

#### Aim of the Project

Aim of the current Project is recognition of possibilities of biogas (methane) production with the use of natural processes carried by the methanogens. These microorganisms utilize simple substrates such as acetates, carbon dioxide and hydrogen. In natural conditions, the methanogens are accompanied by syntrophic bacteria, which are able to decompose organic macromolecules. One of the most carbon-rich substances is coal. The Project aims to identify microorganisms (methanogenic and syntrophic) for which coal reserves comprise natural habitats and furthermore recognize exogenous microbial species able to transform fossil coals into useful biogas.

#### Description of basic research being realized in the project

Subject of the current project will be coals of different age and origin, obtained from currently exploited Polish deposits. Hard coals will originate from Lublin and Upper Silesian Coal Basins while brown coals from Turoszów and Bełchatów Coal Basins. The “youngest” form of coal will be represented by peat material. Basic physical and chemical parameters of the coals will be determined, including e.g. reaction, redox potential, salinity, total organic and inorganic carbon, micro- and macroelements as well as biogenic nitrogen, phosphorous and sulphur.

Methane formation from coal will be assayed by incubation in hermetic jars prevented from light and oxygen. Various experimental treatments will be analyzed, including:

- chemical stimulation by addition of micro- and macroelements and vitamins, aiming to confirm or expel the presence of autochthonic methanogenic consortia able to produce methane from coal.
- biological stimulation by addition of natural microbial consortia transferred from natural methanogenic ecosystems such as peat soil, hypertrophic lake sediment, coal formation water).

The amount of methane generated will be assayed via gas chromatography. Increase in CH<sub>4</sub> concentration in the incubation headspace will appoint the methanogenic activity. Additionally, there will be an attempt to establish methanogenic cultures on artificial mineral media using coal material as inoculum. Acetate, carbon dioxide and hydrogen will be delivered to support growth of the methanogens in the cultures.

Additionally, there will be an attempt to identify microorganisms involved in coal biogasification with the use of latest molecular biology tools, including fluorescence in situ hybridization - FISH and next generation sequencing – NGS. The probes utilized will enable simultaneous identification of both methanogenic Archaea and accompanying syntrophic Bacteria. After completion of the experiment, in each material concentration of humic acids, being a product of coal decomposition will be analyzed.

#### Reasons for undertaking the subject

The issue of obtaining a valuable energetic raw material – methane – from fossil coals via biogasification is extremely interesting and so far poorly recognized. Polish and even European coal deposits were not investigated in that subject. There is also little known about the influence of age and origin on methanogenic potential. Results of the current project will thus deliver a very first knowledge about natural methanogenic potential of Polish coals and possibilities of their stimulation: chemical- by addition of substances lacking in natural conditions, and biological by introduction of allochthonic methanogenic consortia. Identification of the methanogens capable to degrade fossil coals and determination of their activity will open the way for further research towards practical application of this method of methane production e.g. from unminable coal deposits.