GEOLOGICAL SOCIETY OF HONG KONG
NEWSLETTER

Vol 10 No 1
(March 1992)

第十卷第一期
一九九二年三月

香港地質學會通訊

Geological Society of Hong Kong

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EDITORIAL

Although it may at first sight appear that we have produced a much smaller *Newsletter* to start our tenth anniversary year, in fact we have made some significant style changes. This issue contains so many articles and items that I have little room for this column. The total number of words is about 16 000; in 1990 we were managing to produce *Newsletters* of 8-15 000 words, while in 1991 the issues ranged from 13-20 000 words. The number of pages reached a mammoth 64 in one issue, but has generally been in the range of 32-52.

If you would like to write to give your comments on the new style, please also include an article or photograph for publication. We have heard very little from members working in construction, but feel that some very interesting geology must have been exposed in the last couple of years.

This issue also comes with a colour front cover and improved paper quality, in part reflecting a change of printer to an Aberdeen-based company. In addition, space has been left for the new logo, currently being drafted. The Society logo has never been put on the *Newsletter* before, so we thought it appropriate to start a new decade with a new design. The new logo will show the correct ammonite, *Hongkongites hongkongensis*; more details will be given in the next issue.

Richard Langford, Editor

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THE GRAVITY BASE STATION NETWORK AND REGIONAL GRAVITY SURVEY OF HONG KONG

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INTRODUCTION

Until recently Hong Kong was one of the few developed regions where no regional gravity survey had been carried out. Gravity surveys detect density variations in the underlying geology. In Hong Kong it was hoped that sufficient density contrasts would exist at depth to enable structural trends to be mapped, the space form of the granites to be deduced and for the thicknesses of any Tertiary basins to be ascertained.

Before a gravity survey can be undertaken it is necessary to establish a base station network. There are two reasons for this. Firstly, in order to monitor the drift of the gravity meter it is necessary to return to a site of known gravity (a gravity base station) at regular intervals. Since many parts of Hong Kong are relatively inaccessible the base station network needs to be distributed throughout the territory. Secondly, the gravity values measured during the survey are relative to the base station and hence the base stations need to be linked to internationally accepted absolute values. This link to absolute datum will also be of value in providing observed gravity values for scientific laboratories (Evans 1990).

THE BASE STATION NETWORK

The International Gravity Standardization Net 1971 (IGSN71) is a worldwide network of gravity meter, pendulum and other absolute measurements (Morelli *et al* 1974). A total of ten IGSN71 stations were established in Hong Kong. The continual economic development of the territory since the early 1970s has led to the destruction of many of these IGSN71 stations. By the summer of 1990 only three remained, two at the Royal Observatory in Kowloon and one in the US Consulate on Hong Kong Island. There was a possibility that the values of the Royal Observatory stations may have been altered due to mass deficiency caused by the building of the mass transit underground railway system. For security reasons, access to the US Consulate is very difficult, but it was obtained in order to confirm the internal consistency of these three IGSN71 stations. The base station network within Hong Kong was then established from the IGSN71 stations at the Royal Observatory verandah (ROV) and the Royal Observatory basement (ROB).

A gravity base station should have a stable foundation which is not subject to excessive vibrations and its location should endure for decades without demolition. It must be reasonably accessible and no large mass movements, such as underground tunnels, should be anticipated in the immediate vicinity of the station. Ground floor sites in established public buildings with foundations on solid rock are very suitable. To avoid ambiguity of reoccupation a plaque is useful on the wall nearest the gravity base station, usually as a brass disc inscribed, 'Gravity Base Station'.

All of the base station measurements were taken with Lacoste and Romberg gravity meter G97 which was well calibrated and known to have a low drift rate. Tidal gravity corrections for the moon and sun were calculated with a computer program which gave 0.01 mGal accuracy. Base station connections are ideally done in as short a time as possible to minimise any instrumental drift. Hence the procedure is to occupy the IGSN71 station immediately before and after measuring the gravity at the *to be established* base station. However the busy Hong Kong traffic and slow sea transport between islands led to a slight modification of this connection system. Instead a series of interconnected closed loops were established around which errors representing gravity meter drift could be distributed. This is shown in Figure 1 where the mean connection between stations is given for each side and the misclosures for each loop are then distributed between the sides. Most of the loop misclosures were very small, 0.01 mGal or less suggesting very little instrumental drift.

After converting the gravity meter counter readings to mGal via the calibration factor they were related to the IGSN71 via the Royal Observatory

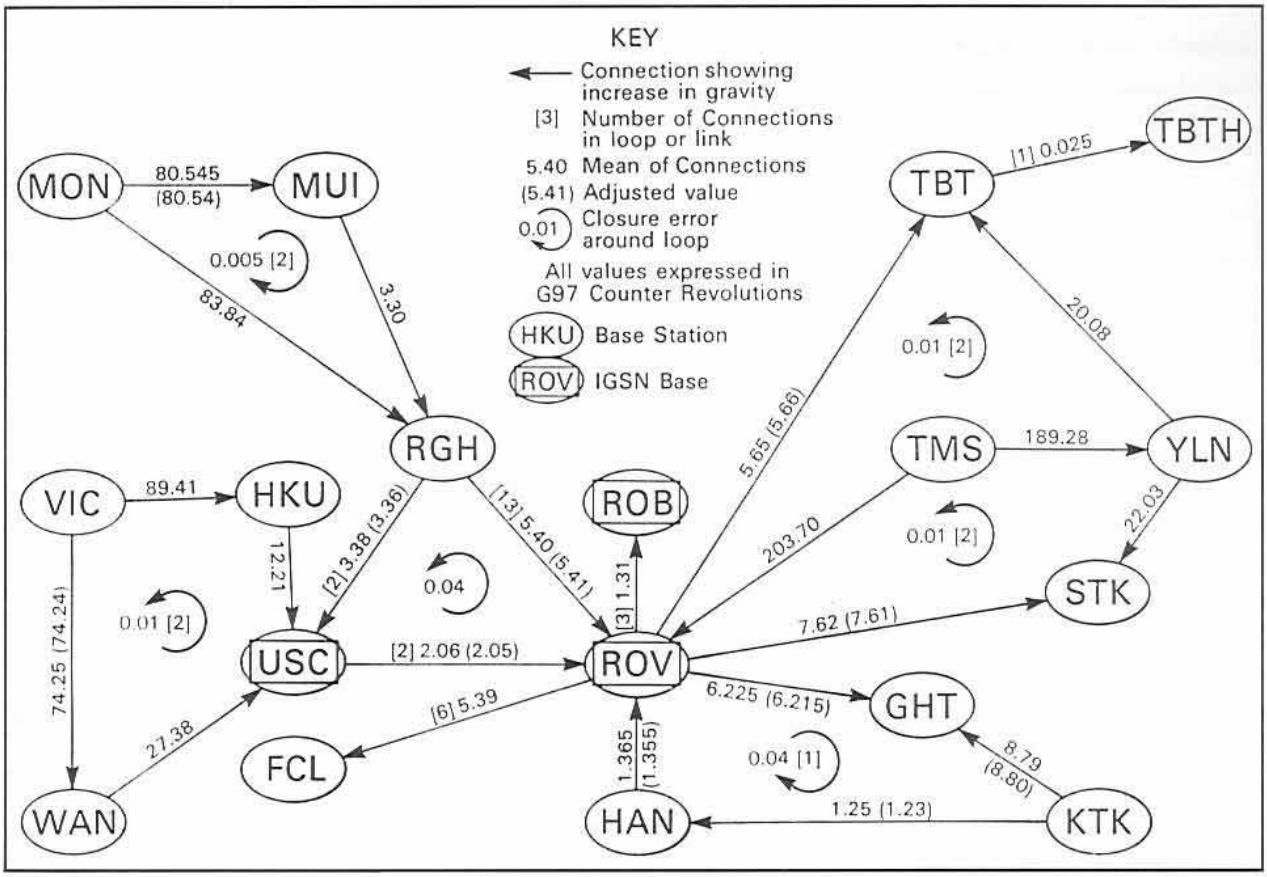

Figure 1 - Diagrammatic representation of the gravity base connections. YLN, WAN, GHT, HAN and RGH are subsidiary bases

or US Consulate bases. The error estimates on IGSN71 values in Hong Kong are given as 0.028 mGal standard error (Morelli *et al* 1974). A further 0.01 mGal error is estimated from misclosures on the loops arising from instrumental drift and another 0.01 mGal for reading accuracy. The resultant gravity values for the Hong Kong base station network are given in Table 1. The gravity difference between the Royal Observatory stations (ROB and ROV) and the Tai Mo Shan trigonometric point (TMS) is over 200 mGal and transit time between the two is about an hour. Hence it is recommended that these stations are used as the standard calibration run for calibrating gravity meters in Hong Kong. A full account of the establishment of the Hong Kong base station network is given in Evans (1990) which also includes details on subsidiary bases.

THE REGIONAL GRAVITY SURVEY

The survey consisted of a total of 632 gravity stations of which 499 were land stations, collected to an average station density of one per km^2, and 133 were marine collected to an average station density of one per four km^2. The land data were collected with Lacoste and Romberg gravity meter G629 and the marine stations with a Lacoste and Romberg model H/U sea bed gravity meter hired from Lacoste and Romberg. Interior land stations were accessed by vehicle, helicopter or on foot whilst for some coastal stations a motor boat was used. Marine stations were taken from a motorised barge which lowered the gravity meter onto the sea floor for each reading.

The height of each gravity station is needed for the processing stage. For regional data the height should be accurate to one metre. Thus interior land stations were taken at bench marks and spot heights taken off the 1:1 000 and 1:5 000 topographic maps. Where such points were adjacent to sharp topographic features, which would have unduly affected the gravity measurement, the station was moved a short distance and the difference in height was measured. Coastal stations were taken at sea level and the heights were adjusted to Hong Kong Principal Datum (1.2 m below mean sea level) from tidal gauge measurements taken throughout Hong Kong. The depths of marine stations were measured by echo sounder and corrections for the tide were again applied to reduce all water depths to Hong Kong Principal Datum.

After correcting for instrumental drift and the tidal gravity of the moon and sun the data were tied to a base station to produce a value of observed gravity. The positions of the gravity stations are shown on Figure 2. Further details on the gravity survey can be found in EGS (1991).

Table 1 - Gravity values for the main base stations of the Hong Kong base station network

Station code	Station description	Co-ordinates East	Co-ordinates North	Gravity value (mGal)
ROB	Royal Observatory basement, Kowloon, IGSN71 HK B	836000	818132	978755.85 ± 0.028
ROV	Royal Observatory verandah, Kowloon, IGSN71 HK N	835985	818132	978754.47 ± 0.028
USC	US Consulate, Hong Kong Island, IGSN71 HK A	834380	815570	978752.31 ± 0.028
HKU	Hong Kong University Science Building	832200	816000	978739.45 ± 0.05
KTK	Kai Tak navigation beacon, Kowloon	837060	821343	978751.75 ± 0.07
MUI	Mui Wo Police Station, Lantau Island	817990	814030	978745.29 ± 0.05
STK	Sha Tau Kok Police Station, NE New Territories	841200	845080	978762.49 ± 0.05
TBT	Tsim Bei Tsui Observatory	819280	838540	978760.43 ± 0.05
MON	Po Lin monastery, Ngong Ping, Lantau Island	808560	812980	978660.44 ± 0.06
TMS	Tai Mo Shan trigonometric point	830880	830080	978539.85 ± 0.06
VIC	Victoria Peak	832800	815080	978654.25 ± 0.06

THE BOUGUER GRAVITY ANOMALY MAP

The observed gravity values must be reduced to Bouguer gravity anomaly values before the density variations in the sub-surface geology become apparent. The reduction procedures are described in standard geophysical texts, eg, Telford *et al* 1990. The datum reduction surface was Hong Kong Principal Datum. The reduction parameters were a free air gradient of gravity of 0.3086 mGal m^{-1}, a Bouguer constant of 0.041929 mGal m^{-1} and normal gravity calculated from the 1967 Geodetic Reference System (GRS 67). The Bouguer reduction density was 2.62 Mg m^{-3} for land stations and 2.62 + σ_s Mg m^{-3} for the sea bottom stations, where σ_s (density of sea water) was given a value of 1.027 Mg m^{-3}. The density of 2.62 Mg m^{-3} represents the average density of the granitic rocks based on physical property measurements. The steep terrain of Hong Kong produces a large topographic effect in the gravity data and must be allowed for by a terrain correction. A digital terrain model was created by digitizing the land and sea bed contours from the 1:20 000 topographic maps of Hong Kong, Admiralty charts and available maps of southern China. These data were gridded onto a 50 m grid and terrain corrections were carried out to a distance of 32 km from each gravity station. The resulting Bouguer gravity anomaly values were then gridded at a grid interval of 0.5 km using a minimum surface tension technique. The Bouguer gravity anomaly map, contoured at two mGal intervals, is shown in Figure 2.

The Bouguer gravity anomaly values cover the range -33.5 to +5.0 mGal. There is a deep low with the minimum values to the southeast of Yuen Long and to the west of Castle Peak. These two lows are split by a ridge of slightly higher values. There is a steep positive SSE to SE gradient towards Lantau and Hong Kong Island. This gradient slackens and has a more northerly trend in the eastern half of the map. In the southeast the Bouguer gravity anomaly values are positive whilst in the northeast, southerly and northerly gradients lead to a local maximum in Mirs Bay.

The deep low is consistent with the low density acidic geology of Hong Kong. However the more positive values in the south are unexpected as all of the islands to the south of Hong Kong Island are known to consist mainly of low density granitic rocks. This suggests that either the crust is thinning or that the outcropping granitic rocks in the south cannot extend to any great depth. There is no correlation between the Bouguer gravity anomaly contours and the western and southern boundaries to the Mirs Bay sedimentary basin. An interpretation of the regional gravity data is given by Busby (1991).

ACKNOWLEDGEMENTS

The work described in this paper was undertaken for the Geotechnical Engineering Office of the Civil Engineering Department of the Hong Kong Government and the paper is published with the permission of the Director of Civil Engineering.

J P Busby and R B Evans thank the Director of the British Geological Survey (NERC) for permission to publish.

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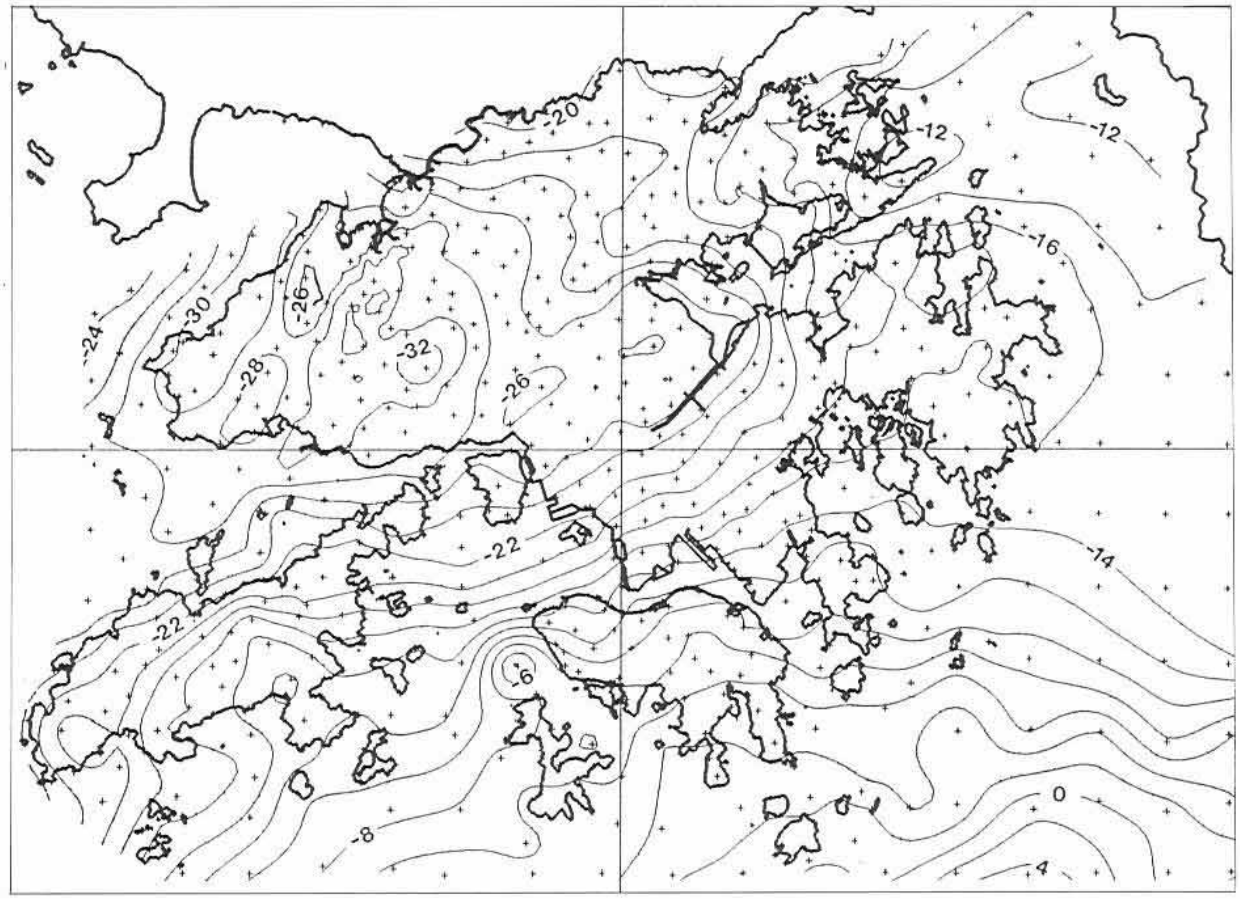

Figure 2 - Bouguer gravity anomaly map of Hong Kong contoured at 2 mGal intervals. The Bouguer reduction density was 2.62 Mg m^{-3}

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MARINE STUDIES GROUP OF THE GEOLOGICAL SOCIETY OF HONG KONG

The Geological Society of Hong Kong was founded in 1982; ten years ago this year. One year later in 1983 the Marine Studies Group (MSG), a specialist sub-group of the Geological Society of Hong Kong, was formed. Both bodies have a strong and active membership, reflecting the widespread interest in the geology of the Territory.

The Marine Studies Group arose out of a common interest in the offshore areas of Hong Kong for reclamation, pipelines, tunnels and as a source of offshore reclamation fill, bringing together a corps of professionals who saw the need for a coordinated approach to understanding the offshore areas and their deposits. The interests of the Marine Studies Group encompass a broad spectrum of topics including sedimentology, palaeoenvironment, archaeology, hydraulics and the engineering characteristics of all superficial deposits that are currently covered by the sea as well as marine deposits found above the present sea level.

Technical discussion meetings are held irregularly throughout the year. Members or invited speakers have addressed the group on topics of both specific and general interest. A wide variety of subjects have been covered, including offshore geological mapping and palaeoenvironmental interpretation in Hong Kong, offshore geophysical surveys and their interpretation, offshore site investigation, hydraulic modelling of Victoria Harbour and Hong Kong waters, the characteristics and distribution of tidal channels, the design of highways and airports on offshore reclamations, and the geotechnics of offshore platform design.

The Group has held four seminars in Hong Kong. The first was in September 1983 on *Marine geology of Hong Kong and the Pearl River mouth*, at which members of both the MSG and the South China Sea Institute of Oceanology, Guangzhou, presented the results of their research work. A meeting on *Sea-level changes in Hong Kong during the last 40 000 years* was held in May 1986. In December 1987 a seminar on *Marine sources of sand* attracted a particularly large audience to hear papers about the offshore geology of Hong Kong, geophysical profiling, site investigation for dredging, dredging programme design, dredging case histories, and the environmental impact of offshore dredging. *Future sea-level rise and coastal development* was the subject of a seminar in April 1988.

Field visits to the Pearl River region and to local reclamation sites, offshore projects and dredging operations are also included in the programme.

New members and overseas visitors, particularly those willing to give presentations, are always welcome. All enquiries should be addressed to Dr Raynor Shaw, Honorary Secretary, Marine Studies Group, c/o Hong Kong Geological Survey, 11/F Civil Engineering Building, 101 Princess Margaret Road, Homantin, Kowloon, Hong Kong.

Geological Society of Hong Kong Newsletter Vol 10 No 1 p 16-17 (1992)

SITES OF SPECIAL SCIENTIFIC INTEREST

M J Atherton

Hong Kong Polytechnic

I would like to draw the attention of members to the protection of important sites in Hong Kong by the Agriculture and Fisheries Department in designating them Sites of Special Scientific Interest or SSSIs. A number of sites have been so designated over the years for their Natural History (botanical, zoological and geological), and the Agriculture and Fisheries Department keeps plans of these.

Any government department or *developer* has to consult the Agriculture and Fisheries Department for permission before going ahead with any project involving these sites. Many of the geological sites were proposed by the writer, and constant vigilance is necessary to prevent them being *developed* as rubbish dumps or covered over in *slope protection works*. Members are invited to propose new sites and report damage to designated sites.

Geological SSSIs include:

1 Cape D'Aguilar
2 Ping Chau
3 Bluff Island & Basalt Island
4 Tolo Channel (northern coast)
5 Lai Chi Chong
6 Centre Island
7 Yim Tin Tsai & Ma Shi Chau
8 Sham Chung coast
9 Nai Chung coast

CAPE D'AGUILAR

This site is located at the southeastern part of Hong Kong Island. It consists of the tip of the Cape D'Aguilar Peninsula, Kau Pei Chau and the coastal water surrounding them. The total site area is 31.5 hectares (10.5 ha of land and 21 ha of sea).

Special Scientific Interest

This site is of high biological, geomorphological and geological interest. It is one of the best examples of rocky shores in Hong Kong. It is rich in coastal features formed by interaction between prevailing wind, tidal actions and the parent rock. Examples of igneous intrusions, dykes, sea caves, geos, cliffs, a sea-arch and wave-cut platforms can be found in the site.

The coastal flora and fauna of the site are rich and their zonations are typical of those found in exposed rocky shores under the influence of tides and wave. This natural habitat provides valuable opportunities for educational studies and scientific research on the diversity of animals and plants living in such habitats, and their adaptations to the harsh environment resulting from wave and tidal actions.

The University of Hong Kong has established the Swire Marine Laboratory at Cape D'Aguilar to serve as a base for marine research. The Laboratory will also provide facilities for international projects on the study of marine biology of Hong Kong. Thus it is important to conserve this coastal habitat for scientific research and educational studies.

PING CHAU

The site is Ping Chau Island in Mirs Bay. The UTM Grid Reference is KV3596 and the area of the island is about 111.4 hectares.

Special Scientific Interest

The geology of the island is of special interest. The rock and soil is representative of the sedimentary rocks found in Mirs Bay (Ping Chau Formation), and is one of the most interesting rock units in Hong Kong. These sedimentary rocks are composed of sandstones and shales, and have a bright red colour. They are limited in their distribution in Hong Kong to the islands on Mirs Bay and to the northern slope of Tolo Peninsula.

BLUFF ISLAND & BASALT ISLAND

The site consists of Bluff Island and Basalt Island in the eastern waters of Hong Kong. Bluff Island is at UTM KV2771 and its area is about 72 hectares. Basalt Island is at UTM KV2870 and its area is also about 72 hectares.

Special Scientific Interest

The vegetation on these two islands is representative of many of the offshore islands of Hong Kong which are covered exclusively by grassland.

A consideration of the environmental conditions existing on these islands suggests that the grassland may be a climax community. Much hillside grassland in the New Territories is not a climax but is maintained by frequent hillfires.

The grassland community on these two islands is a vegetation type which is limited by extreme exposure to wind, often salt-laden; by the rocky, steep slopes carrying only shallow soils and by

being subject to extremes of dryness due to the quick runoff of rainfall and the exposure to direct insolation.

The landform of both the islands shows clearly that the influence of sea waves on the islands is much stronger on the eastern side than on the western. The volcanic rock on the eastern coast of Basalt Island is especially spectacular and is of geographical interest.

TOLO CHANNEL (NORTHERN COAST)

This is the northern land mass of Tolo Channel, extending from Harbour Island to Bluff Head. The area is about 1 287 hectares. The site is located within the designated Plover Cove Country Park.

Special Scientific Interest

The site is made up of sedimentary rocks of the Bluff Head Formation and the Tolo Channel Formation. Fossils, including the ammonite *Hongkongites hongkongensis*, have been discovered along the coast. This belt of land is of special importance in the study of the geological history of Hong Kong. It also provides an excellent demonstration of geological features like dip, strike, folding and faulting. These are useful for educational and scientific purposes.

LAI CHI CHONG

This is a belt of coastal area extending from a river estuary to the eastern side of the ferry pier. The area of the site is about 5 hectares. Most parts of the site are located within Sai Kung West Country Park.

Special Scientific Interest

The site is made up of sedimentary rocks with excellent exposures along the coast. The rock contains plant fossils as well as ammonites. The outcrop of sedimentary rocks here has been well preserved and is of special importance to the study of the geological history of Hong Kong.

CENTRE ISLAND

Centre Island is situated in Tolo Harbour and has an area of about 3.1 hectares.

Special Scientific Interest

This island is of geological interest. It contains plant fossils of Permian age, including *Pecopteris*, *Comsopteris* and *Cordaites*. It is geologically linked to Ma Shi Chau. Rocks on this island also suffered from contact metamorphism; minerals like andalusite has been discovered.

YIM TIN TSAI AND MA SHI CHAU

The site covers the eastern tip of Yim Tin Tsai, the whole island of Ma Shi Chau and the tombolo connecting them. The land area of the site is about 50 hectares.

Special Scientific Interest

Eastern tip of Yim Tin Tsai. There are excellent exposures of an intrusive dyke swarm on the rocky coast and the unconformable contact of the Tolo Harbour Formation with tuff of the Yim Tin Tsai Formation.

Ma Shi Chau. This island consists of Permian Tolo Harbour Formation rich in fossils like *Dictyoclostus*, *Ammonites*, *Antiguationia* and *Duplophyllum*. The coastal area contains a variety of rare geological features such as folding, unconformities and wave-cut platforms. It is an area of special geological interest in the study of stratigraphy, palaeontology and geomorphology. This is an important area for field studies by students from schools, colleges and universities.

SHAM CHUNG COAST

This site is a belt of coast between Sham Chung Wan and Tung King Pai (Flat Reef) on the southern side of Tolo Channel in the northeastern part of Sai Kung Peninsula. The area is about 26 hectares.

Special Scientific Interest

This site contains rich assemblages of fossils, including bivalves, microfossils, plant fossils, ammonites, gastropods and crinoids. The fossil-bearing beds consist of blackish grey mudstone, shale and yellowish white or grey muddy siltstone. These beds comprise eight layers: four layers occur to the southeast of the headland and the other four to the north of the headland.

This is one of the very few sites in Hong Kong where such a rich content of fossils have been discovered and it is of special scientific value for the study of the geological history of Hong Kong and related areas.

NAI CHUNG COAST

This site covers an area extending about 0.87 km along the coast near the ferry pier. The area is about 2.2 hectares.

Special Scientific Interest

To the west of the pier there is a good contact of granite with sedimentary rocks, and to the east there are exposures of black pyritic carbonaceous shales containing a rich variety of fossils. These are rare geological features in Hong Kong.

Acknowledgment to the Department of Agriculture and Fisheries, Hong Kong Government.

Geological Society of Hong Kong Newsletter Vol 10 No 1 p 18-19 (1992)

REPORT ON THE MARINE STUDIES GROUP VISIT TO THE SECOND MARINE GEOLOGICAL INVESTIGATION BRIGADE

R Shaw

Chairman
Geological Society of Hong Kong

Over the weekend of the 9-10 November 1991 the Marine Studies Group of the Geological Society of Hong Kong accepted an invitation from The Second Marine Geological Investigation Brigade of the Ministry of Geology and Mineral Resources to visit their base. This is located at Nangang in the eastern suburbs of Guangzhou, about 20 km from the city centre near the port of Huangpu on the Zhu Jiang branch of the Pearl River. The invitation was extended by Professor Liu Qingmin the Director of the Guangzhou Marine Geological Survey.

Twelve Society members left Kowloon by hoverferry for Huangpu on the Saturday morning, 9th of November. The group was met at the terminal by Dr Zhang Guozhen, the Director of the Second Marine Brigade and a geophysicist by training. First stop was the canteen at the base where an excellent meal, appropriately comprising a large component of seafood, was enjoyed.

After lunch the group was given a slide illustrated introduction to the work of the Brigade, in the South China Sea, the Antarctic and other regions. Investigations have included oil and gas exploration, petroleum geology, regional geology,

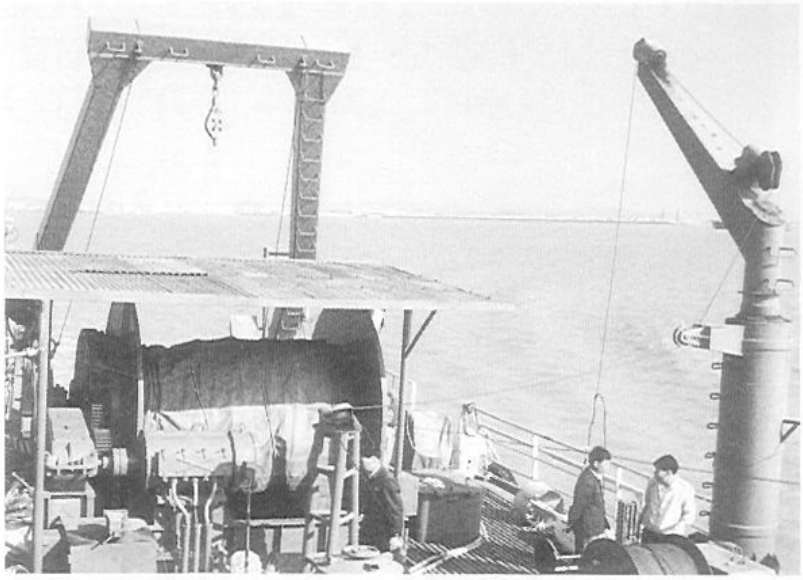
Gravity corer in the stowed position being prepared for a sampling demonstration

marine geology, seashore placer prospecting, marine engineering geology, and offshore geophysical and geotechnical investigations. There then followed a tour of the base, including the corestore, computer centre, navigation section and analytical laboratories. The latter included facilities for particle size analyses, petrography and mineralogy, marine sedimentology, triaxial testing, oedometer testing, palaeontology, organic and inorganic analytical chemistry, isotope chronology and palaeomagnetic analyses. Overall the laboratories were well equipped with a wide range of modern, imported equipment.

Second Marine Brigade ocean-going research vessels Fendou-V (1 000 te) and Haiyang-IV (3 000 te)

A final stop was made at a drawing office where the group was shown recently completed offshore maps of the area immediately adjacent to Hong Kong. These comprised a suite of 1:200 000 scale maps that included seafloor topography and geomorphology, seabed sediments, seabed geol-

ogy and stratigraphy, geohazards and integrated engineering assessments. The maps seen were still at a preliminary stage, being largely diazo-printed paper copies of line-drawn originals that had been carefully shaded by hand using watercolour paints. Maps to the south are printed and published. It was evident that a considerable amount of work had been accomplished, the contents of the map suite including isopachs of the soft marine muds (the Holocene Shunde Formation), and isopach and contour maps of all intervening formations concluding with isopachs of total superficial deposits and contours on the bedrock surface. Seabed sediment and engineering geology maps were also included.



The rear working deck of the Fendou-V showing the 24-channel high-resolution streamer and working equipment

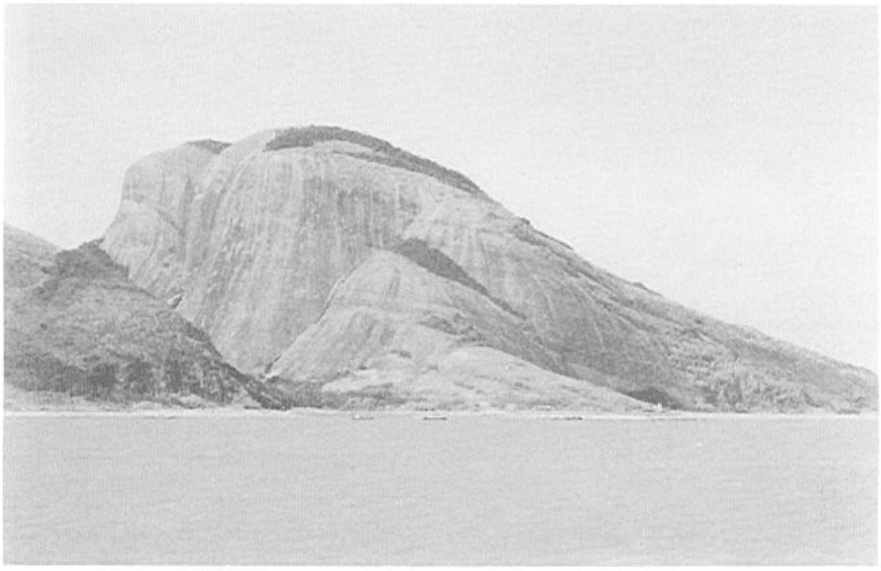
An evening dinner at a nearby seafood restaurant was hosted by Professor Liu. The group spent a comfortable night in the guest reception centre at the base.

On the second day an early start was made, driving to the river to board the R/V Fendou V. This is a 1 000 tonne research vessel, owned by the Brigade, that is specially equipped for marine engineering geology surveys. Our visit was timed to coincide with a training course run by the Brigade for the CCOP (a United Nations body, the Committee for the Coordination of Offshore Prospecting). On the boat was a group of about fifteen geologists largely from Southeast Asia. A guided tour of the boat, its equipment and facilities was followed by demonstrations of various items of equipment as the Fendou V sailed from Huangpu to Humen, at the Boca Tigris narrows.

The Brigade use Argo-Maxiran and an MX-5000 integrated satellite navigation system for offshore work, and Motorola miniranger for coastal and river work (range up to 74 km). Specialist equipment includes marine gravimeter, magnetic gradiometer, multifrequency prospecting system (to detect manganese nodules), echo sounding and side-scan sonar, underwater cameras, box corer, gravity corer, 24 channel high resolution seismic system and sub-bottom profiler. Demonstrations included gravity coring, side scan sonar and sub-bottom profiling.

After a packed lunch on board the group was ferried to shore by dinghies and then visited one of the Humen forts and a museum dedicated to artifacts and dioramas of the Opium Wars. A waiting van transported members to Shekou for the hoverferry journey back to Kowloon.

The weekend was organized by K W Lee and C M Lee of the Society Committee, to whom thanks are due for arranging a varied, interesting and faultless itinerary in very pleasant weather.



View of a Cretaceous sandstone inselberg near Lianhuashan on the voyage to Hunan

Geological Society of Hong Kong Newsletter Vol 10 No 1 p 20-25 (1992)

REPORT ON THE 1991 GEOLOGICAL SOCIETY CHRISTMAS FIELD EXCURSION TO WEST GUANGDONG AND EAST GUANGXI PROVINCES

R Shaw

Chairman
Geological Society of Hong Kong

The 1991 Christmas field excursion was held from 21-30 December and attracted 22 members. A pleasant overnight ferry journey up the Xi Jiang (West River) opened the trip, departing from Kowloon on the late afternoon of Saturday 21 December and arriving in Zhaoqing on the Sunday morning. The group was met at the terminal by our hosts who took us immediately to a hotel for a welcome breakfast before the long drive along the Xi Jiang Valley to Wuzhou in East Guangxi Province. After registering in the hotel we were driven to Bei Yuen Hill, a wooded eminence to the east of the city that afforded a fine view of the Xi Jiang Valley, the city and the narrow, incised left bank tributary valley.

Monday began with a visit to a snake farm where diminutive ladies drew, one by one, a wide variety of snakes from rows of cages and baskets and men in flip flops toddled around the floors of caves and pits among knots of writhing and hissing snakes seemingly mindless of their presence. A snake products souvenir shop displayed a wide selection of delights, including a health drink concocted from the gall bladders removed from two live snakes crushed and mixed in a vaporous alcohol base. A road journey then ensued to Apricot Hill Rock, a large exfoliating granite dome heralded as the second biggest rock in the world, taking second place to Ayers Rock (Plate 1). It measures 1 000 m long by 600 m wide and stood 190 m high, exhibiting a smooth, elliptical dome form with flared sides and numerous large taffoni, small caves and overhanging exfoliation sheets. Not too far along the road a stark contrast of scenery occurred, from a plain dotted with exfoliating granitic inselbergs redolent of the ancient tropical landscapes of Africa to a kegel karst scene rivalling the splendours of Guilin but smaller in extent. Tall karst towers filled the area, separated by wide cultivated plains traversed by rare meandering streams.

Feng Kai Hill was the next stop after lunch, to visit the museum, home of Feng Kai Hill Man. A range of anthropoid specimens were on display

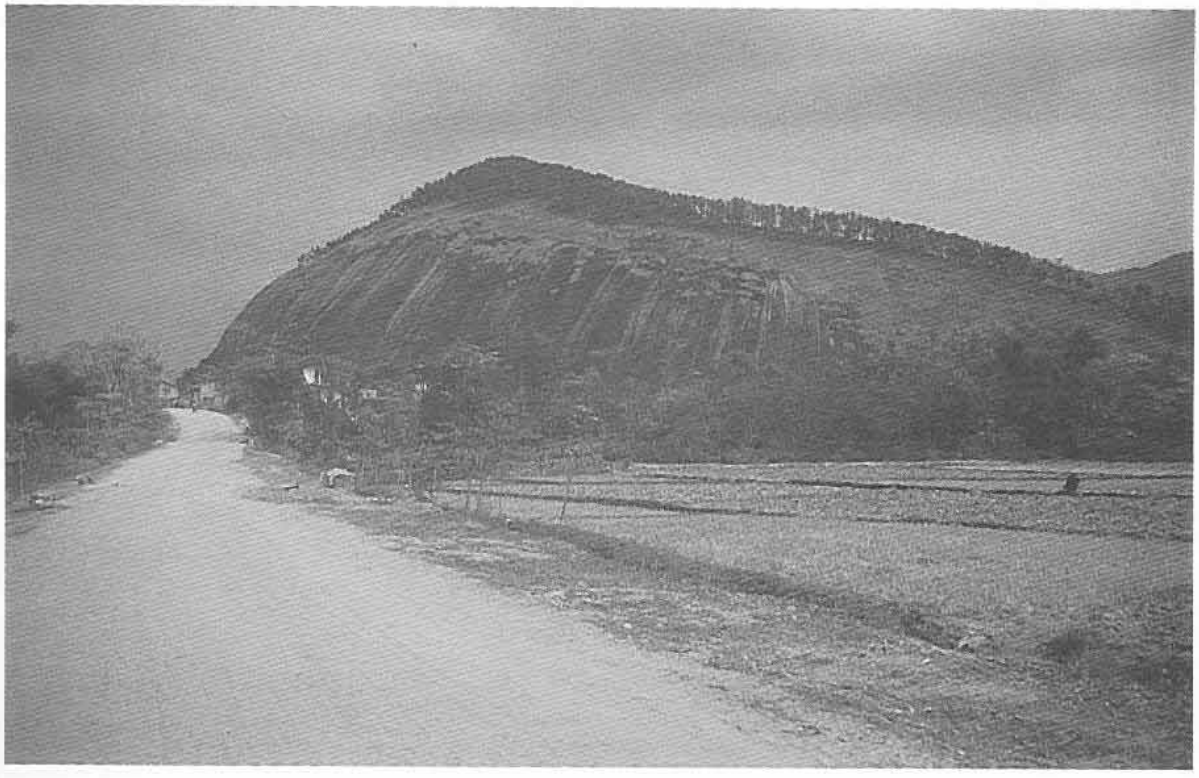


Plate 1 - Apricot Hill Rock, by Tsing Wa Village, Feng Kai County; a large exfoliating granite dome

Plate 2 - Pseudo-karst towers and Thousand Sheet Rock, formed in thinly bedded Devonian sandstones

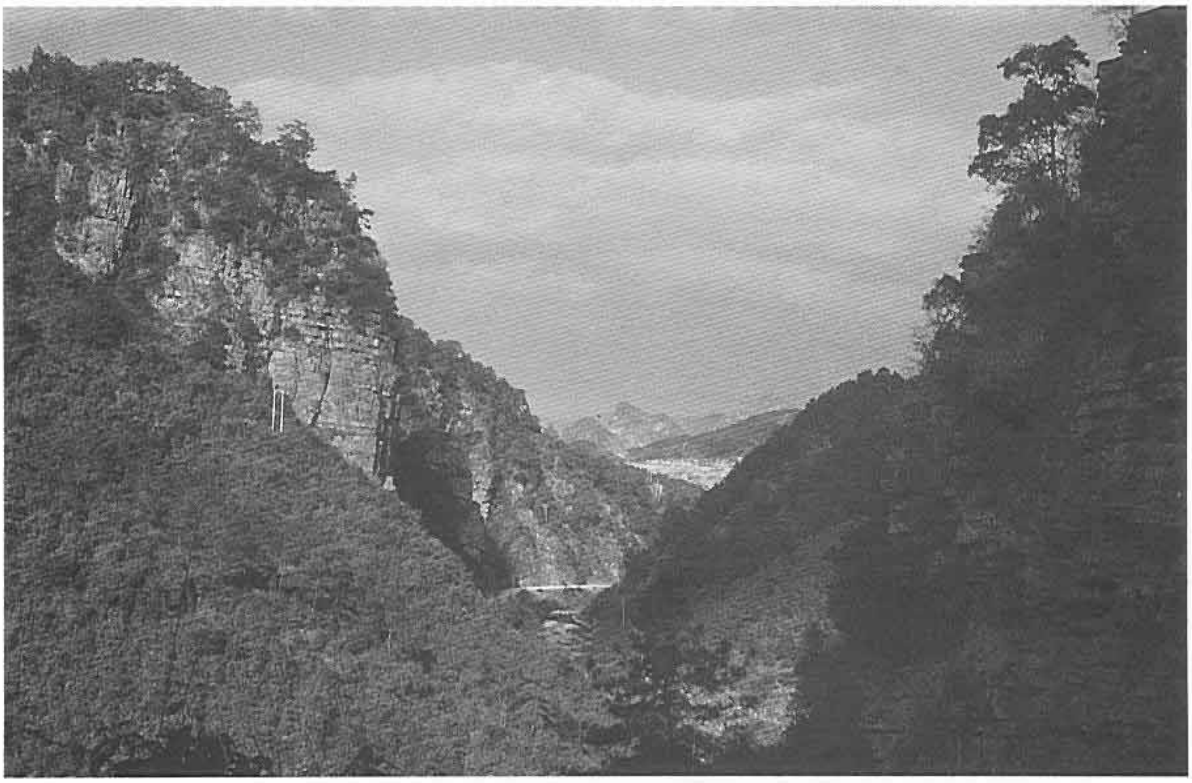


Plate 3 - View from the summit of One Thousand Sheet Rock northwards to the Carboniferous limestone karst towers

alongside the teeth and skeletal remains of a wide variety of animals that co-existed or formed the diet of Feng Kai Man. Radiocarbon dating of a skull from the first layer in the cave had given a date of 11 930 ± 200 BP. Teeth in the third layer had been dated by uranium/thorium methods to 114 800 ± 13 000 BP. In the evening, after supper, a tour of Yulaw Baishek cave was arranged.

Tuesday began with an ascent of One Thousand Sheet Rock, to the Camel Hill Viewpoint, an impressive tower composed of gently dipping Lower to Middle Devonian sandstone (Plate 2) occurring stratigraphically below the Lower Carboniferous limestone forming the karst towers immediately to the north, but giving rise to a similar, but more angular, tower landscape. An extensive multi-level cave was visited on the way back to the hotel. Feng Kai County town was the first stop after lunch and a visit to the Tropic of Cancer Monument in a small park on the banks of the Xi Jiang. This was followed by a meeting in the local government hotel with county officials who described the geographical and economic characteristics of the country. It was considered to be the *Siberia of China*, 300 km from Guangzhou with only a poor road access and no railway link, although it was observed that it was situated on a deep navigable river, but had no port. The county depended on its natural resources of forestry (8 million hectares), granite slabs (15 billion), hydroelectric power (100 000 MW capacity) and agriculture, including chickens, tobacco (40 acres), mushrooms, apples and pears. Tourism to the local caverns was a growing income earner alongside industries developed around forestry (sap for chemicals), a fibreglass factory ($90 million invested), chemicals from limestone, local mineral water, cement

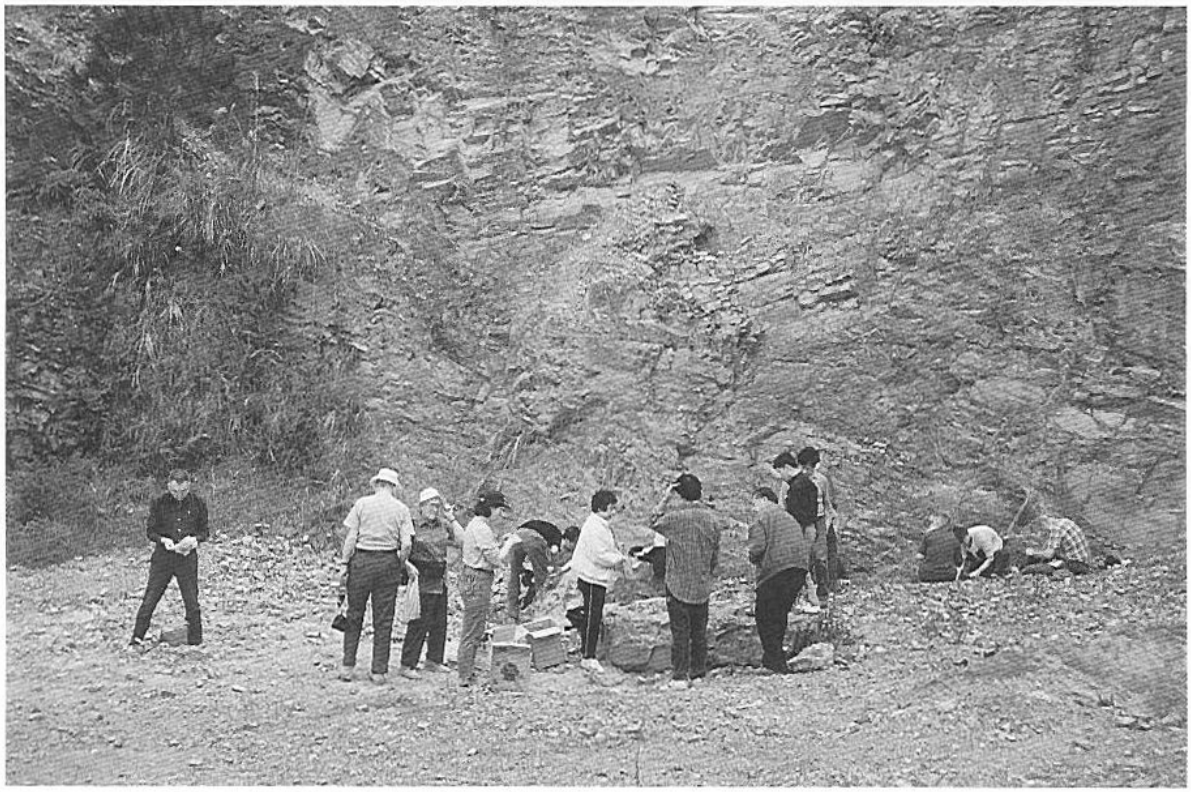


Plate 4 - Society members searching for graptolite fossils in Lower Middle Silurian shales near Liantan Town

(200 000 tonnes a year) and a pulp and paper mill (10 000 tonnes a year).

On Wednesday the Xi Jiang was traversed by ferry prior to a drive to Liantan town where two Silurian graptolite localities were visited. These occurred in Lower to Middle Silurian shales, the only Lower Silurian graptolite locality in Guangdong. The sites had first been described in 1938 by Professor Jang Sai-Ti, and in 1948 Professor Mo An-Ji identified 12 graptolite zones. Time was spent at both sites searching for and collecting specimens from the fissile rocks that were remarkably productive (Plate 4). The rest of the day was spent driving to Yunfu County Town, for a large part of the journey over winding, dusty and unmetalled roads that traversed several uplands with spectacular views. This was the hottest day of the trip.

Thursday commenced with a visit to the Yunfu pyrite mine, a large open pit operation high on a hill to the northwest of the town. The mine is the largest in China, and the second largest in the world, second only to the RTZ mine in Spain. It is part of a National Programme in the Sixth Five Year Plan that began in the 1980s. Production began in 1985 with a development cost of $637 million, and it is calculated that there is a 200 million tonne mineral reserve giving the mine a 60 year life. It was explained that there are six operations carried out: excavation of the open cut, mining of the ore, sieving (trammelling), selecting, sorting and upgrading. The mine

is highly mechanized and it was explained that there is a policy of continually maintaining and upgrading the mining equipment and methods. Water and power supplies were developed and are maintained independently by the mine. A railway exported the ore northwards to the Xi Jiang, and a chemical plant produced sulphuric acid and fertiliser. The mine has 117 customers in China, mostly chemical companies and fertiliser manufacturers, but also exported to Japan. It employs 7 000 workers and supports six subsidiary companies. Plans were afoot to produce 400 000 tonnes of phosphate per annum and increase production from 300 to 400 million tonnes a year, mining 31.04% ores, the highest grade ores in the World. After the introductory talk the remainder of the morning was spent touring several levels of the open pit mine (Plate 5), followed by a tour of the crushing and processing plant built in levels down the hillside above. This was followed by a walk through Panlong Cave, an extensive cave near the town.

On Friday the weather turned, and the morning visit to a marble quarrying and processing operation was done in cool, rainy weather. Quarrying of several karst towers was observed (Plate 6), and a range of processing including blocking, slabbing, grinding, turning and carving.

The Yunfu State owned block factory is one of the largest in China. It is an integrated business producing construction materials, calcite pebbles and cement, plus a variety of other products including polished marble, large marble cubes and marble furniture; over 30 000 pieces were exported to the USA and Japan. The factory mined its own marble on the site, and also processed marble from other areas including Shantung, Sichuan and Kwantung. Explosive-type breaking machines are used to produce 150 000 m^3 a year. Over 100 000 sets of furniture are produced each year, some to customers requests. Over 80% of the slabs produced are for export. Cement and tiles are also produced, with plans afoot to process 100 000 m^2 of granite in 1993. A total of 1 200 workers carried out six integrated processes including marble processing, cement making, construction materials, quarrying and brick making. Granite production is also planned. Carving ceased in 1989 as it was not profitable. A second marble processing factory and its shop preceded lunch before a drive to Zhaoqing in steadily falling temperatures. Upon arrival in Zhaoqing the group went immediately to the 719 Geological Team to see their gold assay laboratories and headquarters.

Saturday dawned cold and wet for the visit to the Duanyan inkstone quarry in Zhaoqing that began at the shop and museum where a range of ornately carved inkstone blocks were available. The group then journeyed to the banks of the Xi Jiang to cross by local ferry, an intriguing experience crossing the paths of many heavily laden cargo boats on a busy waterway in a small boat, made especially exciting by the fact that there was a patchy, but dense mist generated at the interface

Plate 5 - Limonite mining in the tropically weathered overburden of the Yunfu pyrite mine

Plate 6 - Quarrying a karst tower at the Yunfu marble block factory

between the warm waters of the river and the very cold air. On the other bank a short walk was made to the inkstone mine, a steeply-inclined adit that led to low workings in the dense, black shaley rock. It is said that the mine was discovered in the middle Ching Dynasty by a certain Mr Chan who, due to certain defects in his physiognomy, inadvertently lent his name to the mine that was called Pimple Quarry. This fortuitously coincided with the occurrence of green, vitreous mineralic inclusions in the black rock that were intricately worked into the carved inkstone patterns and were particulary favoured by the Emperors. The inkstone quarry began production in the Tang Dynasty, 1 500 years ago. Quarrying was done between February and April when the water table was at its lowest, and the mine has a long history of dewatering methods. Only a small percentage, bands several centimetres wide, can be used for inkstones. The mine provided the best quality inkstones that were used by the Emperors. After lunch a long drive ensued to Hetai to visit a gold mine. The group was not allowed to descend, but pottered around the cold and exposed tailings piles, gathering milky white quartzite veined with pyrites and dotted with the odd speck of gold.

Sunday opened with no respite in the temperatures. The Duanyan inkstone carving factory in Zhaoqing was the first stop to observe rows of girls at stark wooden benches stationed by open windows grasping cold steel etching tools in mitt-clad hands, carefully carving ornate and beautiful inkstone blocks with birds, flowers, grapes, dragons and other traditional motifs. It was not unusual that one month was required to carve some of the more elaborate inkstones. Other departments included inkstone blacking, carving of the wooden bases and cases, slabbing of the inkstone blanks and grading of the blanks. Fortunately the rain subsided as the group drove to the famous Seven Star Crags to climb the largest karst tower for a fine view of the adjacent towers, intervening lakes and ornamental park. The old, straight west-east course of the Pearl River that had been abandoned in favour of a more southerly, looped course could also be seen. Following lunch the large bus was temporarily abandoned in favour of a small and cramped ambulance for a drive up the twisting road, paved with wet and slippery granite sets, to a temple high on the hill to the north of the city. The group then walked down the hill, viewing several levels of the temple and passing through tended woodland paths. A long drive through the late afternoon and early evening to Foshan City followed. The first event enjoyed there was a banquet with local county geologists and officials. Earlier in the day several members of the group had left by train to Guangzhou and then Hong Kong.

Monday began with a long drive out to a bentonite quarry at Lo Chuen. This deposit was discovered in 1987 during a 1:50 000 scale geological mapping programme. The beds are of Upper Eocene age, occurring at the eastern end of the Tertiary Sanshui Basin. Samples of the bentonite were sent to West Germany for analysis, where it was determined to be a calcium-rich deposit, very good for the metallurgical and steel industry, especially for making alloys. Eighty workers produce seven types of bentonite from a 20 km long deposit comprising 8 beds ranging from about 1 m to 3.5 m thick with an estimated reserve of 10 million tonnes. The products are used for metallurgy, drilling fluid, chemicals, ceramics, power isolators, cardboard boxes, high gloss emulsion paint and strengthening cotton threads in the textile industry. After lunch a long drive took us to Wan Shan To in Nanshan County, to a limestone quarry to collect Lower Carboniferous brachiopod fossils in what were unfortunately cold, rainy and windswept conditions. On the return drive the progressively ailing bus gave a final gasp and died at the side of the road. The cheerful, resourceful and ever philosophical driver pulled a replacement, obviously used, distributor core from the dashboard and proceeded to rebuild the distributor with frigid fingers in the failing light. Members of the Society stoically stood on the narrow road directing the constant stream of traffic that began building up behind the bus, threatening to seize up the transport arteries for miles around.

On the final day, Society members assembled for an information exchange. As Chairman of the Geological Society of Hong Kong I delivered a slide illustrated talk on *Environmental geology*, with reference to Hong Kong, explaining the role that geologists play in the life of Hong Kong. Maurice Atherton spoke about *Volcanoes in Europe*. For our hosts, the Geological Society of Foshan, Mr Poon spoke about the *Environmental geology of Foshan*. He explained that Foshan was situated in the Sanshui Basin that contained mainly Tertiary sedimentary rocks, occupying an area of 3 300 km^2 and supporting a population of 2.73 million. The area was predominantly flat, with an east-west structure that controlled the course of the river channel. Geological maps at 1:200 000 scale covered the area, with detailed 1:50 000 scale maps of specific areas. Drinking water had originally been drawn from the West River but with increasing pollution substantial groundwater reserves had been located, which were generally of good quality except under urban areas where the groundwater was slightly polluted. In the central part of the basin the groundwater was saline in the deeper layers, and in the southeastern part the groundwater contained ammonia. Large reserves of mineral waters had been discovered and developed, forming the basis of the Jianlibo carbonated health drink.

Geological hazards were said to be minimal. Since records began in 1300 a total of 42 earthquakes had been recorded, the largest of magnitude 6.0 occurring in 1683; the average magnitude is 2-3, with only small-scale liquefaction registered in the low-lying areas. In 1991 a small cavern was discovered underground in Tertiary limestone, causing subsidence in a sugar cane field. Four fatalities had been caused when excessive explosives had been used in well-jointed rock for a road widening scheme being carried out by local farmers.

Mr Poon explained that 300 million Yuan had been set aside in the Eighth 5-Year Plan for environmental protection, particularly to clean up the Pearl River. Local industries discharged copper, lead and heavy metals into the river. The county has the third largest rate of liver cancer in China, which had been traced to high levels of copper in the local soils and water. A geological agricultural survey has recently commenced to study the groundwater and mineral content of soils to improve productivity. In the northern part of the city it was said that there was a problem with a high salt content in the river, elsewhere pollution from Guangzhou affected the fish and many were diseased.

In summary it was said that the local geological environment was favourable, but it required monitoring, particularly as it was affected by human activity. Geological knowledge to avoid building on faults or caverns, and special investigations and designs were needed when building on the muds of the Pearl River.

Following a farewell banquet lunch the group drove to Shiwan chinaware museum and factory, to the south of Foshan, for a tour of the pottery making workshops where girls painstakingly making ornate clay figures, dioramas and animals from pottery clay. The factory shop offered a wide range of discounted products that were snapped up by members. A short drive to Rongji for the hydrofoil journey to Hong Kong concluded a fascinating, varied and educational field excursion.

Geological Society of Hong Kong Newsletter Vol 10 No 1 p 26-27 (1992)

DISCUSSION ON THE GEOLOGICAL AGE OF THE REPULSE BAY FORMATION, HONG KONG

Newsletter Vol 9 No 2 p 46-51 (1991)

P J STRANGE writes: I refer to the paper by Lee *et al* which discusses the geological age of the "Repulse Bay Formation". It is disappointing to note that although the Repulse Bay Volcanic Group was established five years ago by the Hong Kong Geological Survey (Addison 1986; Strange & Shaw 1986), with its division into a number of lithostratigraphic formations, Lee *et al* continue to use the superseded term "Repulse Bay Formation" which Lee (1987) has divided into five "volcanics" units. Four of these units (Yim Tin Tsai volcanics, Shing Mun volcanics, Ap Lei Chau volcanics and Tai Mo Shan volcanics) are presumably the Yim Tin Tsai Formation, Shing Mun Formation, Ap Lei Chau Formation and Tai Mo Shan Formation as described by Addison (1986), Strange & Shaw (1986) and Langford *et al* (1989). Lee (1987) identifies the fifth division as the Rocky Harbour volcanics, but I would refer the reader to Strange *et al* (1990), which defines six new volcanic formations in the eastern New Territories. It is also worth noting that Allen & Stephens (1971) listed the "Rocky Harbour volcanics" as an obsolete term.

In 1989, the Geotechnical Control Office commissioned the Isotope Geology Group of the UK Natural Environment Research Council to undertake an age dating programme which included samples from six granite plutons and two volcanic formations. The age dating consisted of rubidium/strontium determinations. It yielded excellent isochrons for a number of granite plutons (Strange 1990), and for both the Ap Lei Chau Formation (140 ± 2 Ma) and the High Island Formation (135 ± 8 Ma) (Strange *et al* 1990). The Ap Lei Chau Formation is intruded by the Kowloon Pluton (139 ± 2 Ma) and the Stanley Pluton (138 ± 2 Ma), and is stratigraphically underlain by the Shing Mun Formation which is intruded by the Sha Tin Pluton (148 ± 9 Ma). The Shing Mun Formation must therefore be older than the age given for the Sha Tin granite. The older Yim Tin Tsai Formation produced a K:Ar age of 154 ± 1 Ma (Allen & Stephens 1971).

I agree with the authors that the probable age of some of the plant fossils they have identified is Early Cretaceous. It must be remembered, however, that the locations where they collected these fossils fall within three collapse calderas (two in Sai Kung and one on Lantau Island). The Hong Kong Geological Survey has demonstrated that the calderas in the eastern New Territories represent the youngest part of the Repulse Bay Volcanic Group sequence (Strange *et al* 1990). The authors must therefore be very cautious about assigning the whole "Formation" to the Early Cretaceous on the basis of fossils found in the uppermost part of the volcanic sequence.

From the dating evidence available it seems likely that the intruding granites are only a few million years younger than the intruded volcanics. This suggests that the age of the Repulse Bay Volcanic Group would extend from about 155 Ma (Late Jurassic) to about 130 Ma (Early Cretaceous). The volcanics and the intruding granites are closely related to an episode of late Yenshanian tectonic activity of Late Jurassic to Early Cretaceous age.

ACKNOWLEDGMENTS

Acknowledgment is made to the Director of the British Geological Survey for permission to publish this discussion.

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P J Strange, *British Geological Survey, Keyworth, UK*

TENTH ANNIVERSARY WORKING GROUP ON THE STRATIGRAPHY OF HONG KONG

The Geological Society of Hong Kong was founded in 1982. To celebrate the tenth year of the Society's existence the committee have decided to convene a working group on the stratigraphy of Hong Kong. This event will also coincide with the completion of the Hong Kong Geological Survey 1:20 000 scale mapping programme and the beginning of the 1:50 000 scale map and memoir compilation.

It is, therefore, considered timely that the accumulated geological knowledge and experience gained by a range of specialists over the past ten years, in what has unquestionably been the most accelerated period of development in the history of the Territory, is aired in open discussion to assess and refine the stratigraphical framework. To this end, a series of meetings has been scheduled. Each of these meetings will take the form of an illustrated presentation on a specific topic, expanding upon a classification table and accompanying notes circulated before each meeting. At every meeting, prepared contributions are invited and active discussion encouraged. Salient points raised during the discussion will be recorded.

At the end of the series a Geological Society of Hong Kong Tenth Anniversary Bulletin on the *Stratigraphy of Hong Kong* will be produced. This will comprise the principal presentations, written contributions and edited notes on the discussions, plus a selected bibliography.

The Society earnestly hopes that this will be a seminal document, distilling the results and conclusions of a decade of effort by Hong Kong geologists in a concise reference publication.

All meetings will be held in the Seminar Room, Civil Engineering Building G/F, 101 Princess Margaret Road, Ho Man Tin, Kowloon, from 6 to 8 pm.

Written contributions are to be restricted to one single spaced, typed A4 sheet, and separate page of tables or illustrations. Oral contributions are to be restricted to 10 minutes, and should form the basis of a subsequent written contribution.

For further information, please write to: Dr R Shaw, Chairman, Geological Society of Hong Kong, 11/F Civil Engineering Building, 101 Princess Margaret Road, Ho Man Tin, Kowloon (FAX: 714-0247).

A future issue of the Newsletter will contain a full programme of talks and a timetable, probably covering six weeks in the late autumn of 1992.

FORTHCOMING FIELD VISITS

Please make a note in your diaries of the following proposed field visits. We have a programme planned for the whole year, and we will give more details in the next issue of the *Newsletter*.

Organization of field trips has always been a co-operative effort for the whole committee, but we have always had to rely on a few knowledgable individuals for hiring boats. C H Tan and M Chan have agreed to help with this task, but other volunteers are always welcome.

Sunday 9 August
Fan Lau (boat trip to one of the few remaining unspoilt places on Lantau)

Sunday 4 October
The Brothers (by boat to see all three islands before they disappear)

Saturday 7 November
High Island (by coach to see the ignimbrites and columnar jointing)

EARTH TREMOR MISSED BY MOST

M J Atherton

Hong Kong Polytechnic

A minor tremor struck Sha Tau Kok on 3rd March 1992. The Royal Observatory's analysis indicated the tremor occurred near Yantian, 34 ± 1 km on a bearing 014° from its seismological station in Tsim Sha Tsui, and had a Richter magnitude less than 1.5. The tremor was felt in Wu Shek Kok by a retired engineer, and by a lady in Shatin. The last local earthquake was in the Mai Po marshes in 1983, and two were recorded in 1982 near Discovery Bay, all of magnitude about 1.5.

My plotted position of the latest tremor supports the view that earthquakes usually occur at intersections of NE-trending active faults and NW-trending weakly active faults (Liu 1986).

Realising his village at the border is not far from Daya Bay, where a nuclear plant is being built, 55 year-old Mr L S Wong called the Royal Observatory immediately to make sure he was not imagining it. Mr Wong, a retired civil servant, said he was asleep on the third floor of his house and awoke to find the bed vibrating.

"The whole process lasted for three to four seconds," he said. "I was scared and the thought of an earthquake as well as something ghostly came to mind."

Acknowledgements to the South China Morning Post and the Royal Observatory.

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THIRD ANNUAL FRIDAY LECTURE SERIES 1992/1993

This is the third annual programme of slide illustrated lectures on geological topics from around the world. The variety of subjects and countries reflects the wide range of experience and expertise resident in Hong Kong. You are encouraged to come along and avail yourself of this distilled knowledge, and to meet Hong Kong's community of geologists.

9 October 1992
URANIUM IN THE OLD RED SANDSTONE OF NORTHERN SCOTLAND
Ian Basham
Hong Kong Geological Survey

20 November 1992
SALINE LAKES IN BRITISH COLUMBIA
Bernie Owen
Hong Kong Baptist College

11 December 1992
THE CONTINENTAL SHELF OF SCOTLAND - A NEOLITHIC PERSPECTIVE
Alan Fyfe
Hong Kong Geological Survey

15 January 1993
THE EFFECTS OF SLOPE STABILITY ON MINING DEVELOPMENT IN PAPUA-NEW GUINEA
Jonathan King
Geotechnical Engineering Office

12 February 1993
THE QUATERNARY GEOLOGY OF THE NORTH CHINA LOESS PLAIN
Raynor Shaw
Geotechnical Engineering Office

12 March 1993
VOLCANOES IN INDONESIA
C M Lee
Hong Kong Polytechnic

14 May 1993
ANNUAL GENERAL MEETING
To round off the series members are invited to bring 10-20 slides on any geological subject from anywhere in the world. Presentations will follow the business of the AGM.

All the talks will be held in the Seven Seas Lounge, Mariner's Club, Tsim Sha Tsui, from 6 to 7.30 pm. After the meeting there is the option to retire to the bar or a local restaurant.

GEOLOGICAL SOCIETY OF HONG KONG PUBLICATIONS

Bulletin No 1 (1984). Geology of surficial deposits in Hong Kong, 177 p.
YIM W W S (Editor)

Bulletin No 2 (1985). Geological aspects of site investigation, 236 p.
McFEAT-SMITH I (Editor)

Bulletin No 3 (1987). The role of geology in urban planning, 601 p.
WHITESIDE P G D (Editor)

Bulletin No 4 (1990). Karst geology in Hong Kong, 239 p.
LANGFORD R L, HANSEN A & SHAW R (Editors)

Marine geology of Hong Kong and the Pearl River mouth (1985), 96 p.
WHITESIDE P G D & ARTHURTON R S (Editors)

Marine sand and gravel resources of Hong Kong (1988), 221 p.
WHITESIDE P G D & WRAGGE-MORLEY N (Editors)

Abstracts No 1 (1983). Abstracts of papers presented at the meeting on "Geology of surficial deposits", September 1983, 79 p

Abstracts No 2 (1984). Abstracts of papers presented at the conference on "Geological aspects of site investigation", December 1984, 50 p

Abstracts No 3 (1986). Abstracts of papers presented a meeting on "Sea-level changes in Hong Kong during the last 40 000 years", May 1986, 51 p

Abstracts No 4 (1986). Abstracts of papers presented at the conference on "The role of geology in urban development", December 1986, 65 p

Abstracts No 5 (1988). Abstracts/Extended Abstracts of six papers presented at a meeting on "Future sea-level rise and coastal development", April 1988, 79 p

Abstracts No 6 (1990). Abstracts of papers presented at the conference on "Karst geology in Hong Kong", January 1990, 58 p

Abstracts No 7 (1991). Abstracts of papers presented at the international conference on "Seismicity in Eastern Asia", October 1991, 63 p

Newsletter

Vol 1 (7 issues) 1982-3	Vol 2 (6 issues) 1984	Vol 3 (6 issues) 1985
Vol 4 (4 issues) 1986	Vol 5 (4 issues) 1987	Vol 6 (1 issue) 1988
Vol 7 (4 issues) 1989	Vol 8 (4 issues) 1990	Vol 9 (4 issues) 1991
Vol 10 (1 issue) 1992		

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Bulletin No 1	$40	($60)
Bulletin No 2	$50	($70)
Bulletin No 3	$100	($120)
Bulletin No 4	$150	($180)
Marine geology..	$30	($50)
Marine sand & gravel..	$100	($120)
Abstracts No 2	$10	($20)
Abstracts No 3	$15	($30)
Abstracts Nos 4-6	$20	($40)
Abstracts No 7	$30	($50)

Newsletter, single issue		
Vols 1-3	$10	($20)
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Vols 7-8	$25	($40)
Vols 9-10	$30	($50)

Prices may increase without notice. Prices in parentheses are for non-members. Some publications may be temporarily out of stock. All prices and subscription include surface postage.

Annual Society subscription: $150 (Students $50)

Cover photograph: R B Evans, British Geological Survey, reading gravity at the gravity base station at the foot of the steps to Po Lin Monastery, Ngong Ping, Lantau Island (808560E 812980N)

Publications are available from:

The Secretary
Geological Society of Hong Kong
c/o Department of Geography and Geology
University of Hong Kong
Pokfulam Road
HONG KONG

ISSN 1010-335X