

# Report on geology and available coal reserves in the deposit

## Maritsa Iztok Mines

The assigned task of this report is to present a description of the geology and available coal reserves in the Maritsa Iztok Mines deposit. The information in it is based on the available up-to-date reports and compared with the historical geological sources. The report aims as well as to provide a comprehensive interpretation of these sources for public use.

For this purpose, the available information found in documents and reports of the National Geological Fund and the websites of the Ministry of Energy and Maritsa Iztok Mines EAD was processed.



The information from the National Geological Fund was provided through a Permit of the Ministry of Energy № E-94-00-269 from 06.12.2019 and was used in this report in compliance with the Application for access to geological information.

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### **Geological conditions and creation of the lignite basin (paleogeography and genesis of coal)**

At the end of the Paleogene (25-23 million years ago), two mountain ranges formed - the Balkanids and the Rhodopes, which began to gradually rise, and the intermediate area - the Thracian lowlands decreased. The lowlands stretched from Pazardzhik, through Plovdiv, Stara Zagora and Yambol and all the way to the Black Sea and were covered with a series of large lakes connected by canals. One of these freshwater lakes has later become the current Maritsa Basin. This lake collected waters from torrents

and rivers flowing down from the Balkan and the Rhodopes mountains. The basin has undergone constant sinking, as evidenced by the powerful clay-sandy deposits exceeding 300 meters in depth.

The bottom of the East Maritsa Basin consists of Paleozoic, at some places Mesozoic - Triassic, Upper Cretaceous and Paleogene rocks, mainly of gneisses, granite-gneisses and shales split by quartz veins. It has been established that this Paleozoic substrate (plinth) is an uneven, hilly relief that lies at different depths from 60 to 300 m. Geophysical studies show a rise of this substrate in the northeast-southeast direction.

During the early Pliocene (5.3 million years ago), in the central part of the basin starts a deposition process of sub carbon clay materials. Along with the gradual decrease of the terrain, the deposition occurred in a quiet period as evidenced by the accumulation uniform and fine material. Later processes of shallowing and dynamic accumulation of sand occurred, especially in the outer parts of the Maritsa basin. This rock complex, represented by gray, colorful, greenish dense clays and blue-green sands that acted as accumulator of pressure for groundwaters. Its thickness is up to 40 meters.

After the formation of the sub-coal sand horizon, deepening of the terrain has occurred again, which allowed the accumulation of a layer of gray-green and colorful clays. After the deposition of the clay, an uplift occurred again, which created growth conditions for a rich lake-swamp vegetation which caused the formation of the third and deepest coal layer in the basin. Then a new deepening and accumulation of the characteristic schistoslate clay marker followed and a new shallowing which created the same growth conditions for a lake-swamp vegetation which provided the material for the formation of the second coal layer. From its relatively high magnitude and even deposition, it can be assumed that the conditions under which it was formed were relatively calm and in force over the entire basin. Because of the local distribution of the first, uppermost coal layer - only in the central parts of the basin, it can be assumed that it was due to accumulations brought by existing water currents that have carried wood material and has deposited it together with fine clay and other organic materials which gave the coal its black color.

At the end of the Pliocene (3.5-2.5 million years ago), after the deposition of new clay-sandy sediments, there was a rise of the terrain and outflow of the basin's waters. The subsequent period of drought and erosion has determined the modern relief of the Eastern Maritsa (Maritsa Iztok) lignite basin.

Drillings and mining operations carried out so far has not found sufficient evidence about the origin of the timber component. The parts of trees found there are mostly small, crushed and mixed with other substances, which leads to the conclusion that a significant part of the material was likely dragged into the basin rather than it has grown on the spot.

On the other hand, the consistency and thickness of the second layer, as well as its distribution over the area, leads to the conclusion that at least the formation of this layer was predominantly due to local materials.

It can be said that the wood material of the deposit is of both local (autochthonous) and imported (allochthonous) origin.

## Description of the coal deposit

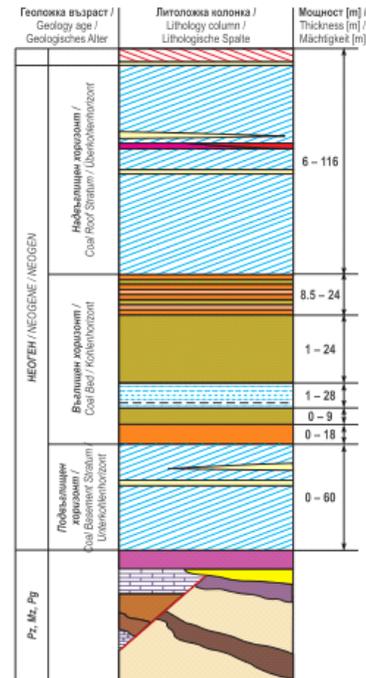
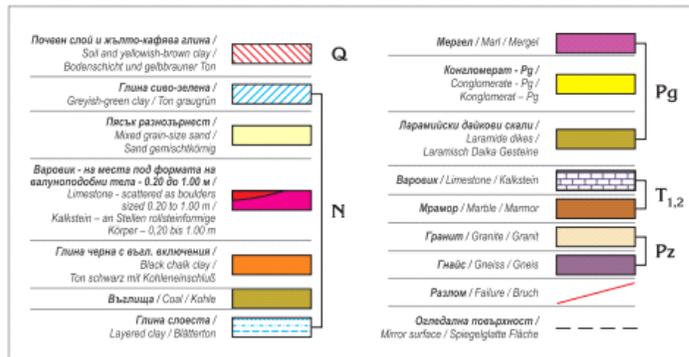
In geology, the "lithological column" is used as a graphic presentation of the earth layers (geological section). FIG. 1 visually presents the components of the Maritsa Iztok lignite basin, discussed above, and also provides data about the age and thickness of each layer, as found through drillings and announced in a report from the Maritsa Iztok Mines EAD in 2013.

FIG. 1

### ОБОБЩЕН ГЕОЛОЖКИ РАЗРЕЗ на Източномаритшкия Възлащен басейн

### GENERAL GEOLOGIC SECTION of the Maritsa Iztok Coal Basin

### ALLGEMEINER GEOLOGISCHER SCHNITT des Kohlenbeckens Mariza Iztok



Looking at the graphic, one can clearly distinguish (in walnut green) the third and second coal layers (III and II), while the first layer and uppermost layer of the deposit (I) manifests as alternating thin coal strips and black clay layers with coal inclusions and sand deposits.

The coal horizon of the deposit is a complex of black clays mixed with coal seams and cores and three coal layers.

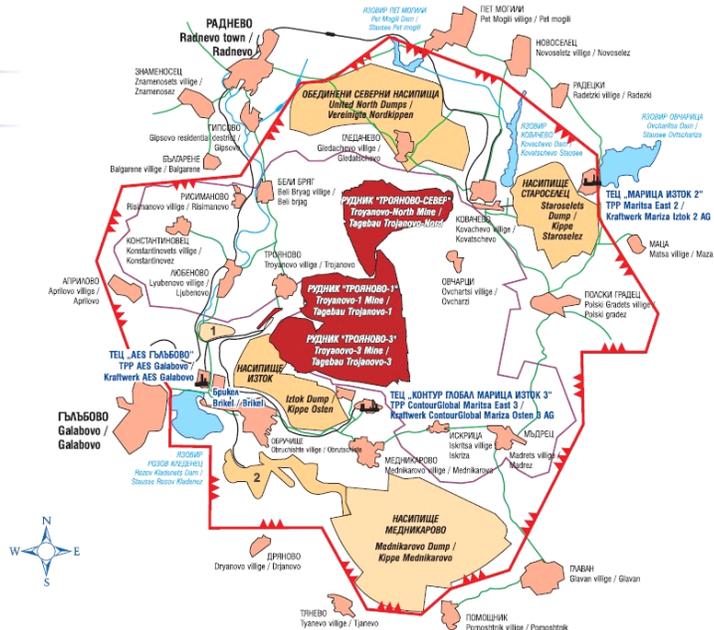
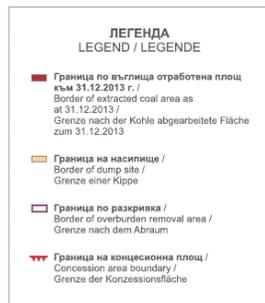
Due to the large variations in thickness of the layers in different areas of the deposit, we will focus on **the explorations of sections "Beli Bryag" and "Aprilovo" to the north and northwest of the existing mines and sections "Gradets II" and "Sokolitsa" to the south and southeast of according to the report from 1957** (Fig. 2) which are of particular interest to the sponsors of this report due to forthcoming or potential development activities in these sections.

FIG. 2

СХЕМА НА  
„Мину Марица-изток“ ЕАД

Mini Maritsa-iztok EAD  
OUTLINE

SCHEMA DER  
Mini Mariza-istok AG



1. НАСИПИЩЕ ОВЧАРИЦА / Ovcharitza Dump / Kirpe Ovtscharitza
2. НАСИПИЩЕ ДРЯНОВО / Dryanovo Dump / Kirpe Drjanovo

The "Beli Bryag" section has an area of 31.42 km<sup>2</sup> in which 24 boreholes with a total length of 3073,40 meters have been drilled in a network pattern of 1000/1000 meters. The "Aprilovo" section occupies an area of 33 sq. kilometers. The boreholes are 31 with a total length of 3207 meters.

Section "Gradets II" has an area of 11.5 km<sup>2</sup> explored with drillings in a network of 1000/1000 meters. A total of 48 boreholes with a total length of 5385 meters were drilled in different years in the period from 1949 until 1955.

The "Sokolitsa" section has an area of 63.9 km<sup>2</sup> and its borders to the south, east and west outline the borders of the coal basin. Researched with 107 boreholes with a total length of 9640 meters during different years in the period from 1949 until 1955. Due to the less dense network (1000/1000 and 2000/2000) of the exploration drillings, only reserves of categories C<sub>1</sub> and C<sub>2</sub> have been estimated.

As a result of these drillings, the thickness of the three coal layers was determined as follows:

Table. 1

Section	I layer	II layer	III layer
Sokolitsa	not in exploitation	I bank	0,60-18,1 m. (average 5,66 m.)
		II bank	1,00-11,4 m. (average 6,70 m.)
		III-bank	1,00-10,0 m. (average 5,46 m.)
		<b>Total</b>	<b>1,00-18,1 m. (average 10,64 meters)</b>
			1,40-9,00 m. (av. 2,80 m.)

Beli Bryag	1,30 meters	I bank	1,00-14,5 m. (av. 7,42 m.)	1,20-3,70 m.
		II bank	0,7-13,5 m. (av. 4,41 m.)	(av. 2,51 m.)
		III bank	1,00-12,6 m. (av. 4,62 m.)	
		<b>Total</b>	<b>1,00-21,2 m. (av. 12,47 m.)</b>	
Aprilovo	0,80 meters	I bank	1,00-12,8 m. (av. 5,95 m.)	0,90-4,30 m.
		II bank	0,7-7,00 m. (av. 1,98 m.)	(av. 2,01 m.)
		III bank	1,00-6,00 m. (av. 3,96 m.)	
		<b>Total</b>	<b>1,00-17,5 m. (av. 8,69 m.)</b>	

According to the report from 1957 in the section "Beli Bryag" significant fluctuations in the coal layers from south to north, both in terms of ash content and magnitude are found.

In section "Aprilovo" the coal deposits also show deterioration due to fluctuations in the thickness of the coal layers and their high ash content which increases in the west-northwest direction.

*"The third, lowest, coal layer, at the end of the "Beli Bryag" section - west and northwest of the village of Gledachevo - gets completely lost."*

*"Previous studies have shown significant changes in the magnitude of the coal layers in the southern, western and northwestern directions of the basin and namely that the thickness of the coal complex is decreasing. The structure of the coal layers at the outskirts of the basin differs from that in the central sections - the thickness decreases, and in the place of the coals there are only black clays." (p. 51)*

The same was also found during additional studies published in a report from 1968 where Rudnik 2 or the northern part of mine Troyanovo 2, that includes also the "Beli Bryag" and "Kovachevo" sections was studied in details.

The coal complex in the area of Rudnik 2 is not a deposit with the same characteristics. The profile of the coal horizon varies from south to north as the magnitude and the coal layers gradually decrease and the quality of the coal deteriorates.

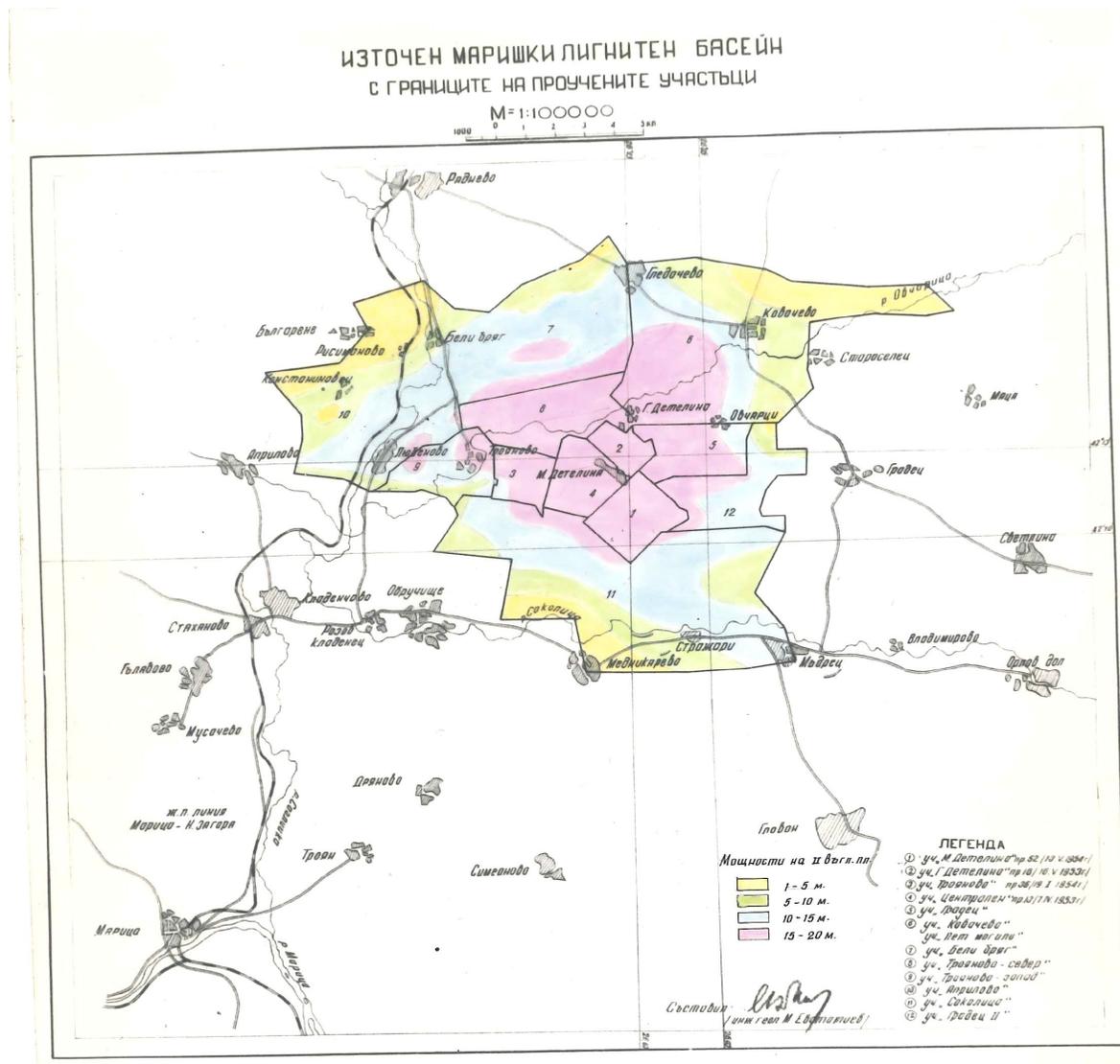
*"While the second coal layer in the southern direction is more abundant, compact, and in addition the coal itself is more woody, going to the north it reduces its magnitude, get stratified by clay layers and the coal changes into earthy ones, and even into black clays. These changes are genetic in nature."* and indicate that the deposit is reaching its limits.

*"As a result of the conducted geological and hydrogeological works in the area of section Rudnik 2 - northern part it is established that in the northern and partly in the western direction significant changes*

are observed both in the magnitude and in the quality of the coal layers. Namely, that in these directions the magnitude of the coal in the second layer gradually decreases and their ash content increases." (p. 32)

The fluctuations in the thickness of the coal layers are clearly presented in Fig. 3 from the report from 1957.

FIG. 3



For "Gradets II" section it was found (p. 262) that in the direction from east to west the second coal layer shows a change in qualitative and quantitative terms - in this direction the magnitude of coal increases while their ash content decreases. The first layer is non-exploitable, the second and third banks of the second layer are not present in the northeastern part of the section due to deterioration of the coal layer in terms of quality. The third bank is also missing in 12 drillings in the northeastern part of the section.

The third coal layer in the easternmost parts turns into black clays with coal seams and disappears completely.

The profile of the coal complex in "Sokolitsa" section differs from that of the central part of the basin. Along the valley of the Sokolitsa River to the west, the thickness of the coal banks decreases, the profile is not constant, the ash content of the coal is higher and the coal turns into black clays.

*"The conducted drilling explorations have shown that the second coal layer is thinning in directions to the west and to the south. In these areas, the ash content also increases."* (p. 336)

Two other characteristics that should be noted and commented on are the **ash content** (solid non-combustible inorganic residue) and the **thickness of the overburden** (the layer from the surface to the coal layer that needs to be removed prior to the coal extraction).

In general, lignite coal from the Maritsa basin is characterized by a high ash content (Ac) which is directly related to the economic efficiency of the extraction. The assessment of the coal (Table 2) in the sections of "Beli Bryag", "Aprilovo", "Gradets II" (Table 2) shows a higher ash content in these sections than the average ash content of the whole deposit - Ac ( $A_2 + B + C_1$ ) = 29.3% given in Table 3.

Table 2.

Section	I layer (Ac)	II layer (Ac – ash content)	III layer (Ac)
Gradets II	-	I bank 22,6% - 45,1% (av. 34,7%)	22,1% - 44,7% (av. 33,7%)
		II bank 15,7% - 22,0% (av. 19,6%)	
		III bank 24,7% - 41,9% (av. 31,9%)	
Sokolitsa	-	I bank 23,4% - 45,7% (av. 34,7%)	25,7% - 43,3% (av. 33,9%)
		II bank 16,1% - 21,3% (av. 18,7%)	
		III bank 23,6% - 40,6% (av. 32,9%)	
Beli Bryag	45,3%	I bank 27,7% - 43,4% (av. 33,4%)	23,7% - 44,4% (av. 31,4%)
		II bank 18,5% - 22,0% (av. 20,8%)	
		III bank 23,2% - 41,1% (av. 32,5%)	
Aprilovo	38,5%	I bank 25,1% - 45,2% (av. 34,1%)	20,3% - 46,4% (av. 34,3%)
		II bank 14,9% - 21,6% (av. 19,7%)	
		III bank 28,1% - 41,0% (av. 33,8%)	

### Reserves and extraction

The established reserves with the geological surveys of the 1957 Report and adopted by Protocol №197 of 01.07.1958 recognize the balance as of 01.01.1958 for the entire deposit of the Maritsa Iztok lignite basin as follows:

Table. 3

Category	Quantity (tons)	Ac (ash content)
A <sub>2</sub>	619 154 000	24,8 %
B	999 646 000	28,2 %
C <sub>1</sub>	1 806 604 000	31,4 %
(A <sub>2</sub> +B+ C <sub>1</sub> )	3 425 404 000	29,3 %
C <sub>2</sub>	174 477 000	34,6 %

According to the annual report of "Maritsa Iztok Mines" EAD from 2013, the condition of the reserves and resources of lignite coal as of 31.12.2013 amounts to the following:

Table. 4

Category	Quantity (tons)
Proven reserves (Cat. 111)	919 840 200
Probable reserves (Cat. 121)	660 049 400
Resources (by categories detailed and pre-assessed)	446 733 200
Total	2 026 622 800

In the same document it is noted that since the beginning of the exploitations of the deposit in 1952 until the end of 2013 the amount of 1 038 217 911 tons of coal were extracted.

Regarding the sections "Beli Bryag", "Aprilovo", "Gradets II" and "Sokolitsa", the proven reserves according to the Report from 1957 are the following:

Table. 5 - section "Beli Bryag"

Category	Quantity (tons)	Ac (ash content)
C <sub>1</sub>	432 892 000	av. 30,5 %
C <sub>2</sub>	49 239 000	av. 37,5 %

Table. 6 – section "Aprilovo"

Category	Quantity (tons)	Ac (ash content)
B	141 154 070	av. 31,0 %
C <sub>1</sub>	207 330 258	av. 33,8 %
(B+ C <sub>1</sub> )	348 484 328	av. 32,4 %
C <sub>2</sub>	11 633 577	av. 32,8 %

Table. 7 – section "Gradets II"

Category	Quantity (tons)	Ac (ash content)
B	175 575 000	av. 28,4 %
C <sub>1</sub>	19 314 000	av. 35,5 %
(B+ C <sub>1</sub> )	194 889 000	av. 29,1 %

Table. 8 – section "Sokolitsa"

Category	Quantity (tons)	Ac (ash content)
C <sub>1</sub>	699 565 000	av. 28,9 %
C <sub>2</sub>	125 238 000	av. 33,5 %

For the current rate of depletion of the deposit, here, we provide the available data about the implementation of the annual production from the recent years according to the Annual Reports of "Maritsa Iztok Mines" EAD.

Table. 8

2013	2015	2016	2017	2018
25 467 875 t.	32 324 062 t.	27 762 163 t.	30 337 319 t.	27 963 142 t.

### **Conclusions:**

- Compared to the average data for the deposit, the reserves of the "Beli Bryag" and "Aprilovo" sections are with deteriorated qualities in terms of main indicators - layer thickness, ash content and overburden coefficient.
- From the findings of the two geological studies, it can be stated with a high degree of reliability that the development of the deposit beyond the contour of the current development of the mines in western, northern and southern directions, and in particular "Beli Bryag", "Aprilovo" and "Sokolitsa" sections, will be technologically difficult due to the lack of well-defined coal layers and the presence of impurities of black clay. Development as well will be less cost-effective due to the lower quality of coal in these sections.
- When comparing the data about the coal reserves from 1958 and 2013 it does show some differences, but we believe that it is within acceptable limits and it is due to the sparse network of boreholes in the old surveys and the reassessment of the reserves categories from the Russian to the international classification.

### **Glossary:**

**Reserves** - this is the part of the mineral resources that are expected to be extracted for commercial purposes within a certain degree of certainty.

**Resources** are potential reserves which exploitation at the moment is not considered as probable, though probability of extraction is considered significant, albeit less than 50%.

The reserves of underground natural resources are grouped in the following classification categories:

**Proven reserves** are those resources for which with a high degree of certainty (90 and over 90%) can be estimated that their extraction is technically possible with the use of existing technology and is economically profitable at corresponding prices.

**Probable reserves** are those that have not yet been proven, but for which there is more than a 50% probability for technically possible and economically feasible extraction.

### **Bibliography**

- Annual report of "Maritsa Iztok Mines" EAD from 2013 - the last published report on the company's website
- Annual activity reports of "Maritsa Iztok Mines" EAD for 2016, 2017 and 2018 by an independent auditor published on the Ministry of Energitcs' web site.
- Report on the results of a detailed geological survey in section "Rudnik 2" - northern part of the Maritsa Iztok lignite basin from 1968.
- Report of a detailed geological survey in the East Maritsa lignite basin from 1957.
- Other documents and reports available at the National Geological Fund and on Internet.