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Impact-induced produtcs from glycine polymers in early Earth's oceans

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Early oceans may have contained appreciable amounts of prebiotic organic molecules, since previous studies have indicated that simple organic molecules are capable to be formed through oceanic impact processes by meteorites. Geologic evidence suggests that the root for the origin of life materials occurred just after or during the heavy bombardment period. At that time the impact energy is considered to have been important for molecules present in oceans to react. Shock reactions of organic molecules in aqueous solutions have been subject to few studies.

Here we investigate the reactions for glycine polymers (dimer G2, trimer G3, and tetramer G4) and alanilglyine (AG) in aqueous solutions in order to know their stability and reaction products during impacts. The starting G2 (>99.o% Tokyo Chemical Industry Co. Ltd), G3 (>98.0%, Tokyo Chemical Industry Co. Ltd), G4 (>95%, Tokyo Chemical Industry Co. Ltd), and AG (>98.0%, Tokyo Chemical Industry Co. Ltd) were used in the present study. Hypervelocity plane impact experiments were carried out using a propellant gun. Sample solutions of glycine polymers in sealed steel containers were subjected to impact at velocities of about 1 km/s. The calculated shock pressures are 5-6 GPa by the impedance match solution. The recovered solutions were analyzed with a hybrid Fourier transform mass spectrometer (Thermo Fisher Scientific LTQ Orbitrap XL) at Hiroshima University.

The analytical results for the recovered samples were compared with those for the initial sample. Limited numbers of amino acids of Glycine, alanine, and their polymers, amines from propylamine to octylamine, and carboxylic acids from acetic acid to decanoic acid were selected due to a measured range of their m/z values. The identification of a molecule was done by the presence of a peak with the calculated m/z value ($\pm$0.002). The results are discussed.

Keywords: Glycine polymers in early Earth's oceans, Impact-induced products