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QUALITATIVE CHARACTERISTICS OF THE COAL DEPOSIT KOTEZI IN THE BUGOJNO BASIN

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SUMMARY

This paper presents study results of the qualitative characteristics of coal deposit Kotezi. Regional geological researches were conducted from 1983 to 1987, and detailed from 2014 to the end of 2018.

Tests were performed on the following coal quality parameters: average thickness of pure coal in coal layers, total moisture content, ash content, total sulfur content and lower heat value. Researches were conducted in the field, laboratory and cabinet. Subsequently, an analysis and interpretation of the obtained research results was carried out. Comparing the research geological results of all represented coal layers, deviations of the considered parameters were determined.

Coals of the Bugojno basin belong to the younger coals, soft to medium hard, no luster (matt), brown to black colored, and have brown streak. Their fracture is plate-like and particleboard. They do not have a distinct lignite structure, except in the lower layers. With their general habitus, they resemble younger brown coals, and belong to humic coals which are relatively low in carbonation. In the vertical profile of coal layers, the highest quality components are from the upper part of the layer, while the slightly lower quality components are from the middle and lower parts of the layer.

Key words: *coal quality, Kotezi, geological researches, qualitative parameters, coal layers*

INTRODUCTION

Coal deposit Kotezi is located in the northwestern part of the coal basin Bugojno (Figure 1). Western boundary of the deposit is represented by peripheral parts of the settlements Poriče, hamlet Miličevići and settlement Ždralovići. Settlements Potkraj and Prusac are in the northwest. Settlements Fakići and Guvna, as well as hamlets Grabovci and Krčevine are all located on the north.

On the south the peripheral parts are settlements Karadže and Gaj Berića, while the eastern border is represented by the settlements Milanovići and Udurlije and the hamlet Orčevići. In the central part of the productive area are settlements Gornji and Donji Kotezi. The deposit is about 5 km long along the longer axis, and about 3 km along the shorter axis [1].

Geological structure of the deposit is represented by the Middle to Upper Miocene sediments, undissected Pliocene-Quaternary sediments and Quaternary formations [2,3,4,5,6,7,8,9,10,11,12,13]. There are four coal layers in the lithostratigraphic column: roof, main, the first and the second bottom layers. [14,15,16], (Figure 2).

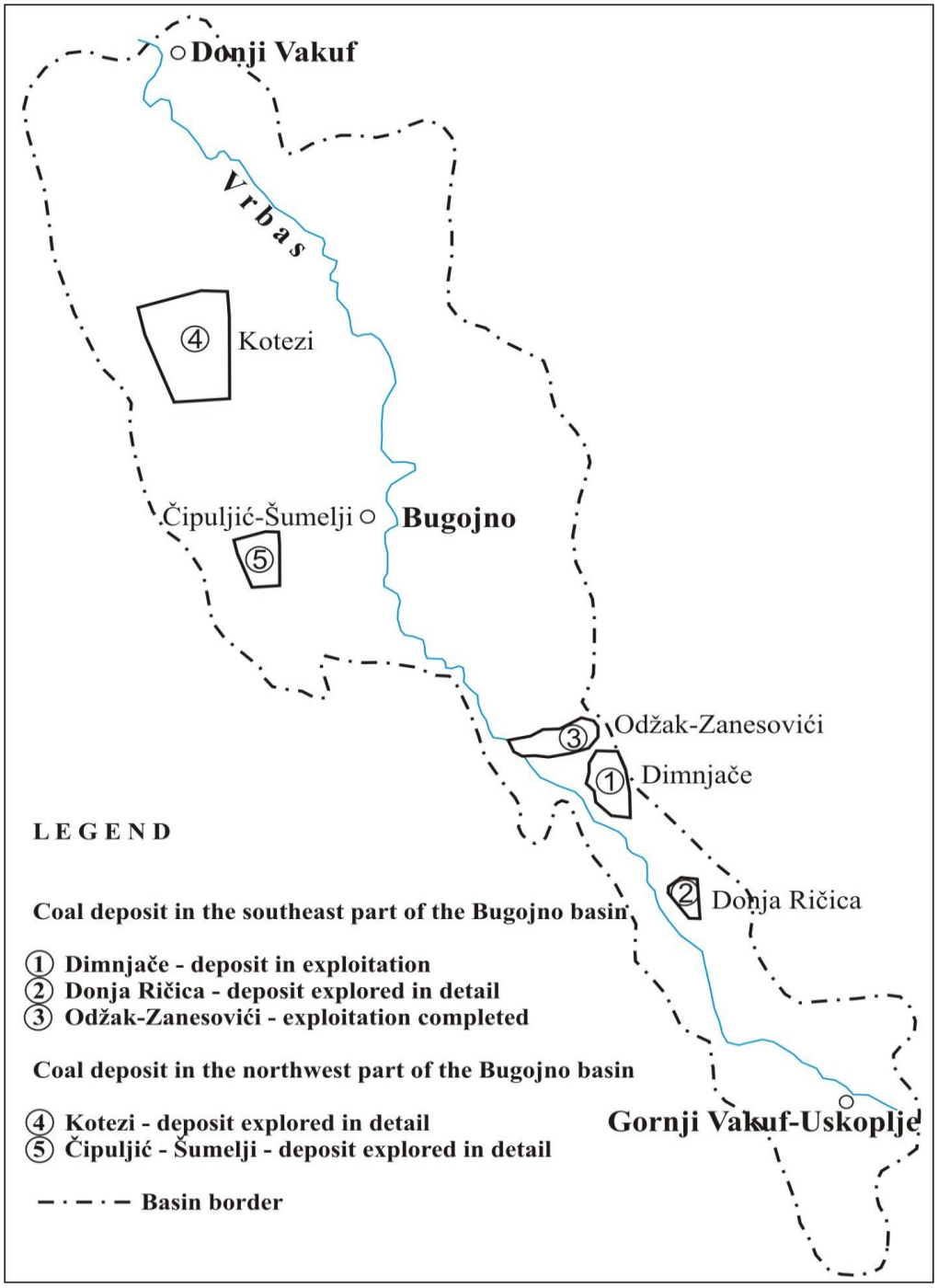

Figure 1. Distribution of the coal deposit in the Bugojno basin (Forčaković Dž.).

In the phase of regional geological research 11124.03 m 'of coal-bearing sediments were drilled and five geological open pits were excavated, while in the phase of detailed geological research 19598.3 m' were drilled and 11 geological oen pits were realized, Table 1, [14,16].

RESEARCH METHODS

Based on the results obtained by boreholes testing and immediate analyzes, through a comparison of primary characteristics (such as median thickness of pure coal, total moisture content, ash content, total sulfur content and lower calorific value), the analysis of qualitative characteristics of coal layers at the Kotezi deposit was performed. [17,18,19]. The reason for that is certainly consideration and

planning of future geological research of the roof and bottom coal layers, in order to increase the degree of geological research and balance the coal reserves to the level of C_1 category.

Table 1. The scope of research geological works and immediate coal analyzes

Coal layers	Geological research phases	Number of tested boreholes (kom)	Number of immediate analyzes (piece)	Geological open pit (piece)
Roof	Regional	1	3	-
Main	Regional	26	151	-
	Detailed	133	610	1
I bottom	Regional	16	16	-
	Detailed	4	4	-
II bottom	Regional	5	7	-
	Detailed	2	2	-
Total:		187	790	1

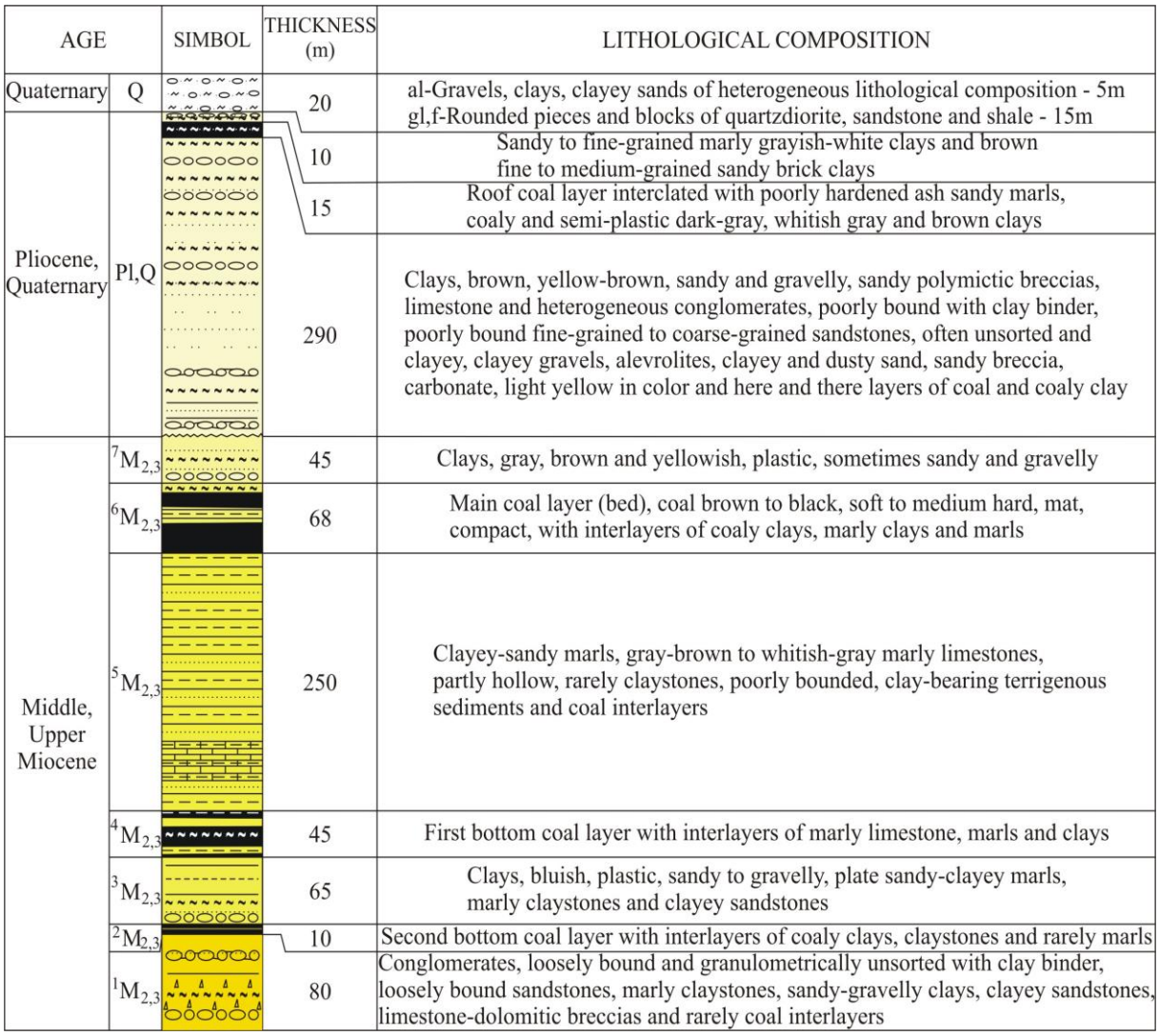

Figure 2. Geological column of the coal deposit Kotezi
(According to Džonlagić Dž., complemented by Forčaković Dž.)

For the purpose of research were applied: exploratory drilling, geodetic works, geological mapping of the boreholes cores, laboratory testing of the boreholes cores and cabinet work. [16,20].

Exploratory drilling was performed with core drilling rigs along the entire borehole with mandatory core removal. A total of 30,722.33 meters of core material was drilled and 16 geological open pits were excavated. The linear percentage of cores in the accompanying coal sediments was over 90%, and between 95% and 100% in the coal layer (drilling interval was not longer than 3 meters).

Detailed mapping of the boreholes cores was performed in the field. Field determination included a macroscopic description of the structural-lithological characteristics of drilled sediments. Special attention is paid to the appearance of special types of sediments (liquid sands, silty materials) due to their extremely unfavorable physical and mechanical characteristics.

The thinnest interlayers of such sediments were also registered, due to their influence on the slopes stability of the future surface mine. Special attention in determining the core is paid to the degree of rock cracking, which in case of cracking could be hydrogeological aquifers. Detailed recording of coal layers included a description of: coal color, degree of coal lustre, thickness of pure coal, thickness of interlayers in coal and structure of coal layers [14], (Figures 2, 3 and 4).

In parallel with the execution of the projected field geological, drilling and laboratory works, processing and analysis of the collected research rusults was performed. After that, geological column and geological profiles of all represented coal layers were made (Figures 2, 3 and 4).

RESEARCH RESULTS

Determination of qualitative coal characteristics was performed on the basis of field and laboratory tests [16,21]. The results of immediate analyzes served as a basis for the calculation of the average quality of pure tested coal (pure coal is coal containing up to 20 cm of tailings).

Using the aritmetic mean method, the mean content of qualitative parameters was determined according to the influence of the matching thicknesses of the coal layer, Table 2.

Table 2. The average values of the qualitative characteristics of coal deposit Kotezi

Coal layers	Pure coal thickness in the layer (m)	Total moisture (%)	Ash (%)	Total sulfur (%)	Lower calorific value (kJ/kg)
Roof	7,7	30,55	21,33	3,68	11489
Main	22,24	36,04	18,41	2,51	11005
I bottom	5,55	31,56	22,32	3,42	10842
II bottom	4,34	32,79	19,70	3,51	10948

DISCUSSION

Comparing results of the pure coal thickness in the layers, and taking into account the scope of performed works, it was proved that the main coal layer has the highest thickness of pure coal, while the first and second floor coal layers have relatively small deviations. The roof coal layer is slightly thicker than the first coal layer [16].

The highest moisture is contained in the main coal layer. However, with increasing depth percentage of moisture in the bottom layers also increases, but it is significantly lower than the percentage of moisture of the main coal seam. The minimum moisture content was calculated for the roof coal layer.

The main and second floor coal layers contain approximately the same percentage of ash, while the roof and first floor layers have approximately the same percentage.

The roof coal layer contains the highest percentage of sulfur, the first and second bottom layers are approximately the same, while the main coal layer has the lowest sulfur content in the deposit. This is very important from the aspect of coal application in thermal energy. In the current phase of research, the roof coal layer is only isolated in a relatively small area, measuring 1.3 km by strike direction and 1.2 km by the dip of the coal layer, in the area of Berića Gaj (extreme southern part of the Kotezi deposit) [15,20].

Coal quality in the represented coal layers of the deposit Kotezi is very variable, both vertically and laterally. In the vertical profile of main coal layer, the highest quality samples are from the upper part of the layer, where black to black-brown, matte coal is present. Slightly lower quality are samples from the middle, and especially from the lower part of the layer where there is coal with wood laminates and it is more stratified [18]. The highest quality coal is in the eastern and northeastern part of the deposit (Figures 3 and 4), compared to other parts of the deposit, what is probably related to the depth of subsidence and a higher degree of carbonization, Table 3.

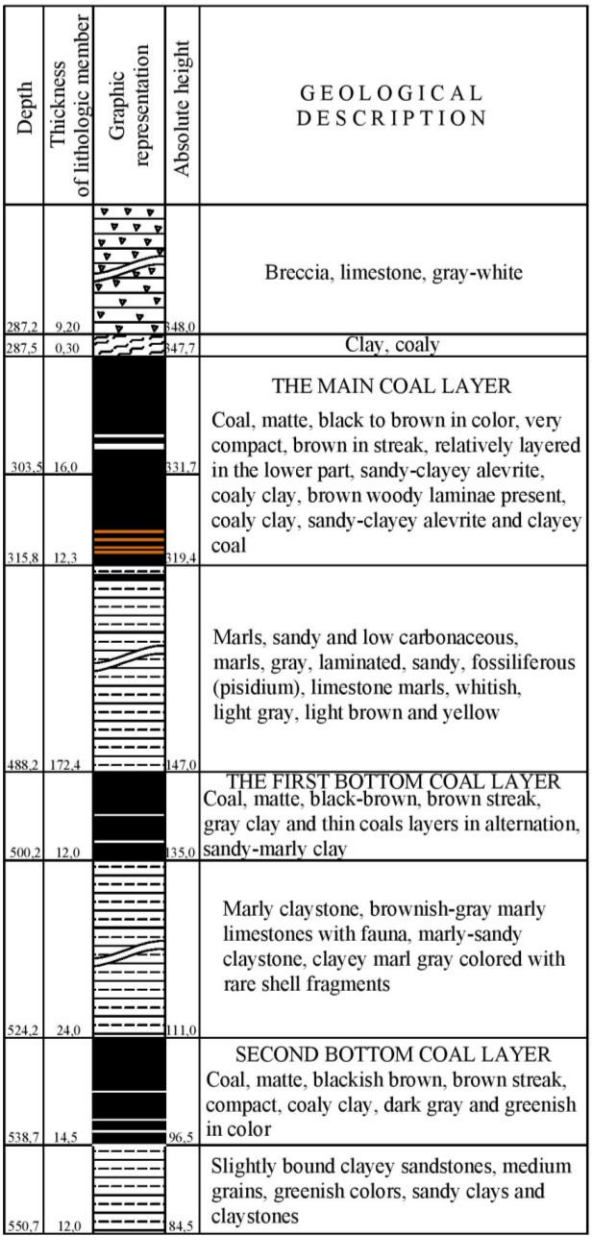

Figure 3. Synthetic detailed geological cross section of coal layers in the northeastern part of the coal deposit Kotezi, (Forčaković Dž.)

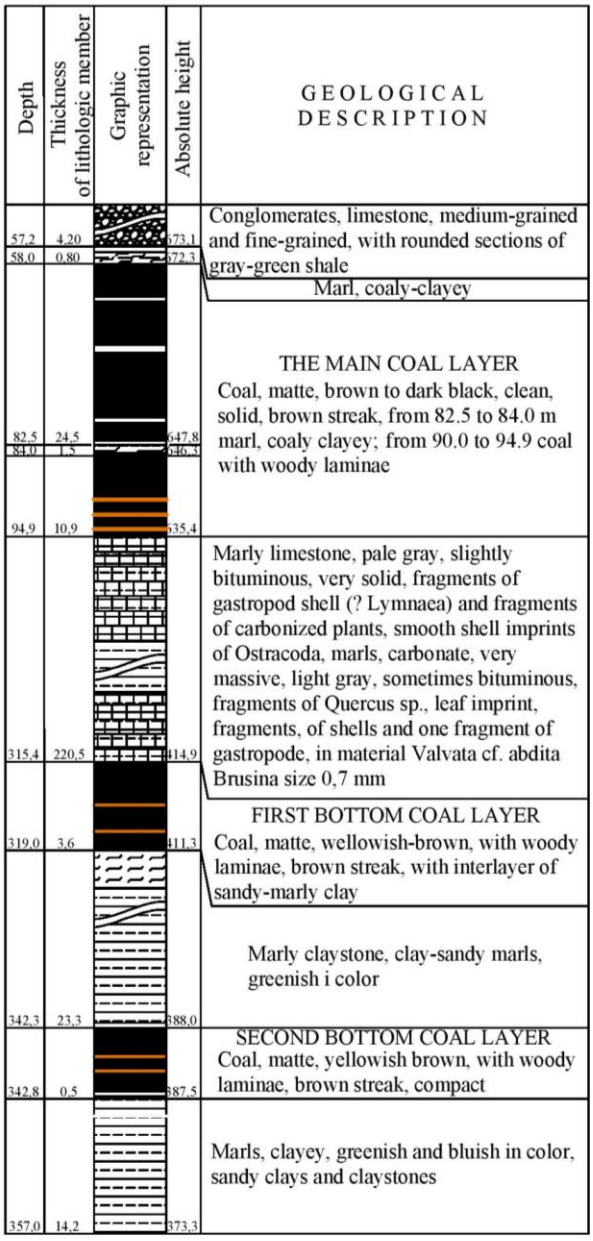

Figure 4. Synthetic detailed geological cross section of coal layers in the eastern part of the coal deposit Kotezi, (Forčaković Dž.)

In terms of lower calorific value, the best quality is coal of the roof and main layer. The roof coal layer has a very low degree of exploration and a small contouring area and has no economic significance for now. The difference between the lower calorific value of the main and first and second bottom coal layers of the Kotezi coal deposit is only 63 kJ/kg, or 57 kJ/kg, which indicates similar parent plant material from which they were formed. [14,16,19].

The first and second bottom coal layers have almost the same lower calorific values. The difference in quality between the roof, main and bottom coal layers is most likely based on the differences of parent plant matter, conditions of its accumulation or the unequal duration of microbiological processes.

Table 3. A comparison of the qualitative characteristics of the Kotezi coal deposit (main coal bed) with other coal deposits in the basin

Coal Deposits in the basin	Thickness of pure coal in the main coal layer (m)	Total moisture (%)	Ash (%)	Total sulfur (%)	Lower calorific value (kJ/kg)
*Kotezi	22,24	36,04	18,41	2,51	11005
*Čipuljić-Šumelji	14,98	36,81	20,49	2,62	9613
**Dimnjače	11,55	32,47	16,09	3,13	11671
**Donja Ričica	7,6	34,90	18,16	2,74	10283

*Deposits located in the northwestern part of the Bugojno basin (Long-term solution – deposits with the greatests economic importance) [15,17,20]

**Deposits located in the southeastern part of the Bugojno basin (Short-term solution – deposits with considerably smaller economic importance) [15,17,20]

The examination determined that the highest percentage of moisture is in the Čipuljić-Šumelji coal deposit. This is followed by the Kotezi and Donja Ričica deposits. The lowest total moisture content was calculated in the coal deposit Dimnjače.

The highest percentage of ash is in the Čipuljić-Šumelji coal deposit. Kotezi and Donja Ričica deposits have approximately the same percentage of ash, while the Dimnjača deposit has the lowest ash percentage.

The highest value of total sulfur is in the deposits of Dimnjača and Donja Ričica, which are located in the southeastern part of the Bugojno basin. Deposits of the northwestern part of the Bugojno basin Kotezi and Čipuljić - Šumelji have approximately the same value.

Calculation determined that the highest value of the lower calorific coal value is at the Dimnjača deposit. However, the exploitation life of this deposit is only six years [20]. Deposit Kotezi, when it comes to its energy value, takes second place. It is very important due to continuity of coal exploitation (on the deposit are proven reserves of about 96 million tons of coal - the deposit with the greatest economic importance in the Bugojno basin) [2,3].

Čipuljić-Šumelji and Donja Ričica deposits have an approximate value of the lower calorific value, and they are economically significant.

The first and second bottom coal layers are continuously present in the entire area of Kotezi deposit, but they are insufficiently explored.

The main coal layer has all the characteristics of relatively good brown lignite coal. It also has the greatest economic significance for the Kotezi deposit, as well as for all explored deposits in the basin. [1,18].

Based on main coal layer reserves of the Kotezi deposit Elektroprivreda BiH d.d. Sarajevo, ZD RU Gračanica d.o.o. Gornji Vakuf-Uskoplje plans to build a new mine as well as a thermal power plant, ie heating plant in the coming period [15,22].

Analyzing the achieved results, it is realistic to expect that in the future geological researches of roof and bottom coal layers will be realized in order to classify and categorize coal reserves to the level of C_1 category and make a decision based on geological and economic assessment whether to conduct detailed geological research or not.

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LITERATURE

[1] Hajdarević, M., Rožnjaković N. (2018). Elaborate on classification, categorisation and calculation of coal reserves in the main coal layer of the deposit Kotezi, municipalities Bugojno and Donji Vakuf. Geoservice Živinice. *[Bosnian language]*

[2] Jovanović, O. (1983). Report on rusults of palynological analysis of coal from borehole B-11 Bugojno basin. Book II. Geological Survey Ilidža. *[Bosnian language]*

[3] Jovanović, O. (1988). Report on palynological tests of coal samples from the area of Bugojno, Gornje Karadže. Geological Survey Ilidža. *[Bosnian language]*

[4] Soklić, I. (2000). Fossil flora and fauna of the Bosnia and Herzegovina, ANU BiH, Sarajevo. *[Bosnian language]*

[5] Čičić, S. (2002). Geological composition and i tectonics of the Bosnia and Herzegovina. Earth science institute. Sarajevo. *[Bosnian language]*

[6] Krstić N., Savić L., Jovanović G., Bodor E. (2003). Lower Miocene lakes of the Balkan Land. Acta Geologica Hungarica, 46.

[7] Harzhauser, M., Mandić O. (2008). Neogene lake systems of Central and South-Eastern Europe: Faunal diversity, gradients and interrelations; Palaeogeography, Palaeoclimatology, Palaeoecology 260.

[8] Neubauer T.A., Mandić O., Harzhauser M., Hrvatović H., (2013). A new Miocene lacustrine mollusc fauna of the Dinaride lake system and its palaeobiogeographic, palaeoecologic and taxonomic implications. Paleontology, Vol. 56, Part 1, London.

[9] Forčaković, Dž., Operta M. (2013). Geological and qualitative-quantitative characteristics of the coal deposit Dimnjače, Municipality Gornji Vakuf-Uskoplje. Proceedings of the V conference of geologists of the Bosnia and Herzegovina with international participation. Pale – Jahorina. *[Bosnian language]*

[10] Operta M., Forčaković Dž., Misilo M. (2013). Geological composition and morphological-tectonical charateristics of the Uskopalje valley. Proceedings of the V conference of geologists of the Bosnia and Herzegovina with international participation. Pale – Jahorina. *[Bosnian language]*

[11] Vrabac, S., Đulović I. (2017). Report on macropaleontological and micropaleontological researches of core samples from boreholes K-40, K-58 i K-45 from revir Kotezi in the Bugojno coal basin. FSD RGGF-a University of Tuzla, Tuzla. *[Bosnian language]*

[12] Vrabac, S., Đulović I. (2018). Report on macropaleontological andi micropaleontological researches of core samples from borehole K-80 from revir Kotezi in the Bugojno coal basin. FSD RGGF-a University of Tuzla. Tuzla. *[Bosnian language]*

[13] Becker, D., Tissier J. (2019). Rhinocerotidae from the early middle Miocene locality Gračanica (Bugojno Basin, Bosnia-Herzegovina). Palaeobiodiversity and Palaeoenvironments.

[14] Džonlagić, Dž., Žugić M. (1983-1987). Final annual report on regional geological researches of coal in the Bugojano basin. Geological Survey - Sarajevo. *[Bosnian language]*

[15] Forčaković, Dž. (2014). Potentiality of coal in deposits of Bugojno basin. Master's thesis. University of Tuzla. *[Bosnian language]*

[16] Forčaković, Dž. (2014-2018). Final report on detailed geological researches of coal in the northwestern part of Bugojno basin. JP EP BiH d.d. Sarajevo, ZD Coal mine Gračanica d.o.o. Gornji Vakuf-Uskoplje. *[Bosnian language]*

[17] Forčaković, Dž. (2012). Analysis of conditions on qualitative-quantitative characteristics of coal deposits in the Bugojno basin, achieved degree of exploration, proposal for replacement capacities and direction for further geological researches. JP EP BiH d.d. Sarajevo, ZD Coal mine Gračanica d.o.o. Gornji Vakuf-Uskoplje. *[Bosnian language]*

[18] Jovović M., Jovović N. (2015-2018). Report on petrographic qualitative-quantitative maceral an microlithotypes analysis of coal samples from locality Kotezi near Bugojna. Geo-Minis Beograd. *[Serbian language]*

[19] Pantić, N., Nikolić, P. (1973). Coal. Scientific book. Beograd. *[Serbian language]*

[20] Forčaković, Dž. (2018). Information on achieved research degree of the wider area of Koteza and further directions in opening of surface mine Kotezi. JP EP BiH d.d. Sarajevo, ZD Coal mine Gračanica d.o.o. Gornji Vakuf-Uskoplje. *[Bosnian language]*
[21] Zaimović, M. (2014-2018). Report on laboratory testing. RGH-Inspekt. Sarajevo. *[Bosnian language]*
[22] Moranjkić, I. (2006). Feasibility study of mine and termal power plant Bugojno construction, with reconstruction of the mine Gračanica. Mining institute Tuzla. *[Bosnian language]*