LESSON 3

Driving Question:
How can we protect communities at risk from volcanoes?

What is a volcanologist?

A volcanologist is a scientist who studies and monitors volcanoes. By observing volcanic activity and analyzing data, volcanologists can predict whether a volcano is likely to erupt. This means they can warn people who might be affected by the eruption, giving them time to prepare or evacuate and helping save lives.

What are the signs that a volcano is going to erupt?

Though it is possible to predict that a volcano is likely to erupt, it is difficult to predict exactly when the eruption will occur. There are a number of warning signs that indicate an eruption will happen soon. These include seismic activity (such as earthquakes and tremors), escaping gases, and physical changes in the surface of the volcano. These phenomena are the effects of mounting pressure within the volcano as the magma rises toward the surface, and their presence is a strong indication of an imminent eruption.

Why is it important to monitor volcanoes?

Monitoring volcanoes is crucial to providing early warnings of impending eruptions. When Nyiragongo erupted in the Democratic Republic of the Congo in 2002, the lack of a warning system and failure to prepare for a potential eruption led to widespread devastation. In the weeks before the eruption, a series of small tremors and earthquakes were ignored by the local community, leaving over 300,000 people little time to evacuate the area. Lava, pumice, and ash engulfed the area, devastating the city of Goma and leaving 120,000 people homeless.

Other countries with active volcanoes, such as the United States and Japan, have implemented warning systems in order to allow time for evacuation and ensure minimal casualties. In 1980, scientists in Washington were able to monitor Mount St. Helens and predict the eruption weeks in advance, allowing 2,000 people to evacuate the area.

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glossary

MultiGAS spectrometer

a piece of equipment used to directly sample gas emissions on the ground

correlation spectrometer

a piece of equipment used to indirectly sample gas emissions from the air

How do volcanologists monitor volcano activity?

Volcanologists analyze both real-time and historic data when monitoring volcanoes. By identifying patterns in the data, they can observe trends in a volcano's eruption cycle. If a volcano's conditions are similar to those that preceded previous eruptions, then it is likely to erupt again soon.

Gas emissions are one indicator that a volcano might be about to erupt. Eruptions give off gases such as sulfur dioxide, carbon dioxide, and hydrogen sulfide. If volcanologists detect these gases in the air, this is a sign that the magma in the volcano has changed and may be about to erupt. Gases can be monitored through direct sampling or indirect sampling. Direct sampling measures the different gases in the air using a piece of equipment called a **MultiGAS spectrometer**, which is positioned at the edge of a volcano's crater. Indirect sampling only measures the amount of sulfur dioxide in the air, and uses a **correlation spectrometer (COSPEC)** which may be positioned on the ground or flown over the volcano by a drone.

Seismometers are used to monitor earthquakes in and around the volcano. Before an eruption, the number and magnitude of earthquakes near a volcano increases due to magma pushing upward into the magma chamber. This increases the pressure on neighboring rock, causing the ground to shake. When a seismometer detects a continuous string of earthquakes, this may indicate that a volcano is about to erupt.

Volcanologists also look for areas where a volcano's surface is changing. When magma and gas push upward, a volcano's slope can begin to swell in a process called deformation. Often, deformation is not visible to the eye, but volcanologists can detect this physical change with GPS receivers. Multiple receivers are placed on the surface of the volcano, and will broadcast their exact location. By monitoring this data, scientists can observe any movement of the surface that might indicate an eruption. Drones and satellites are also used to capture images of a volcano's topography over time. These images are used to develop 3-D maps of a volcano, known as digital elevation maps, which can then be easily compared in order to identify changes.

Before a volcano erupts, its temperature rises due to the increase in magma activity. The temperature of gas vents, geysers, lava flows, and other volcanic features are monitored by volcanologists looking for signs of an eruption. If the area is safe for the scientists to be in, these temperatures can be recorded using sensors called **thermocouples**. Alternatively, thermal imaging cameras or satellites can be used to safely record temperatures from a distance.

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seismometer

A sensor buried underground that detects ground motion. The picture shows the seismometer station where data is recorded.

thermocouple

a sensor used to record temperature

Volcanologists also collect rock core samples to determine how regularly a volcano has erupted in the past, which can help forecast when it might erupt in future. These samples can be taken either from rock on the volcano's surface, or from underground rock extracted by drilling into the ground. By examining the underground rock, scientists can analyze the strata that make up the volcano, looking for evidence of previous lava flows in order to determine how frequently the volcano has erupted during its lifetime.

What are STEM careers in volcanology?

Volcanologist (degree): A volcanologist studies past and present volcanic activity. Volcanologists help us understand volcanic eruptions better and support populations who live close to volcanos. Most volcanologist work in academia. It is necessary to pursue a degree in geology or geophysics to become a volcanologist.

Tour Guide: Many people enjoy visiting active volcanoes. To do so they need the help of experienced and knowledgable tour guides. Tour guides do not need a degree but it might be beneficial to pursue training or certification according to where they want to be active.

Engineering geologist (degree): Engineering geologists support construction works in identifying geological hazards. They provide suggestions and solutions to the construction team on how to mitigate any identified risks. The geological hazards they consider are varied. They range from ground stability to earthquake frequency and risks associated with volcanic activity. Students will have to pursue an undergraduate degree in geology or engineering. This is usually followed by a graduate degree and a specialization in engineering geology.

Emergency Management Specialists (degree): emergency management specialists play an important role in preparing plans for the effective management of a variety of natural hazards. They collaborate with local emergency response teams in creating these plans and coordinate the response should a disaster occur. They are usually employed in the public sector. A bachelor degree in emergency management might be preferred by employers, but a degree in public administration might also be suitable.

Engineering technicians and assistants: Technicians and assistants are always required in engineering as well as disaster management. These jobs can be a good career starting point as they only require community college or associate degrees.