Chapter 3

OCCUPATIONAL SAFETY AND EMPLOYEE HEALTH IN OPEN PIT MINING OPERATIONS: A SAMPLE APPLICATION

Onur DOĞAN[1]

INTRODUCTION

Mines are valuable resources of strategic importance for nations to reach the economic and technological prosperity levels they have today. Minerals are needed directly or indirectly in the production of most of the elements such as tools and equipment that facilitate daily life. The most important inputs of the industry (natural dyes, abrasives, filling materials, etc.), especially metallurgy, construction, and ceramics, are minerals (Önal, 2019). Mining consists of technical processes such as exploration, extraction, and operation of minerals both above and underground. It is an applied science developed to supply minerals with economic value to industry with rational methods. It includes processes such as exploration, project, operation, and enrichment of mines. Today, approximately 70% of mining activities are carried out by open pit mining methods. Open pit mining is the process carried out by removing the cover layer without the need to go underground, which has the economic value of the mine that has been identified or outcropped underground, is called open pit mining. 1/3 of coal mining, non-metallic construction materials and half of metallic minerals are extracted by open pit mining method. Exceptionally for metallic minerals, 74% in the United States, which produces copper ore, and 40% worldwide are mined by open pit mining (ÇSGB, 2015). Table 1 shows the types of equipment used in open pit mining activities.

[1] Assist. Prof. Dr., Gümüşhane University, onur.dogan5065@gmail.com, ORCID iD: 0000-0001-8231-9872

Table 1. Main equipment used in an open pit mine			
Number	**Equipment Type**	**Number**	**Equipment Type**
1	Excavator	13	Carrier Tapes
2	Crawler Backhoe Loader	14	Compressor
3	Wheel Loader	15	Counting Machine
4	Dozers	16	Diamond Wire Cutting Machine
5	Drilling Machines	17	Lever Cutter
6	Truck	18	Hydraulic Block Separation Plates
7	Tractor	19	Welding Machines
8	Irrigation Truck	20	Workshop Equipment
9	Crushing Screening Grinding Plant (Crusher-Mill)	21	Beneficiation Plant (Flotation, Shaking Table Jig etc.)
10	Magneto	22	Compressor
11	Generator	24	Various Hand Tools

Source: (ÇSGB, 2018)

The most important reasons why open pit mining is preferred over underground mining can be listed as follows: the continued existence of mines with high economic value on the surface, the production method is economically cheap, production processes are more controllable, decisions to identify and prevent risks can be taken quickly, production capacity is high and fast, and it adapts quickly to technology.

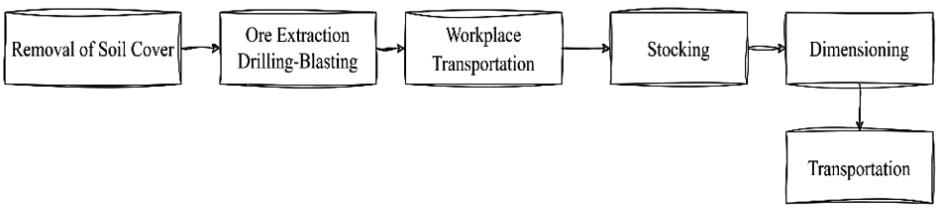

Figure 1. Production process in an open pit mine
Source: (ÇSGB, 2018)

The production of ore with high economic value in open pit mining consists primarily of removal of the cover layer, blasting, excavation-loading, stockpiling, sizing, and general transportation processes (Figure 1).

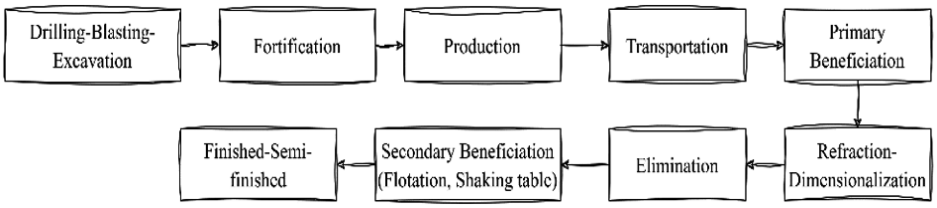

Figure 2. Flow chart for the transformation of ore into product in underground metal mining operations
Source: (ÇSGB, 2018)

Underground mining method is used in 30% of mining activities. Underground mining is the method used for minerals that are deeper in the earth's crust and have high economic value. The underground mining method does not pose a risk to the environment and is not affected by natural phenomena. In Figure 2, the production flow chart in an underground mining operation is given in a simple way within the scope of the steps to be followed briefly. In underground mining methods, after the ore is discovered, holes are drilled using drills such as simba. Various explosives are used to fill the holes and the holes are tightened. After blasting, the roof stones are cleaned. The type of support is determined by considering the ore and slag. A ventilation system is designed for the quarry air (stratifier-harmful gases). Collection ponds are created for quarry water. Necessary lighting is provided, and other requirements identified during the production process are completed.

According to the Communiqué on Workplace Hazard Classes Regarding Occupational Health and Safety, the mining sector is classified as a very hazardous industry. At this point, critical elements such as production methods, machinery, tools, and equipment used, and the competencies of employees are of great importance for the healthy and safe sustainability of production. Although underground mining activities are very risky in this line of work, open pit mines can also be places where serious occupational accidents can occur, if necessary, precautions are not taken. For example, on February 6, 2011, two slope slides occurred in an open pit coal mine. A total of 11 miners lost their lives after this incident. On November 17, 2016, 16 miners lost their lives after a landslide at an open pit metal mine in Şirvan, Siirt. On October 17, 2017, 7 miners lost their lives in a landslide at an open pit coal mine in Şırnak. On February 18, 2019, 3 mine workers lost their lives due to a block slide in Muğla-Milas open pit feldspar mine (Chamber of Mining Engineers, 2021). Donoghue (2004) conducted a study on

occupational and health hazards in mining. Badri et al. (2011) conducted a study on the Integration of Occupational Health and Safety into Risk Management in an open pit mining project in Quebec, Canada. Irgat et al. (2015) conducted a study on the perspective of occupational safety in coal mines operating with open pit mining method. Şafak et al. (2018) conducted a sample application study on occupational safety in open pit mining operations. Kasap (2018) conducted a study within the scope of post-production regulations in open pit coal mines. Nguyen et al. (2020) analyzed the current situation in their study on health and safety in the open pit mining sector and made various recommendations. Ceylan and Başar (2020) evaluated the risks in Tavas Bahçeköy Olivine Production Facility with L Type Matrix method.

This study is a study on the assessment of risks in an open pit mining operation. In the study, L Type Matrix (5x5) method, which is one of the most preferred methods among risk assessments (in terms of being simple, easy and understandable), was applied. A total of 33 risks were identified in the study. These risks were ranked according to their importance levels and protective and preventive practices to prevent risks were mentioned.

L TYPE MATRIX METHOD

According to the Occupational Health and Safety Risk Assessment regulation; risk is defined as the possibility of loss, injury or other harmful situation arising from hazards. Hazard is a situation that exists in the workplace or that may come from outside, that may harm the employee or the enterprise, or that has the potential to harm. A near-miss is a situation that occurs in the workplace and has the potential to harm the employee, the workplace or the machinery and equipment, but does not harm them. Prevention refers to measures planned or taken to eliminate or minimize risks related to occupational health and safety at all stages of the work carried out in the workplace. Risk assessment is the work carried out to identify the hazards that exist in the workplace or that may come from outside, to analyze the issues that cause these risks to turn into hazards and the risks that may arise from hazards and to decide on control measures (Occupational Health and Safety Risk Assessment Regulation, 2012).In this method, first of all, the probability of an event occurring and the result if it occurs are measured and graded. In the analysis, the risk score is obtained by multiplying the degree of damage by the probability (Özkılıç, 2005).

Table 1. Probability rating steps	
Possibility	**Probability**
Very small	Almost never
Small	Very few (once a year)
Middle	Few (more than once a year)
High	Frequently (Once a month)
Very High	Very often (once a week or a day)

Source: (Özkılıç, 2005)

Table 2. Grading of results	
Conclusion	**Rating**
Very light	No loss of working hours, situation requiring first aid
light	No lost working days, no lasting effects
Middle	Mild injury, inpatient treatment required
Serious	Serious injury, occupational disease, long-term treatment
Very serious	Death, permanent incapacity for work

Source: (Özkılıç, 2005)

In obtaining the scores in the L Type Matrix method, the numerical expressions in Table 1 and Table 2 are obtained by substituting the formula below. As a result of these operations, Table 3 is obtained. As a result of the risk assessment, they are ranked from the highest numerical value to the lowest value and necessary protective and preventive practices are implemented (Yılmaz & Kılıç, 2019).

R: Risk, O: Probability, S: Severity

Risk Probability x Severity

Table 3. Severity grading					
	Violence				
Probability	1 (So Light)	2 (Light)	3 (Moderate)	4 (Serious)	5 (Soserious)
1 (Very Small)	1(Meaningless)	2(Low)	3(Low)	4(Low)	5(Low)
2 (Small)	2 (Low)	4(Low)	6(Low)	8(Middle)	10(Middle)
3(Moderate)	3 (Low)	6(Low)	9(Middle)	12(Middle)	15(High)
4 (High)	4(Low)	8 (Middle)	12(Middle)	16(High)	20(High)
5 (Very High)	5(Low)	10(Middle)	15 (High)	20(High)	25 (İntolerable)

Source: (Özkılıç, 2005)

According to the risk score action table in Table 3; the numerical expressions 1,2,3,4,5,6 express low level, i.e., acceptable risk. The numerical expressions 8,9,10,12 express medium level risks, i.e., risks that need to be taken into consideration. The numerical expressions 15, 16, 20 and 25 express high level, i.e., unacceptable risk value (Özkılıç, 2005). While conducting a risk assessment, some issues and some processes need to be considered. Accordingly, the following steps are followed when making a risk assessment, identifying hazards, identifying risks, determining the severity value and risk probability, obtaining risk values, determining the measures to be taken, grading the risks, implementing risk control measures, auditing, supervision and monitoring of the practices. Some documents and information should be taken into account when creating this process. Accordingly, information such as workflow chart, working hours, total number of employees, work processes, machinery-equipment, occupational health and safety instructions, working environment measurements (dust, noise, vibration, etc.) are taken into consideration. The following steps are followed in planning the risk assessment; the area and activities to be studied are determined, the method to be used is determined, hazard sources are determined by taking these two issues into account, contact with experienced authorized personnel related to the area to be studied, and a work schedule is created for the points to be risk assessed (Ünverdi and Çetinyokuş, 2021). According to Law No. 6331 on Occupational Health and Safety, risk assessments are updated every 2 years in very hazardous workplaces, every 4 years in hazardous workplaces and every 6 years in less hazardous workplaces, taking into account the hazard class (Occupational Health and Safety Risk Assessment Regulation, 2012).

MATERIAL AND METHOD

Material

The study was conducted in an open pit limestone quarry. The quarry is quarried about three times a week (drilling in the range of 100-150 holes). Approximately 300 tons of limestone is produced daily. The quarry has 10 work trucks, one driller, 27 employees, 4 work machines (loaders). Production has been carried out in the quarry since 2012. A total of 43 occupational accidents have occurred since the start of production. None of these accidents resulted in loss of limbs or death.

Method

L Type Matrix (5x5) method was used in the study. The L Type Matrix (5x5) method is a method that especially evaluates cause-effect relationships. The simplicity of the method and the fact that it can be performed by a single analyst makes it more advantageous than other methods. However, performing different tasks may not always be sufficient in the face of changing conditions. The success of the analysis used may vary depending on the competence of the person(s) performing the analysis. It is used to identify hazards in cases where it is important to take measures in urgent situations (Özkılıç, 2005). It is a method that requires subjective decisions to be taken on some issues while objective decisions can be taken on some issues in the analysis.

Findings

Table 4 shows the table obtained as a result of risk assessment. Within the scope of the study, a total of 6 high level risks were identified, 13 medium level risks and 14 low level risks were identified. Occupational health and safety training is provided periodically in the enterprise. Within the scope of the training, issues such as occupational health and safety, occupational diseases, near-miss incidents, use of personal protective equipment, business, production and environmental risks are among the main issues addressed within the scope of the training.

Table 4. Risk Assessment Table

P V R					Risk Assessment			
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
1	Lack of Material Safety Data Sheets (MSDS) for Chemicals	Failure to Recognize Chemicals Used, Fire, Explosion	All Employees	Serious Injury, Death	**4**	**5**	**20**	"Communiqué on the Preparation of Safety Data Sheets for chemicals used in the workplace" should be taken into consideration and posted in places where employees can see them.
2	Operations with Electrical Machinery-Equipment	Failure to grounding and maintenance of electrically operated machines	All Employees	Serious Injury, Death	**4**	**4**	**16**	Grounding and periodic checks should be carried out for machinery-equipment with an operating voltage above 42 volts at the workplace .
3	Maintenance and Repair of Trucks and Work Machines	Worker trapped under the dumper, overturning of the cabin	Personnel responsible for maintenance and repair	Crush, Crash, Death	**2**	**4**	**8**	Under no circumstances should work be carried out with the boom of the machine raised. If there is a situation where work needs to be done, a wedge should be placed between the boom or damper.

Table 4. Risk Assessment Table

PVR					Risk Assessment			
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
4	Heaters	Fire	All employees	Death, Injury	**2**	**5**	**10**	Open flame heaters should never be allowed in places where there is a possibility of flare-ups and fires.
5	First Aid	Lack of first aid personnel	All employees	Death or Disability of the injured person	**2**	**3**	**6**	One person for every ten employees should be sent to a first aid training center authorized by the Ministry, and employees should be provided with a basic first aid training certificate
6	Electrical Panel and Secondary Panels	No Leakage Current Role	All employees	Death by Electric Shock	**3**	**3**	**9**	The residual current role must be connected to the main electrical installation against possible electrical leakage.
7	Electric Panels	Electric shock	All Employees	Injury, Death	**3**	**4**	**12**	Insulating material should be placed on the conductive parts of the electrical panels to prevent contact.

Table 4. Risk Assessment Table

P V R					Risk Assessment			
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
8	Backhoe and Loaders	Presence of unqualified and unauthorized persons around the machines	All Employees	Injury, Death	**2**	**4**	**8**	Operators must have a driver's license and unauthorized persons must be prevented from entering and being present in these areas
9	Material Loading	Material Loading	All Employees	Injury	**2**	**3**	**6**	Especially rear-view mirrors and audible warning systems operating during reverse maneuvering must be in working order. During night work, the headlights of the machines should work in such a way that all of them are lit.
10	Environmental Protection	Classification of workplaces	People living around the business	Injury	2	3	6	Quarry entrances should be controlled and necessary protective signs (quarry area, explosives, high voltage) should be placed.

Table 4. Risk Assessment Table

P V R					Risk Assessment			
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
11	Provision of Ear Protectors	Noise exposure	All employees	Occupational disease	2	3	6	Each quarry worker should be provided with ear protection against noise exposure. Employees should be subjected to periodic health examinations (at least once a year)
12	Supply of dust masks	Dust exposure	All employees	Occupational disease	2	3	6	Dust masks should be provided to every quarry worker. Periodic health examinations should be carried out.
13	Personal protectors	Failure to recognize employees working at night	All employees	Injury	2	3	6	Reflective vests should be provided especially for night shift workers so that they can be seen.

Table 4. Risk Assessment Table

P V R					Risk Assessment			
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
15	Personal Protective Equipment Table	Failure to identify personal protective equipment	All employees	Injury, occupational disease	2	4	8	Risks should be identified and the personal protective equipment that should be used against which risks should be provided, as well as training on the use of PPE.
16	In-January Activities	Presence of water pools or ponds	All employees	Death, injury	3	3	9	Puddles of water in or around the stove should be surrounded by wire fences and warning signs should be posted.
17	Tetanus Vaccine	Tetanus occurrence	All employees	getting sick	2	3	6	All precautions should be taken against the risk of tetanus. Health screening should be carried out against possible risk areas.
18	In-January Activity	Steps with high heights	All Employeesr	Injury, death	3	3	9	Step heights should be planned taking into account risks such as slipping or collapse.

Table 4. Risk Assessment Table

P V R					Risk Assessment			
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
19	Activities of Construction Machinery	Lack of Fire Extinguishers on work machines	All Employeesr	Injury, death	3	3	9	Work machines must be equipped with fire extinguishers. Work machines must be equipped with extinguishing devices in accordance with TS 862 EN3 standard.
20	Production Activities	Step Height	all employees	Injury	2	3	6	The step height should not exceed the boom height of the work machine.
21	Production Activities	Press Width	all employees	Death, injury	2	4	8	The tread width should be wide enough for easy maneuvering of the work machine.
22	Cooker powders	Environmental contamination	all employees	Dust-related diseases	2	3	6	Periodically, the quarry roads should be watered with an all-terrainer.

Table 4. Risk Assessment Table

P V R					Risk Assessment			
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
24	Blasting	Stone splash	All employees, other persons	Death, injury	4	4	16	Necessary protective measures should be taken when blasting is to take place.
25	Production	Landslide	all employees	Death, injury	2	4	8	Employees should not be kept at the toe bottoms and toe tips.
26	Production	Landslide	all employees	Injury	2	4	8	Parking or working of construction equipment at the bottom and ends of steps should be prevented.
27	Production in January	Employees Under the Machine	all employees	Death Injury	3	5	15	Information and occupational safety training should be given to employees about the risk of getting under work machines in hot weather

Table 4. Risk Assessment Table

P V R					Risk Assessment			
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
29	Quarry Roads	Overturning of Trucks	Truck drivers and heavy equipment operators	Sickness, allergies	2	2	4	Quarry roads can be damaged by overloading trucks with material.
30	Material Transportation	Environmental Pollution	All employees, other people in the environment	Environmental pollution, disease	2	2	4	Trucks should be covered with tarpaulins to prevent dust flying.
31	Emergency Evacuation	Information Confusion during an Emergency	all employees	Death Injury	3	4	12	All employees should be included in the emergency plan, the plan should be posted where all employees can see it, and periodic updates should be made.

Table 4. Risk Assessment Table								
P V R					Risk Assessment			
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
33	High voltage lines	Electricity surge	all employees	Death Injury	4	5	20	Warning signs should be placed on high voltage poles, and if possible, the construction site should be monitored in real time .

Mining is one of the most dangerous lines of work in the world. If necessary protective and preventive measures are not taken, serious injuries or fatal work accidents can occur. For example, in quarries where open pit methods are used, the process of taking the material from the bottom at an inverted angle, known as reverse chiseling, can cause the upper step to slide en masse to the lower step. Open pit production areas are mostly open and unprotected from the sun. Especially in the process of waiting for loading, operators can get under the machines to protect themselves from the heat. One of the biggest risks is the presence of workers or construction machinery at the bottom and ends of the steps in the open pit operation. This is because the material in the upper level, especially the clay in its structure, can release itself as a block due to cracks. Another important problem is the slope angle. The slope angle (the angle of the excavated area with the surface) should be left in accordance with the standards specified in the legislation, taking into account the properties of rock and side rocks. According to Article 1.11 of Annex-2 of the Regulation on Occupational Health and Safety in Mining Workplaces, in open pits where manual excavation and loading is performed, the step height cannot exceed 3 m. In these quarries, the slope angle cannot exceed 60 degrees in solid ground structures, 45 degrees in depressed, crushed, sandy lands, and 30 degrees in watery and slippery lands. Slope angles that are not left in accordance with these standards can be very risky at every stage of production, especially during seasonal transitions (increase in cracked surfaces after spring rains). For this reason, especially at the beginning of each shift, every step from the top to the bottom of the quarry should be checked. Another important issue is blasting. Blasting is a must in mining activities. Blasting is used to separate the high economic value part of the ore from the side rock. The most important issue to be considered here is the distance between the holes during drilling. The distance between holes can be approximately 1-1.5 m. If the distance between the holes is more than these ratios, the material will be broken into blocks after blasting, which is never desirable. Because reducing the large size to smaller sizes requires the use of a crusher, which increases the cost and slows down production. If the distance between the holes is short, the bounce rate will increase. This creates a damaging effect for people, machinery or other elements around. Places where open pit activities are carried out are areas that should always be surrounded by fences or wire mesh. By preventing unauthorized entry and exit, risks from outside can be minimized. Such issues may vary according to the structure of the ore, employee competence and production method in open pit mining.

Conclusion and Recommendations

This study was conducted in an open pit mining operation. Open pit mining consists of various stages from the discovery of ore to the final product. Open pit mining method is known as a safer production method compared to other mining activities (underground, drilling). However, if the necessary protective and preventive care is not taken, accidents can become inevitable. As a matter of fact, these accidents have been mentioned in the previous sections of the study. In open pit mines, there are various risks such as being easily affected by natural phenomena, blasting, slope slippage, machine accidents.

In this study, risks in open pit mines are discussed in general terms. Risks can be easily identified and prevented where open pit methods are used and coordination is easy. In the study, 6 high level risks, 13 medium level risks and 14 low level risks were identified. In the mining sector, all kinds of situations from the lowest level risk to unacceptable risk should be taken into consideration. Because the smallest risk that is ignored in mining compared to other sectors can negatively affect tens, maybe hundreds of employees. The necessary precautions should be implemented in full, starting from unacceptable risks to the lowest score level risks. In addition to these measures, it should not be forgotten that the integration of safety culture in an enterprise starts with the adoption of the management staff.

REFERENCES

ÇSGB. (2015). *Final report of the programmed inspection for improvement of working conditions in underground and aboveground coal pits and other mines operating underground*, Republic of Turkey Ministry of Labor and Social Security, Presidency of the Board of Labor Inspection.

Önal G. (2019). *The importance of mining in country development*. http://www.cinermediagroup.com/documents/ 153645324347b30ec56284f.doc (Date of Access: 10.05.2023).

Ministry of Labor and Social Security, Presidency of Guidance and Inspection (2018). *Occupational health and safety program in underground and surface mining workplaces and industrial facilities based on mining*. Access Address: https://www.csgb.gov.tr/medias/11979/2017_yeralt%C4%B1-ve-yeruestue-maden_press.pdf. Access Date: 15.05.2023.

Occupational Health and Safety Risk Assessment Regulation. (2012). (December 29, 2012). Access Address: https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=16925&MevzuatTur=7&MevzuatTertip=5. Access Date: 11.02.2023.

Özkılıç, Ö. (2005). *Occupational health and safety, management systems and risk assessment methodologies*, Confederation of Turkish Employers' Associations Publication No: 246, Ankara.

Yılmaz, A. & Kılıç, A.M. (2019). Risk assessment of Kargı Hydroelectric Power Plant Project Tunnel in terms of occupational health and Safety. *Ç.Ü Journal of Science and Engineering Sciences*, 38(3), 28-35.

Ünverdi.Ş. & Çetinyokuş, S. (2021). Risk Assessment with L type matrix method in asbestos application center and sem laboratory in a public institution, *Karaelmas Journal of Occupational Health and Safety,* 5(2), 99-107. DOI:10.33720/kisgd.977714.

Communiqué on Workplace Hazard Classes Regarding Occupational Health and Safety. (2012). (December 26, 2012) Access Address: https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=16909&MevzuatTur=9&MevzuatTertip=5, Access Date: 15.02.2023.

TMMOB Chamber of Mining Engineers (2021) *Report on occupational accidents in mining 2010-2020 access* Address: https://api.maden.org.tr/uploads/portal/resimler/ekler/f4e5d6912a_2079309069_ek.pdf

Şafak, R. E., Şensöğüt, C. & Kasap, Y. (2018). Occupational safety practice in open pit operations: A case study. *Scientific Mining Journal,* 99-108. DOI: 10.30797/madencilik.493320.

Başar, O. & Ceylan, H. (2020). Occupational safety risk analysis in Tavas Bahçeköy olivine production facility, *Journal Of Technical Sciences,* 10 (1), 9-15. DOİ: 10.35354/tbed.638207.

Irgat, H. H., Kocaman, R., Irgat, S. Y. & Kocaman B. (2015). *An overview of occupational safety in coal quarries working with open pit method, symposium on occupational health and safety in mining operations 2015*, 21-22 December, Adana.

Kasap, Y. (2018). Post-production regulations in open pit coal mines. *Soma Vocational School Technical Sciences Journal,* 1 (25), 42-52. Retrieved from https://dergipark.org.tr/tr/pub/somatbd/issue/39818/471939.

Nguyen, T.Anh. & Nguyen, B.Ngoc. (2020). Health and safety among open- pit mining industry: Current situation and recommendations (in Vietnamese). *Journal of Mining and Earth Sciences*. 61, 5 (Oct, 2020), 134-142. DOI:https://doi.org/10.46326/JMES.KTLT2020.12.

Donoghue, A. M. (2004). Occupational health hazards in mining: an overview, *Occupational Medicine,* 54(5), 283–289, https://doi.org/10.1093/occmed/kqh072

Badri, A., Nadeau, S. & Gbodossou, A. (2011). Integration of OHS into Risk Management in an Open-Pit Mining Project in Quebec (Canada). *Minerals,* 1(1), 3-29. https://doi.org/10.3390/min1010003

Regulation No. 28770 on Occupational Health and Safety in Mining Workplaces. (2013). (September 19, 2013). Available at: https://www.resmigazete.gov.tr/eskiler/2013/09/20130919-3.htm. Access Date: 22.03.2023.

Regulation No. 28512 on Occupational Health and Safety Risk Assessment. (2012). (December 29, 2012). Access Address: https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=16925&MevzuatTur=7&MevzuatTertip=5, Access Date: 24.03.2023.