Thermophoresis and the 'Origin-Of-Life' Concept

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Formamide is of special interest in the 'origin-of-life' concept, because it was shown to form a number of prebiotic molecules under catalytic conditions and at sufficiently high concentrations [1]. For nucleotides and short DNA strands, numerical finite-element calculations have shown that a high degree of accumulation occurs in hydrothermal pores [2]. Using thermophoretic data of the formamide/water system measured with Infra-Red Thermal Diffusion Forced Rayleigh Scattering (IR-TDFRS) we show that the same combination of thermophoresis and convection in hydrothermal pores leads to accumulation of formamide up to concentrations high enough to initiate synthesis of prebiotic nucleobases. The high degree of formamide accumulation is due to an unusual temperature and concentration dependence of the thermophoretic behaviour of formamide. Starting with a formamide concentration of 10^{-3} wt %, estimated to be typical in shallow lakes on early earth, the accumulation-fold in part of the pores increases strongly with increasing aspect ratio of the pores, and saturates to highly concentrated aqueous formamide solutions of approximately 85 wt % at large aspect ratios [3]. Time dependent studies show that these high concentrations are reached after 45-90 days. Further, we derived a heuristic model to illuminate the accumulation process and understand the dependence of the accumulation on pore geometry [4].

References:

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