Earth

THE PERFECT PLANET

With all the ingredients to foster and sustain life, Earth is the miracle of the Solar System, but what is it that makes our home so special?

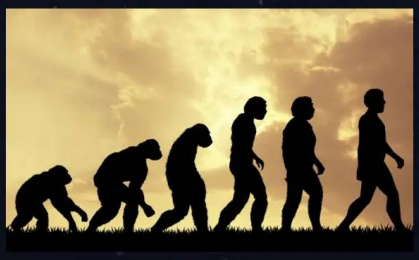
Written by
PHILIP S KAY

During our busy daily routines, we rarely have time to step back and consider how lucky we are to be here. The chances of there being a planet like ours with the ideal circumstances and precise conditions to support intelligent life are so slim that it seems miraculous we exist to ponder anything at all. Earth is unique: it is the only celestial body we know of that hosts living entities. It is home to millions of species and such biodiversity that if there does turn out to be another planet with life on it – and if its inhabitants are advanced enough to visit us – they would surely marvel at the kaleidoscopic range of colour and astounding vibrancy on display. We often take our home for granted, but make no mistake, it is the most extraordinary place in the Solar System, and with a history that goes back over 4.5 billion years, it is almost as old.

Though experts still don't fully understand the early stages of our planet's history, they believe that its formation resulted from a tumultuous process that involved gravity pulling together large amounts of gas and dust particles until they coalesced into more substantial matter. After Earth's initial creation, several notable events heated, sculpted and shaped it over hundreds of millions of years. The first has come to be known as the 'Giant Impact Theory'. In his now widely accepted 1946 hypothesis, geologist Reginald

LIFE AS WE KNOW IT

The process of evolution on our planet was extremely complex, and it took eons. Evidence of modern humans only dates back 300,000 years, despite simple single-celled organisms emerging almost 3.8 billion years earlier. Although rare extinction events affected the evolutionary timeline, intelligent life would never have developed at all without the unique combination of factors on Earth and its relative stability.



LstlTpcEysO6QCb+ILkjgQ==

LstlTpcEysO6QCb+ILkjgQ==

WHAT IS AN OCEAN WORLD?

Oceans cover about 71 per cent of our homeworld. It is the only planet we know of that has the liquid surface water required for life. However, some moons in our Solar System, such as Europa, Ganymede and Callisto, may have oceans trapped beneath their icy surfaces that could hold even more water than Earth. That makes them ocean worlds, too.

Daly proposed that the young Earth collided with another protoplanet (later called Theia), causing a massive ejection of matter that bound together to form our Moon. An occurrence of such magnitude would have generated enough heat on our planet to create a global ocean of molten magma.

Another key phase in Earth's development probably took place about 4 billion years ago and affected the whole Solar System. During a prolonged period referred to as the Late Heavy Bombardment, an enormous quantity of frozen asteroids and icy comets pounded Earth's surface. Although destructive, the projectiles may have delivered life-giving organic molecules and water, though some researchers contend that these already existed in the planet's original matter and were released as gases through volcanic activity. Either way, when the cosmic forces had finished forging their masterpiece, what remained was the largest and most complex terrestrial body in our Solar System. As the planet's temperatures fell, the processes of condensation and solidification facilitated the formation of our oceans and landmasses, but it has only been within the last 200 million years that the continents we are so familiar with took up their current positions.

In total, billions of years passed before Earth's surface came to resemble the place we now call home, but what a home it is. From jungles, forests, mountains, plains and deserts to tundra, ice caps, oceans, rivers and lakes, our planet has it all. It offers a staggering variety of scenic showpieces across its continents – more than anyone could see in a lifetime. How is it possible for one planet to be so beautiful and alive while the others in our Solar System languish in the dead abyss of space? Well, several factors contribute to Earth's success, the first being location.

At an average distance of 93 million miles (150 million kilometres), our planet is far enough away from the Sun not to be a ferocious hothouse like Venus, yet still close enough to avoid the frozen fate of Mars. Earth sits in a narrow orbital band we call the continuously habitable zone,

"Billions of years passed before Earth's surface resembled the place we now call home"

where moderate temperatures allow liquid water to exist on its surface for long periods of time. The persistent presence of water is one of the most important elements in the emergence and development of life, and it is why much of our interplanetary exploration involves trying to find past or present evidence of it.

Like Mercury, Venus and Mars, Earth has a layered structure with a thin, solid crust surrounding a viscous mantle and a dense metallic core. However, it is the only one of those planets whose crust continually breaks apart and shifts. This phenomenon, known as active plate tectonics, relies on the lubricating properties of liquid water and happens because temperature fluctuations in the mantle cause convection currents to push and pull the giant pieces of rock that make up our planet's outer layer. The geological mechanism leads to earthquakes and volcanic eruptions, but it is also an essential component of Earth's long-lasting vitality, as it helps to recycle nutrients, balance our climate and release the energy that generates our protective magnetic field.

We all know how important the Sun is to life. It has been a symbol of birth and renewal for many civilisations, and it energises us with its comforting warmth as it rises over the morning horizon. Nevertheless, for planets without a strong magnetic field, it is a killer. Fortunately,

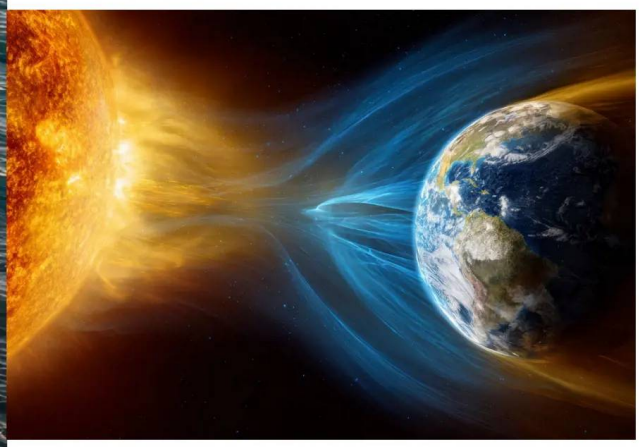
ABOVE Earth's active geology contributes to our planet's stability and safety

LEFT The presence of liquid water affects Earth's plate tectonics in a unique way

BELOW Earth's magnetosphere is the only effective one in the inner Solar System

Earth's natural defensive barrier, called the magnetosphere, prevents most of its deadly solar particles and other deep-space rays from eroding our atmosphere by redirecting them. This feature, which is generated by the churning of Earth's liquid outer core, is critical for life, because without a thick enough atmosphere, there wouldn't be enough pressure to retain surface water. Our magnetosphere surrounds the whole globe and is the only effective one in the inner Solar System.

Safe beneath the embrace of our magnetic field, Earth's atmosphere was free to develop. Initially, it was made up of volatile gases like carbon dioxide, ammonia and methane – compounds that were released when our planet was repeatedly heated – but its composition changed. The instigators were tiny microbes called cyanobacteria that began producing oxygen more than 3 billion years ago through photosynthesis. It took a long time to accumulate in significant amounts, but as the planet matured, its atmosphere gradually attained the perfect balance of oxygen and nitrogen, a chemical cocktail conducive to additional life.



As well as providing the air we breathe, Earth's atmosphere benefits us in other ways: it acts as a shield, preventing most meteoroids and other space debris from impacting on the surface; it ensures that our world doesn't freeze over by trapping heat; its weather systems redistribute moisture across the globe; and its ozone layer stops us from becoming the victims of too much ultraviolet radiation.

In spite of everything that our magnetosphere and atmosphere do for our planet and its inhabitants, they can't save us from all the dangers that exist in our Solar System: rare space-weather events and Near-Earth Objects still pose a threat. Some of the Sun's eruptions can send massive solar storms speeding towards Earth. The huge amounts of high-energy particles they contain can overwhelm our magnetic field, causing damage to satellites, communications and other important infrastructure. More frightening, though, are asteroids and meteoroids that are too large or dense to disintegrate in the atmosphere. History tells us that when these make it through to hit the surface, they can be catastrophic enough to cause global devastation and wipe out entire species, like the dinosaurs.

Of course, the most immediate threat to Earth is humanity itself. With more than 8 billion of us now on the planet, we are depleting its natural resources, polluting its environment and changing its climate at an ever-increasing rate. The damage that we have caused is so extensive and serious that it has been a permanent topic of discussion over the last few decades. We already know that we need to take better care of our home, but if we think about how unlikely it is for a planet with such a unique combination of life-sustaining factors to exist in the first place and consider that it still took billions of years to nurture our species to fruition, we might be motivated to try harder.

LstlTpcEysO6QCb+ILkjgQ==