Updating of Hong Kong Geological Survey 1:20,000-scale Maps

Major Findings and Revisions Map Sheet 5 – Tsing Shan (Castle Peak)

GEO Report No. 375

N.M.C. Yim, T.K. Tse & D.L.K. Tang

Geotechnical Engineering Office
Civil Engineering and Development Department
The Government of the Hong Kong
Special Administrative Region

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Prepared by:

Geotechnical Engineering Office,
Civil Engineering and Development Department,
Civil Engineering and Development Building,
101 Princess Margaret Road,
Homantin, Kowloon,
Hong Kong.

Preface

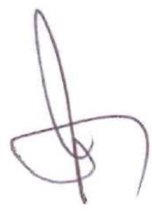
In keeping with our policy of releasing information which may be of general interest to the geotechnical profession and the public, we make available selected internal reports in a series of publications termed the GEO Report series. The GEO Reports can be downloaded from the website of the Civil Engineering and Development Department (http://www.cedd.gov.hk) on the Internet.

Raymond W M Cheung
Head, Geotechnical Engineering Office
August 2024

Foreword

This report describes the major findings on, and significant revisions to, Hong Kong Geological Survey 1:20,000-scale geological map Sheet 5 – Tsing Shan (Castle Peak), undertaken between 2012 and 2022. The work was carried out by the Hong Kong Geological Survey of the Planning Division as part of a programme continually to improve the representation of the geological maps published by the Hong Kong Geological Survey. The updating exercise has taken into account the vast amount of new site-specific information, and advances in geological knowledge gained since the previously published map of 1988 was first surveyed. The map updating work for Sheet 5 has been implemented on a GIS platform using a standard GIS template, and the map has been made available for promulgation in ArcReader format.

The updating of Sheet 5 was conducted by several colleagues in the Hong Kong Geological Survey over various periods, including Ms R.W.Y. Lau (2012-2013) and Mr K.W.F. So (2012-2013) on the onshore and offshore superficial deposits; and Mr S.S.C. Wong (2012-2013), Ms P.N.Y. Lau (2014-2016), Ms Y.M. Sin (2016-2018) and Mr C.K. Tam (2019-2021) on the solid geology of the map. Ms N.M.C. Yim and Mr T.K. Tse were responsible for conducting the geological interpretation and for producing the final updated map, under the supervision of Dr D.L.K. Tang. Technical support was provided by cartographic and technical staff of the Section. All contributions are gratefully acknowledged.



Jeffrey C F Wong
Chief Geotechnical Engineer/Planning

Abstract

The 1:20,000-scale Geological Map Sheet 5 – Tsing Shan (Castle Peak) is the sixth map updated under the map updating programme, currently being undertaken by the Hong Kong Geological Survey of the Geotechnical Engineering Office. The first edition of Sheet 5 solid and superficial geology map was surveyed between 1984 and 1987, and was published in 1988. Reliability of the geological maps has been improved after incorporation of the vast amount of new information that has accumulated over the past thirty years, and advances in the understanding Hong Kong's geology since the published maps were first surveyed.

The key findings and revisions to Sheet 5 include: (a) revision of the nomenclature and classification of volcanic stratigraphy and intrusive rocks, (b) revision of the stratigraphy of the Tuen Mun Formation, (c) updating of the distribution of Kat O Formation in the Deep Bay area, (d) inferred distribution of subcrops of a Triassic granite and an undifferentiated granite in the Deep Bay area, and (e) review of the major lithological-bounding faults in the district.

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1 Introduction

1.1 Background

The Geotechnical Engineering Office (GEO; the then Geotechnical Control Office, GCO, until 1991) commenced a geological survey of Hong Kong in 1982. A series of fifteen 1:20,000-scale solid and superficial geology maps and one 1:20,000-scale solid geology map (Series HGM20 and HGM20S respectively), with six geological memoirs, were published by the Hong Kong Geological Survey (HKGS) between 1986 and 1995 (Figure 1.1). The first edition of the 1:20,000-scale geological map Sheet 5 (hereafter Sheet 5) was published in 1988 (GCO, 1988b) with an accompanying geological memoir (Langford et al, 1989). It was based on field surveys carried out between 1984 and 1987. From 1989 to 1997, thirty-four 1:5,000-scale geological maps (Series HGP5, HGP5A and HGP5B) covering selected, mainly onshore development areas were also produced. In 2000, a series of ten 1:100,000-scale solid and superficial geology and thematic maps, and accompanying memoirs on the pre-Quaternary and Quaternary geology of Hong Kong, synthesising all of the available geological data at that time, were published (Sewell et al, 2000; Fyfe et al, 2000).

In the succeeding years since publication of the 1:20,000-scale maps, new geological information has become available and advances in knowledge and map publishing techniques have occurred. Hence, a geological map updating programme was initiated to improve the reliability of the geological maps.

1.2 Scope and Objectives of the Project

The scope of the map updating project is comprehensive, including revisions of both the bedrock and superficial geology. The project is being conducted on a map-by-map basis (Table 1.1). The geology of the approximately 60 km^2 of offshore areas not previously surveyed (including part of Deep Bay, Urmston Road and area south of Butterfly Beach), which have been included within the Hong Kong Special Administrative Region (HKSAR) since July 1997, is incorporated within the update. Priority is also being given to establishing the locations of faults concealed by superficial deposits in both onshore and offshore areas, and to revising areas of complex geology with reference to the available information after the first edition of Sheet 5. Several inconsistencies between individual map sheets, which have resulted from developments in terminology and interpretation that occurred during the preparation of the 1:20,000-scale maps between 1986 and 1996, are also being resolved. Both an updated solid and superficial geology map (Series HGM20) and a new solid geology map (Series HGM20S) of Sheet 5 will be produced. Major findings and revisions of Sheet 5 are reported here.

Nevertheless, the project is not a resurvey and relies heavily on desk studies of available information with only limited field confirmation. The desk studies involve integration of new data from ground investigations (both onshore and offshore boreholes and including results from recent geophysical surveys) from engineering projects together with a re-evaluation of the data collected during the original field survey. Other published maps and related publications will also be updated where necessary, including the 1:100,000-scale geological maps covering the whole of the HKSAR. The objective of the map updating project is to

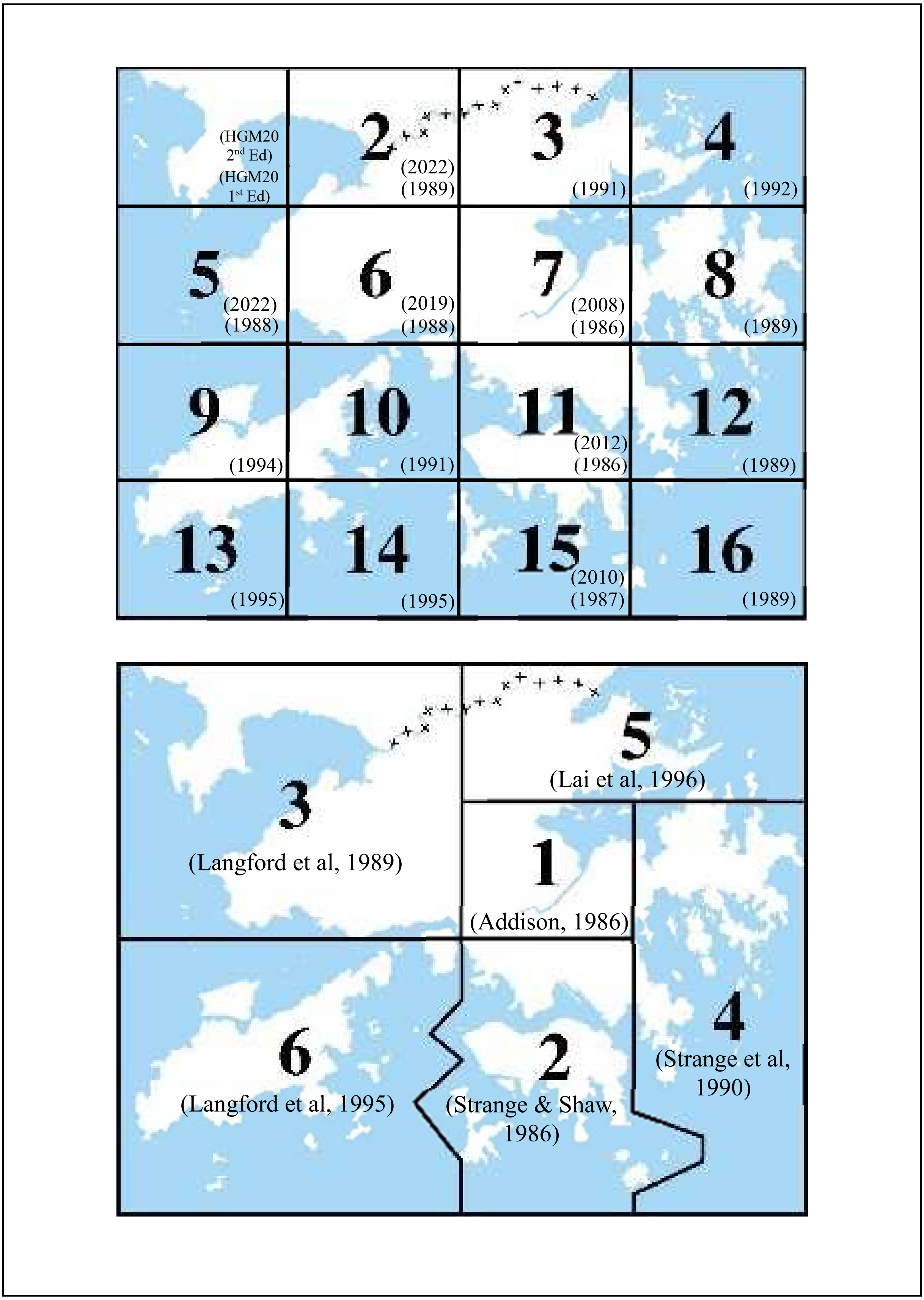


Figure 1.1 Published HKGS 1:20,000-scale Geological Maps (Series HGM20 Editions I and II) and Geological Memoirs, with Year of Publication

Table 1.1 Revised 1:20,000-scale HKGS Geological Map Updating Programme

Sheet No.	Name	Period of Survey (Onshore* and Offshore#)	Year of Publication of First Edition Map (Solid^)	Priority for Revision	Year of Publication of Updated Map
7	Sha Tin	1983-84* #	1986	High	2008
15	Hong Kong South & Lamma Island	1985-86* 1986#	1987	High (north) Low (south)	2010
11	Hong Kong & Kowloon	1984-85* 1985#	1986	High	2012
6	Yuen Long	1984-87* 1986-87#	1988	High	2019
2	San Tin	1985-86* 1986-87#	1989, 1994^	High	2022
5	Tsing Shan (Castle Peak)	1984-86* 1986-87#	1988	High	2023
9	Tung Chung	1989-92* 1991-92#	1994	High	(In progress, anticipate in 2025)
10	Silver Mine Bay	1985-89* 1990#	1991	High	(In progress, anticipate in 2026)
3	Sheung Shui	1988-89* 1989-90#	1991	Medium	
12	Clear Water Bay	1986-87* 1988#	1989	Medium	
8	Sai Kung	1986-88* 1988#	1989	Medium	
13	Shek Pik	1992* #	1995	Low	
14	Cheung Chau	1985-89* 1990-93#	1995	Low	
16	Waglan Island	1983-84* 1988-89#	1989	Low	
4	Kat O Chau	1989-90* 1989-92#	1992	Low	

produce up-to-date, on-demand geological reports and maps, including legends, cross-sections and explanatory notes. Readers are recommended to refer to Langford et al (1989) and Sewell et al (2000) for full descriptions and previous interpretations of the geology of Sheet 5.

2 Methodology

The original 1:20,000-scale geological maps relied heavily on conventional cartographic methods for publication, and paper maps were printed for distribution. In line with modern trends in map production, the updated 1:20,000-scale geological maps are being implemented on a GIS platform using a standard GIS template. The primary software is ArcGIS® Desktop Advanced (formerly ArcInfo® and ARC/INFO®). Multiple layers of geological information (Appendix A) are being developed within a whole-territory geodatabase that forms the basis of the data storage and retrieval system.

The updated geological maps will be published and disseminated as GIS publications in ArcReader (or equivalent) format making them accessible to the public, and useful to engineers and town planners. Geological datasets that have been used for updating Sheet 5 represent available information up to 2022. The whole-territory geodatabase will be updated regularly, and new editions of the digital geological maps will be released from time to time. The procedures, standards and specifications for the HKGS digital geological maps, data model and geodatabase scheme diagram are contained in a separate internal report.

3 Data Sources

The primary data sources for updating Sheet 5 have included 4,229 existing ground investigation stations, 1,236 rock samples, 440 rock thin sections, records of field notes, sketches and photographs, structural measurements and analyses. The ground investigation stations, which are contained in the Geotechnical Information Unit (GIU) of the Civil Engineering Library, exclude duplicated data, field and laboratory testing data, and data from trial pits, trenches and shallow excavations (Figure 3.1). Key boreholes that reveal important geological features, structures or contact relationships in Sheet 5 area are summarised in Appendix B. The other data compiled during the original field survey are contained in the HKGS archive. In addition, whole-rock geochemical analyses (Sewell & Campbell, 2001b), absolute age data (Sewell & Campbell, 2001a), detrital zircon age data (Sewell et al, 2016, 2017), stream sediment geochemical analyses (Sewell, 1999, 2008), seismic lines and selected scanned traces (Cheung & Shaw, 1993, HKGS archive) have also been added to the geodatabase. Gravity and magnetic survey data used in the map update have principally come from onshore and offshore surveys conducted by Electronic & Geophysical Services Ltd. (EGS, 1991, 1993) and the summary by Sewell et al (2000). All these records above have been compiled and are accessible within the geodatabase (Table A2 in Appendix A).

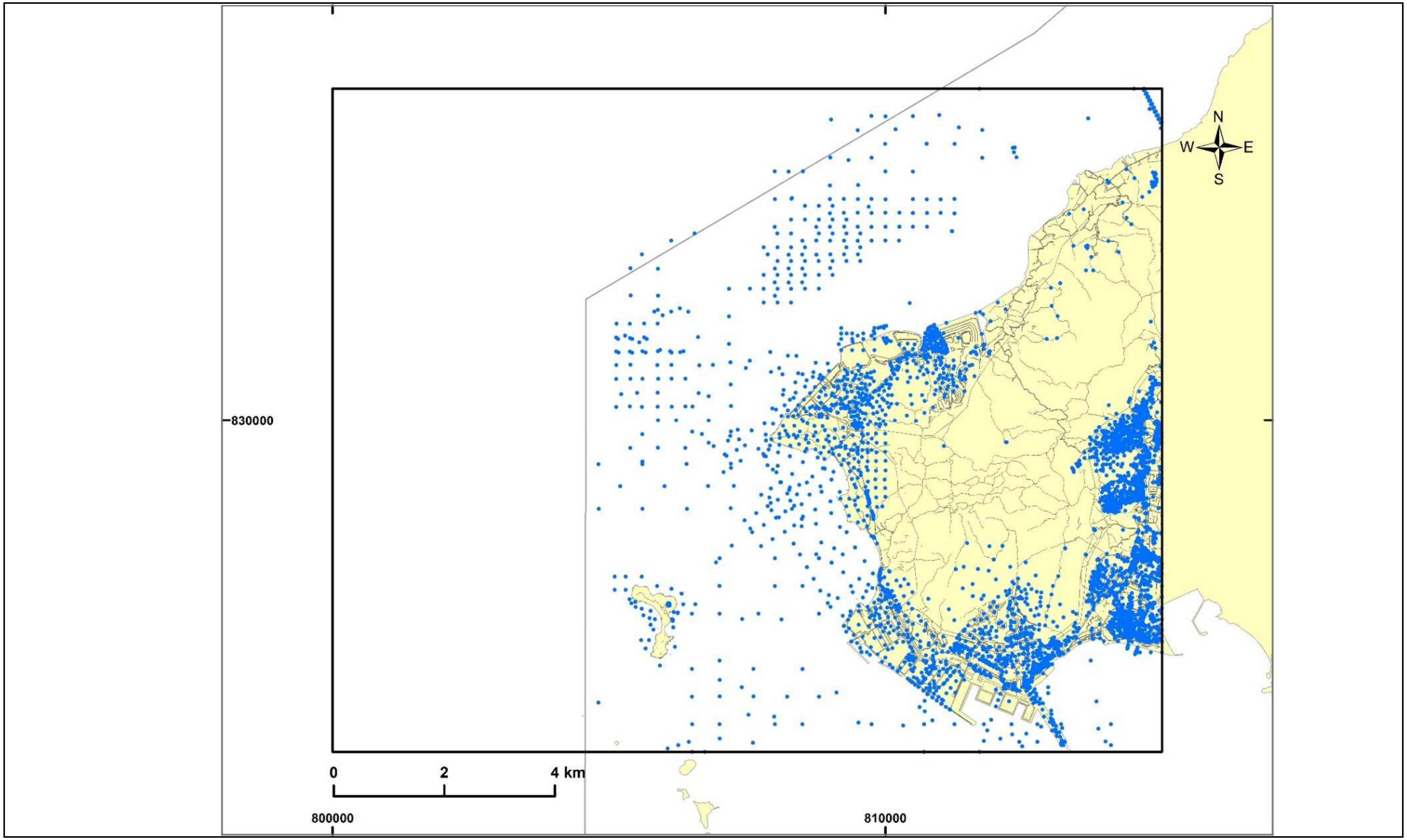


Figure 3.1   Distribution of Interpreted Ground Investigation Data for the Updating of Sheet 5

4 Major Findings and Revisions

4.1 Nomenclature of Stratigraphic and Intrusive Units

The first edition of the HKGS 1:20,000-scale geological maps (GCO, 1986a, 1986b, 1987, 1988a, 1988b, 1989a, 1989b, 1989c, 1989d, 1991; GEO, 1991, 1992, 1994a, 1994b, 1995a, 1995b) assigned volcanic, sedimentary and metamorphic rocks to lithostratigraphic formations, whereas intrusive rocks were classified primarily on the basis of grain size and composition. Subsequent detailed petrographic, geochemical and geochronological analyses of the mapped units enabled a formation- and pluton-based nomenclature, which has been adopted for the major extrusive and intrusive units depicted on the 1:100,000-scale geological map (Sewell et al, 2000). On the updated 1:20,000-scale geological maps (GEO, 2008, 2010, 2012, 2019; 2022), formation/member/pluton names, together with rock type descriptors indicating dominant lithologies when necessary, have been assigned to all geological units. As a result, several inconsistencies among the original 1:20,000-scale maps are now rectified, and the nomenclature is brought in line with the 1:100,000-scale geological map.

The stratigraphy of sedimentary and volcanic formations on the updated Sheet 5 has been reviewed and updated based on the latest nomenclatures adopted by Sewell et al (2000) and So & Sewell (2019) (Figure 4.1). The key updates of the geological units include: revision of the Tuen Mun Formation, which has combined the originally-mapped Tsing Shan and Tuen Mun formations; identification of the offshore subcrops of the Kat O Formation and Deep Bay Granite in Deep Bay; and the inference of an undifferentiated granite subcrop to the west of the Deep Bay Fault. Details of these revisions are discussed in the following sections.

Age	Group	Formation	Member	Principal Lithologies	Thickness (m)
Cretaceous	-	Kat O	-	Breccia, conglomerate, sandstone	?100
(non-conformity on intrusive rocks)					
(no contact with Kat O Formation)					
Middle Jurassic	-	Tuen Mun	#Tuen Mun Andesite	Andesite lava, autobreccia, coarse ash crystal tuff and tuffaceous sedimentary rocks	?1000
			#Siu Hang Tsuen	Tuffaceous and epiclastic sedimentary rocks	> 1100

Legend:

Conformable contact

Unconformable contact

Note: # Tuen Mun Andesite and Siu Hang Tsuen members are essentially contemporaneous.

Figure 4.1 Generalised Stratigraphy of the Updated Sheet 5

4.2 Tuen Mun Formation

On the first edition of the 1:20,000-scale geological map Sheet 5, two Upper Jurassic formations, i.e. the Tsing Shan and Tuen Mun formations, were mapped along the foothill of Tsing Shan (GCO, 1988b; Langford et al, 1989). Later, Sewell et al (2000) proposed to combine these two formations into a single lithostratigraphic unit, the redefined Tuen Mun Formation, which was considered to be Middle Jurassic in age. The lower part of the formation comprises a predominantly epiclastic and volcaniclastic sequence and the upper part comprises a sequence of andesite lavas with minor crystal tuffs and volcanic breccias (Sewell et al, 2000).

Darigo (1990) reported the presence of a member unit in the Tuen Mun Formation, i.e. the Tin Shui Wai Member, which occurred as subcrops in the eastern and central parts of the Tuen Mun valley. The unit was described as an interbedded sequence of volcaniclastic rocks, dominated by breccia and/or conglomeratic layers (50-70%) that contain lithic clasts of mostly marble, quartzite, meta-siltstone and andesitic tuff (Darigo, 1990; Frost, 1992). The origin and stratigraphy of the marble-clast bearing tuffaceous layers had been heatedly debated (e.g. Lai et al, 2004; Tang, 2007; Lai & Chan, 2012; Sewell et al, 2017).

Based on a comprehensive stratigraphic review of the northwestern New Territories (Sewell et al, 2017; So & Sewell, 2019), the Tuen Mun Formation is now considered to be consisting of three members, namely the Tuen Mun Andesite, Siu Hang Tsuen and Tin Shui Wai members, representing the proximal to distal facies in an andesitic volcanic massif. The maximum depositional age of the formation has been constrained by detrital zircon dating at ~ 170 Ma, i.e. Middle Jurassic (Sewell et al, 2017). Detailed stratigraphic descriptions of the three members from key boreholes within the Tuen Mun Valley are given in Sewell et al (2017). Notably, Sewell et al (2017) and So & Sewell (2019) both inferred the relative chrono-stratigraphic positions of the three members, viz. the Tuen Mun Andesite Member being the youngest, and the Tin Shui Wai Member being the oldest. However, it is probably more appropriate to consider that these members were contemporaneous, deposited side-by-side, and locally intercalated.

On the updated Sheet 5, only the Tuen Mun Andesite and Siu Hang Tsuen members are identified. At the Tsing Shan foothill area and underneath much of the southern part of the Tuen Mun Valley, the volcanic sequence comprises andesite lava, lapilli-bearing crystal tuff, autobreccia, with subordinate tuffaceous sediments. A sliver of similar volcanic lithologies is also sandwiched between two branches of a N-S-trending fault near Siu Lang Shui (810950E, 826700N). These sequences, which were mapped originally as the undifferentiated Tuen Mun Formation on the original Sheet 5, are now assigned to the Tuen Mun Andesite Member (Jua) on the updated map. Near Wo Tin Estate (814800E, 830700N) and nearby areas, a notable sequence of massive to thickly-bedded pyroclastic breccia, which contains subangular, bomb to lapilli-sized andesitic lithic clasts, is present (e.g. drillhole nos. 67335/BH3; 66529/S1-AD6; Figure 4.2a) and is mapped as a distinct layer within the Tuen Mun Andesite Member.

The predominantly volcaniclastic layers, which comprise tuffaceous to epiclastic, polymictic conglomerate, sandstone and siltstone, exposed to the west of Por Lo Shan (813650E, 829000N), Tsing Shan Monastery (813850E, 828050N) and eastern part of Tsing Shan (813800E, 827700N) are now assigned to the Siu Hang Tsuen Member (Jus). Individual conglomerate beds of the member are mapped explicitly, as on the originally Sheet 5. The volcaniclastic rocks are locally intercalated with tuff and intruded by andesite dykes, forming subordinate andesite peperites (c.f. Sewell et al, 2017; e.g. drillhole nos. 8696/73806/1973D & 1983D; Figure 4.2b).

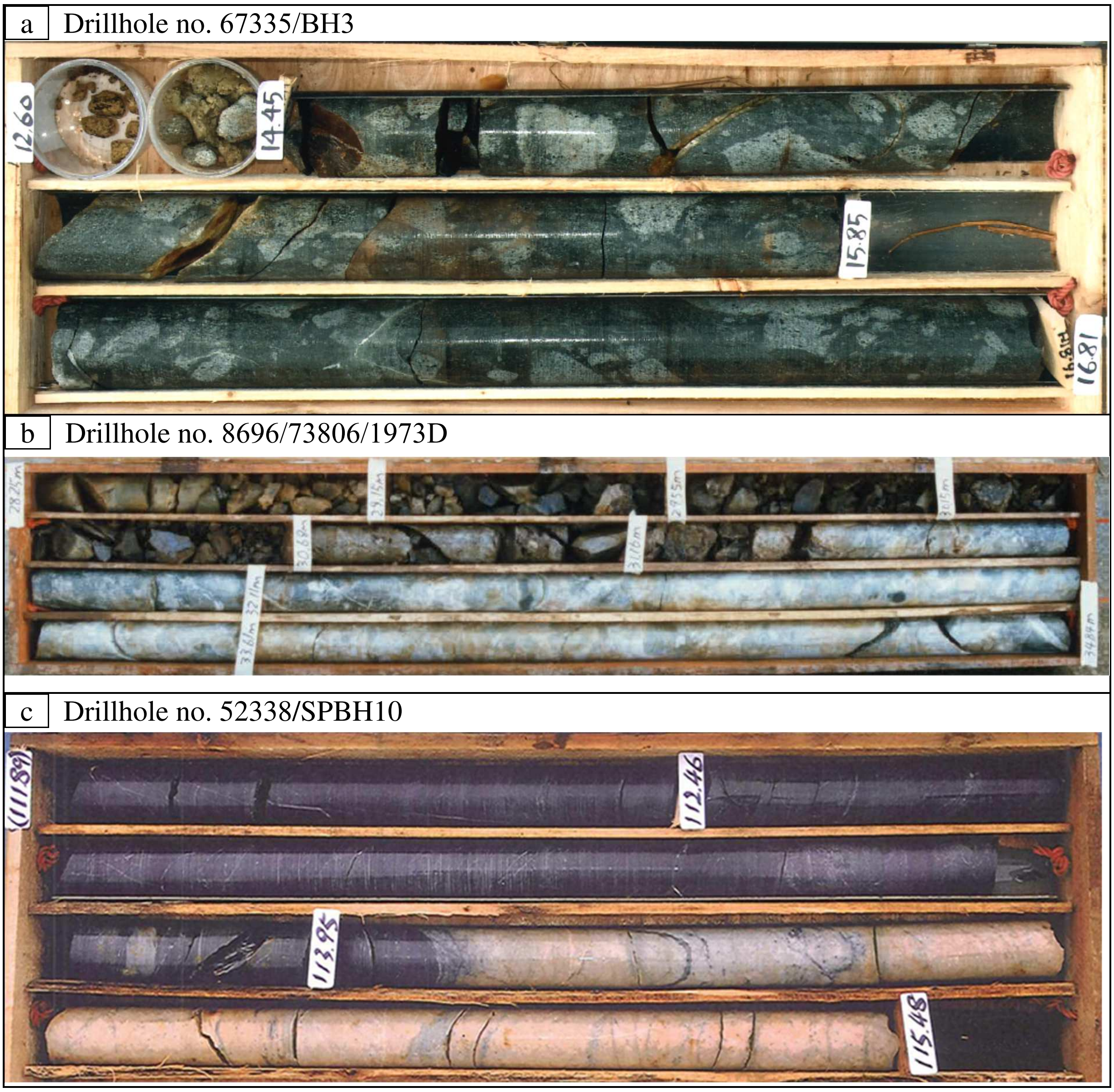


Figure 4.2 a) Massive Pyroclastic Breccia in the Tuen Mun Andesite Member (Drillhole no. 67335/BH3; 814905E, 831279N); b) Tuffaceous, Polymictic, Marble Clast-bearing Conglomerate in the Siu Hang Tsuen Member (Drillhole no. 8696/73806/1973D; 813863E, 827301N); c) Intrusive Contact between Tuffaceous (?) Siltstone and Tsing Shan Granite (Drillhole no. 52338/SPBH10; 813391E, 826534N)

Sewell et al (2000) described that the Tuen Mun Formation was a fault-bounded, tectonically-emplaced block, and in fault contact with the Tsing Shan Granite to the west, and the Tai Lam Granite to the east. However, an intrusive contact between the Tsing Shan

Granite and the volcaniclastic rocks (the then "Tsing Shan Formation") was also mapped locally along the Tsing Shan foothill area (813400E, 828500N) on the original Sheet 5 (GCO, 1988b). Further evidence of a partially intrusive nature of the contact is observed from a number of drillholes (e.g. 12699/BH310, 12699/BH311, 52338/SPBH10; Figures 4.2c & 4.3) during the review under the current map updating exercise. In addition, the Tuen Mun Formation is locally strongly foliated and hydrothermally altered (Langford et al, 1989; Sewell et al, 2000). The extent of metamorphism has been updated on Sheet 5, based on the findings from the review of existing drillholes.

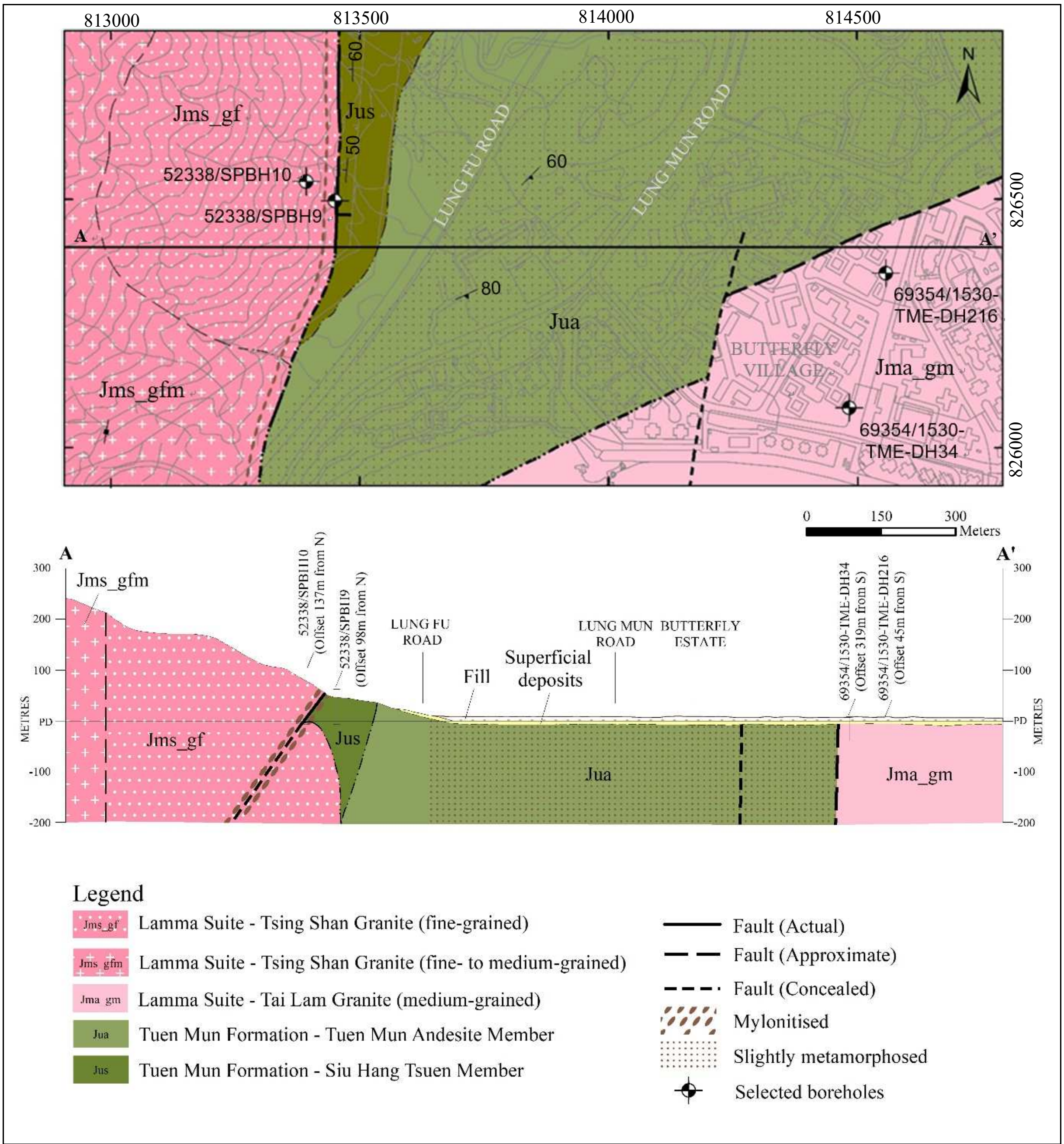


Figure 4.3 Cross-Section of the Sheared, Intrusive Contact between Tsing Shan Granite and Tuen Mun Formation near Butterfly Beach. Top: Extract of Solid Geology Map; Bottom: Cross Section A-A'

Langford et al (1989) observed the presence of cross-beddings and fining-upward sequences in the strata at the Tsing Shan foothill area (i.e. the then "Tsing Shan Formation"). They proposed that the steeply-inclined strata were locally overturned and/or folded and younger towards the east. Furthermore, the stratigraphic column of the redefined Tuen Mun Formation in Sewell et al (2000) has also hinted that the sequence was younger towards the east. If the strata of the Siu Hang Tsuen Member are overturned at the Tsing Shan foothill area, it is conceivable that the entire Tuen Mun Formation might be folded. However, because most of the formation are concealed under the Tuen Mun Valley and are affected by faulting and shearing, any stratigraphic evidence is obscured. Therefore, there is no direct evidence to support that the Tuen Mun Formation is folded as a whole.

As an alternative interpretation to the observed structural features, some tuffaceous strata of the Siu Hang Tsuen Member might have originally deposited in intra-formational channels, and dipped at a shallow to moderate angle to the overall volcanic sequence. Moderate tilting of these strata could have resulted in the observed steeply-inclined and even locally overturned layers in the member. If this was the case, wholesale folding of the Tuen Mun Formation would not be essential. Nonetheless, the minor anticlines and synclines, which were originally mapped in the eastern part of Tsing Shan, are retained on the updated Sheet 5 to illustrate the structural observations.

4.3 Kat O Formation (Ko)

The Kat O Formation, comprising predominantly brownish red, thickly-bedded, poorly- to semi-sorted, granite clast-bearing breccia and sandstone in the district, is mapped as offshore subcrops in the northeastern corner on the updated Sheet 5. The unit, which was recovered in some offshore drillholes for the Kong Sham Western Highway (formerly Shenzhen Western Corridor) project, was found resting non-conformably on top of coarse-grained granite (undifferentiated) in the offshore area (Tse & Tang, 2022). The sedimentary sequence is interpreted to be bounded to the southeast by the NE-trending Deep Bay Fault (c.f. Tse & Tang, 2022).

An isolated offshore drillhole (no. 19102/ODB/4; 807169E, 831378N), located further to the southwest in Deep Bay, has recovered similar redbeds, i.e. poorly-sorted, purplish red, conglomerate and sandstone (Figure 4.4). The extent of the redbeds there is highly uncertain, but most probably only a small subcrop of the redbeds is present based on the drillhole data in the surrounding area.

Figure 4.4 Poorly-sorted, Purplish Red, Conglomerate and Sandstone Encountered in an Offshore Drillhole (no. 19102/ODB/4; 807169E, 831378N) in Deep Bay

4.4 Key Updates on Intrusive Units

4.4.1 Triassic Deep Bay Granite (Td)

The occurrence of a Triassic granite, viz. the Deep Bay Granite (zircon U-Pb age of <236.3 ± 0.8 Ma), in the Deep Bay area was first identified by Davis et al (1997). Sewell et al (2000) described the granite pluton as a weakly-deformed, fine- to medium-grained two-mica leucogranite that lies to the west of the Deep Bay Fault. On the updated Sheet 5, the extent of the Deep Bay Granite has been reviewed and inferred from the existing drillhole data (e.g. drillhole no. 19102/DB-03; Figure 4.5). The geological contacts of the Triassic Deep Bay Granite with other units in the district remain obscured. The granite is likely to be intruded by the undifferentiated granite that is bounded by the Deep Bay Fault (see Section 4.5.1).

To the west of Deep Bay, the Jianfengshan Granite (~223.5 Ma), which yielded a broadly comparable age to the Deep Bay Granite, is reported to be exposed in the eastern part of Neilingding Island (CGSD, 2009). Further to the west, however, no granite of similar age or composition have been identified in Macau based on the findings of recent geochronological and geochemical analyses (Quelhas et al, 2020).

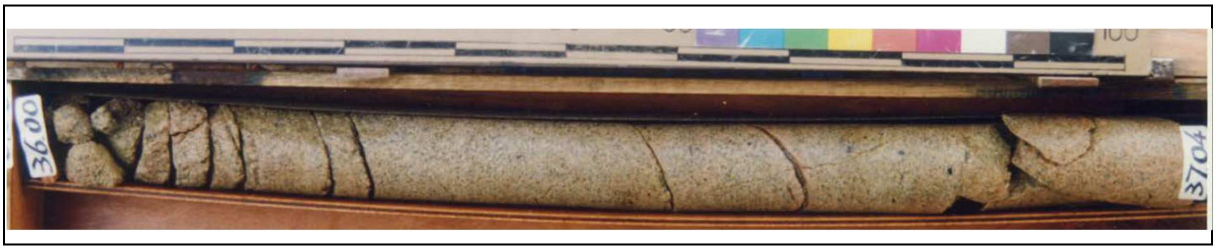


Figure 4.5 The Triassic Deep Bay Granite Encountered in an Offshore Drillhole (no. 19102/DB-3; 807795E, 832629N) in Deep Bay

4.4.2 Middle Jurassic Lamma Suite

On the published 1:100,000-scale geological map, the granites in the district have been divided into two intrusive units, i.e. the Tsing Shan Granite (Jms; zircon U-Pb age <159.6 ± 0.5 Ma; Davis et al, 1997) and Tai Lam Granite (Jma; zircon U-Pb age 159.3 ± 0.3 Ma; Davis et al, 1997), both are assigned to the Middle Jurassic Lamma Suite (Sewell et al, 2000).

On the updated Sheet 5, the Tsing Shan Granite comprises inequigranular to megacrystic, fine- to medium-grained granite and equigranular medium-grained granite that are bounded by the Deep Bay Fault to the west and the Yuen Tau Shan Fault to the east. Mylonitic foliations are common in the granite along the NE-trending faults. Evidence for an intrusive contact between the Tsing Shan Granite and the Tuen Mun Formation was reported from Sheet 5 and Sheet 6 areas (Langford et al, 1989; So & Sewell, 2019) and is confirmed under the current map updating exercise (see Section 4.2 and Figure 4.2c).

The Tai Lam Granite is mapped at the southeastern corner of the updated Sheet 5, underlying the reclaimed land near Tuen Mun Ferry Pier (814600E, 826000N) and Tsing Shan

Wan (Castle Peak Bay; 815000E, 826400N). The granite recovered from the drillholes is typically equigranular medium-grained, and the mapped extent of which is primarily based on the existing drillhole records and inference from the updated Sheet 6 (So & Sewell, 2019). The contact between the Tai Lam Granite and the Tuen Mun Formation is interpreted as essentially faulted in nature. The fault contact is evident in a number of drillholes (e.g. 35752/P330-DH2, 69354/1530-TME-DH34 & DH216), from which highly-fractured to brecciated, chloritised granite and/or volcanic rocks were recovered. In some drillholes (e.g. 69354/1530-TME-DH33(P) & EDH114), however, the granite appears to have intruded the volcanic rocks. The contact with the Tsing Shan Granite, which lies in the offshore area, is largely uncertain, but is also interpreted as an inferred fault.

4.4.3 Undifferentiated Granite

Tse & Tang (2022) reported the presence of an undifferentiated porphyritic coarse-grained granite to the northern side of the Deep Bay Fault on the updated geological map Sheet 2. The undifferentiated granite is inferred to be present as subcrops bounded by the Deep Bay Fault on the updated Sheet 5. The granite is typically coarse-grained, with occasional medium-grained variants, and displays a distinct orangish to reddish colour due to the presence of abundant K-feldspar phenocrysts and/or possibly potassic alteration (Tse & Tang, 2022; e.g. drillhole no. 19102/ODB-11; Figure 4.6a). Along the Deep Bay Fault, the granite is sheared and chloritised (e.g. drillhole nos. 19102/ODB-6; Figure 4.6b). Further investigation is needed to confirm the age and the potential correlation of the undifferentiated granite.

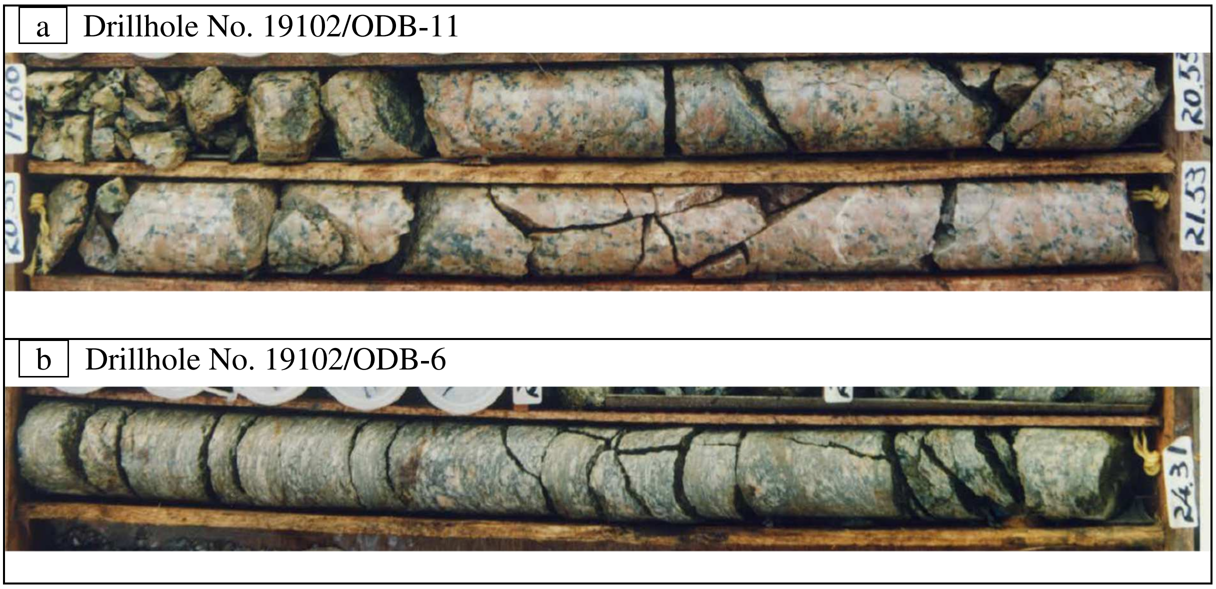


Figure 4.6 Undifferentiated Granite Encountered in Offshore Drillholes in Deep Bay; a) Orangish Pink, Coarse-grained Granite with Possible Potassic Alteration (Drillhole no. 19102/ODB-11; 806799E, 830439N); b) Sheared and Chloritised Granite Found along the Deep Bay Fault (Drillhole no. 19102/ODB-6; 807198E, 830645N)

4.4.4 Felsic and Mafic Dykes (Undifferentiated)

A swarm of ENE-trending quartzphyric rhyolite dykes, intruding the Tsing Shan Granite near Siu Lang Shui (811000E, 825800N) and the volcanic rocks near San Shek Wan San Tsuen (813800E, 826800N), was mapped on the original Sheet 5. Sewell et al (2000) proposed that these dykes formed part of the Chek Mun Rhyolite dyke swarm that cuts across volcanic rocks of the Tsuen Wan Volcanic Group, Tai Po Granodiorite and pre-volcanic sedimentary rocks in the New Territories. A sample of the Chek Mun Rhyolite, collected from outside the Sheet 5 area, has yielded zircon U-Pb age of 160.8 ± 0.2 Ma (Sewell et al, 2012). Based on the published geochronological data, it is considered that the quartzphyric rhyolite dyke swarm, which cuts, and must be younger than, the Tsing Shan Granite (<159.6 ± 0.5 Ma; Davis et al, 1997), cannot be part of the Chek Mun Rhyolite. Therefore, these dykes are shown as undifferentiated on the updated Sheet 5. Similarly, other minor felsic and mafic dykes are not assigned to any specific unit, as there is a lack of geochronological or other geological evidence. These undifferentiated dykes are interpreted as broadly Late Jurassic to Early Cretaceous in age.

4.5 Major Faults

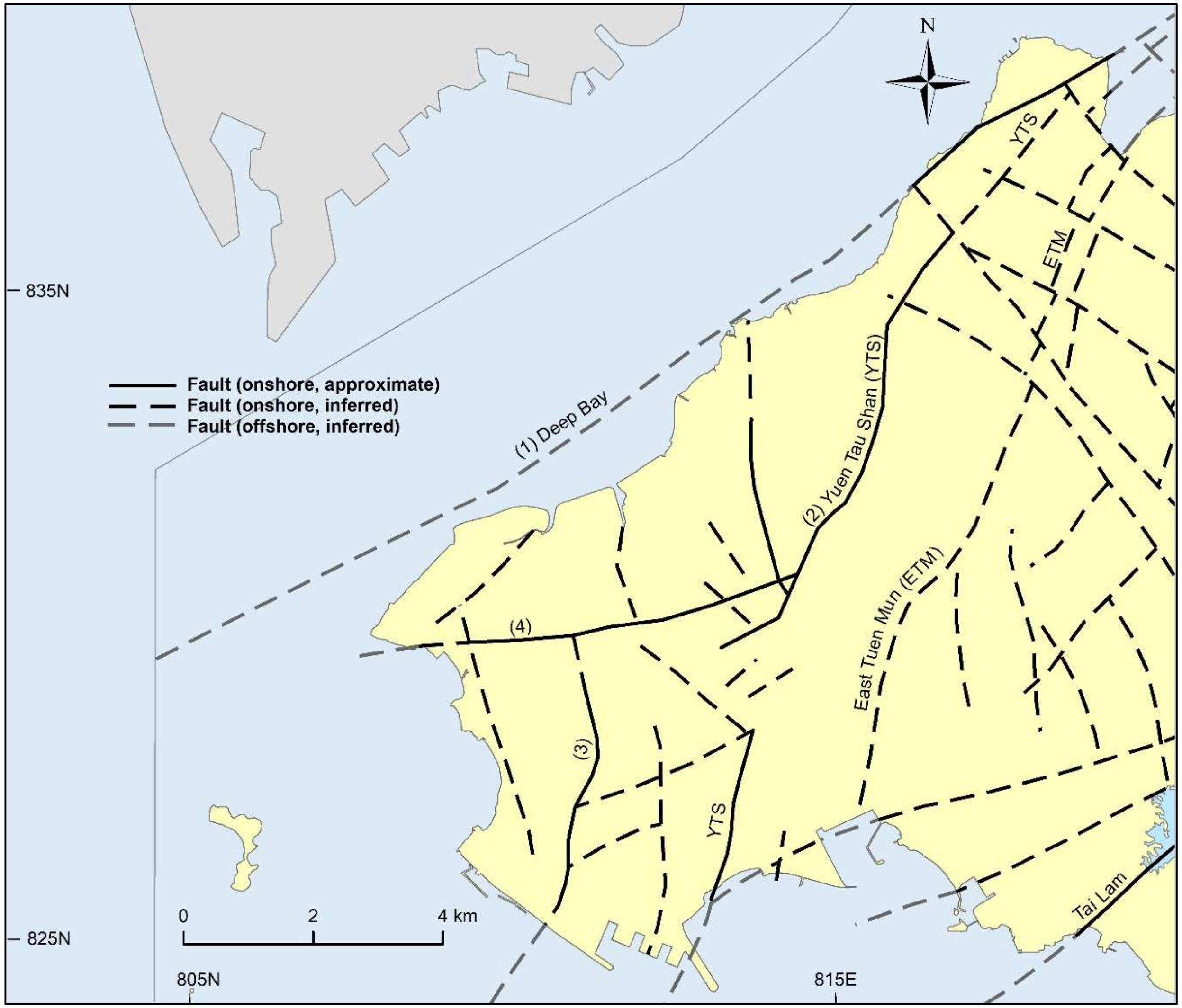
Under the current update, the geological structures, including faults and shear zones, in the Sheet 5 and adjacent area have been reviewed. The major faults in the district include the Deep Bay Fault, Yuen Tau Shan Fault, an unnamed N-S-trending fault near Siu Lang Shui and an unnamed ENE-trending fault in the southern part of the Sheet 5 area (Figure 4.7). The key observations are summarised below.

4.5.1 Deep Bay Fault

On Sheet 5, the NE-trending Deep Bay Fault (renamed from the Lau Fau Shan Fault after Sewell et al, 2000) lies entirely offshore and is not exposed in the district (Figure 4.7). Its alignment on the updated Sheet 5 is essentially inferred from its extension from Sheet 2, the interpreted boundaries of various granites and the Kat O Formation, and the presence of sheared rocks, fault materials and/or silicified rocks, encountered in isolated offshore drillholes (e.g. no. 19102/ODB-6). The inferred fault is considered to be separating the Tsing Shan Granite (Jms) to the southeast, and the Triassic Deep Bay Granite (Td), undifferentiated granite (Ku) and Kat O Formation (Ko) to the northwest.

4.5.2 Yuen Tau Shan Fault

The Yuen Tau Shan Fault, also known as the "Tsing Shan Fault" (Lai & Langford, 1996) and the "Tuen Mun Fault" (Sewell et al, 2000), is a reverse fault between the Tsing Shan Granite and Tuen Mun Formation (Figure 4.7). Its southern segment is NNE-trending (010-020°) and dips at 40-50° W; whereas the northern segment is NE-trending (050-055°) and dips at 50-67° NW (Lai & Langford, 1996). The fault is characterised by a 20-30 m-wide mylonitised and shear zone that coincides with the geological contact (Lai & Langford, 1996; So & Sewell, 2019; drillhole nos. 52338/SPBH9 & SPBH10). All of these geological features are delineated on the updated Sheet 5.



Major faults described in Section 4.5:

(1) Deep Bay Fault
(2) Yuen Tau Shan Fault
(3) Unnamed N-S-trending fault
(4) Unnamed ENE-trending fault

Figure 4.7 Major Faults in the Western New Territories (Modified from So & Sewell, 2019; Tse & Tang, 2022)

4.5.3 Unnamed N-S-trending Faults

Several unnamed N-S-trending faults are inferred cutting across the Tsing Shan Granite and produce some prominent valleys in the western side of the Tsing Shan range. One particular unnamed N-S-trending fault extends from the north of Tai Lang Shui (811100E, 829200N), braches off close to Siu Lang Shui (811000E, 826800N), and are then re-joined near Eco Park (810700E, 825300N) (Figure 4.7; fault numbered ‘3’). A sliver of volcanic rocks of the Tuen Mun Formation is sandwiched between the bifurcated faults. Fault materials, including fault gouge, mylonitic/sheared granites and volcanic rocks, were recovered from the existing drillholes (e.g. nos. 68321/BH13 & BH14) located along the fault near Eco Park. The offshore extent of this fault, however, is uncertain.

4.5.4 Unnamed ENE-trending Faults

In the southern part of Sheet 5, an unnamed ENE-trending fault is inferred to form a sharp boundary dissecting the Tai Lam Granite and the Tuen Mun Formation underneath the reclaimed land near Tuen Mun Area 44 (814800E, 826500N) and in the nearshore area of Butterfly Beach (813600E, 825900N). Evidence from the existing drillholes has suggested that the fault is offset by an inferred NNE-trending structure near Butterfly Estate (814200E, 826300N). In addition, the fault is characterised by highly-fractured to brecciated, chloritised granite and volcanic rocks. The fault might represent one of the branches of the Tai Lam Fault extending from So Kwun Wat on Sheet 6 (So & Sewell, 2019).

Other unnamed, ENE- to NE-trending trending faults, and the associated quartz veins and dykes, are mapped or inferred to be cutting the Tsing Shan Granite. The most prominent ENE-trending fault on Sheet 5 extends from the hillslope above Kwong Shan Tsuen (814200E, 830600N) to Lung Kwu Sheung Tan (809500E, 829500N) (Figure 4.7; fault numbered ‘4’). These structures and shear zones might have controlled the development of drainage valleys and badlands in the Tsing Shan range area.

4.6 Metamorphism

Metamorphism is prevalent in all lithologies in the district, which is generally considered to be a part of a broad thermal-dynamic metamorphic belt in the northwest New Territories (i.e. the Lo Wu-Tuen Mun Fault (Fold) Belt; Langford et al, 1989; Sewell et al, 2000). On the original Sheet 5, metamorphic rocks that display schistose foliations were depicted as either “schist” or “mylonite”, without providing a clear distinction between the two rock types. Considering that dynamic metamorphism is the primary cause of the development of schistose foliations in rocks in the district, these foliated rocks are unified and named as ‘mylonite’ on the updated map. The development of metamorphic foliations in the granites are associated with numerous quartz veins or dykes and silicification. For the Tuen Mun Formation, the volcanic rocks are commonly foliated and contain secondary mineralisations, including epidotisation, chloritisation and sericitisation. Skarn mineralisation is also evident in some marble clast-bearing tuffaceous conglomerate.

4.7 Superficial Geology

The Holocene alluvium has now been assigned to the Fanling Formation, while the Pleistocene alluvium and debris flow deposits have been assigned to the Chek Lap Kok Formation, according to the classification proposed by Fyfe et al (2000). However, on the updated Sheet 5, the Pleistocene and Holocene debris flow deposits remain as an undifferentiated unit as their age is undetermined. The Holocene “estuarine deposits” and “marine sand” originally mapped along the nearshore region have now been combined into “intertidal deposits” within the Hang Hau Formation. Raised beach deposits have been reclassified as back shore deposits based on the recommendations of Wong & Shaw (2009).

The thickness of the Hang Hau Formation and the total thickness of the offshore Quaternary superficial deposits have now been re-interpreted based on available marine seismic survey profiles and offshore borehole data, and are shown as isopachs on the updated Sheet 5. It is noteworthy that the seabeds within the former gazetted offshore dredging and sediment disposal areas in Deep Bay and Urmston Road have been largely modified. The isopachs shown on the updated Sheet 5 only reflect the original status of the offshore sediments before the disturbance by dredging and sediment disposal.

The extents of reclamation lands at Pillar Point, Tuen Mun Area 38 Fill Bank, Black Point, and PFA Lagoon near Ha Pak Lai, as well as the West New Territories (WENT) Landfill are delineated based on aerial photograph interpretation, borehole records and engineering records. The types of fill are categorised in the geodatabase, with years indicating the reclamation history are shown on the revised Sheet 5.

5 Conclusion

The 1:20,000-scale geological map Sheet 5 is the sixth map updated under the map updating project carried out by the Hong Kong Geological Survey. Both the updated solid and superficial geology map (Series HGM20 Edition II) and the new solid geology map (Series HGM20S Edition I) will be available in digital version. The key findings and revisions are summarised below:

(i) The stratigraphy of the Tuen Mun Formation, which includes the previously-mapped Tsing Shan and Tuen Mun formations, has been reviewed and revised with reference to the recommendations of Sewell et al (2017). The distribution of two member units of the formation, viz. the Tuen Mun Andesite and Siu Hang Tsuen members have been differentiated and mapped on the updated Sheet 5. In addition, individual beds of volcaniclastic conglomerates of the Siu Hang Tsuen Member, as well as the pyroclastic breccia sequence of the Tuen Mun Andesite Member, are mapped explicitly on the updated map.

(ii) The presence of Cretaceous redbeds of the Kat O Formation in the Deep Bay area has been revealed from the existing drillhole data. The formation is inferred to have formed two separated small offshore subcrops in Deep Bay in Sheet 5, and have a non-conformable contact with the underlying coarse-grained granite (undifferentiated).

(iii) The extent of the offshore subcrop of the Triassic Deep Bay Granite (zircon U-Pb age of <236.3 ± 0.8 Ma; Davis et al, 1997) has been reviewed based on drillhole data. It is inferred that the Deep Bay Granite is intruded by an undifferentiated porphyritic coarse-grained granite, which lies to the northern side of the Deep Bay Fault.

(iv) The major faults in the district include the Deep Bay Fault, Yuen Tau Shan Fault, an unnamed N-S-trending fault near Siu Lang Shui and an unnamed ENE-trending fault in the southern part. These faults are interpreted as the bounding structures of various geological units.

6 References

Addison, R. (1986). *Geology of Sha Tin*. Hong Kong Geological Survey Memoir No. 1, Geotechnical Control Office, Hong Kong, 85 p.

Cheung, P.C.T. & Shaw, R. (1993). *SEAMAT Study: Final Report*. Geotechnical Engineering Office, Hong Kong, 163 p.

Compilation Group of Shenzhen Dizhi (CGSD). (2009). *Shenzhen Dizhi.* Geological Publishing House, Beijing, 879 p. (In Chinese)

Darigo, N.J. (1990). Marble-bearing Jurassic volcanics of the western New Territories, Hong Kong. In: R.L. Langford, A. Hansen & R. Shaw (eds.) *Karst Geology in Hong Kong*, Geological Society of Hong Kong Bulletin No. 4, pp 61-72.

Davis, D.W., Sewell, R.J. & Campbell, S.D.G. (1997). U-Pb dating of Mesozoic igneous rocks from Hong Kong. *Journal of the Geological Society,* London, vol. 154, pp 1067-1076.

Electronic and Geophysical Services Ltd. (EGS) (1991). *Regional Gravity Survey of Hong Kong (Final Report).* Job Number HK50190, Electronic and Geophysical Services Ltd., Hong Kong, 15 p.

Electronic and Geophysical Services Ltd. (EGS) (1993). *North Lantau Geophysical Survey - Gravity and Magnetic Surveys (Final Report).* Job Number HK72693, Electronic and Geophysical Services Ltd., Hong Kong, 4 volumes, 34 p.

Frost, D.V. (1992). *Geology of Yuen Long*. Hong Kong Geological Survey Sheet Report No. 1, Geotechnical Engineering Office, Hong Kong, 69 p.

Fyfe, J.A., Shaw, R., Campbell, S.D.G., Lai, K.W. & Kirk, P.A. (2000). *The Quaternary Geology of Hong Kong*. Geotechnical Engineering Office, Hong Kong, 208 p. plus 6 maps.

Geotechnical Control Office (GCO) (1986a). *Sha Tin*. Hong Kong Geological Survey Sheet 7, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Control Office (GCO) (1986b). *Hong Kong and Kowloon*. Hong Kong Geological Survey Sheet 11, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Control Office (GCO) (1987). *Hong Kong South and Lamma Island*. Hong Kong Geological Survey Sheet 15, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Control Office (GCO) (1988a). *Yuen Long*. Hong Kong Geological Survey Sheet 6, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Control Office (GCO) (1988b). *Tsing Shan (Castle Peak)*. Hong Kong Geological Survey Sheet 5, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Control Office (GCO) (1989a). *San Tin*. Hong Kong Geological Survey Sheet 2, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Control Office (GCO) (1989b). *Sai Kung*. Hong Kong Geological Survey Sheet 8, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Control Office (GCO) (1989c). *Clear Water Bay*. Hong Kong Geological Survey Sheet 12, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Control Office (GCO) (1989d). *Waglan Island*. Hong Kong Geological Survey Sheet 16, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Control Office (GCO) (1991). *Sheung Shui*. Hong Kong Geological Survey Sheet 3, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Control Office, Hong Kong.

Geotechnical Engineering Office (GEO) (1991). *Silver Mine Bay*. Hong Kong Geological Survey Sheet 10, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (1992). *Kat O Chau*. Hong Kong Geological Survey Sheet 4, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (1994a). *Tung Chung*. Hong Kong Geological Survey Sheet 9, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (1994b). *San Tin*. Hong Kong Geological Survey Sheet 2, Solid Geology, 1:20,000 Series HGM20S, Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (1995a). *Shek Pik*. Hong Kong Geological Survey Sheet 13, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (1995b). *Cheung Chau*. Hong Kong Geological Survey Sheet 14, Solid and Superficial Geology, 1:20,000 Series HGM20, Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (2008). *Sha Tin*. Hong Kong Geological Survey Sheet 7, Solid and Superficial Geology, 1:20,000 Series HGM20 (Edition II), Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (2010). *Hong Kong South and Lamma Island*. Hong Kong Geological Survey Sheet 15, Solid and Superficial Geology, 1:20,000 Series HGM20 (Edition II), Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (2012). *Hong Kong and Kowloon*. Hong Kong Geological Survey Sheet 11, Solid and Superficial Geology, 1:20,000 Series HGM20 (Edition II), Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (2019). *Yuen Long*. Hong Kong Geological Survey Sheet 6, Solid and Superficial Geology, 1:20,000 Series HGM20 (Edition II), Geotechnical Engineering Office, Hong Kong.

Geotechnical Engineering Office (GEO) (2022). *San Tin*. Hong Kong Geological Survey Sheet 2, Solid and Superficial Geology, 1:20,000 Series HGM20 (Edition II), Geotechnical Engineering Office, Hong Kong.

Lai, K.W. & Chan, S.H.M. (2012). New evidence of palaeovolcanic plugs in the Tuen Mun area, Hong Kong: Debate on the volcanic plug or reworked pyroclastic deposits. In: M. Chen (ed.) *Proceedings of the 30th Anniversary Conference of the Geological Society of Hong Kong*, The Geological Society of Hong Kong, Hong Kong, pp 69–85.

Lai, K.W. & Langford, R.L. (1996). Spatial and temporal characteristics of major faults in Hong Kong. In: R.B. Owen, R.J. Neller & K.W. Lee (eds) *Seismicity in Eastern Asia*, Geological Society of Hong Kong Bulletin No. 5, pp 72-84.

Lai, K.W., Campbell, S.D.G. & Shaw, R. (1996). *Geology of the Northeastern New Territories*. Hong Kong Geological Survey Memoir No. 5, Geotechnical Engineering Office, Hong Kong, 144 p.

Lai, K.W., Chan, H.H.K., Choy, C.S.M. & Tsang, A.L.Y. (2004). The characteristics of marble clast-bearing volcanic rock and its influence on foundation in Hong Kong. In: A.T. Yeung (ed.) *Preprints of Conference on Foundation Practice in Hong Kong*, Centre for Research and Professional Development, pp E1-10.

Langford, R.L., James, C.W.C., Shaw, R., Campbell, S.D.G., Kirk, P.A. & Sewell, R.J. (1995). *Geology of Lantau District*. Hong Kong Geological Survey Memoir No. 6, Geotechnical Engineering Office, Hong Kong Government, 173 p.

Langford, R.L., Lai, K.W., Arthurton, R.S. & Shaw, R. (1989). *Geology of the Western New Territories*. Hong Kong Geological Survey Memoir No. 3, Geotechnical Control Office, Hong Kong, 140 p.

Quelhas, P., Dias, A.A., Mata, J., Davis, D.W. & Ribeiro, M.L. (2020). High-precision geochronology of Mesozoic magmatism in Macao, Southeast China: Evidence for multistage granite emplacement. *Geoscience Frontiers*, vol. 11, pp 243-263.

Sewell, R.J. (1999). *Geochemical Atlas of Hong Kong*. Geotechnical Engineering Office, Hong Kong, 120 p.

Sewell, R.J. (2008). *Geochemical Data for Hong Kong Stream Sediments (GEO Report No. 230).* Geotechnical Engineering Office, Hong Kong, 276 p.

Sewell, R.J. & Campbell, S.D.G. (2001a). *Absolute Age-dating of Hong Kong Volcanic and Plutonic Rocks, Superficial Deposits and Faults.* GEO Report No. 118, Geotechnical Engineering Office, Hong Kong, 153 p.

Sewell, R.J. & Campbell, S.D.G. (2001b). *Geochemical Data for Hong Kong Rocks.* Geological Report No. GR 4/2001, Geotechnical Engineering Office, Hong Kong, 120 p.

Sewell, R.J., Campbell, S.D.G., Fletcher, C.J.N., Lai, K.W. & Kirk, P.A. (2000). *The Pre-Quaternary Geology of Hong Kong*. Geotechnical Engineering Office, Hong Kong, 181 p. plus 4 maps.

Sewell, R.J., Davis, D.W. & Campbell, S.D.G. (2012). High precision U–Pb zircon ages for Mesozoic igneous rocks from Hong Kong. *Journal of Asian Earth Sciences*, vol. 43, pp 164–175.

Sewell, R.J., Carter, A. & Rittner, M. (2016). *Middle Jurassic Collision of an Exotic Microcontinental Fragment: Implications for Magmatism across the Southeast China Continental Margin*. Gondwana Research, vol. 38, pp 304-312.

Sewell, R.J., So, K.W.F., Tang, D.L.K. & Carter, A. (2017). Unravelling an allochthonous, subaqueously-deposited volcanic-epiclastic to subaerial andesitic lava assemblage in Hong Kong: Age, stratigraphy and provenance studies of the Middle Jurassic Tuen Mun Formation. *Journal of the Geological Society*, London, vol. 174, pp 913-928.

So, K.W.F. & Sewell, R.J. (2019). *Updating of Hong Kong Geological Survey 1:20,000-scale Maps, Major Findings and Revisions Map Sheet 6 – Yuen Long.* Geological Report No. GR 4/2019, Geotechnical Engineering Office, Hong Kong, 58 p.

Strange, P.J. & Shaw, R. (1986). *Geology of Hong Kong Island and Kowloon*. Hong Kong Geological Survey Memoir No. 2, Geotechnical Control Office, Hong Kong, 134 p.

Strange, P.J., Shaw, R. & Addison, R. (1990). *Geology of Sai Kung and Clear Water Bay*. Hong Kong Geological Survey Memoir No. 4, Geotechnical Control Office, Hong Kong, 111 p.

Tang, D.L.K. (2007). *Geology of Tuen Mun Area, NW Hong Kong: An Updated Model*. MPhil thesis, University of Hong Kong.

Tse, T.K. & Tang, D.L.K. (2022). *Updating of Hong Kong Geological Survey 1:20,000-scale Maps, Major Findings and Revisions Map Sheet 2 – San Tin.* Geological Report No. GR 2/2022, Geotechnical Engineering Office, Hong Kong, 38 p.

Wong, J.C.F. & Shaw, R. (2009). *High-level Coastal Deposits in Hong Kong.* GEO Report No. 243, Geotechnical Engineering Office, Hong Kong, 47 p.

Appendix A

Summary of Geological Datasets

Table A1 Summary of Geological Datasets for Updated Geological Maps

Dataset	Data Type	Description	Series HGM20	Series HGM20S
Solid Geology	Polygon	Areas of solid geological units	✓	✓
Subcrop	Polygon	Areas of marble subcrop		✓
Textures	Polygon	Areas of major textural features	✓	✓
Metamorphism	Polygon	Areas of metamorphism and/or alteration	✓	✓
Metamorphic Foliation	Line	Areas of narrow bands of metamorphic foliations	✓	✓
Dykes	Line	Major dykes	✓	✓
Mineral Veins	Line	Major mineral veins	✓	✓
Solid Contacts	Line	Contact of solid geological units	✓	✓
Faults	Line	Major faults	✓	✓
Fold Axes	Line	Major fold axes	✓	✓
Structures	Point	Major structural measurements	✓	✓
Minerals	Point	Economic mineral occurrence	✓	✓
Fossils	Point	Fossil locality	✓	✓
Former Mine Adits	Point	Former mine adits and shafts	✓	✓
Superficial Deposits	Polygon	Areas of superficial geological units	✓	
Alluvial Terraces	Line	Alluvial terraces	✓	
Hang Hau Isopachs	Line	Isopachs of Hang Hau Formation	✓	
Superficial Isopachs	Line	Isopachs of offshore superficial deposits	✓	
Buried Channels	Line	Offshore channels	✓	
Fill	Polygon	Areas of reclamation and fill bodies	✓	
Seabed Features	Polygon	Areas of various seabed features, including acoustic turbidity, borrow areas and dumping grounds	✓	

Table A2 Summary of Geological Datasets in the Geodatabase

Dataset	Data Type	Description
Boreholes	Point	Locations, records and interpreted geology of selected boreholes
Rock Samples	Point	Sample locations and records of HKGS rock archive
Field Notes	Point	Records of original field notes and sketches
Field Data Maps	Polygon	Scanned images of field data maps
Field Photos	Point	Scanned field photographs
High Resolution Photos	Point	Scanned high-resolution photographs
Tunnel Geology	Line	Scanned images of tunnel data
Seismic Tracks	Line	Scanned images of seismic track plots
Marine Magnetic	Point	Measured values of marine magnetic anomalies
Gravity	Point	Measured values of gravity anomalies
WR-Geochemistry	Point	Sample locations and results of whole rock geochemical analysis
SS-Geochemistry	Point	Sample locations and results of stream sediment chemical analysis
Heavy Minerals	Point	Locations of Analysed Heavy Mineral Samples
Age Dating	Point	Sample locations and results of geochronological analysis of rock and superficial deposit

Appendix B

Summary of Key Borehole Records

Table B1 Summary of Key Borehole Records in Sheet 5 Area

GIU Reference No.	Location	Easting	Northing	Feature
19102/ODB-6	Deep Bay	807198	830645	Sheared granite; inferred location of Deep Bay Fault
19102/ODB-4	Deep Bay	807169	831378	Brownish red, conglomerate and sandstone of the Kat O Formation
67335/BH3	Hong Po Road	814905	831279	Massive pyroclastic breccia in Tuen Mun Andesite Member
66529/S1-AD6	Wo Tin Estate	814875	830676	
8696/73806/1973D	San Shek Wan North	813863	827301	Tuffaceous, polymictic, marble clast-bearing conglomerate in Siu Hang Tsuen Member
10782/2120D	Tuen Mun Area 44	814764	826036	Fault materials, inferred contact between Tuen Mun Formation and Tai Lam Granite
69354/1530-TME-DH34 69354/1530-TME-DH216	Wu King Estate	814482 814556	826079 826349	
12699/BH311	North of Hong Po Road	814859	831403	Fault and intrusive contact between Tuen Mun Formation and Tsing Shan Granite
52338/SPBH10	Tsing Shan foothill	813391	826534	
52338/SPBH9	Tsing Shan foothill	813449	826495	Fault contact between Tuen Mun Formation and Tsing Shan Granite

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