CALIFORNIA ACADEMY OF SCIENCES

Rock Cycle Roundabout

GRADE LEVEL 4th-8th; Standards for 4th and 7th
SUBJECTS Earth & Space Science, Cause & Effect
DURATION Prep Time: 20 min; Activity Time: 60 minutes, or two class periods
SETTING Classroom

MATERIALS

- ☐ *Rock Cycle Roundabout Board* (1 per group)
- ☐ *Rock Cycle Cards* (1 set per 4 – 6 students)
- ☐ small rocks, buttons, or other objects for game pieces (1 per student)
- ☐ *California Maps: Landforms, Waterways, and Faults* (1 per group, or projected for the class)
- ☐ *Rock Types of California Map* (1 per group, or projected for the class)
- ☐ Student science notebooks or scratch paper

OBJECTIVES

Students will be able to:

1. Differentiate among the three types of rock by referring to their methods of formation, providing real-world scenarios as examples.
2. Recognize that some geologic processes are instantaneous, and others extremely gradual.
3. Describe which processes might be affecting a given region, using evidence from natural features present on a map.

SCIENTIFIC TERMS FOR STUDENTS

crust: the thin layer of solid rock that forms Earth's outer surface

mantle: the thick layer of hot, dense, rocky matter found below the Earth's crust and surrounding the Earth's core

magma: the molten material beneath or within the Earth's crust, from which igneous rock is formed

lava: liquid magma that reaches the Earth's surface

weathering: the chemical and physical processes that break down rocks exposed to air, moisture, and organic matter at Earth's surface

erosion: the process by which water, ice, wind, or gravity moves weathered rock or soil

fault: a break or crack in the Earth's crust along which rocks move

subduction: the process by which the collision of two plates in Earth's crust results in one plate being drawn back down into the mantle

rock cycle: a series of processes on the surface and inside Earth that slowly changes rocks from one kind to another

igneous rock: a type of rock that forms from the cooling and hardening of magma or lava

metamorphic rock: a type of rock that forms when a rock has had its mineral composition and/or texture changed by heat and pressure

sedimentary rock: a type of rock that forms when particles from other rocks, or the remains of plants and animals, are pressed and cemented together

BACKGROUND FOR EDUCATORS

The Earth, our rocky planet, is very active. As you are reading this, volcanoes are erupting and earthquakes are shaking. Mountains are being pushed up and are being worn down. Rivers are carrying sand and mud to the sea. And huge sections of the Earth's crust called tectonic plates are slowly moving —about as fast as your fingernails grow.

The rock cycle, the process by which rocks form, is ultimately driven by plate tectonics. Due to the driving forces of plate tectonics, rocks do not remain in equilibrium and are instead forced to change as they encounter new environments.

Because different rocks can be made by the same mineral

components, geologists classify rocks based on how they form. As with the water cycle and other natural cycles, the rock cycle does not occur only in one direction. Instead, depending on what conditions a rock is subjected to, it can transform into any of the other rock types. A rock can even re-form as the same type of rock. Below is an explanation of the different alterations that each rock type can undergo.

Igneous rocks form from hot molten rock produced by volcanic activity on Earth. Geologists classify igneous rocks according to the types of minerals that they contain, and according to the size, shape, arrangement, and distribution of the minerals. Within the igneous rock formation category, two important subtypes exist. Extrusive igneous rocks are formed through cooling and hardening on the Earth's surface. Some examples of extrusive igneous rocks are obsidian and basalt. Intrusive igneous rocks then are formed through a slower cooling that takes place underneath the surface of the Earth's crust. An example of intrusive igneous rocks is granite.

Igneous rocks can either be weathered and compacted into sedimentary rocks, or they can be subjected to heat and pressure causing them to become metamorphic rocks. They can also melt again and reform as igneous rocks.

Sedimentary rocks are formed by mineral and rock fragments that settle out of water, glaciers, or that collects through the action of wind. The weight of the collected fragments along with the mineral-laden water creates a way for these fragments to cement together to create one solid rock body. There are three important types of sedimentary rock formations. Clastic rocks are those like conglomerates, breccia, shale, and sandstone that are made up of pre-existing rock fragments smashed together, creating new rock types. Organic rocks were once living organisms that decomposed after their death and created rocks through their remains. Some organic rocks are limestones and coal. Chemical rocks are created from the minerals in water that are left behind after water evaporates. Chemical rocks include halite (salt) and gypsum.

Sedimentary rocks can be subjected to heat and/or pressure causing them to change form and become metamorphic rocks, or causing them to melt and eventually erupt as igneous rocks. They can also be broken down, and reformed into new sedimentary rocks.

Metamorphic rocks are any type of rock that has been transformed by heat and pressure. Therefore, a metamorphic rock could have once been either an igneous or sedimentary rock, but through heat and pressure has been changed into a completely different type of rock. For example, shale, a sedimentary rock, becomes shale as a metamorphic rock. Granite becomes gneiss, and chalk becomes marble.

Metamorphic rocks can be weathered and compacted into sedimentary rocks, or they can be subjected to heat and/or pressure causing them to melt and eventually erupt as igneous rocks. Alternatively, metamorphic rocks may be transformed again into different metamorphic rocks.

The simplest way to understand the rock cycle is to follow one rock through various transformations. First, imagine lava from a volcano cooling into an igneous rock. Over time this igneous rock can be weathered from wind and rain, which transforms the rock into small bits. These weathered pieces (sediments) are carried away by wind and water via erosion, and are then deposited. After deposition, they can be compacted and consolidated into sedimentary rock. Over time, tectonic activity can cause the sedimentary rock to be buried deep in the Earth. The pressure and heat from within the Earth can change the composition of the rock, turning it into a metamorphic rock. This metamorphic rock can continue to be buried even deeper, eventually becoming so hot that it melts into magma. The magma can then erupt as lava from a volcano and cool as an igneous rock. The cycle begins again.

Geologic time is primarily considered at scales that dwarf the human experience. Some rock cycle processes, like volcanic eruptions, earthquakes, or landslides, can influence the formation of new rocks on a rapid scale. However, the majority of geologic processes occur very slowly, like the uplift of mountain ranges, or the cementation of sediments deposited at a river's delta over hundreds of years. Typically the transformation of one type of rock to another takes on the order of millions of years, if not hundreds of millions of years.

TEACHER PREP

- ☐ Plan how to divide your class into groups of 3 to 6.
- ☐ Print out one *Rock Cycle Roundabout Board* per group.
- ☐ Print and cut out one double-sided deck of the 24 *Rock Cycle Cards* per group.
- ☐ Set aside game pieces, enough for each student.
- ☐ Prepare to project the map, or print out copies for students to share. Label your city's location in advance.

  Note: Although this lesson specifically focuses on the geology of California, you can certainly adjust the activities to draw from maps wherever your school is located.

PRIOR KNOWLEDGE

This activity is best conducted as a review of what students have learned previously about the three types of rocks involved in the rock cycle. The language used on game cards also provides ample opportunity to reinforce scientific terms related to a unit studying the make-up of Earth's layers.

INTRODUCTION

1. Frame the lesson with these essential questions.
   - » **What type of rocks do we find beneath our school: sedimentary, igneous or metamorphic?**
   - » **What types of rocks might we find beneath our schools in ten thousand years?**

2. Pass out or project the triplicate maps as a primary set of clues. Have students work with a partner to find the natural landforms, bodies of water, or faults nearby, and discuss how these might relate to the geology of the area.

   Teacher Tip: *Let students discuss amongst themselves, without reaching conclusions at this point.*

3. As students discuss, distribute the *Rock Cycle Roundabout Board*, shuffled and stacked *Rock Cycle Cards*, and game pieces to small groups of 3 to 6 students.

GAME PLAY

1. To begin, have each student place their game piece on any of the three rock types on the board. Students may play a quick round of "rock, paper, scissors" to determine who goes first.
2. One player pulls a card from the deck and reads the "How do you change?" clue on the back to the person on his or her right. That person is challenged to guess what their rock becomes.
3. If the guesser answers correctly, they keep the card, which can serve as a "point." If s/he guesses incorrectly, then the reader may poll the rest of the group, moving clockwise until the correct answer is given, awarding the card and the point. If no one guessed correctly, then the reader keeps the card and gains a point.
4. Regardless of whether any person guesses correctly, the player will move their game piece to that correct rock type.
5. Once this round is complete, the next student will take a turn as the clue reader. The game will continue until all of the 24 cards have been used, or until the teacher deems appropriate.

   Teacher Tip: *If one group finishes before the others, instruct students to review the sequence of events listed on the cards in their possession. They can create a timeline or comic strip of what happened.*

UNDERSTANDING GEOLOGIC TIME

1. Discuss geologic time with your class by comparing the relative speed at which rocks transformed in sample scenarios from the game. For example, which of the below is most likely to have taken 10 minutes? What about 10,000 years? 100 million years?
   - » **You are melted from the impact of a flaming meteorite and flung through the air where you cool and harden.** *Approximately 10 minutes*
   - » **A glacier slowly flows over you, crushing and dragging you (erosion). As you get ground into tiny pieces, you become cemented to other rock particles (cementation).** *Approximately 10,000 years*
   - » **You are buried under sediment on the ocean floor (sedimentation), pushed under a continent (subduction), melted, and eventually forced back up to harden in cold water.** *Approximately 100 million years*

2. Challenge students to find and share a process on a card that is...
   - » **Relatively rapid.** *Examples: earthquakes, landslides, volcanic eruptions, striking meteorites, cooling lava.*
   - » **Relatively slow.** *Examples: weathering of rock by wind, tree roots cracking rock, erosion of a boulder down to sand at the river's delta, subduction of tectonic plates.*
   - » **Extremely slow.** *Examples: sedimentation of layers, cementation of particles, uplift of mountain ranges.*

   Teacher Tip: *Do not worry about exact durations. Instead, emphasize that some processes are fast and others are slow, and all drive the rock cycle.*

3. Ask students: **Which of these processes continue to this day? Are any processes on those cards happening as we speak?**
4. In their science notebooks, have students reflect on what happened to their own rock throughout the game using drawings and words. Their collection of cards can serve as a reference, but writing should be in their own words.

CHECK FOR UNDERSTANDING
Their notebook entry should include:

- ☐ At least 3 transformations listing the type of rock at beginning and end
- ☐ Clear written descriptions of the processes
- ☐ Labeling of the relative duration of each event (e.g., "instantaneous" to "millions of years" or "fastest" to "slowest")

ANALYZING THE MAP

1. Returning to the maps of California, discuss the following: **What landforms, waterways, plant communities, and faults do you see? How might these affect the changing surface of the Earth?**
2. Remind students of today's essential question as you pass out the colorful *Rock Types of California* map. Modeling how to read the colored key, challenge students to determine the type of rock most prevalent under your city.
3. Using both maps, and drawing on their new knowledge of the geologic processes, discuss the following:
   - » **Where are most sedimentary rocks found? Why do we find them there?** *Sedimentary rocks are found where water is currently located or was located in the past. For example, ocean waves break down rocks. They may not know that the Central Valley used to be a large lake.*
   - » **Where are most igneous rocks found? Why do we find them there?** *Igneous rocks formed where volcanoes and magma pushed through the Earth's crust and caused rocks to melt and reform. This has happened on the eastern edge of the state, near what is now the Sierra Nevada.*
   - » **Where are most metamorphic rocks found? Why do we find them there?** *Metamorphic rocks formed where other rocks were caught between colliding tectonic plates and/or growing mountains.*
   - » **Which are the oldest rocks? Why do you think so?**

WRAP-UP

Ask the class: **What type of rock does the class think the Earth under your city will change into next?**

CHECK FOR UNDERSTANDING
Encourage students to explain their reasoning using evidence from the map and their understanding of the rock cycle. They should describe how geologic processes – whether instantaneous or extremely gradual – might be affecting your area right now.

EXTENSIONS

Assign students the task of finding a rock cycle diagram that best exemplifies their understanding of the process. Have them post it in their journal and explain the reasoning for their selection.

For students already familiar with experimental design, consider running a duplicate set of jars with more sterile potted soil. Or, have groups manage their own setup, with variables controlled at the class level, to add replicate trials, share collective data, and discuss fair tests.

CALIFORNIA SCIENCE CONTENT STANDARDS

Grade Four	Earth Sciences 4a, 5a, 5b, 5c
Grade Seven	Earth Science 4a, 4c

www.nextgenscience.org . www.cde.ca.gov/be/st/ss/documents/sciencestnd.pdf . www.corestandards.org

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Image Credits

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Updated June 2014 MKS