Rock Stars

Grade Level: 6–10

Learner Objectives:

Students will:

- Identify and understand the processes responsible for different appearances of lava rocks
- Recognize rock samples from various parts of a lava flow

Setting: Classroom

Timeframe: 40 minutes

Materials:

- Graphic *"Lava Flow Features"*
- Graphics *"Rock Star Photo Examples"*
- Copies of *"Interview a Rock Star"* student page
- Rock samples (optional) see *"Adaptations"* on page 7
- Station numbers
- Pencils
- Hand lenses

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NATIONAL PARK SERVICE

Living with a Volcano in Your Backyard- An Educator's Guide with Emphasis on Mount Rainier

Prepared in collaboration with the National Park Service

U.S. Department of the Interior
U.S. Geological Survey

General Information Product 19

Overview

Students identify the characteristics of rocks in samples or photos and then tell a story about where and how each formed.

Teacher Background

Understanding a gray rocky landscape

A stroll across the slopes of a volcano is akin to walking the halls of a great natural museum, though the rocks of the volcano are on display in their natural setting. From a distance, Mount Rainier's volcanic landscape appears uniformly gray in color. Upon closer examination, however, subtle and significant differences in rock texture, color, and crystal size become apparent. For the most part, lava rocks on the slopes of Mount Rainier came from a common magma source and have similar chemical composition. Why then do their appearances differ? The conditions under which molten lava rocks cool and solidify have the greatest influence on a rock's appearance. Knowledge of a rock's cooling conditions helps geologists determine whether the rock cooled inside the earth (***intrusive***) or outside the volcano, on Earth's surface (***extrusive***). Intrusive rocks are uniformly coarse grained. Extrusive rocks are fine-grained or have mixed grain sizes.

Rocks from the same lava flow can appear different, depending on where they cooled and solidified.

With practice, students can identify the origin of any lava rock as being from a lava flow's exterior or interior. Lava flows have a dense interior and a rubbly flow top.

Vocabulary: Andesite, breccia, extrusive, granodiorite, hydrothermal alteration, intrusive, lava flow, sandstone

Skills: Compare, describe, identify, visualize, observe

Benchmarks:

See benchmarks in Introduction.

Lava flow exteriors

The tops of lava flows are rubbly and consist of ***breccia*** because the cooled exterior rocks break apart when pulled along by the still moving interior of the flow. Rocks at the exterior of the flow can be rich in gas bubbles. Some exterior rocks that cool instantly, with no time for crystal formation, have a glassy texture and appearance.

Lava flow interiors

The massive interior of a lava flow cools slowly, and requires days to years for complete cooling. Gases are less common in the flow's interior, so rocks contain fewer gas bubbles. The margins of lava flow interiors contract and crack as they cool and can form long columns oriented perpendicular to the cooling surface—the top, sides, base or the toe of the flow. View these features on the graphic "***Lava Flow Features***."

Rusty and hardboiled lavas

The iron in rocks that cool in the presence of steam oxidizes to rust, giving the rocks a red or mauve color. Inside the mountain, hot gases mix with heated ground water to produce a weakly acidic solution that stains rocks yellow, orange, and red or chemically alters the entire rock mass, leaving it weakened and crumbly. This process is called ***hydrothermal alteration***.

With this knowledge at hand, geologists can visit previously unexplored volcanic landscapes and recognize the conditions that existed when the lava flows cooled and solidified. Observations of crystal size, color, and texture of rocks provide valuable clues about a rock's former position within a lava flow and the conditions in which the rocks cooled. Below are some photo examples of rocks that formed within the boundaries of Mount Rainier National Park.

Rock star photo examples

1. ***Gray Andesite***

Andesite commonly appears dark gray to black in color, has a consistent look and texture throughout, and contains no gas bubbles. The rock cooled relatively quickly, within days to years, so mineral crystals are generally fine grained. Typically, crystals (small white and dark spots) are visible that grew in the magma chamber before the eruption.

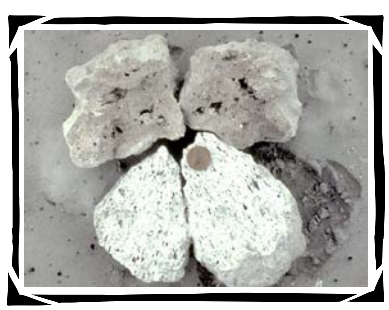

2. ***Red andesite***

Escaping steam caused iron in these rocks to rust and produce the red color. Rocks are sometimes red on one side and gray on the other, which indicates the lava cooled adjacent to cracks in the lava flow.




3. ***Bubbly rock***

Holes form when volcanic gas bubbles are trapped during the cooling process.



4. ***Black glassy andesite***

This rock cooled in just seconds. Mineral grains had no time to grow; thus it appears black with a glassy texture.

5. ***Hydrothermally altered andesite***

Prolonged exposure to hot acidic water changed this rock from gray to a yellow/orange color. This is a process called hydrothermal alteration. The rock is now crumbly and weak.

6. ***Tatoosh Granodiorite***

It took thousands of years for this magma to cool, plenty of time for the mineral grains to grow. Individual crystals of feldspar and hornblende are apparent to the unaided eye in this ***granodiorite***, an intrusive rock.

7. ***Rounded andesite***

Steam action broke off the sharp edges of this lava rock leaving it rounded and polished.

8. ***<u>Open book slabs</u>***

As this lava flow slowed and cooled, fractures developed that later caused the rock to split open into slabs.

9. ***<u>Columnar andesite</u>***

As lava cools, it contracts and forms long cracks perpendicular to the cooling surface. This creates a colonnade appearance. The cooling surface can be on the top, base, the sides, or at the toe of the lava flow.

10. ***<u>Blocky rock rubble/breccia</u>***

Lava exteriors cool faster than interiors because of their exposure to cool air. The hotter, still molten interior continues to flow and eventually the solidified top layer breaks into pieces. This process is akin to the lava flow top being placed on a conveyer belt. The rock is constantly being pulled apart and jumbled as the lava flow creeps down slope. This uneven motion continues until the entire lava flow has cooled and solidified as breccia.

11. ***<u>Sandstone (non-igneous rock)</u>***

This sandstone consists of tiny sand grains. The edges of each grain are well rounded because of the collisions of grains during transport by wind and water.

Procedure

What to do Before Class Begins:

1. Choose one of these teaching options:

- Project images of rocks to the entire class.
- Print color graphics and place at work stations.
- Display actual rock samples (see sample list in "***Adaptations***" on page 8).
- Display combination of actual rock samples and projected images.

2. If you provide actual samples, place one rock sample and a hand lens at each station.

3. Provide each student with a copy of the two student pages "***Interview a Rock Star***."

For purposes of general class discussion, you might review the terms "***intrusive***" and "***extrusive***" with students prior to conducting the activity.

Interview a Rock Star

Students learn to identify the origin of lava-rock samples by observing texture, grain size, shape and color.

1. Prepare the students for their interview by reviewing the visual characteristics of rocks, such as grain size, texture, shape, and color. Ask what characteristics are different in intrusive and extrusive rocks. Use the "***Lava Flow Features***" graphic to discuss how cooling and position within the lava flow can affect the appearance of a rock.

2. Instruct students to either view images projected or to visit each station, study each sample, and answer the guiding questions on the "***Interview a Rock Star***" student page.

3. Review the results after all samples have been viewed. Point out positions of rock origin on the "***Lava Flow Features***" graphic.

4. With the graphic on display, begin a discussion. Discuss how characteristics of the lava rocks can help a geologist learn about the conditions that existed where the rocks formed. What questions might be answered by close observation?

   ANSWER: Geologists might learn whether the lava was gas rich; whether it cooled quickly or more slowly; whether it formed on the interior or exterior of the lava flow; whether it cooled in the presence of steam or adjacent to a glacier.

Adaptations

- Use rock samples instead of the photographs provided.
  - ***Gray andesite***
  - ***Red andesite***
  - ***Bubbly rock***
  - ***Black glassy andesite or obsidian***
  - ***Hydrothermally altered andesite***
  - ***Granodiorite***
  - ***Rounded volcanic rock***
  - ***Plate-like pieces of lava rock***
  - ***Columnar andesite***
  - ***Breccia***
  - ***Sandstone (or other non-igneous rock that contains visible grains)***
- Adapt a broader study of rocks with the addition of information presented in this activity.

Extensions

- Students conduct an Internet or library search for more information about other igneous rocks not addressed in this activity.

Assessment

Use **Interview a Rock Star** student page as an assessment tool. Look for students' understanding of the following concepts: rocks of the same or similar chemical composition can be very different in appearance; cooling conditions determine much of the appearance of igneous rocks; rocks within the lava flow interior cool faster than rocks on the lava flow exterior; steam, gas volume, crystal size, lava flow motion are influences on the color, texture and form of igneous rocks.

References

Francis, P., and Oppenheimer, C., 2003, Volcanoes: New York, N.Y., Oxford University Press, 536 p.

Refer to **Internet Resources Page** for a list of resources available as a supplement to this activity.

Photo Credits

1. Station 1 Gray andesite, Photo by Carolyn Driedger, USGS.
2. Station 2 Red andesite, Photo by Carolyn Driedger, USGS.
3. Station 3 Bubbly rock, Photo by Willie Scott, USGS.
4. Station 4 Black glassy andesite, Photo by Carolyn Driedger, USGS.
5. Station 5 Hydrothermally altered andesite, Photo by Steve Brantley, USGS.
6. Station 6 Tatoosh Granodiorite, Photo by Carolyn Driedger, USGS.
7. Station 7 Rounded andesite, Photo by Carolyn Driedger, USGS.
8. Station 8 Open book slabs, Photo by Carolyn Driedger, USGS Station.
9. Station 9 Columnar andesite, Photo by Carolyn Driedger, USGS.
10. Station 10 Bubbly rock rubble/breccia, Photo by Carolyn Driedger, USGS.
11. Station 11 Sandstone, Photo by Carolyn Driedger, USGS.

Name ______________________

Interview a Rock Star

Station	Guiding Questions	Cooling Conditions for this Rock
1	Explain evidence that suggests this rock cooled quickly.	
2	Explain how the presence of steam influenced the color of this rock.	
3	What formed the holes in this rock?	
4	Why is this rock black and glassy with no visible crystals?	
5	What combined with the sulfur in this rock to change the color from gray to yellow/orange/red? Name the chemical process that transformed this rock from a solid piece to one that crumbles easily.	
6	Describe any evidence that suggests whether this rock cooled instantly or over a long period of years.	

Name ______________________

Interview a Rock Star-continued

Station	Guiding Questions	Cooling Conditions for this Rock
7	Explain why the corners of this rock are rounded.	
8	What lava flow motion caused the platy, "open-book" appearance of these lava rocks?	
9	In a cooling lava flow, lava rock contracts and forms long cracks that point towards the closest cool ground or air. This creates the appearance of lava columns. Draw an arrow in the box that indicates the direction to that nearest cool surface.	
10	In what general part of a lava flow would you expect to find this loose rock rubble? Explain its origin.	
11	Is this an igneous rock? Explain your answer.	

Interview a Rock Star—Answers

Station	Guiding Questions	Cooling Conditions for this Rock
1	Explain evidence that suggests this rock cooled quickly.	***Crystals are not visible. They did not have sufficient time to grow.***
2	Explain how the presence of steam influenced the color of this rock.	***Steam oxidized (rusted) iron within the rock and gave it a red-mauve color.***
3	What formed the holes in this rock?	***Expanding gases enlarged the holes (vesicles), and then escaped into Earth's atmosphere.***
4	Why is this rock black and glassy with no visible crystals?	***This rock cooled and hardened instantly and had no time for crystal formation. Black color is caused by light absorption.***
5	What combined with the sulfur in this rock to change the color from gray to yellow/orange/red? Name the chemical process that transformed this rock from a solid piece to one that crumbles easily.	***Water*** ***Hydrothermal alteration***
6	Describe any evidence that suggests whether this rock cooled instantly or over a long period of years.	***Crystals are visible, and thus had time to grow over a period of years.***

Interview a Rock Star—Answers -continued

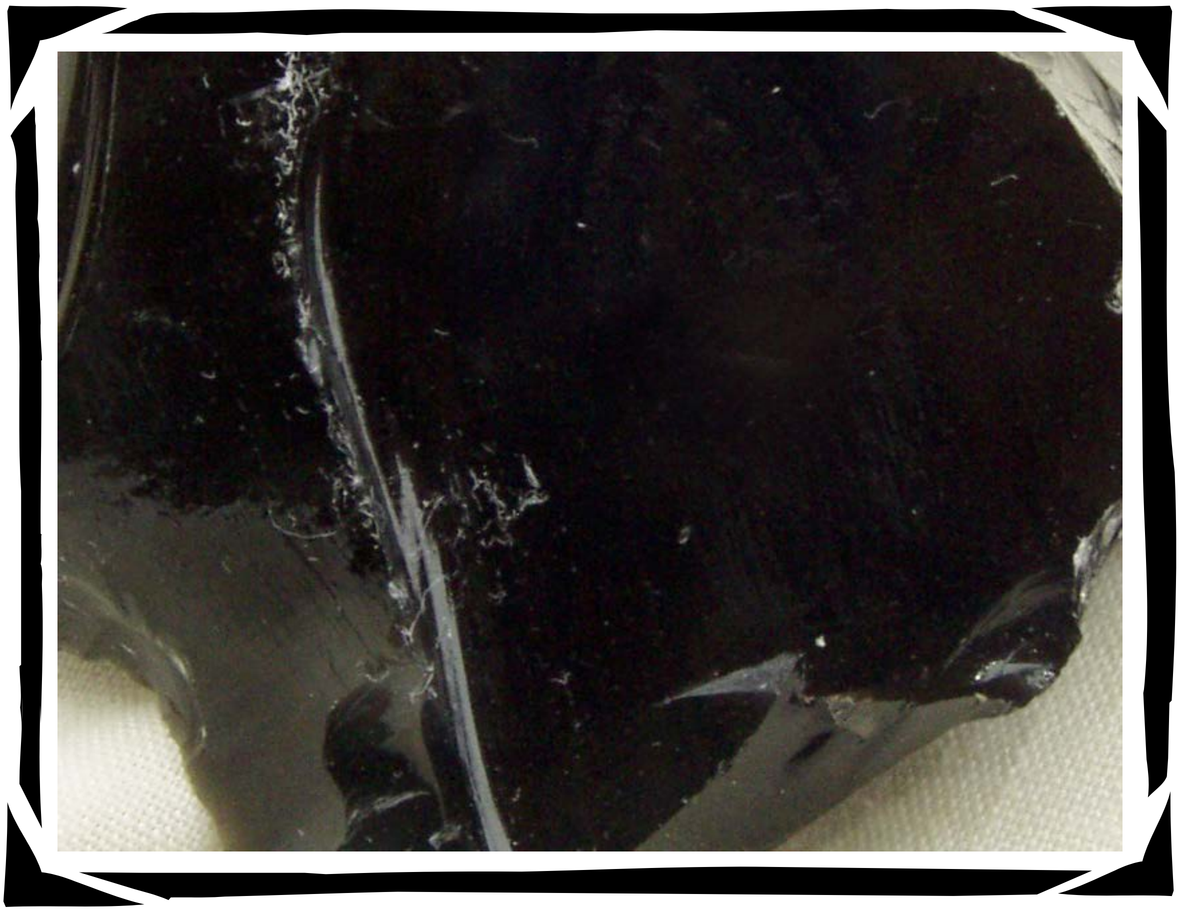
Station	Guiding Questions	Cooling Conditions for this Rock
7	Explain why the corners of this rock are rounded.	***Repeated collisions during river transport rounded off the corners of those boulders.***
8	What lava flow motion caused the platy, "open-book" appearance of these lava rocks?	***As the lava slowed and cooled, fractures developed which later split the rock into slabs.***
9	In a cooling lava flow, lava rock contracts and forms long cracks that point towards the closest cool ground or air. This creates the appearance of lava columns. Draw an arrow in the box that indicates the direction to that nearest cool surface.	***Students should draw an arrow that points towards the upper left.***
10	In what general part of a lava flow would you expect to find this loose rock rubble? Explain its origin.	***Exterior***
11	Is this an igneous rock? Explain your answer.	***No, this is not an igneous rock. It contains round-edged sand particles produced by erosion.***

Gray Andesite—Station 1

Red Andesite—Station 2

Bubbly Rock—Station 3

Black Glassy Andesite—Station 4



Graphic Page

Hydrothermally Altered Andesite—Station 5

Tatoosh Granodiorite—Station 6

Rounded Andesite—Station 7

Open Book Slabs—Station 8

Columnar Andesite—Station 9

Bubbly Rock Rubble/Breccia—Station 10

Sandstone—Station 11

Lava Flow Features