

## Volcanoes May Have Provided Sparks of First Life

*Researchers reanalyze classic Miller experiment to uncover role of volcanoes in early life on Earth*

October 16, 2008

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New research suggests that lightening and volcanoes may have sparked early life on Earth. Researcher Jeffrey Bada at Scripps Institution of Oceanography at UC San Diego and colleagues reanalyzed Stanley Miller's classic origin of life experiment, offering a new analysis on how the essential building blocks of life may have arose from volcanic eruptions.

Bada, Scripps professor of marine chemistry and graduate student of Miller's in the Chemistry Department at the UC San Diego in 1960, preserved Miller's original chemical samples. Bada along with lead author Adam Johnson, Indiana University graduate student and colleagues, reanalyzed the samples to determine if new chemical compounds could be detecting using modern equipment. The paper, "The Miller Volcanic Spark Experiment," is published in the Oct. 17 issue of the journal *Science*.

"We believed there was more to be learned from Miller's original experiment," said Bada, Scripps professor of marine chemistry and co-author of the paper. "We found that a modern day version of the volcanic apparatus produces a wider variety of compounds."

Miller's classic "primordial soup" experiment, published in *Science* in 1953, is still widely used today in high school chemistry labs to mimic chemical reactions that occur in vapor-rich volcanic eruptions. The experiment circulated methane, ammonia, water vapor and hydrogen in a closed experiment, simulating the earth's early atmosphere and sent a lightning-like spark through it. Over a series of days, organic compounds formed in the mixture, demonstrating how Earth's primitive atmosphere may have given rise to life.

It is commonly thought that early Earth was comprised of many small volcanic islands. This study suggests that lightning and the release of gases associated with these volcanic eruptions could have produced the necessary chemical components to give rise to early life.

Bada's lab is the first to perform follow up studies using Miller's original apparatus and chemicals samples, which were discovered following Miller's death in 2007. Researchers reanalyzed 11 of the original samples using contemporary analytical chemistry techniques and produced 22 amino acids, the building blocks of proteins, 10 of which had not been identified previously by Miller.

"Historically, you don't get many experiments that might be more famous than these; they redefined our thoughts on the origin of life and showed unequivocally that the fundamental building blocks of life could be derived from natural processes," said lead author Adam Johnson, a Indiana University graduate student with the NASA Astrobiology Institute team.

Henderson Cleaves (Carnegie Institution for Science), Jason Dworkin and Daniel Glavin (Scripps Institution of Oceanography) and Antonio Lazcano (Universidad Nacional Autonoma de Mexico) also contributed to the report. It was funded with grants from the NASA Astrobiology Institute, the Marine Biological Laboratory in Woods Hole, Mass., and Mexico's El Consejo Nacional de Ciencia y Tecnologia

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