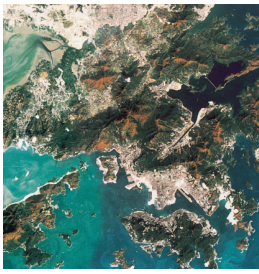
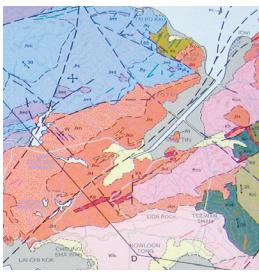
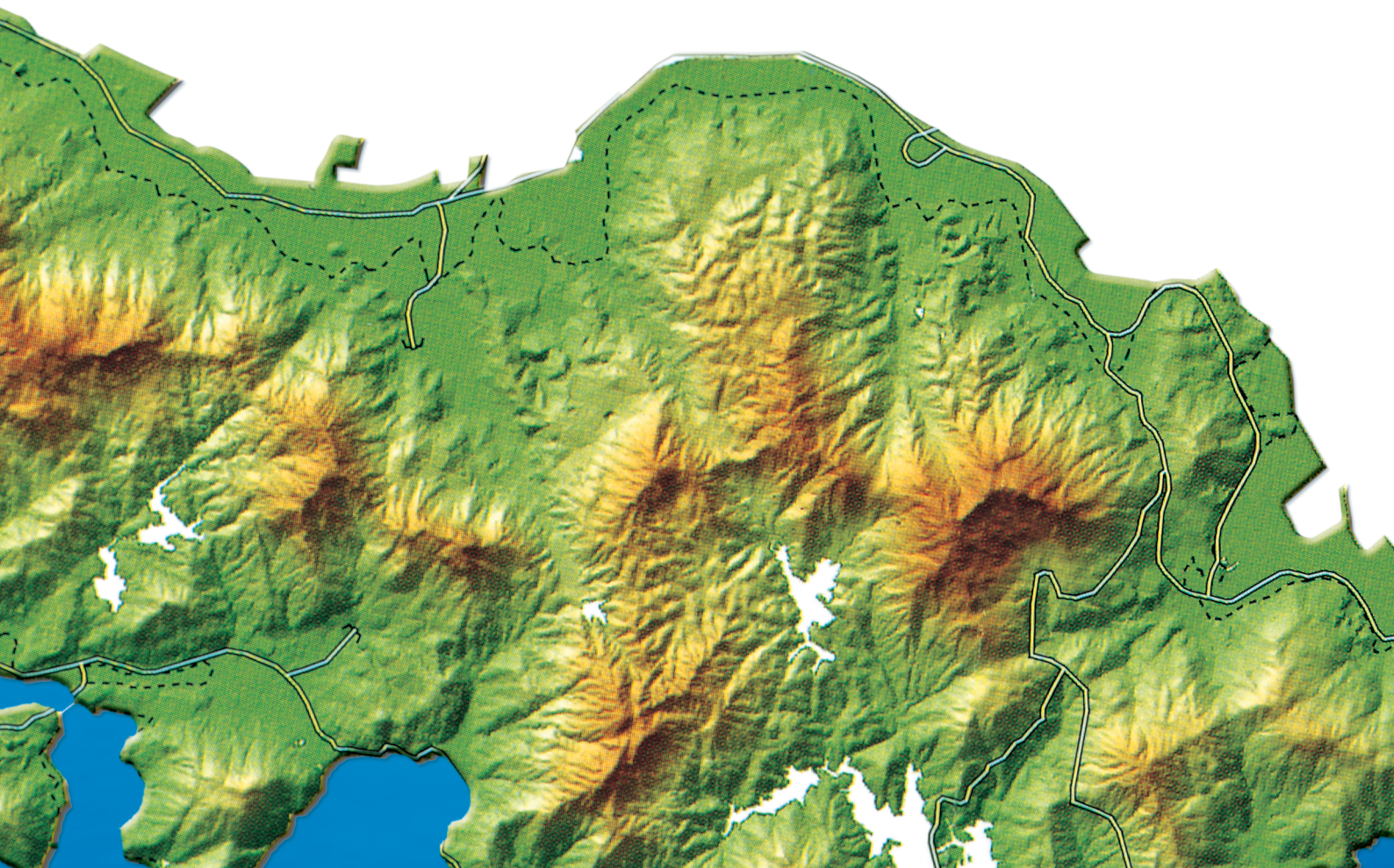
土木工程拓展署
土力工程處
Geotechnical Engineering Office
Civil Engineering and
Development Department

香港的地質圖
GEOLOGICAL MAPS OF HONG KONG

地質圖 3
GEOLOGICAL MAPS 3







前言

教育局於2005年公布，三年新高中學制將於2009年9月在中四級實施。地理科是其中一個重點的選修科目。

新高中地理科課程是根據2005年教育局出版的一份文件和課程發展議會《高中課程指引》(2007)的建議而制訂。在此課程中，地理被視為一門學科讓學生可以從空間的角度了解自身所處的地球。

土木工程拓展署轄下的土力工程處應教育局的請求，在天然災害及地球科學兩個新高中地理科課程內容上製備了一份「教學支援教材套」。其中有關香港岩石及礦物的資料亦適用於部份化學科的課程。

「教學支援教材套」包括了14本小書冊、4張海報、3片光碟及其他一些補充資料。此教材套在香港的斜坡安全、山泥傾瀉、地質及地貌等課題上提供了合適及最新的資料並同時符合新高中地理科課程的水平。

土力工程處的「香港地質調查組」負責編寫有關香港地質及地貌方面的內容，而「斜坡安全部」則負責香港斜坡安全及山泥傾瀉的部份，「斜坡安全部」的同事亦負責整個項目的策劃與安排。我謹向各位參與這項工作的同事致謝。

我相信這教材套對各位負責新高中地理科目的老師在擬備教材時能提供合適的參考。此教材套亦給予有興趣於這些課題的廣大讀者一些有用的資料。

陳健碩
土木工程拓展署
土力工程處處長
2008年12月

Foreword

In 2005, the Education Bureau (EDB) announced that a three-year New Senior Secondary (NSS) curriculum would be implemented at Secondary 4 in September 2009. Geography is one of the elective subjects under the NSS curriculum.

The NSS curriculum has been developed on the basis of the recommendations made by an EDB document in 2005 and a Senior Secondary Curriculum Guide of 2007. Within the curriculum, geography is seen as a key educational discipline that provides students with a spatial understanding of the Earth on which we live and work.

At the request of the EDB, the Geotechnical Engineering Office (GEO) of the Civil Engineering and Development Department have prepared support teaching materials for the NSS Geography curriculum under the topics of Natural Hazards and Earth Science. The materials written on rocks, minerals and ores in Hong Kong are also suitable for part of the Chemistry curriculum.

The "Teaching Support Materials Kit" consists of 14 booklets, 4 posters, 3 CDs and other supplementary information sheets. This teaching kit contains pertinent and up-to-date information on slope safety, landslides, geology and geomorphology in Hong Kong, written at a level that is suitable for the NSS Geography curriculum.

Hong Kong Geological Survey of GEO have compiled the teaching materials that describe the geology and geomorphology of Hong Kong. The Slope Safety Division of GEO have prepared the teaching materials on Hong Kong slope safety and landslides. Colleagues in the Slope Safety Division are also responsible for the overall planning and coordination of this project. Their contributions are gratefully acknowledged.

I am confident that, for years to come, secondary school geography teachers will find the kit invaluable for preparing their classroom teaching materials. The contents will also be of interest to the more general readers who may wish to learn more about these topics.

Raymond K S Chan
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December 2008

引言
Introduction

我們的地球是一個由大氣圈、水文圈、生物圈及岩石圈四個主要部份組成的動力體系。這四個部份在漫長的地球歷史中，持續互相影響。地質學為一門研究岩石圈的科學，並且包含岩石圈與其他三個部份相互作用的研究。

簡單而言，地質圖展示岩石在某地區的分佈形勢。然而，要全面了解地質圖，就必須熟悉一些地質學的基本原則，包括地層學定律、地質年代**(地質圖之一)**及地質構造。對於具經驗的人來說，地質圖反映區內岩石三維分佈的情況，同時，亦能展現該區的地質發展史**(地質圖之二)**。香港備有一系列地質及相關地圖**(地質圖之三)**，為市區規劃、地質資源分佈及地質災害的確認提供有用的資訊。

Our Earth is a dynamic system that comprises four main components: the atmosphere, the hydrosphere,the biosphere and the geosphere. These four components have been continuously interacting throughout the Earth's long history. Geology is the science that studies the geosphere, and encompasses the interactions between the geosphere and the other three components.

In simple terms, a geological map shows the surface distribution of rocks in an area. However, in order to fully understand a geological map, it is necessary to be familiar with several basic geological principles, including the laws of stratigraphy, geological age **(Geological Maps 1)**, and geological structures. To the experienced eye, a geological map reflects the three-dimensional distribution of rocks in an area, and also serves as a visual guide to the geological history of that area **(Geological Maps 2)**. A range of geological and related maps is available in Hong Kong **(Geological Maps 3)**. These maps provide useful information for urban planning, locating resources, and identifying geohazards.

內容
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地質圖以不同比例製作，供特定用途。描述區域地質的小比例地質圖，通常選用1:100,000或較大的比例。這類地質圖只顯示岩石的主要分佈及趨勢。大比例的地質圖(例如1:1,000的比例)可以展示較詳細的資料，普遍用來描述指定地點的地質情況。小比例的地質圖因細節不及大比例地圖的可靠及準確，故不應放大作指定地點的地質地圖之用。

除標準的地質圖外，尚有其他傳達不同地質資料的相關主題圖，包括地下水、地下地質(重力與磁力數據)、地球化學、地形、礦物及工程地質。

香港的地質圖

香港首次的地質勘察於1920年代由加拿大地質學家進行，並於1936年出版香港首幅比例為1:84,480的地質圖(圖1)。地圖上的岩石大致分類為火成岩(火山岩及深成岩)及沉積岩，並作出近代表土沉積分類，但欠缺斷層、褶皺或其他地質構造的資料。

圖1. 於1936年出版的1:84,480比例香港地質圖(摘錄)。
Figure 1. Extract from a 1:84,480-scale geological map of Hong Kong published in 1936.

香港第二次的地質勘察，由兩位來自英國地質調查(前地質科學學會海外組)的地質學家於1968至1969年間完成。於1971年出版兩幅1:50,000比例的地質圖(圖2)，以及一份香港地質的勘察報告。這兩幅地圖較前者更為詳盡，並顯示地質構造及岩石單位。

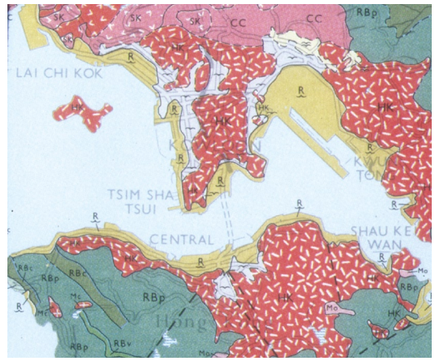

圖2. 於1971年出版的1:50,000比例香港地質圖(摘錄)。
Figure 2. Extract from a 1:50,000-scale geological map of Hong Kong published in 1971.

第三次全面的地質勘察於1983年開始，其時香港地質調查組(土木工程及發展署轄下土力工程處的一個小組)剛剛成立。過去十二年間，香港地質調查組共出版了十五幅比例為1:20,000的地質圖(圖3)，這些地圖連同六份相關的地質報告所提供的資料，較早前的地質圖詳盡得多。

Geological maps are produced at a variety of different scales for specific purposes. Small-scale geological maps depict the geology on a regional scale, typically at 1:100,000 scale or greater. These maps show only general patterns and trends in the rocks. Large-scale geological maps (*e.g.* 1:1,000-scale) are commonly used for site-specific purposes because they show much greater detail. Small-scale geological maps should never be enlarged for use at a site-specific scale, because there is insufficient detail for the maps to be used reliably and accurately at a larger scale.

In addition to standard geological maps, there is a range of other Earth-related maps that convey data on various themes, including groundwater, subsurface geology (gravity and magnetic data), geochemistry, landforms, minerals, and engineering geology.

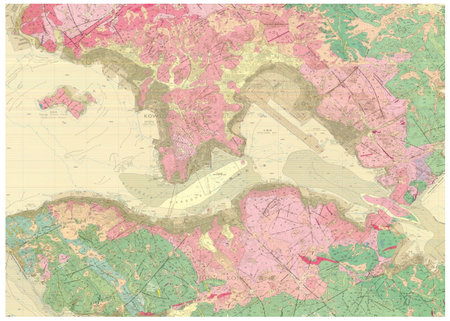

圖3. 1:20,000比例香港地質圖(香港地質調查圖幅十一，1986年出版) (摘錄)。
Figure 3. Extract from a 1:20,000-scale geological map of Hong Kong (Hong Kong Geological Survey map Sheet 11 published in 1986).

Geological Maps of Hong Kong

The first geological survey of Hong Kong was carried out by Canadian geologists in the 1920s, leading to publication of the first geological map of Hong Kong in 1936 at scale of 1:84,480 (Figure 1). The map divided the rocks very broadly into igneous (volcanic and plutonic), and sedimentary rock groups, as well as distinguishing the recent superficial deposits. There was no information about faults, folds, or other geological structures.

The second geological survey of Hong Kong was completed between 1968-69 by two geologists from the British Geological Survey (formerly Institute of Geological Sciences, Overseas Division). This led to publication of two geological maps at 1:50,000-scale (Figure 2) and a report on the geological survey of Hong Kong in 1971. These geological maps were much more detailed than the earlier geological map and showed geological structures and rock units.

A third territory-wide geological survey commenced in 1983 after the establishment of the Hong Kong Geological Survey (a unit within the Geotechnical Engineering Office of the Civil Engineering and Development Department). Over a twelve-year period, 15 geological maps at 1:20,000-scale were published (Figure 3). The maps were accompanied by six memoirs and showed considerably more detail than earlier geological maps.

In 2000, two memoirs, describing the solid and superficial geology of Hong Kong, were published with a set of 1:100,000-scale thematic geological maps (Figure 4). These two memoirs synthesized the geological information from all previous publications.

In Hong Kong, sedimentary and volcanic rocks are grouped into formations based on their distinctive lithological, physical and chemical characteristics. These formations comprise a stratigraphical sequence from the Devonian to the Tertiary. The volcanic formations are assigned to a group that represents a particular magmatic episode, a phase or a period of volcanic activity. The unconsolidated superficial sediments are the youngest stratigraphical units, which form a cover over most of the solid bedrock.

於2000年，兩份香港地質報告，及一套不同主題的1:100,000比例地質圖面世(圖4)。這兩份地質報告是將過往所有地質報告的資料綜合整理而成。

在香港，沉積岩及火山岩會按其獨特的岩性、物質及化學特徵分為不同的岩層(組)。這些岩層由泥盆紀至第三紀之地層序列組成。相關的火山岩岩組被編排至個別火山岩岩群，以代表特定的岩漿活動及火山活躍時期。未固結的表土沉積物是最年輕的地層單位，覆蓋了大部分堅固的基岩。

在香港較大而獨立的深成岩，在1:100,000比例的地質圖上顯示為侵入岩岩體，並按其出現地區命名。多個深成岩或花崗岩岩體，如果它們的化學及礦物特徵關係密切，則會組合為岩套，以代表特定的岩漿活動時期。

香港地質調查組於2003年開始以地理資訊系統作為平台，更新比例為1:20,000的地質圖，並以免費的瀏覽軟件(ArcReader)形式發放。

香港的地質歷史

地質圖不但為工程師、規劃師、礦產公司等傳達實用的地質資訊，同時亦幫助我們了解現時環境的模式及趨勢，特別是當考慮到重要的環境影響，如地質災害及全球暖化等問題時，明白過去的地質環境，有助我們計劃未來。

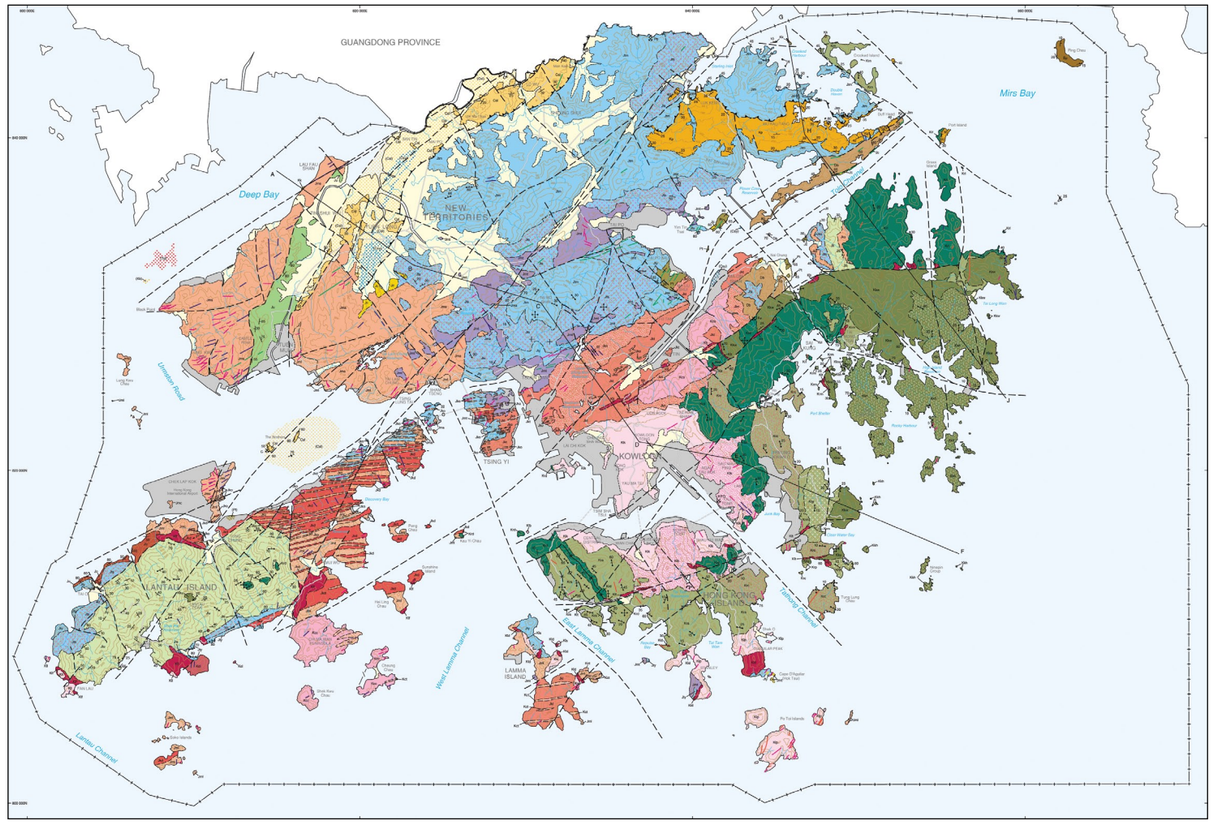

圖4. 於2000年出版的1:100,000比例香港地質圖。
Figure 4. Extract from a 1:100,000-scale geological map of Hong Kong published in 2000.

在過去的四億年，香港的地質歷史深受板塊構造變化操控，導致沉積環境變化，由最早的河流及三角洲演變為溫暖的淺海，然後再演變為大陸深海的環境及其後的火山活動活躍的大陸邊緣，最後演變為乾旱的大陸斷塊環境。

約於三千萬年前，印度板塊與歐亞大陸板塊開始發生碰撞，而香港目前的板塊結構大概於一千萬年前開始發展形成。在過去二百萬年間，地球經歷多段冰河時期，在這期間香港雖然沒有被冰川淹蓋，但是本地的海平面則受到影響而上升或下降。

有關香港的地質歷史之詳細討論，見板塊運動之三。

Geological History of Hong Kong

Not only do geological maps contain information about the ground that is useful for engineers, planners, mining companies, *etc.*, they also provide information about the geological history that can shed light on the current patterns and trends in the environment. Understanding past geological environments can enable society to be better prepared for the future, particularly when considering major environmental impacts such as geohazards and global warming.

The geological history of Hong Kong has been strongly controlled by changes in the plate tectonic setting over the past 400 million years. These have led to shifts in depositional environments ranging from rivers and deltas, to a warm shallow sea, to a deep continental sea, to a volcanically active continental margin, to an arid, block-faulted, continental terrestrial setting.

In Hong Kong, large, single intrusive units are shown as plutons on the 1:100,000-scale geological maps. They are named after the particular geographical locality in which they occur. Closely associated plutons or granitic bodies with a characteristic chemistry and mineralogy are further assigned to suites, which represent a particular magmatic episode.

In 2003, the Hong Kong Geological Survey commenced a programme to update the 1:20,000-scale geological maps on a GIS platform. These updated geological maps are being published and disseminated in ArcReader (a free software) format.

The present tectonic setting probably developed during the last 10 million years, following the collision of India with the Eurasian continent about 30 million years ago. During the past 2 million years, the Earth has undergone several periods of glaciation. However, although ice did not cover Hong Kong during this time, local sea levels were substantially lowered.

Detailed discussion of the geological history of Hong Kong is presented in Plate Tectonics 3.

其他地質學相關的香港地圖

立體地形圖

圖5是香港的立體地形圖，它是根據香港政府地政署提供地形勘察圖的高程數據，編製而成的數碼高程模型視覺地形圖。

立體地形圖協助使用者看到三維的地貌地勢，而顯現在立體地形圖的線條，則可能代表一系列不同的現象，例如水道、地質構造(斷層、節理等)、岩層或不同岩石的邊界。

同時，立體地形圖也是劃分及描繪地質構造，以及進行地形評估的實用工具。

地磁異常圖

在香港差不多整個水域內曾進行海洋地磁測量。這些測量有助於確定離岸地區的岩石地質情況，尤其是斷層位置。觀察所得的地磁場主要視乎不同岩石的磁化率、岩石形成時剩餘的磁性，以及岩石的風化程度。製作地磁場模型利用了鑽探所得及陸上的地質資料，有助於劃定磁性來源的岩石種類、走向及形狀。圖6為香港離岸地磁異常圖。

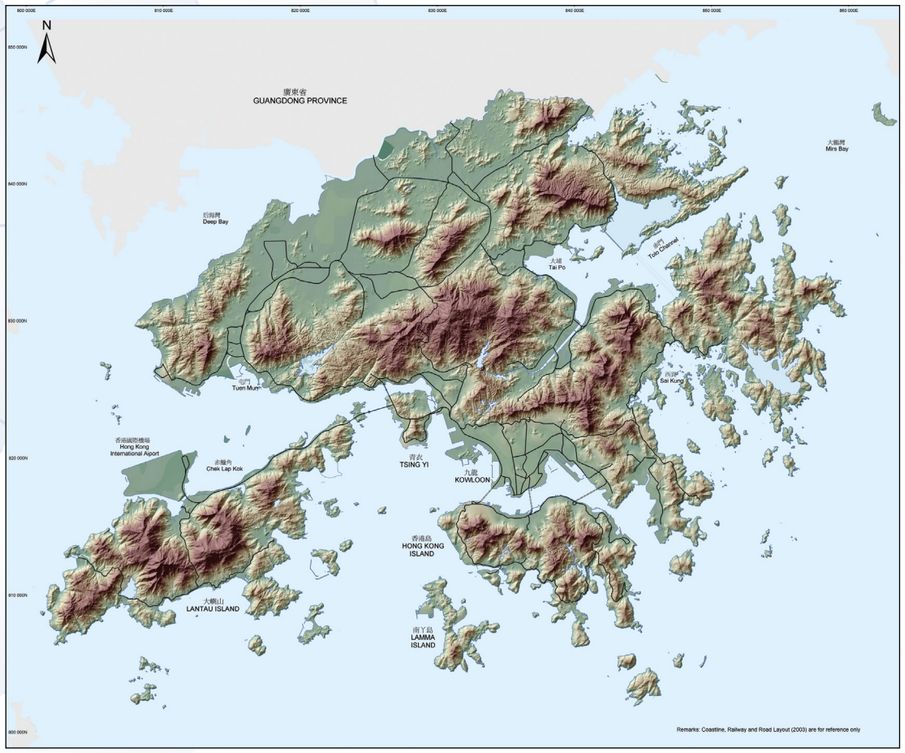

圖5. 香港立體地形圖。
Figure 5. Shaded Relief Map of Hong Kong.

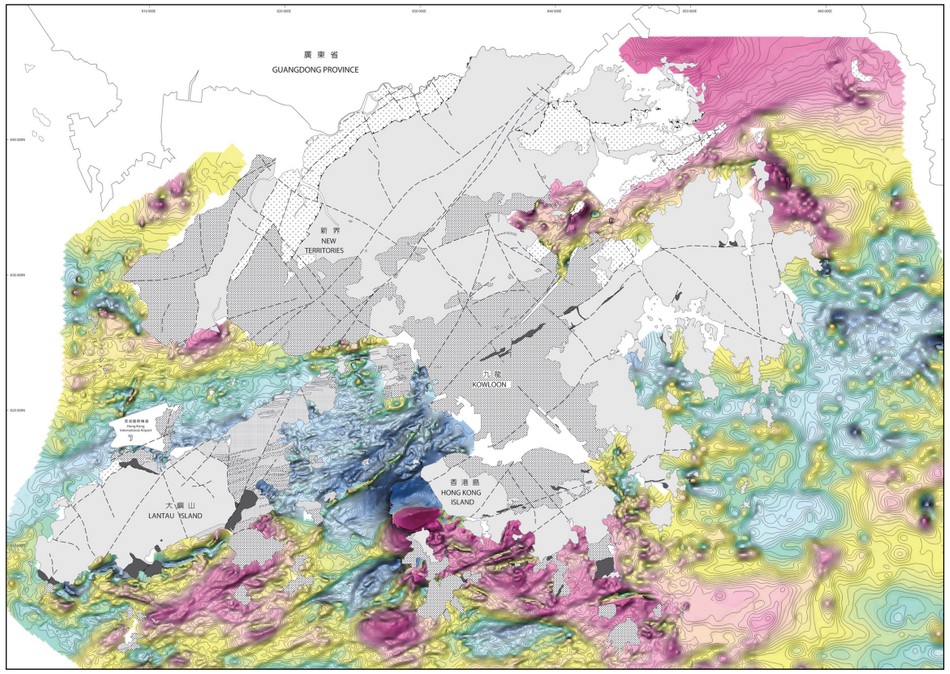

圖6. 香港地磁異常圖。
Figure 6. Magnetic Anomaly Map of Hong Kong.

Other Geological-related Hong Kong Maps

Shaded Relief Map

Figure 5 is a Shaded Relief Map of Hong Kong. It is a visual derivative of the Digital Elevation Model (DEM) that is based on elevation data extracted from the topographical survey maps provided by the Lands Department of the Hong Kong SAR Government.

The Shaded Relief Map helps users to visualise three-dimensional topography. Linear features revealed on the Shaded Relief Map could represent a variety of phenomena, such as drainage lines, geological structures (faults, joints, *etc.*), stratigraphical layering, and boundaries between different rock units.

Also, the Shaded Relief Map is a useful tool in geological mapping, for distinguishing and delineating geological structures, and for terrain evaluation.

Magnetic Anomaly Map

Marine magnetic surveys have been undertaken over nearly all of Hong Kong's waters. The surveys have helped to establish the solid geology for the offshore areas, and in particular the location of faults. The observed magnetic field is mainly dependant on variations in the magnetic susceptibility of the different bedrock types, remanent magnetism imparted to the rocks at the time of formation, and the degree of weathering. Modelling of the magnetic fields includes reference to the known geology from borehole and onshore information, which helps to define the orientations, shapes and rock types of the magnetic sources. The magnetic anomaly map for the offshore area of Hong Kong is reproduced in Figure 6.

地質資源圖

香港的天然資源可分為三大類：

- 陸上的金屬礦產及非金屬工業礦產(圖7)
- 從石礦場開採的石料及建築石材(圖7)
- 離岸沙源(圖8)

礦產

香港雖然面積細小，但礦產的種類相對頗多，一些礦產更曾經供商業開採。多類礦產大部分由中生代的火成活動造成，而與斷層相關的熱溶液活動則在不同程度上提高礦物的密集度。

目前香港並無發出商業性開採礦業，或勘探礦產的經營牌照。

- 金屬礦物

金屬礦物大致可分為四大類：錫(Sn)-鎢(W)-鉬(Mo)的礦物；銅(Cu)-鉛(Pb)-鋅(Zn)的礦物；鐵(Fe)的礦物，以及錫(Sn) 和金(Au)的砂礦。

斷斷續續見到的錫(Sn)-鎢(W)-鉬(Mo)礦物，大多集中於西北向的主要地質構造(如石英脈群)，以及蘊藏於幼粒花崗岩的地方，範圍包括針山、沙螺灣及蓮花山。

有關香港礦物的描述，見岩石與礦物之三。

圖7. 香港具經濟價值的礦產位置圖。
Figure 7. Location of economic mineral occurrences in Hong Kong.

Geological Resource Maps

The natural resources of Hong Kong can be divided into three main categories:

- Metalliferous minerals and non-metalliferous industrial minerals in the onshore area (Figure 7);
- Quarried rock and building stone (Figure 7);
- Offshore sand deposits (Figure 8).

Mineral Occurrences

Despite its small size, Hong Kong has a relatively large number of mineral occurrences. Some mineral deposits have been exploited commercially. Mesozoic igneous activity was largely responsible for this diversity of mineral deposits and the mineral concentrations have been variably enhanced by hydrothermal activity associated with faulting.

There are currently no commercial mining or prospecting licenses operating in Hong Kong.

- Metalliferous Minerals

Metalliferous mineral occurrences are grouped into four broad categories: tin-tungsten-molybdenum (Sn-W-Mo) mineralization; copper-lead-zinc (Cu-Pb-Zn) mineralization; iron (Fe) mineralization: and placer deposits of tin (Sn) and gold (Au).

Sporadic Sn-W-Mo mineralization is mostly concentrated along major NW-trending structures, such as swarms of quartz veins, and in areas underlain mainly by fine-grained granites. These include areas such as Needle Hill, Sha Lo Wan and Lin Fa Shan.

Descriptions of Hong Kong minerals are presented in Rocks and Minerals 3.

銅(Cu)-鉛(Pb)-鋅(Zn)的礦物主要集中在新界東北向的斷層帶，在粗火山灰晶屑凝灰岩之內，地區包括連麻坑及大帽山。

鐵的礦物跟矽卡岩(圖7)相關，是當花崗岩入侵時與大理岩接觸而產生，已知最大的礦床是位於馬鞍山的鐵礦。

曾有報告指出，在上塘一帶的沖積物中發現含有少量錫及金，估計是來自鄰近的幼粒花崗岩。錫及金礦在流水中經過重力篩選，富集形成沖積砂礦沉積。

- 非金屬礦物

曾經進行過商業開採的非金屬礦物，包括高嶺土、長石、石英、綠柱石及石墨。

高嶺土曾在茶果嶺、赤鱲角及青衣開採，但尚有多個較小礦產大部分位於香港西北部，亦曾被開採。

長石一度在茶果嶺的一條大岩脈中有開採，而石英則來自多個以開採花崗岩質土壤及石英脈為主的石礦場。

於魔鬼山，綠柱石與在花崗岩中的鎢脈相關，但從沒有被商業開採過。而石墨則曾於大小磨刀洲上，變質沉積岩的夾層中廣泛開採。

礦石 — 建築石及石料

多年來，花崗岩及火山岩被開採，作為本地興建道路的路基、堆石、護面石及瀝青的石料，現在這些石料則主要用於製造混凝土。目前(2008年)，香港仍有三個石礦場在運作中，以開採花崗岩為主，它們分別位於藍地、石澳及安達臣道。所有石礦場現在處於修復期，預料可供開採時間為兩至八年(由2008年起計)。

藍地及安達臣道的石礦場可開採到幼粒花崗岩，而中粒花崗岩則集中在石澳石礦場。另有小部分的火山岩，其中以晶屑凝灰岩為主，亦可在安達臣道石礦場開採得到。

Cu-Pb-Zn mineralization is concentrated mainly in veins along NE-trending fault zones within areas underlain by coarse ash crystal tuffs in the New Territories. These include areas such as Lin Ma Hang and Tai Mo Shan.

Iron mineralization is associated with skarn deposits (Figure 7) where granite has come into contact with marble. The largest known mineral deposit is magnetite at Ma On Shan.

Traces of tin and gold have been reported in alluvial deposits in the Sheung Tong area and these are thought to be derived from veins within nearby fine-grained granite. The minerals have been concentrated naturally by gravity separation in flowing water to produce alluvial placer deposits.

- Non-metalliferous Minerals

Concentrations of non-metalliferous minerals that have been commercially exploited include kaolin clay, feldspar, quartz, beryl and graphite.

Kaolin clay has been mined at Cha Kwo Ling, Chek Lap Kok, and Tsing Yi, but there have also been numerous other small occurrences mainly in the northwest of Hong Kong.

Feldspar was once mined from a large vein at Cha Kwo Ling, whereas quartz has been produced by numerous mining operations exploiting mainly weathered granite and quartz veins.

Beryl, associated with tungsten veins in granite in the Devil's Peak area, was never commercially exploited, whereas graphite was mined extensively from seams in metasedimentary rocks on The Brothers islands.

Quarried Rocks – Building Stone and Aggregates

For many years, granite and volcanic rocks have been quarried locally for road base, pell mell, armour stone and asphalt, although the main use now is for concrete aggregates. At present, there are three quarries operating in Hong Kong. These are principally in granite and are located at Lam Tei, Shek O and Anderson Road. All the quarries are in the process of rehabilitation and have a life expectancy of between two to eight years (from 2008).

Fine-grained granite is quarried at Lam Tei Quarry and Anderson Road Quarry, and medium-grained granite is dominant at Shek O. A small proportion of volcanic rock, mainly crystal tuff, is also quarried at Anderson Road.

離岸沙源

隨著市區迅速發展，香港對沙粒和填海物料的需求不斷增加。早於1920及1930年代期間，幼細的沙粒多從香港的海灘抽取。由於過度開採，以致政府於1935年制定「沙粒條例」以規管自然沙粒的搬運。在1950年代，香港首次利用海沙進行工程項目。在1960年代，政府展開一項海沙的調查，並紀錄了約三千萬立方米可用於工程項目的海沙蘊存。但到了1980年代，填海規模擴大，對沙粒的需求已超出香港所能供應的沙粒資源。

自1982年起，透過有系統的地質調查及地質繪圖，建立了香港的地質框架，亦有助於探索離岸的沙粒資源。土力工程處於1988年開始進行初步沙源調查，在中部及西部水域勘探到約一億立方米的沙粒及礫石沉積物，以供填海及工程之用。這初步勘察獲得成功後，調查範圍延伸至東面水域，稱為「海床物料」研究。這些勘察根據對香港的離岸表土沉積層及古地理的了解，從而按地質環境推斷沙粒的沉積地點。這項研究一方面勘探沙粒資源，另一方面對離岸的地質情況有更精準的認識。「海床物料」研究已勘探得到14個沙粒沉積體，發現合共有五億八千八百萬立方米的沙粒資源(圖8)。

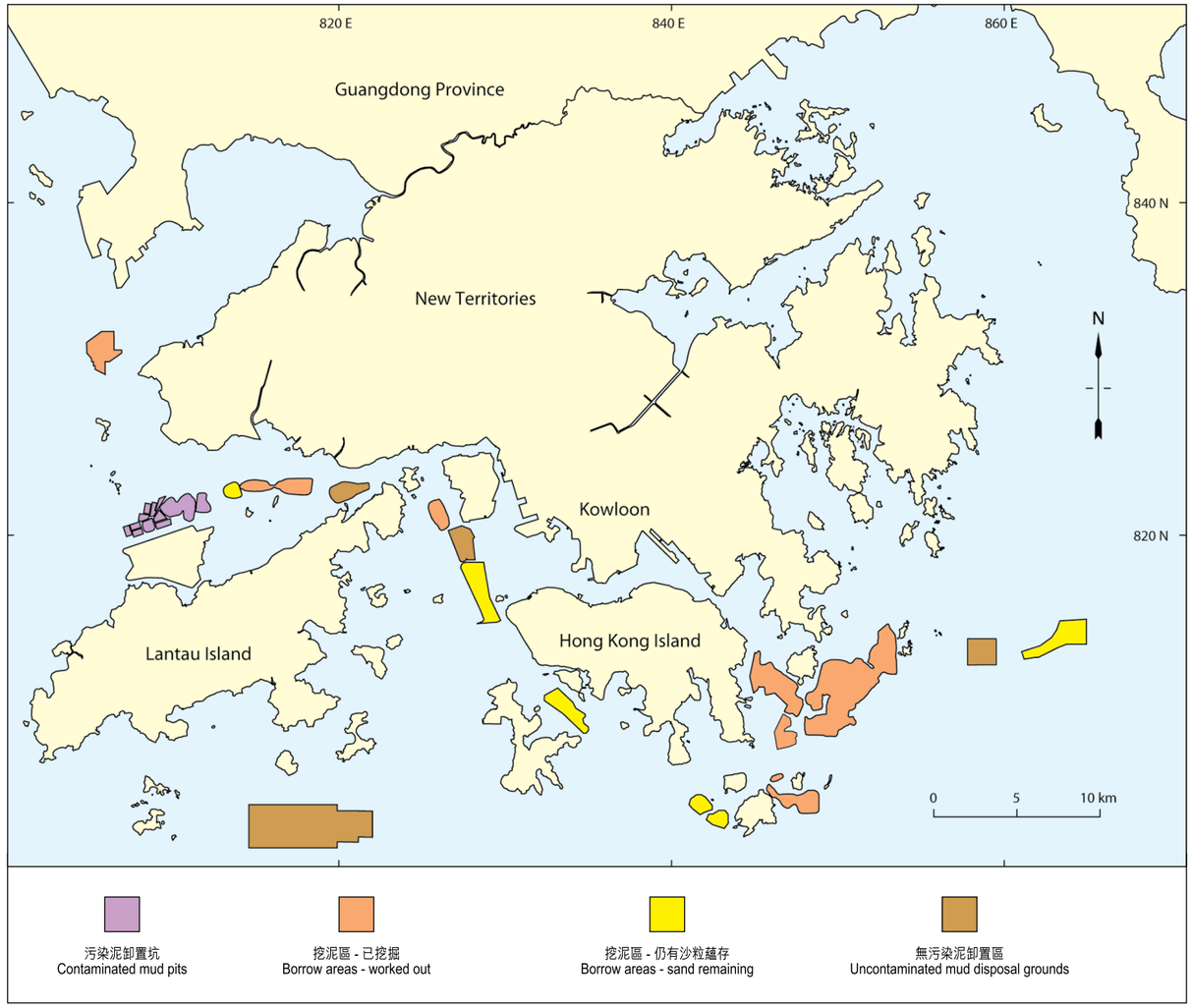

圖8. 海床資源、挖泥區及淤泥卸置區。
Figure 8. Seamat resources, sand borrow areas and mud disposal grounds.

Offshore Sand Deposits

The demand for aggregate sand and reclamation fill in Hong Kong has grown as the rate of urban development has increased. As early as in the 1920s and 1930s, fine aggregate sand was extensively extracted from beaches around Hong Kong. Over-exploitation led to the enactment of the Sand Ordinance in 1935, which was designed to regulate the removal of natural sand. The 1950s saw the first use of sea bed sand for major engineering projects. During the 1960s, the government carried out a sand survey and compiled an inventory of some 30Mm^3 of marine sand that was considered to be suitable for engineering use. However, by the 1980s, the scale of reclamation had increased and the demand for sand outstripped the available sand resources in Hong Kong.

Beginning in 1982, the systematic geological surveying and mapping of Hong Kong provided a geological framework that assisted the exploration for offshore sand resources. In 1988, the Geotechnical Control Office (now Geotechnical Engineering Office) embarked on a preliminary prospecting survey in western and central waters to locate 100Mm^3 of offshore sand and gravel deposits that could be used as both fill and aggregate. Following the success of this initial survey, the search was extended into eastern waters in the Seamat (Seabed Materials) Study. The surveys were based on the prevailing understanding of the offshore superficial stratigraphy and palaeogeography of Hong Kong, from which occurrences of sand deposits in several discrete geological environments were predicted. As the survey progressed, the offshore geological model was continuously refined. The Seamat study located 14 major sand bodies that contained a total volume of 588Mm^3 of identified resources (Figure 8).

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