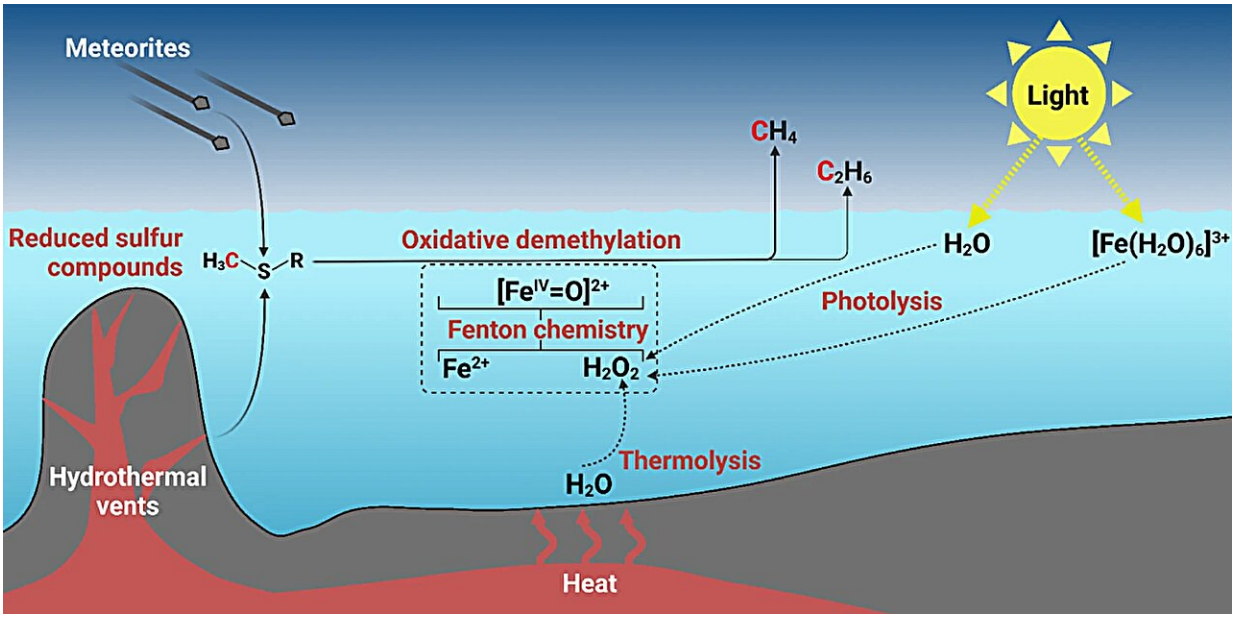
Experiments show methane formation in water may have warmed early Earth

August 2 2023, by Bob Yirka



Reduced, methylated S-/N-compounds are formed abiotically in hydrothermal vents or transported to Earth by carbonaceous meteorites. Under anoxic conditions, H_2O_2 is formed by thermolysis and photolysis of water and $[Fe(H_2O)_6]^{3+}$ complexes, reacting with dissolved ferrous iron (Fe^{2+}) to hydroxyl radicals (•OH) and $[Fe^{IV}= O]^{2+}$ compounds that drive the oxidative demethylation of methylated S-/N-compounds, thereby facilitating CH_4 and C_2H_6 formation. Credit: *Nature Communications* (2023). DOI: 10.1038/s41467-023-39917-0

A team of microbiologists and Earth scientists affiliated with several

institutions in Germany reports that it was possible for methane to form in water on Earth before life began. In their study, reported in the journal *Nature Communications*, the group conducted experiments with early Earth simulations designed to show how methane could have formed.

Last year, the same team discovered a process by which methane can form in living creatures without the use of enzymes. That led them to wonder if the same process could happen outside a living creature. To find out, they set up multiple vials of water and what they describe as "starter chemicals"—those thought to be present in the water on Earth before life began. They heated the vials at temperatures ranging from 37°C to 97°C and let the vials incubate.

In vapor produced in the vials, the researchers detected differing amounts of methane—generally the higher the temperature, the more methane.

The researchers suggest their findings could explain what has been described as the "faint young sun" paradox. Prior research has suggested that life began on Earth approximately 3.7 billion years ago. Prior research has also suggested that early Earth was much warmer than should have been the case, considering that the sun was producing only about three-fourths as much heat as it does today.

Theories developed to solve the paradox have revolved around methane. Because it is a greenhouse gas, it could have trapped heat in the atmosphere, keeping the planet warm. But until now, the only means of methane production during the period were thought to be conditions inside hydrothermal vents—a process known as serpentinization.

Unfortunately, most model-based estimates regarding the amount such vents could produce suggest they could not have made nearly enough to

make the Earth as warm as it was. Now, it appears that methane was also being produced directly in the water as it was warmed by sunlight.

The work will likely influence efforts involved in looking for life on other plants where probes have been designed to look for methane as proof of living creatures.

More information: Leonard Ernst et al, Methane formation driven by light and heat prior to the origin of life and beyond, *Nature Communications* (2023). DOI: 10.1038/s41467-023-39917-0

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