Origins of the Moon

Today most scientists believe Earth's sole satellite formed off the back of a collision event that occurred roughly 4.53 billion years ago. At this time, Earth was in its early development stage and had been impacted numerous times by planetesimals and other rocky bodies – events that had shock-heated the planet and brought about the expansion of its core.

One collision, however, seems to have been a planet-sized body around the size of Mars – dubbed Theia. Basic models of impact data suggest Theia struck Earth at an oblique angle, with its iron core sinking into the planet, while its mantle, as well as that of Earth, was largely hurled into orbit. This ejected material – which is estimated to be roughly 20 per cent of Theia's total mass – went on to form a ring of silicate material around Earth and then coalesce within a relatively short period (ranging from a couple of months up to 100 years) into the Moon.

Layer by layer

Under the influence of gravity, the heavier elements inside the protoplanet sink to the centre, creating the major layers of Earth's structure.

Planetesimal

By this stage the planetesimal is massive enough to effectively sweep up all nearby dust, grains and rocks as it orbits around the star.

Growing core

Heated by immense pressure and impact events, the metallic core within grows. Activity in the mantle and crust heightens.

Atmosphere

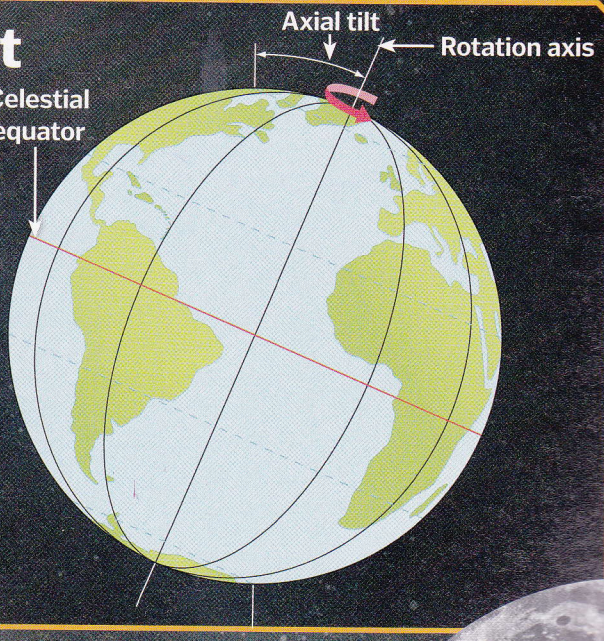
Thanks to volcanic outgassing and ice deposition via impacts, Earth develops an intermediary carbon-dioxide rich atmosphere.

Why does our planet have an axial tilt?

Earth's axial tilt (obliquity), which is at 23.4 degrees in respect to the planet's orbit currently, came about approximately 4.5 billion years ago through a series of large-scale impacts from planetesimals and other large bodies (like Theia). These collisions occurred during the early stages of the planet's development and generated forces great enough to disrupt Earth's alignment, while also producing a vast quantity of debris.

While our world's obliquity might be 23.4 degrees today, this is by no means a fixed figure, with it varying over long periods due to the effects of precession and orbital resonance.

For example, for the past 5 million years, the axial tilt has varied from 22.2-24.3 degrees, with a mean period lasting just over 41,000 years. Interestingly, the obliquity would be far more variable if it were not for the presence of the Moon, which has a stabilising effect.



4.57 BYA
Protostar
The precursor to the Sun (a T Tauri-type star) emerges at the heart of the nebula.

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Disc develops
Around the T Tauri star a protoplanetary disc of dense gas begins to form and then gradually cools.

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Planet
As dust and rock gather, Earth becomes a planet, with planetary differentiation leading to the core's formation.

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Birth of the Moon
Theia, a Mars-sized body, impacts with the developing Earth. The debris from the collision rises into orbit and will coalesce into the Moon.