USGS
science for a changing world

Ores to Minerals

Lesson 6
Ores and Minerals Instruction

LESSON PLAN

Standards Alignment, Learning Objectives, Materials List,
Step-by-Step Instructions, Teacher Key, Vocabulary Bank, Differentiation Suggestions

Standards

AP Environmental Science Standard: 5.9 Impacts of Mining - LEARNING OBJECTIVE-EIN-2.K: Describe natural resource extraction through mining.

Next Generation Science Standard: HS-ESS3-1 - Construct an explanation based on evidence for how the availability of natural resources [and/or the] occurrence of natural hazards...have influenced human activity.

Learning Objective

Students will analyze the causes of the wide and uneven distribution of minerals in Earth's crust.
Students will identify the various properties and characteristics of different minerals.
Students will evaluate the importance of minerals to humans.

Materials

1. Student Worksheet
2. Student Slides

Step-by-Step Instructions

1. Present the Student Slides or have students work through the slides independently.
2. Ask students to complete the cloze notes on the Student Worksheet.

Teacher Key

Cloze Notes

Guiding Question 1: Why are minerals unevenly distributed in Earth's crust?

Minerals accumulate in systems in Earth's crust.

Some minerals are terrestrial and some are marine. Terrestrial minerals are land-based, while marine minerals are extracted from the seabed.

Minerals are unevenly distributed. Mapping mineral systems can help locate areas where certain types of minerals can be found.

Minerals are unevenly distributed because their formation is directly tied to specific geological processes, like:

- Tectonic plate motion
- Volcanic eruptions
- Sedimentation

Earth's crust is divided into tectonic plates that are able to move around. Plates can also go under one another, pushing minerals down. Magma can well up through cracks in plates or between plates, pulling minerals up. So, tectonic plates move minerals all around and through Earth's crust.

Magma, the molten rock that erupts into lava, contains dissolved minerals. At or near the surface, it cools and solidifies, creating new mineral-rich rock formations.

Sedimentation moves minerals by the process of erosion, where weathered rock fragments, called sediments, are transported, often by water, and then deposited in a new location. This moves the minerals along with the sediment.

Guiding Question 2: What are the properties of minerals that make them important?

List the mineral properties and give a brief summary of what is important about each:

- Color - Color allows us to differentiate between minerals, and bright colors make them more attractive to people. Color is caused by impurities.
- Luster - Shininess. Desirable for gemstone and jewelry.
- Streak - The color of the powder left by rubbing. Useful for mineral identification.
- Cleavage or Fracture - Ability to break into a smooth or uneven surface. Good cleavage makes a thin sheet.
- Hardness - A harder mineral will scratch a softer mineral as shown by the Mohs Hardness Scale.
- Density - Mass divided by Volume. The amount of matter in a space. High-density minerals insulate from sound and block radiation. Low-density minerals are good for making lightweight planes, bikes, and cars.
- Magnetism - Useful to separate: iron ore from other minerals, impurities to make ceramics, and recyclable metals from other waste.
- Refraction - Crystals bend light. Used in lasers.
- Radioactivity - Emitting radiation in the form of particles or energy for medical imaging, cancer treatment, and smoke detectors.

Guiding Question 3: Why is it important to assess what minerals are available and what minerals are critical?

Some minerals are comprised of elements that are not commonly found together which makes them rare. Some minerals are hard to find because they require very specific conditions to form. Garnets, for example, only form from extreme pressure and temperature deep in Earth's crust.

Studying mineral distribution is crucial. It allows us to find out where different minerals are located, which is vital for responsible resource management, mining operations, economic planning, industrial development, conservation, and global trade agreements.

Critical minerals are designated as such because they are at risk of becoming unavailable due to high demand, difficulties with extraction and refinement, scarcity, and world politics. One example is lithium used for batteries, which is sourced mainly from Chile and Argentina.

As with many minerals, the refinement of lithium is a complex and environmentally sensitive process. Strict regulations are necessary to ensure it won't contaminate groundwater or soil. Difficulties and regulations include: (add list below)

- Plentiful water source
- Building evaporation ponds
- Long time to extract
- Lengthy process for permits

Critical minerals are essential to our economy, industry, and national security. Critical minerals are necessary for the production of key products.

The United States needs to ensure access to supplies of these materials because they are so important to our lives.

The USGS studies the uses of critical minerals, their supply, and mining locations.
Gallium (shown right), for example, is currently on the 2025 critical minerals list from the USGS in part because its export to the U.S. was banned by China and also because gallium occurs in very small concentrations in ores of other metals, making it hard to obtain in a pure state.

You can learn more about the USGS list of critical minerals at:
www.usgs.gov/science/science-explorer/minerals/critical-minerals

And check out the Mineral Commodity Summaries 2025 at:
https://pubs.usgs.gov/periodicals/mcs2025/mcs2025.pdf

Vocabulary Bank

- **Cleavage** - When a mineral breaks along smooth planes
- **Density** - The amount of mass packed into a given area
- **Eruption** - When magma, ash, and gases are released from a volcano
- **Fracture** - When a mineral breaks in an uneven pattern
- **Hardness** - How much a mineral resists scratching
- **Luster** - The light-reflecting characteristics of a mineral specimen
- **Magnetism** - The property describing a reaction to magnetic forces
- **Marine** - Found in or under seawater
- **Radioactivity** - When unstable atomic nuclei emit radiation
- **Refraction** - The bending of light
- **Sedimentation** - When weathered rock fragments (sediments) are collected in an area after being transported by water, wind, or ice
- **Streak** - The color of the powder produced when a mineral is dragged across a surface
- **Tectonic plate** - A large, solid piece of Earth's crust that moves independently from other tectonic plates
- **Terrestrial** - Found on solid land or rock

Differentiation Suggestions

- Adjust Amount: Reduce the number of properties and examples.
- Scaffolding Support: Provide or allow aids, like additional text or images, as reference resources.
- Reduce Cognitive Load: Limit the amount of text you include in each slide.
- Role Assignments: Assign varying slides to each member of a group.
- Group Composition: Form heterogeneous groups to ensure a mix of abilities and skills, fostering peer support and collaboration.
- Ongoing Check-Ins: Regularly check in with groups to provide feedback and support, ensuring all students participate and understand the task.
- Use extra visual materials showing additional examples.
- Use translation technology or a bilingual dictionary.
- Read text aloud.