

Mineral Identification

Strand Minerals

Topic Investigating Properties and Identification of Minerals

Primary SOL ES.4 The student will investigate and understand how to identify major rock-forming and ore minerals, based on physical and chemical properties. Key concepts include

a) hardness, color and streak, luster, cleavage, fracture, and unique properties.

Related SOL ES.1 The student will plan and conduct investigations in which

a) volume, area, mass, elapsed time, direction, temperature, pressure, distance, density, and changes in elevation/depth are calculated utilizing the most appropriate tools;

c) scales, diagrams, charts, graphs, tables, imagery, models, and profiles are constructed and interpreted.

Background Information

A *mineral* is defined as a solid, inorganic substance that occurs naturally and has a definite atomic structure and chemical composition. Minerals exhibit several properties that are useful for identification. Color, crystal system, hardness, and luster are a few of the properties that can be used to identify a mineral. By contrast, a rock is an aggregate of minerals that is formed through various geologic processes. As a result, rocks do not have a specific chemical make up. Through classification, scientists and students alike are able to identify a mineral by referring to a predefined set of guidelines. This also helps when a new mineral is discovered. Without the classification system, it would be possible to mistake a new discovery for a current mineral.

Materials

- Copies of attached handouts
- Classroom display of minerals
- Access to the Internet to view the mineral ID/geology guides found in the resources section of the lesson.
- Safety goggles
- Identification guides to minerals
- Ultraviolet lamp (optional)
- Set of 20 mineral samples for each group:
 1. Pyrite
 2. Galena
 3. Calcite
 4. Iceland spar calcite
 5. Halite
 6. Magnetite
 7. Sulfur
 8. Quartz (milky and rosy)
 9. Olivine
 10. Biotite mica
 11. Muscovite mica
 12. Potassium feldspar
 13. Plagioclase feldspar
 14. Fluorite
 15. Talc
 16. Gypsum
 17. Satin spar gypsum
 18. Graphite
 19. Hematite
 20. Azurite
- Streak plate
- Glass plate

- Steel nail
- Coin
- Vinegar (or weak HCl acid)
- Magnet

Vocabulary

mineral, crystal, hardness, luster, metallic, nonmetallic, cleavage, fracture, double refraction, fluorescence, streak, texture, density, specific gravity, effervescence

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

In this activity, students will learn five characteristics of a mineral and conduct tests to identify minerals that are found in Virginia.

Use a small plastic container, such as a plastic butter tub or food container, to hold all the testing supplies for each group. You might also consider using small plastic tackle boxes with individual compartments to keep the mineral samples organized. Egg cartons also work for this purpose. To organize the testing sets of minerals, label each mineral specimen with a number 1 through 20. Place a small dot of white correction fluid or white paint on each specimen, and put the letter on the dot with a permanent marker. If you are using plastic containers or egg cartons, write the letters in the compartments to help students organize the samples.

Introduction

1. Discuss the five characteristics of a mineral to help students complete the top section of the What Is a Mineral? handout. Allow time for them to complete the bottom section. After they have finished, discuss the answers, and have students provide reasons for excluding each item that is not a mineral.

Procedure

2. Demonstrate how to use objects such as a fingernail, coin, glass plate, or nail and the Mohs Scale of Hardness to determine the hardness of each mineral sample in order to divide the samples into two groups—those that are harder than 5.6 or 6 and those that are softer.
3. If students will be using the acid test, discuss safety procedures and distribute safety goggles.
4. Put students into small groups and have them complete the Pre-Lesson activity on hardware classification
5. In these same groups, distribute the testing sets of minerals to each group. Ask the groups to classify their specimens into two to four groups.
6. After student groups have sorted the mineral samples, ask them how they made the classifications. Discuss the criteria that were used, and make a list of these criteria on the board. Responses may include color, shape, size, and texture as well as other physical characteristics of the specimens. Is this the same process they used to classify hardware? What classification techniques are unique to minerals?
7. Explain that scientists use a variety of tests to identify minerals. Distribute the attached Mineral Identification Guide to each group. Compare the criteria used by students to the tests listed on the Mineral Identification Guide.
8. Distribute the testing equipment and the attached Mineral Identification Chart to each group. Allow time for students to practice testing a few of the mineral samples in the testing sets.

9. Once groups are familiar with the testing process, allow time for them to test all the mineral samples and record the data on their Mineral Identification Charts. Monitor the groups, and provide assistance as needed.
10. After students have completed all the tests, have them use the collected data and various available identification guides to identify the minerals. You might provide a list of the minerals in the testing sets if students experience much difficulty identifying the samples. Provide time for students to discuss their results with classmates before revealing the names of the minerals.

Assessment

- **Questions**
 - What allows you to differentiate the different types of minerals?
- **Journal/Writing Prompts**
 - Once students are familiar with the properties used for mineral identification, allow each student to “adopt” a mineral found in Virginia and complete a “Mighty Mineral” report project consisting of creation of an advertisement and a data page.
 - Allow students to use printed or online reference materials to complete their data page. If mineral samples are available, have students also perform tests to obtain data.
 - Provide samples of common minerals for students to group according to a specific property, such as hardness.
- **Other**
 - Have the students come up with a list changes they might make to their own classification systems of hardware now that they have completed the exercise with a mineral ID guide.

Extensions and Connections (for all students)

- Write to state geological surveys to ask for mineral samples from across the United States. Use the donated specimens from all 50 states to create a “Minerals of the USA” classroom display.
- Have students research the chemical compositions of their adopted minerals or the minerals in the testing sets. Have them make a master list of the elements, and chart the number of times each one appears in a chemical formula. Have students investigate mineral groups, such as silicates, oxides, and carbonates, and relate findings to the chemical composition of the adopted minerals.
- Use the mineral reports to create a scavenger hunt exploring the uses of the Virginia minerals. Develop one to two questions or riddles about each mineral, and display the reports in the classroom or hallway. Have students find answers by scavenging for information in the report pages.
- Challenge students to create a dichotomous key or other method of classification for the testing set of minerals. Instruct them to use the data on their Mineral Identification Charts to develop the key. Have them incorporate at least five of the mineral samples. Allow groups to trade keys when they are finished and try to identify the new sets of minerals.

Strategies for Differentiation

- Have each student choose his/her favorite mineral and make a drawing of it. Have each student explain in paragraph form why it is a mineral and list the five characteristics of a mineral as applied to this particular mineral.
- Have each student create an advertisement showing a superhero cartoon character and a slogan that highlights one or more important uses of their mineral. For example, fluorite might

be represented by a superhero tooth complete with a cape and the slogan, “Mighty Fluorite saves the day by protecting the world from tooth decay!”

- Have the students come up with a plan to improve on other types of classification systems that currently exist (e.g., tires, computers, and books).

What Is a Mineral?

Name: _____ Date: _____

Pre-Lesson Activity

- Using a mix of nuts, bolts, washers, screws and other hardware, have groups of students come up with their own classification system. Be sure to define what each group is and what its unique characteristics are. Also, be sure to list what each has in common with others and why it is in a group of its own.
- With regard to hardware classification, make a list of items that are easy to distinguish and those that are more difficult. As a class, compare these results to see the consensus and see how like items were classified.

1. A mineral must occur ___naturally_____ in Earth’s crust. To be a mineral, it cannot be a manufactured or human-made substance.
2. All minerals are ___inorganic___ rather than organic. Organic materials are formed from ___living___ things.
3. A mineral is always found in a _____solid___ state of matter.
4. A mineral has a __definite__ __atomic__ __structure__. Minerals may be made of a single element. Some minerals are formed by compounds, or combinations of two or more elements.
5. A mineral’s atoms are arranged in a definite _____pattern_____. This repeating pattern is called a _____.
6. Circle the items below that meet all five characteristics of a mineral:

| | |
|---------------|--------|
| halite (salt) | coal |
| steel | gold |
| cement | wood |
| oxygen | sulfur |
| diamond | ice |
| silver | sugar |
| copper | glass |
| graphite | |

Mineral Identification Guide

Color - Describe the color of your mineral. Color is one of the least reliable properties for identifying a mineral sample, but may provide some clues depending on the specimen.

Streak color – The streak is representative of the color of the mineral when it is ground into a fine powder and may not be the same as the color of the mineral. To obtain a streak, rub the mineral across the white plate provided in your testing kit. Streak may be described as colorless, white, black, gray, red, etc.

CAUTION: The streak plate has a hardness of seven. Using minerals harder than seven will damage the streak plate.

Luster – How would you describe the way the mineral shines?

Metallic – Looks like metal or appears to have metal flakes

Glassy or vitreous – Shines like glass

Earthy or chalky – Dull; does not reflect much light

Waxy, silky, or pearly – Has a muted shine; may resemble shells or pearls

Other? Describe in your own words

Cleavage or Fracture – This test describes the way a mineral breaks, which depends on the way the atoms of a mineral are arranged. Some crystals are formed from atoms that have strong bonds between them, while others have areas of weakness. The crystals will tend to break (or cleave) where the atoms are the weakest.

CAUTION: Don't break the testing samples unless you have permission from your teacher.

Examine the outer surfaces of a mineral specimen for clues.

Cleavage occurs as a mineral breaks smoothly along even planes or surfaces. A few examples include mica forming sheets and halite or galena forming cubes.

Fracture occurs when a mineral breaks into odd shapes or an irregular pattern. It may be described as uneven, splintery, conchoidal (shell-like), jagged, or granular.

Hardness – Mohs Scale of Hardness is commonly used to determine the hardness of a mineral ranging from 1 for the softest mineral to 10 for the hardest mineral. To determine a mineral's hardness, try scratching the mineral with an object (fingernail, coin, nail, or piece of glass) or scratching an object with a mineral sample. Which is harder – the object or the mineral?

Examples: If the mineral is scratched by a fingernail, it would be softer than 2.5. If the mineral scratches a penny, it would be harder than 3.

| # | Mineral | Common Objects |
|----|-----------|--|
| 1 | Talc | Easily scratched by fingernail |
| 2 | Gypsum | Scratched by fingernail (2.5) |
| 3 | Calcite | Very easily scratched by a nail (5.5-6); will not scratch penny (3) |
| 4 | Fluorite | Easily scratched by nail |
| 5 | Apatite | Difficult to scratch with nail; will not scratch glass (5.5-6) |
| 6 | Feldspars | Scratched by steel file (6.5-7); may barely scratch glass |
| 7 | Quartz | May barely scratch steel file; easily scratches glass |
| 8 | Topaz | Scratches a steel file or nail (6.5-7) as well as the streak plate (7) |
| 9 | Corundum | |
| 10 | Diamond | |

Transparency - Can you see through it? Some minerals are highly transparent, which means you can see through them. Minerals that are considered translucent allow only light to pass through them. Other minerals are opaque, which means that you cannot see through them.

Texture – How does the mineral feel?

Gritty or sandy, powdery or chalky, smooth like glass, sharp like metal, soapy or greasy, smooth like wax

Other tests You Can Try

Double Refraction – Some minerals, such as some calcites, cause a double image when placed over words in a book or an object.

Magnetic Attraction – Some minerals are attracted to a magnet or behave like a magnet like magnetite.

Fluorescence – Does it glow under ultraviolet light? If so, it may be fluorite.

Specific Gravity – This property is the weight of the mineral relative to the weight of an equal volume of water. Minerals with a high specific gravity or density feel heavy for their size such as galena. Those with a low specific gravity, such as graphite, feel light for their size.

Reaction to Acids – Does it react when exposed to hydrochloric acid? If yes, it is a carbonate, such as calcium or dolomite.

WARNING: You must have your teacher's permission to perform an acid test.

Mineral Identification Chart

Name: _____ Date: _____

| | Mineral name | Color | Streak color | Luster (check one) | | Breakage (check one) | | Hardness (check one) | | | Other observable properties |
|----|--------------|-------|--------------|--------------------|--------------|----------------------|----------|----------------------|------------|---------------|-----------------------------|
| | | | | Metallic | Non-metallic | Cleavage | Fracture | Less than 2.5 | 2.5 to 6.0 | More than 6.0 | |
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
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| 20 | | | | | | | | | | | |

Mineral Identification—Physical Properties

| | |
|--------------------|--|
| Apatite | Green color; H = 5; may show hexagonal crystal form |
| Augite | Dark or dull green color; two cleavages at approximately 90 degrees; similar properties to hornblende |
| Biotite | Black color; one perfect direction of cleavage resulting in the mineral peeling into thin, flexible sheets; similar properties to muscovite |
| Calcite | H = 3; reacts with HCl; three directions of cleavage (rhombohedral cleavage) |
| Corundum | H = 9; often shows hexagonal crystal form |
| Dolomite | Reacts to HCl in its powdered form; similar properties to calcite |
| Fluorite | Typically purple in color but can be white, clear, yellow, or green; H = 4; four directions of cleavage |
| Galena | Gray color; metallic; three directions of cleavage (cubic) |
| Garnet | Typically reddish brown color; no cleavage; commonly found in twelve-sided crystals (dodecahedrons) |
| Graphite | “Pencil lead”; dark gray color; metallic; gray streak; soft |
| Gypsum | H = 2; can be scratched with fingernail |
| Halite | “Salt”; H = 2.5; cannot be scratched with fingernail; three directions of cleavage (cubic); salty taste |
| Hematite | Reddish brown (rust-red) streak |
| Hornblende | Black to dark green color; two directions of cleavage at 120 or 60 degrees; similar properties to augite |
| Magnetite | Magnetic; metallic |
| Muscovite | Clear or translucent color; one perfect direction of cleavage resulting in the mineral peeling into thin, flexible sheets; similar properties to biotite |
| Olivine | Apple green or yellowish green color; H = 7 (often difficult to determine); conchoidal fracture; no cleavage |
| Orthoclase | Typically salmon pink color; H = 6; perthitic intergrowths are common; two directions of cleavage at 90 degrees; similar properties to plagioclase |
| Plagioclase | White or gray color; H = 6; two directions of cleavage at 90 degrees; striations may be seen on cleavage surface; similar properties to orthoclase |
| Pyrite | “Fool’s Gold”; gold color; metallic; |
| Quartz | Typically white or clear color but can be pink, red, purple, or black; H = 7; conchoidal fracture; no cleavage |
| Sulfur | Yellow color; “rotten egg” smell when burned |
| Talc | H = 1; very soft, easily scratched by fingernail |