PERSATUAN GEOLOGI MALAYSIA
GEOLOGICAL SOCIETY OF MALAYSIA

Proceedings

NATIONAL GEOSCIENCE CONFERENCE 2011

The Puteri Pacific Johor Bahru
11 – 12 June 2011

Geoscientists and Ethics for a Sustainable Society

Co-organiser

Jabatan Mineral & Geosains Malaysia

Universiti Teknologi Malaysia

Collaborators

Institut Geologi Malaysia

Persatuan Kuari Johor

Universiti Kebangsaan Malaysia

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Kata Aluan
MENTERI BESAR JOHOR

Syabas dan tahniah diucapkan kepada Persatuan Geologi Malaysia dengan kerjasama Jabatan Mineral dan Geosains Malaysia dan Universiti Teknologi Malaysia kerana dapat mengadakan Persidangan Geosains Kebangsaan 2011. Kerajaan Negeri Johor merakamkan penghargaan mendalam kerana telah memilih Johor Bahru untuk menjadi medan pada tahun ini.

Pada tahun 1993, negara telah dikejutkan dengan tragedi runtuhnya Highland Towers di Ulu Kelang, Selangor. Bermula daripada kejadian ini, geosains mula memainkan peranan penting dalam setiap perancangan pembangunan. Namun sekiranya berlaku kecuaian dan kegagalan mematuhi serta mengambil sikap acuh tak acuh, pasti kejadian serupa akan berlaku lagi. Lantaran itu, Kerajaan Negeri Johor telah menyediakan Rancangan Tempatan dalam merancang pembangunan yang hendak dijalankan di setiap daerah. Baru-baru ini iaitu pada 19 April 2011 , Draf Rancangan Tempatan Daerah (Pengubahan) bagi daerah Johor Bahru, Muar, Batu Pahat dan Pontian telah dilancarkan. Sehubungan itu, peranan ahli geologi dan saintis diperlukan untuk membuat komen, ulasan dan input bersesuaian sebelum Rancangan Tempatan ini dimuktamadkan.

Walau pun bidang geosains hanya menyumbang sekitar 0.2% atau RM70 juta setahun kepada KDNK Negeri ,Johor, namun diakui bahawa sumbangan bidang geosains amat luas. Umpama pembinaan sebuah rumah yang mana bermula daripada pemilihan tapak hinggalah kepada bumbung, semua komponen memerlukan unsur geosains seperti pasir, agregat, besi dan atap genting yang diperbuat daripada tanah liat. Dalam merancakkan penglibatan geosains serla memberikan kesedaran kepada masyarakat untuk bersamasama memelihara khazanah bumi selain memberi pulangan ekonomi, saya berharap cadangan membina sebuah geopark iaitu Kompleks Taman Negara Endau dan Kepulauan Mersing dapat direalisasikan.

Saya percaya atas faktor di atas, pelbagai kajian telah dilakukan oleh para saintis dan dengan adanya persidangan ini hasil kajian dapat dibentang dan dikongsikan bersama dengan para perancang pembangunan dan pihak industri. Dengan tema ‘Geosaintis dan Etika Masyarakat Lestari’, saya yakin sumbangan dan peranan ahli geologi dan saintis akan dapat mewujudkan sebuah masyarakat yang kehidupannya bersifat lestari dan saling bekerjasama menjadikan bumi sebagai tempat tinggal yang sihat, selamat dan kondusif.

Ini selaras dengan Cabaran ke-4 dan ke-6 Wawasan 2020 iaitu mewujudkan masyarakat yang sepenuhnya bermoral dan beretika dan mewujudkan masyarakat saintifik dan progresif, mempunyai daya peru bah an tinggi dan memandang ke depan, yang bukan sahaja pengguna teknologi tinggi tetapi juga menyumbang kepada tamadun saintifik dan teknologi masa depan.

Sekian, terima kasih.

Y.A.B. DATO’ HAJI ABDUL GHANI BIN OTHMAN
MENTERI BESAR JOHOR

Kata Aluan
PRESIDEN PERSATUAN GEOLOGI MALAYSIA

Sejak ditubuhkan pada tahun 1967, Persatuan Geologi Malaysia telah menjadi penyumbang terbesar kepada perkembangan ilmu geosains di Malaysia. Dalam hubungan ini, Persatuan telah menganjurkan hampir 100 perjumpaan pada peringkat kebangsaan mahupun peringkat antarabangsa. Persatuan juga telah menerbitkan 56 Buletin serta 40 jilid Warta Geologi.

Pada tahun ini, tema yang dipilih adalah “Geoscientists and Ethics for a Sustainable Society”. Tujuan utama persidangan ini adalah untuk menerapkan kepentingan etika di kalangan keahlian disamping memaklumkan penemuan-penemuan baru dalam penyelidikan dan pembangunan. Persidangan ini juga menyediakan pentas bagi ahli geologis untuk menyumbang kepada korpus ilmu di peringkat kebangsaan dan antarabangsa. Justeru, semua pembentang digalakkan untuk menerbitkan kertas kerja mereka dalam Buletin Persatuan Geologi Malaysia, agar sumbangan mereka termaktub dalam khazanah ilmu negara.

Bagi pihak Perstuan Geologi Malaysia, saya ingin mengucapkan setinggi-tinggi penghargaan kepada Jawatankuasa Penganjur Persidangan Tahunan 2011 serta penganjur bersama Jabatan Mineral dan Geosains Malaysia dan Universiti Teknologi Malaysia yang telah membantu untuk merealisasikan Persidangan ini. Saya juga ingin merakamkan setinggi-tinggi penghargaan dan ucapan berbanyak-banyak terima kasih kepada Kerajaan Negeri Johor dan rakan kerjasama lain atas sokongan padu yang telah diberikan. Semoga kita semua mendapat faedah daripada Persidangan ini.

Sekian, terima kasih.

PROF. DR. JOY JACQUELINE PEREIRA
PRESIDEN
PERSATUAN GEOLOGI MALAYSIA

Sekapur Sireh
KETUA PENGARAH
JABATAN MINERAL DAN GEOSAINS MALAYSIA

Assalamualaikum w.b.t, Salam Sejahtera dan Salam 1 Malaysia,

Terlebih dahulu, saya ingin mengucapkan setinggi-tinggi tahniah dan penghargaan kepada Persatuan Geologi Malaysia dan juga kepada Jabatan Mineral dan Geosains Malaysia (JMG), Negeri Johor serta Universiti Teknologi Malaysia (UTM) yang menjadi penganjur bersama Persidangan Geosains Kebangsaan 2011 yang diadakan di Johor Bahru dengan tema "Geoscientists and Ethics for a Sustainable Society".

Sebagai agensi kerajaan yang menjadi peneraju dalam bidang mineral dan geosains serta mempunyai paling ramai geosaintis, tema persidangan tahun ini amat berkaitan sekali dengan peranan yang dimainkan oleh JMG. Berkaitan dengan isu ini, Pelan Strategik JMG 2011-2015 menggariskan beberapa objektif strategik dan pelan tindakan yang perlu dilaksanakan. Di antara objektif strategik tersebut adalah "Memantap pelaksanaan perkhidmatan geosains berkepakaran tinggi ke arah pembangunan mampan yang menyumbang kepada kesejahteraan hidup dan pemeliharaan alam sekitar".

Objektif ini amat berkaitan dengan tema persidangan kerana selain daripada kepakaran tinggi para geosaintis, sikap dan etika yang betul perlu ada pada setiap geosaintis di dalam usaha menjadikan masyarakat ini sebagai satu masyarakat yang sejahtera dan lestari dengan alam sekitar yang didiaminya. Sistem penyampaian perkhidmatan awam yang cekap amat diperlukan bagi menjamin kelancaran dan keberkesanan pelaksanaan dasar serta strategi pembangunan negara. Dengan yang demikian, masyarakat akan dapat menikmati hasil daripada usaha kerajaan untuk menjadikan negara ini maju menjelang tahun 2020.

Akhir kata, saya mengucapkan terima kasih kepada Kerajaan Negeri Johor di atas sokongan yang diberikan. Tahniah kepada semua yang terlibat menjayakan persidangan ini. Mudah-mudahan Persidangan Geosains Kebangsaan 2011 ini berjalan lancar dan mencapai segala objektif yang diharapkan. Selamat Bersidang.

Sekian, terima kasih.

Y.BHG. DATO' YUNUS BIN ABDUL RAZAK
KETUA PENGARAH
JABATAN MINERAL DAN GEOSAINS MALAYSIA

Preface
ORGANISING CHAIRMAN, NATIONAL GEOSCIENCE CONFERENCE 2011

Since its establishment in 1967, the Geological Society of Malaysia (GSM) has been a major contributor to the advancement of knowledge in the field of geoscience at both the national and regional levels. The National Geoscience Conference 2011 (NGC2011) is the 24th in the annual series of conferences organized by GSM. The Conference is a premier geoscientific event in Malaysia, which is well attended by geoscientists from the academia as well as the public and private sectors. The NGC2011 is co-organised by the Minerals and Geoscience Department (JMG) together with Universiti Teknologi Malaysia (UTM) on behalf of GSM with collaboration by six other entities.

The theme of NGC2011 is *"Geoscientists and Ethics for a Sustainable Society"*. In essence, knowledge on the earth systems is the key element in formulating appropriate ethics for sustainability. With such knowledge geoscientists hold great responsibilities in addressing issues that put a sustainable future for human societies in jeopardy. The challenges are certainly enormous, which include utilizing our knowledge as a tool to identify threats to sustainability and to develop viable solutions for these threats. Most importantly we are also obliged to instill sense of awareness on ethical frameworks of a culture that will pursue a sustainable society. Concerted efforts with other scientific communities are essential in promoting the importance of the ethical consequences in any scientific and engineering endeavors.

The scientific programme of NGC2011 consists of 3 keynote papers, 58 oral papers and 73 posters covering a diverse field of geoscience subjects, namely engineering geology, geotools including geophysics and remote sensing, sedimentary geology, marine geology, conservation geology, structural geology, economic geology, petrology, stratigraphy, environmental geology and petroleum geology. It is expected that the papers will improve our knowledge of geosciences and to apply it for the betterment of mankind in general. It is hoped that the presentation will generate fruitful discussion and exchange of ideas among the participants of the Conference.

Finally, on behalf of the NGC2011 Organizing Committee, I would like to acknowledge wholeheartedly our warmest gratitude to the State Government of Johor for their support, all the authors for their contributions, the sponsors for their generosity and the participants for their presence.

SHAHAR EFFENDI BIN ABDULLAH AZIZI
Organising Chairman NGC2011

PROGRAMME

DAY 1 – SATURDAY 11 JUNE 2011

08:00 – 09:00	REGISTRATION	
09:00 – 10:00	**OPENING CEREMONY** Arrival of Invited Guests Arrival of Y.A.B. Dato' Hj. Abdul Ghani bin Othman, Menteri Besar Johor Doa Recital Singing of — Bangsa Johor — Negaraku Choral Speaking Presentation Welcoming Speech by Y.Bhg. Dato' Yunus bin Abdul Razak, Ketua Pengarah Jabatan Mineral Dan Geosains Malaysia Welcoming Speech by Prof. Dr. Joy Jacqueline Pereira, President Geological Society of Malaysia Opening Speech by Y.A.B. Dato' Hj. Abdul Ghani bin Othman, Menteri Besar Johor Montage Presentation	
10:00 – 11:00	**POSTER SESSION 1** AND TEA BREAK	
11:00 – 11:30	**KEYNOTE 1** Ng Chak Ngoon Ethics in engineering geology	
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11:30 – 11:50	**PAPER A1** Look Keman bin Sahari Geoscientists and ethics for a sustainable society — Contribution from mineral related engineers	**PAPER B1** Rodeano Roslee, Tajul Anuar Jamaluddin, Mustapa Abd. Talip, James Anthony Collin & Budirman Rudding Application of the analytical hierarchy process (AHP) for landslide risk analysis (LRA) at Kota Kinabalu, Sabah
11:50 – 12:10	**PAPER A2** Wong Chong Kian, Edy Tonnizam Mohamad & Rosli Saad Challenges ahead for Johor granite quarry industries	**PAPER B2** Zakaria Mohiuddin, Chowdhury Quamruzzaman, A.S.M. Woobaidullah, Syed Golam Sarwar, Mahfuza Khanam & Kaniz Fatema A proposal of rehabilitation after abandonment of Madaripur open pit mine, Madaripur, Bangladesh
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16:00 – 16:20	**PAPER A10** Tan Boon Kong A tale of two airports: the new LCCT, Sepang, and the Senai Airport	**PAPER B10** Ariesty R. Asikin, Andri Hendriyana & Rachmat Sule Application of partial CRS-Stack method to enhance gas reservoir characterization in a complex geological structure
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Penggunaan kaedah indek halaju sebagai kaedah alternatif penilaian kualiti jasad batuan

P1-2 Mohd Hariri Arifin, Abdul Rahim Samsudin, Mohd Rozi Umor & Hamzah Husin
2-D resistivity survey for cavity detection at Chiku 5, Gua Musang, Kelantan

P1-3 Syed Mustafizur Rahman, Noushin Naraghi Araghi, Rosli Saad, M. N. Mohd Nawabi & Khairul Arifin Bin Mohd Noh
Numerical computation of depth of buried geologic structure from the gravity anomaly data

P1-4 Md. Omar Faruk, Syed Mustafizur Rahman, Md. Abul Hashem & Mumnunul Keramat
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P2-18 Ng Tham Fatt
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P2-20 Mohammed Hail Hakimi, Wan Hasiah Abdullah & Mohamed Ragab Shalaby
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P2-36 Edy Tonnizam Mohamad, Darleen Athila Leng & Rosli Saad
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ABSTRACTS

NOTES

Keynote 1

Ethics in engineering geology

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The essential role of geology has long been established in activities such as mineral and petroleum exploration and major engineering works like the construction of dams and tunnels. In Malaysia, the newly enacted Geologist Act is the key that unlocks the doors to newer areas such as the application of geology in minor engineering works where geological knowledge is greatly needed but geologists are denied entry. While this new field presents new opportunities it is also a minefield of questions especially on ethics. For example, since this is a new field for many geologists, who will be those considered to have the necessary qualifications and professional experience to practice it? When a geologist makes sensational, exaggerated, and unwarranted statements bringing disrepute to the profession who is obliged to report to the IGM? Questions like these have to be answered and answered quickly. In most instances of breach of ethics, the root cause lies in the relatively undeveloped body of knowledge that constitutes engineering geology especially when practiced in this country. Therefore, it is important for engineering geologists to quickly raise their levels of performance; engineering geology reports must be relevant as well as correct in interpretation of consequences. Otherwise clients' interests will not be served and engineering geology will merely increase cost but contribute no value.

Keynote 2

Inundation modelling from tsunami propagation into the Straits of Melaka

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The recent tsunami disaster in Japan brought to the forefront, once again, the large scale and unstoppable power of the ocean. The magnitude and severity of the devastation is unfathomable, even with the memories and images of the 2004 Indian Ocean tragedy still fresh on our minds. Seismic activities in the neighbouring Indian Burma Plate revealed the vulnerability of the shoreline along Malacca Straits, especially the north-western coast of Peninsular Malaysia, to the dangers of potential tsunami waves. These areas, especially along the Kedah coastlines, are low lying and flat. The island and mainland of Penang on the other hand is densely populated and housed numerous industrial and high-economic value activities. This presentation will highlight a tsunami inundation study that focuses on the high risk areas along the North-Western coast of Peninsular Malaysia. Among the objectives of this study are to simulate the coastal inundation into lowland areas using the hydrodynamic model Telemac-2D and to produce a tsunami hazard map based on nearshore heights, flood depths and inland penetration limits that relate to the worse-case scenario. Based on historical assessments of tsunami events originating from the Andaman and Sumatran waters, five possible scenarios were simulated using the tsunami generation and propagation model, TUNA and verified by another model TUNAMI-N2. From these results and based on a Tsunami Index Ranking System suited to the Malaysian local conditions, a tsunami risk map were produced and four specific areas of high risks were selected for the inundation modelling. They are the western coasts of Langkawi, Kuala Muda, the northern coast of Penang island that include Gurney Drive and Batu Feringghi, and the western coast of Penang island. The inundation distances were computed based on the projected wave heights and actual topography of the areas derived from aerial and LiDAR surveys. It was projected that western Langkawi coastlines will experience 5 to 7 m maximum wave heights and maximum inundation distance of up to 1500 m. At Kuala Muda, the maximum wave height and inundation distance is 4 m and 1000 m respectively. For the western coast of Penang, the maximum wave height is 5.5 m but having a relatively flat terrain, the inundation travels up to 2.5 km inland. Similar projections at Batu Feringghi and Gurney Drive areas yield maximum waves of 4 m and 3 m respectively with maximum inundations of 200 m and 750 m respectively.

Keynote 3

Geoscience governance for sustainable development

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Governance is a useful point of departure, to authenticate the relevance and significance of geoscience-knowledge in addressing issues related to sustainability. Both state and non-state actors play an important role in governance. Good governance requires both state and non-state actors to navigate complementary and occasionally competitive functions in steering society towards agreed goals economic, environmental and social goals for sustainable development. Geoscience institutions such as national geoscience organisations or geological surveys, academic institutions and scientific bodies, as well as geoscientists in non-government organizations, community groups, corporations and other interest groups have important roles to play in steering society towards sustainable development.

Geoscience has provided significant contribution to the national development agenda as reflected by the contribution mineral and energy resources to economic growth of the country. The Geological Survey in Malaysia, established in 1907, served to harness geoscience knowledge in the pursuit of tin, gold and coal resources. Academic institutions and scientific bodies supported mineral exploration through the expansion of branches of geology such as mineralogy, petrology, structural geology, geochemistry, sedimentology, stratigraphy, paleontology and geophysics. The 1970s saw geoscience supporting the construction industry in achieving socio-economic goals through the introduction of engineering geology. A growing population and limited surface water required the exploitation of more groundwater resources in the 1980s and geoscience knowledge was the basis to meet the demand for water selected areas. Rapid development in the early 1990's resulted in expansion of growth centres and brought to fore the importance of geological inputs for urban planning and development.

Unfortunately, the awareness of the relevance and significance of geoscience information, particularly among policy and decision makers appears to be very low. National geoscience organisations often operate within a sectoral system of government with narrow mandates where inputs from these organisations target a single sector or level. The pursuit for sustainability calls for cross-sector and holistic approaches; where geoscience inputs are integrated with other information and channeled to a targeted audience at the appropriate level. Such a scenario requires open communication and flow of information both within and outside of government. In order for the inputs to be effective and relevant, the policy context has to understood, levels and sectors need to be differentiated, and communication pathways have to be clear. Geoscience governance offers a pathway to bridge disconnects between the policy arena and geoscience institutions, to increase their effectiveness and relevance in supporting sustainable development.

Paper A1

Geoscientists and ethics for a sustainable society: Contribution from mineral related engineers

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Council Member, Institute of Quarrying Malaysia

To achieve a developed society, we need to utilize all available minerals, metals and also rock aggregates, dimension stone etc in our country. What we don't have then we import from other countries. We are not like Japan or Singapore which are poor in natural resources and thus have to rely on foreign resources. So far we only scrape the surface to get our tin, gold and many other minerals. Compared to the deepest mine in the world which is more 4 km deep we barely went down a few hundred meters (former Sungai Lembing tin mine). Our quarries are generally quite small in size though there are many of them and many are facing problems from encroachment from incoming development. We, the geologists and the mineral engineers need to work together to help our countries become more self sufficient by identifying and developing our mineral and rock deposits.

For the past hundred years or so we have had easy years. We only need to scrape the surface to get tin ore. Many of the ore deposits were found by accidents or the miners did not need to spend a lot of money to find them. Banka drills were the order of day, which are easy to operate and cheap. There is little need to hire engineers or geologist especially in opencast gravel tin mines. Professional engineers were only needed to draw plan and to sign mining scheme once a year. There is no requirement for the opencast/gravel pump mining operators to retain them on a permanent basis. Only the dredge operators and big opencast miners hire engineers as professional staff. There was very little need for geologists in tin mining operation.

For the past fifty years or so we had been mining areas that had been mined before and had been facing many problems due to poor understanding of soil mechanics and suffered many slope failures that resulted in many fatal accidents. The slope failures at Capitol Mining, Puchong and two other gravel pump mines in 1981 that resulted in 27 death attest to this problems. Neither mines had mineral engineers on their payroll. They only hire consultant engineers to prepare mining scheme once a year.

That prompted the former Mining Department to seek assistant from the United Nation to train the Department staffs in soil mechanics for mining application particularly slope studies. The course were also offered to fellow Asean Countries. However it was a bit late because by that time, we had very little tin reserve left and the crash in tin price had almost decimated our tin mining industry. That was history and now we had to import tin to feed our smelting plant.

Do we have anymore mineral in Malaysia? That is a difficult question to answer. Why? For the past 100 years or so we have had things so easy that we barely bother to explore below the bedrock. The authority rarely allowed the miners large leasehold to enable the mine to operate on a larger scale. Small acreage and short leasehold of five years was the order of the day. This did not encourage exploration work for minerals hundreds or thousand of metres underground. We are paying it today. We do not know what we have and thus have to import almost all the minerals that we need for our industry.

The author intent to discuss a little bit more on this in the presentation and what the geologist and mineral engineers can do to help our country to be less reliant on the import of minerals and would like to touch also on current quarrying industry.

Paper A2

Challenges ahead for Johor granite quarry industries

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Quarrying is an essential industry to drive the economic development of one country. The quarry products are key materials for road construction and buildings in Malaysia. KLCC and Petronas Twin Tower has poured in multi million m^3 of concrete which required million ton of aggregates produced from the quarry industries. As per 2010 budget, the mining sector contributes 15% of GDP of Malaysia.

Malaysia is very rich in mineral resources, especially the granite, which is the main material for buildings. In the two recent construction industrial review (IR) of Singapore, the republic has imported more than 2.5 million ton of granite aggregates from Indonesia and Malaysia during 2008/2009 (Lo Yen Lee, 2011). It is estimated to have imported nearly 1.2 million tons of granite aggregates from Malaysia. The granite from Malaysia has contributed significantly for the successful execution of these two republic IRs and eventually propelled the country to became the first SEA country recover from financial turmoil in 2008/2009.

Recent Board of Construction Authority (BCA, 2011) estimated that the republic will need approximate 10 million m^3 concrete which estimated to require 11 million ton of aggregates of which 50% (5.5 million ton) will be imported from Malaysia. Hence this is an interesting question on how much economic benefit we have retained in Malaysia through the exporting of granite products. Ready-Mix Concrete (RMC) has a low value to weight ratio and is highly perishable. It must be discharged from the mixer truck before it hardens. For this reason, foreign trade in RMC is essentially nonexistent between the Singapore and Malaysia. Hence, Singapore traditionally imports million of tons of granite products from Malaysia and Indonesia for making RMC. RMC is mixed with sand, granite aggregates, water and small amount of chemical admixtures to make concrete. For making of 1000 m^3 of G35 RMC will need about 1000 tons of aggregates, 800 tons of sand, 440 tons of cement and small amount of admixtures chemical plus water.

In the past, the quarrying and mining industries have taken a “devil may care” attitude to the impacts of its operations. They operate in areas without social legitimacy, causing major devastation and then leave when an area has been exhausted of all economically valuable mineral resources. Cost benefit has often been used to justify the damage caused in one place because it is outweighed by the overall financial benefits. However, it is a global trend that mining industries have started to address its social and environmental responsibilities.

Corporate Social Responsibility (CSR) is the manifestation to move towards greater sustainability in the mining industry. CSR in quarrying industries in Southern Johor is framing their attitudes and strategies towards better relationship with stakeholders including shareholders and employees, and to care for the environment and practice sustainable mining, as well create high value added mining activities to improve the local economic development in Johor.

The natural concrete sand mining has been an issue due to environment devastation caused by sand extraction from many locations. They are facing a number of recurring issues including a range of environmental issues. The use of many land-based sand is being increasingly restricted by encroachment of incompatible landuse or economic exhaustion of resources. The manufactured sand from granite quarries can be a replacement for coarse natural sand in RMC application. Production of manufactured sand involved recycling of quarry dust.

Moving forwards, the challenges for the Johor granite mining companies are to adopt sustainable good CSR strategies with emphasis on the environment and natural resources preservation by adopting a good mining practices, and also to engage in high value added activities including R&D in manufactured sand so that higher yield in profit will means higher tax and salary to local employees.

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Lo Yen Lee, 2011. Singapore Construction Prospects 2011, Building and Construction Authority of Singapore.

Paper A3

Rock slope stability assessment by using kinematic analysis and Slope Mass Rating at Bandar Seri Alam, Johor

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Keywords: Kinematic analysis, Slope Mass Rating (SMR), overblasting, rock mass classification, discontinuities

A hilly area of granitic rock mass was exposed and interrupted construction of a road alignment in Bandar Seri Alam, Johor. Blasting operation was performed to break this massive rock mass into manageable sizes so that the rocks can be removed. However, it was found that the excessive overblasting has caused widening of major joints, excessive overbreaks, forming unstable and loose overhanging blocks that created at least 2 sets of new joints on the rock face, which has to be trimmed with a pre-splitting method. A post-construction geological assessment carried out on the rock slope indicates that majority of the unstable elements are essentially due to excessive blasting and lack in proper design of blasting operations. Moreover, profile of weathering zone is slightly to completely weathered in this particular site. The objectives of this study are to evaluate the stability of the rock slope and to point out that it may have the potential to undergo planar, wedge and toppling failures. In addition, probability of failure has been estimated. The objectives can be achieved by using kinematic analysis on the discontinuities and perform Slope Mass Rating (SMR) classification system. In order to carry out the study, the slope has been divided into five panels. They were named A, B, C, D and E, respectively from left hand side to right hand side of the slope. Each panel is about 50 m long and the maximum height of the slope is 18 m. It should be remarked that Panel "D" and Panel "E" were found to be unsuitable for this study because they consist of completely weathered rock (grade V) and the methodology that has been used, is not appropriate for such material. According to the survey, the orientation of the slope face is 80˚/65˚. A total number of 21, 28 and 33 joints were surveyed as most critical joints in panel A, B and C respectively. The relevant data which comprised of both geomechanical and surveyed discontinuities data by scanline technique, are used to analyze each of the panels. Three major joint sets were identified in panel A and B and there are 4 major joint sets in panel C. Discontinuity survey has shown that at least 36.6% of new discontinuities were generated from uncontrolled blasting work. The kinematic analysis revealed that the rock slope has two possible modes of failure consisting of planar failure and toppling failure. Panel "A" is in stable condition. Planar failure may occur in panel "B" and its probability of failure is 40%. The most critical joints that may cause planar failure in panel B, has peak orientation 078°/48°. Panel "C" has potential of toppling failure and its probability of failure is 60%. In panel C, toppling failure can be generated by a joint set which has peak orientation 263°/74°. Consequently, according to probability of failure estimated based on SMR for each panels, the most hazardous zone is located in the middle of the rock slope due to its higher probability of failure.

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Paper A4

Quantification of geomechanical strength of Malaysian schists

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Keywords: Rock mechanics, uniaxial compressive strength, Brazilian tensile strength, point load strength index

Summary

The geomechanical strength of rock materials plays a significant role in influencing the stability of both cut rock slopes and underground openings. The strength characteristics are influenced by both material characteristics and the condition of weathering. This paper presents the results of a systematic research to quantify the mechanical characteristics of fresh as well as slightly weathered schists. A total of 420 geomechanical strength tests were conducted for fresh as well as slightly weathered rock material employing the uniaxial compressive strength test, Brazilian tensile strength as well as the point load strength index test. Statistical analysis of the results at 95 percent confidence level exhibited that the respective means of compressive strength for fresh and slightly weathered schists were 137.3±9.2 MPa and 84.8±5.1 MPa. The respective mean values of tensile strength for fresh and slightly weathered schists were 17.1±0.9 MPa and 10.5±0.4 MPa. The means of the point load strength for fresh and slightly weathered schists were 10.9±0.42 MPa and 7.0±0.10 MPa respectively. The results revealed that the geomechanical strengths of fresh rock material deteriorated by approximately 1/3 upon weathering from fresh to slightly weathered rock materials.

Introduction

Rock material strength and condition of weathering play significant roles in influencing the stability of rock masses for both cut rock slopes as well as underground excavation. In this context, the characteristics of geomechanical strength of rock materials are of considerable importance. This paper presents the findings of a systematic research to quantify the mechanical characteristics of rock material, employing the uniaxial compressive strength, Brazilian tensile strength and point load strength index of fresh as well as slightly weathered schists.

Materials and methodology

Rock blocks were collected from the different test sites and were prepared into core samples, as outlined by the International Society for Rock Mechanics (ISRM, 1981, 1985). The mechanical strength of the core samples were determined by the standard testing machines as illustrated in Figure 1. The respective mechanical strength tests of uniaxial compressive strength, Brazilian tensile strength and point load strength index (Is_{50}) were determined based on the recommendations of the International Society for Rock Mechanics (1981, 1985). Taking into consideration

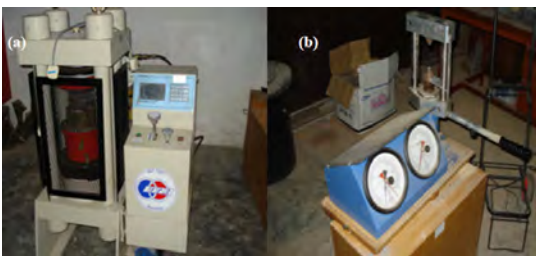

Figure 1: (a) Standard laboratory set up for uniaxial compressive strength and Brazilian tensile strength tests. (b) Point load strength index testing machine.

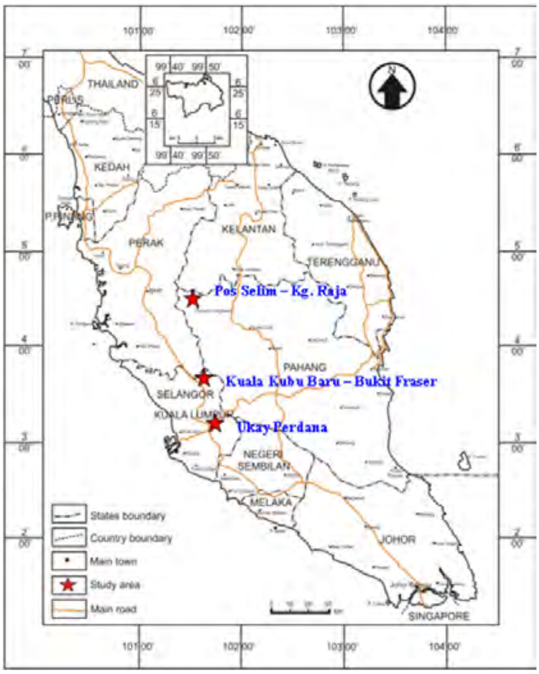

Figure 2: Location of test sites, Peninsula Malaysia.

the foliation of schists, the stress direction for the mechanical strength tests were applied perpendicularly to the direction of foliation.

The weathering characterization and classifications were conducted based on the recommendations of the International Society for Rock Mechanics (1981), Hariri et al. (2009) and Baizura et al. (2009) using the Schmidt rebound hammer. Grade I rock material is fresh, with no discoloration being observed. For Grade II, discoloration along discontinuity planes is clearly visible and the rock material itself appears “faded”, especially for the finer grain metamorphic rocks (schists). Test sites were selected to represent schists that have widespread occurrence in Peninsula Malaysia. Figure 2 shows the locations of the different sites. Schist occurs at Ukay Perdana and Kuala Kubu Baru – Bukit Fraser. Along the newly constructed road from Pos Selim to Kg. Raja, schists also occur. At all sites, rock blocks of both fresh and slightly rock material were collected using hand tools such as geological hammers of different sizes, chisels and picks.

The test results of mechanical strength were then analyzed at a 95 percent confidence level using the statistical software package SPSS Version 16. In order to determine the significance of the measured differences of the test results between grade I and II rock materials, the independent-sample t-tests of SPSS were performed. If the value of P was less than 0.05, the alternative hypothesis (ha) was accepted and it indicated that the measured difference of the test results between grade I and II was significant. The null hypothesis (ho) would be accepted if the value of P was larger than 0.05 and it illustrated that the measured difference of the test results between grade I and II was not significant. The hypotheses of the test results were:

(a) Null hypothesis (ho):
Mean of mechanical strength, grade I = Mean of mechanical strength, grade II

(b) Alternative hypothesis (ha):
Mean of mechanical strength, grade I ≠ Mean of mechanical strength, grade II

Results and discussion

A total of 82 uniaxial compressive strength tests, 79 Brazilian tensile strength tests and 259 point load strength index (Is_{50}) tests were conducted for fresh and slightly weathered rock materials. The results of testing were analyzed at a 95 percent confidence level using the statistical software package SPSS Version 16. The box plots of uniaxial compressive strength, Brazilian tensile strength and point load strength index test results are illustrated in Figure 3. The values of mean, standard deviation and median together with value of P and skewness of the data distribution for fresh and slightly weathered schists are summarized in Table 1. Negative skewness implies more test results have of higher value for the mechanical strength compared to the mean value. Positive skewness implies more test results have lower values of the mechanical strength compared to the mean value.

The values of P of uniaxial compressive strength, Brazilian tensile strength and point load strength index test result for schists were 0.000. The test results indicated that the measured differences of uniaxial compressive strength, Brazilian tensile strength and point load strength index between fresh and slightly weathered schists were significant at confidence level of 95 percent.

For uniaxial compressive strength testing, the values of mean for fresh and slightly weathered schists were 137.3±9.2 MPa and 84.8±5.1 MPa. The measured difference between fresh and slightly weathered material was 52.5 MPa (-38%).

Brazilian tensile strength tests revealed measured differences of 6.6 MPa (-39%) between fresh and slightly weathered schists. The respective mean values for fresh and slightly weathered schists were 17.1±0.9 MPa and 10.5±0.4 MPa.

Measured differences of 3.9 MPa (-36%) between fresh and slightly schists were obtained from point load strength index tests. The values of mean for fresh and slightly weathered schists were 10.9±0.42 MPa and 7.0±0.10 MPa.

Conclusion

The test results of uniaxial compressive strength, Brazilian tensile strength and point load strength index tests exhibited significant differences between fresh and slightly weathered schists at 95 percent confidence level. The results also showed that the values of uniaxial compressive strength, Brazilian tensile strength and point load strength index of fresh rock material deteriorated by approximately 1/3 (~30%-40%) upon weathering from fresh to slightly weathered rock materials. These also means that the mechanical strengths for slightly weathered rock materials for schists was approximated 2/3 (~60% - 70%) of the strengths of fresh rock material. The results illustrated that the condition of weathering influences the strength of schists.

Acknowledgements: The authors wish to thank the lab staff of the Geology Programme for assistance in the field and lab as well as the Government of Malaysia for the financial assistance through grant UKM-ST-01-FRGS0060-2006.

Table 1: Summary of the statistical result of respective mechanical strength tests, Peninsula Malaysia.

Type of Test	Lithology and weathering grade	Total no. of tests	Standard Deviation (MPa)	Median (MPa)	Skewness	Mean (MPa)	Value of P	Difference with grade I
Uniaxial compressive strength test	schist (grade I)	61	35.9	124.8	positive	137.3±9.2	0.000	-
	schist (grade II)	21	11.1	85.9	negative	84.8±5.1		-38 %
Brazilian tensile strength test	schist (grade I)	56	3.5	16.9	positive	17.1±0.9	0.000	-
	schist (grade II)	23	0.9	10.5	normal	10.5±0.4		-39 %
Point load strength index test (Is_{50})	schist (grade I)	179	2.9	10.1	positive	10.9±0.4	0.000	-
	schist (grade II)	80	0.5	7.0	normal	7.0±0.1		-36 %

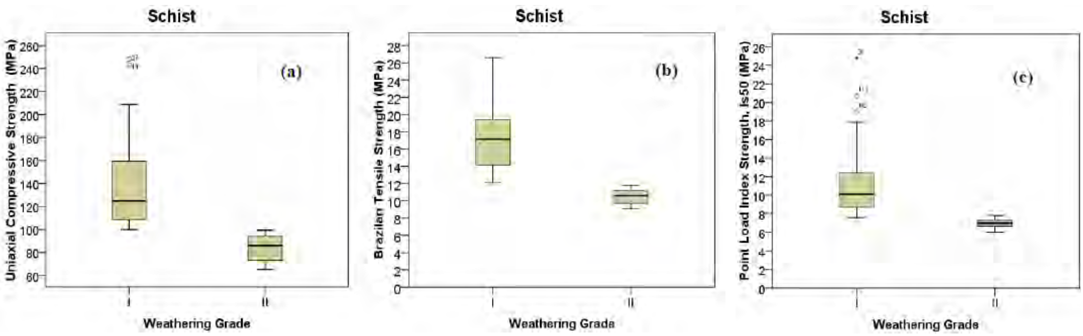

Figure 3: Boxplots of (a) uniaxial compressive strength, (b)Brazilian tensile strength and (c) point load strength index (Is_{50}) test results for schists.

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Paper A5

Rock Mass Quality of the Crocker Formation from Tamparuli, Sabah, Malaysia

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The quality of a rock mass can be represented by the rock mass classification system. Methods of classifying hard rock masses based on simple field and drill core observations have been extensively used as an aid for excavation design of tunnels, mines, slope and foundation (Bieniawski, 1993). RMR (Rock Mass Rating) geomechanics classification was introduced and developed by Bieniawski (1973, 1984, 1989). In Bieniawski (1976), the 'rating adjustment for discontinuity orientation' for slope are very favourable (0), favourable (-5), fair (-25), unfavourable (-50) and very unfavourable (-60). No guidelines have been publishing for the definition of each class. Romana (1985, 1993) proposed a new definition for the RMR concept, especially suited to slopes and called it Slope Mass Rating (SMR) system, which has been endorsed by Bieniawski (1989). Ismail Abd Rahim *et al.* (2009a) adjusted the calculation and determination of some parameters in SMR system to produced the Modified Slope Mass Rating (M-SMR) system for interbedded Crocker Formation in Kota Kinabalu, Sabah.

This paper highlights the application of M-SMR system in cut rock slopes (slope B1, B2, B3 and B4) (Figure 1) of the Crocker Formation in CPSB Stone Quarry, Tamparuli (Figure 2) to assess the value of rock mass quality. The aims are to measure the value of M-SMR, to determine the controlling factor for M-SMR value and nature of rock slope failure for this rock formation. In the M-SMR system, the rock mass quality is representing by the risk to slope instability. The M-SMR is obtained from basic Rock Mass Rating (RMR_b) by adding a new adjustment factor (discontinuity orientation parameter, Ismail Abd Rahim *et al.,* 2011) which is dependant on the relative orientation of discontinuity and slope (parallelism between discontinuities and slope, discontinuities dip angle in failure modes, relationship between slope, and discontinuity dip) as well as another adjustment factors depending on the method of excavation. The RMR_b consists of unconfined compressive strength (UCS), rock quality designation (RQD), discontinuity spacing, discontinuity condition and water flow, which is determined by lithological unit thickness (LUT) approach (Ismail Abd Rahim *et al.,* 2009b) and Deere *et al.* (1967) method, weighted average of discontinuity set spacing, weighted average of discontinuity condition and normal water flow. Kinematic analysis (Markland, 1972) has been used in determining the mode of slope failure.

The intact rock strength for rock slope material is classified as very strong, 'good' quality of RQD and wide to very wide discontinuity spacing. The discontinuity condition is smooth surface, separation between the wall is less than 1 mm and containing soft infilling material (illite and montmorillonite), continuous and moderately weathered. The water flow condition is dry and the discontinuity orientation is fair to very unfavourable. The RMR_b value is good for the rock mass in the study area. The result of analysis shows that the rock mass quality or values of M-SMR are 19.45, 7.20, 42.60 and 21.50 for slope B1, B2, B3 and B4, respectively (Table 1). Slope B1 and B2 are predicted to have very high risk, slope B4 is high risk and slope B3 is moderate risk rock mass. The rock mass quality or M-SMR value is control by discontinuity orientation parameters (adjustment factor). The mode of slope failure in slope B1, B2 and B3 and B4 are classified as wedge and planar failures.

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Table 1: M-SMR value and class. Note: IRS-intact rock strength; DC sp-discontinuity spacing; DC cond-discontinuity condition; DO-discontinuity orientation; RMRb-basic RMR; F-favourable; Fr-fair; UF-unfavourable; VUF-very unfavourable; VS-very strong.

Slope	IRS	RQD	DC sp (m)	DC cond	Water	DO	RMR_b	M-SMR	Class Risk
B1	129.15	83.40	1.93	11	Dry	VUF	70.35	19.85	V
	VS	Good	Wide		15	-50.5	Good		Very High
B2	108.19	80.42	0.56	12	Dry	VUF	66.20	7.20	V
	VS	Good	Moderate		15	-59	Good		Very High
B3	116.66	86.59	2.21	10	Dry	Fr	74.60	42.60	III
	VS	Good	Very Wide		15	-32	Good		Moderate
B4	147.61	88.12	2.10	12	Damp	VUF	72.00	21.50	IV
	VS	Good	Very Wide		10	-50.5	Good		High

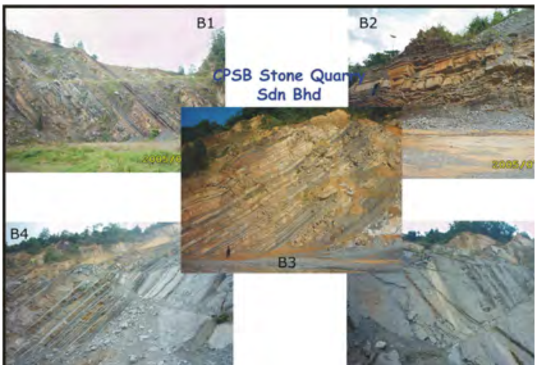

Figure 1: Four slope (B1, B2, B3 and B4) in the study area. B1, B2, B3 and B4 means slope B1, B2, B3 and B4, respectively.

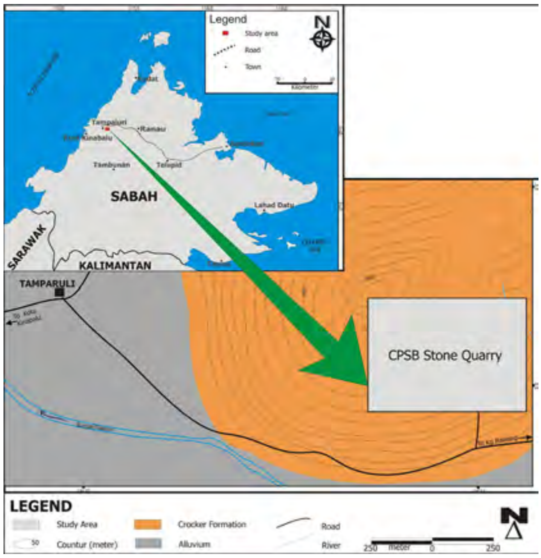

Figure 2: Location of the study area (from Yin, 1985).

Paper A6

Strength reduction of various weathering grades of granite due to moisture content

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Keywords: Moisture content, strength, point load test, weathered granite

This paper presents the strength reduction due to the moisture content on granite with various weathering grades. Both field and laboratory studies were carried out in order to assess the strength of rock. The field study involved weathering characterisation and observations at site. Laboratory tests were carried out to determine the strength, weathering grade, and moisture content of the material. Two types of tests were adopted in this study, which are point load test and moisture content. The procedure of these tests are in accordance to ISRM, 1981 and ISRM, 1985 methods. A total of 300 samples were tested at a wide range of moisture contents varying from oven-dried to saturated condition. The results revealed that the point load index reduced up to 137.99% with the increase of only 21.40% of moisture content for highly weathered granite (grade IV). However, in a lower weathering grade, a strength reduction of only 21.41% was noted with increase of moisture of 0.27%, although samples have been immersed for 60 minutes. With increased weathering grade, strength reduction due to the increase in moisture content become greater.

Paper A7

Kepentingan fotograf udara merungkai sejarah gelinciran tanah di Bukit Antarabangsa Hulu Kelang, Selangor Darul Ehsan

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Katakunci: Geobahaya, geobencana, gelinciran tanah, fotograf udara, Bukit Antarabangsa

Bukit Antarabangsa terletak di pinggir kotaraya Kuala Lumpur dan terkenal kerana sering dilanda geobencana gelinciran tanah terutama pada musim hujan lebat. Antara kejadian geobencana gelinciran tanah yang tercatat dalam sejarah hitam negara ialah runtuhan blok Highland Tower (1993) yang meragut 48 nyawa, gelinciran-aliran tanah di bawah Kemuncak Athenaeum (1995, 1999), dan gelinciran Taman Hill View (2002) yang meranapkan sebuah banglo dan mengorbankan 8 nyawa. Ketiga-tiga geobencana ini berlaku di bahagian barat daya Bukit Antarabangsa. Terdapat banyak lagi kejadian tanah runtuh di sekitar kawasan Bukit Antarabangsa yang sering diperbincangkan di dalam literatur. Timbul pelbagai persepsi masyarakat tentang kekerapan kejadian gelinciran tanah di kawasan ini. Ada yang menganggap tanah dan batuan granit di kawasan ini lemah, longgar, mudah terhakis, wujud aliran air bawah tanah dan sebagainya, hinggakan kawasan ini tidak selamat diduduki. Tidak hairanlah kini terdapat lambakan iklan rumah dan hartanah untuk dijual di kawasan ini.

Kajian fotograf udara telah dilakukan di bahagian baratdaya Bukit Antarabangsa, yang pada asalnya bertujuan untuk menilai geobahaya tanah runtuh di kawasan ini. Bagaimanapun, kajian ke atas fotograf udara bersiri yang diambil pada tahun 1972, 1981, 1989, 1992, 1997, 1999, 2002, dan imej satelit Google Earth 2004, 2008, telah menemui maklumat penting yang dapat merungkai sejarah dan menjelaskan punca utama kepada ketiga-tiga bencana tanah runtuh yang tersebut di atas. Hasil kajian mendapati bahawa kejadian gelinciran tanah tersebut berpunca terutamanya daripada gangguan aktiviti manusia pada cerun dan di atas cerun. Amalan kerjatanah yang tidak terkawal dan lemah seawal dekad 1970-an hingga awal 1990-an telah mengubahsuai morfologi cerun, regim aliran air permukaan dan air bawah tanah. Malah yang lebih memburukkan keadaan ialah apabila sisa-sisa kerjatanah dibuang dan dilambakkan ke bawah cerun sebagai bahan tambakan yang tidak sempurna. Kini bahan-bahan tambakan cerun yang longgar itu telah ditutupi oleh hutan sekunder yang tebal dan kelihatan seakan-akan cerun semulajadi, dan merupakan geobahaya yang menunggu masa untuk mencetuskan geobencana.

Kesimpulannya, kajian ini merupakan suatu contoh betapa pentingnya kajian fotograf udara bersiri dilakukan di sesebuah kawasan berbukit yang telah pesat membangun sebelum sebarang pembangunan baru dilaksanakan. Ada kemungkinan projek-projek pembangunan terdahulu telah mencipta dan mewariskan geobahaya kepada pembangunan yang sedia ada mahupun pembangunan baru yang bakal dibina. Hasil kajian ini juga secara tidak langsung telah menemui jawapan utama kepada persoalan kenapa cerun-cerun di Bukit Antarabangsa mudah terdedah kepada geobencana gelinciran tanah. Mendiami kawasan di bawah parut tanah runtuh lama, di atas atau di bawah cerun tambakan sisa kerja tanah, bukanlah suatu pilihan yang bijak dan amat berisiko.

The Importance of Aerial Photographs in Unraveling the History of Landslides in Bukit Antarabangsa, Ulu Kelang, Selangor Darul Ehsan

Bukit Antarabangsa is located in the outskirt of Kuala Lumpur metropolitan and is prevalent for its appalling landslide incidences. Amongst the infamous landslide geodisasters in the nation's history are the collapse of a block of the Highland Towers (1993) which claimed 48 lives, earth slides-flows below the Athenaeum Tower (1995, 1999), and the Taman Hill View landslide (2002) which destroyed a bungalow and claimed 8 lives. All these three landslides occurred in the southwestern flank of Bukit Antarabangsa. In the literature, a number of landslides were also reported from some other parts of Bukit Antarabangsa. Public perceptions on the causing factors for these landslides varied. Some believed that the landslides were attributed largely to the poor nature of the granitic soils and bedrock, weak, loose, highly erodible soils, and the presence subsurface flows of groundwater, act of God, and etc, which rendered this area unsafe. It is not surprised today to find so many advertisements for selling houses and properties from this area.

Aerial photograph studies on the southwestern flank of Bukit Antarabangsa was carried out with an initial goal to assess the pertinent threat of landslide geohazards in this area. However, studies on the serial aerial photographs captured in 1972, 1981, 1989, 1997, 1999, 2002 and Google Earth's satellite images of 2004, 2008; have lead to very important findings that revealed the history and at the same time could explain the major factors for those three landslides described above. The results show that the landslides were largely attributed to the human disturbance on and above the slopes. Excessive and poorly-practiced earthworks in the 1970s until early 1990s have greatly modified the hill slopes morphology, surface runoff and groundwater flow regimes. The whole situation was worsened by dumping off the earth and debris down the slopes instead of being safely deposited elsewhere. These poorly compacted fills are now densely covered by secondary vegetation and apparently looked like natural slopes, and became potential geohazards that in anytime might induce geodisasters.

In conclusions, this paper shows the importance to carry out detailed studies on serial aerial photographs for any new developments in a hilly terrain especially when the surrounding areas have been extensively developed. Possibility for the previous developments in hilly terrain to generate and inherit geohazards to the existing and future developments is always admissible. Findings of this study have also found answers on why slopes in Bukit Antarabangsa are prone to landslide. To live in area situated below old landslide scars, above or below tip fill slopes, is definitely not a good choice and is highly risky.

Paper A8

Evaluation of the preliminary assessment of rock properties in different sites

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Preliminary or desk study is an important stage in assessing suitability of a site for major construction. At this stage, assessment is usually based on existing infomation pertaining to the geological conditions and *in situ* materials of the chosen site. With regard to bedrocks, geological map seems to be the only source of infomation on rock types and their distributions. If the area has been investigated before, then the site investigation (SI) and laboratory test reports can provide additional data on the *in situ* rocks, but this information is often difficult to acquire due to logistic problem. It is believed that besides the rock types and their distributions, additional data like typical material properties, RQD and depth of bedrock will certainly help to widen the scopes of the initial assessment and consequently, this will entail more appropriate and indicative findings from the assessment. Presenting rock mass properties for the preliminary assessment of several sites is the main goal of this study.

Paper A9

Effects of moisture and clay microstructure on the strength of soil along Kota Belud – Ranau Road, Tamparuli, Sabah

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Lanslides had long been regarded as a one of the major geohazards in Sabah. Humid tropical climate of the region act as a catalyst that speed up the weathering process resulting in the decreasing resistance in rock mass and the formation of clay. Clay, a microstructure mineral in soil that is a product of weathering process contributes to the occurrence of landslides because of their chemical and physical properties. Due to constant heavy downpour that acts as the main triggering factor, it causes a decrease in shear strength. This paper discusses the effect of clay microstructure on the strength of soil taken from 6 different soil slopes along Kota Belud Ranau-Road (Figure 1).

The strength of soil is determined using uniaxial compression test, where data obtained from the compaction curve are manipulated by preparing samples with different percentage of moisture content. This is achieved by treating the samples with 5% of increment and decrement in moisture from the original optimum moisture content of each sample. As for clay microstructure, X-Ray Diffraction and Scanning Electron Microscope method is applied to determine the types of clay mineral. The results indicate shear strength is inversely proportional to the percentage of soil moisture content in all samples (Figure 2).

Samples with clayey material show the highest percentage of shear strength reduction when treated with 5% increase of moisture from optimum moisture content (Table 1 and Figure 3). Whilst, samples with sandy material show highest percentage of shear strength increment when treated with 5% decrease of moisture from optimum moisture content.

X-Ray Diffraction analysis shows the existence of illite, montmorillonite and halloysite in all samples (Figure 4 A). Scanning electron micrograph analysis show the existence of halloysite (Figure 4 B) which looks like little rods or tubes. Halloysite is a member of the kaolin group, where individual layers are separated by sheets of water. Illite can be seen with its irregular flaky clay platelets parallel to each other and often looks like thin flakes with ribbon-like projection (Figures 4B and C).

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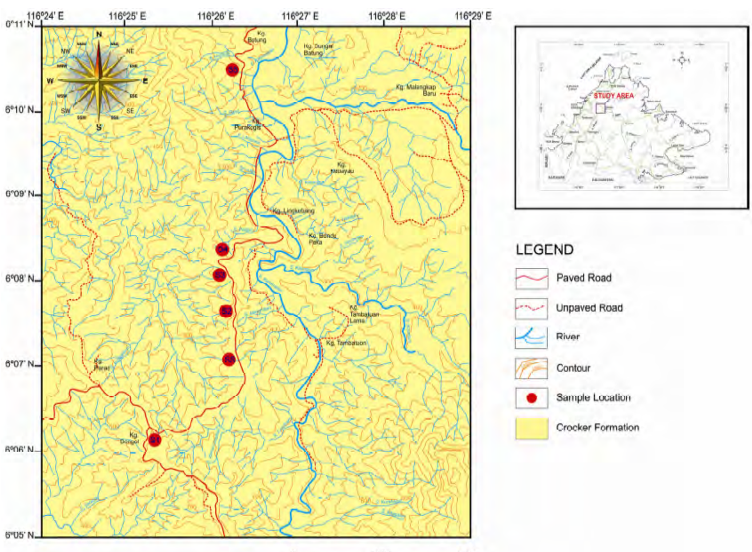

Figure 1. Location of study area and sampling station.

Table 1. Sample shear strength based on manipulated moisture content.

	S1			S2			S3			S4			S5			S5		
	Sandy Silty Clay			Clay			Sandy Silty Clay			Sandy Silty Clay			Clayey Sand			Clayey Sand		
	Moisture Content %	Shear Strength (kPa)	Shear Strength Difference (%)	Moisture Content %	Shear Strength (kPa)	Shear Strength Difference (%)	Moisture Content %	Shear Strength (kPa)	Shear Strength Difference (%)	Moisture Content %	Shear Strength (kPa)	Shear Strength Difference (%)	Moisture Content %	Shear Strength (kPa)	Shear Strength Difference (%)	Moisture Content %	Shear Strength (kPa)	Shear Strength Difference (%)
< 5% Moisture Content	12.6	138	63	17.3	198.5	81	20.8	98	74	14.7	181	55	11.6	210.5	64	11	152	51
Optimum Moisture Content	14.7	104	NIL	21	130	NIL	23.7	77	NIL	19	113	NIL	14.6	86.5	NIL	15	50.5	NIL
> 5% Moisture Content	21.7	38	33	27.6	24.5	53	27.9	20	30	25.9	50	60	23.5	31	143	22.8	25	201

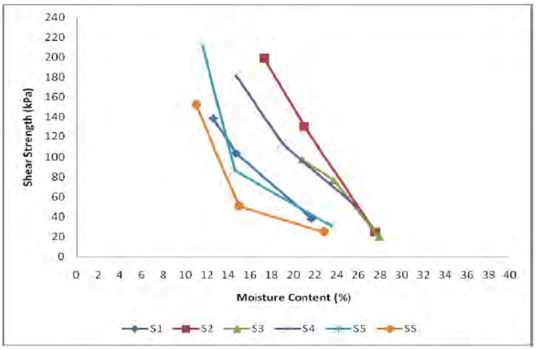

Figure 2. Graph showing inversely proportional relationship between shear strength and moisture content.

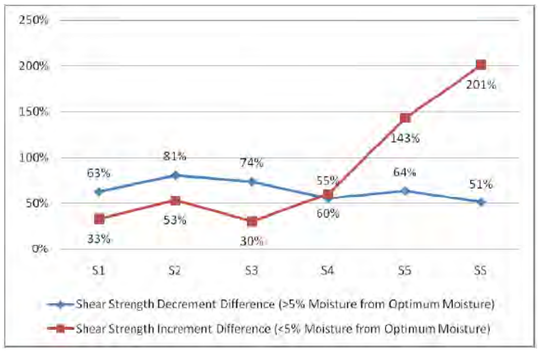

Figure 3. Shear strength difference based on manipulated moisture content.

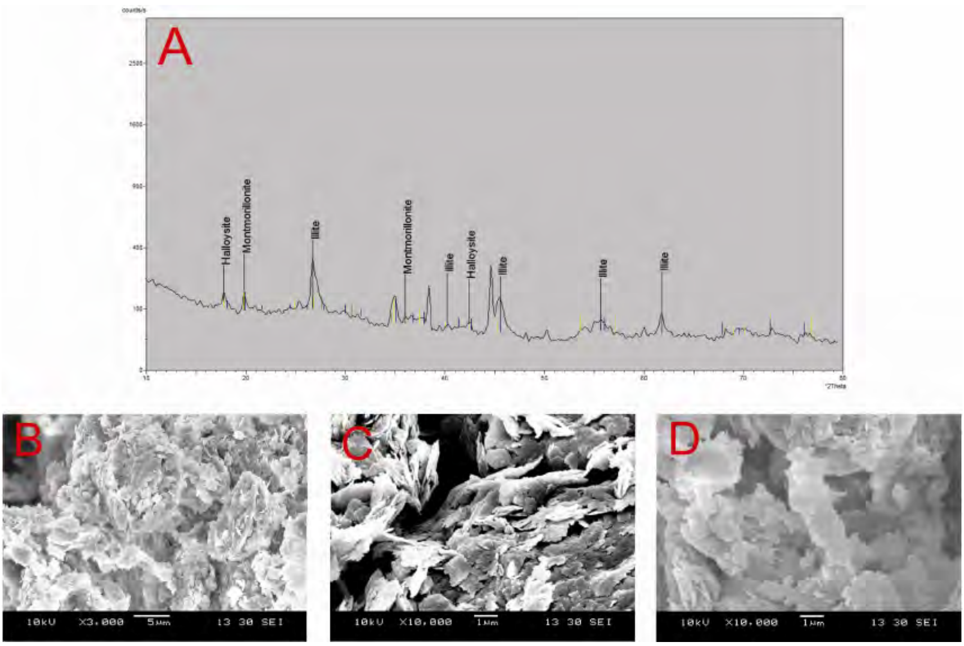

Figure 4. (A) X-Ray diffraction analiysis graph, (B,C and D) scanning electron micrograph.

Paper A10

A Tale of Two Airports: the New LCCT, Sepang, and the Senai Airport

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Owing to severe congestion problems in the present Low Cost Carrier Terminal (LCCT) in Sepang, a new LCCT has been planned and is currently under construction. The new LCCT is located adjacent to the Kuala Lumpur International Airport (KLIA) in Sepang, and has been re-designated as KLIA2. The terminal or project area is underlain by thick deposits of Quaternary sediments and peat, with Kenny Hill formation as the underlying bedrock. The soil profile typically consists of three layers, namely (from top to bottom): Quaternary Sediments/Peat, Residual Soils (of Kenny Hill formation), and Bedrock (Kenny Hill formation).

The main concern with the construction of the terminal and runway is the settlement or differential settlement problems arising from the thick Quaternary deposits and peat. Thus, the determination of the spatial distribution and thickness of these deposits is crucial, and this has been done via a series of boreholes. Borehole data shows that the thickness of the soft deposits in general increases towards the seaward side, with a maximum thickness of about 30 m been recorded from the boreholes. Figure 1 shows an isopach map of the Quaternary sediments/peat. The soil settlement problem is tackled during construction with the use of pre-loading/surcharging and incorporating vertical drains to accelerate the consolidation of the soft soils.

The Senai airport (Sultan Ismail International Airport) in Johor was recently re-developed, with the runway extended. In contrast to the KLIA2 area, the underlying geology in the Senai airport area comprises stiff to hard granitic residual soils underlain by granite bedrock. Detailed soil profiles and soil properties were again determined via boreholes and laboratory tests. The granitic residual soils typically consist of stiff to hard yellow-brown-red sandy SILT and sandy CLAY. Standard Penetration Test (S.P.T.) N values increase with depth, as is the case in general for residual soils. The granite "bedrock" occurs at depths of 11.5 – 39.0m, i.e. a large variation in depth. It could also mean that some of the shallower (say < 20 m) "bedrock" were in fact core boulders. Some boreholes did not encounter rock and were terminated at S.P.T. N > 50 (for 6 consecutive N>50 values). The granite rock is described as a light grey, medium to coarse-grained, slightly fractured weathered granite (grade III?), strong rock. Groundwater depth ranges from 1.0 to 7.5m, but is mostly at shallow depths of < 3m. One borehole encountered GABBRO, described as grey-brown fine-grained, highly fractured, moderately weathered (grade III), very weak rock. The topography of the project site consists of low-lying, undulating hills/hillocks, of contours ranging from 40-50m. Many of the low hills/hillocks were excavated as borrow pits. The highest borrow pit of 50m contour is located near the runway extension just south or southeast of the present runway. Earthworks cut-and-fill operations have resulted in most of the low-lying small streams/valleys being backfilled to attain the various platform levels required for the development.

As the original topography was low-lying and consist of small hills/hillocks of 40-50 m contours, there are no major concerns with slopes or slope stability problems to begin with. Furthermore, the current development involving cut-and-fill operations would effectively "flatten" the entire project sites, and hence, no slope problem to be concerned about. Granitic residual soils are generally of high strengths, and stability of cut slopes would generally not be a problem. The cut-and-fill operations involve compaction of the fill materials borrowed from the various hillocks/borrow pits. Granitic residual soils provide good fill materials for compaction, partly due to the well-graded nature of the soils (sandy CLAY, sandy SILT). The laboratory compaction test results show:

– maximum dry density = 1.44–1.61 Mg/m^3 , i.e. high mdd,
– optimum moisture content = 12.0–20.5 %., i.e. low omc.
(compaction by 4.5Kg rammer, 5 layers, with 15 blows/layer).

Hence, engineering wise, this second project is less problematic compared to KLIA2.

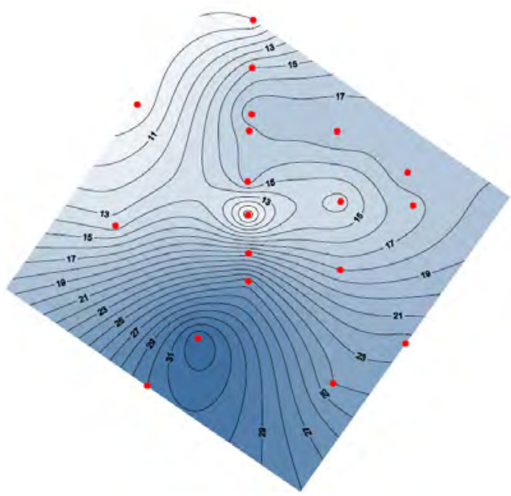

Figure 1: Isopach map of Quaternary Sediments/Peat in the new LCCT area, Sepang (contours in meter).

Paper A11

Correlating Schmidt hammer rebound values with some engineering properties of the Dinding Schist in the Ukay Perdana area, Selangor

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Keywords: Dinding Schist, dry unit weight, index properties, Schmidt hammer, uniaxial compressive strength

Most exposures of the Dinding Schist described by some authors as meta-rhyolitic tuff of Lower Palaeozoic are massive and display a well developed foliation marked by the parallel alignment of thin (<5 mm thick) dark greenish grey layers alternating with thicker, light greenish gray layers (Gobbett, 1964, 1965). In various exposures, the Dinding Schist is found with late-phase granitic phenomena involving metasomatism and marked by contortion of the original bedrock structure. Observed structural changes start from discoloration, loosening along planes of foliation, jointing and microfracturing, and ending with failures (Nkpadobi, 2009).

The use of Schmidt hammer rebound values to evaluate some engineering properties of rock has overtime been widely employed and very valuable in its correlation with these rocks engineering properties. The N-type Schmidt hammer was used in carrying out this work on both dry and wet in-situ bedrocks yielding rebound values of 51, 62, 44, 53, and 40 on dry in-situ bedrocks, while rebound values on wet in-situ bedrocks yielded 25, 50, 24, 33, and 23. A great convenience is the reliable correlation between L and N hammer rebound values by both Ayday & Goktan (1992) and Aydin & Basu (2005) yielding regression equations for easy conversion of values for the purpose of estimating rock engineering properties; though the regression equation of Aydin & Basu (2005) was applied in this work. The uniaxial compressive strength of the Dinding schist was estimated from Schmidt rebound values on both wet and dry in-situ bedrocks using the conversion chart. Uniaxial compressive strength values of 110, 180, 72, 120, and 57 MPa where recorded on dry in-situ bedrock, whereas 34, 105, 31, 48, and 28 MPa were recorded on wet in-situ bedrocks. In comparison with other previous researches, the uniaxial compressive strength of the Dinding schist shows lower rock strength. Plots between Schmidt hammer rebound numbers and uniaxial compressive strength with regression coefficient (r) 0.995 and 0.993 for dry and wet in-situ bedrocks respectively show a strong relationship between these two variables.

Results of the index properties carried out on both weathered and unweathered rock samples were derived employing the saturation and buoyancy technique of ISRM (1979). This test shows that unweathered rock samples have average dry unit weight and saturated unit weight of 25.82 kN/m^3 and 26.08 kN/m^3 respectively, with 2.5% apparent porosity and average dry density of 2,636.1 kg/m^3. Results of similar test on weathered samples yielded 23.99 kN/m^3 and 24.78 kN/m^3 for dry unit weight and saturated unit weight respectively, with apparent porosity of 8.2% and average dry density of 2,447.3 kg/m^3. The plots of Schmidt hammer rebound numbers against dry unit weight, saturated unit weight, and dry density also show a strong relationship given their corresponding regression coefficients (r) 0.889, 0.886 and 0.877 respectively. For further studies, it is advised that the application of the results of regression analysis in this work should be used for the specified rock types.

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Paper A12

Gunung Batur beserta kalderanya sebagai geologi warisan Kintamani, Provinsi Bali, Indonesia

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Gunung Batur merupakan salah satu gunung berapi jenis stratovolkano yang masih aktif di Indonesia. Ianya terletak pada latitud 8°14'5" LS 115°22'5" BT, Kabupaten Bangli, Kintamani, Provinsi Bali. Di barat laut berbatasan dengan Gunung Agung. Ketinggian Gunung ini mencapai 1,717 m atau 5,633 kaki. Salah satu yang menjadi keunikan Gunung Batur ini adalah terdapatnya kaldera yang merupakan salah satu kaldera yang terbesar dan terindah di dunia. saiz kaldera lebih kurang 138 Km, dan tingginya 1,267 m – 2,152 m. terdapat lebih kurang dua kaldera di kawasan tersebut (Kaldera I dan Kaldera II). Kaldera ini wujud disebabkan adanya dua letusan besar yang terjadi 29,300 dan 20,150 tahun yang lalu. Di dalam kaldera tersebut terdapat danau yang berbentuk bulan sabit di bahagian tenggara dengan saiz panjangnya lebih kurang 7,5 km dan lebarnya 2,5 km. Dicatitkan terdapat lebih kurang 26 kali letusan yang terjadi di Gunung Batur daripada tahun 1804-2011. Letusan terakhir terjadi pada tahun 2000. Manakala letusan paling kuat pada 2 Agustus 1926. Di sekitar Gunung Batur terdapat singkapan batuan skoria yang berwarna hitam gelap, berongga dan agak tumpat. Batuan skoria ini dimanfaatkan oleh masyarakat setempat sebagai bahan konkrit bangunan dan bahan pembuatan bikar. Selain itu terdapat juga batuan aglomerat tuff yang mempunyai klas dengan julat 20 cm-30 cm, ianya tersingkap di bahagian barat Gunung Batur iaitu sepanjang jalan Panelokan. Terdapat juga di kawasan tertentu batuan ignimbrit.

Paper A13

Preliminary geological findings of the Imbak Canyon 2010 Scientific Expedition, Tongod, Sabah

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The Imbak Canyon Conservation Area is a huge elongate valley located along the Imbak River in central Sabah (Figure 1). The Imbak Canyon is about 750 m deep and about 3 km wide. The floor of the canyon lies about 250 m above sea level whereas the rim of the canyon is about 1000 m above sea level. The canyon is characterized by a broad valley floor with gentle slopes on its northern and southern sides. The gentle slope abruptly becomes steep near the rim of the canyon (Figure 2). In an attempt to understand the geological evolution of the southern part of the canyon a study on its geomorphology and geology was carried out during the 3rd Imbak Canyon Scientific Expedition from 26 November – 5 December 2010 organised by Akademi Sains Malaysia and Yayasan Sabah. Satellite images, aerial photographs and topographic maps were used to study the landscape of the canyon and its surrounding areas. Fieldwork along the southern tributary of the Imbak River and its sub-tributaries provided information on rock types (surface and bedrock), orientation of strata and geological processes.

The southern part of the Imbak Canyon is underlain by Tertiary sedimentary rocks with minor occurrence of igneous rocks. The sedimentary rocks, referred to as the Kapilit Formation consists of three lithological units, a Lower Mudstone Dominated Unit, a Mixed Sandstone and Mudstone Unit, and an Upper Sandstone Dominated Unit. The Mudstone Dominated Unit has a sandstone-mudstone ratio of about 10:90 and is characterized by the presence of dark grey mudstones with concretions. The Mixed Sandstone and Mudstone Unit has a sandstone-mudstone ratio of about 50:50 and is characterized by the occurrence of cross-bedded amalgamated fine-medium grained grey sandstone. The Sandstone Dominated Unit has a sandstone-mudstone ratio of about 80:20 and is characterized by the intercalations of dark grey mudstone and cross-bedded sandstone layers. Two thin layers (5-20 m) of andesitic volcanic rocks occur intercalated with the Mixed Sandstone and Mudstone Dominated Unit.

The moderately dipping (25-30°) layers of the Kapilit sedimentary units shows two opposing strike orientations, one trending NE-SW and another trending NW-SE located on the northern and southern side of the study area, respectively. The drastic change in orientation is marked by the presence of a regional thrust fault zone (informally called the Kuli Fault) oriented NW-SE. The Kapilit sedimentary units are interpreted to have been deposited in a coastal-shelf environment sometimes during the Middle Miocene. During the early Middle Miocene minor volcanic eruptions producing magma flows covered parts of the coastal sedimentary deposit. The volcanic activity may represent the southwest extension of the submerged ancient Cagayan Ridge volcanic arc located in the Sulu Sea. Tectonic compression oriented NE-SW during the Upper Miocene resulted in the gentle folding of the sedimentary unit in approximately NW-SE direction, and later thrust faulting to the northeast. Continued tectonic compression in this region during the Pliocene may have uplifted this area near to its present height above sea level and since then has undergone denudation.

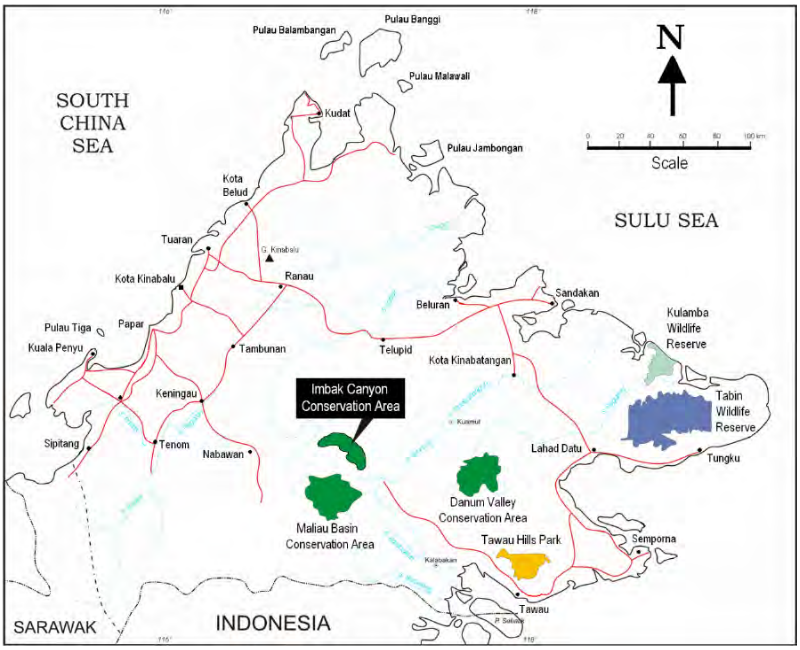

Figure 1: Location of Imbak Canyon Conservation area.

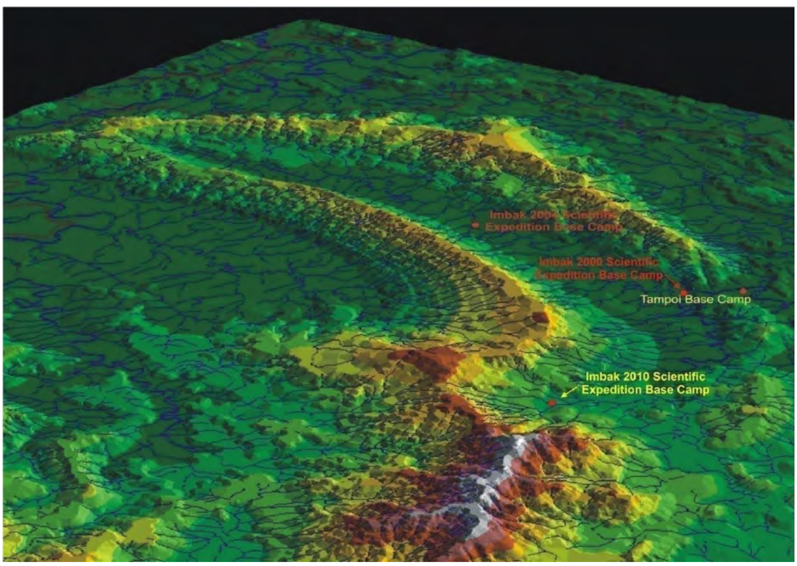

Figure 2: Digital elevation model of the elongate Imbak Canyon showing the location of the Imbak Canyon 2010 Scientific Expedition base camp. Image provided by Yayasan Sabah.

Paper A14

Effects of geological conditions on surface settlement due to tunnelling in soft soils

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Keywords: Geological conditions, surface settlement, numerical modeling, soft soils

Rapid growth in urban development has resulted in increased demand for the construction of transportation systems, water supply and sewage disposal systems. Tunnels are an essential component of these schemes and constitute one of the major parts of project expenditure. Many attempts have been done to predict and subsequently control the ground movements due to the recently increasing number of tunnels in urban areas, which are located mostly in soft ground. According to historical reasons, more cities are built in alluvial environments. Hence, tunnelling through cities with this kind of environment usually associated with soil movements around the tunnels and subsequent surface settlement. The factors influencing ground movements include the geological conditions, tunnel dimensions and construction method. Research has been carried out to investigate the effects of geological condition on surface settlement due to tunneling work. A numerical simulation is developed for sensitivity analysis of soil movements around a tunnel and surface settlement, which includes various geological conditions. Several researches have investigated the effects of tunnel construction method on surface settlement (Breth & Chambosse 1974, Morton & King 1979, Attewell *et al*., 1986, Rankin 1988, Vermeer & Bonnier 1991, Burland 1995, Mroueh & Shahrour 1999, Coutts & Wang 2000, and Cheng *et al*. 2006). However, very limited research had been conducted to analyse the effect of geological parameters on the soil movements around the tunnel. Geometric and geological parameters had been obtained from Shiraz Subway Tunnels that were excavated in soft cohesive soils below the groundwater level using earth pressure balance shield (EPB) machines. Sensitivity analysis is useful as complementary aid for tunnel construction modeling to assess the importance of diverse geological parameters to control the surface settlement. This paper presents the sensitivity analysis which focuses on the soil properties and groundwater conditions. The modeling work has been performed under different condition using a finite element method of Plaxis code, whereby the influence of soil properties could be determined. It is found that the evaluation of the sensitivity analysis could help to achieve more detail information on the geological parameters for tunnel designing with a reasonable settlement.

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Paper A15

Study on the effectiveness of Managed Aquifer Recharge (MAR) technique in Kg. Salang, Tioman Island, Malaysia

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Tioman Island is situated in the east coast of Peninsular Malaysia and it is experiencing rapid growth in tourism industry. The expansion of the tourism industry has caused an increase in water demand. In recent years, the available water resources have been under pressure due to increasing demands by tourism industry and domestic water supply, and the water supply shortage is more acute during dry spell (June, July and August). The situation is further aggravated because at the same time, these periods are the peak season for tourist arrivals. From the survey of water consumption study made, the estimated water consumption in the study area is approximately 1 MLD. Groundwater is a potential source of water to meet the demand in the island (Daulay *et al*., 2001).

Geologically, the island is made up of mainly Triassic granite with Permian volcanics on the eastern part. Low-lying areas are underlain by alluvium consisting of silt, sand and gravel with some clays and corals. The alluvium in the Kg. Salang area overlay the granite. The alluvial deposits, which comprise of clay, fine sand to fine gravel ranges in thickness from <1 m to about 30 m. Groundwater could be tapped in areas where the aquifer is thin by constructing both vertical and horizontal wells to complement the existing surface water supply (Mohd Nazan, 1998; JMG Pahang, 2002). Conjunctive use of water resources has also been proposed in managing the water supply system (Saim, 1999). Pumping test conducted on three recently completed wells in Kg. Salang indicated the capability of 0.4 MLD. Managed Aquifer Recharge (MAR) describes intentional storage and treatment of water in aquifers. The term 'artificial recharge' has also been used to describe this, but adverse connotations of 'artificial', in a society where community participation in water resources management is becoming more prevalent, suggested that it was time for a new name. Managed recharge is intentional as opposed to the effects of land clearing, irrigation, and installing water mains where recharge increases are incidental (Bouwer, 2002). MAR has also been called enhanced recharge, water banking and sustainable underground storage. MAR is part of the groundwater manager's tools, which may be useful for re-pressurising aquifers subject to declining yields, saline intrusion or land subsidence. On its own it is not a cure for over-exploited aquifers, and could merely enhance rates of abstraction. However, it may play an important role as part of a package of measures to control abstraction and restore the groundwater balance. MAR can also play a central role in water harvesting and reuse. Many cities drain storm water into aquifers via infiltration basins, sumps or wells and subsequently reuse this water in drinking or irrigation supplies. MAR technique is proposed to increase groundwater capacity to meet the demand in the study area.

There are 3 methods of MAR that could be used in the study area, i) subsurface dam to increase groundwater capacity and to tap the groundwater runoff; ii) horizontal well and well point system, large diameter well or radial well could also be considered in sustaining the water demand; and iii) aquifer recharge by channelling surface water from one of the rivers to a recharge ditch near the wellfield.

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Paper A16

Groundwater contamination in North Kelantan: How serious?

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Groundwater is a major source of public water supply in Kelantan, which constitutes 47% of the total water supply. In the northern part of Kelantan, groundwater contributes about 90% of the total drinking water demand in the area. A number of groundwater wellfields and monitoring wells have been established in the area. The groundwater is mainly used for potable water supply, as well as for agricultural and industrial purposes.

At present, the groundwater consumption is about 146 Ml/d obtained from 94 production wells at 14 wellfields and treated at 7 groundwater treatment plants (Figure 1 & Table 1). Groundwater from these wellfields is drawn from shallow aquifer system except in Tanjung Mas, and new wells at Pintu Geng and Kg. Puteh. The demand for groundwater in potable use is estimated to be 165 Ml/d in 2010 and will increase at a pace of 2.5% per year (Ismail, 2009).

The North Kelantan River Basin is underlain by unconsolidated Quaternary alluvium of marine and fluviatile origin, with thickness from a few meters to more than 200 m. These alluvial deposits thicken towards the coast. Bedrock in the south-western part of the Basin consists predominantly of Permian shale, sandstone, phyllite, slate and volcanic rocks, with granitic rocks are found in the east (MacDonald, 1967).

The alluvium consists mainly of medium to coarse sand with interlayering of gravel, clay and silt. The sand layers of different thickness occur separated by silt or clay layers locally forming the confining layers. The shallow sand layers are generally unconfined with areas of confined and semi-confined occurring locally.

The alluvial aquifers in the study area constitute an important source of groundwater for public water supply and contribute to the 90% of the total drinking water demand. The aquifers consist of two main aquifer systems known as shallow aquifer which is mostly unconfined but occasionally confined or semi-confined, with thickness normally 2-3 m and may reach up to 17.5 m, usually referred to as first aquifer. The second is deep aquifer which is mainly confined, with thickness usually more than 15 m. This deep aquifer comprises three different layers, separated from each other by semi-permeable strata of silt, normally referred to as the second, third and fourth aquifer (Saim, 1997).

These two main aquifer systems are hydraulically interconnected especially the first and the second aquifer as they are mainly separated by semi-permeable strata of silt. The interconnection between the shallow and deeper aquifers, or leakage from the lower or upper aquifers depends significantly on the lithology of the aquifer at a particular location.

The first aquifer is notably productive for development; however, since it is shallow, it is threatened by pollution as groundwater development is concentrated in the populated area of Kota Bharu town. The second aquifer is generally not suitable for large-scale exploitation as the groundwater from this layer of aquifer is normally saline. The third aquifer is the most promising in terms of production and also protected from potential pollution. The fourth aquifer is not distributed uniformly throughout the entire region as it forms the contact with the underlying granite or meta-sedimentary rocks. Regionally, the groundwater flows north to north-east.

The population growth heightens the risk of contamination of the groundwater. The unsystematic sewage treatment and waste disposal expose the water resources to biological contamination such as Coliform and *E. coli*. Industrial sectors also contribute to the increase in risk of groundwater contamination. Automobile workshops, for example, have the potential to cause oil and grease contamination. The same goes with petrol stations when there is a leakage in the underground storage tank.

Agricultural sectors, on the other hand, contribute to the contamination through the use of fertilisers which increase the contents of nitrate and nitrite in the soil and subsequently seep through to the groundwater. Heavy pumping of groundwater during dry season (January to March) for tobacco crop causes groundwater levels to drop and might induce saltwater intrusion particularly in areas near the coastal line. But in reality, there are no significant groundwater lowering in the area because during the rainy (wet) season from October to December, complete water level recovery occurs. If there is a significant lowering of the water levels, it enhances the flow in the aquifer and increase contaminant transport.

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Table 1: Current groundwater abstraction for water supply in Kelantan

No.	Groundwater Treatment Plant	Wellfield	Nos. of Production Wells	Treatment Plant Capacity	Groundwater Abstraction (Ml/d)
1.	Chicha			80.0	62.461
		Zone 1	(19)		34.605
		Pasir Hor	7		
		Penyadap	5		
		Seribong	5		
		Pasir Tumboh	2		
		Zone 2	(10)		10.226
		Kubang Kerian	5		
		Kenali	5		
		Zone 3	(2)		8.911
		Chicha A	2		
		Zone 4	(2)		8.719
		Chicha B	2		
2.	Kg. Puteh		(28)	40.0	48.000
		Kg. Puteh	20		37.200
		Kota	8		10.800
3.	Pintu Geng	Pintu Geng	10	8.0	9.696
4.	Tanjung Mas	Tanjung Mas	8	10.0	9.875
5.	Wakaf Bharu	Wakaf Bharu	9	19.0	9.642
6.	Kg. Chap	Kg. Chap	4	4.9	3.498
7.	Perol	Perol	2	3.2	2.642
	TOTAL		**94**	**168.9**	**145.814**

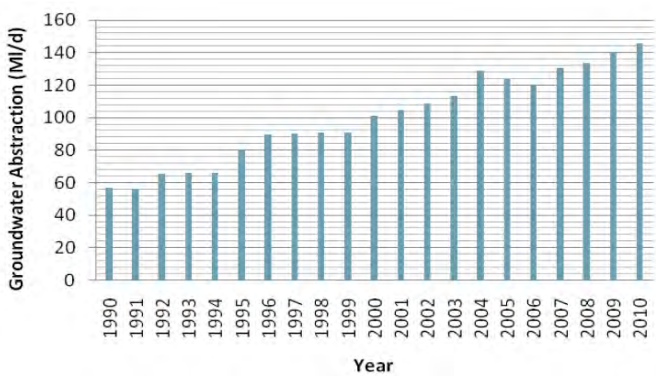

Figure 1: Total groundwater production by AKSB (1990-2010).

Paper A17

Penglibatan JMG Sarawak dalam pembangunan sistem bekalan air graviti Negeri Sarawak

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Jabatan Mineral dan Geosains Malaysia Sarawak (JMG) telah terlibat dalam melaksanakan projek bekalan air graviti di bawah Projek Bekalan Air Luar Bandar – Sistem Alternatif sejak 2006. Sehingga kini, jabatan telah menyiapkan 51 projek dengan kos RM6,435,000.00 yang diterima daripada Kementerian Kemajuan Luar Bandar dan Wilayah (KKLW). Skop-skop projek ialah membangunkan sistem bekalan air graviti bukit dengan menggunakan paip jenis HDPE, dan membina takungan air yang baru atau membaiki/menaiktaraf takungan yang lama. Pelaksanaan projek ini adalah terdiri daripada dua komponen, iaitu, membekal bahan-bahan binaan dan membina/menaiktaraf dengan pembabitan penduduk kampung. Bahan-bahan binaan seperti paip dan aksesori, dan bahan-bahan lain adalah dibekalkan melalui proses sebutharga manakala pemasangan paip, dan pembinaan/naiktaraf/pembaikian takungan air adalah dibuat secara gotong-royong oleh penduduk rumah panjang/kampung dengan dipantau dan diselia oleh kakitangan Jabatan. Sejumlah 2,225 isirumah dengan jumlah penduduk seramai 16,345 orang telah mendapat faedah daripada projek ini.

Involvement of JMG Sarawak in the development of gravity-feed water supply system in Sarawak

The Minerals and Geoscience Department Malaysia, Sarawak (JMG) has been involved in implementing the gravity-feed water supply projects under the Rural Water Supply – Alternative System Project since 2006. Until present, the department had completed 51 projects with a total cost of RM6,435,700.00 received from the Ministry of Rural and Regional Development (KKLW). The scopes of the project are construction of gravity-feed water supply using HDPE pipe and construction of new gravity-feed system or repairing/upgrading the old ones. The project implementation comprises two components: supply of construction materials and construction/installation through community involvement of the villagers. Construction materials such as pipes and accessories, and other building materials were supplied through the quotation process whereas the installation of pipes, and construction / upgrading / repair of dam was carried out by the villagers through 'gotong-royong' under the supervision and monitoring by the JMG staff. A total of 2,225 families with a total of 16,345 villagers have benefited from the project.

Paper A18

Kajian fotograf udara untuk geologi kejuruteraan cerun di kawasan Bukit Chendering, Kuala Terengganu

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Pengenalan

Penafsiran fotograf udara merupakan salah satu alat yang sangat penting dalam projek kejuruteraan untuk mendapat gambaran awal mengenai geologi tapak projek pembangunan. Fotograf udara mampu memberi pandangan dalam bentuk tiga dimensi dan memudahkan pengecaman fitur-fitur geologi utama seperti lineamen negatif, parut tanah runtuh, termasuk aliran puing, dan longgokan sisa tanah runtuh yang sedang atau telah berlaku. Memetakan lineamen negatif melalui penafsiran fotograf udara penting kerana dapat memberikan maklumat awal mengenai orientasi dan ketumpatan ketakselanjaran pada batuan dasar. Kawasan yang mempuyai ketumpatan ketakselanjaran yang tinggi, seelok-eloknya perlu dielakkan kerana boleh menimbulkan masalah kejuruteraan pada cerun yang akan dibina. Kajian fotograf udara ini dilakukan di kawasan Bukit Chendering yang terletak lebih kurang 7 km dari bandar Kuala Terengganu. Kajian kes ini menyajikan contoh pentingnya penafsiran fotograf udara dalam sesebuah projek pembangunan berskala besar yang melibatkan pembinaan jalan, bangunan dan cerun di kawasan terbabit.

Bahan dan kaedah

Dalam kajian ini, fotograf udara berskala 1:250000 telah digunakan. Penafsiran fotograf udara ini dilakukan dengan menggunakan alat stereoskop. Setiap maklumat geologi yang penting terutamanya lineamen disurih. Lineamen merupakan kelurusan yang terdapat pada muka, dibentuk oleh permatang-permatang, lurah-lurah serta tebing curam. Lineamen negatif biasanya diwakili oleh ketakselanjaran utama seperti sesar, kekar, retakan dan zon ricih pada batuan. Lineamen yang panjangnya 5 kilometer atau lebih adalah lineamen rantau manakala lineamen yang kurang dari 5 kilometer dianggap sebagai kekar utama atau sesar (Tjia,1971). Bacaan jurus setiap lineamen diukur dan diplotkan dalam gambarajah ros untuk mendapatkan bilangan set lineamen utama beserta orientasi puratanya. Hasil tafsiran fotograf udara ini ditentusahkan melalui pemetaan dan pemeriksaan di lapangan.

Hasil dan perbincangan

Untuk memudahkan analisis data, kawasan kajian telah dibahagikan kepada enam domain (domain A–F). Pembahagian domain dibuat berdasarkan kepada struktur major dan/atau fitur-fitur geomorfologi utama seperti lurah-lurah major, permatang atau lineamen major itu sendiri. Setiap domain itu sendiri dicirikan oleh persamaan formasi batuan seperti unsur geomorfologi, dan corak, ketumpatan dan gaya taburan lineamen. Daripada gambarajah roset yang dihasilkan, jelas terdapat sekurang-kurangnya empat set lineamen major pada setiap domain. Domain A mempuyai enam set lineamen manakala domain C, D, E dan F masing-masing mempuyai lima set. Tiga daripada set lineamen major yang dikesan pada setiap domain berorientasi T-B, TL-BD, dan BD-Tenggara. Darjah ketumpatan lineamen didalam sesebuah domain menentukan keadaan jasad batuan didalamnya. Domain yang berketumpatan lineamen lebih tinggi, contohnya domain C, mempuyai jasad batuan yang lebih rendah berbanding domain A dan B, yang berketumpatan lineamen jauh lebih rendah. Jasad batuan didalam domain C berkeadaan hancur kerana padat dengan ketakselanjaran. Ini menyebabkan pembinaan cerun-cerun potongan didalam domain C mudah terdedah kepada masalah kegagalan. Pelbagai bentuk kegagalan cerun telah ditemui seperti kegagalan baji majmuk, hakisan galur, termasuklah jasad batuan pembentuk cerun yang mudah terurai dengan sendirinya apabila terdedah kepada agen luluhawa dan hakisan. Nilai penanda mutu batuan (RQD) jasad batuan didalam domain C juga lazimnya sangat rendah (0-10%). Sebagai perbandingan, kawasan yang rendah ketumpatan lineamennya seperti domain A, B, D, E dan F, keadaan jasad batuannya tidaklah seburuk domain C. Walaupun terdapat beberapa set lineamen yang sepadan dengan keadaan ketakselanjaran di dalam jasad batuan, masalah kestabilan cerun adalah kurang kritikal berbanding domain C.

Kesimpulan

Hasil kajian menunjukkan penafsiran fotograf udara sangat penting sebagai suatu alat untuk mengesan kehadiran ketakselanjaran didalam jasad batuan pada batuan dasar sebelum sesuatu projek pembinaan dijalankan di sesebuah kawasan. Satah-satah lineamen yang ditafsirkan daripada fotograf udara lazimnya terbukti wujud dilapangan. Dan ini telah dibuktikan melalui pemetaan lapangan. Sekurang-kurangnya empat lineamen yang ditafsirkan daripada fotograf udara wujud sebagai ketakselanjaran di dalam jasad batuan. Kawasan yang lebih tinggi ketumpatan lineamen menandakan batuan dasarnya juga padat dengan ketakselanjaran. Maklumat-maklumat seperti ini sangat penting dalam kerja-kerja kejuruteraan cerun potongan.

Paper A19

Pengaruh cecair larut resap terhadap had-had Atterberg dan sifat pemadatan tanah alluvium

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Katakunci: Cecair larut resap, alluvium, tanah tercemar, had Atterberg, pemadatan

Cecair larut resap merupakan larutan yang terhasil dari kawasan tapak pelupusan sisa pepejal. Peresapan cecair ini ke dalam tanah di kawasan sekitar tapak pelupusan sampah menyebabkan pencemaran terutamanya kepada sumber air bawah tanah. Pencemaran ini bukan sahaja mempengaruhi tahap kualiti malah mengubahsuai sifat-sifat geoteknik tanah yang dicemari. Maklumat ini perlu memandangkan kawasan tapak pelupusan akan digunakan kelak bagi pembangunan semula yang melibatkan kerja-kerja berkaitan penambakan, pendasaran dan sebagainya. Oleh itu, kajian ini bertujuan untuk melihat sifat-sifat geoteknik tanah alluvium yang tercemar dengan cecair larut resap. Sampel-sampel cecair larut resap dan tanah alluvium yang dikaji diambil dari kawasan bekas tapak pelupusan di Sungai Sedu, Banting, Selangor. Sampel-sampel tanah tercemar disediakan dengan mencampurkan cecair larut resap sintetik pada kandungan berbeza iaitu 0, 5, 10 dan 20% terhadap berat kering tanah asas. Berdasarkan hasil kajian ini menunjukkkan tanah alluvium terdiri daripada mineral kuarza, kaolinit, muskovit dan mikroklin. Analisis taburan saiz butiran menunjukkan bahawa sampel kajian adalah jenis pasir lodak berlempung. Hasil ujian graviti tentu pula menunjukkan nilai Gs adalah berjulat antara 2.1 hingga 2.3. Kesan cecair larut resap terhadap had-had Atterberg menunjukkan penyusutan nilai-nilai had cecair (38 hingga 45) dan had plastik (23 hingga 34) dengan pertambahan kandungan bahan cemar. Nilai ketumpatan kering maksimum dan kandungan air optimum menunjukkan penyusutan dengan pertambahan cecair larut resap. Ini menunjukkan bahawa cecair larut resap mampu mempengaruhi sebahagian sifat geoteknik tanah tercemar ini.

Paper A20

Effect of joints on mass properties of limestone - with regard to design of cast *in situ* micropiles

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Keywords: Limestone, mass properties, RQD, deformation modulus, micropile, skin friction

Presence of joints in a rock mass has rendered it to be discontinuous and inhomogeneous in nature. Commonly evaluated in terms of RQD, it is these prevailing joints that make a rock mass to behave quite differently as compared to intact rock samples used in laboratory tests. Usually the intact rock samples are much stronger and relatively more homogeneous than the discontinuous rock mass in the field. Such behaviour of *in situ* rock often leads to some level of uncertainty in evaluating the performance of cast *in situ* micropiles, as their behaviour depends on the condition of surrounding rocks where these piles are socketed. In fact, the rock mass properties like *in situ* modulus and RQD form the essential input parameters for the design of this type of pile, particularly in determining the skin friction between the pile and the rock socket. Surface roughness and strength of the socket wall, main contributors to the skin friction, are very difficult to quantify as they depend on several factors like drilling method and characteristics of the *in situ* rock. It is due to these complex interactions between the pile and surrounding rock mass that the design approach of micropile is semi-empirical in nature. Such design approach often leads to a certain level of uncertainty, especially in verifying the reliability of the adopted design and whether the pile is over- or, under-designed.

This paper highlights some findings on mass properties of limestone in Pandah Indah, Kuala Lumpur. Data analysed are rock properties which are relevant for design of micropile, and were obtained from various laboratory and field assessments. Field tests undertaken include Pressuremeter Test (PMT), Trial Pile Test (TP) and Suspension PS Logging (PS Logging), undertaken in rock mass of known RQD and intact properties. Despite of constraints on reliability and number of field data, there are indications on the existence of correlations between pile behaviour and the discontinuous states of the *in situ* limestone. For example, correlation exists between mobilised skin frictions (F_s) and RQD. The plotted curve (see Figure 1) indicates that within the range of RQD studied, rocks with lower RQD tends to induce a higher F_S. This contrasting behaviour of F_s is probably due to a higher frictional strength at the socket wall, which is contributed by broken rock fragments produced from fracturing of weaker rock (i.e. lower RQD value). A good correlation (R^2 = 0.99) exists between RQD and *in situ* deformation modulus (E_m), where it is found that rock mass with a higher RQD displays a higher E_m. This implies that RQD value can be used for estimating E_m of *in situ* limestone. Further verification shows that for limestone with RQD < 25 %, its value of E_m drops as much as 99 % (relative to intact modulus E_i). Similar trend is observed on the effect of RQD on the dynamic modulus and Poisson's ratio of limestone.

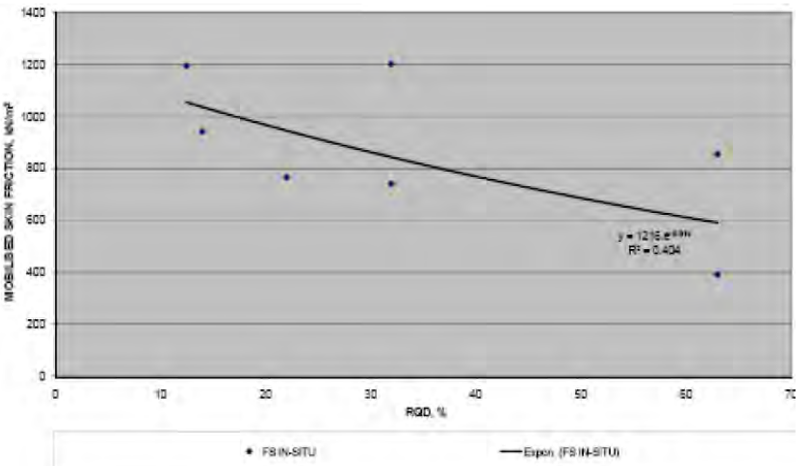

Figure 1: Mobilised ultimate skin friction (measured *in situ*) versus RQD.

Paper A21

Engineering geological mapping of Kundasang Lama landslide, Kundasang, Sabah

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Kundasang area, situated at the foot of Mount Kinabalu, is generally susceptible to landslides. Several landslide systems known as Kundasang Landslide Complex were reported occurring in the area, and is still active. In April 2011, a number of new landslides occurred in Kundasang after consecutive days of prolonged rain. Among the affected areas, the most hard-hit was Kampung Kundasang Lama, where a 230 m x 450 m-sized landslide had paralyzed the roads leading to several villages and structurally impaired the foundation of a resort hotel. A walkover detailed mapping of 1 m grid size was carried out on Kundasang Lama Landslide to record rock types and materials, geometry, deformation and geodynamic features around the landslide area; including scarps, bulging units, cracks, direction/dimension of movement, seepages, and changes to built structures and vegetation. Sequential aerial photograph and satellite image interpretation from 1967 to 2008 was performed in determining geomorphology and historical changes to the area. Previous field mapping in 2003-2010 and GIS terrain modeling were also used to complement analysis. The result of this engineering geological mapping will facilitate investigation to identify causing factors, risk, and potential impact to the surrounding community. Based on this mapping, mitigation and future development plans could be charted for this landslide region.

Pemetaan geologi kejuruteraan gelinciran tanah Kundasang Lama, Kundasang, Sabah

Kawasan Kundasang yang terletak di kaki Gunung Kinabalu umumnya rentan terhadap gelinciran tanah. Beberapa sistem sistem gelinciran tanah yang dikenali sebagai Kompleks Gelinciran Tanah Kundasang dilaporkan berlaku, dan masih lagi aktif pergerakannya. Pada April 2011, beberapa kejadian gelinciran tanah berlaku lagi di sekitar Kundasang setelah hujan yang lebat dan berlarutan beberapa hari. Antaranya, gelinciran tanah di Kampung Kundasang Lama di mana gelinciran tanah bersaiz sekitar 230m x 450m ini telah melumpuhkan hubungan jalan ke kawasan perkampungan dan menjejaskan pendasaran satu hotel resort. Lanjutan ini, pemetaan geologi kejuruteraan telah dijalankan untuk menyiasat fenomena Gelinciran Kundasang Lama ini. Teknik pemetaan di lapangan secara jalan kaki pada grid 1m untuk merekodkan jenis batuan dan bahan, geometri, fitur deformasi dan geodinamik di kawasan gelinciran tanah seperti cenuram, gembung, retakan/canggaan, arah/dimensi gerakan, mata air, dan perubahan pada tumbuhan/ struktur buatan. Analisis beberapa siri fotograf udara dan imej satelit dari tahun 1967 hingga 2008 juga dijalankan untuk melihat sejarah perubahan pada kawasan gelinciran tanah dan geomorfologi. Pemetaan ini turut disokong data lapangan yang direkodkan sekitar tahun 2003-2010 dan data model terain GIS untuk membuat analisis. Hasil pemetaan membolehkan tafsiran dapat dilakukan untuk menentukan faktor yang mempengaruhi gelinciran tanah, menilai risiko dan potensi impak kepada komuniti di kawasan sekitarnya. Berasaskan pemetaan ini, satu cadangan mitigasi dan pembagunan masa depan di kawasan ini dapat dilakukan.

Paper A22

Nature of occurrences and sustainable groundwater resources of hard rock aquifers — Small islands of Johor, Malaysia

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Small islands usually have problems with potable water for the daily needs. Furthermore shallow aquifers contribute little or insignificant amount for the daily needs of the islands.

The Department of Minerals and Geoscience Malaysia (JMG) has initiated a study to further explore the deep hard rock aquifers of Johor small islands, particularly at Pulau Sibu and Pulau Pisang. The exploration works have to take care of all the constraints to develop groundwater resources in small islands, not only on mobilization of machines and choice of drilling techniques, but also on the vulnerability of water quality with respect to sea water proximity and locating of highly fractured beds with fresh water.

This effort is first of its kind being done in Malaysia and the results seem very encouraging as the drilling encountered promising water bearing layers at depths and water quality is exceptionally good. With long duration pumping tests at required rate, the wells are producing enough water to the villages and resorts alike. To ensure sustainability of the resources, JMG makes necessary tests, observations and strategies to ensure groundwater resources in these small islands are sufficient for their needs.

Paper A23

Joint patterns in granite and its relationship with its slope failure: Bukit Lanjan rock slide revisited

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Introduction

Geological condition plays an important role in slope stability particularly to major engineering projects such as the construction of dams and highways. The use of 'geologist' to evaluate the natural risks and sites for engineers works has a long history that developed from the lore of our forefathers (George, 2001). The reason for the structural geologist attempts to classify fractures on the basis of their mechanism of formation is that this allows the allocation of each fracture set to a specific stress field or geological setting which is an information that can be critically important in determining the structures evolution of a region and understanding the changes in the regional and local stress fields with time (Hudson *et al.*, 1997). Granite, the rock that is considered as having massive structure is often assumed as stable and suitable for any construction projects. Research and exploitation activities relating to ornamental granite destined for construction industry have in recent years and in various parts of the world become increasingly significant (Taboada *et al*., 1999). However, many engineering failures had happened arising from construction on granite terrain particularly in hilly areas. Examples of such failure include the Highland Tower tragedy in 1993, rock slide of Bukit Lanjan in 2003 and landslide of Bukit Antarabangsa in 2008. The Highland Tower tragedy had caused an economic lost of about RM184 million, death of 48 people and left homeless of total 1000 people (Arazi *et al*., 2010). While the Bukit Lanjan rock slide resulted in an economic lost of about RM 836 million as the results of NKVE highway closure for 6 months. The questions are; can such disasters be avoided? Can geologist play roles and provide a clues that such disasters would occur?

Objectives and methodology

This paper attempts to provide answers to the above questions by providing an analysis of a case study of the rock slide at Bukit Lanjan, Damansara. The main objective is to examine the relationship between fracture patterns, road alignment and possible slope failures.

Field studies were conducted on granite outcrops in Damansara and Bukit Lanjan areas with a particular attention given to joints and faults. Measurement of joint planes in terms of strike and dip were conducted in all the major outcrops. A total of 741 measurements were collected from the outcrops within 3 km radius from the location of Bukit Lanjan rock slide. The poles of the joint planes were plotted using GeOrient software and the projections of the poles were presented by contouring to obtain areas of high density. To facilitate the interpretation of joint patterns, the study area was divided into four sections of locations namely L1, L2, L3 and L4 where L1 and L3 reveal very good outcrops from slope cutting around Bukit Lanjan (Figure 1). Block diagram were developed for visualization of the major fracture orientations.

Results and discussions

Results of the plotting of pole to joint planes are shown in Figure 2a. Location 1 and Location 3 were found to have a common joint pattern with three major orientations as follows: (i) Steep dipping of 75^0 to 80^0 towards South-East; (ii) Gentle dipping of 7^0 to 15^0 towards South-East and (iii) Steep dipping of 68^0 to 82^0 towards South-SouthWest. Location 2 and 4, have major joint plane orientations as follows: (i) Steep dipping about 58^0 to 73^0 towards North-East; (ii) Gentle to moderate dipping about 24^0 to 30^0 towards South-West and (iii) Moderate dipping about 57^0 to 65^0 towards North-West.

The representation of the above joint planes is illustrated in a block diagram as shown in Figure 2b. The different orientation of joint pattern between locations maybe due to the presence of faults or exfoliation joints that vary in orientations according to their locations near the surface of the granite body. The important feature of the block diagram from location 1 and 3 is the presence of wedge-shape blocks gently dipping towards South-East as shown in Figure 2b. This wedge-shape block has the potential to slide if it is located at a steep road cut that has the orientation of NorthEast-SouthWest direction. Similar finding was reported to be the reason for the rock slide that blocked the NKVE highway at Bukit Lanjan in 2003 (Gue & Cheah, 2008). Recognizing the importance of this report, it would be important to note that a detail geological report is necessary for hazard identification and the necessary mitigation-measures to protect human life and prevent asset is damage and economic losses.

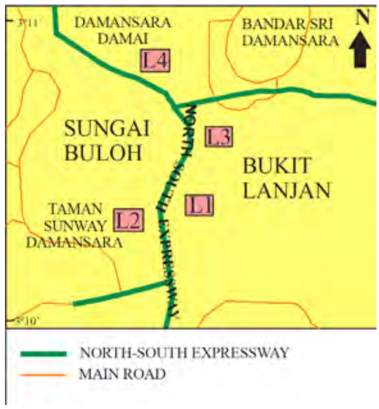

Figure 1: Location of study area and the location of outcrops (L1, L2, L3 and L4).

Conclusion

The rock slide such as the incident in Bukit Lanjan that blocked the NKVE highway for 6 months can be predicted by joint pattern analysis and development of block diagrams oriented according to the alignment of the cut slope. The rock slide could have been prevented should a detail geological report be incoperated in the design of the slope.

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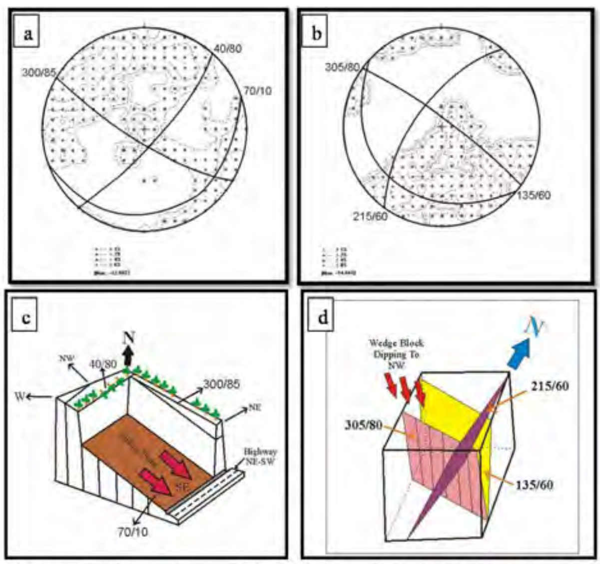

Figure 2: Fa) Equal area projection of poles to joint planes for location L1and L3, b) Equal area projection of poles to joint planes for location L2 and L4. c) Block diagram of joint planes showing the presence of wedge block for location L1 and L3 and d) Block diagram of joint planes showing the presence of wedge block for location L2 and L4 respectively.

Paper A24

Engineering properties of residual soil of weathered siltstone of Puncak Alam, Selangor

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In spite of the considerable area at SPK Puncak Alam that is covered by siltstone, little is known about their geotechnical, physical and chemical properties, and the effects of weathering process on them. As this country has heavy rainfalls, the rocks are exposed to wide variation in temperature and high humidity throughout the year. The change in temperature will affect the rock minerals. Richard (1993) reported the natural weathering processes that transform a rock into soil. This include physical weathering processes that fracture and comminute the rock and chemical weathering reaction that destroy the mineral structure. According to Dobereiner (1990) typical weathering profiles of weak sedimentary rocks are subdivided into two types which are shale or siltstone, and shale or siltstone interbedded with sandstone. Siltstone can be considered as in the argillaceous group according to the sizes of its component particles. Based on Nahon (1982) the siltstone is a detrital rock in which the 4-62.5μm granulometric fraction represents more than 50% of the total volume of the rock, are unusual rocks. Due to inconclusive about the residual soil of weathered siltstone, thus this paper presents the result of a study on engineering properties of residual soil of weathered siltstone. The purpose of this study is to investigate and to determine the engineering properties of the residual soil of weathered siltstones. The samples were collected from an area at SPK Puncak Alam. In order to get the information and to check the consistency of engineering properties of siltstone residual soil, five (5) samples was prepared in this study. It involved a series of laboratory works and methods adopted are in accordance with the British Standards BS 1377. The laboratory tests that were carried out are Atterberg limits, sieve analysis, pyknometer test, falling head permeability test, compaction and triaxial test. The purpose of Atterberg limit test is to determine the plastic limit and liquid limit of soil. Wet sieving also known as hydrometer test was conducted to determine the particle size distribution. From this test, the soil sample can be classified based on British Soil Classification System for engineering purposes. The pyknometer test was carried out to determine the particle density and the compaction test using probe machine is to determine the optimum moisture content and maximum dry density. The result of compaction test was used for sample preparation for triaxial test. The falling head test was carried out to determine the permeability of residual soil for the hydraulic conductivity. For this test, undisturbed sample was collected using hand auger. The Unconsolidation Undrained (UU) triaxial test was carried out to determine the shear strength of the residual soil. From the result it was found that, the optimum moisture content of the residual soil is 20.77% and the permeability is 3.745×10^{-5} m/s. The results show that the permeability value of residual soil of weathered siltstone is within the range of silt as given in British Soil Classification System for engineering purposes. The characteristic residual soil of the siltstone are fine grained and loose. The results that were obtained from other physical testing will also be discussed in this paper. In conclusion the results from this study can contribute to rock engineering, since there is little information on the residual soil originated from weathered siltstone. This also can serve as a future reference for researchers on the subject where the materials are residual soil of weathered siltstone.

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Paper A25

Bank infiltration: A case study for an alluvium river bank

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It is known that most surface water sources in Malaysia are polluted by various pollutants coming from landfills, industrial waste and non-point sources of agricultural related activities. The water operator incurred higher cost of water treatment particularly in conventional sedimentation treatment plant in which the high levels of pollutants requires higher volumes of chemicals. At the same time, the disinfection by-product (DBP) is also increasing. Hence, the R&D work is being carried out on Bank Infiltration (BI) or Riverbank Filtration (RBF) method as a form of natural treatment in increasing the quality of water source for public water supply system. Bank infiltration refers to the process of surface water seeping from the bank or bed of a river or lake to the production wells. During the water's passage through the ground, its quality changes due to microbial, chemical and physical processes, and due to mixing with groundwater (Weiss *et al.,* 2005; Singh *et al.,* 2010). The BI study in Jenderam Hilir, Selangor is a pilot project to develop a better and sustainable source of water and will provide a good platform to introduce this method in Malaysia which has been successfully implemented in many Asian and European countries. This site was chosen due to the high water demand in the area and groundwater is seen as one of the source with very high potential to be developed as supplementary to meet the high public water supply demand. Twenty five (25) monitoring wells and 2 test wells were constructed at the study site and pumping tests have been carried on these two test wells. The pumping tests indicated that DW1 and DW2 were able to produced more than 15.9 m^3/hr and 128 m^3/hr respectively during the duration of 72 hours pumping test with drawdown for DW1 is 4.17 m and DW2 is 2.63 m. The distance between the surface water sources and the test well is more than 18 m and the shortest travel time is 10 days. The objective of this study is to determine the effectiveness of BI in reducing selected water quality parameters and improving the quality of river water which is filtered through a 16 m thick silty sand for DW1 and 13 m thick gravely sand for DW2. Both wells are located in confined aquifer close to Sungai Langat, and to determine the effective rate of water extraction between different two lithologies of study area. Water quality sampling was carried out on Sg. Langat and groundwater from the study site. The water quality analysis show decreased in turbidity, arsenic, nitrate, aluminium and sulphate in groundwater from BI well but very high concentrations in Sg. Langat. Microorganism count (Coliform, *E-coli*, *Cryptosporidium* and *Giardia*) was carried out. Results from sampling from the 2 test wells confirmed that a microorganism counts are significantly reduced during the passage in BI and capable to achieve more than 99.9 % removal of *E-coli*, total coliform and *Giardia* as shown in Table 1, 2 and 3. Farizawati (2005) conducted study on *Cryptosporidium* and *Giardia* previously in Sg. Langat. The R&D on BI method is a proactive effort of NAHRIM to improve the surface water quality for domestic drinking water of the modern urbanised area.

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Table 1: Occurrence of Cryptosporidium and Giardia in river water and groundwater samples in Jenderam Hilir, Dengkil, Selangor.

Station No	Sampling Site	Date collected	Sampled volume (L)	Parasitological analysis				
				Concentrated volume (ml)	No. of Giardia cysts counted on the slide	Giardia (cycts/ litre)	No. of Cryptosporidium oocysts on the slide	Cryptosporidium (oocysts/ litre)
SW1	Sungai Langat	20/4/2010	10	10	29	2.9	0	0
SW2	Sungai Langat	20/4/2010	10	10	1	0.1	0	0
DW2	Production well	20/4/2010	10	10	0	0	0	0

Table 2: Occurrence of total coliform and *E. coli* in river water and groundwater sample in Jenderam Hilir, Dengkil taken in May 2010.

Samples	Quantitative Bacteria Analysis	
	Total Coliform	*E. coli*
Sungai Langat	>2420 MPN/100 ml, 35.5± 0.5^{0}C/24 h	488 MPN/100 ml, 35.5± 0.5^{0}C/24 h
DW2	<1.0 MPN/100 ml, 35.5± 0.5^{0}C/24 h	<1.0 MPN/100 ml, 35.5± 0.5^{0}C/24 h

Table 3: Occurrence of total coliform and *E. coli* in river water and groundwater sample in Jenderam Hilir, Dengkil collected in October 2010.

Samples	Quantitative Bacteria Analysis	
	Total Coliform	*E. coli*
Sungai Langat	>2420 MPN/100ml, 35.5± 0.5^{0}C/24 h	1414 MPN/100ml, 35.5± 0.5^{0}C/24 h
DW2	<1.0 MPN/100ml, 35.5± 0.5^{0}C/24 h	<1.0 MPN/100ml, 35.5± 0.5^{0}C/24 h

Paper A26

Geological terrain mapping of South West Santubong Peninsula

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Santubong Peninsula forms a promontory along the South Sarawak coastline some 40 km to the north of Kuching city at the west mouth of the Sarawak River. Much of the peninsula is steep hilly terrain 600 m above sea level. A number of star hotels have been developed along the beaches located at the west coast with a view to ecotourism. Yet there is still potential for further development in the area. Therefore, geological terrain mapping of an area around 20 km^2 was carried out mainly to cater for future land use planning and sustainable development in Santubong Peninsula area. Basic information such as geology, topography, landform and zones which are potentially unstable are required to produce thematic maps. These maps would serve as a guide for the planned development in Santubong Peninsula area. The results of the study showed that 26.5% of the Santubong areas are in Classes I and II, viz. suitable for land development purposes, with low to moderate geotechnical constraints. 73.1% are in Classes III and IV, of which 62.17% which are in Class III are less suitable for development and would have high geotechnical constraints, while 10.93% are in Class IV that are not suitable for development. The Class IV land would encounter extreme geotechnical constraints, require very high development costs and very intensive site investigations. 0.4% of the areas are water bodies which consist of ponds and rivers.

Semenanjung Santubong membentuk sebuah promontori di garispantai Sarawak Selatan 40 km ke utara bandaraya Kuching di muara barat Sungai Sarawak. Kebanyakan semenanjung ini dilitupi oleh terrain berbukit yang curam 600 m di atas paras laut. Beberapa hotel bertaraf bintang telah pun dimajukan di kawasan pantai sepanjang pantai barat dengan tujuan untuk ekopelancungan. Namun masih wujud potensi untuk kemajuan lanjutan di kawasan ini. Oleh itu pemetaan geologi terain untuk kawasan berkeluasan 20 km^2 telah dilakukan bagi membantu dalam merancang gunatanah dan pembangunan yang lestari. Maklumat-maklumat asas seperti geologi, topografi, bentuk bumi serta zon-zon yang tidak stabil dicerap bagi menghasilkan peta-peta tematik. Peta-peta ini kemudiannya digunakan sebagai panduan untuk pembangunan yang dirancang bagi Semenanjung Santubong. Hasilnya, kajian memunjukkan bahawa 26.5% kawasan kajian iaitu bahagian tenggara Semenanjung Santubong adalah dalam Kelas I dan Kelas II, iaitu sesuai untuk sebarang pembangunan dengan kekangan geoteknikal yang rendah ke sederhana. 73.1% adalah dalam Kelas III dan IV yang mana 62.17% yang berada dalam Kelas III adalah tidak sesuai untuk pembangunan dan mempunyai kekangan geoteknikal yang tinggi, sementara 10.93% yang berada dalam Kelas IV adalah langsung tidak sesuai untuk sebarang pembangunan. Kawasan dengan Kelas IV juga mempunyai kekangan geoteknikal yang ekstrim, kos pembangunan yang tinggi dan akan memerlukan penyiasatan tapak yang sangat intensif. Sebahagian kecil iaitu 0.4% merupakan jasad air terdiri dari kolam dan sungai.

Paper A27

Jujukan fasies batuan Pulau Singa Besar dan Pulau Singa Kecil, barat laut Pulau Langkawi

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Pengenalan

Pulau Singa Besar dan Pulau Singa Kecil merupakan sebahagian daripada gugusan kepulauan yang terletak di bahagian barat daya Pulau Langkawi. Keseluruhan pulau dibentuk oleh singkapan batuan Formasi Singa dan Formasi Chuping. Singkapan kajian terdiri daripada singkapan pantai dan singkapan bukit dua buah pulau berasingan di bahagian timur laut Pulau Singa Besar dan Pulau Singa Kecil. Singkapan ini merupakan unit atas batuan Formasi Singa yang secara umumnya terdiri daripada batu lumpur, batu lodak dan batu pasir yang saling berselanglapis dan membentuk lapisan terputus-putus. Di beberapa bahagian, lapisan batu pasir halus dan batu lumpur bersifat tebal hingga masif. Bahagian atas Formasi Singa di Pulau Langkawi ditindih secara selaras oleh Formasi Chuping di mana sempadan selaras ditemui di Pulau Singa Besar dan Pulau Singa Kecil (Ahmad Jantan, 1973). Lapisan batuan di sini umumnya berjurus baratlaut-tenggara dan mempunyai kemiringan lapisan ke arah timur laut.

Bahan dan kaedah

Terdapat enam log sedimen yang telah dipetakan di kawasan kajian mengikut jujukan yang dilihat berterusan. Pemetaan log sedimen dilakukan dari jujukan tua ke muda iaitu dari barat ke timur. Arah jujukan memuda lapisan dikenalpasti melalui struktur-struktur sedimen seperti kas beban dan lapisan tergred. Huraian mengenai struktur-struktur sedimen, saiz butiran dan warna batuan dilakukan di lapangan dan ditandakan di dalam log sedimen. Persampelan dilakukan dan ditandakan di dalam log sedimen dan peta dasar. Setiap log dikorelasikan mengikut kesamaan fasies batuan.

Analisis makmal melibatkan analisis petrografi di mana beberapa sampel dipilih untuk dijadikan irisan nipis, terdiri daripada batuan keras dan lembut. Bagi batuan yang lembut, sampel dikeraskan terlebih dahulu dengan larutan asid aseton sebelum diproses. Sampel-sampel dipotong dan diproses sehingga mencapai ketebalan lebih kurang 0.003mm sebelum dilakukan analisis di bawah mikroskop cahaya. Seterusnya, pengelasan dan penamaan batuan diberikan bagi mengetahui batuan punca dan menafsir sekitaran pengenapan batuan.

Hasil dan perbincangan

Log sedimen terperinci telah dibina bagi beberapa singkapan batuan Formasi Singa merangkumi bahagian timur laut Pulau Singa Besar dan Pulau Singa Kecil. Jujukan Formasi Singa di sini memperlihatkan empat fasies utama mengikut penamaan fasies (Reading H.G, 1978) di mana setiap fasies dikelaskan kepada beberapa subfasies berdasarkan kehadiran pelbagai struktur sedimen. Antara struktur sedimen termasuklah lapisan silang planar dan palung, lapisan dan laminasi selari, nendatan, struktur *flaser,* struktur kekanta, riak, dan kesan aktiviti organisma.

Fasies-fasies yang dikenalpasti terdiri daripada fasies heterolitik, fasies batu pasir, fasies batu lumpur dan fasies diamiktit. Jujukan sedimen yang dikaji mengandungi lima sekutuan fasies yang dikenalpasti iaitu sekutuan fasies batu pasir tebal, sekutuan fasies batu lumpur tebal, sekutuan fasies heterolitik tebal, sekutuan fasies batu lumpur berselanglapis dengan batu pasir dan sekutuan fasies heterolitik berselanglapis dengan batu pasir. Sekutuan-sekutuan ini ditafsirkan terenap di sekitaran laut cetek iaitu dari muara hingga zon neritik. Pelbagai fosil surihan yang ditemui tergolong dalam iknofasies *Cruziana* iaitu korekan mendatar, rayapan permukaan, korekan mengufuk dan korekan berbentuk tiub-U yang menggambarkan sekitaran hidupan laut cetek iaitu di sekitaran sublitoral. Beberapa fosil di dalam fasies batu lumpur dikenalpasti iaitu *Spinomartinia prolifica* Waterhouse, *Bandoproductus* sp., *Deltopecten,* karang tabulata dan osikel krinoid yang mana lebih mirip kepada fauna berusia Sakmarian yang pernah dilaporkan daripada Ko Yao Nai di selatan Thai. Struktur batu jatuh di dalam batu lumpur menunjukkan batu lumpur berpebel adalah diamiktit glasier samudera dan bukti fosil menunjukkan kawasan kajian berikilim sejuk dan terletak berhampiran dengan benua Gondwana (Mohd. Shafeea Leman, 1997).

Pada bahagian sempadan antara Formasi Singa dan Formasi Chuping dijumpai zon peralihan berketebalan 20 cm yang memperlihatkan susunan butiran bergred mengkasar ke atas dengan kehadiran sedikit laminasi lumpur. Di bahagian lain pula dijumpai zon peralihan yang terdiri daripada batu pasir berkapur. Zon ini menunjukkan perubahan beransur-ansur peralihan Formasi Singa kepada litologi batu kapur Formasi Chuping yang mana berwarna cerah, berlapis nipis, kaya dengan nodul rijang dan lazimnya mengalami pendolomitan.

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Paper A28

Facies analysis and sandstone diagenesis of the Tajau Member, Kudat Formation, Kudat Peninsula, Sabah

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Summary

The Kudat Formation is an important part of the geological history of north Sabah developed during Early Neogene after the major uplift of the Crocker Basin *sensu lato*. The Neogene sedimentary facies exposed onshore Sabah were deposited within sedimentary environments ranging from marginal coastal areas which were affected by coastal settings, waves and tidal processes, to shallow submarine region. The Early Miocene sedimentary sequence was deposited during the early development of the shallow marine of the region. The sedimentary unit is widely exposed in the northern part of Kudat Peninsula with special remarks on the Tip of Borneo where excellent exposures can be measured for the facies analysis. The study is intended to investigate and determine the sedimentary sequence and the characteristics of the sandstone to deduce facies association of the Tajau Member, Kudat Formation. Understanding the properties of sandstones is essential in the economic potential from the subsurface sedimentary strata as these properties strongly influenced their reservoir qualities. The Tajau Member of the Kudat Formation, late Early to early Middle Miocene, composed of clastic and limestone facies. The clastic facies composed of mainly thick bedded sandstone interlayered with medium to thin bedded mudstone and is represented by well-sorted, fine to coarse grained arenite. The coarse sandy deposits are characterised by hummocky and swaley cross stratification, while the fossiliferous limestone lenses exposed at Suang Pai, Tj. Kapor and Dampirit forming part of the limestone facies of the Tajau Member. The field characteristics of the clastic facies were analysed and interpreted to have formed within the shoreface of a shelf environment. Benthic foraminifera found as the major bioclasts in limestone lenses revealed equivalent environmental deposition to that of the sandstone facies. The depositional environment of the analysed facies was equivalent to littoral zone, with moderate to high energy conditions. The sedimentary structures found can be interpreted as a product of a combination of both bed load sediment transport and sediment falling out of suspension. Sandstones are texturally and mineralogically mature quartz arenite with good sorting, that may retain the primary porosity during the preceding diagenetic level. However, the presence of unstable lithic grains and feldspars in the advancement of diagenetic processes contributed to the reduction of porosity, giving irregular effective porosity, due to deformation by compaction, and susceptibility to chemical alteration. Lithic fragments, feldspars and authigenic cement were altered to form diagenetic mineral suites, which tend to occlude porosity; however, dissolution and chemical reactions of some of the calcareous matrix and grains enhanced secondary porosity development. Most observed porosity in the sequence sandstones is secondary, developed from dissolution of both carbonate cement and unstable framework grains.

Stratigraphy

The established rock units of the area are as shown in Table 1. The oldest rock unit in Kudat Peninsula is the ophiolite sequence (Chert-Spilite Formation) aged Early Cretaceous, which is unconformably overlain by the Late Eocene turbidite sequence, the Crocker Formation. The ophiolite unit is mainly exposed along the Kudat Fault Zone consisting of serpentinite, spilite and chert. The chert layers are highly folded and fractured. The Early Miocene Kudat Formation is unconformably overlying the Crocker Formation and is divided into the Tajau Member and the Sikuati Member. The unconformable boundary between the Crocker Formation and the Kudat Formation can be observed at Kg. Lajong near Sikuati. This paper explains the facies analysis and the sandstone diagenesis of the Tajau Member. The clastic facies comprises of mainly thick bedded sandstone interlayered with medium to thin bedded mudstone identified as shoreface depositional environment (Table 2).

Facies Characteristics of the Tajau Sandstones

The Tajau Member is composed of clastic facies and limestone facies. The clastic facies comprises of mainly thick bedded sandstone interlayered with medium to thin bedded mudstone (Table 2). The thickness of the sandstone layer is up to 4 m and the maximum thickness of the mud layer is 50 cm occupying most of the tip of Kudat Peninsula. Very thick amalgamated sandstone layers can be observed at Tiga Papan with a measured section up to 38 m. The sandstone is represented by well-sorted, fine to coarse grained arenite. The coarse sandy deposits are characterized by hummocky cross-stratification and swaley cross stratification, interpreted as shoreface deposits (Walker, 1984). The sandstone sequence has the following features:

Amalgamated and low angle planar cross-stratified coarse grained sandstone
Hummocky-swaley cross-stratified fine to coarse grained sandstone
Rare hummocky cross-stratified fine grained sandstone-siltstone

The characteristics of the sandstone beds are interpreted to have formed within a shoreface of a littoral environment. The thicker beds indicate abundant supply of terrigenous sediments from the beach environments during storms. Benthic foraminifera found as lenses and incorporated with the sand grains indicated a water depth just below tidal zone. This type of facies is equivalent to upper littoral, moderate to high energy conditions. The sediment structures found can be interpreted as a product of a combination of both bedload sediment transport and sediment falling out of suspension.

Characteristics of Sandstone Diagenesis

The Tajau sandstone facies is represented by well-sorted, fine to coarse grained sandstone. Early deposited of the facies have largely been affected by the initial phase of physical compaction and this effect progressively accelerated with increasing depth of burial. The grains were squeezed and extruded between rigid sand particles blocking the throats and leaving abundant unconnected pores. In this study, development of pseudomatrix by crushing of soft lithic grains is a common phenomenon in Tajau sandstone that significantly affected the sandstone porosity and permeability (Sanudin Tahir *et al*., 2009). In few samples, locally developed K-feldspar overgrowths as euhedral crystal on detrital feldspar grains partially stabilize the grain framework and locally arresting grain compaction. Calcite is susceptible to the presence of acidic fluids. The development of secondary porosity as the common diagenetic feature largely depends on the leaching of feldspar as detrital grain and dissolution of calcite cement suggests the dissolution of stable grains as a mechanism of secondary porosity development in the Tajau Sandstone. Leaching and dissolution process lead to the formation of clay minerals and quartz overgrowth in the subsequent stages.

Grain framework as detrital of the Tajau Sandstones is dominated by quartz, feldspar and lithic fragments. Cement component recognized in this study include quartz, kaolinite, calcite, illite and chlorite. Grain-coating illite and calcite are locally abundant in most of the samples showing early diagenetic cements. Kaolinite locally developed and accelerated the minor porosity loss due to pore-occlusion. Kaolinite has been interpreted to be a by-product at the expense of K-feldspar at depth temperature as a result of the diagenetic advancement. Kaolinite formation probably predates the quartz overgrowth cement. Early diagenesis in sandstones took place in low ionic concentration waters which generated dissolution secondary porosity and formed kaolinite. Chlorite occurs as pore-lining and pore filling cement. Quartz overgrowth is generally pore occluding cement in some of the samples. Quartz overgrowth is estimated to be the final stage of diagenesis observed

Table 1: Stratigraphy of Kudat Peninsula.

AGE		North Sabah (Sanudin & Baba, 2007)	North Sabah Stratigraphy (Bol & Van Hoon, 1980)	North Offshore (Foo, 1982)	Banggi & Kudat (Tjia, 1988)
HOLOCENE				Aluvium	Aluvium
PLEISTOCENE		Timohing Fm			Timohing Fm
PLIOCENE		Bongaya Fm	Late Post Geosyncline Stage 4		
MIOCENE	LATE	Hiatus			Bongaya Fm
	MIDDLE	Wariu Fm		Bongaya Fm	South Banggi Fm
	EARLY	Kudat Fm	Early Post Geosyncline	Kudat Fm	Crocker Fm
OLIGOCENE		Crocker Fm	Late Post Geosyncline Stage 2	Crocker Fm	
EOCENE					
PALAEOCENE			Eugeosyncline Stage 1		Chert Spilite
CRETACEOUS		Ophiolite			

Table 2: Shoreface depositional environment of the Tajau Sandstone (Sanudin Tahir *et al*., 2009).

Rock Unit	Lithology	Grain Size and Sorting	Sedimentary Structure
Amalgamated Sandstone	Very thick sandstone interbeded with thin mudstone	Moderately to coarse grain with good sorting	Amalgamated planar cross-stratification with swaley cross bedding
Thick Sandstone	Thick sandstone interbedded with mudstone	Moderately to coarse grain with good sorting, fining upward sequence	Hummocky – swaley cross-stratification with common cross lamination
Thinly bedded Sandstone	Interbedded sandstone and shale (<.6 meter)	Moderately to coarse grain with good sorting, fining upward sequence	Hummocky and planar Cross- stratification with convolute structure

prior telodiagenetic stage of the Tajau sandstone. It developed from pressure dissolution forming minute euhedral crystals and locally as large pyramidal crystals in the primary pores (Fuctherbauer, 1967). The presence of illite associated with kaolinite flakes either as coatings on detrital grains or surrounds kaolinite flakes on grain surfaces. Illite also observed growing out into pore-filling kaolinite aggregates. Porosity, permeability and cement volume exhibit good agreement to each other occurred within the mesodiagenetic stage. Thus, the sandstones of the Tajau Member, Kudat Formation are generally fair porosity, due to the long history of diagenetic processes in a deep burial stage.

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Paper A29

Facies analysis of the Late Miocene Belait Formation of Labuan

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Introduction

A traverse was made for sedimentological investigation of interbedded sandstone and mudstone sequence in the Late Miocene Belait Formation strata across about 2 km of the exposed section of northern tip of Labuan Island. The Belait Formation in Labuan is conformably underlain by the Setap Shale. The field characteristics of the clastic sequence were studied by using facies analysis method and interpreted to have formed within the shoreface and equivalent environments. The presence of hummocky cross-stratification, swaley cross-stratification, deep depositional scours, and intraformational conglomerates indicates that storms were an important depositional agent during the accumulation of the sedimentary sequence. Swaley cross-stratification is a relatively recognised feature of storm influenced shoreface deposits, and so far has not been reported from any localities in Labuan. Combining information from trace fossils and sedimentary structures allows the subdivision of the sequence into deposits of the upper shoreface, lower shoreface and distal lower shoreface. The sediment structures found can be interpreted as a product of a combination of both bed load sediment transport and sediment falling out of suspension. The clastic facies composed of mainly thick bedded sandstone interlayered with medium to thin bedded shale and is represented by well-sorted, fine to coarse grained arenite. The coarse sandy deposits are characterized by hummocky and swaley cross stratification. Sandstones are texturally and mineralogically mature quartz arenites with good sorting. However, the presence of unstable lithic grains and feldspars during diagenetic processes contributed to the reduction of porosity, due to compaction by increased of burial, and susceptibility to chemical alteration.

Methodology and Result

From the field observations, the oldest rock unit of Labuan is the Crocker Formation graded from thick sandy sequence to shaly unit, the Temburong Formation aged Late Eocene to early Miocene. From the sections measured, both rock units are unconformably overlain by the Setap Shale. The young geologist is hardly differentiating between the Temburong Formation and the Setap Shale in the field due to almost equivalent characteristics of the argillaceous sequences of both units. However, both units can be differentiated by the presence of turbidite characteristic of Bouma (2006 & 2004) in the sandstone layers of the Temburong Formation compare to that of the Setap Shale of littoral environment and is separated by the Middle Miocene unconformity (Sanudin Tahir *et al*., 2009). The distribution of the rock units are as shown in Figure1. Figure 2 shows the lithostratigraphy of Pulau Labuan.

Two kilometer-sections were measured with varying degrees of detail during this study. Sections were concentrated in the Tip of Labuan (Figure 1). There are two good sections measured and associated together to differentiate the lithofacies changes between sections. Tracing towards the southern section of the tip, complete sections were measured along the traverse. The main outcrops were logged to define grain size, sedimentary structures, bed contacts, stacking patterns and trace fossil distribution. The logs were then analysed and interpreted with respect to the sedimentary structures and other characteristics to determine depositional environments (Hafzan Eva Mansor *et al*., 2010). Numerous partial sections in other locations of the island were also measured in areas to complete the analysis. Facies interpretations and paleocurrent measurements were made along the measured sections. Correlations were made where available and many key beds were identified in the area. The cross section was constructed at the study area to facilitate additional information to conclude the lithofacies as shown in Table 1.

Discussion and conclusions

The depositional history of the Belait Formation was primarily controlled by the Middle Miocene tectonic framework and fluctuations in the sediment supply. The facies represents shoreface depositional environment, influenced by fluctuations of high and low flow regimes. Under these circumstances recurring and frequent sediment transport took place during periods of high shoreface turbulence accompanied with high sediment input. It was intermittently contrasted by periods of low water agitation reflected by the deposition of thick mud. The summary of the facies association is given in Figure 3. The examination of distribution, composition, association and thickness of facies of the Belait Formation helps to evaluate the mechanism to reconstruct the depositional history. On the basis of the dominant facies distribution (Walker 1984), facies association has identified three depositional sequences, namely; upper shoreface, lower shoreface and distal lower shoreface environment.

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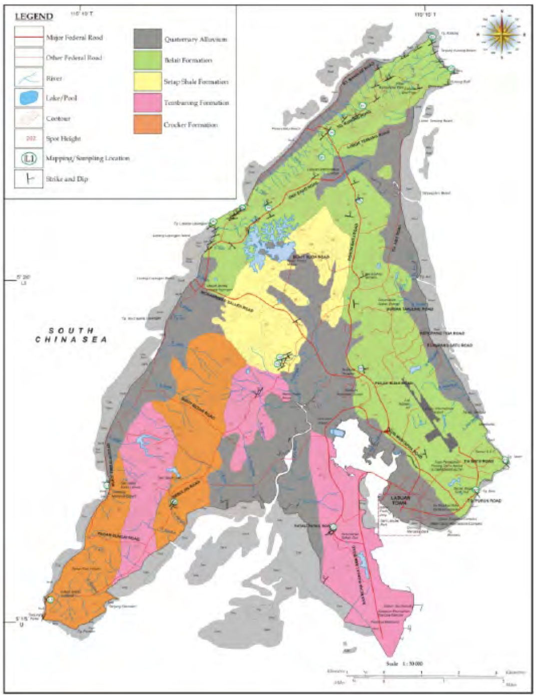

Figure 1: Geological map of the Labuan Island showing the tip of the island (Modified from Wilson & Wong, 1964).

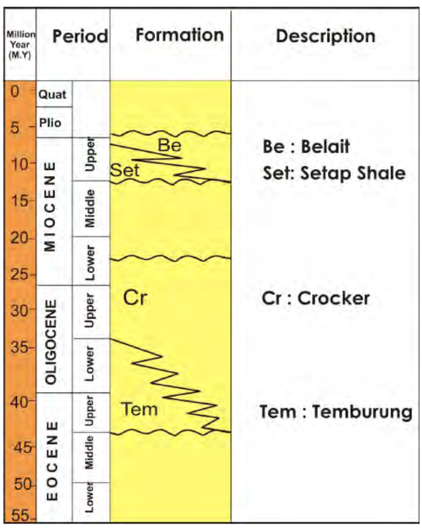

Figure 2: Lithostratigraphic column of the Labuan Island.

Figure 3: Hummocky and Swaley cross beddings in shore face sandstone facies of Belait Formation, Pulau Labuan.

Table 1: Facies analysis of the Late Miocene clastic sequence of the Belait Formation

Lithofacies	Description	Interpretation
A. Planar and bioturbated sandstones: foreshore	This facies is bioturbated sandstone with thicknesses range from 50 cm to approximately 3m. Identifiable trace fossils include *Ophiomorpha* and *Planolites*. These traces are isolated within a mottled disarray of unidentifiable and immeasurable burrows. Planar cross beddings and cross laminations are common with fine to coarse grained amalgamated sandstone layers comprise the upper most marines and sandstone unit of a shoreface facies succession.	Planar beddings and laminations represent seaward-inclined indicative of beach or swash zone deposits. Biogenic rich layers with good sorting indicate the upper portion of the foreshore and estimated to be longshore sediment supply and reworking process via wave energy producing amalgamated sandstone layers. This facies represents the shallowest marine of the succession interpreted as part of the foreshore.
B. Trough cross-stratified sandstones: upper shoreface	Fine- to medium-grained sandstones demonstrate a thickening from under lying HCS and SCS units. These sandstones have good sorting, bleached white and characterized by trough cross-bedding. Large-scale low-angle troughs form cosets up to 15m thick with amalgamated packages. Trough cross stratified sandstones with isolated *Ophiomorpha* are observed throughout this facies.	Trough cross-stratification, rare trace fossils and coarsening upward trends are all indicative of upper shoreface deposits. Upper shoreface sediments are deposited within the breaker zone along a coastline The paleo-current trend usually follows shore-parallel longshore drift currents which is parallel to the coastline. This section is interpreted as upper shoreface.
C. Hummocky and swaley cross-stratified sandstones: middle shoreface (Figure 3)	Very-fine to fine sandstone beds interbedded with mudstone. In the upper portion of the unit, HCS cosets reach up to 2m thick. In the upper sections, both HCS and SCS cosets are thinner and amalgamated. Some layers exhibit combination of hummocky and swaley cross stratification. Lower section show alternate with SCS and planar laminated intervals of almost equivalent thickness.	Sedimentary structures indicate that sediment was deposited near fair-weather wave base within a shallowing upward storm wave dominated succession. SCS and alternating bioturbated and laminated beds suggest periodic storm energies of the middle shoreface. Trace fossils represent typical marine assemblages, but their rarity suggests that sedimentation commonly outpaced burrowing. This part of the sequence is interpreted as middle showface.
D. ssociation of interbedded thin sandstones and shales: lower to distal lower shoreface.	This facies is composed of interbedded siltstones and mudstone with various thickness ratio. Both siltstone and shale intervals contain wavy bedding and planar laminations. Siltstone beds thicken and coarsen upward to very-fine to fine-grained sandstones. Cross lamination is common in the fine sandstone.	Distal lower shoreface facies consists of interbedded mudstones and siltstones reflect alternating conditions from periods of fair-weather to storm events. Distal lower shoreface facies represent the deepest facies seen in this measured section dominated by mudstone interbedded with thin layer of fine sandstone siltstone.

Paper B1

Application of the analytical hierarchy process for landslide risk analysis at Kota Kinabalu, Sabah

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Keywords: Analytic hierarchy process (AHP), landslide risk analysis (LRA), decision making, Kota Kinabalu

A very good landslide risk analysis (LRA) model was developed for the area of Kota Kinabalu, Sabah. Using multivariate statistics, the interactions between spatial factors and landslide distribution were tested, and the importance of individual factor to the LRA was defined. On the basis of the statistical results, landslide prediction model were developed using the Analytical Hierarchy Process (AHP) method. The AHP is defined as theory of measurement through pairwise comparisons and relies on the judgements of experts to derive priority scales. It is these scales that measure intangibles in relative terms. The comparisons are made using a scale of absolute judgements that represents, how much more, one element dominates another with respect to a given attribute. The judgements may be inconsistent, and how to measure inconsistency and improve the judgements, when possible to obtain better consistency is a concern of the AHP. The derived priority scales are synthesised by multiplying them by the priority of their parent nodes and adding for all such nodes. LRA, beside risk evaluation and risk assessment, is part of the holistic concept of risk management. Within this study, LRA is considered only, focussing on the risks to life. To calculate landslide risk, the spatial and temporal probability of occurrence of potential damaging events, as well as the distribution of the elements at risk in space and time, considering also changing vulnerabilities, must be determined. Within this study, a new raster-based approach is developed. Thus, all existent vector data are transformed into raster data. The specific attribute data are attributed to the grid cells, resulting in specific raster data layers for each input parameter. The calculation of the LRA follows a function of the input parameters hazard, damage potential of the elements at risk and their vulnerability. Within the quantitative LRA the associated uncertainties are estimated semi-quantitatively. Ratings of different spatial factors from the best models calculated with the AHP method were derived. The results showed that the geology (17 % variance), geodynamic features (17 % variance), slope conditions (30 % variance), hydrology/hydrogeology (17 % variance), types of landuse (6 % variance), and engineering characteristics of soils (10 % variance), and rocks (10 % variance) play an important role in landslide susceptibility in general. In terms of LRA, the result indicates that 14% of the area is in Very Low Risk zone, 10% in Low Risk zone, 52% in Medium Risk zone, 22% in High Risk zone and 2 % in Very High Risk zone. In the study area the highest risks throughout all of the analyses (individual risk to life and object risk to life) are caused by landslide, showing that risk heavily varies depending on the process considered. The resultant maps show areas, in which the individual risk to life exceeds the acceptable risk (defined in the aforementioned regulation), so that for these locations risk reduction measures should be developed and implemented. Accuracy assessment of landslide risk map was performed using correlation coefficient. The correlation coefficient result is equal 0.88. It can be concluded that the newly developed method works satisfactory and is applicable to further development in Kota Kinabalu, Sabah, and potentially to expand with different environmental settings.

Paper B2

A proposal of rehabilitation after abandonment of Madaripur Open Pit Mine, Madaripur, Bangladesh

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Bangladesh is an agro-economy based country and agriculture at present contributes 19.6% to the national GDP. 61.2 % of the total land of Bangladesh is arable, but because of high population and unplanned land use, amount of cultivable land and forest area are decreasing day by day. Considering the present situation, land reclamation becomes essential for food stability by converting abandoned open pit mines, swampy lands and costal areas into cultivable lands. Reclamation and rehabilitation processes of land have been carrying out in many countries to acquire more usable lands. In this respect the International Institute for Land Reclamation and Improvement (ILRI), founded in 1955 as an independent, non-profit-making institute under the Netherlands Ministry of Agriculture, Nature Management and Fisheries, with the mandate to collect and disseminate knowledge for better and sustainable use of land and water resources, is playing a vital role especially in developing countries. Based on a joint collaboration Project between Bangladesh and the Netherlands for developing new lands, Bangladesh is trying to develop new lands in the coastal area.

Bangladesh is also not rich in energy resources and has to depend on gas resources as energy fuel. Bangladesh is now looking for alternative energy resources as gas production is not sufficient to meet the demand of energy sector. Madaripur, in the central part of Bangladesh, has a large peat deposit having highest reserve with an areal extent of 518 km^2 at shallowest depth in the Holocene sedimentary sequence. Bangladesh Government is attempting to exploit the peat through private investors to use the peat mainly for thermal power generation. The present research proposed optimum reclamation and rehabilitation plan after abandonment of the open pit mine, by considering the geographical and geological conditions, geo-technical characteristics of the soil, techno-economical aspect and environmental impact of the surrounding area. Un-cemented hydraulic slurry backfilling method has been proposed for land reclamation because of low operating cost, suitable for agriculture and environmentally friendly. Soil samples were collected from five locations of three rivers and two cannels to determine the geotechnical properties like standard proctor, direct shear and soil permeability for best matching of back filling materials. All the samples were tested at IMMM (Institute of Mining, Mineralogy and Metallurgy) Laboratory Joypurhat, Bangladesh, under BCSIR (Bangladesh Council of Science and Industrial Research). It was found that Kumar River, that is very close to proposed mine, has got the best soil characteristics for backfilling materials. Appropriate International Standards for reclamation guide have been proposed for the study area that include: overburden must be salvaged as topsoil, reclaimed area should be used for cultivation in proper way, all toxic and hazardous wastes refuse and mine tailings must be safely disposed, surface structures must be removed unless they are converted to a beneficial function in accordance with the approved post-mining land use, any openings must be sealed and measures must be taken to prevent subsidence. The proposed mine area in Madaripur is a low lying marshy area and 1 to 2 m above mean sea level and remains under water more than 6 months of the year. In the proposed reclamation plan, it is suggested to uplift 3-4 m above the mean sea level to keep the area dry round the year and to construct special dam for flood water protection. Considering the soil and climatic conditions of the area the following agricultural issues are proposed for rehabilitation in the reclaimed land: crop modeling, seven crops combination method, crop rotation, consideration of moisture status, selection of sustainable low-input risk-aversion type of crops, consideration of unimodal monsoon climate of the area, selection of best possible rain fed crops and experienced crop pest control selection. Proper implementation of the proposal will lead to additional crop production to ensure local food security, work opportunities for hundreds of thousands people, sustainable environment and poverty alleviation in the proposed area and the growth of national GDP.

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Paper B3

Coals combustion characteristic of selected Pinangah Tertiary coal

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Malaysia has been blessed with different types of energy sources, namely hydrocarbons (oil and natural gas), hydroelectric power, coal and others. However, Malaysia only has 33 years of natural gas reserves and 19 years of oil reserves, whilst the demand for energy is steadily increasing (Salsuwanda & Che Zulzikrami, 2011). So the need for an alternative energy source is vital to meet the demand of population growth. Coal currently constitutes only one fourth of all the sources of energy consumed in Malaysia, behind oil, hydropower and natural gas (Kamaruzzaman & Abdul Halim, 1992). Coal reserves are abundant in Malaysia especially in Sabah and Sarawak. According to the data from World Energy Conference (1983), it is estimated that the total coal resource in Malaysia is 468 millions of tones. However, there are major concerns and problems using coals as energy source, especially the emissions of carbon dioxide, a major greenhouse gas, from coal power plant. In order to overcome this problem, research on carbon dioxide emissions and clean coal technology has intensively taken place for quite sometime. This paper presents results of coal combustion experiment for Pinangah Tertiary coal as a part of research for clean coal technology. Pinangah coal sample used in the study were obtained from the Pinangah areas Sabah, Malaysia, as channel sampling and classified as sub-Bituminous A (subA) or high volatile bituminous C (hvCb) grade. Using a Thermogravimetric analyzer (TGA), Pinangah coal samples are investigated for combustion reactivity purposes. The combustion parameters used are combustion temperature, combustion heating rate, oxygen atmosphere and fluid velocity. The combustion experimental was performed under mild gasification conditions. Thermogravimetric analysis data recorded shows that the Pinangah coal has 56.67% of fix carbon content, 36.68% of volatile matter, 5.10% moisture content, 1.55% ash content and low sulfur content. The results from Pinangah coal were compared with Silantek, Merit-Pila and Mukah-Balingian coals to identify similarities and differences. Silantek coal has the highest content of carbon while Mukah-Balingian coal contains the lowest carbon content. Pinangah coal sample shows 8031 cal/gram in calorific value which is the highest calorific value compare to Mukah-Balingian coal which recorded the lowest calorific value of 4413 cal/gram. The results indicated that the TGA could be qualitatively used in the prediction of burning behavior of coals and Pinangah coal is recommended and not hazardous for energy development systems based on the TGA analysis.

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Paper B4

Seabed morphology and the implications on sand mining at One-Fathom Bank area, Selangor

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The One-Fathom Bank (OFB), also known as Permatang Sedepa, is arguably one of the most strategic oceanographic features in Malaysia territorial waters. Located west of and adjacent to the Klang archipelago, off the West Coast of Peninsular Malaysia, the OFB has always had a major significance where navigation is concerned. As its name suggests, the shallowness of the OFB is a serious impediment to shipping and boat traffic. From an oceanographic standpoint, the OFB may be playing a vital role in mediating chemical and physical processes in the Straits of Malacca. Located roughly where the Indian Ocean and South China Sea fronts meet, the OFB could represent a major nodal point for the current and nutrient movements that both these water bodies bring with them. Such patterns may account for the high bioproductivity of Selangor waters especially off Klang, which accounted for over 25% of the Peninsular Malaysia fish catch.

The sediment transport, littoral currents and pollution dispersal in the region could all be inter-related to the OFB, directly or indirectly, and the hydro-dynamics and chemo-dynamics environment it engenders. This, in turn, governs the environmental health of the Selangor coastline. The OFB also appears to be a major repository of sand resources. Any attempt to mine, dredge or otherwise disturb the OFB and the shoals around its vicinity can have widespread environmental and economic impacts, some of which could have regional as well as national implications. Thus, the study undertaken under the RMKe-9 is directed towards bridging this gap in information on the OFB. It attempts to provide a baseline appraisal of the physical, chemical and biological environment of the OFB and identify its impacts and economic implications towards sand mining.

Paper B5

Sustainable method of using cyanide in gold mining

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Gold mining activity in Malaysia has started since many years back. It has started since around the 1800s. Many of our gold mining activity has started in the state of Pahang. It is because the western Pahang is located along the central gold belt. Gold deposits can be mine using various methods. The methods chosen are based on factors such as the amount of the raw available gold in the soil. For example in Raub, Pahang, this mine is currently using a method known as carbon-in-leach method to replace the old gravitational method used around the 1800s due to its limitation of raw gold. The gold is present in the form of fine flakes therefore it has to be done with the aid of strong chemicals to extract the gold from the soil. This method is done by using a few hazardous chemicals, which can bring great harm to the environment. One of the chemical is sodium cyanide, which can affect human respiratory system if inhale in too large an amount. Cyanide is well known for its toxicity. One teaspoon of cyanide is able to kill a human. Due to this particular reason, a non-governmental agency has been set up internationally to supervise the usage of cyanide. This agency draft a document known as the Cyanide Code. In this document, it is essential to practise according to this document to ensure that cyanide used is safe, well handle, and also dispose properly so that it will not create any havoc for the future generation. It is important to use this method as an early guideline for the public and the local communities. With this guideline, it will certainly improve the living quality of the mining community which include the gold miners and the local community surrounding the gold mine. Although this document play an important role in preserving the environment, unfortunately in Malaysia and other developing countries, many parties are not playing their role in ensuring that the cyanide code is used as a proper reference. Many parties take the cyanide code lightly because it is a draft as a NGO document, whereas in some countries, it has been enforced that cyanide code needs to be obeyed in order to run the operation in the particular factory. Therefore with this paper, it is hope that this issue can be highlighted to the community and also the miners about the presence of the cyanide code and also the importance to put the cyanide code into practise, so that the environment remain healthy and safe for the future generation and also the current communities. At the same time, with this document being highlighted, it is hope that our country will also look into this document more seriously. This document should not be taken lightly if Malaysians want to live in a peaceful and pristine environment as it is now.

Paper B6

Application of electrical resistivity method in road subsurface profiling

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In highway engineering projects such as design, rehabilitation and maintenance of existing pavement, a geotechnical assessment at the proposed site is required. Recently, the most commonly method to obtain subsurface profile is by using borehole drilling, which takes a long period to complete and costly. Even though borehole drilling provides the subsurface depth, but it is only at the sampling location. The data in between the boreholes need to be interpolated and the result was in an assumption data. In road engineering study, the conventional approach to evaluate the properties of asphalts and subgrade soils involves a core sampling procedure and a complicated laboratory testing such as resilient modulus, Marshall Test and Dynamic Cone Penetration test (Livneh *et al*., 1994). In order to improve the method of road subsurface profiling, the use of electrical resistivity as an alternative method was proposed. This paper presents the findings of a study on the application of electrical resistivity method in road subsurface profiling. The purpose of this study is to obtain the road subsurface profile including the thickness of the sub layers. In this study two field tests were carried out, electrical resistivity and Dynamic Cone Penetration test (DCP). The electrical resistivity measurement was conducted at the parking vicinity using ABEM Terrameter SAS4000 LUND Imaging System. Direct current was applied into the ground through two current electrodes and measuring the resulting voltage differences at two potential electrodes. A multi-electrode resistivity data acquisition system proposed by Dahlin (1996) was used. Forty-one electrodes were connected with two multi-cored cables along 20 m road within 0.5 m spacing. By using a computer program RES2DINV, a 2-D image of road subsurface was produced. By inversion analysis, the appropriate resistivity value was determined. The DCP test was conducted to determine the thickness of the surface course, base course, sub-base course and the sub-grade course. Surface course is the upper layer of the pavement while base course is the main pavement structural layer. The sub-base course is the secondary load spreading layer underlying the base meanwhile subgrade course is an embankment on natural earth. The pavement was cored to measure the actual thickness of the structural layer. Then, the DCP test was carried out by dropped the hammer and the data which is the number of blow was recorded. The tip on cone was laid to the testing surface as the first step in DCP test. The lower shaft containing the cone moves independently from the reading rod sitting on the testing surface throughout the test. This process is continued until a desired penetration depth is reached. The resistivity result is produced in the image form. From the resistivity image, the thickness of each road sub surface layers was determined. DCP test resulted the blow counts versus penetration depth which was plotted as a graph as shown in Figure 1. A curve line with four different degrees of gradient was displayed in the graph, which can be interpreted as four straight lines. From the graph, it was interpreted that the different in gradient indicated the subsurface which is consists of four layers. Both results of resistivity image and DCPT graph were compared. It was found that the thickness of each layer in the resistivity image was matched to the layers determined by DCP test. From this study, it can be concluded that the electrical resistivity method can be used to obtain the subsurface information and the thickness of the sub-grades and sub layers. So that the coring method that can damage and defect the road pavement can be avoided.

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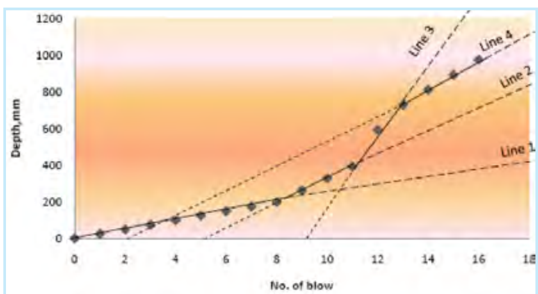

Figure 1: Interpretation of dynamic cone penetration test result.

Paper B7

The use of remote sensing data for iron ore exploration in the western part of Wadi Shatti, District, Libya

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Keywords: remote sensing, iron ore, Wadi Shatti, Libya

This study examines the use of Remote Sensing (RS) technology in geology to discover probable extensions of an iron ore deposit in the western end of Wadi Shatti, Libya. The study area is situated in the province of Sabha, bounded by latitudes 27° and 28° N, and longitudes 12° and 13° 30' E. The territory covering an area of nearly 16,500 km^2. This study deals with the iron ore deposits and its occurrences in the western part of Wadi Shatti area. The deposit is a belt of upper-Devonian sedimentary formation including iron ore bearing layers, which extends over 160 km, in ENE-WSW direction, on the northern border of the Murzuq basin, in the province of Sabha. The western and eastern ends of the iron ore bearing layers are covered by more recent formations which completely covered the ore outcrops (Sterojexport, 1977). Enhanced Thematic Mapper Plus (ETM+) data is registered in eight thematic bands in order to produce false colour image were used in this study. The eight bands are subjected to different methods of statistical analysis and lead to the choice bands 7, 4 and 2 assigned as red, green and blue. Landsat TM images were geometrically corrected and registered. Well distributed control points were interactively selected on both images. The coordinates of these points were compared to determine a polynomial equation for adjustment between them. The images were thus rectified according to the geographic projection (lat/long) and WGS84 datum. Radiometric corrections were applied to remove the effects that alter the spectral characteristics of land features. The two Landsat images Raw no (187, 188) were joined together using mosaicking process after it was registered with the same projection to set one image covering the area of study. Ratio images are known for enhancement of spectral contrasts among the bands considered in the rationing and have successfully been used in mapping alteration zones (Segal, 1983; Kenea, 1997). Ratio images were used in this study for lithologic investigation and mineral discrimination. They were made by dividing the digital (DN) in a band by the DN corresponding to a different tape for each pixel aspect ratio of the resulting value and draw the new values as an image. The selected bands (7, 4, and 2) have been used in the image-supervised classification technique, namely maximum likelihood classifier (MLC) to classify lithological units. Few ore samples were collected from the promising new areas and analyzed by XRD and XRF techniques. The results show new iron ore occurrences located along the western and north-western ends of Wadi -Shatti iron ore deposit. The new finding of these iron ore bodies may give new information about the extension of iron ore deposit in Wadi Shatti area. A new potential map of the iron ore bodies indicating new area of the mineral occurrences will be produced.

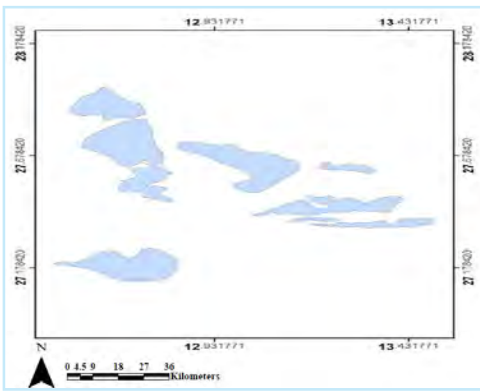

Figure 1: Iron ore deposit potential map of the study area.

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Paper B8

Lineament analysis for groundwater exploration using remotely-sensed imagery in upper Langat Basin

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Remote sensing technique is popular in groundwater exploration due to several advantages of spatial and spectral data, having access to large coverage and inaccessible areas with regular revisit capability. Lineaments are long and linear geological structures (faults and/or joints) that may be represented on satellite images as a straight course of streams, vegetation alignment or topographic features such as aligned ridges. Lineaments play an important role in groundwater recharge in hard rock terrains which act as conduits for groundwater flow, and hence hydrogeologically significant. A number of researchers have been engaged recently in applications of using lineament for groundwater studies (Mondal *et al.,* 2007; Ettazarini *et al*., 2007; Prasad *et al*., 2008, Madrucci, 2008; Dhakate *et al*., 2008; Pradhan, 2009).

The main objective of this paper is to test the hypothesis that the groundwater occurrence of the study area is controlled by the lineaments (fractures). This is done by analyzing the spatial distribution and statistical analysis of lineaments extracted from remotely sensed image. The study area covers parts of the Upper Langat Basin and located in Hulu Langat district of Selangor state, Malaysia. It is within the latitude 2^o 53' north to 3^o 15' north and longitude 101^o 43' east to 101^o 58' east, with an area of around 500 km square. In this study, satellite image of Landsat 5 TM imagery (path/row 127/058) acquired on 18 July 2004, was obtained from Agency of Remote Sensing Malaysia (Remote Sensing Malaysia). In general the quality of the imagery is good and with less visible cloud. Lineament map was prepared by visual interpretation of geocoded satellite image using false colour composite, by morphological analysis using 1:50,000 scale topographical maps and the digital elevation model (DEM). Contrast linear stretching of individual bands, sobel directional filtering and high pass directional filtering was also performed to improve the interpretability of geological structure. The extracted information then was carefully matched with the previous mapped structural features from existing published geological map.

The results show that the concentration of lineaments is more in northeastern and south-western part of the study area. The lineament map of the study area reveals the presence of structural features such as fault and lineaments. A total of 121 lineaments were identified with a rose diagram (the azimuth length and azimuth-frequency plots) show two prominent structural directions of lineaments; NE-SW and NNW-SSE. Minimum lineament length is 1.28 m and the longest lineament observed was 20,737 m. The trend of interpreted lineament is similar to that of faults in Kuala Lumpur area as described by Hutchinson & Tan, 2009. Lineament density map was prepared from the lineament map to identify the fracture concentration using IDW interpolation method. Lineament density means cumulative length of lineaments per unit area. The highest lineament density (> 0.0075 km/sq. km) is found in the eastern side of the basin whereas the lowest density (< 0.0015 km/sq. km) is recorded as isolated patches over the entire basin. The area of higher lineament density has secondary porosity like joints and fractures and considered to be potential sites for locating high-yielding wells. Proximity analysis shows that groundwater borehole wells with higher yields are located near to the lineament. A statistical analysis of yield and distance to the major lineaments reveals a negative low correlation coefficient of 0.326 and coefficient of determination R^2 of 0.106. Proximity and statistical analysis was also performed to determine the significant correlation between dependent variables of well yield and explanatory variables of lineament intersection. However the results indicate no significant correlation or little if any correlation (standardized coefficient = -0.138 and $R^2 = 0.019$) between the two variables.

It concluded that the results output definitely support the hypothesis of fracture controlled groundwater occurrence of the study area. These results can be used for future planning of groundwater exploration and development by related government agencies and private sectors in Malaysia. The results may be also transferable to other areas of similar hydrological characteristics.

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Paper B9

Understanding the mechanism effect of the subduction process to the surface seismicity and volcanic activity in Central Java, Indonesia by using high resolution tomography

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High resolution subsurface seismic velocity structure image beneath onshore and offshore of Central Java by using Double Difference Tomography method (TomoDD) is presented. This study is conducted in order to understand the mechanism effect of the subduction process to the surface seismicity and volcanic activity in Central Java. The data set was collected by a temporary seismic network called MERapi AMphibious EXperiment (MERAMEX), which was deployed for 150 days in May – August 2004. The network consists of 134 seismographic stations (106 short-period stations; 14 broadband stations; 8 ocean bottom hydrophones; 6 ocean bottom seismometers), which were installed onshore and offshore of Central Java. 210 events were selected for this research.

Tomo-DD is a simultaneous method to obtain a three-dimensional seismic velocity structure, and at the same time more precise earthquake hypocenter could also be determined. Although only absolute arrival times are used as input data, but this method could produce both more accurate hypocenter locations and seismic velocity structure near the source region. These products are the benefit of TomoDD application, in which standard tomography process could not facilitate them. During TomoDD calculation, cross-correlation of P- and S-wave differential travel-time measurements could also be conducted, if it is necessary. In this study, we used the only absolute travel-time measurement data.

From the preliminary results, the joint inversion of the event locations and seismic velocity structure considerably improves the resolution of the subsurface image. The final locations of the sources after the inversion show a narrow region of the double seismic zone which correlated with the subducting slab. The dip angle of the slab increases gradually from almost horizontal beneath offshore to 65°-80° beneath the northern part of Central Java. The seismic gap at depths of 140 km – 185 km is also imaged clearly. It is showed that the subduction plays an important role in causing the volcanism in this study area. The strong negative velocity anomalies under the Merapi Complex Volcano are interpreted as the upward migration of fluids rejected from the slab because of the phase transition. These fluids may have caused decreasing viscosity, and possibly, partial melting. The partially molten materials are soft and less rigid, thus the velocity decreases.

Paper B10

Application of partial CRS-Stack method to enhance gas reservoir characterization in a complex geological structure

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The application of partial CRS-stack method is presented in this paper. This method is introduced in 2009 and proved as an alternative method that can produce excellent subsurface image. Similar to CRS-stack method that is developed previously, the partial CRS-stack has advantage, especially when this method is applied to a seismic data that is acquired from an area with complex subsurface structures. Besides that, the additional significant advantage of partial CRS-stack is its ability in providing more traces in the resulted CDP supergathers. The characterization of gas reservoir can theoretically be done more easily and clearly if it is conducted in the CDP supergather rather than normal CDP gather

The partial CRS-stack method is tested by using a synthetic seismic dataset, which was made from a complex geological structure model that contains a gas reservoir. Since partial CRS-stack method uses the information of reflectors along Fresnel zone, instead conventional method that only uses information in a CDP, the stacked section resulted from partial CRS-stack is much better than the result of conventional one. We would like to prove its ability in conducting gas reservoir characterization by applying this method to synthetic dataset, e.g. by conducting cross product analysis. Cross product analysis is a convolution operation between intercept and gradient, which will have positive value in gas reservoir area. Since the quality of the seismic data increases, the results of cross product analysis could show the occurrence of gas in a better way, thus the bound of the reservoir could be identified more clearly.

As a conclusion, the partial CRS-stack method is proved as a good alternative method to give better seismic sections. Because of this, the interpretation of unclear events that are seen in the conventional stack section can be avoided and also it can enhance the analysis of gas reservoir characterization.

Paper B11

Artificial Neural Network in porosity and permeability estimation from wireline data

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One of the most challenging tasks of a log analyst is to understand the log responses. In some fields the log data alone cannot be used to derive accurately the Bulk Volume Model due to insufficient log data and the presence of special minerals which affects the log responses significantly. Core analysis had helped the log analyst to further refine the petrophysical model of the reservoir which led to a more accurate computation of reserves. The correlation across the field is difficult and it is mainly because of the poor log data, sand discontinuity and absence of distinct marker beds. In un-cored intervals and well heterogenuos formation, porosity and permeability estimation from conventional well logs has been difficult and complex problem to be solved by statistical method. This paper is about developing an Artificial Neural Network model in estimating the porosity and permeability properties by taking Field 'X', offshore Peninsular Malaysia as the case study. An Artificial Neural Network is developed to estimate the porosity and permeability in un-cored interval from the well logs with respect to a core value as the reference. The methodology has been implemented successfully with four steps: (1) Fuzzy Curve Analysis, (2) Core Porosity/Permeability K-means Clustering, (3) Well Logs Prediction using the Probabilistic Neural Networks (PNN) (4) Models evaluation and validation. An excellent agreement existed between the estimated properties and the core data with correlation coefficient nearly one ($R^2 \approx 1$). This powerful tool will provide a realistic reservoir characterization with an economic advantage by lowering the exploration and production cost. Furthermore, this intelligent approach has offered an alternative to the others conventional methods in determining the porosity and permeability properties especially in complex shaly sand reservoir.

Paper B12

Organic facies characterization of Tertiary Coal-bearing sequence of the West Middle Block of the Pinangah Coal Field, Sabah, Malaysia

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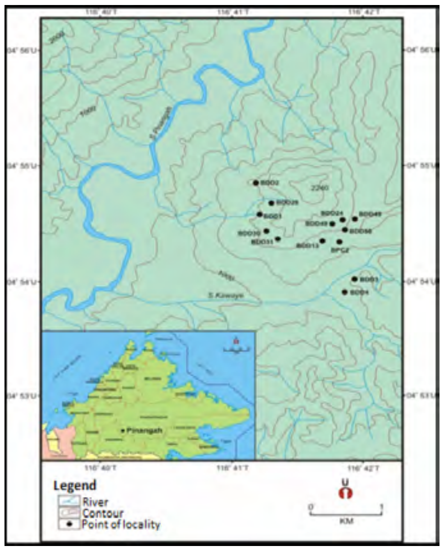
The oganic facies evaluation of this study based on the organic petrological and organic geochemical characteristic. The coal- bearing sandstone and shale sequence of the Early to Middle Miocene Tanjong Formation in the West Middle Block of the Pinangah Coal Field, central Sabah, was studied to evaluate the organic matter content, type, maturity and the depositional environment. The location of the study area is shown in figure 1.The Pinangah area is underlain by the Tanjong Formation and was described by Collenette (1965),consists of a sequence of mudstones, siltstones, limestones, conglomerates and coals. Balaguru and Nichols (2004) classified Tanjong Formation into two Units: Unit I and Unit II. Unit I consists of a mudstone and siltstone-dominated sequence and Unit II consists of coarse grained sandstone, conglomerate, carbonaceous mudstone and coals seams. The Pinangah coals are classified as humic coals based on dominant of vitrinite maceral and lesser amount of liptinite and inertinite. Suberinite, cutinite, sporinite, resinite are the dominant liptinite macerals in the coal Pinangah in these study. The common occurrence of the suberinite maceral support the Tertiary age for the Pinangah coal- bearing strata (figure 2). The vitrinite reflectance (%R- performed under oil immersion of the coal range from 0.45 to 0.55%. Based on the vitrinite reflectance, these coals are ranked as sub- bituminous B – A and high volatile bituminous C, and are considered thermally immature to early mature for petroleum generation. This is supported by the presence of exudatinite as shown in figure 3.

Biomarker parameters such as CPI, Ts/Tm, C_{31} hopane and sterane isomeration supported the result indicated by vitrinite reflectance. Acyclic isoprenoid are major constituent and the pr/ph ratio varies between 5 to 13, which suggested oxic conditions during sedimentation in a peat swamp environment of deposition. The high content of terrigenous higher plant organic source input with the coal sequence is supported by oleanane and absence of tricyclic terpanes. Sterane distribution that is dominated by C_{29}. The depositional environment for these study area is probably in a deltaic setting under oxic condition.



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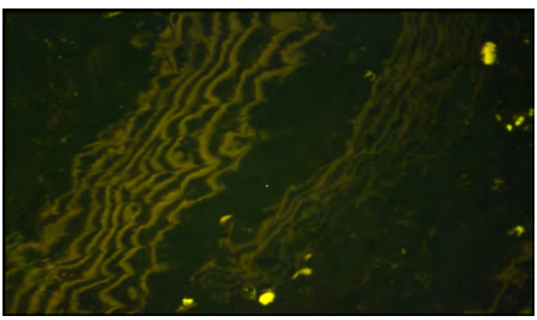

Figure 2: Suberinite maceral in the Tertiary Coal-Bearing Sequence, Pinangah Sabah.

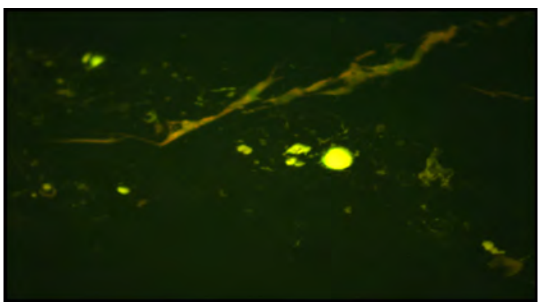

Figure 3: Extrusion of hydrocarbon in the form of exudatinite.

Paper B13

Organic-rich sequences of the Miri Formation, Sarawak : Implication for oil-generating potential

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Miri in Sarawak is well known as an “oil town” and is now a fast developing city owing in part to its petroleum revenue. Discovery of an onshore oil field in 1910 in Miri led to increased exploration activity and the eventual establishment of the predominantly offshore Baram Delta oil province. Although onshore reservoir analogues are well illustrated, such as those along the Airport Road, the source rocks that give rise to oil accumulated within the region remain uncertain.

In this study, two sections of organic-rich, sandy, heterolithic sequences around Miri town were investigated by both field studies and organic petrological methods. The Miri Formation (Middle Miocene) is a predominantly arenaceous sequence interpreted to be deposited in a littoral to inner neritic shallow marine environment (Liechti *et al*., 1960). Based on the field investigation carried out in this study, the thick sandstone beds within the Miri Formation are lean in organic matter content. In contrast, thinner sandstone beds are observed to be organic-rich with coal clasts and are commonly associated with carbonaceous laminae and thin shale beds. These heterolithic sequences range in thickness from about 30m to 60m in the study area.

Microscopical study performed under normal reflected white light and UV light excitation showed that the organic matter content within the thin sandstone beds contain significant amounts of liptinite macerals. Vitrinite is observed to be the most dominant maceral while inertinite is minor in abundance. Resinite, sporinite, suberinite and cutinite are among the most common observed liptinite macerals. These macerals show greenish-yellow to bright yellow fluorescence under UV light excitation (Figure 2). Vitrinite is vaguely fluorescing, and is observed to be associated with oil smears and is generally dark grey in appearance (Figure 1), suggesting heavy impregnation with bitumen or early generated hydrocarbons. Consequently this has lowered the vitrinite reflectance (Ro) measurement. The bitumen impregnated vitrinite recorded a low value of about Ro 0.35%, whilst those in the same locality that appear to be free of bitumen impregnation, or only lightly impregnated with bitumen, recorded a relatively higher value of about Ro 0.50% (Figure 3).

Vitrinite reflectance values in the range of Ro 0.50-0.60% are generally regarded as just entering oil generation window (Tissot and Welte, 1984), and thus suggest that the organic-rich sequence of the Miri Formation within the study area are early mature and capable for hydrocarbon generation.

Microscopical oil-generative features are commonly observed within the Tertiary coals of NW Borneo and Australia (e.g. Wan Hasiah 1997 & 1999; Khorasani 1986). Based on petrographic methods, however, it is not possible to quantify the amount of hydrocarbon

generated, although these organic-rich Miri Formation sequences can be considered as having good source rock potential owing predominantly to the high abundance of liptinitic macerals. This is supported by the common presence of oil smears associated with vitrinite particles as well as intense fluorescence shown by the liptinite macerals and in fractures that are observed to be partly filled with fluorescing hydrocarbons within the studied samples.

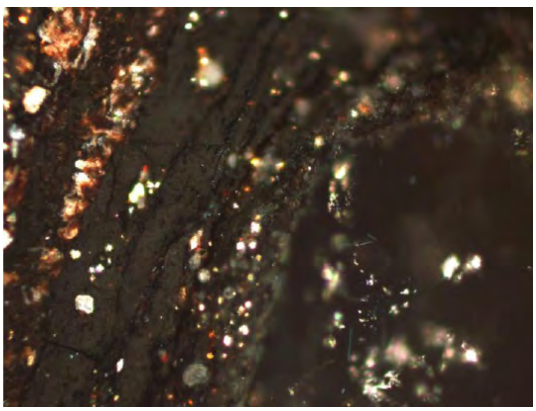

Figure 1: Heavily-stained vitrinite due to bitumen impregnation in carbonaceous sandstone of Miri Fm; oil immersion, reflected white light, field width = 0.2 mm.

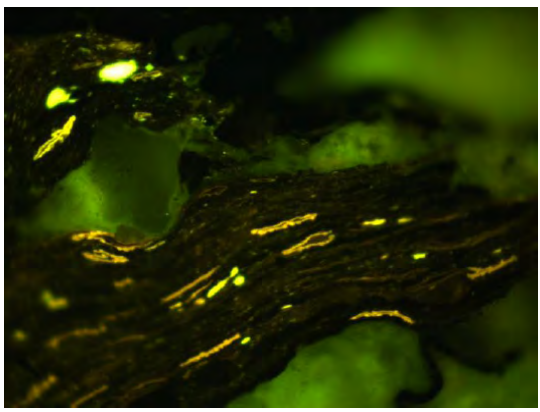

Figure 2: Yellow fluorescing sporinite associated with greenish yellow fluorescing terpene resinite under UV light excitation; field width = 0.2 mm.

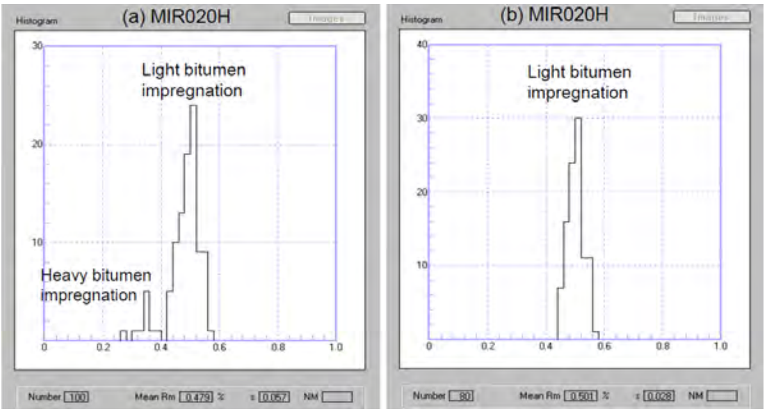

Figure 3: Vitrinite reflectance distribution showing variation in mean values due to influence of bitumen impregnation in a coaly sandstone sample of Miri Fm.

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Paper B14

Penerbitan sudut geseran puncak satah ketakselanjaran berdasarkan penentuan kekasaran permukaan dan ujian kemiringan: Contoh batuan syis, Semenanjung Malaysia

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Peranan dan pengaruh satah ketakselanjaran tidak dapat dinafikan bagi penilaian kestabilan jasad batuan, samada cerun potongan batuan mahupun pengorekan bawah tanah. Selain orientasi satah ketakselanjaran utama sesuatu jasad batuan, pencirian mekanik permukaan satah seperti kekasaran permukaan, bukaan dan kehadiran bahan pengisi juga berperanan dalam penilaian kestabilan jasad batuan. Kajian pengkuantitatifan parameter kekasaran permukaan yang merupakan sesuatu ciri mekanik penting, mula diselidik secara sistematik tiga tahun lepas (Ghani Rafek *et al*., 2009) dan pembentangan ini mengemukakan antara hasil yang dicapai dalam tempoh tersebut. Pendekatan yang diamalkan adalah yang mudah dan berbelanja rendah dan boleh diguna di lapangan. Ianya juga tidak memerlukan peralatan yang mahal dan persampelan serta ujian yang rumit. Penentuan Pekali Kekasaran Kekar, PKK (*Joint Roughness Coefficient, JRC*) dan sudut geseran puncak, ϕ_{puncak} permukaan satah ketakselanjaran yang bersamaan digunakan untuk menerbitkan suatu perhubungan di antara kedua parameter tersebut supaya penganggaran sudut geseran puncak, ϕ_{puncak} dapat dilakukan berdasarkan pengukuran kekasaran permukaan satah ketakselanjaran di lapangan. Hasil kajian kawasan batuan syis dilaporkan. Pekali Kekasaran Kekar, PKK satah ketakselanjaran semulajadi ditentukan dengan alat *profiler* berdasarkan syor Barton & Choubey (1977) dan untuk satah yang sama sudut geseran puncak, ϕ_{puncak} ditentukan dengan ujian kemiringan mengikut cadangan Priest (1993). Sebanyak 2200 ujian kemiringan dilakukan untuk satah ketakselanjaran syis segar manakala bagi syis terluluhawa sedikit sebanyak 2150 ujian dijalankan. Bilangan penentuan PKK yang sama, iaitu 2200 bagi syis segar dan 2150 untuk yang terluluhawa sedikit juga dilakukan. Hasilnya ditunjuk dalam Jadual 1.

Berdasarkan hasil yang dicapai, dua persamaan polinominal yang memperkaitkan sudut geseran puncak dengan Pekali Kekasaran Kekar, PKK diterbitkan. Untuk syis segar, persamaan ini ialah:

$\phi_{puncak} = -0.022PKK^2 + 3.21\ PKK + 28.1$ dengan koefficien penentuan $R^2 = 0.98$.

Persamaan untuk syis terluluhawa sedikit adalah:

$\phi_{puncak} = -0.025\ PKK^2 + 3.24PKK + 26.6$ dengan nilai $R^2 = 0.98$.

Kedua-dua persamaan ini boleh digunakan untuk penganggaran nilai sudut geseran puncak, ϕ_{puncak} berdasarkan survei ketakselanjaran dengan pengukuran PKK. Penyelidikan ini dibiayai Kerajaan Malaysia melalui projek penyelidikan UKM-ST-02-FRGS-0023-2007.

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Jadual 1: Hasil ujian kemiringan dan penentuan PKK, batuan syis, Semenanjung Malaysia.

Gred Lulu-hawa	Nilai Pertengahan PKK	Bilangan Ujian	Median (°)	Sisian Piawai (°)	Purata (°)	Perbezaan dengan gred I (°)
I	1	920	30.0	2.2	29.6±0.1	-
	3	130	38.0	3.4	37.9±0.6	-
	5	110	42.0	6.1	44.3±1.2	-
	7	330	52.0	6.2	51.9±0.7	-
	9	140	57.0	5.1	56.6±0.8	-
	11	90	58.0	5.4	58.5±1.1	-
	13	140	68.0	5.5	67.5±0.9	-
	15	120	66.0	5.5	66.3±1.0	-
	19	220	84.0	5.2	83.3±0.7	-
II	1	1020	28.0	2.2	28.1±0.1	-1.5
	3	50	38.0	3.1	38.3±0.9	+0.4
	5	90	40.0	6.2	41.7±1.3	-2.6
	7	180	49.0	7.6	49.6±1.1	-2.3
	9	240	51.0	7.0	52.5±0.9	-4.1
	13	140	66.0	8.9	66.9±1.5	-0.6
	15	40	68.0	5.1	68.1±1.6	+1.8
	17	130	70.0	8.3	70.4±1.4	-
	19	260	82.0	5.8	82.3±0.7	-1.0

Paper B15

Correlation between 2-D resistivity and seismic refraction methods in shallow subsurface investigation

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Keywords: 2-D resistivity, seismic refraction, correlation, weathered zone

Geophysical study was conducted to provide supporting data for engineering and environmental works. The study was to determine depth of bedrock, overburden and near surface structures such as faults and cavities. 2-D resistivity method is to measure the apparent resistivity of the subsurface including effects of any or all of the following: soil type, bedrock, contaminants and ground water. Variations in 2-D resistivity may indicate changes in composition, layer or contaminant levels. Seismic refraction method is to measure P-wave velocity in the medium. This paper presented the correlation between the two geophysical methods conducted in Selangor, Malaysia. Resistivity results show three main zones. The first zone was alluvium or highly weathered zone with resistivity value of 100-1000 Ohm-m with depth of >20 m. This zone consists of saturated zone with resistivity value <100 Ohm-m and boulders with resistivity value 300-700 Ohm-m. The second zone with resistivity value 1200-3500 Ohm-m was interpreted as weathered zone. The area with >5000 Ohm-m was the bedrock. Seismic refraction result shows the first layer was topsoil or highly weathered bedrock with velocity of 311-446 m/s. The second layer consist of two zones; the first zone was highly weathered bedrock mix with boulders with velocity of 500-873 m/s and second zone was weathered bedrock with velocity of 946-1091 m/s. The depth of the second layer is 5-7 m. The third layer was bedrock with a velocity 2598-4554 m/s with depth of 20-30 m. Correlation between the two geophysical methods match and can be used for shallow subsurface works.

Paper B16

Enhancement of resistivity method with different arrays to detect void using miniature model

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Keywords: geophysical survey, resistivity method, void, enhancement

Geophysical methods can be used to determine depth to bedrock, nature of overburden materials and near surface structures such as sinkholes, cavities, voids, faults and boulders. Application of resistivity method is usually used for subsurface, engineering and environmental works. Resistivity method is predominantly used in shallow subsurface. Resistivity method is being developed in order to get detailed and deeper penetration. In this study, the enhancement of resistivity method is needed in order to get a depth of penetration in shallow subsurface study. By using a combination of resistivity data to establish targets, most of the required information can be mapped and the results verified, thus maximizing the efficiency of the engineering and environmental work. Resistivity data was collected using four different arrays: Wenner, Schlumberger, Wenner-Schlumberger and Pole-dipole on the homogenous ground with 1 cm electrodes spacing. Subsequently, one square hole was made below the homogeneous ground. The dimension of the hole was 30 cm x 15 cm x 40 cm which was situated 25 cm from the ground surface. The resistivity survey was carried out with 1 cm electrodes spacing. Next, the electrodes were move 0.5 cm on the same line with 1 cm electrodes spacing and with the same array. Both survey lines were then combining during data processing. The resistivity survey was repeated using the four different arrays on the surface above the man-made hole with the same technique. In general, the result for homogenous ground shows a low resistivity value. However, result from the man-made hole shows high resistivity value around the hole. The results of the four arrays are then compared. With the new technique, Pole-dipole array produced the best image of the man-made hole with very good horizontal and vertical coverage.

Paper B17

2D electrical resistivity imaging survey to determine ground water at Kuala Baram, Miri, Sarawak

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Geophysical survey was conducted to determine the occurrence of the ground water and to locate a strategic location for a tube well to be developed. A 2D electrical resistivity imaging method with Gradient and Pole-Dipole protocols were used to measure the subsurface apparent resistivity data during the survey. The survey consists of 8 lines with total length of 16.5 km and the survey area mainly along the roadside. Field data processing was done using a software RES2DINV (2D forward modeling computer program) which calculates the apparent resistivity pseudo-section. By means of this process, it will generate the two dimensional subsurface model. Based on the 2D resistivity result, it shows that the top layer zone in the area has the resistivity value ranging from 4 Wm to about 120 Wm, which corresponding to the peat, silt and upper sand layer. The high resistivity zone (found near Kuala Baram Industrial Area) with a value above 2000 Wm is probably the gas pocket. The possibility interested zone potential for water aquifer is ranging from 50 Wm to 100 Wm (compact very fined sand) as shown in subsurface profile for KB 9 and KB 7.

Siasatan geofizikal telah dijalankan bagi menentukan kehadiran air tanah dan menentukan lokasi yang strategik bagi pembinaan telaga tiub. Kaedah pengimejan keberintangan elektrik dua dimensi dengan protokol Gradient dan Pole-Dipole telah digunakan bagi mengukur keberintangan ketara subpermukaan semasa siasatan. Siasatan merangkumi 8 garisan kajian dengan jumlah panjang 16.5km dan kawasan kajian adalah di sepanjang jalan-jalan utama. Pemerosesan data lapangan dibuat menggunakan perisian RES2DINV (program computer untuk 2D forward modeling) yang menghitung nilai keberintangan ketara keratan rentas pseudo dan melalui proses itu seterusnya menghasilkan model subpermukaan dua dimensi. Berdasarkan keputusan keratan rentas 2D, menunjukkan bahawa zon lapisan atas di kawasan kajian mempunyai nilai keberintangan antara 4 Wm hingga 120 Wm, mewakili tanih gambut, lodak dan pasir atas. Zon keberintangan tinggi (dijumpai di kawasan Perindustrian Kuala Baram) dengan nilai keberintangan melebihi 2000 Wm, mungkin mewakili lapisan gas poket dan sebarannya. Zon yang dikehendaki berpotensi membentuk aquifer adalah dalam julat 50 Wm hingga 100 Wm (pasir halus padat) seperti yang ditunjukkan profil keratan rentas pada telaga tiub KB 9 dan KB 7.

Paper B18

Basaltic soil and their utilization for drilling fluid and weighting agent

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Drilling fluid or drilling mud is a critical component in the drilling process, where it provides the gel to efficiently lift cuttings, maintain stable wellbore and produce sufficient hydrostatic pressure that could prevent the influx of formation fluids into the wellbore. For over eight decades, drilling grade barite remains to be the most profound weight material used to adjust drilling mud densities around the world. However, barite resources globally are depleting especially in terms of its quality, economical viability and attainability – thus making it becoming more expensive. Understanding problems during drilling operations including lost of circulation and differential sticking could reveal more beneficial application of utilizing basaltic soil in this field as other existing remedy substances are expensive. Basaltic clay soil is seen as a potential alternative to be utilized in drilling fluids additive and also as barite substitute for the weighting agent. Literature reviews on the significance of using basaltic soil is that is has the gel characteristics to lift up drilled cuttings, produces suitable mud weight and economically inexpensive due to its abundance. This report concentrates around the literature review on basaltic soil, rocks, its composition, physico-chemistry, sample collection, sample preparation and initial laboratory experiments done in using basaltic soil as additive in drilling fluids. Understanding the mineral constituent and alterations in weathered basaltic rock is also important in order to select the depth zone of basaltic soil with the desired compositions. Development of prototype drilling fluids using basaltic soil shall be tested using standard variations of mud tests on its rheological properties to determine basaltic soil's most suitable application to be used in drilling operations.

Paper B19

Investigation on a sungai long granitic laterite for compressed earth blocks

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This paper highlights a project that aims to appraise laterite for use as compressed earth blocks. The *in situ* characteristics of laterite including colour, texture and structure were ascertained by field studies. Others characteristics such as compaction, grain distribution, plasticity, compressive strength, geochemistry and mineralogy were also determined. These Sungai Long granitic laterite are mostly made up of coarse to fine particles consisting of 63% sand+gravel and 37% clay+silt . Their chemical composition is dominated by silica (37.09 – 53.15% SiO_2), alumina (41.80-45.89%) and iron (ranging from 3.30 to 14.85% Fe_2O_3). Their main minerals are quartz, anorthoclase, muscovite, clinochlore and poorly crystallized kaolinites as the main clay phases. The liquid limit (41-83%) and plastic limit (28-43%) indicate that Sungai Long granitic laterite has supreme plasticity. The studied laterites are appropriate for making compressed earth blocks.

Paper B20

Aggregate stability of tropical soils: Its implication to sustainable mining

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The present state and future prospect of world's soil resources anchors upon the issue of soil quality and sustainable land management. Unguided soil management practices and soil erosion leads to the lack of or degradation of soil aggregate stability and in turn cause dispersion. The concept of soil quality is pertinent to disturbed systems such as reclaimed mine soils. The restoration of soil function and mine soil quality is essential to long-term ecosystem stability. A key soil quality is aggregate stability. The stability of aggregates is affected by soil texture, the predominant type of clay, extractable iron, and extractable cations, the amount and type of organic matter present, and the type and size of the microbial population. Some researchers found that soil organic matter is found to influence soil aggregate water stability (Rillig, 2004) whereas others found that iron oxides and aluminium oxides have greater influence than soil organic matter (Igwe *et al.,* 2009). Alekseeva *et al.* (2009) found that iron oxides mainly participated in the formation of micro-aggregates; Al and Mn contributed to the formation of macroaggregates. A strong correlation has been found between glomalin and glomalin related soil protein (GRSP) and soil aggregate water stability in a wide variety of soils where organic material is the main binding agent (Haddad & Sarkar, 2003; Rillig & Mummey, 2006). The objective of the study is to determine the influence of organic carbon and iron oxides on aggregate stability of tropical soils from different parent material in Malaysia. The soils were also studied for their particle size distribution and mineralogy. The main clay mineral in these soils is kaolinite. Aggregate stability was determined by measuring water stability aggregate (WSA) and mean weight diameter (MWD). Total free iron was determined by the dithionite-citrate-carbonate method while amorphous iron was determined by the oxalate extractable method. A wide range of WSA was recorded for soils derived from alluvium (2.47-45.09%) , metasediment (1.55-56.94%) and serpentinites (9.80-20.59%) while WSA for soils derived from granites tend to show high values (51.89-89.70%). For MWD, there is a general trend observed according to parent material: granite>serpentinite>metasediment>alluvium. Soils derived from granites recorded MWD values of 0.30-1.61mm, MWD for serpentinites ranges from 0.39-0.87 mm, MWD for metasediments ranges from 0.02-0.78mm, while for alluvials MWD ranges from 0.05-0.27mm. The results indicate that both forms of iron exist in these soils. The results also show that iron oxide, either in the form of total free iron oxide or amorphous oxalate extractable iron oxide, does not influence aggregate stability while organic carbon exerts varying effect on aggregate stability. Positive correlation between organic carbon and water aggregate stability was observed for soils derived from granites (for WSA, r^2=0.93; for MWD, r^2=0.90) and serpentinites (for WSA, r^2=0.58, for MWD, r^2=0.64) but no correlation was observed for soils derived from metasediments and alluvium. These findings highlight the importance of understanding tropical soil properties in managing mining sustainably.

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Paper B21

Stratigraphy of the Devonian sediments in the northwestern part of the Shan Plateau, Myanmar

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A new lithostratigraphic subdivision for the Devonian sediments of the Pyin Oo Lwin Township, in northwestern Shan Plateau is proposed as follows (younger to older); Maymyo Formation comprising "Padaukpin Limestone" and "Wetwin Shale" (Eifelian-Givetian), Zebingyi Formation (Pragian-Emsian) with three members, Khinzo chaung Limestone, In-ni chaung Limestone and Doganaing chaung Orthoquartzite.

The Maymyo Formation (Aye Ko Aung, 2010) consists predominantly of relic fossil-bearing dolomitic limestones associated with minor calcareous siltstones and shale. The "Padaukpin Limestone" (La Touche, 1913), which is herein considered as a counterpart of the Maymyo Formation, consists of light, to dark grey, dolomitic limestone commonly associated with loose muddy particles and in places they are interbedded with thin shale. The "Wetwin Shale" (La Touche, 1913) is suggested as a similar horizon of the "Padaukpin Limestone", chiefly composed of yellowish, black shale. Corals and brachiopods found abundantly in the "Padaukpin Limestone" at the Padaukpin locality, indicates the Maymyo Formation is of Eifelian age (Reed, 1908; Anderson et al., 1969; Aye Ko Aung, 1995; Khaing Khaing Sann, 2001; Khaing Khaing Sann and Aye Ko Aung, 2004; and Khaing Khaing San, 2005). Corals at the Pwepon locality are of Eifelian-Givetian age (Khaing Khaing San, 2005, Khaing Khaing San and Aye Ko Aung, 2008). Ammonoids at the Myogyi area are of Frasnian age (Aye Ko Aung et al., 2011). The sedimentary characters and fossil assemblages suggest the Maymyo Formation was deposited in a very shallow marine clear sea water environment, occasional deepening sea water and moderate to strong energy caused by wave or storm ("Padaukpin Limestone") and a small lagoonal environment might have been developed near the shore line ("Wetwin Shale") (Aye Ko Aung, 2010).

The Zebingyi Formation consists of dense black, earthy limestone separated by layers of light-coloured, purple, black shale and buff-coloured siltstone (Khinzo chaung Limestone Member). It is rich in macrofauna containing dicranoconarid tentaculites, brachiopods, graptolites, trilobites, nautiloids and a minor amount of conodonts which indicate a Pragian age (Thaw Tint & Hla Wai, 1970; Jaeger, 1983; Kyi Soe, 2000; Aye Ko Aung, 2000, 2001, 2008; Kyaw Min, 2010, Kyaw Min & Aye Ko Aung, 2010). The sequence of the Khinzo chaung Limestone Member is overlain by a whitish to light gray, flaggy, thin-bedded, partially dolomitized unit (In-ni chaung Limestone Member). It is succeeded by thin-bedded, reddish brown quartzose sandstone (Dogaing chaung Orthoquartzite Member), the upper part of which is defined as a new Emsian facies characterized by clast supported conglomerates in association with grey lime mudstone and pinkish brown siltstone which contains rugose coral and conodont faunas (Kyaw Min, 2010; Kyaw Min & Aye Ko Aung, 2010). The Zebingyi Formation as a whole is interpreted as pelagic to shallowing up locally with intertidal channel environment.

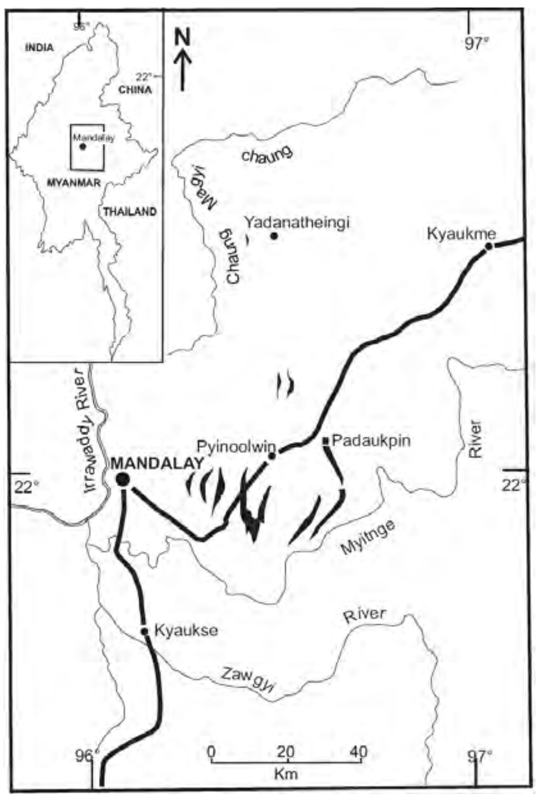

Figure 1: Distribution of the Devonian rocks described in this paper.

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Age			Stratigraphic Units	
DEVONIAN	LATE	Fammenian	Not yet reported	
		Frasnian	MAYMYO FORMATION	
	MIDDLE	Givetian		
		Eifelian	Padaukpin Limestone / Wetwun Shale	
	EARLY	Emsian	ZEBINGYI FORMATION	Doganaing chaung Orthoquartzite Member
		Pragian		In-ni chaung Limestone Member
		Lochkovian		Khinzo chaung Limestone Member

Table 1: Devonian units in the northwestern part of the Shan Plateau.

Paper B22

Some radiolarians from the Baliojong ophiolite, Sabah

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In Tandek area the ophiolitic basement occur as a small slab and surrounded by younger sedimentary rocks, such as the deep-water Paleogene Crocker Formation and shallow-water Neogene Bongaya Formation. The Baliojong ophiolite is a fragment of oceanic lithosphere preserved in Sabah. Continuous exposures of the ophiolite sequence have been mapped along the Baliojong River. The volcanic rocks consist mostly of basalts associated with volcanic breccias, dolerites and gabbros. The rocks are overlain by sedimentary rocks consisting of cherts, mudstones and sandstones. The cherts, mostly red and greyish in colour are quite thin, between 5cm to 30 cm in thickness. The cherts consist of microcrystalline quartz that contains abundant radiolarians. The mudstone and the medium-grained sandstone ranges in thickness from a few centimetres to a metre. The ophiolite sequence was subjected to tectonic compression or shortening which resulted in folding and thrust faulting into several steeply dipping slices oriented approximately North-South. The layers in each slice, dipping between 50-80 degrees, are mostly overturned. Each slice is bounded by faults and consists of volcanic rocks overlain by chert and mudstone sometime with sandstone.

A total of 42 chert samples were collected from along the Baliojong River. Most of the samples contain poorly preserved radiolarians. Nine significant samples were collected from three selected slices of the ophiolite sequence. A total of 33 taxa were identified. Based on the stratigraphic distribution of selected taxa (O'Dogherty, 1994), the radiolarians can be divided into two assemblages. First assemblage is characterized by the occurrence of *Dictyomitra communis, Thanarla lacrimula, Thanarla pacifica*, and *Thanarla brouweri*. The assemblage indicates Aptian in age. The second assemblage contains *Pseudodictyomitra pseudomacrocephal, Dictyomitra gracilis, Dictyomitra montesserei, Novixitus mclaughlini, Dictyomitra koslovae,* and *Dictyomitra obese*. This assemblage indicates an age of Albian and the presence of *Pseudodictyomitra tiara* suggest the age may extend up to Cenomanian. Each slice yielded more or less similar radiolarian assemblages. This indicates those slices are of the same age.

Paper B23

Tertiary palynomorph assemblage from eastern Chenor Pahang

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A palynological study has been carried out on the sample from the well exposed outcrop near Kg. Pejing along the road connecting Chenor and Paloh Hinai located in the central part of Pahang.). This area is previously mapped as the Tembeling Group, formerly known as the Tembeling Formation, introduced by Koopmans (1968) which is consists of four formation namely Kerum Formation, Lanis Conglomerate Formation, Mangkin sandstone formation and Termus Shale Formation. This well exposed outcrop is described as flat bedding of an interbedded coaly/carbonaceous mudstone and sandstone. The lower part of the succession, a coaly lithology is more dominant before it gradually changes to highly carbonaceous mudstone. Possible channelized/erosive contact between sandstone and carbonaceous mudstone can be observed at the upper part of the succession. A total of 20 samples were collected from the outcrop section. The samples were collected from the carbonaceous mudstone and coaly section and a few from sandstone interval. Most of the samples yielded abundant and relatively well preserved palynomorphs, except for sandstone samples which were found to be barren and contained badly preserved palynomorphs. A semi-quantitative method was applied for this study. Due to the condition of the sample which contained highly carbonaceous and coaly material, the samples were treated with Nitric Acid for about 4 to 6 hours. The palynomorphs were identified by comparing to the present day plant community and other published data by previous workers such as Anderson and Muller (1975). A palynological investigation of the outcrop section has revealed that the palynomorphs assemblages were dominated by the typical Tertiary palynomorphs such as *Lanagiopollis emarginatus*, *Discoidites borneensis, Taxodiaceae* spp., *Stenochlaena palustris*, *Asplenium* spp., freshwater, peat swamp pollen and abundant of tricolpate and tricolporate pollen. The palynomorphs assemblages from this outcrop show some similarity to the palynomorphs from Batu Arang by Ahmad Munif Koraini, (1993) and from Layang-Layang Formation, Bandar Tenggara Johor by Ahmad Munif Koraini *et al*. (1994). However, there are certain species are not encountered from this area. For example, the freshwater algae species such as *Pediastrum* sp. and *Botryococcus* sp. which characterized lacustrine environment for both of the formation are relatively absent from all of the samples. The identified assemblages also lack of large spores such as *Cicatricosisporites dorogensis, Crassoretitriletes vanraadshoveni* and *Osmundacidites* sp. where these species are regular in Batu Arang Formation. The freshwater and peat swamp elements are more dominant along with the abundance of angiospemous, tricolpate and tricolporate pollen. This section also recorded regular occurrence of typical climbing ferns taxa such as *Stenochlaena palustris* and a large monolete and bean-shaped spores, *Asplenium* type. The presence of common typical peat swamp pollen such as *Lanagiopollis* spp., an affinity of *Alangium, Blumeodendron, Cephalomappa, Calophyllum* and other fresh water and riparian plant communities such as *Pandanus, Eugenia* and *Sapotaceae* (*Palaquium*) may demonstrate the occurrence of an ephemeral peat swamp and/or a former riparian fringe type environment. The abundance of *Stenochlaena palustris*, characteristic of climbing ferns, may reflect the initial stage of peat swamp development which later dominated and substituted by a truly peat swamp plant communities. The age of the rock succession is probably Late Miocene and/or younger based on the presence of certain stratigraphically significant and age restricted taxa such as *Lanagiopollis emarginatus* and *Stenochlaenidites papuanus*.

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Paper B24

Stratigrafi kawasan Nanga Budu, Sarawak, Malaysia

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Nanga Budu merupakan salah satu daripada kawasan yang dibuat pemetaan geologi pada skala 1:50,000 di bawah Rancangan Malaysia Ke-9. Sebahagian besar kawasan Nanga Budu didasari oleh Ahli Layar daripada Formasi Belaga yang berusia Kapur Atas. Di beberapa bahagian ia didasari oleh Ahli Kapit daripada Formasi Belaga (Paleosen-Eosen). Kedua-dua Ahli Layar dan Ahli Kapit memiliki litologi yang sama; didominasi oleh endapan berlempung yang telah termetamorf pada tahap yang rendah seperti filit, sabak dan argilit dan saling terlapis dengan batu lodak dan batu pasir halus serta lapisan-lapisan konglomerat batu lumpur berkeping. Enapan resen yang terdiri daripada pasir dan aluvium sungai adalah terhad di bahagian baratdaya kawasan, mengelilingi pekan Debak.

Perlapisan batuan Ahli Layar dan Ahli Kapit daripada Formasi Belaga yang dicerap dalam kawasan kajian ini adalah berbeza daripada kawasan-kawasan lain. Perlapisannya memiring dan memuda ke arah baratdaya yang bertentangan dengan trend umum endapan sedimen (flysch) Sarawak seperti Formasi Belaga yang memuda ke arah utara. Fenomena ini adalah hasil kesinambungan proses subdukt yang bermula pada awal Tertier di lembah Lupar.

Sebagai hasilan daripada kajian penderiaan jauh, sesar-sesar telah dikenalpasti; mempunyai trend umum T-B. Kesan-kesan daripada sesar-sesar ini dicerap di lapangan. Sesar Dayu merupakan sesar yang baru ditafsirkan berdasarkan kajian penderiaan jauh. Kehadiran sesar-sesar dan corak perlapisan flysch dalam kawasan ini merupakan bukti jelas bahawa kawasan ini telah mengalami dekolmen dan tokokan ketika berlaku subdukt Tertier di lembah Lupar. Sesar Dayu memisahkan Ahli Layar di sebelah kirinya dan Ahli Kapit di sebelah kanannya. Ia juga meletakkan di atas ahli yang lebih tua berbanding ahli yang lebih muda di kawasan tanah rendah lembah Ulu Julau.

Stratigraphy of the Nanga Budu Area, Sarawak, Malaysia

The Nanga Budu area was one of the geological mapping projects carried out in the Ninth Malaysia Plan, mapped on a scale of 1:50,000. The Nanga Budu area is mainly underlain by the Late Cretaceous Layar Member of the Belaga Formation, however in places; it is underlain by the Kapit Member of the Belaga Formation (Paleocene-Eoecne). Both Kapit and Layar Member is having similar lithology; being dominated by the low-grade metamorphosed argillaceous sediments such as phyllite, slate, and argillite and interbedded with siltstone and fine grain sandstone and with few flat-pebble mudstone conglomerate beds. The recent deposits made up of sand and river alluvium are limited to the southwest area, surrounding the small town of Debak.

The beds of the Layar and Kapit Member of the Belaga Formation observed in this mapping area are different from other areas. The beds are dipping and younging southwestward, which contradicts with the general trend of the sedimentary rocks (flysch) of Sarawak such as the Belaga Formation which are younging northwards. The phenomenon is the result of the continued process of subduction at the Lupar valley which started during early Tertiary.

As the result of the remote sensing study, faults were delineated; trending generally E-W. These faults signatures were located in the field in the study area. Dayu Fault is a newly defined thrust fault is formulated as the result of remote sensing study. Based on the faults and the bedding pattern of the flysch, it is clear evidence that the area had undergone decolment and accretion, during the Tertiary subduction at the Lupar valley. Dayu Fault segregates the Layar Member to its left and Kapit Member to its right. It emplaced the older member over the younger member in the low-lying valley of Ulu Julau.

Paper B25

Evidences for recent seismicities and dating of active faulting in NW Peninsular Malaysia

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Peninsular Malaysia is a lowly elevated area. It is surrounded by vast area of extremely shallow seas called the Sunda Shelf. It form part of the core of Sundaland, widely regarded as a stable region (e.g. Ben-Avraham & Emery, 1973; Gobbett & Hutchison, 1973; Tjia, 1996). It was supposed to have remained undeformed since the end of Tertiary (Hall, 2000) and often assumed to have been stable for a long period and for this reason, data from here are used in construction of global eustatic sea level curves (e.g. Fleming e*t al*., 1998; Tjia, 1992, 1996).

Due to its tectonic setting, Peninsular Malaysia is considered to be very low seismic country. Recent observations (Raj, 1979; Tjia, 1983; 2010; Mustaffa Kamal 2009), showed that the widespread assumption that the Sundaland is a long-term stable region is beginning to be questioned by some authors. They noted that Cenozoic and Quaternary deformations of Sundaland are recorded in the numerous offshore sedimentary basins and onshore basins alongside elevated highlands

This paper outlines further evidences to question the popular believed that the Malay-Thai Peninsula is seismically stable. Several exposed alluvial sections along the Bok Bak Fault was mapped, and analyzed for evidence of faults. The basement was faulted into several graben structures that were eventually filled with alluvial sediments. The entire alluvial sequence is cut by several fault strands showing both apparent normal and reversed displacement revealing the strike-slip nature of the faults. Tremors accompanying the faulting events gave rise to liquefaction structures as indicated from the presence of clastic dykes and fault controlled injection structures. There are three types of clastic injections in the deposit. These include clastic dykes, fault controlled injection structures, and ball and pillow structures.

The ages for these faulted alluviums and hence the age of seismic activities has been determined using radiocarbon dating of the organic matters, which give ages of 2105 ± 30 Gajah Putih, 1280 ± 30 at Bkt. Panjang, Kedah, and 400 ± 30 for Sg. Muda. Yonger ages (90-115 ± 30) of the sediments are found on the river bank deposit along Sungai Muda. Their synsedimetary faults are attributed to slumping along the river bank. The distribution along the Bok Bak Fault zone suggest that the seismicity could be the result of the reactivation of the Bok Bak Fault.

It is concluded that the Malay-Thai Peninsular/Sundaland stability is a questionable. The region is today surrounded by subduction and collision zones. India-Asia collision, and Australia-SE Asia collision. The Quaternary to Recent seismicity in the Malay-Thai peninsular were the result of fault reactivations due to these intraplate stress build-up, especially due to the oblique, north-northeast-oriented subduction of the Indian–Australian plate under the Sundaland. The occurrences indicated that the intraplate deformation zone associated with the Sumatran Subduction Zone is wide and encompasses the Malay-Thai Peninsular. The Quaternary to Recent seismicity have revealed that Malay-Thai peninsular is vulnerable to the earthquakes originating from not only from active plate boundaries but also within-plate. Bridges, high-rise buildings and dams are greatly exposed to these seismic activities during their lifetime.

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Paper B26

Joint patterns of the granite in the eastern flank of Kledang Range, Perak

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Introduction

This paper introduces joint pattern studies in Kledang Range granite (Figure 1). Geological research and application play an important role in wide range of disciplines such as engineering, oil and gas and hydrogeology especially from fracture analysis. This method is also useful to re-analyze data of geological structure for abandoned wells to investigate again its economical probability. In Kledang Range intrusion, the rock it is made up of medium to coarse-grained biotite granite with porphyriric varieties occurring locally (Kwan, 1972). He stated that biotite granite is coarse-grained and light coloured, consisting essentially of light coloured felsic minerals such as quartz, potash feldspar and plagioclase while the associated accessory minerals include zircon, apatite, iron oxide and sphene. The Kledang Range granite is mainly a coarser grained biotite variety and essentially homogeneous (Ooi, 1974). He also stated that within the granites are local occurrences of quartz veins, aplite veins, some porphyritic biotite granite and minor occurrence of schist become a roof pendant. Significant mineral deposits in the southern portion of the Kledang Range occur mainly in the tensional fractures (Tan, 1972). The rock in Kledang Range is jointed, with the major joints striking 330^0 and dipping at 75^0-85^0 to the northeast. Some of the major joints are lined with black tourmaline veins (Aw, 1984). Fracture is a general term of geologic discontinuity that involves fault, joint, fissure, cleavage, and/or crack that may be present in a formation (Berkowitz, 2002, Katsuaki & Yuichi, 2006). National Academy of Sciences 1996 suggests that fractures strongly influence the strength, anisotropy, and fluid flow characteristics of rock masses. Fractures also can be used to infer the stress conditions in the earth (Olson & Pollard, 1980). The real challenge in this study is to measure the fracture and to differentiate between the naturally occurred fractures and exfoliation fractures. So, for this purpose of study, the joint pattern will be analyze to predict the force direction of the major joint plane.

Objectives and methodology

This paper attempts to provide answers to the above questions by providing detail joint analysis. The main objective is to examine the joint pattern and predict the main force direction of the major joint plane.

Field studies were conducted on granite outcrops in the Eastern Flank of Kledang Range areas with a particular attention given to joints. Measurement of joint planes in terms of strike and dip were conducted in all the major outcrops. A total of about 1000 measurements were collected from the outcrops about 20km along Ipoh-Lumut Highway. The poles of the joint planes were plotted on the stereonett and the projections of the poles were presented by contouring to obtain areas of high density. To facilitate the interpretation of joint patterns, the study area was divided into six locations namely L1, L2, L3, L4, L5 and L6 (Figure 2). The outcrops are mostly along the highway which are parallel to the granite range namely for L1, L2, L3, L5 and L6. Whereas for L4 is an outcrop of road cut to the top of the range which is intersecting with other locations.

Results and discussions

Results of strike diagram are shown in Figure 3 for each location. Location 2, Location 3 and Location 6 strike is towards N-S. For Location 4 and Location 5 the strike is towards NE-SW. However, Location 1 shows strike direction slightly different from the other due to high interference area. The different orientation of joint pattern between locations maybe due to the presence of faults or exfoliation joints that vary in orientations according to their locations near the surface of the granite body.

Conclusion

The most prominent joint in Kledang Range strike is towards almost N-S, NE-SW and NW-SE directions.

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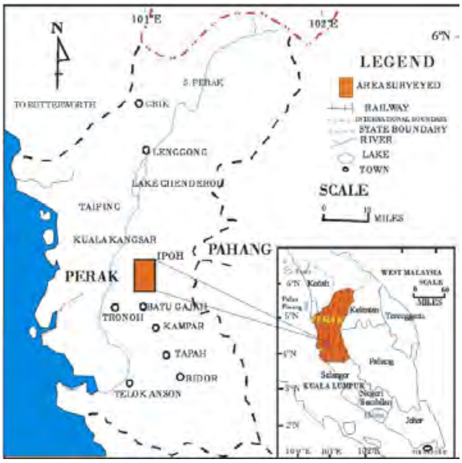

Figure 1: Location of study area is in Kledang Range, Perak.

Figure 2: Outcrop of study area namely L1, L2, L3, L4, L5 and L6.

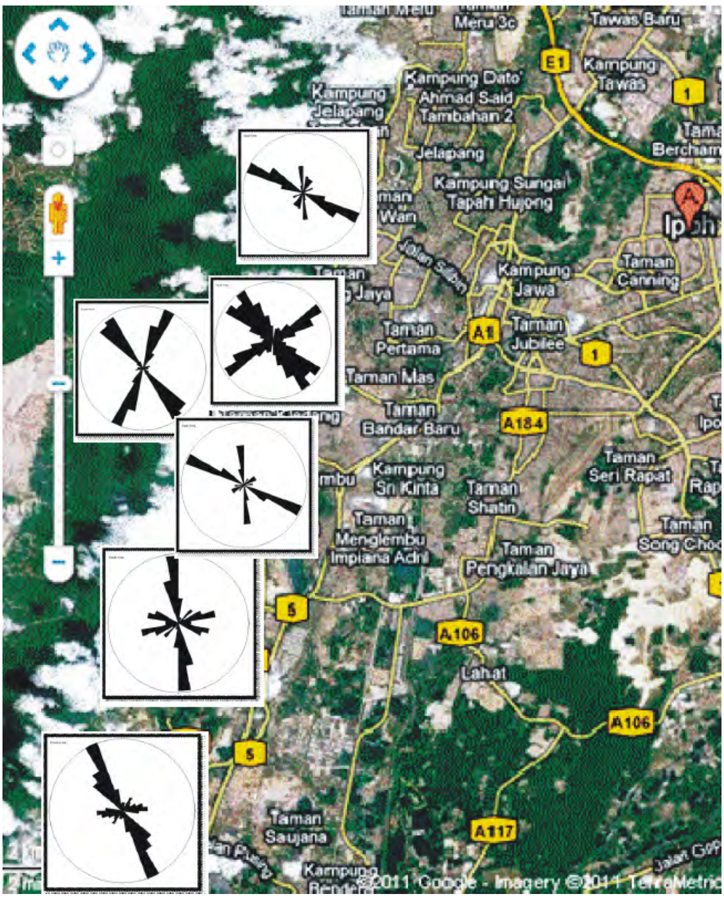

Figure 3: Strike diagram for the studied locations. L1 and L2 strike is towards N-S whereas for L3, L4, L5 and L6 strike is towards NE-SW and NW-SE.

Paper B27

Occurrence of syenite and trachyandesite - trachyte in the Bukut Sepang Loi – Bukit Renchir Area, Buloh Kasap, Segamat, Johor

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The area of interest in the Segamat-Buloh Kasap area, Johor Darul Takzim, includes the trachyandesite-trachyte at Hanson Quarry and syenite at Karisma Untung Quarry. This area is bounded by Sg. Muar on the western side, Sg. Kapeh on the eastern side and Sg. Segamat on the southern side. The area shows interesting outcrops, field relationships and textures of the two different igneous rock types, namely the plutonic syenite and the volcanic porphyritic trachyandesite-trachyte.

Generally the geology of this area consists of the Gemas Beds, volcanic rocks, plutonic igneous intrusions and Quaternary deposits (Burton, 1956; Gubb, 1962; Chong & Evans, 1968; Teng, 1970; Khoo, 1974). The oldest rocks are the clastic sediments of the Gemas Beds. The intrusive igneous plutonic rock in the study area is identified as a syenite with an age probably younger than the Gemas Beds (Bignell & Snelling, 1977). Based on petrography study and modal analysis, the syenite contains primarily of K-feldspar together with other minerals such as plagioclase, quartz and mica. EPMA analysis shows that the syenite contains ≈ 71.17 wt% SiO_2.

Overlying the syenite igneous plutons are the volcanic rocks with a Tertiary age around 62 ± 2 million years (Chakraborty & Kamineni, 1978). Based on the petrography and whole rock geochemical analysis, the volcanic rocks are identified as a trachyandesite and trachyte. EPMA analysis shows that the tranchyandesite contains ≈ 58.94 wt% SiO_2 and the trachyte contains ≈ 61.85 wt% of SiO_2 (Shand, 1947; Streikeisen, 1979; Le Bas *et al*., 1986).

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Paper B28

Chromite composition as evidence for the metamorphism in komatiite from greenstone belt, Manica area, Mozambique

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A large body of data exists in literature describing chromites from ophiolites, layered intrusions, kimberlites, basalts and other provenances, but relatively few studies have looked systematically at chromite in komatites. This paper looks at the factors controlling the crystallization of chromite in komatite and the textural and compositional variation within the chromites which have apparently retained some or all of their metamorphic characteristics. A new data on chromite compositions including microprobe analyses of major and minor elements were presented (carried out in laboratories of Kanazawa University, Japan) using JEOL JXA- 8800 electron probe microanalyzer. Modification of chromite during alteration and metamorphism has been discussed extensively in the literature in the context mainly chromites in ophiolites or 'Alpine ultramafic complexes and a few studies of komatiitic rocks (Barner, 2000). These studies have highlighted two important effects. First, chromite becomes rimmed and progressively replaced by chromian magnetite (or ferritchromite as it is commonly called in the literature). Second, chromite core compositions become progressively modified during prograde metamorphism as a result of exchange of the major elements Mg, Fe, Al and Cr with surrounding silicate minerals such as olivine and chlorite (Smith *et al*., 1980). These effects on komatiitic chromites is discussed in detail in our present paper. In summary, chromite cores appear to retain much of their original igneous chemistry at metamorphic temperatures of up to 500°C and higher in some circumstances.

The Archean rocks of Manica greenstone belt of Zimbabwe, Mozambique and South Africa was formed between 3.1 and 2.6 Ga. These greenstone belts are zones of variably metamorphosed mafic to ultramafic volcanic sequence with associated sedimentary rocks that occur within Archean cratons between granite and gneiss bodies (Vilijoen & Viljoen, 1969; Parman *et al*., 2001). The geology of the greenstone belt in Mozambique is dominated by shear zones occurring at the contacts between upper Bulawayan and the Mbeza metasedimentary rocks and within ultramafic units (Hunting, 1988; Afonso *et al*., 1995; Afonso, 1978). In Manica (Mozambique), the mafic – ultramafic rocks are composed of peridotites, serpentinites, talc, chlorite schist and komatiite (D'Orey, 1979). The present paper focus on the petrograpic study of komatiites occurring as lava flows and the mineral chemistry of the enclosed disseminated chromite grains as well as the textures and microstructures to give some light on the evolution of Mnica greenstone belt of Mozambique. The komatiite allowed us to glimpse into the immense geological processes from deep interior that our continent was undergoing 2.5 bilion years ago. The studied komatiite comprise perdotitic and basaltic komatiite and showing olivine spinifex textures in addition to relics of primary magmatic textures. The spinifex texture consists of long acicular pseudomorphs of alteration minerals after olivine (Arndt *et al*., 2004) . This texture is formed under rapidly cooling environment, namely water. As a consequence of metamorphism, most of the primary magmatic minerals were fully replaced by secondary assemblages of actinolite-tremolite, actinolitic hornblende, anthophyllite, serpentine, chlorite, talc, epidote, chromite and magnetite. In most cases, samples are completely altered and alteration products, of acicular olivine are occasionally serepintine, tremolite, actinolite, spinel and magnetite. Many of the studied sections contain disseminated chromite grains showowing replacement textures (lobate and curved boundaries) between chromian spinel and magnetite indicating metamorphic textures related to metamorphism. Petrographic observation also indicates that alteration and metamorphism have distinict effect on spinel in all the studied komatite samples. The alteration and metamorphism were accompanied by extensive development of rims of metamorphic chromian magnetite or ferritchromite. Magnetite typically form ragged coatings overgrown onto the primary growth faces of the chlorite and penetrating as filling along open fractures. With more extensive fluid interaction, fracture rims of chromite in contact with magnetite becomes defined by diffusive replacement of Mg^2 by Fe^2 in the spinel structure (resulting in lighter shades under the microscope). Chromite grain boundaries are clearly visible. Magnetite occurs as replacement of the original chromite cores rather than forming overgrowth on euhedral chromite cores. The proportion of magnetite appears to increase with increasing metamorphic grade. In the studied amphibolite samples, chromite grains replaced almost completely by magnetite and chromite grains are scarce. The chromian spinel have low Al and Mg values (up to 0.26 and 0.21 % respectively), low $Mg^{\neq}$ and high $Cr^{\neq}$ and $Fe^{\neq}$ values.The mineral chemistry of the chromian spinel indicate that these komatiites underwent regional metamorphism under greenschist amphibolite transition condition in a temperature about 500°C. The high $Cr^{\neq}$ values of spinel chemistry and very low $TiO_2 < 0.2\%$ suggest an upper mantle origin for the Manica komatiite (Green, 1975). The komatiite under considerations may have formed through high degree partial melting of reduced depleted mantle in a mantle wedge or sub-arc mantle environment.

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Paper B29

Petrogenesis and geochemistry of the Central Belt rocks, Peninsular Malaysia: Emphasis on the Stong Igneous Complex, Jeli, Kelantan and Benom Igneous Complex, Kuala Lipis, Pahang

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The study of the Central Belt rocks focuses on the Stong Igneous Complex and Benom Igneous Complex. It is aimed to identify the rock types, their petrography and mineral contents, geochemical characteristics, classification and petrogenesis processes, which occurred during the evolution of the rocks. Integration of these information was used to synthesise the intrusive model and their formation. Stong Complex can be divided into Berangkat Pluton, Noring Pluton and Kenerong Pluton. All these plutons were interpreted to have produced from the same source of magma based on their geochemical trend and rock classification. It is classified as metaluminous with minor peraluminous rock types, I-type granite, and shonshonitic to high K calc-alkali series in the anorogenic tectonic environment. The Benom Complex consists of alkaline and calc-alkaline rock series. Geochemical trend and age dating results show that both were from different sources of magma. Alkaline rock series consists of gabbro to alkaline gabbro, pyroxenite, diorite to quartz diorite, syenite to quartz syenite and monzonite to quartz monzonite. It is classified as metaluminous, I-type granite, shonshonitic series and high content of LILE, especially Ba and Sr. The calc-alkaline rock series consists of granite and granodiorite with texture from coarse-grained porphyritic to medium-fine equal grain size. The petrogenesis interpretation shows that the Stong Complex originated from partial melting of meta-basalt to meta-tonalite and enriched with mantle component. It crystallized and form the Berangkat Pluton which experienced partial melting again to produce Noring Pluton, and the remaining liquid after that forms the Kenerong Pluton. Alkaline rock series of Benom Complex was interpreted produce from the mixing of basic magma (probably mantle component) with the acidic magma from the partial melting of meta-basalt. Field evidence and geochemical characteristic show that a tectonic model involving slab-break off is suitable to explain the petrogenesis process of the Benom Complex. The age dating of the calc-alkaline rock series shows that it is older compare to alkaline rock series. It is interpreted as the product of the partial melting of meta-granite and meta-greywacke. Therefore, it shows the mixing of I-type and S-type granites.

Paper P1-1

Penggunaan kaedah indek halaju sebagai kaedah alternatif penilaian kualiti jasad batuan

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Penentuan kualiti jasad batuan biasanya dilakukan dengan penilaian nilai Perkadaran Jasad Batuan (*Rock Mass Rating*) asas, $RMR_{asas1979}$ yang dicadangkan oleh Bieniawski (1979). Sebagai pilihan, kaedah indek halaju (Vi) boleh digunakan untuk menilai kualiti jasad batuan dengan menggunakan halaju mampatan Vp yang diperolehi daripada ujian seismos biasan di lapangan dan ujian ultrasonik di makmal (Rajah 1). Sampel untuk setiap ujian disediakan mengikut piawaian *International Society for Rock Mechanics*, ISRM (1981). Sebanyak sembilan garis survei di atas enam muka cerun batuan granit bergred I telah dipilih untuk kajian ini iaitu di kuari JKR Bukit Penggorak, Kuantan, Pahang; kuari Kajang Rock dan Lebuhraya Silk Kajang, Kajang, Selangor. Keadaaan luluhawa sampel teras dan cerun batuan ditentukan dengan menggunakan ujian tukul Schmidt (Nurul Baizura *et al*., 2009). Daripada halaju mampatan yang diperolehi daripada ujian seismos biasan di lapangan ($Vp_{lapangan}$) dan ujian ultrasonik di makmal (Vp_{makmal}), indeks halaju (Vi) jasad batuan dan indeks jasad batuan ditentukan berdasarkan persamaan $Vi = Vp_{lapangan} / Vp_{makmal}$ yang disyorkan oleh Bieniawski (1989). Perkadaran Jasad Batuan, RMR_{asas} cerun batuan diperolehi daripada survei ketakselanjaran iaitu penanda mutu batuan (RQD), jarak antara ketakselanjaran dan keadaan ketakselanjaran di lapangan dan ujian beban titik atau ujian mampatan sepaksi di makmal. Kualiti jasad batuan untuk cerun yang disurvei dengan ujian seismos biasan dan ultrasonik bagi lokaliti yang terlibat adalah berkualiti baik sehingga sangat baik (Jadual 1). Perbandingan indeks jasad batuan yang diperolehi daripada ujian seismos biasan didapati mempunyai hubungan yang baik dengan kualiti jasad batuan yang diperolehi daripada survei ketakselanjaran dan ujian geomekanik (RMR_{asas}). Ini bermakna kaedah indeks halaju boleh digunakan sebagai kaedah alternatif untuk menilai kualiti jasad batuan tanpa melibatkan banyak parameter sekali gus menjimatkan masa dan kos.

Rujukan

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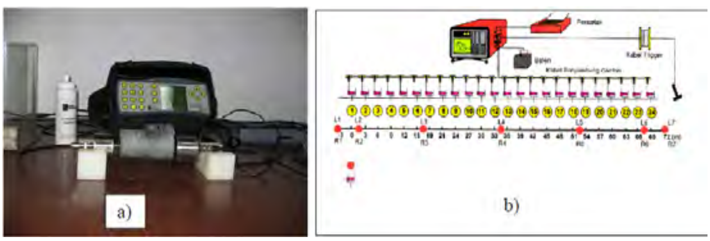

Rajah 1: a) Alat ujian halaju sonik untuk menentukan halaju, Vp_{makmal} teras di makmal. b) Susunatur alat seismik untuk mendapatkan halaju $Vp_{lapangan}$ di lapangan.

Jadual 1: Nilai Vp, indeks halaju dan RMR_{asas} 1979.

Garis Survei (cerun)	Gred	$Vp_{lapangan}$ (lapangan)	Vp_{makmal} (ultrasonik)	Indeks halaju (Vi)	Kualiti/indeks jasad batuan	RMR_{asas} 1979
BPF013 (BPF2)	I	3850	4647	0.83	sangat baik	baik-sangat baik
BPF193 (BPF2)	I	3850	4647	0.83	sangat baik	baik-sangat baik
BPF053 (BPF2)	I	3750	4647	0.81	sangat baik	baik-sangat baik
BPF233 (BPF2)	I	3750	4647	0.81	sangat baik	baik-sangat baik
KRW77 (KRSWS2-1)	I	3190	5130	0.62	baik	baik
KRF94 (KRFS2)	I	3642	5130	0.71	baik	baik-sangat baik
KRW288 (KRSWS5)	I	3633	5130	0.71	baik	baik
KRF110 (KRFS8)	I	4487	5130	0.87	sangat baik	baik-sangat baik
SHF320 (SHFT0)	I	3999	4714	0.85	sangat baik	baik-sangat baik

Paper P1-2

2-D resistivity survey for cavity detection at Chiku 5, Gua Musang, Kelantan

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One of the new developments in recent years is the use of 2-D geoelectrical resistivity imaging or tomography surveys to map areas with moderately complex geology (Griffiths & Barker 1993). The resistivity of common rocks, soil materials and chemicals is shown in Table 1 (Loke, 1997). 2-D resistivity survey was conducted to measure the subsurface resistivity within 20 m-30 m in depth by using Wenner method at eighteen 200 m length lines (Figure 1). The study is to evaluate and present the 2-D view of each resistivity profiles and determination of cavity in limestone. The measured resistivity data were interpreted using RES2DINV inversion software (Loke & Barker, 1996). This enables the identification of the low or high resistivity area to be identified and matched with layout plan that was proposed by developer. This site covered the area of 20 hectare on the Chiku 5 residence. The area of the Chiku 5 is located within the Gua Musang Formation. The borehole data show that study area was covered by soil average 5 m thick, followed by slightly weathered limestone with low fractured and fresh bedrock of limestone after 5 m depth. The area of study was divided into four areas which were marked as north, south, east and west part. For each area, the underground profile was compiled together to investigate the relation between each line survey in order to get the whole view picture for each part of the area. The compilation of lines FC01, FC02, FC03, and FC12 for the north part of the area of study, the existence of bedrock was confirmed by the consistent value of resistivity observed (>1000Ωm). It is located with shallow depth at the south. The cavity is only observed within line FC03 with resistivity value less than 100Ωm. The compilation of survey line for east part is between lines FC04 and FC05. Both are dominated by fresh limestone layer at the bottom. The third compilation of lines represents the southern part of the study area consists of line survey FC06, FC07, FC08, FC09, FC10 and FC11. Line survey FC07 detected the existence of a cavity at the bottom part of survey line. The forth compilation of lines consists of line FC13, FC14, FC15, FC16, FC17 and FC18, located at the western part of the study area. All survey lines within this area show the existence of cavity with average thickness around 5 m (Figure 2). Consideration should be taken to relocate the house at this area as propose in the lay out plan to the other place.

Table 1: The value range resistivity of rocks, soils and minerals (Loke, 1997).

Material	Resistivity (Ωm)	Conductivity (Siemen/m)
Igneous and Metamorphic Rocks		
Granite	$5 \times 10^3 – 10^6$	$10^{-6} – 2 \times 10^{-6}$
Basalt	10^3-10^6	$10^{-6} – 10^{-3}$
Slate	$6\times10^2 – 4\times10^7$	$2.5\times10^{-8} – 1.7\times10^{-3}$
Marble	$10^2 – 2.5 \times 10^8$	$4 \times 10^{-9} – 10^{-2}$
Quarzite	$10^2 – x\ 10^8$	$5 \times 10^{-9} – 10^{-2}$
Sedimentary Rocks		
Sandstone	$8 – 4 \times 10^3$	$2.5 \times 10^{-4} – 0.125$
Shale	$20 – 2 \times 10^3$	$5 \times 10^{-4} – 0.05$
Limestone	$50 – 4 \times 10^2$	$2.5 \times 10^{-3} – 0.02$
Soil and Waters		
Clay	1 – 100	1.01 – 1
Alluvium	10 – 800	$1.25 \times 10^{-3} – 0.1$
Groundwater (fresh)	10 – 100	0.01 – 0.1
Sea water	0.15	6.7
Chemicals		
Iron	9.074×10^{-8}	1.102×10^7
0.01M Potassium chloride	0.708	1.413
0.01M Sodium chloride	0.843	1.185
0.01M acetic acid	6.13	0.163
0.02 Xylene	6.998×10^{16}	1.429×10^{-17}

Figure 1: The close up position of the survey lines at the study area.

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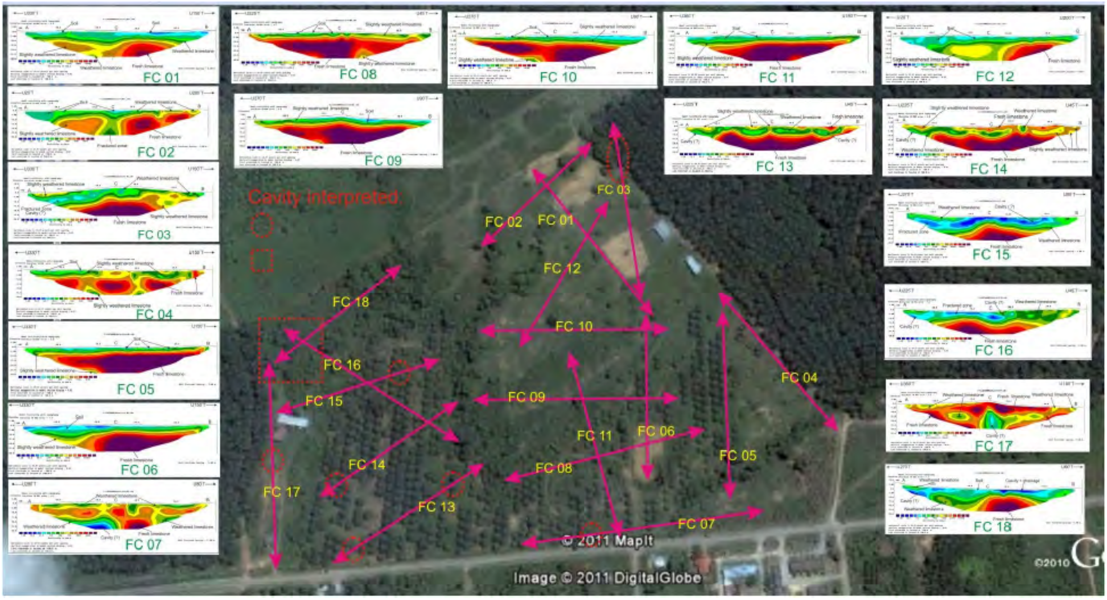

Figure 2: The compilation for all the resistivity profiling from FC01 until FC18 and location of cavity interpreted.

Paper P1-3

Numerical computation of depth of buried geologic structure from the gravity anomaly data

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Keywords: geology, structure, gravity, depth, computation

Introduction

The gravity anomaly interpretation is mostly done by iterative methods. Iterations start to compute gravity anomaly for a model with few known geologic parameters. Computed gravity anomaly is compared with the observed values and sometimes the model needs to be modified in order to obtain reasonable agreement. Several methods have been developed to identify the shape (Sharma & Geldart, 1968; Abdelrahman & El-Araby, 1993; Salem *et al.*, 2003) and depth (Abdelrahman, 1990; Elawadi *et al.*, 2001) of geological structure assuming simple source geometry from gravity data, though the simple geometries are not geologically realistic in most of the cases. In many contributions, numerical methods have been presented the estimation of depths of the geological structures of the gravity anomalies. This research is also introduced a numerical approach to estimate depths of simple models from residual gravity anomaly.

Methodology

The gravity effect of simple gravity models such as a sphere, an infinite horizontal cylinder, and a semi-finite vertical cylinder at an observation point ($x,z = 0$) centered at $x = 0$ and buried at a depth z can be generalized as:

$$g(x) = \frac{DCz^{b}R^{m}}{\left(x^{2}+z^{2}\right)^{a}} \qquad (1)$$

where, $D = \pi G\rho$ and G is the universal gravitational constant, ρ is the density and R is the radius of the shapes. The values of other variables are expressed below as shown in Table 1.

Using the gravity value g_0 at $x = 0$, Eq. (1) can be normalized and written as:

$$g_n(x) = \frac{g(x)}{g_0} = \left(\frac{z^2}{x^2+z^2}\right)^{a} \qquad (2)$$

where, $g_0 = DCz^{b-2a}R^m$. Eq. (2) can be further written as:

$$\left(g_n(x)\right)^{\frac{1}{a}}x^2 + \left(g_n(x)\right)^{\frac{1}{a}}z^2 = z^2 \qquad (3)$$

Eq. (3) has solved for z in this work as:

$$z = \sqrt{\frac{\sum_{i=1}^{N}x_i^4 - \left(\sum_{i=1}^{N}x_i^2\right)^2}{\sum_{i=1}^{N}x_i^2\left(1/g_n(x_i)\right)^{1/a} - \sum_{i=1}^{N}x_i^2\sum_{i=1}^{N}\left(1/g_n(x_i)\right)^{1/a}}} \qquad (4)$$

where, N is a number of observations and using Eq. (4), z can be obtained numerically.

Depth computation

Synthetic data

The proposed method has been investigated using synthetic gravity data. The cylinder and sphere models of having a density contrast of 2.5×10^3 kg/m^3, radius of 5 m and buried at different depths. Though not shown here, the gravity anomalies were computed along a 100 m profile at an interval of 1 m. A different degree of noises have also been added over the synthetic gravity data, however the computed depths were also found less erroneous.

Field data

Figure 1 shows the residual gravity anomaly profile of the gravity map of the Humbolt salt dome, TX, USA. This data has been interpolated with an interval of 0.15 m using splines method. Applying spherical model (C=4/3, b=1, a=3/2 and t=3) the estimated depths are shown in Table 2.

Results and discussions

Computed depth 3.60 km (Table 2) for the field data of the Humbolt salt dome is reasonably good agreement with another contribution as shown 5.15 km by Salem's *et al.* (2003) along with the depth 4.97 km obtained by drilling and seismic experiment (Nettelton, 1976).

In practice, the error can not be removed from the field data as in most of the practical cases buried structures are neither completely spherical nor cylindrical. The error might also be added during removal of regional anomalies, as a result the value of g_0 for normalization might also be changed. Accuracy of the estimation is basically depends on how better way the regional fields are removed for residual gravity. Indeed the proposed method for the computation of depths is seemed to be consistent.

Conclusion

This work demonstrates a simple method for the estimation of depths of buried sphere or cylinder. The method is applied over degraded synthetic gravity anomaly data of sphere and cylinder with different depths. Estimated depths using the method are found to be reasonably good, particularly for the sphere where the estimated errors found to be less than 7%. Standard deviation of the estimated error in depths is also meaningful. Derived formula has shown that the technique can estimate the realistic depths of buried geologic structures conveniently.

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Table 1: The value of the variables for different structure.

	For a sphere	For a vertical cylinder	For a horizontal cylinder
C	= 4/3	= 2	= 1
b	= 1	= 1	= 0
a	= 3/2	= 1	= 1
m	= 3	= 2	= 2

Table 2: Computed depth from gravity field data of Humble dome.

Number of Data Points N	Depth from Drilling and Seismic Experiment* km	Depth km	
		Computed	Average
51		3.56	
41		3.58	
31	4.97	3.59	3.60
21		3.60	
11		3.64	

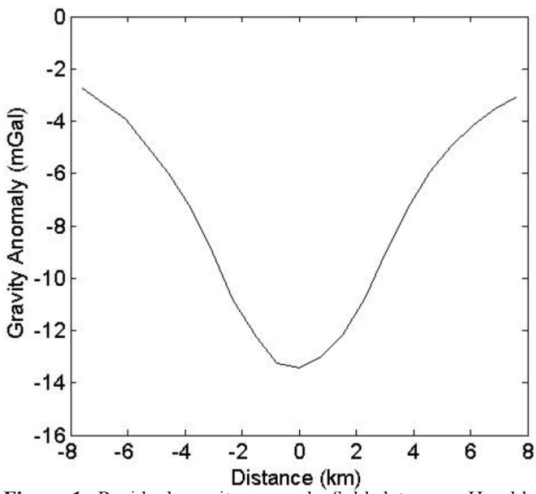

Figure 1: Residual gravity anomaly field data over Humble salt dome, Texas, USA (after Salem *et al*., 2003).

Paper P1-4

Group velocity dispersion analysis of Kolabunia Chittagong earthquake for studying the crustal thickness

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Keywords: Seismic wave, period, group velocity, earthquake data, crustal thickness.

Introduction

The principle used in this research to estimate the crustal structure of the earth, is the surface wave dispersion analysis of the local earthquakes. An indirect modeling is being presented where the group velocity dispersions has been computed and analyzed using graphical method (Ewing & Press, 1952) for the up-down component of the ground accelerated earthquake seismic wave of Kolabunia, Chittagong, Bangladesh of magnitude 5.1 recorded at Dhaka University on 27 July 2003 at 23:17:26.8 UTC. Kolabunia is 300.17 km from the capital city Dhaka, Bangladesh and also not so far from the Himalayan frontal arch which is passing through Myanmar. Table 1 lists the source parameters of the selected event (Figure 1), which is geographically located near the port city Chittagong, Bangladesh. This paper aims to construct a few models to compute the group velocity dispersion by modified Haskell matrix method. Group velocity dispersions by graphical method are then used to interprete the crustal structure of the Chittagong area from the model parameters.

Method

Group velocity dispersion is being considered as a factor by which crustal structure of an area can be depicted. Group velocity from recorded earthquake wave and multilayered crustal model can be obtained respectively by graphical method and modified Haskell matrix method. The group velocity, Ug of seismic surface wave by graphical method can be written as:

$$Ug = \Delta/t \qquad (1)$$

On other hand modified Haskell matrix method for the case of n - 1 homogeneous, isotopic elastic layers over a half-space matrix can be written as (Watson, 1970):

$$J = \hat{E}^n A^{n-1} \ldots A^m \ldots A^2 . A^1 \qquad (2)$$

The matrix, Eq. (2) can be further extended as (Faruk *et al.*, 2011):

$$R_i^m = \sum_{j=1}^{6} B_j^m R_j^{m-1} \qquad (3)$$

where, $B_j^m = A^m |_k^j$ and thus dispersion relation can be expressed as:

$$\Delta(T,c) = R^n B^n = 0 \qquad (4)$$

Dispersion relation Eq. (4) can be solved numerically for the model parameters e.g. Vp, Vs, ρ and thickness to obtain group velocity versus time period plot.

Group Velocity Estimation and Crustal Thickness

Group velocities are computed form both the earthquake data (Figure 1, Table 1) and the crustal models data using graphical method, Eq. (1) and Haskell modified matrix method, Eqs. (2-4). It has observed that group velocities, obtained (not shown all here but observed) from earthquake data and from models, have similar characteristics as both are varying with period, and to a reasonable maximum velocity. Therefore, interpretations have been drawn from the believed model parameters. One of the six models studied here as shown in Fig. 2 and Table 2 is revealed more acceptable. It is thus concluded that the group velocity dispersion analysis of Kolabunia, Chiitagong earthquake wave is indicated that there are four major subsurface layers in 23.5 km crustal depth and layer thicknesses as well as densities are also shown in Table 2.

Discussions and Conclusions

There are few challenges to set up the model parameters. Most critical constraint is to consider the Poisson's ratio of 0.25. In real cases the ratio might be different for different subsurface layers and hence the interpreted crustal structure from model might not be exactly appropriate. However for the computational advantages Vp/Vs ratio or Poisson's ratio were kept fixed as it has seen in many contributions to use the value of 1.732 or 0.25 respectively (Ammon *et al.*, 1990). On other hand from the sensitivity of the models, it has studied but not shown here that the thickness of the layers is a vital factor therefore, thickness setting in the model is also found to be difficult. However, from the investigations it is revealed that the setting of total depth rather than individual thicknesses of the subsurface layers can provide better interpretations, which are seemed to be more acceptable. A total depth of 23.5 km is considered in our models. Despite of the above limitations, interpretation made from the model is appeared good enough with the group velocity obtained by graphical method. Considering the group velocity dispersion from the six models and considering statistical error analysis, it can be said that all the models presented were very close to an acceptable matching level of around 99.9999684% that is close to 100% and better than 99.97%, which is a suitable measure mentioned by Elenean *et al*., (2009). It is thus from group velocity dispersion analysis of Kolabunia, Chittagong, Bangladesh earthquake and an indirect crustal model concluded the interpretation as there are four major crustal layers of the Chittagong area having respectively the thickness and density of 1.5 km, 2.54 gm/cc; 5.0 km, 2.57 gm/cc; 6.0 km, 2.60 gm/cc; 8.0 km, 2.65 gm/cc.

Acknowledgement: Authors acknowledge Prof. Aftab Alam Khan and Prof. Syed Humayun Akhter of the department of Geology of the Dhaka University, Bangladesh for providing seismological data.

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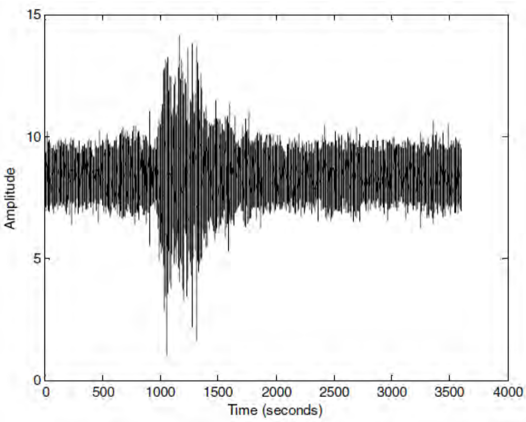

Figure 1: Up-down ground accelerated earthquake seismic wave recorded at Dhaka University occurred at Kolabunia, Chittagong, Bangladesh.

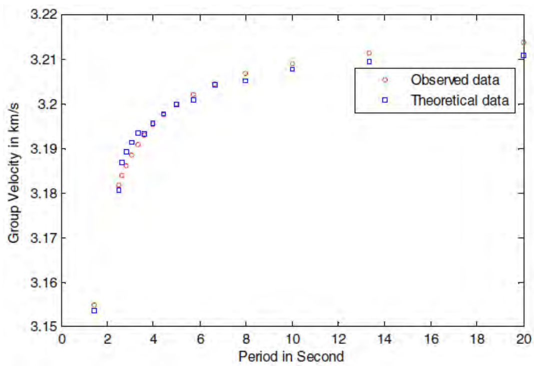

Figure 2: Group velocity dispersion obtained from Kolabunia, Chittagong earthquake data and from modeling as indicated theoretical data.

Table 1: Earthquake source parameters.

Date	27th July 2003
Origin Time	23:17:26.8(UTC) 05:17:26.8(BST)
Location	22.892N, 92.331E
Depth	10 km
Epicentral Distance	300.17 km
Mw	5.1

Table 2: Model parameters and estimated crustal layers and density.

Vp (km/s)	Vs (km/s)	Density (gm/cc)	Thickness (km)
5.52	3.187	2.54	1.5
5.63	3.25	2.57	5.0
5.72	3.30	2.60	6.0
5.89	3.40	2.65	8.0
6.10	3.52	2.72	Inf.

Paper P1-5

Kimiawi batuan serpentinit di sepanjang sempadan Jalur Tengah dan Jalur Barat Semenanjung Malaysia dan implikasi tektoniknya

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Kata kunci: Jasad serpentinid, canggaan, peridotit

Ringkasan

Singkapan-singkapan kecil jasad serpentinit di sepanjang sempadan Jalur Tengah dan Jalur Barat Semenanjung Malaysia membentuk jajaran pada arah antara U340°T-U350°T. Jajaran ini dikenali sebagai Garisan Bentong Raub atau Sutura Bentong. Jasad-jasad serpentinit tersebut tersingkap di Bukit Rokan Barat, Kampung Selaru, Petasih (Negeri Sembilan), Cheruh-Bentong (Negeri Pahang) dan Kelantan barat. Jasad-jasad serpentinit ini mempamerkan struktur-struktur yang dapat menjelaskan sejarah canggaan (deformasi) yang berlaku di sepanjang sempadan Jalur Tengah dan Jalur Barat Semenanjung Malaysia. Daripada data sesar didapati bahawa jasat-jasad serpentinit tersebut pernah mengalami empat fasa canggaan. Hasil analisis kimia dengan kaedah "XRF", menunjukkan bahawa batuan serpentinit ini mempunyai kandungan SiO_2 antara 40.51% hingga 46.05 %. Jasad serpentinit ini berasal dari batuan ultra bes peridotit yang merupakan batuan bahagian dari kerak samudra.

Pendahuluan

Jasad-jasad kecil serpentinit yang bertabur hampir mengutara (utara baratlaut-selantan tenggara: UBL-STG) di sebelah timur Banjaran Titiwangsa dicadangkan oleh Hutchison 1973, sebagai menandai parit subduksi Paleozoik Bawah. Parit tersebut dipercayai sempadan di permukaan antara kerak lautan di timur dan kerak kebenuaan di barat. Parit Subduksi ini dikenali sebagai Garisan Bentong. Hutchison 1977, menafsirkan Garisan Bentong sebagai zon sesar normal yang berakar dalam. Oleh itu bahan mafik dan ultramafik daripada mantel atas boleh mendaki menerusi zon sesar dan menerbitkan jasad-jasad yang kemudian berubah kepada serpentinit. Lakaran yang menggambarkan keadaan tersebut dinyatakan terjadi pada Trias Akhir. Michell 1977, pula mencadangkan bahawa batuan Garisan Bentong wujud dalam lembangan hadapan arka dan telah bercampur dengan batuan yang telah terbit pada arka tektonik dan juga arka magma. Bignell & Snelling, 1977, juga menganggap batuan dalam Garisan Bentong berasal daripada sebuah lembangan tepian antara parit subduksi di timur dan sebuah mikrobenua (yang meliputi Grik serta Baling) di barat. Pemikiran mengenai kewujudan Garisan Raub-Bentong meramalkan rejim tektonik mampatan yang disebabkan perlanggaran antara kepingan lithosfera. Berlainan dengan pendapat Tan (1981, dalam Khoo & Tan, 1983) yang menyatakan garisan itu sebagai zon sesar turun yang berakar dalam dan oleh itu memberi jalan kepada bahan mefik bergerak ke atas dari mantel atas.

Sutura Bentong (Tjia, 1989) meliputi batuan berusia Paleozoik bawah hingga tengah yang terdapat di kaki timur Banjaran Titiwangsa. Zon batuan ini selebar lebih kurang 13 km membentang utara-selatan bermula dari sempadan Malaysia-Thailand di sebelah barat kampung Tomo dan disaliri Sungai Tiang dan Sungai Mangga. Pada peta rantau (Jabatan Penyiasat Kajibumi, 1985) jalur batuan ini dinyatakan berumur Ordovisi-Silur. Ke selatan, granitoid Gunung Noring dan Gunung Camah merupakan pemisah daripada kelanjutannya iaitu di tepi barat Negeri Pahang dan boleh ditandai dengan Sungai Berias - Kuala Betis - Ulu Sungai Nenggiri - Sungai Telom - Cheroh - barat Raub - Teranum - Bentong - Karak. Dari Karak arah taburan batuan bertukar kepada selatan-tenggara mengikuti Sungai Telemong - Durian Tipus - Pertang - Kuala Pilah dan Bahau - Air Kuning - Jasin. Dekat Pertang dan Air Kuning dan dianjak ke kiri sejauh 10-20 km sepanjang ruas Zon Sesar Kuala Lumpur yang berjurus N110° – 120°E.

Pengamatan dan hasil analisis

Pengamatan lapangan dilakukan pada singkapan-singkapan serpentinit di sepanjang sempadan (batas) Jalur Tengah dan Jalur Semenanjung Malaysia, antara lain Bukit Rokan Barat, Kampung Selaru, Petasih, Cheruh-Bentong dan Kelantan Barat, seperti ternampak pada Rajah 1. Hasil pengamatan sesar pada kelima-lima kawasan studi dapat dilihat dalam Jadual 1. Manakala hasil analisis kimiawi daripada Kelima-lima contoh serpentinit dapat dilihat pada Jadual 2.

Hasil analisis kimia dengan kaedah XRF, menunjukkan bahawa batuan serpentinit pada kelima contoh ini mempunyai kandungan SiO_2 antara 40.51% hingga 46.05 % Seperti yang ternampak pada Tabel 2. Sedangkan hasil analisis kimia dengan metode XRD yang dari kelima contoh batuan serpentinit mengandungi mineral utama utuk contoh 1 kawasan Bukit Rokan Barat: lizardit. Contoh 2 kawasan mengandungi mineral antigorit. Contoh 3 kawasan

Petasih mengandungi mineral antigorit, swalerit, talk, walframit. Contoh 4 kawasan Cheroh-Bentong mengandungi mineral aktinolit, antigorit, magnesium aluminium silikat, hidromagnesit. Sedangkan contoh 5 kawasan Kelantan Barat mengandungi mineral antigorit.

Perbincangan

Hasil analisis dengan metode XRF yang menghasilkan kandungan SiO_2 antara 40.51% hingga 46.05 % jika dibandingkan dengan model analisis unsur utama dan Norm CIPW (James, 1971) maka asalan batuan serpentinit ini adalah peridotit.

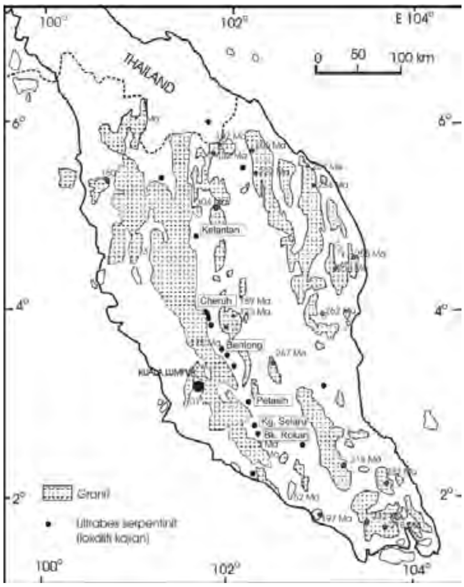
Dari kenampakan karakteristik menampakakan bodi singkapan berupa tabuar-lentikuler, jenis magma tholeitik, tipe major batuan berupa harburgit, tekstur am granular dan ophitik, dan mineral utama plagioklas (albit), klino-piroksen, orto- piroksen, olivin, maka dapat diasumsikan bahawa tipe kompleks batuan igneus ofiolit.

Hal ini diperkuat dengan hasil sayatan nipis batuan serpentinit yang mengandung mineral utama olivine, harburgit (peridotit), clino- pirosen dan orto-piroksin berstruktur opitik, piroksen, plagioklas (albit) dan serpentin menunjukkan bahawa asalan batuan serpentinit adalah peridotit.

Kesimpulan

Batuan serpentinit pada kelima-lima lokaliti penelitian merakamkan empat kali canggaan yang merupakan sejarah canggaan antara Jalur Tengah dan Jalur Barat Semenanjung Malaysia.

Batuan serpentinit berasal dari batuan igneus ultra bes (basa) peridotit yang terbawa naik ke atas sampai permukaan selama canggaan terjadi dan membentuk ofiolit komplek di sempadan anara Jalur Tengah dengan Jalur Barat Semenanjung Malaysia.



Rajah 1: Sebaran jasad serpentinit di semenanjung Malaysia setelah Tan dan Khoo (1981)

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Jadual 1: Hasil analisis sesar pada jasad serpentinit di sepanjang Garisan Bentong-Raub.

No.	Lok. Jasad Serpentinit	Foliasi U...°T/..°	Telerang U...°T/..°	Sesar generasi1 & σ1 (1)	Sesar generasi2 & σ1 (2)	Sesar generasi3 & σ1 (3)	Sesar generasi4 & σ1 (4)	Asalan Batuan
1.	Bt. Rokan Barat	340/65	-	-	350/75 (UBL-STG) 8°,U51°T (TL-BD)	20/80 (UTL-SBD) 9°,U70°T (BBL-TTG)	345/75 (UBL-STG) 14°,U204°T (BD-TL)	Ultrabes
2.	Kg. Selaru	345/60	-	-	165/30 (UBL-STG) 16°,U36°T (TL-BD)	-	-	Ultrabes
3.	Petasih	320/80	120/70 -kalsit -kuarsa -karbon	315/85 (BL-TG) 21°,U13°T (UTL-SBD)	0/80 (U-S) 24°,U59°T (TL-BD)	140/85 (BL-TG) 0°,U85° (T-B)	270/85 (B-T) 12°,U30°T (TL-BD)	Ultrabes
4.	Cheruh & Bentong	350/80 - 320/80	90/50	120/80 (BL-TG) 15°,U173°T (UBL-STG)	175/75 (UBL-STG) 18°,U231°T (BD-TL)	-	-	Ultrabes (Peridotit)
5.	Kelantan Barat	350/75	-	-	340/80 (UBL-STG) 18°,U39°T (TL-BD)	-	-	Ultrabes

Jadual 2: Elemen Major hasil analisis XRF daripada kelima-lima contoh disebandingkan dengan peridotit.

Lokaliti Konsentrasi	Bukit Rokan Barat (%)	Kampung Selaru (%)	Petasih (%)	Cheruh & Bentong (%)	Kelantan Barat (%)	**Peridotit (Wehrlit) (O.B. James, 1971) (%)**
SiO2	41.04	41.39	46.05	40.51	44.23	44.21
TiO2	0.03	0.12	0.05	6.65	0.06	0.11
Al2O3	1.02	1.60	1.01	10.74	1.98	0.91
Fe2O3	8.62	9.81	8.13	19.80	7.21	1.80
MnO	0.08	0.16	0.08	0.26	0.20	FeO 9.36
MgO	36.70	36.06	32.05	7.94	35.25	32.86
CaO	0.03	0.03	1.12	9.61	0.03	8.88
Na2O	1.47	1.56	1.31	3.46	1.19	0.11
K2O	**0.00**	**0.00**	**0.00**	0.03	**0.00**	0.01
P2O5	**0.03**	**0.00**	0.02	0.02	0.01	0.01
LOI	12.49	11.71	10.31	2.63	12.51	Min. lain 1.20
JUMLAH	101.47	102.39	100.09	101.64	102.66	99.9

Paper P1-6

Probabilistic seismic hazard assessment in Gilan Province of Iran

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Keywords: b-value, Gilan province, peak ground acceleration, probabilistic seismic hazard analysis, return period

Introduction

Iran, one of the most seismically active areas of the world is situated over the Himalayan-Alpied seismic belt along with Iran plate. Tectonic activities of Iran plate is younger, as a result the area is frequently suffered destructive earthquakes that cause casualties and damages. Observed horizontal movements in addition to vertical movements in Alborz have caused turbulent deformation. This has become apparent after 1990 Manjil-Rudbar earthquake. Therefore a pre-assessment of the seismic activities might be an aid to explain the geodynamics of the area. This paper presents to delineate the b-value by which probabilistic horizontal seismic hazard assessment of Gilan province can be performed.

Manjil is an important city of Gilan province in Iran that has experienced one of the largest earthquakes in Iran on 21 June 1990 with the magnitude of 7.4. The earthquake left many casualties along with huge destructions. Historical earthquakes indicate that Gilan province is a high seismogenic zone because of the existance of active faults like Manjil-Rudbar and the distribution of earthquakes of the region.

Tectonic setting of Gilan province

Gilan province is located in south west of Caspian Sea in mountainous area of Talesh and central Alborz range that endure many earthquakes up today. The most ancient earthquake ever occurred in this area is located near Rudbar – Rostam Abad. This ancient earthquake has destroyed this area in the first millennium B.C. (Negahban, 1964; Negahban, 1977; Berberian *et al*., 1992). One of the recent earthquake in the 20th century in this area is Rudbar earthquake in 21 Jun 1990 with magnitude 7.4 that caused many destruction. Complex tectonics of central Alborz and Gilan in the south west of Caspian sea demonstrate many seismic activities. Hence, the area can be said to one of the active high potential seismic areas of Iran (Figure 1).

Tectonic activities in the semi oceanic crust in the bottom of Caspian sea show that it is unstable, which means the area is seismologically hazardous. One of the most unstable feature is Lahijan fault and its magnetic groove in seashore is shown in the Figure 1.

Data and methodology

In this paper we will calculate the b value and presents the results of probabilistic seismic hazard analysis (PSHA) for Gilan Province The spatial distribution of seismic events between the longitudes of 49.10-50.10E and the latitudes of 36.90–37.70N which encompasses the region will be done and the result will be the hazard analysis curve for the area.

An earthquake database, of earthquakes greater than magnitude 4.0 (total 49) and the time ranges from 1980 to 2010 (total of 30 years), is used in this research. Efforts are made on a line source and a brief description of the source is given below.

Total Length: L1 = 200 km; Minimum distance from site: R_{min} = 25 km
Length of each segment: 50 km; Maximum Magnitude = 7.4
Segment 1: L11 = 50 km ,R11=30 km
Segment 2: L12 = 50 km, R12=27.5 km
Segment 3: L13 = 50 km, R13=38.75 km
Segment 4: L14 = 50 km, R14=68.75 km

Earthquake recurrence is expressed by Gutenberg-Richter natural log relation as:

$$\text{Ln } N = a - b M \qquad (1)$$

where, N is the number of earthquake of magnitude lager than magnitude M, and a and b are the constants.

Results and discussions

Table1 shows a summary of calculation and Figure 2 shows the b-line and the result of regression. The peak ground acceleration (PGA) has estimated through the Boore, Joyner and Fumal expression with the coefficients corresponding to the largest horizontal component of the PGA.

The result of the probabilistic seismic hazard analysis, PGA seismic hazard curve is shown in Figure 3 where the vertical axis gives the (desired) level of probability, and the horizontal axis is some ground motion parameter such as peak ground acceleration .

Relationship between return period and probability of exceedance is as:

return period = -T/ln(1-P) (2)

and the estimated PGA for probability and return periods 50 years are shown in Table 2.

Conclusions

For the area the estimated values of a and b are as 1.983 and 1.718, respectively. The bounded Gutenberg-Richter recurrence law is found to give an acceptable ground shaking hazard for the Gilan. Results of the analysis have provided uniform hazard spectra and bed rock level peak ground acceleration (PGA) for various return periods. The b value and probabilistic seismic hazard analysis (PSHA) for Gilan province are well presented in the form of PGA. The PGA at Gilan corresponding to 10% probability of exceedence in a life span of 50 years or in other words a PGA corresponding to a return period of 475 years is 0.35g, which is the indication of low to high seismicity region.

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Figure 1: The active faults of Gilan province (IIEES, 2002)

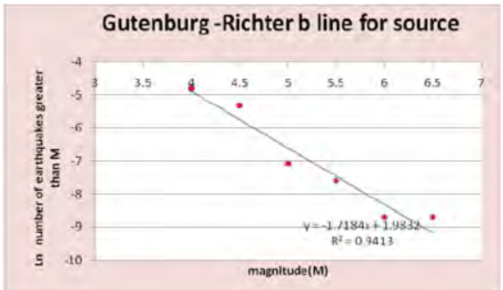

Figure 2: b line for the line source.

Figure 3: Hazard curve for line source using Boore, Joyner and Fumal attenuation expression.

Table 1: Summary of b-line calculation.

magnitude	number	number/year	per length	Ln(N)
m>4	49	1.633	0.0082	-4.808
m>4.5	29	0.967	0.0048	-5.332
m>5	5	0.167	0.0008	-7.090
m>5.5	3	0.100	0.0005	-7.601
m>6	1	0.033	0.0002	-8.700
m>6.5	1	0.033	0.0002	-8.700

Table 2: PGA for different return periods.

Probability of exceedance	Return period (years)	Horizontal PGA (g)
10% probability of exceedance in 50 years	475	0.35
5% probability of exceedance in 50 years	975	0.40
2% probability of exceedance in 50 years	2475	0.55

Paper P1-7

Some Cretaceous Radiolaria from Darvel Bay Ophiolite Complex, Kunak, Sabah

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Darvel Bay Ophiolite Complex is located at Kunak district, southeast Sabah. The complex consists of ultramafic unit, gabbro unit and volcanic-sedimentary unit. The most common rocks in the study area are peridodite, serpentinite, gabbro, basalt, pillow basalt and reddish-brown chert. The aim for this research is to establish the age and environment of deposition for the radiolarian chert. Eighteen chert samples were collected from two new outcrops along the Kunak-Semporna road. All samples were processed according to micropaleontology method and well preserved specimens were photographed by scanning electron microscope (SEM). There are 56 species of radiolarian indentified and 40 species are used for age determination. The radiolarian fossils can be divided into three assemblages i.e. Assemblage I, Assemblage II and Assemblage III. Assemblage I (Aptian to Albian) is characterized by the occurrences of *Sticomitra simplex, Crucella bossoensis*, *Xitus clava*, *Dictyomitra communis*, *Hiscocapsa asseni*, *Obeliscoites vinassai*, *Rhopalosyringium fossile*, *Paronaella grapevinensis*, *stichomitra communis*, *Xitus spicularius*, *Phangalites perpicuus*, *Triactoma cellulose* and *Becus horridus*. Assemblage II (Albian to Cenomanian) consists of *Xitus mclauglini, Pseudoaulophacus sculptus*, *Dictyomitra gracilis*, *Torculum coronatum*, *Dictyomitra montisserei*, *Pogonias prodomus*, *Pessagnobrachia fabianii*, *Sciadiocapsa speciosa*, *Crucella massinae*, *Dictyomitra obesa*, *Pseudodictyomitra languida*, *Tugurium pagoda*, *Dictyomitra farmosa*, *Acaeniotyle rebellis*, *Pseudoaulophacus putahensis*, *Quadrigastrum oculus*, *Pseudodictyomitra tiara*, *Diacanthocapsa euganea*, *Patulella helios* and *Stichomitra stocki*. Assemblage III is represented by the occurrences of *Pseudotheocampe tina*, *Ultranapora cretacea*, *Alievium superbum*, *Dictyomitra multicostata* and *Patulella ecliptica*. *Crucella cahensis* is the index fossil for Assemblage III which is Turonian in age. These fossil assemblages show that the age of radiolarian chert in Darvel Bay Ophiolite Complex ranges from Aptian to Turonian (Cretaceous). Depositional environment of the chert is determined based on fossil analysis and rock association. The occurrence of bedded chert with abundance of radiolarians indicates high plankton productivity which may be related to upwelling of nutrient rich water mass caused by the submarine volcano. The absent of limestone in the bedded chert shows that the radiolarians were deposited below the CCD level. Association of ultramafic rocks and chert indicates that it is part of ophiolite sequence representing oceanic crust that developed at the spreading center.

Paper P1-8

Estimation of anisotropic parameter γ in South Pars Field of Iran

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Keywords: Anisotropy, Dipole Shear Sonic Imager, γ parameter, anisotropic slowness parameter, shear wave slowness

Summary

In this paper, one of the anisotropic parameters of Thomsen (γ) was determined by DSI tool used in gas well of the South Pars field in Iran. In this investigation, for the better estimation of anisotropy the γ parameter compared with anisotropic slowness parameter (α_{DT}). Then the γ parameter has been compared with the Gamma Ray log in the same depth intervals. This shows anisotropy behavior in shaly zones of Kangan Formation. The average of the γ parameter for the K1 sublayer found to be a little higher than K2. There is a good correlation between anisotropy parameter γ and the slowness based on anisotropy slowness vector.

Introduction

Anisotropy has an important role in exploration and reservoir geophysics. Ignoring anisotropy can lead to poor seismic imaging, misleading of the seismic reflector responses, inaccurate well-ties, and incorrect interpretation of seismic amplitudes related to lithology and fluid content.

Anisotropy parameters can be determined in several ways, including velocity measurements on core samples in a laboratory or from field data in VSP experiments. A common form of anisotropy observed in many geological settings (thinly horizontal layers or fractures) which the reference axis of symmetry is normal to the bedding surfaces. Thomsen (1986) introduced three anisotropic parameters (g, e and d) which describing the weak anisotropy, and it is believed to be simple model of anisotropy. Gamma (γ) parameter describes the difference between the horizontally polarized and vertically polarized shear waves.

Shear wave velocity anisotropy is commonly referred to shear wave splitting, because shear wave traveling in anisotropic media, separates into two shear waves. At a given receiver the shear waves are characterized by their orthogonal polarization directions (fast and slow velocities) and a delay between these two arrival times.

Dipole Shear Sonic Imager (DSI)

The DSI tool is a full waveform acoustic imager that delivers measurements of sonic wave propagation in a wide variety of formations. DSI combines monopole and dipole sonic acquisition capabilities. The transmitter section contains a piezoelectric monopole transmitter and two electro-dynamic dipole transmitters which are perpendicular to each other (Figure 1). Electric pulses of different shapes and frequency content can be applied to the transmitters. The dipole transmitters are driven at low frequency to excite the flexural waves around the borehole.

DSI tool can measure the components of shear wave in many directions in a plane perpendicular to borehole axis. In conventional DSI logging, one can present compressional wave, Δt_c, shear wave, Δt_s, and Stoneley wave, Δt_{st}. The DSI could estimate orientation and magnitude of stresses from velocity dispersion. One type of special dipole modes enables recording both the inline and crossline (perpendicular) waveforms. These modes, called both cross receivers (BCR), which are used for anisotropy evaluation around borehole.

Estimation of parameter γ

Anisotropy is measured by method like measuring velocity by using core samples in laboratory (Johnston and Christen, 1995) and compared with field data (Banik, 1984; Leslie & Lawton, 1999). Arrival time and vertical slowness for different arrivals are parameters which can be used for estimation of anisotropy. Anisotropy parameter γ can be calculated by difference between the fast shear wave velocity and the slow shear wave velocity (Chan, 2005). Thomsen (1986) considered a kind of relation by choosing compression and the shear wave velocities along the vertical symmetry axis. In fact five elastic coefficients in VTI media are considered by Vp_0 and VS_0 velocities and also by three dimensionless parameters called g, e and d.

$$Vp_0 = (C_{33}/\rho)^{1/2} \quad (1)$$

$$Vs_0 = (C_{44}/\rho)^{1/2} \quad (2)$$

$$\gamma = (C_{66} - C_{44}) / (2C_{44}) \quad (3)$$

and/or

$$\gamma = E_T/2 \approx (V_{S\text{-fast}} - V_{S\text{-slow}}) / V_{S\text{-slow}} \quad (4)$$

In equation (4) $V_{S\text{-fast}}$ is the fast shear wave velocity and $V_{S\text{-slow}}$ is the slow shear wave velocity. Therefore, $V_{S\text{-fast}} = (C_{66}/\rho)^{1/2}$ and $V_{S\text{-slow}} = (C_{44}/\rho)^{1/2}$ (Teng, 1998).

Also we can write,

$$\varepsilon = (C_{11} - C_{33}) / (2C_{33}) \quad (5)$$

$$\delta = ((C_{13} + C_{44})^2 - (C_{33} - C_{44})^2) / 2C_{33} (C_{33} - C_{44})) \quad (6)$$

Vp_0 and Vs_0 are related to wave velocity transmitting in media and g, e and d are anisotropic parameters which are dimensionless. These three parameters lead to understand the wave behavior in anisotropic media. For estimation of the anisotropy value, another parameter (α_{DT}) can be considered.

$$\alpha_{DT} = (DT_{Slow} - DT_{Fast}) /((DT_{Slow} + DT_{Fast}) /2) \quad (7)$$

In equation (7) α_{DT} is anisotropic slowness. DT_{fast} is the fast shear wave slowness and DT_{slow} is the slow shear wave slowness.

In this paper anisotropic parameter g is determined by DSI for K1 and K2 sublayers in Kangan Formation in the South Pars gas field. Shear wave slownesses are recorded in vertical direction by using DSI tool. g parameter is determined in vertical direction in borehole. Also elastic constants C_{44} and C_{66} are calculated by shear wave velocities in vertical direction from DSI data. For estimation of these two elastic constants, density values should be determined from density log. Also anisotropy values in relation with the equation (7) considered in depth (α_{DT} in comparison with g), gave good correlation between α_{DT} and g. Also gamma ray log for Kangan Formation in comparison with anisotropic parameter g-log was used. In figure (2) g parameter in comparison with gamma ray-log for Kangan Formation is displayed. Gamma ray log in Figures 2a and 2c and g parameter in Figures 2b and 2d in sublayers are also shown. Average of g parameter in K1 is 0.015 and in K2 is 0.012.

In Figure 3, stiffness coefficients C_{44} and C_{66} with R^2=0.962 and g parameter (related to α_{DT}) with R^2=0.993, for K1 sublayer are evaluated. In Figure 4, stiffness coefficients C_{44} and C_{66} with square error of (R^2=0.975) and g parameter (related to α_{DT}) with R^2=0.999, for K2 sublayer are compared.

In Kangan formation gamma ray log in K1 sublayer in comparison with K2 sublayer, shows higher values (probably because of disperesed shale).

Conclusion

For the Kangan Formation the highest value of anisotropy is at depth of 2754 m. Because of higher resolution in DSI logs relative to seismic data, more accurate description of these physical parameters is obtained. In the Kangan Formation, the average value in K1 sublayer is 0.015 and in K2 sublayer is 0.012 which show that K1 sublayer relative to K2 sublayer is more anisotropic. For gamma ray log, in some depths, higher values of g was found in the shaly zones.

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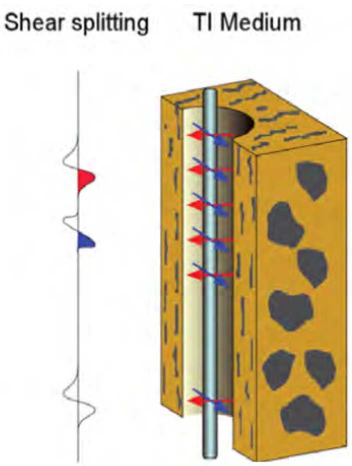

Figure1: DSI tool (both cross receiver tool (BCR) and acquisition system for anisotropy evaluation).

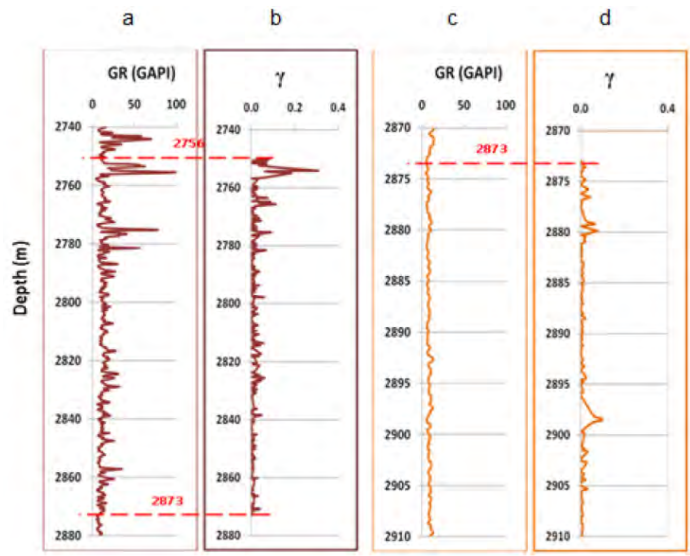

Figure 2: Anisotropy parameter (γ) in comparison with gamma ray log (in meter). a) gamma ray in K1; b) γ parameter in K1; c) gamma ray in K2; d) γ parameter in K2.

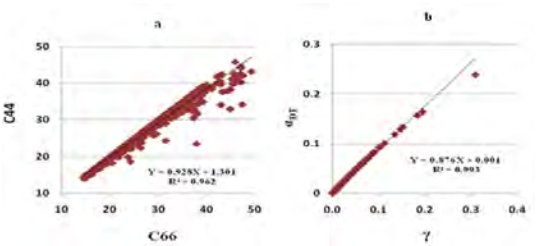

Figure 3: Comparison of correlation coefficients for K1 sublayer. a) stiffness coefficients C_{44} versus C_{66}; b) γ parameter versus α_{DT}.

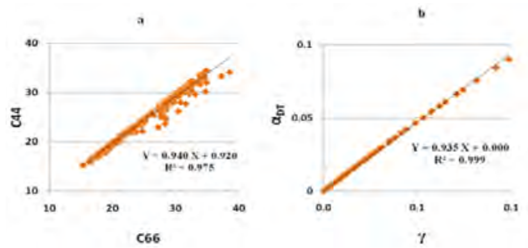

Figure 4: Comparison of correlation coefficients for K2 sublayer. a) stiffness coefficients C_{44} versus C_{66}; b) γ parameter versus α_{DT}.

Paper P1-9

Anhydrous versus hydrous pyrolysis study of selected Tertiary coals from Labuan, Malaysia

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Coal as a source rock for liquid hydrocarbons has been found in a number of worldwide basin, for example the Gippsland Basin of Australia, the Mahakam Delta of Indonesia, the Turpin Basin of China (Li, 2008). There are several pyrolysis techniques to generate and expel oil from organic-rich sedimentary rocks. Pyrolysis extracts potential hydrocarbon from petroleum source rock by thermally degrades kerogen to pyrolysates. Pyrolysis experiments in closed systems can be carried out either with or without the presence water. Hydrous pyrolysis, a closed system technique in the presence of water, was chosen as the best method to extract source rock due to it being more closely analogous to natural crude oil generation (Lewan, 1985; Ruble, 2002). This study compared two different technique of laboratory thermal degradation which is hydrous and anhydrous pyrolysis. The three Labuan coal samples analysed in this study are all of Tertiary age; one sample each from Belait formation (F005-LB-II), Setap Shale formation (F019-LB-II) and Temburong formation (F012-LB-I). This study focuses on determination of kerogen type and maturity of the samples using petrographic and geochemical approach. The anhydrous pyrolysis system i.e. the Source Rock Analyzer (SRA) is used in this study to determine the S1, S2, T_{max}, hydrogen index (HI), oxygen index (OI), and total organic content (TOC). The results are shown in a Table 1. These parameters are used to geochemically characterised the samples analysed in this study while petrographic analysis, using a Leica microscope is used to determine the vitrinite reflectance (VR) values. SRA data was plotted on a modified van Krevelen diagram and shows that sample F005-LB-II and F019-LB-II are predominantly dominated by Type II kerogen and sample F012-LB-I is predominantly dominated by Type III kerogen. These findings are shown in Figure 1. Vitrinite reflectance (%VR_o) of these samples ranges from about 0.42-0.73% suggesting that these samples are generally immature to mid mature for hydrocarbon generation. For hydrous pyrolysis approach, samples are run in PARR 4575 High Temperature High Pressure Reactor. The same three coal samples were subjected to hydrous pyrolysis study and the results of which will be discussed in a comparison to the anhydrous pyrolysis data.

Table 1: Pyrolysis data based on anhydrous system.

Sample Name	S1 mg/g rock	S2 mg HC/g rock	T_{max} °C	HI	OI	TOC %
F005-LB-II	10.23	342.13	418.5	482	7	70.94
F019-LB-II	0.45	9.30	436.8	267	0	3.48
F012-LB-I	9.39	131.11	461.1	327	4	40.10

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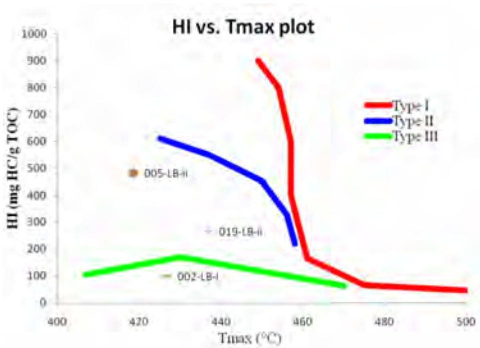

Figure 1: A modified van Krevelen diagram.

Paper P1-10

Monitoring of CO_2 injection into depleted oil reservoir using AVO analysis: Feasibility studies

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CO_2 injection into depleted oil and gas reservoir is an alternative for CO_2 storage mechanism. Unfortunately, CCS (Carbon Capture and Storage) technology is still considered as new and has many flaws. To prevent the unwanted risks, the accumulation of CO_2 in the reservoir should be monitored regularly. In many cases, the standard geophysical methods are limited to differentiate the presence or absence of CO_2 in the reservoir. Hence, in this paper, we investigate the feasibility of AVO analysis for this purpose. Sets of seismic response for oil and gas reservoir model has been generated using ray tracing method. Amplitude versus offset effect was estimated using Aki Richard approximation, meanwhile the properties changes due to CO_2 injection into reservoir was estimated using Gasmann equation. The AVO analysis was performed on common depth point synthetic data. The result shows that the injection of CO_2 into depleted oil and gas reservoir could change the seismic response. Compressibility and velocity of the rock are changed by CO_2 injection, hence the AVO response for oil and gas reservoir before and after injection are different. AVO analysis has a great potential to be used for CO_2 injection monitoring into depleted oil and gas reservoir

Paper P1-11

Faults and folds in the Miri Formation, Sarawak— Revisited

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Keywords: Fault, fold, Miri Formation, structural analysis

Introduction

Recent geological studies carried out in the Miri Formation reveals several structural elements and stratigraphic patterns that warrant further description of the Formation. Particularly the existence of outcrops that shows a very big contrast of a thick vertically dipping section with a sub-horizontal or gently dipping sequence situated side by side. Due to sudden change on bedding orientation and topography, it was interpreted by Schumacher (1941) and Shuib (2003) as thrust fault called the Canada Hill Thrust. Schumacher in 1941 developed a structural model of Miri with the following elements: (i) a set of steep normal faults hading to the northwest with a vertical displacement of thousands of feet; (ii) a set of flat normal faults, hading to the southeast; (iii) a set of merging reverse faults, hading to the northwest (the Canada Hill Thrust); and (iv) an asymmetric, slightly overturned, anticlinal fold. Locally the formation was too competent to buckle thus it broke and creating the thrust faults such as the Canada Hill thrust fault at the back of the Hill (Berbeito, 2003). However, the high angle fault plane (± 55^{o}) separating the two contrasting blocks is not likely to be the feature of a thrust fault (Spencer, 1988). The absence of a drag fold in the field and the presence of a very short contact zone for a very big contrast between a thick sequence of vertically dipping section with a sub-horizontal or gently dipping sequence situated side by side suggests there is a serious weakness in the structural model that was proposed by Schumacher in1941.

Objectives and methodology

This paper attempts to resolve the above problems by collecting new informations on structural elements from recent outcrops that become clearly exposed as a result of slope cutting and earth works activities during the present urban development in and around the Canada Hill. Other information was obtained from the subsurface image of the area. Field observations and measurement of faults, folds, and bedding were conducted at 18 major outcrops. The measurements then were plotted on stereonet. In order to facilitate the data interpretation, the locations of outcrops were grouped into 3 sections; northern, middle, and southern parts.

Results and discussion

The poles density distribution of the bedding and fault planes is shown in Figure 1. In general, the stereonet analysis indicates that the Canada Hill is a non plunging-anticline block trending approximately in NE-SW direction, characterized by a broad anticline with gentle flanks. The axis of the anticline in the middle section is NNE-SSW but swing to NE-SW in the northern and southern sections of the anticlines. The middle section seems received highest compression and have resulted a very steep fold limb. The axial plane at the middle part is moderately inclined to northwest whereas at the northeastern part, the axial plane of the anticline drastically changes to steeply inclined to southeast. Cross sections through the Miri Field indicates the presence of several important structural elements of the Formation: (i) a set of steep normal faults dipping to the northwest; (ii) a set of steep normal faults dipping to the southeast; (iii) a reverse fault, dipping to the northwest and (iv) a gentle to open asymmetric anticlinal fold. This interpretation is proposed to explain the fact that the fault plane of 55^o is too steep to be interpreted as a thrust fault. The structural features of the Miri Formation of this study area are comparable to structural image from seismic data of the offshore Miri. Information from seismic data shows the presence of reverse and normal faults at 900-2200 meters depth.

Conclusions

Structural evidences from the new outcrops in Miri suggest that a set of normal faults that head in the opposite direction to each other and rotational movements on the competent sediment of the Miri Formation may have formed due to the space created during the deformation periods. Meso-structures of the outcrops support this rotational movement, explains the existence of a very big contrast of thick sequence of vertically dipping section with a sub-horizontal or gently dipping sequence situated side-by-side. The change in orientation of the anticline from symmetrical-upright to asymmetrical with axial plane dipping to NW and then to SE direction and trending to NNE-SSW in the middle but swing to NE-SW in the northern southern parts suggests that it was influenced by regional NNW-SSE force probably related to the strike slip faulting in the region (Mazlan 1999). The seismic interpretation of this area is in agreement with the findings from structural analysis of the Miri Formation derived from the field data.

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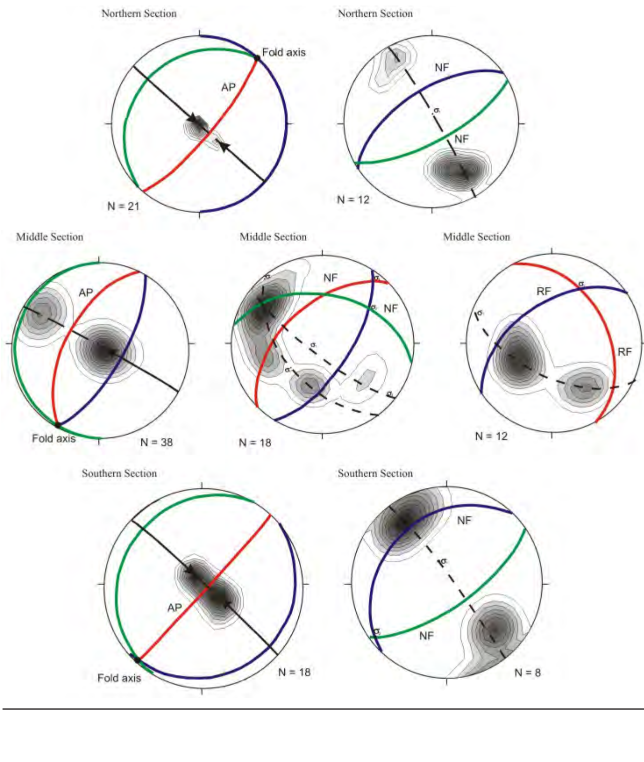

Figure 1: Lower hemisphere equal-area stereographic projection summary of the faults, folds and bedding trend orientation analysis data for the three sections studied. The great circle is the mean fold and fault planes. AP = axial plane; NF = normal fault; RF = reverse fault.

Paper P1-12

Landslide susceptibility mapping at Kota Kinabalu, Sabah using factor analysis model (FAM)

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Keywords: Landslide susceptibility mapping, factor analysis model, geospatial technology, Kota Kinabalu

The aim of the study was to prepare a landslide susceptibility map (LSM) of Kota Kinabalu area, Sabah. The rapid development had a spill over effect in the Kota Kinabalu area where lands was cleared for the construction of highways, high-rise buildings, industrial, housing area and several other heavy infrastructures. These activities had, besides spurring economic growth, indirectly also caused landslide risk management problems. Hence, for further development of the area, it is vital to assess the probability of landslide occurrence. For this purpose, the statistical approach (factor analysis model - FAM) based on GIS (Geographical Information System), has been applied to assess the landslide susceptibility of the area. Landslide susceptibility is defined as quantitative or qualitative assessment of the classification, volume (or area) and spatial distribution of landslides which exist or potentially may occur in an area. Susceptibility may also include a description of the velocity and intensity of the existing or potential landsliding. The FAM is a data reduction technique used to reduce a large number of variables to a smaller set of underlying factors that summarize the essential information contained in the variables. More frequently, this model consists of a statistical comparison between landslide distribution as the dependant variables and a number of separate instability factors (input parameters). This approach makes it possible to calculate the "rating" of an individual input parameter. The method is based on the assumption that landslides will always occur in the same geological, geomorphological, hydrogeological and climatic conditions as in the past and the procedure considers a number of environmental factors that are thought to be connected with landslide occurrence. The following input parameters were compared and analysed: geology, geodynamic features, slope conditions, hydrology/hydrogeology, types of landuse, and engineering characteristics of soils and rocks. The data layers, in which each factor was subdivided into a convenient number of classes, were separately overlain and statistically compared with the landslide distribution map (LDM). Subsequently, the landslide density was calculated and the weighted value was determined for each individual class. The final landslide susceptibility value was expressed as the sum of all parameter classes ranked according to the calculated landslide density for each class. In terms of landslide susceptibility, the resulted of Kota Kinabalu area suggests that 10% of the area can be categorised as Very Low Susceptibility, 16% as Low Susceptibility, 14% as Moderate Susceptibility, 48% as High Susceptibility and 12% as Very High Susceptibility. In contrast, 'high' and 'very high' susceptibilities areas represent the steep slope segments with either buildings or roads and in terms of land use planning is vice-versa. The landslide susceptibility map was analysed with known landslide locations and verified. This FAM had higher prediction accuracy (93.59 % reliability). The resulting LSAM can be used by local administration or developers to locate areas prone to landslide area, determine the land use suitability area and to organize more detailed analysis in the identified "hot spot" areas. This study also shows the ability of geospatial technology as powerful integrated tools.

Paper P1-13

Groundwater investigation using electrical resistivity imaging technique at Sg. Udang, Melaka, Malaysia

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Keywords: 2-D resistivity imaging, electrical imaging, resistivity, borehole, groundwater

Electrical resistivity imaging surveys have been conducted in order to locate, delineate subsurface water resource and estimate its reserve. The resistivity imaging surveys carried out basically measures and maps the resistivity of subsurface materials. 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. The purpose of electrical surveys is to determine the subsurface resistivity distribution by making measurements on the ground surface. In this survey, electrodes were arranged in a straight line with constant spacing and connected to a multicore cable. A 2-D geoelectrical resistivity technique was used. Resistivity imaging measurement was carried out using an ABEM SAS 1000 terrameter with electrode selector system for data collection. A Wenner electrode configuration was employed. The field survey was conducted along four profiles which provide a continuous coverage of the resistivity imaging below surface. Colour-modulated sections of resistivity versus depth were ploted for all lines, giving an approximate image of the subsurface structure. The data gathered in this survey were interpreted using RES2DINV software to provide an inverse model that approximates the actual subsurface structure. Basically, the data from these surveys are commonly arranged and contoured in the form of a pseudosection which gives an appropriate picture of the subsurface resistivity. The surface soil material is mainly clayey silt. The results show that the layers associated with the low resistivities (Ω.m) are located at depth ranging from 2 to 28 m. This low resistivity values are associated with zone of water saturated fractures. The results show that the thickness of residual soil is about 0.5-2.55 m. Borehole data indicate that the depth of bedrock is about 10 m, and the groundwater level is ranging from 8.73 m to 8.54 m. The results of this work further demonstrate that the resistivity imaging is an effective tool for defining the thickness of groundwater aquifers and mapping of bedrock in tropical zones with relatively shallow depth. Electrical imaging surveys can be used as a fast and efficient exploration tool to determine the aquifer boundaries and estimate its reserve.

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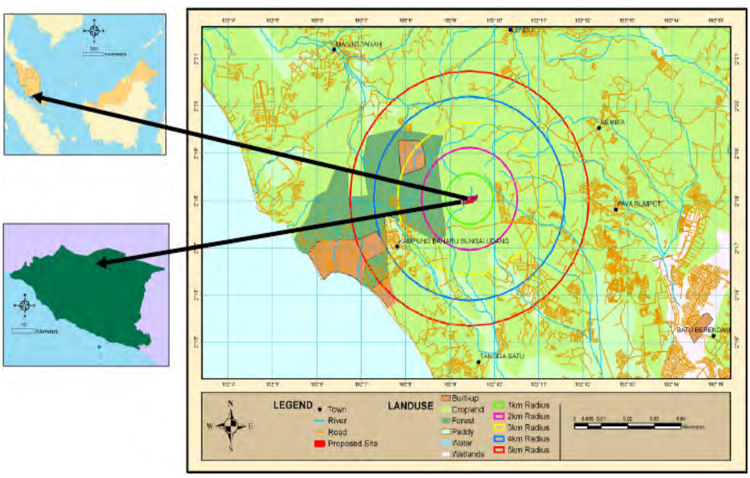

Figure 1: Location map of study area.

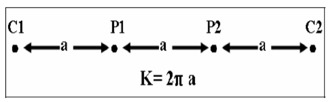

Figure 2: Representation of electrode spacing in the Wenner array configuration. The subsurface resistivity distribution of the area is shown in Figures 3 to 6.

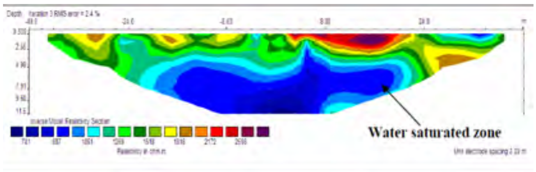

Figure 3: Resistivity image at BH1- Electrode spacing 2 m.

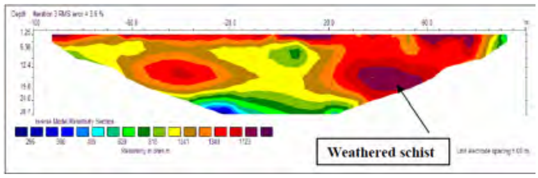

Figure 4: Resistivity image at BH1-electrode spacing 5 m.

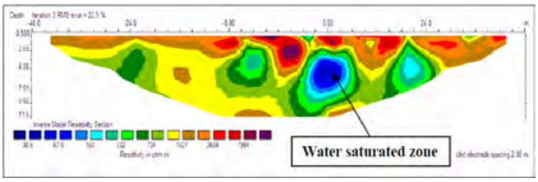

Figure 5: Resistivity image at BH7-electrode spacing 2 m.

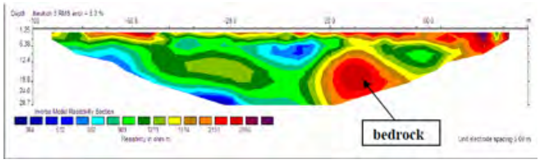

Figure 6: Resistivity image at BH7-electrode spacing 5 m.

Paper P1-14

Bedrock detection using electrical resistivity imaging in Serdang, Malaysia

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Keywords: 2-D geoelectrical resistivity , electrical imaging, resistivity, bedrock elevation, Wenner configuration

Electrical resistivity imaging surveys have been conducted in order to locate, delineate subsurface water resource and estimate its reserve. Surface resistivity now used to monitor groundwater contamination, locate subsurface cavities and fissures. The resistivity imaging surveys carried out basically measures and maps the resistivity of subsurface materials and resistivity imaging method use for the identification of different layers of the earth, the types of bedrock rock, the depth of the water and the recognition of the electrical resistivity in the layers of the earth. A 2-D geoelectrical resistivity technique was used. Resistivity measurement was carried out using an ABEM SAS 4000 terrameter with electrode selector system. The measurement of a resistivity must be waiting for certain time, because the ABEM Terrameter SAS4000 requires a time for measurement and recording the data. Its time depends on the number of electrode that used. The field procedure and data Acquisition have three parts of steps. The first one is list of equipment which is used, the second is set up a measurement and the last one is processing data. A Wenner electrode configuration was employed. The Wenner array is relatively sensitive to vertical changes in the subsurface resistivity below the centre of the array and this array has the strongest signal strength. A measurement of the resistivity of the ground is carried out by transmitting a controlled current (I) between two electrode pushed into the ground, while measuring the potential (u) between two other electrodes. The resistance (R) is calculated using ohm s law: $R=\Delta V/I$

The field survey was conducted along four profiles which provide a continuous coverage of the resistivity image below surface. Colour-modulated sections of resistivity versus depth were plotted for all lines; giving an approximate image of the subsurface structure the geoelectrical resistivity method plays a significant role in the exploration of natural resources like groundwater and mineral deposits. The resistivity imaging surveys can be used to help in delineating the bedrock. The results showed that the layers associated with the resistivities between 20Ω.m and 8000Ω.m and are located at a depth varying from 4 to 36m. Bedrock surface was successfully mapped quite precisely at about 24, 36m depths. The results of this work further demonstrate that the resistivity imaging is an effective tool for defining the thickness of groundwater aquifers and mapping of bedrock in tropical zones with relatively shallow depth.

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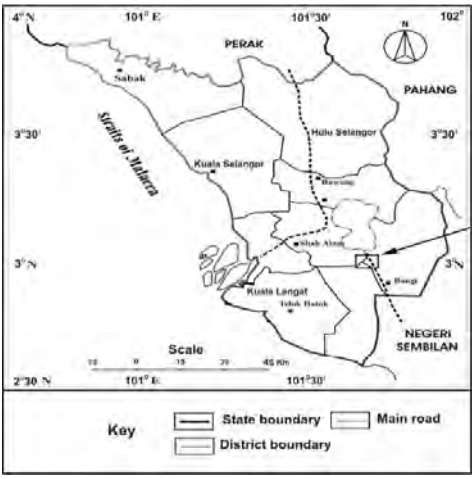

Figure 1: Location of the study area.

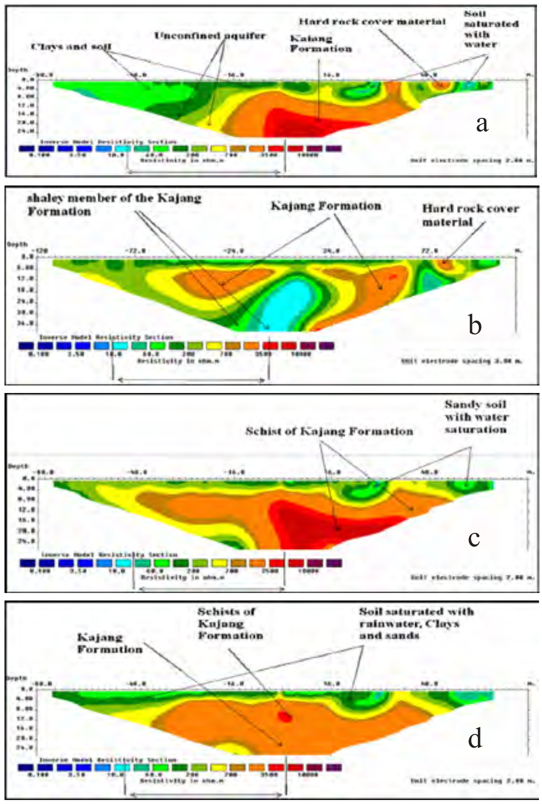

Figure 2: Inverse model section for line area C1 (a), C2 (b), C3 (c), C4 (d).

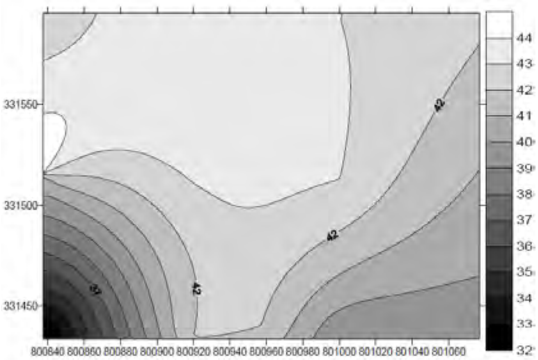

Figure 5: Contour of bedrock elevation.

Paper P1-15

Diagenesis batu kapur Pulau Tanjung Dendang Formasi Setul di Langkawi, Kedah

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Pengenalan

Formasi Setul merupakan formasi batuan karbonat yang tertua di Semenanjung Malaysia. Formasi ini tersingkap di Kepulauan Langkawi dan juga Perlis. Di kepulauan Langkawi, Formasi Setul tersingkap di bahagian timur iaitu dari Tanjong Sabong di bahagian utara meliputi Tanjung Ru, Pulau Langgun, Pulau Tanjung Dendang, Kilim, Pulau Timun, Pulau Tuba hingga ke Pulau Dayang Bunting di selatan. Formasi batuan yang berusia Ordovisi hingga Devon ini terdiri daripada batu kapur tidak tulen yang bercampur dengan lumpur dalam amaun yang agak tinggi, batu kapur dolomit dan dua ahli gersik yang terdiri daripada perlapisan syal, batu lumpur kaya silika, batu lodak, batu pasir dan sedikit rijang. Kamal Roslan Mohamed dan Che Aziz Ali (2001) berpendapat bahawa batu kapur yang membentuk Formasi Setul ini adalah terenap di kawasan sekitaran laut cetek. Sekitaran karbonat ini adalah terdiri daripada lumpur karbonat yang tidak membentuk jasad terumbu. Dalam kertas kerja ini, hanya satu kawasan sahaja yang akan dibincangkan iaitu batu kapur yang tersingkap di kawasan Pulau Tanjung Dendang sahaja.

Bahan dan kaedah

Survei tinjauan telah dilakukan di beberapa kawasan sekitar bahagian timur Langkawi yang termasuk dalam Formasi Setul. Kerjalapangan menfokuskan singkapan batu kapur di bahagian timur kepulauan Pulau langkawi iaitu di kawasan Pulau Tanjung Dendang. Rintisan mengelilingi pulau ini telah dilakukan bagi mendapatkan sampel. Sebanyak 120 sampel batuan telah di ambil untuk di analisis di makmal.

Kesemua sampel tersebut kemudiannya di jadikan sampel hirisan nipis. Daripada hirisan nipis batuan ini, kandungan alokem utama yang terdapat di dalam setiap sampel dapat ditentukan. Penentuan kandungan utama adalah penting bagi penamaan mikrofasies serta proses diagenesis yang telah dialami oleh batuan tersebut. Pengelasan Dunham (1962) digunakan sebagai skema pengelasan utama bagi penentuan mikrofasies. Skema pengelasan ini turut di bandingbezakan dengan skema pengelasan Folk (1969). Kesemua sampel hirisan nipis itu juga di staining dengan menggunakan larutan Alizarin Red S bagi membezakan sama ada sampel batuan itu adalah batu kapur atau dolomit. Sampel batu kapur akan bertukar menjadi warna merah manakala sampel dolomit tidak merubah warna.

Hasil dan perbincangan

Batu kapur di kawasan ini merupakan batu kapur tua yang telah mengalami proses diagenesis yang lama. Proses litifikasi yang dialami oleh batuan tersebut memberikan tekstur diagenesis yang berbeza-beza. Kehadiran peloid dan pelet yang banyak merupakan cirian utama batu kapur di pulau ini. Proses mampatan dapat dilihat dengan jelas pada butiran peloid dan pelet yang menunjukkan pengaturan selari pada satu arah serta bentuknya yang telah terubah daripada bentuk bulat kepada bentuk yang lebih membujur. Terdapat juga butiran pelet yang bersentuhan antara satu sama lain yang membentuk sutura yang menyokong berlakunya pergerakan mekanikal akibat pertambahan tekanan hasil daripada litifikasi batuan.

Pendolomitan dilihat sebagai proses diagenesis utama yang dialami oleh batu kapur di sini. Proses pendolomitan yang berlaku merupakan hasil diagenesis batu kapur itu sendiri dan bukan daripada pemendapan. Hablur dolomit dilihat menggantikan mikrit dalam batu kapur dan mewujudkan tekstur yang bertompok-tompok membentuk gugusan dolomit yang sangat jelas. Selain itu, dolomit juga turut menggantikan kalsit spar dalam bentuk hablur yang berasingan. Pembentukan dolomit ini dipercayai hasil daripada proses penggantian yang berlaku dalam batu kapur memandangkan hablur dolomit yang terbentuk adalah lebih besar secara relatif dengan kalsit.Pendolomitan juga wujud dalam jalur stilolit yang terhasil daripada proses pemampatan batuan ketika litifikasi.

Penstilolitan dilihat memotong fabrik dalam batu kapur membentuk struktur yang beramplitud sama ada tinggi dan juga rendah. Penimbusan dalam yang dialami oleh batu kapur kuno ini menyebabkan batuan mengalami tekanan dan suhu yang tinggi. Ini menyebabkan berlakunya perubahan orientasi butiran untuk mengadaptasi dengan keadaan sekitaran. Pemadatan kimia turut berlaku menghasilkan solution seam yang berasosiasi dengan stilolit yang terbentuk. Kewujudan 'mould' cangkang invertebrate marin seperti bivalve dan brakiopod menbuktikan berlakunya proses pelarutan. Struktur asal cangkang tidak dapat dilihat dengan jelas dan ruang kosong yang terhasil itu diisi oleh simen-simen kalsit yang berbentuk blok mencadangkan berlakunya penyimenan di zon freatik air tawar dan berlaku sebagai pengisi rongga akhir. Walaubagaimanapun terdapat juga bioklas yang masih boleh dilihat struktur asalnya dengan jelas.

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Paper P1-16

Kelimpahan logam-logam terpilih dalam tanah dan sedimen di sekitar Semporna, Sabah

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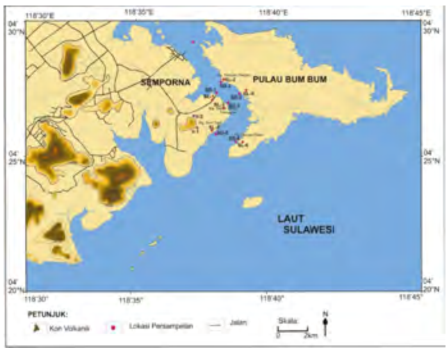
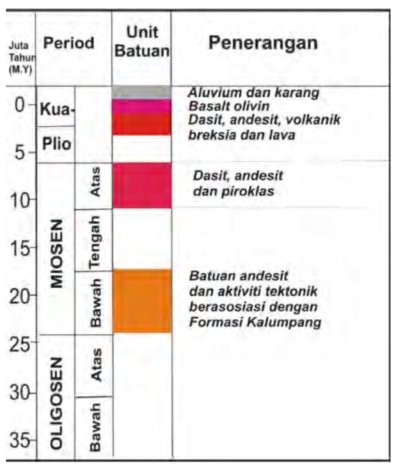
Sebanyak 14 sampel tanah dan sedimen telah diambil di sekitar Pekan Semporna Sabah dan Pulau Bum Bum, Semporna untuk kajian penentuan kelimpahan logam-logam berat terpilih dan mengkaji punca dan faktor yang mengawal kelimpahan logam-logam tersebut (Rajah 1). Perairan di kawasan ini digunakan oleh para nelayan dan bot pengangkutan untuk sampai ke pulau – pulau yang berhampiran khususnya P. Bum Bum. Unit batuan di kawasan kajian terdiri daripada asosiasi batuan igneus volkanik iaitu andesit – dasit dan basalt yang dianggarkan berusia Pliosen hingga Holosen (Rangin *et al*., 1990). Asosiasi batuan volkanik andesit – dasit – basalt ini membentuk tulang belakang banjaran dan mencorakkan landskap pergunungan kon volkanik di kawasan Semenanjung Semporna (Sanudin & Baba, 2007). Menurut Lim (1981) aktiviti volkanik di Semenanjung Semporna termasuk kawasan kajian telah menghasilkan lava andesit dan piroklastik diikuti oleh lava dasit. Rajah 2 menunjukkan siri jujukan dan asosiasi batuan vokanik (Kirk, 1962; Sanudin & Baba, 2010). Terdapat juga endapan sedimen karbonat berusia Kuaternari di sekitar pantai Pekan Semporna dan tersingkap dengan banyak di Pulau Bum Bum. Sampel tanah dan sedimen dihadamkan menggunakan asid pekat sebelum dijalankan analisis fiziko-kimia dan analisis kandungan As, Cd, Co, Cr, Cu, Ni, Pb dan Zn menggunakan peralatan ICPMS-OES. Jadual 1 menunjukkan data daripada analisis fiziko kimia sampel tanah, sedimen dan tanah daripada luluhawa batuan volkanik. Data analisis menunjukkan sampel sampel tanah dikelaskan sebagai tanah lodak dan lodak berlempung yang berwarna coklat dan coklat kelabu gelap. Manakala tanah sedimen pula berwarna putih, kuning gelap dan kelabu cerah dan dikelaskan sebagai pasir dan pasir berlempung. Secara keseluruhan tanah adalah beralkali lemah dengan pH berjulat 7.4 – 8.8. Hasil analisis kandungan logam-logam berat ditunjukkan dalam jadual 2. Hasil analisis menunjukkan logam - logam yang paling tinggi kelimpahannya dalam tanah ialah Zn (Sampel SL-3) iaitu 204.0 µg/g diikuti oleh Cr (103.3) dan Co (29.0 µg/g). Manakala As, Cd, Cu, Ni dan Pb keseluruhannya kurang daripada 25 µg/g. Sampel dalam sedimen pula menunjukkan Pb paling tinggi iaitu 324.2 µg/g (Sampel SD-4) diikuti oleh Zn (108.0 µg/g) dan Cr (42.5 µg/g). Nilai Pb yang terdapat dalam sedimen ini juga lebih tinggi berbanding dengan nilai dalam tanah volkanik di kawasan kajian dan juga berbanding dengan tanah volkanik di kawasan Tawau, Sabah (Baba dan Hennie, 2008). Logam logam lain seperti As, Cd, Co, Cu dan Ni umumnya berjulat 0,1 µg/g hingga 17 µg/g. Merujuk kepada nilai kelimpahan Pb yang tinggi dalam sedimen tepi pantai maka dijangkakan sumber Pb adalah daripada aktiviti manusia (antropogenik) dan bukannya daripada luluhawa batuan induk. Manakala nilai Zn dan Cr yang tinggi dalam sedimen pula adalah daripada proses luluhawa batuan induk dan proses pengayaan dalam tanah dan sedimen adalah hasil penjerapan oleh mineral lempung dan juga bahan-bahan organik.



Rajah 1: Taburan perbukitan kon volkano dan lokaliti persampelan di sekitar Pekan Semporna.



Rajah 2: Jujukan batuan volkanik di sekitar Semporna, Sabah (Sumber: Kirk, 1962; Sanudin & Baba, 2010).

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Jadual 1: Sifat fiziko kimia tanah dan sedimen dari kawasan kajian.

Sampel	Saiz Butiran (%)			Pengelasan Tanah	Warna Tanah	Kandungan Kelembapan, Wo (%)	Bahan Organik OM (%)	Graviti Tentu, SG	pH
	% Sand	% Silt	% Clay						
SL1	25.87	66.46	7.67	Silt	Coklat	49.70	32.87	2.12	8.6
SL2	9.46	72.94	17.61	Silt	Coklat gelap	56.55	31.90	2.17	7.4
SL3	10.90	83.56	5.53	Silt	Hitam	63.89	46.59	1.98	7.8
SL4	13.49	79.09	7.41	Silt	Coklat kelabu gelap	42.03	27.29	2.22	8.0
SL5	15.21	74.19	10.60	Clayey silt	Kelabu sangat gelap	46.84	35.65	2.06	8.2
SL6	18.96	78.59	2.46	Silt	Kelabu gelap	39.25	23.99	2.25	7.7
SD1	95.06	4.94	0.00	Clayey sand	Kuning gelap	37.47	3.54	2.61	8.8
SD2	97.48	2.52	0.00	Sand	Kuning gelap	28.89	3.19	2.56	8.8
SD3	97.48	2.52	0.00	Sand	Kelabu cerah	29.16	3.39	2.64	8.8
SD4	97.48	2.52	0.00	Sand	Kuning gelap	27.79	3.20	2.62	8.8
SD5	95.01	2.49	0.00	Sand	Kuning gelap	48.73	4.11	2.56	8.5
SD6	97.49	2.51	0.00	Sand	Putih	38.22	3.73	2.52	8.7
V-1	29.30	34.13	36.57	Clay	Kelabu gelap	40.93	20.17	2.19	6.6
V-2	37.92	49.15	12.93	Silty Clay	Coklat kelabu gelap	36.01	11.71	2.12	7.4

Jadual 2: Kelimpahan logam-logam berat dalam tanah dan sedimen dari kawasan kajian. BDL – dibawah had pengesanan.

Sampel/Unsur	As (µg/g)	Cd (µg/g)	Co (µg/g)	Cr (µg/g)	Cu (µg/g)	Ni (µg/g)	Pb (µg/g)	Zn (µg/g)
SL-1	2.5	1.4	22.0	46.1	9.9	11.2	11.9	62.0
SL-2	8.1	2.0	28.0	103.3	10.7	17.7	24.0	77.0
SL-3	2.0	0.1	20.0	5.2	5.2	2.1	bdl	204.0
SL-4	7.5	1.2	24.0	83.6	8.4	13.8	21.5	56.0
SL-5	16.0	0.9	29.0	82.8	13.5	14.9	19.1	67.0
SL-6	bdl	1.5	22.0	5.9	8.2	10.6	18.5	74.0
SD-1	1.8	0.0	10.0	6.4	3.9	2.5	bdl	102.0
SD-2	0.6		12.0	6.9	3.8	1.5	bdl	57.0
SD-3	4.6	0.8	16.0	42.5	11.7	10.3	20.1	28.0
SD-4	0.9	0.1	11.0	5.5	29.9	1.5	324.2	89.0
SD-5	0.2	0.1	17.0	5.2	4.4	2.1	2.5	65.0
SD-6	0.7	bdl	13.0	3.8	8.3	1.4	1.0	108.0
V-1	bdl	bdl	29.0	5.7	44.6	2.6	8.0	56.0
V-2	bdl	bdl	24.0	2.8	5.6	0.6	15.7	104.0

Paper P1-17

Aplikasi teknik-teknik geofizik dalam kajian lubang benam di kawasan sekolah SMK Idris Shah Gopeng Perak

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Kajian geofizik dilakukan untuk mengkaji lubang benam di kawasan Sekolah Menengah Kebangsaan Sultan Idris Shah, Kopisan Baru, Gopeng, Perak yang terletak di antara bangunan baru dan lama sekolah. Kawasan kajian termasuk dalam Lembah Kinta terdiri dari granit mesozon termuda, diikuti oleh filit dan kuarzit, lapisan Gopeng dan batu kapur sebagai batu dasar yang tertua. Berdasarkan maklumat lubang gerudi, kawasan kajian terdiri dari pasir, lempung dan lodak yang menindih batu kapur sebagai batu dasar. Satu kejadian tanah runtuh telah berlaku di kawasan ini di sekitar Oktober 2009 menghasilkan keluasan lubang runtuhan bergaris pusat 7m dengan kedalaman 2.5m. Selepas siasatan, lubang tersebut telah ditutup dengan tanah. Kajian dijalankan untuk melihat keberkesanan teknik-teknik geofizik dalam mengesan lubang benam yang telah ditutup dan meneroka potensi untuk berlaku kejadian lubang benam yang lain di sekitar sekolah tersebut. Kaedah kajian yang digunakan ialah pengimejan keberintangan geoelektrik, seismik biasan dan GPR (Ground Penetrating Radar). Pengukuran geofizik melibatkan Sebanyak 5 garis survei keberintangan geoelektrik, 2 garis survei seismik biasan dan 8 garis survei GPR yang dilakukan di sekitar bangunan sekolah. Kedalaman berbeza diperolehi dari teknik-teknik geofizik yang berbeza dimana kedalaman bagi teknik pengimejan geoelektrik ialah di sekitar 7m manakala kedalaman maksimum bagi teknik seismik ialah 12m. Kedalaman paling cetek diperolehi bagi teknik GPR iaitu 6m. Teknik keberintangan geoelektrik telah dapat mengesan 4 anomali dengan keberintangan elektrik setara dengan lubang benam yang berlaku pada tahun 2009 iaitu di sekitar 3000 ohm.m. Keberintangan elektrik ini ditafsirkan sebagai mewakili tanah berpasir pada kedalaman 2 m di atas paras air bawah tanah. Anomali-anomali berkeberintangan tinggi ini mewakili pasir dan lodak kering dan longgar. Pada kedalaman sekitar 3m, di bawah permukaan, berkeberintangan yang diukur bernilai sangat rendah dan ditafsirkan sebagai lapisan longgar tepu air. Teknik keberintangan geoelektrik sangat berkesan dalam mengkaji lubang benam. Imej halaju pada rentasan yang sama dengan garis survei keberintangan geoelektrik juga menunjukkan perubahan halaju dari 150 hingga 3000 m/s mewakili tanah penutup hingga ke batu dasar. Pada kedalaman 6m ke bawah, halaju sekitar 1500m/s ditafsirkan sebagai tanah tepu air. Pada kedalaman melebihi10m, halaju yang diukur adalah sangat tinggi iaitu 3000 m/s yang ditafsir sebagai batuan yang sangat keras dan termampat. Kedudukan lubang benam tertimbus dan kedudukan sebarang potensi lubang benam tidak dapat dicirikan dengan imej halaju yang diperolehi dari teknik seismik biasan. Survei GPR menggunakan sumber gelombang electromagnet pada frekuensi 500 MHz dapat menunjukkan dengan baik imej bekas lubang benam yang tertimbus dan beberapa kaviti berdasarkan cirri-ciri pola pantulan seperti selari, subselari dan kacau. Lubang benam yang telah ditimbus menunjukkan ciri pantulan kacau kerana bahan tanah timbusan tidak menunjukkan cirri perlapisan berbanding dengan tanah atau alluvium semulajadi yang berfasies pantulan selari. Kaviti dalam tanah mempunyai pantulan berbentuk lembangan atau ‘basin-shape features’.

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Paper P1-18

Pelarutan dan fluks jisim logam berat dalam medium poros dengan menggunakan kolum 1-dimensi dalam sistem bawah permukaan tepu

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Pengenalan

Pertambahan penduduk, perkembangan pesat ekonomi dan pembangunan perindustrian adalah antara faktor yang menyumbangkan kepada ketidakseimbangan alam sekitar. Seperti yang diketahui, ketidakseimbangan alam sekitar boleh mendatangkan masalah pencemaran yang seterusnya boleh memudaratkan kesihatan penduduk setempat dan membawa kesan buruk kepada semua kehidupan di bumi. Maka, satu penyelidikan dijalankan bagi melihat pergerakan bahan pencemar di bawah sistem permukaan yang tepu dengan menggunakan beberapa medium geologi. Objektif kajian ini adalah untuk menyiasat kadar pelarutan dan fluks jisim logam berat dengan menggunakan kolum 1-dimensi dalam kepelbagaian bahan semulajadi geologi. Pelbagai ujian makmal dilakukan bagi melihat dan mengira pergerakan logam berat di dalam tanah. Kebanyakkannya menggunakan kolum yang bersaiz kecil sahaja (Christensen, 1989; Selim et al., 1989; Giusquiani et al., 1992 & Howard, 1990) untuk menunjukkan bagaimana keadaan sebenar pergerakan logam berat di dalam tanah di lapangan. Logam berat merujuk kepada elemen kimia logam yang secara relatifnya berketumpatan tinggi dan bersifat toksik walaupun pada kepekatan yang rendah. Hari ini, logam berat hadir dalam kuantiti yang agak tinggi dalam air, udara dan tanah. Sebagai permulaan kepada penyelidikan, hanya satu jenis bahan pencemar digunakan terlebih dahulu, iaitu plumbum (Pb). Plumbum banyak digunakan dalam pembuatan cat, dalam paip air dan juga petrol.

Bahan dan kaedah

Kolum yang digunakan dalam eksperimen ini diperbuat daripada Plexiglas. Panjang kolum adalah 0.3 meter dan diameternya ialah 6.4 x 10^{-3} meter. Kedua-dua hujung gelas kolum di tutup dengan menggunakan penutup getah yang direka sendiri. Penutup getah tersebut dilubangkan ditengah-tengahnya supaya boleh memuatkan tiub yang bersaiz 4 mm. Gelas kolum kemudiannya di gantungkan secara mengufuk, bahagian bawahnya di sambungkan kepada pam peristaltik manakala di bahagian atasnya adalah untuk mengumpulkan bahan pencemar yang keluar daripada gelas kolum. Pasir silika halus kemudiannya di masukkan ke dalam gelas kolum secara perlahan-lahan dan digoncang-goncangkan sehingga kesemua pasir silika tersebut memenuhi ruang gelas kolum dengan padatnya. Air suling yang diisi di dalam bekas air suling kemudian disambungkan kepada pam peristaltik dan pam tersebut disetkan kepada 5 rpm digunakan untuk menyedut air suling masuk ke dalam gelas kolum tersebut melalui bahagian bawah sehinggalah kesemua bahagian gelas kolum tersebut tepu (Rajah 1). Perubahan kecerunan hidraulik diambil kira. kemudian luahan perkadaran,Q juga dicatakan. Bahan pencemar, plumbum 200ppm kemudiannya dipam masuk ke dalam gelas kolum. Setiap bacaan yang penting seperti kekonduksian elektrik, masa, t, kadar luahan dan sebagainya dicatatkan.

Hasil dan perbincangan

Berdasarkan eksperimen yang dijalankan, berat gelas kolum bersama penutup getah adalah 0.784 kg. Manakala berat pasir silika halus yang memenuhi gelas kolum adalah 1.41 kg. Kadar luahan,Q pada masa tertentu adalah 5.23x10^{-4} m^3/hari. Luas permukaan silinder gelas kolum,A adalah 6.096x10^{-3} m^2 dan isipadu gelas kolum pula adalah 9.65x10^{-6} m^3. Manakala kecerunan hidraulik,*i* pula ialah 5.31 m. Ketumpatan pukal tanah yang diperoleh ialah 145 699.5 kg/m^3. Berdasarkan Todd (1980), keberkonduksian hidraulik, K ialah suatu pemalar yang bertindak sebagai ukuran ketertelapan bahan poros, dan *dh/dl* ialah kecerunan hidraulik. Bacaan K yang dikira adalah 0.016 m/hari. Sebanyak 0.8 L air suling dimasukkan ke dalam gelas kolum sehingga kesemua pasir silika menjadi tepu air. Sebanyak 0.25 L air suling dikeluarkan, maka sebanyak 0.55 L air suling yang tinggal di dalam gelas kolum. Ini memberikan nilai porositi sebanyak 0.55 atau 55% dan nilai porositi berkesan, n_e ialah 0.31 atau 31%. Bacaan awal air suling ialah 1.05 µs tetapi setelah dituras melalui pasir

Rajah 1: Gambarfoto eksperimen gelas kolum 1-dimensi di makmal.

silika, nilainya meningkat sehingga 102.6 µs, iaitu bersamaan dengan 163.12 ppm setelah diunjurkan daripada graf kalibrasi Pb. Bacaan awal Pb pula ialah 289.9 µs dan berkepekatan 460.89 ppm. Manakala bacaan akhir Pb yang keluar daripada kolum adalah terdiri daripada 84.6 µs sehingga 203.9 µs (Rajah 2). Maka kepekatannya adalah daripada 134.5 ppm sehingga 324.17 ppm. Nilai Ce/Co pula terdiri daripada 0.29 sehingga 0.70 (Rajah 3). Kebolehsimpanan (*storativity)* bagi pasir silika halus ini adalah 0.093. Jisim fluks, Fx memberikan nilai dari 0.001334 hingga 0.003216.

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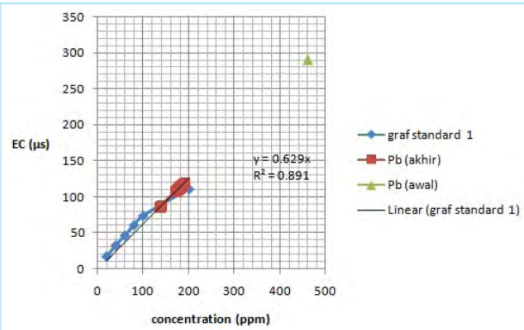
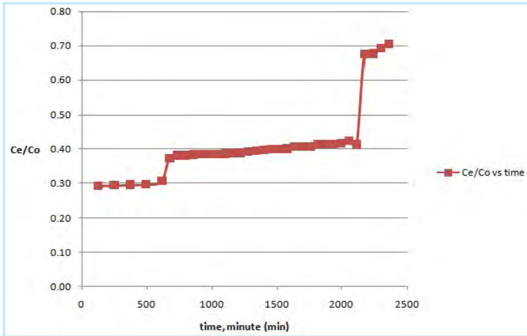


Rajah 2: Graf kekonduksian elektrik melawan kepekatan plumbum.



Rajah 3: Graf Ce/Co melawan masa.

Paper P1-19

Aplikasi teknik-teknik geofizik dalam kajian lubang benam di Kampung Chabang Dua, Kuala Dipang, Perak

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Kajian lubang benam adalah satu kajian bencana geologi kejuruteraan yang mampu menyelamatkan kehilangan harta benda dan nyawa. Mengikut Smith (1999), lubang benam atau *sinkhole* didefinasikan sebagai *"pembentukan lubang pada saiz tertentu dari atas permukaan tanah hingga kedasar dengan bacaan ke dalaman dan diameter tertentu. Ianya terbentuk bermuladari pembentukan lohong atau gua di bawah tanah di kawasan yang didasari oleh batu kapur"*. Lubang benam terbentuk disebabkan oleh hakisan semulajadi yang bertindak balas dengan batu kapur membentuk kaviti dan kemudian membentuk lubang benam. Punca utama berlaku lubang benam ialah air yang berasid meresap masuk melalui retakan dan rekahan dalam batu kapur membentuk kaviti. Tanah penutup yang berada di atas kaviti tersebut akan runtuh. Satu kejadian lubang benam yang telah menenggelamkan sebuah rumah telah berlaku di Kampung Chabang Dua, Kuala Dipang, Perak pada 29 Mac 2005, sehari selepas berlakunya kejadian gempa bumi di Kepulauan Nias, Sumatera. Objektif kajian ini dijalankan ialah untuk mengesan kehadiran kaviti dengan menggunakan teknik geofizik yang bersesuaian. Sebanyak tiga kaedah geofizik telah digunakan iaitu pengimejan keberintangan geoelektrik, seismos biasan dan radar penusukan tanah (GPR). Kaedah GPR dan keberintangan geoelektrik telah dilakukan di sepanjang tujuh garis survei manakala tiga garis survei dilakukan untuk kaedah seismos biasan. Kaedah keberintangan elektrik telah menggunakan tatasusunan Wenner 32SX dengan 41 batang elektrod dan kaedah GPR pula menggunakan antena berfrekuensi 250 MHz jenis *Shielded*. Untuk kaedah seismos biasan pula menggunakan 24 geofon. Hasil kajian mendapati ketiga-tiga kaedah tersebut berupaya mengesan kaviti berdasarkan pencirian yang dibuat. Keratan rentas keberintangan geoelektrik menunjukkan nilai keberintangan tinggi sekitar 24000 Ωm hingga 100000 Ωm yang mewakili kaviti diisi bahan kering iaitu pasir dan lempung kering manakala kaviti tepu pasir basah atau tepu air menunjukkan nilai keberintangan yang rendah di sekitar 10 Ωm hingga 400 Ωm. Hasil keratan rentas GPR menunjukkan gelombang yang terpantul berbentuk hiperbola cembong ke atas mewakili kaviti kosong atau pantulan daripada satu objek keras seperti paip atau kehadiran bebola lempung dalam pasir. Pantulan berbentuk lembangan pula mewakili potensi kaviti yang telah diisi oleh pasir atau air. Batu dasar yang terdiri daripada batu kapur dijumpai pada kedalaman sekitar 7 m. Gelombang elektromagnet tidak boleh dipantulkan semasa melalui medium berair kerana gelombang akan diserap oleh medium tersebut. Oleh itu, zon yang berada di bawah paras air tanah merupakan zon yang bebas pantulan. Keratan halaju survei seismos biasan menunjukkan bentuk lembangan berhalaju rendah sekitar 300 m/s mewakili potensi lubang benam. Terdapat juga bentuk lapisan yang mengalami *depression* seolah-olah berlaku runtuhan tanah yang masuk melalui rekahan dalam batu kapur. Struktur ini berpotensi untuk membentuk lubang benam dan ini andaian dikukuhkan lagi berdasarkan cerapan di atas permukaan di mana terdapat mendapan pada permukaan tersebut. Nilai halaju tinggi diwakili oleh batu dasar iaitu batu kapur sekitar 3600 m/s hingga 4000 m/s. Batu kapur dijumpai sekitar kedalaman 7 m hingga 10 m. Aras air tanah boleh di ketahui melalui halaju lapisan sekitar 1500 m/s hingga 1700 m/s. Korelasi antara garis survei keberintangan geoelektrik dan GPR menunjukkan terdapat rongga berbentuk palung memanjang pada arah utara-selatan dan arah barat daya- timur laut.

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Paper P1-20

Survei geofizik dalam kajian lubang benam di Lapangan Terbang Sultan Azlan Shah, Ipoh, Perak

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Satu kajian geofizik telah dilakukan untuk mengkaji kejadian lubang benam di Lapangan Terbang Sultan Azlan Shah, Ipoh, Perak. Terdapat dua kes kejadian lubang benam yang berlaku di lapangan terbang ini pada April 2010. Runtuhan pada permukaan tanah ke dalam lubang benam merupakan kejadian yang biasa berlaku pada batu kapur. Ini berpunca daripada proses pelarutan dan hakisan di dalam batu kapur akibat aliran air bawah tanah. Air hujan yang turun meresap masuk ke dalam tanah penutup dan mengalir melalui rekahan atau kekar pada batu kapur akan menghakis dan melarutkan sedikit demi sedikit permukaan batu kapur sepanjang retakan atau sesar yang sedia ada dan seterusnya menghasilkan rongga-rongga kecil di dalam batu kapur. Objektif kajian adalah untuk menentukan dimensi lubang benam yang muncul di tapak kajian dengan menggunakan kaedah geofizik, mengesan potensi lubang benam baru menggunakan kaedah geofizik dan memetakan jaringan lubang benam subpermukaan dengan mengesan kehadiran lohong-lohong yang baru di kawasan kaijan. Kaedah geofizik yang digunakan ialah pengimejan keberintangan eletrik, seismos biasan dan radar penusukan tanah (*Ground Penetrating Radar, GPR*). Sebanyak 6 garis survei pengimejan keberintangan eletrik pada lubang pertama, 5 garis survei seismos biasan dan 21 garis survei GPR. Susunatur yang digunakan bagi kaedah pengimejan keberintangan eletrik ialah susunatur Wenner 32SX dan sebanyak 41 batang elektrod disusun sepanjang garis survei. Manakala bagi kaedah seismos biasan sebanyak 24 geofon digunakan dengan jarak antara geofon adalah 1 m. Prinsip pantulan atau *Common Offset Reflection* telah digunakan bagi kaedah GPR untuk kajian ini. Hasil cerapan lapangan di sekitar lubang benam runtuhan pertama didapati saiz sebenar lubang ialah 2 m x 0.58 m dan lubang kedua bersaiz 1.5 m x 1 m. Hasil survei geofizik teknik pengimejan keberintangan eletrik di sepanjang 3 garis rentas menunjukkan profil lubang benam pertama dengan lebih jelas iaitu terletak pada berkedalaman 2.5 m. Berdasarkan survei seismos, kedudukan lubang benam pertama bahagian dalam dapat ditonjolkan dengan lebih jelas dengan dimensi 10 m X 3 m dengan halaju bahan di sekitar 4000 m/s dimana lubang benam tersebut telah ditimbus semula dengan bahan pengisi. Bahan pengisi ini terdiri daripada campuran matriks, tar, premix, gravel dan pasir. Kedalaman lubang benam pertama adalah lebih daripada 8 m yang berjaya dikesan pada data garis survei GPR 7 dan data ini disokong oleh data RES 2. Keratan GPR menunjukkan posisi lubang benam dengan ciri-ciri pantulan beramplitud tinggi tetapi tidak dapat memberikan dimensi lubang benam pertama dan kedua. Walau bagaimana pun, beberapa potensi lubang benam berbentuk lembangan dapat dilihat dalam beberapa keratan GPR yang diperolehi. Survei GPR pada lubang benam kedua mendapati banyak struktur retakan dan sesar sepanjang garis survei yang berpotensi untuk berlakunya lubang benam. Akibat daripada lubang benam tersebut, sebuah palung lohong sepanjang 8.5 m terbentuk di sepanjang paip saliran bawah tanah yang berarah selari dengannya. Hasil survei GPR menunjukkan lubang benam kedua terbentuk oleh kebocoran paip berpunca daripada penyambungan paip saliran bawah tanah yang tidak dipasang dengan sempurna. Kebocoran paip ini membolehkan air yang mengalir didalam paip saliran tersebut menghakis dan melarutkan tanah dinding di sekitar paip saliran tersebut. Berdasarkan peta taburan kaviti bagi sekitar kawasan kedua-dua lubang benam tersebut mendapati bahawa kaviti yang terbentuk menunjukkan teren pembentukan lohong berarah timurlaut – barat daya dan barat laut - tenggara kawasan kajian.

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Paper P1-21

The effects of moisture content on the behaviour of older alluvium

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Keywords: Moisture content, older alluvium, shear strength, point load test, slake durability test

This paper deals with the effects of moisture content on strength of older alluvium under dry, wet and saturated conditions. Older alluvium is semi cemented sediments eroded, deposited and reshaped by water in non-marine setting. Specimens were tested for shear strength, hardness and point load index. According to the results, the petrophysical properties of older alluvium decrease with increasing moisture. The strength was severely reduced after the moisture content was increased over the range of natural moisture content i.e. at saturated condition. However, due to difficulties and non reliable preparation of regular samples at the laboratory, most of the samples were destroyed during the sample preparation. Point load apparatus and Schmidt (rebound) hammer test did not record any reading during the test of the samples for both wet and dry condition. Older alluvium shows equal proportion of clay/silt and gravel with percent finer of approximately 38% and 38.5% respectively, and lower sand contents with percent finer of approximately 23.4%. The range of natural moisture content is from 17.98 to 19.65%. The results revealed that moisture content have great influence in the reduction of the shear strength τ, friction angle Ø and cohesion c.

Paper P1-22

Evaluation on projected and actual granitic rock profile in Pengerang Quarry, Johor

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Keywords: Soil investigation, AutoCAD, rock profile, granite, quarry evaluation

Site investigation is the process of gathering information about the subsurface condition. Information from this survey is needed to ensure that development, such as buildings and roads in an area can be built and designed safely and economically. Similarly, quarry development also requires an accurate site investigation. This is because, all the information obtained from site investigations, such as rock type, overburden thickness and rock profile will be used to develop the quarry, especially in estimating the quantity of rock reserve. However, not all of the information obtained from site investigation is appropriate. For example, problems occur at the Pengerang quarry site. Therefore, this study was carried out to identify the differences between the rock profile projected from the site investigation report prior to the actual profile of observed on site. Observations and measurements were conducted at the site to obtain reliable data. The data were analyzed and simulated in the AutoCAD software to give a clearer profile of the rock. This information is compared with information from previous site investigations, especially in terms of rock reserve quantity estimamation. Finally, some of the causes of these differences are discussed.

Paper P1-23

Different styles of iron mineralization in the Luit area, Sri Jaya, Pahang

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The study area is located in the Luit area, Sri Jaya, in the district of Maran in eastern Pahang. The study area is located about 7 km from the town of Sri Jaya and is bordered by latitude 3° 41' N to 3° 43' N and longitude 102° 49' E to 102° 51' E. There are two active mines carrying out iron ore mining in the area operated by Unitrade Enterprise dan Bakti Juwita Enterprise respectively (Bean, 1969).

Mine 2 is at Bukit Tunggal while Mine 1 is located southwest of Mine 2. Roughly, these two mines have different production prospects of iron ore in terms of quantity and grade because of the topography and the nature of mineralization.

In terms of geology the study area is covered by the Sri Jaya Beds Unit which comprises metasediments and limestone of Permian age (Azhar, 1977; Lee, 1974, 1990). Among the lithologies in the study area are the argillite unit, calcareous unit, igneous pyroclastic and plutonic rocks.

Petrographic study of the rocks show the presence of slate, hornfels, marble, tuff, volcanic breccia and granodiorite. Modal and geochemical analysis proved that the plutonic igneous rock is granodiorite (Streckeisen, 1973).

Polished section study show that iron ore from Mine 1 is dominated by hematite, while Mine 2 by magnetite. Iron mineralization of Mine 1 is of secondary origin from residual process enrichment while Mine 2 is primary magnetite which had intruded the surrounding rocks in the form of dykes.

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Paper P1-24

Limit equilibrium stability equations of soil slopes in complicated geological zones: Considerations and issues

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Keywords: Slope stability, complicated geological zones, factor of safety, limit equilibrium methods

The stability problems of slopes have always been challenging issues in geoscience. Construction activities in urban areas or industrial plants more or less inevitably will encounter slopes. As the basic step of each site planning for establishing any structure above, below or near a soil slope, the slope stability must be determined. This consideration has always been under development from the first equation of the factor of safety (FOS). FOS determines the stability of a slope from dividing the resistance force by driving forces. Among all available methods of calculating the FOS of a slope, the limit equilibrium methods (LEMs) have been most widely used because of their comprehensible modeling process as well as their capability to be solved in a wide range of calculation methods, from simple handy calculations to the complex optimization algorithms. There are two categories in a major classification of LEMs based FOS equations in slope stability analysis, two dimensional (2D) and three dimensional (3D). As the natural shape of many soil slopes are not asymmetric, their modeling is not satisfactory in 2D analysis because this is difficult to make a true model of a real slope with all its forces and specifications in a single 2D section. Therefore, 3D analysis methods were extended mostly from 2D background to make up this problem (Kalatehjari & Ali, 2010). The appearance of 3D methods was a progressive response, but they also have some problems and disabilities in certain circumstances. One of these conditions is in assessing complicated geological zones, where the topography of the slope, soil layers, ground water level or other soil specifications are not systematic. An appropriate 3D analysis have to tolerate all the mentioned characteristics of the slope. Moreover, finding the most critical slip surface– an imaginary surface inside the soil slope which has the least FOS among all possible failure surfaces– is an important task in a 3D analysis, because it defines the probable failure shape and its location. Another important issue of 3D slope analysis is its ability to find the direction of failure (Chen, 2006). Together with these issues, the importance of proper analysis of existence forces throughout the slope body is irresistible, especially in consideration of complex soil slopes with non-symmetrical shapes (Arellano, 2000).

Many of two-dimensional limit equilibrium methods use a special method of analysis which is called "method of slices". These methods were partly developed to 3D limit equilibrium methods, called "methods of columns" (Cheng, 2007). These 2D and 3D techniques have several similarities and differences in assuming the shape of slip surface, solving progress and other assumptions. This paper presents a detailed consideration of available inter-slice and inter-column slope stability analyzes based on LEMs to compare their equations, unknowns and assumptions throughout the modeling. It is usually required to use some assumptions in limit equilibrium problems to make the problem statically determinate. As a result of using these assumptions several different methods were developed (Jiang, 2002). Deriving from the computer usage benefits in geotechnical engineering, some of the simple methods with approximate results are less used. Also, due to increase in computer-based techniques which can solve larger number of calculations in less time, it is possible to make fewer assumptions in equilibriums, use more complex equations and gain more precise results.

Based on the considered previous literature this paper defined the issues of modeling the complicated geological zones. Then after, some solutions and techniques to eliminate those issues were fully considered. Additionally, as the proposed method was also faced some challenges in solving process; the solutions to overcome the difficulties were also proposed. These solutions were based on the progressively application of computer aid techniques. Therefore, some previous assumptions and simplifications were considered extravagance. Based on what has been mentioned, the proposed approach is able to prepare the true 3D modeling of soil slopes in complicated geological zones based on LEMs.

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Paper P1-25

Kajian semula Zon Sesar Lebir di sepanjang Sungai Lebir, Kelantan

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Kata kunci: Zon Sesal Lebir, Sungai Lebir, struktur, Semenanjung Malaysia

Menurut Tjia (1985), struktur geologi di Semenanjung Malaysia dibahagi menjadi 4 (empat) mandala, iaitu Mandala Zon Timur, Mandala Zon Tengah, Mandala Zon Barat dan mandala Zon Baratlaut. Mandala Zon Timur dipisahkan oleh sesar Lebir dengan mandala Zon Tengah manakala mandala Zon Tengah dipisahkan oleh garisan Bentong dengan Mandala Zon Barat. Sesar-sesar utama yang terjadi di Semenanjung Malaysia dimulai dengan sesar yang paling tua dijumpai di Langkawi iaitu Sesar Sungkup Kisap yang diperkirakan berumur Perm Akhir, diikuti oleh Sesar Bokbak, Sesar Lebir, Sesar Kuala Lumpur, Sesar Bukit Tinggi, Sesar Chegar-Benta dan Sesar Kledang yang berusia Trias.

Tulisan ini membahaskan tentang kajian zon Sesar Lebir dengan data terperinci sepanjang Sungai Lebir kawasan Negeri Kelantan. Aw (1967), menggambarkan adanya daik ignimbrit sepanjang 20 km berhampiran Temangan, Kelantan dan Burton (1967a), berpendapat bahawa daik tersebut menipis ke arah utara manakala ke arah selatan selari Sungai Lebir sepanjang 150 km. Menurut Tjia (1972), bahawa Sesar Lebir berupa sesar mendatar kiri dan secara morfologi berupa sesaran blok. Pada kajian ini disimpulkan terjadi sekurang-kurangnya didapati tiga kali canggaan yang melibatkan zon Sesar Lebir. Canggaan pertama dengan σ_1 berarah timurlaut (TL)-Baratdaya (BD) menghasilkan sesar berjurus kemiringan U(340^o-0^o)T/60^o-80^o berupa sesar sinistral songsang dengan kemiringan ke barat baratdaya - timur timurlaut. Canggaan kedua dengan daya mampatan (σ_1) berarah Utara baratlaut (UBL)-Selatan tenggara (STG) menghasilkan sesar konjugat berjurus Barat-Timut (B-T) dan barat baratlaut (BBL) - timur tenggara (TTG). Canggaan ketiga dengan daya mampatan (σ_1) berarah hampir barat-timur (B-T) dan menghasilkan sesar dekstral songsang dan sesar sinistral songsang berjurus tenggara (TG) dan Timurlaut (TL) dengan kemiringan ke arah baratdaya (BD) dan tenggara (TG).

According to Tjia (1985), the geological structures of Malay Peninsular is devided to four zone, i.e., Eastern Zone, Central Zone, Western Zone and Northwest Zone. Eastern Zone is separated by Lebir Fault from Central Zone while Central Zone is separated by Bentong line from Western Zone. The major faults in Malay Peninsular started from the Late Permian with the development of Kisap Thrust followed by Bokbak Fault, Lebir Fault, Kuala Lmpur Fault, Bukit Tinggi Fault, Chegar Benta Fault and Kledang Fault of Triassic ages. Aw (1967) described the ignimbrit dyke along 20 km in Temangan, Kelantan. Burton (1967a) show that the dyke was wedge to the north while to the south it followed the Sungai Lebir abouth 150 km. According to Tjia (1972), Lebir Fault was a sinistral fault and show a block morphology.

In this study it is concluded that a least three deformation has been effected Lebir Fault Zone. The first deformation with (σ_1) from northeast (NE)-southwest (SW), producted sinistral reverse slip faults N(340^o-0^o)E/60^o-80^o, dipping to the West-southwest (WSW) or East-southeast (SEE). The second deformation with (σ_1) from north-northwest (NNW)-south-southeast (SSE), produce conjugate fault striking west-east (W-E) and West-northwest (WNW) - east-southeast (ESE). The third deformation with (σ_1) from east-west (E-W), produced fault striking and resulting the fault left reverse slip and right reverse slip fault with striking Southeast (SE) and Northeast (NE), with diping to southwest (SW) and Southeast (SE).

Pendahuluan

Lokaliti kajian adalah meliputi sepanjang Sungai Lebir yang termasuk dalam kawasan Negeri Kelantan (Rajah 1) dan secara terperinci dapat dilihat dalam Rajah 2. Penelitian ini hanya dapat dilakukan dengan menggunakan perahu kecil dan menyisir sepanjang Sungai Lebir kurang lebih sepanjang 50 km, bermula dari percabangan Sungai Lebir dan Sungai Galas ke arah hulu sehingga perpotongan antara Sungai lebir dengan Jalan Kuala Krei-Gua Musang.

Kajian ini dimaksudkan untuk meneliti ulang data Zon Sesar Lebir secara terperinci di sepanjang Sungai Lebir kawasan Negeri Kelantan.

Secara am di sepanjang Sungai Lebir di Kawasan Negeri Kelantan dijumpai litologi dari tua ke muda adalah Syis Taku yang berusia Permo Trias (Savage, 1925; Kho & Lim, 1935; Khoo, 1997) berupa syis mika garnet, syis kuarza mika garnet dengan syis kuarsa banded dan serpentinit dengan sedikit mengandung sedikit syis berkapur. Menurut Khoo & Lim (1983) Syis Taku ini mengandungi zon metamofik garnet dan biotit. Formasi Gua Musang berusia Perm Tengah-Trias (Yin, 1965; Burton, 1973a; Khoo, 1983; Fontaine et. al., 1986, 1994; Metchalfe, 1992 dan Mohd. Shafeea Leman, 1993). Formasi Gua Musang ini mengandungai batuan-batuan berargilit dan berkapur berselingan dengan batuan-batuan volkanik dan berarenit. Batuan terobosan cetek bersifat andesitik berusia Carbo Akhir- Trias Awal (Rajah 3).

Metodologi dan data

Dalam penelitian ini digunakan metodologi penelitian terperinci dengan pengambilan data secara terperinci di sepanjang Sungai Lebir, Negeri Kelantan sepanjang lebih kurang 60 Km. Sehingga diharapkan dijumpai data-data yang mencukupi untuk analisis Zon Sesar Lebir. Pada lintasan terperinci ini diwakili dengan 11 titik pengamatan terperinci dan dihasilkan data seperti terlihat pada Jadual 1.

Perbincangan

Hasil lintasan terperinci daripada ke sebelas titik pengamatan dijumpai hasil bahawa minimal terjadi tiga kali canggaan yang mengenai Zon Sesar Lebir. Canggaan pertama dengan σ_1 berarah timurlaut (TL)-Baratdaya (BD) menghasilkan sesar berjurus kemiringan U340^{o}T-U0^{o}T/60^o-80^o berupa sesar mendatar kanan songsang, kemiringan sesar dapat ke arah barat atau ke timur. Canggaan kedua dengan daya mampatan (σ_1) berarah baratlaut (BL)-tenggara (TG) menghasilkan sesar konjugat berjurus timutlaut-baratdaya dan baratlaut-tenggara. Canggaan ketiga dengan daya mampatan (σ_1) berarah hampir barat-timur (B-T) dan menghasilkan sesar berjurus kemiringan TL-BD miring 60^o ke TG (Jadual 1).

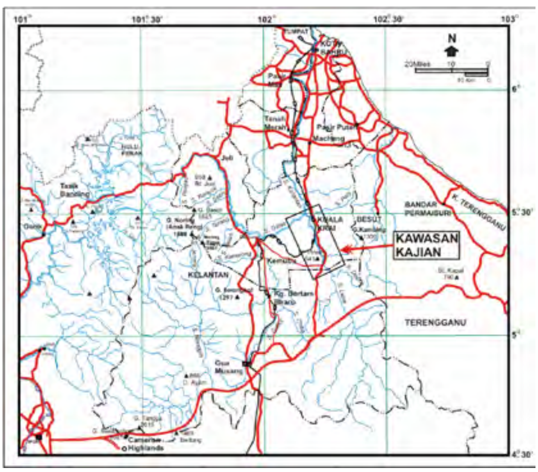
Kehadiran canggaan batuan vulkanik bersifat andesit yang selari dengan Zon Sesar Lebir dan dari hasil analisis umur berdasarkan Radiometrik dating dengan kaidah K-Ar menghasilkan umur 92. 105$\pm$ 0.95 Ma. Hal ini membuktikan bahawa canggaan batuan vulanik ini mengisi Sesar Lebir. Juga membuktikan bahawa sesar tersebut mempunai zon yang lebar dan dalam. Sehingga sepantasnya sebagai zon sempadan antara Jalur Timur dan Jalur Barat.

Penulis mencanggah kepada penulis terdahulu yang mengatakan bahawa batuan vulkanik yang mengisi selari dengan sesar Lebir berumur Perm. Secara keseluruhan dapat di lihat pada Peta Geologi (Rajah 3).

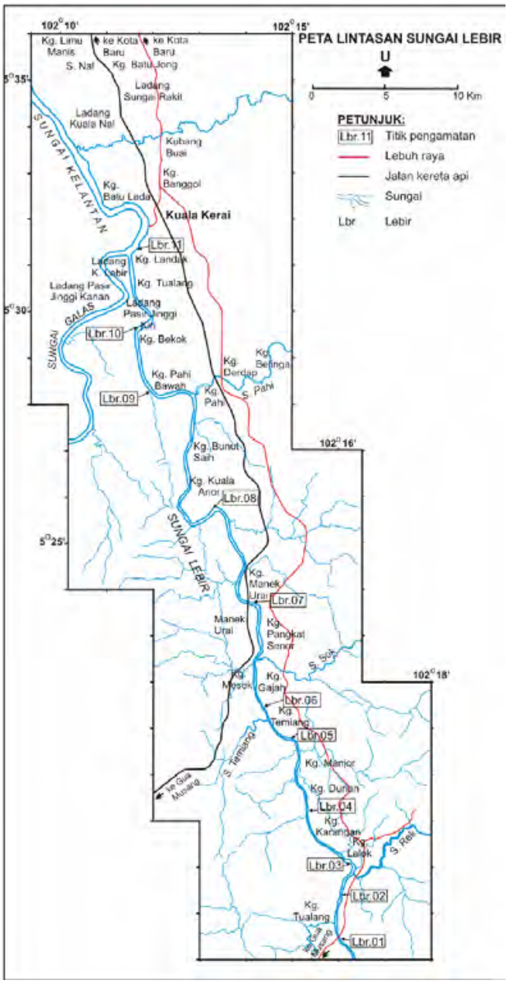
Kesimpulan

Dari hasil perbincangan dapat disimpulkan bahawa:

- Zon Sesar Lebir berdasarkan data di sepanjang Sungai Lebir pernah mengalami minimal 3 (tiga) kali canggaan.
- Batuan vulkanik yang mengisi zon sesar lebir berumur Kapur (92. 105$\pm$ 0.95 Ma) bukan berumur Perm.
- Penulis menyokong penulis terdahulu bahawa Zon Sesar Lebis sebagai sempadan antara Jalur Tengah dan Jalur Timur Semenanjung Malaysia.



Rajah 1: Peta lokaliti kajian.



Rajah 2: Peta lintasan Sungai Lebir.

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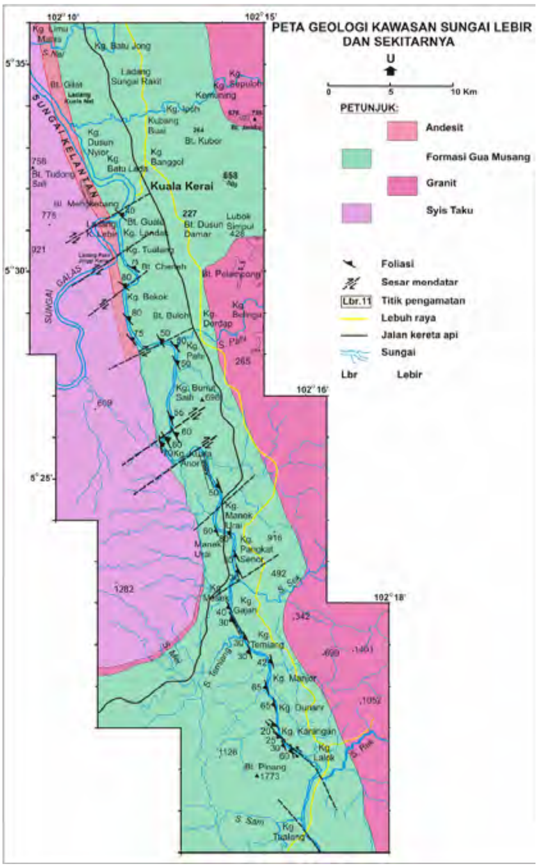
Jadual 1: Rangkuman hasil analisis sesar di sepanjang Sungai Lebir.

Lokaliti	Periode I Arah σ1 & Satah Sesar	Periode II Arah σ1 & Satah Sesar	Periode III Arah σ1 & Satah Sesar
1	-	σ1: 1°,U116°T U160°T/70° Sesar sinistral	σ1: 21°,U91°T U135°T/60° Sesar sinistral songsang
2	σ1: 17°,U229°T U180°T/55° Sesar dekstral songsang	σ1: 4°,U287°T U235°T/70° Sesar dekstral songsang	-
3	σ1: 6°,U31°T U170°T/65° Sesar dekstral songsang	-	-
4	σ1: 20°,U41°T U345°T/80° Sesar dekstral songsang	-	-
5	-	-	-
6	σ1: 26°,U39°T U170°T/85° Sesar mendatar kanan songsang	σ1: 10°,U104°T U150°T/60° Sesar dekstral songsang	-
7	σ1: 16°,U235°T U180°T/80° Sesar dekstral songsang	-	σ1: 6°,U264°T U45°T/70° Sesar dekstral songsang
8		σ1: 8°,U314°T; U270°T/80° Sesar dekstral songsang & σ1:26°,U326°T U110°T/35° Sesar dekstral songsang	
9		σ1: 2°,U290°T; U60°T/70° Sesar dekstral songsang	
10	σ1: 6°,U23°T; U340°T/70° Sesar dekstral songsang		
11	σ1: 16°,U30°T; U350°T/75° Sesar dekstral songsang		



Rajah 3: Peta geologi kawasan Sungai Lebir dan sekitarnya.

Paper P1-26

Deformation in Pokok Sena Area and its tectonic significance

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A study was undertaken to characterize the structures and interprets the deformational history of selected dated Kubang Pasu and Semanggol Formation outcrops in the Pokok Sena area with the goal to determine whether there is a structural break within the Permo-Triassic sequence and consequently the timing of the major tectonic event.

The Permo-Carboniferous Kubang Pasu Formation which comprises essentially of thick interbeds of argillite, sandstone and tuffaceous sandstone and minor cherts exhibit close to tight sub-horizontal northerly trending folds that formed linear ridges. The cherts shows intense slumping as indicated by stratal bounded convolute folds and stratal disruption. The earliest tectonic structure to develop is the presently rotated synsedimentary conjugate normal faults on steeply dipping to sub-vertical strata. Upon restoration these faults suggests an early east-west oriented extension. The sequence is cut by at a series of northerly trending but opposingly dipping reversed faults suggesing transpressional deformation.

Similarly, the Lower to Upper Permian lower cherts of the Semanggol Formation found in several earth quarries at Kg. Kolam area are steeply dipping to sub-vertical, exhibit close to tight sub-horizontal northerly trending folds that formed linear ridges. Intense slumping is indicated by the presence of stratal bounded recumbent to upright convolute folds and stratal disruption. The strata were cut by synsedimentary normal faults and upright folds together folded both. The earliest tectonic structure to develop is the presently rotated synsedimentary conjugate normal faults on steeply dipping to sub-vertical strata. The sequence is cut by at a series of northerly trending but opposingly dipping steep reversed and dextral strike-slip faults with flower structure geometry typical of dextral transpressionnal deformation. These structures were later superimposed by minor steeply plunging cross folds.

The Middle to Late Triassic upper cherts are exposed at the JKR Bukit Barak Quarry. The cherts contain Late Triassic allothonous limestone blocks. As with the other sequences, they are steeply dipping to sub-vertical, exhibit close to tight sub-horizontal northerly trending folds that formed linear ridges. The strata were folded into recumbent isoclinal slump folds that were superimposed by synsedimentary normal faults. These early soft sediment structures were folded into tight northerly tending folds.

All the three sequences exhibit similar and same structural styles and deformational histories. They recorded a history that involved deposition in an unstable deep marine basin giving rise to slumping and gravity sliding. This was followed by synsedimentary extension. A major dextral transpressional event further folded and faulted the sequences. This was followed by the cross folds which superposed the earlier folds. There is no evidence to support the suggestion of a structural break within the Semanggol Formation suggesting that the Lower Triassic closure of the Paleo-Tethys were not recorded in the Semanggol Formation in the form of deformational structures. The major deformational event in the area post-dated the Semanggol Formation (i.e. Late Triassic).

Paper P1-27

Lithostratigraphy of the Late Neogene sedimentary sequence in Sandakan Peninsula

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Keywords: Lithostratigraphy, Neogene, Sandakan

Summary

New outcrops were measured to give better interpretation on the lithostratigraphic framework of the Late Neogene clastic facies in Sandakan Peninsula. Currently, the established rock units of the area consist of the Garinono Formation and the Sandakan Formation. The Middle Miocene Garinono Formation is the oldest rock unit exposed in the study area and it is widely distributed in east Sabah. The lower sequence of the Garinono Formation consists of sedimentary mélange considered as the olistostrome of the rock unit by the previous authors, and is associated with mudstone matrix. The upper sequence of the Garinono Formation is dominated by volcanic facies which is known to be part of the Cagayan Volcanic Arc during the Middle Miocene. The distribution of volcanic facies ranges in composition from andesite - dacite association to tuffite– tuffaceous sandstone. An unconformity separates the volcanic facies of the Garinono Formation from the base of the Sandakan Formation also aged Middle Miocene evidenced by Globorotalia fohsi fohsi. There are two main clastic lithofacies in the Sandakan Formation, namely; thick mudstone facies with abundant macrofossil and thick cross-stratified amalgamated sandstone forming steep ridges trending NNW-SSE strike in southern part of Sandakan Peninsula. The estimated thickness of the Sandakan Formation is approximately 12 kilometers. Younger clastic facies predominantly exposed in the northwest of Sandakan Peninsula conformably overlying the Sandakan Formation and is characterised by interbedded fine grained sandstone and siltstone. Lignite seam and fossilised wood are abundant in the sequence, while consolidated quartz pebble lenses are common.

Introduction

A new lithostratigraphy of the Late Neogene sedimentary sequence in Sandakan Peninsula is proposed based on compilation of several previous and current studies. One of the earlier detail geological mappings in Sandakan peninsula is constructed by Lee (1970), followed by Ujiie (1970) whom studied foraminiferal assemblage in the Sandakan Formation and volcanic facies contact. Noad & Harbury (1997) studied the sedimentology and depositional environment in the area.

Tectonic settings of the region

Tectonism was extensive by the subducted of the Cagayan Volcanic Arc into Eurasia passive margin in the East Sabah during the earliest Middle Miocene (Rangin et al., 1990). Garinono formation is a part of broken formation in East Sabah, which consists of Sabah Ophiolite basement (Chert Sphillite Formation). The distribution of mélange in East Sabah (Ayer Formation and Kuamut Formation) is simplified as shown in Figure 3. Extensive volcanic activities culminated the Middle Miocene subduction event forming the volcanic sequence of Dent and Semporna Peninsulas (Sanudin *et al*., 1995). *Globorotalia fohsi fohsi* assemblage in the volcanic unit indicates the Middle Miocene age (Ujjie, 1970; Basin & Sanudin 1987). During the latest Middle Miocene towards the earliest Late Miocene shallow marine clastic was deposited overlying the volcanic deposits classified as the Sandakan Formation in Sandakan Peninsula; the Tanjong Formation and the Sebahat Formation in Dent Peninsula and the Kapilit Formation in Semporna Peninsula.

Geological Settings of the Sandakan Peninsula

The Garinono Formation was formed as the basement of Sandakan Peninsula consisting of mélange and volcanic unit. Sandakan Formation is widely distributed in Dent Peninsula with predominantly massive sandstone and macrofossil-rich mudstone. The measured outcrops of the Sandakan Formation is approximately 12 km across Sandakan Peninsula. A younger bed which was considered as high level alluvium by Lee (1970) is consolidated pebble quartz lenses formed in the interbedded fine sandstone and siltstone. This younger clastic facies is conformably overlying the Sandakan Formation in the north of the peninsula (Figure 1) and could be considered as the upper part of the Sandakan Formation.

Lithostratigraphy of the Late Neogene in Sandakan Peninsula

Sedimentary mélange (olistostrome) was formed as the lowest sequence of the lithostratigraphy in the Sandakan peninsula and predominantly distributed in Labuk area. Olistoliths range in sizes of different lithologies, namely: serpentinite, basalt, gabbro, diorite, ophicalcite, sandstone and mudstone embedded in a pervasively sheared mudstone matrix (Lee, 1970). Serpentinite and limestone olistoliths can be found in Tanjung Papat coastline. Lee (1970), Ujiie (1970), Rangin *et al*., (1990) and Noad & Harbury (1998) have reported the contact between volcanic deposits with the basement of Sandakan Formation at Tanjung Papat (Figure 2) and Sandakan harbour. The unconformity between the two formations is also known as a Deep Regional Unconformity (DRU) as the evidence of major tectonic event in Sabah and Northern Borneo.

The Sandakan Formation is formed by two main lithofacies, namely; thick cross stratified amalgamated sandstone and thick macrofossil–rich mudstone. The thick sandstone facies distribution is predominantly in the east peninsula at Tanjong Papat, Buli Sim Sim and Berhala Island. Thick mudstone distribution can easily be found in central of the peninsula which crops out along Jalan Bokara and Jalan Sibuga. Common species in the thick mudstone lithofacies are *Turritella sp.* and *Vicarya sp*. some bivalve species with amber (Figure 3). Average dip of the Sandakan Formation sequence is 30^{o} towards west-northwest.

The younger clastic facies, which is made up of finer clastic deposit and small scale lenses of consolidated pebble quartz (Figure 4) conformably overlies the Sandakan Formation. The beds are rich in lignite seam, fossilized wood fragments cropping out at the north of the peninsula. The facies itself have similarities with adjacent formations; the Bongaya Formation and the Ganduman Formation (Figure 5), now considered as part of the Sandakan Formation.

Various studies have been done to determine the lithostratigraphic sequences in East Sabah that included Sandakan Peninsula. Figure 5 shows the correlation between Sandakan Peninsula and Dent peninsula. Sabah crystalline basement is the oldest sequence that has been recorded by Sanudin Tahir (1989) in Dent Peninsula, but absent in Sandakan Peninsula. The mélange distribution and volcanic facies in the Garinono Formation is widely associated with the Ayer Formation and the Kuamut Formation in the eastern area. Furthermore, Sandakan Formation was an isolated basin shared equivalent terrigenous clastic sediments source with the adjacent basins (Tanjong Formation, Sebahat Formation and Kapilit Formation) during the Late Miocene to Pliocene.

Conclusion

The lower part of Sandakan Peninsula sequence is olistostrome of the Garinono Formation, which is underlain by volcanic facies conformably. Olistolith varies from igneous, serpentinite, limestone, gabbro, sandstone, mudstone and basalt in composition. The broken formation and ophiolite sequence could possible to be part of the obducted slice during Middle Miocene tectonic activity from adjacent area of an arc-continent collision (Rangin *et al*., 1990). Volcanic facies in the Garinono Formation is believed as an extension of the Middle Miocene volcanic arc region in Eastern Sabah by the presence of *Globorotalia Fohsi Fohsi* assemblage.

The Sandakan Formation is formed as one of the isolated circular shallow marine basins in East Sabah with the presence of abundant brackish macrofossil. Younger clastic facies is proposed to be the continuous deposition of the Sandakan Formation as a different and single unit in uppermost lithostratigraphy of the Late Neogene sedimentary sequence in Sandakan Peninsula.

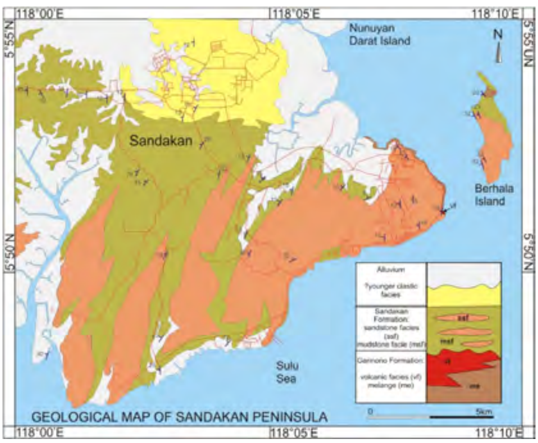

Figure 1: Geological map of Sandakan Peninsula (modified after Hutchison 2005; and Lee 1970).

Figure 2: The contact between volcanic facies and Sandakan Formation at the bottom of Tanjung Papat Mosque.

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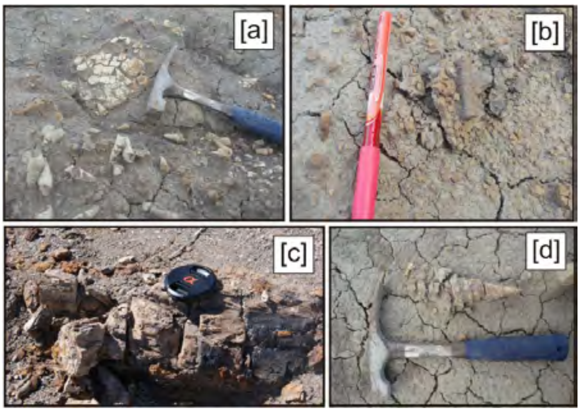

Figure 3: Macrofossils assemblage in thick mudstone lithofacies in Jalan Bokara outcrop. [a] ? giant Tellinoidea and abundant *Turritella sp.* [b] crinoid stem [c] fossilized trunk plant[d] *Vicarya* species.

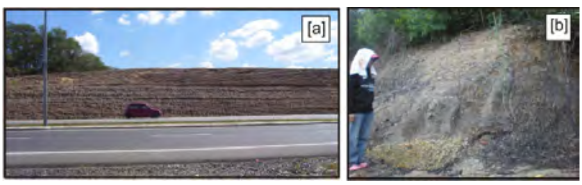

Figure 4: Younger clastic facies outcrops. The outcrop is located at the north of the peninsula. [a] large scale planar cross bedding in Jalan Lintas Utara. [b] A consolidated quartz pebble lenses in interbedded outcrop in Sandakan Airport.

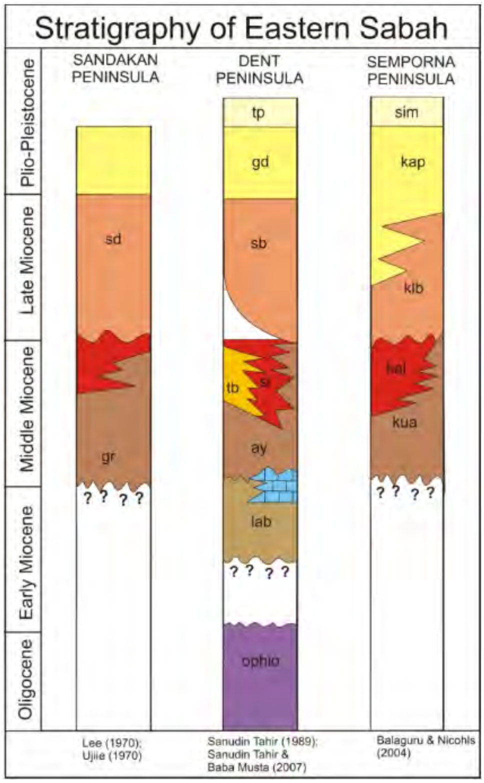

Figure 5: The simplified Eastern Sabah Stratigraphy. Note that the eastward continuity of Sandakan Peninsula lithostratigraphy in Dent and Semporna Peninsula. sd: Sandakan formation, gr: Garinono formation, tp: Togopi formation, gd: Ganduman formation, sb: Sebahat formation, si: Silabukan formation, tb: Tabanak formation, ay: Ayer formation, lab: Labang formation, ophio: Ophiolite (Chert- Sphilite Formation), sim: Simenggaris formation, kap: Kapilit formation, klb: Kalabakan formation, kal: Kalumpang formation, kua: Kuamut formation.

Paper P1-28

Effects of landfill contamination of soil using resistivity method

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Nowadays, the problem of landfill leachate had been implicated in environmental pollution, soil contamination, birth defect and surface and groundwater pollution worldwide. Uncontrolled releases of pollutants will contaminate soil and groundwater, which creates environmental and human health problems. This problem became one of the important environmental issues in Malaysia. Many methods have been used to study the effect of landfill contamination to the soil such as to estimate the thickness of landfill wastes with seismic refraction method (Becker, 1986), to identify subsurface contamination and its sensitivity with dielectric spectroscopy method (Jonscher, 1983, 1999; Kaya & Fang, 1997; Shang *et al*., 2004), to characterize agricultural soils and landfills leachates using ground penetrating radar (GPR) method (Doolitle & Collins, 1995), to identify leachate plume using direct current resistivity method (Benson *et al.,* 1997; Abu-Zeid *et al.,* 2004) and also using electromagnetic induction method (Buselli *et al.,* 1991), However, an alternative method called as electrical resistivity can be used to identify, delineate and map subsurface features such as electrically conductive contamination plumes, the contaminated zone and electrically conductive lithologic units such as clay (Dawson *et al*., 2002). The resistivity values can identify the level of soil contaminant by giving the value of electrical resistivity. Therefore the study in electrical resistivity value for identifying the level of contaminant of soil needs to be conducted. This paper presents the finding of a study on the effects of landfill contamination of soil by using laboratory resistivity method. The objective of this study is to determine the effects of leachate in soil to resistivity values. This study involved a series of laboratory works in order to determine basic properties of soil, leachate compositions and laboratory resistivity measurement. The basic properties of soils that were determined are moisture content, particle density and particle size distribution. The soil samples were classified in according to the British Soil Classification System, BS 1377: 1990. Samples of landfill leachate were collected from Sanitary Landfill, Jeram, Selangor. This leachate was used as a contamination liquid and was injected into the soil samples. The compositions of leachate were determined by using a spectrophotometer. Three types of disturbed soil samples were collected by hand augering which are sandy soil, silty soil and clayey soil. Resistivity measurements were performed on cylindrical shape soil samples. The resistance was measured by using impedance analyzers (LCR Meter) with constant frequency of 500 kHz (Awang, 2010). The resistivity (ρ) value was determined by dividing the measured resistance (R) and cross sectional area (A) with the length of the sample (L), which is can be simplified as $\rho = R\ A/L$. From this laboratory resistivity test the effects of electrical resistivity value between contaminated soil and uncontaminated soil were determined. From the results, it was found that the electrical resistivity values decrease with increasing leachate percentages from 0% , 2.5%, 5%, 7.5% and 10%. The decrease in electrical resistivity values means higher content of leachate in soil samples. This is because the leachates have some negative matter, which are high in biochemical oxygen demand (BOD), high in concentration of organic carbon and other chemicals. It was also found that the clayey soil has the lowest resistivity value compared to sandy soil and silty soil. This result is due to high conductivity characteristics of clay particles that easily allow the current to flow. It can be concluded that soil experienced direct impact of landfill contamination and these effects can be determined by laboratory resistivity test. It is important to make an evaluation of ground condition for possible contamination before carrying out any construction and one of the best method to evaluate contaminated soil is by laboratory resistivity method.

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Paper P1-29

Pembangunan bahan geologi sebagai Zero Valent Iron (ZVI) dalam merawat pencemaran logam berat

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Pengenalan

Pencemaran mengikut Akta Kualiti Alam Sekitar, 1974 ditakrifkan sebagai apa-apa perubahan langsung atau tidak langsung kepada sifat-sifat fizikal, kimia atau biologi mana-mana bahagian dalam alam sekeliling dengan melepaskan, mengeluarkan atau meletakkan bahan buangan hingga menjejaskan apa-apa kegunaan berfaedah, menyebabkan suatu keadaan yang merbahaya atau mungkin merbahaya kepada kesihatan, keselamatan atau kebajikan awam, atau kepada binatang, burung, hidupan liar, ikan atau hidupan dalam air, atau kepada tumbuhan-tumbuhan. Kini, dapat dilihat bahawa pencemaran merupakan satu masalah alam sekitar yang masih lagi tiada penyelesaian terutama berkaitan dengan logam berat. Maka, satu bahan termaju daripada bahan geologi dihasilkan untuk perawatan kawasan tercemar logam berat. Bahan ini dikenali sebagai *Zero Valent Iron* (ZVI). ZVI ini mampu menukarkan bahan yang bertoksik kepada bahan yang tidak bertoksik sebagai hasil. ZVI ini akan bertindak sebagai satu penghalang yang telap kepada air dan pada masa yang sama, menjerap logam berat apabila bahan tersebut melaluinya. Bahan ini boleh digunakan dalam merawat air bawah tanah yang tercemar dengan logam berat.

Bahan dan kaedah

Penghasilan ZVI dalam kajian ini melibatkan satu kaedah iaitu kaedah pembakaran. Lima jenis bahan geologi digunakan seperti magnetit, konkresi besi, kapur dan karbon. Kaedah pembakaran melibatkan 3 jenis suhu berbeza iaitu 550ºC, 750ºC dan 950ºC mengikut tiga peratusan tiga campuran bahan (konkresi besi/magnetit, kapur dan karbon). Tiga peratusan tersebut ditandakan sebagai zampel ZVI 1, ZVI 2 dan ZVI 3. Analisis kimia iaitu Analisis Kapasiti Pertukaran Kation, Kawasan Permukaan Spesifik dan Ujian Penjerapan Berkelompok telah dijalankan ke atas sampel ZVI yang dihasilkan daripada konkresi besi dan magnetit.

Hasil dan perbincangan

Analisis kapasiti pertukaran kation (CEC) menunjukkan ZVI 3 konkresi besi dan ZVI 3 magnetit yang dihasilkan pada suhu 950°C memberikan nilai yang tinggi iaitu 384.70 meg/100g dan 238.65 meg/100g berbanding ZVI 1 konkresi besi, ZVI 2 konkresi besi ZVI 1 magnetit dan ZVI 2 magnetit pada suhu yang lain. Kedua-dua ZVI konkresi besi dan magnetit yang dihasilkan pada suhu 950°C mempunyai nilai Kawasan Permukaan Spesifik (SSA) yang tinggi iaitu 274.00 m^2/g - 278.64 m^2/g dan 29.55 m^2/g – 40.64 m^2/g berbanding ZVI lain. Berdasarkan Wan Zuhairi (2003a & 2003b), keupayaan penjerapan tanah meningkat apabila nilai CEC dan SSA jega meningkat. Ujian berkelompok menunjukkan kesemua ZVI yang dihasilkan telah berjaya menukarkan pH yang berasid (pH 4) kepada pH alkali serta berjaya menurunkan kekonduksian elektrik dalam larutan logam berat yang diuji. ZVI yang dihasilkan pada suhu 950°C mempunyai pekali taburan (Kd) yang tinggi iaitu sebanyak 504.59 L/Kg (ZVI yang dihasilkan daripada konkresi besi) dan 29.97 L/Kg (ZVI yang dihasilkan daripada magnetit). Hasil analisis kepada semua ZVI yang telah dilakukan membuktikan bahawa bahan-bahan geologi yang dibangunkan untuk mencipta suatu bahan termaju mampu menjadi teknologi yang efektif dalam merawat pencemaran logam berat.

Penghargaan: Terima kasih diucapkan kepada penyelia penulis, Prof. Madya Dr. Wan Zuhairi Wan Yaacob kerana telah memberikan dana bagi membolehkan penulis membuat penyelidikan dan menampung pengajian sarjana penulis di Universiti Kebangsaan Malaysia (UKM). Terima kasih juga kepada pelajar prasiswazah kerana kerjasama dalam berkongsi maklumat dengan penulis dan kepada kakitangan makmal yang menbantu dalam melakukan analisis.

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Paper P1-30

Effects of compressional stress to P-wave and S-wave velocities in granite

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Normally, wave propagation in a rock mass is measured using field tests, such as seismic refraction test. Ultrasonic pulse velocity (UPV) test has been reported by several authors as a technique to measure the wave velocity. Since this technique is non-destructive and easy to apply, it is increasingly being used in geotechnical engineering (Sharma & Singh, 2008). Hassan (1995) used the UPV as a useful and reliable non-destructive tool to assess the mechanical characteristics of rock and concrete. The parameters of mechanical properties can be subsequently used in the safety evaluation for design and construction. The field result is difficult to correlate with other engineering and physical properties of the rocks. Therefore, in order to develope a relationship between the p-wave and s-wave with engineering properties of rock, a laboratory test to determine the p-wave and s-wave is very useful to be carried out. Measurements of wave are often done on p-wave and sometimes on s-wave. According to Manoj & Rajith (2010), the velocity of ultrasonic pulses travelling in a solid material depends on the density and elastic properties of that material. Usually, to determine the wave velocity in laboratory, an ultrasonic wave velocity test is carried out using Pulse Ultrasonic Non Destructive Test (PUNDIT) equipment. The problem arise when the stress or force that is applied manually to the sample as in Figure 1 is inconsistent. This paper highlights the findings of a study to determine the effect of stress applied to p-wave and s-wave in granite. Test and experimental works carried out on granite to investigate how wave velocity varies with different applied stresses. In this study, five core samples of granite were used. The material are collected from Hulu Langat, Selangor. The cylindrical rock samples were trimmed by cutting and lapping on both ends. The material were prepared with average diameter (D) of 52 mm and the length (L) of specimen is in ratio of L=2D, which average about 104 mm. The diameter, length and mass of specimen was measured. The flatness of the both ends of the cylindrical specimen is very important for the accuracy of the test result. The specimens were installed in the cell of ultrasonic velocity equipment shown in Figure 2. Six different stress levels were applied on the specimens which are 0.5 MPa, 1.0 MPa, 1.5 MPa, 2.0 MPa, 2.5 MPa and 3.0 MPa. The wave velocity of the rock was determined by recording the first arrival time of the p –wave and s-wave at different compressional stresses. The ultrasonics program were set up to collect the p-wave and s-wave data using the ULT software. Both p-wave and s-wave velocities were measured and waveform of p-wave and s-wave were plotted. The test results were interpreted statistically and the relationships between compression stress and velocity were developed. From the result, it was found that the both waves velocity increases with the increasing of stress values. Finally, the findings of this study shall contribute some knowledge to rock engineering study.

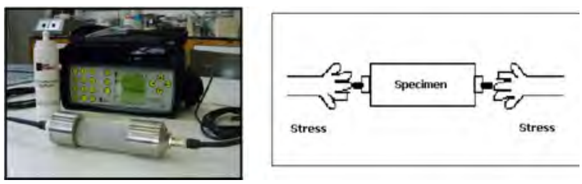

Figure 1: PUNDIT (Pulse Ultrasonic Non Destructive Test) equipment.

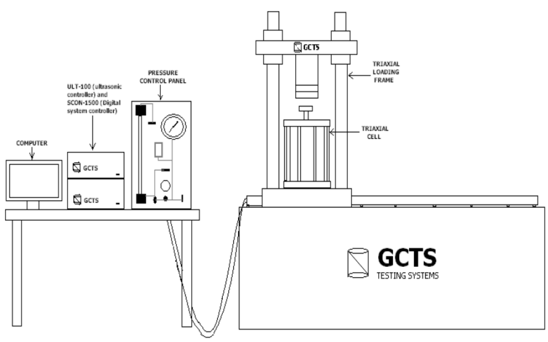

Figure 2: Schematic diagram of Rock Triaxial equipment.

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Paper P1-31

Geophysical modeling of a part of Potwar (Missa Keswal) area by using seismic and well data

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Summary

The geophysical modeling of a part of Potwar at Missa Keswal (Qazian Anticline) has been carried out in the present work. The 2-D seismic data consisting of ten seismic lines (GNA-09, GNA-10, GNA-11, GNA-13, GNA-14, GNA-15, GNA-16, GNA-19, MN-20 and GNA-21) were re-interpreted for the purpose. The well data of Missa Keswal-01 was used for the confirmation of the reflector identified through synthetic seismogram and also to confirm the depth of the interpreted reflectors. Structural interpretation depicts two broad types of fault sets namely, thrust and back thrust faults. These faults together give rise to pop up structures in the study area, and are also considered responsible for many structural traps. Structural interpretation includes time and depth contour maps of Chorgali Formation, Velocity modeling and fault modeling. It is hoped that the present work may help in better understanding of the variations in the subsurface structure and stratigraphy of the Missa Keswal area.

Introduction

Eastern Potwar Plateau is characterized by north-east, south-west trending tight, faulted anticlines separated by broad synclines (Moghal *et al*., 2003). Chorgali Formation of Eocene age is the main reservoir rock in the study area. The shale and clays of Murree formations act as cap rocks (Aamir & Siddiqui, 2006)

Seismic interpretation

Reflection seismic uses sound waves to investigate the subsurface Badley, 1985.The reflectors of top Eocene (Chorgali Formation) was picked from the seismic sections on the basis of synthetic seismogram prepared from the well data of Missa Keswal-01 (Figure 1).

Three thrust faults were marked on the basis of clear breaks in the continuity of top Eocene reflectors. The Oil water contact has been marked by using the well log of MissaKesawal-01 at the depth of 1803 m. Porosity and water saturation curves have been used to mark this contact.

Chorgali Formation can be seen as two individual formations in anticlinal portion that's why they have been treated individually as Chorgali A and Chorgali B in mapping. Such a complex structure and over thrown of the whole sequence of strata may be due to the compressional forces, salt diaprisim and existence of normal fault in the basement directly below this pop up structure.

Time and depth contour maps of top of Chorgali A (Figures 2 & 3) and Chorgali B are prepared to delineate the structure accurately. These contour maps show the presence of pop up structure bounded by the two thrust faults dipping NW and SE and the orientation of the structure is NE-SW.

Generalized velocity model is prepared by using interval velocities given on the seismic dip lines and two way travel time which shows the overall velocity variation in the study area. To understand the nature of thrust system, 3D geological model of interpreted horizons and fault surfaces was constructed. Well tops are also correlated on the basis of available well data. This correlation shows the presence of anticlinal structure.

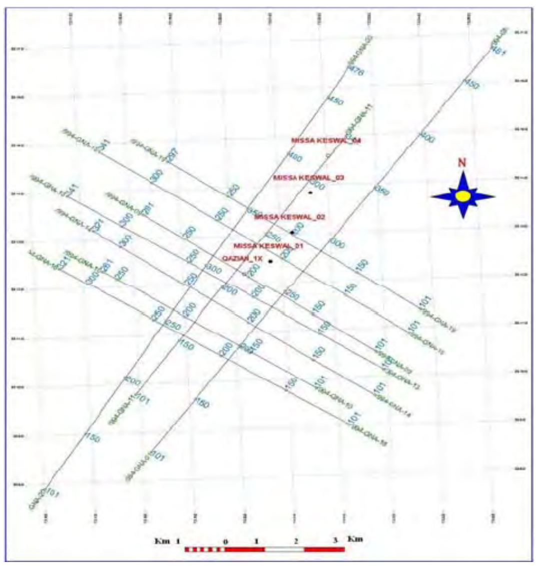

Figure 1: Base map of the study area.

Conclusions

Thrusting is observed in all dip lines. The fractured carbonates of Chorgali formation and Sakesar formation are the major producing reservoirs in Missa Keswal area. On the basis of the interpretation of Chorgali B Formation a new well location is proposed in Chorgali

B at the shot point 212 of seismic line 94-GNA-09 in the pop up structure. At this point the values of time and depth contours are decreasing and hence minimum (i.e. 1740msec and 3000 m).

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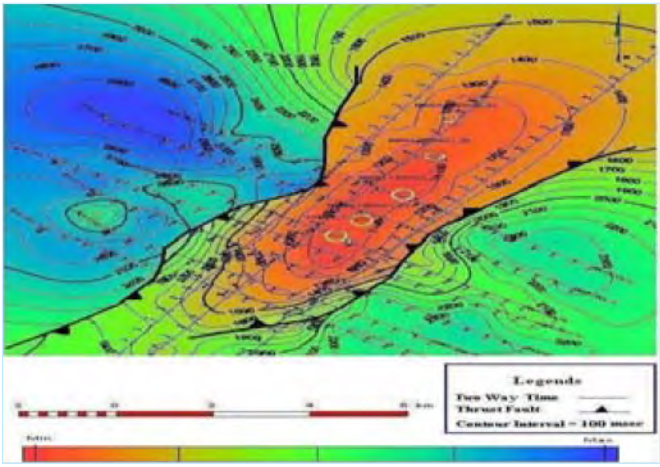

Figure 2: Time contour map of top of Chorgali A plotted on the base map.

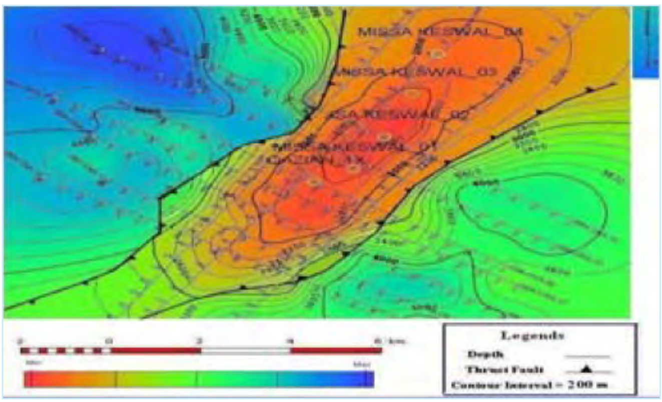

Figure 3: Depth contour map of top of Chorgali A plotted on the base map.

Paper P1-32

Evaluation of S-wave propagation due to natural rock joint surface

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Keywords: Natural rock joint surface, elastic wave propagation, S-wave, QSRC test

Geophysical survey by utilizing elastic wave has been widely used for site investigation especially in rock formation. Propagation of shear wave (S-wave) as an elastic wave is heavily affected by joint conditions in the rock mass, especially the joint surface. This effects can be used to investigate the S-wave propagation-stress behavior. Thus fundamental understanding and systematic evaluation of the S-wave velocity and attenuation in jointed rock mass is important for a reasonable analysis in geophysical survey. In this study, an experimental setup for Quasi-Static Resonant Column (QSRC) test was developed based on previous studies to simulate the S-wave propagation. The purpose of this experimental program is to investigate the characteristic of S-wave velocity and its attenuation due to natural surface profile of rock joint that classified and quantified with statistic parameters. This study shows that the presence natural roughness profile on the joint surface consequently influence S-wave propagation by reducing its velocities and its attenuation. Thus, this rock joints condition acted as attenuation mechanism for elastic wave propagation. Typically, the wave is analyzed as equivalent continuum during the assessment since the columnar specimens were erected in multi jointed for S-wave propagation. Three columnar multi jointed specimens with different natural surface profiles of rock joints were formed for evaluation. As the result, correlation between elastic wave propagation of S-wave and natural roughness surface profiles of rock joint was established.

Paper P1-33

An accurate XRF technique for the analysis of geological materials

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Four certified reference materials (CRMs) with varying SiO_2 contents were used to verify a developed XRF technique suitable for rock and soil samples in particular and other geological materials in general. The CRMs are USGS-DNC-1 (Dunite, SiO_2= 47.15%), USGS-BCR-2 (Basalt, SiO_2 = 54.10%), CANMET SY-2 (Syenite, SiO_2 = 60.10%) and CRPG-GSN (Granite, SiO_2 = 65.80%). For major elements verification, the dunite, basalt and granite standards were used while the syenite and granite were employed for trace elements verification. The developed technique comprises of 26 intensity-concentration curves – 10 major elements and 16 trace elements – which were constructed using 10 CRMs of geological materials. All the curves show linear correlation of y = mx, passing through the origin. The spectrometer used is BRUKER S8 TIGER, housed in the Physics Program of the Faculty of Science & Technology, UKM. Rhodium K-α line was used as the exciting source and standard parameters were applied for all the 26 elements. The 30 µm grain size powder were made into 32 mm diameter fused beads for analyzing major elements and 32 mm diameter pressed-powder palettes for measuring trace elements. The fused beads have been prepared by igniting 0.5 g of sample with 5.0 g of Johnson-Matthey 110 spectroflux, giving a dilution ratio of 1:10. As for the pressed-powder palettes, the preparation involves applying a pressure of 20 tones for one minute to 1 g of sample against 6 g of pure boric acid powder.

For each of the four CRMs, all the 26 elements measurements have been repeated six times and the calculated average and the relative standard deviation (RSD) were used to indicate the precision, which is largely controlled by the precision of the XRF spectrometer itself. It was found that the precision for major element is very high with RSD of 0.04-0.95%. As for trace element, the precision is high, with RSD of 0-5.30%.

The measure of accuracy of elements studied is their respective relative errors which were derived by the formula: Relative error = $(x-x_o)/x \times 100$, where x = true value of the quantity (reccommended value of the CRMs), x_o= observed value of the quantity (from the XRF machine).

The study has shown that the range of relative error of measurements for major elements is as follows: SiO_2 (0.36-0.92), TiO_2 (0-2.08), Al_2O_3 (0.71-1.04), Fe_2O_3 (1.74-3.73), MnO (13.27-33.33), MgO (0-1.11), CaO (0.28-2.70), Na_2O (0.53-6.88), K_2O (1.08-4.35), and P_2O_5 (0-2.86). As for trace elements the average of relative errors is: Ba (5), Ce (10), Cr (12), Cu (43), Ga (4), Hf (6), Nb (16), Ni (23), Pb (13), Rb (7), Sr (9), Th (3), U (11), V (15), Zn (8), and Zr (11).

Among the major elements SiO_2 and Al_2O_3 show very high accuracy (relative error of less than 1%), TiO_2, MgO, CaO and P_2O_5 show moderate accuracy (relative error of 1-3%). Fe_2O_3, Na_2O and K_2O, however show only reasonable accuracy with relative error of 4-7%. Being a low concentration element, MnO shows rather high relative error of 13-33%. The dependency of accuracy upon the concentration for nine of the major elements is shown in Figure 1.

Among trace elements Ba, Ga, Hf, Rb, Sr, Th, and Zn show accurate analysis (relative errors are less than 10%); Cr, Ni, Pb, Zr, V, Nb, U, and Ce show reasonable accurate analysis (relative error of 10-25%). Cu belongs to the group which show relative error between 25-50%, thus having rather low accuracy. The dependency of accuracy upon the concentration for nine of the trace elements is shown in Figure 2.

In general, for both major and trace elements under study the general trend is increasing accuracy (lower error) by increase in elemental composition.

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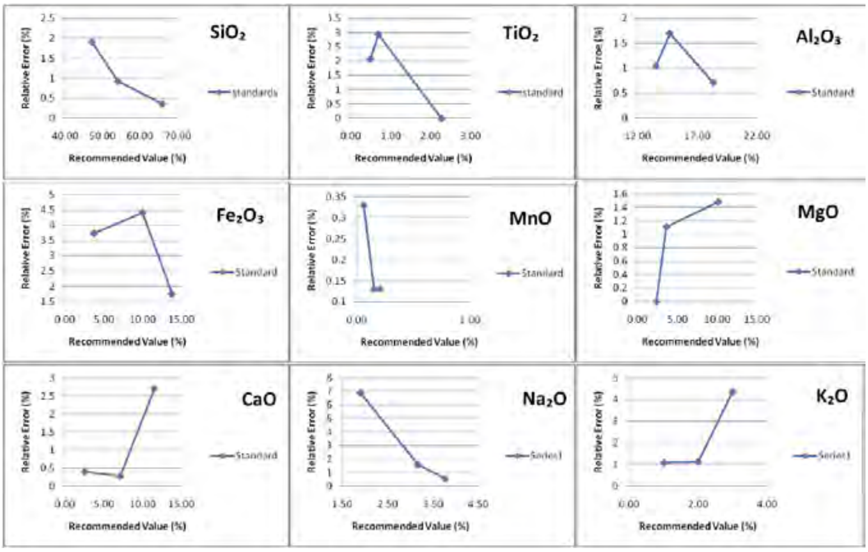

Figure 1: The measure of accuracy of major elements.

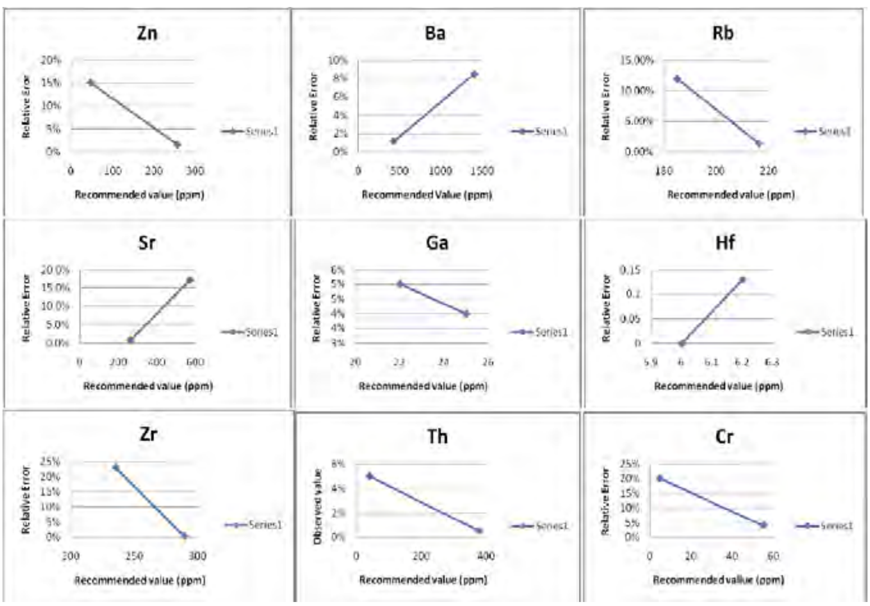

Figure 2: The measure of accuracy of trace elements.

Paper P1-34

Uncorrelated surface water and soil geochemistry in ultrabasic land of Ranau, Sabah

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Keywords: Geochemistry, ultrabasic soils, surface water, Ranau

A total of 27 surface water (river) samples and 16 soil samples overrun by the surface water were collected from Ranau area in North West of Sabah and were analyzed elementally. The aims are to relate the geochemistry of the running water and the overrun soils, and also to evaluate the possible heavy metal pollution of surface water in the area. The geology of Ranau is dominated by ultrabasic-ophiolitic sequences, which are surrounded by Crocker Formation of clastic metasedimentary rocks. Ultrabasic rocks have attracted the attention of many researchers in the world due to their high concentration of certain heavy metals, notably Ni, Cr, Co, Mg and Fe. Moreover, some studies have established that deep chemical weathering in tropical areas has enriched some elements in the soil significantly, especially Cr, Co and Ni. Consequently, high toxic potential of heavy metals in surface water running on ultrabasic soils is expected. The prime objective of the research is to determine whether the geochemistry of the ultrabasic soils has affected the quality of the run-off waters flowing through them. Crocker's formation in the vicinity of ultrabasic land was used as a control, due to their low content of the elements under study. The pH, electrical conductivity and turbidity of surface waters were measured immediately after sampling. Two mL of concentrated HNO_3 was added to each sample to preserve the metals and to avoid precipitation. The sample were analysed for 27 elements using Inductively Coupled Plasma (ICP) machine, housed in the School of Science & Technology, Universiti Malaysia Sabah. The chemical composition of soil samples, comprising 10 major elements and 20 trace elements were determined by employing the X-ray fluorescence spectrometer (XRF, Bruker S8 Tiger), house at Faculty of Science and Technology UKM. The soil samples were powdered to 30 µm grain size and were made into 32 mm diameter fused-beads for measuring major elements and 32 mm diameter press-powder pallets for measuring trace elements. In addition, X-ray diffraction (XRD) technique was used to identify and estimate the mineralogical composition of the soils, using Siemen D5000 machine, housed at Faculty of Science & Technology UKM.

XRD patterns have shown that the ultrabasic soils are made up of mainly oxides and oxyhydroxides of iron (hematite, goethite). Biotite, clay minerals (kaolinite) and phyllosilicates (muscovite and clinochlore) as the products of ultrabasic rock alteration are also predominant in the soils.

Table 1 shows the composition of Fe_2O_3 and MgO (in weight percentages) and Cr, Co and Ni (in µg g−1) for ultrabasic soils and the soils of the Crocker Formation. The element ranges for ultrabasic soils are: Fe_2O_3 11.35-45.47, MgO 0.27-8.71, Cr 2427-27863, Co 35-167, and Ni 850-4753, while soils of Crocker Formation show the following amounts: Fe_2O_3 3.29-11.88, MgO 0.25-3.96, Cr 67-136, Co 11-23, and Ni 33-270. The elemental compositions between the two groups of soils differ significantly, with the ultrabasic soils predominate the Crocker soils by the following factors: Fe 5, Mg 2, Co 6, Cr 100, and Ni 15.

In terms of natural soil pollution, Cr, Co and Ni within the ultrabasic soils exceed the optimum and action values given by Dutchlist, with Cr and Ni 37 and 8 times higher, respectively. Moreover, Fe_2O_3 reveals amounts considerably higher than required values in the environment. The high amount could be potentially harmful to ecosystem and human health.

Table 2 shows the maximum, average and minimun concentration of elements in rivers flowing through ultrabasic rocks, Crocker Formation and tap water in Ranau area (in µg g−1). The following ranges are noted: ultrabasic soils Fe 359-1920, Mg 84784- 253635, Cr 5-14, Co 1-7, Ni 11-94; Crocker Formation Fe 381-2299, Mg 35607- 854747, Cr 4-9, Co 1-14, Ni 8-172; villages's tap water Fe 265-439, Mg 16628-115440, Cr 2-9, Co 1-3, Ni 9-13.

Despite what was expected, all elements except Fe have concentrations below the standard limits, both in surface and drinking waters of Ranau. The geochemical data of soils, especially ultrabasic, do not show correlation with the surface, and subsequently the drinking water. A possible explanation is the hardness of the igneous formation does not permit the formation of much soils, thus the rock-water interface limits the material from the rocks from entering into the running water. Further study on the relative mobility of elements in rock-water and soil-water interface is very much needed.

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Table 1: The elemental composition of ultrabasic soils and soils of Crocker Formation from Ranau, Sabah and values for Dutchlist standards (in weight % for Fe and Mg and μg g−1 for other elements).

Elements	Ultrabasic Soils			Crocker Soils			Standard for soils (Dutchlist)	
	Max.	Ave.	Min.	Max.	Ave.	Min.	Optimum value	Action Value
Fe	45.47	33.08	11.35	11.88	7.34	3.29	-	-
Mg	8.71	3.10	0.27	3.96	1.44	0.25	-	-
Co	167	110	35	23	18	11	20	240
Cr	27863	14233	2427	136	136	67	100	380
Ni	4753	1645	850	270	107	33	35	210

Table 2: The elemental composition of rivers flowing through ultrabasic and Crockers Formation and tap water in Ranau area (in μg g−1).

Elements	Rivers on Ultrabasics			Rivers on Crockers			Tap water		
	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.
Fe	1,920	963	359	2,299	971	381	439	326	265
Mg	253,635	190,064	84,784	854,747	259,009	35,607	11,440	31,316	16,628
Co	7	3	1	14	5	1	3	2	1
Cr	14	8	5	9	6	4	9	6	2
Ni	94	40	11	172	68	8	13	11	9
Mn	220	76	9	494	153	10	4	3	2

Paper P1-35

Characterisation of strength and durability of bedded sedimentary rock at Gelang Patah, Johor

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This study was carried out to characterize the weathering profile, durability and strength properties of bedded sedimentary rocks of an exposed outcrop found at Kampung Lima Kedai, Gelang Patah, Johor. Both field and laboratory studies were carried out in this study. The field study involved site measurement, general observation and sample identification. Laboratory tests were carried out to determine the strength, weathering grade and durability of the rock material. A total of forty five samples comprising of 27 of sandstone samples and 18 of shale samples have been tested by using point load and slake durability test. The procedure of these test were in accordance the ISRM (1981) and ISRM (1985) methods. The results obtained from the site and laboratory tests revealed that the lithology, topography and stratification influenced the extent of weathering at the site. In addition, strength index Is(50) and durability index Id2 is developed based on the different rock types.

Paper P1-36

Assessment of potential alkali silica reaction in aggregates from Teluk Ramunia, Johor, Malaysia

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Keywords: Alkali silica reaction (ASR), ASR tests, petrographic analysis, aggregates

Alkali Silica Reaction (ASR) is a set of physiochemical reactions and it affects the strength and durability of concrete. ASR occurs when soluble alkali ions present from the cement, admixtures, or other sources containing sodium and potassium, react with certain types of silica structures present in the aggregates. This paper deals with the effectiveness of various test methods in determining whether alkali silica reaction (ASR) occurs in six different type of aggregates obtained from Pengerang, Teluk Ramunia, Johor. Four testing method were adopted in this research, which are the chemical method (ASTM C289), the accelerated mortar bar test (ASTM 1260), the conventional mortar bar test (ASTM C227) and the petrographic test (ASTM C295). From this research, the six types of aggregates obtained from Teluk Ramunia, Pengerang, Johor are found to be innocuous. ASTM C227 has longer testing term duration and may not produce significant expansion whereas ASTM C289 gives quick results but it is not that reliable as some aggregates give low expansions even though they have high silica content. ASTM C295 is a very useful method for identifying potentially reactive minerals and rocks but its reliability depends on experience and skill of the petrographer. Hence, ASTM 1260 is considered the most effective yet simple method as it gives better result and is more reliable in testing alkali silica reaction.

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Paper P1-37

Determining of the soil strain characteristics through the constant plastic index method

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Keywords: Constant plastic index (CPI), void ratio, stratum plastic index (SIF)

Confusion between the terms of fixed boundary and moving boundary which is sometimes plainly referred as Terzaghi – Biots Theory are not unusual among the practitioners. This paper clarify the definitions of both theories as expansion soil theory. Moreover, a constant plastic index (CPI) has been derived base on ultimate settlement where soils are classified accordingly using void ratio function and stratum index factors. Finally, a method for determine soil strain using constant plastic index (CPI) and solving prediction settlement is supported through theoretical example.

Paper P2-1

Assessment of mechanical properties of granite aggregates using simple tests

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In Peninsular Malaysia, granitic rocks are the most important source of construction aggregates. About three-quarters of the crushed rock aggregates are produced from granites. Granite is the dominant granitic rock in most quarries, but significant microgranite and minor pegmatites occur in some quarries. The quality of the granitic aggregates is influenced of by alteration, weathering and deformation. The quality of the aggregates is assessed by performing mechanical (aggregate impact value AIV, aggregate crushing value ACV, ten percent fines TFV, Los Angeles abrasion value LAAV), physical (flakiness index If, relative density, water absorption W) and soundness tests (magnesium sulphate soundness value MSSV).

Practical sampling entails taking a sample large enough to be representative within acceptable and known limits, but small enough for convenient handling (Harris & Sym, 1990). There must also be enough material available for the tests that are envisaged. Testing of rock samples for aggregate properties involved crushing of the rock blocks and screening to obtain appropriate particle size for testing. For granites, only about one-third of the crushed aggregates have the appropriate particle size (10 to 14 mm for AIV, ACV, TFV and If, and 19 mm for LAAV) (Ng, 2001). Hence, in order to perform the mechanical tests, at least 50 kg of rock is required to produce sufficient quantity of test portions.

This study is aimed to establish suitable simple tests that can be carried out on intact rock materials or small quantity of aggregates, to assess the mechanical properties of aggregates. Such assessment is useful especially when representative samples are insufficient to cover the mechanical aggregate tests, such as during the initial stages of investigation for potential rock quarry, where only limited samples are obtained from bore hole rock cores. Due to intense weathering under humid tropical climate, fresh natural surface outcrops suitable for sampling are often scarce.

In this study, about 150 *in-situ* rock samples were collected from 43 locations consisting of quarries and cut slopes in Selangor, Negeri Sembilan and Kuala Lumpur. After preliminary examination of hand specimen and thin sections, 50 representative samples were selected for aggregate tests. For the preparation of aggregates, each sample consists of 50 kg to 75 kg of rock blocks collected *in-situ*. Aggregates were prepared by crushing the rock blocks in a laboratory single toggle jaw crusher. The crushed aggregates were sieved to obtain the appropriate size fraction for laboratory tests. The tests are If, AIV, ACV, TFV, LAAV, MSSV, W, relative densities (oven dried, saturated and apparent). Point load test was carried out axially on cylindrical samples and rock lumps. Petrographic analysis was carried out to determine the mineral contents, grain size, intensity of deformation and alteration. All the tests were carried out following recommended methods by the British Standards Institution (BSI, 1975a,b, 1989a,b,c & 1990a,b,c) or American Society for Testing and Materials (ASTM 1987, 1989, 1990 & 1991). Simple and multiple regressions were carried out using Statistica version 9 to establish the relationship between the tested mechanical and physical properties.

Statistical analysis shows that there is a highly significant ($p<0.001$) relationship between the mechanical properties of aggregates (AIV, ACV, TFV & LAAV) and the Point Load Index (IS(50), Table 1). Between 64% and 77% of the variability of the mechanical properties can be accounted for by Is(50). The remainder of the variability could be caused by variation in the physical properties of the aggregates. Multiple regression analysis shows slight improvement in the correlation when relative dry density or water absorption is included in the regression. The largest multiple correlation coefficient values ($R>0.9$) and highly significant correlations ($p<0.0001$) were obtained involving Is(50), flakiness index and dry relative density (Table 1).

The study shows that Is(50) can be used to estimate the mechanical properties of granite aggregates. Further improvement to the assessment can be obtained if the flakiness index and dry relative density are known.

Acknowledgement: This study is supported by the University of Malaya Research Grant.

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Table 1: Results of correlations between the mechanical properties of granite aggregates (AIV, ACV, TFV, LAAV) and Point Load Index (IS(50)), dry relative density (RD), water asorption (W) and flakiness index (If). R is the correlation coefficient.

Parameter	AIV	ACV	TFV	LAAV
Is(50)	AIV=39.820 – 3.701Is(50) R=0.878	ACV=38.200 –3.010Is(50) R=0.802	TFV=18.412 + 27.388Is(50) R=0.818	LAAV=54.044 –4.673Is(50) R=0.878
Is(50) & RD	AIV=116.761 –3.255Is(50) – 30.377RD R=0.902	ACV=91.141 –2.702Is(50) – 20.847RD R=0.818	TFV=23.039Is(50) + 157.867RD – 251.168 R=0.828	LAAV=157.153 –0.383Is(50) – 40.602RD R=0.904
IS(50) & W	AIV=35.295 – 3.193Is(50) – 2.832W R=0.887	ACV=39.058 –3.111Is(50) – 0.562W R=0.803	TFV=24.530 + 26.667Is(50) – 4.001W R=0.839	LAAV=46.281–3.758Is(50) – 5.083W R=0.896
Is(50), If & RD	ACV=97.456 – 0.387If – 2.265Is(50) – 21.620RD R=0.928	ACV=61.285 – 0.598If – 1.170Is(50) – 7.305RD R=0.901	TFV=4.925If + 12.444Is(50) + 46.343RD – 136.615 R=0.901	LAAV=138.370 – 0.376If 3.111Is(50) – 32.023RD R=0.919

Paper P2-2

Application of geoaccumulation index and enrichment factor for assessing metal contamination in the sediments of Mamut River, Sabah

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Mamut river has been reported being polluted based on previous studies done by Ali *et al*. (2004), Razi *et al*. (2005) and Abdullah *et al*. (2008). Previous studies done also show that there is elevated level of heavy metals in sediments, indicates the possible contamination from the ex-mining site nearby. This study is important for monitoring purpose in determining the current status of the degree of pollution in Mamut river. The objective of this study is to evaluate the degree of heavy metal contamination along Mamut river and the extent to which the sediment quality of the Mamut river has deteriorated. A total of six sampling sites located along Mamut river were chosen for collecting sediment samples. The sediment digestion method is according to Wilson *et al*. (2005), where 1 g of sediments (63μm) was subject to aqua regia digestion. The samples were analyzed using atomic absorption spectroscopy (AAS) for determination of heavy metals in sediment, where as the characterization of minerals was analyzed using X-ray Diffraction (XRD). The average concentrations showed a significant increase pattern from upstream to downstream for Cu (104.8-1605.9 $mgkg^{-1}$) and Zn (157.24-463.65 $mgkg^{-1}$) while vice versa for Pb (63.57-218.09 $mgkg^{-1}$) which is shown in Figure 1. Trend of heavy metals studied (Cu, Pb, Zn) are as follows which Cu>Zn>Pb. XRD analysis indicate that the sediments of Mamut river are mainly composed of quartz and silicon oxide while kaolinite, mica and muscovite can be found in some sampling sites reflecting the geology of the study area (Table 1). The composition of mineral in sediment influences the distribution of heavy metal in sediment. However, the antropogenic sources also contribute to the levels of heavy metals exists in the sediment. The enrichment factor (EF) and geoaccumulation index (Igeo) have been calculated and the relative contamination levels assessed in the study area. Igeo results reveal that the study area is not contaminated with respect to Cu, Pb and Zn. However, EF value of Cu and Zn indicates the sources of metal in the sediment are from anthropogenic sources while EF value for Pb indicate the metal concentration in study area are from the natural sources. The assessment of sediment quality was also done by comparing the concentration of Cu, Pb and Zn from studied area to the sediment quality guidelines (SQG). Based on SQG, M2, M3 and M4 exceeded the SQG limit (197 $mgkg^{-1}$) while all sampling sites exceeded the SQG limits for both Pb (36 $mgkg^{-}$1) and Zn ($mgkg^{-1}$). Thus, this study shows that the Cu and Zn in the sediments are from the anthropogenic sources and the sediment quality of studied areas are deteriorated as it exceeded the SQG limit assigned.

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Table 1: Characterization of mineral in sediment.

Sampling Sites	Mineralogical Composition
M1	Quartz, Silicon oxide
M2	Quartz, calcium aluminium mesitylenesul-fonatehydate, sodium ethanesolfunate, edenite, pyrite, chrysotile
T1	Quatz, silcon oxide
M3	Silicon oxide, kaolinite, mica, chalcopyrite
T2	Quartz, silicon oxide
M4	Quartz, muscovite, caldecahydrite, manga-nocummingtonite, chrysotile

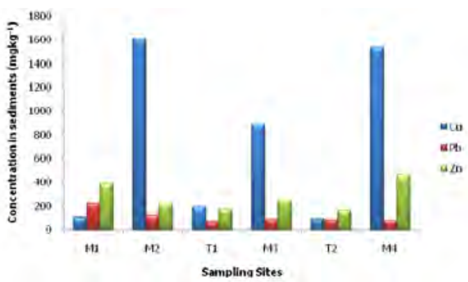

Figure 1: Concentration of Cu, Pb and Zn in sediments ($mgkg^{-1}$) from the sampling sites

Paper P2-3

Landslide susceptibility mapping using the weights of evidence (WOE) method along the E- W Highway (Gerik – Jeli), Malaysia

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Keywords: GIS methodology, Landslide causative factors, landslide susceptibility mapping, East- West highway (Malaysia)

This study aims to produce a landslide susceptibility map for a landslide-prone area located at the central northern part of Peninsular Malaysia along the E-W highway (Gerik – Jeli). The study area is frequently subjected to landslides following heavy rains, especially alongside the highway since it was constructed. The area is characterized by rugged hills and mountain terrains covered by thick rain forest. The relief of the study area varies between 74 and 1268 meters above sea level. Slope gradient ranges between 0° to 88°. The climate is humid and precipitation is very heavy during the rain seasons which can reaches to 3970 mm/y. The weights of evidence (WOE) method has been applied to evaluate the landslide susceptibility of the area using geographic information system (GIS). The method is based on the assumption that future landslides will occur under the conditions similar or equal to those of past comparable landslides. Like all the statistical methodologies, this method requires to identify and to map landslides and all the instability factors which affect landslides in the area. In order to achieve this purpose, a landslide location map of the study area was prepared based on the interpretation of aerial photographs, previous landslide maps and field surveys. In addition, a spatial database for landslide-related factors was constructed. Eleven relevant thematic maps representing considered factors were extracted from the constructed spatial database. Slope gradient, slope aspect, elevation, distance from road and drainage density, all were calculated from the topographic database; lithology, strata dip map and foliation dip map were generated from the geologic database; lineament density was prepared from Enhanced Thematic Mapper Plus (ETM+) Landsat -7satellite image; soil map was prepared from the soil database and the rainfall map was produced from annual rainfall data for the years 2000, 2005 and 2009 which were collected from three meteorological stations at the area. The thematic factor maps were all combined with the landslide location map for the calculation of the positive weight (W+), the negative weight (W-) and the contrast value (C) for each factor. The weights were assigned to the classes of each thematic layers to produce weighted thematic maps, which were overlaid and numerically added to each other to produce a landslide susceptibility index (LSI) map by which the area has been divided into five zones of susceptibility, namely very low, low, moderate, high and very high . The analysis applied with this method has pointed out the importance of some classes above others on landslide occurrence. The highest contributing classes to landslide were found as follows: areas under 300 m distance from road, lineament density higher than 1.5 km/km² (high and very high lineament density classes), slope gradient between 35° and 45°, and lithological unit composes of phyllite and slate.

Paper P2-4

Workflow to reconstruct 3D pore space from 2D CT-scan image of Berea Sandstone

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Keywords: 3D pore space image, stochastic reconstruction, permeability, CT-scan

Physical properties (e.g. porosity, permeability) prediction can be accurately estimated using numerical simulations of fluid flow through 3D pore space image. A digital volume can be obtained from CT-scan. However, for practical useful in massive experimentation the device is still prohibitively expensive and the scanning time is too long. An alternative is to reconstruct 3D volume from 2D image (e.g. thin section) information. These thin sections are relatively easy and cheap to prepare and often done at the drill site.

In this study, instead of using thin section, we used 2D image from CT-scan for training image. This image can be used as an input, similarly like thin section image. The density between pores and grains can be differentiated clearly from CT-scan measurement. The validation of the workflow can precisely validate since the 3D image is already there. 2D image was obtained from 3D X-ray tomography image of Berea sandstone. This data was used as the benchmark data for the test study of stochastic reconstruction. Berea sandstone generally serves as a basis for many rock physics experiments due to its fine-grained and well sorted characteristics. This sandstone also occurs in the oil and gas producing formation in the Michigan Basin. The goal of this study is to predict permeability using 2D image as input and validate the stochastically reconstructed pore space with actual porous media that obtain from CT-scan. LBM was used to simulate fluid flow in porous media to estimate permeability.

A geostatistics method (SIS) to reconstruct 3D porous media using 2D image was validated in this paper. Berea sandstone was used for this study because of their pore size and simplicity. Isotropy is assumed in the reconstruction; however more conditioning data, such as several images can be used as constrains and multi-orientation images can provide more statistics when anisotropy is expected. If detailed geological history is available, Process-based reconstruction (Oren & Bakke, 2003) is promising methods to reconstruct 3D porous media of rock. MPS is more general and it can generate realistic pore space image without knowledge of geological processes by which the rock was forms. However, this method still time consuming and take hours even to reconstruct one porous media (Okabe, 2004).

This method can be solution for simple, fast and robust prediction of porosity and absolute permeability from 2D image (e.g. thin section). Physical properties prediction; porosity and absolute permeability were compared with permeability estimation from CT-scan image and the results have good agreement with CT-scan image which is directly acquired 3D image from the CT-scan equipment.

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Table 1: Permeability estimation by the Lattice-Boltzmann flow simulation on stochastically generated 3D porous media and CT-scan.

	CT-Scan	SIS
ρ	19.60 %	19.56 %
k	1111 mD	1023 mD

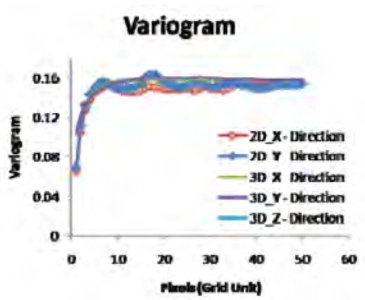

Figure 1: Variogram from X and Y direction from 2D image. Variogram from X, Y, Z direction from 3D image.

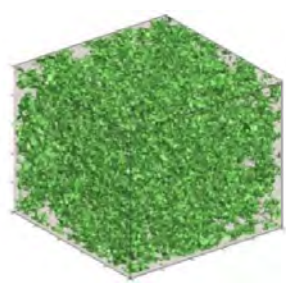

Figure 2: Green color represent surface of porous media reconstructed using geostatistical (SIS) method.

Paper P2-5

Evaluation of effective parameters for the drilling and blasting of boulders

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Keywords: Boulders, drilling, blasting, coupling ratio, physicochemical properties, ANFO, detonator

Ground leveling is commonly done during preparation for building construction. Heavy machinery usually is used to scrape the layers of soil and soft rock. But when the strength of rock is very high, the machine wear costs become too high and it is economical to take out the rest of material by blasting. In some instances, excessively large fragments (boulders) remain during primary blasting. The boulders need to be fragmented by surface blasting in order to be handled by loading equipment for easy hauling. Considerable care must be taken to keep fragmentation fairly small and regular because the debris has to be hauled in smaller equipment that can be used in a residential or industrial area. Care must also be exercised to control vibration for the same reason of taking care with the surroundings. There were huge granite boulders with weathering grade II during an earthwork for housing development in Bandar Seri Alam, about 300 km to the southeast of Kuala Lumpure. These boulders prevented building construction at the site. To overcome the problem, drilling and blasting method was chosen. In this study, an investigation on the properties of the boulders was performed and a pattern of blasting was proposed based on the data acquired. The breakage mechanism after the blast was studied based on the proposed blasting pattern. The investigation revealed that four executive factors that affected the breakage efficiency are coupling ratio (which is called the ratio between charge and borehole diameters), effects of humidity on the physicochemical properties of ANFO (main charge), location of detonator in the primer and holes deviation. When the coupling ratio is small, the empty space between the charge and borehole wall is filled by air. In some of the boreholes the charge diameter was much less than the borehole diameter which was filled by air. The air reflects the explosive energy and reduces the crush zone. The second factor which is very important in the tropical climate is the effects of moisture on the ANFO. The physicochemical properties of the ANFO are changed by attracting the moisture and decrease the efficiency of the explosion. Inspection of ANFO pills shows that in some of the cases, the pills were hard and their colour had changed to white. It is revealed that the pills were degraded and have lose their properties. The investigation in the site shows incorrect cartridge priming with electrical detonator also can affect the quality of boulder blasting. Reviewing the detonating cords reveals that the detonators were located in the middle with skew in contrast to the previous studies which propose that the electrical detonator should be place along to the axis of the primer cartridge for increasing the shock effect. In some of the high boulders, the drilling machine boom could not reached the top of the boulders and the rock was drilled with positive deviation to the top. Using short delay detonators leads the blasting wave consequent of the upper rows, maybe shock the main charge down the blast hole, throw it outside, and has negative effects on the rock fragmentation. To optimize boulder drilling and blasting, this case study illustrates that the abovementioned factors need to be considered in addition to the technical calculations.

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Paper P2-6

Evaluation of subsidence along the Kuala Lumpur-Karak Highway using 2D electrical imaging

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Summary

The KL-Karak highway is one of the expressway connecting Kuala Lumpur (western cost of Malaysia) and Pahang (eastern cost of Malaysia). The area between km 48.6 to km 48.8 along the KL-Karak highway is prone to subsidence. Five survey lines using 2D electrical imaging method was run parallel to the highway. The result shows there are few saturated zones (cavity) and fractured zone. Most probably the water flow from line 1 scatted toward line 2, 3, 4 and 5. The source water has to be study in detail.

Introduction

The area between km 48.6 to km 48.8 along the KL-Karak highway is prone to subsidence. The purpose of this survey project is to obtain subsurface information such as the depth to bedrock, boulders and the composition of the subsurface structures. Subsequently, the flow of subsurface water will be mapped. The 2-D resistivity imaging method was used in the survey. Resistivity measurements were made along five lines (Figure 2). The survey fieldwork was carried out in from 26 - 27 Oct 2007.

Field procedures

Electrical Imaging System is now mainly carried out with a multi-electrode resistivity meter system (Figure 1). Such surveys use a number (usually 25 to 100) of electrodes laid out in a straight line with a constant spacing. A computer-controlled system is then used to automatically select the active electrodes for each measure (Griffith and Barker, 1993). Throughout the survey conducted in the proposed site, the Wenner array has been used with the ABEM SAS4000 system. The data collected in the survey can be interpreted using an inexpensive microcomputer.

The resistivity method basically measures the resistivity distribution of the subsurface materials. Table 1 shows the resistivity values of some of the typical rocks and soil materials (Keller & Frischknecht, 1996). Igneous and metamorphic rocks typically have high resistivity values. The resistivity of these rocks is mainly dependent on the degree of fractures. Since the water table in Malaysia is generally shallow, the fractures are commonly filled with ground water. The greater the fracture, the lower is the resistivity value of the rock. As an example, the resistivity of granite varies from 5000 ohm-m in wet condition to 10,000 ohm-m when it is dry. When these rocks are saturated with ground water, the resistivity values are low to moderate, from a few ohm-m to a less than a hundred ohm-m. Soils above the water table is drier and has a higher resistivity value of several hundred to several thousand ohm-m, while soils below the water table generally have resistivity values of less than 100 ohm-m. Also clay has a significantly lower resistivity than sand.

Survey area

Five resistivity survey lines were carried on the site (Figure 2). Line 1, Line 2 and Line 3 was carried out using pole-dipole protocol while line 4 and Line 5 was carried out using Wenner 32SX protocol. The length of Line 1 is 300 meters and carried out at the edge of the road. The length of Line 2 and Line 3 is 240 meters and carried out on the highway. Line 4 and Line 5 is 200 meters and carried out on the slope embankment. For Line 1 and Line 2 both resistivity and IP surveys were carried out.

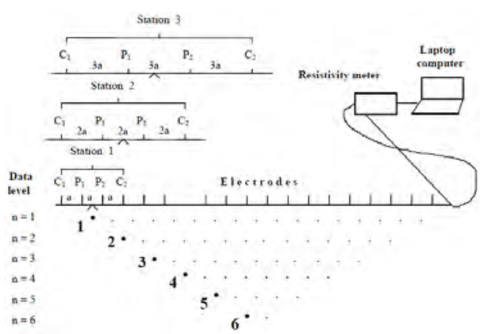

Figure 1: The arrangement of electrodes for a 2-D electrical imaging survey and the sequence of measurement used to build up a pseudosection.

Results and discussion

Lines 1 to 3 are approximately on the same level (Figure 2). Line 4 is about 15 m below the Line 3 on the slope embankment and Line 5 is about 15 m below Line

Table 1: Resistivity of some common rocks and soil materials in survey area.

Material	Resistivity (ohm-m)
Alluvium	10 to 100
Sand	60 to1000
Clay	1 to 100
Groundwater (fresh)	10 to 100
Sandstone	8 - 4 x 10^3
Shale	20 - 2 x 10^3
Limestone	50 – 4 x 10^3
Granite	5000 to 1,000,000

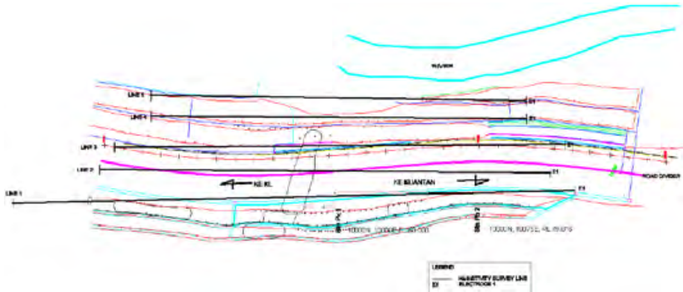

Figure 2: Location map of 2D resistivity imaging survey.

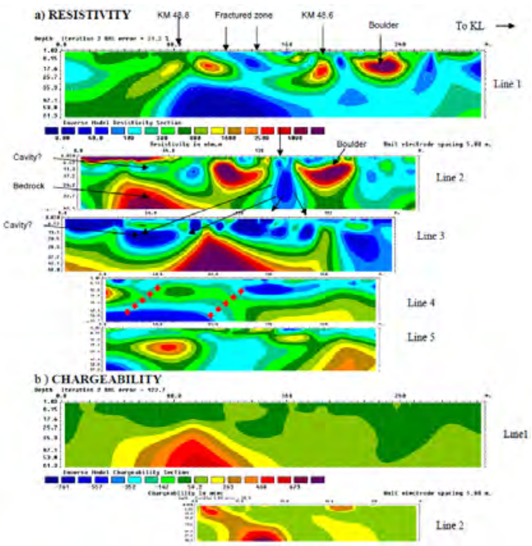

Figure 3: (a) Resistivity sections of Line 1 -5. The arrow shows the flow of underground water. (b) IP section showing the chargeability of Line 1 and 2.

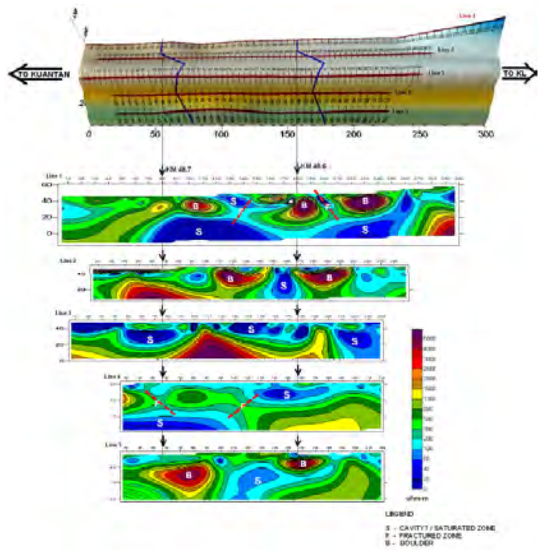

Figure 4: 3-D representation of Line 1 to 5 showing the flow of subsurface water along fractured zones.

4 on another embankment (Figure 2). Figure 3 show the resistivity sections of all the five line and IP sections of Line 1 and Line 2. Not much significant information about clay can be seen in IP section (Figure 3b). Figure 4 show the five resistivity sections in 3-D for the five lines. Note that there are two distinct features on all the resistivity sections. The high resistivity values with more than 3000 ohm-m are made of granite – either as boulders or bedrock.

The low resistivity values, less than 40 ohm-m are probably saturated soil, firm clay and silt, sand and gravels. It could also be interpreted as cavity filled with saturated soil. The resistivity value of between 100 ohm-m to 2000 ohm-m is due to weathered material such as weathered granite. The arrows in Line 1 indicated the fractured zones and the arrows in Line 2 and Line 3 show the flow and direction of water flowing through the fractured zone into the subsurface. The low resistivity value below 40 m and between km 48.6 and km 48.8 in Line 1 indicate that the water might create an aquifer in that region.

Figure 4 show the possible flow of subsurface water from the surface through the fractured zone or between boulders and created an aquifer above the bedrock.

Conclusion

Two distinct features high resistivity values of more 3000 ohm-m made of granite and low resistivity value of less 40 ohm-m caused by saturated material such as clay, sand and gravels. Subsurface water can be traced through fractured zones or between boulders and forming aquifer below.

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Paper P2-7

Kesan mikrostruktur terhadap kekuatan tanah berlempung dari Formasi Trusmadi yang distabilkan dengan kapur terhidrat

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Teknik penstabilan kapur telah lama diaplikasikan (Rao *et al*., 1996) untuk meningkatkan sifat kejuruteraan tanah sebagai penguat kepada bahan dasar bagi tanah berlempung (Bell, 1996). Kertas kajian ini bertujuan untuk mengkaji ciri-ciri mikrostruktur dan kekuatan batun terluluhawa Formasi Trusmadi yang distabilkan dengan kapur. Kawasan kajian terletak di sepanjang jalan raya Ranau-Tambunan pada garis bujur U05°59.275 dan garis lintang T116°35.322' (Rajah 1).

Analisis saiz butiran tanah kawasan kajian adalah lempung berpasir yang mempunyai peratusan kandungan lodak 26.51%, lempung 11.51% dan pasir 61.98% (Jadual 1). Jenis kapur yang digunakan sebagai analisis pengawetan adalah kapur terhidrat [$Ca(OH)_2$] dengan mengandungi 63.31% kalsium oksida (CaO). Sampel tanah dari Formasi Trusmadi telah diambil di sekitar kawasan Kundasang-Ranau. Sampel tanah dianalisis dengan menggunakan kandungan peratusan kapur yang berbeza iaitu 0%,2%,4%,6%,8% dan sampel diawet selama 0,7,14,21 dan 28 hari pada suhu bilik (25°C-27°C).

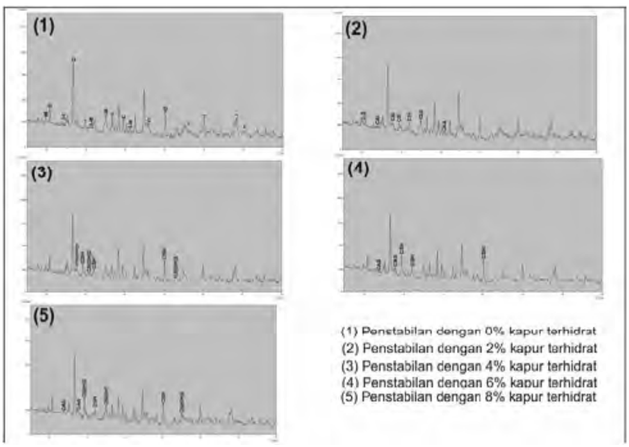
Antara kaedah analisis mikrostruktur yang diguanakan dalam kajian ini adalah XRD (pembelauan sinar-X) dan SEM (mikroskop pengimbas elektron). Daripada hasil analisis XRD menunjukkan pembentukan mineral sebagai simen pengikat tanah adalah kalsium silikat hidrat (CSH), kalsium aluminium silikat (CAS) dan kalsium silikat hidroskida [$Ca_5(SiO_4)_2(OH)_2$] seperti dalam Rajah 2.

Selain itu, daripada analisis XRD juga menunjukkan jumlah keamatan mineral lempung (ilit dan ilit-monmorilonit) semakin berkurang dengan penambahan peratusan kapur terhidrat. Analisis SEM menunjukkan keporosan tanah semakin berkurang dengan penambahan kapur terhidrat kerana ruang-ruang pori tanah telah diisi dengan mineral simen pengikat iaitu CAS dan CSH (Rajah 3).

Rajah 3 menunjukkan hasil imej mikrograf daripada analisis mikroskop pengimbas elektron (SEM). Analisis ini menunjukkan terdapat perbezaan ciri-ciri mikrostruktur sebelum dan selepas penstabilan kapur terhidrat mengikut penambahan peratusan kapur terhidrat yang digunakan dalam kajian. Didapati, pembentukan mineral ilit-montmorilonit yang hadir dalam sampel tanah (Imej 3-1) dimana struktur yang tidak padat tanpa penambahan kapur terhidrat. Struktur penggumpalan dan agglomerasi mineral lempung telah terbentuk dengan penambahan 6% kapur terhidrat (Imej 3-3). Pembentukan kepingan simen sebagai pengikat antara butiran mineral lempung jelas kelihatan dengan penambahan 8% kapur terhidrat (Imej 3-4). Kelimpahan pembentukan penghabluran kapur terhidrat iaitu kalsium alumina silikat (CAS), kalsium alumina hidrat (CAH) dan kalsium silikat hidroskida [$Ca_5(SiO_4)_2(OH)_2$] yang telah mengisi ruang pori antara butiran mineral tanah (Imej 3-5,3-6).

Pembentukan mineral simen pengikat adalah hasil tindakbalas daripada pozzolanik antara kapur dengan butiran halus mineral silikat (Eades & Grim,1960; Bell, 1996; Rao *et al.*,1997). Tindakbalas pozzolanik juga dipengaruhi oleh masa dan suhu pengawetan (Arabi & Wild, 1986; Bell, 1996; Boardman *et al*., 2001; Sukhadar & Shivananda,

Rajah 1: Kawasan persampelan tanah lempung berpasir bagi Formasi Trusmadi.



Rajah 2: Graf analisis XRD menunjukkan perbezaan keamatan perubahan mineral CSH,CAS dan [$Ca_5(SiO_4)_2(OH)_2$] bagi sampel tanah selepas 28 hari pengawetan pada suhu bilik (25°C).

2005). Pembentukan CSH dan CAS akan meningkatkan lagi sifat kekuatan tanah di kawasan kajian. Daripada analisis kekuatan mampatan tak terkurung didapati nilai kekuatan maksima mencapai 407.5 kPa iaitu pada penambahan 8% kapur terhidrat dan selama 28 hari pengawetan sampel dijalankan (Rajah 4 dan 5) .

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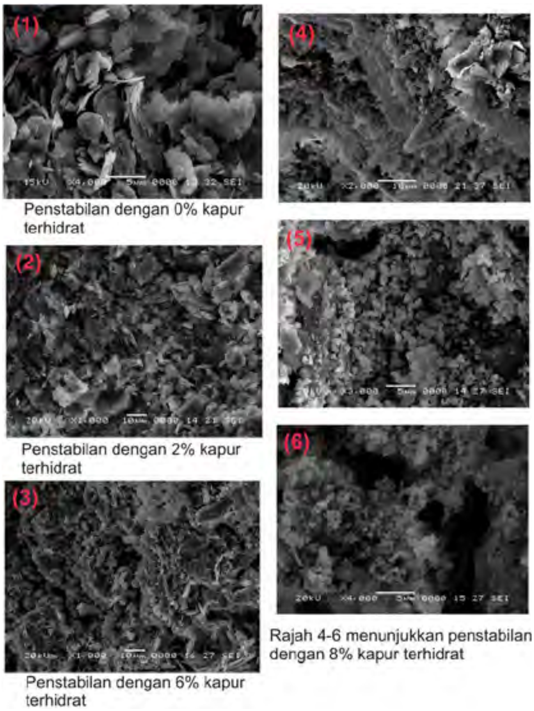
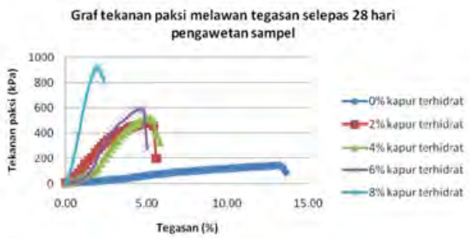


Rajah 3: Hasil imej mikrograf analisis SEM (Mikroskop pengimbas elektron) bagi sampel pengawetan tanpa 0% kapur terhidrat (1), 2% kapur terhidrat (2) 6% kapur terhidrat (3) dan 8% kapur terhidrat (4-6).



Rajah 4: Menunjukkan kekuatan optima tekanan paksi bagi sampel yang dirawat dengan 8% kapur terhidrat pada 850 kPa.

Rajah 5: Menunjukkan kekuatan optima analisis kekuatan mampatan tak terkurung melawan penambahan peratusan kapur terhidrat.

Jadual 1: Menunjukkan ciri-ciri fiziko kimia tanah bagi Formasi Trusmadi di sekitar kawasan Ranau-Tambunan.

Ciri-ciri fiziko kimia tanah	
USCS (Lodak 26.51%, Lempung 11.51% & Pasir 61.98%)	Lempung Berpasir
Kandungan Kelembapan (%)	15.02
Graviti tentu	2.7
Had Cecair (%)	29.05
Had Plastik (%)	29.05
Indeks Keplastikan (%)	13.29
Had Pengecutan Linear (%)	5.67
Ketumpatan Kering (mg/m^3)	1.85
Kandungan Kelembapan Optima, w_{opt} (%)	14.5
Ketumpatan Pukal (Mg.m^3)	2.14
Kekuatan Mampatan Tak Terkurung (kPa)	38
Kebolehtelapan (m/s)	1.52×10^{-9}
pH	6.45

Paper P2-8

Lineament mapping using Landsat TM5 in Penang Island, Malaysia

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Keywords: Landsat TM-5, directional filters, Canny filter, fault map

This study implies on the usage of the satellite image Landsat TM-5 for lineament mapping in the Pearl Island of Penang, which covers an area of 293 km^2. The study area is located at northwest Peninsular Malaysia. The main objective of this study is to select the best lineament map of the study area in regard to the integration between Landsat TM-5 and different kinds of filtering techniques which are directional filters and Canny algorithm filter. Generally, directional filters had been used by many researchers previously and Canny algorithm filtering is just newly method arose used to enhance the lineament features in the image. Band 4 of Landsat TM-5 image has been selected as a best band of TM for applying filters, because it showed clear morphology and lineaments outstandingly compared to the other six bands. Canny algorithm filter and directional filters were applied to detect the lineaments from Band 4 of Landsat TM-5. Therefore, this study is carried out to compare the number of reliability lineaments that can be mapped out from the image with two different techniques of filtering. The results shown that directional-filtered of Landsat TM-5 had 383 lineaments with the total length of 542.8 km whereas Canny-filtered of Landsat TM-5 had 406 lineaments with the total length of 336.9 km. Several lineament analyses used to test the reliability of the lineaments that mapped out from different filters which involves matching percentage (lineaments - faults matching) and the direction frequency compared with the fault map of the study area. The total length of matching was calculated to be 58.81 km for directional filtering, and 43.7 km for Canny algorithm filtering. This is 69.7 % and 51.8 % of the faults identified in the area using different filtering techniques of lineament extractions. Besides, both directional filtered and Canny filtered of Landsat TM-5 maps showed same dominant direction between N 350°-10° W which is NNW to SSE. According to these results, the directional-filtered technique gives the best lineament map where more than half of the faults in the whole area were identified by using this technique, and also reflect the accuracy of the lineament map prepared in this study for the area using a manual method.

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Paper P2-9

Lithofacies analysis of Kapilit Formation in Kalabakan Tawau

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Facies analysis of Kapilit Formation are base on the body of rock that characterize by a particular combition of lithology, physical and biological structures of the formation. The data collected on the exposed outcrop through out Kalabakan area where Kapilit Formation deposited. Kapilit formation is part of the Neogene basin in Sabah. Analysis of the data collected shows that the Kapilit formation consists of three (3) different facies that have been encountered on the exposed outcrops. The first (1) lithofacies consists of thick sanstones and interbedded between layers of mudstones. The second (2) lithofacies is layers of interbedded sandstones and mudstones with the existence of lenses of coal and coal seams. The last (3) lithofacies is consisting of thick mudstones comprises silt and clay materials that were deposited and interbedded of sandstones. The facies are grouped into 3 major facies association : (1) channel-levee, (ii) shore face and (iii) marine shale. The measured vertical succesion shows a series of fining upward sequence and coarsening upward sequence representing the delta front toward shore face and ended in shallow marine environment.

Paper P2-10

The influence of initial water content and dry density on consolidation of compacted laterite soils

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Keywords: Tropical soil, laterite soil, dry density, water content, consolidation, double oedometer, triple oedometer

The climate of every region creates specific environment conditions. One of the most effective conditions of the environment, particularly in Malaysia, is its humidity level. The climatic zones where tropical soils occur are often characterized by alternate wet and dry seasons. Laterites are soil types which are rich in iron and aluminum, formed in hot and wet tropical areas. In Malaysia, residual laterite soils occur extensively. Evaluation of consolidation of compacted soils is significant issue for the analysis, design and performance of geotechnical works. This paper has explained an experimental work carried out to evaluate the effects of initial water content and dry density on the consolidation of compacted laterite soil. The representative laterite soil samples were collected at a depth of 1.7 m from UTM campus area in Johor. First, X-Ray Diffraction analysis was carried out on some specimens. Then the laterite soil samples were tested under medium degree of compaction with various water content and dry densities. The first two series of soil samples were compacted to a dry density of 1.2 Mg/m^3 (relative compaction 85%) at water content of 22% (8% dry of OMC) and 42% (12% wet of OMC). Also two other series compacted to densities of 1.31 Mg/m^3 (natural condition) and 1.41 Mg/m^3 (maximum dry density) for series 3 and 4 respectively. Single and double Oedometer tests, as a new triple Oedometer, were accomplished on three identical samples of the laterite soil in conventional Oedometer. The results indicate that the influence of initial water content on coefficient of consolidation c_v is less significant for the low dry density and the high vertical loads. However, in the same dry density and vertical load condition, the sample with higher initial water content value illustrated an increase in c_v of up to 5 percent.

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Paper P1-11

The stabilization of subgrade in tropical soils using chemical stabilisers

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Keywords: Tropical road, soil stabiliser, shredded tire, waste polymer, laterite soil, clay, sulfonated oil, subgrade

Roads have essential and important role in the development of a country and most of the transportation and services are done via roads. Therefore quality of roads is important. Pavement level is a very important part of the road structure, which could cause safe and fast transportation. Less important roads in many country are not completed to the pavement level and are called unpaved roads. There are many unpaved roads in Malaysia, especially in Johor and due to the rapid development in Malaysia, more unpaved roads will be established. Often these roads are built to make a faster and better access to local villages or not populated areas. During the construction of unpaved roads, many problems arise. Some of the major problems are the deterioration of the surface, diffusion of dust on the road and maintenance problems of road surface under the wet and dry cycles. Furthermore, road repairing and maintenance is difficult and have a costly procedure that is also disruptive to the traffic flow. Therefore, stabilization of local road materials in some crowded areas is necessary during the construction, which could be accomplished by several methods. One of the potential solutions is by using chemical additives to the soil. These chemical materials, including waste polymer compounds, cements or ordinary chemical compounds such as lime and some sulfuric acid treated mineral oil. So far, there are many research done in the world and reported as papers in the geometrical journals. The purpose of this study is the development of the geotechnical strength properties of Johor unpaved road materials using selected available chemical compounds as soil stabilisers. The behavior of the soil stabilisers were tested to determine their influence in improving the strength of unpaved roads. This experimental was a function of laterite soil and clay for a limited range of soil stabilisers under wet and dry cycles. The effectiveness was tested over a certain period. In this study, also, the compactability of the material was recorded during the curing time to evaluate the influence of stabilisers. After collection and analysis of the results, it is shown that the mentioned stabilisers are able to improve the strength behavior of subgrade material under certain conditions. It was found that the sulfonated oil-treated materials had an increase in strength over the test period, and it was concluded that these stabilisers need a curing time of a few dry months to reach their maximum strength. The materials treated with the waste polymer and shredded waste tires gained their highest strength within two months after construction. Moreover, the sulfonated oil-treated material seemed better when applied for a clay material containing a reactive clay mineral. The waste polymer materials and shredded waste tires showed no material-specific properties. Finally, these chemical stabilisers can be recommended for using on low cost unpaved roads to reduce construction and maintenance costs, ensure that the unpaved roads remain drivable in rainy weather and dust-free in dry conditions.

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Paper P2-12

Faktor bencana banjir di Daerah Pitas, Sabah

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Kata kunci: hujan kumulatif, topografi rendah, morfologi sungai, air pasang surut

Ringkasan

Daerah Pitas merupakan suatu kawasan yang selalu dilanda bencana banjir seperti yang telah berlaku pada tahun 2006, 2007, 2008, 2009, 2010 dan 2011. Banjir ini telah menyebabkan kemusnahan harta benda dan kehilangan nyawa. Banjir 2009 merupakan banjir paling teruk kerana telah meyebabkan kerugian sehingga RM 10 juta. Untuk mencari penyelesaian bagi bencana banjir ini, satu kajian telah dilakukan di kawasan Pekan Pitas. Kajian ini adalah bertujuan untuk mengenalpasti faktor-faktor yang menyebabkan banjir dan menentukan kawasan yang berpotensi mengalami banjir. Antara faktor-faktor penyebab banjir adalah jumlah hujan kumulatif yang tinggi untuk beberapa hari yang berlaku pada musim monsun Timur, topografi yang rendah, morfologi sungai iaitu sungai bermeander dan cetek dan pengaruh air pasang surut dari laut. Antara kawasan yang sangat berpotensi dilanda banjir adalah Kampung Kusilad, Kampung Kabatasan, Kampung Kemiri, Kampung Sibaung, Kampung Feri, Kampung Kalumpang Pantai, Kampung Taka dan Kampung Pondoi.

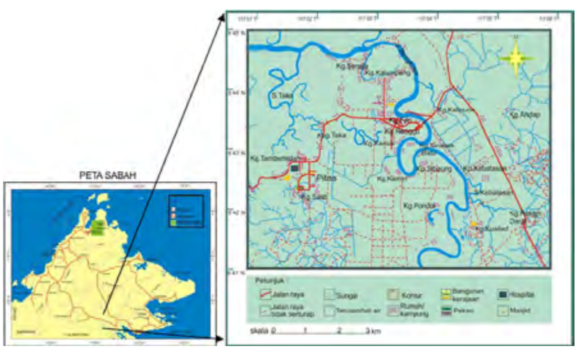
Pengenalan

Banjir dirumuskan sebagai bencana alam yang paling kerap berlaku di Malaysia. Banjir boleh didefinisikan sebagai aliran air sungai yang deras dan mempunyai ketinggian yang lebih tinggi dari ketinggian sungai sehingga sungai tidak mampu untuk menampung dan berlaku limpahan air di sekitar sungai (Gupta, 1979). Secara umumnya punca kejadian banjir yang melanda di negara ini adalah disebabkan oleh keamatan hujan yang tinggi pada setiap kali pertukaran musim monsun yang melanda dua kali dalam setahun. Hujan lebat pada musim monsun akan lebih kerap berlaku dari biasa (Yap, 2007). Banjir secara am adalah tidak bahaya dalam semua konteks pada semua masa ini kerana banjir yang berlaku di kawasan paya bakau yang tidak didiami orang bukannya bahaya (Chan, 1995). Corak sosio-ekonomi masyarakat Malaysia yang juga secara tradisinya gemar menghuni kawasan muara dan sepanjang tebing sungai selain di kawasan-kawasan dataran banjir juga meningkatkan lagi jumlah kehilangan nyawa dan harta benda setiap kali banjir melanda. Oleh itu satu kajian mengenai bencana banjir perlu dilakukan bagi mengurangkan risiko dan kemusnahan akibat banjir. Kajian banjir ini lebih terarah kepada faktor-faktor yang menyebabkan banjir berlaku di kawasan kajian. Pengenalpastian faktor-faktor banjir membolehkan kawasan yang berpotensi dilanda banjir ditentukan. Kawasan kajian adalah terletak di dalam Daerah Pitas yang berada di bahagian utara Sabah iaitu kira-kira 195 kilometer dari Kota Kinabalu yang dibatasi oleh garis lintang 06^{o} 41’ Utara hingga 06^{o} 45’ Utara dan garis bujur 117^{o} 00’ Timur hingga 117^{o} 06’ Timur dan luas kawasan kajian adalah 71.25 km^{2}. Sungai Bengkoka merupakan sungai utama bagi kawasan ini yang berpunca dari kawasan tanah tinggi di selatan Pitas dan mengalir di sepanjang kawasan rendah di utara Pitas sebelum berakhir di Teluk Marudu.

Kaedah kajian

Kajian faktor-faktor bencana banjir di kawasan kajian terbahagi kepada tiga fasa iaitu Fasa Pengumpulan dan Penyediaan Data, Fasa Kerja Lapangan dan Fasa Analisis Data. Fasa Pengumpulan dan Penyediaan Data menumpukan kepada pengumpulan maklumat kejadian banjir yang pernah berlaku di kawasan Pitas terutamanya melibatkan Sungai Bengkoka dari laporan akhbar lama mahupun laporan-laporan rasmi dari jabatan kerajaan atau majlis kerajaan tempatan seperti Pejabat Daerah Pitas dan Jabatan Pengairan Saliran Sabah. Data-data hidrologi seperti data hujan, data luahan sungai dan data ketinggian paras air sungai juga diperolehi dari Jabatan Pengairan dan Saliran Sabah. Data jadual pasang surut air diperolehi dari Tentera Laut Diraja Malaysia. Pemerhatian menggunakan fotoudara yang diperolehi dari Jabatan Tanah dan Ukur Sabah juga dilakukan bagi memerhati perubahan bentuk Sungai Bengkoka bagi beberapa tahun yang lepas dengan yang terkini.

Pada Fasa Kerja Lapangan, kajian soal selidik dijalankan ke atas penduduk kampung yang terlibat



Rajah 1: Peta kawasan kajian di Daerah Pitas.

dengan banjir bagi mendapatkan maklumat dari pengalaman penduduk tempatan sendiri seperti banjir yang paling teruk pernah berlaku, ketinggian air banjir dan punca-punca banjir. Di lapangan, pemerhatian terhadap kawasan yang sering dilanda banjir dilakukan bagi mengetahui dengan lebih lanjut punca banjir. Ketinggian paras air banjir dan jarak rumah dari sungai juga turut diukur. Pemerhatian terhadap morfologi sungai seperti kelurusan meander sungai juga dilakukan. Geomorfologi tempatan khususnya kawasan-kawasan rendah atau dataran banjir di kawasan kajian juga diteliti.

Fasa Analisis Data adalah fasa di mana data-data yang diperolehi dari Fasa Pengumpulan dan Penyediaan Data dan Fasa Kerja Lapangan dianalisis. Data hujan dan sejarah banjir dianalisis dengan menghasilkan graf hujan lawan masa pada tempoh masa suatu kejadian banjir dengan menggunakan perisian Microsoft Excel. Morfologi sungai dianalisis dengan pemerhatian perubahan bentuk Sungai Bengkoka pada setiap 10 tahun dari tahun 1960-an hingga sekarang. Kajian topografi kawasan dilakukan dengan menggunakan perisian Global Mapper dan menggunakan peta ketinggian digital iaitu DEM (*Digital Elevation Map*). Dengan menggunakan perisisan ini, kawasan yang bertopografi rendah dan tinggi dapat dikenalpasti.

Hasil dan perbincangan

Berdasarkan Rajah 2, didapati bahawa curahan hujan terkumpul atau kumulatif selama beberapa hari telah menyebabkan banjir. Curahan hujan yang tinggi pada satu hari melebihi purata hujan bulanan normal bagi kawasan Pitas. Data hujan dari Stesen Kobon yang terletak di kawasan hulu menunjukkan hujan terkumpul yang sangat tinggi berbanding dengan data hujan dari Stesen Pitas. Curahan hujan terkumpul bagi Stesen Pitas menunjukkan curahan hujan yang tinggi semasa banjir manakala dari Stesen Kobon adalah sebelum banjir. Luahan sungai yang banyak dari hulu akibat dari curahan hujan kumulatif ini menyebabkan banjir di Pitas. Banjir bertambah teruk dengan bertambahnya curahan hujan di kawasan Pekan Pitas. Rajah 3 menunjukkan pengaruh pasang surut air laut, morfologi sungai dan topografi rendah terhadap bencana baanjir di Pitas. Apabila air laut pasang, air sungai tidak dapat mengalir terus ke laut dan menyebabkan air sungai melimpah ke sekitar tepi sungai. Kampung yang berkedudukan hampir dengan laut boleh mengalami banjir disebabkan air laut pasang seperti Kampung Senaja dan Kampung Taka. Selain itu, topografi rendah turut memainkan peranan penting sebagai salah satu faktor bencana banjir kerana kawasan yang landai dan rendah lebih berisiko dilanda banjir kerana air sungai boleh melimpah di kawasan yang luas jika kawasan landai. Kebanyakkan kampung di Pitas berkedudukan hampir dengan sungai dan terletak pada ketinggian lima meter dari paras laut terutamanya Kampung Kusilad, Kampung Kusilad Ladang dan Kampung Taka. Morfologi sungai seperti meander dan sungai cetek juga merupakan faktor banjir berlaku di Pitas ini kerana Sungai Bengkoka merupakan sungai yang mencapai peringkat tua di mana terdapat banyak meander dan meander yang telah putus menjadi tasik ladam. Terdapat juga meander sungai yang sangat lengkung dan dijangka akan putus pada masa akan datang. Kampung yang terletak berhampiran kawasan meander lebih berpotensi dilanda banjir kerana air sungai mudah melimpah kerana halaju air adalah tinggi ditambah lagi air sungai selalu menghakis tebing meander sungai. Kampung yang berpotensi dilanda banjir akibat morfologi sungai yang bermeander ini adalah Kampung Sinasak Batu, Kampung Kemiri, Kampung Sibaung, Kampung Feri, Kampung Kerasik dan Kampung Kalumpang Pantai. Sungai Bengkoka di kawasan hilir lebih cetek berbanding di kawasan hulu dan ini juga menyebabkan banjir berlaku kerana sungai tidak dapat menampung isipadu air sungai semasa curahan hujan yang tinggi.

Kesimpulan

Secara kesimpulannya, kejadian bencana banjir di Daerah Pitas terutamanya kawasan Pekan Pitas dan kawasan yang berhampiran dengan Sungai Bengkoka adalah disebabkan beberapa faktor. Faktor-faktor yang mempengaruhi banjir di kawasan ini adalah curahan hujan kumulatif tinggi yang berlaku pada bulan Disember hingga Februari iaitu dalam musim monsun Timur Laut, pengaruh pasang surut air laut, topografi kawasan yang sangat rendah dan morfologi sungai.

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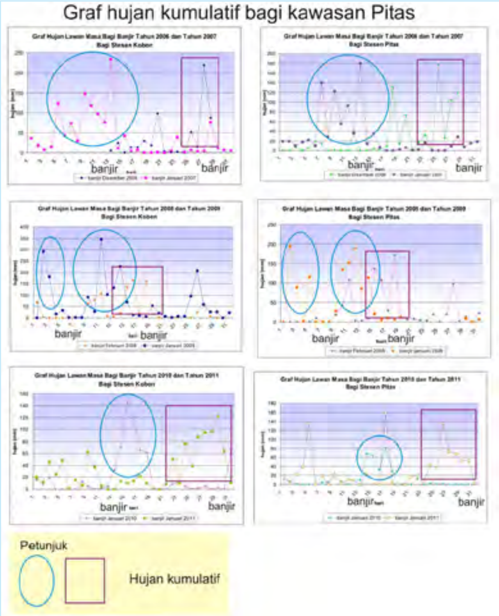
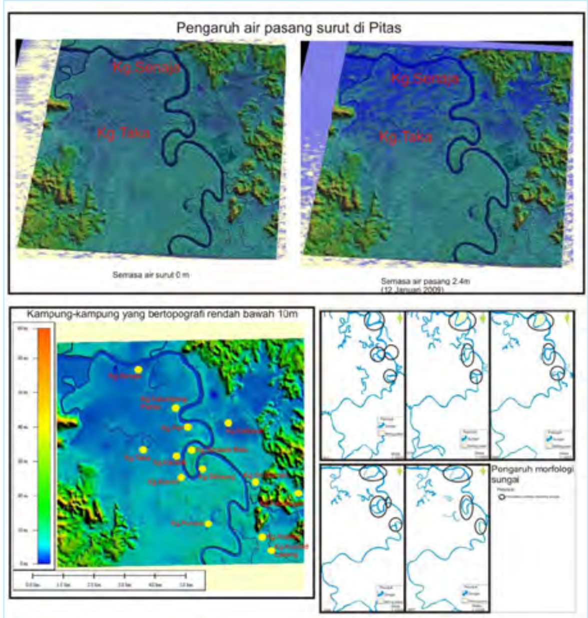


Rajah 2: Graf hujan kumulatif bagi kejadian banjir di Pitas dari tahun 2006 hingga 2011.



Rajah 3: Pengaruh pasang surut air, topografi rendah dan morfologi terhadap bencana banjir di Pitas.

Paper P2-13

Pengaruh morfologi keatas kejadian banjir di kawasan pekan Beaufort, Sabah

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Beaufort adalah salah satu daerah yang sering dilanda banjir di negeri Sabah. Banjir di sini berkait rapat dengan monsun Timur Laut yang berlaku pada bulan November hingga Mac setiap tahun. Hujan kumulatif yang tinggi dalam kawasan tadahan Sg. Padas yang sangat besar, iaitu 8,800 km², merupakan punca utama terjadinya banjir besar seperti yang berlaku pada tahun 1981, 1985, 1996, 2000, 2002, 2006, 2007, 2008, 2009 dan 2011. Banjir yang berlaku pada bulan Mac 2009 mengakibatkan kerugian infrastruktur yang memerlukan kira-kira RM1 juta untuk proses pemulihan selain telah menjejaskan aktiviti pertanian dan penternakan di beberapa buah kampung (New Sabah Times, 2009). Antara kawasan-kawasan yang sering dilanda banjir adalah seperti Pekan Beaufort Utara, Kg. Cina, Kg. Bekalau , Kg. Jimpangah, Kg. Luangan Beruang, Kg. Luangan Sanginan, Kg. Selagon, Kg. Pintas, Kg. Malalugus dan Kg. Bingkul . Banjir tertinggi yang pernah dicatatkan berlaku pada bulan Februari 1997 yang mencapai ketinggian hingga 9.82 m di atas paras laut, melibatkan Kg. Luangan Senginan dan Kg. Luangan Beruang.

Selain daripada pengaruh hujan monsun Timur Laut yang tinggi, banjir di kawasan ini juga dikaitkan dengan keadaan bentuk morfologi kawasannya yang landai dan hampir rata. Daerah Beaufort secara amnya bertopografi rendah namun semakin berbukit-bukau apabila menghala ke timur kawasan kajian. Kawasan perbukitan ini terdiri daripada Formasi Crocker. Sungai Padas merupakan sungai utama yang mengalir dari arah timur ke barat di Laut China Selatan. Kajian yang dijalankan oleh Jabatan Mineral dan Geosains (2002), mendapati dataran banjir Sungai Padas merupakan endapan aluvial sungai yang terdiri daripada pasir, liat dan lodak serta sedikit bahan organik. Berdasarkan kajian yang dijalankan oleh Jabatan Pengairan dan Saliran Sabah, (1996), didapati bahawa 50% daripada 50,000 populasi penduduk Beaufort tinggal di kawasan dataran banjir Sg. Padas yang sering diancam masalah banjir ini.

Analisis topografi menggunakan data *remote sensing* iaitu *Digital Terrain Model* (DTM) yang mempunyai ketepatan hingga 1.0 m menegak dan 2.0 m mendatar telah dijalankan. Kontur daripada DTM ini diekstrak menggunakan perisian Global Mapper v10.0 dengan selang antara kontur adalah 1m (Rajah 1). Global Mapper digunakan untuk menghasilkan imej 3D limpahan air berdasarkan paras banjir tertinggi untuk satu-satu peristiwa banjir yang pernah berlaku dan direkodkan oleh Jabatan Pengairan dan Saliran daerah Beaufort. Imej ini dapat memeberikan gambaran kawasan yang dilimpahi air yang mana dikawal oleh bentuk muka bumi dan topografi kawasan tersebut, (Rajah 2). Beberapa buah kampung di sekitar kawasan Pekan Beaufort sangat berpotensi dan beisiko dilanda banjir berdasarkan analisis topografi ini. Kampung-kampung tersebut terletak berhampiran dengan Sg. Padas dan mempunyai ketinggian kurang daripada 10 meter dari paras laut, (Rajah 3).

Daripada analisis peta topografi beresolusi tinggi ini, dianggarkan hampir 10% bertopografi di bawah 5 meter dari paras laut, 60% di bawah 10 meter, manakala 30% terdiri daripada topografi di atas 10 meter hingga 174 meter. Kawasan yang sering dilanda banjir adalah kawasan bertopografi di bawah 10 meter daripada paras laut. Data topografi ini berguna untuk kajian berkaitan dengan risiko banjir dan boleh digunakan untuk mencari langkah yang lebih efektif untuk menghadapi dan mengatasi masalah banjir di kawasan tersebut.

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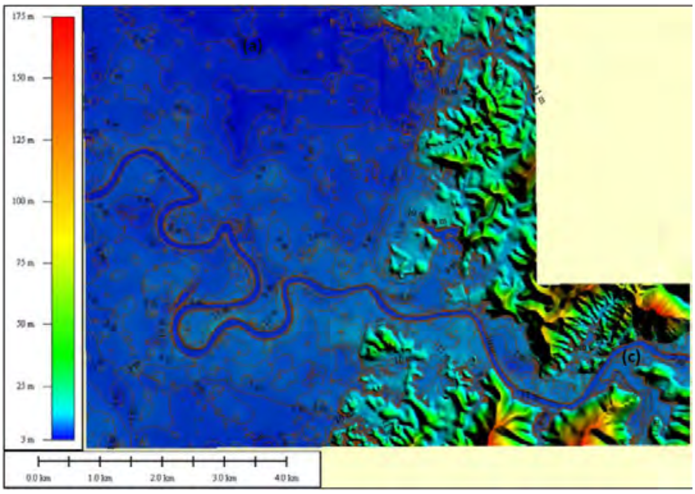
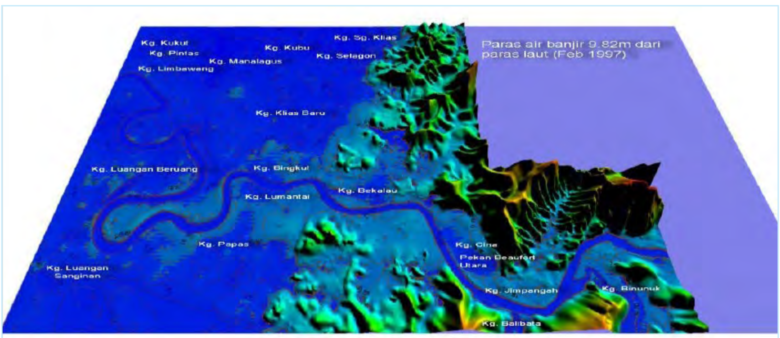


Rajah 1: Kontur selang 1 meter untuk kawasan Beaufort yang diekstrak daripada data remote sensing Digital Terrain Model.



Rajah 2: Imej 3D limpahan air banjir yang dikawal oleh topografi kawasan kajian berdasarkan paras air banjir 9.82m dari paras laut yang berlaku pada bulan Februari 1997.

Rajah 3: Kawasan-kawasan yang bertopografi di bawah 10 meter dari paras laut.

Paper P2-14

Organic matter distribution and preservation in modern environments: Sedili Besar estuary and offshore area case studies

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The aim of this study is to determine the source rock potential of the different depositional facies identified using the integration of sedimentology and biostratigraphy within the Sedili Besar estuary. Essentially, the interpretation of source rock potential takes into account the organic matter (OM) productivity, and preservation during deposition, as well as the distance during transport of the organic material from its source to the environment of deposition.

Results from both Sedili Besar study area show that the quantity and quality of OM being deposited and preserved in the sediments depend, to a certain extent, on the distance of the source of OM and the environment of deposition, and the preservation condition during deposition. This is because in both areas, the main component of OM being deposited in these environments is the higher land plant present in great abundance farther upstream. During transportation from the source to the environment of deposition, the OM would undergo degradation and oxidation, thus reducing the quality of the OM. While the OM is being deposited, it would be further subjected to either oxic or anoxic condition within the environment of deposition. Coupled with the sedimentation rate and grain size of the sediments it would influence the preservation of the OM during deposition.

The distance of OM transportation can be clearly demonstrated in the Sedili Besar estuary study area where the fluvial channel recorded an average total organic carbon (TOC) content of 1.89 wt% compared to 0.51 wt% in the shoreface and offshore areas. Furthermore, in the shoreface and offshore areas, the transported organic matter that reaches the open marine is being dispersed into a larger and open environment of deposition and is therefore being diluted. Despite the relatively lower quantity of organic matter content in the distal environment (shoreface and offshore) compared to the proximal (fluvial channel), the resultant quality of organic matter between the two environments is almost equivalent. This is indicated by Hydrogen Index values of 133 and 144, respectively. This is simply because of the better preservation of organic matter in the offshore environment compared to the fluvial and possibly complemented by contribution from marine organisms such as phytoplankton. Furthermore, the oxidation level in the open marine with finer grain size is lower than those of the fluvial channel.

Paper P2-15

Pengaruh zon sesar keatas kerosakan jalan raya di kawasan Kundasang-Ranau, Sabah

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Kata kunci: tanah tinggi, kerosakan jalan raya, zon lemah, sesar, lineamen

Sesar merupakan retakan yang mempunyai pergerakan ketara yang selari dengan satah retakan. Sesar itu dikatakan aktif apabila berlaku pergerakan di sepanjang satah sesar dalam masa 120 000 tahun dahulu dan berkemungkinan besar bergerak lagi pada masa akan datang. Bukti-bukti sesar aktif boleh dilihat melalui permukaan bumi yang mengalami pergerakan secara berulang kali. Pergerakan sesar ini walaupun hanya beberapa sentimeter setahun sudah cukup untuk merosakkan struktur binaan seperti jalan raya, bangunan dan juga landasan kereta api. Kawasan yang mempunyai sesar aktif boleh ditentukan berdasarkan intensiti gempa bumi dan tanah runtuh yang pernah berlaku. Sehingga Julai 2010 Jabatan Meteorologi Negara telah mencatatkan sebanyak 336 gempabumi yang berlaku di Malaysia dan Sabah merupakan negeri ketiga tertinggi dengan jumlah 40 kes selepas Pulau Pinang.

Kawasan Kundasang-Ranau merupakan kawasan tanah tinggi yang sering mengalami kerosakan jalan akibat susutan tanah atau runtuhan tebing. Sepanjang tahun 2008 JKR telah merekod 39 kerosakan jalan raja pelbagai skala. Sebahagian besar kerosakan jalan ini adalah berkaitan dengan masalah kejuruteraan, dimana jalan dibina dikawasan tebing yang sangat curam. Selain daripada masalah kejuruteraan satu kemungkinan penyebab kerosakan jalan disini adalah kewujudan zon lemah akibat kehadiran sesar yang merentasinya. Kajian keatas petageologi, petatopografi, fotograf udara dan imej satelit mendapati bahawa kawasan Ranau-Kundasang menunjukkan beberapa trend lineamen negative pada arah seperti Barat Laut-Tenggara, Utara-Selatan dan lain-lain. Lineamen negative ini berkemungkinan mewakili zon sesar. Pemerhatian dilapangan mendapati bahawa zon sesar biasa dijumpai dalam unit batuan Formasi Trusmadi yang mendasari kawasan Kundasang-Ranau. Data kerosakan jalan raya telah diperolehi daripada Jabatan Kerja Raya dan kerja lapangan yang dilakukan menunjukkan bahawa terdapat kaitan antara kerosakan pada jalan raya dengan jurus lineamen.

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Paper P2-16

The Sabha clay deposit, Libya: Its mineralogy and impending industrial significance

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This research paper gives attention to the mineralogical and physical characterisation of Sabha clays from Libya. Apart from that, the impending of the Sabha clays to industrial application was also evaluated. The Sabha clays are geologically linked to Messah Formation of Jarmah Member and the industrial significance was not tested yet. Mineral recognition and characterization studies were accomplished using X-ray diffraction (XRD), differential thermal analyses/thermo gravimetric analyses and scanning electron microscopy with an energy dispersive X-ray spectrum (SEM-EDX) technique. Physical test such as plasticity, colour, brightness, pH, cation exchange capacity and water content were also performed. Based on the analyses, the Sabha clays is composed of kaolinite as its major phyllosilicate, whereas quartz occurs in minor amounts and could be used for industrial application.

Paper P2-17

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

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

The study area is located in a horst bounded by two parallel NE-SW trending faults 4.5km apart. The gently folded Ransi Conglomerate Member that is located at the base of the Tatau Formation, sits above an angular unconformity that separates it from the underlying more tightly folded Belaga Formation.

The Ransi Conglomerate Member is made up of mostly thick bedded conglomerate and sandstone interbedded with thin shale horizons. The conglomerate in Tutong Hill, Tatau Hill and Ransi Hill are mainly composed of pebbles of angular to sub-angular clasts of chert, quartz, igneous and metamorphic fragments. The igneous clasts are composed of dacite similar to that in the Middle - Upper Eocene igneous intrusion at Bukit Piring in the Tatau Area. A very thick black carbonaceous horizon was found at the Hormat Pacific Quarry, to the northeastern part of Tatau Hill. Victrinite reflectance from the coal of this carbonaceous horizon is similar to that of the Tatau Formation but higher than that of the younger Nyalau and Balingian Formations. Cross-bedded sandstone channels are dominant in the Ransi Conglomerate Member.

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

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Paper P2-18

Effects of fault deformation on the quality of granite aggregates

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Peninsular Malaysia is cut by several major fault zones (Mustaffa, 2009) and numerous smaller faults have also been identified, particularly in areas underlain by granite. Faulting has generated a diverse variety of deformed granites and caused severe straining and grain size reduction of the granites (Ng, 1994).

In Peninsular Malaysia, granitic rocks are the most important source of construction aggregates. About three-quarters of the crushed rock aggregates are produced from granites. Granite is the dominant granitic rock in most quarries, but significant microgranite and minor pegmatites occur in some quarries. The quality of the granitic aggregates is influenced of by alteration, weathering and deformation. In this study, the effects of fault deformation on the quality of granite aggregates are assessed by comparing the mechanical and physical properties of undeformed granitic aggregates with mylonitic and cataclastic granites formed by faulting.

About 150 *in-situ* rock samples were collected from 43 locations in Selangor, Negeri Sembilan, Pahang and Kuala Lumpur. After preliminary examination, samples consisting of 17 undeformed granite (Group 1), 13 mylonitic granite (Group 2), 3 cataclastic granite (Group 3), 10 undeformed microgranite (Group 4) and 1 cataclastic microgranite (Group 5) were crushed and sieved for aggregate tests. Although fault breccia and fault gouge are common, these incohesive fault rocks that are usually removed as scalpings in the quarrying process, are not tested.

Group 1 – The is the most common rock used in the production of aggregates in the study area. Generally, the rocks of Group 1 are grey, coarse grained, moderately megacrystic, slightly to moderately discoloured, slightly to moderately altered, biotite-muscovite GRANITE. Rocks of this group contain 5% to 20% of K-feldspar megacrysts, mainly 2 to 3 cm in length. The hypidiomorphic to allotriomorphic groundmass is predominantly coarse grained and comprises mainly quartz (21% - 32%), K-feldspar (25% - 46%) and plagioclase (15% - 36%), with minor biotite (3% - 18%) and muscovite (up to 5%).

Group 2 – Two samples of this group are mesomylonite from the well-defined Bukit Tinggi Fault Zone. The rest of the samples are protomylonites from 0.5 to 1 m thick fault zones within the Kuala Lumpur Granite pluton. Generally, rocks of Group 2 are mainly grey, medium to coarse grained, moderately porphyroclastic, slightly to moderately discoloured, slightly to moderately altered, biotite-muscovite mylonitic GRANITE. They contain 5% to 30% of K-feldspar porphyroclasts with size ranging from 1 cm to 5 cm. The groundmass is predominantly coarse grained. It contains quartz (21% - 38%), K-feldspar (34% - 58%), plagioclase (17% - 30%) and biotite (2% - 12%).

Hand specimens of protomylonitic granite often appear similar to the undeformed granite, but microfaulting of feldspar porphyroclasts, flattening and stretching of quartz and mica grains can be seen on closer inspection. Foliation is vague and only small amount of recrystallised matrix is present. Foliation is weak but can be clearly seen in the mesomylonitic samples. Microscopic examination shows mortar texture and strain microstructures that are related to brittle-ductile deformation.

Group 3 – The cataclastic granite occurs in fault zones up to a few meters wide and usually can be recognised with ease from the undeformed granite. The rocks in the fault zones are commonly darker due to chloritisation and grain size reduction, and have fragmental texture and abundant fissures. Generally they are greenish grey to grey, medium to fine grained, highly discoloured, and moderately altered, biotite-muscovite cataclastic GRANITE. Two samples are very hard and sound and one is hard but breaks easily with a blow of the geological hammer, along the abundant fissures and chlorite veins.

They consist mainly of angular to subangular quartz and feldspar clasts enclosed by fine matrix composed of quartz and feldspar clasts, sericite, chlorite and opaque minerals. The coarse clasts contain abundant microfractures, which may be healed or filled by the matrix and secondary minerals. The cataclastic granites are deformed in the brittle regime where microbrecciation is the main cause of grain size reduction.

Group 4 – The microgranite is light grey to grey, medium grained, slightly discoloured, non-megacrystic to slightly megacrystic, moderately sericitised muscovite MICROGRANITE. Three samples were collected from microgranite-pegmatite bodies and have weak compositional banding (Ng, 1997). This group of rocks contains mainly quartz (18% - 34%), alkali feldspar (26% - 32%) and plagioclase (24% - 34%), with minor amounts of muscovite and biotite (2% - 6%) and tourmaline (up to 6%).

Group 5 – Cataclastic microgranite is not common and is only observed to form a 2 m wide fault zone in Perkuat Quarry. The sample collected is a greenish grey, medium grained, highly discoloured, moderately altered, cataclastic MICROGRANITE. The sample is very hard although it is highly discoloured and contains abundant healed fractures. Under the microscope, fragmental texture is conspicuous. The angular to subangular clasts of quartz, alkali feldspar and plagioclase are enclosed by about 20% of fine matrix.

The aggregates are tested for flakiness index If, aggregate impact value AIV, aggregate crushing value ACV, ten percent fines TFV, Los Angeles abrasion value LAAV, magnesium sulphate soundness value MSSV, water adsorption W and relative densities (oven dried, saturated and apparent). Petrographic analysis was carried out to determine the mineral contents, grain size, intensity of deformation and alteration.

Results of the physical and mechanical tests are summarised in Table 1. There is no significant reduction in mechanical performance between the undeformed and deformed granitic aggregates. The physical properties are also similar, apart from grain size, which is significantly finer in the cataclastic granite and cataclastic microgranite compared to the protoliths. The similarities in physical and mechanical properties of the undeformed and mylonitic granites are not unexpected. Although microfractures occur in feldspars, the grain boundaries of the mylonitic granite are interlocked and strongly bonded. Despite having fragmental texture, there is no significant reduction in mechanical performance cataclastic samples. This is probably due to the combination of grain size reduction (mechanical strength is inversely related to grain size) and cementation of the clasts and healing of microfissures by secondary minerals, especially quartz.

Some of the mylonitic and cataclastic granites contain significant amount of strained quartz, microcrystalline quartz and fine secondary sericite. Petrographic examination and accelerated mortar-bar test show that some of these fault rocks are potentially aggregate reactive and thus may not suitable to be used as concrete aggregates (Ng & Yeap, 2007; Ng, 2010).

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Table 1: Summary of the physical and mechanical properties of the five groups of granitic aggregates. n=number of samples; SD=standard deviation

Group	n	Mean grain size, mm			Flakiness Index, %			Elongation Index, %		
		range	mean	SD	range	mean	SD	range	mean	SD
Group 1	17	1.7 – 5.4	3.2	0.9	19 - 26	21	2	17 - 28	22	3
Group 2	13	1.8 – 5.4	3.6	1.4	18 - 26	21	3	16 - 22	19	2
Group 3	3	0.2 – 0.7	0.5	0.3	16 - 28	22	6	16 - 25	20	4
Group 4	10	0.7 – 1.4	1.1	0.2	23 - 28	26	2	18 - 30	23	4
Group 5	1		0.6			25			25	
Group	n	Aggregate Impact Value, %			Aggregate Crushing Value, %			Ten Percent Fines, kN		
		range	mean	SD	range	mean	SD	range	mean	SD
Group 1	17	19 - 26	22	2	21 - 27	24	2	120 - 170	145	15
Group 2	13	18 - 27	22	3	20 - 27	24	2	125 - 185	145	20
Group 3	3	13 - 28	19	8	15 - 26	19	6	120 - 230	190	60
Group 4	10	15 - 20	17	2	17 - 24	20	3	155 - 215	190	15
Group 5	1		20			21			160	
Group	n	Los Angeles Abrasion Value, %			MgSO4 Soundness Value, %			Water Adsorption, %		
		range	mean	SD	range	mean	SD	range	mean	SD
Group 1	17	26 - 39	31	3	93 - 96	95	1	0.3 – 1.1	0.56	0.22
Group 2	13	28 - 38	32	4	94 - 96	95	1	0.4 – 1.0	0.64	0.16
Group 3	3	24 - 40	29	9	94 - 95	94	1	0.4 – 1.2	0.71	0.43
Group 4	10	23 - 31	26	3	94 - 96	96	3	0.3 – 0.7	0.54	0.10
Group 5	1		31			95			0.6	
Group	n	Dry Relative Density, gcm^{-3}			Saturated Relative Density, gcm^{-3}			Apparent Relative Density		
		range	mean	SD	range	mean	SD	range	mean	SD
Group 1	17	2.57–2.67	2.62	0.03	2.59–2.68	2.64	0.02	2.63–2.71	2.66	0.02
Group 2	13	2.52–2.65	2.61	0.03	2.59–2.67	2.63	0.02	2.63–2.69	2.66	0.02
Group 3	3	2.56–2.64	2.61	0.04	2.60–2.66	2.63	0.03	2.65–2.67	2.66	0.01
Group 4	10	2.60–2.64	2.62	0.02	2.61–2.68	2.64	0.02	2.64–2.70	2.66	0.02
Group 5	1		2.63			2.65			2.67	

Paper P2-19

Permian foraminiferal assemblages from the limestone unit of the Gua Musang Formation in the Padang Tengku area, Pahang, Malaysia.

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Rich Middle to Late Permian smaller foraminifera occur in the limestone unit of the Gua Musang Formation (Middle Permian-Upper Triassic) (Mohd Shafeea Leman, 1993, 2004) which outcrops in the Selbourne Estate area, four kilometers northwest of Padang Tengku, Pahang, Central Malaysia. The geology of the area was investigated by one of us (Ng, 1986) in the frame of an Honours study in Applied Geology, University of Malaya and for the preparation of a detailed geological map of the area. It includes general geology and stratigraphy of the units mapped, mineralization and geological history of the area.

This study is concerned primarily with detailed geological mapping of the Padang Tengku area and biostratigraphic collection of the fossils occuring in the limestone. This limestone is bedded at its base and massive at the top. It consists of light to dark grey bioclastic wackestone locally rich in fragments of fenestellid bryozoans, brachiopods (shell and spines), and crinoids on the weathered surface and showing very fine and micritic texture when they are fresh. Chert nodules of variable sizes and shapes are frequent in most fossiliferous parts. The present collection allows integration of the coral-foraminifera faunas. The only one well preserved solitary rugose coral species (*Iranophyllum* sp.) was collected (Ng, 1986) from that limestone outcrop and we hope to find more corals in the present research. In this study, we identified 18 foraminiferal genera from a single limestone outcrop at Selbourne Estate locality. They comprise the genera *Tetrataxis, Reichelina, Climacammina*, *Geinitzina, Dagmarita, Pachyphloia, Globivalvulina, Paleotextularia, Ozawainella, Pseudokahlerina, Colaniella, Multidiscus, Tuberitina, Nodosinelloides, Deckerella, Frondina, Langella,* and *Maichelina*. Fusulinids are entirely absent, however, we are able to identify the affinity of the present smaller foraminiferal assemblages from Middle to Upper Permian (Upper Murghabian-Lower Midian) of East Peninsular Malaysia (Fontaine *et al*., 1988), to other successions such as: a limestone ridge, eastern part of Phra Nang Bay, Peninsular Thailand (Fontaine *et al*., 1994), the Plateau Limestone of the Lebyin area, eastern Myanmar (Tin Tin Latt et al., 2008), parts of the Middle Permian (middle Murgabian) Moulmein Limestone of the Zwekabin Range, Hpa-an township, Kayin State, southeastern Myanmar (Tin Tin Latt *et al*., 2011) and the Hambast region of Central Iran (Mohtat-Aghaï & Vachard, 2005). The foraminiferal assemblages of the limestone unit from the Padang Tengku area is thus tentatively assigned to late Middle to early Late Permian age.

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Paper P2-20

Evaluation of Lower Cretaceous Saar Formation as petroleum system in the Western Central Masila Basin, Republic of Yemen

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The Saar Formation is an attractive petroleum exploration target in the deeper part of the Masila Basin because it is favorably positioned with respect to source and seal units. Saar petroleum system was identified in the western central Masila Basin (Figure 1). During Early Cretaceous the sea level rose on a flat ground, resulting in marine transgression and sedimentation of widespread shallow marine carbonates of Saar Formation (Beydoun at el, 1998). These deposits unconformably overlie the Naifa Formation. In general, the Saar Formation is composed mainly of limestone, with some mudstone and sandstone, which were deposited in a restricted marine environment (Figure 2; King, 2003; Canadian Oxy Oil Company, 2001"personal communication"). Oil companies classified this formation into lower Saar carbonate and upper Saar clastic (Canadian Oxy Oil Company, 1999, 2000 and 2001"personal communication"). The lower unit of the Saar is characterized by the predominance of limestone, dolomite, mudstone, and marl. The upper part is mainly sandstone and limestone facies (Canadian Oxy Oil Company, 1999, 2000 and 2001"personal communication"). Shale samples from Saar Formation were analysed using organic geochemical analysis (Rock-Eval pyrolysis, bitumen extraction and biomarker distributions). An assessment, based on organic facies characteristics, has been carried out on these sediments, in order to distinguish, characterise and evaluate source rock deposited in marine deposition setting. The Saar shale samples generally contain TOC values less than 2.0 wt% and have been fair to good hydrocarbon potential. Kerogen is predominantly Type III with minor Type III-II. T_{max} values range from 430 to 443°C, indicating that the Saar samples are thermally mature for hydrocarbon generation. Biomarker approach here has been able to interpret the depositional environment of the Saar Formation in the Masila Basin. Biomarker parameters such as Pr/Ph, Pr/C_{17}, Ph/C_{18}, Tm/Ts and C_{29}/C_{30} hopane rations appear to reflect variation in depositional conditions and source input. Although there is a marine-derived organic matter in Saar sediments, whereby the Saar shale were deposited in a suboxic marine condition.

Reservoir rock characterization was conducted on the Lower Cretaceous Saar Carbonates using integrated results (petrographic, core and well log analyses). The Saar reservoir is composed mainly of carbonate rocks dominantly dolomite and limestone (Figure 3). The Saar carbonate rocks have good reservoir quality, where porosity reaches up to 8% as indicated by fracture and vuggy pores (Mohammed, 2011; Figure 3). However, the hydrocarbon potentiality is relatively low due to high water saturation, which was calculated from well log analysis (Mohammed, 2011; Figure 4). Saar carbonate reservoirs are sealed by shales and massive carbonate beds within the Saar Formation (Canadian Oxy Oil Company, 2000; PEPA, 2004 "personal communication").

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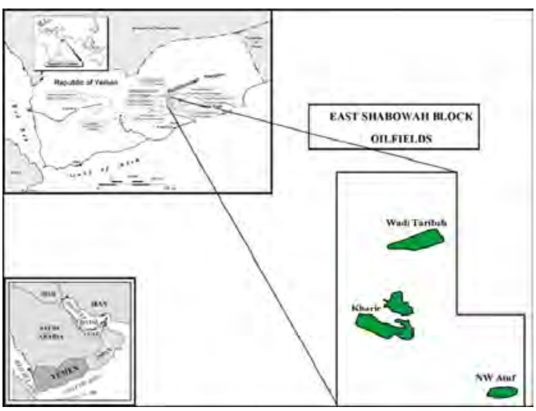

Figure 1: Location map of Masila Basin, showing the study area (East Shabowah Oilfields).

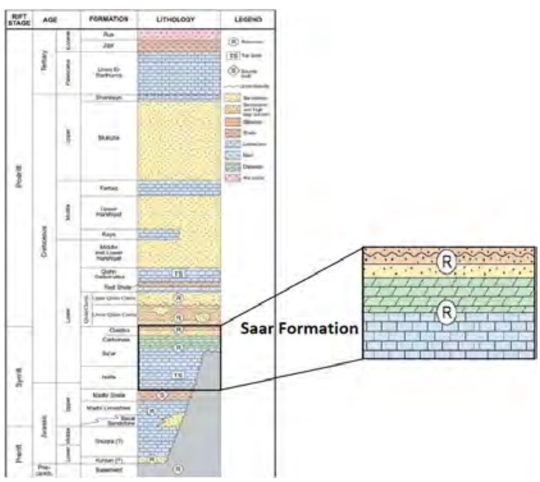

Figure 2: Regional stratigraphic nomenclature of Masila Basin, Republic of Yemen and showing Saar Formation (modified after King, 2003; Canadian Oxy Oil Company, 2001"personal communication".

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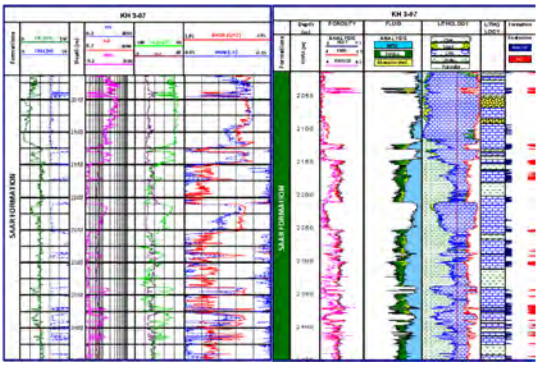

Figure 4: The corrected log datasets (left) and the litho-saturation cross-plot (right) illustrating vertical variations of the petrophysical characteristics of the Saar Formation studied in the KH 3-07 well.

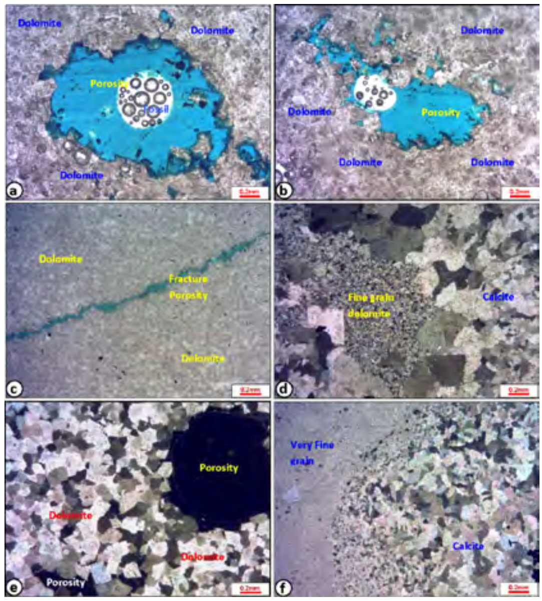

Figure 3: Features of petrographic reservoir characterization of the core samples studied from the Upper Saar Carbonate reservoir in NWATOF-001 well.

Paper P2-21

Kajian faktor banjir di Daerah Tenom, Sabah

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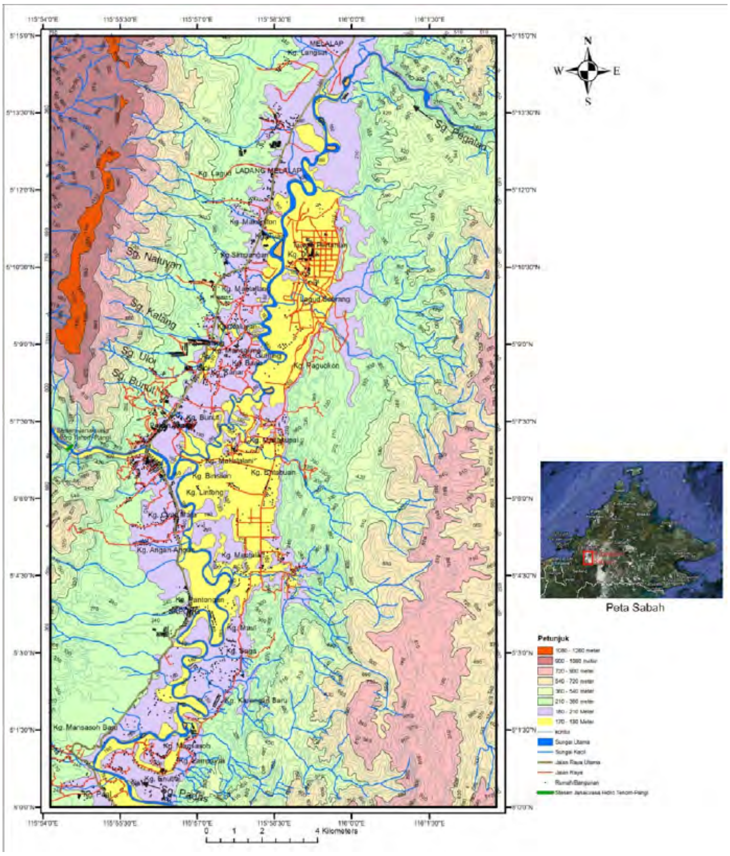
Kata kunci: Hujan lebat, topografi yang rendah, morfologi sungai, sistem perparitan yang kurang efektif, Stesen Janakuasa Hidro Tenom-Pangi

Daerah Tenom merupakan kawasan yang sering dilanda banjir. Setiap tahun Daerah Tenom dilimpahi banjir monsun seluas 14 km^2 (Jabatan Pengairan dan Saliran, 1996). Tujuan kajian dijalankan adalah untuk mengetahui kenapa banjir kerap berlaku di Daerah Tenom. Metodologi kajian terbahagi kepada analisis data sekunder dan kerja lapangan. Banjir di kawasan kajian dikawal oleh dua sungai utama iaitu Sungai Pegalan dan Sungai Padas dan juga beberapa sungai kecil yang terdapat di kawasan kajian (Rajah 1). Dua jenis banjir dikenalpasti iaitu banjir kilat dan banjir monsun. Kedua-dua jenis banjir ini dipengaruhi oleh proses semulajadi dan aktiviti manusia. Banjir monsun dipengaruhi tadahan yang besar, topografi yang rendah, morfologi sungai yang bermeander, operasi Stesen Janakuasa Hidro Tenom-Pangi dan sungai utama yang agak cetek. Tadahan kawasan kajian adalah besar yang berkeluasan kira-kira 8,000 km^2 yang meliputi hampir seluruh pedalaman Sabah iaitu dari Tambunan hingga sempadan Sabah-Kalimantan. Dataran Tenom terletak pada kawasan yang paling rendah sebelum Stesen Janakuasa Hidro Tenom-Pangi dengan ketinggian 170 meter hingga 200 meter dari paras laut purata. Morfologi sungai mempengaruhi kelajuan arus air sungai. Sungai Pegalan agak lurus dan sedikit bermeander bermula dari Keningau hingga Melalap yang sejauh kira-kira 17 km. Sungai Padas juga agak lurus bermula dari Kuala Tomani hingga Kampung Enubai di kawasan kajian yang sejauh kira-kira 20 km. Di Kawasan kajian pula, kedua-dua sungai utama berbentuk meander sehingga ke Pekan Tenom. Sungai utama yang cetek di kawasan kajian adalah akibat daripada beberapa faktor yang saling berkaitan seperti pembukaan hutan di sekitar kawasan kajian dan operasi Janakuasa Hidro Tenom-Pangi. Banjir kilat dipengaruhi hujan yang lebat, topografi setempat yang rendah, morfologi sungai kecil, sungai bersaiz kecil dan cetek, sistem perparitan yang kurang efektif. Sebanyak tiga kejadian banjir kilat di kawasan kajian telah berlaku iaitu pada 23 Januari, 13 Mac dan 14 Mac 2009 akibat jumlah hujan yang sangat tinggi. Kawasan banjir kilat terletak pada dataran yang bertopografi rendah di sekitar 180 meter hingga 200 meter dan berhampiran sungai utama iaitu kurang dari dua kilometer. Dari segi morfologi sungai, sungai kecil iaitu Sungai Naluyan, Sungai Kalang dan Sungai Uloi berbentuk agak lurus di bukit. Namun, apabila ketiga-tiga sungai ini bertembung menjadi Sungai Naluyan utama di dataran rendah (170-180 meter), sungai menjadi lebih bermeander. Sungai bersaiz kecil dan cetek menyebabkan sungai tidak dapat menampung kuantiti air hujan yang banyak. Sistem perparitan yang kurang efektif juga tidak dapat menampung air larian yang banyak pada masa kini kerana kecil dan cetek.



Rajah 1: Peta topografi kawasan kajian.

Paper P2-22

Geochemistry and petrogenesis of metamorphic rock along Simpang Pulai, Perak – Cameron Highland, Pahang road

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Introduction

This purpose of this research is to study and understand the petrological and geochemical aspects of the rock present at the study area. The metamorphic rocks occur as roof pendants on top of the Main Range batholiths. It is a small remnant of the original depositional system and the rest has been destroyed by the intrusion and denudation processes. Gobbet & Hutchison (1973) suggested that the original depositional system may be very far from the land because the absent of coarse clastic rock deposits. Mohd Azamie (2002) described the coexisting of miarolitic cavities containing tourmaline, indicates accumulation of volatiles near the batholith roof which were unable to escape because of the deep seated environment. Besides the igneous and metamorphic rocks, Quartenery to Recent alluvium deposits also present on the study area (Walker, 1956). The age of the rock on the study area has long been the debated topic that interest many geologists. Alexander (1965) had interpreted that the oldest rock in the study area is from the schist series, followed by arenaceous series then calcareous series. Bignell & Snelling (1979) share the same opinion. They stated that the oldest rock in the study area is schist that overlain by younger marble. They also suggested that the metamorphic rock was formed from the regional metamorphism, then the rock re-crystallized by contact metamorphism when the upper Triassic granite intruded during the Mesozoic orogenic phase. However, Ingham & Bradford (1960) stating that the oldest rock is the limestone deposits that continually deposited from Devonian to middle Permian. Scrivenor (1931) also interpreted that the marble is older than the schist that interbedded with slate. From the data gathered, it will be easier to identify the original depositional system that had been destroyed. Once the depositional system has been confirmed, then this research will be able to determine whether this rock was a part of petroleum system or not.

Objectives and methodology

There are several objectives that have been targeted to achieve in the end of this research:

- To identify the petrology and petrochemistry behaviour of the metamorphic rock.
- To determine the protolith of the metamorphic rocks.

Field study was conducted earlier in this research to gather all the raw data and sample were collected accordingly. The samples were made into thin sections and XRF analysis was also carried out. Interpretation was carried out by plotting the data into appropriate graphs.

Results and discussion

The schist present at the study area shows very clear and perfect schistocity. Individual mineral can be recognized and the segregation line is present. The schist at the study area have a few metamorphic grade indicator minerals. From microscope study of the thin section samples, there are 3 types of schist at the study area:

The first type is quartz-mica schist, which has lower grade metamorphism. The biotite found in the sample has started to form foliation. Muscovite occurs together with biotite and parallel to the foliation. Quartz in this sample had been strained and have a wavy extinction. Iron oxides also present in this sample as a accessory mineral (Figures 1 & 2)

The second type of schist that had been identified is quartz schist. The minerals of this samples is showing the same structure and features as the first one. The difference is the mineral percentage. This sample has a higher percentage of quartz of more than 80%. Biotite and muscovite are platy and form the foliations. There are some muscovite plates that are not parallel to the foliation, which are believed to be a second generation of the minerals (Figure 3)

The third type of schist found in the study area is garnet-mica schist. Garnet present in the sample as a fractured porphyroblasts. The presence of garnet has disturbed the schistocity of the schist that is formed by biotite and muscovite.

A total of 24 samples were sent to the laboratory for X-Ray Fluorescence analysis to determine the major elements for geochemical studies. Niggli numbers are calculated from the results, to be used in the later analysis. A few diagrams were built from the major element contents to find the correlation between the minerals and to identify the protoliths of the metamorphic rocks. The ACF and AKF triangular diagram was first introduced by Eskola (1915) to identify the minerals present in the metamorphic rock. Kurt Butcher & Frey (2002) also used the diagram to determined the protoliths of metamorphic rock based on the minerals plotted on the diagrams. AKF and ACF diagrams plotted to interpret the minerals assemblages are shown in Figure 4 and 5. All the diagrams and graphs used as suggest by Winkler (1974). A binary graph of log (Na_2O/K_2O) against log ($SiO_{2/}Al_2O_3$) is also plotted to determined the specific protoliths of the metamorphic rock (Figure 6). A binary graph of al-alk against c is plotted by using the calculated Niggli's number. The purposed of this graph is also to determined the origins of the metamorphic rocks (Figure 7).

Conclusion

From the microscopic and geochemical studies so far, the analysed geochemical data strongly suggest that the protoliths of the metamorphic rocks are from sedimentary rock, namely greywacke and arkose.

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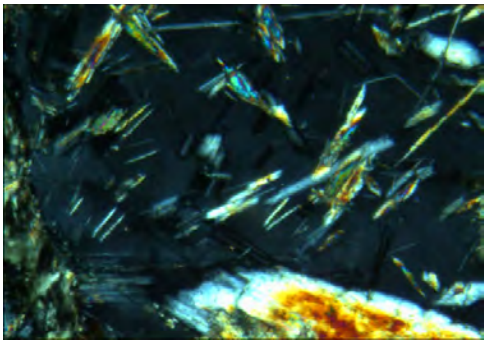

Figure 3: Muscovite in form of needle-like shape.

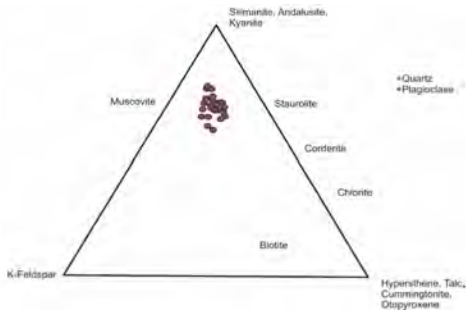

Figure 5: AKF ternary graph also plotted by using the major elements to identify the minerals present in the rocks.

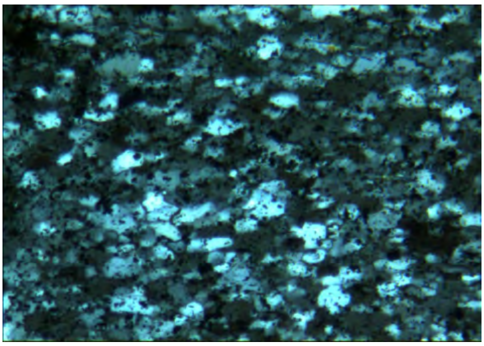

Figure 1: Photomicrograph showing that the schist is of intermediate metamorphism grade. Quartz in this sample had been sheared and has wavy extinction. Iron oxides also present in this sample as a accessory mineral.

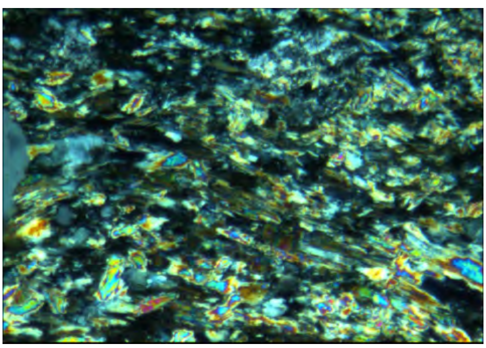

Figure 2: The biotite found in the sample has started to form foliation together with muscovite.

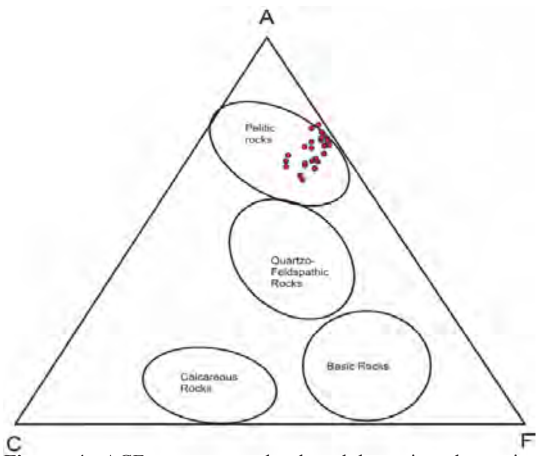

Figure 4: ACF ternary graph plotted by using the major elements.

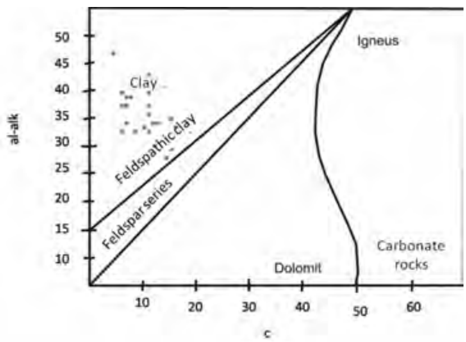

Figure 7: Binary graph of log (Na_2O/K_2O) against log (SiO_2/Al_2O_3).

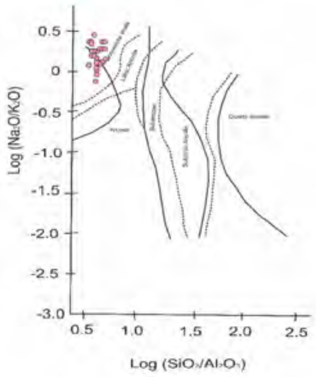

Figure 6: Binary graph of log (Na_2O/K_2O) against log (SiO_2/Al_2O_3).

Paper P2-23

A comparative study of the source rocks in the Shoushan Basin, Egypt and the Malay Basin, Malaysia

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This paper discusses the source rock quality of the Jurassic shales of the Khatatba Formation in the Shoushan basin, Egypt, and Tertiary shales in the Malay Basin, Malaysia (Figure 1; EGPC, 1992). The Khatatba Formation is composed mainly of shales and sandstones. These sediments are interpreted to deposit in a marine environment (Figure 2a; Schlumerger, 1984, 1995).

Lacustrine shales have been recognized as perhaps the single most oil-prone facies, especially in the Southeast Asian Tertiary basins (Cole and Crittenden, 1997). In the Malay Basin, it has been widely accepted that lacustrine shales are closely associated with the sediments of Groups K, L and M (Figure 2b; Petronas, 1999), which occur in the Oligocene/Early Miocene time. An assessment, based on organic facies characteristics, has been carried out on these sediments, in order to distinguish, characterize and evaluate source rocks deposited in different sedimentary basins. Organic matter content, type and maturity as well as some petrographic characteristics of the Jurassic source rock exposed in the Shoushan Basin and Tertiary source rock in the Malaya Basin were evaluated and their depositional environments were interpreted using organic geochemical and organic petrological studies.

In the Shoushan Basin, the Jurassic Khatatba Formation source rock composed mainly of shales and coal seams. The TOC contents are high and range from 1 to 32 wt. %. The Jurassic Khatatba sediments have a Rock-Eval T_{max} of 441–458 °C and HI values range of 100- 265 mg HC/g TOC, pointing to kerogen Types II-III and III (Figure 3a). Vitrinite reflectance values range between 0.77 and 1.07%, indicating that the samples are thermally mature and have entered the mature to late mature stage for hydrocarbon generation. In construct, the Tertiary lacustrine shale sequences in Groups K, L and M in the Malaya Basin have TOC content from 0.35 to 2.00 wt.% (Abdul Jalil, 2010). Kerogen composition of these shales varies, showing mixtures of Type I to Type III indicating variable combination of organic source input (Figure 3b). This is indicated by hydrogen index (HI) values ranging from 137 to 403. The variation in the source rock quality within the Groups K, L and M may be due to a combination of organic source input and factors controlling the preservation of organic matter within the environments of deposition (Abdul Jalil, 2010). The lacustrine shales have a Rock-Eval T_{max} of 435–455 °C, indicating thermal maturity level (oil window) sufficient for hydrocarbon generation (Figure 3b; Abdul Jalil, 2010).

The organic geochemical (biomarker distributions) approach here has been able to clearly differentiate between marine and lacustrine depositional setting. Biomarker parameters such as Pr/Ph, Pr/C_{17}, Ph/C_{18}, Tm/Ts and C_{29}/C_{30} hopane rations appear to reflect variation in depositional conditions and source input. Although there is a mixture of land-derived and marine-derived organic matter in both sediments, the depositional conditions of these formations can be distinguished based on these organic facies parameters, whereby the Khatatba shale samples were deposited in a reducing suboxic marine condition while the lacustrine shales of Groups K, L and M in oxic condition of deposition.

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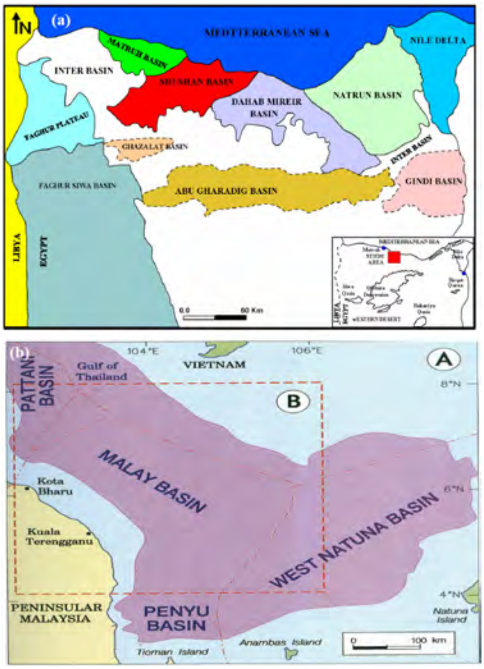

Figure 1: (a) Location map of the Shoushan Basin, Egypt (EGPC, 1992) and (b) Malaya Basin, Malaysia (Petronas, 1999).

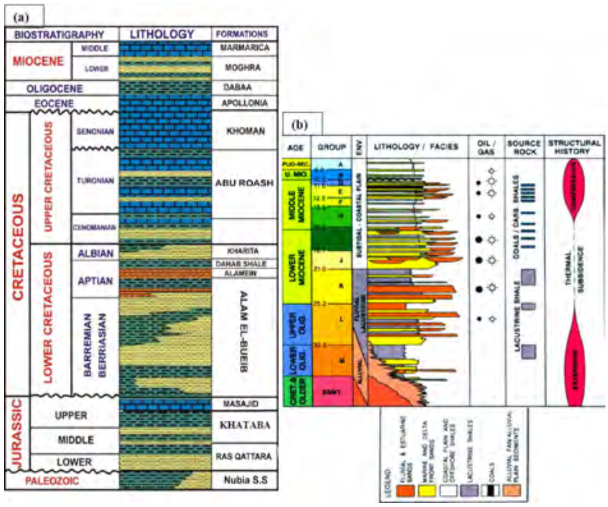

Figure 2: (a) Generalized stratigraphic column for the Shoushan Basin, Egypt (Schlumerger, 1984, 1995) and (b) Malaya Basin, Malaysia (Petronas, 1999).

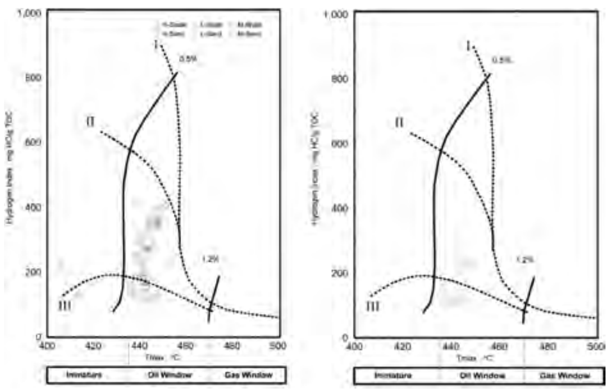

Figure 3: Plot of Hydrogen Index versus Rock-Eval T_{max} for the samples analysed from Malaya Basin, Malaysia (left) and Shoushan Basin, Egypt (right), showing kerogen quality and thermal maturity stages

Paper P2-24

Image processing for geological applications

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Digital image processing is a rapidly evolving field with applications to many areas of technology and science. Image processing techniques include restoration of image distortions, reconstruction of images from indirectly sampled data. These techniques have many applications in remote sensing, geophysics, astronomy and space research, radar and sonar imaging. In the past, color image processing applications, were based on local measurements, such as computation of histogram. Recently, complex filtering is widely applied by highly sophisticated, powerful application build with powerful programming languages such as Matlab and Java Swing. For example, image processing software known as "GeoJava" is a Graphical User Interface (GUI) powerful software, yet very simple to use. It provides the means to filter color images in RGB (Red-Green-Blue) color space and YUV color space, to produce a high quality filtered images. The YUV model defines a color space in terms of one luminance and two chrominance components. Y stands for the luminance component (the brightness) and U (blue-yellow axis) and V (red-green axis) are the chrominance (color) components. YUV models human perception of color more closely than the standard RGB model used in computer graphics hardware. The main advantage of the YUV model in image processing is that the luminance and the color information are independent. Thus, the luminance component can be processed without affecting the color contents (Gonzales & Woods, 2002; Rubert et *al*., 2005*)*

YUV color space model enable the filter of images in a smooth way without losing any data, and only enhancing the image structures. This technique was applied in different common-depth-midpoint (CDM) seismic reflection sections for detecting the geohazard of buried karstic limestone bedrock at developing and ex-mining areas. The images are processed for better extraction of information especially the hidden parts. There are many ways in which images can be processed for the following reasons: There may be a need to improve its quality, such as increasing contrast, improving the ability to make out certain details or contours, enhancing the clarity of certain zones or shapes or reducing the noise or interference, which might have a variety of causes and make the information less useful. It is therefore a matter of enhancement techniques which make use of such varied procedure such as convolution, filtering, etc., in order to produce smoothing contour accentuation, enhancement and so on.

Enhancing the quality of an image may also mean the search for an "ideal" image of the object if it has become degraded in a number of ways. There is a need to correct geometrical or photometric distortion using a sensor, to reduce fluctuations caused by atmospheric turbulence, or other noise sources.

There may be a need to look for certain shapes, contours or texture of a particular kind, but unnecessary to keep other information in the image. This is referred as detection, where it is concerned with the need to extract a signal of a known shape when everything other than the useful signal is behaving like a sea of noise.

Different stacking filter techniques with different CDM seismic section using color image processing software (GeoJava) in filtering CDM seismic reflection section in two different color spaces (Shariah, 2001). The images of the CDM seismic reflection sections are filtered using RGB mode as shown in Figures 1. These images show the exact location of cavities, displacement system, fractures and weakness in cavity system, location of a sinkhole and its shape. It also locates the area under deformation and stress. Enhancing the CDM seismic reflection section using the image processing technique provided supplementary results that are useful for evaluating and locating the margins of the geohazard zone (Shariah, 2001; Abu Shariah, 2002). YUV model improved the quality of the CDM seismic section by increasing contrast, enhancing the clarity of certain geohazard zone and its shape, and reducing the noise in reflectors to locate the weak zone of fractures and conduit systems that are associated with sinkhole development or slow subsidence. Satisfactory results were obtained of multi-applications objectives. Image processing enhances the images of geological targets using different stacking filters to provide supplementary results that are useful for evaluation geohazard. The results in the images purify clearly the exact location of geohazard zones, localization the areas that are under stress, and delineate the weak zones (Shariah, 2001; Abu Shariah, 2002).

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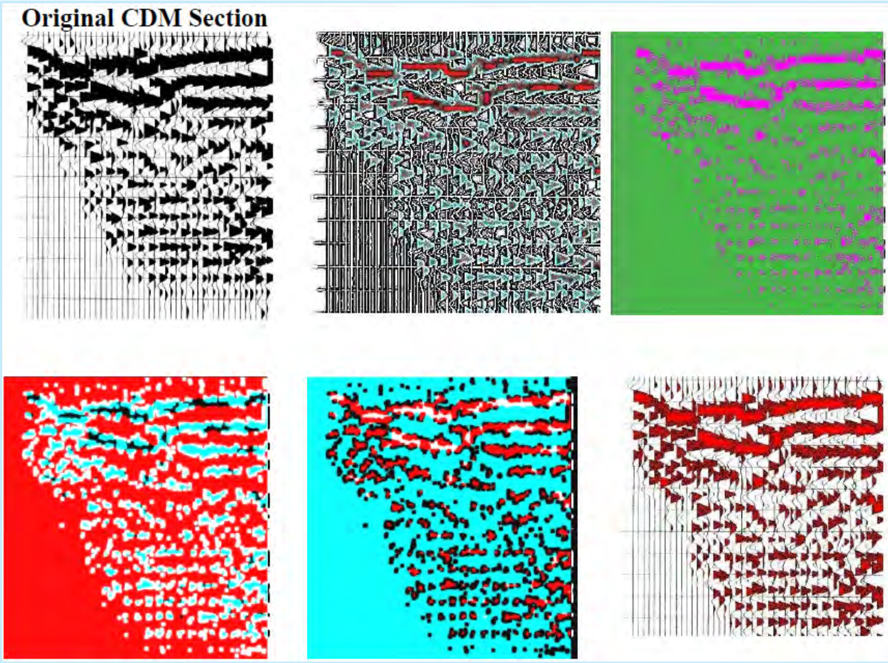

Figure 1: CDP seismic reflection section filtered by different RGB mode filtering.

Paper P2-25

Where is the Permian–Triassic boundary (PTB) in central Peninsular Malaysia?

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Keywords: Permian, Triassic, boundary, stratigraphy, Malaysia

The Permian–Triassic boundary (PTB) is defined by the first appearance of the conodont species *Hindeodus parvus* (Kozur & Pjatakova). It is now indicated to be 252.3 Ma by zircon U-Pb radio-isotopic dating (Mundil *et al*., 2004; Mundil *et al*., 2010).

Despite decades of searching (e.g. Metcalfe, 1984), the PTB has not been located precisely to date in Malaysia. In Pahang, central Peninsular Malaysia, there are several limestone sections, which have yielded biostratigraphic data indicating the plausible presence of the PTB. Two of them, Gua Bama and Gua Sei, have now emerged as the most promising localities, since they both exhibit carbonate strata ranging from Upper Permian to Triassic.

The Triassic nautiloid *Sibyllonautilus bamaensis* was recently reported from the top of Gua Bama, confirming the presence of the Triassic (Sone *et al*., 2004). The Triassic nautiloid-bearing deposit accompanies abundant algae, which in general are extremely rare in the Early Triassic; therefore, it is interpreted that the uppermost part of the Gua Bama strata likely extends to the post-Early Triassic, most likely Middle Triassic (Sone *et al*., 2008).

From the base of Gua Bama, Late Permian colaniellid foraminifers have been reported (Lim and Nuraiteng, 1994), and conodonts and brachiopods have recently been discovered. The conodonts include several species of *Clarkina*, *Hindeodus julfensis* and *Iranognathus movschovitschi*, confirming a Changhsingian age. The brachiopods were found in the siliciclastic strata 2 m below the conodont beds; that is, passage strata from the underlying siliciclastic sequence to the limestones. They include the rare genus *Dongpanoproductus*, known elsewhere only from the upper Changhsingian of South China (He *et al*., 2005). Thus, the lowest part of Gua Bama is dated as late Changhsingian age, suggesting that the Gua Bama sequence probably includes the PTB transition.

Another limestone hill Gua Sei is located about 3 km east of Gua Bama and is known to yield basal Triassic conodonts (Metcalfe, 1995); they now include *Hindeodus parvus* and *Isarcicella staeschei* indicative of Early Induan (Griesbachian) age. Our recent investigation confirmed extended strata of more than 30 m below the conodont horizons in Gua Sei (Sone et al., 2008), and the Late Permian foraminifer *Colaniella* has been discovered, implying the Late Permian in Gua Sei. Thus, the PTB is most likely located within this interval of 30 m. It is anticipated that the PTB at either or both Gua Bama and Gua Sei can be precisely located in the near future.

The two localities now stand as candidates for the geological heritage of Malaysia, targeting the famous Meishan Section of the Changhsing Geopark in China, where GSSP (Global Stratotype Section and Point) for the PTB is defined.

Acknowledgments: This paper forms a contribution to IGCP Project 572 "Restoration of marine ecosystems following the Permian–Triassic mass extinction: Lessons for the present".

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Paper P2-26

Determination of suitable landfill site in Lawin, Perak using Geographical Information System (GIS)

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Keywords: Landfill, thematic maps, weightage, suitability map

Landfill is a disposition area for solid waste, which are collected from nearby area before it is being treated and managed systematically. Landfill is also known as one of the important aspect, which affecting growth and development of rural and industrial areas. A Geographical Information System (GIS) approach is used in the process of determining a suitable site for landfill in the Lawin district. In this method, there are several steps taken starting from the preparation of base maps, production of thematic maps, weightage designation and combination of thematic maps in order to produce map of landfill suitability. Types of data needed for this research are lithological map, soil type map, landuse map, fault buffer zone map, lineament density map, drainage distance map, road distance map, settlement distance map, rainfall map and topographic elevation map. The designation of weightage is solely based on influence of each factor towards the determination of landfill suitability map. There are four areas with high suitability level detected in the landfill suitability map which are produced by overlaying process of all the thematic maps mentioned above. The area with the highest level of suitability is determined by comparing all four areas. This area is situated at the south-east of Lawin district. Lithology of the area is comprised of granite rocks which is low in porosity. It is also free from fault zone and the density of lineament is low. The soil in the area choosen is from the Serdang-Bungor-Munchong series, which is comprising of clay with fine grained sand-clay that has a low permeability value. Landuse in the area is in the forest category. It is also strategic when it comes to the factors of road, drainage and settlement distance. The average amount of rainfall in the area is moderate while the topographic elevation is low.

Penentuan kesesuaian tapak pelupusan sampah di daerah lawin, perak melalui kaedah Sistem Maklumat Geografi (GIS)

Tapak pelupusan sampah merupakan kawasan yang digunakan sebagai pusat pengumpulan sampah-sarap di kawasan sekitarnya sebelum ianya dirawat dan diuruskan secara sistematik. Tapak pelupusan sampah merupakan salah satu aspek penting dalam pembangunan dan kemajuan sesebuah kawasan perumahan mahupun perindustrian. Salah satu kaedah penentuan kawasan yang sesuai di daerah Lawin untuk dijadikan tapak pelupusan sampah ialah kaedah Sistem Maklumat Geografi (GIS). Penggunaan kaedah ini melibatkan beberapa peringkat iaitu penyediaan peta asas, penghasilan peta tematik, pemberian nilai pemberat dan gabungan peta tematik untuk menghasilkan peta kesesuaian tapak pelupusan sampah. Data–data yang digunakan dalam kajian ini ialah peta litologi, peta jenis tanah, peta guna tanah, peta zon penimbal sesar, peta ketumpatan lineamen, peta zon jarak saliran, peta zon jarak jalan raya, peta zon jarak penempatan, peta taburan hujan dan peta ketinggian topografi. Nilai pemberat untuk peta tematik diberikan berdasarkan kepada pengaruh kepada penentuan kesesuaian tapak perlupusan sampah. Setelah tindanan kesemua peta tematik parameter yang berkaitan dibuat, terdapat empat kawasan yang mempunyai kesesuaian yang tinggi untuk dijadikan tapak pelupusan sampah. Perbandingan antara keempat-empat tapak tersebut dibuat untuk mengenalpasti tapak terbaik dan hasilnya didapati bahawa tapak yang paling sesuai terletak di bahagian tenggara daerah Lawin. Litologi kawasan tersebut adalah batuan granit yang mempunyai keporosan yang rendah. Kawasan tersebut juga adalah jauh dari pengaruh sesar dan mempunyai ketumpatan lineamen yang rendah. Tanah di kawasan tersebut adalah dari jenis Serdang-Bungor-Munchong yang terdiri daripada lempung pasir halus-lempung yang mempunyai ketertelapan yang rendah. Daripada aspek guna tanah pula kawasan terpilih tersebut adalah kawasan hutan. Kedudukannya juga strategik kerana terletak jauh dari saliran, jalan raya serta kawasan penempatan. Daripada segi taburan hujan pula kawasan tersebut tergolong dalam pengelasan sederhana dan topografi kawasan tersebut adalah rendah.

Paper P2-27

Rain detection and removal using a new algorithm

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Image filtering is a highly demanded approach of image enhancement in digital imaging systems design. In most image processing applications, the Spatial content of the image is very important. The need of images obtained during a rainy episode might be a valuable tool for enhancing low resolution geological photographs/images, due to Malaysia as a tropical country is gifted with heavy rain all the year around.

Noise removal or de-noising is an important task in image processing. Image enhancement is a collection of techniques that improve the quality of the given image, which is making certain features of the image easier to see or reducing the noise. In general, the results of the noise removal have a strong influence on the quality of the image processing techniques.

The visual consequence of rain in videos is convoluted. Rain consists of spatially disseminated drops falling at high velocities. Each drop refracts and reflects the background, producing sharp intensity changes in an image. A group falling drops creates a complex time varying signal in vision. Detection and enhancing videos from raindrops is the aim of this research, but due to the limited revelation time of the camera, concentration due to rain are motion blurred and hence depend on the background intensities, thus the visual manifestations of rain are a amalgamation of both the vitalizing of rain and the photometry of the surroundings. Efficient algorithm based on Spatial-temporal depth techniques will be utilized for detecting and enhancing degraded rainy videos.

The weather elements especially rain causes high degradation for video obtained that causes the distortion of the scene. This in turn creates havoc in certain cases where high resolution images are of great concern. The problem is more complicated in video shots taken that involve human life risk issues such as surveillance cameras, where crimes can be prevented with the existence of the suitable video obtained, whereas when obtained during rain most of the scene I lost or degraded leading to a missing of valuable information, that might lead to the saving of a human being life.

In the present work, a method of video enhancement in rainy state is proposed. The aim is the identification of the scene without the presence on the noise (rain particles forming at high speed streaks). Video enhancement algorithms were developed. The algorithms were calibrated, validated and tested for rain streak removal from a rainy video. Their application has wide field of interest regarding surveillance cameras issues and to support decision making for information validation when the video is degraded by the rain.

The algorithms were created using MATLAB image processing toolbox. The algorithms were implemented based on several different approaches and techniques. The rainy video data where imported from a camera into a file format acceptable by MATLAB. The outcome from the enhancing filter provided an enhanced video almost free from rain streaks, with better image colorization. A method of video enhancement in rainy state is proposed. The aim is the identification of the scene without the presence on the noise (rain particles forming at high speed streaks).

Figure 1: Sawsan's filter four was applied to the rainy image and results are shown the filtered images using a new filter algorithm .

The main idea is to improve color rendition and contrast of the objects, as if the scene has been captured in a normal sunny day. This method is based on normalizing each color channel separately, for a better light attenuation after the filter processing has taken place. The polluted Pixels of rain streak are further smoothed with the neighborhood pixel for a better color perception and to gain a full colored value as shown in Figure 1.

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Paper P2-28

The Segamat Volcanics – OIB/Rift REE profiles with crustal contamination

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The Segamat Volcanics comprise a body of high-K basalt and basaltic andesite, of minimum Paleocene age (62 ma), erupted in the vicinity of Segamat, Johore. They may represent the southern extent of an arc of Cenozoic basaltoid occurrences extending from northern China, through Korea and Hainan, down through Indochina, the Phillipines, Borneo and Thailand.

New REE data shows OIB-like enrichment in normalized LREE values, and depletion in HREE values, with a slight negative Eu anomaly. $^{87}Sr/^{86}Sr$ values are in the range of 0.713. OIB-like REE trends are associated with rift basalts as well as oceanic islands, and are thought to be mantle plume related, caused by partial melting in the deep mantle. The Eu anomaly and high $^{87}Sr/^{86}Sr$ values point to the contamination of this melt with continental crust.

Although the data seems to indicate that the Segamat Volcanics were generated by a mantle plume, no other evidence for such a plume is present, and the true reason for the existence of the Segamat Volcanics must, at this time, remain enigmatic.

Paper P2-29

Naturally fractured granite characterization at Pulau Redang

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Summary

Limited information on fracture orientation and fracture density is available from core and borehole image data and high quality/high resolution 3D seismic is lacking in this area. Well and core data do not contain information on important fracture parameters such as length distribution, crosscutting relationships, fracture density and lithology and bed thickness. The understanding of fracture distribution and formation in the Anding Field, their effects on fluid flow can be improved by the use of outcrop analogue data at Redang Island. The superb exposure of the Redang outcrops are in close vicinity to the Anding hydrocarbon fields (200 km NW of Anding) and ideally suited for an outcrop based fracture study (Mohamad Kadir, 2010). To validate these assumptions, surface outcrop study was carried out at Redang island and surrounding areas to firm up the fractures trend and surface analogue. A line sampling technique (scan-lines) was used for the main data collection, following the discontinuity survey. This paper also presents new observations on the spatial distribution of fracturing from satellite images which is the Quickbird over the Redang island and outcrop observations of sector scale fractures which could be analogous to producing fractures in the Anding oil field. The Redang outcrop is important in the generation of discrete fracture network (DFN) models and the population of the fracture properties in the reservoir models. Therefore, the value of an outcrop analogue is greatly increased for a hydrocarbon province in the Anding fields where there maybe technical difficulties in acquiring good quality seismic data and hence resolution limits on the imaging of structural geometries at the reservoir scale.

Introduction

All petroleum reservoirs contain natural or man-made fractures. Natural fractures result from the interaction of earth stresses while man-made fractures result from drilling activities, increase in pore pressure in injection operations, reservoir cooling during water flooding, redistribution of earth stresses in the field as a result of injection and production practices, etc. Nowadays, geoscientists have undertaken research to characterize naturally fractured reservoirs. Geoscientists have focused on understanding the process of fracturing and the subsequent measurement and description of fracture characteristics.

The origin of the fracture system is postulated from data on fractured dip, morphology, strike, relative abundance and the angular relationships between fracture sets. In this research, these data can be obtained from surface outcrop at Redang island and applied to empirical models of fracture generation. Available fracture models range from tectonic to others of primarily diagenetic origin (Narr *et al*., 2006).

The interpretation of fracture system origin involves a combined geological/rock mechanics approach to the problem. It is assumed that natural fracture patterns depict the local state of stress at the time of fracturing, and that subsurfaces rocks fracture in a manner qualitively similar to equivalent rocks in laboratory test performed at analogous environmental conditions. Natural fracture patterns are interpreted in light of laboratory-derived fracture patterns and in terms of postulated paleo-stress fields and strain distributions at the time of fracturing.

Most of the research in the study area consist of describing the general geology and the petrological studies of the granite and very few about the study of structural geology especially fractures characterization. However recently, PCSB & PMU has shown keen interest to explore the study of fractured basement on the surface outrop at Redang island.

The Redang island are situated off the coast of the Besut district of Terengganu. According to Macdonald (1967), this island are rocky, jungle-covered island and its mainly composed of granitic rocks with some small islands of sedimentary and volcanic rocks. The sedimentary rocks consists of 3 units and each of this units are distinguished based on the lithology and sediment facies, tectonic structural and deformation caused, and the degree of metamorphism. Based on these three factors, Mohd Zaidi Mohd. Yah (1996) has divided the sedimentary rocks in the Redang Island into Pinang Formation, Redang Formation and Tumbu Kili conglomerate.

Fracture classification

A genetic classification scheme for natural fractures systems, which is an expansion of that found in Stearns & Friedman (1972), permits separation of complicated natural fracture systems into superimposed components of different origin. They classify fractures into those observed in laboratory experiments and those observed in outcrop and subsurface settings. Their classification scheme, together with modifications forms a useful basis for fracture models as described in the Table 1. The major modification to their scheme is addition of two categories of naturally occurring fractures: contractional fractures and surface-related fractures. A minor modification to the experimental fracture classification is the addition of a category similar to extension fractures in morphology and orientation, but having a different stress state at generation and rock strength: tension fractures.

Table 1 : Experimental and natural fracture classification.

Experimental Fracture Classification : Shear fractures Extension fractures Tensile fractures
Naturally Occuring Fracture Classification : Tectonic fractures (due to surface forces) Regional fractures (due to surface forces or body forces) Contractional fractures (due to body forces) Surface-related fractures (due to body forces)

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Paper P2-30

Groundwater finding in hard rock and alluvium using 2-D resistivity imaging

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Keywords: Groundwater, hard rock; alluvium, 2-D resistivity imaging, sand lens

Two types of groundwater can be found, which are groundwater in hard rock and in alluvium. Groundwater found in hard rock usually occurs in faults and fractures, while in alluvium is in sand lenses. This study describe two different survey areas representing the two different groundwater types. The survey locations are in Ayer Putih, Pulau Pinang and Inderapura, Pahang. The method used for the finding of groundwater is 2-D resistivity imaging survey with pole-dipole array. The equipment used was ABEM SAS400 system with minimum electrode spacing of 5 m. The length of each survey lines in Ayer Putih and Inderapura were 400 m. From the results, the survey location in Ayer Putih shows that groundwater is found in hard rock while in Inderapura, groundwater was found in alluvium.

Paper P2-31

Evaluation of subsurface karst features: A case study of geophysical investigation of piling problems at Gopeng, Perak

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Keywords: Limestone; 2-D resistivity; fractures; alluviums; cavity

Limestone areas have posed various problems to geotechnical engineers due to the karstic features such as steeply inclined bedrock, cavities, floaters and pinnacles. The practicability of using geophysical techniques in investigating karstic limestone site that impede piling process was tested in Gopeng, Perak by utilizing 2-D resistivity method using ABEM Terrameter SAS4000 and electrode selector ES10-64. Provided borehole and Mackintosh probe records were adapted to enhance the use of geophysical survey. Generally, results show that rock head of limestone bedrock encounter at depth 8-12 m with resistivity value of 70 Ωm. There is competent limestone bedrock and weak/fractured limestone with resistivity value > 100 Ωm and 20-100 Ωm, respectively. In correlation with borehole records, there is layer of alluvium with thickness of 6-10 m, which predominantly consists of loose silty sand to medium stiff sandy silt with some gravel and traces of clay. Other karstic features such as pinnacle and cavity with resistivity value 20-40 Ωm are also detected.

Paper P2-32

Slope stabilty analysis using geotechnical properties and geophysical characteristics of soil

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Keywords: Geophysics, seismic, resistivity, property, slope stability

A pre-requisite in slope stability analyses is that the internal structure and the mechanical properties of the soil mass of the slope are known or can be estimated with a reasonable degree of certainty. Geophysical methods to determine the internal structure of a soil mass may be used for this purpose. Various geophysical methods and their merits for slope stability analyses are discussed. Seismic methods are often the most suitable because the measurements depend on the mechanical properties that are also important in the mechanical calculation of slope stability analyses. Other geophysical method, such as electric resistivity, is useful to determine the internal structure, but require a correlation of found boundaries with mechanical properties. This research was conducted to investigate the slope stability through geotechnical properties and its geophysical characteristics.

Paper P2-33

Usaha-usaha pemuliharaan dan pembangunan sumber geowarisan Langkawi geopark untuk geopelancongan

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Semenjak mendapat status geopark Langkawi telah menyaksikan peningkatan jumlah pelancong yang mendadak. Sehingga kini kedatangan pelancong telah mencapai hampr 2.5 juta orang setahun. Sejauh manakah tarikan sumber-sumber warisan geologi di Langkawi mampu menarik kedatangan pelancong? Persoalan ini boleh dijawab dengan meneliti tapak-tapak semula jadi yang menjadi tarikan pelancongan pada masa ini. Tiga kawasan pemuliharaan utama Langkawi yang terdiri daripada Kilim Geoforest Park, Machinchang Geoforest park dan Dayang Bunting Geoforest park mempunyai geotapak-geotapak yang sangat cantik, menarik dan unik. Sehingga kini sebanyak 97 geotapak telah dikenalpasti yang sebahagian daripadanya telah dibangunkan untuk geopelancongan sementara sebahagian lagi masih belum dikaji dengan lengkap. Di samping itu usaha pemuliharaan juga giat dilakukan bagi memastikan kelestarian sumber tersebut di masa akan datang. Beberapa isu berkenaan cabaran pengurusan sumber, status pemuliharaan dan aspek geopelancongan sangat memerlukan perhatian dan dibincangkan di dalam kertas kerja ini.

Paper P2-34

Peta kejuruteraan geologi bagi kawasan Ampang-Ulu Kelang

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Pengenalan

Kejadian tanah runtuh merupakan suatu fenomena berterusan yang membelenggu rakyat negara kita semenjak kebelakangan ini. Sejak beberapa dekad yang lalu, bencana tanah runtuh semakin kerap terjadi sehingga memusnahkan jaringan infrasturktur dan sistem sosial yang ada. Malahan, bencana ini turut melibatkan kehilangan nyawa penduduk yang terlibat apabila rumah mereka ditimbusi tanah mahupun runtuh akibat dihempap tanah runtuh. Tanah runtuh berlaku samada secara semulajadi atau akibat aktiviti manusia. Apabila tanah runtuh berlaku, kandungan bahan gagal ini boleh mencapai jumlah yang besar sehingga 1,000,000 m^2 dan mengakibatkan kemusnahan yang besar kepada kawasan sekitarnya. Tanah runtuh menyebabkan perubahan landskap yang ketara terhadap permukaan bumi. Timbunan tanah dan juga lumpur daripada kegiatan tanah runtuh menyebabkan kawasan tanah tinggi mungkin menjadi rata dan pengendapan sedimen juga boleh menjadi tebal dengan pantas. Tanah runtuh juga boleh menyebabkan cerun tanah atau batuan menjadi semakin cerun dan tidak stabil. Peta kejuruteraan geologi ini mengkelaskan kestabilan cerun sesuatu kawasan kepada beberapa kategori, berjulat dari stabil kepada tidak stabil, dan pengkelasan ini akan di buat berdasarkan penggunaan warna, iaitu warna sejuk (seperti biru dan hijau) untuk kawasan yang stabil, dan warna panas (seperti jingga, merah dan kuning) untuk kawasan yang tidak stabil.

Metodologi

Bagi penghasilan peta kejuruteraan geologi bagi kawasan Ampang-Ulu Kelang, pengelasan kestabilan cerun akan dilakukan berdasarkan parameter-parameter terpilih yang diperoleh sewaktu peringkat inventori cerun dilakukan. Parameter-parameter tersebut adalah seperti berikut:

Bagi setiap parameter, akan terdapat sub-parameter masing-masing. Setiap sub-parameter akan diberikan pemberat tersendiri bergantung kepada kadar sumbangan terhadap potensi tanah runtuh untuk berlaku (Jadual 1). Pengkelasan akan diberikan sejurus semua parameter-parameter dijumlahkan pada jumlah tertentu mengikut spesifikasi tersendiri cerun yang dikaji, dan kemudiannya ditentukan sama ada berisiko rendah, sederhana atau tinggi untuk berlakunya kejadian tanah runtuh. Penilaian ini turut mengambil kira segala faktor yang telah di analisis berdasarkan fotoudara dan data inventori, dan turut mengambil kira faktor penilaian individu. Pemberat ditetapkan pada nilai 10 bagi kadar keseriusan tertinggi, dan semakin rendah nilai bagi kadar keseriusan yang rendah, dan tidak diwakili sebarang unit. Nilai 10 dijadikan sebagai nilai rujukan yang diseragamkan bagi penentuan nilai-nilai sub-parameter yang lain.

Penggunaan matematik mudah diaplikasi bagi penentuan pemberat setiap sub-parameter, iaitu :

Pemberat = (tahap keseriusan sub-parameter/jumlah sub-parameter) * 10

Contoh : Penentuan pemberat parameter gred luluhawa bagi gred luluhawa 1V. Diketahui bahawa semakin tinggi darjah luluhawa, semakin tinggi sumbangan kepada ketidakstabilan cerun. Gred luluhawa pula terbahagi kepada 6 sub-kumpulan. Maka; tahap keseriusan sub-parameter gred 1V daripada 6 gred luluhawa = 4. Jumlah sub-parameter gred luluhawa = 6. Pemberat = (4/6) * 10 = 6.7

Kaedah gred kumulatif ini diasaskan daripada sistem penilaian cerun (SAS) yang telah dibangunkan oleh Jabatan Kerja Raya (JKR) dan diadaptasi dan ditambah baik menggunakan kepakaran individu bagi menghasilkan sistem pengkelasan yang tersendiri. Kaedah ini turut berpandu kepada kaedah G-Rating yang dicadangkan oleh Huzaidi Omar (2004) serta *Hong Kong Hazard Index* yang dibangunkan oleh Chau *et al*. (2004) dari Universiti Politeknik Hong Kong, Jabatan Kejuruteraan Awam dan Struktur. Berikut merupakan pengiraan yang digunakan bagi menentukan julat pengkelasan tertentu bagi potensi kejadian tanah runtuh yang tertentu.

Jumlah terkumpul minimum = 39.9; jumlah terkumpul maksimum = 110; dan beza minimum dan maksimum = 70.1. Terdapat 4 sub-pengkelasan, maka akan terdapat empat pembahagian di antara nilai terkumpul minimum dan nilai terkumpul maksimum. 70.1/4 = 17.5 ~ 18, maka julat antara sub-pengkelasan adalah 18. Nilai 18 akan di tambah pada jumlah terkumpul minimum, bagi mendapatkan nilai-nilai sempadan berikutnya bagi jenis potensi yang berlainan.

Berdasarkan kepada Jadual 2, zon tanah runtuh kawasan Ampang-Ulu Kelang akan dipetakan menggunakan warna yang berbeza bagi mengambarkan tahap risiko berbeza untuk kemungkinan berlakunya tanah runtuh. Empat julat pengkelasan yang dipilih adalah tidak berpotensi - rendah (hijau), berpotensi rendah- sederhana (kuning), berpotensi sederhana – tinggi (jingga), dan sangat berpotensi (merah). Pengiraan potensi dilakukan secara manual, manakala penghasilan peta dilakukan dengan menggunakan perisian *Corel Draw*.

Hasil dan perbincangan

Cerun yang dikategorikan sebagai tidak berpotensi-rendah merupakan cerun yang selamat pada dasarnya disebabkan oleh sudut gradient yang landai, kepadatan tumbuhan yang tinggi, kehadiran sistem sokongan cerun yang menyeluruh serta kadar hakisan yang rendah/tiada. Ia merupakan sebahagian daripada hutan sekunder yang tebal dan tidak pernah mengalami sebarang kejadian tanah runtuh sebelumnya. Bagi cerun yang dikategorikan sebagai berpotensi rendah-sederhana, cerun-cerun ini kebanyakannya mempunyai kepadatan tumbuhan yang tinggi dan turut dilengkapi sistem sokongan cerun. Kadar hakisan di kawasan ini juga lebih rendah dan tiada rekod tanah runtuh di laporkan di sini. Namun demikian, potensi tanah runtuh masih wujud memandangkan terdapat beberapa ciri fizikal cerun yang menyumbang kepada potensi berlaku tanah runtuh seperti sudut cerun yang curam dan kadar luluhawa yang sederhana-tinggi. Sebahagian besar cerun yang dikategorikan sebagai berpotensi sederhana-tinggi terletak di Ampang-Ulu Kelang. Cerun-cerun ini kebanyakkannya melibatkan cerun-cerun yang pernah gagal, sebagaimana yang terjadi di Bukit Mewah, Highland Tower dan Taman Hillview. Sebahagian cerun-cerun di dalam kategori ini mempunyai sistem sokongan cerun, namun demikian pembinaan struktur sokongan ini hanya meliputi sebahagian kecil cerun sahaja, iaitu pada bahagian cerun yang telah mengalami kegagalan. Bahagian yang tidak gagal lazimnya dibiarkan tanpa sebarang struktur sokongan dan ini sama sekali tidak banyak membantu dalam aspek pengukuhan cerun yang efektif, lantas mendedahkan peluang tanah runtuh untuk berlaku lagi.

Jadual 1: Parameter-parameter yang digunakan bagi proses inventori cerun.

No	Parameter	Sub-Parameter	Pemberat
1	Tanda-tanda tanah runtuh (kritkal)	Ada	10
2	Tinggi cerun	>24m	10
		12m-24m	6.7
		<12m	3.3
3	Sudut cerun	0-5	1.7
		6-15	3.3
		16-25	5
		26-35	6.7
		36-60	8.3
		>60	10
4	Jenis cerun	Batuan	3.3
		Tanah	10
		Batuan + Tanah	6.7
5	Gred luluhawa	I-II	3.3
		III-IV	6.7
		V-VI	10
6	Kehadiran air pada cerun	Ada	10
		Tiada	5
7	Kepadatan tumbuhan	Padat	3.3
		Sederhana	6.7
		Rendah-Gondol	10
8	Aktiviti pada/di atas cerun	Ada	10
		Tiada	5
9	Binaan sokongan cerun	Ada	5
		Tiada	10
10	Sejarah tanah runtuh	Ada	10
		Tiada	5
11	Ketakselanjaran	Ada	10
		Tiada	5

Jadual 2: Pengkelasan potensi tanah runtuh berdasarkan kaedah gred kumulatif terkumpul.

Istilah	Julat Pengkelasan
Sangat berpotensi	>93.1
Berpotensi sederhana - tinggi	75.1-93
Berpotensi rendah - sederhana	57.1-75
Tidak berpotensi - rendah	39-57

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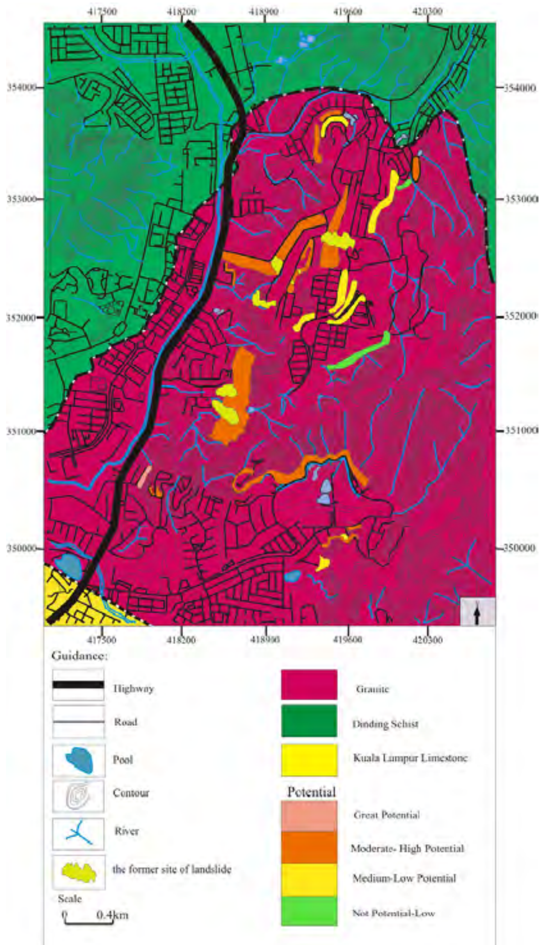

Rajah 1: Peta potensi tanah runtuh di kawasan Ampang-Ulu Kelang. Sumber: Nor Syahidah (2010).

Paper P2-35

Environmental impact of mining activities in Terengganu, Malaysia

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Key words: Acid mine drainage, mining, pollution, topographic change, Terengganu

Study on mining activities and its environmental impact in Terengganu state of Peninsular Malaysia reveals acid mine drainage and unpleasant topographic changes. Environmental effects of mining activities have been studied to identify physical and chemical changes that have resulted from mining activities and to estimate acid generation progress. Several site visits have been carried out to identify the most affected areas among sand, clay, base metals, gold, tin, manganese and iron mining sites. Subsequently, areas around Bukit Besi mine sites have been selected for sampling to conduct chemical and mineralogical investigation. Tailings, leachate, surface and groundwater samples were collected from the locations where field inspections show evidence of environmental degradation.

Pyrite was present in tailing samples in both of the areas, average 0.9 and 16 percent for Durian Mas and Bukit Besi, respectively. High concentration of Ce, La and Ba has been detected in Durian Mas soils. Surface water in the mine sites has acidic character, and sulfate, Cu and Ni concentrations were higher than levels recommended in INTERIM IIA/IIB standard for supply water in Malaysia. Groundwater samples also have higher amount of iron and manganese according to the standard, even though they have been collected from villages outside of the mine sites. Results from leachability test in the site showed low pH and high TDS and chemical analysis of the leachate of these test indicated high sulfate ion content (SO_4^{2-} is 66 ppm in Durian Mas and 2604 ppm in Bukit Besi tailings samples). Present condition of generated acid was estimated using a rapid test on tailing samples, which is based on neutralization of acidity using NaOH. According to the suggested method, Durian Mas acid mine drainage progress falls in moderate potential-low progress area while Bukit Besi samples match the moderate potential-progressive boundary. Change of topography also has remained in the mine sites, and vegetation quality is not desirable in some parts even after decades of ceased activities.

Paper P2-36

Factors influencing the excavation of hard material during trenching works at Kuching, Sarawak

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Surface excavation is usually one of the common debatable issues between the contractor and client. Problems occur when the origin of material cannot be classified as either soil or rock, thus the existing terms and excavation in tender documents may become disputable. However, it becomes more complicated when the material is relatively hard for ripping but it is too soft for blasting. This material is usually term as Hard Material. This paper would discuss on different terminology of hard material used by different parties in earthwork, the relevant parameters for rock material/ mass that affects the excavation process and the progress of excavation with the actual excavation process on site based on the borehole data. The several terminologies of Hard Material, were obtained from contractual data from both government and private sectors. A case study on a project in Kuching, Sarawak was done to compare the actual excavation method and the proposed excavation scheme as suggested by Pettifer & Fookes (1994) through borehole data and observations. This study shows that different parties have different ways to define Hard Material, which has its own disadvantages. The best method to define would be a combination of more than one way to define hard material which has to be clearly stated in the contractual data. We found out that the Pettifer & Fookes (1994) graph is not necessarily right all the time and that the core samples sometimes is not representative to the actual rock mass. This is due to the nature of formation and the effect of moisture.

Notes

Notes

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