John Jarvie Historic Ranch:

Geology

Authored by: Kylee Ehmann

Grade 4-5

LESSON PLAN DETAILS

Time Frame:
One 45 Minute class per activity

Group Size:
- Activity 1: Entire Classroom
- Activity 2: Groups of 2-3
- Activity 3: Groups of 2-3

Materials:
Activity 1: Classroom Chairs
Activity 2: Printed Out Handouts
Activity 3: Shoe boxes, dirt/sand, small bowl, marbles, spoons, popsicle sticks, plastic trees, small animals.

Life Skills:
Critical thinking skills and visual analysis

Intended Learning Outcomes:

Students will see geology as part of a dynamic system with which humans interact. z

Jarvie Ranch Ecology of Brown's Park Lesson Plan

By: Kylee Ehmann

This lesson plan is intended for fourth and fifth grades. See comments throughout lesson plan for ideas on how to adjust this material for lower or higher grades.

SUMMARY

This lesson plan is intended to help students recognize the geology that exists around them and to acknowledge the relationships that exist between people and the land.

Through a three-part lesson plan, students will differentiate between a rock v. mineral, define the rock cycle, identify the main geological forms and types of rock in Brown's Park and in their own neighborhoods, as well as explore the history of mining in the region and in Utah at large.

Part one of this lesson plan focuses on the geology of Brown's Park (the region that Jarvie Ranch rests in) and exploring how students can use their knowledge of rocks to identify rocks out in nature. Part three focuses on how humans interact and use their environment.

The first two sections are tied to fifth grade science standards implemented in the 2020-2021 school year. The final section is specifically tied to the fourth grade social studies standards.

Relevant Core Standards

Utah Social Studies Standards 4th Grade

Standard 1: Students will understand the relationship between the physical geography in Utah and human life.

- Objective 1: Classify major physical geographic attributes of Utah.
  - Identify Utah's latitude, longitude, hemisphere, climate, natural resources, landforms, and regions using a variety of geographic tools
  - Examine the forces at work in creating the physical geography of Utah (e.g. erosion, seismic activity, climate change)
- Objective 2: Analyze how physical geography affects human life in Utah.
  - Identify population concentrations in the state of infer casual relationships between population and physical geography ○ Classify the distribution and use of natural resources.
  - Compare the development of industry and business in Utah as it relates to its physical geography (e.g. mining, oil, agriculture, tourism)
  - Examine the interactions between physical geography and public health and safety (e.g. inversions, earthquakes, flooding, fire) ○ Examine how archaeology informs about the past (e.g. artifacts, ruins, excavations)
- Objective 3: Analyze how human actions modify the physical environment.
  - Describe how and why humans have changed the physical environment of Utah to meet their needs (e.g. reservoirs, irrigation, climate, transportation systems and cities)
  - Explain viewpoints regarding environmental issues (e.g. species protection, land use, pollution controls, mass transit, water rights, trust lands).
  - Outline the development of recreation in Utah since 1900 (e.g. sports, tourism, state, and national parks)
  - Make data-supported predictions about the future needs of Utahns and the natural resources that will be necessary to meet those needs

Social Studies language students should know and use: natural resources, landforms, regions, erosion, seismic activity, tourism, communication, transportation, archaeology, artifacts, excavations

Colorado Social Studies Standards

History Explain the role of individuals, diverse cultural groups, and ideas in the historical development of Colorado; organize and sequence events in Colorado history in chronological order; recognize the connections between important Colorado events and important events in the history of the United States. **(4th Grade):** Using map keys, symbols, and legends to show how Colorado cities, towns, and neighborhoods were settled,

and how they have developed and changed over time; exploring the connections between Colorado's physical resources (mountains, plains) and why diverse populations have chosen to live here. **(5th Grade):** Use various geographic tools and sources to answer questions about the geography of the United States; Causes and consequences of movement).

Geography (4th Grade): Use maps to ask and answer questions about the geography of Colorado and to understand the interactions between humans and their environment. (Describing unique products and services provided in Colorado; exploring the connections between Colorado's physical resources and what is produced and provided in the state.)

Wyoming Social Standards

Content Strand 5: People, Places, and Environments – Students apply their knowledge of the geographic themes (location, place, movement, region, and human/environment interactions) and skills to demonstrate an understanding of interrelationships among people, places, and environment.

Utah Science Standards 5th Grade

Strand 5.1 Characteristics and Interactions of Earth's Systems: Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). Within these systems, the location of Earth's land and water can be described. Also, these systems interact in multiple ways. Weathering and erosion are examples of interactions between Earth's systems. Some interactions cause landslides, earthquakes, and volcanic eruptions that impact humans and other organisms. Humans cannot eliminate natural hazards, but solutions can be designed to reduce their impact.

Standard 5.1.1: Analyze and interpret data to describe patterns of Earth's features. Emphasize most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans while major mountain chains may be found inside continents or near their edges. Examples of data could include maps showing locations of mountains on continents and the ocean floor or the locations of volcanoes and earthquakes. (ESS2.B)

Standard 5.1.2: Use mathematics and computational thinking to compare the quantity of saltwater and freshwater in various reservoirs to provide evidence for the distribution of water on Earth. Emphasize reservoirs such as oceans, lakes, rivers, glaciers, groundwater, and polar ice caps. Examples of using mathematics and computational thinking could include measuring, estimating, graphing, or finding percentages of quantities. (ESS2.C)

Standard 5.1.3: Ask questions to plan and carry out investigations that provide evidence for the effects of weathering and the rate of erosion on the geosphere. Emphasize weathering and erosion by water, ice, wind, gravity, or vegetation. Examples could include observing the effects of cycles of freezing and thawing of water on rock or changing the slope in the downhill movement of water. (ESS2.A, ESS2.E)

Standard 5.1.4: Develop a model to describe interactions between Earth's systems including the geosphere, biosphere, hydrosphere, and/or atmosphere. Emphasize interactions between only two systems at a time. Examples could include the influence of a rainstorm in a desert, waves on a shoreline, or mountains on clouds. (ESS2.A)

Standard 5.1.5: Design solutions to reduce the effects of naturally occurring events that impact humans. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data from testing

solutions, and propose modifications for optimizing a solution. Emphasize that humans cannot eliminate natural zards, but they can take steps to reduce their impacts. Examples of events could include landslides, earthquakes, tsunamis, blizzards, or volcanic eruptions. (ESS3.B, ETS1.A, ETS1.B, ETS1.C)

Colorado Science Standards

Earth and Space Science: Understand how Earth has changed over time, and how energy and fuels that humans use are derived from natural sources and their uses effect the environment in multiple ways. **(4th Grade):** Identifying evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time; Obtaining and combining information to describe that energy and fuels are derived from natural resources, and their uses affect the environment). **(5th Grade):** Earth's surface changes constantly through a variety of processes and forces.

Wyoming Science Standards

4-ESS1-1: Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

4-ESS2-1: Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features.

4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from renewable and non-renewable resources and how their sues effect the environment.

4-ESS3-2: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

3-5-ETS102: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to conserve Earth's resources and environment.

Background for Teachers

Prior to teaching this lesson, teachers should know the rock cycle, the general geography of the Brown's Park area, the general geography of the area in which they live, and how people have historically interacted with the geology of the Brown's Park area.

Teachers should impart to their students the idea that landscapes are dynamic and slowly changing over time thanks to weathering, erosion, earthquakes, and human involvement. Human involvement can include moving rocks to create roads and tunnels and mining. Not all human involvement with the land is a negative thing. Teachers should emphasize sustainable land management and mining practices when discussing human interactions with the environment.

Included in this lesson plans are three distinct activities that can be used in conjunction or implemented separately based on classrooms needs.

For Students

Students will need to be familiar with the idea that there are three main kinds of rocks and that rocks are different than minerals.

Students should be able to locate Brown's Park on a map and be able to pinpoint Jarvie Ranch's location within it.

The goal of this lesson plan is for students to identify that a landscape is a dynamic environment that changes thanks to outside pressures. For fourth graders, these outside pressures will focus on the impact of human use of a landscape's geography. For fifth graders, these outside pressures will focus on more natural forces, such as the rock cycle itself and weathering and erosion.

Lesson Plan Procedure

Day One

- **Teachers should walk students through the rock cycle. Ensure all students understand the primary parts of the rock cycle.**
- **Play rock cycle musical chairs game.**

Day Two

- **Finish all prompts from the Booklet Activity.**
- **Have students present their findings.**

Day Three

- **Human interaction activity.**
- **Begin discussion around the impacts of humans on the geological landscape via mining.**

Teacher Resource: The Geology of Brown's Park

John Jarvie Historical Ranch sits in the Brown's Park region, a stretch of land that stretches between Wyoming, western Colorado, and eastern Utah.

Like many areas in Utah, the Brown's Park formation has a lot of sedimentary rocks. This is because much of the land that is now known as Utah was once covered by large tracts of water. As rocks are worn down by weathering and erosion, they are turned into geological detritus (e.g. gravel, sand, slit). This geological detritus can combine with the biological detritus such as dead aquatic organisms (e.g. shells, bones, feces). This collection of detritus is cemented together at the base of oceans, lakes, or other bodies of water. Thanks to geological forces such as earthquakes and tectonic movement and to these bodies of water drying up, we are able to see these layers over time.

This area is constantly changing, even if it is changing slowly. Like everywhere on our planet, the earth and geology are dynamic and part of an ever-evolving world. Humans are embedded within this changing landscape. It is important to note that even as we change ourselves to suit these geological features, we change these geological features to suit ourselves. It is important to note the ways in which this change in the geology can effect non-humans in the world around ourselves.

Key Vocabulary	
Sedimentary Rock	(of rock) that has formed from sediment deposited by water or air and is compacted by time and gravity (sandstone).
Igneous Rock	(of rock) that has formed from sediment deposited by water or air. (obsidian)
Metamorphic Rock	denoting or relating to rock that has undergone transformation by heat, pressure, or other natural agencies, e.g. in the folding of strata or the nearby intrusion of igneous rocks. (granite)
Rock Cycle	an idealized cycle of processes undergone by rocks in the earth's crust, involving igneous intrusion, uplift, erosion, transportation, deposition as sedimentary rock, metamorphism, re-melting, and further igneous intrusion.
Erosion	The transportation of bits of rock and minerals worn down by weathering to a different location to form new rock.
Weathering	The break down/dissolving of rocks and minerals on the surface of the earth (water, ice, acids, salts, plants, animals, temperature changes can all work in the weathering process)

First Activity: Rocks & the Rock Cycle

Rocks v. Minerals

What Is A Rock?

Step 1: Have your students define what a rock is.

- At the board, write down the word rock and ask your students to give a definition of a rock. If your students are struggling, ask them to name some characteristics of rocks (i.e. hardness, found outside, naturally occurring, etc.).

Step 2: Give your student the official definition of rocks and show how their understandings of rocks tie into the technical definition of what a rock is.

- Merriam-Webster Dictionary Definition: *consolidated or unconsolidated solid mineral matter*. In other terms rocks are made up of minerals, other rocks, and organic remains pushed together into a new form.
- Additionally, rocks often lack the luster and sheen that minerals have.

Step 3: Show pictures of rocks to your classroom.

- You can use images you find online (the Wikipedia page for minerals has a good collection, or you can use the images after the “compare and contrast” worksheet located at the end of this lesson plan.

What Is A Mineral?

Step 1: Have your students define what a mineral is.

- At the board, write down the word rock and ask your students to give a definition of a mineral. If your students are struggling, ask them to name some characteristics of minerals (i.e. shiny, hard, etc.).

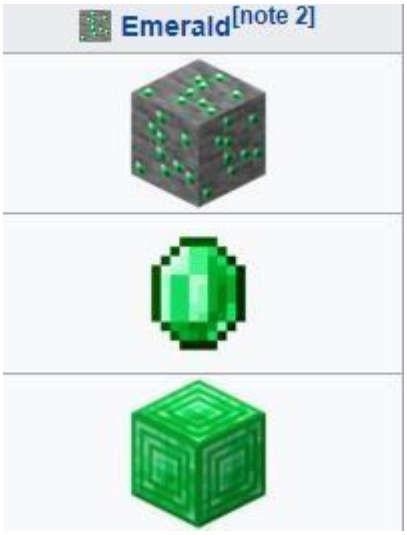
Step 2: Give your student the official definition of minerals and show how their understandings of minerals tie into the technical definition of what a rock is.

- Merriam-Webster Dictionary Definition: *any of various naturally occurring homogenous substances obtained (usually) from the ground.* In other words, minerals are a solid mass of a single element or compound. They are naturally occurring, completely inorganic, solid at room temperature (with the exception of mercury), have an ordered internal structure that is the same, has a definite chemical composition that is the same everywhere that that mineral occurs.

Step 3: Show pictures of minerals to your classroom. **(**You can use images you find online (the Wikipedia page for minerals has a good collection, or you can use the images after the “compare and contrast” worksheet located at the end of this lesson plan)

Note: rocks and minerals are a prominent feature of the popular video game Minecraft. If your student's first reaction or knowledge of rocks and minerals is to mention Minecraft, encourage your students to use the knowledge from the video game (that minerals are different than rocks, that they are often part of a rock, etc.) to start a conversation about real world rocks and minerals.

For example: the emerald is a kind of "ore" found in Minecraft. It is embedded into rocks, but it itself is a single entity. Meanwhile, the rock "granite" is found in Minecraft. It is not found in other rocks, as it is its own rock.



Help your students see that these video game features have a corresponding relation in the real world. Not all of your students may be familiar with the game, so only be productive in helping some students understand the differences.

Compare & Contrast

Once you have covered what the differences are between the rocks and minerals, give your students the first worksheet located at the end of this lesson plan. Students can work together or in groups while completing this worksheet.

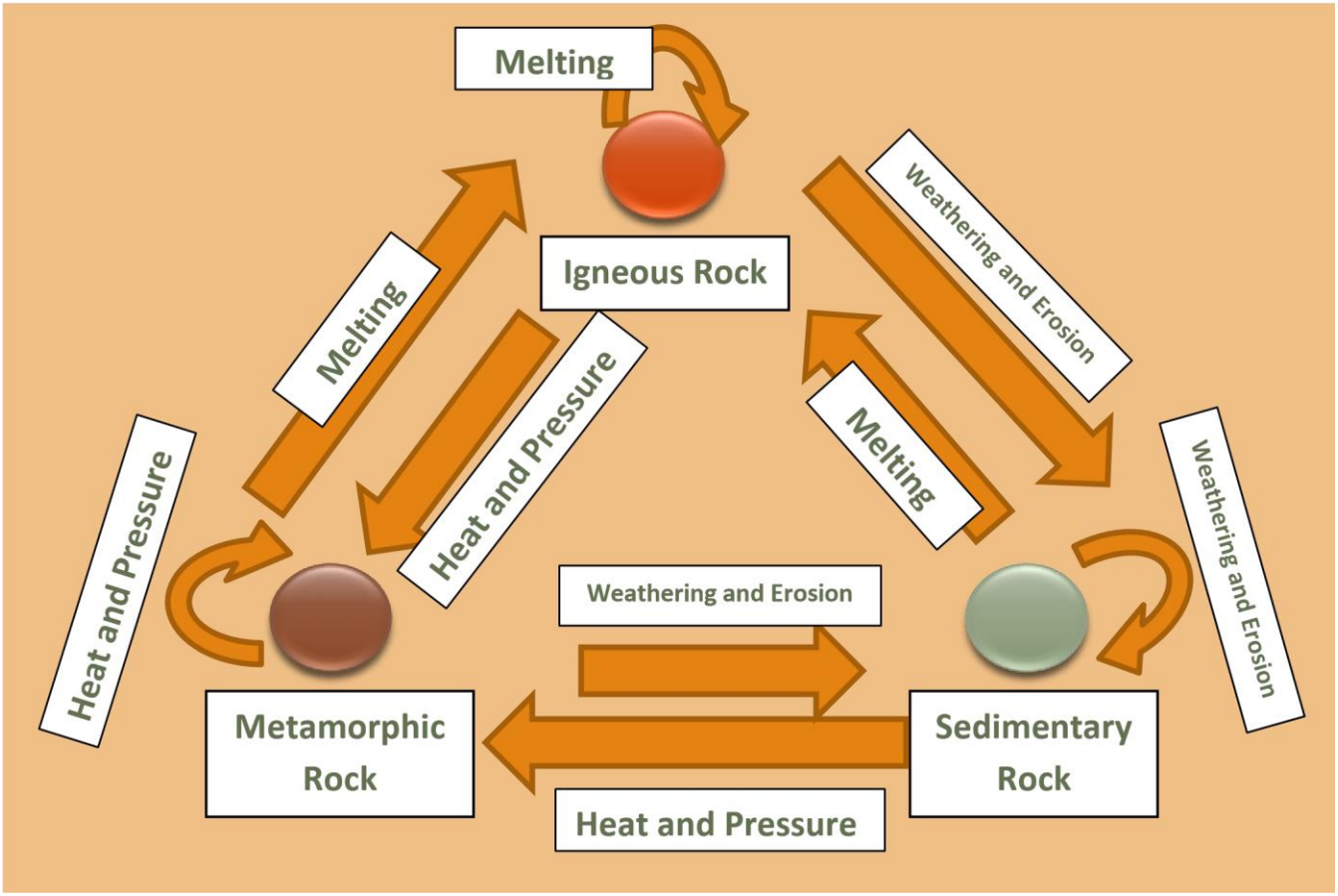
Rock Cycle

What is the Rock Cycle?

Although rocks seem to last forever, they are always changing thanks to the rock cycle. Rocks exist in a state of slow but constant change.

Rocks can be worn down by wind, water, and ice (weathering and erosion), they can be pushed deep into the earth by the moving plate tectonics and melted by magma, or they can

be changed by the pressure of the earth. All rocks move through this circle, though not in any strict order. For example, a rock can be an igneous rock formed from a volcanic eruption, be eroded and then have that detritus cemented into a sedimentary rock, and then a sedimentary rock can be forced under the earth and forced through pressure to become a metamorphic rock. However, the rock cycle can also work the following way: an igneous rock can melt in magma and then cool to become a new igneous rock. A sedimentary rock can be eroded and then reformed into a different sedimentary rock. A metamorphic rock can erode, become a sedimentary rock, which can then be turned into a metamorphic rock, which can become a sedimentary rock again, which can then finally become an igneous rock.



Igneous

Igneous rocks are formed from magma. Igneous rocks are formed when rocks cool inside the earth's surface or when it hits air or water on the outside of the earth's surface. They can become visible through tectonic plate movements moving these rocks to the earth's surface and by cooling around volcanoes and hot spots.

All rocks, including other igneous rocks, can be melted by magma and then cooled. All rocks can become new igneous rocks.

Metamorphic

Metamorphic rocks are formed when a rock is forced under the earth by the movement of tectonic plates. When these rocks are under the earth, they are faced with intense heat and

pressure that changes the rocks into a different rock. Metamorphic rocks make up most of the earth's crust. They become visible when the movement of tectonic plates and erosion force them up beyond the earth's surface.

All rocks, including other metamorphic rocks, can be forced under the earth and changed through heat and pressure. All rocks can become new metamorphic rocks.

Sedimentary

Sedimentary rocks are formed through weathering and erosion. Water, ice, wind, and other natural forces break down rocks into little particles. Organic matter (e.g. seashells, mollusks, bones, feces) can also be broken down to particles, which are then cemented together through the pressure of more layers above it. Because it forms in layers, and these layers don't get as hot as metamorphic and igneous, you are most likely to find fossils in sedimentary rocks.

All rocks, including other sedimentary rocks, can be broken down over time through weathering and erosion. All rocks can become new sedimentary rocks.

Draw the Rock Cycle

Step 1: Project an image of the rock cycle for your students to see. Alternatively, pass out an image with the rock cycle on it. You can use the image provided above or an image you find on the internet.

Step 2: Have your students take out a paper and ask them to copy the rock cycle. They can use crayons, markers, colored pencils, pens, whatever they are most comfortable with.

Step 3: Have your students get into pairs. Have each student explain how the rock cycle works to one another. Remind them that rocks are in a constant state of change and that any rock can transform into any rock given the right conditions.

SUGGESTIONS FOR ROCKS AND MINERALS WITH OLDER STUDENTS:

- **HAVE YOUR STUDENTS RESEARCH AND IDENTIFY THE DIFFERENCE BWETEEN ROCKS AND MINERALS ON THEIR OWN.**
- **HAVE EACH STUDENT/GROUP DO A PRESENTATION ON A ROCK OR A MINERAL AND HOW IT IS FORMED.**

Rock Cycle Musical Chairs

Once you have covered the differences between the three main types of rock, it is time to quiz your students on the different kinds.

Materials: Three different colors of stickers.

Step 1: Have your students move their chairs into a circle.

Step 2: Divide your students into three groups, roughly of equal size. These three groups will represent each type of rock.

Step 3: Hand each of the groups a different color of sticker, one per student. For example, all of the students in the igneous category will get a red a sticker, sedimentary will get a brown sticker, and metamorphic will get a green sticker.

Step 4: Have all students sitting in a chair. One per person. Chairs will be removed after the game starts.

Step 5: Randomly read one of the following statements about one of the kinds of rocks. For example, “This is the kind of rock you are most likely to find fossils in.” This will refer to sedimentary rocks. All students in the sedimentary rock groups should stand up.

Step 6: Remove one of the chairs. Tell the students who are standing that when you count to 3, they must move to a new chair. Only the students who are part of the group mentioned in the rock statement should be moving.

Step 7: Whomever doesn’t get a chair is out. If a student stood up and they were not part of the group that was called, they are out. If a student does not stand up with the rest of their group, they are out.

Step 8: Repeat reading the categories randomly until you have three or two children left. If all three children are of different rock categories, play normal musical chairs. If two or three of the children have the same category, continue calling out rock statements.

Step 9: When you reach the final two students, you can finish by playing a normal musical chairs game or by having students compete to see who can answer the most questions about rocks and the rock cycle.

Rock Statements for Rock Cycle Musical Chairs

Igneous Rocks

1. This type of rock is formed when magma cools down and becomes solid.
2. This type of rock begins to form when rocks are pushed deep, deep down into the earth’s surface and begin to melt.
3. Obsidian is a kind of black, shiny, smooth kind of rock that is formed from lava flows. What kind of rock is obsidian?
4. The name of this rock means “of fire” because it is formed from magma.

5. Because so much of the ocean's crust is pushed into and out of the inside of the earth, most of the oceanic crust is made out of what kind of rock?
6. Granite is formed from the slow cooling and crystallization of magma under the earth's surface. What kind of rock is granite?
7. Only the minerals that are already found in magma can make this kind of rock.
8. This kind of rock is found most often around hot spots, thin portions of the earth's crust that volcanoes and magma can pour through.
9. Pumice is a kind of rock formed when magma is cooled and puffed up with gas bubbles. What kind of rock is pumice?
10. Because this kind of rock is formed from magma, there are no fossils found in it.

Sedimentary Rocks

1. This is the kind of rock you are most likely to find fossils in.
2. The name of this rock refers to the fact that it is made of little particles that have settled and cemented into one place.
3. This kind of rock gets its start when weathering and erosion breaks down sedimentary, igneous, and metamorphic rocks.
4. Sandstone is created when layers of sand accumulate in one area and then is compacted together by the pressure of deposits above it. What kind of rock is sandstone?
5. What kind of rock has visible, straight and flat layers in it?
6. Limestone is a kind of rock that is created from the rocks and the skeletal fragments of coral, seashells, mollusks, and single-celled organisms that is compacted together. What kind of rock is limestone?
7. The straight and flat layers found in this kind of rock are called strata.
8. This kind of rock is commonly found at the bottom of lakes after layers of sediments have been compacted over the years.
9. This kind of rock makes up most of the material in the arches in Arches National Park.
10. Because this kind of rock doesn't do well under intense heat and pressure, it is usually not found deep within the earth's crust. It is typically only found on the earth's surface.

Metamorphic Rocks

1. The name of this rock comes from a word that means "change in form."
2. This kind of rock is formed by deep pressure and heat under the earth's surface. This heat and pressure are not hot enough to completely melt the rock.
3. Marble is formed when sedimentary rocks are forced under the earth and put under intense heat and pressure. What kind of rock is marble?
4. Because this kind of rock does well under heat and pressure, it makes up a large part of the earth's crust.
5. When two tectonic plates collide together, they produce intense heat without magma called friction. The extreme heat of these movement causes what kind of rock?

6. This kind of rock is only formed underneath the earth's surface. It cannot form above ground.
7. These kinds of rocks often have visible wavy and warped lines called "bands."
8. Gneiss is a kind of rock formed when igneous or sedimentary rocks are forced underground and face high pressure and heat.
9. We often find this kind of rock in mountain ranges. Tectonic plates moving together bring these rocks up into mountain ranges, and weathering and erosion help uncover these rocks that are usually only found underground.
10. Diamonds are created when carbon faces intense heat and pressure. What kind of rock is most likely to have diamonds in it?

General

1. This kind of rock can become sedimentary rock through weathering and erosion.
2. This kind of rock can become igneous rock if it melts in magma.
3. This kind of rock can become metamorphic rock if it faces intense heat and pressure.
4. This kind of rock will change over time.
5. This kind of rock can be broken down and changed due to water.
6. These two types of rocks can form above the earth's crust.
7. These two types of rocks can form below the earth's crust.
8. These rocks form thanks to the movements of the earth's crust and the heat within the earth.
9. This kind of rock will never change over time. **Whoever stands up at this is out.**

Second Activity: Geology of Brown's Park

The goal of this section is to have students recognize that they are interacting with geology on a daily basis, and to use the area of Brown's Park as a starting point to begin observing the geology that they can easily see in the area around themselves.

Materials: Images (located at end of this lesson plan). Local Geology Worksheet. Rocks for your students to study (if doing the Geology Worksheet indoors).

Step 1: Ask your students to gather in groups of 2-3. Your students will be making observations about some rock formations near Jarvie Ranch.

Step 2: Show your students images of rock formations near the Green River and Jarvie Ranch (located at the end of this lesson plan).

Step 3: Have your students write down 2-3 observations about the rocks they see. What kind of rock do they think it is made out of?

After students share their observations and inferences, share the facts of the geology of Brown's Park and ask your students to compare what they observed and what they inferred to what geologists have to say about the area. (See un-bolded text below).

The John Jarvie Historical Ranch Site sits in a tract of land known as "Brown's Park." Like much of the earth's land surface, the most prominent geological form in the area is sedimentary rock. The detritus that makes up much of this sandstone comes from sediment from the near Uintah mountain range. The detritus is made up of other sandstone, metamorphic rock from within the nearby mountain range, and the remains of volcanic conglomerate originating from widespread volcanic activity in what would become the western United States during the Miocene era (23.03-5.337 million years ago). The area has long been undergoing slow rearranging and erosion of these rocks since it was formed.

And this landscape is still changing thanks primarily to wind and water. Sandstone is particularly prone to erosion. Thanks to the fact that it is made of compressed sand, mud, and the smaller particles from other rocks, it is particularly susceptible to wind and erosion. The spectacular formations sandstone can form (arches, caves, etc.) are caused because once erosion takes away some of a rock, the rest of the rock rests heavily on what remains. This increased pressure binds the remaining particles together. Even as it solidifies, it is still eroded by the pressures of the wind, rain, ice, snow, and the water of the Green River.

Much of the sandstone in the Jarvie Ranch area is tan-light red. Sandstone is often light in color because it is composed of other light-colored materials. Tan/yellowish sandstone indicates that the material is made up of a blend of material like clear quartz and the compacted sand. Sandstone can be other colors depending on the chemical makeup of the

soil. The reddish tint to the sandstone of Brown's Park lets us know that the chemical compound iron oxide is in the particulates that made the materials.

If your students' inferences do not align with what they see in this activity (for instance, if they say the main rock type that they see is metamorphic instead of sedimentary), remind them that being wrong and learning from mistakes is part of the scientific process. As long as they can work to accept new knowledge, they are engaging with the scientific process.

Step 4: Hand your student groups the Local Geology worksheet at the end of the page. One per group. This activity can be done inside or outside depending on your classroom resources and time constraints.

Step 5 (Indoors): Give each group a rock (rocks can be either ordered online or gathered outside independently).

Step 6 (Indoors): Have your student groups study the rock you have given them and discuss what they see. What kind of rock is it? What are the characteristics of each rock? Where would this kind of rock be found? Do they think there is similar rocks near Jarvie Ranch? Why or why not?

Step 7 (Indoors): Have your student groups write down their findings on the worksheet.

Step 8 (Indoors): Students will be presenting their findings from their rocks to the class. Each group will present their rocks and tell their classmates the answers from the worksheet.

Step 5 (Outdoors): Take your students outside to the playground, to a local park, etc. and have them look for rocks in their neighborhood. This can include the entirety of a mountain, or a small piece of gravel they find while exploring.

Step 6 (Outdoors): Have your student groups analyze the rock/geological feature. What kind of rock is it? What are the characteristics of each rock? Where would this kind of rock be found? Do they think there is similar rocks near Jarvie Ranch? Why or why not?

Step 7 (Outdoors): Have your student groups write down their findings on the worksheet. For the outdoor activity, it is important to have a visual representation of the rock. Students are welcome to take photos of the rock/geological feature they choose or to draw a picture of it.

Step 8 (Outdoors): Students will be presenting their findings from their rocks to the class. Each group will present their rocks and tell their classmates the answers from the worksheet.

Third Activity: Human Interaction with Geology

Humans are shaped by the lands in which we live. The rocks of a landscape, while not alive, shape the ways in which we interact with our environment. Even when we are not actively moving rocks and digging into the earth, we are interacting with geology. For instance, the geology of the area Jarvie Ranch sits in is called Brown's Park. Thanks to the high surrounding mountains that help block some of winds, the area's geology means that it has comparatively milder winters than the areas surrounding it. The ways in which the rock dipped and was eroded by wind and waters meant that this region was flatter and easier to cross than areas around this. Partially because of these reasons, peoples from Native tribes such as the Ute, Comanche, Shoshoni, Blackfoot, Arapaho, Sioux, and Navajo visited and lived within this area.

SUGGESTIONS FOR OBSERVING THE LANDSCAPE WITH OLDER STUDENTS:

HAVE YOUR STUDENTS FOCUS THEIR RESEARCH ON PROMINENT GEOLOGICAL FORMATIONS IN STATE AND NATIONAL PARKS IN UTAH (THE HOODOOS IN GOBLIN VALLEY, ARCHES IN ARCHES, ETC.). WHY DO THESE GEOLOGICAL FORMATIONS LOOK THE WAY THEY DO, WHAT FORCES SHAPED THEM, HOW LONG DO THESE KINDS OF FORMATIONS LAST BEFORE WEATHERING AND EROSION CHANGE THEM, ETC.?

FIELD TRIPS TO A LOCAL PARK (LOCAL, STATE, NATIONAL) TO OBSERVE THESE FEATURES THEMSELVES

Continuing with this trend, when white settlers invaded the Brown's Park region in the mid-1800s and started building their permanent settlements, they were drawn by the region's relatively mild winters and the more crossable terrain. In addition, these new settlers began mining in the area. As mentioned, the primary rock making up much of the surface of the Brown's Park area is sedimentary rock. Due to the layering in sedimentary rock, it tends to be rich in materials such as coal, fossil fuels, and other ores that humans tend to use to make our modern society work.

People like John Jarvie invested in mining as part of their way of living in the valley. On February 20, 1897, Jarvie and two other individuals purchased an interest in the Bromide Lode Mining Claim in nearby Colorado. Jarvie purchased multiple other interests in other mines located throughout Brown's Park. Mining was often seen as a surefire way to get wealthy, especially when one was investing in a mine and not actually doing the work involved in digging up materials. However, this kind of investment was often an incredibly risky scenario, as you couldn't be sure that your particular mining stakes would yield a particularly profitable source of coal or valuable ore. This kind of hit-or-miss strategy to early mining meant that most people who invested in mines or tried to mine themselves often went broke and lost most of their savings. Because of this, the people who tended to get rich off of mining were the people who sold things to miners (housing, tools, plots of land, etc.).

John Jarvie was no exception. None of the mines he ever invested in ever paid off, and he would suffer from the loss of this money for the rest of his life. However, he was never deterred. After these major investments, he continued to sink holes and dig tunnels, searching for gold. None of these investments ever panned out either. Fortunately, his general store was more profitable than these ventures and kept him from running out of money.

For this following activity, you are going to ask your students to "mine" and what the stakes were in choosing a mining site.

Materials: shoe boxes (or any small boxes that students/teachers can bring from home), dirt/sand/gravel, small paper/plastic bowl, marbles of different colors, spoons, popsicle sticks with numbers on them, small plastic trees, fences, animals, etc.

Step 1: Fill the boxes with dirt/sand/gravel before students arrive in the classroom. Place the marbles in the dirt/sand/gravel.

- Decide on what each marble means. For instance, a solid green, blue, or black could equal coal, a solid red or yellow could represent a valuable ore like gold. Marbles that are multi-colored or have a single stripe of color in them could represent less valuable strain of coal or valuable ore.
- Ensure that each box has a different ratio of marbles within it. Some boxes should only have one or two marbles total. Some should have only striped, some only colored, and some should have many.
- Since this is an activity for children, each box should contain at least two or three marbles so that each group has something to find.

Step 2: Cover the marbles with the dirt completely. On top of these covered marbles, place the small plastic trees, animals, buildings, etc. (e.g.: Plastic Trees, small items that can be purchased in bulk at a local grocery store or from Thrift Stores, items from home or from other teachers). Place these mini-diorama boxes throughout the room.

Step 3: Ask your students to get into groups of 2-3. These groups are going to be the miners. Each group should have at least one pencil and paper to record their findings.

Step 4: Have each group draw one numbered popsicle stick.

Step 5: Ask the group that drew the #1 popsicle stick to go to the boxes and make a claim. Students should stand by their claim, but not start digging yet.

Step 6: Repeat the claim process in order in which students drew the popsicle sticks until each group has made a claim in the classroom.

Step 7: Ask your students to take turns digging into their claim. Each student should get a turn to remove some dirt/sand/gravel. When a scoop is removed, ask your students to place this in the nearby bowl. Let your students know that they can stop mining at any point they think they've found all the material they want to find.

Step 8: Ask your students to mark down what they find as they go along on the paper and pencil their group has. What color is the marble, is it solid, etc. How much are they earning through their efforts? While your students are working, walk around and ask them why they are deciding to dig in certain areas, what are they finding, etc.?

Step 9: When your students have either dug as much as they want to do, ask them to put their pencils down and ask each group to share what they found while digging.

Beyond Mining

Step 10: After each student has shared, ask your class what the landscape of their area looks like now that they have dug in the mines. Where are the trees, the animals, the buildings, etc. that were there before they started?

Step 11: What does mining do to a community's landscape?

- Did your students think about the animals, trees, etc. while they were mining? Why or why not? What did they do with these items while they were mining (did they try to move them to another area of the box, did they just move them out of the box entirely, did they put them back when they were done mining?
- For older students, you can encourage students to debate whether mining is an ultimate force for good or destruction for a community. Ask students to consider economic, social, and environmental arguments for supporting or opposing mining in an area.

Step 12: Now that your students are done mining, ask your students to restore the landscape to what it was approximately when they were done. While your students work, ask them to chat with their group about why many mines practice mine reclamation (explanation below), why is it important? Should we do this with older mines? Why or why not?

- Although this was not the norm for John Jarvie's day, nowadays there are laws that require most mining practices to practice "mine reclamation." This means the mining company plans to restore a landscape once the mine stops operating. Most modern mines in Europe and the United States are planned with the idea that the company will restore the landscape afterwards. The mines try to restore the landscape as close to what it was before the land as possible.
- There are no right or wrong answers. Students are encouraged to have discussions based on their own personal experiences with mining and their relationships to the environments where they live.

At the end of the "mine reclamation" your students will have ideally placed all of the dirt/gravel/sand back in the box along with the little animals, saving you clean up time.

SUGGESTIONS FOR HUMAN INTERACTIONS WITH GEOLOGY WITH OLDER STUDENTS:

- **AFTER THE ACTIVITY, HAVE YOUR STUDENTS RESEARCH THE LOCAL POLICIES SURROUNDING LAND RECLAMATION IN UTAH. WHAT POLICIES ARE IN PLACE OR ARE NOT IN PLACE FOR LAND RECLAMATION AND HOW DO THEY COMPARE TO OTHER STATES?**
- **ENCOURAGE A DEBATE AMONGST YOUR STUDENTS WITH LESSON PROMPTS LIKE: WHAT IS THE RESPONSIBILITY OF A CORPORATION OR COMPANY TO THE ENVIRONMENT THEY WORK IN? WHO SHOULD BE RESPONSIBLE FOR RUNNING LAND RECLAMATION PROJECTS—THE STATE, THE COMPANY, LOCAL PEOPLE, THE FEDERAL GOVERNMENT?**
    - **IN THESE DEBATES, ENCOURAGE STUDENTS TO THINK BEYOND THEIR LOCAL PERSPECTIVES AND TO ARGUE IN A RESPECTFUL MANNER.**

Jarvie Ranch Visit Extension

This lesson plan is an extension of the Local Geology worksheet. Students will work to compare the geology of the Jarvie Ranch region with the region in which they live.

Before the Visit:

Have your students work through the entirety of the Local Geology Worksheet for a geological feature/rock near their school or home.

During the Visit:

Have your students work through the entirety of the Local Geology Worksheet while visiting and walking around the Jarvie Ranch visit site.

After the Visit:

Ask your students to compare the landscape they observed at Jarvie Ranch to the landscape/geology of the region near their school. Ask students to compare both worksheets they completed about the local geology of their area and the area around Jarvie Ranch

On a sheet of lined paper, have your students write the differences and similarities of the geology of their area and the Brown's Park site that they observed. Ask your students to comment on

1) The noticeable differences and similarities?
2) Why do they think that these differences and similarities exist?
3) What forces helped shape the geology of their area and the area of Brown's Park?

Encourage your students to share their responses with their classmates in a presentation or in a group discussion format. Whichever works best for your students and class time needs. The goal of this exercise is to get students to think about the geology they are walking through and on in their daily lives and how these areas have been shaped throughout time.

Lesson Assessment

At the end of the two lesson plans, arrange chairs in the classroom in a circle for a discussion on the lesson plan. Go around the circle and ask your students to answer the following questions:

1. What did you learn from these activities?
2. What was your favorite part of each of the activities?
3. What was your least favorite part of each of the activities?

Once your students have answered each of these questions (or as many of the questions they felt comfortable answering, ask the group in general:

1. What do you wish you wish you had learned during this lesson?
2. What parts do you want to try again?

Encourage your students to comment on each other's comments, and to have a discussion about what they learned, what they liked, what they didn't like as they take turns in the circle.

For students who are less inclined to talk, you can also present these questions on the board and have them write their answers down to hand in at the end of the class.

Other Resources

Rocks Cycle Video: https://www.britannica.com/video/143173/materials-cycleforms-sedimentary-rock-Sediments-magma

Mining Reclamation Videos: https://www.youtube.com/watch?v=3zEAicSEBME

https://www.youtube.com/watch?v=chOpjYnQvV8

https://www.youtube.com/watch?v=_b_-E7Wt988

Rock Cycle Explanation from National Geographic:
https://www.nationalgeographic.org/encyclopedia/rock-cycle/

Work Cited

Photos found in public domain, Wikipedia Commons, or are own work.

"Browns Park." Wikipedia. https://www.wikiwand.com/en/Browns_Park

Carey, Byrl D. "A Review of the Browns Park Formation." Net-Centric Geothermal Data System, ngds.egi.utah.edu/files/GL03243/GL03243.pdf.

Geolex - BrownsPark Publications, ngmdb.usgs.gov/Geolex/UnitRefs/BrownsParkRefs_7354.html

"USGS: Geological Survey Professional Paper 1356 (Browns Park Formation)." National Parks Service, U.S. Department of the Interior, 9 Nov. 9AD, www.nps.gov/parkhistory/online_books/geology/publications/pp/1356/sec4.htm.

"Utah: A Geologic History." Utah Geological Survey, geology.utah.gov/popular/generalgeology/geologic-history/utah-a-geologic-history/.

William L. Tennant. *John Jarvie of Brown's Park* (Salt Lake City: Utah State Office Bureau of Land Management, 1981).

Rocks v. Minerals Worksheet

Name_____

Look at the following pictures. Decide if the picture is of a rock or of a mineral. Write an "R" in the box next to the picture if you think it is a rock and an "M" if you think it is a mineral.

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Rocks v. Minerals Worksheet

TEACHER COPY

Look at the following pictures. Decide if the picture is of a rock or of a mineral. Write an "R" in the box next to the picture if you think it is a rock and an "M" if you think it is a mineral.

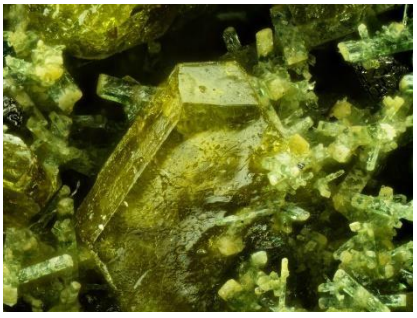
R

R

M

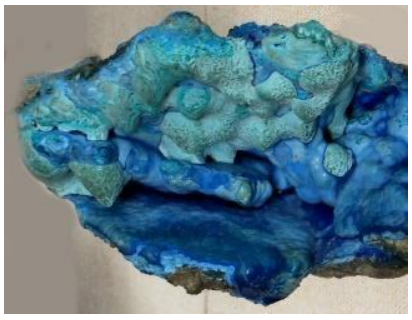
M

M



M

R



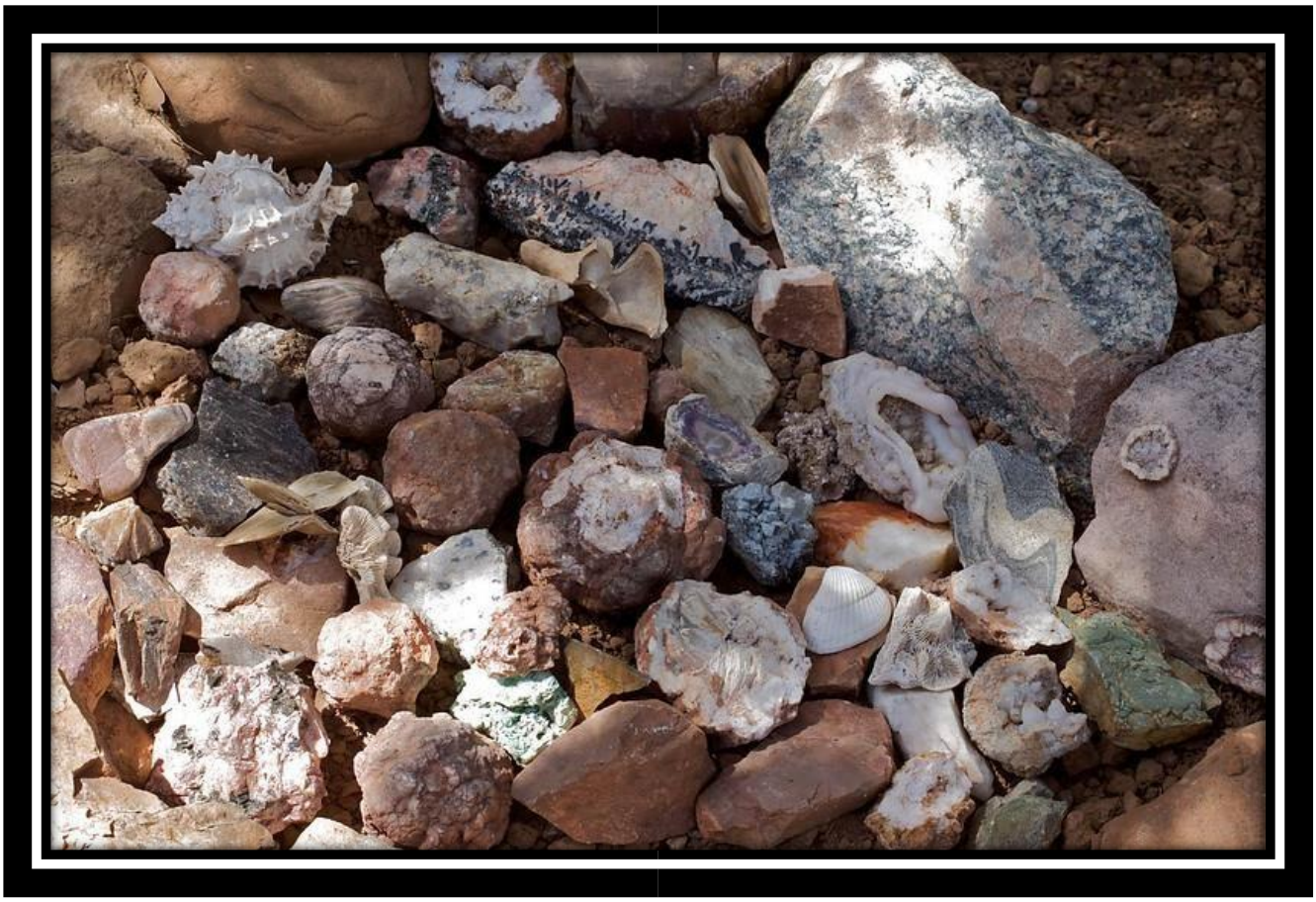
M

R

R

Rocks

Rocks are made up of minerals, organic materials, and other rocks that are brought together in for a new form.



Minerals

Minerals are an inorganic, solid mass of a single element or compound. They have ordered structures and are created when atoms from more than one element are bonded together.

Local Geology Worksheet

Names_____

What are three characteristics you notice about your rock (color, banded, weight, etc.)?

Based on your observations, is your rock a sedimentary, metamorphic, or an igneous rock?

Based on your observations and your guess at what kind of rock you have, what can you infer (educated guess) about the environment that your rock came from? (Was it underground, aboveground, full of magma, watery?)

If you are doing the outside version of this activity, draw a picture of your rock or take a picture with a camera. Your group will show this picture to the class.

EXAMPLE Based on image on pg. 29

What are three characteristics you notice about your rock (color, banded, weight, etc.)?

This rock formation is a tan color with a little bit of red coloring around the base of formation.
The rock has a lot of evidence of erosion. There are holes in the rock showing where wind and
rain have hit the rock. It is also more worn away at the bottom than at the top. There are some
banding visible in this image. These bands are straight lines and they are not warped.
I can't tell how heavy the rocks that make up this image because I am not physically there to hold
them.

Based on your observations, is your rock a sedimentary, metamorphic, or an igneous rock?

Sedimentary Rock.

Based on your observations and your guess at what kind of rock you have, what can you infer (educated guess) about the environment that your rock came from? (Was it underground, aboveground, full of magma, watery?)

Since these rocks are large sedimentary rocks, I infer that these rocks came from being at the
bottom of a watery environment that was aboveground and not affected by magma.

If you are doing the outside version of this activity, draw a picture of your rock or take a picture with a camera. Your group will show this picture to the class.


JESSE EWING