NEW UNDERGROUND INFRASTRUCTURE IN "VARBA – BATANTZI" MINE

Zdravets Eftimov, Dimitar Anastasov

University of Mining and Geology "St. Ivan Rilski" 1700 Sofia; Zdravetse@yahoo.com

ABSTRACT. In this report the need of building up a new underground infrastructure in "Varba – Batantzi" mine is presented with the aim of reaching the deposits in depth. New capital workings and equipment, such as new underground mobile equipment are reviewed and presented. The changes and improvement of the workings for reaching and preparing the deposits connected with the new underground equipment are described. The report presents the challenges connected with the water drainage and ventilation of the "Varba – Batantzi" mine. The results and conclusions about the need of building a new infrastructure are presented, as well as equipping the mine with a new mobile equipment and the results that should be met.

Keywords: underground infrastructure, mine, water drainage, ventilation

НОВА ПОДЗЕМНА ИНФРАСТРУКТУРА В РУДНИК „ВЪРБА – БАТАНЦИ"

Здравец Ефтимов, Димитър Анастасов

Минно-геоложки университет "Св. Иван Рилски", 1700 София

Резюме. В статията е представена е необходимостта от изграждане на нова подземна инфраструктура в рудник "Върба – Батанци", с цел разкриване на запасите в находището в дълбочина. Разгледани и представени са нови капитални изработки и съоръжения, както и нова мобилна самоходна механизация. Описани са промените в минно-проходческите работи за подготовка на запасите с оглед на новата механизация. В статията са разгледани и предизвикателствата свързани с водоотлива и вентилацията в рудник "Върба – Батанци". Представени за изводи и заключения относно необходимостта от изграждане на нова подземна инфраструктура, оборудване на рудника с нова мобилна самоходна механизация, както и резултатите, които следва да бъдат постигнати.

Ключови думи: подземна инфраструктура, рудник, водоотлив, вентилация

Need to reach the deposits in the "Varba - Batantzi" mine in depth (Anastasov, Eftimov, 2013, 2018)

With the advancement of mining and the development of the "Varba - Batantzi" underground mine there is a need for reaching the reserves in depth below the 540th horizon. This is dictated by a number of factors, on the one hand, the fact that the currently discovered and prepared for mining reserves in the mine are above the horizon 540, at the same time, in depth the deposit is studied up to level 300. On the other hand, considering the concessionaire's wish to increase the annual production capacity of the mine. These are the two main tasks to be solved in the "Varba - Batantzi" deposit.

To accomplish these tasks, it is necessary to change the technology and the working order of the entire deposit. It is necessary to make adjustments in the mining methods. In order to accomplish this task, it is necessary to build an entirely new underground infrastructure in the underground mine "Varba - Batantzi". This, in itself, is not sufficient for the complete fulfilment of the two main tasks, it is necessary to undergo a modernisation of the mechanisation and equipment in the underground mine besides the construction of a new infrastructure.

Capital workings and facilities. Choosing a mobile self-propelled underground equipment

The new capital workings and facilities are related to the changes, which should occur in the "Varba - Batantzi" mine, in order to reveal the reserves in depth as well as to increase the production capacity of the mine 2.5 times.

The new capital inclined ramp "Varba" is designed to reach the deposit in depth, starting from the end of the existing working – from level 733 m. The capital inclined ramp "Varba" is designed to develop in an approximately vertical plane with direction to the northwest and southeast. The inclined shaft is positioned to be as far away from the ore body as possible to avoid areas of influence from the mining operations and possible deformation processes caused by them.

The project route of the capital inclined ramp "Varba" is 3885 m. The initial elevation of the track is 733 m and the final elevation is 194.3 m, which determines the displacement of 538.7 m. The slope of the construction is permanent and is 14%. Curved sections are designed with a minimum radius of 20 m, according to the possibilities of mobile equipment.

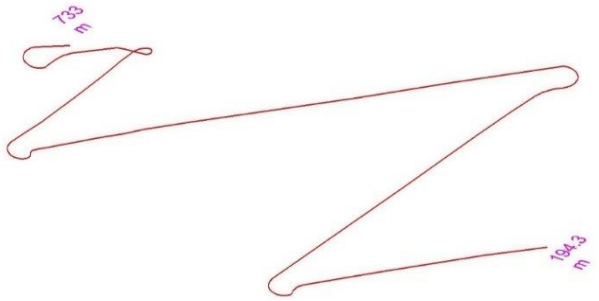

Fig. 1. Project track of the capital inclined ramp "Varba"

Fig. 2. Part of the new underground infrastructure in "Varba – Batantzi" mine

From the capital inclined ramp route, mine workings for connection on different levels are planned to be done at 610-600 m, 680 m, 550-540 m and 540 m. There are also two connections with the Varba 2 shaft at 540 m and 300 m. From level 412 m downstream in the southeast inclined shaft for the reserves in the Batantzi deposit is planned to be developed.

In view of the project for development of the mine works of the "Varba - Batantsi" underground mine, the mine is planned to be reequipped with new self-propelled mobile equipment. It consists of three sets of machines of small and medium-class mechanisation. For drifting and mining, combined drill rigs type DD 210 from Sandvik are planned, front-end loaders for transport and delivery of the mined ore and rock fill are planned with a bucket volume of 1.75-1.9 m^3 from Sandvik and underground mine trucks TH 320 with a load capacity of 20 t for extraction of the ore from the mine to the entrance of the flotation plant and transport of rock mass for backfill.

Mine drifting workings and operations for preparation of the reserves

The mine drifting workings in the "Varba-Batantzi" underground mine are characterised by building new main level workings, new cross entries, creating new ventilation and auxiliary workings, developing new local ramps for the preparation of each individual ore body and the enlarging of the existing workings. When designing the parameters of all of the new underground workings, attention is paid to the dimensions of the new mobile self-propelled mechanisation, the shape and dimensions of the ore bodies, the requirements for increasing the annual mine productivity as well as the specific requirements of the concessionaire. On this basis, the optimal solutions for the number, cross-sections and lengths of workings were taken.

In order to ensure a normal mining production process and preparation of the ore bodies, cross entries from the main inclined shaft to the main level gallery at horizon 435 are done, as well as connections with the existing infrastructure (Varba vertical shaft - 2, local ramps, existing level galleries, etc.). The overall length of the workings is 2546 m with a cross section of 14 m^2. It is also planned to install vertical ventilation drifts with a section of 4 m^2 and enlarging the gallery at a horizon 590 from 7 m^2 to 14 m^2 with a length of 2039 m. Through the launch of this new underground mining network, the total volume of prepared reserves is about 3.2 million tons.

For the preparation of each individual ore body in the project local ramps are designed. In their design, the aim is to cover a maximum quantity of ore reserves with a minimal amount of workings, ensuring a normal working environment and maximum execution of production tasks (such as annual ore volumes). Local ramps are designed to be drifted aside from the ore bodies as they are equipped with vertical drifts, overload points and material storage.

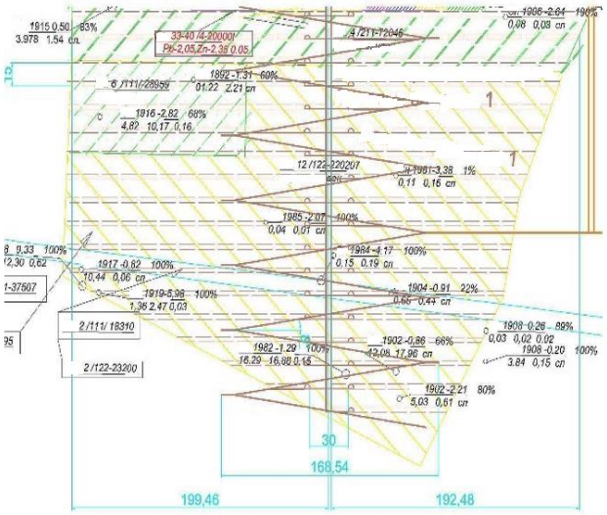

Fig. 3. Mine drifting workings for preparation of the reserves by applying the sublevel caving mining method

Each local ramp is uniquely projected to the particular body to which it relates as well as to the corresponding mining method that is applied in the given area of the underground mine, the sublevel caving mining method and the cut and fill mining method. The local ramps for the preparation of the reserves in the ore bodies are designed with a general slope of 8° and a cross section of 14 m^2 with a total length of 14489 m. Thus, the mining of the whole quantity of the studied reserves at the deposit up to the moment is being prepared.

The mine drifting workings in a deposit, for each applied mining method consists of sublevel drilling galleries for the sublevel caving method in the first mining layer (cut layer) in the cut and fill mining method. In blocks where the cut and fill method is used, the cut layers are developed through 63 m in height in order to increase the number of mine faces and to enable an earlier start of the ore extraction. The cross section of these layers is 7.5 m^2 (2.5x3.0). According to the sublevel

caving method, the sublevel galleries are drifted in 15 m through ore, and the cross section again is 7.5 m². The number and lengths of the galleries are connected with the dimensions of each individual ore block to which they are applied.

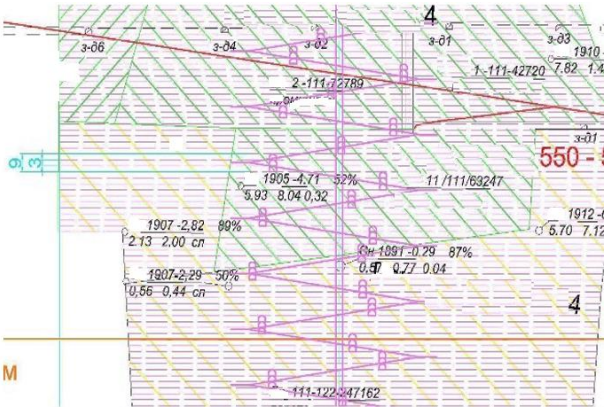

Fig. 4. Mine drifting workings for preparation of the reserves by the applying cut and fil mining method

The total volume of the mine drifting workings for the preparation of the reserves in "Varba-Batantzi" deposit are as follows: (Anastasova, Yanev, 2015; 2013)

- Linear coefficient:

$$\sum \ell_{\text{п.}} = 28\,377\ m; \sum V_{\text{п.}} = 318\,745\ m^3;$$
$$\sum \ell_{\text{н.}} = 16\,920\ m; \sum V_{\text{н.}} = 124\,770\ m^3;$$
$$K_{\text{п.н.}} = \frac{\sum \ell_{\text{п.н.}}.1000}{Z_{\text{об.}} - Z_{\text{п.н.}}} = \frac{45\,297.1\,000}{3\,202\,290 - 376\,805{,}4} = 16{,}03\ m/1000\ t$$

- Volume coefficient:

$$K'_{\text{п.н.}} = \frac{\sum V_{\text{п.н.}}.1000}{Z_{\text{об.}} - Z_{\text{п.н.}}} = \frac{443\,515.1\,000}{3\,202\,290 - 376\,805{,}4} = 156{,}97\ \ m^3/1000\ t$$

In this way, we obtain relative costs of 12.11 BGN/t in the mining works for the preparation for extraction and 3.56 BGN/t during the drifting of the first sublevels and layers.

The mine drifting workings for preparation of the deposits are characterised by completely new parameters of mine drifts (galleries, crosscuts, rises, ramps etc.) and implementation of completely new underground mining equipment for ensuring the mine-production processes and tasks.

Water intake and ventilation in the "Varba" and "Batanzi" deposits

The project for the Varba - Batantsi deposit envisages vertical and horizontal workings that will be used for ventilation, water intake, transport of ore and materials, auxiliary purposes and emergency exits from the main levels. The ventilation scheme of the Varba - Batantsi mine provides a suction operation of the ventilation system, as the analysis of the airflow of the individual main levels and workplaces will be carried out by means of ventilation partitions, ventilation doors and fans for local ventilation.

The following air quantity was calculated for the ventilation of the "Varba - Batantsi" underground mine.

- the required amount of air needed – during drifting

Table 1.

Factor	Blasting works	Minimal air seed	Dust
AIR m³/s	19.96 m³/s	3.5 m³/s	16.64 m³/s

- the required amount of air needed – during mining

The production programme and the applied mining methods in the mine foresee the simultaneous exploitation of 3 ore blocks, from which follows:

Table 2.

Factor	Drilling	Mobile equipment	Blasting works	Maximum number of persons
AIR m³/s	19.5 m³/s	61.68 m³/s	40.38 m³/s	5.5 m³/s

According to the requirements of "PBT for the development of ores and non-metallic deposits in the underground mines" and "Instruction for safe application of self-propelled non-rail machines in the underground mines" the required and sufficient air flow for ventilation of the "Varba - Batantszi" mine is taken to be 90 m³/s.

For normal mine operation on local ramps and mine faces in the ore bodies, the use of local ventilation fans form Epiroc Atlas Copco AVH 100 is envisaged.

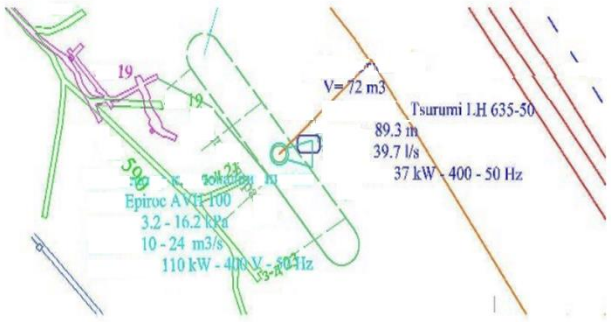

Fig. 5. Water intake and ventilation complex to a local ramp

Ventilation fans for local ramps should be placed at the beginning of each ramp: on level 590 for spirals 1.2 and 3; on level 540 for spirals 5, 6 and 7; on level. 640 for spiral 4. As mining work progresses in depth on each of the local spirals, it is necessary to use additional ventilators for local ventilation in a combined scheme. The aim is to facilitate and optimise the process of ventilation of workplaces by creating normal working conditions.

The water intake scheme provides water drainage to be carried out by 3 main water intake complexes located on level. 300 and level. 435 for the Varba deposit and level. 435 for Batantzi deposit.

Fig. 6. Main water intake complex at level 435 "Batanzi"

The volume of each of the water intake complex must comply with Art. 499 from PBT B-01-02-04 or V = 8 hours X 144 m^3/h = 1152 m^3

- For the Varba section of the deposit - the pumping of the water will take place at two levels (two stages) from a main water intake complex at level 300 with a displacement of 105 m to the main water intake complex at level 435, and from there with a displacement of 135 m to an existing water intake complex at level 540 (Vertical Shaft Varba 1) from where, on the existing grid, water will go out of the mine. For the implementation of the water drainage and water intake scheme, it is necessary to build connections (drift mining galleries and rises) between the newly built underground infrastructure and the Vertical Shaft Varba 2.

- For the Batantsi section of the deposit – the water drainage scheme foresees the mine water to be pumped by a main water intake complex at level 435 with a displacement of 155 m through a ventilation stack to a gallery on level 590 from where the water will enter the existing catchment complex and through the existing network the water will go away from the underground mine.

In view of the development of the mining works in depth, a possibility is provided for pumping the water from the water intake complex at level 435 in the direction of the Vertical Shaft Varba 1 through a central inclined ramp.

The water intake of the local ramps and the mining blocks should be carried out by mining pumps type LH 637-50 and the water will be led to the main water intake complexes.

Conclusions

The new infrastructure in the deposit is designed in line with the need for reaching the reserves in depth, the commissioning of an entirely new self-propelled mobile equipment, the introduction of new mining methods and the overall modernisation of the mine (Siderova, 2016).

The following investment will be needed for the implementation of the project for construction of new infrastructure in the "Varba - Batanti" underground mine:

Table 3.

No	Type of cost	Total amount, BGN
1.	Purchase of a new self-propelled mobile equipment – 3 full sets	5 420 000
2.	Capital workings	9 401 000
3.	Ventilation	300 762
4.	Water intake	1 695 700
5.	Auxiliary mine workings	375 000
6.	Mine ore and rock mass storages	962 500
7.	Electricity	575 590
	Total	18 730 552

As a result, lower production cost is obtained, the ore production is increased from 101.000 tons to 236.000 tons, i.e. 2.3 times more per year, flexibility and mobility in terms of the overall mining process and the individual production processes are created. There will be a positive final effect of the mining activities.

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