

## GEOELECTROCHEMICAL PROCESSES IN CHEMICAL EVOLUTION

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The goal of this presentation is to propose a novel hypothesis on the role of sulphide minerals in prebiotic evolution. Physicochemical parameters of these minerals, as well as the conditions in hydrotherms accompanying their deposits, are sufficient for a formation of electrochemical systems capable to reduce  $\text{CO}_2$  and produce primitive metabolites.

1. Lithosphere and hydrosphere components, such as magmatic melts, volcanic products, thermal and oceanic waters, are participants of widely spread electrochemical phenomena, which involve both electron conductors, solid minerals, and the ion conductors, aqueous solutions of mostly mineral electrolytes. A source of electric currents and fields in the Earth's crust are diverse mineral components of heterogeneous ore deposits, as well as the separately located ore bodies.

2. The contact of mineral conductor with electrolyte solution results in formation of a double electric layer at the electrode-electrolyte interface and in the generation of potential. A dry contact between two electrochemically distinct mineral conductors submerged by their other parts into electrolyte solution gives rise to a circuit. A mineral surface contacting the solution and bearing a higher potential value will be a cathode of this circuit, and the lower potential component will act as anode.

3. Sulphide minerals, pyrites, which are active participants of these process, are abundant in lithosphere, and their deposits contact hydrotherms (in particular black smokers) and oceanic water. Precambrian rocks contain products of pyrites anoxygenic weathering, thus indicating their presence in crust at the early stages of its development [4,6]. Pyrites differ by composition, and most of these minerals, such as pyrite, pyrotine, etc., contain iron as a main metal component. These minerals conduct electric current [1] and can participate in formation of circuits.

4. Carbon dioxide, a common gas component of natural thermal solutions, is known to participate in electrode reactions resulting in formation of organic products. The electrode potential values of different pyrites fall in a range between 0 and 1000 mV and under certain conditions can exceed one volt [5]. Such potential values are sufficient to support

cathode reduction of CO<sub>2</sub> to organic compounds, as well as the subsequent electrochemical transformation of products. Like the electrode materials, most optimal for electrochemical reduction of CO<sub>2</sub> to organic molecules, pyrite minerals show semiconductor properties [1] and their surfaces have a weak adsorption capability.

It should be noted, that electrochemical processes and the reactions of pyrites proposed for chemical evolution by other authors [3,8], are underlied by fundamentally different mechanisms. The initial stage of electrochemical process involves direct electron transfer from cathode to the acceptor molecule in solution, without intermolecular electron exchange occurring in course of chemical reactions in solution.

5. The recent results of our group give a good support to a core point of the concept. The laboratory experiments have demonstrated, that pyrite cathode submerged into a model hydrothermal solution drives electrochemical reduction of CO<sub>2</sub>. The process needs low potential values and proceeds even at the normal atmospheric pressure [2,7]. Along with the literature data, these results allow to presume, that electrochemical processes in the Earth's crust could make a significant contribution into the formation of organic matter on early stages of evolution.

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