



Exploring volcanoes

TEACHER'S GUIDE

Goal of the activity

To educate students about the significance of volcanoes in geology, ecosystems, and the broader environment. It covers various aspects of volcanoes, including their basic concepts, types, eruption mechanisms, and the environmental and biological impact of volcanic activities.

Student outcomes

Students will

- ✓ develop an understanding of what defines a volcano, including its structural components and the reasons behind volcanic eruptions.
- ✓ learn to differentiate between various types of volcanoes based on their shapes and eruption styles.
- ✓ gain insight into the mechanisms of volcanic eruptions and learn to classify them into explosive and effusive types.
- ✓ become aware of the environmental impacts of volcanic eruptions, particularly concerning air quality and climate changes.
- ✓ understand the biological adaptations in organisms living in volcanic environments and comprehend the significance of extremophiles in scientific research.
- ✓ familiarize themselves with volcanic rocks and minerals, enhancing their knowledge of the Earth's geological processes and the study of volcanology.

Prerequisite knowledge

State what knowledge, skills and competences the students are expected to possess before engaging with this activity.

Biology

- ✓ A basic understanding of ecosystems, adaptation mechanisms in organisms (particularly in extreme environments)

Chemistry

- ✓ Knowledge of chemical compositions, particularly relating to different types of rocks and gases

Physics

- ✓ Familiarity with basic physical processes, such as pressure and force, which are relevant in understanding why volcanoes erupt.

Mathematics

- ✓ Skills in data analysis and interpretation might be beneficial for understanding research findings related to volcanology



DESCRIPTION OF THE ACTIVITY

Classroom activity: Discussion: Basic Concepts of a Volcano

Q1: What defines a volcano?

A1: A volcano is a geological formation, typically a mountain, where magma (molten rock) emerges from within the Earth. Through eruptions, volcanoes can release lava, ash, and gases into the environment.

Q2: What are the main parts of a volcano?

A2: The main parts include the magma chamber, where the magma is stored, the vent through which magma exits, the crater at the summit, and the cone built by accumulated volcanic material.

Q3: Why do volcanoes erupt?

A3: Volcanoes erupt due to the pressure from gaseous vapors and molten rock beneath the Earth's surface. When this pressure exceeds the strength of the Earth's crust, an eruption occurs.

Q4: Are all volcanic eruptions the same?

A4: No, eruptions can vary widely, from explosive blasts that release huge amounts of ash and rock, to gentle lava flows that slowly build new land.

Q5: Can we predict volcanic eruptions?

A5: While we have made advances in monitoring volcanic signs, such as seismic activity, gas emissions, and ground deformation, predicting the exact time and size of an eruption remains challenging.

Types of Volcanoes Based on Shape and Eruption Style

Volcanoes are diverse geological structures that can be classified based on their shape and eruption style. The three main types are:

1. **Shield Volcanoes:** These volcanoes have a broad, domed shape with gently sloping sides. They are primarily formed by effusive eruptions of low-viscosity lava that travels long distances. An example is Mauna Loa in Hawaii.
2. **Cinder Cone Volcanoes:** These are the simplest type of volcano, with steep, conical hills made up of volcanic debris called cinders. They are relatively small and usually have a single eruption point. Paricutin in Mexico is a well-known cinder cone.
3. **Composite/Stratovolcanoes:** Composite volcanoes are large, symmetrical volcanoes with steep sides, composed of layers of hardened lava, tephra, and volcanic ash. They are known for their explosive eruptions and pyroclastic flows. Mount St. Helens in the USA and Mount Fuji in Japan are classic examples.

Each volcano type has distinctive characteristics due to the underlying magma's composition, the volcano's eruption history, and the tectonic setting. Understanding these differences is crucial for studying their behaviors, predicting potential eruptions, and preparing for any associated risks.

Eruption Mechanisms: Explosive and Effusive Eruptions

Volcanic eruptions are primarily categorized into two types based on their explosivity and the characteristics of their magma: explosive eruptions and effusive eruptions.



Explosive Eruptions: Explosive eruptions are violent and can project gases, ash, and volcanic debris into the atmosphere at high velocity. These eruptions typically occur when the magma is high in viscosity, which means it has a thick, sticky consistency due to a high silica content. This type of magma traps gases, building up pressure until it releases suddenly and forcefully.

The intensity of explosive eruptions can vary from moderate to cataclysmic. The volcanic landforms associated with these eruptions often have steep slopes and can form calderas – large, basin-shaped depressions created when a volcano collapses into itself after an eruption. Examples include the infamous Mount Vesuvius in Italy and Krakatoa in Indonesia.

Effusive Eruptions: In contrast, effusive eruptions are characterized by the outpouring of low-viscosity magma that flows steadily from vents and fissures. These lavas are typically basaltic, with lower silica content, allowing volcanic gases to escape more easily, resulting in less violent eruptions.

The landforms created by effusive eruptions include shield volcanoes, like those found in Hawaii, and lava plateaus, where successive layers of lava accumulate over time. Effusive eruptions can still be hazardous but are generally less destructive than explosive eruptions.

Theoretical part:

Volcanic eruptions have profound effects on the environment and climate. Eruptions spew volcanic gases like sulfur dioxide, which can form sulfuric acid in the atmosphere, leading to acid rain that harms ecosystems. Ash and particulate matter from eruptions can blanket the sky, reducing air quality and causing health problems. Furthermore, these particles can reflect sunlight and cool the Earth's surface, impacting global climate patterns.

Extremophiles near volcanoes demonstrate life's incredible adaptability. These organisms have unique biochemical processes that allow them to survive and even thrive in conditions that would be lethal to most other life forms. Their existence suggests that life might be possible in similar extreme environments elsewhere in the universe, such as on the surface of Mars or the moons of Jupiter and Saturn.

In volcanic regions, sustainability involves utilizing the unique resources provided by the environment while mitigating the associated risks. For instance, volcanic soil, enriched with minerals from ash, can be highly fertile, but it requires careful management to prevent erosion and maintain productivity. Communities living in these regions often incorporate traditional knowledge and modern science to create resilient agricultural practices and disaster preparedness strategies.

The study of volcanic rocks and minerals like basalt, pumice, and obsidian reveals much about the Earth's geological processes. These materials not only provide a record of past volcanic activity but also offer resources for construction and industry. Understanding the chemical composition of volcanic materials is essential for interpreting the conditions under which they formed and for predicting future volcanic behavior.

Environmental Impact of Volcanic Eruptions

Q: How do volcanic eruptions affect air quality?

A: Volcanic eruptions can release large amounts of ash, gases, and particulate matter into the atmosphere. Ash and fine particles can reduce air quality, causing respiratory problems for living creatures and reducing visibility. Gases like sulfur dioxide can lead to acid rain, which further deteriorates air quality.



Q: In what ways can volcanic eruptions contribute to climate change?

A: Volcanic eruptions can have a cooling effect on the climate in the short term. The sulfur dioxide and ash released can form a veil in the stratosphere, reflecting sunlight away from the Earth and lowering global temperatures. However, the carbon dioxide released, a greenhouse gas, has the potential to contribute to long-term warming if emitted in large enough quantities.

Q: What are the long-term climate effects of large volcanic eruptions?

A: Large volcanic eruptions, like the one at Mount Pinatubo in 1991, can lead to a temporary global cooling. The sulfur dioxide released reacts in the atmosphere to form sulfate aerosols, which can reflect sunlight and cool the Earth's surface for a few years.

Biological Adaptations to Volcanic Environments

Q: How have organisms adapted to the extreme conditions of volcanic environments?

A: Extremophiles have developed unique adaptations to survive in the harsh conditions of volcanic environments, such as high heat, acidity, and sulfur-rich atmospheres. These adaptations may include specialized enzymes that function at high temperatures and mechanisms to neutralize acidic surroundings.

Q: Why are extremophiles significant to scientific research?

A: Extremophiles are significant because they expand our understanding of the conditions that life can endure. Studying these organisms can provide insights into the origins of life on Earth and inform the search for life on other planets, where similar extreme conditions may exist.

Sustainability in Volcanic Regions

Q: What are some sustainable practices that help communities thrive in volcanic regions?

A: Practices like terracing and the use of volcanic ash as a natural fertilizer can help maintain soil fertility and prevent erosion. Sustainable water management practices are also essential in these regions to conserve water and protect the quality of the water supply.

Q: Can you give an example of a community that has adapted well to living with volcanic risks?

A: The people of Iceland are a prime example. They utilize geothermal energy from volcanic heat for power and heating, demonstrating a sustainable way to harness the energy provided by their volcanic environment.

Volcanic Rocks and Minerals

Q: What are some common volcanic rocks and minerals?

A: Basalt is a common volcanic rock that forms from the rapid cooling of basaltic lava. Pumice is a light, porous volcanic rock that forms during explosive eruptions. Obsidian, known for its glassy texture, forms from the rapid cooling of silica-rich lava.

Q: Why is it important to study the chemical composition of lava and volcanic gases?

A: Understanding the chemical composition of lava and volcanic gases helps us predict the style of an eruption and its potential impacts. For example, lava rich in silica is more likely to lead to explosive eruptions, while low-silica lava tends to flow more easily and produce effusive eruptions.



MATERIALS

1. Power point presentation with images of volcanoes
2. Projector
3. Computer

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