SAMPLE

Earth's Dynamic Systems: Volcanoes

Fire From Within

Aira Astralis

Free sample: Introduction & Chapter 1

putrabooks.github.io

Buy the full book:

Carousell carousell.sg/p/earth-s-dynamic-systems-volcanoes-ebook-pdf-1467854306

ElevenReader

Payhip

Contents

Introduction

Chapter 1: How Volcanoes Work

Chapter 2: Types of Volcanoes

Chapter 3: The Ring of Fire

Chapter 4: Famous Volcanic Eruptions

Chapter 5: Volcanoes and Plate Tectonics

Chapter 6: Volcanic Hazards

Chapter 7: Volcano Monitoring and Prediction

Chapter 8: Volcanoes and Climate

Chapter 9: Volcanoes in the Solar System

Chapter 10: Hotspots and Mantle Plumes

Chapter 11: Volcanoes and the Origin of Life

Chapter 12: Fun Facts and Trivia About Volcanoes

Chapter 13: Living with Volcanoes

Chapter 14: Volcanoes and Earth's Formation

Chapter 15: Volcanic Rocks and Minerals

Chapter 16: Conclusion: The Power of Volcanoes

Conclusion

This free sample contains the Introduction and Chapter 1. The complete book contains the full contents above.

Introduction

Volcanoes are one of the most powerful and fascinating geological features on Earth. A volcano is a rupture in the crust of a planetary-mass object, such as Earth, that allows hot lava, volcanic ash, and gases to escape from a magma chamber below the surface. Volcanoes are found on Earth and on other planets and moons, including Mars, Venus, and Jupiter's moon Io. Earth has about 1,500 active volcanoes, with about 50 to 70 erupting at any given time.

The most active volcanoes include Kilauea in Hawaii, which erupted continuously from 1983 to 2018, and Mount Etna in Italy, which has been erupting for thousands of years. The Ring of Fire, a horseshoe-shaped belt around the Pacific Ocean, contains about 75 percent of the world's active volcanoes. Volcanoes are formed by the movement of tectonic plates. The Earth's crust is divided into about 15 major tectonic plates, which move at rates of 2 to 15 centimeters per year.

When plates collide, one plate can subduct beneath the other, melting and producing magma that rises to the surface, forming volcanoes. When plates pull apart, magma rises from the mantle to fill the gap, forming new crust and volcanic ridges. The study of volcanoes, called volcanology, is a branch of geology that deals with the formation, the eruption, and the effects of volcanoes. Volcanologists study volcanoes to understand how they work, to predict eruptions, and to mitigate the hazards.

The study of volcanoes is important because eruptions can cause significant damage and loss of life, with the most destructive eruption in recorded history being the 1815 eruption of Tambora, which killed about 71,000 people. Volcanoes are not just destructive; they are also constructive. Volcanic eruptions produce new land, fertile soil, and important mineral resources. The Hawaiian Islands, which were formed by volcanic eruptions, are home to rich ecosystems and fertile volcanic soils.

Volcanic gases, including water vapor, carbon dioxide, and nitrogen, are thought to have played a role in the formation of the Earth's atmosphere and oceans, making volcanoes essential for the habitability of our planet. Earth has about 1,500 active volcanoes with 50 to 70 erupting at any given time. Volcanoes are formed by tectonic plate movement at 2 to 15 cm per year with 1500 active volcanoes and the Ring of Fire containing 75 percent of them. Kilauea erupted 1983 to 2018 and Mount Etna has been erupting for thousands of years. Volcanic gases formed Earth atmosphere and oceans. Earth has 1500 active volcanoes 50 to 70 erupting at any time Ring of Fire 75 percent. Kilauea 1983-2018 Etna thousands of years. Volcanic gases water

vapor CO2 nitrogen formed atmosphere and oceans. 1500 active Ring of Fire.

1500 active.

On Earth, volcanoes are most often found where tectonic plates are diverging or converging, and because most of Earth's plate boundaries are underwater, most volcanoes are found underwater.

For example, a mid-ocean ridge, such as the Mid-Atlantic Ridge, has volcanoes caused by divergent tectonic plates whereas the Pacific Ring of Fire has volcanoes caused by convergent tectonic plates. Volcanoes resulting from divergent tectonic activity are usually non-explosive whereas those resulting from convergent tectonic activity cause violent eruptions. Volcanoes can also form where there is stretching and thinning of the crust's plates, such as in the

East African Rift, the Wells Gray-Clearwater volcanic field, and the Rio Grande rift in North America.

This results in hotspot volcanism or intraplate volcanism, in which the plume may cause thinning of the crust and result in a volcanic island chain due to the continuous movement of the tectonic plate, of which the Hawaiian hotspot is an example. Volcanoes are usually not created at transform tectonic boundaries where two tectonic plates slide past one another.

The subject rewards the attention. Volcanoes are the planet's way of shedding the heat of its own formation and of the radioactive elements that remain inside it; every eruption anywhere is a surface expression of the same slow convection that moves the continents, builds mountains, and recycles the ocean floor. A book about volcanoes is therefore a book about the Earth's engine room, told from the exhaust pipe, and it draws on every branch of earth science to make sense of what it sees: the physics of melting rock, the chemistry of gas and crystal, the mechanics of plumbing systems kilometers underground, and the fragile, necessary art of forecasting events that no one has ever watched from the inside.

Chapter 1: How Volcanoes Work

Volcanoes are powered by heat from the Earth's interior. The Earth, which has a radius of about 6,371 kilometers, has a layered structure: the crust, the mantle, the outer core, and the inner core. The mantle, which extends from about 35 to 2,890 kilometers depth, is made of solid rock that flows slowly, at rates of a few centimeters per year, due to convection.

The convection of the mantle drives the movement of the tectonic plates and the formation of volcanoes. Magma is molten rock that forms deep in the Earth, typically at depths of 50 to 200 kilometers. Magma forms when the temperature and pressure conditions cause rock to melt.

The melting can be caused by decompression, which occurs when hot rock rises and the pressure decreases; by flux melting, which occurs when water or other volatiles are added to the rock, lowering the melting point; and by heat transfer, which occurs when hot magma from the mantle heats the surrounding rock. Magma, which is less dense than the surrounding rock, rises through the crust. As the magma rises, it may accumulate in a magma chamber, a reservoir of molten rock beneath the surface.

The magma chamber, which can be several kilometers wide and hold several cubic kilometers of magma, is the source of volcanic eruptions. The magma in the chamber may cool and solidify, forming intrusive igneous rocks like granite, or it may erupt at the surface. Volcanic eruptions occur when the pressure in the magma chamber exceeds the pressure of the overlying rock. The magma, which contains dissolved gases, rises through a conduit to the surface.

As the magma rises, the pressure decreases, and the dissolved gases come out of solution, forming bubbles. The bubbles expand, fragmenting the magma into ash and pumice, and driving the eruption. The type of eruption depends on the composition and the gas content of the magma. Magma that is low in silica and low in gas tends to erupt effusively, producing lava flows. Magma that is high in silica and high in gas tends to erupt explosively, producing ash and pumice.

The most explosive eruptions can send ash columns to heights of 30 kilometers or more, and can produce pyroclastic flows that travel at speeds of hundreds of kilometers per hour. The Earth has a radius of about 6,371 kilometers with a layered structure of crust mantle outer core and inner core. Magma forms at depths of 50 to 200 kilometers. Magma low in silica and gas erupts effusively producing lava flows. Magma high in silica and gas erupts explosively producing ash and pumice. The Earth radius is 6371 km the mantle

extends from 35 to 2890 km and magma forms at 50 to 200 km depth with ash columns reaching 30 km. Magma forms at 50 to 200 km depth by decompression flux melting and heat transfer.

Low-silica magma erupts effusively as lava flows and high-silica magma erupts explosively as ash and pumice with columns reaching 30 km. Earth radius 6371 km mantle from 35 to 2890 km magma at 50 to 200 km depth. Earth radius 6371 km mantle 35 to 2890 km magma 50 to 200 km depth. Decompression flux melting heat transfer.

Radius 6371 km. Volcanoes, based on their frequency of eruption or volcanism, are referred to as either active, dormant, or extinct. Active volcanoes have a history of volcanism and are likely to erupt again, while extinct ones are not capable of eruption at all as they have no magma source. However, dormant volcanoes are technically considered to be seismically "active".

These categories are not entirely uniform; they may overlap for certain examples. Large eruptions can affect atmospheric temperature as ash and droplets of sulfuric acid obscure the Sun and cool Earth's troposphere. Historically, large volcanic eruptions have been followed by volcanic winters which have caused catastrophic famines. Other planets besides Earth have volcanoes. For example, volcanoes are very numerous on Venus. Mars has significant volcanoes. In 2009, a paper was published suggesting a new definition for the word 'volcano' that includes processes such as cryovolcanism.

It suggested that a volcano be defined as 'an opening on a planet or moon's surface from which magma, as defined for that body, and/or magmatic gas is erupted.'

The word volcano (UK: ; US:) originates from the early 17th century, derived from the Italian name Vulcano, a volcanic island in the Aeolian Islands of Italy, which in turn comes from the Latin name Volc?nus or Vulc?nus, referring to Vulcan, the god of fire in Roman mythology.

The engine underneath it all is a paradox: the interior of the Earth is almost entirely solid, and yet stone somehow becomes magma. Most of the mantle is hot enough to melt but compressed too much to do so; melting happens only where something releases the pressure or adds the heat. At mid-ocean ridges, plates pull apart and the mantle rock beneath rises, and as it rises the pressure drops and the melting point falls with it, so the stone liquefies without getting any hotter. Above subduction zones, water squeezed out of the sinking plate acts as flux, lowering the melting temperature of the rock it soaks through. At hotspots, a plume of exceptionally hot rock from deep in the

mantle does the work by temperature alone. In each case only a fraction of the rock melts, a few percent to twenty, and that buoyant liquid gathers itself into droplets, rises, and accumulates in chambers.

What happens next is governed by a liquid's two stubborn properties: viscosity and gas. Magma deep underground carries dissolved water and carbon dioxide the way a sealed soda carries its fizz, and as the liquid rises and the pressure eases, the gas comes out of solution and forms bubbles. If the magma is runny, basalt of the sort that builds ocean islands, the bubbles slip through it easily, the gas escapes ahead of the liquid, and the eruption pours out as rivers of lava. If the magma is sticky, silica-rich andesite or rhyolite, the bubbles cannot get free; they grow until the foam itself shatters, and the eruption is an explosion that tears the magma into ash and hurls it skyward. Almost every distinction that matters to a person standing downslope, gentle flow or blast, lava fountain or collapsing column, comes down to that one recipe of viscosity and dissolved gas.

The shape of an eruption is also shaped by timing. A volcano's plumbing is not a smooth pipe but a series of sponges, regions of crystal mush and melt that connect and disconnect over years and centuries, and an eruption begins when some threshold is crossed: a fresh injection of magma from below, a slow accumulation of bubbles, or the failure of a chilled cap over the vent. Geophysicists can watch the approach of these thresholds in the ground's trembling, its swelling, and the changing chemistry of the gases that leak out, which is the entire basis of the forecasting craft, and the reason a volcano, unlike most natural hazards, usually announces itself.

End of free sample. The full book is available at putrabooks.github.io

ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.