

Earth Science in the News: Volcanoes

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Recently, a series of major volcanic eruptions and related earthquakes has occurred around the rim of the Pacific Ocean. The human and scientific implications of these eruptions provide rich, teachable moments for students on all levels. In the interest of supporting teachers, this document summarizes three related news articles, discusses the Earth spheres impacted by these events, and highlights lesson connections for elementary school students.

Summary of Articles

The following three articles about recent volcanic eruptions provide much food for thought on the topic.

These Are the Biggest Dangers from Hawaii's Erupting Volcanoes (Gibbens, May 4, 2018)

This article describes the effusive (slow-flowing) eruptions that have oozed from Kilauea continuously since 1983. Although the slow-flowing eruptions allow for time to escape the lava, Kilauea remains dangerous because of its proximity to residential neighborhoods and its enormous size. Magma travels a tremendous distance through the crust to the surface and can take many different directions during its journey. As a result, it is very difficult to predict where or when an eruption will occur. In addition, the runny nature of the Kilauean magma allows poisonous gases to bubble out at any point.

Geologists have proven that Kilauea has experienced intense eruptions in the past and they are concerned about the possibility of another violent eruption. Our contemporary technology is too limited to predict what may happen next, and what impact it will have on the highly populated regions of Hawaii.

Why Guatemala's Volcano Is Deadlier than Hawaii's (Gibbens, June 4, 2018) This article describes the differences between the effusive lava flow from Kilauea in Hawaii and the

pyroclastic flows from Volcan de Fuego in Guatemala. The geology of each volcano creates a unique composition of magma. Kilauean magma is very runny, which allows gases to escape as it slowly seeps out of fissures. Runny magma escapes from many different fissures and slowly oozes down the slopes, releasing poisonous gases along the way.

In contrast, the Guatemalan magma tightly holds onto its gases because it is sticky and viscous. Eventually, the gases cause the air pressure to build up until there is an explosion. The debris from the explosion (ash and rock) is caught up with the escaping lava, creating quick moving avalanches that spread out and cover everything in its path. Those in the direct path of the lava do not have adequate time to escape. Additional mudflows (called lahars) that can lead to catastrophic flooding are triggered by tropical rains

The Scary State of Volcano Monitoring in the United States (LaFrance, 2017) The premise of this article is that most Americans believe that volcanic activity is unlikely to be a danger to them because volcanoes rarely erupt and because science is able to accurately predict eruptions that will occur. LaFrance (2017) indicates that these assumptions are false – more than 55 of the 169 active volcanoes in the United States are considered dangerous, and the scientific infrastructure needed to predict eruptions is not universally present. Additional ground sensors and an extensive satellite system devoted to collecting information on volcanoes around the world is needed to develop a more accurate system for detecting volcanoes. In addition, improved communication between volcanic monitoring stations around the country would help scientists to use the patterns available in previous volcanic data to make predictions. Hopefully, the recent eruptions at Kilauea will serve as a powerful motivation to improve volcano monitoring across the United States.

Definition and Discussion of the Spheres Involved

The Next Generation Science Standards separates the study of Earth Science into four spheres: atmosphere, lithosphere, biosphere, and hydrosphere. Although each of these spheres can be defined as a unique entity, the systems that occur within each impact the functioning of all of the other spheres.

Atmosphere The primary impact of the volcanoes on the atmosphere is the release of poisonous gases (primarily sulfur dioxide) and ash plumes that can affect living creatures both nearby and far away. NASA's Earth Observatory (Votland, 2018) provides extensive data sets tracking the path that the ash plumes from Kilauea traveled up into the atmosphere and around the globe. These plumes have traveled as far as 30,000 feet into the air, impacting airplane travel as the sharp edges of the ash can scratch up windows and severely damage engines.

Lithosphere In addition to all of the volcanic activity detailed above, Kilauea's recent eruptions have increased the size of the island of Hawaii, which was originally created by volcanic activity. Clearly, these events in the lithosphere are having a dramatic influence on the rest of Earth's systems.

Biosphere A volcanic flow destroys all living things in its path and releases toxic gases and matter that can travel great distances through the air. Despite the obvious danger to living creatures, over the long term volcanoes can be helpful to the biosphere as the ash falls add nutrients to the soil. (Votland, 2018)

Hydrosphere Sometimes, when lava interacts with seawater explosions occur. (Gibbens, May, 4, 2018) Generally, when lava reaches the ocean it begins to cool and form new land. Intense tropical rainstorms falling on pyroclastic flows can lead to devastating mudslides and catastrophic flooding. One positive impact of volcanic activity on the ocean is that ash falls provide the

nutrients needed for phytoplankton blooms. This explosive growth of microscopic plants creates new food sources for marine life. (Votland, 2018)

Connection to Lessons

The immense power of volcanoes, along with their profound impact on human communities, make them highly engaging phenomena that serve as the entry point into several different NGSS and related lesson activities.

Volcanoes as an Engaging Phenomena The awesome power of volcanic eruption make highly engaging learning experiences for students on all levels. Many different videos exist that illustrate different types of volcanic eruptions. This can be used along with the Question Formulation Technique (QFT) developed by the Right Question Institute. (Source: rightquestion.org) QFT is a sequential process designed to help students learn to ask their own question. QFT is a highly effective tool for integrating the Science and Engineering Practice – Asking Questions and Defining Problems – into classroom instruction on many levels. The basic outline of this protocol is as follows:

1. Identify the question focus (QFocus)
2. State the Rules for Producing Questions
3. Producing Questions
4. Categorizing Questions
5. Prioritizing Questions
6. Next Steps
7. Reflections

This can also be integrated with a review of solids, liquids, and gases so that students can begin to understand that magma/lava are liquid rocks. Exploring sticky liquids (like honey), compared to runny liquids can help students to understand that magma/lava can have different textures and properties depending on the minerals it contains. Volcanoes make an engaging extension to a study of rocks and minerals.

ESS2.B Plate Tectonics and Large Scale System Interactions Studying maps of the locations of volcanoes around the world is an appropriate follow-up to the questioning sessions discussed above. Students can study maps illustrating the tectonic plates along with the volcanoes to begin to understand large scale phenomena like the Mid-Atlantic Ridge and the Pacific Ring of Fire. (<https://volcanoes.usgs.gov>) This work can be connected to reading books about volcanoes around the world.

ESS3.B Natural Hazards Students can read books about famous historical volcanoes – like Mount Etna in Pompeii – that are written for young readers. The teacher can modify/summarize current event articles (using appropriate videos and pictures) to help students understand the volcanic eruptions in Guatemala and Kilauea. It is important that the teacher be very selective about what content is shared with younger students to prevent students from becoming frightened.

Concluding Thoughts

One of the privileges (and challenges) of teaching is having the opportunity to share exciting phenomena with students. Volcanoes serve as very powerful teaching phenomena because they highlight the impact of the natural world on the human condition. We can only hope that these phenomena will inspire students to learn more about science, and how it can be used to improve the human experience.

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