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《中課程指引》(2007)的建議而訂製。在此過程中，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。

土木工程拓展署資助下的土木工程處及教育局的邀請，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本小冊冊、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。

土木工程處的「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。我謹向各位職員及同事致謝。

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。

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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.

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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態。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(地質圖之三)及
地質構造。對於具經驗的人來說，地質圖反映著某地岩石系分佈的情況。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圖地圖
(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.
岩群、岩組、岩套

岩層單位是指分立並可明確劃定的地層或岩體，具有獨特岩性、物質及化學特徵的地層單位，以岩組顯示於地質圖上。兩個或以上地理相近且具有相似特質的岩組，被分配為同一岩群，亦即岩組以上的一個級別。香港的火山岩組通常被劃分至一個岩群，以表示特定的岩漿活動時期（即火山活動期）。未經鑑定的表土沉積物是最低層的地層單位，覆盖了大部分基層的基岩。香港的表土沉積物包括陸上的沖積物（河流沖積）及坡積物（山坡沉積），海泥、海沙以及更新世的離岸沖積。

Geological maps are used for a wide variety of purposes including land use planning, natural hazard assessments, mineral resource investigations, water resources evaluations, and engineering construction projects. Geological maps are a visual representation of a wide variety of geological data, including the distribution of rocks and sediments in a particular area, the types of rocks, their age relationships, and the structural features in that area. Using an underlying topographical base map and special symbols to depict geological details, geological maps provide all the information necessary for the user to assess the three-dimensional geological structure of the rocks in the map area.

A geological map is a summary document from which the geological history of an area can be deciphered. However, it should be realised that a geological map is an interpretation, by a geologist, of the geological facts that were available at the time that the map was prepared. The accuracy of a geological map is largely a function of the time spent walking over the area, and time available for data collection. Geological maps can be revised and improved as more field work is carried out, and as more data from boreholes and excavations becomes available.

Groups, Formations and Suites

A stratigraphical unit is a discrete stratum or body of rock that occurs as a definable and mappable feature. Stratigraphical units with distinctive lithological, physical and chemical characteristics are shown as formations on geological maps. Two or more geographically associated formations with similar characteristics may be assigned to a group, which is the next order above a formation. In Hong Kong, the volcanic formations are commonly assigned to a group that represents a particular magmatic episode, a phase or period of volcanic activity. The unconsolidated superficial sediments are the youngest stratigraphical units, which form a cover over most of the solid (consolidated) bedrock. In Hong Kong, superficial deposits comprise alluvium (river deposits) and colluvium (hillside deposits) onshore, and marine mud, sand, and Pleistocene alluvium offshore.

Large, single intrusive units are shown on geological maps as plutons or granite bodies, named after the particular geological locality in which they occur. The stratigraphical status of these features is equivalent to a formation. Closely associated plutons or granite bodies with a characteristic chemistry and mineralogy are grouped as suites. In Hong Kong, suites are the plutonic (intrusive) equivalent of volcanic (extrusive) groups, and represent a particular magmatic episode.
What is shown on a Geological Map?

A geological map normally comprises a topographical base map, overlain by areas of colour, to show the distribution of stratigraphical units (rocks and sediments), and special symbols, to show structural and other geological information. The colours, lines and symbols on a geological map represent a large amount of detailed information that has been gathered by geologists during fieldwork. Geological maps include a legend that explains the meaning of the symbols, the ages of the stratigraphical units, and provides a key to the units. In some cases, the geological legend may also show stratigraphical relationships. To assist the user with an interpretation of the geology, geological maps usually include one or more representative cross-sections (Figure 1).
顏色範圍

在地質圖上，每個地層單位（非指出的岩石）
都會被分配一個專用顏色，顏色的選擇通常
視乎地層單位的年齡而定。國際上有數個
認可的顏色標準系統，給特定的地層單位及
地質時期。然而某程度上，為了配合圖面的
獨特用途，差不多所有的地質圖上採用的
顏色都跟標準的系統有所不同。

除個別專用顏色外，文字符號亦經常被用來
識別特定地方的地層單位。首個字母為
大樹，通常代表地質年代，例如：J是指
侏羅紀（二億五至一億四千五百萬年前），P則
表示二疊紀（二億九千九百萬至二億五千
一百萬年前）；及D代表泥盆紀（四億一千六
百萬至三億五千年年前）。後者的字母
(小樹)則代表其岩組的名字或主要的岩石
種類。

地質線

觀察不同岩石單位的接觸方式是閱讀
地質圖的重要元素，而三種主要的地質接觸
類型為：侵入接觸、沉積接觸及斷層接觸。

在地質圖上，侵入及沉積接觸一般以字樣
表示，至於斷層接觸則以粗線顯示(圖2)。

<table>
<thead>
<tr>
<th>地質線</th>
<th>頭層物</th>
<th>斷層</th>
<th>擊層</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial deposits</td>
<td>Solid geology</td>
<td>Fault</td>
<td>Thrust</td>
</tr>
</tbody>
</table>

Geological Lines

The type of contact between different rock units is a critical factor to observe on a geological map.

There are three main types of geological contact:
- intrusive contact, a depositional contact, and
- a fault contact. On geological maps, intrusive and
depositional contacts are generally shown by fine
lines, whereas a fault contact is represented by a
heavy line (Figure 2).

Coloured Areas

A unique colour is assigned to each stratigraphical unit (but not to each lithological type) on a geological map. The selection of colours usually depends on the age of the stratigraphical units, with several internationally recognised colour schemes adopted for specific stratigraphical units and geological periods. However, to a greater or lesser extent, almost all geological maps depart from the standard colour schemes, depending upon the specific purposes of the map.

Geological boundaries are shown as either solid or dashed lines on a geological map. This reflects the degree of certainty, and hence accuracy, of the geological contact represented on the map. Usually, in the field, geological contacts are obscured by vegetation, soil, or urban construction. Wherever a geological boundary is observable, it is shown as a solid line on the map, but where a boundary is uncertain, or inferred, the line is dashed. Generally, the shorter the dash, the more uncertain is the location of the boundary.

The lines on a geological map may be modified using symbols (for example, filled triangles, small tick marks, arrows, etc.). These symbols provide additional information about the nature of the geological line. For example, faults (heavy lines) with triangle symbols show that the fault is a thrust fault, and that the side of the line with the triangles has been passed over the side without the triangles. Other line symbols are explained on the map legend.
地質符號

地質面（如岩層、節理、斷層或紋理等）的三維方向，以走向及傾角符號表達。當地質學家見到成層岩石露頭（非斷裂的巨石），
便會使用地質圖樣及指北針來量測這些構造的方向，以走向及傾角記錄下來（圖3）。
每個地質面的走向及傾角符號，一般採用

走 向：走向是指傾斜的地質面與虛擬的水平面相交而成的線所指的方向（圖4）。

傾 傾：傾角一般是指傾斜角度，即地質面

水平之間的角度，指地質面於傾斜方向

水平的傾角為0°，垂直的平面的傾角

為90°。

行

图例

圖例是地質圖的重要部分，解釋地質圖上

的顏色、線條及符號的意義，要充分解

地質圖，圖例是不可或缺的。圖例為每個

地質單位的顏色及字母代號，並分年份

排列，在最上列為最新年，或新近形成

的層位單位(例如火山碎屑物)，而最古老的

則放在最下。另外，圖例亦同時列出岩石或

可用材料的名稱、簡介及年份。

| 30 | Bedding, inclined, dip in degrees |
| 40 | Bedding, horizontal |
| 40 | Bedding, vertical |
| 40 | Bedding, overturned, dip in degrees |
| 40 | Volcanic layering (ashfall, flow-banding),
  | incline, dip in degrees |
| 40 | Volcanic layering, vertical |
| 40 | Anticline, axial trace |
| 40 | Syncline, axial trace |

图3. 地質圖例分類

Figure 3. Examples of some geological symbols.

Map Legends

An important component of geological maps is the legend (or key), on which examples of all the colours, lines and symbols are reproduced and explained. A legend is necessary for a full understanding of a geological map. The legend itemises the colour and the letter symbol of each stratigraphical unit as a column, with the youngest, or most recently formed, units (e.g. the man-made deposits) at the top, and the oldest units in the area at the bottom. The name of the stratigraphical unit, a short description of the types of rocks or sediments present, and their age, are also included.

Legends also explain the types of geological lines used, the strike and dip symbols, and the other kinds of geological symbols shown. These may include mineral occurrences, fossil locations, and other geological features that might be important in the area.

Geological Symbols

Strike and dip symbols provide information about the three-dimensional orientation of geological surfaces such as bedding, joints, faults or foliations. Using a compass and clinometer, geologists measure the orientation of these structures wherever they can find suitable solid rock exposures (as opposed to loose boulders). The orientation and angle are recorded as a strike and a dip respectively (Figure 3). Each dip and strike symbol on a geological map usually represents the average of several measurements.

Strike: The strike of an inclined geological plane is the direction of an imaginary horizontal line projected across the surface (Figure 4). Strike may be visualised by immersing a sheet of glass into a bowl of water. Because the water surface is horizontal, the waterline on the glass is a horizontal line, or a strike line. The direction (azimuth) of the waterline is the strike.

Dip: Dip generally refers to the dip angle, which is the angle between a geological plane and the horizontal, i.e. the angle at which the plane slopes downwards, as measured in the dip direction. The dip direction is always perpendicular to the strike, and is the direction of maximum slope of an inclined plane. Thus, an horizontal plane has dip of 0°, and a vertical plane has a dip of 90°.
Understanding Outcrop Patterns

Slab-shaped Rock Units

In the case of a rock unit with a slab-shaped geometry, for example a sedimentary rock bed or a sheet-like dyke, the width of the rock band exposed at the surface depends upon the angular relationship between the rock unit and the land surface. Thus, if the rock unit is perpendicular to a horizontal ground surface, then the true thickness of the rock unit can be measured directly. At the other extreme, a planar rock unit that lies parallel to the land surface has continuous outcrop. For intermediate cases, where the rock unit is inclined at an angle to a horizontal ground surface, then only the apparent width of the rock unit is observed on the surface. The width of the outcrop depends upon the angle of dip, but it is always greater than the true thickness (Figure 5).

Folded Rock Units

A fold is a bend of a planar structure, such as a bedding plane, in a rock.

In order to depict folded strata on a geological map, the folding history of the rocks has to be understood. This is accomplished by studying the geometry of the folds to determine the orientation of the hinge line of the fold, the trend and plunge of the fold axis, and the shape of the fold.

On many geological maps, so-called “fold axes” are depicted using symbols that define whether the fold is an anticline or syncline.

Refer to Plate Tectonics 2 for a discussion of folds.
解讀地質歷史

從地質圖上，要了解該區域地質歷史，必須對地質現象有透徹的了解，並需相關的專業知識。圖7是個例子說明如何從地質圖解讀地質歷史。

步驟一：檢查圖面內的地形，確認出現的岩石種類及季節性變化，岩石的特徵及它們的地層關係。

步驟二：檢查地圖上的構造符號，這些符號提示出岩層的間隔角度，並體現出岩石形成影響的規模及斷層的資料。

步驟三：檢查從上到下岩石的層次、斷層及表土沉積物之間的關係，例如斷層將表土沉積年老或年新。

步驟四：注意表土沉積物的覆蓋層，這些是第四紀山洪與洪流作用所產生的沉積物。

步驟五：總結現今所見的地質事件及發展過程，並製成地質柱以圖形化地描述地質歷史。

例子中的地質圖(圖7)表示發生於地質事件順序大致如下：
1. 中粒花崗岩侵入
2. 流紋岩侵入
3. 火山爆發：火山岩形成
4. 由北向南推進的斷層活動及火山岩積累
5. 上升及侵入
6. 表土沉積物堆積

Interpretation of Geological History

Interpreting the geological history of an area from a geological map requires a thorough understanding of geological principles, experience, acquired skills, and practice. An example of how to interpret the geological history of an area from a geological map is given in Figure 7.

Step 1. Examine the topography of the area, identify the range of rock types present, igneous, sedimentary, and metamorphic, the ages of the rocks, and their stratigraphical relationships.

Step 2. Examine the structural symbols on the map. These provide information about the dips of the beds, and of folds and faults that may have affected the rocks.

Step 3. Examine the relationship between igneous intrusions, the surrounding rocks, faulting, and superficial deposits. For example, is it faulting older or younger than the superficial deposits?

Step 4. Consider the cover of superficial deposits. These are unconsolidated (loose) sediments that were deposited during the Quaternary by processes such as landslides and rivers.

Step 5. Summarize the sequence of events that have produced the geology seen today, and construct a geological model to visually describe the geological history.

The sequence of geological events that can be inferred from the geological map (Figure 7) is probably:
1. Intrusion of medium-grained granite
2. Intrusion of mafic dykes
3. Eruption of volcanic rocks
4. Faulting (N-S-trending) and folding of volcanic rocks
5. Uplift and erosion
6. Deposition of superficial deposits