

HYDROTHERMAL POLYMERIZATION AND PHOSPHORYLATION OF PREBIOTIC PRECURSORS

An interdisciplinary project to explore mineral-assisted chemical reactions under dry / hydrothermal conditions. The main prebiotic precursors of higher-order organic structure are alpha-amino acids, short polyols and carbohydrates, beta-nucleosides and long carbon-chain alcohols (alkanols) or fatty acids (alkanoic acids). Amino acids can directly polymerize into short peptides under low water activity. Nucleic acids and phospholipids only form when the aforementioned precursors are first phosphorylated, that is, dehydrated in the presence of a phosphate source, to provide metastable C-O-P bonds. The spontaneous phosphorylation of alcohols occurs under plausibly prebiotic conditions, if a dehydrated milieu can be maintained for long enough time periods. This PhD project aims at exploring the role of natural phosphate minerals, plausible during Hadean and early Archean, in conjunction with hydrothermal conditions, that could promote the polymerization of amino acids, enable phosphorylation and therefore the formation of nucleotides, as well as phospholipid membranes, at the same time and under mutually compatible prebiotic reaction conditions.

A series of organic compounds form abiotically in hydrothermal vents, where minerals catalyze the formation of H-C, C-C and C-O bonds between ca. 400°C and 120°C. In the lab, Strazewski and Fiore have reported that long-chain alkyl phosphates and related amphiphilic phosphorylated compounds could be formed under anhydrous phosphorylation conditions. Moreover, upon hydration the crude phosphorylation mixtures self-assembled in vesicular objects observed by optical microscopy.

This PhD project aims at extending this preliminary but feasible work with selected natural or synthetic (di)hydrogenphosphate bearing minerals. These reactions should also be investigated under hydrothermal conditions favorable to spontaneous polymerization. The evolution of organic compound mixtures will be monitored by in situ Raman, IR, heteronuclear (^1H , ^{13}C , ^{31}P) NMR spectroscopies, as well by ESI-mass spectrometry coupled to HPLC and UPLC.

The recruited PhD candidate will share his/her time between the ICBMS and the LGL-TPE. Experiments under hydrothermal conditions, in situ Raman measurements will be performed at the LGL-TPE. The phosphorylation reactions at ambient pressure will be done at the ICBMS to profit from the HPLC, [spectroscopic](#) and [spectrometric](#) facilities. The candidate will be highly interested in carrying out interdisciplinary research in geology and organic chemistry. He or she will have a **Master degree in Geology, Earth & Planetary Sciences, Molecular Biology, Chemistry or Chemical Engineering**.

PhD supervisor: Isabelle Daniel, *Laboratoire de Géologie de Lyon (LGL Team) – Terre, planètes, environnement* ([LGL-TPE](#), UMR CNRS 5276), bâtiment Géode, 2 rue Raphael Dubois, *Université Claude Bernard Lyon 1 – ENS de Lyon*.

Co-direction by Peter Strazewski & Michele Fiore, *Systems Chemistry Group (SysChem), Chimie Organique 2 Team* (équipe [CO2glyco](#)), *Institut de Chimie et Biochimie Moléculaires et Supramoléculaires (ICBMS, UMR CNRS 5246)*, bâtiment Edgar Lederer, 1 rue Victor Grignard, *Université Claude Bernard Lyon 1*.

Salary and social benefits will be proposed in accordance to French laws and regulations. An annual 3000 € package is provided for small equipment and travel expenses.

The [Lyon Institute of Origins](#) (LIO) is a long-term project gathering four laboratories of the University of Lyon, in a «Laboratory of Excellence (LabEx)» created in 2011 to investigate the topics of the origins, from the origin of matter to the origins of cosmic structures and life. It funds technical facilities, positions for early career scientists, training and valorization.

The candidates will be selected in partnership with the [Doctoral School Physics and Astrophysics](#)

Please submit you application with your academic achievements in the last three years, a letter of motivation, and a letter of recommendation to isabelle.daniel@univ-lyon1.fr and strazewski@univ-lyon1.fr with a copy to Mrs Souad Lafahal (souad.lafahal@univ-lyon1.fr) before **June the 2nd, 2020**. Candidates on the short list will be invited for an interview via videoconference on June 9th or 10th.