## Preservation of Nine Rock Carvings in Hong Kong

### A Consultancy Study of Ancient Rock Carvings

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Introductory Remarks

This study was undertaken according to the specifications set out in the contract dated July 27, 2009 between the author and the Government of the Hong Kong SAR, in particular the Leisure and Cultural Services Dept. (LCSD). The study consisted of site visits to the nine rock carvings in October 2009, plus research and the preparation of this report.

There are a number of issues that apply to some or all of the carvings. Due to the contract term specifying a (rather inappropriate) format of reporting under the heading of each carving and requiring a minimum of 500 words per carving, these issues are discussed at length under one or another of the carvings. This discussion is then referred to in other sections but not repeated in full. A short index of the main issues is included at the end of this report.

I have done a considerable amount of research on the rock carvings prior to the current study, in the years 1974-2009, resulting in a small book published in 1976 and a much revised and enlarged version of the book published in September 2009. Before the formal signing of the contract, I informed the LCSD of the pending publication and related activities. The Antiquities and Monuments Office (AMO) was informed of the publication of the new edition on September 14, 2009. A copy of this book *Rock Carvings in Hong Kong* (hereafter "my book") is attached as reference material to the report, and some photographs in the book are specifically mentioned herein, but all intellectual property rights to the book and its contents are reserved to the author.

In the course of the above-mentioned research for the book and the public issue of the preservation of the carvings, I consulted several internationally recognized experts in rock art preservation and local experts in other related fields such as microbiology, rock chemistry and civil engineering. In accordance with the strict confidentiality imposed (again inappropriately) by the contract, no outside expertise was consulted as

part of the present study, but this is considered to be an unnecessary and serious limitation on the full evaluation of the complex problems associated with the preservation of Hong Kong's rock carvings. This question is discussed further in the concluding section.

I am not a rock art conservator, nor do I have expertise in any of the relevant fields other than archaeology. However, I do understand and try to apply some basic tenets of modern conservation theory, first and foremost of these being the following: 1) that rock carvings have survived several thousands years in a state of nature and should be left alone and preserved as far as possible in that state, and 2) the most serious threat often comes from man, in the form of visitors to the site and also through government actions which are well-intentioned but have potentially harmful consequences.

One of the first things one learns as an archaeologist, confronted by myriad problems requiring outside expertise, is how to ask the right questions and find the right people to seek answers from. In the months since October 2007 when I discovered Po Toi to have a serious problem with the bio-film, I have sought out and corresponded with some of the small number of internationally recognized experts in the field of rock art conservation. This is a highly specialized field that very few archaeological conservators have any training or experience in. In this report I have cited statements from that correspondence.

#### I. Shek Pik, Lantau

## *I.1. The present condition and the potential hazards that will affect the well being of the rock carving* –

The rock carving at present appears to be in stable condition, but there are potential hazards, mostly created by human intervention in recent years. The pavilion structure, while better than Perspex in allowing air flow, still alters the natural conditions, notably the amount of rain, sunlight and ultraviolet (uv) radiation that reaches the rock face. The extensive roof cover effectively blocks any sunlight that would ordinarily reach the rock, being already much reduced by the trees and other vegetation that nearly surrounds the site. According to Andre Rosenfeld, a veteran rock art conservator in Australia, "a covering structure [of any kind] would alter the microclimate at the rock surface, and hence have implications for the stability of the rock." Blocking virtually all the ultraviolet radiation from the sun can lead to growth of microorganisms that may cause damage. The amount of lichen and other growths on the rock seems to be more than in the 1970s, judging from memory and photographs, and although it does not seem to pose a threat at present, one must be aware of the future possibility, and also that of endolithic bacteria living in the pores of the rock and not visible to the naked eye.

The second potential threat arises from the concrete that has been used to implant the new pavilion type structure, and also added at the back of the rock face as a small dam to divert surface water away from the carvings. In addition to being unsightly and terribly crowding the carving, the presence of concrete in close proximity to the carved



rock poses a threat. According to Australian rock art conservator Andrew Thorne, "concrete contains very destructive salts and while these may be washed away by rain they can become quite aggressive in an enclosed site" and "concrete sitting above the site ... is a potential disaster and perhaps the best way to destroy rock."

The greatest hazard at this site and several others is from man. The purpose of the enclosure first and foremost is to allow visitors to see and appreciate the rock art but prevent them from touching it. They should be kept at least an arm's length plus twenty centimeters away from the carved surface. The large spaces above the grillwork on all four sides of the pavilion at Shek Pik provide easy access to the inside, thus defeating the purpose. Graffitti scratched or painted would cause significant and possibly permanent damage to the carving.

#### I.2. Review of the present preservation and conservation practice –

Satisfactory in that no chemical treatment has been applied to the rock, but the hazards noted above have not been recognized and corrected.

#### I.3. A practicable preservation strategy for the rock carving –

All concrete should be removed from the rock outcrop. The roof should be replaced by metal mesh or chainlink fence so as to allow sunlight through to the rock. To control surface water and slope stability, a screen of low bush vegetation should be planted behind rock outcrop.

#### I.4. The current display settings and improvement measures –

The metal grillwork of the pavilion and its concrete supports severely crowd the carved rock face. Its coverage should be expanded so that the entire rock outcrop of approximately 8m in width is enclosed. The grillwork of the present pavilion is too ornate and seriously detracts from the natural setting. It should be much simpler and

wider so that the visitor can appreciate the whole rock outcrop where the carving was made, not only the small area of the carving itself. Also, one of the patterns is now totally buried in soil, and another one partially. There is about 40 cm of soil covering these two patterns. Compare the points marked with Xs on the photo below taken in



October 2009 with that taken in 1975 on page 26 of my book. This soil should be removed so that all the carved patterns can be seen.

#### I.5. A comprehensive management plan –

The immediate environment should be improved and the rubbish collection point moved further away. The enclosure itself needs to be monitored regularly, so that leaves and soil can be removed when needed. Also, insect nests were noted at quite a few points on the inside of the enclosure. The plaque should have an outline of the design and give details about the individual carving.

### II. Po Toi Island

## *II.1. The present condition and the potential hazards that will affect the well being of the rock carving*

The present condition of the rock has temporarily stabilized, but has over the past few years proven to be rather volatile and at times threatening to the rock carving. Once again, these hazards are almost entirely due to human interventions since the 1970s. A natural process of spalling off from the rock surface in thin layers is occurring naturally, but its timeframe is unknown and unpredictable. Any human intervention on the site should be very carefully considered in order to avoid increasing the incidence of spalling.

As discussed above in section I.1, the presence of concrete poses a danger due to its decomposition products affecting the rock. A second possible impact of the concrete is that it may encourage the growth of microorganisms, due to its tendency to hold moisture and dry slower than the rock. Thorne mentions a site that he studied in New Zealand "with a similar [to Po Toi] mass of concrete placed around it and believe that this has led to the development of prolific localized biota." Dr Alice Tratebas, a US archaeologist who has specialized in and published widely on rock art conservation, noted the same phenomenon: "The concrete directly below the rock art [at Po Toi] may be trapping and holding moisture and consequently may be contributing to the microorganism growth."

The serious threat posed by biological growth was very clearly revealed in October 2007 when I visited the site. The two carvings to the east were literally covered in a bio-film that was peeling away and pulling off a paper-thin portion of the rock surface as it peeled. This was recognized by all concerned as a serious threat, but the chemical measures taken to alleviate it could have been worse than the threat itself. This issue is discussed further below.

Another likely impact of the concrete platform, and concrete blocks used to fix the Perspex cases, is that the hydrology of the rock outcrop has been altered. This may contribute to the growth of microorganisms not only in the retention of moisture but also acting as a huge reservoir and re-directing water movement within the rock itself. On the other hand, superficial attempts to divert this ground water as it seeps out of the rock have been a total failure, as witnessed most dramatically on a site visit in September 2009. A trickle of water was observed seeping out from **under** one of the concrete dams above the eastern carvings and running down unto them. This trickle of water had started a new growth of black biota, indicating that the biocide and water proofing of 2007 had already worn off or was ineffective.

The Perspex cases themselves have proven to be part of the problem. It is absolutely certain that they do create a microclimate inside, by virtue of the fact that they block wind and sea spray, and reduce the amount of sunlight reaching the rock. They block a whopping 80% of uv radiation. Wind and sunlight serves to increase evaporation of surface moisture, while sea spray and uv inhibit many types of growth. Tratebas noted, in relation specifically to Po Toi:

"The enclosure, by reducing direct sunlight and trapping moisture behind the Perspex, has contributed the two most common reasons for microorganisms to start growing on rock art. Emergency action is needed ... to help increase evaporation of moisture and let in a little more sunlight. Removing it offers the best hope for stopping spread of the biological growth."

Thorne concurred: "a microclimate conducive to the current biological colony has obviously been created by the screen."

#### II.2. Review of the present preservation and conservation practice

The use of a "silane based hydrophobizing agent" (as stated in the letter of Nov. 8, 2007 from the AMO) along with a "moss retardant" biocide to prevent future recur-

rences of the bio-film was ill-advised, for several reasons. As summed up by Rosenfeld:

"Chemical treatment of the rock surface **is always to be avoided** !! Chemical treatment will cause changes in the surface rock chemistry and rock structure. While these may initially appear to enhance the visibility of engravings, either by removing algae or lichen, or by enhancing colour differentiation between the engraving and surrounding rock, in the longer term such induced changes **can only be deleterious**." [emphases added]

In addition, chemical sealants have been shown to decrease porosity and increase the risk or incidence of spalling, especially where the process has begun naturally as it has at Po Toi. The risks associated with the use of these chemical agents is discussed in further detail in section IX.2 below.

The biological agents involved in the bio-film have been identified as two species of lichen (Ref. No 2/2008) on the information disk for this rock carvings study. However, an expert at the University of Hong Kong was of the firm opinion that the biofilm was produced by cyanobacteria. This question needs further investigation by experts. It is not possible to evaluate the report at Ref. No. 2/2008 as no illustrations are provided, and no information is given about the authors or the institution where the analysis was done. It is clear that identification of the causative agent is vital in designing measures to prevent or at least inhibit its growth.

Another apparent attempt to control the water movement inside the rock outcrop was equally ill-adivsed, namely the drilling of drainage holes ("weep holes") some 3 to 4 m into the rock. This serves only to drain the end point on the inside, while creating a long tube of highly polished and impermeable rock that will have unknown consequences in diverting the water flow.

The most serious and immediate priority is to protect the eastern carvings from being touched by visitors. The destruction of the Perspex case by a typhoon in September 2009 has left them completely exposed and easily accessible to visitors'touch. One vandal could do unthinkable damage and the carvings could be ruined forever. This is simply an unacceptable risk. A fence or other temporary protective screen is urgently needed, while long-term measures are planned.

#### II.3. A practicable preservation strategy for the rock carving

An enclosure that retains all the natural elements in the same equilibrium that they have been in over the centuries is desirable. This would allow rain, wind, sunlight, ground water and sea spray to continue to interact at the site without interference. To achieve this, **all** concrete and Perspex cases should be removed from the immediate area of the rock carvings and a grillwork frame constructed over the two groups of carvings. Details of this proposal are discussed further below in Part Two.

Of crucial importance regarding the biological growth is to refrain from any future chemical treatment of the rock surface. Regular monitoring and gentle removal by mechanical means of any bio-film is recommended, especially at the beginning of the dry season. Installation of a video-camera with direct feed to the internet is also advisable, to monitor both the environmental conditions at the site and the behaviour of visitors.

### II.4. The current display settings and improvement measures

The most objectionable aspect of the current display is the concrete platform that completely obscures the archaeological setting of the carvings. There was a natural rock platform that connected the eastern and western carvings at Po Toi (see the upper photograph on page 33 of my 2009 book), and this platform undoubtedly played a role in the selection of the site and its ceremonial use. This ledge has been buried in concrete. Even worse is the smaller ledge in front of the eastern carvings which could well have served as an altar. Not only does the concrete block completely bury this feature, but it runs into the rock art face itself, just a few centimeters below the carving. This is an archaeological, aesthetic conservation outrage and should never have been allowed.



Worse, it poses a serious hazard to one of Hong Kong's most impressive carvings. The archaeological and natural setting of this site has thus been radically altered, but the original rock is still there, and it can and should be re-instated.

After all the concrete has been removed, hand rails can be installed at the edge of the rock outcrop overlooking the sea, well away from the platform and the carvings but as a safety measure to prevent visitors from falling into the water. See the design suggestions in Part Two of this report.

#### II.5. A comprehensive management plan

The key components of such a plan are: a) monitoring of the site through webcam and

regular visits; b) cleaning of any biological growth when required; c) no chemical treatment of the rock; d) restoring the site to its original state so that both the archaeological and environmental elements are preserved as they have existed over the last three thousand years.

### III. Tung Wan, Cheung Chau

# *III.1. The present condition and the potential hazards that will affect the well being of the rock carving*

This carving is enclosed in a glass structure and has undergone major changes in its appearance since the 1970s. The "Past Treatment" provided on the information disk does not record that the entire surface of the main (uppermost) carving was painted green in the early 1970s by vandals, and solvents were applied by AMO staff in an attempt to remove the paint, without much success. Traces of the green paint remain today, but now just as 30-odd years ago, the best method of dealing with this extremely sturdy outdoor paint is simply to let it gradually weather away.

The most striking change in the rock outcrop from the 1970s to today is that a grey accretion of some sort that was present all over the rock outcrop is almost entirely gone: compare the photograph taken in 1975 (on page 52 of my book) with this one taken in October 2009:



The colour of most of the rock has changed from grey to yellowish brown. Inspection of the grey coating that remains today suggests that it is either a man-made sandy slurry, possibly used in construction, or more likely it is a naturally formed and rather thick skin on the rock. Its removal might have taken place during the attempt to remove the painting, or it has gradually worn off over the years. It does not seem to pose any threat to the rock, so no action is needed to remove what remaining.

The enclosure however does pose a long-term threat to the rock carvings and it should be modified or replaced altogether. That a microclimate is created inside this enclosure cannot be denied, as wind, sunlight, sea spray and rain are all largely blocked. The disintegration of the grey layer coating the rock could well be due to this altered climate. In the 1970s, this grey layer was hard and fast on the rock; now where it still exists it is loose and easily pulled off. More importantly, just behind the upper rock carving, one large rock face is experiencing extreme degradation (see the photo below), and turning into a silty powder. It is not known what is causing this, it could be water dripping from the roof of the enclosure, wind focused by the openings in the



enclosure, salt crystals expanding and disintegrating the rock structure, or other processes. The phenomenon should be investigated immediately by a competent geologist. Should the focus of this degradative process shift onto the face with carving, the result would be disastrous. The condition of the rock outcrop cannot be said to be "stable."

Again as in numerous other "protective structures" over the rock carvings, the enclosure at Cheung Chau has space at the top large enough for someone to climb through and gain access to the carvings. This poses a continuing danger and should be eliminated.

#### III.2. Review of the present preservation and conservation practice

Apart from the enclosure and related construction, there has been little direct intervention on the rock art or the rock outcrop, and this passive preservation should continue. However, in view of the degradation noted above, monitoring of this site should be increased from the present once per quarter visit by AMO staff, to at least once every two months. Consideration should also be given to the installation of a webcam inside the glass enclosure focused on the degrading area in order to obtain more data on what is causing the process.

#### III.3. A practicable preservation strategy for the rock carving

The long-term preservation of the rock carving as with all the others depends on reestablishing the equilibrium that has existed for 3000 years and that has enabled the carvings to survive down to the present. The glass enclosure should be modified or totally replaced, in order to restore the natural environment as much as possible.

#### III.4. The current display settings and improvement measures

In addition to inhibiting the natural environment, the enclosure creates a zoo cage appearance. Some visitors have wondered where the animal is, until the plaque was pointed out to them. The stone wall on which the glass panels sit obscures the natural ledge which is part of the archaeological context of the carvings. While obviously an attempt has been made to "blend in" with the rock outcrop, the stone wall, stone infill behind the wall and stone plinthe for the plaque are unacceptable distractions which deny to the visitor the appreciation of the original setting for the carvings. The stone infill seen from above resembles a pile of rubble and seriously detracts from the rock art.

#### III.5. A comprehensive management plan

All the stone rubble construction should be removed, along with the enclosure as presently constituted. A new design could incorporate some of the glass panels as windows in a metal frame cover for the entire site, including the natural ledge in front of the carvings which is now buried under the stone infill and stone wall. The handrails should be relocated further away from the rock outcrop, if possible.

#### IV. Kau Sai Chau, Sai Kung

## *IV.1.* The present condition and the potential hazards that will affect the well being of the rock carving

This rock carving is very heavily weathered, especially the lower half. On cloudy days or when the sun's rays are not striking the rock face at an angle, the carving is very difficult to discern at all. This is due to its natural weathering rather than any human intervention, and will continue, although at presumably a very slow pace measured in centuries rather than decades.

The only hazard that presents itself is that of vandalism, due to its extremely remote location. While the possibility of such an unfortunate event may be slight, it still deserves consideration and possible mitigation, as suggested below.

#### IV.2. Review of the present preservation and conservation practice

The stainless steel "protective cage" is not only totally useless in providing any protection to the carving, but actually creates a danger by drawing attention of any one passing by in a boat (fishing, pleasure or smuggling). It is nothing short of astonishing that the same mistake could be made over and over again with regard to these cages: their sole purpose should be to keep people from touching the carvings, yet in this case the cage is so close to the carving that it can be touched from both sides by simply reaching through the bars. Thus no protection at all is being offered. On the other hand, from a distance the cage simply beckons as if there is something valuable there. What seems likely to happen eventually is that the cage itself will be stolen, but the carving itself is put at risk by calling attention to it.

The information disk states that a "channel above the carving" was also constructed. It is unclear to me what exactly this is, but if it was cut into the rock face above the carving then it was a serious mistake. No physical intervention in the rock face should be contemplated without very careful study beforehand. Like the "weep holes" drilled into the rock outcrop at Po Toi, this was a highly ill-advised and incorrect attempt to divert water flow in and on the rock.

#### IV.3. A practicable preservation strategy for the rock carving

The carving should not be interfered with in any way. No attempt should be made to prevent its natural weathering or to shield it from natural forces. Regular monitoring and a detailed photographic record should be made every year. Over the next 10 to 20 years it might be possible to determine at what rate it is weathering. Consideration could in the longer term be given to removing the carving from the rock outcrop and storing it in a museum, but this should only be contemplated after serious study.

#### IV.4. The current display settings and improvement measures

The cage, stone viewing platform and stand for the plaque should be removed, and a much smaller and less obvious plaque installed. The cage as noted above serves no protective purpose and instead may draw attention to the carving. The viewing platform is an unnecessary alteration of the archaeological setting, and without it the carving can still be seen quite adequately, if the lighting is right. The plaque should be located at a lower level than at present, and sited so that it is not too obvious from a distance. That is to say, only those know about the rock carving and who set out to see the rock carving will find it.

The plaque on this and all other carvings should provide a simple drawing of the pattern and outline of the rock face, so that the viewer has an instant idea of what the art looks like and where it is on the rock. In addition, the plaque should provide some information about the individual carving, notably when and by whom it was discovered, what the pattern is composed of (in very general, descriptive terms), some brief information about other rock carvings in the territory, and some very basic ideas about what they might have meant to the ancient people and their dating. The current supplementary plaque at certain sites has some good information but probably goes too far in including a drawing or photograph of all carvings in the territory. Rather, a website should be given on the plaque where much more detailed information can be found.

#### IV.5. A comprehensive management plan

Removal of all existing man-made construction from the site, installation of a new plaque mount at a lower level and a little further away from the rock art face. And,

monitoring with record photographs on a yearly basis from the same angle and distance; three-dimensional laser scanning for a permanent digital record.

### V. Joss House Bay, Sai Kung

## *V.1.* The present condition and the potential hazards that will affect the well being of the rock carving

The rock with inscription is in good and apparently stable condition at present, but there are longer term hazards to it that need to be studied in detail. Most notable among these is the tendency of this rock and others in the immediate vicinity of the footpath to foster growth of lichen and moss, whereas others further away (e.g. in the bamboo) have little or no such growth. The reasons for this are unclear, and a microbiologist should be engaged to determine what factors are leading to this situation. There is also a pronounced area of green growth in a rough square surrounding the inscription but smaller than the area shielded by the Perspex. Outside of this square area a black growth is seen. These growths are probably not related to the Perspex screen but may possibly be due to the chemical treatments applied and the removal of previous colonizers.

Yet again, in this case the protective Perspex screen does not provide adequate protection, as much of the inscription can be touched from under the screen: up to the fourth character from the bottom in all columns, and on the right side to the fourth column). This results from the screen being some 20 cm away from the rock surface. While a good idea to provide air flow, the outer edges should have been blocked with some kind of chainlink or grill.

#### V.2. Review of the present preservation and conservation practice

The inscription has been treated with biocide and water-proofing chemicals. As stated above, this practice should be terminated, due to its possible future harmful impact on the rock and decreased porosity. The danger of using sealant-type chemicals is discussed in detail in section IX.2.

As for the biocide, several factors should have been considered, most importantly the identity of the biological agent or agents present. Prof Larry St. Clair, a biologist at Brigham Young University in the US who has been deeply involved in rock art conservation studies, commented:

"Certainly, the approach the local [Hong Kong] authorities have taken is less than desirable. Failing to identify the [biota] reduces the prospect for success in treating [them]; and covering with a sealant may simply exacerbate the problem – many bacteria are both resistant to biocides and perfectly capable of thriving under anaerobic conditions. Follow up samples should be informative but sample identification really should have been the starting point."

In a similar vein, before any chemical treatment was applied, the exact rock type should also have been identified. The inscribed rock at Joss House Bay is in an area of

several different rock types, and furthermore the boulder itself has an unusual surface; these should have been studied so that the potential impact of any treatment on the rock chemistry could have been better understood. As noted in the previous citation from Rosenfeld, chemical treatment will invariably cause changes in the surface rock chemistry and rock structure. It should be avoided in most cases.

### V.3. A practicable preservation strategy for the rock carving

The most important element in a preservation strategy at this site is to acquire greater understanding of the microbiological environment, in order to take effective action to minimize it. This could involve cutting back some of the vegetation in the vicinity, or even replacing it with other types such as bamboo. Regular cleaning by gentle mechanical means would be the preferred method to keep biological growths under control, rather than the use of chemicals.

### V.4. The current display settings and improvement measures

The Perspex is cloudy and dirty on the inside and out, and thus prevents the viewer from obtaining a clear and unobstructed view and appreciation of the inscription. It should be replaced with a glass window set in a stainless steel frame covering also the four edges to prevent any touching of the inscription. The structure should be set even further away (40 cm) from the inscription to give a better view, and regular cleaning of the glass should be done.



- 1. Multiple growths of different kinds and colours!
- 2. Cloudy screen detracts from view.
- 3. Messy railing needs painting, or better complete removal.

The plaque and viewing area are well done except for the low concrete wall beneath the inscription which is unkempt and serves no purpose. Removing it would make the boulder even more impressive. Regarding the reading of the inscription itself, several of the characters are given on the plaque as illegible (an empty box) whereas parts of each character can be discerned in the inscription. A good rubbing plus the context would probably lead to their decipherment but if uncertain the proposed reading could be put inside the box with an expanatory note at the bottom.

#### V.5. A comprehensive management plan

Most important is the control of biological growth, and general cleaning of the viewing area and protective screen. The inscription will survive another thousand years if not drastically interfered with!

### VI. Lung Ha Wan, Sai Kung

## *VI.1. The present condition and the potential hazards that will affect the well being of the rock carving*

The status of this feature as a carving has not been established and is still debated among experts. The rock in which this feature occurs has a very unusual structure and is prone to strange weathering patterns. What is noteworthy is that there are other odd weathering patterns nearby, formed by pitting and eventually combining into groovelike forms following the vein of the rock. What is most unusual, even freakish, about the "carving" pattern is the flat and smooth rock surface on which it has formed. Whether the pattern was carved originally by man or not, it is not disputed that considerable weathering has taken place. The weathering process will surely continue and attempts such as the use of a consolidant to retard the process will almost certainly make it worse.

The application of a consolidant poses a significant potential hazard, especially as the consolidant was applied in too thick a solution and forms a visible coating on the surface. The very use of a consolidant, even when correctly applied (it was not in this case), poses a long-term threat to the rock.

#### VI.2. Review of the present preservation and conservation practice

Whereas in the case of Po Toi, Joss House Bay and Wong Chuk Hang only a waterproofing chemical was applied, Lung Ha Wan was given a "double-whammy" of water-proofing **and** consolidant. This treatment is certain to block water movement and trap moisture inside the rock, with harmful consequences. As one of Australia's leading rock art experts Robert Bednarik wrote to me:

"If the site was treated with silane that is indeed bad news. You are completely right to expect surficial spalling, rock art sites have previously been ruined with this silly treatment which is known to block water movement."

While silane-based water proofing might allow water vapour to escape, both it and especially the consolidant would block liquid water from escaping. With a rock as porous as that at Lung Ha Wan, it is unavoidable that some water would seep through pores where consolidant has not completely closed them, or enter from above the consolidated zone, but then become trapped behind the surface where consolidant and water-proofing does effectively seal off the exit. See the further discussion of silane



based agents in section IX.2.

The Perspex screen further exacerbates the situation by partially blocking sunlight, wind and sea spray. The evidence of a microclimate behind the screen is especially dramatic and undeniable at this site. The consolidant residing on the surface is visible as a creamy light brown paper-thin layer (seen in the photos). Although the consolidant was applied to the entire rock face with "carving" it now survives as a surface coating only behind the screen and has weathered away around the outer part of the rock face. Clearly the screen has enabled the consolidant



layer to remain by reducing the natural elements that have gotten rid of it where unshielded by the screen.

Moreover, the Perspex cases have proven to be unable to withstand violent weather. The first screen at Lung Ha Wan was damaged within the first two years by a typhoon, and the cases at Po Toi have been broken at least twice. In the latest instance at Po Toi, the Perspex appears to have scratched the rock face of the western carving as it broke apart—another reason that the use of Perspex should be abandoned altogether.

#### VI.3. A practicable preservation strategy for the rock carving

Three elements for future strategy: no use of chemicals, removal of the screen, and detailed recording. Like at Kau Sai Chau, a detailed close-up photographic record and laser scan should be made every year so as to determine whether or at what rate it seems to be weathering.

#### VI.4. The current display settings and improvement measures

As discussed above in relation to Kau Sai Chau, this carving is in a very remote location and does not need protection from human interference (except those of the government!). Its presence should not be prominently advertized on the road or the coast. A small sign stating simply "Ancient Rock Carving" on the road would suffice for those who set out to visit it.

The steps on the right as one descends should be removed, along with the handrails, so that the visitor approaches from the left, walking over the original rock surface for the last 10 metres. The site can thus be left unencumbered of any human construction except for the plaque.

#### VI.5. A comprehensive management plan

In addition to the measures suggested in items 3 and 4 above, the authority should commission specific studies to determine the origin of this feature, ie whether manmade or natural. Possible methods are 1) shallow penetrating X-rays or radar to show the structure and veins of the rock and whether they mimick the surface pattern; 2) spectral or other analysis of the grooves for traces of bronze. The latter would first need to be done on other rock carvings to ascertain whether they do indeed bear traces of the bronze implements presumed to have been used.

### VII. Tung Lung Island

# *VII.1. The present condition and the potential hazards that will affect the well being of the rock carving*

As discussed already in relation to Po Toi and Lung Ha Wan, the protective case radically alters the equilibrium that the carving has been in for several thousand years and creates a microclimate inside with reduced wind, sunlight and sea spray. One direct impact of this reduction in the natural elements is the persistence of paint traces that derive from an unknown party having painted the grooves with a very sturdy outdoor silver paint sometime in the 1960s or earlier. A largely unsuccessful attempt was made by the AMO in the 1970s to remove this paint with solvents; it was decided to leave it to nature to gradually remove the paint and this process was working well but was certainly slowed down when the Perspex case was installed. However, the traces of paint that remain are relatively minor and do not appear now to pose any threat to the rock.

While the case itself poses a hazard, it fails to fully protect the carving from human hands. The opening at the sides allow the grooves to be touched some 20 to 30 cm into the pattern. Several graffiti were observed scratched and painted on the side of the boulder, underlining the potential hazard posed by visitors lacking respect for the monument.

The deleterious effects of concrete on the rock have been discussed above. Thorne summed up the situation with this statement: "Concrete has no place in heritage preservation other than to restore concrete structures perhaps." It should all be removed from the site except where removal would pose a serious problem for the rock itself, specifically under the boulder where the concrete would also be very difficult to remove.

#### VII.2. Review of the present preservation and conservation practice

As mentioned in relation to Po Toi, the natural ledge in front of the carving is an important part of the archaeological setting and context. It is now buried totally in concrete. And like at Po Toi, a concrete slab has been placed, shockingly, onto the carved rock face itself, just a few centimeters below the carving. The visitor is thus unable to appreciate the original context of the rock art, and is given instead the impression of a museum exhibit. Conservation and preservation does not only involve the carved pattern itself, but the rock face on which it is found and the general lay of the rock outcrop. Preservation of the rock carvings in situ should mean preserving them **in their natural state** as far as possible.

#### VII.3. A practicable preservation strategy for the rock carving

Following on from items 1-3 above, the future strategy should include removal of all concrete from the immediate vicinity (10 m on either side of the carving), removal of the Perspex case, and restoring the site to its original state, except for one safeguard – a protective cage to prevent visitors from touching the carving. And of course, no use of chemicals.

#### VII.4. The current display settings and improvement measures

A geologist and former senior civil servant visited the site in November 2009 and remarked to me that it was "hideous: cloudy case, no good photo angle, cement all over the site, long slog down the hill and back up again." I also heard similar comments from visitors when I was at the site in the summer. Two teenaged hikers remarked that there was "nothing to see" and a lady said "maybe the pattern had been washed away by acid rain." This carving is the most impressive of all Hong Kong petroglyphs, and to hear such reaction from visitors is highly regrettable. To truly appreciate this magnificent carving, one needs to view it from at least 3 or 4 metres away. Clearly significant improvements are needed, and redesigning the site without concrete and Perspex case as suggested above will go a long way to make the site as impressive as it should be for the ordinary person. The enclosure would have to include the lower flat boulder immediately in front of the rock art face (since it is rather small), and part of the sloping boulder leading up to it. An elevated steel walkway can replace the present concrete viewing platform, as suggested in the drawing and altered photograph in Part Two, allowing the visitors to appreciate the unique setting of this monument. A much improved plaque along the lines suggested in section IV.4 is also needed.

An alternate footpath from the pier along the coast at a low elevation is absolutely necessary, so that visitors are not faced with a harrowing climb back up the very steep



staircase, right after the long climb down.

#### VII.5. A comprehensive management plan

With the improvements suggested above, the long-term management would only require occasional monitoring of the condition of the protective structure and plaque.

The proposed footpath along the coast could be a low cost, low maintenance dirt path. Occasional landslips do happen, as noted in the information disk, and a company or even local villagers should be contracted to monitor and restore the footpath when required.

#### VIII. Big Wave Bay

## *VIII.1. The present condition and the potential hazards that will affect the well being of the rock carving*

The rock carving here is well preserved, complete and intact. But it faces hazards in the form of drastically altered hydrology in the surrounding rock. There is concrete in front of, beside and behind the carved rock face in the form of a paved platform, steps and footpath. To make matters worse, a clumsy attempt has been made to divert surface run-off by means of a small concrete dam directly behind the engraved face. All of these concrete structures have an impact on the hydrology of the site, by retaining moisture longer than the rock itself, and by changing the movement of water in and on the rocks. At times a black bio-film similar to but not as thick as the one seen at Po Toi in 2007 has been noted on the Big Wave Bay carving, as recently as 2005 (see the photograph on page 154 of my book).

The site has high visitor traffic, yet the "protective structure" has gaps large enough to allow anyone except the obese to climb inside. As pointed out in relation to the other rock carvings, the case or cage has one primary purpose: to keep visitors' hands of the carving. This is a serious flaw and continuing threat that must be eliminated.



Although the structure does allow nearly full access to wind and sea spray, the roof reduces the rain and sunshine on the rock, again creating a microclimate underneath. While not as serious as the Perspex cases, it still may have a long-term possibly negative impact. There has been a dramatic change in the colour of the rock since the 1970s. Photographs taken at the time (see pages 46 and 47 of my book) show the rock with carving to be the same colour as all the surrounding rocks, namely grey-black. Now the rock with carving is a light, yellowish brown, in sharp contrast to the surrounding rocks which remain the same as in the 1970s. A similar colour change has occurred

Above — Adjacent rocks remain the same grey colour as they were in the 1970s. Below — The rock inside the enclosure has changed to a yellowish brown. at Cheung Chau as noted above. The information disk does not record any serious chemical or mechanical cleaning at either site, but it does note that the Big Wave Bay carving was encased in a steel cage with glass from 1983 to 1995. The microclimate created inside the glass would have been more pronounced, and combined with the continued reduction of sunlight and rain since 1995, it may have caused the loss of the grey-black skin colour of the rock. The serious implication of this is that the microclimate is acting on the surface of the rock, and in the longer term could reduce the relief of the carving itself. The statement on the information disk that "the overall condition of the rock carving is stable" is thus incorrect.

#### VIII.2. Review of the present preservation and conservation practice

As in the case of Po Toi and Tung Lung, the archaeological site and context of this rock carving has not been preserved. The natural platform in front of the rock has been buried in concrete, the smaller ledge directly beneath the carving has had a concrete and rubble stone slab attached to it. Concrete dabs are also at the base of the carving and on each side, apparently from previous construction. And part of a large rock forming the smaller ledge has broken off, probably also during construction activities. All of these aspects reflect very poorly on the "preservation and conservation practice," indicating a total lack of proper controls.



- 1. Dabs of concrete on the rock just below the carving
- 2. Large break that has occurred after 1975
- 3. Intrusive concrete and stone rubble slab
- 4. Position of left hand in lower photo, page 47 of my book

#### VIII.3. A practicable preservation strategy for the rock carving

As for the other rock carvings, a restoration of the original setting and environment of the rock as far as possible.

#### VIII.4. The current display settings and improvement measures

This site is perhaps the most crowded of all with recent construction "amenities." The footpath, steps, handrail and cage are all too close to the rock art, the large concrete block detracts from the immediate setting of the carving, the concrete viewing plat-form covers the archaeologically important natural platform. Regarding the latter, it is highly ironic that the plaque at Big Wave Bay states:

"It is noteworthy that ledges or platforms exist in front of several of the rock carvings, places where ritual gatherings could have been accommodated."

Ironic because these natural rock platforms that undoubtedly played an important part in the ancient people's activities at the site are now covered with a modern "random rubble paving." Instead of displaying the actual archaeological features, it is left to the visitor to imagine how the site might have been.

All of the present construction on the site within 10 m of the carving should be removed, including the concrete footpath and steps. The path should be diverted onto the rocks and around to the very prominent natural ramp leading up to the carving, at which point it should stop. A handrail at the edge of the rocks would prevent visitors



Natural ramp leading to the (very cluttered) rock art site. Visitors should use this approach, and all man-made construction should be removed.

from accidentally falling into the sea. That handrail, a protective metal structure over the carving, and a small, inconspicuous stand for the plaque should be the only modern constructions near the carving.

#### VIII.5. A comprehensive management plan

Once the site has been re-designed, regular monitoring and maintenance would be needed. A closed circuit tv camera could be installed with feed to the lifeguard station; this would give an extra layer of protection and would also serve as a deterrent to any miscreant.

### IX. Wong Chuk Hang, Hong Kong Island

## *IX.1.* The present condition and the potential hazards that will affect the well being of the rock carving

The wider environment of the site changed with the construction of a large school building 80 to 100 metres downstream from it in the 1990s. The stream was channeled into pipes that run under the school, and the large building effectively blocks the small valley. It is unclear how these changes might have affected the site, but they could have given rise to increased moisture and/or humidity which in turn could have brought about a growth of moss that was observed in 2006. Other explanations are possible, and the factors which may foster growth of the moss should be investigated by experts. It is significant that from the time of the discovery of this carving in 1983

no such growth of moss was seen until 2006.

As a response to the moss, the rock face was cleaned and treated with a biocide and water repellant. The use of these chemicals poses a long-term hazard to the site, as discussed below. The black mineral stains present on the rock may have deepened in hue since 1983. Colour photographs taken by the AMO photographer at the time should be compared with the present. (Mine are not of sufficient quality to make any determination.)

There is also a steep slope directly above the carvings, with ruins of squatter huts and an old chunam that covers the slope down to the edge of the rock face. Surface water run-off is thus directed right onto the rock art and creates the potential for damaging biological growths. The concrete dam recently installed above the rock face is ineffectual, as illustrated by the drip lines below it, and it may cause pooling during heavy rain.

- 1. Chunam covering the slope
- 2. Concrete dam
- 3. Drip lines below dam



#### IX.2. Review of the present preservation and conservation practice

This site is the best in terms of being preserved as nearly as possible in its natural state. It was something of a risk to design the visitor access without a physical barrier, but it has proven to be quite effective. However, this success is due in large measure to the rather obscure location of the site and the fact that it is seldom visited and not widely known even to residents of the area nor to students (even teachers!) at the school just below.

The treatment with chemicals poses a serious long-term risk and should be discontinued. The problem with silane based sealants such as that used for water proofing is that they may react with the rock leading to discoloration, and more seriously that they may increase the likelihood of spalling. Tratebas has studied this issue in depth, and she sent me the following comments:

"It is highly controversial and widely condemned to apply silane to fine scale heritage resources like rock art. ... Many rock art sites that are on porous surfaces depend on the porosity of the rock for long term preservation. Rocks that quickly absorb water are quick to loose the water through evaporation and outflow. Experiments with silane show porosities reduced to, for example, 20 or 10 % of the natural porosity of the rock. The loss of porosity can vary greatly depending on how many coats of silane, type of catalyst, and so forth. Treated rocks retain moisture longer than the natural rock, and the retained moisture slowly deteriorates and disintegrates the rock. ... Coating the substrate with a water repellant chemical does not prevent growth of microorganisms. Water enters the rock art substrate through higher rocks on the cliff and would be retained longer in the rock art substrate because of the reduced porosity. This causes gradual spalling of the rock art surface. ....

The use of biocides also poses risks although these are less well known. Tratebas commented:

"Biocides are short term solutions that add foreign chemistry to the rock art surface. Usually they must be reapplied at frequent intervals. The long term effects of this altered chemistry are unknown because no one has adequately studied the full effects of any of the commonly used biocides. Some chemicals can have a damaging effect on the substrate. Much better is to re-establish the natural equilibrium of the rock art surface that allowed it to be preserved for so long."

As the long-term effects from the use of chemicals could be harmful, their use on rock carvings should be discontinued.

#### IX.3. A practicable preservation strategy for the rock carving

Action should be directed to improve the environment above the rock face. The slope should be cleared of the remnants of squatter huts and the chunam. It should then be

planted with low brush or hedge vegetation to increase slope stability and water absorption. The ineffectual concrete dam and channel directly above the cliff should be removed.

An expert in moss ecology should be engaged to determine what conditions are giving rise to the moss growth. On the site visit in October 2009 a small patch of moss was noted on the rocks a few metres downstream from the carvings. It is quite likely that moss will appear again on the rock art face when the biocide wears off, and the causes of this growth need to be discovered and dealt with.

#### IX.4. The current display settings and improvement measures

Satisfactory as noted above. The plaque should include more data, along with a drawing of the patterns and outline of the rock. The sign at street level needs to be repainted from time to time.

#### IX.5. A comprehensive management plan

Maintenance of the footpath and regular monitoring of the site.

## Part Two – Discussion of issues relevant to most or all rock carvings

#### The proposed grillwork protective structure

I have suggested that a metal grillwork structure replace the current cages or Perspex cases at all the rock carving sites except Kau Sai Chau, Lung Ha Wan and Wong Chuk Hang. These three sites are remote and/or seldom visited and thus can be left open. The other six are definitely in need of protection from human hands and implements!

At first I had in mind a grillwork like that seen in some residences and parks, with attractive patterning, or a latticework like that in the Shek Pik pavilion, since the straight bars at Big Wave Bay seemed too dull and jail-like. However, on reflection it seemed that any ornamentation draws attention away from the natural setting which should be the primary focus. The former cage at Shek Pik is a good example of a simple enclosure, but better without the stone wall at the base and the glass on the roof.

> The former cage at Shek Pik, photo taken in 1980s (?). Copyright William Meacham; All Rights Reserved.



Basic cage-type structures as depicted in the two (very rough) drawings below would suffice, allowing for the visitor to take in the setting all around with minimal distraction. A single 1 x 1 metre window of bullet-proof glass of the type now at Cheung Chau would provide a good view and photo opportunity without creating a microclimate inside. The entire structure could ride over the natural rock surfaces as does the cage on each side at Big Wave Bay, being secured only at the four corners, with thus minimal instrusion on the rock outcrop.



Above — Sketches of how simple metal frames could provide protection and appreciation of the original setting of the rock carvings. Below — The metal frame at Big Wave Bay rides over the contours of the rock and is only secured at the corners.



The metal structure need not be of expensive or high quality metal, as its purpose is to deter the random miscreant from an impulsive act of graffiti or vandalism. Even high-grade steel would not stop someone armed with bolt cutters or hacksaw. The top of the structure could be of wide metal mesh, allowing all natural elements in but keeping mischievous people out. And there would be very little weight on the vertical bars.

A creative graphic artist or architect can certainly come up with very pleasing designs, incorporating the priorities stated above.

#### Restoration of sites

I have also suggested major restorations at Po Toi, Big Wave Bay, Tung Lung and Cheung Chau, returning the sites to their natural rock topography. This would involve removal of large expanses of concrete to reveal the underlying rock. It would require a degree of learning through trial-and-error, as normally removing concrete is quite rough with no need to preserve any substratum. It is possible that there exist somewhere workers with the know-how to remove concrete selectively and carefully, perhaps in breaking up concrete around a pipe. But more likely it will be necessary to engage and train a team for this work, and retain the team for all of the restorations.

Several methods could be tried out on concrete quite distant from the more sensitive and important areas near the rock art face. The upper portions of concrete could be demolished with ordinary jackhammers. Approaching the original rock, a small drill that scrapes away a few centimeters of concrete at a time could be used. Alternatively, getting at the interface of rock and concrete with a hand chisel might achieve a better separation.

This would be a difficult task, and would surely leave the original rock with scratches and scars. Not all of the concrete could be removed from the nooks and crannies. But over time the rock surface would weather, and the remaining concrete would become less firmly attached and could be removed, bit by bit. The end result would certainly justify whatever minor damage is done to the rock in the short term. It is the price that needs to be paid for past mistakes.

Even badly scarred rock would be preferable to the concrete mutilation of the sites that exists at present!

From these roadside display stands:



To this archaeological site:



concrete path ends

handrail at edge of rock platform

Above — Po Toi in October 2009

Below— Photo and graphics to indicate how Po Toi would look when returned to its original state with only the minimum of modern construction.

#### The proposed steel walkway

With the concrete viewing platforms removed and the natural rock topography restored, only Tung Lung would require a new viewing stand for visitors. As described above in section VII.4, the small flat boulder beneath the rock art face and part of the natural ramp leading up to it would need to be contained within the protective enclosure. Half of the existing concrete footbridge could be retained, to connect with an elevated steel walkway around the enclosure, as indicated on the drawing and doctored photograph (See illustrations on next page).

This viewing experience would be enhanced by the feeling of being out in the air, over the water, and face-to-face with Bronze Age art. For special group visits, entry into the enclosure would allow close inspection of the carving from the low flat boulder in from—the very spot where it was executed and admired by the ancient people.

The display would be a marvelous way to appreciate this aspect of Hong Kong's heritage, and far removed from the "hideous" state of Tung Lung at present.





Above— Old and new photos combined to indicate how Tung Lung might look after restoration to its original state, with only a simple protective metal frame and elevated walkway.



lower flat and sloping boulders

enclosure

Below — Plan showing how the site could be laid out after restoration.

30

The latex mould-making in 1979

The information disk failed to mention this important event in the recent history of all he rock carvings except for Wong Chuk Hang and I believe also Joss House Bay. While highly invasive and damaging at the time to the rock surface, it is probable that all the chemicals related to that operation have long since been washed away.

The resulting replicas are however useful as an exact record of the micro-relief of each carving. They should be compared with the three-dimensional laser scanning reportedly being planned. Furthermore, the detailed photography recommended in this report can also be compared against the replicas to discover any change in the rock.

Index to main issues

Biocide – IX.2 Change in rock since 1975 – III.1, VIII.1 Concrete on rock – I.1, II.1, VII.1, VIII.1 Consolidant – VI.2 Enclosure microclimate – I.1, II.1, III.1, VI.2 Microbiology – V.2, IX.3 Plaque – IV.4 Rock outcrop hydrology – II.1, VIII.1 Water proofing chemical – II.2, IX.2

#### Conclusions and Follow-up studies

The restrictions imposed on this consultancy were counterproductive. It seemed most unreasonable not to have the advisers interact with each other. The interplay of various specialists can lead to a much deeper understanding of the issues and the pros and cons of possible solutions. But this interaction can still happen, at least to a degree. When all the reports have been submitted, they should all be sent to each of the advisors for comment.

During my visits to the sites and discussions with LCSD and AMO staff, it was clear that certain types of expert advice were needed that no rock art conservator or archaeologist would have—namely, that of geologists, civil engineers and microbiologists. In my report several recommendations were made about the need for such experts to take the investigation further and find solutions. Probably these experts can be found locally in the universities, private sector or government.

A local working group should be formed to digest the advisers reports, plus their comments on the others' reports, and to involve specialists as the need was identified. The working group should consist of government and non-government people. One person I would suggest is an archaeological conservator (Paul Harrison) who knows the local conditions, and has worked on local rock in an outdoor situation (the Jewish cemetery).

The working group should endeavor to produce a set of recommendations which would go to the AAB and LCSD for final consideration. This process should be open and transparent so that the public knows what is being proposed. Its agenda should be published and it should be open to other experts to offer ideas as well. In light of the abnormal and secretive manner in which the consultancy was set up and conducted, it is important to dispel any appearance that the results of the consultancy study might be manipulated to favor a certain position.

The Bronze Age rock carvings are one of Hong Kong's most valuable heritage assets. Many mistakes have been made in the last 30 years, but one dares to hope that we can get on the right track now to preserve them for future generations.

#### Appendix I – Measurements

During the nine site visits, hand measurements were made of each carving, and photos taken with a scale where possible.

Shek Pik: pavilion W2.8m D 2.5m whole rock outcrop at level of top rock inside pavilion W8.1m main square spiral pattern 34 x 56cm

Po Toi: Rock dyke W 20m approx Eastern carving across 3 spirals at top W42cm Fracture at widest W71cm Eastern carving left side at bottom W77cm Distance from eastern to western carving 6.6m Rock face of western carving at middle W191cm Western carving "emblem" from upper right to lower left Diagonal 67cm

Kau Sai Chau: Carving at middle W38cm Carving longest L64cm Rock face W110cm From bottom of carving to bottom of rock 165cm

Tung Lung: Upper left to lower right of entire carved area Diagonal 3.2m Right figure top to bottom 128cm Left figure top to bottom 189cm Widest point across entire carved area 250cm

Lung Ha Wan: Entire rock face W195 Entire rock face top to bottom H195 (NB: bottom is concreted surface)

Joss House Bay: Inscription area W130cm H111cm

Big Wave Bay: Widest point of carving W190cm Top to bottom in middle H82cm Wong Chuk Hang: Baseline measurement of carved areas starting at left edge of far left carving: 0-80, 130-155, 195-205, 250-295 From lowest point of carving to floor 150cm From bottom of far right figure to floor 160cm Far right figure top to bottom H55cm

Cheung Chau: Main carving 90 x 45 cm Far left carving 50 x 70 Middle carving 70 x 45 From right edge of main to right edge of far left carving 125cm

Appendix II — Rock Carvings Geology

In seeking to identify the rock types for each carving, I discovered some fairly wide differences in geological maps and other sources. I have compiled this information in the attached table (overleaf). It is clear from these that samples will need to be taken at each site in order to obtain a firm identification of the type of rock.

	5	eology of Rock C	arving Sites	
		Data compiled by William Meacl	ham October 2009	
Site	Allen and Stephens <sup>1</sup>	TN Chiu <sup>2</sup>	<u>Sewell revision of Chiu <sup>3</sup></u>	<u>Geological Survey</u> <u>Map <sup>4</sup></u>
Shek Pik	Undifferentiated volcanic rocks	Weathered volcanic rock, showing small phenocrysts of quartz and feldspar in a groundmass that shows some flow banding.	Weathered coarse-ash crystal tuff, showing small phenocrysts of quartz and feldspar in a groundmass that shows some flow banding.	Rhyolite lava and tuff Sheet 13, 1995 "Shek Pik"
Tung Lung	Welded lapilli tuff with excellent eutaxitic texture	Volcanic welded tuff, coarse fragments of quartz and feld- spar in a microcrystalline ma- trix which shows distinct ash flow structure	Welded rhyolitic tuff. Coarse grains of quartz and feldspar set in a microcrystalline matrix that shows a distinct flow banding.	Undivided, mainly eutax- ite Sheet 12, 1989
Kau Sai Chau	Acid lavas	Rhyolite, phenocrysts of cor- roded quartz and feldspar in a microcrystalline groundmass. No flow structure observable.		Undivided, mainly fine ash tuff Sheet 8, 1989

Cheung Chau	Feldspar porphyry	Fine grained granite with a few phenocrysts of feldspar.		Feldsparphyric rhyolite Sheet 14, 1995 "Cheung Chau"
Po Toi	Porphyritic micro- granodiorite, contains abundant basic xeno- liths	Sample No. 1 – Porphyritic biotite gramite. Medium grained, biotite has been largely altered to chlorite, epidote and iron ore through hydro-thermal action. Feld- spar is partly altered to sericite mica and epidote. Sample No. 2 – Same as No. 1 except that it shows many spherulitic structures made up of radiating aggregates of feldspar and quartz. Mar- ginal facies of the same rock as No. 1 (?). Sample No. 3 – Very fine- grained felsite composed of a spherulitic groundmass with abundant small needle- like biotite and a few phenocrysts of quartz. Mar- ginal facies of No. 1 (?).	Sample No. 1 – Porphyritic medium-grained biotite gran- ite. The biotite has been largely altered to chlorite, epidote and iron ore. Feldspar is partly altered to sericite mica and epidote. Sample No. 2 – Same as No. 1 except that the granite shows many spherulitic structures made up of radiating aggre- gates of feldspar and quartz. Marginal facies of the same rock as No. 1 (?). Sample No. 3 – Very fine- grained granite composed of a spherulitic groundmass with abundant small needle-like biotite and a few phenocrysts of quartz. Marginal facies of No. 1 (?).	Basalt Sheet 15, 1987

ruce as to coarse as to tuffs, tuff-brescia and tuf- fite Sheet 15, 1987	Undivided, mainly trachy- dacite and rhyolite lava Sheet 12, 1989	Fine ash vitric tuff Sheet 11, 1986	Unsorted debris flow at boundary with quartz trachyte Sheet 12, 1989
Pyroclastic rock with some lavas	Mainly banded acid lava, some welded tuffs	Pyroclastic rock with some lavas	Acid lava, OR quartz monzonite and porphy- ritic adamellite
Big Wave Bay	Lung Ha Wan	Wong Chuk Hang	Sung inscrip- tion

NOTES:

From *Report on the Geological Survey of Hong Kong*, by P.M. Allen and E.A. Stephens, 1971; Hong Kong Government Printer.
Identifications by Dr T.N. Chiu, geologist in the Dept of Geography, University of Hong Kong, published in volume XI (1986) of the *Journal*

of the Hong Kong Archaeological Society, p. 13; based on rock samples taken and examined.

4. Rock types as given on the geological maps produced by the Hong Kong Geological Survey; all 1:20000 except for "Shek Pik" and "Cheung 3. Revisions of Dr Chiu's identifications by Dr Rod Sewell of the Hong Kong Geological Survey, using more recent (2008) terminology Chau" which are 1:5000.