GEOCHEMICAL CHARACTERISTICS OF COAL WASTES ORGANIC MATTER FROM TWO PARTS OF UPPER SILESIAN COAL BASIN (POLAND)

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Introduction

The Upper Silesian Coal Basin is located in the southern part of Poland and northern Czech Republic covering the area of ca 7500 km^2. Its coals show distinctive differences in rank and petrographic composition when comparing the western and eastern parts of the basin (Jurczak-Drabek 1996). Since the coal industry in Poland has been generating substantial amounts of waste rocks, ca 0.6-0.7 t for every ton of coal mined, there are enormous amounts of gangue stored in coal waste dumps (Skarżyńska, 1995). Many of them are in the state of spontaneous heating, with the highest intensity of the process registered in the western part of the basin. There are many adverse effects of the process affecting the environment such as gases, volatiles and dust emission, bitumen formation due to coal waste pyrolysis or heavy metals and phenols leaching to water (Skręt et al., 2010, Misz-Kennan and Fabiańska, 2011, Fabiańska et al., on-line).

The aim of the research was to compare geochemical characteristics of organic matter present in coal waste rocks from two marginal parts of the basin, i.e. the Janina Coal Mine, the most eastern mine of the basin and the Marcel Coal Mine located in the Rybnik Industrial Region, the most western part of the basin.

Samples and methods

The set comprises 13 Janina and 13 Marcel coal waste rocks. The weathering stage of coal wastes has been taken into account since each sample set comprises gangue from fresh to that which spent up to twelve years in the dump. The samples were powdered to the size <0.20 mm and subjected to rapid extraction with dichloromethane in elevated temperature and under pressure. The composition of the total not separated extracts was analyzed with GC-MS using an Agilent gas chromatograph 7890A, a HP–5 column (60 m × 0.25 mm i.d, a 0.25 μm stationary phase) coupled with a mass spectrometer 5975C XL MDS (70 eV, 50 - 650 Da, full scan). The compounds were identified by using their mass spectra, comparison of peak retention times with those of standard compounds, interpretation of MS fragmentation patterns and literature data (MSD 2012). Ratio values were calculated using manually integrated peak areas.

Results

Despite the relatively long exposure to the dump environment, lasting several years for some of the samples, most of the geochemical features of coal wastes has been preserved. This allows assessing the depositional environment, types of kerogen and thermal maturity of organic matter. Values of Pr/Ph, Pr/*n*-C_{17} and Ph/*n*-C_{18} are close to each other in both sample sets and are 4.43, 2.92, and 0.49 (on aver.), respectively. This indicates kerogen III and high input of terrestrial biogenic matter deposited in the oxic environment. Trimethylnaphthalene Ratio (TNR5) values, are similar in samples from both mines, ca 0.57, what is also common for kerogen III.

There are distinct differences in organic matter thermal maturity in both parts of the basin, analogous to that seen in the case of Upper Silesia bituminous coal. Average values of Carbon Preference Index (CPI) are 2.56 and 1.13, C_{31} αβ S/(S+R) 0.26 and 0.59 and Ts/(Ts+Tm) 0.46 and 0.91, respectively for the Janina and Marcel samples. The basic difference in maturity is shown in Figure 1 presenting pentacyclic triterpanes distributions in both sample sets. The Janina coal wastes hopanes show such immature features as higher βα hopanes concentrations than αβ hopanes, and hopenes presence. The same trend occurs when average values of thermal maturity ratios based on alkyl aromatic hydrocarbons are compared, Methylphenanthrene

Ratio (MPI3) 0.58 and 0.81, Dimethylnaphthalene Ratio (DNR) 1.41 and 1.82, Trimethylnaphthalene Ratio (TNR2) 0.58 and 0.81, respectively. Steranes were absent in the extracts of coal wastes investigated, as it is often the case in Upper Silesia coals.

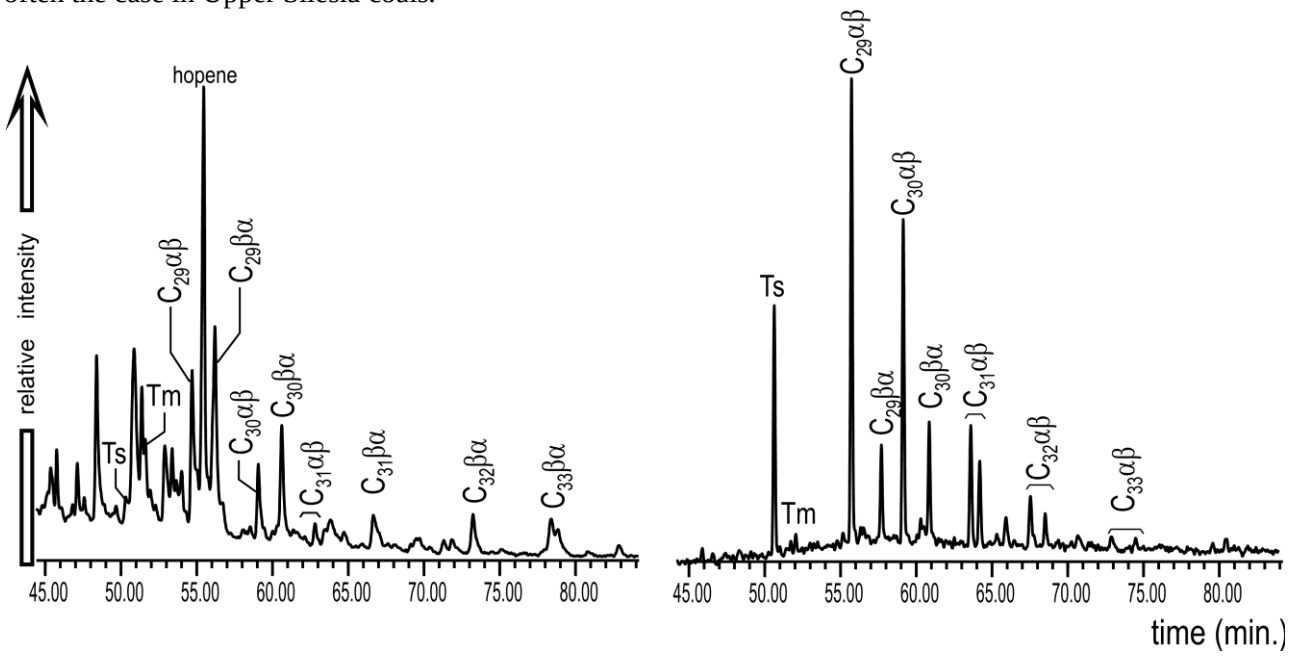

Figure 1. *Comparision of pentacyclic triterpanes distributions in coal waste rocks from a. the Janina Coal Mine (Jan9), b. Marcel Coal Mine (Mac1).*

Conclusions

Coal wastes organic matter shows features of kerogen III deposited in the oxic environment. There is a distinct difference in thermal maturity between the eastern part of Upper Silesia Coal Basin represented by the Janina and the western part represented by the Marcel coal wastes. In the eastern region organic matter has reached the beginning of catagenesis whereas in the western Rybnik region organic matter is much more mature reaching the advanced catagenesis stage at least.

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