

CO₂ fixation in hydrothermal vent environments

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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 [1]. Alkaline hydrothermal systems have been proposed as a plausible site to drive proto-metabolism [2], 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 (e.g., [3]). 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electrical current through the vent structure, and electrons are concentrated at the vent–seawater interface (Yamamoto, unpublished). Electrochemistry is a very effective way 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 –1.3 V) [4]. 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 these 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.

References

- [1] Braakman & Smith (2013) *Phys Biol* 10, 011001.
- [2] Russell et al. (2010) *Geobiology* 8, 355. [3] Huber & Wächtershäuser (1997) *Science* 276, 245. [4] Yamaguchi et al. (2014) *Electrochim Acta* 141, 311.