# Plate Tectonics Theory

*The ground beneath your feet is moving all the time — but fear not, it's moving really, really, really slowly (about the same speed as your toenails grow. Yuk, toenails). Plate tectonics theory explains this movement...*

## Part of the Earth's Mantle is Semi-molten

1) At the **centre** of the Earth is the **CORE**, which is split into an **inner** core and an **outer** core:

- The inner core is a **solid ball** containing lots of **iron and nickel**.
- The outer core is **semi-molten** and also contains lots of **iron and nickel**.

2) Around the core is the **MANTLE**, which is mostly made of **silicate rocks** (rocks that have loads of the element silicon in them):

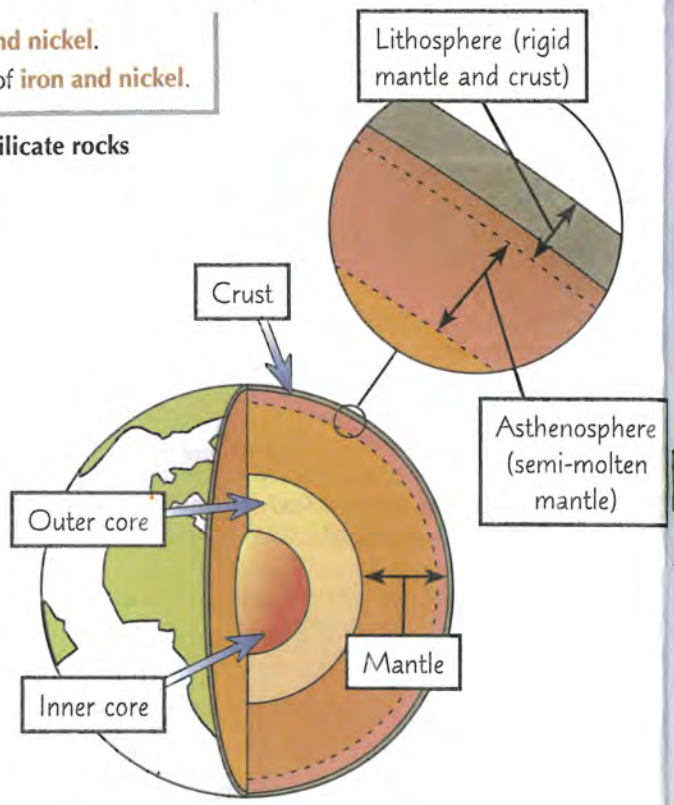
- The part of the mantle **nearest the core** is **quite rigid**.
- The **layer above** this, called the **asthenosphere**, is **semi-molten** (it can flow).
- And the **very, very top bit** of the mantle is **rigid**.

3) The **outer layer** of the Earth is called the **CRUST**.

4) The **rigid top part** of the **mantle** and the **crust** together are called the **LITHOSPHERE**.

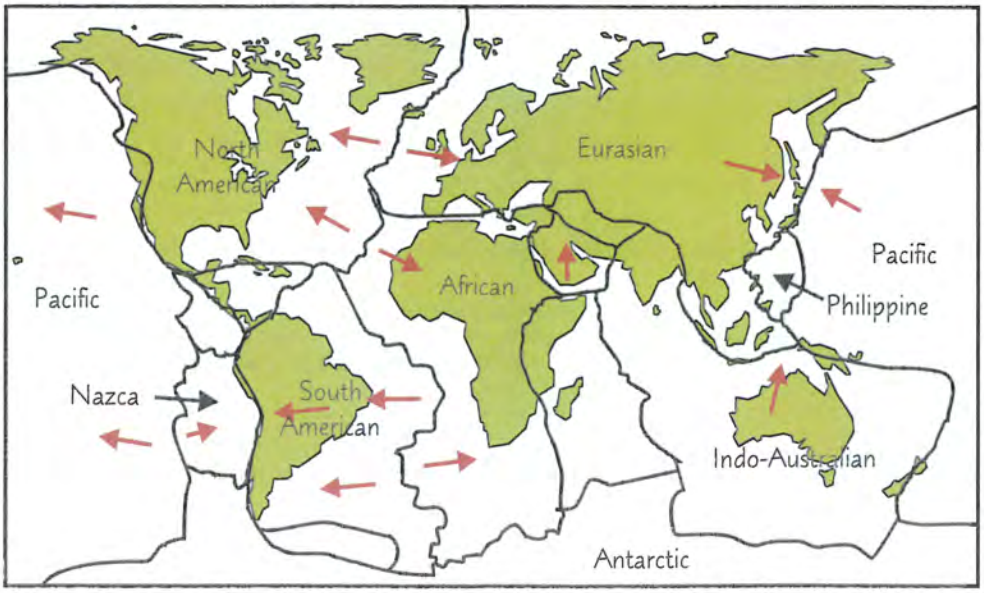
5) There are **two types** of crust — **CONTINENTAL** and **OCEANIC**:

- **Continental** crust is **thicker** (30-70 km thick) and **less dense**.
- **Oceanic** crust is **thinner** (6-10 km thick) and **more dense**.




## The Earth's Surface is Separated into Tectonic Plates

1) The lithosphere is **divided** into lots of slabs called **tectonic plates**.
2) The plates are **moving** due to **convection currents** in the **asthenosphere** (see the next page).
3) The places where plates meet are called **boundaries** or **plate margins**.




Pierre really loved continental crust.

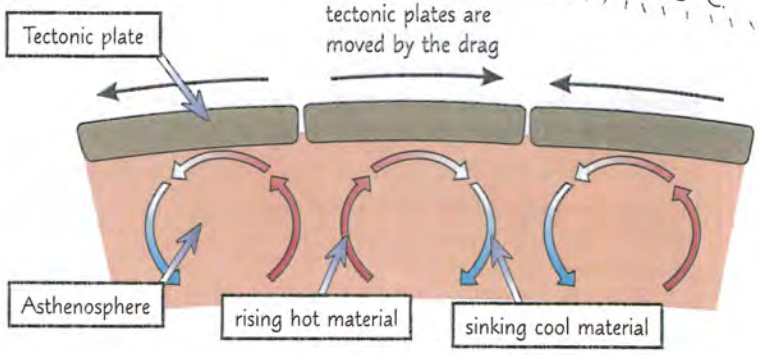
4) The idea that the Earth's lithosphere is made up of many plates that are moved around by convection currents is the **theory of plate tectonics**.

# Plate Tectonics Theory

## The Tectonic Plates Move due to Convection Currents in the Mantle

1) **Radioactive decay** of some elements in the mantle and core, e.g. uranium, generates a **lot of heat**.
2) When **lower parts** of the **asthenosphere heat up** they become **less dense** and slowly **rise**.
3) As they move towards the **top** of the asthenosphere they **cool down**, become **more dense**, then slowly **sink**.
4) These **circular movements** of semi-molten rock are called **CONVECTION CURRENTS**.
5) Convection currents in the asthenosphere **create drag** on the **base** of the **tectonic plates** (which are solid and rigid) — and this causes them to **move**.

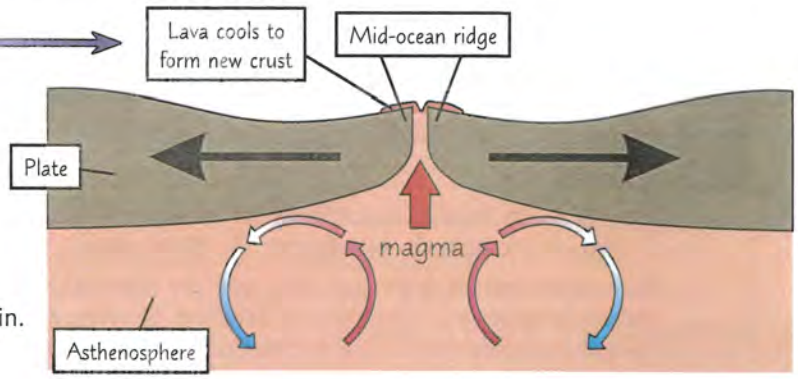
The Earth's core is extremely hot — it's over 4000 °C.




## Crust is Created When Plates Move Apart

1) **Rising convection currents diverge** (move apart) at the base of the lithosphere.
2) The drag of the convection currents causes the **plates** above them to **diverge too**.
3) **Magma rises up** to fill the gap created, then **cools** to form **new crust**.
4) Over time, the **new crust** is **dragged apart** and even **more new crust forms** between it.
5) When this happens at a plate margin under the sea the **sea floor gets wider**.
6) This **process** is called **sea floor spreading**... imaginative name.
7) It creates structures called **mid-ocean ridges** — ridges of higher terrain on either side of the margin.
8) A similar process of spreading occurs at **land margins** where the plates are moving apart.
9) When plates move together, sometimes the crust is **destroyed** and sometimes it's pushed up into **mountains** (see p. 6 for more).

New crust formation at mid-ocean ridges doesn't happen at the same speed everywhere — at some it's less than 10 mm per year and at others it's more than 100 mm per year.




## Practice Questions

Q1 What is the asthenosphere?
Q2 What is the lithosphere?
Q3 Briefly describe sea floor spreading.

**Exam Questions**

Q1 Describe the structure of the Earth. [8 marks]

Q2 Describe and explain how convection currents cause tectonic plates to move. [8 marks]

## Plate tectonics — it's a cracking theory...

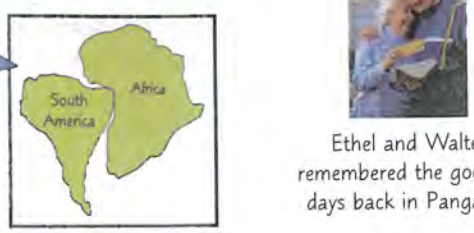
*What a lovely couple of pages to ease you in gently, but don't think you can get away without knowing this stuff inside out. If you don't get the basics, the rest of this section will be more painful than stubbing your toe on a slab of oceanic crust. A bit of work now will help make the rest of plate tectonics a piece of Victoria sponge. You'd better get learning...*

# Plate Tectonics Theory

*The theory of plate tectonics is widely accepted by scientists. It grew out of the theory of continental drift — which a clever bloke called Alfred Wegener came up with early in the 20th century...*

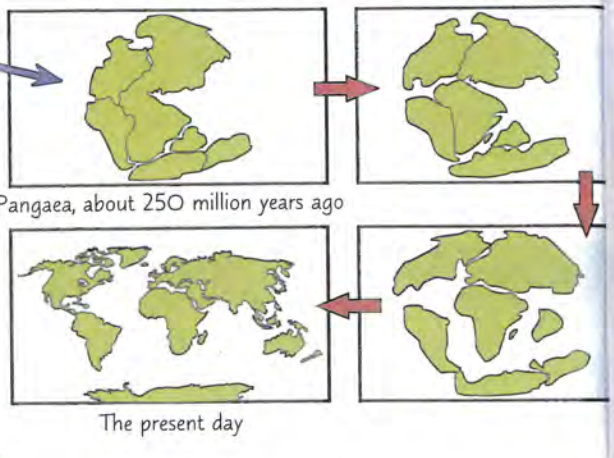
## The Theory of Plate Tectonics started with Alfred Wegener

1) In the **17th century** people first noticed that **South America** and **Africa** looked like they could **fit together**, like pieces of a **jigsaw**.
2) There were suggestions that the **continents** might once have been **joined together** before moving apart, but most people believed the continents were fixed in place.
3) In 1912 **Alfred Wegener** proposed the theory of **continental drift**.
4) He suggested that **all the continents** were once **joined** as **one supercontinent** (called **Pangaea**) which drifted apart.
5) Wegener based his theory on **geological evidence** and **fossil records** (see below), but he **couldn't** back it up with a **mechanism** that explained how the continents **moved**.
6) But in the **1950s**, **palaeomagnetism** (see the next page) provided **evidence** that supported continental drift.
7) And in the **1960s** the process of **sea floor spreading** (see previous page) was discovered — it provided the **mechanism** for continental drift.
8) The continental drift theory was **developed further** by scientists after these findings. It grew into the **theory of plate tectonics**.





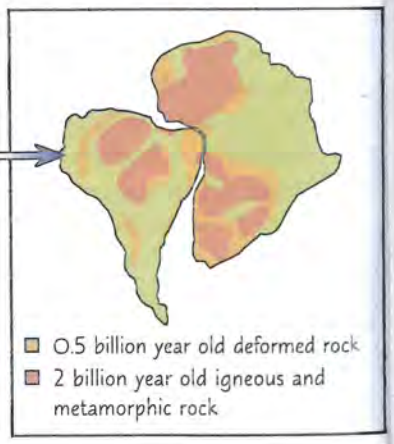

Ethel and Walter remembered the good ol' days back in Pangaea...

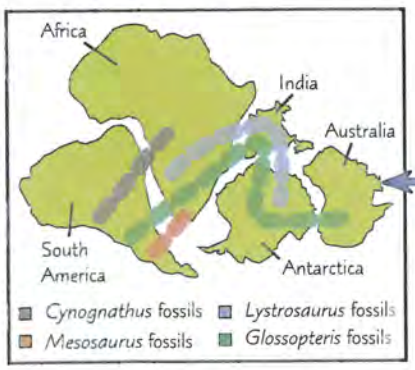



## There's Plenty of Evidence for the Theory

### Geology

1) Areas of **South America** and **Africa** have **rocks** of the **same age and composition** — if you fit these continents together, the **distribution** of the rocks **matches up**.
2) You can also **match up** the age, rock type and distribution of some **mountain ranges**, e.g. mountains in **Scotland**, **Norway**, **Sweden** and **Finland** are similar to those on the **east coast of North America**.
3) These rocks and mountains must have formed under the **same conditions** and in the **same place** in order to match so well — this would **only be possible** if the **continents were once joined**.




### Fossil Records

1) By fitting land masses together you can **match up** the **distribution** of some **fossils**, e.g. fossils of *Lystrosaurus*, *Cynognathus*, *Mesosaurus* (all reptiles) and *Glossopteris* (a plant).
2) It's **very unlikely** that these species **migrated** across thousands of miles of water, or that they **evolved** in different places.
3) So the fossil records **suggest** that these places were **joined together** when these organisms were alive — **hundreds of millions of years ago**.

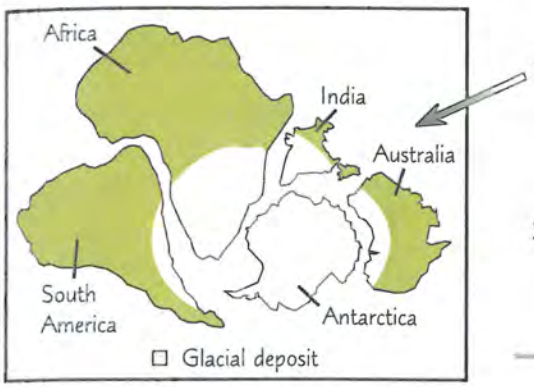
### Living Species

1) The same living organisms can also be found on **different continents** — like with the fossilised organisms above, it's **unlikely** that some of them **migrated** across the oceans, or **evolved** in different locations.
2) For example, **earthworms** of the family *Megascolecidae* are found in **New Zealand**, parts of **Asia** and **North America**. This suggests that the **continents were once joined**, allowing the earthworms to travel between them.

# Plate Tectonics Theory

## Climatology

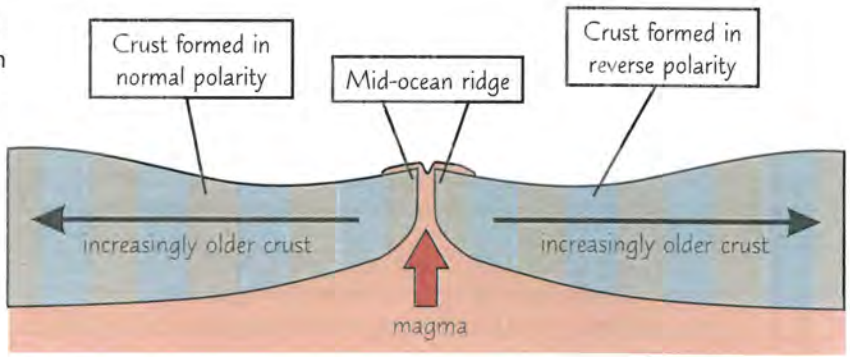
There's evidence that the **past climates** of some continents were **similar**, despite being **thousands of miles apart** now. This suggests that they were **located together** and in a **different place** on Earth to where they are now. Here are a **couple of examples**:




1) Similar **glacial deposits** are found in **Antarctica, Africa, South America, India** and **Australia**. By fitting these places together you can **match up the distribution** of the deposits, which suggests that they were **joined together** millions of years ago and located **close to the South Pole**.
2) Large **coal deposits** that were **formed in tropical conditions** have been found in **North America** and parts of **Europe**. This suggests these regions were once **closer to the equator** than they are now — they've drifted over time.

## Palaeomagnetism

1) **Palaeomagnetism** is the study of the history of the **Earth's magnetic field**.
2) **Once every 200 000 years** or so, the Earth's magnetic field **reverses polarity** (the magnetic north and south poles switch).
3) Palaeomagnetism has provided evidence for the process of **sea floor spreading** (see page 3).
4) As **magma erupts** from mid-ocean ridges, **magnetic minerals** in the molten rock **align themselves** with the direction of the **Earth's magnetic field**.
5) When the new crust has **solidified**, the **alignment** is **fixed**.
6) The magnetic minerals in crust created in periods of **normal polarity** (magnetic north near the North Pole) are aligned in the **opposite direction** to those in crust created in periods of **reverse polarity** (magnetic north near the South Pole).
7) This creates a series of **alternating magnetic stripes** along the sea floor. The stripes show that the **crust** is **older** the **further away** from a **mid-ocean ridge** you go — this means that the **plates are moving apart**.




## Practice Questions

Q1 Describe the theory of continental drift.

Q2 Name five sources of evidence for the theory of plate tectonics.

**Exam Question**

Q1 Describe the different types of evidence for the theory of plate tectonics. [40 marks]

*Increasingly older crust usually goes hard and grows green stuff...*

*Two things to bear in mind when you're learning this little lot. Firstly, despite it being called a theory, plate tectonics is pretty much accepted as fact — there's an overwhelming amount of evidence that proves the plates are moving around. Secondly, continental drift takes place over hundreds of millions of years — it's unlikely that the UK will be nestled next to Australia any time soon...*