Earth: A Borderline Planet for Life?

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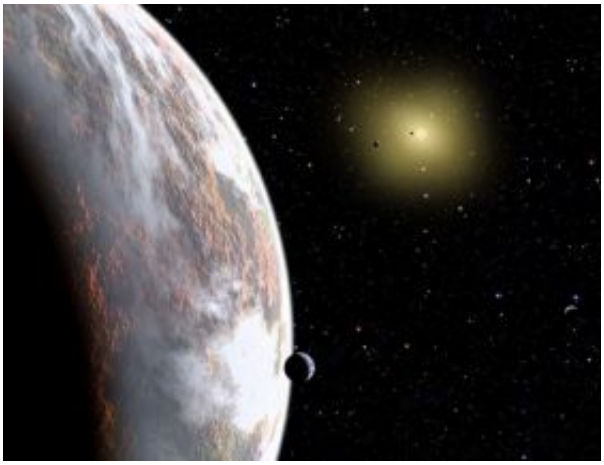

A super-Earth like the one in this artist's conception can grow twice as large as Earth with up to 10 times the mass. Super-Earths are likely to be more life-friendly than our world because they would be more geologically active. Credit: David A. Aguilar (Harvard-Smithsonian CfA)

Our planet is changing before our eyes, and as a result, many species are living on the edge. Yet Earth has been on the edge of habitability from the beginning. New work by astronomers at the Harvard-Smithsonian Center for Astrophysics shows that if Earth had been slightly smaller and less massive, it would not have plate tectonics - the forces that move continents and build mountains. And without plate tectonics, life might never have gained a foothold on our world.

"Plate tectonics are essential to life as we know it," said Diana Valencia of Harvard University. "Our calculations show that bigger is better when

it comes to the habitability of rocky planets."

This research was the subject of a press conference at the 211th meeting of the American Astronomical Society.

Plate tectonics involve the movement of huge chunks, or plates, of a planet's surface. Plates spread apart from each other, slide under one another, and even crash into each other, lifting gigantic mountain ranges like the Himalayas. Plate tectonics are powered by magma boiling beneath the surface, much like a bubbling pot of chocolate. The chocolate on top cools and forms a skin or crust, just as magma cools to form the planet's crust.

Plate tectonics are crucial to a planet's habitability because they enable complex chemistry and recycle substances like carbon dioxide, which acts as a thermostat and keeps Earth balmy. Carbon dioxide that was locked into rocks is released when those rocks melt, returning to the atmosphere from volcanoes and oceanic ridges.

"Recycling is important even on a planetary scale," Valencia explained.

Valencia and her colleagues, Richard O'Connell and Dimitar Sasselov (Harvard University), examined the extremes to determine whether plate tectonics would be more or less likely on different-sized rocky worlds. In particular, they studied so-called "super-Earths"-planets more than twice the size of Earth and up to 10 times as massive. (Any larger, and the planet would gather gas as it forms, becoming like Neptune or even Jupiter.)

The team found that super-Earths would be more geologically active than our planet, experiencing more vigorous plate tectonics due to thinner plates under more stress. Earth itself was found to be a borderline case, not surprisingly since the slightly smaller planet Venus is

tectonically inactive.

"It might not be a coincidence that Earth is the largest rocky planet in our solar system, and also the only one with life," said Valencia.

Exoplanet searches have turned up five super-Earths already, although none have life-friendly temperatures. If super-Earths are as common as observations suggest, then it is inevitable that some will enjoy Earth-like orbits, making them excellent havens for life.

"There are not only more potentially habitable planets, but MANY more," stated Sasselov, who is director of the Harvard Origins of Life Initiative.

In fact, a super-Earth could prove to be a popular vacation destination to our far-future descendants. Volcanic "rings of fire" could span the globe while the equivalent of Yellowstone Park would bubble with hot springs and burst with hundreds of geysers. Even better, an Earth-like atmosphere would be possible, while the surface gravity would be up to three times that of Earth on the biggest super-Earths.

"If a human were to visit a super-Earth, they might experience a bit more back pain, but it would be worth it to visit such a great tourist spot," Sasselov suggested with a laugh.

He added that although a super-Earth would be twice the size of our home planet, it would have similar geography. Rapid plate tectonics would provide less time for mountains and ocean trenches to form before the surface was recycled, yielding mountains no taller and trenches no deeper than those on Earth. Even the weather might be comparable for a world in an Earth-like orbit.

"The landscape would be familiar. A super-Earth would feel very much

like home," said Sasselov.

Source: Harvard-Smithsonian Center for Astrophysics