高等院校精品规划教材

ENGLISH FOR GEOLOGICAL AND GEOTECHNICAL ENGINEERING

地质与岩土工程专业英语

李华晔　刘汉东
王四巍　于怀昌　编著

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内 容 提 要

本书以培养学生英语专业文献阅读和翻译能力为主要目标，内容包括岩石学、构造地质学、地形地貌学、地震学、地下水动力学、工程地质学、岩体力学、土力学、地基与基础工程、水利工程、喷锚支护与盾构施工等方面的基础知识。全书由20个单元组成，每个单元均有译文。书后附有科技文章翻译和写作指南及生词表。

本书可作为地质工程、岩土工程、水利工程、土木工程等专业的本科生和研究生的教材或课外阅读材料，也可供从事相关专业的工程技术人员、管理人员和教师参考。

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前　言

自 1987 年，笔者在华北水利水电学院为水文地质与工程地质专业讲专业英语至今已 20 多年，先后编写了两次内部教材供学生使用。从 2000 年以来一些教师建议由笔者牵头编写一本适合地质与岩土工程的专业英语教材，于是笔者按照教育部颁发的《大学英语教学大纲》英语教学 4 年不间断的精神，根据教育部学科和专业调整目录开始进行材料收集和编写工作，经两年半的时间，编著了《地质与岩土工程专业英语》一书。

本书涉及的内容包括岩石学、构造地质学、地形地貌学、地震学、地下水动力学、工程地质学、岩体力学、土力学、地基与基础工程、水利工程、喷锚支护与盾构施工等方面的基础知识，旨在为两个专业学生阅读英文文献打下专业词汇和理解原文的基础。为了提高学生的专业知识和英语写作水平，编写了科技文章翻译和写作指南及生词表供读者查阅。

全书共分 20 个单元，每个单元分为两部分——课文和阅读材料，均给出了参考译文和词汇表。20 个单元课堂教学全部讲授一般需 40 ~ 50 学时，如学时不够，可根据专业性质有针对性地讲解一些相关的内容。本书语言规范、内容广泛、针对性强，有利于自学。

参加本书编著的有华北水利水电学院李华晔、刘汉东、王四巍和于怀昌。

全书由李华晔教授统稿并对原文、译文进行了多次校对，但由于编者水平有限，错误和不足之处在所难免，恳请广大读者批评指正。

编著者

2007 年 12 月

目　录

Unit 1

Text

Igneous Rock

1 What is Magma

Magma is molten rock that flows within the earth. It may be completely liquid or, more commonly, a fluid mixture of liquid, solid crystals, and dissolved gases. When magma reaches the Earth's surface, we call it lava, or molten rock that flows above ground.

Magma forms when underground temperatures become high enough to break the bonds in some minerals, causing the minerals to melt. The rock then changes from a crystalline solid to a fluid mix containing freely moving ions and atoms as well as some still-solid crystalline fragments. Different minerals melt out of the rock at different temperatures as the heat gradually increases, with the minerals having the highest melting points remaining the longest as still-solid fragments in the magma. At the same time, the composition of the magma changes as each newly molten mineral enters and enriches it.

When heat dissipates from magma, its bonds no longer break and new bonds start to form. Firstly, some of the free atoms and ions in the liquid bond to form tiny crystals. Additional ions and atoms bond at prescribed sites in the crystal structures. The crystals grow until they touch the edges of adjacent crystals. As cooling progresses, different minerals crystallize from the magma, again changing the magma's composition. If cooling continues long enough, the entire body of magma will become solidified as igneous rock.

2 Classification of Igneous Rocks

Igneous rocks are classified based on their two most obvious properties: their texture, which is determined by the size and shape of their mineral crystals and the manner in which these grew together during cooling, and their composition, which is determined by the minerals that they contain.

3 Igneous Textures

A rock's texture refers to the appearance of its surface—specifically the size, shape, and arrangement of the rock's mineral components. The most important factor controlling these features in igneous rocks is the rate at which a magma or lava cools. When a magma's minerals crystallize slowly underground over thousands of years, crystals have ample time to grow large

enough to be seen clearly with the unaided eye. The resulting texture is called phaneritic rocks (Fig. 1.1). Slow cooling occurs when magmas enter, or intrude, preexisting solid rocks; thus rocks with phaneritic textures are known as intrusive rocks. They are also called plutonic rocks.

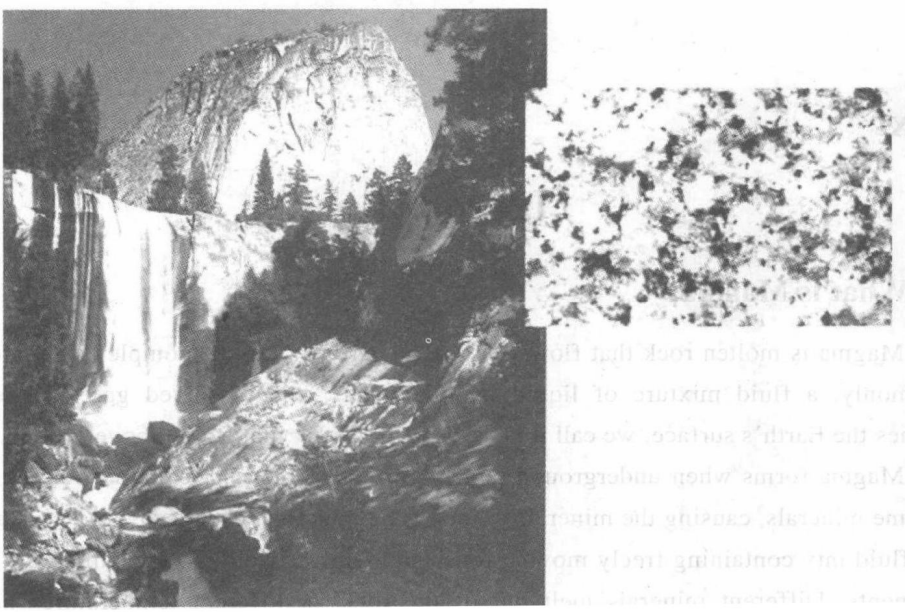


Figure 1.1 Phaneritic rocks
Rocks that solidify slowly underground, as did this granite in Yosemite National Park, California have phaneritic (coarse-grained) textures

Some igneous rocks develop at relatively low temperatures from ion-rich magmas containing a high proportion of water. Under these conditions, ions move quite readily to bond with growing crystals, enabling the crystals to become unusually large (sometimes several meters long). Rocks with such exceptionally large crystals are called pegmatites (Fig. 1.2). In western Maine, near the towns of Bethel and Rumford, some pegmatitic rocks contain 5-meter long crystals of the mineral beryl.

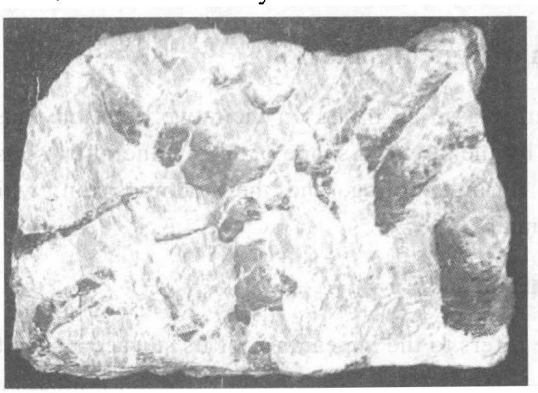


Figure 1.2 Pegmatites
Extremely coarse-grained pegmatites, such as the one shown here, form from ion-rich magmas having a high water content

Some igneous rocks solidify from lava so quickly that their crystals have little time to grow. These aphanitic rocks have crystals so small that they can barely be seen with the naked eye (Fig. 1.3). Rocks with aphanitic textures are called extrusive rocks, because they form from lava that has flowed out, or been extruded, onto the Earth's surface. They are also known as volcanic rocks, because lava is a product of volcanoes.

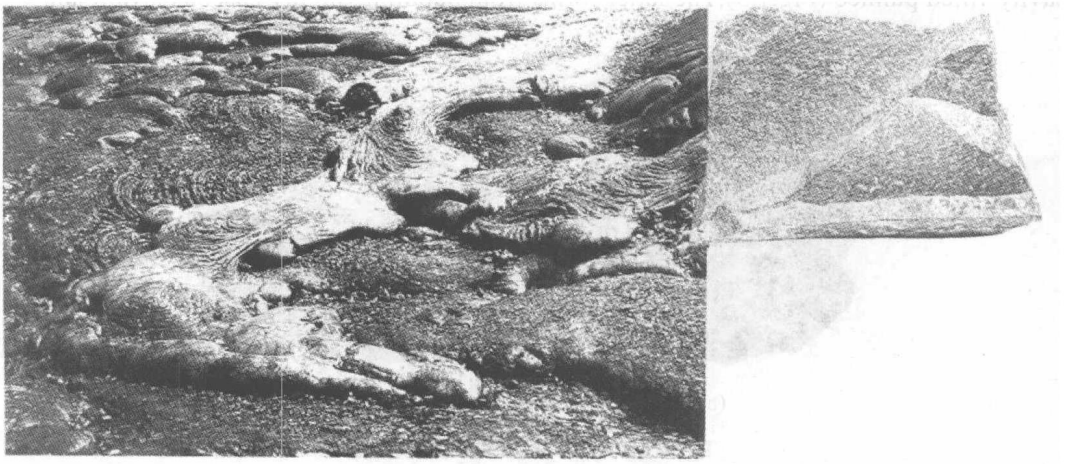


Figure 1.3 Volcanic rocks

Volcanic rocks, such as this basalt, typically have aphanitic (very small-grained) textures, because they solidify rapidly above ground

In some igneous rocks, large, often perfect, crystals are surrounded by regions with much smaller or even invisible grains (Fig.1.4). These porphyritic textures are believed to form as a result of slow cooling followed abruptly by rapid cooling. First, gradual underground cooling produces large crystals that grow slowly within magma. Next, the mixture of remaining liquid magma and the early-formed crystals is forced close to the surface or actually escapes into the air. There the liquid cools rapidly to produce the body of smaller grains that envelops the larger crystals.

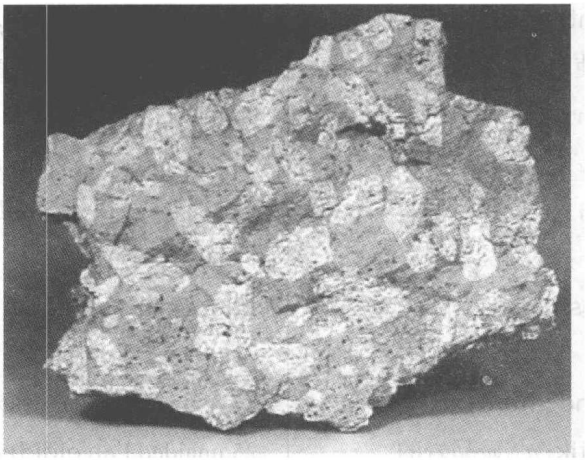
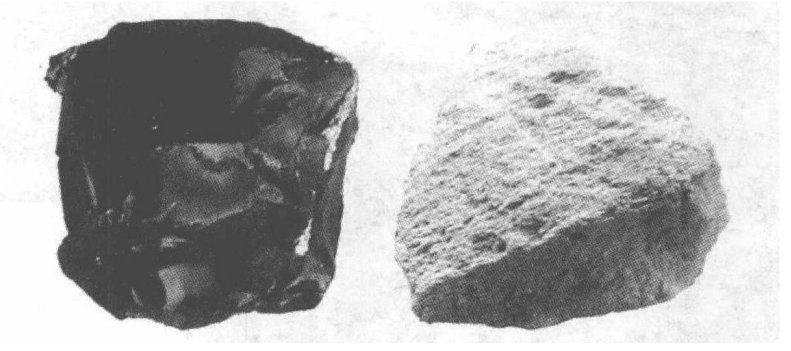


Figure 1.4 Porphyritic rocks

Some rocks have a porphyritic texture, marked by large crystals surrounded by an aphanitic matrix

When lava from a volcano erupts into the air or flows into a body of water, much of it cools so quickly that its ions don't have time to become organized into any crystals. The texture of the resulting rock is described as glassy. Two common types of volcanic glass exist, both produced by instantaneous cooling of lava: dark-colored obsidian and light-colored, cavity-filled pumice (Fig.1.5).The latter forms from bubbling, highly gaseous lava foam.



(a) (b)

Figure 1.5 Glassy volcanic rocks

Obsidian (a) and pumice (b) contain no crystals because they solidify instantaneously. Pumice, which forms from lava foam, commonly has so many tiny air-filled cavities that it can float in water

New Words and Expressions

1.magma ['mægmə] *n.* 岩浆
2.lava ['lɑ:və] *n.* 熔岩，火山岩
3.crystalline ['kristəlain] *a.* 晶质的
4.crystalline solid 结晶固体
5.fragment ['frægmənt] *n.* 碎屑，碎片
6.enrich [in'ritʃ] *vt.* 使富足，使肥沃
7.dissipate ['disipeit] *v.* 驱散，(使)(云、雾、疑虑等)消散
8.solidify [sə'lidifai] *n.* 凝固，结晶
9.igneous ['igniəs] *a.* 火成的
10.classification [ˌklæsifi'keiʃən] *n.* 分类，分级
11.arrangement [ə'reindʒmənt] *n.* 排列
12.phaneritic [fænə'ritik] *a.* 显晶岩的
13.plutonic [plu:'tɔnik] *a.* 深成的，火成的(岩石)
14.pegmatite ['pegmətait] *n.* 结晶花岗岩
15.beryl ['beril] *n.* 绿玉，绿柱石
16.aphanitic [ˌæfə'nitik] *a.* 非显晶(质)的，隐晶(质)的
17.name for 与(另一人)同名
18.porphyritic [ˌpɔ:fi'ritik] *a.* 斑状的
19.matrix ['meitriks] *n.* 基质
20.volcano [vɔl'keinəu] *n.* 火山
21.instantaneous [ˌinstən'teinjəs] *a.* 瞬间的，即刻的
22.obsidian [ɔb'sidiən] *n.* 黑曜岩
23.pumice ['pʌmis] *n.* 浮岩
24.foam [fəum] *n.* 泡沫，水沫
25.unaided ['ʌn'eidid] *a.* 无助的，独立的
26.unaided eye 肉眼

火成岩

一、什么是岩浆

岩浆是在地球内部流动熔化的岩石。岩浆可以是完全液态的，或者是更常见的液体、固态晶体和溶解气体组成的流动混合物。当岩浆到达地表，我们称之为熔岩，或者叫在地表流动的熔岩。

当地下温度增高到足以破坏某些矿物连接时，导致矿物熔化就形成了岩浆。然后岩石从结晶固体变为液态混合物，但它包含自由运动的离子和原子以及一些仍然保持固态的晶质碎屑。当热量逐渐增加时，不同的矿物在不同温度下会从岩石中熔化分离，熔点最高的矿物在岩浆中以固态碎屑形式保持时间最长。同时，当有新熔化的矿物混入和富集时，岩浆的成分发生改变。

当热量从岩浆中消散后，矿物的胶结不再受到破坏，重新胶结开始形成。首先，液体中的一些自由原子和离子结合形成微小晶体。增加的离子和原子会在晶体结构特定位置处胶结。晶体生长直到触及相邻晶体边缘才停止。当冷凝发生时，不同的矿物从岩浆中结晶，再次改变了岩浆成分。如果冷凝时间足够长，整个岩浆体将变成固体即火成岩。

二、火成岩的分类

火成岩是根据其两个非常明显的特征分类：火成岩的结构与成分。火成岩的结构由其矿物晶体的大小、形状以及这些矿物晶体在冷凝过程中的生长方式来确定；火成岩的成分由岩石所含有的矿物来确定。

三、火成岩结构

岩石的结构指岩石表面的特性，尤其矿物大小、形状和排列方式。在火成岩中控制这些特征的最重要因素是岩浆或熔岩的冷却速率。当岩浆中的矿物在地下缓慢结晶上千万年，晶体就有充足时间生长变大，用肉眼可以看得很清楚。产生的结构被称为显晶质(见图 1.1)。当岩浆进入或侵入已存在的岩石中，缓慢冷却，岩石具有显晶质结构叫侵入岩。侵入岩也被称为深成岩。

一些火成岩在相对较低温度下从富含离子的岩浆中形成，这种岩浆含有高比例的水分。在此条件下，离子移动，非常容易与正在生长的晶体结合，使晶体变得异乎寻常的大(有时几米长)。含有这样异常巨大晶体的岩石被称为伟晶岩(见图 1.2)。在西缅因州，靠近 Bethel 和 Rumford 城，一些伟晶岩含有 5 m 长的矿物绿柱石晶体。

一些火成岩从熔岩中固结速度非常快，以至于矿物晶体生长时间很短。这些隐晶质岩石中的晶体非常小，以至于用肉眼几乎看不到晶体(见图 1.3)。具有隐晶质结构的岩石被称为喷出岩，它们是由流出或喷出地表的熔岩形成。熔岩是火山的产物，所以喷出岩也被认为是火山岩。

在一些火成岩中，较大的、通常完好的晶体被许多细小的、甚至看不见的颗粒在边界包围着(见图 1.4)。这些斑状结构被认为是开始缓慢冷却其后突然快速冷却的结果。首

先，在地下逐渐冷却产生大的晶体，但它在岩浆中生长很慢。然后，剩余的液态岩浆和早期形成的晶体组成的混合物受到约束接近地表甚至冲入大气。液体在这里快速冷却，产生包裹较大晶体的小颗粒体。

当火山中的熔岩喷到大气中或流入水体，熔岩的大部分快速冷凝，熔岩中的离子来不及改变原结构而形成晶体。产生的岩石结构叫做玻璃质。火山玻璃质两种常见类型都是由熔岩瞬间冷凝形成的：暗色的黑曜岩和浅色的、充满孔洞的浮岩(见图 1.5)。后者是由带泡的、高度气态化的熔岩泡沫形成。

Reading Material

Igneous Rock

4 Igneous Compositions

The Earth's magmas consist largely of the most common elements: oxygen, silicon, aluminum, iron, calcium, magnesium, sodium, potassium, and sulfur. The relative proportions of these components found at any given time within a body of magma give the magma its distinctive characteristics and ultimately determine the mineral content of the rocks it will form. Igneous rocks and magmas are classified into four main compositional groups—ultramafic, mafic, intermediate, and felsic—based on the proportion of silica (oxygen and silicon) they contain (Table 1.1). Figure 1.6 shows how the mineral content of igneous rocks varies in these categories.

Table 1.1 Common Igneous Compositions

Composition Type	Percentage of Silica	Other Major Elements	Relative Viscosity of Magma	Temperature at Which First Crystals Solidify	Igneous Rocks Produced
Felsic	>65%	Al, K, Na	High	600~800 °C (1 112~1472°F)	Granite (plutonic) Rhyolite (volcanic)
Intermediate	55%~65%	Al, Ca, Na, Fe, Mg	Medium	800~1 000 °C (1 472~1 832 °F)	Diorite (plutonic) Andesite (volcanic)
Mafic	40%~55%	Al, Ca, Fe, Mg	Low	1 000~1 200 °C (1 832~2 192 °F)	Gabbro (plutonic) Basalt (volcanic)
Ultramafic	<40%	Mg, Fe, Al, Ca	Very low	>1 200 °C (2 192 °F)	Peridotite(plutonic) Komatiite(volcanic)

Ultramafic Igneous Rocks The term "mafic" is derived from magnesium and ferrum.

Ultramafic igneous rocks are dark in color and very dense, because they are dominated by the iron-and magnesium-containing silicate minerals (called ferromagnesian minerals) olivine and pyroxene and contain relatively little silica (less than 40%).The most common ultramafic rock, peridotite, contains 40% to 100% olivine. Ultramafic rocks generally crystallize slowly deep within the Earth's interior and appear at the Earth's surface only where extensive erosion has removed overlying crustal rocks. They are most likely to be found near continental collision plate boundaries, where deep rocks have been uplifted.

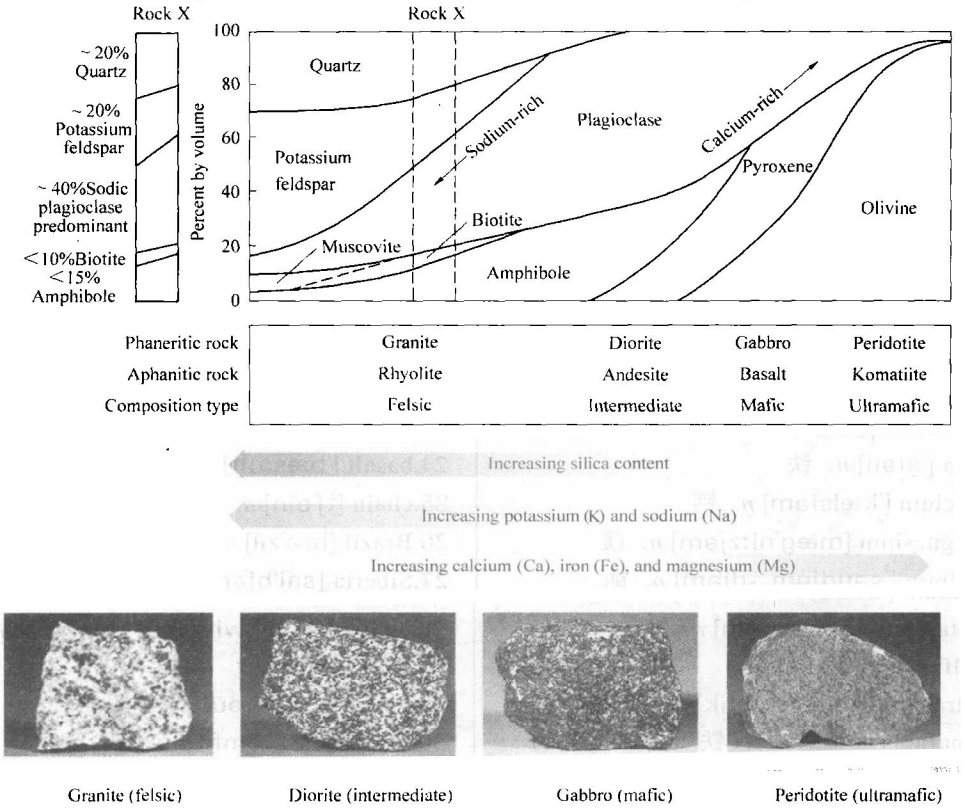


Figure 1.6 An igneous rock classification chart

Compositional types among the igneous rocks range from felsic to ultramafic. The mineral components of the rocks are indicated by colored areas in the body of the chart (The sample segment shows how to interpret the chart, using as an example a rock falling between granite and diorite in composition)

Mafic Igneous Rocks Mafic igneous rocks have a silica content ranging between 40% and 55%, with the principal minerals being pyroxene, calcium feldspar, and a minor amount of olivine. They are the most abundant rocks of the Earth's crust; the aphanitic volcanic rock basalt is the single most abundant of them. Most of the ocean floor and many islands, such as the Hawaiian chain, are composed of basalt. Basalt also constitutes vast areas of our continents and is found in Brazil, India, South Africa, Siberia, and the Pacific Northwest of North America, the plutonic equivalent of basalt is gabbro; it has the same composition as basalt but, because it cools more slowly deep within the Earth, is coarse-grained.

Intermediate Igneous Rocks Intermediate igneous rocks contain more silica than mafic rocks, including between 55% and 65% silica, and are generally lighter in color. They typically consist of some ferromagnesians, such as pyroxene and amphibole, along with sodium-and aluminum-rich minerals such as sodium feldspar and mica, and a small amount of quartz. Examples of intermediate igneous rocks include the aphanitic volcanic rock andesite (named for the Andes Mountains of South America, where this type of igneous rock dominates the local geology) and its phaneritic plutonic equivalent diorite.

Felsic Igneous Rocks The term "felsic" is derived from feldspar and silica. Felsic igneous rocks contain more silica—65% or more—than either mafic or intermediate igneous rocks. They are generally lighter in color because they are poor in iron, magnesium, and calcium silicates, but rich in potassium feldspar, aluminum-rich (muscovite) mica, and quartz. Examples of felsic igneous rocks include the common plutonic phaneritic rock granite and its volcanic aphanitic equivalent, rhyolite. Rocks of felsic composition have a greater variety of textures than any other igneous rock and include several glassy rocks and ultra-coarse pegmatites.

New Words and Expressions

1.silicon ['silikən] *n.* 硅，硅元素
2.aluminum [ə'lju:minəm] *n.* 铝
3.iron ['aiən] *n.* 铁
4.calcium ['kælsiəm] *n.* 钙
5.magnesium [mæg'ni:zjəm] *n.* 镁
6.sodium ['səudjəm, -diəm] *n.* 钠
7.potassium [pə'tæsjəm] *n.* 钾
8.sulfur ['sʌlfə] *n.* 硫
9.ultramafic [ˌʌltrə'mæfik] *a.* 超基性的
10.mafic ['mæfik] *a.* 镁铁质的，镁铁的
11.intermediate [ˌintə'mi:djət] *a.* 中间的
12.felsic ['felsik] *n.* 长英质的(矿物)
13.silica ['silikə] *n.* 二氧化硅
14.ferrum ['ferəm] <拉> *n.* 铁
15.silicate ['silikit] *n.* 硅酸盐
16.ferromagnesian [ˌferəumæg'ni:ʃən] *a.* 含有铁镁的
17.olivine [ˌɔli'vi:n] *n.* 橄榄石
18.pyroxene [pai'rɔksi:n] *n.* 辉石
19.peridotite [ˌperi'dəutait] *n.* 橄榄岩
20.crystallize ['kristəlaiz] *vi.* 结晶
21.uplift [ʌp'lift] *v.* 举起，升起，隆起
22.principal mineral 主要矿物
23.feldspar ['feldspɑ:] *n.* 长石
24.basalt ['bæsɔ:lt] *n.* 玄武岩
25.chain [tʃein] *n.* 链，山脉
26.Brazil [brə'zil] *n.* 巴西
27.Siberia [sai'biəriə] *n.* 西伯利亚
28.equivalent [i'kwivələnt] *n.* 等价物，同期地层
29.gabbro ['gæbrəu] *n.* 辉长岩
30.amphibole ['æmfibəul] *n.* 闪石
31.mica ['maikə] *n.* 云母
32.quartz [kwɔ:ts] *n.* 石英
33.andesite ['ændizait] *n.* 安山岩
34.diorite ['daiərait] *n.* 闪长岩
35.calcium silicate 硅酸钙
36.muscovite [ˌmʌskə'vait] *n.* 白云母
37.granite ['grænit] *n.* 花岗岩
38.rhyolite ['raiəˌlait] *n.* 流纹岩
39.pegmatite ['pegmətait] *n.* 伟晶岩
40.terrestrial [ti'restriəl] *a.* 地球的，大地的
41.as well as 既……又

阅读材料

火 成 岩

四、火成岩的成分

地球的岩浆通常主要由以下元素组成：氧、硅、铝、铁、钙、镁、钠、钾和硫。某一时间在岩浆中所发现的相关成分相对比例会使岩浆具有自身与众不同的特性，并最终决定了所形成岩石中矿物的含量。根据二氧化硅(氧和硅)的比例，火成岩与岩浆被分为四种主要成分组：超基性、铁镁质、中性和长英质(见表 1.1)。图 1.6 显示了在这些分类中火成岩的矿物成分是如何变化的。

超基性火成岩 术语“铁镁质的”来自镁和铁。超基性火成岩颜色深，非常致密，这是由于岩石主要由铁镁的硅酸盐矿物(称为铁镁矿物)橄榄石和辉石组成，含相对少量的二氧化硅(小于 40%)。最常见的超基性岩——橄榄岩含 40%～100%的橄榄石。超基性岩通常在地球深部缓慢结晶，当覆于其上的岩石受到剥蚀才会在地表出露。在大陆板块碰撞边界附近会发现这类岩石，因为在这里它们受到抬升。

铁镁质火成岩 铁镁质火成岩中二氧化硅含量为 40%～55%，主要矿物为辉石、钙长石和少量橄榄石。铁镁质火成岩是地壳中含量最丰富的岩石；隐晶质火山玄武岩是铁镁质火成岩中含量最多的一种。洋底的大部分和许多岛屿，如夏威夷山脉，都是由玄武岩组成的。玄武岩也形成了我们大陆的广阔区域，在巴西、印度、南非、西伯利亚和北美洲的太平洋西北地区都发现了玄武岩，玄武岩的深成同类岩石是辉长岩；辉长岩与玄武岩成分相同，但因为辉长岩在地球深部冷却更缓慢，所以颗粒粗大。

中性火成岩 中性火成岩比铁镁质岩石二氧化硅含量更多，含量为 55%～65%，通常颜色更浅。中性火成岩典型成分是铁镁矿物，如辉石和闪石，以及富含钠和铝的矿物如钠长石和云母，和少量的石英组成。中性火成岩的实例有隐晶质火山安山岩(以南美洲安第斯山命名，在那里这种类型火成岩控制了区域地质)，它的显晶深成岩为闪长岩。

长英质火成岩 术语“长英质的”来源于长石和二氧化硅。长英质火成岩比铁镁质或中性火成岩的二氧化硅含量更高，含量在 65%或更多。因为长英质火成岩中含铁、镁、钙硅酸盐少，但富含钾长石、富铝(白云母)云母和石英，所以通常颜色更浅。长英质火成岩的实例包括常见的深成显晶质花岗岩和其火山隐晶质同类流纹岩。长英质火成岩结构比其他火成岩的结构种类更多，包括一些玻璃质岩石和超大颗粒的伟晶岩。

Unit 2

Text

Sedimentary Rocks

1 The Origins of Sedimentary Rocks

Sediments are classified according to the source of their constituent materials as either detrital or chemical (Fig.2.1). Detrital sediment is composed of solid fragments, or detritus, of

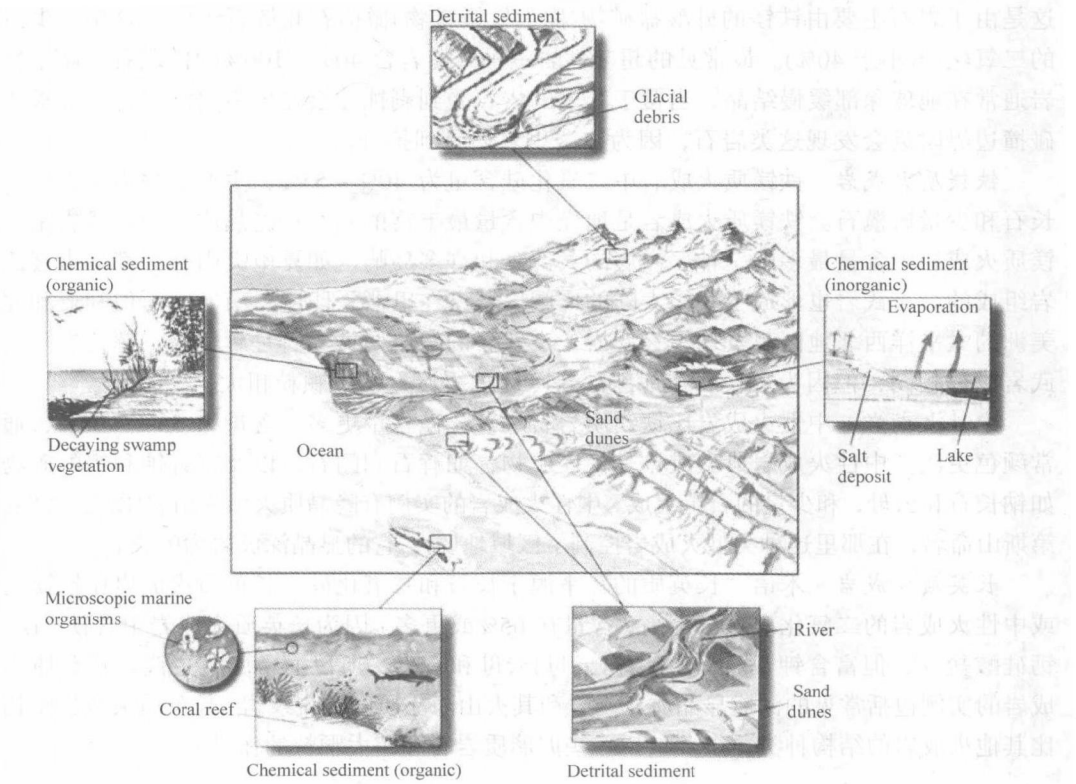


Figure 2.1 Various types of sediments and their origins

Detrital sediments, such as glacial debris or river-channel sand, consist of preexisting rock fragments. Chemical sediments often consist of minerals precipitated directly from water, such as salt deposits produced by evaporation of small temporary lakes; they may also be composed of organic debris, such as partially decayed swamp vegetation or the shells of small marine organisms