2.1 Distribution of earthquakes and volcanoes

You need to know:

- the global pattern of earthquakes and volcanoes
- plate tectonics (crust, plates and plate margins).

Student Book
See pages 10–11

The pattern of earthquakes

An **earthquake** is a sudden, violent period of ground-shaking. Most occur at the margins of slowly-moving tectonic plates. Friction and sticking between plates create enormous pressures and stresses which build to breaking point.

Tectonic plates

- The Earth's crust is split into seven major and several minor tectonic plates.
- There are two types of crust – dense, thin *oceanic* crust and less dense, thicker *continental* crust.
- Plates move, driven by convection currents within the mantle and under gravity.
- Plates separate at **constructive** margins forming new crust, causing volcanic eruptions.
- Plates collide at **destructive** plate margins causing subduction, earthquakes, volcanic eruptions and fold mountains.
- Plates slide by each other at **conservative** margins, causing earthquakes.

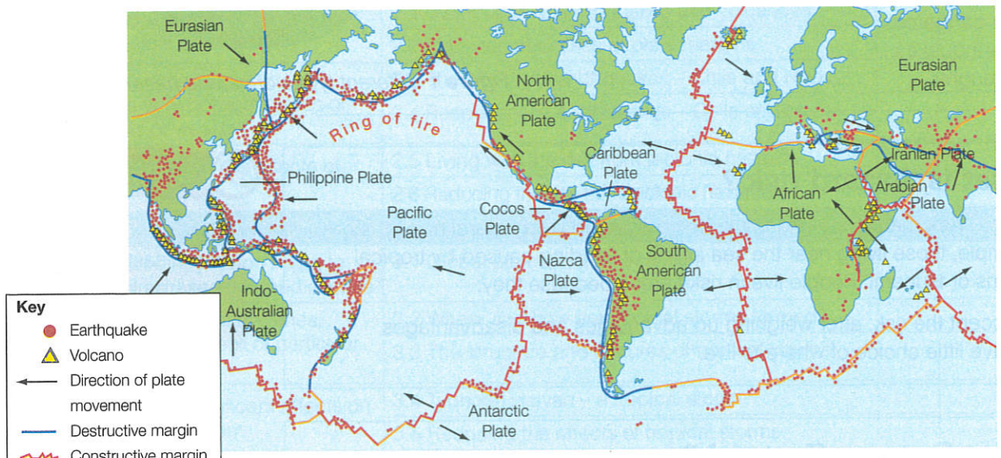

Figure 1 *The location of tectonic plates, earthquakes and volcanoes*

Distribution of volcanoes

Volcanoes are large, often cone-shaped landforms, formed over long periods by several eruptions. They are fed by molten rock (magma) deep within the Earth's mantle. Like earthquakes, most volcanoes occur in belts along plate margins (e.g. the 'Pacific Ring of Fire' and the Mid-Atlantic Ridge). But some occur at *hot spots* where the crust is thin and magma breaks through the surface (e.g. Hawaiian Islands).

Six Second Summary

- Plate movement and tectonic activity at plate margins cause earthquakes and volcanoes.

Over to you

- Name **three** plate margins where earthquakes occur.
- Give **one** reason why more earthquakes occur than volcanic eruptions.
- Explain why earthquakes and volcanoes occur at plate margins.

2.2 Physical processes at plate margins

You need to know:

- the physical processes at constructive, destructive and conservative plate margins.

Student Book
See pages 12–13

What happens at tectonic plate margins?

Constructive margin

The two plates move apart and magma forces its way to the surface. As it breaks the crust it causes mild earthquakes. The magma is very hot and fluid allowing the lava to flow a long way before cooling. This results in typically broad and flat *shield volcanoes* (e.g. Mid-Atlantic Ridge).

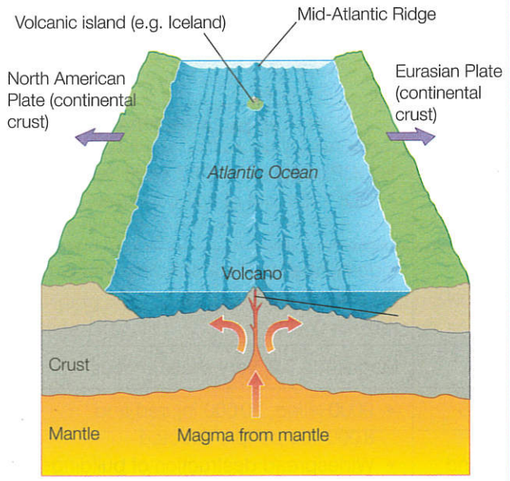

Figure 1 *Constructive plate margin*

Destructive margin

Two plates move towards each other (e.g. west coast of South America, Figure **2**). Here, the dense oceanic plate is *subducted* beneath the less dense continental plate. Friction causes strong earthquakes. The sinking oceanic plate creates sticky, gas-rich magma. This results in steep-sided *composite volcanoes* which erupt violently.

Where two continental plates meet there is no subduction, so no magma to form volcanoes. The crust crumples and lifts to form fold mountains (e.g. Himalayas). Powerful earthquakes can be triggered.

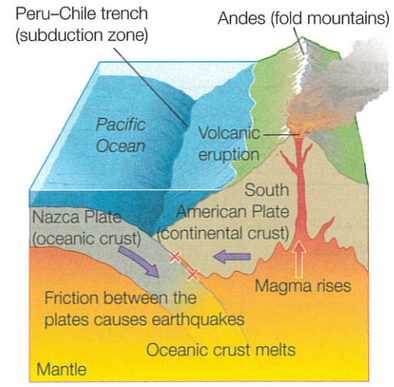

Figure 2 *Destructive plate margin*

Conservative (transform) margin

Two plates move past each other at different rates. Friction between the plates build stresses and trigger earthquakes when they slip. There are no volcanoes because there is no magma.

Figure 3 *Conservative plate margin*

Six Second Summary

- Plates *separate* at constructive margins causing mild earthquakes and volcanic eruptions.
- Plates *collide* at destructive margins causing strong earthquakes and violent volcanic eruptions.
- Plates *slide by* at conservative margins causing powerful earthquakes.

Over to you

Summarise in a table the physical processes that happen at **each** type of plate margin.

You need to know:

- the primary and secondary effects of earthquakes in contrasting countries – Chile in 2010 and Nepal in 2015.

Student Book
See pages 14–15

Example

The earthquakes in Chile and Nepal

Earthquakes can have devastating social effects requiring **immediate** and **long-term responses**:

- **Primary effects** (caused by ground shaking) destroy buildings and infrastructure, and kill and injure.
- **Secondary effects** (resulting from the shaking) include fires and landslides.
- Responses include emergency care, support and longer-term reconstruction.

Figure 1 *Location of Chile and Nepal*

Figure 2 *Comparison of Chile and Nepal earthquakes*

	Chile, February 2010	Nepal, April 2015
Wealth (GDP) and quality of life (HDI) indicators	• GDP 38th out of 193 countries • HDI 41st out of 187 countries	• GDP 109th out of 193 countries • HDI 145th out of 187 countries
Cause	Nazca Plate subduction beneath the South American Plate, just off the coast of central Chile	Indo-Australian Plate colliding with the Eurasian Plate
Size	Magnitude 8.8, shallow focus (35 km)	Magnitude 7.9, very shallow focus (15 km)
Primary effects	• 500 killed, 12 000 injured and 800 000 people affected • Significant destruction of buildings and infrastructure • Power, water and communications cut • US$30 billion damage	• 9000 killed, 20 000 injured and 8 000 000 people affected • Widespread destruction of buildings and infrastructure • Power, water, sanitation and communications cut • US$5 billion damage
Secondary effects	• Communities cut off by landslides • Coastal towns devastated by tsunami • Chemical plant fire near Santiago forced evacuations	• Communities cut off by landslides and avalanches • Avalanches on Mount Everest killed at least 19 people • Flooding caused by (landslide) blocked rivers

Six Second Summary

- Both earthquakes had primary and secondary effects.
- Both earthquakes had devastating effects on people's lives and activities.
- Contrasts in wealth and development affected the impacts.

Over to you

Study information in the table.

- Name **three** indicators (figures) which show that Nepal is poorer than Chile.
- Highlight **five** main similarities and **five** main differences between the two earthquakes.

You need to know:

- the immediate and long-term responses to earthquakes in Chile and Nepal.

Student Book
See pages 16–17

Example

Comparing immediate and long-term responses

Earthquakes in Chile are quite common. Both government and local communities are prepared, experienced and wealthy enough for rapid and effective response.

Earthquakes in Nepal are not uncommon. Scientists are familiar with the risks, but poverty prevents widespread adoption of new building regulations or effective preparation.

Figure 1 *Immediate and long-term responses to Chile and Nepal earthquakes*

	Chile, February 2010	Nepal, April 2015
Immediate responses Search, rescue and short-term aid keeping survivors alive by providing medical care, food, water and shelter	• Swift and effective response by emergency services • Key roads repaired within 24 hours • Most power and water restored within 10 days • US$60 million national appeal built 30 000 emergency wooden shelters	• Overseas aid included widely active NGOs (e.g. Oxfam) • Aid included helicopters for search, rescue and supply drops in remote areas, such as on Mount Everest • 300 000 people migrated from Kathmandu for shelter and support from family and friends
Long-term responses Rebuilding and reconstruction, to restore normal life and reduce future risk	• Strong economy reduced need for foreign aid • Government reconstruction plan to help 200 000 households • Full recovery within four years likely	• Roads repaired, landslides cleared and flood lakes drained • International conference to seek technical and financial support • Indian border blockade in 2015 caused crippling fuel, medicine and construction material shortage

Figure 2 *Temporary wooden shelters for the homeless in Chile*

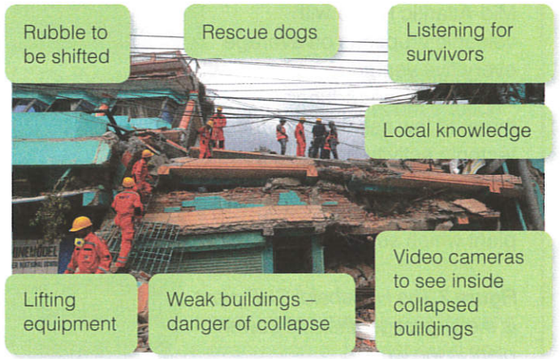

Figure 3 *Searching for survivors in Kathmandu, Nepal*

Six Second Summary

- Chile was prepared, experienced and wealthy enough for a rapid and effective response.
- Nepal's response was hindered by poverty, and it depended on overseas countries to provide aid.

Over to you

Practise describing **three** immediate and **three** long-term responses to **each** of the disasters in Chile and Nepal.

Living with the risk from tectonic hazards

You need to know:

- why people continue to live in areas at risk from earthquakes and volcanoes
- how tectonic activity in Iceland brings huge benefits.

Student Book
See pages 18–19

Living at risk from tectonic hazards

The majority of **tectonic hazards** occur at plate margins, some of which run through densely populated regions such as Japan, parts of China and southern Europe.

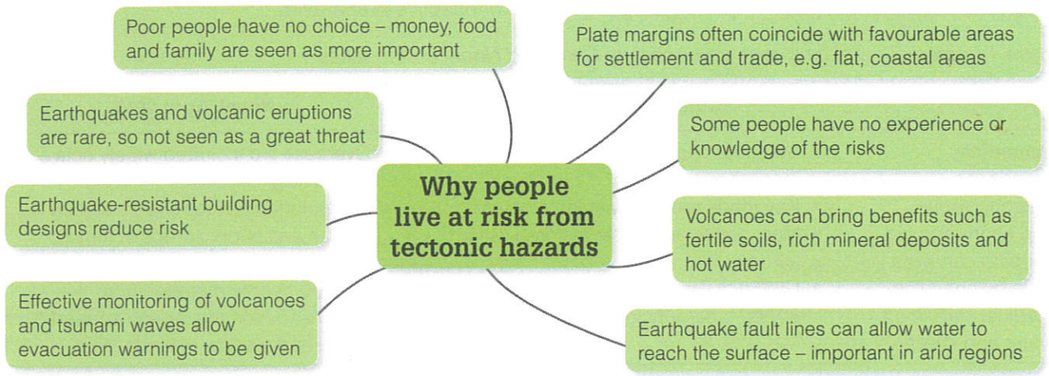

Figure 1 *Why people live at risk from tectonic hazards*

Living on a plate margin: Iceland

Iceland straddles the Mid-Atlantic Ridge with volcanic eruptions on average every five years. But awareness and monitoring reduces the threat to low risk. Indeed, the tectonic activity brings huge benefits, such as the Hellisheidi combined heat and power (CHP) plant which serves Reykjavik.

Figure 2 *The Hellisheidi CHP plant is the largest geothermal power plant in the world*

Six Second Summary

- Plate margins run through densely populated regions such as Japan and southern Europe.
- Effective monitoring, prediction and protection reduce the risks.
- Iceland benefits from tectonic activity with geothermal power and tourism.

Over to you

List **three** key reasons to explain **each** of the following:

- why people live at risk from tectonic hazards
- how the people of Iceland benefit from living on a plate margin.

Reducing the risk from tectonic hazards

You need to know:

- how risks from tectonic hazards can be reduced by monitoring, prediction, protection and planning.

Student Book
See pages 20–1

How can risks from tectonic hazards be reduced?

There are four main **management strategies** for reducing the risk from tectonic hazards.

1 Monitoring

Volcanoes

All active volcanoes are now monitored using hi-tech scientific equipment including:

- *Remote sensing* – satellites detect heat increases
- *Seismicity* – seismographs record microquakes
- *Ground deformation* – laser beams measure changes in the shape of the ground.

Earthquakes

Earthquakes generally occur without warning. A number of events can occur before an earthquake strikes, but these are never certain enough to issue warnings. These events include:

- microquakes before the main tremor
- bulging of the ground
- raised groundwater levels.

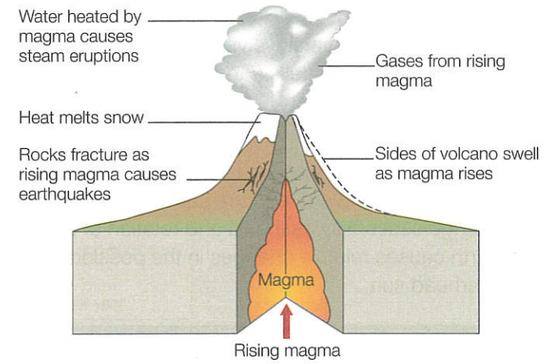

Figure 1 *Warning signs of a volcanic eruption*

2 Prediction

Volcanoes

Monitoring is now allowing accurate prediction and effective evacuation (e.g. Eyjafjallajökull, Iceland, 2010).

Earthquakes

Accurate predictions are impossible due to a lack of clear warning signs. But historical records can help determine probability and so help in planning for them (e.g. Istanbul's risk on the North Anatolian Fault, Turkey).

3 Protection

Volcanoes

Little can be done to protect property, but earth embankments and explosives have been used to successfully divert lava flows (e.g. Mount Etna, Italy).

Earthquakes

Earthquake drills help keep people alert and prepared. But earthquake-resistant construction is the best way to reduce risk.

4 Planning

Volcanoes

Risk assessment and hazard mapping to identify areas to practise evacuation or restrict building.

Earthquakes

Risk assessment and hazard mapping to identify areas to protect buildings and infrastructure.

Six Second Summary

- The risk from tectonic hazards can be reduced by monitoring, prediction, protection and planning.
- Buildings can be constructed to be earthquake-resistant.

Over to you

Write **three** questions about the material on this page (with answers) to test a friend.