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Earth's first life may have fuelled itself with a metal metabolism

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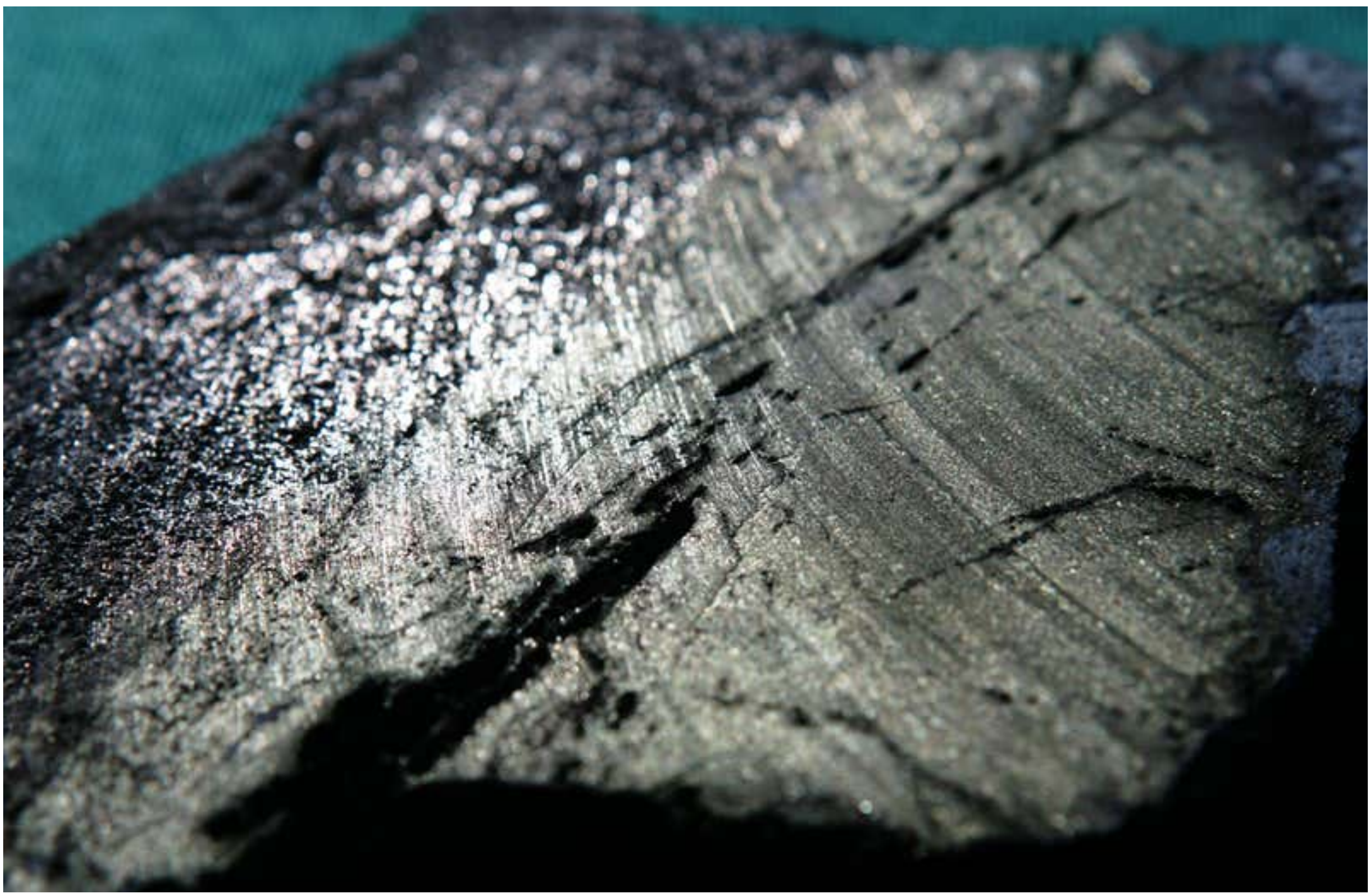
By Michael Marshall



Nickel sulphide – critical for the first life forms?
Ian Waldie/Bloomberg via Getty Images

The first living organisms may have relied on nickel and sulphur to obtain energy and sustain themselves. That is the conclusion of a study that shows how nickel sulphide can transform simple chemicals into many of the substances that underpin life. It is one of several recent studies indicating that life-like processes can be kick-started by metals.

"We are able to build up important biomolecules from simple precursors," says Claudia Huber at the Technical University of Munich in Germany.

Huber and her colleagues have spent over 20 years investigating how life started. They focus on the origin of metabolism – the chemical reactions that organisms use to obtain energy and build their bodies.

Modern organisms such as plants convert carbon dioxide into sugars – technically called "fixing" carbon – by carrying out intricate cycles of chemical reactions. These reactions are controlled by complicated molecules called enzymes, which cannot have existed when life started. So Huber's team has studied whether other, simpler chemicals can make the reactions work. The team's work was prompted by the ideas of Günter Wächtershäuser, a Munich patent lawyer who suggested in 1988 that iron sulphide kick-started the first metabolism.

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The researchers began with two carbon-based chemicals: carbon monoxide and acetylene. Both are thought to have been present when Earth was young. They mixed them with nickel sulphide, a common mineral, and heated them to 105°C – the sort of temperature seen in water heated by volcanic rocks.

The result was a smorgasbord of carbon-based chemicals, including acetate, pyruvate and succinate. These chemicals are found in the metabolic processes used by all microorganisms, says Huber.

It doesn't stop there. "Our products undergo further reactions in the same system," mimicking those that take place in living cells, says Huber. She thinks that the kind of carbon fixing reactions we see in plants and bacteria today could have evolved from these systems.

In a 2016 study, Huber's team showed that the same mix of chemicals can also form fatty lipids, which could have formed the outer membranes of the first cells.

Primordial metabolism

"It's well supported," says Joseph Moran at the University of Strasbourg in France. "They've been thinking about the connections to carbon fixation chemistry, which I think is a good thing to think about."

However, Moran isn't convinced that acetylene and carbon monoxide are the most likely starting points. "Everyone agrees carbon dioxide would be present on the early Earth and we know that's how life gets its carbon today, so that would be the ideal feedstock," he says.

The issue is that carbon dioxide is fairly unreactive, so minerals like nickel sulphide don't give enough of a chemical push to convert it into other substances. Huber's team avoided this problem by replacing carbon dioxide with the more reactive acetylene and carbon monoxide.

However, in his own research Moran has used carbon dioxide, instead mixing it with more potent drivers. "In our work we use metallic iron," he says. "It's 80 per cent of the core of the Earth, and it's in meteorites."

In a series of recent papers, Moran's team has shown that iron converts carbon dioxide into the chemicals found in many metabolic processes, and those chemicals then start up simple versions of these processes, without the need for enzymes.

Huber says Moran and his colleagues are doing valuable research into the earliest metabolism – particularly since it also focuses on the importance of fixing carbon.

"I'm very hopeful that there'll be, in short order, non-enzymatic versions of all the metabolic pathways," says Moran.

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