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Formation of Activated Biomolecules by Condensation on Mineral Surfaces – A Comparison of Peptide Bond Formation and Phosphate Condensation

Thomas Georgelin · Maguy Jaber · Houssein Bazzi · Jean-François Lambert

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Abstract Many studies have reported condensation reactions of prebiotic molecules, such as the formation of peptide bonds between amino acids, to occur to some degree on mineral surfaces. We have studied several such reactions on the same divided silica. When drying steps are applied, the equilibria of peptide formation from glycine, and polyphosphate formation from monophosphate, are displaced to the right because these reactions are dehydrating condensations, accompanied by the emission of water. In contrast, the equilibrium of AMP dismutation is not significantly favored by drying. The silica surface plays little role (if any) in the thermochemistry of the condensation reactions, but is does play a significant kinetic role by acting as a catalyst, lowering the condensation temperatures with respect to bulk solids. Of course, the surface also catalyzes the inverse hydrolysis reactions.

Keywords Amino acids · Polymerization · Nucleotides · Phosphorylation · Silica · Catalysis

Introduction

Interesting results have appeared since the 1970s involving "interfacial" prebiotic scenarii, where two molecules or more are made to react together after adsorption on a mineral surface, yielding activated molecules such as peptides from amino acids ((Lambert 2008) and references therein). However, progress in this field has been irregular, largely a hit-or-miss affair, and fundamental questions raised early about these scenarii remain unanswered (de Duve and Miller 1991). This is in part because the thermodynamic and kinetic aspects of the problem are not clearly distinguished and we will therefore start by recalling a few basic facts.

Many thermodynamically uphill prebiotic reactions are in fact condensation reactions accompanied by the elimination of one water molecule, of the general form:

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T. Georgelin · M. Jaber · H. Bazzi · J.-F. Lambert (✉)
Laboratoire de Réactivité de Surface (UMR 7197 CNRS), UPMC Univ Paris 06, Case courrier 178, 3 Rue Galilée, Ivry-sur-Seine, 94200 Paris, France
e-mail: jean-francois.lambert@upmc.fr

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