Analysis of Sutter's Mill fragments reveals organic compounds not seen in other meteorites

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Fragments of the Sutter's Mill meteorite obtained from Henningsen Lotus Park, Lotus, California. Credit: NASA

(Phys.org) —A team of researchers from Arizona State University has found that the space rock known as the Sutter's Mill meteorite had organic compounds in it that have not been found in any other known

meteorite. In their paper published in the journal *Proceedings of the National Academy of Sciences*, the researchers describe how they applied hydrothermal treatment to fragments of the meteorite which allowed the organic compounds to be released.

Sutter's Mill meteorite was seen streaking through the atmosphere above northern California in April 2012. That led to a search by many interested parties for the chunks that survived the intense heat and made their way to the Earth's surface—in all 77 rocks were found and turned over to scientists eager to study their composition—initial testing of some of the specimens revealed few dissoluble organic compounds. Undaunted, the researchers took another approach, applying hydrothermal treatment—a process that is meant to mimic the conditions scientists believe existed on certain parts of the Earth during the time life first emerged. This time, the team reports, the fragments released organic compounds that had never before been seen in a meteorite.

Organic compounds in meteorites (most of which are believed to come from the asteroid belt between Jupiter and Mars) are important to researchers who believe it's possible that life got its start here on Earth thanks to meteorites that carried payloads that added to material found on Earth. Taken together, the ingredients made for the perfect cocktail, eventually giving rise to the mysterious process that resulted in the creation of living organic matter and eventually all the forms of life that came after.

Looking to meteorites as a possible source for life on Earth has come about due to scientists' inability to nail down a rational explanation for the development of life based on theories of how the Earth came to exist. Of course, such theories only move the debate to another arena—if life came here from somewhere else, how did it get started in that other place? Scientists have no answer, but hope studying rocks brought from space will offer clues that may help to someday solve the puzzle.

More information: Processing of meteoritic organic materials as a possible analog of early molecular evolution in planetary environments, *PNAS*, Published online before print September 9, 2013, DOI: 10.1073/pnas.1309113110

Abstract

The composition of the Sutter's Mill meteorite insoluble organic material was studied both in toto by solid-state NMR spectroscopy of the powders and by gas chromatography–mass spectrometry analyses of compounds released upon their hydrothermal treatment. Results were compared with those obtained for other meteorites of diverse classifications (Murray, GRA 95229, Murchison, Orgueil, and Tagish Lake) and found to be so far unique in regard to the molecular species released. These include, in addition to O-containing aromatic compounds, complex polyether- and ester-containing alkyl molecules of prebiotic appeal and never detected in meteorites before. The Sutter's Mill fragments we analyzed had likely been altered by heat, and the hydrothermal conditions of the experiments realistically mimic early Earth settings, such as near volcanic activity or impact craters. On this basis, the data suggest a far larger availability of meteoritic organic materials for planetary environments than previously assumed and that molecular evolution on the early Earth could have benefited from accretion of carbonaceous meteorites both directly with soluble compounds and, for a more protracted time, through alteration, processing, and release from their insoluble organic materials.

Press release