**Tectonics** is the topic of [Dynamic Planet](https://scioly.org/wiki/index.php/Dynamic_Planet_Topics) for the [2017](https://scioly.org/wiki/index.php/2017) and [2018](https://scioly.org/wiki/index.php/2018) seasons.

**Contents**

**History of Plate Tectonics Theory**



In 1912, Alfred Wegener composed the theory of Plate Tectonics. The idea of a supercontinent was derived from inspecting fossil patterns and crust thickness. Wegener theorized that around 250-300 million years ago, the supercontinent named Pangea, was slowly split apart to their current positions (continental drift). He suggested that the continental coastlines on the opposite sides of the Atlantic Ocean could be “fit together” like jigsaw puzzle pieces, and found similar plant and animal fossils across oceans.

While the theory certainly made sense from a practical point of view, Wegener didn't have a geological way of proving this was true. After looking at various pieces of evidence such as the aforementioned fossil patterns, mountain formation statistics, and glaciation in the Appalachian Mountains during the Pennsylvania Period of the Carboniferous Era, he came up with a geological theory that the Earth were made up of plates that moved around thanks to the rotation of the Earth, causing Pangaea to split up. However, that theory was shot down very quickly, as was the idea that America's movement came from the gravitational forces of the sun and the moon. Thus, Wegener's theory was soon discredited for lack of an explanation. At around the same time, in 1929, Arthur Holmes came up with a way to explain plate tectonics through mantle convection, which would cause the plates to move around the Earth on a bed of mantle convection belts. This idea was not paid attention to at the time until the 1960s, when scientists discovered geomagnetic anomalies along the ocean floor near trenches and the existence of island arcs near continental margins, suggesting the possibility of convection. These pieces of evidence led Harry Hess in 1962 and Robert Dietz in 1961 to publish independently a theory known as sea-floor spreading, which thus became the main way to explain why plate tectonics exists.

**Elements of Plate Tectonics**

**Layers**

**Mechanical Divisions of the Earth's Layers**

**Lithosphere:** the upper 100 km of the earth, comprised of the crust and the uppermost mantle.

**Asthenosphere:** the layer beneath the lithosphere comprising part of the mantle. The Asthenosphere is known as the Low Velocity Zone, as seismic waves travel more slowly through it than they do through the Lithosphere. The boundary between the Lithosphere and the Asthenosphere is generally considered the 1300 C isotherm. Above this boundary, the mantle behaves rigidly and below it behaves in a more ductile manner.

**Mesospheric Mantle:** the mantle beneath the Asthenosphere and above the outer core (about 660 km deep to 2700 km deep) that is distinguished by a sharp increase in seismic wave velocity and density.

**Outer Core:** a liquid layer composed of iron, nickel, and other elements in trace quantities. Convection in the outer core is thought to be the cause of the Earth's magnetic field.

**Inner Core:** The central layer composed primarily of iron with some nickel. The inner core is too hot to hold a permanent magnetic field and is slowly becoming thicker as more of the outer core solidifies slowly over time due to the gradual cooling of the Earth.

**Chemical Divisions of the Earth's Layers**

The Earth's layers are also classified chemically as the Crust, Mantle, Outer Core, and Inner Core.

**Crust:** the uppermost layer ranging from about 5 km - 70 km in depth. Continental crust is considerably thicker than oceanic crust and is primarily composed of granite and other felsic sodium potassium aluminium silicate rocks, while oceanic crust is thinner and composed mostly of basalt and other mafic iron magnesium silicate igneous rocks.

**Mantle:** the layer below the crust that is composed of silicate rocks that are richer in iron and magnesium. The boundary between the Crust and the Mantle is the Moho (Mohorovicic discontinuity). Above the Moho are rocks containing plagioclase feldspar, below it are rocks containing no feldspars.

**Outer Core:** see above

**Inner Core:** see above

**Plates**

Tectonic plates are the pieces of the Earth's crust that "float" on the asthenosphere and make up the lithosphere. They are driven by convection currents in the mantle caused by the heat of the core due to pressure. There are two types of plates: oceanic and continental plates. Continental plates are thicker than oceanic plates, but oceanic plates are denser than continental plates. Oceanic plates are made of denser rocks due to cooling quickly and having fine-crystals.

**Plate Boundaries**

Plate boundaries are where the different pieces of the crust, known as tectonic plates, meet.

**Convergent**

When two plates collide with each other or come together, the boundary between the two plates is known as a convergent boundary.

*Oceanic-Oceanic*

When two oceanic plates converge, it causes subduction and creates a trench. The trench is the deepest part of the ocean because one plate is actually going underneath the other. Oceanic-oceanic convergent boundaries are also responsible for hotspots as magma from the mantle gets trapped between the two plates and is forced upwards.

*Oceanic-Continental or Continental-Oceanic*

When a continental and an oceanic plate converge, the oceanic plate always subducts underneath the continental. These boundaries create volcanoes and active margins and trenches, but the trenches are not as deep.

*Continental-Continental*



When two continental plates converge, the plate is pushed upwards creating mountains.

**Divergent**

*Oceanic*

Oceanic divergent plate boundaries are marked by mid ocean ridges. At these boundaries, seafloor spreading occurs as plates separate and new oceanic lithosphere is formed along the spreading center. The Mid Atlantic Ridge is a well-known example of an oceanic divergent plate boundary.

*Continental*

Divergent boundaries over continents can cause rifting, in which the continental lithosphere stretches and thins before being broken apart, after which seafloor spreading begins. The East African Rift is an example of an active continental divergent boundary and is currently splitting the African Plate into two plates: the Somali Plate and the Nubian Plate.

**Transform**

When two plates slide past each other, the boundary is known as a transform boundary. No old plate is subducted and no new plate is formed at transform boundaries, which are marked by large faults and often earthquake activity. The San Andreas Fault is one of the most famous faults that occurs along a transform boundary.

**Basins**

**Tectonic Plate Movement**

**Driving Forces**

Tectonic plate movement is primarily driven by convection currents in the Earth's lower mantle.

**Isostasy:** Isostasy is the gravitational equilibrium between the lithosphere and the asthenosphere. The asthenosphere is weaker and more ductile than the lithosphere and flows laterally under the force of the lithosphere. The depth at which pieces of the lithosphere "float" in the asthenosphere is determined by their size and density. Denser and larger sections of crust will sink lower in the asthenosphere, which accounts for some differences in elevation of the Earth's crust. These different topographic heights can be accounted for by differing crustal thicknesses (Airy-Heiskanen model) and by differing densities (Pratt–Hayford model). Events that cause the crust to thicken, such as accumulation of sediment or collisions resulting in the development of mountains cause the crust to depress, while events that take weight off of the land, such as glacial retreat, cause the crust to "rebound".

**Basal Drag:** Basal drag is plate movement due to friction between the asthenosphere's convection currents and the lithosphere.

**Slab Suction:** Slab suction is plate movement due to local convection currents that pull plates down at subduction zones in ocean trenches.

**Impacts of Plate Movement**

**Effects of Tectonics**

**Tectonic Hazards**

*For more detailed information on earthquakes, volcanoes, and tsunamis, please see the* [*Earthquakes and Volcanoes*](https://scioly.org/wiki/index.php/Dynamic_Planet/Earthquakes_and_Volcanoes) *page.*

**Landslides**

**Mitigation of Hazards**

**Effects on Geology**

**Rock Deformation**

**Magnetic/Gravity Anomalies**

**Geological Composition**

The effects of plate tectonics can create settings of various types of rocks and minerals within existing rock.

**Effects on Climate**

**Geologic History of North America**

One specific topic included in the rules for [2017](https://scioly.org/wiki/index.php/2017) and [2018](https://scioly.org/wiki/index.php/2018) was the study of specific aspects of North American geologic history. This was focused on four different topics: the North American craton, the Rocky Mountains, the Appalachian Mountains, and the Yellowstone Hot Spot.

**Common Tasks**

**Ordering Rock Layers**

Ordering rock layers appears to be a commonly tested skill in the 2017 season. Because rock layers are deposited from the bottom up, it is fairly easy to order these rock layers. The oldest rocks are at the bottom, and the newest rocks are on top. This is known as the **Law of Superposition**.

The **Law of Original Horizontality** states that layers of sediment, rocks, or other geologic material are always deposited in horizontal layers. If rock layers are not horizontal, that indicates some sort of geologic activity.

The **Law of Crosscutting Relationships** states that geologic features, such as faults, and igneous intrusions are younger than the rocks they cut. Similarly, if rocks are folded, the folding is younger that the youngest rock affected.