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Longhole Stoping at the Asikoy Underground Copper Mine in Turkey

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1. Introduction

Asikoy underground copper mine is located in Küre county, some 60 km north of Kastamonu province and 25 km from Black Sea cost. Underground mining method is longhole stoping with post backfill. Ore production is 420.000 ton/year with an average of %2 copper grade[1].

2. Geology of the region

Küre copper deposits occur along the middle pontide zone. Although it exists in a region which has considerably different geological past from the southeast Anatolian ophiolite zone, Küre massif sulfide deposits comprise properties that could be classified within the Kieslager type, which is between Cyprus type and Kuroko type [2]. In the region, there exist the plagical sediments formed of subgrovacs and shales and also the toleitic basalt volcanites that are the products of the mid-ocean extension. It is seen that important tectonic movements occurred within the Küre formation. The units are intercepted with an N-S oriented fault. The mineralization takes place in the weak zone induced by this fault and also within the toleitic basalts and along the borders of the plagical sediments. The overall geologic map of the study area is demonstrated in Figure 1.

The ore mass occurs within the altered basalt series that are a part of the Küre ophiolites and is overlain with black shale. The ore mass consists of coarse lenses broken with faults and thrusted. The ore, which is composed of pyrite and chalcopyrite, is in the form of massif lenses with high grades under the hanging wall black shale and in the form of stock work pyrite and chalcopyrite veins with low grades within the altered footwall formation. Pyrites and chalcopyrites occasionally show colloform textures. (Figure 1).

3. Underground mining method

In Aşıköy underground copper mine, there are two main mineralisation zones named as the east and west sector between the 945 m level and 792 m level. The main access adit is horizontal and connects with spiral ramp at 932 m level. Spiral ramp that developed in the

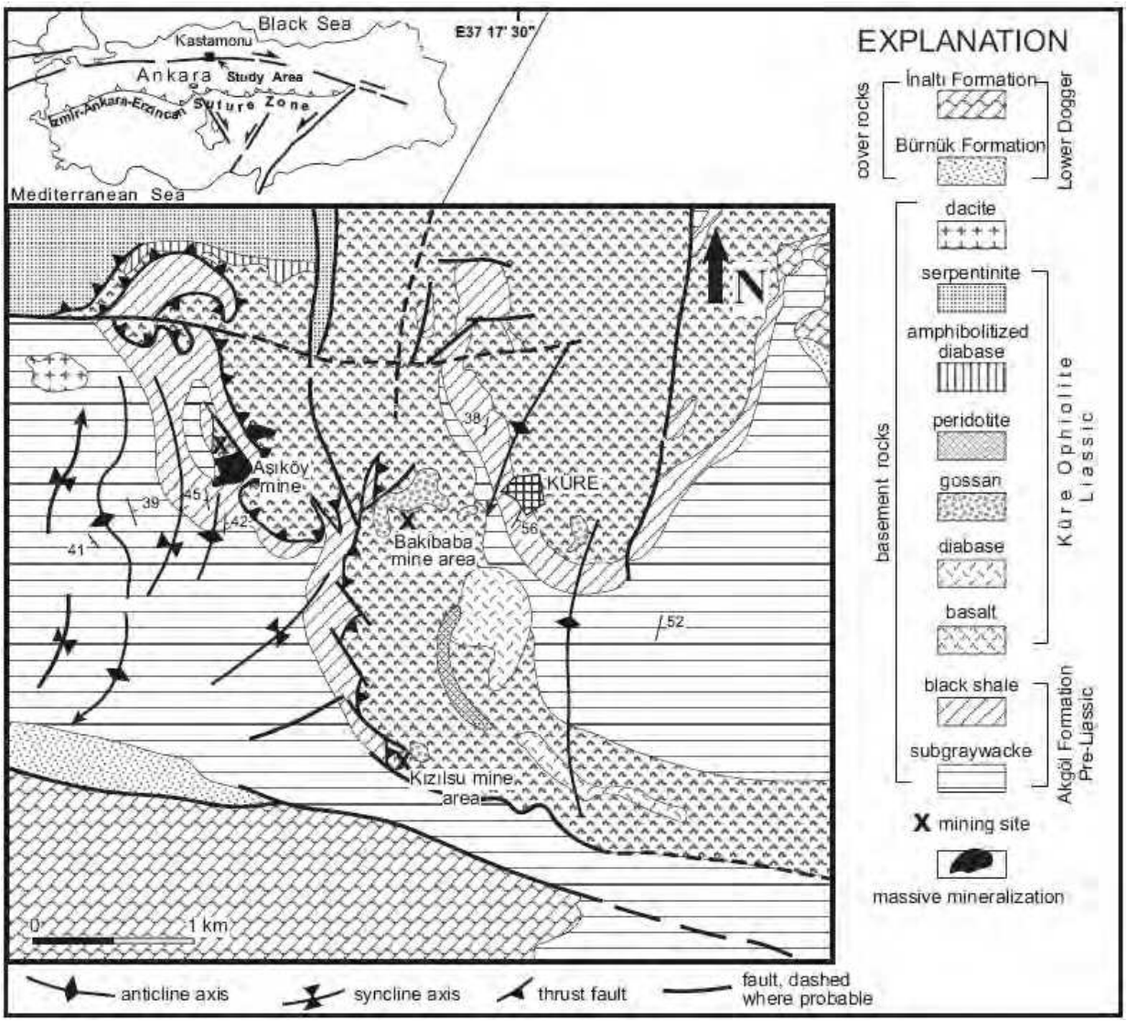


Fig. 1. Simplified geological map of the Küre mining district (Kuşçu and Erler, 2002) [3].

footwall of the orebody was driven between 932 m level and 792 m level at 6-7 degrees (Figure 2). There are two vertical shafts from surface (1080 m level) to bottom level for ventilation. The exhaust shaft is equipped with a winch-raised cover, which can be raised in winter to induce natural air movement.

Most development is within the competent footwall rock mass. Drilling rounds are about 53 holes, 45 mm in diameter and 3.5 m hole length. The orebody exhibits different rock mass characteristics. Ground support is by shotcrete, bolting with mesh, mesh reinforced shotcrete, standard Swellex in 2.4 m and 3.3 m lengths, and cement grouted bolts in 3 m, 4 m and 6 m lengths.

Orebody, which dips at 60 degrees, is accessed from this ramp, along the levels that are spaced 12 m in vertical interval. At each level, along footwall contact or in the center of the orebody, strike access drifts are developed with 4.5 m-wide x 4.5 m-high dimension. Across the strike, 7 m-wide x 4.5 m-high sill drifts are driven until the hangingwall contact. These drifts vary in length, depending on the thickness of the orebody [1].

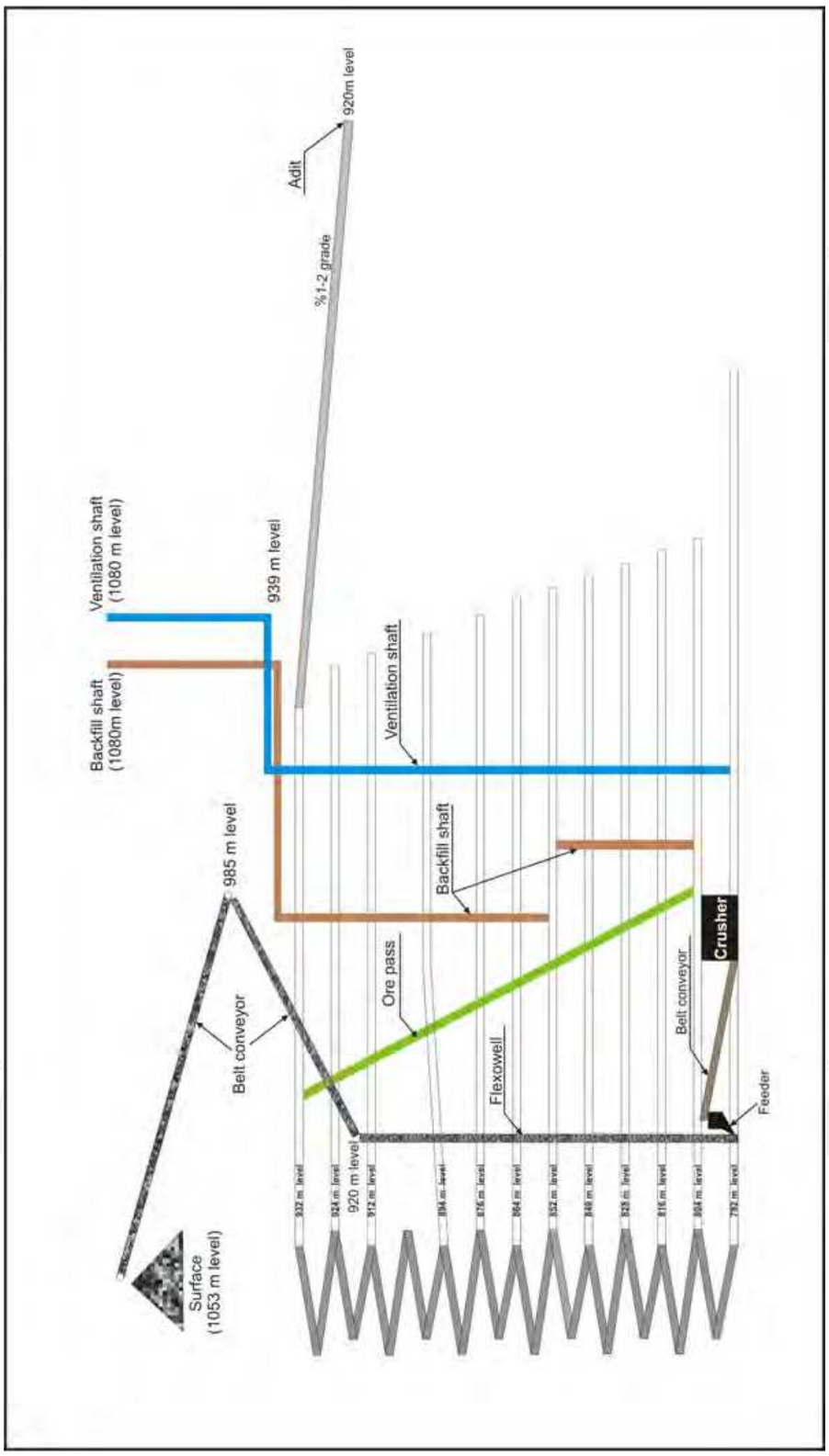


Fig. 2. General underground mine layout.

At the end of the sill drifts, 1.5 m x 1.5 m slot raise is opened and then widened out to 7 m to drift width. Blast holes are drilled parallel with 76 mm diameter in the downward direction between two sill drifts. Hole lengths are 7.5 m and one or two rows are blasted at a time. Spacing and burden between holes are 2.1 m and 1.9 m respectively. The main blasting agent is ANFO, with powergel primers and nonel initiation (Figure 3).

Blasted ore is mucked from lower sill drift by remote controlled LHD and transported to orepass. At 804 m level, orepass system feeds the underground crusher. -10 cm crushed ore travels along a conveyor belt to a feeder and into flexowell vertical conveyor belt system at 792 m level. At 920 m level, a belt conveyor at an avarage grade of 8 degrees transfers the ore to the surface primary crusher.

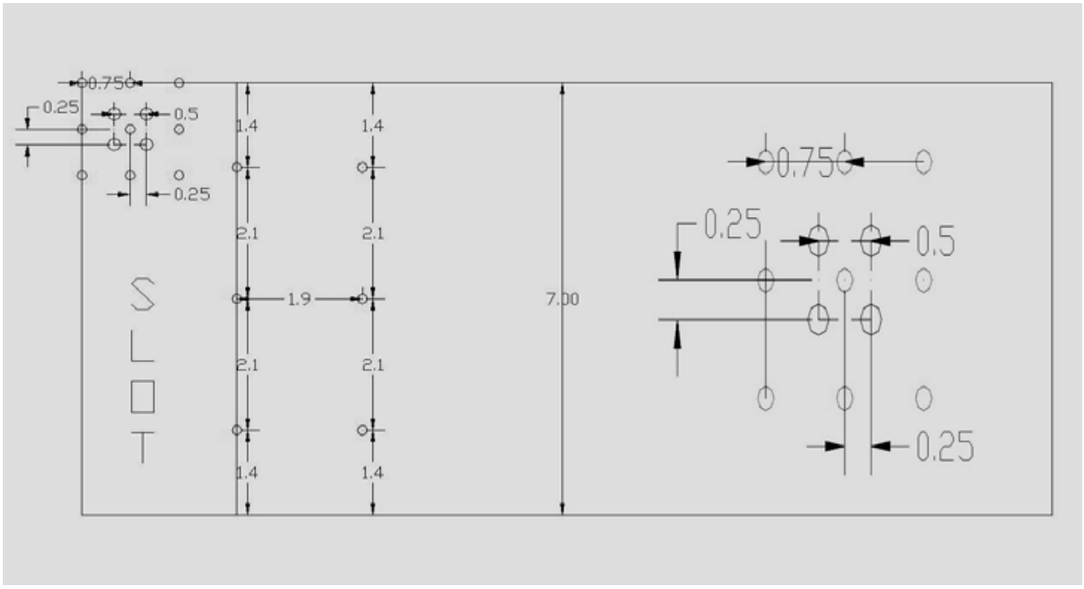


Fig. 3. Slot opening at the end of the stope.

After extracting the ore between two sill drifts, the open stope is backfilled from upper sill drift (Figure 4). Two types of backfill material are used. These are cemented rock fill and uncemented rock fill. Cemented rock fill has % 5 cement content by weight and is used for backfilling of primary stopes. After two adjacent primary stopes are backfilled, the primary pillar between them can be mined as secondary stope and backfilled with uncemented rock fill. Trucks are used for both types of backfilling. Open stopes, especially located at orebody boundaries, are backfilled with cemented rock fill.

4. Mine stability and mining sequence

In order to analyse the stability of the stopes and pillars and the the whole mine in general, a series of rock mechanics tests were performed on the core samples taken from the ore, basalt and backfill material and the geomechanical properties of the samples were determined as in Table 1. In the models set up by using Phase^2 program, namely the finite element method, these values obtained in the laboratory were used [4].

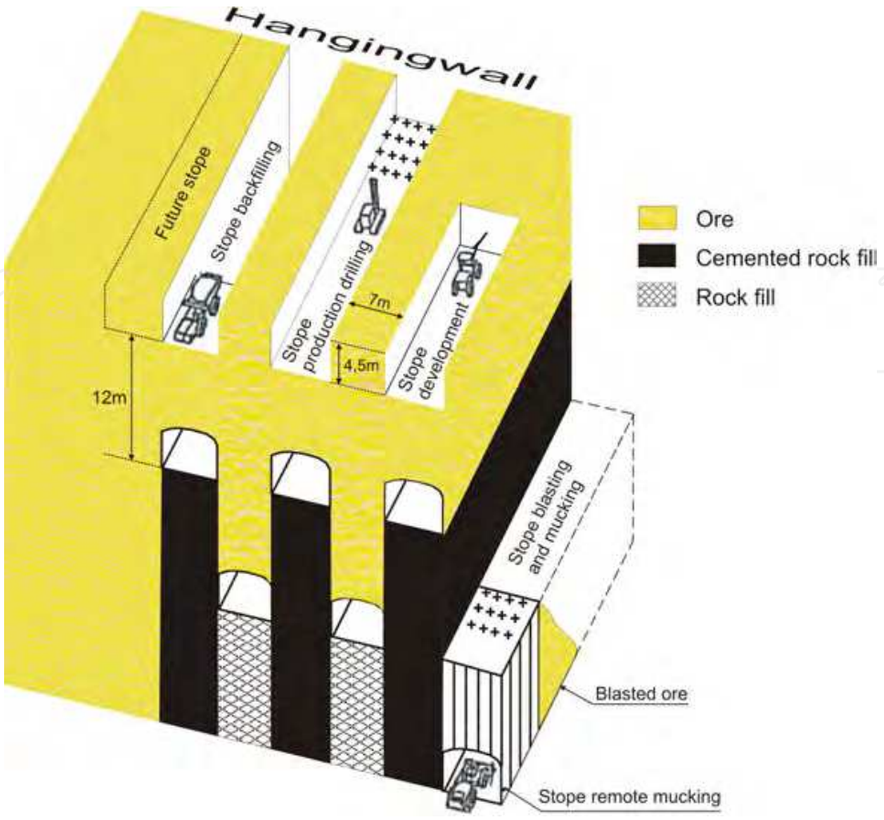


Fig. 4. Development, production and backfilling operations.

	Ore	Basalt	%5 Cemented Backfill
Density (gr/cm^3)	4,1	2,7	2,1
Uniaxial Compressive Strength (MPa)	55	65	6,5
Indirect Tensile Strength (MPa)	4,9	6,1	0,7
Cohesion (C) (MPa)	12,3	13,5	1,4
Internal Friction Angle (ϕ)	43,8	45,5	25,4
Young Modulus (MPa)	33500	47600	2850
Poisson's Ratio	0,26	0,25	0,34

Table 1. Geomechanical properties of the ore, basalt and backfill.

When the stresses are analysed in the case in which the stopes are extracted moving upward and the cavities were filled with either the cement added backfill or ordinary uncemented backfill, it was understood that no stability issue would arise. An example of vertical stress distribution around open stopes and pillars is shown in Figure 5 [5].

Although the production sequence of the stopes proceeds from bottom to the top, not all the stopes in the lower level are extracted to move on to the production of the upper levels. There are two main reasons for this condition. With respect to the former one; since the head entry of the lower stope is employed again as the tail entry of the upper stope later, it can not be filled with any backfill material, which means that the bottom part of the tail entries

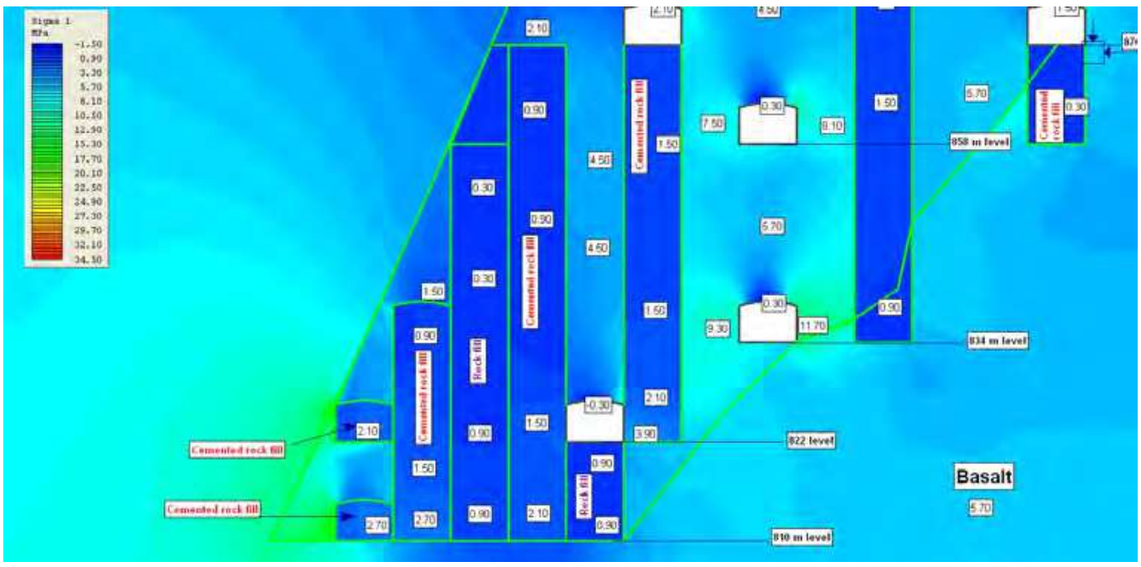


Fig. 5. Vertical stresses between 810 m level and 858 m level at west sector of mine.

of the upper levels is composed of backfill material. In this case when all the drifts come side by side (as the width of the drift equals the width of the stope), stability problems will be observed as there will be no support beneath the prospective unextracted stopes. With respect to the latter one; since there are many stopes at the same level, the production of many stopes from the same level entries will be hard.

Therefore, to make simultaneous productions out of a couple of levels will be convenient from the aspects of stope stability, machinery-equipment organization and the ore grade optimization. Generally, the production sequence from bottom to the top happens to be in triangular or diagonal shape. This mentioned production sequence is very important from the view of stability of the underground mine.

5. References

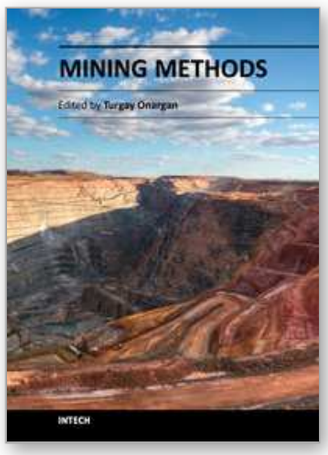
[1] Köse, H., Yalçın, E., Gönen, A., Evaluation of Etibakır Asikoy underground copper mine the second-stage project tecnically (in Turkish), Project report, Dokuz Eylul University Foundation, Izmir, 2007.

[2] Koç, Ş., Unsal, A., Kadıoğlu, Y. K., Geological, Geochemical and Geotechnical Properties of Küre(Kastamonu) Ore Deposit, (in Turkish), MTA Journal 117, pp 41-54. 1995.

[3] Kuşçu, İ., Erler, A., Pyrite deformation textures in the deposits of the küre mining district (Kastamonu-Turkey), Turkish Journal of Earth Sciences (Turkish J. Earth Sci.), Vol. 11, pp. 205-215, 2002.

[4] Gönen, A., Investigating The Underground Mining Method Of Etibakır Co. Küre Copper Mine Technically And Economically. (in Turkish), Phd Thesis, Dokuz Eylul University The Graduate School of Natural and Applied Sciences, İzmir, 2010.

[5] Köse, H., Yalçın, E., Gönen, A., Investigation of Stability of Open Stopes and Pillars in Longhole Stoping Method at the Asikoy Underground Copper Mine (in Turkish), Project report, Dokuz Eylul University Foundation, Izmir, 2007.



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An economic viability of a modern day mine is highly dependent upon careful planning and management. Declining trends in average ore grades, increasing mining costs and environmental considerations will ensure that this situation will remain in the foreseeable future. This book describes mining methods for the surface and underground mineral deposits. The methods are generalized and focus on typical applications from different mining areas around the world, keeping in mind, however, that every mineral deposit, with its geology, grade, shape, and volume, is unique. The book will serve as a useful resource for researchers, engineers and managers working in the mining industry, as well as for universities, non-governmental organizations, legal organizations, financial institutions and students and lecturers in mining engineering.

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