

BAO001-P02

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## Formation of Amino acids in non-reducing gas mixtures

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### Introduction

It was suggested that the terrestrial atmosphere at the time of the generation of life was non-reducing gas dominated carbon dioxide and nitrogen. It was widely believed that organic compounds such as amino acids are not formed effectively from neutral gas mixtures. In 2008, however, Cleaves pointed out that low yield of amino acids from non-reducing gases previously reported was due to be oxidation of amino acids to nitrosamines by nitrate/nitrite during acid hydrolysis: He reported that the yield of amino acids was greatly increased when ascorbic acid was added to the discharge samples as an antioxidant before acid hydrolysis. However, it was not clear that amino acids were produced merely by spark discharges or not. In addition, the precursors of amino acids by the spark discharges have been unknown. We analyzed organic compounds synthesized by spark discharges in neutral gas mixtures, and examined possible formation pathways of amino acids.

### Experimental

A mixture of 300 Torr of carbon dioxide and 300 Torr of nitrogen was added to a 1.6 L flask with 40 mL of water, and sparks were fired between two tungsten electrodes for 24 hours. Organic compounds such as carboxylic acids in the products were analyzed by capillary electrophoresis. Amino acids were analyzed by HPLC and GC/MS after acid hydrolysis in 6 M HCl at 120°C for 24 h with or without ascorbic acid. A mixture of pyruvic acid, nitric acid and ascorbic acid was heated at 65°C for 4 days to examine formation of amino acid since it was previously reported that keto acids were formed from neutral gas mixtures by spark discharge.

### Result & Discussion

Formaldehyde, formic acid, ammonia and nitric acid were detected in the spark discharge products. After acid hydrolysis with ascorbic acid, Gly, Ala and beta-Ala were detected, while no amino acids were detected without ascorbic acid. After acid hydrolysis of heated products from a mixture of pyruvic acid, nitric acid and ascorbic acid, a large amount of Gly and trace of aspartic acid and beta-Ala were formed. This result indicates that amino acids may be formed from reaction between some spark discharge products such as keto acids with ascorbic acid. In order to test this hypothesis, we are going to perform spark discharge in a gas mixture with <sup>13</sup>C-Labelled carbon dioxide.

Keywords: Amino acids, Prebiotic synthesis, Spark discharge, Neutral atmosphere