GEOLOGICAL SOCIETY OF HONG KONG

香港地質學會

NEWSLETTER
通 訊

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GEOLOGICAL SOCIETY OF HONG KONG

NOTES FOR THE GUIDANCE OF CONTRIBUTORS TO THE NEWSLETTER

GENERAL: Articles of a technical nature, as well as reports of interesting events, reviews and other topical items are welcome. Typescripts, enquiries and all correspondence pertaining to the Newsletter should be addressed to the *Editor, Geological Society of Hong Kong, c/o Department of Geography and Geology, University of Hong Kong, Pokfulam Road, Hong Kong*. The Society does not assume copyright of material published in the Newsletter. Any other previous, current or expected future use of such material by the author must be stated at the time of submission.

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ILLUSTRATIONS: Send the originals of all illustrations, each marked with the author's name. Diagrams should be in black on tracing material or smooth white paper or board, with a line weight suitable for reduction. A metric scale should be included, and North Point (or where relevant, coordinates of latitude and longitude) on all maps. Plates should normally be provided as negatives plus prints, or as transparencies; half-tone plates to final publication size are preferred. Refer to a recent issue of the Newsletter for size and style of tables, figures and plates.

REFERENCES: The author is responsible for ensuring that all references are correct. The list of references should be given in full, with no abbreviations.

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Geological Society of Hong Kong Newsletter
Vol 9 No 3 (September 1991)

CONTENTS

EDITORIAL

This issue of the Newsletter comes to you a little later than usual, but we have managed to include two substantial contributions; on the Hutton Conference Excursion in Hong Kong and on the Needle Hill wolframite deposit. Together with some interesting correspondence and Society news, we have managed to get the Newsletter over 50 pages again.

This cannot continue if we do not receive more contributions. It does not matter how large or small your contributions are; or perhaps it is a good photograph with an interesting caption. The Society needs articles, stimulating correspondence and news items. Please think about your work and interest in geology, and see if you have anything to send in for publication.

If any members attended or contributed to our recent conference on Seismicity in East Asia, you will know that we have a Society which has yet again proven its ability to host excellent international and local conferences.

The seismicity conference also happened to coincide with the move of the renamed Civil Engineering Department to its refurbished headquarters at Ho Man Tin. The renamed Geotechnical Engineering Office, formerly Geotechnical Control Office, is now brought under one roof in this building, resulting in the greatest concentration of geologists per square metre in the whole Territory. As the dust settles after the conference and the move, we hope that you will be thinking about putting pen to paper for our Newsletter.

While the Society and our members have seen big events in the past few months, so has the little island of Chek Lap Kok. The rate of change in the landscape of the island is astonishing, and so is the potential for extracting geological information. With the necessity for confidentiality it will be some time before all the new geological data is available, but the recent past history of the island is now being researched and written up by the Hong Kong Archaeological Society under Bill Meacham's direction. The Society and Geological Survey are co-operating on rock and artefact identification, and we hope that some of the data will be made available in the Newsletter as well as in the archaeological publications. One interesting feature of this co-operation has been the re-emergence of Schofield's original field notebooks from the 1920s and 30s. An extract from one of these, for Chek Lap Kok, is included in this issue.

The attendance at the occasional Friday evening talks at the Mariner's Club has been good, which I find particularly pleasing having given the last talk. There is a pleasant bar and relaxed atmosphere, public parking next door, and the MTR and Star Ferry a few minutes walk away. Please come along and support both the speakers and the Society.

At the moment we have underway a complete bibliography of Society publications; this includes all articles and all references in those articles. With conferences such as Landplan III the scope will be wide, but it will be a very useful and comprehensive source of information. As a first step we will publish a cumulative reference list and index for all Newsletter articles in the next issue, leaving us to start Volume 10 and our second decade with a clean slate.

Richard Langford, Editor

Geological Society of Hong Kong Newsletter Vol 9 No 3 p 3-28 (1991)

SECOND HUTTON SYMPOSIUM ON THE ORIGIN OF GRANITES AND RELATED ROCKS

EXCURSION C2 - GRANITES OF HONG KONG
30 September - 2 October 1991

R J Sewell & R L Langford
Hong Kong Geological Survey
Hong Kong Government

This excursion was designed to focus on the field, petrographic and geochemical characteristics of Hong Kong granites. Much of the information presented here is published for the first time, and represents the interim results of detailed geochemical and isotopic studies currently in progress in the Hong Kong Geological Survey. As such the conclusions drawn should be treated as provisional.

Introduction

Situated on the southern coast of China at the mouth of the Pearl River, the Territory of Hong Kong encompasses a portion of mainland China (Kowloon and the New Territories), two large islands (Hong Kong and Lantau) and several dozen smaller islands. The geology of the Territory is dominated by granite plutons and associated volcanic rocks (Figure 1) which cover approximately 90% of the exposed land area (1149 km^2). Rb-Sr geochronology (Sewell *et al* 1991) has established the age of plutonism as middle Yenshanian (150 - 135 Ma), placing the granites between the two main phases of granitoid intrusion in southern China (Jahn *et al* 1976)

Regional geological setting

The Territory lies within the Lianhuashan Fault Zone, a broad (200 km) northeast-trending fault-bounded depression (Figure 2) located between the South China Fold System to the northwest and the Maritime Fold System to the southeast (Huang 1978). The main trends of the tectonic elements within the fault zone are northeast and east, with northeast-striking faults being dominant. Prominent northeast-trending faults are generally thought to represent older zones of crustal weakness which have been periodically reactivated since the Proterozoic; their rectilinear nature has been inferred to indicate strike-slip movement (Bennett 1984).

Voluminous eruptions of intermediate to silicic volcanic rocks and emplacement of granite plutons along the continental margin of southeast China is thought to have occurred during the polyphase Yenshanian Orogeny associated with interaction between the Kula-Pacific oceanic plate and the Eurasian continental plate in Late Triassic to Cretaceous times (Jahn *et al* 1976).

The Yenshanian Orogeny was characterised by movement on deep northeast-trending faults and the development of broad open folds. Holloway (1982) associated the late Yenshanian activity with inception of tensional conditions and block faulting of the continental margin. An east-west oceanic spreading centre developed in the South China Sea from Late Cretaceous to middle Tertiary times (Ben-Avraham & Uyeda 1973), and Tertiary sediments accumulated in structurally controlled eastnortheast-oriented troughs and basins.

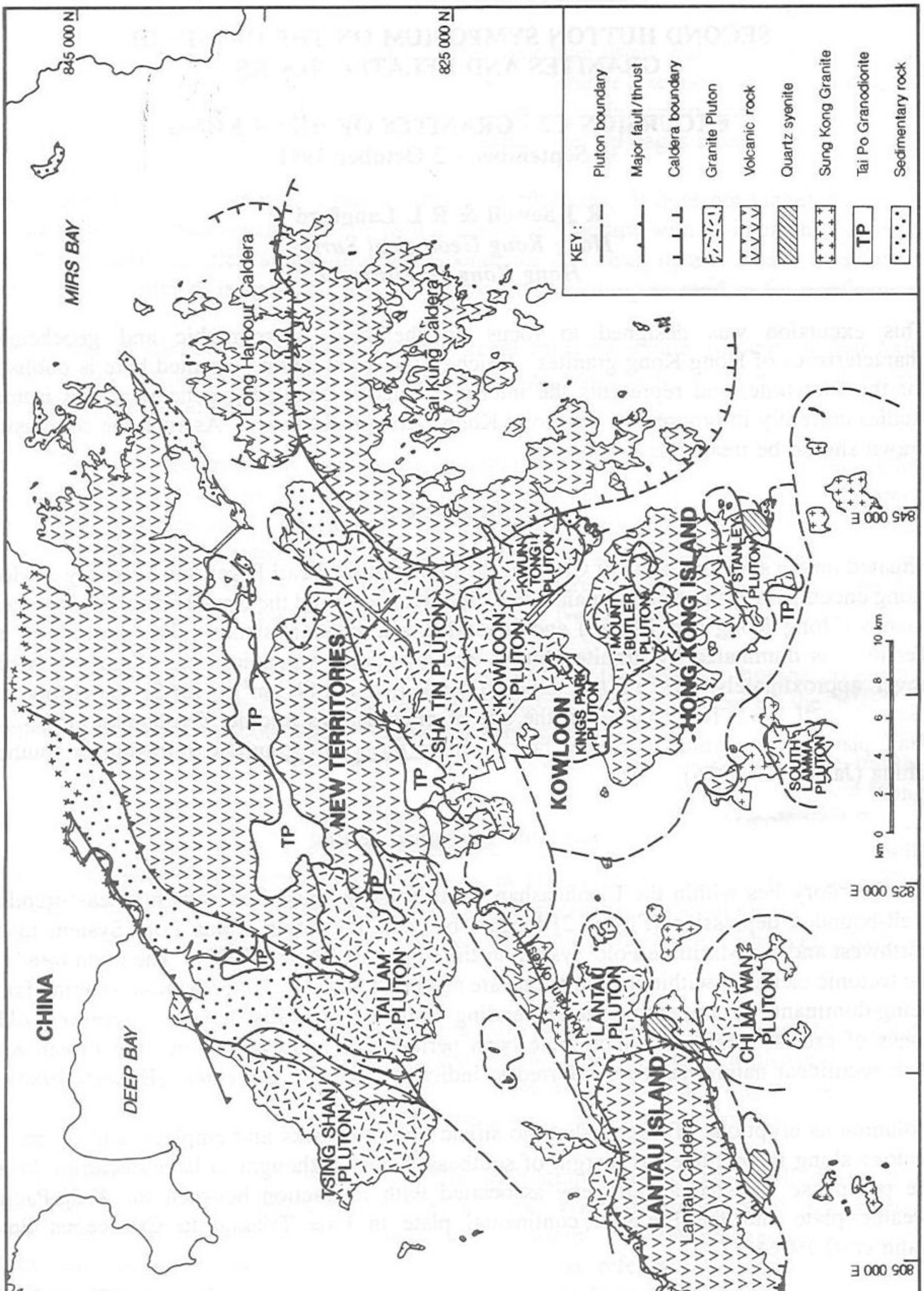

Figure 1 *Simplified geology map of Hong Kong showing the distribution of the main intrusive units*

Geology of Hong Kong

Basement rocks outcrop mainly in the New Territories; these consist of Devonian sandstone, siltstone, and mudstone; Carboniferous metasandstone, metasiltstone and marble; and Permian sandstone and siltstone. They are unconformably overlain by Lower Jurassic mudstone and sandstone, and Upper Jurassic to Lower Cretaceous volcanic rocks which form the bulk of the Mesozoic cover. The volcanic rocks comprise intermediate to silicic lavas, welded tuffs, and volcaniclastic sedimentary rocks of the Repulse Bay Volcanic Group (Addison 1986), intruded by granite plutons of similar age. Upper Cretaceous-Tertiary rocks, comprising moderately deformed conglomerate, sandstone, siltstone and mudstone, rest unconformably on volcanic rocks in the northeastern New Territories; they represent the youngest sedimentary strata exposed in the Territory.

The Western New Territories is cut by the northeast-trending Tuen Mun-Lo Wu fault zone (Figure 2) which constitutes a series of subparallel thrust faults, folds, and shear zones separating Carboniferous basement rocks in the west from presumed Devonian basement in the east (Langford *et al* 1989). The Tuen Mun-Lo Wu fault zone has been periodically active since the Late Palaeozoic and may represent a deep crustal structure (Chaquon 1989). It forms a branch of the Shenzhen-Wuhua Fault which trends northeast through Shenzhen and Wuhua in Guangdong, and beyond to Fujian. The eastern part of the Territory is dominated by two major collapse calderas (Figure 1, Strange *et al* 1990) defined on the basis of outcrop distribution, field characteristics and intrusion of plutonic rocks along the suspected ring faults. The calderas are separated by the east-trending Cheung Sheung-Chek Keng Fault. The central part of the Territory is cut by the northeast-trending Tolo Channel fault zone which defines the southern limit of basement rock exposure. It also marks the southern boundary of two major volcanic units (Shing Mun Formation and Tai Mo Shan Formation). The Repulse Bay Volcanic Group is weakly folded in a northeast orientation, and basal units rest with angular unconformity on deformed Mesozoic and Palaeozoic sedimentary rocks. Folding of the Repulse Bay Volcanic Group has been ascribed to the intrusion of granite plutons (Bennett 1984).

Classification and nomenclature for Hong Kong granites

The first systematic geological survey of Hong Kong in the late 1960s (Allen & Stephens 1971) recognized four main phases of Upper Jurassic syn-tectonic plutonic intrusion. Widely mapped lithological units were assigned to a phase according to appearance and mutual cross-cutting relationships, but no attempt was made to delineate individual plutons. Consequently, considerable textural variation within some bodies resulted in an unworkable system of naming and classification. Recent systematic field mapping by the Hong Kong Geological Survey at scales of 1:20 000 and 1:5 000 scale, including traverses of intrusive contacts and detailed geochemical and isotopic studies, has enabled a clearly defined pluton-based nomenclature for Hong Kong granites to be established (Table 1).

Granite plutons are roughly circular or elliptical in shape, and vary between 5 km and 20 km in diameter. They dominantly consist of biotite granite of normal to highly evolved character, and record separate episodes of high-level intrusion. On the basis of whole-rock major and trace element, rare earth element (REE) and Rb-Sr geochronology (Sewell *et al* 1991), these intrusive units may be conveniently grouped into two suites: the Lamma Suite comprising two relatively unfractionated I-type (Chappell & White 1974) batholithic bodies, and the younger Lion Rock Suite comprising several cross-cutting, normal to highly evolved granite plutons of I-type to intermediate I-A type character. Representative whole rock chemical analyses of granitoids, dykes and volcanics are given in Table 2.

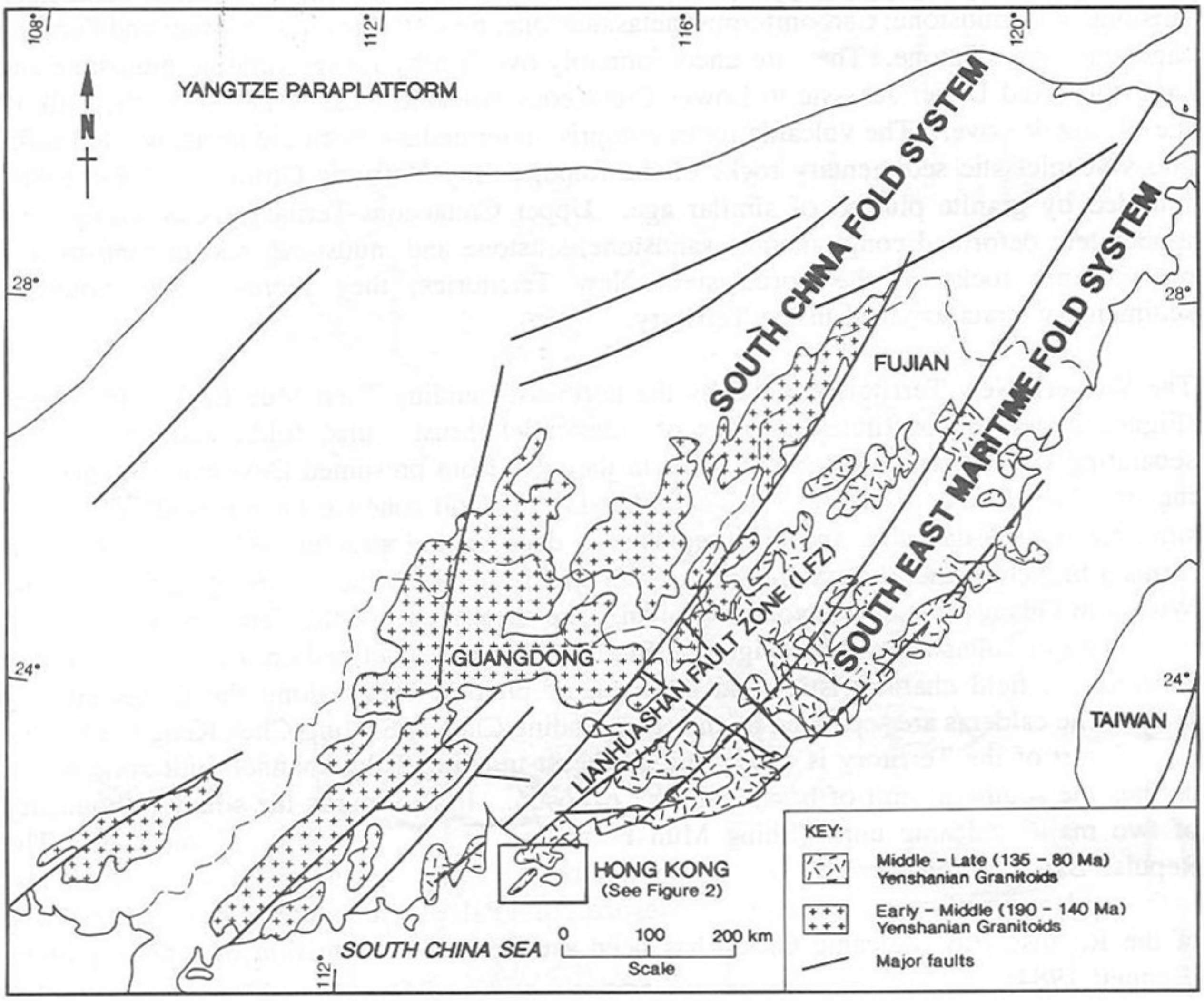

Figure 2 *Summary of the regional geology of southeast China showing the main structural elements and distribution of Mesozoic granites*

Lamma Suite

The Lamma Suite, which comprises the Tai Po Granodiorite and Sung Kong Granite, represents the oldest intrusive units in the Territory. Isolated outcrops are exposed throughout much of the central and southern sectors of the Territory (Figure 1). Owing to post-intrusive alteration, rocks of the Lamma suite have proved difficult to date by the Rb-Sr technique.

The Tai Po Granodiorite, recognised as the oldest intrusive unit in the Territory, is dominantly porphyritic and fine-grained, but may vary to medium-grained, non-porphyritic lithologies. Porphyritic granodiorite is often characterised by large (up to 45 mm) euhedral alkali feldspar crystals set in a fine-grained groundmass, and may contain abundant xenoliths of fine-grained mafic rock. The principal mafic minerals are biotite and hornblende; biotite is more abundant, forming large dark brown euhedral crystals, whereas amphibole is dark green and subhedral. Accessory minerals include apatite, magnetite, sphene and zircon.

The Sung Kong Granite previously included all coarse-grained, porphyritic granite in the Territory (Allen & Stephens 1971) as well as two large areas of equigranular medium-grained granite in the New Territories. The Sung Kong Granite is here redefined as comprising all known outcrops of coarse- and medium-grained porphyritic biotite granite exposed in the southern parts of the Territory. The unit is recognised as being older than every other intrusive body except for Tai Po Granodiorite. It is commonly associated with outcrops of Tai Po Granodiorite, and both units are often seen intruding the oldest known tuff unit (Yim Tin Tsai Formation). Porphyritic granite in southern parts of the Territory is often invaded by thin veins of microgranite. The chief mineral constituents of the Sung Kong Granite are alkali feldspar, plagioclase, quartz, green-brown biotite and hornblende, with accessory apatite, magnetite, sphene and zircon.

The Tai Po Granodiorite and Sung Kong Granite are metaluminous, and are characterised by high Na2O (>2.8 wt%) and CaO (1.4-2.7 wt%), low Nb and Y contents, and low $(K_2O+Na_2O)/CaO$ ratios (1.5-7) (Figure 3). SiO_2 varies from 63 to 68 wt% in the granodiorite and from 71 to 75 wt% in the granite. On major and trace element variation diagrams (Figure 4), the units lie on similar fractionation paths. On a REE plot normalised to chondritic values (Figure 5) negative europium anomalies (Eu/Eu*=0.62-0.63) in the granodiorite indicate that plagioclase fractionation was important. The mineralogy and geochemistry of the rocks suggests the suite was derived from an I-type or meta-igneous source.

Lion Rock Suite

On the basis of field, petrographic, geochemical and age relationships, granites of the Lion Rock Suite have been divided into three sub-groups.

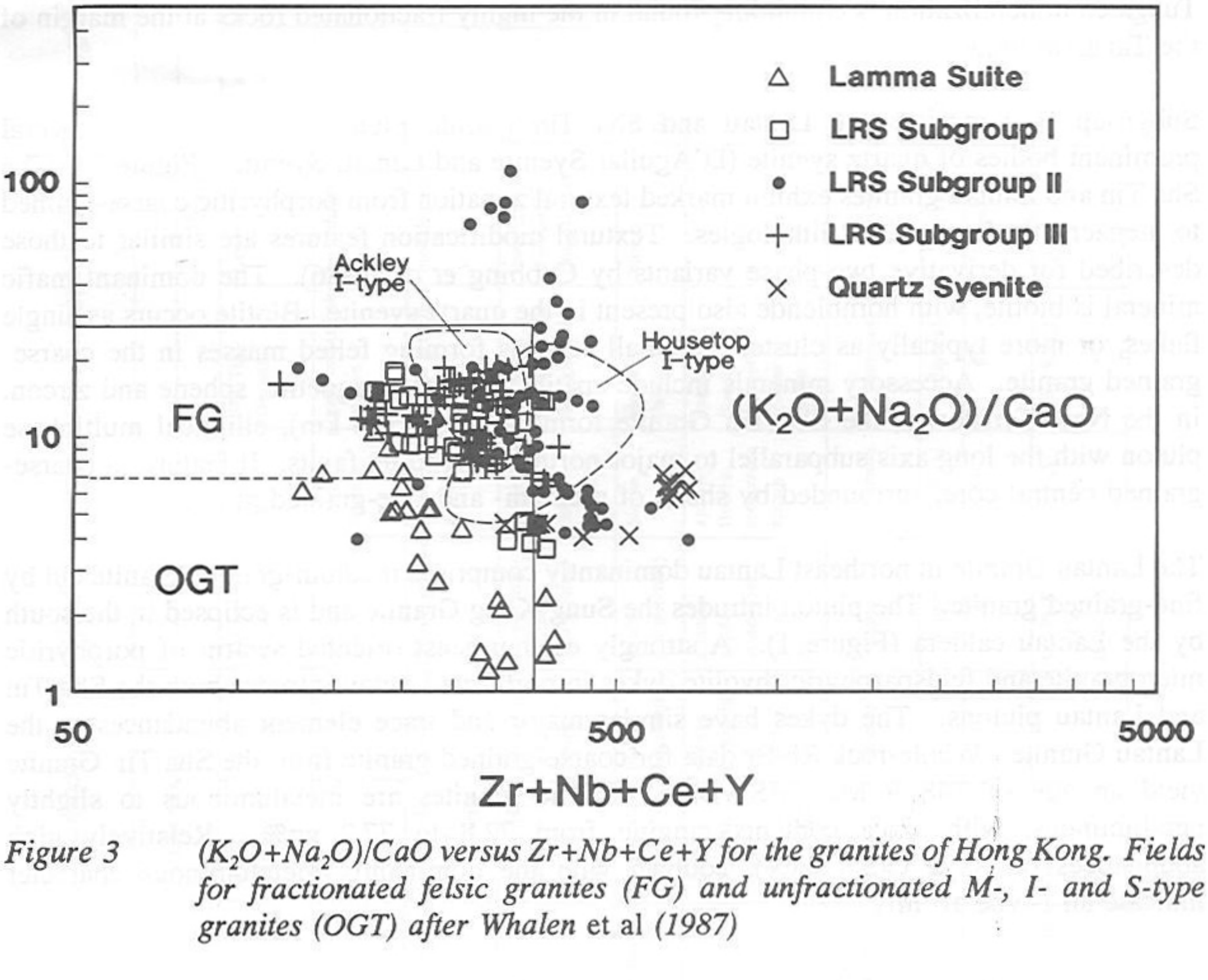

Figure 3 *$(K_2O+Na_2O)/CaO$ versus Zr+Nb+Ce+Y for the granites of Hong Kong. Fields for fractionated felsic granites (FG) and unfractionated M-, I- and S-type granites (OGT) after Whalen* et al *(1987)*

The oldest subgroup is represented by the Tai Lam and Tsing Shan granites (Figure 1), which form large (>20 km) circular to elliptical plutons varying from porphyritic coarse- to megacrystic fine-grained lithologies. Whole rock Rb-Sr data for fine- to medium-grained granite from the Tai Lam pluton yielded an age of 155±6 Ma (MWSD=4.6). The chief mineral constituents are quartz, alkali feldspar and plagioclase, with minor amounts of microcline, biotite, muscovite and hornblende; the biotite typically occurs as felted aggregates. Accessory minerals include allanite, apatite, fluorite, sphene and zircon.

On the basis of field relations, petrography, and the size and abundance of megacrysts, Langford (1991) has described the textural variation in the Tai Lam Granite in terms of a two-phase granite sequence (after Cobbing *et al* 1986). From primary texture to inequigranular texture end-members there is a systematic increase in SiO_2 and Na_2O, and decrease in TiO_2, Al_2O_3, total Fe_2O_3, MgO, CaO and K_2O abundances. Trace element abundances show progressive enrichment in Rb and Nb, and depletion in Sr, Ba and Zr.

Megacrystic fine-grained and fine- to medium-grained granite are thought to represent syn-intrusive mobilization and resorption of a partly cooled deep-seated phase of weakly evolved medium- and coarse-grained granite. The Tai Lam and Tsing Shan granites are metaluminous to slightly peraluminous with silica abundances ranging from 72.5 to 78.0 wt%. On Harker variation diagrams (Figure 4) they are characterised by high Nb, Y and Rb contents, and low Sr and Ba contents at similar stages of differentiation relative to older granite plutons of the suite. Flat REE patterns and strong negative europium anomalies shown by the most evolved rocks confirms that plagioclase and a LREE-rich mineral were important liquidus phases.

No clear distinction in chemistry between the Tai Lam and Tsing Shan granites is apparent. Tungsten mineralization is commonly found in the highly fractionated rocks at the margin of the Tai Lam pluton.

Subgroup II comprises the Lantau and Sha Tin granite plutons, together with several prominent bodies of quartz syenite (D'Aguilar Syenite and Lantau Syenite) (Figure 1). The Sha Tin and Lantau granites exhibit marked textural zonation from porphyritic coarse-grained to megacrystic fine-grained lithologies. Textural modification features are similar to those described for derivative two-phase variants by Cobbing *et al* (1986). The dominant mafic mineral is biotite, with hornblende also present in the quartz syenite. Biotite occurs as single flakes, or more typically as clusters of small crystals forming felted masses in the coarse-grained granite. Accessory minerals include apatite, fluorite, magnetite, sphene and zircon. In the New Territories, the Sha Tin Granite forms a large (>20 km), elliptical multiphase pluton with the long axis subparallel to major northeast-trending faults. It features a coarse-grained central core, surrounded by shells of medium- and fine-grained granite.

The Lantau Granite in northeast Lantau dominantly comprises medium-grained granite cut by fine-grained granite. The pluton intrudes the Sung Kong Granite and is eclipsed in the south by the Lantau caldera (Figure 1). A strongly eastnortheast oriented swarm of porphyritic microgranite and feldsparphyric rhyolite dykes in northeast Lantau intrudes both the Sha Tin and Lantau plutons. The dykes have similar major and trace element abundances to the Lantau Granite. Whole-rock Rb-Sr data for coarse-grained granite from the Sha Tin Granite yield an age of 148±9 Ma (MSWD=0.1). The granites are metaluminous to slightly peraluminous, with silica contents ranging from 72.8 to 77.2 wt%. Relatively high abundances of Na_2O (>2.8 wt%), coupled with the dominantly metaluminous character indicate an I-type affinity.

Table 1 *Summary of the field and petrographic characteristics of Hong Kong granites*

	LAMMA SUITE		LION ROCK SUITE												
			Subgroup I			Subgroup II			Subgroup III						
UNIT	Tai Po Granodiorite	Sung Kong Granite	Tai Lam Granite	Tsing Shan Granite	Sha Tin Granite	Lantau Granite	Lantau Syenite	D'Aguilar Syenite	Kowloon Granite	King's Park Granite	Stanley Granite	South Lamma Granite	Chi Ma Wan Granite	Mt Butler Granite	Kwun Tong Granite
Colour	grey	grey	light grey or white	light pinkish grey	grey or pinkish mauve	pinkish grey	grey	grey to pinkish grey	light pink or grey	grey	light pink or grey	light pink	light grey or pink	light pink to grey	light pink
Rock Type	hornblende -biotite granodiorite	biotite granite	biotite granite	biotite granite	biotite granite	biotite granite	quartz syenite	quartz syenite	biotite granite	biotite granite	biotite granite	biotite granite	biotite granite	biotite granite	biotite granite
Dominant texture	porphyritic coarse to medium-grained	porphyritic coarse-grained	porphyritic coarse to fine-grained	porphyritic coarse to fine-grained	coarse- to inequigranular fine-grained	inequigranular medium to fine-grained	porphyritic fine-grained	porphyritic fine-grained	equigranular medium-grained	inequigranular medium-grained	equigranular medium-grained	equigranular medium-grained	equigranular medium-grained	equigranular fine-grained	equigranular fine-grained
Mafic minerals	hornblende biotite	biotite hornblende	biotite (hornblende)	biotite	biotite (hornblende)	biotite	biotite hornblende	biotite hornblende	biotite	biotite	biotite	biotite	biotite	biotite	biotite
Accessory minerals	apatite magnetite sphene zircon	apatite magnetite sphene zircon	allanite apatite muscovite sphene zircon	apatite fluorite muscovite zircon	apatite fluorite magnetite sphene zircon	-	-	allanite apatite magnetite sphene zircon	apatite magnetite muscovite zircon	allanite apatite magnetite sphene zircon	apatite magnetite monazite muscovite zircon	-	allanite apatite magnetite monazite zircon	apatite magnetite monazite zircon	magnetite zircon
Alkali feldspar megacrysts	common	common	common	common	common	sparse	?	sparse	absent	sparse	absent	absent	absent	sparse	absent
Pluton shape	-	-	elliptical	elliptical	elliptical	elliptical	irregular	irregular	circular	circular	circular	circular	circular	circular	circular
Area exposed (km^2)	30	35	80	40	65	30	6	3	68	1.5	10	12.5	14	11	12
Mineralization	Mo	-	Mo,Pb,F, Zn,Cu, Be,W,Sn	Mo,Sn,W, F	W,F,Pb,Zn,Fe	-	-	-	-	-	-	-	-	-	Mo,W,F,Be

Table 2 *Major oxide (wt%) and trace element (ppm) data for Hong Kong rocks (Hong Kong Geological Survey, unpublished data). Sample numbers refer to rocks registered in the Hong Kong Geological Survey collection*

No	8743	10119	8002	8511	9747	9735	8732	8683	8703	8709	8721	8710	8724	8717	5322	10118
Type	TPgd	SKgc	SKgm	TLgc	TSgc	STgm	LTrf	CDsq	KLgm	KLgm	SYgm	CMgm	KTgf	MBgf	JYT	l
SiO_2	66.21	72.46	73.04	72.35	75.65	78.49	76.37	67.40	72.96	76.61	77.42	75.92	75.68	76.75	68.24	56.73
TiO_2	0.72	0.34	0.22	0.29	0.08	0.08	0.15	0.33	0.25	0.13	0.06	0.16	0.06	0.02	0.54	1.03
Al_2O_3	14.43	13.36	13.14	13.45	12.57	11.57	11.66	15.52	13.26	12.01	11.81	12.03	12.94	12.23	14.63	15.40
Fe_2O_3t	5.29	2.60	2.28	2.70	1.38	0.75	1.56	3.31	2.41	1.48	0.99	1.59	1.02	0.84	4.37	7.98
MnO	0.10	0.11	0.04	0.04	0.04	0.02	0.02	0.12	0.09	0.06	0.08	0.04	0.05	0.04	0.09	0.16
MgO	1.59	0.54	0.37	0.36	0.04	0.12	0.03	0.43	0.33	0.07	-	0.15	-	-	0.99	4.06
CaO	3.23	2.14	1.54	1.99	0.99	0.47	0.87	1.59	1.34	0.89	0.72	0.90	0.71	0.49	3.12	6.52
Na_2O	3.10	3.16	3.20	2.56	3.12	3.39	3.04	3.74	3.40	3.16	3.61	3.37	3.98	4.05	2.94	2.84
K_2O	3.98	4.48	4.94	5.21	5.32	4.60	5.06	6.81	5.33	5.25	4.85	5.27	5.29	4.94	4.01	3.32
P_2O_5	0.18	0.07	0.07	0.06	0.01	0.01	0.01	0.06	0.05	-	-	0.02	-	-	0.12	0.44
LOI	0.93	0.45	0.77	0.63	0.48	0.53	1.23	0.40	0.33	0.13	0.48	0.45	0.35	0.45	1.04	1.23
TOTAL	98.17	99.71	98.66	99.64	99.68	99.99	100.00	99.71	99.75	99.79	100.02	99.90	100.08	99.81	99.95	99.71
Ba	606	296	308	509	113	65	111	483	416	208	25	242	28	-	561	702
Nb	14	15	13	13	18	14	17	10	25	16	22	23	17	39	10	14
Rb	221	312	334	219	385	307	260	169	276	217	291	290	314	446	175	245
Sr	285	168	200	149	45	42	52	194	179	108	32	91	34	7	261	479
Y	41	32	16	38	62	26	41	30	66	39	56	49	46	137	34	33
Zr	193	127	119	177	107	74	141	389	182	127	89	141	105	88	186	167

8743 Tai Po Granodiorite, north Tsing Yi (828400E 824200N)
10119 Sung Kong Granite, Pak Kok, Lamma (830165E 811340N)
8002 Sung Kong Granite, Kau Yi Chau (825670E 816075N)
8511 Tai Lam coarse-grained granite, Tuen Mun (816090E 827597N)
9747 Tsing Shan coarse-grained granite, west Tsing Shan (810612E 829510N)
9735 Sha Tin medium-grained granite, northeast Lantau (823940E 821805N)
8732 Feldsparphyric rhyolite dyke, Penny's Bay, Lantau (822110E 820800N)
8703 Kowloon medium-grained granite, Ko Shan Park (837080E 819530N)
8683 D'Aguilar Syenite, Cape D'Aguilar (843630E 808320N)
8709 Kowloon granite, Pak Tin Estate (834930E 822090N)
8721 Stanley medium-grained granite, Shek O (842720E 809290N)
8710 Chi Ma Wan medium-grained granite, Tai Long Wan, Lantau (818000E 808780N)
8724 Kwun Tong fine-grained granite, Anderson Road Quarry (842720E 820190N)
8717 Mt Butler fine-grained granite, Mt Butler Quarry (838920E 814440N)
5322 Yim Tin Tsai Formation coarse ash tuff, Cape D'Aguilar (844660E 807669N)
10118 Lamprophyre, Lamma Quarry (831795E 808320N)

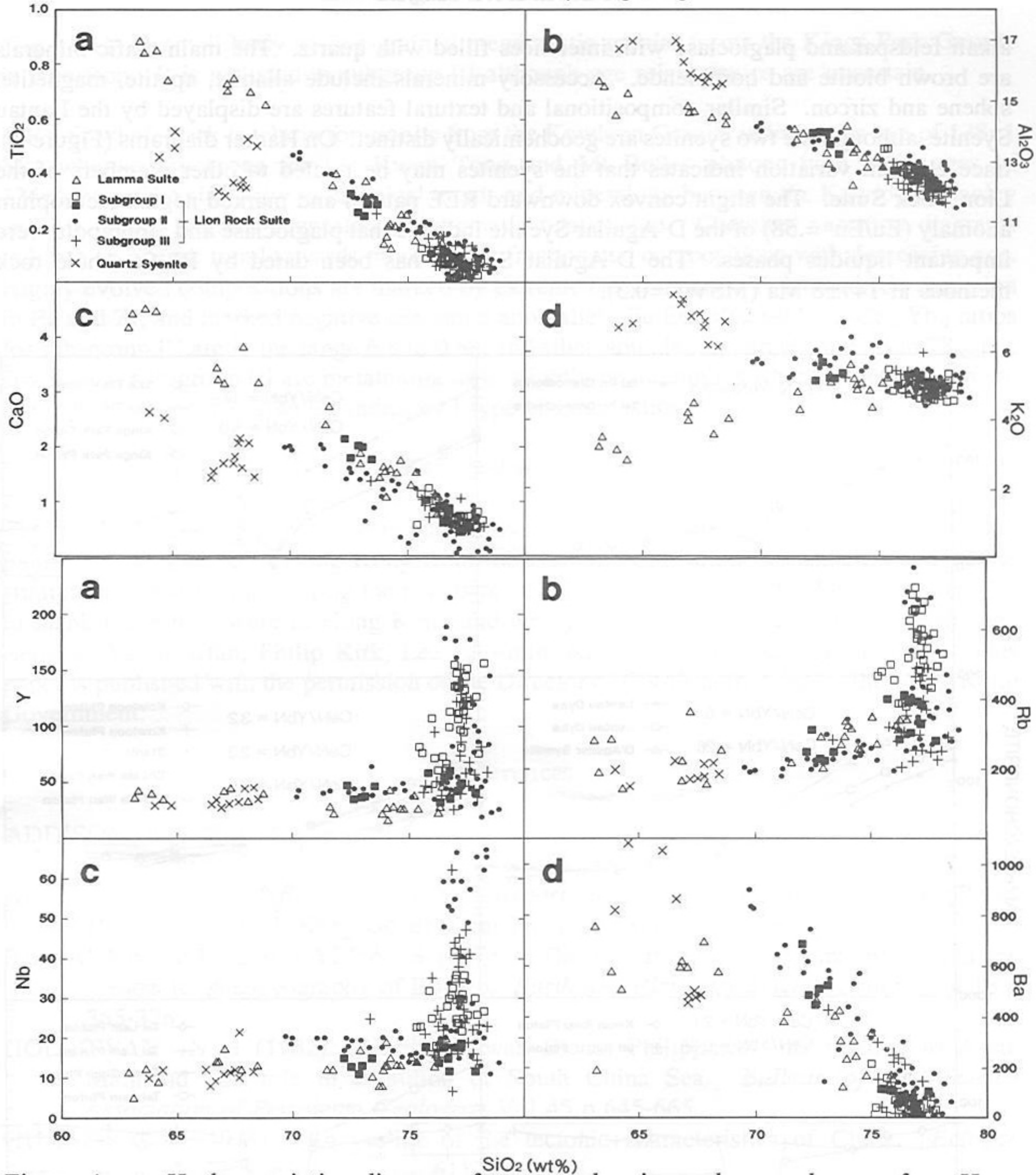

Figure 4 *Harker variation diagrams for selected major and trace elements from Hong Kong granites*

Highly evolved compositions are characterised by strong enrichments in Rb, Nb and Y, and depletion in Ba. REE patterns for sub-group II feature marked negative europium anomalies (Eu/Eu*=0.73-0.15) indicating that plagioclase was an important crystallising phase. Tungsten mineralisation has been reported in the highly evolved rocks, whereas molybdenite has been noted in the less fractionated granites (Addison 1986).

Quartz syenite outcrops as a three major plutonic bodies in southern Hong Kong and Lantau, as well as a host of smaller intrusions throughout central and eastern parts of the Territory. At Cape D'Aguilar the syenite is fine- or medium-grained and porphyritic. Small alkali feldspar phenocrysts are strongly oriented in a pilotaxitic groundmass comprising euhedral alkali feldspar and plagioclase with interstices filled with quartz. The main mafic minerals are brown biotite and hornblende. Accessory minerals include allanite, apatite, magnetite, sphene and zircon. Similar compositional and textural features are displayed by the Lantau Syenite, although the two syenites are geochemically distinct. On Harker diagrams (Figure 4), trace element variation indicates that the syenites may be related to other members of the Lion Rock Suite. The slight convex downward REE pattern and marked negative europium anomaly (Eu/Eu*=.58) of the D'Aguilar Syenite indicate that plagioclase and amphibole were important liquidus phases. The D'Aguilar Syenite has been dated by Rb-Sr whole rock methods at 147±8 Ma (MSWD=0.3).

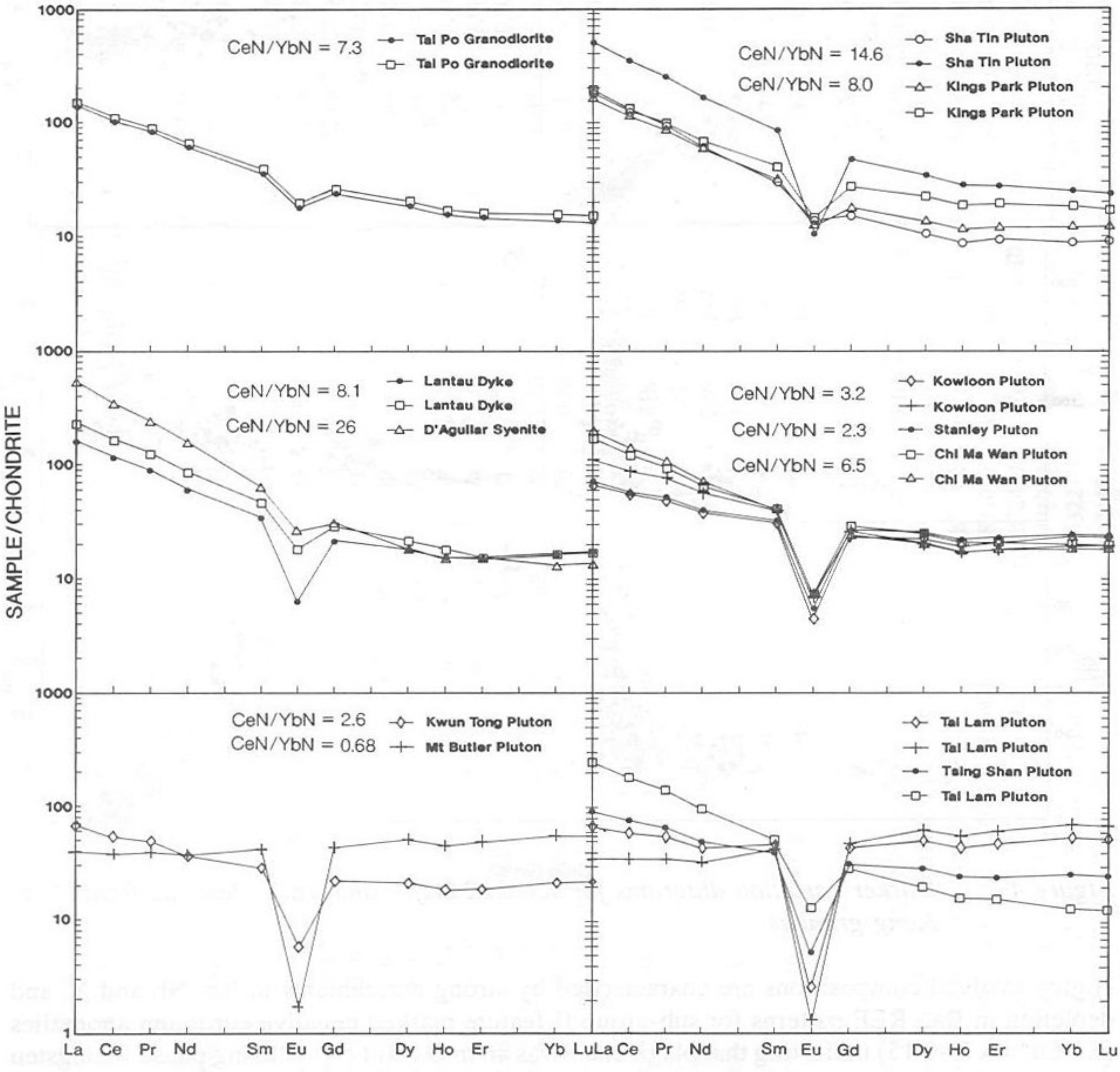

Figure 5 Chondrite normalised REE plots for Hong Kong granites

Sub-group III comprises smaller (4-15 km) plutons which are generally circular in outcrop and dominated by texturally uniform medium- or fine-grained granite. The mafic mineral is biotite, and there is accessory allanite, apatite, magnetite, monazite, muscovite, sphene and zircon. They include the Kowloon, Chi Ma Wan, Stanley, South Lamma, Mt Butler and Kwun Tong plutons occurring in the southern and southeastern parts of the Territory

(Figure 1). A small body of fine-grained megacrystic granite forms the Kings Park Granite in Kowloon. It is included in subgroup III although age relationships are uncertain.

A Rb-Sr whole-rock isochron for granite from the Kowloon Granite indicates an age of 138±1 Ma, whereas isochrons for the Kwun Tong and Mt Butler plutons both yield ages of 136±1 Ma. The similarity in chemical trends and mineralogy between the Kowloon, Stanley and Mt Butler granites suggests a comagmatic relationship. Chemical variation diagrams indicate an overall trend towards more highly fractionated compositions with decreasing age. Highly evolved compositions are marked by extreme enrichment in Y, Nb and Rb, depletion in Ba and Zr, and marked negative europium anomalies ($Eu/Eu^*=0.23-0.04$). Ce_N/Yb_N ratios for sub-group III are in the range 6.8 to 0.68, and silica abundances range from 73 to 78 wt%. Granites of sub-group III are metaluminous to slightly peraluminous which, together with the high Na_2O contents (>3 wt%), indicates I-type characteristics.

Acknowledgments

The authors would like to thank Fiona Darbyshire, Tim Griffin, Patrick Le Fort and Bob Pankhurst, who came to Hong Kong from the Hutton Symposium in Canberra, and whose stimulating contributions during the excursion were greatly appreciated. We would also like to thank those who were in Hong Kong and who joined the excursion; Ian Basham, John Bennett, Yalcin Irfan, Philip Kirk, Lee Cho-min, Keith Nicholls and Raynor Shaw. This paper is published with the permission of the Director of Civil Engineering of the Hong Kong Government.

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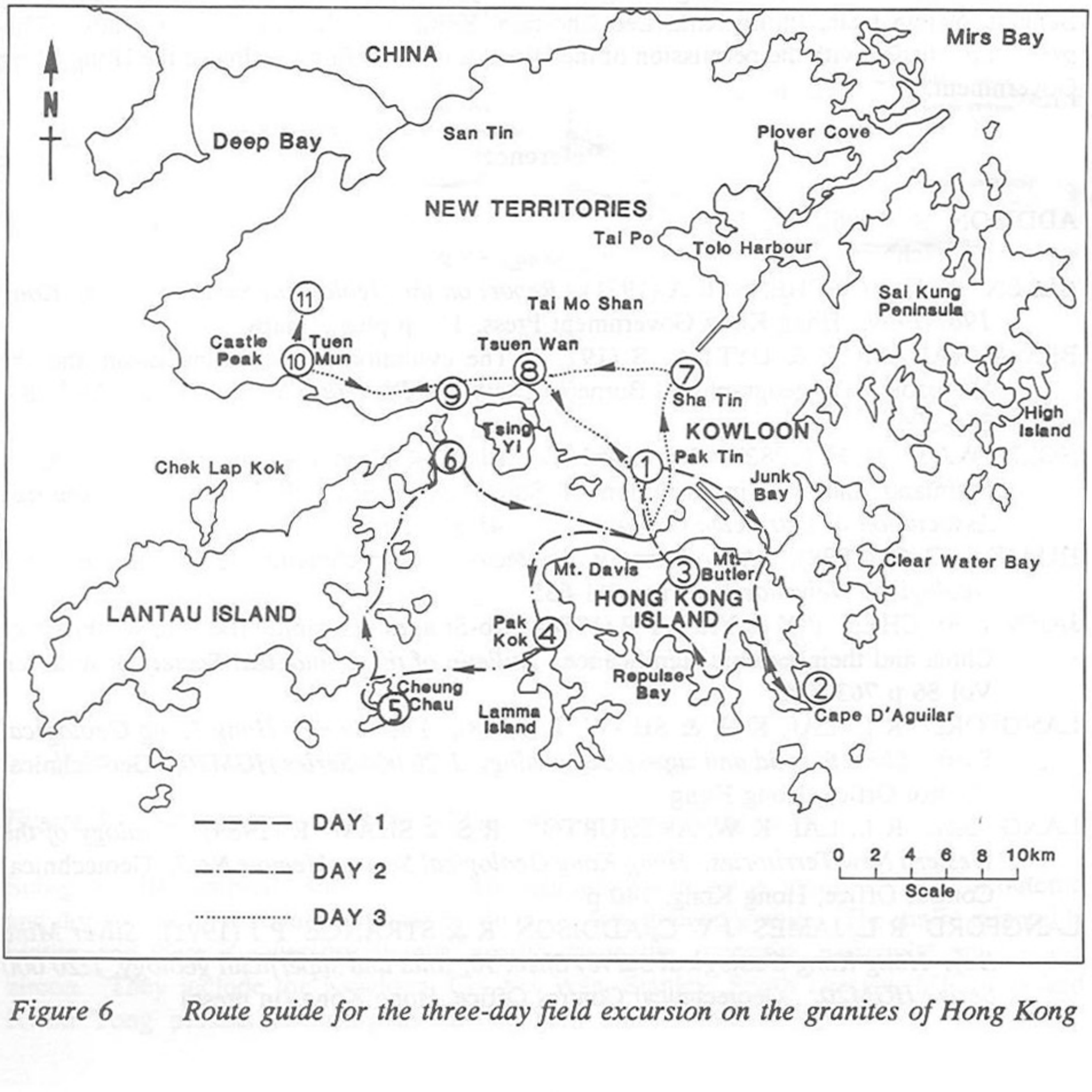

Figure 6 *Route guide for the three-day field excursion on the granites of Hong Kong*

ITINERARY

The excursion was designed to cover the widest range of granite geology features in the available three days, and focused on three main geographic areas (Figure 6). Day 1 concentrated on the geology of Hong Kong and Kowloon, with stops to examine the Kowloon Granite, D'Aguilar Syenite, Tai Po Granodiorite and the Mt Butler Granite (Figure 7). Day 2 was concerned with the granites of the outer islands including the Sung Kong Granite, Chi Ma Wan Granite and the Lantau dyke swarm (Figure 9). Day 2 involves a full day junk or ferry trip around the outer islands. Short, but rugged, stretches of coastline have to be traversed at Pak Kok (Lamma Island) and on northeast Lantau. On Day 3 the granites of the New Territories were examined, with particular emphasis on two-phase variants of the Tai Lam Granite and compositional zonation in the multiphase Sha Tin Granite (Figure 12).

Day 1 - Geology of Hong Kong Island and Kowloon

Stop 1 - Pak Tin Estate. Head south at the roundabout at the junction between Cornwall St and Nam Cheong St, and immediately turn right into a narrow road adjacent to the Tai Woh Ping Temporary Housing Area. Turn left 150 m along the track, and walk along the track heading south to the Water Supplies Service Reservoir. Driving along this road is only possible with a closed road permit. About 300 m south of the barrier is the cut slope behind Pak Tin Estate, and a footpath to the bottom of the hill.

This stop provides a splendid overview of the geology of Hong Kong Island and Kowloon. The highly urbanised metropolitan areas of Kowloon and northern Hong Kong Island are founded on medium-grained granite of the Kowloon Granite. The Kowloon Granite forms a roughly circular granite body delimited by a chain of hills extending from Beacon Hill in the northwest to Kowloon Peak in the east, and on Hong Kong Island from Mount Parker in the southeast to Mount Nicholson in the southwest. In the middle foreground the King's Park Granite forms the small hill on which the Royal Observatory is located. Excellent exposures of equigranular, medium-grained biotite granite are found at this locality (Plate 1).

Stop 2 - Cape D'Aguilar. From the Pak Tin lookout return to Nam Cheong St and head north, across Lung Cheung Road into Lung Ping Rd. Take the first right after Beacon Heights and turn left into Lung Cheung Road eastbound. Follow signs for East Kowloon and East Hong Kong, joining Kwun Tong Road and then Lei Yue Mun Road before passing under the harbour in the Eastern Harbour Tunnel. Turn east out of the tunnel and head along the Island Eastern Corridor towards Chai Wan. Continue towards Chai Wan along Chai Wan Road, but at the brow of the hill, before dropping into Chai Wan, turn right along Tai Tam Road towards Shek O. After about 2.3 km turn left at the roundabout towards Shek O along Shek O Road. After about 5 km the road to Cape D'Aguilar leaves the Shek O Road on a hairpin bend. About 1 km down this Closed Road is the first stop, and Cape D'Aguilar is about 3 km from the junction.

A brief stop is made on the Cape D'Aguilar Road to examine boulders of D'Aguilar Syenite (Plate 2). The syenite forms a small ($1.5km^2$) intrusive body centred on D'Aguilar Peak. It displays a well-developed trachytoid texture and, except for a fine-grained zone along its southern margin, the unit is remarkably uniform in texture and composition (Tables 1 & 2)

Cape D'Aguilar provides excellent exposures of the Tai Po Granodiorite intruding the oldest known tuff of the Repulse Bay Volcanic Group (Yim Tin Tsai Formation) (Figure 8). It is not easy to distinguish the granodiorite (Plate 3) from the coarse ash crystal tuff (Plate 4), and the two units also have similar geochemistry (Figure 4). Dykes and sills of quartzphyric rhyolite intrude the granodiorite and coarse ash tuff, and are themselves cut by thin (<1m) basalt or lamprophyre dykes; the age of the dykes is uncertain. Allen & Stephens (1971) reported K-Ar ages between 76±2 and 57±2 Ma but then described composite dykes from two areas, Ma Wan and Sung Kong, where quartzphyric rhyolite was seen intruding lamprophyre; this suggests the possibility of a bimodal association.

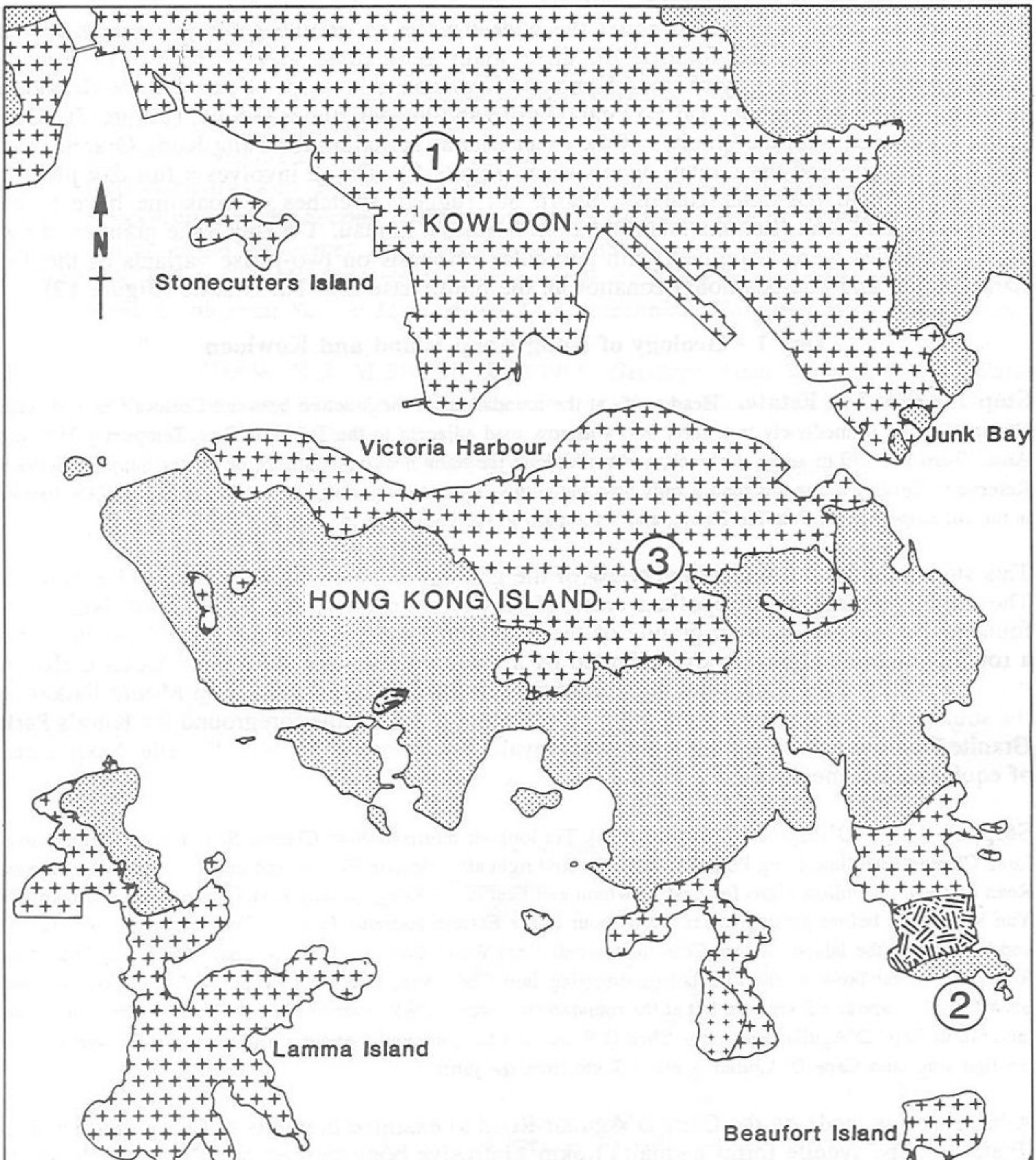

Figure 7 General geology and route guide for Day 1 (after Strange & Shaw 1986)

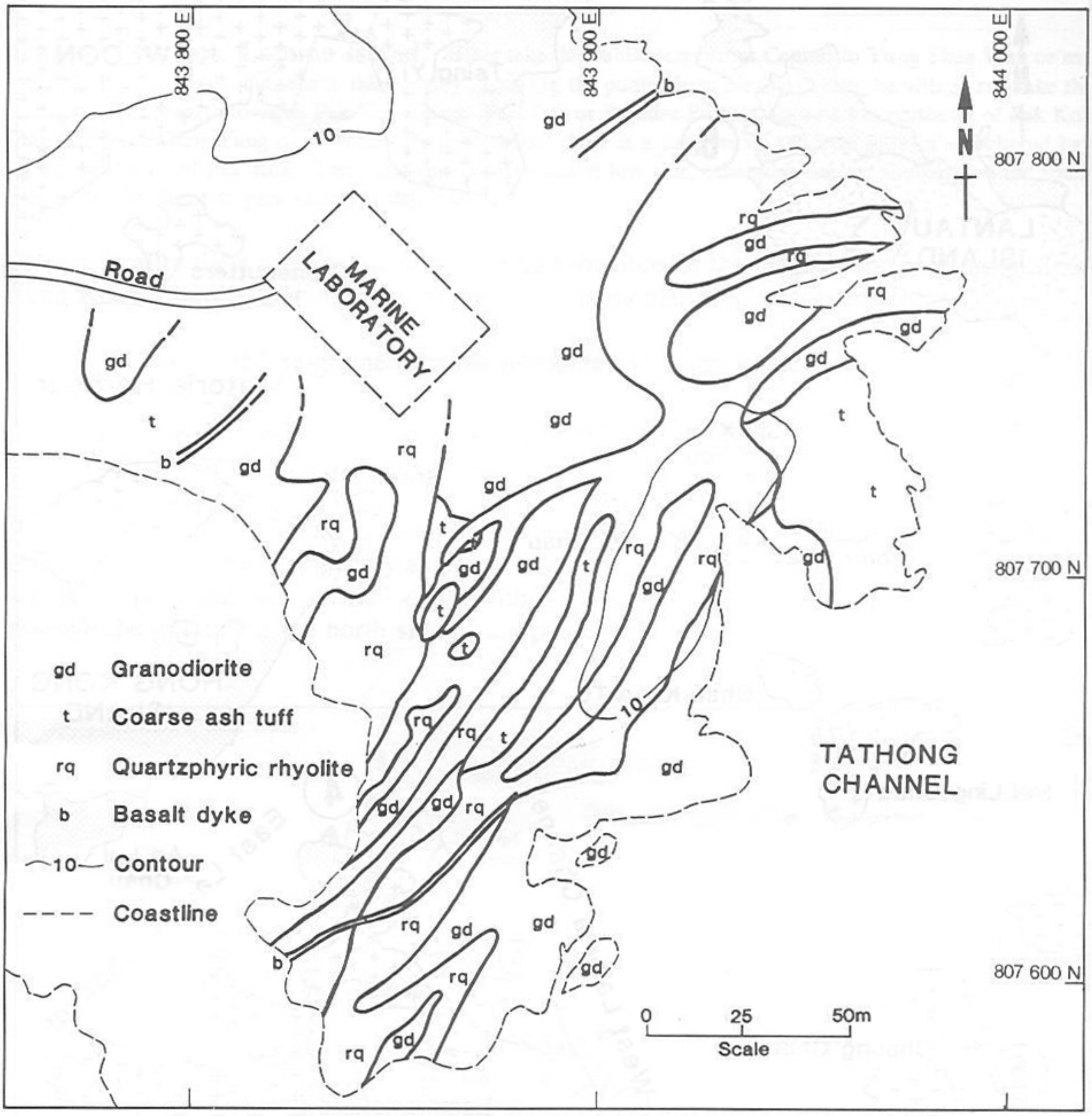

Figure 8 *Simplified geology map of Cape D'Aguilar*

Stop 3 - Mt Butler. Return to Shek O Road along Cape D'Aguilar Road and turn right back towards Chai Wan. At the roundabout turn south along Tai Tam Road towards Stanley and Repulse Bay. North of Repulse Bay, at Wong Nai Chung Gap, turn north at the roundabout along Wong Nai Chung Gap Road. Continue down the hill for 850 m before taking the slip road to the left to the roundabout. Turn right at the roundabout along Tai Hang Road, and go straight over at the roundabout at the junction with Blue Pool Road. About 750 m along Tai Hang Road from her take a right turn up Mt Butler Road. About 1.5 km along this road is the entrance to the disused Mt Butler Quarry. Walking into the quarry (permit require for vehicles) proceed to the second bench on the main face.

The fine-grained equigranular to sparsely megacrystic Mt Butler Granite (Plate 5) is thought to represent a highly fractionated I-type granite. In the Mt Butler Quarry, megacrystic fine-grained granite is mingled with equigranular medium-grained granite resembling that of the Kowloon pluton. This association, together with the chemically evolved character of the Mt Butler Granite, suggests that it may be a derivative two-phase variant of Kowloon Granite. Further detailed mapping of intrusive contacts is required in order to clarify the relationship.

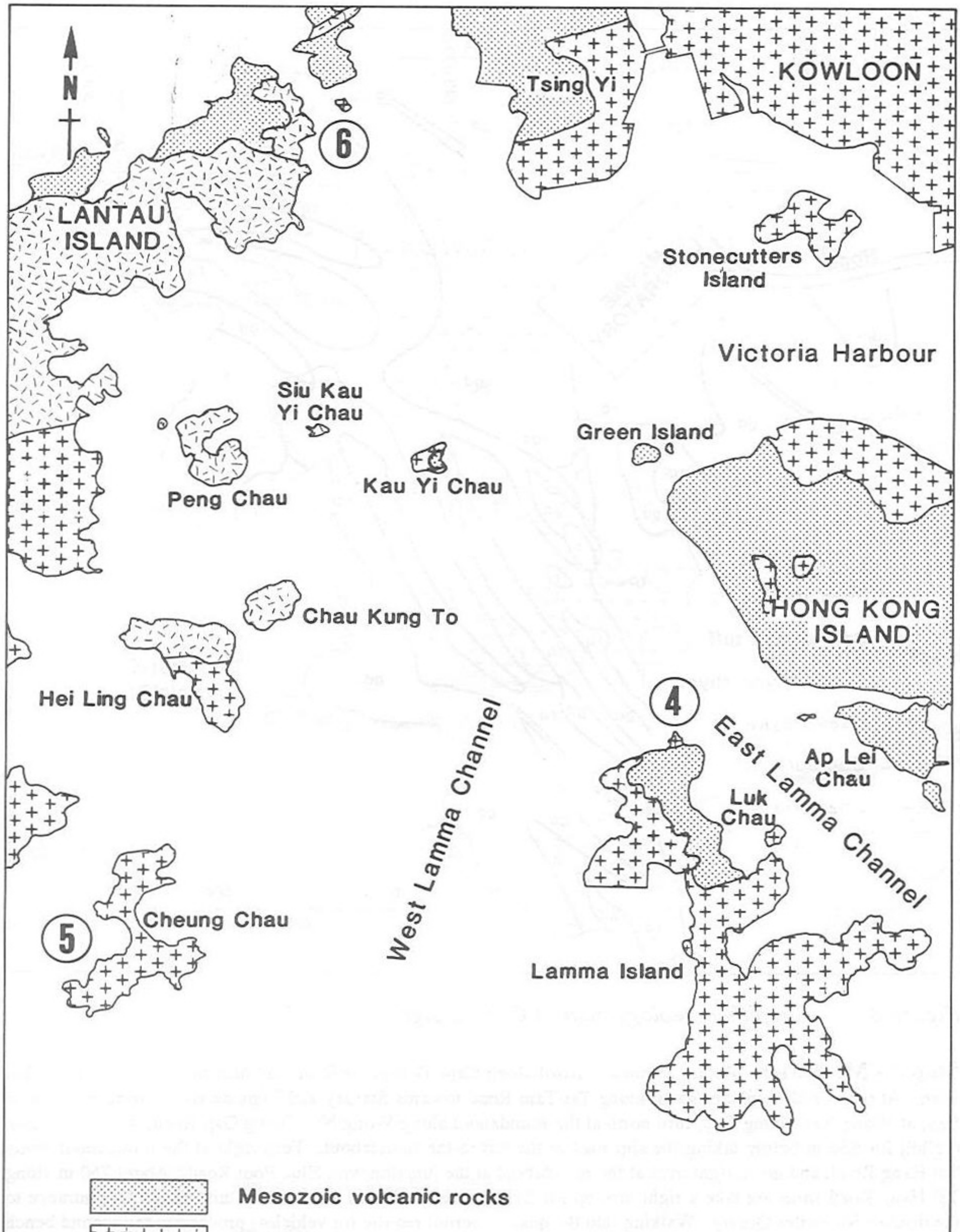

Figure 9 *General geology and route guide for Day 2 (after Strange & Shaw 1986 and Langford* et al *1991)*

Day 2 - Granites of the Outer Islands

Stop 4 - Pak Kok, Lamma Island. Either take the public ferry from Central to Yung Shue Wan or use a hire boat to gain direct access to this locality. Leaving the public ferry pier walk into the village and take the northeasterly footpath towards Pak Kok Tsuen. Pak Kok or Boulder Point is about 1 km northeast of Pak Kok Tsuen, 2.5 km from Yung Shue Wan. By private boat there is a deep-water concrete jetty in a sheltered bay on the west side of Pak Kok. The coast can be traversed at low tide, otherwise use the footpath on the south side of the headland to gain access to the eastern side.

At this locality there are exposures and contact relations of the megacrystic medium-grained Sung Kong Granite and volcanics (Figure 10). Particular points of interest are:

1. Veins of fine-grained granite intruding the megacrystic medium-grained granite (Plate 6)
2. The contact between Sung Kong Granite and Yim Tin Tsai Formation tuff
3. The well-developed mylonitization in the Sung Kong Granite

Allen & Stephens (1971) interpreted the mylonite as syn-tectonic deformation. Xenoliths of Sung Kong Granite enveloped by an apron of dark coloured, fine-grained tuffaceous material are particularly abundant at this locality within the finer granite, and a lamprophyre dyke cuts through the granite on the north side of the point.

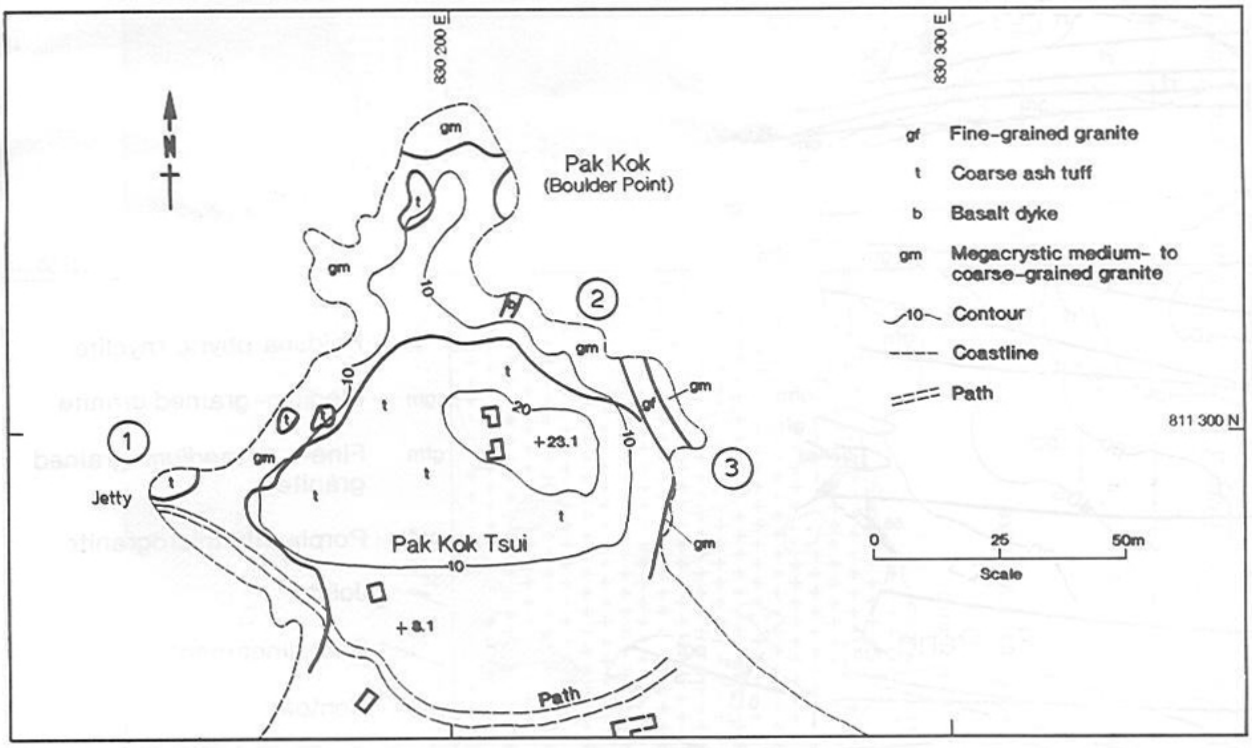

Figure 10 Simplified geology map of Pak Kok, Lamma Island

Stop 5 - Cheung Chau. Either take the public ferry from Central to Cheung Chau or use a hire boat to gain direct access to the island. From the public ferry pier walk across the island on Tung Wan Road, then walk south alongside Tung Wan to the steps leading up to the Warwick Hotel. The first locality is at the Neolithic rock carvings a short way to the east. Continue east round the headland to Kwun Tam Wan (Afternoon Beach) where rock is exposed on the coarse sandy beach.

On Cheung Chau it is possible to examine equigranular medium-grained granite of the Chi Ma Wan pluton. The Chi Ma Wan Granite is texturally very uniform and is similar in composition to the Kowloon Granite (Table 2). It forms a circular pluton covering an area of approximately $14 km^2$. Exposures of feldsparphyric rhyolite and porphyritic microgranite should be examined adjacent to the Warwick Hotel on the east side of the island, and equigranular medium-grained granite of the pluton can be seen on the beach to the south.

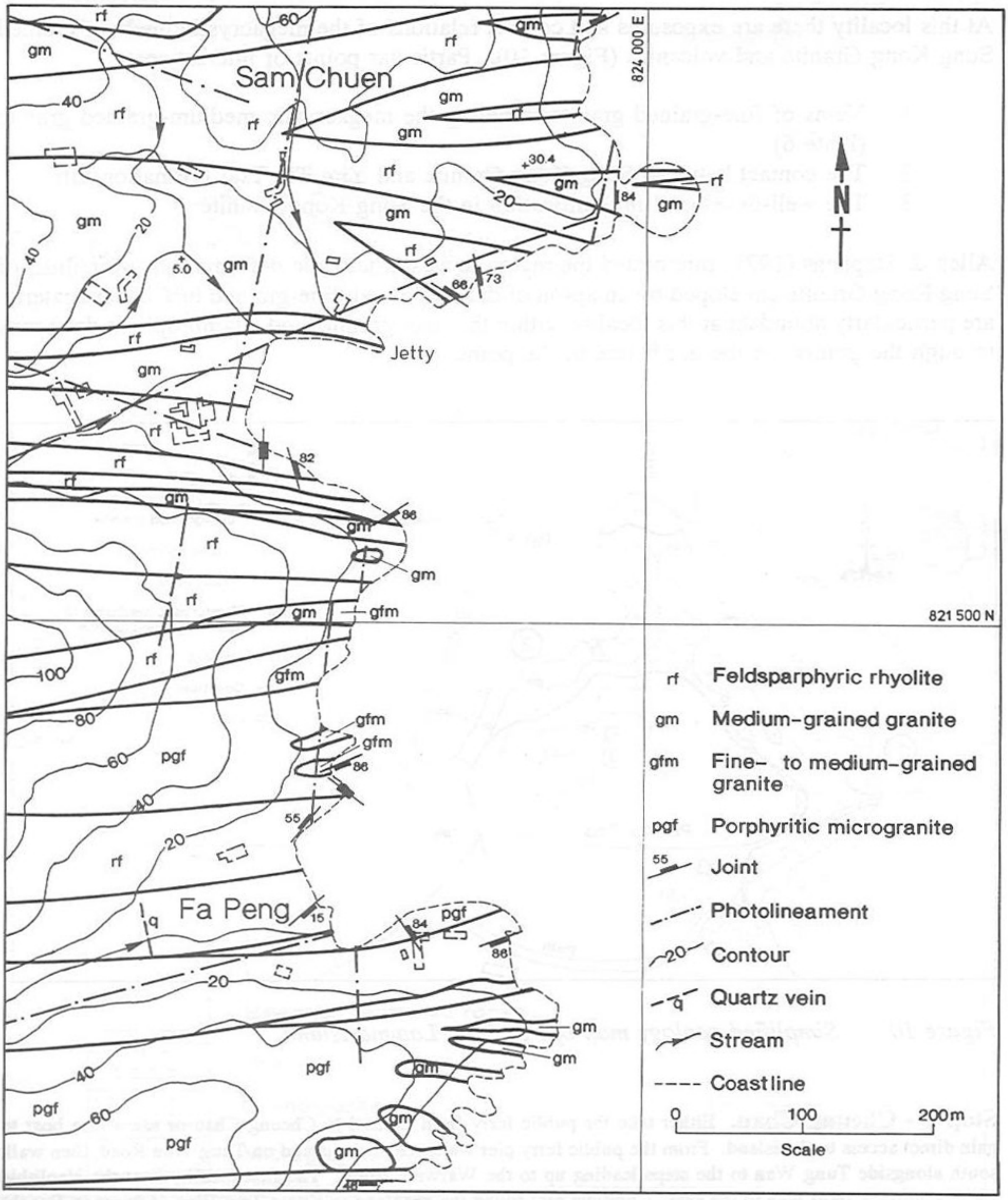

Figure 11 *Simplified geology map of northeast Lantau Island (after Sewell & James 1991)*

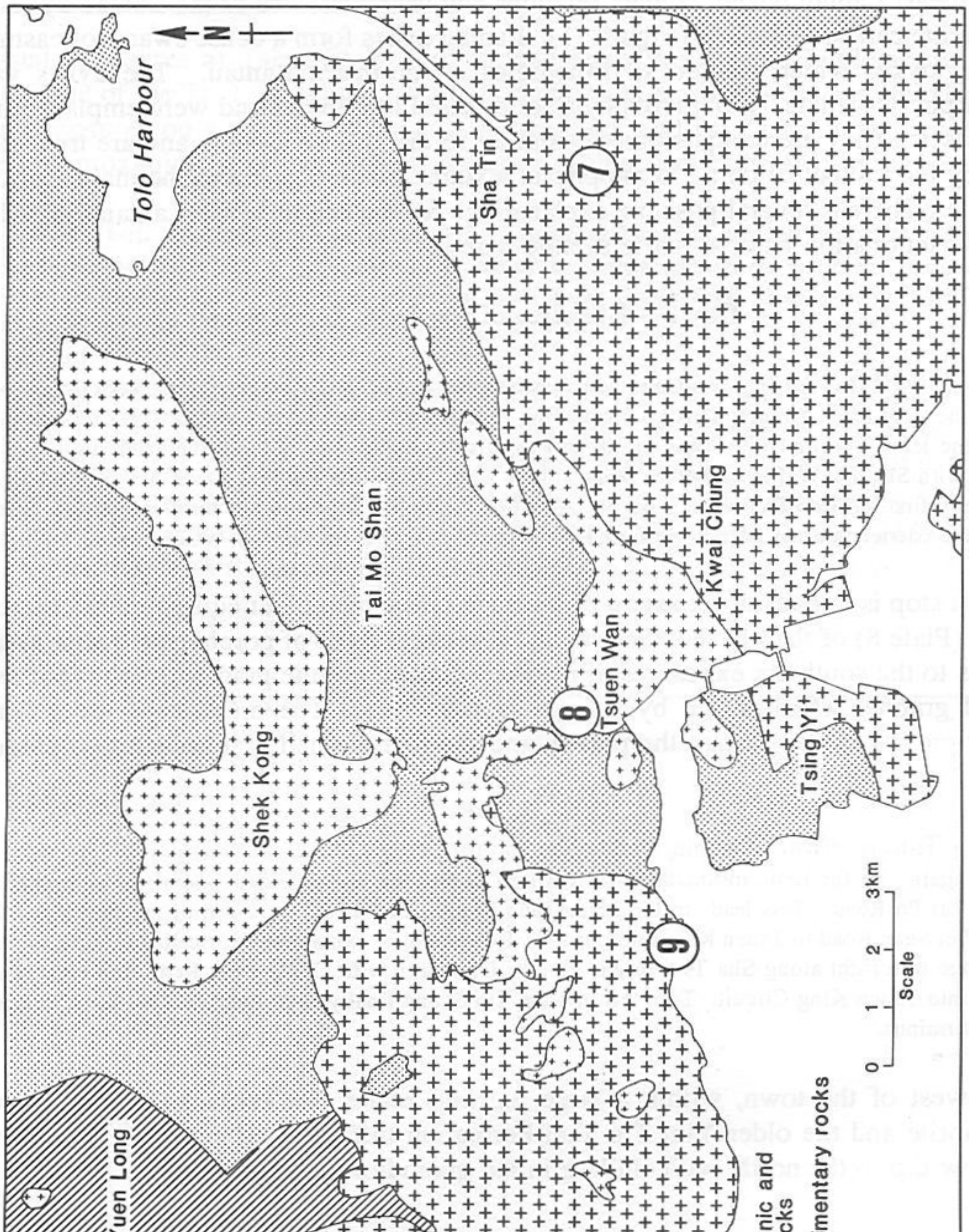

Figure 12 Geology and route guide for Day 3 (after Addison 1986 and Langford et al 1989)

Stop 6 - Northeast Lantau Island. Either take the kaido from Sham Tseng to Ma Wan via Fa Peng or use a hire boat to gain direct access to Fa Peng jetty. The best exposures are on the coast to the south of the jetty.

On northeast Lantau Island, contact relations and characteristics of the Lantau dykes and Sha Tin Granite can be examined (Figure 11). Lantau dykes form a dense swarm of eastnortheast-trending dykes which intrude all lithologies on northeast Lantau. The dykes vary from feldsparphyric- (Plate 7) to quartzphyric-dominated lithologies and were emplaced in at least two phases. They are compositionally similar to the Lantau Granite and are truncated in the south by the Lantau caldera. Granophyric textures predominate and the main mafic mineral is biotite. There a several possible explanations for the origin of the Lantau dykes including crystal fractionation from a quartz syenite parent.

Day 3 - Granites of the New Territories

Stop 7 - Sha Tin. Travel north from the Cross Harbour Tunnel and Kowloon along Waterloo Road and pass through the Lion Rock Tunnel. Drive 3.5 km along Lion Rock Tunnel Road and Sha Tin Road and take the slip road to the left. The first locality is on the left-hand side of this slip road, but vehicles must turn left at the junction with Sha Tin Wai Road before being able to stop. From Sha Tin Wai Road turn first left into Sha Kok St and then first left into Shui Chuen Au St. About 600 m up the road is a left turn leading to a barrier. Walk up past the barrier into the borrow area, and the second locality is on the first bench behind the road.

The first stop is a roadside exposure of the contact between older equigranular coarse-grained granite (Plate 8) of the Sha Tin Granite and a younger dyke of porphyritic quartz syenite. On the hills to the south are exposures of medium-grained granite grading into megacrystic fine-grained granite, which is cut by a large syenite dyke. The megacrysts are relicts of the coarser granite in the core of the pluton, and the fine-grained granite is a two-phase variant within the pluton.

Stop 8 - Tsuen Wan. Returning to Sha Kok St turn left, and at the T-junction with Tai Chung Kiu Road turn left again. At the first crossroads turn right into Lion Rock Tunnel Road, and at the next crossroads turn left into Tai Po Road. This leads to the Shing Mun Tunnel, and at the west end of the tunnel continue along Cheung Pei Shan Road to Tsuen Kam Interchange. Take the third exit along Tai Ho Road North, and at the next interchange turn right along Sha Tsui Road. At the T-junction with Castle Peak Road turn right, and take the first left into Tsuen King Circuit. Turn left into On Tin St and finally right into On Yuk Road, stopping before the bus terminus.

In the west of the town, within a large housing estate, the contact relations between the granodiorite and the older Yim Tin Tsai Formation tuff are well exposed. The contact has a shallow dip to the north, with chilling in the granodiorite but no obvious thermal alteration of the tuff.

Stop 9 - Sham Tseng. Return to Castle Peak Road and turn left. Take the first left into Sai Lau Kok Road and then right into Tai Ho Road, returning to the interchange with Sha Tsui Road. From Sha Tsui Road turn first left into Yuen Tun Circuit leading into Hoi Shing Road. Take the first left to the roundabout below Tsuen Wan Road and turn right towards Sham Tseng and Tuen Mun. Leave Tuen Mun Road at Sham Tseng Interchange and turn left at the bottom of the hill along Castle Peak Road. The first stop is about 700 m along on the left. The exposures are alongside a narrow busy road as well as on the adjacent coastline, so great care must be exercised in viewing the geology at this locality.

Along the Castle Peak Road are exposures of primary texture medium-grained granite of the Tai Lam Granite which is locally modified to a megacrystic fine-grained two-phase variant. Textural variations in the groundmass and the nature of the megacrysts can be demonstrated.

Stop 10 - Tsing Shan Wan. **Return to Tuen Mun Road and head west towards Tuen Mun, leaving the highway at Siu Lam Interchange. Turn left along Castle Peak Road and travel west for about 3.8 km to the east end of Castle Peak Beach. Here a left turn leads to the first locality at the kaido jetty between Castle Peak Beach and Kadoorie Beach. The small headland adjacent to Castle Peak Beach, only accessible at low tide, is the second locality.**

The coastal exposures at Tsing Shan Wan (Castle Peak Bay) are in equigranular coarse-grained granite of the Tai Lam pluton. There is no textural modification, but abundant aplite dykes in exposures on a small headland at the southern end of Castle Peak Beach are an indication of proximity to the subsequent intrusion giving rise to the two-phase variants.

Stop 11 - Lam Tei. **Continue north along Castle Peak Road for 2 km and turn left then right to regain Tuen Mun Road. Travel past Lam Tei on the right, taking note of the borrow area access just over 1 km north of the village. Take the first available right turn, returning south along Castle Peak Road towards Lam Tei. The entrance to the borrow area is a poorly marked track on the left.**

The granite of the Tai Lam pluton is dominantly a two-phase variant. Megacrystic fine-grained and fine- to medium-grained granite is well exposed in rock cuts and borrow areas for the new Tuen Mun-Yuen Long Eastern Corridor. A narrow dyke of basalt can be seen in the rock face adjacent to the access road for the borrow area. Depending on the time available after visiting Lam Tei, the party can return to Kowloon by the Tuen Mun highway or over Tai Mo Shan on Route Twisk, allowing spectacular views of the area.

Plate 1 *Equigranular medium-grained granite (HK458) from Pak Tin Estate (834970E 821820N); XPL plus 1/4λ plate*

Plate 2 *Porphyritic fine-grained quartz syenite (HK4018) from Cape D'Aguilar Road (843282E 808328N); XPL plus 1/4λ plate*

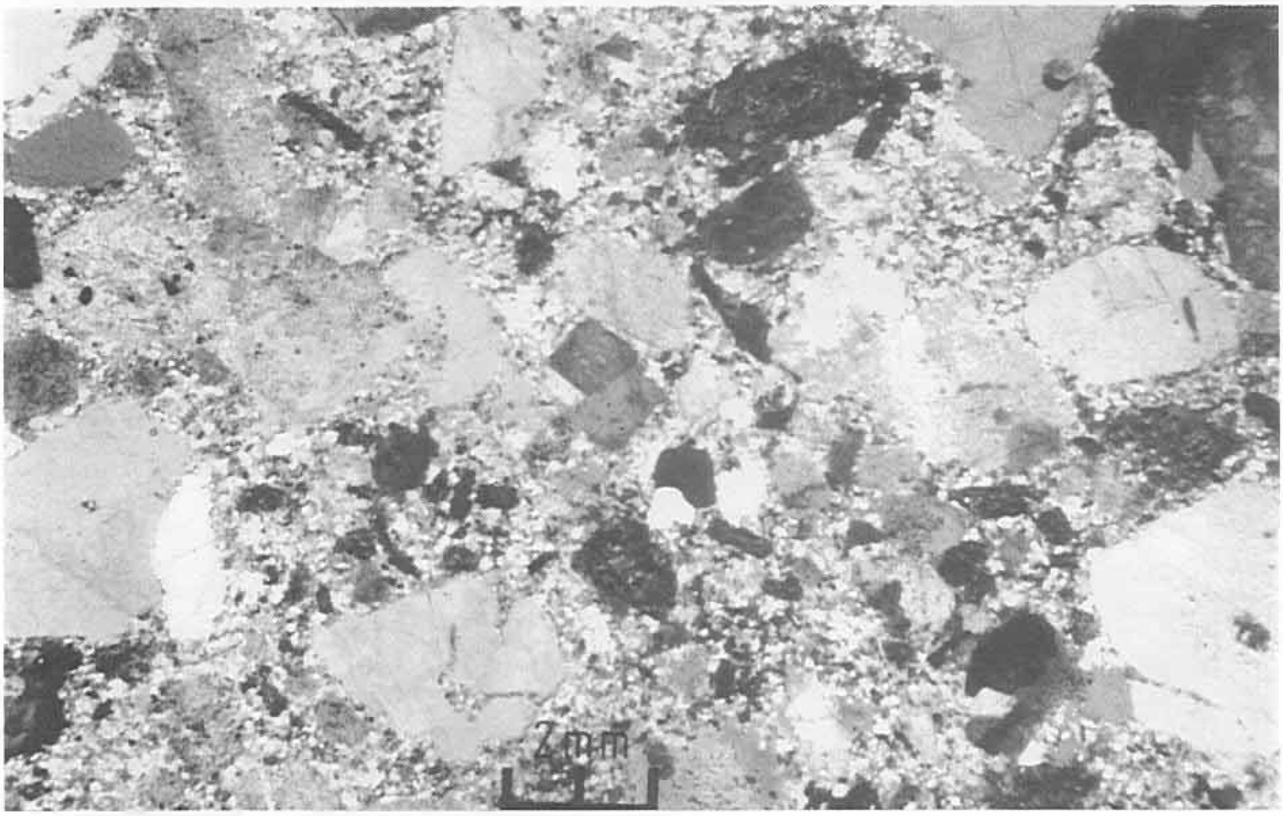

Plate 3 *Porphyritic microgranodiorite (HK4225) from Cape D'Aguilar (844920E 807750N); XPL plus 1/4λ plate*

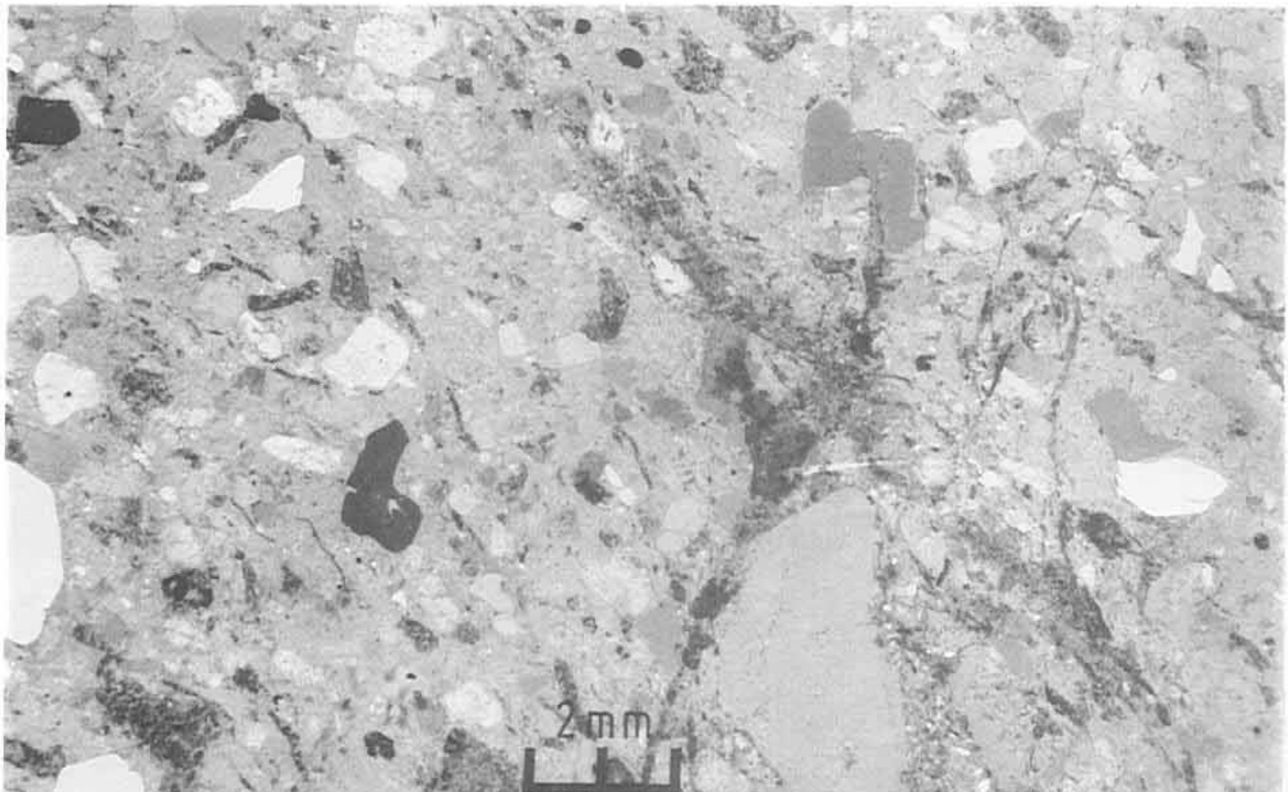

Plate 4 *Yim Tin Tsai Formation tuff (HK4223) from Cape D'Aguilar (844488E 807900N); XPL plus 1/4λ plate*

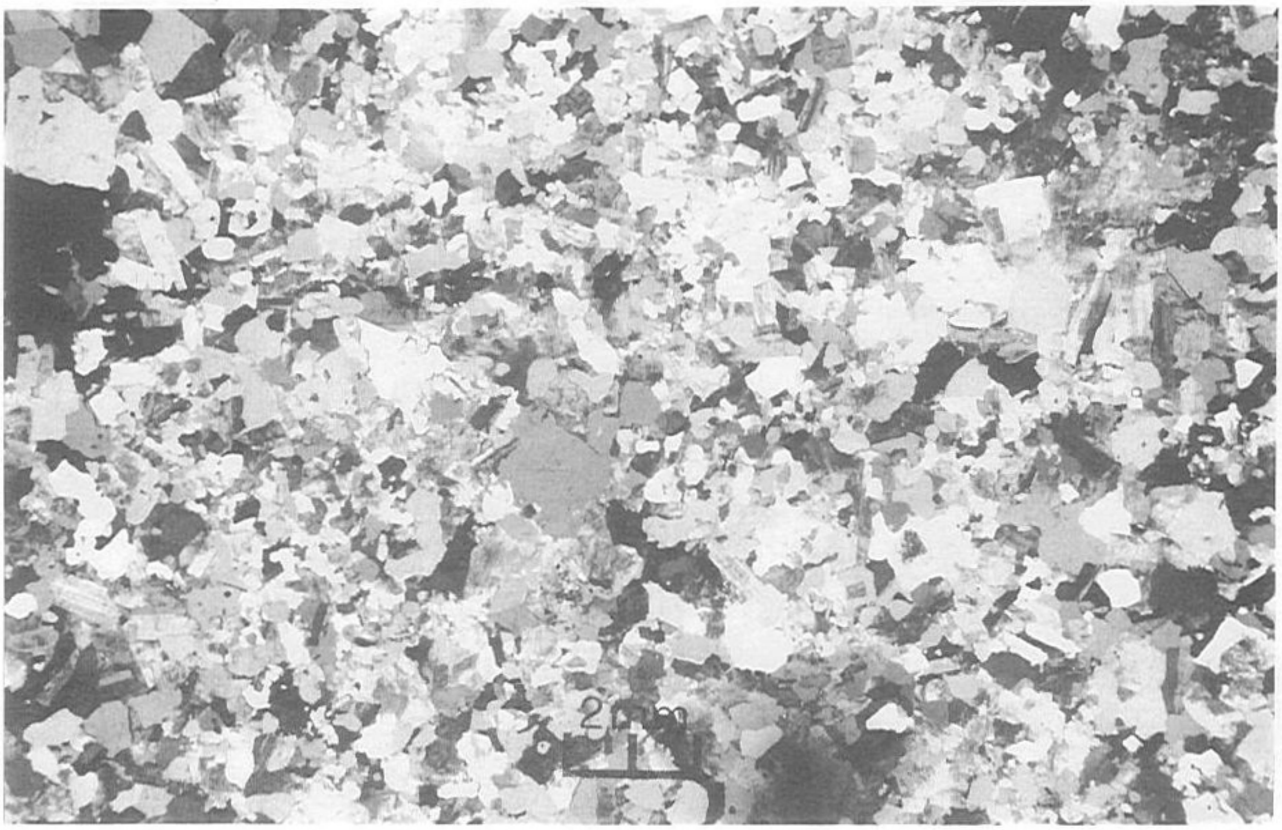

Plate 5 Fine-grained granite (HK8714) from Mt Butler Quarry (839070E 814410N); XPL plus 1/4λ plate

Plate 6 Fine-grained granite cutting megacrystic medium-grained Sung Kong Granite at Pak Kok, north Lamma (830120E 811230N)

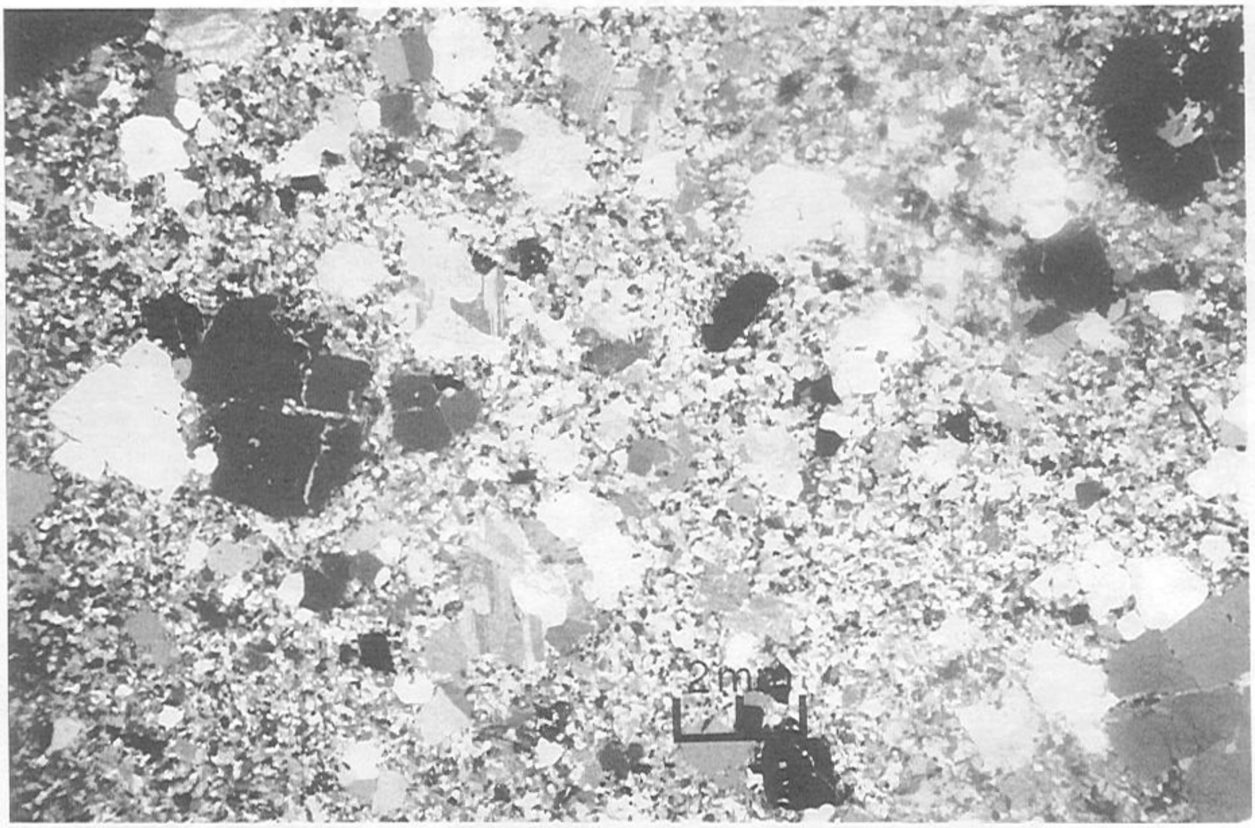

Plate 7 Feldsparphyric rhyolite (HK9732) from Fa Peng, northeast Lantau (823770E 821375N); XPL plus 1/4λ plate

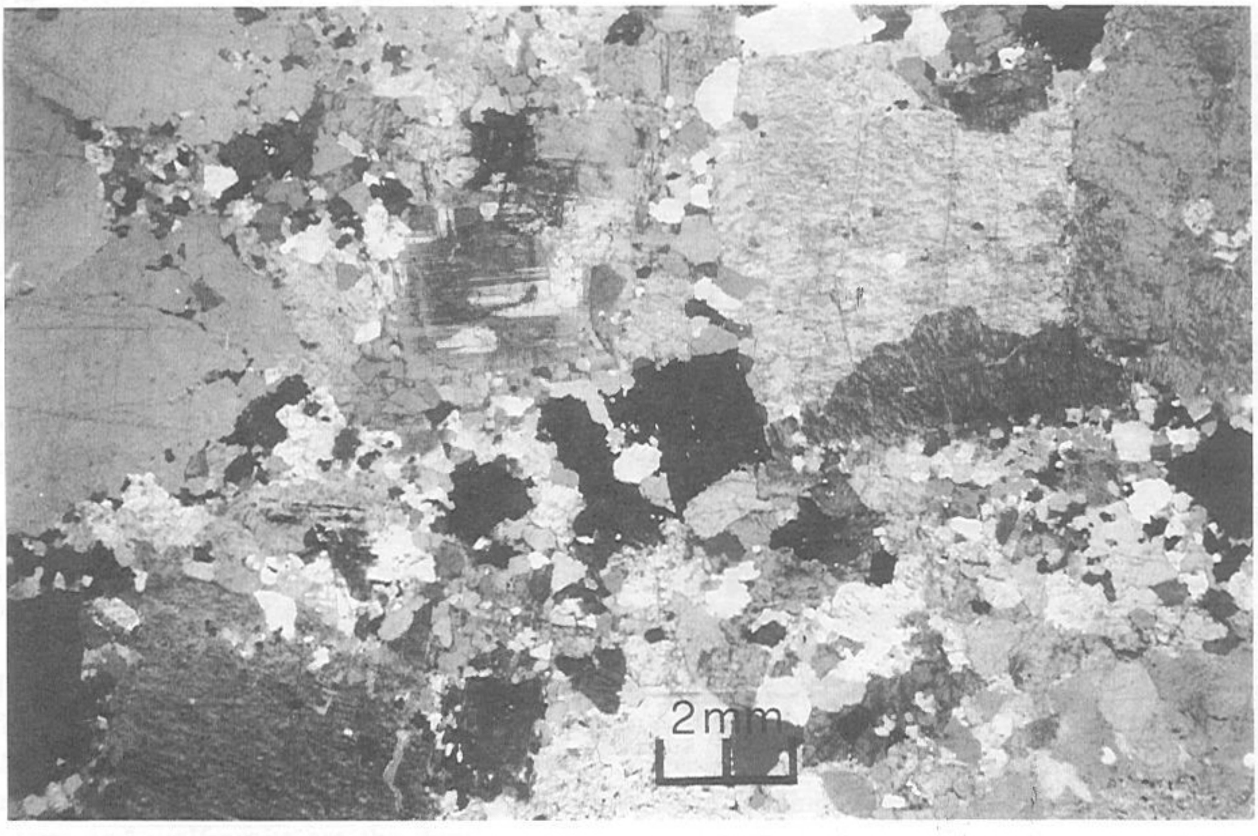

Plate 8 Microcrystic coarse-grained granite (HK8697) from south Sha Tin (837650E 825910N); XPL plus 1/4λ plate

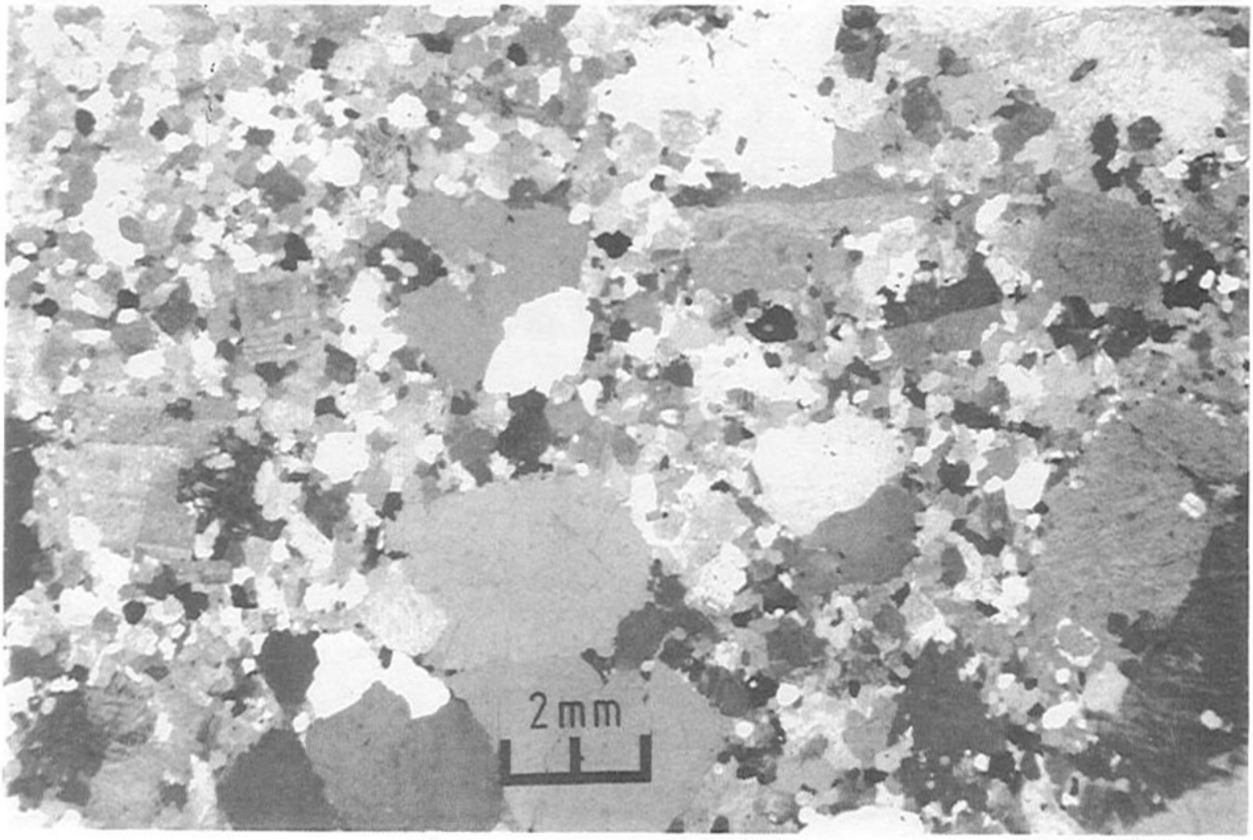

Plate 9 *Megacrystic fine-grained granite (HK4097) from Sham Tseng (824810E 825050N; XPL plus 1/4λ plate*

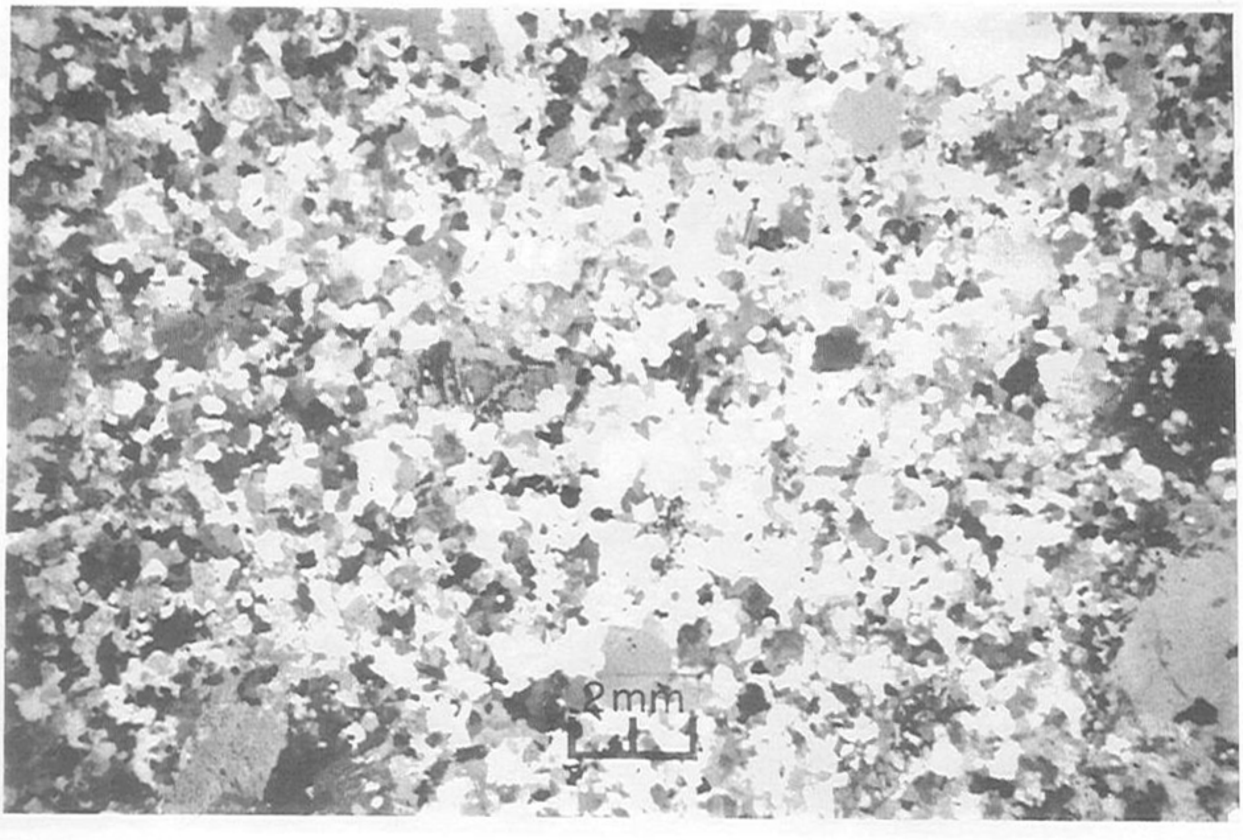

Plate 10 *Sparsely megacrystic fine-grained granite (HK8755) from Lam Tei (817990E 831850N); XPL plus 1/4λ plate*

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THE GEOLOGY AND EXPLOITATION OF THE NEEDLE HILL WOLFRAMITE DEPOSIT

K J Roberts & P J Strange

Geotechnical Engineering Office
Hong Kong Government

Abstract

The abandoned Needle Hill Mine is situated on the southern slopes of Needle Hill, approximately 3 km west of Sha Tin in the New Territories. The principal mineral extracted from the mine was the tungsten mineral wolframite, which occurs in a series of steeply dipping, northwest striking fissure veins within medium- and fine-grained granites of the Sha Tin pluton. The mineralisation represents late-stage injections of high temperature hydrothermal mineralised fluids along the common NW-SE fault trends.

The deposit was discovered in 1935 and mining commenced in 1938. Mining continued during the occupation of Hong Kong by Japanese forces between 1942-1945. Production records are not available for the period 1942-1951. However, between 1951-1955 it is recorded that 222 tonnes of wolframite concentrate were produced. In 1955 the mining lease was transferred to the Yan Hing Mining Co Ltd and between the period 1956-1967, 63 846 tonnes of crude ore were mined yielding 223 tonnes of wolframite concentrate. Mining was suspended in 1967 due mainly to declining tungsten prices and increasing labour costs. In 1977 the Yan Hing Mining Co Ltd estimated probable ore reserves of 329 404 tonnes.

Geology

The abandoned Needle Hill Mine is situated on the southern slopes of Needle Hill approximately 3 km west of Sha Tin in the New Territories (Figure 1). The principal ore mineral extracted from the mine was the tungsten ore, wolframite $(Fe,Mn)WO_4$, with the principal gangue mineral being quartz. Molybdenite also occurred, although concentrations were generally uneconomic.

The mineralisation consists of a series of parallel, steeply dipping, northwest striking fissure veins which cut the granite of the Sha Tin pluton (Figure 2). The Sha Tin pluton comprises a core of coarse-grained granite surrounded by zones of medium- and fine-grained granites. All the grain size varieties are characterised by blotchy aggregations of minute biotite crystals set in an equigranular groundmass. The fine-grained granite also possesses a megacrystic texture. Age dating (Strange 1990) has indicated a Rb-Sr age of 147±8 Ma for the coarse-grained granite, thus placing it within the earliest phase of the pluton intrusion sequence.

The medium-grained granite on Needle Hill is interleaved with fine-grained granite without signs of chilling (Addison 1986). The similarity in the times of intrusion is confirmed by very similar geochemical analyses for the fine- and medium-grained varieties.

The mineralisation at Needle Hill occurs within the medium- and fine-grained granites. The fissure veins are parallel to the common northwest-trending fault directions. It is presumed that the mineralisation represents late-stage injections of high temperature hydrothermal mineralised fluids along parallel northwest-trending fractures (Addison 1986). Although quartz and wolframite are the dominant minerals, the presence of galena, sphalerite, pyrite, molybdenite and fluorite have also been recorded (Peng 1978). Hui (1978) noted a zonal distribution of wolframite and molybdenite mineralisation, with high concentrations of wolframite in quartz in the upper zones of some veins becoming generally poorer with depth with an associated increase in the molybdenite concentration.

During the history of the mine, 11 principal veins were mined, and their approximate dimensions are listed in Table 1. Although one lode, vein A, was worked over a distance of about 450 m, the other veins extended over distances varying from 200 m to 400 m and, where worked, had an average vein width of 0.41 m. Figure 3 shows the location and extent of the main adits developed on the No 2 and No 20 hills at Needle Hill, in relation to the principal veins encountered at these locations.

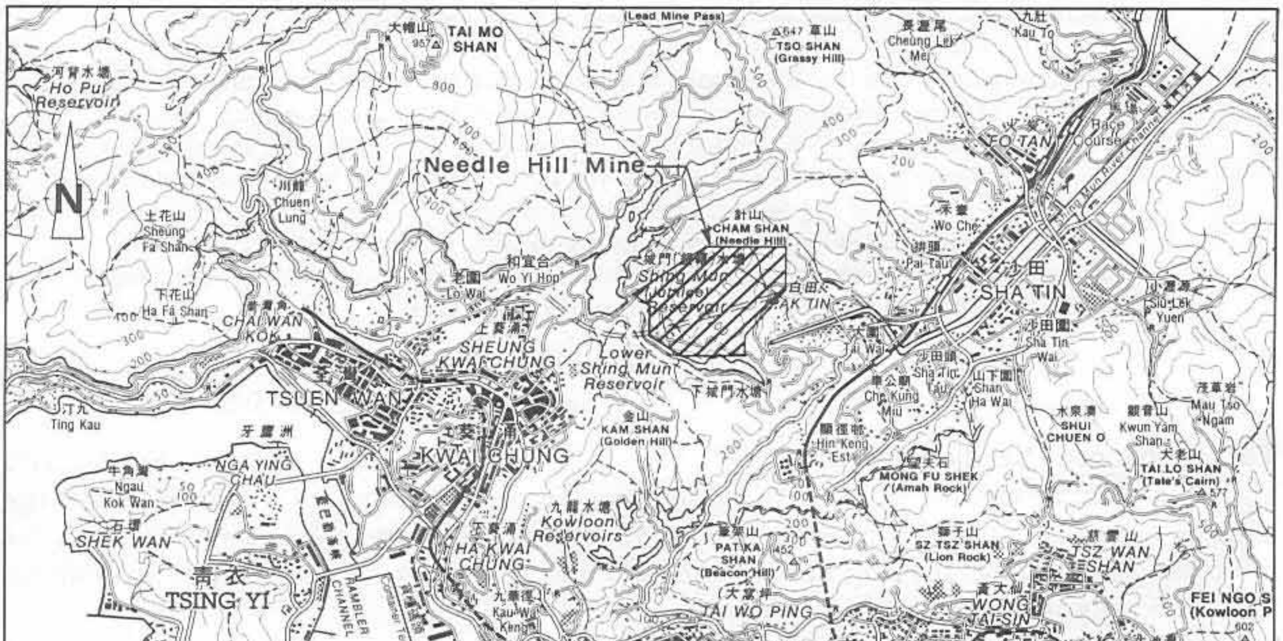
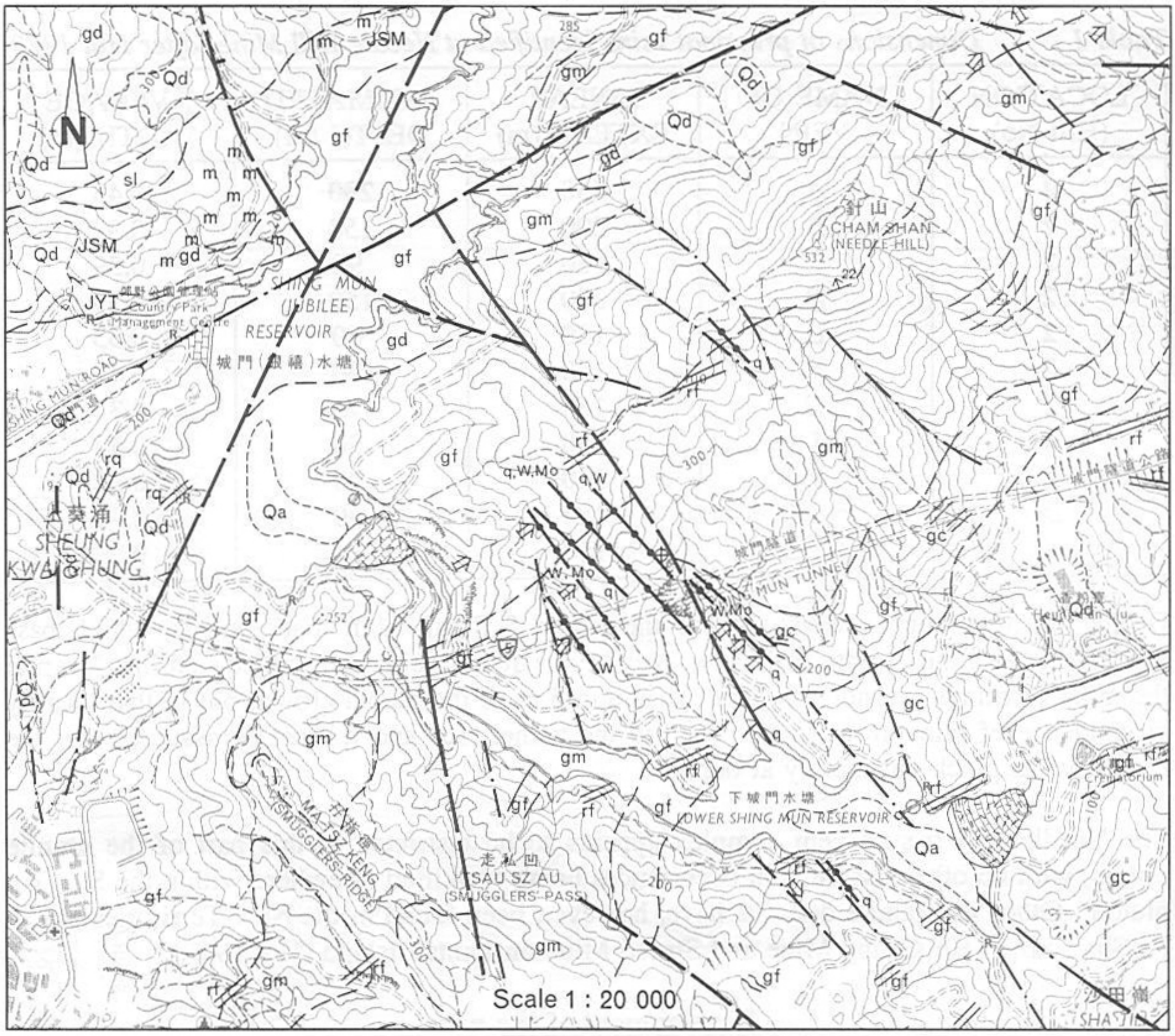


Figure 1 *Location map of Needle Hill Mine lease area, New Territories*



LEGEND

SUPERFICIAL DEPOSITS (Quaternary)

- Qa — Alluvium
- Qd — Debris flow deposits

SOLID GEOLOGY

Repulse Bay Volcanic Group (Upper Jurassic)

- JSM — Shing Mun Formation
- JYT — Yim Tin Tsai Formation

Major Intrusive Rocks (Jurassic-Cretaceous)

- gf — Fine-grained granite
- gm — Medium-grained granite
- gc — Coarse-grained granite
- gd — Granodiorite

Minor Intrusive Rocks (Jurassic-Cretaceous)

- rf — Feldsparphyric rhyolite
- rq — Quartzphric rhyolite

GENERAL

- m m m — Thermally altered rock around granitic intrusions
- q — Quartz
- W — Wolframite
- Mo — Molybdenite
- Geological boundary, superficial deposit
- Geological boundary, solid rock
- Fault
- Mineral vein
- Photogeological lineament
- Mine adit, abandoned
- Mine shaft, abandoned

Figure 2 *Solid and superficial geology of the Needle Hill area (after Addison 1986)*

Table 1 Dimensions of principal veins identified at Needle Hill Mine (after Hui 1978)

LOCATION (Hill No)	NAME OF VEIN	LINEAR EXTENT (m)	ESTIMATED DEPTH (m)	AVERAGE WIDTH (m)
2	A	450	230	0.43
2	B	300	150	0.39
2	C	180	90	0.39
2	D	300	150	0.39
2	E	120	60	0.33
2	F	180	90	0.42
2	G	150	75	0.37
4	I	180	90	0.43
4	J	180	90	0.42
20	No 1	180	90	0.42
20	No 2	150	75	0.39

During the tunnelling excavations for the Route 5 Shing Mun road tunnels, which pass directly beneath the Needle Hill Mine, only minor quartz veins were noted. At one location the mine workings extended in depth to within 5 m of the tunnel crown, but in that locality no evidence of mineralisation was seen in the tunnel face and it must be assumed that the fissure veins pinch out rapidly at depth.

The Needle Hill fissure vein complex appears to be restricted to this part of the granite pluton, with no other fissure vein occurrences being identified elsewhere within the Sha Tin pluton. Other wolframite deposits have, however, been found in the New Territories at Lin Fa Shan Mine, Ho Chung Mine and Struco Mine on Lantau Island (Hui 1978).

Development of the mine

The deposit was discovered in 1935 by a civil engineer, Mr G Hull, working on the construction of the Jubilee Reservoir. He recognised wolframite-rich placer deposits in sediments being excavated from the Upper Shing Mun River and traced the mineralisation to quartz veins on Needle Hill. The first mining licence was issued to Mr Hull in 1935 and the lease was subsequently transferred to Marsman Hong Kong China Ltd.

Marsman undertook prospecting from 1935-1937, and development works began in 1938. From 1938-1941 three adits were developed to intersect veins in the No 2 Hill (Figure 3). The No 1 Adit was developed at 116 mPD in a N70°E direction, whilst Adit Nos 2 and 3 were developed at 198 mPD in a N30°E direction (Figure 3). From 1938-1941 an estimated average annual production of 120 tonnes of wolframite concentrate (65% WO_3) was achieved with the establishment of a medium capacity gravity concentration plant capable of treating 100 tonnes of crude ore per day.

In December 1941 Hong Kong was occupied by Japanese Imperial Forces and the mine was abandoned until July 1942 when a Japanese concern, the Taiwan Development Company, began operating the mine (Davis 1952). By the end of the occupation in 1945 the No 4 and No 5 adits had been developed at 140 mPD on No 20 Hill in a N30°E direction to intersect the No 1 and No 2 veins (Figure 3). Although no production records exist for the period 1942-1945, an annual production of 140 tonnes of wolframite concentrate has been estimated from reports by old miners.

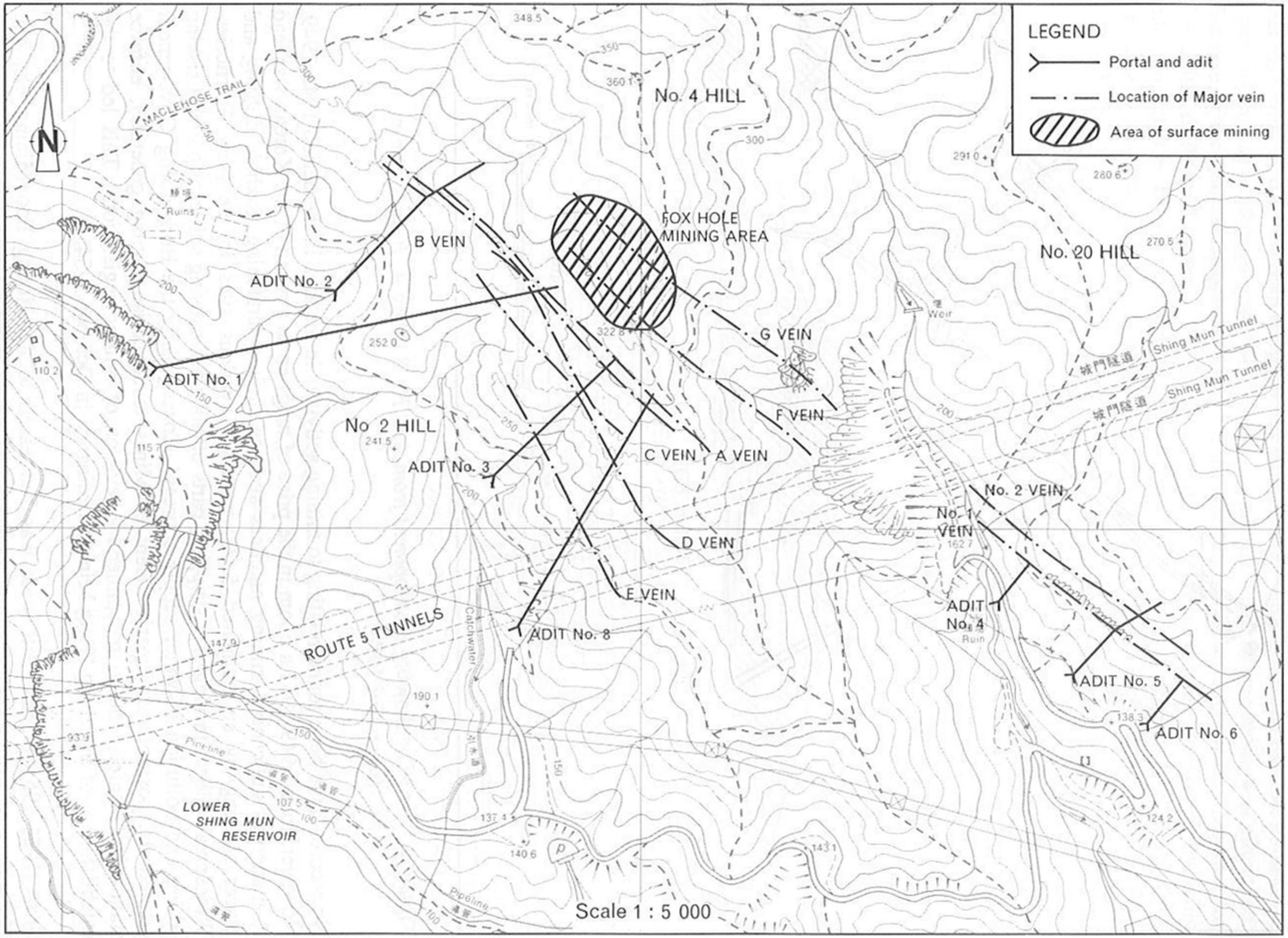


Figure 3 *Location of the major veins on the No 2 and No 20 hills, Needle Hill (Source: Yan Hing Mining Co Ltd)*

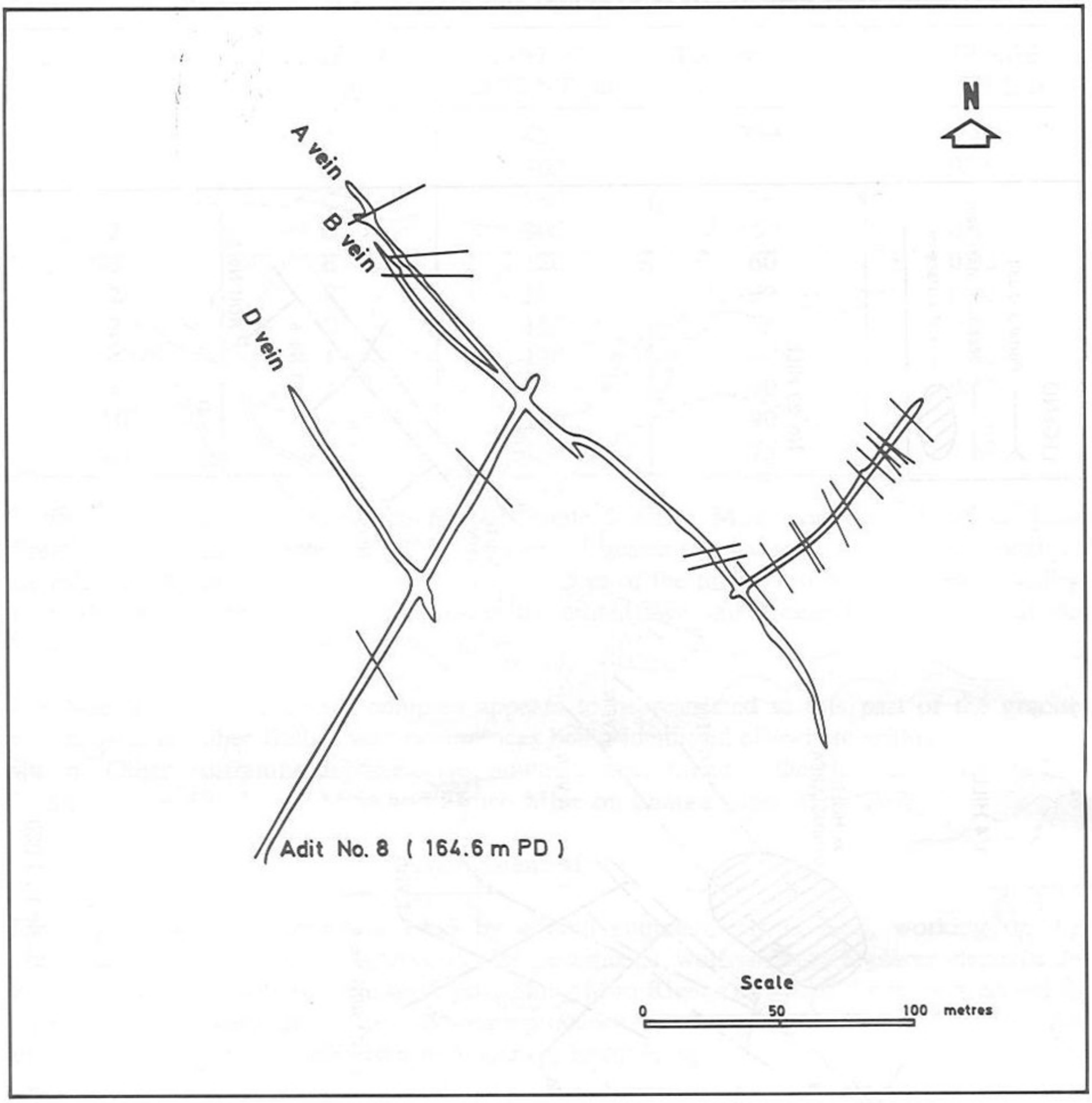


Figure 4 *Plan showing development from Adit No 8 along A, B and D veins (after Hui 1978)*

No records have been found relating to mining activities in the area in the period 1945-1949. However, from 1949-1951 a boom in the price of tungsten as a result of the Korean war lead to numerous unlicenced mining practices such as surface scratching, foxhole digging and placer sluicing by an estimated 5 000 miners at various sites in the New Territories. Widespread illegal mining was stripping parts of hillsides, causing soil erosion, and risking silting and pollution of water supply sources. Consequently the Hong Kong Government created the position of Superintendent of Mines to supervise mining generally, enforce standards of safety and to recommend a revision of mining legislation. This led to the establishment of the Hong Kong Mining Ordinance in October 1954.

From 1951-1955 Needle Hill mine was sub-leased to the Hoong Foo Mining Co, and 222 tonnes of wolframite concentrate were produced by mining contractors under a system whereby they were paid fixed rates for standard grade (65% WO_3) concentrate. In 1955 mine ownership was transferred to the Yan Hing Mining Co Ltd, and mining resumed in 1956. Adit No 8 was developed at 164 mPD at No 2 Hill in 1958 in a N32°E direction (Figures 3 & 4).

The period 1958-1967 is the most informative in the mine's history due to the detailed records maintained by the Yan Hing Mining Co Ltd. The mining method used was sub-level open stoping, and although veins were narrow, a mining width of one metre was employed. Because of the general competent nature of the granite, no timber support was required for the adits, drifts and raises. A natural system of ventilation was developed by adits interconnected by a series of drifts, raises and crosscuts at different elevations. Milling of the ore was by a simple gravity concentration method which achieved a recovery of 93.3% WO_3 (Hui 1978).

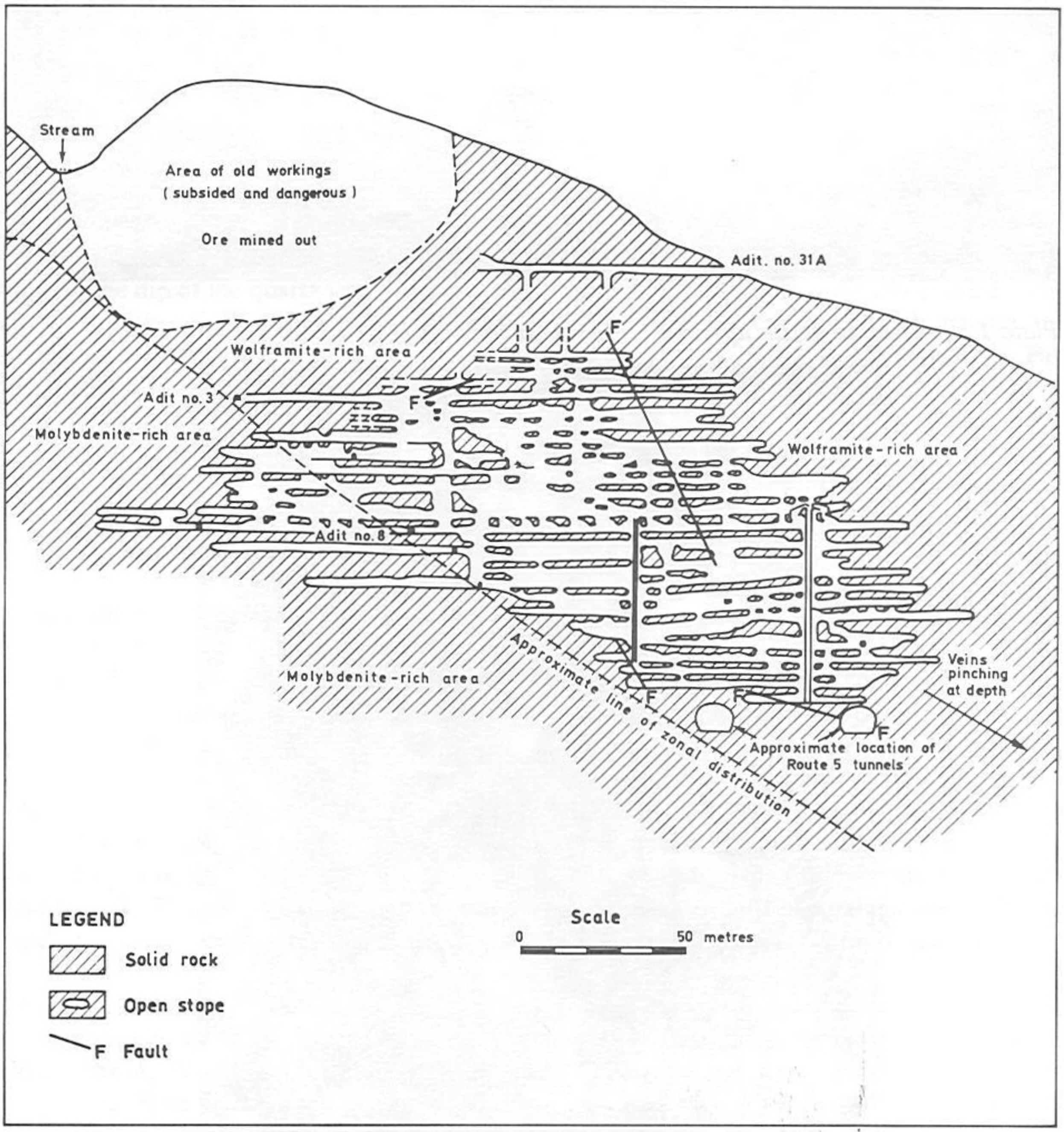


Figure 5 *Cross-section showing the extent of mine workings along the A vein striking N60°W and dipping 75°SW (after Hui 1978)*

Plate 1 *Mine waste tips to the northwest of No 2 Hill, Needle Hill*

Plate 2 *Example of foxhole digging south of No 4 Hill, Needle Hill*

Mining records indicate a total extraction of 63 846 tonnes of crude ore with an average wolframite mineral content of 0.33%, giving a total production of 223 tons of wolframite concentrate (69.6% WO_3). In 1967 mining was suspended due to the low market price of tungsten and increasing labour costs.

In 1977 the Yan Hing Mining Co Ltd produced estimates of the remaining probable ore reserves, assuming the development of only the 11 veins listed in Table 1. These estimates were crude due to the lack of detailed mining records in the period 1938-1955. However, assuming an average grade of ore of 0.48% WO_3, a total tonnage of 329 404 tonnes of probable ore was estimated, providing 2 272 tonnes of 69.6% WO_3 concentrate. Based on a production rate of 22 000 tonnes per year this is equivalent to a predicted mine life of approximately 15 years.

In 1984 the condition and extent of the mine workings was investigated to assess the potential implications for the Route 5 Shing Mun road tunnels because existing mine records indicated that the tunnels would pass through or very close to the mine workings. The survey and inspection was carried out by Mott Hay Anderson Far East (MHAFE) under a contract let by the Highways Office, Hong Kong.

Initial investigations indicated that the A vein workings accessed by Adit No 8 would extend to the level of the tunnels (Figure 5). Unfortunately, the workings were flooded and dewatering was required to gain access to the lower levels via the sub-vertical shafts which follow the dip of the quartz vein. Ground conditions were found to be generally good, except in the vicinity of the quartz vein where completely and highly decomposed rock material up to two metres thick has been recorded on either side of the vein. Mott Hay and Anderson Far East (1984) concluded that the tunnels would pass as close to the workings as one metre at one location, and that dewatering and concrete backfilling of some sections of the mine workings would be required prior to excavation of the Route 5 tunnels. All of the adits investigated were subsequently sealed with concrete bulkheads to prevent unauthorised access.

The mine today

The main evidence of mining activity in the Needle Hill area are the numerous waste tips and ruins of old mine buildings in the vicinity of Adits No 1 and No 2 (Plate 1) to the northwest of No 2 Hill (Figure 3). Plate 2 shows an example of one of the small exploratory foxholes which was probably excavated during the early 1950s when numerous illicit mining concerns were operating.

Access into the underground mine workings proved difficult because of problems in locating the adits amongst the dense vegetation and because most of the adits have been securely sealed by concrete bulkheads. Access to the A vein workings was finally achieved through Adit No 8 (Plate 3). However, entry was very difficult, and as the workings are extensive and in places unstable and dangerous, the reader is advised not to attempt to enter them.

Plate 4 shows the condition of the workings along the D vein and indicates the general dimensions of the exploratory headings. Figure 4 shows the development from Adit No 8 along the A, B and D veins, although the main stoping was on the A vein as indicated in Figure 5. Plate 5 shows the general condition of the workings above the level of Adit No 8 with potentially dangerous loose timber props. However, the hangingwall and footwall conditions appeared generally stable. The lower workings were accessible via small travelling ways, although the timber and bamboo ladders, which were probably left from the 1984 ways, although the timber and bamboo ladders, which were probably left from the 1984 investigations, were not considered safe enough to risk descending to the lower levels.

Ventilation of the workings was adequate, with a minor throughflow of air indicating interconnections with other levels. Adit No 8 was generally dry, with any water draining to the lower levels.

Acknowledgements

Acknowledgement is made to the Director of Civil Engineering, who is also Commissioner of Mines, Hong Kong Government, for permission to publish this paper.

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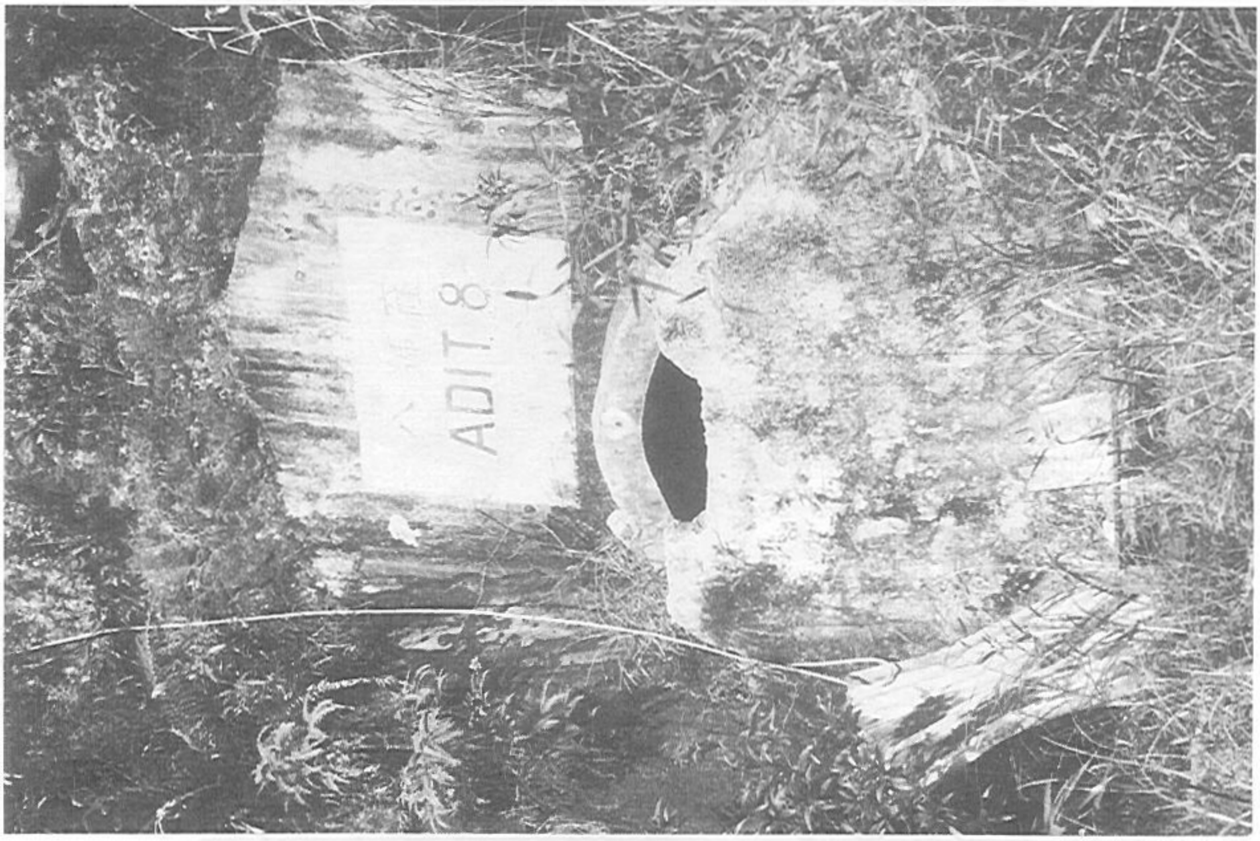

Plate 3 Portal for Adit No 8 (see Figure 3)

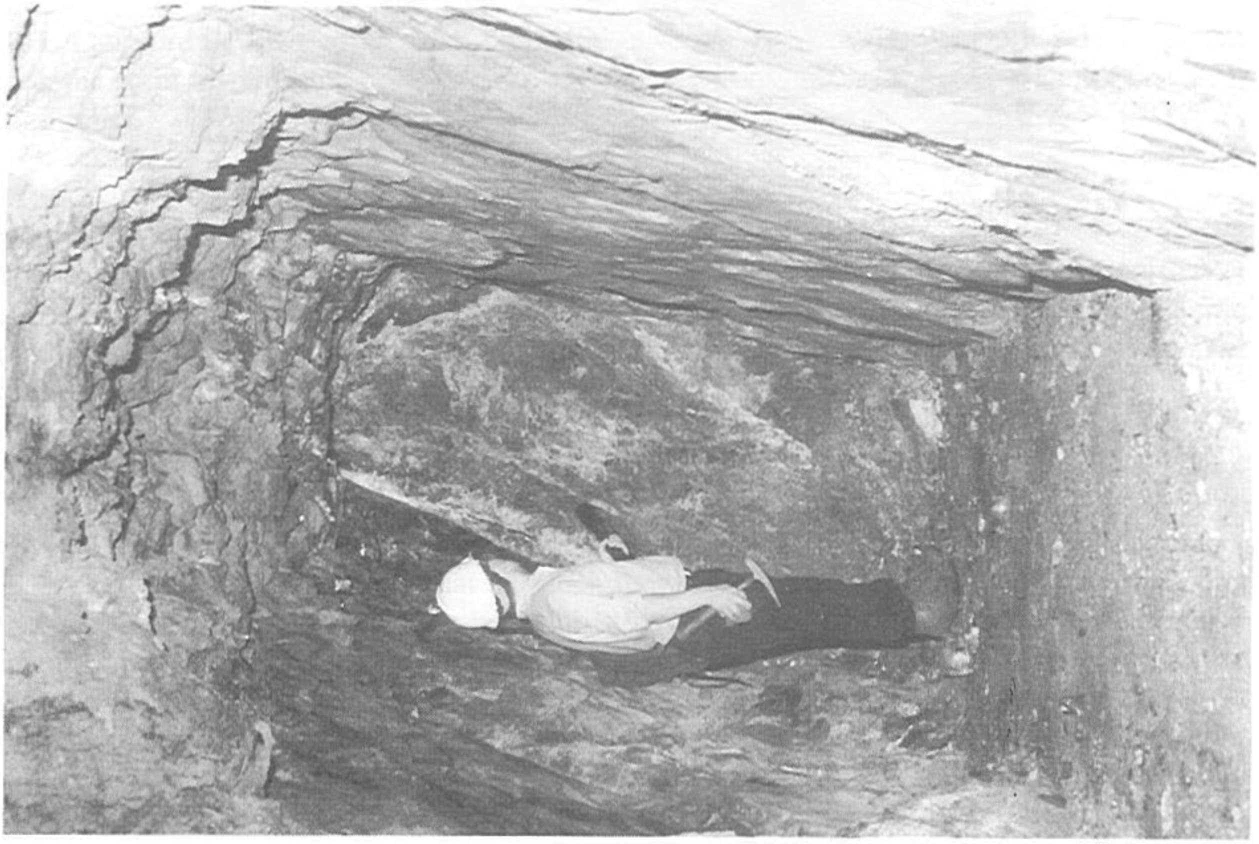

Plate 4 Exploratory heading along the D vein, via Adit No 8

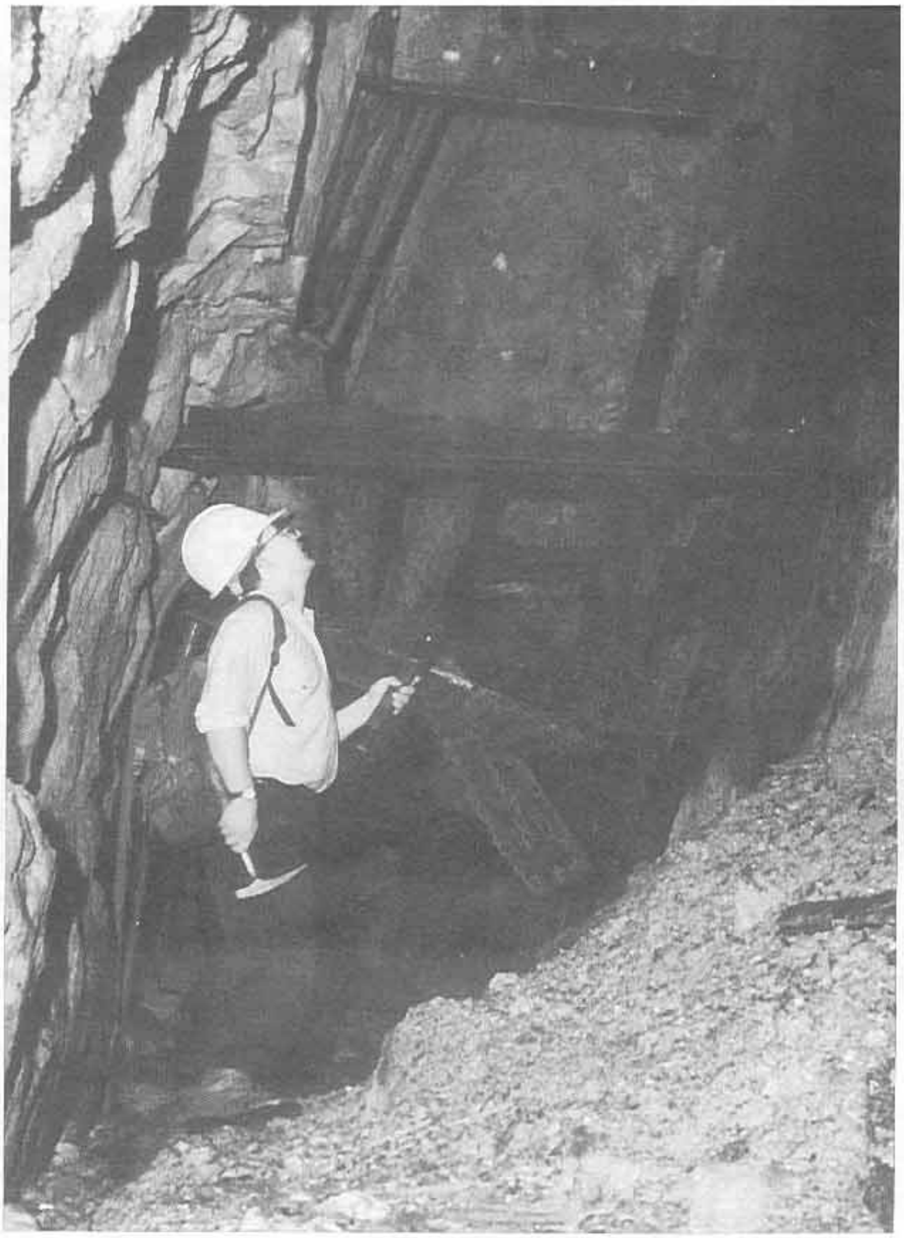

Plate 5 *Stoping along the A vein above the level of Adit No 8*

DISCUSSION ON MARBLE CLASTS IN COARSE ASH CRYSTAL TUFF AT AU TAU, NEW TERRITORIES, HONG KONG

Newsletter **Vol 9 No 1 p 16-19, 1991**

Introduction

K H Nicholls writes: K M Wong has recently reported (Wong 1991) the occurrence of marble clasts within a rock mass exposed in a site formation excavation at Au Tau consisting of coarse ash lithic tuff (Plate 1). These rocks were previously mapped as part of the metamorphosed Tai Mo Shan Formation (Langford *et al* 1988). A recent examination of the exposures by the writer has revealed that the structures observed are associated with low angle thrusting. Furthermore, there is no need to invoke the presence of sedimentary carbonate rocks in the immediate vicinity, as suggested by Wong (1991).

The rocks are associated with three subparallel fault planes orientated at approximately 18° dip towards 130°. A distinctive thick quartz development is clearly visible on these surfaces. In places, the quartz has a thin black mineral coating. Clear evidence of slickenside development can be seen within this black mineral, confirming that the planes are faults (Plate 2). The quartz development can be related to localized melting due to frictional heating on these fault surfaces.

Mineralogy

Examination of samples taken from both above and below the fault planes confirm that the rock is Tai Mo Shan Formation tuff, with lithic clasts (Langford 1991). The presence of marble fragments within the tuffs is taken by Wong (1991) to indicate the likely presence of sedimentary carbonate rocks in the immediate vicinity. A sample of the black mineral coating was analyzed by the Hong Kong Geological Survey under a polarizing microscope and confirmed as tourmaline, showing marked pleochroism from bluish grey to brown (R L Langford & I R Basham, oral communication, November 1991). Crystal development took the form of long thin laths or fibres, typical of tourmaline; crystals are length fast with high relief.

Structure

The orientation of the fault planes are at variance with the regional dip toward the northwest generally associated with the area (Figure 1). This can be explained by later tectonic modification of the regional dip by, for example, intrusion of granite, or by the development of back thrusts within a southeasterly moving thrust sheet (Butler 1987).

Conclusions

Given the presence of low angle, probably thrust faults, it is likely that the rocks are now found in a different location to that in which they were formed. It should be borne in mind that the Carboniferous rocks have been thrust over the Jurassic volcanic rocks, which have in turn been subject to intraformational thrusting. The presence of sedimentary carbonate close to the original volcanic source of the tuffs is obvious. However, the widespread thrust faulting of the area allows the marble-bearing tuffs to be removed considerable distances from their parent sedimentary carbonate rocks. The distance of 3 km between the present day outcrop of Carboniferous rocks and the site is not surprising; rocks within thrust sheets can be transported many tens of kilometres. There is consequently no reason to suspect the likely occurrence of marble in the immediate vicinity as implied in the original paper (Wong 1991).

Acknowledgements

This discussion is published with the permission of the Director of Civil Engineering. My thanks are given to the resident site staff of Watson Hawkesley Earth Science Ltd who allowed a site visit at very short notice. Dr R Langford of the Hong Kong Geological Survey has provided detailed discussion with regard to the geology of the area.

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K H Nicholls, *Geotechnical Engineering Office, Hong Kong Government*

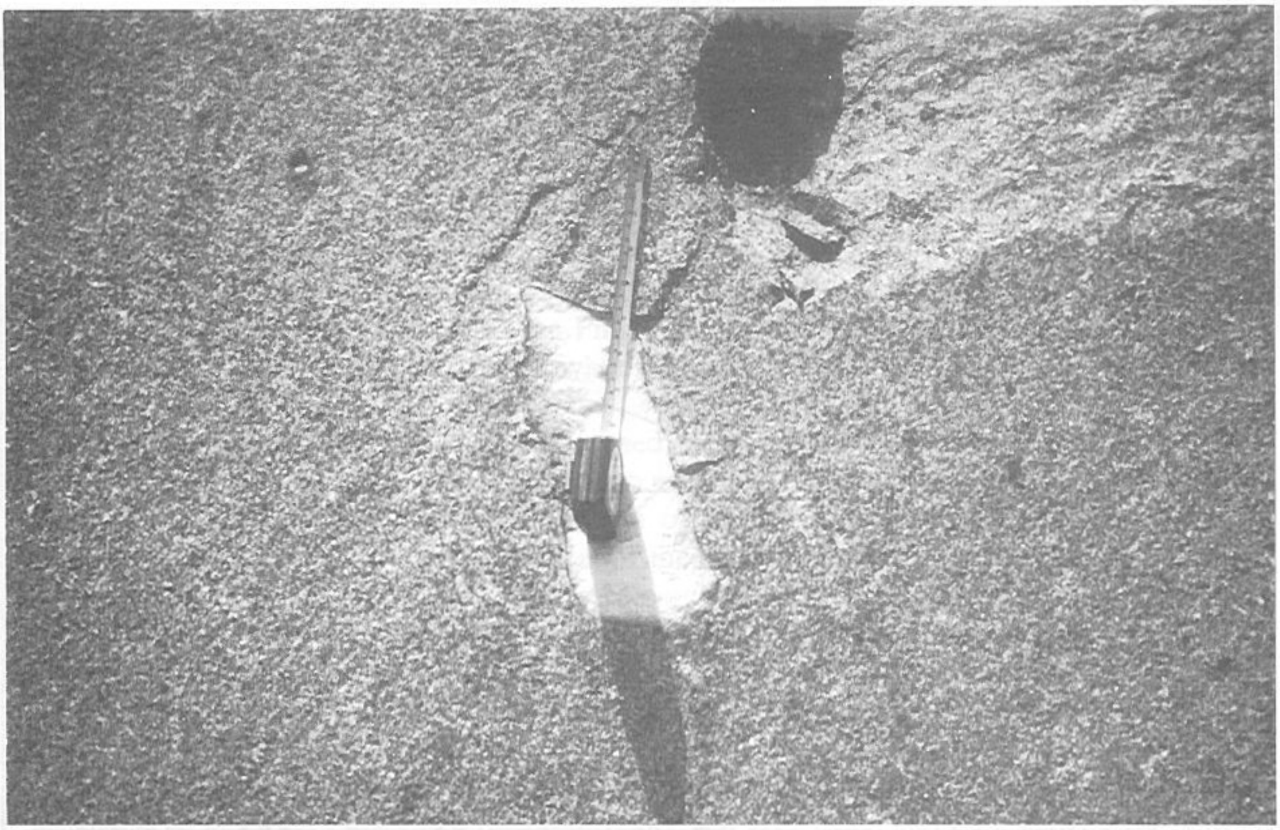

Plate 1 *Sub-angular 150 mm marble clast within metamorphosed Tai Mo Shan Formation tuff, Au Tau*

Plate 2 *Fault plane showing 20 mm thick quartz vein development and black mineral coating (tourmaline)*

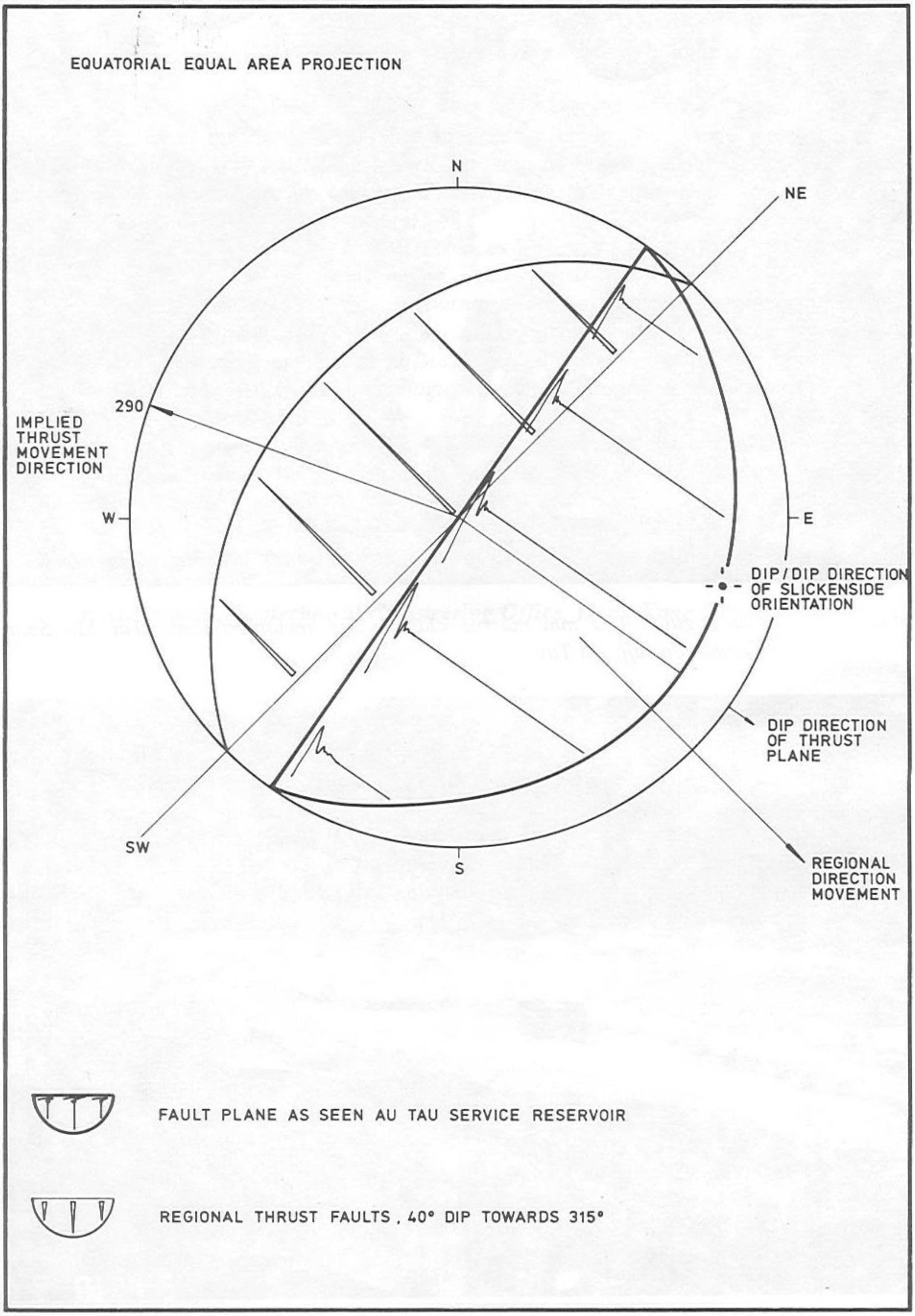

Figure 1 Stereographic representation of the thrust plane and structural geology

DISCUSSION ON ON THE AGE OF THE PING CHAU FORMATION *AND ON* DISCOVERY OF ANGIOSPERM FOSSILS FROM HONG KONG - WITH DISCUSSION ON THE AGE OF THE PING CHAU FORMATION

Newsletter Vol 9 No 1 p 34-49, 1991
Newsletter Vol 9 No 1 p 50-60, 1991

G Taylor writes: In the latest issue (Vol 9 No 1) of the Geological Society of Hong Kong Newsletter two papers on the age of the Ping Chau Formation appear. There are a number of matters arise from these two articles which deserve some comment.

Firstly the palaeontological evidence presented seems to be somewhat shaky. In the first paper Lee *et al* (1991a) write "....some generic names in the list are not very reliable ....", but then go on to use them in their consideration of the age of the formation. It is the same fossils which appear to be the prime subject of their second paper (Lee *et al* 1991b). Perhaps the reason that the two papers reach different conclusions (the first paper concludes that the Ping Chau rocks are Late Palaeocene to Eocene while the second states that the authors ".... would like .... a Late Cretaceous age ...") is that their data are not of adequate quality. These separate conclusions are reached despite 66% common authorship between the two papers.

The palynological data presented in Lee *et al* (1991a Table 5 p 45) clearly indicate a Palaeogene age for the Ping Chau rocks, provided the taxa listed and their ranges are correct. These same data are again presented in Lee *et al* (1991b) and the authors write that these taxa " ... might be dated to the Early Tertiary" but a different conclusion is reached. How is this possible?

A second point I wish to make is that Lee *et al* (1991a) make much of the correlation between the Ping Chau Formation and "black beds", coal, and oil shales from Guangdong. This is done on the basis of a description of the Ping Chau Formation (their Table 3, p 39) as "black beds containing bituminous material", and (p 34) "...comprise black shale and dark grey or dark brown calcareous siltstone, interbedded with dolomitic shales or marls .... The rocks of the black series, even the shales, are very hard." The reality is the rocks of Ping Chau are predominantly carbonates with virtually no terrigenous detrital components except rare felsic volcanic debris (Taylor 1990). How then is it possible to correlate on a lithological basis with oil shale, coal and terrigenous clastic rocks in Guangdong?

Again Lee *et al* (1991a) contend that there is "...much gypsum..." in the Ping Chau rocks. Peng (1967, 1971) certainly reports that some minerals possibly pseudomorphing salts rocks exists, unless Lee *et al* have recent data. Certainly my petrographic examination of rocks collected during 1990 and thin sections made by Peng in the 1960s have not revealed any gypsum.

Despite the apparent lack of data, Lee *et al* (1991a) launch into a long argument to explain how gypsum exists in rocks they argue, from floral data, were deposited under humid conditions. Taylor (1990) has concluded for other reasons that the Ping Chau rocks were probably deposited under arid alkaline lake conditions, as do Peng (1967, 1971) and Atherton & Burnett (1986).

The various conclusions presented by the authors Lee *et al* (1991a, 1991b) based on the same data are confusing and serve no scientific purpose. After the comments by Workman (1990) I hope that we will see more consistent view expressed by the geologists concerned.

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G Taylor, Faculty of Applied Science, University of Canberra, AUSTRALIA

BOOK REVIEWS

The range of geological books coming onto the market is astronomical, as sometimes are the prices. However, some reviews that appear are either of general interest or raise issues of genuine interest to the geological community. I believe the review below, produced by the publishers, falls into the latter category.

Memoirs of an Unrepentant Field Geologist, *F J Pettijohn*

Pettijohn is an unrepentant field geologist, and he brings his view to bear in an informal survey of American geology during the past fifty years. His accounts of the geology departments at Minnesota, Berkeley, Oberlin, Chicago and Johns Hopkins, and of his work for the US Geological Survey and Shell Oil reveal the changes over time in the practice of geology itself - the gradual overshadowing of field geology by geochemistry, geophysics and theoretical laboratory studies. Pettijohn brings to life the research collaborations, friendships and enmities, the changes in curricula, and the rise and decline of great geology departments.

"(This book) contains...a reassuring conviction that to solve many geological problems we still have to depend on our field boots, hammer and eyes." - *Geotimes*

"A splendid, readable history of American geology in the twentieth century, by one who played a great part in its making." - Derek Agar, *Nature*

1984, 260 p, 54 halftones, 3 maps
Paperback ISBN 0-226-66405-8 US$10.95, University of Chicago Press

Hong Kong Minerals, *C J Peng*

Of more direct interest to most Hong Kong geologists will be the good news that the late C J Peng's excellent book on minerals, first published in 1978, has been reprinted by the Urban Council. The new edition was published in 1991, with amendments made by P S Nau of Hong Kong University. The geology map in this 80 page booklet has been completely redrawn, and is now based on the work of the Hong Kong Geological Survey.

The booklet, reference number UC30304, costs only $25 and is available from Urban Council bookshops.

ANNOUNCEMENTS

REPRINTING GSHK PUBLICATIONS

The Society has been successfully selling its publications over the years, and while there are large stocks of some, others have sold out. The Committee has reviewed the most urgent need for reprinting, depending on cost and demand.

Anyone interested in obtaining a copy of *Bulletin* No 2, "Geological aspects of site investigation", should inform the Editor or one of the Committee members. If demand is thought to be insufficient, or the cost is too high, we will not be able to reprint. Please let us know if you feel we ought to be reprinting this or other publications.

1992 SUBSCRIPTION

Included with this issue is an application form for subscription renewal. Please note that the 1992 subscription of $150 is due now. Students will continue to be subsidised as part of our long term growth policy, and their subscription rate, although increased, will only be $50.

For administrative convenience the half-yearly subscription will be dropped, and new members joining after 1 January 1992 will be entitled to back issues of the Newsletter for the whole year.

FRIDAY LECTURE SERIES 1992

17 January 1992	RIFT VALLEY TECTONICS AND SEDIMENTATION IN MALAWI Bernie Owen (*Hong Kong Baptist College*)
14 February 1992	THE SHAKY ISLES - A BRIEF GEOLOGY OF NEW ZEALAND Phil Kirk (*Hong Kong Geological Survey*)
20 March 1992	GEOMORPHOLOGY AND HYDROLOGY OF FRASER ISLAND, AUSTRALIA Ron Neller (*Chinese University of Hong Kong*)

All the talks will be held in the Seven Seas Lounge, Mariner's Club, Tsim Sha Tsui, from 6 pm to 7.30 pm. Please make a note in your diary and keep a copy of this notice for future reference. Contact Dr Shaw on 723-0441 for further details.

NATURAL HISTORY SOCIETY FIELD VISITS

The NHS has given details of its programme on an exchange basis, so we may see their members on our trips as well as being able to join their trips. The provisional programme for early 1992 is:

Sunday 14 January	Kadoorie Farm and Tai To Yan
Sunday 16 February	Pat Kam Chung
Sunday 15 March	Hong Kong Trail
11 and 12 April	Mai Po Marshes

The contact is Donald Smith (Tel: 846-9341, FAX: 810-1007) if anyone wants to confirm dates and places on the visits.

COACH TRIP TO MA ON SHAN

Saturday 25 January 1992

The last trip to the top of Ma On Shan was in low cloud on 2 February 1986, and since then the area has seen rapid urban development. New geological mapping at 1:5 000, and studies of Ma On Shan iron mine, reported in the Newsletter (Vol 9 No 1 p 3-15), have greatly increased our knowledge of the area. The proposed route is by coach to Ma On Shan Tsuen, up to Ngau Ngak Shan (The Hunch Backs), along to Mo On Shan (702 m), down to Tai Kam Chung (Pyramid Hill) and finally down to the disused mine spoil heaps. Those who do not wish to go up the track along the ridge to the summit can go directly to the mine.

The coach will leave Middle Road, Tsim Sha Tsui, at 9 am, return there by 4 pm. Bring a packed lunch and drinks, and clothes and boots suitable for clambering over steep rocks. It is not recommended that very young children are taken.

Cost per person:	Members and spouses	$ 25
	Student Members	$ 15
	Member's children under 18	$ 15
	Guests	$ 30

BOOK NOW: FIRST COME, FIRST SERVED (LIMITED TO 50 SEATS). MEMBERS AND FAMILIES WILL HAVE PRIORITY OVER GUESTS. YOU WILL BE CONTACTED ONLY IF THERE ARE NOT ENOUGH PLACES TO ACCEPT YOUR BOOKING.

Booking slip: MA ON SHAN, 25 JANUARY 1992

I wish to book ______ places at $ 25, ______ places at $ 15 and ______ places at $ 30. I enclose the total payment of $ ______

NAME: ________________________________

CONTACT TELEPHONE: ________________(OFFICE)________________(HOME)

NAMES OF OTHERS (state if Member, Student Member, spouse, child or guest):

____

____

Cheques should be payable to *The Geological Society of Hong Kong* and crossed. Send completed slips, with payment, to P S Nau, Department of Geography and Geology, University of Hong Kong, Pokfulam Road, HONG KONG.

FERRY TRIP TO PAK KOK (LAMMA ISLAND)

Saturday 29 February 1992

In this issue is a detailed account of the granite excursion run by the Hong Kong Geological Survey for the Hutton Symposium on "Origin of Granites and Related Rocks". One locality of great interest is Pak Kok on north Lamma Island, and the complex relationship between volcanics and a host of complex intrusive rocks has fascinated all those who have puzzled over its origin. If you would like the opportunity to take a closer look in the company of field mapping geologists from the Survey, join this trip.

In addition to looking at Pak Kok, the party will have the opportunity to have a seafood lunch in Yung Shue Wan, or walk across the island to Sok Kwu Wan before returning to Hong Kong. The ferry times are:

Central-Yung Shue Wan	8.35 am (42 min trip)
(Central-Sok Kwu Wan)	10 am (50 min trip)
Yung Shu Wan-Central	1.40 pm, 3 pm, 4.40 pm
Sok Kwu Wan-Central	3.30 pm, 5.20 pm

The preferred route is Central-Yung Shue Wan (8.35 am), return Yung Shue Wan-Central (3 pm), but other routes and timings are possible as long as everyone meets at Pak Kok mid-morning. Families with small children are most welcome, as there is very little walking and only a little clambering on rocks.

THERE IS NO NEED TO BOOK AS TRANSPORT IS BY PUBLIC FERRY, AND LUNCH IS AT YOUR OWN EXPENSE. PLEASE CONTACT RICHARD LANGFORD (762-5382) OR ROD SEWELL (762-5385) TO CONFIRM THAT YOU WILL BE JOINING THE FIELD PARTY.

Booking slip: PAK KOK, LAMMA ISLAND, 29 FEBRUARY 1992

I wish to inform you that ______ people will be joining the ferry at 8.35 am/ 10 am**.
I would / would not** like to join the party for lunch in Yung Shue Wan at my own expense.
**Delete as appropriate

NAME: ________________________________

CONTACT TELEPHONE: ______________(OFFICE)______________(HOME)

NAMES OF OTHERS:

____

____

Send completed slips to P S Nau, Department of Geography and Geology, University of Hong Kong, Pokfulam Road, HONG KONG.

BOAT TRIP TO PING CHAU (MIRS BAY)

Sunday 8 March 1992

Ping Chau, always a popular destination, needs no introduction for most of our members. It is geologically and scenically unique in Hong Kong, with an atmosphere all its own. Delightful walks over the easy terrain, intriguing geology, pleasant beaches and outstanding views. Food and drink are available at shops opened specially at weekends in the two more or less abandoned hamlets near the pier, but business is usually brisk at these establishments and many prefer to bring picnics.

The boat will depart from Ma Liu Shui ferry pier, near the KCR University Station, at 9.30 am. Allow at least 10 minutes for the walk from the station. We will get back at about 5 pm.

Cost per person:	Members and spouses	$ 60
	Student Members	$ 30
	Member's children under 18	$ 30
	Guests	$ 80

BOOK NOW: FIRST COME, FIRST SERVED. MEMBERS AND FAMILIES WILL HAVE PRIORITY OVER GUESTS. YOU WILL BE CONTACTED ONLY IF THERE ARE NOT ENOUGH PLACES TO ACCEPT YOUR BOOKING.

Booking slip: PING CHAU (MIRS BAY), 8 MARCH 1992

I wish to book ______ places at $ 60, ______ places at $ 30 and ______ places at $ 80. I enclose the total payment of $ ______

NAME: ________________________________

CONTACT TELEPHONE: ________________(OFFICE)________________(HOME)

NAMES OF OTHERS (state if Member, Student Member, spouse, child or guest):

____

____

Cheques should be payable to *The Geological Society of Hong Kong* and crossed. Send completed slips, with payment, to P S Nau, Department of Geography and Geology, University of Hong Kong, Pokfulam Road, HONG KONG.

EPHEMERA

Schofield's field notes - Chek Lap Kok, 25 November 1925

The Hong Kong Archaeological Society recently obtained the original field notebooks used by Schofield in his geological survey of the Territory in the 1920s and 30s. The notebooks contain many archaeological as well as geological observations, reflecting his interest in both subjects.

Most of the books are in remarkably good condition, having been stored untouched by his family for many years after his death. However, the paper has yellowed, making the pencilled notes hard to reproduce from the original. The Hong Kong Geological Survey has borrowed these precious notes and photocopied them, ensuring that the archive will be preserved in at least two locations for future scholars.

As Chek Lap Kok is of great interest to the scientific and engineering community, we have extracted Schofield's notes for the island. They are printed here without editing.

Ch'ik Lap Kok, 25-11-25.

Large sandy bay, W. side, has behind it a terrace 30 to 40 ft high, sloping inland, apparently of decayed granite. Many of the stones found on top of the terrace are waterworn. Terrace repeated at S. beach. Stone sinker, of granitic type of rock, found here, along with fragments of jars, probably burial urns. Just north of this beach great quantities of quartz can be seen: it is v. common all over the island. Orthoclase-bearing granite is found on E. coast between the low terrace by S. beach & the 1st bay to N. of it; the belt of this granite is not very wide but no measurement was made. Possibly it is 200 yards. At N. end of the small bay just S. of no. 2 quarry some boulders of dark gray broken rock were seen, perhaps fragments of a basic dyke trending E.-W. 1 sp. vein quartz taken.

It is difficult to pin down exact locations from the sketchy descriptions given, but the large sandy bay on the west side may be Fu Tei Wan or Cheung Sha Lan. No 2 quarry is almost certainly east of Miu Wan, as the stone quarries were only situated in the north of the island. A "sinker" is a stone used for sinking or weighing down a fishing net.

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