Astronomy Reviewer

How the Earth was Formed

The formation of the Earth started 4.6 billion years ago from planetesimals that formed through accretion and gradually formed into planets. This is known as the **core accretion model** and it is where the Earth started.

An artistic depiction of the molten Early Earth. Credit: Tim Bertelink/Creative Commons

Because of the constant bombardment of space bodies and the decay of radioactive elements, the early Earth was dominantly molten. As time passed, bombardment declined and the temperatures began to cool.

Heavier elements like iron and nickel sank to the center of the Earth forming the **core**, while lighter elements migrated towards the surface. This allowed the Earth to produce layers in a process called **chemical differentiation**. It is during this cooling period where the Earth's primitive crust started to form and the magnetic field was produced.

The **Giant Impact Hypothesis** states that around 4.5 billion years ago, a large Mars-sized celestial body called **Theia** impacted the Earth which resulted in the ejection of undifferentiated Earth materials, forming our Moon.

The impact is also said to have been the cause of the tilt in the Earth's axis.

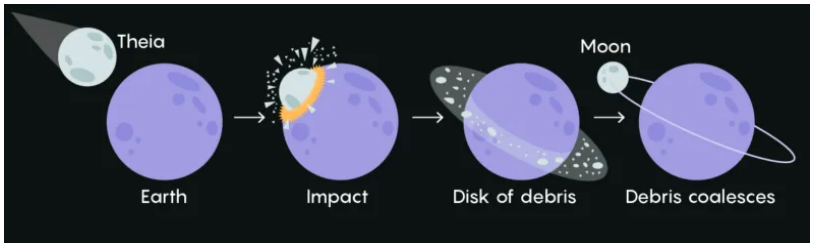

Diagram illustrating the events of the Giant Impact Hypothesis. Credit: Citronade/Creative Commons

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Around 4.37 – 4.20 billion years ago, Earth was bombarded by asteroids in a period known as the **Late Heavy Bombardment stage**. It is theorized that these asteroids carried atmospheric, oceanic, and biological components such as water and bio-elements, which set the stage for life on Earth.

As the Earth cooled, the outgassing of gases (via intense volcanism) from the Earth's interior formed Earth's first atmosphere. Unlike now, the first atmosphere was very hot and mostly composed of gases such as NH_3, CH_4, CO_2, and a bit of H_2O.

Around 4.0 billion years ago, water vapor in the atmosphere began to condense which produced torrential rains that formed our vast oceans.

Cyanobacteria (a type of aerobic bacteria) played an important role in the production and increase of O_2 in the Earth's atmosphere. Because of this, aerobic bacteria began to thrive while anaerobic bacteria declined in an event called the **Great Oxidation Event**.

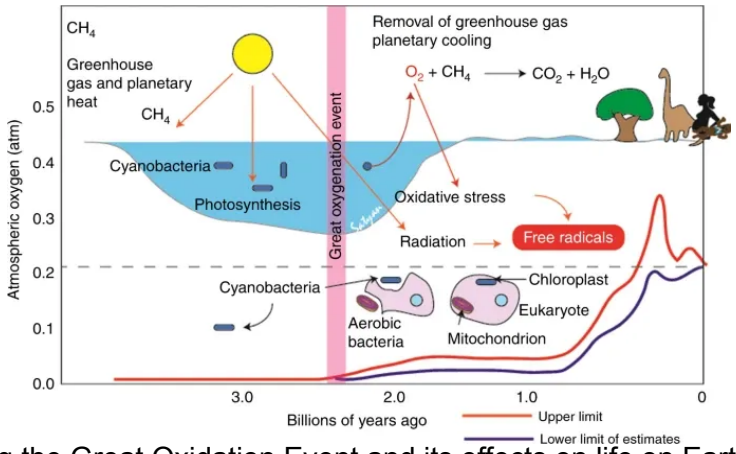

Diagram showing the Great Oxidation Event and its effects on life on Earth. Credit: Saugstad, et. al. (2019)

Accelerated weathering of the Earth's surface introduced elements such as Na, Ca, K, and Si from the land to the oceans, increasing its salinity. Seawater and $CaCO_3$ in the oceans "locked up" large amounts of CO_2 in the atmosphere, cooling the Earth significantly.