



KIDS ENVIRONMENTAL LESSON PLANS

This lesson developed by:



CALIFORNIA
ACADEMY OF
SCIENCES

Rock Cycle Roundabout

Overview:

A board game designed to learn how to differentiate the three ways rocks can form.

Ocean Literacy Principles:

1. The Earth has one big ocean with many features
2. The ocean and life in the ocean shape the features of Earth
7. The ocean is largely unexplored

Key Concepts:

- Differentiate among the three types of rocks by referring to their methods of formation, providing real-world scenarios
- Recognize that some geological processes are instantaneous, and others are extremely gradual

Materials:

- Rock Cycle Roundabout Board (1 per group)
- Rock Cycle Cards (1 per group)
- Small rocks, buttons or other objects for the game (1 per student)
- Paper

Set-up Prior to Activity:

- Print out board
- Print out cards double sided on heavy weighted paper or print out cards on two sheets and glue front and back together



Rock Cycle Roundabout (cont.)

Duration:

60 minutes

Physical Activity:

Low

Background:

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.



Rock Cycle Roundabout (cont.)

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.

Vocabulary:

Earth's Layers

- **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

Geologic Processes

- **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



Rock Cycle Roundabout (cont.)

- **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

The Rock Cycle

- **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

Activity:

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. 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.

Discussion:

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 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*




Rock Cycle Roundabout (cont.)



- Extremely slow. *Examples: sedimentation of layers, cementation of particles, uplift of mountain ranges.*
3. Which of these processes continue to this day? Are any processes on those cards happening as we speak?

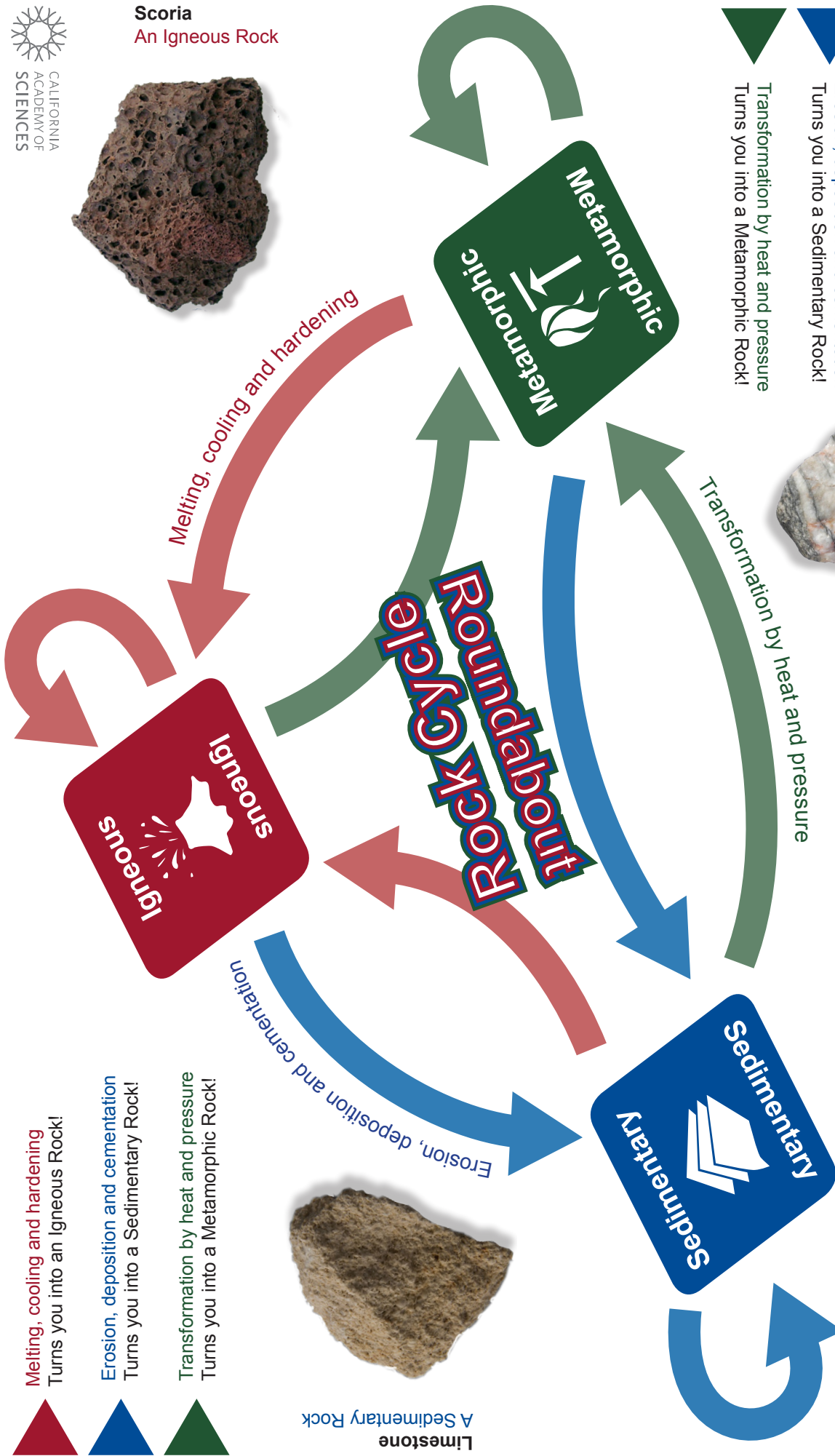
Scoria
An Igneous Rock






- 
Melting, cooling and hardening
 Turns you into an Igneous Rock!
- 
Erosion, deposition and cementation
 Turns you into a Sedimentary Rock!
- 
Transformation by heat and pressure
 Turns you into a Metamorphic Rock!



Gneiss
A Metamorphic Rock

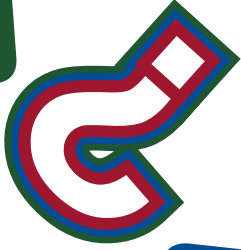


Limestone
A Sedimentary Rock

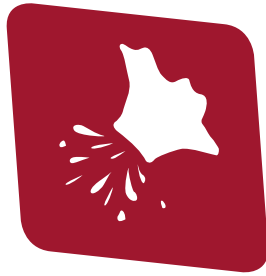
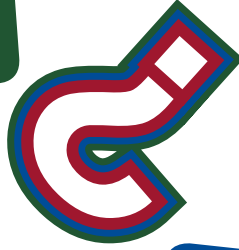
- 
Melting, cooling and hardening
 Turns you into an Igneous Rock!
- 
Erosion, deposition and cementation
 Turns you into a Sedimentary Rock!
- 
Transformation by heat and pressure
 Turns you into a Metamorphic Rock!



Which rock do you change into?



Which rock do you change into?



Which rock do you change into?



Which rock do you change into?



How do you change?

- 1) You lie deep in the Earth's crust
- 2) You slowly melt from the heat of the Earth's mantle.
- 3) You erupt out of a volcano as liquid rock (lava) and harden in the cool air.

How do you change?

- 1) You lie deep below the surface of the earth, where there is extreme heat and pressure.
- 2) A fault (crack in the Earth's crust) nearby fills with magma, increasing the temperature around you.
- 3) The heat causes your minerals to change.

What rock do you change into?

Answer: Change into an **igneous** rock!

What rock do you change into?

Answer: Change into a **metamorphic** rock!

How do you change?

- 1) You lie deep in the Earth's crust
- 2) You slowly melt from the heat of the Earth's mantle.
- 3) As the Earth's plates shift, you get pushed up, towards the surface and cool and harden in the process.

How do you change?

- 1) A glacier slowly flows over you, crushing and dragging you.
- 2) As you get ground into tiny pieces, you become cemented to other rock particles.
- 3) The glacier passes over, and leaves behind clusters of these cemented particles.

What rock do you change into?

Answer: Change into an **igneous** rock!

What rock do you change into?

Answer: Change into a **sedimentary** rock!

How do you change?

- 1) You slowly crumble as rain, ice and wind erode you.
- 2) Rain washes you down to the bottom of a river.
- 3) You are glued to other deposits under the pressure of the river's water.
- 4) When the river runs dry, the hot sunlight bakes you, making you hard.

What rock do you change into?

Answer: Change into a **sedimentary** rock!

How do you change?

- 1) The roots of trees grow into your cracks, breaking you out of your rock bed. You fall into a nearby stream.
- 2) The stream breaks you down into smaller pieces which get washed downstream.
- 3) The stream dries up and your pieces become cemented to other bits of rock around you.

What rock do you change into?

Answer: Change into a **sedimentary** rock!

How do you change?

- 1) You get buried under sediment on the ocean floor.
- 2) You get forced underneath (subduction) the North American continent, towards the center of the Earth.
- 3) You slowly melt from the heat of the Earth's mantle.
- 4) You get forced up and harden in the cold water.

What rock do you change into?

Answer: Change into an **igneous** rock!

How do you change?

- 1) You are part of a tectonic plate colliding with another plate.
- 2) Your plate gets forced under the other, causing incredible friction.
- 3) The friction produces heat and pressure, transforming your minerals.

What rock do you change into?

Answer: Change into a **metamorphic** rock!

How do you change?

- 1) You lie near the bottom of the Earth's crust, 10 miles below the surface!
- 2) With the intense pressure of the rocks above you and the heat from below you are transformed into another type of rock.

How do you change?

- 1) You lie deep below the surface of the earth, where there is extreme heat and pressure.
- 2) A fault (crack in the Earth's crust) nearby fills with magma, increasing the temperature around you.
- 3) The heat causes your minerals to change.

What rock do you change into?

Answer: Change into a **metamorphic** rock!

What rock do you change into?

Answer: Change into a **metamorphic** rock!

How do you change?

- 1) You lie deep in the Earth's crust
- 2) You slowly melt from the heat of the Earth's mantle.
- 3) You erupt out of a volcano as liquid rock (lava) and harden in the cool air.

How do you change?

- 1) You slowly crumble as rain, ice and wind erode you.
- 2) Rain washes you down to the bottom of a river.
- 3) You are glued to other deposits under the pressure of the river's water.
- 4) When the river runs dry, the hot sunlight bakes you, making you hard.

What rock do you change into?

Answer: Change into an **igneous** rock!

What rock do you change into?

Answer: Change into a **sedimentary** rock!

How do you change?

- 1) An earthquake jolts you from your resting place and you tumble downhill, breaking into smaller pieces.
- 2) A flood washes these pieces away to the ocean.
- 3) The weight of the ocean's water cements you to other bits of rock on the ocean's floor.

What rock do you change into?

Answer: Change into a **sedimentary** rock!

How do you change?

- 1) A glacier slowly flows over you, crushing and dragging you.
- 2) As you get ground into tiny pieces, you become cemented to other rock particles.
- 3) The glacier passes over, and leaves behind clusters of these cemented particles.

What rock do you change into?

Answer: Change into a **sedimentary** rock!

How do you change?

- 1) You are part of a tectonic plate colliding with another plate.
- 2) Your plate gets forced under the other, causing incredible friction.
- 3) The friction produces heat and pressure, transforming of your minerals.

What rock do you change into?

Answer: Change into a **metamorphic** rock!

How do you change?

- 1) You lie deep in the Earth's crust
- 2) You slowly melt from the heat of the Earth's mantle.
- 3) As the Earth's plates shift, you get pushed up, towards the surface and cool and harden in the process.

What rock do you change into?

Answer: Change into an **igneous** rock!

How do you change?

- 1) Boom! A volcano close by has just erupted!
- 2) Lava flowing from the volcano swallows you, melting you instantly.
- 3) As part of the stream of molten rock, you eventually cool and harden.

What rock do you change into?

Answer: Change into an **igneous** rock!

How do you change?

- 1) You are a stone deep under the ocean's floor.
- 2) A new fault in the oceanic plate allows magma to erupt to the surface near you.
- 3) The intense pressure and heat from the eruption causes you to change as your minerals re-crystallize.

What rock do you change into?

Answer: Change into a **metamorphic** rock!

How do you change?

- 1) You lie near the bottom of the Earth's crust, 10 miles below the surface!
- 2) With the intense pressure of the rocks above you and the heat from below you are transformed into another type of rock.

What rock do you change into?

Answer: Change into a **metamorphic** rock!

How do you change?

- 1) You get buried under sediment on the ocean floor.
- 2) You get forced underneath (subduction) the North American continent, towards the center of the Earth.
- 3) You slowly melt from the heat of the Earth's mantle.
- 4) You get forced up and harden in the cold water.

What rock do you change into?

Answer: Change into an **igneous** rock!

How do you change?

- 1) You lie on the ocean floor and are buried deeper and deeper under sediment.
- 2) As you sink lower in the Earth's crust, the heat and pressure increases.
- 3) Eventually this heat and pressure is great enough to change your minerals.

What rock do you change into?

Answer: Change into a **metamorphic** rock!

How do you change?

- 1) You are lying in the middle of a field.
- 2) Suddenly, a flaming meteorite from space smashes into you!
- 3) You are melted from the impact with the hot space rock and flung into the air where you cool and harden.

What rock do you change into?

Answer: Change into an **igneous** rock!

How do you change?

- 1) An earthquake jolts you from your resting place and you tumble downhill, breaking up into smaller pieces.
- 2) A series of storms causes floods which wash you away to the ocean. Along the way, you crumble into still smaller bits of rock.
- 3) With the tremendous weight of the ocean water above, you get smashed and cemented to other sediments on the ocean's floor.

What rock do you change into?

Answer: Change into a **sedimentary** rock!

How do you change?

- 1) The roots of trees grow into your cracks, breaking you out of your rock bed. You to fall into a nearby stream.
- 2) The stream breaks you down into smaller pieces which get washed downstream.
- 3) The stream dries up and your pieces become cemented to other bits of rock around you.

What rock do you change into?

Answer: Change into a **sedimentary** rock!