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PETROGRAPHY OF THE HELVETIAN LIGNITE FROM THE CHUKUROVO BASIN, BULGARIA

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ABSTRACT

The complicated coal seam (complex) in the south part of the Chukurovo basin was sampled and 25 samples were taken. Polished block samples were prepared and the petrographic composition of the coal was established. There were found macerals from the three maceral groups. Macerals from the Huminite group were textinite, texto-ulminite, eu-ulminite, attrinite, densinite, phlobaphinite, and psudo-phlobaphinite. The following liptinite macerals were observed: cutinite, sporinite, resinite, suberinite, alginite, liptodetrinite, and chlorophillinite (?). Fusinite, sclerotinite, and inertodetrinite presented the inertinite macerals. Their amount was very vow. Minerals found with reflected light were clay minerals, pyrite (euhedral, framboidal and massive) and epigenetic calcite. The peat bog was determined as wet forest bog according the maceral composition. According to the calculated indices of the coal facies (Groundwater Influence Index and Vegetation Index), the type of the peat bog was determined as "limnitic ombrotrophic bog forest". The Tissue Preservation Index (TPI) and Gelification Index (GI) was determined peat bog as "forested peatland", where the water level was increasing continuously or in a forested, continuously wet raised bog. On the basis of the huminite reflectance, the coal was determinate as "Lignite".

Key words: lignite, macerals, indices of the coal facies, type of peat bog, Chukurovo basin.

INTRODUCTION

The Chukurovo lignite basin is located 40km southeast from the city of Sofia. It is situated in the central part of the Sofia coal province. The coal-bearing sediments have Helvetian age Паламарев (1964). They are separated by Бл. Каменов as a *Formation of the clay sandstones and shale with the Chukurovo coal seam* (Кацков, Илиев, 1993). It is composed by shale, sand shale, sandstone layers and coal seams, which number is 12 to 18. Кацков, Илиев (1993), published data that all coal layers make one complicated coal seam thick up to 40 m. The coal-bearing sediments fill Chukurovo graben, which has Northwest-Southeast orientation. They are low banded. The underlying rocks of the basin are diabase phillitoide complex (DFK) with Middle Triassic (Pancharevska formation) and Middle-Upper Jurassic (Ginska formation) (Кацков, Илиев, 1993).

Petrographic investigations of the coal were done by Плачков, Стойнова (1961), Минчев (1963) and Константинова (1969). The main purpose of the study is to determine the maceral composition of the lignite from the complicated coal seam (complex) in the south part of the basin and to update the data for the Liptinite macerals, using fluorescent light. On the basis of the present investigations were calculated the indices of the coal facies and the type of the peat bog, where the plant tissue were accumulated.

METHODS

The complicated coal seam in the South part of the basin was sampled. Twenty polished block samples were studied with a microscope "Leica" with reflected light (λ=546 nm), fluorescent light, and a computer program "Leica mpv_meas". Oil immersion objectives 50x/0.85 and 100x/0.25 were used also. Automatic counter "Prior-G" was used for the counting of the macerals. For determination of maceral percentage four hundred macerals were counted and 50 points for vitrinite reflectance were measured of each sample. Yttrium-alluminium-granat with reflectance 0.899% was used for a standard for determination of the vitrinite reflectance.

RESULTS AND DISCUSSION

Average huminite reflectance was measured as Ro=0.23%, Rmin=0.18%, Rmax=0.25% with standard deviation ±0.0204. According to the huminite reflectance the coal was determined as Lignite.

Macerals from the Huminite group. All amounts of these macerals are 82.23% and 84.82% from the organic matter (Table 1). The macerals from the *subgroup Humotellinite* are prevailing in the studied coal. Textinite is observed as bands and lenses. It associates with the ulminite, attrinite and densinite. Clay minerals, resinite (Fig. 2b) and phlobaphinite fill the textinite lumens. The textinite amount is relatively high (Table 1). The two maceral types present the ulminite. Its amount is highest in the coal (Table 1). The maceral type texto-ulminite is prevailing significantly. It builds thick bands. The texto-ulminite lumens are filled with clay minerals (Fig. 1d) and phlobaphinite (Fig. 1a) or resinite (Fig. 2a). The texto-ulminite associates with eu-ulminite, textinite, attrinite and densinite. The eu-ulminite significantly presents in the samples. It is like bands, which alternates with the texto-

ulminite and textinite. These bands make wood annual circles. That maceral is observed as lenses with different sizes also. Resinite (Fig. 2d) and rarely phlobaphinite fills the lumens of the eu-ulminite.

Table 1. Petrographic composition of the Chukurovo lignite.

Macerals	Content,%	Content in organic matter, %
Huminite *group*	82.23	84.82
Textinite	15.50	
Texto-ulminite	31.30	
Eu-ulminite	20.24	
Attrinite	8.33	
Densinite	1.8	
Phlobaphinite	4.79	
pseudo-phlobaphinite	0.27	
Liptinite group:	14.44	14.90
Cutinite	0.13	
Sporinite	0.13	
Resinite	10.38	
Suberinite	1.86	
Alginite	0.13	
Liptodetrinite	1.6	
Chlorophillinite	0.01	
Inertinite group:	0.27	0.28
Fusinite	0.01	
Sclerotinite	0.13	
Inertodetrinite	0.13	
Minerals:	3.06	
pyrite	0.13	
epigenetic calcite	0.53	
clay minerals	2.4	

The amount of the macerals from the *subgroup Humodetrinite* is relatively lows (Table 1). The attrinite is prevailing, as the densinite amount is insignificant (Table 1). These macerals in association with clay minerals consolidate all other macerals (Fig. 1c,e; 2c,f).

Subgroup Humocollinite is presented only by the maceral corpohuminite. The phlobaphinite is prevailed maceral type of the corpohuminite (Table 1). It fills the ulminite lumens (Fig. 1a) and rarely of the textinite. The second maceral type – pseudo-phlobaphinite associates with attrinite and densinite (Fig. 1c). The shape of the both maceral types is oval or circle and they have low relief (Fig. 1a, c).

According to Кортенски et al. (2001), the amount of the macerals from the *Huminite group* increases in the central part of the basin.

Macerals from the Liptinite group. The amount of the macerals from this group, with an exemption of the resinite, is low (Table 1). The cutinite has the lowest amount (Table 1). It was observed as well-shaped and preserved bodies (Fig. 2e) or as single particles with different sizes. Cutinite associates with attrinite and densinite. The sporinite is rarely observed (Table 1) and it is presented mainly from miosporinite. It is probably pollen relicts. The sporinite associates with attrinite, densinite, liptodetrinite (Fig. 2c), sometimes with suberinite (Fig. 2f) and cutinite. The suberinite is frequently observed maceral, which is typical for the coal from Sofia province (Кортенски, 1993), but its amount is low in the studied coal. It was observed as well shaped bands with good structure (Fig. 2b), or bed preserved bands (Fig. 2f) or particles with different sizes (Fig. 2e). It associates with the other Liptinite macerals, attrinite, densinite, textinite and ulminite. The resinite is most spread Liptinite maceral (Table 1) and it is a sign for participation of Conifer plants at the time of peat accumulation. It was observed as spherical, oval or long bodies mainly into the textinite (Fig. 1b), texto-ulminite (Fig. 1a; 2a) and eu-ulminite (Fig. 2d) lumens. The resinite has more weak fluorescent color than the detrial resinite, which was observed also into the studied coal. It is like single bodies among the attrinite and densinite (Fig. 1c) and with associations with other Liptinite macerals. The alginite amount is insignificant (Table 1), which is typical for the forested swamps (Stach et al., 1982). It was observed as small lenses-shaped bodies among attrinite with an association with sporinite and liptodetrinite (Fig. 2c). The liptodetrinite is from 1 to 2.5% in the samples. It associates with the other Liptinite macerals, mainly sporinite and attrinite (Fig. 2c). The maceral chlorophillinite is determined, using fluorescent light. It is like small bloody-reds bodies into the Lipten bands with low Huminite reflectance (Ro=0.21%). It associates with cutinite

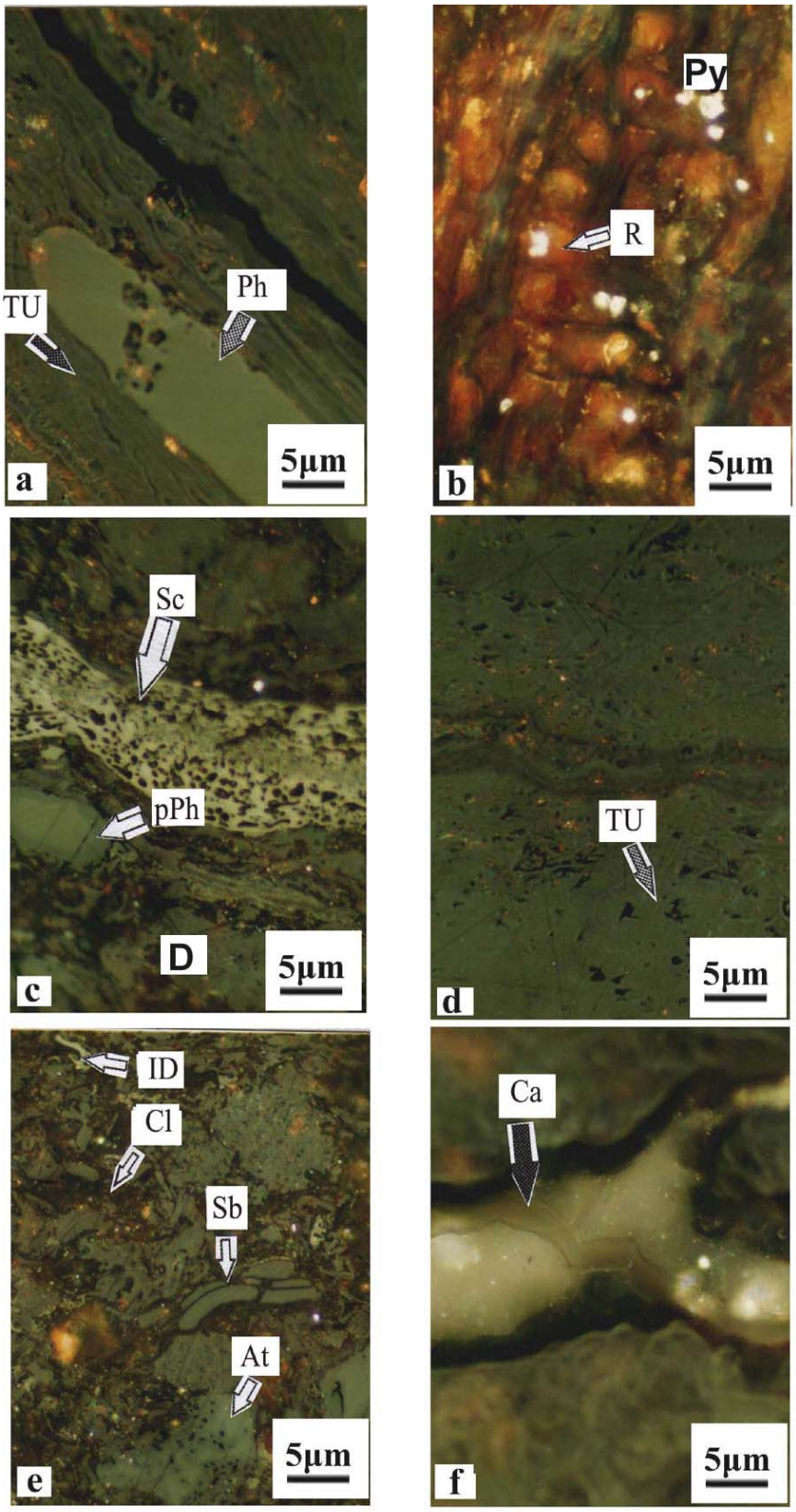

Figure 1 Petrographic composition of the lignite from the Chukurovo basin, reflected light, oil immersion: a)Texto-ulminite, phlobaphinite (Ph); b) Resinite (R) into textinite; c) Sclerotinite (Sc)-plectenhiminite, pseudo-phlobaphinite (pPh), densinite (D); d) Texto-ulminite (TU); e) Inertodetrinite (ID), clay minerals (Sh), suberinite (SB), attrinite (At); f) Epigenetic calcite (Cc).

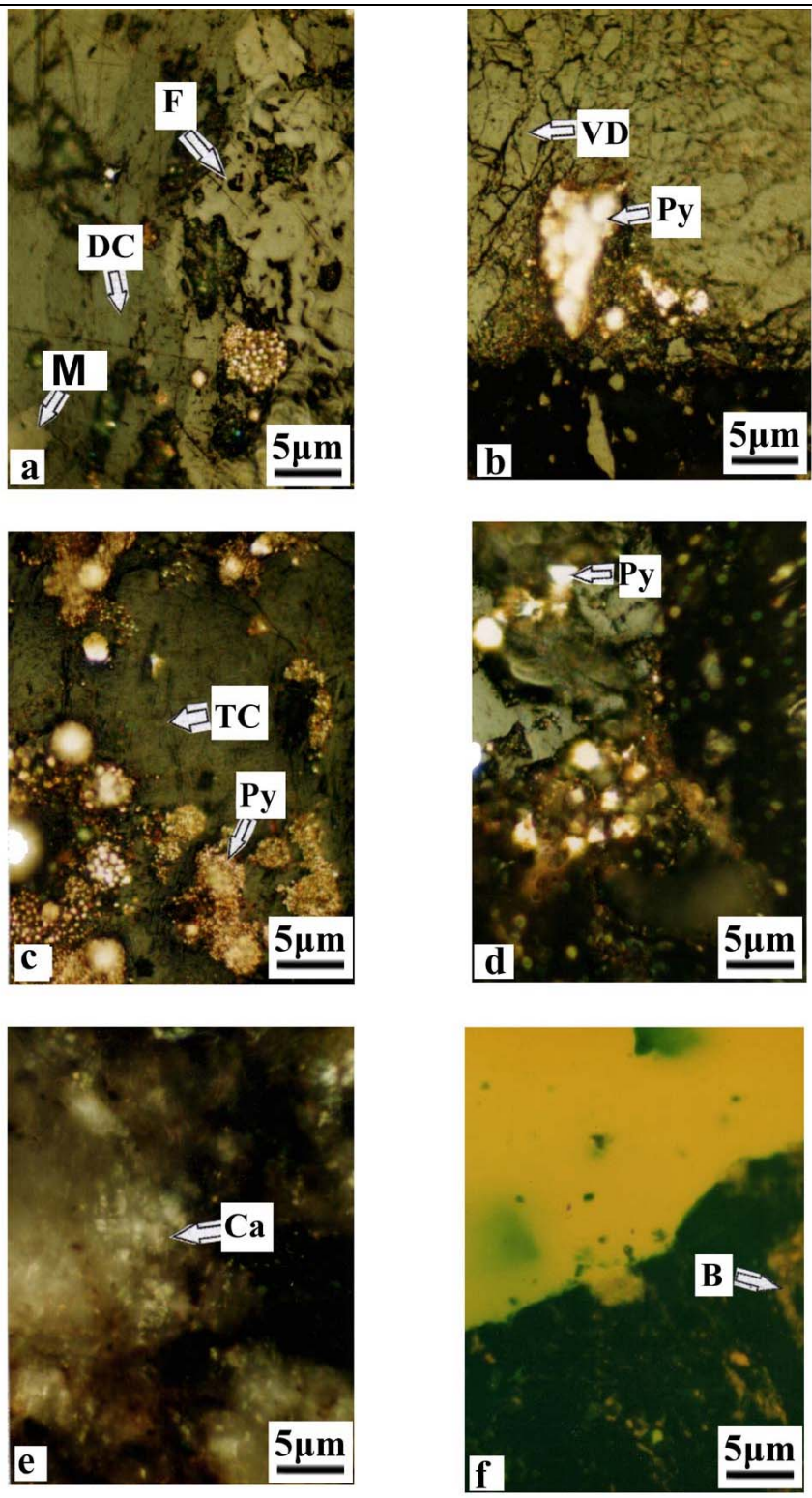

Figure 2 Petrographic composition of the lignite from the Chukurovo basin, fluorescent light, oil immersion: a) Resinite (R) into texto-ulminite; b) Suberinite (Sb); c) Alginite (A), liptodetrinite (LD), sporinite (S), attrinite (At); d) Resinite (R) into eu-ulminite; e) Cutinite (C), chlorophillinite (?) (Ch) attrinite (At); f) Suberinite (Sb), sporinite (S), attrinite (At).

(Fig. 2e). Taylor et al. (1998) wrote that the chlorophillinite is relicts from chlorophill around the cutinite bodies.

The color of the most studied Liptinite macerals is yellow with different intensity (Fig. 2) or orange, because of the low rank of coalification of the coal (Taylor et al., 1998). Only the

chlorophillinite has bloody-red color. The Liptinite macerals have similar surface distribution as the Huminite macerals and their amount increases toward the central part of the basin (Кортенски et al., 2001).

Macerals from the Inertinite group. The amount of the Inertinite macerals in the studied coal is lowest, moreover it is below 1% (Table 1). The fusinite has lowest content (Table 1). It is highly destroyed and it was observed as small particles among the attrinite. The fusinite associates with the inertodetrinite. The sclerotinite is presented mainly by plectenhiminite, which was observed as relatively large bodies among the attrinite (Fig. 1c). It was established also one-cell and two-cell fungi-sclerotinite. The inertodetrinite particles associate mainly with attrinite (Fig. 1e) or fusinite. The Inertinite macerals increase their amount toward the periphery of the basin (Кортенски et al., 2001).

Minerals

Clay minerals. They fill the lumens of the textinite, texto-ulminite and fusinite and create small lenses or associate with attrinite (Fig. 1e).

Pyrite. Its amount is low. It is fine-grained and it is presented from framboidal, euhedral and massive pyrite. They were observed as single grains among the attrinite and densinite (Fig. 1c, e). Sometimes pyrite was observed into the lumens of the textinite (Fig. 1b), texto-ulminite (Fig. 1d) or fusinite.

Epigenetic calcite. It was established into single cracks (Fig. 1f). Its amount is low (Table 1).

Indices of the coal facies

On the basis of the petrographic composition the indices of the coal facies were determined. The maceral percentages, calculated on the basis of all matter were used.

Groundwater Influence Index (GWI) by Calder et al. (1991):

GWI=gelinite+corpohuminite+mineral matter / textinite+ ulminite +densinite=0.1

Vegetation Index (VI) by Calder et al. (1991):

VI = textinite+ulminite+fusinite+suberinite+resinite / densinite +inertodetrinite+alginate+liptodetrinite+sporinite+cutinite=22.35

According to these two indices, the type of the peat bog was determined as "limnitic ombrotrophic forested swamp". Calder et al. (1991) determined the conditions of this type as low groundwater supplying and higher acidity.

Tissue Preservation Index (TPI) by Diessel (1992):

TPI = textinite+ulminite+fusinite / densinite+macrinite+ inertodetrinite=78.76

Gelification Index (GI) by Diessel (1992):

GI=huminite +macrinite / fusinite+inertodetrinite=634.15

According these two indices, the origin of the peat bog was determined in a forested peatland or forested swamp with continuing increasing of the water level. According to Diessel (1992), the plant tissue was suffered of intermittently humification and strong gelification.

CONCLUSION

The Chukurovo lignite is characterized with high content of Huminite macerals and low content of Inertinite macerals. The high amount of textinite and ulminite is a result of accumulation of wood plants and well preservation of the plant tissue. They are low disintegrated and because of this reason the contents of attrinite and densinite is low. The presence of suberinite in the studied coal is related with wood plants and one part of them was coniferous, which is seen from the high content of resinite. According the maceral content, the Chukurovo lignite is located into group C (subgroup C_1), divided by Шишков (1988) with accordance of the type of the coal-generated paleobiotypes. According to the maceral composition, the peat generation was developed in a typical forest swamp. It had been continuously wet, and because of that reason the Inertinite macerals are not many. There were established low contents of minerals – clastic (clay minerals) and singenetic (pyrite). The epigenetic calcite is accumulated into fractures of the coal seam. The calculated indices of the coal facies prove the conclusion for typical forested swamp. The values of Groundwater Index and the Vegetation Index determine the peat bog as limnetic ombrotrophic forested swamp. According to the Tissue preservation Index and Gelification Index the origin of the peat bog was in a continuously wet forested peatland or swamp.

The petrographic composition of the Chukurovo lignite is similar to the coal from Sofia province and they are characterized with high contents of textinite and ulminite, presence of corpohuminite and suberinite, relatively high content of resinite and low content of Inertinite macerals (Кортенски, 1993). But the maceral percentages are different for the Sofia coal. The Chukurovo coal is different than the Sofia province coal, because of the low amount of attrinite, densinite and fusinite and the presence of chlorophillinite. Some conditions of peat forming were different also and especially it relates for the Sofia basin after Kortenski and Sotirov (2001).

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