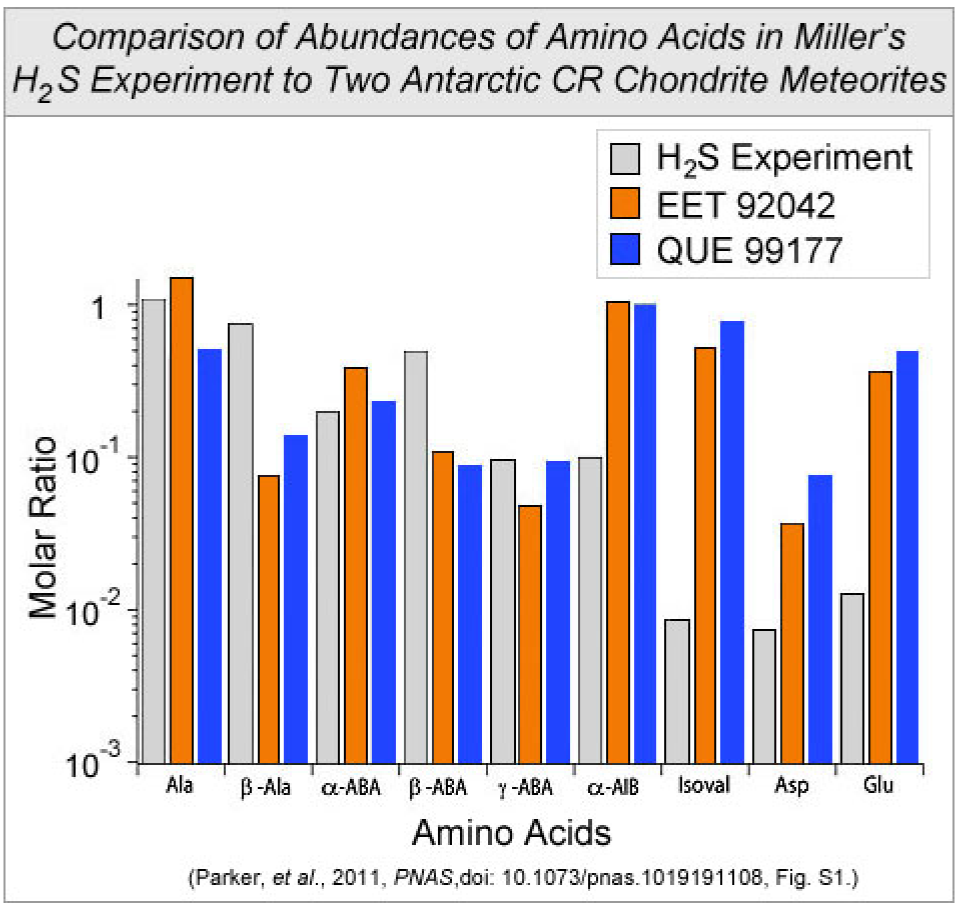
The Role of H_2S in Amino Acid Synthesis on Primordial Earth and Elsewhere

Deep in the heart of the origin of life issue is the subject of amnio acids--the chemical building blocks that make proteins and that serve many important functions in the body to help maintain life. Ground-breaking experiments performed in the 1950s by American chemist Stanley Miller proved basic molecules important to life, like amnio acids, can be formed through simple physical processes in mixtures of gases sparked by lightning, perhaps similar to conditions somewhere on the primordial Earth. That "somewhere" could have been near volcanic eruptions. If lightning was not so important, then that somewhere could have been an asteroid.



The chart shows a comparison of the molar ratios (relative to glycine=1) of nine of the amino acids detected in samples from Stanley Miller's H_2S-rich spark discharge experiment (grey), and in the meteorites EET 92042 (orange), and QUE 99177 (blue). Data for amino acids in the meteorites are from Glavin and Dworkin (2009) and Glavin et al. (2011).

The types and relative amounts of amino acids synthesized in Miller's 1958 H_2S-rich spark discharge experiment are intriguingly similar to those found in some carbonaceous chondrite meteorites. These are the findings of a team of researchers from the US and Mexico who published their results in the April 5, 2011 issue of the Proceedings of the National Academy of Science.

They analyzed the archived samples from Miller's previously unreported 1958 experiment that sent electric sparks (simulating lightning) and steam through a glass flask containing methane (CH_4), hydrogen sulfide (H_2S), ammonia (NH_3), and carbon dioxide (CO_2) gases (simulating primitive Earth conditions) to better understand prebiotic (non-biologic) synthesis of organic compounds. Using techniques and lab instruments that are ten billion times more sensitive than methods used in the 1950s, Eric Parker (Scripps Institution of Oceanography, UC San Diego) and coauthors found organic compounds including 23 amino acids, six of which contain sulfur. The presence of ***racemic*** amino acids (equal proportions of L- and D-structures) supports the idea that the amino acids were indeed made in the experiment and were not simply contaminated during storage or processing. (Life on Earth uses L-amino acids in proteins.)

The overall abundances of the experimentally-synthesized amino acids in the presence of H_2S gas are very similar to the abundances found in some carbonaceous chondrite meteorites, suggesting to the authors that a mixture of oxidized and reduced gases, including hydrogen sulfide, may have been important for prebiotic reactions in early Solar System environments--on Earth and elsewhere. They go on to say that H_2S was likely present in the environment that produced the carbonaceous chondrite amino acids, either during amino acid synthesis on the asteroid or during amino acid precursor synthesis in the solar nebula.

See:
Parker, E. T., Cleaves, H. J., Dworkin, J. P., Glavin, D. P., Callahan, M., Aubrey, A., Lazcano, A., and Bada, J. L. (2011) Primordial Synthesis of Amines and Amino Acids in a 1958 Miller H_2S-rich Spark Discharge Experiment. *Proceedings of the National Academy of Science,* v. 108(14), p. 5526-5531, doi: 10.1073/pnas.1019191108 [***online abstract***] and the **PSRD** article ***Wet, Carbonaceous Asteroids: Altering Minerals, Changing Amino Acids***.

See also:
Glavin, D. P. and Dworkin, J. P. (2009) Enrichment of the Amino Acid L-isovaline by Aqueous Alteration on CI and CM Meteorite Parent Bodies, *Proceedings of the National Academy of Sciences,* v. 106(14), p. 5487-5492, doi: 10.1073/pnas.0811618106.
Glavin, D. P., Callahan, M. P., Dworkin, J. P., and Elsila, J. E. (2011) The Effects of Parent Body Processes on Amino Acids in Carbonaceous Chondrites. *Meteoritics and Planetary Science,* v. 45(12), p. 1948-1972, doi: 10.1111/j.1945-5100.2010.01132.x.

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