

## Ammonium fertilized early life on Earth: study

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A team of international scientists—including researchers at the University of St. Andrews, Syracuse University and Royal Holloway, University of London—have demonstrated a new source of food for early life on the planet.

Life on Earth relies on the availability of critical elements such as nitrogen and phosphorus. These nutrient elements are ubiquitous to all



life, as they are required for the formation of DNA, the blueprints of life, and proteins, the machinery. They are originally sourced from rocks and the atmosphere, so their availability to life has fluctuated alongside significant changes in the chemistry of Earth's surface environments over geologic time.

The research, published in *Nature Geoscience*, reveals how the supply of these elements directly impacted the growth of Earth's <u>oxygen-rich</u> <u>atmosphere</u> and were key to the evolution of <u>early life</u> on Earth.

The most <u>dramatic change</u> in Earth history followed the evolution of oxygenic photosynthesis, which fundamentally transformed the planet by providing a source of carbon to the biosphere and a source of oxygen to the atmosphere, the latter culminating in the Great Oxidation Event (GOE) some 2.3 billion years ago.

Despite the critical importance of nutrients to life, the availability of nitrogen and phosphorus in pre-GOE oceans is not well understood, particularly how the supply of these elements drove and/or responded to planetary oxygenation.

Using samples of exceptionally well-preserved rocks that have been associated with early evidence for oxygenic photosynthesis 2.7 billion year ago, the team of researchers examined Earth's early nitrogen cycle to decipher feedbacks associated with the initial stages of planetary oxygenation.

"There is precious little rock available from this time interval that is suitable for the type of analyses we performed. Most rocks that are this old have been deformed and heated during 2.7 billion years of plate tectonic activity, rendering the original signals of life lost," says Christopher Junium, associate professor of Earth sciences in the College of Arts and Sciences.



The rock samples showed the first direct evidence of the build-up of a large pool of ammonium in the pre-GOE oceans. This ammonium would have provided an ample source of nitrogen to fuel the early biosphere and associated oxygen production.

Research team leader Aubrey Zerkle, reader in the School of Earth and Environmental Sciences at the University of St Andrews, says: "Today we think of ammonium as the unpleasant odor in our cleaning supplies, but it would've served as an all-you-can-eat buffet for the first oxygengenerating organisms, a significant improvement on the dumpster scraps they relied on earlier in Earth's history."

As well as helping scientists better understand the role of the nitrogen cycle in global oxygenation, the new findings also provide context for other nutrient feedbacks during early planetary evolution.

"It is becoming ever more clear that the game of nutrient limitation has tipped back and forth through Earth's history as <u>life</u> has evolved and as conditions have changed," Junium says.

Surprisingly, evidence for significant atmospheric oxygenation does not appear until 400 million years later, meaning that some other nutrient, such as phosphorus, must have been important in setting the evolutionary pace.

**More information:** J. Yang et al, Ammonium availability in the Late Archaean nitrogen cycle, *Nature Geoscience* (2019). <u>DOI:</u> <u>10.1038/s41561-019-0371-1</u>

Provided by Syracuse University



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