Analysis of amino acids synthesized in a gas plume by projectile-impact in nitrogen gas (Model experiment of asteroid's impacts)

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When asteroids have impacted onto Titan with atmosphere, hot gas-plumes were formed, in which many kinds of organic molecules and clusters could have synthesized, and the products deposited on the surface. To make clear these hypothetical reactions, simulations experiment has been carried out using a JAXA 2-staged gas-gun. [1] A polycarbonate bullet (7.1 mm diam.) is accelerated to 7 km/s and impacted onto an iron target in a pressurized chamber, where nitrogen pressure is 1 atm (On the iron target, ice or ice+ hexane layer is set). Immediately after the impact, a hot and bright gas plume appears and grows to the size of 10 cm for about 25 us. Then, it is cooled and disappears. In the gas plume, many kinds of organic molecules and nano-particles are synthesized and deposit on the inner surface of the chamber as black soot. This soot is carefully collected and analyzed. Collected soot is refluxed and the extracted liquid is dubsyllized (labeled) and measured by HPLC. As a result, amount of amino amino acids (glycine and alanine) are detected. [2] Especially, in case of the hexane + ice + iron target, the amount of amino acids increased. In 1 mg of the soot, about 2 nmol of glycine is included. By several contamination tests, it can be concluded that these amino acids are synthesized by the impact reaction. Then, 6 M of HCl is added in the produced soot and hydrolysis at 110 C for 24 hrs is carried out. After deionization, the cation-ion HPLC analysis is carried out. [3] As a result, glycine, alanine, aspartic acid, γ-aminobutyrate, etc are detected. The amount is much larger by the hydrolysis. This mean that the amino acids are generated in the form of precursors. To prove the effect of contamination, D/L ratio of the amino acids will be measured. We will also do the impact experiment by changing the experimental conditions. On the other hand the sample is measured using FT-IR and LD-TOF-MS. And we could confirm that there are amount of amino acids in the soot samples. Titan has nitrogen atmosphere and has been impacted by huge number of asteroids. Now we demonstrated the synthesis of amino acids by the impact experiment. Therefore, we could consider that large amount of amino acids were produced and stored on Titan. References: [1] T. Mieno, S. Hasegawa, "Production of carbon clusters by impact reaction using light-gas-gun in experiment modeling asteroid collision", Appl. Phys. Express 1(2008) 067006-1-3.[2] K. Okochi, T. Mieno, K. Kondo, S. Hasegawa, K. Kurosawa, "Possiblity of Production of Amino Acids by Impact Reaction Using a Light-Gas Gun as a Simulation of Asteroid Impacts", Orig. Life Evol Biosph 45 (2015) 195-205.[3] T. Horiuchi, Y. Takano, K. Kobayashi, K. Marumo, J. Ishibashi, T. Urabe, "Amino acids in water samples from deep sea hydrothermal vents at Suiyo Seamount, Izu-Bonin Arc, Pacific Ocean", Org. Geochem., 35 (2004)1121-1128.

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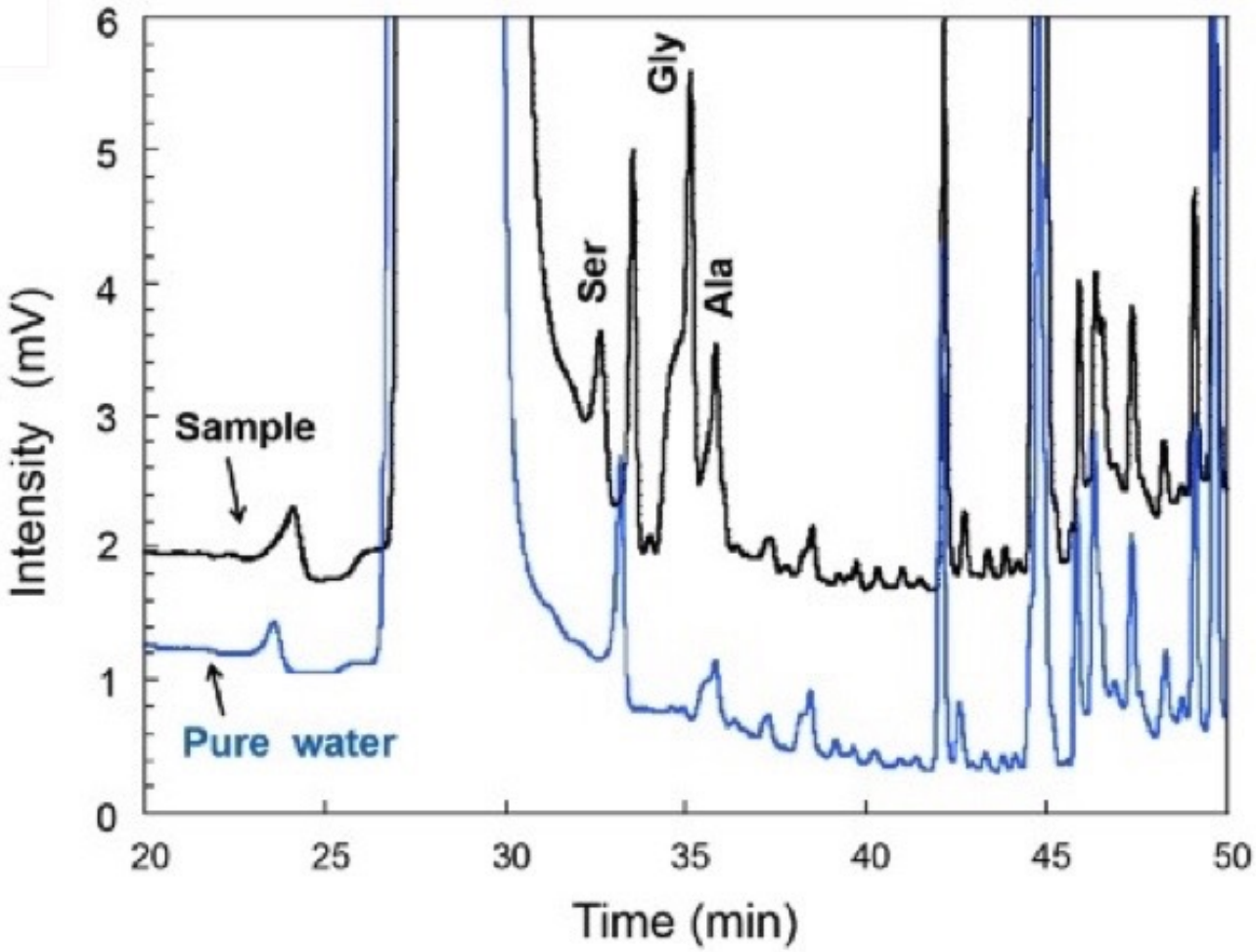

Fig. 1 HPLC chart of the sample refluxed by pure water and dabsylized, where the ice + hexane + iron target is used. The chart of dabsyliezed water is also shown. (quoted from ref. 2.)

