

The Mining Industry

Overview and Trends

KEY MESSAGES

- Minerals are solid substances, formed through biogeochemical processes, with specific chemical compositions and physical properties.
 - Extracting valuable, desired minerals often involves a process of separating desired minerals from other minerals that are within the same rock or ore.
 - The life cycle of a mine includes many stages that can include a production phase that lasts as long as 100 years.
 - In contrast to the petroleum sector, the largest mining companies are privately held.
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WHAT ARE MINERALS?

This reader covers basic information about minerals and the industry that extracts them. It is intended to give a basic understanding for those who aim to promote better use of revenues from mineral extraction.

A *mineral* is a solid substance, formed through biogeochemical processes, that has a specific chemical composition and physical properties. There are over 2,500 different types of minerals as diverse as coal, gold, and rubies. A *rock* is a solid composed of different minerals and other substances.

When mining, companies operate processes to extract or take away from the surrounding rock the minerals that they want to commercialize. A rock that contains a commercially profitable quantity of one or more minerals (or metals in particular) is called an *ore*. The left-over, worthless rock material from the ore is called *gangue*. The content of the ore, the cost per unit weight of the extracted mineral, is measured on a scale called the *grade*. Minerals are generally measured in ton, though gemstones are measured in *carats*. (One carat is equal to approximately 200 milligrams.)

Minerals can vary in quality. Coal, for example, ranges from *brown coal*, used for electric power plants, to *anthracite* coal, used for residential space heating. Minerals are also found in varying states of purity. Gold's purity is commonly measured in *karats* (not to be confused with the weight measure of *carats*). Most minerals must be *refined* for their end use. For example, after tantalum is taken out of the ground it often needs to be *chemically refined*, a process that separates the tantalum from other particles that might

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be found in the same rock, before it is used to create an electrical component that eventually ends up in a mobile phone. Gems, a type of mineral noted for their hardness and beauty, often gain value after extraction through the process of polishing and cutting.

HOW DO MINERS GET MINERALS OUT OF THE GROUND?

The process of getting minerals out of the ground begins with exploration and appraisal. Exploration usually begins with airborne studies and mapping. Even when minerals are below the ground, geologists can gather initial information based on formations and recordings of magnetic fields. Next, geologists conduct seismic analysis during which they use sound waves to get information about the chemical composition and density of rocks.

If this initial information is promising, companies may apply for exploration licenses with which they can conduct further research, usually including some drilling and extraction of core samples. The samples are analyzed to estimate the composition and size of a field. Mineral finds are often classified using three categories: *inferred mineral resources*, when it can be inferred that there are minerals but there is insufficient evidence to be certain; *indicated resources*, when there is reasonable confidence, also called a *probable reserve*; and *measured resources*, when there is a high degree of confidence, also called a *proven reserve*.

Even when a reserve is proven, a company must consider a variety of factors before deciding whether extracting the minerals will generate enough profit to justify the effort. It must determine what type of mine will be required (as explained in the following section); how to separate the waste from the desired minerals, and where to put the waste; how to minimize the social, environmental and economic impact of extraction; and how to get the mineral from the mine site to market. This is often done through a series of *feasibility studies*, which assess the costs of each of these actions.

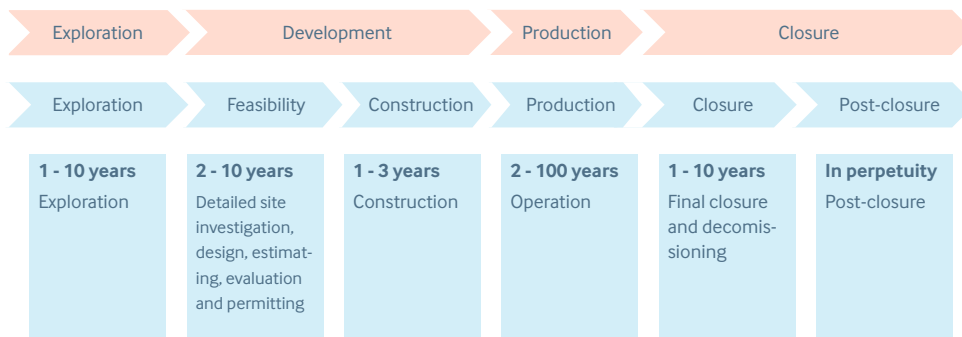


Figure 1. Mine life cycle

Source: NRGi

Once the mineral deposit is deemed commercially viable and the appropriate contracts have been signed, the company will begin the production phase. During this phase, the company extracts the minerals from the ground and often rinses or separates some of the minerals from the ore. Depending on the size of the mine, this phase can last as long as 100 years.

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Last, the extraction company has a responsibility to close the mine. During the *closure and rehabilitation* phase, the company often has to make the area around the mine safe, including securing the waste piles produced by the mine. While this is a very important phase for the community surrounding the mine, it is not a very profitable phase for the company. In order to ensure a thorough and safe closure, the government must carefully create liability for the companies in crafting laws and negotiating contracts.

WHAT TYPES OF MINES ARE THERE?

There are four major types of mining operations:

- **Surface.** Surface mining includes many types of mining during which the ore is all removed from the ground. When there are hard rocks, such as coal and diamonds, companies often use an *open pit*, while *open cast* mining is used for soft rocks, such as limestones. Generally, the terms open-pit, open-cast and open-cut are often used interchangeably. In this process, the minerals are often separated from the other rocks after they are removed from the mining pit. This form of mining often has a large impact on the surface environment both from the extraction site and the nearby waste deposits.

- **Underground.** With underground mining, the surface remains intact and workers and machines remove the minerals through tunnels or shafts. Underground mining begins with a phase of *development mining* whereby rocks are extracted so that miners can get closer to the ore. *Production mining* is when the ore with the desired mineral is extracted. Health and safety of workers is particularly important to successful underground mining, including ensuring a proper ventilation system and stable tunnels.

- **Dredge.** This process occurs when rocks and sediments are removed from the the floor of a body of water. The sediment and ores are sorted and the undesired minerals are returned to the water or deposited elsewhere. Traditionally this type of extraction has taken place in shallow areas, but new technology is taking it to deeper sea locations where there are expectations for high yields. This form of extraction often has a large impact on aquatic life that is very difficult to restore after mining operations are complete.

- **Artisanal.** Artisanal mines can be either on the surface or below the ground but are distinct in that there is no large company overseeing the extraction. Sometimes artisanal mines are completely informal (i.e., they do not possess mining rights) and self-organized, while in other cases there is a small company that owns a license and hires day laborers to extract the minerals. Often those who work at artisanal mines do so on a subsistence basis. Artisanal mining is notable for having fewer protections for health and safety of workers and environmental impact. It is also an area of mining that involves a comparatively large percentage of women and children.



Source: Nautilus Minerals



Source: PenPlusBytes

WHO ARE THE KEY PLAYERS IN THE INDUSTRY?

The mining industry is comprised of a mix of large and small companies. The large international companies, such as BHP Billiton and Vale, are referred to as *majors*. These companies have access to large amounts of capital and are capable of developing a major mine on their own. While there are many large state-owned mining companies, in contrast to the oil and gas sector, the biggest players are mostly privately held international corporations. Some notable exceptions include state-owned enterprises like China's Shenhua, India's Coal India Limited, and Chile's Codelco.

Junior companies tend to focus on exploration. They tend to have significantly less access to capital and rely on project-specific equity financing to fund new operations. A few of them also produce minerals on their own or in collaboration with other companies.

The specialization that mining requires for certain minerals has resulted in different company types and areas of operation. Some, like Rio Tinto, operate throughout the globe. In contrast, Lonmin is a British company that produces only in South Africa. Similarly, some larger companies diversify their portfolios across many different types of minerals while others specialize in extracting one or very few types of product. Freeport, for example, is a large international company that specializes in extracting copper and manufacturing copper products. Freeport also has interests in the gold and hydrocarbons sectors.

The International Council of Mining and Minerals (ICMM), an organization composed mostly of large extraction companies, has an increasing influence on best practices in the industry. Its standards for health and safety, environmental impact, and community consultation are increasingly viewed as a resource for the major companies. The junior companies, who are not members of ICMM, are less likely to be in compliance with these high standards.

Mining Data

Several organizations regularly publish information on mineral deposits and trends.

- **EY** publishes an annual risk assessment of the mineral sector: www.ey.com/GL/en/Industries/Mining---Metals/Business-risks-in-mining-and-metals
- **The US Geological Society** publishes annual overviews of the geology in most countries: www.usgs.gov/
- **BP** publishes an annual assessment of the global energy outlook that includes a detailed assessment on coal mining: www.bp.com

QUESTIONS TO ASK

- What types of minerals are found in my country? How much is available? How much is being produced? When will it be depleted at current production rates?
- Who are the key players in my country?
- How do changes in the price of minerals impact production in my country?
- What type of extraction processes are used in my country?

ADDITIONAL RESOURCES

Further reading

The PWC annual *Mine Series* provide up to date information on mining industry performance and profitability. See for instance, *Mine 2014: Realigning Expectations*, available at: www.pwc.com/gx/en/mining/publications/mine-realigning-expectations.jhtml

International Council on Mining and Metals, *Trends in the mining and metals industry* (Mining's contribution to sustainable development, ICMM, October 2012), available at: www.icmm.com/trends-in-the-mining-and-metals-industry

International Council on Mining and Metals, *The role of mining in national economies* (Mining's contribution to sustainable development, ICMM, October 2014, 2nd edition), available at: www.icmm.com/national-economies

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