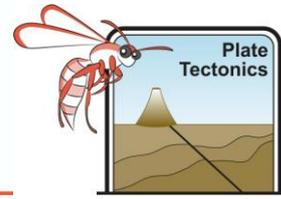


Plate Tectonics - Teacher Background



The Theory of Continental Drift proposed that continents moved but did not suggest a convincing mechanism to power this movement. The Theory of Plate Tectonics builds on these earlier concepts and suggests how movement is maintained. Good general background information can be viewed on National Geographic's, "Colliding Continents" at www.youtube.com/watch?v=KCSJNBMOjJs

Scientific data recorded to support the theory that continents were moving apart:

1. Discovery of mid-ocean ridges

The possibility of undersea mountain ranges in the middle of the Atlantic Ocean was already suggested by readings from naval marine depth soundings. It was noticed that the ocean did not become deeper towards the centre. The presence of these ridges were later inferred when telephone lines were laid on the seafloor but shallowed markedly in the middle. However, when telephone and cable lines laid across oceans repeatedly snapped and had to be repaired it was suggested that this might be because they were being stretched. (This led to the "Expanding Earth" theory which as since been discounted).

Exploration of the ocean floor since the early 1950s gave us images of, and rock samples from, mid-ocean ridges, which have been found to spread 80,000km around the planet. These ridges are volcanically active producing iron rich rocks suggesting a source in the asthenosphere or mantle.

2. Seafloor spreading at mid-ocean ridges and rock ages

Further exploration along the Mid-Atlantic Ridge collected evidence that lavas spreading from a trench in the middle of the ridge were pushing older material apart. The lavas contained radioactive minerals that decayed at a known rate permitting their age since eruption to be estimated. Mirrored bands of rocks of the same ages were found to line up either side of the ridge with youngest rocks close to the ridge and ages increasing as you move away.

3. Seafloor spreading and magnetic stripes

Evidence was also collected from magnetic minerals in the lavas. Molten iron rich magma chills to rock on exposure to air or under the sea. In molten rock magnetic minerals align themselves to the poles. This orientation is "frozen" on crystallisation. New magma erupting from the ridge displaces earlier lava flows to either side of the spreading seafloor. Continuous eruptions leads to the formation of parallel bands of lava of the same age spreading outwards on either side of the ridge. Our magnetic poles constantly move and even "flip" occasionally. These parallel bands of polar orientation and reversal have been observed and measured in the rock.

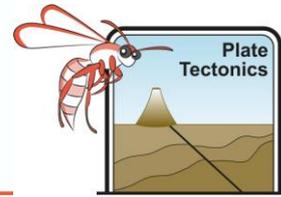
Aside: Early in Earth's history planetary differentiation took place creating a crust, mantle and core. Less dense silica rich rocks form our outer lithosphere and iron and magnesium rich rocks increase towards the core. This concentration of iron and nickel is responsible for the creation of our magnetosphere. Earth's magnetic field is not constant.

4. Satellite based measurements (GIS & GPS)

Laser measurement from satellites has given us primary data on the relative movement of our present landmasses. Twenty four satellites circle the Earth. Each satellite has a computer, an atomic clock and a radio. More information and activities can be found at the IRIS website (http://www.iris.edu/hq/programs/education_and_outreach/animations/14)

This data suggests that continents "float" on denser oceanic crust. Oceanic crust is formed at mid-oceanic ridges

Plate Tectonics - Teacher Background



Scientific data recorded to support the theory that continental plates were converging:

1. Mountain ranges and gravity

Folding and faulting of sedimentary beds observed in many major mountain ranges appears to be the result of compression. Folded fossil beaches are found near the top of Mount Everest. This land must have been compressed and uplifted from sea level.

Scientists working in the Andes and in the Himalayas discovered that a pendulum would be attracted to large mountain ranges. This suggested that the mountains had a greater gravitational pull than the surrounding plains and that this must be because they had “hidden” mass. This mass of thickened continental crust forms a “keel” below the range and its mass attracts the pendulum.

2. Marine trenches

Marine exploration scientists also observed deep trenches along active volcanic continental margins. Ocean sounding using weights and cables has been superseded by LIDAR, an echo sounder which measures reflected light or sound. Trenches can be over 10km deep. Our knowledge of trenches is restricted by the paucity of surveyed areas.

It is suggested that trenches form where oceanic crust is being subducted under continental crust. This is supported by measurement of progressive low angle seismic activity zones leading away from the trench under the overriding plate. It is also supported by the presence of volcanic island arcs erupting lava whose composition reflects melted oceanic crust and sediments.

This data suggests that oceanic crust is recycled at plate margins and oceanic trenches.

Development of the theory

In 1958 Carey suggested that the lithosphere consisted of seven major tectonic plates and many minor ones. The lithosphere lies above the asthenosphere but is moved by convection currents in it. Where plates move apart there is a zone of divergence and new oceanic crust is formed. Where the plates move together there is a zone of convergence where deep oceanic trenches or mountain ranges can form. The edges of tectonic plates are associated with the production of violent geological events such as earthquakes and volcanoes.

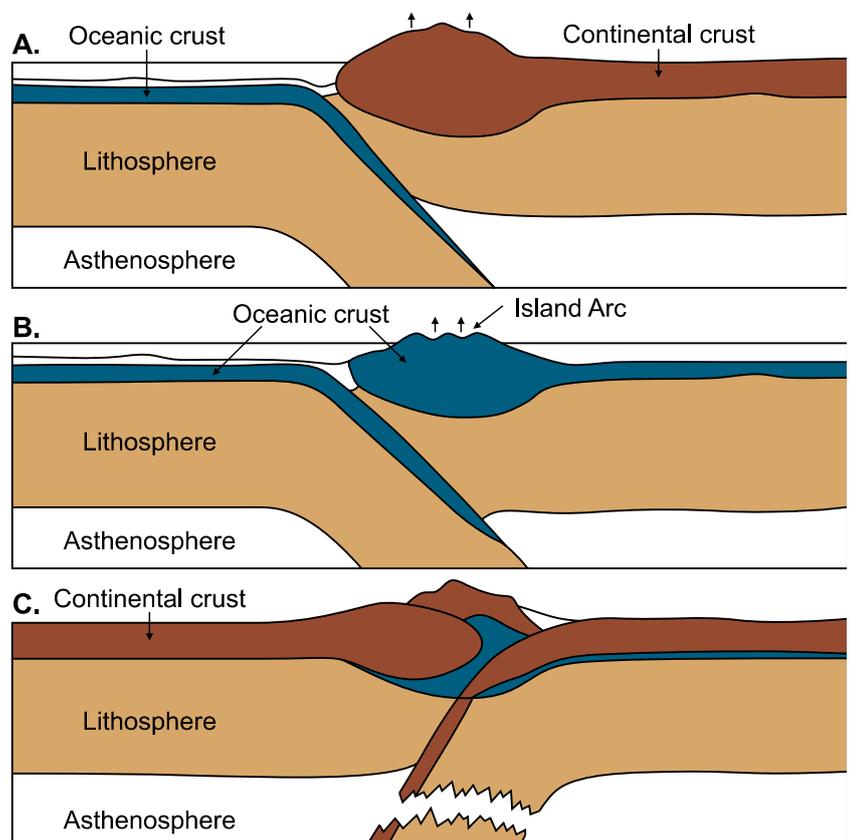


Diagram: Figure 13.19 (Exploring Earth & Environmental Science, Tompkins, 2010)

Plate Tectonics - Teacher Background

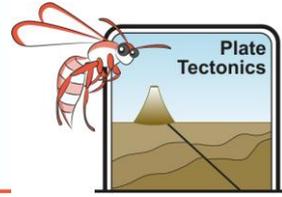


Plate Tectonic Theory suggests that:

- 1. The Earth's surface (lithosphere) is made of large plates.*
- 2. These plates move a few centimeters per year*
- 3. Convection currents in the underlying partially melted asthenosphere drive this movement.*
- 4. The convection currents are powered by heat from radioactive decay and slab pull from dense descending plates.*
- 5. The ocean floor is spreading from mid-oceanic ridges along zones of divergence.*
- 6. Plates can be brought together, moved apart or passed alongside each other.*
- 7. Plate margins are sites of intense geological activity such as earthquakes, mountain building, trench formation and volcanism.*