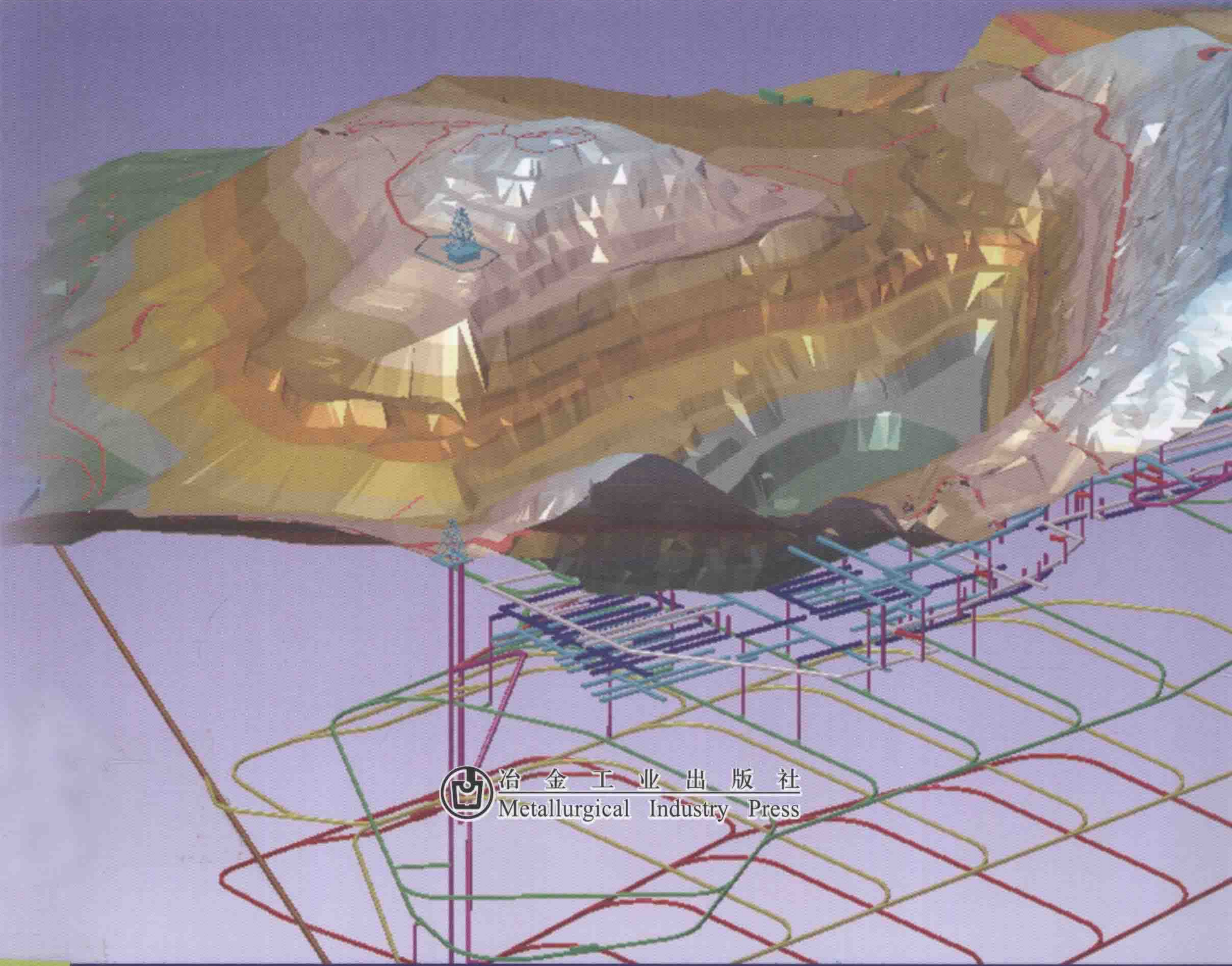
王光进　孔祥云　编著

矿山及矿山安全专业英语



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专业英语

王光进　孔祥云　编著

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内 容 提 要

本书分为两部分。第一部分为矿山专业英语，包括十三个单元，其主要内容为：矿山简介；矿山开采的几个阶段；矿山的单元作业及循环；露天矿山的开采方法；地下矿山的开采方法以及一些新型的采矿方法与技术的介绍。第二部分为矿山安全专业英语，包括十个单元，其主要内容为：矿山安全法规；矿山的安全管理；矿山安全分析方法；矿山事故；人为因素、矿山机械和电气设备等对矿山安全的影响；海上开采业的事故与安全等。

本书既可作为高等院校采矿工程专业及安全工程专业双语教学用书，同时也可供矿山工程技术人员参考。

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前　言

近年来，我国采矿业的迅速崛起，推动了国民经济的快速发展。矿产资源的安全开采涉及矿山开采及矿山安全两个方面。矿山开采是一个综合性的技术行业，涉及地质、采矿、通风、运输、安全、机电和电气、爆破、环境保护及企业管理等多方面的内容。同时，采矿受自然地理条件等因素的影响，工作环境和安全状况非常复杂，有的甚至十分恶劣，安全生产受到很大的威胁。所以采矿工程人员不仅要熟悉矿山开采技术及工艺，而且要掌握好必要的矿山安全知识。基于行业现状和教学需要，作者编写了本书。

同时，为了便于读者更好地阅读和理解，本书不仅在每个单元后面列出了生僻词汇，而且将矿山及矿山安全专业词汇作为附录放在书后，供读者查阅和参考。本书分为两部分。第一部分为矿山专业英语，包括十三个单元，其主要内容为：矿山简介；矿山开采的几个阶段；矿山的单元作业及循环；露天矿山的开采方法；地下矿山的开采方法以及新的采矿方法与技术。第二部分为矿山安全专业英语，包括十个单元，其主要内容为：矿山安全法规；矿山的安全管理；矿山安全分析方法；矿山事故；人为因素、矿山机械和电气设备等对矿山安全的影响；海上开采业的事故与安全等。

本书相当于一本简明的英文版矿山及矿山安全概论，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。

在编写过程中，本书参阅了国内外矿山及矿山安全方面的资料。在此，谨向原作者和相关人员表示衷心的感谢。

感谢国家自然科学基金委员会（重点项目“尾矿坝稳定性评价与安全监控基础性研究”(51234004)）对本书出版的支持。

由于编者的水平所限，书中不足之处，恳请广大读者及同行批评指正！

编　者

2013 年 10 月

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Unit 1 Mining and Mining Technology (采矿及采矿工艺)

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. The abundance of minerals also provides a method of creating wealth. Minerals can be marketed on the open market, enabling the countries that possess them to obtain valuable currency from countries that do not. This generally results in the minerals-rich countries being the great civilizations of the world while the "have-not" countries generally suffer from a lower standard of living. The ability to use mineral resources as a means of creating wealth opens the possibility that a given country or countries will attempt to control the entire market in a particular mineral, that is, to create an economic cartel in that mineral.

As one of humanity's earliest endeavors—and certainly one of its first organized industries—mining has an ancient and venerable history. To understand modern mining practices, it is useful to trace the evolution of mining technology, which has paralleled human evolution and the advance of civilization. Mining in its simplest form began with Paleolithic humans some 450,000 years ago, evidenced by the flint implements that have been found with the bones of early humans from the Old Stone Age. Our ancestors extracted pieces from loose masses of flint or from easily accessed outcrops and, using crude methods of chipping the flint, shaped them into tools and weapons. By the New Stone Age, humans had progressed to underground mining in systematic openings 0.6 to 0.9m in height and more than 9m in depth. However, the oldest known underground mine, a hematite mine at Bomvu Ridge, Swaziland, is from the Old Stone Age and believed to be about 40,000 years old. Early miners employed crude methods of ground control, ventilation, haulage, hoisting, lighting, and rock breakage. Nonetheless, mines attained depths of 250m by early Egyptian times. Metallic minerals also attracted the attention of prehistoric humans. Initially, metals were used in their native form, probably obtained by washing river gravel in placer deposits. With the advent of the Bronze and Iron ages, however, humans discovered smelting and learned to reduce ores into pure metals or alloys, which greatly improved their ability to use these metals.

The first challenge for early miners was to break the ore and loosen it from the surrounding rock. Often, their crude tools made of bone, wood, and stone were no match for the harder rock, unless the rock contained crevices or cracks that could be opened by wedging or prying. As a result, they soon devised a revolutionary technique called fire setting, whereby they first heated the rock to expand it and then doused it with cold water to contract and break it. This was one of the first great advances in the science of rock breakage and had a greater impact than any other discovery until dynamite was invented by Alfred Nobel in 1867.

Mining technology, like that of all industry, languished during the Dark Ages. Notably, a political development in 1185 improved the standing of mining and the status of miners, when the bishop of Trent granted a charter to miners in his domain. It gave miners legal as well as social rights, including the right to stake mineral claims. A milestone in the history of mining, the edict has had long-term consequences that persist to this day. The greatest impact on the need for and use of minerals, however, was provided by the Industrial Revolution at the close of the eighteenth century. Along with the soaring demand for minerals came spectacular improvements in mining technology, especially in scientific concepts and mechanization, that have continued to this day. During the last two centuries, there has been great progress in mining technology in many different areas. Such progress is often made in an evolutionary rather than a revolutionary manner. Yet every once in a while, a revolutionary discovery comes along and changes the process of mining profoundly. During the nineteenth century, the invention of dynamite was the most important advance. In the twentieth century, the invention of continuous mining equipment, which extracts the softer minerals like coal without the use of explosives, was perhaps the most notable of these accomplishments. The first continuous miner was tested in about 1940, with its usefulness greatly enhanced by the development of tungsten carbide inserts in 1945 by McKenna Metals Company (now Kennametal). By 1950 the continuous miner had started to replace other coal mining methods. The era of mechanized mining had begun.

1.1 Stages of Modern Mining（现代采矿的运行阶段）

The overall sequence of activities in modern mining is often compared with the five stages in the life of a mine: prospecting, exploration, development, exploitation, and reclamation. Prospecting and exploration, precursors to actual mining, are linked and sometimes combined. Geologists and mining engineers often share responsibility for these two stages—geologists more involved with the former, mining engineers more with the latter. Likewise, development and exploitation are closely related stages; they are usually considered to constitute mining proper and are the main province of the mining engineer. Reclamation has been added to these stages since the first edition, to reflect the times. Closure and reclamation of the mine site has become a necessary part of the mine life cycle because of the demands of society for a cleaner environment and stricter laws regulating the abandonment of a mine. The overall process of developing a mine with the future uses of the land in mind is termed sustainable development. This concept was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The ideas presented therein have been widely endorsed as a practical means of providing for future generations.

1.1.1 Prospecting（勘探）

Prospecting, the first stage in the utilization of a mineral deposit, is the search for ores or other valuable minerals (coal or nonmetallics). Because mineral deposits may be located either at or below the surface of the earth, both direct and indirect prospecting techniques are employed. The direct method of discovery, normally limited to surface deposits, consists of visual examination of either the exposure (outcrop) of the deposit or the loose fragments (float) that have weathered away from the outcrop. Geologic studies of the entire area augment this simple, direct technique. By means of aerial photography, geologic maps, and structural assessment of an area, the geologist gathers evidence by direct methods to locate mineral deposits. Precise mapping and structural analysis plus microscopic studies of samples also enable the geologist to locate the hidden as well as surface mineralization. The most valuable scientific tool employed in the indirect search for hidden mineral deposits is geophysics, the science of detecting anomalies using physical measurements of gravitational, seismic, magnetic, electrical, electromagnetic, and radiometric variables of the earth. The methods are applied from the air, using aircraft and satellites; on the surface of the earth; and beneath the earth, using methods that probe below the topography. Geochemistry, the quantitative analysis of soil, rock, and water samples, and geobotany, the analysis of plant growth patterns, can also be employed as prospecting tools.

1.1.2 Exploration(探矿)

The second stage in the life of a mine, exploration, determines as accurately as possible the size and value of a mineral deposit, utilizing techniques similar to but more refined than those used in prospecting. The line of demarcation between prospecting and exploration is not sharp; in fact, a distinction may not be possible in some cases. Exploration generally shifts to surface and subsurface locations, using a variety of measurements to obtain a more positive picture of the extent and grade of the ore body. Representative samples may be subjected to chemical, metallurgical, X-ray, spectrographic, or radiometric evaluation techniques that are meant to enhance the investigator's knowledge of the mineral deposit. Samples are obtained by chipping outcrops, trenching, tunneling, and drilling; in addition, borehole logs may be provided to study the geologic and structural makeup of the deposit. Rotary, percussion, or diamond drills can be used for exploration purposes. However, diamond drills are favored because the cores they yield provide knowledge of the geologic structure. The core is normally split along its axis; one half is analyzed, and the other half is retained intact for further geologic study.

An evaluation of the samples enables the geologist or mining engineer to calculate the tonnage and grade, or richness, of the mineral deposit. He or she estimates the mining costs, evaluates the recovery of the valuable minerals, determines the environmental costs, and assesses other foreseeable factors in an effort to reach a conclusion about the profitability of the mineral deposit. The crux of the analysis is the question of whether the property is just another mineral deposit or an ore body. For an ore deposit, the overall process is called reserve estimation, that is, the examination and valuation of the ore body. At the conclusion of this stage, the project is developed, traded to another party, or abandoned.

1.1.3 Development (发展)

In the third stage, development, the work of opening a mineral deposit for exploitation is performed. With it begins the actual mining of the deposit, now called the ore. Access to the deposit must be gained either by stripping the overburden, which is the soil and/or rock covering the deposit, to expose the near-surface ore for mining or by excavating openings from the surface to access more deeply buried deposits to prepare for underground mining.

In either case, certain preliminary development work, such as acquiring water and mineral rights, buying surface lands, arranging for financing, and preparing permit applications and an EIS, will generally be required before any development takes place. When these steps have been achieved, the provision of a number of requirements—access roads, power sources, mineral transportation systems, mineral processing facilities, waste disposal areas, offices, and other support facilities—must precede actual mining in most cases. Stripping of the overburden will then proceed if the minerals are to be mined at the surface. Economic considerations determine the stripping ratio, the ratio of waste removed to ore recovered; it may range from as high as 38m^3/tonne for coal mines to as low as 0.8m^3/tonne in metal mines. Some nonmetallic mines have no overburden to remove; the mineral is simply excavated at the surface.

Development for underground mining is generally more complex and expensive. It requires careful planning and layout of access openings for efficient mining, safety, and permanence. The principal openings may be shafts, slopes, or adits; each must be planned to allow passage of workers, machines, ore, waste, air, water, and utilities. Many metal mines are located along steeply dipping deposits and thus are opened from shafts, while drifts, winzes, and raises serve the production areas. Many coal and nonmetallic mines are found in nearly horizontal deposits. Their primary openings may be drifts or entries, which may be distinctly different from those of metal mines.

1.1.4 Exploitation (开采)

Exploitation, the fourth stage of mining, is associated with the actual recovery of minerals from the earth in quantity. Although development may continue, the emphasis in the production stage is on production. Usually only enough development is done prior to exploitation to ensure that production, once started, can continue uninterrupted throughout the life of the mine.

The mining method selected for exploitation is determined mainly by the characteristics of the mineral deposit and the limits imposed by safety, technology, environmental concerns, and economics. Geologic conditions, such as the dip, shape, and strength of the ore and the surrounding rock, play a key role in selecting the method. Traditional exploitation methods fall into two broad categories based on locale: surface or underground. Surface mining includes mechanical excavation methods such as open pit and open cast (strip mining), and aqueous methods such as placer mining and solution mining. Underground mining is usually classified in three categories of methods: unsupported, supported, and caving.

(1) Surface mining. Surface mining is the predominant exploitation procedure worldwide, producing in the United States about 85% of all minerals, excluding petroleum and natural gas. Almost all metallic ores (98%), about 97% of the nonmetallic ores, and 61% of the coal in the United States are mined using surface methods, and most of these are mined by open pit or open cast methods. In open pit mining, a mechanical extraction method, a thick deposit is generally mined in benches or steps, although thin deposits may require only a single bench or face. Open pit or open cast mining is usually employed to exploit a near-surface deposit or one that has a low stripping ratio. It often necessitates a large capital investment but generally results in high productivity, low operating cost, and good safety conditions. The aqueous extraction methods depend on water or another liquid (e. g., dilute sulfuric acid, weak cyanide solution, or ammonium carbonate) to extract the mineral. Placer mining is used to exploit loosely consolidated deposits like common sand and gravel or gravels containing gold, tin, diamonds, platinum, titanium, or coal. Hydraulicking utilizes a high-pressure stream of water that is directed against the mineral deposit (normally but not always a placer), undercutting it, and causing its removal by the erosive actions of the water. Dredging performed from floating vessels, accomplishes the extraction of the minerals mechanically or hydraulically. Solution mining includes both borehole mining, such as the methods used to extract sodium chloride or sulfur, and leaching, either through drill holes or in dumps or heaps on the surface. Placer and solution mining are among the most economical of all mining methods but can only be applied to limited categories of mineral deposits.

(2) Underground mining. Underground methods—unsupported, supported, and caving—are differentiated by the type of wall and roof supports used, the configuration and size of production openings, and the direction in which mining operations progress. The unsupported methods of mining are used to extract mineral deposits that are roughly tabular (plus flat or steeply dipping) and are generally associated with strong ore and surrounding rock. These methods are termed unsupported because they do not use any artificial pillars to assist in the support of the openings. However, generous amounts of roof bolting and localized support measures are often used. Room-and-pillar mining is the most common unsupported method, used primarily for flat-lying seams or bedded deposits like coal, trona, limestone, and salt. Support of the roof is provided by natural pillars of the mineral that are left standing in a systematic pattern. Stope-and-pillar mining (a stope is a production opening in a metal mine) is a similar method used in non-coal mines where thicker, more irregular ore bodies occur; the pillars are spaced randomly and located in low-grade ore so that the high-grade ore can be extracted. These two methods account for almost all of the underground mining in horizontal deposits in the United States and a very high proportion of the underground tonnage as well. Two other methods applied to steeply dipping deposits are also included in the unsupported category. In shrinkage stoping, mining progresses upward, with horizontal slices of ore being blasted along the length of the stope. A portion of the broken ore is allowed to accumulate in the stope to provide a working platform for the miners and is thereafter withdrawn from the stope through chutes. Sublevel stoping differs from shrinkage stoping by providing sublevels from which vertical slices are blasted. In this manner, the stope is mined horizontally from one end to the other. Shrinkage stoping is more suitable than sublevel stoping for stronger ore and weaker wall rock.

Supported mining methods are often used in mines with weak rock structure. Cut-and-fill stoping is the most common of these methods and is used primarily in steeply dipping metal deposits. The cut-and-fill method is practiced both in the overhand (upward) and in the underhand (downward) directions. As each horizontal slice is taken, the voids are filled with a variety of fill types to support the walls. The fill can be rock waste, tailings, cemented tailings, or other suitable materials. Cut-and-fill mining is one of the more popular methods used for vein deposits and has recently grown in use. Square-set stoping also involves backfilling mine voids; however, it relies mainly on timber sets to support the walls during mining. This mining method is rapidly disappearing in North America because of the high cost of labor. However, it still finds occasional use in mining high-grade ores or in countries where labor costs are low. Stull stoping is a supported mining method using timber or rock bolts in tabular, pitching ore bodies. It is one of the methods that can be applied to ore bodies that have dips between 10° and 45°. It often utilizes artificial pillars of waste to support the roof.

Caving methods are varied and versatile and involve caving the ore and/or the overlying rock. Subsidence of the surface, normally occurs afterward. Longwall mining is a caving method particularly well adapted to horizontal seams, usually coal, at some depth. In this method, a face of considerable length (a long face or wall) is maintained, and as the mining progresses, the overlying strata are caved, thus promoting the breakage of the coal itself. A different method, sublevel caving, is employed for a dipping tabular or massive deposit. As mining progresses downward, each new level is caved into the mine openings, with the ore materials being recovered while the rock remains behind. Block caving is a large-scale or bulk mining method that is highly productive, low in cost, and used primarily on massive deposits that must be mined underground. It is most applicable to weak or moderately strong ore bodies that readily break up when caved. Both block caving and longwall mining are widely used because of their high productivity.

In addition to these conventional methods, innovative methods of mining are also evolving. These are applicable to unusual deposits or may employ unusual techniques or equipment. Examples include automation, rapid excavation, underground gasification or liquifaction, and deep-sea mining.

1.1.5 Reclamation (复垦)

The final stage in the operation of most mines is reclamation, the process of closing a mine and recontouring, revegetating, and restoring the water and land values. The best time to begin the reclamation process of a mine is before the first excavations are initiated. In other words, mine planning engineers should plan the mine so that the reclamation process is considered and the overall cost of mining plus reclamation is minimized, not just the cost of mining itself. The new philosophy in the mining industry is sustainability, that is, the meeting of economic and environmental needs of the present while enhancing the ability of future generations to meet their own needs. In planning for the reclamation of any given mine, there are many concerns that must be addressed. The first of these is the safety of the mine site, particularly if the area is open to the general public. The removal of office buildings, processing facilities, transportation equipment, utilities, and other surface structures must generally be accomplished. The mining company is then required to seal all mine shafts, adits, and other openings that may present physical hazards. Any existing highwalls or other geologic structures may require mitigation to prevent injuries or death due to geologic failures.

The second major issue to be addressed during reclamation of a mine site is restoration of the land surface, the water quality, and the waste disposal areas so that long-term water pollution, soil erosion, dust generation, or vegetation problems do not occur. The restoration of native plants is often a very important part of this process, as the plants help build a stable soil structure and naturalize the area. It may be necessary to carefully place any rock or tailings with acid-producing properties in locations where rainfall has little effect on the material and acid production is minimized. The same may be true of certain of the heavy metals that pollute streams. Planning of the waste dumps, tailings ponds, and other disturbed areas will help prevent pollution problems, but remediation work may also be necessary to complete the reclamation stage of mining and satisfy the regulatory agencies.

The final concern of the mine planning engineer may be the subsequent use of the land after mining is completed. Old mine sites have been converted to wildlife refuges, shopping malls, golf courses, airports, lakes, underground storage facilities, real estate developments, solid waste disposal areas, and other uses that can benefit society. By