PHYS: Division of Physical Chemistry

258 - Properties and origins of cometary and asteroidal organic matter delivered to the early Earth

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Abstract: Comets and asteroids may have contributed much of the Earth's water and organic matter. The Earth accretes approximately $4x10^7$ Kg of dust and meteorites from these sources every year [1]. The least altered meteorites contain complex assemblages of organic compounds and abundant hydrated minerals. These carbonaceous chondrite meteorites probably derive from asteroids that underwent hydrothermal processing within the first few million years after their accretion. Meteorite organics show isotopic and chemical signatures of low-T ion-molecule and grain-surface chemistry and photolysis of icy grains that occurred in cold molecular clouds and the outer protoplanetary disk [2]. These signatures have been overprinted by aqueously mediated chemistry in asteroid parent bodies, forming amino acids and other prebiotic molecules. Comets are much richer in organic matter but it is less well characterized. Comet dust collected in the stratosphere shows larger H and N isotopic anomalies than most meteorites, suggesting better preservation of primordial organics [3]. Rosetta studies of comet 67P coma dust find complex organic matter that may be related to the macromolecular material that dominates the organic inventory of primitive meteorites [4]. The exogenous organic material accreting on Earth throughout its history is made up of thousands of molecular species formed in diverse processes ranging from circumstellar outflows to chemistry at near absolute zero in dark cloud cores and the formative environment within minor planets.
NASA and JAXA are currently flying sample return missions to primitive, potentially organic-rich asteroids

[5,6]. The OSIRIS-REx and Hayabusa2 missions will map their target asteroids, Bennu and Ryugu, in detail and return regolith samples to Earth. Laboratory analyses of these pristine asteroid samples will provide unprecedented views of asteroidal organic matter relatively free of terrestrial contamination within well-determined geological context. Studies of extraterrestrial materials and returned samples are essential to understand the origins of Solar System organic material and the roles of comets and asteroids to providing the starting materials for the emergence of life.

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