Telltale chemistry could betray ET

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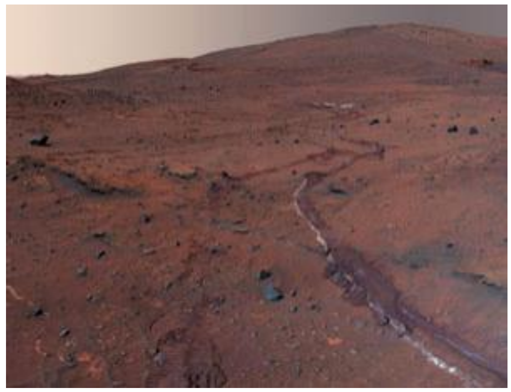
ALIEN life might be hard to find for the simple reason that it is fundamentally unlike Earth life. It might not use DNA, or contain protein. But whatever and wherever it is, its tendency to chemically alter its environment might just give it away.



Mars may yet show signs of life (Image: NASA/JPL /Cornell)

Life has had a radical impact on Earth's chemistry - perhaps most notably leading to soaring atmospheric oxygen concentrations around 2.2 billion years ago. If life has had a comparable impact elsewhere in the solar system, the relative abundances of chemicals key for its survival - whatever they may be - could betray its presence.

On Earth, those key chemicals, such as amino acids, are modestly sized, exist in relatively small numbers and act as building blocks to form all complex life. Identifying the alien equivalents of those chemical building blocks "is our only way to detect life not as we know it", says astrobiologist Chris McKay of NASA's Ames Research Center in Moffett Field, California. He calls this the Lego principle.

To test the idea, Christoph Adami of the Keck Graduate Institute of Applied Life Sciences in Claremont, California, and colleagues pulled together 30 measurements of amino acid abundances from abiotic sources, including meteorites and lab synthesis experiments, and compared them with 125 samples taken from soils, ocean sediments and water.

The lifeless samples were dominated by the simplest amino acids, glycine and alanine. In contrast, the biological sources also had plenty of the more complicated amino acids fundamental to terrestrial life.

Adami found a similar signature for carboxylic acids, which include common substances like formic acid. Lifeless samples were dominated by small acids up to six carbon atoms long, while biological samples contained acids up to 30 carbon atoms long, with a preference for even-numbered chains.

Adami then went a step further. Since 1993 he has worked with Avida, a computer system in which programs called avidians compete for processing power. Each avidian is an artificial organism, built from a set of 29 simple instructions analogous to the 20 amino acids found in terrestrial life and able to evolve through mutation and selection.

If the organisms were absent each of the instructions would be equally abundant. But when Adami ran 350 populations of avidians under a range of conditions, he found that certain instructions always became more abundant at the expense of others, creating an avidian "chemical" signature that indicated their presence (*Journal of Molecular Evolution*, in press).

"That's very important," says McKay. "What we see on Earth is not a quirk of Earth biology but a universal principle."

That may be true, says Dirk Schulze-Makuch of Washington State University in Pullman, but he warns chemical ET hunters that different minerals, temperatures and pressures could allow for chemical reactions that do not occur on Earth. So determining whether the recorded abundances represent abiotic baseline conditions or the presence of life might prove tricky. "There's a lot of uncertainty," he says.

Adami agrees that it is a challenge, but thinks it is not an insuperable one. "You would have to establish the geochemistry well enough to know what the 'alphabet' of molecules was" before hunting for unusual relative abundances, he says. n

The search for alien lego

No Mars mission has yet tried to detect life using the Lego principle (see main story), but similar methods are being investigated.

The team behind the ExoMars rover, scheduled for launch in 2018, plans to look for amino acids that have the same symmetry as each other. All Earth life is based on amino acids of the same symmetry, so this could be a telltale sign - assuming Martian life uses amino acids at all.

Victor Parro of the Centre for Astrobiology in Madrid, Spain, and his colleagues have a different approach. Rather than staking everything on one type of molecule, their device, SOLID2, can detect a wide range of molecules including DNA and sugars.

In work yet to be published, Parro found that SOLID2 successfully detected life in two largely lifeless environments - Antarctica during winter, and the height of summer in the Atacama desert. He is now exploring ways to get it flown to Mars.

According to Christoph Adami of the Keck Graduate Institute, SOLID2 is too Earth-centric, because it looks for specific sequences of molecules. "They are looking for phrases like 'I think therefore I am', whereas I am looking for the frequencies of individual letters," he says. Still, he thinks the technology could be modified to fit this purpose.

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