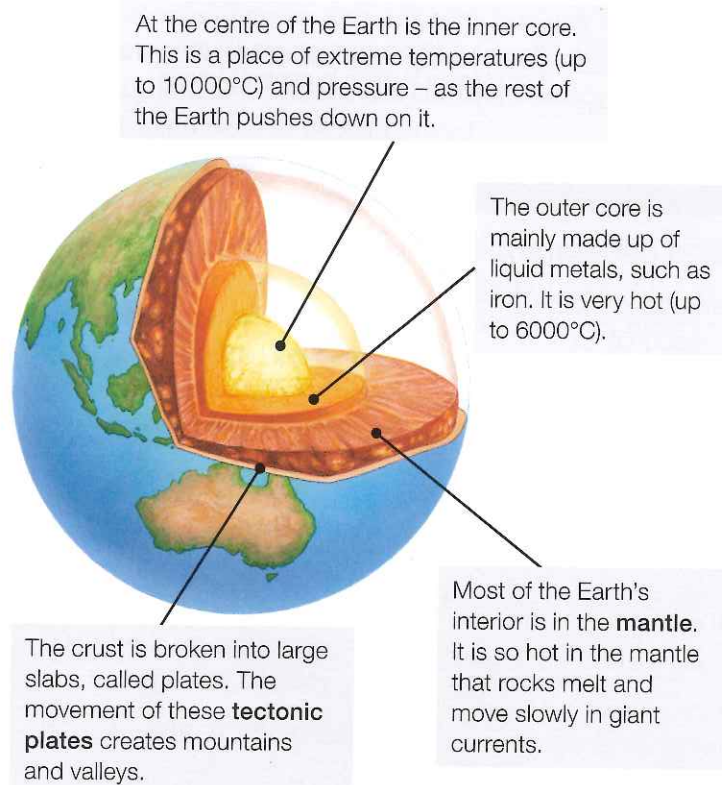


How mountains are formed

Mountains are formed where the surface of the Earth has been pushed upwards. Tremendous forces inside the Earth can crumple the surface into long mountain chains, such as the Andes or Himalayas, or punch right through the surface to create volcanoes, such as Kilauea on the island of Hawai'i and Mount Kilimanjaro in Tanzania. To understand how this happens you need to know about the world beneath your feet.

You may be used to thinking of the Earth as a solid ball like a giant shot-put, but this is far from the reality. The Earth is more like a giant peach with a thin skin and a core at the centre surrounded by soft flesh. Scientists believe that the Earth is made up of four layers (see Source 2.14).



Source 2.14 The Earth's layers

Tectonic plates

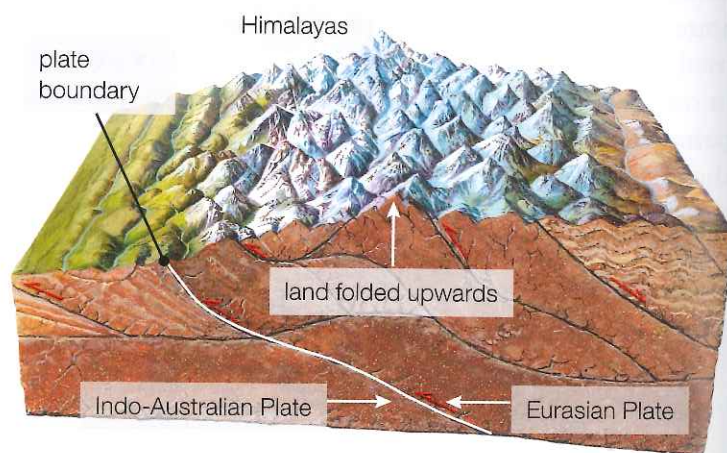
The outer layer of the Earth's surface (known as the crust) is broken into large pieces called **tectonic plates**. These plates are around 100 kilometres thick and fit together like enormous pieces of a jigsaw puzzle. Currents in the

red-hot molten material (**magma**) under these tectonic plates cause them to move about (see Source 2.14).

In some places, they are being pushed into one another (converging). This process creates mountain ranges. The world's highest mountain ranges such as the Himalayas and the Andes are located along a converging plate boundary.

In other places, tectonic plates are being pulled apart from one another (diverging). This process creates rifts in the Earth's surface that allow hot magma to ooze to the surface and create new land. The world's longest mountain range, the mid-Atlantic Ridge, is an undersea mountain range formed along a diverging plate boundary.

The movement of tectonic plates is also responsible for many other features and natural events on the Earth's surface, such as volcanoes and earthquakes. Volcanoes are formed when magma is pushed through an opening in the Earth's crust. Earthquakes are caused when the edges of tectonic plates push and grind against one other.



Source 2.15 The collision of tectonic plates caused the formation of the Himalayas.

Types of mountains

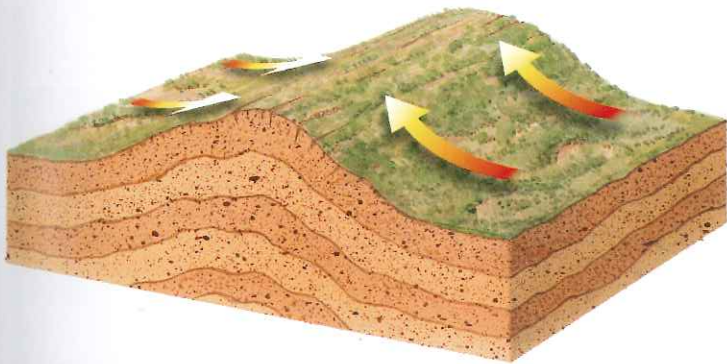
Mountains are classified according to how they were formed. There are three main types of mountains:

- 1 fold mountains
- 2 block mountains
- 3 volcanic mountains.

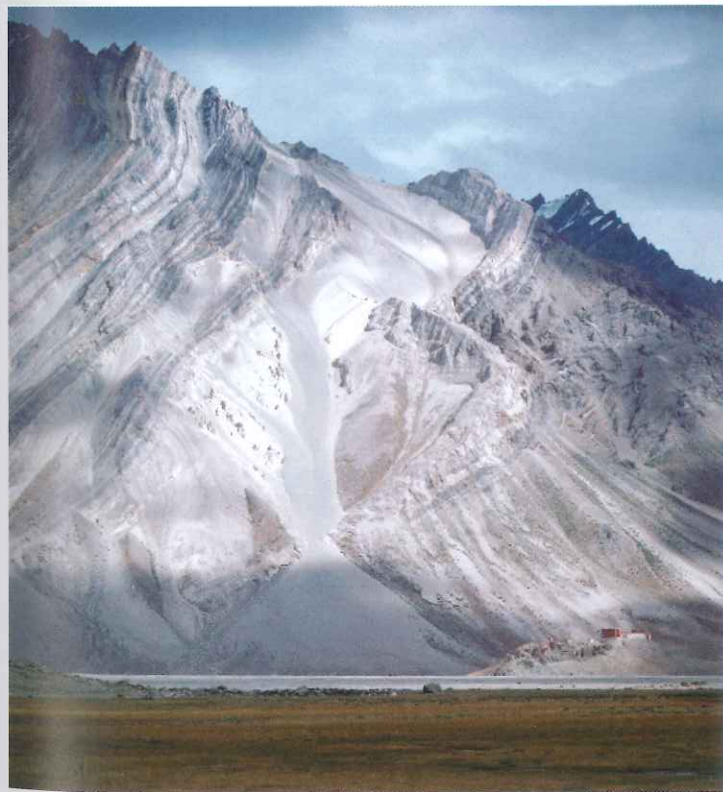
1 Fold mountains

Fold mountains are created by upward pressure where two tectonic plates collide. As the plates converge, layers of rock are buckled and pushed upwards creating fold mountains. Most of the world's highest mountain ranges are fold mountains.

The world's largest fold mountains are the Himalayas, which separate southern Asia from central Asia. They have been formed by the collision between the Indo-Australian plate and the Eurasian plate over the last 55 million years. Currents within the mantle are moving the Indo-Australian plate northwards, and its front edge is bulldozing into the Eurasian plate, folding the edges of both plates upwards.



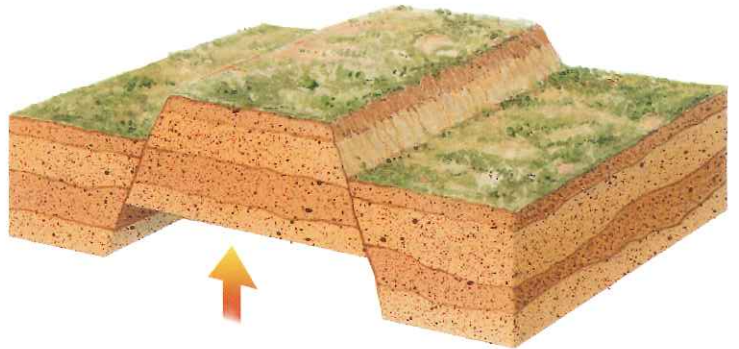
Source 2.16 Creation of a fold mountain



Source 2.17 These mountains on the edge of the Zaskar Valley in Ladakh, India, are clearly distinguishable as fold mountains.

2 Block mountains

Block mountains are created when cracks in the Earth's crust known as faults force blocks of land upwards. Rocks that are cooler because they are close to the surface tend to crack and break apart when compressed from the sides. Rather than folding, they are often lifted up in giant blocks along fault lines to create block mountains. Geologists refer to this mountain-building process as faulting.



Source 2.18 Creation of a block mountain



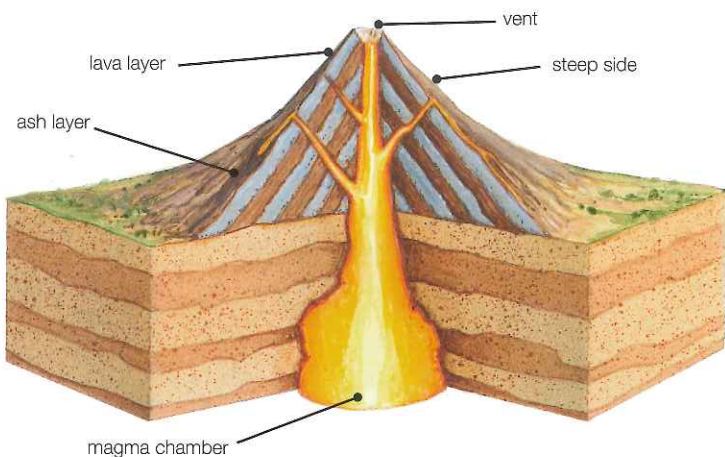
Source 2.19 Block mountains in the Arctic region of Norway

3 Volcanic mountains

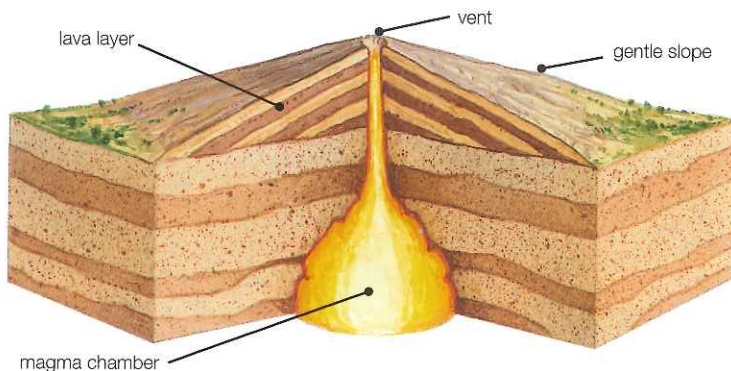
Volcanic mountains are created by volcanoes, as the name suggests. They are created when magma pushes its way from beneath the Earth to the crust. The material that comes out of a volcano builds up the Earth's surface, creating new land and new landforms.

Each eruption brings new material to the surface, as ash or **lava** or both. As lava flows across the surface it covers the rocks from previous eruptions and builds up the height of the land in layers. Runny lava can travel many kilometres from the crater and leave behind a shallow layer of new rocks over a wide area. These types of volcanoes are known as **shield volcanoes** (see Source 2.21).

The Hawaiian volcanoes and Mount Kilimanjaro in Tanzania are examples of shield volcanoes. The more familiar steep-sided volcanic cones (see Source 2.20), such as New Zealand's Mount Taranaki and Mount Fuji in Japan, are formed when lava and ash do not travel far from the crater. These materials are then left as a new layer on the sides of the cone, building it higher.



Source 2.20 A cutaway diagram of a volcanic cone



Source 2.21 A cutaway diagram of a shield volcano

Most of the world's volcanoes are located on or near plate boundaries where plates collide and one plate is forced downwards into the mantle. This causes pressure to build up and molten rocks, called magma, to rise to the surface and force their way out through a weakness in the crust. This is what we see as an eruption. Other volcanoes are located in **hot spots**, which are areas that are often in the centre of a plate where the mantle is particularly hot. In these places molten rock from the mantle is forced upwards through the moving crust.

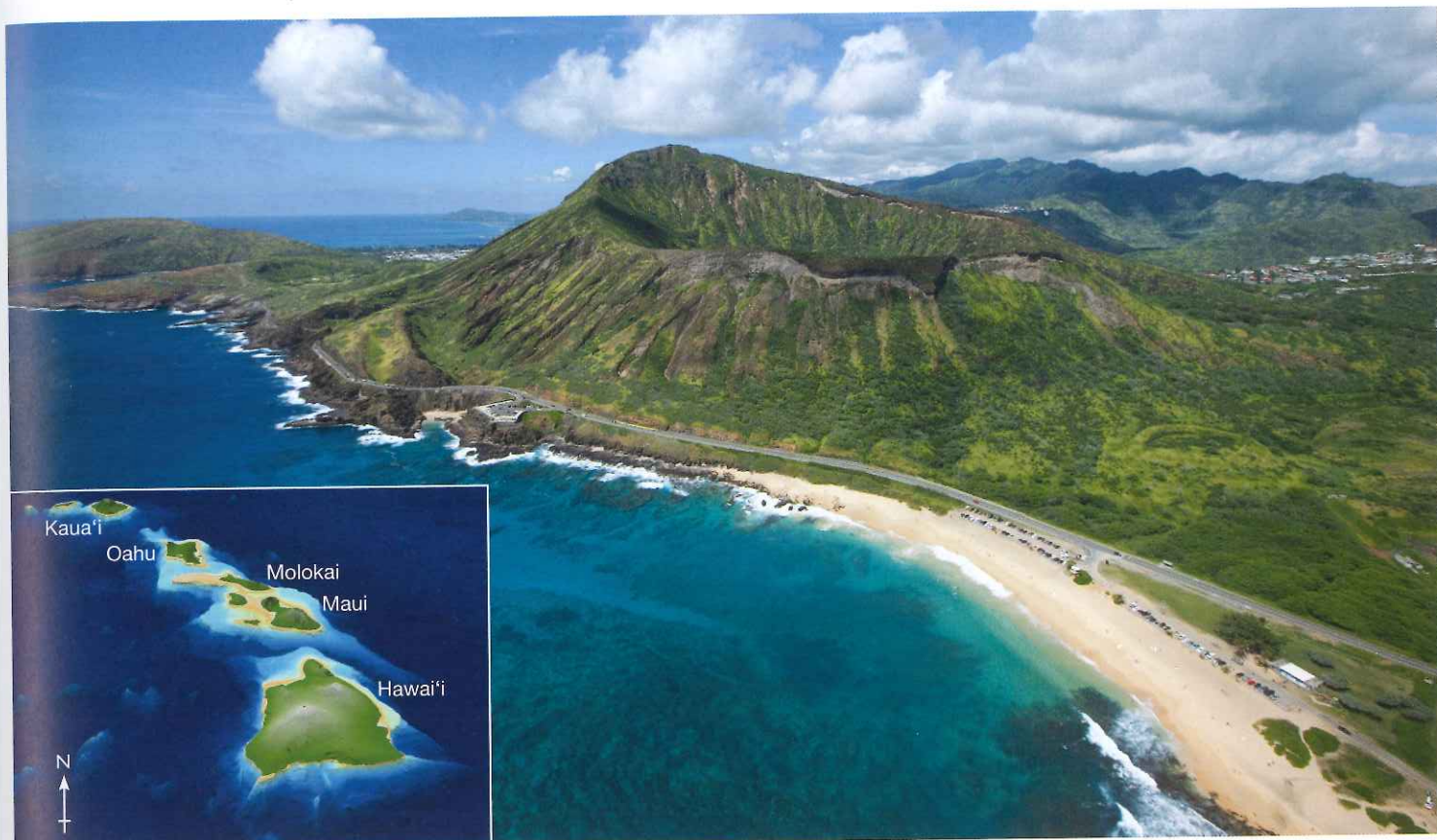
The Hawaiian Islands have been formed above a hot spot. As the Pacific Plate moves over the hot spot a line of volcanoes has been created. The oldest volcanoes have been eroded so that little remains above sea level. The newest island, Hawai'i, has many active volcanoes and is increasing in size every year.



Source 2.22 Mount Fuji in Japan is an example of a volcanic cone.



Source 2.23 Rangitoto Island in Auckland, New Zealand, is an example of a shield volcano.



Source 2.24 The Koko Crater on Oahu (main) and a digital terrain model of the Hawaiian Islands showing them sitting on top of a chain of massive volcanoes (inset)

Check your learning 2.4

Remember and understand

- 1 What are the four layers of the Earth?
- 2 In this section, the Earth is described as being more like a peach than a shot-put. In what ways is the Earth like each of these objects: an inflated balloon, an apple and an egg?
- 3 How do the Earth's tectonic plates move?
- 4 Describe the process of folding.
- 5 How does a volcanic eruption change the shape of the land?

Apply and analyse

- 6 What are the similarities between folding and faulting? What are the important differences?
- 7 Sketch and label a diagram of the block mountains in Norway (Source 2.19) to show how they are formed.
- 8 Explain why some volcanoes are steep-sided cones and some are not.
- 9 Why is every volcano in the world a different shape?

Evaluate and create

10 Scientists have been able to work out the age of the lava flows on each of the Hawaiian Islands. Here is their data with the age of lava in millions of years.

Island name	Age of lava (million years)
Kaua'i	3.8–5.6
Oahu	2.2–3.4
Molokai	1.3–1.8
Maui	0.8–1.3
Hawai'i	0.7

- a On which island is the oldest lava found?
- b On which island is the newest lava found?
- c How does this data support the theory that the islands formed as they passed north over a hot spot?
- d Which of these islands is the smallest?
- e Which of these islands is the largest?
- f Suggest a possible reason for this difference.