

Roll the Rock Cycle: Where Does Earth's Material Spend Its Time?

Investigation question: If every rock-cycle change is a roll of the dice, where does rock material pile up, which routes does it take, and how do the results change when we rewrite the rules for a different place on Earth?

Collaborative systems modeling

Groups of 4

1 session

Setup 5 · Activity 42 · Cleanup 3 min

MS-ESS2-1 · assesses

Name _____

Group _____

Date _____

Your role today

- ☐ **Roller:** Rolls the die for the current traveler, announces the number, and keeps the die on the desk between rolls.
- ☐ **Table reader:** Finds the current station's table, reads the outcome aloud in full (process, energy source, destination or stay), and confirms the traveler's new station.
- ☐ **Recorder:** Writes one row per roll in the roll log: traveler, station before, roll, process, energy source, station after. Checks that each row's energy source matches the process.
- ☐ **Tally keeper and reporter:** Keeps the running tally of turns at each station, posts the group totals on the class chart, and leads the choice of setting for the modified-rules run.

Safety

- No physical hazards. Keep dice on the desk, not thrown across the room; a dropped die is a trip hazard on a hard floor.
- If the lab is run as a floor game with taped stations, clear bags and chairs from the walking paths and walk, do not run, between stations.

Procedure

1. Read all five station tables aloud as a group. For each table, check that every outcome names a process and an energy source, and say which outcomes are 'stay' and which are 'move.' Note that moving and staying are both allowed results.
2. Place the four traveler tokens on their starting stations: Magma, Sediment, Sedimentary rock, Metamorphic rock. Each traveler will make 10 rolls, one traveler at a time.
3. Run traveler 1. The Roller rolls; the Table reader reads the outcome for the traveler's current station; the Recorder writes the row (traveler, station before, roll, process or 'stays', energy source, station after); the Tally keeper adds a mark under the station where the traveler ends the turn. Move the token. Repeat until 10 rolls are logged.
4. Run travelers 2, 3 and 4 the same way. Rotate the Roller role after each traveler so everyone rolls at least once.

5. Total the tally: how many of the group's 40 turns ended at each station. Calculate each station's percent of the 40 turns and post the group's five counts on the class chart.
6. Trace each traveler's route on the recording sheet as a chain of station names with the process on each arrow. Mark any traveler that never visited Magma and any traveler that skipped from one rock type directly to another rock type.
7. When the class chart is complete, copy the class totals and percents into your sheet and compare them with your group's percents and with the rule probabilities the teacher posts.
8. Choose a setting from the slide. Decide which one or two station tables would be different there and why. On a blank template, rewrite those tables (keep six outcomes, each with a process and an energy source). Write a prediction: which station will gain turns, which will lose.
9. Run two travelers for 10 rolls each with the modified tables, log the rows on the second roll log, and tally. Compare with your prediction.
10. Answer the analysis questions individually.

Record your observations

Lab 3 recording sheet: Roll the rock cycle

Log every roll as one row. If the traveler stays, write 'stays' in the process column and the reason the table gives. The energy source must match the process: Sun and gravity for surface processes, Earth's interior for melting, uplift and heat-and-pressure changes, and 'none needed' when the material simply sits.

Roll log, run 1 (standard rules). Continue on the back for all 40 rolls.

Traveler	Station before	Roll	Process (or stays)	Energy source	Station after
1	Magma				
1					
1					
1					
1					
1					
1					
1					
1					
1					
2	Sediment				
2					

Station tally

Station	Group turns (of 40)	Group percent	Class turns	Class percent	Rule probability the teacher posts
Magma					
Igneous rock					
Sediment					
Sedimentary rock					
Metamorphic rock					
Total	40	100		100	100

Routes

Traveler	Route as a chain of stations (write the process on each arrow)	Ever visited Magma? (yes/no)	Skipped from one rock type straight to another? (which)
1			
2			
3			
4			

Run 2: our modified rules

Setting chosen	Station table(s) we changed	What we changed and why	Prediction: station that gains, station that loses	Result after 20 turns

1. Which station held your group's travelers for the most turns, and which for the fewest? Give the counts.

2. Did any of your four travelers complete all 10 rolls without ever visiting Magma? Copy that traveler's route and explain why this is possible in the real rock cycle.

Analysis questions

3. A group's 40 turns ended at Metamorphic rock 11 times and at Igneous rock 4 times. Calculate the percent of turns at each of these stations and show the arithmetic.

4. Look at the Metamorphic rock table. On what fraction of rolls does material stay at that station (including 'changed again')? Convert the fraction to a percent and explain why the rule was written that way, using what you know about how long real rock stays metamorphic.

5. Compare your group's percents with the class percents and with the rule probabilities. Which was closer to the rules, your group or the class? Explain why, using the number of turns in each.

6. Pick one row from your roll log where the material moved. Write the process, the energy source and the station it moved to, then explain in one or two sentences what that same change looks like on Earth and roughly how long it takes.

- 7.** Describe the rules your group wrote for run 2, the prediction you made, and what happened. Did the material pile up where you expected? Use your counts.

- 8.** The model treats a turn at Magma and a turn at Sedimentary rock as the same length of time, and it never lets material be at two stations at once. Name two more ways the dice model is unlike the real rock cycle and one thing the model shows well.
