教育部高等学校地矿学科
教学指导委员会采矿工程专业规划教材

丛书主编 古德生

Mining Engineering English

采矿工程专业英语

周科平 李杰林 主编

MINING ENGINEERING ENGLISH

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序

站在21世纪全球发展战略的高度来审视世界矿业，可以清楚地看到，矿业作为国民经济的基础产业，与其他传统产业一样，在现代科学技术突飞猛进的推动下，也正逐步走向现代化。就金属矿床开采领域而言，现今的采矿工程科学技术与20世纪90年代以前的相比，已经不可同日而语。为了适应矿业快速发展的形势，国家需要大批具有现代采矿知识的专业人才，因此，作为优秀专业人才培养的重要基础建设之一——教材建设就显得至关重要。

在2006—2010年地矿学科教学指导委员会（以下简称地矿学科教指委）的成立大会上，委员们一致认为，抓教材建设是本届教学指导委员会的重要任务之一，特别是金属矿采矿工程专业的教材，现在多是20世纪90年代出版的，教材更新已迫在眉睫。2006年10月18～20日在中南大学召开了第一次地矿学科教指委全体会议，会上委员们就开始酝酿采矿工程专业系列教材的编写拟题；之后，中南大学出版社主动承担该系列教材的出版工作，并积极协助地矿学科教指委于2007年6月22～24日在中南大学召开了"全国采矿工程专业学科发展与教材建设研讨会"，来自全国17所院校的金属、非金属矿床采矿工程专业和部分煤矿开采专业的领导及骨干教师代表参加

了会议，会议拟定了采矿工程专业系列教材的选题和主编单位；从那以后，地矿学科教指委和中南大学出版社又分别在昆明和长沙召开了两次采矿工程专业系列教材编写大纲的审定工作会议。

本次新规划出版的采矿工程专业系列教材侧重于金属矿床开采领域。编审委员会通过充分的沟通和研讨，在总结以往教学和教材编撰经验的基础上，以推动新世纪采矿工程专业教学改革和教材建设为宗旨，提出了采矿工程专业系列教材的编写原则和要求：①教材的体系、知识层次和结构要合理，要遵循教学规律，既要有利于组织教学又要有利于学生学习；②教材内容要体现科学性、系统性、新颖性和实用性，并做到有机结合；③要重视基础，又要强调采矿工程专业的实践性和针对性；④要体现时代特性和创新精神，反映采矿工程学科的新技术、新方法、新规范、新标准等。

采矿科学技术在不断发展，采矿工程专业的教材需要不断完善和更新。希望全国参与采矿工程专业教材编写的专家们共同努力，写出更多、更好的采矿工程专业新教材。我们相信，本系列教材的出版对我国采矿工程专业高级人才的培养和采矿工程专业教育事业的发展将起到十分积极的推进作用，对我国矿山安全、经济、高效开采，保障我国矿业持续、健康、快速发展也有着十分重要的意义。

中南大学教授

中国工程院院士

教育部地矿学科教指委主任

2008 年 8 月

序言

随着中国经济的飞速发展，中国的矿业也正向国际化、全球化方向发展。国外矿业企业不断地涌入中国和中国矿业企业实行走出去的发展战略，必将给中国的矿业发展带来新的机遇和挑战。同时，也彰显出了我国在国际化经济大背景下，社会对国际化矿业人才的迫切需求。对培养矿业人才的高等院校来说，必须把握时代脉搏，培养出适应社会发展的国际化矿业人才。正是在这样的背景下，我们编写了该书，该书全部内容均选自国内外权威的专业书刊和网站，全书贯穿了金属矿山(包括露天和地下矿)从地质勘探开始，到可行性研究、矿山设计、进度计划编排、生产施工、矿业企业运营管理和未来采矿技术等各个方面的内容。

在编写本书的过程中，编者精心挑选了一些概括性较强的文章，尤其是一些工艺步骤的介绍。全书中每篇文章内容约1000字，长度适中，为便于读者更好地理解课文内容，每篇文章后还列出了生词和注释。通俗易懂，能让读者快速地学习和掌握采矿专业知识的英文表达方式，提高专业英语技能。同时，希望能够抛砖引玉，让读者可结合自己实际情况，去查阅和掌握更多的采矿专业英语。

本书的内容包括了矿山地质勘探、矿床资源评估、可行性研究、露天/地下矿山的设计和进度计划、露天采矿技术、地下矿山开拓系统、地下矿采矿方法、矿山岩石力学、矿山附属设施、矿山企业运营管理、未来采矿技术等专业知识。可以说，该书相当于一本简明的英语版金属矿采矿概论，通过阅读和学习，读者能够掌握最基本的采矿专业英语词汇。

本书既可作为有色工业高等院校采矿工程专业的英语教材，也可供矿山企业管理、工程技术人员以及从事矿产资源开发的人员自学参考。

由于编者的水平有限，错漏、不足之处在所难免，恳请读者批评指正！本书在编写过程中参阅了大量的国内外资料，在此谨向有关文献的作者表示衷心的感谢！

编　者
2010年4月

目　录 Contents

Introduction to Mining 前言

1. Mining's Contribution to Civilization

Mining may well have been the second of humankind's earliest endeavors—granted that agriculture was the first. The two industries ranked together as the primary or basic industries of early civilization. Little has changed in the importance of these industries since the beginning of civilization. If we consider fishing and lumbering as part of agriculture and oil and gas production as part of mining, then agriculture and mining continue to supply all the basic resources used by modern civilization.

From **prehistoric** times to the present, mining has played an important part in human existence. Here the term mining is used in its broadest context as encompassing the **extraction** of any naturally occurring **mineral** substances—solid, liquid, and gas—from the earth or other heavenly bodies for utilitarian purposes.

2. Mining Terminology

There are many terms and expressions unique to mining that characterize the field and identify the user of such terms as a "mining person". The student of mining is thus advised to become familiar with all the terms used in mining, particularly those that are peculiar to either mines or minerals. Most of the mining **terminology** is introduced in the sections of this book where they are most applicable. Some general terms are best defined at the outset; these are outlined here. The following three terms are closely related.

Mine An excavation made in the earth to extract minerals Mining: the activity, occupation, and industry concerned with the extraction of minerals Mining engineering: the practice of applying engineering principles to the development, planning, operation, closure and reclamation of mines.

Some terms distinguish various types of mined minerals. Geologically, one can distinguish the following mineral categories:

Mineral A naturally occurring inorganic element or compound having an orderly internal structure and a characteristic chemical composition, crystal form, and physical properties.

Rock Any naturally formed aggregate of one or more types of mineral particles.

Economic differences in the nature of mineral deposits are evident in the following terms:

(1) Ore A mineral deposit that has sufficient utility and value to be mined at a profit.

(2) Gangue The valueless mineral particles within an ore deposit that must be discarded.

(3) Waste The material associated with an ore deposit that must be mined to get at the ore and must then be discarded. Gangue is a particular type of waste.

A further subdivision of the types of minerals mined by humankind is also common. These terms are often used in the industry to differentiate between the **fuels**, **metals** and **nonmetallic** minerals. The following are the most common terms used in this differentiation:

Metallic ores Those ores of the **ferrous metals** (**iron**, **manganese**, **molybdenum** and **tungsten**), the base metals (copper, lead and tin), the **precious metals** (gold, silver, the **platinum** group metals) and the radioactive minerals (**uranium**, **thorium** and **radium**).

Nonmetallic minerals (also known as industrial minerals) The nonfuel mineral ores that are not associated with the production of metals. These include **phosphate**, **potash**, **halite**, **trona**, **sand**, **gravel**, **limestone**, **sulfur**, and many others.

Fossil fuels (also known as mineral fuels) The organic mineral substances that can be utilized as fuels, such as coal, petroleum, natural gas, coalbed methane, **gilsonite and tar sands**.

The essence of mining in extracting mineral wealth from the earth is to drive an excavation or excavations from the surface to the mineral deposit. Normally, these openings into the earth are meant to allow personnel to enter into the underground deposit. However, **boreholes** are at times used to extract the mineral values from the earth. These fields of boreholes are also called mines, as they are the means to mine a mineral deposit, even if no one enters into the geologic realm of the deposit. Note that when the economic profitability of a mineral deposit has been established with some confidence, ore or ore deposit is preferred as the descriptive term for the mineral occurrence. However, coal and industrial mineral deposits are often not so designated, even if their profitability has been firmly established. If the excavation used for mining is entirely open or operated from the surface, it is termed a surface mine. If the excavation consists of openings for human entry below the earth's surface, it is called an underground mine. The details of the procedure, layout and equipment used in the mine distinguish the mining method. This is determined by the geologic, physical, environmental, economic and legal circumstances that pertain to the ore deposit being mined.

Vocabulary

prehistoric [ˈpriːhisˌtɔrik] adj.	史前的
mineral [ˈminərə] n.	矿物；矿石；矿物质
terminology [ˌtəːmiˈnɔlədʒi] n.	专门用语，术语
excavation [ˌekskəˈveiʃən] n.	发掘；挖掘；开凿
fuel [fjuəl] n.	燃油
metal [ˈmetl] n.	金属
nonmetallic [ˈnɔnmiˈtælik] adj.	非金属的
ferrous [ˈferəs] adj.	铁的，含铁的
ferrous metals	黑色金属
iron [ˈaiən] n.	铁
manganese [ˌmæŋgəˈniːz] n.	锰
molybdenum [məˈlibdinəm] n.	钼
tungsten [ˈtʌŋstən] n.	钨
precious metals	贵金属
platinum [ˈplætinəm] n.	铂；白金
uranium [juəˈreinjəm] n.	铀
thorium [ˈθɔːriəm] n.	钍
radium [ˈreidjəm] n.	镭
phosphate [ˈfɔsfeit] n.	磷酸盐
potash [ˈpɔtæʃ] n.	碳酸钾，苛性钾
halite [ˈhælait] n.	岩盐
trona [ˈtrəunə] n.	天然碱
gravel [ˈgrævəl] n.	沙砾，砾石

limestone [ˈlaimstəun] n.	石灰岩
sulfur [ˈsʌlfə] n.	硫磺，硫黄
gilsonite [ˈgilsəˌnait] n.	硬沥青
tar sand	沥青砂
borehole [ˈbɔːhəul] n.	孔，炮[井]眼；矿井；钻井

Unit 1 Geology, Surveying and Feasibility Studies 地质、测量及可行性研究

1.1 Mineral Exploration 地质勘探

Mineral exploration is the process undertaken by companies, partnerships or corporations in the endeavour of finding ore (commercially viable concentrations of minerals) to mine. Mineral exploration is a much more intensive, organised and professional form of mineral **prospecting** and though it frequently uses the services of prospecting, the process of mineral exploration on the whole is much more involved.

Stages of mineral exploration are includes:

1. Area Selection

Area selection is a crucial step in professional mineral exploration. Selection of the best, most prospective, area in a mineral field, geological region or **terrain** will assist in making it not only possible to find ore deposits, but to find them easily, cheaply and quickly.

Area selection is based on applying the theories behind ore genesis, the knowledge of known ore occurrences and the method of their formation, to known geological regions via the study of geological maps, to determine potential areas where the particular class of ore deposit being sought may exist. Oftentimes new styles of deposits may be found which reveal opportunities to find lookalike deposit styles in rocks and terranes previously though unprospective, which may result in a process of pegging of leases in similar geological settings based on this new model or methodology.

This process applies the disciplines of basin modeling, **structural geology**, **geochronology**, **petrology** and a host of **geophysical** and **geochemical** disciplines to make predictions and draw parallels between the known ore deposits and their physical form and the unknown potential of finding a "lookalike" within the area selected.

Area selection is also influenced by the commodity being sought, exploring for gold occurs in a different manner and within different rocks and areas to exploration for oil or natural gas or iron ore. Areas which are prospective for gold may not be prospective for other metals and commodities.

Area selection may also be influenced by previous finds, a practice affectionately named nearology, and may also be determined in part by financial and taxation incentives and tariff systems of individual nations. The role of infrastructure may also be crucial in area selection, because the ore must be brought to market and infrastructure costs may render isolated ore uneconomic.

The ultimate result of an area selection process is the pegging or notification of exploration licenses, known as tenements.

2. Target Generation

The target generation phase involves investigations of the geology via **mapping**, geophysics and conducting geochemical or intensive geophysical testing of the surface and subsurface geology. In some cases, for instance in areas covered by soil, **alluvium** and platform cover, drilling may be performed directly as a mechanism for generating targets.

3. Geophysical Methods

Geophysical instruments play a large role in gathering geological data which is used in mineral exploration. Instruments are used in geophysical surveys to check for variations in **gravity**, **magnetism**, **electromagnetism** (resistivity of rocks) and a number of different other variables in a certain area. The most effective and widespread method of gathering geophysical data is via flying airborne geophysics.

Airborne magnetometers are used to search for magnetic anomalies in the Earth's magnetic field. The anomalies are an indication of concentrations of magnetic minerals such as **magnetite**, **pyrrhotite** and **ilmenite** in the Earth's crust. It is often the case that such magnetic anomalies are caused by mineralization events and associated metals.

Ground-based **geophysical prospecting** in the target selection stage is more limited, due to the time and cost. The most widespread use of ground-based geophysics is electromagnetic geophysics which detects conductive minerals such as sulfide minerals within more resistive host rocks.

Ultraviolet lamps may cause certain minerals to fluoresce, and is a key tool in prospecting for tungsten mineralisation.

4. Remote Sensing

Aerial photography is an important tool in assessing mineral exploration tenements, as it gives the explorer orientation information—location of tracks, roads, fences, habitation, as well as ability to at least qualitatively map outcrops and **regolith** systematics and vegetation cover across a region.

Satellite based **spectroscopes** allow the modern mineral explorationist, in regions devoid of cover and vegetation, to map minerals and alteration directly. Improvements in the resolution of modern commercially based satellites have also improved the utility of satellite imagery. For instance, IKONOS satellite images can be generated with a 30cm **pixel** size.

5. Geochemical Methods

The primary role of geochemistry, here used to describe assaying or geological media, in mineral exploration is to find an area anomalous in the commodity sought, or in elements known to be associated with the type of mineralisation sought.

Regional geochemical exploration has traditionally involved use of stream **sediments** to target potentially mineralised catchments. Regional surveys may use low sampling densities such as one sample per 100 square kilometres. Follow-up geochemical surveys commonly use soils as the sampling media, possibly via the collection of a grid of samples over the tenement or areas which are amenable to soil geochemistry. Areas which are covered by transported soils, alluvium, **colluvium** or are disturbed too much by human activity (roads, rail, farmland), may need to be drilled to a shallow depth in order to sample undisturbed or unpolluted **bedrock**.

Once the geochemical analyses are returned, the data is investigated for anomalies (single or multiple elements) that may be related to the presence of mineralisation. The geochemical anomaly is often field checked against the outcropping geology and, in modern geochemistry, normalised against the regolith type and landform, to reduce the effects of weathering, transported materials and landforms.

Geochemical anomalies may be spurious or related to **low-grade** or subgrade mineralisation. In order to determine if this is the case, geochemical anomalies must be drilled in order to test them for the existence of economic concentrations of mineralisation, or even to determine why they exist in the place they exist.

The presence of some chemical elements may indicate the presence of a certain mineral. Chemical analysis of rocks and plants may indicate the presence of an underground deposit. For instance elements like **arsenic** and **antimony** are associated with gold deposits and hence, are example pathfinder elements. Tree buds can be sampled for pathfinder elements in order to help locate deposits.

6. Resource Evaluation

Resource evaluation is undertaken to quantify the grade and tonnage of a mineral occurrence. This is achieved primarily by drilling to sample the prospective horizon, lode or **strata** where the minerals of interest occur.

The ultimate aim is to generate a density of drilling sufficient to satisfy the economic and statutory standards of an ore resource. Depending on the financial situation and size of the deposit and the structure of the company, the level of detail required to generate this resource and stage at which extraction can commence varies.

For small partnerships and private non-corporate enterprises a very low level of detail is required whereas for corporations which require debt equity (loans) to build capital intensive extraction infrastructure, the rigor necessary in resource estimation is far greater. For large cash rich companies working on small ore bodies, they may work only to a level necessary to satisfy their internal risk assessments before extraction commences.

Resource estimation may require pattern drilling on a set grid, and in the case of sulfide minerals, will usually require some form of geophysics such as down-hole probing of drillholes, to geophysically delineate ore body continuity within the ground.

The aim of resource evaluation is to expand the known size of the deposit and mineralisation. A scoping study is often carried out on the ore deposit during this stage to determine if there may be enough ore at a sufficient grade to **warrant** extraction; if there is not further resource evaluation drilling may be necessary. In other cases, several smaller individually uneconomic deposits may be socialised into a "mining camp" and extracted in tandem. Further exploration and testing of anomalies may be required to find or define these other satellite deposits.

7. Reserve Definition

Reserve definition is undertaken to convert a mineral resource into an ore reserve, which is an economic asset. The process is similar to resource evaluation, except more intensive and technical, aimed at statistically quantifying the grade continuity and mass of ore.