'Lost' samples from famous origin of life researcher could send search for first life in new direction

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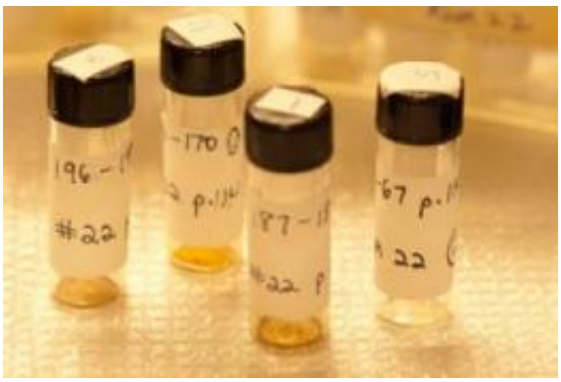

Preserved samples from a 1958 experiment done by "primordial soup" pioneer Stanley Miller contain amino acids created by the experiment. The samples had not undergone analysis until recently when Miller's former student Jeffrey Bada and colleagues discovered a wide range of amino acids. The find could be an important step toward understanding how life on Earth could have originated. The vials have been relabeled but the boxes are marked with Miller's original notes. Credit: Scripps Institution of Oceanography, UC San Diego

(PhysOrg.com) -- Stanley Miller gained fame with his 1953 experiment showing the synthesis of organic compounds thought to be important in setting the origin of life in motion. Five years later, he produced samples from a similar experiment, shelved them and, as far as friends and colleagues know, never returned to them in his lifetime.

More 50 years later, Jeffrey Bada, Miller's former student and a current Scripps Institution of Oceanography, UC San Diego professor of marine chemistry, discovered the samples in Miller's laboratory material and made a discovery that represents a potential breakthrough in the search for the processes that created Earth's first life forms.

Former Scripps undergraduate student Eric Parker, Bada and colleagues report on their reanalysis of the samples in the March 21 issue of Proceedings of the National Academy of Sciences. Miller's 1958 experiment in which the gas hydrogen sulfide was added to a mix of gases believed to be present in the atmosphere of early Earth resulted in the synthesis of sulfur amino acids as well as other amino acids. The analysis by Bada's lab using techniques not available to Miller suggests that a diversity of organic compounds existed on early planet Earth to an extent scientists had not previously realized.

"Much to our surprise the yield of amino acids is a lot richer than any experiment (Miller) had ever conducted," said Bada.

Scripps Oceanography professor of Marine Chemistry Jeffrey Bada holds a preserved sample from a 1958 experiment done by "primordial soup" pioneer Stanley Miller. The residue in the sample contains amino acids created by the experiment. The samples had not undergone analysis until recently when Bada and colleagues discovered a wide range of amino acids using modern detection methods. Credit: Scripps Institution of Oceanography, UC San Diego

The new findings support the case that volcanoes — a major source of atmospheric hydrogen sulfide today — accompanied by lightning converted simple gases into a wide array of amino acids, which are were in turn available for assembly into early proteins.

Bada also found that the amino acids produced in Miller's experiment with hydrogen sulfide are similar to those found in meteorites. This supports a widely-held hypothesis that processes such as the ones in the laboratory experiments provide a model of how organic material needed for the origin of life are likely widespread in the universe and thus may provide the extraterrestrial seeds of life elsewhere.

Successful creation of the sulfur-rich amino acids would take place in the labs of several researchers, including Miller himself, but not until the 1970s.

"Unbeknownst to him, he'd already done it in 1958," said Bada.

Miller's initial experiments in the 1950s with colleague Harold Urey used a mixture of gases such as methane, ammonia, water vapor and hydrogen and electrically charged them as lightning would. The experiment, which took place in a closed chamber meant to simulate conditions on early Earth, generated several simple amino acids and other organic compounds in what became known as "primordial soup."

This is a photo of Stanley Miller in his UC San Diego lab in 1970. Credit: Scripps Institution of Oceanography Archives

With the gases and electrical energy they produce, many geoscientists believe the volcanoes on a young planet covered much more extensively by water than today's served as oases of raw materials that allowed prebiotic matter to accumulate in sufficient quantities to assemble into more complex material and eventually into primitive life itself. Bada had already begun reanalyzing Miller's preserved samples and drawing conclusions about the role of volcanoes in sparking early life when he came across the previously unknown samples. In a 2008 analysis of samples left from Miller's more famous experiment, Bada's team had been able to detect many more amino acids than his former mentor had thanks to modern techniques unavailable to Miller.

Miller, who became a chemistry professor at UCSD in 1960, conducted the experiments while a faculty member at Columbia University. He had collected and catalogued samples from the hydrogen sulfide mix but never analyzed them. He only casually mentioned their existence late in

his life and the importance of the samples was only realized shortly before his death in 2007, Bada said. It turned out, however, that his 1958 mix more closely resembled what geoscientists now consider early Earth conditions than did the gases in his more famous previous experiment.

The original box containing archived spark discharge samples prepared by Stanley Miller in 1958. For unknown reasons, Miller never analyzed these even though this is his first experiment using hydrogen sulfide. The label shows Miller's original writing: p 114 refers to his notebook. Credit: Jeffrey Bada and Robert Benson/Scripps Institution of Oceanography, University of California at San Diego

"This really not only enhances our 2008 study but goes further to show the diversity of compounds that can be produced with a certain gas mixture," Bada said.

The Bada lab is gearing up to repeat Miller's classic experiments later this year. With modern equipment including a miniaturized microwave spark apparatus, experiments that took the elder researcher weeks to carry out could be completed in a day, Bada said.

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