

The Crust

How does the crust move?

Introduction

Discuss with the aid of a world map

Have the Earth's land areas always looked the same?

Can you show any evidence if you think the position of continents has changed?

Some continents look like they fit together like a jigsaw puzzle eg the east coast of South America and the west coast of Africa.

What forces might cause continents to change position?

Something underneath the Earth's surface must be able to carry huge parts of the Earth's crust. What do you already know about the interior of the Earth? It's hot and parts of the mantle can flow very slowly.

Activities

1. To show that the crust 'floats' on the denser, heavier layers underneath:

- **Float** a mandarin in water.
The mandarin represents the Earth and should float low in the water.
- **Peel** the mandarin so that the skin is in one piece if possible.
- **Predict** which parts will float now.
- The skin represents the crust of the Earth and the flesh represents the core and mantle.
- **Test** your predictions

The skin (crust) will float because it is lighter than the same volume of water. The flesh will sink.

Point out to students that the skin is lighter and floats even though it looks more solid when compared with the flesh which is mainly liquid.

2. To show that the crust is broken into plates which can move over the softer layer underneath.

- **Break** the mandarin skin into 3 or 4 large pieces. These represent the crust of the Earth broken into plates.
--The Earth's crust is broken into a number of massive, rigid slabs called tectonic plates. They move very slowly over the hot mantle below. Different plates move at different speeds and in different directions. The average speed is about as fast as your fingernails grow, 3-4 cm per year or 3-4 m per century.
- By holding 2 pieces of mandarin skin against the peeled mandarin work out how the plates could behave as they move around on the Earth's surface.

Students should work out that the plates (sections of mandarin peel) can interact in at least 5 ways:

- push into one another, resulting in both plates being forced up and crumpled.
- push into one another, resulting in one plate being pushed under the other.
(You may need to force this one to happen)
- slide past one another, resulting in the edge of both pieces being rubbed.
- move away from one another so that they are no longer touching. --rotate like a wheel so that one grinds into the other.

Learning Intentions

- See that the Earth's crust is broken up into huge plates.
- Explore ways in which the plates could move around the Earth.

Success Criteria

- Students can
- Explain what plates are
 - Explain why they can move
 - Explain some possible results when plates interact.

Resources

- World map
- Mandarins
- Water containers

Vocabulary

tectonic plate,
push, slide, grind, rub, crumple,
interact, rigid

The Crust and Plates

How does the crust move?

What pushes the plates along?



As early as the 1600's scientists noted that the shapes of continents on opposite sides of the Atlantic Ocean (South America and Africa) seemed to fit together like pieces of a jigsaw puzzle.

In the following centuries scientists began to speculate that the Earth's landmasses had once been joined in a 'supercontinent' and some force had split them apart.

In 1912 Alfred Wegener, a German scientist, proposed the theory of continental drift which said that the continents were slowly drifting around the Earth. He used evidence of matching rock types, geological structures and fossils to show that continents had once formed a giant continent he called Pangaea. Wegener's theory was not widely accepted at the time because he could not provide a mechanism to explain how Pangaea split up to form the continents we know today.

By the 1960's there was evidence from new areas of scientific research, such as under sea exploration and the magnetism of rocks, to support Wegener's theories and explain possible mechanisms for the movement of continents. Within less than a decade a new theory called plate tectonics was widely accepted. It combined Wegener's continental drift theory with evidence from many new areas of Earth science that explained the mechanisms causing continents to move. Plate tectonic theory states that the Earth's outer shell, the lithosphere (including the crust and upper mantle), is broken up into a number of large rigid plates that slowly move about the planet.

These plates are continually being formed and destroyed. Plates are separating at mid ocean ridges where new plate material (magma) is welling up from the mantle and pushing the plates apart. The other edge of the plate is pushed into or alongside a neighbouring plate or plates. When two plates collide a number of things can happen depending on which plate is heavier and the angle of collision.

The heaviest plates are those made mainly of sea floor. Although the crust under the seafloor is thinner it is heavier than continental plate material because of the type of rock (basalt) that is formed at mid ocean ridges.

Many plates are a mixture of oceanic and continental crust and some carry parts of more than one continent.

When a heavy plate is pushed against a lighter plate, the heavy plate will be forced beneath the lighter plate and the lighter plate will ride over the top. This is called subduction.

Over time the heavier plate will be forced deeper and deeper down into the mantle where it may partially melt and later rise to produce volcanoes along the edge of the subduction zone. This is the process creating the Taupo Volcanic Zone, Taranaki and the Kermadec Arc volcanoes.

The reason why plates move is a good example of the Nature of Science strand of the curriculum in action.

There is scientific debate over whether plate movement is caused by 'ridge push' or 'slab pull'. It is possible that the new plate material formed at a mid ocean ridge pushes the plate along but it is also possible that the opposite edge drags the plate along behind it as it is subducted. The movement of the mantle (convection) could be the cause of, or caused by either of these mechanisms.

Both are stories that fit the current state of scientific knowledge and they will change over time.

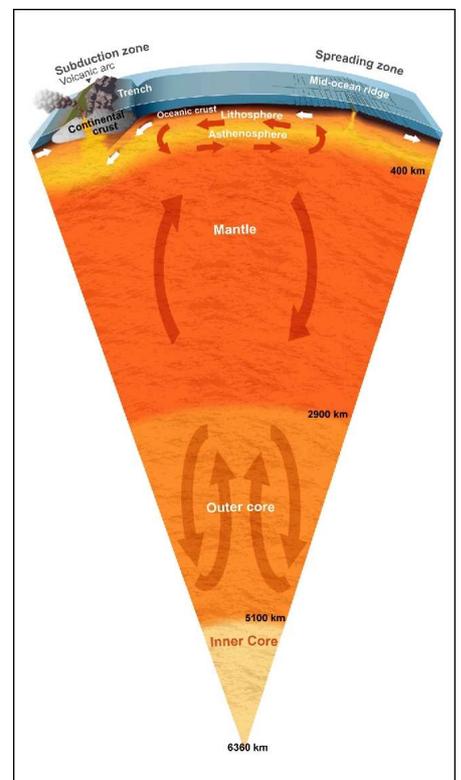
Whatever the mechanism plate movement averages 3-4 cm per year or 3-4m per century, Very slow!

Curriculum Links

Planet Earth and Beyond

Physical World

Science Concept	NOS
PE-Earth Systems L3/4 –develop an understanding of what makes up our planet PW-Physics Concepts L1/2 -explore physical phenomena such as movement, forces and heat.	Understanding about Science
	Investigating in Science



GNS Science

For a more detailed explanation of convection see:
http://www.msucleus.org/membership/html/k-6/pt/plate/2/ptpt2_1a.html

The Crust and Plates

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How many plates are there?

Most scientists agree that there are between 8 and 15 plates. Some large plates have areas within them that behave like a separate plate. They are often called 'micro' plates. This makes it difficult to give a definite number.

What plate is New Zealand on?

New Zealand lies across the boundary of two plates.

Some parts are on the western edge of the Pacific Plate and some parts are on the eastern edge of the Australian Plate.

The Australian Plate is called a continental plate because a lot of it is covered by land.

The Pacific Plate is mostly seafloor so it is called an oceanic plate.

Oceanic plates are heavier than continental plates even though the crust they are made of is thinner. Oceanic crust is mainly basalt, a dark, dense rock formed by the magma upwelling at ocean ridges where plates grow.

How does being across 2 plates affect New Zealand?

The two plates are crashing together. You could say New Zealand is a geological car crash!

The force of the collision causes our earthquakes and volcanoes.

Plate boundaries (edges) are not straight lines so this means the collision between the same two plates can have different results at different places. This is why some areas of the collision zone in NZ have volcanoes and some areas have mountain building and earthquakes.

Which plate are you on?

All of the North Island is on the Australian Plate and so is everything to the west of the Alpine Fault in the South Island, including Nelson and Westland.

The rest of the South Island, Stewart Island and the Chatham Islands are all on the Pacific Plate.

The collision zone (plate boundary) can easily be seen on the map running from north of East Cape around the east of the North Island, curving below Cook Strait, down the mountainous spine of the South Island and out to sea south of Milford Sound.

Which plate is Australia on?

All of Australia is on the Australian Plate. There are no plate boundaries running through Australia. Because there are no plate collisions happening in Australia they have fewer volcanoes and earthquakes.

If the plates are continually moving what did the world look like before and what will it look like in the future?

For animations see:

http://www.tki.org.nz/r/wick_ed/science/crusty.php

http://www.gns.cri.nz/research/tectonics/images/v2Low_res2.html

What will New Zealand look like in the future?

For an animation of NZ's future shape see

<http://www.gns.cri.nz/store/download/plates.html>

