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Reaction of amino acids by shock wave

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The amino acid is the essential molecule of the life, and various amino acids have been detected from carbonaceous chondrites. However, many of the amino acids detected from the meteorite are different from those that the life body on the earth uses. By the process which reaches the life body from the level of the chemical evolution, it is estimated with that some secondary reactions affected the amino acid synthesized in the protoplanet environment. This time, shock wave was applied on the simple amino acids which were detected from the meteorite, and the reaction products generated on the shock were examined.

In this study, glycine which is the most structurally simple amino acid and 1:1 mixtures of glycine and alanine, which seemed to be the next simple amino acid, were used as samples. Commercial glycine was used as particulates crystal tightly packed in capsule (I) and as a frozen aqueous saturated solution filled in capsule (II). The mixture of glycine and alanine finely grained by the agate mortar was packed tightly in capsule (I).

The shock experiments were carried out using the rail gun at ISAS by hitting the capsule surface with a projectile (1g made of polycarbonate) flying at 6.0-6.5km/s speed. The pressure in the capsule surface in the moment where projectile came to hit is estimated as 80G Pascal. In the experiment which used the crystal of glycine in the powder, almost all of the sample was recovered and the gray color of recovered sample suggested clearly that there were some changes in comparison with the sample before the impact. However, only the spectrum of glycine of the raw material was obtained on the recovery thing, when FT-IR was measured by the KBr pellet method. However, when spread powder of the recovery thing on the aluminum foil surface was measured by the laser Raman microscope, the part which shows the spectrum of glycine and the part which shows the spectrum of the imperfect graphite were observed. By dissolving and filtering the recovery sample in the water, it was possible to separate glycine and graphite-like compound. Since the crack of the crater was reaching the part of the sample, in case of the mixture of glycine and alanine, the recovery rate of the sample was bad. The recovered sample was a mixture of the raw material and graphite as well as the case of glycine, when the spectrum was measured as well as the case of glycine. Some part of the graphite-like compound showed the spectrum of the almost perfect graphite. There was slightly the change at the ratio of glycine and alanine, when the water-soluble part was examined by GC.

The whole quantity was almost recovered as aqueous solution, when the impact was applied on the freezing aqueous solution of glycine. In this case, glycine of the raw material perfectly altered into the chemical compound which seems to be a peptide. The characterization of this chemical compound is under way.

From the above results, following fact clarified:

(1) When impact pressure was added to powder sample, the shock wave affects only the surface of the powder, and the carbonization by high temperature heating of the surface of the crystal grain progresses, and there is no effect on the chemical structure of the material in the inside. (2) The shock wave totally transmitted, when impact pressure was added to the frozen aqueous solution, and generated thermal polymerization reaction. It is indicated that the property of solid material as raw material in the planet formation gives large effect on the processes of the chemical evolution of rganic compounds.