IN THE KNOW

Mountains and Volcanoes

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Accurate and reliable background information to underpin your geography lessons

Introduction

The soaring grandeur of mountains and the elemental power of volcanoes has always fascinated adults and children alike. Mountains may be tourist attractions or national symbols. They can denote a country's borders or become the source of its mineral wealth. They can be inspirational, spiritual and challenging; they are loved by artists, climbers and engineers alike.

The connection between mountains and volcanoes lies at the molten core of our planet, where the gradual cooling of Earth's core over millions of years has formed the mountains and volcanoes we see today. This geological formation of Earth is constant. Often in the news, volcanoes demonstrate the raw power of nature, and are a stark reminder of how our world was so violently created and how our human existence is dependent on a thin crust of Earth's surface that lies above these primal, elemental forces beneath. With all these elements, mountains and volcanoes give tremendous scope for developing a stimulating and creative topic.

What makes something a mountain and not a hill?

Any rugged outcrop of rock that is over 600 metres (2000 feet) in height above sea level is called a mountain. That is the definition used by the Ordnance Survey and the UK Government to define any mountain; it is also the standard used by many other countries. However, there is no internationally agreed standard for what constitutes the height a mountain. Some countries have their own criteria, starting at 1000 feet (350 metres) and not necessarily measuring from sea level.

Highest mountains in the United Kingdom

Scotland – Ben Nevis is the highest mountain in the UK at 1344 metres (4406 feet)

Wales – Snowdon in North Wales is the second highest mountain in the UK at 1085 metres (3560 feet)

England – Scafell Pike in the Lake District is the third highest mountain in the UK at 978 metres (3209 feet)

Northern Ireland – Slieve Donard in County Down is the fourth highest mountain in the UK at 852 metres (2795 feet)

FACT The highest mountain on land is Mount Everest at 8848 metres (29,029 ft).

FACT Mountains can also have their base under the sea, the tallest of which is the volcano Mauna Kea in Hawaii at 10,203 metres (33,474 ft) – it beats Everest by over 1000 metres.

How are mountains formed?

Mountains can be formed in several different ways:

- the collision of continental (tectonic) plates
- the faulting and folding of rocks
- the eruption of volcanoes.

Plate tectonics

The surface of Earth is made up of large plates or slabs, called **continental or tectonic plates** (Figure 1). These plates ride on red-hot molten lava, but so slowly that we rarely notice their movement. Occasionally these plates slip and collide, resulting in earthquakes and/or tsunamis. Over many millions of years, the continuous pressure of the plates colliding can cause them to lift and fold upwards to form mountains.

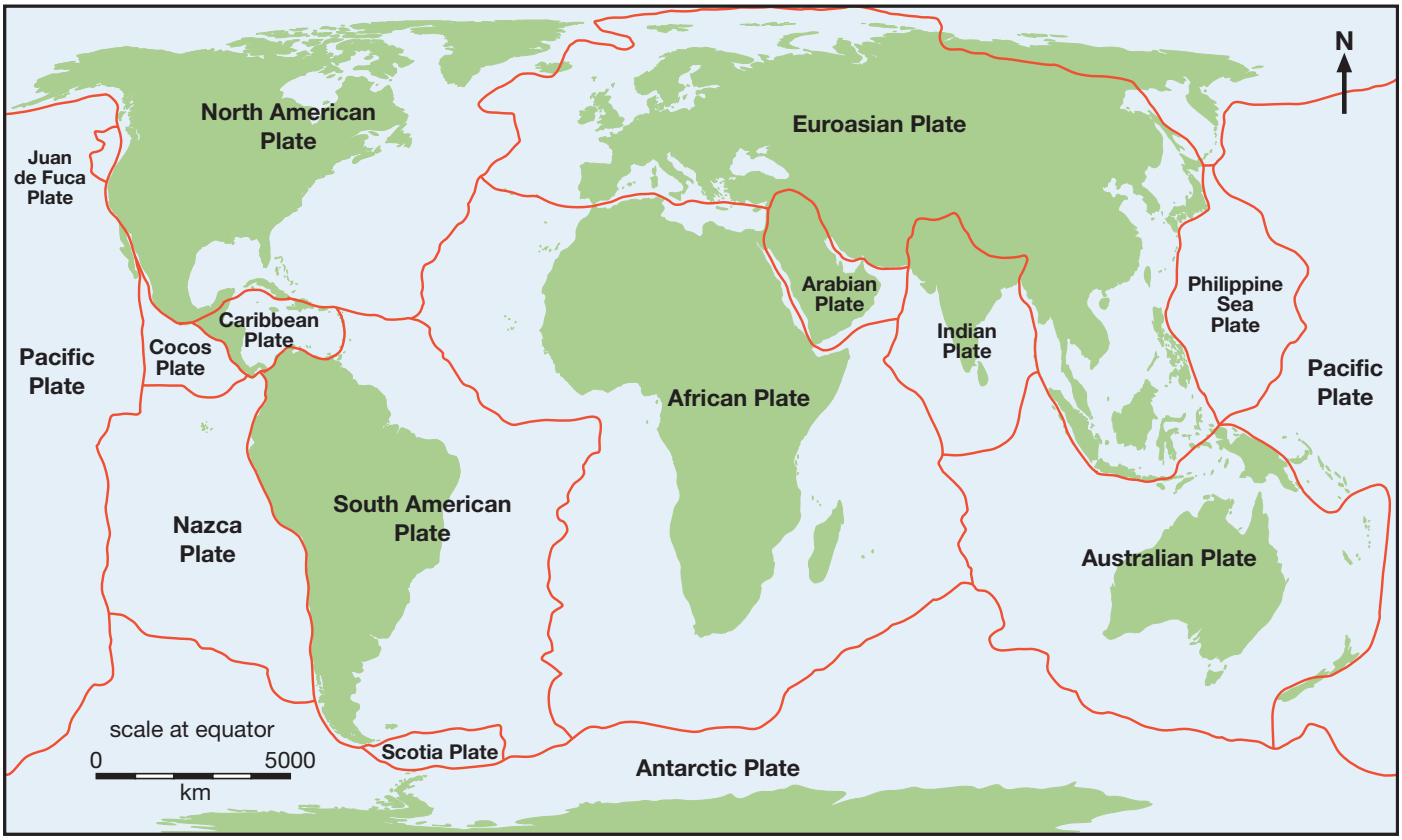

Figure 1: The continental or tectonic plates.

Fold mountains

As the plate layers lift and fold upwards they form ranges of mountain topped by individual peaks (Figure 2). These are called **fold mountains** and this type of geographical formation has created many of the mountain ranges found around the world. The Alps were formed this way, squeezed and sandwiched between the continental plates of Northern Europe and North Africa.

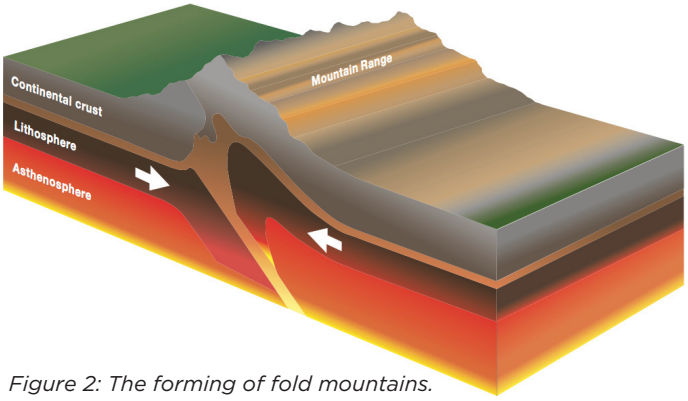

Figure 2: The forming of fold mountains.

The formation of many of these mountains or mountain ranges is continuous. Mount Everest is still growing at around 13 millimetres a year as the plates continue to push up the Himalayas.

Block mountains

Tectonic plates can also create up or down pressures on Earth's surface, causing rocks to shatter. This creates large **faults**, or cracks, in the rock material. When the pressure of tectonic plates pushes upwards it causes the formation of **block mountains** (Figure 3).

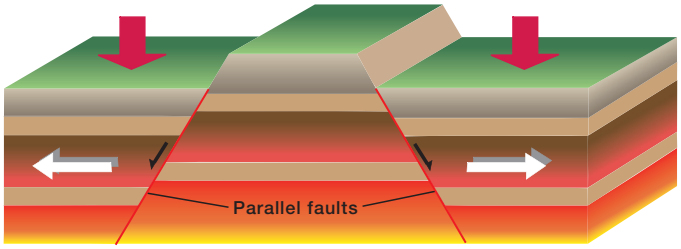

Figure 3: The forming of block mountains.

When slabs of rock slip downwards, which usually happens when the rock is softer in certain areas, it causes the formation of what are called **rift valleys** (Figure 4). The softer rock in these areas is gradually eroded to leave very sheer cliffs on the rock face.

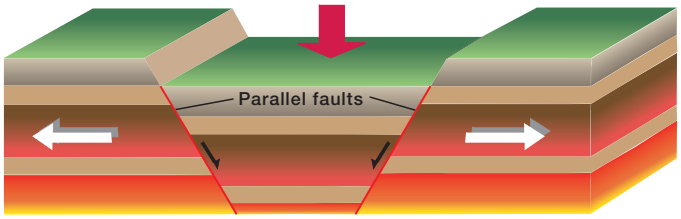

Figure 4: The forming of rift valleys.

FACT Most mountains are found in ranges, such as the Alps or the Himalayas. The longest mountain range is the Andes at 8000 kilometres long.

FACT Individual mountains tend to have been formed by volcanoes.

Figure 5: The Matterhorn was formed by glacial movement scouring around what became the peak. Photo © Martin Abegglen.

Mountain Features

What shapes a mountain?

Erosion

The shape and form of a mountain is greatly influenced by the forms of weathering and erosion that it is subjected to. **Weathering** is the gradual wearing away of rock by rain, ice, wind, rivers and glaciers. **Erosion** is the removal of the weathered remains from the surface. The softest rock is the first to erode, while harder rock survives longer and eventually creates the shape and form of the mountain.

Over millions of years the mild acidic content of rain will slowly wear away the rock. Water trapped in the cracks and fissures of rock expands when it freezes and the expanding pressure can crack the surrounding rock. Rivers made up of rain water falling on mountains can carve valleys and waterfalls, and as the river picks up and carries fractured smaller rocks in its path, more parts of the mountain are worn away.

Glaciers, very slow-moving masses of compacted ice and snow, can scour the sides of mountains with collected rubble, made up of fractured rock buried in their layers of ice. The extreme forces of glaciers can create mountain peaks called horns. The Matterhorn is a good example of a peak carved by a massive glacier during the ice age (Figure 5).

Corries are ice-scooped basins. They occur where a glacier has scooped out a section of a mountain. Corries often remain as lakes after the glacier has disappeared.

U shaped valleys are created when a glacier scours the sides and bottom of a valley, changing it from its V shape formed by the river, to a rounded U shape.

An Arête is formed when two adjacent glaciers create two U shaped valleys, leaving a narrow ridge of rock in between.

Weather and temperature

Mountain climates can be very changeable, with shifts of weather from sunshine to heavy rain, sleet and snow in a single day.

Clouds can form quickly over mountains, significantly increasing the amount of rain that falls and altering the temperature and wind level quite suddenly. The height of a mountain can create changes in the wind; as moving air warmed by the land rises to get over the top of the mountain it meets cold air and the wind speed increases as a result.

Temperatures on a mountain can vary enormously and the higher you climb the colder it gets. This is partly due to the snow on mountains, which

reflects heat away from the surface. For every 150 metres you ascend it becomes on average one degree colder. As you climb higher the air also gets thinner and clearer. Clear air contains little dust and dust is important for trapping the heat given out by the sun.

FACT The temperature at the top of Mount Everest can get as low as minus 60 degrees centigrade, which is extremely cold. Your freezer at home is only minus 18 degrees centigrade!

The mountain environment

A mountain can have a significantly variable range of environments, which are dependent on the variation of soil level in different areas of the mountain, the amount of exposure of different areas to wind and rain, and the height of the mountain. Alpine plants, a type of plant that has adapted to mountain climates, grow above the **tree line**, which is the point above which trees are unable to grow due to poor rocky soils and lack of soil depth. The snow line is the point at which snow will remain on the ground throughout the whole year. Valleys in mountainous areas can offer good land for pasture and for farming and many animals have adapted to mountain living, from bears and lions, to deer and goats.

Why do people live near mountains?

Mountains often attract many visitors, who visit during winter for outdoor activities such as skiing and snowboarding, and in summer walking and cycling are popular. Some mountain regions have health resorts where people come to relax and take health remedies. The hotels and resorts create employment for the local community.

Photo: Sergey Novikov Shutterstock

Volcanoes

Along the lines of the continental plates, where Earth's crust is thinner and weaker, hot molten material can push through to the surface and erupt as a volcano (Figure 6). These weaker areas of

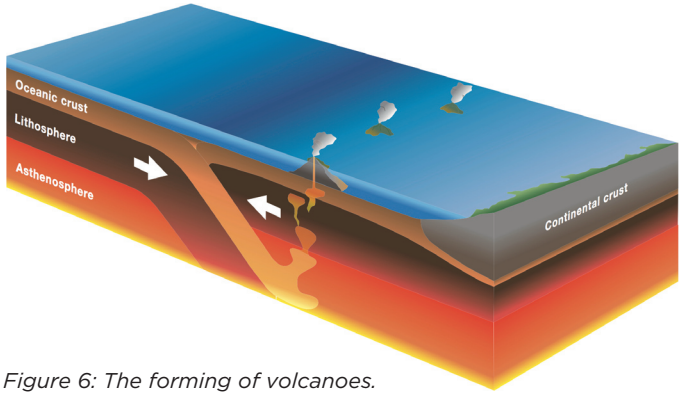

Figure 6: The forming of volcanoes.

Earth's surface exist around the world, both on land and under the sea. Further eruptions build up the exterior of the volcano (Figure 7).

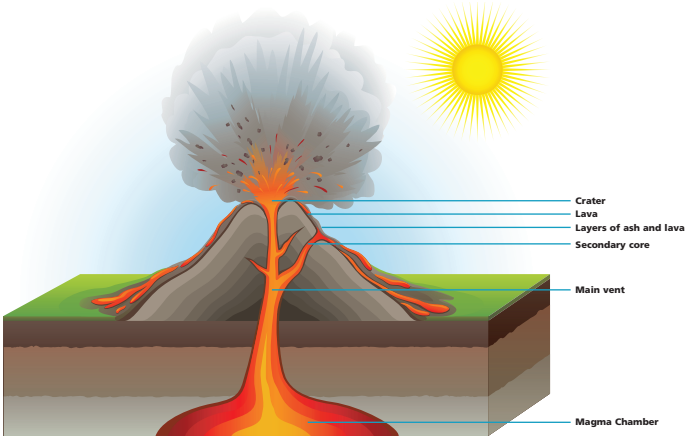

Figure 7: The basic process of active volcanoes.

Dormant, extinct and active volcanoes

A **dormant** volcano is one that has been inactive for a period of time, but could erupt again at some time in the future. An **extinct** volcano is one that is incapable of erupting; extinct volcanoes may have been silent for millions of years. Some volcanoes are continuously **active**, emitting varying amounts of **lava** and/or hot gas.

FACT Magma is hot – very, very hot – at 1000 degrees centigrade it can cook and melt rocks!

FACT There are also vast mountain ranges under the sea, created by underwater volcanoes.

The nature of active volcanoes around the world ranges from the very explosive to those that just emit a steady outflow or stream of lava. Volcanoes are classified by the type of rock that is created within them, by their shape, and by their history of

eruption. The type of eruption that takes place can vary and is influenced by the amount of ice, water and air that is present when the volcano is formed.

Shield volcanoes are created when the magma makes runny lava that flows slowly down the side of the volcano creating a gentle slope.

Cinder cone volcanoes throw up blobs of magma that cool rapidly, turning solid before they hit the ground. These lumps of cinder build up into what is called the cone.

Composite or stratovolcanoes emit lava that is thick and viscous. The lava from a composite volcano is also inclined to blast out huge clouds of cinder and ash. This type of volcano is built up from layers of cinder and ash that becomes smothered with lava, in a process that repeats and repeats over time. These volcanoes can also blow their tops in a very impressive manner, leaving a vast hole called a **caldera** in the volcano's centre. Mount Vesuvius and Mount Fuji are composite volcanoes.

Fissure volcanoes occur when there is a fracture in Earth's crust that opens up a long fissure, through which magma erupts. The sides of the fissure gradually build up over a succession of eruptions.

Pyroclastic flows occur when the volcano emits explosive clouds that are made up of a mixture of hot gases, hot rock fragments and extremely hot air (as high as 700 degrees celsius). Rolling swiftly down the volcano at speeds of 160kmh (100 mph), pyroclastic flows engulf everything in their path. Vesuvius emitted pyroclastic flows that destroyed Pompeii in AD 79.

Rocks thrown up by pyroclastic flows are known as bombs and can be thrown in vast volumes smothering a large area of land. Hot mud flows may also be emitted and can cause an equal amount of destruction and damage, the mud becoming solid when it dries.

Volcanoes can also emit vast amounts of ash into the atmosphere, which causes problems for aircraft since it blocks up their engines and also affects Earth's climate by blocking out the sun. This ash can smother both vegetation and housing when it lands and can take weeks to clear.

Fumaroles are vents that can appear around the sides and in the caldera of a volcano. They issue hot steam and sometimes mud.

Why do people live near active volcanoes?

Although active and dormant volcanoes can create a risk for those living nearby, because the land is very fertile farmers may be willing to take the risk since they can grow excellent crops in the good volcanic soil. Mining may also take place in the area around a volcano as it can be rich in mineral deposits. Cities can also grow up near volcanoes; Naples in Italy has grown up next to Vesuvius which, although dormant at present, can become active at times. Plans have been put in place to evacuate the city should this happen.

Can you tell when a dormant volcano will erupt?

Volcanologists study volcanoes to understand how they work and to create methods to predict their activity. Build-ups of pressure can take place deep underground and inside a volcano over many years. This is caused by trapped magma being forced up by tectonic plate movement or a gradual mix of water, steam and gas. All this immense pressure underground will burst or explode out to the surface when it finds a weak area of Earth's crust.

Seismographs detect vibrations, movements and tremors underground. Satellites can also track and calculate movement above ground. Additional signs such as the appearance of fumaroles can also help to indicate the possibility of an eruption.

FACT Edinburgh is built on a volcano. However, all the volcanoes in Britain have been extinct for millions of years.

Bibliography

Allaby, M., Coenraads, R., Hutchinson, S., McGhee, K. and O'Byrne, J. (2008) *The Encyclopedia of Earth: A complete visual guide*. Oakland, CA: University of California Press.

Glossary

Alpine zone – the upper slopes of a mountain where grass and low-growing plants are able to grow.

Avalanche – a sudden fall of rock or snow on high ground, usually a mountain or valley.

Block mountain – where a block of rock is forced upwards through a fault to form a mountain or mountain range.

Caldera – the crater made by a violently exploding volcano.

Cinder cone volcano – formed of blobs of magma that land as cinder and gradually build up into a cone.

Composite or stratovolcano – formed by layer upon layer of cinder, ash and lava

Cone – the rounded, tapered form created by a volcano.

Core – the hot molten centre of Earth.

Continental plates – another description for a tectonic plate (see below).

Crust – the outer layer of Earth.

Dormant – a volcano that has been inactive for a period of time.

Erosion – gradual wearing down of rocks by wind, ice and water.

Eruption – when hot rocks, ash and lava are forced out of a volcano.

Extinct – a volcano that is incapable of erupting.

Fault – a crack or fissure through Earth's crust, usually found on the edge of a tectonic plate.

Fissure volcano – formed in a line by lava erupting along a crack in Earth's crust.

Fold mountain – where crumpled land is concertinaed between colliding tectonic plates.

Fumaroles – vents which can appear around the sides of a volcano.

Glacier – a dense mass of compacted ice and snow that moves very slowly under its own weight.

Igneous rock – a rock formed by magma cooling.

Lava – the molten rock, originally from inside Earth, that surfaces when a volcano erupts.

Magma – the molten rock found below Earth's surface.

Mantle – the very hot layer of rock deep below Earth's crust.

Metamorphic rock – originally igneous or sedimentary rock that is changed by pressure and heat.

Pyroclastic flow – a mix of gases, molten rock and very hot air that travels at great speed down the volcano

Shield volcano – created by runny lava that gradually forms a gently sloping cone.

Rift valley – a valley area created when a fault causes land to slip downward.

Sedimentary rock – rock formed in seas, lakes and rivers from layer upon layer of eroded deposits.

Seismograph – a machine that detects earthquakes and tremors underground.

Tectonic plates – massive rocky slabs, often as big as a continent, making up Earth's crust.

Tree line – the point on a mountain at which trees are unable to grow.

Volcanologist – a scientist who studies volcanoes.

Volcanic plug – hardened magma that forms a plug in a vent in an active volcano.

Weathering – where extreme hot and cold weather conditions break up the rock.

Further ideas, links and resources to support your teaching of mountains and volcanoes can be found at: **www.geography.org.uk/investigating-mountains-and-volcanoes-at-key-stage-1-2**

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