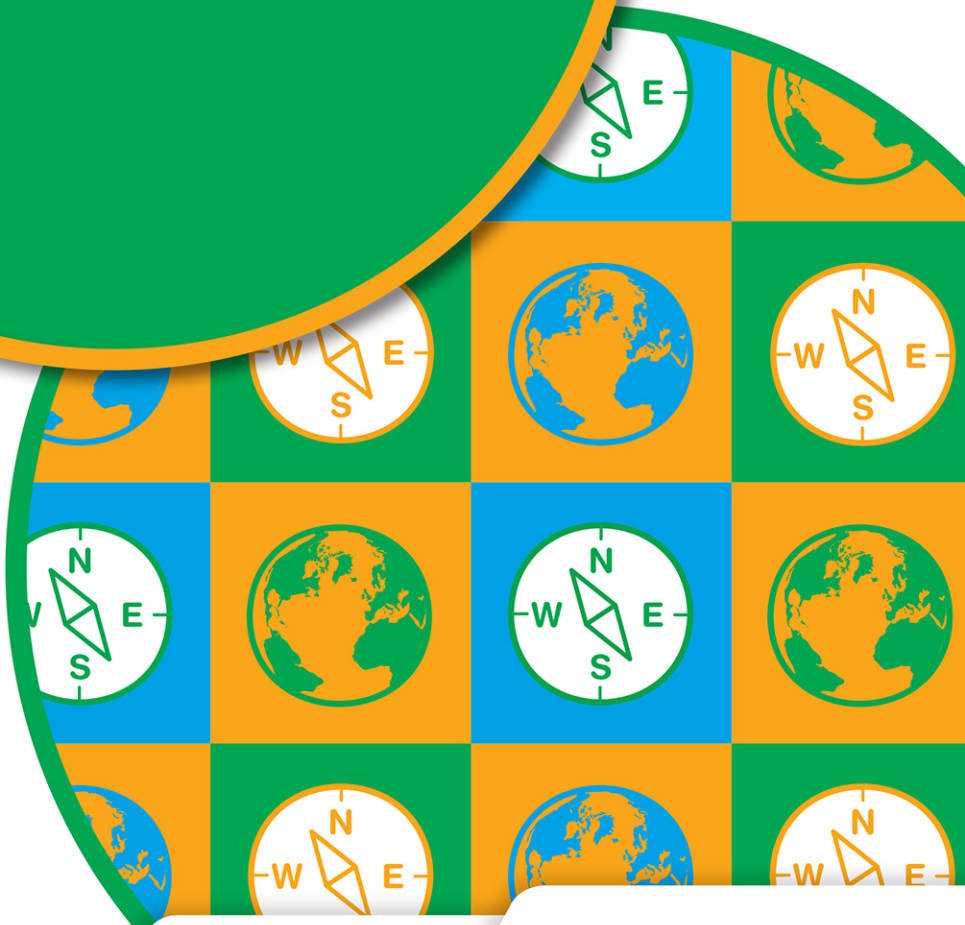
COMMON ENTRANCE • KEY STAGE 3

CE

Geography

ISEB
Independent Schools Examinations Board



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Boost
GALORE PARK

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Introduction

Common Entrance 13+ Geography for ISEB CE and KS3 is for pupils in Key Stage 3 – at a preparatory school where pupils sit ISEB Common Entrance at the end of Year 8, or at a mainstream secondary school.

What is geography and why is it important?

Geography is a big subject. You can't get much bigger, because in geography you study the world! Through *Common Entrance 13+ Geography for ISEB CE and KS3*, you will study places near and far. In doing so, you will begin to understand better how the world works. The exciting thing about geography is that the world is changing, so there are always new things to learn.

Even as this book was being written in 2020, the world was changing. The COVID-19 pandemic came along and changed the way we learn; it changed the way we live and work; it changed the world. Hopefully, by the time you read this book, we will have learned more about the world and how to deal with future pandemics.

However, the world faces many other, even bigger, challenges – population growth, inequality, environmental pollution and global warming, to name a few. Geography helps us to understand these challenges and enables us to deal with them, too. Geography focuses on the present and looks to the future.

How do we learn in geography?

Like all subjects, there are lots of facts to remember and new skills to practise and master. Nevertheless, geography is not all about facts – far from it. It is about learning to ask important questions and finding the answers that will help us to better understand the world. It is always important to be curious in geography. That is how we really learn. In many ways, geography is less of a subject and more of a way of thinking.

In geography we often learn through case studies or real-life examples – to illustrate the theory and principles through real world events and processes. We can also apply the lessons we learn about places and phenomena to other places and predicted events, thus increasing the chance of averting negative outcomes and disasters. In that way, we become real geographers, capable of safeguarding the natural beauty and bio-diversity of our planet and changing our world for the better.

What topics will you study in geography?

For ISEB Common Entrance 13+ Geography, you will study six themes through this book. These correspond and are arranged sequentially as they appear in the new 13+ Geography specification. You have probably studied some of these topics before but you might not recognise the geographical terms. Here are the six topics, with words in brackets you are more likely to recognise, to give you an idea about what you will be studying:

- Chapter 1: Tectonics (earthquakes and volcanoes)
- Chapter 2: Meteorology (weather and climate)
- Chapter 3: Geomorphology (rivers and coasts)
- Chapter 4: Demography (population and settlement)
- Chapter 5: Economy (transport and industry)
- Chapter 6: Environment (sustainability and stewardship)

Each section is colour-coded in order to help you find the relevant pages.

Through using this book, you will also acquire a range of transferable skills that are listed in the new ISEB specification.

These intrinsic geographical skills include the following:

- Location knowledge skills – knowing where places are found in the world
- Ordnance Survey map reading skills – being familiar with OS 1:25,000 and 1:50,000 scales of mapping and being able to interpret the landscape being mapped
- Fieldwork skills

What is the importance of fieldwork?

One of the great things about geography is that you can learn outdoors in the real world, not just in the classroom. We call this fieldwork. Fieldwork does not have to be in a field – it can be anywhere outdoors, such as your school grounds, a town, a river or a coastline.

Fieldwork usually starts with a geographical question you want to investigate. You can then use different fieldwork activities, such as measuring, mapping or carrying out a survey, to help you answer the question. This involves the collecting of primary data rather than merely relying on secondary data, as found in books and online. It is a good way of learning because most of us remember the field trips we went on!

Notes on features in this book

Each of the following features in the book will help you to learn geography successfully.

Key words are shown in **blue bold**. These are the geographical words you need to learn for your exam. You will also find the words explained in the glossary at the back of the book.

Case studies

Case studies are real-life examples from the British Isles and other parts of the world. You don't need to remember all the facts but they should help your understanding.

Activities

Activities for you to do are on every double page. These are linked to the text and resources on the pages to help develop your understanding and skills. Answers (along with a scheme of work) are provided in the separate resource, *Common Entrance 13+ Geography for ISEB CE and KS3 Textbook Answers*.

Your challenge

These challenges are more demanding activities to develop your understanding even further. They may involve you doing some extra research, beyond the book.

Your enquiry – the big question

This is a question at the start of each unit that you will investigate. At the end of the unit you will answer the question using what you have learned.

Test yourself

Test yourself is an opportunity to check how much you have learned in the unit. You can use it to help your revision when you prepare for the exam.

Notes on the Common Entrance 13+ Exam (from Autumn 2023)

Section A: Location Knowledge (10–15 marks): these questions are to be answered using outline maps of the British Isles, Europe and other individual continents or maps of the world. The questions will be confined to the features and places listed in Appendix I of the specification.

Section B: Ordnance Survey Map Reading (10–15 marks): this section will comprise Ordnance Survey mapwork questions. Ordnance Survey map extracts to the scale of 1:50,000 and 1:25,000 will be used and a key to conventional symbols will be provided. The map extracts may be of any part of the United Kingdom (Great Britain and Northern Ireland).

Section C: Physical Geography (25–30 marks): this section will contain two questions, which will be based on any of the following predominantly physical topics:

- Tectonics (earthquakes and volcanoes)
- Meteorology (weather and climate)
- Geomorphology (rivers and coasts)

Section D: Human & Environmental Geography (25–30 marks): this section will contain two questions, which will be based on any of the following predominantly human and environmental topics:

- Demography (population and settlement)
- Economy (transport and industry)
- Environment (sustainability and stewardship)

For both Sections C and D, photographs, maps, diagrams, graphs and data tables may be used as stimulus material. Questions will include a mix of multiple choice, data response, short answers and extended answers.

This book was written by John Widdowson (a longstanding author, experienced teacher and fieldwork leader) and edited by Simon Lewis (Head of Geography, ISEB Geography Editor and Setting Team Leader).

This book is available as an eBook on our new online learning platform, Boost.

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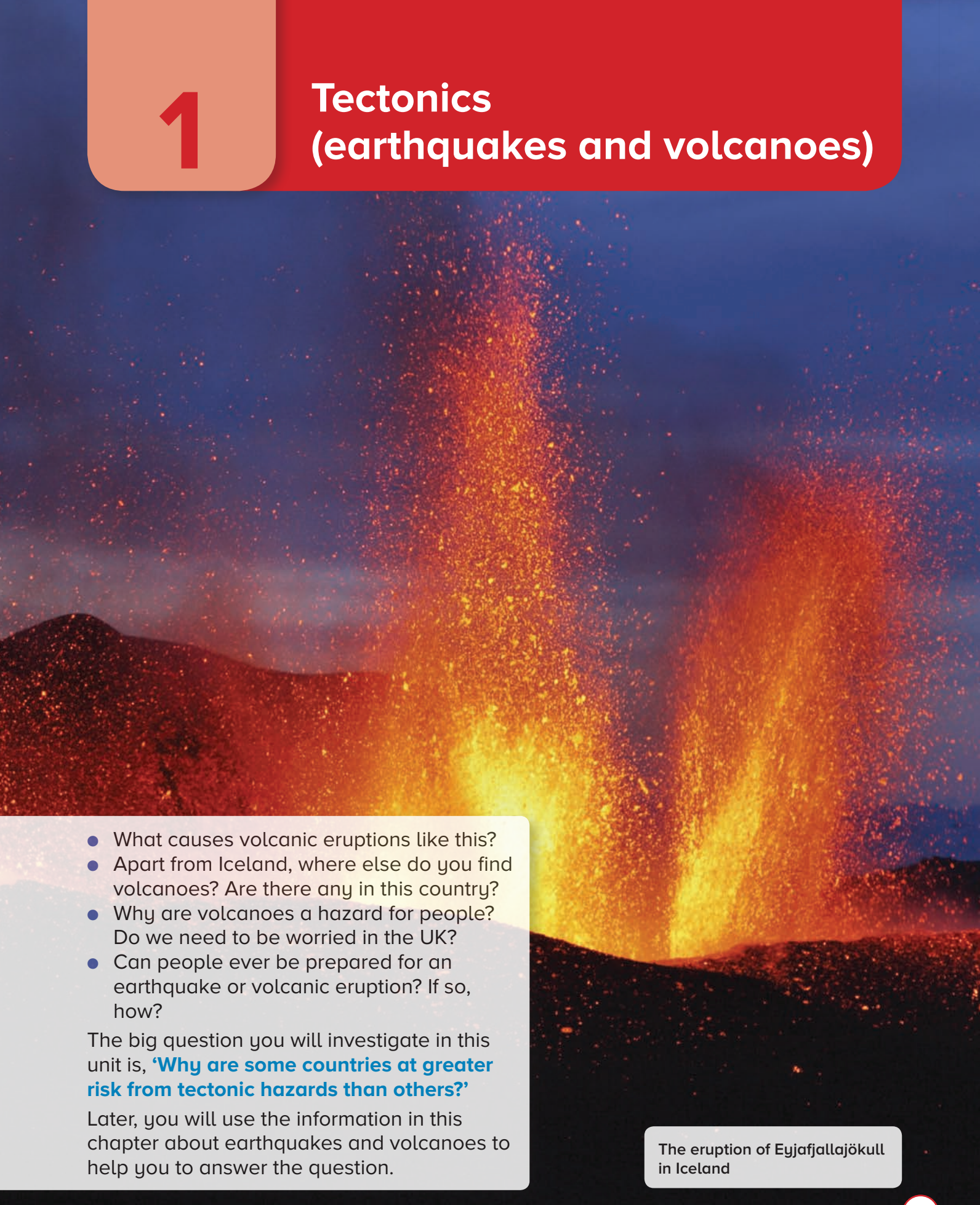
1 Tectonics (earthquakes and volcanoes)



- What causes volcanic eruptions like this?
- Apart from Iceland, where else do you find volcanoes? Are there any in this country?
- Why are volcanoes a hazard for people? Do we need to be worried in the UK?
- Can people ever be prepared for an earthquake or volcanic eruption? If so, how?

The big question you will investigate in this unit is, **'Why are some countries at greater risk from tectonic hazards than others?'**

Later, you will use the information in this chapter about earthquakes and volcanoes to help you to answer the question.

The eruption of Eyjafjallajökull in Iceland

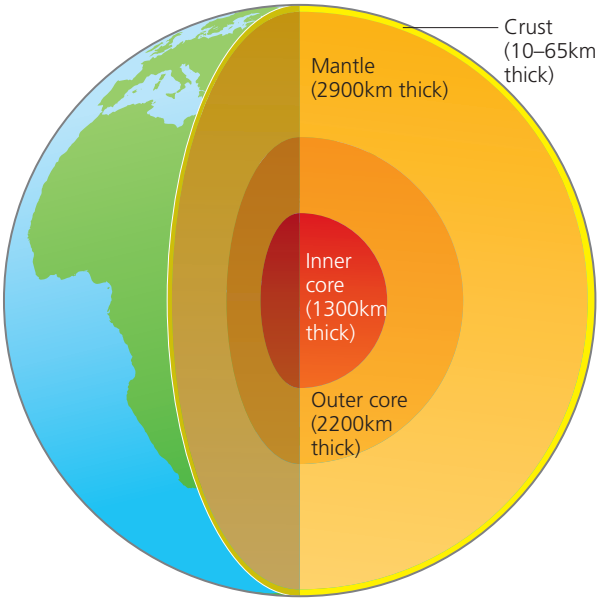
1.1 The Earth's structure

To understand why **earthquakes** and **volcanoes** occur, first, we need to explore deep within the Earth.

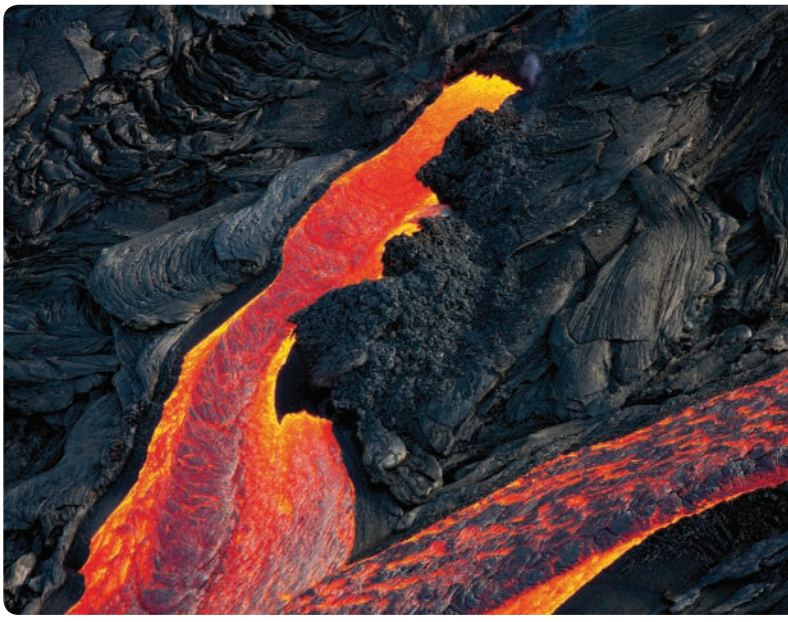
Scientists think the Earth was formed from hot gases about 4500 million years ago. Ever since then, the Earth has been slowly cooling down.

You can think of the Earth like an apple with three layers – skin, flesh and core. Except, in the Earth, the layers are called the **crust**, the **mantle** and the **core**.

- The crust is the outermost layer of solid rock on which we live.
- The mantle lies beneath the crust. It is a much thicker layer of rock, which is extremely hot. It is so hot that the rock behaves as a liquid, moving very slowly, like thick treacle.
- The core is at the centre. It is divided into two layers, the **outer core** and **inner core**. The outer core is so hot that the rock is essentially liquid.



A: Inside the Earth

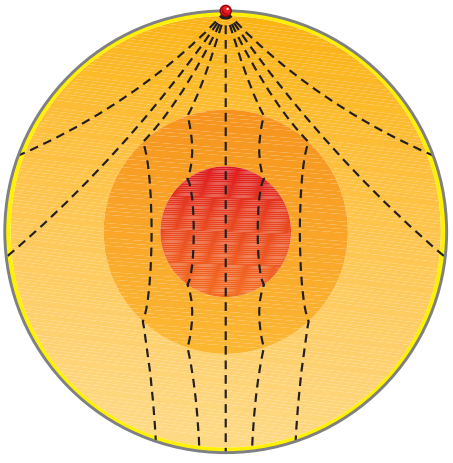


B: Lava from a volcano

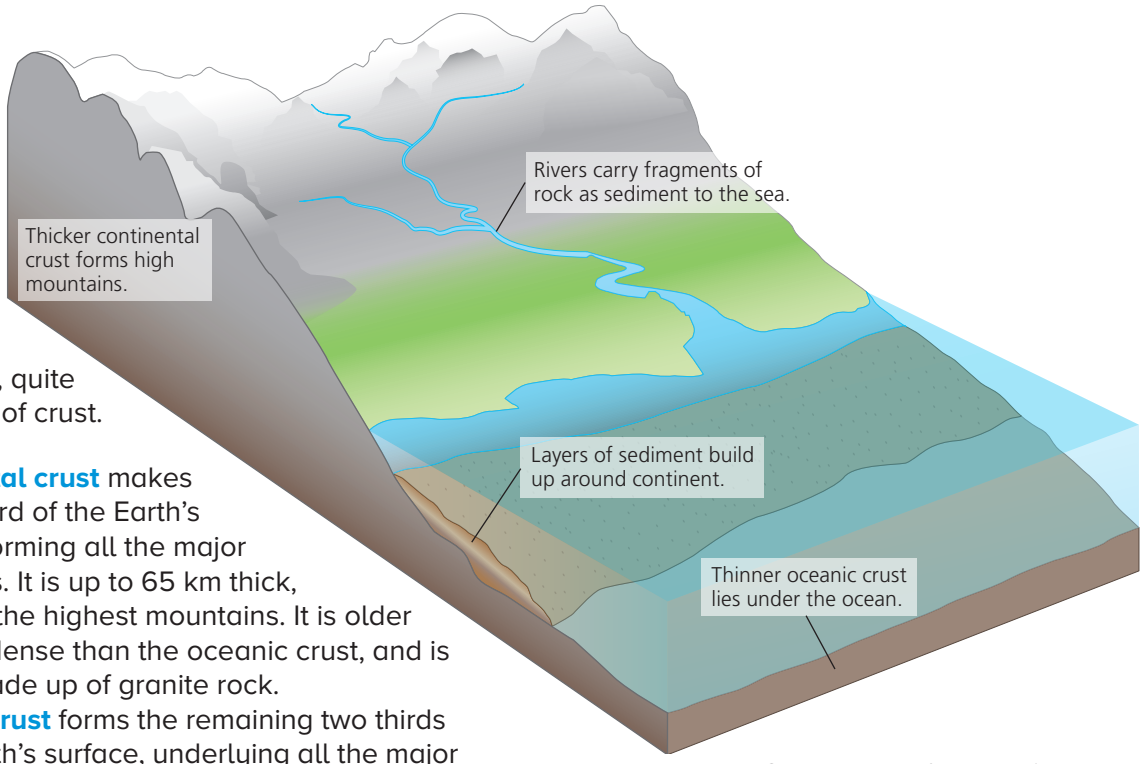
How do we know what lies deep within the Earth? After all, no one has ever been that deep and the deepest hole ever drilled only went down 12 km.

Two of the main clues about what the Earth is like inside come from volcanoes and earthquakes.

- The molten rock, emitted by volcanoes as **lava**, tells us it must be very hot deep within the Earth.
- Vibrations from earthquakes, called **seismic waves**, also help. Geologists can measure how these waves travel through the Earth. This tells them a lot about the different layers.



C: Seismic waves from an earthquake



D: Cross-section of the Earth's crust

There are two, quite distinct, types of crust.

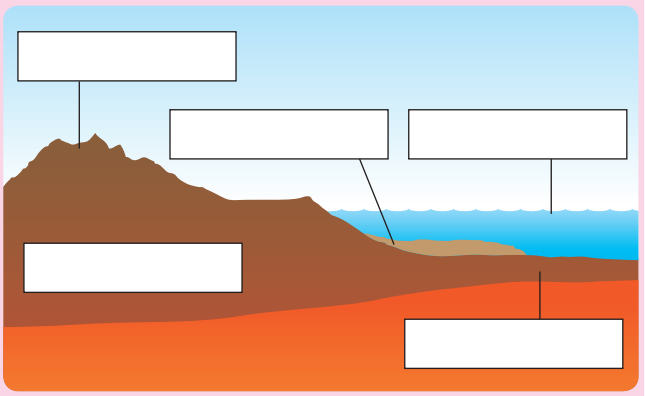
- **Continental crust** makes up one third of the Earth's surface, forming all the major continents. It is up to 65 km thick, including the highest mountains. It is older and less dense than the oceanic crust, and is mainly made up of granite rock.
- **Oceanic crust** forms the remaining two thirds of the Earth's surface, underlying all the major oceans. It is about 10 km thick and rarely rises above the surface of the ocean. It is younger and more dense than the continental crust and is mainly made up of basalt rock.

Activities

1 Look at diagram A.
Draw your own simple cross-section of the Earth.
   - **a)** Choose a suitable scale to fit the cross-section on your page, e.g. 1 cm: 1000 km. Use the scale to make each layer the correct depth.
   - **b)** Label the layers of the Earth on the cross-section.

2 Explain what, **a)** volcanoes, and **b)** earthquakes, tell us about the Earth. Use photo B and diagram C to help you.

3 Look at diagram D.
Label a copy of the cross-section on the right.
Choose your labels from – *continental crust, oceanic crust, mountains, sediment, ocean.*



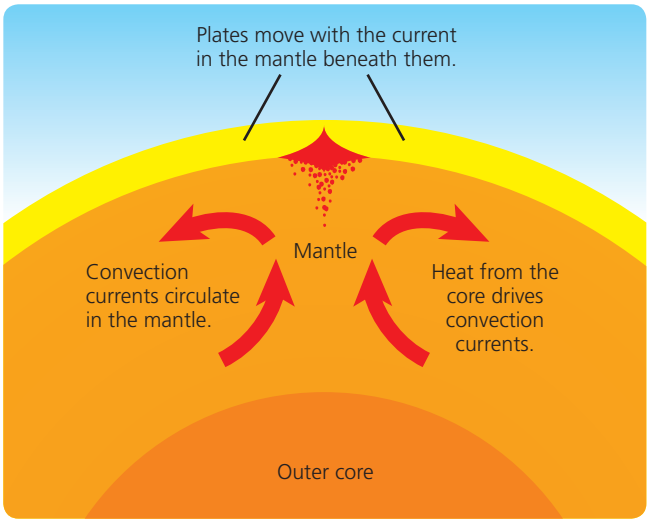
Your challenge

4 Do your own research to find out:
- the name, location and height of the world's highest mountain. (This is height above sea-level. The depth of the crust is greater.)
- the name, location and depth of the world's deepest ocean. (This is the depth of the ocean. The crust lies beneath this.)

1.2 The Earth's crust and tectonic plates

The Earth's crust is broken into enormous segments, called plates or – to give them their proper name – **tectonic plates**. The plates fit together like the pieces of a jigsaw, covering the surface of the Earth.

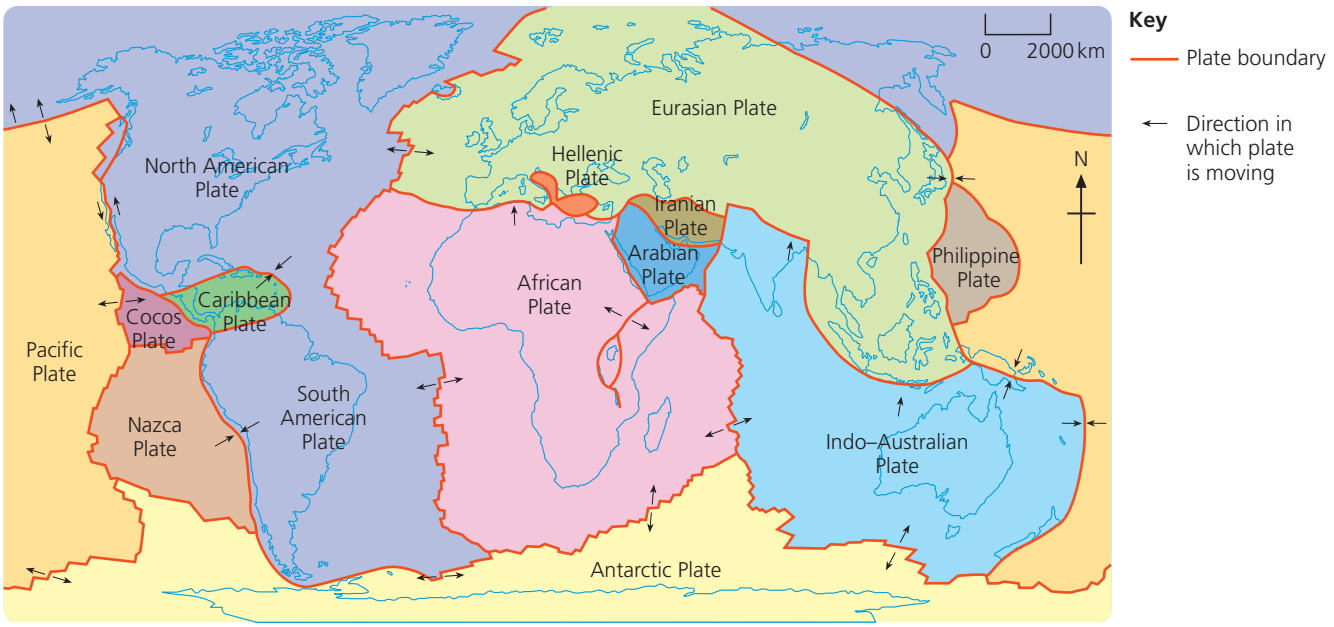
The plates float like rafts on top of the mantle. Heat from the Earth's core creates **convection currents** in the mantle, rather like a pan of boiling soup in slow motion (diagram A). As rock in the mantle moves, so the overlying plates are dragged along with the current. Plates move very slowly, just a few centimetres each year (your fingernails grow at a similar speed). However, over millions of years, whole continents shift across the Earth, oceans appear and disappear, and mountains are pushed up.



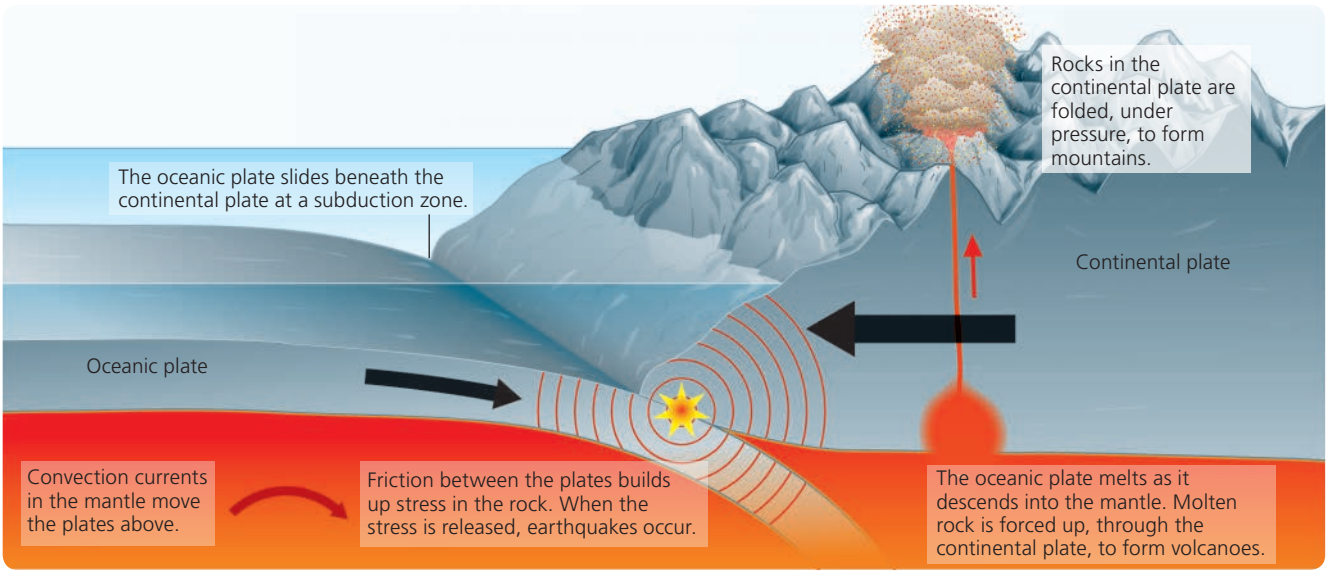
A: How the plates move

The line where two plates meet is a **plate boundary**. It is along plate boundaries that most of the world's earthquakes and volcanoes occur. Look carefully at map B. You will notice arrows showing the direction in which individual plates move. The arrows help you to identify three types of plate boundary.

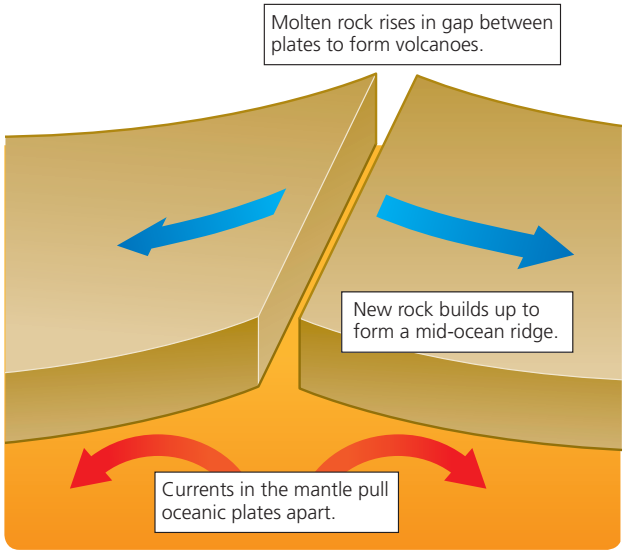
- A **destructive boundary** occurs where a continental plate and an oceanic plate push towards each other. The oceanic plate slides beneath the continental plate and is destroyed at the **subduction zone** (diagram C).
- A **constructive boundary** occurs where plates pull apart, so molten rock from the mantle rises between them, forming new crust (diagram D).
- A **conservative** (or sliding) **boundary** occurs where plates slide past each other, neither forming nor destroying rock (diagram E).



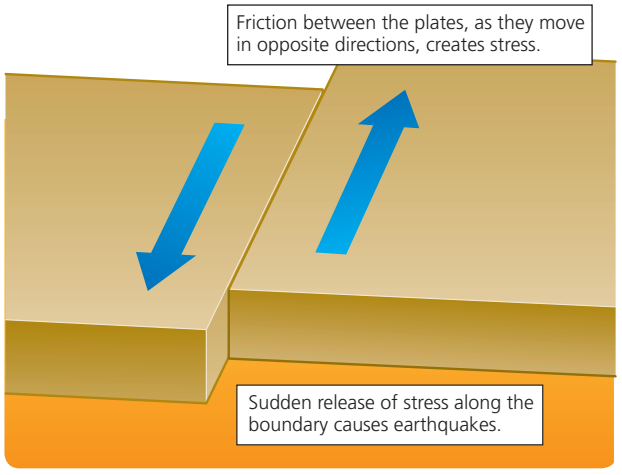
B: The world's plates



C: Cross-section of a destructive boundary



D: Cross-section of a constructive boundary



E: Cross-section of a conservative boundary

Activities

1 Look at diagram A.
   - **a)** Draw a pan of boiling soup sitting on a cooker. Show the convection currents.
   - **b)** Explain why the Earth's mantle is like a pan of boiling soup.

2 Look at map B. Identify at least one example of each type of plate boundary:
   - **a)** a destructive boundary
   - **b)** a constructive boundary
   - **c)** a conservative boundary.

   In each case, name the plates on either side of the boundary.

3 Look at diagram C. Explain why, **a)** earthquakes and, **b)** volcanoes, occur at destructive plate boundaries.

4 Look at diagrams D and E. Explain why:
   - **a)** volcanoes are likely to occur at a constructive plate boundary
   - **b)** earthquakes are likely to occur at a conservative plate boundary.

Your challenge

5 Identify five countries that lie on, or close to, a plate boundary. You can use an atlas to help you by comparing a world map with map B. Then find out more about these countries. Do they ever experience earthquakes or volcanoes?

1.3 Volcanoes and earthquakes

Volcanoes and earthquakes around the world

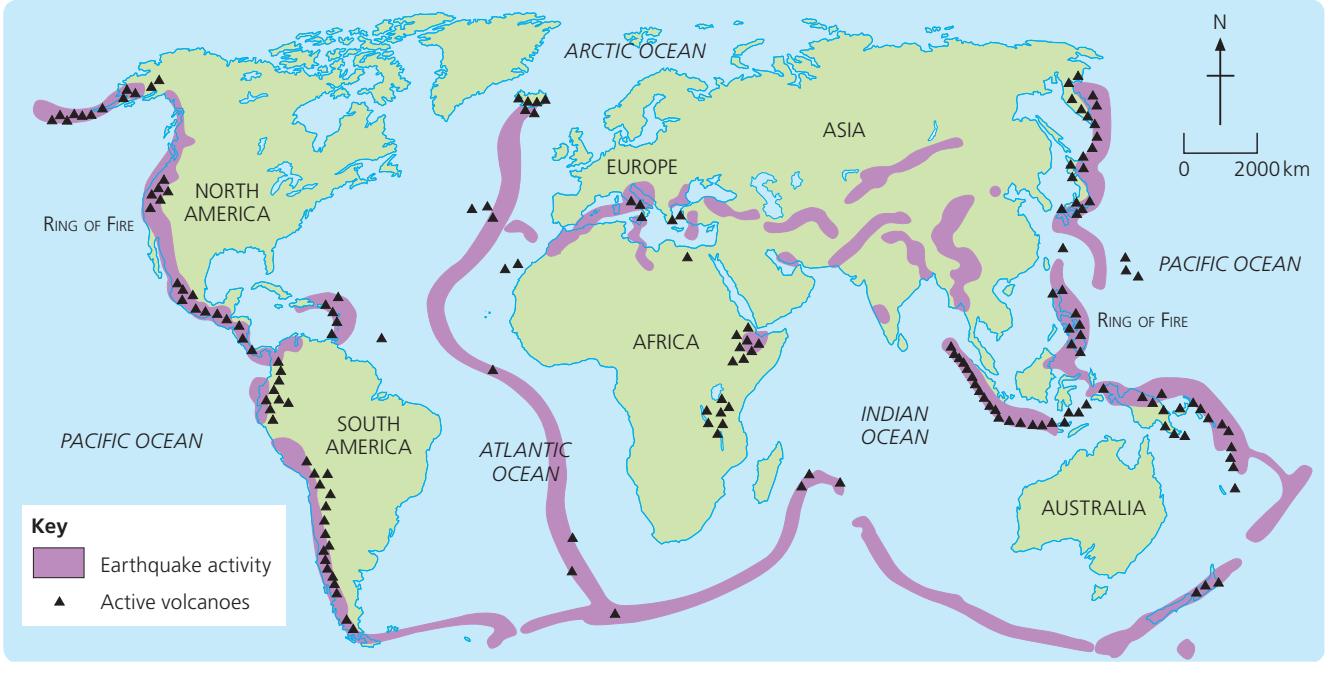
In any one year, volcanoes and earthquakes can kill thousands of people worldwide. You may think that being hit by such natural disasters is very bad luck. However, it is not so much a matter of luck, more location!

Look at map A. You will notice that the **distribution** of earthquakes and volcanoes around the world is not random. There is a pattern. Now, compare the map with map B in Section 1.2. You will immediately notice the similarity. Earthquakes and volcanoes mostly occur close to plate boundaries.

About 80 per cent of the world's major earthquakes and volcanoes are found around the edge of the Pacific Ocean – the, so-called, **'Ring of Fire'**. Here, the Pacific Plate under the Pacific Ocean meets the surrounding continental plates. These destructive boundaries are where earthquakes and volcanoes occur.

Earthquakes occur in other parts of the world too, indeed, anywhere there is a **fault**, or crack, in the Earth's crust. Worldwide, hundreds of minor earthquakes occur every day, most of them too small to be felt. Even Britain has small earthquakes occasionally!

Volcanoes also occur at constructive boundaries where plates are moving apart, allowing molten rock to rise. Two notable examples are the Mid-Atlantic Ridge, where Iceland is found, and the East African Rift Valley, where the **continent** is slowly splitting apart.



A: Areas in the world where major earthquakes and volcanoes occur

Earthquake	Year	Magnitude	Latitude + longitude
Valdivia, Chile	1960	9.5	40° S 73° W
Alaska, USA	1964	9.2	61° N 147° W
Sumatra, Indonesia	2004	9.1	3° N 96° E
Kamchatka, Russia	1952	9.0	53° N 159° E
Honshu, Japan	2011	9.0	38° N 142° E
Bio-Bio, Chile	2010	8.8	36° S 73° W
Aleutian Islands, Alaska	1965	8.7	51° N 178° W
Sumatra, Indonesia	2005	8.6	2° N 97° E

B: The eight most powerful earthquakes since 1920

Bio-Bio earthquake, 2010

Volcano	Year	Deaths	Latitude + longitude
Nevado del Ruiz, Colombia	1985	23,000	5° N 75° W
El Chichon, Mexico	1982	3,500	17° N 93° W
Mt Lamington, Papua New Guinea	1957	2,942	9° S 148° E
Mt Merapi, Indonesia	1930	1,369	7° S 110° E
Mt Agung, Indonesia	1963	1,184	8° S 115° E
Mt Pinatubo, Philippines	1991	847	15° N 120° E
Mt Hibok-Hibok, Philippines	1951	500	9° N 124° E
Anak Krakatoa, Indonesia	2018	437	6° S 105° E

C: The eight most deadly volcanic eruptions since 1920

Mt Pinatubo eruption, 1991

Activities

1 Look at map A.
- **a)** Describe the pattern of earthquakes and volcanoes on the map. Choose three of the sentences below to write your description.
  - Earthquakes and volcanoes happen everywhere.
  - Earthquakes and volcanoes happen in the same places.
  - Earthquakes and volcanoes happen in the oceans and on land.
  - Earthquakes and volcanoes happen only on large continents.
  - Earthquakes and volcanoes happen only in hot countries.
  - Earthquakes and volcanoes happen along particular lines on the map.
- **b)** Add further details to your description. Name at least five regions of the world where earthquakes and volcanoes occur.

2 Look at tables B and C.
- **a)** Locate each of the places listed in an atlas. Use the latitude and longitude to find the exact location.
- **b)** Mark and name each earthquake and volcano on a map of the world. It will help if lines of latitude and longitude are already shown on the map.

3 Explain the distribution of earthquakes and volcanoes around the world. (Clue: use map B and diagram C in Section 1.2 to help you.)

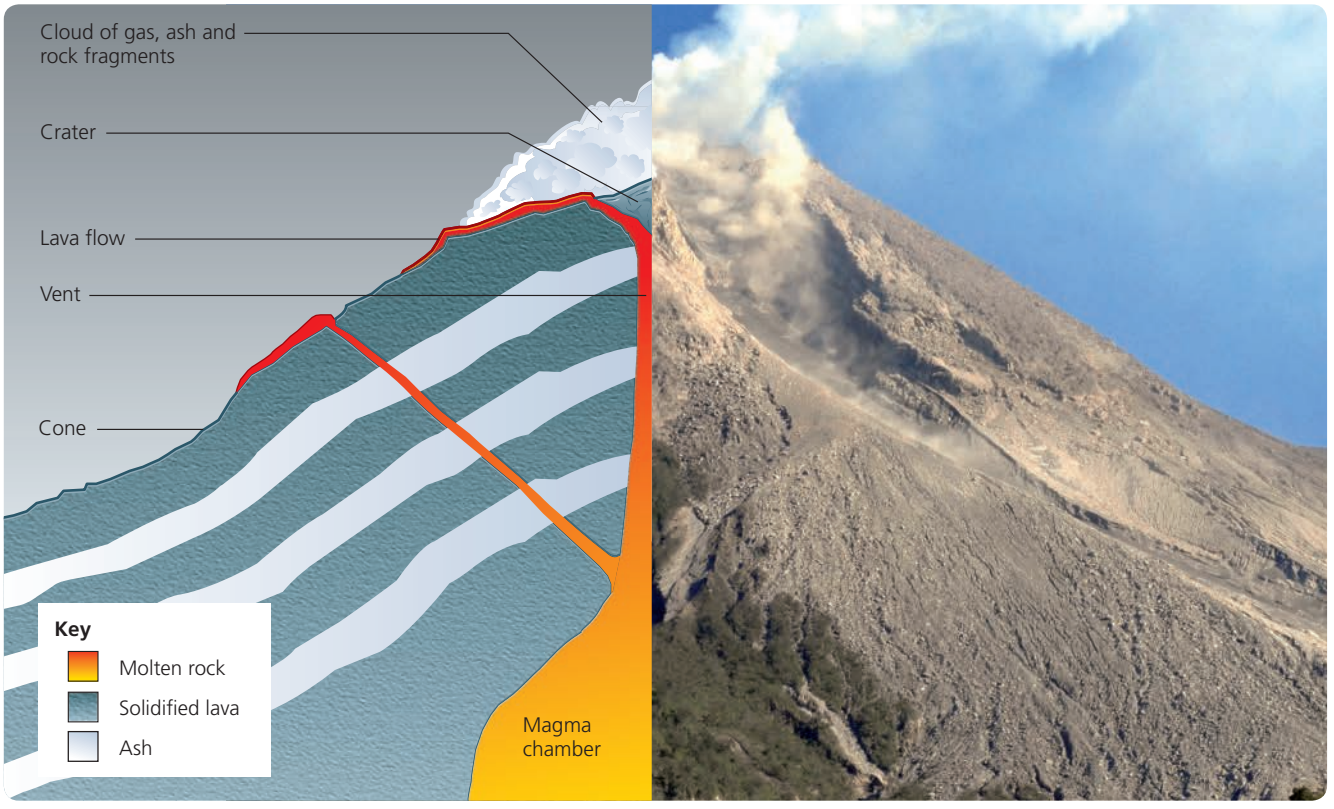
Your challenge

4 Go online to find out where the most recent earthquakes and volcanic eruptions have happened. You can use these websites, or others.
http://earthquake.usgs.gov/
http://volcanodiscovery.com/

The nature and causes of volcanic eruptions

A volcano is an opening in the Earth's crust where **magma**, molten rock deep below ground, comes to the surface as lava. Volcanoes come in many shapes and sizes. A typical volcano is formed from layers of lava and ash built up from previous eruptions (diagram A). It is known as a **composite volcano**.

Volcanoes erupt when pressure builds up inside the Earth. Magma is forced to rise through cracks and weaknesses in the Earth's crust and, when the pressure is too great, explodes at the surface. Lava flows from the crater and cools to form a layer of solid rock. Gas and ash are blasted into the air and rush down the sides of the volcano as a red hot **pyroclastic flow**, leaving a vast layer of ash. Melted snow and ice combine with ash to form **lahars**. Pyroclastic flows from the eruption of Mount Vesuvius destroyed the Roman city of Pompeii in AD79.



A: Inside a volcano

Volcanoes can be described in one of three ways.

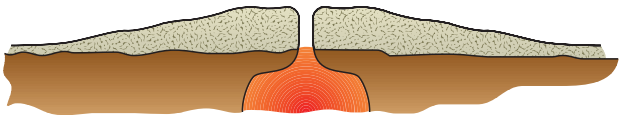
- **Active volcanoes** erupt regularly. Mount Etna, on the Italian island of Sicily, is the most active volcano in Europe, erupting every few years.
- **Dormant volcanoes** have been inactive, or asleep, for a long time. These volcanoes are less predictable and, therefore, more dangerous. Anak Krakatoa erupted in 2018 with the loss of 437 lives.
- **Extinct volcanoes** have stopped erupting altogether. The city of Edinburgh, in Scotland, is built on an extinct volcano.

Although volcanoes are dangerous, in the long term they also bring benefits. Many people around the world live near volcanoes.

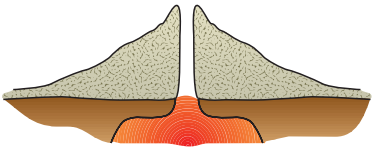
- Lava and ash deposited in an eruption can form fertile soil that is good for farming. The slopes of Mount Vesuvius, for example, have many vineyards.
- Heat underground, close to volcanoes, can be used to provide **geothermal energy**, for example, in Iceland and New Zealand.
- Dramatic scenery created by volcanoes can attract tourists, bringing income to the area.

Kilauea is a **shield volcano**, a low-rise volcano with gently sloping sides. It is made from thin, runny lava. Eruptions are frequent but gentle.

Mount St Helens erupted violently in 1981 after being dormant for hundreds of years. It sent ash many kilometres into the **atmosphere**. The ash formed a new steep-sided cone inside the crater of the old volcano.



B: Kilauea, Hawaii in the Pacific Ocean



C: Mount St Helens, USA

Activities

1 Look at diagram A.

a) Match the labels with the definitions below.

- molten rock from a volcano
- pipe that brings magma to the surface
- store of molten rock below ground
- circular opening at the top of a volcano
- shape of a volcano, formed from layers of lava and ash.

b) Now, close the book. Draw your own, labelled cross-section of a volcano from memory.

2 Read the following sentences from a geologist's diary. They describe events during a volcanic eruption, but the sentences have got muddled up. Rewrite the sentences in a sensible order.

- Red hot ash was thrown high into the air like a firework display.
- There was a huge explosion deep inside the volcano.
- The cloud of ash fell and settled on the solidified lava.
- The volcano was rumbling and steaming as it does most of the time.
- The lava thickened, slowed down and, finally, turned to solid rock.
- Suddenly, the volcano became quiet and stopped steaming.
- Lava poured out of the crater and began to flow down the side of the cone.

3 Compare Kilauea and Mount St Helens in B and C. Which of the volcanoes do you think is:

a) most predictable

b) most dangerous?

Give reasons for your answers.

Case study: Anak Krakatoa volcano, 2018

A volcano in Indonesia

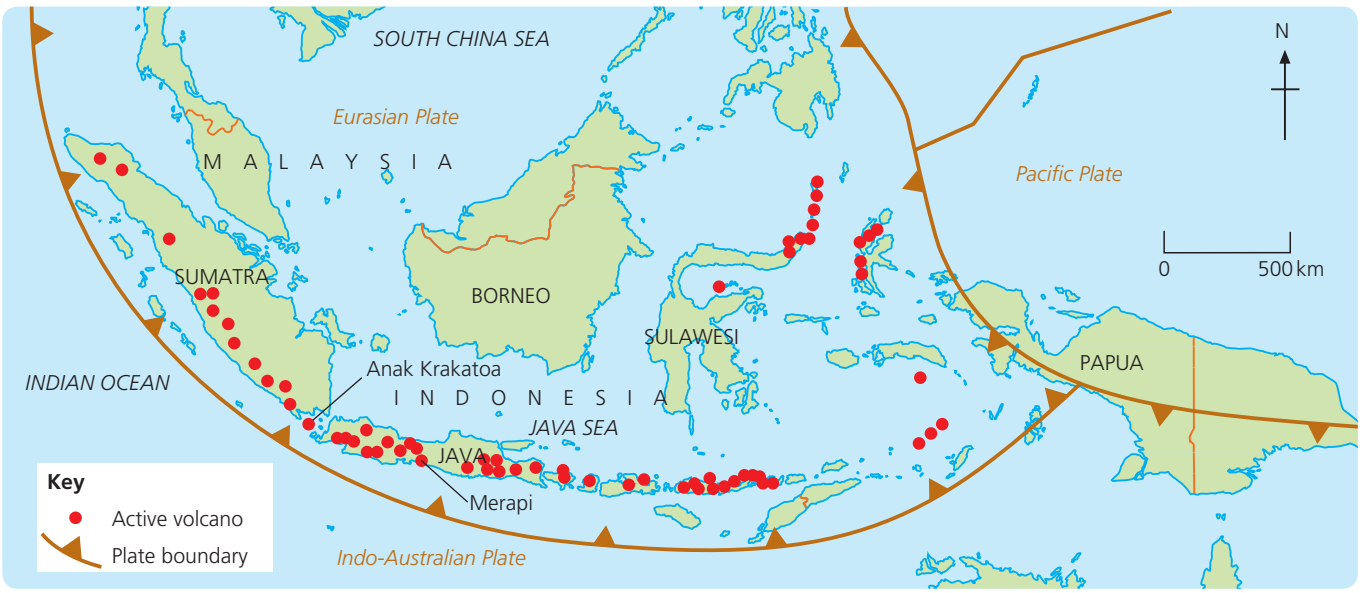
Anak Krakatoa (photo A) is a volcano in Indonesia, one of the most tectonically active countries in the world. It lies on the destructive plate boundary between the Indo–Australian and Eurasian plates (map B).

The volcano forms a small island in the Sunda Strait, between the much larger Indonesian islands of Java and Sumatra. On 22 December 2018, Anak Krakatoa erupted, leading to a deadly **tsunami** with **waves** up to five metres high reaching the islands around it. As a result, 437 people died and 14,000 were injured. It became the world's most deadly volcanic eruption so far in the twenty-first century.

The history of Anak Krakatoa goes back over a century (see timeline C). Its name means 'Child of Krakatoa' and gives a clue to its origins. In recent years, there were frequent eruptions, and steam plumes were often seen coming from the top of it, caused by water heating inside the volcano and rising to the surface. The eruptions became more intense from July 2018.

A: Anak Krakatoa – a small eruption with ash rising from the volcano

Finally, on 22 December, there was a violent explosion, when water reacted with magma rising from the mantle, leading to an underwater collapse of the volcano. A huge volume of water in the ocean was displaced by rock, triggering the tsunami (see pages 20–21).



B: Plates and plate boundaries in Indonesia, showing the location of volcanoes

1883: Krakatoa, a large volcanic island in the Sunda Strait (photo D), blows itself apart. It is the world's biggest recorded eruption. The sound is heard 5000 km away. Dust from the explosion goes high into the atmosphere and travels around the world, causing temperatures worldwide to fall by 1 °C. In Indonesia, more than 36,000 people are killed.

1927: Anak Krakatoa appears as a new island in the Sunda Strait. It has been growing slowly beneath the ocean from the remnants of Krakatoa. Through the twentieth century, the island grows slowly, by an average of about 7 metres per year, as a result of frequent eruptions.

1994: A new eruptive episode begins on Anak Krakatoa, with quiet periods of a few days alternating with longer periods when it is erupting. Hot gases, rock and lava are released, continuing to build the height of the island.

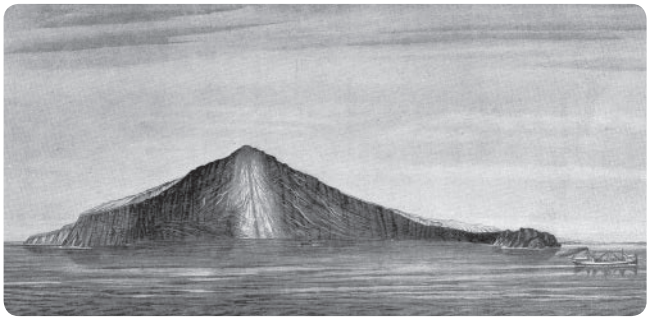
2008: Scientists monitoring the volcano warn people to stay out of a 3-km zone around the island to avoid being hit by rocks or lava bombs. An expedition to the volcano discovers that a new lava dome is growing inside the crater from magma pushing up from below.

July 2018: Eruptions of the volcano increase, sending more gases, ash and rock into the atmosphere. By September, it begins to pose a threat to air traffic and to people's health on neighbouring islands (photo E).

22 December 2018: A violent explosion of Anak Krakatoa leads to the collapse of the volcano and resulting in a tsunami that hits the coasts of Sumatra and Java. The volcano loses two-thirds of its volume, its height reducing from 338 m to just 110 m above sea level.

2019: Since the major eruption, Anak Krakatoa has begun to grow again. A new crater has formed and the volcano has been erupting.

C: Timeline for Anak Krakatoa



D: Krakatoa, before it erupted in 1883

E: Anak Krakatoa erupting in 2018, seen from a satellite above

Activities

1 Look at photo A.
Describe **a)** the appearance and **b)** the location of Anak Krakatoa.

2 Study map B.
- **a)** Describe the distribution of volcanoes in Indonesia.
- **b)** Explain this distribution. (The plate boundaries shown on the map will help you.)

3 Read timeline C and then answer these questions.
- **a)** Why do you think Anak Krakatoa was given its name?
- **b)** What reasons might people in Indonesia have had to be worried about Anak Krakatoa even before it erupted in 2018?

Your challenge

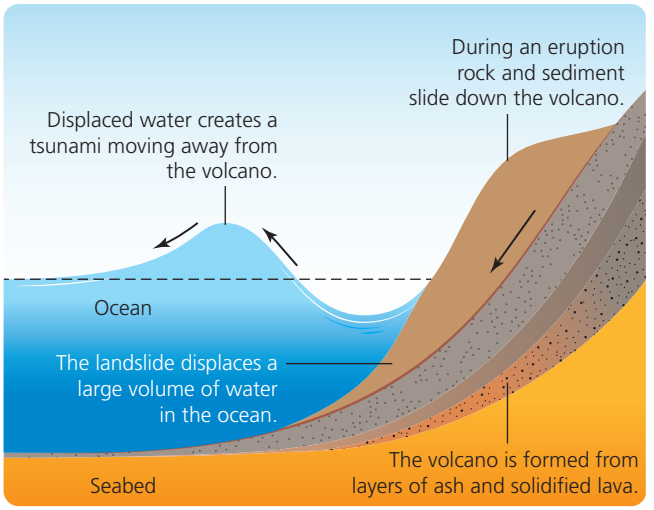
4 Imagine you are a scientist monitoring Anak Krakatoa. How could you monitor the volcano to warn people when it might erupt? (If you are not sure, read page 30 to find out how scientists monitor volcanoes.)

The wave that followed

All the deaths in Indonesia from the eruption of Anak Krakatoa were caused by the tsunami that followed. A tsunami is a large wave created by movement on the seabed, as a result of either an earthquake or volcanic eruption. Tsunami is a Japanese word that means 'harbour wave'.

In the case of Anak Krakatoa, the collapse of the volcano after the violent eruption led to an underwater landslide that displaced a huge volume of water (diagram F). This created a wave that spread out from the volcano in all directions, a bit like dropping a stone in a pond and watching the ripples spread out in a circle.

Tsunamis travel across the ocean at speeds of hundreds of kilometres an hour. Anak Krakatoa is only about 50 km from the nearest coasts on Sumatra and Java (map G). The tsunami hit within minutes. A tsunami early warning system for the Indian Ocean did not help, as there was not enough time for any warning to be given.



F: How a volcanic eruption can lead to a tsunami

G: How the tsunami spread around the Sunda Strait

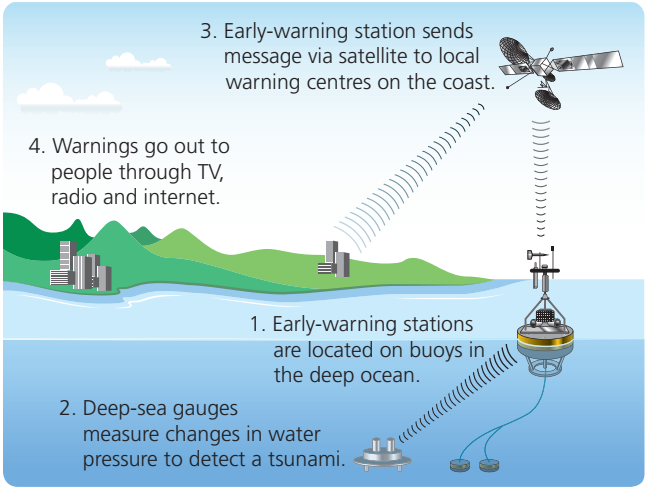
Impacts of the tsunami

The tsunami affected about 300 km of coastline in Sumatra and Java around the Sunda Strait. It struck after dark, at 9.30 p.m., without any warning, destroying buildings, sweeping away cars and uprooting trees (photo H). The disaster had many impacts on people's lives:

- The death toll was 437 with 14,000 casualties.
- 40,000 people were made homeless because their homes were destroyed or damaged.
- Several tourist resorts were hit, including Tanjung Lesung in Java. The wave hit a marquee where a rock band was playing a concert. Members of the band were washed away.
- The main road into Pandeglang was blocked, making it difficult for rescue vehicles to reach the area. Pandeglang is where most of the casualties were treated.
- After the tsunami struck, there was confusion about what had happened. At first, it was reported as a tidal surge, because there was no earthquake (most tsunamis in Indonesia follow earthquakes).

In 2004, a much bigger tsunami was triggered by a powerful earthquake off the coast of Sumatra in the Indian Ocean. It killed about 228,000 people in 13 countries, most of them in Indonesia. After this, a tsunami early-warning system was set in the Indian Ocean to detect tsunamis and to warn people before they reach land (diagram I).

H: Damage caused by the tsunami that hit northwest Java



I: How a tsunami early-warning system works

Activities

1 Study diagram F.
Explain how a volcanic eruption can lead to a tsunami. Use the labels on the diagram to help you.

2 Study map G.
- **a)** Describe the pattern on the map, showing the areas worst affected by the tsunami. Refer to their location in relation to the Sunda Strait and distance from Anak Krakatoa.
- **b)** Explain why, **i)** Tanjung Lesung was badly affected, and **ii)** Jakarta was not badly affected.

3 Look at photo H.
- **a)** What has happened here? Try to write in as much detail as you can.
- **b)** What might people need in the next few days in order to survive? List at least five things.
- **c)** What might people need over the next year in order to recover? List five more things.

4 Study diagram I.
Explain why a tsunami early-warning system might have helped with the Indian Ocean tsunami in 2004, but did not help with the Anak Krakatoa tsunami in 2018.

Your challenge

5 You are responsible for the long-term planning of the coastal region of Indonesia around the Sunda Strait, shown in map G. How would you advise people:
- **a)** how to recognise warning signs before another tsunami
- **b)** where to build their new homes
- **c)** where it is safe to develop a resort?

Write three short paragraphs – one for each piece of advice.

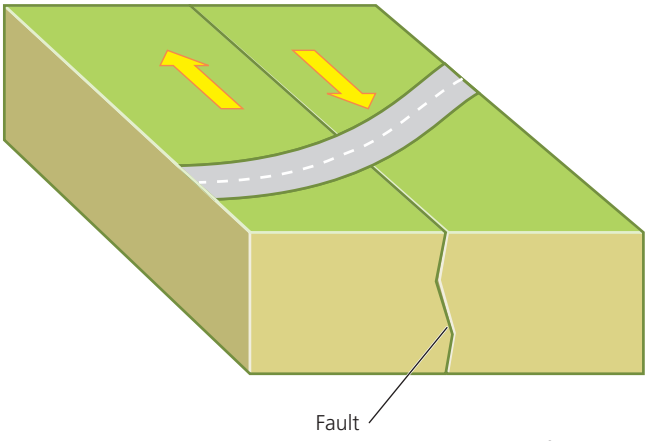
The nature and causes of earthquakes

An earthquake is a sudden movement in the Earth's crust that occurs along a fault, or crack, in the rock (diagram A). Most active faults, like the famous San Andreas Fault in California (photo B), lie close to plate boundaries where the rock is under greatest stress.

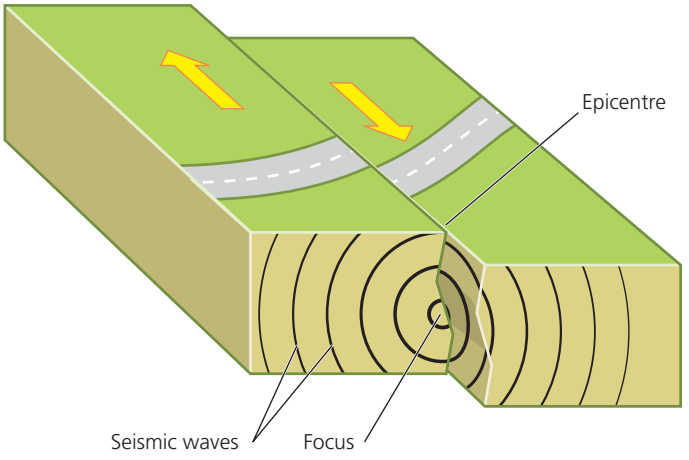
The magnitude, or strength, of an earthquake can be measured on the **Richter Scale** (drawing C). The scale goes from one to nine, each number on the scale marking an earthquake eight times stronger than the one below. Geologists measure the magnitude of an earthquake using an instrument called a **seismometer** that picks up seismic waves. The closer to the **epicentre** of the earthquake, the more powerfully it will be felt.

Major earthquakes are usually followed by smaller earthquakes called **aftershocks**. Aftershocks are particularly dangerous. Buildings, already damaged by the earthquake, can easily collapse. **Foreshocks** sometimes come before a major earthquake, but are not reliable enough to be used as a warning.

Earthquakes also happen in rock beneath the seabed. Here they can trigger a tsunami, or giant wave, that grows in height as it approaches land.



Forces deep in the Earth put pressure on rocks near the surface. Sometimes, slabs of rock on either side of a fault are being pushed in opposite directions. They get locked together and stress builds up.



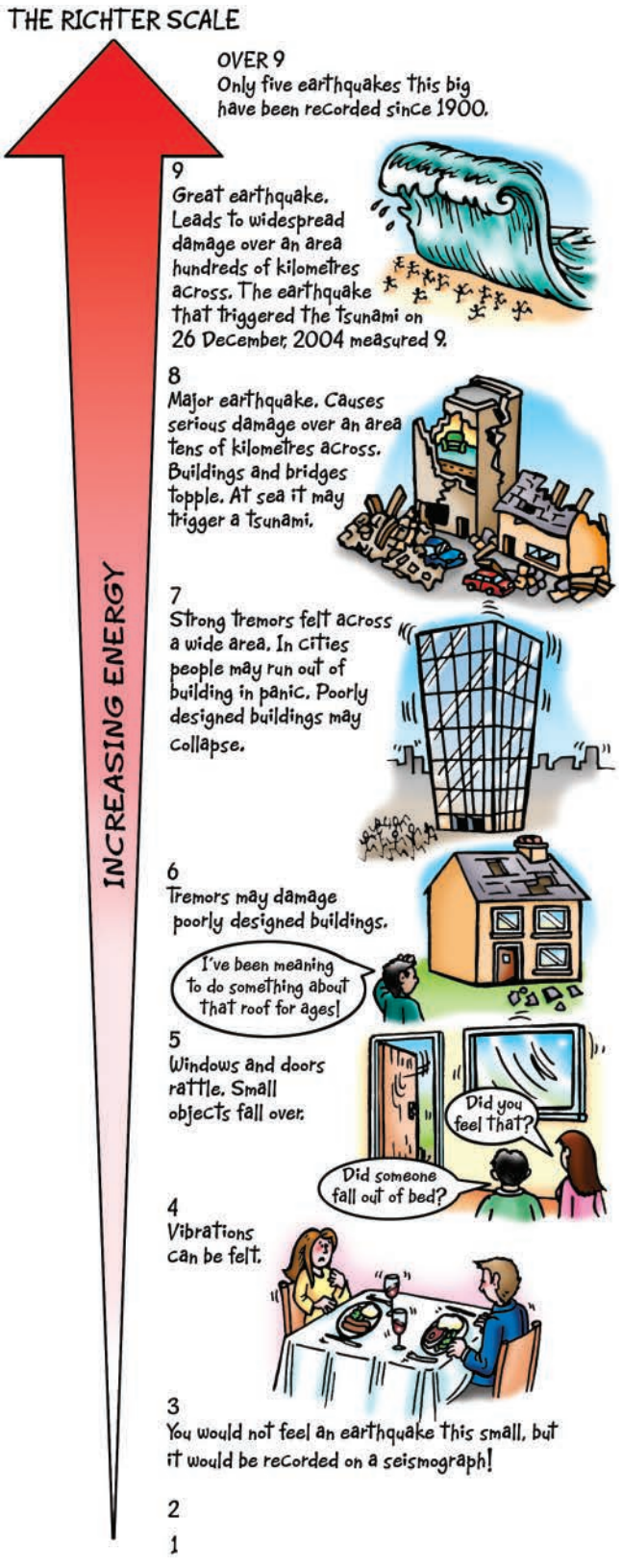
Suddenly, the slabs give way, releasing huge amounts of energy and sending out seismic waves. The point underground where this happens is the **focus** of the earthquake. The point on the surface, directly above, is the epicentre, where the quake is felt most strongly.

A: How an earthquake happens

B: The San Andreas Fault, visible from the air

Activities

1 Define these words using the text on this page:
- **a)** earthquake
- **b)** fault
- **c)** focus
- **d)** epicentre
- **e)** seismic wave
- **f)** seismometer
- **g)** aftershock
- **h)** tsunami.



C: The Richter Scale

DAY THE EARTH MOVED IN LEIGHTON BUZZARD

Shocked southerners in Britain were left trembling yesterday – after they were hit by an earthquake. Witnesses describe seeing houses shaking after the tremor at 8.45 a.m. The epicentre of the quake is believed to have been the Bedfordshire town of Leighton Buzzard. A spokesman for the British Geological Survey said, 'We've had a hundred or so reports of the earthquake. People are saying they heard a loud bang, their windows were rattling, that kind of thing. This is quite a large earthquake for the UK. We maybe get two or three this size a year'.

D: News report of an earthquake in Britain, 2020 (Extract adapted from *Daily Mirror*, page 1, 9 September 2020)

Activities

2 Look at the Richter Scale in C and read the news report in D.

a) Suggest the magnitude of the earthquake on the Richter Scale.

b) Give evidence to support your answer.

Your challenge

3 You are given these materials:


sandpaper

block of wood

elastic band


pins

heavy weight

a) Suggest how you could use them to make an earthquake model.

b) Explain how your model shows what happens in an earthquake.

Case study: Central Italy earthquakes, 2016

Earthquakes in 2016

On 24 August 2016, at 3.30 a.m., an earthquake measuring 6.2 on the Richter Scale struck central Italy (photo A). The epicentre was close to the historic town of Amatrice. 299 people were killed. Tremors from the earthquake were felt as far away as Rome, Naples and Bologna.

Amatrice lies in the Apennine Mountains, which form the spine of Italy, running from north to south (map B). The central Apennines is one of the most tectonically active parts of Italy, suffering from frequent earthquakes. In 2009, there had been another major earthquake in L'Aquila, a town 50 km south of Amatrice, when over 300 people were killed.

The earthquake on 24 August was the first of a series of earthquakes and aftershocks that hit Central Italy in 2016. On 26 October, two more earthquakes, magnitude 5.5 and 6.1, occurred 30 km north of Amatrice. Then, on 30 October, the strongest earthquake to date, magnitude 6.6, struck the town of Norcia. Fortunately, because residents had already been evacuated due to recent earthquakes, no lives were lost.

The earthquakes did not come as a complete surprise, even though no one predicted exactly when they might occur. Over three centuries ago, in 1703, the same region was hit by a series of three large earthquakes. Compared to then, scientists now know more about what causes earthquakes and how to prepare for them.

A: Earthquake damage in Central Italy in 2016

B: Location of the earthquake on 24 August 2016 in Central Italy

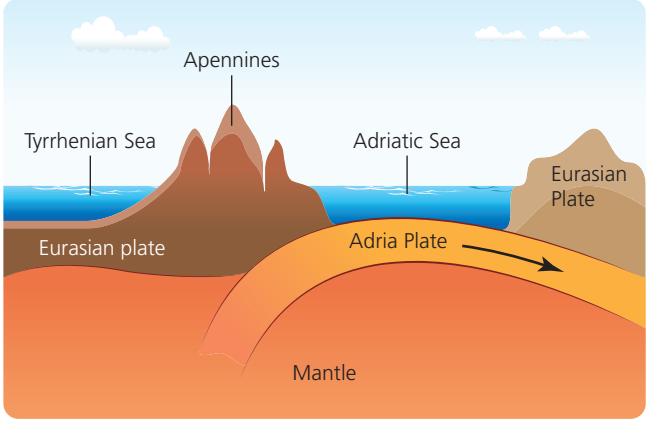
Why is Italy prone to earthquakes?

The reason why Italy is prone to earthquakes is complicated. For the past 100 million years, the African Plate has been moving north, colliding with the Eurasian Plate. The collision between the two plates has built the Alps in Europe. Southern Europe has fragmented into a number of smaller plates. This includes the Adria Plate, which sticks out like a finger into the Eurasian Plate (map C). The two plates form a plate boundary along the line of the Apennines down the middle of Italy.

Today, the Adria Plate is slowly moving northwards, splitting away from the Eurasian Plate. This has created a network of short faults in the Apennines, along which earthquakes can occur. The length of the fault controls the power of the earthquake. Most earthquakes in the Apennines have magnitudes between 6 and 7 (relatively powerful, but not the most powerful). An earthquake on one fault can sometimes trigger an earthquake on another fault. This explains why earthquakes in Italy often come one after another.

Another way to understand this is to look at a cross-section of southern Europe, showing what is happening under the ground. When the Adria Plate pulls away from the Eurasian Plate under Italy, it puts stress on the rock, creating cracks, or faults, along which earthquakes occur (diagram D).

C: Tectonic plates in southern Europe



D: Cross-section of southern Europe

Activities

1 Look at photo A. What do you notice about **a)** the shape of the land and **b)** the age of the buildings? Why might each of these factors make the impact of an earthquake worse?

2 Study map B.
- **a)** Describe the location of the 2016 earthquake in Amatrice.
- **b)** Tremors from the earthquake were felt in Rome, Naples and Bologna. Using the scale on the map, work out how far the tremors travelled in each direction.

3 Study map C and diagram D. In your own words, try to explain why the 2016 earthquake happened. Use the following words in your explanation:
- Eurasian Plate
- Adria Plate
- plate boundary
- fault

Your challenge

4 Find out more about the earthquakes that have happened recently in Italy. You can do this using the Earthquake Track website at **www.earthquaketrack.com**.
- **a)** How many earthquakes have there been in:
  - the last day
  - the last week
  - the last month
  - the last year?
- **b)** What was the largest earthquake:
  - this week
  - this month
  - this year?

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ISBN 978-1-3983-2207-3
9 781398 322073
FSC