



5.3 IMPACTS OF MINING

College Board Topic 5.9

RSK ch. 23

Objectives and Essential Knowledge

ENDURING UNDERSTANDING

EIN-2

When humans use natural resources, they alter natural systems.

LEARNING OBJECTIVE

EIN-2.K

Describe natural resource extraction through mining.

ESSENTIAL KNOWLEDGE

EIN-2.K.1

As the more accessible ores are mined to depletion, mining operations are forced to access lower grade ores. Accessing these ores requires increased use of resources that can cause increased waste and pollution.

EIN-2.K.2

Surface mining is the removal of large portions of soil and rock, called overburden, in order to access the ore underneath. An example is strip mining, which removes the vegetation from an area, making the area more susceptible to erosion.

EIN-2.L

Describe ecological and economic impacts of natural resource extraction through mining.


EIN-2.L.1

Mining wastes include the soil and rocks that are moved to gain access to the ore and the waste, called slag and tailings that remain when the minerals have been removed from the ore. Mining helps to provide low cost energy and material necessary to make products. The mining of coal can destroy habitats, contaminate ground water, and release dust particles and methane.

EIN-2.L.2

As coal reserves get smaller, due to a lack of easily accessible reserves, it becomes necessary to access coal through subsurface mining, which is very expensive.

SUGGESTED SKILL

 *Environmental Solutions*

7.E

Make a claim that proposes a solution to an environmental problem in an applied context.

Mining Basics

- Rocks provide the minerals we use.
 - A **rock** is a solid aggregation of minerals.
 - A **mineral** is a naturally occurring solid chemical substance or inorganic compound with a crystal structure, a specific chemical composition, and distinct physical properties.
 - Geologic processes influence the distribution of rocks and minerals.
- We obtain minerals by mining.
 - **Mining** is the extraction of any resource that is not renewable on a human timescale.
 - Mining can refer to the extraction of fossil fuels and groundwater, but usually refers to the extraction of mineral resources.
- Metals are extracted from ores. Ore must be processed to extract the metals.
 - Metals are not present in a pure state in Earth's crust, but are present in **ore**, a mineral or grouping of minerals from which the metals can be extracted.
 - Ores are crushed and pulverized and desired minerals are isolated by chemical or physical means.
 - Copper, iron, lead, gold, and aluminum are examples of metals extracted from mineral ore.



At current rates of use, a child born in the U.S. today is predicted to use over 1.3 million kg of minerals and fossil fuel

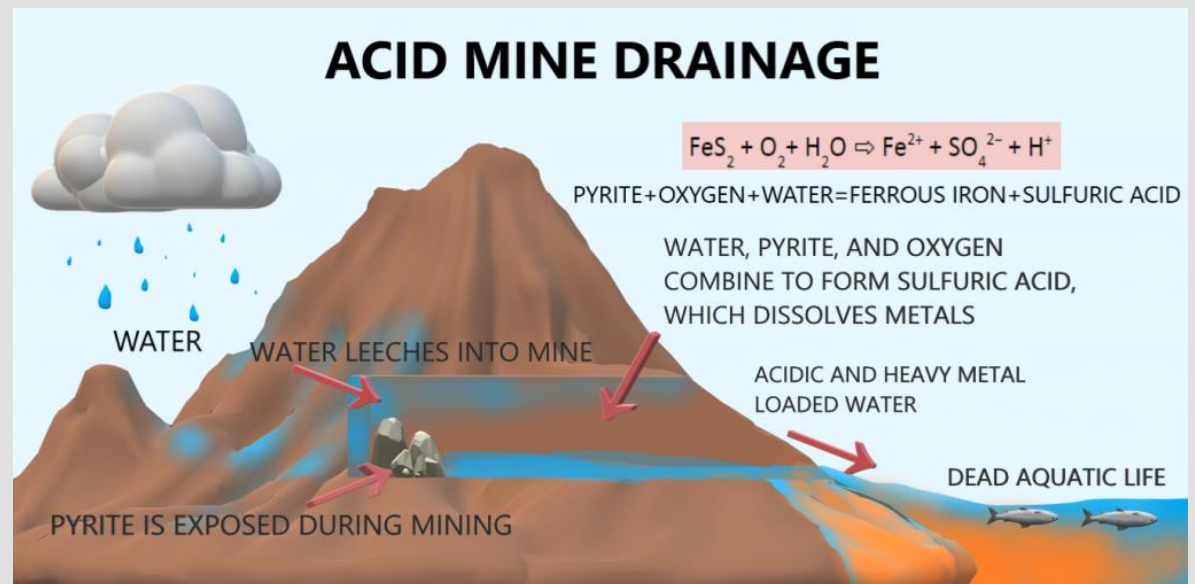
Mining Basics

- **Smelting** allows for the production of **alloys**, mixtures of two or more metals
 - Steel is an alloy of iron and carbon.
- Processing the minerals from which metals are derived has a large ecological footprint.
 - Processing of ore and smelting often emit toxic air pollutants.
 - Most methods are very water and energy intensive.
 - Processing of ore generates large amounts of contaminated wastewater.
 - **Tailings** are piles of ore left over after metals are extracted. They may leech heavy metals as well as toxic chemicals that were applied to them during their extraction and processing.
 - Gold ore is treated with cyanide and copper ores are treated with sulfuric acid during processing
 - Toxic slurries of chemically treated tailings are often dumped in **surface impoundments**.
 - Surface impoundments have failed catastrophically (Inez, Kentucky, 2000 and Cariboo, British Columbia, 2014)



Surface or Strip Mining and Its Impacts

- Heavy machinery is used to remove the overlying soil and rock (***overburden***) to reach mineral ore near the surface.
- Surface mining often leads to pollution of surface waters through ***acid mine drainage***.
 - Sulfide minerals (FeS_2) in the newly exposed rock of the overburden react with water to create sulfuric acid (H_2SO_4) which can leach toxic metals from the surrounding soil and rock and runoff into surface waters.



Surface or Strip Mining and Its Impacts

- **Open Pit mining**

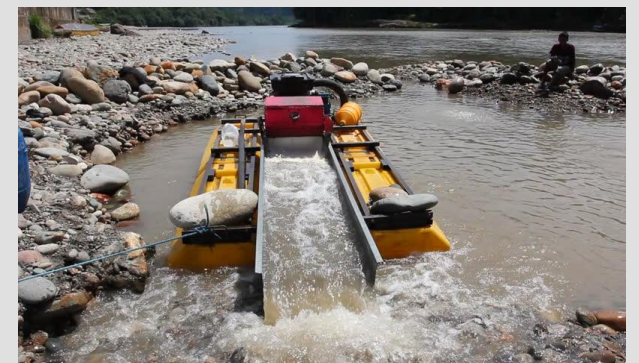
- When ore is distributed widely and evenly throughout a rock formation, digging a giant hole with terraced sides allows workers and machinery the most efficient access to the ore.
- Ore and overburden are removed as the pit is dug deeper and wider, until the ore runs out or becomes too expensive to recover.
- Widely used for mining various metals (copper, iron, gold) as well as diamonds and coal

- **Mountain top removal**

- When a resource occurs in underground seams, near the tops of ridges and mountains, scraping away the overburden and pushing it down slope into valleys to expose the resource is the most cost effective mining method
- Mountain top removal involves clear cutting the forest, removing the topsoil, and blasting away the overburden.
- Commonly used to mine coal in the Appalachia region of the eastern U.S.

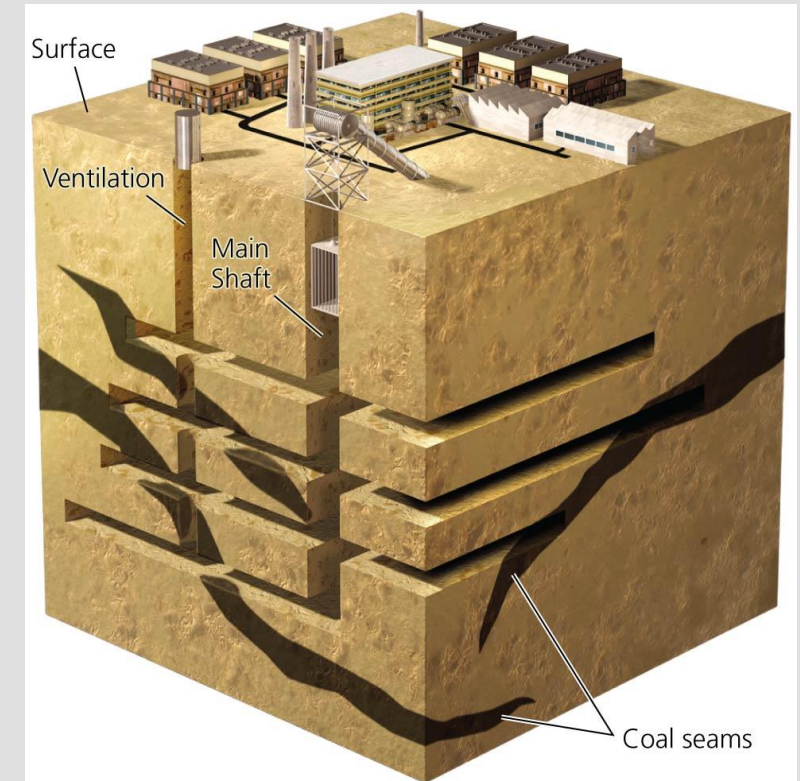
- **Placer Mining**

- When minerals accumulate in riverbed deposits, mining uses running water to separate the denser mineral resource from the lighter silts, sands and gravels.
- Highly destructive to riparian habitats and aquatic environments due to damage to stream banks and sediment pollution of the streams themselves.
- Banned in California, since 1884, when the gold rush in the Sierra washed debris all the way to San Francisco Bay.



Subsurface Mining

- **Subsurface mining** involves tunneling through the Earth, following concentrated pockets or seams of the desired resource.
 - A system of tunnels are dug or blasted and material is systematically moved to the surface.
 - Commonly used for metals, gemstones, phosphate, and especially coal.
 - Subsurface mines also lead to acid mine drainage from the mines as well as the tailing piles.
- Mining in general is dangerous, but subsurface mining is the most dangerous form of mining.
 - Acute risks such as dynamite blasts, tunnel collapse, poisonous gases
 - Chronic disease from long term exposure to poisonous gases and coal dust can lead to respiratory disease such as **Black Lung Disease**.
- Abandoned mines can cause problems in the future.
 - Sink holes can form, altered groundwater flows, underground fires in coal seams (Centralia, Pennsylvania)

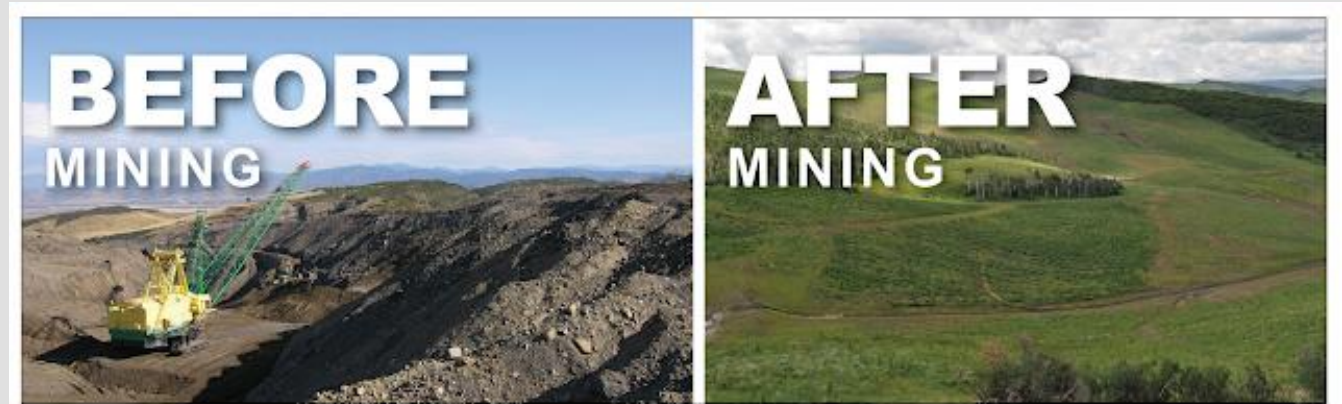


(b) Subsurface mining

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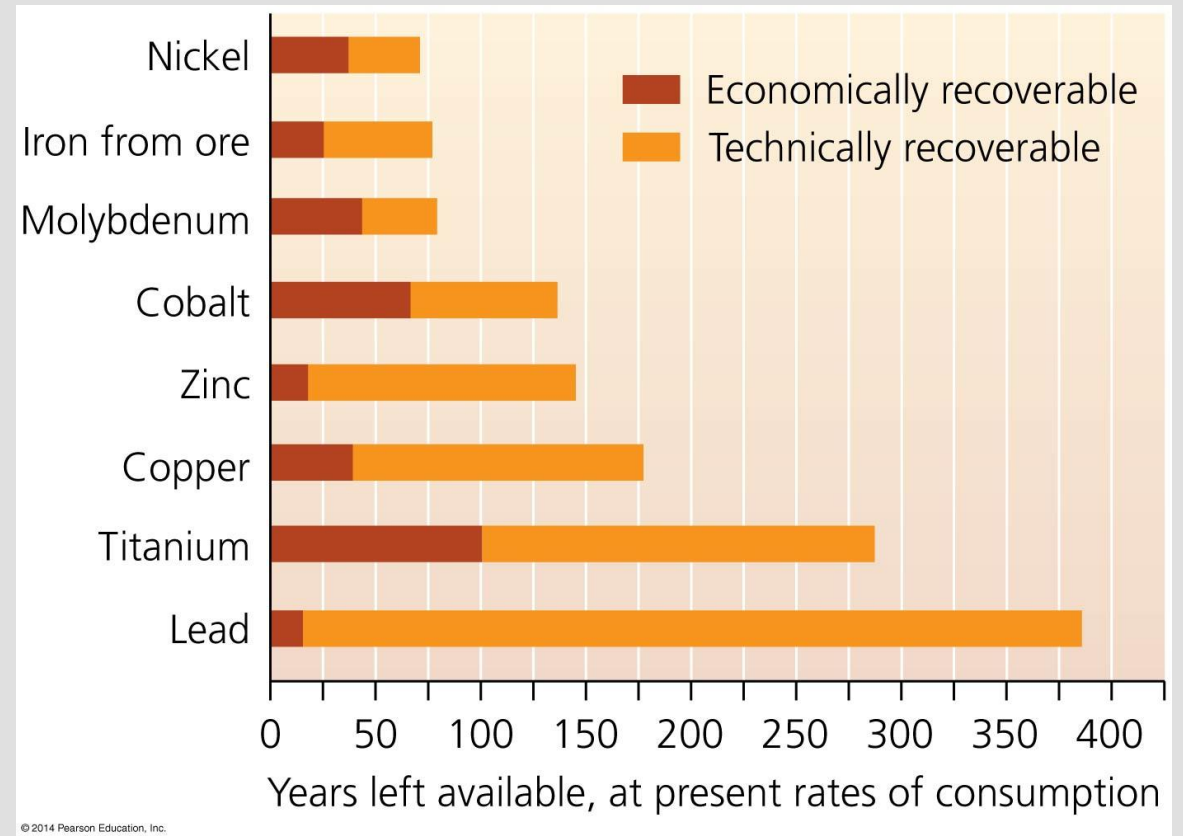
Mining Reclamation

- **Mine reclamation** is the restoration of formerly mined sites to conditions similar to those present before mining began.
- The U.S. and other developed nations require a reclamation plan and bond before mining can begin, to ensure reclamation will occur once mining is complete.
- Reclamation requires removal of all buildings and structures, filling in mine shafts, removing tailings piles, replacing overburden, restoring the original contours of the land, and replanting with native vegetation.
- Reclamation is difficult because of the impacts mining has on soils and water.
 - Soils become more acidic and the concentrations of heavy metals in the soil increase.
 - Soils are often heavily compacted and lack the permeability and organic matter necessary for good water holding capacities
 - The nutrient rich topsoil and its accompanying biotic community is destroyed by mining.
 - These conditions make it difficult to establish new communities of native vegetation and favor the generalist species common to earlier successional stages



Global reserves of mineral and fuel resources are declining

- As the more accessible ores are mined, the remaining reserves are harder to access, resulting in greater costs, and greater environmental damage.
- As coal reserves get smaller, due to lack of easily accessible reserves, it becomes necessary to access coal through subsurface mining.
 - Subsurface mining is more expensive
 - More man power required, less reliance on heavy machinery
 - Insurance costs are greater due to increased risks



Sustainable Mineral Use

- As mineral and fuel resources become more scarce, there will be more pressure on industry to develop technologies that improve extraction methods, which could reduce mining impacts
- Changes in consumer technology could reduce the demand for some metals
 - Changing from copper wiring to fiber optic cabling in communications technologies has reduced the demand for copper, extending remaining reserves.
 - The change from NiCd batteries to lithium ion batteries has changed demand for these metals
 - Synthetic diamonds are reducing the demand for natural diamonds
- Advances in recycling technology and in the accessibility of recycling can extend the lifetime of remaining mineral resources.
 - E-waste recycling could conserve many rare mineral resources whose demand is increasing rapidly



