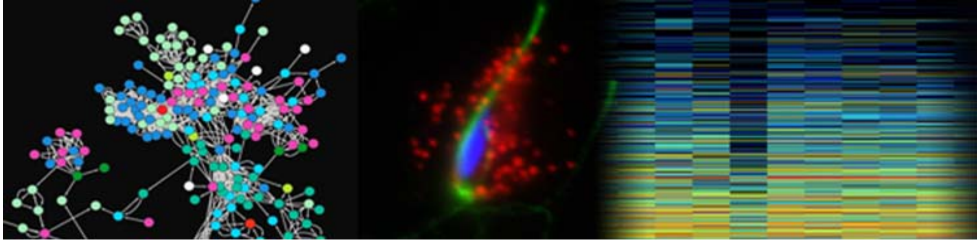

PhD Position open (3 years, DFG funded)

Topic: Transition metals in modern microbes and hydrothermal vents: A missing link between early Earth and early life

Research group of Prof. Dr. W. Martin, Molecular Evolution, HHU Düsseldorf

Requirements and information for application:
A MSc degree in Chemistry, Biochemistry, or Chemical Engineering is required. Experience in basic analytics like NMR and HPLC are preferred for this position.
The open position is supported by German Research Foundation (DFG) and it is part of the collaboration with Harun Tüysüz (MPI for Coal Research, Mülheim/Ruhr). The tasks of the PhD candidate will be to design and work out new experiments for the investigation of native metals and heterogeneous catalysts to promote H_2-dependent CO_2 reduction to biological pathway intermediates in the context of prebiotic chemistry in hydrothermal vents.

Applications can be sent by e-mail to MSc Chem. Martina Preiner preiner@hhu.de, and should include a curriculum vitae, the names of at least two potential references and a personal statement (max. one page) describing your qualifications and reason for the interest in this position. Starting date: autumn 2018.

Project summary:
Physiological and genomic evidence suggests that the first cells were H_2-dependent autotrophs that inhabited environments similar to modern serpentinizing hydrothermal vents. Today, spontaneous exergonic geochemical reactions at vents still generate H_2 from H_2O and small organic compounds from CO_2. Such exergonic reactions are broadly similar to segments of the acetyl-CoA pathway in acetogens and methanogens, which are primordial lineages by the measure of ancient genes. The midpoint potential of H_2 however requires anaerobes that reduce CO_2 with H_2 to use flavin based electron bifurcation, a complex mechanism involving proteins, to generate low potential reduced ferredoxins for CO_2 fixation. Electron bifurcation entails proteins, however, raising the central question of this proposal: How, where, and via what reductant did primordial CO_2 reduction occur, both prebiotically (before the existence of proteins) and at the onset of microbial metabolism? In the laboratory, Fe^0 reduces CO_2 inter alia to acetate, methane, and methanol, and hydrothermal vents harbour awaruite, Ni_3Fe, a natural compound of native metals. Here we propose to investigate the abilities of nanoparticular awaruite, Ni_3Fe, and biologically relevant native metals (Ni, Co, W, Mo, Fe) alone and in combinations, to reduce CO_2 to CO and small organic compounds under hydrothermal conditions (100, 200 and 400 °C). We will test metals as reductants (no H_2) and catalysts (with H_2) with and without water. Some acetogens and methanogens can use Fe^0 as the sole electron donor. Should native metals be able to serve as nonenzymatic precursors of electron bifurcation as an electron source for CO_2 reduction, this would open up fundamentally new perspectives for the investigation of early chemical evolution and its connections to the physiology of microbes that thrive in primitive habitats today.

References:

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Sousa, F. L.; Preiner, M.; Martin, W. F. Native metals, electron bifurcation, and CO2 reduction in early biochemical evolution. Curr. Opin. Microbiol. 2018, 43, 77–83, doi:10.1016/j.mib.2017.12.010.

Preiner, M.; Xavier, J. C.; Sousa, F. L.; Zimorski, V.; Neubeck, A.; Lang, S. Q.; Greenwell, H. C., Kleinermanns, K.; Tüysüz, H.; McCollom, T. M.; Holm, N. G.; Martin, W. F. Serpentinization: Connecting geochemistry, ancient metabolism and industrial hydrogenation. Life 2018 *accepted.*