Greenhouse gases production in open-pit mines

Buzek F.[1], Cejkova B.[1], Jackova I.[1], Gerslova E.[2], Mach K.[3], Lhotka M.[4], Curik J.[1], Veselovsky F.[1]

[1]Czech Geological Survey, Geologicka 6, 152 00 Prague 5, Czech Republic
[2]Department of Geological Sciences, Masaryk University, 601 77 Brno, Czech Republic
[3]North Bohemia Mines, 5. kvetna 213, 41829 Bilina
[4]University of Chemistry and Technology Prague, Technicka 5, 166 28 Prague 6, Czech Republic

The Czech Republic belongs to largest soft-coal producers in Europe. Lignite is mined in CR today only at the surface, in the North Bohemian Basin and in the eastern part of the Sokolov Basin. The opencast Bilina coal mine (North Bohemian basin) produces eight million tons of subbituminous coal per year.

Open-pit coal mines are significant sources of methane (CH_4) and carbon dioxide (CO_2) emissions into the atmosphere. We studied the chemical and isotopic ($\delta^{13}C$-CH_4, $\delta^{13}C$-CO_2, $\delta^{2}H$-CH_4) composition of gases from three opencast mines in the North Bohemian lignite basin, Bilina, CSA, Libous and Jiri in the Sokolov Basin. The release of greenhouse gases from a coal mine starts with coal seam degasification during the initial removal of overburden, continues during coal mining, crushing, pulverization and ends with CH_4 being released from abandoned mines.

Gas samples were collected at two locations in one mine at several distances from the coal bed. Coal samples were taken at the same locations, directly from a freshly excavated seam.

Using the canister method, we measured gas emissions from fresh coals as a function of time until equilibrium was reached, then the coals were crushed into pieces about 1 cm in diameter and the released gases were analysed. Finally, the samples were crushed into powder (particle size less than 1 mm) in a closed mill with a gas septum to analyse the residuals. We monitored the amount of methane and CO_2 released, the dependence of the amount and isotopic composition of the gases on time and subsequently on the particle size during gradual erosion of the coal structure (effect of coal treatment). The surface size, the amount of pores and their distribution were also monitored (BET) since the ability to retain gases is influenced by the volume of the pores and their surface area.

The isotopic composition was used to determine the origin of the emitted gas from coal samples collected in the Bilina open-pit mine. The $\delta^{13}C$ values of the released methane (CH_4) and carbon dioxide (CO_2) indicates their biogenic origin ($\delta^{13}C$ (CH_4) −70 ‰ to −55 ‰ vs. VPDB, $\delta^{2}H$ −275 ‰ to -260 ‰ vs. VSMOW, $\delta^{13}C$ (CO_2) -10 ‰ to -16 ‰ vs. VPDB). We assume that the secondary biogenic gas production replaced original coal bed gases and the excavated coal is rich in CO_2, but very low in CH_4. Additionally, most of the secondary CH_4 was released before excavation.