Concentrations of two, the most important greenhouse gases (GHGs), carbon dioxide (CO_2) and methane (CH_4), in Earth's atmosphere have reached the record levels in recent years. Extraction, storage, and transportation of fossil fuels contributing to climate change and global warming, with long-term environmental consequences after the mine closure and adverse impacts on the health of inhabitants living in vicinity of mining sites. Dumping of various mining waste causes measurable emission of GHGs and leads to the release of numerous toxic compounds to the atmosphere.

Variability of greenhouse gas emissions associated with mining is still poorly recognized and many questions remain about GHG source-to-atmosphere pathways and rate of production in potentially endangered areas. In most cases, methane emissions are estimated using the rate of total fossil fuel production for each sector (oil, coal, gas) in a single year multiplied by country-specific emission factors or the Intergovernmental Panel on Climate Change (IPCC's) default emission factors. However, such estimates of anthropogenic emissions are not of the highest quality and tend to have a high degree of uncertainty.

Generally, different CO_2 and CH_4 origins/genesis have distinct stable isotope signatures, which is related to the way they were produced and the fractionation processes (separating multi-component mixture). Isotopes are atoms of the same elements with the same number of protons but a different number of neutrons. In the environment, two carbon isotopes light carbon-12 (^{12}C) and heavy carbon-13 (^{13}C) are called stable; in the case of hydrogen, two stable isotopes are known as hydrogen-1 (^{1}H) and hydrogen-2 (^{2}H or deuterium). The characterization of carbon ($\delta^{13}C$) and hydrogen ($\delta^{2}H$) stable isotopic composition of CH_4 can help with distinguishing the specific emitters of methane from underground coal mines.

The central element of this project will be to improve the temporal (over various meteorological conditions and seasonal timescales) and spatial (for land surface structures) coverage of measurements of greenhouse gas (CO_2 and CH_4) levels by using in-situ measurement campaigns in the coal mine region. Constraining the most dangerous issues related to climate change also requires accurate estimation of sources of methane emissions and leaks into the atmosphere, especially the attribution of emissions to specific source types and processes in the areas of active and closed coal mines. The current project aims to bridge the gap between large-scale emission monitoring programs (International Methane Emissions Observatory, IMEO), including the bottom-up reporting approach of GHGs from emission databases used in the national inventory, and a spatio-temporal representation of CO_2, CH_4 levels, and their isotopic composition under various sources of emissions from coal mining (operating, recently closed and abandoned coal mine shafts and coal waste dumps).

The nature (origin) of coal mine gas and its temporal variability in hard coal areas in the Lviv-Volyn Coal Basin (LVCB) in Western Ukraine has not been studied until now. The Chervonohrad mining-industrial district (CH MID) of LVCB represents one of the largest coal-bearing regions in the northwestern part of Ukraine, with 6 operating coal mines over 50 years, an active concentrating factory and 5 coal mines closed in the period of 2005–2010, with the number of coal waste dumps (thermally active or not) and pond sedimentation sites.

Understanding the impact of various natural and anthropogenic factors and the mechanisms of carbon dioxide and methane turnover in the coal mining area is critically important to deepen our knowledge on the issue of coal mining methane emissions as a second most important greenhouse gas influences global warming. Application of $\delta^{13}C$ and $\delta^{2}H$ isotopes of methane for tracing negative environmental effects of coal mining, closed mines and their remnants can also be used for better quantification and spatial representation (mapping) of methane emissions, as well as more sophisticated modelling of CH_4 emission rates. Such maps are critical for monitoring changes in CH_4 emission distribution spatially and temporally, and will support local authorities and industry in the context of issues related to quantification of methane emissions, policy planning and implementing measures of reducing GHG emissions.