Isotopic Signatures of Abiotic Organic Synthesis Under Geologic Conditions

T.M. MCCOLLOM[1], J.S. SEEWALD[2], B. SHERWOOD LOLLAR[3] AND G. LACRAMPE-COULOUME[3]

[1] Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder CO, USA ; mccollom@lasp.colorado.edu

[2]Woods Hole Oceanographic Institution, Woods Hole, MA, USA; jseewald@whoi.edu

[3]University of Toronto, Ontario, Canada; bslollar@chem.utoronto.ca

Attempts to identify the oldest traces of life on Earth have relied heavily on the isotopic compositions of carbon compounds as an indicator of biologic origin. Several occurrences of rocks more than 3 billion years old have been found to contain reduced carbon compounds whose isotopic composition closely resembles that observed in modern sediments. Although this isotopic signature has frequently been used to infer an ancient biological origin of the carbon compounds, this conclusion presumes that there are no abiotic processes that are capable of producing the same isotopic signature. However, this critical presumption remains largely untested owing to a lack of data available on the isotopic composition of the products of abiotic organic synthesis. While it is widely believed that abiotic organic synthesis can occur in many geologic environments such as hydrothermal systems, there are few data available to constrain the isotopic composition of abiotic compounds produced in such environments.

We are currently testing this presumption by conducting laboratory experiments to investigate the isotopic composition of organic compounds produced by Fischer-Tropsch-type abiotic synthesis under hydrothermal conditions. Results obtained to date indicate that abiotic organic products have carbon isotopic signatures similar to those produced by biological processes, suggesting that carbon isotopes cannot be relied upon to infer a uniquely biological origin for organic matter in ancient rocks [1]. In addition, thus far the experimental products of FTT synthesis do not appear to produce the type of isotopic fractionation patterns observed in many natural samples of hydrocarbon gases with an apparent abiotic origin, suggesting that some other process such as methane polymerization may be responsible for formation of these compounds. Ongoing experiments are focusing on evaluating which reaction steps are responsible for isotope fractionation during abiotic synthesis.

Reference

[1] McCollom T.M. and Seewald J.S. (2006) *EPSL* **243,** 74-84.