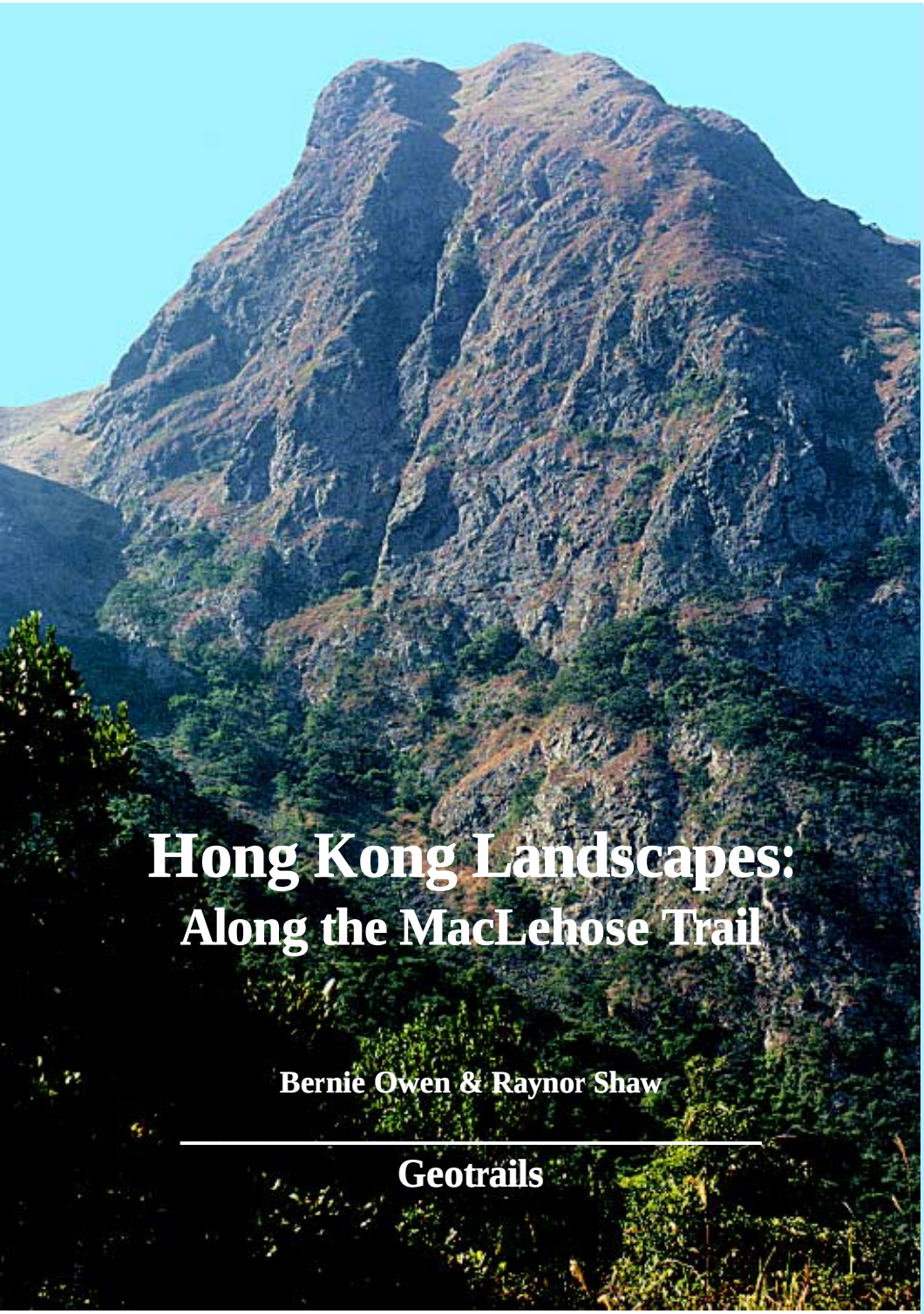


# Hong Kong Landscapes:
## Along the MacLehose Trail

**Bernie Owen & Raynor Shaw**

**Geotrails**

## *Hong Kong Landscapes*

*The urban and commercial successes of Hong Kong have captured the attention of the world, yet the impressive peaks, thickly wooded valleys, secluded beaches and picturesque islands that lie within minutes of the densely populated urban centres remain largely unknown. Only a small proportion of the resident or visiting population ever venture away from the paved streets into the surrounding areas of outstanding natural beauty. Even fewer people have had the opportunity to learn about the origins of the fascinating Hong Kong scenery, an intricate landscape that has determined the historical development of Hong Kong.*

*This book explains, in simple terms and with numerous illustrations, the natural origins and human contributions to the modern landscape. Using the 100 kilometre long MacLehose Trail as a convenient route across the territory, the authors describe and explain aspects of the geology, scenery, climate, soils, and vegetation, and how these have influenced the agriculture, history, customs, and ultimately the modern urban development of Hong Kong.*

***Bernie Owen*** *was a geology undergraduate at Sheffield University before going on to do postgraduate research at Queen Mary College, London. His interests include geomorphology (the study of landforms), lacustrine and marine sedimentology, and microfossils. He spent eight years in Africa, lecturing in geology and physical geography at the University of Malawi. In 1991 he moved to Hong Kong, where he now teaches at the Hong Kong Baptist University. He has carried out research in Kenya, Malawi, British Columbia, Thailand, Sri Lanka and Hong Kong.*

***Raynor Shaw*** *studied geography and geology at London and Edinburgh Universities, specialising in geomorphology. He lectured in geomorphology at McMaster University in Canada, and has worked in West Africa and Venezuela prospecting for alluvial diamonds and gold. Since 1983 he has been making geological maps of Hong Kong and publishing reports about the geomorphology, weathering and Quaternary sediments. An enthusiastic hill walker and traveller, he enjoys exploring, photographing and teaching others about the geology and scenery of Hong Kong and the region.*

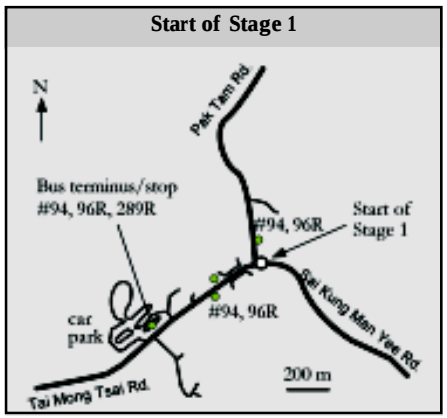
# STAGE 1 - PAK TAM CHUNG TO LONG KE WAN

**Major features of interest:**
1. High Island Reservoir & Dams
2. Slope protection measures
3. Volcanic rocks
4. Columnar jointing
5. Coastal scenery and erosion

## Access

Note that public transport is subject to future changes and details should be checked before travelling. There are two buses that will take you to either Pak Tam Chung car park or to one of the bus stops nearer to the start of the MacLehose Trail. These are the #94 from Sai Kung and the #96R from Diamond Hill MTR station (Sundays & Public Holidays). From Pak Tam Chung car park, you need to walk about 0.5 km north-eastwards along the main road (turn left as you leave the bus station). Just after the bridge, you will reach a road junction, which is the start of the MacLehose Trail. Follow the Sai Kung Man Yee road that runs off to the right.

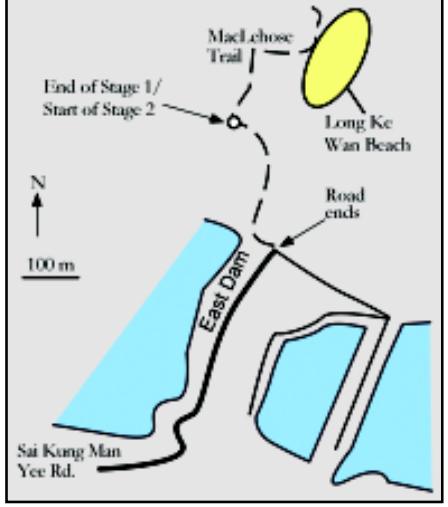
**Start of Stage 1**

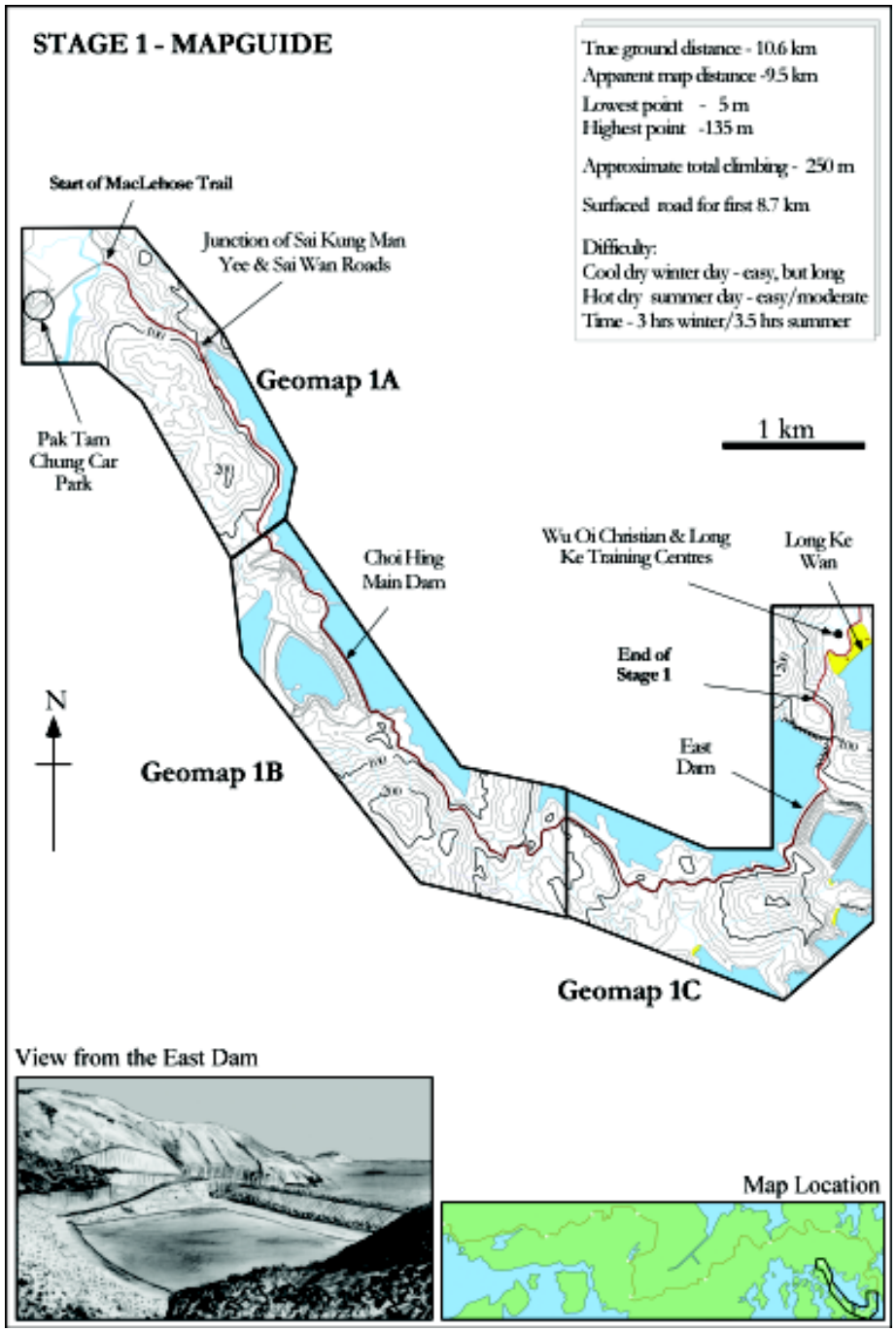


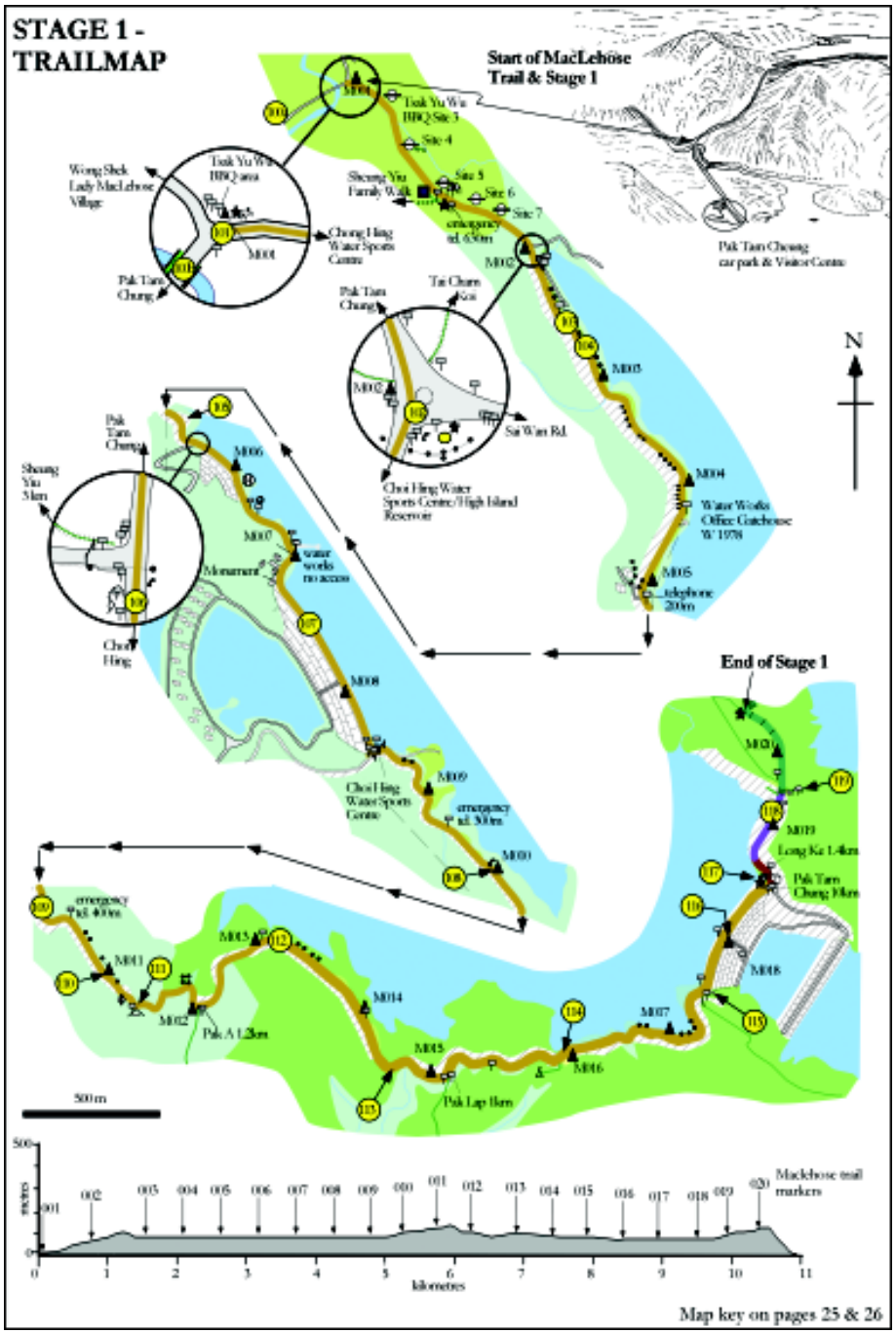

*The first stage of the MacLehose Trail follows the southern shore of High Island Reservoir and terminates at Long Ke Wan. The distinct pointed mountain in the upper left is Sharp Peak. Reproduced with permission of the Director of Lands © Government of Hong Kong SAR.*

A major problem with Stage 1 is that the end of the section is many kilometres from any transport. You can carry straight on to Stage 2 (a 24.1 km total walk) and finish at Pak Tam Au, where you can catch a bus. Alternatively, you might wish to take a taxi direct to the East Dam, at the far end of High Island Reservoir. From there, it is a short walk to the end of the trail, which offers excellent views of Long Ke Wan (better still go down to the beach and have a swim). You can then reverse the route and walk back to Pak Tam Chung.

**End of Stage 1**






## STAGE 1 - TRAIL GUIDE

*This point bar is visible on the downstream side of the road bridge from location 100b. Note that the pebble size varies with coarser material on the outer part of the bend. The outer bend itself is being eroded.*

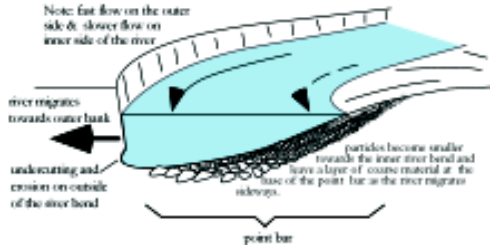
**100a** - Just before beginning the MacLehose Trail, it is well worth going to the Sai Kung Country Park **Visitors Centre**, which presents a series of displays and information panels that describe the natural and cultural history of the Sai Kung Country Parks. The Centre, opened by Lady Youde on the 22nd March 1985, is open daily from 0930 to 1630 hours, except on Tuesdays.

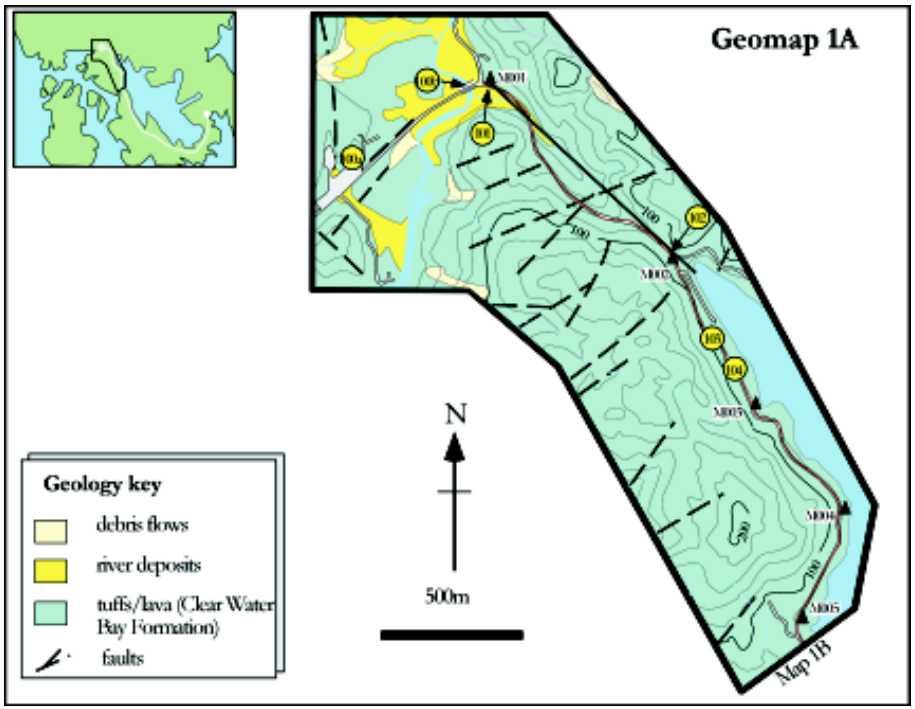
**100b** - From the bridge you can see a large number of well-rounded pebbles and cobbles. Such rounding is typical of rock fragments that have been transported by rivers (BN101). The pebbles and cobbles are not randomly arranged, but are organised into a series of elongate mounds called *bars*. Downstream, in a partially tidal area, lies an accumulation of pebbles on the inner bend of the channel. This is a **point bar**. Note how the material is smaller on the inside of the bend and coarser on the outside (see photo and BN101).

You may be able to walk down to the channel at the car park end of the bridge, though a fence appeared here in

### BN101 River sediments

In general, sediments transported by a river gradually become smaller and more rounded, due to grain to grain impacts, as they are carried and rolled downstream. Most rivers and streams in Hong Kong are dominated by large particle sizes (coarse sand, pebbles and boulders ), which reflects the relatively short distance that the particles have been carried. River materials are also size-sorted by variations in water speed at different points along the river course. This is particularly pronounced at river bends, where point bars develop. These are accumulations of loose particles on the inside bend of a river. Such locations are characterised by slower flowing water and are areas where smaller particles can be deposited. Towards the outside, water flow is faster and only larger particles are laid down. The change is gradual, with material size decreasing towards the inside bend. Water flows especially fast at the outer limit of the bend and, there, erosion dominates. This gradually cuts the bank away. Because the channel is being eroded on one side and is accumulating material on the other bank the river will slowly migrate sideways and downstream.





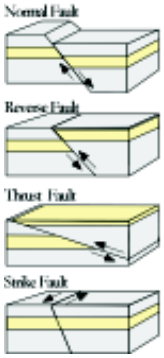

2000. Take a look at the **rocks** that form the pebbles. These are mainly volcanic tuff, some containing small white and pink feldspar crystals (see *common rocks* section in the introduction) Such rocks dominate throughout the Sai Kung Country Parks. The tuffs were formed from violent eruptions about 142 million years ago.

**101** - The MacLehose Trail starts here and rises through a wooded valley that follows a **fault line** (Geomap 1A). Faults (BN102) like this crush and weaken rocks, which can then be more easily weathered and eroded. This tends to produce straight valleys. The fault continues through the pass at the top of the road and runs under the High Island Reservoir.

Faulting is common in Hong Kong (BN103) with most major faults trending NE to SW. Minor faults, such as the one guiding this valley, follow a wide range of other

## BN102 Faults & joints

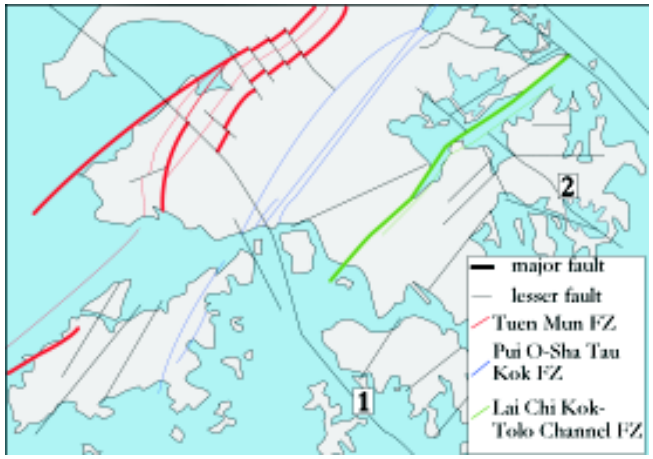
There are two types of fracture in rocks. Joints are cracks involving no movement and are often of small to moderate size. Faults tend to be larger and are surfaces along which movement has occurred. There are several types. A Normal Fault occurs when the rock vertically above the fault plane moves down. In a Reverse Fault, the rocks above the fault move upwards. A Thrust Fault is similar to a reverse type, except the fault plane lies at a very low angle. Strike Faults involve only lateral movement. Normal Faults develop when rocks are pulled apart (tension). Reverse and Thrust Faults form as a result of compression. Strike Faults occur when there are lateral stresses.




## BN103 Faults & earthquakes in Hong Kong

About 24 earthquakes of Richter magnitude 6 and above have occurred within 650 km of Hong Kong in the last 1000 years. Only 2 such events occurred within 250 km of the SAR. In the 20th century there were at least 72 of magnitude 5-6. Hong Kong residents have reported feeling more than 80 tremors since 1900. Within the Hong Kong territorial area, earthquakes are few, often not noticed, and mostly <4 on the Richter scale.

Despite the absence of major seismicity, there are numerous faults. These occur in sub-parallel groups that form lines of weakness across the countryside that weather more easily than adjacent areas. Streams erode more rapidly along such faults and over time develop structurally controlled valleys.




There are two major sets of faults that cross Hong Kong, roughly at right angles to one another. The NW aligned faults generally have smaller offsets and are shorter and discontinuous. Nevertheless they control the alignment of several valleys. Point 1 on the map shows an example where a submarine valley (the Lamma Channel) follows a NW trending fault. Point 2 lies near the start of the MacLehose Trail, where a NW trending fault controls the alignment of a small valley that rises towards the High Island Reservoir. Note how the fault continues under the reservoir and passes out to the south east. This too represents an old valley system, now submerged, that was controlled by the same fault.

In contrast, the NE trending faults are longer (extending along the south China coast on an ENE trend) and are more important in controlling landscape in Hong Kong. Three systems in particular are significant. The Tuen Mun Fault Zone is a set of faults that control the orientation of the Tuen Mun to Yuen Long Valley. There is a considerable depth of weathered rock along these faults, which also reflects their relative weakness. The fault zone extends southwestwards to the northern shore of Lantau Island. The Pui O-Sha Tau Kok Fault Zone also exerts a major influence on the morphology of Hong Kong, guiding the orientation of Sha Tau Kok (Starling Inlet), and the alignment of the Lam Tsuen Valley, as well as other geomorphic features. Perhaps the best example is related to the Lai Chi Kok-Tolo Channel Fault Zone. This controls the orientation of Tolo Channel, the Sha Tin valley and also the pass between Stages 5 and 6 of the MacLehose Trail.

orientations. Earthquakes associated with the major faults are common, but small, with most showing **Richter magnitudes** of <5.5 (you will not notice these). Occasionally larger earthquakes of up to 6.5 occur near to Hong Kong. While worrying, these are unlikely to cause serious damage.

*High Island Reservoir looking to the southeast, along a fault line, from the Man Yee Sai Wan road junction.*

**102** - Just beyond the fault-controlled pass you reach the junction of the Man Yee and Sai Wan roads. There is an observation point near the pagoda with excellent views of the **High Island Reservoir** (a HK$1,348 million scheme) and one of the larger impacts that man has had on the country parks of Hong Kong. Originally, the area was an inlet of the South China Sea. Two large rock filled dams (110 and 103 m high), completed in 1979, closed the former marine inlet and sea water was pumped out. The original catchment was too small (15 $km^2$) and 40 km of tunnels were built to divert fresh water to the reservoir – effectively adding 61 $km^2$ to the drainage basin. Today, the reservoir holds 281 million $m^3$ of water, and, when full, the surface stands 61.5 m above sea level.

The foreground **vegetation,** from the viewpoint, is dominated by mixed trees and scrub. More generally, the hill tops in Sai Kung East Country Park are dominated by grasses such as Minireed, Duck-beak Grass and False Staghorn Fern. The midslopes are mainly covered by shrubs such as *Baekea*, *Eurya*, *Gordonia*, *Melastoma*, and *Rodomyrtus*. The Chinese New Year Flower (*Enkaianthus quinqueflorus*) is a hardy shrub producing a flush of numerous red-white bell-shaped flowers in February. Woods tend to be confined to lower hill slopes and valleys. An extensive original covering of trees was removed by early agricultural activity, involving direct felling and burning. Today, agriculture is absent from the parks, but fire remains a control on vegetation. Between 1988 and 1998 there were 1,480 fires inside the country parks. **Fire prevention & control** efforts, include a restriction on lighting fires to BBQ sites only, and a hazard warnings signs at key points. Helicopters with water buckets strung below are often used to put out hill fires. Nevertheless, fire still gets out of control. Particularly during the grave sweeping ceremonies of the Ching Ming and Chung Yeung festivals (BN104) when paper offerings are burnt at ancestral graves.

### BN104 Festivals affecting the countryside

There are two local festivals that have a significant impact on the countryside of Hong Kong. The Ching Ming festival is held on the fourth or fifth day of the third moon. This Confucian festival is the first of two that honour the dead, and dates back to Han times - about 2000 years ago. Graves are swept, washed and repaired by descendants. Offerings, including meat, vegetables, wine and flowers, are left at the graveside and paper money and incense are burnt as an offering. Often sparks and smouldering paper blow onto the adjacent vegetation and start fires. The second festival is that of Chung Yeung, held on the ninth day of the ninth moon (the double ninth). Offerings, including burning paper money, are again made to the ancestors and there is a tradition of walking to high places. This dates back to a Han scholar (Woon King) who was warned of a disaster, which he and his family avoided by moving to the hills. When he returned his livestock were dead and they gave thanks for being saved from this disaster.

**103 -** Human activities have affected the visual appearance of the SAR in many ways. At this point there are extensive **slope protection** measures to deal with the after effects of cutting a road through the area. These concrete slopes (BN105) are intended to reduce the risk of landslides, but have had a detrimental effect on the visual landscape of Hong Kong. In response to public concern, a number of former concrete slopes have been converted to grass. Hopefully, this effort will be extended to this part of the trail.

**104** - There are several locations on the right of the road where rocks can be seen protruding through the slope protection measures. These are **tuffs** formed by violent volcanic eruptions some 142 million years ago. When geologists recognise a group of rocks as being similar and as having formed at about the same time they group them together as *Formations*.

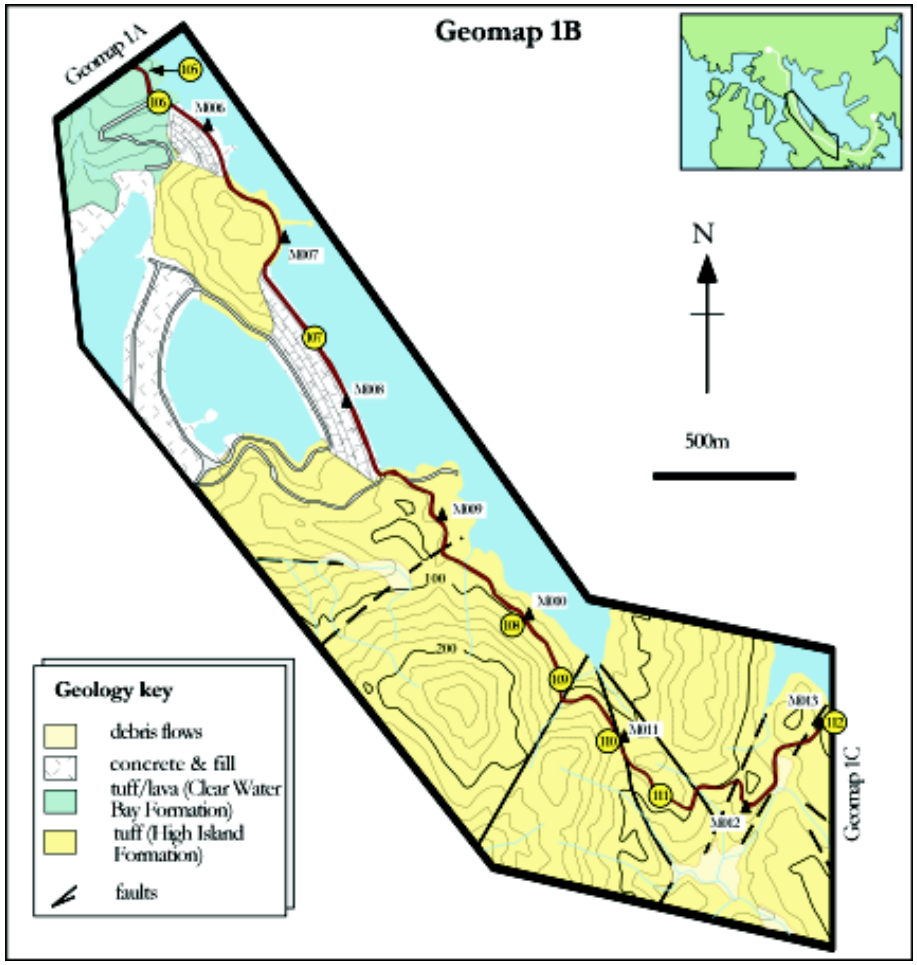
*Tuffs of the Clear Water Bay Formation with prominent white feldspar crystals.*

These particular tuffs were placed in the *Clear Water Bay Formation* (see geomap 1A and 1B for the outcrop area). Even geologists sometimes have problems identifying rocks. They were originally thought to have been lavas, were reclassified as tuffs, then re-identified as lavas again before being recognised as tuffs once more (the present view). After being formed they were buried deeply, faulted and folded and have been brought back to the surface by erosion. Today, they are being weathered. At some locations,

### BN105 Slope protection

Hong Kong experiences a hot humid climate in summer, which causes intense chemical weathering. Rocks are decomposed as minerals break down to new stable types (e.g. feldspar changes to clay). Such alteration may extend to more than 50 m deep locally. When combined with steep slopes (made steeper by road cuttings) there is great potential for collapse. Often landslips are triggered by heavy rain, which saturates the soil and weathered materials. The Geotechnical Engineering Office operates an on-call service where experts will go to dangerous slopes and issue safety warnings.

Efforts to prevent slope collapse are directed at keeping soil and weathered rock dry. A concrete-like material called *shotcrete* (top photo) is sprayed on the surface to keep rain out. All shotcreted slopes have protruding pipes (figure) called weepholes that are designed to let ground water escape. There will also be a drainage ditch above the slope to direct surface water away. Sometimes more substantial stone pitching is used to strengthen a slope (second photo). At difficult locations bolts may be drilled through to solid rock to add further support.




rock shows fresh broken surfaces and at others there is a duller weathered appearance. Occasionally you may be able to find a transition zone between fresh rock and the weathered outer layers.

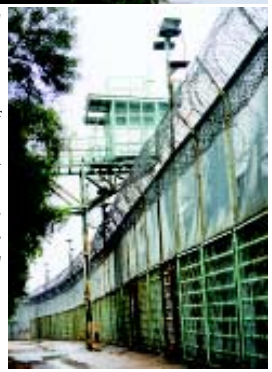
**105** - On the reservoir side of the road bend there was an outcrop of rock in 2000 - hopefully it is still there when you pass by. There is a steeply inclined **fault** cutting through the tuffs that is filled with crushed rock - weathered to a white colour. The fault is about 15-20 cm wide. Note how weak the materials within it are. This weakness has a major controlling influence on landscape. If you want a challenge, see if you can spot the fault on the other side of the road where it has been covered by shotcrete.

*Clear Water Bay Formation tuff with a pale weathering zone towards the top left corner*

*An inclined fault (Trailnote 105), from bottom left to top right. Inset shows white crushed & weathered rock gradually being removed by erosion.*

**106 -** The viewpoint near the shelter provides excellent views of Tai Tau and Kau Sai Chau. The highly indented shoreline of Hong Kong is called a *ria* coast and has formed by **flooding of river valleys**. The channel separating the islands from point 106 (Sham Tuk Mun) is such a former river valley. Sea level was about 130 m lower than today about 18,000 years ago and it would have been possible to walk across. Valleys eroded by rivers at that time were flooded by rising seas as the northern and southern hemisphere ice caps melted from the land. The shoreline you see before you has only existed for about 6,000 years (BN106).

From this point, you can also see the Choi Hing Water Sports Centre. Through much of the 1980s and 1990s the narrow neck of land was used for a **Vietnamese Detention Centre** (BN107). These were inhospitable places that were unoccupied by 1999, and due to be demolished and replaced.



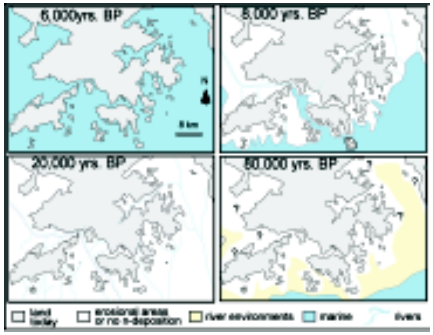
*The High Island Detention Centre (Trai Cam Man Yee in Vietnamese) was the grim home of thousands of Boat People for many years and represented a difficult episode in Hong Kong history. The photos show the Centre in December 1999, after it was closed and before planned demolition.*


*Panoramic view from point 106 showing the flooded river valley that forms the modern inlet of Sham Tuk Mun.*

## BN106 Sea level change

Global warming is not a new phenomenon. At the end of the last ice age air temperatures rose by about 5°C causing sea levels to rise by about 130 m. In fact, over the last 2 million years both cooling and warming trends have occurred, with several glacial episodes being separated by periods at least as warm as those of today. These changes had a profound affect on Hong Kong with sea levels rising and falling many times. When the sea retreated, rivers advanced and deepened their valleys. During periods of high sea level (such as the present) coastal erosion advanced landward.

The oceans of the world were particularly low, for example, at about 140,000 and 20,000 years ago, with sea level being high 120,000 years ago and in the modern era. The adjacent maps show the effect on Hong Kong's environment for four time-slices.




These changes were not caused by man, but by natural processes. Future changes remain uncertain, but given that the difference between the last ice age and today is only about 5°C the potential for human-induced problems is clear.

## BN107 Vietnamese refugees

The Vietnamese refugee saga began with the fall of Saigon in 1975. Tens of thousands escaped in small, often dangerous, boats. The lucky ones that survived the journey landed on the shores around Asia. In Hong Kong, then under British administration, several detention camps were set up. One was located at High Island, near the MacLehose Trail. The largest was at Whitehead (near Ma On Shan), with other smaller facilities being placed in relatively remote locations. Large numbers of Vietnamese spent many years in the camps. Others landed in Indonesia, Malaysia, the Philippines, Singapore and Thailand. A total of about two and a half million people left Vietnam, Laos and Cambodia, with the numbers passing through Hong Kong at one stage peaking at 57,000. Many moved on to the USA and other host nations. Some were not officially recognised as refugees and were returned to Vietnam. A small number remained in Hong Kong.

**107** - This is the second dam as you walk along Stage 1. Note the numerous large blocks of **granite** on the left. These were imported from other parts of Hong Kong because the local rocks tend to break into pieces too small for some of the construction needs of the dam. The angular boulders placed in a neat row on the right are quite different volcanic **tuffs** with large feldspar crystals. They belong to the *High Island Formation*, which begins just after the first dam (Geomap 1B). The remainder of Stage 1 is dominated by these tuffs (see photo below).

*Two examples of volcanic tuff are shown. Both have large crystals (phenocrysts) in a very fine matrix. The High Island Formation (left) includes numerous quartz and feldspar crystals whereas the Clear Water Bay Formation tuffs (right) are darker, with just a few feldspar crystals.*

**108** - The land where you are standing is part of **High Island** (Leung Shuen Wan). Prior to dam construction this was a genuine island. At M010 note the continuing **slope protection** measures. Stone pitching, using rectangular cut granite blocks, can be seen on the slopes immediately ahead. Beyond, many slopes are covered with shotcrete (BN105) and have plastic weephole pipes protruding.

**109** - Notice the pattern of cutslopes along this section, which reveals a lot of information about the **topography**. The road was cut through a series of ridges. Protective facings along the right hand side are mostly triangular in shape, indicating the cross-sectional form of the severed ridge lines. Shallow valleys running down the slopes separate the ridges. Many smaller valleys were truncated while others were filled during road construction, a process commonly carried out using the debris created by the cutting. These intervening valleys are green and vegetated with drainage provisions at the point where they meet the road, to capture the water and convey it safely in a culvert under the road.

**110** - At the MacLehose sign (M011), look back at the valley that the road has just climbed. This is a good example of a **structurally controlled (fault) topography**. Geomap 1B shows the main valley with a fault running along it. There is also a fault just below the MacLehose sign, though not visible at the surface. At the head of the feature two cols mark the position of these structural lines. The former valley floor below is now a flooded arm of the reservoir.

**111** - From the Viewpoint, there is an excellent panorama of the highly indented coastline and outlying islands of eastern Hong Kong. The water is part of **Rocky Harbour** (Leung Shuen Wan Hoi). During Ming times this was a trade route, with local villagers using a type of long boat called Lung Shuen (Dragon Boat). Bluff Island is in full view, Basalt Island pokes above the ridge on the right. Formerly the area lay within the **Basalt Island Firing Range** and the much larger Port Shelter Range used by the British Navy. Tung A village is in the immediate foreground, with Sha Kiu Tau beyond. This secluded bay, with several seafood restaurants, is the destination for many weekend pleasure boats. A Tin Hau Temple (BN108) is concealed behind the ridge on the northern shore of the bay.

## BN108 Tin Hau temples

There are many Tin Hau temples located along the coast of Hong Kong. These are dedicated to the Goddess of the Sea - Tin Hau, who is said to look after fishermen. The temples commemorate a 12th century legend. Followers believe that at that time a girl with magical powers was born in Fukien Province. These allowed her to calm the waves, to increase fish catches, and to prevent illness and shipwrecks. She is said to have rescued her two brothers during a particularly bad storm. Today, there are well attended celebrations each year on the 23rd day of the 3rd moon, which involve parades, cultural performances and outings to the temples by many junks and sampans.

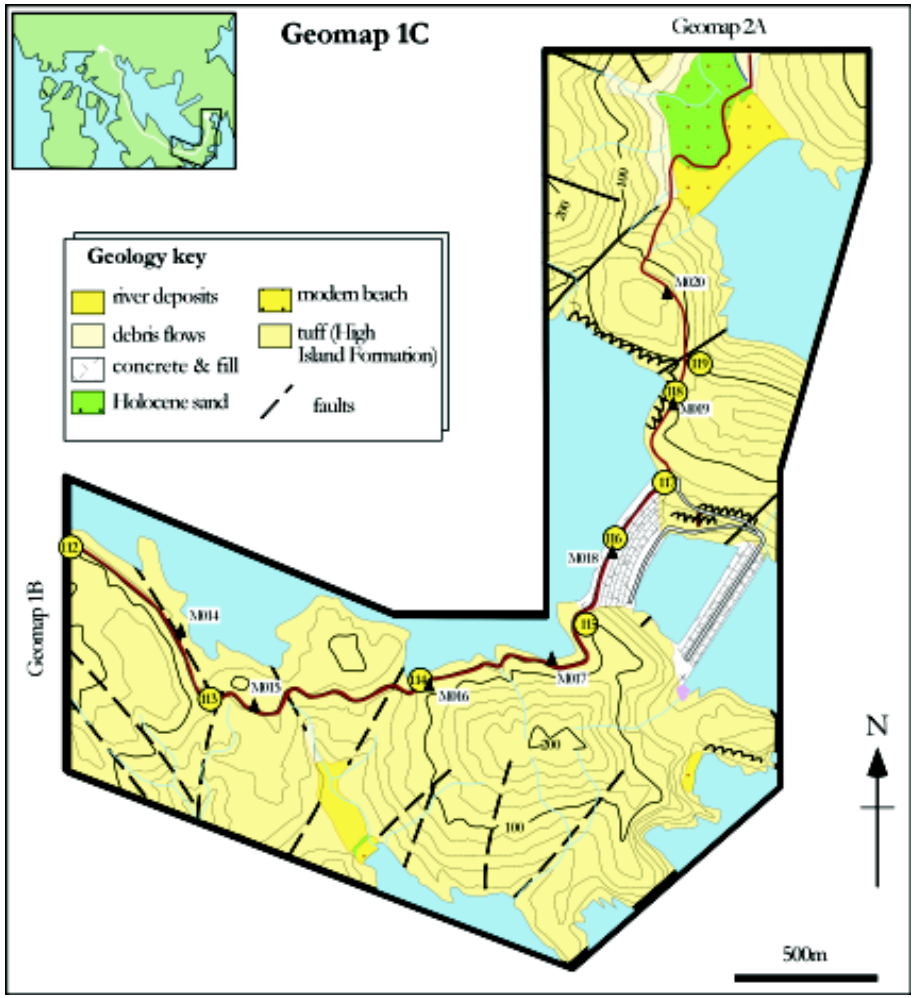
**112** - The reservoir comes into view at this point, and the first glimpse of the High Island East Dam. To both the right and left, on the opposite shore, are former **borrow areas** (quarries) created during construction of the dams. Note also the pointed hill, surmounted by a rocky pinnacle (tor), in the centre of the field of view.

When the dam is below capacity, observe the **trim line** cut by water during fuller periods. Water levels in the reservoir depend upon many factors including the season, which determines the demand for water, the rainfall and the temperature. The latter affects the rates of evaporation from the water surface. Waves, generated by winds blowing across the water surface, erode the banks removing the thin soils and damaging the vegetation. During windy weather a rim of orange to yellow coloured water up to 30 metres wide, may be

visible. This indicates a zone of turbulence, or disturbance, in the water which raises all the fine-grained sedimentary particles eroded from the weathered rocks. The colour of the water varies depending upon the amount and nature of the suspended material, the cloudiness of the sky, and the angle of the sun.

*Plumes of suspended clay form at the waters edge on windy days.*

**113** - Look at the view of Pak Lap Tsai. Note the very square bay with a coarse **storm beach** at its head. The beach has a stepped profile with a high back beach composed of large pebbles and cobbles. This bay is exposed to the southeast and to oceanic waves driven by typhoons (BN109) and strong winter monsoonal winds from that direction. Also, note how the coastline is steep and cliffed, indicating that this region has an erosional regime rather than the quiet deposition characteristic of the western side of Hong Kong. The very straight back beach gives the bay a square appearance. The back beach dams a short coastal river valley, in which the drainage has backed up to create a poorly-drained, marshy valley floor. This is a common phenomenon in Hong Kong.





*The view from point 113 is typical of southeastern shores of Sai Kung. These are high energy rocky coastlines exposed to strong ocean waves.*

**114** - Note the rock outcrops on the shore to the left and on the cutslopes on the right. Strong **vertical jointing** characterizes these outcrops giving a hint of the impressive structures ahead. The steep rock walls of the former borrow area (quarry) can be seen across the reservoir.

**115** - The **dolo** (BN110) at this point was erected as a monument to five men who died during construction of the dams. There is also a fine view of the protective coffer dam, built up of carefully placed dolos, that lies beyond the shallow man-made lagoon.

**Columnar jointed fine ash tuffs** of the High Island Formation can be seen at the far side of the dam. Note the dark inclined band running obliquely across the

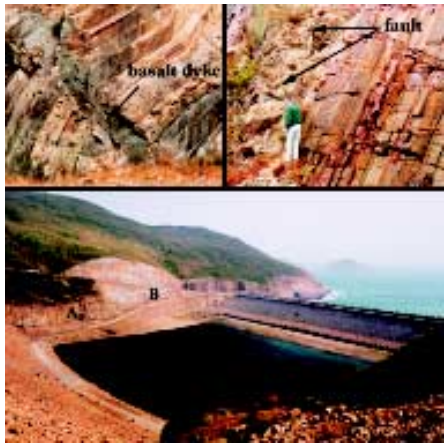
### BN109 Typhoons

Typhoons affect Hong Kong between May and November, but are most common from July to October. Typhoons (hurricanes in North America) are intense low pressure systems that develop only in the summer, when sea surface temperatures are greater than 26°C. Most are slow moving, and all are powerful and dangerous. They develop from tropical cyclones and consist of large masses of warm, humid air that, in the northern hemisphere, rotate in an anticlockwise direction around a low pressure centre, or eye. The eye averages 50 km in diameter and is surrounded by banks of cloud up to 20 km thick, beyond which are spiral rain bands. Estimates suggest that 20 million megawatts of mechanical energy is generated by an average tropical cyclone. This is enough power for more than 6,000 cities the size of Hong Kong. An average of 30 tropical cyclones form each year, although only half become typhoons with winds of more than 64 knots. Hong Kong experiences an average of one typhoon a year that brings gales, although five occurred in 1964 and three hit the SAR in 1999.

### BN110 Dolos

Some 7,000 concrete dolos (an Afrikaans word for a sheep knuckle) where placed on a coffer dam (originally used at the time of construction) to protect the East Dam from strong storm waves of up to 12 m height. These allow water to pass between them, absorbing wave energy by converting it to frictional heat. They can also move position, further absorbing energy. Note the many holes at the back of the coffer dam holding the dolos, these allow water to pass through, reducing the risk of storm damage.

columnar jointed rock face (see *A* in the photo below). This is a **basalt dyke**, a fine-grained intrusive igneous rock that was emplaced along a bend in the jointing (called a kink band). To the right, at *B* (see photo) occurs a fault, which can also be seen in Geomap 1C. It is not visible unless you make a detour down the road. When viewed from nearby, the rocks are clearly fragmented - a result of fault movement.




*View from point 115 showing the protective coffer dam and columnar jointed cutslopes. Detail of a basalt dyke at A is shown to the top left. The fault at B is shown to the top right.*

**116** - From the top of the steps, near the middle of the dam, note the isolated island that has formed at the end of the headland on the right. This is Po Pin Chau, which is a good example of a **sea stack** (BN111).

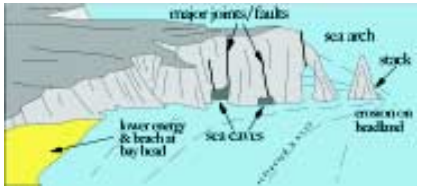
**117** - From the end of the dam look back to the rocks just above the man-made lagoon. (see Geomap 1C). On the opposite side, a weak structure (possibly an extension of the fault marked at *B* in the photo above - see Geomap 1C) has been exploited by **coastal erosion**, prior to construction of the coffer dam, to form an impressive sea cave (BN111). It is possible to walk down the road and along the base of the dam to have a closer look (a round trip detour of about 2 km that also allows a better look at the fault and dyke). Close examination reveals a long narrow cave with a high roof, eroded into strong rock. The floor of the cave is flooded, and shoals of small fish swim around contentedly in the waters.

## BN111 Coastal erosion

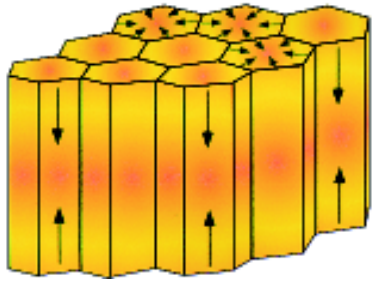
As waves approach a shoreline they *feel* the sea floor and slow down as a result of friction. However, water depths are not constant, especially where there is an irregular coast such as around Hong Kong. As a wave approaches the shore it will first encounter shallow water opposite a headland and slow down. The same wave in the adjacent deeper water bays will pass by the headland without *feeling* the sea floor and continue without slowing down. As a result the wave bends towards the sides of the headland and concentrates its energy there, producing erosional landforms. This process of wave bending is called wave refraction.

Erosion is greatest where the coast is weakest, which may be where softer rocks occur, or where there are structural weaknesses. The Sai Kung shoreline is dominated by rocks composed of volcanic ash, but with a few basalt dykes also occurring. The dykes act as weak points, but more important are structural controls such as joints and faults.

Initially, wave impact erodes the cliffs to form sea caves that are aligned along weak rocks, faults or joints. Further wave erosion will enlarge these caves, which may cut through the headland, or join up with another cave forming on the opposite side. At this stage a sea arch begins to develop. Continued wave erosion will further expand the sea arch until the roof can no longer support its own weight and it collapses, leaving an isolated sea stack. Over time this will be reduced to a low island and eventually disappear below the sea surface.




At the end of the dam, you can see **hexagonal joint columns** in the High Island Formation tuffs. These were formed as a result of cooling of hot volcanic ash. Temperatures start to fall first at the surface of such hot ash layers. As the material cools it shrinks and polygonal cracks develop that slowly extend inward. A similar process may also occur at the base of the ash layer, where it is in contact with cooler rocks below.

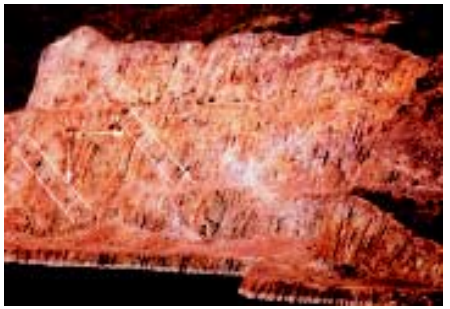


*Columnar jointing develops when a hot ash, or lava, cools slowly. Polygonal cracks develop that extend into the centre of the hot material.*

Sub-horizontal jointing also occurs just above the main columnar joints near the roundabout (photo) in a broad lensoid mass. They increase in frequency and decrease in spacing near the top of the face, perhaps due to differences in origin of the material and\or local cooling history.

*Columnar jointing occurs at the bottom of the rock face at the NE end of the dam. This is overlain by subhorizontal patterns, with shotcrete covering vertical joints at the top.*

**118** - From here you can see columnar jointing in the large borrow area to the left of the path. This was once a **quarry** that was used to provide material for dam construction. Note that the tuffs are very thick here and that the columnar joints are very long. The ash was trapped in a large depression called a **caldera** (BN112). This ash may have formed from a single large eruption, or could have been laid down by several distinct eruptions separated by short time periods. However, all of the ash must have cooled at about the same time in order to generate the long and continuous columnar joints.

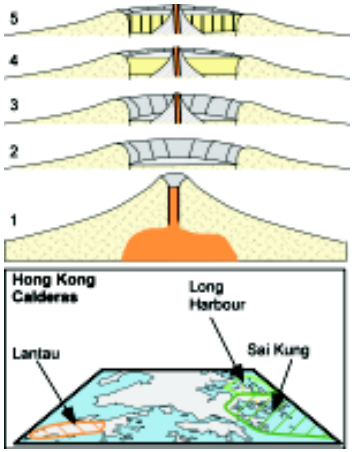


*The quarry face is crossed by several near horizontal tracks, but notice the kink bands sloping from left to right. These are zones where the columnar joints have been sheared and bent.*

Also note how the columnar joints are distinctly bent in some places. This occurs in narrow zones called **kink bands**, which are formed by shearing. This would have been caused by movement, perhaps slumping, on an ancient surface, shortly after the ash was deposited and the joints had formed, although later earth movements are also a possible cause.

**119** - From the fault controlled pass at the top of the track, go to the right to a shelter at the end of the short path. Look across to the far shore of Long Ke Wan where a number of small caves can be seen marking the position of major joints that have been preferentially eroded by wave action. These are sometimes referred to as **slot caves**.

## BN112 Hong Kong calderas




Calderas result from the subsidence of craters or the explosive destruction of large volcanoes (1). Over time pressures build up in the underlying magma chamber until it is released suddenly and very violently. As a result of loss of material from below during the eruption the volcano collapses along circular faults and forms a large depression (2). In Hong Kong, at least three such calderas have been recognised and named. These are the Lantau, Long Harbour and Sai Kung calderas.

The Sai Kung caldera is the largest and dominates the first two stages of the MacLehose Trail. After the major eruption that created it, further volcanism occurred, possibly creating a volcano within a volcano (3). However, if a second volcano did actually form evidence for it is now lacking and its precise location is uncertain. Nevertheless, eruptions did occur and the caldera was infilled with thick ash deposits of the High Island Formation (4). These are some of the younger ashes in Hong Kong and are dated at about 140 million years. Over time, these slowly cooled to form the columnar joints that subsequent erosion has exposed at the modern land surface in eastern Sai Kung.

There are also good views of **Long Ke Wan** and its bay head beach, one of the most remote in Hong Kong. The mountains dominating the skyline are all composed of the same High Island Formation tuffs that were noted at point 118. It is perhaps also worth remembering that Hong Kong has one of the highest population densities (BN113) on earth, and yet even here it is possible to escape to a quieter setting.


*Long Ke Wan is the first of a series of bayhead beaches along the MacLehose Trail. Stage 1 finishes shortly after this viewpoint with Stage 2 continuing down to the beach and over Sai Wan Shan.*

## BN113 Population

Prior to 1841 the population of Hong Kong was estimated to be about 3,650 persons inhabiting isolated villages, with about 2,000 fishermen living on boats. Immigrants began arriving seeking employment, the security of law and order, and improved living standards. By May 1841 there were approximately 5,450 residents on Hong Kong Island and about 2,000 boat dwellers, which increased to about 15,000 persons in October 1841, and 32,983 in 1851. Major influxes occurred as a result of specific disturbances in Mainland China, in particular the Tai Ping Rebellion of 1850-1864 and the Japanese invasion of Kwantung in October 1938. About 100,000 immigrants arrived each month following the Japanese surrender in 1945. Further increases followed the communist victory in China in 1948/49. By 1996 the population stood at 6.3 million and rose to about 7 million by the year 2000.