Characterization of complex organic compounds from simulated interstellar matter

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A wide variety of organic compounds have been detected in extraterrestrial bodies, such as meteorites and comets, which suggest that they delivered organic compounds essential for the generation of life to the Earth. The major organic compounds found in meteorites and comets are complex organics. It is suggested that these organic compounds were originally formed from interstellar media in molecular clouds by cosmic rays and/or UV light. We synthesized organic compounds from possible interstellar media by radiation, and characterized them with spectrometric and chromatographic techniques.

Three types of simulated interstellar complex organics were examined.

(1) CA: A mixture of carbon monoxide (350 Torr) and ammonia (100-350 Torr) was irradiated with 3 MeV protons from a van de Graaff accelerator.

(2) CAW: A mixture of carbon monoxide (350 Torr), ammonia (100-350 Torr), and 5 mL of liquid water sealed in a Pyrex tube was irradiated with the 3 MeV protons.

(3) MeAW: A mixture of methanol, ammonia and water (molar ratio was 1:1:2.8) was irradiated with carbon ion beams from HIMAC at National Institute of Radiological Sciences. Irradiation was performed at room temperature or at 77 K in liquid nitrogen.

The resulting products were characterized by gel filtration chromatography, amino acid analysis after acid hydrolysis, FT-IR, elemental analysis, and MALDI-TOF-MS.

It was shown that complex organic compounds were formed whose molecular weight was over 1000. Hydrolysates of the products gave amino acids, even when frozen mixtures were irradiated. FT-IR and elemental analyisis suggest that the products have amide bonds in them.

The present results suggest that complex organic compounds that contain amino acid precursors can easily formed from interstellar media (ISM) in molecular clouds. Amino acid precursors could be formed even if the temperature of ISM was frozen at low temperature. These organic compounds might have been incorporated into comets and/or planetesimals in the early stage of the solar system, and delivered to planets such as Earth. If these organics were essential for the generation of life on the Earth, it was also possible that they were important sources of lives on early Mars and/or Europa.