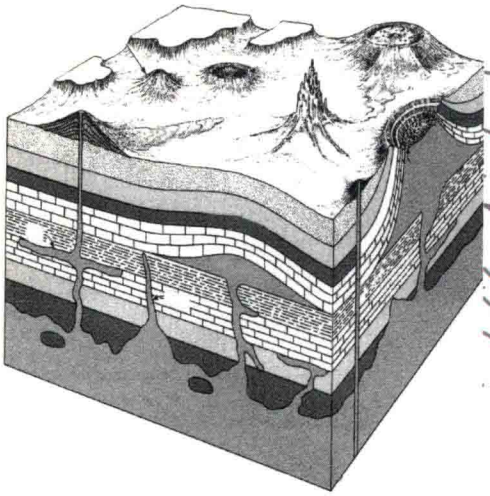

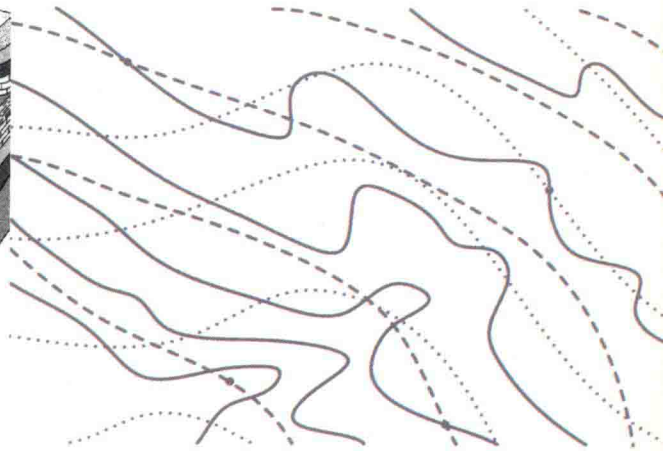

Engineering Geology

工程地质学

Feng Jinyan Chen Jun Yao Yangping

冯锦艳 陈 军 姚仰平

北京航空航天大学出版社
BEIHANG UNIVERSITY PRESS

Engineering Geology
工程地质学

Feng Jinyan　Chen Jun　Yao Yangping
冯锦艳　陈　军　姚仰平

北京航空航天大学出版社

Abstract

The basic principle and application of Engineering Geology are expounded systematically in this book, which is divided into six chapters, namely, geological process and geological time, rock forming minerals and rocks, rock stratum and structures, weathering, river and groundwater, common geological disasters and engineering geological investigation. Contents are systematic and easy to be mastered. Thinking questions are provided in each chapter.

This book is written for undergraduate and postgraduate students of civil engineering. It is also a good reference book for qualifying examinations, such as Civil Engineering Qualifying Examination, Geotechnical Engineering Qualifying Examination and Environmental Assessment Qualifying Examination.

图书在版编目(CIP)数据

工程地质学 = Engineering Geology:英文 / 冯锦艳,陈军,姚仰平编著. -- 北京 : 北京航空航天大学出版社,2016.11

ISBN 978-7-5124-2307-7

Ⅰ. ①工… Ⅱ. ①冯… ②陈… ③姚… Ⅲ. ①工程地质—英文 Ⅳ. ①P642

中国版本图书馆 CIP 数据核字(2016)第 266808 号

版权所有,侵权必究。

Engineering Geology

工程地质学

Feng Jinyan Chen Jun Yao Yangping

冯锦艳 陈 军 姚仰平

责任编辑 冯 颖

*

北京航空航天大学出版社出版发行

北京市海淀区学院路 37 号(邮编 100191) http://www.buaapress.com.cn

发行部电话:(010)82317024 传真:(010)82328026

读者信箱:emsbook@buaacm.com.cn 邮购电话:(010)82316936

北京九州迅驰传媒文化有限公司印装 各地书店经销

*

开本:710×1 000 1/16 印张:8.75 字数:186 千字

2016 年 11 月第 1 版 2016 年 11 月第 1 次印刷

ISBN 978-7-5124-2307-7 定价:29.00 元

若本书有倒页、脱页、缺页等印装质量问题,请与本社发行部联系调换。联系电话:(010)82317024

此为试读,需要完整PDF请访问: www.ertongbook.com

Preface

As noted in the preface of *Engineering Geology* written by F. G. Bell, engineering geology can be defined as the application of Geology to engineering practice. In other words, it is concerned with those geological factors that influence the location, design, construction and maintenance of engineering works. Accordingly, it draws on a number of geological disciplines such as geomorphology, structural geology, sedimentology, petrology and stratigraphy. In addition, engineering geology involves hydrogeology and some understanding of rock and soil mechanics. This book is written for undergraduate and postgraduate students of civil engineering. It is hoped that this book will also be of value to those involved in the profession.

It is a regret that this book can not cover all the needs of the variety of readers who may use it. Therefore, references are provided for those who want to pursue some aspect of the subject matter to greater depth. Obviously, students of civil engineering will have done much more reading on engineering geology than the basic geological material. Moreover, this book will reflect the background of its authors and their views of the subject. However, its authors have attempted to give a balanced overview of the subject. The first, second and third chapters are compiled by Feng Jinyan, the fourth chapter is compiled by Yao Yangping, and the fifth and sixth chapters are compiled by Chen Jun.

The authors of this book gratefully acknowledge all those who have given permission to publish material from other sources. Meanwhile, the authors would like to acknowledge the National Natural Science Funds of China (Grant No. 41302273) and the support of the School of Transportation Science and Engineering, Beihang University and all of the readers.

Beihang University
Feng Jinyan
April, 2016

Contents

Introduction

Geology is an important component of Earth Science, which has developed into a branch and consists of two categories of theoretical system by the 1980s. One category is to discuss the basic subjects (such as Petrology, Mineral Deposit Geology, Dynamic Geology, Structural Geology, Geomorphology and so on), and the other category is to research the interdisciplines (such as Geophysics, Geology Mechanics, Hydrogeology, Geochronology, Engineering Geology, Disaster Geology and so on). Engineering Geology, which is a branch of Geology, is to research geological problems related to human's engineering and construction activities.

China is a country with an ancient civilization, which has built many large projects as early as the Spring and Autumn Period. All of these suggest that the ancient Chinese people not only have superb construction techniques, but also know the engineering geological environment of building sites.

After the First World War, the whole world began to enter a large-scale construction period. In 1929, Karl Terzaghi, who is an Austrian, published the first book of *Engineering Geology* in the world. In the 1930s, the former Soviet Union geologists put forward a complete and systematic engineering geology and a theory system. In 1935, Savarenski Fiodor Petrovich (1881—1946) established the engineering geological and hydrogeological research laboratory in Institute of Geological Exploration in Moscow (Московский геологоразведочный институт), and published *Hydrology Geology* (1933) and *Engineering Geology* (1937), which marked the birth of Engineering Geology. Savarenski Fiodor Petrovich put forward and developed the natural history viewpoint of Engineering Geology. R. F. Legget wrote the book of *Geology and Engineering* in 1939 and published another great work of *Civil Engineering Geology Manual*. Austrians named J. Stini and L. Müller J. are the earliest people to realize the influence of structural plane on the rock mass , and

此为试读,需要完整PDF请访问: www.ertongbook.com

established the journal of *Geology and Civil Engineering* in 1951.

Engineering Geology in China began to develope only after the founding of the People's Republic of China. In the early 1950s, Ministry of Geology established Bureau of Geology and the corresponding research institutions with the needs of national defense and economic construction, and set the Hydrological Geology to cultivate professional personnel.

Many major projects in that time promoted the rapid development of Engineering Geology in China, such as Sanmenxia Reservoir, Wuhan Yangtze River Bridge, and Xin'anjiang Hydroelectric Power Station. At the same time, some new engineering geological theories and ideas had been formed. Mr Gu Dezhen proposed structure control theory in the research of the stability of rock mass, and published a book of *Basement of Rock Engineering Geomechanics*. Mr Liu Guochang pointed out the research direction of regional stability on the basis of regional engineering geological condition and published a book of *China Regional Engineering Geology*. Mr Hu Haitao inherited and developed geomechanics theory from Mr Li Siguang, and published an article named *Regional Stability Analysis and Evaluation on Guangdong Nuclear Power Station Site Selection and Planning* combined with the thought to find a relatively stable "safety island" in an active region for the site selection of large-scale projects. In recent years, Engineering Geology in China develoopes very rapidly and keeps synchronizing with the world, which has formed its own feature. For example, in 2014, Mr Huang Runqiu completed the project named as "Geological Hazard Assessment and Prevention of Wenchuan Earthquake" and put forward the distribution regularity of seismic geological disaster dominated by "the seismogenic fault effect" and "topography effect".

Human activity is closely related to the engineering geological environment. Bad behavior will cause massive destruction of geological environment, for example, impoundment of reservoirs may induce earthquake, and over-exploitation of groundwater will cause ground subsidence of the city. The influence of human activities on the geological environment has reached or exceeded the degree of some certain natural geological function. Mr Wang Sijing considers that Environmental Geology is a new branch of Engineering Geology in terms of its research objects and theoretical basis, whose innovation point is to emphasize the effect and role of human engineering activities on the environment. Along with the increasing scale of environmental engineering geological problems and the enlarging influence range, China issued Registration of EIA Engineer, whose object is to assess and evaluate the influence of all the construction and planning on environment.

The research purpose of Engineering Geology is to find out the engineering geological conditions of the construction areas or building sites, analyze and forecast possible engineering geological problems and its effects on buildings and geological environment, put forward the measures of prevention and control of bad geological phenomena, and provide reliable geological scientific basis for normal use.

With the development of economic construction, massive infrastructure projects will be built, such as high-grade highway, harbor wharf, bridge, tunnel, airports subway, reconstruction project and many high-rise buildings, which will bring many new research topics. Geological workers need to develop new theories, new methods, and new technologies to overcome problems, and promote the development of engineering geology subject further.

This book is designed for civil engineering and airport road engineering, which have a wide range of contents, focus of the outstanding and the rich practice. It forms a system with Soil Mechanics, Rock Mechanics and Foundation Engineering, Construction Technology and other related courses. This book is divided into six chapters, namely, geological process and geological time, rock forming minerals and rocks, rock stratum and structures, weathering, river and groundwater, common geological disasters and engineering geological investigation.

Through the study of this course, engineering geology exploration task, content and method will be understood, engineering geological problems will be analyzed, the influence of human's engineering activities on the geological environment will be evaluated , and the corresponding countermeasures and management measures will be put forward.

Chapter 1

Geological Process and Geological Time

1.1 The Earth

The Earth is made up of different state material layers, namely crust, mantle and core (shown in Figure 1.1).

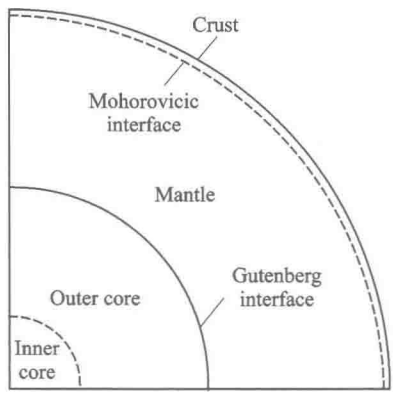

Figure 1.1 Interior structure of the Earth

1.1.1 Crust

The Earth's crust is a very thin and uneven layer, whose average thickness is about 17 km. The thickness of continental crust can amount to 70 km and the average thickness is about 33 km. Qinghai-Tibet Plateau is the thickest place of the

crust, whose thickness is more than 70 km. Oceanic crust is relatively thin, whose thickness is 5 ~ 10 km and the average thickness is about 7 km.

The Earth's crust consists of two layers described in below:

- The upper layer is sialic layer, also known as granite layer.
- The lower layer is sima, also called basaltic layer.
- Sialic layer and sima are separated by Conrad discontinuity.

The average density of the Earth's crust is about 2.8 g/cm^3, the sialic layer is about 2.7 g/cm^3 and the sima is about 2.9 g/cm^3. Sialic layer at the bottom of the ocean is very thin, especially ocean pelvic floor area. Sialic layer is missing in the middle of the Pacific, which is a discontinuity layer. The sima distributes on the continents and oceans, which is a continuous layer.

1.1.2 Mantle

The interface between the Earth's crust and the mantle is termed as the Mohorovicic (Moho) surface, which is found by seismologist Andrija Mohorovicic of Yugoslavia in 1909. He found that some seismic waves arrived at observation station faster than expected, the speed of longitudinal wave increased from 7.0 km/s to 8.1 km/s suddenly, and the shear wave velocity increased from 4.2 km/s to 4.4 km/s under the Earth's crust. This is because there is an interface between the crust and the mantle, namlhy Moho surface.

The mantle's range is from the Mohorovicic surface to the depth of 2 900 km, which accounts for about 83.3% of the Earth's volume. The mantle is divided into two layers according to the change of seismic wave. The depth of upper mantle is from 33 km to 980 km, which is composed by ultrabasic rocks. The depth of lower mantle is from 980 km to 2 900 km, which is composed by silicate, metallic oxide and sulfide. The density of lower mantle is about 5.1 g/cm^3.

Lithosphere includes the Earth's crust and the top of the upper mantle, which is on the asthenosphere. The asthenosphere is located in the upper portion of the upper mantle—of which the temperature is up to about 1 300 ℃ and the pressure is about 30 000 atmospheres. It is called asthenosphere because it can move slowly with half a viscous state. The asthenosphere is likely to be the birthplace of magma.

In 1914, German geophysicist Gutenberg (He became an American in 1936) found that longitudinal wave velocity decreased and shear wave disappeared at the underground of about 2 900 km depth. Later, it turned out that there is an interface between the core and the mantle, which is known as the Gutenberg interface.

1.1.3 Centrosphere

The centrosphere is the core part of the Earth and below the Earth's mantle. The centrosphere includes three layers, namely the outer core, the transition layer and the inner core.

The range of the outer core is from 2 900 km to 4 700 km below the Earth's surface, which is mainly composed by the mixture of molten iron and nickel, and a small amount of light elements such as Si and S. The density of the outer core is about 10 g/cm^3. The range of inner core is from 5 100 km to 6 371 km below the Earth surface, which is mainly composed by heavy metals such as iron, nickel.

The density of the inner core is about 12.5 g/cm^3.

The transition layer is located between the outer core and the inner core, whose thickness is 400 km. The state of matter of the transition layer is from liquid to solid.

1.1.4 Information Statistics of the Earth Structure

Table 1.1 is the information statistics of the Earth structure.

Table 1.1 Information statistics of the Earth structure

Name of the Earth's spheres				Depth/km	Seismic P-wave velocity/(km·s^{-1})	Seismic shear wave velocity/(km·s^{-1})	Density/(g·cm^{-3})	State of matter
The first classification	The second classification		Traditional classification					
Ectosphere	Crust		Crust	0～33	5.6～7.0	3.4～4.2	2.6～2.9	Solid
	Outside transition layer	Upper	Upper mantle	33～980	8.1～10.1	4.4～5.4	3.2～3.6	Part of the molten material
		Bottom	Lower mantle	980～2 900	12.8～13.5	6.9～7.2	5.1～5.6	Liquid—Solid
Liquid layer	Liquid layer		Outer Core	2 900～4 700	8.0～8.2	It cannot pass	10.0～11.4	Liquid
Endosphere	Inside transition layer		Transition layer	4 700～5 100	9.5～10.3		12.3	Liquid—Solid
	Centrosphere		Inland nuclear	5 100～6 371	10.9～11.2		12.5	Solid

1.2 Geological Process

Geological process refers to the changes of the Earth's crust material composition, internal structure and surface morphology caused by the natural power. Some geological processes occur very quickly such as earthquake and vulcanian eruption, and some geological processes are very slow, for example, the Dutch coast goes down 2 mm per year on average.

The power of geological process comes from the internal thermal energy produced by metamorphosis of radioactive elements of the Earth's interior, solar radiation, the rotating force of the Earth and gravity. Geological process is divided into endogenic geological process and exogenic geological process according to the position and the origin of the energy.

1.2.1 Endogenic Geological Process

Endogenic geological process refers to the changes of material composition, structure, form of the lithosphere caused by the Earth's interior energy, which are divided into crustal movement, magmatism, earthquake action and metamorphism.

1. Crustal Movement

Crustal movement (tectonic movement) includes lifting and sunken of the Earth's crust or lithosphere, the outline changes of the land and the sea, the formation and development of mountain trench, etc. According to the motion directions, crustal movement can be divided into horizontal motion and lifting movement.

Horizontal motion refers that the Earth's crust or lithosphere block moves along the horizontal direction, such as adjacent blocks' separation, meeting or shearing, which is the most intense crustal evolution process. It is generally believed that horizontal motion is the main reason for the formation of various tectonic on the Earth's crust surface, such as fold, fracture or basin. San Andreas Fault in the United States and the Himalayas in China are the products of the horizontal motions.

Lifting movement refers that the Earth's crust moves perpendicular to the surface, namely along the Earth's radius direction, which causes regression and transgression of the sea and large uplift and settlement.

Table 1.2 provides the comparison between horizontal motion and lifting movement.

Table 1.2 Horizontal motion vs lifting movement

Crustal movement	Motor direction	Rock performance	Motion result
Horizontal motion	Material of the Earth's crust moves along the horizontal direction	Rocks bend and uplift, or break and open	Huge folded mountain, rift valley and ocean
Lifting movement	Material of the Earth's crust moves perpendicularly to the surface of the Earth	The Earth's crust rises or drops	The Earth's surfac is up and down, and the exchange appears between the land and the sea

2. Magmatism

Magmatism is that the active magma intrudes or even erupts out of the Earth surface along weak zones due to great pressure, which is divided into vulcanian eruption and intrusion (refer to Subsection 2.4).

3. Metamorphism

Metamorphism refers that the matter, structure or texture of the rocks has changed under the conditions of high temperature, high pressure and participation of other chemicals (refer to Subsection 2.3).

4. Earthquake Action

Earthquake action refers to the rapid vibration phenomenon of the Earth's crust, most of which are caused by crustal movement and named tectonic earthquake (refer to Subsection 5.4).

1.2.2 Exogenic Geological Process

Exogenic geological process refers to the geological process caused by the energy beyond the Earth. The energy mainly comes from solar radiation and the gravitational pull of the Sun and the Moon.

Exogenic geological process is divided into weathering, denudation, transportation, deposition and diagenesis.

Weathering refers to physical and chemical change processes on site of the Earth's crust under the conditions of the ambient temperature and pressure.

Denudation refers to the peeling of the weathering products from rocks, destruction of unweathered rocks and change of the appearance of rocks. It is divided

此为试读,需要完整PDF请访问: www.ertongbook.com