Persatuan Geologi Malaysia

Geological Society of Malaysia

Proceedings of the NATIONAL GEOSCIENCE CONFERENCE 2013

Kinta Riverfront Hotel and Suites, Ipoh

8-9th June 2013

UNIVERSITI TEKNOLOGI PETRONAS

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Edited by: Nur Iskandar Taib

Co-organizers:

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Published by the Geological Society of Malaysia
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Printed by Art Printing Works Sdn. Bhd.
29 Jalan Riong, 59100 Kuala Lumpur

A message from the Chairman

Assalamualaikum and Good Day,

Dear Participants,

The National Geoscience Conference (NGC) is a yearly affair of the Geological Society of Malaysia (GSM) that serves as a platform for geoscientists to present and discuss new findings and interesting researches. It especially encourages new and budding geoscientists to present their research outcomes in an official forum. Apart from that, it actually serves as an annual gathering and meeting of geoscientists nationwide.

This year's NGC (NGC 2013) has chosen Ipoh as the venue for the conference. The NGC 2013 organising committee is represented by members from the Minerals and Geoscience Department (JMG), University Technology Petronas (UTP) and the GSM. The committee has decided that the venue of the conference to be at the Kinta Riverfront Hotel & Suites where memories of what Ipoh was initially built upon would reel in and for that matter, the role and contribution of geosciences in the tin mining industry. It is apt that our meeting venue will be at the Pusing and Gopeng Halls - well known places among the tin fraternity.

The theme for NGC 2013 "Geoscience for Environmental Wellbeing" reflects the important role geoscientists could contribute to resolve the many environmental issues affecting our planet at present. Global warming, climate change and sea level rise are among the global scale phenomena much discussed. Questions that are commonly posed include their causal factors, whether they are natural, man-induced, or both and can they be contained or resolved. On the other hand, to cope for the betterment of our standard of living and lifestyle, our earth's natural resources like oil and gas, minerals and construction materials are slowly being depleted. In extracting them and to cater for our development needs we also create much damage and disorderliness to the environment. Are there alternatives and can they be recycled for our future generations? These constitute the many questions that geoscientists need to ponder, consider and provide answers to.

The NGC 2013 has been overwhelmingly received and had attracted107 technical papers from diverse geosciences fields. To be fair with the submitters and to promote the science to the newcomers and the audience, the organizing committee has accepted all the papers. The papers have been selected for either oral or poster presentation. As in previous NGC's, the conference is a two days event and has two parallel sessions running simultaneously.

The organizing committe would like to thank the authors and writers for their interests and the support given by the various Universities and organizations concerned. May the deliberations elevate the science to a higher level and at the same time benefit the people and the nation. To the conference sponsors we indeed appreciate the contributions and sponsorships provided. To the conference committee members I would like to express my sincere gratitude for the help and assistance to make the conference a success.

On behalf of the NGC 2013 organizing committee I would like to cordially welcome the participants of the NGC 2013 to Ipoh - a city that was built upon tin and its spillover industries. Please do look around, enjoy your stay and participate actively.

Thank you and Wassalam.

Dr. Kamaludin bin Hassan
Chairman
NGC 2013

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2000-2200	**ICEBREAKER – FRIDAY 7 JUNE 2013 (sponsored by JMG)**	
DAY ONE, SATURDAY 8 JUNE 2013		
0830-1000	**Opening ceremony**	
1000-1030	**KEYNOTE I** **Mohd Shafeea Leman (UKM) -** Proposed Kinta Valley Geopark – Utilizing Geological Resources for Environmental Quality Improvement and Society Well Being Enhancement	
1030-1100	**Tea break**	
	TECHNICAL SESSION A1	**TECHNICAL SESSION B1**
1100-1120	**A01** **Jasmin Saw, Chow Weng Sum and Bernard J. Pierson:** Potential Impact Of Pollution By Oil Spills On Coastal Facies In Pulau Pangkor, Malaysia	**B01** Noraisyah Sapon, Rosnan Yaacob, Peter R. Parham, Lokman Husain & Rokiah Suriadi: Volumetric Changes And Sediment Characteristics At Selected Beaches Of Terengganu, Malaysia
1120-1140	**A02** Lee Qiao Yun, Sahibin Abd Rahim, Wan Mohd Razi Idris, Zulfahmi Ali Rahman & Tukimat Lihan: Soil Erosion Potential From Sungai Paya Merapuh Sub-Catchment To Lake Chini, Lake Chini, Pahang	**B02** Sanudin Hj Tahir, Baba Musta, Hafzan Eva Mansor, Fauziah Hanis Hood and Dayang Nor Asyilla Abang Abdullah: Facies Analysis Of The Late Miocene Sedimentary Sequence In Sabah, Malaysia
1140-1200	**A03** Mohamad Yusof Che Sulaiman, Ismail Yusoff & Muhammad Aqeel Ashraf: Environmental Impacts of Batik Industry Effluents in Kota Bharu, Kelantan	**B03** Mohamed Hilmi Mohamed Khassim, Abdul Hadi Abdul Rahman, Ahmad Munif Koraini: Sedimentary Facies and Depositional Environments of the Nyalau Formation (Oligocene - Middle Miocene) North Bintulu Area, Sarawak
1200-1220	**A04** Hazirah Hatar, Sahibin Abd Rahim, Wan Mohd Razi Idris, Fathul Karim Sahrani: Pencirian fiziko kimia air saliran lombong berasid di kawasan lombong terpilih di Malaysia	**B04** Junaidi Asis & Basir Jasin: Miocene Larger Benthic Foraminifera from the Kalumpang Formation, Tawau, Sabah: preliminary interpretation

1220-1240	**A05** Kamaludin Hassan, Tuan Rusli Tuan Mohamed, Suzannah Akmal, Kadderi Md Desa, Habibah Jamil & Yongqiang Zong: Paleo sea level change at Merang, Kuala Terengganu	**B05** Basir Jasin: Posidonia (Bivalves) from northwest Peninsular Malaysia and its significance
1240-1300	**A06** Tjia H,D.: Evidence of Holocene and historical changes of sea level in the Langkawi Islands	**B06** Rokiah Suriadi, Peter R. Parham, Noraisyah Sapon, Behara Satyanarayana., Mohd Lokman Husain, Wan Nurzalia Wan Saelan: Sub-Surface And Infaunal Foraminifera Of Kelantan Delta, East Coast Of Peninsular Malaysia: Their Potential For Interpretation Of Sea Level Change
1300-1400	**LUNCH AND DZUHOR PRAYER**	
	TECHNICAL SESSION A2	**TECHNICAL SESSION B2**
1400-1420	**A07** Mohd Shafeea Leman, Mokhtar Saidin & Islahuda Hani Sahak: 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	**B07** Siti Nur Fathiyah Jamaludin and Manuel Pubellier: Interpretations On Seismic Volume Over Two Miocene Carbonate Platforms In Central Luconia, Sarawak
1420-1440	**A08** Tuan Rusli Muhamad, Kamaluddin Hassan, Mohd Shafeea Leman, Saiful Abdullah & Ahmad Khairut Tarmizi Mohd Daud: Geotapak Kompleks Kars Gunung Datok dan potensinya sebagai tunggak pembangunan Geopark Kebangsaan Lembah Kinta, Perak, Malaysia	**B08** Siti Hafizah Ramli, Abdul Rahim Samsudin, Mokhtar Saidin, Nur Hamizah Mohd Jafar, Umar Hamzah & M Shyeh Sahibul Karamah: Magnetic signature of impact structure at Lenggong Perak, Malaysia
1440-1500	**A09** Nur Liayana Che Jamil, Dony Adriansyah Nazaruddin, Elvaene James, Hafzan Eva Mansor, Mohammad Muqtada Ali Khan: Geoheritage Of Lata Renyok Cascade: A Potential Geotourism Development In Jeli District, Kelantan	**B09** Nadiah Hanim Shafie, Abdul Rahim Samsudin, Tjia Hong Djin, Abd Rahim Harun, Ibrahim Abdullah, Wan Zuhairi Wan Yaacob & Kamal Roslan Mohamad: Geological Analysis Of GPS Data: Malaysian Case Study

1500-1520	**A10** Dony Adriansyah Nazaruddin, Arham Muchtar Achmad Bahar, Nor Arina Binti Muhamad Aris: Geotourism Potentials Of Jeli District, Kelantan	**B10** Peter R. Parham, Yoshiki Saito, Noraisyah Sapon, Rokiah Suriadi, Noor Azariyah Mohtar: An Early Mid-Holocene Coral Reef And Extensive Marine Deposits On The Terengganu Mainland, Peninsular Malaysia: Implications For Maximum Holocene Transgression
1520-1540	**A11** Ismail Ibrahim, Md Muzayin Alimon and Salmah Baharuddin: The recovery of fine cassiterite from metasedimentry rock	**B11** Muhammad Hatta Roselee, Azman Abdul Ghani, Kyaw Kyaw Nyien, Fatin Izzani Hazad. Ahmad Farid Abu Bakar, Khairul Azlan Mustapha: Petrology and geochemistry of A-type igneous from Teluk Ramunia, Southeastern of Johor
1540-1600	**A12** Rosmalia D. Nugraheni, W. S Chow, Abdul Hadi A. Rahman, Mohd Faisal Abdullah: Challenges Of Tertiary Coal-Bearing Heterolithic Packages As Low permeability Source And Reservoir Rocks In The Balingian Sub-basin, Sarawak, Malaysia	**B12** Aftab Alam Khan, Wan Hasiah Abdullah, Meor Hakif Amir Hassan and Nasim Ferdous: An overview on the tectonics and sedimentation of Kuching – Lundu – Sematan transect of South-West Sarawak Basin, Malaysia
1600-1620	**Tea Break**	
1620-1640	**A13** KK Cheang, Kamar Shah Ariffin, Hareyani Zabidi, Mohd. Yaras Basattu and Nor Amni Adira Abdul Moin: Micron-Sized Gold Particles from Resistates in the Straights Creek area, Gua Musang, Kelantan	**B13** Abang Caspian Abang Thairani & Wan Zuhairi Yaacob: Virtual Geological Fieldwork App For eLearning
1640-1700	**A14** Haniza Zakri and Azimah Hussin: The Evaluation Of Quartz Deposit In Kg. Padang Biawas, Negeri Sembilan As A Source Of High Purity Quartz	**B14** Yong Joy Anne, Samsudin Hj Taib and Ng Tham Fatt: Crustal features underlying Peninsular Malaysia across Bandar Tun Abdul Razak to Rompin from aeromagnetic data
1700-1720	**A15** Ramli Mohd Osman: Rate of Development of Ex-Mining Land in Peninsular Malaysia	**B15** Abdul Rahim Samsudin, Mokhtar Saidin, Abdul Rahim Harun, Mohd Hariri Ariffin, Umar Hamzah, Dewandra Bagus Eka Putra & M Shyeh Sahibul Karamah: A possible structure of impact crater at Lenggung Perak: Gravity evidences

1720-1740	**C01** Mohamad Tarmizi Mohamad Zulkifley, et al.: Effects of soil fillers, vegetation lateral variation and basin 'dome' shape on tropical lowland peat stabilization.	**D01** Nor Ashikin Binti Shaari, Mohammad Muqtada Ali Khan, Arham MuchtarAchmad Bahar and Dony Adriansyah bin Nazaruddin: Infiltration rate assessment of some major soil types in Kota Bharu, Kelantan, Malaysia
1740-1800	**C02** Ida Ayu Purnamasari*, Hilfan Khairy, Abdelazis Lotfy Abdeldayem: Rock Physics Modeling For Lithology Prediction Using Hertz-Mindlin Theory	**D02** Muhammad Murtaza, Abdul Hadi Abdul Rahman & Chow Weng Sum: The marginal marine successions of the Balingian Formation (Upper Miocene), Mukah Area, Sarawak: Facies, Stratigraphic Characteristics and Paleoenvironmental Interpretation
1800-1820	**C03** Ali Rahman, Z., Hasan Ashari, N. H., Abd Rahim, S., Lihan, T. & Idris, W. M. R.: Cirian Geoteknik Tanah Baki Terawat Abu Sekam Padi (ASP)	**D03** Rahman Yaccup and Peter Brabham: The use of the Ground Electromagnetic Survey (GEM-2) technique to map the contaminant dispersion in the subsurface at Barry Docks, Wales, UK
1820-2030	**Rest and Leisure**	
2030-2230	**Conference Dinner Hosted by YAB MB Perak (Sposored by the State Government of Perak)**	
DAY TWO SUNDAY 9 JUNE 2013		
0830-1030	**Poster Session I (P01-P22)**	**Poster Session II (P23-P45)**
1030-1050	**Keynote II** **Prof. Dr. M. Pubellier**, Dean, Geoscience & Petroleum Engineering Faculty, UTP: Re-exploring the formation processes of SE Asian Basins, from rifting to mountain belts	
1050-1120	**Tea break**	
	TECHNICAL SESSION A3	**TECHNICAL SESSION B3**
1120-1140	**A16** Choong Chee Meng, Manuel Pubellier, Chow Weng Sum, Abdelaziz Lotfy Abdelaziz Abdeldayem: Deformation Styles and Structural History of the Paleozoic Limestone: Kinta Valley, Perak, Malaysia	**B16** Juna Azleen Abdul Ghani, Syed Fuad Saiyid Hashim: The importance of K and β values for Scaled Distance technique for prediction of ground vibrations level induced during granite quarry blasting for Peninsular Malaysia

1140-1200	**A17** Ahmad Faiz Salmanfarsi, Mustaffa Kamal Shuib: Kinematic study of the Bok Bak Fault at Bina Quarry, Bukit Perak, Kedah	**B17** Tan Boon Kong: Engineering Geology of the Ipoh-Simpang Pulai-Gopeng Segments of the North-South Highway, Peninsular Malaysia
1200-1220	**A18** Tang Hung Yung & Zaiton Harun: Perbandingan Lineamen Foto Udara dengan Surihan Retakan dalam Formasi Setul di Kuari Kang Giap, Perlis	**B18** Hareyani Zabidi, Abdul Ghani Mohd Rafek & Kamar Shah Ariffin: Evaluating ground conditions ahead of a tunnel face using probe drilling data at NATM-1, Karak, Malaysia
1220-1240	**A19** Mustaffa Kamal Shuib: Paleoearthquakes and active faulting in Cameron Highlands	**B19** Kamar Shah Ariffin and Hareyani Mohd Zabidi: Preventive evaluation of the limestone quarry face safety at the Khantan Cement Work, Chemor, Perak
1240-1300	**A20** Mohd Razlan Abd Rahman, Askury Abd Kadir: Fractured Granite & Meta-sediment at Pulau Redang: an outcrop analogue to The Fractured Basement in Anding Field and its Relation to Fractured Reservoir Modelling	**B20** Kennedy Hj. Mohd Imran Aralas and Ramli Mohd Osman: Discontinuity Survey of Bukit Memaloh, Kanowit, Sibu Division, Sarawak
1300-1400	**LUNCH AND DZUHOR PRAYER**	
	TECHNICAL SESSION A4	**TECHNICAL SESSION B4**
1400-1420	**A21** Gan Wei Di: Integrated 3d reservoir characterization through simultaneous inversion: qualitative and quantitative approaches	**B21** Azman A Ghani, C.-H Lo and S.-L Chung Ar Ar Geochronology of Volcanic Rocks from Eastern Part of Peninsular Malaysia
1420-1440	**A22** Mohammed I. I. Abu Shariah and Baleid Ali Hatem: Subsurface Fracture Zone and Hot Springs Detection in Hardrock Aquifer Using Electrical Resistivity Tomography Techniques at Hulu Langat, Selangor	**B22** Hamzah Hussn, Tajul Anuar Jamaluddin & Muhammad Fadz Potensi Aliran Puing di Bukit Panji, Kuala Terengganu: Penilaian Bahaya dan Langkah Mitigasi Yang Sesuai_li bin Deraman:

1440-1500	**A23** Yuniarti Ulfa, Mardiana Samsuardi, Nur Fathin Mohd: The use of Ground Penetrating Radar to Detects Stratigraphy and Structure in a rock slope	**B23** Abdul Ghani Rafek & Amirruddin Rosni: Influence Of Water On Buckling Failure Of Thinly Stratified Phyllite Rock Mass At Kampung Jeram Bungor, Kuala Lipis, Pahang Darul Makmur
1500-1520	**A24** Andy A. Bery, Rosli Saad and Mark Jinmin: Seismic Refraction Tomography Application for Environmental Study	**B24** Frederick Francis Tating, Robert Hack, Victor Jetten: Quantification of rock mass deterioration process for cut slope design in humid tropical areas – case study Northern Kota Kinabalu, Sabah Malaysia
1520-1540	**A25** Soni Satiawan, Hilfan Khairy, Zuhar Zahir bin Tn. Harith: Amplitude versus Offset and Azimuth (AVOZ) Study for Fractured Characterization: a Basis Tool for Velocity versus Offset (VVO) Analysis	**B25** Mohd Khairul Nizar Shamsuddin, Hafizan Juahir, Wan Nor Azmin Sulaiman, Azrul Normi, Saim Suratman: Determining the Interaction between Geostatistical and Geochemical Analysis of Rivers, Lakes and Groundwater at a Small Bank Infiltration Study Site in Jenderam Hilir, Selangor
1540-1600	**A26** Abdul Halim Abdul Latiff, Deva Prasad Ghosh, Zuhar Zahir Tuan Harith: Seismic Illumination Analysis of Different Shallow Gas Cloud Velocities by Focal Beam Method	**B26** Kamarudin Samuding, Mohd Tadza Abdul Rahman and Roslanzairi Mostapa Application of Environmental Isotope Techniques in Groundwater Study
1600-1630	**Closing Ceremony**	
1630-1700	**Tea break**	

POSTERS

P01	Achmad Rodhi	Indikator-indikator struktur di dalam zon ricih plastik di Jalur Timur Semenanjung Malaysia
P02	Gan Wei Di	Sand fraction and pore fraction inversion through acoustic impedance data: tools for qualitative thin-bed reservoir characterization and net pay volumetric estimation.
P03	Rosmalia Dita Nugraheni, Chow Weng Sum, Abdul Hadi A. Rahman	Burial Diagenesis of Coal-Bearing Mudrock and Its Relationship to The Evolution of Pore Types and Abundance
P04	Nur Susila Md. Saaid & Basir Jasin, Md. Saaid Nur Susila	Occurrence of pyroclastic rock in the Kubang Pasu Formation, Northwest Peninsular Malaysia
P05	Rezal Rahmat & Shariff A.K. Omang	Jujukan Batuan Kompleks Ofiolit Marudu Bay (KOTM) : Cerapan Lapangan & Petrografi
P06	Muhamad Nur Hafiz Sahar & Azimah Hussinsir Hafiz Sahar	Cirian fiziko-kimia bahan geologi semulajadi dan sintetik yg digunakan sebagai bahan pozolan dalam pembuatan mortar
P07	Hazerina Pungut, Junaidi Asis, Muhammad Abdullah, Haezerina Pungut	Heavy Metals Distribution of Nukakatan Valley River Sediments, Tambunan, Sabah
P08	Kamar Shah Ariffin, Hareyani Mohd Zabidi, KK Cheang	Gold mineralization prospect within upper Sg. Galas-Tan See vicinity, Ulu Galas, Kelantan
P09	Nur Hannani S. Ali, Dony Adriansyah Nazaruddin, Elvaene James, Mohammad Muqtada Ali Khan, Hafzan Eva Mansor	Geoheritage And Geotourism Potential Of Gunung Reng And Its Surroundings, Jeli District, Kelantan

P10	Nurul Atiqah Ahmad Zahudi, Dony Adriansyah Nazaruddin, Mohammad Muqtada Ali Khan, Elvaene James, Hafzan Eva Mansor	Geotourism Potential Of Jeli Hot Spring, Kelantan
P11	Atiqah Abdul Samad,Che Aziz Ali dan Kamal Roslan Mohamed Atiqah abdul samad	Sebaran Dan Mineralogi Sedimen Delta Sungai Pahang.
P12	Muhammad Afiq B. Md Ali, Meor Hakif bin Amir Hassan and Azhar Hussin Muhammad Afiq Ali	Reef Facies Distribution, Destruction and Rejuvenation: Salang and Soyak Island, Tioman Island, Pahang
P13	Azman A Ghani, C.-H Lo & S.-L Chung	Basaltic dykes of the Eastern Belt of Peninsular Malaysia: Geochemistry, age and tectonic implication
P14	Norbert Simon, Mairead de Roiste, Michael Crozier, Abdul Ghani Rafek, Rodeano Roslee, Norbert Simon	Using Stepwise Logistic Regression To Select Important Landslide Causal Factors In Landslide Susceptibility Mapping
P15	Mohammed Ismail Abu-Shariah and Ahmed Adam Wady.	Detection Hydrosphere Contamination in Hard-Rock by Using Electrical Resistivity Tomography Technique at Hulu Langat Basin, Selangor, Malaysia
P16	Mohammed Ismael Abu-Shariah and Sawan Kamel Shariah	Detection The Groundwater Flow Using Electrical Resistivity Tomography Technique
P17	Joel Ben-Awuah and Eswaran Padmanabhan, Joel BEN-AWUAH	Extraction Potential Of Different Solvents In The Study Of Organic Matter Concentrations In The Environment
P18	Nurainisyamimi Mohd Bistamim, Sahibin Abd Rahim, Wan Mohd Razi Idris, Zulfahmi Ali Rahman & Tukimat Lihan Sahibin Abd Rahim	Komposisi Logam Berat Di Dalam Beras Dan Dalam Tanah Sawah Tercemar Tanah Ultrabes Di Ranau, Sabah, Malaysia
P19	Tanot unjah, Kadderi Md Desa & Ibrahim komoo, Tanot Unjah	Kepelbagaian Landskap Granit Langkawi

P20	Romziah Azit, Mohd Ashraf Mohamad Ismail, Romziah Amir	Analysis Of Rock Burst Potential In Critical Section Of Pahang-Selangor Raw Water Transfer Tunnel Project
P21	Mohd Amir Asyraf , Nur Atikah, Umar Hamzah, Wan Zuhairi Wan Yaacob & Abdul Rahim Samsudin, Amir Asyraf	Pengukuran Pola Migrasi Bahan Cemar LNAPL Menggunakan Teknik Keberintangan Elektrik Dua Matra Dalam Makmal
P22	Elvaene James, Hamzah Mohamad, Shariff A.K. Omang, Mohd Rozi Umor	Penentuan Usia Mutlak Batuan Granit Hornblend Gunung Kinabalu Menggunakan Kaedah U – Pb Zirkon.
P23	Elvaene James, Hamzah Mohamad, Shariff A.K. Omang, Mohd Rozi Umor	Ciri-Ciri Batuan Igneus Jenis Intrusif Di Bahagian Barat Daya, Gunung Kinabalu: Kajian Petrografi Dan Geokimia.
P24	Pongga Wardaya	To see the deep inside digital rocks: assessing the micro scale pore space heterogeneity on carbonate and Berea sandstone
P25	Zainey Konjing, Abdul Hadi Abdul Rahman and Ahmad Munif Koraini, Zainey James	Facies And Stratigraphic Successions Of Marginal Marine To Shallow Marine Deposits Of The (Upper Oligocene-Middle Miocene) Nyalau Formation, South Bintulu, Sarawak, Malaysia
P26	Babangida S.Y.D, Wanhasia Abdullah, Abubakar M.B, Babangida Moh'd S.Y.D	Biomarker characteristics of heat affected sediments from the Lower Bima Member (Lower Cretaceous) in the Yola Sub – basin, Northern Benue Trough Nigeria.
P27	Muhammad Ashahadi Dzulkafli, Basir Jasin & Mohd Shafeea Leman	Zon Himpunan Radiolaria Pseudoalbaillella Globosa (Roadian, Awal Perm Tengah) Dari Sekitar Pos Blau, Ulu Kelantan
P28	Mahmoud Khaki, Ismail Yusoff and Nur Islami, Mahmoud Khaki	Electrical Resistivity Imaging to detection of bedrock in Langat Basin, Malaysia

P29	Naufal Bakhudin, Frank Pittard, T. Matsumoto, Al-Adzam Shah, Lee Khye Keat Naufal Bakhudin	Geophysical Application for Predicting Geological Condition and the Correlation of Evaluated Rock Mass Properties with Rock Mass Classification (PSRWT Tunnel, Malaysia)
P30	Hardianshah Saleh & Abdul Rahim Samsudin, Hardianshah Saleh	Potensi Aquifer Dalam Formasi Ganduman Di Semenanjung Dent, Lahad Datu, Sabah Dengan Menggunakan Kaedah Keberintangan.
P31	Dayang Nor Asyilla Abang Abdullah & Sanudin Tahir Dayang Nor Asyilla Abang Abdullah	Lithofacies Of The Paleogene And Neogene Formations In Klias Peninsula, Sabah
P32	Muhammad Azfar Mohamed, Abdelaziz L. Abdeldayem & Abd. Hadi A. Rahman, Azfar Mohamed	Facies and Sedimentary Succession of the West Crocker Formation (Oligocene-Early Miocene), Kota Kinabalu, Sabah
P33	Noorain Mohd Isa and Ahmad Zaharin Aris, Noorain Mohd Isa	Geostatistical analysis using principal component analysis in observing the groundwater quality changes in Kapas Island
P34	Numair Ahmed Siddiqui, Abdul Hadi bin Abd Rahman, Manoj Joseph Mathew, Numair Siddiqui	Facies characteristics and reservoir sandstone quality of shallow marine sandstones, Nyalau Formation, Sarawak, East Malaysia
P35	Shama Mohammed Balulla and E. Padmanabhan, Shama Balulla	Variation Of Hydrocarbon Distribution In The Devonian Marcellus Shales
P36	Nuur Hani Bte Mohammed Honey	Characterization Physico-Chemical Of Schist And Grabite And The Effect Addition Of Bentonit As A Liner Material
P37	Norbert Simon, Mairead de Roiste, Michael Crozier, Abdul Ghani Rafek, Norbert Simon	Using Stepwise Logistic Regression To Select Important Landslide Causal Factors In Landslide Susceptibility Mapping

P38	L. X. Quek, A. A. Ghani, Long Xiang Quek	Pyroxene-bearing microgranular enclaves from Taiping pluton amphibole-bearing granite, Main Range Granite Province, Peninsular Malaysia
P39	Sivappriya Bhubalan, Tanaskumar Kanesan, E. Padmanabhan	Dissolution Kinetics Of A Carbonate Rock From The Subis Limestone, Sarawak.
P40	Goh T. L., Ghani Rafek, A. & Hariri, A. M.	Perbandingan Perkadaran Jasad Cerun dengan Analisis Kegagalan Cerun & Ujian Kemiringan
P41	Kyaw Kyaw Nyein, Azaman A. Ghani, Wan Fuad Wan Hassan & Aye Ko Aung Kyaw Nyein	Geochemical Characters of the Langkawi Granite
P42	Suraya Hilmi Hazim & Mohd Rozi Umor	Pencirian Granit Kuantan, Pahang Secara Lapangan, Petrografi dan Geokimia
P43	Nazatul Athirah bt Abdul Khalil & Mohd Rozi Umor	Kajian Batuan Igneus di Air Terjun Berkelah, Gambang, Kuantan, Pahang dari Aspek Pemetaan Terperinci, Petrografi dan Geokimia.
P44	Sofia Ehsan, Mohd Shafeea Leman, Rawshan Ara Begum & Ibrahim Komoo	Geotouristic Attitude Of The Tourists Towards Scientific Value Of Geological Heritage: The Case Of Langkawi Global Geopark
P45	Muhd Nur Ismail Abdul Rahman & Sanudin Hj. Tahir	Kajian Fasies Formasi Crocker Dan Formasi Temburong, Tenom Dan Pedalaman Beaufort
P46	Muhammad b Abdullah & Sanudin Tahir	Analisis Fosil Surih Formasi Crocker dan Formasi Meligan di Sipitang, Sabah
P47	Muhammad b Abdullah & Sanudin Tahir	Analisis Sekitaran Kuno Formasi Meligan Berdasarkan Struktur Endapan di Sipitang, Sabah
P48	Ismail Abd Rahim	Anggaran sokongan berdasarkan system Pengelasan Jasad Batuan: Kajian kes di terowong keretapi Tenom, Sabah

P49	Azman A. Ghani, Michael Searle, Laurence Robb and Sun-Lin Chung	Transitional I-S type Characteristics in the Main Range Granite of Peninsular Malaysia

NOTES

KEYNOTE 1

PROPOSED KINTA VALLEY GEOPARK – UTILIZING GEOLOGICAL RESOURCES FOR ENVIRONMENTAL QUALITY IMPROVEMENT AND SOCIETY WELL BEING ENHANCEMENT

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Introduction

Located in the heart of Perak State, proposed Kinta Valley Geopark covers an area of about 2000 Square kilometres comprising of Ipoh City, Batu Gajah and Kampar Districts (Figure 1). The valley which runs in north-south direction in between the Main Range in the east and the Kledang Range in the west is well known for its many historical towns that are closely associated with tin mines. Remains of alluvial tin mining activities mostly in forms of mine ponds are found scattered all over the Kinta alluvial plain. Today, a combination between mining remains, rehabilitated ex-mining lands, urbanize areas and the naturally preserved karstic landforms had created a rare scenic view, not seen anywhere in this region. The Kinta Valley limestone karst can be devided into cockpit karst and isolated tower karst containing many caves, valleys and natural monuments of high heritage values not only from geological point of view (geosites in Figure 1), but also from archaeological, historical, cultural and biological perspectives (Islahuda Hani Sahak et al, 2009; Ros Fatihah Muhammad & Ibrahim Komoo 2003). Apart from features related to mining and limestone karst the proposed Kinta Valley Geoparks also features many natural landscapes related to mountain peaks and those related to running water along the western flank of the Main Range and the eastern flank of Kledang Range (Islahuda Hani Sahak et al, 2009).

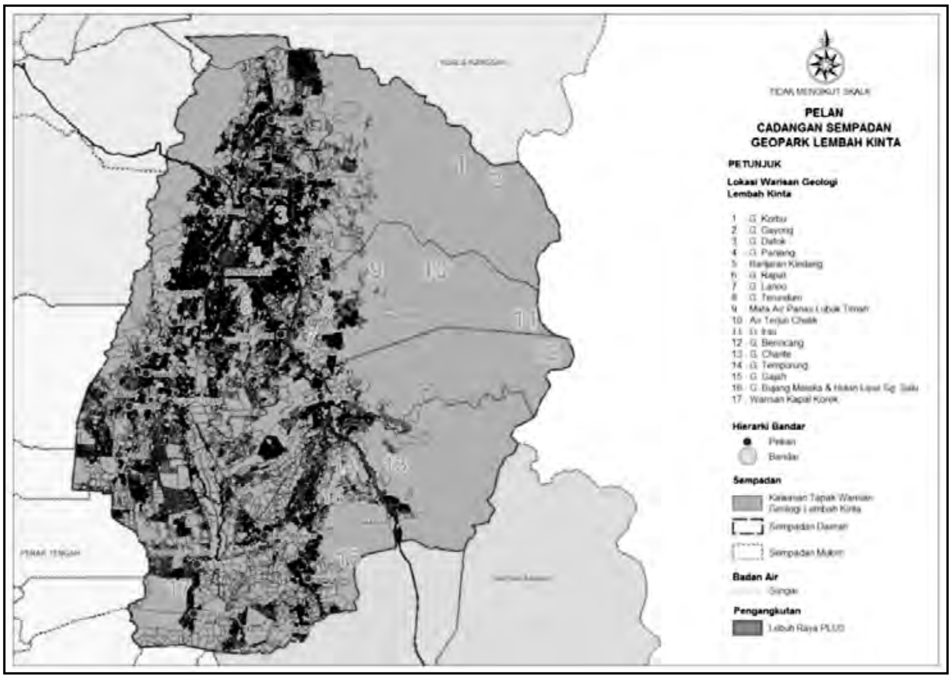

Figure 1. Map showing boundary of the proposed Kinta Valley Geopark, district boundaries and locations of some of the geoheritage sites.

Perhaps the biggest asset for the proposed Kinta Valley Geopark is the strong support from its community. The community of Kinta Valley has shown a high degree of awareness about geological and landscape heritage, geological hazards and the need to protect the natural environment. This is probably due to negative impacts resulted from long mining episodes and the recent quarrying activities on some limestone hills within the valley and due to the long historical memory of the mining industry in the valley. Frequent geological hazards such as lands cave in and rock falls are also important factors in raising public awareness in Kinta Valley. At this stage, several establishment related to geoheritage conservation and education have already been put in place within the proposed Kinta Valley Geopark and activities in enhancing public awareness have also been conducted by various stakeholders. This is very much in line with the geopark concept. Perhaps with little support from the Perak State Government, Kinta Valley could become a very good example of a bottom-up geopark initiative, hence will portray a very good image not only for Perak State Government, but also for the country.

General Geology of Kinta Valley

In general, the valley floor of Kinta is made up of Old Alluvium or the Simpang Formation overlain by Younger Alluvium or the Beruas Formation (Raj et al 2009). It is within this thick alluvium that rich sedimentary tin ores were concentrated and were mined. Older metamorphic rocks are exposed as the bedrock within this valley or stood up as isolated hills above the valley floor, while intrusive rocks form mountains on both eastern and western slopes of the basin. The geology of Kinta Valley and its surrounding area was well-described and illustrated by Ingham & Bradford (1960, see Figure 2). It started during the Silurian time with the deposition of the clastic sediment in a relatively deep marine setting followed by the deposition of limestone following the progressive shallowing of the sea floor. This is evidence by the presence of rich shallow marine benthic organisms within the Kinta Limestone from Devonian to Permian age. Both of these clastic and calcareous Palaeozoic rock formations were intruded by acidic igneous rocks during the Late Triassic-Early Jurassic time. This intrusion formed the Main Range, Kledang Range and Bujang Melaka Granites which comprised mainly of coarse grained porphyritic biotite granites. These are S-type granites formed due to the collision between the Sibumasu and the East Malaya Block. This intrusion was also responsible in transforming the older sedimentary rocks into marble and schist and the deposition of rich tin and iron ores during its late phase emplacement.

Following the collision of Sibumasu-East Malaya, Peninsular Malaysia was uplifted to form a new terrestrial environment and to allow exogenic processes to take place. The Post Triassic exogenic geological processes have eroded weaker rocks and formed the Kinta Valley prior to the deposition of the Simpang Formation and rich plaser tin deposits and have etched the limestone to form several cock-pit and isolated tower karst with many small and large cave.

Geoheritage Conservation

Kinta valley possesses many geological and landscape features with heritage value of national and regional significant. Among them are cave and cave features at Gua Tempurung, Gua Kandu and Gunung Rapat, pencil rock monuments and hotsprings at Gunung Dato, vertebrate fossil at Gua Naga Mas, Tanjung Tualang Dredge Museum, ancient cave painting at Gunung Panjang, waterfalls and rapids at Sungai Kampar, Lubuk Timah, Sungai Chellik, Sungai Salu, Batu Berangkai, Ulu Kinta and Ulu Chepor, landscape at Gunung Lang, Gunung Dato, Gunung Korbu and Kledang-Saiong (see Figure 1). Beside their geological significance these geological and landscape heritage sites are also serving as ecosystems for various flora and fauna as well as hosting some important archaeological, historical and cultural artefacts and remains. Conserving some of these geological and landscape features as protected geoheritage sites and establishing others as nature geotourism sites will help the proposed Kinta Valley Geopark to protect its natural environment from further damages due to any large scale unsustainable utilization of its natural resources.

Activities pertaining to conservation of these heritage sites and promotion of geotourism and geopark products would create ample innovative career opportunities for local community. Among highly potential geopark products are innovative products based on the Tambun pomelos, Gopeng agarwoods, Buntong nuts, Bukit Merah shoes, Ipoh Old Town White Coffee, Kinta Valley ducks, souvenirs from tin, local culinary, and many others. Kinta Valley Geopark will also be an excellent vehicle to promote historical buildings such as the Kellie's Castle, Istana Raja Billah, Kataketsu Museum, Malim Nawar Japanese Incinerator, Ipoh Railway Station, Ipoh Old Town and native settlements at Ulu Kinta and Kampar as well as nature conservation areas such as Kinta Nature Park, Bukit Kinding Stud Farm, Kledang-Saiong and Ulu Kinta Recreation Forests.

For public awareness purposes, the proposed Kinta Valley Geopark benefits a lot from the establishment of Geological Museum of the Mineral and Geoscience Department, Tanjung Tualang Dredge Museum, Perak State Museum, two privately owned Kinta Tin Mining (Gravel Pump) and Gopeng Mining Museums, mini museum at the Ipoh Sunway City and some well organized guided trips and activities conducted by the Gua Tempurong and Gua Kandu authorities.

Closing Remarks

Listed above are among significant geological and landscape heritage sites, essential geopark components and actively supporting stakeholders within the proposed Kinta Valley geopark territory. With these readily available components, perhaps by incorporating the various keen stakeholders and with a small budget for establishing the management unit and necessary infrastructures Kinta Valley could become Malaysia's first geopark established through a "bottom-up" initiative. Through geopark development concept we could ensure that geological resources within Kinta Valley will be utilized sustainably for improving environmental quality and enhancing society well being.

Acknowledgement

The author would like to thanks the Department of Mineral and Geoscience (Perak State Branch), Perak State Department of Urban and Rural Planning, Ipoh City Council and District Offices of Batu Gajah and Kampar for their supports during the preliminary initiatives in developing the Kinta Valley Geopark. The author is also supported by the Institute for Environment and Development (Lestari) through special HiCoE Research Grant Project No XX-08-2012.

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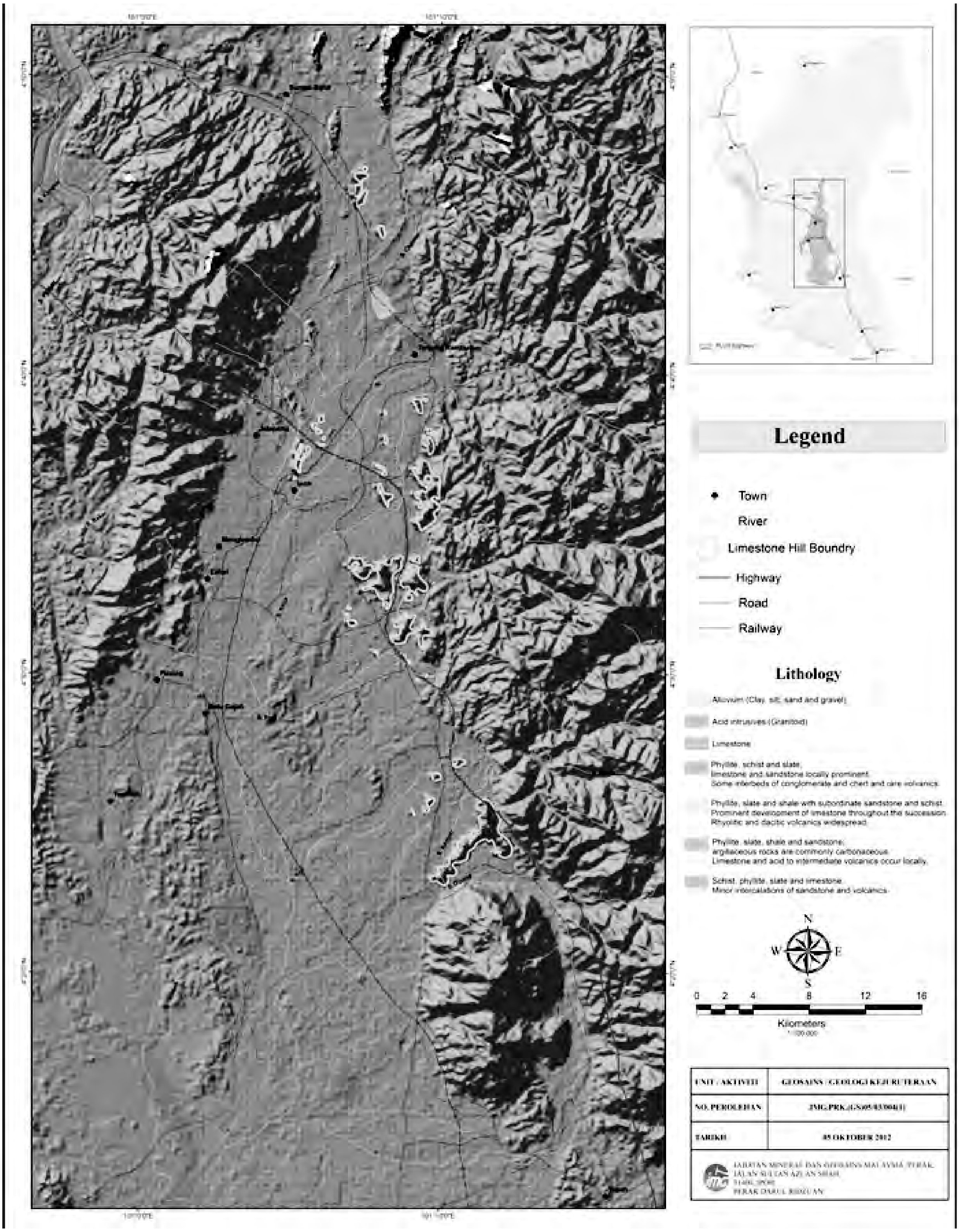

Figure 2. General geology of Kinta Valley and surrounding areas.

KEYNOTE 2

RE-EXPLORING THE FORMATION PROCESSES OF SE ASIAN BASINS, FROM RIFTING TO MOUNTAIN BELTS

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Basins were explained in the early days as a result of asthenospheric convexion processes. Later, pure rigid plates or continental block motions were invoked to explain some of the basins of SE Asia. The advances in Spatial Geodesy showed the non-rigidity of the plates and boundary conditions became a hot subject of discussions. In SE Asia, recent studies on the basin formation seems to be largely controlled by low angle crustal faults during early or late stages of the rifting, and also seems to be sensitive to the modification of the geologic and geodynamic framework near the subduction zone. In the recent years, deformation linked to mantle or lower crust flow has been evidenced and raises question about the importance of the deep layers in the processes of rifting. These questions are more difficult to answer in the mountain ranges where basins have suffered severe deformation. This paper illustrates the basins opening and closure in SE Asia where their young age allows combining geophysical and geological studies.

Basin evolution from rifting to shortening and accretion is often obscured in mountain belts. However, it is documented with great detail in SE Asiabecause of the relatively young age (Tertiary). There. The global life of the basins can be viewed as part of a ‘‘collision factory’’(Pubellier and Meresse, 2012) which integrates both the opening of basins by rifting and sea floor spreading within the upper plate, and the shortening. The two are subduction-controlled.

The structural architecture of the SE Asian continental margin is a result of extension along the southern margin of Asia since the Cretaceous and includes a succession of marginal basins that are separated by continental fragments (Fig. 1). From north to south and, these basins and continental fragments are the South China Sea and the continental Palawan Block, the extended composite continental and oceanic crust of the NW Sulu Sea separated by the Cagayan volcanic arc; the Sulu Sea back-arc basin; the western edge of Mindanao and the Sulu arc, characterized by continental basement; the Celebes basin floored by oceanic crust; and, the Northern Arm of Sulawesi. All the basins have opened successively during the Tertiary in a diachronous manner (Pubellier, 2004) in a fan-shaped pattern on the eastern half of the Sunda Plate. The first basin that opened was the Proto South China Sea (Cretaceous/Paleogene). Other smaller basins did not reach the oceanic stage like the Beibu basin and the Palawan Trough which opened on both side of the South China Sea during Paleogene, of the Malay and Thailand basins (Fig. 2). The Celebes Sea opened during the Middle Eocene (47 Ma, Silver et al., 1989), followed by the South China Sea during the Oligocene (33–15 Ma, Taylor and Hayes, 1983; Briais et al., 1993) and the Sulu Sea during late Early Miocene (18 Ma). Further south, the North Banda Basin opened in the Late Miocene (Hinshberger et al., 2001) and the Damar (South Banda Basin) in the Pliocene (6.5–3.5 My).

In SE Asia, the processes of basin closure started in the Early Miocene when subduction of the Indian Ocean began to be perturbed by Australian continental fragments. The early stagesof the compression and shortening of basins are illustrated in the eastern Sunda arc where the subduction of the Sunda Trench is blocked in Sumbaand Timor region, and flipped into the Flores Trough in less than 2 My. This represents a typical example of subduction reversal which gives insight of how subduction jumps occur. The incipient shortening is at presenttaking place in the Pliocene Damar

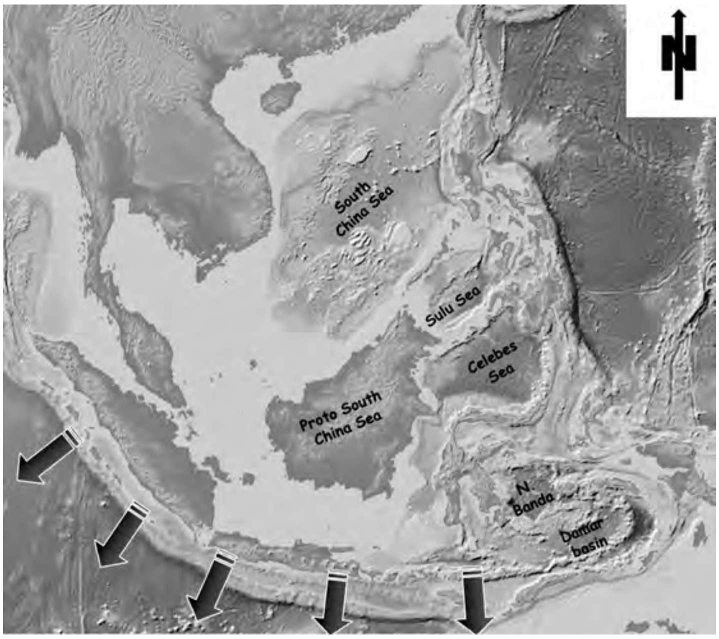
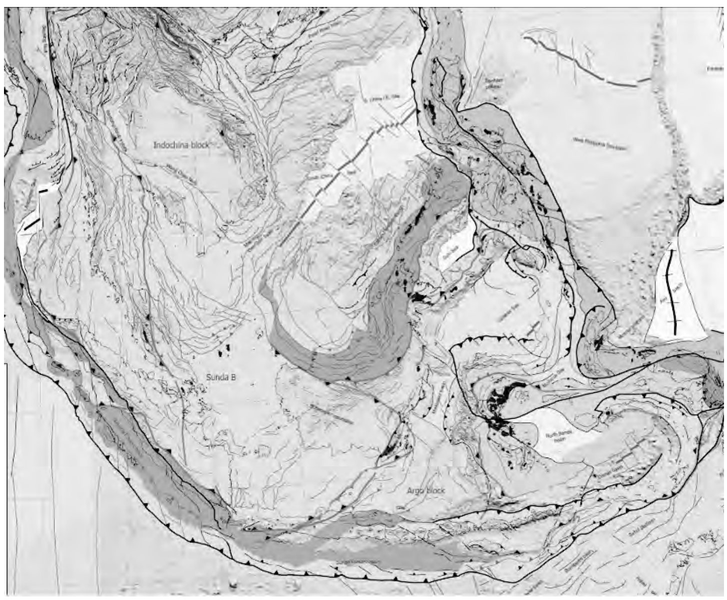


Figure 1 : Main basins underlain by oceanic crust in the Sunda Plate; and forces acting at the Southern boundary along the Sunda subduction zone (red arrows). Other basins.

Figure 2 : Main Tertiary faults (red), and accretionary complexes/Fold-and-Thrust Belts (orange). Active accretionary complexes are in yellow. Brown color represents the Melanesian and Philippine arc terranes. Grey color is for the thicker continental crust or Plateau/intra-oceanic ridges crust.



basins. The Celebes Sea represents another stage, where half of the basin has disappeared. The next evolutionary stage is the completeconsumption of the marginal basin where both margins collide and the accretionary wedge is thrust overthe margin. This is observed in NW Sabah, Brunei, Sarawak and Palawan. Each of these stages is responsible for a singleshort-lived tectonic event. Tectonic events may be integrated within an orogen which may last for over10 My. These events predate the arrival of the conjugate margin of the large ocean, which marks thebeginning of continental subduction as observed in the Himalaya–Tibet region.Because the basins vary in size along strike, the closure is generally diachronous through time as illustrated in the Philippines.

We observe that the ophiolite obducted in such context is generally of back-arc origin (upper plate) rather than the relict of the vanishing large ocean which is rarely preserved. In the Philippines, once the crust is accreted the subduction zone progressively moved southward until its present position. In this process, the lithospheric mantle and the lower crust play an important role in terms of location of detachments and delamination. The upper crust reacts in a brittle manner with compressional geological features.All the models somehow invoke gravity forces at different scales.

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PAPER A01

POTENTIAL IMPACT OF POLLUTION BY OIL SPILLS ON COASTAL FACIES IN PULAU PANGKOR, MALAYSIA

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This research, conducted at Pulau Pangkor aimed at identifying the impact of potential oil spills by predicting the route of oil spills, the transport of oil along the coast and studying oil penetration depth and speed in the different types of beach sediments at Pulau Pangkor (pulau = island) in Western Malaysia. The dominant wind direction in the area of Pulau Pangkor is from northwest. On each beach, the grain size of beach sands tends to be coarser to the north and finer to the south, indicating a transport of sediments from north to south. Beach sand composition varies from the northern to the southern beaches, with a predominance of carbonate particles in the north, a mixture of carbonate particles, feldspar, quartz and traces of mica in the central coastline and mainly quartz sediments on the southern beaches of Pulau Pangkor. The different sand composition on the beaches suggests that there is very little sediment transport from one beach to the other. The implications of these findings are that, should an oil spill occur and reach the beaches of Pulau Pangkor, the oil would tend to settle on the beaches and would not be removed or transported away by the slow, ineffective longshore currents. Oil would have to be mechanically removed to clean up the beaches.

Keywords: oil spills, coastal facies, longshore current, Pulau Pangkor.

SOIL EROSION POTENTIAL FROM SUNGAI PAYA MERAPUH SUB-CATCHMENT TO LAKE CHINI, LAKE CHINI, PAHANG

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The deterioration of water and soil quality at Tasik Chini was reported due to the active development of eco-tourism and agriculture. This study was aimed to assess the amount of potential soil erosion from Sg. Paya Merapuh sub-catchment, Tasik Chini. Field sampling and measuring was carried out twice once during August which represents dry season and January which represents the rainy season. Determination of physical characteristics of soil samples involved particle size distribution, soil organic matter content, soil structure and hydraulic conductivity. Soil loss potential is calculated based on the Revise Universal Soil Loss Equation (RUSLE) model. Total suspended solid in the stream was also determined. The soil textures at the study area were loam, clay loam, silty clay loam, clay, and silty clay. The organic matter content is at the range of 2.64-7.66 %. The hydraulic conductivity rates are at the range of 0.31-11.37 $cmhr^{-1}$. Structures are mainly angular blocky. Rain erosivity values are at the 16587.77 Mg mm ha^{-1} hr^{-1}, whereas while soil erodibility value is at the range of 0.0233 to 0.0347 (ton/ha)(ha.hr/MJ.mm). The slope length and steepness factor (LS) are at the range of 0.56-7.04. The rate of potential soil loss was determined to be very low to moderate at the range of 0.13-68.57 ton/ha·yr. The average of potential soil loss for Sg Paya Merapuh sub-catchmaent is low with value of 16.56 ton /ha.yr.

Keywords: RUSLE, Soil loss, soil erodibility, Tasik Chini, texture

PAPER A03

ENVIRONMENTAL IMPACTS OF BATIK INDUSTRY EFFLUENTS IN KOTA BHARU, KELANTAN

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Kelantan is famous for its Malay culture, traditional arts and crafts as well as its firm Islam religion practice. Main economic activities for Kelantan are arts and craft oriented such as batik painting, songket weaving and other craft related activities. Recently, Batik has become the largest textile industry in Kelantan and has major contribution to the state's economic development. Batik industries also produce large amounts of waste effluents with high concentration of variety pollutants which required treatment before discharging into the environment. Groundwater is mainly used as potable water resource in North Kelantan; there is a need to study the impacts of the batik effluents to the environment especially to the groundwater. Sampling were carried out in Pantai Cahaya Bulan and Pintu Geng areas, where most of the batik establishments are located. The locations represent the area for the unconfined and confined aquifer respectively. Samples were analysed for 22 major and trace elements (Na, Mg, K, Ca, Al, Fe, Mn, Zn, Ni, Cd, Cr, As, Se, Pb, Cu, CO3, HCO3, Cl, PO4, SO4, F and Br). Physio-chemical parameters such as pH, Turbidity, Dissolved Oxygen, Specific Conductivity were measured in situ.

The batik effluents samples were found to contain higher concentration of Na and Al with significantly high pH, TDS, COD and Turbidity. Elevated level of TDS, Na, Mg, Ca, K, Cl, HCO3 and NO3was detected in the groundwater samples adjacent to the batik establishments compared to the background level. Results from the two locations shows that, the unconfined aquifer in Pantai Cahaya Bulan contained higher concentration of the elements compared with Pintu Geng area. Alternatively, the concentration of all the elements in groundwater except for Fe and Mn are well below the limit set for Malaysian drinking water standard MS 2010.

PENCIRIAN FIZIKO KIMIA AIR SALIRAN LOMBONG BERASID DI KAWASAN LOMBONG TERPILIH DI MALAYSIA
(PHYSICO-CHEMICAL WATER CHARACTERISTICS OF ACID MINE DRAINAGE IN SELECTED MINING AREAS IN MALAYSIA)

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Pengenalan

Mineral ferum dan sulfida, dalam bentuk FeS2 dalam batuan yang terdedah di permukaan akibat aktiviti perlombongan akan mengalami proses luluhawa dengan kehadiran air dan oksigen. Proses pengoksidaan yang berlaku ini menyumbang kepada pembentukan saliran lombong berasid (SLB) dengan penghasilan sulfat. SLB yang dicirikan oleh kehadiran kation asid, H+ dan SO42- dalam kepekatan tinggi. Air berasid ini mempunyai kepekatan logam berat yang tinggi. SLB yang terhasil akan dibawa oleh air larian hujan atau permukaan ke kawasan sungai atau tasik yang berdekatan, serta berlakunya proses larut resap ke dalam air bawah tanah menyebabkan kualiti air sungai, tasik dan air bawah tanah tersebut terjejas. SLB bukan sahaja menjejaskan nilai estetika sungai terutamanya dari segi perubahan warna air, malah ianya memberi impak negatif terhadap flora dan fauna, dengan pelbagai spesies tidak dapat bertahan dalam keadaan pH yang rendah dan kepekatan logam berat yang tinggi (Bulusu et al. 2005). Sesetengah logam seperti kromium, kobalt, ferum, selenium dan zink yang merupakan nutrien penting dalam kepekatan yang rendah namun pada kepekatan yang tinggi ianya bertukar menjadi toksik. Kepekatan logam berat yang tinggi menyebabkan kualiti air semakin merosot. Ini kerana logam-logam berat tidak mudah mengalami biodegradasi dan akan kekal dalam persekitaran sistem akuatik. Kajian ini dijalankan bagi mengenalpasti ciri-ciri SLB yang terbentuk di kawasan kajian. SLB dicirikan oleh pH rendah yang sangat berasid, kandungan jumlah pepejal terlarut yang tinggi, serta kandungan sulfat dan logam berat yang tinggi (Jopony 2009).

Metodologi

Tiga kawasan lombong yang terletak di bahagian pantai timur telah dipilih dalam kajian ini melibatkan 14 buah stesen iaitu 3 stesen di Lombong Barit, Tasik Chini, Pahang, 7 stesen di Sungai Lembing, Kuantan, Pahang dan 4 stesen di Lubuk Mandi, Marang, Terengganu. Analisis sampel air dijalankan secara in-situ dan ex-situ dengan merujuk kepada kaedah piawaian APHA (1999) dan HACH (2003). Analisis air di makmal dijalankan bagi menentukan kualiti air SLB di kawasan kajian. Beberapa parameter utama seperti kandungan sulfat, jumlah keasidan, dan juga kandungan logam berat turut dianalisis. Keseluruhan data kemudiannya dianalisis secara statistik melalui ujian korelasi bagi mengkaji kekuatan dan kepentingan hubungan antara setiap parameter air.

Hasil dan Perbincangan

Keputusan menunjukkan ketiga-tiga kawasan kajian mempunyai nilai pH yang rendah serta berasid iaitu kurang daripada 6 (Jadual 1). pH di semua kawasan kajian berada dalam julat antara 2.04-5.90. pH yang berasid ini disebabkan oleh kehadiran ion hidrogen dan ion sulfat yang dilepaskan semasa proses pengoksidaan mineral sulfida (Gurdeep Singh 1987). Kandungan bahan organik (ion logam, ion H+ dan ion SO42-) yang terlarut menyebabkan peningkatan dalam jumlah pepejal terlarut (TDS) (Akcil & Soldas 2005). Jumlah pepejal terlarut yang terkandung di semua kawasan kajian adalah dalam julat antara 54-1318 mg/L. Analisis kandungan sulfat menunjukkan julat antara 9-309 mg/L bagi ketiga-tiga kawasan kajian. Kepekatan sulfat yang terkandung dalam

SLB menunjukkan kehadiran mineral sulfida yang masih reaktif yang terdapat dalam batuan di sekitar kawasan kajian (Gurdeep Singh 1987). Jumlah keasidan merupakan suatu parameter yang mengukur kandungan ion logam terlarut dan ion hidrogen. Biasanya ion logam terlarut adalah komponen dominan yang diukur, khususnya Fe^{3+} dan Al^{3+} (Espana et al 2005). Analisis statistik menunjukkan hubungan korelasi yang positif antara jumlah keasidan dan kepekatan logam ferum ($r=0.727$, $p<0.01$). Jumlah keasidan di semua kawasan kajian mencatatkan julat antara 65.00-478.33 mg$CaCO_3$/L. Pada pH yang berasid, logam berat lebih mudah terlarut dalam air. Jadual 1 menunjukkan antara unsur-unsur logam yang dominan terdapat di kawasan kajian. Kepekatan logam berat mengikut susunan menurun di Sungai Lembing adalah Fe>Cu>Mn>Zn>Al, di Lombong Barit adalah Fe>Cu>Mn>Al>Zn dan di Lubuk Mandi adalah Al>Fe>Mn>Zn>Cu. Berdasarkan Piawaian Kualiti Air Kebangsaan Malaysia (NWQS), hasil kajian mendapati SLB di semua kawasan kajian berada dalam kualiti air kelas III dan IV, menunjukkan SLB merupakan air tercemar yang memerlukan rawatan intensif sebelum dilepas keluar. Kajian terdahulu yang dijalankan oleh Wan Zuhairi et al. (2009) di Sungai Lembing dan oleh Jopony (2009) di Lombong Tembaga Mamut, Sabah dijadikan sebagai rujukan bagi melihat ciri-ciri SLB yang terbentuk di kawasan perlombongan di Malaysia (Jadual 1).

Kesimpulan

Secara keseluruhannya, data menunjukkan nilai setiap parameter berada dalam spektrum kepekatan pencemar dalam sesebuah SLB yang terbentuk. Kajian ini juga mendapati pembentukan SLB yang serius berlaku di Sungai Lembing. Walaupun aktiviti perlombongan telah lama berhenti beroperasi, namun impaknya masih kekal sehingga hari ini. Longgokan bijih dan sisa buangan lombong yang terbiar di sekitar kawasan lombong masih mengandungi mineral sulfida yang bertindak balas dengan oksigen dan air menyebabkan berlakunya kejadian saliran lombong berasid.

Penghargaan

Projek penyelidikan ini dibiayai oleh geran UKM-GUP-2011-199. Penulis juga ingin merakamkan penghargaan kepada Universiti Kebangsaan Malaysia di atas kemudahan penyelidikan yang disediakan.

PALEO SEA LEVEL CHANGES AT MERANG, TERENGGANU

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Preliminary study on paleo sea level changes at Merang, Terengganu was initiated through the Inter-agency Technical Committee Meeting to study on the impact of sea level rise due to climate change, coordinated by the National Hydraulic Research Institute of Malaysia (NAHRIM). The study was carried out using minimal fund disbursed by NAHRIM to the related agencies. The site selection was based on the on-going studies undertaken by NAHRIM at Kuala Terengganu.

The study identified three sea level index points using the litho-, bio-, and chrono- stratigraphic approach. The sea level indicator is derived from the regressive contact of the intercalated peat and marine deposits. The indicative meaning of the sea level indicator is estimated based upon the microfossil relationship between fossil sea level indicators and the contemporary samples from the present-day ecological environments.

The sea level index points identified in the study are also compared to the corrected Holocene sea level data from peninsular Malaysia. The study presents an interesting preliminary new finding of the Little Ice Age sea level manifestation in Malaysia.

PAPER A06

EVIDENCE OF HOLOCENE AND HISTORICAL CHANGES OF SEA LEVEL IN THE LANGKAWI ISLANDS

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About eighty radiometrically dated biogenic and morphological indicators of sea level of the Langkawi Islands prove that since the maximum Mid-Holocene inundation, the paleo-sea surface descended step-wise thrice to reach its current position several hundred years ago. In presumably historical time some parts of the island group were raised between 0.5 and one metre. One of such events was related to the Aceh mega-earthquake of December 2004 which caused live bands of rock-clinging oysters and barnacles to shift 30 to 40 centimeters upward at Teluk Burau. GPS study also yields evidence of 9 to 11 millimeters co-seismic uplift of the northwestern sector of Peninsular Malaysia. The anomalously high sea stands in the early part of the Holocene and latest Pleistocene in northwestern Peninsular Malaysia remain the most outstanding issue in this investigation. Comparison with recently published sea-level curves of the Sunda Shelf strongly suggests that the geoid of the Strait of Malacca was 75 to 40 meters higher in the period from the LGM (21 ka to 19 ka) to the early half of the Holocene at 10 ka to 5 ka.

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.

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Introduction

Kinta Valley limestone karst host many caves bearing a number of important geological heritage sites. These geological heritage sites not only revealed geological resources and geological processes but also contained historical relics, cultural and archaeological artefacts (Islahuda Hani Sahak et al 2009). Among most famous archaeological remains in Kinta Valley is the Gua Tambun pre-historic rock painting that is located on the southwestern cliff of Gunung Panjang, a few kilometres east of the Ipoh City Centre (Figure 1). This painting has been considered as the most extensive and most important ancient rock arts ever recorded in Malaysia, hence it has drawn various topics of discussion among local as well as international archaeological communities. Most of the discussions are however, concentrated on the interpretations of painting images and their conservation issues (Adnan Jusoh 2007, Tan & Chia 2011), with very few reports on scientific aspects of the painting. All earlier reports have similar views that most of these images were painted

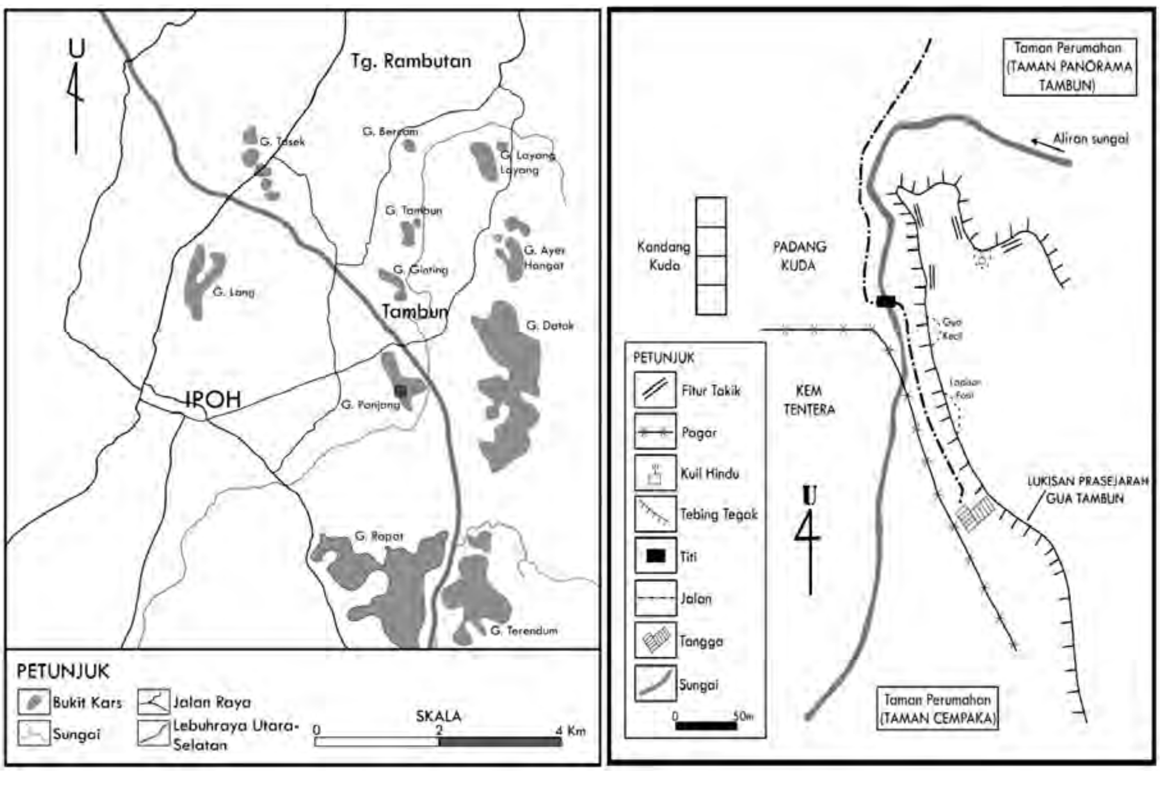

Figure 1. Location of Gunung Panjang (left) and the pre-historic paintings (right).

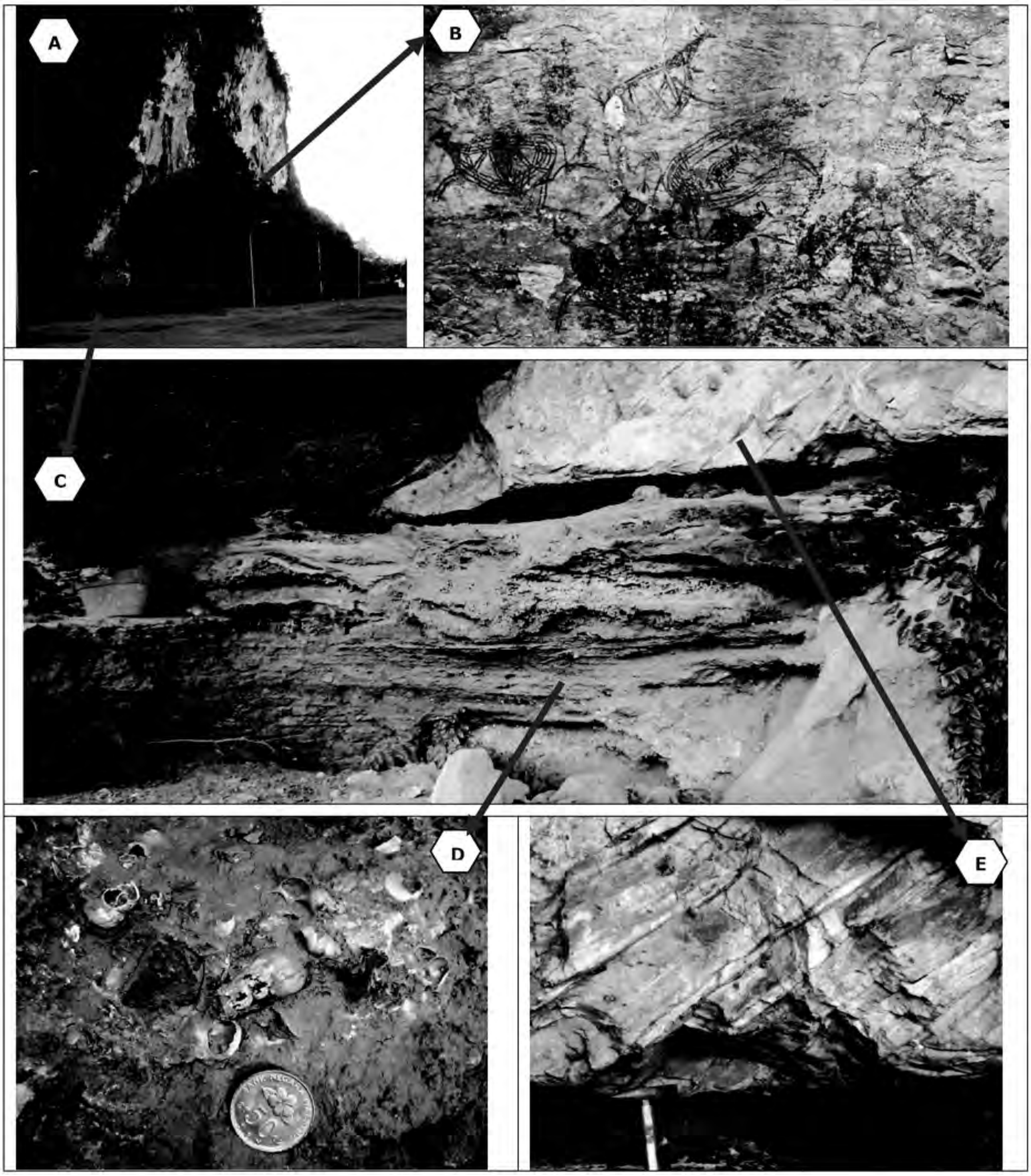

Figure 2. Photographs representing outcrops related to the Gua Tambun Pre-Historic paintings; A – Southwestern face of Gunung Panjang showing the position of the pre-historic kitchen wastes (C) in relation to the Gua Tambun painting wall (B); B – stained and weathered painted surface of Gua Tambun; C – outcrop of the travertine deposit showing thin compact travertine alternately interbedded with thicker porous calcareous sediments (shell beds); D – Porous bed showing abundant consumed shell remains (kitchen wastes) and several hematite fragments; and E – traces of bedding planes observed within the Kinta Limestone marbles.

by hematite. This paper will report about the discovery of kitchen wastes around the Gua Tambun and their bearing on the plausible age of the painting.

Geology of Gua Tambun

Gua Panjang is a large karstic hill, nearly 2 kilometres long and elongated roughly in northwest-southeast direction (Figure 1). It is mostly made up of light grey marble belonged to the Devonian-Permian Kinta limestone. Despite of its metamorphic nature, traces of sedimentary features such as bedding planes are still observable along the cliff (Figure 2E). The special site for the pre-historic paintings is located at latitude 04o 36’ 07.26” north and longitude 101o 08’ 50.18” east, along the southwestern cliff face. These ancient paintings spread along the cliff wall for 30 metres wide, from elevation of 2.5 to 15 metres above the narrow rather undulating platform representing the floor of the limestone shelter named as the Gua Tambun. The floor of this shelter is located about 40 metres above the green field belonged to the Malaysian Royal Air Force Headquarters (Figure 2A). A nearly vertical staircase is provided by the Museum Department to reach up to the limestone shelter or Gua Tambun.

The Paintings

The surface of the cliff that formed the screen for the painting has apparently been unevenly tarnished by various shades of secondary colours, mostly brown, thus have given blurring effects to the original paintings (Figure 2B). In places several paintings have been erased by white patches of bleached wall resulted from the dissolution of limestone by running water. These staining and bleaching effects have made it very difficult for one to trace the whole paintings exactly as they were originally painted. Based on their analysis, Tan & Chia (2011) have classified all these paintings into several motifs, i.e. zoomorphic, anthropomorphic, geometric, botanic, and abstract. Adnan Jusoh (2007), Islahuda et al. (2009), Tan & Chia (2011), among others have identified the use of hematite (FeO) for most of the painting. As a matter of fact Tan & Chia (2011) have also noted the presence of hematite fragments at the floor of the cave but could not elaborate further with regards of the origin of these fragments.

Figure 3. Hand specimens of porous calcareous sediments with weakly aligned shells of *Brotia costula*, fragments of hematite and baked red clay.

Quaternary Travertine Deposit

During recent visit to the Gua Tambun, the authors have also encountered pieces of hematite fragments as well as some apically truncated gastropod shells belonged to the species of Brotia costula. Some samples of shells were collected from the floor of the Gua Tambun.

At the foot of the Gunung Panjang there are several caves which have partially been filled with travertine deposits as well as recent mud. Located about 80 metres north of the staircase, there is an interesting small cave in which outcrop of travertine deposits were observed. This 1.6 metres travertine deposits is made up of several beds of thin compact travertine interbedded with several thicker beds of more porous calcareous sediments, sometimes showing internal sedimentary features of planar and cross beds (Figure 2C). Within these beds there are scattered apically truncated gastropod shells of Brotia costula, mostly in complete form with some smaller fragments, probably belonged to the same species (Figure 2D). These nearly complete gastropod shells (apart from being anthropogenically truncated) show weak orientation (Figure 3), but tend to be accumulated in particular horizons within the thicker beds (Figure 2C). Most interestingly, within these thicker porous beds there are a few small hematite fragments up to 4 centimetres long, and also fragments of baked red clay (Figure 2D, 3). Some samples of gastropod shells from this travertine deposit were collected for age dating purpose.

Age date of Brotia costula

Several samples of Brotia costula from both the travertine deposits at the foot of Gunung Panjang and at the floor of the Gua Tambun shelter (some 40 metres above the former) were sent to the Beta Analytic Radiocarbon dating laboratory in Florida, USA for dating analysis. As a results, based on Accelerator Mass Spectrometry (AMS) dating techniques, the shells from the foot of Gunung Panjang has been dated back to 9980 ± 50 years before present while the age of the shells from the floor of Gua Tambun is only 5330 ± 40 years (before present here refers to the date of processing, i.e. June 13, 2011).

Interpretation

First of all, data presented may not necessarily correct as these shells are found within the limestone area. According to Chia (2007), the data given for samples taken from limestone area might show much older age owing to contamination from older carbonate. However, presuming that both ages are correct, the age of the travertine deposit probably represents true age of pre-historic kitchen waste since there was very little evidence of reworking to the shells. Brotia costula alone is a common fresh water snail, but their presence with all apical parts being consistently truncated showed that these shells were all belonged to food remains or kitchen wastes left by pre-historic human. Their presence in particular horizons with a weak alignment seems to indicate that these kitchen wastes were dumped into or caught by weakly flowing water. The presence of hematite fragments in the same bed indicates that this mineral is already available since around 9,980 years ago (or perhaps even older), and thus readily available be used for painting by the same people who consumed the snail. This is about the same age with the Perak Man (a Palaeolithic Man) discovered at Gua Gunung Runtuh, near Lenggong, Perak (Mokhtar Saidin 2010). The age given by the shells from the floor of the Gua Tambun i.e. around 5530 years old is much younger than the age of the travertine deposit at the foot of Gunung Panjang. The presence of kitchen product at 40 metres above the ground would certainly raised some questions with regards of the eating behaviour of the pre-historic community i.e. the reasons for them to bring and processed their food at a much higher ground. There is a need to provide better sampling in order to explain this issue. Furthermore, this age could not represent the true age for the painting as the hematite found there might not be related to the in-situ sediments as mentioned earlier by Tan & Chia (2011). Meanwhile, the presence of baked red clay fragments may indicate that this ancient community has already capable in producing pottery. However, the date given for the horizon is far too old compared to the oldest records of pottery in Malaysia, i.e. around 4,000 years ago although an anomalous age of 6,890 had also been recorded in the vicinity of Lenggong, Perak (Chia 2007). Is it possible for the pottery technology to have had started since the Palaeolithic Age?

Summary

AMS ages given to gastropod shells of *Brotia costula* are 9980 ± 50 and 5330 ± 40 years for the travertine deposits at the foot of Gunung Panjang and at the floor of Gua Tambun, respectively. The occurrence of hematite within the same bed indicate that hematite was readily available to be used as the painting material perhaps since 10,000 years ago or even much earlier. However, these data alone cannot precisely date the age of the pre-historic paintings at Gua Tambun. More data with better sampling techniques are needed in order to get a closer date for the paintings.

Acknowledgement

The fieldwork for this project was carried out under the tenure of the UKM Project No: UKM-GUP-PLW-08-11-141-2008. This paper is supported by the special HiCoE Research Grant Project No: XX-08-2012 awarded to Lestari UKM. The dating of samples was supported by Pusat Penyelidikan Arkeologi Global of Universiti Sains Malaysia.

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PAPER A08

GEOTAPAK KOMPLEKS KARS GUNUNG DATOK DAN POTENSINYA SEBAGAI TUNGGAK PEMBANGUNAN GEOPARK KEBANGSAAN LEMBAH KINTA, PERAK, MALAYSIA

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Pendahuluan

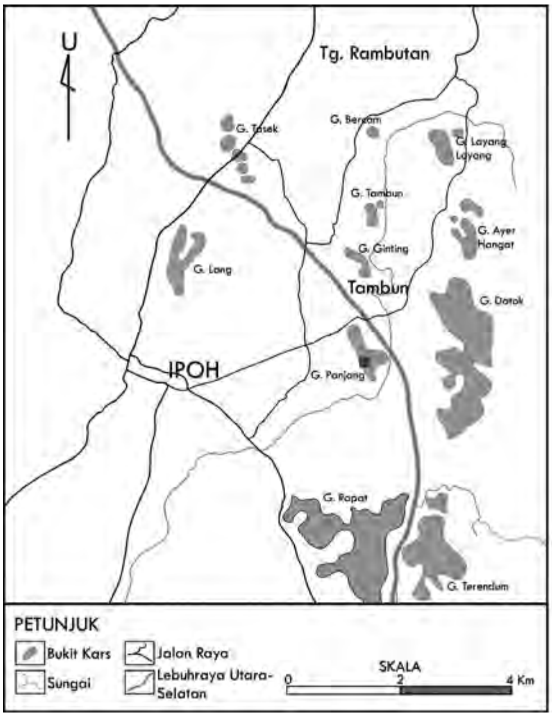
Kekayaan sumber bijih, khususnya bijih timah dan besi telah meletakkan Lembah Kinta di dalam peta dunia. Kekayaan ini diwarisi oleh kedudukan geologi Lembah Kinta di mana granit berusia Trias – Jura Awal merejah batuan sedimen klastik (Silur-Perm) dan batu kapur (Devon-Perm) sempena pembentukan Banjaran Utama (atau Titiwangsa) (Ingham & Bradford 1960) dan penutupan Lautan PaleoTethys. Pada hari ini, banyak kesan tinggalan perlombongan dan fitur geologi luar biasa telah dikenalpasti sebagai sumber geowarisan Lembah Kinta. Sebahagian besar sumber geowarisan ini mempunyai perkaitan rapat dengan marmar dari unit Batu Kapur Kinta dan kebanyakannya telahpun dibangunkan oleh pelbagai pihak untuk tujuan ekopelancongan dan rekreasi (Islahuda Hani Sahak et al. 2007). Antaranya yang paling terkenal adalah Gua Tempurung, Gua Kandu, Gua Naga Mas, Gunung Rapat, Gunung Lang, Gunung Panjang dan Gunung Datok.

Gunung Datok merupakan salah sebuah kompleks kars cockpit yang terbesar di Lembah Kinta. Kompleks ini terletak sekitar 7 kilometer di timur Bandaraya Ipoh (Rajah 1). Kompleks ini menganjur pada arah utara-selatan dan membentuk sempadan timur bagi Lembah Kinta. Kelurusan ini dikongsi bersama dengan Gunung Layang-Layang dan Gunung Air Hangat di sebelah utara, dan Gunung Terundum dan Gunung Lano di sebelah selatan yang mempamerkan sempadan sentuhan dengan granit Banjaran Utama (Titiwangsa). Kompleks kars Gunung Dato ini merupakan salah sebuah kompleks yang masih belum terjejas oleh aktiviti pengkuarian dan sangat perlu dipelihara bagi mengekalkan landskap semulajadi Lembah Kinta (Ros Fatihah Muhammad dan Ibrahim Komoo 2003) dan demi memelihara pelbagai fitur warisan geologi yang disebut di bawah.

Geologi dan Geowarisan

Kajian awal menunjukkan bahawa geologi kawasan sekitar Gunung Datok adalah sama seperti geologi kompleks kars Gunung Gajah, Gunung Terundum dan Gunung Lano di mana batuan igneus kelihatan merejah batuan sedimen klastik dan batu kapur. Kedua-dua unit batuan yang direjah pada kompleks kars Gunung Dato telah termetamorf dan pada sempadan rejahan telah terbentuk longgokan bijih besi. Selepas peristiwa rejahan berlaku episod penyesaran terhadap batuan yang menghasilkan sesar dan kekar. Hakisan di sepanjang satah kekar, khususnya yang melalui batu kapur telah membentuk pelbagai fitur geomorf menarik seperti gua, pinakel dan pelbagai fitur permukaan dalam kompleks kars Gunung Dato. Aktiviti perlombongan pula telah menghasilkan landskap buatan yang telah sedikit sebanyak mengubah landskap geologi asal. Berikut dijelaskan beberapa fitur geowarisan yang terdapat dalam kompleks kars Gunung Dato.

Gua Dato merupakan salah sebuah gua terbesar di Lembah Kinta selain Gua Tempurung. Gua ini terbentuk pada salah satu sistem rekahan yang terdapat di kawasan ini dan kaya dengan pelbagai fitur enapan gua seperti stalaktit, stalagmit, batu alir, tirai dan sebagainya.



Rajah 1. Peta menunjukkan kedudukan kompleks Gunung Datok berbanding komplek kars lain di sekitar Bandaraya Ipoh.

Rajah 2. Beberapa fitur geologi yang menjadi tarikan pelancong di kawasan sekitar Gunung Dato; A – batu pensil (atau batu jarum) yang sebenarnya merupakan kepingan batuan tertegak, B – kolam tinggalan aktiviti perlombongan berlatarkan sentuhan antara syis dan marmar, C – Gua kecil yang telah dibangunkan sebagai galeri sejarah perlombongan di kawasan Lembah Kinta.

Batu pensil (atau batu jarum) yang menakjubkan semua pengunjung adalah tinggalan slab (bukannya turus) batu kapur tertegak yang terbentuk akibat pembentukan salah satu sesar utama di kawasan ini (Rajah 2A). Kajian ini juga menunjukkan kehadiran banyak satah-satah kekar yang terdedah kepada potensi jatuhan batuan yang bersaiz kecil dan besar/

Air Panas Tambun merupakan salah sebuah mata air panas termasyhur di pinggir Bandaraya Ipoh terhasil akibat pembukaan terhadap salah satu sesar utama yang dalam di kawasan ini. Selain fitur-fitur geowarisan utama ini, kompleks kars Gunung Dato juga mengandungi landskap karst berpemandangan indah, sempadan sentuhan antara batuan granit, syis dan marmar (Rajah 2B) dan pemineralan bijih besi. Kompleks kars ini juga turut menyimpan maklumat sejarah berkaitan aktiviti perlombongan timah dan besi, sejarah penempatan awal, campurtangan British, kemasukan Jepun, perjuangan Komunis dan sebagainya. Kompleks yang belum terjejas oleh aktiviti perlombongan ini juga mempunyai potensi yang tinggi untuk menyimpan khazanah warisan biologi ekosistem kars dan gua.

Pembangunan Geotapak

Kehadiran pelbagai fitur geologi bernilai warisan ini membolehkan kawasan kars Gunung Dato dijadikan sebuah geotapak mengikut konsep yang dipelopori oleh Kumpulan Warisan Geologi Malaysia. Sebahagian besar fitur-fitur geologi bernilai warisan dalam geotapak ini telah pun dibangunkan sebagai tapak rekreasi di bawah kelolaan syarikat Sunway the Lost World of Tambun. Syarikat ini juga telah memulakan inisiatif kesedaran alam sekitar dengan menyediakan sebuah galeri kecil (Rajah 2C) bagi tujuan pendidikan awam berkaitan sejarah perlombongan bijih timah yang telah membawa ke arah pembangunan Pekan Tambun dan seluruh Lembah Kinta. Inisiatif awal oleh syarikat persendirian ini perlu dibantu dengan membekalkan maklumat saintifik berkaitan fitur-fitur geologi luar biasa serta pelbagai maklumat saintifik dan sejarah lain di kawasan ini bagi menyerlahkan unsur geopelancongan.

Dengan peningkatan maklumat yang boleh meningkatkan kesedaran awam tentang keperluan penjagaan alam sekitar ini di harap segala sumber asli yang terdapat dalam kompleks ini dapat dikekalkan yakni dibangunkan secara lestari melalui aktiviti pemuliharaan, pendidikan dan geopelancongan bagi mendokong hasrat pembangunan Geopark Kebangsaan Lembah Kinta. Jika ini semua dapat dilaksanakan tidak mustahil industri geopelancongan Gunung Dato berupaya menyaingi keupayaan industri geopelancongan Gua Tempurung.

Penghargaan

Penulis mengucapkan terima kasih kepada Jabatan Mineral dan Geosains (cawangan Perak), Institut Alam Sekitar dan Pembangunan (Lestari) melalui Projek No XX-08-2012, dan pihak pengurusan Sunway Lost World of Tambun yang telah membantu kerjalapangan bagi menghasilkan kerta ini.

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GEOHERITAGE OF LATA RENYOK CASCADE: A POTENTIAL GEOTOURISM DEVELOPMENT IN JELI DISTRICT, KELANTAN

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Lata Renyok Cascade in Jeli district, Kelantan offers outstanding scientific, aesthetic, recreational and cultural values. The cascade is located amid the forest and the rubber plantation in Kampung Renyok, around 14 km from Jeli town. It is a part of the Renyok River, a river which starts from the Main Range flowing into the Pergau River, and surrounded by the hilly areas. It is a series of cascade of about 100 m with the high of dropping cascade of about 8 m. The beauty of the cascade comes from the cascade itself and the underlying rock, which is gneiss (from metamorphism of granitic rocks). This cascade is quite popular among the locals in Jeli district. This may be not only due to the natural beauty of the area, but also because of the existence of some infrastructures such as mosque, community hall, playground, parking lot, and public toilets. Residents in the near village can get clean water from this cascade. This recreational spot is suitable for swimming and fishing activities. This cascade is also utilized as a mini hydroelectric station that generates and supplies electricity to residents. The aim of this paper is to expose the geoheritage characteristics of the Lata Renyok Cascade for potential geotourism development.

Keywords: Geoheritage, Geotourism, Lata Renyok Cascade, Jeli district, Kelantan.

PAPER A10

GEOTOURISM POTENTIALS OF JELI DISTRICT, KELANTAN

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There are wonderful geological landforms or landscapes, amazing geological phenomena, and precious Earth materials exist all around the world. Mountains, hills, rivers, lakes, waterfalls, cascades, caves, hot springs, rock and mineral outcrops and other geological features are potentials to be identified as geotourism sites. The study area is Jeli district, a district within the state of Kelantan which possesses several attractive geological features. Geological setting of Jeli which is situated at the foot of the Titiwangsa mountain range along with the impacts of some geological processes and structures has created some potential geotourism resources in the area. Some potential geotourism sites of Jeli are Gunung Reng hill, Jeli hot spring, Pergau lake (dam), gold deposits in Tadoh river (Tadoh village), Pergau river, Lata Janggut cascade, Lata Rual cascade, Lata Renyok waterfall, Lata Terang cascade, and Setir cave complex.

Keywords: Geotourism, geological landforms/landscapes, geological phenomena, Earth materials, Jeli district.

THE RECOVERY OF FINE CASSITERITE FROM METASEDIMENTRY ROCK

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It is known that ore containing cassiterite has been our most important source of tin since antiquity and its successful separation continuously pose problems to mineral processors. The situation is more pronounced since depletion of the more easily recoverable reserves and forces us to consider the more complex deposits such as hard rock cassiterite ore, for mining in the near future. In order to understand more about challenges in processing the complex tin ore deposits, a Malaysian metasedimentary rock ore sample from a mine was used for a study. Chemical analysis by wet method shows that SnO_2 content in the sample was 2.86%, while for mineralogical analysis, the diffractogram of XRD of the sample had identified that beside cassiterite, the sample also contained minerals such as quartz (SiO_2), clinochlore minerals, ferroan and also glycolated and oriented $(Mg,Fe,Al)_6(Si,Al)_4O_{10}(OH)_8$. Furthermore, the field emission scanning electron microscope (FESEM) micrograph analysis carried out on a polish section of the sample indicated that the fine cassiterite particles (approximately 80 µm) were found to be disseminated in quartz. Prior to separation processes, grinding for 16 minutes on crushed sample was the most appropriate time period to liberate the cassiterite from other gangue minerals and at the same time, to avoid from producing higher percentage of fines. For the separation of tin from gangue minerals on the ground samples, two (2) stages gravity separations by shaking tables were carried out. The first stage was run on ground samples and for the second stage, the middling product from the first stage was re-tabling. Magnetic separation process on concentrate 1 (stage 1) and concentrate 2 (stage 2) products from the shaking tables increased the grade of SnO_2 to 46.85% and 61.90% respectively (as non-magnetic product). Further concentration process of SnO_2 on this non-magnetic product by high tension separator has increased the grade of SnO_2 from 85.05% to 98.77%.

Keywords: fine cassiterite, grinding, shaking table, magnetic separation, high tension

1. INTRODUCTION

It is known that gravity separation processes such as by shaking table, only can be performed effectively for an ore at certain size ranges (~ between 105 to 600 um). So, at the processing plant, the comminution processes have to be carried out on the rock containing cassiterite in order to liberate the mineral and also to enable its concentration process by physical means. However, as the liberation size may well below 105 um and given that the separation process of the shaking table, magnetic separator or high tension are only suitable for mineral separation in a relatively coarser size range, using the same method for separation of fine cassiterite is quite challenging.

This paper will discuss the grindability process performance using ball mill grinding on the selected ore sample. Apart from that, the possibilities of using shaking table, magnetic separator and high tension to recover the fine cassiterite, will also being studied. For this purposes, the performance of each processes were measured through grade and recovery of SnO_2.

2. MATERIALS AND METHODS

Sample of metasediment rock used in this experimental works was obtained from Sungai Perlis Bed, Ulu Paka, Terengganu located in Malaysia. For sample preparation, at first the rock samples were crushed using jaw and cone crushers and mixed thoroughly. Grindings of crushed materials were performed in 10, 12, 16, 20, 24 and 28 minutes to achieve a particle size in which the particle size corresponds to the liberation size as confirmed by mineralogical analysis. Then the sieved materials (-600 µm) from batches were mixed together and was gone through shaking table to pre-concentrate the cassiterite. The middling from tabling was then re-run by shaking table. Those table concentrates and middling were then passed through double disk magnetic separator to get rid of iron content. Those non-magnetic materials were then carried out high tension separation test. All products of shaking table (concentrate, middling and tailing) and high tension separator (conductor, middling and non-conductor) were analyzed by wet assay to determine the percentage of Sn. The Fe content of magnetic and non-magnetic materials from magnetic separation tests were analyzed by atomic absorption spectrophotometer (AAS). Sample Characterization such as X-ray Fluorescence (XRF), X-ray diffraction (XRD), field emission scanning electron microscope (FESEM) and energy dispersive x-ray (EDX) were used to support the studies.

3. RESULTS AND DISCUSSIONS

3.1 Characterization test

The SnO_2 in ROM sample content by wet assay was 2.86%. The chemical composition of the sample in the experimental works showed the percentage of SiO_2 (64.57%), Al_2O_3 (13.41%), Fe_2O_3 (9.66%), MgO (1.6%) and SnO_2 (1.25%). The field emission scanning electron microscope (FESEM) micrograph on polish section sample indicated that the fine cassiterite particles around 100 µm were found to be disseminated in quartz (Figure 1(a) and 1(b)).

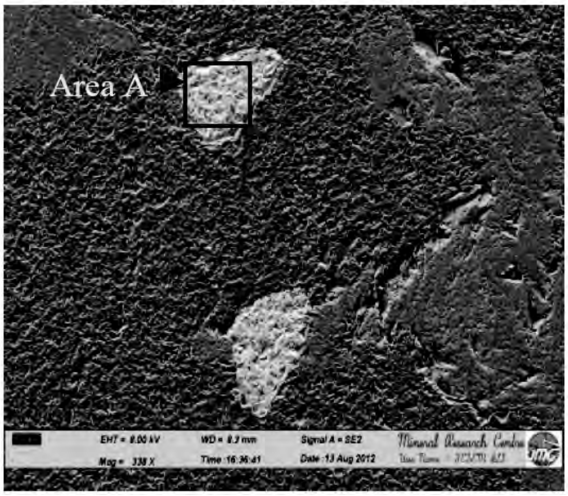

Figure 1(a): FESEM analysis on polished ROM sample at Area A.

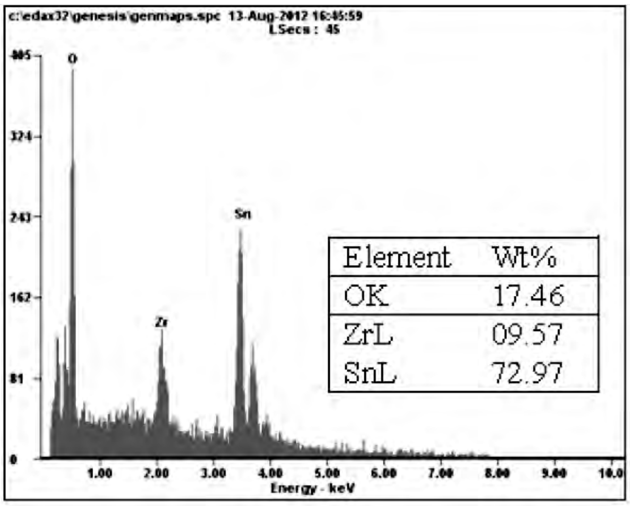

Figure 1(b): EDAX analysis on polished ROM sample at Area A from Figure 1(a).

3.2 Grindability tests

Size distribution of particles (Figure 2) was reported as cumulative percentage passing in the size range 8000 µm to 105µm. Grinding for 16 minutes on crushed sample i the most appropriate time period to liberate the cassiterite from other gangue minerals and to avoid from producing higher fines thus giving 80% passing through the size, d80 = 3400 µm. Sn distribution in various fractions can be shown in Figure 3. For the grinding period of 10 minutes and 12 minutes, there were more than 48% of Sn existed in the size range between 600 µm to 800 µm, whereas for the grinding period of 20 minutes, 24 minutes and 28 minutes, it was found that more than 30% of Sn in the range below

105 µm. The ideal grinding time was in 16 minutes where the minimal percentages of Sn for below 105 um and above 600 µm were identified to be approximately 25%.

3.3 Tabling, magnetic separation and high tension separation

The separation results of SnO_2 for the test sample by shaking table showed that SnO_2 had already increased to 64.21% (in concentrate). Since the grade of SnO_2 in middling was 3.75% which is very low, the middling material was re-tabled and produced 38% SnO_2. Magnetic separation processes on concentrate 1 (stage 1) and concentrate 2 (stage 2) products from the shaking tables increased the grade of SnO_2 to 46.85% and 61.90% respectively which identified as non-magnetic product. The concentration process of SnO_2 on non-magnetic product by high tension separator has increased the grade of SnO_2 from 85.05% to 98.77% giving 82.08% to 84.35% SnO_2 recovery as conductor and middling products.

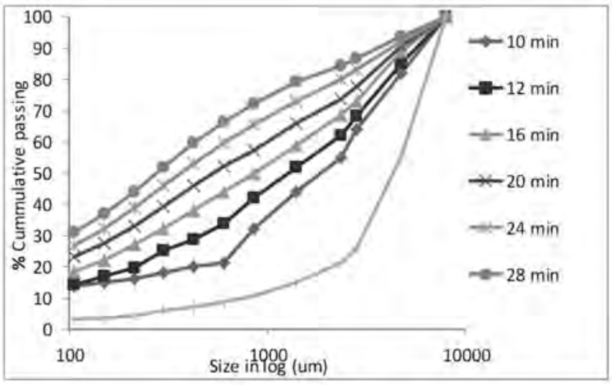

Figure 2: Particle size result at different grinding time

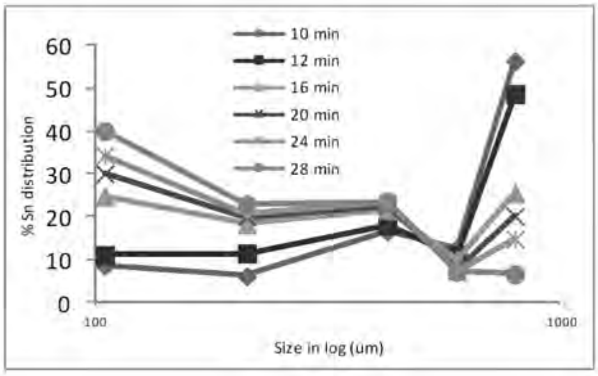

Figure 3: Sn distribution in various size fractions

4. CONCLUSION

Fine cassiterite particles approximately 80 µm were found to be disseminated in quartz. Therefore in order to release of cassiterite from host minerals or to prevent the formation of a lot of mud, the crushed ROM sample has to be ground for 16 minutes which can be considered the most appropriate time. Hence, for pre-concentration of cassiterite, gravity separation by shaking table should be carried out in two (2) stages (i) the first stage of ROM samples comminuted and (ii) on a sample of middling results from the first stage of tabling process. Subsequently the grades of SnO2 for non-magnetic products initially from shaking table concentrates 1 and 2 have been increased to 46.85% and 61.90% respectively. Eventually, the process of high tension separation on non-magnetic product (non-mag) from the magnetic separation process was a significant to increase of SnO2 grade 85.05% to 98.77% SnO2 which gave percentage recovery of 82.08% to 84.35% as a conductor and middling products.

ACKNOWLEDGEMENTS

The authors would like to thank and also pleased to acknowledge the support:

The Director of Mineral Research Centre, Minerals and Geoscience Department and fellow staffs of the Centre especially to the staffs of Section of Mineral Processing Technology Section for their assistance of this research can be carried-out.

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CHALLENGES OF TERTIARY COAL-BEARING HETEROLITHIC PACKAGES AS LOW PERMEABILITY SOURCE AND RESERVOIR ROCKS IN THE BALINGIAN SUB-BASIN, SARAWAK, MALAYSIA

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Keywords – coal-bearing, heterolithic strata, source rock, reservoir characterization, Balingian Formation

Between 1930 and 1940, oil shows, as well as free oil were found in the Mukah area, but none of the discoveries were developed. Drilling results suggest that oil shows are common, while gas shows are present at a deeper depth. Exploration requires a knowledge of heterogeneities in the rock.The Balingian Sub-basin contains more than 6 km of sediment infill and is believed to be an important hydrocarbon kitchen. The area studied is located in the coastal regions of Sarawak, along the Mukah-Selangau road in the Mukah-Balingian district. This study focuses on the Balingian Formation as the older molasse rock along the Mukah-Selangau road. Field data collection includes measuring stratigraphic succession of the rocks and studying the lithostratigraphy unit, facies, boundaries between different units and bed thicknesses (Fig. 1). The rock exposures along the Mukah-Selangau road are stratigraphic equivalents to those in the offshore areas. For source rock assessment, TOC, Rock Eval pyrolisis and Vitrinite Reflectance were conducted to determine the carbon content, maturity and gas generation. For reservoir assessment, petrographic analysis was performed on 12 samples using optical microscopy on blue-dyed thin sections and 11 samples were examined using SEM and XRD.

The heterolithic successions exist over 50 percent of the rock exposures along the Mukah-Selangau road and have a dual role as source and reservoir rock. The coal-bearing sedimentary packages are composed of shale or mudstone, alternating with sandstone layers of varying lateral extent and locally intercalated with coal beds. They were deposited in Upper Miocene tide-influenced or tide-dominated deltaic and estuarine environments. The carbonaceous material, in the form of maceral vitrinite (Fig. 2C) is substantially important to generate gas. However, some coals and carbon derived from the hydrogen-rich parts of plants such as cuticles and spores/ sporinite may generate and expel oil during thermogenic maturation (Tyson, R.V., 1995). Mudrock samples studied using LECO machine showed that their carbon content vary from 1.18 to 11.29% and Hydrogen Index (HI) in the range of 30-98 mgHC/gTOC, with potential yield varying from 0.36 to 11.52. This implies that Type III kerogen is present, and the rocks can be a potential hydrocarbon source varying from poor to very good (Waples, D.W. 1985).

The sandstones observed are fine grained. Detrital quartz, feldspar and lithic grains dominate the mineralogical composition. Most of the sandstones appear to have a low to moderate amount of detrital clay matrix. Depositional processes influence the grain size and matrix content and subsequent diagenetic processes result in grain-coating and pore-filling cements which reduce the effective porosity of the reservoir rocks. Overall, the porosity in all the stratigraphic sections is enhanced by the presence of coarser grained sand/ silt (in the form of bed, lamination and lenses) which provide intergranular pores. However, micropores are also observed among the plates of kaolinite, chlorite as well as sucrosic pyrite, which provide the pathway for gas flow. Diagenetic events are an additional aspect of heterogeneity. Clay cements have grown as a combination of grain-coating/ pore-lining and pore-throat-blocking clots. The pore-throat-blocking cements cause a rapid decrease of porosity, so that it has an effect on the permeability similar to that of ductile grain compaction. The grain-coating and pore-lining cements in contrast cause a slight reduction in the permeability as the pore-throats are only partially blocked. Clay cements occasionally prevent the development of quartz overgrowths and allowed the preservation of micro-pores (Fig. 2B).

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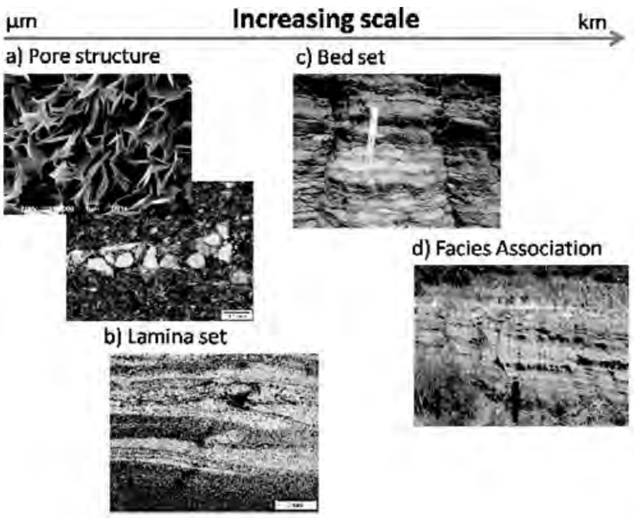

Figure 1 (left). Assesment of source and reservoir heterogeneities of the heterolithic sedimentary packages is dependent on the scale of observation

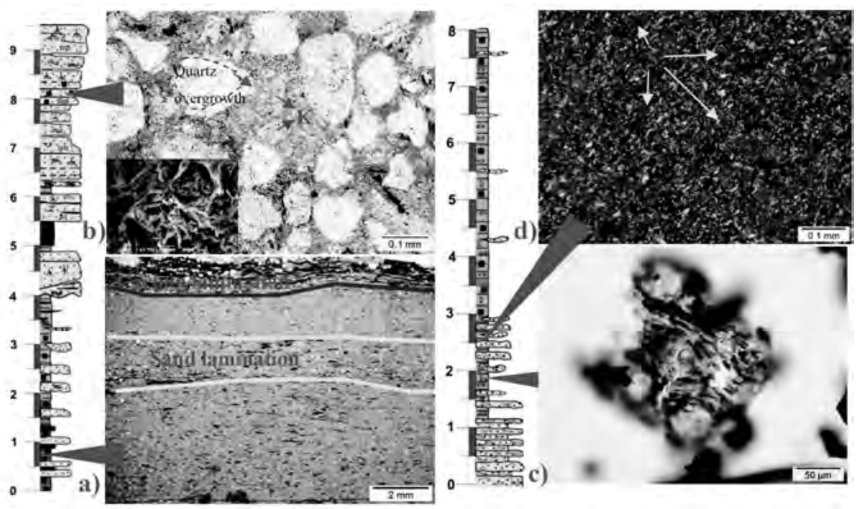

Figure 2 (below left) a) Facies succession and its microphotographs. Diagenetic events are evidenced by dissolution, alteration and cementation. Dissolution and alteration of labile feldspar to kaolinite (K) and chlorite (C) may increase the pore volume (b); Etched vitrinite cryptocorpocollinite surrounded by cryptotellinite present as typical maceral vitrinite that can generate gas (c). More brackish water environment is evidenced by the occurrence of iron-siderite (d)

MICRON-SIZED GOLD PARTICLES FROM RESISTATES IN THE STRAIGHTS CREEK AREA, GUA MUSANG, KELANTAN.

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In the Gua Musang area of south Kelantan, alluvial gold occurs generally as large (1-3mm) granular grains within the stream sediments in the bedrock of phyllites, slates and tuffs. In a few cases, the gold particles can be as large as 10-30 mm.

In particular, the Straights Creek area in Gua Musang, Kelantan, is one of the gold target areas for geochemical exploration by international companies. The resistates (after removal of clays), from in-situ soil samples, obtained at a depth of approximately 1 m below the ground surface, in the Straights Creek area, were studied and characterized using a comprehensive mineralogical approach including binocular microscope and Scanning Electron Microscope (SEM) equipped with EDAX, in order to understand how the gold occurred, as this may have ramification for choosing the right processing or extraction techniques later. In the resistates (sizes around 1-2 mm), the various minerals found are magnetic iron ore, cubic iron ore, irregular iron ore, milky quartz, clear quartz and greisen. All the samples showed micron-sized gold particles, mainly in the reddish brown, irregular iron ore, greisen and milky quartz fragments. The gold particles cannot be seen under the binocular microscope even though magnified by 40 times, but can be observed using the SEM, as the gold particles are only around 0.1-2 micron in diameter and have subangular shapes. Some of the elements detected with the gold include Cu, Zn, As, Ag and Hg, which are common to low or moderate temperature type of hydrothermal deposits. The other elements detected with the gold are Mg, K, Al and Si.

The SEM and EDAX may be utilized as a fast new technique/tool in detecting micron-sized gold for exploration and processing using the resistates from the soil after the clay component has been removed. The subangular shapes of the resistates, indicate little transportation from the source. The gold is likely to be associated with hydrothermal quartz vein system based on the high amount of milky quartz in the resistates, the occurrence of gold within the quartz and iron ore resistates, and from previous work (magnetic and gamma-ray spectrometry), which indicated two potential granitic sources under the volcanics.

PAPER A14

THE EVALUATION OF QUARTZ DEPOSIT IN KG. PADANG BIAWAS, NEGERI SEMBILAN AS A SOURCE OF HIGH PURITY QUARTZ

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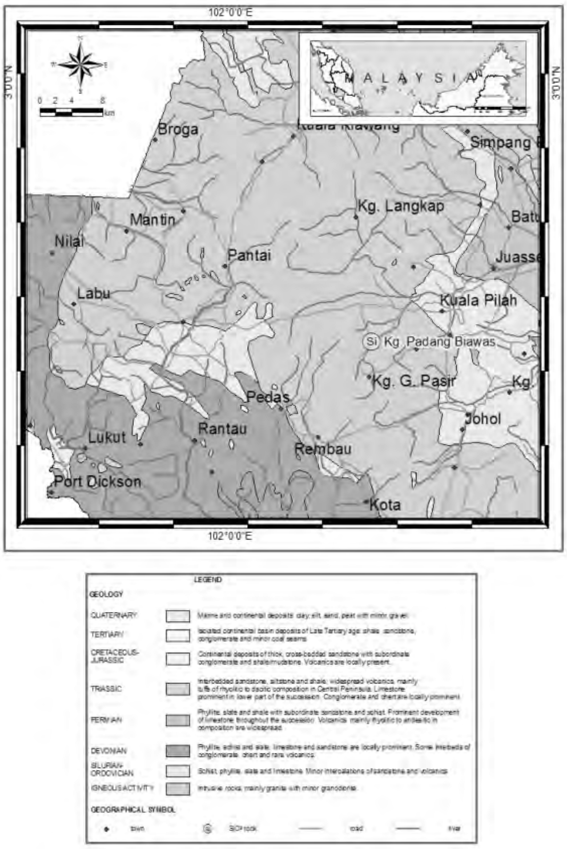

Figure 1. The study area in Kg. Padang Biawas, Kuala Pilah, Negeri Sembilan.

Quartz occur as an essential component in many sedimentary, igneous and metamorphic rocks. Highly pure quartz in the form of rock crystal, vein quartz and pegmatite quartz are economically the important types. Although quartz is one of the most abundant minerals on earth, only very few deposits are suitable for high purity applications such as semiconductors, high temperature lamp tubing, telecommunications and optics, microelectronics, and solar silicon applications.

The study area is located between 2o 40.7’-2^{o} 41.7’N and 102^{o} 9.3’-102^{o} 9.8’E, at Kg. Padang Biawas, Kuala Pilah covering about 2.14 km^2 of area. It is a private area surrounded by rubber and bushes. The study area is underlain by granite as shown in Figure 1. The quartz deposit in Kg. Padang Biawas occurs as prominent ridge and is obviously identified from aerial photo. The quartz ridge is about 1 km long, with an average of 0.5 km in width.

The characterisation starts with bulk chemical analysis of representative samples of raw quartz. The results will serve as a reference point for the next stages of quartz assessment procedure. The main technique used in the study are the X-ray Fluorescence (XRF) and ICP-MS (inductively-coupled-plasma mass-spectrometry) since the requirements are the purity of the quartz.

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RATE OF DEVELOPMENT OF EX-MINING LAND IN PENINSULAR MALAYSIA

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

For the many uses of the ex-mining land in the country, we would like to know how much of it is still available for development and when it would be totally developed into other land-uses. To answer the latter question, Mineral Research Centre (MRC), Minerals and Geoscience Department (JMG) Malaysia made a study to predict the rate of development of the ex-mining land in Peninsular Malaysia.

The rate of development of the ex-mining land in Perak was determined to be 3,550 ha/yr. At this rate, it is expected that all the idle land in the ex-mining land of Perak will be completely developed into some other land-uses by 2020 (i.e. 7 years from 2013).

Linear regression study from three sources of data on the ex-mining land distribution in Peninsular Malaysia shows the rate of reduction (development) of ex-mining land in Peninsular Malaysia is 2,760 ha/yr. At this rate, it is expected that all the ex-mining land in Peninsular Malaysia will be fully developed into some other land-uses by 2028 (i.e. 15 years from 2013).

Keywords: ex-mining land, rate of development, linear regression study

1.0 INTRODUCTION

JMG Malaysia has yet to come up with a complete database on the distribution of ex-mining land of Malaysia. As a department that is given the responsibility in overseeing the development of the mineral industry of the country, information on the post mineral industry activities, i.e. the ex-mining land, is needed as it is to be used by various stakeholders such as Malaysian Centre of Geospatial Data Infrastructure (MaCGDI), Department of Urban and Rural Planning (JPBD), Department of Agriculture (JPM), local authorities, government departments, institutions of higher learning, entrepreneurs, and private agencies.

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

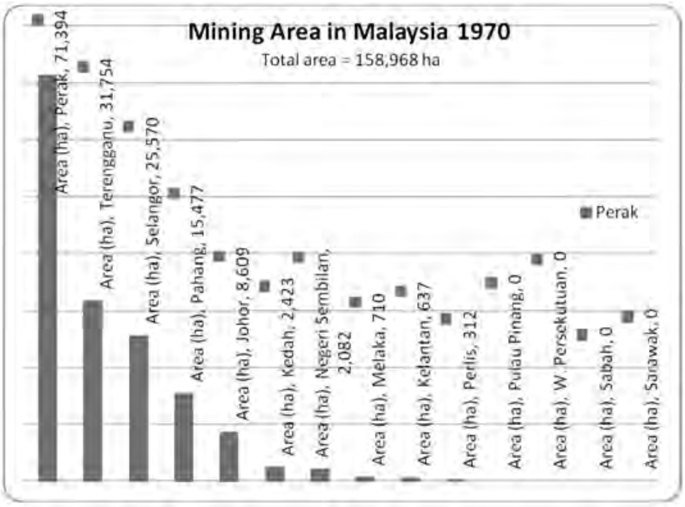

Figure 1. The study area in Kg. Padang Biawas, Kuala Pilah, Negeri Sembilan.

Figure 2. Mining and ex-mining land area in Peninsular Malaysia in 2000.

Year	Area (ha)	Number of years from 2013	Data source
1970	158,968		Lim, 1995
2000	81,246		JPM, 2000
2008	51,658		JPM, 2008
2009	52,210		
2010	49,450		
2011	46,690		
2012	43,930		
2013	41,170	0	
2014	38,410	1	
2015	35,650	2	
2016	32,890	3	
2017	30,130	4	
2018	27,370	5	
2019	24,610	6	
2020	21,850	7	
2021	19,090	8	
2022	16,330	9	
2023	13,570	10	
2024	10,810	11	
2025	8,050	12	
2026	5,290	13	
2027	2,530	14	
2028	-230	15	
2029	-2,990	16	
2030	-5,750	17	

Table 1: Statistics and projected linear regression of area of the ex-mining land in Peninsular Malaysia..

Figure 3. Mining and ex-mining land area in Peninsular Malaysia in 2008

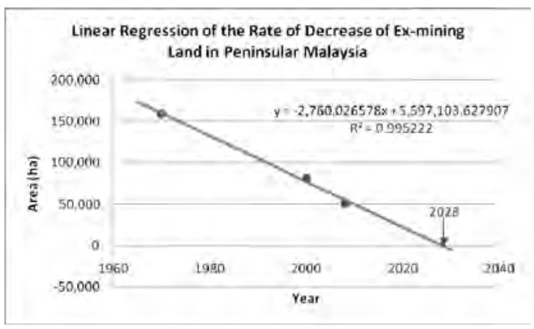

Figure 4: Linear regression of the rate of decrease of ex-mining land in Peninsular Malaysia

proper monitoring and planning to ensure that the provisions of these ex-mining lands are adequately developed and conserved for current and future generations.

For these reasons, MRC, JMG Malaysia has undertaken a project to develop a digital database on the distribution of ex-mining land in the country from 2011 to 2012 of the Tenth Malaysian Plan (Abdullah et al., 2011; Ramli et al., 2011a; Ramli et al., 2011b; Ramli et al., 2011c; Ramli et al., 2012a; Ramli et al., 2012b).

For the many uses of the ex-mining land in the country, we would like to know how much of it is still available for development and when it would be totally developed into other land-uses. To answer the latter question, a study was made to predict the rate of development of the ex-mining land in Peninsular Malaysia (Ramli, 2013). This paper describes the method used and provides the results obtained from the study.

2.0 RATE OF DEVELOPMENT OF EX-MINING LAND

2.1 Rate of Development of the Ex-mining Land in Perak

Ramli & Mohd Anuar (2012a) showed that in 2008 the idle land in the ex-mining land of Perak was 40,597 ha. By using GIS techniques, Ramli et al. (2011a) showed that in 2011 the idle land in the ex-mining land of Perak was 29,948 ha. The technique requires the use of committed development data of 2011 obtained from JPBD Perak. The study shows that within a period of 3 years, 10,649 ha or 26% of the idle land had been developed for other land-uses; this gives the rate of development as 3,550 ha/yr. At this rate, it is expected that all the idle land in the ex-mining land of Perak will be completely developed into some other land-uses by 2020 (i.e. 7 years from 2013).

2.2 Rate of Development of the Ex-mining Land in Peninsular Malaysia

To study the rate of development of the ex-mining land in Peninsular Malaysia, ex-mining land data were obtained from three sources, i.e.:

Mining area in Malaysia 1970 data (Lim, 1995), as shown in Figure 1. The mining area (now classified as ex-mining land) statistics does not include Sabah and Sarawak. The total area or mining in Malaysia (excluding Sabah and Sarawak) in 1970 was 158,968 ha.

Mining and ex-mining area data in 2000 obtained from JPM. The total area of the mining and ex-mining land in 2000 in Peninsular Malaysia was 81,246 ha (Figure 2).

Mining and ex-mining land area data in 2008 obtained from JPM. The total area of mining and ex-mining land in 2008 in Peninsular Malaysia was 51,658 ha (Figure 3).

From these three sources of data on the ex-mining land distribution in Peninsular Malaysia, a study of linear regression was made using Microsoft Office Excel 2007. The study shows the linear equation is $y = -2,760.026578 x + 5,597,103.627907$ with a regression coefficient, $r2 = 0.995222$, which is very close to 1, thus showing a very good fit (Table 1 and Figure 4).

The analysis shows the rate of reduction (development) of the ex-mining land in Peninsular Malaysia is 2,760 ha/yr (given by the coefficient of x in the linear equation). At this rate, it is expected that all the ex-mining land in Peninsular Malaysia will be fully developed into some other land-uses by 2028 (i.e. 15 years from 2013).

3.0 CONCLUSION

The rate of development of the ex-mining land in Perak was determined to be 3,550 ha/yr. At this rate, it is expected that all the idle land in the ex-mining land of Perak will be completely developed into some other land-uses by 2020 (i.e. 7 years from 2013).

Linear regression study from three sources of data on ex-mining land distribution in Peninsular Malaysia shows the rate of reduction (development) of ex-mining land in Peninsular Malaysia is

2,760 ha/yr. At this rate, it is expected that all the ex-mining land in Peninsular Malaysia will be fully developed into some other land-uses by 2028 (i.e. 15 years from 2013).

ACKNOWLEDGMENTS

The author thanks Y. Bhg. Dato' Hj. Zulkifly Abu Bakar, Director of Mineral Research Centre, Ipoh for his unwavering support and encouragement in carrying out the project and to Y. Bhg. Dato' Hj. Yunus Abdul Razak, Director General of Minerals and Geoscience Department Malaysia for granting permission to publish this paper.

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DEFORMATION STYLES AND STRUCTURAL HISTORY OF THE PALEOZOIC LIMESTONE: KINTA VALLEY, PERAK, MALAYSIA

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Although many geological studies have been carried out in the Kinta Valley over the past century, neither the regional configuration, nor the structure of the limestone has been understood. The geometry of the Kinta Valley is asymmetric, and includes large fractures and folds of regional-scale, which may result from successive deformation events. The Paleozoic limestone was affected by intense fracturing, which ultimately make it an analog for fractured reservoirs. However, the deformation is expressed differently in the basin and along the edge of the Kinta Valley in the Late Paleozoic sequences. Relatively weak deformation was observed in the limestone of the middle of the valley (eg. Gunung Rapat); whereas limestone at the eastern edge of the valley exhibit intense deformation illustrated by tight folds and often vertical limestone bars (few kilometers away from Gunung Rapat, Fig. 1). The focus of this study is to characterize the deformation style for each major fracture sets in the Paleozoic limestone, identify the cross-cutting relationships and attempt to reconstruct their structural evolution in view of that of the Kinta Valley.

Extensive study was carried out at different scale (Fig. 2), including macro-scale (satellite imagery) and meso-scale (outcrop and oriented hand specimen). Through the study, four deformation stages have been identified in the limestone, and referred to as, D1, D2, D3 and D4. D1 was represented by conjugate normal fault-like fracture set occurring within beds of various rheologies (e.g. competent and incompetent lithologies). The fractures formed in the competent beds are often highly dipping, and sometimes it propagated toward the next incompetent beds via a relatively low-angle connecting fracture. The overall combination responds to a pure shear behavior. The D2 fractures are observed in the gently dipping limestone of Bercham. They consist of nearly vertical conjugate strike-slip (pitch ~ 0^0) fault set which comprises both E-W striking dextral and sinistral NE-SW faults. Based on the orientation of the conjugate set, it clearly showed ~E-W compression. D2 stage has also been recognized as conjugate fracture set in the limestone at east flank of the valley where bedding is very steep (often up to 80^0). There, the D2 configuration is also identified after unfolding the bedding. D3 stage, illustrated by reverse faults and tight kink-folds is also showing E-W compression, and may be the continuation of the D2. This deformation is mostly expressed along the eastern flank of the Kinta Valley (Fig. 3). The slickensides found on the bedding plane indicated thrusting. The faults often run along the bedding planes and propagate via a ramp across the competent beds into the next weak lithologies. Both east and westward thrusts were found. D4 consists of ~NNW-SSE striking conjugate normal faults with high dip angle, and results from ~E-W extensional regime. The normal faults may re-activate pre-existing D3 thrust faults.

In terms of chronology, D1 fracture occurs within relatively thin beds (a few centimeters) and is believed to have taken place in situ during the last stages of the basin infill, probably right after the deposition of the carbonate sediments. As such, it may result from sagging rather than tectonics. Both D2 and D3 fracture sets were observed in the limestone of Bercham area, in the middle of the valley. D2 fracture set was clearly cross-cut by the D3 thrust fault, indicated that the D2 occurred prior to D3. D4 fracture set is clearly a late deformation, because it often propagates through the whole outcrop and cross-cut the previously-formed features.

Figure 1. Aerial photograph of the limestone hills: Gunung Datok, Tambun, Ipoh. The narrow valleys are formed between the steeply dipping limestone beds. The limestone overlies the granite to the east.

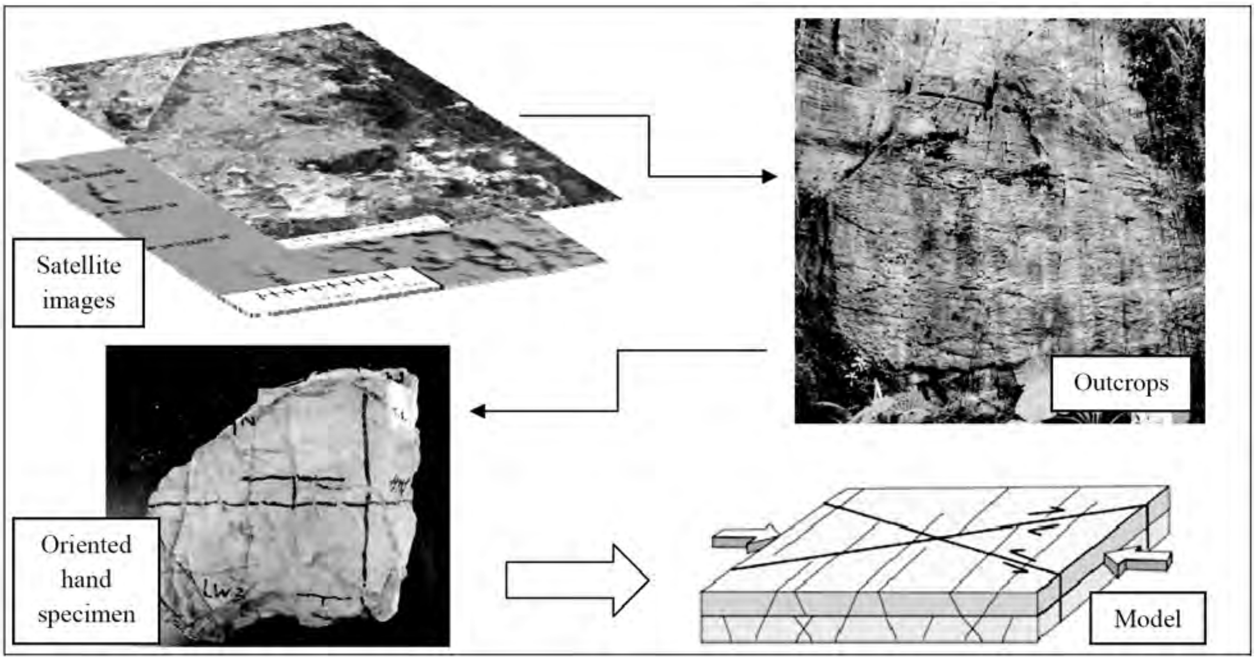

Figure 2. The study of the deformation of the Paleozoic limestone started from the regional-scale using satellite image and digital elevation model, continued with field-based observations. Oriented hand specimens were collected to do the detailed observations, and support a structural model.

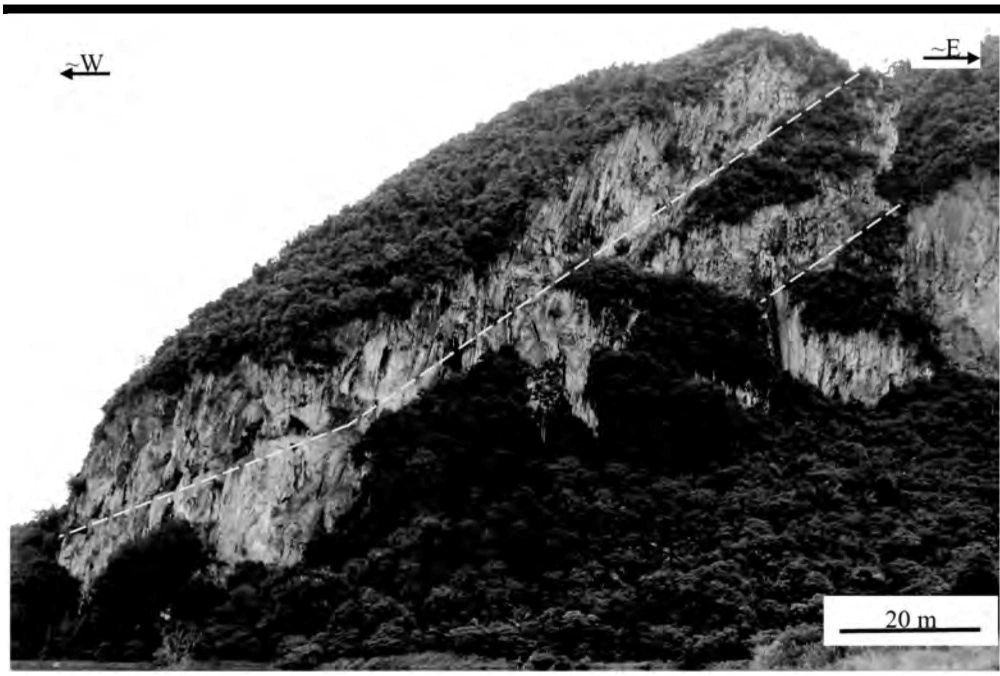

Figure 3. The Paleozoic limestone of the Tambun was highly crystallized and intensely fractured. The major fractures (yellow dashed lines) were interpreted as thrust faults. The fault zones were experienced intense dissolution, and result numerous caverns.

The carbonate sediments are deposited until Middle Permian (Suntharalingam, 1968), and subsequently hardened due to overloading, until they eventually broke with small scale brittle normal faults. This basin development process was active until the collision between the Sibumasu and Indochina blocks, during Triassic (Metcalfe, 2013). The cessation of the magmatism by Early Jurassic (Krahenbuhl, 1991), was probably followed by the formation of the D2 conjugate strike-slip faults and possibly immediately after, the D3 compression. D3 probably generated a series of thrust within the horizontal carbonate strata, which evolved toward the East approaching the granite contact. When the thrust sheets abutted the uplifting batholiths, the limestone became severely folded and formed the vertical attitude of the bedding. 100m next to the contact with the hot granite, the limestone behaved in a ductile manner, as illustrated by localized flow structures and ductile pure shear. The extension D4 could be correlated with the Tertiary basement (horst and graben) of the Strait of Malacca, the Mergui basins and onshore Tertiary basins of the Peninsular Malaysia, due to their similar orientation and structure. It would therefore date back from Eocene to Middle Miocene (Liew, 1995).

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PAPER A17

KINEMATIC STUDY OF THE BOK BAK FAULT AT BINA QUARRY, BUKIT PERAK, KEDAH

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Bok Bak Fault, a major NW trending fault zone in the Peninsular, was first described by Burton (1965) based on the apparent displacements of the Semanggol Formation north and south of the fault. He traced the fault from Baling to Jeneri in Kedah. Raj (1982) from LANDSAT lineament study, have extend the fault southward to central Perak and southwest Kelantan. The fault was further extended northwestward into north Kedah and Perlis from evidence of drag in strike ridges (Mustaffa, 1994) and displaced lithologic unit (Syed, 1996). A study was undertaken at Bina Quarry, located on the Bukit Perak to determine the characteristics of the Bok Bak Fault. Two intersecting faults cut the granite: the NW trending main Bok Bak Fault trend, and a conjugate NE trend fault, referred to as the Lubok Merbau Fault (Abdullah, 1993). A fault kinematic study was undertaken to determine the nature of deformation and sense of displacement of the fault. The granite within the quarry is cut by the main NW trend strand of the Bok Bak Fault. It exhibit several sets of faults and fault rocks as a result of Bok Bak Fault deformation. The area was mapped along the quarry face, and the kinematic indicators of the faults and deformed granite were examined.

The Bukit Perak Granite, shows porphyrytic texture with feldspar crystals showing preferred orientation exhibiting a distinct primary foliation of magmatic origin. The crystals are generally randomly oriented, but in the vicinity of faults they show arrangements that are roughly parallel to the adjacent fault. The preferred orientation implies that the magmatic foliation is also partly related to synkinematic intrusion of the Bukit Perak Granite along Bok Bak Fault Zone. This suggests that the faulting was initiated in the Late Triassic.

Within the Bok Bak Fault Zone, the rock was deformed by both brittle and ductile deformation. Brittle deformations gave rise to two main sets of fault identified by slickensides and cataclastic fault plane. Two main fault trends are observed. Kinematic indicators on fault plane such as steps, grooves and slickenlines indicate a sinistral shear sense along NW-SE trend faults and dextral shear sense along NE-SW trending fault. The plunge of the slickensides shows that these faults are oblique strike-slip faults, with some amount of dip-slip movement. Crosscutting relationship of the faults show that the NE trend fault cuts the NW trend fault. Both sets correspond to the main NW trend of Bok Bak fault and the conjugate NE trend fault respectively. Based on the fault kinematic analysis, it was shown that the fault zone is a sinistral oblique fault with compression direction in the SE direction.

Ductile deformed granites give rise to shear zones and mylonites. The mylonites produce textures that indicate the kinematic of the ductile shear zone, such as S-C foliation, rotated clast, shear bands, and offset veins. The main trend of the mylonites is NW-SE trending – similar to the main trend of Bok Bak fault – with both component of dip slip reverse movement and strike slip indicated by stretching lineation. The presence of both components of movement along the shear zone suggests progressive deformation.

From the relationship of the structures, it was shown that Bok Bak Fault was initially formed concurrently with the granitic intrusion of Bukit Perak granite during the magmatic stage, as suggested by the preferred orientation of the granite porphyroclast. The earlier ductile deformation result in dip slip and strike slip movement along the shear zone. Subsequent brittle deformation along the shear zone forms the main NW-SE trending sinistral Bok Bak Fault. The NE-SW dextral Lubok Merbau Fault occured as a conjugate antithetic fault set to the main set of the Bok Bak Fault.

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PAPER A18

PERBANDINGAN LINEAMEN FOTO UDARA DENGAN SURIHAN RETAKAN DALAM FORMASI SETUL DI KUARI KANG GIAP, PERLIS

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Surihan lineamen foto udara dalam Formasi Setul di daerah Kurong Batang, Perlis telah menunjukkan kehadiran lineamen-lineamen utama dalam arah Baratlaut (BL), Utara-Baratlaut (UBL), Utara-Timurlaut (UTL) dan Timurlaut (TL). Di kuari Kang Giap, lineamen ini mewakili sistem retakan dalam arah yang serupa telah dikenalpasti. Pemetaan struktur batu kapur Formasi Setul menunjukkan perlapisan batuan adalah berjurus TL dan miring landai hingga sederhana curam ke arah tenggara. Dua sesar utama iaitu sesar sinistral dan sesar dekstral telah dicerap. Sesar sinistral berjurus BL dan satahnya tegak hingga curam ke arah timur. Sesar ini dicirikan oleh kinematik anjakan ke-kiri yang memotong perlapisan batu kapur Formasi Setul dan satah sesar tersebut mempunyai gores upaman dan jinjang cabut hablur kalsit yang menunjukkan arah pergerakan. Lineamen berjurus 160-170 adalah sesar dekstral. Satah sesarnya miring ke arah barat secara sederhana curam hingga tegak dan dicirikan oleh pergerakan dekstral serong normal. Sesar dekstral ini juga memotong dan menanjakkan perlapisan batu kapur dan sesar sinistral. Terdapat sebilangan sesar sinistral BL telah diaktifkan semula dan dianjakkan ke-kanan. Bukti kinematik kedua-dua arah boleh dijumpai pada gores upaman satah sesar. Pemetaan geologi telah membuktikan sesar sinistral berjurus BL adalah lebih tua berbanding dengan sesar dekstral berjurus UBL. Lineamen arah TL terdiri daripada sesar songsang yang miring sederhana curam ke arah tenggara. Sesar songsang ini adalah selari dengan perlapisan batu kapur di kuari Kang Giap. Sesar normal yang miring secara landai hingga curam ke arah timur dan barat pula mempunyai jurus dalam arah UTL. Lineamen-lineamen ini dapat dikesan keserupaan sistem dalam foto udara dan sistem retakan batu kapur Formasi Setul di kuari Kang Giap.

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Surihan Lineamen Foto Udara
Formasi Setul di Kuari Kang Giap
U
Sempadan
Antarabangsa
Bukit C
Bukit B
Bukit A
Empangan
Bukit Bintang
Kuari
Kang Giap
Sg. Abi
Jln. Batu Pahat
2 km

PAPER A19

PALEOEARTHQUAKES AND ACTIVE FAULTING IN CAMERON HIGHLANDS.

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Recent remote sensing and field investigations in Cameron Highlands have identified faults displaying evidences for Quaternary Pleistocene to Holocene movements. This study identified two fault controlled Quaternary basins here. Geomorphic data, and the evidences of active faulting from pit data, show that the surface rupturing events on these faults are Late Pleistocene to Holocene. These Quaternary active faults are considered capable of producing large earthquakes.

INTRODUCTION

Peninsular Malaysia is the southern tip of the Malay-Thai Peninsular which form part of the core of Sundaland which is considered to be very low seismicity and relatively stable for a long period (e.g. Ben-Avraham and Emery, 1973; Gobbett and Hutchison, 1973; Tjia, 1996). These are due to its tectonic setting; the region includes extensive shallow seas, and is not significantly elevated. Prior to December 2007, the Peninsular Malaysia was experiencing only low to medium seismic activity level tremors due to seismic waves generated with epicentres located in Sumatra or rarely the induced seismicity near Kenyir Lake (Raj, 1994; Che Noorliza Lat, 1997, 1999a & b, 2002).). Active seismicity have been recorded in the Thai part of the peninsular, but the Mw = 2.7 to 3.7 earthquake occurrences near Bukit Tinggi, Malaysia, from November 2007 to January 2008, which occurred right at the core of supposedly stable Sundaland has stimulated considerable interests and debate.

Tjia (2010) and Mustaffa Kamal Shuib (2011 & 2012) summarized some evidences for Quaternary deformational activities onshore and offshore of Peninsular Malaysia. This paper further report on the increasing evidences of Quaternary deformation and faulting in the Malay Peninsula. This paper outlines evidences from Cameron highlands to question the popular believed assumption that the Malay-Thai Peninsula is seismically stable. The main objective of this paper is to illustrate geomorphic evidences of Quaternary fault activities within Cameron Highlands using remote-sensing and field information. The result of the research can be applied to predict seismic hazard in this area.

ACTIVE FAULTING IN CAMERON HIGHLANDS

Cameron Highlands is characterized by NW, NE and N-S lineaments and cut by NW, NE and N-S through going faults displaying evidence for Cenozoic movements. Recent remote sensing and field investigations have identified that some of these faults display evidence for Quaternary Pleistocene to Holocene movements. Some short NW, NE and N-S faults along a major NE to ENE trending fault zone show abundant geomorphic, structural and stratigraphic evidences for Late Quaternary activity.

This study identified two fault controlled Quaternary basins here (Figure 1). The geomorphic evidences found associated with these basins include fault scarps on Quaternary alluvial and colluvial deposits; vertical and horizontal displacement of Quaternary terrace surfaces; triangular facets along escarpments with progressive steepening towards the base; and lateral offset of stream courses and ridge crests. Their association with alluvial/colluvial basins identified at Brinchang, Tanah Rata and Ringlet are a testament to Late Quaternary movements along these faults.

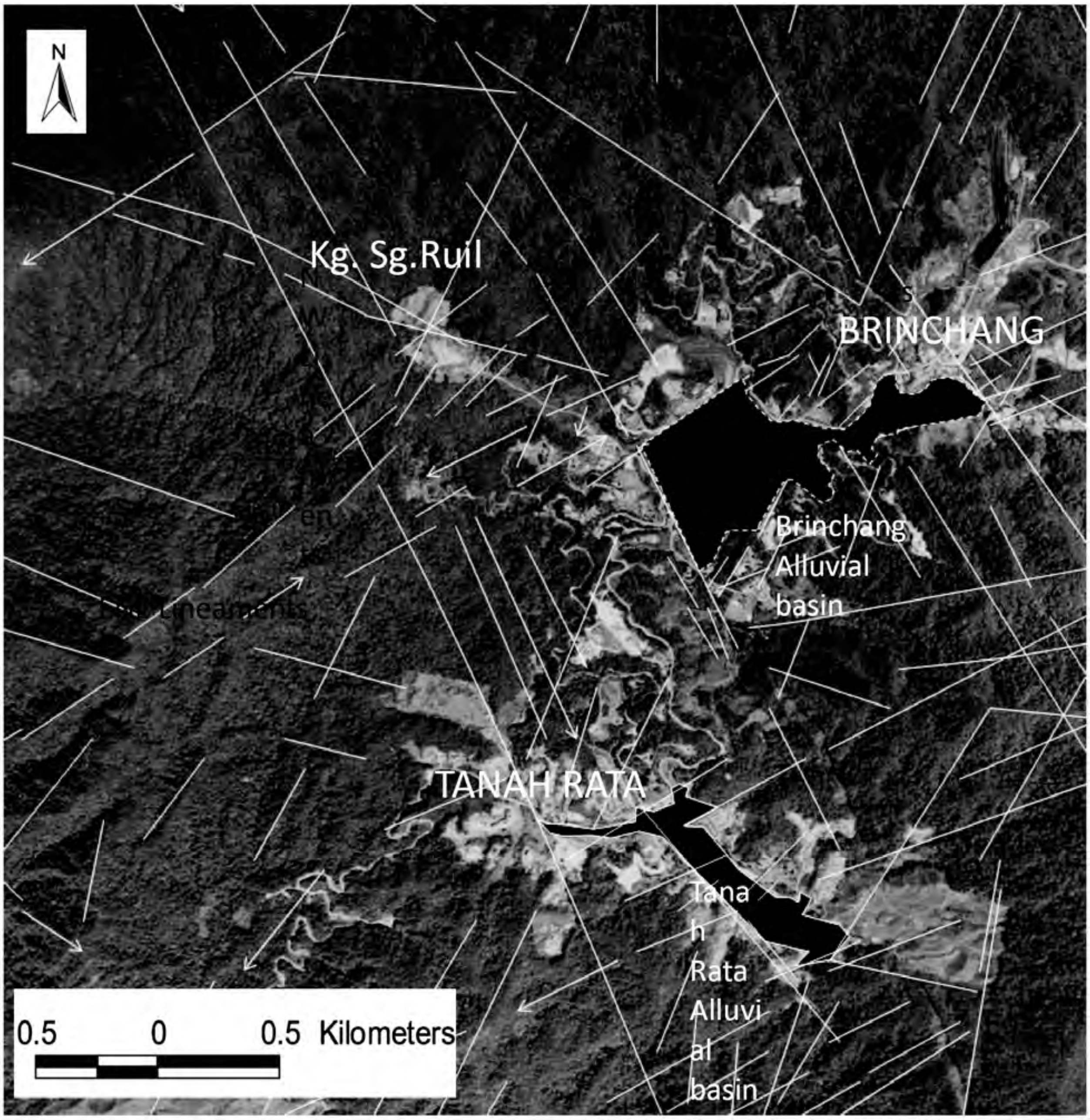

Figure 1 Aerial photo interrpretaion of Cameron Highlands showing the two alluvial basins associated with distinct lineaments.

Field observations revealed the presence of faulting in recent alluvial gravels. The alluvial shows evidences of rapid sedimentation in a subsiding environment. A 30 m wide fault zone offsetting young horizons developed in a sequence of alluvial gravels and clays in a pit along Sungai Ruil. The alluvial sediments showed the presence of seismites suggesting paleoearthquake activities during sedimentation. The complex nature of faulting exposed in the pit, involving both normal and reverse faulting, suggest that movement involves a significant lateral component. The youngest deposit offset by faulting is a soil horizon developed in clayey gravels, immediately below peat, a modern soil. The deformed alluvial gravels and clays horizon is considered to be Holocene in age on account of its lack of reddening and poorly developed rubification.

Aerial photo interpretation shows that the tear drop shaped Sungai Ruil catchment constitutes a complex of relict landslide scars, erosional surfaces and other mass movement features. The presence of fault bounded alluvial basin with evidences of young movements at the base suggest that relict mass movement complex could have been triggered by young paleoearthquakes during faulting.

CONCLUSION

These geomorphic data, and the evidences of active faulting from pit data, show that the most recent surface rupturing events on these faults are Late Pleistocene to Holocene. These Quaternary active faults are considered capable of producing large earthquakes.

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CHARACTERIZATION AND MODELING OF NATURALLY FRACTURED GRANITE, REDANG ISLAND, TERENGGANU

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This study has been carried out at Redang Island which situated off the the coast from the Besut district, Terengganu and it is mainly composed of granitic rocks with surrounding small islands of sedimentary and volcanic rocks. It is believed that this island has connectivity within the basement reservoir in the Malay basin and it is presents a good analogue for in-depth studies of fracture distribution (Mohamad Kadir, 2010). Thus, the main primary objectives for this study is to characterize the fracture orientation, fracture density as well as to build the static DFN fracture model based on the surface outcrop analogue at the Redang Island. A systematic data sampling approach is necessary for a proper statistical analysis of fracture parameters in order to have a sound basis for fracture modeling. A line sampling technique (scan-lines) has been used for the main data collection. Five scan-lines were observed having an extension fractures and maximum stress (α1) oriented with two major orientations at NE-SW and ENE-WSW which is almost consistent with those demonstrated by FMI data from the Malay Basin. This study suggests that the connectivity and the continuity of consistent fractures system between fractured basement in the Malay Basin and the Redang Island.

PAPER A21

INTEGRATED 3D RESERVOIR CHARACTERIZATION THROUGH SIMULTANEOUS INVERSION: QUALITATIVE AND QUANTITATIVE APPROACHES

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This work demonstrates an example of integrated deterministic AVO/AVA simultaneous inversion performed on a reservoir characterization study conducted on a field in Gulf of Mexico by using Jason Geoscience Workbench® (JGW). The main objective of this case study is to delineate the clastic reservoir bodies based on surface seismic and well data via seismic inversion and ultimately discriminate and characterize pay sand from other lithology. The inversion technique demonstrated would eventually convert multiple angle stacks of 3D seismic data into a consistent reservoir model described by 2 elastic properties: P-impedance and Vp/Vs . Through these inverted layer properties, quantitative and qualitative analysis could then be performed, substantially improving interpretations of reservoir.

SUBSURFACE FRACTURE ZONE AND HOT SPRINGS DETECTION IN HARDROCK AQUIFER USING ELECTRICAL RESISTIVITY TOMOGRAPHY TECHNIQUES AT HULU LANGAT, SELANGOR

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Groundwater quality has been one of the most serious issues in the developing countries. In particular there has been a decline in groundwater quality is predominantly influence by anthropogenic activities and recent issues such as climate change and global warming. Assessment and Monitoring of groundwater quality should be undertaken in real-time to identify the source of principle contaminants that affect the probability of groundwater and protecting them from further contamination. (Abd Manap el at, 2009). The Langat Basin, with its explosion in development could potentially have to rely on groundwater to meet it ever increasing demand. It must also be emphasized that the basin provided majority of water (Taha, 2004). The Langat River and its left bank tributary, the Semenyih River, originate in the western slope of the mountain ridge penetrating the Malay Peninsula. Both rivers collect water in the mountainous areas and generally flow southwest in the mountainous terrain. They gradually change their direction to the west after flowing in the hilly areas near Kajang and Bangi, respectively. The two rivers then join, enter the flat land near Kg. Dengkil and flow westward. In some location the joined river heavily meanders and finally flows into the Straits of Malacca as shown in Figure 1. The total catchment area of the Langat Basin and neighboring southern basins is approximately 2,750 (JICA, 2002).

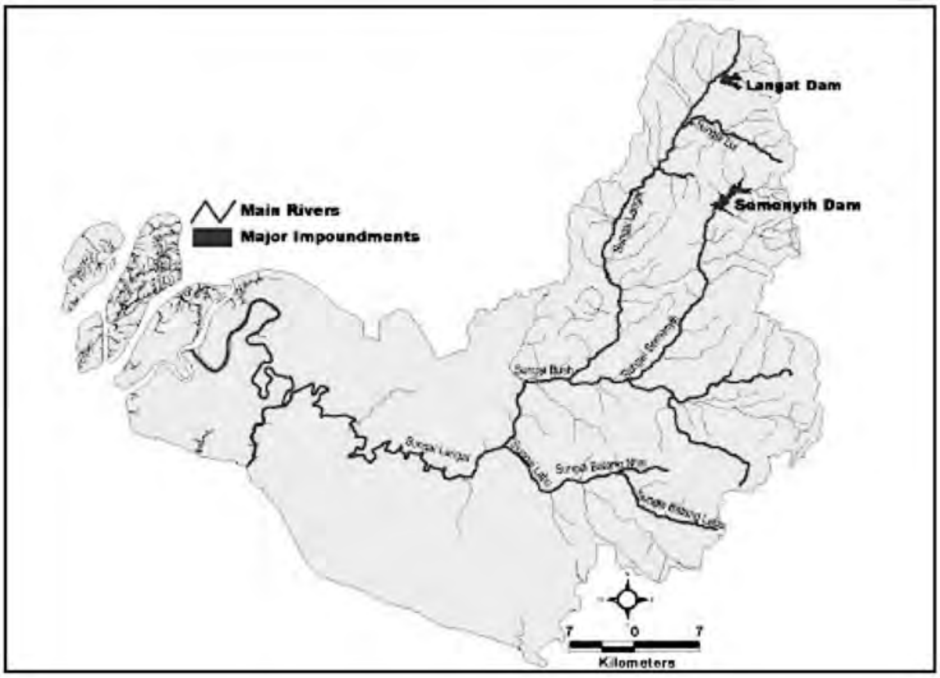

Figure 1: Main Rivers and its Tributaries in the Langat Basin (Source: LESTARI, 2000).

Electrical resistivity tomography (ERT) technique was carried out at Hulu Langat area, Selangor. The objectives of the survey were to delineate major geological structures that may be associated with the occurrence of groundwater aquifer within the granite hardrock and high terrain regions in the area. This study provided a guideline with quantitative information based on ERT, which helps in storing the results in various categories of varying reliability. The electrical resistivity survey detected two major faults along part of Sungai Langat and Sungai Semenyih as shown ib Figure 2. These faults cratered a fractured zone. This fracture zone provided a conduit for the hot spring (Figure 3) to seep through also indicates the presence conductive zones which are attributed to fractures within the bedrock. The transient electromagnetic method done by Abd Rahim Harun (1996) to delinate the hot spring source. The results of the survey indicate the presence of two conductive zones due to thermal water containing relatively high content of total dissolved salts TDS.

The expected results of detailed hydrogeological studies and geophysical will provide good solution, in order to cope with water deficit in the basin, this study is considering using groundwater as an alternative water source. In this regard, good groundwater management is needed to assure the sustainable utilization of this groundwater quality disturbance and modification of the hydrology of basin ecosystem. Thus, monitoring of groundwater quality is important to ensure its supply is not contaminated and corrective measure can be taken. In order for the basin to maintain groundwater and geoenvironmental quality for its sustainable development various precautionary measure are essential and proposed in this research.

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Acknowledgement

The authors would like to extend thier sincere appreciation to University of Malaya for giving them an opportunity to work on this research through the High Impact Research (HIR) grants with account no J-21004-73829. In additional, we would like to express our sincere appreciation to Dr. Sawsan Kamel Shariah for her help in this research.

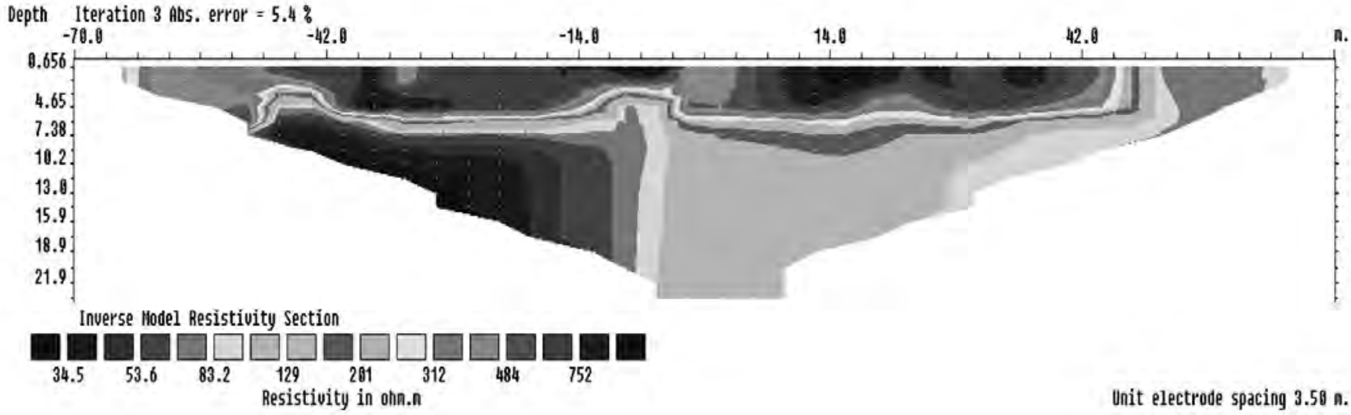

Figure 2: 2D ERT inverse model shows the fault.

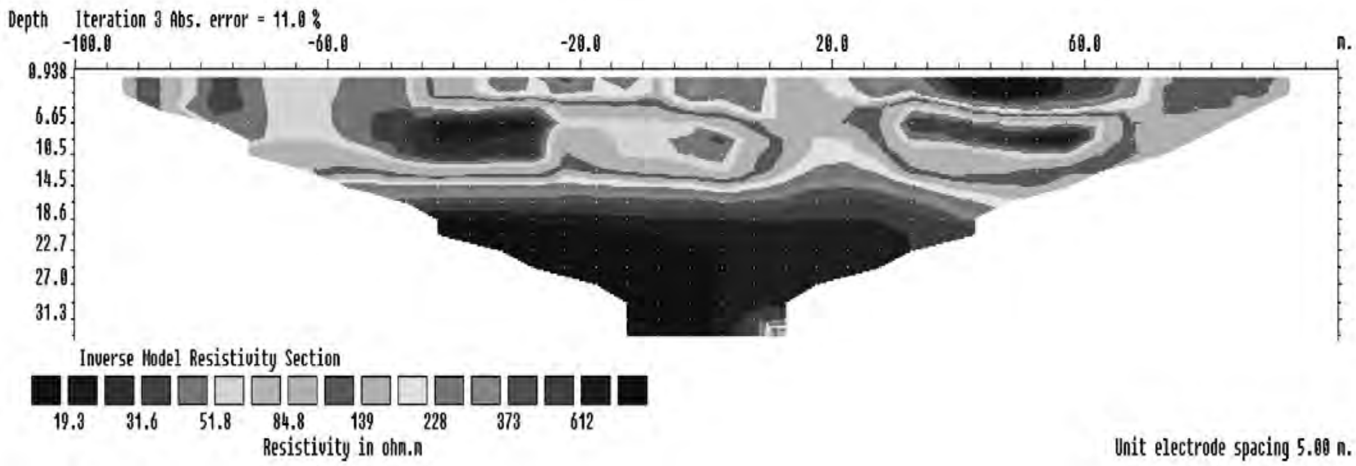

Figure 3: 2D ERT inverse model shows the low resistivities anomalies that are interpreted as hot springs.

PAPER A23

THE USE OF GROUND PENETRATING RADAR TO DETECTS STRATIGRAPHY AND STRUCTURE IN A ROCK SLOPE

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Ground penetrating radar (commonly called GPR) is a high resolution electromagnetic waves technique that is designed primarily to investigate the shallow subsurface of the earth, building materials, road and bridges (e.g. Mellet, 1995). The use of GPR for shallow subsurface mapping studies has also increasing because it can detect shallow underground discontinuity and heterogeinity (e.g Nascimento et al., 2004; Rashed et al., 2002) and can assess the geological hazards associated with shallow ruptures in and near fault zones (e.g. Toshioka et al., 1995; Rashed et al., 2002). The use of GPR to reveal the shallow structures and subsurface strata in a road-cut rock slope can help road maintenance and reduce the risk of road-cut collapse instead of visual inspection by road investigators (Toshioka et al., 1995).

In this study, an integrated geological-geophysical characterization was done across the vertical wall of silty shale interbedded with beds of greywacke (Burton, 1970; Ulfa et al., 2012) in Baling, Kedah with the objective of investigating the shallow geological structures and characterizing the stratigraphy features inside the rock. This site is part of the Semanggol Formation which is Triassic in age (Burton, 1970), presents a very good outcrop. It is located along the East-West highway route 67, Baling area, Kedah as a road-cut rock slope in a vertical wall exists about 8 m high.

A measuring line was established horizontally along 66 m on the top of the vertical wall. The following investigation was conducted:

(1) Geological survey: the wall surface was visually checked for joints, faults and fold distribution, its direction, the presence of any materials contained within the fractures and the sequence of the stratigraphic layer.

(2) GPR measurement: Two GPR profiles were done along the same line but using different frequency values (500 and 250 MHz) to a depth of about 4 m. The GPR profiles were obtained using the Sensors and Software® MALA Geoscience radar.

Comparison of the measurement records obtained using each antenna resulted the following interpretations (Figure 1a and 1b):

(1) From the radargram obtained with the 250 and 500 MHz were possible to identify the sets of structures: joints, faults and stratigraphic layer in the form of fold.

(2) The maximum GPR penetration depth is about 1.2 m (16 ns) for the 500 MHz antenna and about 2 m (39 ns) for the 250 MHz antenna. The deeper penetration depth is obtained with the lower frequency antenna.

(3) The 250 MHz antenna gives the best results for both penetration depth and resolution quality.

Combined interpretation of GPR images and field structural geologic and stratigraphic data revealed that the rock slope is composed of two sets of discontinuities: SW-dipping sub-vertical faults trend in NW-SE direction and SE-dipping sub-vertical faults trend in NE-SW direction; and sub-

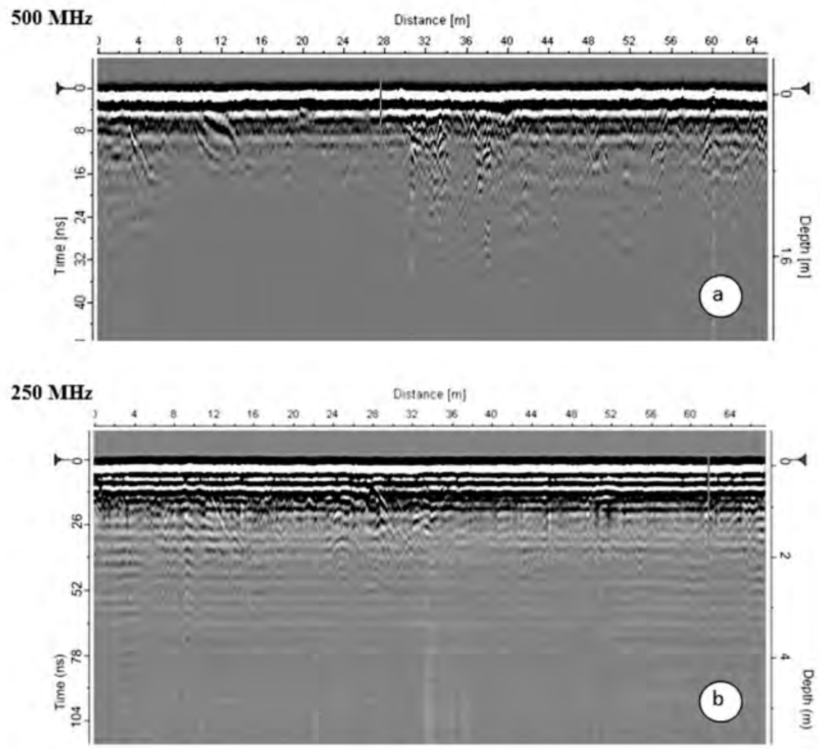

Figure 1: Processed radargram obtained using antenna frequencies of 500 and 250 MHz.

vertical joints parallel to the faults which are distributed along NW-SE and NE-SW directions. Joints in the SW-dipping are relatively open containing clay and soil.

Fold features were also detected in the slope due to the interbedded of clay or shale contain. However, by comparing with the visible condition at the rock surface, not all features were recognized in the G PR record. Most dry discontinuities as observed on the wall are not reflects EM waves. It was also confirmed that the electromagnetic waves were strongly reflected by clay beds and faults or joints containing clay.

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PAPER A24

SEISMIC REFRACTION TOMOGRAPHY APPLICATION FOR ENVIRONMENTAL STUDY

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Seismic refraction tomography (SRT) involves more complex mathematic algorithms to fit more flexible model. In the field procedure SRT in generally needs more shot points than standard seismic refraction survey to obtain high resolution profile. In this study we used 9 numbers of inline shot-points and 10 numbers of offset shot-point in purpose to obtained high resolution of seismic refraction tomography. During a recent geophysical test site, the subsurface material was mapped along survey line using seismic refraction method. Analyses of the site investigation data revealed that the studied site was made up of two layers of the subsurface. The upper layer has velocity values with range of 500 m/s to 1500 m/s which can be classified as unconsolidated surface deposits and mixtures of unsaturated sands and gravels. Meanwhile the lower layer has velocity values with range of 2000 m/s to 5500 m/s which is classified as compacted fine's soil due to high pressure of the overburden. Analysis of seismic refraction data demonstrated that refraction tomography software systems are able to reveal subsurface material which represented by their seismic velocity value. Furthermore, the velocity model obtained in this study is agreed with its synthetic modelling result as initial model. This validity and reasonable results was able to assist in interpretation of the seismic refraction method for the environmental study.

Keywords: Seismic refraction tomography; Seismic velocity; Synthetic modelling; Validity

Introduction

The seismic refraction surveying was the first major geophysical method to be applied in the search for oil bearing structures. Today, however, oil exploration relies almost exclusively on some variety of modern reflection seismographs. Recent progress in exploration geophysics has stemmed from the computer-assisted processing and enhancement of the data interpretation. Seismic refraction surveys are still used occasionally in oil exploration, particularly where they can assist in resolving complicated problems in structural geology. Although the application of seismic refraction method in the oil industry has diminished over the years, the method has found increasing use foe site investigation for civil engineering. It is a valuable investigation tool well-suited for shallow surveys, particularly when used in conjunction with the exploratory drill.

The relatively recent advent of seismic refraction tomography techniques has provided a significant new geophysical tool. Several initial studies by Carpenter, et al., (2003), Cramer and Hiltunen (2004), Hiltunen and Cramer (2006) and Sheehan et al., (2005) indicate that refraction tomography performs well in many situations where traditional refraction techniques fail, such as velocity structures with both lateral and vertical velocity gradients. Recently, seismic refraction method has been use in environmental and engineering study.

Materials and Methods

Seismic data were recorded using a 24 channels ABEM Terraloc MK8 seismograph with 24 geophones of 14Hz, 2 seismic cables, a roll of trigger cable, a striker plate and 16 lb seismic hammer to generate seismic source. In this study, we have deployed geophones with 2 m interval with 9 inline shot-points and 10 offset shot-points. The geometry setting used in this study is shown in Table 1.

Sampling Interval (μs)	50
No. of sample	4096
Rec. Time (μs)	204.8
Geophone Interval (m)	2.0

Table 1: Geometry setting used for seismograph and geophone interval

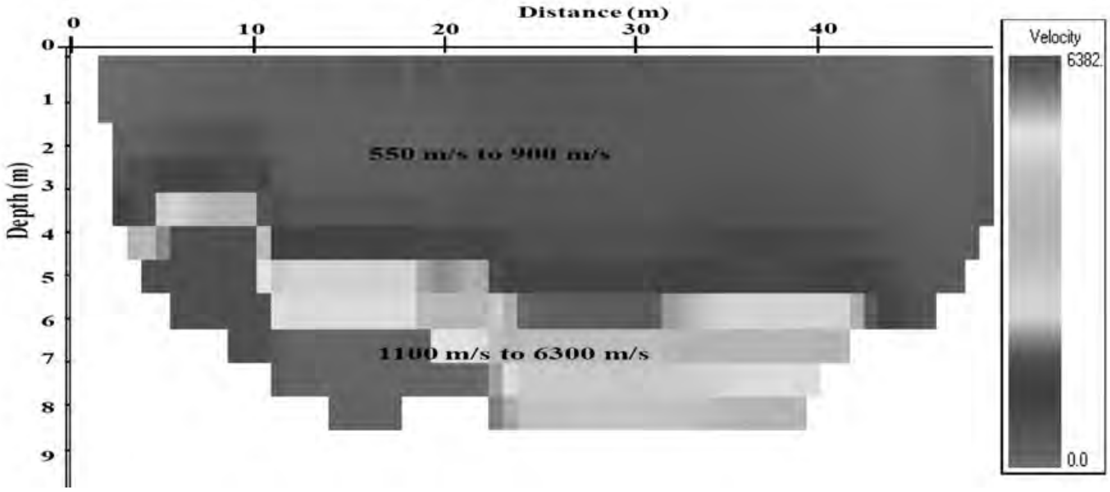

Figure 1: The synthetic velocity model for the initial model.

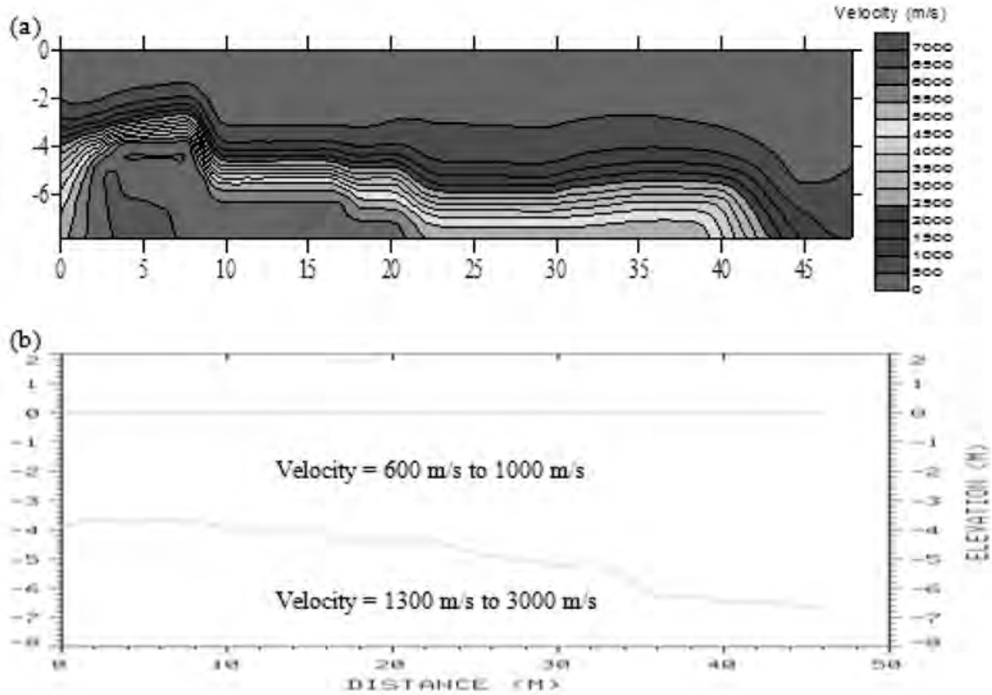

Figure 2: The comparison between the SeisOpt and GREMIX15 velocities model result

Results and Results

The synthetic model of the velocity model of the test site was carried out in this study is the result of forward modelling the seismic response of an input earth model, which in term of 2D variation in physical properties. Figure 1 shows the synthetic model of the velocity model for the test site. This approach is used to examine the seismic response of the geological section as initial model.

In this study, we show that the synthetic velocity model is nearly matched to the final result of velocity tomography model for the test site. Base on interpretation for the velocity tomography model (Figure 2), there is two main velocity layers which can be classified as layer one or upper layer and the lower layer. The upper layer has velocity values with range of 500 m/s to 1500 m/s which can be classified as unconsolidated surface deposits and mixtures of unsaturated sands and gravels. Meanwhile the lower layer has velocity values with range of 2000 m/s to 5500 m/s which is classified as compacted fine's soil due to high pressure of the overburden.

Conclusion

The SeisOpt velocities model in particularly display some strange features within the lower half. These features typically occur in regions of low ray path coverage. Meanwhile the GREMIX15 velocities model unable to display the contouring such as SeisOpt velocity scheme. However, GREMIX15 velocity scheme able to give the reasonable result as SeisOpt software. The high resolution of seismic refraction tomography used in this study is able to verified and give reasonable interpretation of the subsurface rather than normal seismic refraction survey.

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AMPLITUDE VERSUS OFFSET AND AZIMUTH (AVOZ) STUDY FOR FRACTURED CHARACTERIZATION: A BASIS TOOL FOR VELOCITY VERSUS OFFSET (VVO) ANALYSIS

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Introduction

Characterization of the hydrocarbon reserves will be more difficult in the future since the complexity of remaining reservoir is higher than the existed now. The complexity of hydrocarbon reservoir is due to the physical properties of the reservoir, geological regional setting in the prospect area, geological structure and evidence in the prospect area or reservoir, the existence of the fracture in the reservoir, etc. Nowadays, fracture is a topic that should be studied to characterize the hydrocarbon because fractured has a great importance; especially it becomes the main factor to control fluid flow and permeability within the rock in the reservoir system. Therefore, it requires the deeper analysis to perform the reservoir characterization in order to obtain the good result that has a high confident level.

AVO analysis is still a popular method and mostly used for hydrocarbon reservoir characterization. In addition, AVO is widely used in industry for reservoir characterization. AVO analysis is used for example for hydrocarbon detection, lithology identification, and fluid parameter analysis. It becomes the powerful tool for these cases due to the fact that seismic amplitudes at layer boundaries are affected by the variations of the physical properties between the upper and lower layer. On this study, we apply AVO analysis to characterize the fractured reservoir with its parameter including fracture density, fracture orientation, and saturating fluid (fluid-filling the fracture).

Anisotropy analysis is a factor that must be considered in this study because the existence of fracture will induce the medium or the reservoir to be anisotopic. Therefore, Thomsen’s parameters; epsilon, delta, and gamma are needed in the calculation of AVO analysis.

Methodology

On this study, we perform forward modeling based on theoretical framework of Hudson penny-shaped model (Hudson 1980, 1981, 1982, 1984) and Schoenberg linear-slip model for analyzing the fracture of our model (table 1 and 2). We assume that the fractured is vertically aligned and the reservoir is HTI medium. The calculation of amplitude versus offset for isotropic medium with anisotropic medium is different and for HTI medium we should consider the azimuth parameter to obtain the amplitude versus offset response of the model or known by Amplitude versus offset and azimuth (AVOZ). By using Ruger’s approximation (1996, 1997) for HTI medium, we calculate the AVOZ response for the model in two conditions (gas and water) with several differences in physical properties.

Result and Discussion

We found that 00 of azimuth induces more azimuthal anisotropy which will rapidly decrease until the azimuth in 900. In the other hand, when the azimuth is 900, the reflectivity response will be the same as the reflectivity response in an isotropic medium. Types of fracture fluid-filling give the same pattern of the reflectivity response. However, it influences the value of reflectivity response; gas saturation induces more azimuthal anisotropy than water saturation. On this study we did AVOZ analysis that combines the Hudson penny-shaped crack and Schoenberg linear-slip model to find the

Table 1. Model 1 and physical properties of model and fracture

Vp of layer 1	4561 m/s	crack density (e)	0.1
Vs of layer 1	2988 m/s	Aspect ratio of cracks	0.01
ρ of layer 1	2670 kg/m^3	Bulk Modulus of fluid	0.93 x 10^9 Pa
Vp of layer 2	4860 m/s	Miu of fluid	0 Pa
Vs of layer 2	3210 m/s	Incident angle	(0:50)
ρ of layer 2	2320 kg/m^3	Azimuth	0, 30, 45, 60, 90

Table 2. Model 1 and physical properties of model and fracture

Vp of layer 1	4561 m/s	crack density (e)	0.1
Vs of layer 1	2988 m/s	Aspect ratio of cracks	0.01
ρ of layer 1	2670 kg/m^3	Bulk Modulus of fluid	2.2 x 10^9
Vp of layer 2	4860 m/s	Miu of fluid	0 Pa
Vs of layer 2	3210 m/s	Incident angle	(0:50)
ρ of layer 2	2320 kg/m^3	Azimuth	0, 30, 45, 60, 90

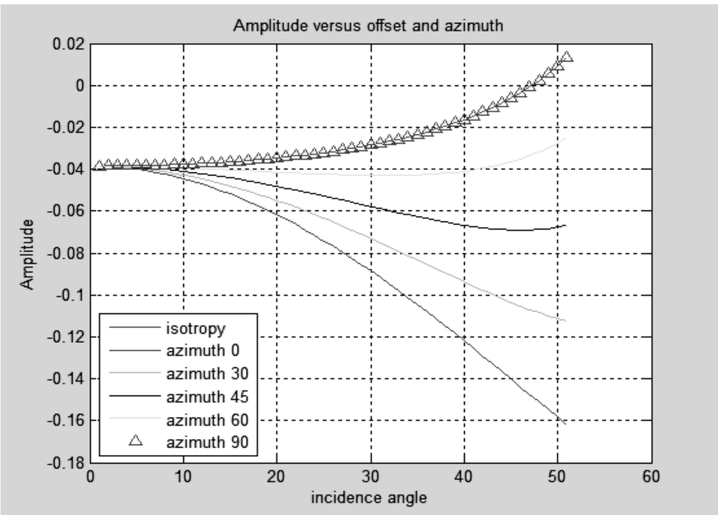

Figure 1. AVOZ response of model 1 gas condition

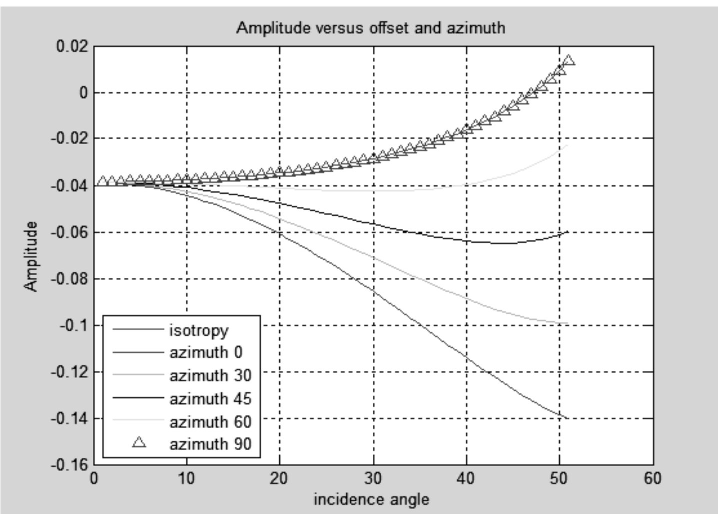

Figure 2. AVOZ response of model 1 water condition

correlation between P–wave reflectivity and the fracture parameters which include fracture orientation, fracture density, and fracture fluid filling. Result of AVOZ modeling is shown in figure 1 and 2. In the future, this study will be applied as the theoretical basis for developing the Velocity versus offset analysis (VVO) as a new tool for direct hydrocarbon indicator.

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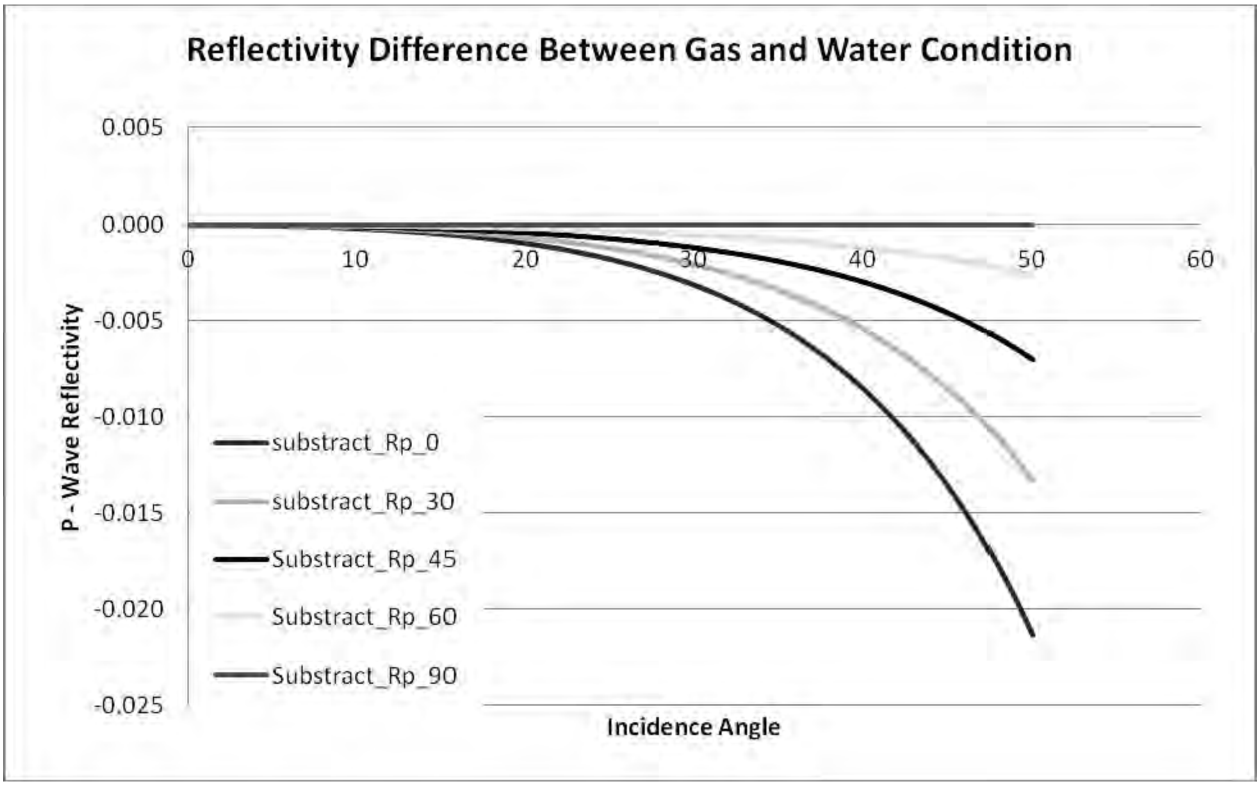

PAPER A26

SEISMIC ILLUMINATION ANALYSIS OF DIFFERENT SHALLOW GAS CLOUD VELOCITIES BY FOCAL BEAM METHOD

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This research aims at improving our understanding on seismic data in shallow gas cloud region where subsurface image quality is generally poor. The distorted image underneath gas zones depends on three major factors: the complex structure, reflector position and source and receiver locations on surface. However, current imaging procedure requires a lot of computational power and data space to determine viability of each three factors stated. With this constraint in mind, an integrated approach was develop in focal beam analysis which enable faster evaluations of an acquisition design, understanding subsurface structure while review migration operator capability.

In this study, these three factors will be scrutinized into details by using focal beam method. The focal beam method, which based on double focusing concept as in shown in Figure 1, was used to obtain the resolution function and amplitude versus ray parameter (AVP) imprint. As seen in Figure 2, both functions form the integral part in focal beam quantitative assessment. The analysis started by developing a heterogeneous layer model, with increasing velocity along with depth. Within the shallow section of velocity model, there was a low velocity zone (LVZ) represent gas cloud accumulation from deeper reservoir. The existence of LVZ above the target reflector affected the wave propagation from source to receiver hence eventually produce poor image on target subsurface.

Throughout this work, four different gas cloud velocity values were analyzed (Figure 3), with four different target reflector positions were chosen to understand their effect on illumination. Source and receiver configuration was kept constant (Full 3D) throughout the investigation as the objective is to understand the effect of strength of lens, i.e. the gas cloud velocity. The work produced by this research is a stepping stone towards further research and development in shallow gas cloud area.

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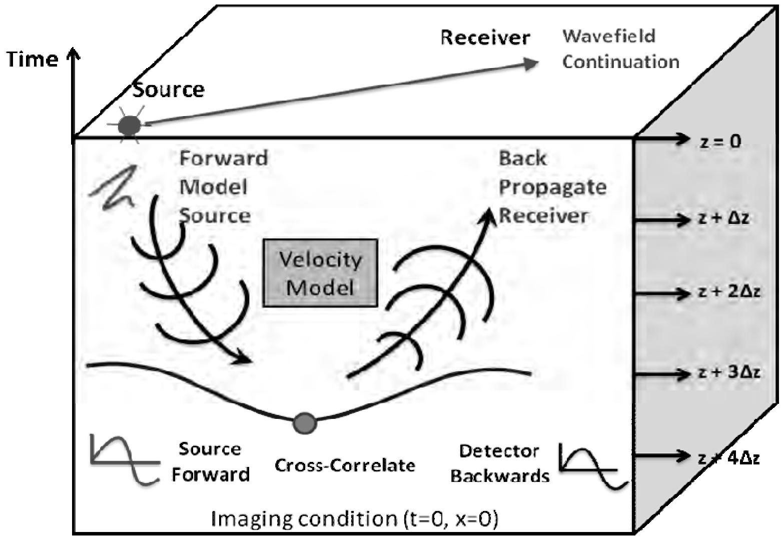

Figure 1: Diagram explains a workflow used for imaging a point reflector. Similar to this concept, focal beam method also exhibit forward propagation and back propagation from source and receiver location.

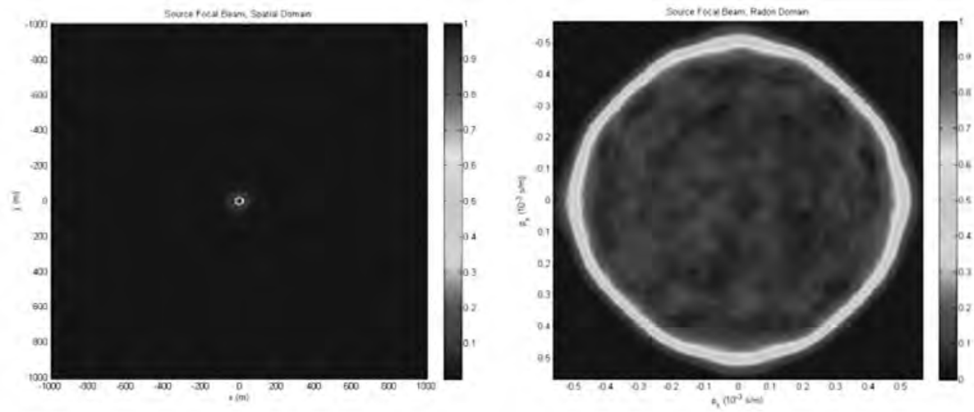

Figure 2: Spatial domain focal beam (left) and radon domain focal beam (right) for depth point at 500m and velocity gas cloud of 1700 m/s. Notice that both beams have similar properties for source and receiver due to their identical location on surface

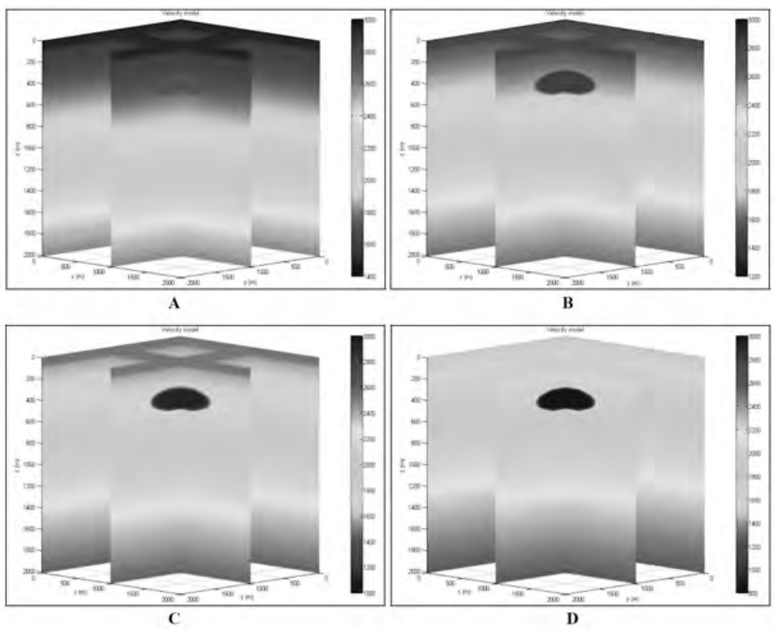

Figure 3: Velocity model for gas cloud at 1700m/s (Figure 5A), 1400m/s (Figure 5B), 1100m/s (Figure 5C) and 800m/s (Figure 5D). In the middle of each model, there is a low velocity zone, marked by ellipsoid shape. The colors at the side of each model indicate the velocity distribution. Note that every model colour bars represent different velocity ranges.

PAPER B01

VOLUMETRIC CHANGES AND SEDIMENT CHARACTERISTICS AT SELECTED BEACHES OF TERENGGANU, MALAYSIA

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Understanding sediment characteristics and beach dynamics is essential for wise coastal zone management. This survey was conducted to identify and evaluate erosional and accretionary characteristics of eleven Terengganu beaches during a one-year cycle from February 2008 to February 2009. Study areas were selected based on their economic, transportation, residential and recreational functions. Distances between stations are uneven as this study examines changes of the beach according to lateral arrangement. Sampling and statistical analysis showed that mean grain size, sorting and skewness varied somewhat from beach to beach. Mean sizes ranged from very coarse to medium sand (-0.48 to 1.79 phi) with dominant sorting types consisting of moderately sorted to moderately well sorted. During the study period, the beaches of Penarik, Batu Rakit, Seberang Takir, Kuala Ibai, Kuala Abang and Teluk Kalung experienced net erosion while the remaining beaches experienced net accretion. The beaches of Seberang Takir and Teluk Kalung experienced the most loss of sediment (1543 m3 and 1300 m3 respectively). Breakwater constructed updrift at Seberang Takir and the occurrence of headlands near Teluk Kalung are suspected as causative factors to severe erosion and sediment loss at these two areas. The beaches of Merang and Teluk Mak Nik showed the least amount of sediment loss. During Northeast Monsoon, high wave energy tends to result in beach erosion and redeposition of eroded material as shore-parallel bars in the nearshore. Accretion appears to result from shoreward movement of nearshore bars during periods of fair weather, lowered wave energy conditions. These bars ultimately become welded to the beach increasing its width. It was concluded that the changes in beaches are strongly influenced by physiography, incident wave energy and direction, available sediment supply, tendency of erode or accrete, and level of anthropogenic development. It also can be noted that the cycles of changes in beach profile configuration and sediment volume could be associated with changes in the relative energy levels of Northeast Monsoon versus calm period wave climates.

Keywords: Sediment Volume, Sediment Classifications, Mean sizes and Sorting

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PAPER B02

FACIES ANALYSIS OF THE LATE MIOCENE SEDIMENTARY SEQUENCE IN SABAH, MALAYSIA

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The present study documents facies associations recorded from the Neogene rock units in Sabah namely; the Kudat Formation, the Belait Formation, the Tanjong Formation, the Meligan Formation, the Kapilit Formation, the Sandakan Formation and the Bongaya Formation. Sections of the rock units were examined in detail to reveal their depositional facies and sequential variations. The succession of the sequence is composed of a major shoreline deposits from Sabah during Late Miocene. The sections are predominantly composed of interbedded sandstone and mudstone with shallow marine fossils and plant fragments. The sandstone usually shows sedimentary structures which are indicative of wave and tidal processes, such as swaley, hummocky, trough and planar cross stratifications. Bioturbation is common and include range of inchnofacies Skolithos to Cruziana, indicative of shoreface to inner shelf depositional environments. The major depositional system, reconstructed as partly storm-dominated nearshore package that includes four major depositional facies, namely the tidal inlet sandstone facies, lagoon mud facies, upper to lower shoreface sandstone facies and inner shelf facies. The sequence grades up-section into facies packages of increasing tidal energy and terminate with the deposition within the upper flow regime estuarine settings. Petrographic observations of different sandstone samples from different facies are used to demonstrate the palaeo environmental interpretations and to describe the diagenetic alteration of the rocks. The arrangement of these facies suggests a pattern of normal regression of sedimentary successions in this part of Borneo during Late Miocene.

Keywords: Sabah; Facies; Sedimentary Environments; Shoreface; Tidal Flats; Late Miocene Sedimentary Sequence.

PAPER B03

SEDIMENTARY FACIES AND DEPOSITIONAL ENVIRONMENTS OF THE NYALAU FORMATION (OLIGOCENE - MIDDLE MIOCENE) NORTH BINTULU AREA, SARAWAK

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This study presents a sedimentological analysis of the well exposed outcrops of Nyalau Formation (Mid Miocene) from North Bintulu area. Nyalau Formation has been well documented to contain many characteristics of marginal marine depositional systems. The aim of this study was to characterize the lithofacies and interpret the depositional environment; and improving the understanding of palaeoenvironmental evolution of sedimentary succession in the Nyalau Formation. A detailed sedimentary facies and biofacies studies of three principal outcrops (namely: Sibiu Road-1, Sibiu Road-2 and Taman Jasa Putra) revealed thirteen sedimentary facies (Table 1) and seven major facies associations that suggest a deposition in similar marginal marine settings but their palaeoenvironmental interpretation and correlation is more complex than previously thought. Sibiu Road-1 outcrop is dominated by sand-dominated mudstone interbedding with a moderate diverse euryhaline-to-shelfal foraminifera suggesting marginal marine to shelfal setting. Most of the Sibiu Road-2 succession is characterized by mud-dominated sandstone interbedding and laminated mudstone, with a few brackish foraminifera. While Taman Jasa Putra outcrop is dominated by well bedded HCS sandstone, distinct feature of this outcrop is the present of thick black / carbonaceous mudstone indicating shallow / low energy setting. Sedimentary rocks of the Nyalau Formation in the North Bintulu area show a variety of facies types and inferred to represent elements of tidally-to-wavy marginal marine depositional systems. In combination these study provide the next step of further knowledge of Nyalau Formation deposits, to realize in the future the correlations between outcrops and offshore data may contribute to a better regional understanding.

Keywords: Sedimentary facies, foraminifera, Nyalau Formation

Facies		Description	Sedimentary Structure	Bioturbation Index
A	Thin Bedded HCS Sandstone	well-very well bed, thin bed: flat- irregular-wavy	HCS, low-angle cross-stratification, couplet mud drapes, mud lenses, nodules / concretions, coal streak	BI: 1-3
B	Cross-Stratified & Planar-Laminated Sandstone	poorly bed, very well laminated: parallel, wavy-ripple	HCS, low-angle cross-stratification, couplet mud drapes, mud clasts, mud lenses, nodules / concretions	BI: 2-4
C	Wavy, Ripple, Cross-Stratified Sandstone	well-very well bed, thin bed: wavy-ripple, lenticular	HCS, low-angle cross-stratification, mud drapes, mud clasts	BI: 1-2
D	Herringbone & Wavy-Flaser Bedded Sandstone	poorly bed, well laminated: irregular-wavy, flaser	low-angle cross-stratification, herring bone, organic rich mud drapes, mud clasts, mud lenses, coal streak	BI: 1-3
E	Moderate-to-High Bioturbated Sandstone	poorly bedded, fairly laminated, flaser	HCS, low-angle cross-stratification, reactivation surface, organic rich mud drapes, mud clasts, mud lenses	BI: 3-4
F	Trough Cross-Stratified Sandstone	well bed: parallel, wavy, flaser,	trough cross-stratified, low-angle cross-stratification, mud drapes, mud clasts, coal streak	BI: 1-2
G	Sand-Dominated Mudstone Interbedding	well-very well bed, thin bed: parallel-irregular, well laminated	low-angle cross-stratification, mud drapes, nodules / concretions	BI: 1-3
H	Laminated Siltstone	massive, no apparent bedding, fairly laminated: parallel	mud drapes, mud clasts	BI: 0-1
I	Intense-Complete Bioturbated Siltstone	massive, no apparent bedding	mud drapes, nodule / concretions, coal streak, sand-silt laminae	BI: 5-6
J	Mud-Dominated Sandstone Interbedding	poorly-fairly bedded, thin bed, fairly-well laminated: irregular-wavy, lenticular	low-angle cross-stratification, mud drapes, sand-silt laminae, nodules / concretions	BI: 1-4
K	Muddy Heterolithic	poorly bed, well laminated: parallel-irregular-wavy, lenticular	mud drapes, sand-silt laminae, nodules / concretions	BI: 3-4
L	Laminated Mudstone	poorly bedded, fairly laminated; irregular-wavy	sand-silt laminae	BI: 0-1
M	Black / Carbonaceous Mudstone	fairly lamination: parallel	nodules / concretions, sand-silt laminae	BI: 0

Table 1: Summary of the sedimentology and ichnology of the twelve sedimentary facies recognized in the studied outcrops.

PAPER B04

MIOCENE LARGER BENTHIC FORAMINIFERA FROM THE KALUMPANG FORMATION, TAWAU, SABAH: PRELIMINARY INTERPRETATION

Junaidi Asis and Basir Jasin

Introduction

The Kalumpang Formation firstly introduced by Kirk (1962) and consists predominantly of mudstone and shale with interbedded sandstone (graywacke), conglomerate, limestone, marl, chert and volcanic rocks. Kirk (1962) suggested the age of this formation range from Upper Oligocene to Upper Miocene and confirmed by Lee (1988). Lim (1981) reported that the age of the Kalumpang Formation is Early to Middle Miocene age. This formation is divided into 4 units which are Sebatik Sandstone-Shale Member, Sipit Limestone Member, Sandstone Chert Facies and Volcanic Facies (Kirk, 1962). The formation is thrusted and faulted against the Darvel Bay Ophiolite Complex and overlain by Umas-Umas Formation in the lower Umas-Umas Valley and is overlain by Miocene volcanic rock in the Mount Wullersdorf and the Mount Magdalena area then covered by Quaternary sediments in the Balung Valley (Kirk 1962; Lee et al. 2004).

Miocene larger foraminiferas are recovered from the limestone unit of the Kalumpang Formation in the Teck Guan Quarry, Tawau, Southeast Sabah. These limestones are generally massive consisting of grey color and white spot of larger benthic foraminifera. The limestone unit at study area is a part of Sipit limestone member of the Kalumpang formation. The objectives of this researcher are to indentify the larger benthic foraminiferal species, their age and their depositional enviroments.

Material and Method

A total of five samples of carbonate rocks have been collected at Teck Guan Quarry at Tawau, Sabah. Fifty thin sections have been analysis for carbonate classification and foraminifers' identification. Preparations of thin sections are based on standard micropaleontology method. The identification of larger benthic and other faunas is based on previous researchers.

Result and Discussion

Based on classification of Dunham (1962), there are 3 types of carbonate rock which are packstone (sample 5), wackstone (sample 2-4) and mudstone (sample 1). According to Folk (1962), samples 2, 3, 4, 5 classified as biomicrite and sample 1 is classified as fossiliferous micrite.

The limestone beds display well-preserved faunal assemblage (eg. larger benthic foraminifera, alga, coral and planktonic foraminifera). In this study the most abundance fossils are larger benthic foraminifera and have been used for age determination. A total of 14 species of larger benthic foraminifera have been indentified i.e, Lepidocyclina (Nephrolepidina) parva Oppenoorth, Lepidocyclina (Eulepidina) formosa Schlumberger, Lepidocyclina (Nephrolepidina) sumatrensis (Brady), Lepidocyclina (Nephrolepidina) ferreroi Provale, Miogypsina sp A., Miogypsina sp.B., Cycloclypeus (Katacycloclypeus) annulatus (Martin), Cycloclypeus (Katacyloclypeus) martini (Van der Vlerk), Cycloclypeus (Cycloclypeus) carpenteri (Martin), Cycloclypeus (Cycloclypeus) indopacificus Tan Sin Hok, Cycloclypeus sp., Flosculinella bontangensis (Rutten), Operculina complanata (Defrance), Amphistegina bowdenensis Bermudez and Amphistegina sp. This assemblage indicates the age of limestone range from Early Miocene to Middle Miocene (Aquitanian to Serravallian).

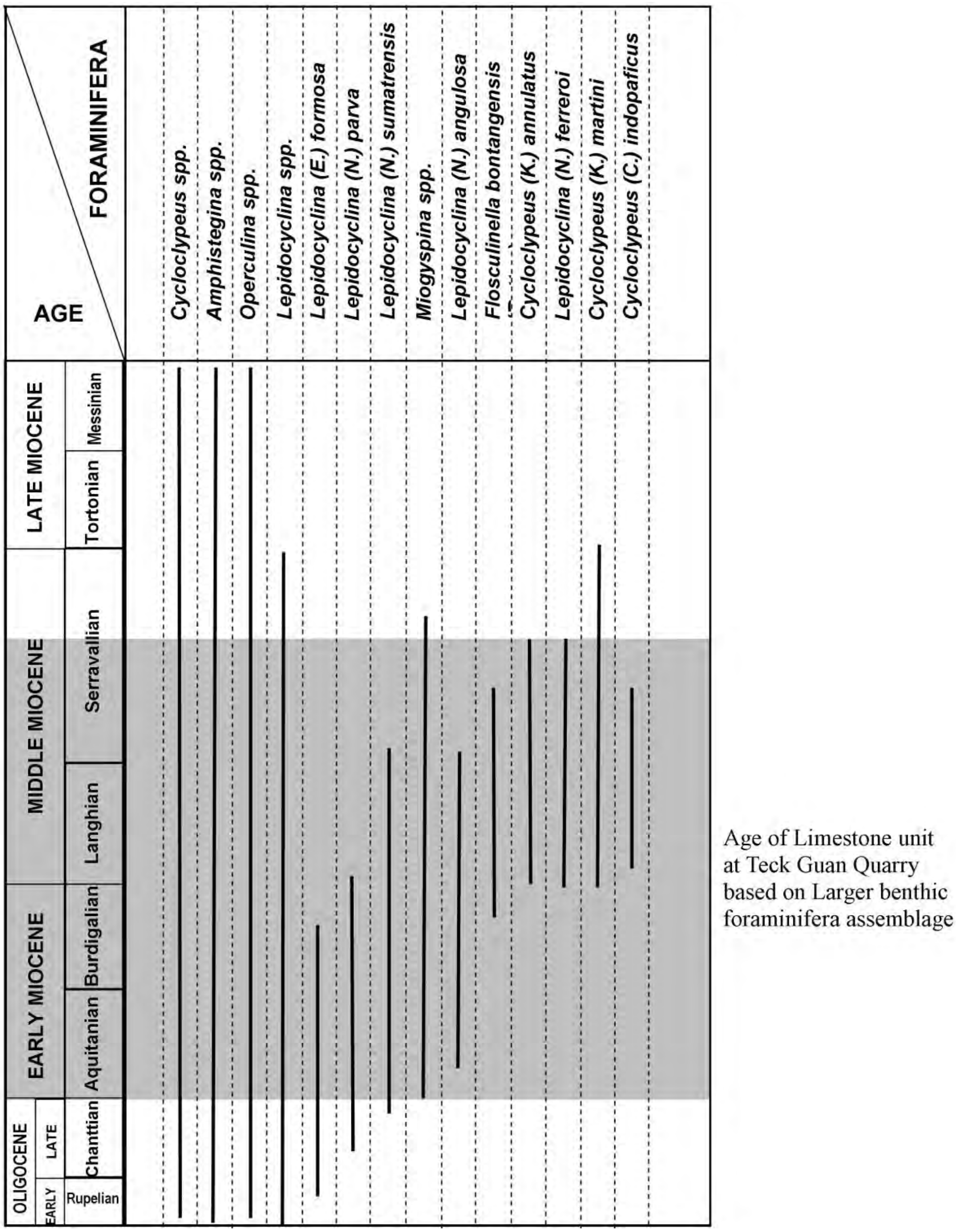

Figure 1 Stratigraphic distribution of selected larger benthic foraminifera.

The carbonate rock in this study area was deposited in warm and very shallow-marine environment. The water depth is within the euphotic zone, that is less than 120 m. The depositional environment of the limestone unit is interpreted as forereef shelves. In the forreef shelves area the percentages of bioherm of corals and algae are decreased. Meanwhile larger benthic foraminifera are dominant and cemented by calcite. At this area the most dominant foraminifera are Cycloclypids, lepidocyclinids, operculinids, Amphistegina, Heterosteginids (Baudagher-Fadel 2008).

Conclusion

The limestone unit from Teck Guan Quarry is some part of Sipit Limestone Member in the Kalumpang Formation. This limestone unit contains larger benthic foraminifera that indicated an Early Miocene to Middle Miocene in age ((Aquitanian to Serravallian). Based on larger benthic foraminiferal assemblage, the depositional environment was a warm and shallow-marine water at the forereef shelves zone.

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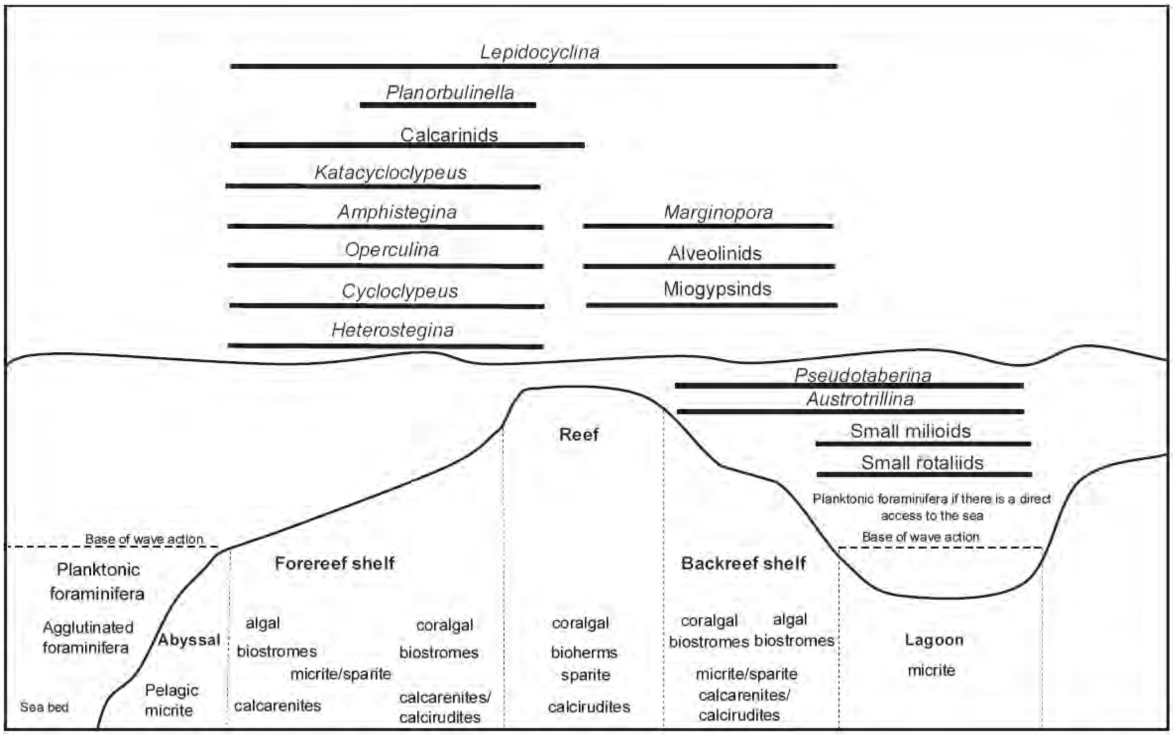

Figure 2 Depositional environment model of dominant Neogene Foraminifera Taxa (Baudagher-Fadel 2008).

POSIDONIA (BIVALVES) FROM NORTHWEST PENINSULAR MALAYSIA AND ITS SIGNIFICANCE.

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Posidonia is a common fossil in the Kubang Pasu and the Singa Formations in northwest Peninsular Malaysia. Posidonia is generally found in mudstones. In Perlis, Posidonia was recorded in several earth quarries at Utan Aji, Guar Sanai, and Ulu Pauh. It was reported from several earth quarries at Tunjang, Pokok Sena, Bukit Telaga Jatoh, Kampung Jelutong, and Bukit Jambul in Kedah. Posidonia was also reported from Pulau Langgun and Pulau Rebak Besar, Langkawi. Four species of Posidonia were previously described i.e. Posidonia elongata Sarkar, Posidonia dilatata Sarkar, Posidonia intermedia Sarkar, and Posidonia conspicua Sarkar. Previous works indicated that the age of Posidonia ranged from Middle Devonian to Carboniferous. Genus Posidonia was reported very common in Early Carboniferous Kulm facies in central Europe. Some species have been used for biostratigraphic zonations such as Posidonia becheri, Posidonia kochi, and Posidonia corrugata. Based on the distribution of the genus in Europe, It is possible to conclude that Posidonia is restricted to Lower Carboniferous (Tournaisian to Namurian). This suggests that the Posidonia from Peninsular Malaysia may have the same stratigraphic range. It has a wide geographic distribution from Europe, Turkey, China and Southeast Asia. This indicated it occupied the paleogeographic province of the Palaeo-Tethys during Early Carboniferous.

Introduction

The name Posidonia is shared between the marine biologists and the paleontologist. Posidonia was first used by König (1805) for seagrass which is commonly found in the temperate regions. Bronn (1828) coined the term Posidonia for the bivalves he discovered near Herbon, Germany. Although the name was first used by König, the term Posidonia has been used as a valid nomenclature (Amler, 2004, Hosgor et al., 2012).

Posidonia is a thin-shelled bivalve which was commonly found as imprints on the surface of mudstone and very rare on the sandstone. The thin-shells are easily dissolved. Most of the fossils are compressed and broken. It is very difficult to find the well-preserved specimens. The identification of the genus is based on the external features only such as overall shape, presence of concentric growth line and the position of umbo.

In the earlier works, Posidonia Bronn was considered to have stratigraphic range from Early Carboniferous to Late Cretaceous (Cox et al., 1969). The genus Posidonia is separated to three genera; the large Posidonia is assigned to Carboniferous, Peribositra Kurushin & Trushchelev for smaller Triassic form and Bositra de Gregor for the Jurassic bivalves.

Sarkar (1972) described four new species of Posidonia from Rebak Island, Langkawi namely Posidonia elongata, Posidonia dilatata, Posidonia intermedia and Posidonia conspicua. Only Posidonia elongata seems to be well-preserved the rest are poorly preserved. He assigned these species to Early Carboniferous age. It is not known whether the holotypes of these species are still preserved. To date, the species have not been validated.

More specimens of Posidonia have been discovered from several earth quarries, at Hutan Haji, Bukit Wang Tangga, Guar Sanai, Bukit Tuntung and outcrops in the vicinity of University Malaysia Perlis new campus Ulu Pauh, Perlis. In Kedah, Posidonia was found at Kuari Tunjang, Kuari Modal, and several outcrops in the vicinity of Pokok Sena (Fig. 1). Most of the Posidonia found in the area exhibit external morphology very closely related to Posidonia becheri Bronn.

Stratigraphical implications.

Outcrops at Guar Sanai, Bukit Tuntung and Bukit Meng show that the beds containing Posidonia are located on top of the bedded cherts which contain Tournaisian radiolarians (Basir and Zaiton, 2011). This suggests that Posidonia beds are younger than the chert. Hamada (!968,1969) reported that Posidonia occurred together with trilobite Cyrtosymbole (Waribole) perlisensis Kobayashi & Hamada, brachiopods Schuchertella sp., Tornquistia burtonae Hamada, Malayanoplia demiluna Hamada, Malayanoplia convexa Hamada, Semenewia (?) orientalis Hamada, Perakia (?) palcentiformis Hamada, Langkawia jonesae Hamada, Emanuella malayensis Hamada, Echinocoeliopsis sculpta Hamada and Echinocoeliopsis ladjioidea Hamada. Most of the species described by Hamada are endemic species. Only Posidonia has widespread distribution. Therefore, Posidonia can be utilized to determine the age of the assemblage. All beds containing Posidonia are considered as Early Carboniferous in age including the Langgun Red beds.

Paleogeographic significance

Posidonia is a pseudoplanktic bivalve which has a wide geographic distribution. It is a common fossil in shallow marine deposits, especially in shale and sandstones from the Early Carboniferous of Ireland (Yates, 1962), North England (Lebour, 1885), Central Europe (Amler, 2004), Poland (Nicolous, 1963), Morocco (Huvelin, 1961), Turkey (Hosgor et al., 2012), South China (Renjie and Daoping, 1993) and Southeast Asia (Reed, 1920, Yancey, 1972, Sarkar, 1972; Jones 1981). This suggests that Posidonia occupied the Palaeo-Tethys during Early Carboniferous (Fig. 2).

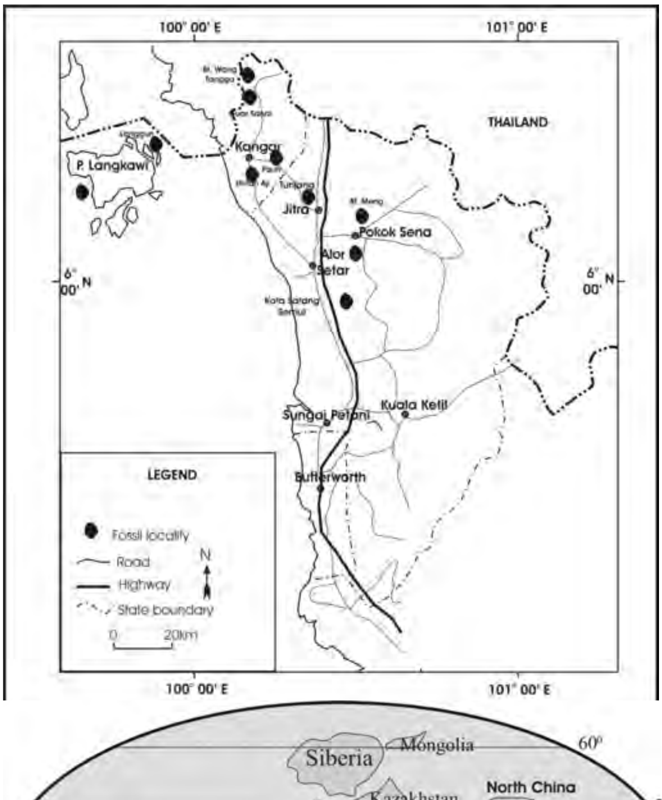

Figure 1. Distrbution of Posidonia in northwest Peninsular Malaysia

Figure 2. Distribution of Posidonia in the Palaeo-Tethys during Early Carboniferous.

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PAPER B06

SUB-SURFACE AND INFAUNAL FORAMINIFERA OF KELANTAN DELTA, EAST COAST OF PENINSULAR MALAYSIA: THEIR POTENTIAL FOR INTERPRETATION OF SEA LEVEL CHANGE

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This paper documents distribution and abundance of benthic foraminifera living in the upper 50 cm of mangrove sediment in the Kelantan Delta, Tumpat, northeast coast of Peninsular Malaysia and uses the results to interpret past environmental change and reconstruct historical trends. Kelantan Delta sedimentary environments consist of bay, mangrove, and estuary. During annual monsoon (November to February), Kelantan Delta is exposed to strong northeasterly waves from the South China Sea. Anthropogenic modifications to the system are substantial. Short cores (50 cm) were taken from three sites (Che Minah, Timun, and Terendak Islands) during field sampling in August 2009. Substrate sediment was dominated by silty mud. Salinity was recorded in situ during field sampling and ranged from 4 to 25 ppt. Lowest salinity was reported in Timun Island where the value ranged between 4 to 5 ppt and heavy rainfall that took place just before the sampling might be responsible for this. Meanwhile salinity in Che Minah and Terendak Islands ranged from 17 to 25 ppt. Eighteen agglutinated and one calcareous foraminifera species representing two sub orders and five families were observed. All were benthic and dominated by Arenoparrella mexicana. All species documented are common in the mangrove environment. Che Minah Island showed the lowest species richness (9 species encountered), while the highest species richness was documented in Timun Island (17 species). A considerable number of infaunal foraminifera (Rose Bengal – stained) were also discovered at the 40 - 50 cm depth in the cores. These were exclusively Miliammina fusca. Presence of infaunal foraminifera can alter the composition of dead assemblages in subsurface sediments and affect the accuracy of paleoenvironmental interpretations. Thus, the presence of infaunal Miliammina fusca in this study area suggests that their modern counterparts living in the surface sediment are not reliable to be used as paleo- sea level index points.

KEYWORDS: foraminifera, Kelantan Delta, Rose-Bengal, agglutinated, infaunal

INTRODUCTION:

Due to higher wave energy from the South China Sea, mangroves are less extensive along the east coast than the west coast of Peninsular Malaysia (Mohd Lokman and Yaakob, 1995; Mohd Lokman and Sulong, 2001; Sulong et al., 2002). Mangroves harbour a large benthic foraminiferal community where the species compositions vary according to the tidal-flooding-related zones and a well-defined vertical range, from front to the back mangroves (Scott and Medioli, 1986). Mangrove sediments by its nature possess the ability to fossilize the test of foraminifera especially the agglutinated one. Thus, the study on mangrove foraminifera can reveal the past, and benefits the paleoclimate-related studies such as sea-level changes (e.g. Horton et al., 2003).

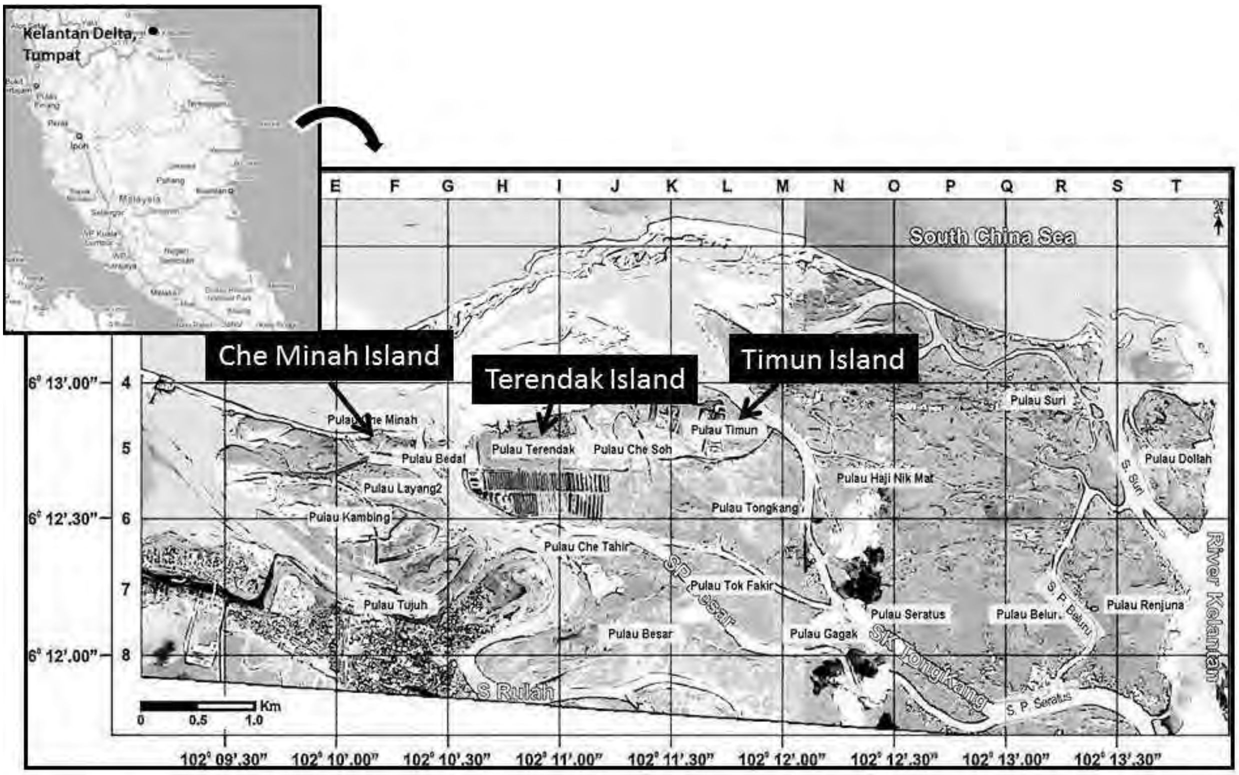

Figure 1: Locations of the three sampling sites in Kelantan Delta (modified from Kasawani, 2003)..

MATERIALS AND METHODS:

Field sampling in Kelantan Delta mangroves was conducted in August 2009 and 3 locations were selected. Short sediment cores (50 cm) were taken from three sites (Figure 1) using a D-section corer. Each core was then divided into 10 cm increments, wrapped in polythene sample bags and labelled (e.g. T1C1= Core site 1, subsample 0-10 cm). Fifteen sub-samples were collected from the three cores and gently washed within 36 hours of collection using a set of sieves (63-600 µm mesh size). The sample fractions retained on the small sieve were kept in a liquid suspension by adding 10% of formalin and Rose Bengal mixture for staining and preservation of foraminifera. Samples were prepared according to the methods of Scott and Medioli (1980). In the laboratory, preserved foraminifera were poured onto a petri dish and the empty test and living foraminifera were picked in a wet medium and mounted on the micro slides. They were identified according to standard nomenclature key from Leoblich and Tappan (1964) under a binocular microscope. The photographs for each species were taken with Scanning Electron Microscope (SEM).

RESULTS AND DISCUSSION:

Eighteen agglutinated and one calcareous foraminifera species representing two sub orders and five families were observed. All were benthic and dominated by Arenoparrella mexicana. All species documented are common in the mangrove environment. Che Minah Island showed the lowest species richness (9 species encountered), while the highest species richness was documented in Timun Island (17 species) (Table 1). A considerable number of infaunal foraminifera (Rose Bengal – stained) were also discovered at the 40 - 50 cm depth in the cores. These were exclusively Miliammina fusca. Presence of infaunal foraminifera can alter the composition of dead assemblages in subsurface sediments and affect the accuracy of paleoenvironmental interpretations. Thus, the presence of infaunal Miliammina fusca in this study area suggests that their modern counterparts living in the surface sediment are not reliable to be used as paleo- sea level index points.

No.	Species	Transect 1	Transect 2	Transect 3
1	*Acupeina triperforata*	×	√	×
2	*Ammobaculites exiguus*	√	√	√
3	*Ammotium pseudocassis*	×	√	×
4	*Ammotium salsum*	√	√	×
5	*Ammotium* sp.	×	√	√
6	*Amphistegina* sp.	×	√	×
7	*Arenoparrella mexicana*	√	√	√
8	*Caronia exilis*	×	×	√
9	*Haplophragmoides manilaensis*	×	√	√
10	*Haplophragmoides wilberti*	×	√	√
11	*Jadammina* sp.	√	√	√
12	*Miliammina* sp.	×	×	√
13	*Miliammina obliqua*	×	√	×
14	*Miliammina fusca*	√	√	√
15	*Paratrochammina* sp.	√	√	√
16	*Siphotrochammina* sp.	√	√	×
17	*Trochammina inflata*	√	√	×
18	*Trochammina macrescens*	×	√	√
19	*Trochammina* sp.	√	√	√
	Total species	9	17	12

√ = Present
× = Absent

Table 1: Species of foraminifera found in the core sediments of Kelantan Delta mangroves

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PAPER B07

INTERPRETATIONS ON SEISMIC VOLUME OVER TWO MIOCENE CARBONATE PLATFORMS IN CENTRAL LUCONIA, SARAWAK

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Keywords: Central Luconia, Carbonate Platforms, Seismic Interpretation, Faulting, Growth Architecture

Interpretation of two Miocene carbonate platforms in Southeastern part of Central Luconia Province has provide a clear idea on the structural history of the platforms, relating syn-depositional faulting with the platform evolution and it's internal architecture. The interpretation was done on 3D Seismic volume over two Miocene carbonate platforms.

These carbonate platforms were initiated on topographically high horst blocks, resulted from crustal extension from opening of the South China Sea during Eocene to Early Miocene (Epting, 1980). Reactivation of faults during the crustal extension formed horst-graben pattern, which controls the size and distribution of carbonate platforms in Central Luconia Province (Yamin & Abolins, 1999). These blocks remain high enough through out the Middle-Late Miocene to provide a favorable environment for shallow-water carbonate production.

Six horizons including carbonate base, carbonate top and four inter-carbonate horizons have been interpreted on both platforms. These horizons represent four different stages of carbonate growth,starting with build-out phase, followed by build-up and build-in phase, and carbonate production stopped when the platforms were drowned and subsidied. Internal architecture of these platforms ranges from standard layer-cake of carbonate platform with flat top (Platform FY) to sub-circular, steep sided margins that appear tilted and ends-up in pinnacle look-alike before carbonate production stop (Platform EX).

Growth of carbonate platforms in Central Luconia Province are influenced by sediment supply from Borneo onshore and syn-depositional tectonic, together with eustatic sea level changes, climate and wind direction. Both interpreted platforms received the most influence of sediment supply from Middle- Late Miocene Siliciclastics Influx from Borneo Onshore compared to other platforms in Central Luconia Province. These influxs have favour platform growth during build-out and build-up stages by suppling nutrient to the reef when the carbonate deposited . However, it also affects the demise of the platforms by providing extra clastic input. Extra clastic input creates unfavourable water environment for carbonate growth, and leads to subsidence and collapsed of the platforms due to increase of gravity loading from rapid accumulation of sedimentary deposits above the platform.

Subsidence and collapsed of the platform are associated with syn-depositional faulting (Zampetti et al., 2004). Both platforms have been intensively affected by active faulting during their growth stages. All faults are normal faults, oriented in N-S orientation which seems to govern the north-south elongation of platforms in Southeastern part this province. The faults are dipping approximately 15°-50° in NE-SW orientation . Most of the faults cut through all the horizons on both platforms. Some of the fault(s) are initiated earlier before carbonate starts to deposit on the platforms and continues to move during deposition of carbonate, making a syn-depositional faulting. On Platform EX, all the faults stop moving before the platform was drowned. While, on Platform FY, some of the faults continues to move even after the drowning event.

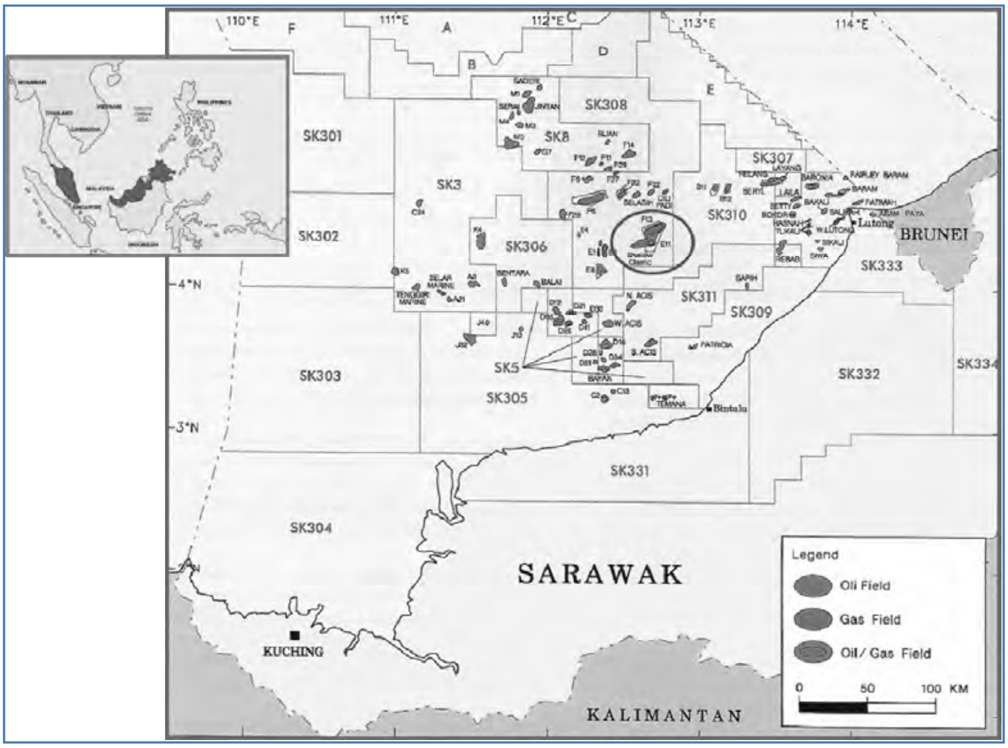

Figure 1: Study area is located in Southeastern part of Central Luconia Province, offshore Sarawak. Circle is showing two carbonate platform studied for this research (Yamin & Abolins, 1999)

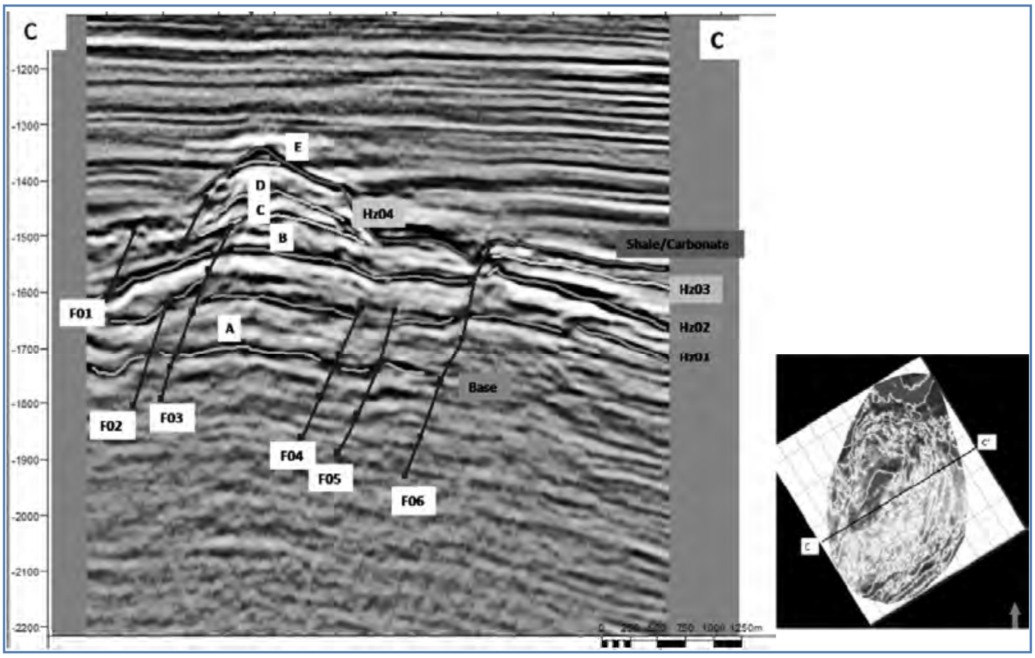

Figure 2: One of the studied platform, Platform EX showing sub-circular shape on time-slice with steep-sided margin that appears as pinnacle look-alike carbonate platform. Interpreted horizons with syn-depositional faulting are labelled in this diagram, showing that this platform has been extensively affected by faulting during the carbonate deposition.

Platform tilting is also observed on both platforms. Major faulting on the platforms is believed to be responsible for the tilting. Active seismic shaking is created when major fault moves at the same time of carbonate deposition. Apart from active seismic shaking created during syn-depositional faulting, increase of overburden from growing carbonate layers also responsible for platform tilting. As the platform tilted, lateral environmental facies on the platform has changes from reef build-up to quiet lagoonal facies environment. The changes are observed laterally in distance approximately 2.5-3.5km.

In conclusion, interpretation of two carbonate platforms in Central Luconia Province has provide a clear idea how syn-depositional faulting incorporate with carbonate platform growth, affecting its internal architecture and facies distribution through out the platforms.

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MAGNETIC SIGNATURE OF IMPACT STRUCTURE AT LENGGONG PERAK, MALAYSIA

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A magnetic survey was conducted at Lenggong, Perak which involved an area of 1600 square kilometres by using two proton precession magnetometers. One of the magnetometer was located at the base station for diurnal correction purposes and the other was used for magnetic field data measurement. The magnetic total field intensity readings were taken at 694 stations in the study area with spacing between the stations of about 100 to 1000 meters. The magnetic readings at the base station were recorded manually for every 10 minutes time interval. General geology of the study area was obtained from previous geological report and field observation during the extensive magnetic survey. The study area comprises of granite, schist, limestone, alluvium and some boulders of suevite. Oasis Montaj software was used for data processing and filtering to obtain the total field magnetic anomaly map which includes its derivative maps such as Reduction to Equator (RTE), Low-Pass Filter (LPF), High-Pass Filter (HPF) and Total Horizontal Derivative (THD) maps. The Oasis Montaj software was also used to obtain two dimensional model of the subsurface structure. The magnetic anomaly and its derivative maps were studied to determine their possible relation with the meteorite impact structure at the study area. A pattern of circular distribution of magnetic anomaly in the study area was interpreted to be the outer rim's boundary of the impact crater. Negative magnetic anomaly appears to be dominated within the Bukit Bunuh area which exhibits a subdued negative magnetic response, implying demagnetization due to the impact. The magnetic anomaly map shows a diameter of approximately 5 km for the impat crater and it was successfully modeled as a 2-D complex crater with maximum depth of less than 600m.

Keywords: Earth magnetic field, magnetic anomaly, iron deposit, impact crater

PAPER B09

GEOLOGICAL ANALYSIS OF GPS DATA: MALAYSIAN CASE STUDY

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ABSTRACT

GPS data analysis was carried out to study the movement of the earth's crust and to determine the effects of the earthquakes (in Indonesia) on the tectonic blocks of Peninsular Malaysia. GPS data from five MyRTKnet stations in West Malaysia were selected to study the movement of two major tectonic blocks of Peninsular Malaysia: the western belt (represented by Behrang and UPM Serdang stations) and the central belt (Bentong, Jerantut and Temerloh stations). GPS data recorded at every 15th day of the months from 2005 to 2010 were analysed based on the horizontal and vertical displacements of the respective stations. The accumulated displacement of GPS stations based on readings recorded from May 2007 to December 2010 show that the western belt has shifted around 5.59 to 23.18 cm towards southeast in counter clockwise fashion while the central belt shifted around 0 to 19.45 cm to the northwest also in counter clockwise fashion. Bentong station which is located in the Bentong-Raub suture zone has shifted 23.43 cm towards southeast and more or less similar to the direction of the western belt. Although the yearly movement of the five stations is generally in the same direction, the study found that the movement for most of the GPS stations, except Temerloh, occurred in different directions in certain months such as in July 2007 (Jerantut), January and May 2008 (Behrang), September and March 2009 (UPM Serdang and Jerantut) and November 2010 (Bentong). These different direction of movements are interpreted to be due to the influence of different movement of faults in the study areas which have been reactivated and stimulated by several large earthquakes that occurred in the period between 2005 and 2010. These results suggest that the integrated GPS data and geological structures analysis are necessary to understand more detail about the earth's crustal movement and tectonic evolution of Peninsular Malaysia.

Keywords: GPS data, tectonic movement, Faults, earthquake

AN EARLY MID-HOLOCENE CORAL REEF AND EXTENSIVE MARINE DEPOSITS ON THE TERENGGANU MAINLAND, PENINSULAR MALAYSIA: IMPLICATIONS FOR MAXIMUM HOLOCENE TRANSGRESSION

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A fossil coral reef and extensive shelly marine deposits occur 6 to 8 km inland from the modern coastline west of Merang, Terengganu. Upper portions of the in situ fossil reef extend to an elevation of ca. 50 cm above present MSL and are comprised of at least 15 coral species with associated bivalves (commonly articulated) and gastropods. Radiocarbon age analyses of two coral specimens produced age estimates ca. 7 ka. The fossil coral reef is situated ca. 70 m northeast of a range of bedrock hills that formed a peninsula of the mainland during sea-level highstand conditions. To the west of this range of hills is a several km broad flat landscape with elevations generally less than 2 m. Drainage ditch excavation, not exceeding 3 m depth below the land surface, has produced abundant and diverse fossil mollusk material in tailings. Fossil shells are extremely well preserved and bivalves are commonly articulated indicating in situ burial. Small coral colonies occasionally encrust mollusk shells. The flat area west of the range of hills is interpreted as having been a shallow marine embayment with muddy sediment dominant in the embayment's interior and sandy shoreface landward. During life, the fossil coral reef northeast of the range of hills is interpreted as having been exposed to full marine conditions seaward of a rocky headland. South and southwest of the shallow embayment deposits in the vicinity of Kampung Bukit Kecil, a white sand ridge represents the landward most occurrence of paleo-beach deposits in the study area. Data from this study suggest that maximum transgression in this region occurred ca. 7 ka with relatively stable sea-level and environmental conditions persisting long enough for development of a diverse coral reef assemblage. If tidal range conditions were similar to today (ca. 1.8 m), sea level ca. 7 ka could have been no less than 1.4 m above present and was likely more. Following this time, abundant sediment supply in the coastal system resulted in the construction of a beach-barrier system seaward of the coral reef site, conversion of the area to a turbid lagoonal environment no longer suitable as coral habitat, and in situ burial by muddy lagoonal deposits. If regional sea-level data indicating maximum Holocene highstand of as much as 5 m above present between 6 and 4 ka are correct, our data suggest that maximum transgression preceded maximum Holocene sea level in the study area by at least one thousand years.

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PAPER B11

PETROLOGY AND GEOCHEMISTRY OF A-TYPE IGNEPOUS FROM TELUK RAMUNIA, SOUTHEASTERN OF JOHOR.

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The main objective of this study is to investigate the petrology, geochemistry and petrogenesis of volcanic rocks from southeast Peninsular Malaysia mainly within Teluk Ramunia. The volcanic rocks from that area are located on the eastern belt magmatism dominated by I-type rocks. The rocks from study area are dominated by rhyolite, trachydacite and diorite and they show irregular contact which suggests contemporaneous crystallization. Petrographically, all rocks shows occurrence of micrognanophyric, interstitial biotite and hornblende which is characteristic of the A-type rocks and sub-volcanic emplacement. Field and geochemical evidence shows that the rhyolite is derived from a different magmatic pulse than trachydacite and diorite. The value of Ga/A and HFSE (Zr+Nb+Ce+Hf) for all rocks from study area is comparable to the average A-type rocks. All rocks shows range from metaluminous to weakly peraluminous in term of their A/CNK value. All rocks yield high saturation temperature calue (>810OC average) and high content of high field strength elements (Zr,Nb,Ce and Hf) which are clearly indicative of dry source derived which is high probably charnockite. Based on U-Pb isotope, rhyolite gave age about 238 + 2 Ma which suggest that all rocks are formed during subduction of the Palaeo-tethys ocean underneath Indochina (volcanic arc). However the occurrences A-type give implication that all rocks are formed during crustal extension due to oceanic slab rollback. The under-plated mantle derived basalt will intrude into the lower crust during lower crustal extension. The high heat yield by the mantle derived basalt will contribute to the dehydration of the granulite to become charnockite and the magma derived from melting of charnockite will likely to form the A-type rocks within the study area during Middle Triassic time.

PAPER B12

AN OVERVIEW ON THE TECTONICS AND SEDIMENTATION OF KUCHING – LUNDU – SEMATAN TRANSECT OF SOUTH-WEST SARAWAK BASIN, MALAYSIA

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Detailed geological study of the out-crops and a good coverage of geophysical gravity data acquisition covering an area of about 100 km by 100 km around Kuching along the transect Kuching – Lundu – Sematan have aided in an effort to overview tectonics and sedimentation of the SW Sarawak on-shore basin. The tectonic imprints of the region suggest that the SW Sarawak on-shore basin, west of "Lupar Line", has been evolved through subduction tectonics wherein the southwestern region of the "Lupar Line" is characterized by back-arc basin zone. This back-arc basin has undergone extension mechanism due to both sedimentary and volcanic loading wherein the basin has experienced igneous intrusions and lava flow. Basin subsidence has caused synthetic faulting and slope failure in the sedimentary sections. Occurrence of extensive turbidite sequence lends support to long prevailing slope to deep marine environment of sedimentation with the development of sub-marine fans.

The occurrence of andesitic lava in Sematan and Lundu area suggests partial melting of the subducting basaltic crust. The occurrence of pillow basalt near Sematan further supports that a NW – SE trending arc-proper zone of the converging plate setting occurs in the Kuching – Lundu – Sematan area. We name this arc as Semantan – Serian volcanic arc. Greenstone, which is the source of small deposits of mostly-low-grade bauxite at Tanjong Serabang, Gunong Angus, Gunong Tamin Tungku, Bukit Batu, and in the lower Samunsam Valley, has been derived from dynamic metamorphism of dolerite, gabbro, basalt lava and basic tuff. This signifies a tectonic transportation and emplacement of the oceanic crust onto the arc-proper zone. The occurrence of tonalite intrusion with a lenticular outcrop extends northwest from near the mouth of the China River, north of the Samunsam Estuary further signify the northward extension of Borneo Core, believed to be the Precambrian Gneiss, as a peri-cratonic shelf which eventually has been obducted over the Luconia block. The obduction has exhumed the Rajang Group accretionary prism and arranged structurally as imbricate thrust zone.

The NW – SE strike of the gravity trend suggest that the subduction has commenced from northeast. It is interpreted that Luconia block has subducted below SW Sarawak on-shore basin. A linear NW – SE striking southward gravity low signify a basin which suffered two phases of deformations having a maximum thickness of sediments around 8 Kms. A tectonic scheme is proposed for the SW Sarawak basin as from north to south: a) Rajang accretionary prism, b) Semantan – Serian arc proper, c) Northwest Borneo back-arc basin.

Greenstone belts are zones of variably metamorphosed mafic to ultramafic volcanic sequences with associated sedimentary rocks that occur within Archaean and Proterozoic cratons between granite and gneiss bodies.

The name comes from the green hue imparted by the colour of the metamorphic minerals within the mafic rocks. Chlorite, actinolite and other green amphiboles are the typical green minerals.

A greenstone belt is typically several dozens to several thousand kilometres long and although composed of a great variety of individual rock units, is considered a 'stratigraphic grouping' in its own right, at least on continental scales.

Typically, a greenstone belt within the greater volume of otherwise homogeneous granite-gneiss within a craton contains a significantly larger degree of heterogeneity and complications and forms a tectonic marker far more distinct than the much more voluminous and homogeneous granites. Additionally, a greenstone belt contains far more information on tectonic and metamorphic events, deformations and palaeogeologic conditions than the granite and gneiss events, because the vast majority of greenstones are interpreted as altered basalts and other volcanic or sedimentary rocks. As such, understanding the nature and origin of greenstone belts is the most fruitful way of studying Archaean geological history. Greenstone belts are basically metamorphosed volcanic belts.

PAPER B13

VIRTUAL GEOLOGICAL FIELDWORK APP FOR ELEARNING

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Geology Fieldwork is a practical method of learning in which students are exposed to geology informaKon in the field (ie, outside their lecture hall). Some of the important aspects of geology can be learnt are the rock types, mineral content of rocks, structural geology (faults, folds, joints and bedding) and fossils. However, typical fieldworks usually involved high financial cost and duration to complete (about 2 weeks). There is also problem of where the outcrops that can be lost permanently if the rocks are quarried (to produce aggregate materials) or rocks are excavated to make room for more important development. So when this happens, we lost resources for very important geology informaKon. To overcome these problems, a research project called Virtual Fieldwork is being undertaken with the use of latest Information Technology. The Virtual Geology Fieldwork will help to enhance students understanding what they have to learn in actual fieldwork. This study has the following objecKves; (i) to produce a database of geological information specifically at the East Coast of Peninsular Malaysia, (ii) to produce a tool that is more effecKve in teaching geology by way of virtual learning; (iii) to study the effecKveness of virtual learning assistance than ordinary learning. The project began with the collection of geology information and then converted them to digital form. The work started with intensive fieldwork along the east-coast federal road comprises of three states of Pahang, Kelantan and Terengganu. During the trip, the digital images of the localities were recorded using Panoramatic 360 Apps using an IPAD. Mineral, rock and fossil samples were collected and were taken to the laboratory for 3-D photography. Rock samples were used to prepare the thin secKon for rock classificaKons. All informaKon collected were put together using a computer coding to produce virtual e-learning software that runs on Apple platform. The significance of this project is to produce prototypes for virtual learning for the Universiti Kebangsaan Malaysia. This will set a standard or benchmark to produce a few more virtual fieldworks for other science courses in the future.

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SIMILARITIES IN MIDDLE-LATE PERMIAN FOSSILS FROM MYANMAR AND MALAYSIA AND ITS PALEOGEOGRAPHIC IMPLICATIONS

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This paper describes and illustrates some Middle-Late Permian rugose corals and a trilobite species from the “Plateau Limestone”, Myanmar. This will provide a basis for comparison with faunas from Malaysia and their paleogeographic relations in Middle-Late Permian.

The rugose corals stratigraphically distributed in the southern Shan State occur throughout the Permian (Pseudoschwagerina-Verbeekina) Zones (Oo, 2010; Aye KoAung, 2011) and very recently from Late Permian (Paleofusulina-colaniella) Zone (Aye KoAung et al., 2013) although the richest faunas are from strata of Wordian/Murgabian age. The small numbers of Lower Permian (Kungurian) coral species (Anfractophyllum n.sp., Pavastehphyllum n. sp., Thomasiphyllum n. sp., and Wentzellophyllum n. sp.) (Aye KoAung, in prep.)are also recognized in some areas (Kazet, Thayetpya and Taungni areas of the southern Shan State). Some Middle Permian rugose corals from the Sibumasu Block in Myanmar (Waagenophyllumyini Fontaine, Multimurinusfontainei (Kato & Ezaki), and Ipciphyllumsubelegans Minato & Kato) also resemble those from Bukit Kepayang, Pahang State (Fontaine et al. 1988) and Bukit Biwah, Terengganu State (Kato & Ezaki, 1986), both are located in the East Peninsular Malaysia Indochina Block. In one locality named Linwe, a Permian (Murgabian-Capitanian) phillipsiid trilobite was recovered from the Thitsipin Limestone (Aye KoAung, 1994) for the first time from Myanmar and is closely comparable to that from the Permian (Guadalupian) Bera Formation, Pahang, central Peninsular Malaysia (MohdShafeea Leman &Sone, 2002).

The presence of early Middle Permian (Roadian) small solitary non-dissepimentedrugose coralLophophyllidiumorientalis(Smith) in association with abundant lacy bryozoans, brachiopods and debris of crinoid ossiclesfrom the black bioclasticwackestone, in the Htamsang area, Hopong Township suggest that the southern Shan State was in the Peri-Gondwanapaleogeographic provinciality during the early Middle Permian (Roadian)for a very brief time interval (270.6-265.8 M) only, but Thomasiphyllum n. sp. indicate Cimmerian provinciality andWentzellophyllum n. sp. Indicates Cimmerian-Cathaysian mixed provinciality. The similarities between the Middle Permian rugose corals Waagenophyllumyini Fontaine, Multimurinusfontainei (Kato & Ezaki) and IpciphyllumsubelegansMinato & Kato from the Sibumasu Block in Myanmar and that of the East Peninsular Malaysia Indochina Block suggest that both were at a close paleogeographic position, likelyin the Cathaysianpaleogeographic provinciality during the Middle Permian. Iranophyllumpahangense Aye KoAungfound in both Shan States and Pahang, eastern Peninsular Malaysia confirmed that both are in theCathaysianpaleogeographic provinciality during the Late Permian.

These lead to the question on the width of the Permian Palaeotethys and timing of its demise.The result of the study imply that the Middle Permian Paleo-Tethys is just anarrow ocean or seaway and that by Late Permian, the ocean disappeared by collision as shown in figure (1) below.

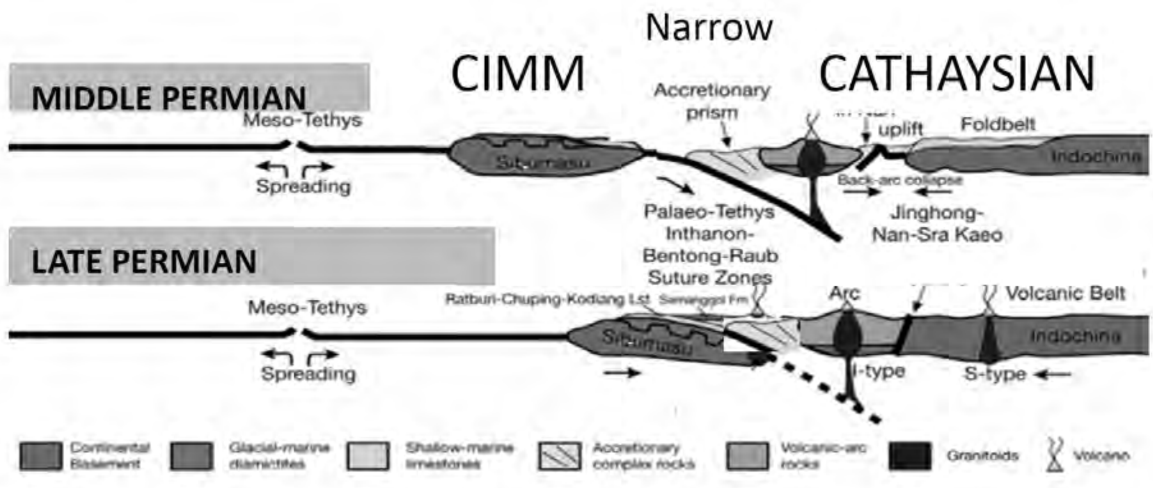

Figure 1. Proposed paleogeographic and tectonic evolution (modified from Metcalfe,2011)

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A POSSIBLE STRUCTURE OF IMPACT CRATER AT LENGGUNG PERAK : GRAVITY EVIDENCES

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Geophysical measurements have always played a major role in the investigation and study of impact craters (impact structures). In this study, a regional gravity survey focusing at Bukit Bunuh and its surrounding area was conducted to determine whether the gravity anomaly in the vicinity of the Bukit Bunuh area is related to a possible remanent of meteorite impact crater. The gravity survey was conducted using Scintrex CG5 gravity meter. A total of 544 gravity stations had been established with approximately 500m spacing (except 50 m spacing around Bukit Bunuh area), covering an area of approximately 160 square km. The elevation of the gravity stations were determined by using a pair of Wellace and Tiernan altimeters and the station coordinates determined by using global positioning system (GPS). The observed gravity data were tied with an established absolute gravity station in Ipoh. The gravity data were corrected for drift, free air, bouguer, latitude and terrain in order to produce corrected bouguer anomaly data of the study area. The data were processed and analysed using Oasis Montaj Geosoft software to produce bouguer, residual, THD residual, regional and THD regional anomaly maps for qualitative and quantitative interpretations. The bouguer gravity map shows relatively low negative anomaly with nearly circular shaped contour around the Bukit Bunuh area. This anomaly was interpreted as a remnant of meteorite impact structure with rounded shaped crater in the study area. The bouguer anomaly map shows that the Bukit Bunuh impact crater has a diameter of approximately 2.5 km. The impact structure was successfully modeled as a complex impact crater with maximum depth of about 400 m. The bouguer anomaly map also shows the possible occurences of at least two more impact craters located in the northeast and southeast areas of the Bukit Bunuh impact crater and these structures need further investigation for confirmation.

Keywords: Archaeology, meteorite Impact structures, complex crater, gravity anomaly

PAPER B16

THE IMPORTANCE OF K AND B VALUES FOR SCALED DISTANCE TECHNIQUE FOR PREDICTION OF GROUND VIBRATIONS LEVEL INDUCED DURING GRANITE QUARRY BLASTING FOR PENINSULAR MALAYSIA

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Ground vibrations induced during rock blasting is one of the problems which have an impact on the environment and people. Hence, vibration control study plays an important role in minimizing blasting effects in quarry operation. To establish a useful relationship between peak particle velocity and scaled distance technique two granite quarries were selected. The study begins with the collection of blasting records and blast monitoring records from the selected quarries. In this study, blast design parameters including maximum charge weight per delay, distance from blast area to monitoring station, number of holes, hole depth and peak particle velocity of each blasting operation were recorded for analysis. In order to derive prediction equations, data pairs of scaled distance and particle velocity values obtained from two quarries were analyzed statistically using simple regression analysis. From this analysis, site constants, K and β value for each quarry would also be derived. Then, to validate whether these prediction equations are suitable for predicting peak particle velocity, several blast monitoring records from granite quarries throughout Peninsular Malaysia were selected and combined with derived prediction equations. From the analysis at various case study sites, the suitable prediction equation for predicting ground vibrations at granite quarry is determined as PPV = 37* SD ^ -0.63 where K= 37 and β = -0.63, Overall conclusion from this research, for granite quarry, prediction equation derived from regression analysis i.e. Peak Particle Velocity = 37 (SD) -0.63 is the most suitable and relevant prediction equation in predicting ground vibrations level induced during blasting for Peninsular Malaysia.

PAPER B17

ENGINEERING GEOLOGY OF THE IPOH-SIMPANG PULAI-GOPENG SEGMENTS OF THE NORTH-SOUTH HIGHWAY, PENINSULAR MALAYSIA

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The Ipoh-Simpang Pulai-Gopeng segments of the North-South Highway in Peninsular Malaysia traverses various interesting geologic/rock formations, namely: limestone, granite, schist and colluvial deposits – basically Kinta Valley geology with its famous, picturesque limestone hills. The construction of the North-South Highway in this region encountered a slew of problems which are directly related to the nature of these rock formations and soil deposits. This paper discusses the engineering geologic problems encountered during the construction of the Highway, which, among others, include the following:

a) Granite rock slope stability,

b) Limestone hill slope stability,

c) Stability of cut-slope in schist intruded by aplite dykes,

d) The problematic colluvial deposits.

Various techniques were used to overcome these problems, and they were by-and-large successful. However, there were also some post-construction failures and incidents, including a major debris flow which damaged part of the Highway. Figure 1 shows a view of the Highway under construction, depicting contrasting geologic formations.

Figure1: North-South Highway under construction, looking north. G. Tempurung (limestone) on the left, schist in cut-slope on the right, and granite further right (Main Range). Colluvium occurs along the Highway mainly as valley fills.

PAPER B18

EVALUATING GROUND CONDITIONS AHEAD OF A TUNNEL FACE USING PROBE DRILLING DATA AT NATM-1, KARAK, MALAYSIA

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Alternative means in determining rock and geological conditions in advance of a tunnel face constructing using the New Austrian Tunnelling Method (NATM) at NATM-3, Karak, Malaysia which is part of the Pahang Selangor Raw Water Transfer (PSRWT) Tunneling project are explored. A probe drilling operation involves in using a long horizontal percussive drilling method, commonly a 30 m long probing, that precedes the NATM provided drilling speed, cutting condition, slime color, water flow and slime condition data which to anticipate the change in ground conditions, rock strength, discontinuities of rock, water bearing zone and bad roof conditions. This paper presents the probability of obtaining an accurate prediction of rock mass profiles prior to the respective tunnel faces by performing different numbers of probing drilled at different tunnel distances and its comparison to the actual recorded geological condition. An analysis of the state-of-the-art is revealed in order to foresee any potential hazard thus to avoid the tunnel from collapse. The probe drilling data is a computer synthesized to develop a digital representation of the ground ahead, and the resulting "picture" of the ground is compared with the recorded geological tunnel face mapping data. As the result of this study, the interaction of rock condition with hydraulic, mechanical and hydromechanical approach by using probe drilling method may offer higher precision data to evaluate the rock conditions where, is more efficient, economical and significantly less intrusive in tunneling operations ahead.

Keyword: Probe drilling, Drilling speed, NATM, Meta-sedimentary rock, Geological tunnel face

PREVENTIVE EVALUATION OF THE LIMESTONE QUARRY FACE SAFETY AT THE KHANTAN CEMENT WORK, CHEMOR, PERAK

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Quarry faces are dynamic slope and always subjected to inconsistency in terms of variability in lithology, weathering grade, structural features and hydrogeology. Furthermore is often subjected to vibration due to blasting (design) impact and movement of machineries in the work places while the quarry operation advancement. Analyzing of the above parameters is important input in the quarry planning and design in ensuring safety operation and productivity. Rock mass classification (GSI method) and kinematic analyses have been used critically to evaluate the geotechnical conditions of the quarry faces stability as well as the potential, scale and modes of the failures.

Limestone rock mass in many survey windows are characterized with different and unique structural and weathering profile, often massive, competent and occasionally interbedded with carbonaceous shale, carbonaceous limestone and pink dolomite. Throughout, the rock bed are variably, often look massive, medium to very strong, heavily jointed (3 to 4 joint sets), fractured, and occasionally faulting and gently folded in places. Geotechnically, it is having Geological Strength Index (GSI) between 70-90%, indicative strong to very strong rock mass (R4-R5) in the field classification. A few are with GSI < 70% and often very blocky in nature. Planar sliding mode is critical in the selective dipping orientation or joint surface. Especially when quarry face is coincide with slope faces. Wedge sliding mode is critical where 3 or more joint sets and bedding intersected. Tendency of slope failure in such modes are selective and very variable depending upon bedding and joint set occurrences and orientation in most investigated survey windows. It is often over 50% as planar sliding failure and maximum 45% as wedge sliding mode.

PAPER B20

DISCONTINUITY SURVEY OF BUKIT MEMALOH, KANOWIT, SIBU DIVISION, SARAWAK

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OBJECTIVE

The objective of the study was to ascertain whether there is a risk of possible landsliding activity involving the Bukit Memaloh, as this hill is a strategic landform for atop its peak lies the Kanowit Water Treatment Plant and directly beneath it lies a row of shophouses along the two rows of streets sandwiched between the hill and the Sg. Kanowit, effectively the main town of Kanowit. Further along its boundary also along its foothills is the primary school of SRJK St. Xavier which has since been abandoned for fears of rockfall and possible landslide onto the school which has a clearance of only a meter or two in certain places between the hill and some parts of the school buildings.

GEOLOGICAL SETTING

According to Leichti et al. (1960) the oldest rocks (Upper Carboniferous) in Sarawak occur at the southwestern edge and becomes younger proceeding northeasterly upwards through Central Sarawak and Eastern Sarawak (Upper Cretaceous and mostly Tertiary) till the Quaternary period, the rocks mostly represented by isolated basins. This is also seen in the Kanowit area in Central Sarawak, where the oldest rocks belong to the Belaga Formation (Upper Cretaceous).

Igneous activity intruded into these rocks of the so-called “Northwest Borneo Geosyncline” (Haile, 1961 and 1969) in various phases with the last phase occurring in Pliocene-Pleistocene. Regional metamorphism is widespread, affecting rocks older than late Eocene in age. In Kanowit town area, this is represented by slate of the Belaga Formation. Thermal metamorphism is limited to narrow aureoles around igneous bodies.

Faulting and folding are common and appear to have affected all the rocks in the area except the Quaternary rocks. In the study area, only the Kapit Member of the Belaga Formation is exposed.

METHODOLOGY

Discontinuity survey was conducted along the footslope of Bukit Memaloh at 3 sites namely, Pasar Tani, Pasar Ikan, and the former site of St. Xavier Primary School. The scan-line method was used for the Pasar Tani and Pasar Ikan cut slopes while the random-survey method was used for the St. Xavier cut slope. The scan-line method measured every discontinuity intersecting the scan-line of 20-50 m length with approximately 1 m height.

The data obtained were plotted into the Schmidt-net poles to obtain the pole concentrations to be classified as the major discontinuities. Then, the potential instability analysis was done using stereo-plot by DIPS software. This technique enabled determination of any intersection among the discontinuities that would result in the formation of unstable blocks into wedge or planar shapes that would tend to induce failure.

INTERPRETATION

At all 3 sites, the bedding planes all dip into the slope and away from the slope face, showing inherent slope stability. However there exists a preferred joint plane that dips into the direction of the slope face, and this could become a potential sliding plane for the wedges that may form as a result of the intersection between the other joint planes.

Thus the wedge failure may only occur when the joint planes have been intensely and sufficiently weathered to cause wedges to form.

The comparison between actual performances of the slope with the modes of failure identified using DIPS analysis is shown in Table 1 below. There is a good agreement between site observation and stereonet analysis. Planar failure is difficult to identify in the fractured rocks.

Table 1: Comparison between analysis and failure mode observation

	Slope	Failure mode from analysis	Observed site failure
1	Pasar Tani	Wedge and planar	Wedge
2	Pasar Ikan	Wedge and planar	Wedge
3	St. Xavier Primary School	Wedge and planar	Wedge

CONCLUSIONS

Geological investigation revealed that much of the slopes of Bukit Memaloh are made up of slate of the Belaga Formation in various stages of weathering, from intact rock to weathered soil.

DIPS analyses of the Bukit Memaloh Hill show that wedge failure may occur only if the joint planes are intensely and sufficiently weathered since the bedding planes are dipping away from the slope face.

For the time being although there is no major landslide as yet, the structure of the Kanowit Water Treatment Plant on top of Bukit Memaloh is already experiencing localised settlement of 5-10 cm along the outside perimeter of its fence along its western wall. Signs of earth erosion along its eastern wall are also already evident despite its small scale of only a few centimetres. There is thus a need for caution and proper remedial engineering work at the area.

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PAPER B21

AR AR GEOCHRONOLOGY OF VOLCANIC ROCKS FROM EASTERN PART OF PENINSULAR MALAYSIA.

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Contemporaneous volcanic lavas and pyroclastic rocks occur interstratified with lower Paleozoic, upper Paleozoic and Mesozoic strata. There are also post orogenic flows of Cenozoic age. Most of the volcanic rocks are dated based on their stratigrapic position. The volcanic rocks of the Eastern Belt are much more extensive compared to those in the Western Belt. In terms of field occurrence, the main volcanic area can be divided into two, along the eastern margin of the Bentong-Raub suture in west Pahang, to Kelantan state and south and southeastern Johore state. The volcanics at the eastern margin of the Bentong-Raub suture were previously believed to be Middle to Upper Permian and Triassic in agr. This volcanic zone is identified as an elongate strip to the east of the Bentong-Raub suture through the eastern peninsula, and possibly extending to Bangka and Billiton, along the western edge of the Indochina Terrane. Andesitic and acidic volcanism occurs in the Upper Permian, and acidic volcanism predominates in the Triassic. Another main volcanic occurrence is in southeastern and east Johore including the islands off the east coast of Johore.

A total of 22 volcanic rock samples were collected for this study and dated using the $^{40}Ar/^{39}Ar$ step–heating technique. All samples were analyzed at the Department of Geosciences, National Taiwan University. Age results are shown in Table 1. The youngest volcanic samples obtain from this study is the Pyroclastic rock from Tinggi island (84.6 ± 4.8 Ma) and the oldest is the bedded pyroclastis from Sibu island (335.6 ± 9.4 Ma) Hornblende separates from andesite at Kampung Awah give an age of 266 ± 0.69 Ma. The age is consistent with the 269 ± 46 Ma determined by using whole rock K-Ar method by Wan Fuad and Sigit Purwanto (2004). They suggested that the andesite was extruded in the Middle Permian and not, as previously thought, in the upper Permian. The oldest age of 297.6 ± 11.54 to 335.6 ± 9.4 Ma was given by a sample from bedded pyroclastic rock on Sibu Island, southeastern Johore. Interestingly rhyolitic tuff from nearby Tinggi island gave a significantly younger age (84.6 ± 4.8 to 122 ± 11 Ma). This clearly indicates that the Sibu and Tinggi island volcanics are not related. A U-Pb Zircon age of a rhyolite sample from Pengerang area (bauxite bearing) gives an age of 235 ± 4 Ma.

Table 1: 40Ar/39Ar result of volcanic rocks from Peninsular Malaysia

Sample	Location	Age (Ma)	Rock type/SiO_2	Remarks
FA3	Nenas island Johor	106.6 ± 4.29	Rhyolite/73.17	Wholerock
GMTT1	Gua Musang-K Krai	170 ± 3.49	Andesite/55.54	Wholerock
GMTT3	Gua Musang-K Krai	137.3 ± 4.27	48.51	Wholerock
P3	Teluk Ramunia	201.3 ± 6.75	Rhyolite/69.37	Wholerock
KL4	Nenas island Johor	102.9 ± 1.8	Rhyodacite/63.12	Wholerock
SS6	Selai Endau Rompin	221.2 ± 5.04	Pyroclastic ash/n.d.	Wholerock
PBXZ	Sibu Island	297.6 ± 11.54	Pyroclastic ash/n.d.	Wholerock
PS11	Sibu Island	299 ± 12.58	Pyroclastic ash/n.d.	Wholerock
BM2	Sibu Island	335.6 ± 9.40	Pyroclastic ash/n.d.	Wholerock
SPB	Sibu Island	2968 ± 0.69	Pyroclastic ash/.81.24	Wholerock
TT1a	Tinggi Island	88.95 ± 6.61	n.d.	Wholerock
TGRC	Tinggi Island	89.17 ± 6.02	n.d.	Wholerock
BK5	Tinggi Island	120.1 ± 4.8	n.d.	Wholerock
BK4	Tinggi Island	111.6 ± 4.3	n.d.	Wholerock
PC2	Tinggi Island	92.3 ± 4.8	n.d.	Wholerock
TGRC2	Tinggi Island	84.6 ± 4.8	n.d.	Wholerock
TIN1	Tinggi Island	84.28 ± 3.68	Andesite/58.16	Wholerock
TIN2	Tinggi Island	122.3 ± 11.7	Basaltic/48.83	Wholerock
TMRH	Tanah Merah	142.7 ± 2.7	Basalt/47.33	Wholerock
J10	Jerantut	107.1 ± 0.3	Andesite/63.95	Wholerock
AWAH Hbl	Kampong Awah	266.6 ± 0.7	Basaltic andesite/40.96	Hornbende separate
TiOV	Tioman island	88.9 ± 0.2	Andesite/56.08	Wholerock

NOTES

POTENSI ALIRAN PUING DI BUKIT PANJI, KUALA TERENGGANU: PENILAIAN BAHAYA DAN LANGKAH MITIGASI YANG SESUAI

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Aliran puing merupakan suatu proses geomorfologi semulajadi yang berlaku di kawasan tanah tinggi atau berbukit. Pergerakannya yang laju dengan kuantiti puing yang banyak boleh menyebabkan kerosakan bukan sahaja kepada harta benda malah kepada nyawa manusia. Kajian mengenai aliran puing di Malaysia masih kurang dilakukan samada oleh pihak berkepentingan atau saintis kerana jumlah kejadiaan pertahun yang sedikit dan lokasi punca aliran puing berada jauh di dalam hutan belantara. Hasil cerapan lapangan menunjukkan enam morfologi lurah tergantung telah dikenalpasti berpotensi untuk menjana aliran puing. Lokasi-lokasi tersebut dicirikan oleh kawasan sub-tadahan dengan lurah-lurah yang sempit, curam dan mengandungi sumber pembekalan puing yang mencukupi disertai dengan aliran anak sungai bermusim. Kesesuaian pemilihan jenis mitigasi untuk setiap lurah aliran puing berbeza bergantung kepada kedudukan dan keadaan lurah. Lurah yang sempit dan terlalu hampir dengan infrastruktur sesuai dipasang dengan sistem perangkap puing kerana sifatnya yang fleksibel. Pembinaan perangkap puing boleh dilakukan pada lurah berbentuk V atau U. Jika kedudukan lurah jauh daripada bangunan, penyediaan zon penampan serta membina kawasan perangkap puing merupakan antara langkah mitigasi yang sesuai digunakan.

PAPER B23

INFLUENCE OF WATER ON BUCKLING FAILURE OF THINLY STRATIFIED PHYLLITE ROCK MASS AT KAMPUNG JERAM BUNGOR, KUALA LIPIS, PAHANG DARUL MAKMUR

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Introduction

Thinly stratified rock mass with low rock mass strength can undergo buckling failure when the strata are approximately parallel to the slope and steeply dipping. For buckling failure to occur, the forces causing failure must exceed the tensile strength of the rock mass. In the case study presented here, the role of water in causing buckling failure of a phyllite rock mass along the Kuala Lipis – Jerantut road from Kampung Jeram Bungor to Kampung Batu Sembilan, Kuala Lipis, Pahang is quantified. A location map of the investigated site is shown in Fig.1.

Methodology

Field surveys and laboratory testing were conducted to classify the rock mass in accordance to Bieniawski's rock mass rating (RMR) system (Bieniawski ,1989). To obtain the tensile strength of the rock mass the Hoek and Brown Criterion (2002 version) by Hoek et al. (2002) was employed. Finally an estimation of the water pressure caused by entry of water into the rock mass was based on the proposal of Tommasi et al. (2009) in which the Bernoulli's equation as shown below was used.

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{total water pressure} \qquad \text{Bernoulli's Equation}$$

P = Atmospheric pressure
ρ= Density of water (1000 kgm^{-3})
v = Velocity of water (estimated at 2 ms^{-1})
h = Height of slope berm at failure location (determined as 4 m).

Results and discussion

From the RMR determination and the Hoek and Brown Criterion the tensile strength of the phyllite rock mass ranged from 0.023 MPa to 0.056 MPa. From the Bernoulli's equation using the values above, the pressure produced by the water was 0.041 MPa and this pressure was enough to cause the failure of the phyllite rock mass after several series of rain fall events. Even if only the hydrostatic water pressure is considered, that is there is no movement of water (velocity = 0 ms-1) its value at 0.039 MPa is sufficient to cause failure. These results shows that the water pressure can exceed the tensile strength of the phyllite rock mass leading to buckling failure. Furthermore when the rock mass is slightly weathered, its tensile strength undergoes reduction and the opening of the discontinuities due to weathering enchances the entry of water into the rock mass. Field observations showed damaged berm drains allowing run-off water to enter into the rock mass contributing towards this type of failure. Fig. 2 (a) and 2 (b) show the actual field conditions.

Conclusion

Systematic classification of the rock mass and a quantification of the role of water provides a plausible explanation of the occurrence of buckling failure at this site. This study also shows the importance of slope maintenance as the damage to the berm drains leads to entry of run-off water into the slope mass, causing an increase of water pressure.

Acknowledgement

This research was supported by the research grant UKM – ST – 07 – FRGS0019 – 2010 which is gratefully acknowledged. Special thanks to the technical staff of Geology, UKM for assistance rendered during this project.

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Figure 1: Site location, Kuala Lipis – Jerantut road, Pahang.

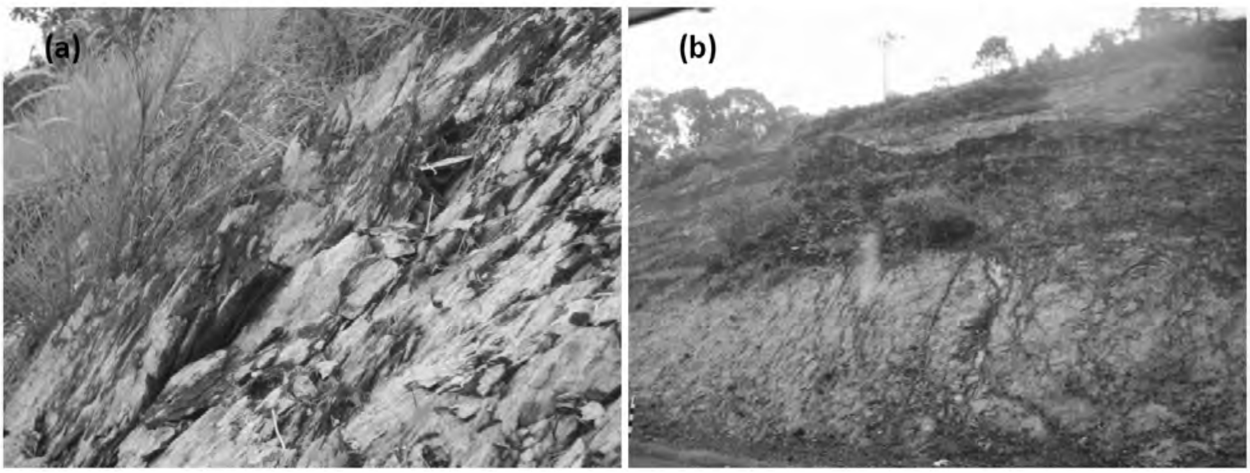

Figure 2 (a) shows the small scale of buckling failure at the first berm and (b) shows the overall scale of buckling failure.

PAPER B24

QUANTIFICATION OF ROCK MASS DETERIORATION PROCESS FOR CUT SLOPE DESIGN IN HUMID TROPICAL AREAS – CASE STUDY NORTHERN KOTA KINABALU, SABAH MALAYSIA

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Keywords: Weathering, Intensity Rate, Intact Rock Strength, Sandstone, Sabah

Road construction in mountainous areas especially in humid tropical climates is often afflicted by slope instability. Road cut slopes are designed to be stable over a certain time span; i.e. the engineering lifetime, however many slopes or parts of slopes fail before the end of the lifetime. The reasons for failure sometime after construction are likely due to the deterioration of rock masses in cut slopes. Deterioration is mainly due to stress relief and weathering. Deterioration rates depend on the properties of rock mass including its history, and the environment in which it is exposed. The rate decreases with time due to formation of a layer of residual material that prevents further contact between fresh mass and weathering agents. Stress relief and weathering are often marginally quantified or simply neglected in slope design (Huisman, 2006), due to lack of understanding and appreciation of the processes. In addition, the limited quantitative information available makes it difficult to incorporate the degradation in design. A proper design of a slope for the entire engineering lifetime of the slope say up to 50 years should include quantitative factors accounting for the degradation of the rock mass over its lifetime.

This paper presents the result of research that has been done to develop quantitative factors for incorporation in the design of slopes to account for stress relief and weathering in humid tropical areas. The quantitative factor was developed by establishing the relationship between weathering intensity rate and exposure time for the intact rock strength (IRS) of sandstone (SST unit) in the area around Kota Kinabalu, Sabah, Malaysia. The geology in the area consists of interbedded thick-bedded sandstone and thinly laminated shale beds belonging to the Crocker Formation.

The weathering intensity rate is determined by the change brought by the processes of weathering on intact rock strength (IRS) after it was exposed for a certain period of time. It is done by comparing the initial property value before and after weathering has occurred (Colman, 1981). Property refers to the geotechnical properties such as intact rock strength (IRS), and rock mass internal angle of friction and cohesion. These properties are preferred as these are directly related to slope stability. Therefore, the empirical relationship to describe change of property value (for this research intact rock strength) as a function of time is expressed as (Tating et al., 2013):

$$IRS_t = IRS_{init} + R_{IRS}^{app} \log(1+t) \quad (1)$$

where, IRS_t is the *IRS* value at exposure time *t*, IRS_{init} is the initial *IRS* value and R_{IRS}^{app} is the apparent rate of the *IRS* change. The property value change rate in this equation refers to the *"apparent rate"* which is quantified by the change in property value from the initial state divided by a function of the total exposure time.

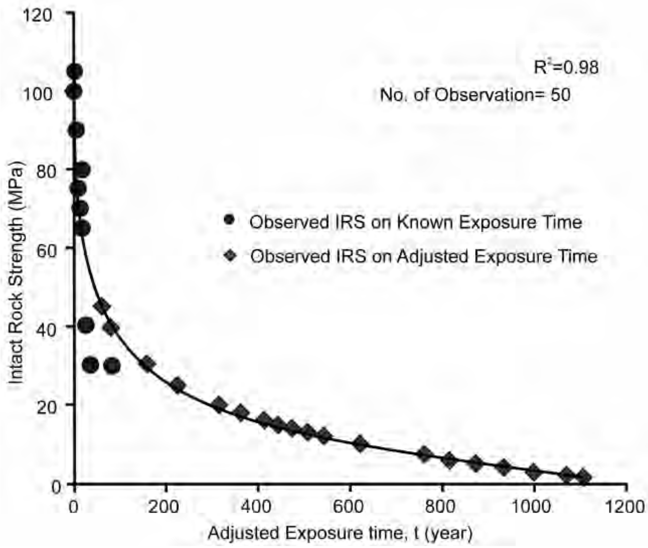


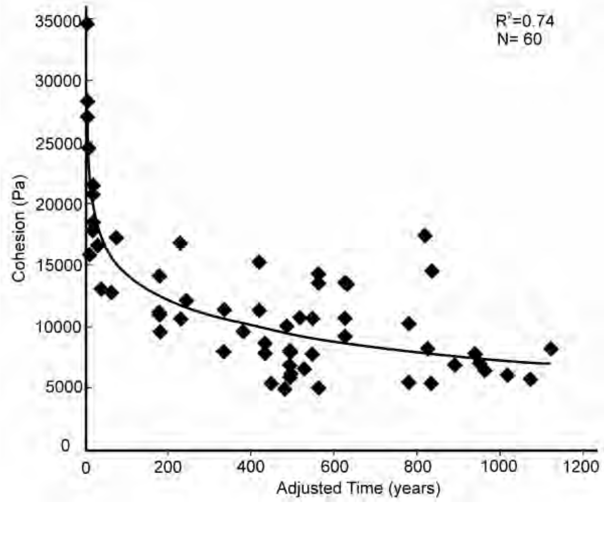
Figure 1 Relationship between IRS and exposure time of sandstone (SST unit) expressed in logarithmic function for the whole observation.

The result of the research (Figure 1) shows that effect of weathering on *IRS* is related to time following a logarithmic function:

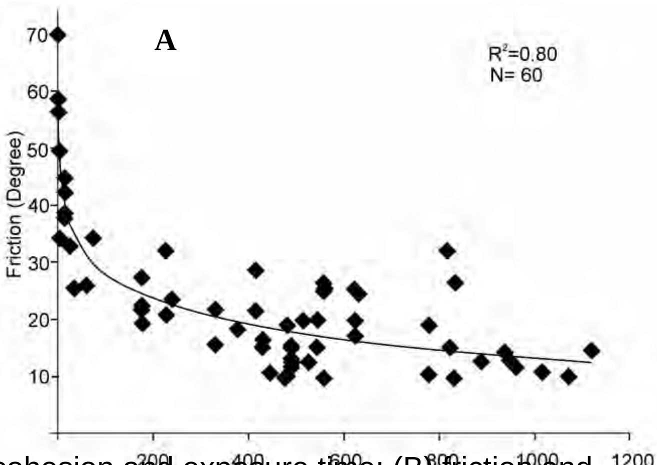
Similar analyses are carried out for the cohesion and friction angle for the SST unit, which is estimated by using SSPC method (Hack et al., 2003). This is shown in Figures 2(A) and 2(B). Based on the graphs, the SST unit cohesion reduction in time is expressed as:

$$Cohesion_t = 27004 - 6850.3\log(1+t) \quad (3)$$

$Cohesion_t$ (Pa) is the intact rock cohesion of SST at the time t, and t is the time since exposure in years. 27004 is the initial value of the cohesion in Pascal of the fresh SST unit at the time of excavation, and 6850.3 is the apparent reduction rate in Pa/log [year].



A



B

Figure 2 (A) Relationship between the cohesion and exposure time; (B) friction and exposure time of sandstone (SST unit) expressed in logarithmic function for the whole observation.

For the SST unit friction angle, the relationship is expressed as:

$$Friction_t = 56.1 - 15\log(1+t) \quad (4)$$

$Friction_t$ (Deg) is the intact rock friction angle of SST unit at the time t, and t is the time since exposure in years. 56.1 is the initial value of the cohesion in degree of the fresh SST unit at the time of excavation, and 153 is the apparent reduction rate in Degree/log [year].

This relationship is likely also valid in other tropical areas and thus can be used for prediction of the intact rock strength development of sandstone over the engineering lifetime of man-made slopes in tropical areas.

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DETERMINING THE INTERACTION BETWEEN GEOSTATISTICAL AND GEOCHEMICAL ANALYSIS OF RIVERS, LAKES AND GROUNDWATER AT A SMALL BANK INFILTRATION STUDY SITE IN JENDERAM HILIR, SELANGOR

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Bank infiltration (BI) is a method that has long been known but still new and not being widely practiced in Malaysia. At present, the conventional river water treatment for water supply is using chemicals to reduce several contaminants due to pollution. However, chemicals application in drinking water during water treatment could give long term effects to the health of consumers. BI is natural process of surface water seeping from the bank or bed of a river to the groundwater production wells through the natural filtration (aquifer) to treating river water. Higher frequency of pollution to rivers in Malaysia could affect the drinking water resources. This paper focuses, multivariate analysis approaches such as discriminant analysis (DA) and principal component analysis (PCA), were used in the analysis of the water quality data set including 36 parameters of Langat River, lakes and groundwater at the Jenderam Hilir from 2009–2011 (49 observations) to characterise the BI site and to identify the impact of potential pollution sources of surface water (rivers and lakes) on groundwater quality (Figure 1). Ten (10) principle component (PCs) with Eigenvalues greater than 1 were produced from the PCA. Each component was examined for variables with high loadings responsible to the variation of the water quality. The total cumulative variance percentage of the ten factors is 83% with 17.171% for factor 1, 13.836% for factor 2, 9.59 % for factor 3, 8.715% for factor 4, 8.257% for factor 5, 6.948% for factor 6, 5.638% for factor 7, 4.543% for factor 8, 4.267% for factor 9 and 3.91% for factor 10.

DA and PCA analysis provide valuable support to determine hydrochemical variation related to the river, lakes and groundwater interactions. They also allow analysis of the contribution of contaminated water along the river. The result of the statistical analysis offers an overview of the main process responsible for the characterisation of the BI site in Jenderam Hilir. The DA gave the best result of the redox parameters containing Fe and Mn, under anaerobic conditions. Table 1 shows the classification matrix for DA of spatial variations in the BI site and Figure 2 shows the distribution of discriminant variables using standard mode.

Clearly , redox processes show significantly high variation in the aquifer ($p<0.05$) in whichthe quality of groundwater located near to the river bank of the Langat River and lakes in Jenderam Hilir was mainly affected by quality changes due to BI. The study of rivers-lakes-groundwaters interactions at different sampling sites, yeilded an important data reduction, where six parameters (pH, NO2, NO3, F, Fe and Mn) were close to 98% correct assignment. Therefore, the temporal and spatial similarities and differences could optimise the future monitoring program by reducing monitoring frequency, the number of sampling sites, monitoring parameters and the subsequent cost. Figure 3 shows the box and whisker plots of some parameters separated by DA associated with the water quality data of Langat and Jenderam Hilir rivers, lakes and groundwater. The PCA helped in identifying interaction, infiltration and pollution between the river, lakes and groundwater. These factors suggest significant contribution of geology in study area to the water quality, groundwater hydrochemistry, a redox conditions, surface runoff, pollution, and surface water and groundwater interaction. The multivariate statistical analysis application method could help significantly in monitoring cost reduction, and allowed effective and efficient river-lakes-groundwater interaction as well as BI method characterisations in the study area.

Keywords: Langat River, Bank infiltration, hydrogeochemistry, Principal Component Analysis, Discriminant Analysis, redox

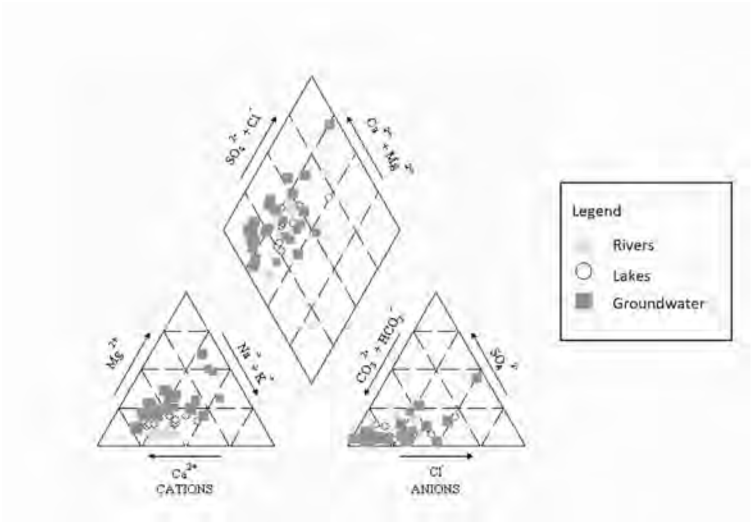

Figure 1: Piper trilinear diagram for the data obtained from chemical analysis of river, lake and groundwater sample from Jenderam Hilirsite

Samples	Samples assigned by DA			Total	% correct
	GW	LK	RW		
Sampling DA mode (28 variables)					
GW	27	0	0	27	100.00%
LK	0	13	0	13	100.00%
RW	0	0	10	10	100.00%
Total	27	13	10	50	100.00%
Forward stepwise mode (6 variables)					
GW	26	1	0	27	96.30%
LK	0	13	0	13	100.00%
RW	0	3	7	10	70.00%
Total	26	17	7	50	92.00%
Backward stepwise mode (13 variables)					
GW	27	0	0	27	100.00%
LK	0	13	0	13	100.00%
RW	0	1	9	10	90.00%
Total	27	14	9	50	98.00%

Table 1: Classification matrix for DA of spatial variations in Bank Infiltration site. Note: GW = groundwater, LK = lake water, RW = river water

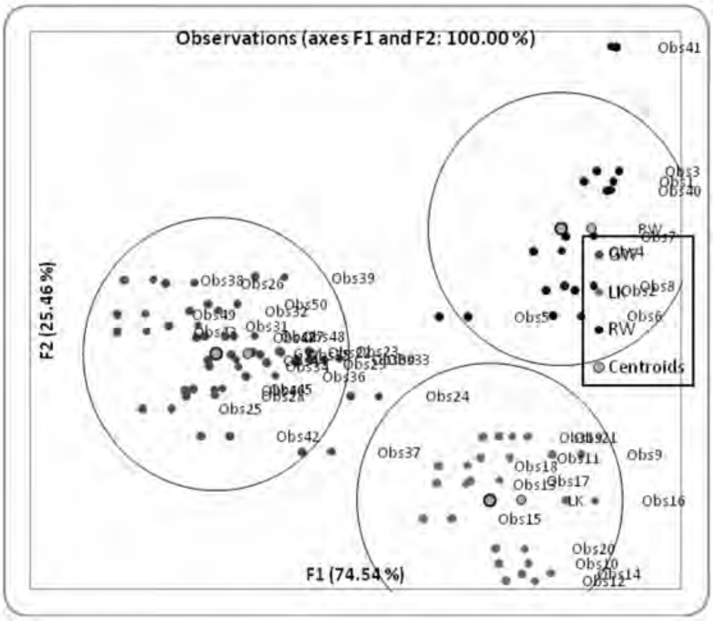

Figure 2: .Distribution of discriminant variables using standard mode.

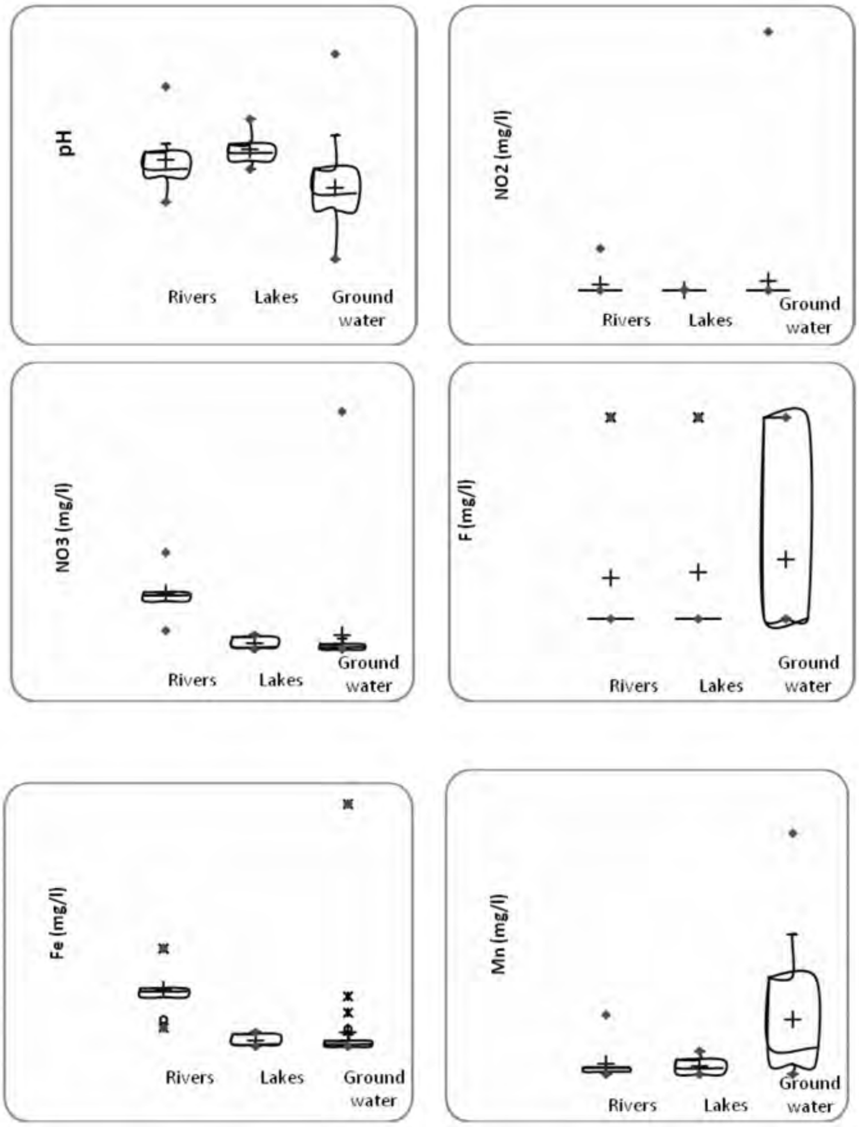

Figure 3: Box and whisker plots of some parameters separated by DA associated with the water quality data of Langat and Jenderam Hilir rivers, lakes and groundwater. Red crosses are mean values, top and bottom of whiskers indicate maximum and minimum values respectively, while horizontal lines of the boxes from top to bottom indicate the third quartile, median and first quartile respectively.

PAPER B26

APPLICATION OF ENVIRONMENTAL ISOTOPE TECHNIQUES IN GROUNDWATER STUDY

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The application of environmental isotope as a tracers in groundwater study is presented. The isotope technology is useful tool in determining the groundwater recharge sources, ages of water bodies, the interaction between surface water and groundwater, the source of groundwater contamination, the degree of mixing and for estimating subsurface residence times (Sidle, 1995 and Sidle, 1998). Previous studies have successfully used δ^{13}C-DIC, δ^{2}H-water and δ^{18}O-water measurements of groundwater from landfill monitoring wells to detect leachate influence (Hackley, et al., 1996, North, et al., 2007). The environmental isotopes particularly stables isotopes (^{18}O, ^{2}H and ^{13}C) are measured using Continuous Flow Isotope Ratio Mass Spectrometer (CF-IRMS). Oxygen and hydrogen isotope compositions are expressed as units of parts per thousand or delta per mill (δ ‰) deviation from standard mean ocean water (SMOW). Whilst, ^{13}C of dissolved inorganic carbon (DIC) data analysis reported in δ- notation with regard to National Bureau of Standards (NBS). The precision of the analytical measurement is ±0.05‰, ±1‰ and ±0.1‰ for δ^{2}H and δ^{18}O, and δ^{13}C respectively. For the isotope analysis, the samples were measured in triplicates in each analytical run for better results. The usual way to interpret stable isotope data is on a plot of δ^{2}H versus δ^{18}O from the precipitation isotopes values. In hydrological cycle, precipitation is considered as the input for surface water and groundwater. Hence the importance of establishing Local Meteoric Water line thus establishing weighted mean precipitation was adopted (Ayub, 2005).

These techniques have been used to study the groundwater contamination within the landfill area, riverbank infiltration study as well as to determine groundwater resources. Result from the landfill site study shows that the δ^{2}H–H_2O, δ^{18}O–H_2O and δ^{13}C–DIC ranged from +7.70‰ to –48.57‰, –0.05‰ to –7.56‰ and +10.60‰ to –23.17‰ respectively with unique distinct isotopic signature for some surface waters (leachate and pond) and groundwater. This technique demonstrated the ability to distinguish the leachate impacted water samples compared to the conventional technique and thus can be used in determining landfill leachate contamination. The isotope results also clearly delineated the interconnection, recharge process and transport mechanism of the contaminant between the water bodies particularly during the dry period.

Results from the riverbank infiltration study indicate that the δ^{2}H and δ^{18}O compositions for the groundwater that is closed to the river is relatively depleted and similar to that of the river water. This indicates that infiltrating river water is the main source for the groundwater that is closed to the river especially during high flow conditions. On the other word, recharge of these confined aquifers is currently taking place by direct infiltration through the river. Meanwhile, the isotopic composition of groundwater that is located about 500 m and 700m from the river is relatively enriched and similar to the pond nearby. This can explained that there are interconnection between groundwater and surface water. As a summary, the application of these techniques has shown that they not only confirm the

results obtained by classical hydrological methods but as an alternative to provide more information and immediate answers to some hydrological problems.

***Keywords*: Environmental isotopes, groundwater, surface water, contamination, recharge area**

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PAPER C01

EFFECTS OF SOIL FILLERS, VEGETATION LATERAL VARIATION AND BASIN 'DOME' SHAPE ON TROPICAL LOWLAND PEAT STABILIZATION.

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Field mapping involving observation, identification, characterization, classification (von Post) to map and identify the natural extent and occurrence of tropical lowland peat deposits was carried in the Kota Samarahan-Asajaya study area in West Sarawak (Malaysia). Field identification and classification indicates that there is a lateral variation of peat humification levels (von Post) in the form of dominantly occurring fibric, fibric to hemic, sapric and hemic to sapric peat, occurring from margin and towards the centre of the tropical lowland peat dome or basin (Engineering Geology Working Group, 2007). Cement-peat stabilization (Alwi, 2008; Wong, 2010; Wong et al., 2008; 2009 and 2011) can be achieved or enhanced with the addition of mineral soil fillers (silt, clays and fine sands) obtained from Quaternary floodplain deposits and residual soil (weathered schist). Unconfined Compressive Strength (UCS) of the stabilized cement-mineral soil filler-peat mix is observed to increase with the further addition of selected mineral soil filler (msf) in increasing quantities.

Results indicate that there is a lateral variation of stabilized peat strength (UCS) occurring on the top 0 to 0.5 metres layer, from margin towards the near-centre, of the tropical lowland peat dome. This study indicates that these stabilized strength variations are at the maximum near the dome/basin margin/periphery, followed by a decrease to a low (intermediate) at the mid-section area and progressively increases back again further towards basin centre of the peat dome. Almost all the stabilized cement-filler-peat mix specimens with added msf (silt, clay and fine sands) that were tested, exhibited brittle or shear failures with no barrelling except for the specimen with peat obtained from KS.TP.08 which exhibited dominantly more shear failure than barrelling failure. In conclusion, topogenic, clayey, high-ash or shallow peats (with more naturally occurring in-situ msf content) occurring near or at the margin/periphery of the peat dome/basin have relatively higher UCS compared to the deeper intermediate topogenic to ombrogenic, low-ash peats (with relatively lesser or no natural msf content) occurring at midsection or towards the basin centre. Furthermore, stabilized peat specimens from topogenic, marginal, shallow, transitional peat areas also exhibited relatively better, uniform and consistant cylindrical shape, less deformation, are denser, are harder, has lesser cracks, lesser holes, less indentations and lesser joints/discontinuities at the tamped layer planes. These observations may probably reflect the enhanced field conditions of the stabilized peat columns if msf were applied in the cement-filler-peat stabilization process and targetted at the marginal/fringe, topogenic, shallow peat areas of the peat basin/dome.

Variations of UCS of stabilized tropical lowland peats occurring with varying distance from periphery towards the centre of the peat dome in the current scope of this study, is probably caused by a combination of factors due to variations of mineral soil or ash content in the peat and the indirect effect of horizontal zonation or, lateral variation of dominant species of plant assemblages (due to peat swamp forest successive vegetation zonations occurring from periphery towards centre of the tropical lowland peat dome). These factors are further associated to the shape of the peat basin or 'dome' shape (Anderson, 1964; Anderson and Muller, 1975). The observed stabilized strength zonations are: (a) Fibric or fibric to hemic, topogenic, clayey, shallow, transitional peats that usually occur near the basin margin or near the peat-soil lithological boundary with relatively higher natural, mineral soil (naturally deposited silt/clay/sand) or ash content that act as "natural fillers", that may probably have contributed to relatively higher UCS of cement-msf stabilized peat when compared to peats occurring at locations intermediate and towards the centre of the peat dome; (b) Sapric, intermediate topogenic to ombrogenic peats that occur at intermediate locations between basin margin and towards the centre of peat basin with lesser "natural msf" or ash content that may likely produce cement-msf stabilized peat with a relatively lower UCS; (c) Ombrogenic, sapric peat (from decomposed hardwood fragments of tree logs, broken branches, bark and roots contributed by dominant, hardwood, plant species (e.g. Shorea type)) that occur in these vegetation zones (phasic community II to IV) towards and near the centre of the peat swamp forest, may produce cement-msf stabilized peat with a relatively higher UCS compared to stabilized peats occurring at the mid-section area (phasic community I) .

Hence, lateral or horizontal vegetation succession (phasic community zonation) which is indirectly due to the tropical lowland peat basin "dome" shape and unconfined compressive strength of the stabilized cement-mineral soil filler (msf)-peat mix may probably be associated in tropical lowland peat basins/domes.

Keywords: tropical lowland peat dome or basin; mineral soil filler; cement-soil filler-peat stabilization; topogenic to ombrogenic; unconfined compressive strength; lateral vegetation succession

Acknowledgements:

The authors greatly appreciate financial assistance from University of Malaya IPPP research grant no PV018/2011A.

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PAPER C02

ROCK PHYSICS MODELING FOR LITHOLOGY PREDICTION USING HERTZ-MINDLIN THEORY

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Rock physics represents the link between geologic reservoir parameters (e.g.,porosity,clay content,sorting,lithology,saturation) and seismic properties (e.g., VP/VS,density,elastic modulus). Most of the sand rock physics models required contact models to calculate the elastic modulus of the dry frame (loose random grain pack) at critical porosity. The friable sand model of Dvorkin and Nur (1995) is used to describe the velocity porosity relation for a clean, high porosity and unconsolidated sand. It assumes that the porosity decreases from critical porosity due to the addition of a solid mineral in the pore space. The bulk and shear modulus of the solid end member are then used to calculate the properties of the sphere pack at critical porosity. This can be done by using one of contact theory models such as Hertz-Mindlin model (Mindlin,1949). End-member bulk modulus calculated using Hertz-Mindlin theory is 1.98 GPa and shear modulus 2.9 GPa (for initial porosity equal 40%). This is usually rigid for such a compressible rock. The dry bulk modulus in clean sand is greater than in shaly-sand. It will makes the P-wave velocity (VP) in the dry condition also greater in clean sand than shaly-sand so that the clean sand is tend to more compressible.

Keywords – rock physics model, friable sand model, Hertz-Mindlin theory, dry bulk and shear modulus, P and S-wave velocities

INTRODUCTION

Rock physics establishes a link between the elastic properties and the reservoir properties such as porosity, water saturation, clay content, cement volume and degree of sorting. Rock Physics models allow us to link seismic properties and geological properties, and the application of rock physics models can guide and improve on the qualitative seismic interpretation. Moreover, if we understand the link between geological parameters and rock physics properties, we can avoid certain ambiguities in seismic interpretation, particularly fluid/lithology, sand/shale and porosity/saturation. The link between rock physics and various geological parameters, including cement volume, clay volume and degree of sorting, allow us to perform lithology prediction from rock types observed at a given well location to rock types assumed to be present nearby (Bjørlykke, 2010). The way in which geological trends, in this case depositional trends, in an area can be used to constrain rock physics models is also investigated. If we can predict the expected change in seismic response as a function of depositional environment or burial depth, this will increase our ability to predict hydrocarbons, especially in areas with little or no well log information. Understanding the geological constraints in an area of exploration reduces the range of expected variability in rock properties and hence reduces the uncertainties in seismic reservoir prediction (Avseth et al., 2005).

A typical approach to testing rock physics models is to define the elastic properties of the end members, being bulk and shear moduli of the two different minerals, in this case clay and sand (quartz). This assumes that the rock's properties must then fall between the two end members and interpolation between them can be calculated using the modified Hashin-Shtrikman bound. Then the P and S-wave velocities can be calculated. Single mineral models consist of just one mineral type that is commonly clean sand or quartz. Rock physics models can generally be separated into different types. Empirical models are the simplest and only require the solid mineral bulk and shear modulus to calculate the changes in velocity as the porosity increases (Harbert, 2006).

The Friable Sand Model

The friable-sand model, or the “unconsolidated line”, describes how the velocity-porosity relation changes as the sorting deteriorates. The “well-sorted” end member is represented as a well-sorted packing of similar grains whose elastic properties are determined by the elasticity at the grain contacts. The friable-sand model represents poorly sorted sands as the “well-sorted” end member modified with additional smaller grains deposited in the pore space. These additional grains deteriorate sorting, decrease the porosity, and only slightly increase the stiffness of the rock. The friable sand model of Dvorkin and Nur (1995) is initiated by estimating the solid phase end member elastic moduli. The rock at zero percent porosity in sandstones often has the same value as that of pure quartz. The bulk and shear modulus of solid end member are then used to calculate the properties of the sphere pack at critical porosity. This can be done using one of the contact theory models, Hertz-Mindlin model (Mindlin, 1949).

Hertz-Mindlin Theory

The elastic moduli at high porosity (usually critical porosity) is modeled as an elastic sphere pack subject to confining pressure, given by the Hertz-Mindlin theory (Dvorkin et al., 1995) as follows:

$$K_{HM} = \left[\frac{n^2(1-\phi_c)^2\mu^2}{18\pi^2(1-\nu)^2}P\right]^{\frac{1}{3}} \qquad (1)$$

$$\mu_{HM} = \frac{5-4\nu}{5(2-\nu)}\left[\frac{3n^2(1-\phi_c)^2\mu^2}{2\pi^2(1-\nu)^2}P\right]^{\frac{1}{3}} \qquad (2)$$

where,

KHM , µHM = dry rock bulk and shear moduli, respectively, at critical porosity φc

P = confining pressure, which is equal to effective pressure (i.e., the difference between the overburden pressure and the pore pressure)

µ = shear modulus for solid phase (mineral modulus)

v = Poisson’s ratio for solid phase

n = coordination number (the average number of contatcs per grain)

The Poisson’s ratio can be expressed in terms of the bulk (K) and shear (µ) moduli as follows:

$$\nu = \frac{3K-2\mu}{2(3K+\mu)} \qquad (3)$$

Effective pressure versus depth is obtained with the following formula:

$$P = g\int_0^Z(\rho_b - \rho_{fl})dz \qquad (4)$$

where,

g = gravity constant

ρb and ρfl = bulk density and fluid density, respectively

Z = depth

The coordination number, n, depends on porosity. The relationship between coordination number and porosity can be approximated by following empirical equation :

n = 20 - 34φ + 14φ2 (5)

Hence, for a porosity φ = 0.4, n = 9.

At porosity φ the concentration of the pure solid phase (added to the sphere pack to decrease porosity) in the rock is 1 = φ/φc and that of the original sphere-pack phase is φ/φc. Then the bulk (Kdry) and shear (µdry) moduli of the dry friable sand mixture are :

$$K_{dry} = \left[\frac{\phi/\phi_c}{K_{HM}+4\mu_{HM}/3} + \frac{1-\phi/\phi_c}{K+4\mu_{HM}/3}\right]^{-1} - \frac{4}{3}\mu_{HM} \quad (6)$$

$$\mu_{dry} = \left[\frac{\phi/\phi_c}{\mu_{HM}+z} + \frac{1-\phi/\phi_c}{\mu+z}\right]^{-1} - z \quad (7)$$

where,

$$z = \frac{\mu_{HM}}{6}\left(\frac{9K_{HM}+8\mu_{HM}}{K_{HM}+2\mu_{HM}}\right) \quad (8)$$

Forward Modeling of The Effective Medium Model

The rock physics model of friable sand is applied to model texture, lithology and pressure changes. The effective medium model (friable sand model) is used to predicting velocities in unconsolidated sands, as a function from pressure and porosity. This model is used to predict the high porosity end-members (bulk and shear moduli) using Hertz-Mindlin theory(Avseth et al., 2005). This stage of work applied in two different reservoirs condition, clean sand and shaly-sand in dry condition. Here are the to predict P- and S-wave velocity as a function of porosity, using effective medium model (friable sand model) :

1. Estimation of dry bulk and shear modulus, Kdry and µdry for clean sand pack at critical porosity using Hertz-Mindlin contact theory (equation 1 and 2), then apply modified Hashin-Shtrikman bound (equation 6, 7 and 8) to interpolate high porosity end member and the zero porosity mineral point, for the clean sand and shaly-sand reservoirs.
2. Calculate the P- and S-wave velocity in dry condition at the critical porosity, for each porosity.

Velocity – Porosity Rock Physics Models

Based on previously described methodology, the elastic modulus and velocities for the porosity range from 0 to 40% were calculated. The rock properties data are in Table 1. There are 2 types of sandstones used in this model, clean sand and shaly-sand which contained 70% of quartz and 30% of clay.

Parameter	Value	Parameter	Value
Bulk modulus of clay**	17.5 GPa	Critical porosity	40%
Shear modulus of clay**	7.5 GPa	Poisson's ratio	0.08
Bulk modulus of quartz*	36.6 GPa	Coordination number	9
Shear modulus of quartz*	45 GPa	Peff	20 MPa
Density of quartz*	2650 kg/m3	Porosity	0 – 40 %
Density of clay**	2300 kg/m3	Rock mineral composition	70 % of quartz and 30 % of clay

Table 1. Rock properties data used as input parameter model (*Mavko et al., 1998, **Avseth et al., 2000)

The results are plotted as dry elastic modulus against porosity, dry velocities (VP and VS) against porosity in dry conditions (Figure 1). End-member bulk modulus calculated using Hertz-Mindlin theory is 1.98 GPa and shear modulus 2.9 GPa (for initial porosity equal 40 %). This is usually rigid for such a compressible rock. The dry bulk modulus in clean sand is greater than in shaly-sand. It will makes the P-wave velocity (VP) in this dry condition also greater in clean sand than shaly-sand so that the clean sand is tend to more compresible. In Figure 1 (left) near to the critical porosity, the dry bulk modulus has almost the same value with dry shear modulus both in clean sand and shaly-sand. Otherwise, these elastic modulus are approximate to each other at low porosities, both in clean sand and shaly-sand. On the other hand, dry P-wave velocity (Vp) in shaly-sand is almost similar to dry S-wave velocity (VS) in clean sand. If these velocities measured at the same time, it may cause an ambiguities for the interpretation. In Figure 1 (right) shows the decrease in both P and S-wave velocities as the porosity increases. The results are subjected to possible errors in uncertainties in the mineral properties, their composition and the model applied.

CONCLUSIONS

Most of the sand rock physics models required contact models to calculate the elastic modulus of the dry frame (loose random grain pack) at critical porosity. The friable sand of Dvorkin and Nur (1995) was used to analyse the P and S-wave velocity versus porosity trends for the clean uncosolidated sands and shaly-sand.

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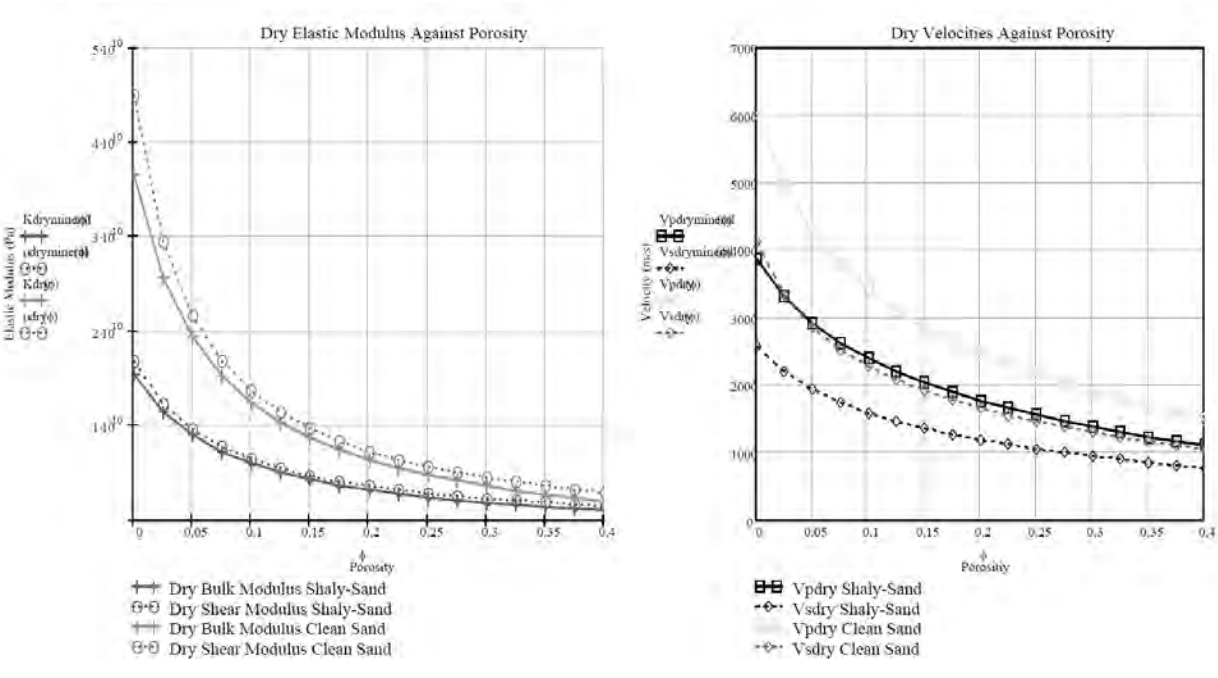

Figure 1 Theoretically predicted dry bulk and shear modulus (left), P and S-wave velocities (right) for dry condition as a function of porosity with porosity ranging from 0 to 0.4 (Peff = 20 MPa)

PAPER C03

CIRIAN GEOTEKNIK TANAH BAKI TERAWAT ABU SEKAM PADI (ASP) (GEOTECHNICAL PROPERTIES OF RICE HUSK ASH (RHA) TREATED RESIDUAL SOIL)

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Tanah baki sering dikaitkan dengan sifat kekuatannya yang rendah. Ia mewakili darjah luluhawa yang terakhir (VI) dan tanah ini sering digunakan dalam kejuruteraan tanah. Pembangunan infrastruktur yang pesat meningkatkan permintaan bagi tujuan penambakan dan pendasaran. Kebergantungan kepada sumber ini menyebabkan kehausan sumber semulajadi dan peningkatan kos pembinaan. Oleh itu bahan alternatif diperlukan bagi mengurangkan kebergantungan bagi memenuhi permintaan. Terdapat pelbagai sisa sampingan yang dihasilkan dari sector perindustrian dan pertanian yang boleh diterokai. Abu sekam padi (ASP) merupakan salah satu sisa sampingan dari aktiviti pemprosesan padi. Kertas ini mempersembahkan hasil awal kajian kesan penambahan abu sekam padi ke atas sifat geoteknik tanah baki yang dirawat. Tanah baki dirawat dengan kandungan ASP di antara 0 dan 20 %. Cirian geoteknik yang diperhatikan adalah sifat had Atterberg, pemadatan, ketelapan air dan kekuatan ricih tanah. Nilai had Atterberg bagi had cecair dan had plastik menunjukkan corak pengurangan dengan peningkatan kandungan ASP dalam tanah. Ujian pemadatan menunjukkan peningkatan kandungan air optimum, wopt dan penyusutan ketumpatan kering maksimum, ρ_{max} dengan pertambahan kandungan ASP. Manakala nilai konduktiviti hidraulik meningkat dengan peningkatan kandungan ASP. Kekuatan ricih tanah pula menunjukkan nilai yang semakin meningkat daripada 141.7 kPa kepada 404.7 kPa dengan pertambahan kandungan ASP. Hasil kajian ini menunjukkan bahawa berlaku perubahan cirian geoteknik kesan daripada penambahan ASP ini.

Kata kunci: Tanah baki, abu sekam padi (ASP), sifat geoteknik; kekuatan ricih

INFILTRATION RATE ASSESSMENT OF SOME MAJOR SOIL TYPES IN KOTA BHARU, KELANTAN, MALAYSIA

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Infiltration is the process by wich water on the ground surface enters the soil and the infiltartion rate is a measure of the rate at which soil is able to absorb rainfall or irrigation. The soil texture and structure, vegetation types and cover, water content of the soil, soil temperature, and rainfall intensity play a significant role in controlling infiltration rate. Coarse grained soils having large pore spaces with stable structure allows water from rainfall to enter unimpeded throughout a rainfall event. Otherwise, soil that have reduced infiltration may cause flooding in the area (USDA, 1998). The study area is located in the eastern part of Peninsular Malaysia with latitude of 06˚10'N and longitude of 102˚20'E. The study area, Kota Bharu is one of the main districts in Kelantan and become the capital city of Kelantan which is the main location of commercial centre and state management office. The total land area of Kota Bharu is about 394 km². Geology of the area is mainly consisting of Quarternary alluvium having fluvial and marine origin which is constituted of mainly sand, gravel, silt and clay underlain by granite and meta-sedimentary rocks. From the soil classification map produced by Department of Agriculture (DOA), selected soil samples were tested using double ring method to identify the infiltration rate of the study area. This method consists of two metal cylinders of diameter 30 cm and 60 cm that is driven partially into the soil. The ring is filled with specific level of water and the time at which water moves into the soil is measured, thus the rate of infiltration were calculated in the field. An infiltration map will be produced at the end of the study and this study will be very useful for decision makers while dealing with flood management and also in agricultural field.

Keywords: Infiltration, double ring method, flood, Kota Bharu

PAPER D02

THE MARGINAL MARINE SUCCESSIONS OF THE BALINGIAN FORMATION (UPPER MIOCENE), MUKAH AREA, SARAWAK: FACIES, STRATIGRAPHIC CHARACTERISTICS AND PALEOENVIRONMENTAL INTERPRETATION

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This paper presents the results of field investigations carried on rock succession belonging to the Balingian Formation in Mukah area, Sarawak (Fig. 1A). The area is underlain by a succession of coal-bearing molasse sediments of Balingian Formation (Upper Miocene), Begrih Formation (Pliocene) and Liang Formation (Late Pliocene- Pleistocene) (Fig. 1B). These formations unconformably overlie the Upper Cretaceous to Eocene Belaga Formation of the Rajang Group.

The initial reported geological studies in Mukah-Balingian were accomplished by the Government Geological Survey (British Territories in Borneo) with the cooperation from oil companies (Leichti et al., 1960). Leichti and other (1960) defined the Tertiary succession in the area. The geological map was published in the same year indicated that the Tertiary Formations are resting unconfirmably on the Belaga Formation (Wolfendon, 1960). De Silva (1986) later studied some outcrops along the Mukah-Selangau road and reported it as thick succession of pebbly sandstone, sandstone, fossiliferous mudstone with abundant seams of coal and lignite.

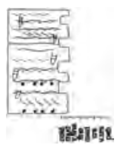
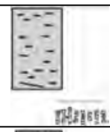
The Balingian Formation shows a variety of sedimentary facies in terms of composition, sedimentary structures and bed geometry. Twelve sedimentary facies from six outcrops has been identified and interpreted (Table 1). These twelve facies are grouped into five facies associations; 1) FA1- Fluvial channel facies association; 2) FA2- Floodplain facies association; 3) FA3- Estuarine facies association; 4) FA4- Marshes and mires facies association, and 5) FA5- Tidal flat facies Association.

Fluvial channel facies association (FA1) shows fining upward succession, which comprises lithofacies Gcm, Sc and Sm. The facies Gcm, Facies Sc and Sm represent confined channel deposits. The base of the FA1 consists of conglomerate (Gcm) facies or basal lag conglomerate that passes into Sm and Sc, representing fluvial deposits. The succession indicates a change from poorly organised channel lag, to more ordered fluvial sedimentation, coalesced with a marked reduction in grain size, up section.

Floodplain facies association (FA2) characterised by Mc, Mcp, Mm and thin coal facies which overlies the FA1. The cross-laminated thin beds of sandstone, bounded by mudstone and gley mud represent the finger like crevasse splays deposition. The abundant root traces and leaves in the base of these mud facies represent vegetated flood plain in the upper coastal plains.

Estuarine facies association (FA3) consist of the heterolithic facies (Hs & Hm), Mm and Mc lithofacies. The occurrence of sandstone and mud dominated heterolithic facies in this association indicates tidal influence on the depositional environment. These sandier heterolith variants facies (Hs, Hm) with mud drapes displays localized lenticular and mud draped ripple foresets, which represents the estuarine depositional environment. The presence of ophiomorpha burrows also favours the incursion of some marine influence.

Table 1: Details of the sedimentary facies belonging to the Balingian Formation, based on outcrop data.

Facies	Characteristics	Sketch	Interpreted environment of Deposition
Conglomerate (G_{CM})	Clast and matrix supported conglomerate. Sorting: poor. Colour: light to dark grey, brown. Subordinate lithology: interbedding of grey, medium to coarse-grained sandstone. Characteristics: scour fills, sandstone lenses having cross and parallel lamination, coal clast, discontinuous coal layers. Clast size: mm to 5 cm Clast Composition: sedimentary clasts, quartz, mudstone clast. Boundaries: lower contact erosive or not exposed, upper contact is sharp. Thickness: <1-6 meter.		Bed load deposition in fluvial channel.
Cross bedded sandstone (S_C)	Fine to coarse grained sandstone. Colour: greenish grey, yellowish brown, Sorting: moderate. Characteristics: discontinuous mud layers, localized flaser bedding, plant debris/tissues, rip up clast, carbonaceous laminations. Sedimentary structures: Trough cross lamination. Boundaries: overlain by mud facies and overlies conglomerate facies. Thickness: <1-2 meters.		Meandring channels, point bar deposition in established fluvial system.
Sandstone with subordinate mudstone (S_M)	Fine to coarse grained sandstone. Colour: white to grey. Sorting: poorly to moderately. Characteristics: clay layers, dispersed coal clast, discontinuous coal layers, wood fragments, carbonaceous matter. Sedimentary Structures: flaser bedding. Boundaries: erosive lower contact and contain pebbly sandstones in the base. Ichnofossils: Vertical and horizontal burrows (Skolithos) Thickness: <1-2 meters.		Tidal channel bars deposits.
Inclined Heterolithic facies (H_i)	Fine grained sandstone, carbonaceous mud laminations and clayey mud layers. Colour: Sandstone-grey to light grey Mudstone-Dark grey. Sorting: well sorted sandstone.. Characteristics: sandstone beds 1-7 cm, carbonaceous shale thickness is 1-3 mm, abundant rootlets. Sedimentary Structures: Parallel lamination, mud draped cross laminations, load structures, IHS. Boundaries: sharp and undulatory lower contact with the coal while upper contact is unknown. Thickness: Increases from south to north from 2 meter to maximum 3.4 meter.		Tidally influenced fluvial channel, tidal creeks
Sandstone dominated heterolithic facies (H_S)	Very fine to fine grained sandstone with thin beds of mudstone. Sorting: Moderate. Colour: brown-weathered, grey-fresh. Characteristics: Massive and cross-laminated sandstone beds (5-18 cm). Sedimentary structures: Cross laminations, rippled contact, convolute bedding, mud drapes, rip up clast. Thickness: 1.2 meters, thickness of the individual bed varies laterally. Boundaries: transitional/gradation upper contact with the overlying mud dominated heterolithic facies. Lower contact not exposed		Upper estuarine deposits, tide influenced fluvial channel
Mudstone dominated heterolithic facies (H_M)	Gley mud and shale with some carbonaceous laminations. Colour: Grey Sorting: moderately sorted sandstone beds. Characteristics: leaves remain and paleosols, carbonaceous laminations. Sedimentary Structures: wavy bedding, lenticular bedding, Cross bedding with mud draped foresets. Boundaries: The lower gradational contact with the Hs, sharp with facies Sc while upper transitional contact with pinstriped mudstones. Thickness: 2-4 meters.		Upper estuarine deposits. Tide influenced floodplain
Pin-striped clayey mudstone (M_{CP})	Gley mudstone with very thin laminations (<1mm-2mm) of sand and silt. Colour: dark to light grey. Characteristics: laths and thin carbonaceous laminations, plant leaves. Sedimentary structures: micro cavity (ripples) filling, cross lamination, siltstone lenses. Both vertical and horizontal burrows. Boundaries: sharp contact with the coal and gradational contact with mud dominated heterolithic facies. Thickness: 1-5 meters.		Flood plain, abandoned mud plug, mid estuarine deposits
Massive mudstone (M_M)	Mudstone with silty content. Colour: greenish grey to grey. Characteristics: more compacted and lithified than the clayey mudstone facies, no plant material, negligible carbonaceous material. Boundaries: transitional with M_C and M_P. Thickness: 2-3 meters.		Overbank deposits, mid estuarine muddy deposits
Clayey mudstone (M_C)	Massive gley mud. Colour: grey. Characteristics: Abundant carbonaceous material (lath/micro lamination), abundant rootlets (varies laterally and vertically), occur with coal. Boundaries: transitional upper and lower contact with the coal. Thickness: 1->4 meters.		Swamps, mire, flood plains
Mudstone with plant residue (M_P)	Gley Mudstone with abundant plant residue. Colour: fresh-light grey, weathered-yellowish brown Characteristics: leaf remains (brown and black), their imprints, undistinguishable plant residue, reddish brown coloured floating concretions, discontinuous layers of concretions, horizontal and vertical burrows. Boundaries: sharp and erosional contact with the sandstone and conglomerate while sharp with coal. Thickness: few centimetres to over 4 meters.		Swamps, marshes, mires, flood plains

Coaly shale, Gley mud and sandstone (C_S)	Carbonaceous shale (coaly shale), mud and very fine-fine grained sandstone. Colour: coaly shale-Black, Mud- Dark grey, Sandstone- light grey. Characteristics: dominated by carbonaceous shale (coaly shale), carbonaceous shale-70%, Gley mud-20, Sandstone-10%. Dense laths of brown rootlets. Sedimentary structure/Bedforms: Parallel laminations (<1mm-3mm) in the base, wavy bedding in the middle, lenticular bedding, and lenses of sandstone with internal mud drapes. Boundaries: The lower contact is not exposed while crimped like upper transitional contact with the sandstone facies. Thickness: 3 meters.		Muddy tidal flats, marches, coastal mires
Coal (C)	Coal. Colour: brownish to black coal. Characteristics: highly fractured, crumbled, concoidal fracture (few coals), contain undifferentiated plant residue, intra-formational patches of brown shale. Boundaries: mostly underlain and overlain by the M_P, M_C facies. Thickness: few centimetres to 1 meter.		Swamps, mires, floodplain

Figure 1: Map showing the location of the study area in Mukah, Sarawak.

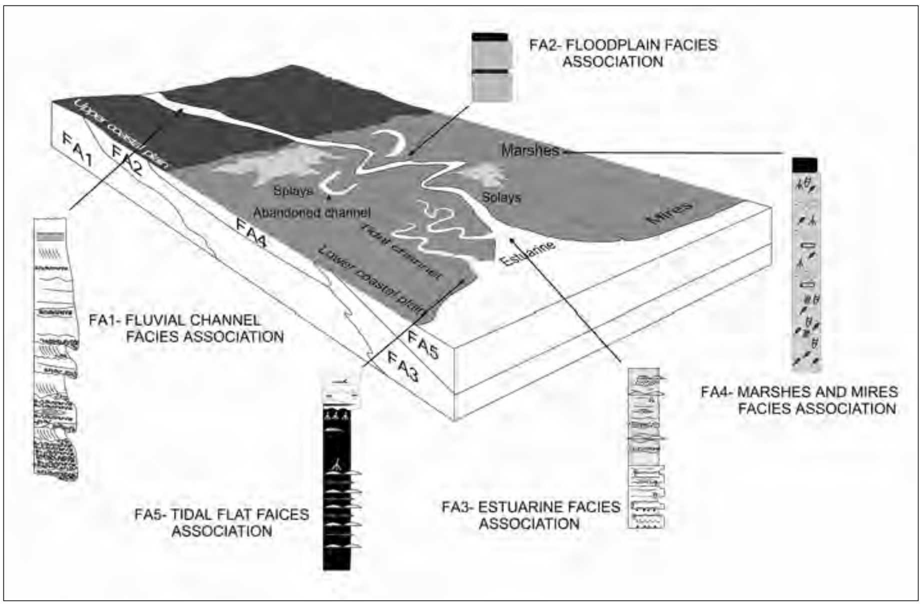


Figure 2: The proposed depositional setting and facies associations of the Upper Miocene Balingian Formation.

Marches and mires facies association (FA4) consist of lithofacies C, carbonaceous mud, and organic-rich mud rocks that are interpreted to represent the deposits of wetlands; Fresh water marshes and lower coastal plain mires. The mudstones and heterolithic facies associated with the fluvial channel and upper estuarine channel show leaves and other undifferentiated plant material, indicating forested zone in the upper coastal plain.

Tidal flats facies association (FA5) is a coarsening upward sequence, consist of CS and Sm facies. The lower CS facies reveal tidal signatures; wavy and lenticular bedding. The upper well-sorted sandstones with thin mud laminae and vertical burrows (skolithos?) suggest that the sandstone was deposited on the margins of broad estuary covered by salt mires in the lower coastal plain.

The Balingian Formation records a complex history of relative sea level change and sediment influx, evidenced by the deposition of different type of facies during the Upper Miocene. The facies architecture developed on depositional environments which can be related to the upper and lower coastal plain (Fig. 2). The coarser part of the fluvial load was deposited in the upper coastal plain (south), while the lower coastal plain (north) in dominated by the fine material. The southern most exposed rocks show major fluvial lag conglomerates, which possibly developed within incised valleys, formed during previous relative sea level fall. During the subsequent sea level rise, these valleys were drowned and successively filled with the channel lags. This episode of sea level rise developed broad estuaries in the lower reaches of these incised valleys. The coarser material was deposited in the upper reaches of the channels. The fine-grained sediment, which passed into the upper coastal plain, filled the estuary. This is evident from the basal upper estuarine facies, which are overlain by thick sequence of mud facies. The estuary environment was overcome by lower coastal plain, dominated by extensive supratidal coal forming marches and mires over the estuarine deposition. The interfluve in the upper and lower coastal plains were forested zone as evident from the presence of plant remain in the distal flood plain deposits. Thin coal seams bounded by flood plain fine were deposited in the distal flood plain. The major channels were divided into small meandering channel due to low gradient and estuary fills. These channels were influenced by tidal currents in the lower reaches of the coastal plain as evident from the inclined heterolithic facies.

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PAPER D03

THE USE OF THE GROUND ELECTROMAGNETIC SURVEY (GEM-2) TECHNIQUE TO MAP THE CONTAMINANT DISPERSION IN THE SUBSURFACE AT BARRY DOCKS, WALES, UK

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The Geophex GEM-2 electromagnetic (EM) instrument provides a rapid multifrequency technique for shallow geophysical exploration. Survey applications include; ground contamination, hydrogeology, groundwater contamination mapping and archaeological investigations. This highly portable hand-held instrument, when linked with active GPS tracking provides typical 1.5 ground point spacing and allows a surveyor to collect around 20,000 data points per hour over five frequencies. GEM-2 uses an active EM signal to detect variations in subsurface conductivity. EM currents result in a secondary magnetic field that is measured together with the original transmitted signal, using a receiver coil on the EM instrument. The depth of ground penetration attained is dependent on a number of factors, and the most significant is the ground conductivity and the chosen EM wave frequencies. Typically five wave frequencies are used in the surveys; 825Hz, 7075Hz, 16075Hz, 31025Hz and 40075Hz. This paper is presented the results from the investigation at Barry Docks site undergoing redevelopment from a 50 year old oil terminal into future residential use. Typically, polluting contaminants will increase the electrical conductivity of the ground materials and ground water. However measured ground conductivity values actually depend upon the types of contaminant. The present of heavy metal give a high electrical conductivity while the hydrocarbon is always given lower conductivity. But, based on recent studies, some of pure hydrocarbons that are electrically resistive increase their conductivity values (less resistive) through time due to biodegradation over many years. This research programme carries out detailed GEM-2 surveys in conjunction with chemical sampling to investigate this conductivity and ground chemistry relationship on the first layer of the GEM-2 data. The study shows the high conductivity zones are corresponds to the location of the hydrocarbon storage tanks, although there is a tank (No. 3) response showed no such signal.

Keywords: Electrical Conductivity, Contamination, GEM-2 System, Barry Docks

INDIKATOR-INDIKATOR STRUKTUR DIDALAM ZON RICIH PLASTIS DI JALUR TIMUR SEMENANJUNG MALAYSIA

Achmad Rodhi

Formasi batuan tertua yang terdapat di Jalur Timur Semenanjung Malaysia ialah batuan metasedimen yang tersebar luas menganjur dari Kelantan, Terengganu, Kuantan sehingga Johor, dan mengandungi fosil berusia Karbon.

Maklumat para penyelidik struktur geologi yang telah bekerja di Jalur Timur Semenanjung Malaysia bahawa batuan metasedimen yang ditafsirkan berusia Karbon telah mengalami canggaan berganda dan dijumpai zon ricih yang lebar di kawasan Terengganu dan Johor Timur. Analisis kuantiti yang direkodkan dalam maklumat para penyelidik terdahulu yaitu Lipatan yang berada di kawasan Cendering mempunyai *julat diantara terbalik sehingga rebah dengan bidang sumbu miring ke TG*. Kawasan Cendering dapat digolongkan menjadi dua iaitu bahagian utara dan bahagian selatan yang *dibatasi oleh zon ricih sesar (filonit) yang lebar mengarah ke E-W dan NNW.* (Tjia, 1978). Manakala di kawasan Tanjung Balau, Tanjung Lompat dan Tanjung Siang juga direkodkan merupakan *zon ricih dekstral mengarah ke UBL dengan perlapisan mengarah juga UBL-STG* menganjur selari dengan garis pantai Semenanjung Malaysia. Lipatan-lipatan berskala kecil jenis lipatan bersilang ira, lipatan periklin tersilang ira dan lipatan terlipat semula banyak dijumpai sebagai *bukti bekerjanya canggaan transpresi dekstral*. Selain itu juga dijumpai ira kerdutan ekstensi dan boudin yang terlipat sebagai *bukti canggaan berganda dan canggaan transpresi dekstral.* (Tajul Anuar dan Mustaffa, 1999).

Definisi zon ricih pada makalah ini adalah suatu zon yang disempadani oleh dua margin atau dinding zon ricih yang memisahkan zon ricih dengan dinding batuan. Strain didalam zon ricih lebih tinggi daripada batuan sekitar. Zon ricih dibahagikan berdasarkan sifat kemuluran (mulur atau rapuh) dan mekanisme ubah bentuk (geseran atau plastis). Zon ricih yang dibina berdasarkan sifat mulur dengan mekanisme ubah bentuk plastis dinamakan zon ricih plastis, manakala zon ricih yang dibina berdasarkan sifat rapuh dan mekanisme ubah bentuk geseran dinamakan zon ricih sesar. Anjakan (displacement) di zon ricih plastis tidak seperti pada zon ricih sesar. Anjakan (displacement) zon ricih plastis berlaku dengan cara mekanisme ubah mulur tidak terbentuk rekahan. Mekanisme ubah mulur ini juga dinamakan aliran kataklastik atau milonit.

Indikator-indikator struktur didalam zon ricih plastis dapat digolongkan menjadi 2, iaitu struktur yang dibina oleh proses aliran kataklastik dan struktur yang dibina oleh proses ricihan (shearing). Struktur-struktur yang dibina proses aliran kataklastik dipertontonkan oleh kompleks struktur butiran berekor (grain-tail complexes) dan lipatan-lipatan silindrical disharmonis. Manakala struktur yang dibina proses ricihan dipertontonkan oleh struktur butiran-butiran yang dipecah-belah (disrupted grains), foliasi, ira, lipatan-lipatan silindrikal ricihan dan lipatan non silindrikal ricihan.

Zon ricih plastis di Jalur Timur Semenanjung Malaysia dapat digolongkan menjadi empat kawasan, iaitu kawasan Tanjung Balau, Kawasan Mersing (Johor Timur), kawasan Kemaman-Dungun, kawasan Marang, dan kawasan Cendering (Terengganu). **Kawasan Tanjung Balau** dapat dijumpai struktur-struktur sebagai berikut : struktur aliran daripada milonit skala sangat kecil, kecil dan sederhana, lipatan-lipatan yang dibina oleh aliran skala sangat kecil, kecil dan sederhana, lipatan-lipatan yang dibina oleh ricihan (shearing) jenis silindrikal dan non silindrikal, skala sederhana dan skala besar, lipatan-lipatan berskala kecil jenis lipatan bersilang ira, lipatan periklin tersilang ira dan lipatan terlipat semula, juga dijumpai ira kerdutan ekstensi dan boudin yang terlipat. Kesemua strktur sebagai indikator-indikator adanya *bukti canggaan berganda dan canggaan transpresi dekstral dengan arah NNW-SSE.* **Kawasan Kemaman – Dungun** dapat dijumpai struktur aliran daripada milonit skala sangat kecil, kecil dan sederhana, lipatan-lipatan yang dibina oleh aliran skala sangat kecil, kecil dan sederhana, lipatan-lipatan yang dibina oleh ricihan (shearing) jenis silindrikal, skala sederhana dan skala besar, lipatan-lipatan berskala kecil jenis lipatan bersilang ira, lipatan periklin tersilang ira dan lipatan terlipat semula, juga dijumpai boudin ekstensi. Kesemua strktur sebagai indikator-indikator adanya *canggaan berganda dan canggaan transpresi dekstral dengan arah N-S.* **Kawasan Marang** dapat dijumpai struktur-struktur sebagai berikut : struktur aliran daripada milonit skala sangat kecil, kecil dan sederhana, lipatan-lipatan yang dibina oleh aliran skala sangat kecil, kecil dan sederhana, lipatan-lipatan yang dibina oleh ricihan (shearing) jenis silindrikal dan non silindrikal, skala sederhana dan skala besar, lipatan-lipatan berskala kecil jenis lipatan bersilang ira, lipatan periklin tersilang ira dan lipatan terlipat semula, juga dijumpai ira kerdutan ekstensi dan boudin yang terlipat. Kesemua strktur sebagai indikator-indikator adanya canggaan berganda dan canggaan transpresi sinistral dengan arah NW-SE. **Kawasan Cendering** dapat dijumpai struktur-struktur sebagai berikut : struktur aliran daripada milonit skala sangat kecil, kecil dan sederhana, lipatan-lipatan yang dibina oleh aliran skala sangat kecil, kecil dan sederhana, lipatan-lipatan yang dibina oleh ricihan (shearing) jenis silindrikal dan non silindrikal skala sederhana dan skala besar, lipatan-lipatan berskala kecil jenis lipatan bersilang ira, lipatan periklin tersilang ira dan lipatan terlipat semula, juga dijumpai boudin ekstensi. Kesemua strktur sebagai indikator-indikator *adanya canggaan berganda dan canggaan sonsang.*

SAND FRACTION AND PORE FRACTION INVERSION THROUGH ACOUSTIC IMPEDANCE DATA: TOOLS FOR QUALITATIVE THIN-BED RESERVOIR CHARACTERIZATION AND NET PAY VOLUMETRIC ESTIMATION.

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This paper present a case study on inversion and characterization of thin-bed reservoirs which is beyond seismic resolution. The ultimate aim of this study is to deterministically estimate the volume of thin pay constrained by inverted impedance data in seismic resolution, with minimal well controls during the late exploration stage. To address the limitations of thin pay and lateral heterogeneity of reservoir in the seismic scale, it is proposed that empirical relationship of sand fraction and pore fraction as a function of impedance are exploited from wells. Subsequently sand fractions and pore fractions are propagated into the inverted impedance volume to produce models characterized by sand fractions and pore fractions. Various strategies for volumetric estimations are then explored and discussed in this papers. Each strategy would then be compared and explained to suit different interpretations and assumptions.

Data used in this study includes 3D seismic data (near, far, full stack) with two wells 4km apart. Constrained Sparse Spike algorithm is employed to invert full stack seismic into quantitative acoustic impedance which are calibrated to the wells. Low frequency trend model are built from the wells.

Petrophysical works is done to obtain reservoir parameters such as shale volume, porosity and gas saturation; while preliminary rockphysics analysis is carried out to study the reservoir's thin-bed character by using well data and inverted seismic data. Quantitative and qualitative interpretations are then performed using acoustic impedance and other attributes to delineate reservoir gross body. As a result, net pay volumetric estimation are then carried out based on sand fraction and pore fraction from impedance data in addition to petrophysical gas saturation.

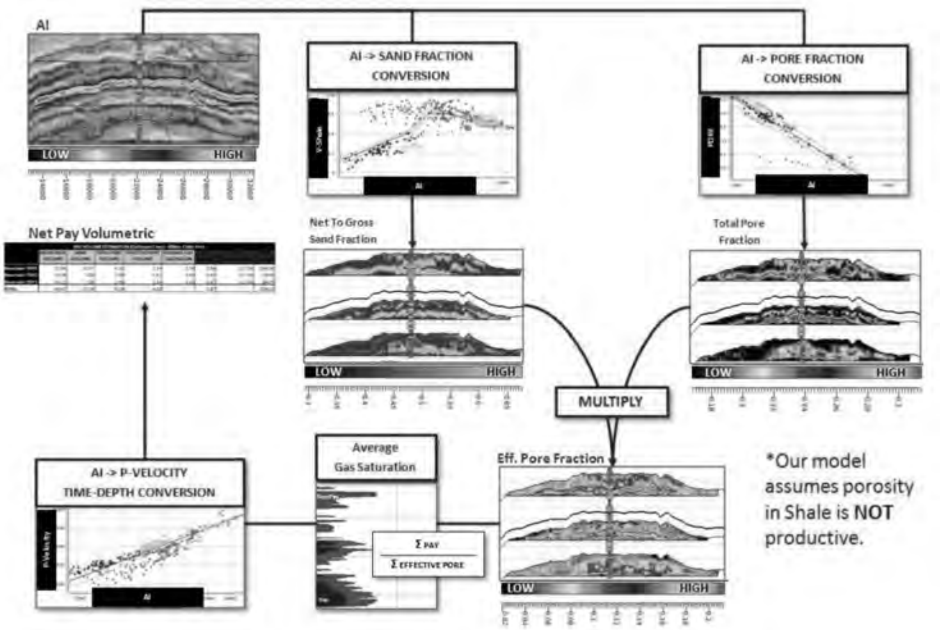

Figure 1: Chart showing the general workflow in inversion Sand Fraction and Porosity Fraction from P-Impedance data (AI).

PAPER P03

BURIAL DIAGENESIS OF COAL-BEARING MUDROCK AND ITS RELATIONSHIP TO THE EVOLUTION OF PORE TYPES AND ABUNDANCE

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Keywords – mudrock, burial diagenesis, pore-types, pore-network, pore-distribution

The coastal region of Sarawak is primarily covered by thick Neogene coal-bearing mudrocks. The mudrocks are composed of shale or mudstone, alternating with sandstone layers and locally intercalated with coal beds. Carbonaceous material in the mudrocks in the form of maceral vitrinite is substantially important to generate gas. The study of pore-types and networks in mudrocks related to burial diagenesis provides the framework on how gas can be stored and flow through the pores. Nano- to micrometer-sized pores were observed in the matrix-related pore network of the mudrocks. These pores together with natural fractures form the flow path network that allows gas flow from the mudrock. The pore types associated with mineral particles are subdivided into interparticle and intraparticle. During burial, mudrocks undergo compaction that decreases substantial pore volume and it also causes thermal hydrocarbon maturation, where organic matter (OM) changes to kerogen. As such, the porosity and gas content is directly associated with the TOC content.

INTRODUCTION

The types of pores in the rocks are determined based on the relationships to particles as mentioned by Pittman, 1979. Pores formed by the arrangement of mineral grains can be interparticle (interP) and intraparticle (intraP). Organic matter also has intraparticle pores (intraP OM). Fracture also contribute to the rock porosity. Identification of pores, such as type, size, arrangement of pore, connectivity and wettability provides an insight to reservoir properties. Micro- to nano- scaled pore spectrum is easily recognized using scanning electron microscope (SEM), whilst macro-scaled pore can be seen under polarized microscope. The porosity of the mudrocks of the Balingian and Begrih Formation, Sarawak were studied in this project.

RESULTS and DISCUSSION

Typical interparticle pores are commonly found in the young or shallow-buried sediments of the Balingian and Begrih Formation with characteristics of well-connected and permeable layers. Subsequent overburden stress and diagenesis occurred during burial and closed the InterP pore spaces and plugged the pore throats. Ductile or plastically deformable grains (e.g. clay floccules, mica and organic matter) exacerbate the rate of porosity loss. The age of the sediments has a bearing on the volume of intraparticle pores (Fig. 1). Older sediments have less intraparticle pores as they are cemented by secondary minerals. The existence of fracture pores can have a significant effect on hydrocarbon production, because most of them are not completely cemented. During maturation of the organic matter, if it reaches a Ro level of approximately 0.6 or higher, intraP pores of organic matter begin to develop (Dow, 1977). This pore has an irregular, bubble-like, elliptical cross section and a length generally ranging from 5 to 750 nm. The pores appear to be isolated in 2D but are actually connected as displayed in 3D (Loucks et al., 2009). With a maturity of less than 0.6% Ro, the intraparticle OM pores are absent or extremely rare. Studies showed that the Balingian mudrocks have a Ro of 0.3 to 0.7% and some of the samples have bubble-shaped intraparticle OM pores (intraP OM). Balingian shales predominantly have Type III kerogen. Generally, type III kerogen shows no development of intraparticle OM pores, even if a mudrock has a Ro > 0.8%. It can be inferred that the type of kerogen present controls the formation of intraparticle OM in thermally matured rocks.

ACKNOWLEDGEMENT

The authors would like to thank Sarawak Coal Resources Sdn. Bhd. for their contributions in providing data and gaining access to the coal mines.

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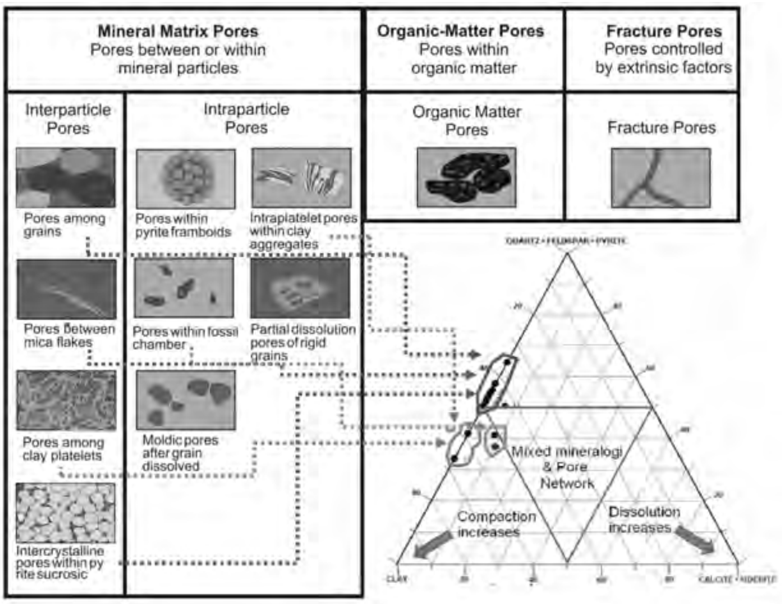

Figure 1. Cartoon of pore types exist in the shale samples of the Balingian and Begrih Formation

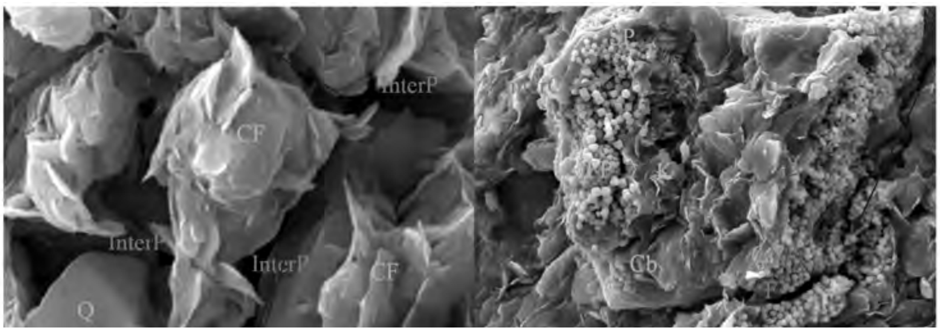

Figure 2. left : Well-connected interparticle pores (InterP) in between quartz and clay floccules. Red lines represent possible hydrocarbon migration pathways; right : Typical of pyrite, sucrosic and framboids, create intercrystalline (InterC) and intraparticles (IntraP) respectively. Fracture pore leads to the pore network.

PAPER P04

KEWUJUDAN BATUAN PIROKLAS DALAM FORMASI KUBANG PASU, BARATLAUT SEMENANJUNG MALAYSIA. (OCCURRENCE OF PYROCLASTIC ROCK IN THE KUBANG PASU FORMATION, NORTHWEST PENINSULAR MALAYSIA)

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Formasi Kubang Pasu telah dienapkan pada sekitaran lautan cetek di bahagian Barat dan menjadi semakin dalam ke sebelah Timur. Formasi ini terdiri daripada selang lapis batu pasir dan batu lumpur serta sedikit rijang. Sebelum ini tidak pernah dilaporkan kewujudan batuan piroklast atau pun tuf di dalam Formasi Kubang Pasu. Walau bagaimanapun semenjak kajian ini dijalankan terdapat penemuan baru batuan piroklast yang nampaknya seakan-akan batuan tuf berlumpur. Sebelum ini batuan mungkin telah disalah anggap sebagai batuan sedimen. Kajian terperinci yang telah di jalankan menunjukkan bahawa batuan piroklast ini telah membentuk struktur daik dan sil dalam batuan sedimen Formasi Kubang Pasu. Singkapan ini dapat di lihat di Kuari Guar Sanai (Bukit A) dan di Kuari Bukit Tuntung, Perlis: juga di Kuari Bukit Pala, Kuari Bukit Teriak dan juga bekas Kuari Bukit Meng, Kedah (Rajah 1, 2 dan 3). Batuan ini nampaknya seperti sama dengan batu lumpur bertuf, walau bagaimanapun ianya tidak menunjukkan struktur primer kerana ketiadaan perlapisan atau pun laminasi. Kajian petrogafi juga menunjukkan kehadiran kuartz berkaca dalam pelbagai saiz dengan matriks yang sangat halus. Di lapangan batuan ini sangat mengelirukan kerana nampaknya sama seperti batuan sedimen bertuf. Di Bukit Guar Sanai batuan ini seperti debu volkano, tetapi di Bukit Tuntung ianya nampak seperti kuartza yang sangat retak dan berongga. Di Bukit Pala dan Bukit Teriak Nampak seperti batuan volkano dengan kehadiran matrik serta klast-klast pelbagai jenis, saiz dan bentuk. Di Bukit Meng singkapan batuan piroklast ini telah memotong perlapisan Formasi Kubang Pasu. Manakala di Bukit Inas pula intrusi batuan piroklas ini telah menyebabkan singkapan rijang Formasi kubang Pasu telah terbahagi kepada dua bahagian. Kajian petrografi menunjukkan batuan ini terdiri daripada matrik yang sangat halus dengan kehadiran kuartz berkaca yang berbagai saiz dan bentuk (Rajah 4). Kajian telah melibatkan semua sampel daripada kawasan yang disebutkan beserta keputusan analisis kualitatif XRD dan juga XRF. Kesimpulanya batuan piroklas di dalam Formasi Kubang Pasu ini adalah intrusi lewat yang masuk menerobosi retakan di dalam Formasi Kubang Pasu. Kemungkinan aktiviti limpahan volkanik ini telah berlaku semasa usia Perm Akhir atau Trias Awal.

The Kubang Pasu Formation was deposited prominantly within the shallow marine continental shelf on the west and deepening towards the deep marine on the east. The Kubang Pasu Formation comprises mainly interbedded sandstone and mudstone with minor cherts. There was no record of the occurrence pyroclastic or tuff in the formation. Recently, we discovered some pyroclastic rock similar to tuffaceous mudstone. The rock was thought to be sedimentary rock. A detailed observation exhibits that this pyroclastic rock forms dikes and sills in the Kubang Pasu Formation. The rock intruded the Kubang Pasu Formation. The rock is exposed at Bukit A Guar Sanai and Bukit Tuntung, in Perlis; Bukit Teriak, Bukit Inas and Bukit Meng in Kedah (Figure 1, 2, 3). The pyroclastic rock

Figure 2: The arrow showing an intrusion of pyroclastic rocks (yellow brown color) at Bukit Guar Sanai, Perlis are perpendicular to the bedding.

Figure 3: Pyroclastic Flow of the Bukit Meng outcropt..

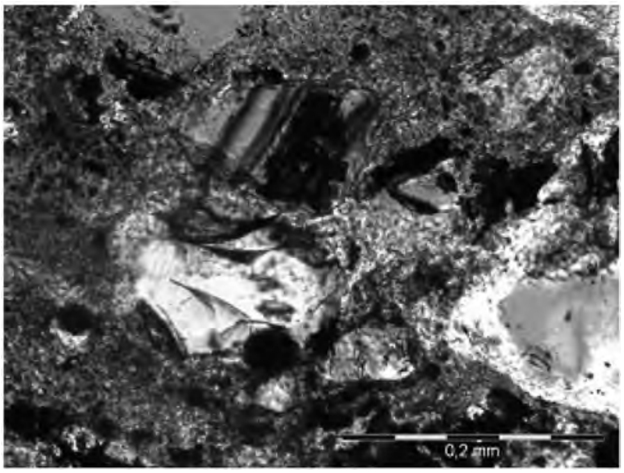

Figure 4: Thin section of Pyroclastic rocks (Bukit Meng) showing glass shard and feldspar in the fine grain matrics.

appears to be very similar to tuffaceous mudstone but lacking of primary structures such as beddings or laminations. The rock is easily confused with tuffaceous sedimentary rock. It looks very much like volcanic ash at Bukit Guar Sanai, Perlis but at Bukit Tuntung, Ulu Pauh, Perlis it contains quartz grains and has a lot of fractures and vesicles. At Bukit Teriak and Bukit Pinang in Kedah, it contains quartz grains of varying sizes and shapes. At Bukit Meng the rock cuts the bedded Kubang Pasu Formation. At Bukit Inas the intrusion separates the bedded chert into two parts. Petrographic observation shows that the rock is very fine grain containing some quartz grains of varying in sizes and friable (Figure 4). The pyroclastic rock is younger than the Kubang Pasu Formation and intruded the formation through fractures. It probably formed the volcanic swarm during active volcanism during the Late Permian and Early Triassic.

Keywords: Pyroclastic, Late intrusion, Kubang Pasu Formation, Northwest Peninsular Malaysia

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JUJUKAN BATUAN KOMPLEKS OFIOLIT MARUDU BAY (KOTM) : CERAPAN LAPANGAN DAN PETROGRAFI

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Batuan dasar atau ofiolit yang berusia Kapur bawah-Paleosen tersingkap di beberapa lokaliti di utara Sabah sekitar kawasan Kota marudu – Pitas dan dirujuk sebagai Kompleks Ofiolit Teluk Marudu (KOTM) dalam artikel ini (Rajah 1). Jujukan batuan ofiolit di kawasan ini merupakan sebahagian daripada Formasi Rijang-Spilit (Stephen, 1957). Sanudin & Tan (1986) pernah mencadangkan Formasi Rijang-Spilit dimasukkan dalam satu unit stratigrafi yang di namakan Mélange Sabah (*Sabah Mélange*). Tjia (1988) pernah mencadangkan satu jaluran yang dinamakan Zone Sutura Kinabalu (*Kinabalu Suture Zone*) yang terdiri daripada kesemua ofiolit dan mélange di Sabah. Basir (1991) kemudiannya telah mencadangkan nama baru iaitu Kompleks Sabah (*Sabah Complex*) yang merujuk Formasi Rijang-Spilit yang tidak berasosiasi dengan percampuran batuan bercelaru (*Mélange*). Basir dan Tongkul, (2012) dalam kajian radiolaria yang tertumpu di sepanjang Sg. Baliojong telah merujuk kawasan tersebut sebagai kompleks baliojong. Artikel ini akan membincangkan dan memberi gambaran ringkas tentang ciri-ciri batuan jujukan Kompleks Ofiolit Teluk Marudu (KOTM).

Hasil daripada cerapan lapangan dan analisis petrografi, jujukan batuan KOTM ini terdiri daripada batuan ultrabes terserpentinit, batuan gabro, basalt masif, basalt bantal, assosiasi batuan felsik (diorit) dan sedimen lautan kuno yang terdiri daripada rijang, batu lumpur dan batu kapur.

Jujukan batuan KOTM (Rajah 2) hampir menggambarkan difinisi ofiolit seperti yang pernah dibincangkan dalam Konferens Penrose, 1972 dan Coleman 1977. Tanpa kehadiran beberapa bahagian pada jujukan (kompleks daik dan mafik-ultramafik kumulat), KOTM hadir sebagai satu jujukan ofiolit yang tidak lengkap (*dismembered ofiolite*).

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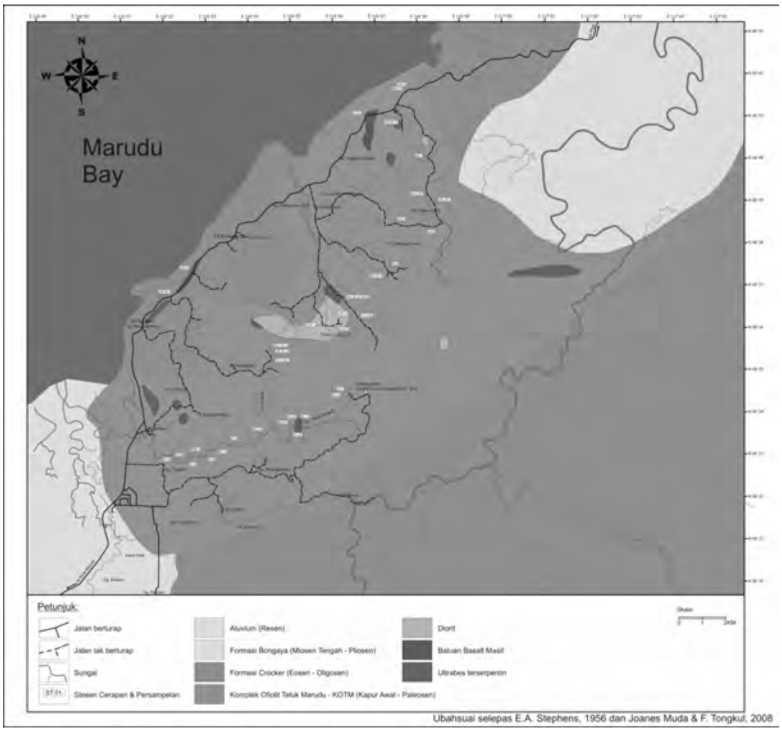
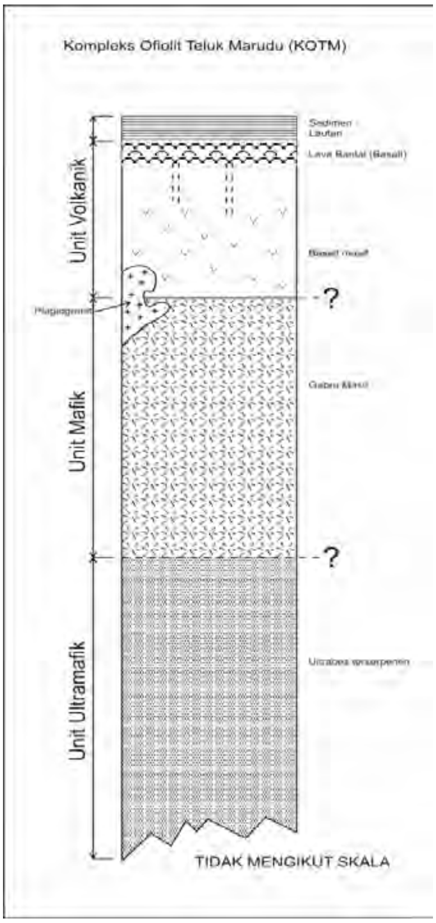


Rajah 1 Peta geologi kawasan kajian (ubahsuai selepas Stephens, 1956 dan Muda & Tongkul, 2008)



Rajah 2 Jujukan batuan Kompleks Ofiolit Teluk Marudu (KOTM 8)

CIRIAN FIZIKO-KIMIA BAHAN GEOLOGI SEMULAJADI DAN SINTETIK YG DIGUNAKAN SEBAGAI BAHAN POZOLAN DALAM PEMBUATAN MORTAR

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Bahan pozzolan samada yang semulajadi atau sintetik merupakan bahan yang melimpah dengan komponen silika atau aluminosilika dan jika dicampurkan dengan simen portland serta air, ia berupaya secara reaktif meningkatkan penghasilan komponen penyimen, kalsium-silikat terhidrat. Peningkatan komponen penyimen, kalsium-silikat terhidrat ini sekaligus mempertingkatkan kekuatan mekanikal mortar atau konkrit. Kajian ini tertumpu kepada penilaian sifat fiziko-kimia bahan pozzolan terpilih seperti lempung kaolin, serbuk batu kapur, bahan-baki gipsum serta serbuk halus silika yg diproses daripada kelapa sawit (POFA). Kesemua bahan pozzolan ini telah diteliti cirian fiziko-kimianya seperti pH, peratus kecerahan, sifat kekonduksian elektrik, komposisi kimia dan kandungan mineralnya.

PAPER P07

HEAVY METALS DISTRIBUTION OF NUKAKATAN VALLEY RIVER SEDIMENTS, TAMBUNAN, SABAH

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This paper discusses on the analysis of some selected heavy metals distribution of Nukakatan Valley river sediments which situated in the district of Tambunan, Sabah. The area was made up of Crocker Formation aged Late Eocene to Early Miocene, consisting thick sandstone interbedded with thin shale facies and thin sandstone interbedded with thin shale facies. The main river in the valley was Nukakatan River that flows from northwest to southeast. Apart from the heavy metals analysis using ICP-OES, the physical properties of the soils were also analyzed to see the pH value, moisture and organic content and particle size as these parameters were important in controlling the presence of heavy metals. These river sediments have acidic characteristics as shown by the pH values ranging from 5.75-6.26. The soil moisture content ranged 3.29% to 8.49%, while the organic matter content were very low with less than 0.30%. The sediments were classified into sandy loam, sandy clay loam and loamy sand. A total of seven heavy metals were detected where zinc (Zn) shows the highest concentrations with the average value of 205.13 µg/g, then followed by copper (Cu), nickel (Ni), chromium (Cr) and arsenic (As) with the average less than 20.00 µg/g, while lead (Pb) show 6.15 µg/g and the lowest was cadmium (Cd) with the average of 1.18 µg/g. Two samples show significantly high concentrations of Zn, where S4 recorded 696.35 µg/g and 220.74 µg/g in S6. The presence of these heavy metals was due to their mobility and leaching process during chemical weathering and also adsorption by clay minerals and organic matter, added with the contribution of human activities within the area.

GOLD MINERALIZATION PROSPECT WITHIN UPPER SG. GALAS-TAN SEE VICINITY, ULU GALAS, KELANTAN

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This paper reports the analysis results on the prospect of finding a hard rock gold mineralization within the upper Sg Galas-Tan See vacinity, Ulu Galas, Kelantan The occurrence of the alluvial type of gold deposits along the Sg Tan See and Sg. Galas river valleys may due to the detaching of gold-bearing rock originated from higher ground hillside. Current active alluvial mining operation and relic of old mining works in the area may granted further exploration for finding of primary, hard rock gold mineralization in the area. Previous information acquired during the initial stage of exploration on geochemical and related activities as well as recent geological mapping and geochemistry data were analyzed. Widespread occurrence (epiclastic), volcanic to volcaniclastics comprising crystal-lithic tuff, which rhyolitic to andesitic composition, dominated the central part of the prospect. Phyllite and slate restrain the eastern and western, N-S trending margin with the volcanic. Fine-grained, limestone occupied the Sg. Tan See valley on the west. Au content in seven (7) milky white quartz veins, 5-30cm wide with black spot (striking N70°E or N25°E) are less than 1.3ppb, whilst Ag< 0.1ppm, As<1.2ppm, Cu < 9.3ppm. Ni (212ppm) and Cr (237ppm) are the higher constitutions. However, grid soil sampling at many points show good “halos” that me granted further investigation where show a significance As (1000-2000ppm) and Sb (Max 8.5ppm) anomalies. Promising gold mineralization (soil sampling) indicated the anomalous is coincide with regional geological structural alignment, and believed to be associated and hosted along sheared zone along metamorphic-volcano-clastic margin. However, detailed structural features mapping and geochemical analysis are required.

PAPER P09

GEOHERITAGE AND GEOTOURISM POTENTIAL OF GUNUNG RENG AND ITS SURROUNDINGS, JELI DISTRICT, KELANTAN

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Gunung Reng is located in Batu Melintang sub-district, along the East-West Expressway in Jeli district in western Kelantan. Though the local people designated it as a ‘gunung’ (the Malay word for ‘mount’), it is not a mount in the true definition but it is actually a mogote hill towering above the flat alluvial topography. Gunung Reng is composed of metamorphosed limestone (marble) sitting on the intrusive body (granitic rocks) and surronded by quarternary alluvial deposits. The aim of this paper is to present a state of knowledge about geoheritage and geotourism potential of Gunung Reng and its surroundings. Its beautiful geological landscape and some unique geological features that occur in the area offer geoheritage values, including of scientific, aesthetic, recreational and cultural values. It has also geotourism potential that can attract interests of geoscientists and general public. The hill possesses some caves, where the main cave go through the top of the hill. Another attraction of the area is the Pergau River (the main and the largest river in the district of Jeli) flowing through the south of the hill which significantly beautify the area. This recreational area is also equipped by the authority with some infrastructures such as mosque, community hall, playground, parking lot, public toilets and food stalls. Because of its spectacular natural beauty and uniqueness, it is proper that Gunung Reng become the icon of Jeli tourism.

Keywords: Geoheritage, Geotourism, Gunung Reng, Jeli district, Kelantan.

GEOTOURISM POTENTIAL OF JELI HOT SPRING, KELANTAN

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There is a unique and rare geological phenomenon in the district of Jeli, Kelantan, which is the one and only hot spring in the area, namely Jeli hot spring. This hot spring is located in Helai River valley and surrounded by hilly area, about 1 km from the East-West Expressway in Bendang Lawa village, Batu Melintang sub-district. It flows out hot water continuously from the fracture of the granitic rock with the temperature of about 49 degree Celsius. It can attract people to enjoy the fresh hot water and the natural "sauna" that might give freshness to the body. In addition, the content of sulphur in the water is believed to be able to cure some skin problems. There are some infrastructures in the area such as roofed huts equipped with tables and chairs provided for visitors. This hot spring is very potential to be promoted as one of geotourism spots in Kelantan.

Keywords: Geotourism, Jeli hot spring, Helai River, Jeli district, Kelantan.

PAPER P11

SEBARAN DAN MINERALOGI SEDIMEN DELTA SUNGAI PAHANG

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Delta Sungai Pahang yang terletak di bahagian timur semenanjung Malaysia adalah salah satu contoh terbaik bagi delta yang dipengaruhi oleh ombak. Sebanyak 57 sampel sedimen permukaan daripada sistem muara sungai Pahang telah diambil bagi tujuan analisis saiz butiran dan pembelauan sinar X. Sebanyak 46 sampel telah diambil di kawasan hadapan muara Sungai Pahang manakala selebihnya iaitu 11 sampel telah diambil di dalam muara Sungai pahang. Hasil analisis saiz butiran menunjukkan perubahan corak saiz butiran dipengaruhi oleh tindakan ombak dimana tiada perubahan signifikan pada corak penyebaran sedimen. Ciri-ciri penyebaran sedimen bagi setiap lokasi persempelan banyak bergantung kepada gabungan daya fizikal iaitu aliran sungai dan proses marin (air pasang surut dan ombak). Bagi analisis pembelauan sinar-x pula, antara mineral yang didapati mempunyai kelimpahan yang tinggi adalah mineral Kuarza dan Muskovit. Mineral lempung yang dominan dalam semua sampel adalah Illite dan Kaolinite. Terdapat juga kewujudan mineral berat seperti Magnetit dan Zircon.

REEF FACIES DISTRIBUTION, DESTRUCTION AND REJUVENATION: SALANG AND SOYAK ISLAND, TIOMAN ISLAND, PAHANG

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Introduction

This paper describes coral distribution patterns on a modern reef environment at Salang bay Soyak Island, Tioman. The reef system mainly comprises hermatypic hard corals displaying higher distribution and greater health seaward of Salang Bay (M.W.R.N De Silva, 1984). However, construction on top of the Salang bay headland is suspected to have affected reef health. This study investigates physical factors influencing coral reef distribution patterns. Additionally, the dynamics of frame builders in different environments and human impact on coral reef health at Salang Bay were also analyzed.

Data and Methodology

Snorkelling, free diving and kayaking were conducted to map different reef environments, substrate and depth parameters at selected sites. These parameters were correlated with satellite images from Google Earth and plotted in Macromedia FreeHand Mx. Reef distribution maps of Salang and Soyak Island along with two facies models at both sites were produced with attributes of depth, environments and substrates.

Results and Interpretation

Two main types of reefs were recognized; windward fringing reefs at Salang and northern Soyak Island and a leeward fringing reef at southern Soyak Island. Windward reefs are stressed by strong wave action, resulting in development of lesser coral cover on the reef flat, but becoming greater towards the fore reef (Fig. 1). The calm and shallow waters of the leeward reef at southern Soyak Island is dominated by Acropora cervicornis at the reef flat, indicating high coral cover but lesser diversity as compared to the windward reef. The dense and diverse coral cover on the reef flat decreases drastically towards the fore reef, where it is replaced by abundant sea urchins. Sedimentation from both river source and headland at Salang seems to distress the hard corals, and calcareous algae cover the dead corals. Despite this, deepening towards the fore reef produces favourable conditions as both intensity of sedimentation and wave action is decreased.

A change in coral growth form and species replacement (Barnes, R. S., 1982), from encrusting to delicate branches to massive forms, occurs with increasing depth in the windward reefs. Changes in wave energy influence the development pattern of hermatypic corals (Montaggioni, 2005). The encrusting forms were observed to adapt to harsh, high wave energy environments whereas the delicate branched forms adapt to quieter environments.

Reef build-up in the form of delicate branched coral types successively growing on top of dead branches was observed in southern Soyak Island. Sediments filled up the cavities and later were cemented by coralline algae which serve as secondary frame builders, forming hard rock. Reef build-up on the Salang fore reef is in the form of mound corals developing into massive structures. Various forms of corals and clams bore into the surface of the massive structures, forming tower reefs.

The damage made to the pristine coral reef was probably caused by development on top of the headland. The previously coral-dominated Salang bay reef has changed to algae-dominated with widespread sand covering the dead coral, implying extreme sedimentation from major run-off. Yet, some of the reef terrace is still being physically removed for boat sheltering and creation of channels. Improper garbage disposal to the river, extraction of marine life and disposal of litter have all resulted in destruction of the reef system.

Conclusion

Physical processes including wave action and sedimentation control the density, diversity and health of coral present. However, human activities have changed the distribution of coral reefs at Salang bay. Increased sedimentation possibly due to headland development has resulted in coral death and replacement by algae.

Acknowledgment

The authors would like to thank the authorities and residents of Tioman for their help and hospitality. This study was part of Afiq's BSc thesis at University of Malaya.

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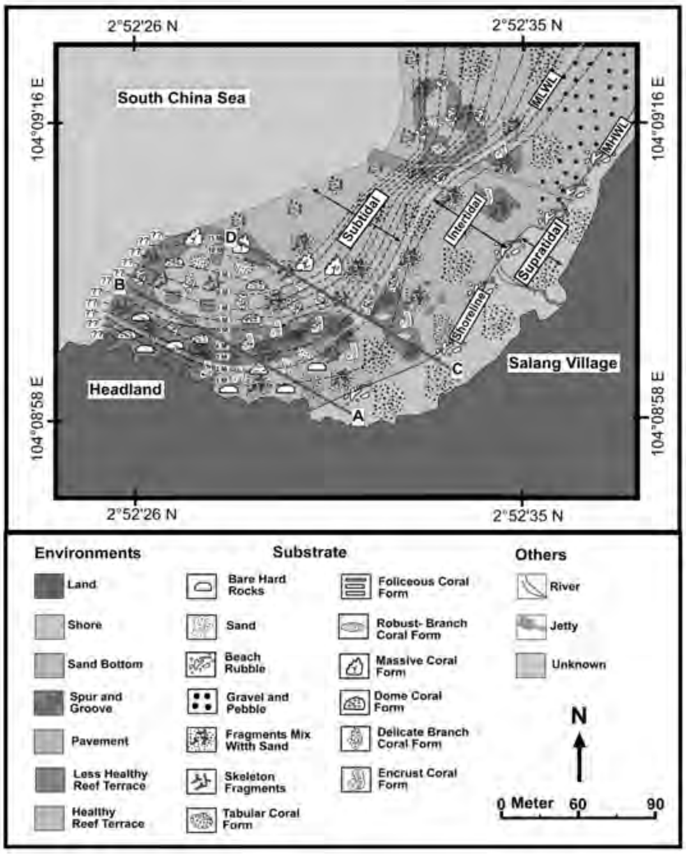

Figure 1: Surface map of the Salang bay windward fringing reef, Tioman.

BASALTIC DYKES OF THE EASTERN BELT OF PENINSULAR MALAYSIA: GEOCHEMISTRY, AGE AND TECTONIC IMPLICATION

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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 (Figure 1). Thus it is difficult to correlate the dykes with the closure of Tethys during Permo Triassic time because of the younger age of the dykes. The majority of the dykes exposed in the Eastern Belt may have been attributed to the difference of crustal thickness between the Eastern and Western belt of Peninsular Malaysia (Figure 2). By the period of time (79 ± 2 Ma to 179 ± 2 Ma), the subducted Tethys oceanic slab is expected to have mostly thermally equilibrated with the surrounding mantle beneath Peninsular Malaysia. The slab was likely to have sunk below the upper mantle. A thicker Western Belt crust is difficult to rupture with normal plate tectonic stress and therefore serves to contain the rise of a mantle derived melt. The chemistry indicates they are olivine to quartz normative and are of the continental within plate category. The bulk composition and the major elements variation patterns of the dykes point to their evolution through crystallization controlled by fractionation of clinopyroxene and plagioclase in the early stage. Furthermore, the strong positive correlation of some of the major and minor elements (TiO_2, FeO and P_2O_5) against Zr suggests the importance of fractionation of early phases such as ilmenite and clinopyroxene in the magma.

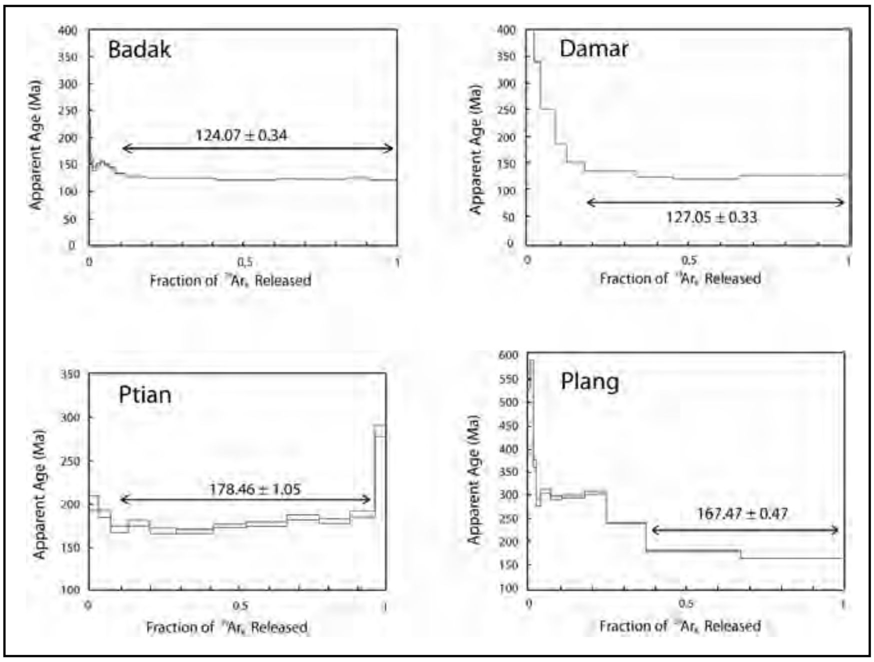

Figure 1: $^{40}Ar/^{39}Ar$ plateau diagrams for samples (a) BADAK, (b) DAMAR, (c) PTIAN, and (d) PLANG. Plateau ages with 2σ analytical errors were calculated using the steps between arrows.s.

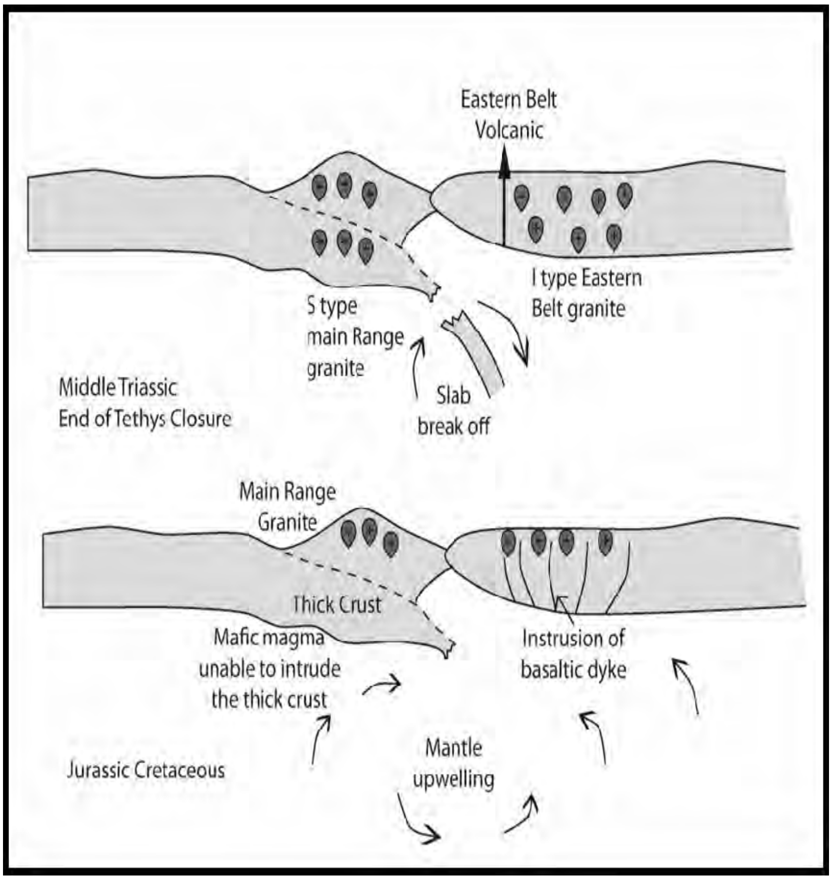

Figure 2: Cartoon cross-sections illustrating differences in crustal thickness of Eastern and Western belts of Peninsular Malaysia. A thicker western Belt crust is more difficult to rupture with normal plate tectonic stress and therefore serves to contain the rise of a mantle derived melt.

USING STEPWISE LOGISTIC REGRESSION TO SELECT IMPORTANT LANDSLIDE CAUSAL FACTORS IN LANDSLIDE SUSCEPTIBILITY MAPPING

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The aim of this study is to identify landslide influencing factors that causes landslides in the west coast region of Sabah. Thirteen landslide factors were selected in this study. These factors are slope angle, slope curvature (plan, profile, & tangential), slope aspect, elevation, drainage density, lineament density, soil type, lithology, annual rainfall, road density, and land use. A total of 137 landslides were identified through aerial photographs interpretation and these landslides were used for analysis and also for validation. From the analysis, the model identified slope angle, elevation, road density and lithology as important landslide causal factors. These factors were later used in GIS to construct a landslide susceptibility map using the logistic regression method. The degree of fit method was used to validate the accuracy of the landslide susceptibility map which shows an accuracy of 70-79% indicating that the landslide susceptibility map has an acceptable accuracy for mapping landslides.

Introduction

Statistical approach has gained serious attention from many researchers over the years in landslide susceptibility mapping (e.g. Pradhan & Lee, 2007; Jaiswal et al., 2010; Lin et al., 2010; Mezughi et al., 2012). This study aims to show how a statistical model can help to determine important landslide causal factors by applying a stepwise procedure. The logistic regression model is used to achieve the study aim.

The study area

The west coast region of Sabah is selected for this study. The study area comprises the state capital Kota Kinabalu and several smaller towns such as Menggatal, Telipok and Tuaran. It covers an area of 387 km2 involving four adjacent 1:50,000 topograhic maps. The study area is bounded by the Crocker Range at the east while most of the central part is a flatland with several hilly area ranging from 20 to 384 m in elevation.

Selection of Data Layers

A landslide inventory map containing 137 landslides serves the most important purpose in this study where it was used together with the landslide causal factors to generate the landslide susceptibility map and also used for validation. Out of the 137 landslides, 69 landslides were used together with the landslide causal factors to construct the landslide susceptibility map and the other 68 landslides were used to validate the map. For modeling purpose, 81 stable units that are free of landslides were randomly selected and were also intersected with all 13 landslide causal factors. The 13 landslide causal factors used in this study are slope angle, slope curvature (plan, profile, &

Attributes	B	S.E	Sig (*p*)	Attributes	B	S.E	Sig (*p*)
Lithology			0.61	*Slope angle (°)*	0.133	0.030	0.000
Alluvium	-1.166	1.062					
Interbedded sandstone and shale	1.055	0.706		*Road density (m/40,000m^2)*	0.004	0.001	0.002
Sandstone	0.889	0.700					
Shale	0[a]	-		Elevation (m)	-0.010	0.002	0.000
Constant	-2.426						

Table 1 The coefficient (B), standard error (S.E) and significance (*p*) values for each landslide factor class

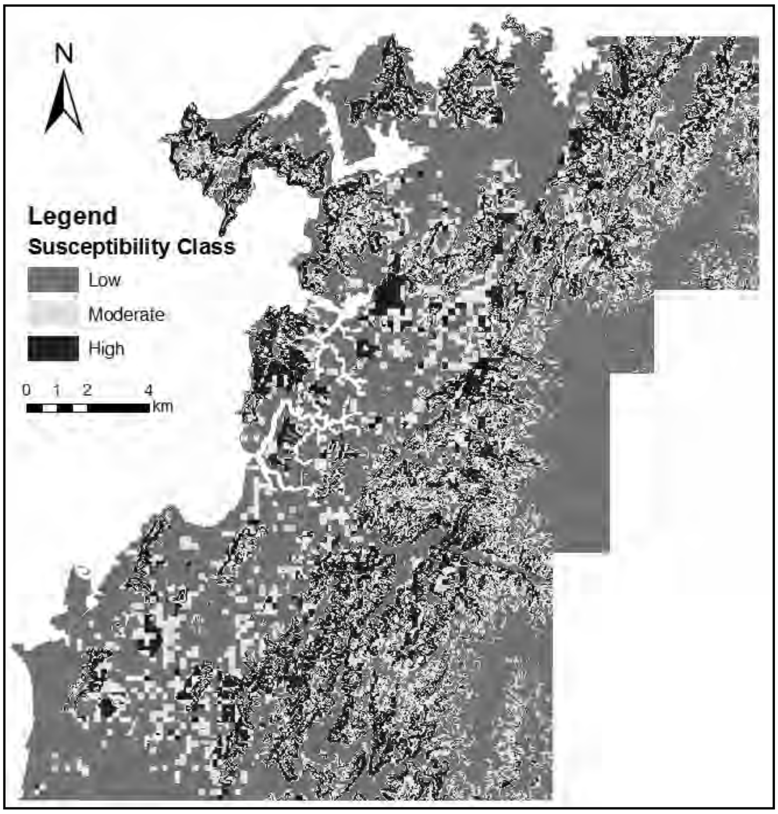

Figure 1 The landslide susceptibility map based on the logistic regression method

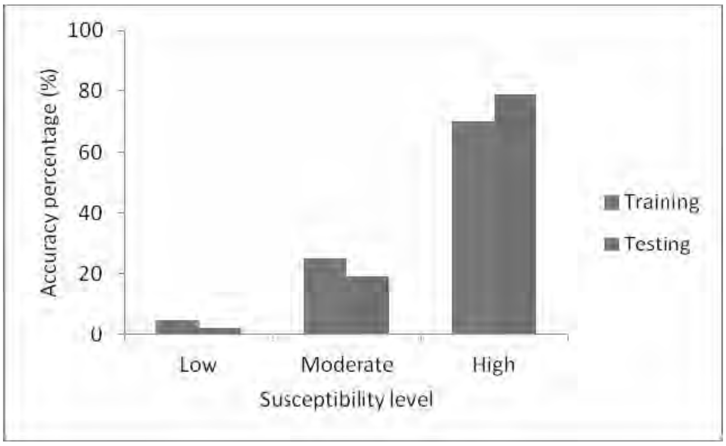

Figure 2 Validation results for the training and testing data sets.

tangential), slope aspect, elevation, drainage density, lineament density, soil type, lithology, annual rainfall, road density, and land use. The 69 landslides and 81 stable units were analysed using stepwise logistic regression to determine the important landslide causal factors.

Result & Discussion

Based on the analysis, three landslide factors were indicated as significant to landslide occurrences (Table 1). These factors are slope angle, road density and elevation. Although lithology is not indicated as significant, the lithology factor was included by the model to improve the model's performance. The landslide susceptibility map constructed from the four factors using logistic regression method is shown in Figure 1.

The map was validated using the training and testing datasets. The validation results showed that the training and testing datasets have an accuracy of 70% and 79% respectively (Figure 2). The testing validation result recorded higher accuracy because of higher percentage of landslides presence in the high susceptibility class.

Conclusion

This study has demonstrated the use of stepwise logistic regression in landslide susceptibility mapping. The model is also capable through stepwise statistical analysis to identify factors that significantly influence landslide occurrences in the study area.

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PAPER P15

DETECTION HYDROSPHERE CONTAMINATION IN HARD-ROCK BY USING ELECTRICAL RESISTIVITY TOMOGRAPHY TECHNIQUE AT HULU LANGAT BASIN, SELANGOR, MALAYSIA

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Hydrosphere pollution is a major global issue at challenge that is affecting the Earth's systems. Hydrosphere is a discontinuous layer of water at or near to the Earth's surface (Araya, 2005). More specifically, the hydrosphere includes the region that includes all the earth's liquid water, frozen and floating ice, water in the upper layer of soil, and the small amounts of water vapor in the earth's atmosphere. Beside that the term pollution is referring to the environmental damage caused by waste that is discharged into the hydrosphere. It is also used to refer to the occurrence of waste in the hydrosphere or to the presence of waste itself. The hydrosphere in the study area has been contaminated due to rapid expanded of agriculture activity, illegal landfills, and other activities. This expansion has been accompanied by increasing pollution and anthropogenic activities.

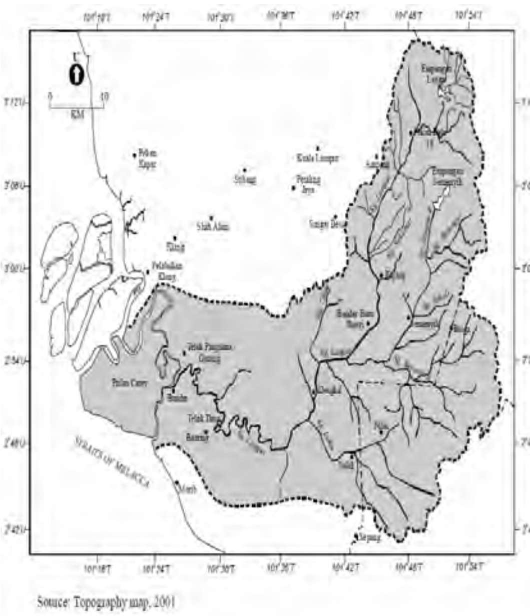

Figure 1: Map shows the location of the study area.

The study area is situated in the Hulu Langat watershed and along the upper stream of the Langat River Basin, Selangor, Malaysia (Figure 1). Hulu Langat watershed's geographical position in Selangor contributes to the states rapid development as an industrial hub Hydro meteorologically. Hydrosphere can be affected by various aspects either natural or physical changes in the area.

The principal objective of this paper is to determine the effect of the hydrosphere contamination in the study area that is located in hard-rock aquifer "Granite Formation" at Hulu Langat watershed Basin (Figure 1) by using Electrical Resistivity Tomography (ERT). In additional, to determine the geoelectrical and hydrogeological characteristics of the contaminated hydrosphere present in the study. Wenner-alpha array was used with electrode spacing of 5m and the total traverse line length of 200 m. This profile is conducted in an undeveloped area that located as shown in Figure 1. This area is considered as illegal landfills and flood area. The survey line is carried along Jalan Datok Alias, Kampung Maleka, Selangor as shown in Figures 1 and 2. The profile line is trend from North to South. It is located in Granite Formation "Hard-rock aquifer".

The ERT inverse model (Figure 2) shows the low resistivity anomaly of contaminated hydrosphere with a resistivity value range from ≤ 2 ohm.m to ≈ 100 ohm.m. The 2D ERT inverse model shows the continuation flow direction from N to S based on low resistivity anomaly that is extended from Earth's Surface till around 22 m at the northern part. The contaminated water has been introduced to the hydrosphere from the illegal landfills, mining activities and other anthropogenic activities as shown in Figure 2 that located north of the profile survey line. Therefore, ERT Method provided a vital planning for identifying and detecting hydrosphere contamination in the study area by proposing methods for controlling and monitoring water index quality.

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Acknowledgement

The authors would like to extend their sincere appreciation to University of Malaya for giving them an opportunity to work on this research through the High Impact Research (HIR) grants with account no J-21004-73829. In additional, we would like to express our sincere appreciation to Dr. Sawsan Kamel Shariah for her help.

Figure 2: Photo and satellite image show Langat River and water contamination sources that are located around the study area.

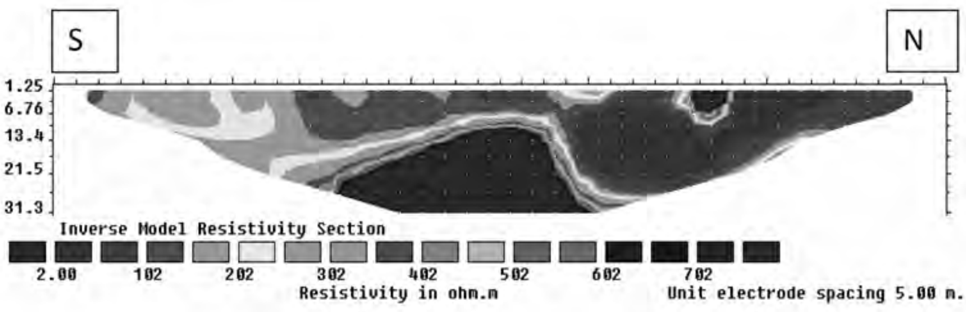

Figure 3: 2D Electrical resistivity inverse model shows the low resistivity

PAPER P16

DETECTION THE GROUNDWATER FLOW USING ELECTRICAL RESISTIVITY TOMOGRAPHY TECHNIQUE

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Geophysical techniques are concerned with investigation of the earth's crust and subsurface conditions, usually with an economic exploitations and objectives, by making and interpreting measurements of physical properties of earth (Abu Shariah, 2002). The application of geophysical surveys to evaluate the geological and hydrological conditions of underground water studies and prospecting is called hydro-geophysics. Hydro-geophysics utilizes different physical properties of earth materials to study subsurface structures. A preliminary stage of the investigation involves a desk study and reconnaissance survey; this is followed by the main stage of detailed field exploration and ground investigation; data review then continues during the groundwater extraction to expose more details of the groundwater quality and conditions (Abu Shariah & Yusoff, 2010). The significance of the research appears considerably in the exploration and studying geological units by mapping their subsurface features and characteristics using electrical resistivity tomography (ERT) technique for hydrogeological applications. Geoelectrical resistivity imaging method works through the measurements of ground resistivity involves passing an electrical current into the ground using a pair of steel electrodes and measuring the resulting potential differences at points on the earth's surface using a second pair of electrodes. Variations in resistance to current flow at depth cause distinctive variations in the potential difference measurements, which provide information on subsurface structure and materials (Burger, 1992). The resistivity (ρ) is a tensor in nonisotropic and inhomogeneous earth's materials. The electrode configuration used in this research was Wenner Alpha configuration (Figure 1).

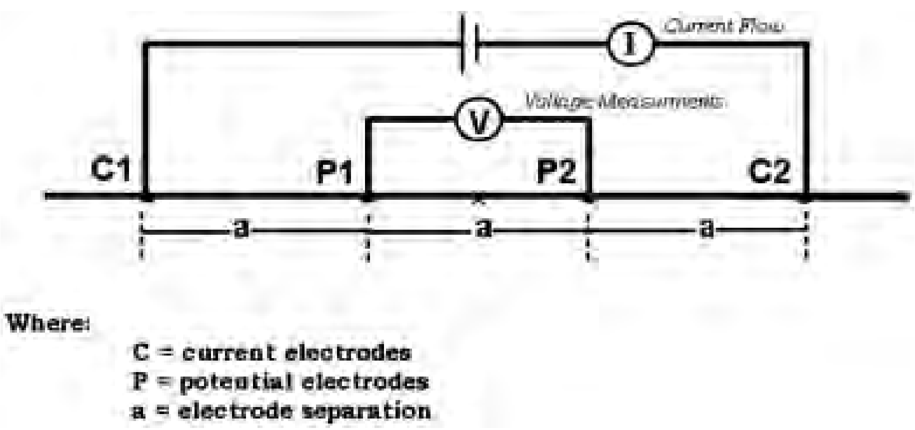

Figure 1: Layout of Wenner-alpha configuration (Abu Shariah, 2009)..

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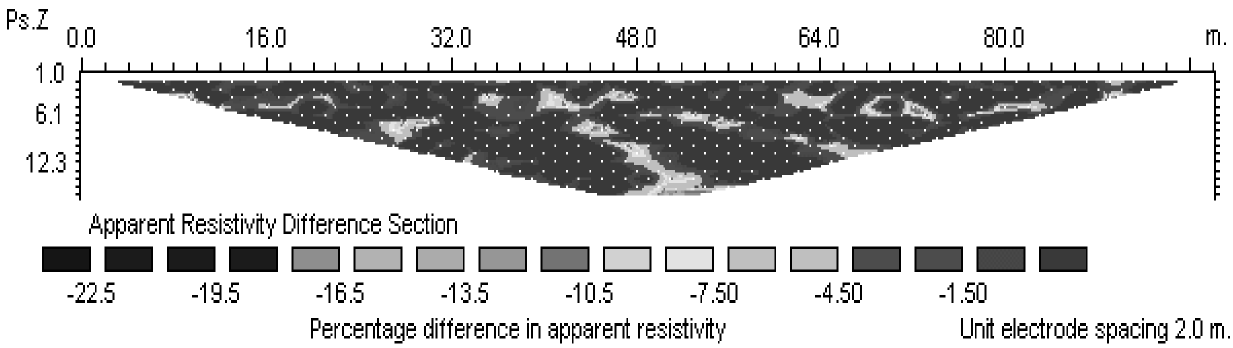

Figure 2: 2D difference inverse models show the contaminant pathways through fractures and conduit system...

PAPER P17

EXTRACTION POTENTIAL OF DIFFERENT SOLVENTS IN THE STUDY OF ORGANIC MATTER CONCENTRATIONS IN THE ENVIRONMENT

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Keywords: Solvent, organic matter, humic and fulvic acid, pyrophosphate, dichloromethane

The extraction potential of three solvents: dichloromethane, sodium pyrophosphate and dichloromethane:methanol (DCM:MeOH, 93:7 v/v) in extracting organic matter for organic matter type and concentration studies in the environment has been tested. Three sandstone samples were dissolved in the solvents and the extract analyzed using UV-Vis spectrophotometer. Analysis based on the absorbencies of humic acids (E4) and fulvic acids (E6) indicate sodium pyrophosphate as the most potent solvent, followed by dichloromethane and finally DCM:MeOH, 93:7 v/v.

Introduction

The quantity and quality of organics has an impact on environmental geochemistry. The quality of organics can be evaluated by a variety of extraction techniques. These techniques include variations in solvents such as methanol, dichloromethane and sodium pyrophosphate. The response of samples to various types of extractants is also indicative of the potential of the samples to release such organics in similar geochemical conditions. Therefore, the objective of this study is to use different solvents in the extraction of organic matter for ultra violet visible (UV-Vis) studies and to determine which solvent has the highest extraction potential.

Materials and Methods

UV-Vis is a powerful technology used by scientists to characterize organic fractions (Schnitzer and Khan, 1978). Previous work by researchers such as Stevenson (1982) used the UV-Vis technique as a measure of aromacity. For the purpose of this study, the UV-Vis analysis will be focused on absorbencies at 465nm (E4) and 665nm (E6). These represent absorption of humic and fulvic acids respectively in the environment. A ratio of E4 to E6 which is independent of concentrations of the humic material can be calculated as a measure of aromacity (Ramli and Padmanabhan, 2010).

Three samples (S1, S2 and S3) have been analyzed in this study. 0.1g of each sample was treated with three different solvents: dichloromethane, 0.1M sodium pyrophosphate and dichloromethane:methanol (DCM:MeOH, 93:7 v/v) (Pan et al., 2005) to extract the organics for 48hours and the extract analyzed using a Shimadzu UV-3150 UV Vis Spectrophotometer.

E4 and E6 values for dichloromethane extracts range between 1.12-1.42 and 0.96-1.68 respectively (Table 1). E4 and E6 values for sodium pyrophosphate extracts range between 1.05-1.80 and 0.96-1.68 respectively (Table 2). E4 and E6 values for DCM : MeOH extracts, 93:7 v/v range between 1.14-1.43 and 0.88-1.17 respectively (Table 3). The highest E4 and E6 values were recorded for sodium pyrophosphate followed by dichloromethane and finally DCM : MeOH, 93:7 v/v. Sodium pyrophosphate therefore has the highest extraction potential among the three solvents and is the most efficient among them for extraction of organic matter for analysis.

Conclusion

All three solvents used have the potential to extract considerable amounts of organic matter. Sodium pyrophosphate has the highest extraction potential followed by dichloromethane and finally DCM:MeOH, 93:7 v/v.

Acknowledgements

I am grateful to UTP for offering me scholarship for my PhD. This work is partly supported by the FRGS grant awarded to E. Padmanabhan.

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Table 1: E4 and E6 of S1, S2 and S3 with dichloromethane

Sample ID	E4 (Humic acid)	E6 (Fulvic acid)
S1	1.42	1.39
S2	1.26	1.03
S3	1.12	0.79

Table 2: E4 and E6 of S1, S2 and S3 with 0.1M sodium pyrophosphate

Sample ID	E4 (Humic acid)	E6 (Fulvic acid)
S1	1.05	0.96
S2	1.70	1.58
S3	1.80	1.68

Table 3: E4 and E6 of S1, S2 and S3 with DCM : MeOH, 93:7 v/v

Sample ID	E4 (Humic acid)	E6 (Fulvic acid)
S1	1.43	1.17
S2	1.42	1.15
S3	1.14	0.88

PAPER P18

KOMPOSISI LOGAM BERAT DI DALAM BERAS DAN DALAM TANAH SAWAH TERCEMAR TANAH ULTRABES DI RANAU, SABAH, MALAYSIA

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Kajian ini dijalankan di kawasan tanah sawah yang di kelilingi tanah ultrabes di Lembah Ranau, Sabah. Kajian ini dilakukan untuk menentukan kandungan logam berat dalam padi (beras)(beras) dan tanah sawah yang dicemari oleh tanah ultrabes. Logam berat yang ditentukan adalah Fe, Mn, Ni dan Cr. Sebanyak 36 sampel tanahatas (0-20 cm) diambil secara rawak menggunakan auger keluli. Kandungan logam berat telah diekstrak secara berjujukan. Kandungan logam berat tersedia diekstrak menggunakan amonium asetat–asid asetik, manakala kandungan logam berat jumlah telah diekstrak dengan menggunakan asid nitrik pekat bersama asid perklorik dalam nisbah 3:1. Sampel padi (beras)dari 36 stesen persampelan telah diekstrak menggunakan kaedah penghadaman basah. Logam berat yang ditentukan adalah, Fe, Mn, Cr dan Ni. Kandungan logam berat daripada hasil pengekstrakan tanah dan tumbuhan ini ditentukan menggunakan Inductively Couple Plasma Mass Spectrometry (ICP-MS). Analisis menunjukkan kandungan logam berat jumlah dalam tanah adalah tinggi melebihi aras kritikal dalam tanah, manakala logam berat tersedia adalah rendah. Peratusan kebolehdapatan logam berat dalam tanah adalah 0.36%, 12.16%, 0.91% dan 4.54% bagi Fe, Mn, Cr dan Ni, masing-masing. Kandungan logam berat dalam beras berada di dalam sempadan bawah sela kritikal bagi Cr dan di bawah aras kritikal bagi Ni. Koefisien penumpukan biologi (BAC) oleh tumbuhan adalah sangat tidak aktif dengan nilai BAC kurang dari 0.1.

Kata Kunci: Logam berat, beras, ara kritikal, tanah ultrabes, Ranau.

PENDAHULUAN

Kawasan kajian adalah merupakan kawasan tanah sawah di Lembah Ranau yang telah tercemar dengan tanah ultrabes. Kawasan kajian di Lembah Ranau Sabah ini merupakan kawasan yang disempadani oleh batuan ofiolit urutan ultrabes, Formasi Crocker dan batuan klastik metasedimen di bahagian utara dan timur. Batuan ultrabes ini kebiasaannya mempunyai kepekatan logam berat yang tinggi terutamanya Ni, Cr, Co, Mg, Mn dan Fe (Alloway 2013). Lembah Ranau menerima endapan klastik daripada batuan ultrabes, granit dan metasedimen dari bahagian utara dan timur, serta batuan metasedimen dan batuan granit dari selatan dan barat. Kajian terdahulu menunjukkan tekstur tanah di kawasan kajian secara umumnya adalah lempung dengan kandungan lempung hampir 40% (Sahibin dan Adams 1998). Bradl (2005) menjelaskan lempung mempunyai kebolehan untuk memegunkan logam berat dengan berkesan disebabkan oleh jumlah kapasiti pertukaran kationnya yang tinggi. Tumbuhan pula merupakan rantaian asas dan sumber makanan untuk kegunaan haiwan dan manusia. Tumbuhan yang ditanam di kawasan tanah yang mempunyai kandungan logam berat yang tinggi lebih cenderung untuk mengumpul logam berat tersebut. Logam berat bersifat toksik walaupun pada kepekatan yang rendah dalam tanah dan logam berat ini juga akan menjadi toksik kepada tumbuhan jika melebihi aras kritikal yang dibenarkan dalam tanah (Kabata-Pendias, 2011). Penumpukan logam berat yang tinggi dan berlebihan memberikan kesan negatif kepada manusia dan haiwan yang memakan tumbuhan tersebut. Masalah yang dihadapi oleh tumbuhan ialah penghasilan buah berkurang, buah tidak bulat dan sempurna serta pengeluarannya yang lambat. Kepekatan Cr dan Ni yang tinggi dalam tanah ultrabes boleh menyebabkan tumbesaran pokok terbantut. Dalam kes di kawasan kajian, pencemaran logam berat ke dalam tanah sawah disebabkan oleh hakisan tanah ultrabes di bahagian terdedah di kawasan berbukit yang mengelilingi sawah padi (beras)di Lembah Ranau. Pada musim hujan tanah ini memasuki alur kecil yang seterusnya memasuki alur besar dan sungai yang mengairi kawasan sawah tersebut. Di kawasan sawah yang dicemari tanah ultrabes hasil padinya sangat berkurang malah ada yang tidak berbuah langsung. Kajian ini menentukan kandungan logam berat dalam substrat tanah sawah yang dicemari tanah ultrabes dan pengambilan logam ini dalam biji padi (beras)(beras).

BAHAN DAN KAEDAH

KAWASAN KAJIAN

Kawasan Kajian yang dikaji terletak di Lembah Ranau, Sabah iaitu pada kedudukan garis bujur 5°58'52''N, dan garis lintang 116°40'42''E.

SAMPEL TUMBUHAN DAN TANAH

Sebanyak 36 sampel tanah dan biji padi (beras)telah diambil secara rawak di Lembah Ranau, Sabah. Sampel tanah diambil dengan menggunakan auger keluli dan dimasukkan ke dalam beg plastik yang dilabel untuk diuji di makmal. Sampel tanah dikeringkan pada suhu bilik, selepas itu dihancurkan dengan menggunakan penumbuk kayu untuk mendapatkan saiz <2 mm. Untuk penentuan logam berat, sampel tanah ditumbuk menggunakan penumbuk agat dan diayak menggunakan pengayak nilon untuk mendapatkan saiz <63 µm. Sampel biji padi (beras)dikupas kulitnya dan akan ditimbang sebanyak 2g sebelum dianalisis kandungan logam berat di dalamnya. Sampel biji padi (beras)ini diserbukkan dan sedia untuk dianalisis.

PENENTUAN KANDUNGAN LOGAM BERAT DALAM TANAH

Sebanyak 5g tanah kering udara bersaiz <63 µm ditimbang dan dimasukkan ke dalam bikar PTFE 50 mL yang tahan suhu tinggi dan diletakkan di atas kukus pasir. Sebanyak 25 mL asid nitrik pekat ditambah dalam PTFE dan dipanaskan dalam kukus pasir pada suhu 90-100°C selama 2 jam. Apabila hampir kering, 10 mL asid perklorik ditambah dan dihadam selama 2 jam lagi. Sampel tanah dipindahkan ke dalam tiub pengempar dan diempar kemudian dituras menggunakan kertas turas 0.45 µm. Kandungan logam-logam berat pada fraksi ini ditentukan dengan menggunakan ICP-MS.

PENENTUAN KANDUNGAN LOGAM BERAT DALAM TUMBUHAN

Sebanyak 1g serbuk sampel biji padi (beras)ditimbang dan dimasukkan ke dalam kelalang kon. Sebanyak 15 mL 69% asid nitrik pekat ditambah, kemudian campuran ini dikukus di atas kukus pasir pada suhu 90-100°C sehingga semua wasap perang asid nitrik tersejat. Selepas itu, 5 mL 60% asid perklorik ditambah dan pemanasan sampel diteruskan sehingga warna kuning kelihatan. Selepas itu, sampel disejukkan pada suhu bilik sebelum dituras dengan menggunakan kertas turas (Whatman no. 6) ke dalam kelalang kon. Larutan tersebut dituras sekali lagi dengan menggunakan kertas turas 0.45 µm ke dalam botol ubat 100 mL. Hasil turasan dicairkan sehingga 50 mL dengan air suling. Kandungan logam berat dalam larutan ditentukan menggunakan ICP-MS.

Koefisien penumpukan biologi (BAC) dikira berdasarkan nisbah kandungan logam berat dalam buah tumbuhan dan tanah menggunakan formula berikut (Cui et al. 2007; Li et al. 2007);

$$BAC = [Logam]_{buah} / [Logam]_{tanah}$$

HASIL DAN PERBINCANGAN

Jadual 1 menunjukkan taburan logam berat di kawasan kajian iaitu di dalam tanah dan tumbuhan yang meliputi kandungan logam berat jumlah, logam berat tersedia dan peratusan logam berat yang tersedia. Ia juga menunjukkan kandungan logam berat dan koefisien penumpukan logam berat dalam padi.

Secara amnya kandungan logam berat dalam tanah adalah tinggi. Ferum mempunyai sela dari 32235.01 hingga 215362.93 mg/kg dengan purata dan sisihan piawai 61528.71 ± 44577.70 mg/kg.

Sela kepekatan Mn adalah dari 282.59 hingga 5454.54 mg/kg dengan purata dan sisihan piawai 917.51 ± 1032.00 mg/kg. Purata kepekatan Ni dan Cr masing-masing adalah 686.92 ± 970.54 mg/kg dan 970.69 ± 1368.40 mg/kg. Kepekatan logam Ni dan Cr telah melepasi aras kritikal yang dinyatakan oleh Kabata-Pendias (2011). Walaupun purata kandungan logam berat di dalam tanah adalah tinggi tetapi purata kandungan logam berat tersebut yang tersedia untuk diambil oleh tumbuhan adalah rendah iaitu 187.91 mg/kg bagi Fe, 78.35 mg/kg bagi Mn, 4.48 mg/kg bagi Cr dan 20.95 mg/kg bagi Ni. Dalam bentuk purata peratusan kandungan logam tersedia ini hanyalah sebanyak 0.36%, 12.16%, 0.91% dan 4.54% bagi Fe, Mn, Cr dan Ni, masing-masing.

Jadual 1. Kandungan logam berat di dalam tanah dan tumbuhan

Logam Berat		Jumlah (mg/kg)	Tersedia (mg/kg)	Tersedia (%)	Tumbuhan (mg/kg)	BAC	*Aras Kritikal dalam Tanah (mg/kg)	*Aras kritikal dalam Tumbuhan (mg/kg)
Fe	Min	32235.01	35.84	0.03	1.06	0.00004		
	Maks	215362.93	713.02	0.96	118.72	0.00092		
	Purata	61528.71	187.91	0.36	14.88	0.00021	-	-
	Sisihan Piawai	44577.70	150.22	0.24	24.28	0.00026		
Cr	Min	92.52	1.55	0.15	0.27	0.00031		
	Maks	5768.35	17.22	2.68	11.68	0.03409		
	Purata	970.69	4.48	0.91	2.42	0.00408	75-100	2-18
	Sisihan Piawai	1368.40	3.66	0.67	3.42	0.00722		
Mn	Min	282.59	25.78	1.26	3.99	0.00341		
	Maks	5454.54	271.43	32.87	63.65	0.05215		
	Purata	917.51	78.35	12.16	12.64	0.01926	-	-
	Sisihan Piawai	1032.00	54.92	5.98	10.65	0.01291		
Ni	Min	72.02	5.22	1.88	0.25	0.00025		
	Maks	3745.57	142.50	9.42	15.20	0.08261		
	Purata	686.92	20.95	4.54	2.25	0.00637	100	8-220
	Sisihan Piawai	970.54	32.32	2.24	2.91	0.01375		

Jumlah kandungan logam berat yang diambil oleh tumbuhan adalah rendah ditunjukkan oleh kandungan logam berat dalam padi (beras)iaitu 14.88 ± 24.28 mg/kg bagi Fe, 12.64 ± 10.65 mg/kg bagi Mn, 2.42 ± 3.42 mg/kg bagi Cr, dan 2.25 ± 2.91 mg/kg bagi Ni. Bagi logam Cr purata kepakatan dalam padi (beras)berada pada aras bawah kepekatan yang kritikal dalam tanah manakala bagi Ni purata kepekatannya dalam tumbuhan berada di bawah aras kritikal.

Koefisien penumpukan biologi (BAC) bagi semua logam yang diuji menunjukkan nilai yang sangat rendah (< 1.0) menunjukkan pengambilan logam berat oleh padi (beras)adalah tidak aktif.

PENGHARGAAN

Penulis ingin mengucapkan jutaan terima kasih Fakluti Sains dan Teknologi, UKM yang telah memberi kemudahan menjalankan penyelidikan ini. Penyelidikan ini dibiaya sebahagiannya oleh projek penyelidikan LRGS/TD/2011/UKM/PG/01 dan UKM-AP-PI-18-2009/2.

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PAPER P19

KEPELBAGAIAN LANDSKAP GRANIT LANGKAWI

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Abstrak

Landskap granit di Langkawi Geopark merupakan landskap menonjol dengan puncak tertinggi kepelbagaian bentuk yang terhasil dari kawasan bukit sehingga sekitar pantai. Bentuk landskap ini dipengaruhi oleh dua faktor utama iaitu proses endogen yang melibatkan pembentukan batuan dan proses eksogen yang dihasilkan selepas landskap timbul kepermukaan. Proses endogen yang terdiri daripada pengangkatan menghasilkan dua bentuk utama iaitu batolith dalam bentuk membulat dan seakan sil yang menyisip diantara bukaan retakan atau sesar. Proses eksogen memberikan fitur yang lebih pelbagai khususnya hasil luluhawa yang intensif disekitar kawasan tropika. Antara fitur yang dapat diperhatikan adalah siri kon pada puncak yang dihasilkan oleh aliran sungai, fitur tebing curam yang menegak, fitur batu hampar, tor yang membulat di pantai bergelora dan bongkah batuan yang menghasilkan fitur seakan tafoni di dikawasan yang lebih tenang khususnya kawasan pasang surut. Kepelbagaian granit penting dalam memahami sejarah pembentukan batuan dan sebagai tarikan kepada perkembangan geopelancongan di Langkawi Geopark.

ANALYSIS OF ROCK BURST POTENTIAL IN CRITICAL SECTION OF PAHANG-SELANGOR RAW WATER TRANSFER TUNNEL PROJECT

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Tunnelling under high overburden and high in-situ stress can posed a major threat to the tunnel construction due to the phenomenon of rock burst. Rock burst is a typical phenomenon caused by underground excavation due to stress release and rock explosion where the rock masses broken in large or small pieces. Thus, predicting the occurrence of this phenomenon and its mechanism is important especially in determining suitable tunnel support system. In this study, the potential of rock burst phenomenon at the Pahang-Selangor Raw Water Transfer Tunnel which is evaluated between the Chainage of 12.5 to 27 km beneath the Titiwangsa Main Range. This is the most critical section because of high overburden up to 1200 m and presence several faults zone. Numerical analysis by using finite element method was used to analyse the tunnel behaviours under high overburden stress base on strength factor maximum displacement and differential stress. Analyses results show that section with high overburden have high possibility of rock burst. Furthermore, it allows a reasonable prediction of the tunnel behaviours under different rock conditions, support systems and overburden stress which serve as a tool in the observational design and construction method for long deep tunnel.

Keywords: Geotechnical Hazards; Tunnel; Rock burst; Numerical Analysis; Prediction.

PAPER P21

PENGUKURAN POLA MIGRASI BAHAN CEMAR LNAPL MENGGUNAKAN TEKNIK KEBERINTANGAN ELEKTRIK DUA MATRA DALAM MAKMAL (LABORATORY STUDY OF MIGRATION PATTERN OF LNAPL CONTAMINANTS USING 2D ELECTRICAL RESISTIVITY TOMOGRAPHY)

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Pola pergerakan bahan cemar hidrokarbon jenis LNAPL dilihat secara ujian makmal pada graviti normal (1g) dengan menggunakan kaedah keberintangan elektrik dua matra. Pasir silika bersaiz butiran halus dan kasar serta lempung dihomogenkan dengan kandungan air sebanyak 5% dan 15% untuk dijadikan media ujian. Tangki perspeks berukuran 0.2m x 0.1m x 0.4m digunakan dalam kajian ini. Bahan cemar jenis LNAPL (minyak enjin dan diesel) diwarnakan dengan pewarna Sudan V dan dituang di tengah-tengah permukaan model pencemaran sebelum pengukuran. Pemerhatian secara visual pergerakan bahan cemar juga dibuat di dalam tangki perspeks. Pengukuran keberintangan elektrik dibuat menggunakan 41 elektrod mini dan jarak antara elektrod 1cm dengan menggunakan tatasusunan Wenner dilakukan selepas hari ketiga dan hari ketujuh LNAPL dituang. Data keberintangan diproses menggunakan perisian RES2DINV untuk mengenalpasti pergerakan LNAPL secara menegak dan mendatar dari segi ruang dan masa. Melalui model songsangan, migrasi LNAPL dapat dicamkan berdasarkan pola keberintangan. LNAPL mempunyai nilai keberintangan yang tinggi dan mempunyai bentuk plume yang tertumpu di bahagian tengah tangki. Corak migrasi LNAPL yang mendatar di atas paras air adalah disebabkan oleh kesan kapilari air. Pergerakan bahan cemar LNAPL turut dipengaruhi oleh beberapa faktor parameter mobiliti LNAPL dalam media poros. Ujian pencemaran yang terdiri daripada 5% kandungan air mempunyai nilai keberintangan lebih tinggi berbanding model pencemaran yang mempunyai kandungan air 15%. Pada model ujian pencemaran dengan 15% kandungan air, LNAPLmudah dikesan kerana terapung di atas zon tepu air. Secara amnya, dapat disimpulkan bahawa migrasi LNAPL adalah terhad pada model ujian yang mengandungi air yang banyak. Sebaliknya, LNAPL bergerak lebih jauh pada model ujian dengan kandungan air yang rendah (5%). Pola migrasi LNAPL dalam medium lempung dengan 30% kandungan air lebih mudah dilihat berbanding pola migarasi dalam medium pasir kasar. Selain ketumpatan, kelikatan bahan cemar juga menjadi faktor kepada migrasi bahan cemar pada media poros dan lempung. Minyak enjin yang mempunyai kelikatan lebih tinggi menyebabkan ia tersebar secara mendatar di permukaan pasir silika dan lempung sebelum meresap masuk ke dalam rongga media. Manakala bahan cemar diesel terus menjerap masuk ke dalam rongga-rongga pasir silika stelah dimasukkan. Bahan pencemar yang mempunyai kelikatan tinggi dan berketumpatan rendah akan bergerak secara mendatar dan vertikal akibat tarikan graviti Bumi.

Kata kunci : LNAPL, keberintangan elektrik, model tangki

PENENTUAN USIA MUTLAK BATUAN GRANIT HORNBLEND GUNUNG KINABALU MENGGUNAKAN KAEDAH U – PB ZIRKON.

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Granit hornblend merupakan batuan yang dominan dengan hampir 70 peratus daripada keseluruhan barat daya Gunung Kinabalu. Kajian ini bertujuan untuk menentukan usia mutlak granit hornblend menggunakan kaedah U – Pb isotop mineral zirkon. Pengusiaan zirkon batuan telah ditentukan dengan menggunakan alat Laser Ablation Inductively-Coupled Plasma Mass Spectrometry (LA-ICP-MS) geokronologi zirkon di Universiti Tasmania Australia. Pada setiap butiran zirkon yang mempunyai diameter kurang daripada 100 m, usia zirkon boleh ditentukan oleh kaedah U – Pb dan Pb – Pb menggunakan alat LA-ICP-MS. Unsur-unsur yang terdapat di dalam zirkon dianalisis dengan menggunakan kaedah oleh Kosler iaitu penggunaan Zr sebagai elemen piawai dalaman, kadar andaian stoikiometrik dan menggunakan 91500 zirkon sebagai pembetulan piawai untuk jisim (mass bias). Sebanyak 10 analisis telah dilakukan terhadap butiran-butiran zirkon batuan. Hasil analisis daripada 10 butiran zirkon mendapati granit hornblend berusia 7.74 ± 0.20 Ma. Ini menunjukkan bahawa granit hornblend di Gunung Kinabalu terbentuk semasa Miosen.

Kata Kunci: Gunung Kinabalu, penentuan usia, kaedah U – Pb, zirkon, granit hornblend

PAPER P23

CIRI-CIRI BATUAN IGNEUS JENIS INTRUSIF DI BAHAGIAN BARAT DAYA, GUNUNG KINABALU: KAJIAN PETROGRAFI DAN GEOKIMIA.

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Batuan igneus jenis intrusif di bahagian barat daya Gunung Kinabalu terbahagi kepada granit hornblend, granit hornblend porfirit, monzodiorit piroksen-kuarza, batuan ultrabes, korok keandesitan, korok aplit dan korok pegmatit. Kajian petrografi menunjukkan granit hornblend mempunyai tekstur tak sama butiran, saiz butiran ialah sederhana dan mempunyai kandungan mineral plagioklas (35 %), feldspar alkali (40 %), kuarza (15 %) dan hornblend (7%). Granit hornblend porfirit mempunyai tekstur porfiritik, saiz butiran matriknya ialah sederhana dan mempunyai kandungand mineral yang hampir sama dengan granit hornblend. Selain itu, monzodiorit piroksen-kuarza mempunyai tekstur porfiritik dan bersaiz butiran halus. Batuan ini mempunyai mineral feldspar alkali (25%), plagioklas (50%), kuarza (10%) dan piroksen. Tafsiran geokimia menunjukkan bahawa batuan igneus jenis intrusif ini adalah berasal daripada satu magma yang sama (dari jenis-I). Ini merupakan hasil daripada tren gambarajah Rare Earth Element (REE) dan gambarajah Labah-labah. Walaupun A/CNK menunjukkan korok aplit tergolong dalam magma jenis S, namun ini mungkin disebabkan oleh pencemaran batuan sekeliling. Gambarajah REE turut menunjukkan terdapatnya penghabluran secara berperingkat di dalam batuan igneus intrusif, dengan granit hornblend dan korok keandesitan memperlihatkan anomali Eu. Proses evolusi magma telah menghasilkan siri batuan igneus intrusif berkomposisi asid hingga pertengahan (dengan SiO2 55-75%). Graf indeks alkali kapur menunjukkan batuan igneus intrusif terkelas sebagai siri batuan jenis kalk-alkali.

Kata Kunci: batuan igneus, Gunung Kinabalu, kajian petrografi, magma

TO SEE THE DEEP INSIDE DIGITAL ROCKS: ASSESSING THE MICRO SCALE PORE SPACE HETEROGENEITY ON CARBONATE AND BEREA SANDSTONE

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\Background

The advancement of digital rock physics study in recent years has been boosted by the being widely used the X-ray CT scan to accurately image the internal rock structure. Digital rock physics brings the lab routines into the computer simulation in which the physical properties measurements are undertaken e.g. permeability, bulk and shear modulus, formation factor, thermal conductivity, NMR properties, etc. (Keehm et al, 2003; Andra et al, 2013; Richa, 2010). Despite of its limitation that it could only resolve the very small part of the rock, which is only few mm cubes, digital rock physics measurement at the x-ray scanned rocks gives the relatively close result to the real lab one. However, it can be suggested that in case the sample is heterogeneous, both lab and digital rock physics measurement may differ significantly. This is true based on fact that if the sample is heterogeneous a mm cube scale does not represent the cm cubes scale measured in the real laboratory. Therefore, quantifying the heterogeneity is important to describe the relevancy of the digital rock physics result when being compared to the real lab measurement. This study aims at investigating the micro scale pore heterogeneity of the x-ray scanned rocks of the Carbonate and Berea sand.

Methodology

X-ray computed tomography of carbonate and Berea sandstone, taken from the benchmark dataset of Andra et al, (2013) are used in this study. These samples were taken at different imaging resolution and recorded as RAW grayscale data with size of 1024x1024x1024voxel. We processed the data by implementing the image processing routine to segment between pore and solid part of the rock. Otsu's segmentation technique was used to create the binary image that can be further quantified. The heterogeneity assessment was performed by analyzing the 2D slices taken randomly from the 3D cube of the samples. Dimensional heterogeneity is introduced as the standard deviation ratios between 2D and 3D porosity whereas spatial heterogeneity is defined as the standard deviation of the 2D porosity from slice to slice. In addition shape heterogeneity also quantified as the standard deviation of the aspect ratios of the slices. The aspect ratio is taken to be the ellipsoidal approximation of the arbitrary shape of the pore spaces.

Result and Discussion

We found that the heterogeneity in carbonate is higher than in Berea sandstone. The reference 3D porosity was obtained from Andra et al, (2013) where the carbonate of 23.3% whilst Berea porosity is 19.7%. The Otsu segmentation gives Berea porosity of 18.5% whereas carbonate of 25.1%. Spatial heterogeneity of the Carbonate sample is 1.54 meanwhile Berea spatial heterogeneity is 0.59. The dimensional heterogeneity is 0,97 for Berea and 1.07 for Carbonate. Aspect ratio heterogeneity for Berea is 1.09 meanwhile carbonate aspect ratio heterogeneity is 1.29. From the results it can be concluded that carbonate is relatively more heterogeneous as compared to Berea sandstone. Consequently, the discrepancies between digital rock physics and real laboratory measurement should be greater in carbonate.

Dimensional heterogeneity which implies the relationship between 2D and 3D porosity can be used as the quantitative scaling factor for extrapolating the 3D porosity from 2D porosity. This means that 2D optical porosity that can be obtained from thin section, in case x-ray scanner is not available, can be used to predict the 3D porosity. This can reduce the computation time since the processing of x-ray CT scan data involves the large amount of data and time consuming. In the other hand, spatial heterogeneity implies the variation of pore size distribution in different position or depth inside the rock. It is also correlated to the pore throat size distribution inside the rock which in turn is closely related to the fluid flow in the pore spaces.

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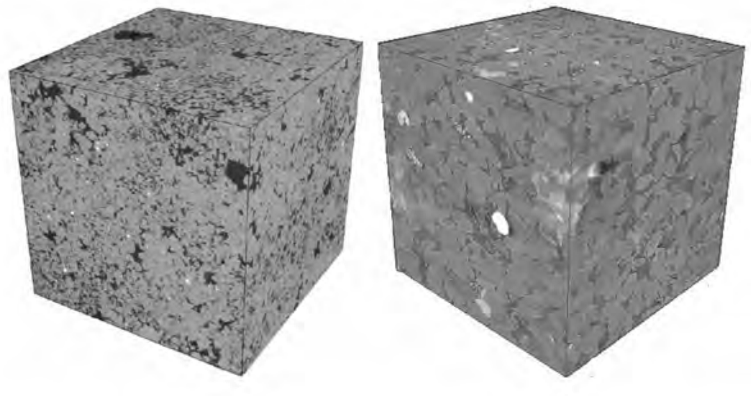

Figure 1. Carbonate and Berea sandstone samples. Carbonate has the reolution of 2.02 µm whereas Berea with 0.74 µm. Both are 1024x1024x1024voxel.

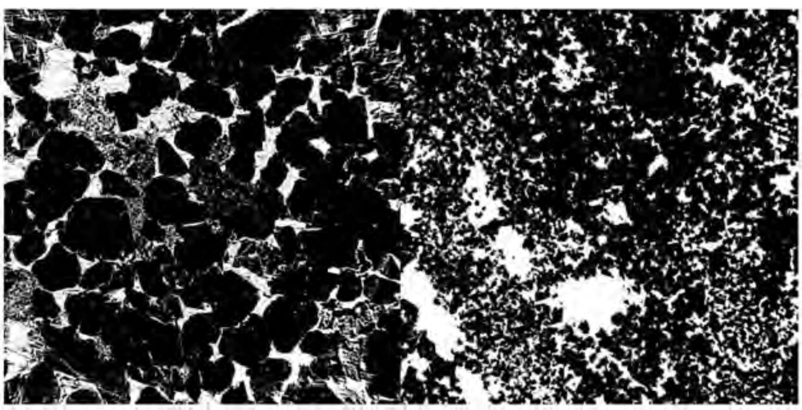

Figure 2. segmented binary slices of Berea and Carbonate.

FACIES AND STRATIGRAPHIC SUCCESSIONS OF MARGINAL MARINE TO SHALLOW MARINE DEPOSITS OF THE (UPPER OLIGOCENE-MIDDLE MIOCENE) NYALAU FORMATION, SOUTH BINTULU, SARAWAK, MALAYSIA

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The upper Oligocene-Middle Miocene Nyalau Formation is well exposed in the south Bintulu, Sarawak. Integrated facies analysis and biofacies studies were carried out on four well-exposed outcrops in this area to characterize the facies, facies associations and biofacies and interpret the depositional environment of the successions. Fourteen sedimentary facies were recorded and grouped into five facies associations (Figure 1) and these are; tabular-planar cross bedded sandstone, amalgamated trough cross bedded sandstone, trough cross bedded sandstone, flaser-wavy rippled sandstone, bioturbated flaser to-wavy-rippled sandstone heterolithic, bioturbated heterolithic mudstone, well-bioturbated mudstone, interbedded sandstone and well bioturbated mudstone, hummocky cross stratified sandstone, interbedded hummocky cross stratified sandstone and bioturbated mudstone, laminated mudstone, carbonaceous mudstone, coal and paleosol. The facies associations are; lower to middle shoreface, tidal fluvial channel, tidal flat, mangrove (lagoonal) and coastal peat swamp. The biofacies study has revealed that each facies association consists of different biofacies characteristics based on palynomorphs and foraminifera assemblages. The lower to middle shoreface characterized by winnowed and reworked palynological assemblages with relatively barren foraminifera. The tidal channel and tidal flat facies associations consist of largely mangrove and back mangrove pollen with low abundance and bad preservation of arenaceous agglutinated foraminifera. Mangrove (lagoonal) facies association is overwhelmed by mangrove pollen notably *Zonocostites ramonae* and *Florschuetzia trilobata* including high percentage of typical marginal marine and mangals foraminifera such as *Ammobaculites* sp., *Arenoparella Mexicana*, *Miliammina fusca* and *Trochammina macrescens*. The coastal peat swamp facies association is dominated by common peat swamp pollen such as *Palaquium, Blumeodendron, Stemonurus, Metroxylon, Pandanus* and *Campnosperm*a including high proportion of typical climbing fern spores such as *Stenochlaena palustris*. The overwhelming of mangrove palynomorphs may reflects the occurrence of a former mangrove belt within coastal area, which related to the event of relative rise in sea level (e.g., Poumot 1989) and bounded by peat swamp vegetation in landward direction. The richness of mangrove along with common peat and fresh swamp pollen are also characteristics of tropical vegetation and linked to everwet and seasonal climatic condition (Germeraad *et al.*, 1968). Based on the integration studies, the studied sedimentary successions were deposited within mixed tide- and wave- influenced coastal environment ranging from estuarine system to wave and storm-dominated shallow marine setting with varying degree of fresh water and salinity influx. The interpretation of shallow to open marine wave-dominated system is based on Walker and Plint (1992). While the terminology and environmental subdivision within estuarine and tidal setting is according to Dalrymple *et al*., (1992).

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BIOMARKER CHARACTERISTICS OF HEAT AFFECTED SEDIMENTS FROM THE LOWER BIMA MEMBER (LOWER CRETACEOUS) IN THE YOLA SUB – BASIN, NORTHERN BENUE TROUGH NIGERIA.

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The sediments of the Lower Bima member in the Yola Sub – basin, Northern Benue Trough of Nigeria were investigated based on organic geochemical characteristics in particular biomarker distribution with the aim of assessing the effect of heat caused by Tertiary volcanic plugs on the sediments. The Benue Trough is the major rifted basin in Africa. It is divided into Northern, Central and Southern portions. The Northern Benue is made up of two arms; Gongola Sub - basin and Yola Sub - basin. The Bima Formation is the oldest formation occupying the base of the Cretaceous successions. It is differentiated into three members; Lower (B1), Middle (B2) and Upper Bima (B3). Volcanic plugs have being reported in the Northern Benue unrelated to any specific tectonic control and the rocks were thought to represent the youngest within the Tertiary period. Fifteen samples (shale and mudstones) were collected. Approximately 30grams were crushed from each sample and were subjected to bitumen extraction. The extracts were separated by column chromatography into aliphatics, aromatics and NSOs. The aliphatic fractions were analyzed by gas chromatography – mass spectrometry. The biomarkers identified are; n-alkanes (C13 to C29), pristane (Pr), phytane (Ph), tricyclic terpanes and steranes. The n-alkanes to isoprenoids ratio (Pr/n-C17 and Ph/n-C18) indicate the organic source as marine algae and bacteria. The tricyclic terpanes and diasteranes/steranes increases at high levels (late oil window) whilst moretane/hopane relatively decreases (late oil window). This also agrees with organic petrographic investigation whereby vitrinites reflectance (%Ro) ranges 1.1 to 3.0 (end of oil generation/dry gas zone) and weak fluorescence were observed under Ultraviolet light. It is envisaged here that the Tertiary volcanic plugs intruded into the sediments and bring with them heat, causing the sediments to be overcooked to dry gas stage of oil generation.

Keywords: Northern Benue, Yola Basin, Bima Formation, Volcanics, Biomarkers, Source of organic matter, maturity.

Introduction

The Benue Trough was one of the major rifted basins in Africa that extends about 1000km in length and 50km in width (Fig. 1a). It is divided into Northern, Central and Southern portions. The Northern Benue is made up of Gongola Sub - basin and the Yola Sub – basin (Fig. 1b). The Bima Formation is the oldest occupying the base of the Cretaceous successions in the Northern Benue deposited in a continental environment (Guiraud, 1990). It is differentiated into three members (Carter et al. 1963); Lower Bima (B1), Middle Bima (B2) and Upper Bima (B3). Volcanic plugs of Tertiary period have being reported in the Northern Benue unrelated to any specific tectonic control. The volcanic plugs overlay some of the Cretaceous formations (Carter et al. 1963). The effect of the volcanic plug may have on the sediments with regards to petroleum potential in the Yola Sub – basin is of obvious importance and interest.

Biomarkers are molecular fossils composed of carbon, hydrogen and other elements. They occur in sediments, rocks, and crude oils and show little or no change in structure from their parent organic

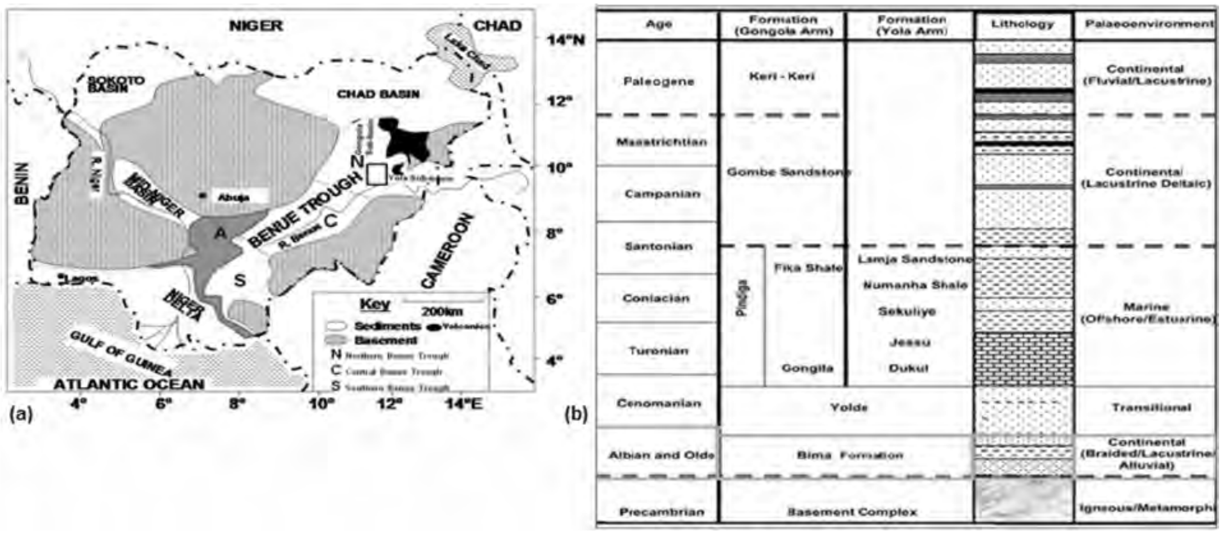

Figure 1.(a) Geological map of Nigeria showing the study area and (b) Stratigraphic sequence of North Benue Trough (after Abubakar et al. 2008).

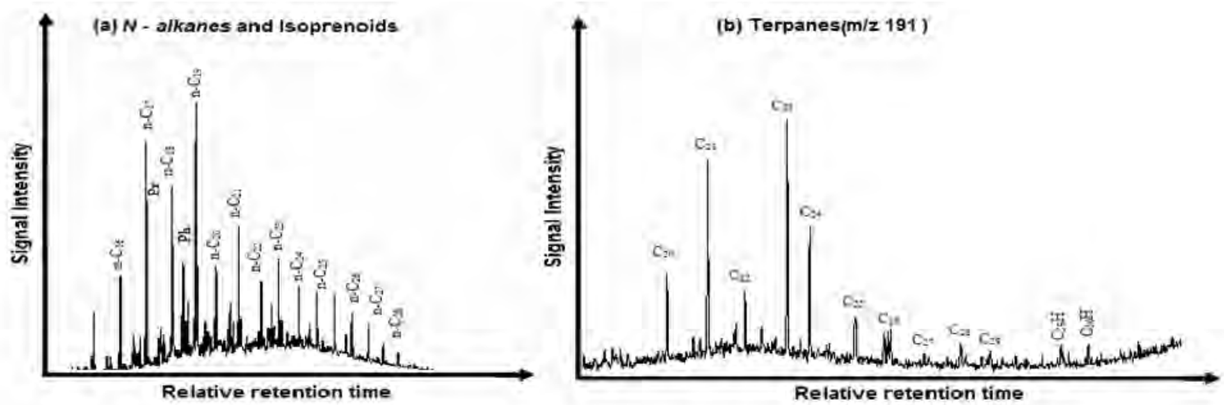

Figure 2. a) TIC – normal alkanes and isoprenoids (b) m/z 191 mass fragmentograms – tricyclic terpanes

molecules in living organisms, thus are commonly applied in depositional and source input interpretation (Peters et al., 2005). However, biomarkers are only commonly presence within oil window and occur in very low amount or virtually absence in gas window. Fifteen samples were analyzed. About 30grams of each sample were crushed to powder form then extracted in a soxhlet apparatus for 72hrs using dichloromethane and Methanol (93:7). Extracts were separated into aliphatics, aromatics and NSO compound fractions by column chromatography. The aliphatic fractions were dissolved in hexane and analyzed by Gas Chromatography (GC) and Gas Chromatography –Mass spectrometry (GCMS).

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PAPER P27

ZON HIMPUNAN RADIOLARIA *PSEUDOALBAILLELLA GLOBOSA* (ROADIAN, AWAL PERM TENGAH) DARI SEKITAR POS BLAU, ULU KELANTAN

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Satu singkapan rijang telah ditemui di sebelah timur cerun potongan jalan raya di kilometer 38, lebuhraya Gua Musang-Cameron Highland berhampiran Pos Blau pada kedudukan 4°45´09.70´ utara dan 101°45´46.11´ timur (Rajah 1). Umumnya, kawasan ini terletak di dalam Zon Sutura Bentong-Raub. Singkapan ini merupakan blok batuan yang terdiri daripada jujukan rijang yang berselanglapis dengan batu lumpur bertuf. Jujukan ini mempunyai kemiringan ke arah timur-timurlaut dengan sudut kemiringan yang rendah. Rijang dicirikan berwarna coklat kemerahan dan kelabu cerah. Ketebalan individu rijang berjulat dari 2 cm hingga 14 cm. Batu lumpur bertuf pula berwarna coklat keperangan dengan ketebalan dari 4 cm hingga 40 cm. Sebanyak 13 sampel rijang telah dipungut untuk tujuan kajian mikropalaeontologi. Cerapan petrografi ke atas beberapa sampel rijang terpilih menunjukkan bahawa rijang di singkapan ini boleh dikelaskan sebagai batu lumpur bersilika dan rijang berargilit. Sebanyak 11 daripada 13 sampel rijang yang dipungut mengandungi fosil radiolaria. Sejumlah 20 spesies radiolaria berusia Perm telah dikenal pasti yang tergolong dalam 10 genera daripada 8 famili. Spesies-spesies ini terawet dengan agak baik. Spesies-spesies tersebut termasuklah *Pseudoalbaillella scalprata postscalprata* Ishiga, *Pseudoalbaillella ornata* Ishiga & Imoto (Jenis-S), *Pseudoalbaillella* cf. *elongata* Ishiga & Imoto, *Pseudoalbaillella longtanensis* Sheng & Wang, *Pseudoalbaillella* sp. aff. *Pseudoalbaillella longicornis* Ishiga & Imoto, *Pseudoalbaillella fusiformis* (Holdsworth & Jones), *Pseudoalbaillella globosa* Ishiga & Imoto, *Hegleria mammilla* (Sheng & Wang), *Hegleria* sp. B, *Latentifistula crux* Nazarov & Ormiston, *Latentifistula texana* Nazarov & Ormiston, *Latentifistula* sp. A, *Latentibifistula asperspongiosa* Sashida & Tonishi, *Pseudotormentus kamigoriensis* De Wever & Caridroit, *Deflandrella* sp., *Ishigaum trifustis* De Wever & Caridroit, *Quadricaulis inflata* (Sashida & Tonishi), *Copielintra orbiculata* Nestell & Nestell, *Copicyntra* sp. dan *Stigmosphaerostylus* sp. Berdasarkan kehadiran spesies *Pseudoalbaillella globosa* Ishiga & Imoto, *Pseudoalbaillella fusiformis* (Holdsworth & Jones), *Pseudoalbaillella longtanensis* Sheng & Wang dan *Pseudoalbaillella* sp. aff. *Pseudoalbaillella longicornis* Ishiga & Imoto bersama-sama *Hegleria mammilla* (Sheng & Wang), himpunan ini sesuai dimasukkan ke dalam Zon Himpunan *Pseudoalbaillella globosa*

yang mewakili usia Roadian (Awal Perm Tengah) (Rajah 2). Berdasarkan kajian terdahulu, radiolaria berusia Perm Tengah pernah dilaporkan ditemui di dalam Formasi Semanggol di baratlaut Semenanjung Malaysia oleh Sashida et al. (1995), Spiller & Metcalfe (1995a,b), Spiller (2002), Basir Jasin et al. (2005) dan Basir Jasin (2008). Selain itu, radiolaria berusia Perm Tengah turut dilaporkan di Jengka, Pahang oleh Basir Jasin et al. (1995) dan di Pos Blau, Ulu Kelantan (Basir Jasin et al. 2012). Rijang beradiolaria di singkapan ini berselanglapis dengan batu lumpur bertuf dan jujukan sebegini dikategorikan sebagai sekutuan rijang dan volkano bersilika. Sekutuan ini menunjukkan pengendapan sekitaran tektonik di kawasan lembangan dekat arka kepulauan (Jones & Murchey 1986) atau di lembangan rekahan di sepanjang pinggir benua (Karl 1989). Ini membuktikan bahawa aktiviti volkano bersilika di Jalur Tengah Semenanjung Malaysia telah bermula lebih awal daripada usia Perm Tengah dan aktiviti ini berterusan hingga Trias Tengah. Kewujudan rijang berusia Roadian ini sebagai blok di dalam Zon Sutura Bentong-Raub ditafsirkan sebagai bakian Lautan Palaeo-Tethys. Zon Himpunan *Pseudoalbaillella globosa* yang ditemui di singkapan ini merupakan rekod baru bagi batuan rijang di Pos Blau dan di dalam Zon Sutura Bentong-Raub.

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PAPER P28

ELECTRICAL RESISTIVITY IMAGING TO DETECTION OF BEDROCK IN LANGAT BASIN, MALAYSIA

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Two-dimensional Electrical Resistivity Imaging (ERI) survey was used to investigate and delineate a groundwater alluvial aquifer in the Kuala Langat. The electrical resistivity imaging surveys conducted to measures and maps of the resistivity subsurface materials. This method is applicable for the identification of subsurface formations, groundwater zones, groundwater salinity and anthropogenic contamination. A Wenner electrode configuration was employed. The field survey was carried out successfully performed along and perpendicular to the Langat River. The results show that the layers correspondence with the resistivities between 30 Ωm and 500 Ωm and are located at a depth varying from 20 to 65 m.

Keywords: Resistivity, Bedrock, 2D

Introduction:

The basis of any geophysical method is measuring a contrast between physical properties of the target and the surrounding of the target. This paper describes the results obtained with resistivity method using electrical resistivity imaging (Wenner array), applied to environmental studies related to bedrock. The study area is located in the Kuala Langat District in the State of Selangor, near Dengkil, which is approximately 50 km from Kuala Lumpur by road (Fig. 1). The Langat River Basin has two monsoons a year. The northeast monsoon occurs from November to March while the southwest monsoon occurs from May to September. In between the two monsoons are the two inter-monsoon periods. The average annual rainfall ranges from approximately 2,200 to 2700 mm. It gradually increases from the coast towards the mountain areas. The average humidity of the study area is estimated at around 80%. Temperature varies in the range of 24 ºC (minimum) and 32 ºC (maximum). The bedrock of the study area consists of Kenny Hill Formation. The Kenny Hill Formation consisting of monotonous sequence of interbedded shale, mudstones and sandstones [1].

Methodology

2D Electrical Resistivity Imaging

The main aim of electrical surveys imaging is to determine the subsurface resistivity distribution by making measurements on the ground surface. From these measurements, the true resistivity of the subsurface can be estimated. Electrical resistivity surveys have been used for many decades in hydro geological, mining and geotechnical investigations. More recently, it has been used for environmental surveys [2]. Electrical imaging is an appropriate survey technique for areas with complex geology where the use of resistivity sounding and other techniques are unsuitable to provide detailed subsurface information [3]. ERI survey was performed using the ABEM Terrameter SAS 1000 with a multi-electrode switch system with 64 channels. The electrode spacing is 5 m with a total length of 400 m.

Result and Discussion

A maximum depth of 65 m is considered for the resistivity surveys. The resistivity line 1 runs in east-west direction for a total length of around 11 km. Figure 2a shows a typical of inverse resistivity model of this line. The upper part of the image in the range of 3.7 to 19.3 Ωm show good comparison with the surface clay layer. Underlain this layer of higher resistivity with a depth of about 15 to 35 m.

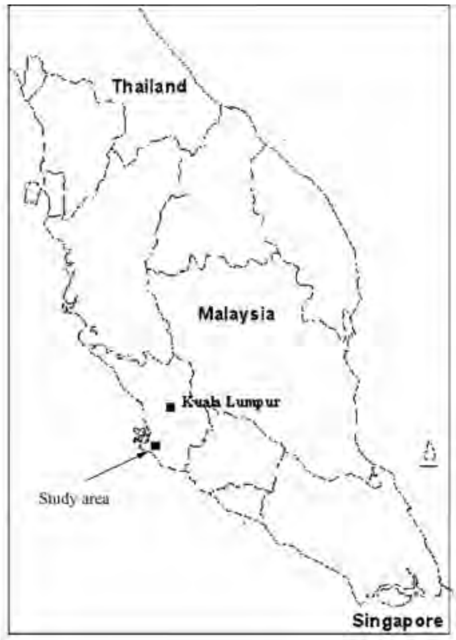

Figure 1: Location of the study area

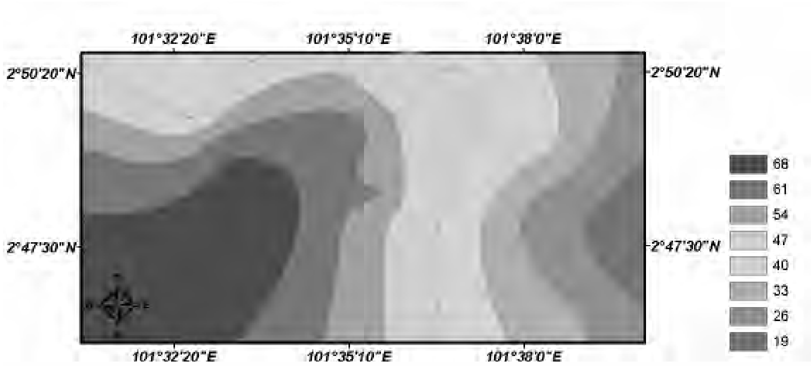

Figure 3: contour map of bedrock elevation

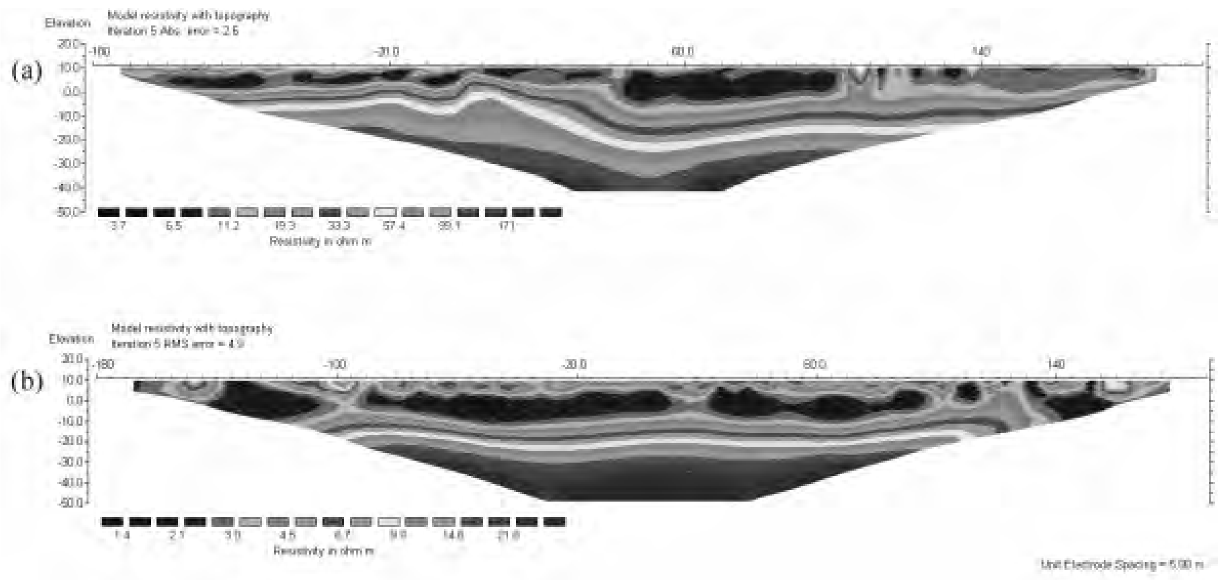

Figure 2: Resistivity inverse model section of (a) line 1, (b) line 2

Based on borehole information this second layer corresponds to sand and zones of more than 99 Ωm correspond to the bedrock surface which is at a depth of 35 m.

Figure 2b shows the resistivity pseudosection and the interpretation of line 2 same as a line 1. The depth of the bedrock is approximately 60 m. The blue region with a resistivity lower than 3 Ωm is considered the clay layer. At the borehole location, this layer is found at a depth of about 21 m. The aquifer (Simpang Formation) is identified in the region 3 Ωm to 21.6 Ωm.

Bedrock Elevation

The bedrock elevation with the coordinates of each line was used to contour or to view the elevation of the bedrock throughout the area (Fig 3).

Conclusion

Electrical resistivity imaging is an effective method to investigate subsurface and groundwater in the study area. The bedrock and aquiferous sand and gravel zones, which are located below the clay layer, were mapped during the research. The mapping of bedrock and aquiferous sand and gravel zones which are located below the clay layer are defined in the survey.

Acknowledgements

This work was supported by the University of Malaya under research grant PV112-2012A.

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GEOPHYSICAL APPLICATION FOR PREDICTING GEOLOGICAL CONDITION AND THE CORRELATION OF EVALUATED ROCK MASS PROPERTIES WITH ROCK MASS CLASSIFICATION (PSRWT TUNNEL, MALAYSIA)

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Geophysical methods are one of the most selected tools for geological exploration and investigation purpose. Tunnel Seismic Prediction (TSP) is a rapid, non-destructive and highly sophisticated geophysical method used for predicting geological properties ahead of tunnel faces in hard rocks that has been developed by Amberg Technologies of Switzerland. For one Malaysian mega project, the Pahang Selangor Raw Water Transfer Project (PSRWT), TSP was applied as a tool to forecast rock mass structure by employing P- and S- wave velocities. The project includes a 44.6m long tunnel constructed for the purpose of supplying raw water from Semantan intake in Pahang to a new water treatment plant in Selangor. The tunnel has a diameter of 5.2 m, a gradient of 1:1900 and is being excavated beneath the Main Range mountains which have elevation typically around 1200 m. Many TSP surveys have been carried out during construction and one of these was at Chainage 30+741.6 to predict the geological conditions underneath an anticipated lineation along the alignment of Sungai Chongkak, one of the famous recreational parks in Selangor, Malaysia. At the investigated the tunnel is around 80 to 130 m below the ground surface. The survey was carried out without any adverse environmental impact at the recreation area itself. The TSP result have a good correlation to the Tunnel Boring Machine (TBM) data, tunnel geological mapping, rock mass classification and Compressive Strength measurements (Mohd Ashraf et al., 2013). A major problem in most tunneling projects is the knowledge of surrounding rock masses and the geotechnical parameters (Pooyan and Roozbeh, 2006). Detailed geological mapping and rock mass classification was done for every single meter of the constructed tunnel. Rock mass classifications, namely the Japanese Highway Classification (JH), NGI Tunnel Quality Index (Q-System), Rock Mass Rating (RMR) and Geological Strength Index (GSI). The evaluated rock mass parameters obtained from TSP and the rock mass classification were compared to understand the correlations that exist between the predicted and actual data. The use of TSP successfully contributed to rapid excavation of the tunnel and in determining the most appropriate rock support system.

Keywords: Tunnel Seismic Prediction, Environmental, Tunnel Geological Mapping, Rock Mass Classification, Geotechnical Parameters.

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PAPER P30

POTENSI AQUIFER DALAM FORMASI GANDUMAN DI SEMENANJUNG DENT, LAHAD DATU, SABAH DENGAN MENGGUNAKAN KAEDAH KEBERINTANGAN (AQUIFER POTENTIALS OF GANDUMAN FORMATION IN DENT PENINSULA, LAHAD DATU, SABAH AREA BY USING RESISTIVITY METHOD)

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Kajian keberintangan elektrik telah dijalankan dikawasan batuan Formasi Ganduman yang merupakan sebahagian daripada batuan sedimen Kumpulan Dent di kawasan Semenanjung Dent, Lahad Datu, Sabah. Sebanyak 35 stesen keberintangan duga dalam (Vertical Electrical Sounding, VES) dengan menggunankan tatahrajah Sclumberger telah di ukur bagi menentukan potensi akuifer formasi ini. Teknik duga dalam melibatkan dua elektrod bagi mengukur potensi (P1 dan P2) dan dua elektrod bagi mengukur arus (C1 dan C2) yang disusun secara linear dengan jarak maksimum elektrod arus 500m dan kedalaman penembusan sekitar 100m. Data keberintangan lapangan di setiap stesen diproses dengan menggunakan perisian PROGRESS 3.0. Data VES ini di korelasi bagi menghasilkan keratan rentas geo-elektrik dua matra dan dibandingkan dengan data lubang gerudi. Hasil kajian menunjukkan terdapat dua corak lapisan keberintangan geo-elektrik yang ditafsirkan sebagai mewakili Formasi Ganduman Atas dan Formasi Ganduman Bawah. Formasi Ganduman Bawah mempunyai empat lapisan keberintangan geo-elektrik manakala Formasi Ganduman Atas mempunyai tiga hingga lima lapisan keberintangan geo-elektrik. Lapisan keberintangan geo-elektrik menunjukkan Formasi Ganduman Bawah mempunyai potensi membentuk lapisan akuifer terkekang kerana formasi ini mempunyai lapisan batu pasir (23.24 hingga 89.93 Ohm-m) berketebalan sekitar 15 hingga 60m yang didasari dan ditindih oleh lapisan lempung berlodak. Formasi Ganduman Atas pula mempunyai potensi sebagai akuifer tak terkekang yang mempunyai batu pasir (22.53 hingga 34.66 Ohm-m) berketebalan 5 hingga 25m. Selain itu Formasi Ganduman Atas mempunyai lapisan lodak berkapur (53.23 hingga 136.52 Ohm-m) berketebalan 10 hingga 40m.

Kata Kunci: Akuifer, Teknik duga dalam menegak, Keberintangan, Formasi Ganduman.

LITHOFACIES OF THE PALEOGENE AND NEOGENE FORMATIONS IN KLIAS PENINSULA, SABAH

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The research is focused at the Klias Peninsula which is located at the south-western part of Sabah. It lies between the latitudes of 05˚17.1'N to 05˚38.6'N and longitudes from 115˚24.6'E to 115˚37.9'E with an area about 1332 km2. Facies analysis has been done to the five rock units in the Klias Peninsula by measuring the outcrops that are exposed between Kuala Penyu and Menumbok. Lithology and sedimentary structures are the main aspects to differentiate and establish the lithofacies of the rock units in the Klias Peninsula. A total of eleven stations throughout the whole peninsula have been chosen which representing thirteen lithofacies that can be found at the research area (Figure 1).

The five rock units in ascending order in age which recognised in the study area are the Crocker Formation, the Temburong Formation, the Setap Shale, the Belait Formation and the Liang Formation. A stratigraphic column for the rock units with their respective ages is shown in Figure 2. The oldest formation in the Klias Peninsula is the Crocker Formation. Three lithofacies that belongs to the formation have been distinguished which are the interbedded thin sandstone and thin shale unit, the interbedded sandstone and shale unit and the interbedded sandstone and thin shale unit. The age of the Crocker Formation is Upper Eocene. There are also three lithofacies that have been classified for the Temburong Formation. The three lithofacies are namely the interbedded shale with thin sandstone unit, the interbedded sandstone with thin shale unit and the interbedded thick shale with thin sandstone unit. The age of the Temburong Formation is equivalent to the age of the Crocker Formation. For the Setap Shale, there is only one lithofacies distinguished from the formation which is the interbedded shale with thin siltstone unit. The age of the Setap Shale Formation is early Middle Miocene. There are five lithofacies that can be distinguished from the Belait Formation. The five lithofacies are the basal conglomerate unit, the hummocky crossbedded sandstone unit, the swaley-hummocky crossbedded sandstone unit, the swaley crossbedded sandstone interbedded with thick shale unit and the swaley crossbedded sandstone unit. The age of this formation is Upper Miocene. Lastly, the youngest formation in the Klias Peninsula is the Liang Formation. This formation has only one lithofacies that can be classified from the research area which is the graded conglomerate unit. The age of this formation is Pliocene, and later the Quaternary alluvium was deposited on top of it.

The outcrops for every formation are shown in Figure 3. The whole sequence of the rock units in the Klias Peninsula is interpreted as the result of regression which happened at the whole research area ever since the deposition of the oldest formation to the youngest formation. The Crocker and the Temburong formations are interpreted to be deposited at the deep marine environment, specifically as submarine fan. Regression occurred slowly which resulting the Setap Shale and the Belait formations to be deposited at the shallow marine environment, from the inner shelf to the upper shoreface. Lastly, the Liang Formation is interpreted to be deposited at the alluvial environment which is at the river mouth.

KEYWORDS. Lithofacies, Klias Peninsula, depositional environment

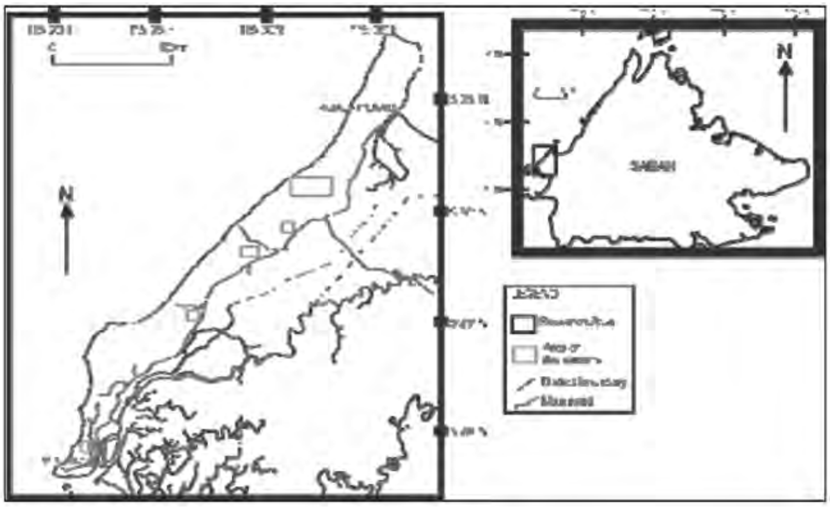

Figure 1: Map of the Klias Peninsula showing the area of the eleven stations.

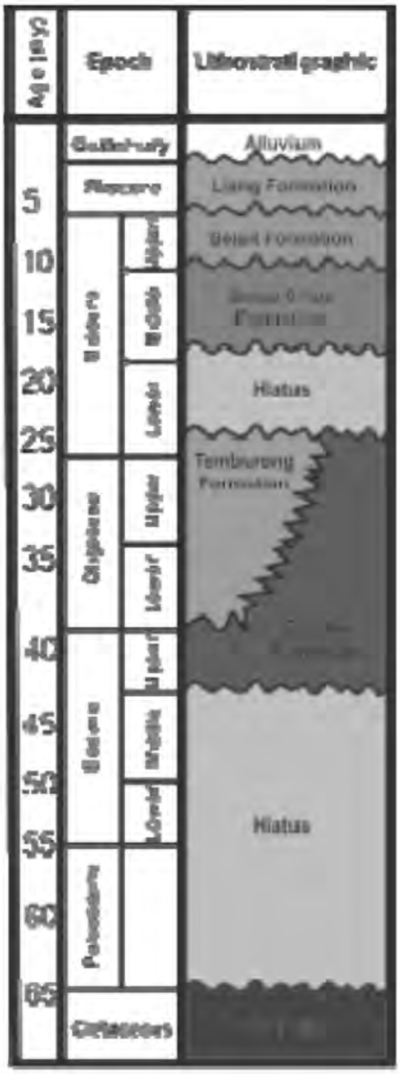

Figure 2: Stratigraphic column for the rock units in Klias Peninsula. (Modified after Sanudin & Baba, 2007).

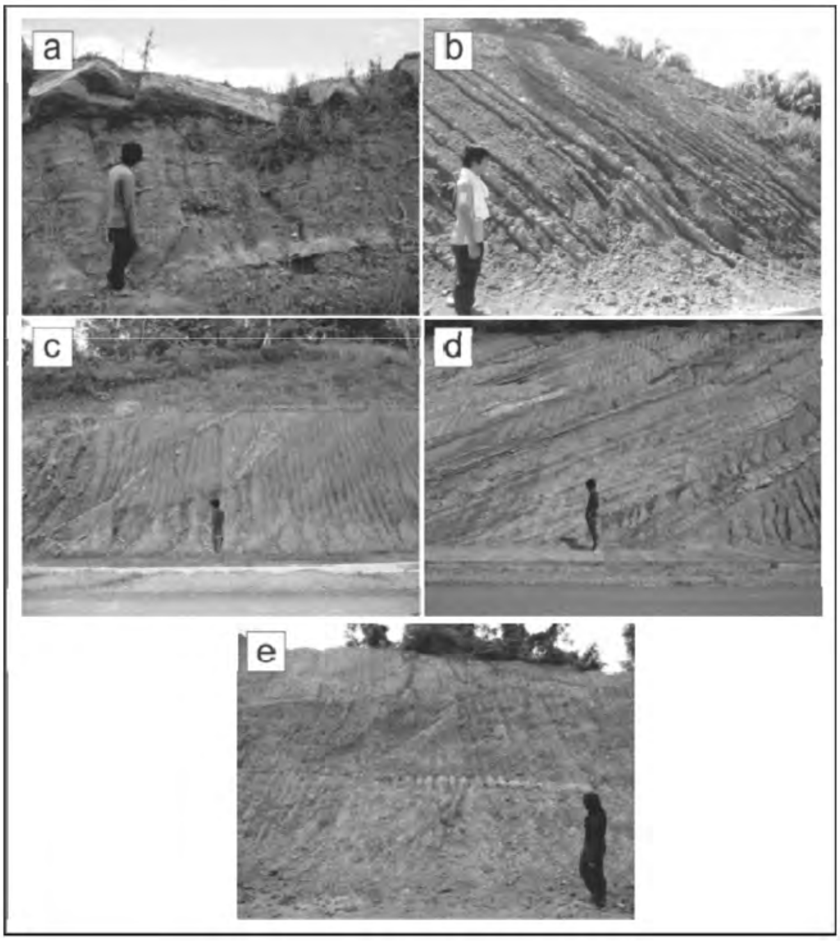

Figure 3: The outcrop for every formation in the Klias Peninsula (a) the Crocker Formation showing the interbedded thin sandstone and thin shale unit; (b) the Temburong Formation showing the interbedded shale with thin sandstone unit; (c) the Setap Shale Formation showing the interbedded shale with thin siltstone unit; (d) the Belait Formation showing the hummocky crossbedded sandstone and (e) the Liang Formation showing the graded conglomerate unit.

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PAPER P32

FACIES AND SEDIMENTARY SUCCESSION OF THE WEST CROCKER FORMATION (OLIGOCENE-EARLY MIOCENE), KOTA KINABALU, SABAH

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The study area covers part of Kota Kinabalu district and some other parts around Kota Kinabalu itself, and is bounded by longitude 116 °00'E to 116°16'E and latitude 5°57'N to 6°14'N with an estimated coverage of 20 km². The West Crocker outcrops in western Sabah are scattered and represent mostly an exposed turbidite system. This formation is selected for detailed research regarding its sedimentary and stratigraphic succession.

The West Crocker Formation of Sabah occupies part of western Sabah (Collenette, 1958; Stauffer, 1967) and as a part of Palaeogene Basin. This essentially siliciclastic succession has been interpreted as flysh, turbidites submarine fans, and/or "mass-flow" deposits (e.g Stauffer, 1967; Tongkul, 1987; Hutchison, 2005) of a foreland basin that developed along the Oligocene-Early Miocene subduction zone along NW Sabah margin. The depositional setting and stratigraphic architecture of turbidites in the West Crocker Formation have the potential contribute to better understanding of the complex geological history of Sabah and more effective explanation upon the deepwater system.

The sedimentological analysis of the West Crocker Formation outcrops has resulted in three sedimentary facies identified through detailed outcrops logging in (e.g table 1 & 2) based on grain size, bedding contacts, sedimentary structures, and bioturbation styles and intensity. The three facies are categorized as i) massive to internally parallel laminated sandstone (F1), ii) interbedded sandstone and shale (F2), and iii) shale (F3). The F1 is the oldest at the bottom generally occur as a thick bedded unit that varies in thickness from 0.8m to 1.0m This sandstone is characterized as light brown, fine to coarse grained moderately sorted as looked in hand specimen. The lower facies boundary is commonly sharp, loaded bases associated with tool marks, relatively few are scoured and granule to pebble- filled flute cast. The existences of flute cast at lower part of facies enable a paleocurrent data and determine to be dominantly northwards direction when corrected to structural dip. With typical of other known turbidites sequences, the lower sandstone beds generally grades upward from coarse sand to fine sand, laminate silt and finally shale. Most beds are massive (internally structureless) at the base and may occasionally contain planar parallel lamination. The uppermost part is massive with fine grained sand bodies locally containing well developed of planar parallel, current ripples and climbing ripples lamination. Trace fossils could not be found. Facies 2 (F2) occurs in units of 4-8 cm thick of sandstones which are monotonously alternating with 0.5-2 cm shale. The unit extends laterally about 500m with the sandstone layers generally fine to medium grained sand. Most of sandstone beds have sharp basal and top contacts capped by thin homogenous laminated shale layers. F3 is homogenous and range from 0.5m t0 1.0m in thickness. It extends laterally and can be traced for at least 200m on the top the other facies. The lower part of the shale units usually have thin interbeds of fine to silty sand that exhibit straight, sharp contacts, and ripple cross lamination.

The obtained results to date indicate that facies F1 was deposited rapidly deposition either en masse by hyperconcerntrated gravity flow (sensu Mudler and Alexander, 2001) or by "grain by grain" associated with high density sediment flow (Kneller and Branney, 1995; Jackson et al., 2009). For facies F2, the alternations between sandstone and shale implies fluctuating flow condition, where the period of sand deposition alternate with periods of shale that settle from the water column. Facies F3 composed mainly of shale unit records low energy, suspension fallout deposition in the absence of waves and currents (Buatois & mangano, 2002). Moreover, this fine grained material could also have been associated transported within the flow in response to a rapid settle down (Amy et al., 2005). The lack of bioturbation indicates the oxygen- depleted condition (Potter et a.l, 2005).

The sedimentary structures recognized in the West Crocker Fromation showed that the sandstone unit were deposited by gravity driven density currents known as turbidity currents. In these cases, most beds contain partial Bouma sequences with division of Ta, Tb, Tc, and Td. The massive and structureless sandstone beds with sharp and straight top and basal contact refer to high density of turbidites (Walker, 1992). The generally structureless and massive turbidites also indicate rapid deposition, probably by collapse fallout from high density turbidity currents (Stow and Johanson, 2000) caused by an abrupt decrease in slope angle along the transport path. The parallel lamination and climbing ripples at the top of sandstones are the sequence of the rapid and continuous fall out of finer grains during the final stages of deposition. The overall sedimentary characteristic can be interpreted as deep marine environment controlled by turbidity current.

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PAPER P33

GEOSTATISTICAL ANALYSIS USING PRINCIPAL COMPONENT ANALYSIS IN OBSERVING THE GROUNDWATER QUALITY CHANGES IN KAPAS ISLAND

Noorain Mohd Isa and Ahmad Zaharin Aris

Groundwater is a major water resource in Kapas Island; hence, a long-term monitoring of groundwater quality is essential. This study aims to assess (i) the hydrochemistry characteristics of groundwater and to obtain (ii) the factor controlling groundwater chemistry using multivariate statistical method, namely principal component analysis (PCA). Groundwater samples from Kapas Island were collected during two different monsoons, pre-monsoon (Aug – Oct 2010) and post-monsoon (Feb – Apr 2011), and analyzed for major elements (Ca, Mg, Na, K, HCO3, Cl and SO4) and physical parameters (Temperature, pH, DO, EC, TDS, Salinity and Eh). Na-HCO3 and Ca-HCO3 water types were observed during pre and post-monsoons respectively. It was a different in the concentration levels which lead to dissimilar factor controlling groundwater chemistry during pre and post-monsoon seasons. PCA was applied to datasets of different monsoons and resulted in five and three effective components explaining 45.1% and 54.6% of total variance respectively. Components in pre-monsoon represents Cl, Na, Sal, TDS and EC explained slightly saline process while components in post-monsoon represent TDS, EC, Sal, Na, Mg, Cl, Ca and HCO described the mineralization process of the geological matrix. Results from PCA revealed the mineralization processes have controlled the groundwater hydrochemistry in Kapas Island. The study shows the importance of groundwater monitoring associated with powerful statistics for better understand of a complex groundwater systems.

Keywords: Hydrochemistry, monsoons, multivariate, water type, small island

FACIES CHARACTERISTICS AND RESERVOIR SANDSTONE QUALITY OF SHALLOW MARINE SANDSTONES, NYALAU FORMATION, SARAWAK, EAST MALAYSIA

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A significant percentage of the world's hydrocarbon reservoirs are found in shallow-marine sandstones. Understanding the internal characteristics, distribution, geometry and lateral extent of these sandstones is an essential part of a successful exploration and production strategy. This study focuses on reservoir facies characteristics of the shallow-marine sandstones of the Nyalau Formation (Oligocene-Middle Miocene), Bintulu area, Sarawak, East Malaysia. We examine five different types of shallow-marine, reservoir-quality sandstones on the basis of facies, grain size distribution, porosity (ø) and permeability (k). These sandstones are; i) hummocky cross-stratified sandstones (medium- to fine-grained, yellowish-gray to gray, well- to moderately-sorted; ø=32.07%, k=6.7md; thickness from 1-2m); ii) herringbone cross-bedded sandstones (coarse- to very fine-grained, whitish to light- gray, sorted with some internal structures of planner cross-bedding; ø=31.31%, k=17.7m; thickness from 1-10m); iii) trough cross-bedded sandstones (fine- to very-fine-grained, light-brown to light-gray, moderately-sorted to sorted, with coal laminations; ø=35.80%, k=5.97md; thickness from 0.5-1m); iv) wavy- to flaser-bedded sandstones (very fine-grained, light yellowish-gray sandstone consisting of flaser bedding, typically bifurcated-wavy or rare wavy with coal laminated; ø=19.84%, k=2.31md; thickness from 0.5-3.5m); and v) bioturbated sandstones (very-fine to fine-grained, mostly whitish gray, moderately-sorted to sorted; ø=25.21%, k=19.46md; thickness from 1-2m). By integrating these parameters we examine the best reservoir quality sandstone is hummocky cross-stratified sandstones and herringbone cross-bedded sandstones, because it has better porosity-permeability then that of other sandstone facies, and the grain size analysis shows the probability curve with steep trend with almost same grain size, roundedness and sorting.

Keywords: Shallow-marine, facies, grain size, reservoir quality, porosity and permeability.

PAPER P35

VARIATION OF HYDROCARBON DISTRIBUTION IN THE DEVONIAN MARCELLUS SHALES

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Introduction:

The Marcellus shale Early of Mid Devonian is distributed through out of the Appalachian basin in the United States (Hall, 1839). Marcellus strata is subdivided into three major lithofacies associations: 1) thin, condensed mudrock faces; 2) thick, synorogenic clastic facies association; and 3) carbonate-dominated facies. The black shale of Marcellus strata is characterized by high weight percent TOC vary (from 1 to > 17% (Straeten et al., 2011). There is a lack of information on the variation of hydrocarbon distribution in these shales at the molecular level. This is important as there is growing evidence of complexities in the distribution of hydrocarbon in source rocks.

Therefore, the aim of this study is to carry out an evaluation using FTIR analyses on the variability of hydrocarbon distribution in the Marcellus shales, USA.

Materials and Methods:

The FTIR analysis was done in three samples from the Chettinango member from Marcellus shale Fig (1) & (2). The spectra were obtained using Agilent FTIR- ATR spectrometer scans range from 400 cm-1 to 4500 cm-1. The peaks have been identified from (Stuart, 2004).

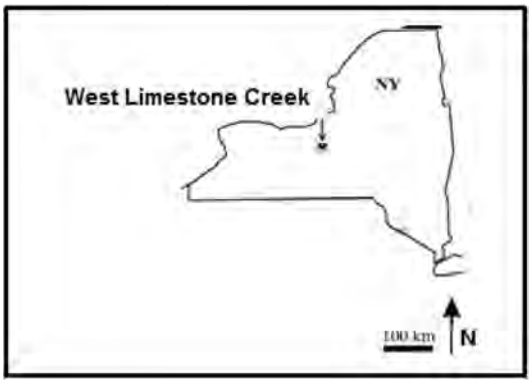

Figure 1: Location map of Marcellus shale samples.

Results and discussion

The Marcellus shale samples had C-H2 aliphatic, C-H methylene, C-H aromatic, O-H alcohol stretching, sulfurs compound S-S and C=O carbonyl compound bonds. Ketone compounds were present only in some samples. Similarly O-H carboxylic acid compounds were present in some samples only (Fig.3).

Conclusion:

The study shows that the Marcellus samples are dominated by aliphatic compounds. Of these, the CH bond groups are very dominant as evidenced in the FTIR spectra. Sample 3 shows the highest possible concentration of these bonds, follwed by sample 1 and lastly, sample 2. This indicates very clearly that there is a vertical variation in the distribution of aliphatics in the Marcellus Shale.

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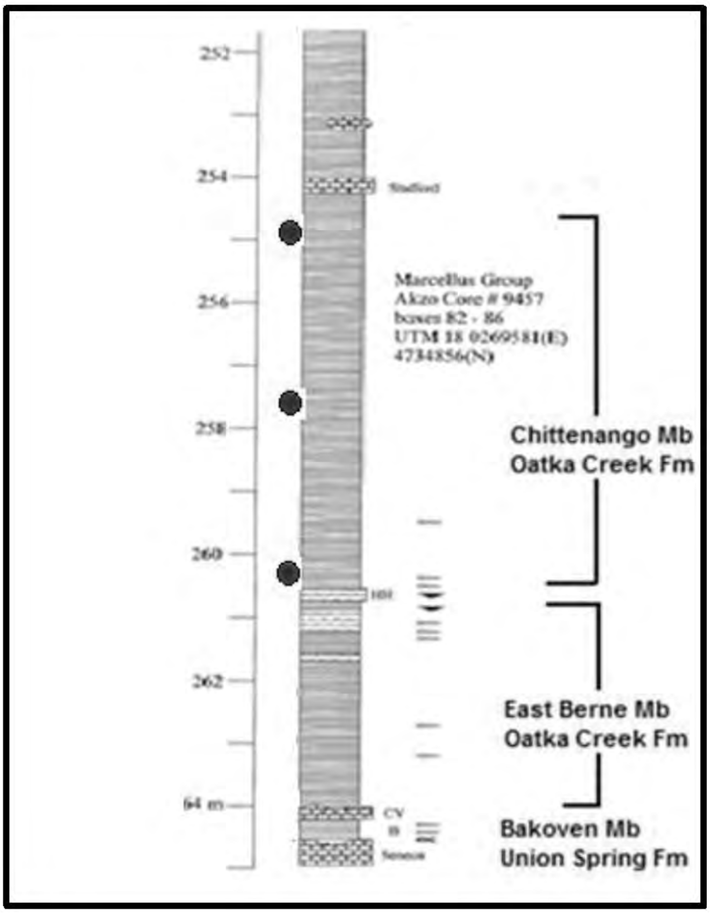

Figure 2: Well log shows the Marcellus shale sample location.

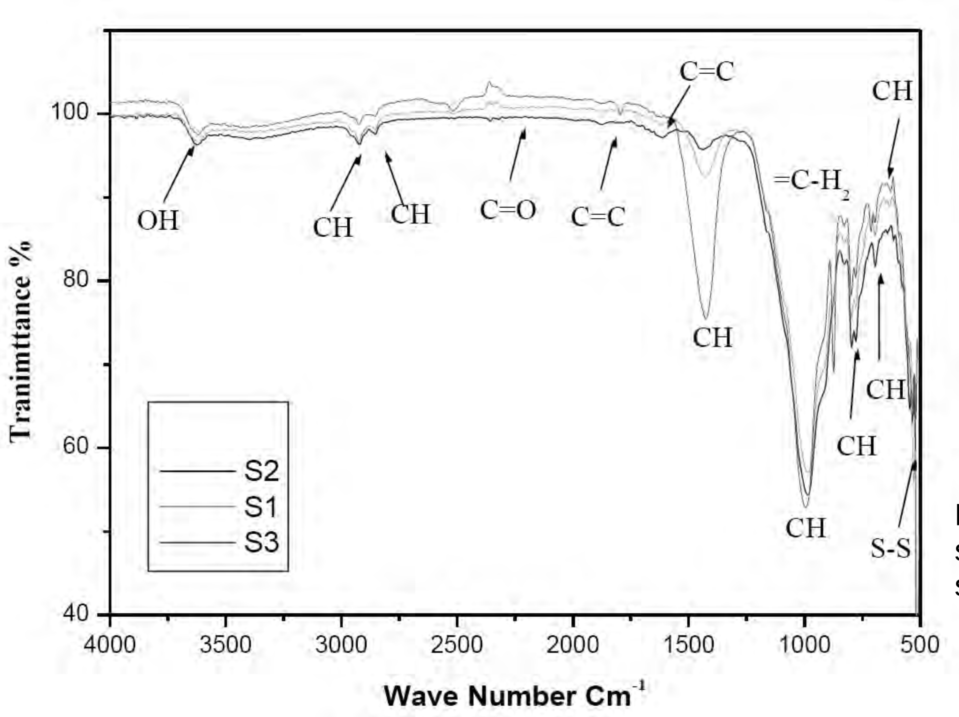

Figure 3: FTIR spectra for Marcellus shale

PAPER P36

CHARACTERIZATION PHYSICO-CHEMICAL OF SCHIST AND GRABITE AND THE EFFECT ADDITION OF BENTONITE AS A LINER MATERIAL

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Solid waste and leachate infiltration of garbage is one major problem in countries experiencing rapid population growth. This study was conducted to identify the types of lining materials and the most appropriate and effective in the system to overcome the garbage landfill leachate flow uncontrolled. Five residual soil samples from Kg. Malayu Sg. Sering and five sample from Taman Bistari Ukay, Jalan Ukay Perdana was used for the study. There are nine methods performed to study the physico-chemical characteristics, such as grain size distribution tests, Atterberg limits test, compaction test, test and relative density of soil (Gs), organic content test, ion exchange (CEC), batch equilibrium test (BET) and X-ray diffraction analysis (XRD) as well as special test involves the addition of bentonite. The study conducted found that granite residual soils are rich in kaolinite types of clay fraction have low permeability (1.621 x 10-7 m/s hingga 3.512 x 10-8 m/s). The physical testing also found that the soils has high water absorption rate based on the liquid limit value (43% to 60%) and the maximum density (1.8 Mg/m3 of 2.1 Mg/m3) more higher than schist type of soil.. The value of organic content and specific surface area (SSA) found high in granite residual soils have the potential to adsorb pollutants such as Pb, Zn and Cu. From batch equilibrium test results (BET) also found that the amount of heavy metals adsorbed on the study material, qe is directly proportional to the increasing of the concentration 25 mg / L, 50 mg / L, 75 mg / L, 100 mg / L, 150 mg / L and 200 mg / L. Based on the value of the equilibrium concentration for each element, granite residual soils indicates that the samples have higher adsorption capacity to adsorb Cu than schist residual soil, meanwhile schist residual soil have high capacity to adsorb Zn from the other elements studied. Additional findings with a mixture of bentonite with soil samples showed the characteristic of physico-chemical will increased with each addition of bentonite. Fine-grained fraction will increase with increasing water absorption properties and also adsorption of heavy metals with each rate bentonite mixture, which is an important feature in the selection of garbage landfill liners.

PAPER P37

2D ELECTRICAL RESISTIVITY IMAGING METHOD FOR IDENTIFYING SINKHOLES ALONG JALAN RAJA DR. NAZRIN SHAH, IPOH, PERAK

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Sinkholes usually occur where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that can naturally be dissolved by ground water circulating through them. These types of rocks are dissolved by water circulating through them (Friend, 2002). Sinkholes are a natural, common geologic feature in Ipoh due to underground soluble rocks such as the limestone and dolomite that form the Ipoh bedrock. Therefore, karstic limestone region at Kinta Valley imposes serious unique engineering and environmental hazards to humans and their properties, particularly in developed areas, which occur naturally and can be influenced by land-use modification and mining activities (Abu-Shariah, 2002).The study area is located along Jalan Raja Dr. Nazrin Shah, Ipoh, Perak, Malaysia (Figure 1).

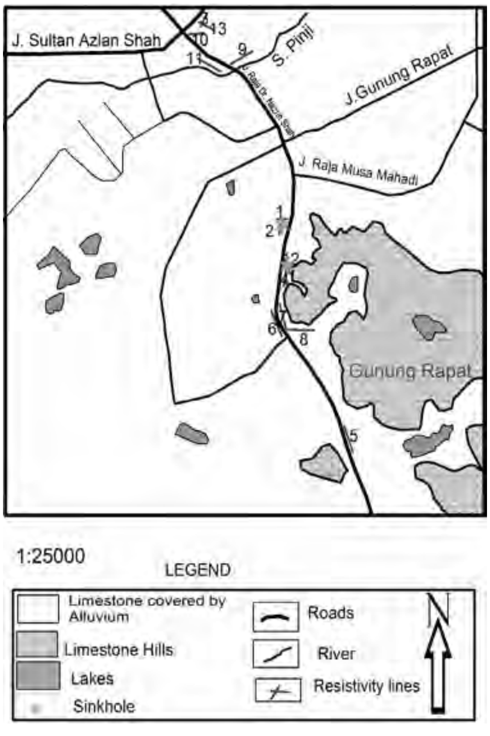

Figure 1: Map show location and sinkholes distribution of the study area

The dissolution of the limestone in the study area forms several types of karst features such as depressions (subsidence), sinkholes, caves, and solution hollows as shown in Figures (1& 2). The three main types of sinkholes that have been found in the study area are subsidence, solution, and collapse sinkhole. In addition, subsidence and collapse sinkholes were observed in the study area as shown in Figure 2. The objectives of this paper is to determine the presence of karst features by using electrical resistivity imaging (ERI) method for identifying sinkholes and for creating a database of sinkholes distribution.

ERI method was conducted on the site by using Wenner-alpha configuration to detect subsurface voids or probable sinkholes on the site. An Example as shown in Figure 3; the inverse model section shows an elongated thin layer of low resistivity on the left side of the section (blue color) anomalies at shallow depth (between 3 & 6.4 m), which can be related to cavities filled up with water and probable developing a sinkhole. The inverse model also shows rounded shape anomaly of low resistivity (blue color) on the right side of the section (below 30.0m mark), which may be interpreted as a subsurface limestone cave filled by water or a probable sinkhole. Moreover this anomaly may correspond to a sinkhole associated with the subsidence shown in Figure (3A). Directly above this anomaly, there is a small rounded shape with high resistivity (red & dark brown color), which may be related to the same subsidence (as a hole filled by air). The high resistivity that located in the middle (below -12.5m mark & at 12.0 meters depth) of the section is related to the limestone bedrock. The slightly low resistivity value on the right side of the section (after the limestone bedrock) is represents weathered limestone.

Figure 2: The photographs show karstic features that were observed in the study area such as subsidence and collapse sinkholes, and caves.

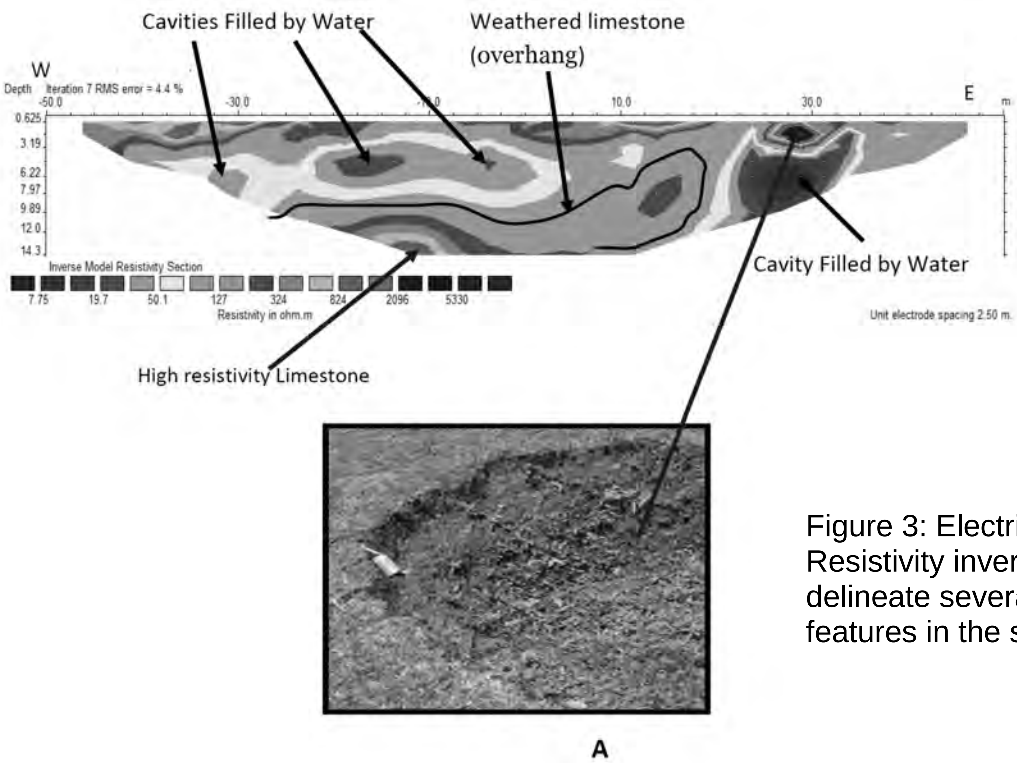

Figure 3: Electrical Resistivity inverse model delineate several karstic features in the study area

In General, a depth to the limestone bedrock is range from 2.5 to 12.7 meters, these results reach a decision to Ingham and Bradford (1960) who mentioned that the alluvium is generally 3 to 20 m deep. Alluvium and weathered limestone of the study area were characterized by low resistivities (50 to 150 ohm-m and 150-300 ohm-m respectively), whereas fresh limestone (bedrock) and air-filled voids were characterized by very high resistivities (>300 ohm-m). The lowest resistivities values (< 50 ohm-m) in study area are characteristic features of water filled cavities (Figure 3). However, these resistivity values are variable depending on moisture content, purity, and unit shape/size, and the conductivity of the encompassing strata. Finally, ERI technique has the ability to delineate and detect the karstic features with high accuracy for disaster reduction and management.

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Acknowledgement

The authors would like to extend thier sincere appreciation to University of Malaya for giving them an opportunity to work on this research through the University Malaya Research Grant (UMRG) with project account no. RG106/10AFR “Mapping Subsurface Karstic Terrain and Geohazard Assessment at Ipoh, Perak. In additional, we would like to express our sincere appreciation to Dr. Sawsan Kamel Shariah for her help in this research.

PAPER P38

PYROXENE-BEARING MICROGRANULAR ENCLAVES FROM TAIPING PLUTON AMPHIBOLE-BEARING GRANITE, MAIN RANGE GRANITE PROVINCE, PENINSULAR MALAYSIA

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Introduction

The origin of ME is still an unsolved enigma to petrology community. Some researchers (Vernon 1988; Kumar 1988; Maas et al. 1997; Perugini and Poli 2012) interpreted ME as product of magma mingling or mixing between two melts of different composition, while others see ME as restite or modified restite originating from partial melting of the source (Whalen and Chappell 1988; White and Chappell 2004; Chappell and Wyborn 2012). We decided to test these ideas while studying the pyroxene-bearing ME from amphibole-bearing granite of Taiping pluton using petrographical method. The older idea suggests the more mafic bodies found in the felsic rocks as ME are product of felsic magma mixing and mingling with mantle derived mafic magma, retaining composition near to the initial mafic magma (Clemens et al. 2011). On the other hand, the newer idea suggest ME are recognizable “restite” components of granites (Whalen and Chappell 1988). Chappell and Wyborn (2012) would later explain that “restite” is actually entrained peritectic phase minerals formed from incongruent melting of source rock, agreeing with the term peritectic crystal entrainment suggested by Clemens et al (2010).

Materials and Methods

We sampled a number of fresh amphibole-bearing granite core from a core drilling project at four locations near Bukit Bunoh, Lenggong, Perak (the eastern side of Taiping pluton). Samples from all four locations contain ME, suggesting ME is relative widespread in the area. About 42 granite core samples are collected for this study. We noticed 4 of the core samples are unusually felsic. We made 15 thin sections for petrographic analysis. Around three of the thin sections are on the pyroxene-bearing ME, two of them are on granite with higher felsic content, while the rest of the thin sections are on the general granite facies which may contain a small amount of biotite clots. These granite core samples are believed to hold additional information on the amphibole-bearing granite that is not easily observable in outcrop due to Malaysia tropical climate. Preliminary petrographic observation suggests highly felsic sample are probably related to chemical alteration by fluid (hydrothermal). These samples contain significant amount of chlorite and sericite. Wartlike myrmekite are only found in these samples.

Results and Discussion

The host rock is coarse and porphyritic. Alkali feldspar megacryst can be found in the granite but their distribution is highly erratic. Quartz, plagioclase and alkali feldspar are the common felsic minerals. Mafic minerals are chiefly represented by biotite and amphibole. Accessory minerals are zircon, apatite, sphene, allanite and tourmaline. Small amount of secondary calcite, chlorite, sericite has also been found. Most crystals beside pyroxenes are usually larger in the clots than in the ME. Unaltered pyroxenes are commonly found in the ME, or sometimes in the biotite clots. Amphiboles from this granite have been observed to alter from pyroxenes. We suggest the pyroxenes, amphibole and some plagioclase in the granite came from peritectic reactions. Careful study on the crystals found evidence of peritectic reactions such as crystal cluster, patchy zoning and inclusions. We also found that our ME contains components of an I-type peritectic assemblage: clinopyroxene, orthopyroxene and plagioclase, commonly formed from incongruent breakdown of hydrous mafic silicates. The model reaction for I-type has the form Bt + Hbl + Qz + Pl1 = melt + Pl2 + Cpx + Opx +

Ilm ± Grt (Clemens et al. 2011). Important peritectic minerals such as clinopyroxene (besides plagioclase and ilmenite) give I-type magma much of its distinctive chemistry (Clemens et al. 2011). Kumar (1985) petrographic description on the ME of Taiping pluton (he observed a total of eight enclaves) also reported similar assemblage, but with orthopyroxene missing. Peritectic mineral grains are not always observable due to their size and reactive nature. Ferromagnesian peritectic minerals, such as pyroxenes, will commonly react with melt, as temperature decreases and water activity rises, to form biotite and/or hornblende. Well developed exsolution textures are found on pyroxene grains in the ME. Our observation suggests that ME are most likely not related to large scale magma mixing and mingling as these texture requires slow cooling to form. In a simple model of magma mixing, the high temperature and low volume mafic magma will cool down rapidly as it disaggregate into magma globules when it enter into the cooler, higher volume felsic magma. This will usually discourage well developed exsolution texture in pyroxenes. However, in other scenario where large volume of mafic magma is slowly diluted by the felsic one (Perugini and Poli 2012), it is possible for well developed exsolution texture to occur.

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PAPER P39

DISSOLUTION KINETICS OF A CARBONATE ROCK FROM THE SUBIS LIMESTONE, SARAWAK.

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There is scarce information on dissolution kinetics of carbonate rocks in Malaysia. A sample taken from Subis limestone shows variation in loss of mass as well as removal of calcium cations with time. There appears to be a good correlation between loss of mass and total amount of calcium removed. However, a jump in the loss of mass with time at 25minutes indicates a change in mineralogy as well as active surface areas. This study then shows that carbonates from Sarawak would behave differently to dissolution.

Keywords: Subis limestone, atomic absorption spectrophotometer, dissolution kinetics, grainstone.

INTRODUCTION

The Subis limestone has been known to be spatially and temporally variable. This variation has its impact on petrophysical properties (Yin Sing and Padmanabhan, 2011). However, despite numerous researches having been conducted, there is still very little information on the kinetics of dissolution of limestone found in Malaysia. Therefore, the purpose of this study is to evaluate the kinetics of dissolution of a carbonate sample from the Subis limestone Formation, Sarawak.

MATERIALS AND METHODS

The sample was taken from the Subis Limestone Formation (Niah Cave) in Sarawak, Malaysia. Samples were prepared for dissolution kinetics and thin section analysis. Thin sections were prepared for petrographic analyses and described according to Flugel (2004) and Scholle and Scholle (2003). Core plugs were prepared and subsequently used in the dissolution kinetics experiments. A concentration of 0.1 mol of hydrochloric acid (HCI) was used for the 60 minute timed experiment conducted at room temperature (25°C) at 5 minutes intervals. Weight loss was recorded and aliquots of extracts were taken for analyses of Calcium concentration for every 5 minutes. An Atomic Absorption Spectrophotometer (AAS) (Shimadzu, AA-6800) was used for this purpose. Weight loss was plotted against time and changes in ionic concentration in extractant plotted against time.

RESULTS AND DISCUSSION

Petrography

The limestone (Fig. 1) consists of 20-25% of micrite (carbonate mud) which is light to dark brown in colour. The average grain size is less than 5µm. Approximately 5% microspar which has a average grain size ranging from 8-10µm and 7% of sparry calcite of 15-70µm of size which occur as void space infilling cement of anhedral to subhedral in shape were also detected. Iron oxide stains were detected. Fossils are closely packed and make up to about 60% of the rock fabric. Fossil types include miliolid, algae and fragmented parts of foraminifera shells.

Therefore, according to the Dunham Classification system this sample is classified as Grainstone.

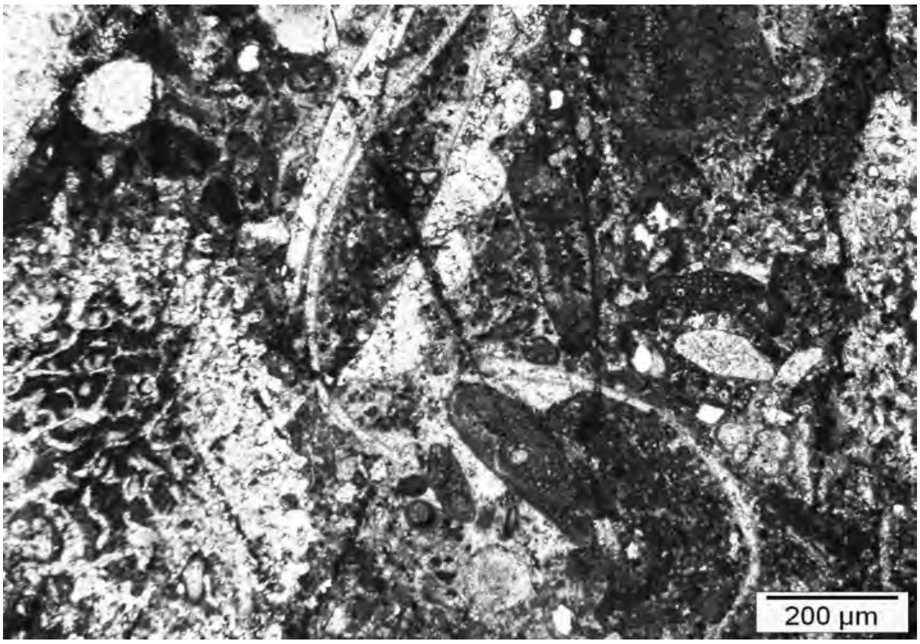

Figure 1: Photomicrograph showing fossil distribution in the limestone sample. Cross-nicols.

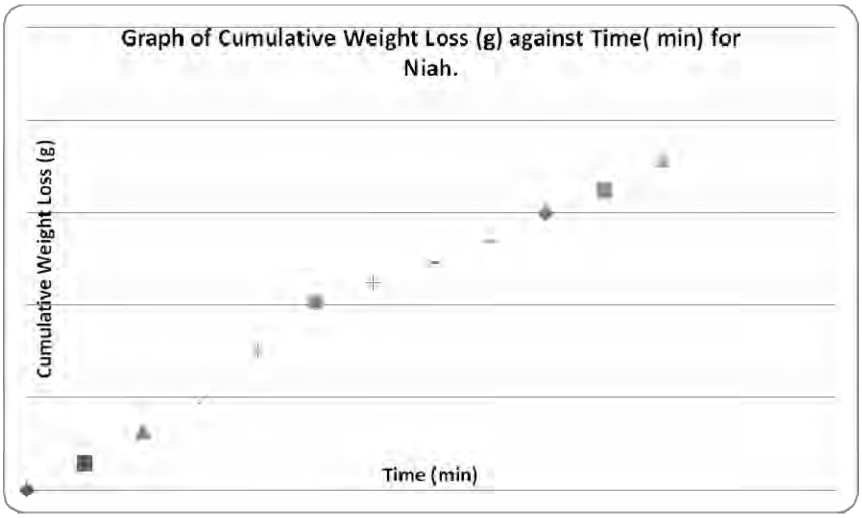

Figure 2: Cumulative graph of weight loss (g) against time (min).

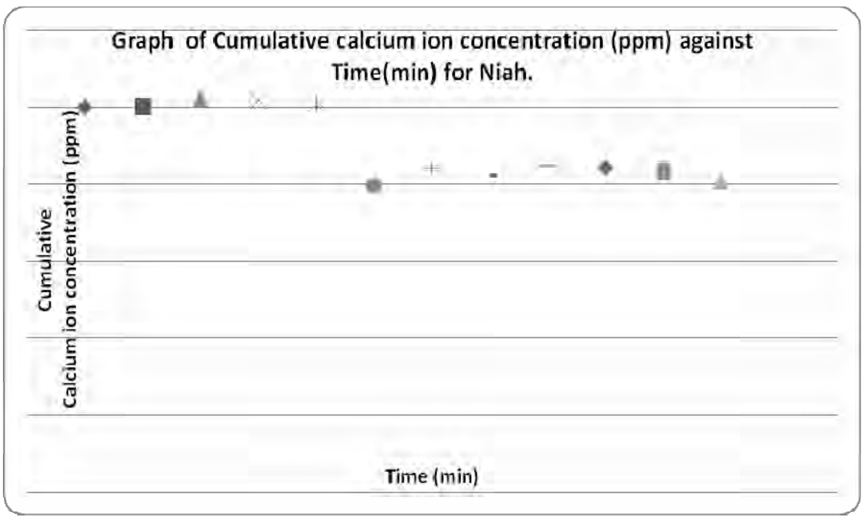

Figure 3: Cumulative calcium ion concentration (ppm) plotted against Time (min).

The petrographic analyses of the fabric shows that the fossil fragments, voids and calcite crystals are randomly oriented. This suggests that there is a variation in the distribution of active surface areas to chemical reactions.

Dissolution Kinetics

The loss of mass with time (Fig 2 & 3) indicates that there is a shift in gradient after 25 minutes of dissolution from high to low gradient. This is indicative of a change in dissolution kinetics from fast to slow. The concentration of calcium in the extracts drops from about 50ppm to 40ppm after 25 minutes as well. This indicates that there is a change in mineralogy and as such a change in the composition of the extractable cation. This coincides with the differences in fabric of the carbonate rock.

CONCLUSION

The study shows that carbonate rocks dissolve differentially. The study also shows that the rate of change in mass is proportional to the rate of removal of individual components.

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PERBANDINGAN PERKADARAN JASAD CERUN DENGAN ANALISIS KEGAGALAN CERUN DAN UJIAN KEMIRINGAN

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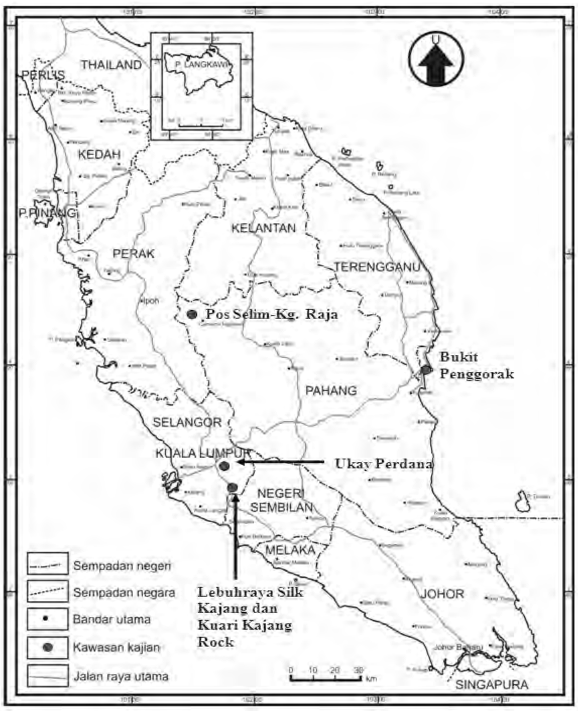
Perkadaran Jasad Cerun (*Slope Mass Rating*-SMR) telah diperkenakan oleh Romana (1985, 1993, 1995) sebagai tambahan kepada konsep Perkadaran Jasad Batuan (*Rock Mass Rating* – RMR) (Bieniawski 1979, 1989) dalam penilaian kestabilan cerun potongan. Sistem SMR mengambilkira RMR_{asas} dan ditambahkan dengan perkadaran yang mengambil kira orientasi ketakselanjaran utama dan cerun. Akan tetapi, sistem pengelasan SMR tidak mengambilkira kesan kekasaran permukaan ketakselanjaran. Kekasaran permukaan amat mempengaruhi parameter ricih dan nilai sudut geseran puncak sesuatu satah ketakselanjaran dan perlu diambilkira dalam penilaian kestabilan cerun batuan. Oleh yang demikian, kertas kerja ini membandingkan hasil SMR dengan analisis kestabilan cerun dan hasil ujian kemiringan. Analisis kestabilan cerun dijalankan mengikut kaedah yang disyorkan oleh Hoek dan Bray (1981). Untuk meramalkan ragam kegagalan cerun batuan, sudut geseran asas (ϕ_b) 30° digunakan dalam plot stereograf. Semua ragam kegagalan pada cerun batuan adalah pada keadaan di mana $\psi_f > \psi_i > \phi_b$ iaitu '*daylighting*'. Sudut geseran puncak permukaan satah ketakselanjaran (ϕ_p) ditentukan dengan menggunakan ujian kemiringan seperti yang dicadangkan oleh Ghani et al. (2011), Ghani Rafek et al. (2011), Ghani Rafek et al. (2012) dan Abdul Ghani Rafek & Goh (2012). Sudut kemiringan ketakselanjaran (ψi) yang diperolehi daripada stereograf untuk ragam kegagalan yang tertentu dibandingkan dengan sudut geseran puncak (ϕ_p) yang diperolehi daripada ujian kemiringan. Sekira sudut kemiringan ketakselanjaran (ψi) lebih tinggi daripada sudut geseran puncak (ϕ_p) permukaan satah ketakselanjaran, kegagalan cerun (gelongsoran) berpotensi berlaku. Lokasi



Rajah 1. Peta lokasi kajian.

tapak (Rajah 1) kajian adalah di JKR Kuari Bukit Penggorak, Kuantan, Pahang, Lebuhraya Silk Kajang (km 14.6), Selangor, Kuari Kajang Rock, Semenyih, Ulu Langat, Selangor, jalan Pos Selim-Kampung Raja, Cameron Highlands, Pahang/Perak (km 18-39) dan Ukay Perdana, Ulu Klang, Selangor. Sebanyak 18 cerun yang merangkumi 56 satah ketakselanjaran yang berlitologi granit dan syis telah dinilai dengan menggunakan sistem pengelasan SMR dan analisis kestabilan cerun serta ujian kemiringan. Hasil analisis kestabilan cerun dan ujian kemiringan ditunjukkan dalam Jadual 1. Di dalam sistem pengelasan SMR, kebarangkalian cerun akan gagal dikelaskan berdasarkan jumlah perkadaran SMR. Perbandingan kebarangakalian akan gagal dengan hasil analisis kegagalan cerun yang berdasarkan ϕ_p ujian kemiringan ditunjukkan dalam Jadual 2. Simbol singkatan TG ialah tidak gagal, G ialah gagal, S ialah sama dan TS ialah tidak sama. Di dalam pengelasan SMR, cerun dikelaskan sebagai

Jadual 1: Potensi kegagalan cerun yang diperolehi daripada perbandingan ψi sterograf dengan ϕp ujian kemiringan

Nama Cerun	Jenis Kegagalan	Orientasi (°)	Miring (°)	PKK	ϕ_p (°)	Potensi Kegagalan cerun
	Baji (J2 & J3)	252/41	41	5	59	tidak gagal
BPMW1	Baji (J3 & J4)	248/32	32	5	59	tidak gagal
	Baji (J2 & J5)	216/59	59	5&7	59	gagal
	Baji (J4 & J5)	212/41	41	5&7	59	tidak gagal
	Baji (J2 & J4)	241/51	51	7&9	60	tidak gagal
BPF2	Baji (J4 & J5)	249/66	66	5&7	55	gagal
	Baji (J3 & J5)	213/62	62	5&9	55	gagal
	Baji (J2 & J5)	216/63	63	4&9	54	gagal
	Baji (J3 & J5)	033/54	54	5&9	55	tidak gagal
SHFT0	Baji (J3 & J4)	056/52	52	5	55	tidak gagal
	Baji (J1 & J3)	074/49	49	5	55	tidak gagal
	Baji (J2 & J3)	086/45	45	5&9	55	tidak gagal
	Baji (J1 & J2)	093/54	54	5&9	55	tidak gagal
SHFT2	Baji (J1 & J2)	235/42	42	7&9	60	tidak gagal
	Baji (J1 & J6)	233/41	41	8&9	60	tidak gagal
	Baji (J2 & J6)	233/41	41	7&8	60	tidak gagal
SHSWT4	Baji (J1 & J3)	085/48	48	5&9	41	gagal
	Satah (J3)	223/42	42	7	46	tidak gagal
SHSWT5	Baji (J1 & J3)	192/38	38	5	41	tidak gagal
	Baji (J1 & J4)	192/38	38	5	41	tidak gagal
	Baji (J3 & J4)	192/38	38	5	41	tidak gagal
KRFS2	Baji (J2 & J4)	229/45	45	5	55	tidak gagal
	Baji (J1 & J3)	337/50	50	5&7	59	tidak gagal
KRMWS2-2	Baji (J2 & J3)	018/64	64	5	59	gagal
	Baji (J2 & J5)	029/35	35	5	59	tidak gagal
KRSWS5	Baji (J3 & J5)	002/34	34	5&9	41	tidak gagal
	Baji (J4 & J5)	320/63	63	7&9	46	gagal
PSF1	Baji (J1 & J2)	235/58	58	5&7	55	gagal
	Baji (J1 & J3)	218/78	78	5	55	gagal
PSF2-1	Baji (J1 & J3)	336/58	58	9	60	tidak gagal
	Baji (J2 & J3)	304/65	65	8&9	60	gagal
	Satah (J5)	240/47	47	9	60	tidak gagal
	Baji (J2 & J4)	281/65	65	7&9	60	gagal
PSF2-2	Baji (J1 & J2)	259/74	74	7&9	60	gagal
	Baji (J1 & J4)	250/64	64	9	60	gagal
	Baji (J1 & J5)	223/46	46	9	60	tidak gagal
	Baji (J2 & J3)	231/77	77	5&7	55	gagal
	Baji (J4 & J5)	198/38	38	9	60	tidak gagal
	Satah (J4)	020/72	72	5	41	gagal
PSSW2-4	Baji (J4 & J6)	355/70	70	5	41	gagal
	Baji (J1 & J2)	313/36	36	5&7	41	tidak gagal
	Baji (J1 & J4)	306/38	38	5	41	tidak gagal
	Baji (J2 & J4)	303/36	36	5&7	41	tidak gagal
PSF3-1	Baji (J1 & J3)	199/73	73	3&9	38	gagal
	Baji (J2 & J3)	226/77	77	3&9	38	gagal
PSSW3-2	Baji (J1 & J5)	015/55	55	5&9	42	gagal
	Baji (J2 & J4)	121/66	66	5	42	gagal
	Baji (J1 & J3)	263/52	52	3&6	38	gagal
PSSW4	Baji (J2 & J3)	281/47	47	6&8	50	tidak gagal
	Baji (J1 & J4)	228/67	67	3&9	38	gagal
	Baji (J1 &J2)	278/29	29	3&8	38	tidak gagal
PSF7-2	Baji (J1 & J3)	262/36	36	7&9	52	tidak gagal
UPF1	Baji (J3 & J4)	173/35	35	5&7	44	tidak gagal
	Baji (J1, F1 & J5)	240/58	58	3, 9,11	38	gagal

Jadual 2: Perbandingan kebarangkalian akan gagal SMR dengan analisis kegagalan jasad batuan

Cerun	Gred	R.Keg	SMR	Kelas	Kebarangkalian akan gagal (berdasarkan SMR)	Analisis kegagalan cerun (berdasarkan ϕ_p)	Kesamaan
BPF2	I	baji	75.00	II	0.20, TG	TG	S
BPF2	I	baji	72.00	II	0.20, TG	G	TS
BPF2	I	baji	79.00	II	0.20, TG	G	TS
BPF2	I	baji	79.00	II	0.20, TG	G	TS
BPMW1	III	baji	22.00	IV	0.60, G	TG	TS
BPMW1	III	baji	37.00	IV	0.60, G	TG	TS
BPMW1	III	baji	55.00	III	0.40, G	G	S
BPMW1	III	baji	58.00	III	0.40, G	TG	TS
SHFT0	I	baji	71.00	II	0.20, TG	TG	S
SHFT0	I	baji	48.00	III	0.40, G	TG	TS
SHFT0	I	baji	23.00	IV	0.60, G	TG	TS
SHFT0	I	baji	45.00	III	0.40, G	TG	TS
SHFT0	I	baji	54.00	III	0.40, G	TG	TS
SHFT2	I	baji	41.00	III	0.40, G	TG	TS
SHFT2	I	baji	39.00	IV	0.90, G	TG	TS
SHFT2	I	baji	39.00	IV	0.60, G	TG	TS
SHSWT4	II	baji	62.00	II	0.20, TG	G	TS
SHSWT5	II	satah	27.00	IV	0.60, G	TG	TS
SHSWT5	II	baji	68.00	II	0.20, TG	TG	S
SHSWT5	II	baji	68.00	II	0.20, TG	TG	S
SHSWT5	II	baji	68.00	II	0.20, TG	TG	S
KRSWS5	II	baji	58.00	III	0.40, G	TG	TS
KRSWS5	II	baji	53.00	III	0.40, G	G	S
KRFS2	I	baji	66.00	II	0.20, TG	TG	S
KRMWS2-2	III	baji	55.00	III	0.40, G	TG	TS
KRMWS2-2	III	baji	2.00	V	0.90, G	G	S
KRMWS2-2	III	baji	34.00	IV	0.60, G	TG	TS
PSF1	I	baji	69.00	II	0.20, TG	G	TS
PSF1	I	baji	64.00	II	0.20, TG	G	TS
PSF2-1	I	baji	80.00	II	0.20, TG	TG	S
PSF2-1	I	baji	40.00	IV	0.60, G	G	S
PSF2-2	I	satah	38.00	IV	0.60, G	TG	TS
PSF2-2	I	baji	76.00	II	0.20, TG	G	TS
PSF2-2	I	baji	66.00	II	0.20, TG	G	TS
PSF2-2	I	baji	53.00	III	0.40, G	G	S
PSF2-2	I	baji	33.00	IV	0.60, G	TG	TS
PSF2-2	I	baji	31.00	IV	0.60, G	G	S
PSF2-2	I	baji	69.00	II	0.20, TG	TG	S
PSSW2-4	II	satah	47.00	III	0.40, G	G	S
PSSW2-4	II	baji	27.00	IV	0.60, G	G	S
PSSW2-4	II	baji	66.00	II	0.20, TG	TG	S
PSSW2-4	II	baji	67.00	II	0.20, TG	TG	S
PSF3-1	I	baji	37.00	IV	0.60, G	G	S
PSF3-1	I	baji	61.00	II	0.20, TG	G	TS
PSSW3-2	II	baji	62.00	II	0.20, TG	G	TS
PSSW3-2	II	baji	66.00	II	0.20, TG	G	TS
PSSW4	II	baji	27.00	IV	0.60, G	G	S
PSSW4	II	baji	42.00	III	0.40, G	TG	TS
PSSW4	II	baji	18.00	V	0.90, G	G	S
PSSW4	II	baji	44.00	III	0.40, G	TG	TS
PSF7-2	I	baji	73.00	II	0.20, TG	TG	S
UPF1	I	baji	48.00	III	0.40, G	TG	TS
UPF1	I	baji	31.00	IV	0.60, G	G	S
UPF1	I	baji	31.00	IV	0.60, G	G	S
UPF1	I	baji	31.00	IV	0.60, G	G	S
UPF1	I	baji	31.00	IV	0.60, G	G	S

gagal apabila nilai kebarangkalian akan gagal SMR ≥0.4. Cerun dikelaskan tidak gagal apabila nilai kebarangkalian akan gagal SMR < 0.4. Daripada analisis, sebanyak 46 % ramalan kedua-dua kaedah ini adalah sama dan 54 % ramalan adalah tidak sama. Kebanyakan hasil ramalan kegagalan kedua-dua kaedah ini berbeza kerana sudut geseran yang berlainan digunakan oleh kedua-dua kaedah ini dalam penentukan kegagalan cerun. ϕ_p ujian kemiringan yang bergantung kepada nilai pekali kekasaran kekar, PKK (*Correlation of joint roughness coefficient*) permukaan ketakselanjaran digunakan dalam analisis kegagalan cerun. Manakala, sudut geseran asas sebanyak 30° (dalam stereograf) digunakan dalam pengelasan SMR. Semua kekar yang berpotensi gagal yang diperolehi daripada stereograf adalah dianggap akan gagal dalam sistem pengelasan SMR tanpa mengambilkira sudut puncak kekasaran permukaan. SMR mengambilkira parameter geomekanik dan orientasi kekar dengan muka cerun tetapi tidak mengambilkira sifat ricih kekar (kekasaran permukaan kekar) dalam pengelasannya. Akan tetapi, analisis kegagalan cerun yang berasaskan sudut puncak ujian kemiringan mengambilkira kekasaran permukaan. Ini bermakna, sekiranya mengabungkan kedua-dua kaedah, ramalan kegagalan cerun yang lebih tepat boleh diperolehi.

Kata kunci: SMR, analisis kegagalan cerun dan ujian kemiringan.

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PAPER P41

GEOCHEMICAL CHARACTERS OF THE LANGKAWI GRANITE

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This study investigates the geochemical research of the Langkawi granite. The Langkawi granite consists of four main bodies, Gunung Raya, Kuah , Pulau Tuba and Pulau Dayang Bunting granites. Wan Fuad et al. (2001) has divided the Langkawi granite into two sub-groups, Gunung Raya-Dayang Bunting granite and Kuah –Tuba granite based on the rare earth element (REE). Based on K-Ar dating by Bignell & Snelling (1977) the age of the granite from Langkawi is 217±8 which is during Late Triassic time.

The Langkawi granite is characterized by high SiO_2 content (68.1 - 77%), which according to Chappell & White (1984) is characteristic of rocks, were derived from SiO2 rich sources. The highly evolved magma of the Kuah granites is supported by high Rb/Sr ratio (~20.55), compared to the Gunung Raya granite which is less differentiated (~7.84). In addition to that, both granites have no significant differences. All granites have ASI >1 which is peraluminous. Both the Gunung Raya and Kuah granites show a fundamental S-type feature like peraluminous composition, high K_2O / Na_2O ratio (~1.56%), low total Fe and restricted composition range dominated by high SiO_2, normative corundum > 1%. Strongly negative Eu anomaly is normally subscribed to fractionation of plagioclase due to the similar ionic radius and charge of Eu^{2+} and Ca^{2+} (Rollinson 1993, Blatt et al, 2006). A comparative studies of the Langkawi granite REE pattern with that of the Main Range granite show that the Langkawi granite constitutes familiar birds-wing REE pattern and strong negative Eu anomaly which is similar to the dominant S-Type granites of Main Range (Liew, 1983 ; Wan Fuad & Suhaimi 1998).

Wan Fuad et al. (2001) pointed out that the REE modeling of both the Gunung Raya and Kuah granite show that they may be derived from the Cambro-Ordovician Machinchang Formation which is chiefly composed of the siliciclastic sediments by simple batch melting and fractional crystallization. The Gunung Raya granite differs slightly from the Kuah granite in having higher LREE contents and a steeper LREE gradient.

Major and trace elements Harker diagram shows that the Gunung Raya and Kuah magmas might have been derived from the different magmatic pulses but they were controlled by the same mineral assemblages. Thus they may probably be formed from the same magma sources. On the other hand, a comparison of LIL modeling between the Langkawi and Main Range granites show the same mineral vectors trend. The Langkawi and Main Range granites fall within the syn-collisional granites. This supports their S-type characteristic and association with the tin mineralization in relation to the Indosinian Orogeny (Azman Ghani, 2009).

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PAPER P42

PENCIRIAN GRANIT KUANTAN, PAHANG SECARA LAPANGAN, PETROGRAFI DAN GEOKIMIA

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Kajian dilakukan ke atas batuan granit yang tersingkap di sekitar Kuantan, Pahang. Tujuan kajian dijalankan adalah untuk mengetahui jenis-jenis batuan granit yang tersingkap melalui cerapan lapangan dan mencari asal mula setiap batuan tersebut menggunakan kaedah petrografi dan geokimia. Kajian difokuskan kepada beberapa kawasan iaitu: Bukit Ubi, Bukit Galing, Bukit Pelindung, Bukit Beserah, Kawasan Perumahan Kos Rendah Semambu, Bukit Tembeling dan Teluk Cempedak. Terdapat 53 lokaliti cerapan telah dilakukan dalam kawasan ini. Sebanyak 48 sampel telah diambil untuk dilakukan analisis makmal. Hasil cerapan lapangan mendapati bahawa terdapat lima jenis batuan utama di Kuantan, Pahang iaitu granit berbutir kasar, granit berbutir sederhana, granit merah jambu, granit porfir dan juga terobosan dolerit. Terobosan dolerit ditemui di tiga kawasan iaitu di Loji Air Bukit Ubi, Tanjung Tembeling dan Teluk Cempedak. Terobosan dolerit di Teluk Cempedak boleh dibahagikan jenisnya kepada dua, iaitu dolerit A yang berbutir halus dan dolerit B yang bersifat porfir. Sebanyak 8 sampel batuan granit digunakan untuk analisis geokimia. Set data geokimia yang diperolehi daripada kaedah XRF diolah untuk mengelaskan batuan berdasarkan kandungan kimia, asalan magma dan sekitaran tektonik. Pengelasan asas berdasarkan peratus berat unsur silika, dimana sampel batuan memberikan nilai peratus berat unsur silika melebihi 70% mengesahkan batuan adalah terdiri daripada kumpulan asid. Plot pada gambarajah Harker memberikan korelasi negatif bagi unsur FeOt, Al_2O3, TiO_2 dan CaO melawan unsur SiO_2 dan korelasi positif bagi unsur Na_2O dan K_2O melawan SiO_2. Berdasarkan dapatan nilai A/NK dan A/CNK, batuan dikelaskan kepada dua iaitu jenis paralumina dan metalumina. Pengelasan geotektonik Batchelor dan Bowden (1985) meletakkan sekitaran asal mula batuan pluton Kuantan sebagai sekitaran sin-pelanggaran.

KAJIAN BATUAN IGNEUS DI AIR TERJUN BERKELAH, GAMBANG, KUANTAN, PAHANG DARI ASPEK PEMETAAN TERPERINCI, PETROGRAFI DAN GEOKIMIA.

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Kajian disertasi ini telah dilakukan di Air Terjun Berkelah, Gambang, Kuantan, Pahang. Air Terjun Berkelah ini terletak di Hutan Lipur Berkelah kira-kira 46 km dari Bandar Kuantan, Pahang. Kawasan ini terletak pada kedudukan garis lintang 102° 47. 02'U hingga 102° 59. 56'U dan garis bujur 03° 41. 55' T hingga 03° 45. 11' T. Objektif kajian ini adalah untuk memetakan kawasan kajian dan juga menentukan jenis-jenis batuan yang terdapat di dalam kawasan kajian. Seterusnya ialah untuk menentukan kandungan mineral berdasarkan kajian petrografi dan membuat penamaan secara sistematik berdasarkan peratusan mineral di bawah mikroskop. Selain itu, untuk menentukan kandungan geokimia batuan meliputi unsur-unsur major dan unsur-unsur surih. Kajian ini juga dilakukan untuk membuat tafsiran petrogenesis batuan di dalam kawasan kajian berdasarkan kajian lapangan, analisis petrografi dan analisis geokimia batuan. Skop kajian ini berdasarkan kepada tiga aspek utama iaitu pemetaan, kajian petrografi dan analisis geokimia batuan. Melalui cerapan di lapangan, terdapat tiga jenis batuan utama yang ditemui iaitu granit berbutir halus, granit berbutir sederhana dan granit berbutir kasar. Selain itu, terdapat juga struktur-struktur geologi yang dapat dilihat seperti kekar, sesar, dan juga zenolit. Terdapat juga batuan yang telah mengalami proses luluhawa. Sebanyak 21 sampel batuan yang telah diambil dan 9 daripadanya telah dilakukan analisis geokimia batuan untuk menentukan unsur-unsur major dan unsur-unsur surih yang wujud dalam sampel tersebut. Pelet tekan dan kaca terlakur dibuat untuk mendapatkan maklumat mengenai kehadiran unsur-unsure major dan unsur-unsur surih. Daripada analisis gambarajah Harker dan skema pengelasan pluton, pengkaji mengetahui bahawa batuan di kawasan kajian adalah berasal daripada asalan magma yang sama tetapi telah mengalami evolusi yang menyebabkan pelbagai saiz dan tekstur batuan terbentuk. Sebanyak 1 sampel batuan dibuat analisis petrografi untuk menentukan mineral yang wujud dalam sampel batuan. Mineral yang dominan ialah kuarza, diikuti oleh alkali feldspar dan plagioklas. Terdapat juga mineral aksesori seperti biotit. Berdasarkan kajian setakat ini, Air Terjun Berkelah boleh disimpulkan terdiri daripada tiga jenis granit, iaitu granit berbutir halus, sederhana dan kasar. Ketiga-tiga batuan ini mempunyai komposisi mineral yang hampir sama. Daripada data geokimia yang diperoleh, dapat disimpulkan batuan di kawasan ini berasal dari magma yang sama tetapi telah mengalami evolusi.

PAPER P44

GEOTOURISTIC ATTITUDE OF THE TOURISTS TOWARDS SCIENTIFIC VALUE OF GEOLOGICAL HERITAGE: THE CASE OF LANGKAWI GLOBAL GEOPARK

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Geotourists are those who participate in activities towards appreciating aesthetic, cultural, recreational and scientific value of geoheritage resources. They contribute to the economic sector by spending for geotourism products and services, social sector by preferring local goods and services and respecting local beliefs and traditional uses, environmental sector by their non-consumptive behavior and participation in conservation and preservation of geoheritage resources for future generation (Sofia et al. 2013). Economic value of geological heritage resources refers to abilities of such resources in sustaining or enhancing environment quality due to the realization of their intrinsic value which include importance in geological records or history of the earth and environmental benefits associated with it (Tongkul 2006). Geotourists should realize the intrinsic value of geological resources and are expected to value the nature from geocentrism approach.

Langkawi Geopark was established in 2006 and it was approved by UNESCO in 2007 as the first Global Geopark in Malaysia and Southeast Asia (Mohd Shafeea Leman et al. 2007). Thus, evaluating geotouristic attitude of tourists visiting Langkawi Global Geopark towards scientific valuation of geological heritage is essential to understand at what extent the tourists perceived the intrinsic worth of geological heritage and how they value geological heritage resources. In this paper, attitude towards scientific valuation were evaluated from anthropocentrism (human centered valuation) and geo-centrism (geologically centered valuation) approach based on extensive survey carried out in June 2012 at the Kilim Karst, Machinchang Cambrian and Dayang Bunting Marble Geoforest Parks of Langkawi. The idea of a human-centered nature, or anthropocentrism, explicitly states that humans are the sole bearers of intrinsic value and all other things are there to sustain humanity’s existence (MacKinnon 2007) whereas geocentrism derived from ecocentrism definition by MacKinnon (2007) and Armstrong & Botzler (1993) recognizes a nature-centered system of values, on maintenance of geological processes and protecting geologically significant areas for their intrinsic worth irrespective of any worth to human. The variables measuring anthropocentrism and geo-centrism are derived from the understanding of the existing literatures on environmental values.

Results indicate that on average there were 59.70% of the tourists had the strong anthropocentrism or instrumentalism attitude (valuing nature as it fulfills a practical function in satisfying basic, concrete human needs or desires defined by Armstrong & Botzler, 1993) towards scientific valuation for geological heritage. On average 97.1% of the tourists possessed geocentrism attitude of assigned value (valuing natural resources for less tangible reasons as defined by

Table 1: Scientific Valuation from Anthropocentrism to Geo-centrism Approach

Scientific Valuation Criteria				Strongly Agree	Agree	Total	Mean %
Anthropocentrism	Strong	Instrumentalism	Nature is a tool to satisfy human greed	41.80%	29.90%	71.70%	59.7%
			Human can alter nature as they will	22.70%	25.00%	47.70%	
	Weak	Assigned Valuation	Geologically and Ecologically significant areas should be protected for Research and Educations	63.10%	34.00%	97.10%	97.1%
Geocentrism		Functional Valuation	Geology is the foundation of for ecosystem	61.00%	36.70%	97.70%	97.6%
			Biological diversity is dependent on Geological diversity	58.40%	40.10%	98.50%	
			Geological diversity should be preserved because of it is threatened, biological diversity is also threatened	65.20%	32.30%	97.50%	
			Nature should be preserved as it stores geodiversity and biodiversity	63.40%	33.20%	96.60%	
		Held Valuation	If destruction activities continue their present course, we will soon experience a major ecological catastrophe	57.00%	35.70%	92.70%	96.2%
			Nature should be preserved for future generations	72.30%	25.50%	97.80%	
			Tourism should be more environmental friendly	69.50%	28.70%	98.20%	
		Intrinsic Valuation	Geological structure, Rock formation are unique as they keep record of its origin and evolution (Earth History)	63.90%	33.70%	97.60%	96.8%
			Landscape should be preserved for geological artifacts	62.30%	33.70%	96.00%	

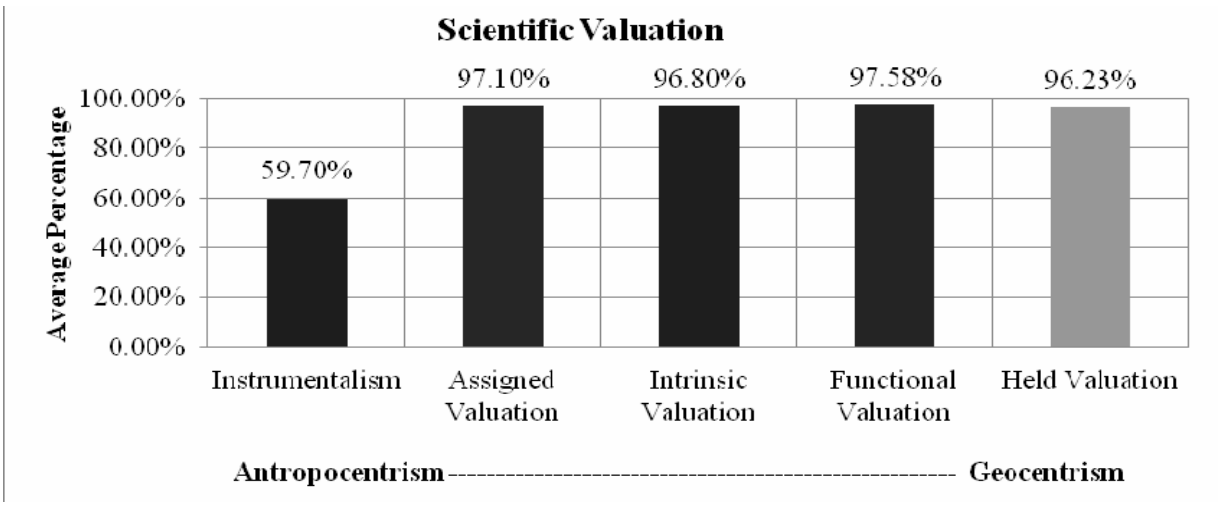

Figure 1. Attitude Evaluation of Scientific Value of Geological Heritage

Armstrong & Botzler, 1993, p. 276) since they believed that geologically and ecologically significant areas should be protected for research and educations. Results also show that 97.58% of the tourists possessed geocentrism attitude of functional value (valuing nature due to the technical relationship between the existence of an entity and the natural area as defined by Lockwood, 1999) and 96.23% of the tourists are found to have geo-centrism attitude of held value (valuing nature due to the principles or ideas that are important to people, such as notions of liberty, justice or responsibility as defined by Lockwood, 1999). Most tourists believed that nature should be preserved for future generations (97.80%). Hence if destruction activities continue their present course, we will soon experience a major geoenvironmental catastrophe (92.70%) and thus geotourism should be more environmental friendly (98.20%). Additionally, there are on average 96.8% tourists who had the geo-centrism attitude of intrinsic value (valuing natural environment due to its presence as an end in itself defined by Lockwood, 1999). Generally more than 95% tourists had geotouristic attitude for each variable of assigned, intrinsic, functional and held value. Results also indicate that overall, tourists' attitude towards scientific value was found to be consistent with the values of geotourism since on average 87.53% of the tourists had geotouristic attitude towards the scientific value of geological heritage.

Results also indicated that 56.54% of the respondents can be classified as genuine geotourists since they strongly agreed with assigned, intrinsic, functional and held values and strongly disagreed with instrumentalism values of geological heritage. 30.99% of the respondents are considered as amateur geotourists as they perceived positive attitude towards assigned, intrinsic, functional and held values and negative attitude towards instrumentalism. On the other hand, 12.40% did not perceive geotouristic attitude towards scientific value of geological heritage.

Majority of the tourists visiting Langkawi Global Geopark had positive attitude towards assigned value (97.65%) and functional value (97.58%) of geological heritage. In other words, geological heritage are valuable to them due to the less tangible goods and services provided (e.g. for research and education) and due to the fact that these values serve as links between geoheritage resources and the existence of other nature resources such as ecosystem and biodiversity. Finally, recommendations are provided in this paper in order to increase awareness on intrinsic value of geological heritage for future tourists visiting Langkawi Global Geopark.

Acknowledgement.

This research was carried out under the tenure of Research Project No UKM-GUP-2011-272. The author would like to thanks the Geopark Division of Langkawi Development Authority (LADA) and the Langkawi Research Centre (PPL) of UKM for their supports and encouragement during the field survey of this research.

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KAJIAN FASIES FORMASI CROCKER DAN FORMASI TEMBURONG, TENOM DAN PEDALAMAN BEAUFORT

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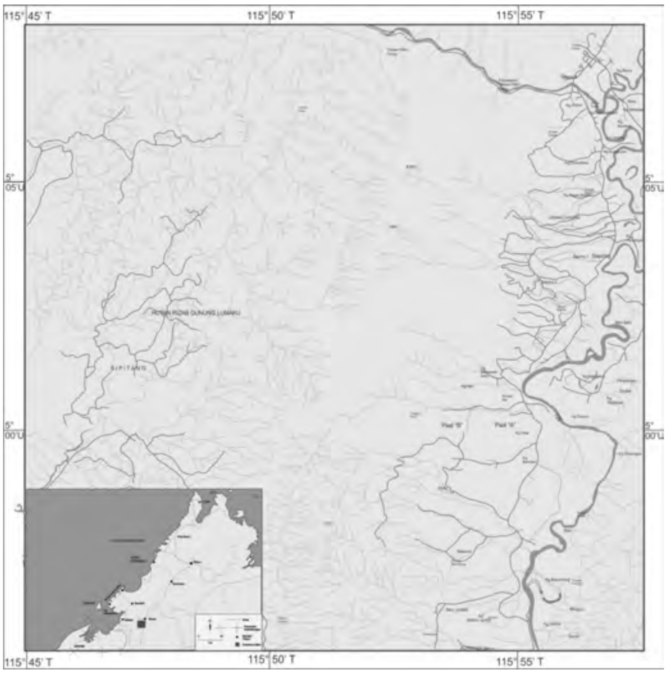
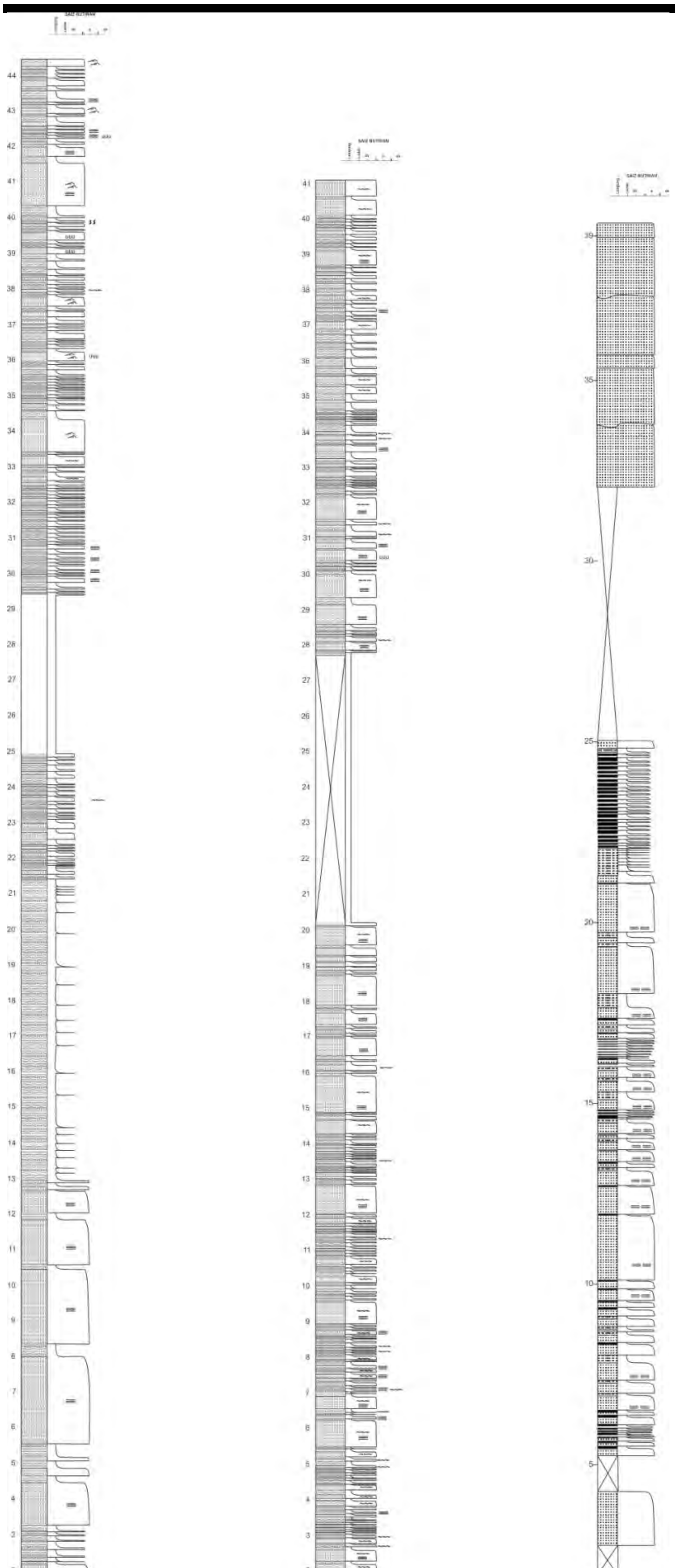
KATA KUNCI: Fasies, Formasi Crocker, Formasi Temburong, Unit Bouma, Kipas Tengah, Kipas Luar



Rajah 1: Peta lokasi kawasan kajian.

Kawasan kajian terletak di bahagian Pedalaman Beaufort dan Tenom yang bergaris bujur dari 115º 45’ T hingga 115º 57’ T dan bergaris lintang 05º 05’ U hingga 04º 55’ U (Rajah 1). Unit litostratigrafi yang terdedah di kawasan kajian memberi maklumat yang cukup penting dalam kajian fasies terhadap Formasi Crocker dan Formasi Temburong. Kedua-dua formasi ini merupakan jujukan batuan yang membentuk jalur belakang banjaran di bahagian Pantai Barat Sabah. Kajian terdahulu menunjukkan Formasi Crocker adalah sebahagian daripada Formasi Temburong, berdasarkan kesamaan unit batuan yang terdapat pada kedua-dua formasi tersebut (Wilson, 1964). Kedua-dua formasi ini seperti yang dijelaskan oleh pengkaji terdahulu seperti Wilson dan Wong (1985) dan Hutchison (2004) berada dalam keadaan melidah atau menjari. Untuk parameter fasies, seperti yang disepakati oleh pengkaji terdahulu seperti Selley (1988), Tucker (2003), Sanudin dan Baba (2007), adalah seperti geometri, litologi, struktur endapan, fosil dan paleoarus. Kajian fasies ini diharapkan memberi maklumat yang jelas mengenai perbezaan dan kesamaan fasies-fasies bagi Formasi Crocker dan Formasi temburong. Analisis lapangan pada kedua-dua formasi menunjukkan beberapa unit batuan yang berbeza terdedah dan dengan sifat yang sama. Formasi Crocker terdiri daripada empat unit batuan, antaranya: Unit Batu Pasir Tebal (Fasies B), Unit Selang Lapis Batu Pasir dan Syal (Fasies C) (Foto 1), Unit Selang Lapis Batu Pasir Sederhana Tebal dan Syal (Fasies D) dan Unit Selang Lapis Batu Pasir Nipis dan Syal (Fasies E) (Rujuk litolog rajah 2). Manakala Formasi Temburong terdiri daripada tiga unit batuan, antaranya: Unit Selang Lapis Batu Pasir Sederhana Tebal dan Syal (Fasies D) (Foto 2), Unit Selang Lapis Batu Pasir Nipis dan Syal (Fasies E) dan Unit Syal Tebal (Fasies G) (Rujuk litolog rajah 2). Struktur sedimen yang terbentuk memainkan peranan yang penting dalam membezakan setiap formasi. Struktur alur hanya wujud di bahagian Formasi Crocker dan tidak wujud pada Formasi Temburong. Geometri alur merujuk kepada fasies B dan fasies C dalam Formasi Crocker. Jujukan Bouma yang terbentuk di beberapa bahagian lapisan memberi gambaran yang jelas berkenaan dengan sekitaran pengendapan. Pembahagian unit Bouma yang mempunyai unit yang hampir lengkap Ta hingga Te berlaku di bahagian fasies C,



Rajah 2: Analisis jujukan menegak Formasi Crocker. Tiada penafsiran sekitaran pengendapan.

Foto 1: Singkapan Formasi Crocker dengan geometri alur..

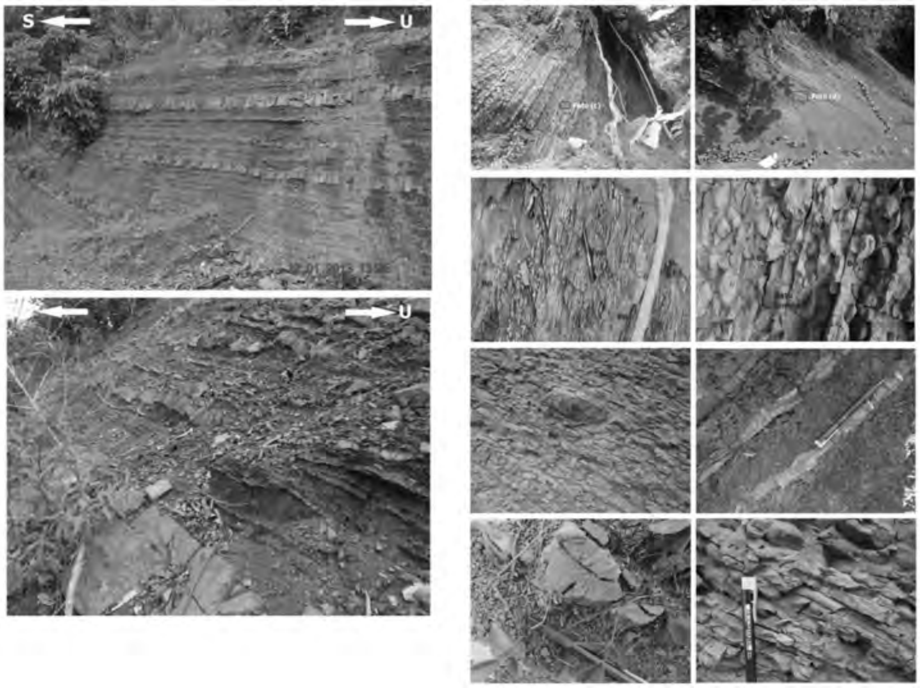


Foto 2: Sebahagian daripada singkapan Formasi Crocker dan Formasi Temburong

kemudian terdapat unit-unit yang hilang seperti di fasies D dan E yang bermula daripada Tb, Tc, Td dan Te. Perbezaan yang ketara berlaku pada fasies D, E dan G pada Formasi Temburong dengan dominan Te yang lebih tinggi berbanding fasies D dan E pada Formasi Crocker. Keseluruhan asosiasi fasies yang dapat dibentuk terdiri daripada alur, levee, lob, lob distal dan dataran lembangan. Keterangan lanjut berkenaan fasies bagi kedua-dua formasi ini memberi gambaran bahawa sekitaran pengendapan bagi Formasi Crocker adalah di bahagian kipas tengah laut dalam, manakala Formasi Temburong adalah di bahagian kipas luar laut dalam.

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PAPER P46

ANALISIS FOSIL SURIH FORMASI CROCKER DAN FORMASI MELIGAN DI SIPITANG, SABAH

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Satu kajian perbandingan telah dijalankan untuk mengkaji fosil surih di antara jujukan Formasi Crocker dan jujukan Formasi Meligan di kawasan Sipitang, Sabah (Rajah 1). Stratigrafi kawasan kajian pula adalah dirujuk pada Rajah 2. Tiga lokaliti utama iaitu Stesen 1 dan Stesen 2 yang terdiri daripada jujukan Formasi Meligan dan stesen 5 yang terdiri daripada jujukan Formasi Crocker dikaji dan dicerap dari aspek iknofasies dan pengenalan iknogenus menggunakan dua rujukan utama iaitu Pemberton et al. (1992a) dan Seilacher (2007).

Tiga iknofasies utama dikenalpasti iaitu terdiri daripada iknofasies Scolithos, iknofasies Cruziana dan iknofasies Nereites. Iknofasies Scolithos terdiri daripada dua iknogenera utama iaitu Arenicolites (Rajah 3c) dan Ophiomorpha (Rajah 3b) manakala iknofasies Cruziana terdiri daripada dua iknogenera iaitu Ophiomorpha dan Thallasinoides (Rajah 3a). Kedua iknofasies ini dikesan pada Stesen 1 dan Stesen 2, iaitu jujukan Formasi Meligan dan sekitaran pengendapan bagi formasi ini ditafsir sebagai laut cetek sehingga pantai. Stesen 5 iaitu jujukan Formasi Crocker pula terdiri daripada satu jenis iknofasies iaitu iknofasies Nereites, yang terdiri daripada iknogenera Spyrophycus (Rajah 4b), Paleodictyon (Rajah 4c), Nereites (Rajah 4e), Helminthoida (Rajah 4a) dan Paleomeandron (Rajah 4d). Jujukan bagi Stesen 5 ini ditafsirkan sebagai persekitaran pelantar sehingga laut dalam berdasarkan kepada faktor kadar kelimpahan iknogenera. Daripada keseluruhan kajian, dapat disimpulkan bahawa iknofasies dalam Formasi Meligan terdiri daripada iknofasies Cruziana dan Scolithos manakala Formasi Crocker terdiri daripada iknofasies Nereites, dan menunjukkan perbezaan sekitaran pengendapan kuno yang jelas.

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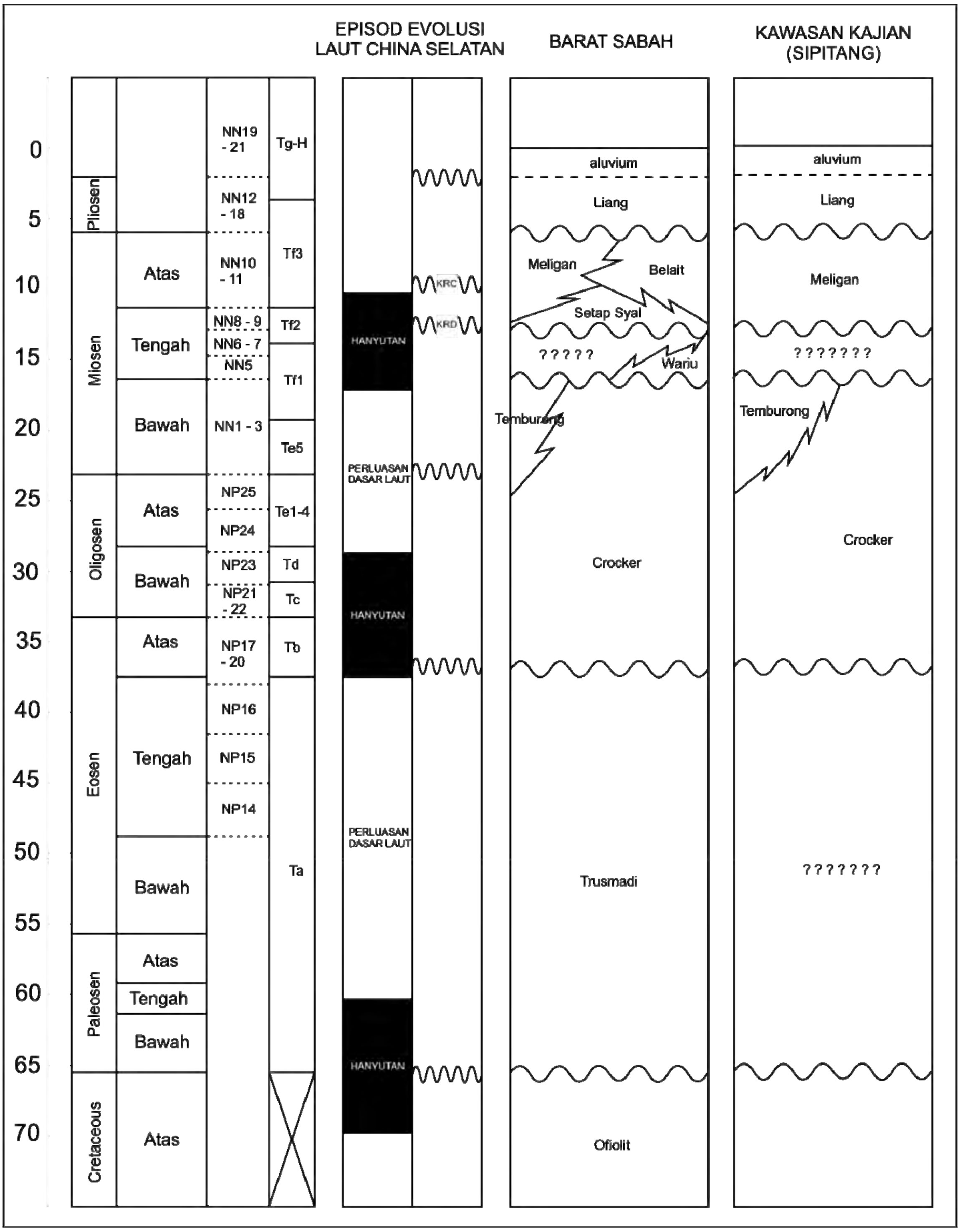
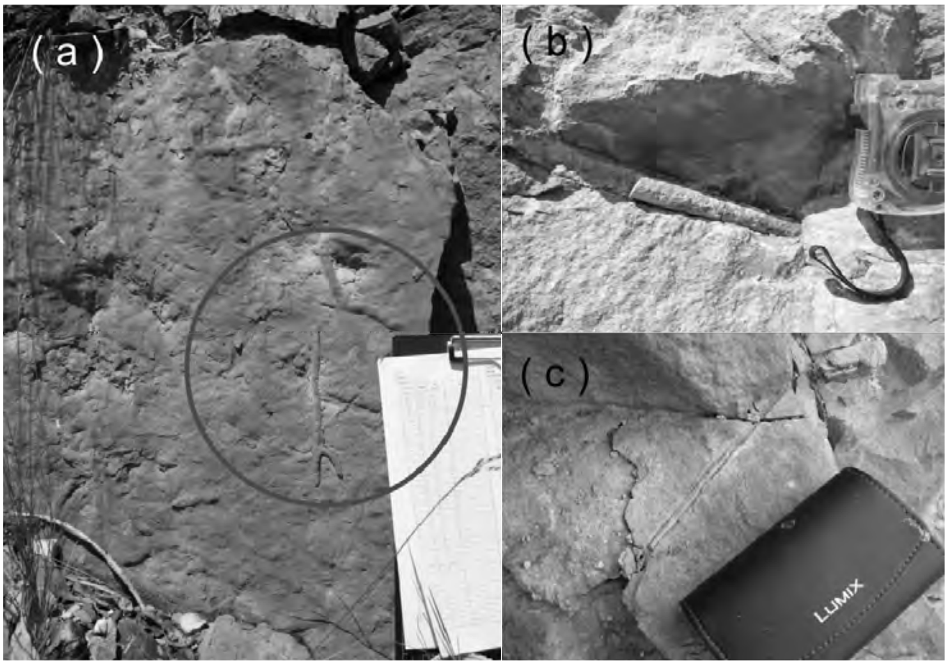
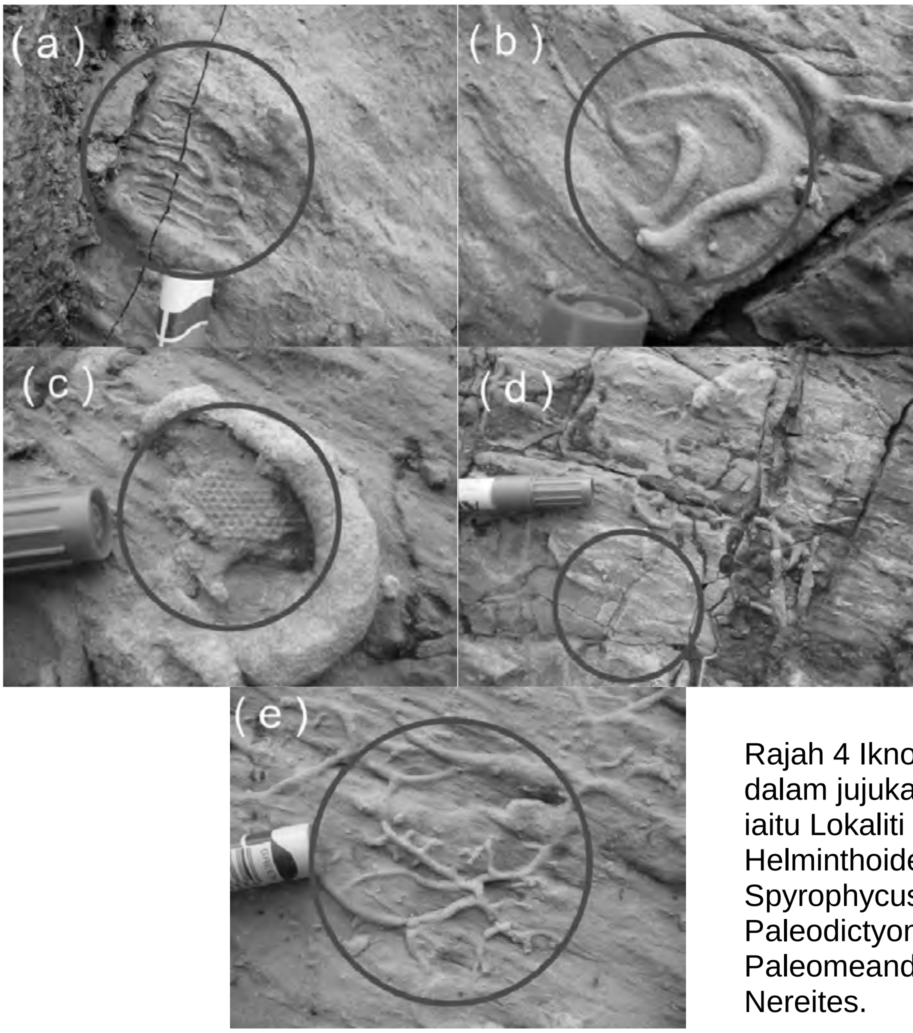


Rajah 2 Jujukan stratigrafi di kawasan kajian. Ubahsuai daripada Sanudin dan Baba (2007) dan Tan & Lamy (1990).



Rajah 3 Iknogenera utama di dalam jujukan Lokaliti 1 dan Lokaliti 2. (a) Iknogenera Thallasinoides (Lokaliti 1) (b) Iknogenera Ophiomorpha (Lokaliti 2) (c) Iknogenera Scolithos (Lokaliti 2).



Rajah 4 Iknogenera utama di dalam jujukan Formasi Crocker iaitu Lokaliti 5. (a) Iknogenera Helminthoides (b) Iknogenera Spyrophycus (c) Iknogenera Paleodictyon (d) Iknogenera Paleomeandron (e) Iknogenera Nereites.

PAPER P47

ANALISIS SEKITARAN KUNO FORMASI MELIGAN BERDASARKAN STRUKTUR ENDAPAN DI SIPITANG, SABAH

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Satu kajian telah dijalankan untuk mengkaji hubungkait di antara struktur sedimen fizikal dan biologi yang terdapat di dalam jujukan Formasi Meligan di kawasan Sipitang, Sabah (Rajah 1).

Dua singkapan Formasi Meligan yang paling lengkap di kawasan kajian iaitu Stesen 1 dan Stesen 2, masing – masing berketebalan 42.66m dan 25.71m dicerap dan diwartakan ke dalam borang litolog yang diubahsuai daripada Tucker (2003). Antara data yang dicerap adalah saiz butiran dan ketebalan lapisan, struktur sedimen fizikal dan biologi serta litologi batuan. Litolog komposit yang diukur di lapangan untuk menjelaskan jujukan batuan adalah seperti pada Rajah 2. Lima jenis kombinasi antara struktur endapan fizikal dan struktur endapan biologi (fosil surih) berdasarkan pembahagian litofasies dikenalpasti dan ditunjukkan di dalam Jadual 1. Struktur sedimen biologi, iaitu fosil surih yang dicerap didapati terdiri daripada tiga iknogenera utama iaitu Thallasinoides, Ophiomorpha dan Scolithos (Rajah 3) manakala beberapa struktur sedimen fizikal turut dikenalpasti seperti lapisan silang planar, lapisan silang hummocky dan lapisan silang swaley (Rajah 4). Dua jenis iknofasies turut dikenalpasti iaitu iknofasies Scolithos dan iknofasies Cruziana, masing – masing memberi petunjuk awal persekitaran yang berjulat daripada laut cetek hingga pelantar. Daripada analisis dan tafsiran yang dijalankan, didapati bahawa persekitan pengendapan kuno Formasi Meligan adalah berjulat daripada pelantar atas (inner shelf) yang diwakili oleh Litofasies Sh, muka pantai bawah (lower shoreface) yang diwakili oleh Litofasies Sh dan Litofasies H, muka pantai tengah (middle shoreface) yang diwakili oleh Litofasies SwH, muka pantai atas (upper shoreface) yang diwakili oleh Litofasies SwP sehingga persekitaran lagun (lagoon) yang diwakili oleh Litofasies Lg. Litofasies H dan Litofasies Lg tidak menunjukkan sebarang struktur endapan biologi memandangkan tenaga arus persekitaran yang kuat mungkin telah memusnahkan struktur sedimen biologi seperti kesan organisma ataupun tidak sesuai untuk organisma seperti yang dicadangkan oleh Fraser (1989)..

Daripada kombinasi antara struktur endapan fizikal dan struktur endapan biologi, dapat disimpulkan bahawa sekitaran pengendapan untuk Formasi Meligan adalah berjulat diantara pelantar atas (inner shelf) sehingga lagun (lagoon), iaitu terdiri daripada lima litofasies utama dan dua iknofasies utama.

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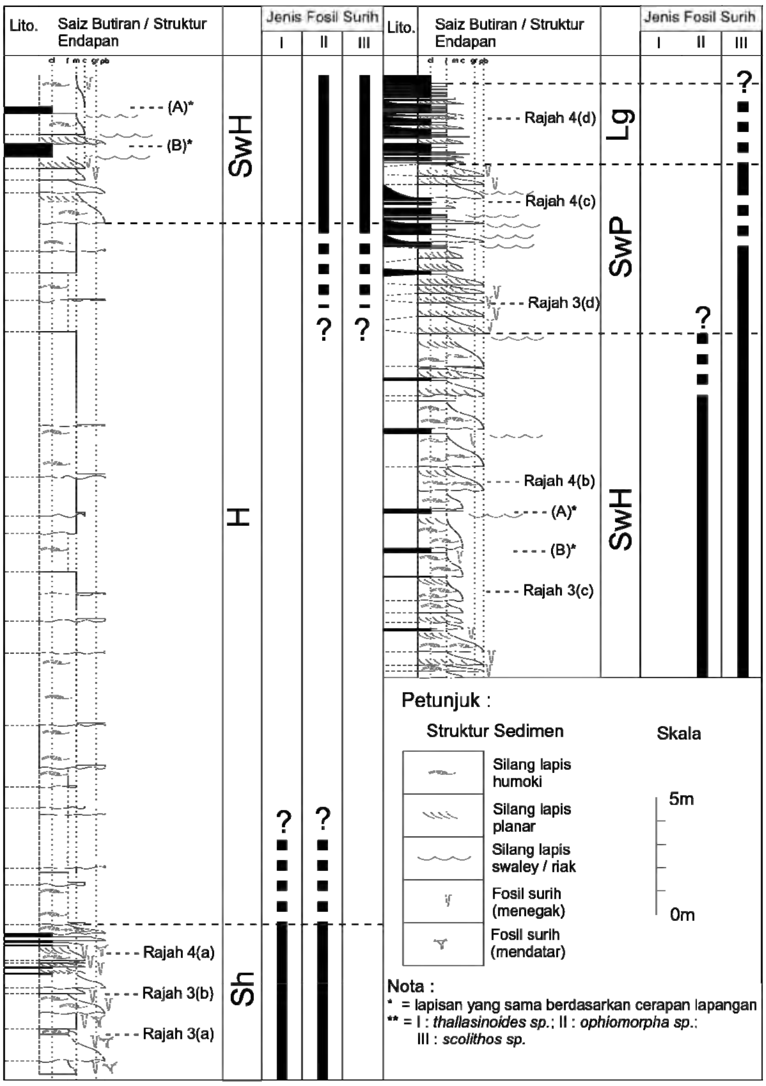
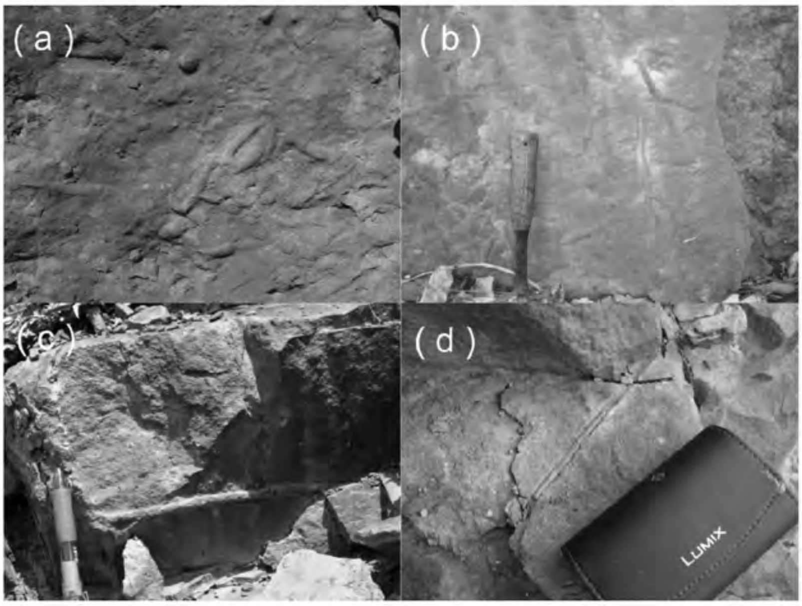
Jadual 1 Kombinasi struktur endapan fizikal dan biologi berdasarkan litofasies.

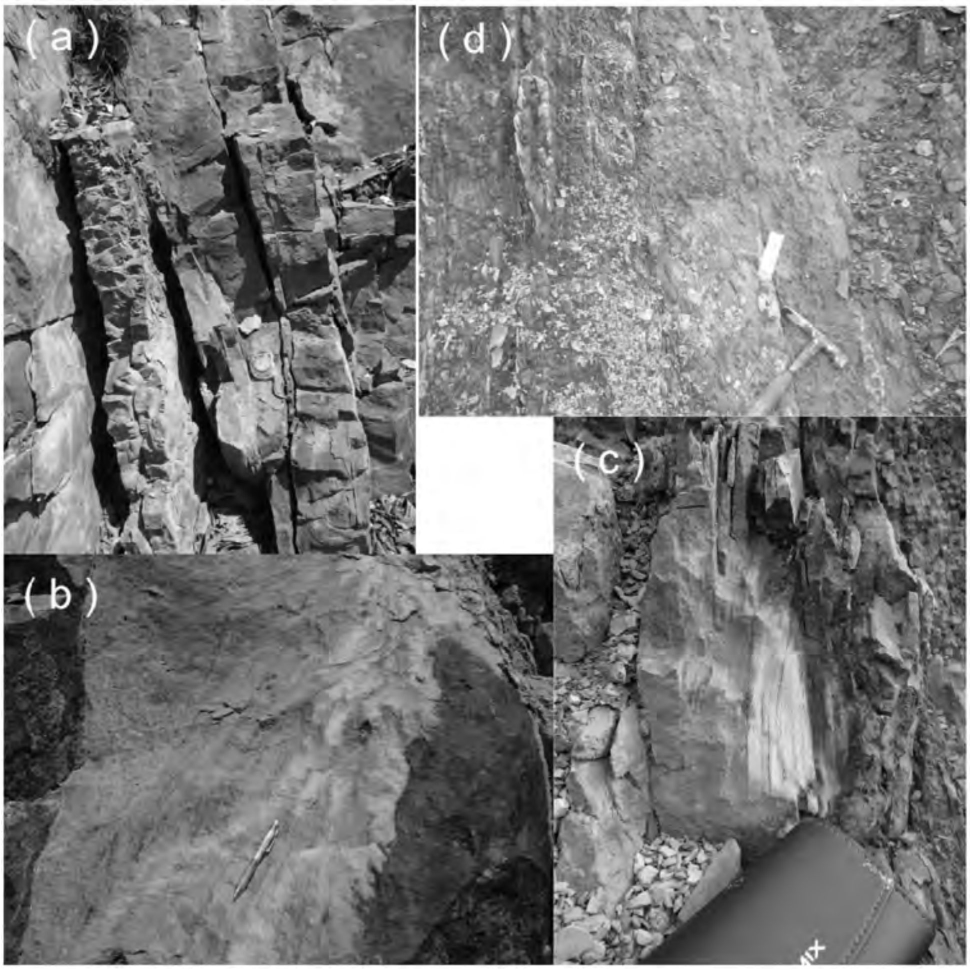
Litofasies	Struktur fizikal	Struktur biologi (iknofasies)	Tafsiran Persekitaran Kuno
Lg	Tiada struktur endapan yang jelas.	-	Lagun
SwP	Lapisan batu pasir mengandungi silang planar bersudut rendah, lapisan silang *swaley* dan fosil surih menegak.	*Scolithos* (Scolithos)	Muka pantai atas – beting pasir
SwH	Lapisan batu pasir yang teramalgamasi, mengandungi lapisan silang hummocky dan swaley dan fosil surih menegak.	*Ophiomorpha*, *Arenicolites* (Scolithos)	Muka pantai tengah
H	Lapisan batu pasir teramalgamasi, mengandungi lapisan silang hummocky dan bersisihan baik	-	Muka pantai bawah
Sh	Lapisan batu pasir teramalgamasi mengandungi lapisan silang hummocky dan kesan bioturbasi yang padat, terdiri daripada fosil surih mendatar dan menegak.	*Thallasinoides* (Cruziana), *Ophiomorpha* (Scolithos)	Pelantar atas – muka pantai bawah



Rajah 2 Litologi komposit Lokaliti 1 (kiri) dan Lokaliti 2 (kanan) yang diukur di lapangan..



Rajah 3 Struktur endapan biologi yang ditemui di Lokaliti 1 dan Lokaliti 2. a) Kesan fosil surih Ophiomorpha dan Thallasinoides pada bahagian Litofasies Sh b) Kesan fosil surih Thallasinoides pada bahagian Litofasies Sh c) Kesan fosil surih Ophiomorpha pada bahagian Litofasies SwH d) Kesan fosil surih Arenicolites pada bahagian Litofasies Sw..



Rajah 4 Struktur endapan fizikal yang ditemui di Lokaliti 1 dan 2. a) Struktur lapis silang hummocky pada Litofasies Sh b)Struktur lapis silang hummocky pada Litofasies SwH c) Struktur lapis silang swaley pada Litofasies Sw d) Struktur lapis silang swaley pada Litofasies Sw.

ANGGARAN SOKONGAN BERDASARKAN SISTEM PENGELASAN JASAD BATUAN: KAJIAN KES DI TEROWONG KERETAPI TENOM, SABAH

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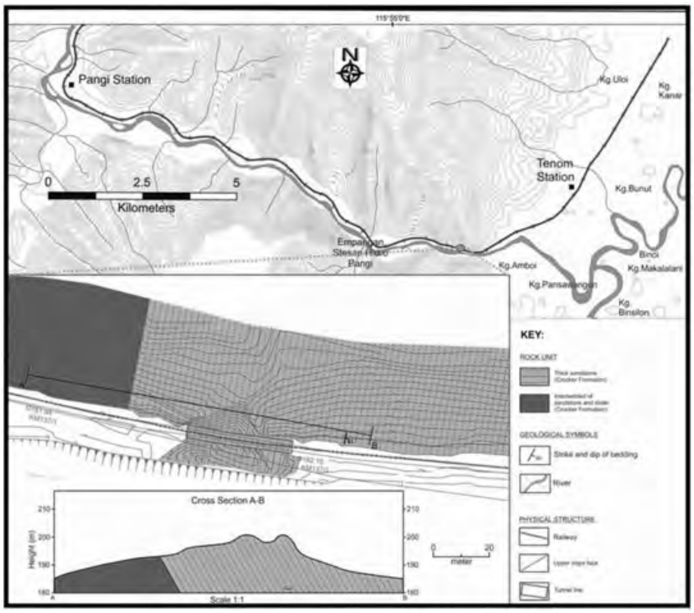
Kawasan kajian terletak di terowong keretapi Tenom Sabah yang didasari batu pasir tebal teramalgamasi dan unit selang-lapis batu pasir dan syal Formasi Crocker berusia Eosen Lewat – Miosen Awal (Rajah 1 dan Foto 1). Objektif kajian ini adalah untuk menentukan kualiti jasad batuan dan seterusnya menentukan anggaran sokongan untuk terowong keretapi satu lorong tersebut menggunakan sistem pengelasan jasad batuan iaitu sistem Perkadaran Struktur Batuan, RSR (Wickham et al., 1972), Perkadaran Jasad Batuan, RMR (Bieniawski, 1989) dan Sistem Q (Barton et al., 1974).

Kajian lapangan melibatkan pemetaan geologi dan garis imbasan (scan line), sementara kajian makmal adalah kajian petrografi, analisis kinematik, ujian beban titik (point load test) dan analisis data ketakselanjaran. Kajian petrografi mendapati batu pasir di terowong Tenom adalah litik wak sederhana kasar. Ujian Markland (Markland, 1972) menunjukan ragam kegagalan yang berpotensi adalah kegagalan baji (persilangan kekar 1 dan 4) dan kegagalan satah (masing-masing kekar 3 dan 5). Ujian beban titik (ISRM, 1981) pula menunjukan batu pasir berbutiran sederhana kasar berkekuatan sederhana kuat (94.88 MPa).

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

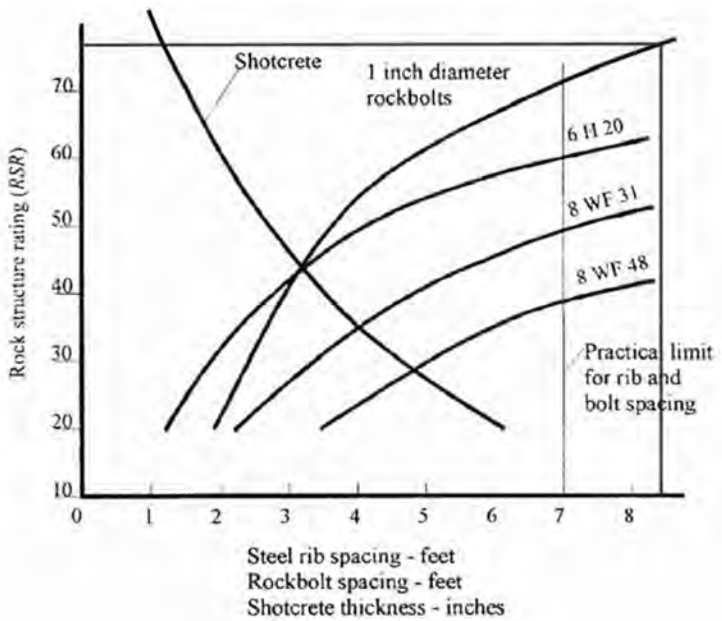


Rajah 1 Lokasi dan peta geologi kawasan kajian.

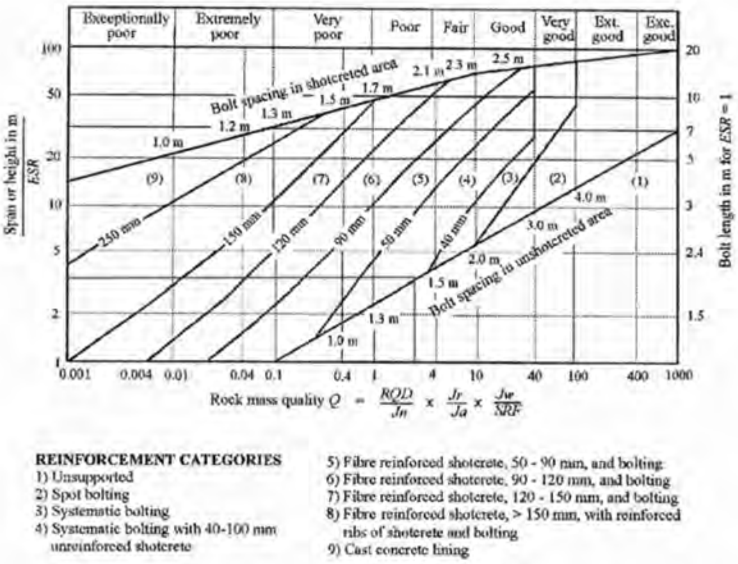
Anggaran sokongan bagi sistem RSR adalah 8 kaki jarak bagi 1 inci kancing batuan (rock bolt) dengan 1 inci semburan konkrit (shotcrete) (Rajah 2). Bagi sistem RMR, anggaran sokongan adalah 20mm diameter, 4m panjang dan 1.5-2m jarak kancing batuan pada bumbung dengan 50-100mm dan 30mm tebal semburan konkrit, masing-masing di bumbung dan dinding terowong dan tidak memerlukan set keluli (steel set). Sementara untuk sistem Q, 1.4m jarak kancing batuan dengan 40-100mm semburan konkrit yang tidak diperkuat (unreinforced) dianggarkan sebagai sokongan (Rajah 3).

Sebagai kesimpulan, anggaran sokongan berdasarkan sistem pengelasan jasad batuan dan cerapan

Foto 1 Batu pasir tebal teramalgamasi Formasi Crocker.



Rajah 2 Anggaran sokongan untuk RSR (Wickham et al., 1972). Garis merah merujuk kepada nilai di kawasan kajian.



Rajah 3 Anggaran sokongan untuk sistem Q (Barton et al., 1974). Garis merah merujuk kepada nilai di kawasan kajian.

lapangan bagi kawasan kajian adalah 20mm diameter, 4m panjang dan 2m jarak kancing batuan, 50mm tebal semburan konkrit serat keluli diperkuat (steel fiber reinforced shotcrete) dan lubang leleh (weep hole di kedudukan terpilih).

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

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

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

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

Catatan: DC-ketakselanjaran

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

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

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

Key words: Rock Mass Rating (RMR), Rock Structure Rating (RSR), sistem Q, Crocker Formation, Tenom.

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PAPER P49

TRANSITIONAL I-S TYPE CHARACTERISTICS IN THE MAIN RANGE GRANITE OF PENINSULAR MALAYSIA

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The dominantly Triassic Main Range Granite of Peninsular Malaysia that occurs west of the Bentong Raub suture zone was previously regarded exclusively as S–type granite. Among the S-type characteristics of the granite are, (a) high initial 87Sr/86Sr isotope ratio > 0.710, (b) low Na_2O content, < 3.2% Na_2O in rocks with ~ 5% K2O, (c) narrow range of felsic rock (SiO_2: 65.95 to 77.4%), (d) high K_2O/Na_2O ratio, 1.4-2.8, (e) usually ilmenite-bearing (f) contains pelitic or quartzose meta-sedimentary xenoliths and (g) narrow range of highly evolved rocks with SiO2. However, the present review shows that the granites also have many features that are more characteristic of I-type granites. They are (a) Al-rich minerals such as sillimanite and cordierite are generally absent, (b) occurrence of primary titanite and pale green amphibole especially in the northern part of the batholith, (c) occurrence of mafic, hornblende bearing enclaves, (d) increasing peraluminosity towards the most differentiated rocks (cf. S-type granite: increasing peraluminosity towards the most mafic varieties) and (e) similar trends in P_2O_5 vs. Rb and P_2O_5 vs SiO2 and (f) A-B plots of Debon and LeFort, (1983) and Villaseca et al., (1988).

Aluminium saturation index of the Main Range granite are mildly metaluminous to moderately peraluminous with ACNK value ranging from 0.92 to 1.18 (Figure 1). Thus, only some 20% of the Main Range samples plot in the S–type field according to Chappell criteria (ACNK =1.1). More than 50% of amphibole bearing granite samples plot below ACNK < 1 compared to the amphibole free granite which has only about 4% of the samples plotted in the same area. The trend increases with increasing SiO2 which is different to the trend observed in S-type granites from the Lachlan Fold Belt and consistent with the I-type features. Thus it is likely that the source rocks of the Main Range Granite were either mildly peraluminous or mildly metaluminous in character. Partial melting of these source rocks will give rise to a mildly peraluminous magma. It is however a part from the partial melting, peraluminousity can be brought about by mechanisms such as (1) reaction with host rocks, (2) fractional crystallization of metaluminous magmas, (3) interaction with hydrothermal fluids during late- or post-magmatic stages

In P_2O_5 vs. SiO_2 plot, the Main Range Granite produce a decreasing trend with increasing SiO_2 content which is comparable to the general trend produced by the I type granites. Plots of the Main Range Granites on the P_2O_5 vs. Rb diagram also produce a trend similar to the I-type granite pattern. The variability in the abundances of P between the strongly fractionated I- and S-type granites is related to a higher apatite solubility in peraluminous melts, P becoming progressively more abundant in the felsic S-type melts during fractionation whereas in I-type melt P decrease as a result of fractional crystallization of apatite.

Clemens (2003) suggested that terranes dominated by sediments with a few igneous rocks or terranes dominated by andesitic to basaltic igneous successions with minor intercalated sediments may produce a magma with transitional I- and S-type characteristics. The presence of andalusite, although in minor amounts, suggests that at least part of the Main Range Granite magma was Al-saturated. The presence of titanite and the higher Fe_2O_3 contents in the ilmenite in the amphibole-bearing granites indicate that the magma was derived from relatively oxidized magma. The moderately peraluminous nature of the bulk Main Range Granite, without containing cordierite, Fe Mg garnet or sillimanite, is most consistent with derivation from metasedimentary source rocks undersaturated with respect to Al_2SiO_5. The high K_2O content and high K_2O/Na_2O ratio of the Main Range granite compared to the Lachlan Fold Belt reflects differences in source characteristics. It is likely that the sedimentary source material of the Main Range Granite has a greater proportion of high K/Na clay like illite and hydromuscovite.

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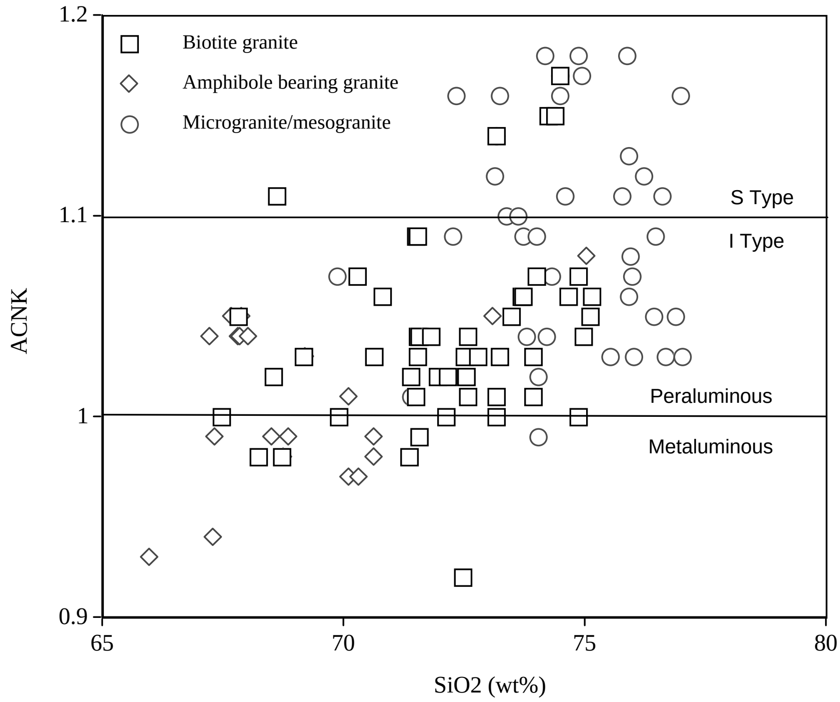

Figure 1: ACNK vs SiO2 plot for the Main Range Granite of Peninsular Malaysia

NOTES