QUALITATIVE COAL FEATURES FROM DEPOSIT NEGOTINO, R. MACEDONIA

Milica Nikolova[1], Orce Spasovski[1]

Faculty of Natural and Technical Sciences University "Goce Delchev" – Stip
orce.spasovski@ugd.edu.mk

Abstract
The study will show quantitative features of the latest researches performed on samples of coal from the site Negotino. In the area of the coal deposit Negotino coal quality was assessed by making more types of chemical analysis like: basic analysis, analysis of chemical composition and melting of the ash, performing petrographic analysis, grinding level of coal etc.. In order to show the results of technical analyzes of coals in more picturesque way, in the section that follows are given medium calculated values for each category of stocks, groups of categories of reserves in the entire site, using certain methods which involves the cumulative amounts of coal as well. Quality is homogeneous, petrographical determined as kutikulin - duren. Macerals are presented with xylene and poluxylene with presence of resin parts in it. Based on the values of qualitative parameters of coal it could be concluded that this is soft brown coal (lignite)

Key words: qualitative features, brownish coal, chemical composition, macerals, site Negotino, top heat value, bottom heat value, petrographic composition.

INTRODUCTION

The coal deposit Negotino is situated in the Central part of the Tikvesh valley, 2-3 kilometers south from city Negotino. Altitude of the site is 200-340 meters with 25 km^2 of surface situated among the following villages: north-west from Timjanik, south-west from Tremnik, south form Dolni Disan and west form villages Marena and Glisic.

The first scientific treatment of geological problems in this area are analyzed in the work of Cvijic (1906), a fundamental tectonic geological study, especially in the eastern section are given by Kosmat (1924). Researches till World War are focused on certain areas, so Bonchev (1920), Maric (1938, 1940), Baric (1936) with great accuracy speak about petrographic composition of granites, gneisses, mica and other rocks. After the Second World War researches are conducted by Jenko (1946), Antonovikj (1951), Ivanov and Stojanovic (1960), Izmajlov (1958, 1960) Pavlovic (1958), Ciric (1952) and Temkova (1958) and others. With the making of basic geological map of Yugoslavia, the authors of the paperwork „Prilep" (Rakichevikj, Stoyanov and Arsovski, 1965) and "Kavadarci" (Hristov Karajovanovikj, Strachkov, 1973) in the Interpreters they give detailed info of the processed lithological composition of rocks from the paperwork "Prilep" and Kavadarci.

In the second half of last century, knowledge of the existence of coal in Negotino area were obtained by performing the first researching digs in 1951. But first research boreholes were performed in 1954/56.

During the 1954's is started performing of research drilling.

In 1979 more additional geological researches were conducted to define the hydrogeological, geomechanical and tectonic features of the site and to re-categorize the mineral reserves of coal and place it in a higher category. In 1982 another additional researches were performed with same goal, to explore a particular area of the site with starting with opencast PC 1 and PC - 2 and run a re-categorization of mineral reserves in the limited area of the site.

In the period 2008 - 2009, additional geological researches were made by the Construction Institute of Macedonia in order to thoroughly reviewing the hidrogeological engineeric geological features of the site.

GEOLOGICAL FEATURES

In geological composition of the deposit Negotino are participating sediments from top-Eocene flish serie, Pliocene lake sediments, Pliocene - Pleistocene limestone and travertine, deluvial and alluvial sediments and river terraces (Figure 1).

Of all the sediments of top-Eocene flish series in this part of Tikvesh basin, the upper zone of

flish is most prevalent, have the most of space and greatest thickness (more than 2500 meters). The area around the river Vardar is composed with the same sediments, whereas in Rosoman, Trstenik and Manastirec are covered by sediments of the Pliocene (Fig 1).
According to lithological composition two subunits are allocated: down unit represented by sand areas, conglomerates and rarely lime, and upper unit represented mainly by clay, marls and rarely sand areas. In the lower sand area according to colour of sand we can find gray and yellow sand, which are in specified boundaries.
The upper unit has the most expressed flish characteristics. The lowest article of sequences is with large grained, and the highest with low grained. In different sequences appear detritical or sandy, sometime even bumpy lime. Most frequent participants of the sequence are sand and marl parts.
Pliocene lake sediments are creating most of the site. They are presented with a series of clay in different colours(1 pl) which was detected in the stream in villageTremnik near hill Svrchka and in the stream near village Prždevo. According to all available data, especially to the earlier mentioned sites and drilling holes, it can be concluded that the Pliocene sediments lie on the transgressive marls and claystones in paleogene.
Pliocene is also presented with a series of marls and clays with layers of coal (2Pl). Almost along the whole series is covered with young sediments and it can be found only on two localities: Crveni Bregovi and Timjanichka Cucka represented by yellow - red baked clays. South-west of the village Tremnik on the hill Svrchka there are thin sheets of gray marl with a total thickness of 3 meters which are on top of colorful clays under the yellow sands. Within pliocentic sediments a sandy series are derived (3Pl) which has the largest regional distribution. This series are homogeneous, consisting of yellow sands with and sandy gravel clay and grainy gray sand areas.
Upper Pliocene of the wider area is presented by limestone.
Limestones occur in two striking panels that are separated by yellow sands and agglomerating andenzite tuffs. Just over pliocentic yellow-gray sand, and sand areas on height of 420 meters, lie desalinatedlimestone (thickness 40 m), then yellow sand areas and sands (30 meters) andenzite agglomerating tuffs (10 m) and finally ending with the second limestone panel with thickness around 15 meters.
As oldest quartile sediments are considered lake conglomerates and breccia then andezite agglomerating tuffs, latites, proluvijal and glacial deposits, limestone breccia and river terraces.
The largest distribution of these sediments have edge parts of the lake depressions, where we have a significant amount of Pliocene freshwater lake sediments. They are presented by low rounded conglomerates and breccia.

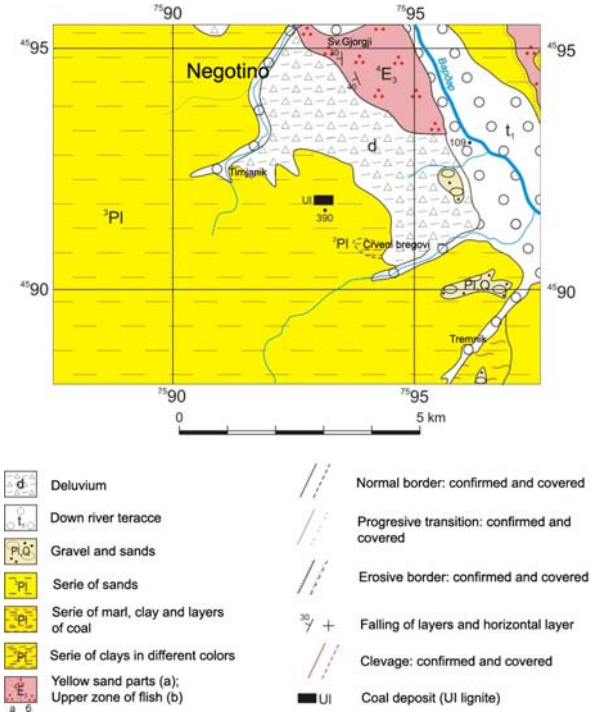

Figure 1. Geological map of coal deposit Negotino

According to the way of appearance, shape of boulder and position in space these sediments can be treated in two ways. First, that they are regressive terraced forms, lake islands of the youngest finished lake stadium and second as a cause of major volcanic activity at that time. Meaning , by ejecting volcanic pyroclastic material in water, the process of abrasion was strengthened , which caused formation of such coarse sediments. The thickness of conglomerates and breccia is approximately 100 meters.
In the valleys of the Vardar and Crna Reka we see lower (t1) and higher (t2) river terraces, deluvial (d) and modern alluvial (al) deposits.

Qualitative features

For qualitative parameters of coal, arithmetic average value was calculated per boreholes without calculating their weighted values, but it is given a range of qualitative parameters.

Qualitative parameters of coal are shown in Table 1 according to data obtained from research.

Table 1. *Qualitative parameters of coal*

total moisture content	7,77 - 30,24 %
content of rough moisture	2,20 - 20,50%
content of higrated moisture	7,62 - 15,07%
content of ash	34,09 - 61,09 %
content of coke	52,27 - 71,59 %
content of C-fix	9,31 - 25,99 %
content of volatile substances	14,00 - 30,50 %
total amount sulfur	1,17 - 2,11 %
Combustible sulfur	0,50 - 1,00 %
Sulfur in the ash	0,32 - 1,92 %
DHV	1332 - 2985 kcal/kg

Along the processing of data for quality by samples from boreholes certain parameters were used in of the protocols of the column with a total moisture, while others were used from the column with moisture in analytical sample.

A calculation was made of the weighted values of qualitative parameters of coal boreholes for the whole site. When calculating the weighted average GHV and DHV ksal / kg have been converted in kJ / kg.

While analyzing the individual results for the qualitative parameters of the values by boreholes it can be concluded that certain values appear in a wide diapason including:

The content of total moisture borehole D-214 is 10.26%, while in borehole D-331 is 35.61%.

The content of ash in borehole D-251 was 18:38%, while in borehole D-317 is 59.14%.

DHV in the coal ranges from 4231 kJ / kg in borehole D-320 to 11,382 kJ / kg in borehole D-220.

Table 2 gives a cumulative preview of the weighted average quality of coal for certain categories of reserves and for the whole site.

Table 2. *Cumulative summary of the weighted average quality of coal for certain categories of reserves and for the whole site.*

Category of reserves	Geological reserves [t]	Qualitative parameters of coal									
		Total amount of moisture [%]	Ash [%]	Total amount of sulfur [%]	Sulfur in ash [%]	Combustible sulfur [%]	Coke [%]	S-fix [%]	volatile substances [%]	Combustible substances [%]	DHV [kJ/kg]
A	25.493.349	22,17	40,32	1.51	0.65	0.86	56.35	15.88	21.21	37.51	8166
B	36.933.339	23,73	40,7	1.46	0.48	0.98	55.78	14.34	21.09	35.57	7810
C_1	20.058.420	24,44	45.35	1.07	0.45	0.62	54.91	12.59	19.48	30.21	6430
Total	**82.485.108**	**23,42**	**41,71**	**1.38**	**0.53**	**0.85**	**55.74**	**14.39**	**20.73**	**34.87**	**7584**

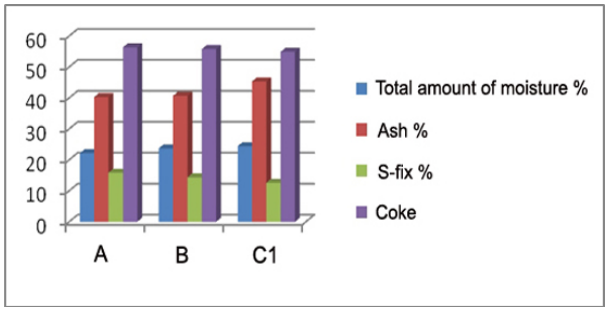

Figure 2. Histogram display of qualitative parameters of coal for A, B and C1 category

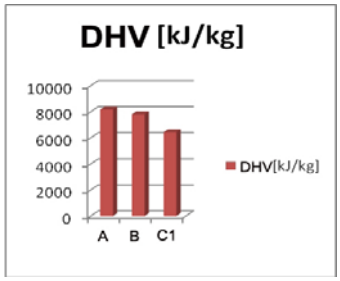

Figure 3. Histogram display of DHV

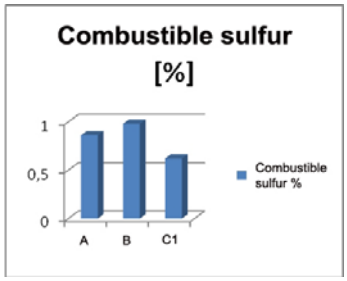

Figure 4. Histogram display of combustible sulfur in A, B and C_1 category

Elemental composition of coal - To determine the content of carbon, hydrogen and the sum of nitrogen and oxygen (C, H and $N+O_2$) in coal expressed in %, 32 composite tests of coal were produced along with technical analysis of the composite.

Table 3. *Elemental composition of coal - Analysises are made of composite samples of coal from drillholes with total moisture in the sample of 2009*

No	Research drillhole	Percentage content of individual elements			Nitrogen + oxygen
		C [%]	H [%]	Combustible [S]	$N+O_2$ [%]
1	2	3	4	5	6
1	4/13	16,08	1,67	0,83	7,50
2	6/13	16,42	1,59	0,66	8,90
3	8/15	19,69	2,05	0,56	10,25
4	8/21	21,98	2,05	0,53	10,94
5	10/11	16,69	1,73	0,86	7,84
6	10/15	19,39	2,13	1,18	9,43
7	10,27	25,05	2,06	0,67	13,20
8	10/29	12,06	1,34	0,36	7,04
9	10/31	19,59	2,01	0,76	9,09
10	12/9	14,01	1,57	0,83	7,80
11	12/31	20,04	2,09	1,02	11,14
12	14/15	20,23	2,04	1,19	9,18
13	14/21	22,76	2,21	0,71	10,93
14	14/27	22,93	1,97	0,94	12,08
15	14/29	22,08	2,07	0,68	11,77
16	16/17	21,61	2,23	1,25	10,93
17	16/19	20,66	1,91	0,69	9,72
18	16/33	15,94	1,50	0,94	8,71
19	16/35	24,38	1,93	1,55	9,83
20	16/37	18,01	1,84	0,94	9,84
21	18/7	21,24	1,98	0,80	9,44
22	18/9	20,07	2,02	0,94	9,29
23	18/13	16,42	1,75	0,73	10,00
24	18/15	21,00	1,85	1,47	8,33
25	18/17	21,95	1,79	1,05	9,79
26	18/21	23,00	2,10	1,10	9,67
27	18/25	23,67	1,95	1,43	10,40
28	18/27	21,19	1,89	1,29	9,79
29	18/29	20,07	1,92	0,65	10,29
30	18/31	19,94	1,91	0,92	9,54
31	18/37	13,50	1,51	0,45	7,93
32	20/25	17,58	1,77	1,30	9,08

Chemical composition of ash from coal. With chemical analysis of ash from coal the content of SiO_2, Fe_2O_3, Al_2O_3, CaO, MgO, CO_3, TiO_2, P_2O_5, Na_2O and K_2O are determined and expressed in %. Ash contains products of thermal and chemical changes of mineral substances as parts of solid fuel during its combustion. 20 composite tests were made during 2009 and the results of tests are shown in Table 4.

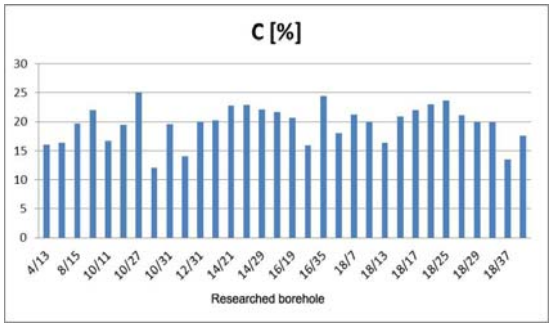

Figure 5. Histogram display of the percentage content of C in the coal deposit Negotino

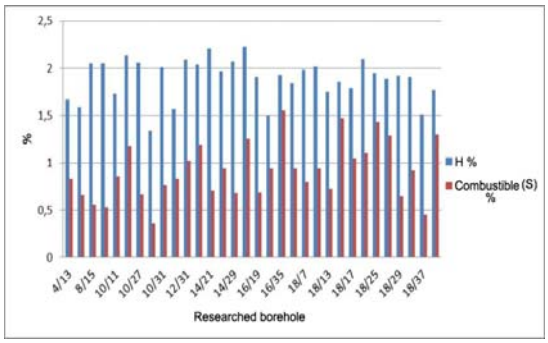

Figure 6. Histogram display of the percentage content of N and S in combustible coal from the coal deposit Negotino

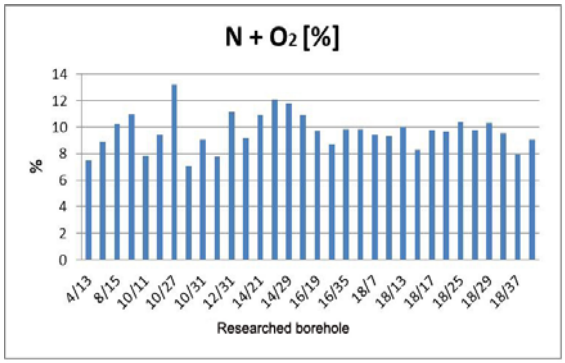

Figure 7. Histogram display of the percentage content of $N + O_2$ in the coal deposit Negotino

Table 4. *Percentage content of individual chemical compounds obtained in analysis of ash from coal in 2009*

Number	Researched drilling hole	Percentage content of individual components									
		SiO_2,	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3	TiO_2	P_2O_5	Na_2O	K_2O
1	2	3	4	5	6	7	8	9	10	11	12
1	6/13	64,80	9,98	9,32	6,27	3,17	3,79	0,06	0,89	0,79	0,92
2	8/21	47,50	4,59	21,33	12,33	6,03	5,62	0,10	1,08	0,58	0,82
3	10/11	64,94	9,38	12,33	5,18	1,86	3,22	0,09	0,95	0,89	1,18
4	10/15	63,,82	8,78	10,24	6,31	3,11	4,73	0,1	1,08	0,7	1,03
5	10/27	34,86	8,58	14,1	23,95	6,48	9,38	0,08	1,14	0,4	0,92
6	10/31	60,40	8,58	11,84	7,29	5,25	3,59	0,08	0.90	0,88	1,12
7	12/9	55,60	8,58	10,86	10,29	8,39	3,18	0,09	0,92	0,90	1,14
8	14/15	59,24	8,78	10,83	10,49	3,42	4,30	0,08	0,86	0,94	1,00
9	14/29	47,82	6,99	19,31	10,65	6,52	5,64	0,11	1,00	0,80	1,06
10	16/17	60,74	8,78	12,12	7,00	3,35	5,15	0,10	1,00	0,76	0,94
11	16/19	54,34	7,78	19,7	6,45	5,12	3,92	0,11	0,96	0,61	0,96
12	16/33	60,06	9,58	15,3	5,56	3,85	2,94	0,09	1,01	0,68	0,92
13	16/35	57,52	9,98	14,72	5,75	4,23	4,77	0,10	0,01	0,73	0,98
14	16/37	55,18	8,98	19,69	5,89	3,61	3,95	0,08	1,00	0,70	0,90
15	18/7	57,64	9,98	15,43	5,18	4,45	4,57	0,06	0,9	0,76	1,01
16	18/9	63,68	9,18	13,35	4,20	3,27	3,63	0,08	0,99	0,60	0,92
17	18/17	60,88	8,18	15,95	5,43	3,33	3,28	0,08	0,99	0,80	1,00
18	18/21	52,00	7,58	22,27	5,75	4,96	4,49	0,09	1,11	0,70	0,95
19	18/29	58,52	9,18	16,3	5,85	3,46	3,94	0,07	0,9	0,78	0,95
20	20/25	50,14	10,98	20,63	6,87	4,47	3,80	0,07	1,12	0,80	1,04

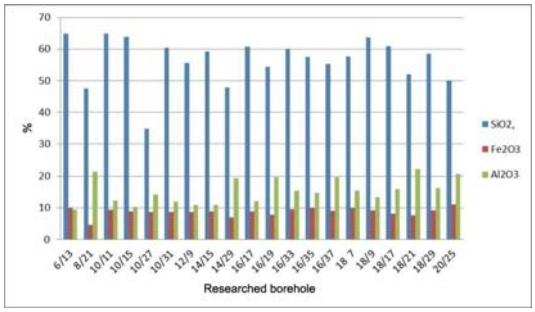

Figure 8. Percentage content of SiO_2, Fe_2O_3 and Al_2O_3 in ash from coal deposit Negotino

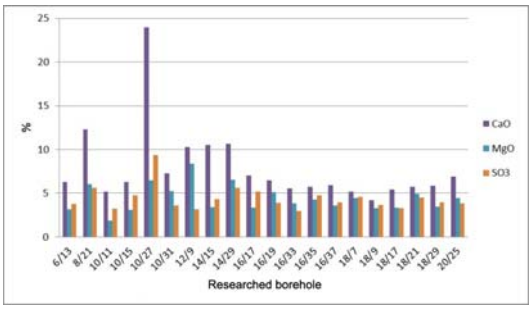

Figure 9. Percentage content of CaO, MgO and SO_3 in coal ash deposit Negotino

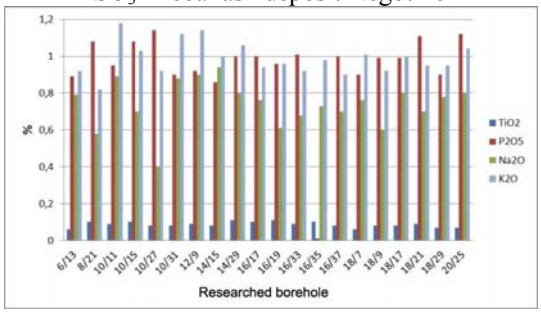

Figure 10. Percentage contents of TiO_2, P_2O_5 and K_2O and Na_2O in ash from coal deposit Negotino

According to the presented values for the content of individual compounds it may be noted that in the coal ash dominant is SiO_2, than Al_2O_3, CaO and Fe_2O_3. Due to the high content of SiO_2, the ash is characterized as a strong acid.

PETROGRAPHIC CHARACTERISTICS

The coal is of humus origin and is with distinctive line-form where as the main ingredient appears to be durene. Petro-graphically coal is determined as kutikulin duren composed mostly of fine cuticules. Lastly included are resin bodies which are part of xylene or are scattered across durene. Rest mass of durene constitute of line-form opakoides and mineral material. More over the ingredient duren contains layers of macerals of xylene and xylene klaren that are far less prevalent and almost anywhere without resin bodies. More often this sites appear roundish without structural material (opakoides) that indicates of vegetabile origin of coal or from

the same mineralogical nature. Macerale xylene is semixylene originating from poorly plants with form of tree. Quantitative petrographic analysis indicates that the coal is poor in macerale rezinite and resin bodies kutikulen duren is relatively poorly present. The low percentage of xylene which often passes klaren and who is often without resin bodies can compensate the lack of rezinite. The petrografic examination is without doubt proven the genesis of autochthonous origin of coal, which indicates the peaceful and proper stratification of individual petrographic micro-ingridients, macerals. Coal is originating from humus substances in which except lignin cell-ulose participates too (cellulose lignin-coal).

CONCLUSION

The area that occupies the site is a central part of Tikves basin and it is exceptionally with low hills. Tikves basin where the Negotino site belongs is in the Vardar zone. Basically paleorterrain the basin has the form of graben, created by radial tectonics during herzin orogenezis. Analyzing the individual results for the qualitative parameters of the given values by boreholes can be concluded that certain values appear in a wide range including: The content of total moisture in borehole D-214 is 10.26%, while in borehole D-331 is 35.61%. The content of ash in borehole D-251 was 18:38%, while in borehole D-317 is 59.14%. DTV in the coal ranges from 4231 kJ / kg in borehole D-320 to 11,382 kJ / kg in borehole D-220. According to the reported values for the content of individual compounds it may be noted that coal ash is dominant and then SiO2 Al2O3, CaO and Fe2O3. Because of the high content of SiO2, the ash is characterized as a strong acidulous. Coal deposit Negotino mikrolitotip was created by the lowest degree of carbonation with xylitene composition and rare presence of kutinite, sporinite and skleotinite. Detrit gelo is present in small amounts, and formed of detritus texts with sporadic structure gelinite with great presence of resin bodies. In a number of samples Detrit gelo was built by detrinite with resin bodies and colonial bacteriological pyrite. The goof in coal has silicate – carbonate composition with coal detritus of nature or more political terige quartz with alevrolitichal size of the grains. Generally, coal from Negotino site has lowest level carbonation and converting tissue in form of tree to gelificated state of detritus-tex with transforming the detri-gel and makrolitotipe in the highest degree of carbonation which is a tekstit-gel.

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