4 Natural Hazards Caused by Earthquakes and Volcanoes

READING

WHEN SELECTING A site to store nuclear waste, it is important to identify risks of natural hazards caused by earthquakes or volcanoes. An **earthquake** is a sudden release of energy in Earth's interior, which can cause shaking at the surface. A **volcano** is an opening in Earth's surface through which lava, gas, and ash escape from magma underground. **Magma** is hot liquid rock under Earth's surface. Earthquakes and volcanoes can cause natural hazards. If these events were to take place near a nuclear waste storage facility, they could present problems for the safe storage of radioactive material.

GUIDING QUESTION

What natural hazards are caused by earthquakes and volcanic eruptions?

The smallest type of volcano is called a cinder cone. In many cases, cinder cones form on the sides of a larger volcano. The photo above shows a cinder cone on Mount Etna in Italy.

During earthquakes, blocks of rock move along a fracture called a fault. The deep line shown in the middle of the picture on the left shows one of the best-known faults in the United States—the San Andreas Fault in California.

MATERIALS

For each student

- 1 Student Sheet 4.1, "Directed Reading Table: Natural Hazards Caused by Earthquakes and Volcanoes"
- 1 Student Sheet 1.1, "Considering Where to Store Nuclear Waste"

PROCEDURE

1. Below you will find four reading passages about four different earthquakes or sites of volcanic activity and the natural hazards they have caused. Decide with your group which of the passages each student will read.
2. Read your assigned passage individually. Complete the row for your reading passage on Student Sheet 4.1, "Directed Reading Table: Natural Hazards Caused by Earthquakes and Volcanoes," as you read.
3. When everyone in your group has finished reading and taking notes on their sheets, take turns sharing what you have learned with your group members. As your group members share, be sure to listen carefully, and record information about each event on the remaining rows of Student Sheet 4.1.

The 2010 Haitian Earthquake: Ground-Shaking

On January 12, 2010, a strong earthquake shook the Republic of Haiti. This earthquake happened about 25 kilometers (km) southwest of the capital, Port-au-Prince. Haiti's population was 9.6 million. More than 316,000 people were killed or missing and presumed dead, 300,000 were injured, and over 1.3 million lost their homes. The cost of the damage was estimated between 7 to 14 billion U.S. dollars.

Many buildings in Haiti were not designed or built to withstand intense ground-shaking during an earthquake. It was estimated that about 300,000 homes collapsed or were badly damaged in the country. Also, many structures housing

key services, such as hospitals, schools, and government buildings, were severely damaged or destroyed. The city of Léogâne [LAY-oh-zhahn] was closest to the source of the earthquake. The ground shaking damaged or destroyed 80–90% of the buildings.

These images show a hospital in Port-au-Prince before and after the earthquake.

In areas where earthquakes happen a lot, such as Haiti, new buildings can be designed and built to lessen the risk of collapse during ground-shaking caused by earthquakes. Older buildings can be fixed to increase the chance that they will not collapse during an earthquake. One way governments ensure that buildings are safe is to adopt and enforce a building code. A building code provides standards for builders to follow as they build new buildings or fix old ones. These standards can ensure that the structures will withstand ground-shaking in the event of an earthquake. In the United States, local governments enforce the building code. However, adopting and enforcing a building code is very expensive. Ensuring that buildings are designed and built to be safe during an earthquake is a tremendous challenge in Haiti because it is one of the poorest countries in the world. At the time of the earthquake, Haiti did not have a national building code in place.

The 2015 Nepal Earthquake: Landslides

On April 25, 2015, a very strong earthquake shook Nepal. It was centered in Gorkha, Nepal. Gorkha is 82 km northwest of the capital city, Kathmandu. Scientists estimate that the earthquake may have caused between 10,000 and 60,000 landslides. Landslides are common in this mountainous area during the wet monsoon season. But these landslides occurred during the dry season when the land is most stable. The intense ground-shaking from the earthquake caused the rock, soil, and other earth materials to become unstable. Once the materials were unstable, gravity pulled them down the mountainous terrain.

One significant landslide caused by the earthquake happened nearly a month after the event. The earthquake in Gorkha, as well as another large earthquake that happened in the area on May 12, 2015, caused large cracks to form in the rock in a steep cliff above the village of Baisari. When rock began to fall from the cliff on May 22, 2015, the Nepal Army evacuated the area. A few days later, the cliff failed, which generated a large landslide. Huge amounts of earth materials flowing downslope from the cliff destroyed 27 buildings and buried the village. A nearby river flooded and formed a lake.

Scientists use a variety of equipment to monitor hillsides in areas where earthquakes happen a lot. One instrument the scientists put on the slopes in Nepal were seismometers [size-MOM-uh-ters]. Seismometers measure ground-shaking and allow scientists to gather data about how much the ground shakes in an area. They can use this information to determine how much ground-shaking it takes to cause a landslide. Their goal is to use the data to make better predictions of when and where landslides will happen. This is very challenging in Nepal because there are several different kinds of events that can trigger landslides. There are earthquakes, heavy rains, and steep slopes. This makes it hard to know where to build villages and towns in Nepal that will be safe from landslides.

A landslide caused by earthquakes in Nepal buried the village of Baisari.

The 1980 Volcanic Eruption of Mt. St. Helens: Ash Fall

On May 18, 1980, the Mt. St. Helens volcano in Washington State, USA, erupted violently, blasting gas and volcanic ash high up into the air. Volcanic ash is very small pieces of rock and volcanic glass that are ejected from a volcano during an eruption. Wind can carry these tiny particles very long distances, as far as hundreds or even thousands of kilometers from an eruption site. A few hours after Mt. St. Helens erupted, people in a town called Yakima, about 230 km (about 145 miles) east of the volcano, noticed dark clouds in the sky. As the dark clouds moved over the town, ash began to fall. The area was covered in as much as 10 centimeters (cm; 4 inches) of ash. By the end of the day, about 500 million metric tons of ash from the eruption at Mt. St. Helens had fallen across three states.

Volcanic ash falls cause many problems. After the 1980 eruption, roads in eastern Washington were closed. Drivers couldn't see and had difficulty driving due to the ash fall. Heavy ash fell on buildings. Roofs were at risk for collapse. Ash falls can also cause widespread power outages. Hospitals and other emergency services cannot respond quickly without electricity. There is also a high health risk for people when they breathe in volcanic ash. Children, seniors, and people with breathing problems, such as asthma, are especially at risk. Ash falls can also harm crops and livestock.

Scientists monitor active volcanoes using a variety of scientific equipment. There are early warning signs that a volcano may erupt. If these signs are observed, they can then warn the public. In the 1980 Mt. St. Helens eruption, scientists gathered data that showed that a significant volcanic eruption was likely. Areas close to the volcano were evacuated before the event.

Mt. St. Helens erupted violently in 1980.

Areas near active volcanoes can prepare for ash falls by developing plans for evacuation. They can also plan for emergency response teams to be ready for an eruption. People who live in these areas should prepare emergency kits. The kits should have supplies for a few days if they need to stay inside while the ash falls.

Mammoth Mountain: Volcanic Gas

Mammoth Mountain is a volcano located in California, USA. The volcano formed during a series of eruptions, and the last large eruption occurred about 57,000 years ago. Smaller eruptions continued since then, but the volcano hasn't erupted for many hundreds of years. There is still volcanic activity occurring on the mountain. In parts of the volcano, volcanic gases escape through layers of soil.

Magma releases water vapor, a harmless gas. But other volcanic gases can be dangerous for nearby organisms. At Mammoth Mountain, carbon dioxide gas is released from the magma underground and it rises through the soil. Carbon dioxide is denser than the air around it, so it collects in areas of low elevation. As the gas collects, it can reach high concentrations. High concentrations of carbon dioxide gas can be harmful to living things.

The carbon dioxide emitted from the magma in Mammoth Mountain is closely monitored. The gas can escape from underground for weeks, months, or years.

One area where the carbon dioxide is frequently measured is near Horseshoe Lake on the mountain. Many trees have died there. Monitoring these areas allows scientists to know when the level of this gas is unsafe. At those times, people must stay away from these areas. Scientists also use these data to create maps that show where the gas is escaping. They look for patterns in the amount of volcanic gas emitted over time. Collecting and analyzing data about the release of volcanic gas helps scientists better understand the volcanic activity happening at the mountain.

Trees killed by high concentrations of carbon dioxide gas at Mammoth Mountain

ANALYSIS

1. Look back at the facts about natural hazards caused by earthquakes and volcanoes from Student Sheet 4.1. Which of these natural hazards do you think presents the least challenge for the safe storage of nuclear waste underground? Explain your answer, making sure to use evidence to support your ideas.
2. Add the consideration "natural hazards caused by earthquakes and volcanoes" in a new row on Student Sheet 1.1, "Considering Where to Store Nuclear Waste." In the second column, write the recommended action you would take in regard to this consideration. Explain why you recommend taking this action when deciding where to store nuclear waste.