



## Developing your understanding 1.1

1 Top 10 iconic landscapes – the choice of the top 10 may depend on what a student finds interesting/unique about the landscape, how many visitors go to see the landscape, what makes the landscape important in the context of the wider region and so on. Some examples they may choose are listed below, with a few example descriptions. Many of these are classified as UNESCO World Heritage Sites:

- Grand Canyon – carved out by the Colorado River in Arizona (USA), the canyon is considered one of the Seven Wonders of the Natural World. It is 446 km long, nearly 30 km wide at some points and up to 1.8 km deep – this gigantic canyon is an amazing case study of erosion and tectonic uplifting.
- Hawaii – a series of shield volcanoes in the Pacific Ocean, Hawaii overlies a volcanic 'hot spot'. The constant movement of the massive tectonic plate over this hot spot results in active volcanoes like Kilauea, which has been erupting continuously since 1983.
- Niagara Falls – the most famous falls in the world, this series of spectacular waterfalls crosses the United States–Canada border and connect the Niagara River to another iconic landscape formation, the Great Lakes. The falls, carved out by ice during previous Ice Ages, release well over 2 million litres of water per second!

Others could include the Himalayas in central Asia and neighbouring Tibetan Plateau, the Great Barrier Reef off the Queensland coast, the Great Rift Valley (Africa/Middle East), the Nile Delta (Egypt), karst landscapes in France, the Everglades (Florida), the Amazon River/Rainforest (Brazil), Halong Bay (Vietnam), Patagonia (Argentina), the volcanic region of Iceland, Monument Valley and Death Valley in the United States, the Dover cliffs in the United Kingdom, the Sahel



region of the Sahara desert in Africa, Yellowstone National Park (USA) and many more. Our planet contains an endless array of amazing landforms and landscapes!

- 2 Students to use Google Earth to find the landscapes.
- 3 Student responses will vary depending on which landscape they choose.
- 4 A landform is a naturally formed feature on the Earth's surface with distinctive characteristics – for example, a floodplain is low-lying ground adjacent to a river. A landscape is an area of land incorporating different geographic characteristics and activities, such as flora and fauna, human land uses, climatic conditions and physical features (including different *landforms*).
- 5 Types of landforms in riverine environments may include rivers and tributaries, channels, floodplains, levees, meanders, waterfalls, rapids, oxbow lakes, river mouths and deltas.
- 6 Types of landforms in:
  - Coastal landscapes – cliffs, dunes, beaches, bays, headlands, estuaries, inlets, wave-cut/rocky platforms, caves, arches, stacks, sandbars, spits, tombolos, berms and coastal plains.
  - Arid landscapes – mesas, canyons, dunes, buttes, alluvial fans, salt flats, bad lands and wadis.
- 7 For the model or sketch, students could choose any type of landscape. They will need to consider where different landforms may occur in the landscape. For example, if they choose a riverine landscape, upper sections of the river may include smaller channels and waterfalls/rapids, middle sections will become less steep and may contain meanders and oxbow lakes, while lower sections may include floodplains and a delta. Annotations should state what each landform/feature shows, as well as a brief description of that feature (e.g. a meander occurs as the river begins to follow the shape/structure – soil density/rock hardness – of the landscape).



## Developing your understanding 1.2

- 1 A sequence of features at different geomorphic scales:

| Geomorphic feature | Example              | Additional examples |                        |
|--------------------|----------------------|---------------------|------------------------|
| Continent          | Australia            | North America       | Europe                 |
| Landscape          | Coastal              | Arid                | Glacial                |
| Landform           | Dune                 | Butte               | Hanging valley         |
| Weathering feature | Honeycomb weathering | Chemical weathering | Freeze-thaw weathering |
| Quartz grain       | In coastal dunes     |                     |                        |
| Clay mineral       | In weathered rock    |                     |                        |

- 2 Students could choose any landform, although some will be easier than others to find and understand on a topographic map. They will need to have already learnt how to read topographic maps and contour lines. Some examples may include valleys, spurs, hills, saddles, ridges, cliffs and plateaus.

Teachers may need to direct students towards simple examples of how contour lines indicate landform features.

The weathering features can be discussed in relation to their influence on the landform features found – for example, how chemical weathering may have influenced the shape of a canyon.

- 3 Examples of landforms in different landscape types:
- Dunes – may occur in both coastal landscapes and arid landscapes, where winds commonly transport relatively fine sediments.



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- Plains – may occur in a variety of landscapes – for example, river floodplains or coastal plains, as a result of land movements (e.g. tectonic processes such as faulting).

Example of weathering feature in different landscape types:

- Honeycomb weathering – affect rocks in areas of high salinity. Coastal and arid landscapes both commonly have high salinity levels – for example, from ocean salt spray or evaporation of salty soils/salt flats in deserts.
- Freeze–thaw weathering – occurs where water, such as from rainfall or melting ice, becomes trapped in a crack in the rock and then freezes and expands. This is most common in landscapes that fluctuate around 0°C – for example, on mountain slopes or glaciers. However, this may also occur in deserts, where temperatures fluctuate enormously between day and night.



## Developing your understanding 1.3

- 1 Students' diagrams should contain the crust, asthenosphere, upper and lower mantle, and the outer and inner core. They need to annotate each layer with some important characteristics, such as its depth, key elements and temperature.
- 2 Scientists have studied earthquakes and the seismic waves that travel through parts of the Earth as a result. Equipment such as seismometers can detect seismic waves and provide information about the material through which it has travelled.
- 3 The Earth's crust, containing the continents, sits on top of the asthenosphere (the uppermost part of the upper mantle). The crust is less dense than the asthenosphere, and so 'floats' upon it.



## Developing your understanding 1.4

- 1 Students will notice that certain regions/continents appear to fit together better than others. Examples of seemingly close matches include Antarctica and the southern coastline of Australia, as well as the western coastline of Africa and the eastern coastline of South America.
- 2 Evidence supporting this theory and the matches described above include similar flora and fauna species in adjoining regions, fossil discoveries and similarities in rock layers. Also, sea-floor spreading from mid-oceanic ridges helps to explain the movement of these continents away from each other.
- 3 On close examination, these continental fits are far from perfect, and they may not consider the impact of continental shelves that extend beyond the continents themselves. It was also a few hundred years between the theory of continental drift was first proposed and additional evidence, such as fossil matches, was discovered. It also took longer for theories to emerge that explained this drift – such as convectional currents in the Earth's mantle.



## Developing your understanding 1.5

1 There are four main plate boundary types:

- Divergent – where tectonic plates move apart, divergent boundaries occur when oceanic plates spread away from mid-oceanic ridges.
- Collision – where tectonic plates, normally both continental plates, collide causing tectonic uplift/mountain formation.
- Convergent (subduction) – where a denser, heavier oceanic plate converges and slides underneath a lighter continental plate.
- Transform – where two plates are grinding (moving) past each other, moving in either the same or different directions.

2 Collision boundaries are between two continental plates with similar rock densities and weight (due to their geological composition/age), and therefore they hit each other, forcing the plates upwards. As mentioned above, convergent (subduction) zones occur when two plates meet that have different compositions and densities and one slides underneath the other. When this occurs between two oceanic plates moving at different speeds a trench is formed (e.g. the Marianas Trench).

3 Earthquakes typically occur on all tectonic plate boundaries except for divergent boundaries – that is, collision, convergent (subduction) and transform.

4 An example of each boundary type and associated landforms:

| Nature of plate boundary | Example (location)                    | Landform/s                    |
|--------------------------|---------------------------------------|-------------------------------|
| Collision                | Himalayas                             | High mountains                |
| Divergent                | Atlantic Ocean                        | Mid-Atlantic ridge, volcanoes |
| Convergent (subduction)  | Pacific and Philippine plate boundary | Marianas trench               |
| Transform                | Western United States                 | San Andreas fault             |



## Developing your understanding 1.6

**1** Two maps:

- a** For a good map showing the Pacific 'Ring of Fire', see:

[education.nationalgeographic.com/education/encyclopedia/ring-fire/?ar\\_a=1](http://education.nationalgeographic.com/education/encyclopedia/ring-fire/?ar_a=1)

- b** For a good map showing plate movements, see:

[www.shorstmeyer.com/msj/geo130/plates\\_and\\_trenches.html](http://www.shorstmeyer.com/msj/geo130/plates_and_trenches.html)

- 2** The types of plate boundaries around the ring of fire are mainly convergent, but also divergent and transform boundaries.

- 3** The convergent plate boundaries have definitely caused the Ring of Fire. These plates have converged with each other, creating subduction zones (where a heavier plate slips underneath the lighter plate) where volcanoes frequently occur.

The East Pacific Rise in the Ring of Fire is caused by divergent plate boundaries where significant seafloor spreading has occurred. This allows magma to well up between the plate boundaries. The cold water cools the lava, creating new crust.





## Developing your understanding 1.7

### 1 Volcanoes:

- For a good image showing a flood/plateau volcano, see:  
[www.earthrandom.com/wp-content/uploads/2012/08/Lakagigar-Iceland.jpg](http://www.earthrandom.com/wp-content/uploads/2012/08/Lakagigar-Iceland.jpg)
- For a good image showing a Shield volcano, see:  
[kilauealavaflowmount.files.wordpress.com/2008/03/eruption1.jpg](http://kilauealavaflowmount.files.wordpress.com/2008/03/eruption1.jpg)
- For a good image showing a Cinder cone volcano, see:  
[www.mnh.si.edu/onehundredyears/expeditions/Paricutin/specimen266\\_1.jpg](http://www.mnh.si.edu/onehundredyears/expeditions/Paricutin/specimen266_1.jpg)
- For a good image showing a composite/stratovolcano, see:  
[http://en.wikipedia.org/wiki/Mount\\_Fuji#mediaviewer/File:FujiSunriseKawaguchiko2025WP.jpg](http://en.wikipedia.org/wiki/Mount_Fuji#mediaviewer/File:FujiSunriseKawaguchiko2025WP.jpg)
- For a good image showing a volcanic/lava dome, see:  
[www.lepinparasol.com/images2008/france\\_holiday\\_photos/auv-puyy.jpg](http://www.lepinparasol.com/images2008/france_holiday_photos/auv-puyy.jpg)
- For a good image showing a caldera volcano, see:  
[upload.wikimedia.org/wikipedia/commons/e/e3/Caldera\\_de\\_Taburiente\\_MichaD.jpg](http://upload.wikimedia.org/wikipedia/commons/e/e3/Caldera_de_Taburiente_MichaD.jpg)

### 2 Where the volcanoes are located and when they erupted last:

- This flood volcano is Lakagigar. It is located in the south of Iceland. Where many flood volcanoes erupted in prehistory, Lakagigar erupted over a period of eight months in the years 1783–84.
- Mount Kilauea is an active shield volcano. It is located on the Big Island of Hawaii, on the south-eastern slope of Mauna Loa, Hawaii. Mount Kilauea's current eruption, which continues today, began on 3 January 1983. It has had 61 eruptions in total.



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- This cinder volcano is named Paricutin, and is located in the Michoacan–Guanajuato volcanic fields in west-central Mexico. Its eruption took place between February 1943 and February 1952.
- Mt Fuji, located on Honshu Island in Japan, is a composite volcano. It last erupted in 1707–08 and is still an active volcano.
- Puy de Dome is located in the Chaime des Puys in South-Central France. Its last eruption was in 5760 BCE.
- The crater left from this caldera volcano is on the island of La Palma, Canary Islands, Spain. The date for its last eruption is unclear but it is believed to have originated 20 million years ago.

**3 The impacts on human populations of the volcano types:**

- Flood volcanoes have a substantial impact well beyond the local area because of their size and the toxicity of the gases that are produced. Lakagigar's eruption had 14 km<sup>3</sup> of basalt lava that poured out, as well as poisonous gases that had devastating impacts on Iceland's population. Half the country's livestock were killed, which led to starvation and a significant death toll (approximately 25%). The sulphur dioxide caused changes to global temperatures in the Northern Hemisphere and also caused crop failure in Europe.
- Shield volcanoes like those currently erupting in Hawaii do not have significant impacts on the human population. This is because they are considered 'effusive' eruptions with a prolonged, predictable and slow lava flow. However, sometimes the lava flow might reach agricultural areas or infrastructure that is in relatively close proximity to the volcano.



- Cinder volcano eruptions are normally small to moderate in size, but they can have a significant effect on nearby populations. Cinder volcanoes are normally located in areas that are used for farmland (usually elevated land with higher than usual rainfall). Therefore, eruptions can have an enormous impact on the local agrarian population. Whole populations may have to shift as a consequence. Volcanoes like Paricutin had a significant impact on the local populations. During its 1949 eruption, nearly 1000 people died and ash from the volcano reached Mexico City, 320 km away.
- Composite volcanoes are usually quite beautiful, and people can visit them or live close to them. Even when a volcano is active, it may not appear to be so. However, these eruptions are usually violently explosive. This is because, as the viscous magma rises, it often gets clogged in the crater pipe, causing a huge buildup of pressure – the greater the pressure, the greater the size of the eruption. During a composite volcano eruption, there can be enormous amounts of debris (e.g. pyroclastic flows), lava flow and huge volumes of toxic gases. They can also cause landslides and tsunamis. These volcanoes can cause the most significant amount of damage. See flood volcanoes for similar impacts on crops, loss of livestock, etc.
- Lava domes usually erupt slowly and the lava piles up on the vent, so lava flow is not a significant danger. The exception to this is if a lava dome has pyroclastic flows (fast-moving current of hot gas and rock) from explosive eruptions. This is when life and property can be threatened or damaged.
- Caldera volcanoes are the largest and most explosive volcanoes; however, no eruptions have occurred in recorded history. It is assumed that eruptions from these enormous super-volcanoes have had a global impact – changes to global



temperatures and therefore effects on vegetation, the food chain and the human population.



## Developing your understanding 1.8

- 1 Look for images on features like granite outcrops, wave rock (see example in textbook), mesas, inselbergs, etc.
- 2 Landforms:
  - Landform only on igneous rocks – granite outcrops.
  - Landforms only on sedimentary rocks – sedimentary folds (e.g. monoclines), deep solution hollows and disappearing streams.
  - Landforms on both sedimentary and igneous rocks – inselbergs.
- 3 The development of landforms on different types of rocks is influenced by a range of factors – for example, tectonic activity such as uplift and folding, the rate at which rocks are formed (e.g. how quickly igneous rocks solidify), the location of the rocks (e.g. whether on the surface or underground) and the climate (e.g. how water and wind shape the landforms via erosion and deposition). Sedimentary rocks may be influenced by climate more than igneous rocks are, due to their softer properties.



## Research 1.1

The processes and activities will depend on the landform students choose – these may include weathering, erosion, transportation, deposition or tectonic activity such as folding or faulting. Example landforms may include Uluru, the Great Dividing Range, the Olgas, Wave Rock and the Grampians.



## End-of-chapter questions

### Short-answer questions

- 1 Students could choose any landscapes to compare (e.g. riverine and arid landscapes differ due to amounts of precipitation present, amounts of erosion, landforms present, etc.).
- 2 Students to describe four of the following types of volcanoes: Flood/plateau, shield, cinder cone, composite/stratovolcano, volcanic/lava dome and caldera volcanoes. Refer to Source 1.13 on p. 19.
- 3 Divergent plate boundaries are where two oceanic plates spread apart and new igneous rock is produced, often fluid basaltic rock that produces distinctive landforms. Subducted plate boundaries are where an oceanic plate slides underneath a continental plate – magma that rises to the surface mixes with older sedimentary rocks, again producing distinctive landforms due to the different rock compositions.
- 4 Refer to theories by Ribeiro, Wegener and Du Toit on p. 8, citing examples such as matching of continent outlines and fossil linkages.
- 5 Folds and faults develop as the Earth's crust is constantly on the move and/or tectonic activity creates cracks and folds in the Earth's surface.

### Extended-response question

The different scale examples used are up to the students (e.g. large-scale landforms may include mountain ranges and small-scale landforms may include coastal caves or stacks). In their reports, students should mention that many landforms are developed as the result of plate movements (e.g. volcanic landforms and mountain ranges are often the direct result of tectonic



activity). However, they should also mention that many other landforms are more the result of processes such as erosion and deposition (e.g. river valleys, mesas and coastal spits).