INTRODUCTION TO MINING

1-1 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.

- 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. Or Mining is extracting ore or minerals from the ground.

  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 is evident in the. following terms:

Ore: a mineral deposit that has sufficient utility and value to be mined at a profit.

Gangue*:* the valueless mineral particles within an ore deposit that must be discarded.

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, zinc, 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 , coal bed methane, and tar sands.

It should be noted that the mining engineer is associated with the extraction of nearly all these mineral resources. However, the production of petroleum and natural gas has evolved into a separate industry with a specialized technology of its own.

- **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.
    - 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 ***mining method*** distinguish by:
        - Details of the procedure
        - Layout
        - Equipment used in the mine the.
    - The ***mining method*** is determined by the *geologic*, *physical*, *environmental*, *economic*, and *legal circumstances* that pertain to the ore deposit being mined.

- Mining is never properly done in isolation, nor is it an entity in itself. It is preceded by:
    - ***Geologic investigations*** that locate the deposit and
    - ***Economic analyses*** that prove it financially feasible.
- Following extraction of the fuel, industrial mineral, or metallic ore, the run-of-mine material is generally cleaned or concentrated. This preparation or beneficiation of the mineral into a higher-quality product is termed ***mineral processing***.
- The mineral products so produced may then undergo further concentration, refinement, or fabrication during ***conversion***, ***smelting***, or ***refining*** to provide consumer products.
- The end step in converting a mineral material into a useful product is ***marketing.***

❖ Quite frequently, excavation in the earth is employed for purposes other than mining. These include:

- ***Civil*** and ***military works*** in which the object is to produce a stable opening of a desired size, orientation, and permanence.
- Examples are vehicular, water, and sewer tunnels, plus underground storage facilities, waste disposal areas, and military installations.
- Many of these excavations are produced by means of standard mining technology.

❖ Professionally, the fields of endeavor associated with the mineral industries are linked to the phase or stage in which an activity occurs.

- Locating and exploring a mineral deposit fall in the general province of ***geology*** and the earth sciences.
- ***Mining engineering***, already defined, encompasses the proving (with the geologist), planning, developing, and exploiting of a mineral deposit.
- The **mining engineer** may also be involved with the closure and reclamation of the mine property, although he or she may share those duties with those in the environmental fields.
- The fields of processing, refining, and fabricating are assigned to ***metallurgy***, although there is often some overlap in the mineral processing area with mining engineering.

1-2 Stages in the life of a mine

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.
- 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****.*

TABLE 1 Stages in the Life of a Mine

	Stage/ (Project Name)	Procedure	Time
		Precursors to Mining	
	Prospecting (Mineral deposit)	***Search for ore by:*** a. Prospecting methods Direct: physical geologic Indirect: geophysical, geochemical b. Locate favorable loci (maps, literature, old mines) c. Air: aerial photography, airborne geophysics, satellite d. Surface: ground geophysics, geology e. Spot anomaly, analyze, evaluate	**1-3 yr**
	Exploration (Ore body)	***Defining extent and value of ore (examination/evaluation)*** a. Sample (drilling or excavation),assay, test b. Estimate tonnage and grade c. Valuate deposit: present value, income cost, Feasibility study: make decision to abandon or develop	**2-5 yr**
		Mining Proper	
	Development (Prospect)	***Opening up ore deposit for production*** *a.* Acquire mining rights (purchase or lease),*if not done in stage 2* b. File environmental impact statement, technology assessment, permit c. Construct access roads, transport system d. Locate surface plant, construct facilities e. Excavate deposit (strip or sink shaft)	2 — 5 yr
	Exploitation (Mine)	***Large-scale production of ore*** a. Factors in choice of method: geologic,geographic, economic, environmental, societal safety b. Types of mining methods Surface: open pit, open cast, etc. Underground: room and pillar, block caving, etc. c. Monitor costs and economic payback (3 — 10 yr)	**10-30 yr**
		Post-mining	
	Reclamation (Real estate)	***Restoration of site*** a. Removal of plant and buildings b. Reclamation of waste and tailings dumps c. Monitoring of discharges	**1-10 yr**

1-3 Prospecting

- *Prospecting*, the first stage in the utilization of a mineral deposit, is the search for ores or other valuable minerals.
- 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.
- 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.
- In the ***indirect search****,* the most valuable scientific tool employed 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, can also be employed as prospecting tools.

1-4 Exploration

- The second stage in the life of a mine, 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.
- Exploration generally 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 ***evaluation techniques*** that are meant to enhance the investigator's knowledge of the mineral deposit such as: *chemical, metallurgical, X ray, spectrographic, or radiometric*.
- 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.
- An evaluation of the samples enables the geologist or mining engineer to:
    - Calculate the tonnage and grade, or richness, of the mineral deposit. Estimates the mining costs,
    - Evaluates the recovery of the valuable minerals,
    - Determines the environmental costs,
    - Assesses other foreseeable factors in an effort to reach a conclusion about the profitability of the mineral deposit.
- 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.