

Sedimentary rocks are the largest reservoir of organic carbon on Earth. It is estimated that they contain approximately 1.5×10^{22} g of fossil organic carbon in the form of polycondensed macromolecular kerogen. Kerogen is produced in the process of diagenesis, i.e. biochemical and geochemical transformation of substances of plant and animal origin. The kerogen is a mixture of interconnected macromolecular organic compounds, mainly aromatic, and is defined as an organic substance resistant to organic solvents.

An example of a fossil sedimentary rock is a subterrestrial polymetallic Kupferschiefer shale rock found in the area of the Fore-Sudetic Monocline. This rock was created about 256 million years ago and belongs to one of the largest copper ore deposits in the world. The organic carbon content of the Kupferschiefer is up to 30% by weight. The fossil organic matter of Kupferschiefer is a gas-forming and oil-forming kerogen II.

Until recently, it was believed that the carbon deposited in the form of kerogen is immobilized, and excluded from circulation on Earth. Our research so far has confirmed, however, that the bacteria inhabiting Kupferschiefer are capable of dehydrogenation and oxidation of primary kerogen II. This process changes its type into kerogen III and IV and led to an increase in the content of extractable simpler oxidized organic compounds, including alcohols, esters and fatty acids.

Based on our results, we have developed a hypothesis that oxidized organic compounds mobilized from kerogen during its biotransformation can be substrates for the biosynthesis of monocarbon compounds, including greenhouse gases such as methane and carbon dioxide. The preliminary studies confirmed also the ability of microorganisms inhabiting shale rock to methane oxidation and production of methanol and formaldehyde.

The aim of our research is to understand the role of bacteria and archaea in the aerobic and anaerobic transformations of kerogen II, III and IV. The project will investigate the processes of methanogenesis, methanotrophy and methylotrophy as well as halogenation and dehalogenation, including the identification of bacteria and archaea, the identification of enzymes as well as key intermediates for these processes.