GEOLOGY G11

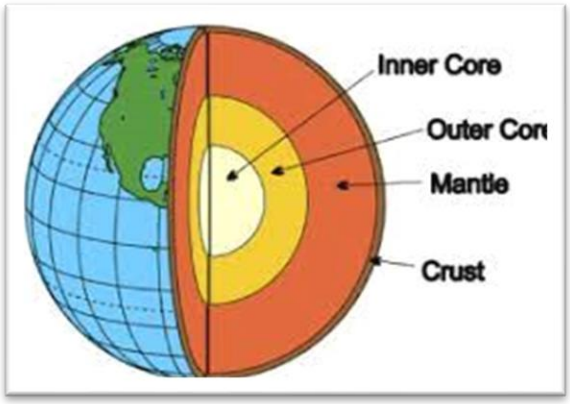
Learning outcome 1: Earth Evolution.

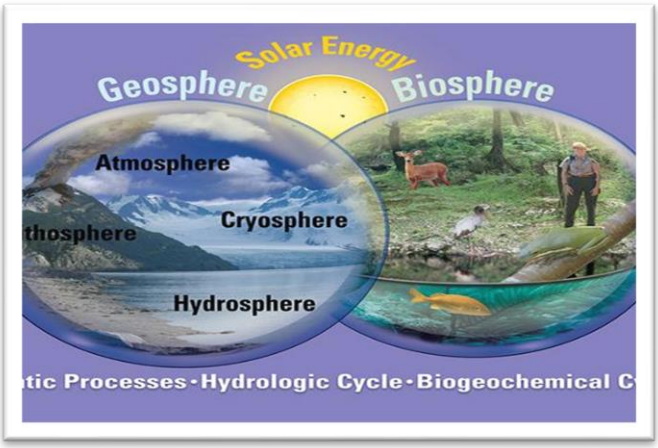
* geologic province: a large region of Earth's surface with a common geologic history

Earth starts as proto planet.

* The oldest oceanic crust is not older than 200 million years. However, continental rocks are much older.

Geosphere: **includes the rocks and minerals on Earth** – from the molten rock and heavy metals in the deep interior of the planet to the sand on beaches and peaks of mountains.





* Geographers break down the Earth's systems into four spheres that make up the world's

air (atmosphere)- water (hydrosphere) - land (geosphere) - living organisms (biosphere).

*The lithosphere is **the rocky outer part of the Earth**. It is made up of the brittle crust and the top part of the upper mantle. The lithosphere is the coolest and most rigid part of the Earth.

Mantle:

- *Earth's mantle* is a layer of silicate rock.

- between the crust and the outer core.

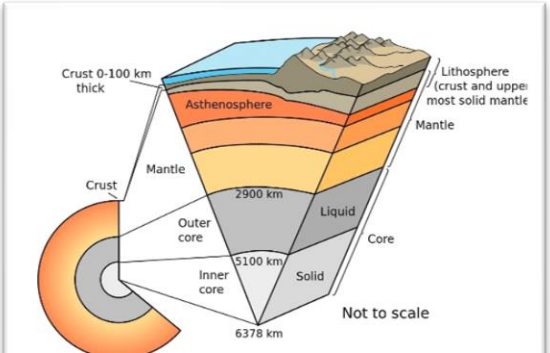
- It has a mass of 4.01 × 10^{24} kg and thus makes up 67% of the mass of Earth.

- In terms of its constituent elements, the mantle is made up of 44.8% oxygen, 21.5% silicon, and 22.8% magnesium. There's also iron, aluminum, calcium, sodium, and potassium.

- These elements are all bound together in the form of silicate rocks, all of which take the form of oxides.

***Earth was formed 4.6 million years ago.**

***It was smaller than today, one third of its current size.**



EARTH is:

Inner core → 5100 km → Iron

Outer core→ 2900 km→ liquid iron and nickel

Mantle→ Minerals in general (silicate rock contains Al , Mg, Ca, Na , K and silicone)

Crust→ 0-100 km thick → Metals

--* the first 500 million years, Earth was a hostile place. There were many volcanoes on its surface. Also, it was hit often by many meteorites. These meteorites cause the rise in temperature that makes Earth internal heat.

--* **Heat flow in young Earth = 3 times today**. This mysterious Earth of **4.6 to 3.8 billion years ago** is called the Hadean. Like "hades "in Greeks. During this the bombardment of earth decreases.

--* the meteorites cause heat of earth to increases, and it its surface to be molten and melting every mineral in the surface and forming patches. Some material is recycled in mantle crust; thus, the molten rocks were in basaltic form.

--* The minerals in **basaltic crust** are stable at higher temperatures. They can crystallize, on Earth. like those at mid-ocean ridges. However, the melting and re-melting of basaltic crust eventually formed granites out of the recycled rock.

Earth's oldest continental materials are tiny crystals of zircon. (Its chemical name is zirconium silicate.) Zircon is hard and durable. It was originally formed in igneous rocks. These rocks were later weathered and recycled into younger sedimentary rocks. The age of one of these crystals is 4.4 billion years old! The date is not 100 percent accurate. However, it does indicate that minerals formed a crust more than 4 billion years ago.

Crustal Evolution The oldest known rock on Earth is about 4.1 billion years old. It is a granodiorite from Canada's Northwest Territories.

It formed below the surface as an igneous rock.

Its chemistry is somewhere between that of granite and diorite.

Granodiorite is usually formed at subduction zones.

It is possible that plate tectonics was very active over 4 billion years ago.

There probably were many very small plates. Collisions of these plates would have formed island arcs. As plates joined together, the first small continents formed. This process is called accretion.

Southwest Greenland contains the oldest preserved crust of a continental landmass. It is 3.8 billion years old. It is Earth's oldest surviving accretionary orogen.

orogen: a linear or arc-shaped region that has been subjected to intense folding and other deformation during the tectonic cycle.

- Subduction: the sideways and downward movement of the edge of a plate of the earth's crust into the mantle beneath another plate. Subduction of the young crust was very important for the early development of continents.

- Continental collisions result in subduction that melts the leading edges of plates. As a result, andesitic magma forms. Magma is then being less dense and thicker that makes it harder to be subducted again so the upper surface cool and minerals have became not recycled into mantle side.

* This type of magma has a lower density than surrounding crustal rocks. Rising plumes of light, andesitic magma form circular or oval-shaped batholiths(rocks) in the crust.

*They make it not only less dense, but thicker. This increases its buoyancy. This makes these parts of the crust difficult to subduct under other plates.

* The thicker crust is also better insulated from the upper mantle and becomes more stable. These areas of the crust form continental shields.

shield: a large area of rocks that form the roots of a continent. Shields are part of a craton. They commonly have a gently convex surface and are surrounded by sediment-covered platforms.

- Craton: a large stable block of the earth's crust forming the nucleus of a continent.
- greenstone: Found around shields, green colored metamorphic rocks formed from dark igneous rocks that often occur in belts within Precambrian shields.

/// Greenstone belts consist of a mix of metamorphosed lava flows and sediments from chains of volcanic. The Evolution of the Geosphere of oceanic crust.

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supergroup: a very large stratigraphic unit consisting of many important smaller groups of greenstones belts.

ROCK CYCLE

- Three-billion-year-old sedimentary rocks form the top part of the Barberton Supergroup. The rock is about 2.5 km thick. These rocks indicate that Earth’s young, very small continents were subject to weathering and erosion.

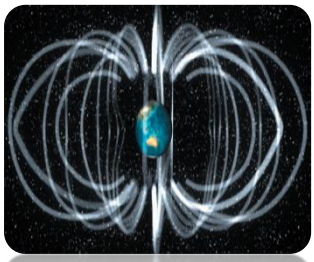
- No soil or plants on land. The atmosphere had yet to develop free oxygen.

- The surfaces of the young continents were rapidly stripped of weathered particles. Rains washed their rocky surfaces. Sediment was transported by rivers.

- Coarse sediments were deposited in shallower water. They formed conglomerates and sandstones.

- Rocks that travel deeply, become mudstones.

The rock cycle takes about 3.5 billion years.



Magnetosphere **creation of Earth**

The loss of heat from Earth's exterior allowed its interior structure to develop.

As molten iron solidified, it created the dense, solid inner core at the center of the planet.

The outer core is liquid. Motion in the iron-rich outer core continuously generates electrical currents.

This in turn produces Earth's magnetic field. You may recall from physics classes the effect of rotating a bar magnet through an electrical field. A similar effect occurs in Earth's core. It is called the dynamo effect. Earth's magnetic field is self-sustaining. It is able to maintain itself.

The magnetic field shields Earth from the solar wind.

Without the magnetic field, the constant stream of particles from the Sun would have eroded Earth's atmosphere. It would be lost into space.

When igneous rocks cool, magnetic minerals record the direction and strength of Earth's magnetic field.

terrane: a region of crust added to a craton from a tectonic plate as a result of accretion.

basement: the lowermost units of rocks that can be mapped (often Precambrian in age) in a region. The units are often igneous and metamorphic.

Earth Planet Evolution Stages

-**formation of the core→ minerals**

- the formation of the mantle → minerals

- the formation of oceanic-type crust-→ reaches of metals like iron and nickel (NiFe)

- the formation of ancient platforms, and consolidation (the present stage) after which there will presumably be no more earthquakes or volcanic activity.

NOTE:

Earth formed its chemical structure after it's early assembly and melting, is one marked by progressive chemical segregation and distillation of solid (By lowering temperature by subliming), Liquid (by melting), and gaseous components (boiling) .