Underground Mining of Metalliferous Deposits

Professor Kaushik Dey
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Lecture: 09

Determination of Cut off Grade – III

Cutoff grade (continued)

Now the steps of the net value computation are outlined below for an ore containing 0.35% Copper. All of the costs and revenues will be calculated with respect to one ton of ore (2000 lbs).

Step 1. Compute the amount of saleable copper (lbs/st of ore).

[1] Contained copper (CC) in the ROM is

$$CC = 2{,}000\ Ibs/st \times \frac{0.35}{100} = 7.0\ Ib$$

[2] Copper recovered by the mill (RM) is

$$RM = 7.0\ \times \frac{80}{100} = 5.6\ Ib$$ $$RM = 7.0\ \times \frac{80}{100} = 5.6\ Ib$$

[3] Concentration ratio (r). The ratio of concentration is defined as

$$r = \frac{Ibs\ Cu/st\ of\ concentrate}{Ibs\ Cu\ recoverd/st\ of\ ore}$$ $$r = \frac{Ibs\ Cu/st\ of\ concentrate}{Ibs\ Cu\ recoverd/st\ of\ ore}$$

Since the mill product runs 20% copper there are 400 lb of copper contained in one ton of concentrate. One ton of ore contains 5.6 lb of recoverable copper. Hence

$$r = \frac{400}{5.6} = 71.43$$ $$r = \frac{400}{5.6} = 71.43$$ ton of ROM

This means that 71.43 tons of ROM running 0.35% cu are required to produce 1 ton of concentrate with running 20% cu.

OR in other words, From 2000 lbs ROM, Concentrator receives 28 lbs contains 5.6 lbs copper

Thus, to produce 2000 lbs of concentrator, ROM required is 71.43 ton i.e st

[4] Copper recovered by the smelter (RS). The mill concentrate is sent to a smelter. Since the smelting loss is 10 lb of copper/st of concentrate, the smelting loss (SL) per ton of ore is

$$SL = \frac{10\ lb/st \text{ of concentrate}}{71.43\ tons\ of\ ore/st\ of\ concentrate} = 0.14\ lb$$

$SL = \frac{10\ lb/st \text{ of concentrate}}{71.43\ tons\ of\ ore/st\ of\ concentrate} = 0.14\ lb$ /ton of ROM

Thus the recovered copper after smelting is

$$RS = 5.6 - 0.14 = 5.46\ lb$$

OR in other words,

There are 28 lbs concentrator which has 5.6 lbs cu. So the loss is 10 lbs copper. So the loss of copper with respect to ROM (2000 lbs) is (10/71.43) = 0.14 lbs

Thus now after smelting of one ton ROM the copper content is = 5.6– 0.14 = 5.46 lbs

So from one ton ROM, Blister copper got is 5.46 lbs of copper.

[5] Copper recovered by the refinery (RR).

2000 lbs (1 ton) ROM has 5.46 lbs copper as input to refinery (blister copper). So if blister copper has 2000 lbs copper, pure copper comes out 1995 lbs. So the ROM required to give 2000 lbs cupper as input to refinery is = 366.3 ton. So 366.3 ton of ROM will give 1 ton cu in blister copper.

So the overall recovery as pure copper per ton of ROM is

1995lbs/366.3 = 5.45 lbs.

And the refining loss is = 5 lbs/ 366.3 = 0.01 lbs per ton of ROM.

Copper recovered by the refinery (RR). The number of tons of ore required to produce one ton of blister copper is

$$\frac{\text{2,000 lbs cu per st of copper in blister}}{\text{5.46 lb of copper/st of ROM}} = 366.3$$

Since refining losses are 5 lb/st of blister copper, the refining loss (RL) per ton of ore is

$$RL = \frac{5\ lb\ of\ copper/st\ of\ blister\ copper}{366.3\ tons\ of\ ore/st\ of\ blister\ copper} = 0.01\ Ib$$

Thus the recovered copper is Refinery returns –>

5.46- 0.01 = 5.45 Ib

[6] Cost Analysis for *One ton of ROM ore containing 0.35%* .

	Cost/ROM
Mining	$1.00
Milling	$2.80
General and administration(15% of mining and milling)	$0.57
Direct Production Cost	= $4.37
Depreciation	= $0.87

[1]

The copper price assumed $1.00/lb

Furthermore, there is a by-product credit for gold, molybdenum,

etc. of $1.13 per st of ROM of 0.35% cu. Thus the gross value is -

GV = 5.45 × $1 + $1.13 = $6.58

[2]

Assume, Mining cost is .$1.00 per st. ROM

Assume, Milling cost is .$2.80 per st. ROM

Other cost (mining and milling) @ 15% = $ 0.15*3.80 = $ 0.57

So Direct Production Cost = $4.37

[3]

Depreciation is 20% of production cost = 0.2*$4.37 = $0.87

[4]

Transport cost from mill to smelter = $1.40 per ton of concentrate

= $1.40/71.43 ton of ROM = $ 0.02

[5]

Smelting cost = $50 per ton of concentrate

= $50/71.43 ton of ROM = $ 0.70

[6]

Transport cost from smelter to refinery = $50 per ton of cu in Blister

= $50/366.3 ton of ROM = $ 0.14

[7]

Refining cost = $130 per ton of cu in Blister

= $130/366.3 ton of ROM = $ 0.35

[8]

Final shipment cost = $0.01 per lbs of pure cu

= $0.01 *5.45 ton of ROM = $ 0.05

[9]

Other cost in smelter, refinery etc = $0.07 per lbs of pure cu

= $0.07 *5.45 ton of ROM = $ 0.38

NET VALUE = GV-TE

$6.58 - $6.88 = - $0.30

	Cost/ROM
Mining	**$1.00**
Milling	**$2.80**
General and administration(15% of mining and milling)	**$0.57**
Direct Production Cost	**= $4.37**
Depreciation	**= $0.87**

Mill to smelter	**=$0.02**
Smelting cost	**= $0.70**
smelter to refinery	**=$0.14**
Refining cost	**= $ 0.35**
Final shipment	**= $ 0.05**
General cost at plant	**= $0.38**

One ton of ROM ore containing 0.55% .

NET VALUE = GV-TE

$10.33 - $7.83 = $2.50

One ton of ROM ore containing 0.35% .

NET VALUE = GV-TE

$6.58 - $6.88 = - $0.30

For, NV = 0, Grade = 5.2/14 = 0.37

Cut-off-Grade

NV= -$5.20. + $14.00 * (% Cu)

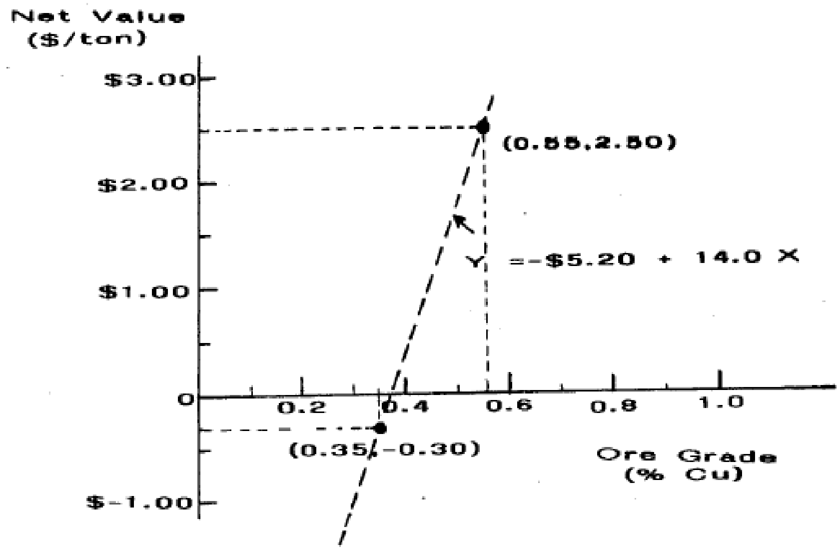

Figure 5.6. Net value – ore grade curve.

For, NV = 0, Grade = 5.2/14 = 0.37

Cut-off-Grade

Considering the Overburden stripping cost = \$1/ m^3

For an average grade of 0.55% cu

BESR = $\frac{NV}{Stripping\ cost}$ $\frac{NV}{Stripping\ cost}$ = $\frac{\$2.50}{\$1.0}$ $\frac{\$2.50}{\$1.0}$ = 2.5

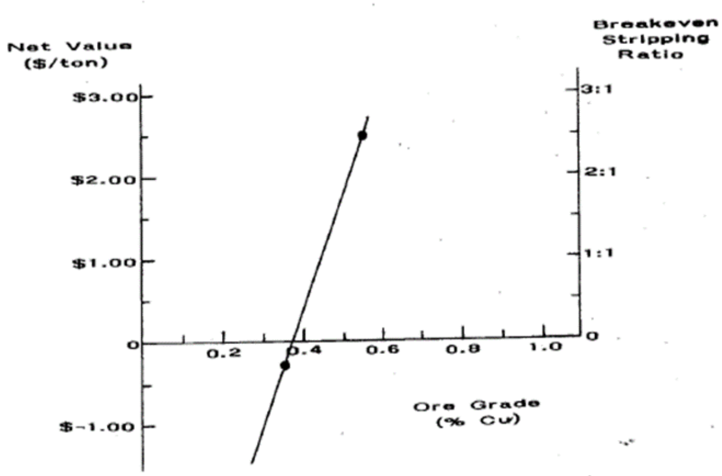

Figure 5.7. Net value and breakeven stripping ratio versus ore grade.