Geological Society of Malaysia.

Dr. Selvarajah Marimuthu, 2008. Technical Paper Volume 5, Mineral And Geosciences Department Malaysia, 45-50 m.s.

Jabatan Perancang Bandar Dan Desa, 2009, Laporan Penemuan Rancangan Tempatan Majlis Perbandaran Kangar 2009-2010, 4: 1-95

Jabatan Perancangan Bandar dan Desa Negeri Perlis : Rancangan Struktur Negeri Perlis 2030. Warta Kerajaan Jilid 55 No.25 Tambahan No.1 Bertarikh 6 Disember 2012.

Kadderi Md Desa,1997. Geopelancongan : Potensi Geologi Dalam Memajukan Industri Perlancongan Di Malaysia. Di dalam Ibrahim Komoo, Mohd Shafeea Leman, Kadderi Md Desa & Ibrahim Abdullah. Warisan Geologi Malaysia LESTARI, UKM , 65-72

Mohd Shafeea Leman, 1997. Geology In The Malaysian tourism Industry. Di dalam Ibrahim Komoo, Mohd Shafeea Leman, Kadderi Md Desa & Ibrahim Abdullah. Warisan Geologi Malaysia LESTARI, UKM , 73-83

Unit Perancang Ekonomi Negeri perlis, 2010. Perangkaan Sosioekonomi Negeri Perlis 2010, m.s.70

Zamila Abdul Rahman, 2005. Pemetaan Sumber Warisan Geologi Perlis, Data Lapangan, Jabatan Mineral dan Geosains Malaysia Kedah/Perlis/Pulau Pinang

Source Rock Characteristics, Burial History Reconstruction and Thermal Maturity Modelling of Late Cretaceous Sequences in the Chad (Bornu) Basin, NE Nigeria.

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INTRODUCTION

Chad (Bornu) Basin, one of Nigeria's frontier inland sedimentary basins has recently been subject of interest where exploration activities are currently being undertaken. These inland basins constitute parts of a series of rift basins in central and west Africa whose origin is linked to the separation of the African crustal blocks in the Cretaceous as part of the West and Central African Rift System (Genik, 1993). Apart from the Chad (Bornu) Basin in Nigeria, commercial hydrocarbon deposits have been discovered in the other parts of the rift trend in neighbouring countries of Chad, Niger and Sudan, which are genetically related and have the same structural settings (Obaje et al., 2004). The poor knowledge of the evolution of the subsurface rocks in the Chad (Bornu) Basin, especially with respect to their characteristics and their thermal/burial histories may have been responsible for the unsuccessful exploration attempts within the basin. Although, few studies have been undertaken on the basin's source rock potential and organic matter (OM) maturity (Obaje et al., 2004), detailed organic geochemical investigations on the origin of organic matter, and their thermal/burial histories, and the timing of hydrocarbon generation and expulsion are lacking.

Basin modelling is a very useful discipline to reveal the timing, and to understand and quantify the complex processes of petroleum formation (Waples, 1994). The incorporation of source rock characteristics into basin modelling can give more detailed information needed to answer exploration questions on hydrocarbon generation and expulsion of the source rocks. This current study focuses on the detailed geochemistry of the Upper Cretaceous sediments in Chad (Bornu) Basin, to provide an overview of the organic richness, hydrocarbon generation potential and level of maturity of the organic matter in the sediments. In addition, the results of source rock characteristics were incorporated into basin modelling in order to know and determine the timing of hydrocarbon generation and expulsion of the source rocks. This is aimed at providing further insight into the source rocks of the basin, for the current and future petroleum exploration programme and resource assessment in the basin.

SAMPLES AND METHODS

Organic geochemical analyses were carried out on a total of 115 cutting samples from five exploration wells (Kanadi-1, Kemar-1, Kinasar-1, Kuchalli-1 and Tuma-1 Wells) drilled by the Nigerian National Petroleum Corporation in the Chad (Bornu) Basin. The samples were collected from Gongila and Fika formations, which have been generally regarded as potential source rocks in the basin.

GEOCHEMICAL ANALYSES

The Geochemical methods used to evaluate the source rock potential of the sediments included the determination of total organic carbon (TOC) content, pyrolysis and open pyrolysis-gas chromatography (Py-GC). Whole rock samples were crushed and analysed using Weatherford Source Rock Analyzer-TPH/TOC (SRA) instrument. Parameters measured include total organic carbon (TOC), free hydrocarbons (S_1) in the rock, remaining hydrocarbon generative potential, mg HC/g rock (S_2), CO_2 expelled from pyrolysis of kerogen (S_3) and temperature of maximum pyrolysis yield (Tmax). Hydrogen (HI), oxygen (OI), production yield (PY), and production (PI) indexes were calculated. Following pyrolysis, some samples were selected for further geochemical analyses and microscopic examinations. Open system pyrolysis-gas chromatography (Py-GC) was applied to provide compositional and structural characteristics of kerogen. This analysis was performed on isolated kerogen samples using a *Double-Shot Pyrolyzer PY-2020iD* from Frontier Laboratories Ltd. An HP-Ultra1, 50 m x 32 mm i.d., dimethylpoly-siloxane-coated column (0.52 lm film thickness) was fitted into an Agilent GC chromatograph equipped with a pyrolysis unit and flame ionization detector. Pyrolysis products were released over the range 300–600 °C (25 °C/min) and collected in a nitrogen-cooled trap. Identification of peaks based on reference chromatograms was done manually with Agilent ChemStation software. Samples for petrographic examinations were made using standard organic petrographic preparation techniques. Polished sections of cutting samples were analysed. Petrographic examinations were carried out under oil immersion in a plane polarized reflected light, using a LEICA DM 6000M microscope and LEICA CTR6000 photometry system equipped with fluorescence illuminators. Mean vitrinite reflectance (Ro %) was measured and conducted on particles of vitrinite maceral that are not associated with strong bitumen staining using a microscope with white light source, photometer, and oil immersion objectives.

1-D BASIN MODELS

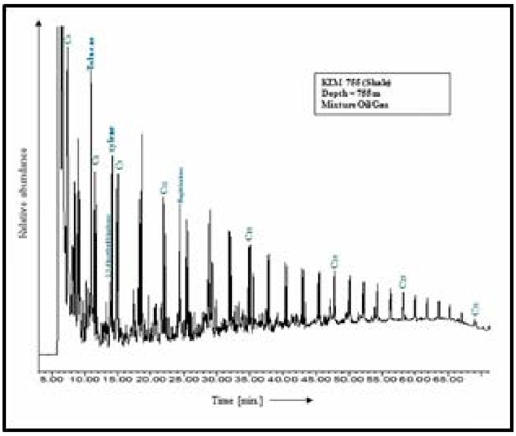
In this study, quantitative one-dimensional (1-D) basin modeling was performed to evaluate the burial/thermal histories and timing of hydrocarbon generation and expulsion of the Late Cretaceous sequences in the Chad (Bornu) Basin. The reconstruction of the burial, thermal and maturity histories was modelled using PetroMod 1-D (version 10.0 SP1) software developed by IES, Aachen, Germany. Major 1-D model input parameters comprise events or formations within the chronostratigraphy, deposition age, present and eroded thicknesses of formations and events, volumetric lithological mixes, kerogen types and kinetics and further geochemical parameters such as initial %TOC. The modelling results were also calibrated with measured vitrinite reflectance and borehole temperatures (BHT) of the five wells in the study area.

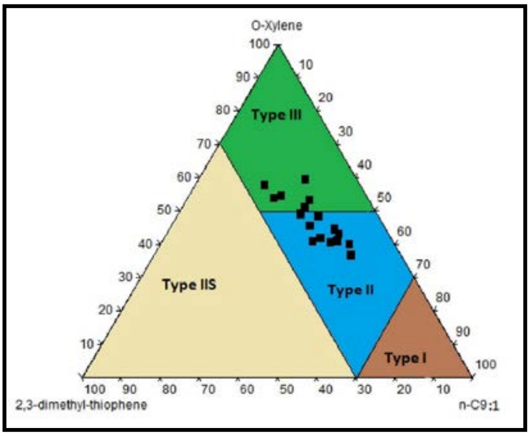
RESULTS AND DISCUSSION

Over 90% of the analysed samples have TOC > 0.5 wt.%, which is the required threshold for hydrocarbon generation (Peters and Cassa, 1994). The analysed shale samples also have S_2 pyrolysis yield and HI values in the range of 0.06–1.96 mg HC/g rock and 18–185 mg HC/g TOC, respectively. These values reveal that most of the analysed samples meet the accepted standards of a source with fair to good hydrocarbon generative potential. Characterisation of organic matter type conducted based on whole rock samples using pyrolysis data such as HI, OI, and T_{max} values indicates that the organic matter in the shale samples is predominantly Type III kerogen with mixture of Type II-III kerogen. All of the shale samples have hydrogen indices that can be expected for mainly gas- and oil- prone source rocks.

The Py-GC pyrograms of the isolated kerogen from shales samples are generally dominated by a homologous series of *n*-alkene/alkane doublets, reaching a maximum chain length of > 30 carbon atoms. The Py-GC pyrograms also display prominent *n*-alkane/*n*-alkene doublets in the low molecular weight end ($<n$-C_{10}) and high molecular weight end ($>n$-C_{15}) with some abundant light aromatic compounds such as benzene, toluene, ethylbenzene, xylenes, alicyclic compounds such as naphthalenes, and sulphur compounds, mainly thiophenes (Fig. 1). These are indicative of relatively aliphatic- rich with significant aromatic compounds and suggest a mixture of oil and gas generation. Eglinton et al. (1990) introduced a ternary diagram based on pyrolysate 2,3-dimethylthiophene, o-xylene and C_9:1 (alkane component), which represents the organic sulfur, aromatic and aliphatic structures within the macromolecular organic matter. Furthermore, the selected compounds can be directly related to different kerogen types (I, II, III and II-S). Following this classification, most of the organic matter in the analysed samples comprises of Type II to Type III paraffinic kerogen (Fig. 2). Horsfield (1989) has also shown that the distribution of *n*-alkyl chains within kerogen pyrolysates can be directly related to the petroleum type formed from the respective kerogen in nature. The majority of the analysed shale samples fall within the field of low wax paraffinic-naphthenic-aromatic (PNA) oils with a gradual transition into the high wax PNA and paraffinic oil field.

Calibration of the model with measured vitrinite reflectance (Ro) and borehole temperature (BHT) data reveals that the present-day heat flow in the Chad (Bornu) Basin varies from 55.0 mW/m2 to 60.0 mW/m2 and paleo-heat flow value at approximately 68 mW/m^2. The maturity modelling of the wells indicates that the Gongila and Fika source rocks are presently at a stage of oil, condensates and gas generation with thermal maturity ranging from 0.70% to 1.39% Ro. The modelled burial history also suggests that maximum burial occurred in the late Miocene and that erosion might have been the cause of the thinning of the Tertiary sediments in the present time.





Left- Fig. 1: Representative Py-GC chromatogram of one of the analysed samples (KEM 755), a wax rich Type II kerogen (oil and gas-prone). *Right*- Fig. 2: Kerogen type classification of Pyrolysis-GC data according to Eglinton et al. (1990).

CONCLUSIONS

Organic geochemical and petrographic investigations indicate that the Upper Cretaceous sediments possess generally fair to occasionally good source generative potential. The sediments have attained sufficient burial depth and thermal maturity for significant hydrocarbon generation potential. The incorporation of source rock characteristics into basin modelling has given more detailed information needed to answer exploration questions on hydrocarbon generation and expulsion of the source rocks. This has provided further insight into the source rocks of the basin, for the current and future petroleum exploration programme and resource assessment in the basin.

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REFERENCES

Eglinton, T.I., Sinninghe Damsté, J.S., Kohnen, M.E.L., de Leeuw, J.W., Larter, S.R. & Patience, R.L., 1990. Analysis of maturity-related changes in the organic sulfur composition of kerogens by flash pyrolysis-gas chromatography. In: Geochemistry of Sulfur in Fossil Fuels. American Chemical Society, pp. 529–565.

Genik, G.J., 1993. Petroleum geology of Cretaceous-Tertiary rift basins in Niger, Chad, and Central African Republic. American Association of Petroleum Geologists Bulletin, 77,1405–1434.

Horsfield, B., 1989. Practical criteria for classifying kerogens: Some observations from pyrolysis-gas chromatography. Geochimica et Cosmochimica Acta, 53, 891–901.

Obaje, N.G., Wehner, H., Scheeder, G., Abubakar, M.B., & Jauro, A., 2004. Hydrocarbon prospectivity of Nigeria's inland basins: from the viewpoint of organic geochemistry and organic petrology. American Association of Petroleum Geologists Bulletin, 88, 325–353.

Peters, K.E. & Cassa, M.R., 1994. Applied source rock geochemistry. In: Magoon, L.B., Dow, G.W. (Eds.), The Petroleum System – from Source to Trap. American Association of Petroleum Geologists Memoir, 60, pp. 93–120.

Waples, D.W., 1994. Maturity modelling: thermal indicators, hydrocarbon generation, and oil cracking. In: Magoon, L.B., Dow, W.G. (Eds.), The Petroleum – System from Source Trap. American Association of Petroleum Geologists Memoir, 60, pp. 285–306.

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Kepelbagaian Sumber SilikaDi Negeri Perak

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Keunikan persekitaran geologi negeri Perak menjadikan negeri ini terkenal sebagai pengeluar pelbagai jenis mineral di Malaysia. Secara umumnya geologi negeri Perak terdiri daripada 42% batuan igneus (granit), 31% batuan sedimen/ metasedimen dan 27% enapan kuaterner/ aluvium. Sebahagian besar enapan aluvium (enapan plaser) di negeri Perak pernah dijalankan aktiviti perlombongan bijih timah (terutamanya lombong pam kerikil) yang secara tidak langsung menghasilkan hampas lombong yang sebahagiannya terdiri daripada pasir. Kebanyakan butiran pasir tersebut terdiri daripada komponen bahan silika (SiO_2). Secara komersialnya, pasir yang mengandungi peratusan SiO2 ≧95% dikelaskan sebagai pasir silika manakala selebihnya dianggap pasir binaan. Rizab pasir silika yang pernah dilaporkan terdapat pada kawasan Segari, Tronoh, Jeram, Malim Nawar, Kampar, Coldstream, Sungkai, Ulu Slim dan Behrang adalah sekitar 80.4 juta tan metrik. Terdapat juga enapan pasir semulajadi yang terbentuk terutamanya di kawasan pantai dan disepanjang kebanyakan sungai di negeri ini. Sumber pasir ini tidak diketahui jumlah rizab sebenarnya tetapi rekod pengeluaran tahunannya menunjukkan negeri Perak adalah antara pengeluar utama pasir di Malaysia. Pengeluaran keseluruhan pasir yang direkodkan pada tahun 2012 adalah 8.7 juta tan mertik. Daripada jumlah tersebut, 6.2 juta tan mertik adalah pasir lombong, 2.2 juta tan mertik pasir sungai dan selebihnya (0.3 juta tan mertik) adalah pasir silika (pasir lombong berketulinan SiO2 ≧95%). Sumber silika ini digunakan sebagai bahan asas dalam industri kaca, seramik dan pembinaan infrastruktur. Selain daripada pasir silika, sumber baru silika yang sedang diteroka adalah dalam bentuk agregat batuan yang membolehkan kegunaannya dalam industri seperti penghasilan ferrosilicone alloy dan polysilicone (bahan mentah kepada industri berteknologi tinggi seperti peralatan optik, elektronik, penghasilan panel solar, farmasiutikal dll). Sumber tersebut boleh diperolehi daripada jasad kuarza dan kuarzit. Maklumat awal menunjukkan terdapat dua kawasan permatang kuarza dan satu kawasan permatang kuarzit yang masing-masing mempunyai rizab sekitar 6.5 juta tan metrik (kuarza) dan 4.4 juta tan metrik (kuarzit) berpotensi untuk dimajukan di negeri Perak. Kuarza yang ditemui di kawasan Hulu Lasah mempunyai ketulinan purata SiO2 sekitar 99.1% manakala Ulu Kinta sekitar 98.4%. Kuarzit yang ditemui di kawasan Lawin pula menunjukkan ketulinan purata SiO2 sekitar 97.9%. Ketiga-tiga sumber batuan silika ini dipercayai boleh digunakan dalam industri penghasilan ferrosilicone alloy manakala sumber daripada Hulu Lasah dipercayai boleh juga digunakan dalam industri polysilicone. Kebergantungan penggunaan produk berasaskan silika dalam kehidupan kita seharian bergantung kepada keterusan bekalan bahan mentah silika dunia. Kualiti sumber silika dari segi ketulinan SiO2 dan sifat fizikalnya amat penting bagi penentuan penggunaannya dalam indistri tertentu. Kepelbagaian sumber silika yang terdapat di negeri Perak boleh dianggap sebagai pemberian alam yang amat berharga. Ia boleh memacu kepada perkembangan pembangunan dan kemajuan ekonomi negeri Perak serta negara dan seharusnya diterokai dan dirancang pengusahasilannya secara lestari agar etika pembangunan mapan dapat dipatuhi.

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Optimization of Malaysian Mica in Oil Based Mud

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It has been observed that lost circulation is one of the troublesome and costly problems encountered during drilling operation even with the best drilling practices. severity of loss of circulation can be classified according to the mud lost rate in the fractured formation. Considering the fact that lost circulation is one of the most serious and expensive problems the drilling industry is currently facing, lost circulation material (LCM) is one of the methods to solve this problem. This report basically discusses the preliminary research and basic understanding of the chosen topic, which is Optimization of Malaysian Mica in Oil Based Mud. Preliminary research will lead to further study on the subject until the satisfactory result is obtained. This research will be a stepping stone for future research of the potential drilling fluid additives which is obtainable from abundant local resources. Malaysia has not been explored for the possible use of local MICA. Local MICA will be experimented for possible use as MICA and to be compared with the characteristics of the existing MICA in the market. The source of Mica is taken from Tapah, Malaysia where KAOLIN(M) SDN BHD is operating the quary. This project involves a lot of lab work to test the efficiency of Malaysian Mica. Finally, this project will identify the optimization of Malaysian Mica to be use in drilling operation as LCM in oil based mud.
Keywords: Malaysian Mica, Lost Circulation Material, Oil Based Mud

INTRODUCTION

Drilling fluid performance is a major component that contributes to the drilling operations' success. This fluid is mainly used to promote borehole stability, removing drilled cuttings from borehole, cool and lubricate the bit and drill string, and to control the subsurface pressure.

For drilling fluids perform these functions and allow drilling to continue, the drilling fluids must be present in the borehole . Unfortunately, undesirable formation conditions are encountered causing drilling fluids lost to the formation. A proper designed drilling fluid will enable an operator to achieve and overcome the desired geological objectives at the lowest overall cost.

According to Ross, Williford and Sanders (1999), fluid loss has long been recognized as a major concern when determining completion costs and assessing well management. Even with best drilling practices, fluid circulation loss still occurring. For this reason, much research has been dedicated to investigating various methods and equipment to address the scenarios from which fluid loss results.

Lost circulation is a term used to define the loss of drilling fluid into the formation voids instead of returning up to the surface. Loss circulation occurs when applying more mud pressure on the formation than it is strong enough to withstand, thereby mud flows into fracture that have been created. This process is known as overbalanced drilling. Lost circulation can take place while drilling is in progress or during "trips", when pressure surges occur because of the lowering of drillpipe or casing in the hole. After the lost circulation occurs, the level of the drilling fluid in the annulus may drop and stabile at a particular level, depending on the formation pressure (Nayberg T., 1987). Loss zone can be classified as seepage loss(minor loss), partial loss and complete loss(major loss). Loss circulation problem is both troublesome and costly such as lost rig time, stuck pipes, blow outs and reduction in production.

PROBLEM STATEMENT

Mica used in the drilling fluid to ensure the control loss circulation in a wellbore formation. Micas' are usually imported from India. Having to import Mica is one of the reasons why drilling fluids are expensive. This project sees whether or not the Mica found in Malaysia is suitable as an additive for the drilling fluid.

It is best to be able to use the Mica found in Malaysia due to several economical reasons, the first is that the balance of payment of a country decreases. Money leaves the country when you import items, not only do you pay for the item; you have to also pay for the imports and tariffs that come with it. However if the Mica was produce locally, manufactures not only save money on the transaction and transportation cost, they also save money on paying import tariffs. Thus, making the much more attractive to be produce in a larger amount.

Now that we have seen the benefit it gives to the private company, we will see how much it helps the economy of our country as a whole. The campaign "Belilah Barangan Buatan Malaysia" will now be applicable in a larger framework.

Due to the benefit of both the private companies and our country, I am determined to study if the Mica available in Malaysia are suitable for forming drilling fluids.

OBJECTIVES

Develop LCM from local Mica (Malaysia)

Formulate oil based mud with LCM chosen and testing with current technology

Evaluate the efficiency and compatibility of Malaysian.

LITERATURE REVIEW

Loss circulation is a major problem in determining the completion cost and during the assessment of well management. . Numerous papers have been written over the years on loss circulation. Many of these papers describe a specific method that has been used to address the problem, and a number of innovative devices and fluids have been developed.

According to the journal Effect of Material Type and Size Distribution on Performance of Loss/Seepage Control Material. In general, four types of formations are responsible for lost circulation which is natural fractured formations, cavernous formations, highly permeable formations or unconsolidated formations and induced fracture formations. Even with the best drilling practices, circulation losses can occurs in varying degrees and the severity of these losses is an indicator of the mud loss to the formation. Loss zones can be classified as:

For the study of LCM, the paper entitled Laboratory Study of Lost Circulation Materials for Use in Both Oil-Based and Water-Based Drilling Mud published by Nayberg T. on 1987 was reviewed. The objective of this paper is to give a rough idea on estimating the appropriate loss circulation material (LCM) to be used in drilling fluid to prevent loss circulation. In this paper, LCM can be divided into three groups according to their morphology: fiber(ex. : raw cotton and cedar wood fibers) , flakes(ex.: cellophane, mica and cork) and granules(ex.: grounded walnut shell and gilsonite). Based on this paper, there are four basic factors affecting the performance of a LCM which are the concentration of LCM in mud, LCM particle size distribution, the size of largest particles in the material and the quantity of the largest particles.

Besides that, the journal entitled Effect of Material Type and Size Distribution on Performance of Loss/Seepage Control Material by Pilehvari A. and Nyshadham R. on 2002 has been reviewed. A wide variety of materials have been used to combat lost circulation over the years. The choice of lost circulation material to use in a given case is influenced to some degree by cost and availability in a given drilling area. According to the journal, for the purposes of classification, LCM's can be divided into fibers, flakes, granules and mixtures. The fibrous LCM's are used mainly in drilling muds to lessen the mud loss into large fractures or vugular formations, where as flaky type LCM's can plug and bridge many types of porous formations to stop the mud loss or establish an effective seal over many permeable formations. The granular LCM's form bridges at the formation face and within the formation matrix, thus providing an effective seal, which depends primarily on proper particle size distribution to build a bridge having decreasing permeability, as it is being laid down. Finally blended LCM's are combination of granular, flake and fibrous materials that will penetrate fractures, vugs or extremely permeable zones and seal them off more effectively.

SCOPE OF STUDY

The research will involve in the understanding of LCM in drilling fluid. The study of this project can be broken down to the identification of the appropriate LCM and the method of studying and evaluating effectiveness of LCM in oil-based drilling fluid.

The scope of study mainly investigates the fluid loss properties of the Malaysian Mica. The study will be divided into two stages, the first stage involves researching the basic properties of the Mica and determining an ideal formulation to be developed. The second stage will focus on experimental work in the lab, using the mica with particular attention given to the characteristics of Malaysian Mica and its fluid loss behavior.

Type of Loss Zones	Lost Severity (bbl/hr)
Seepage Loss	1-10
Partial Loss	10-500
Complete Loss	>500

Table 1: Loss Zone Classification (Ali A. Pilehvari 2002)

Table 2: Activities And Description

Activities	Description	
Research and Review Literatures	Building the research base Extract relevant parameters and procedures	
Preparation of LCM and mud formulation	Order Mica in powder form prior to mix with mud Design mud formulation for oil based mud system to analyze the LCM applicability and effectiveness Tools required (multimixer)	
Testing mud plus industrial used LCM	Prepare oil based mud with current uses Mica Measure all the properties of with Malaysian Mica	
Testing mud plus new LCM	Properties	Tools Required
	Density	Mud Balance
	Viscosity	March Funnel
	Electric Stability	ES Meter
	Plastic Viscosity Gel Strength Yield Point	Viscometer(Fann 35)
	Filtrate Volume Mud cake thickness	High Pressure High Temperature Filter Press
Analyze the Results	Discuss the findings from the results obtained and make a conclusion out of the study	
Report Writing	Compilation of all works into a final report	

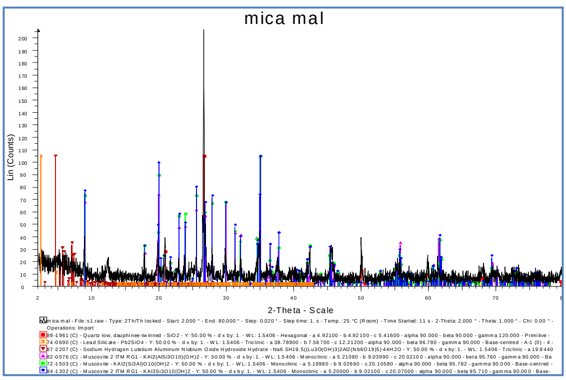

Figure 1: XRD on Malaysian Mica

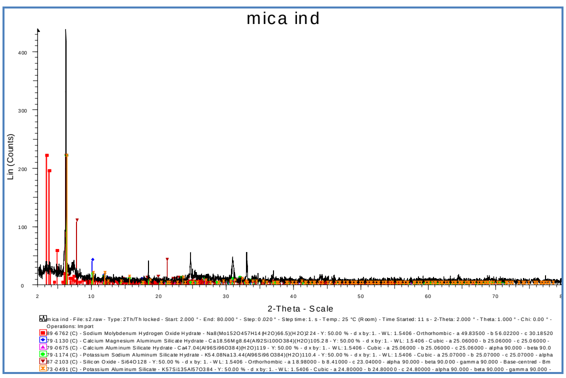

Figure 2: XRD on Indian Mica

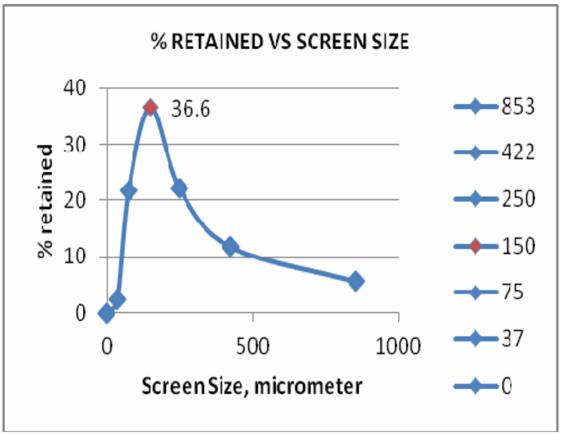

Figure 4: PSD on Malaysian Mica

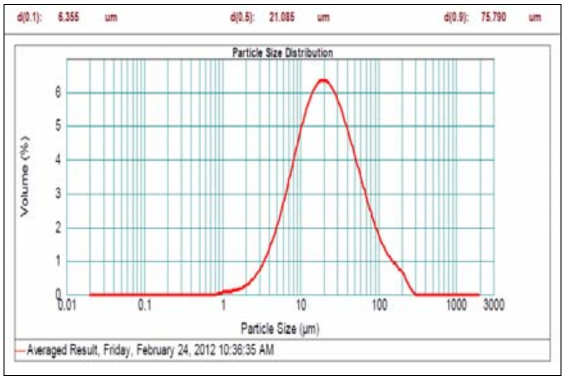

Figure 5: Plastic Viscosity vs Amount of Malaysian Mica

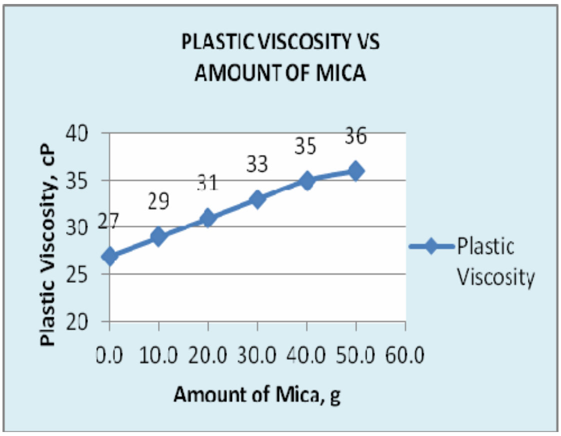

Figure 6: Yield Point vs Amount of Malaysian Mica

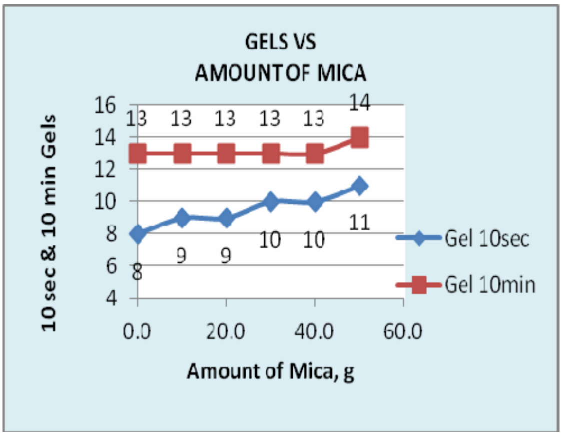

Figure 7: Gel Strength vs Amount of Malaysian Mica

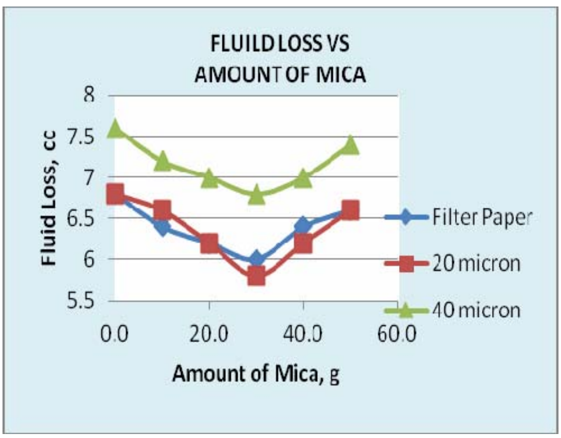

Figure 8: Gel Strength vs Amount of Malaysian Mica

METHODOLOGY

The assessment on the efficiency of Malaysian mica as LCM in comparison with overseas mica will be done in oil-based mud. The main criteria for evaluate the LCM is through running the loss circulation experiment. Besides that several studies and experiment conducted on the properties of the LCM such as mud density, rheology of mud, filtration and thickness of mud cake.

There are 2 types of experiments are being carried out in this project. First, is to test the physical properties of the Malaysian and Indian Mica. Physical properties of the materials that are tested:-

Mineralogy of the material (XRD machine)

Particle Size Distribution (Sieving method)

Second experiment that is carried out is upon mixing the mud using the Malaysian Mica(Table 2).

DISCUSSIONS

Based on both the XRD results interpretation, Malaysian Mica is from Mica Muscovite(ground Mica) with general chemical formula of KAl2(AlSi3O10)(F,OH)2 and Indian Mica is from Mica Biotite with general chemical formula of K(Mg,Fe)3AlSi3O10(F,OH)2. Based on these results, direct comparison of Indian Mica and Malaysian Mica cannot be made since the materials are different.

The average particle size distribution for Indian Mica is 150 micronmeter whereas the average particle size distribution is 21.085 micronmeter.

In conclusion, to compare both LCMs', the basic criteria is to have the same particle size distribution(PSD). In our case, the PSD is far different. Since, direct comparison cannot be done in the project. The author has decided to test the compatibility of Malaysian Mica to be used in certain formations.

DISCUSSION OF MALAYSIAN MICA IN OIL BASED MUD

Viscosity is the term that describes resistance to flow. So high force need to be applied for move the high viscosity liquids, whereas low viscosity fluids flow relatively required less force and easy to move. Plastic viscosity is a function of solids concentration and shape. It will be expected to increase with decreasing particle size with the same volume of solids. Moreover, it also can be increased by addition of more lost circulation material in the mud. This can be proven in the experiment as the amounts of LCM are increased, the value of PV also increased. In short, PV should be as low as possible in order to have low pumping rate for mud circulation.

Yield point is the attractive force in the mud under flow conditions. The magnitude of these forces will depend on the type of their solid present, the ion concentration in the liquid phase (Growcock F, 2005). From the figure below which represents by the mud plus LCM, the value of yield point for mud increasedas the concentration of LCM increased.The value of yield point will increase as the amount of solid increased. It is similar compared to the actual results.

Gel strength indicates the pressure required to initiate flow after the mud has been static for some time and the suspension properties of the mud. In short, gel strength is the abilit of a drilling fluid to suspend the cutting when the drilling fluid is in stationary condition. Gel strength, 10 seconds and 10 minutes indicate the strength of attractive forces in drilling fluid under static condition. Excessive forces is caused by high solids concentration leading to flocculation. The 10 minutes gel strength will lead to a higher floculation since it has more time. The best drilling fluid has a fragile gel strength where the forces needed to break the circulation is low over time. In general, high gel strengths are not desirable and can even be dangerous. However, the concentration of Malaysian Mica does not give significant change to the gel strength reading.

Based on the experiment, it is observed that the solid from the mud will form a layer of solid called "mud cake" on the filter paper where the mud is pressurized. Filtrate volume from the experiment indicates the amount of fluid loss from the mud to the formation where it simulates the quantity of fluid loss inside the wellbore. The preferable filter cake should be thin, impermeable, and have correct solids distribution to prevent fluid loss effectively. In normal conditions, Thick filter cake will increase the chance of stuck pipe. The lower the filtrate volume the thinner the mud cakes, means that good fluid loss control in mud. When the LCM concentration is increased, the filtrate volume will reduce until one point, then it will start increasing after reaching the optimum point due to excessive Mica in the drilling fluid. Since our Mica is about 21micronmeter in average. It works better in 20 micron ceramic disk compared to 40 micron.

Based on the results and discussions above, the optimum concentration of Malaysian Mica is 30g. So, this concentration was chosen to be compared to the formulation without to evaluate the properties Malaysian Mica as LCM. The results are shown in Appendix 2. Based on the results in Appendix 2, viscosity is increased about 22.2%, the yield point is increased about 15.4%, the gel strength is around the same, and the amount of filtrate is decreased by 11.8% for filter paper, 14.7% for 20 micron ceramic disk and 10.5% for 40 micron ceramic disk. In short, the properties of Malaysian Mica as LCM can be used in the drilling fluid industry depending to the type of formation problem.

CONCLUSION

The aim of the project to identify the effectiveness of Malaysian Mica as a Loss Circulation Material(LCM) is achieved for certain formations. Lost circulation material is very important in preventing mud losses to the formation. Even with the best drilling practices lost circulation still occur. Thus it is essential to put lost circulation material to minimize mud losses to the formation and Malaysian Mica was chosen to be the lost circulation material in this project. Overall, it is justified that Malaysian Mica is appropriate and can be used as a new LCM because of its availability, cost effective, and effective in combating loss circulation problem for certain type of formations.

RECOMMENDATIONS

There are still a lot of things need to be done first before the product can be commercialized to the market as the experiments only covered the testing of the mud with ultra fine Malaysian Mica only. Further testing with all different particle size (fine, medium and coarse) are still needed to confirm the effectiveness of using Malaysian Mica as lost circulation material in the industry. More tests should be conducted to get an accurate result such as formation damage system test, X-Ray fluorescence test, and etc. These tests should be able to justify, identify and investigate further the properties of the fluid and the Malaysian Mica itself.

ACKNOWLEDGEMENT

The author would like to extend his deepest gratitude to AP Askury, his FYP supervisor and the lab technicians from drilling fluid lab for the guidance rendered throughout this project period. Special thanks also to Universiti Teknologi PETRONAS for providing him lab facilities to run the experiments.

REFERENCES

Colby M. Ross, James Williford, and Michael W. Sanders, (1999), Current Materials and Devices for Control of Fluid Loss, SPE 54323.

T.M Nayberg and B.R Petty, 1986, Laboratory Study of Lost Circulation Materials for Use in Both Oil-Based and Water-Based Drilling Mud, Journal of Society of Petroleum Engineers, SPE 14723.

Ali A Pilehvari and Venkata R. Nyshadham, 2002, Effect of Material Type and Size Distribution on Performance of Loss/Seepage Control Material, SPE 73791

Mark W. Sanders, Jason T. Scorsone and James E. Friedheim, SPE,MI-SWACO 2010, High Fluid Loss, High Strength Loss Circulations Material, Journal of Society of Petroleum Engineers, SPE 135472.

Clarence O.Walker, Richmond, 1985, Encapsulated Water Absorbent Polymers As Loss Circulation Additives for Aqueous Drilling Fluids, US Patent Number – 4664816.

H.C.H. Darley, and George R. Gray, (1988), Composition and Properties of Drilling and Completion Fluids, 5th ed. USA: Gulf Professional Publishing.

Growcock F. (2005), Driilling Fluids. ASME Shale Shaker Committee, Elsivier, USA.

Recommended practice standard procedure for field testing oil-based drilling fluids(1998), American Petroleum Institute.

Hydrocarbon Generation Potential, Source Input and Depositional Condition of the Miocene Bhuban Formation Shales, Bengal Basin, Bangladesh.

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1. INTRODUCTION

The Bengal Basin covers whole of Bangladesh and part of India and it is bordered with three sides by India and one small side by Myanmar. The Bhuban Formation of the Miocene age is composed mainly of alternating shales and sands whereby the shales having long been considered as source rocks and the sandstones as reservoirs for gas/oil in the Bengal Basin. To date, no comprehensive study has been published of the organic geochemistry or organic petrography of the Bhuban Formation. Here we present data from both techniques for Bhuban Formation and draw some conclusions relating to hydrocarbon generation potential and depositional condition of this formation.

Table 1. Source Rock Analyzer (of Rock-Eval equivalent) parameters and vitrinite reflectane (%Ro) data of the analyzed Bhuban shale samples.

Sample	Gas Field	Well no.	Formation	Depth (m)	TOC	S1	S2	S3	Tmax (˚C)	HI	OI	PI	%Ro
KSH2	Kamta	1	Bhuban	3138	0.26	0.05	0.22	0.45	429	85	139	0.19	0.59
KSH3	Kamta	1	Bhuban	3139	0.27	0.06	0.26	0.39	433	96	143	0.19	0.60
KSH4	Kamta	1	Bhuban	3377	0.53	0.11	0.33	0.42	435	84	107	0.25	0.63
BSH5	Begamganj	1	Bhuban	3142	0.28	0.05	0.22	0.29	435	80	105	0.19	0.71
BSH6	Begamganj	1	Bhuban	3173	0.32	0.05	0.24	0.25	439	75	78	0.17	0.71
FSH7	Fenchuganj	2	Bhuban	3142	0.29	0.06	0.23	0.48	431	81	168	0.21	0.57
FSH8	Fenchuganj	2	Bhuban	3772	0.36	0.05	0.23	0.44	440	63	121	0.18	0.60
FSH9	Fenchuganj	2	Bhuban	3773	0.40	0.05	0.24	0.36	440	60	90	0.17	0.71
TSH54	Titas	11	Bhuban	2714	0.61	0.33	1.41	0.81	434	232	133	0.19	0.58
TSH65	Titas	11	Bhuban	2783	0.34	0.03	0.13	0.02	439	39	64	0.19	0.62
TSH68	Titas	11	Bhuban	2792	0.30	0.10	0.38	0.27	441	128	91	0.21	0.66

[Note: TOC= total organic carbon (wt.%), S1= free HC (mg HC/g Rock), S2= hydrolysable HC (mg HC/g Rock), S3= CO2 generated from pyrolysis, Tmax= maximum temperature at top S2 peak (deg C), HC= hydrocarbon, HI= hydrogen index (mg HC/g TOC), OI= oxygen index (mg HC/g TOC), %Ro= random vitrinite reflectance]

2. SAMPLES AND METHODS

A total of 11 shale core samples of Bhuban Formation are collected from four different drilled wells of respective four gas fields. A Weatherford Source Rock Analyzer (SRA) is used for source rock screening. Gas chromatography (GC) and gas chromatography mass spectrometry (GCMS) (Agilent V 5975B MSD) is used for organic geochemical study. Petrographic examination was carried out under oil immersion in plane polarised reflected white light using a LEICA DM6000M microscope equipped with fluorescence illuminators.

3. RESULTS AND DISCUSSION

3.1. Source rock properties

All samples are organic lean (<1%) and HI values of Bhuban Formation range from 39 to 232 (Table 1). Most samples are plotted in the Type III range except for a sample showing admixtures of Type II which implies a mixture of kerogen types (III/II) within the organic matter. Tmax values vary from 429 to 441 °C and the mean vitrinite reflectance value ranges from 0.57to 0.71 (%Ro) for the studied shales.

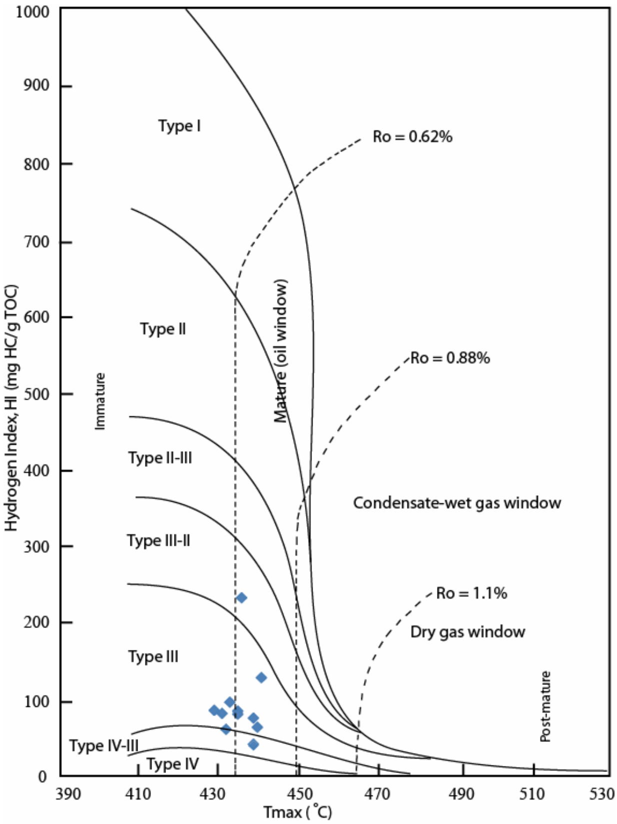

Fig.1. Cross-plot of HI vs Tmax whereby the analyzed samples correspond mostly immature to peak mature oil window and Type III (mainly) kerogen (adopted after Koeverden et al., 2011; Farhaduzzaman et al., 2013 and 2014).

3.2. Organic matter type and quality

The organic matter consists of a mixture of Type III/II kerogens with Type III being dominant (Fig.1). It is consistent with the dominance of vitrinite macerals in the studied samples as observed under reflected light microscope. Based on SRA and biomarkers data analysis, the analyzed Bhuban Formation shales of Bengal Basin, Bangladesh possess poor to fair quality source potential for hydrocarbon generation.

3.3. Thermal maturity and hydrocarbon generation

Bhuban shale samples are found to be thermally immature to peak mature oil window for hydrocarbon generation based on the mean vitrinite reflectance of 0.57 to 0.71 %Ro and Tmax values (429-441 °C). The biomarker parameters based on 22S / (22S + 22R) hopane, moretane/hopane ratio and sterane data also supported this level of thermal maturity.

3.4. Depositional condition and source of organic matter

Gas chromatographic parameters including n-alkane CPI, Pr/Ph, Ts/Tm, sterane distribution suggest that the organic matter of the Bhuban Formation has derived mainly from terrestrial sources with a minor contribution from marine inputs. Alternating dominance of odd over even and even over odd homologs in n-alkanes and high abundance of C29 regular steranes support that the organic matter of the analyzed shales were sourced from land plants of terrestrial environmental settings with minor contribution from marine source inputs.

4. Conclusions

Kerogen in the studied shale samples is classified mainly as Type III. Vitrinite is the dominant maceral group. The thermal maturity of the organic matter in the studied samples ranges from just pre-oil window to mid-oil window. The analyzed Bhuban shales are ranked as poor to fair quality source rocks and they are gas-prone. The organic matter was derived mainly from terrestrial sources.

REFERENCES

Farhaduzzaman, M., Wan Hasiah A., Islam, M. A. and Pearson, M. J., 2013. Organic facies variations and hydrocarbon generation potential of the Gondwana coals and related sediments, Barapukuria and Dighipara Basins, NW Bangladesh. J. Petrol. Geol., v.36(2), p.117-138.

Farhaduzzaman, M., Wan Hasiah A. and Islam, M. A., 2014. Hydrocarbon source potential and depositional environment of the Surma Group shales of Bengal Basin, Bangladesh. J. Geol. Soc. India (accepted).

Koeverden, J. H., Karlsen, D. A. and Backer-Owe, K., 2011. Carboniferous non-marine source rocks from Spitsbergen and Bjørnøya: comparison with the Western Arctic. J. Petrol. Geol., v.34, p.53-66.

P001

Meeting the Challenge of Penjom Gold Mine Geology in the Recovery of Fine Gold in Carbonaceous Ores

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1.0 INTRODUCTION

Penjom Gold Mine (PGM) in Malaysia produces one of the world's worst preg-robbing gold ores, yielding very low recoveries from traditional carbon-in-leach (CIL) methods (Lewis 1999). The gold processing facilities in PGM are designed to address the challenges of gold recovery from these carbonaceous ores. A resin-in-leach (RIL) gold recovery process was implemented in place of the CIL process. Since employing the RIL process in mid-1999, gold recovery rates consistently run close to 90% which is a remarkable 30% improvement over recovery rates using activated carbon (Ramli 2013).

Pre-cyanidation treatments are required for preg-robbing carbonaceous ores as the naturally occurring finely divided carbon in the ores acts in the same manner as the activated carbon introduced in the adsorption process with traditional CIL systems (Lewis 1999). Preg-robbing is defined as the preferential absorption of gold-cyanide complex ions [$Au(CN)_2^-$] by organic carbon in the carbonaceous ore, that is the carbonaceous ore allows cyanide to dissolve gold but will reabsorb the solubilized gold onto the active carbon in the ore (Tretbar, Arehart & Graves 2004).

This paper investigates the optimum process parameters for treatment of preg-robbing carbonaceous gold ores by conducting plant research on the resin-in-leach (RIL) method adopted by PGM. In order to study and analyse the processing plant of PGM, data on the process parameters were collected during the author's three months of practical work at PGM from December 2012 to February 2013 (Ramli 2013). These will be supplemented with existing records provided by PGM.

2.0 GOLD PROCESSING CIRCUIT

PGM adopts the following processing design to recover gold from the ores, as shown in Figure 2.1 (Ramli 2013):

- Comminution circuit – jaw crusher, semi-autogenous grinding (SAG) mill, and regrinding mill (RGM)
- Hydrocyclones
- Gravity concentration circuit – Knelson concentrator and shaking table
- Hydrometallurgy circuit – RIL tanks and RGM-RIL tanks
- Stripping columns
- Electrowinning cells
- Pyrometallurgy circuit – calcination and smelting

3.0 PROCESS PARAMETERS

Major factors affecting the dissolution rate of gold and the recovery of fine gold are cyanide concentration, temperature, and pH.

Mudder and Gladstone (1989) believed that theoretically, due to the powerful leaching properties of cyanide and its ability to extract gold from complex chemical and mineral matrices, a free cyanide concentration as low as 100 ppm (parts per million) in solution is capable of achieving maximum rate and extent of gold dissolution. However, most cyanide leaching takes place with 0.1 kg NaCN/ton of ore and concentrations of cyanide range between 50 and 1000 ppm (Free 2013).

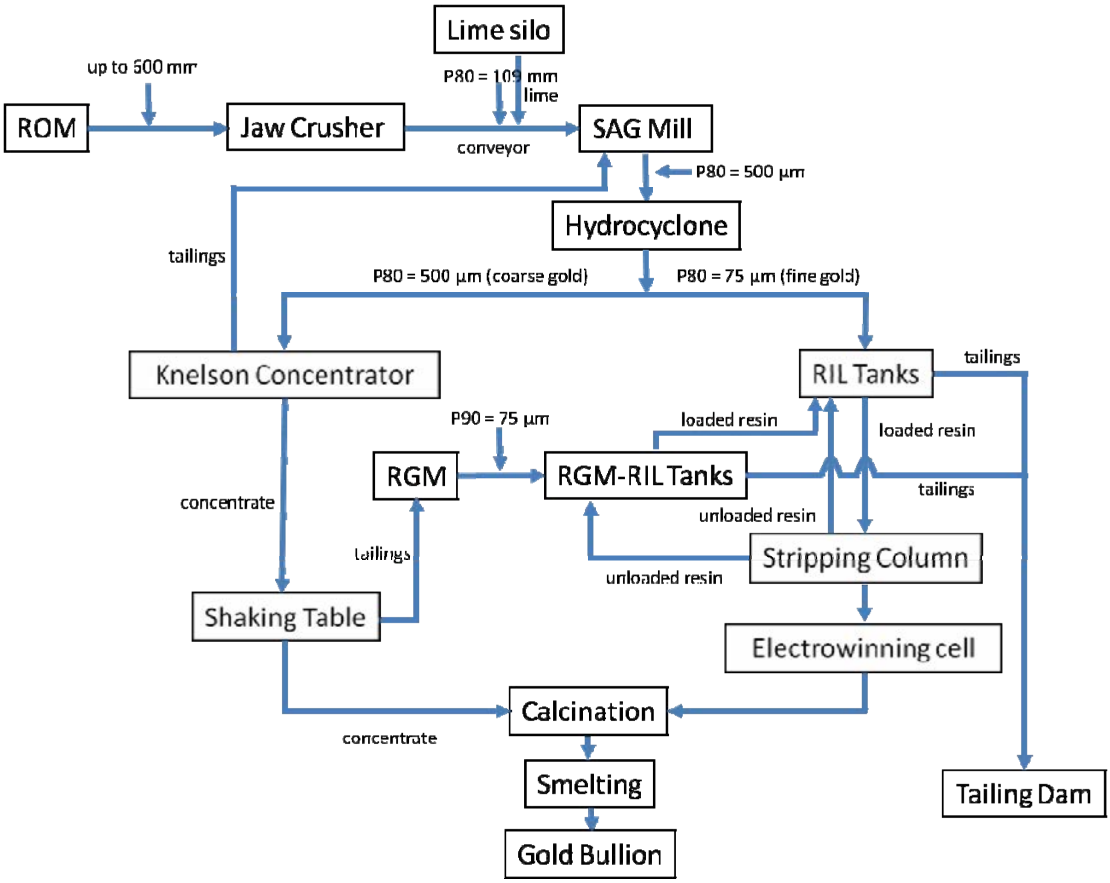

Figure 2.1: Simplified version of gold processing circuit in PGM

The rate of gold dissolution increases with temperature as a result of the increased activities and diffusion rates of reacting species (Marsden & House 2006). However, increasing the temperature will incur additional cost thus only used for leaching of high-grade materials. For the treatment of low-grade materials, ambient temperatures are applied.

Optimum pH range is important for process control as it affects the hydrolysis of cyanide and reaction kinetics. Under normal conditions, gold cyanidation is optimized between pH 9.6 and 11.

4.0 CONCLUSIONS

The most important finding from this paper is the success of the RIL process in recovering gold from carbonaceous gold ores. By using RIL technology, carbonaceous gold ores can successfully be processed as demonstrated by PGM, Malaysia. PGM uses the following process parameters to achieve maximum gold recoveries: cyanide concentration between 230 and 280 ppm in RIL tanks, and between 1000 and 2000 ppm in RGM-RIL tanks; slurry temperature between 35 and 38°C; and pH level between 10.5 and 11.

REFERENCES

Free, ML 2013, *Hydrometallurgy: Fundamentals and Applications*, John Wiley & Sons, Inc., Hoboken, New Jersey.

Lewis, GV 1999, 'Increased Recovery from Preg-Robbing Gold Ore at Penjom Gold Mine', *Proceedings of Randol Gold and Silver Forum*, Randol International Ltd., Golden, CO, pp. 105-108.

Marsden, J & House, I 2006, *The Chemistry of Gold Extraction Second Edition*, Society for Mining, Metallurgy, and Exploration, Colorado.

Mudder, TI & Goldstone, AJ 1989, 'The Recovery of Cyanide from Slurries', *Proceedings of Randol Gold Conference 1989 in Sacramento, California*, Randol International Ltd., Golden, CO, pp. 199-201.

Ramli, CS 2013, *Plant Optimization of Process Parameters for Treatment of Preg-Robbing Gold Ores at Penjom Gold Mine*. BE (Chemical Engineering & Process) Thesis, University of Western Australia.

Tretbar, D, Arehart, GB & Graves, RS 2004, 'Preg-robbing carbon in the processing of gold-bearing ores: definitions, analytical methodology and characterization'. Paper presented at the *Rocky Mountain (56th Annual) and Cordilleran (100th Annual) Joint Meeting*, The Geological Society of America, Boise ID.

P007

Geospatial Analyses of Ex-Mining Land in Johor

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Ex-mining land plays important role in socio-economic development, such as, mining and quarrying, agriculture, aquaculture, livestock, 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 this ex-mining land are adequately developed and conserved for current and future generations. As of 2011 various efforts have been carried out by Mineral Research Centre, Minerals and Geoscience Department Malaysia to develop a digital database on the distribution of ex-mining land in the country and to study the geospatial information on the use of the ex-mining land. Developing a digital database for the land-use in the ex-mining land of Johor is one of them. Using the most recent digital data available, geospatial analyses of the current land-use, lithology, and ex-mining land in Johor were conducted for each of the eight districts. The paper shows the results of these analyses and it is hoped that this work provides a continuing effort to establish a dynamic digital database of the ex-mining land in Johor for the exploitation of its mineral resources and other developments in a sustainable manner.

Keywords: ex-mining land, geospatial analyses, land-use, sustainable

1.0 INTRODUCTION

Ex-mining land plays important role in socio-economic development, such as, mining and quarrying, agriculture, aquaculture, livestock, 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 this ex-mining land are adequately developed and conserved for current and future generations.

For these reasons, Mineral Research Centre (PPM), Minerals and Geoscience Department (JMG) Malaysia is undertaking a project to develop a digital database on the distribution of ex-mining land and to study the geospatial information on the use of the ex-mining land in Malaysia. The project is carried out in the Tenth Malaysian Plan (RMKe-10). To meet this objective, a number of efforts have been made to develop the digital database and to study the geospatial information on the use of the ex-mining land (Ramli et al. 2011a; Ramli et al., 2011b; Ramli et al., 2011c; Ramli and Mohd Anuar, 2012a; Ramli and Mohd Anuar, 2012b; Ramli, M.O., 2013a; Ramli, M.O., 2013b; Ramli and Mohd Anuar, 2013c; Ramli et al., 2013d).

Geospatial analyses of the distribution of ex-mining land and the distribution of land-use in this ex-mining land were conducted for each of the eight districts in Johor. It is hoped that this work provides a continuing effort to establish a dynamic digital database of the ex-mining land in Johor for the exploitation of its mineral resources and other developments in a sustainable manner.

2.0 MATERIALS

The current digital land-use map of Johor was obtained from JPBD Johor. The gazetted years for land-use for each of the district in Johor are as follows:

Segamat: 2010
Muar: 2011
Batu Pahat: 2011
Kluang: 2009
Mersing: 2008
Pontian: 2011
Johor Bharu: 2011
Kota Tinggi: 2009

Digital ex-mining land base map of Johor was obtained from Department of Agriculture Malaysia (JPM). It shows the distribution of ex-mining in Johor as of the year 2000. This base map was chosen because it shows the largest extend of ex-mining land in the state.

Digital map for distribution of mines and quarries in Peninsular Malaysia, as of 2011, was obtained from JMG. The digital lithology map of Peninsular Malaysia was also obtained from JMG.

3.0 GEOSPATIAL ANALYSES

3.1 Current land-use of Johor

Geospatial analysis shows that much of the land-use of Johor is under agriculture, 1,134,607 ha (59.9%) followed by forest, 503,733 ha (26.6%); idle land, 83,249 ha (4.4%); water bodies, 47,239 ha (2.5%), transportation, 36,183 ha (1.9%); residential, 34,219 ha (1.8%); open space and recreation, 15,833 ha (0.8%); institutions and public facilities, 15,821 ha (0.8%); industry, 11,302 ha (0.6%); infrastructure and utilities, 5,407 ha (0.3%); business and services, 4,428 ha (0.2%); and others, 641 ha (0.0%), as shown in Figure 1.

3.2 Ex-Mining Land of Johor

Geospatial analyses show that the ex-mining land in Johor covers 6,779 ha or 0.35% of the state (1,911,085 ha) and the third largest distribution of ex-mining land in the country after Perak (49,948 ha) and Selangor (13,226 ha). The district of Kota Tinggi has the highest acreage of ex-mining land, 3,555 ha (52.44%) followed by Mersing, 2,813 ha (41.49%); Muar, 381 ha (5.62%); Batu Pahat, 16 ha (0.23%); and Johor Bahru, 14 ha (0.21%). Segamat, Kluang, and Pontian do not have any ex-mining land (Figure 2).

3.3 Current Land-Use in Ex-Mining Land of Johor

To obtain the current land-use in the ex-mining land of Johor, the current land-use map of Johor (Figure 1) was clipped into the ex-mining land base map of Johor (Figure 2).

Figure 3 shows the distribution of land-use in the ex-mining land of Johor. Much of the land in the ex-mining land is secondary forest, 2,351ha (34.1%). The remaining land-use in the ex-mining are idle land, 2,049 ha (29.7%); agriculture, 1,885 ha (27.4%); industry, 431 ha (6.3%); transportation, 48 ha (0.7%); open space and recreation, 32 ha (0.5%); infrastructure and utilities, 30 ha (0.4%); institutions and public facilities, 30 ha (0.4%); business and services, 18 ha (0.3%); residential, 12 ha (0.2%); and water bodies, 6 ha (0.1%).

Geospatial analyses of the distribution of land-use in each of the 8 districts of Johor follow:

3.3.1 Kota Tinggi

Table 1 shows statistics of land-use in the ex-mining land of Kota Tinggi. Much of the land in the ex-mining land is idle, 1,105.7 ha (31.4%). The remaining land-use in the ex-mining are agriculture, 1,047.3 ha (29.7%); secondary forest, 899.5 ha (25.5%); industry, 421.4 ha (12.0%); infrastructure and utilities, 30.3 ha (0.9%); business and services, 15.1 ha (0.4%); water bodies, 3.9 ha (0.1%); transportation, 1.3 ha (0.0%); residential, 0.6 ha (0.0%); open space and recreation, 0.2 ha (0.0%); and institutions and public facilities, 0.2 ha (0.0%). The total land-use in the ex-mining land of Kota Tinggi is 3,525.5 ha or 51.2% of the total land-use in the ex-mining land of Johor.

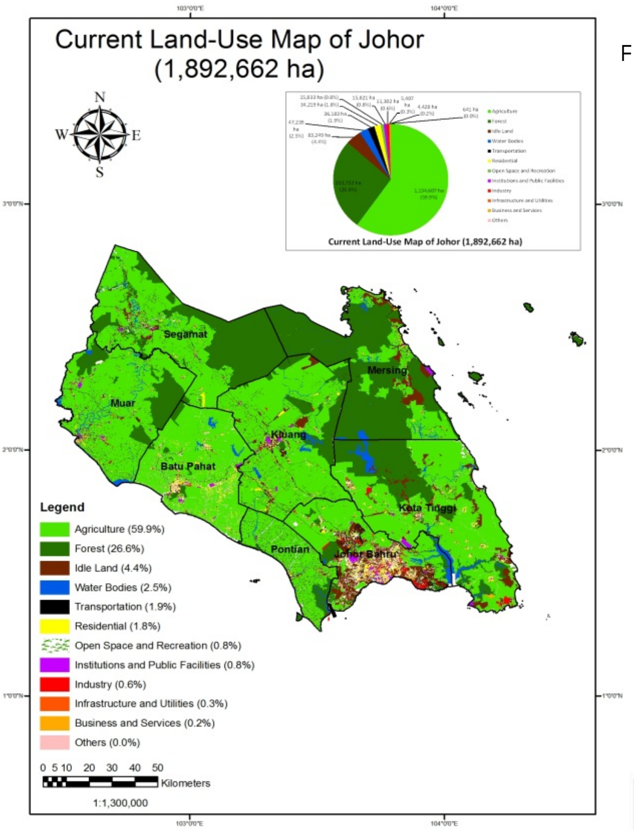

Figure 1: Current land-use map of Johor

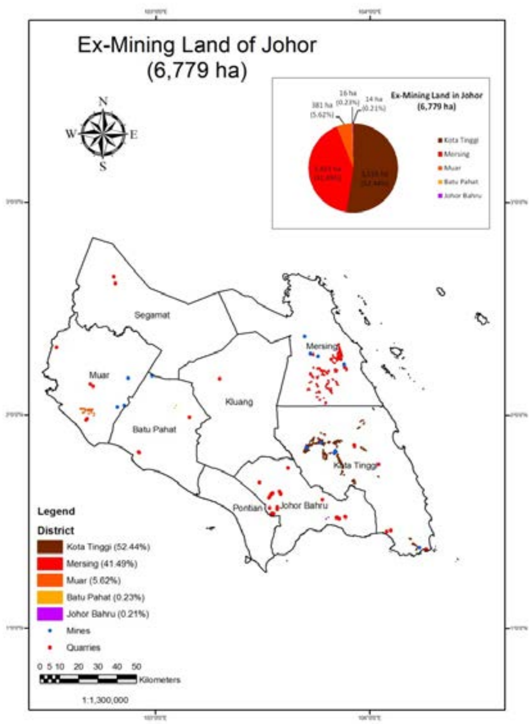

Figure 2: Ex-mining land of Johor and distribution of mines and quarries

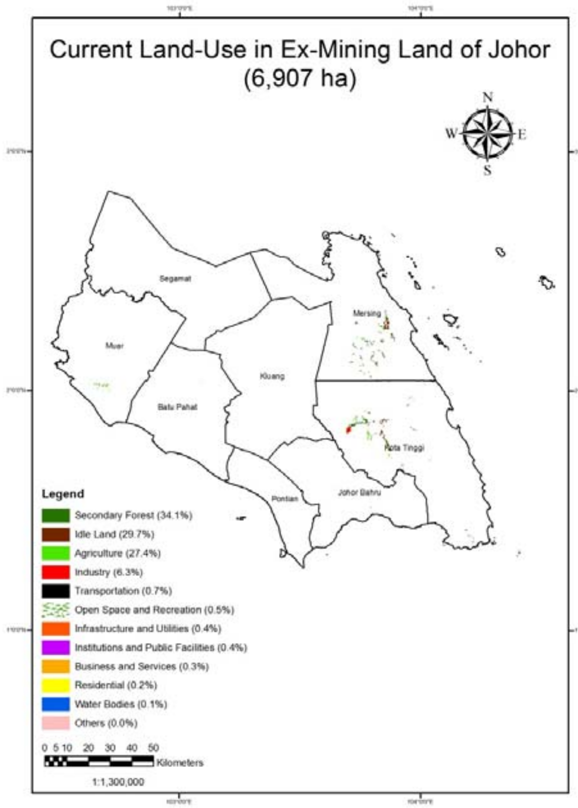

Figure 3: Current land-use in ex-mining land of Johor

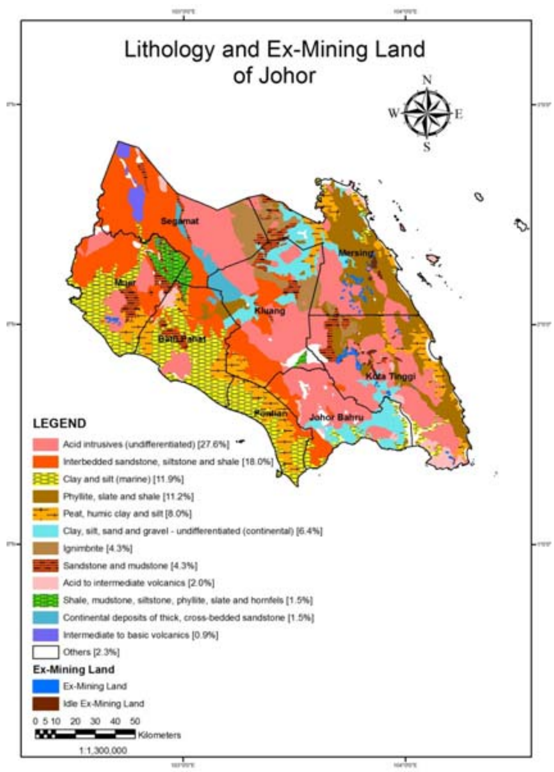

Figure 4: Lithology and ex-mining land of Johor

Table 1: Statistics of land-use in ex-mining land of Kota Tinggi

No.	Land-Use	Area	
		(ha)	(%)
1	Idle Land	1,105.7	31.4
2	Agriculture	1,047.3	29.7
3	Secondary Forest	899.5	25.5
4	Industry	421.4	12.0
5	Infrastructure and Utilities	30.3	0.9
6	Business and Services	15.1	0.4
7	Water Bodies	3.9	0.1
8	Transportation	1.3	0.0
9	Residential	0.6	0.0
10	Open Space and Recreation	0.2	0.0
11	Institutions and Public Facilities	0.2	0.0
Total		3,525.5	100.0

3.3.2 Mersing

Table 2 shows statistics of land-use in the ex-mining land of Mersing. Much of the land in the ex-mining land is secondary forest, 1,451.2 ha (49.1%). The remaining land-use in the ex-mining are idle land, 942.6 ha (31.9%); agriculture, 466.9 ha (15.8%); institutions and public facilities, 30.0 ha (1.0%); transportation, 28.3 ha (1.0%); open space and recreation, 25.6 ha (0.9%); residential, 5.2 ha (0.2%); water bodies, 1.8 ha (0.1%); and business and services, 1.5 ha (0.1%). The total land-use in the ex-mining land of Mersing is 2,953.2 ha or 42.9% of the total land-use in the ex-mining land of Johor.

Table 2: Statistics of land-use in ex-mining land of Mersing

No.	Land-Use	Area	
		(ha)	(%)
1	Secondary Forest	1,451.2	49.1
2	Idle Land	942.6	31.9
3	Agriculture	466.9	15.8
4	Institutions and Public Facilities	30.0	1.0
5	Transportation	28.3	1.0
6	Open Space and Recreation	25.6	0.9
7	Residential	5.2	0.2
8	Water Bodies	1.8	0.1
9	Business and Services	1.5	0.1
Total		2,953.2	100.0

3.3.3 Muar

Table 3 shows statistics of land-use in the ex-mining land of Muar. Much of the land in the ex-mining land is agriculture, 355.1 ha (92.6%). The remaining land-use in the ex-mining are transportation, 18.0 ha (4.7%); industry, 9.4 ha (2.4%); and business and services, 1.0 ha (0.3%). The total land-use in the ex-mining land of Muar is 383.4 ha or 5.6% of the total land-use in the ex-mining land of Johor.

Table 3: Statistics of land-use in ex-mining land of Muar

No.	Land-Use	Area	
		(ha)	(%)
1	Agriculture	355.1	92.6
2	Transportation	18.0	4.7
3	Industry	9.4	2.4
4	Business and Services	1.0	0.3
Total		383.4	100.0

3.3.4 Batu Pahat

The land-use in the ex-mining land of Batu Pahat is exclusively agriculture, 15.6 ha or 0.2% of the total land-use in the ex-mining land of Johor.

3.3.5 Johor Bahru

Table 4 shows statistics of land-use in the ex-mining land of Johor Bahru. Much of the land in the ex-mining land is open space and recreation, 6.5 ha (48.5%). The remaining land-use in the ex-mining are residential, 6.2 ha (46.5%); idle land, 0.6 ha (4.2%); and infrastructure and utilities, 0.1 ha (0.8%). The total land-use in the ex-mining land of Johor Bahru is 13.4 ha or 0.2% of the total land-use in the ex-mining land of Johor.

Table 4: Statistics of land-use in ex-mining land of Johor Bahru

No.	Land-Use	Area	
		(ha)	(%)
1	Open Space and Recreation	6.5	48.5
2	Residential	6.2	46.5
3	Idle Land	0.6	4.2
4	Infrastructure and Utilities	0.1	0.8
Total		13.4	100.0

The above analyses show that there are 2,048.9 ha of idle ex-mining land in Johor that has potential to be developed. Kota Tinggi has the highest acreage of idle ex-mining land, covering 1,105.7 ha (54.0%) as shown in Table 5. This is followed by Mersing, 942.6 ha (46.0%) and Johor Bahru, 0.6 ha (0.0%).

Table 5: Idle ex-mining land of Johor

No.	Land-Use	Area	
		(ha)	(%)
1	Kota Tinggi	1,105.7	54.0
2	Mersing	942.6	46.0
3	Johor Bahru	0.6	0.0
Total		2,048.9	100.0

3.4 LITHOLOGY OF JOHOR

Geospatial analyses show that much of the lithology of Johor is under acid intrusives (undifferentiated), 524,664 ha (27.6%) followed by interbedded sandstone, siltstone and shale, 341,776 ha (18.0%); clay and silt (marine), 226,941 ha (11.9%); phyllite, slate and shale, 212,104 ha (11.2%); peat, humic clay and silt, 152,657 ha (8.0%); clay, silt, sand and gravel - undifferentiated (continental), 121,751 ha (6.4%); ignimbrite, 81,744 ha (4.3%); sandstone and mudstone, 81,318 ha (4.3%); acid to intermediate volcanics, 37,241 ha (2.0%); shale, mudstone, siltstone, phyllite, slate and hornfels, 29,299 ha (1.5%); continental deposits of thick, cross-bedded sandstone, 29,246 ha (1.5%); intermediate to basic volcanics, 17,258 ha (0.9%); and others, 43,948 ha (2.3%) as shown in Figure 4.

Quarry statistics of Johor, as of 2012, indicate that there were 47 quarries in Johor: 45 granite, 1 tuff, and 1 basalt (MGD Malaysia, 2012a). This is not surprising because most of the lithology of Johor is under acid intrusives (undifferentiated), i.e. granite. Under the classification of lithology as shown in Figure 4, tuff is under acid to intermediate volcanics and basalt is under intermediate to basic volcanics.

Geospatial analyses also show that most of the lithology under the idle ex-mining land of Johor is phyllite, slate and shale, 1,080 ha (52.7%) followed by acid intrusives (undifferentiated), 695 ha (33.9%); clay, silt, sand and gravel - undifferentiated (continental), 248 ha (12.1%); acid to intermediate volcanics, 25 ha (1.2%); and peat, humic clay and silt, 1 ha (0.0%) as shown in Figure 4 and Table 6.

Table 6: Lithology under idle ex-mining land of Johor

No.	Lithology	Area (ha)	Area (%)
1	Phyllite, slate and shale	1,080	52.7
2	Acid intrusives (undifferentiated)	695	33.9
3	Clay, silt, sand and gravel - undifferentiated (continental)	248	12.1
4	Acid to intermediate volcanics	25	1.2
5	Peat, humic clay and silt	1	0.0
Total		2,048	100.0

DISCUSSION

As of 2012, there were 23 mines in Johor. Of these, 16 were iron ore mines, 2 bauxite mines, 1 tin mine, 1 kaolin mine, and 3 silica sand mine (MGD Malaysia, 2012b). Digital distribution of mines data obtained from JMG showed that were 6 mines that reworked the ex-mining land of Johor. Of these, 4 were iron mines, 1 tin mine, and 1 silica sand mine. There were no quarries in the ex-mining land (Figure 2).

From geospatial analyses point of view, there is little potential for the idle ex-mining land in Johor to be developed into aquaculture, sport fishing, or wetlands (for open space and recreation or conservation of wildlife) because water bodies in the ex-mining land only constitute 6 ha or 0.1% of the land-use in the ex-mining land of Johor (Figure 3).

Geospatial analyses also show that there is little potential for the idle ex-mining land in Johor to be developed for sub-surface quarrying of granite and tuff because the acreages of acid intrusives (undifferentiated), 695 ha and acid to intermediate volcanics, 25 ha respectively are not encouraging (Table 6). There are large reserves of acid intrusives (undifferentiated) rocks (524,664 ha) and acid to intermediate volcanics rocks (37,241 ha) elsewhere in Johor (Figure 4).

It is proposed that the ex-mining land should be further prospected for left over iron ore, bauxite, tin, kaolin, and silica sand. Once the ex-mining land is depleted of mineral and industrial mineral resources, they could be developed for agriculture, infrastructures, or restored into natural forest or forest parks. The latter option is the more attractive because much of the existing ex-mining land is already under secondary forest, 2,351ha or 34.1% of the ex-mining land in Johor (Figure 3). Also, since much of previous forest areas have been taken up by agriculture, it is possibly the only right decision to make, i.e. to restore the disturbed land into natural forest to maintain a balance ecosystem of forest and development land-use.

CONCLUSION

Geospatial analyses show that the ex-mining land in Johor covers 6,779 ha or 0.35% of the state. The district of Kota Tinggi has the highest acreage of ex-mining land, 3,555 ha (52.44%) followed by Mersing, 2,813 ha (41.49%); Muar, 381 ha (5.62%); Batu Pahat, 16 ha (0.23%); and Johor Bahru, 14 ha (0.21%). Segamat, Kluang, and Pontian do not have any ex-mining land.

Much of the ex-mining land in Johor is secondary forest, 2,351 ha (34.1%). The remaining land-use in the ex-mining are idle land, 2,049 ha (29.7%); agriculture, 1,885 ha (27.4%); industry, 431 ha (6.3%); transportation, 48 ha (0.7%); open space and recreation, 32 ha (0.5%); infrastructure and utilities, 30 ha (0.5%); institutions and public facilities, 30 ha (0.4%); business and services, 18 ha (0.3%); residential, 12 ha (0.2%); and water bodies, 6 ha (0.1%).

Digital distribution of mines data obtained from JMG showed that were 6 mines that reworked the ex-mining land of Johor. Of these, 4 were iron mines, 1 tin mine, and 1 silica sand mine. There were no quarries in the ex-mining land.

There are 2,048.9 ha of idle ex-mining land in Johor that has potential to be developed. Kota Tinggi has the highest acreage of idle ex-mining land, covering 1,105.7 ha (54.0%) as shown in Table 7. This is followed by Mersing, 942.6 ha (46.0%) and Johor Bahru, 0.6 ha (0.0%).

It is proposed that the ex-mining land should be further prospected for left over iron ore, bauxite, tin, kaolin, and silica sand. Once the ex-mining land is depleted of mineral and industrial mineral resources, they are recommended to be restored into natural forest or forest parks because much of the existing ex-mining land is already under secondary forest, 2,351ha or 34.1% of the ex-mining land in Johor. Also, since much of previous forest areas have been taken up by agriculture, it is possibly the only right decision to make, i.e. to restore the disturbed land into natural forest to maintain a balance ecosystem of forest and development land-use.

It is hoped that this geospatial analyses of the ex-mining land in Johor could be used for strategic development of the remaining 2,049 ha of idle ex-mining land in the state that has potential to be developed for the exploitation of its mineral resources and other developments in a sustainable manner.

ACKNOWLEDGMENTS

We thank Y. Bhg. Dato' Hj. Yunus Abdul Razak, Director General of Minerals and Geoscience Department Malaysia for his support and encouragement in carrying out the project and for granting permission to publish this paper. Thank is also due to the Department of Town and Rural Planning of Johor for providing the land-use digital data and Department of Agriculture Malaysia for providing the ex-mining land distribution data.

REFERENCES

MGD Malaysia, 2012a. Industrial Mineral Production Statistics and Directory of Producers in Malaysia 2012, Minerals and Geoscience Department Malaysia.

MGD Malaysia, 2012b. Malaysian Minerals Yearbook 2012, Minerals and Geoscience Department Malaysia.

Ramli, M.O., Mohd Anuar, I., and Mohd Zulkiflee, C.S., 2011a. Idle ex-mining land of Perak 2011. *Proceedings of SIMPOMIN 2011*, 18-20 October 2011, Tower Regency Hotel Ipoh, Perak.

Ramli, M.O., Mustafar, H., and Mohd Anuar, I., 2011b. Spatial distribution of ex-mining ponds in Perak and Selangor using satellite images and ArcGIS. *Proceedings of SIMPOMIN 2011*, 18-20 October 2011, Tower Regency Hotel Ipoh, Perak.

Ramli, M.O., Noor Bakri, E., and Hamid, A., 2011c. Mapping of ex-mining land land-use of Malim Nawar-Ipoh area using Spot 5 satellite images. *Proceedings of SIMPOMIN 2011*, 18-20 October 2011, Tower Regency Hotel Ipoh, Perak.

Ramli, M.O. and Mohd Anuar, I., 2012a. Geospatial analysis of ex-mining land in Perak. *Proceedings of National Geoscience Conference 2012*, 23-24 June 2012, Pullman Hotel Kuching, Sarawak.

Ramli, M.O. and Mohd Anuar, I., 2012b. Land-use of ex-mining land in Perak. *Proceedings of the International Symposium on Reclamation, Rehabilitation and Restoration towards a Greener Asia*, 3-5 July 2012, Kuala Lumpur.

Ramli, M.O., 2013a. Kajian maklumat geospatial tanah bekas lombong negara RP2 (2012). *No. Laporan: PPM R001/2013*, Pusat Penyelidikan Mineral, Jabatan Mineral dan Geoscience Malaysia, Ipoh, Perak.

Ramli, M.O., 2013b. Rate of development of ex-mining land in Peninsular Malaysia. *Proceedings of the National Geoscience Conference 2013, 8-9 June 2013, Kinta Riverfront Hotel & Suites, Ipoh.*

Ramli, M.O. and Mohd Anuar, I., 2013c. Geospatial analyses of ex-mining land in Perak 2013. *Paper presented in Symposium Mineral 2013*, 12– 13 November 2013, Kinta Riverfront Hotel, Ipoh, Perak.

Ramli, M.O. and Mohd Anuar, I., and Ahmad Zukni, A.K., 2013d. The need to practiced sub-surface limestone quarrying in Perak. *Paper presented in Symposium Mineral 2013*, 12– 13 November 2013, Kinta Riverfront Hotel, Ipoh, Perak.

P009

Estimating Uniaxial Compressive Strength from Slowness : Malaysian Granites

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The uniaxial compressive strength (UCS) is one of the most important rock strength parameters which commonly influenced the stability of structures such as cut slopes and excavation of opening in rock mass. Determination of UCS values can be made by conducting the uniaxial compressive strength test. The uniaxial compressive strength test, however, is a destructive testing, which makes it a disadvantage to be conducted under the condition of a limited rock samples. UCS test also requires an extensive and expensive laboratory testing, and is often substituted for indirect laboratory testing methods which is more convenient to be conducted with limited time and rock samples. There are several laboratory methods that can be conducted to estimate UCS including the ultrasonic test. Ultrasonic test is relatively fast, inexpensive, and easy to be conducted. The method has also proven to be the most favourable rock strength testing method for applications in rock engineering because of its ease of use. There are several correlations previously established in estimating UCS from ultrasonic test. However, these correlations are applicable for rock samples under saturated condition and thus, are not suitable to estimate UCS values of dry sample. This paper presents a reliable correlation in estimating uniaxial compressive strength (UCS) values from slowness for dry Malaysian granites. A total of 77 ultrasonic tests and uniaxial compressive strength tests were conducted to establish a correlation of UCS and slowness ($1/V_p$). This correlation was UCS = 214.98 · $e^{-4762(1/V_p)}$, where $1/V_p$ was the slowness of rock sample. The coefficient of determination (R^2) value is 0.91, which indicates a strong correlation have been achieved between slowness and UCS values.
Keywords: uniaxial compressive strength (UCS), ultrasonic test, granite

REFERENCE

Deere, D. U. & Miller, R. P. 1966. "Engineering classification and index properties for intact rock," *Technical Report No. AFNL-TR-65-116 Air Force Weapons Laboratory*. New Mexico.

Freyburg, D. 1972. "Der Untere und mittlere Buntsandstein SW-Thuringen in seinen gesteinstechnicschen Eigenschaften," *Ber. Dte. Ges. Geol. Wiss. A; Berlin*, Vol. 17, No. 6, pp 911–919.

Goh, T.L. 2012. "Classification and quantification of rock mass in rock slope evaluation," Unpublished Ph.D. Thesis, Geology Programme, National University of Malaysia, Bangi.

Goh, T. L., Ghani Refak, A. & Hariri Arifin, M. 2012. "Geomechanical strength of granites and schist of Peninsular Malaysia," Sains Malaysiana Vol. 41, No. 2, pp 193-198.

Horsrud, P. 2001. "Estimating mechanical properties of shale from empirical correlations," *SPE Drilling and Completion*, Vol. 16, No. 2, pp 68–73.

ISRM, 2007. "*The Complete ISRM Suggested Methods for Characterization, Testing and Monitoring: 1974-2006*," Ankara: ISRM Turkish National Group.

McNally, G. H. N. 1987. "Estimation of coal measures rock strength using sonic and neutron logs," *Geoexploration* Vol. 24, pp 381–395.

Militzer, H., & Stoll, R. 1973. "Einige Beitraegeder Geophysik zur primaerdatenerfassung im Bergbau," *Neue Bergbautechnik, Leipzig*, Vol. 3, No. 1, pp 21–25.

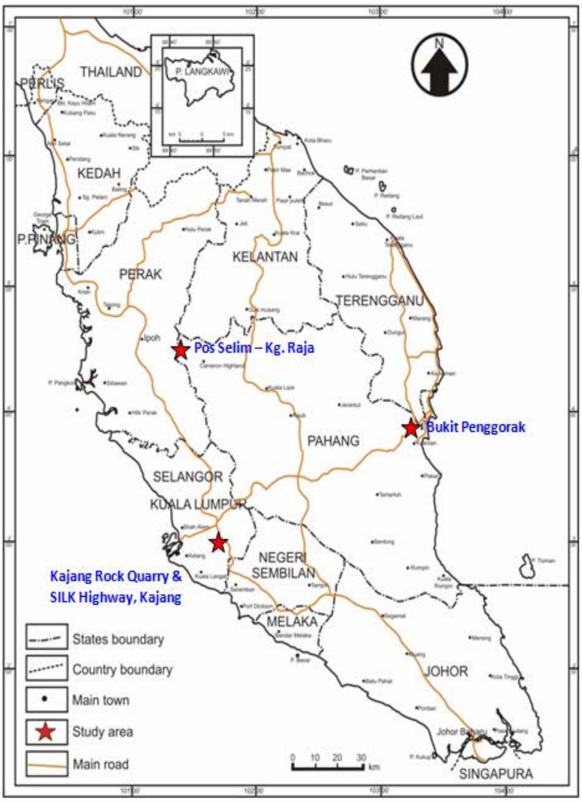

Figure 1 shows the location of study area. Granite samples were collected from four different locations- Kajang Rock Quarry & SILK Highway, Kajang, Selangor; Bukit Penggorak Quarry, Kuantan; and Pos Selim to Kg. Raja Road (km 29-30), Cameron Highland, Pahang/Perak.

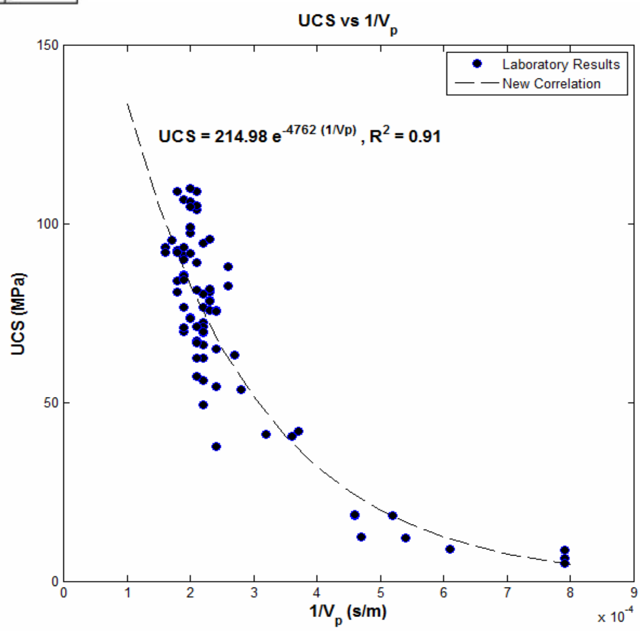

Figure 2 shows the new correlation established from to estimate uniaxial compressive strength from ultrasonic test. The new correlation to estimate UCS from slowness is 214.98 · e-4762 (1/Vp) with coefficient of determination (R^2) of 0.9

P015

Ladle Furnace Slag, Bentonite, Zeolite And Active Carbon For Remediation Of Acid Mine Drainage

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Abstract. Acid Mine Drainage (AMD) is highly acidic, sulphate rich and frequently carries a high transition metal and heavy metal burden. These AMD's eventually migrate into streams and rivers and impact negatively on the quality of these water bodies. So it is necessary to treat this AMD. Various materials such as ladle furnace slag (LFS), bentonite (B), zeolite (Z), active carbon (AC) and kaolinite (K) are currently available to remove heavy metals from contaminated water. All these materials are capable to rise up the pH value and adsorb heavy metals. The process divides into two stages; screening test and tank experiment. Screening test is conduct by using Batch Equilibrium Test (BET), XRD and XRF identification, also SEM characteristic. After BET, all the concentrations of heavy metal are decreasing extremely and pH value rise up except for kaolinite. From screening test only ladle furnace slag, bentonite, zeolite and active carbon are choosing for the tank experiment. Tank experiment design with 18cm (H) X 15cm (L) X 15cm (H) and made by silica glass. All these treatment materials are stirring in the tank for 50 days. Initial pH for all tanks is 2.4 and after 50 days is changing into 7.05, 4.27, 2.38 and 1.98 for LFS, bentonite, active carbon as well as zeolite respectively. LFS is the best material for absorption of Pb, Cd, Ni, Zn, Mn and Cu in the synthetic solution. Meanwhile, bentonite is the best absorbent for Fe. The conclusion shows that LFS might have big potentials to control AMD pollution base on neutralize pH, resulting in a great improvement in the quality of the water.

Keyword: Acid Mine Drainage, ladle furnace slag, bentonite, treatment

P020

Sheared granite along K173, Baling-Gerik Highway, Kedah

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The East-West Highway Route K173 of Baling-Gerik provides exposure of shear zones and sheared granite along the Bok Bak fault trace in southeast Baling. The granite here are of the Bintang Hills Granite (Jones, 1970), leucocratic porphyrytic textured granite with porphyroclasts of feldspar set in matrix of quartz, feldspar and mica. The granites are intruded by NW-SE and NE-SW sets of veins and dikes, with composition ranging from microgranite, quartz veins with substantial amount of tourmaline grains. Shear zones which cut the granite produce mylonite with S-C structures, whereas fault zone produce brittle fault rocks and fault planes. Given an extensive work on the Bok Bak Fault, not many studies have focused on the sheared granites and ductile shear zones along the fault zone.

Satellite imageries study of the study area was carried out. From field mapping, a main NW-SE/ WNW-ESE with subsidiary E-W and NE trending shear zone was found to transect the granite. The NW shear zone displayed both sinistral and dextral displacement. E-W and NE-SW shear zones were found to be transected by the NW-SE shear zone, although their structure and kinematic indicator were less defined. Lineations of the mylonite indicate strike-slip and oblique slip shearing. These shear zones does not produce negative lineaments from satellite imageries, suggesting that they are not zone of weaknesses. However the NW-SE shear zones are roughly parallel to nearby similarly trending negative lineaments.

Petrographic studies show that the sheared granites exhibit clear difference from the protolith. Quartz grains shows recrystallization, with bulging recrystallization and sub grain rotation being the primary texture. Other deformation structures include undulose extinction, deformation lamellae, ribbon structure, polycrystalline grain. The elongated subgrain show preferred orientation, forming oblique foliation with the long-axis parallel to the S surface. K-feldspar shows microfracturing, bookshelf fracturing, rotated porphyroclast, and minor recrystallization. Recrystallization isn't as extensive as in quartz, limited around grains edges. Plagioclase shows deformation twinning and microfracturing, although the latter is not as prominent as in K-feldspar. Biotite are commonly recrystallized, forming the foliation surface. Larger biotite grains are also commonly rotated to form mica fish.

The study shows that the shear zones had undergone brittle-ductile deformation, with quartz and biotite showing ductile deformation, and feldspar showing both brittle and ductile deformation. The occurrence of dextral shearing in the ductile shear zone of Bok Bak fault have not been reported before. Field evidence point that the fault had undergone an early dextral ductile shearing followed by ductile sinistral shearing. Sinistral shearing in ductile granite along Bok Bak Fault was reported in Bukit Perak as well (Abdullah Zamawi, 1993). The ductile shear zones were overprinted by later sinistral brittle faulting. Similar kinematic history of ductile shear zone reactivated as brittle fault zone was observed in the Bukit Tinggi Fault Zone (Ng, 1994). No radiometric dating have been carried out on the sheared fault rocks of Bok Bak fault, but if the timing and mechanism were taken to be similar with Bukit Tinggi Fault Zone, the early dextral ductile shearing would take place during Late Triassic-Jurassic (Ng, 1994), followed by sinistral ductile shearing in Late Cretaceous and Tertiary sinistral brittle faulting (Zaiton, 2002).

ACKNOWLEDGEMENT:

This paper is part of the first author ongoing MSc research. The funding through University of Malaya research grant PG097-2012B for the research is greatly appreciated.

REFERENCES:

Abdullah Zamawi Muhamad (1993). Geologi Kawasan Sungai Tiang-Kalai, Kedah Darul Aman. Unpubl. B.Sc. thesis, Dept. of Geology, University of Malaya.

Jones, C. R. (1970). The Geology and Mineral Resources of the Grik Area, Upper Perak, Geological Survey Headquarters.

Ng, T. F. (1994). Microstructures of the deformed granites of eastern Kuala Lumpur - Implications for mechanisms and temperatures of deformation. Geological Society of Malaysia Bulletin, **35**: 47-59.

Zaiton Harun (2002). Late Mesozoic-Early Tertiary faults of Peninsular Malaysia. Geological Society of Malaysia Bulletin, **45**: 117-120.

P023

A Study on the Mineral Contents, Sedimentological Characteristics and Chemistry of Kemaman Coastal Sediments

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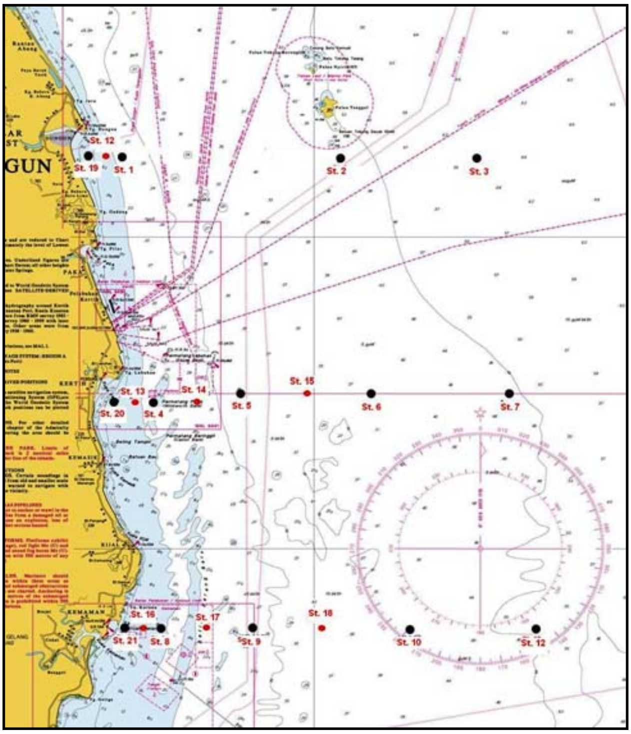

Figure1: Location of sampling site

The eastern coastline of Malaysia was washed by the tempestuous South China Sea and often interrupted by wide flowing rivers from the hinterland. It is one endless stretch of beaches of curving through bays, coves, mangroves and rocks, with dozen of them still in pristine seclusion. Generally, for Terenganu area that stretching from Kuala Terengganu to Kemaman the coastal area were consist of quite a small numbers of sandy beaches due to the area were dominated mostly by rocky headlands (Hutchison, 2009) . Milliman & Meade (1983) estimate that about 12 – 13 x 10^9 tonnes of suspended sediments are supplied to the oceans by rivers annually and that a further 1 – 2 x 10^9 tonnes are supplied by bedload and flood discharges. A study on Kemaman coastal sediments was conducted to determine the sedimentological characteristics and chemical contents and minerals of the study area.

The samples were collected using Smith Mcintyre grab using KL Paus ship own of by the Fisheries Departments of Malaysia. 21 samples were collected and prepared for this study (Figure 1). Sedimentological characteristics analysis was done using several methods such as dry sieving for coarse sediments, Hydrometer for texture, and Particle Size Analyzer (PSA) for finer sediments. For the chemical constituents in the samples, Scanning Electron Microscope - Energy Dispersive X - Ray Spectroscopy (SEM - EDS) machine was used and X-Ray Diffractometer (XRD) was used for the mineralogical contents on the samples. The mean value which indicates the type of grain size showed that all the samples were in a range of medium type sand. The sorting value showed a poorly sorted sample for the average value of the samples in the study area. This indicates the distributions of the grain sized were not distributed evenly for the finer and coarser grain size. Both skewness and kurtosis, give a value of strongly negative skewed and very leptokurtic samples for the overall samples respectively. As for the textural class of the area, Hydrometer method was were used to analyze all the samples and gave three major textural classes which are sandy loam, sand and loamy sand by which the major type of samples were dominated by the sand fractions. SEM - EDS analysis, which has been done to determine the chemical constituents in the study area show a high percentage of Oxygen element, followed by Carbon and then Aluminium.

For the oxides compounds, the major compounds that have been detected was SiO_2, which indicates that the area is dominated by sand fractions (Figure 2). According to Mc Laren et. al. (1996), it is quarts minerals which are relatively resistant to weathering and to a lesser extent the feldspar that are dominant components of the sand and silt sized minerals fractions and of any rock fragments in the soils (Table 1). Mineralogical analysis using XRD machines showed that Quartz is the most dominant, which has a very strong intensity peak compared to other minerals such as kaolinite and feldspars. The high amount of sand fractions in the study area was the major factor that contributes to the high occurrence of the quartz elements in the study area. Other factors that also contribute to the high occurrence of the quartz element in the study area and all the sedimentological characteristics and the chemical constituents in the study area are the geographical setting of the coastal area of the East Coast of Peninsular Malaysia which dominated by granite rocks and also experiencing a various changes in the sea conditions due to its open connection with the open sea.

KEYWORDS. *Kemaman, Grain size, Quartz.*

REFERENCES

Hutchison C. S (2009). Geology of Peninsular Malaysia. Geological Society of Malaysia and University of Malaya. pp.28

Mc Laren R. G. and Cameron K. C., 1996. Soil Science: Sustainable production and environmental protection. Oxford University Press. New Zealand. pp. 10 - 28.

Milliman, J. D. & Meade, R. H. (1983). World wide delivery of river sediment to the oceans. Journal of Geology, 91. pp: 1 – 21

Table 1: Minerals abundance in the study area

Station	Kaolinite	Quartz	Gibbsite	Ilmenite	Rutile	Feldspars	Hematite	Calcite
St. 1	xx	xxx			x		x	xx
St. 3		xxx			x	x		x
St. 5		xxx		x	x			x
St. 6	xx	xxx				x		xx
St. 7	xx	xxx	x	x		x	x	xx
St. 10	x	xxx			x	x		x
St. 11	xx	xxx			x	x		xx
St. 12	xx	xxx	x	x	x	x		
St. 13	x	xxx	x		x	x		x
St. 15	x	xxx			x	x		xx
St. 19		xxx	x		x			x

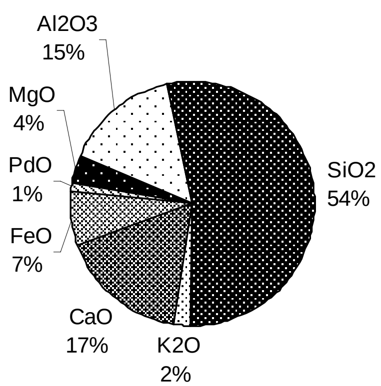

Figure 2: Percentage of compounds found in the study area

P028

Kajian Petrografi dan Geokimia Pluton Bukit Tinggi di sepanjang jalan empangan Kuala Kubu Bharu ke Bukit Fraser, Selangor

Mohd Rozi Umor*, Azman Abd Ghani, Hamzah Mohamad, Mohd Shafeea Leman, Azimah Hussin, Habibah Jamil, Mohd Basril Iswadi, Goh Thian Lai, Norbert Simon, Marilah Sarman and Nur Syafina Roslan.

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Pluton Bukit Tinggi yang dikenali sebelumnya sebagai Pluton Ulu Kali (Liew & Page, 1985) meliputi kawasan yang luas bermula dari Genting Sempah di selatan hingga Kalumpang dan Sg. Sempan yang berada di utara pluton. Ia disempadani oleh sesar Bukit Tinggi yang berada di barat dan bersentuhan dengan metasedimen berusia Silurian dan Devonian di bahagian sempadan timur pluton. Pluton Bukit Tinggi telah dibahagikan kepada unit Granit Gap, unit Ulu Kali, unit Sg. Rodah dan unit Granit Kalumpang (Cobbing et al., 1992). Kajian yang dijalankan ini hanya meliputi sebahagian kecil pluton Bukit Tinggi yang tersingkap di sepanjang jalan raya baru di empangan Kuala Kubu Bharu ke Bukit Fraser. Tujuan kajian ini adalah mengkhusus kepada kajian petrografi granit tericih yang memperlihatkan canggaan yang kuat berlaku kepada mineral-mineral, dan kandungan geokimia batuan yang boleh digunakan untuk pengelasan siri batuan, siri magma dan sekitaran tektonik semasa pembentukan batuan. Terdapat 58 stesen cerapan singkapan batuan yang telah dikaji semasa kerja lapangan. Daripada jumlah ini sebanyak 15 sampel telah dipilih untuk kajian petrografi dan 24 sampel telah dianalisis geokimia dengan kaedah XRF. Berdasarkan cerapan lapangan, batuan tersingkap dikelaskan sebagai granit biotit berbutir kasar berporfir sebagai unit yang utama dan mikrogranit sebagai rejahan fasa lewat memotong unit awal. Terdapat juga batuan migmatit hasil metamorfisme dan canggaan. Granit biotit berbutir kasar berporfir didapati menunjukkan variasi yang ketara dalam peratusan kehadiran fenokris feldspar alkali. Di sesetengah lokaliti fenokris feldspar alkali hadir hampir 50% daripada isipadu batuan dan menunjukkan ciri-ciri pengaturan mineral. Sementara itu, disesetengah lokaliti kelimpahan fenokris hanya sekitar 5 % daripada isipadu batuan. Namun begitu, jisim latarnya masih sama dengan saiz butiran yang kasar. Kebanyakkan batuan menunjukkan kesan ricihan yang tinggi di lapangan. Ia disokong dengan kajian petrografi. Kandungan mineral yang lazim dijumpai di dalam batuan adalah kuarza, feldspar alkali jenis ortoklas dan mikroklin, plagioklas, biotit dan mineral aksesori seperti apatit dan monazit serta mineral skunder seperti muskovit dan klorit. Feldspar alkali menunjukkan tekstur mikropertit dan mengalami retakan yang diisi oleh klorit dan muskovit. Plagioklas menunjukkan herotan pada garis kembaran, begitu juga biotit. Pengelasan geokimia menunjukkan batuan ini adalah granit jenis S, iaitu asalan sedimen, jenis peralumina dan dikelaskan sebagai siri kalk-alkali kaya K. Daripada kajian ini dapat disimpulkan bahawa granit di sepanjang jalan empangan Kuala Kubu Bharu telah mengalami kesan ricihan yang kuat kemungkinan hasil daripada aktiviti sesar Bukit Tinggi. Berdasarkan cirian batuan di lapangan dan hasil geokimia, pluton Bukit Tinggi ini boleh dikelaskan sebagai Granit Jalur Barat yang membentuk Banjaran Utama Semenanjung Malaysia.

Keyword : Pluton Bukit Tinggi, granit Kuala Kubu Bharu, granit tericih dan geokimia,

P040

Geo-Imagination as a New Approach to Socialize Geology to Public: A Case Study In Malaysia

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"Geo-Imagination" is a new proposed term for clarifying a new approach to socialize geology to general public by using imagination when they look at and observe the geological features. The term comes from the words of "Geo" which refers to geology and "Imagination" which may be described as the ability or tendency of the mind to form image of something that is actually not present. In general, Geo-Imagination can be defined as a new approach by using the imagination to attract common people (especially non-geological communities) to observe geological features and in the same time they enjoy learning geology. This paper aims to present a case study conducted in Malaysia regarding Geo-Imagination approach. Some examples of geological features in Langkawi Geopark, Kedah, have been identified for this purpose, such as a "turtle" atop the limestone hill in the Kilim Geoforest Park, a "shoe" in Pulau Kasut of the Kilim Geoforest Park, a "pregnant woman" in Pulau Dayang Bunting of the Dayang Bunting Marble Geoforest Park, and a "ship" Island. Meanwhile some other examples are from the state of Kelantan, they are a "human face" facing upward in Gunung Reng, Jeli District and a "boat" in Mount Chamah, Gua Musang District.

Keywords: Geo-Imagination; geology; geological features; new approach; socialize geology.

P041

Geophysical Evidences of a Possible Meteorite Impact Crater at Langkawi Island , Kedah.

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Previous investigation of geology and lineaments study using aerial photograph, clearly indicates a semi-circular rim structure of a possible remnant of impact crater in the main island of Langkawi, Kedah. A subsequent study of regional gravity survey produced a negative low gravity anomaly within the impact structure. .

An integrated geophysical study employing gravity and magnetic surveys was conducted to determine the geometry and subsurface geological structures of the impact crater. The gravity and magnetic readings were measured using Scintrex CG-5 gravity meter and proton precession magnetometers respectively. A total of 100 gravity stations and 226 magnetic stations were established around the interpreted impact crater covering an area of approximately 35 square km.. Both the gravity and magnetic anomaly data were processed and analysed using Oasis Montaj (Geosoft software).

The bouguer gravity map shows relatively low negative anomaly with rounded shaped contour around the suspected crater area. This anomaly was interpreted as a remnant of meteorite impact structure with distorted shaped crater in the study area. The bouguer anomaly map shows that the structure of the crater has a diameter of approximately 2.0 km. The impact structure has been modeled as a simple type crater in order to determine the thickness of the low density sedimentary fill. The magnetic anomaly map does not show direct correlation with structure of the impact crater, however there is an indication of subdued magnetic anomaly in the region within the impact crater.

Estimation of Sub-Surface Limestone Reserve Under Idle Ex-mining Land in Perak

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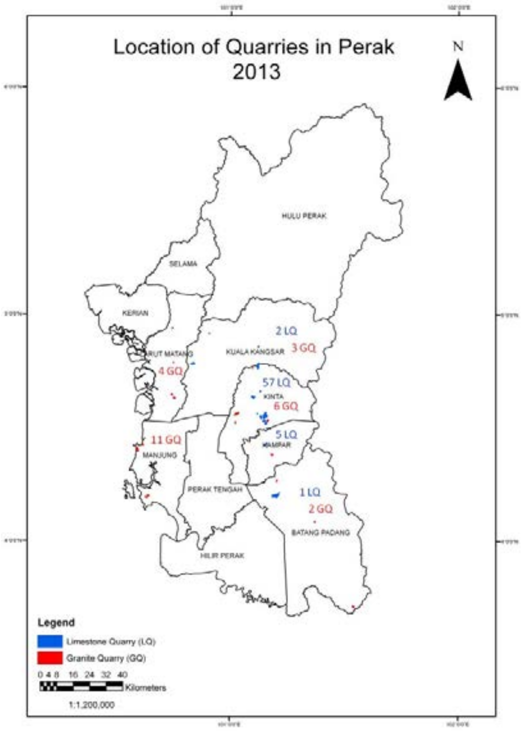

Figure 1: Location and number of limestone quarries (LQ)and granite quarries (GQ) in Perak 2013

To overcome the conflict of natural heritage conservation and the quarrying of surface limestone hills in Perak, Tasek Corporation Bhd. in Kinta, Hume Cement Sdn. Bhd. in Kampar, and Lhoist (M) Sdn. Bhd. in Batang Padang provide examples that sub-surface limestone quarrying under the idle ex-mining land is practical and economical. Geospatial analyses indicated that, as of 2013 there were 78,805 ha of land-use in the ex-mining land Perak. Of this, 38,100 ha are idle, i.e. has potential to be developed and 21,101 ha of which is underlain by limestone. A geospatial analysis was undertaken to estimate the sub-surface limestone reserve under the idle ex-mining land in Perak. This paper shows how the estimate was done by using the method of summation of multiple slices of average area-volume (SMSAV) and compares the result with the estimate of surface limestone reserve done by Geological Survey of Malaysia in 1991. The result shows that the estimated sub-surface limestone reserve under the idle ex-mining land is able to compensate the exploitation of surface limestone from the limestone hills. It is hope that these findings would assist authorization and enforcement government agencies to encourage limestone quarry operators to practice sub-surface limestone quarrying under the idle ex-mining land.

Keywords: sub-surface limestone, idle ex-mining land, SMSAV, reserve estimation

INTRODUCTION

To overcome the conflict of natural heritage conservation and the quarrying of surface limestone hills in Perak, Tasek Corporation Bhd. in Kinta, Hume Cement Sdn. Bhd. in Kampar, and Lhoist (M) Sdn. Bhd. in Batang Padang provide examples that sub-surface limestone quarrying on the idle ex-mining land is practical and economical. Geospatial analyses indicated that, as of 2013 there were 78,805 ha of land-use in the ex-mining land Perak. Of this, 38,100 ha are idle, i.e. has potential to be developed (Ramli and Mohd Anuar, 2013a), and 21,101 ha of which is underlain by limestone (Ramli et al., 2013b).

A geospatial analysis study was undertaken to estimate the sub-surface limestone reserve under the idle ex-mining land in Perak. This paper shows how the estimate was done by the method of summation of multiple slices of average area-volume (SMSAV), a term coined by the first author, and compares the result with the estimate of surface limestone reserve done by Geological Survey of Malaysia in 1991

(Abdullah Sani, 1991). The result shows that the estimated sub-surface limestone reserve under the idle ex-mining land is able to compensate the exploitation of surface limestone from the limestone hills.

It is hope that these findings would assist authorization and enforcement government agencies to encourage limestone quarry operators to practice sub-surface limestone quarrying under the idle ex-mining land.

2.0 QUARRY OPERATION IN PERAK

As of 2013, there were 66 active quarries in Perak. Forty eight quarries work on limestone and the remaining 18 quarries work on granite. Of the 48 quarries that work on limestone, 43 are in the district of Kinta, 2 in Kuala Kangsar, 2 in Kampar, and 1 in Batang Padang whereas of the 18 quarries that work on granite, 6 are in the district of Manjung, 6 in Kinta, 3 in Larut Matang, 2 in Batang Padang, and 1 in Kuala Kangsar (Figure 1).

All of the quarries in Perak are surface quarries except for the 3 sub-surface limestone quarries; they are Tasek Corporation Bhd., Hume Cement Sdn. Bhd., and Lhoist (M) Sdn. Bhd.

3.0 LIMESTONE HILLS THAT ARE AFFECTED BY SURFACE QUARRYING

There are currently 45 limestone quarry operators that quarry the limestone hills in Perak. The limestone hills that are affected by surface quarrying are Gunung Terundum (20 quarries), Gunung Rapat (10 quarries), Gunung Lanno (8 quarries), Gunung Panjang (2 quarries), Gunung Pondok (1 quarry), Sungai Siput (U) (1 quarry), Gunung Khantan (1 quarry), Gunung Temiang (1 quarry), and Gunung Sepah (1 quarry). The location of limestone hills and the number of quarries operating on them is shown in Figure 2.

4.0 PROPOSED KINTA VALLEY GEOPARK

UKM and JMG Malaysia are proposing to setup the Kinta Valley Geopark in the Kinta and Kampar districts covering an area of about 2,000 km^2 (Mohd Shafeea, 2013). Kinta valley possesses many geological and landscape features with heritage value of national and regional significance. Among them are cave and cave features at Gua Tempurung, Gua Kandu, Gunung Rapat, Gunung Lanno, and Gunung Kanthan, pencil rock monument and hot springs at Gunung Datuk, Tanjung Tualang Dredge Museum, ancient cave paintings at Gunung Panjang, waterfall and rapids at Sungai Kampar, hot spring at Lubuk Timah, waterfalls at Sungai Chelik, Sungai Salu, Batu Berangkai, Ulu Kinta, Ulu Chepor, and Buntong, landscape at Gunung Lang, Gunung Korbu, Kledang-Saiong, Gunung Gayong, Gunung Cheroh, Gunung Chante, Gunung Gajah, and Gunung Bujang Melaka (Figure 3).

Works on the pre-historic significance of Gunung Panjang was done by Mohd Shafeea et al. (2013) and the potential of setting up of geopark at Gunung Datuk was studied by Tuan Rusli et al. (2013).

Geospatial data from Figure 2 and Figure 3 show that there is an obvious conflict between setting up of the Kinta Valley Geopark and surface limestone quarrying activities. To begin with, in the heart of the proposed geopark sites, extensive over exploitation and gross defacing of the limestone hills of Gunung Terundum (with 20 quarries), Gunung Rapat (with 10 quarries), and Gunung Lanno (with 8 quarries) has become a centre piece of the landscape in the Kinta Valley. It is more like the valley has become sites of massive destruction of the limestone hills rather than sites of preservation of these natural wonders of great heritage significance.

It is evident that the most seriously affected limestone hill is the Gunung Terundum where we are witnessing a monumental piece of natural heritage systematically being obliterated from the map. This act of merciless destruction is spilling over to the nearby Gunung Lanno, which harbours 36 cave systems of great speleological and geoheritage interest (Geyer et al., 2005). While the destiny of Gunung Terundum is already predetermined, the Gunung Lanno and the Gunung Rapat could still be saved. One of the solutions towards preserving these limestone hills is to practise sub-surface limestone quarrying.

5.0 SUB-SURFACE LIMESTONE QUARRYING IN PERAK

Tasek Corporation Bhd. in Kinta, Hume Cement Sdn. Bhd. in Kampar, and Lhoist (M) Sdn. Bhd. in Batang Padang provide examples that sub-surface limestone quarrying in the ex-mining land is practical and economical to operate. The locations of these quarries are shown in Figure 4.

Statistics of these sub-surface limestone quarries are described in sub-sections 5.1 to 5.4. The cost of quarrying for raw limestone (contract rate per ton) is estimated by considering the cost of dewatering,

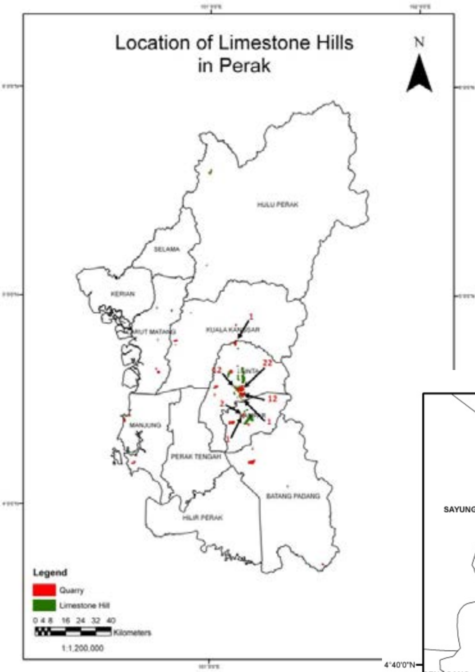

Figure 2: Location of limestone hills in Perak and the number of quarries operating on them

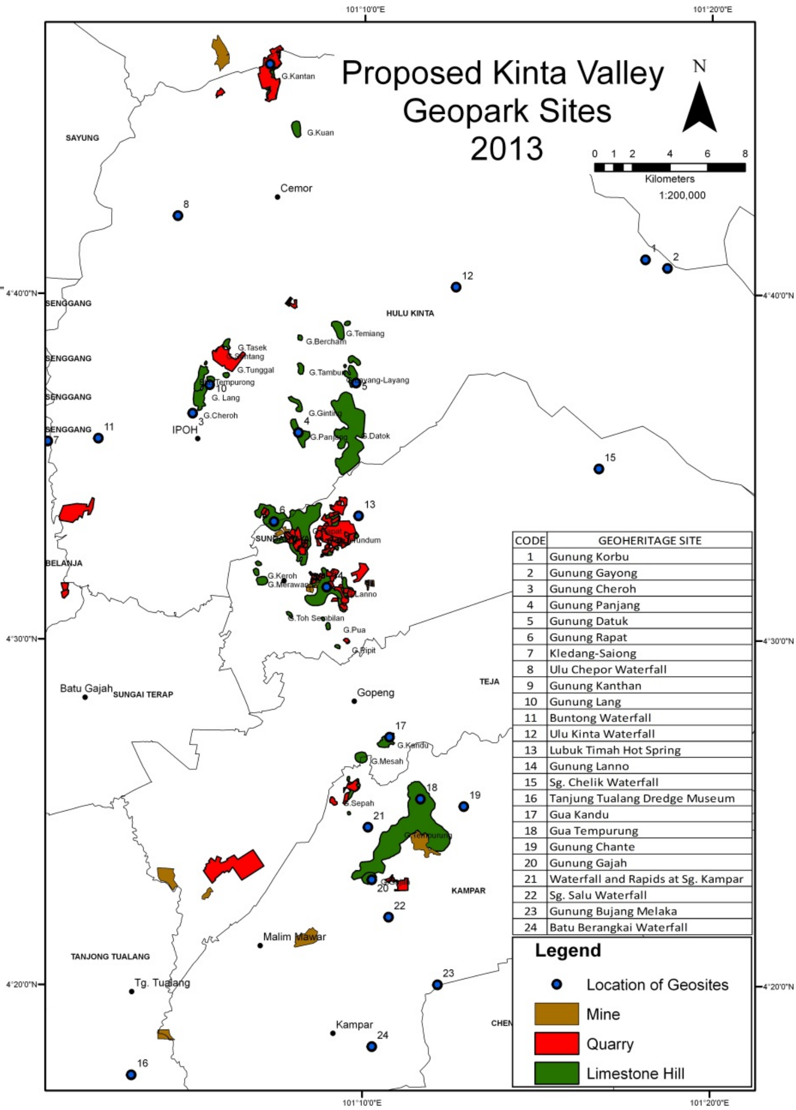

Figure 3: Proposed Kinta Valley Geopark sites 2013

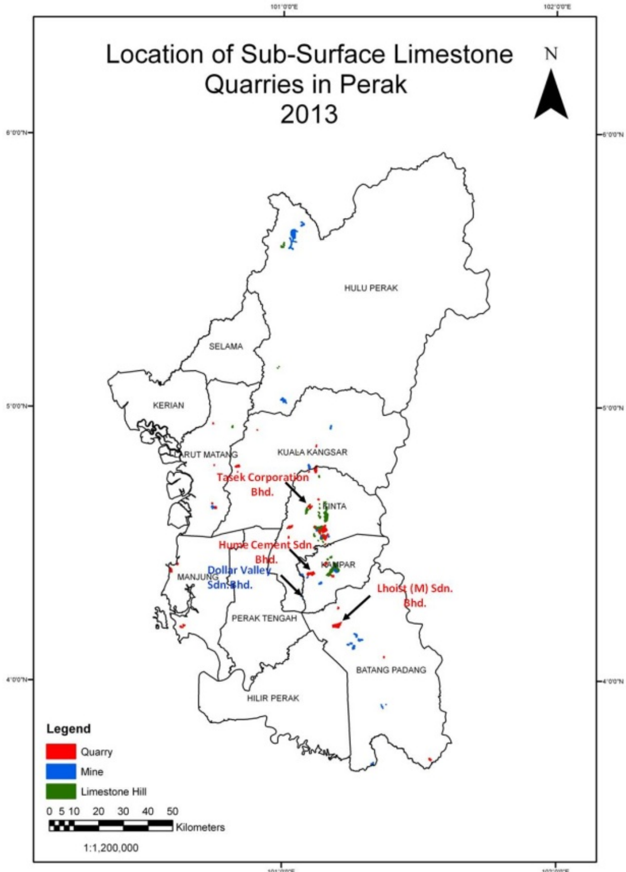

Figure 4: Location of sub-surface limestone quarries in Perak 2013

Figure 5: Tasek Corporation Bhd. sub-surface limestone quarry pit under an ex-mining land

Figure 6: Hume Cement Sdn. Bhd. sub-surface limestone quarry pit under an ex-mining land

Figure 7: Lhoist (M) Sdn. Bhd. sub-surface limestone quarry pit under an ex-mining land

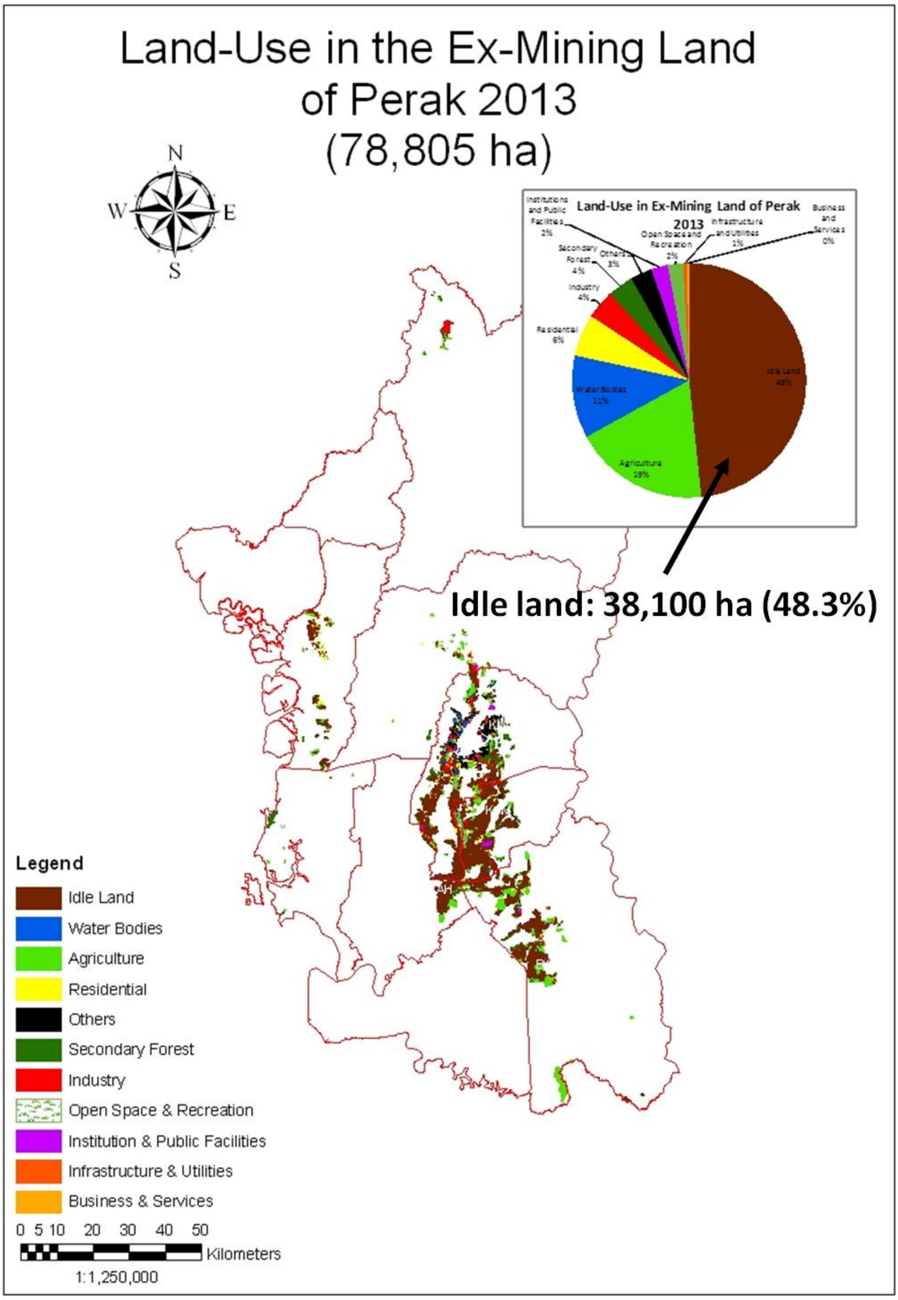

Figure 8: Land-use in the ex-mining land of Perak 2013

drilling, blasting, and hauling to the client factory. The cost of crushing of the raw limestone is borne by the client at the factory.

5.1 TASEK CORPORATION BHD.

Tasek Corporation Bhd. is located in mukim Hulu Kinta, in the district of Kinta. It quarries sub-surface limestone under an ex-mining land for the manufacture of cement. The quarry lease covers 113 ha (278 acres) and the overburden depth varies from 10 to 15 m. The quarry is currently operating at a slope angle of 80° to 90°, bench width of 2 m and bench height of 10 m. The current depth of pit is 70 m with a target depth of 100 m (Figure 5). The limestone quality is > 53-54% CaO and <2% or as high as 18% MgO. The density of limestone is 2.6 ton/m^3. The cost of quarrying for raw limestone (contract rate per ton) is RM 7/ton with a minimum production rate of 200,000 ton/month [Mr. Mohamed Ibrahim Peer Mohamed (Senior Quarry Manager), pers. comm., 5 March 2014].

5.2 HUME CEMENT SDN. BHD.

Hume Cement Sdn. Bhd. is located in mukim Teja, in the district of Kampar. It quarries sub-surface limestone under an ex-mining land for the manufacture of cement. The quarry lease covers 270 ha (668 acres) and the average overburden depth was about 15 m. The quarry is currently operating at a slope angle of 90°, bench width of 6 m and bench height of 15 m. The current depth of pit is 30 m with a target depth of 60 m (Figure 6). The limestone quality is about 60% CaO and <3% or as high as 7% MgO. The density of limestone is 2.6 ton/m^3. The cost of quarrying for raw limestone (contract rate per ton) is RM 5/ton to RM 6/ton with a minimum production rate of 200,000 ton/month [Mr. Chan Chee Hong (Quarry Manager), pers. comm., 3 March 2014].

5.3 LHOIST (M) SDN. BHD.

Lhoist (M) Sdn. Bhd. is a Belgium based quarrying company located in mukim Chenderiang and mukim Batang Padang, in the district of Batang Padang. It quarries sub-surface limestone under an ex-mining land for the manufacture of limestone aggregates and lime. The quarry lease covers 373 ha (922 acres) and the overburden depth ranges from 13 m to 23 m. The quarry is currently operating at a slope angle of 90°, bench width of 5 m and bench height of 15 m. The current depth of pit is 15 m with a target depth of 80 m (Figure 7). The limestone quality is about 51% CaO and <2% MgO. The density of limestone is unknown. The cost of quarrying for raw limestone (contract rate per ton) is RM 6/ton with a minimum production rate of 25,000 ton/month [Mr. Mohd Sarthar Sulaiman (Quarry Manager), pers. comm., 3 March 2014].

5.4 SUMMARY STATISTICS OF SUB-SURFACE LIMESTONE QUARRYING IN PERAK

In 2014, the performance statistics of sub-surface limestone quarries of Tasek Corporation Bhd., Hume Cement Sdn. Bhd., and Lhoist (M) Sdn. Bhd were as follows:

Quarry lease covers from 113 ha (278 acres) to 373 ha (922 acres) and the overburden depth varies from 10 m to 23 m.

The operating quarry slope angle varies from 80° to 90°, bench width varies from 2 m to 6 m, and bench height varies from 10 m to 15 m.

The current depth of pit varies from 15 m to 70 m, whereas the target depth of pit varies from 60 m to 100 m.

As for limestone quality, the CaO varies from 51% to 60%, whereas the MgO varies from <2% to 18%.

The density of limestone is 2.6 ton/m^3 for both Tasek Corporation Bhd. and Hume Cement Sdn. Bhd. The density of limestone in Lhoist (M) Sdn. Bhd. is unknown.

The cost of quarrying for raw limestone (contract rate per ton) varies from RM 5/ton to RM 7/ton whereas the minimum production rate varies from 25,000 ton/month to 200,000 ton/month.

6.0 POTENTIAL SUB-SURFACE LIMESTONE QUARRYING SITES UNDER THE IDLE EX-MINING LAND IN PERAK

One of the best sites to practise sub-surface quarrying is under the idle ex-mining land, which has potential to be developed. A geospatial analysis was undertaken to determine the availability of sub-surface limestone under the idle ex-mining land in Perak. As of 2013 there were 78,805 ha of land-use in

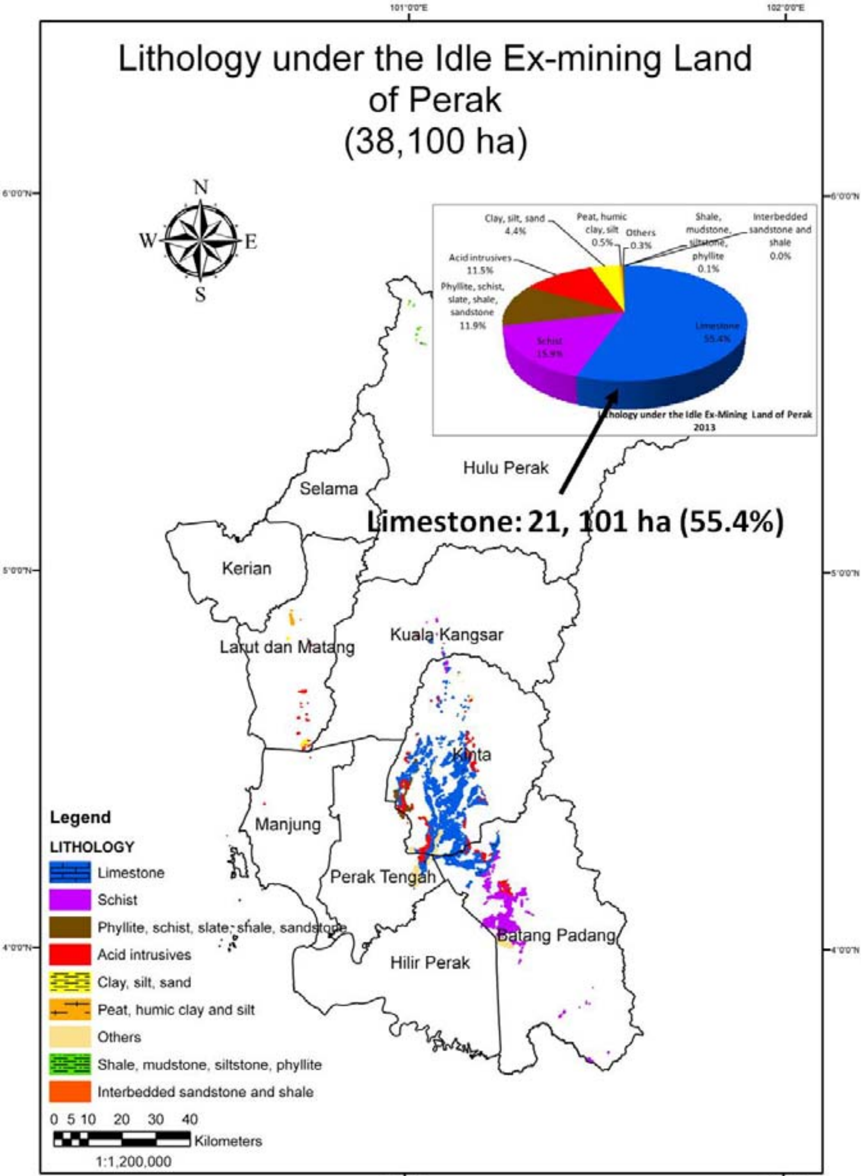

Figure 9: Lithology under the idle ex-mining land of Perak

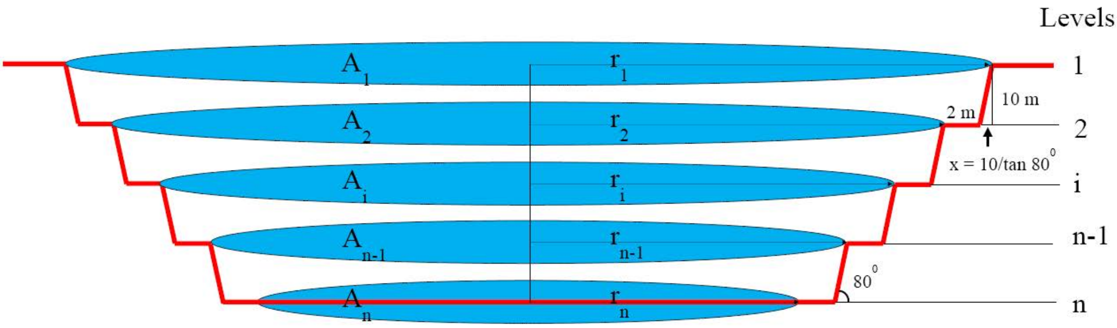

Figure 10: Model used to estimate the volume of sub-surface limestone, where A = area; r = radius; i = ith level; and n = the last level

The equations used to estimate the sub-surface limestone reserve are as follows:

$$Area, A_i = \pi r_i^2$$

$$Radius, r_{i+1} = r_i - \left(bench\ width + \frac{bench\ height}{\tan slope\ angle}\right)$$

$$Radius, r_{i+1} = r_i - \left(2 + \frac{10}{\tan 80^0}\right)$$

$$Total\ volume, V_{tot} = \sum_{i=1}^{i=n-1} [average\ of\ area\ (A_i] + A_{i+1})x\ bench\ height$$

$$Total\ volume, V_{tot} = \sum_{i=1}^{i=n-1} \left(\frac{A_i + A_{i+1}}{2}\right) 10$$

$$Total\ mass, M_{tot} = Vol_{tot}\ x\ density$$

$$Total\ mass, M_{tot} = Vol_{tot}\ x\ 2.65$$

$$Limestone\ reserve, RM = M_{tot}\ x\ RM7\ per\ ton$$

the ex-mining land. Of this, 38,100 ha is idle, as shown in Figure 8 (Ramli and Mohd Anuar, 2013a) and 21,101 ha of which is underlain by limestone, as shown in Figure 9 (Ramli et al., 2013b).

7.0 ESTIMATION OF SUB-SURFACE LIMESTONE RESERVE IN PERAK

Figure 10 shows the method of summation of multiple slices of average area-volume (SMSAV) model that was used to estimate the volume of sub-surface limestone reserve.

7.1 ASSUMPTIONS OF PARAMETERS USED IN ESTIMATING SUB-SURFACE LIMESTONE RESERVE

Area, A_1 = 21,101 ha = 211,010,000 m^2 (determined by geospatial analysis as noted in section 6.0)
Terminal bench width = 2 m (as practised by Tasek Corporation Bhd.)
Bench height, h = 10 m (as practised by Tasek Corporation Bhd.)
Slope angle = 80^0 (as practised by Tasek Corporation Bhd.)
Density of sub-surface limestone, ρ_{lst} = 2.6 ton/m^3 (value from Tasek Corporation Bhd. and Hume Cement Sdn. Bhd.)
Cost to quarry sub-surface limestone = RM7/ton (as practised by Tasek Corporation Bhd.)
Depth of pit = 60 m (conservative terminal pit depth as practised by Hume Cement Sdn. Bhd.)

7.2 RESULT OF ESTIMATION CALCULATION OF SUB-SURFACE LIMESTONE RESERVE

The calculations of sub-surface limestone reserve under the idle ex-mining land are shown in Table 1.

Table 1: Calculations of sub-surface limestone reserve under the idle ex-mining land

Level	A_i (m^2)	r_i (m)	r_{i+1} (m)	h (m)	V_i (m^3)	M_i (ton)	Reserve (RM)
1	211,010,000	8,196	8,192	10	2,109,131,294	5,483,741,364	38,386,189,547
2	210,816,259	8,192	8,188	10	2,107,194,326	5,478,705,248	38,350,936,738
3	210,622,606	8,188	8,184	10	2,105,258,249	5,473,671,446	38,315,700,124
4	210,429,043	8,184	8,180	10	2,103,323,061	5,468,639,958	38,280,479,705
5	210,235,569	8,180	8,177	10	2,101,388,763	5,463,610,783	38,245,275,481
6	210,042,184	8,177	8,173	10	2,099,455,355	5,458,583,922	38,210,087,453
7	209,848,887	8,173	8,169				
Total				60	8,424,906,929	21,904,758,016	153,333,306,114

8.0 ESTIMATION OF SURFACE LIMESTONE RESERVE IN PERAK

Abdullah Sani (1991) estimated the mass of surface limestone reserve from the limestone hills of Perak. He estimated the volume of the limestone hills by multiplying the base area of the hill with its average height. The mass of limestone reserve was estimated by multiplying the volume with the density of limestone taken as 2 ton/m^3.

We reproduced Abdullah Sani (1991) mass reserve estimate of the limestone hills of Perak in Table 2 with the following modifications:

The density of the limestone is taken as 2.6 ton/m^3 instead of 2 ton/m^3.

The limestone reserve in Malaysian ringgit is estimated using RM7/ton. Abdullah Sani (1991) did not estimate the limestone reserve in Malaysian ringgit.

9.0 DISCUSSION

The method of summation of multiple slices of average area-volume (SMSAV) model of sub-surface limestone quarrying to a pit depth of 60 m gives a reserve of 21,905 Mt that translates to RM153 billions of raw limestone reserve under the idle ex-mining land in the state of Perak.

In 1991 Geological Survey of Malaysia estimated the reserve of surface limestone from the limestone hills of Perak. After modification of the density of limestone used in the calculation and the current value of raw limestone, the reserved were re-calculated to be 3,466 Mt that translates to RM24 billions.

Thus, the sub-surface limestone reserve under the idle ex-mining land is sufficient to compensate the exploitation of surface limestone.

10.0 CONCLUSION

There is a need to practise sub-surface limestone quarrying in Perak to overcome the conflict of natural heritage conservation and the quarrying of surface limestone hills. One of the potential sites for sub-surface limestone quarrying is under the idle ex-mining land.

Tasek Corporation Bhd., Hume Cement Sdn. Bhd., and Lhoist (M) Sdn. Bhd. provide examples that sub-surface limestone quarrying under the ex-mining land is practical and economical to operate.

The sub-surface limestone reserve under the idle ex-mining land is sufficient to compensate the exploitation of surface limestone. Therefore, the economic development of limestone quarrying in Perak would not be affected if sub-surface limestone quarrying is practised.

It is hope that these findings would assist authorization and enforcement government agencies to encourage limestone quarry operators to practice sub-surface limestone quarrying on the idle ex-mining land. However, there is a need to study and to determine the impact of sub-surface limestone quarrying on the environment and surface land-use activities in term of, among others, ground vibration and drawing down of water tables.

ACKNOWLEDGMENTS

The authors thank Zaiton Abdullah from Quarry and Mining Unit, JMG Perak for providing data on quarries in Perak and Suzannah Akmal from Information Management Unit, JMG Perak for providing data on Kinta Valley Geopark Sites.

REFERENCES

Abdullah Sani, H., 1991. Kajian penilaian potensi batu kapur di Perak. Laporan No. 21 Projek Mineral Perindustrian (1986-1990), Jabatan Penyiasatan Kajibumi Malaysia, 129 p.

Geyer, E., Schmidt, F. and Jeutter, P. (eds.), 2005. *Speleological Expedition Gunung Lanno Malaysia*. Verein für Höhlenkunde in Obersteier (VHO), Bad Mitterndorf, Austria, 240p.

Mohd Shafeea, L., 2013. Proposed Kinta Valley Geopark Geological Resources for Environmental Quality Improvement and Society Well Being Enhancement. *Proceedings of the National Geoscience Conference 2013, 8-9 June 2013, Kinta Riverfront Hotel and Suites, Ipoh*.

Mohd Shafeea, L., Mokhtar, S. and Islahuda Hani, S., 2013. The occurrence of pre-historic kitchen wastes at Gunung Panjang, Ipoh, Perak and their bearings on the age of the Gua Tambun pre-historic rock paintings. *Proceedings of the National Geoscience Conference 2013, 8-9 June 2013, Kinta Riverfront Hotel and Suites, Ipoh*.

Ramli, M.O. and Mohd Anuar, I., 2013a. Geospatial analyses of ex-mining land in Perak 2013. *Paper presented in Symposium Mineral 2013*, 12– 13 November 2013, Kinta Riverfront Hotel, Ipoh, Perak.

Ramli, M.O. and Mohd Anuar, I., and Ahmad Zukni, A.K., 2013b. The need to practiced sub-surface limestone quarrying in Perak. *Paper presented in Symposium Mineral 2013*, 12– 13 November 2013, Kinta Riverfront Hotel, Ipoh, Perak.

Tuan Rusli, M., Kamaluddin, H., Mohd Shafeea, L., Saiful, A. and Ahmad Khairut Tarmizi, M.D., 2013. Geotapak kompleks kars Gunung Datok dan potensinya sebagai tunggak pembangunan geotapak kebangsaan lembah Kinta, Perak, Malaysia. *Proceedings of the National Geoscience Conference 2013, 8-9 June 2013, Kinta Riverfront Hotel and Suites, Ipoh*.

P060

Ce Anomaly in Weathering Profile of I–Type Fractionated Granitic Rock from Peninsular Malaysia

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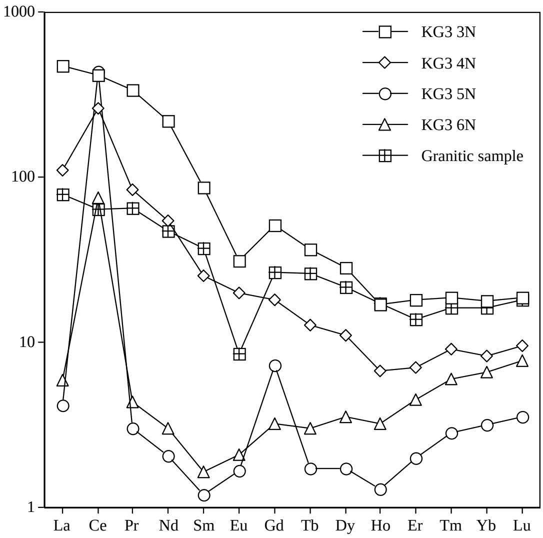

Figure 1: Example of REE profile of granitic sample and soil samples (KG3 3N to KG3 6N). Note that the high positive Ce anomaly of the soil samples.

The Kuantan area is underlain by two main types of igneous rock, i.e. Permian granite and Pleistocene basaltic formations. The contact between these two rocks can easily be traced as the soils of the granite and basalt in this area exhibit significantly different colors and physical characteristics. The main aim of this paper is to describe the REE content in some of the granitic soils and to discuss the possible reasons of the anomaly in the profile. The main granite type ranges from coarse grained primary textured equigranular to porphyritic biotite and hornblende granite with high SiO_2 content > 70% SiO_2. The mineralogy of the granite in decreasing abundance is K-feldspar, quartz, plagioclase, biotite, apatite, allanite and zircon.

Analyses of samples from a weathering profile of Kuantan Granite shows a prominent Ce anomaly in all analysed samples (Figure 1). All samples show positive Ce anomaly with Ce/Ce* value ($Ce/Ce^* = Ce_N/\sqrt{La_N.Pr_N}$) ranging from 1.2 to 125. The sharp enrichment of Ce is a consequence of Ce mobilization and precipitation in the soil and saprolite of the granitic rocks from the study area. High Ce concentration in the granitic weathering product suggests that the element rapidly precipitated during weathering and was retained in the soil. This is partly because Ce is a rare earth element characterized by two different redox states due to its specific electron configuration: III and IV which is in contrast to other rare earth element members which are only trivalent (with the notable exception of Eu^{2+}). The Ce^{3+} can be oxidized by atmospheric oxygen (O_2) and change to Ce^{4+} under alkaline conditions. The less soluble Ce^{4+}, can be fixed in secondary minerals such as clay minerals. Ce4+ may occur as new phase such as cerianite or adsorbed in a clay mineral. Ce3+ along with other REE will be dissolved and removed by solutions. In felsic rock such as granitics, the strong mineral is not soluble in intense weathering. The resistance of minerals to weathering in granitic magma can be divided into three types: (1) strongly resistant to weathering, such as xenotime and zircon; (2) moderately resistant to weathering such as fergusonite, monazite, allanite, and (3) weakly resistant to weathering, such as bastnaesite, parisite, gadolinite-(Y) and doverite The retention of zircon in the weathering product of the granitic rocks also will increase Ce content in the soil. Ce4+ is compatible in zircon. Terrestrial zircons commonly show a positive Ce anomaly due to the incorporation of Ce4+ into zircon. This is partly because Ce4+ has the same charge and a similar ionic radius than Zr4+ (Ce4+ = 0.97 Å; Zr4+ = 0.84 Å).

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P061

Tectonic Setting of Basaltic Dykes from the Eastern Belt of Peninsular Malaysia

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Basaltic dykes of Peninsular Malaysia are confined to the Eastern Belt (Indochina/East Malaya block) as compared with the Western Belt (Sibumasu Block). The dyke intruded through a crustal fracture formed by stress developed from the evolution of two offshore basins (Malay and Penyu basins) east off Peninsular Malaysia. The Ar□Ar dating from the present study combined with the previous geochronology data indicate that the ages of the dykes range from 79 ± 2 Ma to 179 ± 2 Ma. Subduction of Sibumasu beneath Indochina terrane begin with closure of Tethys ocean in the late Permian. By the end of the late Triassic, the crustal thickness of the Western, Central and Eastern Belts as estimated from Metcalfe's model were about 43, 15 and 28 km respectively. Both the Eastern and Central Belts are about 13 km thinner compared to the Western Belt. It is suggested here that the Western Belt contains very few basaltic dykes of the same age when compared to the dykes in the study area because it consists of a much thicker continental crust. A thicker crust is more difficult to rupture with normal plate tectonic stress and therefore serves to contain the rise of a mantle derived melt. The thicker crust may be the result of the continental collision between the Indochina and Sibumasu blocks during the Permo-Triassic. This is supported by gravity work by Ryall (1982) which showed that the Central Belt of Peninsular Malaysia consists of thinner crust compared to both Eastern and Western Belts

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P067

Pelan Kekangan Geologi dalam Penghasilan Pelan Impak Pembangunan Sebagai Kawalan Pembangunan Guna Tanah Majlis Perbandaran Sepang Kes: Kajian Interim Blok Perancangan Kecil (Bpk) 3.2 Sungai Merab, Mukim Dengkil Daerah Sepang, Selangor Darul Ehsan (Kawasan Berbukit / Cerun)

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Kepesatan pembangunan guna tanah di kawasan pinggir Putrajaya atau lebih dikenali sebagai Tanah Rezab Melayu Sungai Merab (TRM Sg. Merab) telah menunjukkan permintaan yang amat tinggi bagi pembangunan bercampur terutamanya pembangunan perumahan atau kediaman. Permintaan tersebut telah mengakibatkan pembangunan ditumpukan dikawasan berbukit dan bercerun di sekitar TRM Sg. Merab. Kawasan TRM Sg. Merab secara geomorfologi merupakan kawasan berbukit serta beralun dan sebahagian kawasan tersebut berada berada pada zon Kawasan Sensitif Alam Sekitar (KSAS). Di negeri Selangor, pembangunan di kawasan berbukit dan bercerun yang mempunyai kawasan Kelas III dan Kelas IV atau cerun berkecerunan melebihi 25 Darjah merupakan kawasan KSAS. Selain terlibat dengan KSAS, TRM Sg. Merab juga terlibat dengan pembangunan lot-lot kecil dengan purata keluasan satu-satu lot adalah kurang daripada 3.0 ekar atau 1.2 hektar dan ini menyukarkan kawalan pembangunan dilaksanakan oleh Majlis Perbandaran Sepang (MPSepang) sebagai Pihak Berkuasa Tempatan. Oleh itu, untuk mewujudkan satu kawalan pembangunan di kawasan berbukit dan bercerun yang sistematik dan teratur, maklumat geologi seperti geomorfologi, litologi, terain, inventori cerun, dan sebagainya amat diperlukan. Maklumat geologi tersebut diterjemahkan dalam satu pelan yang dinamakan sebagai Pelan Kekangan Geologi (PKG). PKG ini menjadi asas utama oleh MPSepang bagi penghasilan Pelan Impak Pembangunan yang mengambilkira beberapa maklumat lain seperti topografi dan sistem saliran, Rancangan Tempatan dan infrastruktur yang akan digunapakai sebagai garispanduan dan peraturan. Pelan Kekangan Geologi yang berkait rapat dengan Pelan Impak Pembangunan MPSepang ini telah berjaya mewujudkan satu kaedah sistematik dengan menyenaraikan semua keperluan dan syarat perancangan dan pembangunan guna tanah mengikut lot pembangunan dengan mengambilkira semua aspek teknikal terkini. Pelan ini telah berjaya digunapakai diperingkat Unit Pusat Setempat (OSC) dimana semua permohonan pembangunan di TRM Sg. Merab perlu mematuhi perkara yang telah digariskan. Beberapa permohonan guna tanah di TRM Sg. Merab juga telah menjadikan Pelan Kekangan Geologi dan Pelan Impak Pembangunan MPSepang sebagai asas dalam merancang pembangunan yang terbaik yang boleh dibangunkan.

P074

Geochemistry Characterization of Clay Mineralogy in Surface Sediment of Kelantan River, Terengganu River and Pahang River of Peninsular Malaysia

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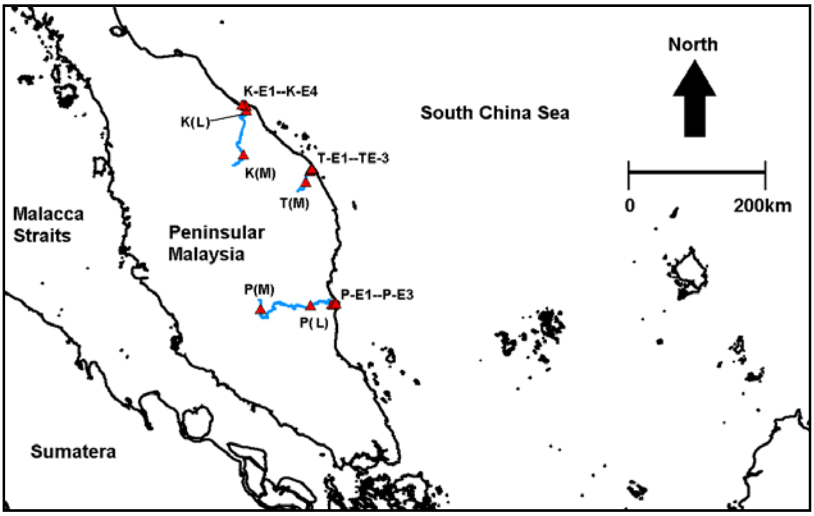

Figure1: Sampling area of the coast of Kelantan River, Terengganu River and Pahang River. Note: K, T and P – Kelantan, Terengganu and Pahang River; M, L and E – middle course, lower course and estuary

Clay minerals assemblage and major-element geochemistry of surface sediments of the tropical river-estuary system of Kelantan, Terengganu and Pahang River (located along the East coast of Peninsular Malaysia) was investigated. Surface sediments (0~10 cm) were found to consist mainly of kaolinite (72%-75%), minor by illite (13%-20%) chlorite (7%-10%) and <1% smectite whereas the offshore region of Pahang River mainly consists of smectite (61%), kaolinite (18%), illite (15%) and chlorite (7%). Geochemical analysis of sediments indicated that the concentrations of major elements (Fe, Mg, Na, Ca) decreased from the middle course to estuary. Elemental ratios suggested that CaO and Na_2O are the most chemically mobile elements while Fe_2O_3 is the least for those three investigated rivers. Formation of clay mineral (Al-rich) occurred with the enrichment of quartz (Si-rich) and feldspar (Na-rich). Illite chemistry index in these rivers basin average 0.49 and supported by high chemical index of alteration (CIA) (>80) which shows an intensive chemical weathering had occurred on, Kelantan River, Terengganu River and Pahang River basins.

Keywords: Clay mineral, major-element geochemistry, chemical weathering, Tropical River, Sediments, Malaysia.

1.0 INTRODUCTION

Geochemistry and mineralogy research on clay minerals are useful for evaluating the continental weathering process and mechanism through their geochemical and mineralogy composition (Liu et al. 2007a, 2009).

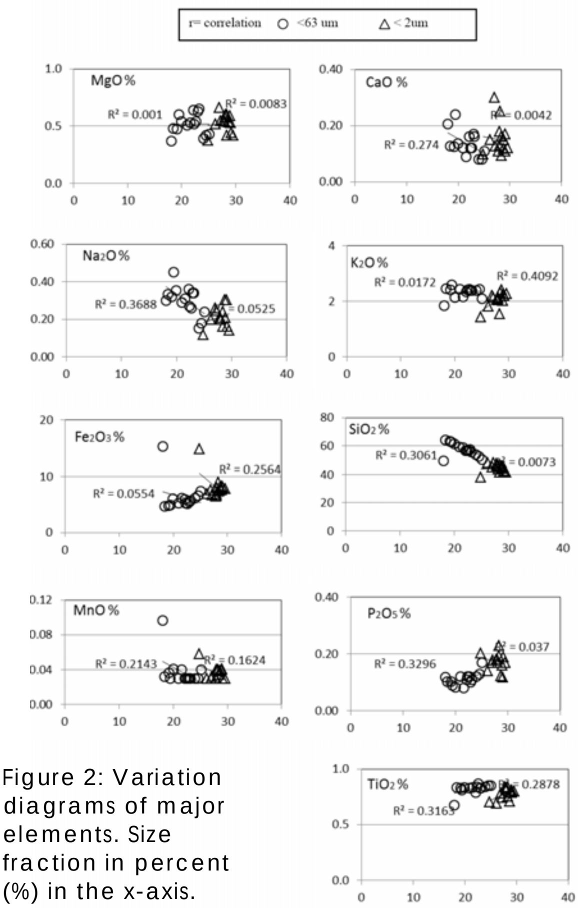

Figure 2: Variation diagrams of major elements. Size fraction in percent (%) in the x-axis.

The east coast Peninsular Malaysia has three main rivers that flow into South China Sea, i.e. Kelantan, Terengganu and Pahang River. Kelantan River basin is located at the north eastern part of Peninsular Malaysia. The river is about 248 km long and drains an area of 13,100 km^2 (Ibbitt et. al. 2002). Terengganu River basin covered approximately 5,000 km^2 State of Terengganu (Sultan and Shazili, 2010). Pahang River is the largest river basin in Peninsular Malaysia. Its length is approximately 440 km and basin area is about 25,600 km^2. Among these rivers, Pahang River basin produces the highest suspended solid load in Peninsular Malaysia as a result of active chemical weathering and erosion processes induced by high rainfalls and temperature and also its basin size (Sathiamurthy, 2008). This study compared the surface sediments clay mineralogy and major-element geochemistry between the middle course and estuary Kelantan, Terengganu and Pahang Rivers. Earlier papers were limited to estuary data only (Wang et. al. 2011).

2.0 METHODOLOGY

Sampling locations are shown in Figure 1. The sediment samples were wet sieved into two sizes; <63 µm (bulk-fraction) and <2 µm (clay-fraction). Bulk-fraction sediments were de-carbonated using 1% HCl and washed repeatedly to neutral. Clay-fraction sediments were obtained from deflocculated suspension, according to Stoke's law and concentrated using centrifugation technique. The resultant pastes were mounted onto glass slides and dried. Their clay minerals composition was identified using X-ray diffraction (XRD) technique. Major elements were measured in clay (<2 µm) and bulk-fraction (<63 µm) of sediments using inductively coupled plasma-optical emission spectrometer (ICP-OES).

3.0 RESULTS

The percentages of clay minerals in Kelantan River, Terengganu River and Pahang River indicated the settling of kaolinite and smectite is associated with and their particle size Kaolinite starts to flocculate with the increase of salinity at the lower course of a river. Flocculated kaolinite particles would be deposited within river system because of its larger particle size. In comparison, smectite has higher stability (lower tendency to flocculate) than kaolinite. Hence, it remains suspended in the estuary. Smectite is flocculated when salinity reaches marine values (around 35 ppt) and gets deposited on the sea bed resulting in smectite rich composition. More than 70% kaolinite were deposited at the lower course to estuary section. Meanwhile, about 61% of smectite were deposited in the offshore region.

Clay-fraction of sediments generally contained higher concentrations of Al_2O_3, Fe_2O_3 and P_2O_5 but lower SiO_2 and Na_2O than the corresponding bulk sediments. Correlations between Al_2O_3 (%) (X-axis) and plotted elements (Y-axis) were made. CaO, Fe_2O_3, MnO and P_2O_5 in clay-fraction, and Na_2O and SiO_2 in bulk-fraction showed negative correlations. This suggests mineralogical control on CaO and Fe_2O_3 concentrations and the leaching of less mobile P_2O_5 and Na_2O elements in weathering processes. On the contrary, K_2O, TiO_2 and MgO in clay and bulk-fraction, and Na_2O and SiO_2 in clay-fraction of sediments showed positive correlations (Figure 2). These patterns represent the enrichment of elements from middle course to estuary. Al-rich clay minerals are being formed at the enrichment of quartz (Si-rich), feldspar (Na-rich) through chemical weathering.

4.0 SUMMARY

The main components of clay mineral assemblages from middle course to estuary of Kelantan River, Terengganu River and Pahang River were dominantly kaolinite minerals followed by illite, chlorite and smectite (scarce). This composition implied active chemical weathering in Malay Peninsula. Intensive chemical weathering of parent rocks resulted in high abundance of kaolinite. Major elements of riverbed sediment were characterized by high content of SiO, Al_2O_3, and Fe_2O_3, accounting for ≥ 80 % of the total composition.

REFERENCES

Liu, Z., Colin, C., Huang, W., Khanh, P. L., Tong, S., Chen, Z. and Trentesaux, A. 2007, Climatic and tectonic controls on weathering in south China and Indochina Peninsula: clay mineralogical and geochemical investigations from the Pearl, Red and Mekong drainage basins. Geochem, Geophys, Geosyst, Vol. 8, Q05005.

Liu, Z., Zhao, Y., Colin, C., Siringan, F. P. and Wu, Q. 2009, Chemical weathering in Luzon, Philippines from clay mineralogy and major-element geochemistry of river sediments. Applied Geochemistry, Vol. 24, No. 11, pp. 2195-2205.

Sathiamurthy, E. 2008, River discharge characteristics of major east coast rivers of Peninsular Malaysia into South China Sea. 1st International Workshop on the Fluvial Sediment Supply to the South China Sea (Abstract), Shanghai, China.

Sultan, K. and Shazili,N,A.2010. Geochemical baseline of major, minor and trace elements in the tropical sediments of the Terengganu River basin, Malaysia. International Journal of Sediment Research 25, pp 340-354.

Wang, H., Liu, Z., Sathiamurthy, E., Colin, C., Li, J., Zhao, Y. 2011, Clay mineralogy and elemental geochemistry of river surface sediments in Malay Peninsula and North Borneo. Science China: Earth Sciences, Vol. 54, No. 2, pp. 272-282.

P078

Lithostratigraphic Correlation of the Rebak/Khuan Klang Formation along the Malaysia-Thailand Border Area

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Keyword: Rebak Formation, Khuan Klang Formation, Carboniferous, Malaysia, Thailand.

INTRODUCTION

During the joint study by the Malaysia-Thailand Working Group in the Bukit Batu Putih-Satun Transect area carried out in 2004-2005, the Carboniferous Kubang Pasu Formation on the Malaysian side is correlated with the Yaha Formation on the Thai side, whilst the Khuan Klang Formation was considered to be exposed only on the Thai side (The Malaysia-Thailand Working Groups, 2010). However, after considering the occurrence of Lower Carboniferous rock sequence in the basal part of the Singa Formation in Langkawi Islands and western Perlis, the Malaysia-Thailand Working Group has decided to study the possibility to correlate this rock unit with the Khuan Klang Formation in Thailand.

On the Malaysian side, it was reported that the Lower Carboniferous to Lower Permian Singa Formation is well-exposed in Langkawi Islands. Previously, the formation is considerably equivalent to the Kubang Pasu Formation well exposed in the Perlis and Kedah areas. The Singa Formation can be divided into four members in ascending order: Rebak, Kentut, Ular and Selang members (Ahmad Jantan, 1973). Several workers reported the discoveries of Late Devonian to Early Carboniferous fossils at Pulau Rebak Besar. During the joint study in 2011-2012 by the Malaysia-Thailand Border Joint Geological Survey Working Group at Pulau Rebak, the team managed to relocate the Early Carboniferous fauna's locality. The occurrence of Permian fossils in the grey shale of the upper part of the Singa Formation at Pulau Langkawi had been reported by previous workers.

In Thailand, the Carboniferous Khuan Klang Formation, approximately 120 m – 250 m thick, is distributed in the N-S direction parallel to the older Paleozoic rocks in the central region of southern Thailand. The type section of the Khuan Klang Formation is located in the vicinity of a large quarry at Khuan Sung, Si-ngam village, Mueang District, Satun Province. Based on the lithological characteristics and fossil contents, the Malaysia-Thailand Border Joint Geological Survey Working Group has agreed that the Rebak Formation in Malaysia is well-correlatable with the Khuan Klang Formation in Thailand.

THE REBAK FORMATION

Based on fossil contents and difference in lithological characteristics, the Malaysia-Thailand Working Group has discussed that the Rebak member is suitable to be taken out from the Singa Formation and considered it as an individual rock unit. The Rebak member is, therefore, proposed to be upgraded into the formation ranking and renamed formally as the Rebak Formation.

The proposed Rebak Formation, approximately 200 m thick, is well-exposed in Rebak Besar and Rebak Kechil Islands in Langkawi. The type section for the Rebak Formation is located at the northwestern coast of Pulau Langgun, Langkawi Islands where about 211 m thick succession is well-

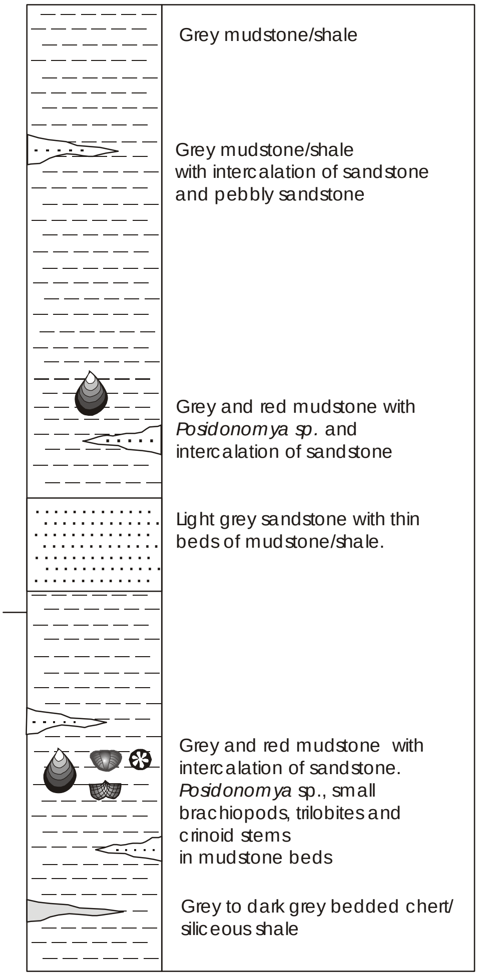

Figure 1:Schematic stratigraphic column of the Rebak/Khuan Klang Formation

exposed. In terms of lithological characteristics and fossil contents, it can be correlated with the similar sequence exposed in the Hutan Aji, Guar Jentik and Wang Kelian areas in western Perlis.

The rock sequence is conformably underlain by the Devonian Jentik Formation and overlain by the Permian Lubok Sireh Formation. Transitional sequence from the Jentik Formation to the Carboniferous Rebak/Khuan Klang Formation was described in detail by Meor Hakif Hasan and Lee (2002). However, the Carboniferous rock exposed at Guar Jentik was then considered as part of the Kubang Pasu Formation. The transitional contact between the Rebak/Khuan Klang Formation and the Permian Lubok Sireh Formation can be observed at the reference section along the Kaki Bukit-Wang Kelian road, about 7 km to the Wang Kelian-Wang Prachan Check Point at the Malaysia-Thailand border. The sequence exposed at this locality was named as the Wang Kelian Redbeds by Lee and Azhar Hj. Hussin (1991).

The type section for the Rebak/Khuan Klang Formation is located at the northwestern coast of Pulau Langgun, Langkawi Islands where about 211 m thick succession is well-exposed. At the type section, three subunits can be identified, namely, the Lower argillaceous beds, Middle arenaceous beds and Upper argillaceous beds.

LITHOLOGY

Generally, the Rebak/Khuan Klang Formation comprises predominantly red and grey shale and mudstone with minor sandstone beds and some pebbly or conglomeratic layers. Some argillaceous beds are fossiliferous. Schematic stratigraphic column of the Rebak/Khuan Klang Formation is shown in Figure 1.

TYPE SECTION

On the Malaysian side, the type section for the Rebak/Khuan Klang Formation is located at the northwestern coast of Pulau Langgun, Langkawi Islands where about 211 m thick succession is well-exposed. At the type section, three subunits can be identified, namely, the Lower argillaceous beds, Middle arenaceous beds and Upper argillaceous beds.

4. FAUNA AND AGE

The age of the Rebak/Khuan Klang Formation is assigned as Early Carboniferous based on the occurrence of several species of *Posidonomya* (previously known as *Posidonia*), chonetid and productid brachiopods. *Posidonomya elongata sp. nov.*, *Posidonomya dilatata sp. nov., Posidonomya conspicua sp. nov.* had been discovered in Pulau Rebak Besar (Sarkar, 1972). *Posidonomy*a sp. that resembles *Posidonomya siamensis* as described by Reed (1920) also had been discovered in Pulau Rebak Besar. It was described as Carboniferous in age. Yancey (1972) reported the discovery of the specimens resembles a chonetid *Chonetes* cf. *rectispina* found in Thailand (Reed, 1920). Jones *et al.* (1966) assigned the *Posidonomya* collected at Pulau Langgun and in Perlis as uppermost Devonian or lowermost Carboniferous age. Other fossils indicative of Early Carboniferous age are trilobites *Macrobole kedahensis, Cyrtosymbol (Waribole) perlisense, Posidonomya* aff. *becheri* Bronn , and the coral species resembling a small tabulate coral '*Cladochonus' malayensis*.

Among the fossils discovered on the Thai side are bivalves *Posidonomya* sp., *Edmondia* sp., *Pterinopecten* sp., *Aviculopecten* sp., and *Allorisma* sp., trilobites *Langgonbole vulgaris* and *Dalmanites* sp.?, brachiopods *Chonetes* sp. and *Echinoconchus* sp., ammonites *Agathiceras* sp. and *Euomphalus* sp., gastropod *Pronorite* sp.?, ostracods and crinoids. The other fossil assemblages e.g., *Edmondia* sp., *Pterinopecten* sp., *Allorisma* sp., trilobite *Dalmanites* sp.?; brachiopods *Echinoconchus* sp.; ammonite *Euomphalus* sp; gastropod *Pronorite* sp.?; ostracods and crinoids are also recognized in the Khuan Klang Formation.

REFERENCES

Ahmad Jantan, 1973. The stratigraphy of the Singa Formation (Upper Palaeozoic) in the southwestern part of the Langkawi Islands, West Malaysia. University of Malaya M.Sc Thesis, 250p.

Jones, C.R., Gobett, D.J. and Kobayashi, T., 1966. Summary of fossil record in Malaya and Singapore 1900-1965. In Kobayashi, T. and Toriyama, R. *Geology and Palaeontology of Southeast Asia*, 2, 309-359, Tokyo University Press.

Lee, C.P. and Azhar Hj. Hussin, 1991. The Wang Kelian Redbeds, a possible extension of the Unnamed Devonian Unit (Rebanggun Beds) into Perlis?. (abstract). *Warta Geologi*. 17(3), 160.

Meor Hakif Hasan and Lee, C.P., 2002. Stratigraphy of the Jentik Formation, the transitional sequence from the Setul Limestone to the Kubang Pasu Formation at Guar Sanai, Kampung Guar Jentik, Beseri, Perlis – a preliminary study. *Bulletin of the Geological Society of Malaysia*, Conference Issue, No. 45, 171-178.

Reed, F.R.C., 1920. Carboniferous fossils from Siam. *Geological Magazine*, vol. 57, 113-120, 172-178

Sarkar, S.S., 1972. On the *Posidonia* from Rebak Islands, Langkawi, West Malaysia. *Geological Society of Malaysia Newsletter* No. 37, 5-10.

The Malaysia-Thailand Working Groups, 2010. Geology of the Bukit Batu Puteh-SatunTransect Area along the Malaysia-Thailand Border, the Malaysia-Thailand Border Joint Geological Survey Committee (MT-JGSC), 111p.

Yancey, T.E., 1972. Devonian fossils from Pulau Rebak Besar, Langkawi Islands. *Geological Society of Malaysia Newsletter* No. 37, 10-12.

P079

Lithology and Stratigraphy of the Panau formation

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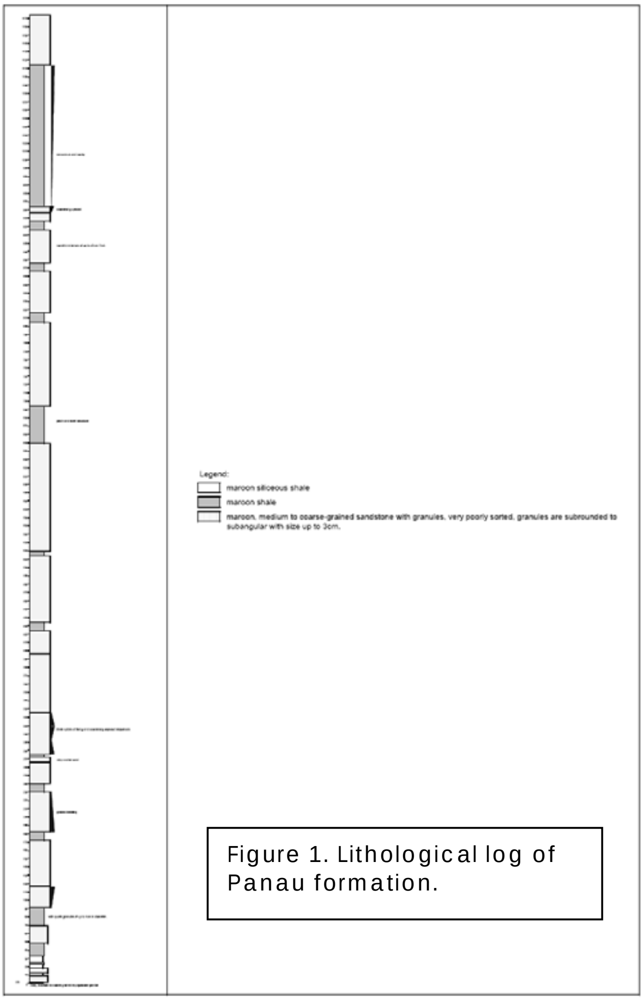

Figure 1. Lithological log of Panau formation.

The objective of this paper is to introduce the lithology and stratigraphy of the Panau formation that exposed at Bukit Panau area bases on field evidences gathered during the Malaysia-Thailand Border Joint Geological Survey Project jointly undertaken by the Minerals and Geoscience Department Malaysia and the Department of Mineral Resources Thailand. The term Panau formation is used to describe a sequence of continental sediments comprised thin- to thick-bedded grey to maroon sandstone, siltstone, mudstone, shale and siliceous shale. Previously, the sequence was named as the Panau beds (The Malaysian and Thai Working Groups, 2006). However since the nomenclature is not in concordance with the Malaysian Stratigraphic Guide (Malaysian Stratigraphic Nomenclature Committee, 1977), the sequence is now proposed to be renamed as the Panau Formation. Shale lenses occur in the lower part of the sequence, and subordinate plant fragment bearing grey to reddish grey shale interbedded with sandstone occur in the upper part. Plant fragment fossil assemblages found within the shale strata of the Panau formation such as *Frenelopsis* sp., *Otozamites* sp., *Calamites* sp., and *Pecopteris* sp. indicate the age of the rock sequence is Cretaceous.

INTRODUCTION

The term Panau formation is a name given to a sequence of continental, channel lag deposit, sedimentary rocks cropping out at Bukit Panau, Tanah Merah, Kelantan. The term is introduced by the Malaysian Working Group after a sedimentary sequence cropping out at an abandoned quarry at the foothill and peak of Bukit Panau, about 30 km north of Tanah Merah town, Kelantan.

The Panau formation crop out only at the Bukit Panau area. Nonconformity between the granite and the overlying Panau formation can be observed at an abandoned rock quarry at the foothill of Bukit Panau.

LITHOLOGY AND STRATIGRAPHY

The Panau formation consist of interbedded thin argillite beds, laminated fine-grained sandstone, poorly sorted pebbly sandstone and paraconglomerate. Some of the argillite rocks are channel lenses within the sandstone beds. The argillite rock consists of maroon, sandy shale and some pebbly sandstone and light greyish to light brownish siliceous shale. The thickness of the beds varies from 1 cm to 1.5 m. Most of the sandy shale shows coarsening upward sequence, in which sand-sized quartz grains can be observed towards the top part of the bed. The arenaceous rock consists of light grey poorly sorted sandstone, mostly pebbly and laminated fine-grained sandstone. The pebbles within the pebbly sandstone are up to 3 cm in diameter. Some sandstone beds show graded bedding. The clasts are angular to subrounded.

The laminated fine-grained sandstone exhibits cross bedding which can be observed at the foothill and peak of Bukit Panau. At the foothill of Bukit Panau, laminated fine-grained sandstone interbedded with grey to reddish grey shale. Some of the argillite beds contain plant fragments. Mineralogically, the sandstones are arkosic due to high content of feldspar which is mostly altered to kaolinite. This indicates that the nearby Boundary Range Granite could be a provenance of this rock unit.

Stratigraphically, the Panau formation can be divided into two lithofacies namely: arenaceous and argillaceous facies. The arenaceous facies is made up of predominantly grey to maroon fine- to coarse-grained poorly sorted graded sandstone with subordinate graded grit, maroon paraconglomerate and very thin- to thin-bedded maroon shale, mudstone and siltstone. The argillaceous facies comprise light grey to grey plant fragment bearing shale, siliceous shale, mudstone and thin-bed of fine-grained sandstone and siltstone. The stratigraphic log of the lower part of the Panau formation is shown in Figure 1.

AGE ASSIGNMENT

The nonconformity structure between the granite and the overlying unit can be observed at an abandoned Bukit Panau quarry, indicating that the Bukit Panau bed is younger than the granite. The presence of plant fossils, most probably fragments of *Frenelopsis* sp., *Otozamites* sp., *Calamites* sp., and *Pecopteris* sp. are probably of Cretaceous age.

CONCLUSION

The occurrence of angular to subrounded clasts within poorly sorted pebbly sandstone and paraconglomerate and maroon colour of argillite rocks that some are channel lenses, indicates that the rocks were deposited in a channel lag, in oxygenated and continental environments. Thus, the Panau formation is proposed to be a new member of the Jurrasic-Cretaceous Tembeling Group.

REFERENCES

Jabatan Penyiasatan Kajibumi Malaysia, 1985. Peta Geologi Semenanjung Malaysia. Jabatan Penyiasatan Kajibumi Malaysia.

MacDonald, S., 1967. *The Geology and Mineral Resources of North Kelantan and North Trengganu.* District Memoir 10, Jabatan Penyiasatan Kajibumi Malaysia.

Malaysian Stratigraphic Nomenclature Committee, 1977. Malaysian Stratigraphic Guide, *Geological Society of Malaysia*, 30 p.

The Malaysian and Thai Working Groups, 2006. *Geology of the Batu Melintang-Sungai Kolok Transect area.* Malaysia-Thailand Border Joint Geological Survey Committee (MT-JGSC).

P080

Application of Seismic Refraction Imaging in Lampas Kaolin Deposit Genetic Modeling, Simpang Pulai-Pos Slim, Ipoh

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This paper describes a case study of shallow seismic refraction imaging in delineating a known kaolinitic occurrence overburden (pallid zone) near the Bukit Lampas, km 12, Spg Pulai-Pos Slim road, Ipoh This kaolinite rich pallid zone is embodied in the Slim granite of Main range granite batholiths with poor layered velocity structure. Lampas kaolin is a product of both hydrothermal and in-situ weathering of sugary aplite, leucogranite, pegmatite and medium to coarse-grained, porphyritic granites of the area concerned. Numerous occurrences of quartz-feldspar veins stockworks, silicification and illite alteration (argillic zone) were apparent and characteristic of the hydrothermal fluid influx system of the area. Elements such as geometrical shape, thickness, lateral extension which are related to geological feature and weathering profile of the area was scrutinized as an attempt to model this kaolin clay formation. Seismic velocity model elucidated that the kaolinitic clay formation at the targeted area is confined in a narrow zone or channel, and at least within a depth of 5 to 15m (Vp < 300ms-1) and 130 meter wide. The thickest segment was found near the lower part of hill slope. These occurrences were lithologically, geomorphologically and structurally control formation processes.
Keywords: Shallow seismic refraction, kaolin deposit, seismic velocity model, weathering profile, pallid zone.

INTRODUCTION

In Malaysia, practical application of shallow seismic refraction is widely used in the field of engineering geology in supporting engineering design, slope failure analysis and remedial works. Knowledge of the soil profile is essential to the engineering design of project like roadway, tunnels, quarry and foundation design [18, 21]. In engineering design requirements, slope stability, amount of blasting required, rippibility rate, fracture zone, sinkhole phenomenon, failure surface determination, depth to bedrock, determine pile length etc. are partly can be addressed based on this method [1, 6, 8,10 ,22, 26]. However, it is less common in economic geology (e.g. kaolin deposit) investigation such as used to define and characterize the Sylvan, Monitoba kaolinite deposit [11]. The prime objective of this study is to delineate the kaolinization zone and to figure out the geometrical shape, extension and to model the kaolin formation system in respect to the geology (parental rocks and geological structure) and geomorphology (topography and drainage) in the designated area.

METHODOLOGY

The physical property of earth materials that is measured in seismic studies is the rate at which acoustic wave energy propagates through the various units of the subsurface. The use of the term velocity (P-wave) is refer the rate at which P-wave energy is propagated through the respective subsurface media and assumed to be have isotropic velocity. Empirically a denser material is generally having higher velocity than less dense materials. The velocity of particular earth material can vary over a wide range as a function of its age, its depth to burial, its degree of fracturing or porosity, and whether water or air fills the void (Telford et al., 1976). However, within a small study area, the range of velocity for a particular rock type is generally small, and certain rock types cannot be identified on the basis of their velocity.

Kaolin deposit or occurrence within granite bedrock is normally possess very poor layered model, and normally has a site that is more complex in geological structure and further governed by the above mentioned parameters. Various methods for analyzing seismic data was invented including simple time-term method, plus-minus method and reciprocal method (delay time) but failed to address the continuous and gradual changes of velocity with depth within complex structure. In this study, tomographic analysis which enabling the lateral velocity changes in a layer analysis was used. This analysis apply a non-linear

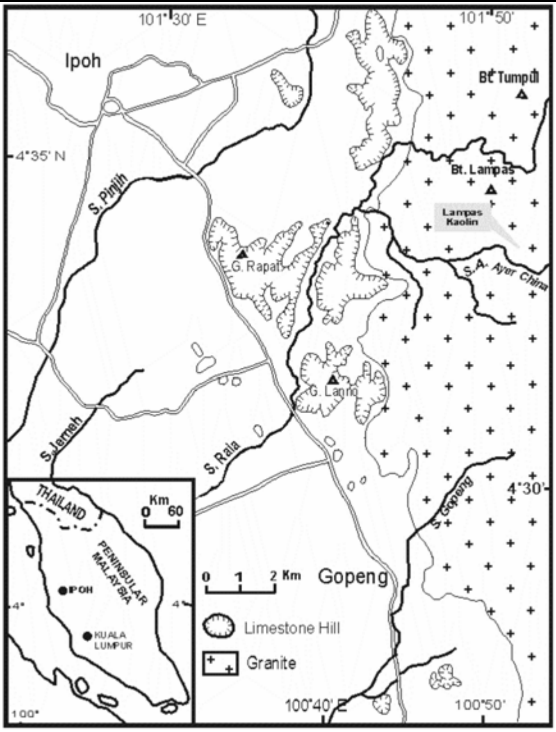


Fig. 1 Location of Lampas kaolinitic clay occurrence, Simpang Pulai-Pos Slim (Km 12 – Km 13) within Slim granitic bedrock (after Kamar Shah, 2006)

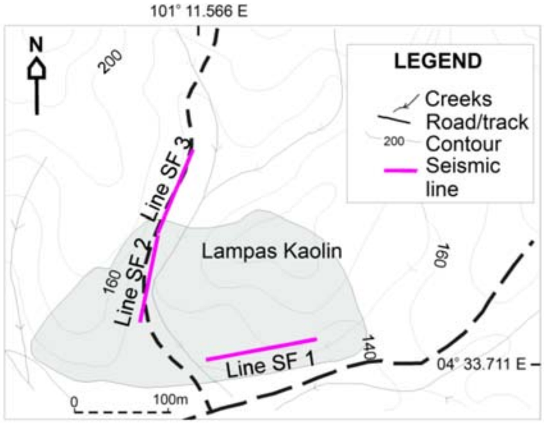
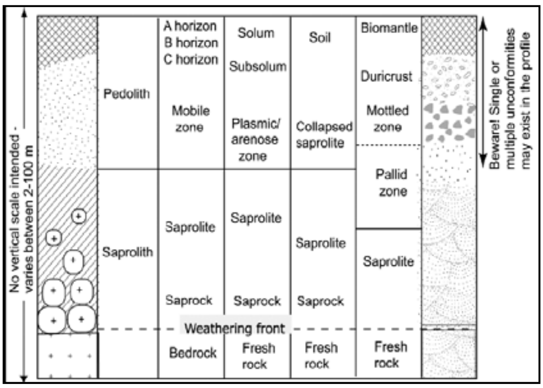


Fig. 2 Lampas Kaolinitic clay occurrence area and seismic refraction survey line (Modified after Kamar Shah 2005)

Fig. 3 This schematic diagram shows various classification of weathering profile of different soil horizon characteristics, features and terminologies of weathered rock and weathered materials (adapted from Govett, .et al., 1992).



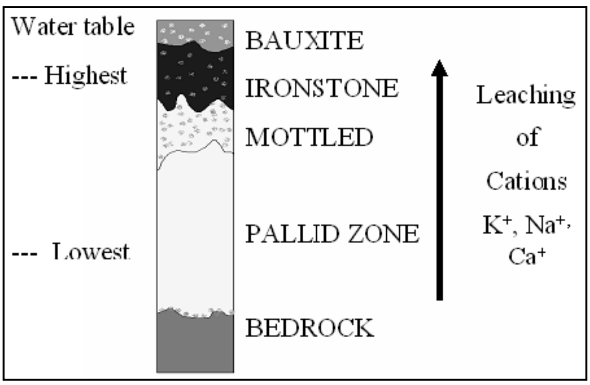


Fig. 4 Typical model of pallid zone of Lampas kaolin derived from granitic rock of Slim granite.

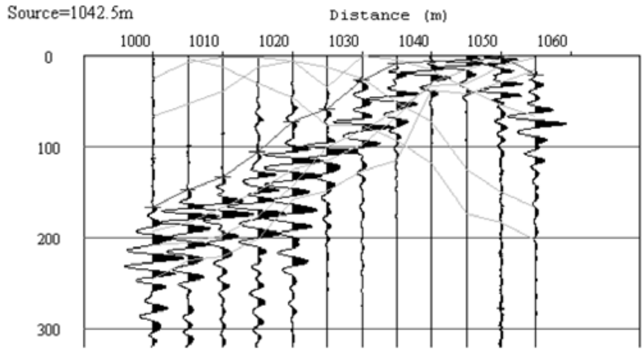


Fig. 5 The example of measured refraction profile traveltime curve along SF1 with 12 channels.

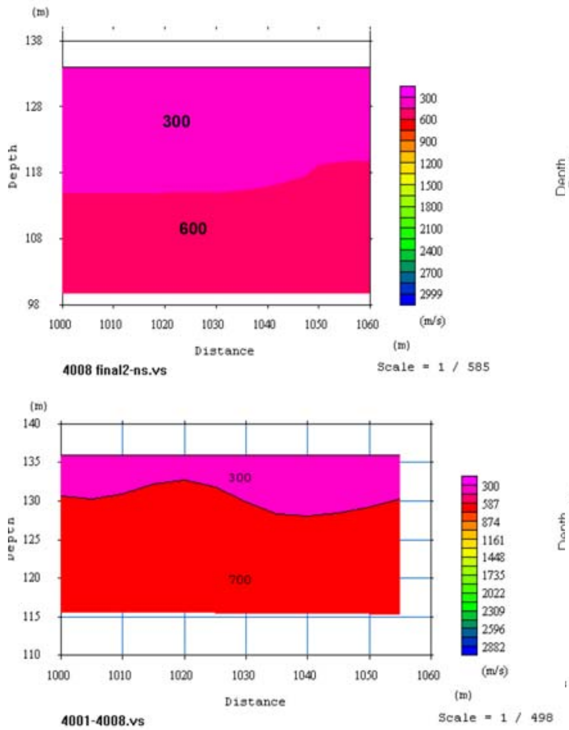
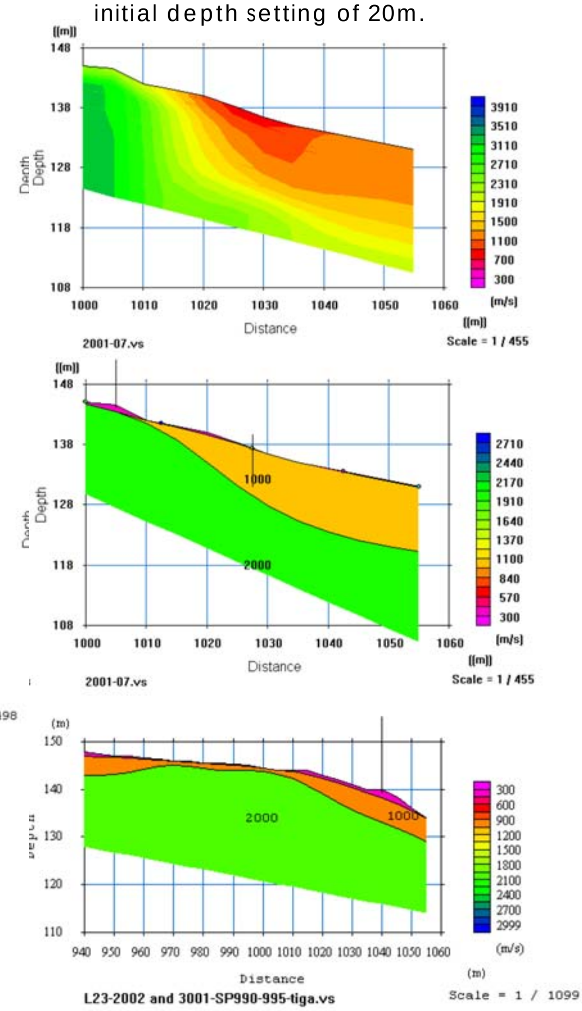


Fig. 6 Inversed and layered velocity models of the kaolin clay overburden near the bottom of the hill slope (line SF1)

Fig. 7 Resultant velocity model obtained with overlapping of SF2 and SF3 lines after inversion as a layered model with the initial depth setting of 20m.



tomography consisting of ray tracing for forward modeling and simultaneous iterative reconstruction technique (SIRT) algorithm for inversion [16].

Data Acquisition, Processing and Analysis

Data acquisition comprises three lines of seismic profiles from 12 channel spread were accomplished. One of the profiles was set across the lower base

2

(SF1) of the kaolin clay occurrence segment, and another two lines (SF2 and SF3) which are running across the top-bottom of the kaolin occurrence located near the left flank of the hill (Fig. 2).

The seismic data were acquired in the field using Geometric Strataview–R model seismograph with 12 channel spreads of 10 Hz geophone and 5m spacing. Seismic energy source was generated with a 5kg sledgehammer, and shots were taken at 7 different points along the spread, at end points, at every 3 geophones, and also at off-shot points (5 and 10 meter respectively). The shot were stacked 2 to 3 times at each shot-point to ensure good signal were reaching across the whole line profile. First breaks were picked and travel-time curves were plotted using the Pickwin module of the SeisImager program from Geometrics. The velocity models were then constructed or selectively modeled using 3 available analysis methods, time-term methods, delay time (reciprocal) and tomographic inversion method. The velocity model analyses were carried out using Plotrefa module of the same program. The reciprocal and tomographic methods require a large number of input and adjustment, and be able to provide significant and better resolution of velocity model. Due to complexity of the subsurface, without discrete layers, tomographic method was preferred in velocity model analysis. This method enable models with gradual velocity increment with depth can be developed. This method requires the input of an initial model as well as instructions on how to iterate, and very robust that enabled the convergence of the results of tomographic into a similar model can be achieved.

GEOLOGY OF LAMPAS KAOLIN

Detailed account on the Lampas Kaolin geology and occurrence was discussed by [2,17,19].

The Lampas area is predominantly underlain by the Slim granite, which forms major part of the main range granite of the western belt pluton. The Slim granite consists of coarse-grained porphyritic biotite granite and medium to coarse granite as well as leucomicrogranite (leucogranite) of Late Triassic [2, 4]. The pluton locally intruded by numerous tourmaline, aplite and occasionally pegmatite veins and dykes as late, dry residual manifestations. The former is categorized as a Phase I intrusion, with the leucomicrogranite (leucogranite), aplite and pegmatites of late intrusion as Phase II. Tan [23] and Cheong [5] further classified and described this igneous rock as adamellite rather than granite. The adamellite, contains oligoclase and potassium feldspars, quartz, and traces of tourmaline in addition to biotite. The leucomicrogranite was emplaced during Late Cretaceous to Early Tertiary [24]. The granite is highly sheared in many parts and bisected with three sets of uniform joints. Some of these joints are in-filled by tourmaline, quartz, calcite and fluorite veins. The dominant orientation of these quartz veins are 270o-280o, 330o-340o and 350o-360o, coinciding with the joint sets [2,13]. They concluded that the veins were deposited by late-phase fluids, upwelling through joint and fracture planes. Koalinization of the feldspars and chloritization of the biotite are intense as well as tourmalinization and greisenization [23].

Thick, sheet-like sequence of fine-grained, slightly to moderately, weathered aplite could be observed outcropping in places along the cutting slope of a logging track and stream within the area. Aplite normally could occur as an intimate association along the footwall portions as a dyke with pegmatite dyke or sill [27]. However, there were no fresh pegmatite outcrop was noticed, nevertheless, some floats from nearby creek were evident. The bedrock geology of the kaolin clay occurrence of the studied area was inferred to be underlain by the light gray, equigranular, medium to course grained biotite granite and leucogranite of the Slim granite. Evidence of E-W trend dip-slip fault zone structure was noticed at a nearby creek with about 2m, almost vertical downthrown (90o/85o).

LAMPAS KAOLIN GENESIS AND MODELING

Clays and clay minerals occur under fairly limited range of geologic conditions. The environments of formation include soil horizons, continental and marine sediments, geothermal fields, volcanic deposits, and weathering rock formations. Most clay minerals form where rocks are in contact with water, air or steam [3,12]. Metastable muscovite, biotite and chlorite will alter progressively to clay mineral in weathering of granite apart from feldspar. Profile depths, however, are not solely controlled by speed of weathering. Geology age, geomorphological history especially in humid, rainforest tropical climate chemically intensified the weathering mechanism four times than in temperate environment. A thickness of weathering profile of more than 27m is common in granite, releasing much of K+ and Na+. Malaysian climate is equatorial with an annual precipitation of 2500 to 3500 mm, potential evapotranspiration of 1,130mm m-1, and the daily temperature of 28 to 33oC [9,14,15].

The main Lampas Kaolin outcrop occur along a stretch between 04o 33.7" N, 101o 11.5" E and 04o 33.71" N, 101o11.61 (135m) in the direction of 85oE. The kaolin occurrence lies over a gentle to medium hill slope between the 135m to 180m terraces. The occurrence is bonded on the southern side by Sg. Anak Ayer China, the road and a lateritic logging track on the left flank, parallel to a small creek [17].

Intense weathering and other process mechanisms has generated a very characteristic pallid horizon, a kaolinitic-riched overburden [20,25]. This hill slope cutting is mainly covered by massive kaolinized overburden known as pallid zone; encompassing an estimated area over 2000 sq. meter. Pallid zone descriptive term, generally referring to bleached kaolinitic zones of the pedolith and saprolite occurring below the ferruginous and mottled zones, usually over felsic rocks. This occurrence is very rare accept near the Sg. Keneras, Gua Musang Kelantan of aplite origin. Laterite forms in tropical rain forests, where extreme leaching removes everything, but clays and iron oxides zone. Lateritic leaching led to the destruction of feldspars, removal of alkalies and alkaline earths, and transformation of mica to kaolinite. Pallid zone is the major characteristic of Lampas Kaolin weathering profile. Pallid zone is a layer where most of the irons oxides have been removed by the percolating water down through the soil and weathered rock. The occurrence appeared restricted to a narrow zone or channel that much governed by the geomorphology landscape, geology and structural features of the area. It lies beneath the lateritic soil horizon and occurs as a cone-shaped accumulation and limited lateral extension. On the upper limit borders the color of the clay progressively altering from white, yellow and orange to the red-brown near the top of the hill slope terrace. It seemed that the kaolin occurrence of the area were also structurally control, associated with complex fracturing and sheared zone that enhanced the influx of hydrothermal fluid and accelerated the kaolinization process. This kaolinized shear zones were apparently intersected by sets of aplite dikes (< 5 cm), which numerous occurrence of silicified aplite and quartz vein swarms. It seemed that the thick sequence occurrence of kaolinization took place or lie within the hanging footwall.

The Si/Al ratio, (alkali)/(H^+) and temperature of hydrothermal systems are important factor plays an important role in kaolinite synthesis, where at the lower temperature presence of complexing organic compound also effect the speed of kaolinite formation [7]. Meanwhile halloysite is a low temperature mineral. Intense in-situ weathering has altered much of the feldspar in the pegmatite and aplite veins as well as the feldspar of the granite into primary kaolin. From field evidence, this clay-riched pallid zone are well preserved thick sandy clay horizon derived from complex granitic bedrock consisting quartz-feldspar adamelite, aplitic-pegmatite, aplite stockwork, mainly leucogranite within granitic material. The average bulk density of pallid zone materials is about 1.74g/cm_3, and contains about 30 to 40% crude kaolin clay, and almost frees from sesquioxides materials. The stiffness or strength of the materials linearly increased with burial depth.

RESULTS AND DISCUSSION

Fig. 5, 6 and 7 shows the seismograph (SF1), inversed and layered seismic velocity models interpreted using Pickwin and Plotrefa module of SeisImager from SF1, SF2 and SF3 profiles respectively.

This investigation anticipated that the upper part of the clay occurrence was overlain by a thick segment of pallid zone which was characterized by koalinitic clay occurrence. The average velocity of the top layer is about 300 ms^{-1}, meanwhile the lower part is 700 ms-1 respectively. The thickness of 300 ms^{-1} layer is about 5 to 6 meters, as revealed in the two layer case velocity model (Fig. 6). Apparently, survey constraints like a short spread (12 channels) and insufficient energy, the weathering grade II and III horizon, including bedrock (Grade I) was unable to be detected along SF1. The SF1 survey line was actually situated over an exposed pallid zone (derived after pseudo-leucogranite/aplite of the area) and suggested that the bedrock (Vp granite > 2000ms^{-1}) were located at a greater depth. In relation to the soil profile, this pallid and saprolite zones materials (Fig. 3 and 4) are generally characterized by the low bulk density 1.74g/cm^3. It was believed that the major mineral alteration (hydrothermal and hydrolysis) mechanism, especially chemical process was extremely different within this zone. In comparison with nearby granite area, this zone is very unique, and has experienced remarkable alteration development, where role of lithology, and structurally and geomorphology influences cannot be denied. Faulting and dilatant zone within a narrow zone have provide a conduit for meteoric water infiltration and hydrothermal fluid. Trace of faulting scarp (Fig. 8) (in the nearby creek), silicified aplite dykes and quartz vein swarm, including green alteration (argilic) materials as shown in Fig. 2 of the area was evident [17].

Velocity model along profiles SF2 and SF3 near the left flank of the hill (Fig. 7) exhibited that the thickness of material with velocity below than 700 ms-1 was less apparent. However, the inversed velocity and layered models along SF2 (down the slope) generally showed that the subsurface materials gradually decreased in velocity and thickening toward the slope toe. Velocity model of SF1 has displayed the existence of depression feature which variable velocity values outline not

more than 1000 ms-1, where weathering process was apparently intensified. Sampling from AU2 proved a good return of sandy kaolinized clay that could exceeding 2.0m in this zone, however presence of significant amount of quartz gravel and course sand prevent further advancing of this hole.

A few model of the late phase II granite intrusion into phase I granite involving Upper Cretaceous granite and Upper Triassic granite in relation to the emplacement of xenothermal and hydrothermal was proposed by [2, 24]. Fig. 8 show a cross section of the proposed model of the kaolinitic clay occurrence associated with lithology, structural and geomorphological features of the area.

CONCLUSION

This indicated that the kaolinization process was owing to the intense weathering process associated with a complex fractured and sheared zone of the parental granitic bedrock, which are also intruded by the late phase magma, aplite/leucogranite. However, the formation of thick profile of kaolin clay pallid zone indicated that hydrolysis process was not one and the only agent in kaolinitic formation process. This phenomenon is peculiar elsewhere in Malaysia. Significant silicification and presence of low grade alteration green mineral (illite/chlorite) features in this kaolin clay outcrop may indicated the upwelling hydrothermal fluid underneath is another cause that accelerate the kaolinized clay formation in the area. Seismic inversion and layered model suggested, the occurrence was confined in a narrow zone/channel, with the regolith thickness can be greater than 10m near the slope toe. Apart from weathering process, this clay occurrence appeared geologically, geomorphology and structurally control, with limited lateral extension as shown by the seismic velocity models and constructed conceptual model respectively. The characteristic of this weathering profile is very unique compared to other granite weathering profile in other part of Malaysia which is poor in pallid zone development.

REFERENCES

[1] Ahmad Zulkifli, K. 2006. Seismic refraction survey to determine peat layer at mission control centre, national space agency, Kg. Sg. Lang Tengah, Banting Selangor. Proc. Geophysical Seminar : Soft Soil Geophysics, Kolej Teknologi Tun Hussein Onn, Batu Bahat, Johor, 106-118.

[2] Ariffin Suhaidi, 1993 Geologi am dan penekanan kepada kajian geotektonik ke atas kestabilan cerun potongan Jalanraya baru dari Simpang Pulai ke Pos Slim (Km 0-Km 15), Keramat Pulai, Perak. Universiti of Malaya (unpublished B. Sc. thesis), K. Lumpur.

[3] Begonha, A. and Sequeira Braga, M.A. 2001. Weathering of the Oporto granite : geothenical and physical properties, Catena, 49, 57-76

[4] Bignell, J.D. and Snelling, N.J. 1977. Geochronology of Malayan granites. Oversea Geology and Mineral Resources, London, 36pp.

[5] Cheong, K.W., 1990. Geology of the Central Portion of Kinta Valley, with special emphasis on mineralization and geotechnique. Universiti Malaya (unpublished B. Sc. thesis), Kuala Lumpur.

[6] Devendran, A, Zuhar Zahir, T.H., Rosli Saad. 2006. Parallel Seismic as NDT method to determine pile length. Proc. Geophysical Seminar :Soft Soil Geophysics, Kolej Teknologi Tun Hussein Onn, Batu Bahat, Johor, 20-32.

[7] Eberl, D. and Hower, J., 1975. Koalinite synthesis : The role of the Si/Al and (Alkali)/H+ ratio in hydrothermal systems. Clay and Clay Minerals, 23, 301-309.

[8] Edy Tonnizam M., Khairul Anwar, K.; Ibrahim Komoo, Tuan Zuhar, T.H, Rosli Saad, 2006. Seismic Velocity as excavatability assessment tool for weathered rockmass. Proc. Geophysical Seminar : Soft Soil Geophysics, Kolej Teknologi Tun Hussein Onn, Batu Bahat, Johor, 20-32.

[9] Eswaran, H. and Wong C.B., 1978. A study of deep weathering of granite in Peninsular Malaysia. Soil Science. Soc. Am. J., 42, 11-158.

[10] Ezersky, M. 2005. The seismic velocities of Dead Sea salt applied to the sinkhole problem, J. of App. Geophysics, 58,45-58.

[11] Ferguson, I.J., Ristau, J.P., Maris J.P, Maris, V.G. and Hosain, I. 1999. Geophysical imaging of a kaolinite deposit at Sylvan, Manitoba, Canada. J. of Applied Geophysics, 41, 105-129.

[12] Foley, N.K.1999. Environmental Characteristics of Clays and Clay Mineral Deposits, USGS Information handout, September, 1999, 2pp.

[13] Gobbett, D.J. (1971) Joint pattern and faulting in Kinta, West Malaysia, Bull. Geo. Soc. of Malaysia, 4, 39-47.

[14] Govett, G.J.S., Butt, C.R.M. & Zeegers, H. (editors) 1992. Handbook of Exploration Geochemistry Volume 4. Regolith Exploration Geochemistry in Tropical and Subtropical Terrains. Elsevier, Amsterdam.

[15] Hamdan, J. and Burnham, C.P., 1996. The contribution of nutrients from parent material in three deeply weathered soils of Peninsular Malaysia. Geoderma, 74, 219-233.

[16] Hayashi and Takahshi, 2001. High resolution seismic refraction method using surface and borehole data for site characterization of rocks, Int. Jour. Of Rock Mechanic and Mining Sc., 38, 807-813.

[17] Kamar S. Ariffin, Haryati A. Rahman, Hashim Husin and Kahirul Anwar A. Hadi, 2008. The genesis and characterization of kaolin clay occurrence of Bukit Lampas associated with Slim granite, Simpang Pulai, Ipoh, Perak, Malaysia, Bull. of Geological Survey Malaysia, 54,9-16.

[18] Michaels, P. 1995. A geophysical site investigation for a bridge foundation in a narrow canyon. Environmental and Engineering Geoscience, 2, 219-226.

[19] Mohd Azamie, W.A.G. and Azman, A.G., 2003 Petrology of granitic rocks along new Pos Slim to Kpg Raja highway (km 0 to km 22) : identification of different granitic bodies, its field and petrographic characteristics. Bull. of Geological Survey Malaysia, 46, 35-40.

[20] Papoulis, D, Tsolis-Katagas, P., Katagas, C., 2004. Monazite alteration mechanisms and depletion measurements in kaolins, Applied Clay Science, 24, 271-285.

[21] Redpath, B. B. 1973. Seismic refraction exploration for engineering site investigation: NTIS, Springfiled, VA, 51p.

[22] Sundarajah, N., Srinivas, Y., Chary, M.N., Nandakumar, G, and Chary, A. H., 2004. Delineation of structures favorable to groundwater occurrence employing seismic refraction method – A case study from Tiruvuru, Krishna district, Andhra Pradesh, Proc. Indian Acad. Sci. (Earth Planet Sci.), 113, 3, 259-267.

[23] Tan, B. K. 1972 Geology and Mineralization of Kramat Pulai area, Perak. Universiti of Malaya (unpublished B.Sc. thesis), Kuala Lumpur.
[24] Teh, G.H., 1969. The Geology of Tekka lode including on account of geochemical soil survey on hill, Tekka, Perak, West Malaysia. University of Malaya (unpublished B.Sc. thesis), Kuala Lumpur.
[25] Turkmenoglu, A.G., Akiman, O.A., Aker, S and Tankut, A., 2000 Geology and Origin of clay deposits at Orta (Cankiri) Area Turkey, Mineral Res. Expl. Bull, 113, 87-92.
[26] Umar Hamzah, Yip, C.H., Abdul Rahim Samsudin. 2006. Perbandingan cirian geofizik dengan kejuruteraan pada Formasi Bukit Kenny di Dengkil, Selangor. Proc. Geophysical Seminar: Soft Soil Geophysics, Kolej Teknologi Tun Hussein Onn, Batu Bahat, Johor, 59-66.
[27] Webber, K.L., Simmons, W.B., Falster, A.U, and Foord, E.U., 1999. Cooling rates and crystallization dynamics of shallow level pegmatite-aplite dikes, San Diego County, California, American Mineralogists, 84, 708-717.

P081

Analisis Morfologi Sungai dengan Teknik Potongan-Masa Seismik 3D: Satu Kajian Awal Pada Blok Timur Laut Lembangan Melayu

(*Analysis of River Morphology by Seismic 3D Time-Slice: A Preliminary Study of Northeast Malay Basin Block*)

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Batupasir sungai merupakan salah satu dari jenis batuan takungan petroleum utama di kebanyakan lembangan sedimen seluruh dunia terutamanya di lembangan Tersier Asia Tenggara. Kehadiran sungai-sungai tersebut boleh dikesan melalui analisis atribut seismic 3D ke atas data yang diperolehi dengan resolusi yang agak tinggi. Oleh itu satu analisis potongan-masa (3D time-slice) telah dilakukan dengan tujuan untuk mencirikan morfologi sungai yang wujud di sekitar pengendapan dalam blok Bundi yang terletak di bahagian timur laut lembangan Melayu. Analisis yang dilakukan menfokuskan imej geometri, dimensa dan taburan sungai secara sisi dan menegak mengikut perubahan masa pembentukan. Lembangan Melayu mempunyai endapan sedimen setebal 8-12 Km berusia Oligosen-Pliosen dan diendapkan pada sekitaran pantai beriklim tropika lembap. Kajian ini menekankan jujukan berusia Plestosen hingga resen yang mempunyai fasies seismic mencerminkan kehadiran saliran sungai dalam alur system surut (lowstand system tract). 4 unit seismic yang dipisahkan oleh sempadan jujukan (sequence boundary) berusia anggaran 1-3 juta tahun telah ditemui berdasarkan cerapan yang telah dibuat ke atas strata lapisan dalam lembangan. Sempadan jujukan yang dicerap mewakili lembah terhakis bersaiz besar atau rantau yang mendasari lembangan sungai dan juga dasar-dasar sungai yang kecil yang memotong system sungai ketika penurunan paras laut secara global.

P082

Stratigrafi dan Paleontologi Paya Peda, Jertih, Terengganu

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1,3Jabatan Mineral dan Geosains Malaysia Terengganu
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Satu himpunan besar fosil flora Cathaysia telah di temui dalam lapisan jujukan batuan syal bertuf dan sabak di kawasan tapak pembinaan Empangan paya Peda, Jertih Terengganu. Penemuan ini tersingkap pada potongan jalan bagi pembinaan sekitar kawasan pembinaan Empangan Paya Peda. Singkapan batuan ini terletak di dalam Formasi Telemong. Himpunan flora Cathaysia ini terdiri daripada *Cordaites* sp., *Archaeoptoris* sp., *Pecopteris* sp., *Neuropteris* sp., *Lepidodendron* sp., *Sigilaria* sp., *Lobatopteris* sp., *Sphenophyllum* sp., *Tinggia* sp. dan *Artisia* horizontalis. Himpunan flora Cathaysia ini memberikan bukti bahawa pada usia Karbon Akhir sebahagian daripada Semenanjung Tanah Melayu merupakan pecahan daripada sebuah benua yang dikenali sebagai Cathaysia (Indochina)..

A large assemblage of Cathysian flora fossils was discovered from a sequence of tuffaceous shale and slate outcropped at Paya Peda Dam construction site, Jertih, Terengganu. This discovery located at a road cutting slope in the Paya Peda Dam construction area. The above mention outcrop is parts of Telemong Formation. These Cathaysian flora assemblage consist of Cordaites sp., *Archaeoptoris* sp., *Pecopteris* sp., *Neuropteris* sp., *Lepidodendron* sp., *Sigilaria* sp., *Lobatopteris* sp., *Sphenophyllum* sp., *Tinggia* sp. and *Artisia horizontalis. These flora assemblage proven that during the Late Carboniferous epoch, parts of Malay Peninsula was a component of a continent known as Cathaysia (Indochina).*

P083

Wind Influence Towards Shoreline Movement at Pantai Sabak, Kelantan Darulnaim

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Pantai Sabak having series of erosion every year and resulting several damages. In this research, remote sensing and GIS has been used to monitor shoreline position. By using Landsat TM, image of shoreline zone in 2000, 2005, 2012 and 2013 are mapped. Wind speed and wind direction influence the shoreline changes. The wind rose diagram showing dominant wind direction that comes from east part, 76 - 105° and beingclassified as number 12 in Beaufort scale that is the highest level.Shoreline map analysis was generated to identify the shoreline movement. In 2013 there is highly increase in distance of shoreline changes almost 400m compared in year 2000.

Keywords : shoreline movement, GIS, wind direction, Beaufort scale

INTRODUCTION

The landscape of Pantai Sabak is a gentle slope with most of the coast is sandy beach and only a small area is swamp.The fisherman village,was threatened by coastal erosion since early 1990s.Certain village along the coast already sunk due to the coastal erosion. As a consequence, tourism activities were threatened and facilities were damaged. Coastal erosion also destructed the historical building as well as affected the aesthetic values of the beach.This coastal erosion hazard is a factor that controlling the shoreline position either move seaward (retreat) or move landward (accretion).Within this few decades, remote sensing and Geographical Information System (GIS) have been widely used to monitor shoreline position(Ryu *et al.,* 2002; Yamano*et al*., 2006). By using satellite imagery, itprovide various ability to monitoring the shoreline at low cost and save the time.

OBJECTIVES

The objectives of this paper is to determine the wind factor’s character changes that control the shoreline movement at Pantai Sabak and to determine the shoreline’s length and its movement by using satellite imagery for the year 2000, 2005, 2012 and 2013.

STUDY AREA

Pantai Sabak shoreline is located between Pantai Pak Amat and Pantai Perkelahan Sabak which covering a distance about 2.14km facing the South China Sea. This coast is bonded between latitude (6°11’42.49 - 6°10’13.49)E and longitude (102°18’16.67 - 102°19’48.97)N. This coast is sand beach and facing South China Sea (Figure 1).

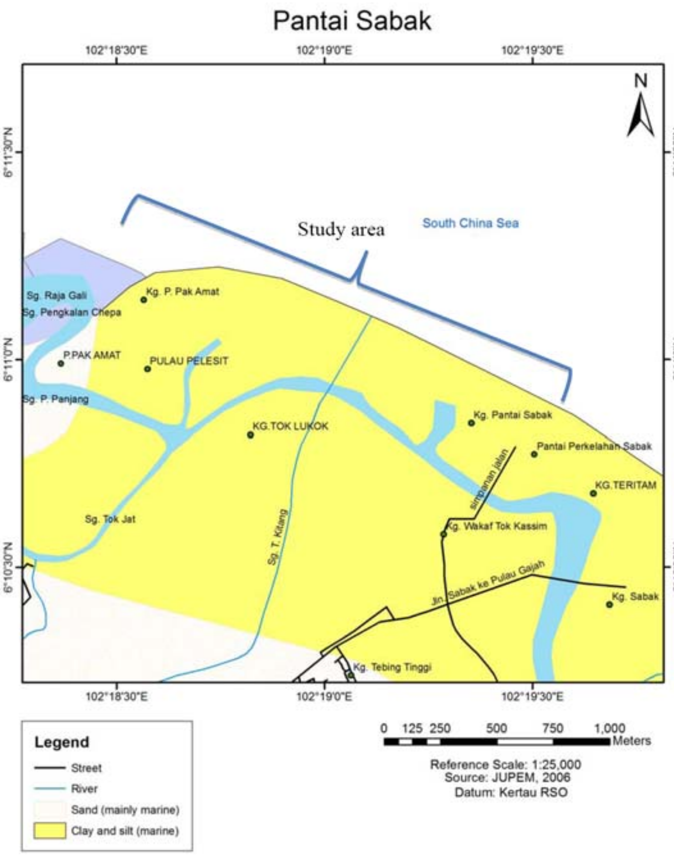
METHODOLOGY

This research used several sets of multi-temporal satellite imagery that taken after embankment from 2000, 2005, 2012and 2013. This shoreline changes was interpreted by using Geographical Information Systems (GIS).

Data used within this study was acquired from different sources covering the Pantai Pak Amat until PantaiPerkelahanSabak such as

- Satellite images data from Landsat TM from year 2000, 2005, 2012 and 2013.
- Satellite imagery from Google Maps.
- Wind speed and direction (2000 – 2005) from Malaysian Meteorology Department.
- ArcView GIS Version 10 was used to overlay the multi-temporal satellite imagery.

Figure 1 : Study area from Pantai Pak Amat - Pantai Perkelahan Sabak



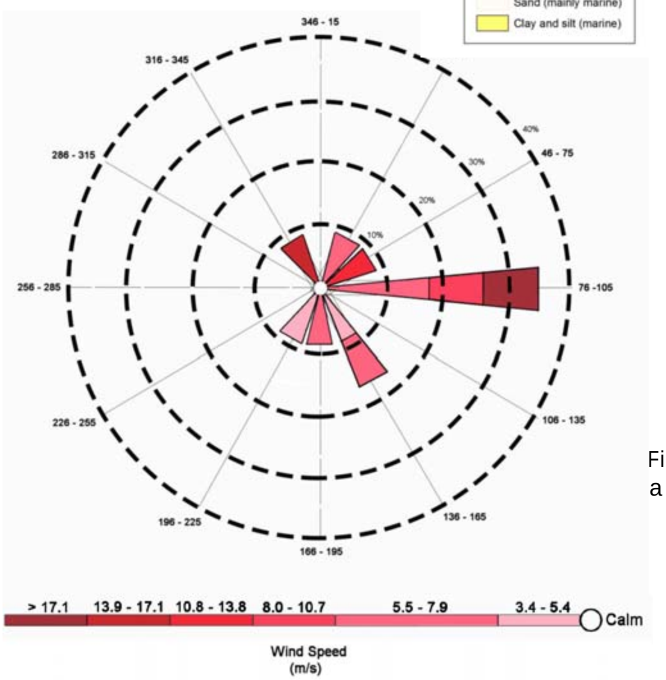


Figure 1.3: Wind rose from 2000 and 2005

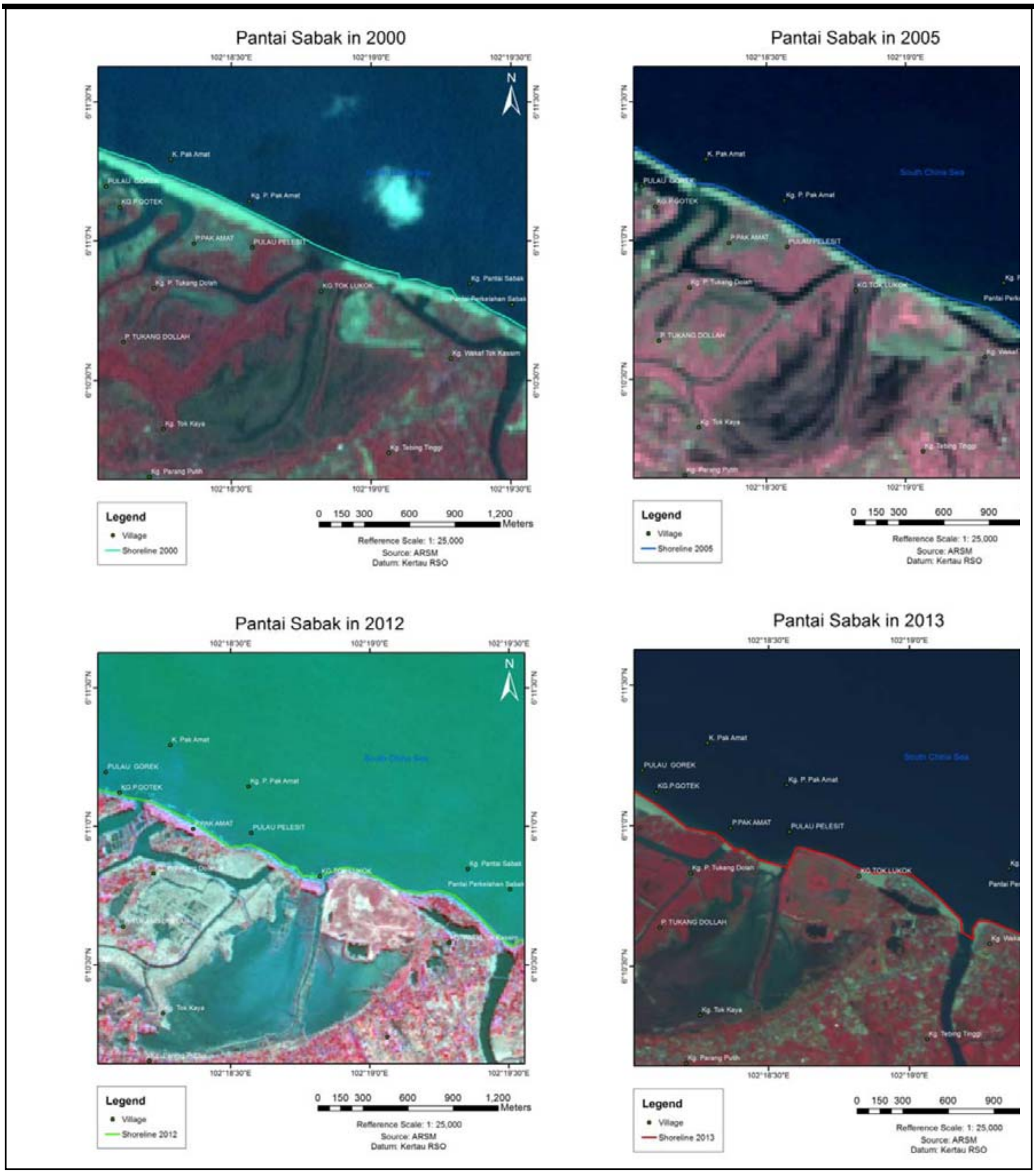


Figure 1.4: Shoreline movement from 2000- 2013

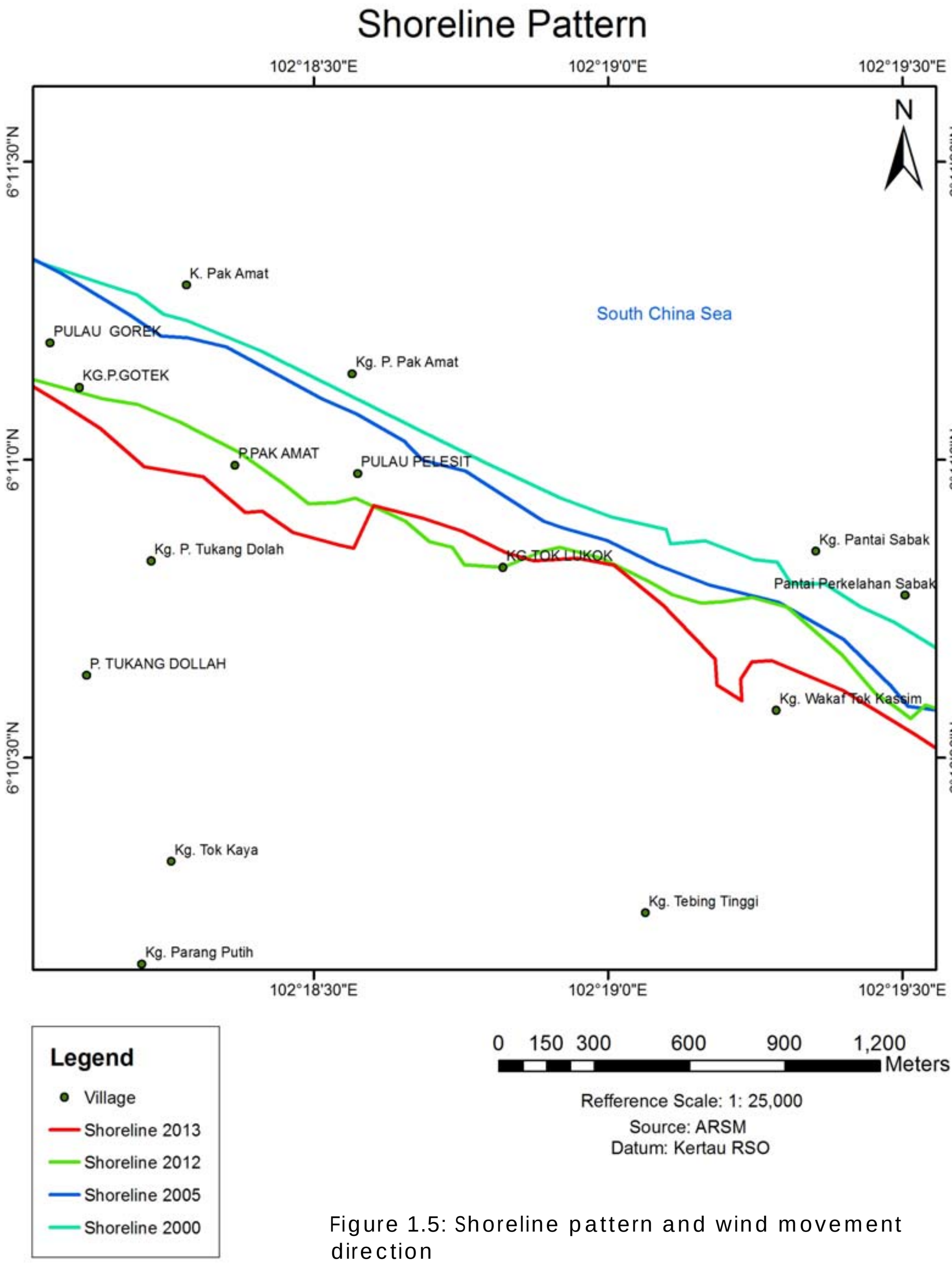


Figure 1.5: Shoreline pattern and wind movement direction

The first step to conduct this research was done by the desk study, observing the topography map and mapping the area that being eroded and possible of having shoreline movement. The satellite images; Landsat TMwas used in order to see the changes of the shoreline. These images were taken in form of serial of years from 2000, 2005, 2012and 2013 and it will be process usingArcGis Version 10. Before the images being overlay in ArcGis, geometric correction need to be done first.

This correction was conducted by ARSM and it is function to avoid the geometric distortion from the distort images. Images that undergo rectification process are use as the reference images. Image enhancement was done to increase the detail of the images. At this stage it also using computer operations to increasing of the spectral visibility of ground features by manipulating of the pixel values of the image. The images will be interpret and digitize using ArcView GIS Version 10 software. The defined shoreline perimeter of the coast was digitized on screen from the aerial photo and satellite images (Khaldom&Irmgard, 2009).

The main of this study is to map the shoreline position within these years by using GIS overlay technique. The satellite images, Landsat TM from 2000, 2005, 2012and 2013 were use to map the shoreline changes. By this stages the changes of the coastal areas can be calculate with GIS processing tools.

DATA ANALYSIS

Wind Analysis

Wind analysis was carried out to show the influences of wind to the coastal erosion that lead to shoreline changes. Analysis had been carried out were helped from Divison of Marine Meteorology & Oceanography, Malaysian Meteorology Department.

Frequency of Wind Speed Analysis

This analysis was done to show the frequency percentage of wind speed and dominant wind direction in a certain period of time. The wind speed that was used based on the Beaufort Scale to determine the effect of wind speed to the wave height and also the land use at the coastal area. The effects on the coastal area contribute to the shoreline changes.

Analyses of the results were presented in the table of percentage frequency of wind speed and wind rose diagram. From wind rose diagram, it explains the frequency and direction of the wind. In rose diagram, projection column referred to the frequency for the certain period and the length of projection column consist of frequency percentage from several classes of wind speed (ms^{-1}). The circle shape at center part of the wind diagram was identified as calmness number of wind speed (Whittow, 1984).

Shoreline Data Analysis

Based on the shoreline changes analysis, the distance of shoreline movement was measured. In this research, writer measured the distance of shoreline movement from Pantai Pak Amat (102°18'28.92E, 6°11'8.86N) and PantaiPerkelahanSabak (102°18'20.01E, 6°10'56.93N) based on data provided (Table 1.3).

Shoreline Movement Analysis

The satellite imagery within 2000, 2005, 2012 and 2013 are analyzed using GIS application. In ArcGis software, Index Overlay Model was used to map the shoreline changes in those years. These maps were being overlaid year by year starting from 2000 until 2013. The shoreline were identified for each year and being showed with different colours in map to indicate the changes. The study area had been observed from Pantai Pak Amat until PantaiPerkelahanSabak.

Table 1:Shoreline movement and area

Year	Interval Distance Within Years		Distance From Year 2000	Area (m^2)
	Min (m)	Max (m)		
2000	-	-	-	169
2005	47.49	150.5/5 years	85.82/5 years	172
2012	7.71	275.83/5 years	171.77/12 years	179
2013	2.65	320.93/1 year	210.89/13 years	-

Table 1.2: Distance of shoreline from Pantai Pak Amat and PantaiPerkelahanSabak

Years	Distance from Pantai Pak Amat (m)	Distance from PantaiPerkelahanSabak (m)
2000	399.99	- 89.77
2005	341.03	- 196.10
2012	40.30	- 207.43
2013	- 92.18	- 396.18

Table 1.3: Result analysis of frequency percentage of wind speed for 2000 and 2005

Direction (°)	Frequency Percentage of Wind Speed (ms^{-1}) for 2000 - 2005: 0.0 – 0.2	0.3 – 1.5	1.6 – 3.3	3.4 – 5.4	5.5 – 7.9	8.0 – 10. 7	10.8 – 13.8	13.9 – 17.1	> 17.1	Total Percentage (%)
346 – 015	0	0	0	0	0	0	0	0	0	0
016 – 045	0	0	0	0	6.9	0	0	0	0	9.1
046 – 075	0	0	0	0	0	0	12.6	0	0	9.1
076 – 105	0	0	0	0	12.6	10.3	0	0	22.4	36.4
106 – 135	0	0	0	0	0	0	0	0	0	0
136 – 165	0	0	0	3.5	7.5	0	0	0	0	18.2
166 – 195	0	0	0	0	5.7	0	0	0	0	9.1
196 – 225	0	0	0	3.5	00	0	0	0	0	9.1
226 – 255	0	0	0	0	0	0	0	0	0	0
256 - 285	0	0	0	0	0	0	0	0	0	0
286 – 315	0	0	0	0	0	0	0	0	0	0
316 - 345	0	0	0	0	0	0	0	14.9	0	9.1
Total	**0**	**0**	**0**	**7**	**32.7**	**10.3**	**12.6**	**14.9**	**22.4**	**100.1**

DISCUSSION

Wind analyses were only done in years 2000 and 2005 due to lack of data recorded form Meteorology Department.Based on the wind analysis in Table 1.3, highest percentage of wind speed is 36.4% at angle 75 - 105°. Highest percentage at 75 - 105° was classify as number 12 in Beaufort scale which is the highest level. According to this scale, it describe the sea condition was completely white with driving spray and visibility very seriously affected. The air condition at that time was filled with foam and spray. This type of wind also destroys the land area and could trigger the potential wave height about 14m. Wind speeds play important roles and influence the wave height. The highest wind speed also recorded within this angle at 22.41 ms^{-1}. It is classified within the range of wind speed more than 17.1 ms^{-1}.

In the range of years 2000 and 2005 the lowest percentage recorded is 0%. This percentage was repeated about five times at angle 346 - 015°, 106 - 135°, 226 - 255°, 256 – 285° and 286 – 215°. It is classified at zero in Beaufort number which is seawater look like mirror and in calm state. At the land area, the smoke rises vertically and the wave height produced at the lowest, 0m. Based on the wind analysis table, dominant frequency percentage at angle 016 - 045°, 046 - 075°, 166, - 195°, 196 - 225° and 316 – 345° were 9.1%. Beaufort scale categorized 9.1% of average wind speed at number five which is sea in moderate waves and landward area cause the small trees to sway. There were also percentage of wind frequency at Beaufort number eight, at angle 136 - 165° with 18.2%.

Data from the table were illustrated in wind rose diagram. In wind rose diagram, the wind dominantly blew from 076 - 105° which is from east. This is shown by the longest rose petal than others (Figure 1.3). Shoreline changes in study area were shown by map the shoreline in years 2000, 2005, 2012 and 2013. From the satellite imagery, shoreline changes become increase every year and it is related with wind speed and wind direction. Based on the data and wind rose diagram, the shoreline become increase in 2000 and 2005. This shown the relationship between the wind speed, wind direction and shoreline changes. In 2000, shoreline seemed far ahead from Pantai Pak Amat and PantaiPerkelahanSabak but in 2005 it moves inwards to the land area.

Based on map, shoreline analysis were done from Pantai Pak Amat and PantaiPerkelahanSabak within the range of 2000 until 2013. There were a lot of shoreline changes were identified and being compared with other years. The shoreline movement occurred showing the increasing value from 399.99m until -92.18m from Pantai Pak Amat meanwhile at PantaiPerkelahanSabak starting from 89.77m until 396.18m (Table 1.2). Data in the table showing the increment of shoreline changes to both area. At PantaiPerkelahanSabak, the sea area become increase and moving to landward area. The negative value showing the shoreline was located behind the actual place of PantaiPerkelahanSabak. This is also showed the coastal area become eroded and PantaiPerkelahanSabak was sank.

PantaiPerkelahanSabak was already sunk in years 2000 and it become worsen when the shoreline changes become increase. Data analysis showing the increasing distance value from 2000 until 2013. Negative value here also showing that shoreline was located behind the PantaiPerkelahanSabak. In years 2000, the shoreline distance from PantaiPerkelahanSabak is less than 100m but in 2013 there is highly increase in distance almost 400m. This illustrate PantaiPerkelahanSabak were become farther away from landwards area and high possibility the coastal area could be sink in future.

Figure 1.5 showing the shoreline trend in 2000, 2005, 2012 and 2013 by using Google Maps as the base map. The increasing pattern of shoreline was map using ArcGis software. From the research had been carried out, the parameter should be consider is wind direction. Data from wind direction such as wind speed and wind angle influence the shoreline changes. There were several limitations within this study which is the wind analysis were done based on data provided and the data recorded by Malaysia Meteorology Department were unstated during tidal or not.

CONCLUSION

From the result, the objective of the study was achieved, whereby the shoreline zone was mapped through time based on satellite imagery allowing changes in shoreline to be identified. Shoreline changes were affected by easterly wind direction that comes from a range of 76 - 105°. The wind rose diagram helped in determining the wind direction. Shoreline map analysis was also used to identify the distance of shoreline changes that have occurred over time. From this research, it can be concluded that satellite imagery was needed to determine the shoreline zone.

Wind speed and direction data also helped to support the detection of shoreline changes by providing dominant wind angle. Based on the analysis the stretch of shoreline from Pantai Pak Amat to PantaiPerkelahanSabak has become a threat to the residential area and the shoreline would moved to the landwards in future. As a consequence, this area could be sink and, thus, is no more suitable to be zoned for residential area.

REFERENCES

Balopoulos, E. T., Collins, M. B., & James, A. E. (1986). Satellite Images and their use in the numerical modelling of coastal processes. *International Journal of Remote Sensing, 7*, 905-919.

Bird, E. (2008).*Coastal Geomorphology: An Introduction.* England: John Wiley & Sons Ltd., p. 2.

Department of Irrigation and Drainage, Malaysia.(2012). *Coastal Management – Activities.*Retrieved from http://www.water.gov.my/our-services-mainmenu-252/coastal-management-mainmenu-279/activities-mainmenu-184#

El Raey, M., El Din, S. H. S., Khafagy, A. A., & Zed, A. I. A. (1999). Remote sensing of beach erosion/accretion patterns along Damietta-Port Said shoreline, Egypt. *International Journal of Remote Sensing, 20*, 1087-1106.

JabatanPerancangan Bandar danDesaSemenanjungMalaysi.(2010). *GarisPandua Perancangan Pemuliharaandan Pembanguan KSAS, KawasanPersisiranPantai.* Retrieved from http://www.mpsns.gov.my/nsm_mpsheme/pdf/Kawasan%20Sensitif%20Alam%20Sekitar/01_GP%20Kawasan%20Pesisiran%20Pantai.pdf

Khaldoun, A. A. &Irmgard, N. (2009). Coastal Monitoring Using Remote Sensing and Komar, P.D. (1998). *Beach Processes and Sedimentation.* Upper Saddle River, New Jersey: Prentice Hall Inc., p. 544.

M-Muslim, A., Foody, G. M., & Atkinson, P.M. (2007). Shoreline mapping for coarse-spatial resolution remote sensing imagery of SeberangTakir, Malaysia. *Journal of Coastal Research, 23*(6), 1399-1408.

ZaitulZahiraGhazali, Joy, J.P., &Juhari Mat Akhir. (2000). PerubahanGarisPantaidanSusutanDarat: CadanganGeoindikator Yang Berpotensi. *Proceedingvolume Geological Society of Malaysia Annual Geological Conference,* Pulau Pinang, Malaysia, pp. 259-268.

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Soil Erosion Risk Assessments Using GIS for Chin Tick Farm, Gua Musang, Kelantan

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The geological mapping had been done in order to make observations of geology in the field. The detailed general geology, geomorphology and lithostratigraphy of the study area had been done to know the geology of the Chin Tick Farm, Gua Musang. There are consist of four type of lithology at the study area. there are acid intrusive, interbedded sandstone, siltstone and shale, limestone/marble and phyllite, schist and shale. Soil erosion is a growing problem especially in areas of agricultural activity where soil erosion not only leads to decreased agricultural productivity but also reduces water availability. Universal Soil Loss Equation (USLE) is the most popular empirically based model used globally for erosion prediction and control. Geographical Information System approach had been used to access soil erosion at the study area. Universal Soil Erosion Equation is used in order for erosion prediction and control. The soil erosion rate was determined as a function of land topography, soil texture, land use/land cover, rainfall erosivity, and crop management and practice in the study area. the average rainfall of the study area was found as 1697 mm and the soil erodibility, k-factor has factor range from 0.042 (ton.ha)(ha.hr/Mj.mm) to 0.0065 (ton.ha)(ha.hr/Mj.mm). The C factor was taken from land use map. The P factor was derived from land use map. Based on the GIS intergration, five classes of soil erosion risk had been determined. In the study area, the The first largest contributor of soil erosion in study area is agricultural activities, then urbanization and finally infrastructures.

INTRODUCTION

Soil erosion generates global crisis that threatens the natural environment. Asia has the highest soil erosion rate, 74 tonnes/acre/yr (El-Swaify, 1994). Universal Soil Loss Equation (USLE) is one of the model used to predict soil erosion by simulating erosion process. Water is probably the main factor which contributes to erosion in most areas with about 7509 tonnes per year (Primentel et al, 1995, Hua Lu *et al* 2001).

During heavy rainfall season, the mud and silt flow into the nearby river and caused erosion from the logging area. Lojing area has suffered due to soil erosion resulting from continuous deforestation. A huge part of the hilly terrain in Sungai Relai has been entirely deforested, a few hills have the vegetation being stripped from top to bottom (NST 2012).

Geographical Information System (GIS) is a powerful tool for handling spatial and non-spatial geo-referenced data for interaction, input or output with the soil erosion risk modeling. GIS application can be used broadly. For example, GIS helps to scale up to regional levels and to quantify the differences in soil loss estimates produced by different scales of soil. The integrated use of remote sensing and GIS could help to assess quantitative soil loss at various scales and also to identify areas that are at potential risk of soil erosion (Saha *et al.,* 1992). Several studies showed the potential utility of GIS technique for quantitatively assessing soil erosion hazard based on various models (Saha *et al*, 1992, Shrestha, 1997, Suresh Kumar&Sharma, 2005).

STUDY AREA

The study area is located at the southern part of Gua Musang district bounded by latitude 4° 49' 30" to 4° 52' 0" N and longitude 101° 58' 0" until 102° 0' 30". The area covers a (5x5)km^2 area. The study area is predominantly agriculture (Figure 1.1) There are also two main rivers in the study area, namely Sungai Ketil and Sungai Bertam. The main housing development in the study area is Taman Wangi.

The area mostly covered by palnattaion which have high tendancy to have soil erosion loss.

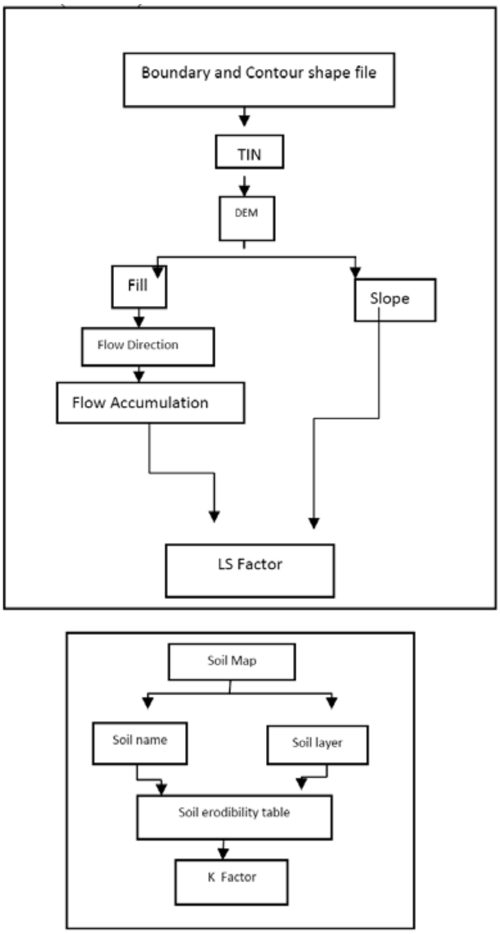

Figure 1 : Schematic diagram for : A) LS, B) K factors   Source : Ministry of Natural Resources & Environment Malaysia, 2010

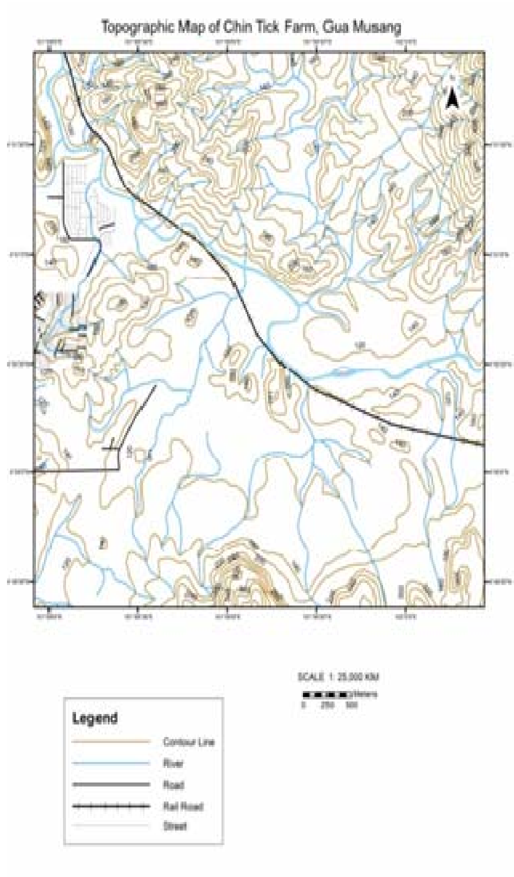

Figure 2 : Location of the study area

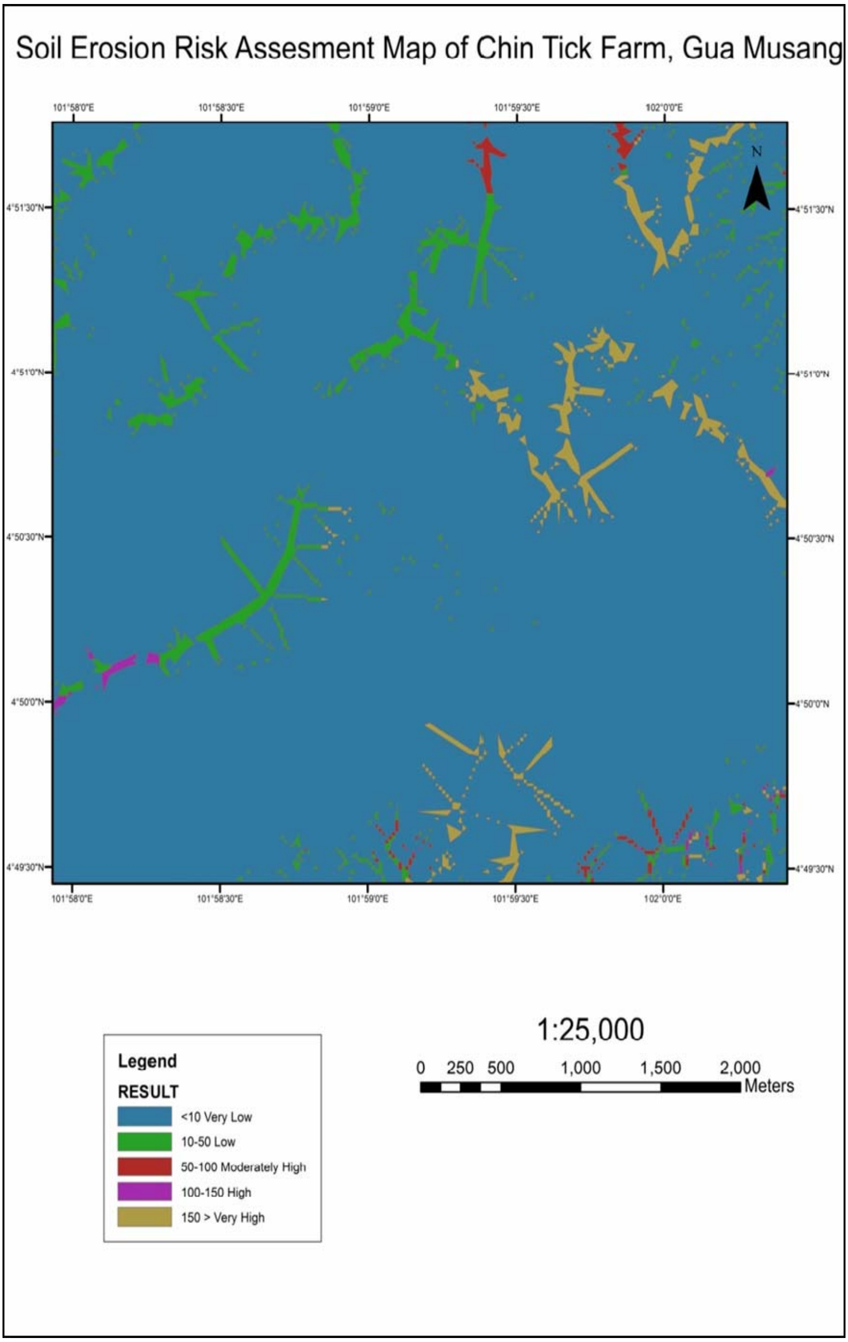

Figure 2 : Location of the study area

METHOD AND MATERIALS

All data for geospatial analysis such as topographic, landuse and soil series map has been collected from JUPEM and DOA. Statistical data; rainfall was collected from Meteorological Department (MET) (Table 1).

The USLE equation was used to calculate the annual average soil loss rate (A) in ton/ha/year. In order to predict the annual average soil loss rate in the study area, all thematic maps were overlays by using Multi Index Overlay Analysis. The soil loss for this area is divided to five class os Soil Loss

Tolerance Rate which is very low, low, moderate, high and very high. Each class is showing the Potential Soil Loss in ton/ha/year unit (Table 1.2)

Table 1 Data Inventories

Type of data	Data description	Sources
Map	Topographic Map	Scale : 1:25 000 Year : 2006 Source : JUPEM
	Landuse and Soil Series	Scale : 1:25 000 Year : 2006 Source : Agriculture Department
Data	Rainfall	Year : 2009, 2010, 2012 and 2013 Source : Meteorology Department

RESULTS AND DISSCUSSION

LS Factor Map

Based on topographic map, the slope data were extracted. Two parameters refer in the map which is the slope length, L, and slope steepness, S. Both data where calculated by using the following equation :

$LS = (0.065 + 0.045\ S + 0.0065\ S^2) \times (L/22.13)^{0.5}$ …… **(EQ1)**

By using ArcGis, the calculation can be generate as a map. The LS Factor Map generate.

K Value Map

The soil series map collected from DOA was update with field survey data. The thematic map produce from the Soil Series Map is the K Values Map (Figure 1). The K value given is based on Soil Erodibility Values (Table 6)

Rainfall

For rain intensity less than the infiltration capacity, the infiltration rate is equal to the rain intensity and there will be no surface runoff (Roslan, 2009). Nassif and Wilson (1975) have evidence to suggest that infiltration capacity is limited also influenced by rainfall intensity, whereby instead of being a constant value, infiltration increases with rainfall intensity. The rainfall distribution map is shown in Figure 5.6. Annual rainfall mean equivalent of the study area which is 2358 mm for the study area. The best estimate of the R factor value calculated for the study area was 1697.5 MJ mm ha/yr.

Land Use

Landuse is the key factor for the erosion to occur. The ground cover will determine either the soil will easily eroded or not. In Malaysia, the values of C factor based on land use have been determined by the Department of Agriculture (DOA). Based on ground conditions, the C factor has been categorized into three groups :

i. C factor for forested and undisturbed lands (Table 4)
ii. C factor for agricultural and urbanized areas (Table 4)
iii. C factor for BMPs at Construction sites (Table 4)

Practice Factor

The P factor depends on the conservation measure applied to the study area. In Malaysia the most common conservation practice is contour terracing in rubber and oil palm plantations. In this study, it was proven that contour terracing practice on slopes was carried out for oil palm plantation. In the current study, the value of P was assigned by using land use map. Table 5 represents the value of support practice factor according to the cultivation method and slope (Shin, 1999).

ANALYSIS

The USLE equation was used to calculate the annual average soil loss rate (A) in ton/ha/year. In order to predict the annual average soil loss rate in the study area, all thematic maps were overlays by using Multi Index Overlay Analysis. The generated map after the analysis is Soil Erosion Risk Assessment Map (Figure 2). The soil loss for this area is divided to five class os Soil Loss Tolerance Rate which is very low, low, moderate, high and very high. Each class is showing the Potential Soil Loss in ton/ha/year unit (Table 2).

CONCLUSIONS

The first largest contributor of soil erosion in study area is agricultural activities such as mixed agriculture, palm oil and rubber. Different agricultural activities pose different erosion risks, the most damaging practice appeared to be kawasan cerang, according to CP values in Table 6. However, forests yield a very low CP value indicating it is a low erosion risk agricultural activity according to Table 6. The second biggest contributor of soil erosion is urbanization which includes construction activities to develop houses, shops and residential area. The last contributor of soil erosion is infrastructure which includes roadwork, building highways and water supply pipelines (Toriman, Karim, Mokhtar, Gazim, & Abdullah, 2010). My analysis agrees with Toriman et. al , 2010 suggesting that agricultural activity is the main contributor of soil erosion followed by urbanization according to Table 5.4 and Table 5.10.

Table 2: Soil loss tolerance rate classes vs. potential soil loss.

Soil Loss Tolerance Rate	Potential Soil Loss (ton/ha/year)
Very low	<10
Low	10-50
Moderate high	50-100
High	100-150
Very high	150>

Table 3 Erositivity, R, factor calculation

Method	Calculation	R value MJ mm $ha^{-1} h^{-1} yr^{-1}$
Morgan (2005)	[(9.28P-8838.15) x 75] / 1000 in metric unit	1196
Roose (1977)	P x 0.75 x 1.73 in metric unit	2199
Best estimation		1697.5

The low risk assessment areas refers to stable conditions. These areas are highly recommended for any future planning developments. In contrast, the high risk assessment represent areas with unstable condition. These areas are not recommended to be developed due to geological, hydrological and geotechnical constrains. However, if developer or local authorities have no choice and want to develop these areas, some procedures need to be taken carefully and continuous assessment must be done in order to prevent erosion to occur.

REFERENCES

Amore E., Modica C., Nearing M.A. and Santoro V.C. (2004) Scale effect in USLE and WEPP application for soil erosion computation from three Sicilian basins, 293 (1-4), 100-114

B. Gregersen, J. Aalbæk, P.E. Lauridsen, M. Kaas, U. Lopdrup, A.Veihe5 and P. Van Der Keur (2003) "Land Use And Soil Erosion In Tikolod,Sabah, Malaysia"

Bayi Jiang (2013) "GIS-based time series study of soil erosion risk using the Revised Universal Soil Loss Equation (RUSLE) model in a micro-catchment on Mount Elgon, Uganda". Thesis. Lund University

D.Lu, G.Li, G.S.Valladares and M.Batistella (2004) Mapping Soil Erosion Risk In Rondonia, Brazilian Amazonia:Using Rusle, Remote Sensing And Gis

De Roo, A.P.J., Hazelhoff, L., and Burroughs, E.R. (1989). "Soil erosion modelling using ANSWERS and Geographical information systems." Earth surface processes and landforms, 14, 517-532.

Engr. Yong Hong Liang, M.I.E.M, P. Eng. (Journal) Contributions of an Agricultural Engineer in the Oil Palm Plantation pg 1-3

Environmental Statistics Time Series, (2012), Department of Statistics Malaysia
Fauzi Hussin & Hussin Abdullah (2012) The Role of FELDA and KESEDAR in the Development of Land in the District of Gua Musang: A Comparison theSocio-Economic Level of the Settlers
G. Wolkerstorfer & P. Strauss (2004) Soil erosion at the mesoscale: comparison of two erosion models for a pre-alpine Austrian basin
Goh Swee Heng, The Guan Hoe, Wan Fuad Wan Hassan (2006) Gold Mineralization And Zonation In The State Of Kelantan
Hickey, R., 2000, Slope Angle and Slope Length Solutions for GIS. Cartography, v. 29, no. 1, pp. 1 - 8.
Hyeon Sik Kim, Department Of Civil Engineering (2006), Thesis Soil Erosion Modeling Using Rusle And Gis On The Imha Watershed, South Korea
Kanya Souksakoun(2008). Soil loss assessment at regional scale for different land use/cover types ; A case study in Lomsak district, Phetchabu, Thailand.Thesis. International Institute For Geo Information Science And EarthObservation Enschede, Netherlands.
Lee Chai Peng, Mohd Shafea Leman, Kamaludin Hasan, Bahari Md. Nasib, Rashidah Karim (September 2004). Stratigraphic Lexicon of Malaysia pp 43 46
LeeChaiPeng* and Nuraiteng Tee Abdulla, Geological Evolution of Peninsular Malaysia After the Palaeozoic Gondwana-Cathaysian Suturing.
Loch, R. J., B. K. Slater., and Devoil, C. (1998). Soil erodibility (Km) values for some Australian soils. Australian journal of Soil Research, 36: 1045-1055.
Lucy Muthoni Njue (2010), Geological Field Mapping
Maidment, D.R., and Djokic, D (2000) “Hydrologic and hydraulic modeling support with geographic information systems. ESRI Press, Redlands, CA
Mohamad Firuz Ramli, Choo Siet Mei,Mohd Kamil Yusoff, Ahmad Makmom (2004) Preliminary Assesment Of Erosion Hazard Using Open SourceGeographical Resources Analysis Support System (GRASS) For Langkawi Island
Mohd Fazly Yusof et al (2011) Modified Soil Erodibility Factor, K for Peninsular soil series. 3rd International Conference on Managing Rivers in the 21st century.
Moore, I.D., Grayson, R.B. and Landson, A.R. (1991) “Digital terrain modeling: A review of hydrological, geomorphological and biological applications.” Hydrological Processes,5, 3-30.
S. Beskowa, C.R. Mello, L.D. Norton, N. Curi, M.R. Viola, J.C. Avanzi a,d (2009) Soil erosion prediction in the Grande River Basin, Brazil using distributed modelling
S.Paiboonsak et al (2000) “Spatial Modeling for Soil Erosion Risk in Upper Chi Basin, Northeast Thailand.
Sharma, K.D., Menenti, M., and Huygen, A.V. (1996). “Modeling spatial sediment delivery in an arid region using thematic mapper data and GIS.” Transactions of the ASAE, 39(2), 551-557.
Shrestha R.P., Apisit E. & Somachai B. (1996) Soil erosion assessment and its policy implications- GIS development .net> AARS >ACRS
Soo Hoey The (2011) “Soil Erosion Modeling Using Rusle And Gis On Cameron Highlands, Malaysia For Hydropower Development”Thesis. University of Iceland & University of Akureyri.
Sujaul Islam Mir et al, (2010) “Soil loss assessment in the Tasik Chini catchment, Pahang, Malaysia”. Bulletion of the Geologicak Society of Malaysia 56.
Suresh Kumar, Shriram B. Dhaimodkar and L.M. Pandey-The assessment of potential land use in the proposed Irrigation command using RS and GIS Journal of Indian Society of Remote Sensing. 30 (3).
Tim, U.S. (1996). “Emerging technologies for hydrologic and water quality modelingresearch.” Transactions of the ASAE, 39(2)., 465-476.
Vieux, B.E., and Gauer, N. (1994). “Finite element modeling of storm water runoff using GRASS GIS.” Microcomputers in Civil Engineering, 9:4, 263-270.
Wase Ahmed, (2000). Petrographic Examination Method. Buehler Ltd., Vol. 3 No. 5, 7 p.
Williams, J.R. (1975). “Sediment yield prediction with universal equation using runoff energy factor.” Agricultural Research Service report ARS-S-40. U.S.Department of Agriculture.
Williams, J.R. (1977). “Sediment delivery ratios determined with sediment and runoff models. In: Erosion and solid matter transport in inland waters. pp 168 179.IAHS-AISH publication No. 122.
Wischmeier, W.H. (1976) “Use and misuse of the universal soil loss equation. Soil and Water Conservation 31(1):5

Wischmeier, W.H. and Smith, D.D. (1965) "Predicting rainfall erosion losses from cropland east of the Rocky Mountains: Guide for selection of practices fro soil and water conservation." U.S. Department of Agriculture handbook No. 537.

Wischmeier, W.H. and Smith, D.D. (1978) "Predicting rainfall erosion losses –A guide to conservation planning." U.S. Department of Agriculture handbook No. 537.

Wischmeier, W.H., Johnson, C.B., and Cross, B.V. (1971) "A soil erodibility nomograph for farmland and construction sites. J. Soil and Water Conserv. 26:189-193.

Wischmeier, W.H., Smith, D.D., and Uhland, R.E. (1958) "Evaluation of factors in the soil loss equation. Agric. Eng. 39:458-462, 474.

Sandy Beach Morphodynamic Classifications Index Based On Wright and Short (1984) at Selected Beaches Along Terengganu, Malaysia

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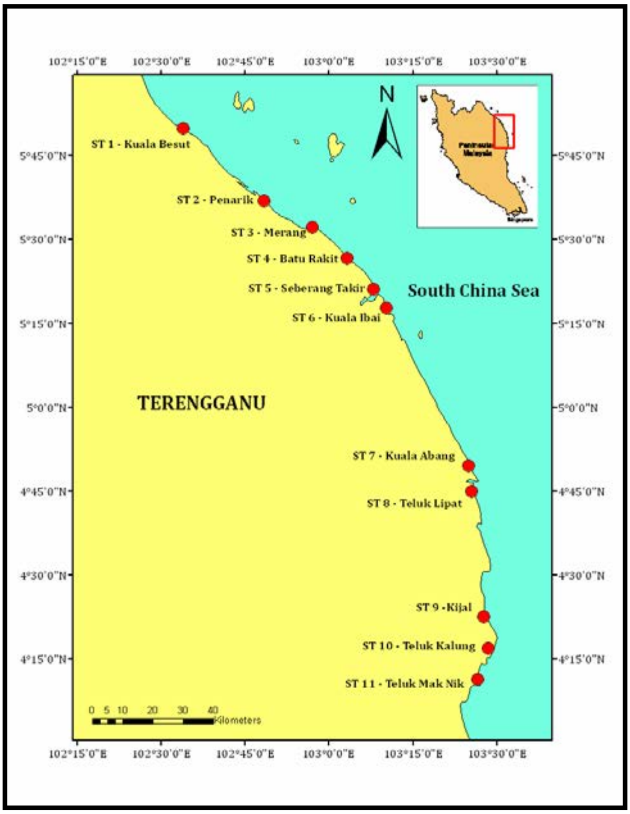

Figure 1: Map of the Study Area

In a coastal region where there are large pressures on the beach resources through recreational usage, understanding the beach morphodynamic classification is paramount. On this basis, some selected beaches along Terengganu coastal region were chosen in order to determine its morphodynamic classification according to the indices modelled by Wright and Short (1984). As a result, the beaches at the northern and southern parts of Terengganu were classified as intermediate state while the middle part classified as reflective beach. Most of the beaches exhibited characteristics resulting from antecedent hydrodynamic conditions with stronger hydraulic forces at the middle region compared with the northern and southern beaches.

Keywords: *Beach morphodynami classificationc, Wright and Short (1984), Terengganu.*

INTRODUCTION

Beach classification can be useful for coastal planners to group beaches of similar characteristics and behaviours. Many beach classifications have been developed for a variety of wave and tidal conditions. The range of classifications was developed because beaches behave and evolve differently under various forces. These classifications were developed for sandy beaches. There is limited applicability for bedrock dominated coasts where behaviour and sand availability is governed by rock outcrops, coral reefs and headlands (Velardo 1998; Jackson et al. 2005). A classification was applied to classify the morphodynamic state of the eleven beaches studied. It describes the variability between the states by the relationships between wave forcing, sediment and beach slope characteristics.

MATERIALS AND METHODS

A classification according to Wright and Short (1984) was applied to classify the morphodynamic state of the beaches studied (Figure 1). It describes the variability between the states by the relationships between wave forcing, sediment and beach slope characteristics. Besides, the morphodynamic indices and parameters have been developed to distinguish between the beach states (Carter, 1988; Short, 1999).

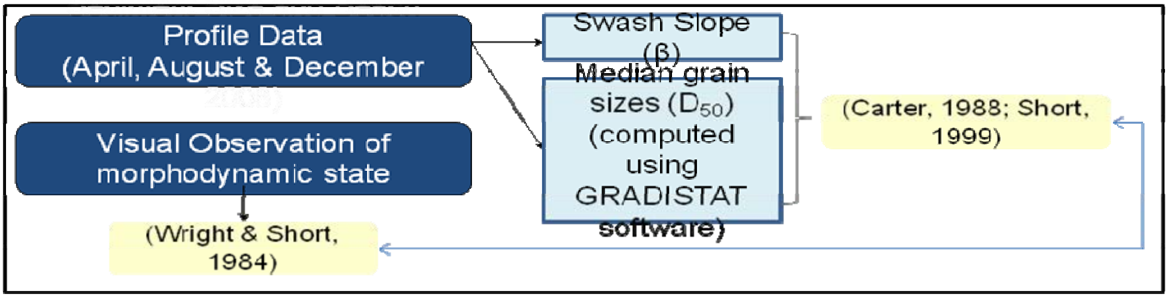

Fig. 2: Methodology outline

Table 1: Beach type, D_{50} (φ) and swash (β)

STATION	Median Grain Size (D_{50}) (phi)			Swash Slope (β)			Visual Observation Morphodynamic classifications, Wright & Short (1984)			REMARK
	Apr-08	Aug-08	Dec-08	Apr-08	Aug-08	Dec-08	Apr-08	Aug-08	Dec-08	
1	0.75 I	1.74 I	1.15 I	6.21 R	5.73 I	5.48 I	I	I	I	Near-dissipative
2	1.11 I	1.68 I	0.44 I	4.68 I	5.46 I	5.90 I	I	I	I	-
3	1.71 I	1.22 I	1.39 I	3.96 I	4.55 I	4.72 I	I	I	I	-
4	0.59 I	-0.09 R	1.15 I	5.40 I	9.01 R	11.71 R	I	R	R	-
5	0.25 I	0.75 I	1.04 I	5.35 I	13.47 R	7.06 R	R	R	R	-
6	1.59 I	1.99 I	-0.21 R	5.47 I	4.07 I	5.88 I	-	-	-	Perched
7	0.90 I	1.03 I	0.89 I	7.62 R	5.10 I	12.18 R	-	-	-	Perched
8	0.41 I	0.82 I	0.90 I	7.85 R	6.21 R	6.88 R	R	R	R	-
9	1.75 I	1.37 I	1.39 I	6.75 R	4.66 I	4.01 I	I	I	I	-
10	2.06 D	1.60 I	1.40 I	6.31 R	5.00 I	6.84 R	I	I	I	Two-headlands (Pocket beach)
11	0.24 I	0.49 I	0.82 I	4.83 I	15.01 R	9.36 R	I	R	R	Headland

*Blue colour cells indicate by perched beach.

Note: R – Reflective.
I – Intermediate.
D – Dissipative.
D_{50} and Swash slope was classify according to Carter (1988) and Short (1999).

Parameter of swash slope (β) and median grain sizes (D_{50}) (computed using GRADISTAT software) were also taken into consideration in order to classify the beach state (Carter, 1988; Short, 1999). These two parameters were then compared with the visual observation based on Wright and Short (1984) morphodynamic classifications to confirm the beach states occurred. Field data was collected in April, August and December 2008 (Figure 2).

RESULTS AND DISCUSSION

From the data gained from swash slope and median grain sizes (Table 1), only swash slope met the criteria for morphodynamic classification based on visual classifications (Wright and Short, 1984). At the northern region of Terengganu, beaches of Kuala Besut (ST 1), Penarik (ST 2) and Merang (ST 3) were classified as intermediate state where the beach at Kuala Besut is likely to be a near-dissipative type. In the middle region however, beaches of Batu Rakit (ST 4), Seberang Takir (ST 5) and Teluk Lipat (ST 8) remained in a reflective state during the three respective months. The Kuala Abang and Kuala Ibai beaches were perched. Otherwise, most of the beaches at southern region of Terengganu were categorized as intermediate beaches with exceptional for Teluk Mak Nik (ST 11).

In this study, we concluded that beaches along the Terengganu coastal region are classified as intermediate and reflective morphodynamic state. The reflective beaches mostly occurred at the middle part of Terengganu due to steeper swash slopes as exposed by wave attack vulnerability. Along the central portion of the study area from Batu Rakit (Kuala Terengganu) to Teluk Lipat (Dungun), there is a diverse assortment of human activities and facilities. These consider that the beaches presently underutilized by the human interference which exclusively leads to erosion and steeper slope condition. These may explain the reflective morphodynamic character of this section of beach. Strong waves collapsing on the beachface during Northeast Monsoon were steadily increased the risk factor of beach hazard which resulted in substantial erosion (Benedet et al., 2004).

In the northern and southern portion of the study area, beaches were classified as intermediate although beaches at Besut (ST 1) and Teluk Kalung (ST 10) exhibited near-dissipative characteristics at certain time. The intermediate beaches are usually longer than the reflective beaches. Wave energy along these intermediate beaches produces rhythmic bars during December 2008 and low-tide terraces during April and August 2008. The beach profile of this type of beach is gentler compared to reflective beaches. This may due to the site specific and differential energy forces (lower) that influence this area at particular times. We conclude that state classification were very dependent on hydraulic forces that influence the beach area, Benedet et al (2004) and Tanya (2005).

REFERENCES

Benedet, L., Finkl, C. W. and Klein, A. H. F. (2004). Morphodynamic classification of beaches on the Atlantic coast of Florida: Geographical variablility of beach types, beach safety and coastal hazards. *Journal of Coastal Research*, 39:1-7.

Carter, B. (1988). *Coastal environment: an introduction to the physical, ecological, and cultural systems of coastlines*, New York: Academic Press.

Jackson, N. L., Nordstrom, K. F., Eliot, I. and Masselink, G. (2002). 'Low energy' sandy beaches in marine and estuarine environments: a review. *Geomorphology 48* (1-3), 147-162.

Short A.D. (1999). *Handbook of beach and shoreface morphodynamics*. Chichester: John Wiley.

Tanya, S. (2005). Physical characteristics of Perth Beaches, Western Australia. Unpublished master's thesis. University of Western Australia, Australia.

Velardo, S. (1998). Patrolled Sandy Beaches of Southwestern Australia: Characteristic Morphology and Public Hazards, Unpublished Honours Thesis, University of Western Australia.

Wright, L.D. and Short, A.D. (1984). Morphodynamic variability of surf zones and beaches: A synthesis, *Marine Geology 56*(1-4), 93-118.

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