

## Surface Mining

A variety of surface mining techniques can be used to remove a mineral or ore deposit that is close to the surface of Earth. **Strip mining**, or the removal of “strips” of soil and rock to expose the underlying ore, is used when the ore is relatively close to Earth’s surface and runs parallel to it, which is often the case for deposits of sedimentary materials such as coal and sand. In these situations, miners remove a large volume of material, extract the resource, and return the unwanted waste material, called **mining spoils** or **tailings**, to the hole created during the mining. A variety of strategies can be used to restore the affected area to something close to its original condition.

**Open-pit mining**, a mining technique that creates a large visible pit or hole in the ground, is used when the resource is close to the surface but extends beneath the surface both horizontally and vertically. Copper mines are usually open-pit mines. One of the largest open-pit mines in the world is the Kennecott Bingham Canyon mine near Salt Lake City, Utah. This copper mine is 4.4 km (2.7 miles) across and 1.1 km (0.7 miles) deep.

In **mountaintop removal**, miners remove the entire top of a mountain with explosives. Large earth-moving equipment removes the resource and deposits the tailings in lower-elevation regions nearby, often in or near rivers and streams.

**Placer mining** is the process of looking for metals and precious stones in river sediments. Miners use the river water to separate heavier items, such as diamonds, tantalum, and gold, from lighter items, such as sand and mud. The prospectors in the California gold rush in the mid 1800s were placer miners, and the technique is still used today.

## Subsurface Mining

When the desired resource is more than 100 m (328 feet) below Earth’s surface, miners must turn to

**Strip mining** The removal of strips of soil and rock to expose ore.

**Mining spoils** Unwanted waste material created during mining. *Also known as Tailings.*

**Open-pit mining** A mining technique that uses a large visible pit or hole in the ground.

**Mountaintop removal** A mining technique in which the entire top of a mountain is removed with explosives.

**Placer mining** The process of looking for minerals, metals, and precious stones in river sediments.

**Subsurface mining** Mining techniques used when the desired resource is more than 100 m (328 feet) below the surface of Earth.

**subsurface mining**, which is mining that occurs below the surface of Earth. Typically, a subsurface mine begins with a horizontal tunnel dug into the side of a mountain or other feature containing the resource. From this horizontal tunnel, vertical shafts are drilled and elevators are used to bring miners down to the resource and back to the surface. The deepest mines on Earth are up to 3.5 km (2.2 miles) deep. Coal, diamonds, and gold are some of the resources removed by subsurface mining.

## The Environment and Safety

The extraction of mineral resources from Earth’s crust has a variety of environmental impacts on water, soil, biodiversity, and other areas. In addition, mineral resource extraction can have human health consequences that affect the miners directly as well as other individuals who are affected by the mining process.

### Mining and the Environment

As you can see in **TABLE 25.2**, all forms of mining affect the environment. Mining almost always requires the construction of roads, which can result in soil erosion, damage to waterways, and habitat fragmentation. In addition, all types of mining produce tailings, the residue that is left behind after the desired metal or ore is removed, and some tailings contaminate land and water with acids and metals.

In mountaintop removal, the mining spoils are typically deposited in the adjacent valleys, sometimes blocking or changing the flow of rivers. Mountaintop removal is used primarily in coal mining and is safer for workers than subsurface mining. In environmental terms, mining companies do sometimes make efforts to restore the mountain to its original shape. However, there is considerable disagreement about whether these reclamation efforts are effective. Damage to streams and nearby groundwater during mountaintop removal cannot be completely rectified by the reclamation process.

Placer mining can also contaminate large portions of rivers, and the areas adjacent to the rivers, with sediment and chemicals. In certain parts of the world, the toxic metal mercury is used in placer mining of gold and silver. Mercury is a highly *volatile* metal; that is, it moves easily among air, soil, and water. Mercury is harmful to plants and animals and can damage the central nervous system in humans; children are especially sensitive to its effects.

The environmental impacts of subsurface mining may be less apparent than the visible scars left behind by surface mining. One of these impacts is acid mine drainage. To keep underground mines from flooding, pumps must continually remove the water, which can



**TABLE 25.2** Types of Mining Operations and Their Effects

Type of operation	Effects on air	Effects on water	Effects on soil	Effects on biodiversity	Effects on humans
Surface mining	Significant dust from earth-moving equipment	Contamination of water that percolates through tailings	Most soil removed from site; may be replaced if reclamation occurs	Habitat alteration and destruction over the surface areas that are mined	Minimal in the mining process, but air quality and water quality can be adversely affected near the mining operation
Subsurface mining	Minimal dust at the mining site, but emissions from fossil fuels used to power mining equipment can be significant	Acid mine drainage as well as contamination of water that percolates through tailings		Road construction to mines fragments habitat	Occupational hazards in mine; possibility of death or chronic respiratory diseases such as black lung disease

have an extremely low pH. Drainage of this water lowers the pH of nearby soils and streams and can cause damage to the ecosystem.

### Mining Safety and Legislation

Subsurface mining is a dangerous occupation. Hazards to miners include accidental burial, explosions, and fires. In addition, the inhalation of gases and particles over long periods can lead to a number of occupational respiratory diseases, including black lung disease and asbestosis, a form of lung cancer. In the United States, between 1900 and 2006, more than 11,000 coal miners died in underground coal mine explosions and fires. A much larger number died from respiratory diseases. Today, there are relatively few deaths per year in coal mines in the United States, in part because of improved work safety standards and in part because there is much less subsurface mining. In other countries, especially China, mining accidents remain fairly common.

As human populations grow and developing nations continue to industrialize, the demand for mineral resources continues to increase. But as the most easily mined mineral resources are depleted, extraction efforts become more expensive and environmentally destructive. The ores that are easiest to reach and least expensive to remove are always recovered first. When these sources are exhausted, mining companies must turn to deposits that are more difficult to reach. These extraction efforts result in greater amounts of mining spoils and more of the

environmental problems we have already noted. Learning to use and reuse limited mineral resources more efficiently will help protect the environment as well as human health and safety.

Governments have sought to regulate the mining process for many years. Early mining legislation was primarily focused on promoting economic development, but later legislation became concerned with worker safety as well as environmental protection. The effectiveness of these mining laws has varied.

Congress passed the Mining Law of 1872 to regulate the mining of silver, copper, and gold ores as well as fuels, including natural gas and oil, on federal lands. This law, also known as the General Mining Act, allowed individuals and companies to recover ores or fuels from federal lands. The law was written primarily to encourage development and settlement in the western United States and, as a result, it contains very few provisions for environmental protection.

The Surface Mining Control and Reclamation Act of 1977 regulates surface mining of coal and the surface effects of subsurface coal mining. The act mandates that land be minimally disturbed during the mining process and reclaimed after mining is completed. Mining legislation does not regulate all of the mining practices that can have harmful effects on air, water, and land. In later chapters we will learn about other U.S. legislation that does, to some extent, address these issues, including the Clean Air Act, Clean Water Act, and Superfund Act.