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Authors: Ravilious, Kate

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Abstract: The article discusses the presence of tectonic plates on Earth. It states that Earth is the only planet that has tectonic plates for its lithosphere is not too thick and its gravitational field is not powerful enough to squeeze any plates together. The exact date of the beginning of plate tectonics is still unknown, however, it is important since it is responsible for the reshaping of the Earth where water, carbon and nitrogen are recycled to make the environment suitable for life.

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Unknown Earth: Why does Earth have plate tectonics?

Without plate tectonics our planet would be a very different place. The constant recycling of the Earth's crust provides us with a stable climate, mineral and oil deposits and oceans with a life-sustaining balance of chemicals. It even gives evolution a kick every few hundred million years.

Earth is the only planet we know of that has plate tectonics. So what went right? Models have shown that for plate tectonics to get going a planet has to be just the right size: too small and its lithosphere - the solid part of the crust and upper mantle - will be too thick. Too big and its powerful gravitational field squeezes any plates together, holding them tightly in place. The conditions also have to be just right: the rocks making up the planet should be not too hot, not too cold, not too wet and not too dry.

Yet even if these conditions are met there is one more crucial factor that needs to be introduced. Somehow the lithosphere has to be cracked in such a way that one piece will dive down beneath the other. Today we see this process, known as "subduction", at the rim of many ocean basins, as cold, dense ocean floor slides under the more buoyant continental crust and dives into the mantle.

However, early Earth was much warmer than it is today, and instead of having a brittle outer crust it had a sticky kind of goo, in which the first cracks must have appeared. Numerous computer models have tried to simulate conditions in which a break in the crust would spontaneously occur, but so far all have failed.

A hot mantle plume could have made the first hole, bursting up from below. Or perhaps an asteroid or comet was the trigger, piercing the gooey surface layer on impact and setting up a chain of events that created the first moving plates.

Another big unknown is when this might have happened. There is very little record in oceanic crust because most of it is not old enough - oceanic crust is usually destroyed in subduction zones just 200 million years after being created in an ocean ridge. Yet evidence from oceanic crust that has avoided subduction is providing clues. "Ophiolites" are slivers of ancient oceanic crust, which were pushed on top of continental crust at a subduction zone rather than being pushed down beneath it. A recent study dated a sample of what is thought to be an ophiolite in Greenland to 3.8 billion years ago - the oldest suggestion of plate tectonics yet.

Whatever the exact date plate tectonics began, it has shaped and reshaped the surface of our planet ever since. The process recycles water, carbon and nitrogen, creating an environment that is perfect for life. It also created many of the oil, gas and mineral deposits that we find on Earth - pressurising and baking rock deposits to just the right degree. Volcanoes spewing carbon dioxide into the atmosphere and the grinding of tectonic plates work together to keep the climate liveable (see "Why is Earth's climate so stable?").

Plate movement also makes oceans open and close, mountains rise and fall and continents gather and split. Every 500 to 700 million years, plate tectonics brings the continents together to form a supercontinent. The last, Pangaea, existed 250 million years ago, and in roughly 250 million years the continents will crash together again.

When these supercontinents slowly break up, separating landmasses and forming shallow seas, evolution goes into overdrive, forming countless new species which colonise the new habitats.

Eventually, the lithosphere will seize up, as Earth cools and convection currents in the mantle become too weak to push the plates around. No one is quite sure how much longer plate tectonics has got to run, or whether it will stop before our planet is consumed by the sun. But let's not worry too much about that: by the time it happens humans are likely to be a distant memory in the life of the planet.

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By Kate Ravilious

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