Lessons 19–20
Global Patterns of Earthquakes and Volcanoes

Prepare

In Lesson 18, students analyzed photographs and a world relief map to discover features and processes associated with canyon formation. In Lesson 19, students analyze and interpret data from additional maps to determine patterns in other features and processes typically found near canyons, including earthquakes and volcanoes. Then, in Lesson 20, students apply their new knowledge to determine the most likely place to look for other canyons in a Conceptual Checkpoint.

Student Learning

Knowledge Statement

Natural processes and features occur in patterns.

Concept 3: Patterns in Features and Processes

Focus Question

How do canyons around the world form?

Phenomenon Question

How can people use global patterns of Earth's features and processes to predict canyon location?

Objectives

- Lesson 19: Describe global patterns in locations of volcanoes, earthquakes, mountains, and canyons.
- Lesson 20: Determine the most likely location of a canyon on a map based on analysis of natural features.

Texas Essential Knowledge and Skills Addressed

4.3A **Analyze, evaluate, and critique scientific explanations using evidence**, logical reasoning, and experimental and observational testing. (Addressed)

4.3B **Represent the natural world using models** such as the water cycle and **stream tables** and **identify their limitations**, including accuracy and size. (Addressed)

4.7B **Observe and identify slow changes to Earth's surface caused by weathering, erosion, and deposition from water, wind, and ice.** (Addressed)

English Language Proficiency Standards Addressed

4A Learn relationships between sounds and letters of the English language and decode (sound out) words using a combination of skills such as recognizing sound-letter relationships and identifying cognates, affixes, roots, and base words.

4G Demonstrate comprehension of increasingly complex English by participating in shared reading, retelling or summarizing material, responding to questions, and taking notes commensurate with content area and grade level needs.

Materials

		Lesson 19	Lesson 20
Student	Science Logbook (Lesson 18 Activity Guides C and D)	●	
	Science Logbook (Lesson 19 Activity Guides A and B)	●	
	Science Logbook (Lesson 20 Activity Guide)		●
Teacher	Earth's Features Photographs (Lesson 19 Resource A)	●	
	Present-Day Grand Canyon Figure 2 (Lesson 1 Resource D)	●	
	Earthquake and Volcano Maps (Lesson 19 Resource B)	●	
	World Relief Map (Lesson 18 Resource B)	●	
	Anchor chart		●
	Anchor model		●
	Grand Canyon (Chin 2017)		●
	Conceptual Checkpoint Map (Lesson 20 Resource)		●
	Driving question board		●
Preparation	None		

Lesson 19

Objective: Describe global patterns in locations of volcanoes, earthquakes, mountains, and canyons.

Agenda

Launch (12 minutes)

Learn (30 minutes)

- Investigate Earthquakes (13 minutes)
- Investigate Volcanoes (12 minutes)
- Organize Knowledge about Earth's Features and Processes (5 minutes)

Land (3 minutes)

Launch 12 minutes

Ask students to share some ideas they have about other Earth features that may occur in global patterns.

English Language Development

Understanding the phrase *global pattern* is required to participate fully in the activity. Introduce this term explicitly. Sharing the Spanish cognate *patrón global* may be useful. Additionally, consider sharing a student-friendly explanation, such as "global patterns occur around the world" (4A).

Sample student responses:

- *Islands are usually located in groups.*
- *Sometimes there are groups of lakes together, like the Great Lakes.*
- *There are mountain ranges, like the Rocky Mountains.*

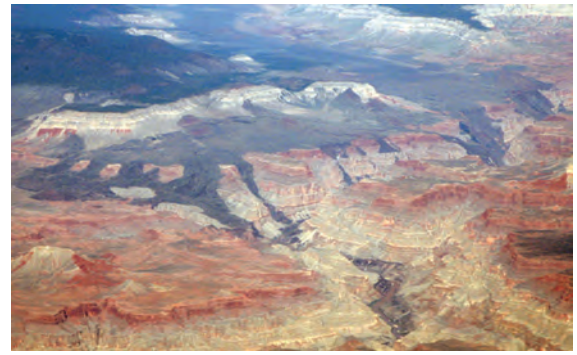
Display two photographs of rock features (Figure 1 from Lesson 19 Resource A and Figure 2 from Lesson 1 Resource D). Have students work with a partner to analyze the two photographs and record what they notice in their Science Logbooks (Lesson 19 Activity Guide A). Ask students to share some of what they notice.

Teacher Note

The first photograph depicts a diagonal fault line running through a layered rock wall (middle of image). Although this photograph was not taken in the Grand Canyon, the walls of the Grand Canyon contain faults. The second photograph depicts a volcanic lava flow (black rock) over portions of the Grand Canyon.

1

2



Sample student responses:

What do you notice in the first photograph?	What do you notice in the second photograph?
▪ *There's a big crack running down the middle of the rocks.* ▪ *There are layers in the rock, but they don't line up exactly.*	▪ *Something dark is covering the rocks of the Grand Canyon.* ▪ *Some of the dark material looks like it's going down the sides of the Grand Canyon.*

Students should then respond to the following question in their Science Logbooks (Lesson 19 Activity Guide A) and share their response with the class.

▶ What processes do you think may have caused the features we see in the two photographs?

- *Someone or something could have hit the side of the rock to make it crack.*
- *Maybe something shook the rocks and made them crack.*
- *A big accident happened and something spilled black stuff all over the Grand Canyon.*

Explain that these kinds of features do not just occur locally at the Grand Canyon; similar features can be found around the world.

Learn 30 minutes

Investigate Earthquakes 13 minutes

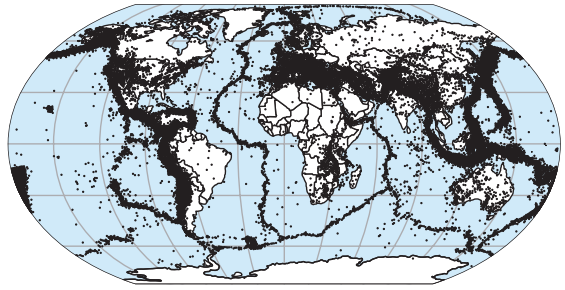
Print out a copy of the photograph of the rock with the fault line running though it (Figure 1 from Lesson 19 Resource A) and cut along the crack as students watch. Demonstrate to students that the rock layers can move along the crack by moving the pieces up and down. As needed, guide students to recognize that the crack was caused by an earthquake.

- ▶ **What Earth process could have enough force to cause the rocks to move in this way?**
  - *Maybe an earthquake could do this?*
- ▶ **Earthquakes are processes that happen globally. How could we find a record of where earthquakes have happened around the world?**
  - *Maybe there are maps of earthquake locations.*

Display the earthquake location map (Lesson 19 Resource B). Explain that each black dot on the map represents an earthquake that occurred between 1963 and 1998.

- ▶ **How many earthquakes are shown on the map?**
  - *The title says 358,214.*
  - *It looks like lots and lots of earthquakes.*
- ▶ **What global patterns about earthquake location do you notice?**
  - *A lot are on one side of North and South America, but there aren't as many on the other side.*
  - *Many are in the middle of the Atlantic Ocean.*
  - *A lot of earthquakes are by Asia and Australia.*
  - *There are so many in Europe that you can't see it!*

Preliminary Determination of Epicenters
358,214 Events, 1963–1998



Teacher Note

If students do not know the term *fault*, they may refer to it as a crack. Through discussion, the term *fault* may be introduced to students.

English Language Development

Earthquake and *volcano* are used repeatedly in this module. Sharing the Spanish cognate for *volcano* (*volcán*) may be useful. Additionally, consider providing images and videos illustrating the terms to students (4A).

Differentiation

If students do not present the idea that earthquakes could move the rocks, consider having them read *Earthquake* by Joyce Markovics (2014). This text can be found on digital libraries such as Epic!: http://phdsci.link/1028 (4G).

Teacher Note

If internet access is available, consider also displaying the online US Geological Survey earthquake map (http://phdsci.link/1001) to observe recent earthquake activity.

Content Area Connection: Geography

Students discuss their knowledge of the world's continents. Students can also research how significant earthquake and volcanic activity affect the environments and cultures of specific regions on the maps.

Instruct students to turn to the world relief map in their Science Logbooks (Lesson 18 Activity Guide C). Tell students to use a colored writing utensil to draw lines on their maps to represent common earthquake locations based on the earthquake location map. Have them analyze data from the maps and answer the following questions in their Science Logbooks (Lesson 19 Activity Guide B).

▶ **What do you notice about the location of earthquakes, mountains, and canyons?**

- *The map shows that there are earthquakes in the same places that the other map showed mountains and canyons.*
- *It looks like earthquakes happen where there are mountains and canyons.*

▶ **What do you notice about earthquake location and the region where you live?**

- *The map shows that there are a lot of earthquakes in California where I live.*
- *I live in the middle of North America, and there aren't many earthquakes here.*

Investigate Volcanoes 12 minutes

Point out that students noticed a black material covering the rock in the Grand Canyon in the second photograph (Figure 2 from Lesson 1 Resource D). Tell students they will now view a close-up photograph of that black material.

Display the volcanic rock photograph (Figure 2 from Lesson 19 Resource A). Tell students that the black material is rock. Ask students to explain how they think rock could flow across Earth's surface like in the picture. As needed, guide students to recognize that lava from a volcanic eruption forms the black rock.

▶ **What could cause rock to flow across Earth's surface?**

- *Volcanoes make lava.*
- *Sometimes rock is melted, like lava.*

▶ **This is volcanic rock. Are volcanoes features or processes?**

- *I think it's a feature because a volcano is like a mountain.*
- *When it erupts, it might be a process, because a process is when something is happening.*

Teacher Note

Some students may wonder how this black rock is different from other rock in the Grand Canyon. The layers of rock they see in the walls of the Grand Canyon are sedimentary rock, while this black rock is basalt, an igneous rock. Sedimentary rock is deposited by rivers or seas slowly over time, while igneous rock forms when molten rock from volcanoes solidifies.

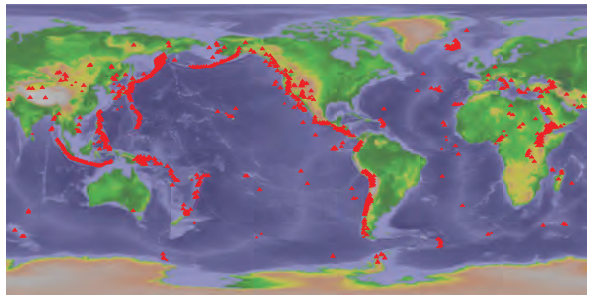
Differentiation

If students do not discuss volcanoes or explain that rock can be found in molten form (lava), consider having them read pages 1–7 and 10–11 of *Volcanoes* by Cari Meister (2016). This text can be found on digital libraries such as Epic!: http://phdsci.link/1029 (4G).

▶ How could we find a record of volcano locations around the world?

- *Maybe there is a map of where volcanoes are found.*

Display the volcano map (Lesson 19 Resource B).



▶ What do you think the symbols on the map stand for?

- *The red dots are different volcanoes.*
- *Some of the dots look like they are under water because they are red but not as bright as the others.*

▶ What global patterns about volcano location do you notice?

- *There are a lot on one side of North and South America, but there are almost none on the other side.*
- *There are many in Africa, Europe, and the Middle East, but not as many as in other places.*
- *It looks like a horseshoe around the Pacific Ocean.*

Have students turn back to the world relief map in their Science Logbooks (Lesson 18 Activity Guide C). Tell students to use a different-colored writing utensil to draw lines on their maps to show common volcano locations based on the volcano map. Have students analyze data from the maps and answer the following questions in their Science Logbooks (Lesson 19 Activity Guide B).

▶ What do you notice about the location of volcanoes, earthquakes, mountains, and canyons?

- *I notice that the maps seem similar. There are volcanoes found near mountains and canyons, and earthquakes seem to occur in those areas too.*
- *They all seem to occur in patterns.*

Extension

Students who are interested in learning more about volcanic eruptions and earthquakes can investigate famous events and share their findings with the class.

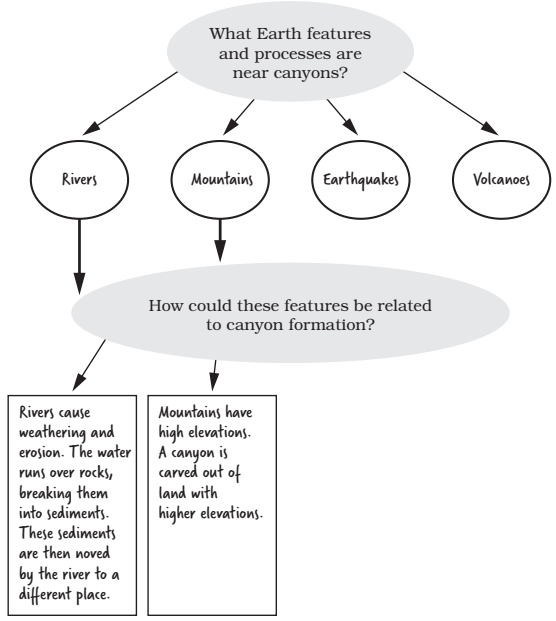
▶ What do you notice about volcano location and the region where you live?

- *I live in North America near the Atlantic Ocean, so there aren't any volcanoes nearby.*
- *There are volcanoes near where I live in the Pacific Northwest.*

Organize Knowledge about Earth's Features and Processes 5 minutes

Have students add the new features and processes they have investigated to the natural features organizer in their Science Logbooks (Lesson 18 Activity Guide D).

Sample natural features organizer:



▶ Why do you think we couldn't answer the second question on our organizer (How could these features be related to canyon formation?) for volcanoes and earthquakes?

- *We only found out that they are near canyons, not whether they form canyons.*
- *We don't have enough evidence.*

Build on student responses to emphasize that events occurring in patterns may or may not have a cause and effect relationship.

Land 3 minutes

Ask students to respond to the Phenomenon Question **How can people use global patterns of Earth's features and processes to predict canyon location?**

English Language Development

The word *predict* is used repeatedly in this module. Introduce this term explicitly. It may be useful to share the Spanish cognate *predecir* and explore the prefix *pre-* and the root *dict*. Additionally, consider sharing a student-friendly explanation, such as "When you predict something, you are making an educated guess about what will happen" (4A).

Sample student response:

- *It looks like canyons are found near mountains, volcanoes, and earthquakes.*

▶ What global patterns do you observe in the locations of mountains, volcanoes, and earthquakes?

- *Mountains, volcanoes, and earthquakes are located in similar places around the world.*
- *Sometimes mountains are found in the middle of continents, but not many volcanoes or earthquakes are in the middle of continents.*

Display the world relief map (Lesson 18 Resource B). Ask for volunteers to point to several locations that provide evidence that mountains, volcanoes, and earthquakes occur in similar places. Then ask students to think deeper about the patterns they have observed.

▶ **What patterns have you observed in rock features on the local, regional, and global levels? What processes caused those features?**

- *We saw a global pattern that mountains are usually around the edges or middle of continents. I don't know what processes form mountains.*
- *We saw a photograph of rock layers with a line cutting through a lot of layers in a diagonal direction. I think that is a local pattern caused by an earthquake.*
- *We saw color patterns in Grand Canyon rock layers. That might be a regional pattern, since the canyon is so big. I think the river weathered and eroded the rock, so we can see the layers.*

Mention that locations of some other natural features occur in patterns, including deep ocean trenches and ocean floor structures. Then bring student attention back to canyon formation.

▶ **We investigated another feature related to canyon formation. What important feature is missing on our maps?**

- *Our maps don't include rivers, and we saw rivers at the bottom of all the canyons. I think rivers are important, too.*
- *Do all canyons have a river at the bottom?*

Extension

Students could research other types of canyons to see if rivers, mountains, volcanoes, and earthquakes are also present. They could also research features of Earth's surface along the ocean floor.

For example, students could explore Monterey Canyon off the west coast of the United States. Monterey Canyon is a submarine canyon that is often compared to the Grand Canyon due to its comparable width and depth. Scientists have not yet discovered how Monterey Canyon was formed. Researchers, such as those at the Monterey Bay Aquarium Research Institute, continue to explore the canyon: http://phdsci.link/1052.