ISSN 0126-5539
PP2509/2/2008

WARTA GEOLOGI

PERSATUAN GEOLOGI MALAYSIA

Newsletter
of the

Geological Society of Malaysia

Title ***: Orthogonal joints in finely laminated sandstone***
Locality : Tg. Layang-Layangan, Labuan, Malaysia
By ***: Dr Ng Tham Fatt***
University of Malaya

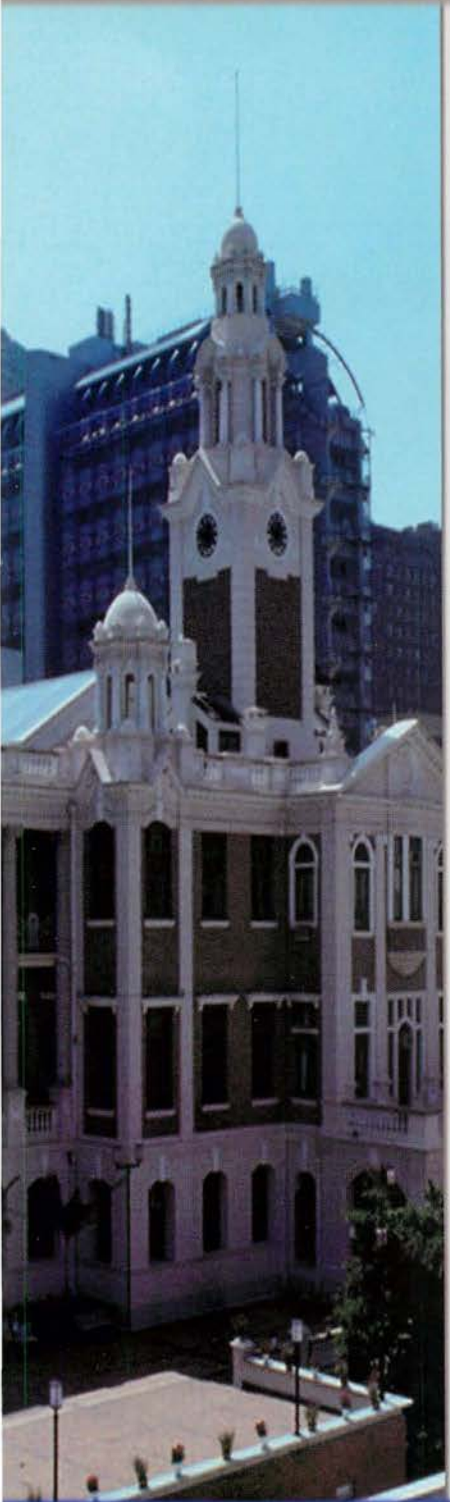
Jilid /Volume 33, No 6. November - December 2007

The University of Hong Kong

Master of Science in Applied Geosciences

(Since 1998)

FACULTY OF SCIENCE *Department of Earth Sciences*



- A one year full-time academic programme in Engineering Geology, Environmental Geology, Geosciences with Sustainable Development or Climate and Earth Sciences Studies
- Held in Hong Kong, an Asian centre of excellence in geotechnics
- At HKU, one of the top 20 universities in the World*.

*(THES-QS World Universities Ranking 2007)

Courses

Geology
Soil mechanics
Rock mechanics
Hydrogeology
Environmental management
Substainable development
Site investigation
Geotechnical design
Geophysics
Rock engineering
Geochemistry
Environmental Geology
Professional practice
Geotechnical failures

Taufik Ali Memorial Scholarships

Persons of Muslim faith born in Malaysia or in Hong Kong are eligible to apply for Taufik Ali Memorial Scholarships
Closing date: 15 May 2008

Contact

Professor Andrew Malone
Email: awmalone@netvigator.com
Tel: + 852 2559 2555 Fax: + 852 2517 6912

Details and application forms: www.hku.hk/science/postgrad

Apply now for admission in September 2008

PERSATUAN GEOLOGI MALAYSIA (GEOLOGICAL SOCIETY OF MALAYSIA)

MAJLIS (COUNCIL) 2007/08

Presiden (President)
Yunus Abdul Razak

Naib Presiden (Vice-President)
Joy Pereira

Setiausaha (Secretary)
Mohd Badzran Mat Taib

Penolong Setiausaha (Asst. Secretary)
Mohd. Rozi Umor

Bendahari (Treasurer)
Ahmad Nizam Hasan

Pengarang (Editor)
Lau YinLeong

Presiden Yang Dahulu (Immediate Past President)
Lee Chai Peng

Ahli-Ahli Majlis (Councillors)
Samsudin bin Hj. Taib
Tan Boon Kong
Jasmi Hafiz Abdul Aziz
Nur Iskandar Taib
Gan Lay Chin
Jasmi Abdul Talib
Ling Nan Ley
Ng Tham Fatt

The Society was founded in 1967 with the aim of promoting the advancement of earth sciences particularly in Malaysia and the Asian region. The Society has a membership of about 600 earth scientists and is worldwide in distribution.

The Warta Geologi (Newsletter of the Geological Society of Malaysia) is published bimonthly by the Geological Society of Malaysia. The Warta Geologi is available free to members of the Geological Society of Malaysia

Geological Society of Malaysia,
Department of Geology,
University of Malaya,
50603 Kuala Lumpur, Malaysia
Tel : 603-7957 7036
Fax: 603-7956 3900
e-mail : geologi@po.jaring.my
Editor email : jadeitejade@gmail.com
URL : www.gsm.org.my

Printed by:
Art Printing Works Sdn Bhd
29, Jalan Riong, 59100 Kuala Lumpur
Malaysia

CATATAN GEOLOGI (Geological Notes)

Assessment of Shuttle Radar Topographic Mission (SRTM) elevation data of Lojing and Hulu Langat, Peninsular Malaysia

Dr Ng Tham Fatt

Geology Department, University of Malaya,

50603 Kuala Lumpur, Malaysia

Abstract

The availability of digital elevation model (DEM) is limited in many developing countries including Malaysia. This has changed when the Shuttle Radar Topographic Mission (SRTM) released data with near global (80% of the landmass) coverage that can be freely downloaded over the internet in 2003. The SRTM data has since been used globally in a wide range of research, including geoscience studies. In this paper, the quality and vertical accuracy of 3 arc-second SRTM data (~90 m resolution) has been evaluated against reference digital 1:50,000 topographic maps for 2 areas in Peninsular Malaysia. The results show that the contour lines and topographic profiles derived from the SRTM data appear to be comparable to those from the topographic maps. There is an average bias of 15.0 m in the hilly and densely forested area of Lojing and 8.1 m for the undulating low hills covered by rubber plantation, forest and developed area of Hulu Langat. The accuracy of the SRTM data is better in less rugged terrains and terrains with slope gradient less than 10° compared to hilly terrains and terrains with slope gradient greater than 10°. The derived SRTM slope gradients show average bias of -1.9° for Lojing and -1.1° for Hulu Langat. The drainage network derived from the SRTM data is comparable to that in the topographic maps but most first and second order streams are not delineated.

Abstrak

Di kebanyakan negara membangun termasuk Malaysia, data model aras digital (DEM) kurang didapati. Keadaan ini berubah bila misi topografi radar shuttle (SRTM) memperolehi data yang meliputi 80% daripada permukaan benua dan data ini boleh didapati secara percuma melalui internet pada tahun 2003. Data SRTM telah digunakan di seluruh dunia dalam berbagai kajian, termasuk kajian geosains. Kertas kerja ini menafsir kualiti dan kejituan menegak data SRTM 3 saat-lengkung (resolusi ~90 m) secara berbanding dengan data rujukan daripada peta topografi digital berskala 1:50,000 untuk dua kawasan di Semenanjung Malaysia. Keputusan menunjukkan garis kontor dan profir ketinggian yang didapati daripada data SRTM dapat dibandingkan dengan apa yang ada pada peta topografi. Di kawasan yang berbukit dan diliputi oleh hutan tebal di Lojing, terdapat perbezaan ketinggian sebanyak 15.0 m. Di kawasan Hulu Langat yang berbukit rendah dan beralun yang diliputi oleh ladang getah, hutan dan kawasan membangun, perbezaan ketinggian adalah 8.1 m. Kejituan data SRTM adalah lebih baik untuk terain yang kurang berceranggah dan kawasan yang bercerunan kurang daripada 10°.

Berbandaing dengan data peta topografi, kecuraman yang dihasilkan daripada data SRTM menunjukkan perbezaan purata -1.9° untuk kawasan Lojing dan -1.1° untuk kawasan Hula Langat. Berbanding dengan peta topografi, rangkaian saliran yang didapati daripada data SRTM adalah hampir sama tetapi kebanyakan sungai berorder pertama dan kedua tidak dapat digariskan.

INTRODUCTION

Digital Elevation Model (DEM) is an important tool in geoscience studies and it has been used in geomorphology and lineament studies (Koike *et al.*, 1998; Jordan *et al.*, 2005; Grohmann *et al.*, 2007), hydrological and watershed modelling (Molnar and Julien, 1998; Aalto and Montgomery, 2003; Valeriano *et al.*, 2006; Ghoneim and El-Baz, 2007) and geohazard studies (van Beek and van Asch, 1998; Baron *et al.*, 2007). In many developing countries including Malaysia, DEM is not widely available. Although the Survey and Mapping Department of Malaysia (JUPEM) has digitized the 1:50,000 scale topographic maps with contours at 20 m intervals, both the digital data and topographic maps are restricted documents that cannot be readily purchased by the public.

The Shuttle Radar Topography Mission (SRTM) data sets are digital elevation model of the Earth acquired using radar interferometry consisted of the Spaceborne Imaging Radar-C (SIR-C) and X-band Synthetic Aperture Radar (X-SAR) systems. In February 2000, the SRTM successfully collected data over 80% of the landmass of the Earth (Farr and Kobrick, 2000; Verner, 2001; Rabus *et al*, 2003, Farr *et al.*, 2007). The C-band SRTM data is available at resolution levels of 1 arc-second (~30 m) and 3 arc-second (~90 m). The 3 arc-second data (SRTM-3) is available globally and for strategic reasons the 1 arc-second data (SRTM-1) is only for the USA territory. The SRTM data can be freely accessed over the internet in 2003 and in 2006 the second or "finished" version was released (SRTM, 2007). The "finished" SRTM data was edited to delineate and flatten water bodies, to define coastlines and to remove "spikes" and "wells". Another difference between the "finished" and the earlier research-grade SRTM data is that the "finished" data was subsampled from the 1 arc-second data, while the latter was averaged or down-sampled from the 1 arc-second data.

The SRTM data contains numerous voids that can be filled by interpolation from surrounding pixels. The SRTM data has absolute horizontal and vertical accuracy of 20 m and 16 m, respectively (Rabus *et al.*, 2003; Rodriguez *et al.*, 2005). In forest area, the SRTM provide elevation data of the top of the canopy, with a slight penetration (Bourgine and Baghdadi, 2005). The release of such high quality DEM data to the public has totally revolutionised the concept of global topographic mapping.

It is envisioned that the SRTM data will be widely used for geoscience studies in Malaysia. This study assess the quality and accuracy of the SRTM elevation data by comparing the elevation values as well as first order topographic derivatives such as slope gradient and flow accumulation between the SRTM data and DEM prepared from 1:50,000 topographic maps.

STUDY AREA

The study was carried out for two areas with different terrain characteristics and landuse: Lojing in the state of Kelantan and Hulu Langat in Selangor (Figure 1). The study area in Lojing is about 200 km^2 and bounded by longitude 101.36 – 101.56°E and latitude 4.64 – 4.73° N (Figure 2). The Lojing area is hilly highlands in the centre of the Main Range and has elevations between 270 m and 2130 m above mean sea level. The area has rugged terrain with steep slopes and narrow valleys. The area is almost completely covered by dense primary forest. A small settlement, Pos Brooke is located near the centre of the area.

The study area in Hulu Langat is about 220 km^2 and bounded by longitude 101.72 – 101.92°E and latitude 3.02 – 3.11° N (Figure 3). The Hulu Langat area is consisting mainly of undulating low hills with gentle to moderate slopes. There are broad alluvial plains along Sungai Langat and its larger tributaries. The elevation is between 30 m and 510 m above mean sea level. The area is covered by rubber plantations, primary and secondary jungle and the lowland at the west and southwest (Cheras, Balakong, Sungai Long) has largely been developed as residential and commercial areas. The natural topography in some of the developed areas has been modified by cut-and-fill activities.

DATA DESCRIPTION, PROCESSING AND ANALYSIS

The research-grade 3 arc-second SRTM data was used in this study. The data of Lojing and Hulu Langat areas has 0.2% and 0.5% voids respectively. The voids were filled by linear interpolation using the free software 3DEM version 19.0 and converted to GeoTIFF raster format. The GeoTIFF files were subsequently converted to ArcGrid in ArcGIS 9.0 for further analysis.

The digital topographic data with 20 m contour interval was obtained from JUPEM. The digital topographic data is similar to the 1:50,000 topography maps published by JUPEM between 1986 and 1996. This dataset referred to as topoDEM in this paper is in West Malaysia RSO Projection and Kertau 1948 datum. The topoDEM was projected to WGS84 datum in ArcGIS 9.0. The nodes of the contour lines were extracted as elevation data points and used to generate ArcGrid with 3 arc-second pixel size using weighted tension spline interpolation in the Geospatial Analyst Extension of ArcGIS 9.0. There are about 210,000 data points for the Lojing area and 104,000 points for the Hulu Langat area.

Terrain derivatives including slope gradient, flow direction and flow accumulation were obtained from the surface analysis tool and hydrology tool of ArcGIS 9.0. The DEM drainage networks were vectorised from the flow accumulation with a threshold value of 25. The differences in elevation values and slope gradients between the SRTM and topoDEM data were calculated using the raster calculator in the Geospatial Analyst. The calculation results were saved in ArcGrid files. All the ArcGrid files were saved in ASCII format and were organised in a spreadsheet table for statistical analysis.

The quality of the SRTM data was assessed by comparing it to the topoDEM data, which is assumed to be correct. Qualitative analysis was carried out by comparing the topographic profiles and contour lines derived from the SRTM data with that from the topographic maps. The magnitude of difference between the SRTM and topoDEM data was analysed statistically to determine the biasness and accuracy of the SRTM data.

RESULTS AND DISCUSSION

The statistics of the SRTM and topoDEM data for Lojing and Hulu Langat areas are summarised in Table 1. Compared to the topographic map, contour lines and topographic profiles derived from the SRTM data are relatively smooth due to its large pixel size (Figures 4 and 5). The SRTM contours are generally close to contour lines of the topographic maps but discrepancies are observed near the southeastern corner of the Lojing area (Figure 4).

To quantify the discrepancies and relative accuracy between the SRTM and topoDEM data, difference in elevation (SRTM elevation – topoDEM elevation) was calculated. The difference in elevation between the SRTM and topoDEM data is shown in Figures 4 and 5 and summarised in Table 2. In the Lojing area the average difference (bias) is 15.0 m and the differences range from -90 m to 111 m. About 48% of the data has differences of 0 m – 30 m (or bias ± 15 m). The area with high magnitude differences is mainly near the southeastern sector, east of Pos Brooke (Figure 4).

In the Hulu Langat area the differences range from -99 m to 71 m, with average value of 8.1 m. About 77% of the data has differences between -7 m and 23 m (or bias ± 15 m). Two areas with high magnitude of differences (-90 m and -60 m, Figure 5) near Bukit Enggang are quarries where the elevation of the quarry pits is not available in the topographic map. It should be noted that the difference in elevation for the filled voids is not significantly greater than the surrounding pixels for both the Lojing and Hulu Langat areas.

The bias of the SRTM data can be attributed mainly to the vegetation cover and buildings. The elevation difference has been used to estimate the height of vegetation (Kellndorfer *et al.*, 2004). In the Lojing, the bias of 15 m is in close agreement to the canopy height of the dense primary forest in the area. The lower bias in Hulu Langat (8.1 m) can be attributed to lower height of canopy in the rubber plantations and height of buildings, which are consisting mainly of 2-storey houses.

Linear regression shows highly significant correlation ($p<0.0001$) between the SRTM and topoDEM data for both Lojing and Hulu Langat areas (Figures 6 and 7). In both cases, the slope of the regression line is close to 1 and the intercept at negative values.

Statistics of the slope gradient derived from the derived from the SRTM and topoDEM data are summarised in Table 3. The average slope gradient in Lojing is about twice of that in Hulu Langat. Differences in the slope gradient between SRTM and topoDEM data are shown in Figures 8 and 9 and summarised in Table 2. In the Lojing area, the average difference is -1.9° and is ranging from -30° to 24°. About 44% of the data has differences of ±2.5° and 73% has differences of ±5°. In Hulu Langat, the differences range from -18° to 19° with average value of -1.1°. However, the difference in slope gradient in most area (91%) is ±5° and about 58% of the area has difference of ±2.5°.

Analysis shows that slope gradient derived from SRTM data is generally slightly lower (negative bias) than that derived from topoDEM data. The magnitude of difference is greater for steep hilly terrain (i.e. Lojing) compared to area with gentle to moderate slopes (i.e. Hulu Langat). The negative bias of slope gradient is due to smoothening of local variation in topography within the pixel. The difference in slope gradient can also be caused by canopy effects (Figure 8).

Drainage networks derived from SRTM data are overlain on the drainage of the topographic maps (Figures 9 and 10). Due to the relatively large pixel size, the derived drainage networks appeared simplified or have low sinuosity. Most of the first and second order streams in the topographic map are absent in the derived drainage. Although decreasing the threshold value of flow accumulation can increase the number of first and second order streams in the derived drainage, many first order streams cannot be detected due to relatively large pixel size of the SRTM data and canopy effects. In Lojing, the derived drainage is similar to the drainage in the topographic map. Although the overall derived drainage network in Hulu Langat resemble drainage in the topographic map, significant differences are observed in several places. Most obvious errors occur along the relatively flat floodplain along Sungai Langat. Problem of deriving drainage networks using DEM in variable topography with floodplains as compared to mountainous terrain has also been reported by Liang and Mackay (2000). In the present study, the errors are partly due to canopy effects where vegetation cover or buildings cause false detection and masking of drainage channels (Figure 8).

The accuracy of the SRTM data is better in Hulu Langat where the standard deviation of the difference in elevation is 13.6 m and the value is 24.3 m for Lojing where the terrain is rugged. Analysis shows that accuracy of SRTM data is better on terrains with slope gradient less than 10° for both Lojing and Hulu Langat (Table 4). Similar results were also reported by Miliasresis and Paraschou (2005) and Gorokhovich and Voustianiouk (2006) in their studies on the influence of slope on SRTM accuracy.

It is also interesting to note that the average difference or bias in elevation for terrains with slope gradient less than 10° in Lojing is higher compared to the steeper terrains (17.3 m vs 14.6 m). However, opposite trend is shown in the Hulu Langat area (6.5 m for <10° slopes; 11.0 m for ≥10° slopes, Table 4). In Lojing, this is probably due to greater canopy heights in areas with gentle slopes compared to terrains with over 10° slopes. In Hulu Langat, development and agricultural activities are concentrated on flat and gently sloping areas, while the rugged and steep areas are still under forest cover.

In this study the vertical accuracy of the SRTM data is assessed relative to the data from digital 1:50,000 topographic maps that were used as references. To analyse the absolute accuracy of SRTM data, a reference DEM acquired from comprehensive field global positioning system (GPS) surveys is desirable. However, implementation of GPS survey in rugged terrain with dense forest cover such as in Lojing is difficult and requires significant resources.

CONCLUSION

The quality and accuracy of 3 arc-second SRTM elevation data has been evaluated against the data of 1:50,000 digital topographic maps for 2 areas in Peninsular Malaysia. The contour lines derived from the SRTM data appear to be comparable to the contours of the topographic maps, albeit being smoothened out. There is an average bias of 15.0 m in the hilly and densely forested area of Lojing and 8.1 m for the undulating low hills covered by rubber plantation, forest and developed area of Hulu Langat. The accuracy of the SRTM data is better in less rugged terrains and terrains with slope gradient less than 10° compared to hilly terrains and terrains with slope gradient greater than 10°.

The derived SRTM slope gradients show average bias of -1.9° for Lojing and -1.1° for Hulu Langat. The drainage network derived from the SRTM data is comparable to that in the topographic maps but most first and second order streams cannot be delineated using SRTM data. Error in the position of the drainage occurs mainly in flat areas.

Overall the SRTM data is of high quality and comparable to the data from the 1:50,000 topographic maps. However, bias of elevation values due to vegetative cover and buildings should be taken into consideration.

Table 1: Descriptive statistics of the SRTM and topoDEM data for Lojing and Hulu Langat areas.

Statistical Parameter	Lojing		Hulu Langat	
	SRTM	TopoDEM	SRTM	TopoDEM
Mean, m	1,001.0	984.0	159.7	151.6
Standard Deviation, m	333.3	336.2	102.3	99.6
Standard Error, m	2.2	2.2	0.6	0.6
Minimum, m	279	271	28	26
Maximum, m	2,140	2,138	512	506
Count	23,230	23,230	25,460	25,460

Table 2: Analysis of differences (elevation and derived slope gradient) between SRTM and topoDEM data for Lojing and Hulu Langat areas (elevation in m and slope gradient in degree).

Statistical Parameter	Lojing		Hulu Langat	
	Elevation	Slope Gradient	Elevation	Slope Gradient
Mean	15.0	-1.9	8.1	-1.1
Standard Deviation	24.3	4.5	13.6	3.3
Standard Error	0.2	0.03	0.1	0.02
Minimum	-90	-30	-99	-18
Maximum	111	24	71	19
Count	23,230	23,230	25,460	25,460

Table 3: Descriptive statistics of slope gradient derived from SRTM and topoDEM data for Lojing and Hulu Langat areas.

Statistical Parameter	Lojing		Hulu Langat	
	SRTM	TopoDEM	SRTM	TopoDEM
Mean, °	15.54	17.56	7.25	8.39
Standard Deviation, °	6.53	7.13	5.73	6.69
Standard Error, °	0.04	0.05	0.04	0.04
Minimum, °	0.25	0.11	0	0
Maximum, °	41.01	46.64	32.51	32.26
Count	23,230	23,230	25,460	25,460

Table 4: Analysis of differences in elevation from SRTM and topoDEM data for terrains with slope gradient less and greater than 10° in Lojing and Hulu Langat areas.

Statistical Parameter	Lojing		Hulu Langat	
	<10°	≥10°	<10°	≥10°
Mean, m	17.31	14.61	6.50	10.99
Standard Deviation, m	21.61	24.7	11.73	16.18
Standard Error, m	0.26	0.18	0.09	0.17
Minimum, m	-49	-90	-99	-95
Maximum, m	110	111	63	71
Count	3,649	19,581	16,403	9,063

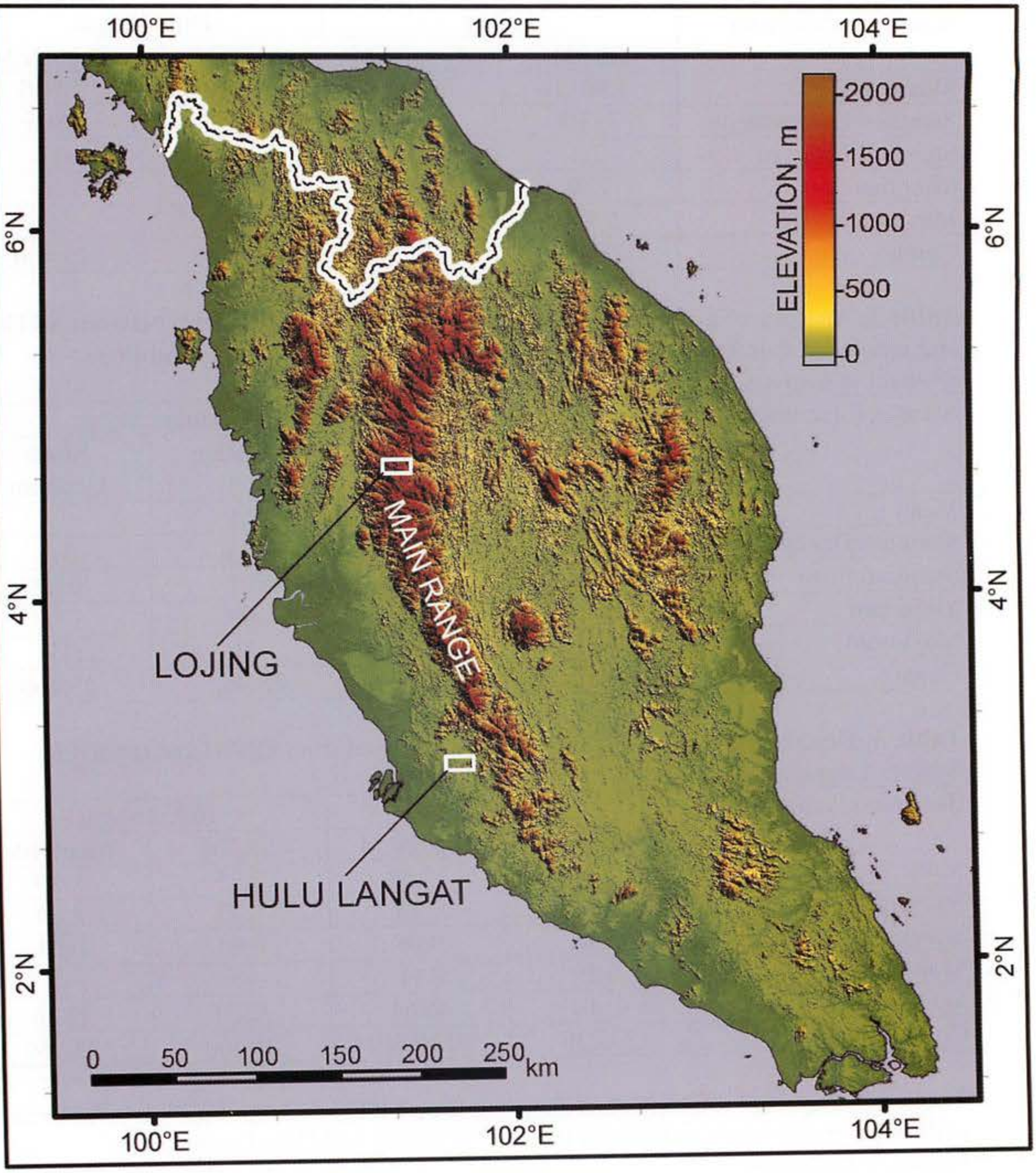


Figure 1. *Shaded relief map of Peninsular Malaysia showing the study areas of Lojing and Hulu Langat.*

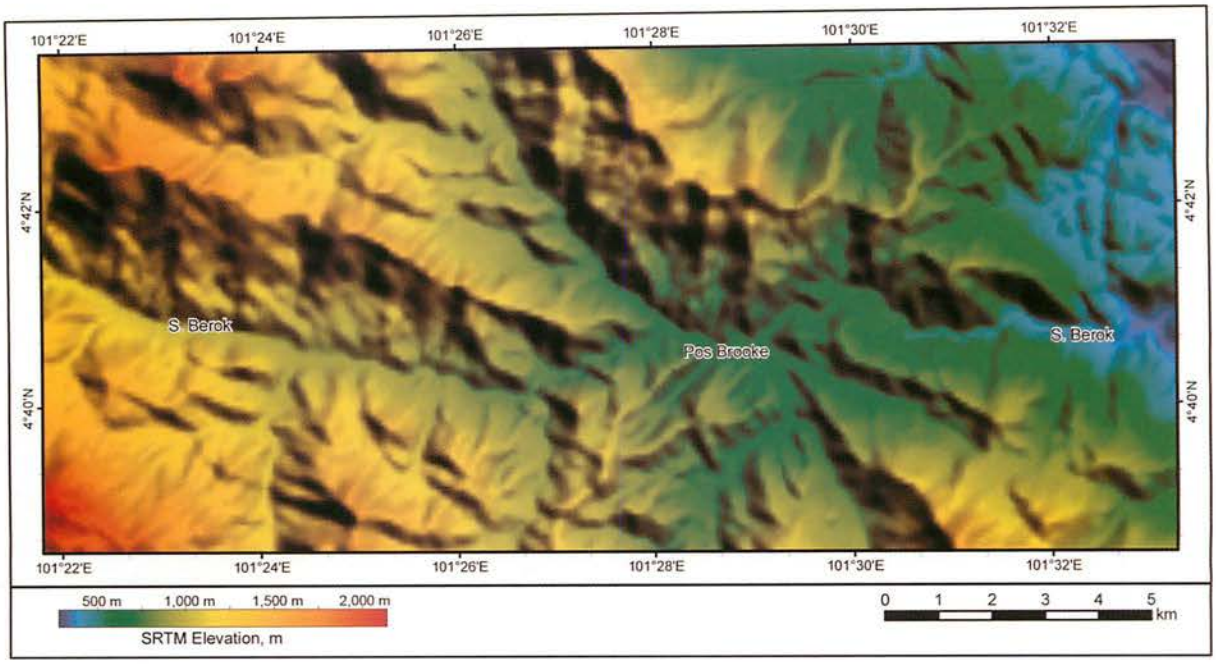


Figure 2. *Shaded relief elevation map of the Lojing area derived from SRTM data.*

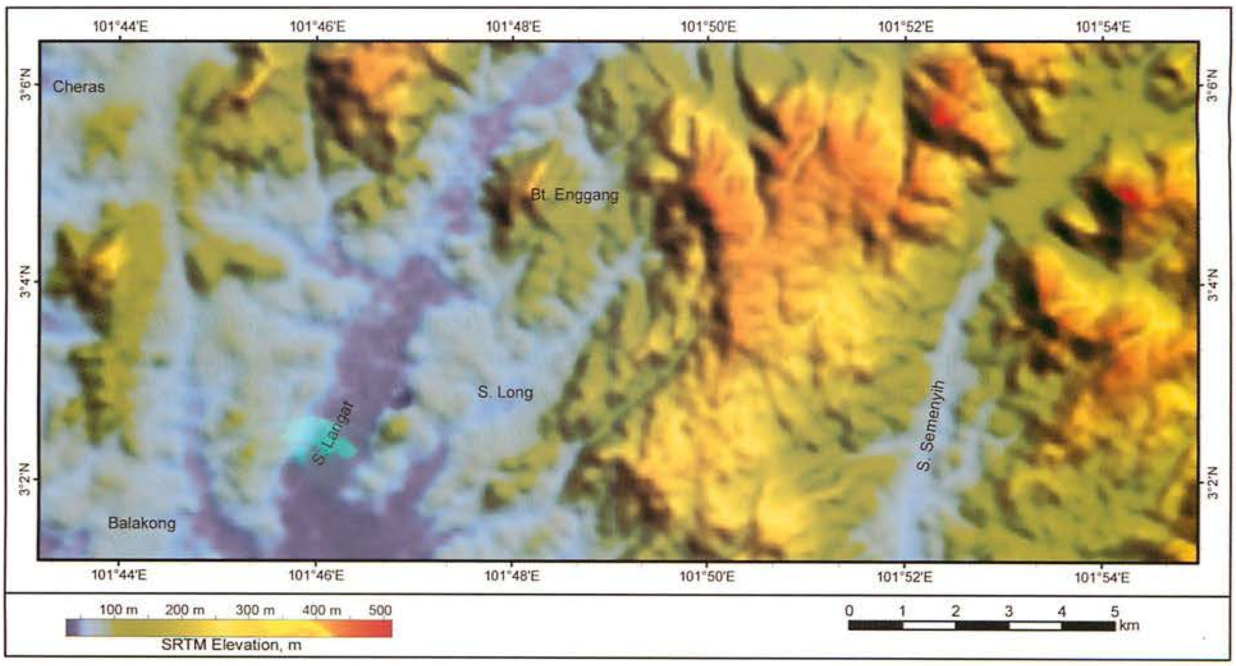


Figure 3. *Shaded relief elevation map of the Hulu Langat area derived from SRTM data.*

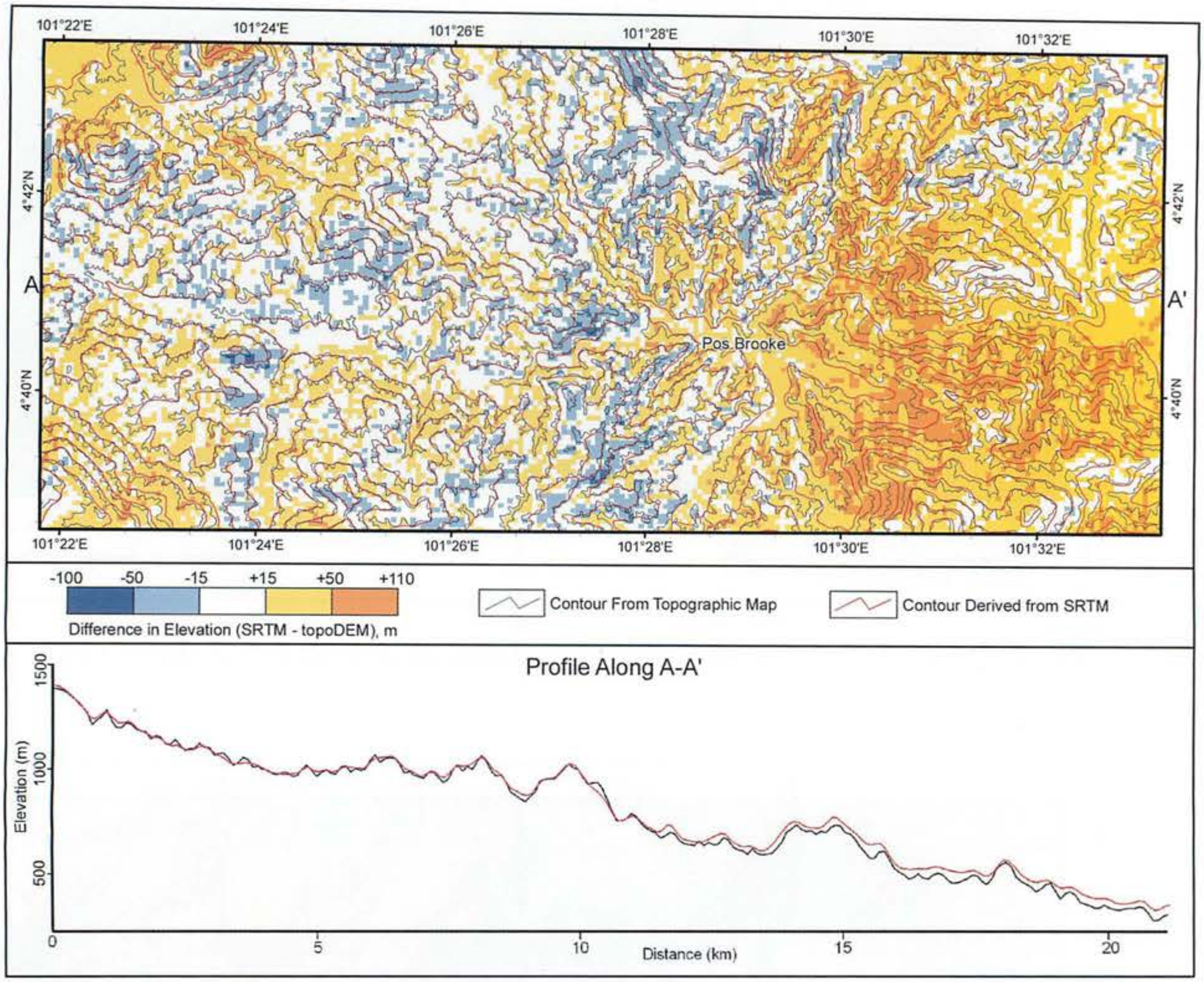


Figure 4. *Map showing the difference in elevation between SRTM and topoDEM data in Lojing. The contour lines derived from SRTM data appear smoothened out compared to the contours of the topographic map. The topographic profile derived from SRTM data is also smoother. Difference in elevation is obvious in areas east of Pos Brooke.*

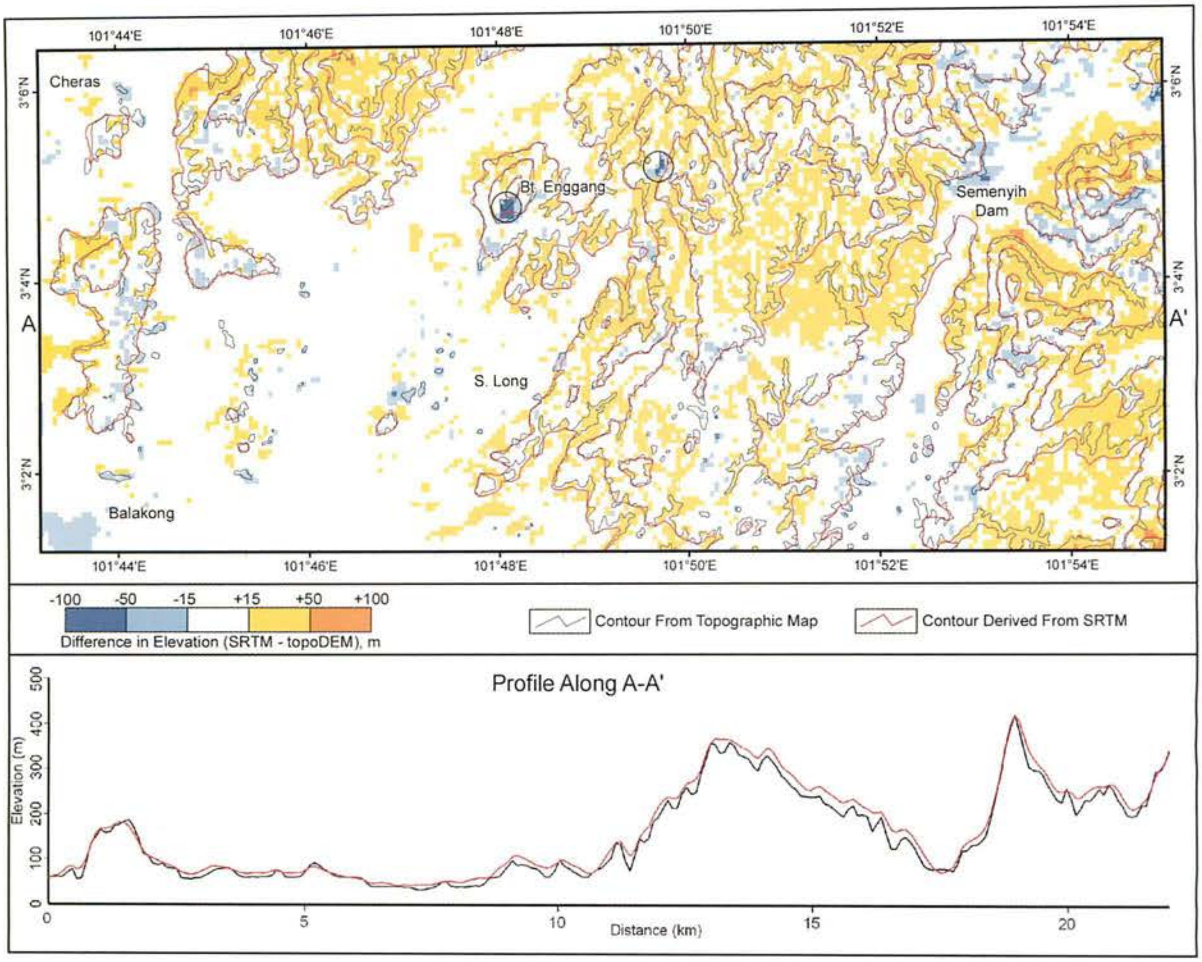


Figure 5. *Map showing the difference in elevation between SRTM and topoDEM data in Hulu Langat. The contour lines derived from SRTM data appear smoothened out compared to the contours of the topographic map. The topographic profile derived from SRTM data is also smoother. Differences in elevation in the circled areas near Bukit Enggang are quarries where the elevation of the quarry pits is not available in the topographic map.*

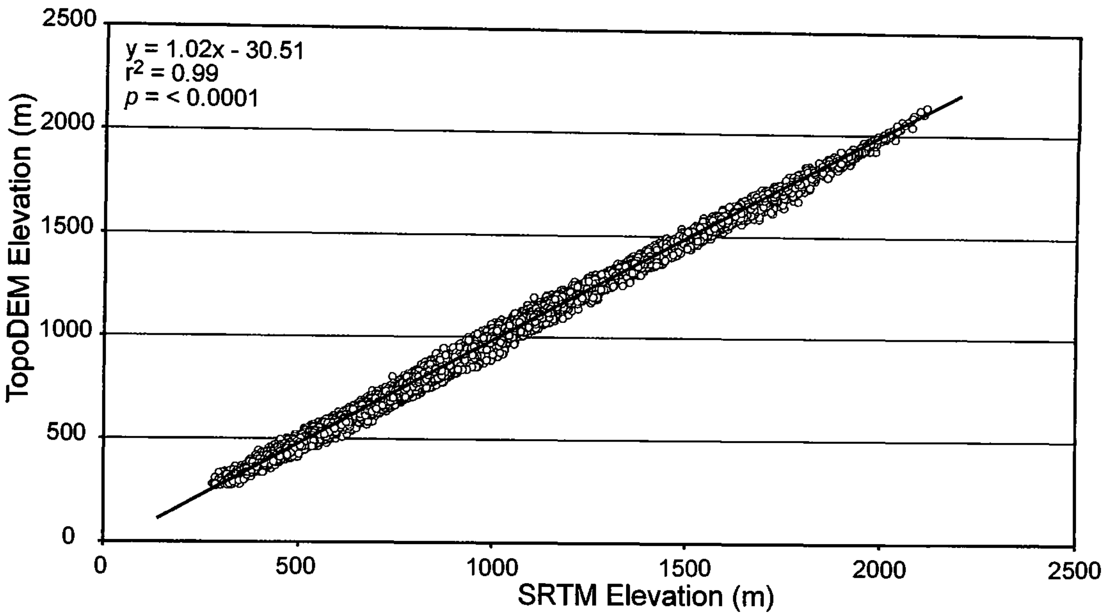


Figure 6. *Correlation between SRTM and topoDEM data for Lojing area.*

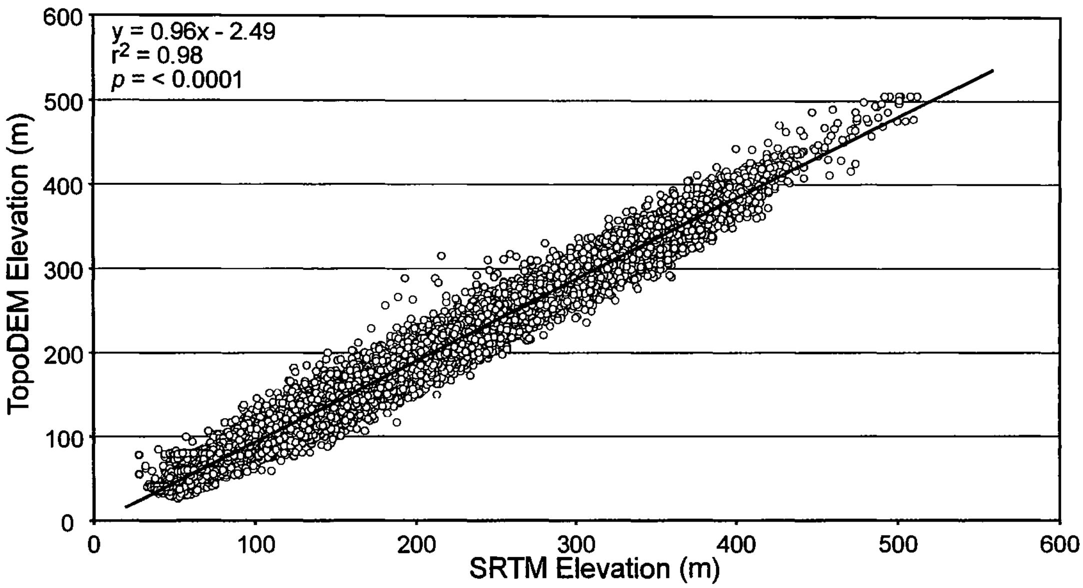


Figure 7. *Correlation between SRTM and topoDEM data for Hulu Langat area.*

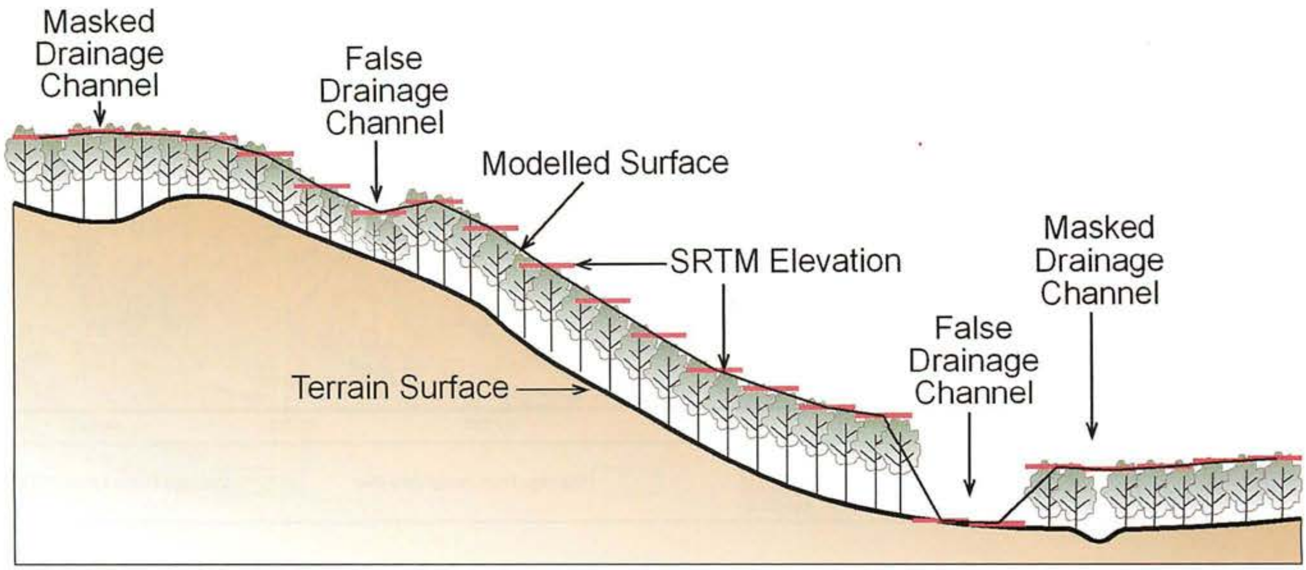


Figure 8. *Hypothetical profiles showing the canopy effects. As the SRTM elevation is measured close to the top of the canopy, dense vegetation can mask drainage channel. Channel can be falsely detected in areas with uneven canopy heights or boundary between vegetated and barren areas. The canopy can also mask local variation in topography causing errors in the derived slope gradient.*

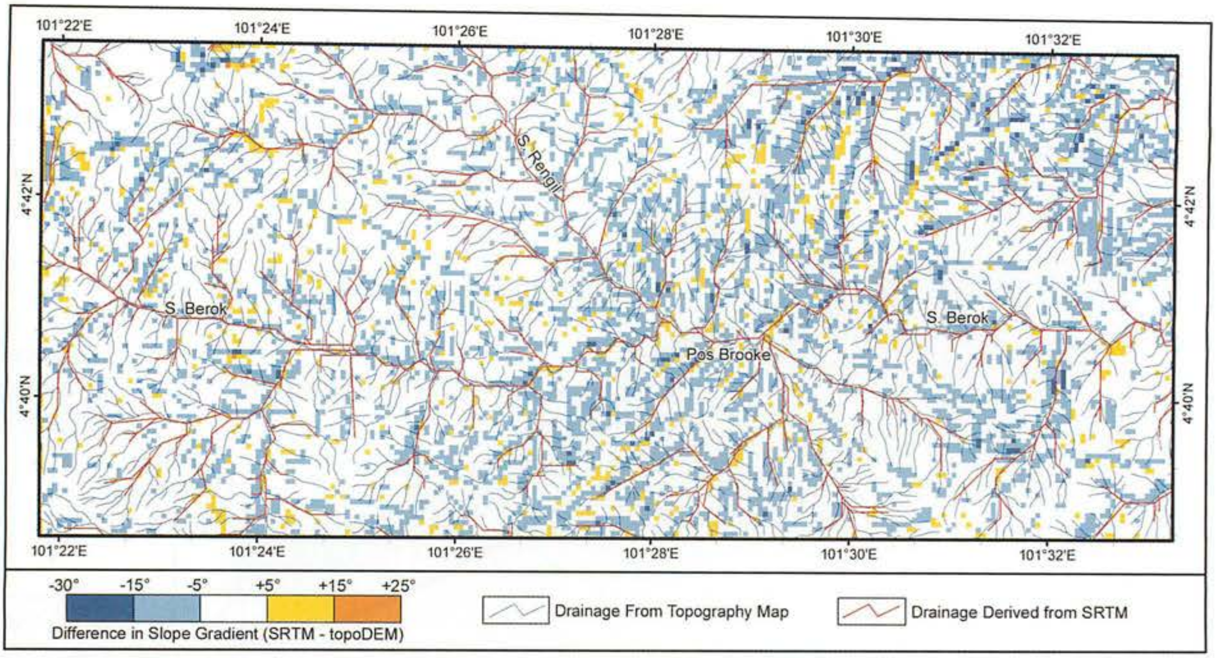


Figure 9. *Map showing the difference in slope gradient and drainage system from SRTM and topoDEM data for Lojing. The SRTM-derived drainage network is comparable to the drainage of the topographic map but most of the first and second order streams are not detected by SRTM.*

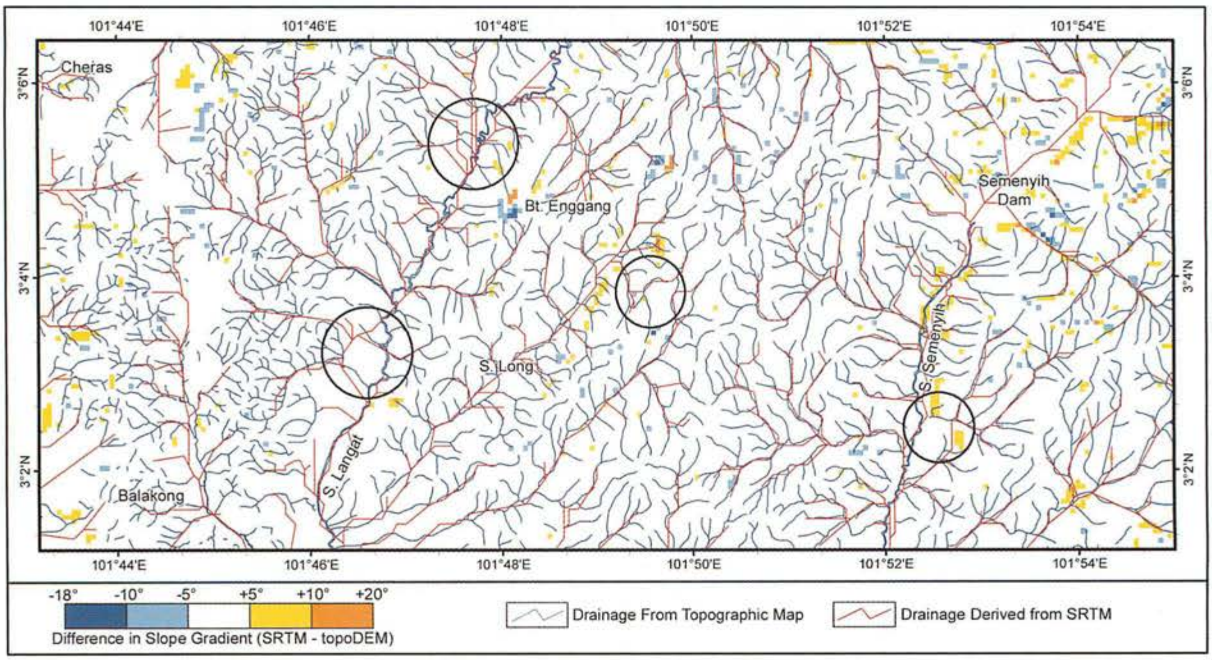


Figure 10. *Map showing the difference in slope gradient and drainage system from SRTM and topoDEM data for Hulu Langat. Errors in the position of the main drainage derived from SRTM data (circled) are mainly in the flat areas.*

REFERENCES

Aalto, R. and Montgomery, D.R., 2003. Characterizing mountain hillslopes and modelling erosion with SRTM. *Geohpysical Research Abstr.*, 5, 04735.

Baron, I., Hradecky, P., Baratoux, L. and Vorel, T., 2007. Geomorphic features and landforms analysis for geohazard assessment in El Salvador and Nicaragua, Central America. *Geophysical Res. Abstr*, Vol. 9, 09005.

Bourgine, B. and Baghdadi, N., 2005. Assessment of C-band SRTM DEM in a dense equatorial forest zone. *C. R. Geoscience*, 337, p. 1225-1234.

Farr, T.G. and Kobrick, M., 2000. Shuttle radar topography mission produces a wealth of data. *Trans. American Geophysical Union*, 81, p. 583-585.

Farr, T. G., Rosen, P.A., Robert Crippen, E.C., Duren, R., Hensley, S., Kobrick, M., Paller, M., Rodriguez, E., Roth, L., Seal, D., Shaffer, S., Shimada, J, Umland, J., Werner, M., Oskin, M., Burbank, D., and Alsdorf, D. 2007. The Shuttle Radar Topography Mission, Rev. Geophys., 45, RG2004, doi:10.1029/2005RG000183

Ghoneim, E and El-Baz, F., 2007. The application of radar topographic data to mapping of a mega-paleodrainage in the Eastern Sahara. *J. Arid Environment*, 69, p. 658-675.

Gorokhovich, Y and Voustianiouk, A., 2006. Accuracy assessment of the processed SRTM-based elevation data by CGIAR using field data from USA and Thailand and its relation to the terrain characteristics. Remote Sensing of Environment, 104, p. 409-415.

Grohmann, C.H., Riccomini, C. and Alves, F.M., 2007. SRTM-based morphotectonic analysis of the Pocos de Caldas Alkaline Massif, southeastern Brazil. *Computer & Geoscience*, 33, p. 10-19.

Jordan, G., Meijninger, B.M.L., van Hinsbergen, D.J.J., Meulenkamp, J.E. and van Dijk, P.M., 2005. Extraction of morphotectonic features from DEMs: Development and applications for study areas in Hungary and NW Greece. *Int. J. Applied Earth Obs. And Geoinfor.*, 7, p. 163-182.

Kellndorfer, J., Walker, W., Pierce, L., Dobson, C., Fites, J.A., Hunsaker, C., 2004. Vegetation height estimation from shuttle radar topography mission and national elevation datasets. *Remote Sensing of Environment*, 93, p. 339-358.

Koike, K., Nagano, S. and Kawaba, K., 1998. Construction and analysis of interpreted fracture planes through combination of satellite-image derived lineaments and digital elevation model data. *Computer & Geoscience*, 24, p. 573-583.

Liang, C. and Mackay, D.S., 2000. A general model of watershed extraction and representation using globally optimal flow paths and up-slope contributing aresa. *International J. Geog. Information Sci.*, 14:337-358.

Miliaresis, G. Ch. And Paraschou, C. V.E., 2005. Vertical accuracy of the SRTM DTED level 1 of Crete. International J. Applied Earth Observations & Geoinformation, 7, p. 49-59.

Molnar, D.K. and Julien, P.Y., 1998. Estimation of upland erosion using GIS. *Computer & Geoscience*, 24, p. 183-192.

Rabus, B., Eineder, M., Roth, A. and Bamler, R., 2003. The shuttle radar topography mission – a new class of digital elevation models acquired by spaceborne radar. *J. Photogrammetry & Remote Sensing*, 57, p. 241-262.

Rodriguez, E., C.S. Morris, J.E. Belz, E.C. Chapin, J.M. Martin, W. Daffer, and S. Hensley, 2005. An assessment of the SRTM topographic products, Technical Report JPL D-31639, Jet Propulsion Laboratory, Pasadena, California, 143 pp. Available at http://www2.jpl.nasa.gov /srtm/SRTM_D31639.pdf, assessed June 2007.

SRTM, 2007. Shuttle Radar Topographic Mission: The Mission to Map the World. NASA Jet Propulsion Laboratory. http://www2.jpl.nasa.gov/srtm/, assessed June 2007.

Valeriano, M.M., Kuplich, T.M., Storino, M., Amaral, B.D., Mendes Jr., J.N. and Lima, D.J., 2006. Modeling small watershed in Brazilian Amazonia with shuttle radar topographic mission-90 m data. *Computer & Geoscience*, 32 p. 1169-1181.

van Beek, L.P.H. and van Asch, Th. W. J., 1998. Quantification of diffuse landsliding by derivation of a general hydrological slope instability treshold. *Proceed. 8th International IAEG Congress*, Vol. 2. p. 899-906.

Verner, M., 2001. Shuttle radar topography mission (SRTM), mission overview. *J. Telecommunication*, 55, p. 75-79.

Paper Code NGC07/61
Manuscript received 11 May 2007
Revised manuscript received 18 November 2007

SHORT NOTES

Shuttle Radar Topography Mission (SRTM) data and Shaded Relief Map of Malaysia are available for download

Void-filled 3 arc-second SRTM data and shaded relief maps of Peninsular Malaysia and Borneo are now available for download from http://geology.um.edu.my/gsmpublic/SRTM/. The SRTM data was merged from 128 height files. The voids were filled by linear interpolation and the DEM data was converted to GeoTIFF raster format that can be utilised in most GIS software. The DEMs are in geographic (Lat-Long) projection and WGS84 datum. The shaded relief maps of Peninsular Malaysia and north Borneo were generated from the DEM data. The list of data and maps are as follows:

1. SRTM data of Peninsular Malaysia. PMsia SRTM_V2.tif (compressed as PMsia SRTM_V2.zip, 21.8 MB)
2. SRTM data of north Borneo. NBorneo SRTM_V2.tif (compressed as NBorneo SRTM_V2.zip, 64.1 MB)
3. SRTM data of south Borneo. SBorneo SRTM_V2.tif (compressed as SBorneo SRTM_V2.zip, 32.1 MB)
4. Shaded relief map of Peninsular Malaysia. Scale 1:500,000. Size 42 in x 50 in. PMsia Relief Map.pdf (22.9 MB)
5. Shaded relief map of North Borneo. Scale 1:750,000. Size 62.4 in x 41.1 in. NBorneo Relief Map.pdf (37.1 MB)
6. Description of the data and maps. Readme.doc

PERTEMUAN PERSATUAN (Meeting of the Society)

Ceramah Teknik (Technical Talk)

THE STRUCTURE OF SUMATRA AND ITS IMPLICATIONS FOR THE TECTONIC ASSEMBLY OF SOUTHEAST ASIA AND THE DESTRUCTION OF THE PALEOTETHYS

14 December 2007
Geology Department
University of Malaya
(In collaboration with the Dept of Geology, University of Malaya)

A.J. Barber[1] and M.J. Crow[2]
[1]Southeast Asia Research Group, Department of Geology,
Royal Holloway University of London, Egham, Surrey, TW20 OEX, U.K.
E-mail: 106731.1236@compuserve.com; tel: +44 (0)20 7228 1897
[2]28A Lenton Road, The Park, Nottingham, NG7 IDT, U.K.

Abstract

It is now generally accepted that Southeast Asia is composed of continental blocks which separated from Gondwana with the formation of oceanic crust during the Paleozoic, and were accreted to Asia in the Late Paleozoic or Early Mesozoic, with the subduction of the intervening oceanic crust. From east to west the Malay Peninsula and Sumatra are composed of three continental blocks, East Malaya with a Cathaysian Permian flora and fauna, Sibumasu, including the western part of the Malay Peninsula and East Sumatra, with Late Carboniferous-Early Permian 'pebbly mudstones', interpreted as glacigenic diamictites, and West Sumatra, again with a Cathaysian fauna and flora. A further unit, the Woyla Nappe is interpreted as an intraoceanic arc thrust over the West Sumatra Block in the mid-Cretaceous. There is a dispute concerning the age of collision of Sibumasu with East Malaya and the destruction of Paleotethys. Triassic radiolarites have been used as evidence that Paleotethys survived until after the Triassic. Structural evidence and the ages of granitic intrusions are used to support a mid-Permian to Early Triassic age for the destruction of Paleotethys. It is suggested that the West Sumatra Block was derived from Cathaysia and emplaced against the western margin of Sibumasu by dextral transcurrent faulting along a zone of high deformation, the Medial Sumatra Tectonic Zone. These structural units can be traced northwards in Southeast Asia. The East Malaya Block is considered to be part of the Indochina Block, Sibumasu can be traced through Thailand into southern China, the Medial Sumatra Tectonic Zone is correlated with the Mogok Belt of Myanmar, the West Burma Block is the extension of the West Sumatra Block, from which it was separated by the formation of the Andaman Sea in the Miocene, and the Woyla Nappe is correlated with the Mawgyi Nappe of Myanmar.

THE STRUCTURE OF SUMATRA AND ITS IMPLICATIONS FOR THE TECTONIC ASSEMBLY OF SOUTHEAST ASIA AND THE DESTRUCTION OF THE PALEOTETHYS

Mr. AJ Barber - the speaker at the talk

GSM's Immediate Past President Prof Dr Lee Chai Peng introducing the speaker

From left: Mr AJ Barber, Mr MJ Crow and Prof Dr Charles Hutchison

Tea break during the talk

A section of the audience at the talk

GSM's Immediate Past President, Prof Dr Lee Chai Peng presenting a memento to Mr A.J.Barber

BERITA-BERITA PERSATUAN (News of the Society)

COUNCIL MEMBERS WANTED

Our Council is looking for suitable candidates to head the following Groups as Chairman:

1. **Working Group on Structural Geology & Tectonic**
2. **Working Group on Petroleum Geology**
3. **Working Group on Sedimentology, Stratigraphy & Paleontology**

Interested candidate please write to GSM or call the Editor, Mr Lau YinLeong at 012-2093098.

Keahlian (Membership)

Life Time Member

1. Sugeng Sapto Surjono (A448022, Indonesia)

Full Member

1. Remi Bosc (01BD65482, French)
2. Iwan Hignasto (JQ063345, Canada)

Address Wanted

1. Ian Longley

BERITA-BERITA PERSATUAN (News of the Society)

Pertukaran Alamat (Change of Address)

1. Quek Cheau Jing, 24, Jalan Cheng Perdana 1/15, Taman Desa Cheng Perdana, 75250 Cheng, Melaka
2. Loke Meng Heng, 115, Cangkat Minden Jalan 5, Minden Heights, 11700 Gelugor, Penang
3. Arthur Chu, A-10-1, Vista Kiara Condo, No. 7, Jalan Kiara 3, Bukit Kiara, 50480 Kuala Lumpur
4. Amie Amir, EPA-T-DGS, Geological Services (Sedimentology), Sarawak Shell Bhd. 98100 Lutong, Sarawak

Pertambahan Baharu Perpustakaan (New Library Additions)

1. Scripta Geologica, nos. 132 & 133, 2006 & no. 134, 2007
2. The Association of Korean Geoscience Societies, Geosciences Journal, vol. 11, no. 2, 2007
3. Austrian Journal of Earth Sciences, vol. 100, 2007
4. Oklahoma Geology Notes, vol. 66, nos. 1 & 2, 2006
5. Journal of Science & Technology in the Tropics, vol. 3, no. 1, 2007
6. Seismic imaging of carbonate reservoirs and systems edited by Gregor P. Eberli, et al. AAPG Memoir 81, 2004
7. Geological Bulletin of Turkey, vol. 50, no. 2, 2007
8. Mineral deposits of South China by Khin Zaw, et al 2007
9. Malaysian Society for Transparency and Integrity, Transparency, vol. 8, no. 2, 2007
10. AAPG Bulletin, vol. 91, no. 5 & 11, 2007
11. Episodes, vol. 30, no. 2, 2007
12. Geological Survey of New South Wales, Quarterly Notes, no. 124, 2007
13. Scripta Geologica, Special Issue 6, 2007
14. Industrial Mineral Opportunities in New South Wales, bulletin no. 33, 2007
15. Biennial Report of the Federal Institute for Geosciences and Natural Resources, 2003/2004
16. Manual on the Geological-technical Assessment of Mineral Construction Materials, 2007

Proceedings for Sale

1. Forum on groundwater, 1994 (3 copies)
2. Forum on environmental geology & geotechnics, 1995 (4 copies)
3. Dynamic stratigraphy & tectonics of Peninsular Malaysia, 3rd seminar – The Mesozoic of Peninsular Malaysia (2 copies)
4. GSM-IEM forum: the roles of engineering geology and geotechnical engineering in construction works: proceedings (10 copies)

BERITA-BERITA LAIN (Other News)

DEPOSITIONAL ARCHITECTURE

Tuesday, October 30, 2007.

Council Hall
Curtin University of Technology, Sarawak Campus

This dynamic technical talk was presented by Mr Maarten Wiemer (Head, Geological Services, Sarawak Shell Berhad) to a packed audience of around 80 people at Curtin University of Technology, Sarawak Campus.

After undertaking a sedimentary geology masters at Leiden University and military service in The Netherlands, Maarten joined Shell, and worked as geologist on many projects in different parts of the world, amongst others in Oman, England, Holland, Madagascar, China, and since early May this year, Malaysia.

This presentation aims to illustrate through a set of examples, the depositional architecture of sedimentary rocks from the regional to the microscopic scale, and demonstrate why this aspect of the sedimentary rock sequence is so relevant to the oil and gas industry.

By studying the depositional architecture at different scales, we can start to understand the distribution of the types of sedimentary rocks (reservoir, seal and source rock) and ultimately predict the occurrence and distribution of these rock types. It is also essential to look at the sediment in terms of grain framework and composition, as part of the depositional architecture story, but now at the hand lens or even microscopic level. For example, clay distribution in sandstone units has an impact on porosity and specifically permeability. Thin laminae of clay will, depending on their distribution (i.e. the depositional architecture), affect the fluid dynamics of a reservoir. Sandstone texture (i.e. grain size, sorting, etc.) has a controlling impact on the porosity and permeability characteristics of a potential hydrocarbon reservoir.

It may stretch the imagination, but these fine scale textural variations, which are so important for porosity and permeability patterns in our oil and / or gas reservoir rocks are not only governed by the local sedimentary process, but are also controlled by the larger even regional scale basin setting and depositional processes. In conclusion, why is it important to know about depositional architecture? First on the finer scale, depositional architecture greatly influences the porosity and permeability pattern of potential reservoir sandstones. Zooming out to the somewhat larger scale, understanding depositional architecture gives us insight in the distribution pattern of reservoir (sandstone) and sealing (i.e. claystone) rocks.

Depositional Architecture

We need to know the geometry and distribution of reservoir sandstones in order to understand how an oil and / or gas reservoir can be best produced. On an even larger (i.e. regional) scale depositional architecture tells us where potential reservoir rock may occur in the basin, and allows the explorer to target areas of higher prospectivity.

Last but not least, Northern Sarawak has great outcrops amongst others in the Miri - Lambir and Bungai - Tusan - Beraya areas, which display similar sequences and depositional architecture as some of the offshore subsurface provinces, which yield oil and gas. Studying these outcrops will help us to better understand similar sedimentary rocks, and their reservoir behaviour, in the subsurface.

The question and answer session was exhilarating with Curtin students taking the lead in fielding relevant questions to the distinguished speaker.

The 1-hour talk concluded at 4:30pm.

Assoc. Prof. Dr. Eswaran Padmanabhan
Curtin University of Technology, Sarawak Campus

Mr Maarten making a point on reservoir architecture.

BERITA-BERITA LAIN (Other News)

Up Coming Events

March 3-7, 2008: Seismic Imaging of Subsurface Geology, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

March 3-7, 2008: Basic Petroleum Geology, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

March 9-12, 2008: The Challenge of Sustainability in the Geoenvironment. Contact: Krishna Reddy (kreddy@uic.edu) or Beth Gross (bgross@geosyntec.com)

March 10-14, 2008: Production Geology for Other Disciplines, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

March 10-14, 2008: Integrated Petrophysics for Reservoir Characterisation, Kuala Lumpur, Malaysia. Contact: HOT Engineering GmbH, Roseggerstrasse 17, A-8700 Leoben, Austria. Tel: +43 3842 43053-33; Fax: +43 3842 43053-1, email: training@hoteng.com; website: www.hoteng.com

March 17-21, 2008: Basic Drilling, Completion and Workover Operations, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

March 31-April 4, 2008: Basic Geophysics, Miri, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

April 01-04, 2008: The 3rd International Conference on Geotechnical & Geophysical Site Characterization, Taipei International Convention Center, Taiwan. Contact: Ms. Zoe Chang, 10F-2, No. 51, Sungjiang Road, Taipei, 104 Taiwan. Tel: +886 2 2504 4338 ext 15; Fax: +886 2 2504 4362; email: zoe329@elitepco.com.tw

April 7-11, 2008: Avo, Inversion and Attributes: Principles and Applications, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

May 22, 2008: Hydrogeology meets Hydroecology, Burlington House, London, UK. Registration details obtainable from www.geolsoc.org.uk

Up Coming Events

May 27-29, 2008: 32nd Annual IPA Convention & Exhibition, Jakarta Convention Center, JCC, Indonesia. Contact: 32nd Annual IPA Convention & Exhibition, Wisma Kyoei Prince, 17th Floor (Suite 170), Jl. Jendral Sudirman Kav. 3, Jakarta 10220, Indonesia. Tel: 62 21 5724161; Fax: 62 21 5724159; email: tpc_ipa@biz.net.id

May 30-June 2, 2008: The 2nd International Conference on Geotechnical Engineering for Disaster Mitigation and Rehabilitation (GEDMAR08), Nanjing, China. Contact: Dr. A. Deng, Dr. T. Zhang, GeoHohai, Hohai University, 1 Xikang Road, Nanjing 210098, China. Tel: +86 25 8378 7917; Fax: +86 25 8371 3073; email: GEDMAR08@hhu.edu.cn; web: www.GeoHohai.com/GEDMAR08

May 12-13, 2008: Exploiting Geoscience Collections. A joint meeting between the Geoscience Information Group and the Geological Curators Group. Contact: Jeremy Giles, National Geoscience Data Centre, British Geological Survey, Keyworth, Nottingham NG12 5GG, UK. Tel: +44 (0) 1159363220; email: jrag@bgs.ac.uk

May 27-29, 2008: 32nd Annual IPA Convention & Exhibition, Jakarta Convention Center, JCC, Indonesia. Contact: Technical Committee Secretariat, Wisma Kyoei Prince, 17th Floor (Suite 1701), Jalan Jendral Sudirman Kav. 3, Jakarta 10220, Indonesia. Phone: (62-21) 5724161/4282/4285/ 4286; Fax: (62-21) 5724159/ 4259; email: tpc_ipa@biz.net.id

May 30-June 2, 2008: 1st International Conference on Long Time Effects and Seepage Behavior of Dams (LTESBD08), Hohai University, Nanjing, China. Contact: Dr. Domenico Gallipoli, Tel: 44 141 330 3927 (direct); 44 141 330 4077 (secret); Fax: 44 141 330 4557; email: Gallipoli@civil.gla.ac.uk; website: http://LTESBD08.hhu.edu.cn

June 1-3, 2008: National Geoscience Conference 2008: Geoconservation, Geotourism and Geohazard, Ipoh, Perak, Malaysia. Contact: Geological Society of Malaysia, c/o Dept. of Geology, University of Malaya, Kuala Lumpur, Malaysia. Tel: 603 79577036; Fax: 603 79563900; email: geologi@po.jaring.my.

June 9-13, 2008: Mapping Subsurface Structures, London, U.K. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

June 16-20, 2008: Structural Styles in Petroleum Exploration, London, U.K. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

June 30-July 4, 2008: 10th International Symposium on Landslides & Engineered Slopes, Xi'an, China. Contact: website: www.landslide.iwhr.com

July 2-3, 2008: International Conference on Flood Recovery Innovation and Response, FRIAR 2008, Institution of Civil Engineers, London, UK. Contact: Kimberley Robberts, Conference Secretariat, FRIAR 2008, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK. Tel: 44 238 029 3223; Fax: 44 238 029 2853; email: krobberts@wessex.ac.uk

Up Coming Events

July 7-11, 2008: Operations Geology, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

July 14-18, 2008: Basic Petroleum Engineering Practices, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

July 21-25, 2008: Introduction to Seismic Stratigraphy: A Basin Scale Regional Exploration Workshop, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

July 21-25, 2008: Sandstone Reservoirs, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

August 4-8, 2008: Well Log Interpretation, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

August 5-14, 2008: 33rd International Geological Congress (IGC), Lillestrom, Oslo, Norway, on behalf of five Nordic countries (Norden) – Denmark (including the Faeroe Islands and Greenland), Finland, Iceland, Norway and Sweden. Website: www.33igc.org

August 11-15, 2008: Shaly Sand Petrophysics, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

August 25-28, 2008: Carbonate Petrophysics, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

August 25-29, 2008: Advanced Drilling Engineering, Kuala Lumpur. Contact: HOT Engineering GmbH, Roseggerstrasse 17, A-8700 Leoben, Austria. Tel: +43 3842 43053-33; Fax: +43 3842 43053-1, email: training@hoteng.com; website: www.hoteng.com

September 1-4, 2008: XIIIth IWRA World Water Congress, Montpellier, France. Contact: email: wwc2008@msem.univ-montp2.fr; website: wwc2008.msem.univ-montp2

September 3-5, 2008: 2nd International Workshop on Geotechnics of Soft Soils: Focus on Ground Improvement. Contact: AMGISS Secretariat, c/o Dept. of Civil Engineering, John Anderson Building, University of Strathclyde, Glasgow G4 0NG, Scotland, UK. Tel: 44 141 548 3277; Fax: 44 141 553 2066, email: amgiss@strath.ac.uk; web: www.iwgss.org/ or www.cc.strath.ac.uk/amgiss/

Up Coming Events

September 15-19, 2008: Carbonate Reservoirs, London, U.K. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

September 22-26, 2008: Sequence Stratigraphy: An Applied Workshop, London, U.K. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

September 29-October 3, 2008: Petroleum Geochemistry: Tools for Effective Exploration and Development, London, U.K. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

October 1-6, 2008: 12th International Conference: Computer Methods & Advances in Geomechanics, Goa, India. Contact: email: dns@civil.iitb.ac.in; website: www.12iacmag.com/

October 6-10, 2008: Turbidite Sandstones, London, U.K. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

October 6-10, 2008: Foundations of Petrophysics, Kuala Lumpur, Malaysia. Contact: HOT Engineering GmbH, Roseggerstrasse 17, A-8700 Leoben, Austria. Tel: +43 3842 43053-33; Fax: +43 3842 43053-1, email: training@hoteng.com; website: www.hoteng.com

October 8-10, 2008: 8th International Hydrogeological Congress of Greece, Athens, Greece. Contact: email: hydrogeology@aua.gr; website: http://iah-hellas.geol.uoa.gr/

October 20-22, 2008: Characterisation of Oil and Gas Reservoirs with Neural Network Technology, Kuala Lumpur, Malaysia. Contact: HOT Engineering GmbH, Roseggerstrasse 17, A-8700 Leoben, Austria. Tel: +43 3842 43053-33; Fax: +43 3842 43053-1, email: training@hoteng.com; website: www.hoteng.com

October 21-23, 2008: 3rd International Conference on Remediation & Management of Contaminated Land: Focus on Asia, Kuala Lumpur, Malaysia. Contact: Brownfield Asia 2008, c/o The Institution of Engineers, Malaysia, P.O. Box 223 (Jalan Sultan), 46720 Petaling Jaya, Selangor D.E., Malaysia. Tel: +603 79684001/4002; Fax: +603 79577678; email: brownfieldasia@gmail.com

October 27-31, 2008: Production Logging and Reservoir Monitoring, Kuala Lumpur. Contact: HOT Engineering GmbH, Roseggerstrasse 17, A-8700 Leoben, Austria. Tel: +43 3842 43053-33; Fax: +43 3842 43053-1, email: training@hoteng.com; website: www.hoteng.com

November 10-14, 2008: Seismic Interpretation, Kuala Lumpur, Malaysia. Contact: Petroskills, P.O. Box 35448, Tulsa, Ok 74153-0448, USA. Tel: +1 918 828 2500; Fax: 918 828 2580; email: training@petroskills.com

GEOLOGICAL SOCIETY OF MALAYSIA PUBLICATION

BULLETIN OF THE GEOLOGICAL SOCIETY OF MALAYSIA
WARTA GEOLOGI - Newsletter of the Geological Society of Malaysia
(Published bi-monthly)

ADVERTISING SPACE ORDER FORM

RATES	WARTA GEOLOGI Format : 20 cm x X 28cm Colour	BULLETIN Format : 20cm x 28cm Colour
Inside Front Cover per issue	RM3,000	RM5,000
Inside full page per issue	RM600	RM1,500
Inside half page per issue	RM500	RM800
Inside full page for 6 issues	RM3,000	-
Inside half page for 6 issues	RM2,500	-

Artwork in digital format must be supplied by the advertisers

Please send the completed form below together with remittance payable to "Geological Society of Malaysia" to:

The Editor
Geological Society of Malaysia
c/o Dept of Geology
University of Malaysia
50603 Kuala Lumpur, Malaysia

For further information, please call 603-7957 7036 or fax 603-7956 3900 or email to geologi@po.jaring.my

---

The Editor
Geological Society of Malaysia
c/o Dept of Geology
University of Malaysia
50630 Kuala Lumpur

We would like to take up advertising space in WARTA GEOLOGI / BULLETIN as follows:

	WARTA GEOLOGI	BULLETIN
Inside full page	one issue ☐ six issues ☐	one issue ☐ ....issue ☐
Inside full page	one issue ☐ six issues ☐	one issue ☐ ....issue ☐

Artwork * enclosed ☐ not enclosed ☐

Company...
Address...
....

Enclosed cheque / money order / bank draft * .... for RM...................................
Person to contact.. Designation ....
Tel..Fax...................................email...

*Please delete as appropriate.

Signature.................................

GEOLOGICAL SOCIETY OF MALAYSIA PUBLICATIONS

Bulletin 2 (Dec 1968). 152 p. Bibliography and Index of the Geology of West Malaysia and Singapore by D.J. Gobbett. Price: RM5.00.
Bulletin 3 (Mar 1970). 146 p. Papers in Geomorphology and Stratigraphy (with Bibliography supplement). Edited by P.H. Stauffer. Price: RM5.00.
Bulletin 4 (Jun 1971). 100 p. Papers in Petrology, Structure and Economic Geology. Edited by P.H. Stauffer. Price: RM5.00.
Bulletin 5 (Feb 1973). 70 p. The Search for Tungsten Deposits by K.F.G. Hosking. Price: RM5.00.
Bulletin 6 (Jul 1973). 334 p. Proceedings, Regional Conference on the Geology of Southeast Asia. A Collection of papers, Kuala Lumpur, March, 1972. Edited by B.K. Tan. Price: RM5.00.
Bulletin 7 (Jun 1974). 138 p. A collection of papers on geology. Edited by B.K. Tan. Price RM5.00.
Bulletin 13 (Dec 1980). 111 p. A collection of papers on geology of Malaysia and Thailand. Edited by G.H. Teh. Price RM5.00.
Bulletin 17 (Dec 1984). 371 p. A collection of papers on geology. Edited by G.H. Teh. Price: RM10.00.
Bulletin 18 (Nov 1985) 209 p. Special issue on Petroleum Geology. Edited by G.H. Teh. & S. Paramanathan. Price: RM15.00.
Bulletins 19 (Apr 1986) & **20** (Aug 1986). GEOSEA V Proceedings Vols. I & II. Fifth Regional Congress on Geology, Mineral and Energy Resources of SE Asia. Kuala Lumpur, 9-13 April 1984. Edited by G.H. Teh & S. Paramanathan. Price for both bulletins 19 & 20: Members: RM30.00: Non-members: RM60.00
Bulletin 21 (Dec 1987). 271 p. Special issue on Petroleum Geology Vol. II. Edited by G.H. Teh. Price: RM20.00.
Bulletin 22 (Dec 1988). 272 p. Special issue on Petroleum Geology Vol. III. Edited by G.H. Teh. Price: RM20.00.
Bulletin 23 (Aug 1989). 215 p. A collection of papers on the geology of Malaysia, Thailand and Burma. Edited by G.H. Teh. Price: RM10.00.
Bulletin 24 (Oct 1989). 199 p. A collection of papers presented at GSM Annual Geological Conference 1987 & 1988. Edited by G.H. Teh. Price: RM10.00.
Bulletin 25 (Dec 1989). 161 p. Special issue on Petroleum Geology Vol. IV. Edited by G.H. Teh. Price: RM20.00.
Bulletin 26 (Apr 1990). 223 p. A collection of papers presented at GSM Annual Geological Conference 1989 and others. Edited by G.H. Teh. Price: RM10.00.
Bulletin 27 (Nov 1990). 292 p. Special issue on Petroleum Geology Vol. V. Edited by G.H. Teh. Price: RM20.00.
Bulletin 28 (Nov 1991). 292 p. Special issue on Petroleum Geology Vol. VI. Edited by G.H. Teh. Price: RM20.00.
Bulletin 29 (Jul 1991). 255 p. A collection of papers presented at GSM Annual Geological Conference 1990 and others. Edited by G.H. Teh. Price: RM10.00
Bulletin 30 (Apr 1992). 90 p. Annotated bibliography of the geology of the South China Sea and adjacent parts of Borneo by N.S. Haile. Edited by G.H. Teh. Price: RM10.00.
Bulletin 31 (Jul 1992). 176 p. A collection of papers presented at GSM Annual Geological Conference 1991 and others. Edited by G.H. Teh. Price: RM10.00.
Bulletin 32 (Nov 1992). 283 p. Special issue on Petroleum Geology Vol. VII. Edited by G.H. Teh. Price: RM30.00.
Bulletin 33 (Nov 1993). 419 p. Proceedings Symposium on Tectonic Framework and Energy Resources of the Western Margin of the Pacific Basin. Edited by G.H. Teh. Price: RM40.00.
Bulletin 34 (Dec 1993). 181 p. Bibliography and Index – Publications of the Geological Society of Malaysia 1967-1993. Compiled by T.F. Ng. Edited by G.H. Teh. Price: RM20.00.
Bulletin 36 (Dec 1994). 186 p. Special issue on Petroleum Geology Vol. VIII. Edited by G.H. Teh. Price: RM50.00.
Bulletin 37 (Jul 1995). 506 p. Proceedings AAPG-GSM International Conference 1994. Southeast Asian Basins: Oil and Gas for the 21st Century. Edited by G.H. Teh. Price: RM60.00.
Bulletin 38 (Dec 1995). 190 p. A collection of papers presented at GSM Annual Geological Conference 1994 and others. Edited by G.H. Teh. Price: RM30.00.
Bulletin 40 (Jul 1997). 247 p. A collection of papers presented at GSM Annual Geological Conference 1996 and others. Edited by G.H. Teh. Price: RM30.00.
Bulletin 42 (Dec 1998). 268 p. Papers from Petroleum Geology Conference 1997, Seminar on Tertiary Basins of Peninsular Malaysia and others. Edited by G.H. Teh. Price: RM50.00.
Bulletin 43 (Dec 1999). 698 p. Papers from GEOSEA '98 (Ninth Regional Congress on Geology, Mineral and Energy Resources of Southeast Asia). Edited by G.H. Teh. Price: RM70.00.
Bulletin 44 (July 2000). 178 p. A collection of papers from Annual Geological Conference 1999. Western Belt & Paleozoic of Peninsular Malaysia Seminar 1999 & others. Edited by G.H. Teh. Price: RM30.00
Bulletin 45 (May 2002). 375 p. Annual Geological Conference 2002. Conference Issue. Edited by G.H.Teh, Ismail Yusoff, Azman Abdul Ghani & T.F. Ng. Price: RM50.00.
Bulletin 48 (May 2004). 130 p. Annual Geological Conference 2004 Conference Issue. Edited by Lee Chai Peng, Mohd. Shafeea Leman, Joy J. Pereira & T.F. Ng. Price: RM30.00.
Bulletin 49 (April 2006). 167 p. Collection of Geological Papers. Edited by K.K. Liew, Nur Iskandar Taib & T.F. Ng. Price: RM30.00.
Bulletin 50 (May 2007). 160 p. Bibliography and Index of GSM Publications 1994 – 2004. Compiled by Robert B. Tate. Price: RM30.00
Issue. Edited by Lee Chai Peng, Mohd. Shafeea Leman, Joy J. Pereira & T.F. Ng. Price: RM30.00.
Bulletin 51 (2005). 199 p. Annual Geological Conference 2005 Conference Issue. Edited by Nur Iskandar Taib. Price: RM30.00
Bulletin 52 (June 2006). 135 p. Collection of Geological Papers. Edited by Nur Iskandar Taib. Price: RM30.00.
Bulletin 53 (June 2007). 128 p. Collection of Geological Papers. Edited by T.F. Ng, Nur Iskandar Taib & Joy J. Pereira. Price: RM30.00.
Abstracts of papers (1972). Regional Conference on the Geology of Southeast Asia. Kuala Lumpur, 1972. 64 p. 8 figs. 3 tables, many extended abstracts. Edited by N.S. Haile. Price: RM2.00.
Warta Geologi (Newsletter of the Geological Society of Malaysia). Price: RM5.00 per bimonthly issue from July 1966.
Geological Evolution of Southeast Asia (2007) (Second Edition) by C. S. Hutchison. 368 p. Price: RM100.00; Student :RM50.00.
Common Rocks of Malaysia (Colour Poster). Price: Member: RM8.00; Non-Member: RM10.00; Student: RM7.00.
Proceedings Annual Geological Conference 2000. 435 p. Edited by G.H. Teh, Joy J. Pereira and T.F. Ng. Price: RM60.00.
Proceedings Annual Geological Conference 2001. 320 p. Edited by G.H. Teh, Mohd. Shafeea Leman and T.F. Ng. Price: RM50.00.
Geology of Borneo Island (2001) (CD, Map (2 sheets) and explanatory notes. Compiled by Robert B. Tate. Price: RM60.00.
Stratigraphic Lexicon of Malaysia (2004). 162 p. By Lee Chai Peng, Mohd. Shafeea Leman, Kamaludin Hassan, Bahari Md. Nasib & Roshidah Karim. Price: RM30.00.
Geological Evolution of South East Asia - Second Edition. By Prof Emeritus Dr Charles Hutchison. Price: Rm100.00, Student Price: Rm50.00

PACKAGE DEAL 1 : Bulletins 2, 3, 4, 5, 6, 7, 13 (7 books)
Member: RM30.00 Student Member: RM15.00
Non-member: RM40.00 Student Non-member: RM25.00
PACKAGE DEAL 2 : Bulletins 17, 18, 21, 22 (4 books)
Member: RM25.00 Student Member: RM10.00
Non-member: RM35.00 Student Non-member: RM20.00
PACKAGE DEAL 3 : Bulletins 19, 20 (2 books)
Member: RM25.00 Student Member: RM15.00
Non-member: RM50.00 Student Non-member: RM20.00
PACKAGE DEAL 4 : Bulletins 23, 24, 25, 26, 27 (5 books)
Member: RM40.00 Student Member: RM20.00
Non-member: RM60.00 Student Non-member: RM30.00
PACKAGE DEAL 5 : Bulletins 28, 29, 30, 31, 32 (5 books)
Member: RM40.00 Student Member: RM20.00
Non-member: RM60.00 Student Non-member: RM30.00
PACKAGE DEAL 6 : Bulletins 33, 34, 36, 37 (4 books)
Member: RM60.00 Student Member: RM30.00
Non-member: RM100.00 StudentNon-member: RM40.00
PACKAGE DEAL 7 : Bulletins 38, 40, 42, 43 & 44 (5 books)
Member: RM120.00 Student Member: RM60.00
Non-member: RM180.00 StudentNon-member: RM80.00
PACKAGE DEAL 8 : Bulletins 45, 48, 49, 50 & 51 (5 books)
Member: RM90.00 Student Member: RM40.00
Non-member: RM130.00 StudentNon-member: RM60.00

All prices quoted are not inclusive of postage. Please write in for details on postage. Allow 8-10 weeks for delivery. For orders, please write to the Society and you will be invoiced. Cheques, money orders and bank drafs must accompany all orders.

Orders should be addressed to:
The Assistant Secretary,
Geological Society of Malaysia,
c/o Dept. of Geology, University of Malaya,
50603 Kuala Lumpur, MALAYSIA
Tel: 603-79577036, Fax: 603-79563900,
E-mail: geologi@po.jaring.my

Geological Evolution of South-East Asia

Second Edition

CHARLES S. HUTCHISON

Geological Society of Malaysia
2007

Latest book by eminient geologist Professor Emeritus Dr Charles Hutchison entitled :
'Geological Evolution of South East Asia - Second Edition.'
Price : Rm100.00
Student Price : Rm50.00
For Overseas mail order please enquire : geologi@po.jaring.my

ISSN 0126-5539/PP2509/2/2008

WARTA GEOLOGI

Newsletter of the

PERSATUAN GEOLOGI MALAYSIA
Geological Society of Malaysia

Mr. AJ Barber

Mr Maarten Wiener

Kandungan (Contents)

Jilid /Volume 33, No 6. November - December 2007