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香港地質學會

NEWSLETTER
通 訊

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Geological Society of Hong Kong

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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.

Typescripts: Typescripts must be accurate, legible and in their final form; two complete copies should normally be sent to the Editor. Typescripts should be double-spaced, including references, on one side only of A4 paper, with 25 mm margins on all sides. All pages should bear the authors name and be numbered serially. Text supplied on diskette using any conventional DOS word processing package (Wordperfect, Wordstar, Multimate, etc) or ASCII text is preferred to hard copy.

Illustrations: Send the originals of all illustrations, each marked with the author's name, figure number and caption. Illustrations can be in black on tracing material or smooth white paper or board, but clear film positives to final size are preferred, with a line weight suitable for reproduction. 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, although generally they should be exactly 16 cm wide by no more than 23 cm high.

References: The author is responsible for ensuring that all references are correct. The list of references should be given in full, including volume, part and page numbers, with no abbreviations in the title of the paper or journal.

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Geological Society of Hong Kong Newsletter

Vol 9 No 4 (December 1991)

CONTENTS

EDITORIAL

Yet again this issue of the Newsletter comes to you a little later it should. Trefor Williams' contribution on the Lin Ma Hang mine was received a long time ago, but the problem of a steady flow of sufficient material to form a readable and varied Newsletter is still with us.

A recent trip to the island of Ping Chau by the Geological Survey led to the discovery of trace fossils, and Alan Fyfe has written a note on their discovery and possible origin. As interest in Ping Chau continues we thought it would to appropriate to include Schofield's map and notes on the island.

Also in this issue is an index and bibliography for all Newsletters to-date. This should show the way forward to the creation of a comprehensive bibliography of all our publications, and possibly all geological publications relevant to Hong Kong. If any reader has any comments on the bibliography, we would very much like to hear from you. Accuracy is important, and we would certainly like to know of any mistakes that have slipped through our editorial fingers.

In 1982, when the Newsletter started, personal computers were a tool of the future. As printing costs have risen, the ability of individuals to enter the world of desktop publishing has become easier. We believe that the standard of articles and the overall appearance of the Newsletter is now very pleasing. However, the Society needs your articles, stimulating correspondence, news items (in English or Chinese) and photographs if this is to continue.

Richard Langford, Editor

2. 6. 1882

THE PALAEOGEOGRAPHICAL EVOLUTION OF HONG KONG'S OFFSHORE ENVIRONMENT

Ron Neller[1], Raynor Shaw[2] & Bernie Owen[3]

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Marine Studies Group Discussion Meeting - A slide-illustrated presentation

Date: Monday 1 June 1992
Venue: Ground Floor Seminar Room
Civil Engineering Building
101 Princess Margaret Road
Homantin, Kowloon
HONG KONG
Time: 6.00 - 7.30 pm

Abstract

The offshore area of Hong Kong is currently the focus of massive and extensive infrastructural developments. A clear understanding of the offshore stratigraphy is considered necessary to facilitate the completion of safe and cost-effective engineering designs.

A layer of Holocene marine mud (the Hang Hau Formation) up to 25 m thick blankets the sea floor over much of the Territorial waters, below which is a stratigraphically complex assemblage of sediments, the Chek Lap Kok Formation, which in turn overlies weathered bedrock. Several conflicting interpretations have been advanced for the origin of the Chek Lap Kok Formation. One view holds that the sequence comprises several marine horizons. A second viewpoint considers that these sediments are essentially nearshore terrestrial facies, whilst a third interpretation is that the sequence represents buried loess deposits and sand dunes.

The Hong Kong Geological Survey has carried out a programme of offshore geological investigations that include seismic refection profiling, combined with boreholes and vibrocore sampling. Detailed analyses of the borehole sediments is currently underway with the aim of determining the depositional environments of the materials. Analyses include particle size, mineralogical and geochemical characteristics and diatom species determination. Several radiocarbon dates are also available. These data have enabled the refinement of the interpreted seismic stratigraphies and are assisting seismo-stratigraphical correlation across the Territory.

Initial results indicate that the distinctive olive-grey, shelly, marine muds overlie a complex sequence of terrestrial and nearshore (deltaic/estuarine and coastal) units of late Pleistocene age in which medium to coarse sand units (essentially structureless and moderately sorted) are interbedded with finely laminated silt units. Definitive interpretations of this sequence, however, are hindered by the occurrence of zones devoid of diagnostic fossils and organic matter.

It is concluded from the work undertake so far that there is no firm evidence of multiple marine transgressions preserved in the offshore sedimentary record. This suggests that the high energy fluvial environments and subaerial weathering conditions that prevailed during the Pleistocene were responsible for removing or masking evidence of previous transgressions. It is also clear that the terrestrial sediments were not deposited under arid aeolian conditions.

Acknowledgment is made to the Director of Civil Engineering for permission to publish this abstract. The paper will be presented in August 1992 at the 27th Congress of the International Geographical Union in Washington, USA.

Geological Society of Hong Kong Newsletter Vol 9 No 4 p 3-27 (1991)

THE STORY OF LIN MA HANG LEAD MINE, 1915-1962

Trefor Williams

Geotechnical Engineering Office, Hong Kong Government

Abstract

Lin Ma Hang mine is situated on Hong Kong's border with the People's Republic of China. The mine operated intermittently from 1915 until 1958, during which period it produced concentrates containing an estimated 16,000 tonnes of lead metal and 360,000 ounces of silver. The mining lease was rescinded by the Hong Kong Government in 1962. The most important period of production was immediately before the Second World War, when substantial capital was injected into the operating company, Hong Kong Mines Limited, for the development of the underground workings and the construction of a modern mill to process the ore.

Introduction

Location. Lin Ma Hang lead mine is located immediately to the south of the border between Hong Kong's New Territories and the People's Republic of China. At this point the Sham Chun River forms the boundary. A road, known as the Border Road, follows the south bank of the river and gives access to the mine site, which is located within a few hundred metres from the road and is visible from the road. The mine site is within 2 km from the village of Lin Ma Hang, from which place the mine received its name. Figure 1 shows the location of the mine.

Since 1950, the part of the New Territories immediately adjacent to the Chinese border has been designated a closed zone, and the mine site falls within this zone. Access to the mine site from Man Kam To along the Border Road is restricted and is only possible with prior permission from the Royal Hong Kong Police.

Geology and ore reserves

Geology. The geology of the Lin Ma Hang area is dominated by a thick succession of coarse ash tuffs with sedimentary intercalatons of the Upper Jurassic Tai Mo Shan Formation. These volcanic rocks belong to the Repulse Bay Volcanic Group. Regional metamorphism has affected these tuffs to varying degrees, often forming mylonitized metatuff. Hydrothermal alteration of the volcanics is evident in places. Figure 2 shows the regional geology in the vicinity of Lin Ma Hang mine (Allen & Stephens 1971).

In the paper on the geology of Lin Ma Hang mine by Davis & Snelgrove (1956) the dominant rock types were identified as Tai Mo Shan porphyry and Lok Ma Chau schist. According to Allen & Stephens (1971) the Tai Mo Shan porphyry was subsequently re-examined and the porphyritic texture was found to have resulted from metamorphism of the coarse ash tuff. Allen and Stephens confirmed the presence of "excellent schistosity" in sedimentary rocks, comprising silty slates and sandy siltstones of the Lok Ma Chau formation on the ridge west of Lin Ma Hang.

The mineralisation consists of a series of en-echelon, NW-SE striking, fissure vein deposits. The dip of the ore veins is generally between 15° and 60°, although in places the veins can be near-vertical. The veins are lenticular, both along strike and down dip, and pinch and swell over a known strike length of approximately 2 km. The vein width can vary between a few millimetres to several metres.

Mineralogy. In the veins, quartz and sericite are the dominant minerals. Sericite, with lesser amounts of chlorite and pyrite, comprise the wall-rock alteration. According to Davis & Snelgrove (1956), the initial vein filling consisted of coarse barren milky quartz, with crystals up to several inches in length. This was followed by the intrusion of a fine-grained quartz. This latter intrusion carries the metallic minerals, which are also contained in the inter-mixed wall-rock.

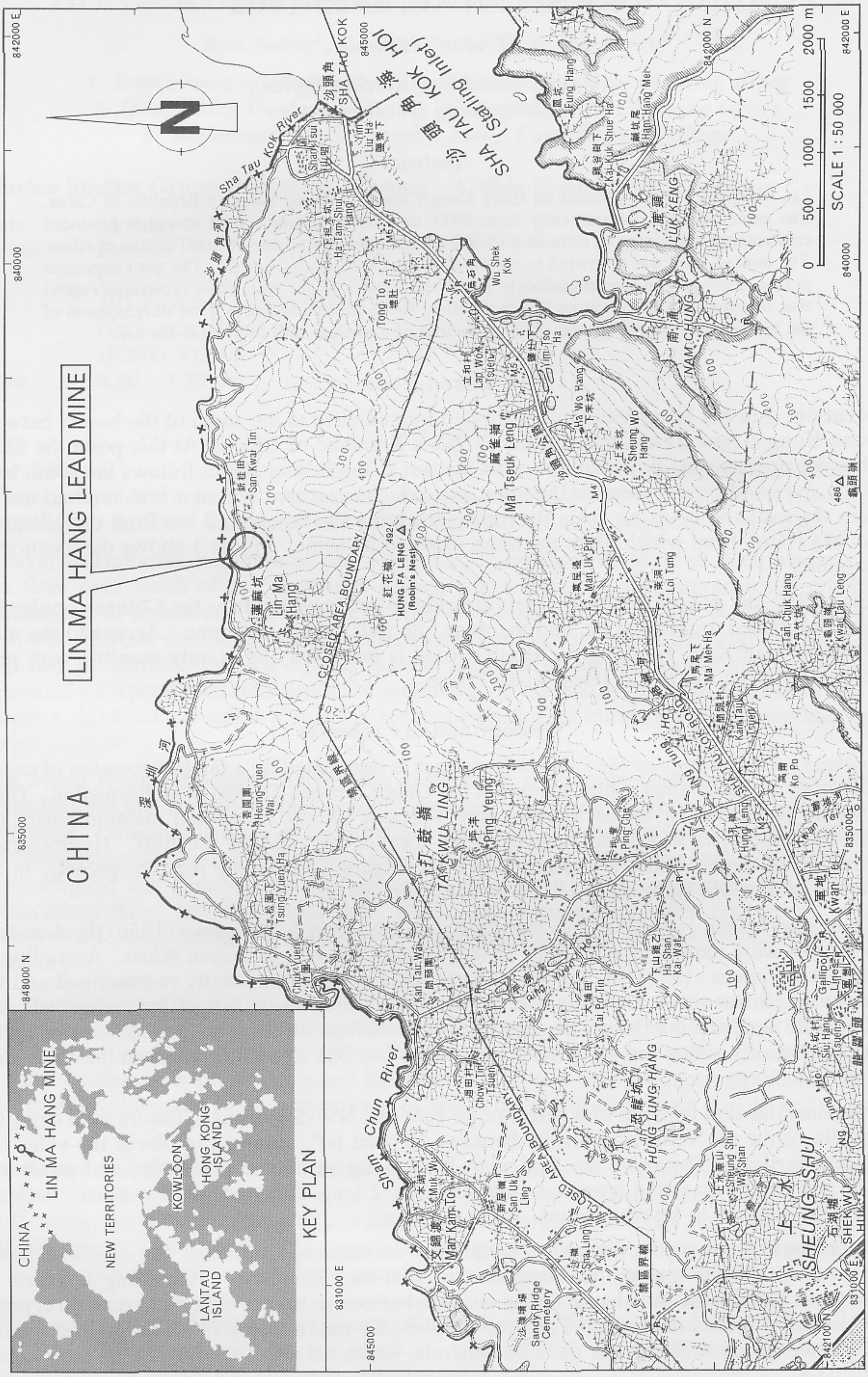


Figure 1 Location of Lin Ma Hang mine

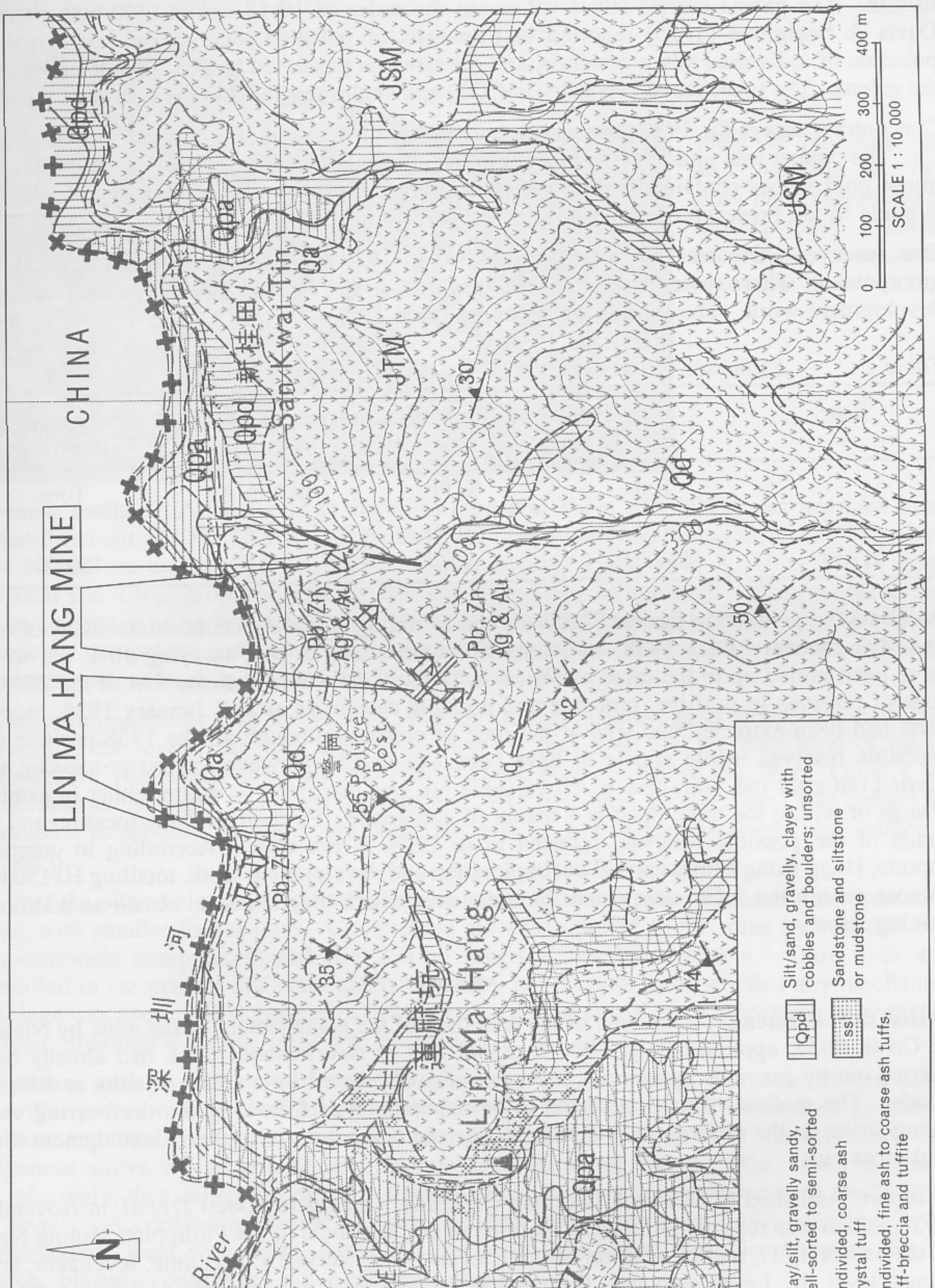


Figure 2 *Geology in the vicinity of Lin Ma Hang mine (after Lai & Shaw 1991)*

In order of abundance, the metallic mineralisation consists of galena, pyrite, sphalerite, and chalcopyrite. The metallic minerals are predominantly fine-grained, rarely exceeding 10 mm in size. The galena carries silver values, in the order of 10-15 oz/ton (300-500 g/tonne). Davis & Snelgrove (1956) reported that analysis of polished sections did not reveal the presence of individual silver minerals, and the silver is presumed to exist in solid solution in the galena. The presence of cerrusite ($PbCO_3$) and anglesite ($PbSO_4$) has also been reported.

Concentrate assays for 1937 gave average values of 0.04 oz/ton (1.3 g/tonne) Au and 1.56% Cu. The copper was undoubtedly present in the concentrate in the form of chalcopyrite, with minor gold values contained within the chalcopyrite. Surprisingly, no subsequent reference is made to the presence of either gold or copper.

Ore reserves. Ore reserves were first quoted in 1936 when Hong Kong Mines Ltd was incorporated. These reserves were revised upwards, as at 1 January 1938, after the first year's development work. The figures are given in Table 1.

Table 1 *Estimates of ore reserves*

Year	Positive & Probable Reserves			Possible Reserves
	Tons	% Pb	oz/ton Ag	Tons
1936	80,000	10.00	1.5	-
1938	111,716	9.75	2.5	120,000

Based on the production figures (Table 2), and assuming an average concentrate assay of 65% and 90% recovery since 1938, an estimated 140,000 tons of ore, assaying 10% Pb would have been mined up to the mine's closure in 1958. This would indicate that of the 230,000 tons of reserves in positive, probable and possible categories as at 1 January 1938, roughly 60% had been extracted and sold at the time of closure, although all the 1938 positive and probable reserves would appear to have been exhausted. However, as no processing was carried out after the War, how much valuable ore was discarded as waste, either in external dumps or within the mine itself is a matter of conjecture. Furthermore, the location and the grade of the possible reserves, referred to in 1938, is not clear. According to company reports, Hong Kong Mines carried out exploration and development work, totalling H$150,000 in cost, within the 1,196 acre extension area, over which they hoped to obtain an additional mining lease.

Mining

Initial development. At the time of the take-over of the management of the mine by Nielson & Co in 1937, approximately 7,000 to 8,000 feet of development work had already been carried out by previous operators. The mine was developed by a series of adits at different levels. The method of mining seems to have been one of following the ore-bearing veins along strike on the different levels, most of the ore being won from these development drifts and cross-cuts.

A report, published in Denver Equipment Company's magazine, *Deco Trefoil*, in November 1938, which was reportedly reproduced from an earlier article in the Philippine Mining News at the end of 1937, makes mention of three levels being worked at that time, level zero, level 1 and level 3. Level zero was the uppermost level and was described as being 80 feet vertically above level 1 but 120 feet up-dip. According to the report, most of the work in 1937 was carried out on level 1. Ore from level 1 was dropped vertically 160 feet down to level 3, from where the main haulage tunnel connected level 3 with the surface portal, at the same elevation as the top of the mill bin. Ore was also hauled out through level 1, trammed around the mountain and dropped to the crusher via an external chute. This chute is visible in Plate 1 immediately above the mill building in the centre of the photograph. The report mentions the construction of a vertical storage raise between level 3 and level zero.

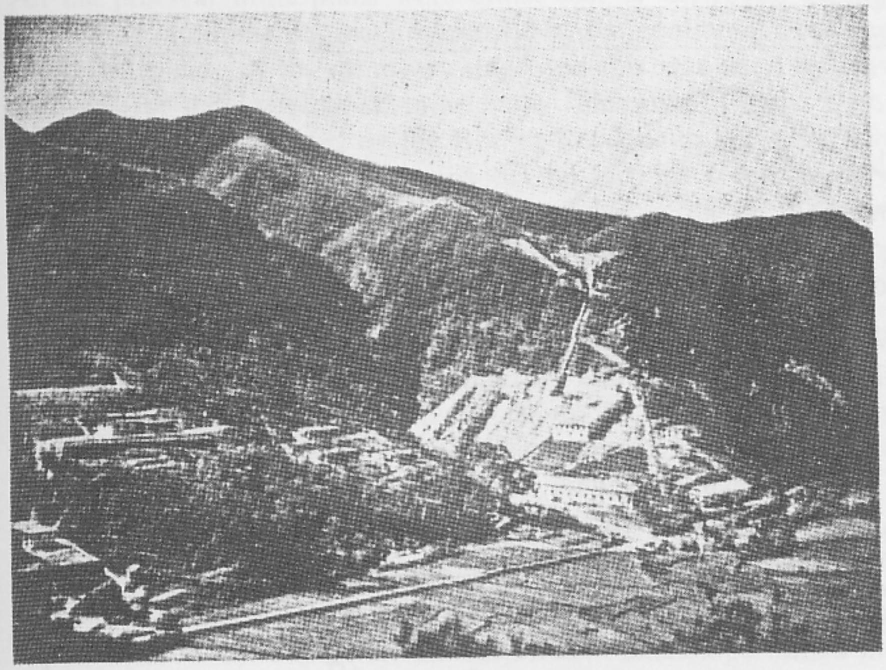


Plate 1

View of the mine and mill building in 1938 from the Chinese border looking south. Note the ore chute immediately above the mill building

Mining method. Above level 1, the veins dipped at about 35°, and it was intended to use a modified cut and fill system to mine this part of the ore body, using slushers to muck out the broken ore and replace it with fill. Between level 1 and level 3, the vein was almost vertical and it was proposed to mine this area by cut and fill methods. There seems to have been a shortage of timber. Chute gate frames were made of concrete. However, the rock was generally competent, and apart from an occasional stull and drift set, little timber was needed underground, at least in the part worked before the War.

A report immediately after the War, in 1946, by George Scholey, gives a different numbering system to the levels. Scholey talks about level 1, zero level and the road level of the old *Portuguese Workings*, which he said produced the best ore before the War. Level 1 was described as the upper level, and the zero level was tunnelled in under level 1 to extract any extension in depth of the "large ore body" on level 1. The uppermost levels were numbered 5 and 6.

Before the War, holes were drilled using pneumatic drills, supplied by an 8" compressed air line, with smaller feeder lines. Compressed air was supplied to the mine by two 600 cu ft Broomewade compressors and one 250 hp Ingersoll Rand compressor. Tram lines were installed in the main levels and outside the mine, but it is not clear whether any mechanised haulage was used. All stores had to be carried up the mountain to the upper levels by manual labour, although a service hoist was planned.

Japanese and post-War workings. The Japanese mined most of the ore extracted during the War years from the Eastern section of the mine. Apparently, ore was mined by robbing pillars, and this resulted in caving of the roof in the part worked by the Japanese. The Japanese drove an additional intermediate level between the pre-War levels 5 and 6. Confusingly, they called this new level No 6, and later it has been referred to as the "new No 5 level". According to Mines Division records from December 1951, working in this intermediate level was highly dangerous, as, with insufficient clearance between the two levels, blasting could bring down the level above.

A fatality was reported in May 1952, but not due to a rock fall. A miner, employed by the contractor Tonley & Co, had climbed the raise in No 2 level, during cleaning operations, and had been overcome by "gas" (probably lack of oxygen). A police inspector, who tried to rescue the miner, was also partially overcome by gas, and had to retreat. The body of the dead miner was later recovered by the Fire Brigade. After the War, Scholey favoured mining in the area between the *Portuguese Workings* and the *main workings* or Eastern section.

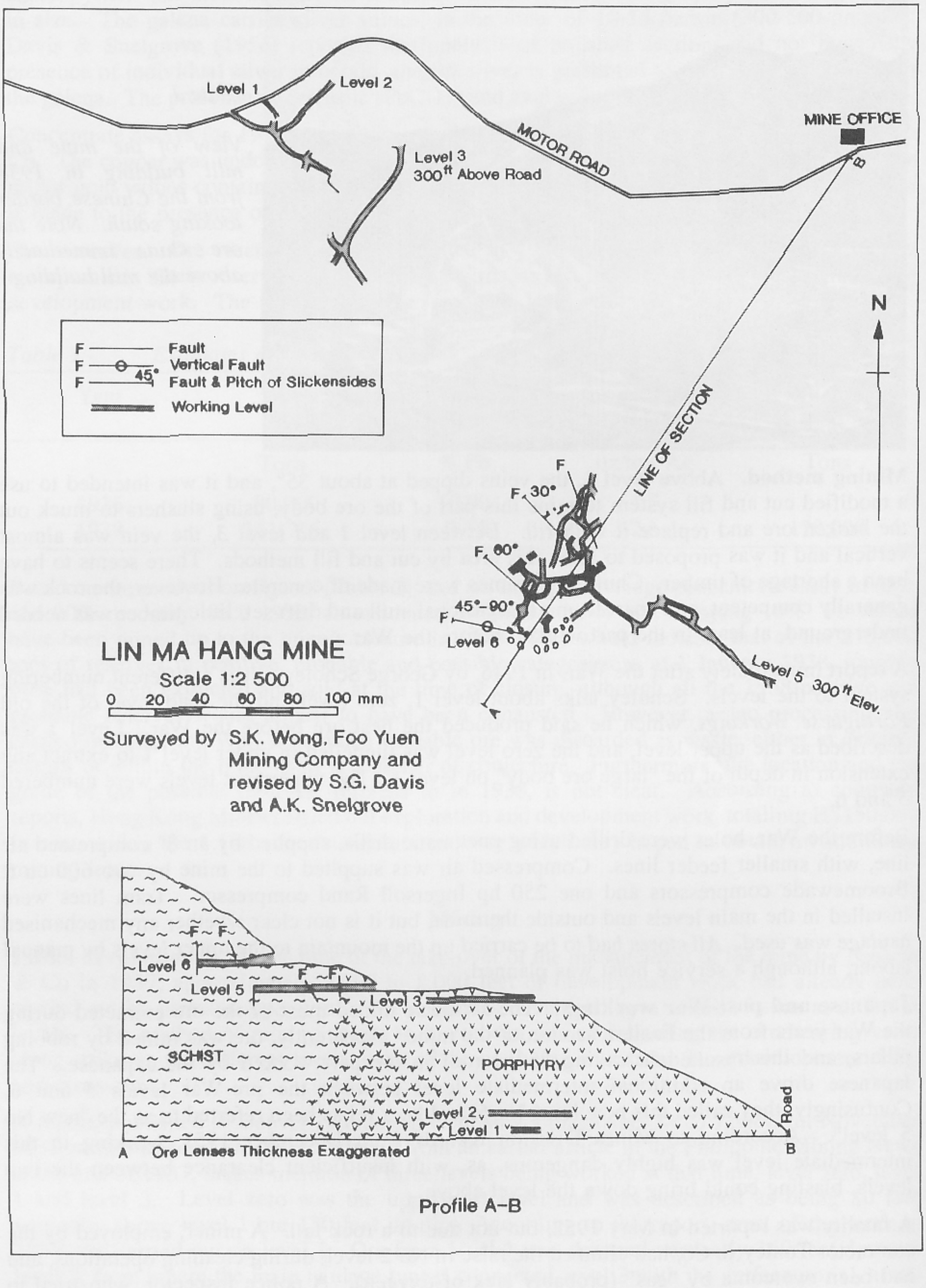


Figure 3 Plan of the mine workings in the 1950s (after S K Wong)

All the pre-War mine plans were either lost or destroyed during the Japanese occupation. S K Wong, a mining engineer employed by the contractor Foo Yuen & Co in 1953, produced a schematic map of the mine workings and this was used by Davis & Snelgrove (1956) as the basis for their geological mine map. This map, Figure 3, shows five levels, 1, 2, 3, 5 and 6. Level 1 is located on the Border Road, with the other levels at progressively higher elevations. The relative locations of the various levels given on this map are suspect, particularly level No 3, which is almost due south of the mine office. The geological descriptions given on the section also differ from the current geological map (Sheet 3), which shows the "schist" as schistose metatuff and the "porphyry" as coarse ash crystal tuff.

In the early Fifties work was only allowed in levels 2, 5 and 6. When worked by contractor, the mining seems to have been haphazard and without any definite planning. One stope on level No 6 was reported to have gone up 40 ft in height and then dropped down again, resulting in very poor ventilation. Waste ore was reported being dropped down the ore pass connecting level No 6 with No 5 below, emerging near the portal of level No 5, from where it was hauled by wheel-barrow to the dumping ground.

In 1953 the contractors were allowed to re-open Level No 3. This involved clearing out about 50 ft of caved tunnel near the entrance. Access was then gained to a stope about 70 ft above the level by way of an old ore chute. This stope mined the same galena vein as was found on the right hand side of No 3 level about 250 ft from the portal.

Figure 4 shows the extent of the workings on level 3 that are currently accessible (1991). This plan clearly shows how the ore-body was developed along strike. Access to the southeast portion of this level has been blocked by a roof fall. Mention is made in July 1954 of a No 8 level with a shaft, fitted with ladders going down from No 5 level.

After the War, when the mine had been stripped bare of almost anything of value, the company had no money to invest in mechanised equipment, and mining was carried out entirely by manual methods. Blast holes were drilled by hand with a sledge hammer and hand-held steel drill (Plate 2). Blasted ore was hauled out of the mine using wheel-barrows. Similarly waste rock that was not dumped underground was transported by wheel-barrows, or by using pannier baskets on bamboo poles, to the waste dumps on the surface. The ore was hand sorted and the concentrates had to be carried down by labourers to the road for transportation to the port. Gelignite was used for blasting. This was supplied by Imperial Chemical Industries (ICI) from their explosives store on Green Island.

In the Fifties much of the preliminary work involved cleaning out collapsed portions of the mine. Some development work was carried out. Sub-level No 2 was driven 87 ft from the portal to meet the top of No 2 ladder raise, which itself was connected to No 2 level. Figure 5 indicates the extent of the accessible workings on level 2. As with level 3, the plan shows the development of the ore-body along strike. The strike direction of the ore-body in level 2 is very similar to that in level 3.

In May 1955 a crosscut was driven to connect No 2 level to No 1 level. A second crosscut was also driven through to improve ventilation in the No 2 level. On instructions from the Government, tunnel entrances, No 1, 1A and the *Portuguese Tunnel*, which opened on to the Border Road were bricked up and a 3-4 ft wide path was constructed over a distance of 450 ft to connect the portals of No 2 level with No 3 level. To prevent waste rock from falling onto the Border Road a retaining wall was built in front of No 2 portal.

After taking over mining operations from the contractor in 1954, the company concentrated most of their attention on levels 2 and sub-level 3A. The so-called Py Nam vein on level 2 appears to have been the richest sector worked during these years. Work on a new sublevel 3B commenced in March 1956. This new sub-level was located 150 ft higher than 3A, 50 ft below No 3 tunnel and approximately 200 ft to the west.

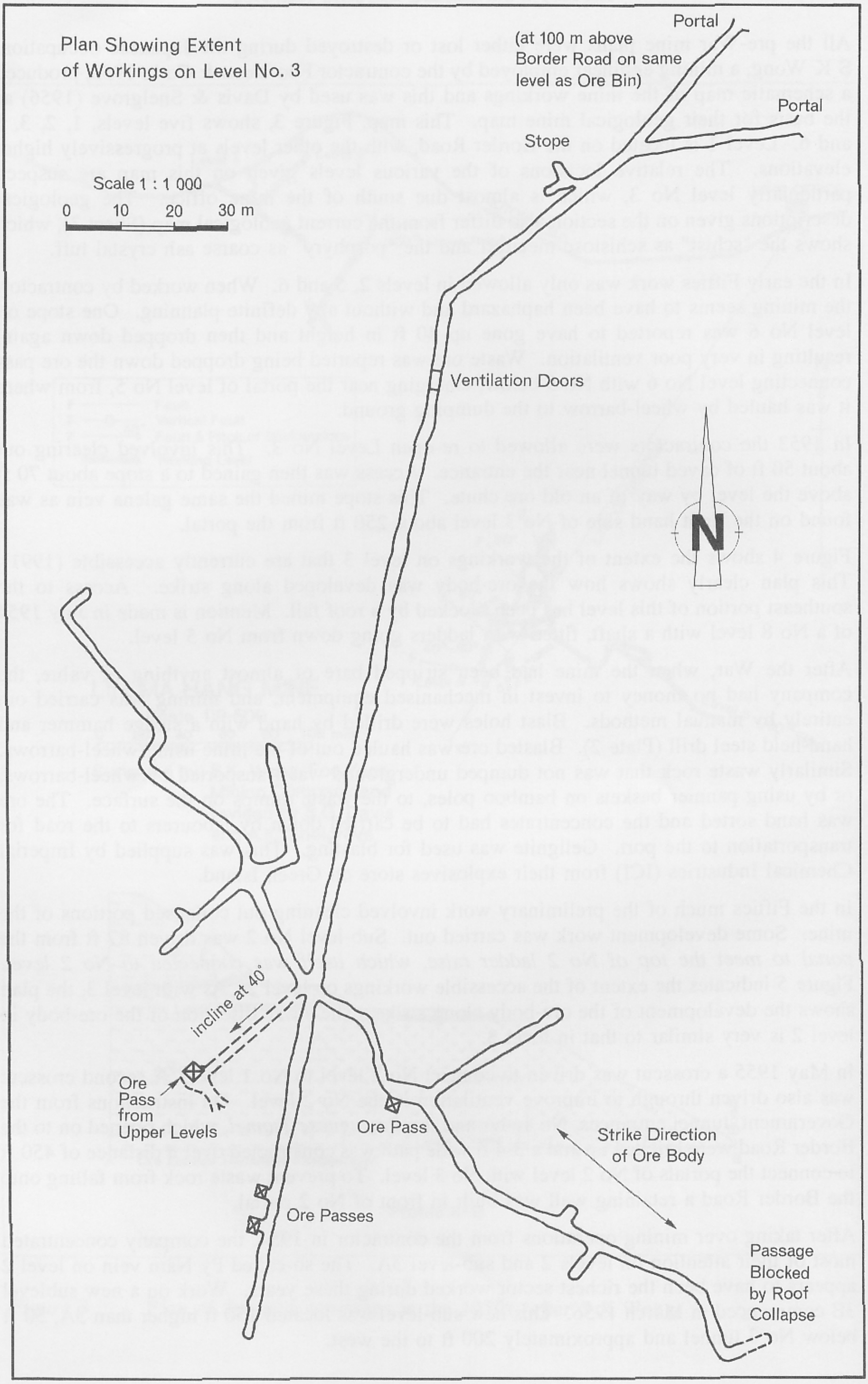


Figure 4 *Extent of workings on Level No 3*

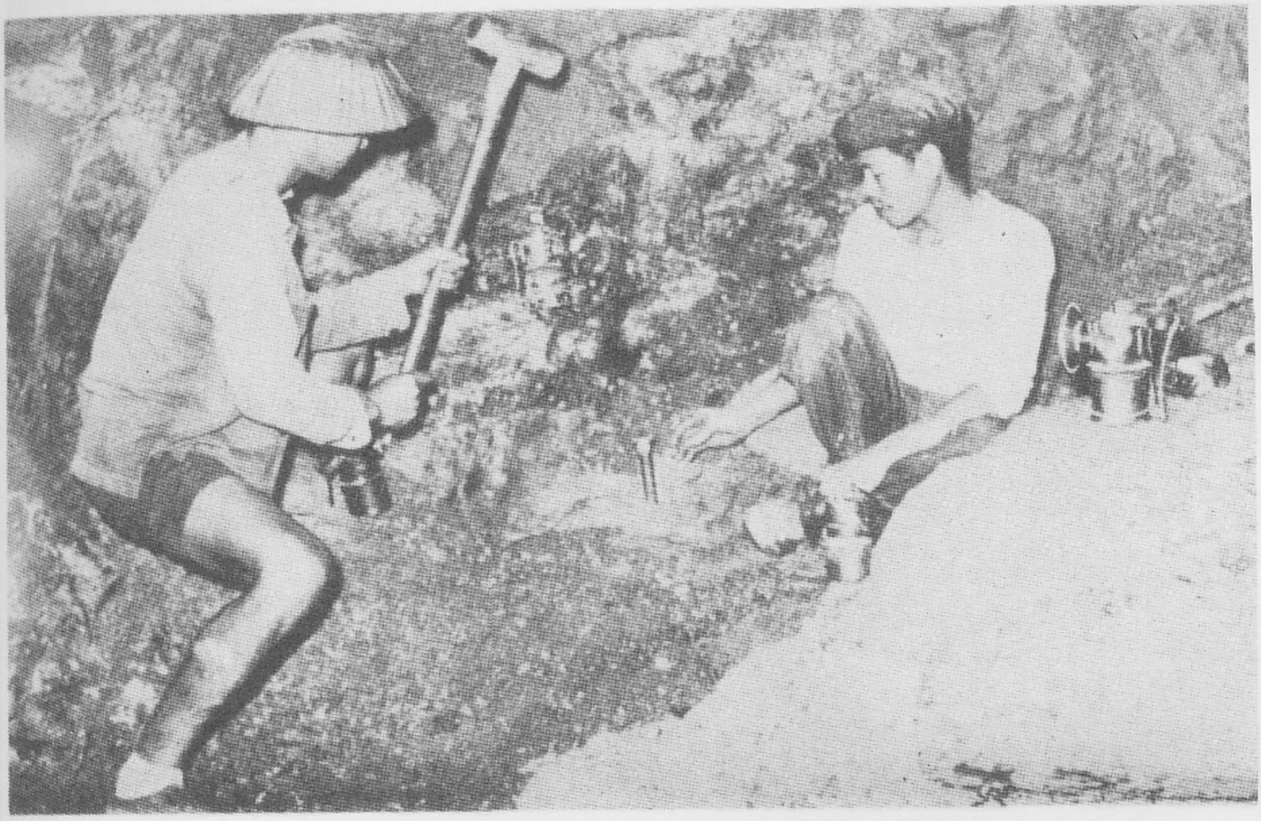


Plate 2 Drilling by hand in the Fifties

Processing

Early operations. In 1917, shortly after the discovery of the main ore body, a six-stamp battery was installed, operated by electric power generated using a Pelton wheel, to crush the ore. This was later shut down due to insufficient water in the winter months to power the Pelton wheel. At this stage, no mention is made of any concentrating plant, and it is presumed that concentration of the galena ore was done by hand-picking to produce a saleable concentrate.

Pre-War mill. After Nielson & Co took over management of the mine, a mill was constructed. The mill was commissioned on 1 October 1937. Plate 3 shows the mill and other surface buildings in 1938. The remains of the mill building and some of the equipment foundations can still be seen at the site, below the portal to No 3 level. Plate 4 shows how the mill site looked in 1956, taken from roughly the same position as Plate 3, only eighteen years later.

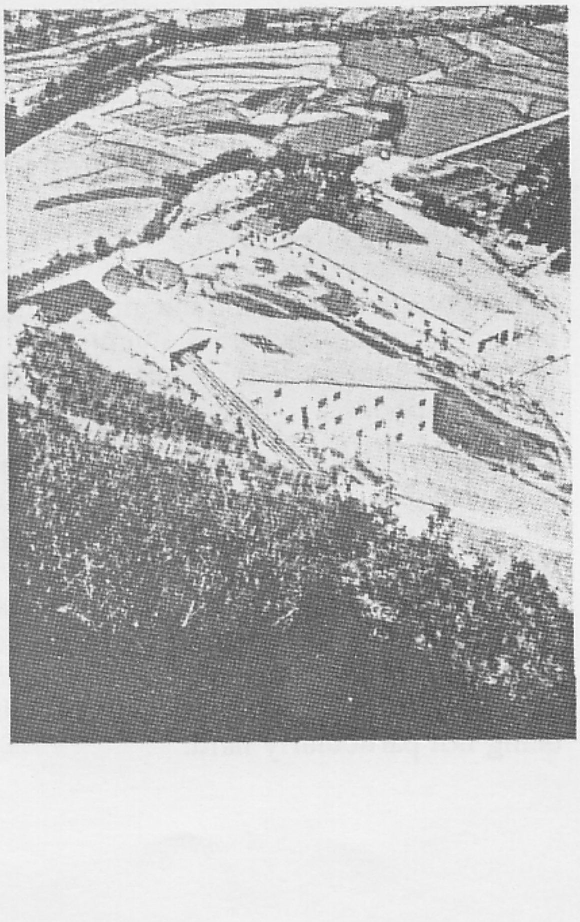


Plate 3 Mill building in 1938. Note thickener immediately to left of mill building. The workshop, office, store building and border road can also be seen.

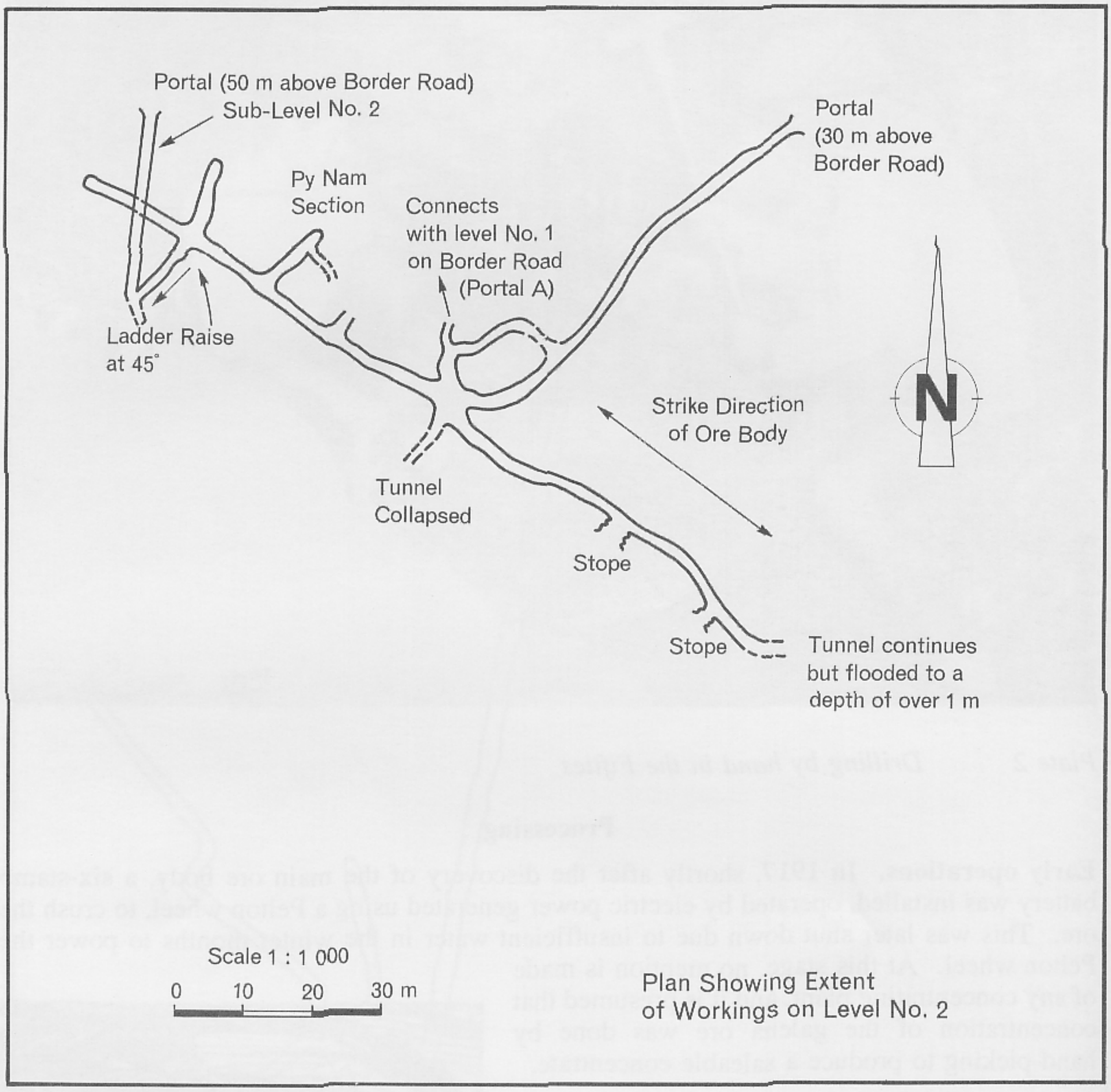


Figure 5 *Extent of workings on Level No 2*

Plate 5 shows a close-up shot of the ruined mill building with the old tailings dump visible in the background behind the mine office building. The mill was of modern design, for 1937, and was constructed on a number of levels to allow gravity flow where possible. The laboratory test work for devising the flowsheet was carried out by Nielson & Co in their Manila laboratory. The original flowsheet is shown in Figure 6.

The mineralogy of the ore is fairly simple, galena being the principle mineral of value. The main gangue mineral was quartz. Although some zinc was known to be present, as sphalerite, there was no attempt in the original design to make a separate zinc concentrate. However, there were future plans, in 1938, to carry out further test work with a view to determining the economic and technical viability of separating the zinc and also the pyrite. The silver was associated with the galena. Very minor amounts of cerussite and anglesite have also been reported. In 1938 the head grade to the mill was reported as assaying 10-12% Pb and 1.5-3.0 oz/ton Ag. The ore was contained in a siliceous gangue, which was described as being not particularly hard.

Plate 4 Remains of pre-War mill building, mine office, stores and staff houses in the Fifties. Note the Sham Chun River in the background forms the border between Hong Kong and China

Plate 5 Remains of pre-War mill building in the Fifties, with old tailings dump in the background

The ore was first crushed, using a jaw crusher, to minus 1.5", after which it was passed to a 100 ft-long sorting belt for hand removal of any free waste. After the sorting belt the ore was fed from a 525-ton bin to a 6 ft diam x 6 ft ball mill, where the ore was ground to minus 65 mesh, in closed circuit with a 6 ft Dorr classifier. Flotation reagents were added both to the ball mill feed and directly to the rougher flotation cells. As the galena was readily floated, there was no need for separate conditioning ahead of the flotation cells. The galena was concentrated by flotation, with two stage cleaning installed to produce high grade concentrates for sale to the smelter. A bank of 10 Denver Sub-A cells were installed for flotation (Plate 6). The concentrates were thickened using a 16 ft Dorr thickener and filtered using a 3-leaf American filter, from where they fell directly to a drier on the floor below. The tailings first passed over a shaking table, to monitor losses, and were then thickened prior to discharge using a 40 ft Dorr thickener. Power was supplied by a 3 mile overhead line from China Light & Power Company's sub-station at Fanling. The original mill capacity was 150 tons per day (tpd), but this was later increased to 225 tpd and a second jaw crusher was installed in parallel with the first.

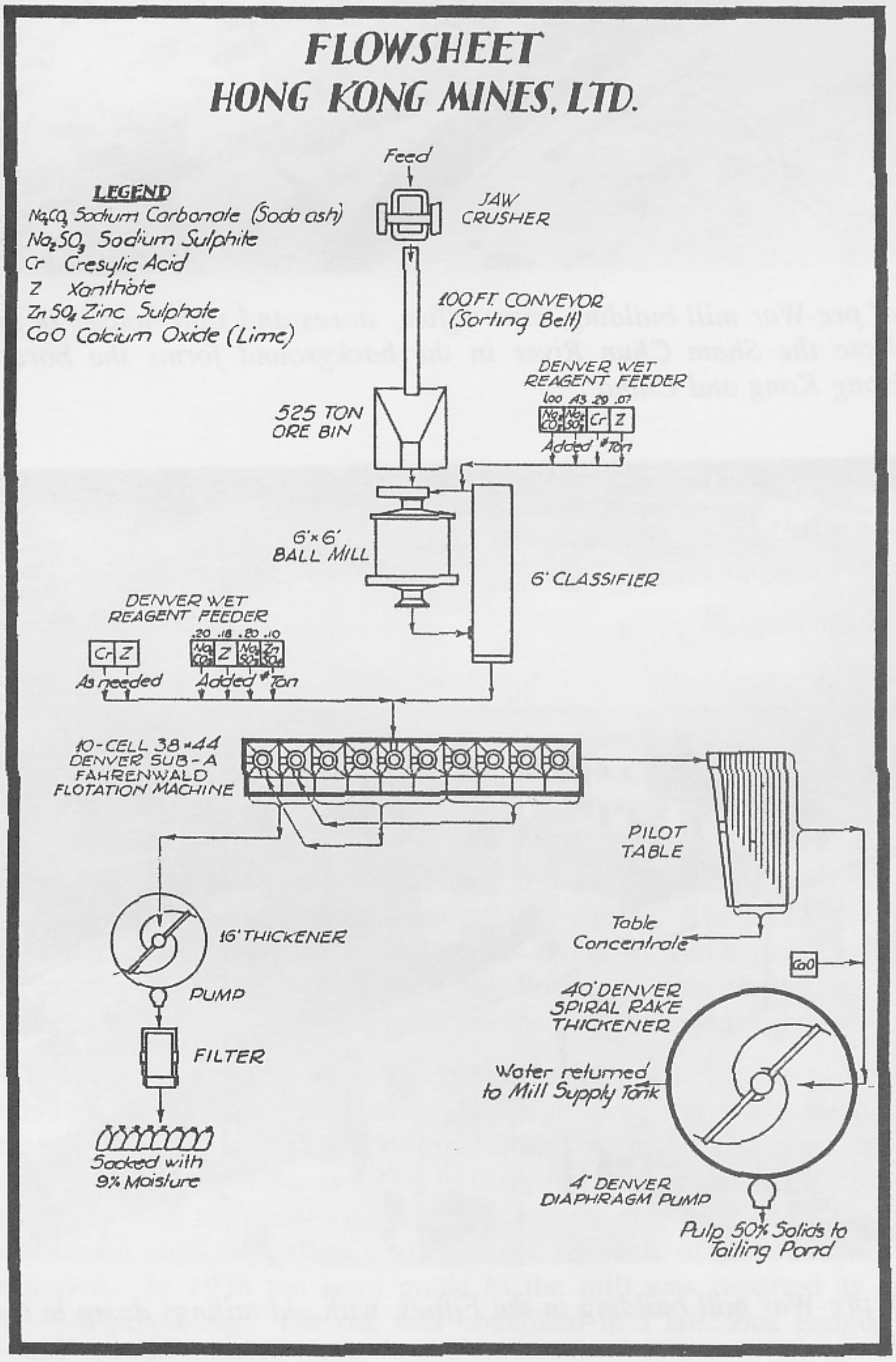
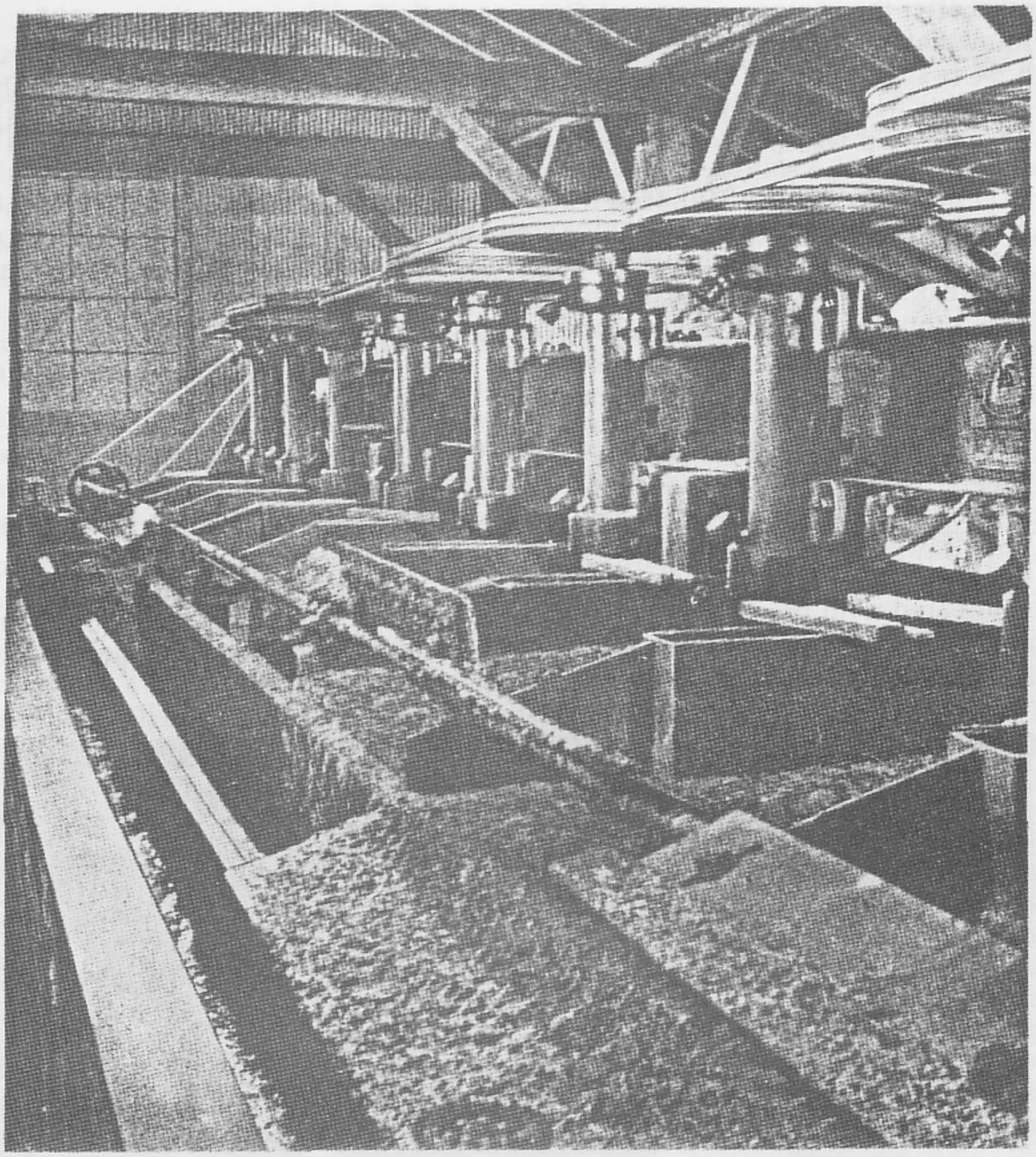


Figure 6

Flowsheet for the mill in 1938

Plate 6

Flotation cells installed in the mill in 1938. Note galena froth being skimmed off the top of the flotation cells



Pre-War reports in *Deco Trefoil* show that concentrates of 71% Pb, with contained silver values of 17 oz/ton Ag were attained at overall recoveries of 95% for lead and 85% for silver. Pure galena has a theoretical lead content of 86.6%, based on stoichiometric proportions. However, in practice it is rare for galena concentrates to exceed much over 80% Pb. The lead concentrates were shipped for sale to lead smelters in Europe.

The figures for Lin Ma Hang before the War indicate that the ore was relatively easy to treat and that the plant operated reasonably efficiently. The recovery and concentrate figures would be acceptable, even by present day standards. Reagent consumption before the War was reported as follows:

Sodium carbonate	1.20 lb/ton	Xanthate	0.25 lb/ton
Sodium sulphite	0.63 "	Zinc sulphate	0.10 "
Cresylic Acid	0.29 "		

The sodium carbonate was used to control the pH. Sodium sulphite and zinc sulphate were used, in conjunction, to depress the minor amount of sphalerite that was present in the ore. Xanthate was used as the flotation collector, with cresylic acid as the frother.

During and immediately after the War, the mill was stripped bare of all equipment. When the mine resumed operations in 1951 under a contract arrangement, no ore processing equipment was installed. All concentrates had to be hand sorted. This arrangement continued even after the company resumed direct control of mining operations in 1954. In August 1954, immediately after resuming control, the company repaired 300 ft of water course and installed a 54 ft sluice box. This was used in conjunction with a 3/16" screen mesh to upgrade fine ore from the waste dumps. At this stage the company intended to install a jig to treat the ore, but this plan was never implemented.

In July 1955, the company proposed installing a 35/50 tpd mill at the site of the pre-War mill. The new mill was to be a gravity concentration plant, unlike the flotation plant of pre-War days. It was proposed that the plant would comprise primary crusher, ball mill, classifier, jig, and shaking table. The plant was to have been powered by a 75/100 kW generating plant. This proposal, which was put forward by the chairman, L R Nielson, at the same time as the company was attempting to resuscitate its claims for the issue of a mining lease over an adjacent area, was never implemented.

During the Fifties, the concentrates were sold to European metal dealers, usually to the UK or the Netherlands. Although some concentrates were sold after the War with Pb assays in the high sixties, even as high as 69% Pb, much of the production could only be concentrated to 40% or 50% Pb. The fines, which were washed on the sluice box (Plate 7) could only be upgraded to 33% Pb. Some unwashed fine galena was sold with an assay of only 14% Pb. Compared with pre-War concentrates, the lack of a proper processing plant would have had a serious detrimental effect on the revenue realised from concentrate sales.

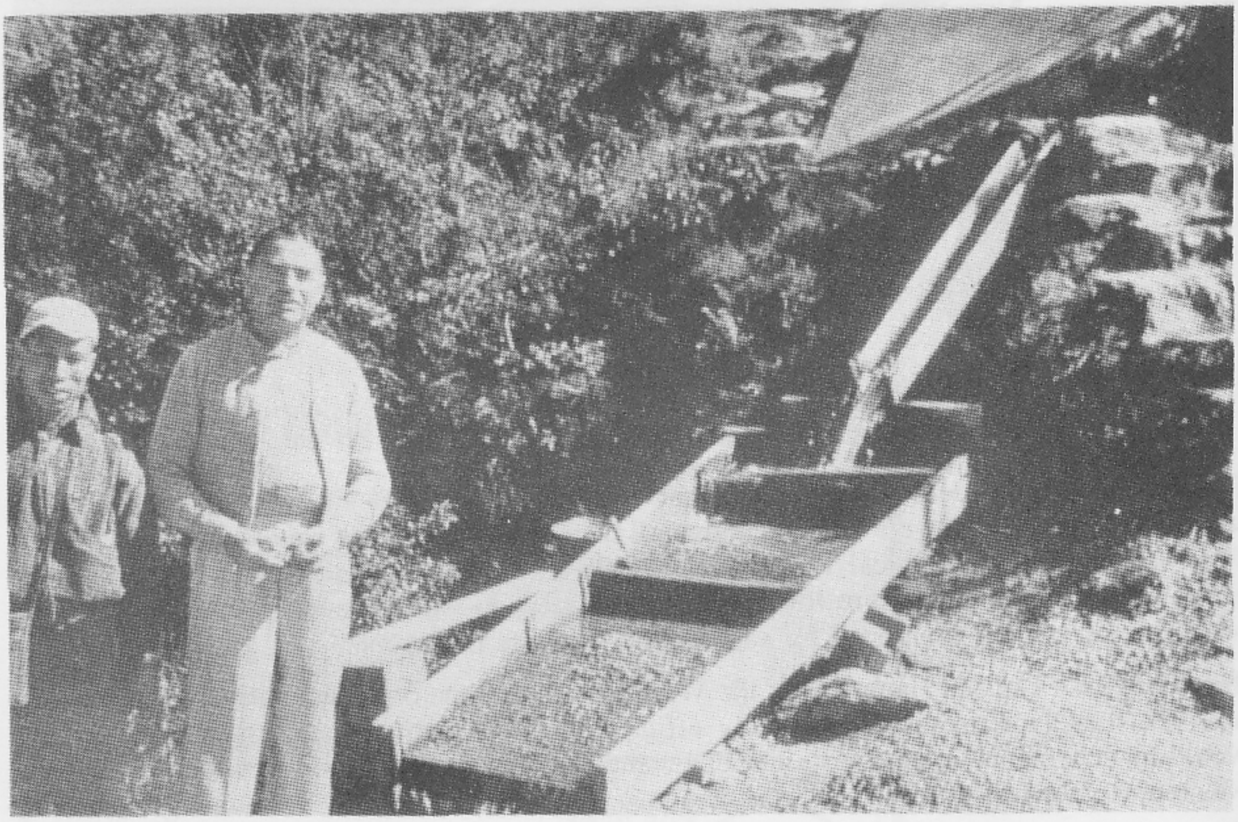


Plate 7 *Sluice box used for separating galena in 1956. Professor S G Davis with sluice man*

Smelter schedules are set to reward sellers of *clean* concentrates and to penalise *dirty* concentrates. Furthermore, without any modern ore processing equipment, the losses of otherwise recoverable ore could have been significant. When the mine finally ceased operations and the Government repossessed the mine, some efforts were made to sell low grade concentrates left at the mine site. As they were considered too low-grade to sell, they were simply used as aggregate for road surfacing.

History

Pre-1936. According to the article published in Deco Trefoil, lead was first discovered in the Sha Tau Kok area around 1860-70. Old workings from this period were found within 1 km from the mine site. These old workings formed part of the property later worked by Hong Kong Mines Limited. However, the precise date of these workings may be in some doubt. The lower workings of the mine, which were known as the *Portuguese Workings*, are reported by Davis & Snelgrove (1956) to date from the beginning of the 19th century. The same article in Deco Trefoil states that the main outcrop of the mine was discovered by local Chinese miners in 1915, whilst searching for limestone. These early miners apparently extracted a considerable quantity of high grade galena from these workings. A company was formed in 1917 but only operated for three years.

On 23 June 1925, a mining lease, Mining Lot No 3, was issued to Morrison Brown Yung for a period of 75 years back-dated to 28 June 1922. This mining lease covered an area of 150.14 acres. The mine was operated by Morrison Brown Yung until his death in 1932. During this period there was substantial development of the underground ore-body. After Morrison Brown Yung's death, the mine was operated for a short period by a Chinese firm, who only extracted a small quantity of high grade ore.

1936-1941. A public listed company, Hong Kong Mines Limited, was incorporated in Hong Kong on 18 November 1936 to acquire the leaseholds and mining property of the Lin Ma Hang mine. The mining lease was transferred to Hong Kong Mines Ltd on 18 March 1937, by deed of assignment. In January 1937, less than two months after incorporation, general management of the company was taken over by an American firm based in the Philippines, Nielson & Co Inc, and L R Nielson was appointed Chairman of Hong Kong Mines Ltd.

Nielson & Co immediately started work on redeveloping the mine. A management and supervisory team of seven Americans and Europeans was set up under George T Scholey, General Manager of Nielson & Co. George Scholey was a well respected American mining engineer, who lived and worked for most of his life in the Philippines. He is credited with the development of successful underground copper mining operations around Baguio in northern Luzon, Philippines, using block caving techniques imported from Arizona, USA. He died in 1979.

A month after Nielson & Co had taken over the general management, a brief report on the mine was made by Dion L Gardner for Marsman & Company. Marsman & Company were a substantial Manila-based company who operated a number of mines in the Philippines, both before and after the Second World War. Gardner's report is generally pessimistic about the prospects of the mine and concludes that reserves delineated at the time did not justify either the construction of a mill or any large expenditure in development work. The report recommended further exploratory work along strike as the best way of extending the reserves.

The connection between Nielson and Marsman is unclear, as is the reason for the report. However, despite this gloomy report, Hong Kong Mines Ltd proceeded with the construction of a modern mill, together with new workshops, stores, office and housing for the staff and workers. The mill was completed in October 1937. Development work on the mine started in June 1937. This included driving a new 650 ft main haulage level and a 230 ft main ore pass, together with cross-cuts and headings so that the mill could be supplied with 150 tonnes of ore per day for treatment.

In 1938 Hong Kong Mines employed a labour force of 500, of whom 350 worked underground and the remaining 150 were employed on surface. A report in 1938 by the Senior Inspector of Mines, Perak, Federated States of Malaya, indicates that the mine was well run and managed. Indeed, this period was the *hay day* of the mine, and the mill was further expanded from 150 to 225 tons per day. However, in the first year of operation there were no sales of concentrates, as it was decided to stockpile all production in the belief that the market price for lead would rise. An application for an additional mining lease, contiguous to, and to the southeast of the existing lease and covering a further 1,196.45 acres, was made during this period. Whether this additional area was actually approved or not was the subject of dispute after the War.

In 1940 work at the mine was curtailed. With the outbreak of the Second World War, the company reported that the Government requisitioned some of the company's mining equipment, including two large compressors, for the construction of air raid shelters. The shelters were built by Marsman & Company.

1941-1951. The mine was worked on a small-scale during the Japanese occupation. In October 1946, George Scholey reported on the state of the mine following a visit earlier in the same month. Scholey estimated that the Japanese had extracted 20,000-30,000 tons of ore, at an estimated grade of 10% Pb and 2.4 oz/ton Ag. Most of this ore came from the old or East section of the mine.

Damage to the mine and surface installations was widespread. The staff houses, office building and assay laboratory had all been damaged and looted. Windows, floors, doors and all electrical and plumbing fittings had been removed. The mill was stripped bare, all the equipment except the ball mill and the frames of two crushers had been removed, and even the ball mill had been stripped of its motor and gear drive. The roof trusses and window frames from the mill and workshop buildings had been taken and all electrical equipment, including insulators and power lines, had been stolen. Most of the rail tracks had been removed, both underground and on surface. The store building had been hit by a bomb and nothing remained of this building.

Scholey concluded that nothing of value remained on the mine. Apparently, most of the damage was not caused by the Japanese occupation itself. The mine was unguarded from the end of the War until Scholey returned to assess the situation in October 1946, a period of one year. According to company reports, it was during this year that the looting and destruction of the majority of the equipment and facilities occurred. Underground, damage was caused by the mining methods employed by the Japanese. They extracted the ore without placing any timbers or supports and extensive caving resulted. However, as the Japanese only worked a section of the mine, other parts of the mine were still in reasonably good condition when inspected by Scholey in 1946.

After his visit Scholey recommended that, because of the weak finances of the company, Hong Kong Mines should attempt to get another interested party to work the mine, either on a royalty basis or under some form of profit sharing agreement. He apparently tried, unsuccessfully, to interest some American companies in the mine.

1951-1962. The re-opening of the mine was not approved by the Colonial Secretary until 1 October 1951. Based on the earlier advice of George Scholey, the company decided not to undertake its own mining operations. From 1951 until 1954 contractors were employed to operate the mine. From 1 November 1951 to 30 April 1952, the mine was operated under contract by Tonley & Co. After Tonley & Co's contract ended in April 1952, they were required to continue work underground to clean out the workings before they could be handed over to the new contractor. This cleaning operation was not completed until July 1952. After several months of negotiation a new agreement was signed in February 1953 with another contractor, Foo Yuen & Co.

In the 1950s there were serious worries about security aspects along the Border Road. A condition of re-opening the mine was that the contractor could not use the Border Road past Lin Ma Hang village and was obliged to construct a track to gain access from behind Lin Ma Hang village. The company also had to construct a road into Lin Ma Hang village. Construction of this new access road was finished in February 1953 and permission to restart mining operations, in the upper levels only, was given in March 1953.

The number of vehicles passing along the Border Road were limited to 10 per day. The partners of Foo Yuen & Co were warned not to use "large American cars" along the Border Road, as this was considered provocative. This warning came after an incident in which workers on the Border Road had stones thrown at them from the Chinese side of the border.

The mining method used was primitive, and entirely manual. There was no mill for processing the ore, which was hand picked. In 1953 eleven labourers were used underground with an additional eleven people employed as foremen, shot-firers, supervisors, and clerks. L R Nielson, who had resumed his position as Chairman of Hong Kong Mines Ltd, visited the mine in December 1953. His report on the visit indicates that he was very displeased with the way the mine was being worked by the contractor's workmen. Waste rock had been thrown down ore passes, as well as being accumulated in the driveways, blocking these passes and restricting access and ventilation. There was a complete lack of timbering and support for weaker areas. Nielson concluded that the mining operation was hazardous and contrary to good mining practice. An eye witness, who accompanied Nielson on his visit, reported that Nielson's displeasure was vented by "showering the men with cursings and swearings for their bad work".

The contract arrangement resulted in the workmen working the mine in a haphazard manner, extracting only what they thought to be the highest grade ore. As royalty to Hong Kong Mines was paid on a tonnage of ore mined basis, it was in the contractors' short term interest to mine the highest grade ore possible. The contract agreement was not renewed after 31 March 1954. However, following a further visit to the mine by Nielson in April 1954, a protracted dispute ensued over the condition of the mine and the contractor was required to clean out the mine before the company would accept the handover. At times this dispute was acrimonious and involved at least one reported fight between the contractor's workers and the company's own staff. The cleaning work was not completed to Nielson's satisfaction until the end of July 1954. At this point, the company decided to resume direct mining operations. Workers were recruited from Lin Ma Hang village, and operations were put under the direct control of Gerald Abbass, who had been employed as Chief Accountant with the company when operations were first started by Hong Kong Mines Ltd in 1937. The company restarted operations in September 1954, employing a total of 24 workers. This had increased to 44 by April 1955.

In July 1955 there was a dispute on the mine between the company and the underground workers over weights and moisture content of the ore mined. The miners were paid piece rates, and the ore weight and moisture content were used in the basis for payment. Many of the men from Lin Ma Hang village refused to work, and the workforce was reduced by half. Further set-backs followed. On 13 June 1956, a typhoon caused severe damage to the mine and the approach roads. Parts of the mine were flooded and the Border Road was breached. This resulted in a delay in effecting ore shipments.

In July 1956, the workers at the mine went on strike. There were fights at the mine between striking workers and the few workers who remained at work, resulting in the arrest and prosecution of three of the strike leaders. The strike continued until September 1956. The strike started apparently because the contractor, who was called in to repair the Border Road, offered a higher daily wage ($4.00 per day compared to $3.20/3.50 paid by the mine) and attracted some of the workers away from the mine. When the company protested to the contractor, the road contractor dismissed the workers, who feeling unjustly treated called on other workers still at the mine to go on strike.

With the decline in the price of lead and the reduced availability of workers, the company decided to shut down the mine, as a temporary measure, on 30 June 1958. At the time of closure the mine employed 12 men. After closing the mine, the company made further attempts to obtain title over the additional area, which had been applied for before the War. The company also started talking to other parties in an attempt to sell their holdings. The mine remained closed, with only three watchmen employed by the company, until January

1961 when the watchmen were dismissed and the mine was left unguarded. At this time the company was still trying to interest other parties in the property.

In early August 1961, there was a rush for Hong Kong Mines shares on the Hong Kong Stock Exchange. The shares had previously been totally inactive and were quoted at 3 cents nominal, and then in the course of one week, the price shot up from 4 cents to 20 cents. Nearly 600,000 shares changed hands during the first week of August 1961. The price rise was driven by rumours in a Chinese language newspaper that American interests might take over the company and resume mining. The "American interests" that had caused this flurry on the stock market was a company called MacArthur International Minerals Co Inc of Guam. This company actually operated out of Manila in the Philippines and purported to have mineral properties in the Philippines. MacArthur claimed to have gained control of over 70% of the company's issued stock.

In the meantime, the company had been warned by the Government that it was in danger of forfeiting its title, as the mine had not been worked for over three years and this contravened a condition of the mining lease, which provided for forfeiture if there was no bona-fide mining for a period of 12 months. As the company was financially destitute and was unable to take any steps to restart workings at the mine, the Government decided to rescind the mining lease and on 13 April 1962 the formal order for *re-entry* was registered, thus ending Hong Kong Mines Ltd's rights over the property. The company did attempt to have the order reversed, but to no avail.

Production, costs and financial results

Production. Records of early production are incomplete. However, some rough assessment can be made as, by the time Nielson & Co took over management of the mine in 1937, 7,000 ft (2,150 m) of tunnels had been developed. Assuming a tunnel cross-section of 1.5 m x 2.0 m, the development of these tunnels would have generated around 20,000 tons of rock or ore. If an average in-situ grade of 10% Pb (ie, combined ore and waste) and a hand-picked concentrate grade of 60% Pb is assumed for this material, approximately 3,300 tons of concentrates could have been produced prior to the take-over by Hong Kong Mines Limited.

Available annual records for production of lead concentrates are given in Table 2. Table 2 indicates that an estimated total of 24,000 tons of concentrates were produced over the mine's life. If an average concentrate grade of 65% Pb and 15 oz/ton Ag is assumed, this would mean that, over the 43-year life of the mine, it produced approximately 16,000 tons of contained lead metal and 360,000 ounces of contained silver.

Metal prices. The key to the profitability of any mine is the metal price. Lead is an *old metal* which has been used by man for several thousand years. But, in modern times lead usage has not expanded, and may even have declined. Certainly, lead usage for water pipes, paints and as a roofing material has declined in recent years. The main usage now is in car batteries, but even here, there is a high proportion of recycled lead (from old car batteries). The lead price over the life of the mine is given in Table 3.

The prices in Table 3 are based on an exchange rate of £1 = US$4.00 prior to 1947 and £1 = US$2.80 after 1947. The exchange rate between the pound and HK$ was fixed at £1 = HK$16 for the whole period. In 1937 silver was worth US$0.65 (HK$2.90) per ounce, and only about 5% of the mine's revenue was attributable to the silver content of the concentrates.

The present day prices (September 1991) for lead and silver are £320 (HK$4,000) per tonne and US$4.00 (HK$31) per ounce respectively. Using present day metal prices, the total value of the lead and silver produced over the mine's life would be worth, in gross terms before smelting costs etc, approximately HK$75 million (US$9.7 million). After allowing for smelting charges etc this would reduce to approximately HK$58 million (US$7.5 million).

About 85% of the value would be attributed to the lead content, with the remaining 15% being the value of the contained silver.

Table 2 Production of concentrates

Year	Tons
1915–1936 estimate	3,300
1937	1,190
1938	3,600
1939	3,200
1940	3,000
1941	3,000
1942–1945 estimate	3,950
1951	176
1952	752
1953	632
1954	368
1955	400
1956	199
1957	194
1958	36
TOTAL	23,997

Table 3 Lead metal prices

Year	Price per ton £	US$	HK$
1913–1922 av	33	130	530
1929	38	150	610
1932	18	70	280
1937	38	150	610
1938	26	100	420
1946	50	140	800
1953	97	270	1,560
1954	97	270	1,560
1955	113	320	1,810
1956	121	340	1,940
1957	96	270	1,530
1958	68	190	1,100
1959	72	200	1,150
1960	68	190	1,100
1961	62	170	980
1962	57	160	910

From 1937, when Hong Kong Mines started operations, until the present day (1991) lead has only increased in value, in HK$ terms, by a mere 6.5 times. In contrast, silver has increased in value 11 times. In relative terms, the value of lead is still depressed on the world market. In HK$ terms, the price now (1991) is still only four times the price when the mine closed in 1958. In the same period gold has increased in value by a factor of 20.

Costs. In November 1936, upon incorporation, Hong Kong Mines Ltd raised a total of HK$1,756,880 (from the issue of 15,137,600 fully paid 10 cent shares and 4,862,400 partly paid 10 cent shares, subscribed to 5 cents) for capital investment in the mine. The leasehold and mining property was acquired for HK$832,830.49. A further HK$555,685.25 was spent on the construction and equipping of the mill, underground air and water lines, rail tracks, office, workshop, store, accommodation buildings, and other infrastructure. Mine development work was also capitalised and by the end of 1940 this totalled HK$105,694.86. Operating costs for 1937 are shown in Table 4.

Table 4 Operating costs for 1937

Cost heading	Annual Cost HK$	Mined HK$/ton	Milled HK$/ton	Concentrate HK$/ton
Mining cost	54,077.72	4.34	6.24	45.44
Milling cost	24,881.99	2.00	2.87	20.91
Overheads	54,410.44	4.36	6.28	45.72
TOTAL	133,370.15	10.70	15.39	112.07
Tonnages		12,471	8,665	1,190

No breakdown is available for labour, stores or fuel costs. However, as the mining was non-mechanised, apart from pneumatic drills, and the work-force totalled some 500-700 men before the War, it can be assumed that the major part of the operating cost would have been for wages.

Estimates were made immediately after the War, for the purpose of determining war loss claims, of the cost to operate the mine in 1946. These figures are given in Table 5.

Table 5 Estimated unit operating costs in 1946

	HK$/ton		HK$/ton
Mining	7.00	Transport	4.00
Milling	4.60	Overheads	2.00
Smelting	15.00	TOTAL	32.60

In 1953, when the mine was worked by contract, direct operating costs borne by Hong Kong Mines Ltd were HK$42,669 for the year. In the following year, 1954, the company took over the running of the mine and the costs doubled to HK$82,571. The tonnage of concentrates produced for 1954 was 368 tons, giving a unit cost of H$224 per ton. Compare this with the 1937 unit cost, given in Table 4, of HK$112 per ton of concentrate.

Financial results. Available financial results for Hong Kong Mines Ltd (1937-1962), from incorporation in 1936 to liquidation in 1962, are shown in Table 6.

Table 6 Financial results for Hong Kong Mines Ltd

Year	Cash surplus HK$	Depreciation HK$	Profit/loss HK$	Accumulated losses HK$
1937-1940	-273,621	747,107	-1,020,728	1,020,728
1941	68,180		68,180	952,548
1942-1945		629,447	-629,447	1,581,995
1946	-13,661		-13,661	1,595,656
1947-1952	83,593		83,593	1,512,063
1953	51,619		51,619	1,460,444
1954	1,758		1,758	1,458,686
1955	71,795		71,795	1,386,891
1956-1960	-70,501		-70,501	1,457,392
1961	-2,289		-2,289	1,459,681

For the period from 1942 to 1945, during the War years, all the fixed assets had their book value written down to a nominal figure of HK$1.00.

Although no profits tax was ever paid by the company, the company did pay royalty to the Government on sales at the rate of 5% of the sales value.

The accumulated losses for the company over its life totalled approximately HK$1.5 million. The company did not even cover its cash operating costs. The company owed Nielson & Co, presumably for management fees, HK$235,989 from the pre-War period. It was only in 1954 that the company had accumulated sufficient cash to settle with Nielson & Co. In settlement, Nielson & Co only received HK$146,142 or 62% of the money owed, which was almost the entire cash surplus generated after the War.

The shareholders lost their entire investment without ever receiving any return. According to reports, the company claimed war damages of approximately HK$2.5 million, for both lost production extracted by the Japanese and for damage caused to the property, from the Reparations Claims Registration Office. The available company accounts show no record of the company having received any compensation for war damages and it seems that this claim was unsuccessful. The most successful time for the company, in terms of operating profit, was the period between 1951 and 1953, when the mine was operated by contractors, and the company's direct costs were low. This also marked the time of relatively high lead metal prices.

Conclusion

What was achieved and was it worth it? No records are available to indicate whether or not the earlier years were profitable. Due to very low metal prices during the Depression years of the early thirties, the mine is unlikely to have been viable, and does not appear to have been worked during this time.

When Hong Kong Mines Ltd was incorporated in 1936, a substantial amount of capital, for those days, was raised to fund development of the mine and the construction of the mill. The mill appears to have been *state of the art* at the time of its construction. Based on reports from the time, the mill worked well. The mine, however, appears to have been very labour intensive and overall costs were high. With narrow lenticular deposits like Lin Ma Hang, it is difficult to employ bulk mining methods which would substantially lower unit costs. However, the ore grade was reasonably rich, the underground mining conditions were not difficult, and the ore was easy to process. So, precisely why the mine failed to cover even its cash operating costs in the pre-War period is difficult to understand.

The onset of the War was a major catastrophe for the company. Even prior to the Japanese occupation, the company's compressors and mining equipment had been requisitioned by the Government for defence work. The Japanese robbed the mine of easy ore, often in pillars, without installing any timbering. This caused sections of the mine to collapse. Nearly all the surface and underground infrastructure was either removed by the Japanese during the War or looted immediately after the War before the company was able to repossess the mine site. When the company repossessed the site after the War nothing of value remained. However, the company's claim for war damages to compensate for these losses seems to have been unsuccessful.

The company had no cash resources to rehabilitate the mine after the War. Operations, once they resumed in 1951, were spasmodic, poorly planned, and on a very small scale compared with the pre-War operation. Mining and processing was entirely manual. Losses of valuable ore were probably substantial during this period. Although some cash was generated between 1951 and 1955, this mostly went towards paying pre-War debts to Nielson & Co, the general managers.

Further bad luck struck the mine on 13 June 1956, when a typhoon caused widespread damage and flooding. The mine was unable to export any concentrates for several months because the Border Road was impassable. This was followed by a period of labour unrest, strikes and some violence, over wage rates paid by the mine. By this time the lead metal price had started another cyclical decline, and with worsening problems over recruiting and retaining workers at the mine, production also declined, until the mine was finally closed on 30 June 1958.

All cash resources had been exhausted and the mine was technically insolvent. The company lingered on for another three years with the mine on *care and maintenance*, hoping for a rise in metal prices or the appearance of a generous purchaser to take the property off the company's hands. In 1961 speculators tried to take over the company and caused a brief flutter on the Stock Exchange. This proved to be the final death throws of the company, and the Government eventually rescinded the mining lease, by formally *re-entering* the property on 13 April 1962, as the company was in contravention of the terms of the lease conditions by not working the mine for a period of over 12 months.

The shareholders received nothing from the mine, and must have totally agreed with the often quoted cynical definition of a mine; "A mine is a hole in the ground down which the owners pour an endless stream of unrecoverable money". The workers received very little in wages, most of the underground work was on a piece-rate system, and, certainly in the post-War period anyway, the rates appear to have been insufficient to either satisfy the workers or to encourage new workers to take jobs at the mine. The only real beneficiary seems to have been the previous owner of the mining lease, who was paid HK$832,000 by Hong Kong Mines Ltd. In 1936 money terms this would have been a large sum of money. In retrospect, it was obviously far in excess of what the mine was worth.

What remains today? The mine site is still in a restricted zone (in 1991) and so access is not available to the general public. All that remains of the surface installations are the foundations for the mill and several other buildings. The portals to the tunnels adjacent to the Border Road were bricked up in the Fifties, although access can be gained though the fitted doors. All the other tunnels are still open. The No 3 level workings are still in excellent condition (Plate 8). The rock appears competent and, apart from the south-east extremity, there has been little caving of the roof since operations were suspended over thirty years ago, although parts of the tunnel are partially filled with water. This level is now home for several species of bats, some of which are rare in Hong Kong.

The upper levels, 5 and 6, are also open (Plate 9), but although the roof is still largely intact, the condition is dangerous in places, and great care needs to be exercised when entering these tunnels. A further potential hazard to the uninitiated are the vertical ore passes, which are unguarded, with drops of 50 metres (Plate 10). Attempts to find a link between levels 3 and 5/6 have so far been unsuccessful.

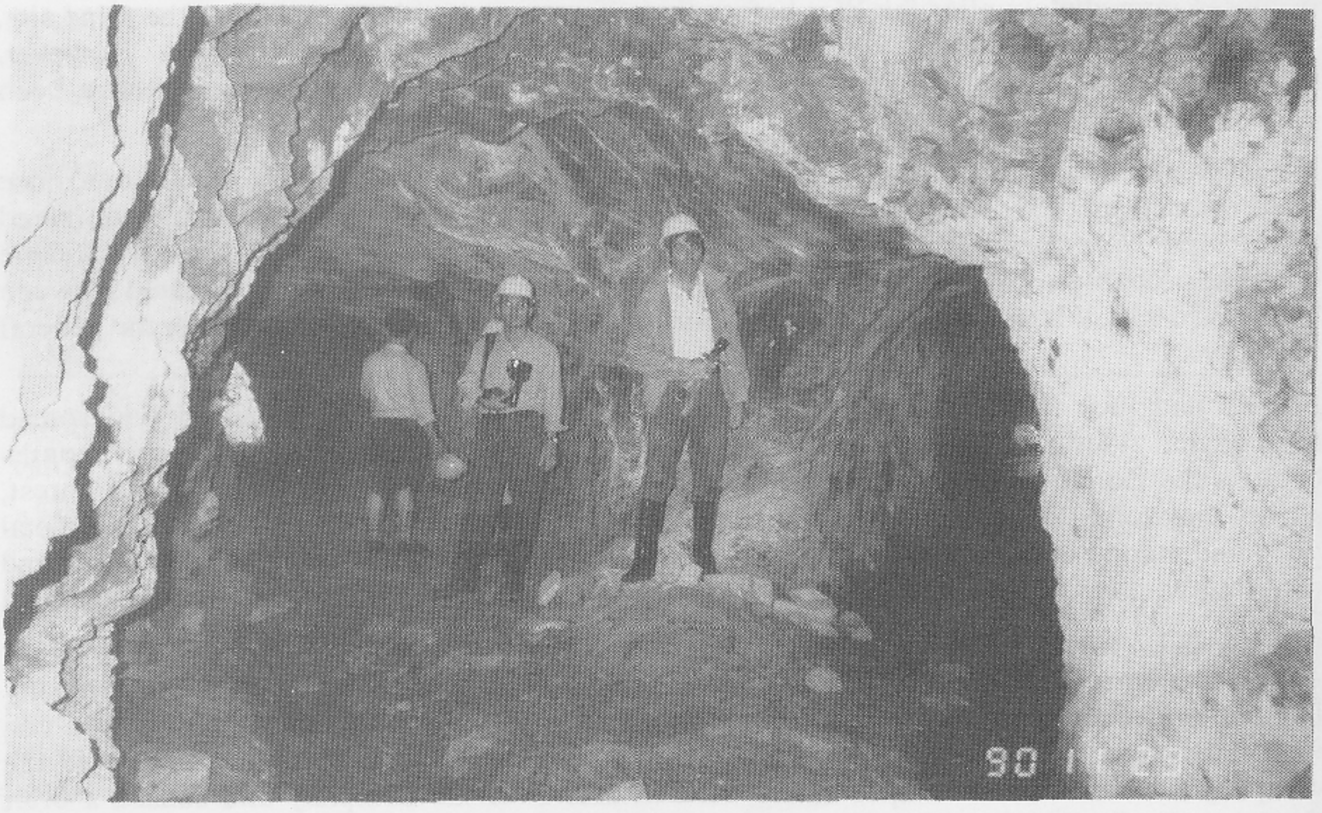


Plate 8 Inside the entrance of Level No 3 in 1991

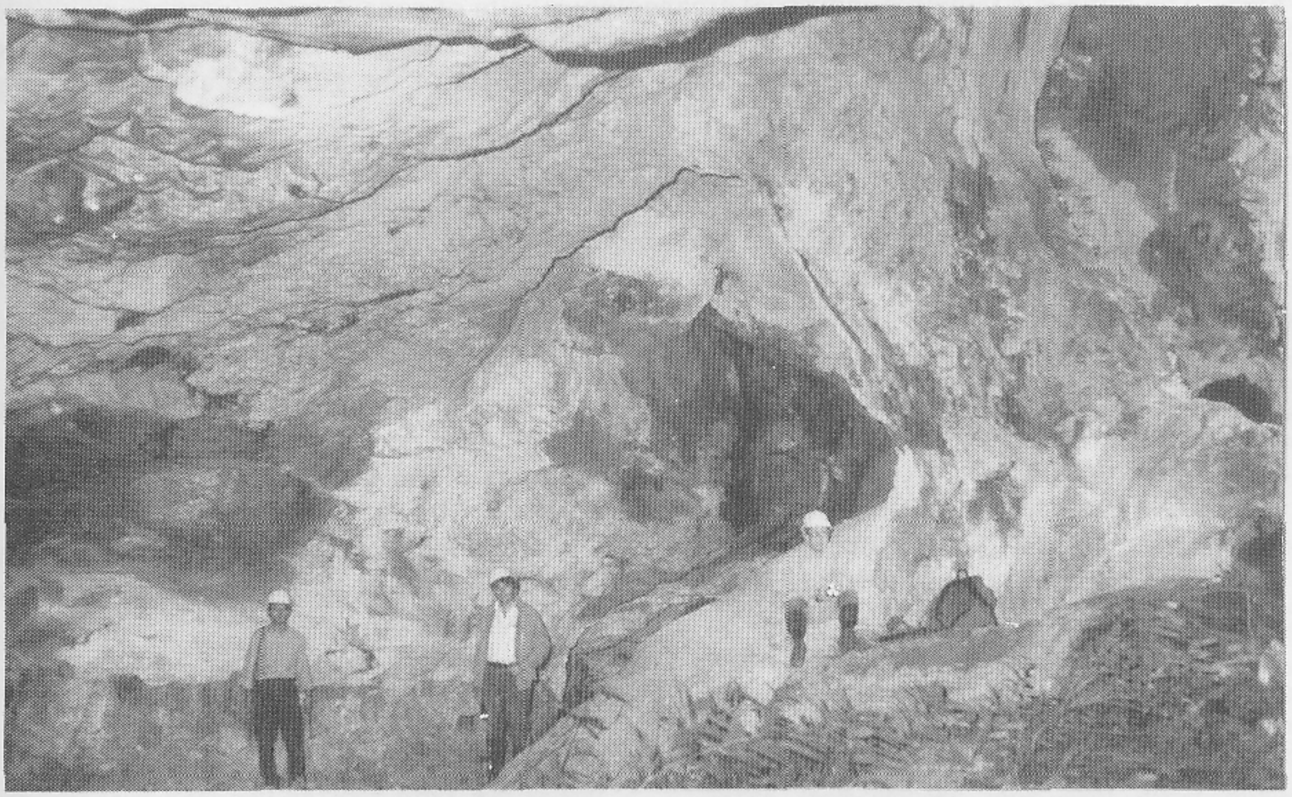


Plate 9 Entrance to Level No 6

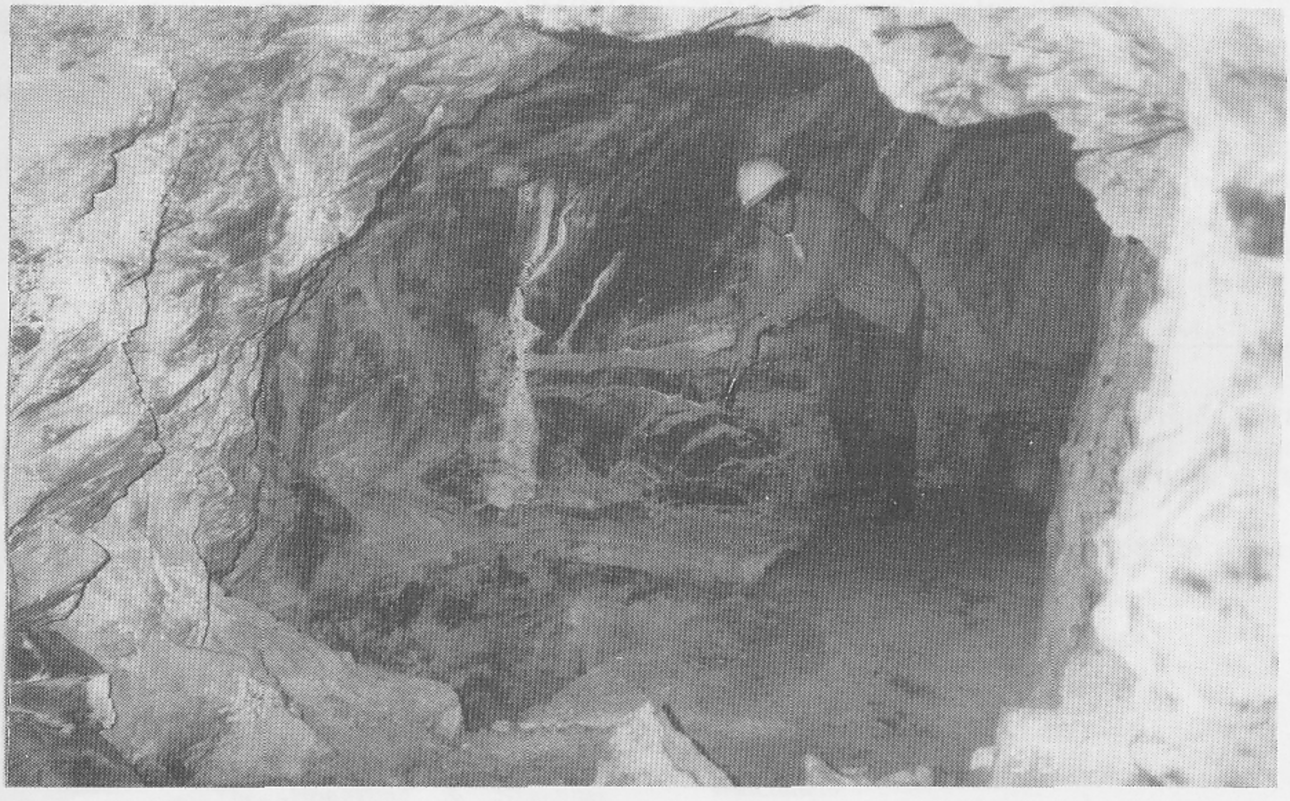


Plate 10 Unguarded vertical shaft on Level No 6 in 1991. The author is pointing to the shaft with a torch

Mineral samples of galena can still be obtained from inside the mine or from sorting through the various spoil dumps on the surface. The mine is located in an attractive mountainous area. The mine is a valuable industrial archaeological site of considerable interest and should be preserved. Gates, with suitably spaced grills to allow free access for the bats, could be fitted to the mine openings to prevent uninitiated members of the general public from being exposed to the underground hazards.

Acknowledgements

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Appendix Personnel involved with Hong Kong Mines

Directors & supervisory staff

At the end of 1937, just two months after Hong Kong Mines Limited was incorporated, the company's directors were:

L R Nielson	Chairman
Geo T Scholey	
Chas C Stark	Managing Director
David Au Wai-kwok	
J M Wong	

On assuming general management duties in January 1937, Nielson and Scholey had replaced two founding directors, J R Paton and F J Gellion on the Board.

The company's 1937 annual report also lists the following supervisory staff on the mine:

B B Bassett	General Superintendent
S Coldren	Mine Superintendent
Wm H Fowler	Mill Superintendent
J Michaelson	Mine Shift Boss
W Roberts	Engineer
Gerald Abbass	Chief Accountant
M A Affannassief	Works Superintendent

When Scholey returned to inspect the mine in October 1946 the only person from the pre-War management team still in Hong Kong was Gerald Abbass. The company's first annual report after the War, issued on 5 June 1947, lists only three directors:

Geo T Scholey	Chairman
H J Armstrong	
G Abbass	

By 1954, when the company had taken over direct operations in the mine, L R Nielson had returned to the Board as Chairman. The company's 1954 annual report lists the following directors:

L R Nielson	Chairman
T A Martin	
G Abbass	
C K Lau	

The last company annual report was issued on 26 September 1962 for the year 1961, by which time the company had ceased all operations at the mine. The report lists the following directors:

C A Henderson
G T Scholey
B K L Lui

Statutory functionaries

The company's first annual report for 1937 lists the following statutory functionaries acting for the company:

General Managers	Nielson & Co Inc
Secretaries	T A Martin & Co
Bankers	The Hongkong & Shanghai Banking Corporation
Auditors	Lowe, Bingham & Matthews
Solicitors	Deacons

The company's last annual report for 1961 indicates little change, listing the following statutory functionaries:

Secretaries	Martin & Co
Bankers	The Hongkong & Shanghai Banking Corporation
Auditors	Lowe, Bingham & Matthews

Level of employment at the mine

Before the War, approximately 500 workers were employed on the mine site, 350 of whom worked underground with the remaining 150 on the surface. At that time, the company provided housing and accommodation for both senior staff and some of the workers.

When operations resumed in 1951, this was on a contract basis, and the company only employed directly site supervisors and guards. The contractor supplied all the workforce. For security reasons, the Government restricted the number of people who could be employed on the mine to 100. A further restriction stipulated that all workers could only be recruited from the vicinity of Lin Ma Hang village.

When the company took over direct mining operations in 1954, it had a work-force of 24 increasing to 44 by 1955. However, after the strike in 1956 the work-force declined, and at the time of the mine's closure in June 1958 only 12 workers were employed.

Wages Paid

No record is available of the wages paid before the War. In 1953, when the mine was operated by a contractor, the following wages were being paid:

Carpenters & Blacksmiths	HK$180-190 per month
Shot firers	$180-240 per month
Miners	$4.00 per picul of concentrate
Labourers for carrying concentrates	$0.65 per picul of concentrate

A picul (which contains 100 catties) is equivalent to 60 kg. It is interesting to note that the contractor was effectively sub-contracting the work to the individual miners.

When the mine closed in June 1958, the workers were being paid as follows:

Underground Workers	$4.00 per picul of concentrate
Foreman	$5.50 per day
Jeep Driver	$5.00 per day
Police Watchmen	$170 per month
Storekeeper	$4.00 per day
Blacksmith	$4.50 per day
Blaster	$4.00 per day

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A CRAWLING TRACE FROM THE PING CHAU FORMATION, HONG KONG

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Introduction

There have been several recent papers on the stratigraphy of the Ping Chau Formation (Wu & Nau 1989; Nau *et al* 1990; Lee *et al* 1991; Lai 1991) and, in addition, an account of the sedimentary geochemistry has been published by Taylor *et al* (1990). This paper now attempts to add to the knowledge by describing a crawling trace which has been identified in the upper part of the sequence outcropping on Ping Chau island. This trace fossil was found near the easternmost point of Ping Chau, just north of Kang Lau Chek (863510E 844532N). The occurrence is believed to be unique in the outcrop of the Ping Chau Formation.

Associated sediments

The Ping Chau Formation comprises a succession of dolomitic siltstones, including aegerine- and zeolite-bearing facies. Sedimentary structures include rain pits, subaerial and subaqueous shrinkage cracks, ripple marks, small-scale cross-bedding and soft-sediment deformation features, including penecontemporaneous faulting and convolute lamination. The Formation has been attributed to a semi-arid brackish water lake environment by Lai (1991), though Taylor *et al* (1990) also accept the possibility that the sediments could have been deposited in an arid coastal lagoon or sabkha.

The trace described in this paper is found in a succession of horizontally laminated carbonate-cemented siltstones. The sediments immediately below the bed in question are highly indurated and are affected by carious weathering. Within 0.1 m above the trace is a bed of fine sandy siltstone distinguished by a set of starved ripples with a wavelength of around 40 mm and an amplitude less than 2 mm. These are interpreted as having been formed in a shallow-water environment with low energy currents and very low sediment input. The trace itself occurs on a bed of red silty mudstone.

Description

The trace (Plate 1, with explanation) is highly sinuous and can be followed over several metres along the bedding plane. Its width ranges between 20 and 25 mm, and it is marked by the conspicuous development of pyrite concretions along its length. A fresh vertical surface reveals no obvious three-dimensional structure, and it is therefore difficult to identify whether the trace was formed beneath the substrate or on the surface of the sediment. No ornamented fabrication can be seen but this, as well as the lack of three-dimensional expression, could well be the result of delicate primary structures being destroyed by the diagenetic carbonate development. The presence of pyrite is attributed to the notion that the animal responsible for the trace was feeding and leaving a trail of organic debris in the form of faeces; the sulphide development is a result of reducing conditions on that organic matter.

Ethology and ichnofacies

Frey & Pemberton (1984) present an ethological classification, based on the functional interpretation of trace fossils, and a review of seven recurrent ichnofacies models. Their sixfold ethological classification includes resting, crawling and grazing traces, and feeding, dwelling and escape structures. The Ping Chau trail is accordingly identified as a *crawling trace*, where the locomotion is probably associated with feeding. The allied *grazing trace* is described as a compact structure making an efficient use of the feeding space. This is clearly not the case with the sinuous Ping Chau trail.

Six of the seven ichnofacies models are marine (littoral, open, intertidal or abyssal). The remaining model is the *Scoyenia* ichnofacies, which is terrestrial and is associated with moist to wet argillaceous to sandy sediments at low-energy sites, either very shallowly submerged, sometime emergent, lacustrine deposits, or waterside subaerial deposits periodically becoming submergent. This facies is characterized by feeding burrows, sinuous crawling traces and vertical dwelling structures; invertebrate diversity is very low. Contrarily, the two most common species in this ichnofacies, *Scoyenia gracilis* and *Ancorichnus coronus* both tend to form curvilinear, as distinct from sinuous traces, and the presence of faecal pellets is not recorded (Frey *et al* 1984).

Paradoxically, the Ping Chau trail has many of the characteristics of the trace fossil *Scalarituba*, described by Chamberlain (1978) as "an interlaminar, meandering, meniscate ribbon of fecal (sic) material". This fossil is normally associated with the *Nereites* ichnofacies, ie, bathyal to abyssal quiet though oxygenated waters on very slowly accreting substrates. Nevertheless, it should be understood that there is a strong relationship between the diversity of ethology, and the sediment input and energy regime of an environment. It is thus reasonable to conclude that low current energy and a low sedimentation rate prevailed during the deposition of the Ping Chau Formation, confirming the evidence of the primary sedimentary structures.

Conclusion

The trace fossil seen in the upper part of the Ping Chau Formation exposed on Ping Chau is identified as a crawling trace. Its sinuous character confirms that low energy currents and low sediment accretion rates prevailed during deposition of these sediments. The paucity of trace fossils suggests that the environment was severe, but the presence of this trail shows that it was not so inclement that life was impossible. Though the trace is enigmatic, it seems more likely that deposition was in a semi-arid ephemeral lake than in the harsher environment of an arid coastal lagoon.

Acknowledgements

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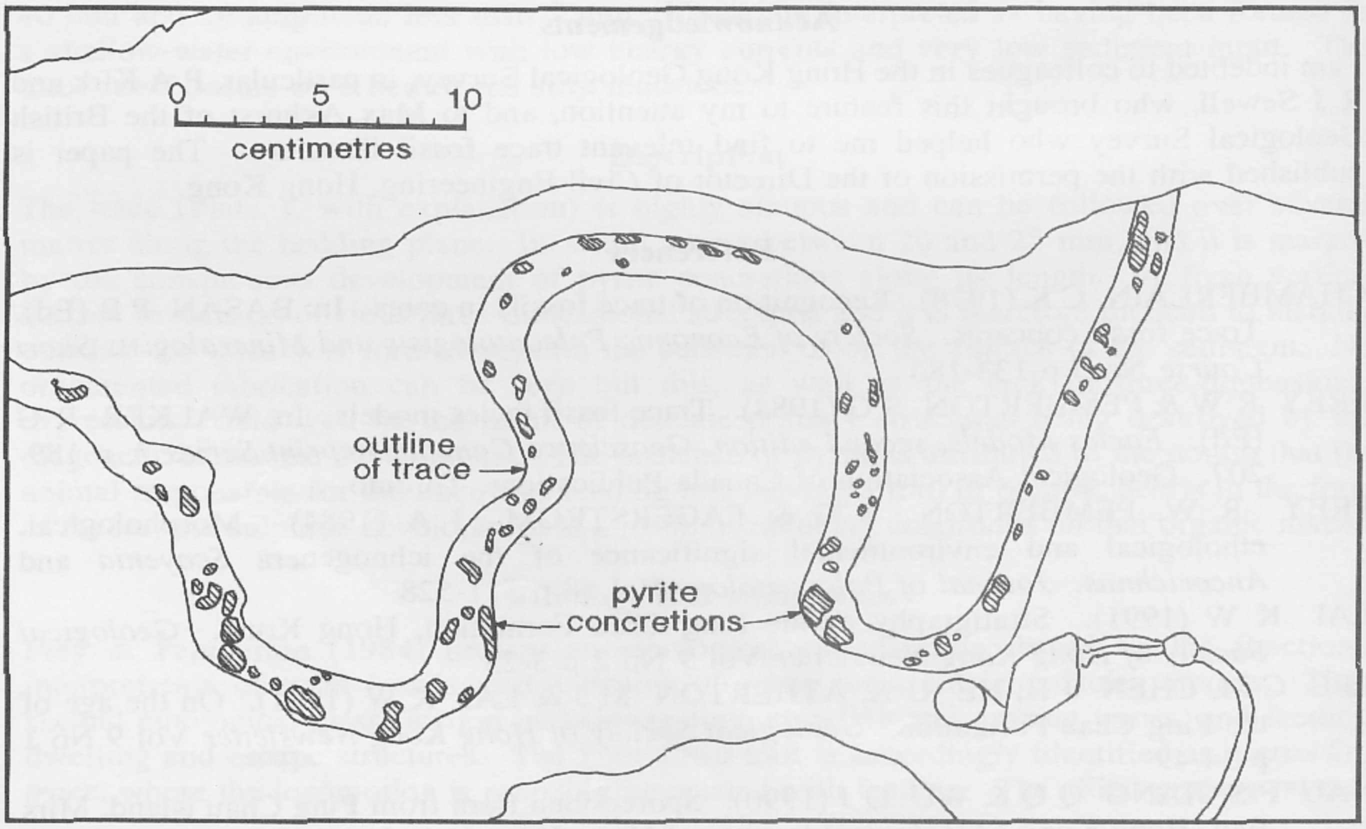
Plate 1 Crawling trace in the Ping Chau Formation (explanation below)



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SCHOFIELD'S FIELD NOTES - PING CHAU, DECEMBER 1921

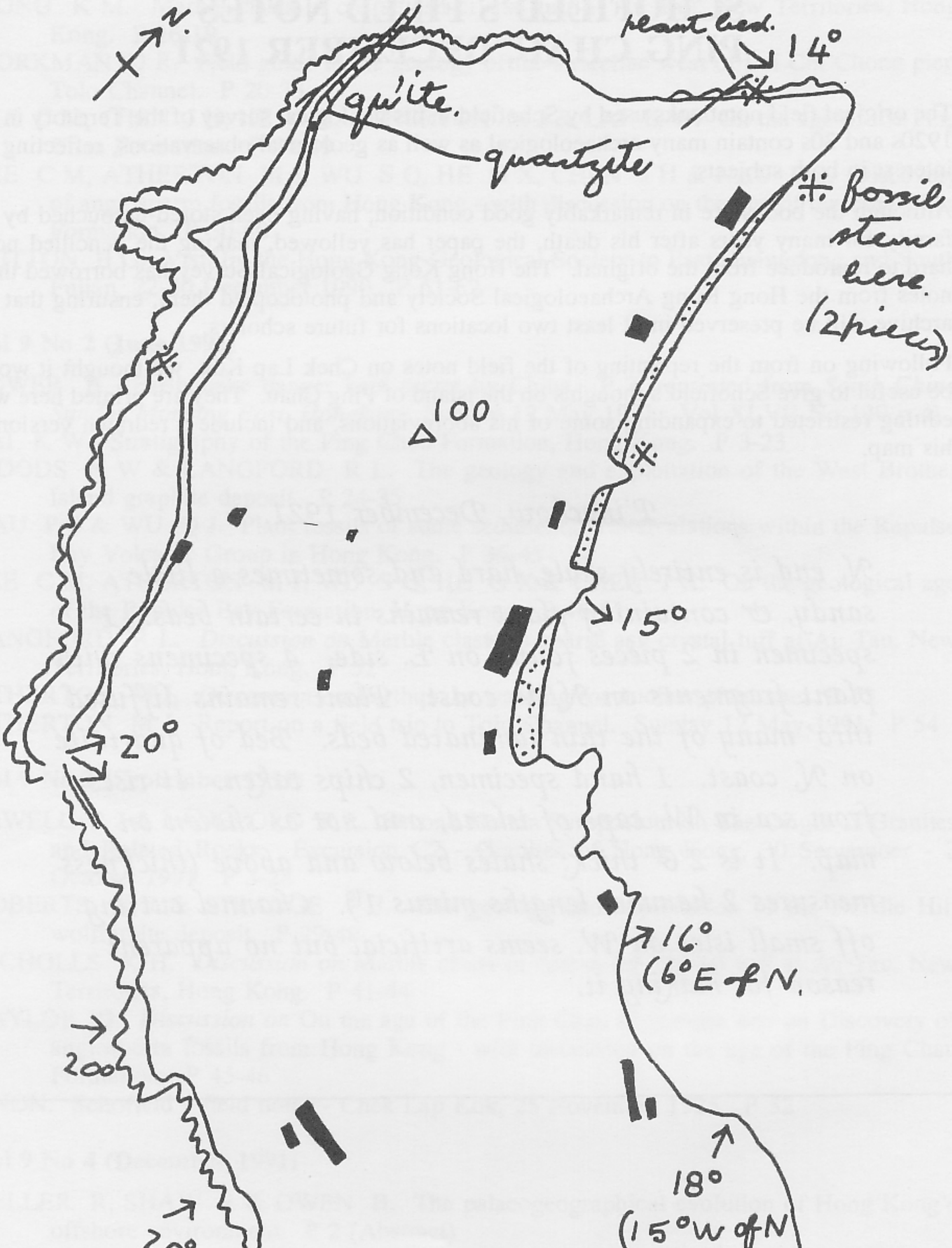
The original field notebooks used by Schofield in his geological survey of the Territory in the 1920s and 30s contain many archaeological as well as geological observations, reflecting his interest in both subjects.

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

Following on from the reprinting of the field notes on Chek Lap Kok, we thought it would be useful to give Schofield's thoughts on the island of Ping Chau. They are printed here with editing restricted to expanding some of his abbreviations, and include a redrawn version of his map.

P'ingchow, December 1921.

N. end is entirely shale, hard and sometimes a little sandy, & containing plant remains in certain beds. 1 specimen in 2 pieces found on E. side. 4 specimens with plant fragments on N.W. coast. Plant remains diffused thro' many of the thin laminated beds. Bed of quartzite on N. coast. 1 hand specimen, 2 chips taken. It rises from sea in W. cape of island, and not as shown on map. It is 2'6" thick: shales below and above (thickness measures 2 hammer lengths minus 1"). Channel cutting off small islet on W. seems artificial but no apparent reason for making it.


N.
plant bed.
14°
quite.
quartzite
fossil stem here (2 pieces)
100
15°
20°
16° (6°E of N.
200
18° (15°W of N
20°
20°
20°(4°W. of N)
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Peng Chau.

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Cover photograph: View of the Pat Sin Leng range looking west from Wong Leng (8395E 8390N). The Cretaceous Pat Sin Leng Formation overlies the Jurassic Tai Mo Shan Formation on the ridge. Fanling is south of centre, and the urban development in Shenzhen, China, can be seen north of centre. Photograph courtesy of K W Lai, Hong Kong Geological Survey

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