Geo-electrochemical CO production: Implications for the autotrophic origin of life

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Hydrothermal activities on the primitive Earth were considered to be much greater than the present level, and hydrothermally produced geo-electrochemical potential may have facilitated CO_2 reduction and the formation of organic compounds that preceded the origin of life. To test the possibility, we examined electrochemical CO_2 reduction on low-crystalline sulfides of various metals (Ag, Cd, Co, Cu, Fe, Mn, Mo, Ni, Pb, W, or Zn) in the simulated ancient seawater. Results showed that CdS and Ag_2S have excellent catalytic efficiency for the CO_2 reduction to CO, together with the H_2 evolution. At potentials below -1.0 V (versus the standard hydrogen electrode), the CO production on CdS and Ag_2S accounted for around 40 and 30 % of the total electric current, respectively. The threshold potential could be readily generated in the H_2-rich, high-temperature and alkaline hydrothermal vents that were probably widespread over the early ocean floor. The electrochemical production of CO, a crucial energy and carbon sources for abiotic and biotic organic synthesis, could have been a key initial step of the prebiotic CO_2 fixation in the early ocean hydrothermal systems, and provided the materials for the origin and early evolution of life.

