Delivery of Prebiotic Organic Matter to the Surfaces of the Early Earth and Mars by Interplanetary Dust

G. J. FLYNN[1] AND S. WIRICK[2]

[1]Dept. Of Physics, SUNY-Plattsburgh, 101 Broad St., Plattsburgh, NY 12901 USA (george.flynn@plattsburgh.edu)
[2]Focused Beam Enterprises, 79 Baycrest Ave, Westhampton, NY 11977 (swirick@optonline.net)

The exogenous contribution to planetary surfaces was demonstrated when Apollo samples showed ~2% chondritic material in Lunar regolith. The mass influx is dominated by interplanetary dust (IDPs) a few hundred μm in size. On planets with atmospheres much of this asteroidal and cometary dust accretes with its organic matter intact, making an important contribution to the prebiotic organic matter [1]. We determined the abundances and functional groups of the carbonaceous matter in IDPs collected by NASA after deceleration in the Earth's upper atmosphere using synchrotron-based infrared and X-ray Absorption Near-Edge Structure spectroscopies [2] and modeled the amounts of dust not heated above the pyrolysis temperature deposited on the surfaces of Earth and Mars in the current era.

On Earth, most dust larger than ~50 μm melts or vaporizes on atmospheric entry. The mean C content of surviving particles collected by NASA is ~12 wt-%, 4 times that in the most C-rich meteorites. In ~10 μm particles we identified substantial amounts of ring-carbon, aliphatic hydrocarbons, and carbonyl, as well as N and O, spatially associated with organic matter, having N/C and O/C ratios an order of magnitude higher than is found in primitive meteorites. High N/C and O/C ratios are used to identify the most primitive (least thermally altered) meteoritic organic matter [3], indicating the organic matter in this dust is not thermally processed. At these levels IDPs contribute ~15 tons/year of unpyrolized organic matter to the Earth's surface in the current era.

Because of Mars' lower gravity, dust enters the atmosphere at lower speeds than on Earth, allowing dust up to several hundred μm to survive entry with their organics intact. As a result the surface density of exogenous prebiotic organic matter accreting onto Mars is about an order of magnitude greater than on Earth.

The Lunar impact rate from formation to ~3.9 b.y. ago was much higher, indicating that the contribution of prebiotic organic matter by a interplanetary dust is likely to have been substantially greater early in Solar System history, making prebiotic organic matter deposited on the Earth's surface by interplanetary dust particularly important after planetary differentiation destroyed any organic matter that accreted with the Earth.

References: [1] E. Anders (1989) Nature, 342, 255-257. [2] G. Flynn et al. (2003) 67, 4791-4806. [3] G. Cody et al. (2008) EPSL, 272, 446-455.