

GEOLOGICAL SOCIETY OF HONG KONG

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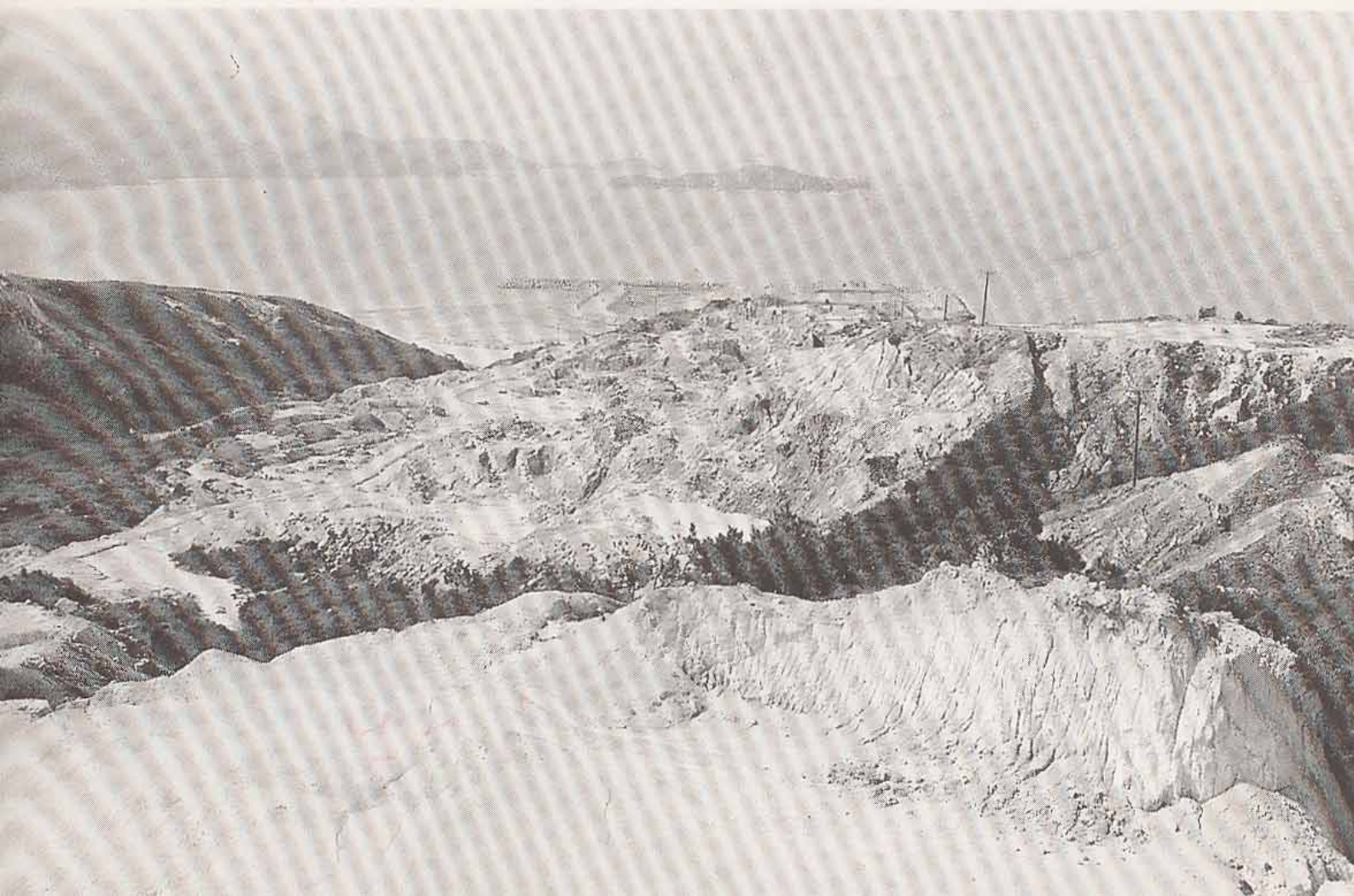
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REPORT ON A FIELD TRIP TO KAT O CHAU AND AP CHAU
ON SUNDAY 21 OCTOBER 1990

M J Atherton

Some thirty members and friends set off by junk from Chinese University on a lovely autumn day for Mirs Bay and the northeastern islands of Hong Kong. Members were led by M J Atherton to view the Kat O Formation which outcrops in a limited area of the northernmost headland of the island. The Formation consists of a crudely bedded calcite-bearing breccia of mainly angular weathered volcanic rocks of uncertain geological age, and may represent deposition against a fault line escarpment. To the east of the Kat O Formation members examined an outcrop of contorted black shales containing slivers of limestone and tuff of possibly Carboniferous age. Further east, tuff exposures contained inclusions of what appeared to be purple shales of the Port Island Formation!

The party continued to Ap Chau and walked around the coast to see the natural arch (Plate 1). The island is entirely composed of Kat O Formation breccia. Although the sea-level terrace is generally thought to be wave cut, Dr R L Langford of the Hong Kong Geological Survey expressed the view that river erosion during the Pleistocene was more likely.

Great excitement on the way back was provided when smoke and steam appeared from the engine room and the junk started to sink in Tolo Harbour. Members got down into the hold to form a bucket chain to bail water out of the engine room. A distress flag was raised and we were soon rescued by another junk captained by the son of our junk owner.

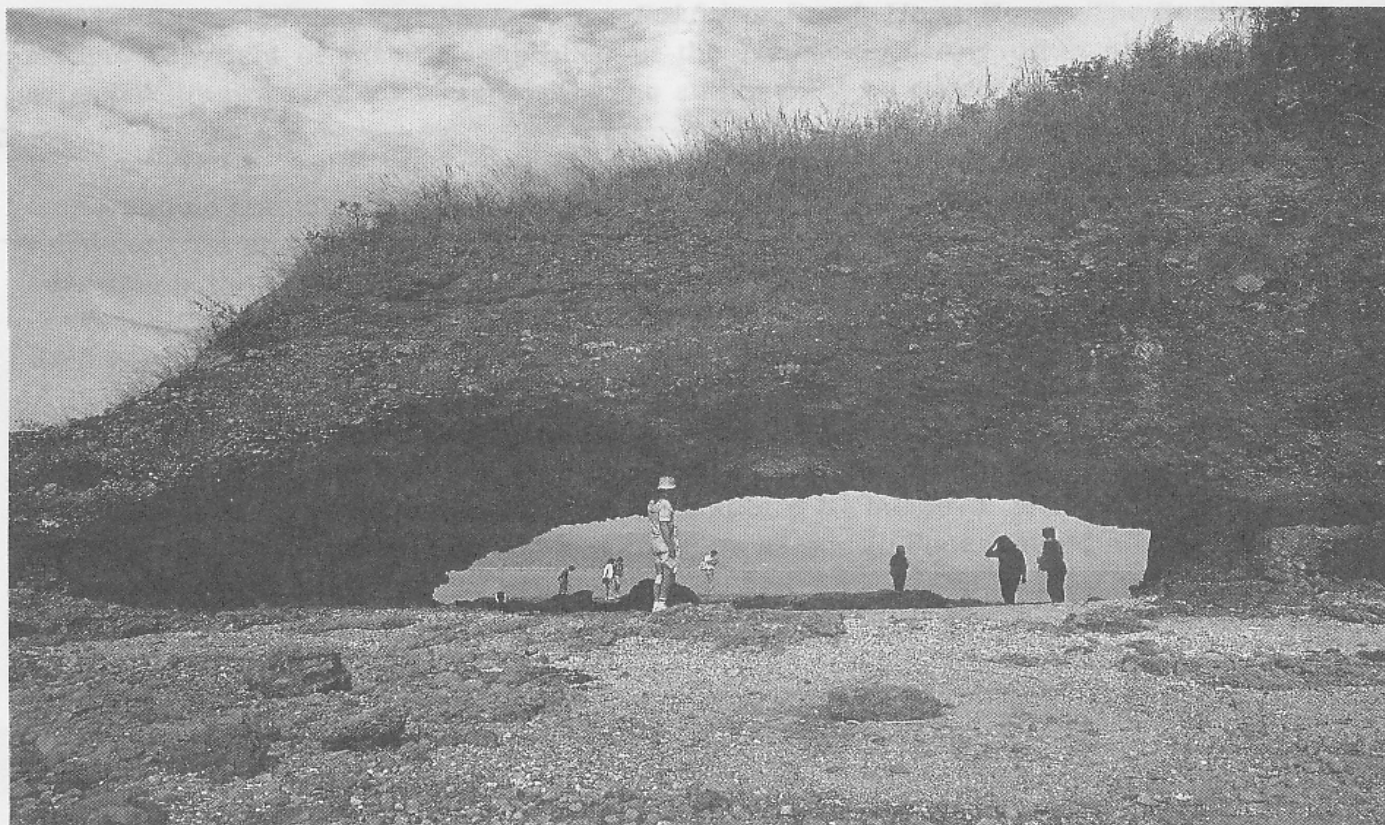


Plate 1 Natural arch in Cretaceous sandstone and breccia of the Kat O Formation on Ap Chau. Courtesy of R L Langford.

A NEW LOCALITY OF LOWER JURASSIC IN HONG KONG

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Introduction

During his geological survey in the middle of 1989, K W Lai of the Geotechnical Control Office of Hong Kong discovered several fossils from Pak Kok Tsai, a small area of north Tolo Channel shore line in the New Territories. At his request we examined these fossils, identifying them as belonging to the Lower Jurassic age (Lai 1989). Four visits were made to the locality guided by Lai to make detailed studies of the area to collect more fossils. It is gratifying that abundant fossils have been found, they will greatly enrich Hong Kong's fauna of Lower Jurassic age. Some new found fossil kinds such as brachiopods, ostracods and scaphapods from this locality, and from Sham Chung as well, will be first discoveries in the marine formations of southeast China of this age. The fossil study concludes that the Lower Jurassic strata are basically continuous from lower to upper at this locality, and thus both the biotic and stratigraphic sequences obtained from there should be of importance in establishing their columns in Hong Kong. Our biostratigraphic studies also prove that the Lower Jurassic sequence seen today at this locality have been overturned. They show a strong influences of tectonic movements in Hong Kong, which is important in the study of structural geology.

General geology

The new locality is located one kilometre northeast of the Fung Wong Wat Bay (Figure 1). There exists a small headland, namely Pak Kok Tsai but nameless on many Hong Kong's maps, nearby the fossil locality (Figure 2). The Lower Jurassic rock outcrops just on the "neck" position of the small headland, where the shore line curves in to form a small bay due to the relative softness of the rock.

The Lower Jurassic strata at Pak Kok Tsai is distributed in an area about 8000m², comprising black, dark-grey shales and shaley siltstones. Their beds strike northeast-southwest and dip northwest at 65-80°.

On the northwest flank of the Lower Jurassic area is developed a suite of quartz sandstone and conglomerate, which constitutes the main body of Tolo Crest and is usually classified as the Devonian Bluff Head Formation. An obvious fault-contact presents itself between the Devonian and the Lower Jurassic formations. The fault dips northwest at about 70° and is believed to be a thrust.

On the opposite flank, ie southeast, of the Lower Jurassic system, there is a rock looking more yellowish and grey in colour, which contains much quartz and other minerals, and being more resistant to weathering forms a headland. The yellowish rock contacts with the rock on its two sides by faults. The rock is very similar to that called "a bread-like intrusive rock" by Heim

(1929) at Fung Wong Wat, the first fossil locality of Hong Kong. Some geologists of Hong Kong think this "intrusive rock" of Fung Wong Wat is a result of volcanic eruption or a tuff. However, we have seen the yellowish rock obviously penetrating into different beds of the Lower Jurassic formation at Fung Wong Wat, and many fragments of the Lower Jurassic rocks (siltstones and shales), it seems like a kind of kata-rock, occurring near the yellowish rock both at Fung Wong Wat and Pak Kok Tsai. M J Atherton considers that the yellowish rocks at the two localities may be in line with each other and controlled by a fault zone. We agree with the latter consideration and interpret the yellowish rock as a result of regmagensis in the fault zone accompanied by hydrothermal alteration instead of volcanic or intrusive origin.

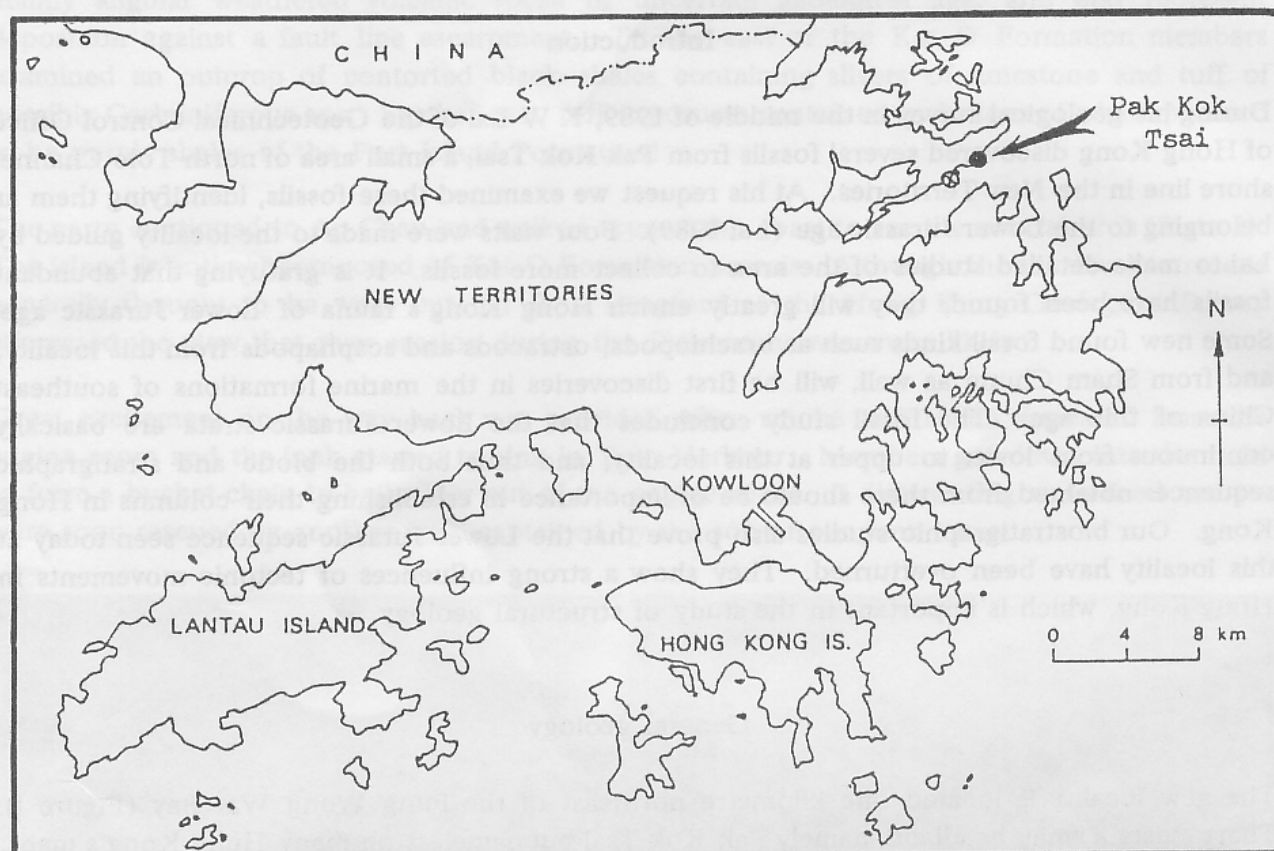


Figure 1 Showing the geographical location of the Lower Jurassic fossils reported in this paper (the western site is Fung Wong Wat found in 1923)

Biostratigraphy

Stratigraphical sequence. A stratigraphical sequence of the Lower Jurassic beds at Pak Kok Tsai is obtained along a line A-B shown in Figure 2 and 3. The line A-B is approximately perpendicular to the strike line of the beds and extends in a direction of azimuth 120° (southeast). Although there are two small-scale faults diagonally occurring at the middle part of the sequence, the total thickness, about 70 m, and the superposition of the beds have not been greatly changed. Therefore it is recognized to be basically continuous from lower to upper, excepting these parts faulted at its bottom and top. It is one of the better sequences of age seen in Hong Kong.

In this sequence Lee has found many subcyclothems in the grey-shales of the Bed 5 and 6. The subcyclothems are the good indicator of the original orientation of the beds on the principle of

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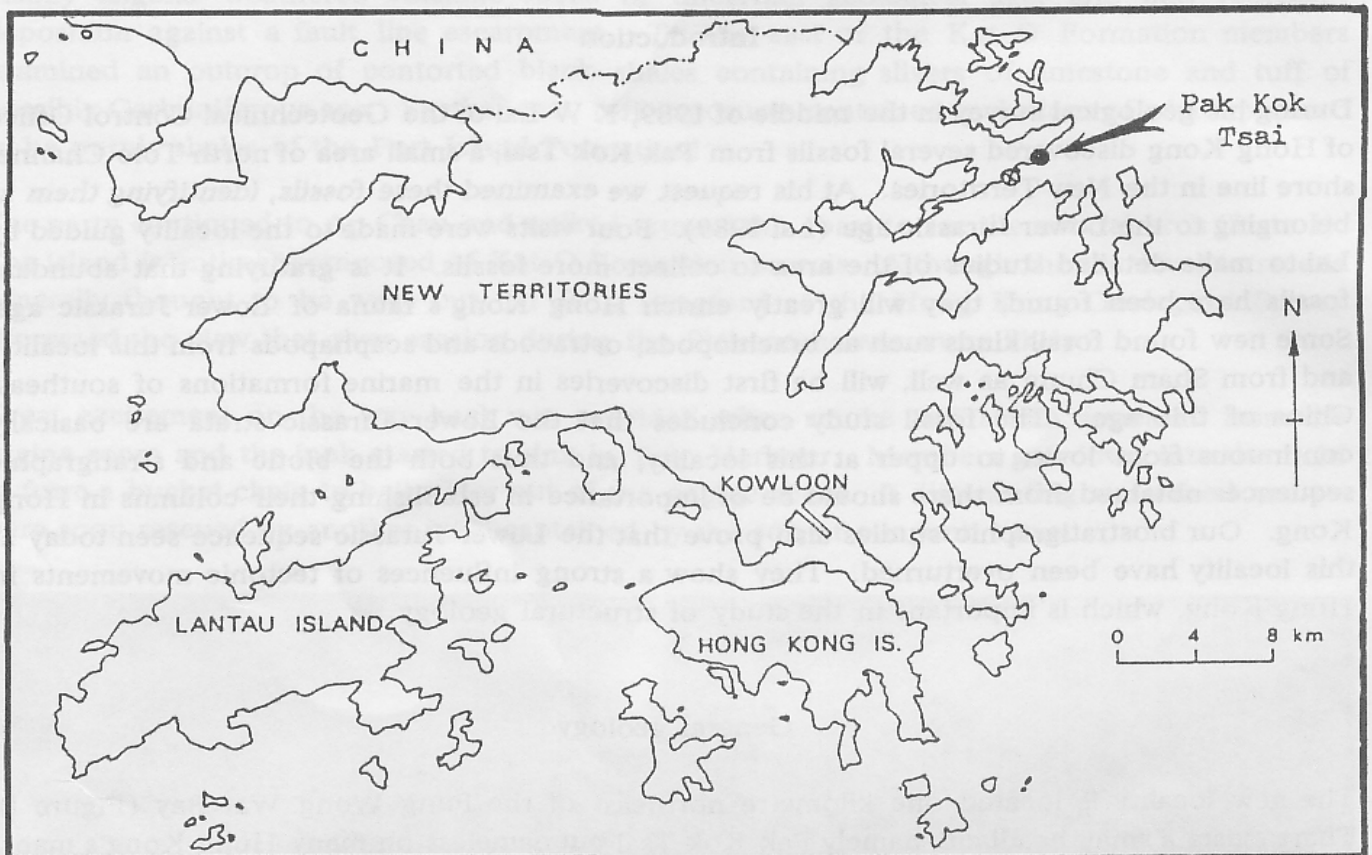


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sedimentary separation, they show the beds grade upwards southeasterly. A relevant fact of the faunal succession also indicates the beds to the southeast are younger than these on the northwest (see below). As mentioned above the dip of the beds is always northwest, therefore they are overturned.

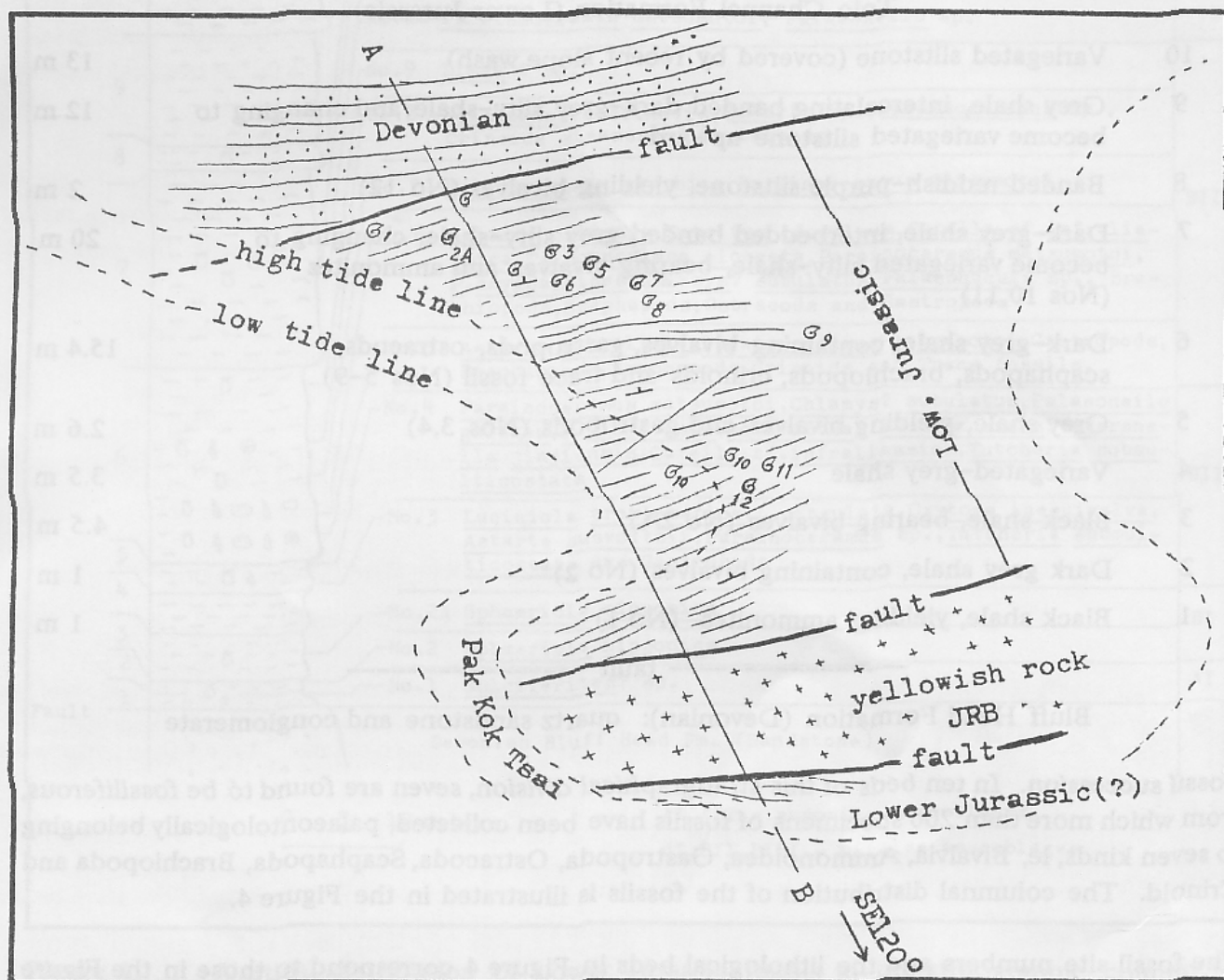


Figure 2 A geologic sketch map in Pak Kok Tsai area

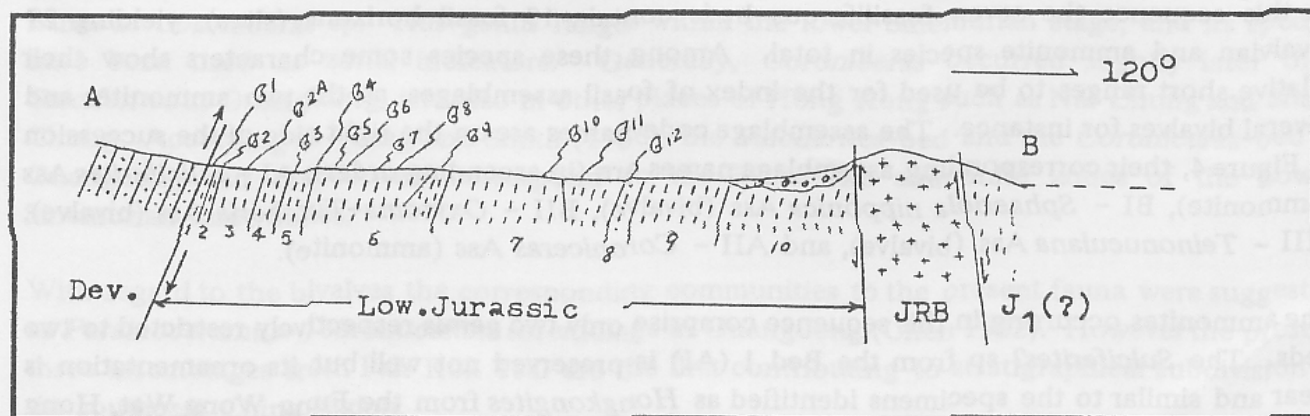


Figure 3 Stratigraphical section across the Lower Jurassic Tolo Channel Formation at Pak Kok Tsai

Our lithological division and description is as follows (in ascending order):

Yellowish brown hydrothermally altered rock

----- fault -----

Tolo Channel Formation (Lower Jurassic)

10	Variegated siltstone (covered by recent slope wash)	13 m
9	Grey shale, intercalating banded dark-grey silty-shale and changing to become variegated siltstone upwards	12 m
8	Banded reddish-purple siltstone, yielding bivalves (No 12)	2 m
7	Dark-grey shale, interbedded banded grey silty-shale, changing to become variegated silty-shale, bearing bivalves and ammonites (Nos 10,11)	20 m
6	Dark-grey shale, containing bivalves, gastropods, ostracods, scaphapods, brachiopods, crinoids and trace fossil (Nos 5-9)	15.4 m
5	Grey shale, yielding bivalves and gastropods (Nos 3,4)	2.6 m
4	Variegated-grey shale	3.5 m
3	Black shale, bearing bivalves (No 2A)	4.5 m
2	Dark grey shale, containing bivalves (No 2)	1 m
1	Black shale, yielding ammonites (No 1)	1 m

----- fault -----

Bluff Head Formation (Devonian): quartz sandstone and conglomerate

Fossil succession. In ten beds of this stratigraphical division, seven are found to be fossiliferous, from which more than 200 specimens of fossils have been collected, palaeontologically belonging to seven kinds, ie, Bivalvia, Ammonoidea, Gastropoda, Ostracoda, Scaphapoda, Brachiopoda and Crinoid. The columnal distribution of the fossils is illustrated in the Figure 4.

The fossil site numbers and the lithological beds in Figure 4 correspond to those in the Figure 2 and Figure 3, and the succession from the bottom to the top in Figure 4 corresponds to that section from A to B in Figure 2 and 3, which means that the older beds of the Lower Jurassic are on the northwest side, while the younger beds are to the southeast.

In this sequence the seven fossiliferous beds contain 13 fossil horizons (sites), yielding 27 bivalvian and ammonite species in total. Among these species some characters show their relative short ranges to be used for the index of fossil assemblages, as the two ammonites and several bivalves for instance. The assemblage code names are on the right side of the succession in Figure 4, their corresponding assemblage names are (in ascending order): AI - *Sulciferites* Ass (ammonite), BI - *Sphaeriola nipponica* Ass (bivalve), BII - *Oxytoma-Tutcheria* Ass (bivalve), BIII - *Teinonuculana* Ass (bivalve), and AII - *Coroniceras* Ass (ammonite).

The ammonites occurring in this sequence comprise only two genus respectively restricted to two beds. The *Sulciferites*? sp from the Bed 1 (AI) is preserved not well but its ornamentation is clear and similar to the specimens identified as *Hongkongites* from the Fung Wong Wat, Hong Kong (Grabau 1923, 1928), which is now regarded to *Sulciferites* (Wang & Smith 1986). This genus ranges from uppermost Hettangian to lowermost Sinemurian, and is greatly developed in the lowermost Sinemurian.

A new locality of Lower Jurassic in Hong Kong

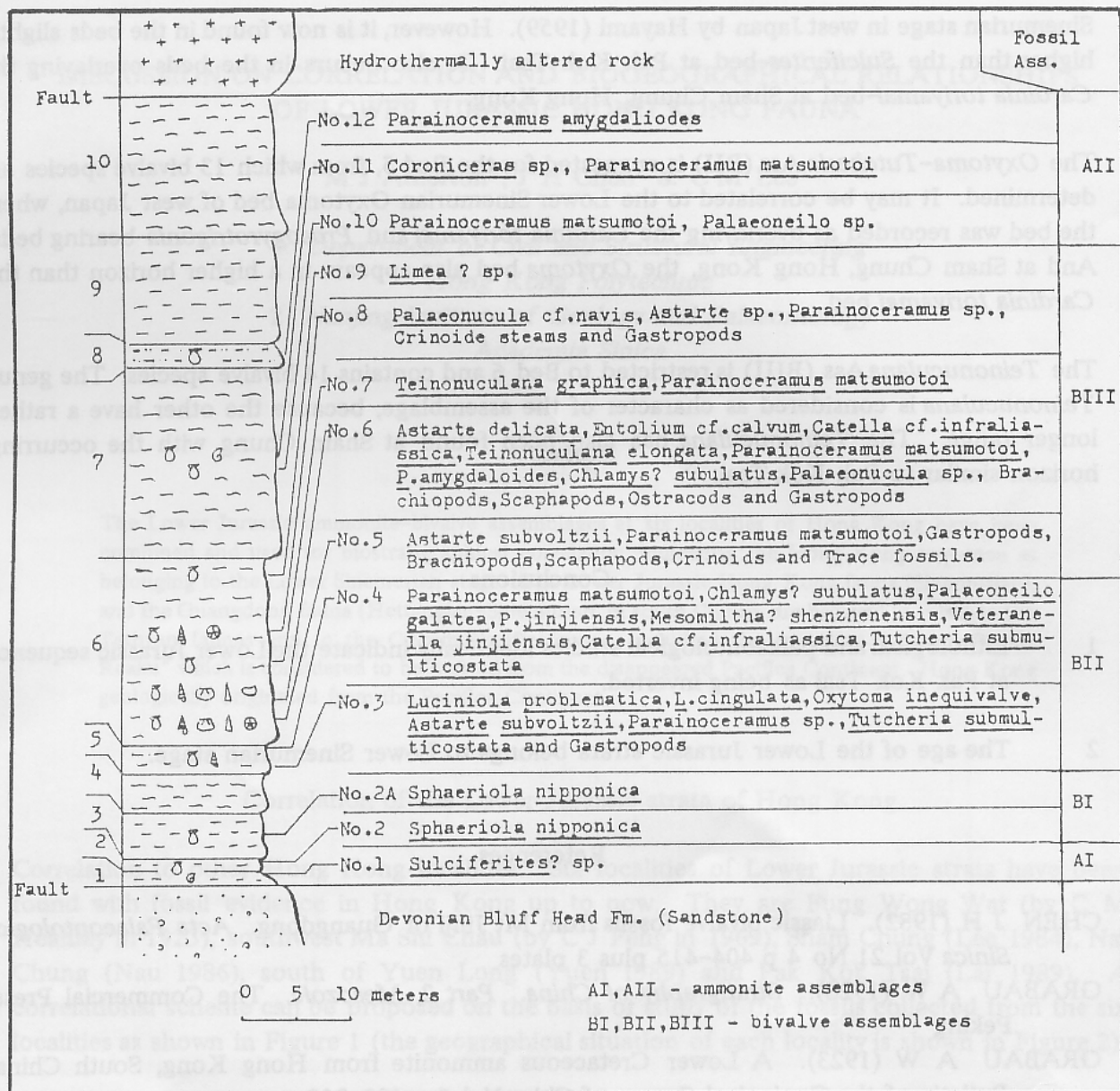


Figure 4 Vertical distribution of Lower Jurassic fossils in the stratigraphic column for Pak Kok Tsui

The specimens from the Bed 7 (AII) are better than the former one, and thus obtain a positive name as *Coroniceras* sp. This genus ranges within the lower Sinemurian stage, and its species have been used as zonal indicators. Generally, *Coroniceras* occurred slightly later than *Sulciferites* in Guangdong, and also in other places of Hong Kong such as Nai Chung and Sham Chung. According to Wang and Smith (1986), the *Sulciferites*-bed and the *Coroniceras*-bed of Guangdong can respectively correspond to the lower two ammonite zones of the Lower Sinemurian three zones.

With regard to the bivalves the corresponding communities to the present fauna were suggested as *Parainoceramus*-*Teinonuculana* assemblage in Guangdong (Chen 1982). However the present three assemblages from Pak Kok Tsai are the first contributing to stratigraphical subdivision in the southeast China region.

The *Sphaeriola nipponica* Ass (BI) is proposed based on the abundant occurrence of *Sphaeriola nipponica* in the Bed 2 and 3. This species was recorded in the *Cardinia toriyamai* bed of Lower

Sinemurian stage in west Japan by Hayami (1959). However, it is now found in the beds slightly higher than the *Sulciferites*-bed at Pak Kok Tsai. It also occurs in the beds overlaying the *Cardinia toriyamai*-bed at Sham Chung, Hong Kong.

The *Oxytoma-Tutcheria* Ass (BII) is suggested for the Bed 5, from which 13 bivalve species are determined. It may be correlated to the Lower Sinemurian *Oxytoma* bed of west Japan, where the bed was recorded as overlaying the *Cardinia toriyamai* and *Prosogyrotrigonia*-bearing beds. And at Sham Chung, Hong Kong, the *Oxytoma* bed also appears in a higher horizon than the *Cardinia toriyamai* bed.

The *Teinonuculana* Ass (BIII) is restricted to Bed 6 and contains 14 bivalve species. The genus *Teinonuculana* is considered as character of the assemblage, because the other have a rather longer range. The *Teinonuculana* has also been found at Sham Chung with the occurring horizon similar to Pak Kok Tsai.

Conclusions

- 1 Lithological and palaeontological studies identically indicate the Lower Jurassic sequence at Pak Kok Tsai as being inverted.
- 2 The age of the Lower Jurassic strata belongs to Lower Sinemurian stage.

References

- CHEN J H (1982). Liassic bivalve fossils from Mt Jinji of Guangdong. *Acta Palaeontologica Sinica* Vol 21 No 4 p 404-415 plus 3 plates
- GRABAU A W (1928). *Stratigraphy of China. Part 2, Mesozoic*. The Commercial Press, Peking
- GRABAU A W (1923). A Lower Cretaceous ammonite from Hong Kong, South China. *Bulletin of the Geological Survey of China* Vol 5 p 199-208
- HAYAMI I (1959). Lower Jurassic lamellibranch fauna of the Higashinagano Formation in west Japan. *Journal of the Faculty of Science, University of Tokyo* Vol 11 Pt 2 p 31-84 plus plates 5-8
- HEIM A (1929). Fragmentary observations in the region of Hong Kong compared with Canton. *Geological Survey of Kwangtung & Kwangsi Annual Report* Vol 2 p 1-32 (plus 1 p errata)
- LAI K W (1989). A new Lower Jurassic fossil locality - the south coast of Pak Kok Shan, Hong Kong. *Geological Society of Hong Kong Newsletter* Vol 7 Pt 3 p 15-19
- WANG Y G & SMITH P L (1986). Sinemurian (Early Jurassic) ammonite fauna from Guangdong region of China. *Journal of Paleontology* Vol 60 No 2 p 1075-1085

DISCUSSION ON CORRELATION AND BIOGEOGRAPHICAL RELATIONSHIPS
OF LOWER JURASSIC HONG KONG FAUNA

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Abstract

The Lower Jurassic ammonite-bivalve assemblages at six localities of Hong Kong have been combined and used for biostratigraphical correlation, indicating the Hong Kong sequence as belonging to the Lower Sinemurian stage. The Lower Jurassic Hong Kong fauna (Sinemurian), and the Guangdong fauna (Hettangian-Sinemurian, in south China), are believed to relate to the Tethyan faunas and to the Circum-Pacific faunas, including the so-called "Circum-Pacific Realm" which is considered to be derived from the disappeared Pacifica Continent. Hong Kong geologically originated from the Pacifica Continent.

Correlation of the Lower Jurassic strata of Hong Kong

Correlation to other Hong Kong localities. Six localities of Lower Jurassic strata have been found with fossil evidence in Hong Kong up to now. They are Fung Wong Wat (by C M Heanley in 1923), southwest Ma Shi Chau (by C J Peng in 1969), Sham Chung (Lee 1984), Nai Chung (Nau 1986), south of Yuen Long (Yuen 1989) and Pak Kok Tsai (Lai 1989). A correlational scheme can be proposed on the basis of study of the fossils collected from the six localities as shown in Figure 1 (the geographical situation of each locality is shown in Figure 2).

From Figure 1 it is seen that the Sham Chung and the Pak Kok Tsai sequences are relatively complete among the six sequences. This is especially true of the Sham Chung sequence reported by Lee (1984). It is over 150 m in total thickness and contains two ammonite-bearing beds and several bivalve assemblages. Its fossiliferous middle and lower parts are comparable with the other sequences. The remainder, ie, the basal conglomerate at the bottom and the *Arnioceras-Juraphyllites* bed in the upper part, find no analogies in the other sequences. The Sham Chung sequence should therefore be suggested as a *lectotype* for the Lower Jurassic Tolo Channel Formation in Hong Kong. It is also suggested that further investigations of this sequence would produce more detail in biostratigraphy and other features, eg, lithology and magnetism; it would then become a standard for regional correlation.

It is well known that the type-locality of the Tolo Channel Formation is at Fung Wong Wat in Tolo Channel; the earliest fossil finds of Lower Jurassic ammonites were made at this locality. The only evidence for dating the Formation when it was defined was found here (Uglow 1926; Brock & Schofield 1926); the strata such as at Three Fathoms Cove, Centre Island, Ma Shi Chau and Yim Tin Tsai were incorrectly included in this formation on the 1936 map by Brock *et al* (1936). However, by our observation, the Fung Wong Wat sequence is very limited in range and is only equal to the *Sulciferites* Assemblage (AI) of Pak Kok Tsai or to the *Cardinia toriyamai* bed of Sham Chung. In view of our biostratigraphical study, the siltstone underlying the fossil-bearing bed at Fung Wong Wat may correspond to the sandstone of the lower part of the Sham

Chung sequence or to the lower part of the Nai Chung sequence at most, but not to the basal conglomerate of Sham Chung. It means that the Fung Wong Wat sequence may have lost (faulted) a greater part of the Lower Jurassic strata, so that, it is not sufficient as the type-locality for correlation.

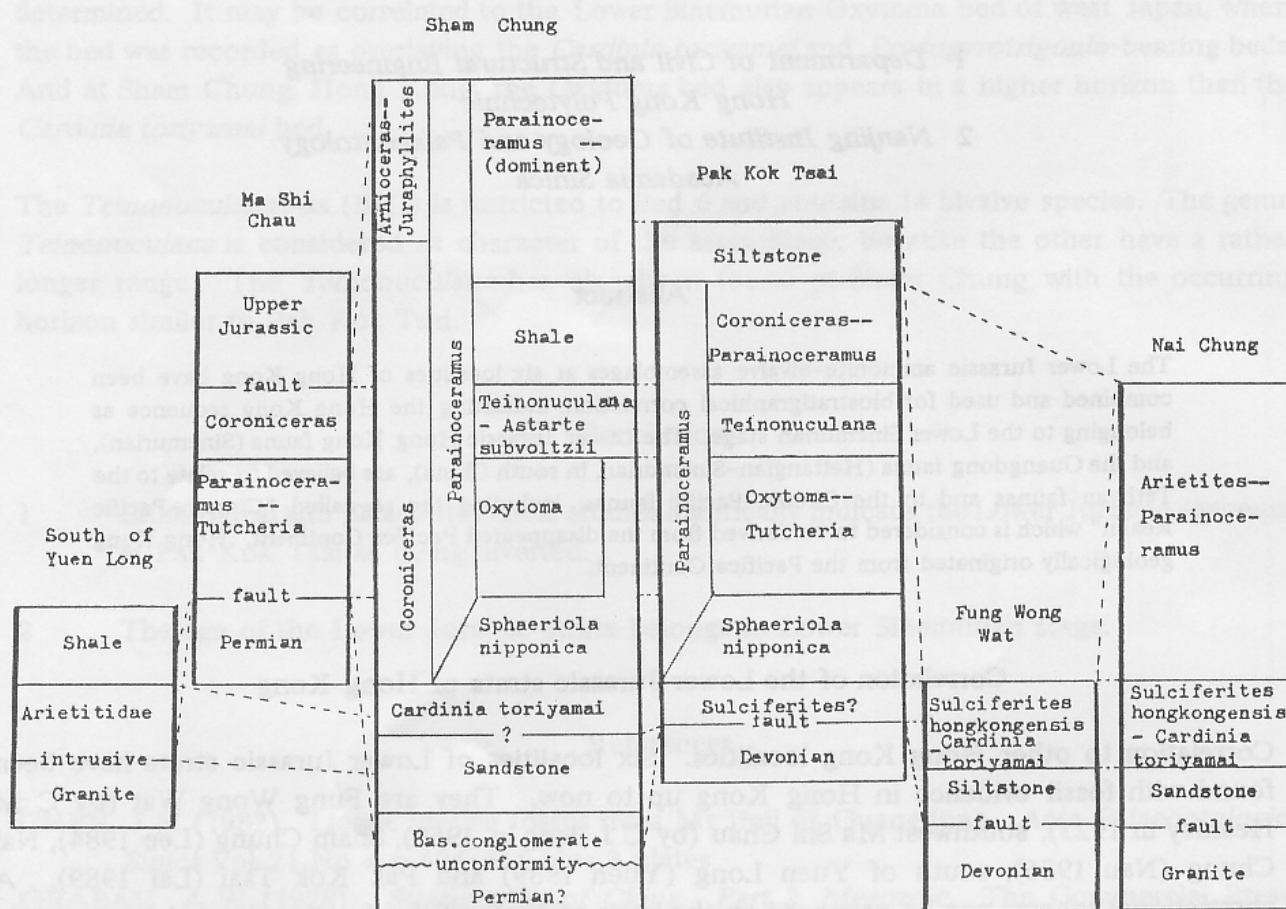


Figure 1 Biostratigraphical correlation of the Tolo Channel Formation, Lower Jurassic, in Hong Kong

An ammonite from sandstone exposures south of Yuen Long is poorly-preserved, and was recorded as *Arietites* sp (Yuen 1989). However, it was only identified as an indeterminate form of the family Arietitidae by G X He. On the other hand, according to the lithological correlation, this ammonite-bearing bed may be similar to the *Cardinia toriyamai* bed (sandstone) of the Sham Chung sequence.

At southwest Ma Shi Chau there exist two fossil-bearing beds, ie, the ammonite-bearing bed in the upper and the bivalve-bearing bed in the lower. It is a pity that the ammonite collected by Dr Peng has disintegrated. However, it was recorded by Nau (1981) and seems likely to be either the genus *Arnioceras* or the genus *Coroniceras*. This means that this ammonite-bearing bed can not be accurately correlated to the middle or to the upper part of the Sham Chung sequence, although it undoubtedly belongs to the Lower Sinemurian stage according to our knowledge of the stratigraphical occurrence of ammonites in Hong Kong.

The bivalves from the lower bed of the Ma Shi Chau sequence comprise *Parainoceras matsumotoi* Hayami and *Tutcheria multicostata* (Goldfuss). The latter species is closely related with that of the *Oxytoma-Tutcheria* Assemblage (BII) of the Pak Kok Tsai sequence stated

*Discussion on correlation and biogeographical relationships
of Lower Jurassic Hong Kong fauna*

above, which may correspond to the *Oxytoma* bed of the middle part of Sham Chung sequence. Because the strata of Lower Jurassic age are limited in thickness (no more than 50 m) at Ma Shi Chau, they may roughly be correlated to the middle part of the Sham Chung sequence or of the Pak Kok Tsai sequence.

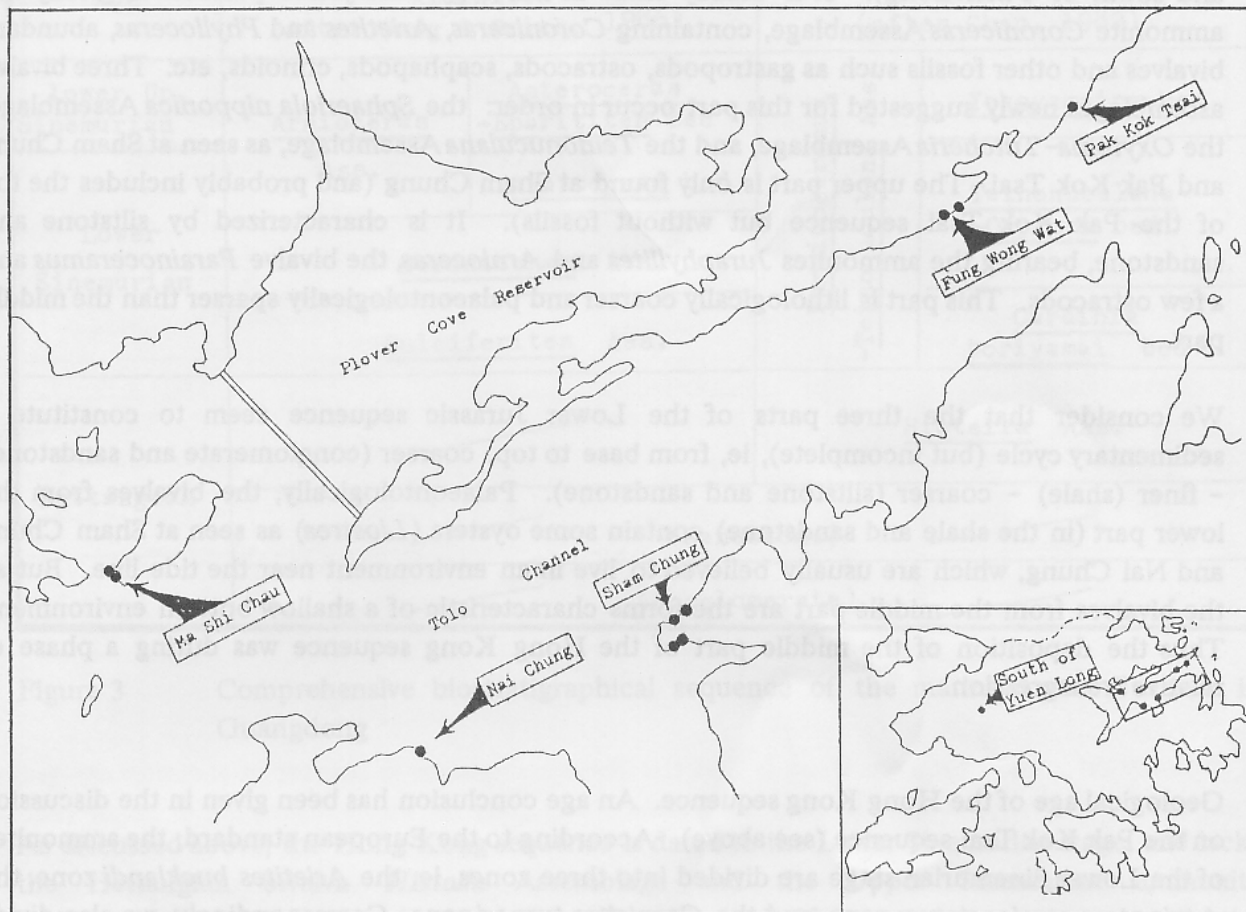


Figure 2 Distribution of the six localities of Lower Jurassic in Hong Kong

The Nai Chung sequence was reported by Nau (1986) and was recently studied by the authors. This sequence contains two ammonite-bivalve assemblages within the 50 m thick strata (except the azoic sandstone in the lower). The *Sulciferites hongkongensis*-*Cardinia toriyamai* Assemblage is almost the same as that assemblage with the same name at Fung Wong Wat. Its important bivalve contents are also found in the *Cardinia toriyamai* bed of the Sham Chung sequence.

The *Arietites*-*Parainoceramus* Assemblage of Nai Chung occurs in the strata from the middle to the upper part of the sequence. Because this assemblage has a fairly monotonous faunal aspect throughout its range, it is difficult to further subdivide it on the basis of palaeontological material. But it is considered that this assemblage is more or less like the middle parts of the Sham Chung sequence and the Pak Kok Tsai sequence, or the whole sequence at Ma Shi Chau, due to the common occurrences of the ammonites *Arietites* and bivalves *Parainoceramus*. However, it would seem impossible that this assemblage can correspond to the upper part of the Sham Chung sequence because of the obvious smaller thickness.

Comprehensive sequence in Hong Kong. Synthetically, it can be concluded that the Hong Kong sequence of the Lower Jurassic age is grouped into three parts. The lower part comprises basal conglomerate, sandstone and shale, ie, the sedimentary grains of this part are gradually becoming finer upwards. Fossils of this part consists of ammonite species of the genus *Sulciferites* and the bivalve *Cardinia toriyamai* Assemblage as seen at five of the six localities (except Ma Shi Chau). The middle part is also widely found in Hong Kong at four localities (except Fung Wong Wat and south of Yuen Long). It is mainly shale in lithology, and yields palaeontologically the ammonite *Coroniceras* Assemblage, containing *Coroniceras*, *Arietites* and *Phylloceras*, abundant bivalves and other fossils such as gastropods, ostracods, scaphapods, crinoids, etc. Three bivalve assemblages newly suggested for this part occur in order: the *Sphaeriola nipponica* Assemblage, the *Oxytoma-Tutcheria* Assemblage, and the *Teinonuculana* Assemblage, as seen at Sham Chung and Pak Kok Tsai. The upper part is only found at Sham Chung (and probably includes the top of the Pak Kok Tsai sequence but without fossils). It is characterized by siltstone and sandstone, bearing the ammonites *Juraphyllites* and *Arnioceras*, the bivalve *Parainoceramus* and a few ostracods. This part is lithologically coarser and palaeontologically sparser than the middle part.

We consider that the three parts of the Lower Jurassic sequence seem to constitute a sedimentary cycle (but incomplete), ie, from base to top, coarser (conglomerate and sandstone) - finer (shale) - coarser (siltstone and sandstone). Palaeontologically, the bivalves from the lower part (in the shale and sandstone) contain some oysters (*Liostrea*) as seen at Sham Chung and Nai Chung, which are usually believed to live in an environment near the tide line. But all the bivalves from the middle part are the forms characteristic of a shallow bottom environment. Thus the deposition of the middle part of the Hong Kong sequence was during a phase of relative transgression.

Geological age of the Hong Kong sequence. An age conclusion has been given in the discussion on the Pak Kok Tsai sequence (see above). According to the European standard, the ammonites of the Lower Sinemurian stage are divided into three zones, ie, the *Arietites bucklandi* zone, the *Arnioceras semicostatum* zone, and the *Caenisites turneri* zone. Correspondingly, we also divide the ammonites of the Hong Kong sequence into following three assemblages: the *Sulciferites* Assemblage, the *Coroniceras* Assemblage, and the *Juraphyllites-Arnioceras* Assemblage. In our three assemblages, the former two are the same as those of Guangdong which were discussed by Wang & Smith (1986) as correlating respectively with the *Arietites bucklandi* zone and the lower part of *Arietites semicostatum* zone in Europe. Our third assemblage, containing the relatively long-ranged genera *Juraphyllites* and *Arnioceras*, is slightly younger than the *Coroniceras* Assemblage of Hong Kong and Guangdong in view of the study of the bio-horizonal succession (see Figure 1), and may correspond to the upper part of the European second zone and the third zone (*Caenisites turneri* zone) or partly to that.

Some Upper Sinemurian characters such as *Asteroceras* and *Eparitites* were reported from Guangdong. However, they have not been found in the Hong Kong sequence. Therefore, the Hong Kong sequence should be restricted to the Lower Sinemurian stage.

Comparison of the Hong Kong sequence with those of South China

Close relations with Guangdong. Because of the close geographical situation, the Lower Jurassic Hong Kong fauna is undoubtedly part of the Guangdong fauna of this age. Many studies have touched upon the Guangdong fauna in thirty years since it was found in 1955. The outcome

*Discussion on correlation and biogeographical relationships
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of these studies has been synthesized in Chen (1982) and Wang & Smith (1984), as shown in Figure 3.

Age	Ammonites (after Wang & Smith, 1986)		Bivalves (after Chen, 1982)	
lower Up. Sinemurian	<u>Arnioceras</u>	<u>Asteroceras</u> - <u>Eparitites</u> bed	<u>Parainoceramus</u> - <u>Teinonuculana</u> Ass.	<u>Yokoyamaina</u> bed
Lower Sinemurian	Ass.	<u>Arnioceras</u> bed		<u>Teinonuculana</u> - <u>Oxytoma</u> bed
	<u>Coroniceras</u> Ass.			<u>Cardinia</u> <u>toriyamai</u> bed
	<u>Sulciferites</u> Ass.			
Hettangian			<u>Hiatella</u> Ass.	
	(sandstone)			
	(conglomerate)			

Figure 3 Comprehensive biostratigraphical sequence of the marine Lower Jurassic in Guangdong

As discussed above, the Hong Kong sequence is dated to the Lower Sinemurian stage, and lacks the Hettangian bivalva *Hiatella* Assemblage and the Upper Sinemurian ammonite *Asteroceras-Eparitites* bed (with bivalves *Otapiria* and *Yokoyamaina*) compared with the Guangdong sequence. However, the development of the marine Lower Jurassic sequences in Guangdong are different in different regions, as seen in Figure 4. The sequences at Jinji in central Guangdong and at Jiexi-Huidong in east Guangdong are relatively complete, but that at Shiwan in central Guangdong is incomplete. The Shiwan sequence is believed to be very similar to the present Hong Kong sequence in three aspects:

- 1 Almost the same range within the Lower Sinemurian stage but losing Hettangian sediments and the corresponding faunal assemblage.
- 2 The same basal part (conglomerate) overlying Permian rocks but not overlying the Upper Triassic rocks.*
- 3 Similar biostratigraphical divisions in the lower and middle parts.

* The Sham Chung sequence of Hong Kong was considered overlying the Upper Triassic "Sham Chung Formation" according to the identification of R Xu for a few of plants from the latter formation. But recently we have collected many Lower Sinemurian bivalves from the plant-bearing beds. Therefore, the "Sham Chung Formation" may be the synonym to the Tolo Channel Formation.

European Standard		Hong Kong (This paper)		Jingji, Kaiping, Centre Guangdong (Compiled from: Sun et al., 1960; Chen, 1982; Wang and Smith, 1984)	Shiwan, Kaiping, Central Guangdong (Compiled from: Sun et al., 1960; Sun et al., 1980; Wang and Smith, 1984)	Jiexi-Huidong, East Guangdong (Compiled from Wang and Smith, 1984, and added by J. H. Chen)	
Jurassic	up. low. Sinem.			Asteroceras		Eparietites	Otapiria
	up. low. Sinem.			Arnioceras		Juraphyllites	
	up. low. Sinem.			Arnioceras		Arnioceras	
	up. low. Sinem.			Coroniceras		(Sandstone)	
	up. low. Sinem.			Coroniceras		Coroniceras	
Lower	Lower			Sulciferites --		Sulciferites	
	Lower			Car. toriyamai		(Sandstone)	
	Lower			(Sandstone)		(bas. congl.)	
	Lower			Hiatella		Hiatella & plants	
	Lower			(bas. congl.)		(coarse sandstone)	
Hett.	Hett.			Upper Triassic		Upper Triassic	
	Hett.			Permian		Permian	
	Hett.			Permian		Permian	
	Hett.			Permian		Permian	
	Hett.			Permian		Permian	
(Substrata)	(Substrata)			Permian		Permian	
	(Substrata)			Permian		Permian	
	(Substrata)			Permian		Permian	
	(Substrata)			Permian		Permian	
	(Substrata)			Permian		Permian	

Figure 4 Correlation of the Lower Jurassic sequence in Hong Kong to those in Guangdong

The only difference between them is that the Shiwan sequence is coarser in sedimentary grain, especially in its upper part (mainly sandstone), and thus its whole thickness is larger (about 300 m). The upper part of the Shiwan sequence is commensurate with the same part of the Hong Kong sequence due to the comparable biostratigraphical horizon, although it has no reported fossils in it.

Differences to the west of South China. During the Lower Jurassic there existed two sea-covered regions in South China, ie, the Guangdong region (including the neighbouring areas such as south Hunan, west Fujian and east Guangxi) and the west of South China region (comprising west Yunnan, south Qinghai and Tibet, and Indochina). Areas between the two regions were under continental or non-marine conditions. Palaeontological evidence shows that the west of south China region (except the Himalayas) bears marine sediments in the middle and upper parts of the Lower Jurassic sequence, dating to the upper Pliensbachian and Toarcian stages. The transgressions extended to Middle Jurassic onward. But the lower part of the Lower Jurassic sequence is characterized by red beds (non-marine). To compare with the Guangdong region, the Lower Jurassic transgressions in the west of South China obviously happened later. In other words, when the Guangdong region was submerged by sea-waters in the Hettangian-Sinemurian stages, the west of South China region was uplifted. It is also exactly the reverse that when the latter was under transgressions in the Pliensbachian stage and later stages, the former had risen (see Figure 5). This case is very interesting for studying the development of the bioprovinces and transgressions-regressions in South China. It leads us to think that the two regions mentioned above may be different in palaeogeography but related in tectonic blocks, between them there may exist a continental screen. This screen is considered to have been in existence in the Lower Jurassic because the Guangdong (and Hong Kong) fauna

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is related to the Circum-Pacific Realm, but the faunas in west of south China belong to the Tethyan Realm.

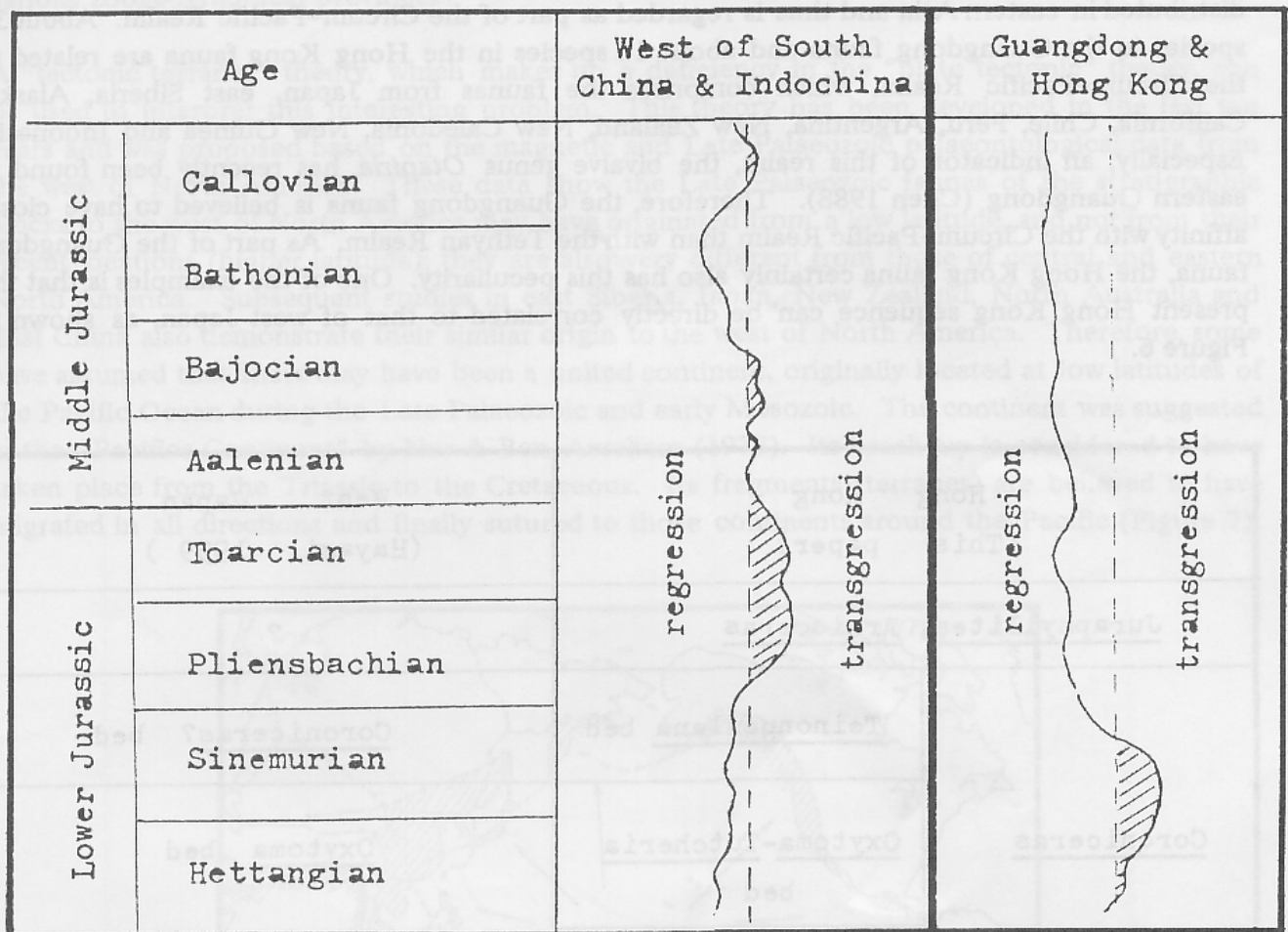


Figure 5 Comparison of the Lower-Middle Jurassic transgression-regression between the two parts of South China. It shows the transgressions happened in Guangdong and Hong Kong only in Sinemurian stage and earlier, but happened in the west part of South China and Indonesia in the later stages.

Faunal relationships and the geological origin of Hong Kong

Relationship with the Tethyan faunas. Although the Lower Jurassic ammonites from Guangdong display themselves as being a part of the cosmopolitical fauna according to Wang and Smith (1984), the bivalves from this region demonstrate some regional features because they are almost all benthic in ecology. Except for these regional members, among 64 species of Bivalvia in the Guangdong fauna, about 20 (or about 13 species in the total 32 species of the Hong Kong fauna) are related to the typical faunas of the Tethyan Realm such as those from Germany, England and the Paris Basin. They are usually also of the same composition as the faunas occurring in the regions around the Pacific, but not the specific ones of the Tethyan Realm. By reason of this aspect the Guangdong fauna was palaeobiogeographically considered by Hayami (1985) as at a transitional location between the Tethyan Realm and the Oriental Province. Therefore, the Lower Jurassic transgression in the Guangdong and Hong Kong region

has a marine connection to the Tethys, although there may be a continental screen in the west of the Guangdong region, as discussed above.

Relationship with the Circum-Pacific faunas. Hayami's (1985) Oriental Province includes regions distributed in eastern Asia and thus is regarded as part of the Circum-Pacific Realm. About 30 species in the Guangdong fauna and about 18 species in the Hong Kong fauna are related to the Circum-Pacific Realm, which comprises the faunas from Japan, east Siberia, Alaska, California, Chile, Peru, Argentina, New Zealand, New Caledonia, New Guinea and Indonesia. Especially, an indicator of this realm, the bivalve genus *Otapiria*, has recently been found in eastern Guangdong (Chen 1988). Therefore, the Guangdong fauna is believed to have closer affinity with the Circum-Pacific Realm than with the Tethyan Realm. As part of the Guangdong fauna, the Hong Kong fauna certainly also has this peculiarity. One of the examples is that the present Hong Kong sequence can be directly correlated to that of west Japan, as shown in Figure 6.

Hong Kong (This paper)		West Japan (Hayami 1959)
<u>Juraphyllites</u> , <u>Arnioceras</u>		?
<u>Coroniceras</u>	<u>Teinonuculana</u> bed	<u>Coroniceras?</u> bed
	<u>Oxytoma-Tutcheria</u> bed	<u>Oxytoma</u> bed
	<u>Sph. nipponica</u> bed	<u>Sph. nipponica</u> <u>Prosogyrotrigonia</u> - <u>Car.toriyamai</u> bed
<u>Sulciferites</u> - <u>Car. toriyamai</u> bed		
Basal conglomerate		Basal conglomerate
(Permian rocks)		(Metamorphic rocks)

Figure 6 Close relationship between the Lower Jurassic Hong Kong sequence and the west Japan sequence (note the biostratigraphic divisions and the characters of the fossil beds of the two regions are similar to each other)

The Circum-Pacific Realm and the Pacifica Continent. The indicators of the Circum-Pacific Realm involve many genera including, the Upper Triassic *Tosapecten*, *Palaeopharus* and *Asoella*, the Lower Jurassic *Otapiria* and *Torastarte*, and the Upper Jurassic and Lower Cretaceous Buchiids of the Mesozoic Bivalvia. Because these indicators sometimes occur on some islands of the Arctic and even in the marginal areas of Antarctic, as well as on the two sides of the

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Pacific Ocean, this realm is also termed the "Arcto-Pacific Realm". But it is very difficult to interpret the principles of animal dispersals: how can the benthic faunas be so widely, and so separately, distributed to these regions, traversing the vast Pacific Ocean and passing through various zoogeographical provinces?

A "tectonic terranes" theory, which makes up a deficiency in the "plate tectonic" theory, can be used to interpret this interesting problem. This theory has been developed in the last ten years and was proposed based on the magnetic and Late Palaeozoic palaeontological data from the west of North America. These data show the Late Palaeozoic faunas of the stratigraphic blocks to the west of North America may have originated from a low latitude, and not from their recent locations (higher latitude); they are also very different from those of central and eastern North America. Subsequent studies in east Siberia, Japan, New Zealand, North Australia and East China also demonstrate their similar origin to the west of North America. Therefore, some have assumed that there may have been a united continent, originally located at low latitudes of the Pacific Ocean during the Late Palaeozoic and early Mesozoic. The continent was suggested as the "Pacifica Continent" by Nur & Ben-Avraham (1978). Its break-up is considered to have taken place from the Triassic to the Cretaceous. Its fragments (terranes) are believed to have migrated in all directions and finally sutured to those continents around the Pacific (Figure 7).

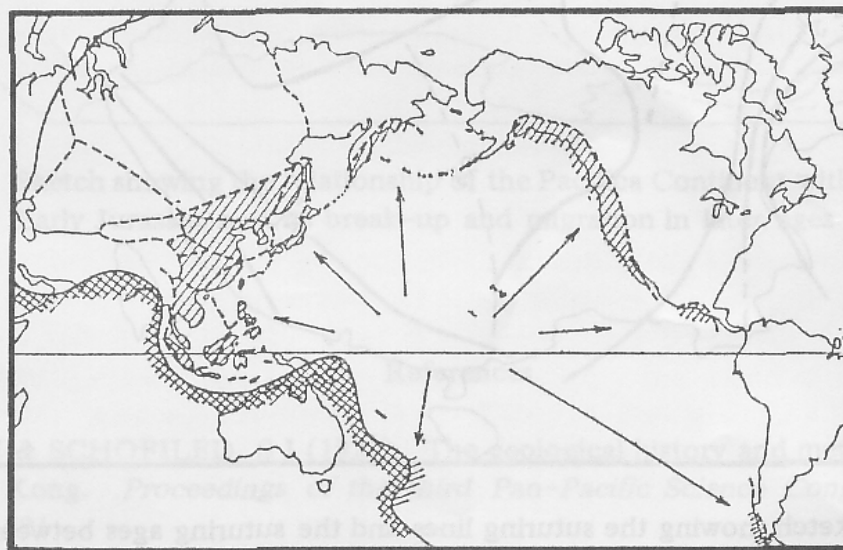


Figure 7 The distribution of tectonic terranes in the Circum Pacific and their origin, based on the Late Palaeozoic faunal studies (after T Ozawa *et al* 1983)

Geological origin of Hong Kong. A study of the palaeobioprovinces of China accomplished by Chen supports the hypothesis of the Pacifica Continent. In his division, the blocks (or terranes) in the southeast are well recognized as being derived from this continent. It is proposed that the final suturing ages between these blocks, when they became a part of the Eurasia continent, are respectively of Early Jurassic Pliensbachian stage, Early Cretaceous Aptian stage and Late Cretaceous, depending on the faunal study (Figure 8). Hong Kong is located at that block on the Figure 8 between two suturing lines marked K_1^5 (Aptian) and K_2 (Late Cretaceous), together with the majority of Guangdong. This block is considered to finish the suturing with the Eurasia continent in the Aptian stage. As is well known, the tectonic grain on this block is dominated by northeast trends, as seen in Hong Kong. This indicates the tectonic movement-source as coming from the southeast side of the block. As pointed above, the Lower Jurassic fauna of

Hong Kong has a close affinity with the so-called "Circum-Pacific" realm, and may actually originate from the Pacifica Continent which was just located to the southeast of the block. This block had not yet separated from the continent in the Hettangian-Sinemurian stages.

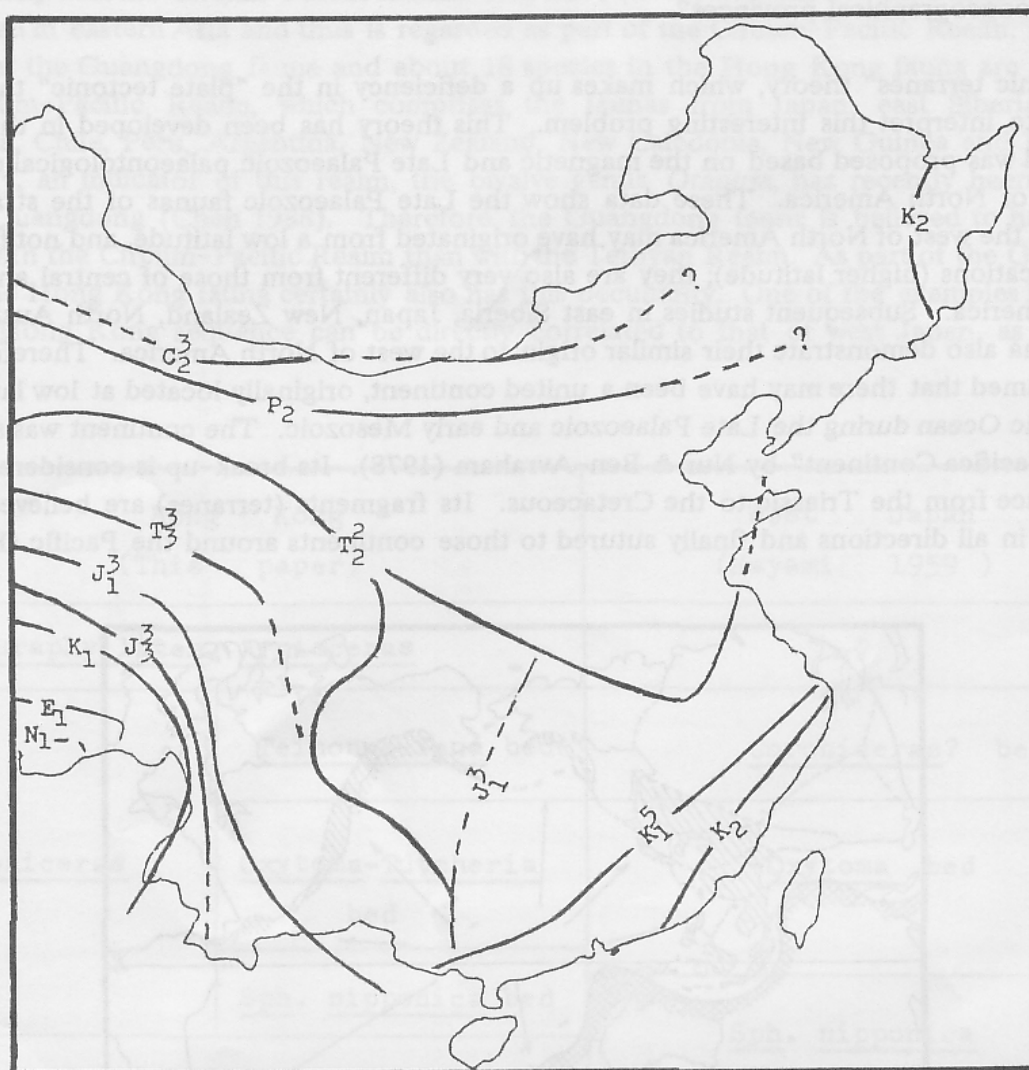


Figure 8 Sketch showing the suturing lines and the suturing ages between the continental blocks in eastern China (contributed by J H Chen)

It merits attention that the very strong volcanic eruptions in Hong Kong (the Repulse Bay Volcanic Group) may indicate an important geological event (similar volcanic rocks are also widely spread in the other places of this block). In our view, the volcanic eruptions may have resulted from the break-up of the Pacifica Continent (partly), and by the subsequent migration of the block and its suturing with the Eurasia continent. The geochronological data from the volcanics show the main eruption phase (break-up age of the related parts of the Pacifica Continent) as in the Upper Jurassic, but the minor phase (suturing age of the block) as in the Lower Cretaceous. However, the continental sediments of the Pat Sin Formation of Hong Kong (unconformably overlying the Repulse Bay Volcanic Group) indicate the Earth's crust as becoming relative stable after the block-suturing. This Formation is correlated to the Hekou Formation of Fujian and to the Guancaohu Formation of Guangdong, dated as Albian-Cenomanian stages. It means that the suturing movement of this block with the Eurasia continent was finished in the Aptian stage. That is to say that Hong Kong was brought to the

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present location from thousands of kilometres away before the Aptian stage (about 120 million years ago).

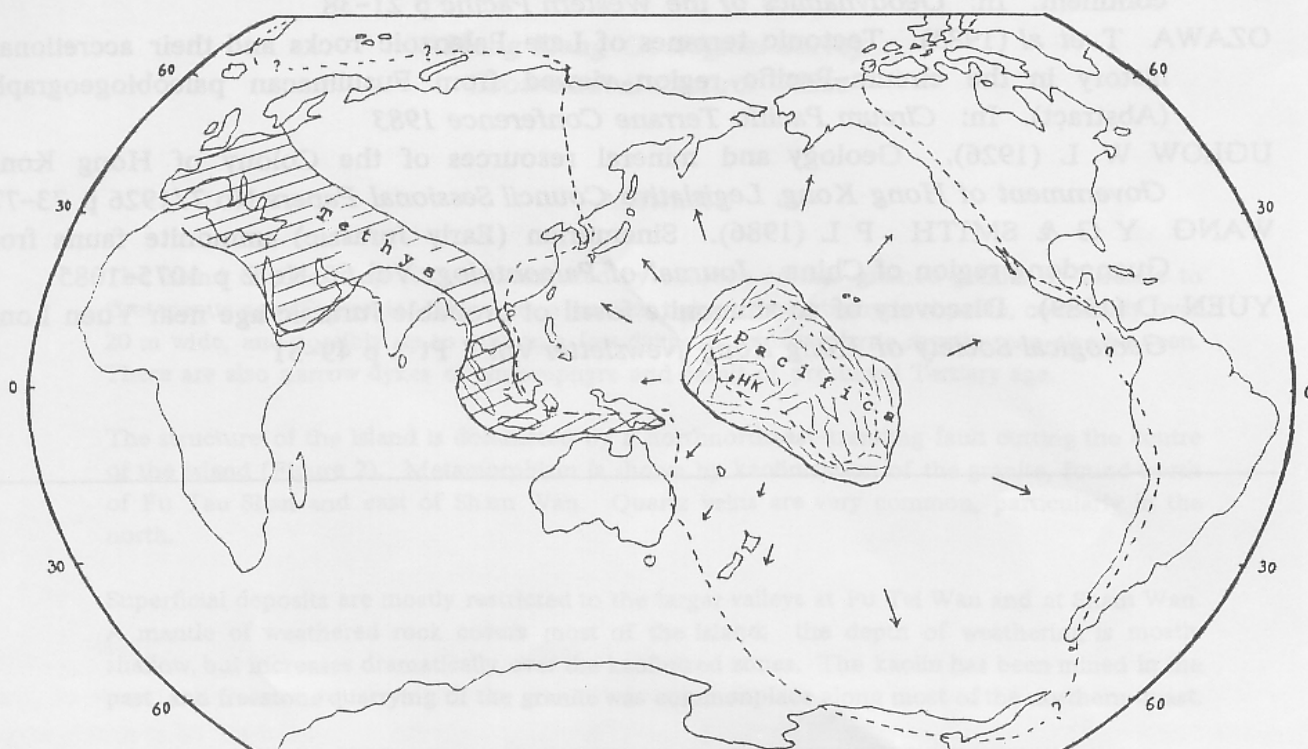


Figure 13 Sketch showing the relationship of the Pacifica Continent with the Tethys in early Early Jurassic, and its break-up and migration in later ages

References

- BROCK R W & SCHOFIELD S J (1926). The geological history and metallogenic epochs of Hong Kong. *Proceedings of the third Pan-Pacific Science Congress, Tokyo* Vol 1 p 576-581
- BROCK R W, SCHOFIELD S J, WILLIAMS M Y & UGLOW W L (1936). *Geological map of Hong Kong, 1:84 480*. Ordnance Survey, Southampton
- CHEN J H (1982). Liassic bivalve fossils from Mt Jinji of Guangdong. *Acta Palaeontologica Sinica* Vol 21 No 4 p 404-415 plus 3 plates
- CHEN J H (1988). Lower Jurassic marine bivalves from Guangdong-Nanling district. *Bulletin of the Nanjing Institute of Geology and Palaeontology, Academia Sinica* No 17, 50 p plus 22 plates
- HAYAMI I (1985). Jurassic paleobiogeography in southeast Asia. In: *South-east Asia geology and palaeontology* Vol 25
- LAI K W (1989). A new Lower Jurassic fossil locality - the south coast of Pak Kok Shan, Hong Kong. *Geological Society of Hong Kong Newsletter* Vol 7 Pt 3 p 15-19
- LEE C M (1984). Lower Jurassic fossil assemblages at Sham Chung, New Territories, Hong Kong. *Geological Society of Hong Kong Newsletter* Vol 2 No 6 p 1-6
- NAU P S (1981). Geology of the Ma Shi Chau Island, New Territories, Hong Kong. *Annals of the Geographical Geological Archaeological Society, University of Hong Kong* No 9 p 17-28

- NAU P S (1986). Upper Triassic strata along the shoreline at Nai Chung Ferry Pier, Nai Chung, New Territories, Hong Kong. *Geological Society of Hong Kong Newsletter* Vol 4 No 1 p 7-12
- NUR A & BEN-AVRAHAM Z (1978). Speculations on mountain building and lost Pacific continent. In: *Geodynamics of the Western Pacific* p 21-38
- OZAWA T *et al* (1983). Tectonic terranes of Late Paleozoic rocks and their accretionary history in the circum-Pacific region viewed from Fusulinacan paleobiogeography (Abstract). In: *Circum Pacific Terrane Conference 1983*
- UGLOW W L (1926). Geology and mineral resources of the Colony of Hong Kong. *Government of Hong Kong, Legislative Council Sessional Papers* No 7/1926 p 73-77
- WANG Y G & SMITH P L (1986). Sinemurian (Early Jurassic) ammonite fauna from Guangdong region of China. *Journal of Paleontology* Vol 60 No 2 p 1075-1085
- YUEN D (1989). Discovery of an ammonite fossil of probable Jurassic age near Yuen Long. *Geological Society of Hong Kong Newsletter* Vol 7 Pt 2 p 49-51

GEOLOGY OF CHEK LAP KOK

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Abstract

The island of Chek Lap Kok is dominated by bedrock of fine-grained granite of Jurassic to Cretaceous age (Figure 1). There are abundant dykes of quartzphyric rhyolite, commonly over 20 m wide, and possibly up to 100 m; a few dykes of feldsparphyric rhyolite can also be seen. There are also narrow dykes of lamprophyre and basalt of presumed Tertiary age.

The structure of the island is dominated by a northnortheast-trending fault cutting the centre of the island (Figure 2). Metamorphism is shown by kaolinization of the granite, found north of Fu Tau Shan and east of Sham Wan. Quartz veins are very common, particularly in the north.

Superficial deposits are mostly restricted to the larger valleys at Fu Tei Wan and at Sham Wan. A mantle of weathered rock covers most of the island; the depth of weathering is mostly shallow, but increases dramatically over the kaolinized zones. The kaolin has been mined in the past, and freestone quarrying of the granite was commonplace along most of the northern coast.

Introduction

This paper describes the onshore geology of Chek Lap Kok, an area that is part of that proposed for a new international airport for Hong Kong. The work is based on geological mapping carried out for 1:20 000 Sheet 9, supplemented by survey work related to the geotechnical investigation for the airport (Langford 1990). The island of Chek Lap Kok lies north of the Lantau coast at Tung Chung Wan. Chek Lap Kok is about 4 km long and 1.5 km wide at its widest point; the land area is approximately 2.8 sq km.

The highest point on the island is Fu Tau Shan, rising to 121 m. Flat land and extensive agricultural development is only to be seen in the north of the island at Sham Wan.

In 1982 a trial embankment for the proposed replacement airport was constructed offshore to the west of the island. The embankment, about 6 ha in area, was built using material excavated from a borrow area to the north of Fu Tau Shan. Between the borrow and Fu Tau Shan is an area in which kaolin and sand was commercially extracted until a few years ago.

The island is now virtually depopulated, having supported a thriving agricultural and fishing community after the last war. Kaido ferries or other boats of shallow draft can make landfall at one of three localities; Cheung Sha Lan, near the old quarry east of Miu Wan or at the jetty at the trial embankment. Small jetties south of Fu Tei Wan are only accessible at favourable tides.

Previous work

The earliest geological survey of the Territory was undertaken between 1923 and 1927 by Brock, Uglow, Schofield and Williams (Brock *et al* 1936). Williams *et al* (1945) subdivided their Hong Kong Granite type into three masses, the most westerly of which commences on the western side of Lantau Island and included the small island of Chu-lou-kok (*sic*); they assumed a Cretaceous age (Yen Shan No 2 in China).

Allen & Stephens (1971) assigned the granite of Chek Lap Kok to the Cheung Chau Granite, partly because it was cut by dykes of feldspar porphyry (feldsparphyric rhyolite). They also mapped several quartz porphyry (quartzphyric rhyolite) dykes with a northeasterly trend in the southern half of Chek Lap Kok.

Prior to the present survey by the Hong Kong Geological Survey, Geotechnical Control Office, a total of 46 boreholes had been sunk on the island. Also, a seismic refraction survey had been completed by Electronic & Geophysical Services Ltd in a small area east of the trial embankment, supplementing an earlier geophysical survey of the island by Gammon.

Classification of the major intrusions

The granite of Chek Lap Kok is fine-grained, grading up into fine- to medium-grained granite. All the varieties are characterized by an inequigranular groundmass, with a wide range of grain sizes seen in hand specimen and thin section. The island forms a small part of a much larger major intrusion of granite extending to Tsing Shan in the north.

Where the rock is megacrystic there are crystals of alkali feldspar up to 20 mm across are commonly seen; rarely they are up to 45 mm long. Rounded glassy grey quartz megacrysts are usually less than 10 mm, while single flakes of black shiny biotite mica may be up to 3 mm across; aggregates or clots of small biotite crystals are larger, often up to 5 mm.

Fine-grained granite

The island is dominantly composed of fine-grained granite, in part markedly megacrystic. The grain size of the groundmass typically lies between 0.5 and 2 mm, ie, around 1 mm. As such the granite lies in the upper size range for fine-grained granite (0.06 to 2 mm), and close to the medium-grain range (2 to 6 mm) (BSI 1981; Strange 1985). Typical fine-grained granite from equivalent outcrops in Tai Lam and Tsing Shan (Langford *et al* 1989) usually has a marked contrast between megacrysts and groundmass, but also grades into fine- to medium-grained granite.

Inequigranular non-megacrystic or sparsely megacrystic fine-grained granite outcrops west of a line from Sham Wan to Fu Tei Wan. Hong Kong Rock Collection Sample HK8362 from Cheung Sha Lan (81101E 81976N) (Plate 1) is typical, displaying single biotite flakes up to 2 mm.

Sample HK8363 from the borrow area for trial embankment (81069E 81905N) (Plate 2) is a finer variety of the granite, and is the rock type that dominates the borrow. Much of the construction material for the trial embankment is fine-grained granite, but there are also blocks of fine- to medium-grained granite, and rarely of medium-grained granite.

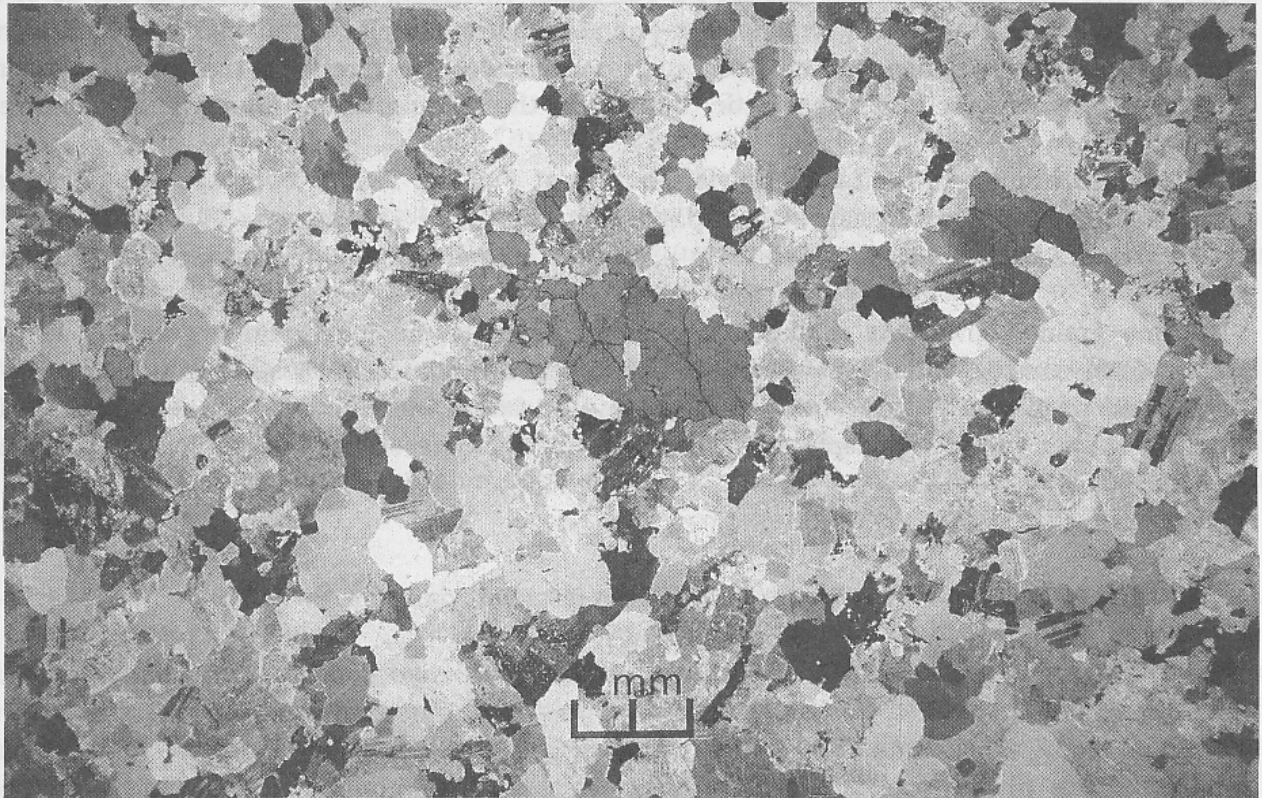


Plate 1 Thin section of fine-grained granite (HK8362) from Cheung Sha Lan (81101E 81976N); XPL plus $1/4 \lambda$ plate x 7

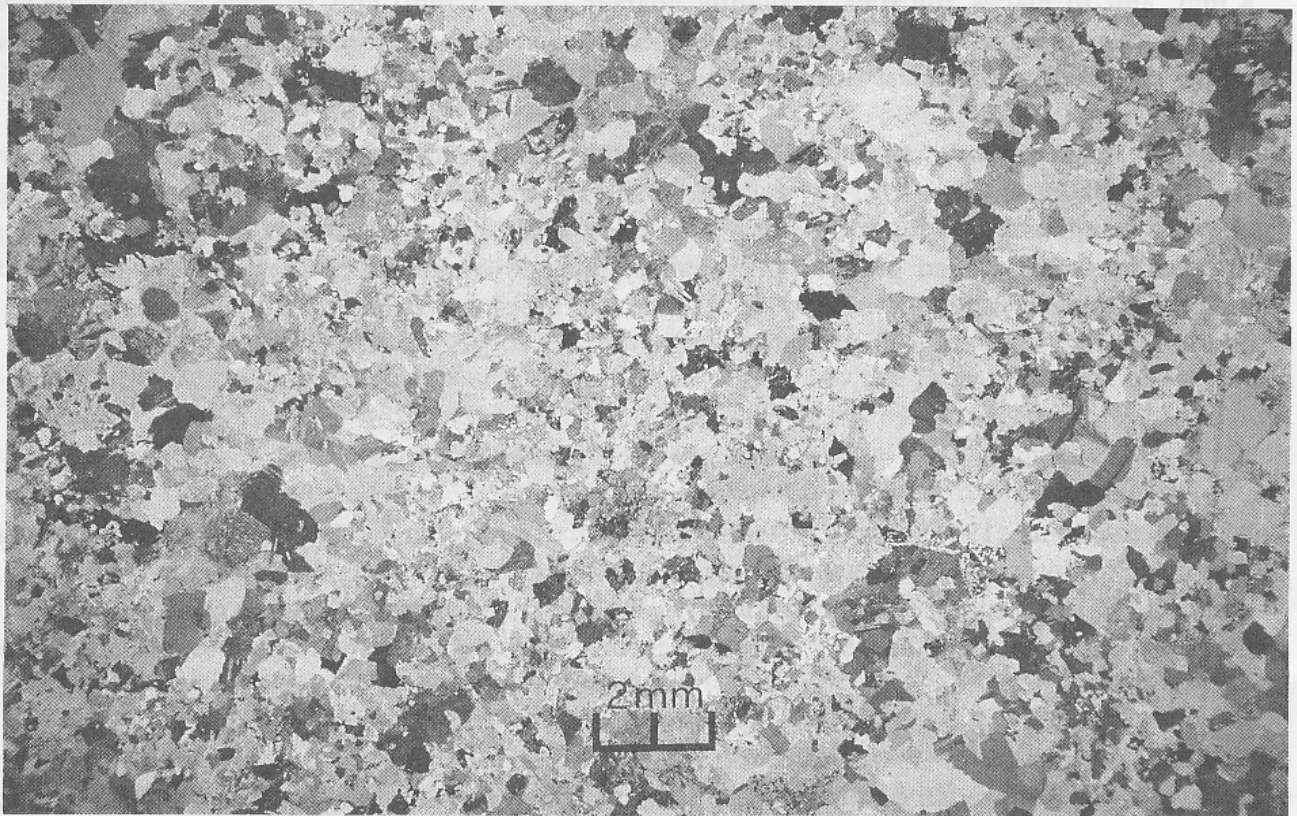


Plate 2 Thin section of fine-grained granite (HK8363) from near the trial embankment, (81969E 81905N); XPL plus $1/4 \lambda$ plate x 7

The coastal exposures and hills east of Fu Tan Shan, extending northnortheast to the tip of the island, are dominated by megacrystic fine-grained granite. In places the rock becomes coarser (fine- to medium-grained granite), but such occurrences are rare. To the west the outcrop becomes progressively less megacrystic, but retains the inequigranular fine-grained character.

The peninsula south of Ha Law Wan, terminating at Pak Sha Tsui, is composed of megacrystic fine-grained granite cut by large quartzphyric rhyolite dykes. Megacrysts of alkali feldspar up to 15 mm are common in the granite, in places forming a prominent feature of the rock.

The fine-grained granite is similar in age to the fine- to medium-grained granite. Textural relicts from coarser varieties have been progressively assimilated in these finer granites. Aplite dykes and pegmatite patches have an intimate association with the fine-grained granite. The rock is cut by younger feldsparphyric rhyolite, quartzphyric rhyolite, lamprophyre and basalt dykes.

Fine- to medium-grained granite

The fine-grained granite, which dominates the island, in places becomes sufficiently coarse for a fine- to medium-grained classification to be appropriate. The fine- to medium-grained granite is not a separate intrusion, but is a textural variation of the same intrusion. The material characteristics of the rock are not different from the fine-grained granite, and both rocks weather in the same manner.

The fine- to medium-grained granite outcrops in three distinct areas; north of Cheung Sha Lan, northeast of Fui Yiu Wan and south of Fui Yiu Wan. Grain size typically varies from 1 to 4 mm, and in places the rock is slightly coarser (2 to 5 mm) and is truly medium-grained. Equigranular medium-grained granite has been seen in the rock forming the trial embankment, and is exposed on the coast northeast of Fui Yiu Wan (81220E 81978N).

The fine- to medium-grained granite is the result of textural modification of coarser granites, and is probably the result of a later intrusion mixing with or modifying earlier rocks. The extreme modification is found in the fine-grained granite, but the age of the fine-grained and fine- to medium-grained granites is probably the same over most of the island. The fine- to medium-grained granite is cut by aplite and lamprophyre dykes. In addition, the rock is occasionally sheared on a northeasterly trend, similar to granite of the Tsing Shan pluton.

Classification of the minor intrusions

Allen & Stephens (1971) recorded feldspar and quartz porphyry dyke swarms in north Lantau (Lamma Porphyry and D'Aguilar Porphyry). These are referred to in this survey by their true composition as rhyolites; feldsparphyric and quartzphyric rhyolite. Although none are shown on their map of the island, Allen & Stephens recorded basic dykes, here referred to as lamprophyre or basalt.

The minor intrusions of the island occur as dykes varying in width from a few cm to 100 m. The dykes are best exposed in coastal sections, but can often be traced across the island for as much as 700 m. The dominant dykes are of quartzphyric rhyolite, with minor occurrences of feldsparphyric rhyolite, aplite, pegmatite, lamprophyre and basalt. Quartz veins are a widely distributed small-scale feature of the island. All except the lamprophyre and basalt are closely

related to Mesozoic granite emplacement; the lamprophyre and basalt formed in a Tertiary extensional phase.

Quartzphyric rhyolite

Quartzphyric rhyolite is characterized by an aphanitic groundmass containing scattered small quartz megacrysts. The rock is commonly fractured. The margins of the narrow dykes in particular are flow-banded, and may be darker and finer than the main body of the dyke.

Quartzphyric rhyolite outcrops as northeast- and eastnortheast-trending dykes cutting the granite of the island. They do not occur in the northern part of the island, but are a prominent feature of the southern end of the island. They are part of the dyke swarm which dominates north Lantau, and their emplacement is probably related to the eastnortheast-trending North Lantau pluton boundary fault.

At Pak Sha Tsui (8111E 8168N) there are extensive exposures of quartzphyric rhyolite, with several slivers of granite country rock adjacent to flow banded margins. These exposures are probably part of a multiple dyke swarm up to 150 m wide. South of Kwo Lo Wan the same quartzphyric rhyolite dyke can be seen exposed on the coast. The dyke is cut by lamprophyre (Plate 3) (81156E 81827N), and has flow-banded margins against the older granite country rock.

Elsewhere in the Territory, quartzphyric rhyolite dykes cut all the Mesozoic intrusive and extrusive rocks. On Chek Lap Kok they cut the major granite intrusion, but no clear relationship with the feldsparphyric rhyolite was seen; they are probably of similar age and genesis. The rhyolite is cut by quartz veins and by the much younger lamprophyre dykes.

Feldsparphyric rhyolite

Dykes of feldsparphyric rhyolite are characterized by abundant large megacrysts of feldspar set in an aphanitic groundmass. Megacrysts of quartz and biotite are also present, but are not as visually dominant as the feldspar crystals up to 12 mm long. Within the island, feldsparphyric rhyolite dykes found only in the south.

Feldsparphyric rhyolite is exposed in coastal sections to the south of Kwo Lo Wan. The feldsparphyric rhyolite dykes appear to be intimately related to the more abundant quartzphyric rhyolite dykes. They follow the same trends and are similarly cut by younger lamprophyre dykes. They are probably part of the same structurally controlled, high-level granitic intrusion which in its later stages produced rhyolite dykes, quartz veins and localized hydrothermal alteration.

Quartz veins

Quartz veins are widely distributed throughout the island, cutting the granite country rock and most of the minor intrusions. They are generally narrow, ranging from stringers a few mm wide to veins up to 0.3 m wide. Quartz veins are especially common in and around the area of kaolinization in the granite east of the trial embankment (Plate 4). The quartz veins are commonly seen as upstanding ribs in the deeply weathered granite. The thin veins tend to separate along cracks on joint faces to produce a mosaic-like wall of quartz (Plate 5).

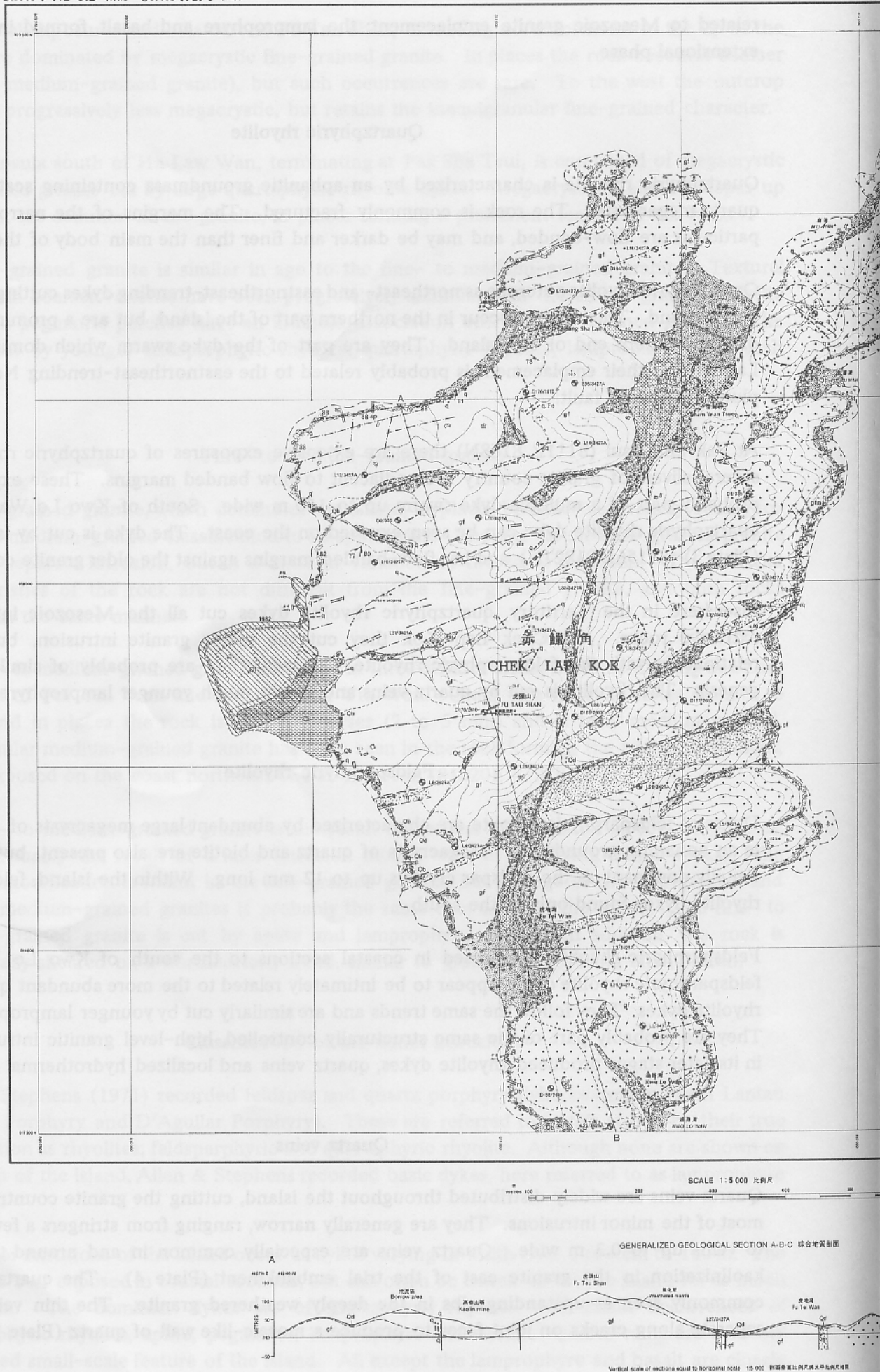


Figure 1

Geological map of Chek Lap Kok (reduction of published map at 1:5 000 scale)

插圖 Inset

香港地質調查

Sheet 9-NE-CID 圖幅

SOLID AND SUPERFICIAL GEOLOGY 基岩和表土地質圖

Series HGP5 組別

Scale 1:5 000 比例

SUPERFICIAL DEPOSITS 地表沉積

GENETIC CLASSIFICATION		地质组别	主要建筑材料	PRINCIPAL MATERIALS
Fill	填土		填土和杂填土	Natural earths and waste
Alluvium	冲积土		卵石、卵石层、砂	Gravel, sand and gravel
Beach deposits	海滩沉积物		砂	Sand
Recent beach deposits	新近海滩沉积物		砂	Sand
Interstitial deposits	夹层沉积物		卵石、卵石层	Gravel sand and clay
Deltaic flow deposits	淤积、冲积层		粘土、粉质粘土、细砂和粉砂	Sand, gravel, siltstone and silts

SOLID GEOLOGY 基础地质

MAJOR INTRUSIVE IGNEOUS ROCKS 主要侵入火成岩

中世侏羅紀
MESOZOIC
中世——白垩紀
JURASSIC
CRETACEOUS

Megacrystic..... 巨大晶體的

網紋花斑地..... Fine-grained granite

中國型花斑地..... Fine-to medium-grained granite

MINOR INTRUSIVE IGNEOUS ROCKS 次要侵入火成岩：脉岩：

中生代 Mesozoic 中生代 Mesozoic 中生代 Mesozoic	1	裸子植物	Gymnosperms
	2	蕨類植物	Lycopodiophytes
	3	石炭植物	Carboniferous plants
	4	蘇鐵植物	Ginkgoophytes
	5	裸子植物	Gymnosperms

METAMORPHIC ROCKS 變質岩

片断: Schläuse
西端: Knechtel

GEOLOGICAL LINES 地質界線

Geological boundary, asperified deposit	海濱沉積物界線
lit boundary, with level of interbedding of data above	1982 地層界面 地層分佈
Geological boundary, silted rock	砂岩界線
Fault	斷裂
Mineral Vein	脈石
Photogeological lineament	航像地質構造線

Broken lines are given South-Southwest orientation. 斷裂線均指南-西南走向

STRUCTURAL SYMBOLS 構造符號

Joining.....

傾斜 Incline	垂直 Vertical	水平 Horizontal
		

All files measured in degrees from horizontal 所有傾角的角度均以水平位置計算

MINERAL SYMBOLS 礦產符號

Quartz 石英 Iron Fe 鐵

BOREHOLE SYMBOLS 鑽孔符號

Borehole 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 103

NOTES FOR USERS 讀者須知

- | | |
|--|---|
| <p>* This geological map only covers the onshore areas and the littoral zone above low water mark.</p> | <p>本地质圖只包括陸域和此海岸以上的海床部</p> |
| <p>* For reference purposes the title of this map is:
 Chik Lee Hoik : Solid and superficial geology
 Hong Kong Geological Survey Map Series HG55,
 Sheet 9-NE-C1D, 1:5 000.</p> | <p>為方便參考起見，本圖名稱為：
 赤角灣：基岩和表層地質
 地質圖系列 HG55
 圖幅 9-NE-C1D
 比例 1:5,000</p> |

Geological Survey at 1:5 000 scale by R.L. Langford in 1989-1990.
Base Map by Survey and Mapping Office, Buildings and Lands
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Cartography by Planning Division, Geotechnical Control Office.
Published by the Geotechnical Control Office, Civil Engineering
Services Department, Hong Kong.

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Aplite

Small impersistent dykes of aplites are occasionally found in the granite. The dykes are leucocratic, with a markedly equigranular grain size of around 0.5 mm. They occur in a number of places around the coast, often in small groups. They can be from 25 mm to 5 m wide, but are commonly around 0.25 m. The aplites and granite are closely linked in age and genesis.

Pegmatite

Pegmatite is very coarse-grained granite with crystals over 20 mm across. It is rare in the island, but an irregular, roughly east-west trending pegmatite patch is exposed west of Fu Tei Wan (81075E 81824N).

Pegmatite is only found in the granite, and is intimately associated with the host rock. It is coeval with the formation of the granite, and is the result of hydrothermal emanations late in the cooling of the pluton.



Plate 3 Lamprophyre dyke with spheroidal weathering, cutting flow-banded quartzphyric rhyolite dyke intruded into megacrystic fine-grained granite, south of Kwo Lo Wan (81156E 81827N)

Lamprophyre and basalt

Basic dykes are widely seen cutting the granite and rhyolite dykes, but all are relatively thin and impersistent. The dykes are mostly lamprophyres, although a few are basalt. Lamprophyre

dykes are rich in ferro-magnesian minerals, with a low magnetic mineral content. Basalt is characterized by calcic plagioclase, pyroxene and iron-ore. In the field, basalt dykes have a significantly higher magnetic susceptibility than most other rocks, and are usually finely foliated.

There are many small lamprophyre dykes cutting granite and rhyolite country rock in the south of the island. Plate 3 shows spheroidal weathering in a lamprophyre dyke about 2.5 m wide trending southsoutheast (81156E 81827N) and cutting both the megacrystic fine-grained granite country rock and a flow-banded quartzphyric rhyolite dyke in the granite. About 100 m to the north is a swarm of lamprophyre dykes cutting the granite (Plate 6, 81151E 81738N).

Two thin basalt dykes cutting fine-grained granite west of Fu Tei Wan are themselves cut by a small fault (81083E 81814N). The basalt is deeply weathered and foliated, and displaced sinistrally southsoutheast by about 0.3 m (Plate 7). The dykes are about 0.3 m wide, and also cut an aplite dyke in the granite.



Plate 4 Quartz vein in weathered granite forming a mosaic-like wall, east of the trial embankment (81111E 81912N)

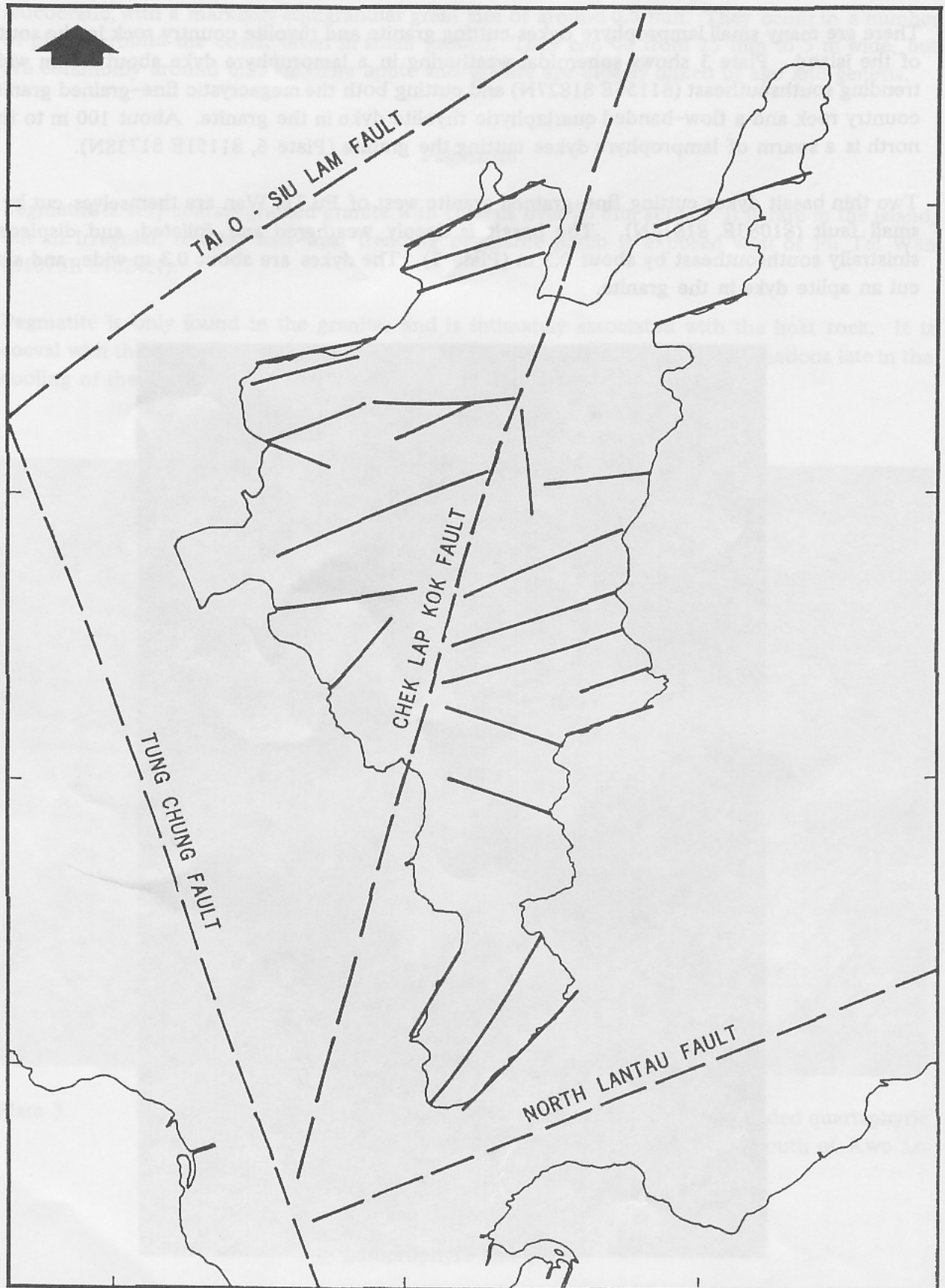


Figure 2 Structural features of Chek Lap Kok

The basalt dykes are believed to be of Tertiary age (Allen & Stephens 1971). They are seen in the island cutting the granite country rock, but are themselves cut by small northwest-trending faults. The lamprophyre dykes also cut the country rock of rhyolite dykes and granite, and are believed to be of a similar age to the basalt dykes.

Structure

The geological structure of the island is dominated by the northnortheast-trending Chek Lap Kok Fault, extending from Fu Tei Wan to Sham Wan (Figure 2). The form of the island is also controlled by a pervasive set of eastnortheast-trending photolineaments and joints. No folding can be detected or is suspected to occur in the granite or dykes.

Histograms of fault and photolineament trends are given as Figure 3. The dominant trend is around 070° (eastnortheast); the northnortheast trend of the Chek Lap Kok Fault is obscured by the dominance of the photolineaments.

The Chek Lap Kok Fault (Figure 2) is probably related to the general north-trending faults in Tsing Shan and Tai Lam (Langford *et al* 1989), and is believed to be an offshoot of the Tung Chung Fault. The fault is not exposed in the island, but is believed to cut quartzphyric rhyolite dykes. Borehole L27-03427A (811609E 818326N) may intersect the silicified fault zone.

Eastnortheasterly trending structures are mostly photolineaments, and as such are probably related to a master joint set in the pluton; quartz veins also dominantly fall on this trend. Coastal exposures are consistently marked with this grain, giving rise to geos and rock walls.

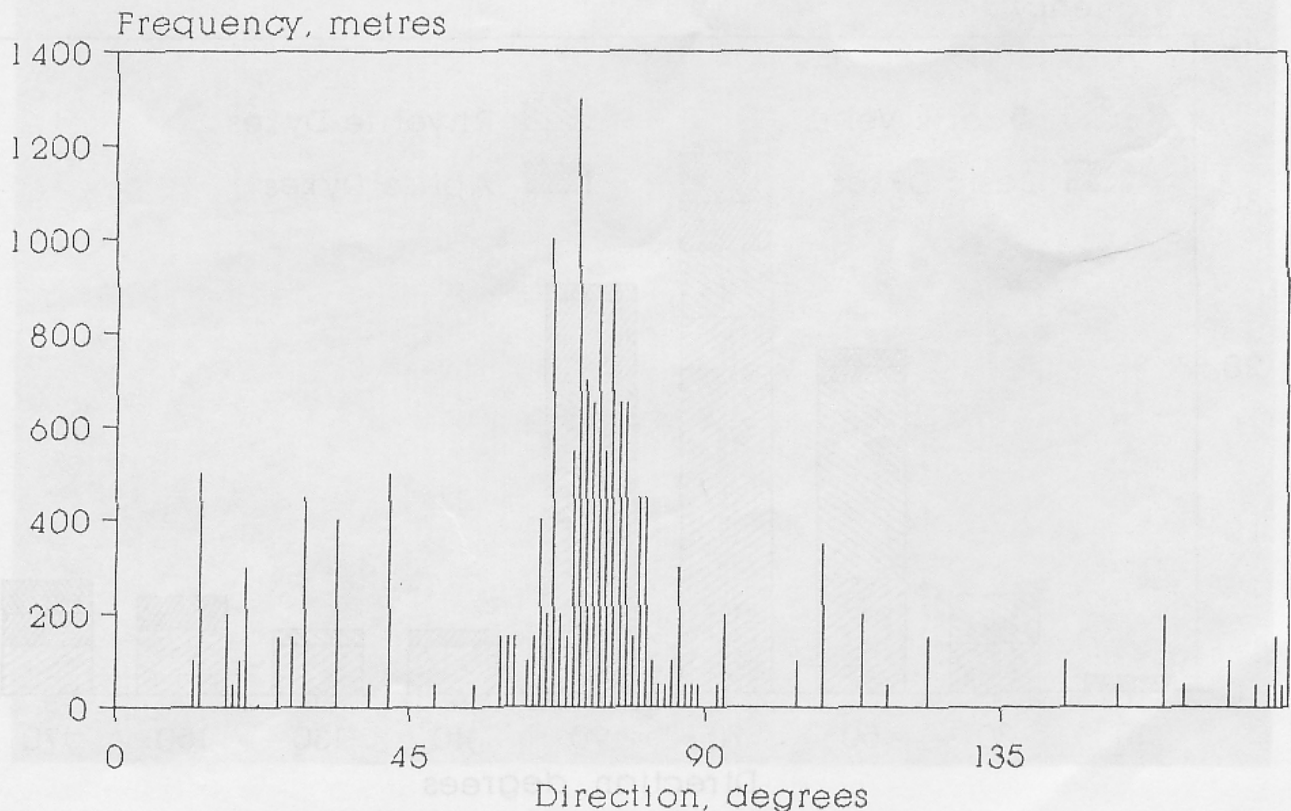


Figure 3 Histograms of fault and photolineament trends

The orientation of dykes and veins has the clearest tectonic control of any of the structural features in the island (Figure 4). The photolineaments are often an expression of these features, which combined with the joints gives a dominant eastnortheast grain to the terrain. Figure 4 gives the trends of the various dykes as measured on coastal exposures. The quartzphyric and feldsparphyric rhyolite dykes almost exclusively trend northeast to eastnortheast. The lamprophyre and basalt dykes variously trend east to northeast, and southeast. A large number of quartz vein orientations were noted on coastal exposures and inland. These dominantly trend eastnortheast to east (Figure 4).

Metamorphic rocks

The metamorphic rocks of the island are dominantly formed by the process of hydrothermal activity or metasomatism. Within the island it takes the form of kaolinization of the granite, and is confined to an area of about 11 ha to the east of the trial embankment and an area of about 8 ha east of Sham Wan.

A metamorphic foliation or mylonitic fabric is seen in the granite in only one locality, north of Cheung Sha Lan (81128E 82013N). Here, thin bands of mylonitic granite trend eastnortheast. Such bands are very commonly found in the Tsing Shan area to the north (Langford *et al* 1989).

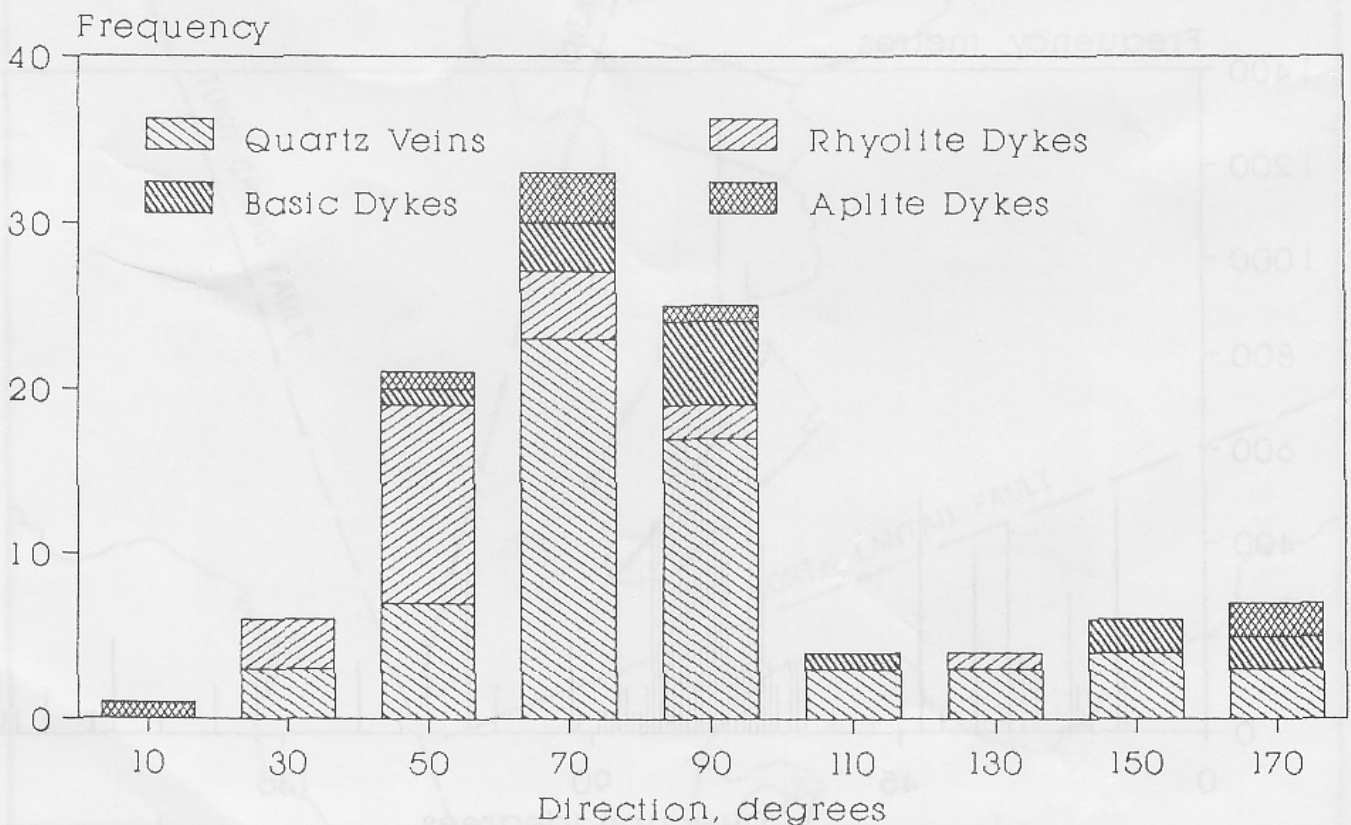


Figure 4 Histograms of trends of dykes and veins



Plate 5 Quartz vein in weathered granite south of Cheung Sha Lan, forming a partially overturned mosaic-like wall (81101E 81930N)



Plate 6 Swarm of lamprophyre dykes trending south in megacrystic fine-grained granite south of Kwo Lo Wan (81151E 81738N)

Economic geology

The mining and quarrying history of Chek Lap Kok is dominated by the extraction of dressed stone for construction, and by the mining of quartz and kaolin.

Around the coast of Lantau and adjacent islands there is ample evidence of stone quarrying. On Chek Lap Kok this seems to be confined to the northern part of the island. Fredenburg (1990) claimed that by the early 19th century, if not before, granite for construction in Guangzhou was being quarried in the north of the island. He remarked that a Tin Hau temple built in 1823 is entirely constructed of granite. This temple can still be seen near Miu Wan (81212E 82005N). There is a small stone quarry near this temple (8122E 8201N) which is reputed to have been in operation after the Second World War (Fredenburg 1990), and ceased production in 1966.

The extraction of kaolin and quartz took place at a number of locations in the north of the island. There are three areas where there is ample evidence in the field of mineral extraction. These are east of the trial embankment, near Cheung Sha Lan and east of Sham Wan. Production figures are available for two of these areas and are given as Table 1.

Table 1 Available mine production statistics for Chek Lap Kok

Kaolin mine east of the trial embankment (Lantau Island Mining Co Ltd)			Kaolin mine east of Sham Wan (Tien Po Quarry Co)	
Year	Silica sand (tonnes)	Kaolin (tonnes)	Year	Silica sand (tonnes)
1981	8 053	9 602 850	1968	111
1982	6 018		1969	704
1983	1 547		1970	442
1984	51 340		1971	132
1985	36 934			
1986	17 272			
1987	56 383			
1988	12 821			

The kaolin mine east of the trial embankment was in continuous operation from 1981 to 1988. During most of that period it did not commercially extract kaolin, but applied on a six-monthly basis for permission to sell the silica sand (quartz) by-product. The company working the site was Lantau Island Mining Co Ltd, and their licence expired in early 1988, at which time the site was abandoned.

The licensed mining area to the east and south of Cheung Sha Lan was for the extraction of quartz. The application was granted in 1959 and expired in 1963. In the field there is some

good evidence of the former workings; for example, a southsoutheast-trending excavation along a quartz vein situated 200 m south of Cheung Sha Lan (81108E 81954N).

To the east of Sham Wan extraction of kaolin and quartz was undertaken by Tien Po Quarry Co in the late 60s and early 70s. By 1973 the mine was abandoned, and the licence expired in that year. They identified an area of kaolinization and quartz veining in the granite, with kaolin preferentially concentrated along the veins.

Superficial geology

The only large scale occurrences of superficial deposits are fluvial and beach deposits. There are debris flow deposits, and one unusual occurrence of an intertidal deposit.

The alluvium is believed to be of Holocene age, although it is probably derived at least in part from the reworking of older deposits. Alluvium is known in three places; Sham Wan Tsuen, Fu Tei Wan and east of the trial embankment. Up to 8 m of alluvial sand and gravel rest on weathered granite in an extensive alluvial tract at Sham Wan Tsuen. A small patch of alluvium lies below the debris flow deposits at Fu Tei Wan. The alluvium lies alongside a stream which flows into the northern end of the bay, and develops into a small mangrove swamp before giving way to the beach deposits. Before development of the kaolin and quartz mine situated east of the trial embankment, there was also a sizeable area of alluvium in the stream valley.

Beach deposits comprise the unconsolidated sediment that extends from the low-tide mark to the uppermost limit of wave action. They are composed of coarse sand or a mixture of sand and cobbles. They form in all the sheltered bays, the largest deposits being at Sham Wan and Fu Tei Wan.

A raised beach deposit is found behind the contemporary sand beach at Sham Wan Tsuen, rising to 5.5 mPD. It probably formed during a period of relatively high sea-level, and its preservation would be due to the protection afforded by Sham Wan from subsequent storm activity.

The beach sand at Sham Wan (8116E 8197N) fills much of this shallow bay, from a height of about 3 mPD down to low water mark. The sand forms a broad dune, with a stream incised into it, and is characterized in the tidal zone by sand bars. It is light brown and varies from coarse sand to fine gravel, with some mud. Pebble-sized fragments of rock litter the surface, derived from the recent stone cutting activities around the bay; in places, broken rock dominates the foreshore. The beach at Fu Tei Wan (8110E 8180N) extends 100 m from the high water mark, and has been intersected by a shallow borehole (89-03955, 810992E 817950N). This shows sand with 3 to 16% mud and a trace of shell fragments extending for at least 3.8 m. The only other relatively large beach in the island is at Cheung Sha Lan (8110E 8197N). It is much narrower than the two larger beaches, and is composed of light brown coarse sand with some shell fragments.

Debris flow deposits are probably Pleistocene in age, although they may be younger. The largest areas of debris flow deposits are along the two valleys connecting Fu Tei Wan and Sham Wan. Elsewhere they form small patches in steep hollows on hillslopes. The largest spread of debris flow material in the island occurs at Fu Tei Wan (8111E 8181N), where there is extensive agricultural terracing in the deposit. Terraced debris flow deposits also occur upslope of beach deposits at Cheung Sha Lan (8111E 8197N) and around the large alluvial tract at Sham Wan Tsuen (8115E 8195N).



Plate 7 Foliated basalt dyke in fine-grained granite, sinistrally displaced by a northeast fault, near Fu Tei Wan (81083E 81814N)

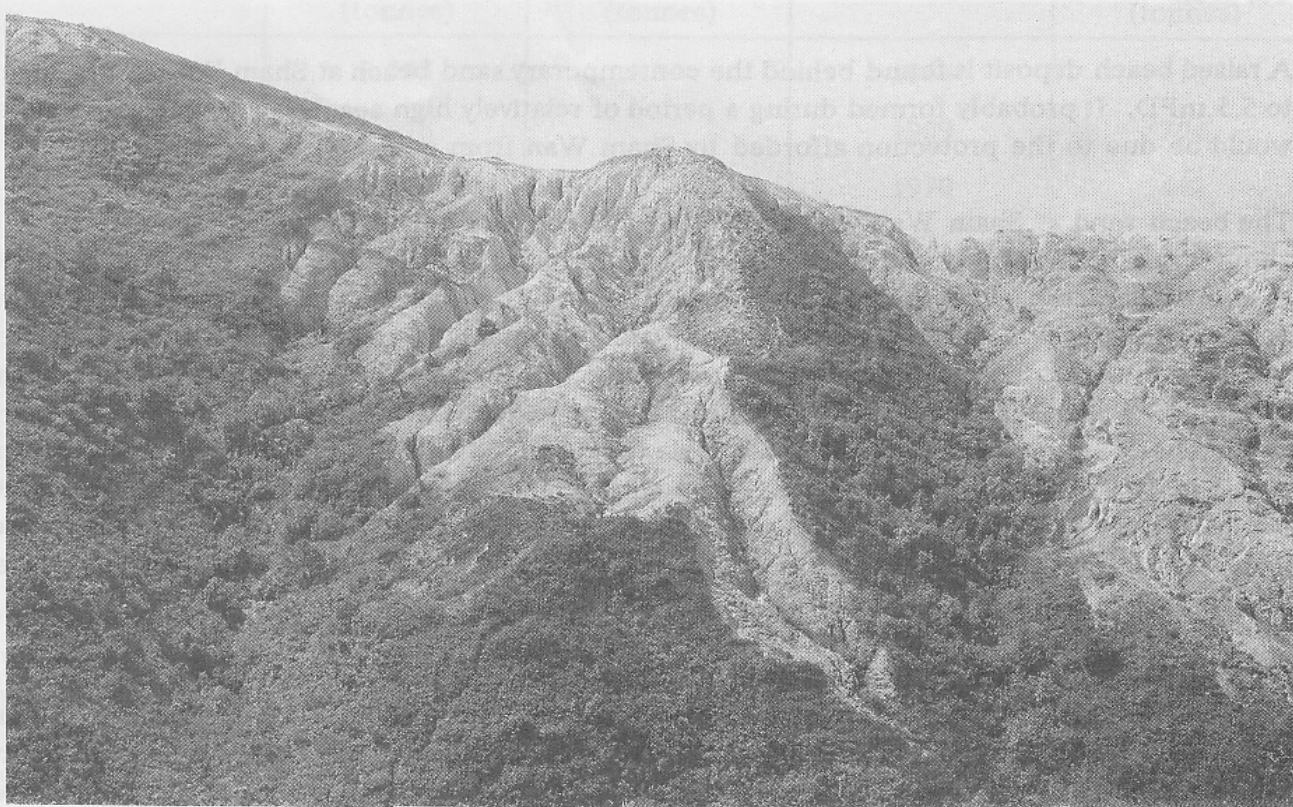


Plate 8 Vegetation regrowth encroaching on gullied weathered granite with quartz veins, north of Fu Tau Shan (8188E 8111N)

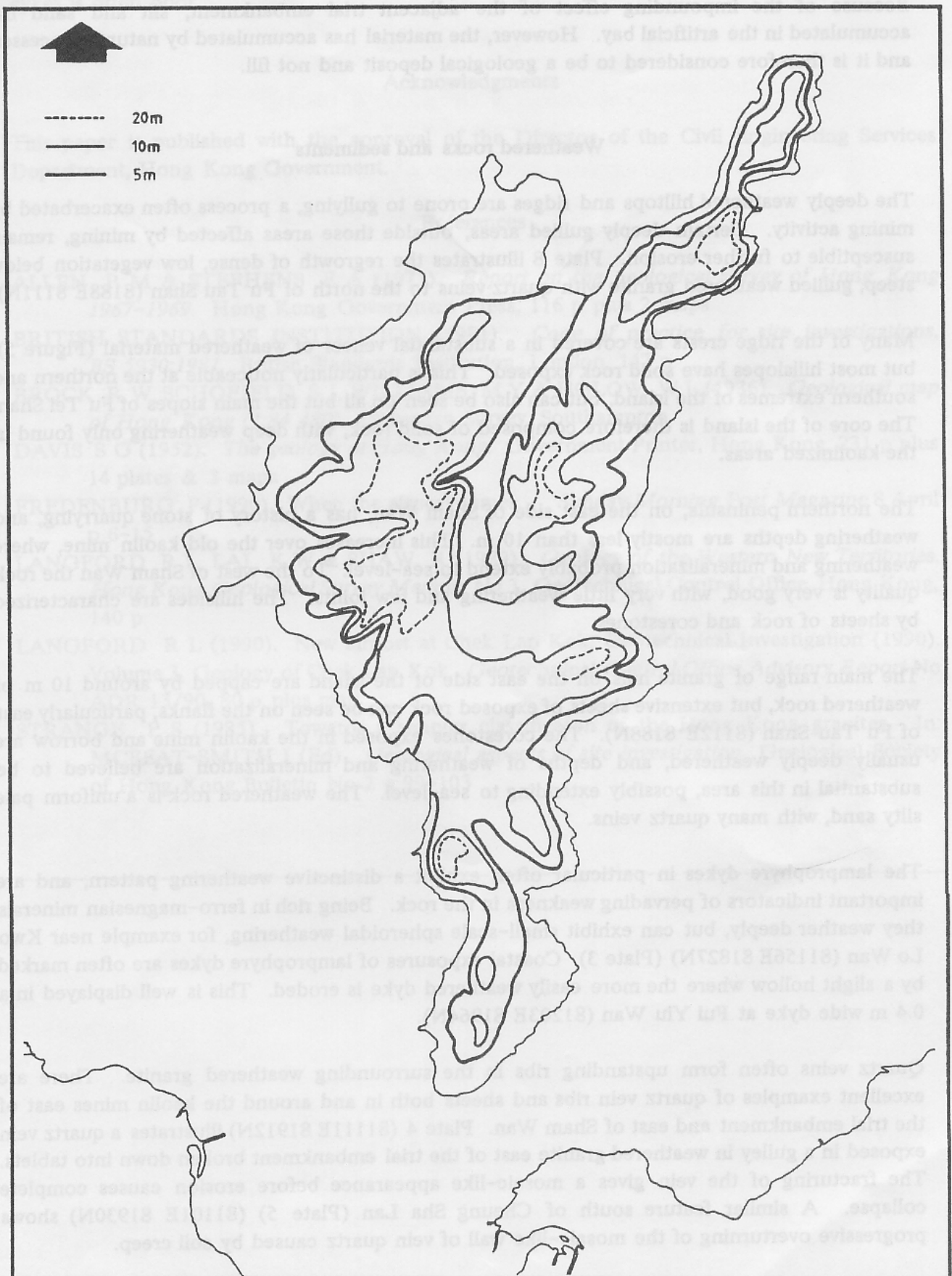


Figure 5 Thickness of weathered profile (grades IV - VI)

There is an unusual occurrence of intertidal deposits largely resulting from man's activity both at the kaolin mine and adjacent trial embankment (8105E 8187N). The deposit consists of fine sand and silt, and is derived from washing of the weathered kaolinized granite to the east. Because of the impounding effect of the adjacent trial embankment, silt and sand has accumulated in the artificial bay. However, the material has accumulated by natural processes, and it is therefore considered to be a geological deposit and not fill.

Weathered rocks and sediments

The deeply weathered hilltops and ridges are prone to gullying, a process often exacerbated by mining activity. Certain deeply gullied areas, outside those areas affected by mining, remain susceptible to further erosion. Plate 8 illustrates the regrowth of dense, low vegetation below steep, gullied weathered granite with quartz veins to the north of Fu Tau Shan (8188E 8111N).

Many of the ridge crests are covered in a substantial veneer of weathered material (Figure 5), but most hillslopes have solid rock exposed. This is particularly noticeable at the northern and southern extremes of the island, but can also be seen on all but the main slopes of Fu Tei Shan. The core of the island is therefore composed of solid rock, with deep weathering only found in the kaolinized areas.

The northern peninsula, on the east side of Sham Wan, has a history of stone quarrying, and weathering depths are mostly less than 10 m. This increases over the old kaolin mine, where weathering and mineralization probably extend to sea-level. To the west of Sham Wan the rock quality is very good, with very little weathering and few joints. The hillsides are characterized by sheets of rock and corestones.

The main range of granite hills on the east side of the island are capped by around 10 m of weathered rock, but extensive sheets of exposed rock can be seen on the flanks, particularly east of Fu Tau Shan (8112E 8188N). The corestones exposed in the kaolin mine and borrow are usually deeply weathered, and depths of weathering and mineralization are believed to be substantial in this area, possibly extending to sea-level. The weathered rock is a uniform pale silty sand, with many quartz veins.

The lamprophyre dykes in particular often exhibit a distinctive weathering pattern, and are important indicators of pervading weakness in the rock. Being rich in ferro-magnesian minerals they weather deeply, but can exhibit small-scale spheroidal weathering, for example near Kwo Lo Wan (81156E 81827N) (Plate 3). Coastal exposures of lamprophyre dykes are often marked by a slight hollow where the more easily weathered dyke is eroded. This is well displayed in a 0.4 m wide dyke at Fui Yiu Wan (81203E 81964N).

Quartz veins often form upstanding ribs in the surrounding weathered granite. There are excellent examples of quartz vein ribs and sheets both in and around the kaolin mines east of the trial embankment and east of Sham Wan. Plate 4 (81111E 81912N) illustrates a quartz vein exposed in a gully in weathered granite east of the trial embankment broken down into tablets. The fracturing of the vein gives a mosaic-like appearance before erosion causes complete collapse. A similar feature south of Cheung Sha Lan (Plate 5) (81101E 81930N) shows progressive overturning of the mosaic-like wall of vein quartz caused by soil creep.

The rhyolite dykes have little compositional contrast with the surrounding granite and the only readily observable weathering contrast is in the abundance of hard, resistant corestones. The

soil derived from weathering of the aphanitic groundmass is much more clayey than that of granite, but this feature is not well seen in the limited exposures in the island. The dykes form good corestones, on the southern peninsula for example, but rock quality on the margins of the dykes is often poor.

Acknowledgments

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References

- ALLEN P M & STEPHENS E A (1971). *Report on the geological survey of Hong Kong 1967-1969*. Hong Kong Government Press, 116 p plus 2 maps
- BRITISH STANDARDS INSTITUTION (1981). *Code of practice for site investigations, BS 5930:1981*. British Standards Institution, London, 147 p
- BROCK R W, SCHOFIELD S J, WILLIAMS M Y & UGLOW W L (1936). *Geological map of Hong Kong (1:84 480)*. Ordnance Survey, Southampton
- DAVIS S G (1952). *The geology of Hong Kong*. Government Printer, Hong Kong, 231 p plus 14 plates & 3 maps
- FREDENBURG P (1990). When the airport comes... *Sunday Morning Post Magazine* 8 April p 6-15
- LANGFORD R L, LAI K W & SHAW R (1989). *Geology of the Western New Territories. Hong Kong Geological Survey Memoir No 3*. Geotechnical Control Office, Hong Kong, 140 p
- LANGFORD R L (1990). New airport at Chek Lap Kok, Geotechnical Investigation (1990). Volume 3, Geology of Chek Lap Kok. *Geotechnical Control Office Advisory Report No ADR 13/90*, 80 p plus map
- STRANGE P S (1985). Towards a simpler classification of the Hong Kong granites. In: MCPEAT-SMITH I (Ed). *Geological aspects of site investigation*. Geological Society of Hong Kong Bulletin No 2 p 99-103

THE RECENT CASTLE PEAK LANDSLIDE - WAS ROCK SLIDING INVOLVED?

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A large landslide occurred on a steep (35-40°) southeast-facing slope on the eastern flank of Castle Peak on September 11th this year (Langford & Hadley 1990). It is proposed here to consider what form the failure might have taken between the head of the slip at elevation 400 mPD (Plate 1) and a point about 45 m downslope.

Over this length of the slip, there is a new hollow in which there is almost bare bedrock (Plate 2 and Langford & Hadley, Plate 2). The exposed rock is a fine- to medium-grained granite, in places megacrystic with phenocrysts of both quartz and feldspar. The granite is universally and rather uniformly decomposed as a result of weathering or pervasive hydrothermal alteration. The decompositional grade (GCO 1988) is generally III (moderate), passing in places into grade II (slight) or IV (high). Local, more general, increases in degree of decomposition to IV or even V are mostly associated with occurrences of quartz veins and are probably due to hydrothermal activity.

Overlying the granite in the newly created hollow there is a small patch of colluvium (soil and rock fragments) on one side, at the head of the slip, with clean granite rubble below it and scattered down the gully (Plate 2), and some small patches of colluvial soil and rock mixtures adhering to joint surfaces a little further down on the same side (left side of Plate 2). All of this material *could* have slumped or been washed into the hollow, and in fact be remnants of a larger mass, formed in this way and subsequently largely eroded.

The upper part of this slip certainly must have involved a quantity of colluvial gully infill. The question is: did this colluvium flow or was it carried? Did the slip involve bedrock as well as colluvium?

A feature of this particular part of the eastern flank of Castle Peak, which is much steeper than most slopes on granite in Hong Kong, is that there are few joints dipping parallel to the slope and relatively few low-angle joints in any direction (although there are some of both types; examples are seen in Plate 5). The slope angle is not controlled overall by sheeting. It stands at a higher angle than sheeting-controlled slopes, giving rise to a situation where there is potential for occasional local failures on suitably intersecting joint surfaces which are not oriented in the same direction as the slope. A cursory examination of the jointing pattern of the rock at the site of the landslide shows clearly that such joint surfaces exist and that sliding along them is kinematically possible. In other words, sliding could occur if restraints against movement should be removed.

Much of the newly exposed granite surface in the hollow is formed on joint surfaces of various sizes. These fall into two main sets, giving the hollow a V-shaped cross-section (Plate 2). Near the head, joints of one of the sets, dipping ENE, are planar and extensive, whereas those of the other set, dipping S/SSW, are less regular and less continuous, so the southwest side of the hollow (right side of Plate 2) is rather smooth while the northeast side is more ridged and

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stepped. There is little sign of the kind of staining or weathering of the newly exposed rock surface that might be expected if it had been formerly a bedrock surface overlain by colluvium.

The head of the slip is formed by a 4 m high overhanging joint surface, inclined at about 68° upslope (Plate 1). This joint belongs to a third major set, which is present throughout the observed length of the slip and forms the faces of several prominent bluffs nearby (Plates 3 and 5).

The overall gradient of the axis of the V-shaped hollow over the upper 45 m is about 37° . The drainage channel over much of this distance undercuts the southwest-dipping joints in the form of an inclined notch, up to 40 cm deep in places, formed by erosion of a narrow strip of highly decomposed granite aligned parallel to the eastnortheast-dipping joints (this notch is clearly visible on Langford & Hadley's Plate 2). For the next 40 m or so, the overall gully gradient steepens to $50\text{--}60^\circ$ (at about 45 m the main channel sidesteps down over a southsouthwest-dipping joint surface to a lower joint intersection, Plate 4). In this steeper section below 45 m, the upper part of which is in the foreground of Plate 5, there must have been an open channel on bedrock before the landslide, as now.

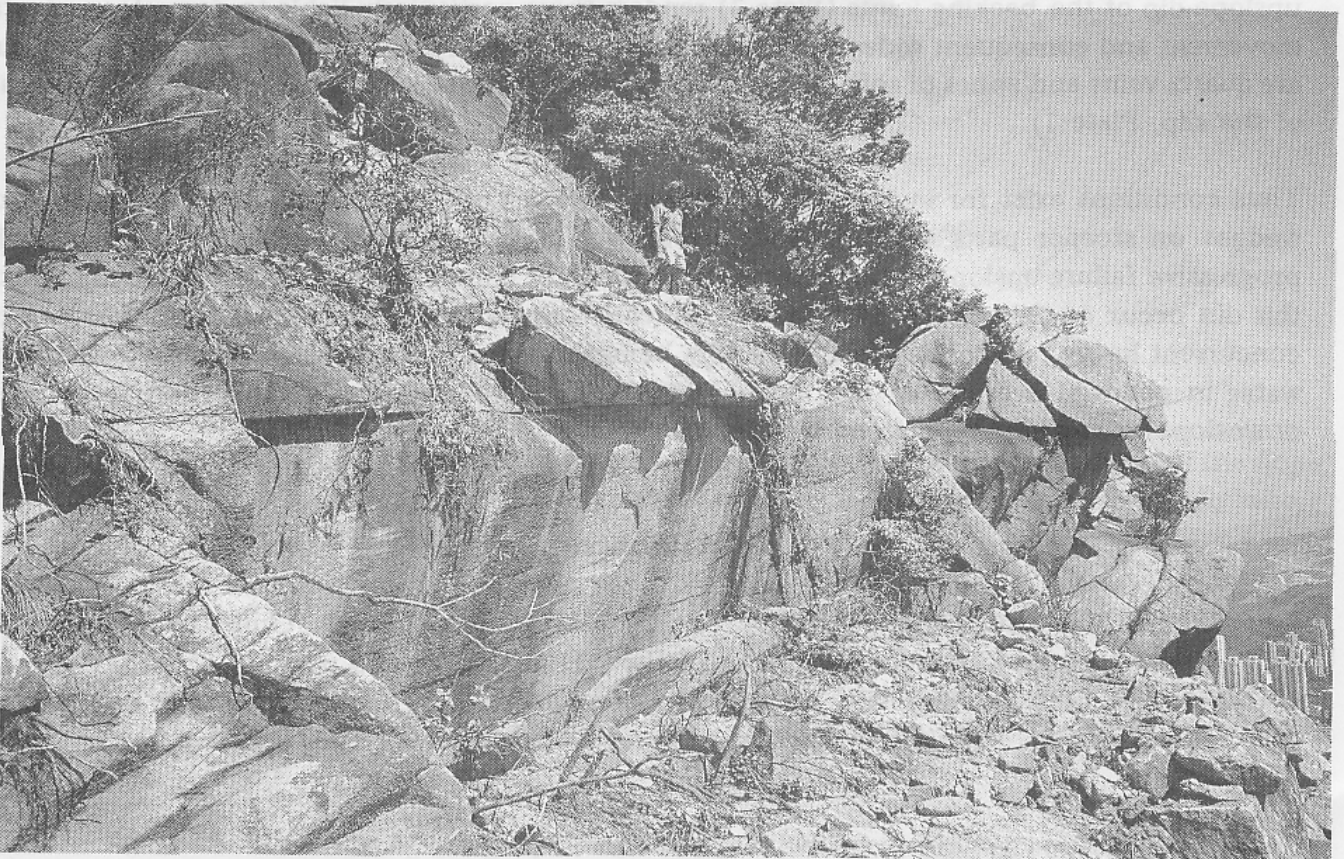


Plate 1

A major joint surface of Set 3, about 80 m down slope from the head of the slip and one the north flank of the gully. On this face there are no joints in Set 2 and only very wide-spaced joints in Set 1, so no wedges. But note the joints parallel to the slope.

The joint system

There is well-defined joint system in the granite. There are three main sets, as already noted, possible subsets (especially of Set 2) and some other joints occurring singly or in minor sets. The main sets are:

	1	2	3
Dip Angle	mainly 50–60°	mainly 35–60°	mainly 65–70°
Dip Direction	ENE	S-SSW	NW-NNW

These three sets form wedges, inclined downslope, with sets 1 and 2 as the bearing joints (Plate 2) and set 3 as the backing joints (Plates 1 and 3).

On Figure 1 are plotted about 60 poles to joints measured in the hollow along the upper 90 m of the slip during a brief visit to the site. The pole distribution shows the observable fact that, overall, the lines of intersection of joints in sets 1 and 2 are parallel to the general gradient of the gully (which is c 37° SE over the upper 45 m) and are not far off perpendicular to the joints of set 3. Set 1 is well defined; set 2 is more scattered. It is variations in set 2 that largely control the small changes in the direction and gradient of the new gully over the length observed.

The existence of set 3, the spacing of which varies greatly, means that joint-bounded wedges of various length are possible, with backing surfaces nearly normal to the basal edges. The steep upslope dip of the backing joints (Plate 3) renders them particularly liable to downslope pivotal movement and consequent widening, and possible toppling. Parallel to these joints, at intervals, are quartz veins and zones of soft, highly decomposed rock (one such zone occurring at the head of the slip, Plate 1).

Thus conditions exist for inclined joint-bounded wedges of various sizes, for "daylighting" of wedges on steeper parts of the slope, for sliding of unsupported wedges and for possible progressive failure upslope by both sliding and toppling if support is removed. If anything like this did occur on September 11th, it was evidently triggered by the immediately preceding or concurrent heavy rainstorm, possible factors being erosional undercutting, increased weight of water in colluvial overburden and open joints or increased water pressures (both uplift and downslope) along joints, or a combination of these.

References

- GEOTECHNICAL CONTROL OFFICE (GCO) (1988). *Geoguide 3: Guide to rock and soil descriptions*. Geotechnical Control Office, Hong Kong, 189 p
- LANGFORD R L & HADLEY D (1990). New debris flow on the flanks of Tsing Shan, Hong Kong. *Geological Society of Hong Kong Newsletter* Vol 8 Pt 3 p 2–12

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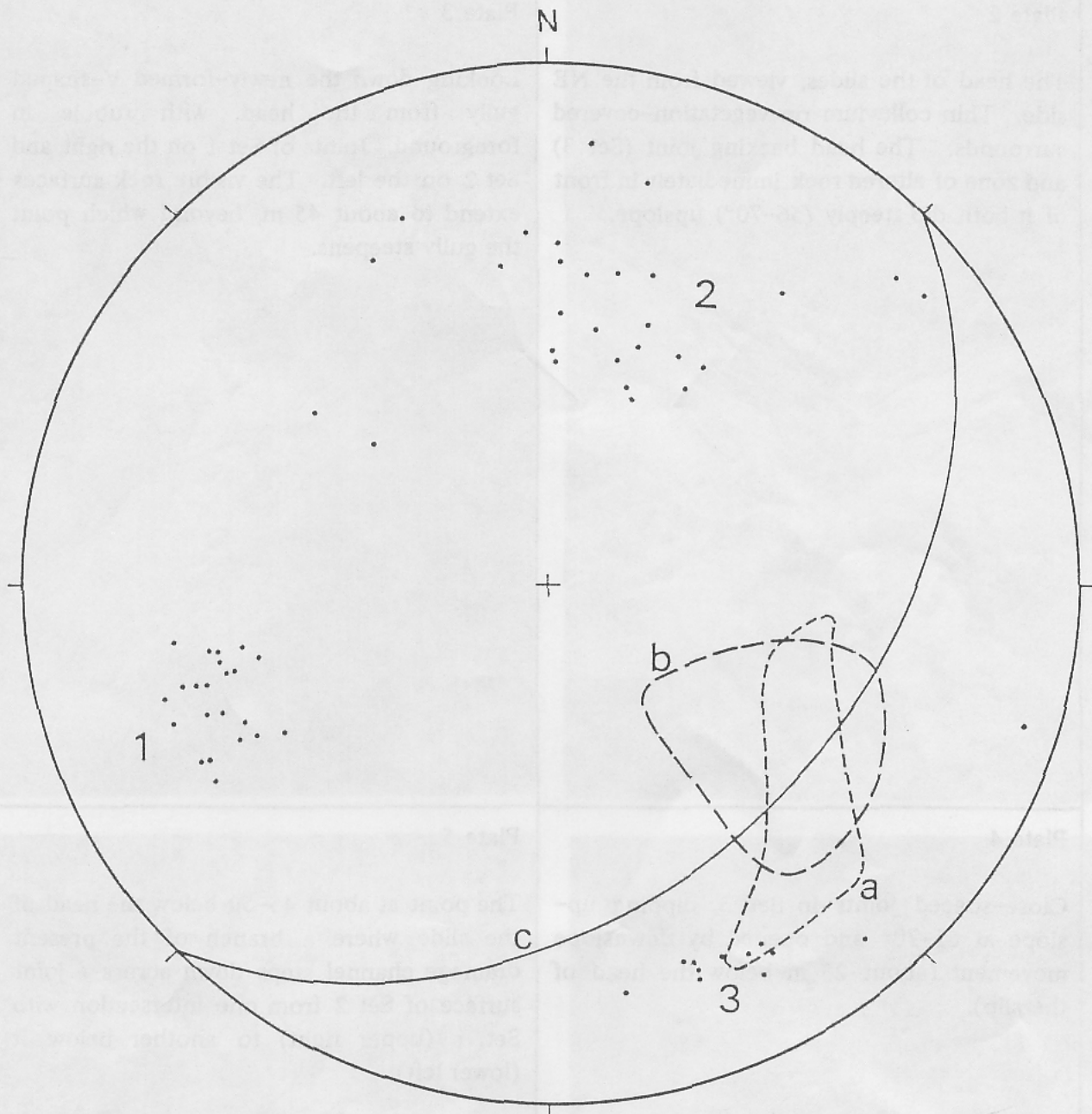


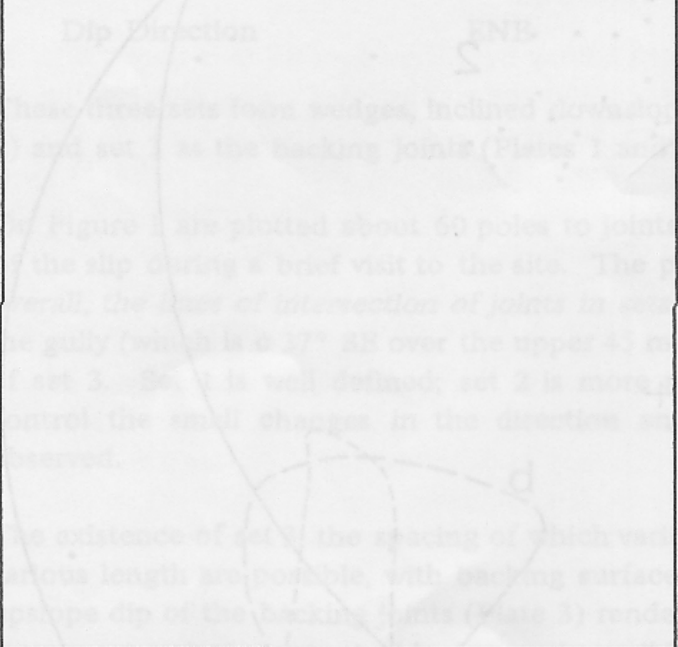
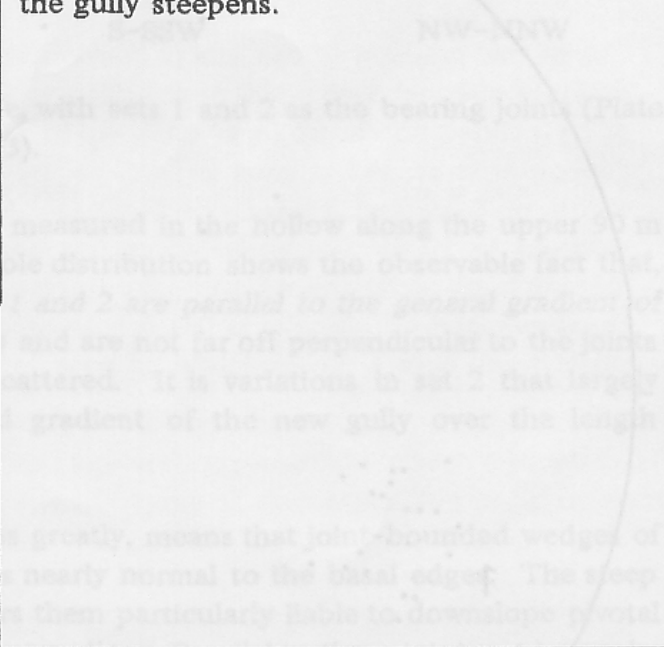
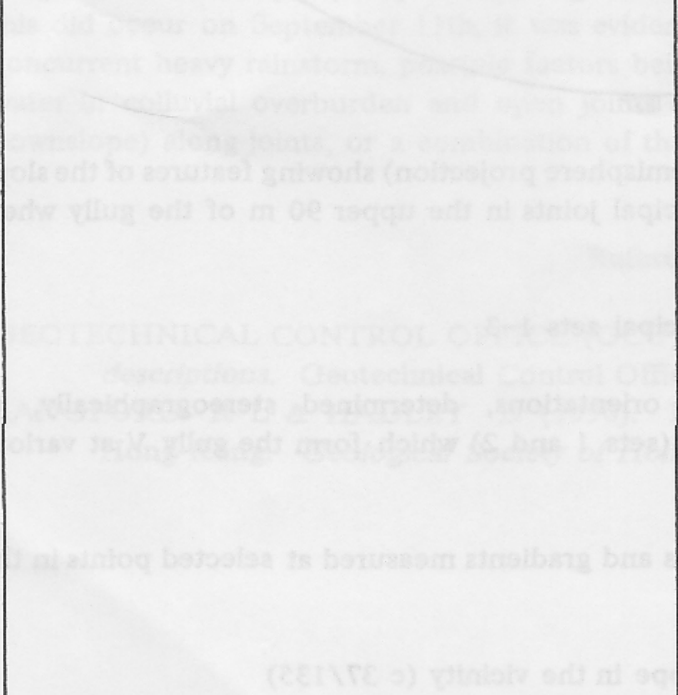
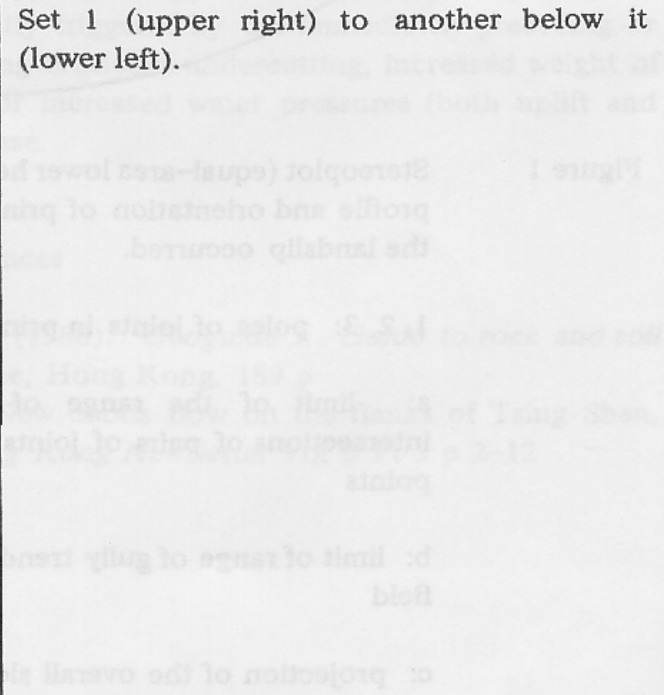
Figure 1 Stereoplot (equal-area lower hemisphere projection) showing features of the slope profile and orientation of principal joints in the upper 90 m of the gully where the landslide occurred.

1, 2, 3: poles of joints in principal sets 1-3

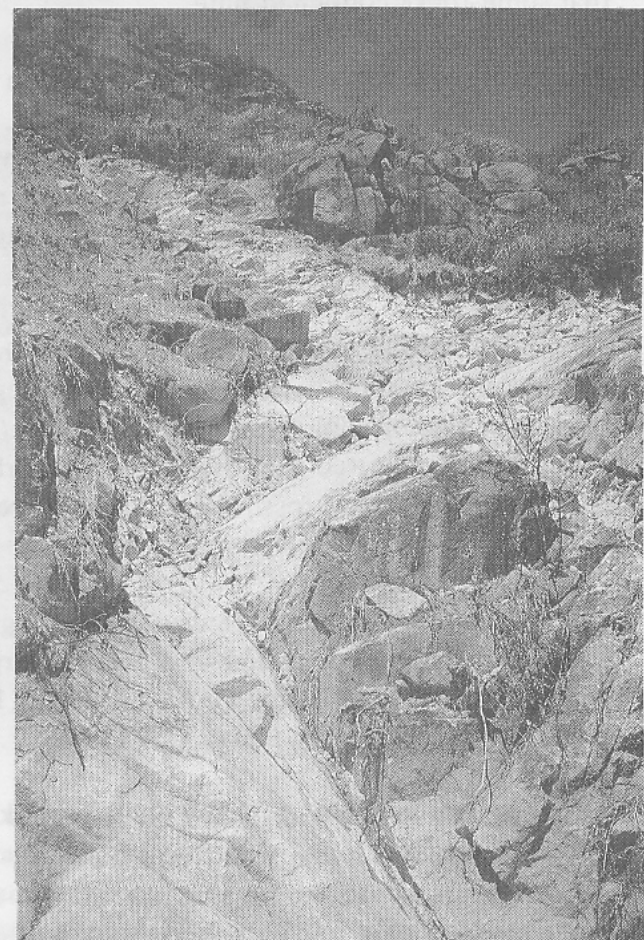
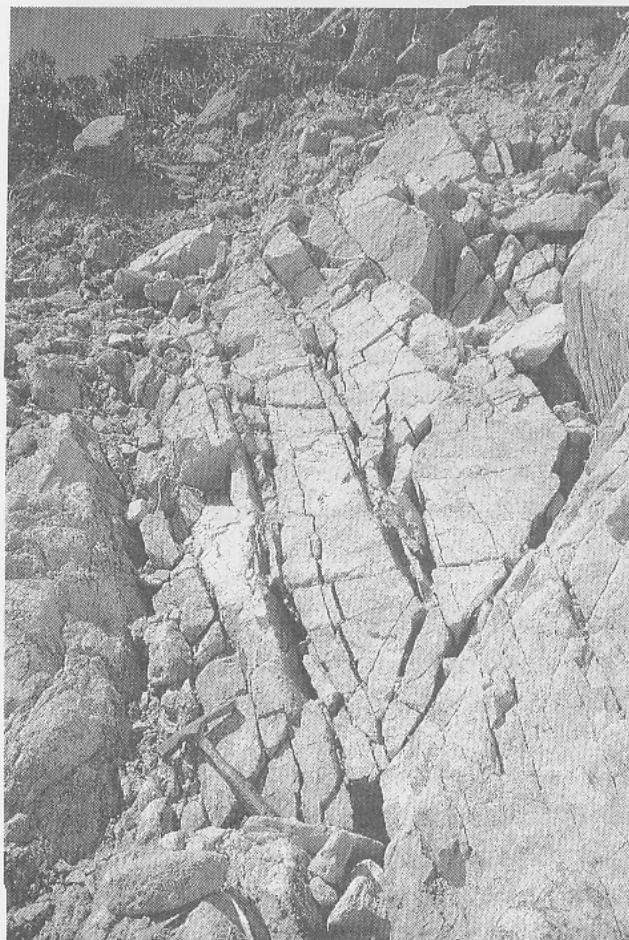
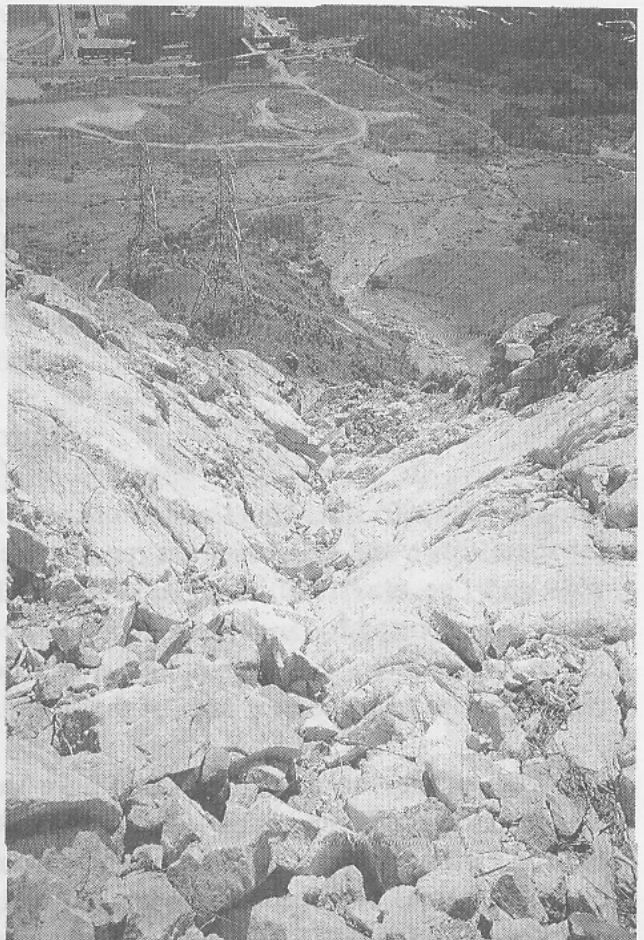
a: limit of the range of orientations, determined stereographically, of intersections of pairs of joints (sets 1 and 2) which form the gully V at various points

b: limit of range of gully trends and gradients measured at selected points in the field

c: projection of the overall slope in the vicinity (c 37/135)

Plate 2 The head of the slides, viewed from the NE side. Thin colluvium on vegetation-covered surrounds. The head backing joint (Set 3) and zone of altered rock immediately in front of it both dip steeply (56-70°) upslope. 	Plate 3 Looking down the newly-formed V-shaped gully from the head, with rubble in foreground. Joints of Set 1 on the right and Set 2 on the left. The visible rock surfaces extend to about 45 m, beyond which point the gully steepens. 
Plate 4 Close-spaced joints in Set 3, dipping upslope at 65-70° and opened by downslope movement (about 25 m below the head of the slip). 	Plate 5 The point at about 45-50 below the head of the slide where a branch of the present drainage channel steps down across a joint surface of Set 2 from one intersection with Set 1 (upper right) to another below it (lower left). 

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THE ROCKS OF PING CHAU, MIRS BAY, HONG KONG

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Introduction

Zhou *et al* (1990) note that the age of the Ping Chau Formation has been a matter of dispute for some fifty years and based on recent articles (Zhou *et al* 1990, Nau *et al* 1989, Wu & Nau 1989 and Lee *et al* 1990) it would seem this is still the case; possible ages based on the same fossils are reported to range from early Cretaceous to early Tertiary. Despite the interest in the age of rocks nothing has been published on the rocks themselves since Nau (1979) produced his now widely used geological map of the island.

The bulk of the rocks on Ping Chau have variously been described as slaty shale, silty shale, marl, siltstone and mudstone (Williams 1943, Ruxton 1960, Nau 1979, Wu & Nau 1989, Lee *et al* 1990). Various authors have noted the calcareous and dolomitic content of the rocks but by using the names of detrital rocks implied a significant detrital mineral content, although none describe any. Lai (1973) did, however, comment that the albite present is remarkably fresh and that some rocks contained illite.

The lower section of the Ping Chau Formation contains a siliceous marker bed 80 - 90 cm thick. Williams (1943) called it a cherty sandstone, Ruxton (1960) a cherty ash and Nau (1979) a cherty siltstone. Wu & Nau (1989) now believe this bed to be a "lacustrine tuff". They record feldspar, quartz, hornblende and zircon with a matrix showing two stages of alteration; carbonate followed by silicification. The most recent map of the island (Nau *et al* 1990) shows this marker bed as a "sedimentary tuff".

Peng (1967, 1971) described a suite of what he called authigenic minerals from the Ping Chau Formation including analcite, natrolite and aegirine, which he suggested were, at least in some cases, pseudomorphing gypsum. Wu & Nau (1989) also report cordierite from Ping Chau. It is also widely reported that the formation is rich in organic components, including vitrinitised and bitumenized plant fossils. Leung (1971) reports he was able to distil organic fractions from the rocks.

Perhaps the most striking feature of the Ping Chau Formation is its uniform and continuous bedding, with fine lamination and detailed large and small sedimentary structures which have been described by Williams (1943), Ruxton (1960), Nau (1979), Wu & Nau (1989), Lee *et al* (1990) and, in detail, by Leung (1971).

All these features Wu & Nau (1989) remark "... indicate that the sediments are mainly of terrestrial origin ...".

Observations

Recent work on the upper part of the Ping Chau Formation between A Ma Wan and Chau Pui examined the rocks in the field, petrographically and by X-ray diffraction (2 samples only). The rocks examined included the following facies defined by Nau (1979):

- z zeolite-bearing mudstone with siltstone
- zp zeolite-pyrite-bearing mudstone with siltstone
- zs zeolite-bearing siltstone with mudstone
- a aegirine-bearing siltstone with mudstone
- s siltstone

The rocks in all these facies are well bedded and many are characterised by extremely thin planar lamination. Most laminae are < 1 mm thick and laterally continuous over tens of metres. In many cases the coarser laminae consist of small ripple trains where the amplitude of the ripples is < 0.5 mm. These laminae are commonly deformed due to wet sediment deformation. Larger scale sedimentary structures also occur, the most common being tabular cross-bedding, generally as isolated sets up to 10 cm thick. Convolute cross-bedding occurs in places. In thin section the details of these structures are clearly defined (Plate 1).

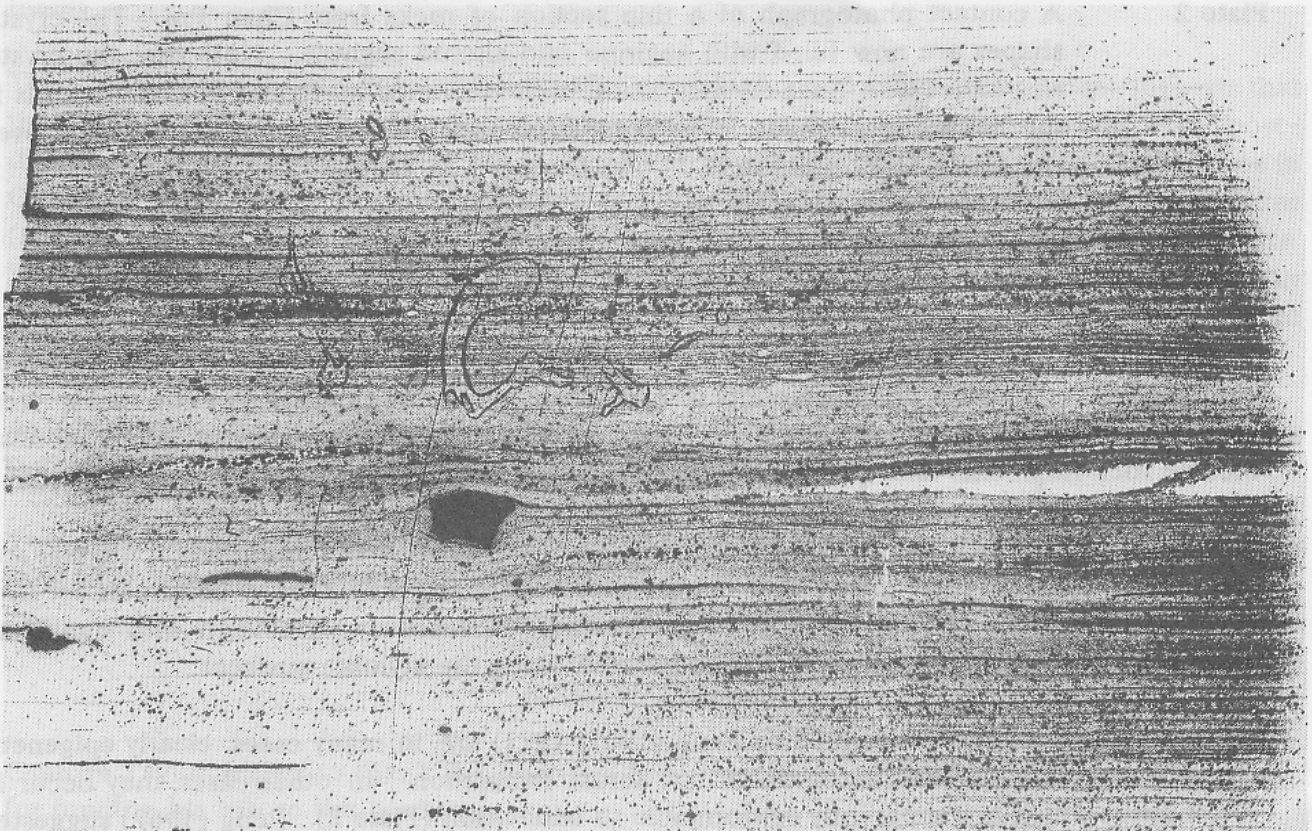


Plate 1 A contact photograph of a thin section from the eastern end of the beach at A Ma Wan. Note the very fine lamination and the lamination draping over the large organic fragment. The clear lenticular area on the centre right is a post-depositional vein of carbonate with minor aegirine. The photo is about 15 mm from top to bottom, and the laminae range in thickness from 0.05 to 0.8 mm.



Plate 2 A contact photograph of a thin section of rocks from Chau Pui. The crystal shapes are now filled with aegirine and altered aegirine. Note that the crystal size varies with finer crystals in the well laminated parts and coarser crystals in the more massive beds. The lamination also is deformed by, and draped over, the crystals. The photo is 15 mm from top to bottom.

Examination of the rocks in thin section and by XRD shows that the sequence is dominated by calcite and dolomite with minor amounts of authigenic albite and (?) illite in some rocks. Very few terrigenous detrital grains have been observed. Some sand and silt sized grains of felsic volcanic rock fragments and quartz have been observed from the upper parts of the section.

The marker bed in the lower part of the section referred to above contains abundant angular and clear albite, some angular quartz and minor ferromagnesians and a trace of zircon set in a siliceous plasma with varying amounts of carbonates. It is heavily stylolitized with significant brown insoluble residues (? organics) concentrated along the stylolite surfaces.

The zeolites and aegirine described by Peng (1967, 1971) are, in many cases, clearly epigenetic as they occur in veins and lenses which cut across lamination. In other cases they occur in crystal forms which are apparently conformable to lamination (Plate 2). Peng (1967) suggested that the crystal forms may be gypsum and that the authigenic minerals have replaced the gypsum. No relict gypsum has been identified and it is possible that at least some of the zeolites and aegirine are syngenetic. Similarly, at a mesoscopic scale nodules of zeolites up to about 5 cm in diameter deform laminae below them and are draped by laminae above them indicating that these nodules are syngenetic. Pyrite nodules and cubes at various scales (from 50 to 0.5 mm) have relationships to bedding which clearly indicate syngensis.

Discussion

Based on the limited observations reported here the Ping Chau Formation is probably best described as a carbonate unit. Whether limestone or dolomite is more appropriate must await further investigation.

The preservation of very detailed primary sedimentary structures within the rocks suggests that diagenetic or metamorphic modifications have been minimal. Any recrystallisation of the carbonates after their deposition would have destroyed the very fine lamination. It thus seems reasonable to conclude that the carbonates are syngenetic and were transported (maybe very locally) after precipitation to form the primary sedimentary structures.

The precipitation of calcite and dolomite suggest a highly alkaline and saline environment rich in Ca and Mg. Pyrite and abundant organic matter (including fossils) suggest a reducing environment in the sediments, with sulphur perhaps being present as sulphate in the lake water and sediment/water interface (perhaps as gypsum).

The presence of the "sedimentary tuff" and occasional isolated felsic volcanic rock fragments in the carbonates shows that contemporaneous felsic volcanism was likely somewhere in the region. Records of such volcanism in Hong Kong may extend into the Cretaceous (McFeat-Smith *et al* 1989) but in Guangdong it extends to the Eocene (Ye & Feng 1990). While the importance of a volcanic contribution to the sediments of the Ping Chau Formation is important it does not help with dating the rocks as the span of volcanism is similar to the range given by fossils.

The presence of the felsic volcanics in an alkaline reducing and saline environment suggests that the "authigenic" zeolites and aegirine may well be forming syngenetically and early post-depositionally in a similar way to the Green River Formation (Hay 1966) or the Pleistocene in Olduvai Gorge (Hay 1966) or the Chugwater Formation (High & Pickard 1965). The zeolites (analcite and natrolite) indicate a sodium-rich environment as does the aegirine and albite. Which of these minerals formed may well have been related to the amount of dissolved silica in the water (Hay 1966) which would presumably be related to fluctuations in pH, in turn related to water levels.

At this stage much research remains to be done but some of this discussion may help in solving the age of the Ping Chau Formation and clarifying the correct lithological name for the rocks.

Two possible depositional environments would meet the above criteria for deposition; arid to semi-arid perennial lake or acid coastal lagoon or sabkha.

Acknowledgements

Graham Taylor wishes to thank the Hui Oi-Chow Trust Fund of the University of Hong Kong for funding his trip to the territory.

References

- HAY R L (1966). Zeolites and zeolitic reactions in sedimentary rocks. *Special paper of the Geological Society of America* No 85, 130 p

- HIGH L R & PICARD M R (1965). Sedimentary petrology and origin of analcime-rich Popo Agie Member, Chugwater (Triassic) Formation, west central Wyoming. *Journal of Sedimentary Petrology* Vol 35 p 49-70
- LAI F H (1973) *Palaeogeographical interpretation of the Ping Chau Formation, Mirs Bay, Hong Kong, from some of its primary sedimentary structures*. BA Dissertation, University of Hong Kong (unpublished)
- LEE C M, CHEN J H, HE G X & ATHERTON M J (1990). On the age of the Ping Chau Formation. In: ATHERTON M J, LEE C M, CHEN J H, HE G X & WU S Q. *Report on the stratigraphy of Hong Kong*. Department of Civil and Structural Engineering, Hong Kong Polytechnic, p F1-F19
- LEUNG F W (1971). *A study of the sedimentary rocks of Ping Chau, Mirs Bay*. BA Dissertation, University of Hong Kong (unpublished)
- MCFEAT-SMITH I, WORKMAN D R, BURNETT A D & CHAU E P Y (1989). Geology of Hong Kong. *Bulletin of the Association of Engineering Geologists* Vol 26 No 1 p 23-107
- NAU P S, JIANG Q Q & WU Q J (1990). Spore-pollen flora from Ping Chau Island, Mirs Bay, Hong Kong. *Geological Society of Hong Kong Newsletter* Vol 8 Pt 2 p 5-29
- PENG C J (1967). Occurrence of zeolites in Upper Jurassic rocks of Hong Kong. *Abstracts of the International Mineralogical Association Meeting, Tokyo*, p 225-226
- PENG C J (1971). Acmite and zeolite-bearing beds of Hong Kong, a new and unusual occurrence. *Abstracts of the 8th International Sedimentological Congress, Heidelberg*, p 76-77
- RUXTON B P (1960). The geology of Hong Kong. *Quarterly Journal of the Geological Society of London* Vol 115 p 233-260 (plus 2 plates & 1 map)
- WILLIAMS M Y (1943). The stratigraphy and palaeontology of Hong Kong and the New Territories. *Transactions of the Royal Society of Canada Third Series* Vol 37 Sect IV p 93-117
- WU Q J & NAU P S (1989). The characteristics of fossil plants and age of the strata of Ping Chau Island, Mirs Bay, Hong Kong. *Geological Society of Hong Kong Newsletter* Vol 7 Pt 4 p 2-11
- YE E K & FENG G R (1990). Preliminary studies on volcanic rocks of Mesozoic and Cenozoic age in the Sanshui Basin of Guangdong Province. *Geological Society of Hong Kong Newsletter* Vol 8 Pt 1 28-34
- ZHOU Z Y, LI H M, CAO Z Y & NAU P S (1990). Some Cretaceous plants from Pingzhou (Ping Chau) Island, Hong Kong. *Acta Palaeontologica Sinica* Vol 29 p 418-428
-

COMMENT ON RECENT CONCLUSIONS ABOUT THE AGE
OF THE PING CHAU FORMATION

Four papers have appeared on this subject this year alone, the fruits of two separate research projects. They are all based on studies of collections of plant fossils. Each of the projects has involved workers at the Nanjing Institute of Geology and Palaeontology of the Academia Sinica. The results of the work at Nanjing appear in the three papers cited and quoted here.

Lee *et al* (1990a) reported on an examination of more than 200 plant specimens. This paper concludes with the statement "the authors believe that the Ping Chau formation is Tertiary..."

Later, the same authors with one other (Lee *et al* 1990b) came to a different conclusion on the basis of additional fossil plant evidence. They decided that the flora of the Ping Chau Formation could be "tentatively determined as Late Cretaceous" and only "might" be Tertiary. They further comment (with a degree of inconsistency) that the flora of the Ping Chau Formation "cannot be older than late Early Cretaceous", is "at least later than the late Early Cretaceous" and is "not very likely (to be) late...Early Cretaceous". They allow that "the flora of the Ping Chau Formation is a flora full of contradiction" but are willing to put forward "a bold viewpoint on a Late Cretaceous age for the Ping Chau Formation".

Meanwhile, also at the Nanjing Institute, a second group has been working on fossil plants from Ping Chau; their results are reported in Zhou *et al* (1990) and Nau *et al* (1990). Their conclusion is that "on balance of evidence the fossiliferous strata (on Ping Chau) seem to be late Early Cretaceous (Albian) in age. It is not impossible that the strata will prove to be of early Late Cretaceous, but *cannot be later...*" (my emphasis).

It will be noted that there is a degree of overlap here, but only just. Both groups allow the possibility of a late Early Cretaceous or early Late Cretaceous age. One prefers the former while the other prefers an early Late Cretaceous age.

All this is rather confusing since, as noted, both groups are working at the same place. Perhaps they could be persuaded by their Hong Kong counterparts to boil all this down into a joint review of all the evidence?

References

- LEE C M, CHEN J H, HE G X & ATHERTON M J (1990a). On the age of the Ping Chau Formation. In: ATHERTON M J, LEE C M, CHEN J H, HE G X & WU S Q. *Report on the stratigraphy of Hong Kong*. Department of Civil and Structural Engineering, Hong Kong Polytechnic, p F1-F19
- LEE C M, ATHERTON M J, WU S Q, HE G X & CHEN J H (1990b). Discovery of Angiosperm fossils from Hong Kong - with discussion on the geological age of the Ping Chau Formation. In: ATHERTON M J, LEE C M, CHEN J H, HE G X & WU S Q. *(Supplement) Report on the stratigraphy of Hong Kong*. Department of Civil and Structural Engineering, Hong Kong Polytechnic, p H1-H13
- NAU P S, JIANG Q Q & WU Q J (1990). Sporepollen flora from Ping Chau island Mirs Bay, Hong Kong. *Geological Society of Hong Kong Newsletter* Vol 8 Pt 2 p 25-29
- ZHOU Z Y, LI H M, CAO Z Y & NAU P S (1990). Some Cretaceous plants from Pingzhou (Ping Chau) island, Hong Kong. *Acta Palaeontologica Sinica* Vol 29 No 4 p 415-426 plus 4 plates (in Chinese with English summary)

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From the Editor

Dr Workman may be interested to know that, first, the two research papers by Lee *et al* (1990a, 1990b) are to be published in the next issue of the Newsletter (Vol 9 No 1 March 1991). Second, the confusion surrounding the age of the Ping Chau Formation has not gone unnoticed in the Hong Kong Geological Survey. Mr K W Lai, District Geologist for the northwest and northeast of the Territory, is obtaining independent advice on the Nanjing palaeontological determinations and age assignments. These will be published in Hong Kong Geological Survey Memoir No 5, and we also hope to publish the results of the review in the Newsletter.

ANNOUNCEMENTS

Talks at the Mariner's Club, 6 pm

- Friday 22 February *Fluvial geomorphology of the Upper Amazon Basin*, by Dr Ron Neller of The Chinese University of Hong Kong
Friday 22 March *Glacial geomorphology in the Kara-Koram Himalya*, by Dr Raynor Shaw of the Hong Kong Geological Survey

Marine Studies Group discussion meetings, 12/F Empire Centre, 6 pm

- Monday 4 February *Engineering geology of the Pearl River mouth basin, South China Sea*, by Jeremy Paisley of Fugro (Hong Kong) Ltd
Monday 4 March *Marine geology of the site of the new airport at Chek Lap Kok*, by Ceri James of the Hong Kong Geological Survey

Volcanic Studies Group

The Volcanic Studies Group aims to promote interest in general topics of volcanic geology, igneous petrology and geochemistry. With the wide range of volcanic rock types and field occurrences on Hong Kong there is considerable scope for local field trips and discussion topics. Interested members are asked to contact Dr Rod Sewell, Hong Kong Geological Survey, Geotechnical Control Office (telephone 369-9374, FAX 369-0007).

Teacher's Group

We are sorry to say that, following the resignation of the Secretary, Keung Hon-ming, nobody can be found to organize the activities of this Group, comprising mostly geography teachers and students. Anyone interested in reforming this Group should contact the Chairman of the Society, Maurice Atherton, on 766-6041 at Hong Kong Polytechnic.

Seismicity in Eastern Asia, Hong Kong, 23 - 26 October 1991

The conference will address aspects of seismicity, tectonic geology, seismic hazards and earthquake countermeasures, with an emphasis on the problem of seismicity and earthquake hazards reduction in Eastern Asia and neighbouring areas. The conference is organized by the Geological Society of Hong Kong with the support and cooperation of the Guangdong Seismological Society. The second circular is being prepared and further details can be obtained from K W Lee, Charles Haswell and Partners (Far East) Ltd, 3/F Bay Tower, 2-4 Sunning Road, Causeway Bay, Hong Kong.

Karst geology in Hong Kong

The publication of Bulletin No 4, "Karst geology in Hong Kong", was delayed during the summer while contributions trickled in. The Editors can now report that the Bulletin will go for printing in January 1990, and should be available in February. Any conference participants will automatically receive their copy. Any orders for copies should be sent, with HK\$ 100 in draft or cheque, to the Chief Editor, Dr R L Langford, Geotechnical Control Office, 6/F Empire Centre, 68 Mody Road, Tsim Sha Tsui East, Kowloon, HONG KONG. Enquiries are welcome for both the Bulletin and Abstracts (published last year) on 366-7916 or FAX 369-0007.

ERRATA

WORKMAN D R (1990). Vol 8 Pt 4 p 40-45

p 41 Plate 1 in the plate caption should be Plate 5

p 41 Plate 5 in paragraph 3, line 8 should be Plate 4

p 44 Plates 2-5 in the plate captions should be Plates 1-4

TAYLOR G, WORKMAN D R & PEART M R (1990). Vol 8 Pt 4 p 46-50

p 49 acid in the last line of paragraph 7 should be arid

GEOLOGICAL SOCIETY OF HONG KONG PUBLICATIONS LIST

Bulletin No 1 (1984). YIM W W S (Ed). Geology of surficial deposits in Hong Kong, 177 p
 Bulletin No 2 (1985). MCFEAT-SMITH I (Ed). Geological aspects of site investigation, 236 p
 Bulletin No 3 (1987). WHITESIDE P G D (Ed). The role of geology in urban planning, 600 p
 Bulletin No 4 (1990). LANGFORD R L, HANSEN A & SHAW R (Eds). Karst geology in Hong Kong (in press)

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

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

Abstracts No 1. Abstracts of papers presented at the meeting on "Geology of surficial deposits", September 1983, 79 p - OUT OF PRINT

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

Abstracts No 3. 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. Abstracts of papers presented at the conference on "The role of geology in urban development", December 1986, 65 p

Abstracts No 5. 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. Abstracts of papers presented at the conference on "Karst geology in Hong Kong", January 1990, 58 p

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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

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Abstracts Nos 4, 5 & 6	HK\$ 20

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Cover photograph: Abandoned kaolin mine on west Chek Lap Kok, with the trial embankment for the replacement airport in the distance. Sha Lo Wan and the island of Lam Chau can be seen in the background. Courtesy of R L Langford.

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