Minerals and Rocks

Level: Middle School
Facilitator Guide

LESSON DETAILS

Objective: Students will investigate the properties and formation of various rocks and minerals to understand their roles within Earth's cycles and practical applications in the local area. (Note: students should not be expected to identify/memorize rocks and minerals.)

Standards

NVACSS and NGSS

- **MS-ESS2-1:** Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
- **MS-ESS3-1:** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes
- **DCI:** Earth Materials and Systems; Natural Resources
- **SEP:** Analyzing and Interpreting Data; Constructing Explanations and Designing Solutions
- **CCC:** Patterns; Cause and Effect; System and System Models; Stability and Change

Career Readiness

- **1.2.6:** Demonstrate lifelong-learning skills by continually acquiring new industry-related information and improving professional skills.

Materials

- computer with internet access
- a variety of rock and mineral samples (preferably local to Nevada)
- magnifying glasses
- hardness test kits (such as a **Moh's hardness kit** or common objects, like a penny and glass plate)
- streak plates
- weak acid in dropper
- scales
- graduated cylinder
- water
- crayons
- crayon sharpeners
- aluminum foil
- wax paper
- hot plates and/or hot water baths
- ice cubes
- plastic knives
- large glass beakers
- tongs
- dice
- copies of "Rock and Mineral Location Map" handout
- copies of "Exploring Earth Samples" handout
- copies of "Rock Cycle Diagram" handout
- copies of **Rock Cycle Game** station descriptions
- copies of "Mineral and Rock Samples" handouts A and B (optional)

Lesson Summary

Students begin by examining rock and mineral samples at stations, using tests for hardness, streak, and density to identify them. They model rock formation with crayons and discuss the rock cycle, distinguishing between rocks and minerals. An interactive rock cycle game reinforces these concepts. Students then explore local geology through field trips or virtual tours, identifying rock origins and uses. The lesson concludes with students researching and presenting a local rock or mineral, focusing on its formation, properties, and significance.

Preparation

- For **Engage,** set up several stations, each with a sample of a different rock or mineral and information on where the sample was collected. See the student handouts for the recommended rock and mineral samples that include a range of Nevada-specific rocks and minerals, as well as examples from all rock types—igneous, metamorphic, sedimentary. These handouts can be printed for each group or can be cut up so that you can place the card for each rock or mineral with the corresponding sample. You may also want to include one or two loose sediment samples from your local area. Students will also need access to a computer or tablet where they can access maps and images of the area where each mineral was collected.

- Between the **Engage** and **Explain** portions of the lesson, place a corresponding label and handout for the rock cycle game with the rock and mineral samples you want to use for the rock cycle game. Place the other handouts that won't have physical samples (e.g., magma) at new stations.

- Compile a list of commonly mined or found rocks and minerals in your area or use NVMA's page on **Minerals in Nevada**. This list will be used during the **Evaluate** portion of the lesson, guiding students on which rocks or minerals to research further. Ensure this list is accessible and includes a brief description of each item to aid students in their initial selection.

Engage

1. Facilitate a class discussion around the following questions:

    - *What types of natural materials can we find on or beneath Earth's surface?* Record student answers on the board as they are given.

    - *Where do these natural materials typically come from? Can you name specific places or types of environments?*

    - *How might these natural materials form? What processes might create them?*

    - *Can you list some ways that people use rocks and minerals in everyday life?*

- *Do rocks and minerals change over time? What natural events might cause these changes?* (Use **Figure 1** to facilitate this discussion)

Figure 1. Eroded desert formation in Clark County, Nevada.
Image Credit: Ken Lane vis Flickr, CC BY-NC-SA 2.0

2. Students will then visit most or all of the rock and mineral stations in groups and make observations of each sample.

   a. If you used the recommended samples, have a copy of the "Rock and Mineral Location Map" handout at each station, or give students **access to the online version** where they can click on each site and get more information about the samples.

   b. Students can also search online to access maps and images of the locations where each mineral was found to see what the environment of each area is like.

3. Facilitate a discussion about the samples. Ask students to share their observations using questions such as:

   - *What physical properties does this rock/mineral have?*
   - *What uses can you think of for this type of rock/mineral?*
   - *How might the environment impact the formation of different rocks/minerals?*

Explore Minerals

4. Introduce different observations and tests that are used to identify minerals.
    a. **Hardness test:** Determines how resistant a mineral is to being scratched.
    b. **Streak test:** Reveals the color of a mineral in powdered form.
    c. **Reactivity test:** Shows if a rock is reactive to acid.
    d. **Density:** Measure the mass and volume to calculate the density.
5. Distribute mineral samples, test materials, and the "Exploring Earth Samples" handouts.
6. Have students make observations and conduct the tests for each mineral sample, and record results on the "Exploring Earth Samples Table" handout.
7. Facilitate a class discussion of their observations and test results. Focus on the process of collecting the data, while also addressing any inconsistencies or surprising findings. Some discussion questions could include:
    - *Which mineral was the hardest? How might hardness help us identify a mineral?*
    - *What does the streak color indicate about the mineral's properties? Why might some minerals have a streak that is a different color than they appear?*
    - *Which had the most interesting reaction with the acid? What can the reactivity test tell us about the composition of the mineral?* (Repeat the test on a piece of metal and a seashell to help students understand what materials likely react with acids.)
    - *How might knowing the density of a mineral be helpful in identifying it?*
    - *Why do we use multiple tests to identify minerals?*
    - *What might these properties mean for the use of these minerals in everyday life or industry?*

Explore Rocks*

*Adapted from ***Modeling the Rock Cycle*** from Natural Bridge Caverns

1. Each student group should start with 4 different colored crayons. Tell students that each crayon represents an igneous rock.

2. Modeling physical weathering:

   a. Students will use a crayon sharpener to create 4 piles of crayon shavings, creating “rock fragments.”

   b. Discuss with students:

      - *What natural process is being modeled by shaving the crayons?*
      - *What do the shavings represent in terms of real-world geology?*
      - *Why are all the fragments not the same size? How does this reflect real rock weathering?*
      - *Can you list some natural factors that contribute to the physical weathering of rocks? How might each factor affect the rocks differently?*

3. Modeling sedimentation:

   a. Have each group fold a piece of aluminum foil in half.

   b. Students will then simulate erosion by transferring one color of sediment to the center of the foil, making about an 8 cm x 8 cm square pile.

   c. They should then layer additional colors on top.

   d. Discuss with students:

      - *What geological process have you just modeled? In what ways is your model similar to the process as it occurs in the real world? How does it differ?*
      - *What might influence the order in which sediments are deposited into layers?*

Figure 2. The Paria River (coming from the left) flows into the Colorado River (coming from the right), introducing a large sediment load.
Image credit: David Topping, USGS.

e. Discuss how different environments (like rivers vs. wind-blown deserts) might affect the sedimentation process. Use **Figure 2** to facilitate this discussion.

4. Modeling compaction, cementation, and lithification:

   a. Groups should fold the foil over the top of the sediment layers, then place a heavy book or weight on top of it to compress it.

   b. should carefully open the packet and make observations.

   c. Discuss:

      - *Compare the compressed layers to the original layers. What geological process does this change represent?*
      - *What happens to the spaces between the fragments when pressure is applied? How does this simulate the natural process of lithification?*
      - *How could we change this simulation to make it more accurate?* Suggestions may include using less pressure over a longer period of time or adding something that can act as a cement, like glue.
      - *Do you think the sediment is completely compressed or are there still some spaces within this rock? How might we test this?*
      - *Why is cementation important in the formation of sedimentary rocks? Can you think of any sedimentary rocks formed through this process?*

5. Modeling metamorphism:

   a. Student groups should make a small boat from their aluminum foil and place their “rock” (compressed crayons) inside.

b. Students will place their boat on a hot plate, taking appropriate safety measures, and heat the boat until the rock becomes mushy/soft when tested with a plastic knife.

c. Students should use a tong to remove the packet from the hot plate.

d. They should then close the foil packet and place a book or weight on it again.

e. Students should then move the packet to a cold water or ice bath to re-solidify it before carefully opening the packet to observe their "metamorphic rock."

f. Discuss metamorphism:

- *How does the texture differ when the rock is on the heat versus after it has been removed from the heat?*
- *How is this process like when real rocks are exposed to heat? How is it different?*
- *Why doesn't actual metamorphism involve melting? What happens to the rock if it melts?*

6. Modeling igneous rock formation and volcanic activity:

a. Return the foil boat with the rock to the hot plate until it melts.

b. During this time, students should create another foil boat and place ice cubes inside.

c. Simulate a volcanic eruption by pouring the liquid rock over ice cubes.

d. Allow the rock to cool and solidify. Have students make observations.

e. Discuss the activity and how it relates to the rock cycle:

- *What substance do the melted crayons represent? What type of rock has formed from cooling the melted crayons?*
- *Describe the texture and shape of the cooled crayons. How do these characteristics compare to real igneous rocks?*
- *Do you observe any crystal formation? How does the rate of cooling affect the size of crystals in igneous rocks?*

7. Review the rock cycle by having students make connections between each phase of the diagram and the crayon activity.

8. Facilitate a discussion:

- *Reflect on each stage of the rock cycle we modeled today. Which stage was most surprising or interesting to you? Why?*
- *Think about how we used crayons to simulate the rock cycle. In what ways was this model effective in demonstrating geological processes? What aspects of the rock cycle do you feel were well represented?*
- *Every model has its limits. What limitations did you notice in our crayon activity? Were there any stages of the rock cycle that were difficult to represent accurately with crayons?*
- *How could this model be improved to better reflect natural geological processes? What other materials or methods might be better to use?*

Explain

1. Facilitate a discussion reflecting on what defines a mineral versus a rock, sharing similarities and differences between the two.
    - **Mineral:** A type of natural, non-living solid that has a specific pattern of chemicals in its structure.
    - **Rock:** A solid made up of one or more minerals. Rocks can be different types, like igneous (formed from melted rock), sedimentary (formed from bits of other rocks or materials), and metamorphic (formed from changes in other rocks when exposed to high heat and/or pressure).
2. Briefly introduce the rock cycle diagram, explaining how it illustrates the continuous transformation of rocks from one type to another over geological time.
3. Introduce students to, and then have them play, the rock cycle game (**The Rock Cycle Game | NASA**), where students will 'experience' the rock cycle and track their changes on the "Rock Cycle Diagram" handout.
    a. Students will use a die to randomly select their starting station in the rock cycle.
    b. Each station in the classroom represents a stage of the rock cycle. Students will move between stations according to the roll of the die, mimicking the journey of a rock through the rock cycle.
    c. As they travel, students will fill in their "Rock Cycle Diagram" handout, tracking their path and noting key processes at each stage.
4. After completing the game, groups will share their experiences. Discuss the journey their "rock" took and what transformations it underwent. Encourage students to reflect on the interconnectedness of the rock cycle steps, as well as that there is no one path through the cycle, but the steps depend on environmental conditions.
5. Facilitate a class discussion about the game and the rock cycle diagram using questions like:
    - *How do the processes by which different rocks form compare and contrast?*
    - *What external factors can cause a rock to change from one type to another?*
    - *Which type of rock is most prevalent on Earth's continents and why?*
    - *In what ways can human activities impact the natural rock cycle? Can you think of examples where human actions have accelerated or altered these geological processes?*
6. Review the types of rocks and key components of the rock cycle, including melting, cooling, sedimentation, burial, metamorphism, and weathering.

Elaborate

1. Have students visit the stations and use keys to identify the type of rock at each station and its location in the rock cycle.
2. Discuss practical uses of the rock types, focusing on how they are used in the community or region. Have students consider the availability of the sample.
3. Have students see the rocks in natural settings by either
    a. Organizing a field trip to a local site, or
    b. Conducting a virtual field trip.
4. While on the in-person or virtual field trip, students should consider the formation, location, uses, and interesting facts about each rock.
5. Facilitate a class discussion about the experience, the importance of understanding local geology, and how the rock cycle plays a crucial role in the environment and economy.

Evaluate

1. Have each student select a rock or mineral that is commonly mined or found in the local area but has not been covered in previous class discussions and activities. Provide a list of potential minerals and rocks to choose from to ensure choices are relevant to local geology.
2. Group students with similar samples to research their rock or mineral. Key areas they should explore include:
    - **Formation:** How and where does the mineral or rock form? What geological processes contribute to its formation?
    - **Properties:** What are the physical and chemical properties that characterize this mineral or rock?
    - **Uses:** How is this mineral or rock used? Consider both historical and modern uses.
    - **Significance:** Why is this mineral or rock important to the area or state? Consider economic, environmental, and cultural factors.
3. Have students prepare a presentation (e.g. poster, slides, video) about their rock or mineral. Provide a rubric for guidance.
4. Have students present their findings to the class. Potentially invite a local geologist to attend the presentations in-person or virtually.

HANDOUTS

Exploring Earth Samples

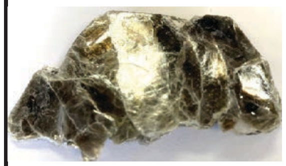
For each sample, record your observations and mineral test results in the “Exploring Earth Samples Table.”

1. Make observations of the color, luster (shine, such as glassy, dull, or metallic), and shapes or patterns you see within each mineral.
2. Hardness Test: Use a Moh’s Hardness test kit or objects of known hardness values to scratch the surface of the mineral to determine the hardness.
    a. Begin with the softest object in your hardness kit.
    b. Gently press the selected object against the surface of your sample and attempt to make a scratch.
    c. Carefully examine the surface:
        i. If the object left a scratch, note the mineral’s hardness must be equal to or less than the hardness of the object you used. Record the hardness level and move to the next mineral.
        ii. If there is no scratch, use the next hardest object in your kit and repeat the process. Continue until you find a tool that scratches the sample.
3. Conduct the streak test: For any mineral with a hardness less than 6.5, rub the mineral gently across the streak plate and record the color left on the plate.
4. Determine the density: Measure the volume of each sample using a graduated cylinder, water displacement, and a properly sized container. Use a scale to take the mass of each sample, then calculate density using the formula: Density = mass / volume.
5. Conduct the reactivity test: Place your sample on a tray and add 2–4 drops of weak acid to the sample. Observe any reaction (bubbling, fizzing, no reaction) and record your observations.

EXPLORING EARTH SAMPLES TABLE

Sample	Color	Luster (Shine)	Hardness	Streak	Density	Reactivity

Mineral and Rock Samples A

1 **BARITE** Non-metallic Mineral  Chemistry: $BaSO_4$ (barium sulfate) Color: White, gray, black, yellow Luster: Glassy, pearly Streak: White Hardness: 3.0–3.5 Specific gravity: 4.5 From: Greystone Mine, M-I Swaco, T28N, R45E, Sec. 35, Lander Co., NV	**2** **FLUORITE** Non-metallic Mineral  Chemistry: CaF_2 (calcium fluoride) Color: White, gray, purple, pink, green, blue, yellow Luster: Glassy Streak: White Hardness: 4.0 Specific gravity: 3.1–3.3 From: Kelly prospect, South Toiyabe Range, Nye Co., NV	**3** **GARNET** (Grossular) Non-metallic mineral  Chemistry: $Ca_3Al_2Si_3O_{12}$ (calcium silicate) Color: colorless, white, yellow, pink, green, brown Luster: Vitreous Streak: White Hardness: 6.5–7.5 Specific gravity: 3.56–4.32 From: Gun Metal Mine, Mineral Co., NV	**4** **TALC** Non-Metallic Mineral  Chemistry: $Mg_3Si_4O_{10}(OH)_2$ (hydrous magnesium silicate) Color: White, gray, greenish-white, brownish Luster: Pearly, waxy Streak: white Hardness: 1.0 Specific gravity: 2.58–2.83 From: Shaw Mine, Palmetto Mining District, Esmeralda Co., NV	**5** **FELDSPAR** (variety: Microcline) Non-metallic Mineral  Chemistry: $KAlSi_3O_8$ (potassium aluminum silicate) Color: White, cream, pink to pinkish white Luster: Glassy, pearly Streak: White Hardness: 6.0 Specific gravity: 2.56 From: Crystal Peak, Sierra County, CA	**6** **GYPSUM** (variety: Selenite) Non-metallic Mineral  Chemistry: $CaSO_4$ $2(H_2O)$ (hydrous calcium sulfate) Color: Clear, white Luster: Pearly, glassy Streak: White Hardness: 2.0 Specific gravity: 2.3 From: Empire Mine, U.S. Gypsum Co., Pershing Co., NV
7 **CALCITE** Non-metallic Mineral  Chemistry: $CaCO_3$ (calcium carbonate); fizzes in hydrochloric acid Color: White, clear, yellow, pink, blue Luster: Glassy to pearly Streak: White Hardness: 3.0 Specific gravity: 2.7 From: Atlas Gold Bar Mine, Roberts Mountains, Eureka Co., NV	**8** **MAGNETITE** Metallic Mineral  Chemistry: Fe_3O_4 (ferric iron oxide) Color: Black Luster: Metallic to dull Streak: Dark Gray to Black Hardness: 6.0 Specific gravity: 5.0 From: Iron Mine, Buena Vista Hills, Pershing and Churchill Counties, NV	**9** **MUSCOVITE** Non-metallic Minerals  Chemistry: KAl2(AlSi3O10)(OH)2 (hydrated phyllosilicate) Color: White or colorless to yellowish, greenish, pink, brownish, multicolored. Luster: Vitreous, Pearly Streak: White Hardness: 2.0–2.5 Specific gravity: 2.7–3.0 From: North Star Mine, North Star Minerals, Acton, Los Angeles Co., CA	**10** **PYRITE** Metallic mineral  Chemistry: FeS_2 (iron sulfide) Color: Dark yellow with occasional iridescent yellow-brown film coating Luster: Metallic Streak: greenish-black Hardness: 6.0–6.5 Specific gravity: 5.0–5.2 From: Ward Mine, White Pine County, NV	**11** **QUARTZ** Non-metallic Mineral  Chemistry: SiO_2 (silicon dioxide) Color: White, clear, pink, purple, brown, black Luster: Glassy Streak: White, but harder than streak plate Hardness: 7.0 Specific gravity: 2.6 From: Unnamed Prospect, Clark Co., NV	**12** **SULFUR** Non-metallic Mineral  Chemistry: S (sulfur) Color: Yellow Luster: Resinous, glassy Streak: Pale yellow Hardness: 1.5–2.5 Specific gravity: 2.0 From: Hycroft Mine, Hycroft Resources and Development, Inc. Humboldt Co., NV

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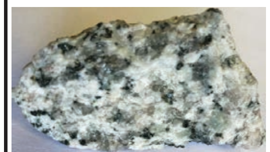
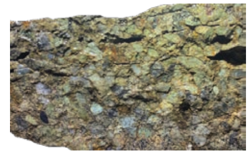
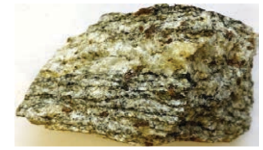
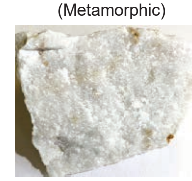
Mineral ID Kit https://www.nevadamining.org/education/ https://minerals.nv.gov/Programs/EO/EO/

Mineral and Rock Samples B

1	2	3	4	5	6
RHYOLITE TUFF (Extrusive igneous) Ash flow tuff	**GRANITE** (Felsic intrusive igneous)	**SHALE** (Sedimentary) Layered Mudstone	**CONGLOMERATE** (Sedimentary)	**SCHIST** (Metamorphic)	**GNEISS** (Metamorphic) Granite Gneiss
					
Description: A fine-grained, light colored rock composed of the same minerals as granite. May contain volcanic glass shards and vesicles (gas bubbles).	Description: Medium to coarsely crystalline rock, generally light colored, composed of quartz (gray, glassy), plagioclase feldspar (white), potassium feldspar (pinkish), biotite mica (dark brown-black, shiny round flakes) and hornblende (greenish-black rectangles).	Description: Very fine-grained, well-sorted. Breaks into layers. Generally soft but will not fall apart on wetting. Dark gray to black color. Some invertebrate fossils.	Description: Moderate to strongly resistant basal conglomerate. Clasts are mostly Paleozoic and Mesozoic carbonate and chert with some sandstone. Matrix is a pale red to pale reddish-brown, fine to coarse sand cemented by calcite.	Description: Foliated rock with visible crystals of mica. Layers consist of flat, parallel crystals of mica and other minerals including quartz, feldspar, and sparse reddish-brown garnet.	Description: Medium- to coarse-grained layered crystalline rock. Alternating bands of light minerals (quartz, feldspars) and bands of dark minerals (biotite mica, hornblende), scattered reddish-brown garnet. Minerals may also be aligned within layers.
Age: Miocene Epoch, 12.4–13.2 million years old	Age: Cretaceous Period, 78–82 million years old	Age: Late Mississippian to Early Pennsylvanian, 300–340 million years old	Age: Tertiary, 15–18.8 million years old	Age: Cambrian Period, approx. 570 million years old	Age: Pre-Cambrian, greater than 570 million years old
Source: Paintbrush Tuff	Source: Sand Springs Pluton	Source: Diamond Peak Formation	Source: Rainbow Gardens Mbr., Horse Spring Fm.		
Location: Stonewall Pass, road cut along US Hwy 95, Nye Co., NV	Location: Gote Flat, Sand Springs Range, T16N, R32E, Sec. 34, Churchill Co., NV	Location: Roadcut approx. 4 miles NW of Elko, Elko Co., NV	Location: South side of Frenchman Mountain, Clark Co., NV	Location: 1 mile south of Beatty, Nye Co., NV	Location: Crescent Peak area, T28S, R61E, NE ¼ Sec. 36, Clark Co., NV
7	**8**	**9**	**10**	**11**	**12**
BASALT (Extrusive igneous)	**Quartz Diorite** (Intrustive, igneous)	**SANDSTONE** (Sedimentary)	**LIMESTONE** (Sedimentary)	**QUARTZITE** (Metamorphic)	**MARBLE** (Metamorphic)
					
Description: Very fine-grained, dark gray to purplish black rock. May contain olivine and orthopyroxene. Some samples may contain vesicles.	Description: Coarse to medium grained dark-colored crystalline rock composed of dark grey plagioclase feldspar, greenish-black biotite and l5 to 20% quartz.	Description: Medium-grained sand (0.25–0.5 mm), well-sorted, moderately rounded quartz grains, cemented by iron oxide and calcite. Shows distinctive layering or bedding. Some faint cross-bedding may be visible.	Description: Fine-grained blue-gray rock with 50% or more of the rock composed of calcium carbonate, primarily the mineral calcite. (Contains invertebrate fossils).	Description: Rock consists mainly of quartz that has recrystallized to form interlocking quartz crystals. Very fine-grained and buff to white in color.	Description: Fine- to coarse-grained crystalline rock composed principally of intergrown, recrystallized calcite or dolomite. Cream to white in color. Little or no iron or manganese veining.
Age: Pleistocene or Holocene Epoch, up to 2 million years old	Age: Late Cretaceous to Early Tertiary, 55-96 million years old	Age: Late Triassic–Early Jurassic Periods, approx. 200–215 million years old	Age: Pennsylvanian–Permian Periods, 240–330 million years old	Age: Middle Ordovician Period, approx. 470 million years old	Age: Lower to Middle Cambrian Period, approx. 520 million years old
		Source: Aztec Sandstone	Source: Bird Spring Limestone	Source: Eureka Quartzite	Source: Carrara Formation
Location: The Crater, 4 miles north of Silver Peak on SR 265, T1S, R39E, Sec. 27, Esmeralda Co., NV	Location: T26S, R64E, Sec. 4, Eldorado Mining District, Nelson, Clark Co., NV	Location: Las Vegas Rock Quarry near Mt. Potosi, Spring Mtns., Clark Co., NV	Location: T24S, R58E, SW 1/4 Sec. 20, Goodsprings District, Clark Co., NV	Location: Arrow Canyon Range near Ute, Clark Co., NV	Location: Carrara Quarry, Bare Mountain, Nye Co., NV

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