Space & Cosmos

MATTER

A Far-Flung Possibility for the Origin of Life

NASA; JPL; Dr. Paul Geissler; Michael Benson

A global dust storm on Mars as captured in a multiple image mosaic made by the Viking Orbiter 2 in 1977.

By CARL ZIMMER
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"We're All Martians, Scientist Claims," The Telegraph wrote on Aug. 28. Similar articles showed up in newspapers and on Web sites around the world.

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The scientist who inspired all the headlines is a chemist named Steven Benner. Headlines notwithstanding, Dr. Benner is not a wild-eyed U.F.O. advocate claiming to have seen Little Green Men. Instead, he is one of the world's leading experts on the origin of life.

"Steve is one of the master organic chemists tackling this problem," said Robert M. Hazen, a mineralogist at the Carnegie Institution and the author of "The Story of Earth."

The cause for Dr. Benner's new-found celebrity is a lecture he delivered at a geology conference in Florence, Italy, on Aug. 29. During his talk, he did not wave satellite pictures of canals on Mars, or of Martian hills that vaguely look like a human face.

Instead, he challenged his fellow scientists to look hard at the evidence we have about how life began.

Depending on how you view that evidence, Dr. Benner argued, Mars might be a more likely place for life to have started than Earth. The best way to determine the actual answer, Dr. Benner argued, is to look for certain types of chemicals on both planets.

"I really don't have a dog in this fight," said Dr. Benner, a distinguished fellow at the Westheimer Institute at the

Earl Wilson/The New York Times

Carl Zimmer

Foundation for Applied Molecular Evolution in Gainesville, Fla., in a telephone interview after he returned from Italy. "It could go either way and I would be equally happy."

Over the past few years, Dr. Benner and his colleagues have amassed evidence for one potential path by which chemicals could have become living matter. Small organic compounds could have reacted with each other to produce string-shaped, self-replicating molecules.

These strands, known as RNA, later combined into double-strands: the DNA in which we and other species encode our genes.

In chemical experiments, Dr. Benner and his colleagues have demonstrated the occurrence of many of the reactions in this path. But they've also discovered roadblocks.

For instance, the precursors to RNA can bond in a lot of ways, some good and some bad. While some reactions can lead organic molecules toward RNA, many others can turn them into gooey tar.

Dr. Benner and his colleagues discovered that minerals containing borate could help life overcome this obstacle. Binding to the precursors of RNA, borate blocks them from reacting in destructive ways, so they are much more likely to form compounds that could eventually give rise to life.

But even in the presence of borate, Dr. Benner and his colleagues have found, these precursors can't make some of the final changes that turn them into RNA. And just recently the researchers found a way out of this bind. Molybdate minerals can react with the precursors to help them become RNA.

While this chemistry may work in the lab, however, it may not have worked on the early Earth. Dr. Hazen and other geologists have argued that it's unlikely that borate or molybdate were abundant on the planet.

Today, borate is found in deserts that formed after large seas evaporated. But deserts may not have existed four billion years ago. A number of studies suggest that the early Earth was covered in water and had few if any continents.

As for molybdate, it only forms in the presence of oxygen. The atmosphere of the early Earth appears to have been nearly oxygen-free.

At the moment, Mars looks more promising to Dr. Benner. The evidence gathered by satellites and rovers suggests that both oceans and continents existed early in the planet's lifetime. Under those conditions, borate might have formed.

Just this June, some more evidence emerged that supports this idea. Studying a meteorite from Mars, scientists at the University of Hawaii reported that it contained high levels of boron, a component of borate.

The atmosphere of early Mars also shows signs of having contained oxygen, enabling molybdate to form. With a supply of both borate and molybdate, Mars might have been a favorable place for RNA to emerge, and for life to start. A giant impact on the Red Planet could then have kicked up microbe-laden rocks, which later fell to Earth.

In his recent lecture, Dr. Benner did not present this argument as proof that we are Martians. Instead, he offered a way to organize our thinking about the origin of life. One of his lecture slides was entitled “A Logic Tree.” It displayed a series of linked questions that scientists should ask themselves.

The first question is, did life start out as RNA? If the answer is no — and some scientists believe that to be the case — then they have to grapple with a different set of challenges to explain the origin of life.

For scientists who do accept an RNA-based origin of life, however, they need to find chemistry to produce it. Dr. Benner has one hypothesis. If scientists don’t like it, then it’s up to them to find an alternative — which other scientists are indeed doing.

And if you accept Dr. Benner’s chemistry, then you have to find a place with oxygen and dry land where it can unfold. If the early Earth doesn’t meet those standards, then we have to look elsewhere.

“That’s the logic that drives you to Mars,” said Dr. Benner.

Dr. Hazen, who invited Dr. Benner to deliver the lecture in Italy, said: “He made a good, logical case.” He praised Dr. Benner’s specific suggestions about what evidence geologists should be looking for to see which way we should travel down the logic tree.

Dr. Hazen, for one, is taking Dr. Benner up on the challenge to find evidence to test our ideas about the origin of life. He is now studying 3.8-billion-year-old rocks from Greenland, inside which are boron-laden minerals. If the boron once existed as borate in deserts — something Dr. Hazen doubts — then it may have left some clues behind in the rocks.

“I want to prove myself wrong before somebody else does,” said Dr. Hazen.

If Dr. Hazen’s research bears fruit, then Dr. Benner will happily abandon the idea that our ancestors started out on the Red Planet. “Then I have all the deserts I need. I don’t have to go to Mars,” he said.

This article has been revised to reflect the following correction:

Correction: September 12, 2013

An earlier version of this article referred incorrectly to borate and molybdate. They are compounds that are found in certain minerals, not minerals themselves.

A version of this article appears in print on September 17, 2013, on page D5 of the New York edition with the headline: Distant Possibility for Origin of Life.