Effects of mineral and chemical composition of aerosols on the origin and diversity of airborne halophilic microorganisms in an underground salt mine

The objective of this project is to undertake a comprehensive, interdisciplinary basic research in mineralogy, geochemistry, and geomicrobiology of airborne aerosols in an underground salt mine. Salt mines are commonly used for underground respiratory therapy, which involves inhaling aerosols of natural salt particles. Our preliminary results indicated that the aerosol from the Bochnia Salt Mine contains alive halophilic ("salt-loving") microorganisms, which may play an important role in salt therapy. However, before the role of halophiles in underground therapy can be clarified, there is a need to determine in basic studies the concentration of airborne halophiles, the role of mineralogical, chemical, and environmental factors controlling their survival in the air, their diversity, and origin.

Three basic hypotheses will be tested to shed light on the studied objectives:
1) The occurrence of newly discovered airborne halophilic microflora are indigenous to a salt mine atmosphere and closely associated with the mineral composition of the specific aerosols,
2) The abundance and diversity of airborne halophilic microflora depends on the chemical composition of the soluble fraction of aerosols and the relative humidity of the mine atmosphere,
3) Airborne halophilic microorganisms present in the underground salt mine are of endolithic origin.

The Bochnia Salt Mine, located near Cracow in southern Poland, was chosen as a testing ground for this research because it is a representative model for historical underground facilities used nowadays for tourist, museum, recreational, and therapeutic purposes. In addition, the mine is ventilated by only one downcast (air inlet) shaft and the sampling points can be easily distributed along an increasing distance from the air inlet. This will extremely facilitate the interpretation of the origin and distribution of airborne particles sucked from the ambient (outdoor) air, as well as particles of indoor origin.

Our recent studies of the inorganic composition of such aerosols have shown that the composition of the air of underground salt mines, used for tourism and spa purposes, is much more complex than previously described. The weathering of parent rocks in a mine is a source of aerosols and dusts that supply natural geogenic components to the underground atmosphere (halite, anhydrite, gypsum, and clay minerals). The presence of visitors and tourist services introduce anthropogenic particles typical for air indoors (fragments of skin, hair, clothing). Because the underground air is actually the ambient air that is drawn in from the surface, the composition of aerosols in the mine is also influenced to some extent by the pollutants sucked by the ventilation system from the ambient air. On the other hand, many internal processes enhance the purification of the polluted ambient air. Moreover, the high salinity reduces the number of microorganisms that can survive in such a hypersaline ecosystem.

The novelty of this project is twofold:
- for the first time, the mineral and chemical diversity of the airborne aerosol in conjunction with the diversity of microbial communities in the air of an underground salt mine will be simultaneously determined and quantified, using as an example the historical salt mine in Bochnia,
- for the first time, the origin and factors influencing the presence, abundance, and diversity of halophilic microorganisms in the air of the underground salt mine will be determined and explained.

This will be accomplished by comprehensive, interdisciplinary basic research in mineralogy, geochemistry, and geomicrobiology as a joint effort of two national and one international complementary, experienced teams. Such work has not been performed in any of the salt mines in the world.

In underground salt mines humans are exposed to inhalation of these microorganisms, thus we believe that this project, although basic in its nature, will open a new scientific discussion on halophiles-human cell interactions. It is an essential issue, since, in addition to health treatments, the underground spaces of salt mines are commonly used for tourist purposes around the globe. Only in Poland the total number of people visiting three currently open to public underground salt mines (Wieliczka, Bochnia, and Kłodawa) reach 2 million per year. Not to mention the number of people for whom the underground salt mine is a workplace. During our project we want to create the Collection of Airborne Halophilic Microflora from the samples analyzed in this project. This unique Collection will be available for the scientific community for further research on halophile-human interactions.