

1 Relief: interaction between internal and external processes

¹**generate:** produce or create something.

²**weather:** make something change colour or shape because of the effect of the sun, rain or wind.

³**deform:** change or damage the usual or natural shape of something.

CLIL activities

- In your notebook, answer the following questions.
 - What two processes transform rocks into different types of rock?
 - What process shapes rocks?
 - How does isostasy affect relief at divergent and convergent boundaries?
- Listen to the students talking about a cliff near their town and answer the questions.
 - What element caused the most erosion of the cliff?
 - What affected the composition of the rock?
 - What happens to the rock that's eroded?

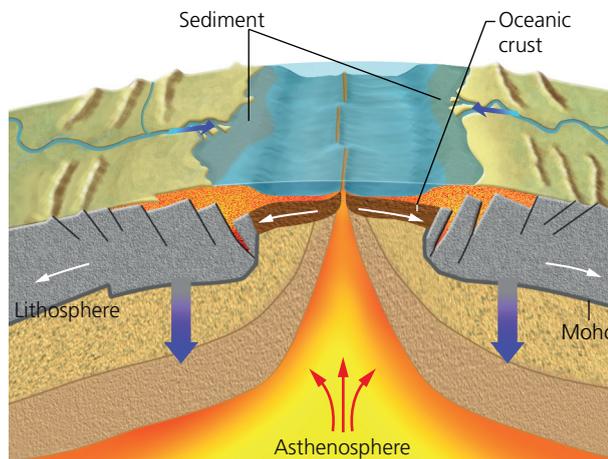
- Research the types of rock and complete the table with the words below. Add three more examples.

Type	Example	How they are produced
Igneous		
Metamorphic		
Sedimentary		

*granite limestone slate
high temperature and pressure
erosion and diagenesis
from magma*

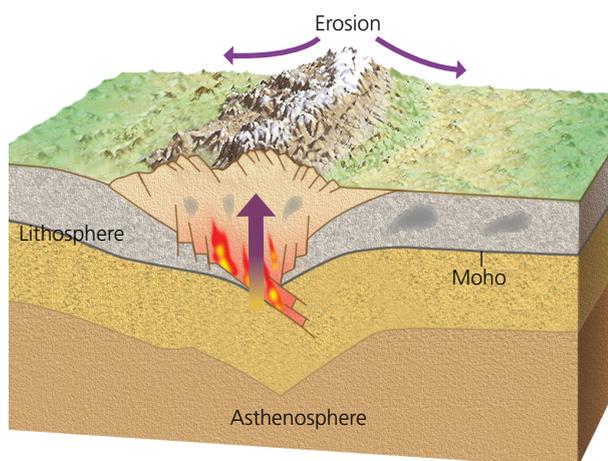
Relief is the shape and height of landforms on the Earth's surface. These landforms are the result of internal and external geographical processes.

INTERNAL PROCESSES	EXTERNAL PROCESSES
<ul style="list-style-type: none"> Magmatism: generation¹, movement and solidification of magma. Metamorphism: transformation of rocks due to high pressure and/or temperature. Orogenesis: creation of mountain ranges. <p>Origins</p> <ul style="list-style-type: none"> Internal heat: leads to plate movements. Gravity <p>Endogenous rocks are formed by internal processes. They can be igneous or metamorphic rocks.</p>	<ul style="list-style-type: none"> Weathering², erosion, transport, sedimentation. Diagenesis: sediment is transformed into sedimentary rocks. <p>Origins</p> <ul style="list-style-type: none"> Sun: affects wind and water cycles. Gravity <p>Exogenous rocks are formed by external processes. These are sedimentary rocks.</p>



Changing relief at divergent boundaries

- The continental crust becomes thinner and separates, producing an ocean.
- Sediment accumulates on the continental shelf.
- The mass of sediment increases and causes an **isostatic** sinking of the lithosphere, allowing the deposit of sediment to continue.

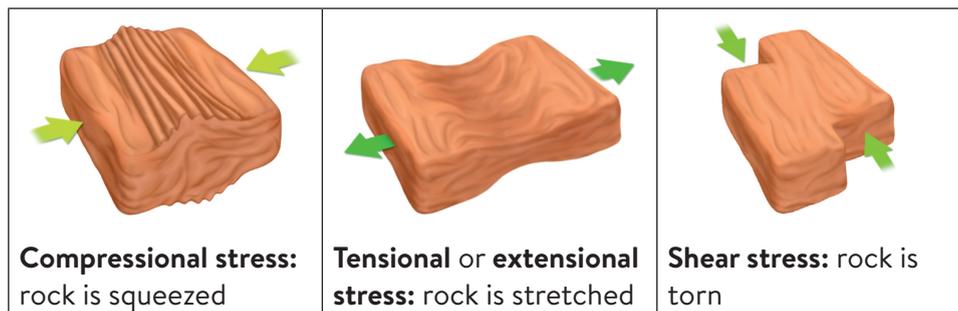


Changing relief at convergent boundaries

- The continental crust thickens and **deforms**³, creating a mountain range.
- Weathering erodes the surface of the mountains.
- This loss of mass produces an isostatic rise, helping erosion to continue.

2 Plate tectonics and rock deformation

Rocks are deformed or changed in three ways by conditions such as **pressure, temperature** and **time**.

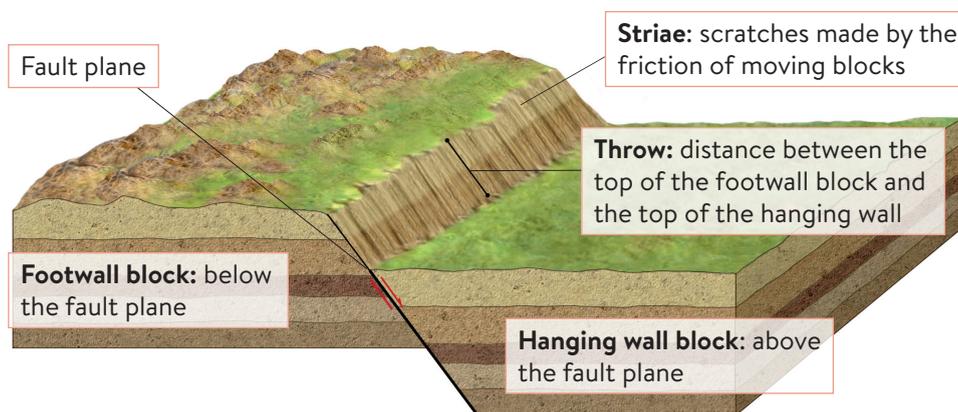


Deformation due to stress depends on the type of rock and its location. Near the surface, rocks are more fragile and fracture more easily. Rocks found deeper underground are often more ductile, especially when under a slow-moving force.

Faults and joints

Rocks that have risen to the surface of the Earth expand and often break or crack. These fractures are called **joints**. When huge blocks of rock move, this is called a **fault**.

Features of a fault



Types of faults

Strike-slip faults: the movement of the blocks is mostly horizontal.

Dip-slip faults: blocks move vertically.

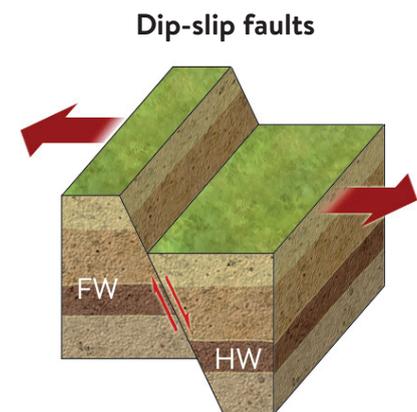
CLIL activities

- 4 In your notebook, match the type of fault with the stress it causes.

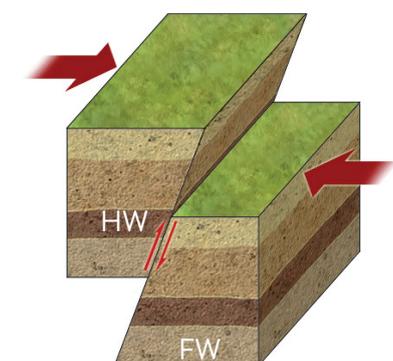
Fault	Stress
normal dip-slip	compressional
reverse dip-slip	tensional
strike-slip	shear

- 5 Listen to the podcast about the San Andreas Fault then answer the following questions:
Where is it? Which plates form the boundary where it lies?
What kind of fault is it?

- 6 What kind of fault is shown in this image?



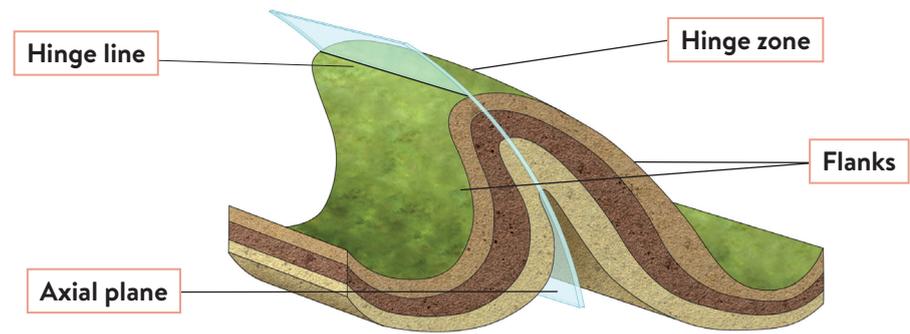
Normal: hanging wall block moves down relative to the footwall block



Reverse: hanging wall block moves up relative to the footwall block

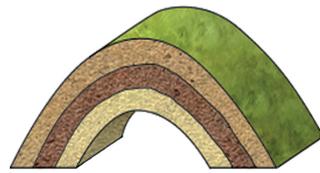


Folds

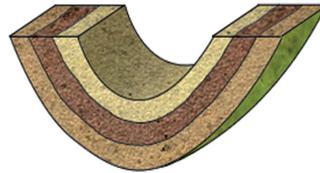


Types of folds

According to the direction of curvature



Anticline

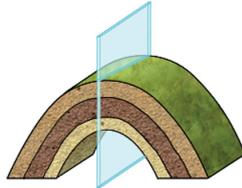


Syncline

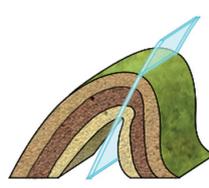


Neutral

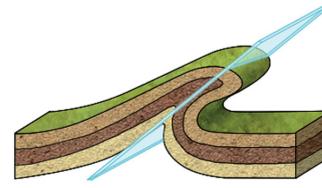
According to the incline of the axial plane



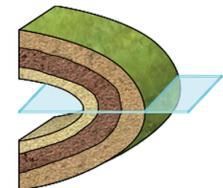
Symmetrical



Inclined

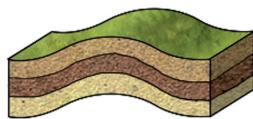


Overturned



Recumbent

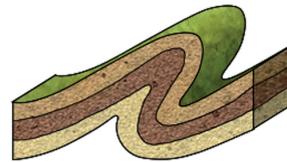
According to the opening between the flanks



Gentle



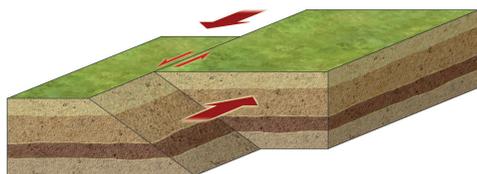
Open



Closed and tight



Isoclinal



An example of a strike-slip fault.

Folds and faults between plate boundaries

- In **divergent boundaries** there's generally tensional stress and normal faults.
- In **convergent boundaries** there's generally compressive stress causing reverse faults and folds.
- In **transform boundaries** there's generally shear stress causing strike-slip faults.

Normal faults produce a **thinning** of the lithosphere, so it rises. **Reverse faults** make the lithosphere thicker, so the weight increases and it descends.

CLIL activities

7 In your notebook, draw the following type of folds.

- gentle syncline
- symmetrical anticline
- closed recumbent

8 Listen to the students talking about the mountain range. Where is it and what geological features can be found in this area?

9 With a classmate, research when rocks are more likely to fold than fracture. Think about: temperature, pressure, time and composition of the rock.

3 Mountain formation

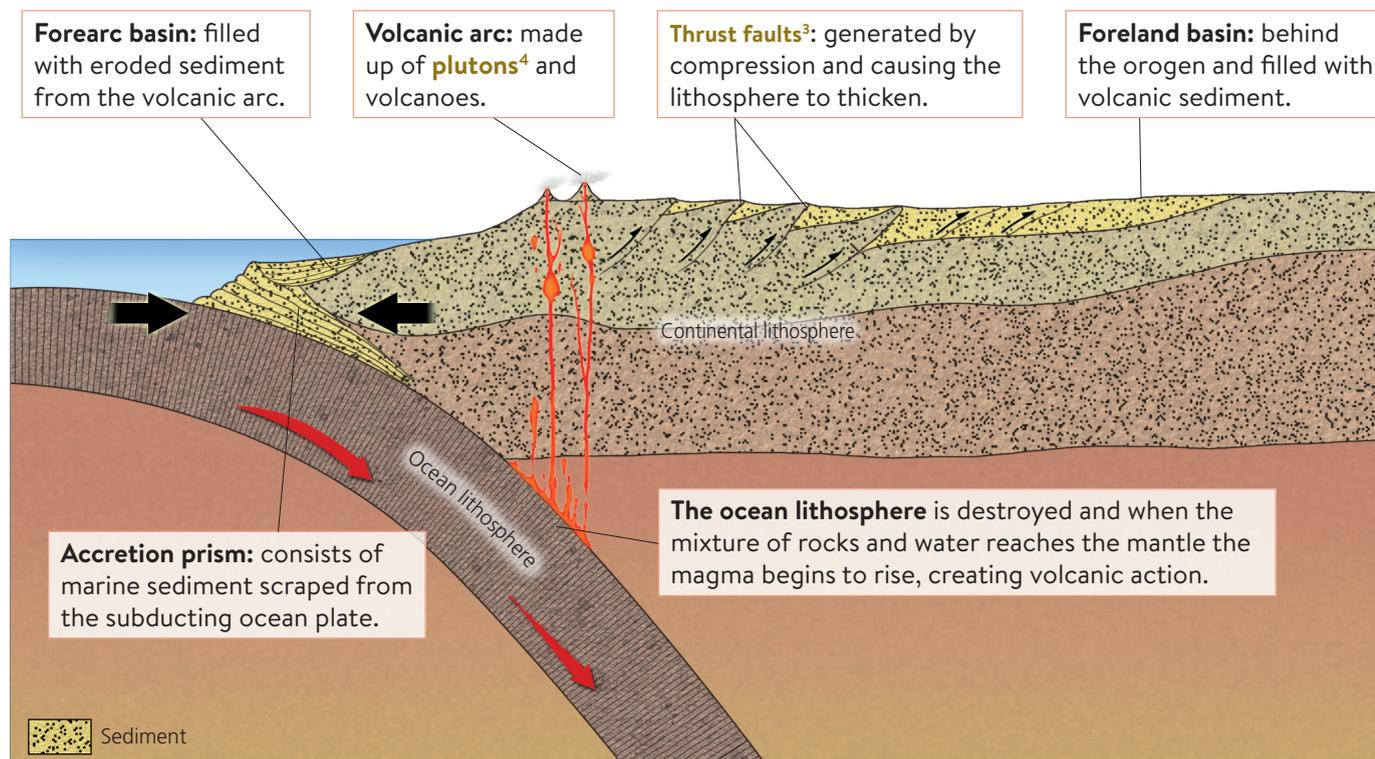
In the 19th century, some scientists believed the Earth was contracting, so mountain ridges were formed like the **wrinkles**¹ on the skin of an apple when it dries out. However, this didn't explain geographical phenomena such as rocks formed from marine sediment found at great altitudes, thick layers of crust in these areas or evidence that mountain ranges had suffered intense compressional forces.

Later, the plate tectonic theory was developed to explain how mountain ranges are formed.

The process of mountain formation is called **orogeny**.

Orogens, or mountain ranges, develop on the edge of continental plates where the ocean lithosphere slips under the continental lithosphere. There are volcanoes and **batholiths**² in these areas. It's mainly volcanic action that causes the formation of the mountain range. These are also called **Andean-type orogens**.

- ¹**wrinkle:** fold or line.
- ²**batholith:** large mass of plutons, bigger than 100 km².
- ³**thrust fault:** where one plate rises up over another.
- ⁴**pluton:** body of igneous rock formed by slowly cooling magma in the Earth's interior.



The process of subduction

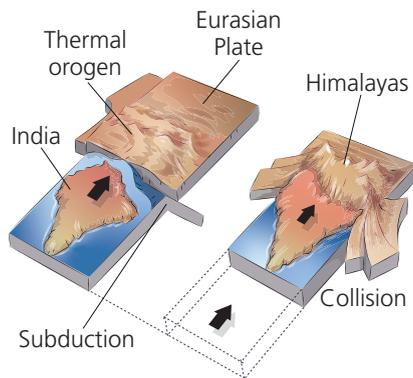
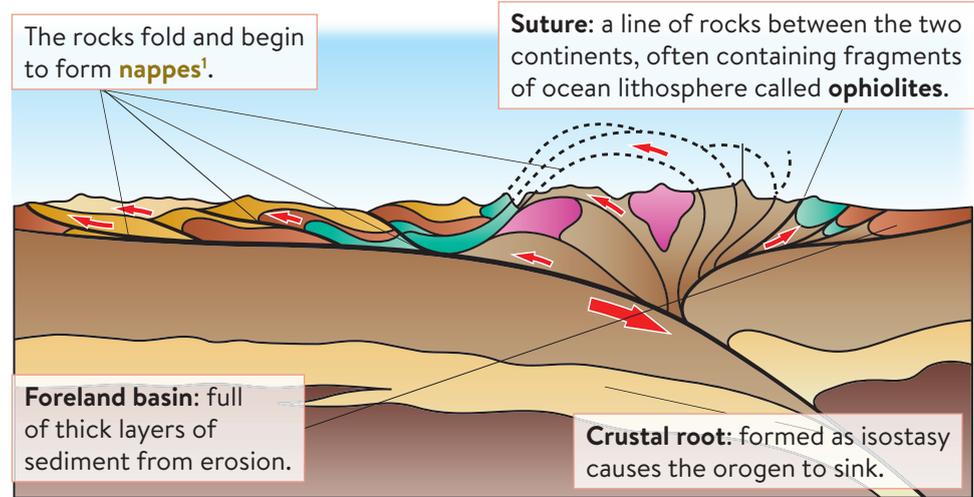
CLIL activities

- 10 In your notebook, list the features of mountain ranges that led to plate tectonics theory.
- 11 Listen to the students discussing a subduction zone diagram. What three mistakes do they make? Check your corrections with a classmate.
- 12 Why are subduction orogens also called Andean-type orogens? With a classmate, research and describe the geological processes that take place in the Andes.
The Andes mountain range is located in...
This orogen is caused by...

- ¹**nappe:** reverse recumbent fold.
- ²**continuous:** spreading in a line or over an area without any spaces.
- ³**extensive:** covering a large area.

Continental collision

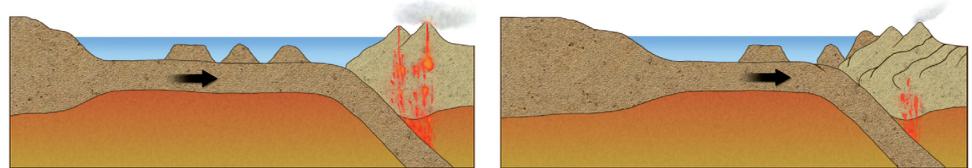
When the land masses of two continents collide, **Alpine-type orogens** are produced. This happens after the subduction of the ocean lithosphere has completely ended and the continents meet. We find fewer volcanoes and more seismic activity in these regions.



Formation of the Himalayas

Accretion

Small ridges in the oceanic plate reach a subduction trench and instead of moving under the continental plate, they rise up onto the edge of the continent creating new relief. For example, the Rocky Mountains in North America.



Formation of the Rocky Mountains

Island arcs

These result from the subduction of oceanic lithosphere at convergent boundaries which form volcanoes under an ocean. Young island arcs, like the **Mariana Islands**, only appear as the tops of volcanic cones in the sea. Older ones, like Japan, Java and the Philippines, have formed more **continuous**² and **extensive**³ masses of land.

CLIL activities

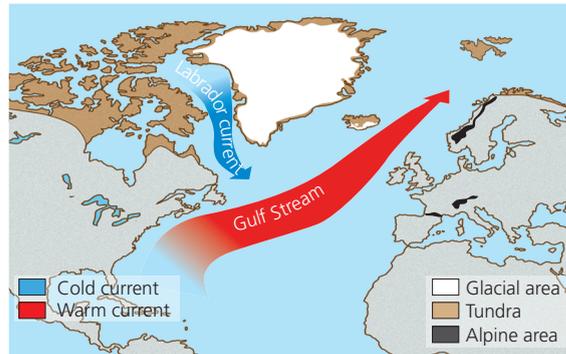
- 13 In your notebook, make a table about the four types of orogens. Use these headings: *Type of orogen, Process of formation, Volcanic or seismic activity, Example*
- 14 Listen to the conversation and list the similarities and differences between an Andean-type orogen and an island arc.
- 15 If an earthquake starts a movement of a nappe by five metres every 80 years, how far will it move in two million years?
- 16 Discuss with a classmate what geological features you would expect to find in the Himalayas and why. Use these words:
 - continental collision* *marine sediment*
 - nappes* *earthquakes* *folds*

I think the Himalayas are a result of...

4 Effect of plate tectonics on sea level and climate

Ocean movements

As ocean ridges rise, the sea level rises. When continents collide, the opposite happens. Ocean **currents**¹ running with north-south orientation move warm water to colder areas and the same in reverse which balances the global temperature and climate.



Glaciation

There are large continental land masses near the poles. Because land cools faster than water there's more glaciation. This means areas near the poles are colder. When covered in ice or snow the **albedo**² increases the cooling process.

Mountain ranges

The elevation of mountain ranges affects atmospheric circulation and precipitation. The climate is much wetter in windy areas facing the ocean, while inland areas on the **leeward**³ slope are much drier.

Plate tectonics and biodiversity

Continents were joined as supercontinents in periods such as the Triassic. There were several reasons why species became extinct during this time:

- Increased competition for space and resources.
- Increased aridity in central areas.
- Decreased oceanic continental shelf where marine species could survive.

When the continents divided, this led to increased biodiversity due to:

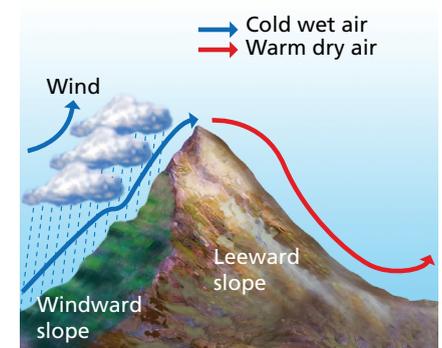
- Development of new species from the original population.
- Smaller, less arid continents.
- Larger oceanic continental shelves.



¹**current:** constant movement of water in one direction.

²**albedo:** percentage of energy reflected from a surface.

³**leeward:** on or towards the side of something that's sheltered from the wind.



CLIL activities



17 In your notebook, explain:

- How ocean currents affect climate.
- Why the polar areas are cold.
- How a mountain affects precipitation.

18 Listen to the lecture about the American continent and answer the questions.

- Which animals moved from North America to South America? And vice versa?
- Why did some of the South American species become extinct in North America?

19 Answer the questions. Then, compare your answers with a classmate.

- What happens to the sea level when the planet warms up after an ice age?
- How does aridity affect biodiversity?
- Why can we only find kangaroos in Australia?

The sea level rises and falls due to...

Living things need...

Kangaroos evolved after...

