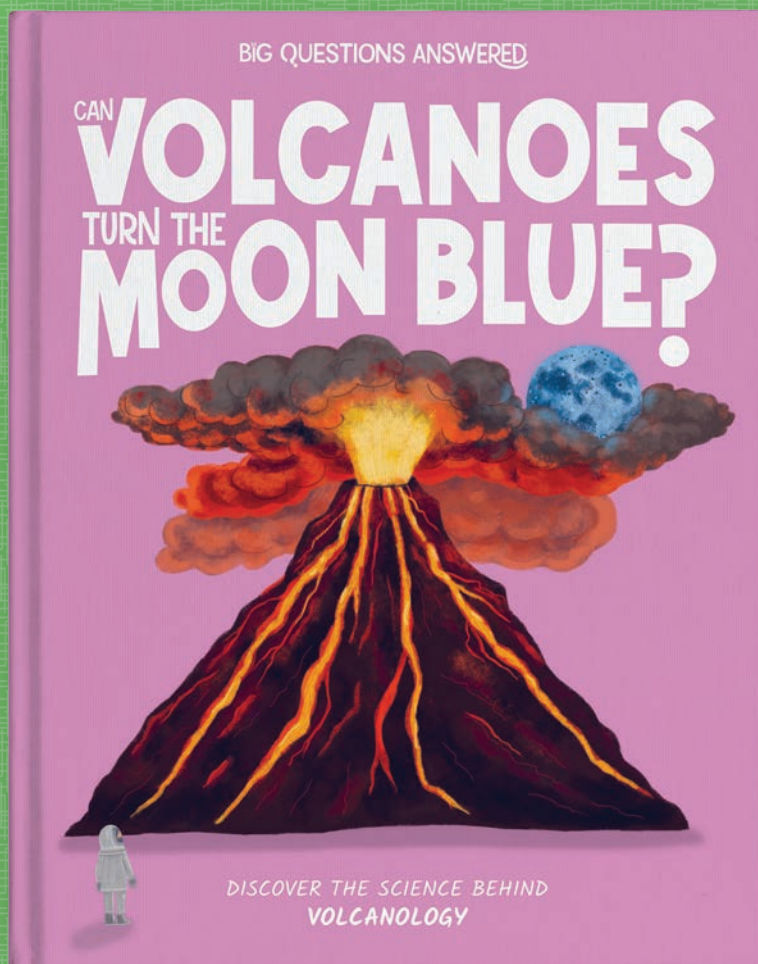
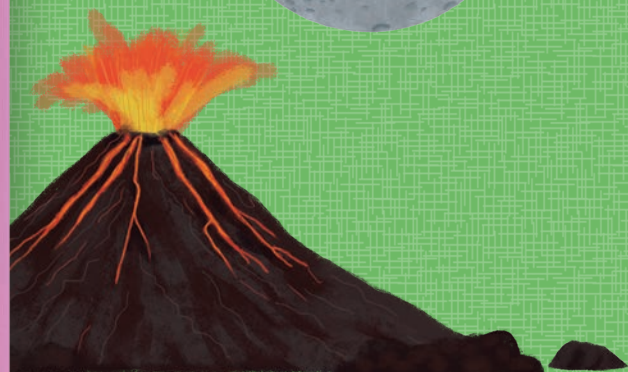
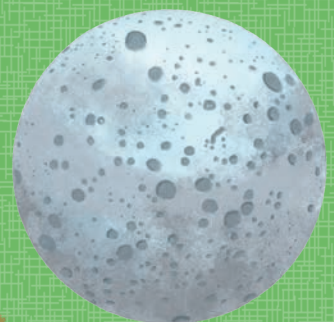


THE BIG QUESTIONS ANSWERED

TEACHERS' & PARENTS' RESOURCES



Full of thought-provoking questions and fascinating extra information to accompany this book!



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INTRODUCTION

NOTES FOR TEACHERS, HOME EDUCATORS AND PARENTS

Inspire children's natural curiosity, improve literacy, and have fun learning about different sciences with The Big Questions Answered. Each book in the series is accompanied by a selection of fantastic, **FREE** downloadable resources.

Our **Teachers' and Parents' Resources** booklets are full of ideas for discussions, extra facts, and links to hands-on activities – all great ways to help children explore each field of science and the key topics surrounding them.

Our **Young Scientists' Activity Packs** are a real bonus. They're full of soft-learning, fun activities, all subtly linked to the field of science, that will encourage independent learning. Visit the 'Kids' Zone' to find out more.

Don't forget, on the website you can also download our **'Meet the Scientist' pages** – there's one to accompany each book – and sign up to our newsletter to follow what's coming up next for The Big Questions Answered. Download all these and more at: www.thebigquestionsanswered.com

Can Volcanoes Turn the Moon Blue? book



Young Volcanologists' Activity Pack

KEY CURRICULUM TOPICS

The resources related to *'Can Volcanoes Turn the Moon Blue?'* tie in with key curriculum topics including:

- Earth and space
- Geography
- Light
- Living things and their habitats
- Materials and their properties
- States of matter
- Rocks
- Working scientifically

The most relevant topics are indicated throughout this guide.

CAN VOLCANOES TURN THE MOON BLUE?

This book explores the extraordinary world of volcanology. Using the 1883 eruption of Krakatoa as a key example, the book journeys through the discovery that volcanoes can make the Moon appear blue. As well as covering key facts related to this discovery, the book explores the wider world of volcanoes by looking at what causes eruptions, what happens during eruptions, and what volcanoes have taught us about Earth's power.

PRE-READING QUESTIONS

Engage in discussion about the general topic of volcanology with the suggested questions below.



- What do you know about volcanoes already?
 - Can you name any volcanoes?
- Do you think volcanoes can turn the Moon blue?

THE MOON IS TURNING BLUE?: SCENE 1

The material for this scene can be linked to curriculum topics, including: Earth and space; everyday materials; geography; light.

Introduce children to the story of the blue Moon and the topics covered in this book by discussing what the Moon is, where its light comes from, and how it interacts with Earth, as well as what volcanoes are.



DISCUSSION PROMPTS

- Do you know what the Moon is and how it glows?

Information overleaf

- What do you think is making the Moon turn blue?

Encourage children to write down their answers. The answer is revealed at the end of the main book, and they'll then be able to see if they were right!

- What is happening to the volcano in the scene?

Information overleaf

- How are volcanoes different from mountains?

Information overleaf

ACTIVITY

Corresponding activity on page 3 of the activity pack: 'Diary Entry' is a creative writing activity which encourages children to imagine they noticed the blue Moon in the sky one day, and describe it in a diary entry.

THE MOON IS TURNING BLUE?: SCENE 1

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

THE MOON

A moon is a **natural satellite** that **orbits** a **planet** or another space object that is not a **star**. Earth only has one moon, but some planets have more – the planet Saturn in our **solar system** has 146 moons!

We call Earth's moon "the Moon" because when it was named (long ago) people thought there was only one moon in the **universe**!

Thanks to space scientists called **astronomers**, we know the Moon affects life on Earth in lots of ways, including causing the oceans to have high and low **tides**, helping us measure time, and being a source of information about ancient Earth and the ancient solar system.

HOW THE MOON GLOWS

The Moon may look like it shines in the sky; however, it doesn't make its own light. When we see the Moon's surface lit up, it's because sunlight is shining on it and lighting it up.

It takes the Moon a month to complete one orbit of Earth. As it moves around Earth, the sun lights up different parts of it, making it seem like it is changing shape. This is just a clever effect of sunlight, shadows, and angles!

VOLCANOES

Volcanoes are openings on a planet's surface, where hot material found underground can rise to the surface and escape. When this material – which includes **ash, lava, rocks,** and **gas** – escapes, we call it an **eruption**. This is what we see happening in the scene.

We often think of eruptions as being incredibly explosive and able to send material really high into the sky, but they can also be calmer, slower, and less dramatic – it all depends on the type of volcano.

Volcanoes look like **mountains**, rising high from the ground due to the layers of rock, ash, and other material that have collected around them after eruptions. They are different from mountains, which form due to the movement of the Earth's surface, causing pieces of land to rise up high. Mountains also aren't able to erupt!

A DEVASTATING ERUPTION: SCENE 2

The material for this scene can be linked to curriculum topics, including: geography; materials and their properties; sound.

Zoom into the action with this close-up of the eruption of Krakatoa, the volcano pictured in the distance in scene 1. Discuss what happens during a volcanic eruption and the consequences of these events.



DISCUSSION PROMPTS

- What can you see happening in the scene? What words can you use to describe it?

- Do you think volcanic eruptions are loud?

Encourage children to discuss what kind of noises they think they would hear from an eruption.

- What is a tsunami?

Information overleaf

ACTIVITY

Corresponding activity on page 4 of the activity pack: 'Explosive Eruptions' is a classic word search activity, using lots of great volcano words to get children familiar with the language of volcanology.

A DEVASTATING ERUPTION: SCENE 2

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

KRAKATOA

This scene is based on the 1883 eruption of Krakatoa, considered one of the most **catastrophic** in history.

The volcano **became active** in May, after a long period of **dormancy**. People reported feeling **tremors** in the ground, huge columns of **ash** rising into the sky, and **explosions** heard up to 100 miles (160 km) away. The activity continued on and off for months.

The iconic eruption happened in August, and lasted a few days. The eruption was so powerful that it shot ash 50 miles (80 km) into the sky which spread so thickly that nearby areas were in complete darkness for more than two days! The volcano's explosions were heard more than 2,200 miles (3,500 km) away, with the final explosion being the loudest sound ever recorded – it was heard across more than 10% of Earth's surface!

Even in places around the world that didn't hear the sound, **pressure waves** in the air were recorded, and the **dust** spread so far that the whole planet got colder for several months, showing the worldwide impact of the eruption.

The eruption was so powerful that it caused most of the island of Krakatoa to be destroyed and **tsunamis** estimated to be as high as 30 m (100 ft). It's estimated that 36,000 people died as a result of the eruption.

TSUNAMIS

Tsunamis are giant sea waves caused by **earthquakes** or **volcanic eruptions** under the sea. They are sometimes called "tidal waves"; however, scientists argue that this is not an accurate name, since they are not caused by the **tide**.

They can be incredibly destructive, moving very fast and having the strength to uproot trees, move whole buildings, and carry boats really far inland.

Today, some places in the world that are more likely to experience tsunamis, such as in the Pacific basin, have **warning systems** which alerts people when an earthquake large enough to cause a tsunami has occurred. This helps to keep people safe.

BLUE MOON THROUGH TIME: SCENE 3

The material for this scene can be linked to curriculum topics, including:
Earth and space; light; history; working scientifically.

Take a look back in time to when cavemen still lived to show how scientists think the phenomenon of the blue Moon has been happening for hundreds of thousands of years. Discuss how the Stone Age contrasts with modern day.



DISCUSSION PROMPTS

- What sort of people are shown in the scene? Do you know how long ago they lived?

Information overleaf

- What can you tell about the people in the scene? How do their lives look different from your own?

Encourage children to talk about factors such as different clothing, lack of shoes, the spear, the location, and so on.

- How do scientists learn about the distant past?

Information overleaf

ACTIVITY

Corresponding activity on page 5 of the activity pack: 'Crafty Cavemen' is a spot the difference activity where children have to spot 10 differences between two versions of this scene.

BLUE MOON THROUGH TIME: SCENE 3

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

ANCIENT HUMANS

Humans have been on Earth for a long time, though they didn't look and act exactly like we do now. The people shown in this scene are often called "**cavemen**". They are early humans that lived thousands of years ago in a time called the "**Stone Age**", which lasted from about 2.5 million to 5,000 years ago.

The time period is called the Stone Age because this is when early humans started using stone to make **tools** and **weapons**, and to light fires.

During this time, the world wasn't very advanced – there was no **electricity** or **technology**. This meant that people's lives were very different from the way most humans live today. Early humans were **hunters and gatherers**, and would go out into the wild every day in search of their own food. Their diets were mostly made up of meat, fish, and plants – they didn't have things like dairy because they didn't keep animals to make it. It's thought that their clothes were made of simple leather or fur collected from animals.

There was poor **hygiene**, harsh living conditions, and no modern **medicine**, so people in the Stone Age didn't grow to be very old. They often wouldn't live past 25 years old!

People didn't know how to write in the Stone Age, so we have had to learn about them in other ways, for example, through tools and **skeletons** that have been buried underground, and **cave paintings**.

ANCIENT EARTH

Earth is estimated to be about 4.5 billion years old! Humans have only been around for a tiny part of that time.

Thankfully, scientists can learn lots of information about the distant past by finding things that have been left behind, like **fossils** of **bones** from humans and animals, and the leaves, stems, and **pollen** of plants. Often different types of **scientists** and **researchers** work together to piece together and better understand the past.

Sometimes volcanoes can tell us about the past. For example, the eruption of Mount Vesuvius in 79 **CE** perfectly **preserved** the belongings, homes, and bodies of many people that had been nearby. Studying these things give us an idea of how people lived at the time.

INSIDE THE VOLCANO: SCENE 4

The material for this scene can be linked to curriculum topics, including: geography; materials and their properties; rocks; states of matter; working scientifically.

Explore what happens deep underground as well as inside a volcano during an eruption, discussing how volcanologists have learnt about these things, as well as what it would be like to witness a volcanic eruption.



DISCUSSION PROMPTS

- Where in the world are volcanoes found?
Information overleaf
- How do you think scientists found out what volcanoes are like inside?
Information overleaf
- How deep underground do you think magma is?
Information overleaf
- How do you think you would feel if you saw a volcano erupting?
Give examples of emotions such as feeling shocked, scared, and so on.

ACTIVITY

Corresponding activity on page 6 of the activity pack: 'Label the Volcano' is an activity where children have to label the volcano with the corresponding part. Brief descriptions have been included to help out.

INSIDE THE VOLCANO: SCENE 4

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

WHERE ARE VOLCANOES FOUND?

Volcanoes are found around the world, but there is a pattern – most are on the edge of things called “**tectonic plates**”.

Earth’s surface is split into huge pieces called tectonic plates. These are so deep down that land and oceans sit on top of them! As they move, they scrape against each other, causing **earthquakes** and leaving gaps where **magma** can rise up to create a **volcano**.

It’s rare, but sometimes volcanoes pop up in the middle of a tectonic plate! This is because some places inside the Earth are hotter than others, allowing magma to rise up closer to the surface. These places are called “**hot spots**”.

PARTS OF A VOLCANO

Thanks to volcanologists, we know the parts that make up a volcano. The main parts are:

- **Magma chamber:** a large space underground filled with magma (melted rock). The magma chamber is usually between half a mile and 6 miles (1 km and 10 km) deep!
- **Vent:** the channels and tunnels that magma rises up through to reach the surface. There is always a primary vent, which is the main channel the magma flows through to reach the surface. Some volcanoes have secondary vents, where a smaller amount of magma follows a different direction.
- **Crater:** the mouth of the volcano. This is usually a circular dip in the middle of the volcano and is where the **lava**, **ash**, and **gas** erupts from.

HOW DO WE KNOW WHAT’S INSIDE VOLCANOES?

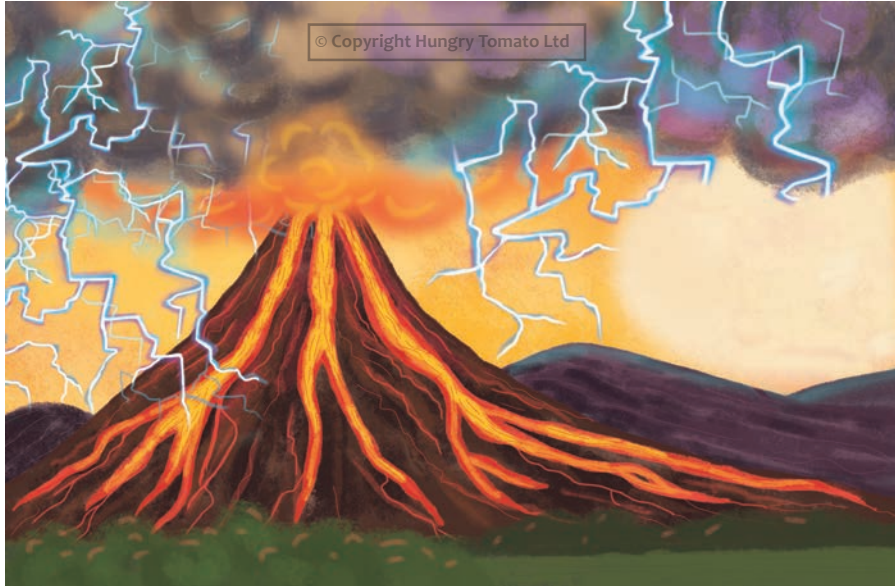
Scientists use clever methods to work out what it’s like inside volcanoes and under the surface of the Earth.

One way they have done this is by looking at the different types of **seismic waves** created by earthquakes – certain types of waves can only travel through solids and others only travel through liquids. This information can help show the shape and depth of different magma chambers deep underground.

VOLCANIC LIGHTNING: SCENE 5

The material for this scene can be linked to curriculum topics, including: electricity; materials and their properties; rocks; states of matter.

Uncover the impressive power of volcanoes by looking at what happens aboveground during eruptions in this dramatic lightning scene. From shooting rocks to lava and lightning, volcanoes remind us how powerful Earth is.



DISCUSSION PROMPTS

- How fast do you think lava moves?
Information overleaf
- Did you know volcanoes can make lightning?
- Do you know what to do to keep safe during a lightning storm?
Information overleaf

ACTIVITY

Corresponding activity on page 7 of the activity pack: 'Word Eruption' is an activity where children have to unscramble the letters to spell out volcano-themed words. In a linked activity, they have to see how many words they can create out of set letters.

VOLCANIC LIGHTNING: SCENE 5

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

LAVA

Lava is **melted rock** that has escaped from under the Earth's surface. Its temperature can range from 700 to 1,200°C (1,300 to 2,200°F).

We think of lava as being fast-moving, and it's true that it can move fast, but it can be slow, depending on the type of lava and how steep the surface is. Some lava is **runny** and moves really quickly; other lava is **thick** and **sticky** and moves much slower. The fastest lava recorded moved quicker than 60 miles (95 km) per hour – almost as fast as a cheetah!

Once lava has cooled, it hardens into a type of rock called **igneous rock**. The **melting** and **hardening** of rock from lava forms an important part of the world's **rock cycle**.

TYPES OF VOLCANOES

Composite volcanoes are tall and made from layers of **ash** and lava. They usually have violent eruptions, with thick, slower moving lava. They're also called "**stratovolcanoes**".

Shield volcanoes are made purely from lava, so are shorter with gentle slopes. Their eruptions are usually less violent, but the lava is much runnier and moves much quicker.

VOLCANIC LIGHTNING

Lightning can happen during eruptions because particles of ash, ice, and **gas** smash into each other, which creates **electricity** and leads to lightning striking inside the **ash column**. Volcanic lightning events are sometimes called "dirty thunderstorms".

LIGHTNING STORMS

During normal lightning, professionals advise **sheltering** inside as quickly as possible. If you can't get inside, they advise avoiding sheltering close to buildings, trees, poles, or other tall objects and avoiding objects that **conduct** electricity. They advise crouching in a ball-like position with your head tucked and your hands over your ears so you are low down with as little of your body touching the ground as possible. Everyone should learn what to do in normal lightning storms.

People who live or are visiting a place near a volcano should learn what to do during volcanic eruptions to help them stay safe.

DEEP SEA VOLCANOES: SCENE 6

The material for this scene can be linked to curriculum topics, including: geography; materials and their properties; rocks; states of matter.

Journey through the mysterious world of underwater volcanoes with this deep-sea scene. Discuss how deep-sea volcanoes form, how volcanologists study them, and how volcanoes create new islands.



DISCUSSION PROMPTS

- Have you heard of underwater volcanoes before?
- How do volcanoes form underwater?
Information overleaf
- Do you know of any islands that were created by volcanic eruptions?
Information overleaf
- What do you think the machine in the scene is doing?
Information overleaf

ACTIVITY

Corresponding activity on page 8 of the activity pack: 'Create Your Own Underwater Volcano Scene' is a creative drawing activity where children create their own underwater scene, and a machine capable of studying deep-sea volcanoes!

DEEP SEA VOLCANOES: SCENE 6

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

UNDERWATER VOLCANOES

Most of the world's volcanoes are deep underwater! They form in the same way that land-based volcanoes do – **magma** rising to, and escaping out of, the surface of the Earth due to the movement of **tectonic plates**. The reason there are so many volcanoes underwater is because most tectonic plate **boundaries** are under the ocean rather than under dry land.

Scientists think there are more than 1 million underwater volcanoes on Earth! However, most of them are considered **extinct** – unlikely to **erupt** in the future. They usually have not erupted in the last 10,000 years, and may no longer have a **magma supply**.

The other classifications of volcanoes are:

- **Active:** have a recent history of eruptions.
- **Dormant:** have not erupted for a long time, but may erupt in the future.

For many years, the deepest underwater volcano was thought to be West Mata in the Pacific Ocean, which is nearly 1.2 kilometres (4,000 feet) below the surface of the ocean. However, scientists now have far more **advanced technology** that has allowed them to find volcanoes more than 3 times as deep as West Mata!

VOLCANIC ISLANDS

There are many islands in the world that have been formed from volcanoes erupting, and the lava **cooling** and **hardening** into **rock**.

Examples of these islands include the Hawaiian Islands, the Canary Islands, and Iceland.

SCIENCE UNDER THE SEA

This scene shows one of the ways that scientists **monitor** and **study** underwater volcanoes, by using **remote-controlled** underwater vehicles. However, this is not the only method they use. They also gather information from:

- Large boats that sit on the surface of the water. They can use **sensors** to produce images of things that are deep below the ocean's surface, and take samples of water that can be taken to the lab and studied.
- **Satellite** images.
- **Hydrophone** listening stations.

INVESTIGATING VOLCANOLOGISTS: SCENE 7

The material for this scene can be linked to curriculum topics, including: materials and their properties; rocks; states of matter; working scientifically.

Explore the role of volcanologists today with this busy expedition scene that shows scientists conducting lots of tests. Discuss the tools and equipment that volcanologists use, as well as the concept of dormancy, linking with other elements of nature.



DISCUSSION PROMPTS

- Volcanoes aren't the only things that become dormant. Can you think of anything else in nature that goes through periods of dormancy?

Information overleaf

- What can you see the volcanologists using and wearing?
What do you think they do?

Information overleaf

- Do you think being a volcanologist is dangerous?

Information overleaf

- If you were a volcanologist, what's the first thing you would want to learn about volcanoes?

ACTIVITY

Corresponding activity on page 9 of the activity pack: 'Volcanologists' Toolkit' is a cut and stick activity where children match up the name of the tool with its description. A fun way to show how volcanologists work!

INVESTIGATING VOLCANOLOGISTS: SCENE 7

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

DORMANCY

Dormancy is when something in nature goes through long periods of **inactivity**. Volcanoes can go through extremely long periods of dormancy, when they don't erupt for a long time. Many plants and animals go through periods of dormancy, but they don't last nearly as long. During these times, plants stop growing or changing, and animals greatly reduce their physical activity, and don't need to eat. Some examples include:

- Many flowering trees that live in places with **seasonal weather** become dormant during winter. As the weather gets colder, they drop their leaves, don't produce flowers or fruit, and enter a sleep-like state. They usually come out of dormancy in spring. This helps them **save energy**, and **cope with extreme weather** and **temperatures**.
- Many animals, including bears and squirrels, **hibernate**, which is a type of dormancy. They usually build up a thick layer of body fat at the end of summer so they can save energy through winter, and **survive when there is less food** around.

VOLCANOLOGISTS' TOOLS

The volcanologists in the scene are using different tools to do different things:

- Using **cameras** to take photographs of the rocks, lava, and volcano.
- Taking **notes** and making **written observations**.
- Using a **magnifying glass** to study rocks and samples. Magnifying glasses make things look bigger, allowing scientists to see things in much more detail.
- **Taking samples** using a **rod** and **bucket**. The rod must be made from a **nonflammable** material, like iron, and the metal bucket must be full of water. Samples are put in the water to help them cool. Only once they're cool can they be handled.

Wearing the right **protective gear** is very important. This can include **gloves**, **boots**, a **hard hat**, a **gas mask** to filter the air and make it safe to breathe, **goggles** to stop any ash or fumes harming the eyes, and a **heat suit** to protect from extremely high temperatures.

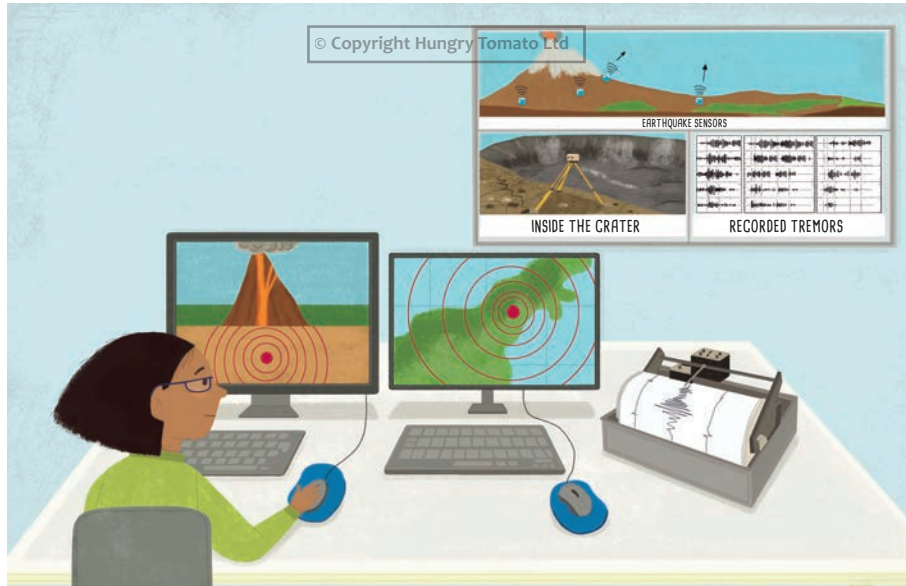
THE DANGERS OF VOLCANOLOGY

Being a volcanologist that does fieldwork can be incredibly dangerous if you don't take the correct **precautions**. Volcanoes are unpredictable. Some volcanologists have lost their lives from some freak events happening in the past.

TRACKING EARTHQUAKES: SCENE 8

The material for this scene can be linked to curriculum topics, including: geography; working scientifically.

Discover the link between earthquakes and volcanoes that allows scientists to improve their predictions of such natural disasters, and talk more generally about what earthquakes are and why they otherwise happen.



DISCUSSION PROMPTS

- How much time do you think there is between the small earthquakes and the volcano erupting?
Information overleaf
- Do earthquakes only happen when a volcano is about to erupt?
Information overleaf
- Have you ever felt an earthquake? What was it like?

ACTIVITY

Corresponding activity on page 10 of the activity pack: 'Extreme Earth' is a classic activity where children fill in the blanks in a series of sentences and facts about earthquakes, volcanoes, and clever scientists.

TRACKING EARTHQUAKES: SCENE 8

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

EARTHQUAKES

Earthquakes are shakes of the Earth's **surface**. They are caused by movements of **tectonic plates** when they move and scrape against each other. Earthquake tremors can be small or very strong, powerful shakes that can cause lots of damage.

Earthquakes aren't always connected to volcanic eruptions – sometimes earthquakes happen in places where there are no volcanoes to erupt and sometimes volcanoes erupt without any earthquake tremors. However, because earthquakes and eruptions can both be triggered by tectonic plate movement, the two events are often connected, meaning earthquakes can be helpful for **predicting** volcanic eruptions.

TIMING AN ERUPTION

It's not just earthquakes; the movement of **magma** underneath the volcano produce **seismic waves** – the same things that scientists measure when an earthquake is happening. **Seismic activity** often increases before an eruption, so by monitoring this, scientists can work out that an eruption might happen soon.

They use seismic **sensors** (like the ones in the top computer screen in the scene) which measure and send information back to a **seismograph** (shown on the desk in the scene) which records the waves as a line graph. The bigger the lines, the stronger the activity.

There is no set time between seismic activity and eruptions, which makes predicting the moment a volcano will erupt very difficult. However, monitoring seismic activity is a really useful way for scientists to know that an eruption is likely to happen soon.

PREDICTING EARTHQUAKES AND ERUPTIONS

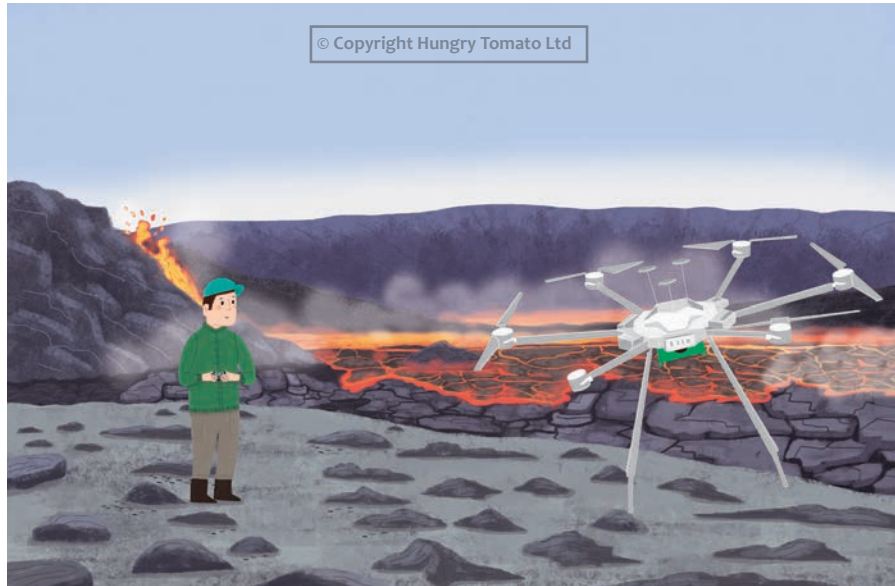
Humans are working hard to learn how to predict **natural disasters** such as volcanic eruptions, but we may never be able to accurately predict earthquakes as the warning signs are very subtle and they have the **potential** to occur in many more places in comparison to volcanic eruptions.

There is evidence, however, that suggests some animals can predict these natural disasters. Animals, such as snakes and goats, sometimes start acting strangely before these events. It's thought they are more sensitive to seismic activity than humans or machines.

DRONE PATROL: SCENE 9

The material for this scene can be linked to curriculum topics, including: geography; working scientifically.

Find out the other clever ways that volcanologists have found to predict eruptions, focusing on the tools and machines they use and why early prediction is so important.



DISCUSSION PROMPTS

- Why do you think scientists want to learn how to predict volcanic eruptions?
Information overleaf
- How far in advance do you think scientists can predict volcanic eruptions?
Information overleaf
- Drones can be very useful for predicting volcanic eruptions. Can you think of any other ways different scientists use drones?
Information overleaf

ACTIVITY

Corresponding activity on page 11 of the activity pack: 'Lost in the Sky' is a classic maze activity where children have to complete the maze to help the drone reach the volcano.

DRONE PATROL: SCENE 9

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

HOW TO PREDICT ERUPTIONS

As mentioned in the main book, volcanologists have learnt the many signs that suggest a volcano is preparing to **erupt**. By constantly **monitoring** volcanoes, even **dormant** ones, they can more easily notice when something changes or is out of the ordinary.

When a volcano starts showing signs that it might be preparing to erupt, volcanologists say it's in a period of "**unrest**". This can happen weeks, months, and sometimes years before an eruption! Sometimes, unrest doesn't lead to an eruption at all. But it's still a useful thing to track – noticing early signs gives scientists more time to study the volcano, understand its activity, and warn anyone who may be in danger if and when it erupts.

At the moment, volcanologists can usually predict a monitored volcano a few days before it erupts, but they are hoping to learn how to make predictions even more in advance. Currently, only about half of all volcanoes are constantly monitored. Those that aren't are much harder to predict as scientists have less information to work with.

WHY PREDICT ERUPTIONS?

Being able to predict volcanic eruptions is very important, as it allows people in nearby areas time to **evacuate**. Eruptions can destroy buildings, and are a risk to people's lives. Also, the effect of eruptions can be widespread, affecting travel because planes cannot take off or fly through an **ash cloud**. If people start to evacuate too late, their options for escape could be dramatically reduced (depending on the situation and where they live).

The more time people have to **prepare**, the better chance they stand at reaching safety.

THE USES OF DRONES

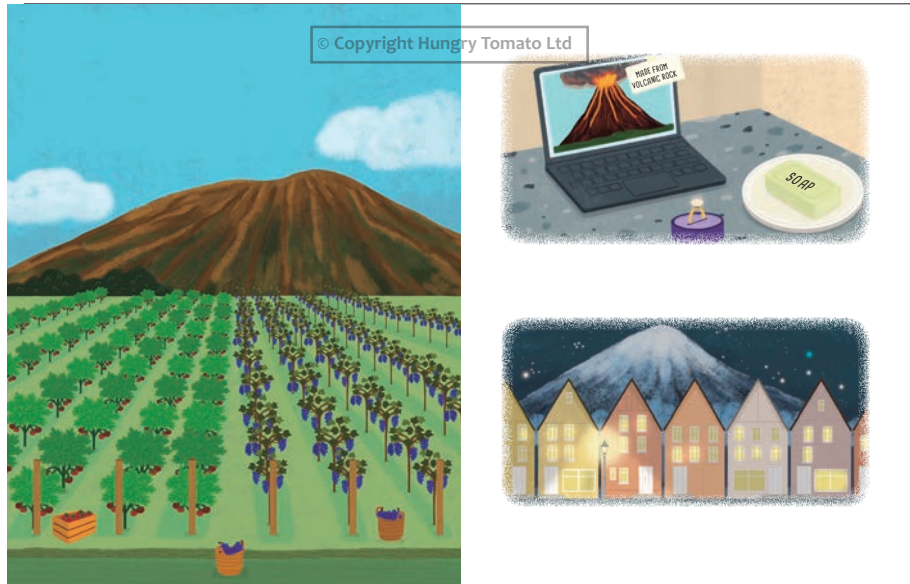
Today, **drones** are used to help people and scientists do lots of different jobs, as they can be designed to collect different types of information, including:

- Ocean and wildlife science: recording how much whales eat, what they sound like, and how they breathe. They have also been used to monitor **endangered** animal **species**.
- Agriculture and plant sciences: sensing plants that need watering, searching for things that could **pollute** nature, and spreading liquids to help **diseased** plants.
- Wildlife and climate sciences: collecting air samples to study, for example after forest fires.

POSITIVE VOLCANO ABILITIES: SCENE 10

The material for this scene can be linked to curriculum topics, including: electricity; geography; materials and their properties; plants; rocks.

Volcanoes aren't always negative; this scene shows three positive things about volcanoes. Discuss other positives and negatives of volcanoes to encourage a healthy debate.



DISCUSSION PROMPTS

- What is clean energy? What is good about it?
Information overleaf
- This scene shows three positives about volcanoes. Can you think of any more good things about volcanoes? How many negative things can you think of?
These questions allow for in-depth discussion, however there is also additional information overleaf.
- Do you know of any places in the world where people live and work close to a volcano?

ACTIVITY

Corresponding activity on page 12 of the activity pack: 'Volcano Verdict' is a reflective writing task where children answer questions about their opinions on a number of volcano-related questions.

POSITIVE VOLCANO ABILITIES: SCENE 10

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

CLEAN ENERGY

The **energy** we can produce from volcanoes is called “**geothermal** energy”. This energy comes from the heat that is naturally coming out of the ground. It can be used for bathing, to heat buildings, and to **generate** electricity. In some places, like Iceland, geothermal energy is used on roads and pavements to stop the ground from freezing over and building up with snow and ice!

Geothermal is an example of **clean energy**. Clean energy is also called “**green energy**” or “**renewable energy**”. This type of energy comes from a source that won’t run out, and usually has a very low impact on the planet because it doesn’t make harmful **emissions**. Other examples of clean energy include **solar power** and **wind power**.

The opposite is **non-renewable energy**, which is energy that comes from a source that will eventually run out. These sources of energy are usually bad for the planet because **mining** them can harm the **environment** and burning them releases harmful **gases** which can speed up **climate change**. Examples include **fossil fuels**, like **coal**, **oil**, and **natural gas**.

POSITIVE AND NEGATIVES OF VOLCANOES

This scene has shown three positives of volcanoes and their eruptions, but they’re not the only things volcanoes can do. Other examples of **positives** and **negatives** include:

Positive

- Lots of tourists are interested in volcanoes and travel to see them. **Tourism** can **bring money** to surrounding areas and **increase the number of jobs** for local people.
- Eruptions can **create new islands** and areas of land.
- Volcanoes can form an important part of a place’s **history and culture**.

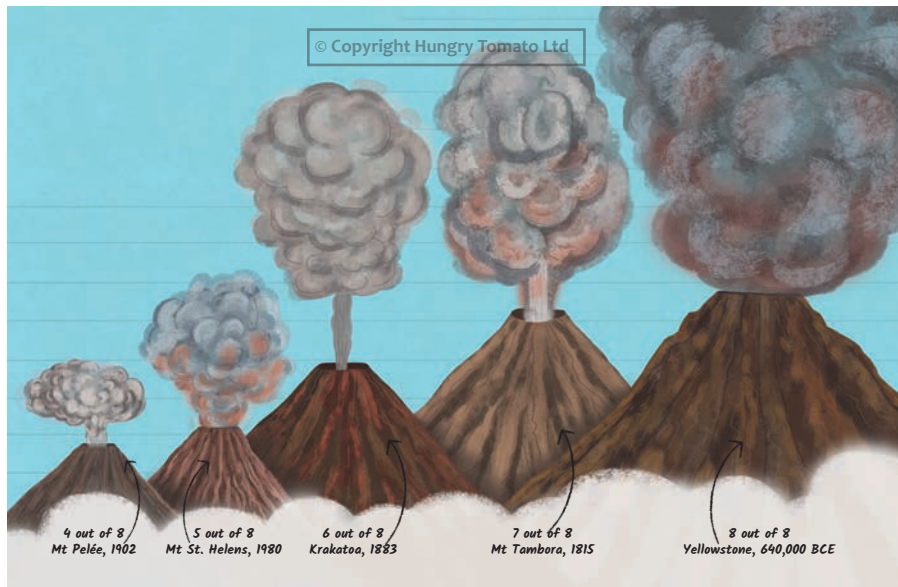
Negative

- Eruptions are **dangerous** and can **kill** people, and **damage** buildings and crops.
- Eruptions can **affect businesses** that may struggle to operate afterward.
- Eruptions can **destroy landscapes**, affecting the way places look, as well as **damaging animal and plant habitats**.
- Eruptions can cause people and animals to have to **move and live in different places**.

THE STRENGTH OF VOLCANOES: SCENE 11

The material for this scene can be linked to curriculum topics, including: geography; materials and their properties; working scientifically.

Discover the scale that volcanologists use to measure and compare the size of eruptions, with this scene that depicts famous eruptions through history. Discuss why this scale is useful, as well as how scientists know about eruptions from long ago.



DISCUSSION PROMPTS

- How do you think we know about volcanoes that erupted hundreds of thousands of years ago?
Information overleaf
- Why do you think scientists developed a scale to measure eruptions?
Information overleaf
- Do you know where any of the volcanoes in the scene are?
Information overleaf

ACTIVITY

Corresponding activity on page 13 of the activity pack: 'Explosive Volcano Facts' is a mixture of research and creativity. Children choose a volcano, research it, fill in the fact file, and draw it.

THE STRENGTH OF VOLCANOES: SCENE 11

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

ANCIENT ERUPTIONS

Scientists can learn about volcanic eruptions that happened in the past, even hundreds of thousands of years ago! They do this by collecting **ash**, **lava**, and **volcanic rock** deposits from around the volcano, usually by drilling deep into the ground or part of the volcano itself. They use **radiometric dating** on **samples**, and surrounding rocks and **fossils**, which tells them how old the samples are.

Different scientists are interested in this information, and can find it in different places. Glaciologists, who are curious to know what Earth was like thousands of years ago, can find layers of volcanic ash in glacier ice. They can work out an approximate date of the eruption, and sometimes even where the eruption took place!

MEASURING VOLCANIC ERUPTIONS

The scale used to **measure** the strength of volcanic eruptions is called the “**Volcanic Explosivity Index (VEI)**”. The scale goes from 1 (the weakest) up to 8 (the strongest). It was created in the 1980s and relies on knowing the amount of material like ash and rock that were thrown out of the volcano during the eruption. The height of the **ash column** and how long the eruption lasted are also taken into account.

Being able to compare information and events on a scale is useful for scientists, and doesn't just happen in volcanology. For example:

- Earthquakes are measured on the Richter Scale.
- Tornadoes are measured on the Enhanced Fujita Scale, or Fujita-Pearson.
- Hurricanes are measured on the Saffir-Simpson Hurricane Wind Scale.

VOLCANOES IN THE SCENE

The volcanoes in this scene are located in different places, written below. Scientists aim to qualify all eruptions to work out their location on the scale; these are just some examples.

- Mount Pelée: a Caribbean island of Martinique
- Mount St. Helens: Washington state, USA
- Krakatoa: an island of Indonesia
- Mount Tambora: an island of Indonesia
- Yellowstone: Wyoming state, USA

THE SECRET OF THE BLUE MOON: SCENE 12

The material for this scene can be linked to curriculum topics, including:
Earth and space; light; rocks; states of matter; working scientifically.

Discover how volcanoes are able to make the Moon look blue because of the way their ash spreads through the air and interacts with light. Explore the tools volcanologists use to study volcanic material, as well as the reason they wear protective gear.



DISCUSSION PROMPTS

- Can you name the piece of equipment the scientist is using in the scene?
What does it do?
Information overleaf
- The scientist is wearing 2 pieces of protective clothing. Can you spot them both?
The items that should be pointed out are the gloves and the lab coat.
- Why do you think scientists wear protective clothing like this when working in the lab and doing experiments?
Information overleaf

ACTIVITY

Corresponding activity on page 14 of the activity pack: 'Volcano Mysteries' is a true or false quiz. Children use what they have learnt from reading the main book, as well as their intuition, to fill in the answers.

THE SECRET OF THE BLUE MOON: SCENE 12

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

MICROSCOPES

The piece of equipment that the scientist in the scene is using is a **microscope**. Microscopes are machines that scientists use to make things look bigger. They magnify and zoom in on an object to allow it to be seen in much more detail than is possible to see with just your eyes.

All sorts of different scientists use microscopes, including **biologists**, **virologists**, **entomologists**, and many more!

LAB GEAR

Scientists almost always wear **protective clothing** when working in the lab. The most common pieces of protective clothing include gloves, hats or hair nets, lab coats, and goggles, but sometimes extra items may be needed. Some scientists even work behind glass screens when handling certain **samples** or doing certain **experiments**.

Wearing protective clothing is really important for two reasons:

- It protects the scientist from being harmed by whatever material they are handling.
- It protects the samples from being harmed or **contaminated** by anything on the scientist's body or clothes. This means that the results of their studies should be more **accurate**.

VOLCANIC ASH AND THE BLUE MOON

Volcanic ash is made of very tiny and light pieces – which is why it can be picked up by the wind and spread so far and wide. Ash can remain in the air for weeks before falling to the ground.

Volcanic ash pieces are so tiny that you may not even notice them once they're in the air. If the pieces are just the right size, they can make the Moon look blue! The reason for this is down to how **light** and **colour** work: light travels to our eyes as **waves**. These waves are different lengths, and the way they reflect in our eyes allows us to see different colours. The tiny ash pieces can stop certain light waves from reaching our eyes, acting like a colour-filter and making the Moon look blue.

Not every eruption makes the Moon look blue; it only happens if the ash is the right size.

POWERFUL FORCES OF NATURE: SCENE 13

The material for this scene can be linked to curriculum topics, including:
Earth and space; light; rocks; states of matter; working scientifically.

Reflect on the amazing power of volcanoes with this impressive final scene.
Discuss how long the blue Moon lasts, if anything else can cause it, and if
the Moon ever changes to a different colour.



DISCUSSION PROMPTS

- How long do you think the Moon looks blue for after a volcanic eruption?
Information overleaf
- Do you think anything else could cause the Moon to look blue?
Information overleaf
- Do you think the Moon ever actually changes to a different colour?
Information overleaf

ACTIVITY

Corresponding activity on page 15 of the activity pack: 'Natural Disaster Detective' is a task where children match the photograph of a natural disaster with its name and description. This activity shows the diversity of natural disasters that happen on Earth.

POWERFUL FORCES OF NATURE: SCENE 13

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

THE BLUE MOON

After one of these strange events, the Moon can continue to look blue for as long as the **volcanic ash** stays in the air. There are lots of factors that can affect how long this lasts, including weather patterns and location; the Moon won't look blue, or the same shade of blue, from everywhere on Earth as it will depend on where the ash is and how much of it there is.

It's not just volcanic ash that can make the Moon look blue – certain **forest fires** and **wildfires** have been known to do the same thing!

ONCE IN A BLUE MOON

The “Blue Moon” isn't always blue! The phrase is also used by scientists to talk about a particular time which occurs very rarely within the Moon's cycle:

There is usually one **full Moon** per month (12 per year). However, every 2.5 years, the Moon's phases fall strangely so that there is an extra full Moon, with 13 in the year instead of 12. The 13th full Moon is called a “blue Moon” even though it's a normal-coloured Moon.

Related to this, some people use the phrase “once in a blue moon” when they are talking about something that doesn't happen often.

CHANGING MOON

Blue isn't the only unusual colour the Moon can appear as in the sky. During a **total lunar eclipse**, the Moon often looks red or pink! When it looks like this, some people call it a “Blood Moon”.

During late summer, the Moon can look yellow or orange. When it looks like this, some people call it a “Harvest Moon”.

POST-READING QUESTIONS

Engage in discussion about the journey taken throughout the book and the facts that were uncovered.

- Were you surprised to learn how volcanoes turn the Moon blue?
 - Did anything else in the book surprise you?
 - What's the coolest thing you've learnt from this book?
-

ACTIVITY

Corresponding activity on page 16 of the activity pack: 'Write Your Own Volcanology Story' is a creative writing activity which encourages children to write a story about volcanology, using three key prompt words.

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