The delivery of organic material to the early solar system

R. VISSER[1]*, E.F. VAN DISHOECK[2,3], S.D. DOTY[4] AND E.A. BERGIN[1]

[1]Dept. of Astronomy, University of Michigan, 500 Church Street, Ann Arbor, MI 48109-1042, USA (*correspondence: visserr@umich.edu)
[2]Leiden Observatory, Leiden University, P.O. Box 9513, 2300 RA Leiden, the Netherlands
[3]Max-Planck-Institut für Extraterrestrische Physik, Giessenbachstrasse 1, 85748 Garching, Germany
[4]Dept. of Physics and Astronomy, Denison University, Granville, OH 43023, USA

The solar nebula, in which the Earth and all other solar-system bodies were formed, was a complex chemical mixture of gas and dust. In order to fully understand the nebula's chemical composition at the time the solid bodies were formed, one has to go back in time and retrace the chemistry to the molecular cloud that collapsed to form the solar nebula. Here we present recent astrochemical observations and models that aim to do just that [1, 2, 3]. The main focus is on water and on simple organic compounds like methanol (CH_3OH) and dimethyl ether (CH_3OCH_3), which are tracers of the organic complexity that likely aided the eventual formation of life. The models predict that water and simple organics were already formed abundantly at an early time. As the parent molecular cloud collapsed and evolved into the early solar system, changes in density, temperature and radiation led to further chemical processing. The abundances of several key species in this simulated solar nebula match those observed in comets [4], but others are off by orders of magnitude. We discuss what both the good and the poor matches mean for the delivery of organic material to the Earth and elsewhere.

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[2] Visser *et al.* (2009) *Astron. Astrophys.* **495**, 881–897.
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Raman spectroscopy of endoevaporitic microbial communities from the Atacama Desert

PETR VÍTEK[1]*, HOWELL G.M. EDWARDS[2], JAN JEHLIČKA[1], ELIZABETH CARTER[3], CARMEN ASCASO[4] AND JACEK WIERZCHOS[4]

[1]Institute of Geochemistry, Mineralogy and Mineral Resources, Charles University in Prague, Albertov 6, 128 43 Prague 2, Czech Republic (*correspondence: vitek2@natur.cuni.cz)
[2]Centre for Astrobiology and Extremophiles Research, School of Life Sciences, University of Bradford, Bradford BD7 1DP, United Kingdom
[3]Vibrational Spectroscopy Facility, School of Chemistry, University of Sydney, Sydney, NSW 2006, Australia
[4]Museo Nacional de Ciencias Naturales, CSIC, c/ Serrano 115 dpdo., 28006 Madrid, Spain

Geobiological systems with emphasis on halite and gypsum crusts from the Atacama Desert, one of the driest places on Earth, were studied. Raman spectroscopic analysis revealed variations in pigment composition within various endolithic colonies, allowing in some cases suggestions to be made about survival strategies.

Scytonemin, an effective extracellular UV-protectant, was found in cyanobacterial colonies within halite and gypsum crust from the hyperarid core of the Atacama Desert using Raman spectroscopy. The amount of scytonemin present differed depending on the particular microhabitat. Substantial differences are proposposed to reflect a variable biosynthesis due to the amount of light available inside the halite and gypsum crust.

Raman spectroscopic analyses of the endoevaporitic colonies from Ca-sulphate exhibited systematic variations in carotenoid composition together with the presence/absence of a phycobiliprotein signal (indicative for cyanobacteria). The cyanobacterial signal was accompanied by two clearly distinguishable ν(C=C) carotenoid bands at ~1516 and 1498 cm^{-1}, pointing to carotenoids of different chain length. Within the colonies living closer to the surface, scytonemin was also identified. The Raman signal of algal colonies from near the rock surface exhibited a ν(C=C) carotenoid band at ~1525 cm^{-1} accompanied by chlorophyll, whereas the same carotenoid band obtained from red algae is shifted towards lower wavenumbers with the spectra lacking chlorophyll.

Fast Raman mapping of the green algal colonies exhibited great potential of the method for the study of endolithic communities in their original habitats.