Underground Mining of Metalliferous Deposits
Professor Bibhuti Bhusan Mandal
Professor Kaushik Dey
Department of Mining Engineering
Indian Institute of Technology, Kharagpur
Lecture 29
Selection of Mining Methods-IV

Quantitative Ranking Systems

STAGE-1

- This Quantitative classification system relies on a series of steps:
    a. The ore geometry and grade distribution
    b. The rock mechanics characteristics of the ore zone, H/W and F/W
    c. Numerical ranking based on addition of scores
    d. Using a weighting factor of the categories based on experience

Exercise 2

Select the appropriate mining method from the ore deposit data using the Nicholas Approach.

	Input Parameters	Description		Input Parameters	Description
Ore Zone	Ore Thickness	40 meters	Hanging Wall	RQD	38%
	Ore Plunge	20 degrees		Joint Condition	Clean joint with a smooth surface
	Deposit Shape	Platy		RSS	4.9
	Grade Distribution	Gradational		RMR	50
	Grade Value	High		UCS	46 MPa
	Depth	285 meters	Foot Wall	RQD	38%
	RQD	75%		Joint Condition	Clean joint with a smooth surface
	Joint Condition	Filled with talk strength less than RSS		RSS	4.9
	RSS	8.7		RMR	50
	RMR	63.5		UCS	46 MPa
	UCS	128 MPa			

Geometry/Grade distribution	
General shape	Tabular/ Platy

Ore thickness	Thick
Ore plunge	Intermediate
Grade distribution	Gradational
Rock mechanics characteristics-Ore zone	
Rock Substance Strength	Strong
Fracture Frequency	very wide
Fracture Shear Strength	Strong
Rock mechanics characteristics-Hanging Wall	
Rock Substance Strength	Weak
Fracture Frequency	Close
Fracture Shear Strength	Weak

Rock mechanics characteristics-Footwall	
Rock Substance Strength	weak
Fracture Frequency	Close
Fracture Shear Strength	Weak

	General Shape*			Ore Thickness†				Ore Plunge‡			Grade Distribution§		
Mining Method	**M**	**T/P**	**I**	**N**	**I**	**T**	**VT**	**F**	**I**	**S**	**U**	**G**	**E**
Open-pit mining	3	2	3	2	3	4	4	3	3	4	3	3	3
Block caving	4	2	0	-49	0	2	4	3	2	4	4	2	0
Sublevel stoping	2	2	1	1	2	4	3	2	1	4	3	3	1
Sublevel caving	3	4	1	-49	0	4	4	1	1	4	4	2	0
Longwall mining	–49	4	–49	4	0	–49	–49	4	0	–49	4	2	0
Room-and-pillar mining	0	4	2	4	2	–49	–49	4	1	0	3	3	3
Shrinkage stoping	2	2	1	1	2	4	3	2	1	4	3	2	1
Cut-and-fill stoping	0	4	2	4	4	0	0	0	3	4	3	3	3
Top slicing	3	3	0	–49	0	3	4	4	1	2	4	2	0
Square-set stoping	0	2	4	4	4	1	1	2	3	3	3	3	3

Source: Nicholas 1992.
*M = massive, T/P = tabular or platy, I = irregular.
†N = narrow, I = intermediate, T = thick, VT = very thick.
‡F = flat, I = intermediate, S = steep.
§U = uniform, G = gradational, E = erratic.

Mining Method	Rock Substance Strength*			Fracture Spacing†				Fracture Strength*		
	W	M	S	VC	C	W	VW	W	M	S
Ore Zone										
Open-pit mining	3	4	4	2	3	4	4	2	3	4
Block caving	4	1	1	4	4	3	0	4	3	0
Sublevel stoping	–49	3	4	0	0	1	4	0	2	4
Sublevel caving	0	3	3	0	2	4	4	0	2	2
Longwall mining	4	1	0	4	4	0	0	4	3	0
Room-and-pillar mining	0	3	4	0	1	2	4	0	2	4
Shrinkage stoping	1	3	4	0	1	3	4	0	2	4
Cut-and-fill stoping	3	2	2v	3	3	2	2	3	3	2
Top slicing	2	3	3	1	1	2	4	1	2	4
Square-set stoping	4	1	1	4	4	2	1	4	3	2
Hanging Wall										
Open-pit mining	3	4	4	2	3	4	4	2	3	4
Block caving	4	2	1	3	4	3	0	4	2	0
Sublevel stoping	-49	3	4	–49	0	1	4	0	2	4
Sublevel caving	3	2	1	3	4	3	1	4	2	0
Longwall mining	4	2	0	4	4	3	0	4	2	0
Room-and-pillar mining	0	3	4	0	1	2	4	0	2	4
Shrinkage stoping	4	2	1	4	4	3	0	4	2	0
Cut-and-fill stoping	3	2	2	3	3	2	2	4	3	2
Top slicing	4	2	1	3	3	3	0	4	2	0
Square-set stoping	3	2	2	3	3	2	2	4	3	2
Footwall										
Open-pit mining	3	4	4	2	3	4	4	2	3	4
Block caving	2	3	3	1	3	3	3	1	3	3
Sublevel stoping	0	2	4	0	0	2	4	0	1	4
Sublevel caving	0	2	4	0	1	3	4	0	2	4
Longwall mining	2	3	3	1	2	4	3	1	3	3
Room-and-pillar mining	0	2	4	0	1	3	3	0	3	3
Shrinkage stoping	2	3	3	2	3	3	2	2	2	3
Cut-and-fill stoping	4	2	2	4	4	2	2	4	4	2
Top slicing	2	3	3	1	3	3	3	1	2	3
Square-set stoping	4	2	2	4	4	2	2	4	4	2

Source: Nicholas 1992.
*W = weak, M = moderate, S = strong.
†VC = very close, C = close, W = wide, VW = very wide.

Mining Method	**Geometry/Grade Distribution**	**Rock mechanics characteristics**				**Grand total**
		Ore	**HW**	**FW**	**Total**	
Open pit	12	12	8	8	28	**40**
Block caving	8	1	12	6	19	27
Sublevel stoping	10	12	-49	0	-37	-27
Sublevel caving	11	9	11	1	20	31
Longwall	-43	0	12	5	17	-26
Room & Pillar	-41	12	1	1	14	-26

Shrinkage stoping	9	12	12	7	31	**40**
Cut & fill	10	6	10	12	28	38
Top slicing	9	11	11	6	28	37
Square set	9	4	10	12	26	35

The numerical assessment is followed by

- Reconciling with other methods available for selection
- Estimation of relative cost involved for the top three/four mining procedure
- Even though UMMS is an iterative procedure at different stages of mine life, it is better to find the most suitable method in the beginning.