BİLİMSEL MADENCİLİK DERGİSİ
SCIENTIFIC MINING JOURNAL
TMMOB Maden Mühendisleri Odası Yayını / *The Publication of the Chamber of Mining Engineers of Turkey*

Teknik Not / *Technical Note*

ANNUAL PLANNING OF ORE AND Pb, Zn, Ag METALS PRODUCTION IN "TREPÇA" MINE IN STANTËRG

STANTËRG'DE "TREPÇA" MADENİNDE CEVHER VE Pb, Zn, Ag METAL ÜRETİMİNİN YILLIK PLANLAMASI

Rafet Zeqiri[a,*]

[a] Faculty of Geosciences, University of Mitrovica, 40000, Mitrovica, KOSOVO

Geliş Tarihi / *Received* : 04 Mart/ March 2020
Kabul Tarihi / *Accepted* : 22 Mayıs / *May 2020*

Keywords:
Mine,
Machinery,
Quality,
Production.

ABSTRACT

Underground mines are known as mines of particular importance, for the production difficulties, production cost, safety factor and workforce number. Ore is mined from the depths of the underground with a preliminary justification on the amount of ore at the source, the quality of the ore and general reserves and then based on them the daily, monthly or annual production is planned. The geological rock stability in the specific case constitutes special importance in determining the underground mining method, dimensioning of the capital mine works and the selection of work machinery. The purpose of the production organization is to produce through mining activities the necessary products for the market (necessary material goods) in the amount and quality required by the market, at the time they are expected by the market and at a price acceptable by the market.

Anahtar Sözcükler:
Maden,
Makine,
Kalite,
Üretim.

ÖZ

Yeraltı madenleri, üretim zorlukları, üretim maliyeti, güvenlik faktörü ve işgücü sayısı açısından özel önem taşıyan madenler olarak bilinir. Cevher, kaynaktaki miktarı, cevher kalitesi ve genel rezerv hakkında bir öngörü ile yeraltı derinliklerinden çıkarılır ve daha sonra günlük, aylık veya yıllık üretim olarak planlanır. Jeolojik kaya özel durumdaki dengesi, yeraltı madenciliği yönteminin belirlenmesinde, maden ocağının boyutlandırılmasında ve iş makinelerinin seçiminde özel önem taşır. Üretim organizasyonunun amacı, madencilik faaliyetleri yoluyla piyasa için gerekli olan ürünleri (malları) piyasa tarafından beklenen miktarda ve kalitede, piyasadan bekledikleri anda ve piyasa tarafından kabul edilebilir bir fiyata üretmektir.

* Sorumlu yazar / *Corresponding author* : rafet.zeqiri@umib.net • https://orcid.org/ 0000-0002-9071-3105

INTRODUCTION

The "Trepça" Mine is an old enterprise established by the English (Trepça Mine Limited Company) active since 1927, whereas its production started in 1930, as a result of researches started six years earlier. The raw material that is mined is led, zinc and silver sulphite ore, and within the positive economic limit about 74 workings are distinguished with 10,500,000 t of ore reserves. The mine exploitation duration, without any further deepening and without opening any new horizons (XII and XIII), if the annual capacity of 650,000 t/year is accomplished, may last over 16 years. The ore transportation from Stantërg to the enriching factory is done through the traverbank that connects Tuneli i Parë with Stantërg, and trucks are used to transport the led and zinc concentrate to the metallurgic units in Zveçan and Mitrovica (Zeqiri, 2008; Eyllie and Mah, 2004). Production at the Stantërg mine is conducted from the VI to the XI horizon, whereas the mining activity in lower horizons is unique.

1. MINING METHODS IN "TREPÇA" MINE

Historically the ore mining in Stantërg mine was conducted in several methods that were based on the horizontal slicing of ore bodies and filling up of created spaces (Rafet et al., 2019). The exploitation method at "Trepça" mine is presented in (Figure 1).

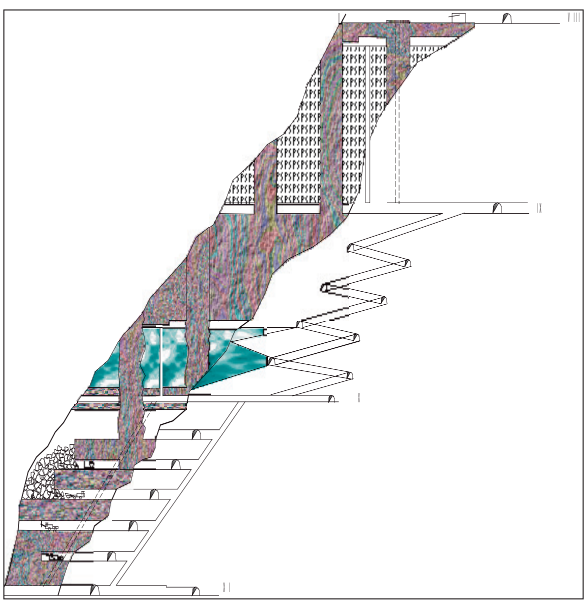

Figure 1. The exploitation method in "Trepça's" mine

There are three stages in this mining process (mining cycle):

• Stage one - cutting the ore body at a 3 m height and primary transportation of the fall.

• Stage two - cutting the floor (or the second subfloor) at a 2-3 m height, so that the entire height of the mining room is at 5-6 m.

• Stage three - filling the empty area with hydro-filling between 0.5-1 m height under the ceiling part of the next cycle.

2. SHAPE OF WORKINGS AND ORE QUALITY

During the production planning of course we are obliged to examine all the mine workings at various levels to prepare them for mining. The assessment of current status of workings is presented below (Zeqiri, 2004).

2.1. Working 119/f

It has a large area of 2856 m^2 suitable for mining with high production equipment with electro-hydraulic energy (Zeqiri, 2012-a). Unexploited height (45 m). The area of up to 5 m high should be filled with 14280 m^3 of hydro-filling material. The production from one floor reaches to 31701 t ore. Quality: Pb-2.20%, Zn-1.80%, Ag-25 g/t, (Figure 2).

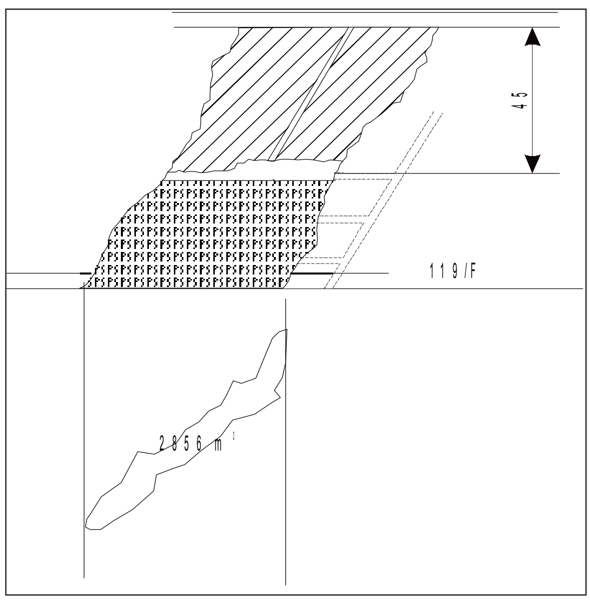

Figure 2. Working 119/F

2.2. Working 129/N

With a horizontal cut of 550 m^2 this working falls in the group of classic equipment appliers with medium productivity that can produce 6105 t of ore from one floor. For undercutting the ore body the following preparatory facilities are required: 40 m shaft for filling and 30m corridor through stable limestone rocks. After the undercutting a large amount of 2750 m^3 of filling material needs to be deposited in the floor area. Unexploited height is 53 m. Quality: Pb-7.35%, Zn-14.17%; Ag = 107 g/t, (Figure 3).

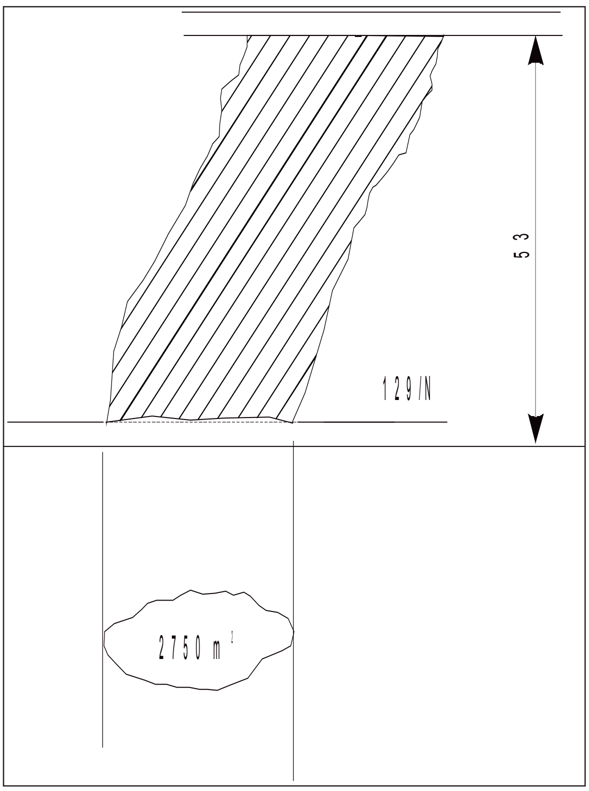

Figure 3. Working 129/N

2.3. Working 139/C1

It has a horizontal area of 737 m^2 of high quality ore body where the option of mining with modern productive equipment is justified. 13634 t of ore of the following quality can be mined from one floor: Pb = 3.46%, Zn = 6.10%, Ag = 60 g/t, (Figure 4).

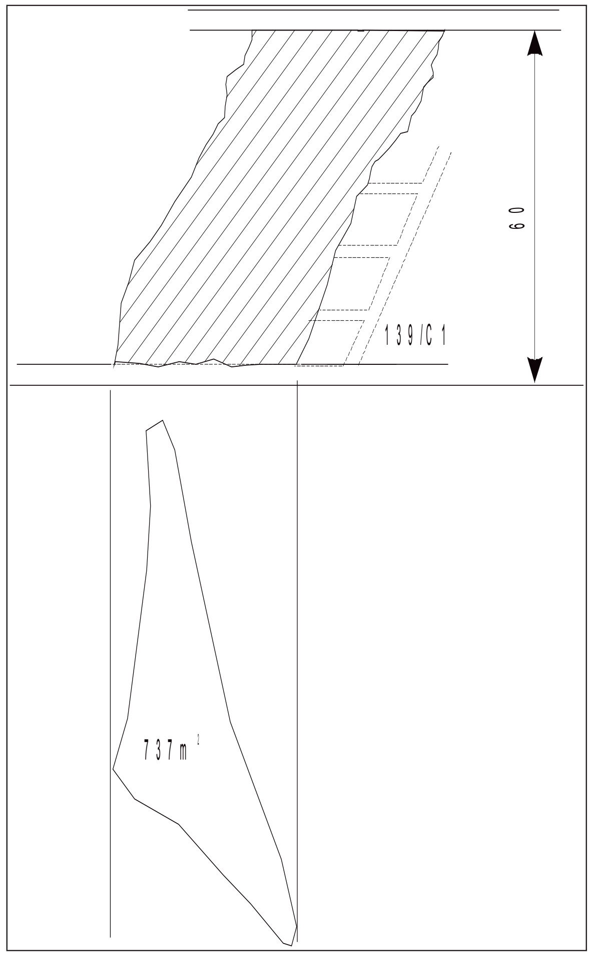

Figure 4. Working 139/C1

2.4. Working 140

This working belongs to the central body of horizons IX and X with a cutting area of 2392 m^2 and unexploited height of 27 m. The capacity of a 5 m high floor is 29600 t of ore with the following quality: Pb-2.98%, Zn-0.77%, Ag-102 g/t. High productivity electro-hydraulic energy cut and fill equipment is used for mining. Working 140 belongs to the central part of the source, the ore is sulphate with high metal composition. The ceiling contains geological contact such as: sericite schist and phyllite, whereas on the floor limestone (Haxhi, 1971). The dip of the ore body is approximately 45º. The ore mass is strong and compact, partially cut by cracks, (Figure 5) (Zeqiri, 2004).

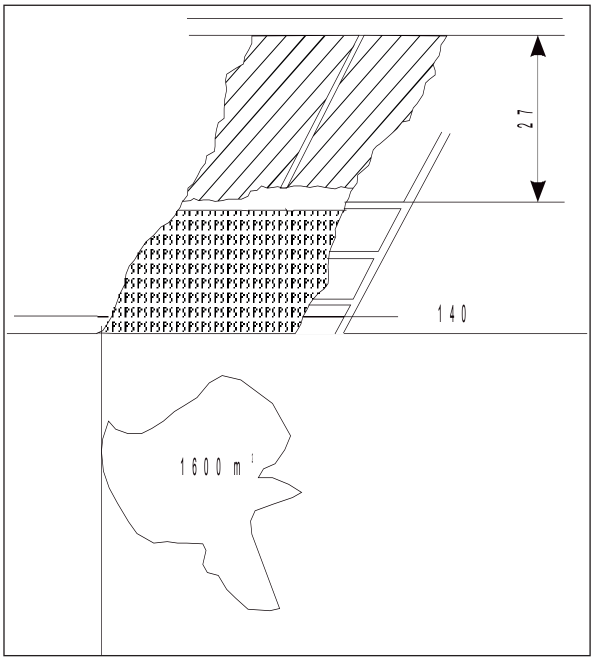

Figure 5. Working 140

2.5. Working 154

It has an area of 1094 m² with modern equipment production. 12143 t ore can be mined from the floor, whereas its unexploited height is 30 m up to the horizon above. The empty area of 5470 m³ has to be filled with hydro-filling material. From the preparation facilities a filling shaft of 60 m needs to be built. Working 154 belongs to the central part of the source. Quality: Pb-2.54%, Zn-1.34%, Ag-100 g/t (Figure 6).

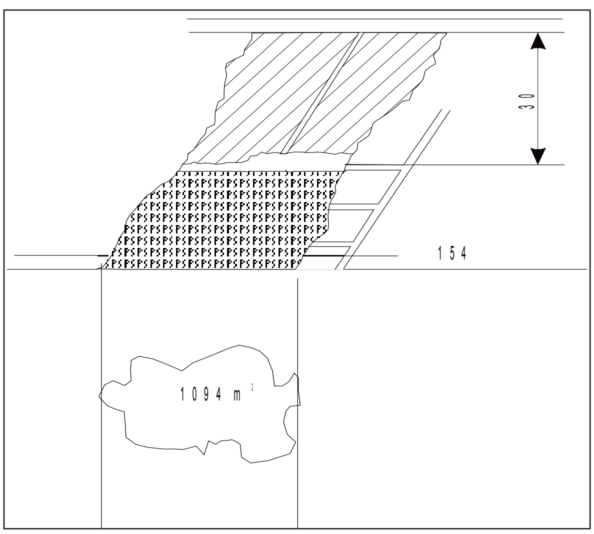

Figure 6. Working 154

3. MECHANIZATION AND COMPARING EFFECTS

Modern mechanization for work in underground mines has recently changed the entire concept of work and traditional philosophy. Drilling machines are mobile with pneumatic tyres and independent driving with diesel or electric engines. Drilling machine (Drifting Jumbo) has high mobility, thus it can quickly be moved from one side to the other without any difficulties. These machines are constructed in many variations (pneumatic tyres, chains, movement in rail tracks, with one branch (Photo 1) or several branches, diesel engine (Photo 2) or electric motor, thus for any specific conditions of any mine the corresponding drilling machine can be found.

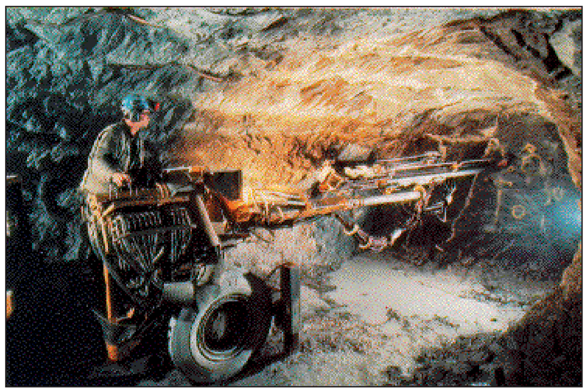

Photo 1. Pneumatic tyres machine

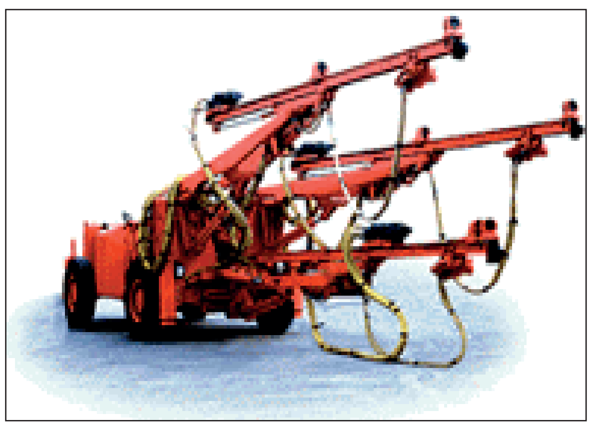

Photo 2 .Diesel engine machine

The brief experience from the application of these machines at the Stantërg mine shows that in mines the best effects could be expected from the two branch Jumbo machines, with hydraulic hammers, diesel engine and dismantling assisting basket in one branch. The bast is connected as a platform for the miner during the primary insurance of the working after mining and during the filling of holes with explosives (Pariseau, 2008; Hoek, 2000).

The integrating system, ore loading - primary transportation to the working, is the next stage in the technological chain and today is presented as LHD (Load - Haul - Dump). These loaders are compact, low for work in underground facilities, with pneumatic tyres, diesel engine and loading spoon of 1.5 – 5 m^3 (Photo 3 and Figure 7). These constructive features enable the quick and efficient loading of the fallen ore from the work site and its hauling to the ore shaft or any other unloading location.

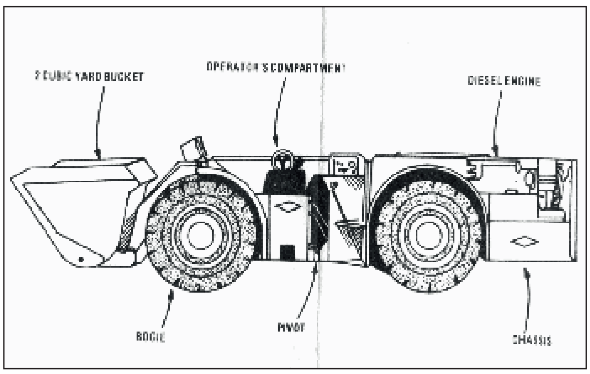

Figure 7. LHD loading machine

Photo 3. Transportation truck

The main ore transportation, which in the classic technology was carried out with locomotives (electric or accumulators), depending on the specific conditions of each mine, could remain the same, but this would cause a higher work cost compared to modern machinery - underground trucks that have a hauling capacity of 15-40 t and greater mobility.

4. PRODUCTION PLANNING BASE FOR YEAR 2020

Initially to start the production calculation and planning it has been taken into consideration the available machinery for mining ore, the area of workings, number of shifts, etc (Zeqiri, 2012-b). Then in the table below we calculate the dynamic plan for workings 140, 149, 154, 119F, 139-C1 and 129/N. In the calculation below we take working 140 where the ore is mined with a boomer and in the same way the calculations are done for the other workings as well. The Stantërg mine works in 3 shifts in drilling and blasting, whereas the loading capacity is at 50 t/h in case of hauling with trucks, whereas the loading capacity with locomotives reaches 10 t/h (Table 1).

4.1. Monthly Metal Production in Ore

In this specific case we review workings, for which we shall calculate the amount of led (Pb), zinc (Zn) and silver (Ag), that is derived from the monthly amount of the ore produced in the mine workings (Table 2).

4.2. Ore Mining Intensity in Workings Floors

Using the characteristics of ore and the conducting rocks, the stability of the plates that should be present during the primary exploitation of the mine, has been analyzed, this verification of the stability is oriented to the central mineral body that in some cuttings plane reaches the size of the surface up to 7000 m^2. First, the stability of ore mass on the plates has been verified according to N. C. Buliqev's equation, where the stability indicator "S" has a value of 8.45 according to the table indicates that the plate is stable (Gundewar, 2014). In the first case, plates thicknesses.

After calculating the production, and after find that monthly ore production, we must also calculate the ore mining intensity in workings, in the specific case of a working 140 with an area of 2987 m^2, floor height 5 m (Table 3).

Table 1. Production planning

Working	Time of drill (h/sh)	Drill speed (m/min)	Drill amount (m)	Number of drills per shift	Drilled volume (m^3)	Fallen amount (t/sh)	Work shifts in drill	Work shifts in load	Load capac. (t/h)	Load capac. (t/d)	Work days per month	Monthly production (t/m)	Quarter production (t^3m)	Annual production (t/v)
			1	2	3	4	5	6	7	8	9	10	11	
140	2	0.6	72	23	50	183.4	3	3	50	300	30	16,507	49,522	198,090
149	2	0.6	72	23	50	183.4	3	3	50	300	30	16,507	49,522	198,090
154	2	0.6	72	23	50	183.4	3	3	50	300	30	16,507	49,522	198,090
119-F	2	0.6	72	23	50	183.4	3	3	50	300	30	16,507	49,522	198,090
139/C1	3	0.12	21.6	12	14	52.0	3	3	10	60	30	4,677	14,031	56,125
128-P	3	0.12	21.6	12	14	52.0	3	3	10	60	30	4,677	14,031	56,125
Total						837.6						75,384	226,152	904,610

Table 2. Monthly metal production

No.	Working	Area of the working S (m^2)	Ore quality			Monthly production Q (t/m)	Amount of metals in ore		
			Pb (%)	Zn (%)	Ag (g/t)		Pb (t)	Zn (t)	Ag (Kg)
1	140	2987	2.79%	2.84%	67.17	16,507	460.6	468.8	1,109
2	149	1050	6.14%	10.84%	93.3	16,507	1,013.6	1,789.4	1,540
3	154	850	2.54%	1.34%	100	16,507	419.3	221.2	1,651
4	119-F	2856	2.20%	1.80%	31	16,507	363.2	297.1	512
5	139/C1	575	3.46%	6.10%	60	4,677	161.8	285.3	281
6	129/N	158	7.30%	14.17%	107	4,677	341.4	662.7	500
					amount	75,384	2,760	3,725	5,593

Table 3. Individual working calculations

No.	Working	Area S (m^2)	Mining height (m)	Amount of ore in floor (t)	Monthly fallen amount (t)	Work days in the working	Real daily production (t/day)
1	140	2987	5	46,971	16,507	85	550
2	149	1050	5	16,511	16,507	30	550
3	154	850	5	13,366	16,507	30	446
4	119-F	2856	5	44,911	16,507	82	550
5	139/C1	575	3	5,425	4,677	35	156
6	128-P	158	3	1,491	4,677	30	50
Amount							2,302

4.3. 2020 Monthly dynamic production plan

The accurate daily and monthly ore production in each working, and also the amount of ore in the floors of mineral bodies is calculated with Microsoft Excel, which will be used every month. In the following tables (Table 4, 5 and 6) have presented 12; 2020 months in some workings that will provide opportunities for high intensity mining and observing the production quality wise (Kelmendi and Zeqiri, 2006).

Table 4. January 2020

Area (m^2)	Amount ore (t)	Work days per month	Production daily (t)	Production monthly (t)	Metal quality Pb (%)	Zn (%)	Ag (g/t)	Remaining amount ore (t)	Area remaining (m^2)
2987	55259.5	22	550	12100	2.79%	2.84%	67.17	43159.5	2332.95
1050	19425	22	150	3300	6.14%	10.84%	93.3	16125	871.62
850	15725	22	150	3300	2.54%	1.34%	100	12425	671.62
2856	52836	22	150	3300	2.20%	1.80%	31	49536	2677.62
575	10637.5	12	90	1080	3.46%	6.10%	60	9557.5	516.62
158	2923	12	90	1080	7.30%	14.17%	107	1843	99.62
			amount	24160					

Table 5. February 2020

Area (m^2)	Amount ore (t)	Work days for month	Production daily (t)	Production monthly (t)	Metal quality Pb (%)	Zn (%)	Ag (g/t)	Remaining amount ore (t)	Area remaining (m^2)
2332.9	43159.5	22	550	12100	2.79%	2.84%	67.17	31059.5	1678.89
871.62	16125	22	150	3300	6.14%	10.84%	93.3	12825	693.24
671.62	12425	22	150	3300	2.54%	1.34%	100	9125	493.24
2677.6	49536	22	150	3300	2.20%	1.80%	31	46236	2499.24
516.62	9557.5	12	90	1080	3.46%	6.10%	60	8477.5	458.24
99,622	1843	12	90	1080	7.30%	14.17%	107	763	41.24
			amount	24160					

Table 6. December 2020

Area (m^2)	Amount ore (t)	Work days per month	Production daily (t)	Production monthly (t)	Metal quality % Pb (%)	Zn (%)	Ag (g/t)	Remaining amount ore (t)	Area remaining (m^2)
2341.6	43319.9	19	90	1710	4.27%	1.34%	100	41609.945	2249.19
514.59	9520	22	150	3300	8.5%	4.36%	62.96	6220	336.22
294.19	5442.5	22	150	3300	2.54%	1.34%	100	2142.5	115.81
1607.4	29736	22	150	3300	2.20%	1.80%	31	26436	1428.97
166.35	3077.5	12	90	1080	3.46%	6.10%	60	1997.5	107.97
70.26	1299.81	22	90	1980	4.20%	4.28%	93	0	0.00
			amount	14670					

5. PRODUCTION TIME PLANNING ORGANOGRAM

Using the characteristics of ore and the conducting rocks, the stability of the plates that should be present during the primary exploitation of the mine, has been analyzed, this verification of the stability is oriented to the central mineral body that in some cuttings plane reaches the size of the surface up to 7000 m^2.

In the mining and preparation of ore bodies for mining stage it is especially important to follow and plan the time interval of each work cycle through the stipulated and planned stages (Hughes, 2001). Starting time of mining and duration of production in workings can be seen in Figure 8.

Figure 8. Production work interval in minings.

CONCLUSION

The production planning with all the required technical details is done by the technical sector of the Mine, and this paper will contain only the more determining details for the workforce, qualification and professional knowledge the workers should have. The planning of ore production and other accompanying indicators (hydro-filling, preparatory works - ramp, galleries, shafts, second exits, technical and determining drills, etc.), is a primary responsibility of the technical sector of the mine.

The annual dynamic plan has to be broken down into monthly dynamic plans. According to these plans the Stantërg mine has the capacities to fulfil this ore and concentrates production dynamic. In relation to the quality of the produced ore, it remains one of the most creative tasks of the engineers, should present and fulfil a production dynamic plan.

REFERENCES

Eyllie, C.D., Mah, EC., 2004. Rock Slope Engineering. IMM, Abingdon.

Gundewar, S.C., 2014. Application of Rock Mechanics in Surface and Underground Mining. Indian Bureau of Mines. p 132.

Haxhi S., 1971.Mechanics of the rocks I, II, III, Tirane.

Hoek, E., 2000. Rock Engineering: Course Notes. A.A. Baklema of Rotterdam.

Hughes, J. R., 2001. The Finite Element Method, Linear Static and Dynamic Finite Element Analysis. Dover Publications, Inc., Mineola, New York, 682 p.

Kelmendi., Sh., Zeqiri., I, 2006. Mathematical Methods in Engineering. University of Prishtina, Kosovo.

Pariseau, W.G., 2008. Solutions Manual to Design Analysis in Rock Mechanics. Taylor & Francis, p 360.

Rafet Z., Jahir G., Festim K., 2019. Stability Analysis of Security Pillars with Dimension 10 × 10 m Fromed by Ore of Mineral Body During the Exploitation of the “Trepça” Mine in Stantërg. Mining Science, vol. 26, 2019, 37–44.

Zeqiri, A., R., 2012-a. Geostatistics in Modern Mining Planning. Fray International Symposium, Volume 5, CanCun, Mexico.

Zeqiri, A., R., 2012-b. Dispense from the Mechanics of the Rocks. University of Prishtina, Faculty of Geosciences, Kosovo.

Zeqiri, A., R., 2008. Sustainability Analysis of Trepca Mine Security Pillars in Stantërg, Professional Analysis. University of Prishtina, Kosovo.

Zeqiri, A., R., 2004. Dimension of Pillars and Safety Pillars in “Trepca” Mining in Stanterg, Professional Analysis. University of Prishtina, Kosovo.