Electrochemical Carbon fixation

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The emergence and evolution of proto-metabolic networks have recently attracted much interest as an essential initial step for the origin of life (Braakman and Smith, 2013). Alkaline hydrothermal systems have been proposed as a plausible site to drive proto-metabolism (Russell et al., 2010), where reduction and fixation of CO2 could have proceeded with the aid of ample and continuous supplies of reductive chemicals such as H2, H2S, and FeS, together with active mineral catalysts (Huber and Wachtershauser, 1997). Recently, a direct electrochemical measurement of a deep-sea hydrothermal vent in the Okinawa Trough demonstrated that the geochemical redox potential between hydrothermal fluid and seawater generates electrical current through the vent structure, and electrons are concentrated at the vent-seawater interface (Yamamoto et al., unpublished). Electrochemistry is an effective means for CO2 reduction and fixation. It has been experimentally shown that electrocatalytic reduction of CO2 on metal sulfide deposits produces CO and CH4 with excellent efficiencies under naturally plausible electrochemical conditions (from -0.4 to -1.3V; Yamamoto et al., 2014). There is a good probability that the geo-electrochemical systems occurring at alkaline hydrothermal vents served as a source of energy and reducing power to drive proto-metabolic reactions. Following there geological and experimental findings, we have been conducting electrochemical experiments in ELSI. Here, we will introduce our research progress and its implication for the origin and early evolution of life.

Keywords: Origin of Life, Alkaline hydrothermal vent, Metabolism

