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Petrographic characteristics of lignite gasification chars

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ABSTRACT

The article presents the petrographic characteristics of lignite subjected to fluidized bed gasification and the residues after the process. The gasifying agents were air, oxygen and carbon dioxide. The petrographic composition of the lignite is dominated by huminite group, with 81.7 vol% share, the inertinite group is 3.6 vol%, while the liptinite group amounts to 7.0 vol%. The mineral matter in the tested samples is 7.7 vol%. The gasification temperature was in the range of 850–950 °C. Therefore, the study focused mainly on the pyrolysis of coal. The dominant particles in the residues after the gasification process include inertoid (35.5 vol%) and crassinetwork (31.6 vol%). The total amount of char with different kinds of pores arising as a result of degassing (tenuisphere, crassisphere, tenuinetwork, crassinetwork, and mixed porous) is 52.3 vol% of all components. The macerals from inertinite group do not change form during the gasification process. The particles with thicker walls (crassinetwork and intertoids) represent approximately 70 vol%, are dominant. Such char composition is related to the chemical structure of coal. During gasification process, the macerals from liptinite group - such as resinite - release carboxyl groups, increased porosity and swelling. A similar phenomenon is observed in the case of textinite. Macerals of low porosity, mainly ulminite, do not substantially increase their porosity and take the inertoid form. Mineroids represent about 8 vol% of char, but the mineral matter is also associated with coal particles. Taking into account the efficiency of gasification process, it should be noted that only a small percentage (<2 vol%) of coal remained unchanged after the gasification in fluidized bed gasifier.

1. Introduction

A sharp increase of oil and natural gas prices in the years 2005–2006 and temporary interruptions in the supply of natural gas from Russia in 2005 increased concerns about energy security in the European Union. After many years of underestimation, coal came back into favor again due to its three main advantages over oil and gas, i.e.: lower price per unit of energy produced, even geopolitical distribution of resources and a much larger amount of resources. In addition, a renewed focus on coal allowed progress in innovative and more reduced environmental impact technologies using carbon (clean coal technologies - CCT). Full implementation of CCT will open new opportunities, which could strengthen the position of this raw material in the market, especially as coal is cheaper than oil and gas. However, the competitiveness of coal to oil and gas is dependent on the efforts aimed at increasing the global resource base. This can be done by: developing and implementing the improved technologies of exploration and identification of coal deposits, improvements to existing underground and opencast coal mining and increased research on non-conventional coal use, such as underground gasification of coal or the use of coalbed methane (Kavalov and Peteves, 2007).

The world's lignite resources are around 1025 billion tones (GT) (WCA, 2015). What is more, additional 207 GT of reserves should be taken into account. The production of lignite in 2013 amounted to 951 Mt (WCA, 2015). Currently, the largest producer of lignite is Germany (WCA, 2015). An increase in lignite production is occurring in India, Indonesia and Turkey. In recent years, the global production of lignite is stable with an increase from 0 to 2% per year. If this trend continues, it can be expected that the global reserves will be used by 2100 (EWG, 2007). Therefore, it can be concluded that lignite – as the energy source – is the foundation of energy security for many countries. No other primary energy source offers such reliable availability in the coming decades than lignite. At the same time, it is noted that both bituminous coal and lignite and their processing products are widely used in major industries. Therefore, more research on the so-called unconventional use of coal, such as underground coal gasification (UCG/Carbon Capture and Storage (CCS)), liquefaction (CTL/CCS) and coal gasification (CTG) - with particular emphasis on CCS and recovery of methane from coal seams - is needed.

The most promising is the fluidized bed gasification (FBG), which is a key technology for the production of energy from coal while taking care

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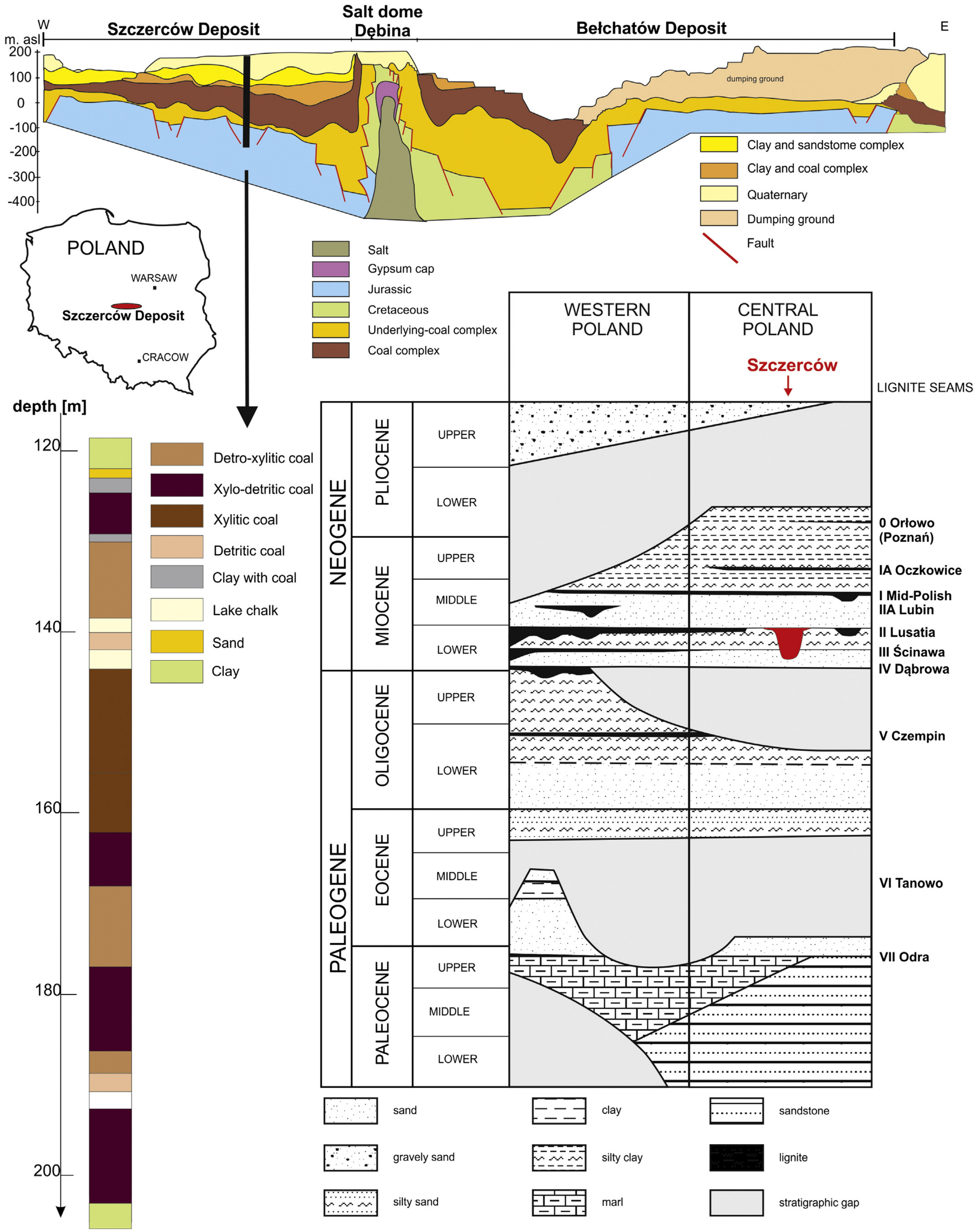

Fig. 1. Cross section through the Szczerców deposit with Paleogene and Neogene stratigraphic columns in the Polish Lowland. According to Kasiński et al. (2010) and Czarnecki et al. (1992), modified.

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