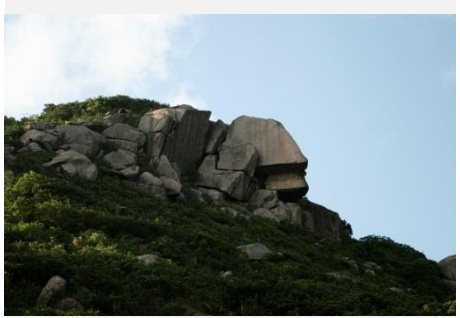
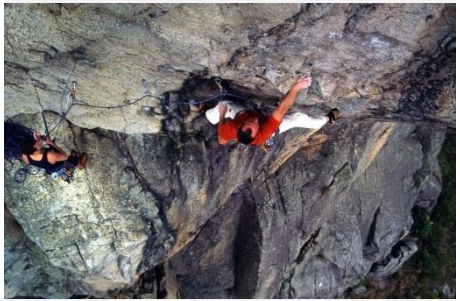





The Geology of Hong Kong

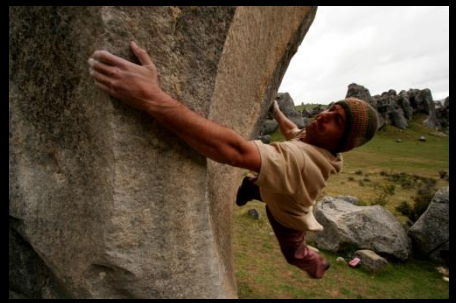
A Rock Climbers Perspective

Stuart Millis
Associate Director
Ove Arup & Partners Hong Kong Limited

24 April 2014

ARUP

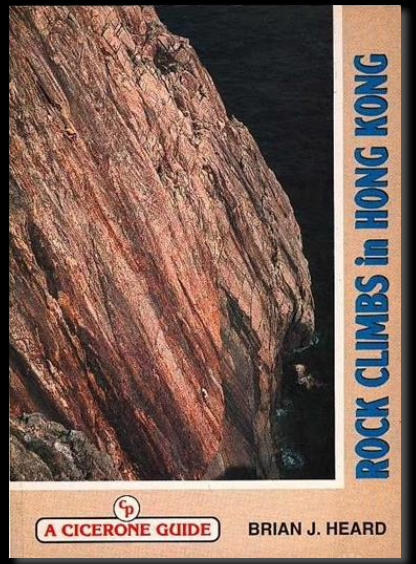
A bit about me



2014	Ove Arup & Partners Hong Kong, HK	Associate Director		Planning to publish a comprehensive guide to all climbing in published Hong Kong by end-2014
2013		Associate Leader of Engineering Geology Team	Elected Chairman of HKRG	
2012				major revamp of www.hongkongclimbing.com
2011			Hon. Secretary, HKRG	
2010				
2009		Senior Engineering Geologist	Hon. Secretary, HKRG	
2008				
2007				
2006		Chartered Engineering Geologist		
2005			CGeol & RPE(G)	
2004	C M Wong & Associates Ltd, HK	Senior Engineer	MHKIE, CEng & MIMMM	
2003		Engineer		published Hong Kong Bouldering
2002		Assistant Engineer		set up www.hongkongclimbing.com
2001	Halcrow China Ltd, HK	Graduate Geologist		
2000	Wardell Armstrong, UK	Engineering Geologist	Fellow of GSL	moved to Hong Kong
1999	MSc Engineering Geology, University of Leeds	including 3-months in Hong Kong for thesis		
1998				
1997	BSc (Hons) Applied Geology, Staffordshire University	First Class Honors		
1996				
1995				started Rock Climbing (Sept 1992)

hongkongclimbing.com

established as the current guidebook (below) was published in 1994 and is very out of date



HONG KONG CLIMBING

the source for rock climbing and bouldering in hong kong

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- INTRO
- NEWS
- COURSES
- GEAR
- WALLS

Mention Hong Kong and most people think about a concrete jungle with sky scrapers towering up towards the heavens.

But hidden behind the urban sprawl lies some spectacular countryside, and nestled amongst these are numerous buttresses of pristine granite and volcanic rock.

Come climbing!

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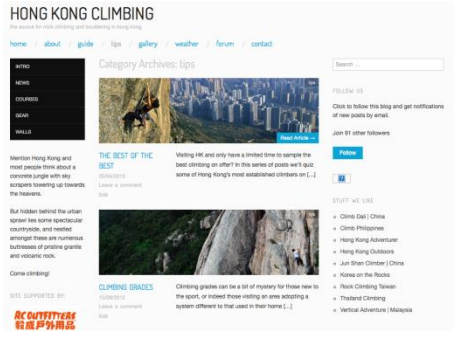
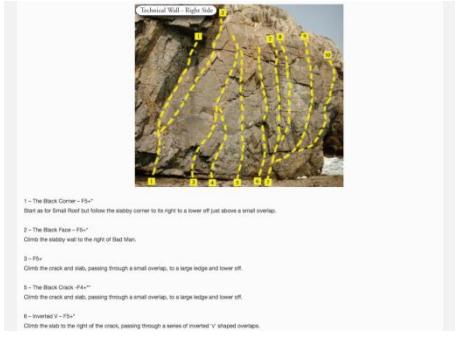
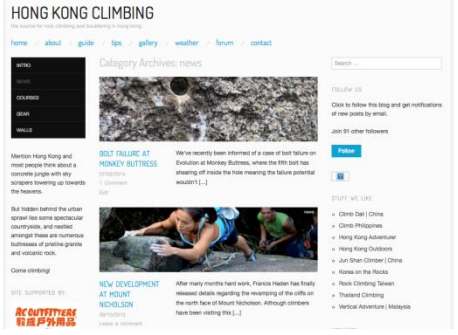
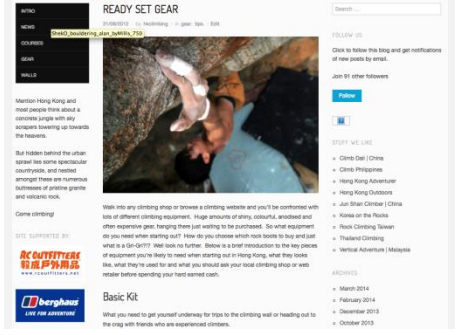
news on matters affecting climbers in Hong Kong







other useful information for visiting climbers



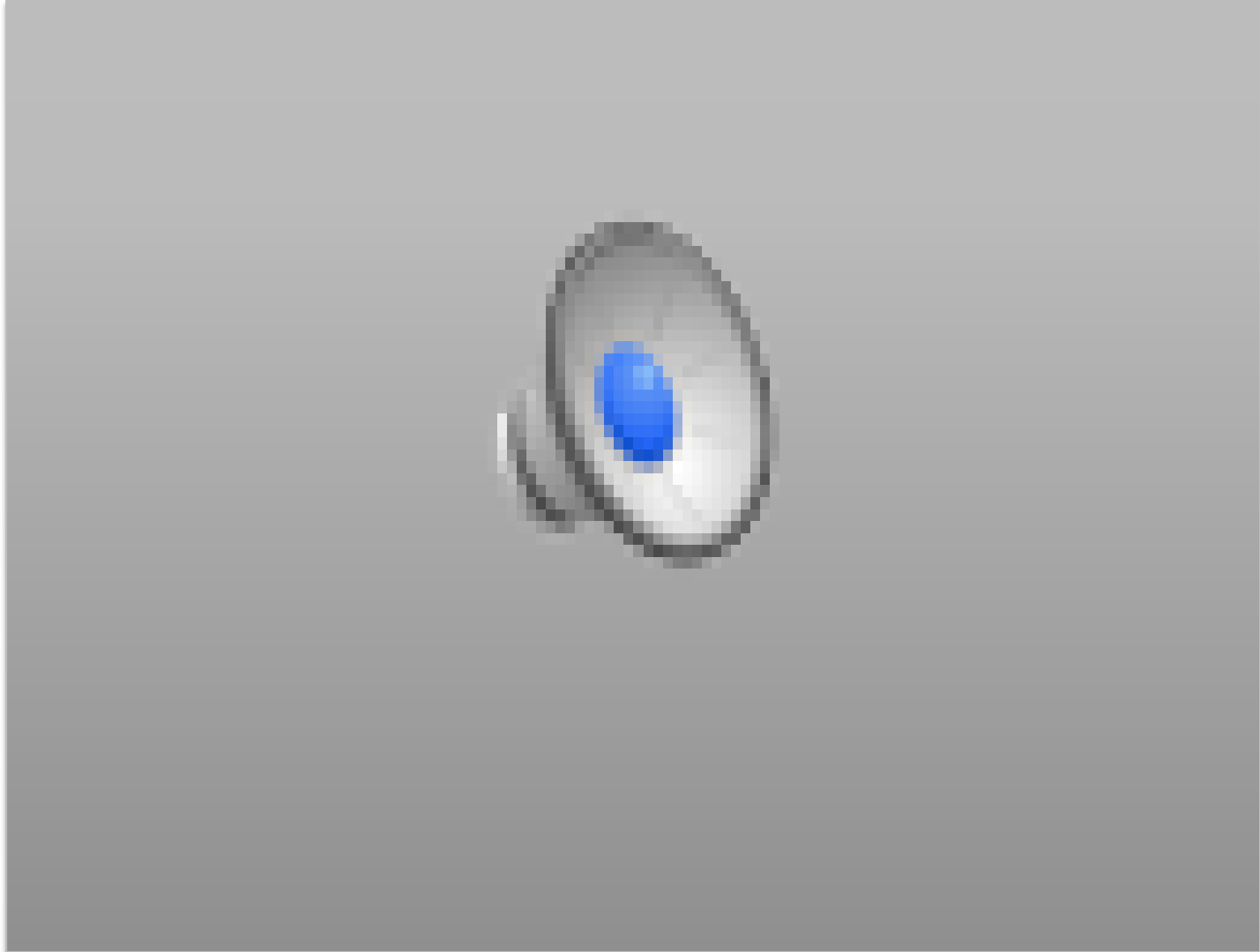
advice articles for people starting out

Climbing Styles

Traditional Climbing

Climbing Styles

Traditional Climbing



Climbing Styles

Traditional Climbing

Climbers place protection into natural cracks in the rock face as they climb

Safety of a climb depends on the frequency of cracks and the skill of the climber in placing the protection

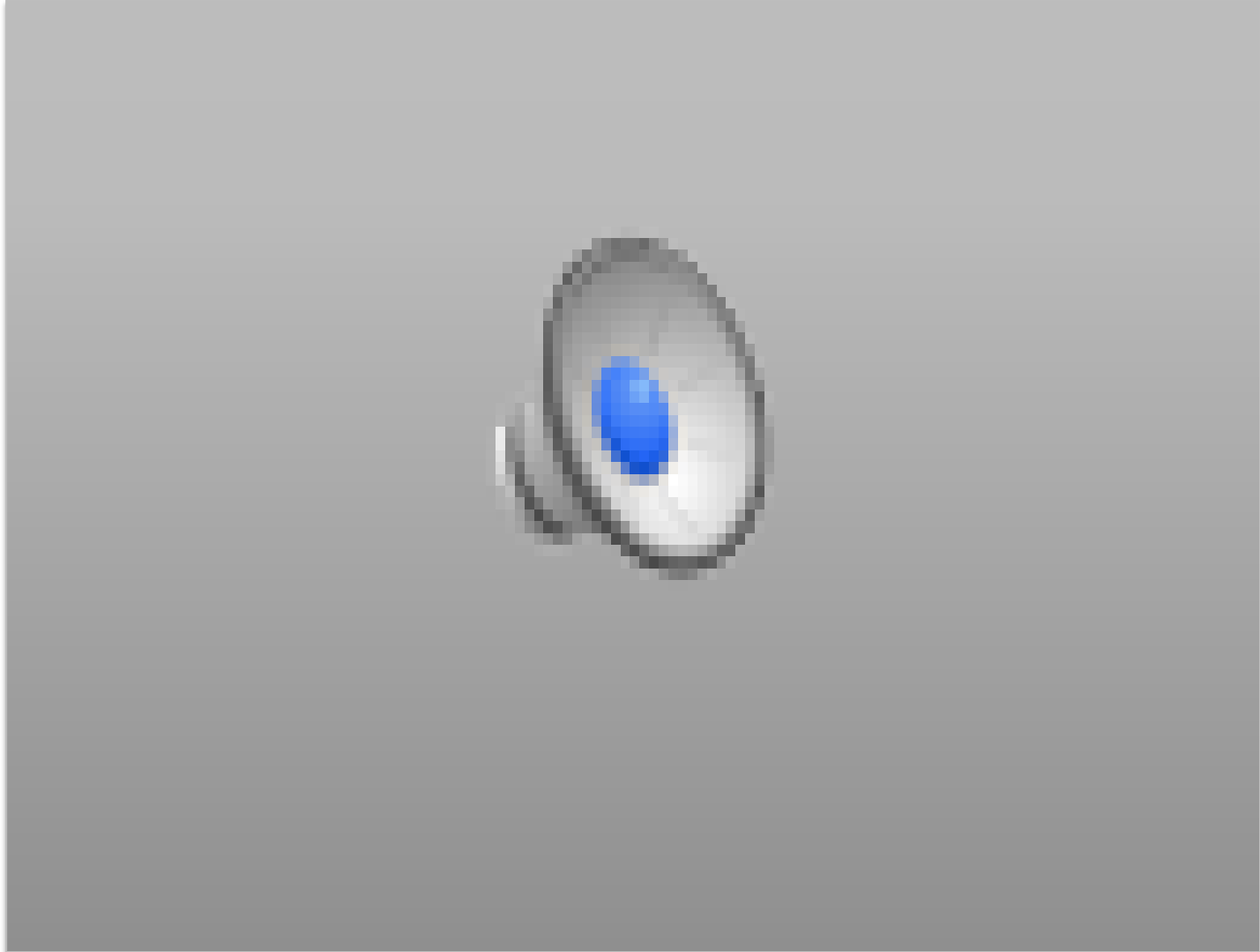
Seldom practiced in Hong Kong

Climbing Styles

Sport Climbing

Climbing Styles

Sport Climbing



Climbing Styles

Sport Climbing

Climbs are protected by bolts drilled into the rock face

Climbs are typically very safe and can therefore be quite gymnastic

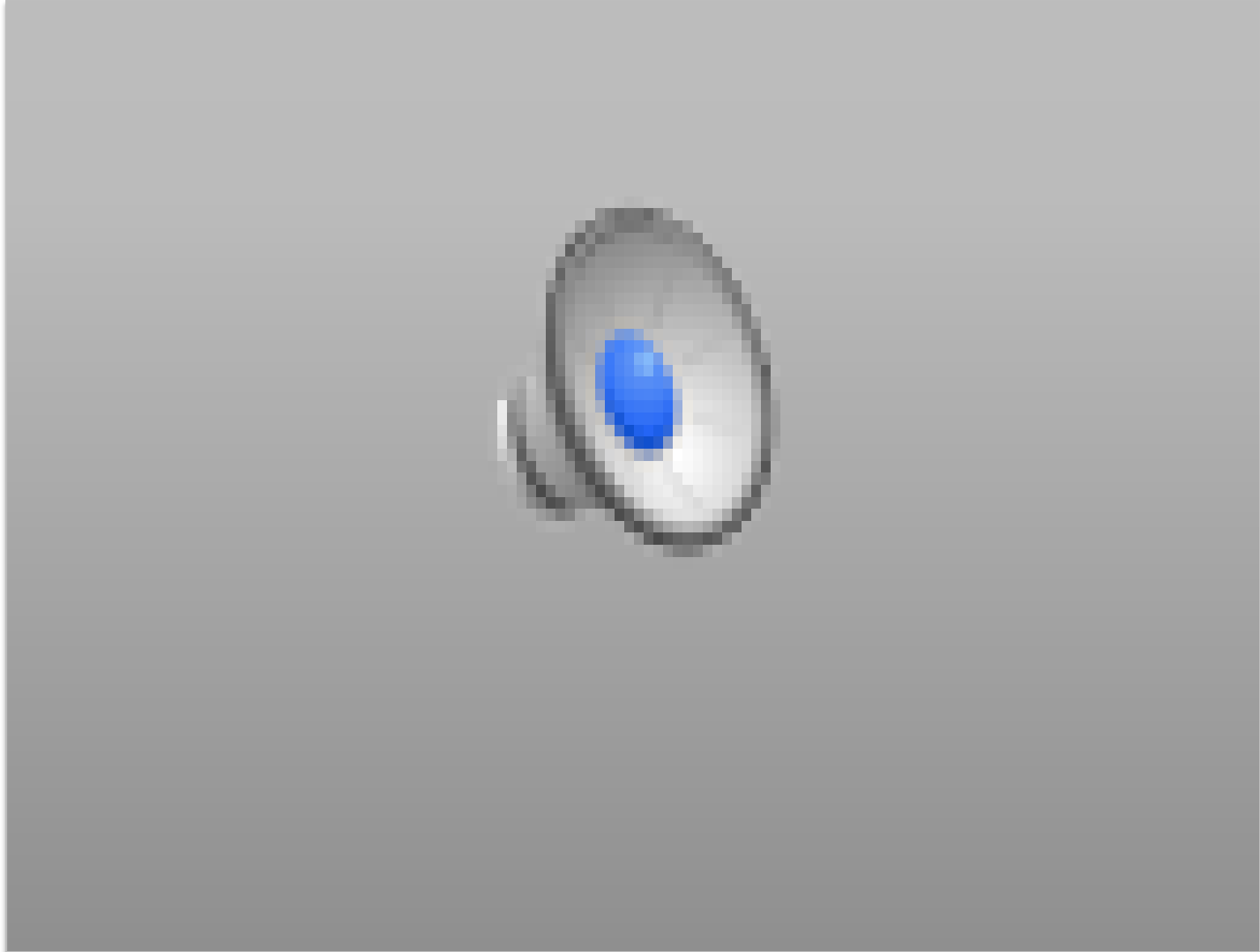
The main style of climbing practiced in Hong Kong

Climbing Styles

Bouldering

Climbing Styles

Bouldering

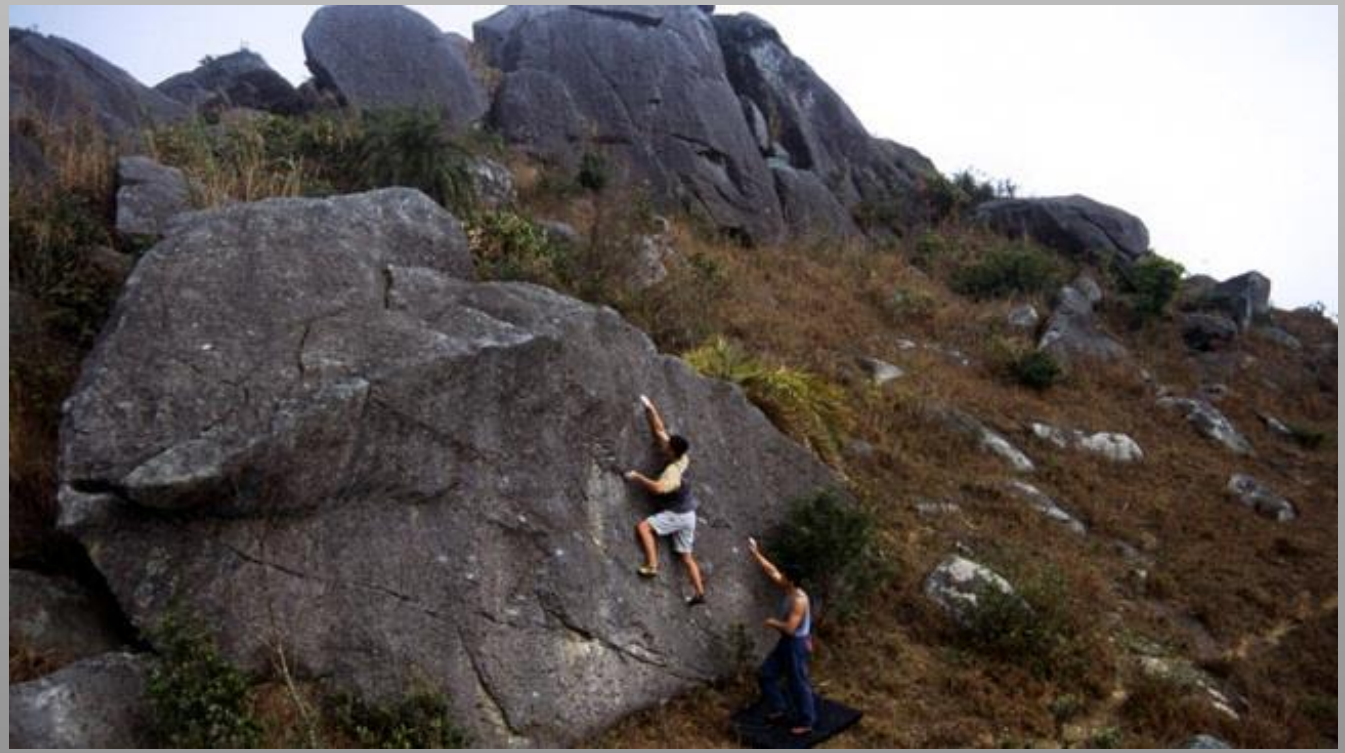


Climbing Styles

Bouldering

Climbs on small boulders or cliffs up to about 5 m in height

Protected by small crash mats and friends to catch you



Another of the main styles of climbing in Hong Kong

Climbing Styles

Solo Climbing

Climbing Styles

Soloing

The purest form of climbing

No ropes, no protection, just you and the rock.

Can be extremely dangerous

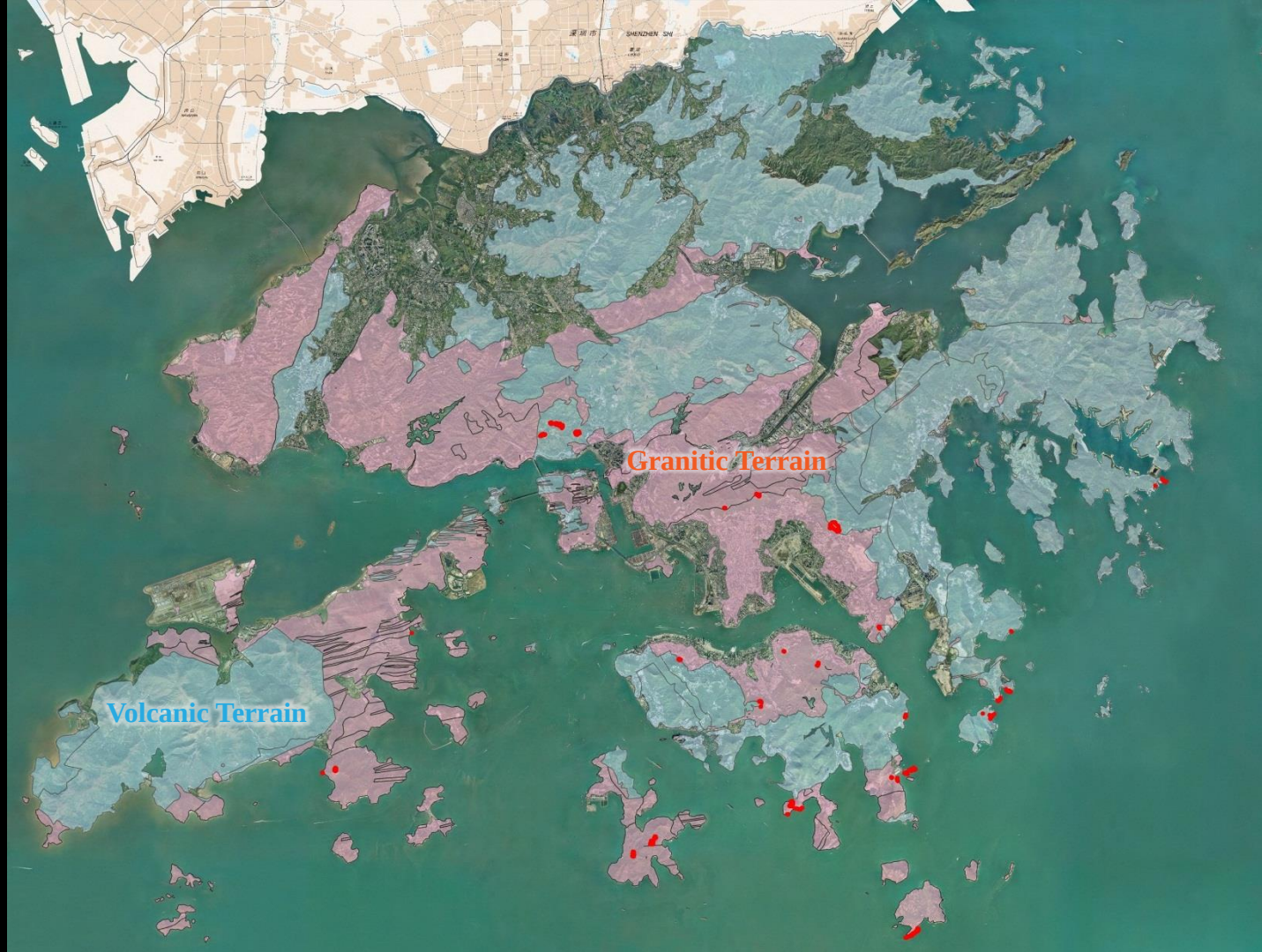
Very rarely practiced in Hong Kong


Rock Climbing in Hong Kong
ARUP

Major Climbing Areas in Hong Kong

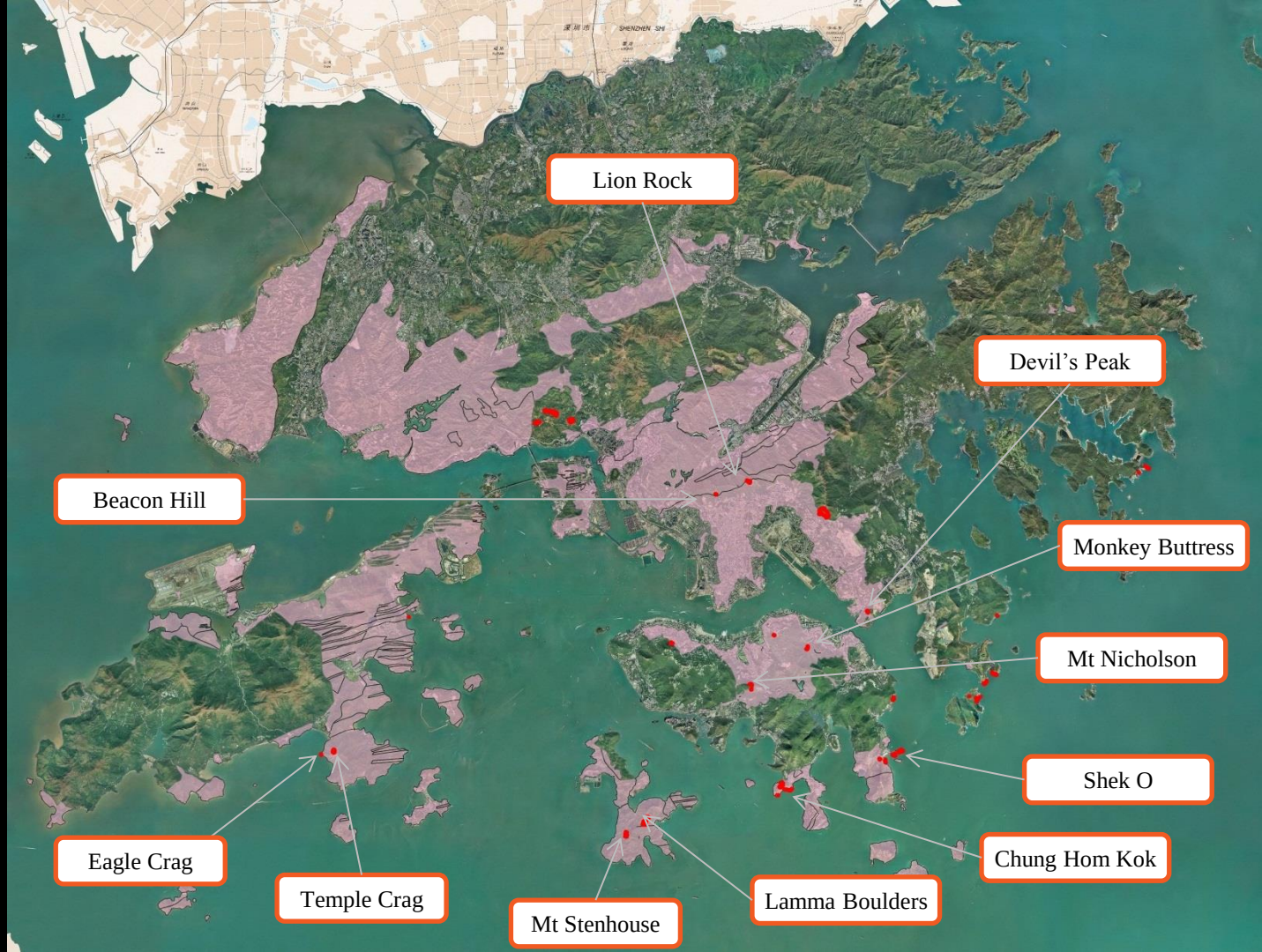
Regional Geology of Hong Kong

Simplified Geology of Climbing Areas



Simplified Geology of Climbing Areas

Granitic Crags

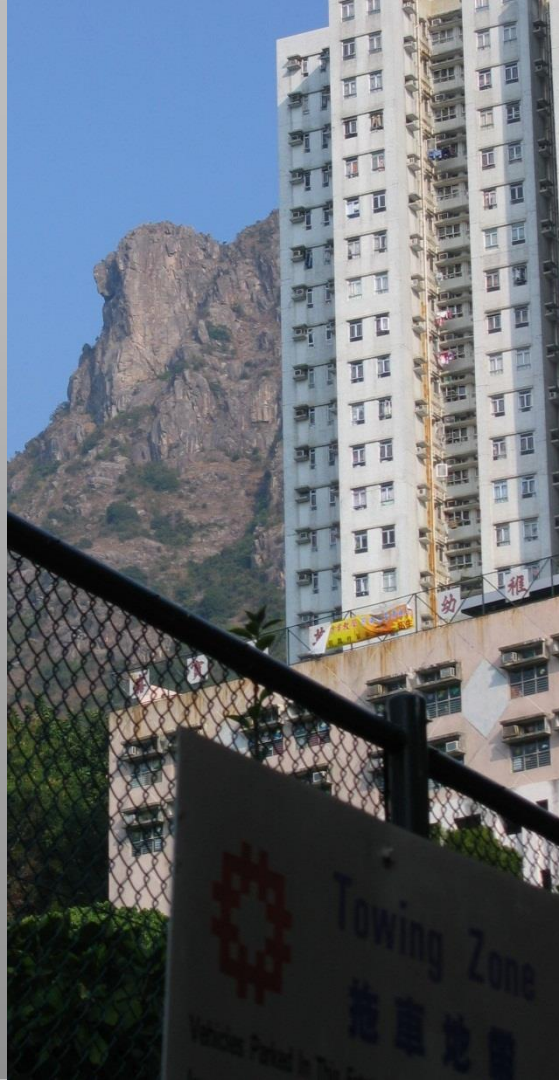


Granite Crags

Characteristics

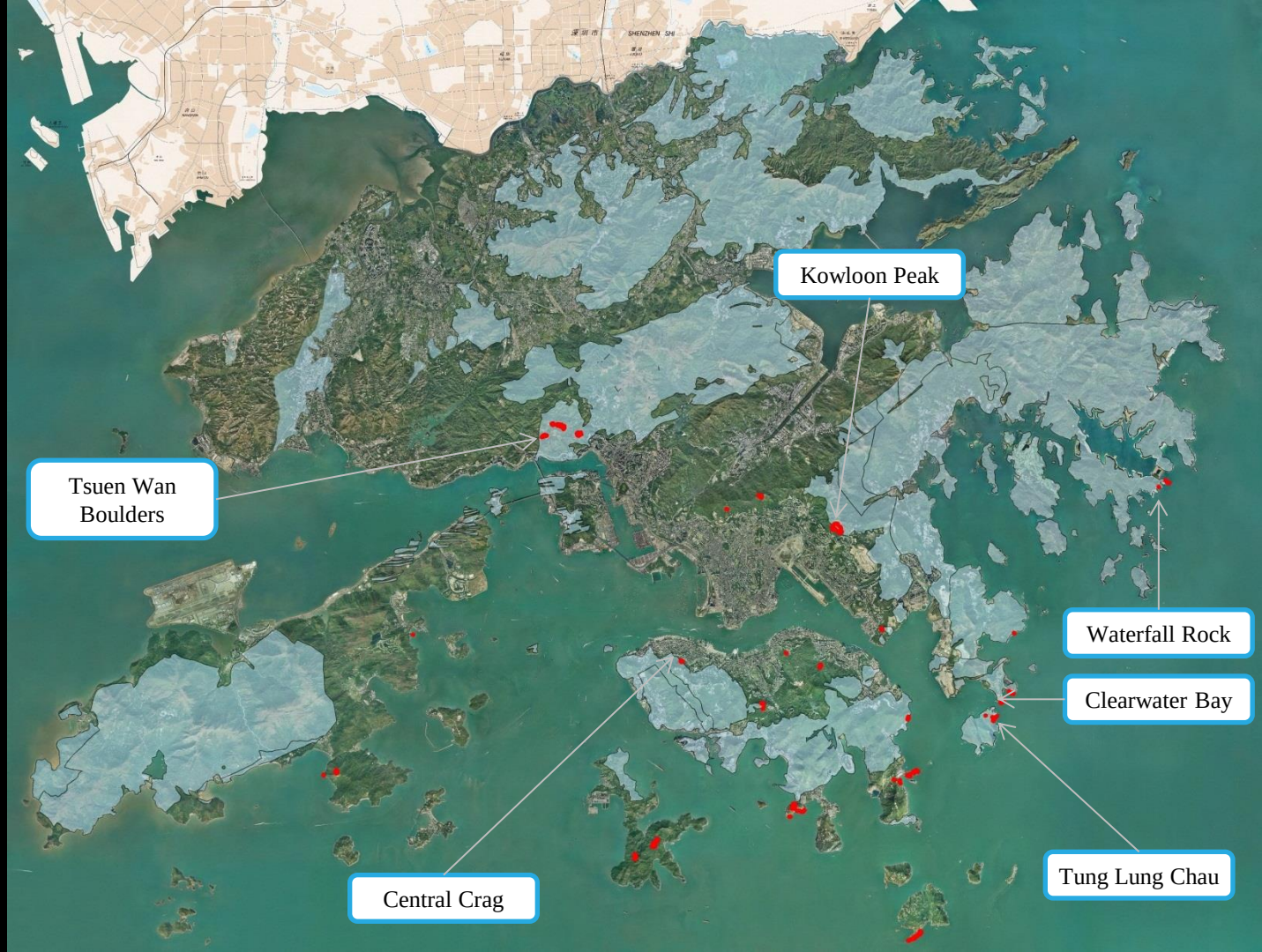
Tend to have quite similar characteristics throughout much of the HKSAR – i.e. predominantly massive slabby to vertical faces that are split by spaced but persistent cracks.

Main variation is in the coarseness of the crystals within the granite



Simplified Geology of Climbing Areas

Volcanic Crags

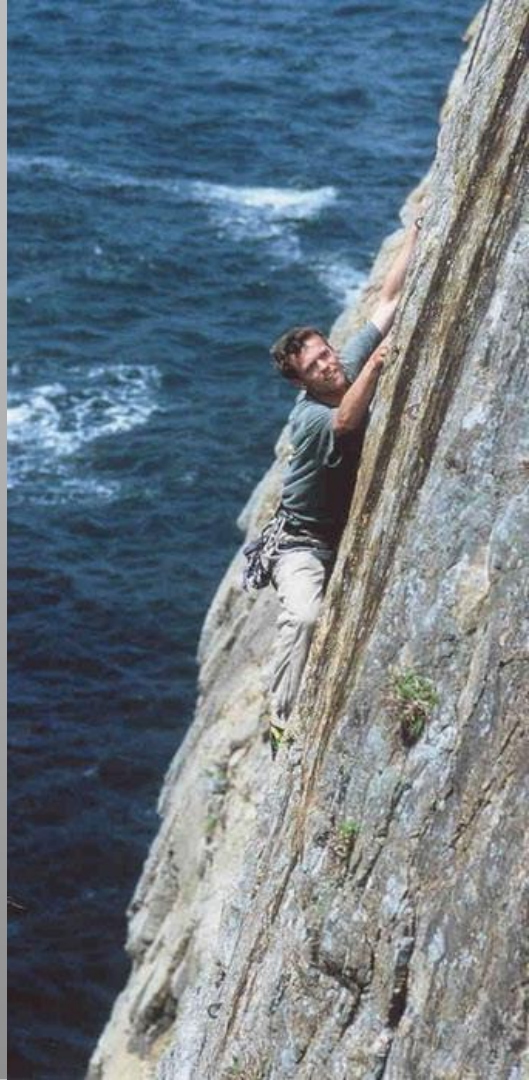


Volcanic Crags

Characteristics

Much wider variety of rock types than the granitic crags

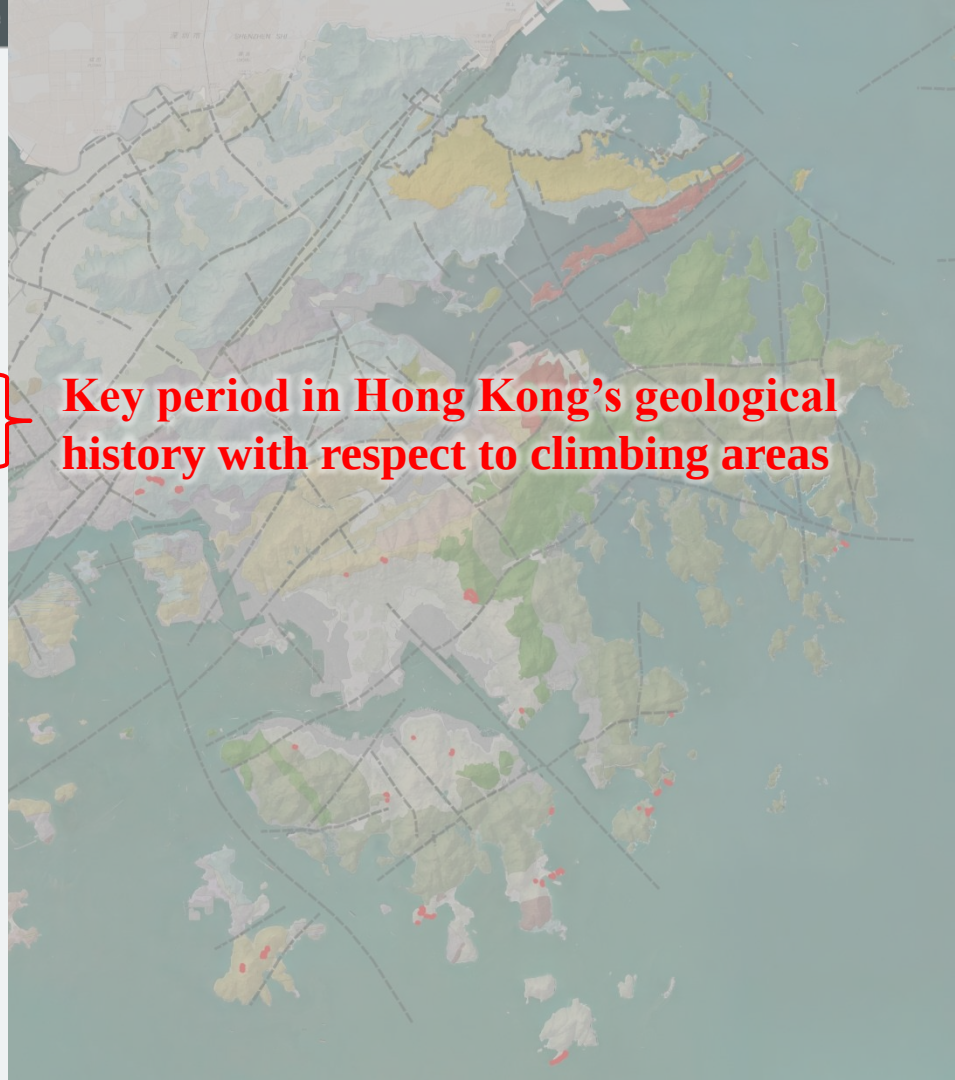
- **Coarse Ash Tuff**: quite similar in style to granite areas (i.e. relatively massive faces with few cracks / features)
- **Fine Ash Tuff / Eutaxite**: much smoother rock faces but with more frequent cracks and features
- **Pyroclastic tuff**: very rough texture (good friction) with frequent pockets (vesicles) and pebbles (xenoliths)
- **Metamorphosed Tuff**: very knobbly texture due to re-crystallisation of the parent rock



Hong Kong Stratigraphy

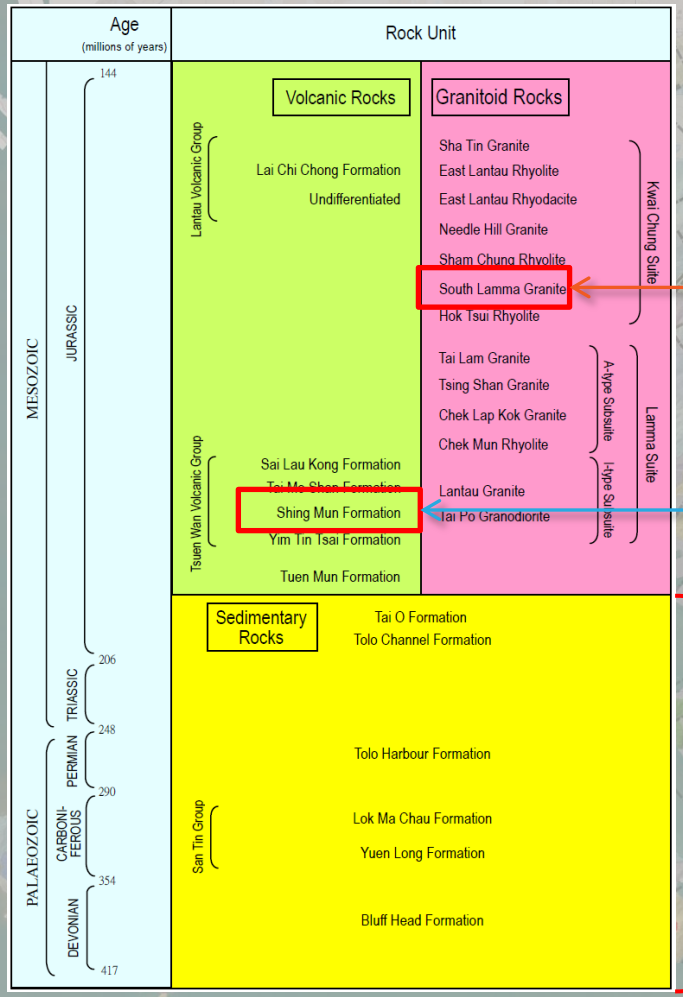
ERA	PERIOD	EPOCH	AGE*
CENOZOIC	Quaternary	Holocene	0.01
		Pleistocene	1.8
	Tertiary	Pliocene	5.3
		Miocene	23.8
		Oligocene	33.7
		Eocene	55
		Paleocene	65
MESOZOIC	Cretaceous		145
	Jurassic		200
	Triassic		251
PALEOZOIC	Permian		299
	Carboniferous		359
	Devonian		417
	Silurian		443
	Ordovician		490
	Cambrian		542
PRECAMBRIAN			3000
			4600

*Age in millions of years (Ma)



Hong Kong Stratigraphy

(Jurassic Crags)



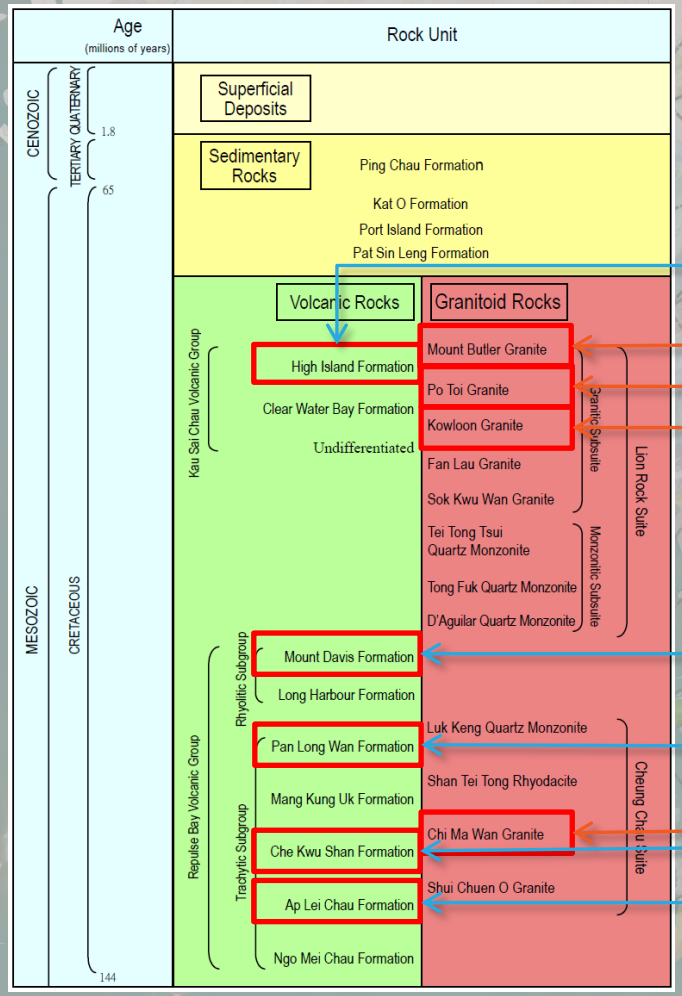
Lamma Boulders & Mt Stenhouse

Tsuen Wan Boulders

No exposures of good enough quality to facilitate climbing

Hong Kong Stratigraphy

(Cretaceous Crags)



No exposures of good enough quality to facilitate climbing

- Monkey Butress
- Waterfall Rock
- Shek O & Chung Hom Kok
- Lion Rock & Beacon Hill
- Kowloon Peak
- Clearwater Bay
- Temple Crag & Eagle Crag
- Tung Lung Chau Cape Collinson
- Central Crag

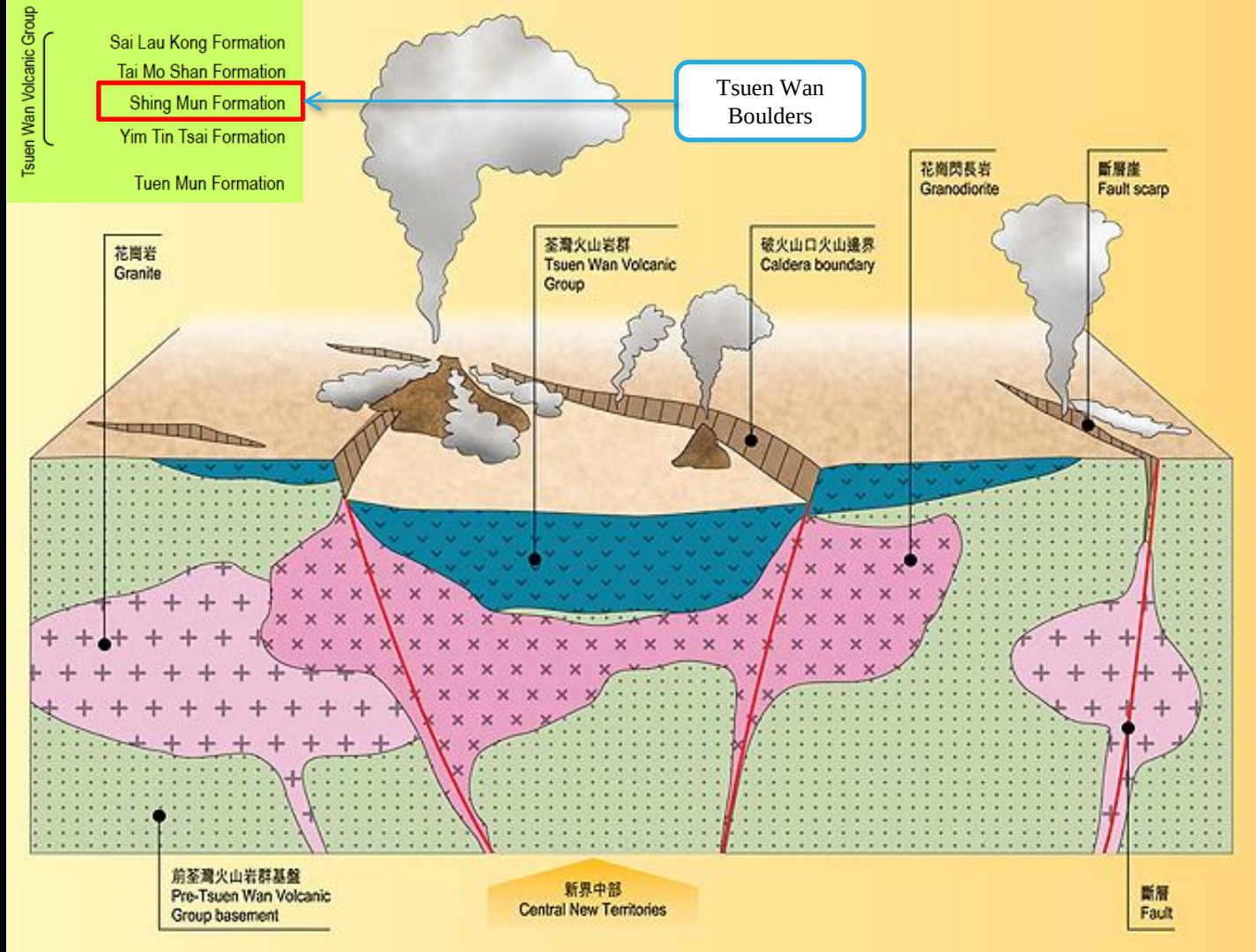
165 to 160 million years ago

The first major episode of eruption formed much of the volcanic rock exposed in the **central New Territories**.

These rocks are dominantly crystal-rich ashes containing abundant rock fragments.

The volcanic eruptions were very violent, and there is very little evidence of any lava flows. Although the caldera that produced the ash has long since disappeared, its approximate location can be determined from the concentration of volcanic vent-type materials and the associated plutonic rocks.

Volcanic vent materials and related plutonic bodies form a discontinuous, northeast-oriented ring-like structure that probably marks the original caldera boundary.



Tsuen Wan Boulders

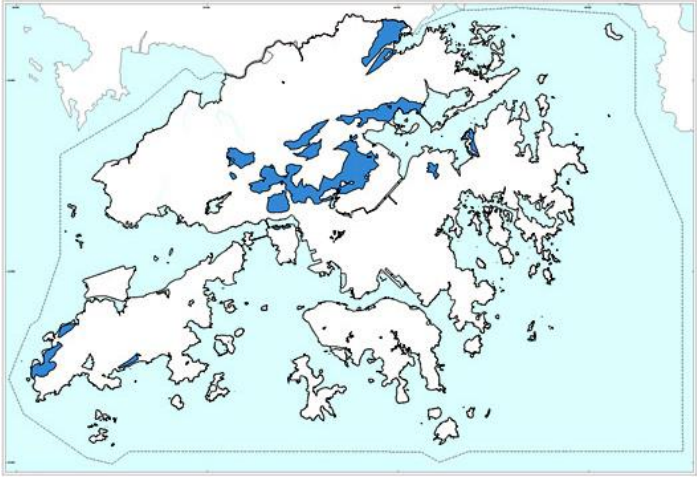
Tsuen Wan Boulders

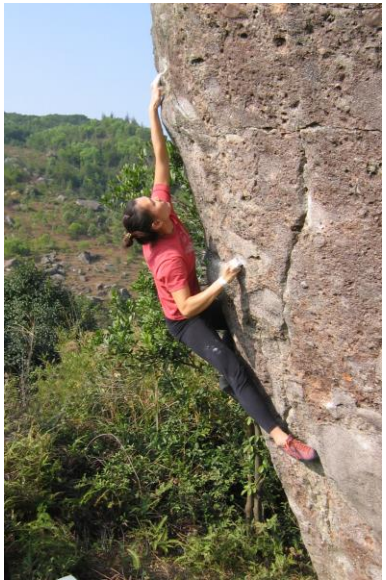
UNIT	Shing Mun Formation
Colour	grey
Composition	rhyodacite to rhyolite
Lithologies	crystal tuff, tuff breccia, tuffite
Dominant texture	coarse and fine ash
Crystals	quartz and feldspar
Lithics	rhyolite lava, marble, tuff, volcanic rock fragments
Glass/Pumice	rare
Fabric	massive to crudely bedded ± eutaxitic
Thickness	600 m

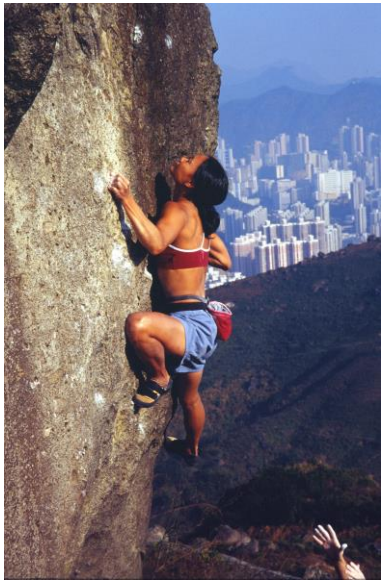
Stratigraphy: Jurassic volcanic rocks with an age of 164.7 ± 0.3 million years ago.

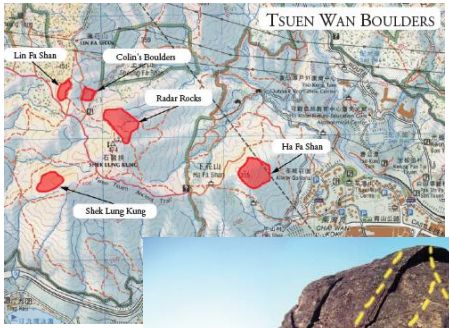
Distribution: The **Shing Mun Formation** mainly crops out in the vicinity of Tai Mo Shan and on the north side of Tolo Harbour.

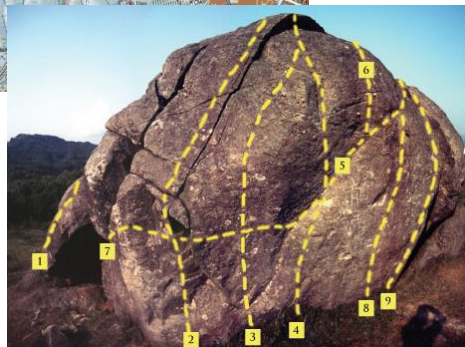
Lithology: Lapilli lithic-bearing coarse ash tuff and tuff breccia with intercalated siltstone.









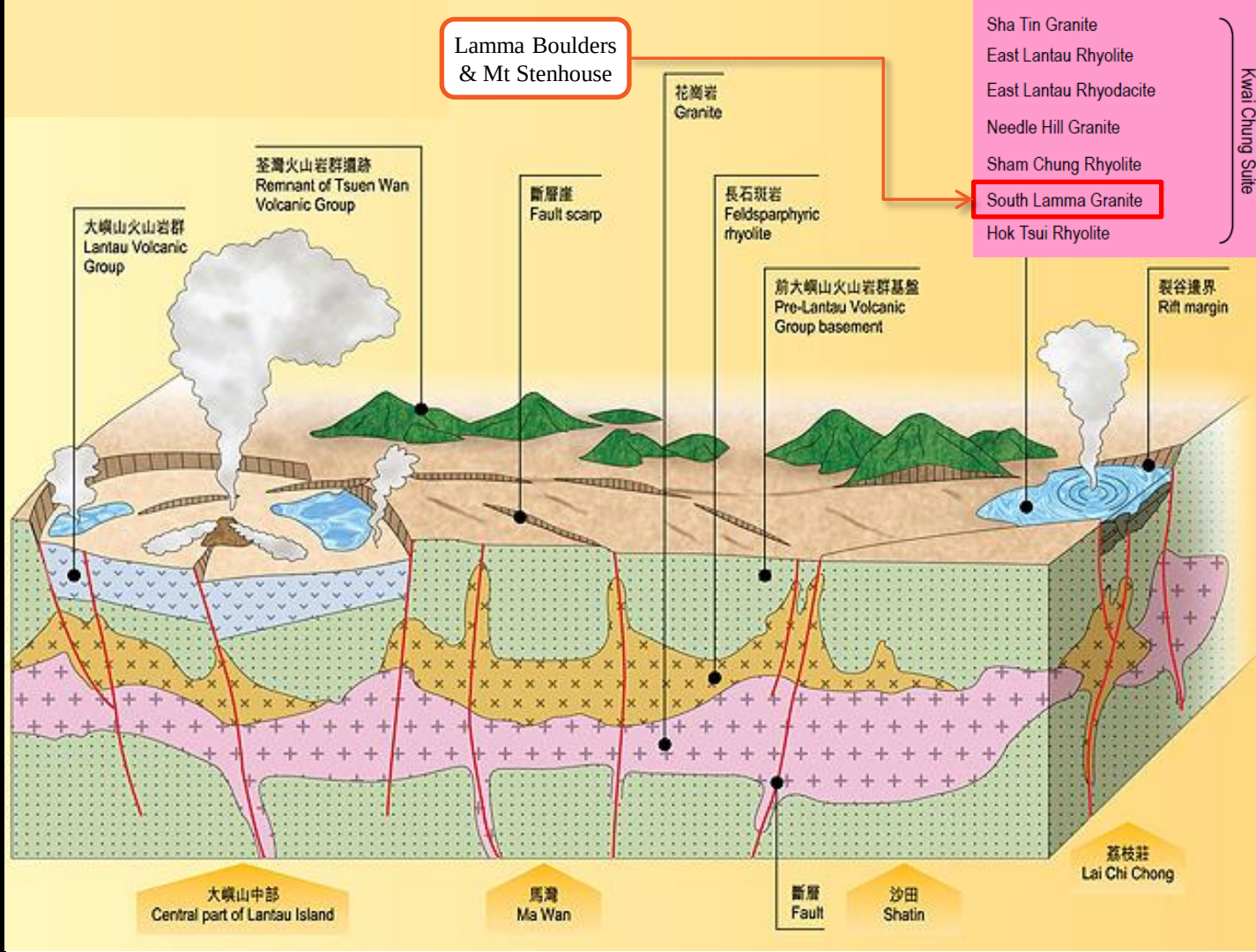


148 to 146 million years ago

Further migration of the convergent margin southeastward led to a shift in focus of volcanism towards the southeast and towards the development of stronger northwest-southeast tensional forces.

A major **new volcanic caldera developed in the area that is now the central part of Lantau Island**. This caldera was fed from a deep magma chamber, with the magma injected along dykes.

A granite body in the vicinity of Sha Tin represents the remnants of the magma chamber, while numerous east-northeast and northeast-trending dykes on northeast Lantau Island, Ma Wan and Tsing Yi represent the feeder dyke plumbing system of the volcano.



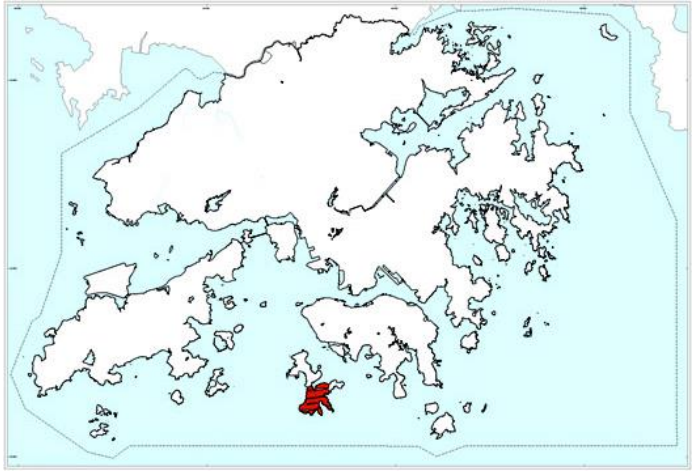
Lamma Island

Lamma Island

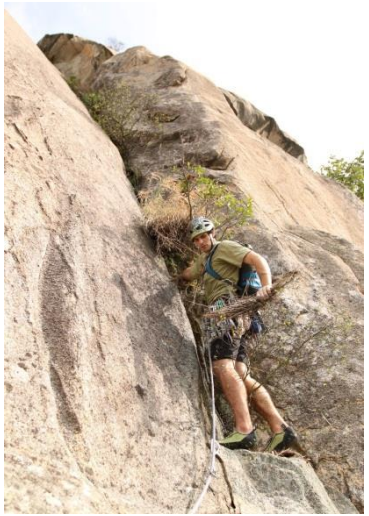
UNIT	South Lamma Granite
Colour	light pink
Rock Type	biotite monzogranite
Dominant texture	equigranular medium grained
Mafic minerals	biotite
Feldspar	microcline, mesoperthite, albite
Accessory minerals	zircon, titanite, allanite, fluorite, Fe-oxide
Alkali feldspar megacrysts	absent
Pluton shape	circular
Area exposed (km^2)	12.5
Mineralization	-

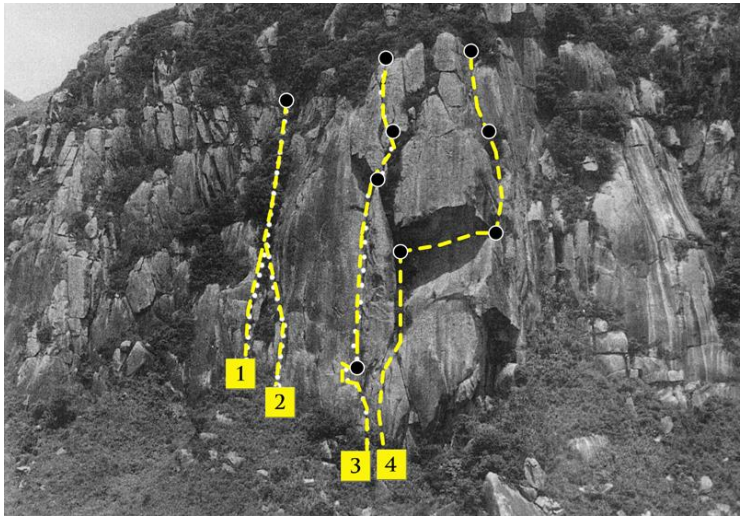
Stratigraphy: Jurassic intrusive rocks with an age of approximately 148.1 ± 0.2 million years before present.

Distribution: The **South Lamma Granite** forms a subcircular, equigranular biotite monzogranite pluton centred on the southern part of Lamma Island.



Lithology: Equigranular medium-grained biotite granite.



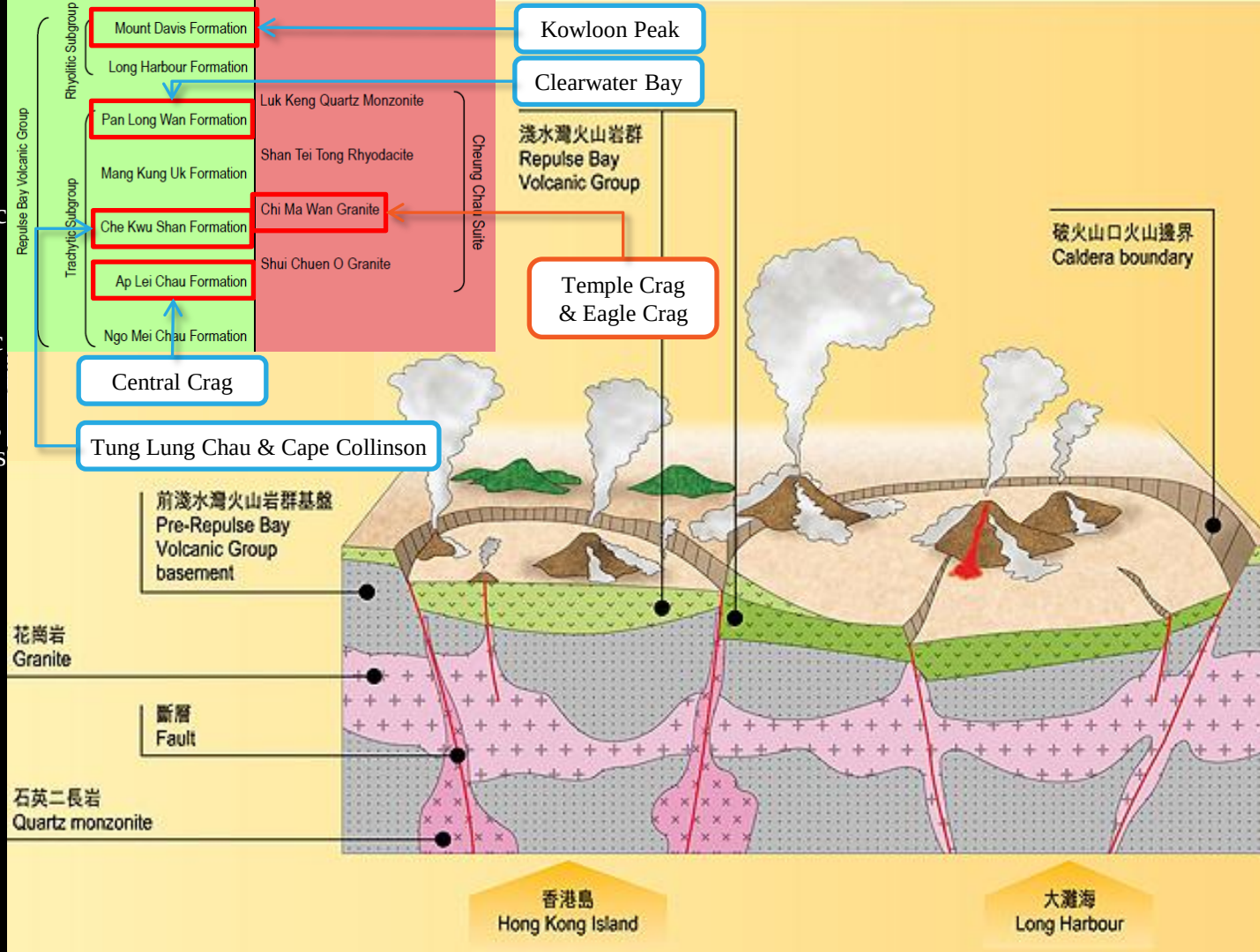


143 to 142 million years ago

The scale and intensity of Mesozoic volcanic activity continued to increase as the convergent margin migrated southeastwards.

The third major episode of volcanic activity in the Hong Kong region is particularly complex, with the **formation of at least two calderas** that each erupted volcanic materials of slightly different compositions.

Evidence suggests that **one caldera, centred on Hong Kong Island**, erupted volcanic ash with very little crystal content, while the **other caldera, centred in the area of Sai Kung and Long Harbour**, erupted volcanic ash with abundant crystal content



Temple Crag

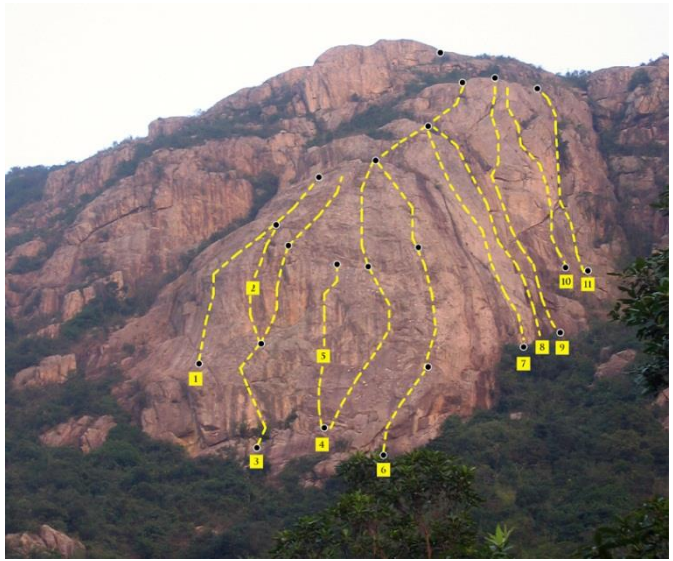
Temple Crag

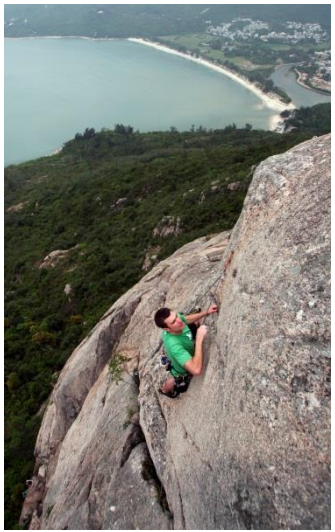
UNIT	Chi Ma Wan Granite
Colour	light grey or pink
Rock Type	biotite monzogranite
Dominant texture	equigranular medium grained
Mafic minerals	biotite
Feldspar	microcline mesoperthite, albite
Accessory minerals	zircon, titanite, allanite, apatite, Fe-oxide
Alkali feldspar megacrysts	absent
Pluton shape	circular
Area exposed (km^2)	14
Mineralization	-

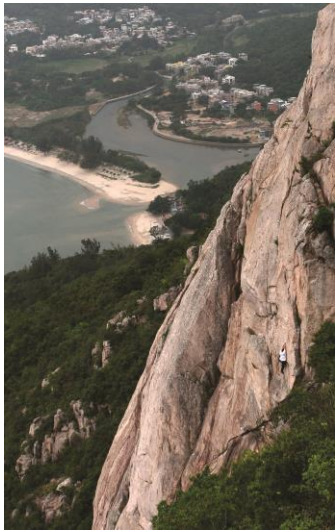
Stratigraphy: Cretaceous intrusive rocks with an age of approximately 143.7 ± 0.3 million years before present.

Distribution: The **Chi Ma Wan Granite** forms a subcircular pluton centred on the Chi Ma Wan Pennisular on the east side of Lantau.

Lithology: Equigranular medium-grained biotite granite.







Eagle Crag

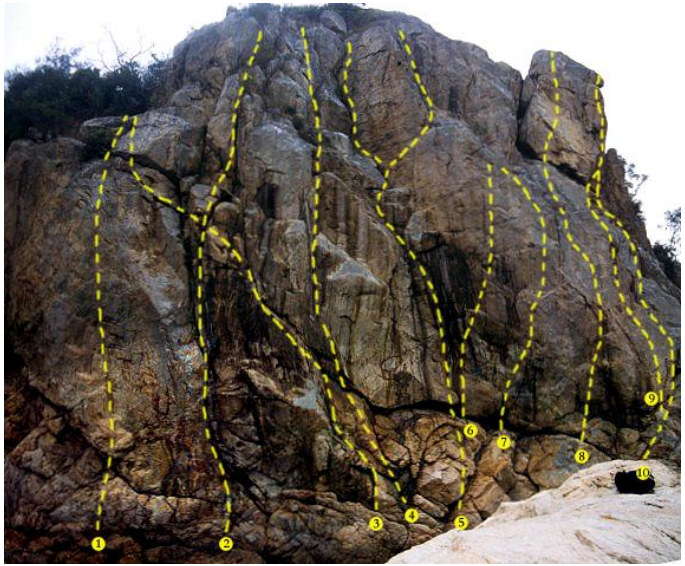
Eagle Crag

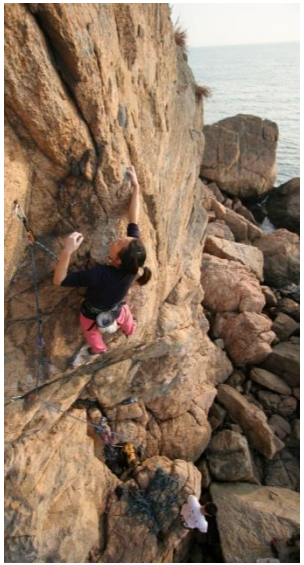
UNIT	Chi Ma Wan Granite
Colour	light grey or pink
Rock Type	biotite monzogranite
Dominant texture	equigranular medium grained
Mafic minerals	biotite
Feldspar	microcline mesoperthite, albite
Accessory minerals	zircon, titanite, allanite, apatite, Fe-oxide
Alkali feldspar megacrysts	absent
Pluton shape	circular
Area exposed (km^2)	14
Mineralization	-

Stratigraphy: Cretaceous intrusive rocks with an age of approximately 143.7 ± 0.3 million years before present.

Distribution: The **Chi Ma Wan Granite** forms a subcircular pluton centred on the Chi Ma Wan Pennisular on the east side of Lantau.

Lithology: Equigranular medium-grained biotite granite.





Central Crag

Central Crag

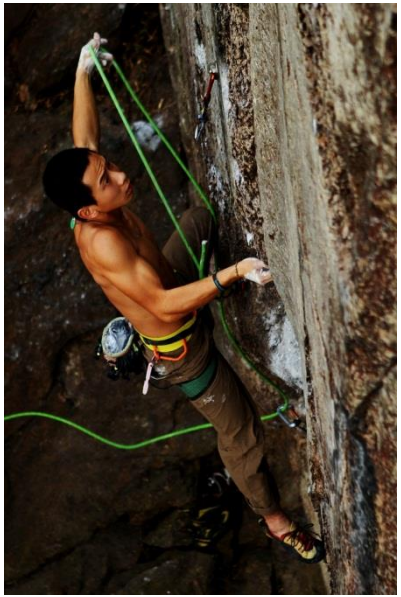
UNIT	Ap Lei Chau Formation
Colour	pale grey
Composition	trachyte to rhyolite
Lithologies	vitric tuff, tuff-breccia, tuffite
Dominant texture	welded fine ash
Crystals	quartz and feldspar
Lithics	-
Glass/Pumice	common
Fabric	± eutaxite
Thickness	>1250 m

Stratigraphy: Cretaceous volcanic rocks with an age of approximately 142.7 ± 0.2 million years before present.

Distribution: The **Ap Lei Chau Formation** occurs in the western and southern parts of Hong Kong Island.

Lithology: Eutaxitic fine ash vitric tuff.

In the vicinity of Victoria Peak the tuffs and minor sediments have been thermally metamorphosed by the Kowloon - Hong Kong granite pluton, the contact with which can be observed immediately below the cliffs of Central Crag.



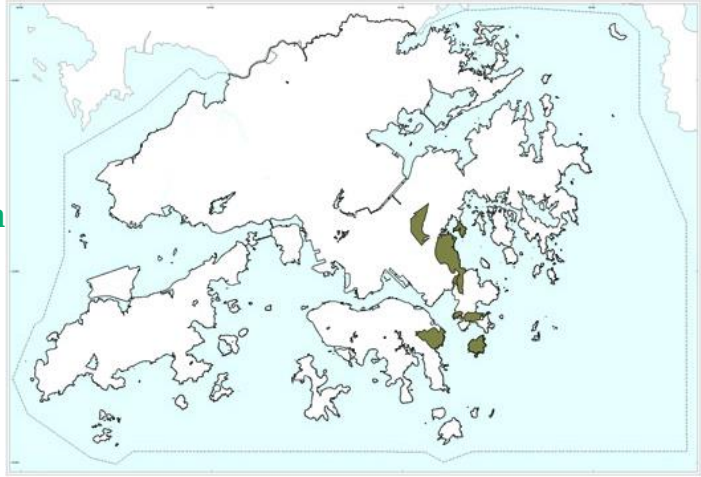
Tung Lung Chau

Tung Lung Chau

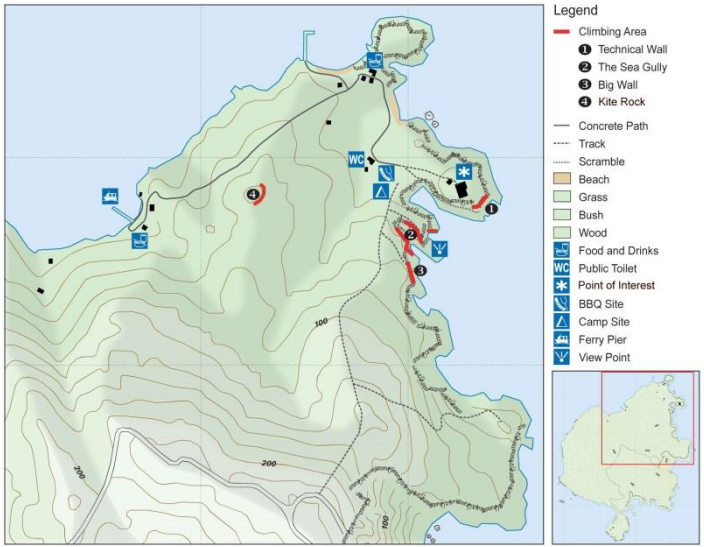
UNIT	Che Kwu Shan Formation
Colour	pale grey
Composition	trachyte to rhyolite
Lithologies	vitric tuff, tuff-breccia
Dominant texture	welded fine ash
Crystals	quartz and feldspar
Lithics	-
Glass/Pumice	common
Fabric	± eutaxite
Thickness	500 m

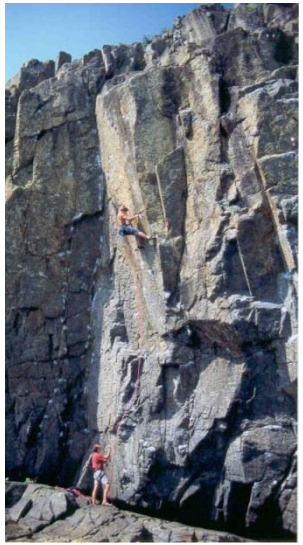
Stratigraphy: Cretaceous volcanic rocks with an age of approximately 142.5 ± 0.3 million years before present.

Distribution: The **Che Kwu Shan Formation** occurs in the eastern Hong Kong Island and eastern Kowloon, Sai Kung area, Silverstrand Bay and Tseung Kwan O.



Lithology: Eutaxitic crystal-bearing fine ash vitric tuff with minor tuff breccia.





Tung Lung Chau

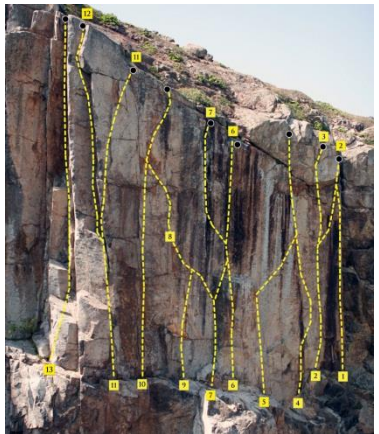
The most popular climbing area in Hong Kong, with a wide variety of climbing styles across the four main areas developed on the island

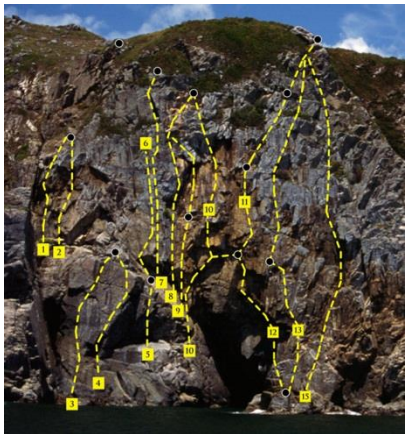
Technical Wall: Eutaxitic fine ash vitric tuff with frequent vesicles and abundant fiamme, providing highly pocketed and features climbing on slabby to overhanging walls.

Sea Gully: Still a eutaxitic fine ash tuff but located within a zawn that has formed as a result of a notable fault. This faulting has led to much smoother and less featured walls that provide a fine contrast to Technical Wall.

The Big Wall: Sort of a half-way house between the rock and climbing styles found at Technical Wall and Sea Gully.

Kite Rock: Volcanic bombs of welded tuff sitting atop the hillside. More akin to climbing at the Tsuen Wan Boulders than the other crags on Tung Lung Chau.





Cape Collinson

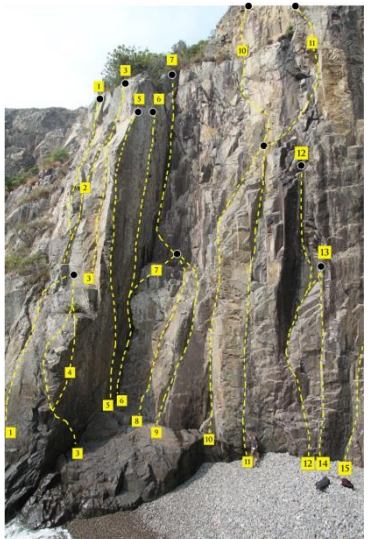
Cape Collinson

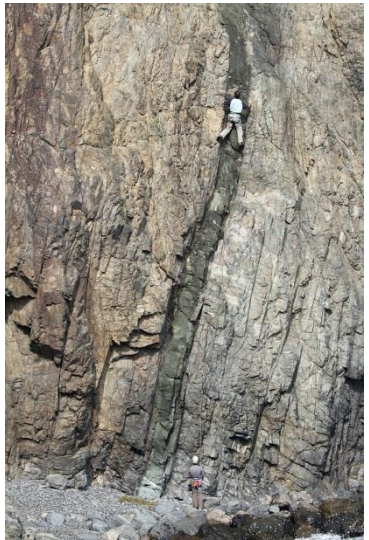
UNIT	Che Kwu Shan Formation
Colour	pale grey
Composition	trachyte to rhyolite
Lithologies	vitric tuff, tuff-breccia
Dominant texture	welded fine ash
Crystals	quartz and feldspar
Lithics	-
Glass/Pumice	common
Fabric	± eutaxite
Thickness	500 m

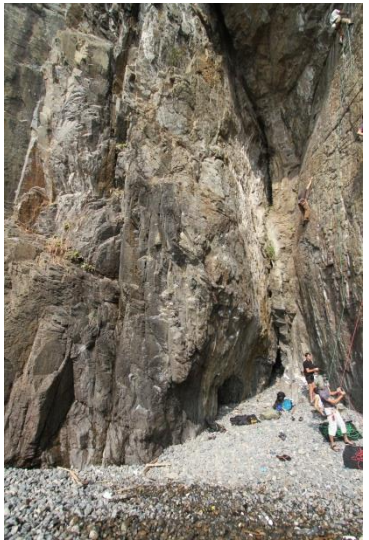
Stratigraphy: Cretaceous volcanic rocks with an age of approximately 142.5 ± 0.3 million years before present.

Distribution: The **Che Kwu Shan Formation** occurs in the eastern Hong Kong Island and eastern Kowloon, Sai Kung area, Silverstrand Bay and Tseung Kwan O.

Lithology: Dark grey to black rhyolitic crystal tuff likely formed by a volcanic ash flow.







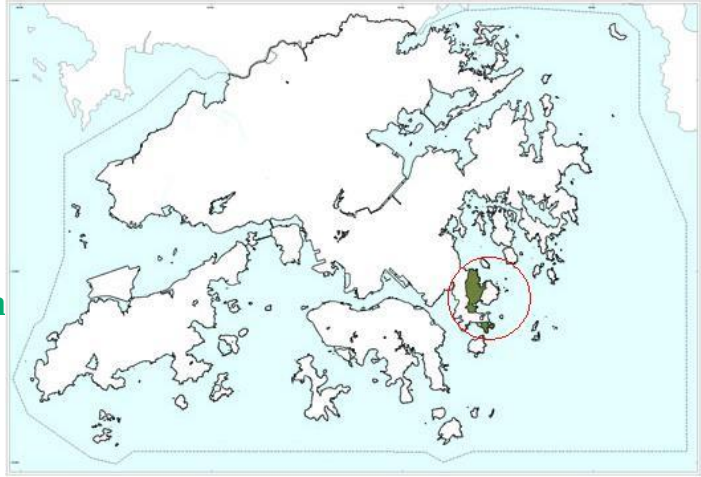
Clearwater Bay

Clearwater Bay

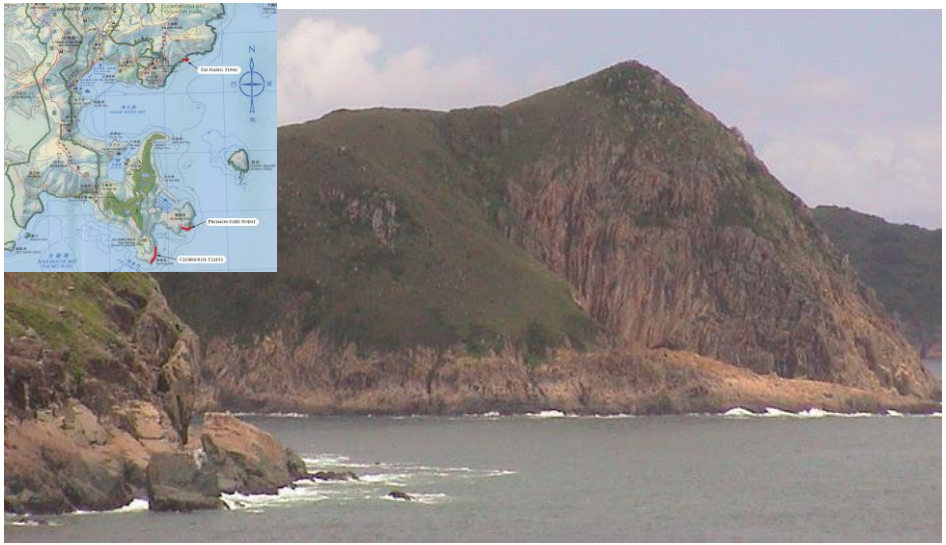
UNIT	Pan Long Wan Formation
Colour	bluish grey
Composition	trachydacite to rhyolite
Lithologies	lava, vitric tuff
Dominant texture	porphyritic and fine ash
Crystals	feldspar and quartz
Lithics	-
Glass/Pumice	rare
Fabric	± eutaxite and flow-banded
Thickness	420 m

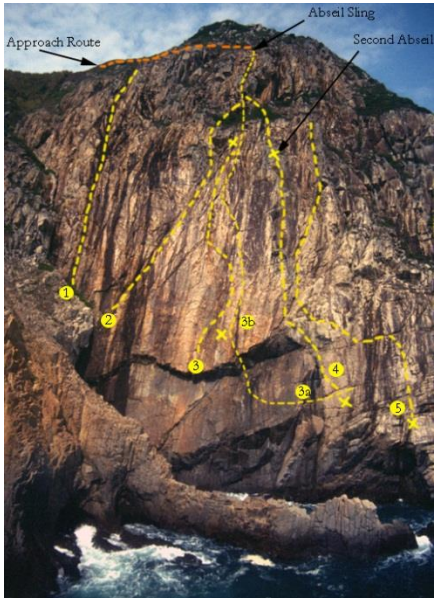
Stratigraphy: Cretaceous volcanic rocks included as part of the Repulse Bay Volcanic Group with an age ranging approximately between 142.5 and 142.9 million years before present.

Distribution: The **Pan Long Wan Formation** crops out mainly to the south of Siu Chung Lam Wan on the Clear Water Bay Peninsula.



Lithology: Tachydacite lava





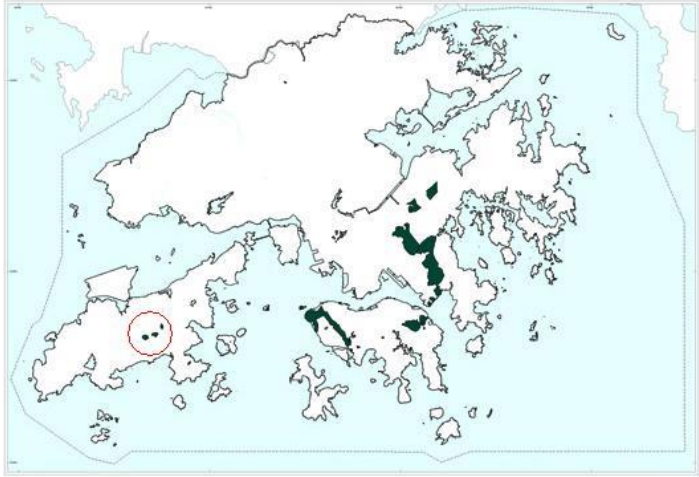
Kowloon Peak

Kowloon Peak

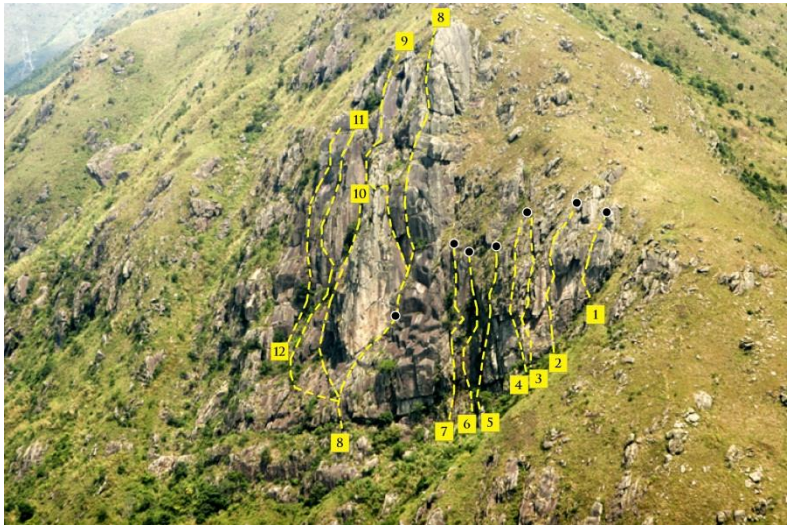
UNIT	Mount Davis Formation
Colour	light grey to grey
Composition	rhyodacite to rhyolite
Lithologies	crystal tuff and tuffite
Dominant texture	lapilli-bearing coarse ash
Crystals	feldspar, quartz and biotite
Lithics	lava and tuff
Glass/Pumice	rare
Fabric	massive
Thickness	950 m

Stratigraphy: Cretaceous volcanic rocks with an age of approximately 142.8 ± 0.2 million years before present.

Distribution: The **Mount Davis Formation** crops out in the northwest and the east of Hong Kong Island, eastern Kowloon, and two areas in the eastern side of the Sha Tin Valley.



Lithology: Dominantly coarse ash crystal tuff with intercalated tuffaceous siltstone and sandstone.



Lion Rock

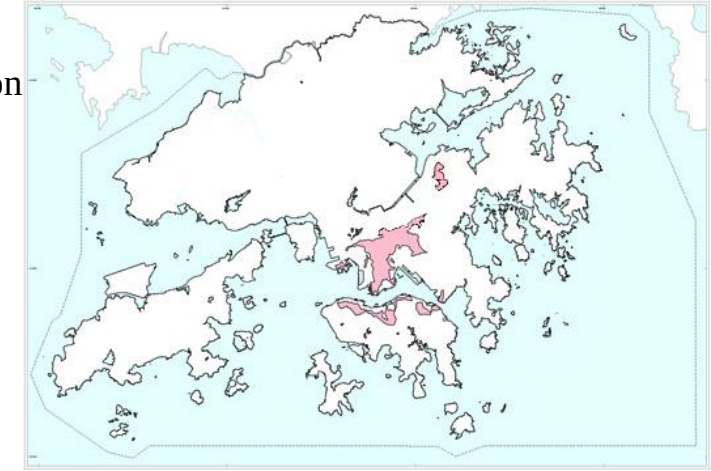
Lion Rock

UNIT	Kowloon Granite
Colour	pale pink or grey
Rock Type	biotite monzogranite
Dominant texture	equigranular medium grained
Mafic minerals	biotite
Feldspar	microperthite zoned oligoclase
Accessory minerals	zircon, allanite, titanite, apatite, Fe-oxide
Alkali feldspar megacrysts	absent
Pluton shape	circular
Area exposed (km^2)	68
Mineralization	-

Stratigraphy: Cretaceous intrusive rocks with an approximate age of 140.4 ± 0.2 million years before present.

Distribution: The **Kowloon Granite** forms a subcircular pluton centred on Kowloon and Hong Kong Island.

Lithology: Equigranular medium-grained biotite granite.



Lion Rock itself is composed of medium-grained granite, with fine-grained granite forming both a thin capping and dykes intruding the prominent overhanging ‘Lion's Head’.

The presence of these finer-grained intrusions may explain the resistance of this feature to erosion

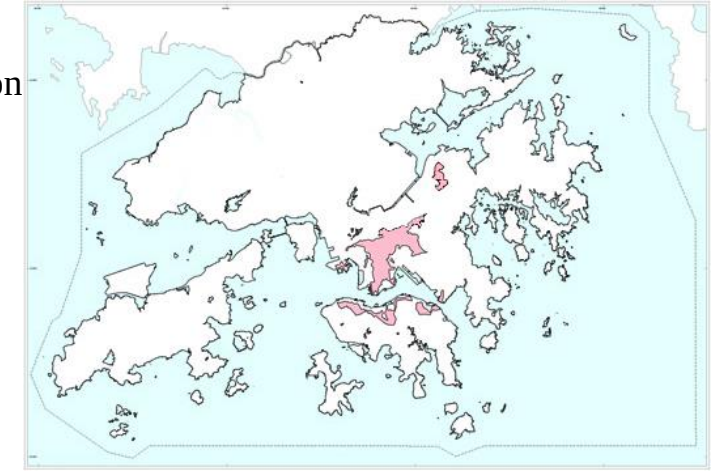
Lion Rock

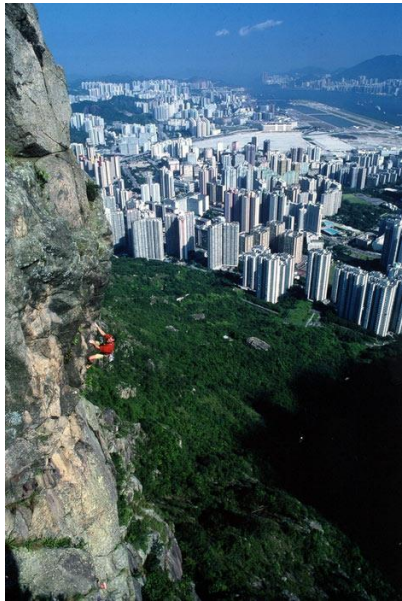
UNIT	Kowloon Granite
Colour	pale pink or grey
Rock Type	biotite monzogranite
Dominant texture	equigranular medium grained
Mafic minerals	biotite
Feldspar	microperthite zoned oligoclase
Accessory minerals	zircon, allanite, titanite, apatite, Fe-oxide
Alkali feldspar megacrysts	absent
Pluton shape	circular
Area exposed (km^2)	68
Mineralization	-

Stratigraphy: Cretaceous intrusive rocks with an approximate age of 140.4 ± 0.2 million years before present.

Distribution: The **Kowloon Granite** forms a subcircular pluton centred on Kowloon and Hong Kong Island.

Lithology: Equigranular medium-grained biotite granite.





Beacon Hill

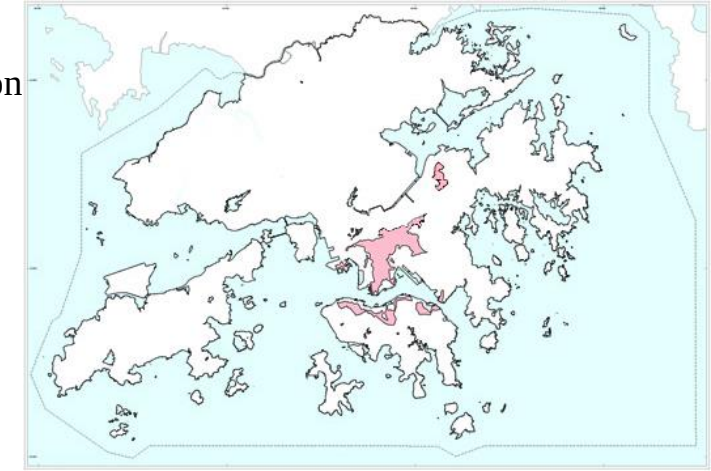
Beacon Hill

UNIT	Kowloon Granite
Colour	pale pink or grey
Rock Type	biotite monzogranite
Dominant texture	equigranular medium grained
Mafic minerals	biotite
Feldspar	microperthite zoned oligoclase
Accessory minerals	zircon, allanite, titanite, apatite, Fe-oxide
Alkali feldspar megacrysts	absent
Pluton shape	circular
Area exposed (km^2)	68
Mineralization	-

Stratigraphy: Cretaceous intrusive rocks with an approximate age of 140.4 ± 0.2 million years before present.

Distribution: The **Kowloon Granite** forms a subcircular pluton centred on Kowloon and Hong Kong Island.

Lithology: Equigranular medium-grained biotite granite.



Although the same stratigraphic unit as Lion Rock, the texture of the granite at Beacon Hill is much coarser and therefore somewhat more painful to climb on.

However, the easy access means it remains one of the most popular climbing areas in Hong Kong irrespective of this

Shek O

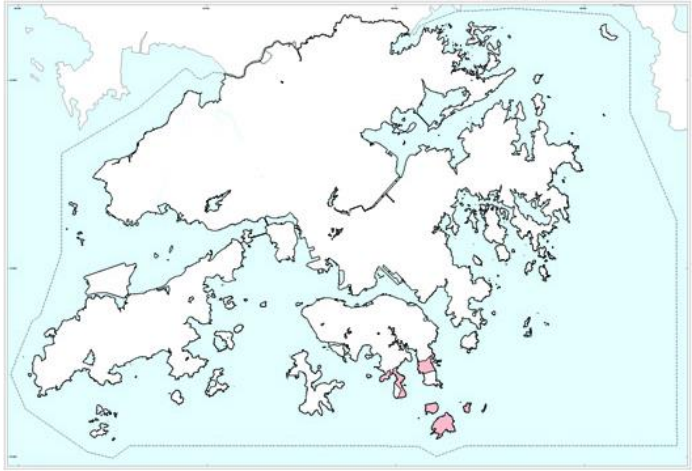
Shek O

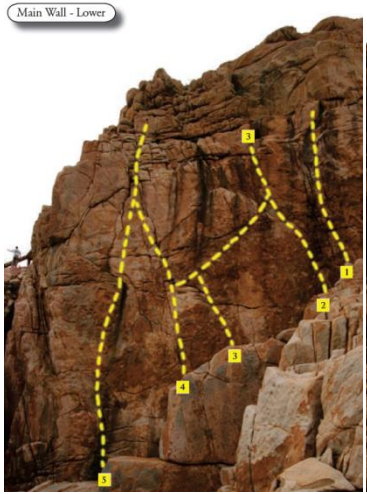
UNIT	Po Toi Granite
Colour	pale pink or grey
Rock Type	biotite monzogranite
Dominant texture	equigranular fine to medium grained
Mafic minerals	biotite
Feldspar	microperthite albite
Accessory minerals	zircon, titanite, allanite, Fe-oxide
Alkali feldspar megacrysts	absent
Pluton shape	circular
Area exposed (km^2)	10
Mineralization	-

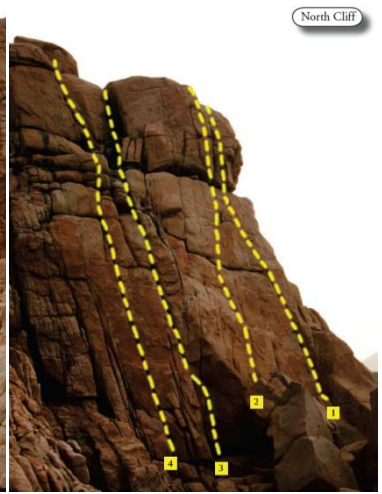
Stratigraphy: Cretaceous intrusive rocks interpreted to have been emplaced no older than approximately 140 million years ago.

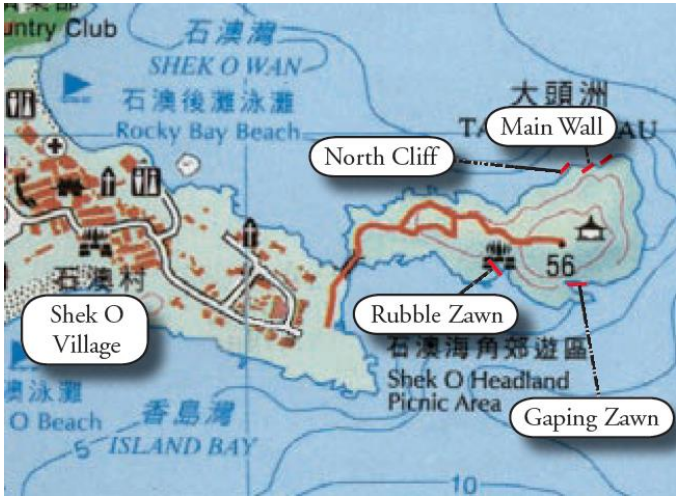
Distribution: The **Po Toi Granite** forms a sub-circular pluton centred on the south-eastern tip of Hong Kong Island.

Lithology: Megacrystic coarse-grained to equigranular fine-grained biotite granite.





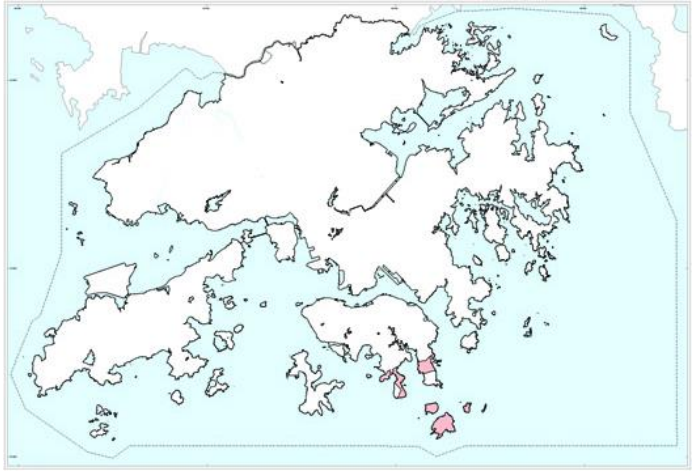




Shek O

UNIT	Po Toi Granite
Colour	pale pink or grey
Rock Type	biotite monzogranite
Dominant texture	equigranular fine to medium grained
Mafic minerals	biotite
Feldspar	microperthite albite
Accessory minerals	zircon, titanite, allanite, Fe-oxide
Alkali feldspar megacrysts	absent
Pluton shape	circular
Area exposed (km^2)	10
Mineralization	-

Also home to a good variety of bouldering in addition to the traditional and sport climbing found there.



Chung Hom Kok

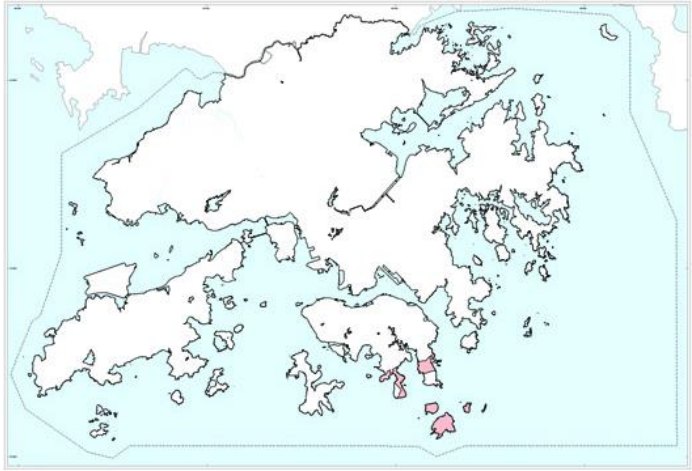
Chung Hom Kok

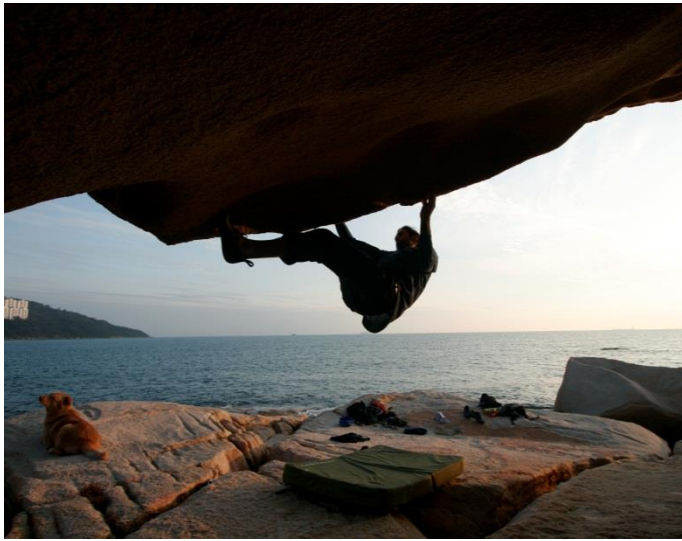
UNIT	Po Toi Granite
Colour	pale pink or grey
Rock Type	biotite monzogranite
Dominant texture	equigranular fine to medium grained
Mafic minerals	biotite
Feldspar	microperthite albite
Accessory minerals	zircon, titanite, allanite, Fe-oxide
Alkali feldspar megacrysts	absent
Pluton shape	circular
Area exposed (km^2)	10
Mineralization	-

Stratigraphy: Cretaceous intrusive rocks interpreted to have been emplaced no older than approximately 140 million years ago.

Distribution: The **Po Toi Granite** forms a sub-circular pluton centred on the south-eastern tip of Hong Kong Island.

Lithology: Megacrystic coarse-grained to equigranular fine-grained biotite granite.



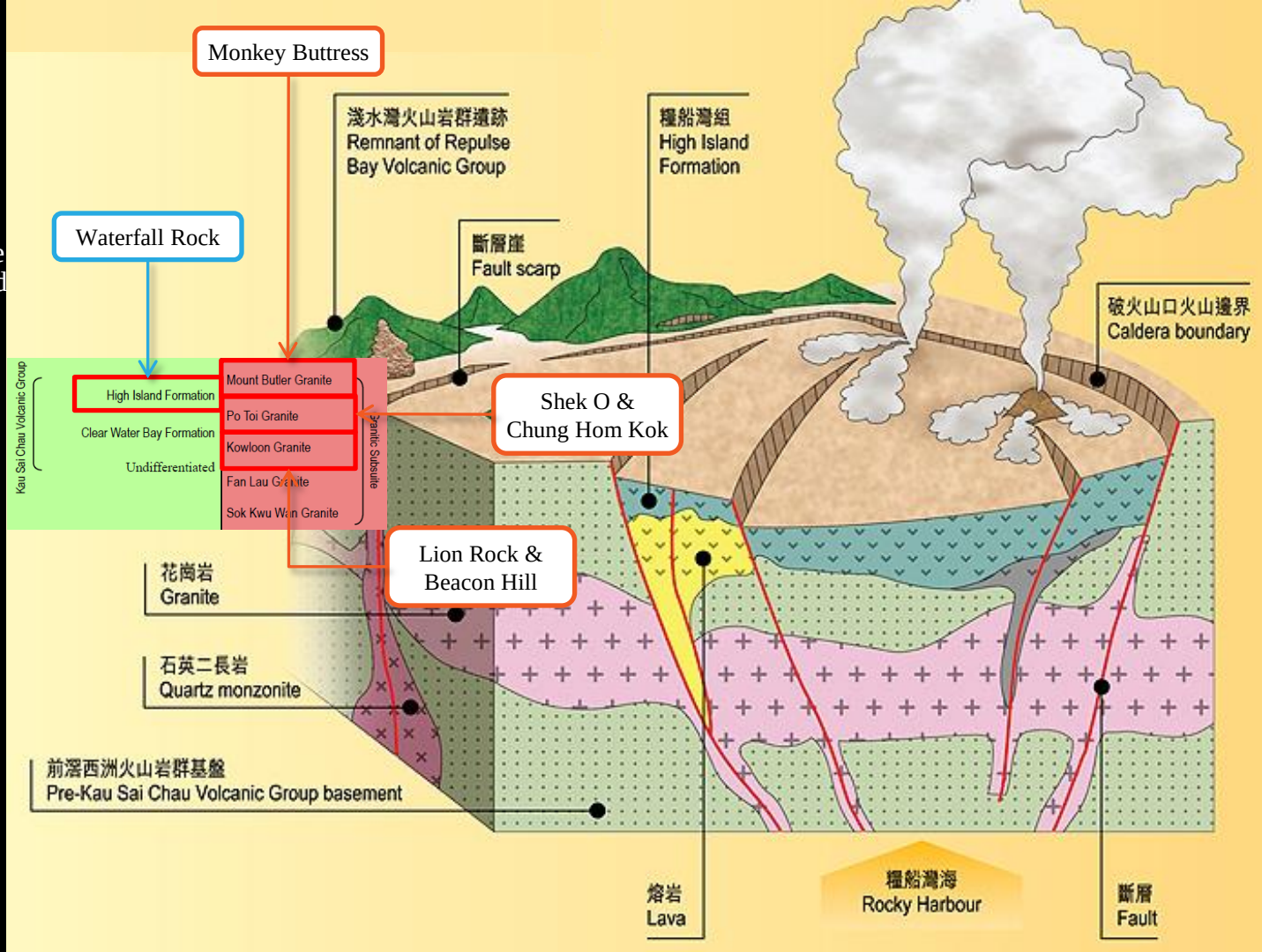


140 million years

The fourth and final episode of volcanic activity in Hong Kong is marked by the development of a large caldera volcano centred in the Rocky Harbour area, which was fed from northeast-trending fissure dykes along its northern and southern margins.

Eruptions were dominated by large volumes of crystal-poor volcanic ash that accumulated as thick layers, which are, in places, strongly fused together.

Fusing indicates that the eruptions were extremely hot.



140 million years

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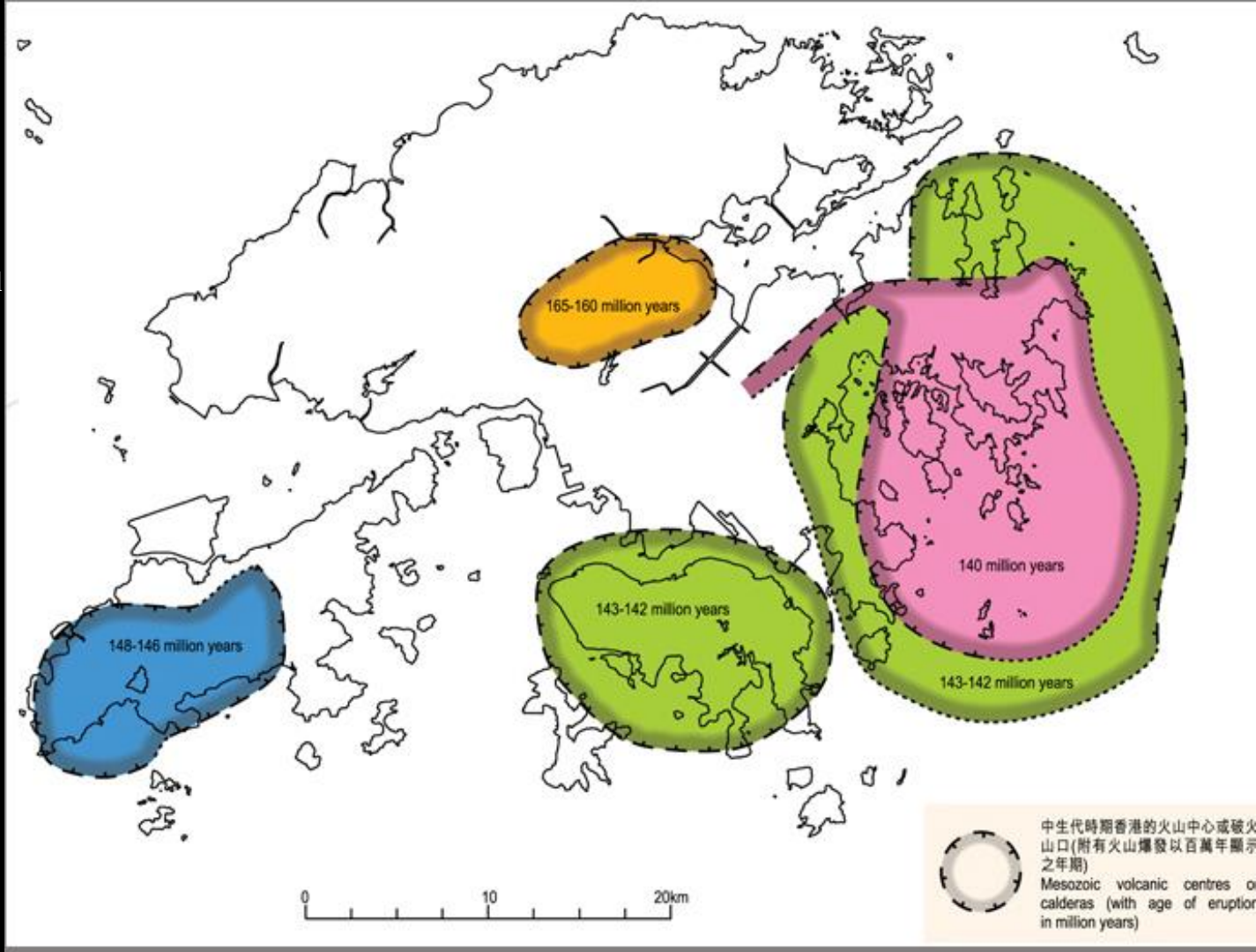


Waterfall Rock

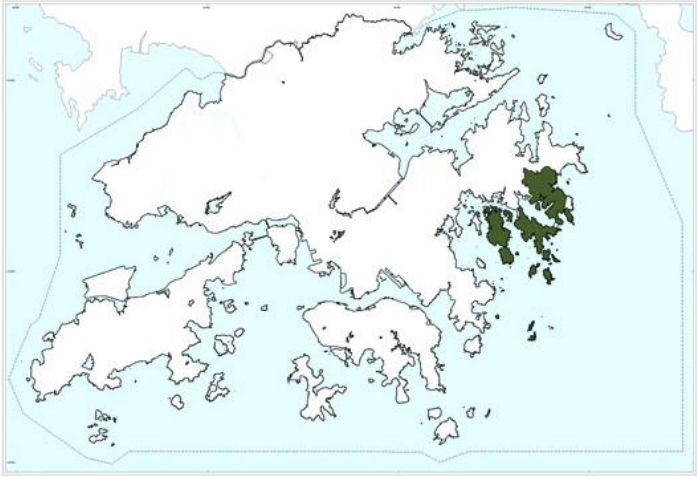
Waterfall Rock

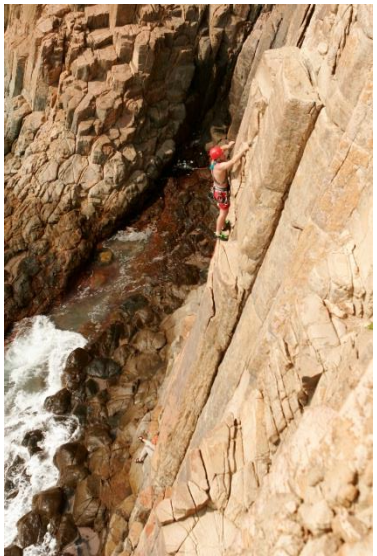
UNIT	High Island Formation
Colour	pinkish grey
Composition	high silica rhyolite
Lithologies	vitric tuff and rare eutaxite
Dominant texture	welded fine ash
Crystals	feldspar, minor qtz
Lithics	-
Glass/Pumice	rare
Fabric	massive and rare eutaxite
Thickness	>400 m

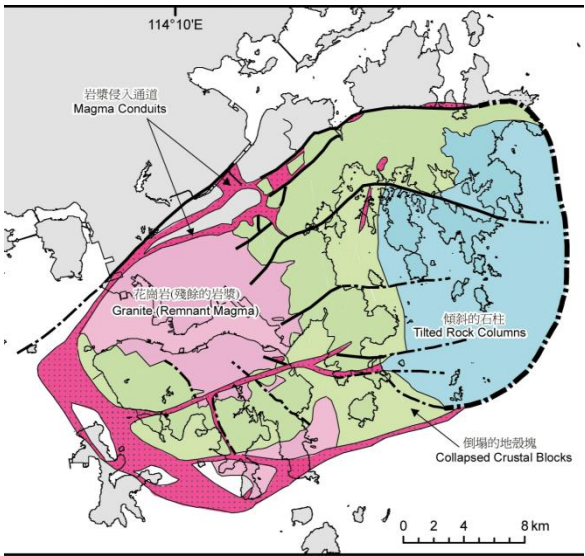
Stratigraphy: Early Cretaceous volcanic rocks with ages of approximately 140.9 ± 0.2 million years before present.

Distribution: The High Island Formation crops out in the Sai Kung and Clear Water Bay districts in eastern New Territories.

Lithology: Dominantly welded fine ash vitric tuff with minor tuff breccia and tuffaceous sandstone.







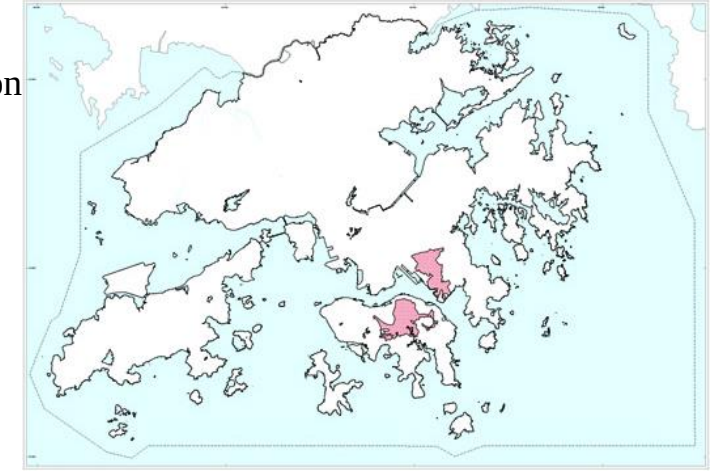
Monkey Buttress

Monkey Buttress

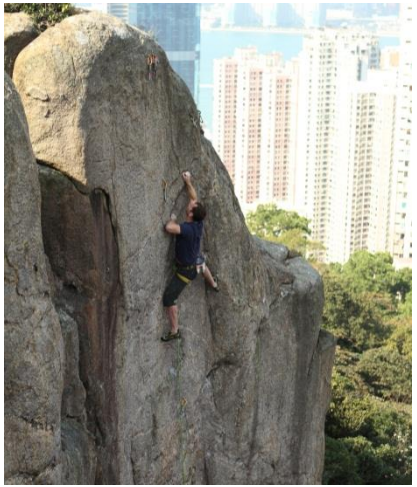
UNIT	Mount Butler Granite
Colour	light pink to grey
Rock Type	biotite monzogranite
Dominant texture	equigranular medium grained
Mafic minerals	biotite
Feldspar	microperthite albite
Accessory minerals	zircon, apatite, Fe-oxide
Alkali feldspar megacrysts	sparse
Pluton shape	circular
Area exposed (km^2)	25
Mineralization	Mo,W,Fe,Be

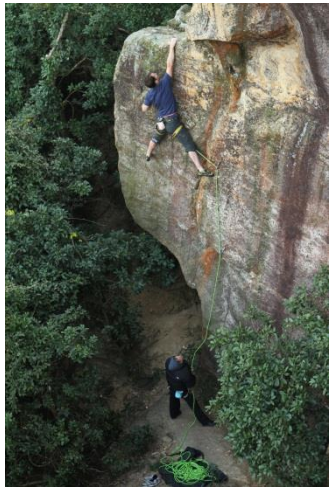
Stratigraphy: Cretaceous intrusive rocks with an age of approximately 136 ± 0.1 million years before present.

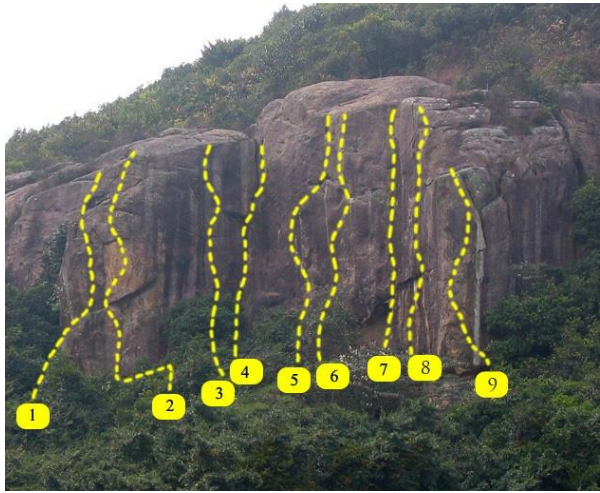
Distribution: The **Mount Butler Granite** forms small, sub-circular intrusions on the southeast and east margins of the Kowloon Granite on Hong Kong Island and in eastern Kowloon.



Lithology: Equigranular fine- and fine- to medium-grained biotite granite







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Climbing info

http://hongkongclimbing.com/2012/08/31/starting-out/

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- INTRO
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- COURSES
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Mention Hong Kong and most people think about a concrete jungle with sky scrapers towering up towards the heavens.

But hidden behind the urban sprawl lies some spectacular countryside, and nestled amongst these are numerous buttresses of pristine granite and volcanic rock.

Come climbing!

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CLIMBING COURSES

31/08/2012 · by hkclimbing · in courses, tips. · Edit

Here's some general information we've put together on how to get started climbing in Hong Kong…

Beginner's Courses

Whilst everything you need to learn about climbing can be taught by an experienced climber on a day out to the crag, this is a time consuming process which can place a substantial burden on the person teaching you. We would therefore recommend completing a basic training course so that the fundamentals of climbing safely are already known to you when you head outside.

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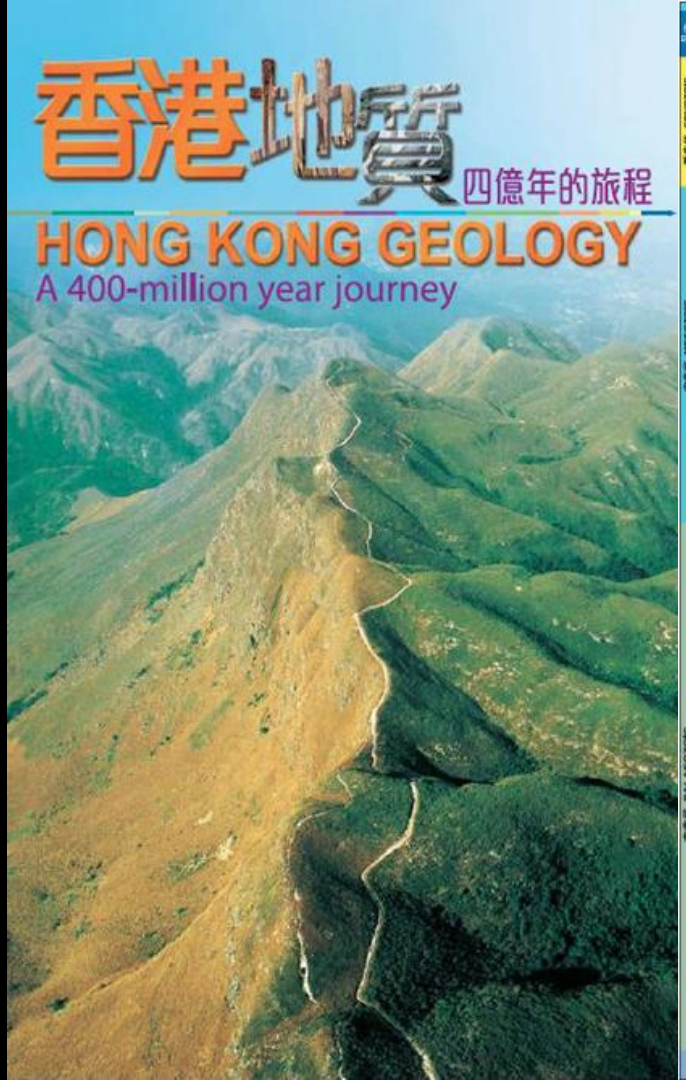
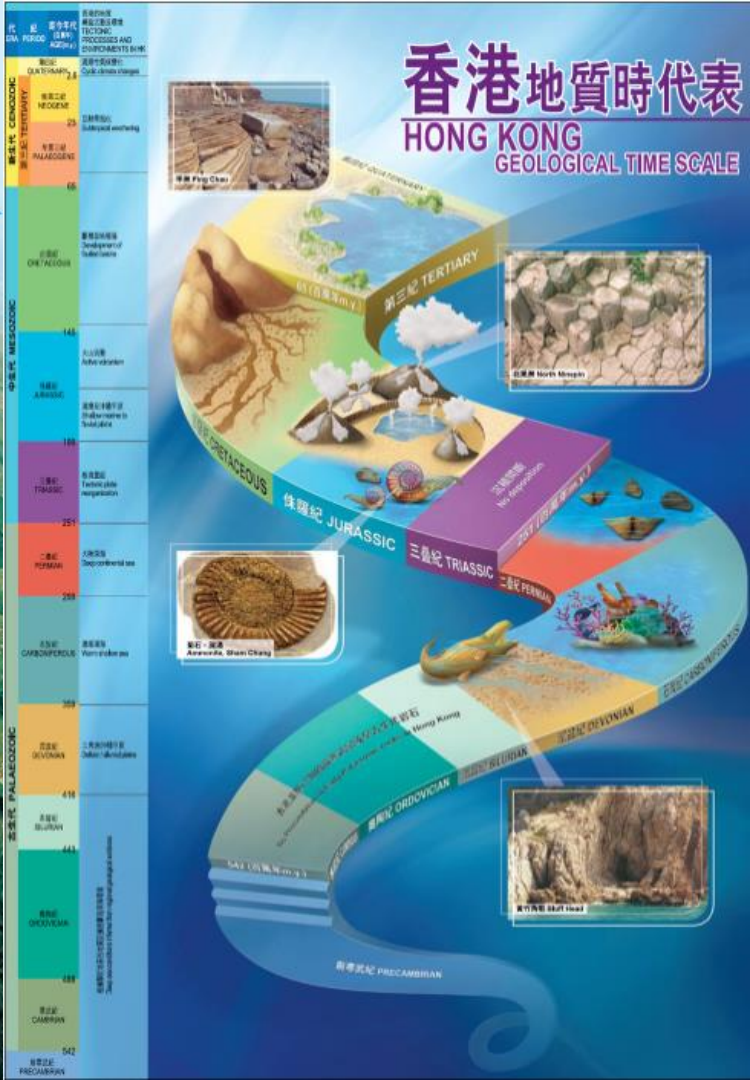
Want to know more?

Geological info

http://hkss.cedd.gov.hk/hkss/eng/education/GS/eng/hkg/indexe.htm

Note: this is where all the geological schematics used today came from





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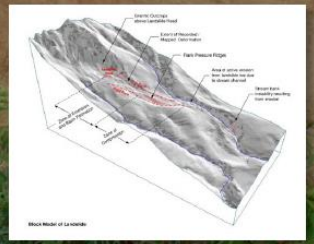
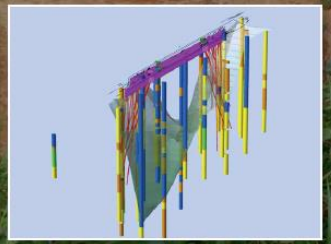
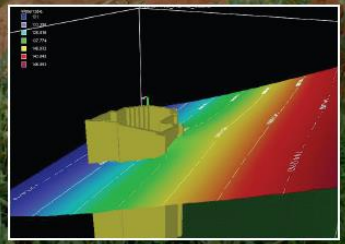
- Groundwater Modelling
- Due Diligence Study / Ground Risk Assessment







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