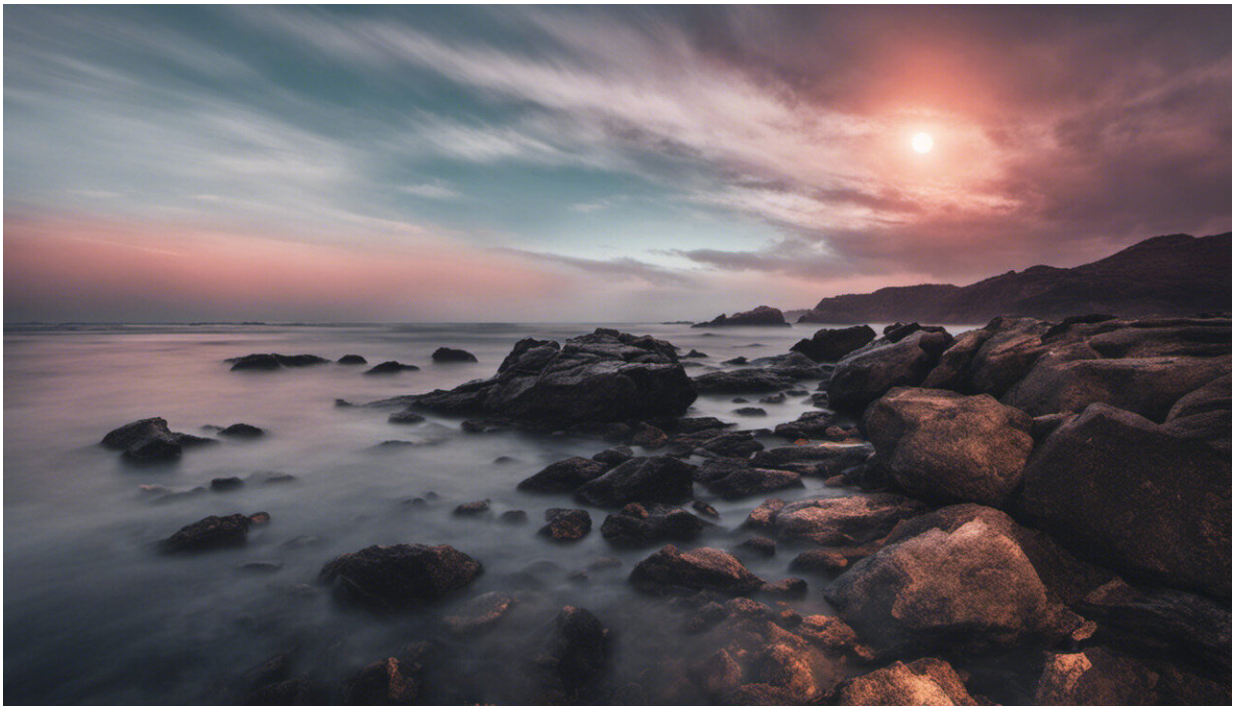
With or without you: The role of the moon on life

March 29 2013, by Jonti Horner



Credit: AI-generated image (disclaimer)

From encouraging the first steps of life migrating from the oceans to the land, to stabilising Earth's axial tilt against chaotic excursions, the moon is often put forth almost as a magical ingredient – a prerequisite for life.

Of course, the question of the origin of life on Earth has long puzzled

scientists. To date, no one has come up with a totally convincing origin story – and there are even suggestions that life may have originated elsewhere, and been delivered to Earth on the comets and asteroids that bombard our planet.

This theory, panspermia, is attractive, since it removes the burden of life having had to form on our planet, giving us an infinitely greater range of origins, mechanisms, and times.

It is certainly the case that biologically-viable bacteria can be transferred between the planets.

Numerous studies (typically involving firing bacteria in small projectiles out of guns at speeds of several kilometres per second to crater a target) have shown that bacteria can survive the shocks involved in the collision between asteroids and planetary surfaces, while experiments on the International Space Station have shown how bacteria can survive and remain viable for long periods of time in space.

But for now, let's just consider those theories that suggest life originated here, rather than being brought from elsewhere.

For theories that suggest life originated on Earth, it has often been proposed that the moon may have played in important role in its origin.

The youthful Earth was a vastly different place to the planet we observe today, but current thinking holds that our early oceans contained a plethora of organic molecules of varying complexity.

Many mechanisms have been proposed for the origin of those molecules, ranging from delivery by cometary and asteroidal impactors to a huge variety of chemical processes, or even production through radioactive decay!

The question of how those molecules went on to become life is another thing entirely. Again, a number of different theories have been put forth, but one particularly relevant to our story relies on the presence of the moon driving vast tides, which created huge tidal areas, in which complex chemistry would occur.

We know that, shortly after its formation, the moon was very, very close to Earth, and that therefore the tides it would raise on the oceans would be far, far greater than those we see today.

Since the days were far shorter, tides washed in and out again with great frequency, creating vast tidal areas on the boundaries of any continents that existed at the time.

Some authors have suggested these tidal regions helped to concentrate radioactive materials near the high-tide line, which would in turn have helped to make the building blocks of life.

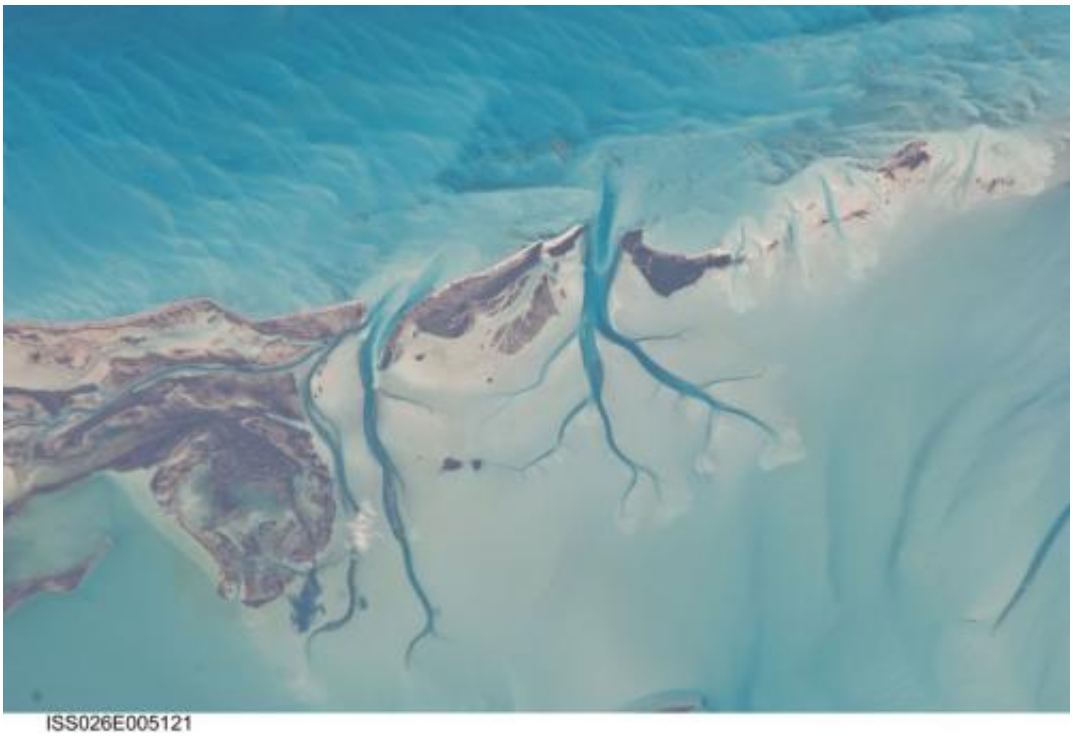
Others point out that the constant grinding of the tides would have created sands and small grained sediments, greatly increasing the surface area available to catalyse chemical reactions, again facilitating the development of life's building blocks.

Although it is far from certain, it's definitely feasible that the moon may have played a role in the origin of life. But what about its influence on life since?

The moon and Earth's habitability

In their book *Rare Earth: Why Complex Life Is Uncommon in the Universe*, published in 2000, Peter Ward and Donald Brownlee argued that planets, such as Earth, hosting complex life are likely to be incredibly rare throughout the universe.

Among many other arguments, the moon played a central role in their "Rare Earth" hypothesis.



Tidal regions create high-energy environments. Credit: NASA

Ward and Brownlee argued that the presence of an over-sized moon, such as ours, is most likely a key component to making a planet habitable.

Part of their argument was based on the fact that, were the moon non-existent, the tides raised on Earth (solely due to the influence of the sun) would be smaller, and that this might have inhibited the development of life.

Beyond this, they argued a key component of Earth's habitability has

been its remarkably stable axial tilt by the presence of the moon.

Without the moon, they argue, the Earth's axis would vary hugely, and chaotically, on timescales of millions of years – ranging from almost no tilt at all, through the planet's current tilt (just over 23 degrees), to our planet being tipped over on its side, like Uranus, causing all locations on the planet to experience six months of daytime, followed by six months of night, every single year.

Our relatively stable axis is apparent in long exposure photos. Credit: Brandon Townley

While such an idea sounds somewhat outlandish, it is based on observations of the planet Mars.

At the current epoch, the axial tilt of Mars is almost identical to that of

Earth – 25 degrees against our 23 and a half.

However, while Earth's axial tilt varies by only a degree or so in either direction, that of Mars is far more chaotic.

In fact, it is thought that Mars' axial tilt varies between 0 degrees and around 60 degrees, over a few million years, as a result of perturbations from the other planets.

Thus, this would render the planet hugely inhospitable for complex life.

This hypothesis (that the moon is required to stabilise Earth's axis) has unfortunately not stood up to scientific scrutiny. A study by Dave Waltham, of Royal Holloway, University of London, revealed something far more interesting.

The Earth's axial tilt is actually remarkably stable for a wide range of Earth-moon configurations (even for scenarios without the moon).

But, were the moon just slightly larger (by around ten kilometres, just a third of 1% of its diameter), it would force Earth's axis to become unstable, driving a hugely chaotic motion.

More recently, other researchers have reached the same conclusion – a giant moon is not needed for Earth's axial tilt to be stable.

In other words, had the "big splash" that formed the Earth-moon system created a satellite just slightly larger, Earth would likely be a far less pleasant place for life to develop and thrive.

And perhaps "Earths" aren't quite as rare as we might otherwise have thought.

More information: Out on the pull: Why the moon always shows its face: phys.org/news/2013-03-moon.html

Source: The Conversation