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ESTIMATION OF THE SUNGUN COPPER DEPOSIT OF IRAN BY MEANS OF INVERSE DISTANCE WEIGHTING METHOD

M. Osanloo
Mining Engineering, University of Amirkabir, Tehran - Iran

M. Ataei
Mining Engineering, University of Amirkabir, Tehran - Iran

ABSTRACT: The Sungun copper deposit is one of the biggest copper deposits in Iran. This deposit is located in about 40km north west of Ahar city in east - Azarbaigan province of Iran. Exploration activities in this area started since 1991. Up to now 5500 m exploration drilling has been made and 2500m exploration tunnels have been excavated. In this study, gathering all information from exploration stages and using DATA M İNE software, the total reserve of the ore deposit is estimated. For this purpose the ore limits are defined as a large block with 1640x 1400 x 770 meter dimensions and the size of small block is designed to be 14 x 20 x 50 m, therefore the total number of small blocks is 126280. Using the inverse distance weighting method, the average grade of each block is calculated. Based upon an average ore grade of each block and the cut off grade (0.32%) only 21153 blocks have ore grade greater than 0.32% by this method, the total reserve of Sungun copper deposit is estimated to be 740 million tons with an average grade of 0.665 Cu %.

1. INTRODUCTION

The Sungun copper deposit is located on the copper belt of the world, it is located near the Sungun village in north west o* Ahar city in east - A7arbaigan. The air distance i' j.e Sungun copper mim: •. • "ehran, the capital city oi Iran, is 525 km. The highest elevation above sea level is 2375m. The Sungun copper deposit is located in longitude between 46° 43' to 46° 44' and in latitude between 38° 40'to 38° 43'.

Exploration activities at the Sungun copper deposit started in 1991. This exploration program included 127 vertical and 13 inclined.borehole on a grid of 200 x 100. The total length of exploration borehole is 5500m. The core samples were recovered from each 2 meter of borehole. In addition, 5 exploration galleries with a total length of 2500m. were excavated (Osanloo and Ataei , 1998). Figure 1 shows the location of boreholes and exploration galleries.

2. MINERALIZATION ZONES

The Sungun porphyry copper deposit like many other porphyry copper deposits around the world has three different mineralization zones. These zones from top to bottom are:

(1) leached zone with average thickness of 80 m. The thickness of mis zone from the west of ore body to the east reduces. The ore grade of die leached zone is less than 0.1 %. The material of this zone is considered to be waste.

(2) The second zone is supergene and the average thickness of this zone is 100m. The most important minerals of this zone are: chalcocite (C^S), Covelline (CuS) and chalcopyrite (CuFeS2). The ore grade of mis zone is ranged from 0.8 to 2 %.

(3) Hypogene zone, this zone contained a large amount of ore deposit with thickness between 320 and 500 m. The ore grade of this zone is ranged from 0.01 to 2%.

The important minerals of the hypogene zone are; chalcopyrite (CuFeS2), Pyrite (FeS2) and a very small amount of molybdenum. Figure 2 shows the mineraization zones of the Sungun porphyry copper deposit of Iran.

3. CALCULATION OF THE NUMBER OF BLOCK

Based on information gathered from the all boreholes and exploration tunnels. A large block from 647710 up to 649350 on X-axis and from 4284275 up to point 4285675 on y-axis and from level 1600 up to 2370 m along z-axis have been defined. Therefore, the dimensions of the block are 1640 x1400 x700m.

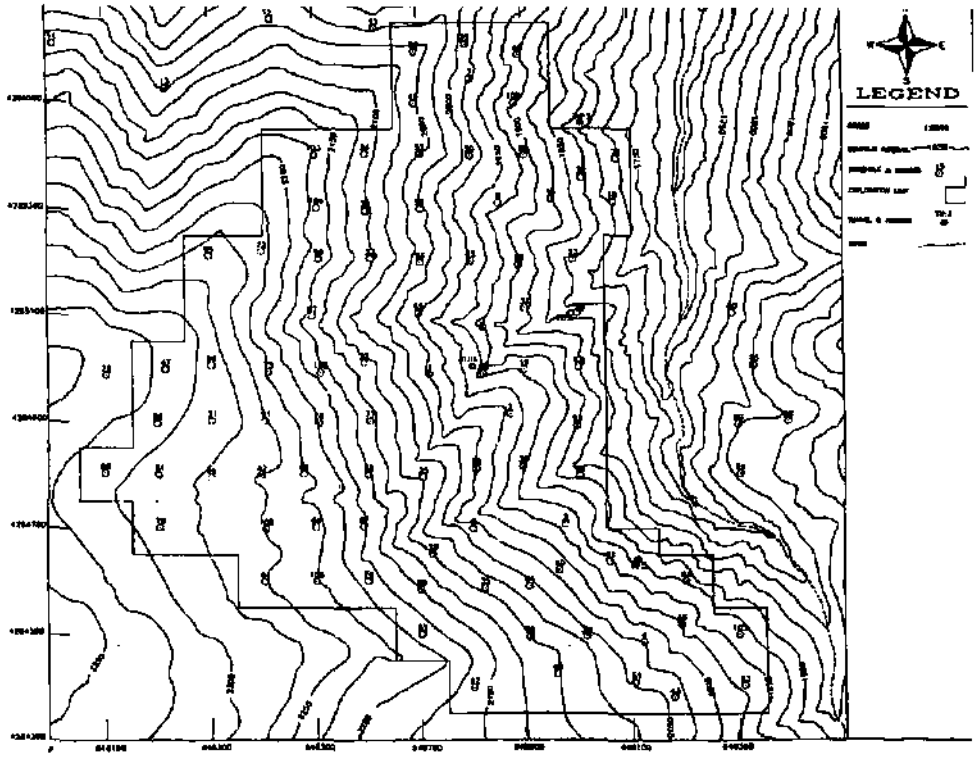

Figure 1. The location of boreholes and exploration tunnels

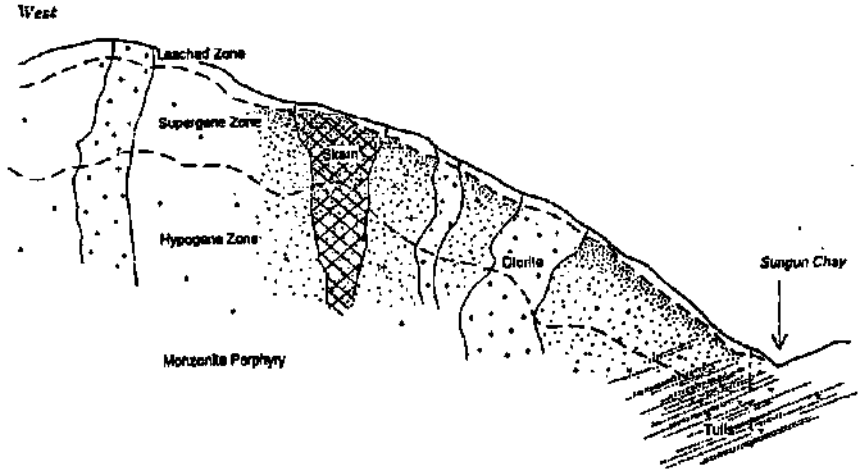

Figure 2. The mineralization zones of Sungun copper deposit of Iran

Considering physical and mechanical properties of rock mass, ground water regime and mine area tectonic, the final pit slope of mine is suggested to be 35° and average specific gravity of the rock mass evaluated to be 2.5 (TECJ 1995), with regard to loading system and drilling machine (Kennedy 1990; Wright 1991). Bench height is selected as 14m. The block width is calculated by the following equation:

$$B = \frac{h_g}{\tan\alpha} \qquad (1)$$

where B is the block width, h,, bench height = block height = 14m and a; Slope angle, Substituting the values of h_g and a in Equation 1 the block width is found to be 20m.

The distance between all geological sections was 50 m (Madani, 1994), hence the third dimension of block is selected to be 50m. The dimension of each small block is 14 x 20 x 50m and the weight of material per block is 35000 tones. Given the size of the large block and small blocks, the number of small blocks is equal to

$$N = \frac{1640 \times 1400 \times 770}{14 \times 20 \times 50} = 126280$$

Using DATA mine software die grade of each block is calculated (SRMMICL 1993) by means of inverse distance weighting technique.

In next step, by entering topographic data of each section of the Sungun copper deposit, the blocks having more than 50% of their portion above topography level are omitted(Hustrulid & Kuchta, 1995). By doing this, the total number of the small blocks reduced to 76114 blocks.

4 ESTIMATING ORE RESERVE

Based upon all geological information gathered from the Sungun copper deposit, DATA MINE program was used for calculation of average grade, cut off grade and estimation of ore reserve. For this purpose three files were created:

(1) Collar file: this file contained the boreholes collar coordinates, x-collar, y-collar and z-collar.

(2) Surveys file: this file included the depth(AT) , dip and strike of each exploration borehole(BRG).

(3)Assay file: this file contained the grade of samples recovered from exploration boreholes (Annels, 1995).

In next step, by processing the DATA MINE program, from combination of aforesaid files, the new file is created. This new file contained the coordinates of all points which samples were recovered.To calculate the cut off grade the following equation is used.

$$BEV = TPB\left[\left(\frac{R.g}{G}\right)AMR - (b+c)\right] \qquad (2)$$

where BEV= block economic value, TPB= tons per block (35000 tons), R= Recovery coefficient (90%), g= average ore grade of each block, G= grade of concentrate (30%), AMR= price of one ton concentrate at mine ($ 405.5 per ton) , Mining cost ($ I per ton) C= concentrating cost ($2.9 per ton) substituting the above values in equation 2, the block economic value is:

$$BEV = 35000\left[\left(\frac{0.9g}{30}\right)405.5 - (1+2.9)\right] \qquad (3)$$

where:

$$BEV = 35000(12.165g - 3.9) \qquad (4)$$

Since all the blocks have identical weight, the BEV is divided by 35000, therefore Equation 4 can be written as follows:

$$BEV = I2.165g - 3.9 \qquad (5)$$

To determine the cut off grade, BEV must be set to zero, giving:

$$g_c = \frac{3.9}{12.165} = 0.32 \qquad (6)$$

where: g_c = cut off grade

Out of 76114 blocks, only 21152 blocks have average grade greater than 0.32% and thus the total ore reserve is 740,320,000 tons. The average ore grade of the Sungun porphyry copper deposit is found to be 0.665 Cu %. Table 1 shows the number of blocks of ore and waste of 28 sections of the Sungun copper deposit.

Gathering all information from geological studies of the Sungun porphyry copper deposit and using DATA MINE software, the geological ore reserve of the Sungun deposit is found to be 740,32 millions tons.

Table 1 . Number of ore and waste blocks Sungun copper deposit

Section	Grade range {%)						total	
	0 - 0.32	0.32-0.5	0.5-0.7	0.7-1	1-1.5	>1.5	ore	waste
1	2306	502	202	96	0	0	800	2306
2	2286	587	291	95	13	2	988	2286
3	2520	292	468	125	20	2	907	2520
4	2532	360	389	146	li	6	912	2532
5	2516	246	399	193	26	10	874	2516
6	1992	308	451	184	40	21	1004	1992
7	2052	230	340	296	24	25	915	2052
8	2388	196	364	293	63	16	932	2388
9	1862	216	226	322	76	24	864	1862
10	998	336	359	349	64	18	1126	998
II	1264	221	296	421	47	8	993	1264
12	1194	427	287	416	22	1	1153	1194
13	1586	231	256	358	38	11	894	1586
14	1490	318	483	216	·)·>	0	1039	1490
15	1840	292	240	163	41	4	740	1840
16	1774	322	239	140	27	0	728	1774
17	1744	353	182	128	34	6	703	1744
18	1694	370	219	92	10	0	691	1694
19	1876	348	218	96	18	I	681	1876
20	1714	420	217	77	6	0	720	1714
21	1534	382	273	!07	8	1	771	1534
22	1800	365	190	67	10	8	640	1800
23	2196	161	173	123	3!	15	503	2196
24	2236	146	151	110	24	14	445	2236
25	2224	130	161	50	20	46	407	2224
26	2432	83	128	41	11	33	296	2432
27	2586	75	98	21	13	2	209	2586
28	2326	98	83	27	7	2	217	2326
total	54962	8015	7378	4752	726	276	21152	54962

5. CONCLUSIONS

1. Using inverse distance weighting technique the total ore reserve of the Sungun copper deposit is estimated to be 740320000 million tons with an average grade of 0.665 Cu %.

2. Based upon DATA MINE program the average grade of more than 21153 blocks was calculated to be more than 0.32 Cu %.

3. In comparison to the manual method for estimationofore reserve, the DATA MINE software is a faster and more precised method.

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