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CATATAN GEOLOGI
Geological Notes

An approach to joint roughness measurement in rock — a comparative study

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HO CHIN KUN AND LOH TAR HER
Fakulti Kejuruteraan Awam
UTM Skudai

Abstract: Surface texture dictates the degree of roughness of a joint surface. Surface roughness on the other hand, has a significant effect on joint strength, particularly, the frictional component of shear strength and surface contact during shear. Joint roughness is therefore, an important aspect to be considered when dealing with joint shear strength. The present approach in obtaining the surface texture of a joint is through the use of profiler. However, the measurement process is laborious and time consuming.

This paper highlights a study on the suitability of *close-range digital photogrammetry*, as an alternative method for measuring surface texture. Specifically, this paper presents the usage of area-based image matching approach. Initial findings give promising indications on the suitability of this method. Apart from being semi-automated, it also exhibits positive characteristics, in terms of reliability and practicality.

JOINT SHEAR STRENGTH AND SURFACE ROUGHNESS

Assessment on joint shear strength is essential for many rock engineering projects. The relevant evaluation includes determination of frictional parameters, that are related to shear strength, and quantification of the influencing factors like surface roughness and impersistence.

Shear strength of joint depends significantly on its surface texture. Surface roughness for instance, not only affect shear strength parameters like JRC and angle of dilation (i) but, also dictates the actual contact area between joint blocks (Power and Hencher, 1996). Even for a matched joint, the contact area changes throughout the shearing process as it depends on the amount of contact between peaks of the interfacing joint surfaces (Hencher and Richards, 1989; Mohd Amin *et al.*, 2000). Usually, the contact is less than the gross projected area and this leads to an over-rated joint strength.

The importance of surface roughness has led to numerous studies specifically, on the quantification of the roughness, its relation to dilation angle i and shear strength. The approach used include empirical method (Bandis *et al.*, 1983) and fractal geometry (Huang *et al.*, 1992). Power and Hencher (1996), proposed a method for measuring the contact area of a rough joint during shear.

In the field, representative data pertaining to joint surface may be sampled from exposed joints. Surface profile is usually measured using profiler (ISRM, 1981). However, collection of sufficient and reliable data may be restricted by unfavourable field conditions and accessibility to the selected joints. Occasionally, critical joints may have to be sampled and profiled in the laboratory (Goodman, 1974). Both methods entailed laborious and repetitive task particularly when it involves a large number of joints. Therefore, the need for a robust and semi-automated method is imminent mainly to reduce the above-mentioned problems. One

feasible method to achieve this is through digital photogrammetry that is widely used in topographic survey (Mustaffar, 1997). In addition, if data can be stored in the form of digital image and processed at a later stage, this enables the handling of a large amount of field data.

CLOSE-RANGE PHOTOGRAMMETRY

In principal, it is a technique of obtaining the position, size and shape of an object without directly measuring the object. A mathematical model can be used to obtain the 3-dimensional coordinates of any discrete point on the object. This model can be developed from the relevant information gathered during image capturing processes. Related measurements on the object can be undertaken indirectly by matching its stereo (left and right) images. With the advancement of digital image processing, the use of photogrammetry has been extended to other fields that require precise surface measurement such as medical surgery and CADCAM.

JOINT SURFACE RECONSTRUCTION USING AREA-BASED IMAGE MATCHING AND SURFACE MODELS

Area-based image matching method adopted in this study is one of the approach used in close-range photogrammetry for finding corresponding points on digital image. This method is capable of yielding high accuracy in three-dimensional surface reconstruction (Mustaffar *et al.*, 2000). The mathematics involved in area-based matching are well documented in many publications (e.g. Grün, 1996) and will not be described here. It may be sufficient to point out that area-based matching method utilises a least square solution of observation equations written for each pixels within the windows. The observation equation for any one pixel involves the difference in image intensity between that pixel and a corresponding pixel on the other image. In this study the position of the corresponding pixel is obtained through an iterative least squares adjustment using information of the camera orientations, projective geometry and suitable surface model.

The basic area-based observation equation, which gives a relationship between the radiometric values of corresponding pixels in the left and right image, can be written as follows:-

$$I_L(x_L, y_L) + n(x, y) = I_R(x_R, y_R) \quad \ldots\ldots (1)$$

where,

I_L, I_R are the intensities of the left and right pixel, respectively.

x_L, y_L are the image coordinates of the left pixel.

x_R, y_R are the corresponding image coordinates on the right image.

$n(x, y)$ is the difference caused by noise at the point (x_L, y_L) on the left image.

If the relationship between image coordinates on the left (x_L, y_L) and (x_R, y_R) on the right is traditionally given by assuming an affine transformation exists between the images, then matching has to be done using only those pixels in those sub-areas of the images in which the affine relationship still holds between the two images.

On the other hand, introducing a suitable surface model to modify Equation 1, means that projective transformation (i.e. collinearity equations) is involved thus ensuring that a better transformation is obtained across the image. Using the collinearity equations also means that three additional parameters, (X, Y, Z) will be introduced. Supposing that the six relative orientation parameters of the cameras or sensors are precisely known, then a simpler relationship of the points used that relates to the object coordinates (X, Y, Z) can be obtained through the epipolar constraint. To do this, a deterministic mathematical model is adopted for the surface, such that the relationship between the coordinates of any one point on the surface, say (X_p, Y_p, Z_p), and the point to be matched (X_o, Y_o, Z_o) on the surface can be determined. Assuming that the refined image coordinates (i.e. with corrections to lens distortion applied) of the point to be matched on the left image is given by (x_L, y_L), then, through the use of the collinearity conditions, the following applies:-

$x_L = f_{xL}(X_o, Y_o, Z_o)$ ..... (2a)

$y_L = f_{yL}(X_o, Y_o, Z_o)$ ..... (2b)

where,

x_L, y_L are the known coordinates of the central point on the left image.

X_o,Y_o, Z_o are the corresponding object space coordinates of the point to be matched.

fx_L, fy_L are the collinearity conditions.

The object space coordinates (X_o, Y_o, Z_o) are not known, but can be estimated. If the neighbouring are represented by shifts (Δx_L, Δy_L), from the point to be matched in x and y directions respectively, then Equation 2a and 2b can be written as:-

$x_L + \Delta x_L = f_{xL}(X_o + \Delta X, Y_o + \Delta Y, Z_o + \Delta Z)$.....(3a)

$y_L + \Delta y_L = f_{yL}(X_o + \Delta X, Y_o + \Delta Y, Z_o + \Delta Z)$.....(3b)

where ΔX, ΔY and ΔZ are the differences between the central point coordinates (X_o, Y_o, Z_o) and (X_p, Y_p, Z_p) in the X, Y and Z directions respectively.

Supposing that matching is to be done for a flat surface, then a planar (first order) surface model can now be introduced across the window to represent the surface. The change of elevation (ΔZ) at any point on the surface is given by:-

$$\Delta Z = \frac{\partial Z}{\partial X}\Delta X + \frac{\partial Z}{\partial Y}\Delta Y \quad \text{..... (4)}$$

where ($\partial Z/\partial X$) and ($\partial Z/\partial Y$) are the gradients of Z in X and Y directions respectively. These gradients define the model surface and they are to be evaluated in the solution. If the changes in X and Y are expressed as ΔX and ΔY as a function of the corresponding shifts on the left image, Δx_L and Δy_L respectively, then Equation 4 can be written as:-

$$\Delta Z = \frac{\partial Z}{\partial X}\left(\frac{\partial X}{\partial x_L}\Delta x_L + \frac{\partial X}{\partial y_L}\Delta y_L\right) + \frac{\partial Z}{\partial Y}\left(\frac{\partial Y}{\partial x_L}\Delta x_L + \frac{\partial Y}{\partial y_L}\Delta y_L\right) \quad \text{..... (5)}$$

The above discussion only serves to provide a brief outline of the functional model used for the image matching. Detailed discussion of the mathematics involved can be found in Mustaffar (1997).

TESTS CONDUCTED

Preliminary tests on the suitability of the proposed approach were performed on a model joint surface. The model (300 mm x 300 mm) was obtained by casting a suitable mix of plaster of Paris on a typical joint surface in granite. A 15 mm square grid was marked on the sample's surface and the nodes of the grid intersections represent points of interest on the surface. Apart from providing well-defined marks on the surface, the grid also provides good texture in the matching process (see Fig. 1). It is thought that in field, such texture may be provided by dark-coloured minerals on the joint surface.

The camera used for the purpose of image acquisition is a DC240 Kodak digital camera which gives a resolution of 1280 x 960 pixels (see Fig. 2). The dimension of the sensor was found to be 4.1 µm in x and 4.5 µm in y. The camera is fitted with a 6–18 mm zoom lens which is equivalent to 39–117 mm lens in 35 mm photography. The advantages of using digital camera include automation of the image measuring process and near real-time output. Image of the model joint surface was captured at focal length setting of 18 mm. It should be noted that, as this is a preliminary study, calibration of the camera was not done. Calibrations such as distortion and focal length of the lens will be performed at a later stage of the study.

For comparison purposes, the model joint surface was also measured using a specially fabricated profiler (Fig. 3). Dial gauge (accuracy ± 0.001 mm) was used to measure the vertical height at the same grid nodes used in the photogrammetric approach. Table 1 lists sets of data obtained at section H-H which lies in the centre of the model joint. The *heights* (mm) shown in Table 1 are values that have been reduced by the mean value for the respective set of data. Hence, the –ve and +ve heights represent the trough and peaks respectively, along section H-H.

Processing of data mainly involved the use of routine photogrammetry and civil engineering softwares like Civil Cad, Matrox Inspector and some basic programming. Figure 4 shows the cross-section obtained by both methods plotted using values in Table 1.

Assuming that the data obtained from the profiler represent the correct profile of the section, it can be seen that both methods produce a similar profile of the cross-section. The maximum difference in height (error) is approximately 1.32 mm and the standard deviation is approximately 0.56 mm. This is a good indication of the suitability of photogrammetric technique in obtaining the surface profile of joint. The angle of inclination of each peak, i can be readily estimated from the sections obtained using photogrammetry.

A possible explanation why the profile obtained by both methods differ slightly at a number of grade nodes could be attributed to the fact that camera calibration was not performed. Since, heights measured are in the

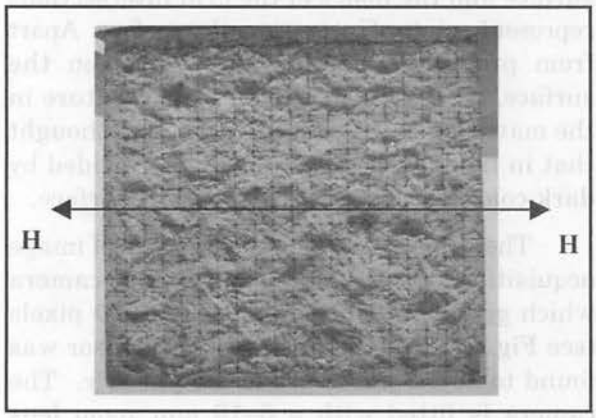

Figure 1. Joint surface model with 15mm grid. Section *H* denotes a cross-section selected for measurement (profiler and photogrammetry).

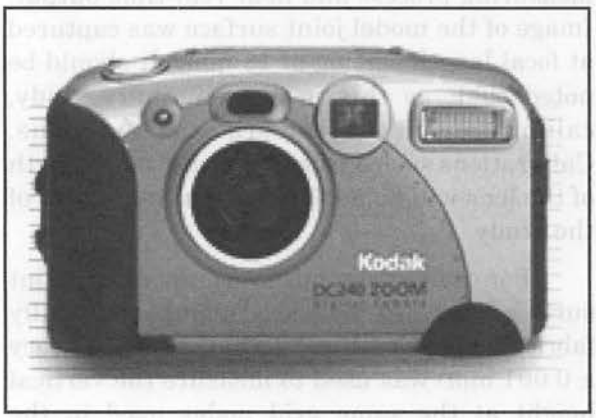

Figure 2. Kodak DC240 digital camera used.

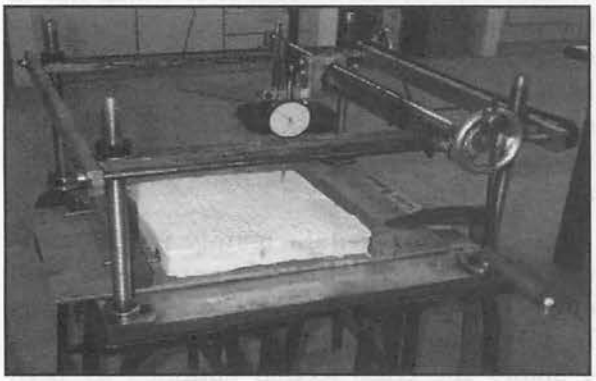

Figure 3. Joint surface profiler for image acquisition.

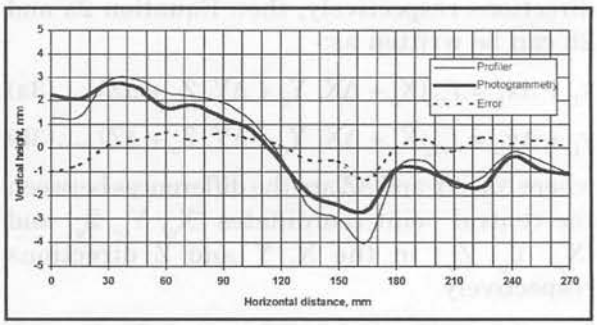

Figure 4. Cross-sectional profile of section H-H (0mm is the mean height).

Table 1. Heights (peak and trough) along cross-section H obtained using profiler and photogrammetry.

Sect. H (mm)	Profiler (mm)	Photogram. (mm)	error
0	1.26	2.21	–0.95
15	1.36	2.08	–0.72
30	2.84	2.69	0.14
45	2.90	2.57	0.33
60	2.34	1.67	0.67
75	2.18	1.83	0.35
90	1.95	1.27	0.68
105	1.14	0.75	0.40
120	–0.43	–0.59	0.16
135	–2.51	–1.99	–0.51
150	–3.00	–2.44	–0.56
165	–3.95	–2.63	–1.32
180	–0.93	–0.93	0.00
195	–0.53	–0.92	0.39
210	–1.63	–1.49	–0.14
225	–1.20	–1.66	0.46
240	–0.15	–0.36	0.20
255	–0.55	–0.91	0.36
270	–1.10	–1.15	0.05
		STDEV =	0.56

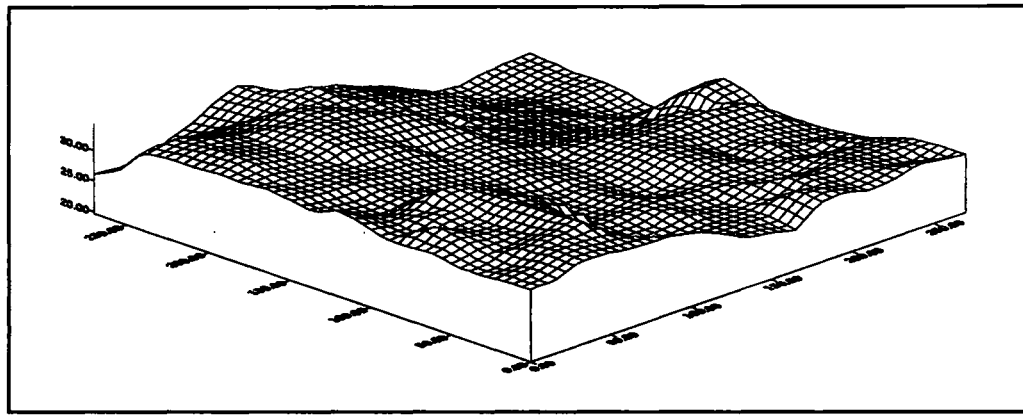

Figure 5. 3-D plot of joint surface based on profiler data.

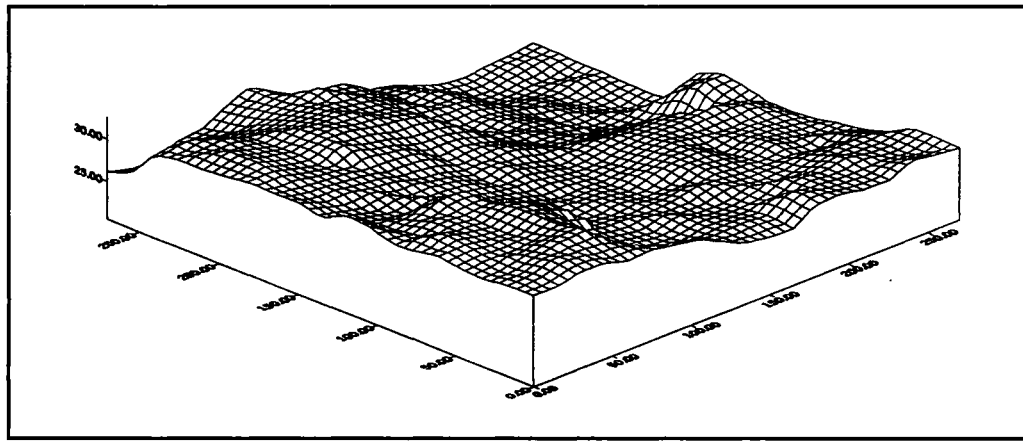

Figure 6. 3-D plot of joint surface based on photogrammetry data.

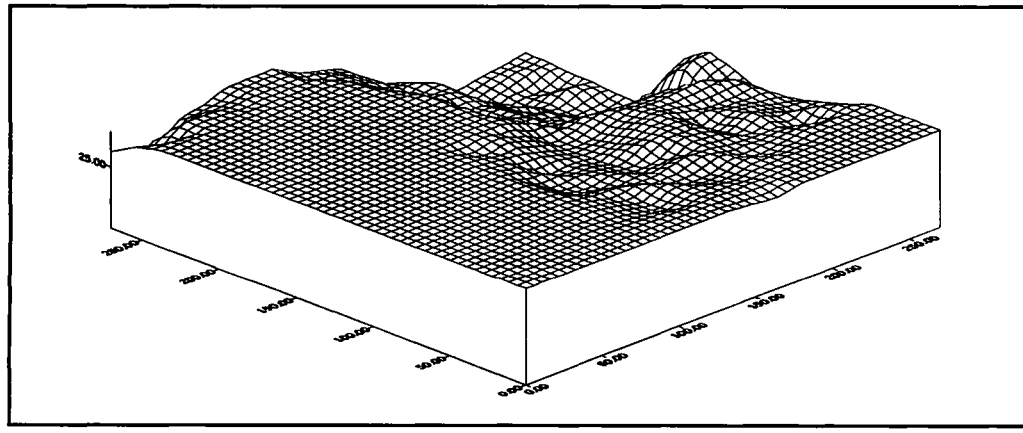

Figure 7. Shear surface, defined as a horizontal plane at mean height.

order of millimetres, it is felt that slight changes in the camera interior orientation will affect the results. In addition, the grade node where height is determined using photogrammetry may not be at an exact location as in profiler.

Profile data of the joint, obtained by both methods, are also plotted as 3-D image and this is shown Figure 5 and Figure 6. The 3-D image produced from photogrammetry data triggers some interesting points. If the shear plane along a joint surface can be defined in a 3-D form then, there is a possibility of estimating the area of contact during shear. This is shown in Figure 7 where, a horizontal plane (taken at mean height) intersects the plotted image of the joint surface. If this horizontal plane represents the sheared surface then, contact area during shear can be accurately estimated. However, further study is required to verify these hypothesis.

CONCLUSION

It has been shown in this preliminary study that close-range digital photogrammetry and in particular, area-based matching using surface models has a future in surface measurements of rock joints. However, the possibility of replacing the conventional method with photogrammetry is not conclusive since further studies and tests on real and variety of samples are needed. The 3-dimensional image plotted using photogrammetry data may be utilised in estimating a number of important aspects that are related joint strength parameters. These include surface contact during shear, angle of dilation and shear direction.

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PERTEMUAN PERSATUAN
Meetings of the Society

Forum on Increasing the Relevance of Geoscience in the 21st Century

Sponsored by
PETRONAS

Report by
Joy Jacqueline Pereira
Institute for Environment and Development (LESTARI)
Universiti Kebangsaan Malaysia

This forum was held on the first day of the 14th Annual Geological Conference at the Shangri-La Hotel, Penang from 8–9 September 2000. About 100 geoscientists attended it from academia as well as the public and private sectors. The six panelists of the forum were Dr. Azhar Hussin from University of Malaya, Dr. Leong Lap Sau from Universiti Sains Malaysia, Prof. Ibrahim Komoo from Universiti Kebangsaan Malaysia, Mr. P. Loganathan from the Minerals and Geoscience Department of Malaysia, Mr. Chong Foo Shin from Institute of Geology Malaysia, and Mr. N. Balasubramaniam from the Ministry of Primary Industries Malaysia. The President of the Geological Society of Malaysia, Dr. Abdul Ghani Rafek, chaired the forum.

GEOSCIENCE EDUCATION, RESEARCH AND DEVELOPMENT

Dr. Azhar Hussin presented his views on challenges facing geoscience education in the 21st century. He was of the opinion that academia should emphasize holistic education to produce geologists that are value based and useful to society, with the ability to contribute towards intellectual and technological advancement. Geoscience education encompasses the entire earth system and is fundamental for understanding and addressing the challenges that face humanity. Such challenges include population growth that has contributed to the degradation of natural systems, sustainable utilization of non-renewable resources and the identification of new renewable resources to replace depleting non-renewable resources, to ensure improved quality of life. Thus, the role of geoscience in the 21st century is indeed a critical one, and geoscience education must produce graduates that can help society meet these challenges.

On the topic of geoscience education in the 21st century, Dr. Leong Lap Sau lamented the fact that geoscience is much ignored among the sciences, in terms of its importance and contribution. He viewed this as the biggest challenge to geoscience education in the second millennium. In addition to focusing on the environmental component, geoscience education should also be expanded to include space geoscience that emphasizes advanced technology.

Linkages between industry and universities should be strengthened, and the role of geoscience education is vital, in this context.

Prof. Ibrahim Komoo provided some insights on challenges facing geoscience research and development in the 21st century. He remarked that some geoscientists are unaware of the great contribution that geosciences can make to ensure societal well being. The geoscientists who are aware tend to be inward looking and focus on the traditional fields of geoscience. They are reluctant to explore new fields and establish new partnerships in research and development. As long as this trend prevails, he reasoned that the contribution of geoscience will shrink and other disciplines will contribute to fill the gap. This will inevitably result in diminishing funds for geoscience research and development activities as well as education. In order to improve the situation, the geoscience fraternity should be more proactive, establish new non-traditional partnerships, participate actively at all levels of government and conduct outreach activities targeting non-geoscientists. This would hopefully, contribute to improve the current scenario and increase the potential for geoscience research and development in the 21st century.

STRENGTHENING THE INSTITUTIONS FOR GEOSCIENCE DEVELOPMENT

Mr. P. Loganathan presented several important observations on strengthening the institutions for geoscience development. There are four types of institutions that should be strengthened to enable geoscience to play an important role in national development. These are the legal institution, the government institution, the educational institution and the fraternity institution.

There are several laws in the country pertaining to the role and use of geoscience information for development purposes. These include the Land Conservation Act (1960), Environmental Quality Act (1974), Geological Survey Act (1974), Street, Drainage and Buildings Act (1974) and Town and Country Planning Act (1976) Revised (1995). The laws stipulate the incorporation of geological information for regional and urban planning, with the Minerals and Geoscience Department being the designated repository of all geological data collected by the public and private sectors. In order to ensure sustainable development, the enforcement of these laws should be strengthened and the requirement for a comprehensive geological report should be made mandatory for all development projects.

The government institution is represented by the Minerals and Geoscience Department, which came about as a result of the merger of the Geological Survey Department and the Mines Department on 1st July 1999. The government institution can enhance the role of geoscience by providing fast, quality information and services that are needs-driven, stimulating growth for geoscience services in the private sector, and forming synergetic linkages with agencies, industries and universities at the local, regional and international levels.

The educational institutions may need to review the curriculum in view of their relevance in addressing current public requirements. Geoscience courses on tunneling and excavation, geohazard management and rehabilitation of former mines, quarries and landfill sites should be emphasized to meet the current requirements. The possibility of incorporating geology into the secondary school curriculum should also be studied.

The two main fraternity institutions are the Institute of Geology Malaysia and the Geological Society of Malaysia. These organizations should play complementary roles to increase the promotion of geoscience among non-geoscience professionals and the public. Dialogues with non-geoscience professionals should be emphasized. All geoscientists should be involved and committed to the activities conducted by fraternity institutions, in this context.

The strengthening of all four institutions requires geoscientists to be dedicated, competent and professional. Thus, the level of expertise in various geoscience disciplines has to be enhanced, in tandem with technological development, so that geoscientists can contribute more effectively in national development.

MARKETING GEOSCIENCE SERVICES AND ENHANCING PROFESSIONALISM

Mr. Chong Foo Shing emphasized the need for marketing geoscience services in the 21st century. Geoscience services are required in several sectors such as mining, soil surveys, slope studies and environmental assessments. In addition, several pieces of legislation stipulate the need for geoscience information. One example is the Town and Country Planning Act (1976) Revised (1995), which requires geoscience information for urban planning. Despite the existing demand, there are still problems in marketing geoscience services in the country. This could be due to the fact that the role of geoscientists is not properly clarified. The lack of a professional body established by an Act of Parliament compounds to this problem. The public should be advised that only trained geologists can produce quality work and that such geologists are currently registered with the Institute of Geology Malaysia. The Institute of Geology is committed to maintaining high standards within the profession and among the long term plans are to conduct training courses and produce guidebooks for its members.

Mr. N. Balasubramaniam confirmed the receipt of a proposal from the Institute of Geology Malaysia for the formulation of a Registration of Geologists Bill in 1995. The aim of the Bill is to ensure that the quality of geological reports is maintained by regulating geologists through the establishment of a mandatory registration programme. Since 1995, the Ministry of Primary Industries has conducted several consultative meetings with organisations that represent the geology profession as well as other interested parties. The Bill will be submitted to the cabinet after being reviewed by the Attorney General's Chamber. Subsequent to this, it will be presented at the Parliament. The Institute of Geology Malaysia has played a critical role in the formulation of this Bill and its role is anticipated to become more important once the Bill is enacted.

DISCUSSION

During the discussion after the panel presentation several pertinent points were raised. These were regarding enhancement of professionalism among geoscientists, networking and awareness building as well as geoscience education.

In order to enhance professionalism among geoscientists, the fraternity institutions, in particular the Institute of Geology Malaysia was requested to look into the following aspects:

- A code of ethics to be practised by geoscientists has to be developed and implemented. Geoscientists should be made aware of this code at the tertiary level.
- The scope of work of engineering geologists should be properly defined so that the current confusion regarding geotechnical and geological reports can be cleared. This information should be widely disseminated to geologists and engineers in both the government and private sectors.
- The enactment of the Registration of Geologists Bill should be hastened to address the problem of poor quality geological reports that are prepared by non-geologists. This practice, which is currently prevalent, tarnishes the image of the geoscience profession. As an interim measure the Institute of Geology Malaysia should circulate the list of registered geologists to all relevant government agencies on an annual basis.
- Apathy among geoscientists on the need for registration to regulate and maintain high standards within the geoscience profession has to be addressed. In addition, geoscientists should continuously update themselves with the latest knowledge and not limit themselves to outdated methods.

The importance of networking and awareness building was emphasized and the following recommendations were made:

- The Institute of Geology Malaysia was requested to conduct more dialogues with non-

geoscience professional organizations to promote awareness regarding the contribution and importance of geoscience.

- The Institute of Geology Malaysia, being the professional body for geoscientists, should encourage more interactions with other professionals, particularly engineers. It was suggested that non-geoscientists be allowed to become members of the Institute for this purpose.
- Promotion of geosciences through articles in the print media for public consumption should also be emphasized by the geoscience fraternity institutions.

In the context of geoscience education, the issue of changing the four-year geoscience curriculum in public universities to three years was highlighted. The shorter duration of training geologists is a handicap to the geoscience profession, as the graduates produced tend to be less competent. Geoscience courses in the United Kingdom are conducted over three years. However, graduates in the United Kingdom are exposed to geology at the Ordinary and Advanced levels. This not the case in Malaysia, where graduates are introduced to geology only at the tertiary level. The Institution of Engineers have requested that engineering courses be maintained for four years instead of being shortened to three. The Institute of Geology and the Geological Society of Malaysia were requested to study this matter and submit a similar proposal to the relevant authorities. On the content of the curriculum, it was requested that computer applications, project management and the relationship between geology and society be emphasized.

The forum would not have been a success without the support of the panelists and the enthusiastic participants. The assistance of Marilah Sarman, Syafrina Ismail, Tanot Unjah and Lakam Mejus in the preparation of this report is gratefully acknowledged. Lim Choun Sian, Zaitul Zahira Ghazali, Victor Lee and James Bachat are thanked for their assistance during the forum. Last but not least, the generous sponsorship from PETRONAS for this forum is acknowledged with appreciation.

Ceramah Teknik (Technical Talk)

Malam S.I.

Tuesday, July 10, 2001

Site investigations: a geologist's view

NG CHAK NGOON

Site investigations: an engineer's perspectives

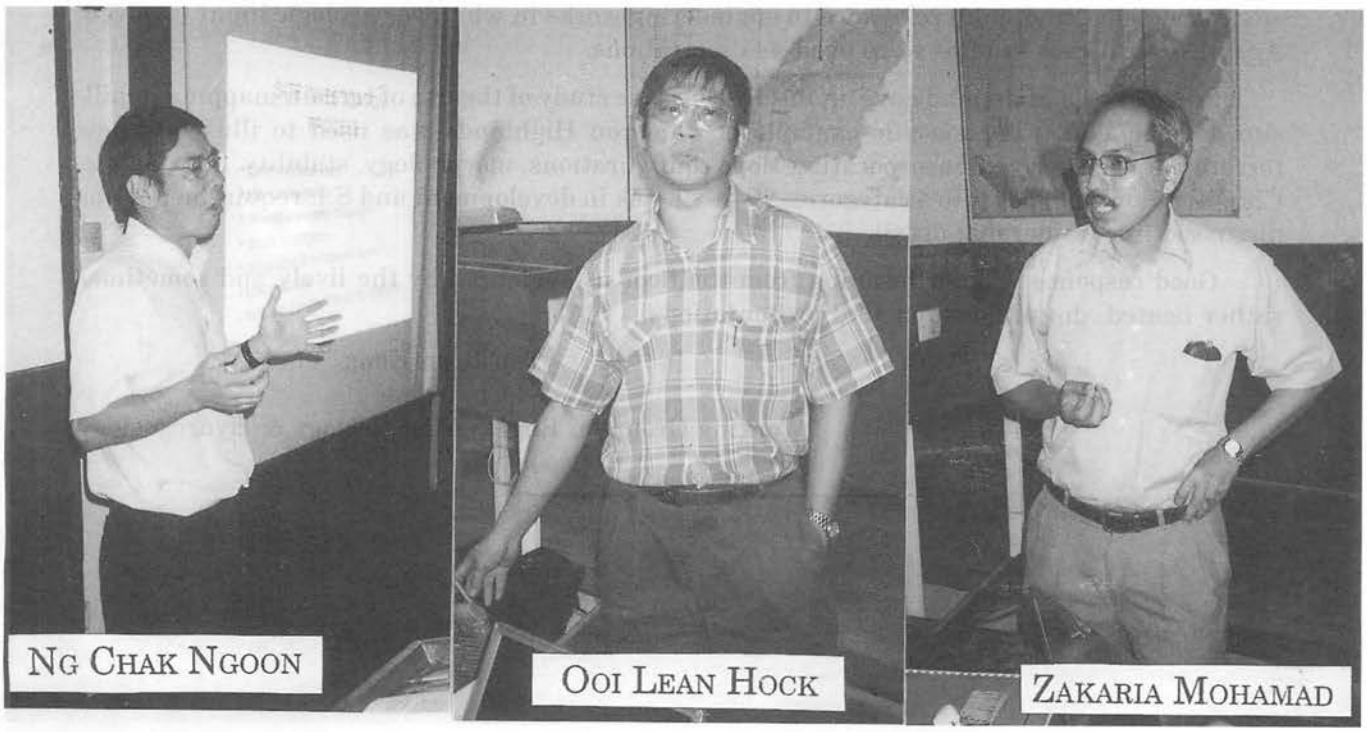
OOI LEAN HOCK

Use of terrain maps for landuse planning

CHOW WENG SUM & ZAKARIA MOHAMAD

Laporan (Report)

Dr. Ooi began by highlighting what engineers look for in S.I., such as tell-tale signs of failures during site visit, design parameters (shear strengths, consolidation, etc.), various other field and laboratory tests beside boreholes. He illustrated his talk with two examples: embankment on soft clays and deep excavation as in basement and tunnelling constructions.



Mr. Ng gave some interesting and somewhat controversial views on the role of geologists in S.I., for e.g. in logging, geologic mapping, etc. He emphasised on geomorphological mapping, site inspections, and more relevance to engineering works in whatever geologic input involved. Again, several case studies were used as illustrations.

Sdr. Zakaria Mohamad gave an interesting case study of the use of terrain mapping in hill-site development. The specific example of Cameron Highlands was used to illustrate how terrain map are derived, incorporating slope configurations, morphology, stability, erosion, etc. Classification of slopes into 4 categories vis-a-vis risk in development and S.I. requirements was discussed in considerable detail.

Good response was forthcoming from the floor as evidenced by the lively and sometimes rather heated, discussions for all 3 presentations.

Tan Boon Kong
Chairman
Working Group on Engineering Geology & Hydrogeology

Seminar sehari kemajuan terkini kaedah geofizik kejuruteraan — Laporan

Kumpulan Geofizik Persatuan Geologi Malaysia dengan kerjasama Program Geologi, Pusat Pengajian Sains Sekitaran & Sumber Alam, Fakulti Sains & Teknologi, UKM telah berjaya menganjurkan seminar sehari yang bertajuk "Kemajuan Terkini Kaedah Geofizik Kejuruteraan". Seminar ini telah diadakan pada hari Sabtu bersamaan 14hb Julai 2001 di Bangunan Geologi, Universiti Kebangsaan Malaysia, Bangi, Selangor telah mendapat sambutan hangat dengan jumlah peserta seramai 84 orang. Peserta-peserta tersebut terdiri daripada jurutera, ahli geofizik, geologis, pengarah syarikat, pegawai penyelidik dan ahli akademik.

Sembilan kertas kerja membincangkan berkaitan dengan hasil kajian terkini geofizik kejuruteraan telah dibentangkan. Semua peserta mendapat satu kompilasi sembilan keras kerja yang telah dibentangkan. Tema utama seminar ini adalah penggunaan kaedah 3-D untuk pemetaan kawasan geologi yang kompleks. Kertas kerja utama dalam bidang "3-D resistivity" ini telah disampaikan oleh pembentang jemputan dari USM iaitu Dr. Loke Meng Heng.

Sebanyak empat kertas kerja terdiri daripada kajian seismos dan lima kertas yang lain adalah membincangkan hasil kajian Keberintangan geoelektrik. Senarai tajuk dan pembentang kertas kerja adalah seperti Berikut:

1. Penggunaan analisis spektrum gelombang permukaan dalam kajian geologi kejuruteraan
   Abdul Rahim Samsudin, Khairul Anuar Mohd Nayan & Azmi Ismail (UKM)
2. Seismic refraction in Bukit Luncu, Johor
   Samsudin bin Hj Taib & Ahmad Nizam Hassan (UM)
3. Anisotropi seismos jasad batuan sebagai penunjuk kualitatif orientasi ketakselanjaran utama
   Abdul Ghani Rafek et al. (UKM)
4. Ground water aquifer mapping using 2.5-D Electrical Imaging technique in Brookland Plantation, Selangor, Malaysia
   A.N., Ibrahim, M.M., Nawawi, Z.T., Harith, M.S., Ayub & A. Alphonse (USM)
5. Gabungan kaedah pengimejan resistiviti 2-D dan seismik pembiasan dalam mengesan terowong konkrit bawah tanah — suatu kajian awal
   Rosli, S., Harith, Z.Z.T, dan Nawawi, M.N.M
6. The use of 3D electrical imaging surveys for mapping complex subsurface structures
   Loke Meng Heng (USM)
7. 2-D Resistivity Imaging — an effective piling 'cross-checking' method in boulders prone area
   Harith Z.Z.T, Nawawi, M.N.M. & Azi, A.M. (USM)
8. Penggunaan kaedah pengimejan resistiviti 2-D dalam kajian lubang benam — suatu kajian awal
   Kahar E.A., Nawawi, M.N.M. & Harith, Z.Z.T. (USM)
9. Pemetaan struktur bawah permukaan dengan kaedah seismos pantulan
   Umar Hamzah et al. (UKM)

Seminar ini telah diikuti sebelah petangnya dengan satu sesi demo "3-D resistivity field data acquisition" di Seri MINT, Bangi, selangor dan teknik pemprosesan dan pentafsiran data di makmal. Dalam sesi perbincangan, Dr. Loke telah menunjukkan cara memproses dan mentafsirkan data keberintangan 3-D serta memberi beberapa contoh kajian yang telah dijalankan.

Seminar sehari kemajuan terkini kaedah geofizik kejuruteraan

Dr. Ghani bersama Dr. Loke dan Prof. Rahim.

Dr. Loke dengan '3-D field demo'.

Sesi demo survei keberintangan 3-D.

Mengikut Dr. Loke, kaedah keberintangan 3-D ini tidak sesuai untuk tujuan komersial kerana melibatkan perbelanjaan yang agak besar dan masa yang lebih lama. Seminar sehari ini tamat jam 5.00 petang dan ditutup oleh presiden Persatuan Geologi Malaysia Prof. Madya Dr. Ab. Ghani Rafek.

Abdul Rahim Samsudin,
Ab. Ghani Rafek &
Umar Hamzah

Public Lecture

Creation-Evolution Debate: latest developments

by

Robert Chapman Newman

Laporan (Report)

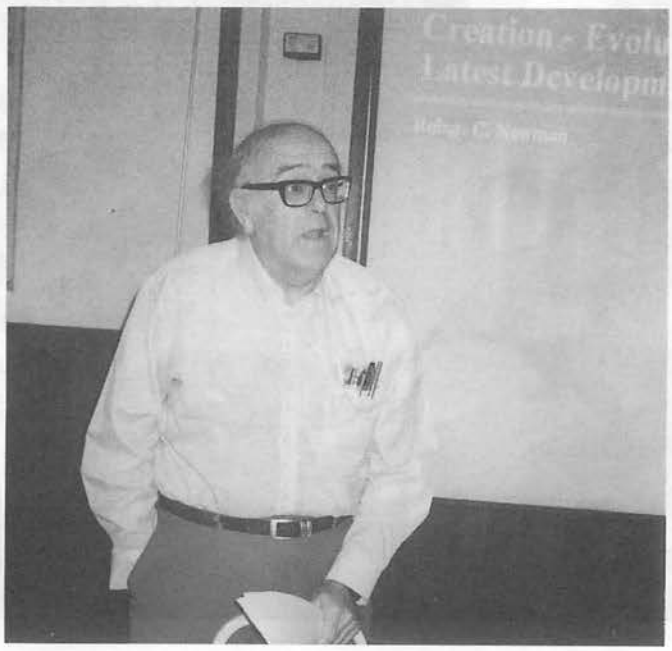
Dr. Robert Chapman Newman is a theologian and seminary professor with a Ph.D. in astrophysics from Cornell University. He is the Director of the Interdisciplinary Biblical Research Institute and has published over 100 articles on Science and Faith.

The public lecture held on 8th August 2001 at 5.30 pm at the Geology Department, University of Malaya, was co-organized with the Department of Science and Technology Studies, Centre for Civilization Dialogue, University of Malaya and the Graduates Christian Fellowship Malaysia.

In his lecture, Dr. Newman dealt with the following topics:

- Favourable evidence for evolution.
- So why doesn't everybody believe in evolution?
- Some scientific problems for evolution:
  - (1) Problems of generating order by randomness & survival
    - — origin of life, origin of specific biochemicals, origin of chemical processes and organs and the Darwinian mechanism.
  - (2) Problems of the fossil record
    - — relative lack of transitional forms, fragmentary fossil record?, the shape of the fossil record, small populations, punctuation, stasis, islands of function.
- Some conclusions: — problems generating order
  — problems with the fossil record.

The talk attracted a record crowd of over 100 participants. There was active participation by members of all the different organisations present in terms of questions, comments and items for discussions with the speaker.



G.H. Teh

Creation-Evolution Debate: latest developments

Comparative studies of the Lower Cretaceous Woburn sands outcrops (UK) and the modern and subsurface field analogues for heterolithic tidal sandstone reservoir characterization

SHUJI YOSHIDA

Laporan (Report)

Shuji Yoshida, who should be now at the Institute for Energy Research, University of Wyoming, gave the above talk on 15 August 2001 at the Geology Department, University of Malaya.

He is an experienced sedimentologist with extensive knowledge and skills in multi-scale research of siliciclastic deposits, ranging from sedimentary basin down to laminae/pore-size, utilizing outcrop data, modern environment and subsurface data. He has broad multi-disciplinary knowledge and communication skills gained from a wide range of both industrial experience and education in geology, geomorphology, geophysics and engineering

Abstrak (Abstract)

Tidal sandstone reservoirs host major hydrocarbon accumulations in the northern North Sea, Venezuela, SE Asia and elsewhere. However, their characterization and modelling are difficult. This is because they contain a complex array of sedimentary heterogeneities at various lengthscales, and predicting their production behaviour has been hampered by a lack of quantitative data on the dimensions and geometries of these heterogeneities.

We have used the well-exposed outcrops of the Lower Cretaceous Woburn Sands (UK) to characterize the small- to intermediate- (millimetre- to metre-) scale heterogeneities of tidal deposits, utilizing architectural element and sedimentary facies analyses within a sequence stratigraphic framework. The unit contains a wide range of tidal sedimentary structures, and is interpreted as recording a transgressive change of depositional environments from a narrow, tide-dominated estuary to a broad, tide-dominated marine embayment, similar to the Holocene history of The Wash Embayment in Eastern England. Mud drapes occur along the set boundaries and foresets of cross-stratification and burrows in various sizes within the Woburn Sands. This unit also contains distinct, thin sub-horizontal, wavy, mud laminae (c. 1–2 mm thick or less) within the ripple cross-laminated part. Most mud drape types have log-normal length distributions within the outcrop, with periodic clustering in the vertical direction.

The Middle Jurassic Beryl Formation (Bruce and Beryl fields, northern North Sea) is interpreted to have been formed under the regional and depositional setting comparable to the Woburn Sands and The Wash Embayment. The Beryl Formation contains abundant thin wavy mud drapes analogous to those found within the Woburn Sands. A range of quantitative outcrop data, suitable for validating and/or populating objects for the stochastic modelling of tidal reservoirs, is presented for the various facies and sand body types, including shale layer and heterolithic facies dimensions.

Saturday Morning Technical Talks

on

Young Geologists' Work Experiences

25 August 2001

Geology Department, University of Malaya, Kuala Lumpur

Laporan

The event was organized by the Young Geologists' Working Group. The purpose of the event was to bring together young geologists to share their knowledge and experience with local geological experts, researchers, academicians and students with the aim of working and contributing towards nation development.

The event will also be used as a platform for young geologists to develop their confidence in presentation, public speaking and answering questions, skills which are lacking in most of our geological graduates.

The was good turnout of about 40 participants.

Programme

8.30 am : Registration

9.00 am : Opening Address by Abd. Rasid Jaapar, Chairman, Young Geologists' Working Group

9.15 am : *Some Experiences on Contaminated Ground Assessment*
— Raja Abdul Halim & Lim Chee Keong (ENSR Corporation Sdn. Bhd.)

9.45 am : *Environmental Impact Assessment on Groundwater Abstraction in the Langat Basin*
— Michael Lau (Perunding Utama Sdn. Bhd.)

10.15 am : *Some Experiences on Quarry Assessment*
— Zaidin Satimin (Shoh Consultancy)

10.45 am : Coffee Break

11.15 am : *Soil & Rock Description: A Comparison between BS5930 (1999), BS5930 (1981), GCOGeoguide 2 and Common Local Specification*
— Nuril Anwar Ahba & Abd. Rasid Jaapar (Soils & Foundations Sdn. Bhd.)

11.45 am : *Rock Fall Hazard Analysis*
— Ong Gim Liok & Md. Zaini Madi (Opus Consultants Sdn. Bhd.)

12.15 pm : *Some Experiences on Geotechnical Instrumentation for Monitoring Field Performance*
— Hamidan Mat Wajib (Soil Centralab Sdn. Bhd.)

12.45 pm : Closing Address

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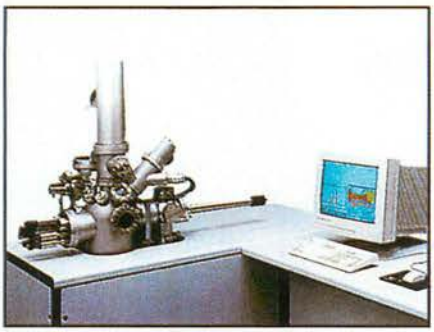

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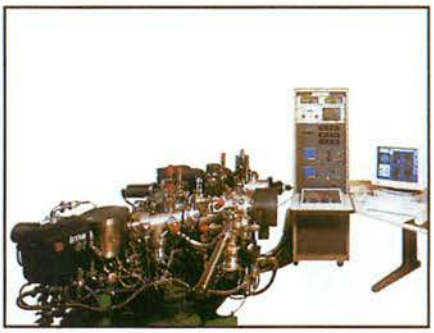

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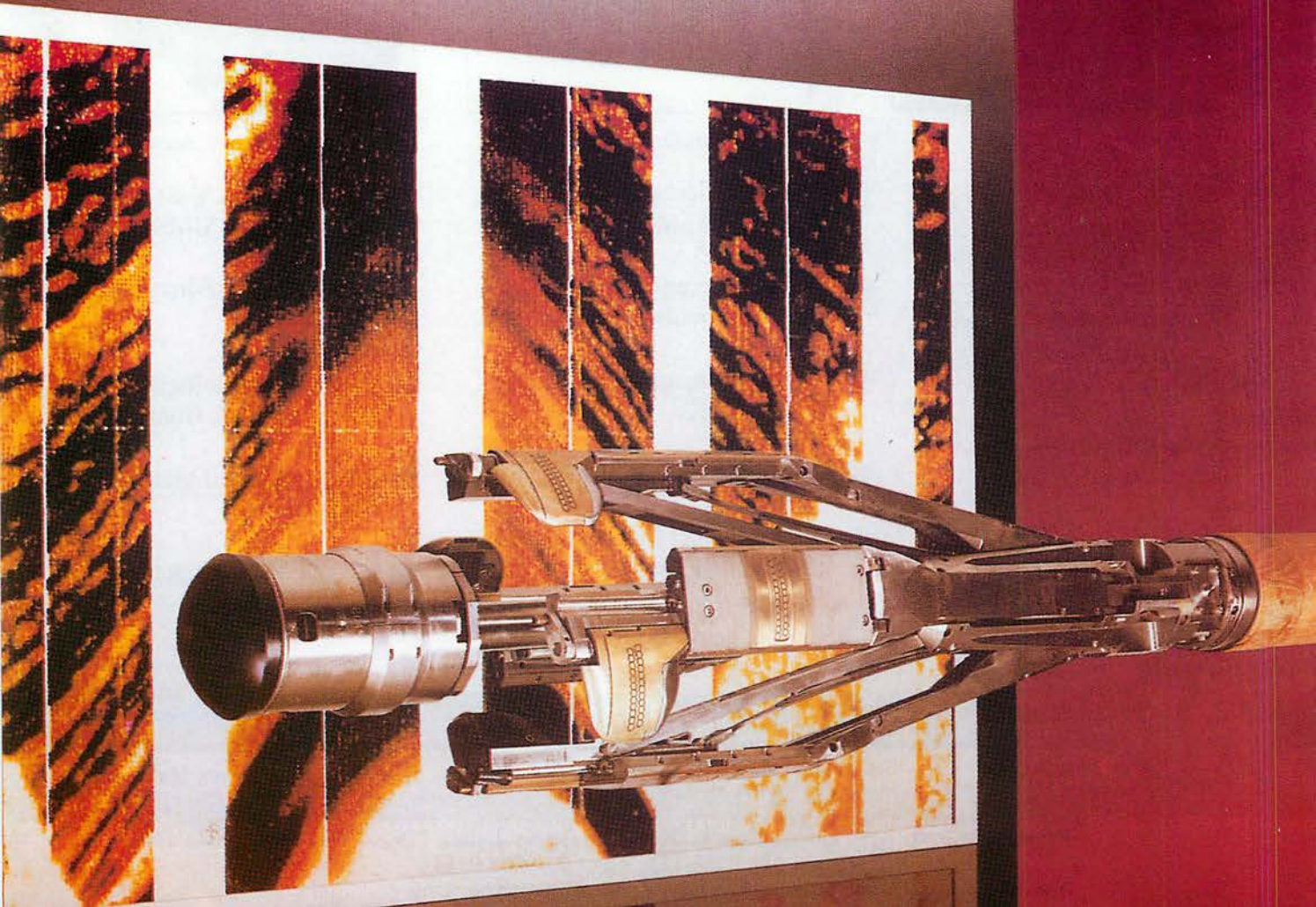

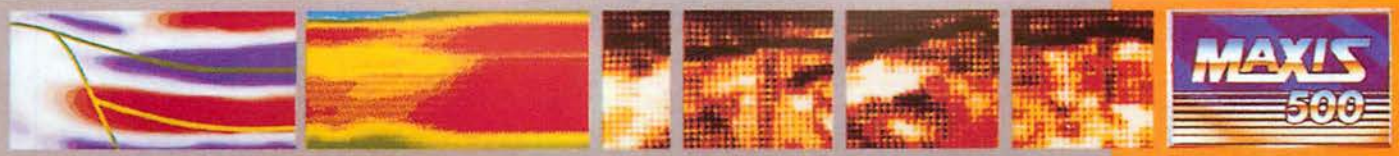

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People, Knowledge & Technology

Young Geologists' Work Experiences

Saturday Morning Technical Talks

on

Young Geologists' Work Experiences

25 August 2001

Geology Department, University of Malaya, Kuala Lumpur

Abstracts of Papers

Some experiences on contaminated ground assessment

RAJA ABDUL HALIM RAJA MUDA

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Environmental Geologist is a new promising career in Malaysia. This paper is explaining the task of Environmental Geologist in a Petrol Service Station and Depot or Terminal. The information such as site geology, hydrogeology and groundwater flow directions are important to understand an overall picture of the contamination present at the site that serve as a baseline for future comparison purposes.

The objectives of an Environmental Site Assessment (ESA) are to assess the existing soil and groundwater conditions at each site/facility, to assess potential subsurface soil and groundwater contamination due to past operations at the sites, to identify contamination sources, and to delineate the extent of contamination, if present.

The scope of work involved of soil sampling and groundwater monitoring well installations. Area of Potential Contamination (APC) with high impact such as tank farm area, oil water separators, drainage systems and the depot's former discharge area were identified. Boreholes were advanced and monitoring well installed to establish the site subsurface conditions and groundwater flow patterns.

Part of scope of work was to assess the potential offsite migration from the site to neighbouring properties and documented the potential of offsite contamination sources, from neighbouring properties. Based on the site investigation and laboratory analytical results, a site conceptual model was developed. The site environmental condition were evaluated through the sampling and analysis of soil and groundwater. Laboratory analyses of the samples was performed in accordance to US-EPA analytical protocol. Develop a site conceptual model based on the result of the site assessment.

As part of the project, a risk assessment was conducted in accordance with comparable standard such as the Australian Oil and Industry Environmental Guidelines Working Group (AOIEG) and Dutch Standard. The risk assessment was based on current and reasonably foreseeable site use and conditions, which was mainly industrial and/or commercial. Later the risk posed by the contamination identified was assessed and documented, and an effective and economical remedial alternative to remediate the site will also developed.

Geological input in environmental impact assessment for groundwater abstraction in Langat basin

MICHAEL LAU

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The Langat basin is one of the very intensely developed areas in the country; especially at areas located downstream of the Sungai Langat. Among geographical areas under the coverage of the basin are Kajang-Rinching-Beranang, Bandar Baru Bangi, Cyberjaya-Putrajaya, Paya Indah-Dengkil, Nilai-Salak Tinggi, Kuala Lumpur International Airport and Sijangkang-Telok Panglima Garang.

Some of the activities being undertaken at the basin are such as groundwater abstraction and which requires Environmental Impact Assessment (EIA) study. Objective of this paper is to present some geological input for a case study of groundwater abstraction at the Langat basin. Geological information can be obtained from library and archives search and also existing data that are not published. The project is described whether it is groundwater abstraction from the alluvial or hard rock aquifers. Other information includes of geological mapping and geophysical investigation, boreholes & test well drilling, assessment of the groundwater potential, contamination and anticipated problems.

A steel mill requires voluminous amount of water to run its operation. Areas at the flat plain of Kuala Langat is well known for its problematic water supply, whether it is low pressure of insufficient or irregular supply. Additional request from the public water supply to the industrialist will add additional burden to the already burdensome demand. Alternative source is therefore from groundwater and groundwater can either be usefully utilised or abundantly wasted!

Some experiences on quarry assessment

ZAIDIN SATIMIN

Shoh Consultancy
6A, Lorong Datuk Sulaiman Satu
Taman Tun Dr. Ismail, 60000 Kuala Lumpur

Quarry is generally defined as extraction and processing of rock materials from lands. There are many usage of the quarry products such as in construction industry principally as aggregates, building stones, making cement, producing fertilizers, glass making etc. In quarry development, some factors should be taken into account including size of quarry site, method of working, site accessibility, rock reserve availability etc. Geological investigations are essential in the preliminary selection of potential quarry sites and such, understanding the distribution of various rock types within our country would certainly be helpful.

The development of quarry is also expected to change the natural environment and therefore proper mitigation measures should be considered in order to minimized the pollution.

Soil and rock description: a comparison between BS5930 (1999), BS5930 (1981), GCO Geoguide 3 and common local specification

NURIL ANWAR AHBA ABDUL HAMID & ABD RASID JAAPAR

Soils & Foundations Sdn. Bhd.
23, Jalan Desa, Taman Desa
Off Jalan Kelang Lama
58100 Kuala Lumpur

Soil and descriptions for civil engineering applications are typically carried out in three main locations;

- In the field, at a natural or man-made exposure.
- In the field, on soil sample or rock core obtained from site investigation drilling rig.
- In the laboratory, on pieces of soil sample or rock core before or after the testing were carried out.

The main purpose of soil and rock description for civil engineering purposes is to give an indication of the likely engineering properties of the material. Soil and rock description is to a certain degree subjective. In order to minimize the subjective element; a systematic examination should be carried out using a standard terminology, whether the material be in natural exposure, trial pit face or samples recovered from borehole. The use of a standardized scheme of description ensures that:

- All factors are considered and examined in logical sequence.
- No essential information is omitted.
- No matter who describes the sample, the same basic description is given using all terms in an identical way.
- The description conveys an accurate mental image to the reader.
- Any potential user can quickly extract the relevant information.

This paper will discuss on comparison between various standards, references and specification currently being used in Malaysia when there is no *'compulsory'* method of soil and rock description. The CIDB's Working Group 3 of Technical Committee 5 had agreed to adopt Section 6 of the latest version of BS5930 published in 1999 as Malaysian Standard for soil and rock description; we, therefore must be ready and familiar with this method. This paper is also intended to provide the brief explanation on the method of description using BS5930 (1999).

Rockfall hazards analysis

ONG GIM LIOK & MD. ZAINI MADI

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58100 Kuala Lumpur

Rockfalls can be defined as rock falls freely or bounces down a steep slope or cliff. Rockfalls are a major hazard in rock cuts along highways, railways and residential areas in mountainous terrain.

The factors that caused rockfalls are generally internal, external and mechanical. The internal and external factors combined with the action of gravity usually resulted instability of rock mass.

The internal factor is related to geological structure of rock mass. The geological structure of rock mass is controlled by its discontinuities behaviour. Discontinuities are breaks, fractures or planes of weakness in the rock mass and include joint, fault, bedding plane, foliation and cleavage fracture. Discontinuities with adverse orientation will cause rockfalls. The external factors are weathering and erosion process, influence of water and plant growth within the rock's discontinuities. Weathering breaks down rock into pieces and erosion is the physical removal of rock particles by an agent such as flowing water. Severe weathering and erosion will tend to decrease the strength or rock mass and caused rockfall. Water is the main agent to reduce the shear strength of discontinuities surfaces within rock mass and caused instability for the rock slope.

In construction stage, the standard practice was to use aggressive blasting and ripping techniques to construct rock slopes. This mechanical factor will probably be one or two orders of magnitude higher to initiate rockfall than the internal and external factors.

Rockfalls trajectory will indicate the path taken for rock to fall. The most important factors controlling rockfall trajectory are the characteristics of rock slopes (slope geometry, slope height, slope angle and slope surface material). Other factors such as the size and shape of the rock boulders, rock friction angle and whether or not the rock breaks into smaller pieces on impact also have minor impact of controlling rockfall trajectory.

It is not possible to detect and prevent all the rockfall problems because some of the rock slope is not accessible due to very steep, high and dangerous condition for the slope inspection. The rockfalls protection method such as wire netting, catch fence and sprayed concrete should be implemented for protection against rockfalls. The factors that caused rockfall and control rockfall trajectory should be known prior to select the best method for rockfall protection.

Some experiences on geotechnical instrumentation for monitoring field performance

HAMIDAN MAT WAJIB

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43650 Bandar Baru Bangi
Selangor D.E.

The practice of geotechnical instrumentation involves a marriage between the capabilities of measuring instruments and the capabilities of people. There are two general categories of measuring instruments. The first category is used for *in situ* determination of soil and rock properties such as strength, compressibility and permeability, normally during the design phase of a project. The second category is used for monitoring performance, normally during the construction of a project and may involve measurement of groundwater pressure, total stress, deformation, load, or strain.

The use of geotechnical instrumentation is not merely the selection of instruments but a comprehensive step-by-step engineering process beginning with a definition of the objective and ending with implementation of the data. Every instrument on a project should be selected and placed to assist with answering a specific question: if there is no question, there should be no instrumentation.

Construction industries do have some limitation or uncertainties in terms of behaviours of soils or structures during and after construction. Therefore, geotechnical instrumentation is a useful tool to determine the following:

- To confirm compliance of real behaviour with design assumptions.
- To ensure the observed behaviour remains within pre-determined permissible limits.
- To demonstrate progressive deformations which require immediate action for ground support strengthening.
- To measure the development of ground movements, *in situ* stresses and variations in ground water conditions.
- To provide early warnings of failures and monitor long term safety.
- To demonstrate safety measures to the public.

This paper indicated the reasons for instrumentation, case study and past experiences in instrumentation and monitoring works.

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(New Library Additions)

The Society has received the following publications:

1. Monthly statistics on mining industry in Malaysia, Nov. & Dec, 2000 and Jan-Mac, 2001.
2. Geological Survey of Japan, Bulletin, vol. 52, nos. 1, 2/3, 2001.
3. AAPG Explorer, June & July 2001.
4. 54th Geological Congress of Turkey, Abstracts & CD 2001.
5. AAPG Bulletin vol. 85, nos. 2, 4, 6 & 7, 2001.
6. Geoscience Journal, vol. 4, no. 3, 2000.
7. Acta Geoscientia Sinica, vol. 21, no. 3, 2000.
8. Journal of Shijiazhuang, University of Economics, vol. 23, nos. 3–5, 2000.
9. Geological Survey of Japan, Bulletin vol. 51, nos. 8 & 9, 2000.
10. CCOP Technical Bulletin vols. 28 & 29, 2000.
11. U.S. Geological Survey of Professional Paper 2000: 1601-A–B, 1626, 1610. 2001: 1603.

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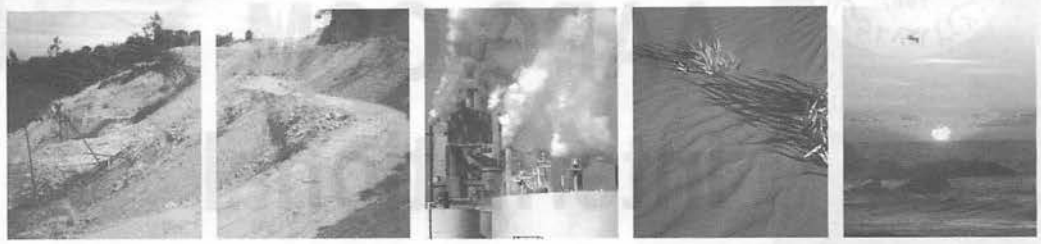

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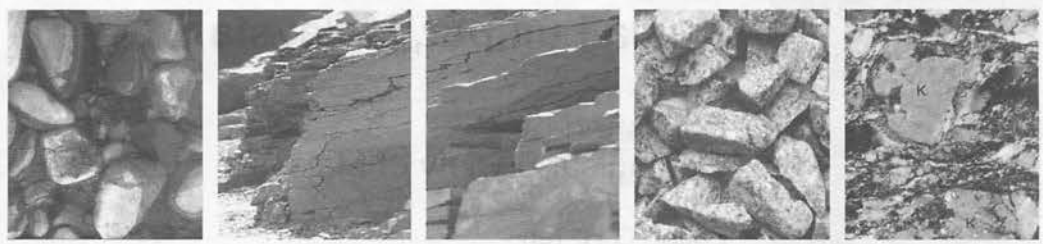

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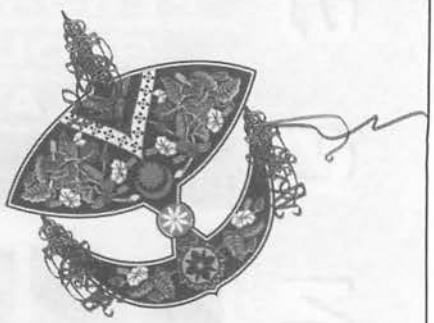

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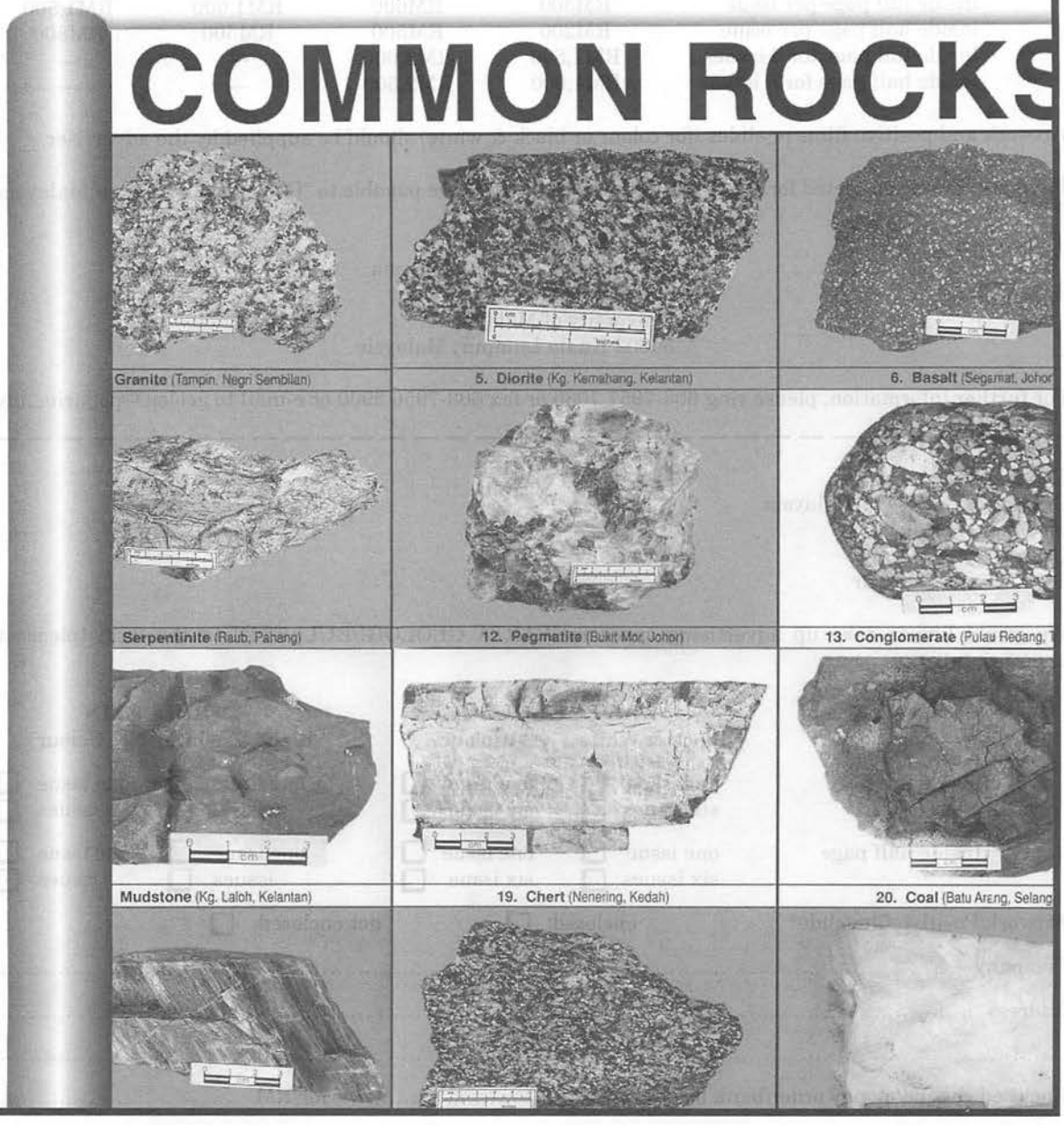

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September 25–29

SIXTH INTERNATIONAL SYMPOSIUM ON LAND SUBSIDENCE (SISOLS 2000), Ravenna, Italy. (Contact: Dr. Laura Carbognin, CNR-ISDGM, S. Polo 1364, 30125, Venezia, Italy. Tel: +39-041 5216826; Fax: +39 041 5216892; E-mail: jane@isdgm.ve.cnr.it)

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HUTCHISON, C.S., 1989. *Geological Evolution of South-east Asia*. Clarendon Press, Oxford. 368p.

SUNTHARALINGAM, T., 1968. Upper Paleozoic stratigraphy of the area west of Kampar, Perak. *Geol. Soc. Malaysia Bull. 1*, 1-15.

TAYLOR, B., AND HAYES, D.E., 1980. The tectonic evolution of the South China Sea basin. *In:* D.E. Hayes (Ed.), The Tectonic and Geologic Evolution of Southeast Asian Sea and Islands, Part 2. *Am. Geophy. Union Monograph 23*, 89-104.

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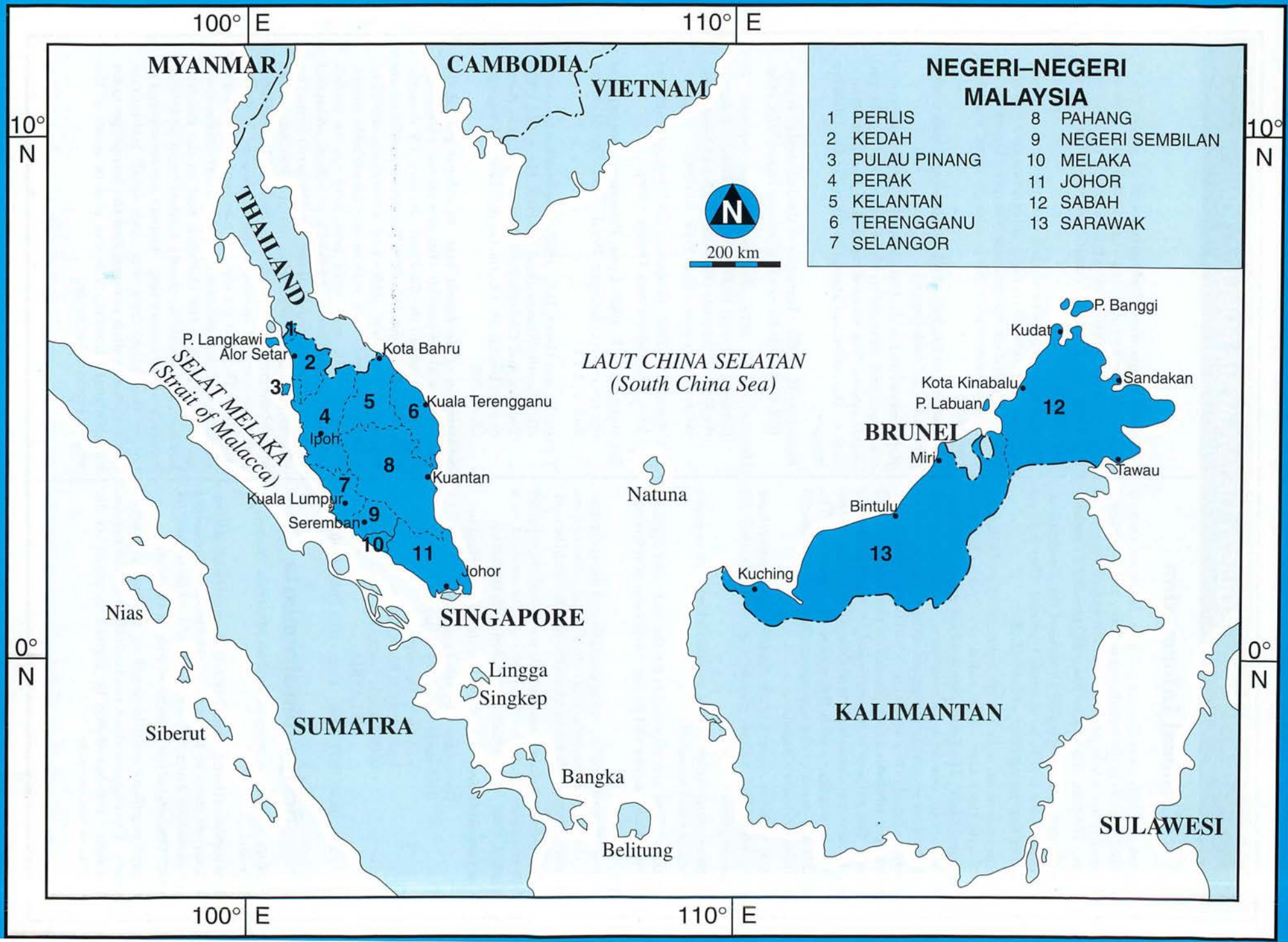
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