

# Rock Cycle Game and Data Analysis

**Goal:** Students use mathematical analysis to deepen their understanding of rock cycle stages and geologic time.

## Objectives

**Knowledge-** The development of a rock can occur and change in a multitude of ways and does not follow a set path.

**Skills-** Students develop mathematic skills of solving multistep problems and converting fractions to decimals. Students will use probability thinking to understand the likelihood of an outcome.

**Values-** Students appreciate the rock cycle and the large expanses of time over which rocks form.

**Grade:** 5th

**Special Safety:** Before setting up cycle game, check area for safety hazards (holes, bare root/branches).

## VA Standards addressed:

**Rock Cycle Game Math 5.15 Science 5.7**

**Rock Cycle Analysis Math 5.2, 5.5 Science 5.7**

## Materials:

- Game
  - Set of 5 game stations (igneous, magma, sediment, sedimentary, and metamorphic) (Appendix A)
  - Set of 5 game dice (Appendix B)
  - Starting dice (1)
  - Five colors of beads (we chose to use color to code the beads to the stations: red for magma, black for igneous, purple for metamorphic, green for sedimentary, yellow for sediment)
  - Fuzzy sticks (one per student)
  - Student data sheets (one per student) (Appendix C)
  - Pencils & clipboards (one each per student)
- Analysis
  - Rock Cycle Game Data Analysis Sheet (one per student) (Appendix D)
  - Pencils (one per student)
  - Clipboards (one per student)

## Setup:

- Create five game stations five dice (note: stations and dice refer to Virginia rocks, modify to correlate with your local geology)
- Set up five game stations with corresponding dice and beads in a rough circle (the size depends on how much you want the students to move around).



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- Determine how you wish students to work, in assigned groups or self-selected groups of a set size, or self-selected groups of varying sizes (including independent) but no more than four. (Students can work in groups or individually. Decide what is best for your students.)
- The game and analysis datasheets are set up for 16 rounds. If you wish to shorten the game, the data sheet may need to be modified.
- Optional Set up: Geologic timeline in an appropriately long area. As currently designed, it is 100m long.

### Instructional Strategy (Game):

1. Provide students with basic gameplay instructions:
  - a. Game starts with a roll of the start dice, directing students to a station.
  - b. Upon arrival at a station, students place a bead on the fuzzy stick, and record the station **name** on the datasheet. (ex: Sedimentary)
  - c. They then roll the dice, and record the **length of time** it indicates they spent at that station before moving to the next and the **reason** for doing so. (ex: compacted for 10,000 years)
  - d. They then move to the next station (or stay if the dice indicates to do so). Repeat b and c until they have 16 beads on their fuzzy stick.
2. As students play their way through 16 rounds of the game, circulate around to check on the class. Many of the dice have very limited outcomes based on the realities of the rock cycle. For example, sediment can only move to sedimentary or stay at sediment. As a result, students may experience some frustration. MATH 5.15
  - a. Draw their attention to the possibilities on the dice, and the probability of moving to each station. (Number of “favorable” outcomes/number of possible outcomes). Use informal terms to describe the degree of likelihood of moving to a particular station (i.e., impossible, unlikely, equally likely, likely, and certain).
  - b. Engage in a discussion of how the probabilities reflect the realities of the rock cycle. If frustration at being stuck is diminishing student experience, consider “placing the dice on a certain location to break the “stalemate””. SCI 5.7
3. Students may finish at different rates. Suggestions for evening the ending time include permitting students to summarize or even eliminate recording the reason for being at the station.
4. For groups who finish early:
  - a. Those who finish early should compare their datasheets with others in their group and make sure the data matches their beads
  - b. Ask students to consider the time in which their rock spent at each station. Instruct them to consider number placements (one, tens, hundreds) and arrange the rock station times so that they can easily add up the number for a total length of time for the rock formation.

### Instructional Strategy (Analysis):

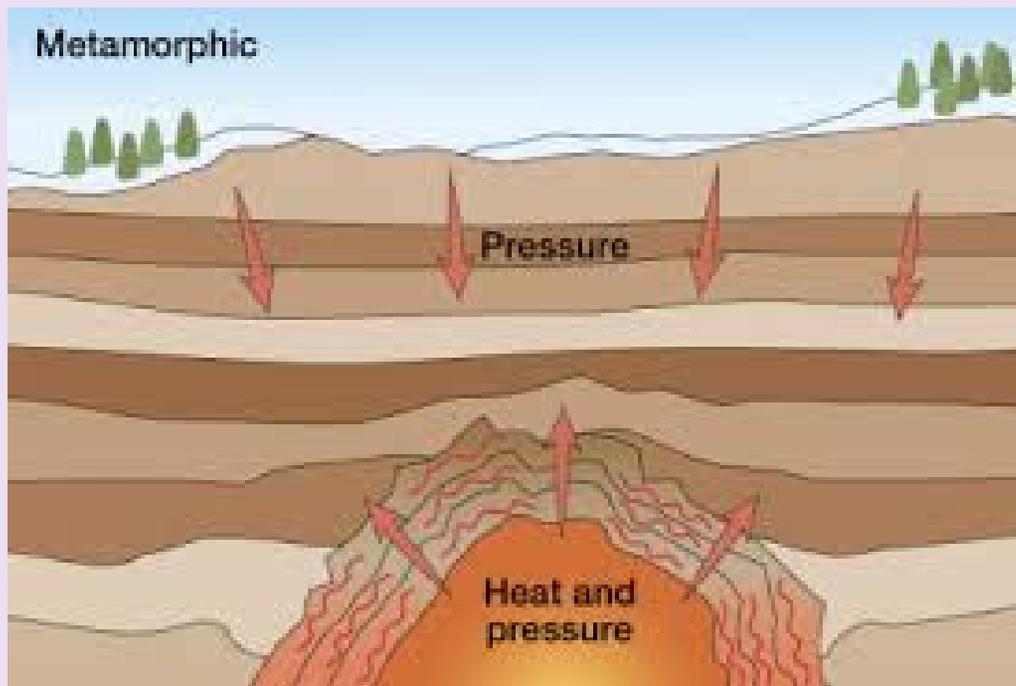
1. Inquire: Now that you have taken on the role of a changing rock in the rock cycle activity, the next step is to analyze your results.
2. Inform students they will use the Rock Cycle Data Analysis (Appendix D) sheet and their group’s journey to analyze/think about their rock cycle. As necessary, point out the tasks on the datasheet: MATH 5.2



- a. First record your total number of stops (16 unless modified)
  - b. Find the factors of your total. (1,2,4,8,16)
  - c. Determine how many stops you made at each of the 5 stations. (4 - Sediment)
  - d. Calculate the fraction of the whole for each. Example: If you had 16 stops total, that is the denominator, and if 4 of them were at the Sediment station, the fraction will be 4/16.
  - e. Use the list of factors to help simplify this fraction if possible. Is there a number by which you can divide both the numerator and denominator?
  - f. Convert fraction to decimal. Discuss. How can we convert/change this fraction into decimals? Assess if students need more guidance to convert. MATH 5.5
  - g. Be sure students double-check their work by adding each column on the datasheet. The results should be very close to 1 or 1 whole.
3. Students then use the circle/pie chart on the back of the datasheet to display the # of stops made at each station. This is an excellent opportunity to assess student understanding of data display and graph making. NOTE: Allow students to decide how to denote different rock cycle stations and number of stops. Some may use symbols and create a legend, some more shade certain areas, etc. SCI 5.7
4. As a class, compare each group's results. Ask: Did each group have the same fractions? Explain why or why not. Discuss how long it takes rocks to transition from one type to another
5. Rock Timeline:
- a. Calculate the TOTAL number of years spent travelling through the rock cycle game.
  - b. Find the events preceding and succeeding that number of years on the geologic timeline.
  - c. Inquire: Why are the events so close in our recent past, but have large spans of time between events from the ancient past? Guide students to consider how fossil evidence can be destroyed as rocks change form.



# Metamorphic



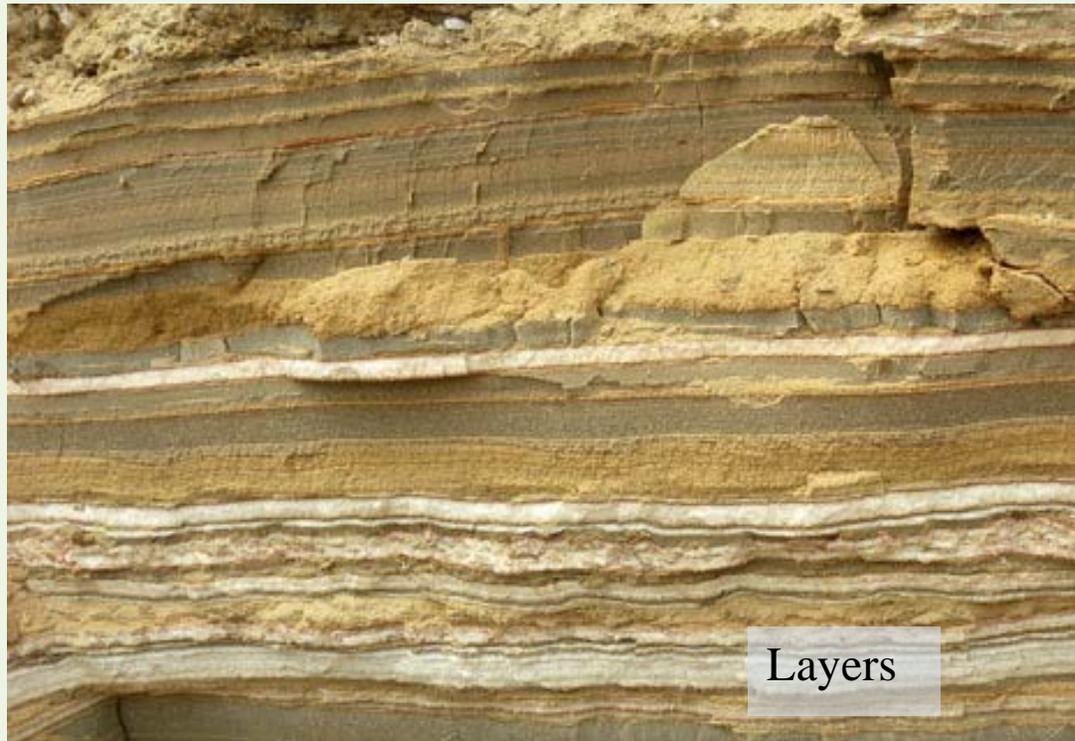


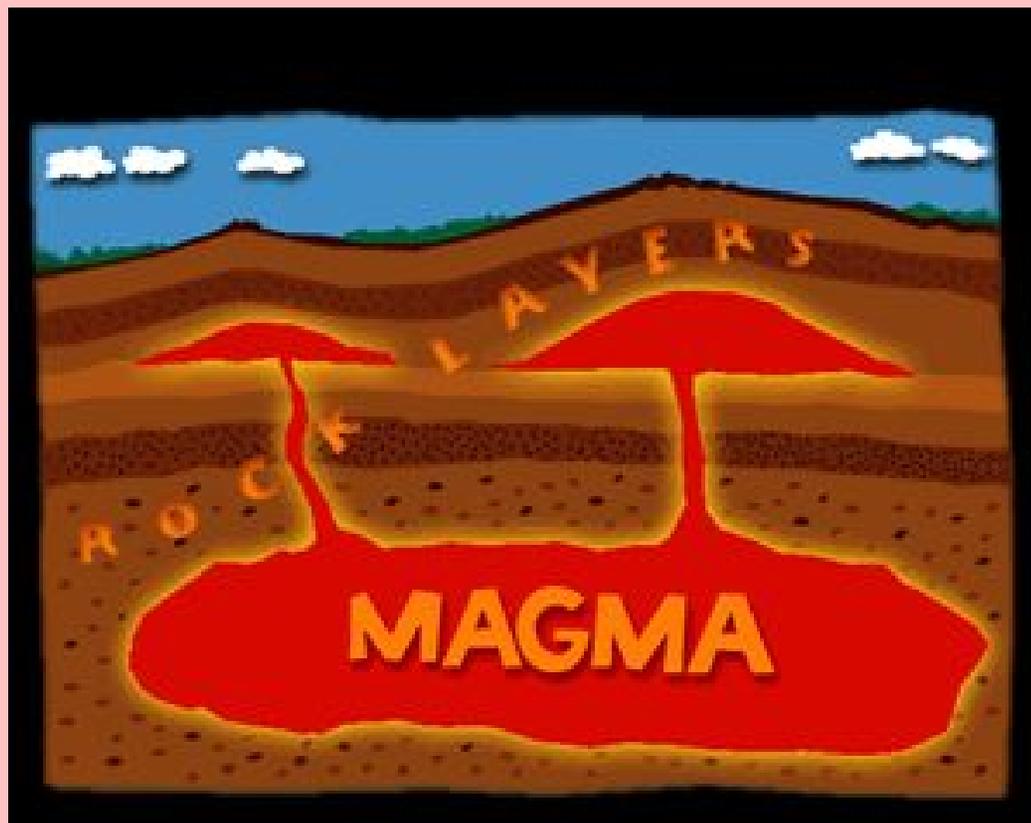
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Blandy Experimental Farm

# Sedimentary





# Magma



# Sediment



100 years

You remain as **SEDIMENT**.

Stay where you are, add another bead and roll again.

Sediment



100 years

You remain as **SEDIMENT**.

Stay where you are, add another bead and roll again.

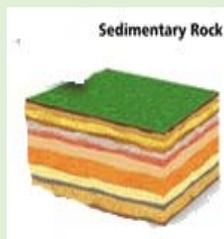
Sediment



10,000 years

You get buried underneath additional layers of sediment and are cemented into limestone.

Go to **SEDIMENTARY**.



100 years

You remain as **SEDIMENT**.

Stay where you are, add another bead and roll again.

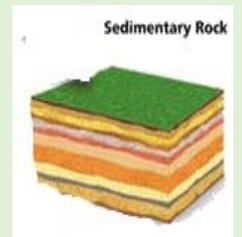
Sediment



10,000 years

You get buried underneath additional layers of sediment and are compacted into coal.

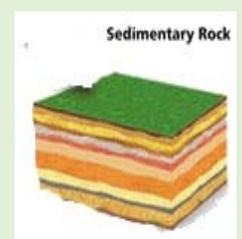
Go to **SEDIMENTARY**.



10,000 years

You get buried underneath additional layers of sediment and are compacted into sandstone.

Go to **SEDIMENTARY**.



Sediment

Sediment

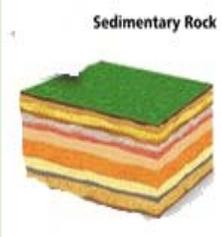
Sediment

10,000,000 years

You are buried beneath the ground and remain there.

Stay at

**SEDIMENTARY**,  
add another bead  
and roll again.



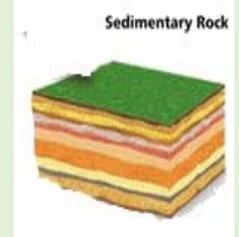
Sedimentary

10,000,000 years

You are buried beneath the ground and remain there.

Stay at

**SEDIMENTARY**,  
add another bead  
and roll again.



Sedimentary

1,000 years

You are exposed to the surface. Erosion breaks you off from your layers. You become sediment again.

Go to

**SEDIMENT.**



Sedimentary

1,000 years

You are exposed to the surface. Erosion breaks you off from your layers. You become sediment again.

Go to

**SEDIMENT.**

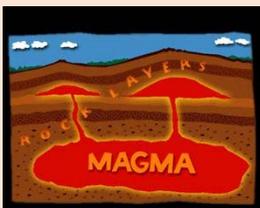


Sedimentary

10,000 years

You are exposed to a nearby source of magma and melt.

Go to **MAGMA.**



Sedimentary

10,000 years

The tectonic plate you are on crashes into another tectonic plate. You are crushed by HUGE forces and become slate. Go to **METAMORPHIC.**



Sedimentary

10,000,000 years

You are part of a pocket of **magma** near the surface, but the rock above is too thick to break through.

Stay at **MAGMA**, add another bead and roll again.

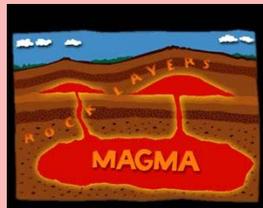


Magma

10,000,000 years

You are carried into the mantle.

Stay at **MAGMA**, add another bead and roll again.

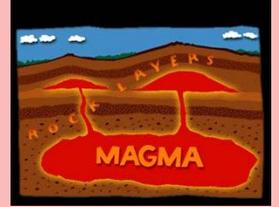


Magma

10,000,000 years

You are carried into the mantle.

Stay at **MAGMA**, add another bead and roll again.



100,000 years

You cool down quickly just below the surface. You are intrusive igneous diabase.

Go to **IGNEOUS**.



Magma

100,000 years

You reach the surface and cool rapidly. You are extrusive igneous metabasalt.

Go to **IGNEOUS**.



Magma

100,000 years

You cool down slowly before you ever reach the surface. You are intrusive igneous gabbro.

Go to **IGNEOUS**.



Magma

1,000,000 years

You remain buried underneath the ground.

Stay at **IGNEOUS**, add another bead and roll again.



igneous

1,000,000 years

You remain buried underneath the ground.

Stay at **IGNEOUS**, add another bead and roll again.



1,000 years

You are exposed to the surface. Erosion breaks you off from the rest of the rock. You become sediment.

Go to **SEDIMENT**.



igneous

10,000 years

You are exposed to a nearby source of magma and melt.

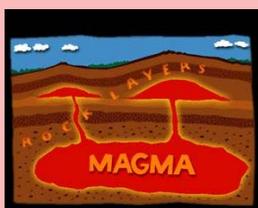
Go to **MAGMA**



10,000 years

You are exposed to a nearby source of magma and melt.

Go to **MAGMA**.



igneous

100,000 years

Your tectonic plate crashes into another and you are exposed to A LOT of pressure. You change into charnockite.

Go to **METAMORPHIC**.



10,000,000 years

You remain buried in the crust.

Stay at

**METAMORPHIC**,  
add another bead  
and roll again.



Metamorphic

10,000,000 years

You remain buried in the crust.

Stay at

**METAMORPHIC**,  
add another bead  
and roll again.



Metamorphic

100,000,000 years

You are exposed to more heat and pressure and become soapstone.

Stay at

**METAMORPHIC**,  
add another bead  
and roll again.



Metamorphic

100,000,000 years

You are exposed to more heat and pressure and become phyllite.

Stay at

**METAMORPHIC**,  
add another bead  
and roll again.



Metamorphic

1,000 years

You are exposed to the surface. Erosion breaks you off from the rest of the rock. You become sediment.

Go to

**SEDIMENT.**



Metamorphic

10,000 years

You are exposed to a nearby source of magma and melt.

Go to **MAGMA.**



Student Data Sheet: Appendix C

Round #	Location in rock cycle	Years spent at this round	Reason for being here
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

Each group member gets one fuzzy stick, making a loop at one end so beads do not fall off. When you arrive at a station, put a bead on your stick, then toss the cube and read what happens during the rock cycle. Share the writing responsibility in your group!

## Rock Cycle Game Data Analysis (Appendix D)

--What is the total # of stops made during your rock cycle journey? \_\_\_\_\_

--Find the factors of this number: \_\_\_\_\_

How many of these stops were at:	# of stops at this station	What is the fraction of the whole that you were at this station?	Convert this to a decimal (round to the hundredths place)
			Can you simplify this fraction? If you can, write that fraction below.
<b>Sediment</b>			
<b>Sedimentary</b>			
<b>Metamorphic</b>			
<b><u>Igneous</u></b>			
<b>Magma</b>			
Does it add up?			
	Total # of stops = 16	Do these fractions add up to <b>16/16</b> ?	Do these decimals add up to 1.00 (or very close to)?

Graph your  
rock cycle journey.

EXAMPLE

3  
16

3 Sedimentary  
16 stations

