

BIG QUESTION

At what point do the costs of mining outweigh the benefits?

Lesson 1 ?

Where do minerals come from?

Lesson 3 ?

How can we reduce the negative impacts of mining and manage mined resources?

Lesson 2 ?

How are mineral resources accessed?

LESSON 1 Minerals and Rocks

- A mineral is a naturally occurring, inorganic solid that has an orderly crystalline structure and a definite chemical composition.
- Minerals can form by crystallization from magma or lava, from precipitation related to evaporation or hydrothermal solutions, or from exposure to high pressure and temperature. They also can be produced by organisms.
- A rock is a solid mass of minerals and mineral-like material that occurs naturally.
- Forces deep inside and at the surface of Earth produce changes in rock that cause the same material to cycle between igneous rock, sedimentary rock, and metamorphic rock stages.

mineral (392)

precipitation (394)

polymorph (394)

rock (395)

rock cycle (395)

LESSON 2 Mining

- Mining companies seek and gather valuable resources such as metals, nonmetallic minerals, and fuel sources.
- Mining companies have developed many techniques to access resources close to the surface of Earth, deep underground, and even underwater.
- After mining, ores and other extracted materials are processed to separate the desired materials, combine them with other materials, or alter their properties.

ore (398)

strip mining (400)

subsurface mining (400)

open pit mining (400)

mountaintop removal (401)

placer mining (402)

tailings (403)

smelting (404)

LESSON 3 Mining Impacts and Regulations

- Environmental impacts of mining include increased erosion, increased sediment and debris, and pollution of water, land, and air. Other negative impacts may arise as undersea mining becomes more prevalent. Mining can also have negative impacts on society, such as property damage and violent conflicts.
- Regulations that govern mining have changed over time. At first, regulations were focused on promoting settlement of the West by making mining an attractive way for settlers to make money. Many modern-day regulations focus on mining safety and reducing the negative environmental effects of mining.
- Because minerals are a nonrenewable resource, we need to be concerned about finite supplies and ways to use them more responsibly, such as reusing and recycling.

acid drainage (406)



INQUIRY LABS AND ACTIVITIES

• Mineral Identification

Describe the hardness, color, and streak of several mineral samples. Then design a procedure to classify the samples.

• Local Geology

What sort of rocks and minerals are found in your local area? Research local geology, and then identify samples outdoors.



Make Your Case

Suppose, in the midst of the resource war in the Congo, you were the head of an international aid agency. How would you work with the government of the Congo, the rebel leaders, the United Nations, and mining corporations to help improve the situation in the Congo?

Review Concepts and Terms

- Which type of rock forms when layers of weathered materials are pressed together over time?
 - igneous
 - sedimentary
 - metamorphic
 - granite
- All minerals
 - have a hardness level of 10.
 - have cleavage.
 - have the same crystal form.
 - are inorganic solids.
- Compared to minerals that form on the surface of Earth, minerals that form within Earth's crust
 - have small crystals.
 - have large crystals.
 - do not have crystals.
 - form from lava.
- Which of the following statements is TRUE of nonmetallic minerals?
 - They are not mined for their metal content.
 - They do not contain metals.
 - They have no value.
 - They are used as energy sources.
- Which type of mining would NOT be used to mine coal?
 - strip mining
 - moutaintop removal
 - solution mining
 - subsurface mining
- What type of mining would most likely be used when a mineral resource is spread evenly and deeply throughout a rock formation, but the ground is not safe for tunneling?
 - placer mining
 - solution mining
 - subsurface mining
 - open pit mining
- Smelting is a process used during
 - ore extraction.
 - metal processing.
 - froth flotation.
 - grinding ore.
- Which mining method contributes to excessive erosion, increased sediment, water pollution, and air pollution?
 - undersea mining
 - placer mining
 - solution mining
 - mountaintop removal
- A main goal of the General Mining Law of 1872 was to
 - ensure that limited mining occurred on public land.
 - ensure the safety of miners.
 - set up royalty rates for miners to pay on their profits.
 - outline the rules for mining on public land.
- Which is NOT a benefit of recycling minerals?
 - Fewer dangerous metals will get into landfills.
 - Often recycling costs less than mining.
 - Recycling fossil fuels increases how long they will be available.
 - Recycling may have less of an environmental effect than mining.

Modified True/False

Write true if the statement is true. If it is false, change the underlined word or words to make the statement true.

- Mineral samples of the same type can have different colors, depending on the conditions under which they formed.
- Granite is an example of extrusive igneous rock because it cooled within Earth's crust.
- Open pit mining has not become widespread because the costs associated with it are so high.
- The mining method in which material in riverbeds and streambeds is sifted for deposited resources is called placer mining.
- A common type of water pollution caused by acidic water leaching metals from strip mining waste is called tailings.

Reading Comprehension

Read the following selection and answer the questions that follow.

In just the two or three centuries since the beginning of the Industrial Revolution, human activity has had major effects on Earth's basic processes. Some geologists have posed the question: "Have these effects been strong enough to justify naming a new geologic epoch after ourselves?" Some have suggested calling the new geologic era the Anthropocene. Through activities such as agriculture, mining, and deforestation, immense amounts of sediment have flowed downstream to oceans. In addition, humans have altered the composition of gases in the atmosphere, which affects Earth's temperature and the acidity of ocean water. Habitat disturbance, pollution, and hunting have also led to mass extinctions. These changes would appear sudden to a geologist of the future.

- Which of the following human activities has had the greatest impact to date on the environment?
 - mining
 - agriculture
 - burning of fossil fuels
 - Industrial Revolution
- How would increased amounts of sediment in the ocean appear to geologists of the future studying the geologic record?
 - as a sedimentary rock layer
 - as an igneous rock layer
 - as a metamorphic rock layer
 - as granite

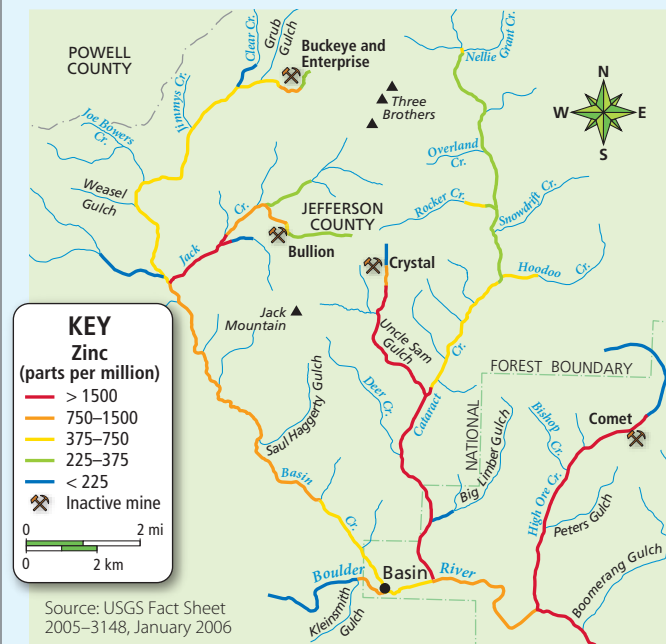
Short Answer

- Describe how metamorphic rocks are formed.
- What is the difference between magma and lava?
- Why isn't coal considered to be a mineral?
- How does increased sediment harm the environment?
- Describe what a mining company must do to reclaim land after mining is complete.
- Explain the process of froth flotation.

- What is an alloy?
- What are two ways to increase how long the reserves of a particular mineral will last?

Analyze Data

In 2005, U.S. Geological Survey scientists completed a study of tributaries that flow into the Boulder River in Montana. From 1880 to 1907, the area was heavily mined for copper, lead, zinc, silver, and gold. Mining ended in the 1970s, but pollution levels are still high. The map indicates the concentration of zinc in streambed sediments. Use the map to answer Questions 26 and 27.

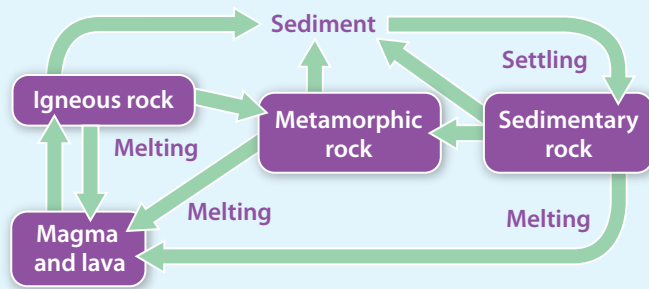


- Apply Concepts** Pollution in this area is associated with entrances to underground mines and dump sites containing mine waste. What are two possible causes of water pollution in this area?
- Interpret Data** Do the data in this map support the hypothesis that the inactive mines are the source of water pollution in this area? Explain.

Critical Thinking

- Compare and Contrast** Describe how diamond and graphite are alike and different.
- Form An Opinion** Can land that has undergone mountaintop removal truly be reclaimed? Explain your answer.

30. **Interpret Diagrams** Use the diagram to describe two ways that the particles in a particular sedimentary rock could eventually become metamorphic rock.



31. **Apply Concepts** Why is it important that people who process minerals understand the characteristics of the minerals they are processing?
32. **Evaluate** One of the attractions of space exploration is the possibility of mining minerals from places other than Earth, such as the moon or Mars. Discuss the challenges and benefits.

Write About It

33. **Persuasion** Some experts think that the reason so few cell phones are recycled is that many people either do not know that cell phones can be recycled or they do not know about available programs. Write to a local environmental agency persuading them to start a cell phone recycling campaign.
34. **Opinion** Throughout the United States there are many inactive mining areas like the one near the Boulder River in Montana. Some of the worst sites are being cleaned up by the EPA. But such cleanups take a long time and are expensive. Should the government, whose efforts are funded by taxes, be responsible for the cleanup of these areas? Explain.
35. **Apply the BIGQUESTION** Describe some ways that you think the environmental costs of mining can be offset.



Ecological Footprints

Read the information below. Copy the table into your notebook and record your calculations. Then answer the questions that follow.

Currently, the average person in the United States consumes metals at a much higher rate than the world average. What would happen to the availability of metals if every individual worldwide started consuming at the rate of an average person in the United States?

- For each metal, calculate and enter in the fourth column the years of supply left. Then, calculate the years of supply left if the world consumed each metal at the U.S. rate. Enter those values in the sixth column.
- Which of these seven metals will last the longest at present rates of global consumption? Which will deplete the fastest?
- The data provided in this table are for 2007. For some metals, availability fluctuates considerably from year to year. What are some factors that would affect the known world reserves and the amount used per year?

Metal	Known World Reserves (thousand metric tons)	Amount Used Per Year (thousand metric tons)	Years of Supply Left	Amount Used Per Year If All Consumed at U.S. Rate (thousand metric tons)	Years of Supply Left
Manganese	5,200,000	11,600.0		20,020.0	
Titanium	1,500,000	6100.0		31,900.0	
Nickel	150,000	1660.0		5082.0	
Tin	11,000	300.0		1290.0	
Tungsten	6300	89.6		316.8	
Antimony	4300	135.0		503.8	
Indium	16	0.5		2.1	

Data are for 2007, from 2008 U.S. Geological Survey Mineral Commodity Summaries. World consumption data are assumed to be equal to world production data. World reserves include amounts known to exist, whether or not they are presently economically extractable.