From dust to planet

To get to grips with how the Earth formed, first we need to understand how the Solar System as a whole developed – and from what. Current evidence suggests that the beginnings of the Solar System lay some 4.6 billion years ago with the gravitational collapse of a fragment of a giant molecular cloud.

In its entirety this molecular cloud – an interstellar mass with the size and density to form molecules like hydrogen – is estimated to have been 20 parsecs across, with the fragment just five per cent of that. The gravitationally induced collapse of this fragment resulted in a pre-solar nebula – a region of space with a mass slightly in excess of the Sun today and consisting primarily of hydrogen, helium and lithium gases generated by Big Bang nucleosynthesis (BBN).

At the heart of this pre-solar nebula, intense gravity – along with supernova-induced over-density within the core, high gas pressures, nebula rotation (caused by angular momentum) and fluxing magnetic fields – in conjunction caused it to contract and flatten into a protoplanetary disc. A hot, dense protostar formed at its centre, surrounded by a 200-astronomical-unit cloud of gas and dust.

It is from this solar nebula's protoplanetary disc that Earth and the other planets emerged. While the protostar would develop a core temperature and pressure to instigate hydrogen fusion over a period of approximately 50 million years, the cooling gas of the disc would produce mineral grains through condensation, which would amass into tiny meteoroids. The latest evidence indicates that the oldest of the meteoroidal material formed about 4.56 billion years ago.

As the dust and grains were drawn together to form ever-larger bodies of rock (first chondrules, then chondritic meteoroids), through continued accretion and collision-induced compaction, planetesimals and then protoplanets appeared – the latter being the precursor to all planets in the Solar System. In terms of the formation of Earth, the joining of multiple planetesimals meant it developed a gravitational attraction powerful enough to sweep up additional particles, rock fragments and meteoroids as it rotated around the Sun. The composition of these materials would, as we shall see over the page, enable the protoplanet to develop a superhot core. ▶

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The history of Earth

Follow the major milestones in our planet's epic development
***(BYA = billions of years ago)**

13.8 BYA*
Big Bang fallout
Nucleosynthesis as a result of the Big Bang leads to the formation of chemical elements on a huge scale.

4.6 BYA
New nebula
A fragment of a giant molecular cloud experiences a gravitational collapse and becomes a pre-solar nebula.