NVMA
Nevada Mining Association
EST. 1913

Minerals and Rocks

Level: High School
Facilitator Guide

LESSON DETAILS

Objective: Students will investigate the properties and formation of various minerals and rocks 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

- **HS-ESS3-1:** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- **HS-ESS3-2:** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- **HS-ESS3-3:** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- **DCI:** Earth Materials and Systems; Natural Resources
- **SEP:** Analyzing and Interpreting Data
- **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
- rock and mineral samples
- Mmneral test kits
- hand lenses
- iron-fortified cereal
- measuring cup
- mortar and pestle or small bowl and spoon
- magnets
- water
- clear, zippered sandwich bags
- scale (optional)

Lesson Summary

Students will use maps to assess where people live across the state and what natural processes and resources may have influenced where people choose to live. They will then focus on rocks and minerals, conducting tests on them to understand more about their properties. Students will then relate the properties of rocks and minerals to their potential uses. A discussion of what makes a mineral "critical" will lead to student-exploration of data on critical minerals within the state, considering what minerals have been mined and how much, as well as how this impacts local or regional environmental and economic conditions. Student understanding can be evaluated by presentations where students analyze a specific critical mineral and consider its future availability.

AGI Developed in collaboration with the American Geosciences Institute

Preparation

Before the **Explore** activity, set up stations for students to test the properties of minerals before identifying rocks. It is recommended these are done separately to allow discussion of what defines a mineral from a rock. See the Mineral and Rock Samples Charts (**A** and **B**) for examples that are common in Nevada.

Engage

1. Analyze Nevada's population density across the state:
    a. Visit "**Nevada's Population Change**" StoryMap from the Nevada Legislative Counsel Bureau.
    b. Go to the "Nevada 101" tab and give students time to make observations about Nevada's population growth over time.
    c. Ask students:
        - *Where do you think people in Nevada live? Describe the distribution across the state.* You may want to mark their ideas on a blank map as you discuss their responses.
    d. Have students work in pairs or small groups to explore the "Population Density" and "Future Projections" sections. They should take notes on the maps.
    e. Discuss population density across the Nevada. Ending with: "*What do you think has influenced this? Why have people chosen to live in specific parts of Nevada and not others?*"
2. Have each group of students analyze a map of the distribution of one of Nevada's natural resources to see if there are correlations to the state's population map:
    a. **Groundwater:** (Interactive Map showing groundwater level trends. Click "View" to get started. You may want students to also view a **map of average rainfall** in Nevada.)
    b. **Lakes and Rivers:** (Static map. You may want students to also view a **map of average rainfall** in Nevada.)
    c. **Minerals:** (Interactive map: Click through all the map types in the top right of the screen and uncheck all layers to turn them off. Go to the "Mineral Resources" map and click each layer to view them separately, then together. Clicking on each point gives you information about each mine site or mineral deposit.)
    d. **Oil and Gas:** (Interactive map: Click through all the map types in the top right of the screen and uncheck all layers to turn them off. Go to the "Occurrences & Production" map and turn on "Oil & Gas Production and Well Data. Expand the key for this to see what each color means.)

e. **Soil:** (Interactive Map: Read the introduction to Nevada soils. Click on each color to get the names of the different soils, then use **The Twelve Orders of Soil Taxonomy** site to learn more about each soil.)

3. Discuss with students if they see a trend in where people live based on the evidence from these maps. Focus on minerals:

   a. Ask students:

      - *Why do you think the location of minerals would have an influence on where people live?*
      - *Do you know any examples of times when the discovery of a mineral caused people to move?*

   b. Discuss the occurrence of gold rushes.

   c. Introduce the **history of mining in Nevada**.

Explore

1. Introduce different observations and tests that are used to identify minerals.

   a. **Observations:** Color the presence and shape of crystals, texture, luster (shine).

   b. **Hardness test:** Determines the resistance of a mineral to being scratched.

   c. **Streak test:** Reveals the color of a mineral in powdered form.

   d. **Reactivity test:** Shows if a rock is reactive to acid.

   e. **Specific gravity/relative density:** Measure the 'heaviness' of the mineral by comparing mineral's weight in water to its dry weight.

   f. **Magnetism:** Use a magnet to determine if a mineral is magnetic.

2. Distribute mineral test kits and mineral samples commonly found in Nevada.

3. Have students make observations and conduct tests for each mineral sample. They should design a data table in which they can record their observations and results. Note: The focus of testing minerals is to practice the process. Students are not responsible for identifying minerals; however, students can practice using a mineral identification key to use the data they collected to identify the minerals.

4. Discuss the students' results:

   - *Which two minerals look similar? Use this as an argument for why mineral tests need to be conducted.*

- *Which mineral was easiest to identify? Which was the most difficult? Why do you think this?*
- *Which test/property do you think is the best for identifying a mineral? Explain your answer.*

5. Facilitate a discussion about how the results students got from the mineral tests are related to the properties of these minerals.
6. Give each group a couple of rock samples. Have students use rock identification keys to name the rocks. Use this as a way to review the differences between rocks and minerals. Discuss how the mineral and rock keys differ and why, given how the two materials differ.

Explain

1. Ask students: *Which are mined: rocks, minerals, or both?* Discuss reasons for mining rocks (e.g., construction materials) versus minerals. Also, discuss that ores are rocks that are rich in a particular mineral, so the rock must be extracted before the mineral can be removed from it.
2. Show students samples or **images** of ores from which iron is extracted.
   a. Assign each student a type of iron ore to learn more about, especially as it relates to Nevada (listed in order of difficulty):
      - **Limonite** mining in Nevada (**description**).
      - **Magnetite** mining in Nevada (**description**).
      - **Hematite** mining in Nevada (**description**).
      - **Siderite** mining in Nevada (**description**).
   b. Ask students:
      - *What are some differences between these ores?*
      - *Which is most commonly found in Nevada? Why do you think this is?*
      - *What is iron used for?* List their responses on the board.
   c. Distribute a few nutrition label from cereal boxes. Discuss why iron might be found in cereal, why different types of cereal have different amounts, and how it gets there. Also, discuss how students might test that there is actually iron in cereal (e.g., what property does iron have that they might take advantage of to "find" the iron in the cereal?).
3. Have students conduct an investigation in which they extract iron from cereal, like in this **Iron Minerals on the Moon** activity (adapted from the Minerals Education Coalition).

   a. Add ½ to one cup of iron fortified cereal to a mortar or small bowl.
   b. Hold a magnet over the cereal at varying distances and observe the cereal.
   c. Crush the cereal with a spoon or pestle to create a fine powder.
   d. Pour the cereal into a clear, zippered sandwich bag. Add enough water to make a slurry, then seal the bag.
   e. Massage the bag to make an even mixture of the cereal and water. Place the bag on a flat surface.
   f. Hold a magnet to the bag and make observations. Moving the magnet around may be helpful.

4. Optionally, have students pull the iron fragments to the top of the bag and use a spoon to collect them. The mass of the iron samples can then be taken. Students can compare the amount of iron they collected per volume of cereal and discuss what might affect the amount of iron each group collected.
5. Discuss why iron is added to some foods.
6. Have other examples of items containing or made of iron to show its versatility (e.g., many types of silverware, cast iron skillets, antique clothing irons). Discuss or show items made of steel (stainless steel cookware, jewelry, bolts, and others) and how it contains iron but differs (contains carbon, which aids in making iron more resistant to corrosion).
7. Discuss the uses of common minerals and the properties of the minerals that allow for these uses. Use handouts like pages **5 and 10 from BLM** or this **from USGS** to discuss what minerals are used for, but with more focus on how their properties allow them to have these functions.
8. Discuss what factors might make a mineral more important (critical) than others.

Elaborate

1. Assess data (visual and quantitative) on **critical minerals** mined in Nevada.
   a. Have students click through the list of minerals or go through the years on the map to look for changes/trends in what has been mined over time.
   b. Have students take notes as they look through the maps. Note that the videos may be of use, but likely provide far more information than what students need.
   c. Examine a **U.S. Map of Critical Mineral Distribution** and compare what critical minerals are mined in Nevada versus the rest of the country.
   d. Then analyze a map of **where critical minerals are mined around the world**.

2. Discuss critical minerals:

   a. How has mining of critical minerals changed in Nevada over time?

   b. What are **economic considerations** that might impact these mining trends?

   c. How does the importation of minerals from other countries affect our economy and sustainability? What are the pros and cons?

Evaluate

1. Have students conduct preliminary research to determine a mineral that is mined in Nevada that they want to learn more about. It is recommended students work in small groups.

2. Have students prepare a presentation (e.g., slides, video, poster) on their chosen mineral, including information on:

   a. its properties, and how these relate the how the mineral is used,

   b. extraction trends and whether it has ever been classified as critical or if they foresee this in the future, and

   c. recommendations for future extraction or if and how this mineral can be reclaimed from products that have been disposed (e.g., lithium from used batteries).

3. Have students present to the class or post presentations where others can see them and provide constructive feedback.

HANDOUTS

Exploring Earth Samples

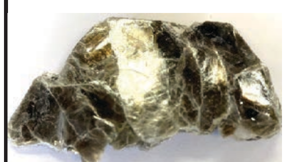
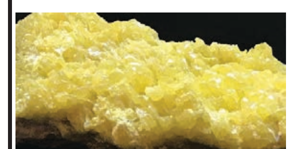
For each sample, record your observations and mineral test results in the “Exploring Earth Samples Table.”

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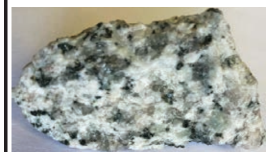
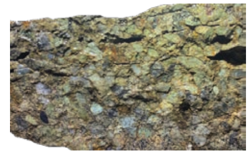
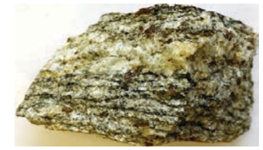
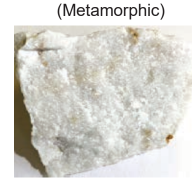
Mineral ID Kit https://www.nevadamining.org/education/ https://minerals.nv.gov/Programs/EO/EO/

Mineral and Rock Samples B

1 **RHYOLITE TUFF** (Extrusive igneous) Ash flow tuff  Description: A fine-grained, light colored rock composed of the same minerals as granite. May contain volcanic glass shards and vesicles (gas bubbles). Age: Miocene Epoch, 12.4–13.2 million years old Source: Paintbrush Tuff Location: Stonewall Pass, road cut along US Hwy 95, Nye Co., NV	2 **GRANITE** (Felsic intrusive igneous)  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). Age: Cretaceous Period, 78–82 million years old Source: Sand Springs Pluton Location: Gote Flat, Sand Springs Range, T16N, R32E, Sec. 34, Churchill Co., NV	3 **SHALE** (Sedimentary) Layered Mudstone  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. Age: Late Mississippian to Early Pennsylvanian, 300–340 million years old Source: Diamond Peak Formation Location: Roadcut approx. 4 miles NW of Elko, Elko Co., NV	4 **CONGLOMERATE** (Sedimentary)  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. Age: Tertiary, 15–18.8 million years old Source: Rainbow Gardens Mbr., Horse Spring Fm. Location: South side of Frenchman Mountain, Clark Co., NV	5 **SCHIST** (Metamorphic)  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. Age: Cambrian Period, approx. 570 million years old Location: 1 mile south of Beatty, Nye Co., NV	6 **GNEISS** (Metamorphic) Granite Gneiss  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: Pre-Cambrian, greater than 570 million years old Location: Crescent Peak area, T28S, R61E, NE ¼ Sec. 36, Clark Co., NV
7 **BASALT** (Extrusive igneous)  Description: Very fine-grained, dark gray to purplish black rock. May contain olivine and orthopyroxene. Some samples may contain vesicles. Age: Pleistocene or Holocene Epoch, up to 2 million years old Location: The Crater, 4 miles north of Silver Peak on SR 265, T1S, R39E, Sec. 27, Esmeralda Co., NV	8 **Quartz Diorite** (Intrustive, igneous)  Description: Coarse to medium grained dark-colored crystalline rock composed of dark grey plagioclase feldspar, greenish-black biotite and l5 to 20% quartz. Age: Late Cretaceous to Early Tertiary, 55-96 million years old Location: T26S, R64E, Sec. 4, Eldorado Mining District, Nelson, Clark Co., NV	9 **SANDSTONE** (Sedimentary)  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. Age: Late Triassic–Early Jurassic Periods, approx. 200–215 million years old Source: Aztec Sandstone Location: Las Vegas Rock Quarry near Mt. Potosi, Spring Mtns., Clark Co., NV	10 **LIMESTONE** (Sedimentary)  Description: Fine-grained blue-gray rock with 50% or more of the rock composed of calcium carbonate, primarily the mineral calcite. (Contains invertebrate fossils). Age: Pennsylvanian–Permian Periods, 240–330 million years old Source: Bird Spring Limestone Location: T24S, R58E, SW 1/4 Sec. 20, Goodsprings District, Clark Co., NV	11 **QUARTZITE** (Metamorphic)  Description: Rock consists mainly of quartz that has recrystallized to form interlocking quartz crystals. Very fine-grained and buff to white in color. Age: Middle Ordovician Period, approx. 470 million years old Source: Eureka Quartzite Location: Arrow Canyon Range near Ute, Clark Co., NV	12 **MARBLE** (Metamorphic)  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: Lower to Middle Cambrian Period, approx. 520 million years old Source: Carrara Formation Location: Carrara Quarry, Bare Mountain, Nye Co., NV

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