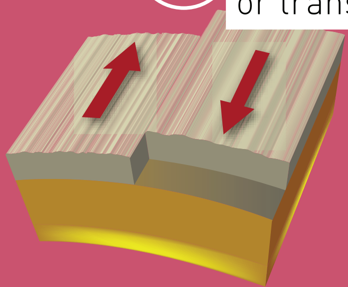
# TECTONIC PLATES

# 6

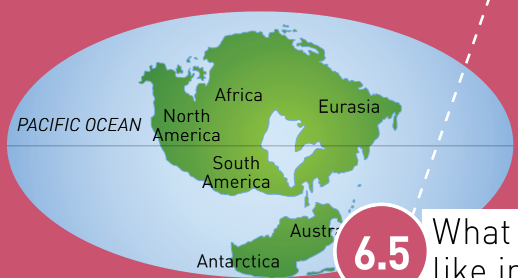
6.1 Is the Earth shrinking or moving?

6.2 The Earth has a solid core

6.3 Boundaries between the tectonic plates can be converging, diverging or transforming




6.4 Tectonic plates can be constructive or destructive




6.5 What will the Earth look like in the future?

## What if?

### Clay plates

**What you need:**

modelling clay

**What to do:**

1 Divide the clay into two equal portions.
2 Flatten the portions out so that they are both approximately 1 cm thick.
3 Gently slide each portion towards each other.

**What if?**

» What if one portion slides over the other?
» What if the two clay portions are jammed together?
» What if the two portions are moved apart?

//SCIENCE AS A HUMAN ENDEAVOUR//

# 6.1 Is the Earth shrinking or moving?

Plate tectonics is a combination of two theories: continental drift and sea-floor spreading. Continental drift is the idea that the continents are continually moving and have significantly changed positions over millions of years. The theory of sea-floor spreading proposes that the middle of the ocean is spreading apart, moving very slowly in opposite directions.

There have been many theories that tried to explain why there are earthquakes, mountains and deep-sea trenches over the surface of the Earth. One of the first theories was that the Earth was cooling down and therefore shrinking, causing 'wrinkles' to form on the surface. Like all theories, this idea is testable and was refined as new evidence became available.

**Figure 6.2** Alfred Wegener pioneered the theory of continental drift in his book *The Origin of Continents and Oceans*.

## Continental drift

One form of evidence was the similarities in shape between the coastlines of Africa and South America. They seem to fit together like a jigsaw puzzle. In the early 20th century, German meteorologist Alfred Wegener put this idea and some other evidence into a book in which he outlined the theory of **continental drift**. He proposed that the continents once all fitted together into a giant continent known as Pangaea.

Wegener proposed that Pangaea was a supercontinent that existed 220 million years ago. When it started to break up, the continents slowly drifted apart as they moved through the oceanic crust. He backed up his claims with the evidence of coastline fit, similar fossils, rocks and landforms created by glaciers in now widely separated continents, and the reconstruction of old climate zones.

**Figure 6.1** The Himalayan Mountains have been pushed up by pressure from beneath the Earth.

## Tectonic plate movement

We now know that it is not just the continents themselves that are moving. The large moving areas include both the continental and oceanic crust. Geologists call these moving areas **tectonic plates.** 'Tectonic' means 'building', so tectonic plates are the 'building blocks' of the Earth.

The movement of the plates explains the existence of landforms such as **continental shelves** (underwater cliffs between the beach and the ocean) and deep trenches in the ocean floor. It also explains how earthquakes and volcanos are distributed, and the very young age of parts of the sea floor. **Plate tectonics** is a good example of how a scientific hypothesis can be suggested, discounted, modified and then reborn.

## Sea-floor spreading

The idea of **sea-floor spreading** was proposed by US geologist Harry Hess. His evidence came from the discovery of the Mid-Atlantic Ridge, a continuous mountain range in the middle of the Atlantic Ocean. Hess's original hypothesis was that convection currents (see Chapter 5) deep inside the mantle caused spreading.

If convection does occur within the Earth's mantle, then rising hot **magma** pushes up, creating a ridge crest. It is pushed to one side by more rising magma and the

**CHALLENGE 6.1A:** RECONSTRUCTING PANGAEA
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**CHALLENGE 6.1B:** MILO CONVECTION CURRENTS
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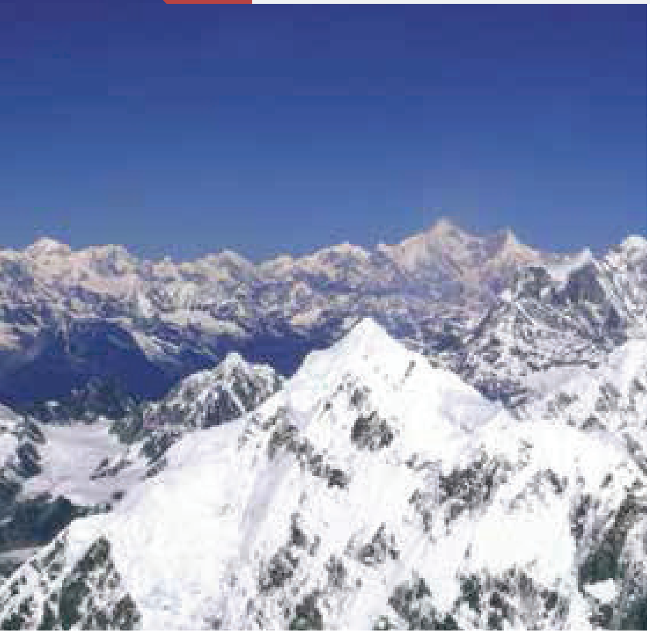

ridge splits and moves apart. As it is pushed away, tension between the surrounding rocks causes a rift zone and shallow earthquakes. As the mantle rock moves away from the ridge crest, it carries the sea floor with it like a piggyback ride. The rock cools, becomes denser and eventually sinks back into the mantle.

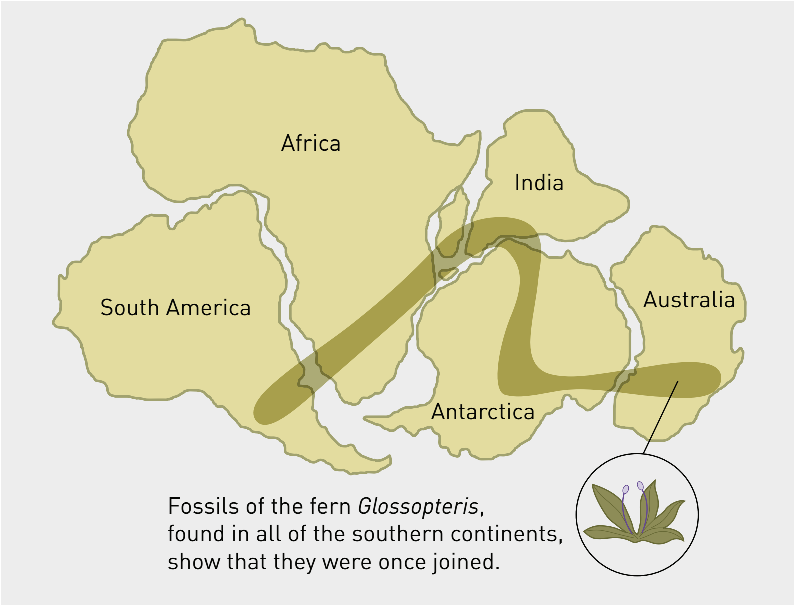


**Figure 6.3** Given that the fossil fern *Glossopteris* cannot walk, swim or fly, how can its isolated occurrence in so many different parts of the world be explained?

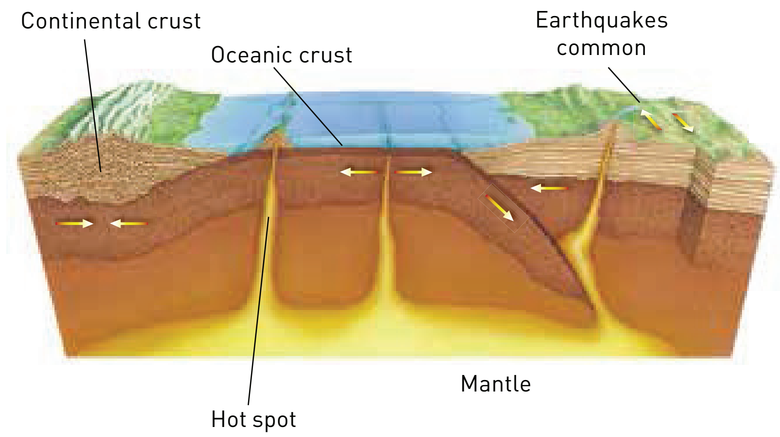


**Figure 6.4** Tectonic plate movement

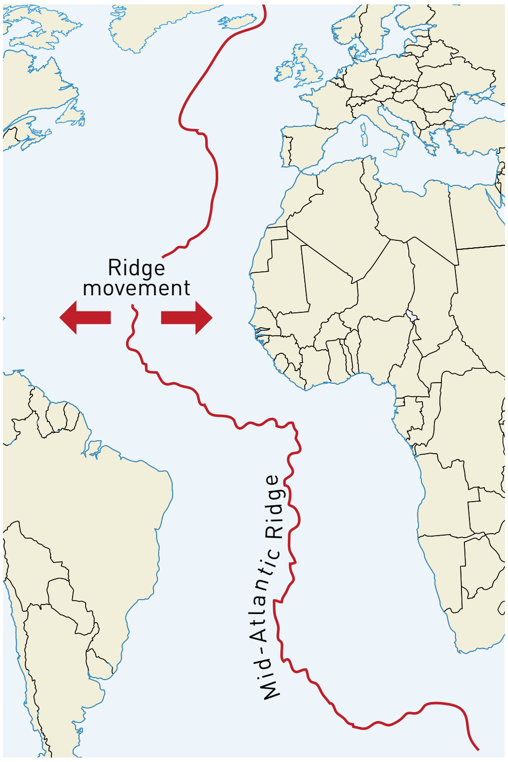


**Figure 6.5** The Mid-Atlantic Ridge provided evidence of sea-floor spreading.

## Extend your understanding 6.1

1. Examine a world map. Apart from Africa and South America, which other regions of the world look as if they could fit closely together?
2. In the face of the evidence that Wegener put forward in support of continental drift, why did many scientists reject the idea at the time?
3. How do convection currents work?
4. How does the rift zone form at the top of a mid-ocean ridge?
5. As plates move away from each other at the mid-ocean ridges due to sea-floor spreading, what forms in their place?

# 6.2 The Earth has a solid core

The Earth is made of several layers. We live on the crust (or lithosphere). Under the crust is the molten rock that makes up the mantle. Next, there is the core, which has two layers. The outer core is liquid iron and nickel, while the inner core is solid.

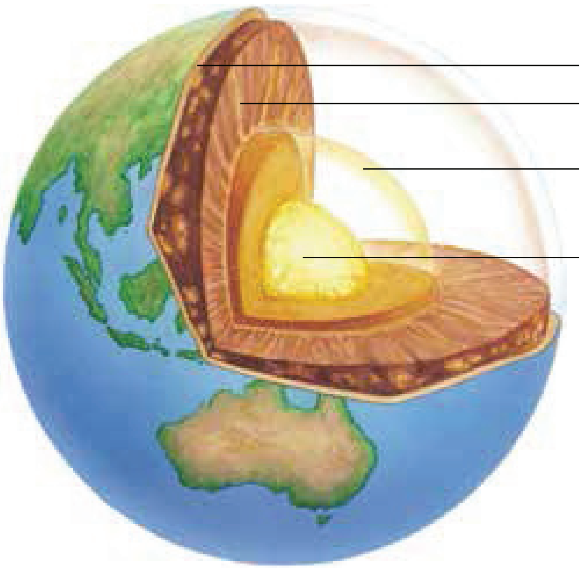


**Figure 6.6** Layers of the Earth.

## What is the Earth made of?

Although the Earth can be described as a solid planet, it began as a ball of molten materials. Scientists believe the Earth and other planets are the result of an explosion billions of years ago. According to this theory, the Earth began as a molten fragment from this explosion. As it hurtled through space, the outside layers cooled, forming a ball of solid rock and ice. The Earth's surface has continued to slowly change and is still changing – many rocks have worn down to form soil and sand, mountains and valleys have formed and the land and oceans have changed shape. Some of this change is caused by weathering and erosion at the surface. Other changes are due to the movement of the molten rocks from deeper down, which in places push their way up to the surface and also move sections of the Earth's crust.

If you could make a journey deep inside the Earth, you would find that it is made of several layers.

### Crust

The **crust** (or lithosphere) is the outer layer (7–50 km thick) of the Earth. It is made up of rocks and minerals and a lot of it is covered by water. The Earth's crust is the thin outer coating of the planet, like the shell on an egg. The Earth's surface is not smooth. It has hills, mountains, valleys, oceans and deserts. In fact, 70% of the crust is covered by oceans. The crust is thickest under the continents and thinnest under the oceans. Compared to the rest of the Earth's layers, the crust is very thin and brittle.

### Mantle

The **mantle** is below the crust. It is about 2800 km thick. Temperatures near the crust are about 500°C and at the bottom of the mantle reach 3000°C. Although the bottom of the mantle is solid, nearer the top the rock slowly moves due to convection currents. The top part of the mantle is more like modelling clay than solid rock. It is the source of volcanoes and earthquakes.

### Core

The **core** is the centre of the Earth. It consists of the outer core and the inner core. The outer core is made mainly of metals, not rock; the main metal is iron, possibly with some nickel. It is very hot and liquid, with temperatures ranging from 4000°C to 6000°C. The heat comes from nuclear reactions and some of the heat is left over from when the Earth was formed. The outer core gives the Earth its north and south poles and magnetic field.

EXPERIMENT 6.2: COOLING AND LAYERS
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CHALLENGE 6.2: MODELLING THE PARTS OF THE EARTH
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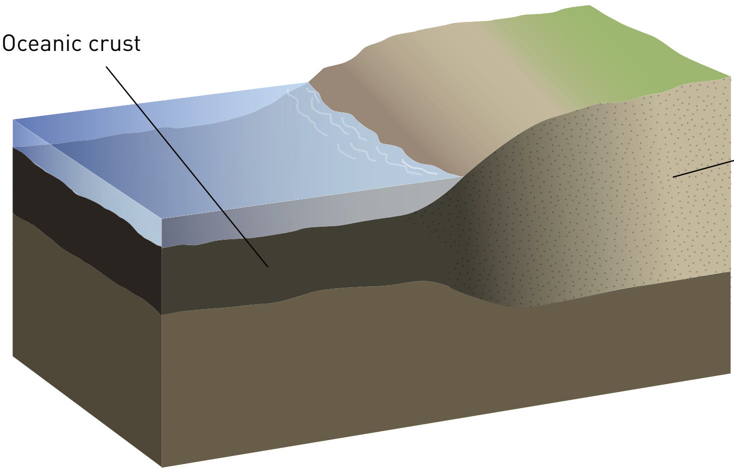


**Figure 6.7** The oceanic crust is thinner beneath the ocean than it is beneath the continents.

The temperature of the inner core is almost 10 000°C. The inner core does not melt or boil because of the force of the rest of the Earth pushing down on it. Of course, no geologist has ever seen the core. Even our deepest mines only penetrate a few kilometres of the Earth's crust.

## The moving crust

The crust is broken into a number of pieces called tectonic plates. These plates float on the semiliquid magma at the top of the mantle. The speed of movement is similar to fingernail growth: between 1 cm and 10 cm per year. Sometimes the tectonic plates crash into one other, causing one plate to slide under another. The plate on top buckles under pressure, pushing the land upwards. For example, the Indo-Australian Plate is sinking under the Eurasian Plate. This has caused the Eurasian Plate to buckle, pushing up the world's highest mountain range, the Himalayas.

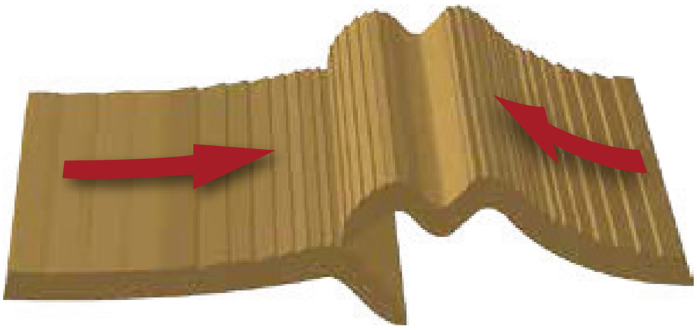

**Figure 6.8** Colliding plates cause the Earth to buckle.

## Check your learning 6.2

### Remember and understand

1 In which layer of the Earth are the tectonic plates found?

2 If the Earth has a radius of about 6370 km, use the information about the crust and the mantle to work out the thickness of the Earth's core.

### Apply and analyse

3 'The Earth's crust is the same thickness everywhere.' Discuss why you agree or disagree with this statement.

4 Could Figure 6.8 model the formation of the Andes Mountains? If so, which plate would be the South American Plate in the diagram?

# 6.3 Boundaries between the tectonic plates can be converging, diverging or transforming

Plate tectonics explains a wide range of features of the Earth. These features, once studied separately, can now be unified by a single concept: plate behaviour at plate boundaries. There are three general types of plate boundaries, based on the direction of plate movement. At transforming boundaries, plates slide past one another; at converging boundaries they come together; at diverging boundaries they move apart.

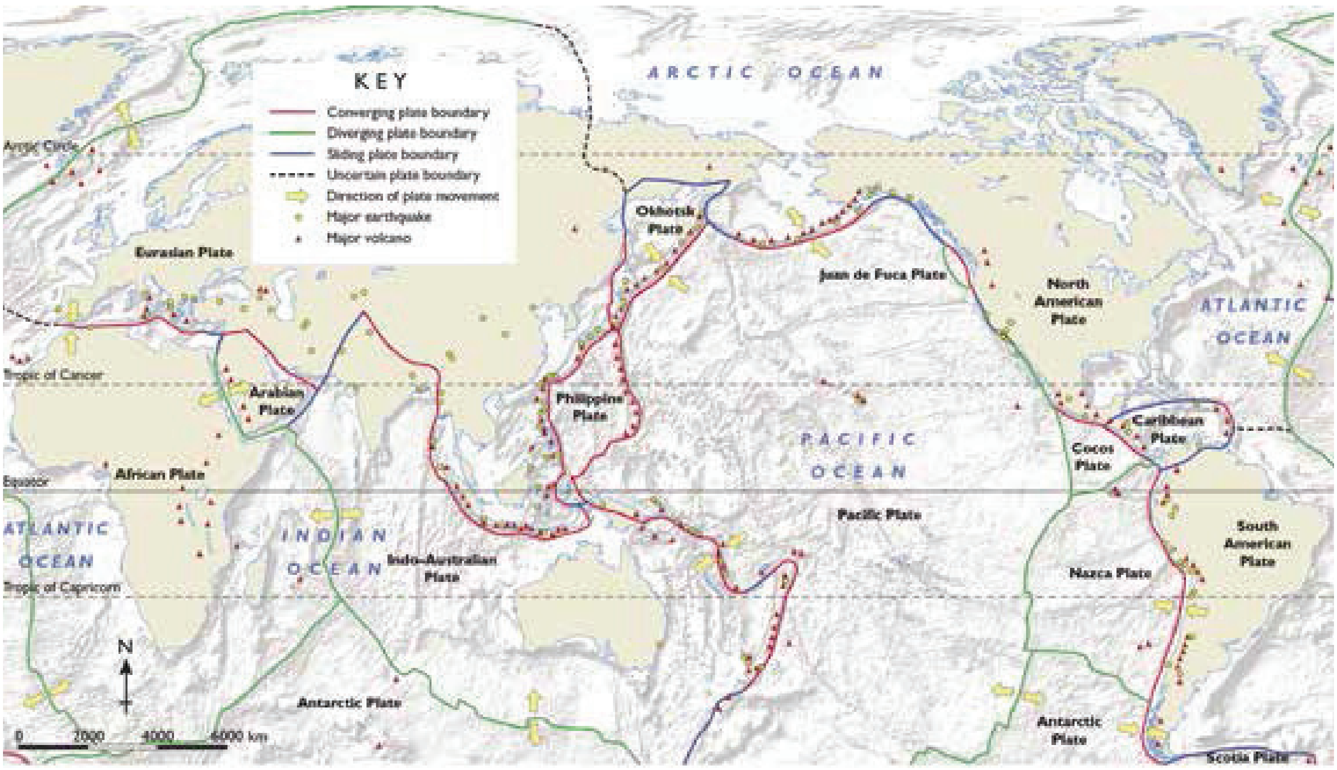


**Figure 6.9** The ring of fire is an area around the Pacific Ocean where a large number of volcanoes are found. This provided hints of a tectonic boundary.

**CHALLENGE 6.3:** MODELLING PLATES
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## Transforming boundaries

One plate can slide past another along a single fault line (Figure 6.10). This is called a **transforming boundary**. A **fault** is a fracture in rock where movement has occurred.

The two plates involved in a transforming boundary can become jammed over a period of time until the pressure builds up and the plates slip. This slipping causes earthquakes such as the large earthquake that destroyed San Francisco in 1906, where the rock of the transform fault slipped by up to 5 metres.

Plate material is not created or destroyed; the plates just slide against each other.

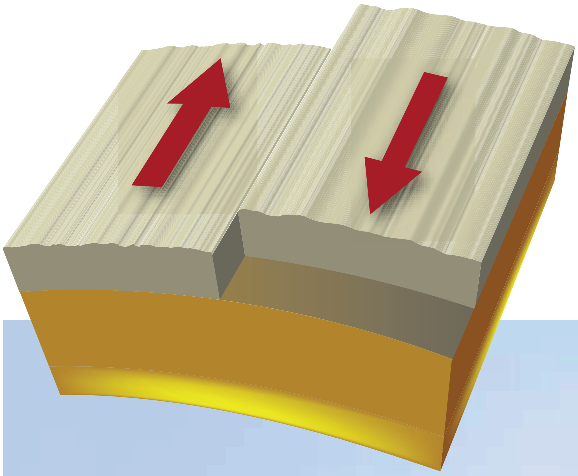

**Figure 6.10** Transforming boundaries: one plate slides against another.

**Figure 6.11** A satellite image of the Southern Alps, New Zealand. The Alpine Fault, a transform boundary, runs along the western edge of the snowline on the South Island.

**Figure 6.12** The San Andreas Fault in the USA

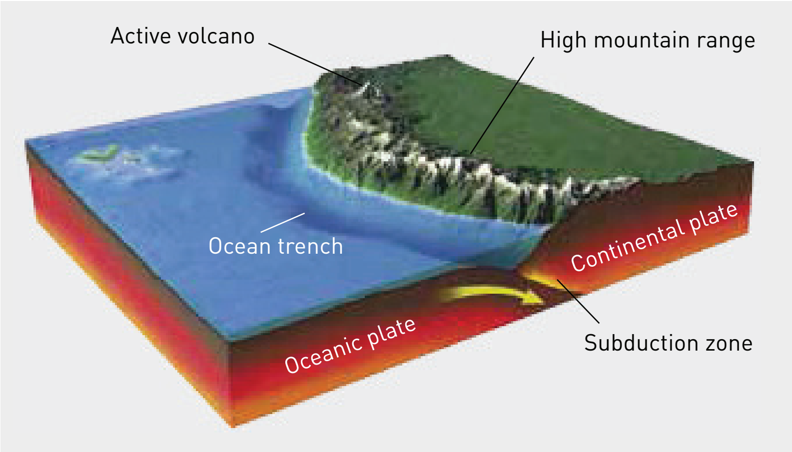


**Figure 6.13** Ocean-to-continent collision causes subduction, and creates mountains, volcanoes and ocean trenches.

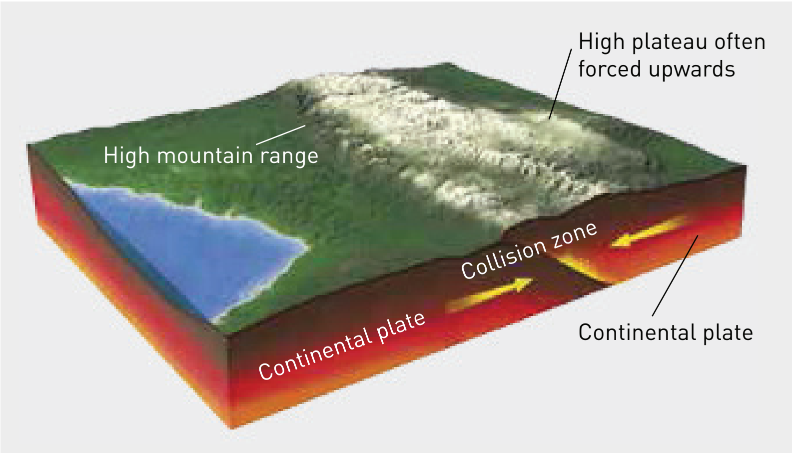


**Figure 6.14** Continent-to-continent collision creates high mountain ranges.

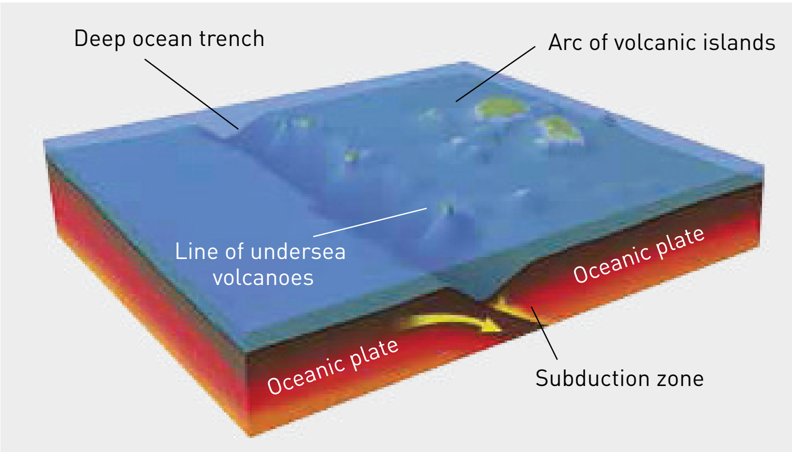


**Figure 6.15** Ocean-to-ocean collision causes subduction and creates a trench and a line of undersea volcanoes.

## Converging boundaries

At converging plate boundaries, two plates move towards each other. There are generally three types of converging boundaries, depending on the plates involved. Mountain ranges, volcanoes and trenches can all be formed by **converging boundaries**.

Many of the world's major landforms are formed by the collision of plates at converging boundaries.

### Ocean-to-continent collision

When oceanic crust collides with continental crust, the oceanic landform is pushed downwards into the mantle because it is denser. This is known as **subduction**. It creates a line of mountains along the crumpled edge, and also volcanoes as heat rises up through cracks in the crust. An **ocean trench** may form at the line of plate contact.

### Continent-to-continent collision

When two continental plates collide, they have similar densities, so no subduction takes place. Instead, the edges of the two plates crumple and fold into high mountain ranges.

### Ocean-to-ocean collision

When two oceanic plates collide, the older, denser crust will subduct below the newer crust, creating a deep ocean trench. The subduction also creates a line of undersea volcanoes that may reach above the ocean surface as an island arc.

## Diverging boundaries

**Diverging boundaries** or spreading plate boundaries form different features from **converging** and **transforming** boundaries. These spreading boundaries can occur in the middle of the ocean or in the middle of land. The breaking up of the supercontinent Pangaea was probably due to **diverging** plate boundaries. Hot rising mantle rock from deep within the Earth might be the first step in a continent breaking apart. As the mantle rock rises, the continental crust is lifted and thins out. Cracks form and large slabs of rock sink into the Earth, forming a **rift valley** like those found in East Africa.

**Figure 6.16** The East African rift valleys may represent the initial stages of the breaking up of a continent.

## Making oceans

As the divergence process continues, the continental crust separates and a narrow sea or lake may form. The Red Sea between the Arabian and African plates is thought to be a diverging boundary at this stage of development. Eventually oceans are formed and a **mid-ocean ridge** is created.

Mid-ocean ridges are very wide – up to 4000 km. Sea-floor spreading occurs at a rate of only 5 cm per year, but none of the ocean floor is dated as older than 180 million years.

**Figure 6.17** The Red Sea has formed as the African and Arabian plates have diverged.

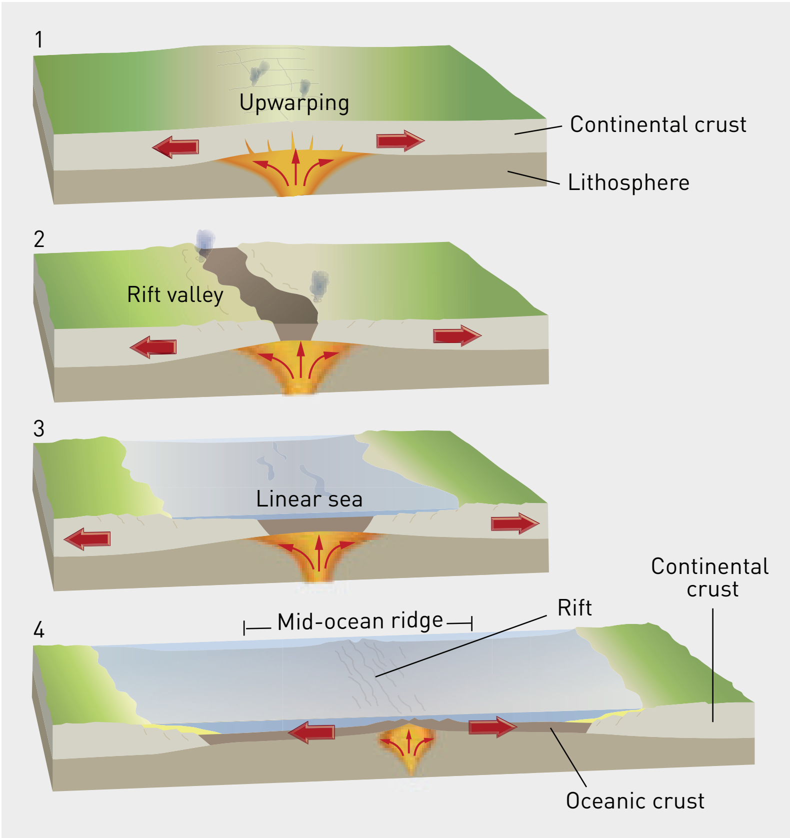


**Figure 6.18** How diverging boundaries form oceans.

### Check your learning 6.3

#### Remember and understand

1. What type of plate movement happens at a transforming boundary?
2. What causes the continental crust to spread and break at a diverging boundary?
3. According to Figure 6.9 where are the major mid-ocean ridges located?
4. According to Figure 6.9 where are diverging plate boundaries located?
5. What determines which plate subducts at a converging boundary?
6. Why would diverging boundaries produce earthquakes and volcanic activity?
7. Transforming boundaries are sometimes called strike–slip fault zones. Why do you think both names are appropriate?

#### Apply and analyse

8. According to Figure 6.9, in relation to the tectonic plates, where do most volcanoes occur? Is this the same for earthquakes?

# 6.4 Tectonic plates can be constructive or destructive

The boundaries between the tectonic plates create a lot of pressure as they try to move against each other. This pressure can be released suddenly in the form of a destructive earthquake, which in turn can form a tsunami. The crust of the Earth can also be very thin and this allows the molten mantle to escape and become lava. This lava may eventually construct new islands.

**Figure 6.19** The San Francisco earthquake in 1906 destroyed much of the city.

## Earthquakes causing tsunamis

Undersea earthquakes can move the sea floor and push up the water to form waves known as **tsunamis**. The earthquake in northern Japan in 2011 was a magnitude 9.0 on the Richter scale. The earthquake was centred 140 km off the coast and sent a 10-metre-high wall of water towards coastal towns and cities. The tsunami wave also travelled away from Japan, right across the Pacific Ocean, and was experienced as far away as North and South America, the Pacific Islands and even in northern Australia as a small wave.

Japan is the most seismic country in the world because it lies near the boundaries of three tectonic plates: the Pacific, Eurasian and Philippine plates. The force of a tsunami can be enormous, enough to demolish buildings and lift cars, and even small ships.

## Volcanoes causing tsunamis

Volcanoes pose great dangers to those who live near them. The volcanic eruption of Krakatoa in 1883 caused a tsunami that raced across the ocean and crashed onto nearby islands, killing 36 000 people. The blast was heard 5000 km away and ash rose 80 km into the atmosphere.

Volcanic eruptions spew lava and ash onto the surrounding land. When this material is broken down by the action of wind and water, and mixed with organic material from plants and animals, it forms some of the richest

CHALLENGE 6.4: VOLCANIC BUBBLES
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soil in the world. So, in spite of the dangers, people continue to live near volcanoes because of the fertile soil they provide.

## Hawaiian Islands

The Hawaiian Islands are in the centre of the Pacific Plate (see Figure 6.21, page 126). Hawaii is not near a mid-ocean ridge, yet it has frequent volcanic activity. Most geologists believe this volcanic activity is caused by the movement of the Pacific Plate over a 'hot spot' beneath the plate. This is where a plume of hot magma from the mantle comes up through a thin area in the crust and creates a volcano. In the case of the Hawaiian Islands, the hot spot formed an undersea volcano. Over time, the volcano grows until it pokes above the ocean surface and creates an island. As the plate moves over the hot spot, other islands are built over millions of years and an island 'chain' is created.

The centre of a plate usually lacks earthquakes, volcanoes or folded mountain ranges because it is a long way from a plate boundary, although these landforms are still possible in areas of weakness or thinning. The theory of plate tectonics and what happens at the plate boundaries corresponds nicely with the distribution of earthquakes and volcanoes around the world. Consider Australia's location and the frequency of earthquakes and volcanoes on our continent.

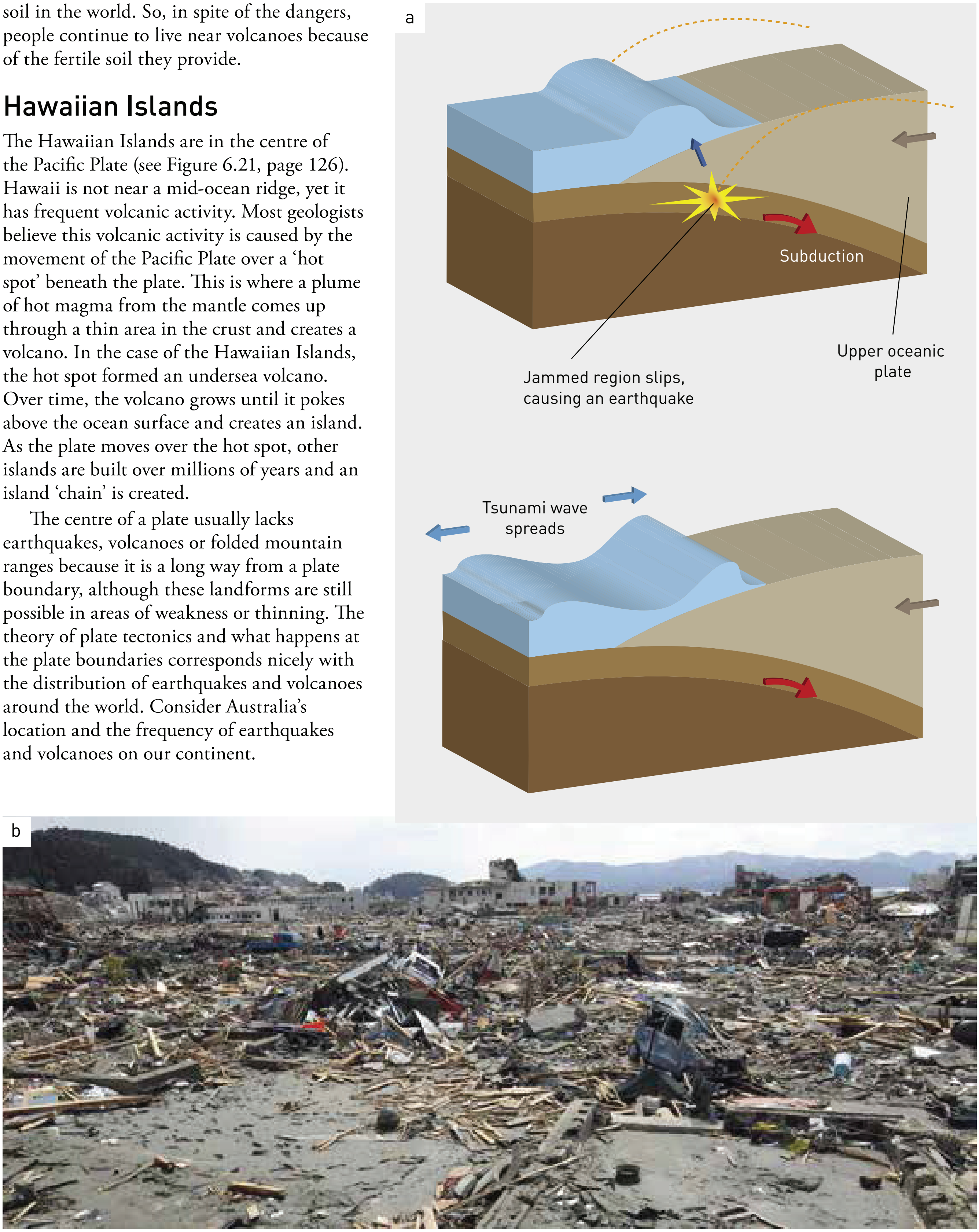


**Figure 6.20** (a) How an earthquake causes a tsunami. (b) The aftermath of the earthquake and tsunami in northern Japan in 2011.

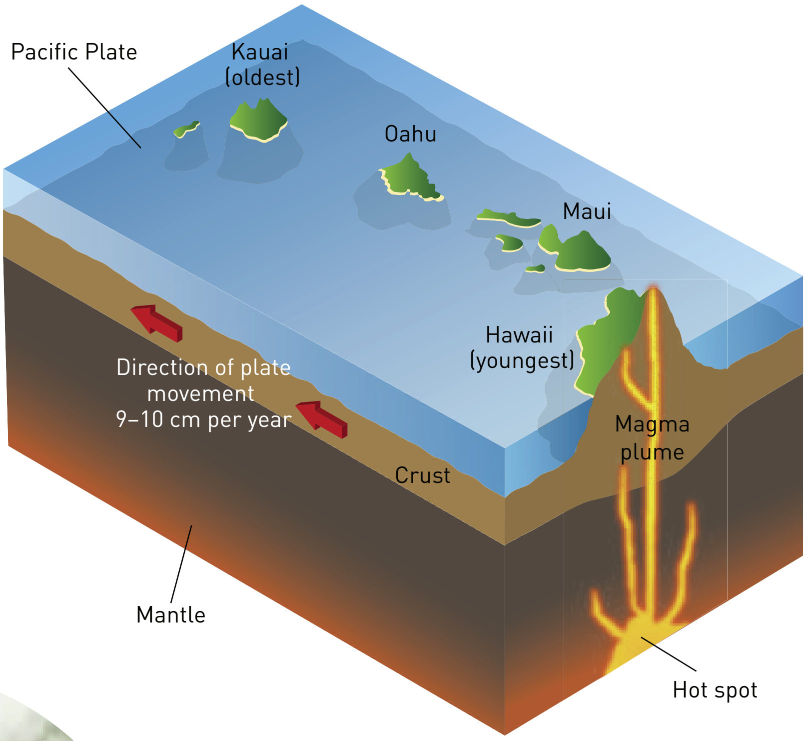


**Figure 6.21** How the Hawaiian Islands were formed. (Only the largest islands are shown.) Hot spots result from magma pushing through the thin crust of the Earth.

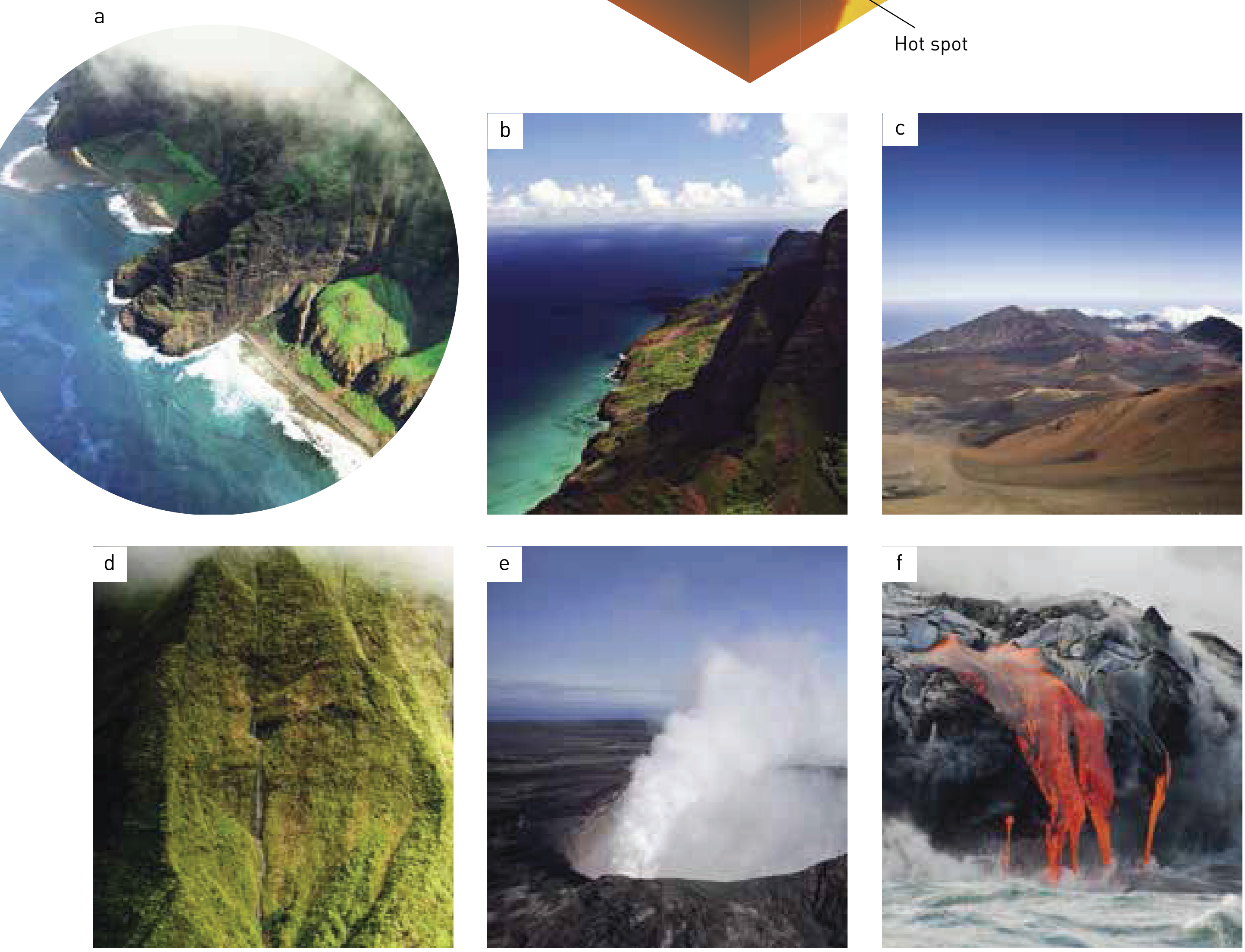


**Figure 6.22** There is much evidence of volcanic activity on the Hawaiian islands such as (a) rocks that appear to flow into the sea formed from old lava flows, (b) mountains that rise out of the sea, (c & d) volcanic rock formations, (e) steam that rises from craters and (f) lava that flows from active vents.

## Earthquakes in Australia

Unlike New Zealand, Australia is not located near a plate boundary and so our earthquake activity is minimal. However, there are still more than 300 magnitude 3.0 or greater earthquakes in Australia every year. Our plate, the Indo-Australian Plate, is moving north towards the Eurasian, Philippine and Pacific plates. This creates stress within our plate and release of this stress creates earthquakes.

One of Australia's worst earthquakes was of magnitude 5.6 and struck near the city of Newcastle in New South Wales on 28 December 1989. It killed 13 people and injured another 160. Larger earthquakes have occurred in Australia, but the damage depends on how close they are to the surface and to large cities. A huge earthquake in the outback is unlikely to cause large loss of life.

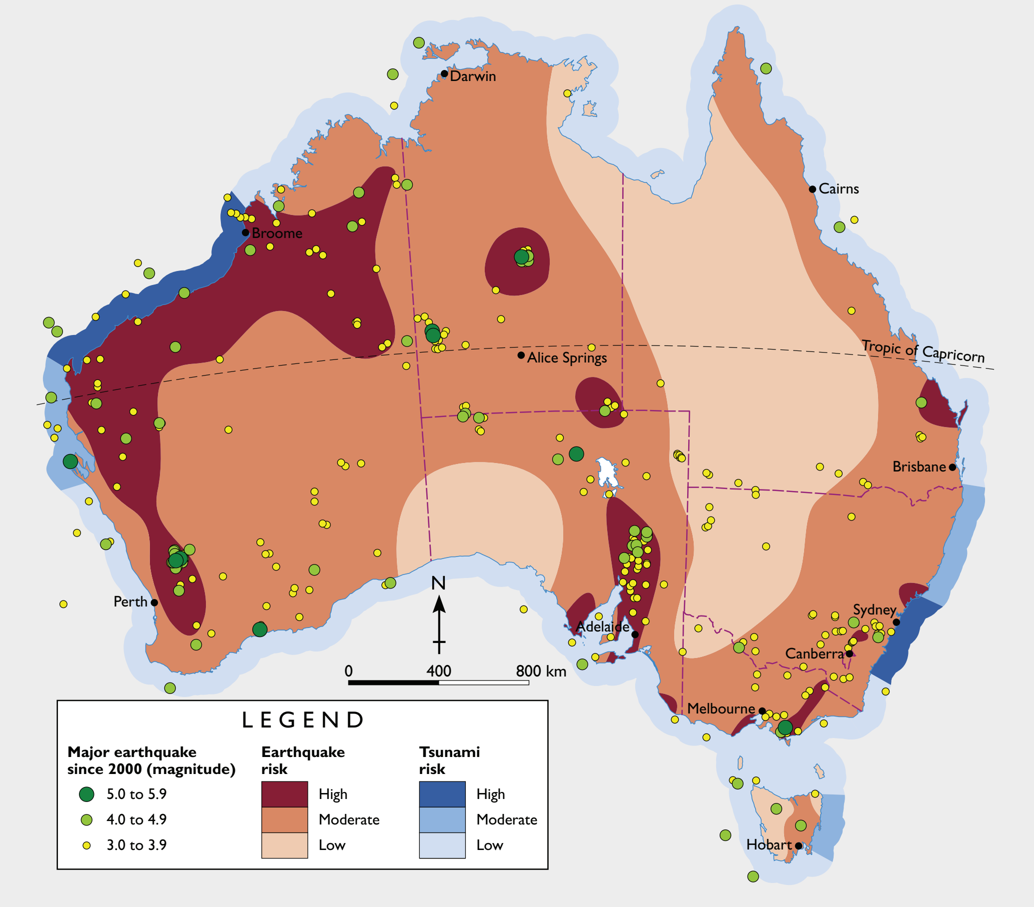


**Figure 6.23** Australia: earthquake and tsunami risk.

### Check your learning 6.4

#### Remember and understand

1. Describe two ways the movement of plate tectonics can be destructive.
2. What is a tsunami?
3. Where do most earthquakes occur? Suggest a reason why.
4. How can the movement of tectonic plates be constructive?
5. Why are there few earthquakes in Australia?

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# 6.5 What will the Earth look like in the future?

Plate tectonics is an ongoing process that will have a major effect on the shape of the Earth over the next 50 million years and beyond. If the motion of the continents continues at the same rate as today, portions of California will separate from the rest of North America, the Mediterranean Sea and Italy's 'boot' will disappear, Australia will move north and become linked to the rest of Asia, and mainland Africa will separate from East Africa and a new sea will form.

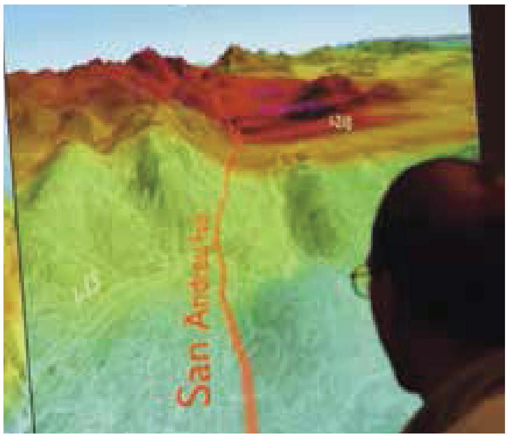


**Figure 6.24** Scientists produce maps and animations that help to explain the Earth's geology to more and more people.

**Figure 6.25** A global positioning satellite base station

## A future Earth

The theory of plate tectonics proposes that the Earth's continents are moving at the rate of a few centimetres each year. This is expected to continue, so that the plates will take up new positions. Forecasting future continental motion is a popular area of geology and draws on new insights, theories, measurements and technologies.

Geologists can measure changes in the continents' positions with great precision using global positioning satellites (GPS) and small base stations in remote areas of the planet. Base stations are carefully selected to represent known locations and act as calibrators for GPS systems.

At present, the continents of North and South America are moving west from Africa and Europe. Researchers have produced several models that show how this plate movement might continue into the future. Since the theory of plate tectonics was proposed, geologists have worked hard to discover what it revealed about the Earth's past. The supercontinent of Pangaea was the result.

In the 1970s, US geologist Robert Dietz proposed that 10 million years from now, Los Angeles will be moving north and passing San Francisco. For his predictions, he focused on the San Andreas Fault in California in the USA. Some modelling predicts that Africa will continue drifting north, joining up with Europe and eliminating the Mediterranean Sea, replacing it with the Mediterranean Mountains. The continents of North and South America may continue to move across the Pacific Ocean until they begin to merge with Asia. This new supercontinent might be known as Amasia.

US geologist Christopher Scotese and his colleagues have mapped out the predicted positions several hundred million years into the future as part of the Paleomap Project. According to their predictions, in 250 million years North America will collide with Africa while South America will join with South Africa. The result will be the formation of a new supercontinent, Pangaea Ultima, encircling the old Indian Ocean. The massive Pacific Ocean will stretch halfway across the planet.

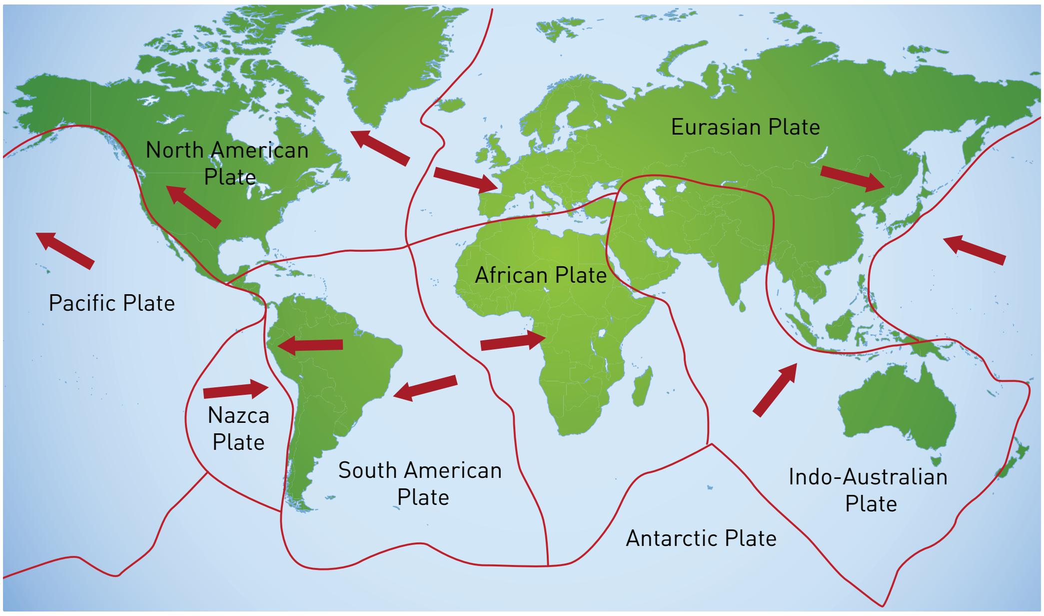


Figure 6.26 The present-day movement of the world's tectonic plates

The formation of another supercontinent will dramatically affect the environment. The collision of plates will result in mountain building, changing climate patterns, and decreasing global temperatures and increasing atmospheric oxygen. These changes will have significant effects on organisms as massive extinctions occur and different organisms emerge. The supercontinent will insulate the Earth's mantle, concentrating the flow of heat and resulting in more volcanic activity. Rift valleys will form, causing the supercontinent to split up once more.

Scientists believe that, in the next few decades, progress in geology is likely to reveal more about the Earth's inner workings, making the art of plate forecasting easier.

While peering hundreds of millions of years into the future may seem like a stretch, geologists consider such spans of time to be the blink of an eye.

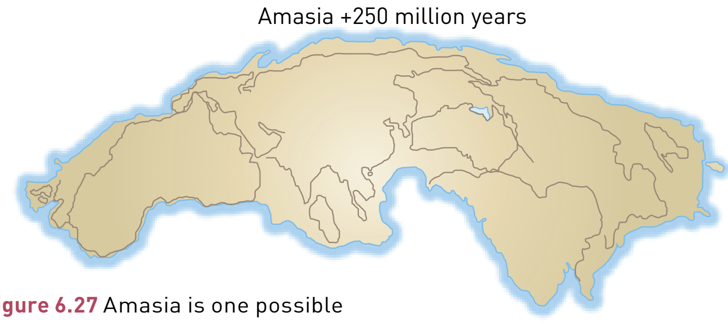


Figure 6.27 Amasia is one possible supercontinent modelled by geologists.

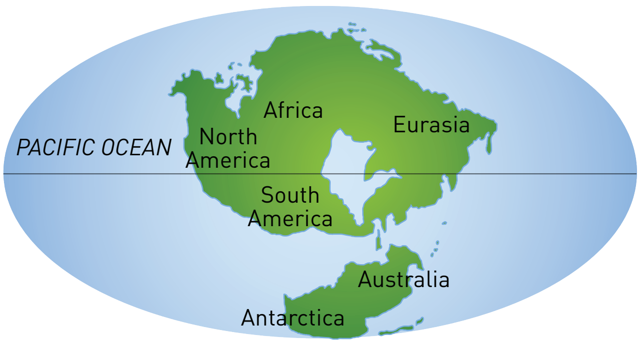


Figure 6.28 Pangaea Ultima: the world in 250 million years according to predictions by Scotese.

## Extend your understanding 6.5

1 What could happen to Los Angeles and San Francisco as their plate motion continues?
2 How would future inhabitants of the Earth know that the Mediterranean Mountains were once under the sea?
3 What might be a good name for the merging of Africa and Europe?
4 If 50 million years is represented by 4 days, what would a month (30 days) represent? Using this scale, how old is the Earth?
5 Why do rift valleys cause a supercontinent to break apart?

* REVIEW

6

## Remember and understand

1 Match the following terms with their definitions.

| TERM | DEFINITION |
|---|---|
| Mantle | Centre part of the Earth |
| Crust | Layer of hot, semi-molten rock below the crust |
| Oceanic crust | Theory that states that the continents moved through oceanic crust |
| Continental crust | Theory that states that large plates of the Earth's crust gradually move |
| Plate tectonics | Less dense crust containing continents |
| Tectonic plate | Hot liquid rock that comes up from the mantle |
| Continental drift | Thin, semi-rigid outer layer of the Earth |
| Convection current | Large area that may include continent and sea floor |
| Magma | Dense crust under the sea floor |
| Core | Movement in liquids or gases caused by the rising of hot material |

2 Write a definition or description for:
   a subduction
   b rift valley
   c transforming fault
   d diverging boundary
   e converging boundary
   f ocean trench
   g mid-ocean ridge
   h sea-floor spreading.

3 What was Pangaea and what happened to it?

4 What evidence did Alfred Wegener use to support his theory of continental drift?

5 What provides the force for moving the tectonic plates over the surface of the Earth?

6 What causes major volcanic eruptions and earthquakes?

7 If Australia moves north to collide with Indonesia and Malaysia, what geographical features will form and how will our climate change?

## Apply and analyse

8 Most earthquakes occur at plate boundaries. How can an earthquake occur in the middle of a plate?

9 Why can't continental crust be subducted?

10 How does sea-floor spreading account for the young age of the sea floor?

11 The Himalayas formed when India collided with the Eurasian Plate. Mt Everest, the highest mountain on the Earth, is 8848 metres high and continues to be uplifted at a rate of about 1 cm per year. How high might Mt Everest be in 1 million years if it maintains its current rate of increase?

12 Examine Figure 6.29, which shows a topographic image of the Mid-Atlantic Ridge. Explain how this provides evidence for sea-floor spreading.

Figure 6.29

13 If a part of the Pacific Plate is moving at a rate of 10 cm per year, how far would it move in 100 years? In 10 000 years? In 1 million years?

14 Why are modern GPS systems useful for predicting future plate movements?

## Evaluate and create

15 Create a poster or multimedia presentation about a famous earthquake or volcanic eruption. List the facts of the earthquake or volcanic eruption and what plate movement caused it, along with the social, environmental and economic impacts and the subsequent recovery process.

16 The Mariana Trench is located where the Pacific Plate is subducting under the Mariana Plate. Its average depth is 11 km below the surface of the water. Surprisingly, ocean explorers have found life at the bottom of the Mariana Trench. Find out what lives so deep and how it survives.

17 Imagine you could travel into the future, to a time when your local environment is drastically different from how it is today. Base your imagined future on the scenarios of plate movement described in the text. Write a travel brochure for a future tourist destination or journey on this new Earth.

18 Once there was one supercontinent called Pangaea. Initially it split in two. One part, Laurasia, moved north while the other, Gondwanaland, moved south. Laurasia gave rise to Europe, Asia and North America. Gondwanaland gave rise to Africa, South America, Australia, India and Antarctica. Consider the climate changes each continent faced as it drifted to its current position and why, today, there are few links remaining between the plants and animals that originally inhabited the Gondwanaland subcontinents.

## Research

19 Choose one of the following topics to research. Some questions have been included to get you started. Present your findings in a format of your own choosing, giving careful thought to the information you are communicating and your likely audience.

> **Subduction zones**
>
> The subduction of one plate under another is well understood by scientists today, but how this process begins is not. What do geologists mean by subduction? Which plates are involved in subduction? What happens to the plates during subduction? What geological features are associated with subduction zones? How do new subduction zones form?

> **The Earth's crust**
>
> The lithosphere and asthenosphere are different internal layers of the Earth. What is the lithosphere? What is the asthenosphere? How do the two 'spheres' interact? What other 'spheres' exist? How do they interact with the lithosphere and asthenosphere?

> **Convection currents**
>
> Although the theory of convection currents in the Earth's mantle is the most widely accepted theory about what drives plate movement, there are several other theories. What other theories exist? Choose one and find out what evidence supports the theory. Who proposed the theory? Why is it less accepted than the theory of convection currents?

> **Magnetic striping**
>
> Magnetic striping was considered by some to be the final proof of plate tectonics. What is magnetic striping? Where does it exist? How is it linked to sea-floor spreading? What does it tell us about the age of rocks? What does it tell us about the Earth's history?

6

# *KEY WORDS

**continental drift**
the continual movement of the continents over time

**continental shelf**
underwater cliffs between the beach and the ocean

**converging**
moving together

**converging boundary**
the boundary between two tectonic plates that are moving together

**core**
the centre of the Earth

**crust**
lithosphere; the outer layer of the Earth

**diverging**
moving apart

**diverging boundary**
the boundary between two tectonic plates that are moving apart

**fault**
a fracture in rock where the tectonic plates have moved

**magma**
semiliquid rock found beneath the Earth's surface

**mantle**
the layer of molten rock located beneath the Earth's crust

**mid-ocean ridge**
a series of underwater mountains that form as a result of tectonic plates moving apart and allowing magma to rise to the surface

**ocean trench**
a deep ditch under the ocean along a tectonic plate boundary

**plate tectonics**
the theory that the surface of the Earth is divided into a series of plates that are continually moving

**rift valley**
a deep valley that forms as a result of tectonic plates moving apart on land

**sea-floor spreading**
a theory that the middle of the ocean is spreading apart, forming new oceanic crust

**subduction**
the movement of one tectonic plate under another tectonic plate

**tectonic plate**
a large layer of solid rock that covers part of the surface of Earth; movement of tectonic plates can cause earthquakes

**transform**
to change form; tectonic plates transform when they slide past each other

**transforming boundary**
the boundary between two tectonic plates that are sliding past each other

**tsunami**
a series of large waves that result from an underwater earthquake