July 16-21, 2017 at UC San Diego, CA, USA

Electrochemistry of early Earth hydrothermal chimneys and simulations of possible prebiotic metabolic pathways

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We present the results of artificial seafloor hydrothermal chimney experiments; chimneys are self-organizing chemical garden precipitates generated from geochemical disequilibria and have been proposed as a possible environment for the origin of life on Earth and on other worlds [1]. Laboratory chimneys were produced using different hydrothermal injection simulants containing sodium sulfide doped with pyruvate, which were injected into a primitive Earth ocean simulant containing a solution of dissolved ferrous iron, nickel, and carbonate [2] (Figure 1). Early Earth anoxic conditions were maintained by continuously purging with argon in the chimney headspace. Electrochemical analysis was performed using custom-made electrodes placed across the chimney wall to analyze the bulk property of surface charge potential at the interface of the chimney / ocean / hydrothermal fluid. We performed *in-situ* electrical properties characterization of the chimney using electrochemical impedance spectroscopy (EIS) and found that when pyruvate was present in the hydrothermal fluid, the electrochemical activity over the entire chimney/ocean chemical system was increased. We postulate that in prebiotic hydrothermal systems, pyruvate or other simple organic acids could serve as key intermediaries to possibly kick-starting metabolic pathways in chimney membranes containing iron-nickel-sulfides as well as other catalytic minerals like iron oxyhydroxides. Further work is needed to investigate whether these chimneys can promote the production of more complex organic products that would be relevant for the emergence of life.

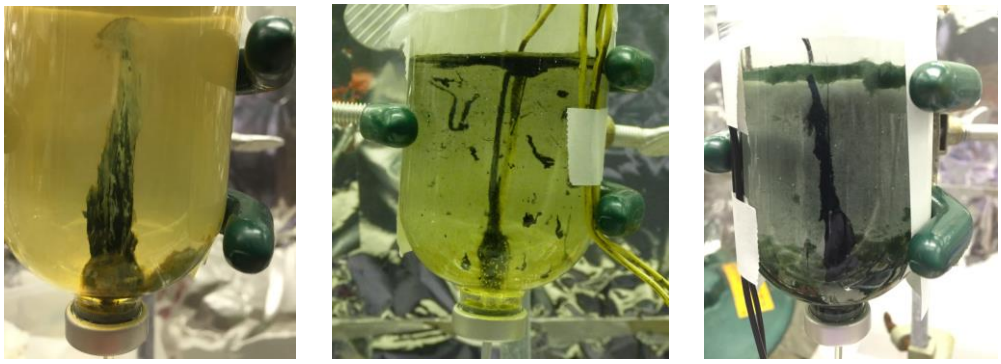

Figure 1: Artificial hydrothermal chimneys

References: [1] Russell, MJ et al. 2014. *Astrobiology*,14, 4, 308-343. [2] Barge, LM et al. (2015) *Journal of Visualized Experiments*, 105, DOI**:** 10.3791/53015.