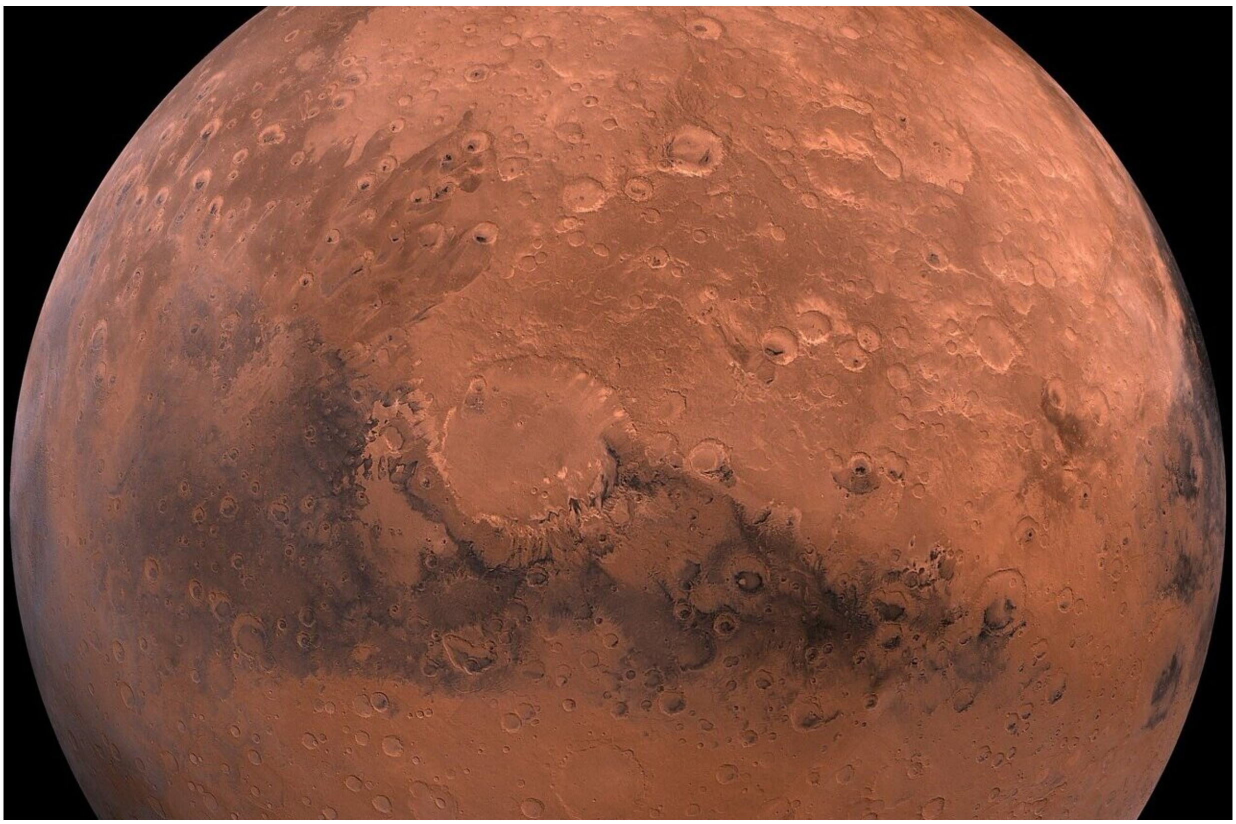
Scientists announce a breakthrough in determining life's origin on Earth—and maybe Mars

June 3 2022



Credit: Pixabay/CC0 Public Domain

Scientists at the Foundation for Applied Molecular Evolution announced today that ribonucleic acid (RNA), an analog of DNA that was likely the first genetic material for life, spontaneously forms on basalt lava glass. Such glass was abundant on Earth 4.35 billion years ago. Similar basalts of this antiquity survive on Mars today.

"Communities studying the origins of life have diverged in recent years," remarked Steven Benner, a co-author of the study appearing online in the journal *Astrobiology*.

"One community re-visits classical questions with complex chemical schemes that require difficult chemistry performed by skilled chemists," Benner explained. "Their beautiful craftwork appears in brand-name journals such as *Nature* and *Science*." However, precisely because of the complexity of this chemistry, it cannot possibly account for how life actually originated on Earth.

In contrast, the Foundation study takes a simpler approach. Led by Elisa Biondi, the study shows that long RNA molecules, 100-200 nucleotides in length, form when nucleoside triphosphates do nothing more than percolate through basaltic glass.

"Basaltic glass was everywhere on Earth at the time," remarked Stephen Mojzsis, an Earth scientist who also participated in the study. "For several hundred million years after the Moon formed, frequent impacts coupled with abundant volcanism on the young planet formed molten basaltic lava, the source of the basalt glass. Impacts also evaporated water to give dry land, providing aquifers where RNA could have formed."

The same impacts also delivered nickel, which the team showed gives nucleoside triphosphates from nucleosides and activated phosphate, also found in lava glass. Borate (as in borax), also from the basalt, controls the formation of those triphosphates.

The same impactors that formed the glass also transiently reduced the atmosphere with their metal iron-nickel cores. RNA bases, whose sequences store genetic information, are formed in such atmospheres. The team had previously showed that nucleosides are formed by a simple reaction between ribose phosphate and RNA bases.

"The beauty of this model is its simplicity. It can be tested by highschoolers in chemistry class," said Jan Špaček, who was not involved in this study but who develops instrument to detect alien genetic polymers on Mars. "Mix the ingredients, wait for a few days and detect the RNA."

The same rocks resolve the other paradoxes in making RNA in a path that moves all of the way from simple organic molecules to the first RNA. "For example, borate manages the formation of ribose, the 'R' in RNA," Benner added. This path starts from simple carbohydrates that could "not not" have formed in the atmosphere above primitive Earth. These were stabilized by volcanic sulfur dioxide, and then rained to the surface to create reservoirs of organic minerals.

Thus, this work completes a path that creates RNA from small organic molecules that were almost certainly present on the early Earth. A single geological model moves from one and two carbon molecules to give RNA molecules long enough to support Darwinian evolution.

"Important questions remain," cautions Benner. "We still do not know how all of the RNA building blocks came to have the same general shape, a relationship known as homochirality." Likewise, the linkages between the nucleotides can be variable in the material synthesized on basaltic glass. The import of this is not known.

Mars is relevant to this announcement because the same minerals, glasses, and impacts were also present on Mars of that antiquity.

However, Mars has not suffered continental drift and plate tectonics that buried most rocks from Earth older than 4 billion years. Thus, rocks from the relevant time remain on the surface of Mars. Recent missions to Mars have found all of the needed rocks, including borate.

"If life emerged on Earth via this simple path, then it also likely emerged on Mars," said Benner. "This makes it even more important to seek life on Mars as soon as we can."

More information: Craig A. Jerome et al, Catalytic Synthesis of Polyribonucleic Acid on Prebiotic Rock Glasses, *Astrobiology* (2022). DOI: 10.1089/ast.2022.0027

Hyo-Joong Kim et al, Prebiotic stereoselective synthesis of purine and noncanonical pyrimidine nucleotide from nucleobases and phosphorylated carbohydrates, *Proceedings of the National Academy of Sciences* (2017). DOI: 10.1073/pnas.1710778114

Hyo-Joong Kim et al, A Prebiotic Synthesis of Canonical Pyrimidine and Purine Ribonucleotides, *Astrobiology* (2019). DOI: 10.1089/ast.2018.1935

Provided by Foundation for Applied Molecular Evolution

Citation: Scientists announce a breakthrough in determining life's origin on Earth—and maybe Mars (2022, June 3) retrieved 26 April 2024 from https://phys.org/news/2022-06-scientists-breakthrough-life-earthand-mars.html