

## THE INFLUENCE OF A COAL-SEAM FIRE ON OVERLYING ROCKS ASSESSED BY GC-MS - A CASE STUDY FROM THE JASTRZĘBIE COAL MINE (POLAND)

M.J. Fabiańska<sup>1</sup>, J. Ciesielczuk<sup>1</sup>, D. Jura<sup>1</sup>, M. Misz-Kennan<sup>1</sup>, A. Matuszewska<sup>1</sup>

<sup>1</sup> University of Silesia, Poland

### Introduction

Variably-coloured rocks, red, green or yellow, are preserved below the unconformity at the roof of the Carboniferous sediments of the Upper Silesian Coal Basin (USCB), Poland. Rocks overlying coal seams which are reduced in thickness, occur locally in the south-western part of the USCB. Macroscopic descriptions of these rocks indicate weathering changes and/or thermal transformations the origin of which is not clear. These rocks may have been formed at the contact of an igneous intrusion or as the result of coal fire. In the Carboniferous sediments of the preserved structure, the chemical changes occur both in the bituminous coal and barren rocks. Various types and irregular geometries of weathered and thermally-altered rocks are recognized in the mining areas in the belt stretching from the vicinity of the Rybnik town to the Karviná region, Czech Republic (Jura, 2011; Probierz et al. 2012). Strongly-altered, variably-coloured breccias occur above thinning or vanishing coal seams. The coal there is grey-black, dull, heavily cracked, brittle without a banded structure. Coal-bearing rocks changed by oxidation and thermally transformed are characterized by increased fracturing, porosity and reduction of physical and mechanical properties (Gabzdyl & Probierz, 1987).

Rocks of two types (1) red-orange in colour (6 samples) and (2) dark-grey with red streaks or patches (8 samples) were collected from the operating Jastrzębie Coal Mine. The aim of the research was to characterize changes in organic matter caused by heating and, if possible, to determine whether it was caused by coal seam fire or a magmatic intrusion. Extraction with dichloromethane was conducted in a Dionex 350 extractor. Extracts were analyzed by an Agilent gas chromatograph 7890A with a HP-5 column coupled with an Agilent Technology mass spectrometer 5975C XL MDS. The mass spectrometer was operated in the EI ionization mode (70 eV, full scan) and scanned from 50 to 650 Da. Compounds were identified by their mass spectra, standard retention times, interpretation of MS fragmentation patterns and literature data. Ratio values were calculated using manually integrated peak areas.

### Results

Extraction yields were from 0.0008 to 0.0580 % (wt), with 10 times higher extractability shown by the (2) sample set. Extracts contained a wide range of biomarkers and aromatic hydrocarbons such as *n*-alkanes, acyclic isoprenoids (pristane and phytane), steranes, tri-, and pentacyclic triterpanes. Aromatic hydrocarbons together with their aliphatic derivatives comprised compounds from naphthalene to 5-ring PAHs. *n*-Alkanes, in the range from *n*-C<sub>15</sub>-*n*-C<sub>33</sub>, showed a monomodal Gaussian type of distribution with a smooth outline for reddish samples (1) and a bimodal distribution type for grey samples (2). The same differences in both sample sets are seen for Pr/Ph values which are 3 times lower for reddish samples, 0.52 on average, but for grey samples they reach values typical for the Carboniferous USCB bituminous coals, i.e., 2.02 (Fabiańska et al., 2013). Results for *n*-alkanes and acyclic isoprenoids seems to indicate more advanced thermal changes in the first sample set, but it is

not the case when pentacyclic triterpanes distributions are compared. These latter compounds are almost absent in the second set, possibly destroyed by heat, whereas they occur in all reddish rocks. The same trend is seen in the case of steranes. It is noting that values of sterane- and pentacyclic triterpane ratios were not affected by heat, except for the decreased values for  $Ts/(Ts+Tm)$ . This feature was previously found in gangue rocks subjected to self-heating in landfills (Nádudvari and Fabiańska, 2016). Values of other pentacyclic triterpane ratios correspond to those found in Upper Silesian coals (Fabiańska et al., 2013). The distribution of steranes present in a small number of extracts is dominated by cholestanes ( $C_{27}$ ) that comprise ca 30-40% (rel.). This indicates a deltaic/open sea depositional environment rather than a coal swamp; these samples differ from USCB coals. Most of lighter aromatic hydrocarbons such as alkyl naphthalenes and alkyl biphenyls were removed, possibly due to heating. In some of the extracts, heavier phenyl derivatives were identified.

## Conclusions

The organic geochemistry and petrography of gangue rocks overlying a Carboniferous coal seam have allowed to recognize the nature of changes in the organic matter of these sediments to be recognized. Organic matter of thermally-affected rocks shows features of low-temperature pyrolysates, e.g., a Gaussian distribution of *n*-alkanes, lowered values of Pr/Ph, the presence of phenol derivatives, and the destruction of less thermally-resistant compounds. The absence of *n*-alkenes in all extracts investigated may indicate that hydrogenation of double bonds has occurred after heat impact. This would indicate indigenous fire of a coal- or peat seam as the source of heat within the deposit rather than a magmatic intrusion into compacted rocks.

**Acknowledgements:** The project has been financed from the funds of the National Science Centre, Poland, project No 2016/21/B/ST10/02293 and the Leading National Research Centre (KNOW) received by the Centre for Polar Studies for the period 2014-2018.

## References

- Fabiańska, M.J., Ćmiel, S.R., Misz-Kennan, M. 2013. Biomarkers and aromatic hydrocarbons in bituminous coals of Upper Silesian Coal Basin: Example from 405 coal seam of the Zaleskie Beds (Poland). *International Journal of Coal Geology* 107, 96–111.
- Gabzdyl, W., Probierz, K. 1987. The occurrence of anthracites in the area characterised by low rank coals in the Upper Silesian Coal Basin of Poland. *International Journal of Coal Geology* 7, 209-225.
- Jura, D. 2011. Zwięzta i termicznie zmienione osady Górnego Zagłębia Węglowego. *Documenta Geonica* 2011/1, 107-111(in Polish).
- Nádudvari, Á., Fabiańska, M. J. 2016. The impact of water-washing, biodegradation and self-heating processes on coal waste dumps in the Rybnik Industrial Region (Poland). *International Journal of Coal Geology*, 154-155, 286-299.
- Probierz, K., Marcisz, M., Sobolewski, A. 2012. Od torfu do węgla koksowych monokliny Zofiówki w obszarze Jastrzębia (południowo-zachodnia część Górnośląskiego Zagłębia Węglowego. *Wydawnictwo Instytutu Chemicznej Przeróbki Węgla*, pp. 285 (in Polish).