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PREBIOTIC CHEMISTRY

Abiotic Formation of Valine Peptides Under Conditions of High Temperature and High Pressure

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Abstract We investigated the oligomerization of solid valine and the stabilities of valine and valine peptides under conditions of high temperature (150–200 °C) and high pressure (50–150 MPa). Experiments were performed under non-aqueous condition in order to promote dehydration reaction. After prolonged exposure of monomeric valine to elevated temperatures and pressures, the products were analyzed by liquid chromatography mass spectrometry comparing their retention times and masses. We identified linear peptides that ranged in size from dimer to hexamer, as well as a cyclic dimer. Previous studies that attempted abiotic oligomerization of valine in the absence of a catalyst have never reported valine peptides larger than a dimer. Increased reaction temperature increased the dissociative decomposition of valine and valine peptides to products such as glycine, β-alanine, ammonia, and amines by processes such as deamination, decarboxylation, and cracking. The amount of residual valine and peptide yields was greater at higher pressures at a given temperature, pressure, and reaction time. This suggests that dissociative decomposition of valine and valine peptides is reduced by pressure. Our findings are relevant to the investigation of diagenetic processes in prebiotic marine sediments where similar pressures occur under water-poor conditions. These findings also suggest that amino acids, such as valine, could have been polymerized to peptides in deep prebiotic marine sediments within a few hundred million years.

Keywords Amino acid · Valine · Peptide · Diagenesis · Early Earth · Pressure

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